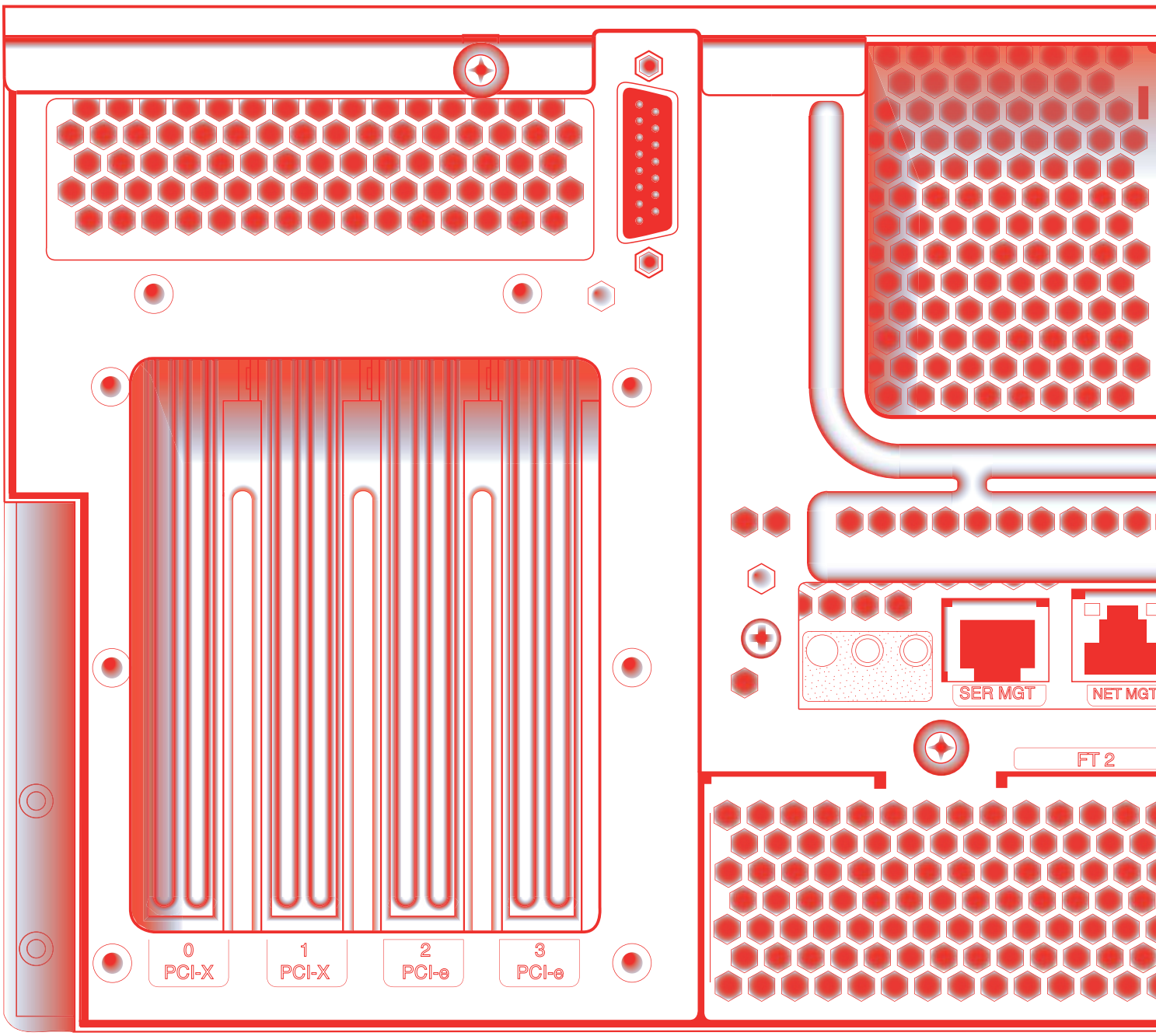


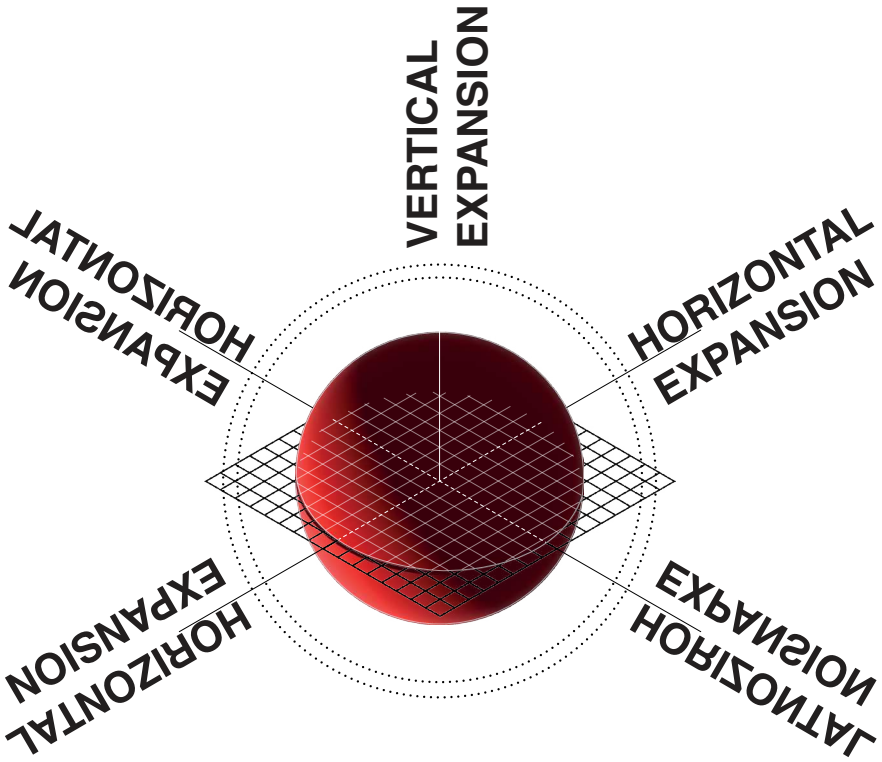
Architecture for the Digital: Inside the Spaces of Data

Giacomo De Caro

Doctoral Thesis

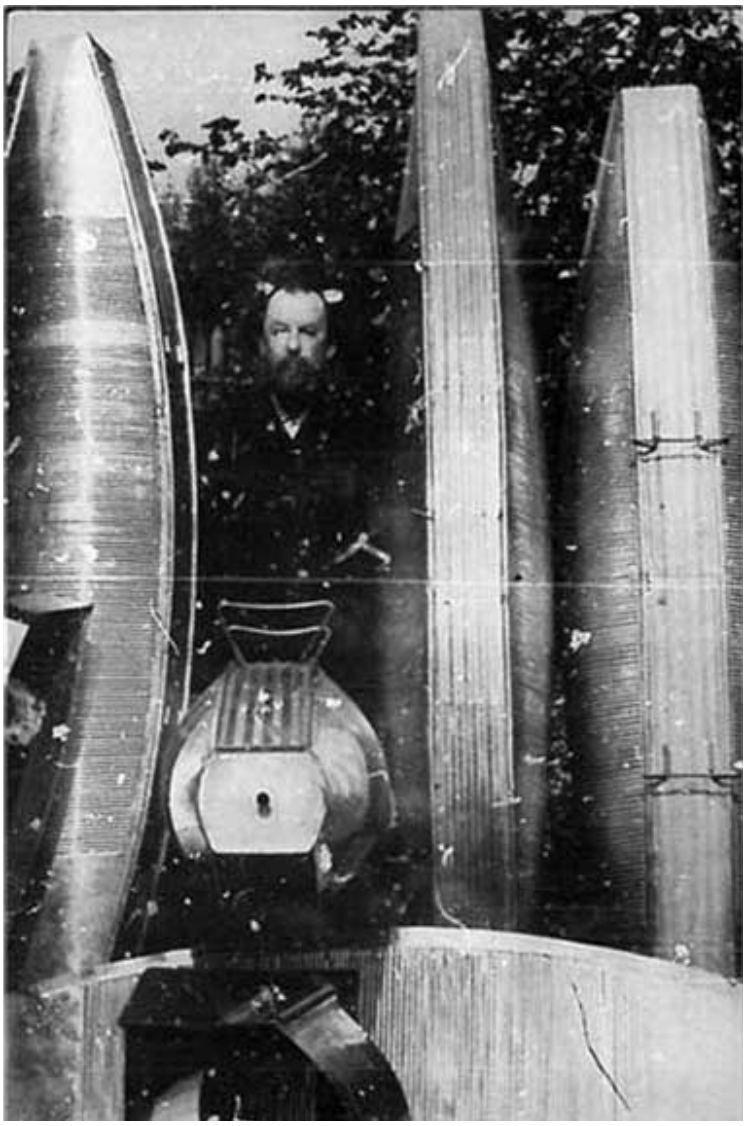
Università Iuav di Venezia

School of Doctoral studies

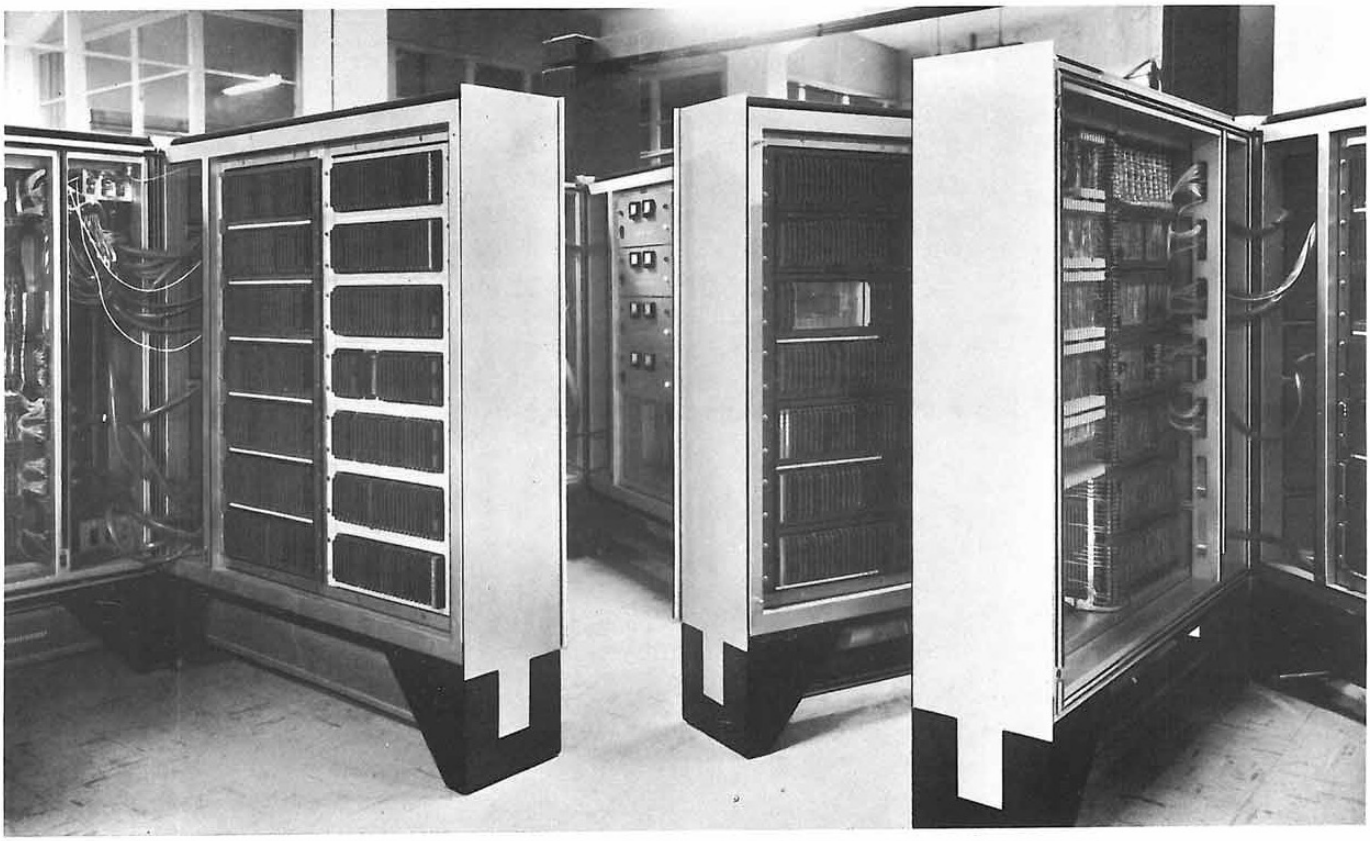


On July 20, 1969, Neil Armstrong and Buzz Aldrin landed on the moon at 20:17:40 UTC. On this mission, the astronauts were accompanied by a travel notebook that helped them travel through uncharted extraterrestrial territory for the first time. That same year also came the results of the efforts employed for ARPAnet, a project directed by DARPA, a government agency of the U.S. Department of Defense. The project was to create a computer network as a possible defense against a nuclear attack, laying the groundwork for the first Internet connection.
In form, the thesis echoes the proportions of the travel notebook that first accompanied astronauts to the moon, this time to traverse the uncharted territories of digital infrastructure.

The metal ring binding mimics the 1:1 pitch of the typical hole pattern used in racks to install servers.



Konstantin Tsiolkovsky in 1903 published in the Russian journal Nauchnoye Obozreniye (Научное Обозрение) *The Exploration of Cosmic Space by means of Reaction Engines*. In the text, the author explores rocket theories for the first time, elaborating on the first fundamental principles that led to the development of rockets and space travel.



ELEMENTI AD ARMADIO DEL SISTEMA ELEA 9003 .—

Mario Tchou in the 1950s was called upon by Olivetti to manufacture the first commercial all-transistor computer, with a design by Ettore Sottsass.

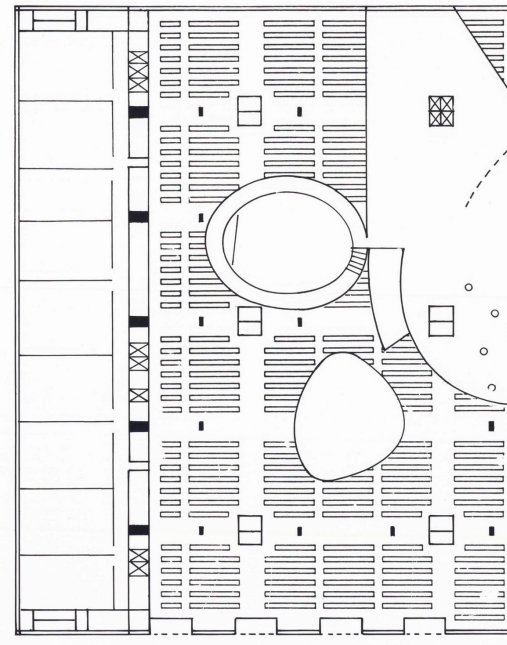
1.1. Caratteristiche generali
L'elaboratore elettronico aritmetico Elea 9003 è uno strumento automatico di grandi capacità per il trattamento delle informazioni aziendali e per la risoluzione di problemi matematici, scientifici e tecnici; esso consente un ciclo di lavoro interamente automatico, essendo l'intervento umano strettamente limitato alla alimentazione delle informazioni e alla raccolta degli elaborati.

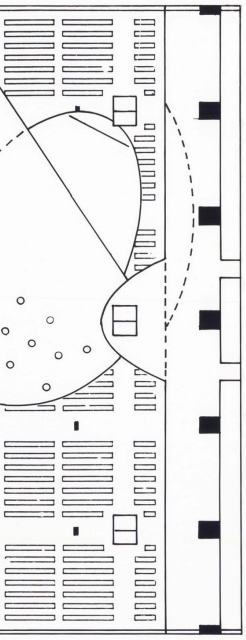
1.2. La struttura modulare
La struttura modulare, che caratterizza l'intero sistema, permette di adeguare la potenza dell'Elea al reale bisogno dell'Utente, e ciò dà completa garanzia di servirsi sempre di una macchina attuale: i problemi possono così essere visti non in senso statico, bensì in senso dinamico. All'inizio, la potenzialità della macchina è determinata in funzione dei problemi che è necessario risolvere; in seguito, aumentando il volume del lavoro, si possono collegare nuove unità, e, se cambia la natura dei problemi, si può ricorrere ad unità di tipo diverso per rendere l'elaboratore più adatto alle nuove esigenze. Queste prerogative consentono all'utente di evitare continue riorganizzazioni del centro di elaborazione.

Olivetti Elea 9003, *Manuale base di programmazione*, Ivrea 1959

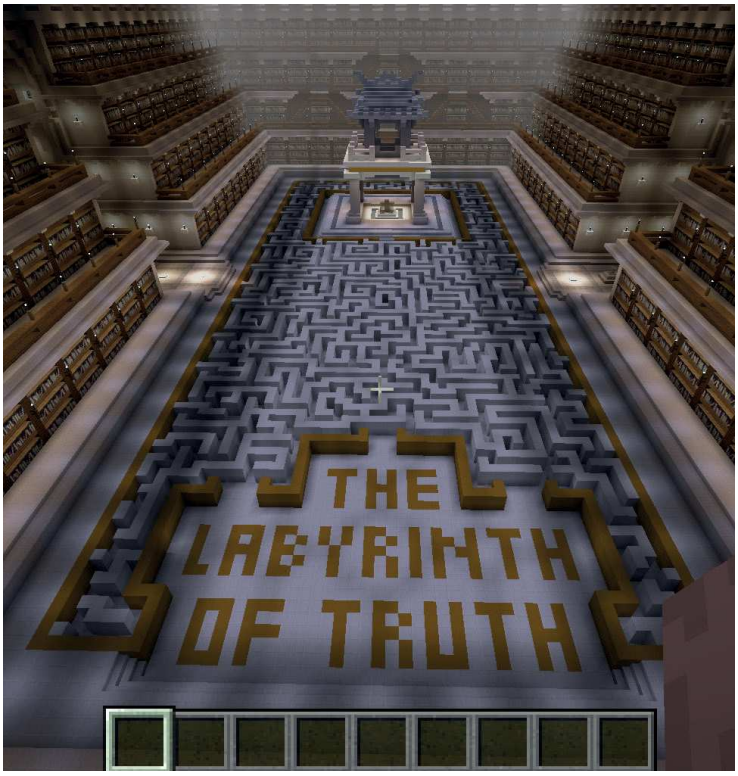
Architecture for the Digital:
Inside the Spaces of Data

Alain Resnais, *Toute le memoire du monde*, 1956. Frame of the documentary.

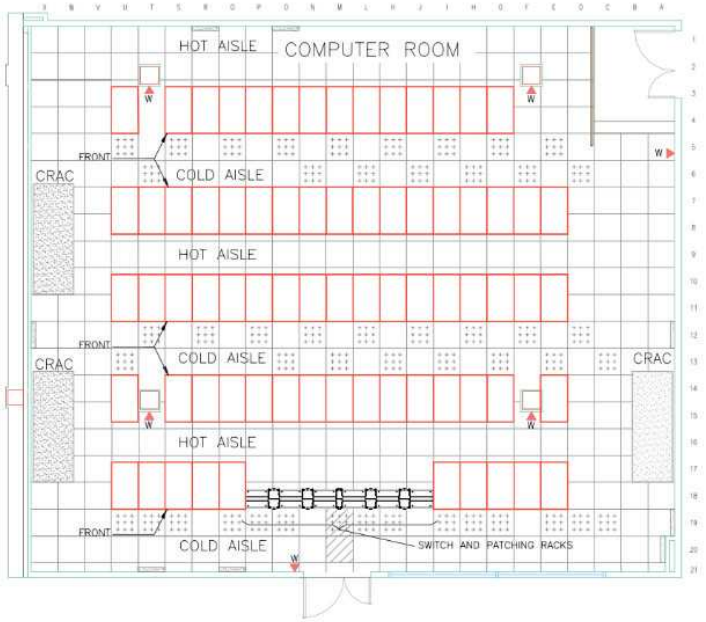




OMA, *Très Grande Bibliothèque*, Parigi, 1989.



Blockworks, *The uncensored library*, 2020. Screenshoot of Minecraft.



TIA-942, *Computer room layout showing "hot" and "cold" aisles*, 2005.

> The space of a sheet of paper (regulation international size, as used in Government departments, on sale at all stationers) measures 623,7 sq. cm. You have to write a little over sixteen pages to take up one square meter. Assuming the average format of a book to be 21 by 29,7 cm, you could, if you were to pull apart all the printed books kept in the Bibliothèque Nationale and spread the page carefully out one beside the other, cover the whole, either of the island of St Helena or of Lake Trasimeno.
>
> G. Perec, *Species of Spaces and Other Pieces*, Penguin Selected Writings, London 1974
> G. Perec, *Specie di spazi*, Bollati Boringhieri, Torino 1989

1956

Alain Resnais, publishes *Toute la Memoire du Monde*.
The French foreign minister commissioned the filmmaker to make a short documentary that illustrates how archiving takes place at the National Library in Paris. The documentary films step by step the arrival of volumes at the library until they are placed there, going through a variety of protocol procedures.
In about 21 minutes, the director films the infrastructural backstage that accompanies the acquisition of a volume in a sequence of spaces usually experienced by system staff. Everything that represents the brains of the national library is revealed and made visible to the citizen, emphasizing the value of the infrastructure. Spatial importance and dignity is heightened even in the most cramped but necessary spaces of the massive organizational machine.

1989

In the summer of 1989, the French government announced a competition for a new 250,000 m² national library in Paris, and OMA's design proposal was the *Très Grande Bibliothèque.*

> "The scheme is based on technological scenarios developed with inventors, systems analysts, writers and electronics companies. They all anticipate the utopia of fully integrated information systems to materialize before the opening of the building: books, films, music, computers will be read on the same magic tablets. The future will not spell the end of the book but a period of new equalities.
>
> The Very Big Library is interpreted as a solid block of information, a repository of all forms of memory – books, laser disks, microfiche, computers and databases. In this block, the major public spaces are defined as absences of building, voids carved out of the information solid. Floating in memory, they are multiple embryos, each with its own technological placenta."
>
> Koolhaas Rem, Mau Bruce, S, M, L, XL, New York,

The design action of matching the volume of the library with the spaces that hold information represents a futuristic effort in imagining the evolutions of the architectural discipline in dialogue with information technology. It is no coincidence that Rem Koolhass himself declares that professionals from different disciplines were involved for this project. The proposal therefore does not restrict the reasoning to the architectural structure, but thinks about the entire information infrastructure: from storage and preservation to the fruition of the material.

2020

In March 2020 in the platform of the popular online game Minecraft, on World Day Against Digital Censorship, a neoclassical architectural structure created by the Block Works collective was designed to house more than 200 books that contained censored articles in Saudi Arabia, Russia, Viet Nam, Mexico and Egypt. The medium used by Minecraft players shifts the boundaries of logical-spatial understanding, structurally altering the protocols illustrated in 1956. The information contained in this library is usable through our personal devices (smartphones, tablets, PCs), which crosses the classical boundaries of architecture, grasping new limits that belong to a supra-national territory.

Research field

These three examples demonstrate how over the past 70 years, the presence and perception of the information infrastructure has drastically changed. The spatial gap across the three cases demonstrates how design logics have been subject to great changes. The progressive speed of finding knowledge seems to have taken away spaces from design, when instead a heavy relocation has taken place. If before the living space was the one that contained the information to be found, we are now in the era of information displaced from the space to draw knowledge from. Its best-known spatial product is the data center, a visible node in a complex global-scale infrastructure composed primarily of cables and servers. With the simple task of storing information, they are used by everyone, every day, in all sectors. The past 10 years have seen a heavy infrastructural increase consisting of pounds and pounds of electronic and electrical equipment filling centralized facilities. These are the data centers, connected together by a network infrastructure concretely made up of cables running around the globe laying on the ground as a new infrastructural layer to deal with.

The thesis therefore examines the data center as a key element of the most contemporary urban transformations. Through the study of its presence and articulation, the research aims to immerse itself in the spatial world of information technology to study its dialogue with the discipline of architecture.

Banham, in Environment and Technique in Modern Architecture of 1969, reappropriates issues that are little faced by modern architecture, analyzing hidden and silent aspects of the discipline: that dealing with systems. Environmental control is an aspect of architectural practice that is taken for granted; air conditioning and artificial light have contributed greatly to making spaces accessible through technological evolution and availability. The infrastructure of which the data center is a part fits into this narrative as an environmental solution that works on contacting "the outside" by keeping us "inside," all through electricity, as with air and light. The data center is part of this infrastructure that tries to process the environment, returning to us a representation of it anywhere. In its reworking of the real, it plays with the spatial actors of the city by going to shape its form, playing on the disten-

sion of potential and the concentration of servers: a great functional-electronic centralization that changes urban dynamics through the digital. While space is shrinking for humans, it gains volume for the machine.
The weights and investments of design practice are changing: more forces and energies are being expended to meticulously design spaces to the square inch in chips and various system boards. The concentration of design tension in so few square centimeters does not create contrasts in the territories we live in, but simply empties built space for now, creating voids of meaning within cities.
Although a global phenomenon, the thesis starts from the United States as the territory that holds the fundamental indicia to the formalization of the data center. In fact, the research sets its gaze in that territory at the moment of the birth of the first electronic computers to the spatial encounter between the architectural discipline and computer science by reflecting on the directions that the infrastructure itself might take.

Purpose Research

> "For thousands of years, artificial transformation and determination of man's world, as well as sheltering from weather and climate, was accomplished by means of building. The building was the essential manifestation and expression of man. Building was understood as the creation of a three-dimensional image of the necessary as spatial definition, protective shell, mechanism and instrument, psychic means and symbol. The development of science and technology, as well as changing society and its needs and demands, has confronted us with entirely different realities. Other and new media of environmental determination emerge.
> Beyond technical improvements in the usual principles, and developments in physical "building materials" through new materials and methods, intangible means for spatial determination will also be developed. Numerous tasks and problems will continue to be solved traditionally, through building, through "architecture." Yet for many questions is the answer still "Architecture" as it has been understood, or are better media not available to us?
> [...]
> Indeed, their importance-the role they play— is based on this effect of information.
> Thus a building might be simulated only.
> An early example of the extension of buildings through media of communication is the telephone booth a building of minimal size extended into global dimensions.
> [...]
> Little consequent experimentation has been undertaken to use nonmaterial means (like light, temperature, or smell) to determine an environment, to determine space. As the use of already existing methods has vast areas of application, so could the use of the laser (hologram) lead to totally new determinations and experiences. Finally, the purposeful use of chemicals and drugs to control body temperature and body functions as well as to create artificial environments has barely started. Architects have to stop thinking in terms of buildings only.
> Built and physical architecture, freed from the technological limitations of the past, will more intensely work with spatial qualities as well as with psychological ones. The process of "erection" will get a new meaning, spaces will more consciously have haptic, optic, and acoustic properties, and contain informational effects while directly expressing emotional needs.
> A true architecture of our time will have to redefine itself and expand its means.
> Many areas outside traditional building will enter the realm of architecture, as architecture and "architects" will have to enter new fields.
> All are architects. Everything is architecture."

Hans Hollein, Bau Magazine 1/2,
Central Association of Austrian Architects, Vienna, 1968

The text published in 1968 by Hans Hollein in the journal Bau, traces the direction

that the research intends to take. With this text the author identifies an important step for the evolution of the discipline of architecture. If up to that point it was believed that architecture was sufficient as the only discipline dealing with space, Hans Hollein expands the directions to which architecture itself must and will have to tend. Design must feed on other disciplines that regulate society; without doing this, architecture will be forced to produce spaces without relating itself to contemporary territories invested by new media, new technologies and new social conformations. The thesis identifies the data center as a system of environmental determination to which the discipline of architecture must refer: information technology becomes space and a physical medium between architecture and territory. This device of environmental determination violently enters the design of the territory precisely because in addition to being a medium, it practices it through a built space.

The research, however, does not stop at the phenomenal aspect of structure, but sees the data center as a transcalar system, a system not strictly related to architecture, but one that at this evolutionary moment in the discipline of computing, meets spatial design with tectonics more akin to the classical idea of architecture. In fact, this is the first time that the two disciplines have come into contact in such an evident way, but prior to this, computer science was already working at full speed influencing the area through its other applications. Software development has now become a spatial issue. The broadening of perception through their pervasiveness in everyday life, has profoundly altered the spatial perception so far.

This thesis therefore investigates the places that have most utilized mediums that relate architecture and territory. With the succession of inventions and patents, it is in the United States that the idea of living "through" is most developed.

The automobile and the elevator are two mainstays of American culture, mediums that adhere perfectly to the territory they cross. The limits of spatial perception are overcome thanks to these two mediums that aim to conquer space horizontally and vertically. Then, in 1969, two important events occur: the conquest of vertical space with the landing of Apollo 11 on the Moon and the first Internet connection that made possible the first transmission of information of this kind, completing the American colonizing dream. From the first connection, Arpanet, there would be a succession of rapid evolutions that led to the need for a spatial organization of the infrastructure, and the data center fits into this narrative as the custodian of the data: the key players acting on the territory.

It was only around 2005 that the need was felt to give a rule to the design and control of the system. At that time, in that territory, the meeting of architecture and information technology takes place which has led to our present. The construction of the data center is dictated by universal standards issued by organizations that are responsible for protocolling the computing discipline by making infrastructural operation efficient. The main contribution has been to trace a direction to data centers that most embrace capitalist logics: the extensive and quantitative one. The research interrogates standards regarding the spatial issue to study formal principles and possible future directions.

Starting with the territorial and spatial question, the thesis traces the dialogue between the two disciplines, highlighting the need for information technology to make use of architecture at this moment in its evolutionary process: now, the orderly jungle of servers is beginning to insist on the form of cities, creating new states of spatial compression and decompression, but questioning a stable and lasting alliance between architecture and information technology.

In fact, the main purpose of the research is to refocus on the authors and factors

that led to this architectural phenomenon, overcoming the common narrative that sees the data center as a large storage of servers, emphasizing how instead it is a transcalar and adaptable system across territories.

Specification of Criteria

TIA-942 and ANSI/BICSI 002-2011 were the first two famous standards to address the practical construction of the data center. The two publications from 2005 and 2011, respectively, are considered basic standards for building a data center at any scale, even for a change of use. They are intended as a thematic guide dealing with the construction of the data center addressed in its different components, with the main purpose of running servers. Usually, all standards dealing with these issues present a similar structure. Mainly they consist of two major sections, the "mandatory" part described mainly in the chapters of the standard and the "advisory" section written in the annexes. With a rigid structure, the text rationally proceeds to fill in doubts about the elements involved or to list data center characteristics in order of performance. It serves as a guide by dictating minimum standards and presenting the subject in a direct and clinical approach.
This thesis intends to unveil the data center system by taking the structure of the above-mentioned standards as a guide. In the chapters, the development of the research takes place by traversing the territories of information technology with the gaze of the architectural discipline, while in the annexes, topics that can help the reading of the final product are explored.
The research is thus shaped as a spatial analysis, geared to guide the analysis of the shared territories between architecture and information technology, focusing on the data center as its most relevant spatial product.
If Hollein is used as an approach to the topic, particularly with regard to new outputs of architecture through contamination with new disciplines, Giedion with The Age of Mechanization is the author who guides the gaze to address the research. Indeed, the author's text remains relevant in the search for the silent traces that have changed the fortunes of technological application in everyday life. The thesis continues to dig beyond the formal appearance and continues the study of a new Anonymous History with authors who are lost among the stories. Giedion writes:

> We shall inquire in the first line into the tools that have molded our present-day living. We would know how this mode of life came about, and something of the process of its growth. We shall deal here with humble things, things not usually granted earnest consideration, or at least not valued for their historical import. [...]
> In their aggregate, the humble objects of which we shell speak have shaken our mode of living to its very roots.
>
> S. Giedion, *Mechanization Takes Command: A Contribution to Anonymous History*, Oxford University Press, Oxford 1948
> S. Giedion, *Le macchine prenderanno il comando. Un contributo ad una storia anonima*, Ghibli, Milano 2019

Instead, the authors who draw the theoretical guidelines of the research remain Banham and Venturi, whose study of the U.S. territory just before the blossoming of digitization serves as the theoretical glue between one spatial medium and the other-the automobile and the data center. The thesis makes use of classic texts in the discipline, certainly dated, but consciously chosen from among authors who have had a fundamental voice in the development of the U.S. spatial and technological gaze in general, to seek common theoretical points useful in narrating the encounter between architecture and computing in the data center system.

In addition to drawing on the disciplinary bibliography, the thesis makes use of reports and manuals that are fundamental to the theoretical framework of the Internet and the physical construction of data centers.
The narrative background afferent to the computing discipline is supported by the RFCs (Request for Comments) free, online documents that describe the invention and the way the Internet works. The site claims:

> "The RFC series has a long history. The series was originated in 1969 by Steve Crocker of UCLA, to organize the working notes of the new ARPAnet research program. Online data access (e.g., FTP) was defined in early RFCs, and the RFC series itself became the first online publication series. For 28 years, this RFC series was managed and edited by the Internet pioneer Jon Postel. The RFC Editor operation was funded by the Defense Advanced Research Projects Agency (DARPA) of the US government until 1998. From 1998 – 2018, the RFC Editor was funded by a contract with the Internet Society, to continue to edit, publish, and catalog RFCs. The RFC Editor was a project at the USC Information Sciences Institute in Marina del Rey, California, through 2009. Currently, the RFC Production Center and Publisher functions are provided by Association Management Solutions, LLC (AMS)."

In addition to the RFCs, the research consults Electropedia, an online vocabulary compiled by the International Electrotechnical Comission (IEC), an instrument formalized in 1938, but with attempts starting as early as the early 1900s. On the home page it is defined as follows:

> "Electropedia is produced by the IEC, the world's leading organization that prepares and publishes International Standards for all electrical, electronic and related technologies – collectively known as "electrotechnology". Electropedia (also known as the "IEV Online") contains all the terms and definitions in the International Electrotechnical Vocabulary or IEV which is published also as a set of publications in the IEC 60050 series that can be ordered separately from the IEC webstore.
> Electropedia is the world's most comprehensive online terminology database on "electrotechnology", containing more than 22 000 terminological entries in English and French organized by subject area, with equivalent terms in various other languages: Arabic, Chinese, Croatian, Czech, Danish, Dutch, Dutch (Belgian), Finnish, German, Italian, Japanese, Korean, Mongolian, Norwegian (Bokmål and Nynorsk), Polish, Portuguese, Russian, Serbian, Slovak, Slovenian, Spanish, Swedish, Turkish and Ukrainian (coverage varies by subject area).
> The world's experts in electrotechnical terminology work to produce Electropedia under the responsibility of IEC Technical Committee 1 (Terminology), one of the 204 IEC Technical Committees and Subcommittees."

While these two tools come with the research to explore and orient the look at information technology, this thesis instead analyzes the data center system through the two aforementioned standards (TIA and BICSI) and other IEC standards to study its spatiality. Instead, to address the most recent developments in the data center system, the latest annual reports prepared by the Uptime Institute (UI) foundation established in 1993 are consulted and analyzed:

> "Uptime Institute is an unbiased advisory organization focused on improving the performance, efficiency, and reliability of business critical infrastructure through innovation, collaboration, and independent performance certifications."

Useful tool as an organization that has succeeded in attracting the attention of infrastructure owners and customers who use it, becoming over time a reference organization that annually photographs the current situation and tracks trends.

Research Structure

As anticipated earlier, the thesis resumes the classic structure of scientific standards and norms. Typically, the drafting includes chapters that delve into the main topic, and annexes that serve as extra support to give the reader more insight into the topic through other or more practical viewpoints or examples.
As in the standards, still part of the introduction is the glossary (Definition of Terms) that helps frame the topic through language. Crossing the territories of information technology has made it necessary to carefully select new lemmas that encroach on the architectural discipline. The definitions of the chosen terms is thus divided into several macro themes: new spatial terminology - foundations, nonprofit organizations and nongovernmental entities - current or past projects that have helped define the development of the global network system.
The main body of the research consists of three chapters that metaphorically take up the projects mentioned at the beginning of the introduction.
The first chapter, in the footsteps of Resnais' documentary, traces the spatial logics that later led to the rise of the data center as a spatial medium. The chapter attempts to circumscribe the research topic by also representing its spatial complexity. The text concludes with 10 Avvenimenti that summarize the complexity of the data center system. Spaces, possibilities and uses of the system are explored by drawing a narrative that breaks away from the rhetoric of land consumption but insists on the different spatial aspects it considers.
The second chapter traces the possibilities brought into play by Oma's project, Très Grande Bibliothèque. If the project seeks a dialogue between computer science and architecture, the chapter seeks to interrogate the discipline in its best-known technical-spatial evolutions, proposing itself as a moment in which the two disciplines are compared through a graphic representation that crosses the evolution and development of computer science in the period of greatest research on software and the architectural discipline's contacts with this world. The timeline crosses and focuses on computer science evolutions and architectural episodes both theoretical and spatial with the aim of documenting the recent clash between the disciplines.
The last chapter addresses the spatialization of the library built on Minecraft. A spatial reading through the TIA-942 and ANSI/BICSI 002-2011 standards and other computing standards, to investigate how the spatial issue is considered within the standards. Those examined, are a selection of standards that deal with both data center composition, such as the two mentioned above, and standards for electronic and electro-technical components. This will delve into the spatial logic chosen by agencies to define shapes, distances and components, later to become necessary notions basic to the construction of any data center.
The four annexes, on the other hand, are useful lunges to guide the reading of the thesis and include insights to better investigate the spatiality of the object studied, bibliography, and conclusions.
Annex A discusses the representation of the infrastructure of which the data center is a part. Investigating the overall aspect of the infrastructure by studying fiber optic cables adds more complexity and knowledge to the research topic. Exploring lengths and quantities annex A asks how this complex infrastructure can be represented. With the help of algorithmic possibility, annex A takes as an example The Opte, a tool designed for a digital representation of the network.
Annex B, on the other hand, goes back inside the data center system to delve into the current issue of performance in the data centers best known to the public, the large facilities that house hundreds and hundreds of servers. Performance of the

machines, but also performance of the space that cannot afford rest at any time.
Annex C and D, on the other hand, are the conclusions and bibliography, respectively, with references used to develop the research. The bibliography demonstrates how the thesis explores the world of computing by making use of portals, protocols, standards, and reports. The incotroduction of the two different disciplinary bibliographies thus seeks to fill a specific theoretical gap, that dealing with the architecture and spatial manifestation of the data center space. This aspect is also addressed by using authors from the discipline of architecture, those who most contributed to the analysis of the U.S. territory after World War II. Thus, by making use of texts belonging to two distant disciplines, the bibliography aims to be the specific crasis that frames through architecture and computer science, everything that gravitates around the topic of the data center system.
Each chapter is supported by an iconographic device that helps the reading, but also adds information and imagery to the research. It can be considered a tool that dialogues with the text, but also makes itself an autonomous narrative logical tool. The visual material is intended to accompany the reader through the territories that have most worked in the development of the system, all the way to its interior, specificities illustrated mainly with iconographic material from illustrations found in the manuals and specific standards that codify these spaces.
The thesis also makes use of the diagram, which is useful in synthesizing vast and complex concepts, giving greater clarity back to the synthesized information, thanks to its visual form. The importance of the diagram in the chapter Spatial Synthesis, accompanied the writing of the entire thesis by offering itself as a research tool that was methodically and constantly being updated, changed and questioned. The diagram in question has several overlapping reading levels that create a unified and compact composition, but when decomposed, it is formed of two timelines and lines representing fields of force and influence of particular events. The first timeline summarizes the spatial evolution of the computer and the network, identifying the major events that have insisted on leading the technological evolutionary path to the most recent days. The second timeline marks the publications of key texts in the architectural discipline that aided the reasoning and writing throughout the thesis. In the same, there are also key projects that helped formalize the spatial theory investigated in the last chapter. While the various overlapping lines that attribute dynamism to the graph represent fields of force, action and intensity with which events of a certain scale have affected the everyday spatial life. Wars, new inventions, successful new applications, and little-considered events are all carefully orchestrated in the graph in an attempt to describe the performance of the two disciplines, so distant from each other but together conceiving a new way of approaching recent space history, which began at the dawn of the last century.
The graphical tools also include key components of the data center system; in fact, the backs of two servers have been redrawn. With full-scale printing of the server on the cover and binding that takes up the pitch of the installation holes, it will be more intuitive to dip into the world of digital's infrastructure.

Definition of Terms

Glossary Introduction

The need to write a glossary to accompany the reading of the thesis, arose soon after the approach to the topic. The subject treated has a relationship with the architectural discipline, but its peculiarity is the new languages that provides for the construction of these spaces.

Hence the selection of new terms that circumscribe the scope. The rise of data centers was perhaps the most rapid system architectural formalization in the history of spatial evolution. While the development of any space has had evolutions, additions and subtractions that took centuries to consolidate through trials and failures, for data centers this evolutionary aspect followed a different kind of time curve. In just a few years, the standard formal execution has been fixed, and the changes that continue to occur concern performance of components that have little effect on the overall composition of the structure in its parts.

Since these are new structures, formalized around 2005, there was a great collective effort on the part of the entire computing and scientific community to produce solid logical reasoning so that the construction could make itself a self-contained, buildable object across the entire earth's surface. This terminology, which must break through language barriers, in no way conflicts with cultures or ways of doing things that characterize specific societies, thus begins the definition of a/symbolic architecture.

The glossary consists of terms describing components that create these spaces, such as racks, the organizational module essential for the orderly construction of the entire system. Component terminology develops a range of services offered, ways in which this tool can be used such as Iaas, Paas and Saas, the main ones.

The glossary also includes a selection of nonprofits, nongovernmental organizations, and industry associations that all work together to maintain the connection infrastructure - such as ISOC (Internet Society) - or that develop standardization regulations useful to companies or individuals, for the functional and performative construction of data centers - such as ECIA (Electronic Components Industry Association). These organizations can be of two types, either evolutions of now obsolete realities, but with know-how that could embrace this new space, or created ad hoc by going to fill regulatory gaps fundamental to the development of these structures.

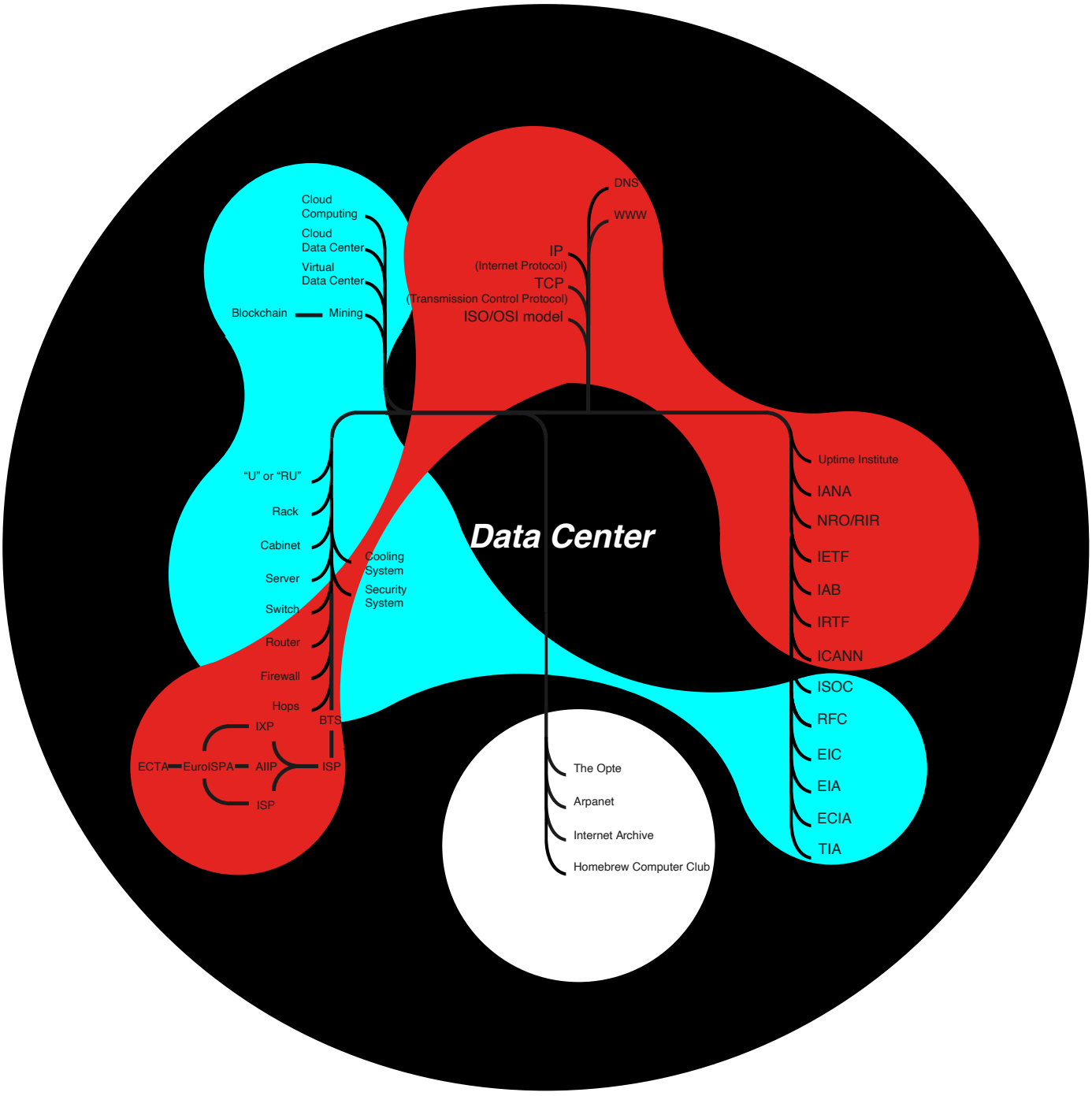
The issue of standards is a fundamental part of the operation of the entire infrastructure, which in addition to data centers has other key components such as submarine fiber optic cabling. The glossary, therefore, also considers various protocols that have helped formalize this transcalar system; the various data transmission protocols, but also the more prehistoric protocols - RFCs - that described the developmental basis for the Internet connection. No less important are the realities of controlling, maintaining and safeguarding the infrastructure. One among many is UI (Uptime Institute), a U.S. organization that produces efficiency standards and periodic reports to keep track of system development.

It behooved to mention meeting groups or projects now ended to make the state of the art clearer. For example, ARPANET, the U.S. military project that started the Internet connection in 1969.

Technical terminology, services, organizations, protocols, control realities and old projects are the macro clusters that make up this glossary. The division into such rigidly separated clusters is an attempt to bring order to a complex system, even though many of the lemmas present intersect with one another and some organizations may be part of other realities that develop an entirely different aspect from

the one for which they are called out.
The glossary is intended to be a fluid constellation that guides during the reading of the research, without claiming to be a fully developed tool in its form.
In its drafting, an intensive dialogue with Open AI's Chat GPT artificial intelligence was essential. Its use proved to be a useful tool for discovery, questioning it on issues far removed from the architectural discipline. All terms were developed with notions taken online, given firstly by the intense dialogue with the artificial intelligence and then deepening the lemmas by visiting the online sites of the different institutions, always having the Electropedia dictionary as a technical reference.

01. Data Center
02. Cloud Computing
03. Cloud Data Center
04. Virtualized Data Center
05. ”U” or “RU”
06. Rack
07. Cabinet
08. Server
09. Switch
10. Router
11. Firewall
12. Cooling System
13. Security System
14. Submarine Communication Cable
15. BTS (Base Transceiver Station)
16. Homebrew Computer Club
17. Mining
18. Blockchain
19. Modello ISO/OSI
20. TCP (Transmission Control Protocol)
21. IP (Internet Protocol)
22. World Wide Web (www)
23. ARPAnet (Advanced Research Projects Agency Network)
24. RFC (Request for Comment)
25. ISOC (Internet Society)
26. IETF (Internet Engineering Task Force)
27. IAB (Internet Architecture Board)
28. IRTF (Internet Research Tack Force)
29. ICANN (Internet Corporation for Assigned Names and Numbers)
30. IANA (Internet Assigned Number Authority)
31. DSN (Domain Name System) | Indirizzi IP
32. NRO (Number Resource Organization) RIR (Regional Internet Registry)
33. The Opte
34. Uptime Institute
35. Internet Archive (and Wayback Machine)
36. ISP (Internet Service Provider)
37. IXP (Internet Exchange Point)
38. AIIP (Associazione Italiana Internet Provider)
39. EuroISPA - The Voice of ISP’s in Europe
40. ECTA (European Telecommunication Association)
41. ECIA (Electronic Components Industry Association)
42. Hops
43. IEC (International Electrotechnical Commission)
44. EIA (Electronic Industries Alliance)
45. TIA (Telecommunications Industry Association)


Data Center
Cloud Computing
Cloud Data Center
Virtual Data Center
Blockchain
Mining
DNS
WWW
IP
(Internet Protocol)
TCP
(Transmission Control Protocol)
ISO/OSI model
"U" or "RU"
Rack
Cabinet
Server
Switch
Router
Firewall
Hops
Cooling System
Security System
BTS
IXP
ECTA
EuroISPA
AIIP
ISP
ISP
Uptime Institute
IANA
NRO/RIR
IETF
IAB
IRTF
ICANN
ISOC
RFC
EIC
EIA
ECIA
TIA
The Opte
Arpanet
Internet Archive
Homebrew Computer Club

01. Data Center

Also known as “data processing center”. It can be considered the spatial product of the digital revolution, which can be summarized as a performance given by the relationship between electronic components that have the function of storing data. Its characteristic is to become architecture as the data to be contained increase in quantity. As a performative typology it succeeds in invading the most diverse spaces; they can fit into garages, home-rooms, entire floors of buildings or a whole skyscrapers, warehouses or actual campuses. Beyond its size, the data center requires electricity to run computing machines and a cooling system to keep them running. Typically, at all scales, the data center has emergency back-up power, in case the flow of electricity not be constant. For the cooling system, solutions range from simple windows, if the data center is small (room, garage), to full-fledged air conditioning systems as in data centers of companies such as Google and Meta. Data centers that contain more sensitive data have 24-hour control of the space, so they may also have rooms reserved for security and for access to data rooms.

02. Cloud Computing

It is a term that refers to the use of computing resources and infrastructure distributed through the Internet. Through the network, cloud computing can be considered as one of the ways of using the Cloud Data Center. Cloud computing is a model that allows the use of physical infrastructure. There are three main services typologies of cloud computing:

_ IaaS (Infrastructure as a Service) this service provides the infrastructure needed to store and safeguard data.

_ PaaS (Platform as a service). This type of service is aimed at those who find themselves developing but without their own infrastructure. The service offers management and processes within the data center and not on the user’s device.

_ SaaS (Software as a Service) is a service that offers software services managed completely from the data center. Now for example also Adobe, with Creative Cloud, has delved into SaaS services, Canva also uses the same system.

These are the main services that have been created over the years offered by Cloud Computing, and it is evident that one of the consequences of this way of using the infrastructure, concentrates toward itself the computation, the performativity of the electronic world. In this way the computational works continues to be channeled into specific spaces making our devices (laptops, smartphones) mere terminals.

03. Cloud Data Center

Not to be confused with data center, cloud data center is the typical advertising narrative used to offer Cloud Computing services. The Cloud Data Center is a physical facility, an IT infrastructure addressed by businesses to users/businesses, specifically designed and optimized to offer data storage services. It is a highly automated and highly scalable environment in which servers perform and connect with each other, creating a network necessary for data storage and consultation by customers who do not have their own hardware facilities.

04. Virtualized Data Center

It is one of the main ways to use the data center infrastructure. It consists of flexibility in the use of storage/software space. It allows you to build virtual machines (VMs) that run different operating systems and applications using the same physical hardware. In this way, it is possible to make several physical servers a single machine by allowing hardware to be used more flexibly, since hardware

space resources can be assigned, from time to time as needed, to different VMs running different software. For example, Microsoft gives the ability to use virtualization to its customers through its cloud computing services with Microsoft Azure; thus, customers have the ability to scale processing capacity and manage their VMs as needed. To give a practical example: even an architecture firm can use this network architecture for the development of its projects. Workers who use CAD or post-production programs do not have the software in their device, but use the "remote desktop," which allows them to run applications in a data center without having to install them in their own computer and by calibrating the various VMs that come to be created, according to the needs of the moment.

05. "U" or "RU"

Also called Rack Unity is a standard unit of measurement used for the physical construction of racks. Thought of in inches and used to regulate expansion in height, the "RU" corresponds to a vertical space of 1.75 inches (44.45 millimeters). The components that fill the rack can then have different U: 2U, 3U, multiplying the unit as needed. This unit of measurement is used as a description for many components housed in racks, servers such as: witches, routers, firewalls, storage and power units.

06. Rack

It is a metal structure that houses the various components useful in composing the data center. It is within it that data is stored, processed and connected, first among the various other racks, then to the network. The dimensions of the racks vary. The unit of measurement in height, corresponds to U; usually they are 42U, or about 1.8 meters. They are, on the other hand, about 60 centimeters wide, with a depth of around 80-90 centimeters (an important decision to make at the design stage, because depth affects ease of access to components and the cooling capacity of the system).
It stands as the containing and constituent module of the data center. The choice of its measurements involves the space occupancy and volumetric result of the final architecture.

07. Cabinet

They are structures that generally accomplish the same function as racks. Racks are open structures that have no filter with the outside and expose electronic components to high risks if the environment outside them is not treated properly, while cabinets, are always closed structures to provide more protection from the outside. They can also be equipped with accessory fans and filters to ensure proper air circulation. They can even be provided with locks to prevent access by unauthorized personnel. Like racks, the cabinets inside them also adopt the RU unit of measurement. Mainly they are used to create small home data centers or for small businesses that operate with their own hardware.

08. Server

It is a specialized computer with its own precise composition; it provides computing services with the role of a control center to manage and distribute processing resources. Mainly, it consists of a processor (CPU) useful for processing data and managing different workloads. The server then has memory (RAM), the temporary storage space for the data that will be processed by the CPU. The vital core of the server is located in the hard disk (which may be internal to the server or

occupy a single space external to the server), the space in which the stored data is properly housed. In some cases, mechanical expedients are provided in servers to dissipate the heat produced; fans are the primary cooling systems that are part of the server itself. In addition to these basic elements, they have a motherboard (to connect all the server's hardware components) and the network card, which is useful for connecting the server to the network. Of course, each server is equipped with a power supply that allows its electrical connection necessary for the machine to function.
The measurements of this component are almost completely standardized, precisely because they are installed in racks. Thus a server is usually designed to be between 43.18 cm and 48.26 cm (17/19 inches) wide. As for the height of individual servers, they are available following the measurement in U. So there can be U-size, 2U, 3U servers. The depth of the server (from the front panel to the back panel), in general are quite compact with a depth between 60 and 90 cm.
As for storage memory, the possibilities are different but, companies like Google, Amazon, Microsoft and Meta have servers that can go up to the capacity of exabytes (EB), which is 1000 petabytes (PB), one petabyte, which is 1000 terabytes.

09. Switch

It is one of the main components of the data center and a type of server. It is a device that allows different elements of a network infrastructure to be interconnected. They play a crucial role in routing data within the data center. They are installed inside racks or cabinets, depending on the choices in infrastructure design. Due to their function, they have many Ethernet ports, ports that physically guarantee the passage of data. They can also be placed on the desk, if they have to handle a minimal amount of data, but usually they too meet the standard by following the RU unit of measurement. They can be installed inside racks or cabinets, depending on the choices in infrastructure design.

10. Router

If the switch is a useful device for internal communication between the various components of the data center, the router is the one that connects the local network with the external network. It is useful to route data traffic between the two different networks by deciding the best way to send data packets, but also to verify its security and authenticity to find the right routing path. If we are not talking about routers used in home environments, this device adheres to the modular measures of racks and RU to facilitate the spatial organization of the data center.

11. Firewall

The real device that performs the task of controlling incoming and outgoing data traffic is performed by the firewall. Its main role is to protect the network from external threats such as hacker attacks or computer viruses. It can appear as software inside the server, or they too find space inside the racks or cabinets, following the standardized RU measure. In either case, it is a security component for the protection of data center networks and resources, as it filters and controls network traffic so as to prevent computer failures to the damage of data or infrastructure.

12. Cooling System

The cooling system is a fundamental tool for maintaining the proper operation of the machines, the data center always seeks a balance with the outside trying to keep the temperature between 18° and 27°, more precisely staying between 20° | 24°.

The cooling method used is chosen according to the design of the data center, so this is a building block that is adapted to the needs at the time of the design choices. So, based on the size and characteristics of the structure, the cooling systems are many: CRAC, Chiller, free cooling, aisle containment, immersion cooling, seawater cooling, outdoor air cooling, adiabatic water cooling, adiabatic air cooling, oil immersion cooling, hot water cooling, carbon dioxide cooling, liquid chiller cooling, forced air cooling.
The choice and size of the cooling system is calculated on the total power dissipated by the equipment inside it (kW). There are many factors that are taken into consideration during the construction of the cooling system, the most important of all are the number and type of servers, their energy efficiency and power density, and local weather conditions.
To give a few examples, the Switch Citadel data center in Las Vegas has a water cooling system covering 16,000 square meters, the Lakeside Technology Center in Chicago occupies 8,000 square meters, and Google's data center in The Dalles, with an air cooling system, covers an area of 11,000 square meters.
These are examples of structured data centers designed to hold many servers, but when considering a cabinet of a small-to-medium enterprise, which presents its infrastructure on site, the cooling system, in addition to having fans built into the servers, may simply be a ventilated environment as well. The function cuts across data center design by adapting to all possible scales, precisely to meet every need, being a part of the system that is physiologically necessary for the machines to function.

13. Security System

At every scale, the entire IT infrastructure is equipped with security systems of different types. These can be mechanical systems or software systems. Security for data centers is central to demonstrating the reliability of their infrastructure.
The perimeter gate of a large data center, is controlled by an operator, inside there are usually intrusion detection systems that check for intruders inside the data center itself. In addition to human intrusion, data center security systems have fire protection systems and protections from electromagnetic interference that can disrupt machine operation, all of which are linked to video surveillance systems that monitor activities both inside and outside. More structured buildings are equipped with access control systems such as biometric scanners or personal badges. All linked to audible alarm systems.
Firewalls, on the other hand, are physical means of security, but they act digitally by protecting the data center network from attempted outside attacks. Then there are cryptographic systems that protect sensitive data stored within servers so that it cannot be read by unauthorized personnel.
The various security systems thus pervade the entire infrastructure: the physical and nonphysical parts, and it depends on the composition of each structure.

14. Submarine Communication Cable

These are fiber-optic cables laid in the seabed where more than 90 percent of the information of the Internet circulating every day. The specific composition of the cables depends on the specific and environmental requirements that the cable passes through. They usually consist of a central core made of thin glass or plastic wires that transmit signals through light signals. The central core is wrapped with a protective layer of metal or polyethylene to protect the cable from physical damage, while externally the cable has a protective outer jacket composed of synthe-

tic material useful for resisting marine environmental conditions.
Then the packet of information is translated into a light signal that travels inside the cable. Through this method called "amplitude modulation," cables can transmit large amounts of data at high speeds. To protect signal travel, some cables may include electromagnetic protection to shield external interference.
The first transatlantic submarine cable laid in the ocean seabed was about 3200 km long and connected the Irish city of Valentia to the city of Trinity Bay in Canada. It was functional for less than a month ceasing operation due to technical problems. In 1866, another cable, more resistant to water and weather, was placed on the same route. Today there are several submarine cables on that section, such as the one laid in 1998 and is fiber optic.
Currently, the longest submarine cable in operation is SEA-ME-WE 3, which spans 39,000 km and connects Southeast Asia, the Middle East and Europe. This cable is owned by a consortium of 92 telecommunications operators from 70 different countries and in Italy it lands in Mazara del Vallo, Sicily.
This type of cable is laid by special boats called "submarine cable ships" or "cable ships." These vessels are equipped with special equipment to lay, repair and replace cables. Many are also equipped with instruments such as side-scan sonar useful for probing the seabed and detecting any obstacles that could compromise the laying of the cable.

15. BTS (Base Transceiver Station)

They are key facilities for providing mobile wireless communication services; they are also those facilities that provide location-based services based on georeferenced advertising. This, like the data center, is also an essential component of the digital infrastructure whose performativity is accompanied by the presence of a physical structure. It is vulgarly called an antenna that changes its mode of presentation according to the territory over which it is placed and according to the amount of data exchanged. The structures have heights ranging from 10 to 50 meters when far from urban settings. In residential areas and city centers, its structure is incorporated by the existing architecture, in fact many times it can be installed in bell towers, towers or skyscrapers. Various companies are active and whose main mission is to install these devices by trying to camouflage them with mimetic devices, such as simulating vegetation (black pine, maritime pine, date palm, coconut palm, dwarf palm, cypress). Or, in urban settings, they can also simulate towers made up of fake bricks. In these cases, digital infrastructure uses real imagery such as architecture and vegetation to awkwardly enter into aesthetic relationships with the landscape.
These devices that invade our contemporary landscape and cities can connect to the Internet in a physical way or not. Through fiber optic cables, copper cables, but also via radio waves or satellite.

16. Homebrew Computer Club

"Are you building your own computer? Terminal? TV Typewriter? I/O device?
Or some other, digital black-magic box?
Or are you buying time on time-sharing service?
If so, you might like to come to a gathering of people with likeminded interests.
Exchange information, swap ideas, talk shop, help work on a project, whatever...
We are getting together Wednesday nite, March 5th, 7 pm at the home of Gordon French 614 18th Ave., Menlo Park (near Marsh Road).
If you can't make it this time, drop us a card for the next meeting.
See ya there, Fred Moore."

In March 1975, Gordon French and Fred Moore founded a club open to those who thought the microcomputer revolution could have implications for people's domestic and daily lives. The meetings were attended by that generation of programmers, engineers and enthusiasts who actively influenced the development of contemporary everyday life through digital devices. All personalities, such as Steve Jobs, who have studied the relationship between digital devices and the human body.
The first meeting took place on March 5, 1975 in Gordon Franch's garage. The domestic-daily future of digital computing found its place in an area of the home in direct contact with the outdoors and typically used as a personal and design laboratory aimed at building, repairing and inventing. Within the domestic, the future of the contemporary relationship between humans and digital computing is theorized and then created.
The club closed in 1986 after an intensive exchange among participants and after creating an influential newsletter that contributed to the development of the topics discussed in the club.

17. Mining

It is an essential process in the bitcoin network. It consists of processing transactions and adding them in the form of new blocks to a blockchain. Mining is a computationally intensive process that requires the use of specific algorithms to process transactions. The addition of blocks to the decentralized, universal blockchain (blockchain) occurs through the work of miners who use their computational facility to verify transactions.
In 2008, an anonymous inventor or group of inventors known by the pseudonym Satoshi Nakamoto, invented Bitcoin, a cryptocurrency that in the financial world is not regarded as a currency, but as a highly volatile store of value that travels through transactions controlled by data centers of different sizes. The volatility in its financial market parallel to the traditional one starts from the basic feature of digital decentralization: its spaces are scattered around the globe in a dense network of servers held together by users in a shared digital register open to all called blockchain.
This organizational and systemic decentralization based on the verification of transactions to prove the trustworthiness of the medium, similar to classical banking systems, has in fact made the entire globe useful but not necessary for the existence of this system.
In the landscape of the new miners, the importance of electricity does not reside in concretely illuminating the traditional tunnels dug by miners, but electricity becomes a key subject for transactions to take place. It is not the digital miner who brings electricity to the mine, but seeks the place where it is easiest to deal with its cost.
Through the study of the spaces used for this activity, the outline of the future of this phenomenon is clear. Early digital excavation took place in revenue spaces, hidden, small and with few pretensions. The intensification of the activity and the difficulty in extraction as time goes on (more difficulty means employing more power for extraction), outline its very obvious spatial future and centralized for greater control. From the very beginning, the avidity of possession began to structure larger and larger energetically powerful spaces that incorporate or destroy the small operational cells in the territory. The spatial clarity of the evolution of this activity will end as excavations in traditional mines have always behaved:

the extractable material will run out and continue to circulate in a few powerful hands.
According to recent calculations, 2 million bitcoins remain to be mined.

18. Blockchain

It is a distributed register that enables secure transactions using cryptography. The system is based on a network of shared nodes, and each node in the network contains a complete copy of the transaction register, updated continuously with new transactions made. The first blockchain is introduced by Satoshi Nakamoto with the goal of serving as a general register for the digital currency Bitcoin.
In this type of ledger once written, data cannot be changed without all subsequent blocks being altered, this makes it an almost unalterable system.
Spatially, this is translated into servers working to support this decentralized infrastructure. Initially, in 2008, a home infrastructure was sufficient. As Bitcoin mining increases and thus the Blockchain becomes more heavy, the necessary infrastructure now requires very expensive resources, leading the system toward centralization, given the rules of the game, but also human greed.
Gradually, until the last bitcoin has been mined, the strain on centralization and the disappearance of small homegrown and productive entities will lead to other issues as yet another unbalance of power and resources.

19. Modello ISO/OSI

During the 1970s, the U.S. Department of Defense interconnected two Supercomputers to study an effective network that could link them together. At the same time, some companies also began to think about network protocols for communication between spatially displaced computers. The incommunicability between different procedures highlighted the need to create non-proprietary protocols. The unifying answer came from ISO (International Organization for Standardization) in 1984, which felt the need to build an open system for interconnection between computers. A unique theoretical model is defined that makes communication between computers agile. The model in question will serve as the starting point for Benjamin H. Bratton's essay The Stack: On Software and Sovereignty. Like the ISO|OSI model, the author also subdivides his theory according to layers taking inspiration from the 1984 model, which also consists of layers useful for conveying and facilitating the application of the communication model.
OSI represents the main model applicable to computers, it represents the archè of this issue that dialogues with técton, which makes the various boxes from which the machine is composed work. OSI is not presented as a network protocol, but rather a reference model that defines how the different layers of network protocols interact with each other. A theoretical reference model that defines through 7 layers (physical layer, data link layer, network layer, transport layer, session layer, presentation layer, application layer) a theoretical framework for the design of computer networks.

20. TCP (Transmission Control Protocol)

The general theoretical model OSI, led to the creation of network protocols, such as TCP. As per its name "Transmission Control Protocol," it is a protocol that stands at the transport layer of the ISO/OSI model. Its main task is reliable data transmission, data flow management and network congestion control. TCP is an example of a protocol that fits the ISO/OSI model, at the software level it is implemented on operating systems and network devices such as routers, switches,

firewalls. It is a fundamental software component for the operation of the Internet along with the IP protocol.

21. IP (Internet Protocol)

IP, like TCP, is also an application protocol. In particular, IP acts at the network layer, according to the ISO/OSI model. Its main action is directing data and splitting data into packets for transmission across the network, without any guarantee of delivery or flow control (an issue addressed by TCP).

22. World Wide Web (www)

The birth is commonly referred on August 6, 1991, the day computer scientist Tim Berners-Lee first published a publicly accessible website. Development began two years earlier by Berners-Lee himself at CERN in Geneva, and the first site featured the very description of the WWW project, and from there began the expansion of this hypertext system that now invades the daily lives of human beings on a daily basis. This system allows documents and resources to be linked together through hypertext links, allowing users non-linear navigation. This search mode allows users to access related information and easily move from one resource to another. After two years in which the system was used by the scientific community, CERN decided on April 30, 1993, to make the WWW protocol available to everyone by releasing its source code, putting it in the public domain.
The Web is an electronic, digital space of the Internet for publishing multimedia content, so it is only one part of the services that the Internet offers that has helped to change the way we approach research and information retrieval.
http://info.cern.ch/hypertext/WWW/TheProject.html

23. ARPANET (Advanced Research Projects Agency NETwork)

Is the first decentralized computer network, created in the United States with the ambitious task of seeking innovative technological solutions. The project was developed at the height of the Cold War with the collaboration of several American universities with the aim of building a communication network that could survive a large-scale nuclear attack: a secure and fast military network for information exchange. After 1974 with the advent of the TCP/IP transmission standard, the network project was called the Internet, and it was with the advent of personal computers that this type of network spontaneously gave rise to e-mail, creating a de facto human network. In the 1990s, after it lost relevance from a military point of view, the first commercial attempts take place. Thanks to a series of services offered to businesses, the Dot-com bubble takes place, in the same years that Tim Berners-Lee was working on the World Wide Web at CERN in Geneva.
The first connection through ARPANET occurs on October 29, 1969 between the University of California (UCLA) and the Institute of Computer Science at Stanford University. The first message sent and received at Stanford was “lo,” first letters of the word “login,” which did not all arrive due to a technical glitch.

24. RFC-editor (Request for Comments)

“A long time ago, in a network, far far away, a great adventure took place!”

This is the opening sentence of RFC 2468: I REMEMBER IANA. This RFC was written in 1998 as a tribute to Jon Postel and for his untimely death. Jon was the one who organized to build and maintain RFC. This system served and still serves today to design or implement network standards. Editing system, born in 1969

along with the ARPANET project, was responsible for designing and building the rules of the game that are then applied to the Internet through protocols. The role of this collection of documents spans the entire history of Internet connectivity through documents written by Internet experts such as engineers and researchers from around the world published and maintained by the Internet Engineering Task Force (IETF), a nonprofit organization that coordinates the development of Internet technologies. The RFCs are not official standards like those established by organizations such as ISO or ANSI, but they carry the same weight and are often used as a reference for the creation of official standards.
The RFCs also contain some curious or joking documents while maintaining an experimental and hilar line.
For example:
RFC 2324 - Hyper Text Coffee Pot Control Protocol (HTCPCP/1.0) describes a joke that suggests using the HTTP protocol to control a coffee machine.
RFC 1149 - A Standar for the Transmission of IP Datagrams on Avian Carriers. Proposes an alternative method for transmitting data using carrier pigeons as "carriers" of IP packets.
RFC 2795 - The Infinite Monkey Protocol Suite (IMPS). This is a joke proposing a set of network protocols based on the idea of using monkeys to randomly generate packets.
After these joke RFCs, it should be noted that most of them were written with the intention of being load-bearing pillars for communication between computers.
For example:
RFC 1 - Host Software. This is the first RFC ever published, dated April 1969. It describes the need for a protocol for communication between different computers, and refers to the Network Control Program (NCP) protocol.
RFC 793 - Transmission Control Protocol. This RFC, published in September 1981, describes the TCP network protocol, which underlies much of the Internet's communication.
RFC 822 - Standard for the Format of ARPA Internet Text Messages. Published in 1982, this RFC describes the standard format for creating e-mail messages.

The RFCs insist on the structure of the Internet almost as an official gazetteer and as a field of research and exchange to implement the smartness of Internet. Inside RFCs Editor there are all the protocols that have changed contemporary cities as we see them today; technical and theoretical writings that have repercussions on society and the spaces in which it insists.

25. ISOC (Internet Society)

The Internet Society is a nonprofit organization founded in 1992 for the purpose of promoting the use and development of the Internet globally. This organization arose to formalize more spontaneous and informal movements such as IETF (Internet Engineering Task Force). Its roles and boundaries are loosely defined, so its scope is not so precise and circumscribed. One of ISOC's most important managements is copyrighting RFCs, which are owned by IETF, but the latter is formally part of ISOC, as is IAB (Internet Architecture Board). Its territory of operation is the entire globe with its two main offices one in Virginia and one in Geneva, working on conferences, publications and seminars discussing Internet issues.

26. IETF (Intenet Engineering Task Force)

It was one of the first open global organizations composed of volunteers who pro-

mote and work to develop Internet technical standards. NGO founded in 1986 by a group of Internet experts who play a key role in the development and promotion of key Internet technologies such as TCP/IP and HTTP protocol; through IETF, Internet technical standards have been developed in an open and collaborative manner, ensuring interoperability and security in online communications for users worldwide. This NGO is now part of the Internet Society, which provides it with administrative, financial and organizational support. While IETF is one of the Internet's leading technical standards organizations, ISOC is the one that provides support for IETF's development.

27. IAB (Internet Architecture Board)

"The "Internet Architecture Board" (IAB) sounds as if it is something rather grand, perhaps consisting of a group of people in formal business clothes, sitting around an impressive oak table, under the watchful eyes of an oil painting of The Founder of the Internet. The reality is rather different, and this article is intended to give a feeling for what the IAB really is, what it does, and equally important what it cannot do."

This is the first statement of presentation of the IAB advisory board that answers the question: what does IAB actually do? Concretely, it is an advisory board that is part of the IETF and oversees the architecture and evolution of the Internet. Created in 1983 its history can be found in RFC 1160 - Internet Activities Board. The organization's responsibilities include overseeing the activities of the IETF, overseeing the Internet Standard Process, and appointing the Editor of the RFCs. The IAB itself, along with the IETF, is part of ISOC, a parent organization that lends all kinds of support to these technical bodies and others.

28. IRTF (Internet Research Task Force)

It is a funded and membership organization of IETF (Internet Engineering Task Force) and ISOC (Internet Society). Its purpose is to do research to explore and define future directions of Internet technology. Its goals are to provide a long-term perspective on Internet technology, anticipate future challenges, and identify new areas for research. While IETF focuses on the development and management of Internet protocols and technical specifications through the production of RFCs, IRTF aims to develop technologies for the future of the Internet.

29. ICANN (Internet Corporation for Assigned Names and Numbers)

ICANN is a nonprofit organization responsible for managing domain names and IP addresses globally. Founded on September 30, 1998 in California under contract with the U.S. Department of Commerce and an agreement with IETF. It was formed to incorporate as its department IANA (Internet Assigned Numbers Authority).From 1998 to 2016, the organization was under the financial control of the United States, but as of October 1, 2016, ICANN has become a private nonprofit organization that is funded primarily through fees paid by domain name registries and other Internet service providers that participate in its domain name and IP address management system.It is also funded by voluntary contributions that support its mission and goals.

30. IANA (Internet Assigned Numbers Authority)

It is part of ICANN and plays a critical role in managing the domain name system (DNS). Initially IANA was part of the U.S. government under the oversight of the Department of Commerce, after 2016 it relies on ICANN and is financed primarily

through fees paid by domain name registries and other Internet service providers involved in the management of domain names and IP addresses. Its task then is to play a coordinating and management role on the Regional Internet Registries (RIRs), then global oversight and management of IP addresses by ensuring proper operation to the 5 RIR organizations.

31. DSN (Domain Name System) | Indirizzi IP

DNS is a hierarchical naming system. When you type the name of a domain into the address bar of your browser, the DNS system automatically takes care of converting the domain name into an IP address (a code for us that we do not understand composed of a series of digits) that the computer can use to connect to the corresponding web server. The DNS system is an essential system, along with the IP address, for human|digital communication. Once the correct IP address has been obtained through the DNS system, the browser that is used for searching opens a TCP/IP connection with the web server. After the web server receives the request, the response arrives in http format. So when a connection is made, the primary request first goes through all the DSN servers and then finds the IP address belonging to a web server that contains the file that the search through the browser has requested. For example, Wikipedia uses Cloudflare's DNS management services to direct Internet traffic to its web servers, the space where the site's content is contained and stored. One could think of the DNS server as a large distributed database that holds information about IP addresses, and then request the information from dedicated web servers.

32. NRO (Number Resource Organization) | RIR (Regional Internet Registry)

NRO is the nonprofit organization representing the 5 RIRs described in RFC 7020. IANA delegates the organization of Internet resources to the RIRs who in turn following their regional lines deliver the resources to their customers. NRO has entered into an agreement with ICANN to establish ASO (Address Supporting Organization) to organize global IP addressing policies within the ICANN framework. So NRO is part of ASO (Address Supporting Organization) one of the three bodies that make up ICANN's governance. NRO coordinates the five regional IP addressing organizations called RIRs, globally. Among ASO's various tasks is to advise on specific issues regarding IP addresses, but it participates in the appointment of ICANN Board members, so NRO (hence ASO), too, until 2016 had collaborative but also oversight contacts with the U.S. Department of Commerce.
The 5 RIRs led by NRO and represented by ASO gift:

_AFRINIC African Network Information Center, on the African continent.
_ARIN American Registry for Internet Numbers, acting on the American continent: North America and South America.
_APNIC Asia-Pacific Network Information Center, which insists on the Asia Pacific region.
_LACNIC Latin American and Caribbean Internet Addresses Registry, for Latin America and the Caribbean
_RIPE NCC Réseaux IP Européens Network Coordination Centre, serving Europe, the Middle East and parts of Central Asia.
In 2003, the four existing groups (ARPNIC, ARIN, LACNIC and RIPE NCC) signed the MoU (Memorandum of Understanding) to coordinate joint connection activities, technical projects and policy coordination. While in 2005, AfriNIC also joined

the MoU of the NRO.

33. The Opte

The project called The Opte started in 2003 by Barret Lyon, works on the graphical representation of the Internet network. The study seeks to graphically represent the vastness of the Internet connection, composed of connection nodes joined by lines that highlight their connections to other networks. The outcome results from the use of a type of algorithms called force-directed graph drawing algorithms. This particular version developed by Lyon, is not in the public domain, so we cannot know exactly how it acts and how it develops the image in detail.
To write the legend for this type of representation by stopping at the different colors present, would be reductive since the image is produced by an algorithm that uses logical schemes different from human ones.
To better understand the reading of this image, it may help to list what data the algorithm takes into consideration to process this representation.

1- Quantity. The infrastructure of the Internet is physical; the algorithm takes into consideration the amount of servers, routers, switches, switch distributions, and network backbones that connect the infrastructure.
2- Connection. What parts of the infrastructure are interconnected? The algorithm identifies the physical paths that information packets travel as they move between devices.
3- Distance. The physical distance between elements alters the production of the image; the positioning in the earth's surface of different infrastructure elements affect the connection forces detected by the algorithm.
4- Hops. The algorithm takes into account "hops," which in computer science are the steps a packet of information makes from one device to another. The hops count, depends on the routing protocols and usually the more hops between the source and destination, the more the real-time performance is affected.
5- Regions. The color assignment is not random, in fact it is used to distinguish different blocks of IP addresses divided by the NRO (Number Resource Organization).

The image is totally developed digitally through the use of the algorithm, making the work of the computer programmer a tool for representation. Reasoning about the interpretation of these types of maps and how they are created is helpful in understanding the complexity of the Internet structure that continues its, seemingly random, expansion day after day.

34. Uptime Institute

It is a consulting and certification firm established in 1993 that spends its time in giving constructive direction to the Internet infrastructure, particularly regarding Data Centers. Over the years it has inserted itself worthily as a consultancy and is among the first consulting firms to help organizations and their infrastructure follow standards of operation and sustainability. It has created a highly coveted certification service to place Data Centers on a rating scale based on the Data Center's own characteristics. The rating is called the Tier Standard and as of now has four levels and takes into consideration the design and management of the infrastructure.
Tier I:
A Tier I data center is the basic capacity level with infrastructure to support infor-

mation technology for an office setting and beyond. The requirements for a Tier I facility include:
_An uninterruptible power supply (UPS) for power sags, outages, and spikes.
_An area for IT systems.
_Dedicated cooling equipment that runs outside office hours.
_An engine generator for power outages.
Tier I protects against disruptions from human error, but not unexpected failure or outage. Redundant equipment includes chillers, pumps, UPS modules, and engine generators. The facility will have to shut down completely for preventive maintenance and repairs, and failure to do so increases the risk of unplanned disruptions and severe consequences from system failure.
Tier II:
Tier II facilities cover redundant capacity components for power and cooling that provide better maintenance opportunities and safety against disruptions. These components include:
_Engine generators.
_Energy storage.
_Chillers.
_Cooling units.
_UPS modules.
_Pumps.
_Heat rejection equipment.
_Fuel tanks.
_Fuel cells.
The distribution path of Tier II serves a critical environment, and the components can be removed without shutting it down. Like a Tier I facility, unexpected shutdown of a Tier II data center will affect the system.
Tier III:
A Tier III data center is concurrently maintainable with redundant components as a key differentiator, with redundant distribution paths to serve the critical environment. Unlike Tier I and Tier II, these facilities require no shutdowns when equipment needs maintenance or replacement. The components of Tier III are added to Tier II components so that any part can be shut down without impacting IT operation.
Tier IV:
A Tier IV data center has several independent and physically isolated systems that act as redundant capacity components and distribution paths. The separation is necessary to prevent an event from compromising both systems. The environment will not be affected by a disruption from planned and unplanned events. However, if the redundant components or distribution paths are shut down for maintenance, the environment may experience a higher risk of disruption if a failure occurs. Tier IV facilities add fault tolerance to the Tier III topology. When a piece of equipment fails, or there is an interruption in the distribution path, IT operations will not be affected. All of the IT equipment must have a fault-tolerant power design to be compatible. Tier IV data centers also require continuous cooling to make the environment stable.

35. Internet Archive (and Wayback Machine)

It is a nonprofit digital library wanted by Brewster Kahle an American entrepreneur and activist, in 1996. The idea was and is to preserve and make accessible to all, digital documents of all kinds such as books, music, movies, images and web

pages that would otherwise be deleted or replaced by new files. Relevant collections include:
_Open Library: concerned with collecting and cataloging every published book in a single database, a project started in 2007
_Archive-It: a service that allows organizations and institutions to collect digital material. This type of archiving then helps third parties who contribute to enrich the Internet Archive itself.
_NASA Images: a project created in 2008 to make the archives of images, video and audio produced by the space agency over the years accessible to the public.
The most interesting project is the Wayback Machine, which aims to catalog the Internet landscape through the extrapolation of now-archived sites; it wants to collect a history of the Internet's evolution. It is created in 2001 with the intent of allowing users to access outdated Web content with the goal of preserving the Web's digital heritage.

36. ISP (Internet Service Provider)

It is an organization or company that offers Internet connectivity services to Internet users. They are the providers that allow us to connect to the Internet through a subscription and they can own the infrastructure or parts of the infrastructure or they rent the infrastructure in order to create space for themselves. Obviously they are companies that also talk to the states whose infrastructure insists on their territory by going to talk to the governments and the owners of the infrastructure.

37. IXP (Internet Exchange Point)

An IXP is a connection point between different Internet networks, infrastructure used by Internet service providers (ISPs) to exchange Internet traffic while trying to improve Internet performance and speed. They are usually operated by nonprofit organizations or telecommunications companies located in different parts of the world, and each state may have one or many in its territory. Essentially it is one of the actors, along with ISP that provides the connection to the end user.

38. AIIP (Associazione Italiana Internet Provider)

AIIP is an organization that represents the interests of Italian ISPs and works to promote the development and spread of the Internet in Italy and protect the interests of companies operating in the sector; in fact, it is a member of Confindustria Digitale, ECTA and EuroISPA.

39. EuroISPA - The voice of ISPs in Europe

It is a European association representing Internet Service Providers (ISPs) in Europe. Founded in 1997, it promotes policies and regulations that encourage innovation, competition and user security.

40. ECTA (European Telecommunications Association)

It is a European association representing the interests of alternative telecommunications operators to the most represented providers. Founded in 1998, it focuses on promoting competition and access to network infrastructure in the telecommunications sector.

41. ECIA (Electronic Components Industry Association)

The organization that holds the standards for assembly measurements for racks and determined the rack unity "RU" is ECIA.

Before ECIA, the standard is dictated by EIA (Electronic Industries Alliance), formed in 1924 by 50 radio manufacturers in Chicago. This organization was designed to control the licensing of the large number of radio patents so that each member could have access to all relevant patents needed to build radio transmitters, antennas and receivers. From the beginning until now, things have evolved, and in 2007 EIA was dissolved into its constituent divisions and in 2011 EIA ended and ECA was given the task of continuing to work on standards and then to dialogue with ANSI on national standardization (ANSI is the national standardization body in the U.S., which in turn dialogues with ISO, the nonprofit organization for international standardization). Later ECA joined with NEDA (National Electronic Distributors Association) to found ECIA, which is still active today.
Following are the activities and purposes of ECIA:

> "ECIA provides resources and opportunities for members to improve their business performance while enhancing the industry's overall capacity for growth and profitability. From driving critical conversations and process optimization to product authentication and industry advocacy, ECIA is your trusted source for support, insight and action.
> Bringing together the talent and experience of a broad array of industry leaders and professionals representing all facets of the electronics components supply chain, ECIA is uniquely positioned to enable individual connection as well as industry-wide collaboration.
> As the supply chain becomes increasingly more complex, ECIA serves as a vital nexus for refinement and progress. Expansion and uncertainty seem to be the only true constants in the electronics industry today. In this dynamically shifting environment, reliable market intelligence is at a premium. Because ECIA's members are the marketplace, we provide a level of visibility into the supply chain otherwise unavailable. From individual anecdotes gleaned from conversations at an ECIA event, to our exclusive market reports, we help keep you in the know.
> As an organization made up of the leading electronic component manufacturers, their manufacturer representatives and authorized distributors, ECIA members share a common goal of promoting and improving the business environment for the authorized sale of electronic components to the end customer."

This organization is important to EIA/ECA-310-E, which develops standards for rack sizes and how they can accommodate all equipment within them. Standard now followed by the entire international market of companies, manufacturers and developers.

42. Hops

One of the main meanings of the word hop in computer science derives from a hop | step that a packet of information performs passing from one network node or network device to another. This presence of information comes in useful if one wanted to determine the efficiency of the network itself.

43. IEC (International Electrotechnical Commission)

Il sito presenta così l'attività di IEC:

> "Founded in 1906, the IEC (International Electrotechnical Commission) is the world's leading organization for the preparation and publication of international standards for all electrical, electronic and related technologies. These are known collectively as "electrotechnology".

La International Electrotechnical Commission nasce ad inizio novecento a Londra con il compito di provvedere ad una standardizzazione delle unità di misura. Nel 1938 pubblica per la prima volta l'international Electrotechnical Vocabulary,

quello che oggi è raccolto nello standard IEC 60050, ma che si trova pure ad accesso libero nel sito dell'IEC sotto il nome di Electropedia. Oggi la sede principale si trova a Ginevra, Svizzera.

> "The IEC is a global, not-for-profit membership organization, whose work underpins quality infrastructure and international trade in electrical and electronic goods. Our work facilitates technical innovation, affordable infrastructure development, efficient and sustainable energy access, smart urbanization and transportation systems, climate change mitigation, and increases the safety of people and the environment.
> The IEC brings together ~170 countries and provides a global, neutral and independent standardization platform to 20000 experts globally. It administers 4 Conformity assessment systems whose members certify that devices, systems, installations, services and people work as required.
> The IEC publishes around 10000 IEC International Standards which together with conformity assessment provide the technical framework that allows governments to build national quality infrastructure and companies of all sizes to buy and sell consistently safe and reliable products in most countries of the world. IEC International Standards serve as the basis for risk and quality management and are used in testing and certification to verify that manufacturer promises are kept."

44. EIA (Electronic Industries Alliance)

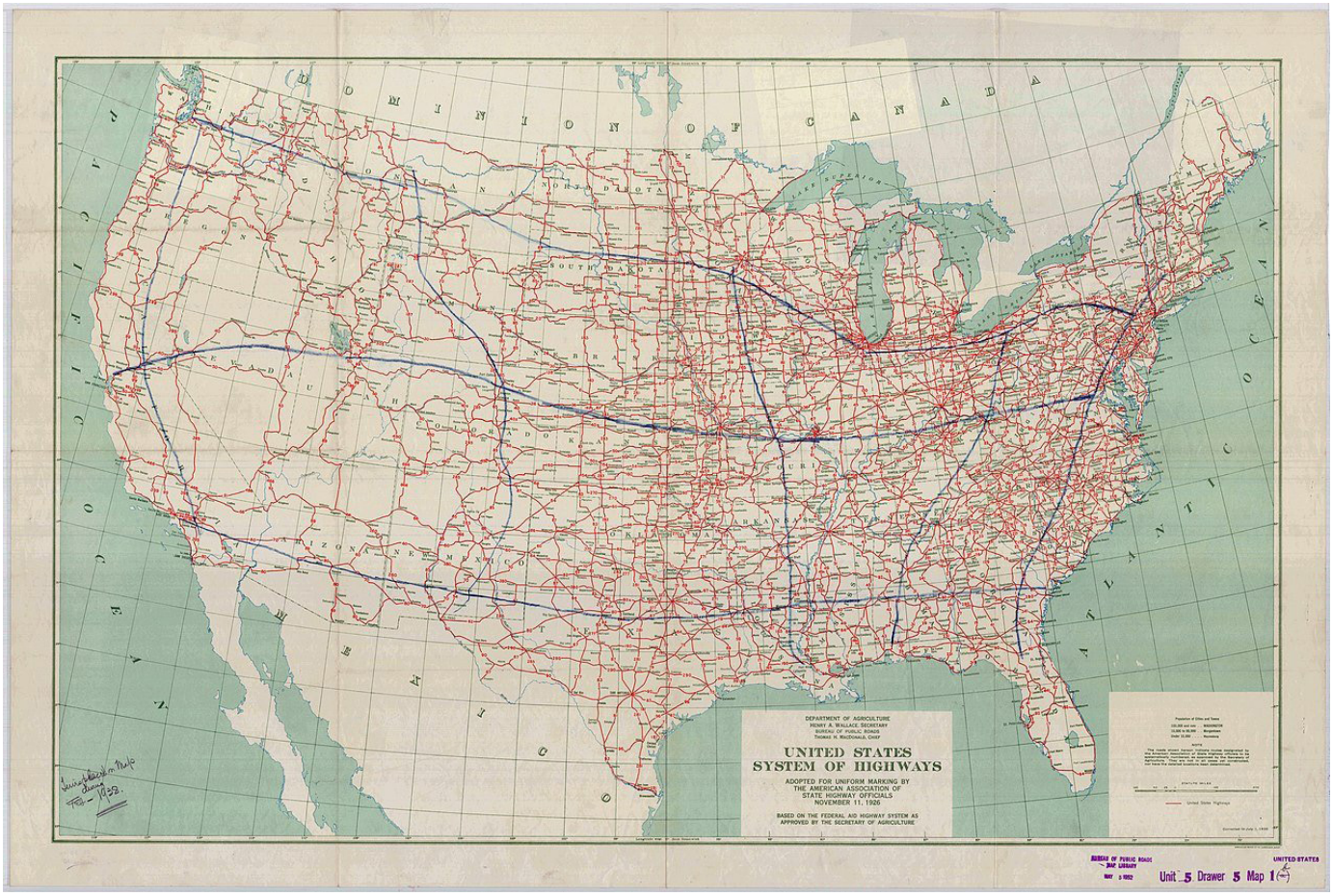
Era un'organizzazione americana nata el 1924 composta da un'alleanza di associazioni di categoria di produttori di elettronica che lavoravano sull'intercambiabilità e la compatibilità tra elementi elettronici. Nata come organizzazione che controllava un grande numero di brevetti radio necessari per costruire trasmettitori, antenne e ricevitori radio. Con il tempo e lo sviluppo di nuove tecnologie, si amplia con nuovi membri. Il suo contributo allo sviluppo dei controlli termina nel 2011 quando EIA chiude definitivamente la sua missione.

45. TIA (Telecommunications Industry Association)

Associazione di categoria che insiste sulle tecnologie dell'informazione e della comunicazione che si basa su associazione volontaria dei membri per tracciare una via comune sul trattamento dei processi attraverso norme tecniche di settore.

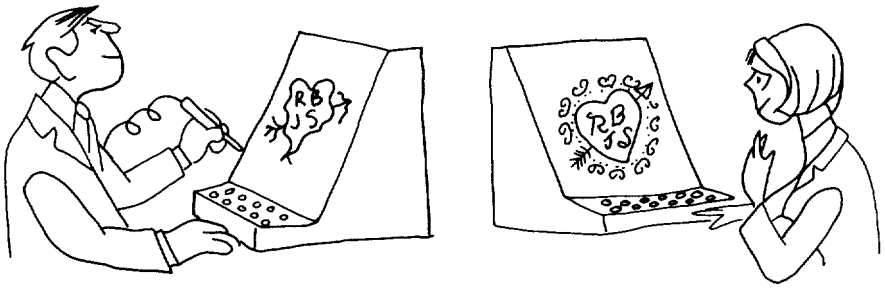
> "The Telecommunications Industry Association (TIA) brings together communities of interest across -- Technology, Government Affairs, Standards, and Business Performance -- to enable high-speed networks and accelerate next-generation Information and Communications Technology (ICT) innovation.
> With a global membership of more than 400 companies, TIA is at the center of a vibrant connected ecosystem of companies delivering technologies and services that are revolutionizing the way the world communicates. Our members include ICT manufacturers and suppliers, network operators and service providers, distributors and systems integrators.Community is at the center of TIA, which convenes the industry's thought leaders and brightest minds, regardless of the size of their business, to solve common challenges, and develop new ideas and approaches that bring tangible value to companies by enhancing their bottom line.TIA is the industry voice that leads the conversations and provides timely information and resources to help expand global investment and trade opportunities and encourage innovation throughout the entire value chain.
> Built upon a values-based culture of accountability, teamwork, engagement, innovation, and being member-driven, TIA delivers results – driving scalable, repeatable, consistent processes that deliver outcomes and value for our members.
> TIA is an Illinois not for profit corporation (501 (C) 6)."

Nel corso degli anni, per mantenere alto il suo grado di diffusione è un organo membro di altre organizzazioni come ISO e IEC.



Griglia come conquista territoriale
Map hand-drawn by Franklin D. Roosevelt, *Natonal Archives Catalog,* 1938.
From the memo attached to the backside: *"In 1938 President Roosevelt personally drew the blue lines on the attached map and forwarded it to the Bureau [of Public Roads] to indicate the routes on which modern express highways should be built."*

The red lines are the track of the railroad infrastructure, the blue of the highway system.
The map in question represents President Roosevelt's proposal delivered to Thomas MacDonald including eight corridors of highways crisscrossing the country, what would in the future become the interstate highway system in the territory of the United States.
Even from the earliest approaches to the vast U.S. territory, the simplest idea representing democracy was found by having the territory crossed by roads forming a grid. Before that in computer electrotechnical components, the grid is put into the territory to create more direct and fluid connections. The grid crosses the boundaries of American cities, is superimposed on the national territory and then reappears in electronic components. With this gesture, the foundation for an efficient communication system is set.



A communication system should make a positive contribution to the discovery and arousal of interests.

J. C. R. Licklider R. W. Taylor, *The Computer as a Communication Device*, Science and Technology, April 1968.
Licklider, a psychologist and computer scientist, in 1962 in charge of the ARPA project, the one that led to the ARPAnet division in 1969. The article, published in Science and Technology, investigates the possibilities a computer can give with its use. The illustrations use a cartoonish representational language, imagining the computer as a communication system.

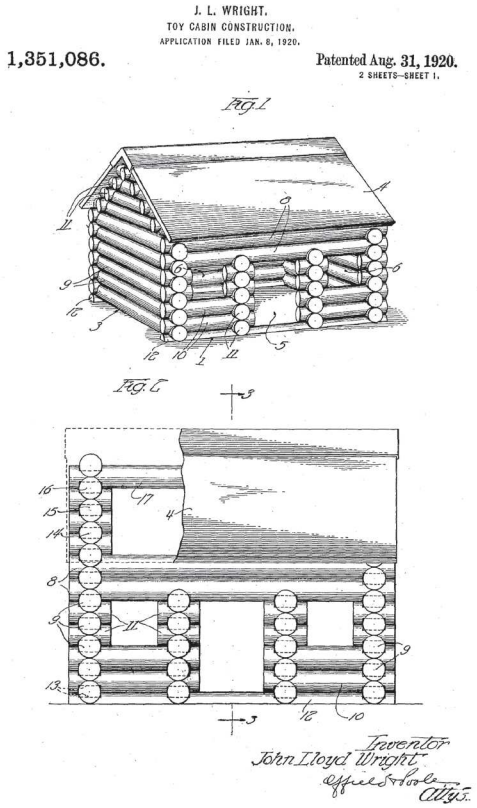
1.1 Heritage

> To all whom it may concern:
> Be it known that I, John Lloyd Wright, a citizen of the United States, and a resident of Chicago, in the country of Cook and State of Illinois, have invented certain new and useful improvements in Toy-Cabin Construction, of which the following is a specification.
> This invention relates to improvements in toys and more particularly to educational toys calculates to develop a child's constructive inclinations.
>
> J. L. Wright (January 8, 1920), *Toy Cabin Construction* (Patent n. US 1,351,086), United States Patent Office.

In 1916, Frank Lloyd Wright's second son-in-law, also an architect by training, began designing a game for children. The box contained the necessary instructions and pieces to enable the development of spatial awareness through the construction of a typical cabin log[1].
This game embodied two fundamental issues that characterized the way in which U.S. land was taken over during the 1800s and 1900s: the cabin log system and the patent.
By the time the game was filed with the U.S. Patent Office, the cabin log construction method had become history. The author was aware that with the design of that game he would touch the national heritage; that construction system had now entered everyone's imagination. In fact, the main characteristic of that seemingly boundless territory was the amount of wood that could be used for its anthropization. The first constructions, now rare, could only be made in this way. It was only with the rise of steel production that the great spatial gap and change in construction technique occurred, which then led to the complete spatial control of the territory. The same industries that produced metal for the construction of skyscrapers on the East Coast are the same ones that produced the precious

1 The game is such a success that in 1999 it is among the first to be inducted along with Barbie and 15 other games, into the National Toy Hall of Fame. The Lincoln Log is also the first game that was designed without a gender difference and is still produced today.

nails shipped in small barrels to the West[2]. From then on, the construction system employed was the balloon frame, a system that helped create the territorial advancement westward.
The difficulty in creating wealth in such a large geographic area is solved by a system of shipping small boxes containing kits, gadgets or inventions all patented that have long maintained a relationship with the built space. According to the Questel-Orbit[3] database, between 1900 and 1966 the United States was the world's largest producer of patents. Years when the nation was growing in all directions. Value that began to decline as time went on in the later period. Between the 1960s and 1980s, the country was overwhelmed by a massive technological revolution: the birth of the first interfaces, the mouse, personal computers (PCs) and early software. In fact, from 1974 to 1980, the U.S. legislative system was busy with research by the CONTU (Commission on New Technological Uses of Copyrighted Works) that aimed to understand and place in federal law the writing of software. Thus in 1980 the commission placed PC programs in Title 17 of the United States Code, the one that outlines copyright law. In the United States therefore, software writing is now equivalent to literary works, underscoring the importance of programming to the nation.


J. L. WRIGHT.
TOY CABIN CONSTRUCTION.
APPLICATION FILED JAN. 8, 1920.

1,351,086. Patented Aug. 31, 1920.
2 SHEETS—SHEET 1.

Fig. 1

Fig. 6

Inventor
John Lloyd Wright
Offield & Poole
Attys.

Illustrazione, J. L. Wright (January 8, 1920), *Toy Cabin Construction* (Patent n. US 1,351,086), United States Patent Office.

2 "The man who changed the face of America had a gizmo, a gadget, a gimmick - in his hand, in his back pocket, across the saddle, on his hip, in the trailer, round his neck. on his head, deep in a hardened silo. From the Franklin Stove, and the Stetson Hat, through the Evinrude outboard to the walkie-talkie, the spray can and the cordless shaver, the most typical American way of improving the human situation has been by means of crafty and usually compact little packages, either papered with patent numbers, or bearing their inventor's name to a grateful posterity. [...] that when Homo Americanus finally sets foot on the moon it will be just as well the gravity is only one sixth of earth's for he is likely to be so hung about with packages, kits, black boxes and waldos that he would have a job to stand under any heavier g."
First appeared in *Industrial Design*, 12, September 1965, pp. 48-59.
R. Banham, *Architettura della seconda età della macchina. Scritti 1955 – 1988*, Mondadori Electa, Milano 2004

3 Cfr. Orbit Intelligence - Patent Search & Analytics Software. An online platform that provides access to a wide range of patent and scientific information.

Over the course of a hundred years there is a shift from a “patent society” to a “software society.”
If before the territory was conquered through steel, wood and thanks to various other compact boxes all patented, with the Internet the advancing happens with software. Thus there is a shift from a spatial language to a codified language that interfaces with and spreads across different digital territories. If the patent kept the spatial question alive, now, with software the design tension seems to be transferred to writing.

1.1.1 Territory in Movement

The territory in which the data center was born has a long history of dialogue between space and movement. Considered over the centuries as a boundless territory full of opportunities, the United States has adopted various mediums as tools to seek a horizontal and vertical relationship with the territory. Through these two generative urges, they have developed a tendency toward stationary movement in which the body undergoes no aerobic exertion, but is invaded by stimuli because it is physically moved from one point to another[4].
Having the ability to ascend to the sky accompanies the construction of the first skyscrapers, whereby the easy attainment of floors at technically unprecedented heights made it possible to experience space continuously without shock to the citizen[5]. This tension toward the conquest of the sky would reach its highest expression in 1969, on July 20th, when the first moon landing took place. As for horizontal land conquest, there have been many attempts and opportunities. Banham talks about the importance of the nail and its easy transportation westward for the construction of typical American ballon frame housing units. There were also companies like Sears, Roebuk and Co. that mailed across the country construction kits to assemble housing units used until the 1950s[6]. The history of American Diners also developed along the flow of these trends. The famous affordable diners, came from restaurant train wagons that found their place in the market by putting the brakes on parcels of land. Later they began to build them still maintaining their narrow and long shape typical of a train car; the relationship between space and movement is thus two-way.
It is a territory built through this principle, finally choosing the twentieth-century tool for excellence as the metric: the automobile. It is it, together with the road infrastructure, that will help create a community of immobile bodies that takes control of the territory at automobile speed. The data center, on the other hand, is the latest medium adopted in this sense, developed precisely in an area accustomed to making use of this kind of dialogue with space.

4 Cfr. E. M. Forster, *La Macchina si ferma e altri racconti*, Mondadori, Milano 2020

5 In *Delirious New York*, Rem Koolhaas offers interesting insights into the way in which the island of Manhattan is one of the protagonists here. With the creation of skyscrapers, new theories were pioneered that pushed man's attentions upward: man and architecture began to confront the design of the sky. In 1909, *Life* magazine published an archetypal skyscraper design. A metal structure supports surfaces of equal size as a replica of the one below. It is evident in the image how the skyscraper is not conceived as a superimposed sequence of floors, but rather as a duplication of the same territory in which architectures are built on top of it. The structure is seen as necessary infrastructure for new architecture.

6 This helps to step into the narrative of logistics and compactness that has allowed the United States to tend to design boxes within which there are worlds all to be discovered, modified, and made their own.

1.1.2 Analysis of a Moving Territory

The authors who have been most influential in elaborating reflections on this issue feel that constant change is the starting condition for the study of this territory. As early as 1960 in *The Image of the City*, Lynch thought about the need to invent a different and more complex cartography in order to be able to account for invisible landscapes. In this case, the author considers the changing perception and relationship between humans and the territory. In this essay, the author seems to be aware of a human point of view and one outside his perception. Speaking of legibility of the environmental image, he argues that those who possess it demonstrate a sense of emotional security, asserting that complete chaos without any trace of connection is never pleasant for those who experience it. Lynch writes that humans have expanded the scope of their perception before and there is little reason to investigate why this may not occur again. By thus emphasizing the environment as an independent variable, the author seems to lay the theoretical foundation for the analysis of spaces beyond reality. The evolution of perception underlies the theoretical reflections carried out by authors such as Banham and Venturi who use the automobile as a point of view, dealing with the study of Los Angeles and Las Vegas, respectively. The perspective and level of reading offered by this tool draws the entire American territory until the point of view receives another fundamental change: fiber optic cables that come alongside the automobile as a system and as a tool. In 1992, Mitchell with his essay *The City of Bits* immerses the reader in a new infrastructure that totally changes the spatial perception of movement.

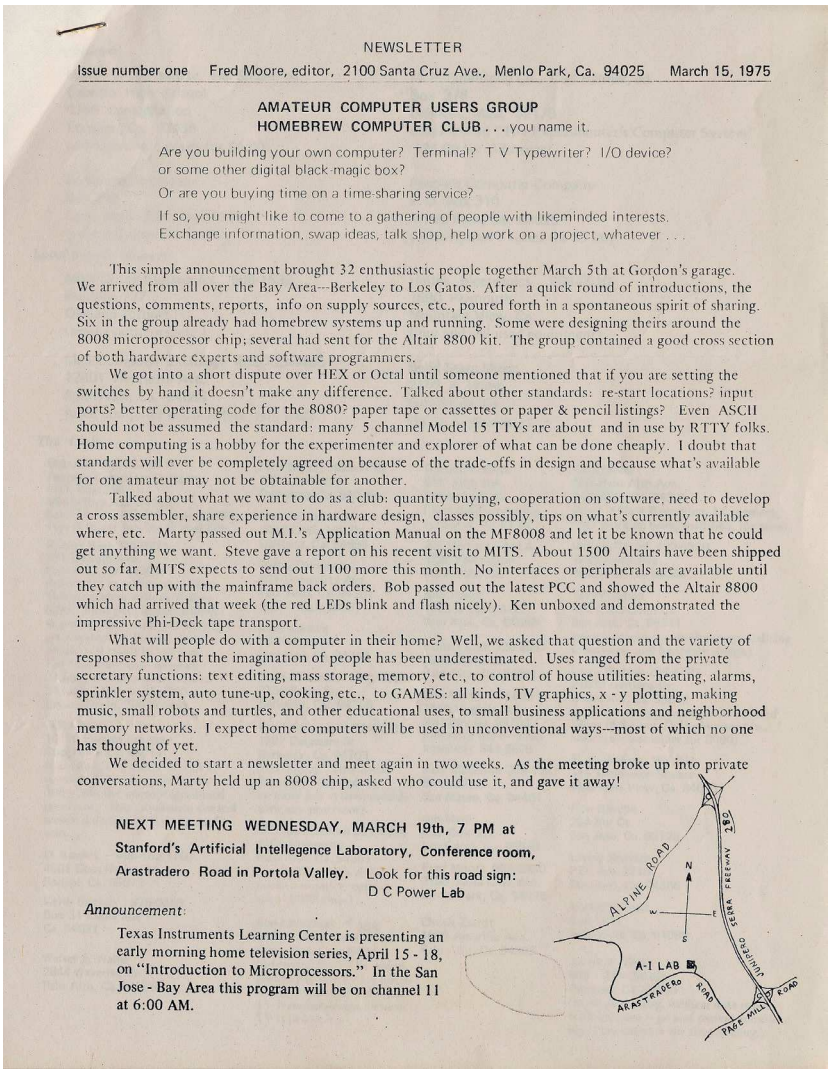
> "As the fin-de-K countdown cranked into the nineties, I became increasingly curious about the technicians I saw poking about in manholes. They were not sewer or gas worker; evidently they were up to something quite different. So i began to ask them what they were doing. "Pulling glass", was the usual reply.
>
> They were stringing together some local, fiber-optic fragments of what was fast becoming a worldwide, broadband, digital telecommunications network. Just as Baron Haussmann had imposed a bold spider's web of broad, straight boulevards on the accent tangle of Paris, and as nineteenth-century railroad workers had laid sleepers and steel to shrink the windy distances of the North American frontier, these post-whatever construction crews were putting in place an infobahn – and thus reconfiguring space and time relationships in ways that promised to change our lives forever. Yet their revolutionary intervention was swift, silent, and (to most eyes) invisible."

Mitchell brings out the most incisive characteristic of this system-infrastructure: its partial invisibility, which until the present day, along with the rhetoric of the cloud, has maintained this immaterial, non-spatial and certainly not very visible appearance. Here the change of perception given by an absence rather than a new presence, makes Lynch's theories converse with Mitchell's having as a common binder the automobile, a medium essential to the development of this story. The relationship between body, perception and movement has undergone an unprecedented change: infrastructural investment in the digital turns in directions in which the immobility of the body tends toward totality, yet exponentially increasing the level of input and stimuli in its stillness.

1.2 What will people do with a computer in their home?

This simple announcement brought 32 entusiastic people together March 5th at Gordon's garage.
We arrived from all over the Bay Area-Berkeley to Los Gatos. After a quick round of introductions, the questions, comments, reports, info on supply sources, etc., poured forth in a spontaneous spirit of sharing. Six in the group already had homebrew systems up and running. Some were designing theirs around the 8008 microprocessor chip; several had sent for the Altair 8800 kit. The group contained a good cross section of both hardware

experts and software programmers. [...] Home computing is a hobby for the experimenter and explorer of what can be done cheaply. I doubt that standards will ever be completely agreed on because of the trade-offs in design and because what's available for one amateur may not be obtainable for another.
[...] What will people do with a computer in their home? Well, we asked that question and the variety of responses show that the imagination of people has been underestimated. Uses ranged from the private secretary functions: text editing, mass storage, memory, etc., to control of house utilities: heating, alarms, sprinkler system, auto tune-up, cooking, etc., to GAMES: all kinds, TV graphics, x - y plotting, making music, small robots and turtles, and other educational uses, to small business applications and neighborhood memory networks. I expect home computers will be used in unconventional ways---most of which no one has thought of yet.



NEWSLETTER

Issue number one Fred Moore, editor, 2100 Santa Cruz Ave., Menlo Park, Ca. 94025 March 15, 1975

AMATEUR COMPUTER USERS GROUP
HOMEBREW COMPUTER CLUB . . . you name it.

Are you building your own computer? Terminal? T V Typewriter? I/O device? or some other digital black-magic box?

Or are you buying time on a time-sharing service?

If so, you might like to come to a gathering of people with likeminded interests. Exchange information, swap ideas, talk shop, help work on a project, whatever . . .

This simple announcement brought 32 enthusiastic people together March 5th at Gordon's garage. We arrived from all over the Bay Area---Berkeley to Los Gatos. After a quick round of introductions, the questions, comments, reports, info on supply sources, etc., poured forth in a spontaneous spirit of sharing. Six in the group already had homebrew systems up and running. Some were designing theirs around the 8008 microprocessor chip; several had sent for the Altair 8800 kit. The group contained a good cross section of both hardware experts and software programmers.

We got into a short dispute over HEX or Octal until someone mentioned that if you are setting the switches by hand it doesn't make any difference. Talked about other standards: re-start locations? input ports? better operating code for the 8080? paper tape or cassettes or paper & pencil listings? Even ASCII should not be assumed the standard: many 5 channel Model 15 TTYs are about and in use by RTTY folks. Home computing is a hobby for the experimenter and explorer of what can be done cheaply. I doubt that standards will ever be completely agreed on because of the trade-offs in design and because what's available for one amateur may not be obtainable for another.

Talked about what we want to do as a club: quantity buying, cooperation on software, need to develop a cross assembler, share experience in hardware design, classes possibly, tips on what's currently available where, etc. Marty passed out M.I.'s Application Manual on the MF8008 and let it be known that he could get anything we want. Steve gave a report on his recent visit to MITS. About 1500 Altairs have been shipped out so far. MITS expects to send out 1100 more this month. No interfaces or peripherals are available until they catch up with the mainframe back orders. Bob passed out the latest PCC and showed the Altair 8800 which had arrived that week (the red LEDs blink and flash nicely). Ken unboxed and demonstrated the impressive Phi-Deck tape transport.

What will people do with a computer in their home? Well, we asked that question and the variety of responses show that the imagination of people has been underestimated. Uses ranged from the private secretary functions: text editing, mass storage, memory, etc., to control of house utilities: heating, alarms, sprinkler system, auto tune-up, cooking, etc., to GAMES: all kinds, TV graphics, x - y plotting, making music, small robots and turtles, and other educational uses, to small business applications and neighborhood memory networks. I expect home computers will be used in unconventional ways---most of which no one has thought of yet.

We decided to start a newsletter and meet again in two weeks. As the meeting broke up into private conversations, Marty held up an 8008 chip, asked who could use it, and gave it away!

NEXT MEETING WEDNESDAY, MARCH 19th, 7 PM at Stanford's Artificial Intellegence Laboratory, Conference room, Arastradero Road in Portola Valley. Look for this road sign: D C Power Lab

Announcement:

Texas Instruments Learning Center is presenting an early morning home television series, April 15 - 18, on "Introduction to Microprocessors." In the San Jose - Bay Area this program will be on channel 11 at 6:00 AM.

Newsletter Homebrew Computer Club, *Amateur Computer Users Group Homebrew Computer Club... you name it.,* March 15, 1975, Menlo Park Ca. 94025.

The words quoted, come from the first issue of a long series of newsletters published by Homebrew Computer Club in the San Francisco Bay Area, between March 15th, 1975 and December 1977 for a total of 21 publications. The text highlights all the fundamental issues that would lead to the construction of a rigorous, millimeter-studied infrastructure, the Data Centers – serving through our contemporary devices – questioning the software and hardware apparatus of Personal Computers. The first meeting among the 32 pioneers of Homebrew Computer Club, takes place on March 5th, 1975. These were the years when the Cold War was acting in new ways of confrontation and a month later the Vietnam War would end.
U.S. technologies at that time were gaining a strong foothold on the international

scene, and ARPAnet, a 1969 project designed to protect itself from the Cold War[7], is now almost dead. Just in 1975, in university and government circles the project is renamed the Internet. These were very turbulent years as far as technological developments were concerned; the warnings that the Internet could become a useful system for everyone seemed clear by this time, but a clear course had not yet been set.
All this is taking place in the San Francisco Bay Area, a vibrant territory that has invested a lot of energy on the technology issue and on the vanguard as a founding aspect of a relatively new territory for WASP culture.
This particular collective of young experts has been the main glue between the presence of an acerbic infrastructure and its exploitation. The first Homebrew Computer Club meeting took place on March 5, 1975 at 7 p.m. at 614 18th Ave. in Menlo Park. In the first published newsletter, the author openly questions the tasks that computers can perform for a home environment. From a purely military service, the computer has mutated into a domestic service whose tasks are invented, discussed, and selected by people who physically know the subject matter and who in an amateur way are passionate computer builders. The first encounter takes place precisely in that unique domestic space, which by its conformation and utility relates man and the drive into unknown territories to the automobile: the Garage.

1.3 Starting Space: the Garage

The automobile is the private transportation vehicle fundamental to U.S. culture. Adopted by all citizens, it serves to inhabit an urbanized territory whose natural characteristic is horizontal sprawl.

> Just as ancient generations of English intellectuals learned Italian in order to read Dante in the original, I learned to drive a car to read Los Angeles.

Reyner Banham justified the use of the automobile this way: as a tool to analyze and study Los Angeles in the book Los Angeles. The Architecture of Four Ecologies. The year after the publication of this essay, Robert Venturi, Denise Scott Brown and Steven Izenour, with Learning from Las Vegas, also used the windshield viewpoint to analyze the Las Vegas Strip.
Bringing the emphasis on the automobile to address the emergence of Data Centers around the world comes in handy when considering its shelter, the domestic space intended to house the car with the engines off.
The garage is a space in the home that most Americans own that serves as a filter between the inside: the personal, the private summed up by the home and the outside: the uncharted territory to be conquered at high speed that happens through the automobile.
By its conformation, the garage possesses two important openings: an interior door that connects it directly to the house and one wall in four that can be completely or almost completely opened to the outside.
The characteristics inherent in the concept of the automobile such as discovery, travel and the unique opportunity to experience certain territories, have also been basic hummus for the development of the concept of the Personal Computer and consequently also the Data Center. Now become two occasions when this space has turned out to be a domestic outpost, a custodian of anticipatory testimonies:

7 Note that ARPANET, reaches its first connection the same year as the first lunar landing by the United States.

home of the automobile and a space for reflection on the new types of movement and utility offered by Internet connection. A unique environment that, in addition to its main function of housing the automobile, possesses that pioneering drive to produce and solve practical problems. Unique domestic space that has a great relationship with the outdoors, but is not made for leisure, but to engage time productively. The only flow allowed: the door between home and garage to the door-wall, directs the eyes and thoughts of those who live it in a direct way to new horizons. The Homebrew Computer Club computer scientists did not meet in a living room or a library, but the first meeting takes place in the garage of Gordon French, who along with Fred Moore initiated meetings among amateur computer builders that still have influences in the production of technology and spaces for digital. The club's incisiveness is also and especially given by the personalities who gravitated to this exchange group. Of all of them it is proper to mention Steve Jobs and Stephen Wozniak the founders of Apple Inc. which today is the most valuable company in the world[8]. Coincidentally, between Banham, Venturi and Jobs, between the automobile and the Data Center, the point of connection is spatial. The garage, a space created to house the automobile and other mechanical equipment of the home, is a place of arrival and departure, of dreams and industriousness, a concentration of power that develops its tensions toward discovery and imagination. A space used to contain aspirations, but also used as a producer of personal and private needs, the garage fits into the composition of domestic spaces as workshop, storage, and production space.

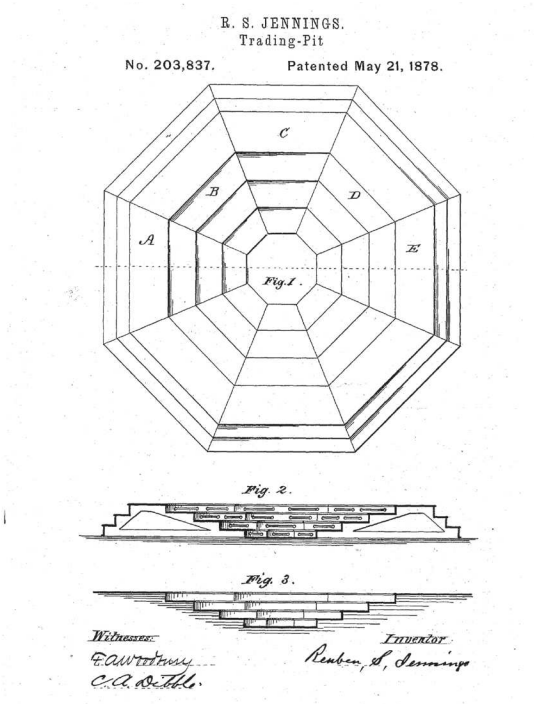
Imagining it filled with tools, boxes, and cabinets makes it an ever-living environment in which to project the future or simply repair parts of the house. A space that aspires to be a small fragment of the laboratory of the future.

The first newsletter of Homebrew Computer Club, drafted after the first meeting that took place in this unusual environment, denotes, through the use of the written word, the propulsive thrust that the garage itself gives to the topics discussed. It is written in black and white that the first meeting discussed ways of using and physically composing Personal Computers. It opens the reflections to all members of the club through a form of questionnaire on the last page of the first publication, to try to give a common path for future directions to take.

From that first meeting to the present, computers have gained space and importance; functions, forms, accessibility, are all features that have evolved and still continue to evolve today. In the early years of the new millennium, the infrastructure and potential of the Internet is increasingly recognized and understood. In 2001 Wikipedia was born on a project by J. Wales and L. Sanger, and in 2005 YouTube platform conceived by three young men Chad Hurley, Jawed Karim and Steve Chen was born, and in the early years of the new millennium Google's search algorithm was refined – all in the San Francisco Bay Area. These are the years when the idea of clustering content in other spaces is stabilized, content is decentralized, with the vision of making our devices increasingly powerful, highly connected terminals. It was at this time that the need was born to create large server spaces that guarded content accessible through the Internet connection.

8 In 2022 we can find a podium that leaves no doubt to the directions taken by companies in the world. The richest and most powerful is confirmed to be Apple, in second place we find Microsoft, and third place is Saudi Aramco: a company that produces more than 10 million barrels of oil per day, the largest financier of the Saudi government. The position of these companies in the world rankings should not be overlooked: the technology-oil relationship accurately reflects how much the latter is involved in technology production. One supports the other. Ranking that in 2022 saw the oil superpower being in a formidable head-to-head with Apple.
https://forbes.it/2022/05/12/saudi-aramco-supera-apple-e-lazienda-pubblica-di-maggior-valore-al-mondo/

The system of information circulation through the network experiences a conceptual transformation that leads to the creation of new spaces, the data centers, a scalar system of servers in which the ideal limitlessness collides only with the human capacity to build them.
The place used for this type of machine and thought is no longer the domestic garage, but very large spaces used to house this machine-infrastructure as an extension of a domestic storage facility: to search for information I connect to the servers.
For their construction, there is a need for millimeter-accurate, modular spatial organization, which is why, in those same years - around 2005 - standards are being developed to help information system workers in the regulated construction of standard telecommunication infrastructure for data centers.



Illustrazione, R. S. Jennings (May 21, 1878), *Trading - Pit* (Patent n. US 203,837), United States Patent Office.

1.4 Arrival Space: Data Center as a Scalable System

To understand the proliferation of the data center system in the world and its scalability, it is useful to analyze the development of the digital financial system, particularly the blockchain system and bitcoins as a highly volatile store of value.
The late 19th century begins the slow replacement of man by machine in the world of finance as well. Technology is set to become the great ally of economics due to their relationship aimed at mutual growth: the more advanced the technology, the greater the profit. The first step was the advent of the stock ticker[9], an electronic device that allowed quotes and orders to be transmitted in a simple and standardized way. The battery-powered device consisted of two independent cogwheels that used a stylus to print the quotes on a strip of paper divided in two: on the top was the abbreviated name of the listed company, on the bottom was the price corresponding to the value of the company's stock. The place where transactions took place had thus been decentralized, and the stock ticker signaled the beginning of financial space melting, precisely because over time, the electronic device became

9 J. Briddle, *Nuova era oscura*, Produzioni Nero, Roma 2018

affordable, making the so-called Trading-pit less and less useful[10].
This spatial feature will always accompany the relationship between finance, technology and humans, even in more recent times when the digital revolution has incorporated many services. The first major decentralization of information through the invention of the stock ticker was followed by others, the latest of which was the introduction of financial algorithms that literally wrested from the hands of the human operator the ability to hold the reins of finance. With the introduction of algorithms, machines have full control of the game, both in time and space, thanks to the physical infrastructure that human beings have created over the past hundred and fifty years[11]. Decentralization has become more and more pronounced: the Milan stock exchange, which paradoxically shared the same space as the London stock exchange, that is, in a data center outside the City of London, one of the most controlled and consequently most secure places in the world, has now, with Brexit, been bought by a Dutch company and its data centers have been moved back to Italy[12]. The space of ultramodern finance becomes post-human:

> It is post-human. There has been no Architecture of a similar vigor in the last 100 years. It is based strictly on codes, algorithms, technologies, engineering, and performance, not intention.[13]

As data centers evolve and meet financial algorithms, an undergrowth of cryptocurrencies that use a shared data structure, called blockchain, and backed by miners also emerges. In 2008, an anonymous inventor or group of inventors known by the pseudonym Satoshi Nakamoto invented Bitcoin, a cryptocurrency that in the financial world is not regarded as a currency, but as a highly volatile store of value that travels through controlled transactions in data centers of different sizes. The volatility in its financial market parallel to the traditional one starts from the basic characteristic of digital decentralization: its spaces are spread across the globe in a dense network of servers held together by users in a shared digital register open to anyone who wants to access it (blockchain). This organizational and systemic decentralization based on verification of transactions to prove the trustworthiness of the medium, similar to classical banking systems, has in fact made the entire globe useful but not necessary for the existence of this system. Unlike other data collection and processing centers, those related to cryptocurrencies had a more spontaneous, vulnerable and spatially uncharacterized initial spread to evolve later into more complex and organized structures due to the inherent characteristics of the digital register model. In 2008, the first pioneers of crypto-

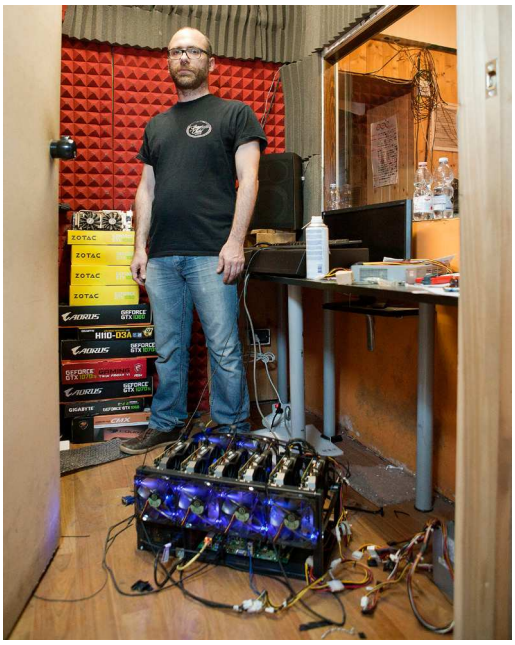
10 On Dec. 19, 1877, Ruben S. Jennings filed patent number 203837 describing the invention of the trading pit, a space conceived and designed for a newly established stock market. This would be the first space designed for financial logistics: "My invention consists of a pit, that is, a series of platforms consisting of several levels, of different heights and widths, the shape of which is a circle or octagon". A stepped space with an enclosed shape that helped traders all see each other in the eyes, while also implementing the acoustics of the space with sound that could travel both horizontally and vertically. Crf. A. Laumonier, *6|5 – La rivolta delle macchine*, Produzioni Nero, Roma 2018

11 In contemporary finance, both the space and time of financial transactions are no longer under human control. Algorithms have displaced the action into spaces and times not usable by human cognitive capacities. Their place - inside cables and computers - and their movements - thousandths of a second -, take the financial process outside the possibilities of comprehension.

12 Cfr. J. Briddle, *Nuova era oscura*, Produzioni Nero, Roma 2018,
D. Monaco, *Il data center della Borsa più grande d'Europa sarà in provincia di Bergamo*, https://www.wired.it/economia/finanza/2021/04/30/borsa-data-center-bergamo/ , (consultalo nel 2022)

13 Cfr. R. Koolhaas, *Tric: Post-human Architecture*, in Id., AMO, *Countryside a Report*, Taschen, Köln 2020, pp. 272-273.

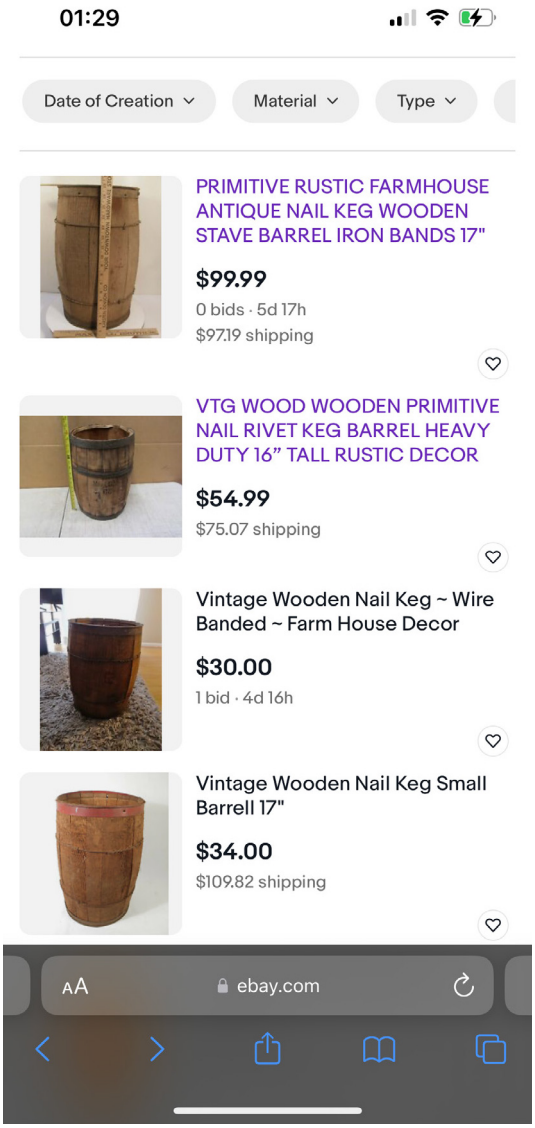
currencies appeared to be actual digital miners who through the use of electricity acted as laborers during the installation of rebar in future mining tunnels. At the beginning of this affair, a modest computer physical apparatus was required, and this also had implications for the simplicity with which cryptocurrencies could be obtained; just as when a new mine is discovered, the first easily mined precious materials are found on the surface. So we find the garage and the closet again as the starting space used by the early bitcoin pioneers. Right from the start, the digital miners grew this complex structure made of intricate codes within domestic spaces that fully respond to the Hollywood imagery of the teenage boy who, from his bedroom, fiddles with rudimentary equipment at sight lit by red, green or blue neon. In reality, that little boy plays a key role in the life of the whole system.



C. Cerasoli, *Miners*, 2017 - 2019. Two Italian miners with their equipment in what looks like a basement and an old recording room.

The miners are in fact the creators and the maintainers of the system because they perform all the computational operations related to the blockchain and at the same time verify thousands of transactions by certifying their honesty, protecting the network against possible hacker attacks and tracking trading activities. Moreover, they are in charge of creating the new currencies to be put into the market, in fact every bitcoin issued is created through mining. As with the old gold mining system, this system, made up of spaces and processes, will exhaust its deposits with an expected date of the last bitcoin mining in 2140.
The development of the digital infrastructure that supports the bitcoin system, has begun to embed itself in the territory again using that home space: the garage, but also basements or closets. Only the passage of years and the intensification of mining has led to a centralization of resources, so much so that those garages have evolved into full-fledged data centers with that single purpose of mining bitcoin by processing financial transactions. The increase in space comes from a human tension to centralized power, exactly the opposite of the pictures taken by Claudio Cerasoli in his project “Miners.”
The author does an Italian reportage of the private infrastructure of some Miners who are slowly organizing their work differently considering the changing ways to get revenues. Cerasoli photographs miners in their work space, spaces crammed with servers and cables that form small data centers. Realities that will go to disappear soon, because the energy needed to continue the work, requires more

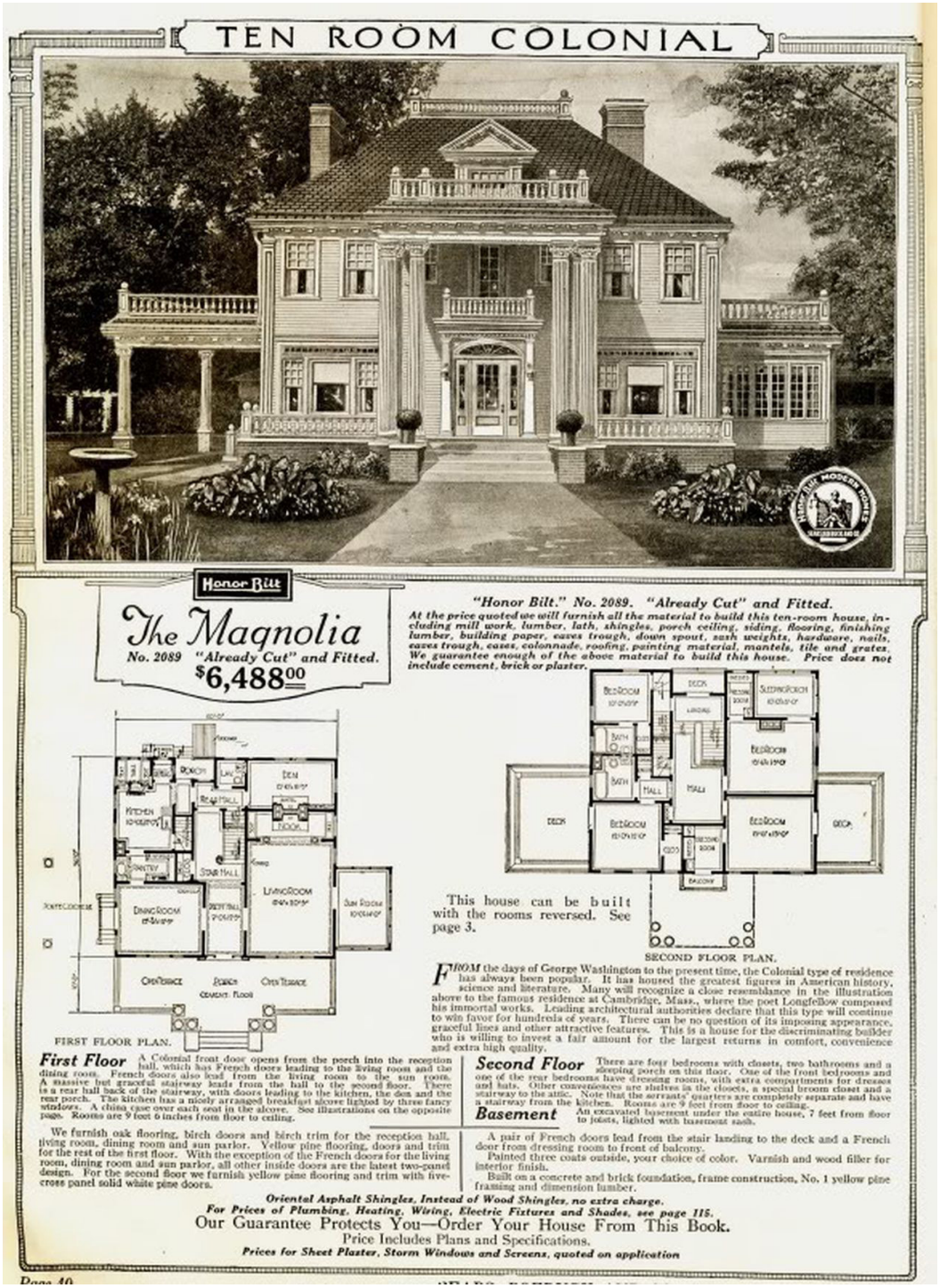
infrastructure, hence more square footage available.
The cryptocurrency world, in its specificity, spatially clarifies the data center system. It is not only and always presented as an architectural structure that occupies thousands and thousands of square meters of floor space, but it is a system that has emerged from millimeter design that has the ability to make itself architecture. One of its phenomenal outputs is the sprawl of servers grouped under a single structure, but its ways of presenting itself, potentially, are several. In contemporary times, the system that centralizes machines in large spaces seems to be the most popular, almost the only possible way, but it must be remembered that it is only one of the ways that this type of scaling technology allows it.



Barrels of nails for sale on ebay, ebay, 2023.
Even today, it is easy to find on the Web the old barrels of nails shipped from the East Coast of the United States. An authentic artifact from the history of the country's infrastructural evolution, it now follows the logic of digital and is redistributed through a new infrastructure for its aesthetic potential.

Children playing with barrels of nails, Wisconsin Historical Museum, (unknown date).
From the earliest shipments, it was not difficult to notice in the American countryside huge quantities of small barrels containing nails useful for the construction of baloon-frame houses.

Sears, Roebuck & Company, Catalog, (from) 1892.
Retail has accompanied U.S. development by becoming a system that envelops the territory of fair potential.



Sears, Roebuck & Company, Catalog, (from) 1892.
Guns, nails, clothes, matches, furniture. Everything was sold along with houses.
Within the catalog were several housing solutions that could be chosen and had shipped. The house was also considered one of many useful kits for experiencing the land equally from coast to coast.

THE LUSTRON HOME

How to ship a house ... Lustron style!

You will be seeing more and more of these big trailers—each with a "live-load" of a complete Lustron Home—on its way from the Lustron factory to quick erection for a proud new owner.

EVERY day, as more and more Lustron Homes come off the production line, more and more of these big trailers move down through the progressive loading stations of our Columbus plant, ready to speed the delivery of the home America has been waiting for.

Each shipment is a complete Lustron Home. Down to the last bolt and screw, every component part of this new kind of house, with the exception of the foundation, has a place of its own on this specially designed trailer.

New Source of Supply in Housing

Never before in America—the land of volume production—has there been such a source of supply for mass production, quick delivery, speedy construction of homes.

It isn't only that Lustron offers a new building material that combines the strength of steel and the lifetime beauty of porcelain enamel . . .

It isn't only that complete Lustron Homes can be mass-produced in a factory at the full production rate of a hundred houses a day . . .

It is also the speed of distribution of the complete house as a unit and the speed of erection at the site that make the Lustron Home meet the needs of a variety of housing situations.

New Standard for Living

Already, two Lustron Homes have been flown to Alaska for testing under the most severe winter conditions. Others have been erected in areas of widely varying climate.

Corporations, considering locations for new plants and expansion of existing plants, have turned to Lustron for help in providing homes in quantity for employees.

Investment and municipal planning groups see in Lustron a logical solution to the problem of high initial costs and high maintenance costs for rental housing developments.

Colleges and universities claim Lustron is the economical solution to the need for housing faculty and student families now crowding every campus in the country.

Private project developers like the speedy erection and quick turnover of the Lustron Home, the high standards of its quality materials, and its acknowledged sales appeal in the mass market.

Truly, the Lustron Home is America's new standard for living.

A special department, the Lustron *Fleet Sales Division*, has been set up to expedite the handling of volume unit sales. Your inquiry is invited and will receive careful and detailed attention.

W. L. G.

LUSTRON CORPORATION, Columbus 16, Ohio.

In the hand! Trailer is loaded with structural units and parts on a "first-off, first-up" basis to speed erection at the home site.

Big Rooms—more than 1,000 square feet of floor area—in a home that eliminates worry about repainting, redecorating, or reroofing—and it's built with all the mass-production techniques of America's industrial "know-how."

Ready to Roll! Part of one day's production is ready to go on its way to town hundreds of miles from Columbus.

Lustron Corporation, Fleet Sales Division
Box 1013K, Columbus 16, Ohio
We are interested in a project of _____ two-bedroom homes to be used for the following purpose:

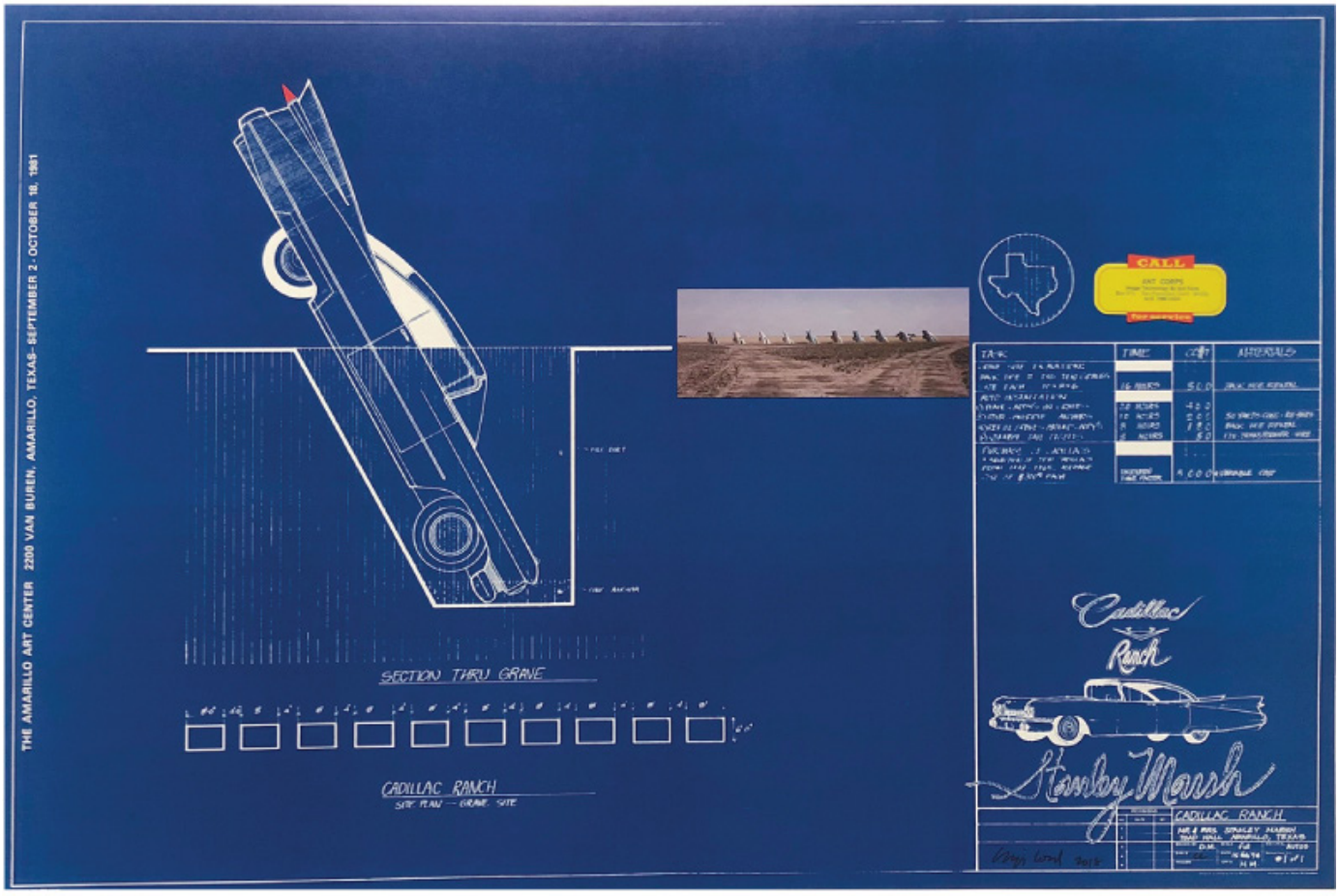
.....

Please write us fully about your interest in the Lustron Home.
Name .....
Organization .....
Street .....
City ..... Zone ..... State .....

Architectural Forum, Aprile 19.**
Another example of American delirium, were the *Lustron Homes*, a project set up between the Lustron steel mill and the federal state to meet the great need for housing after World War II. Such was the demand that for three years Lustron designed all-steel housing units that were completely modular and transportable by road. All the exterior, interior, furniture and even the roof tiles were made of lacquered steel. After three years of operation, the project failed because it failed in its intent and because of the high effort involved in manufacturing and transporting the heavy material.

Serial Numeber, Lustron Home, Screenshot in a Youtube Video.
Every Lustron house held a serial number. This is a clear example of how the United States sought to make the home a device as well. Car, house, computer, smartphone; a territory to be experienced through medium. In this idea of a device, home life also tried to be part of it, although the rapid dismantling of the project after failure.

Watercolor representation of a Lustron Home, web, 2024.
The exterior of the unit features lacquered steel cladding. Clad in brightly colored square panels the houses had a square footage of 1000 ft².


THE AMARILLO ART CENTER 2200 VAN BUREN, AMARILLO, TEXAS– SEPTEMBER 2- OCTOBER 18, 1981
SECTION THRU GRAVE
CADILLAC RANCH
SITE PLAN – GRAVE SITE
CALL
Cadillac
Ranch
Stanley Marsh
CADILLAC RANCH

1.5 Avvenimenti (10 Instances)

Between 1953 and 1958, Edmondo Bacci produced the most poetic and interesting paintings of his artistic production. Called 'Avvenimenti', the series breaks traditional perspective protocols and the space is generated exclusively by the relations of colour events through light, showing different possibilities with which it can manifest itself.

The author's poetics first starts with a precise spatial definition, which is characteristic in the first paintings, gradually getting lost as time goes by. In Bacci's 'Avvenimenti', in fact, space is no longer given by a grid; the generating principle is light in its most spontaneous manifestations.

Since data center is a system based on the grid and the manifestation of light through the presence of electricity, the 10 events shown here are intended to demonstrate different ways in which this system can manifest itself or make itself known, in addition to its classical design scheme. The proposal of these Avvenimenti goes beyond the orthodox method of spatial investigation: the grid of the data centre (a theme taken up in chapter three) is not enough to understand its complexity.

Making a project list of data center structures would in fact be reductive to understanding the complexity of the entire system. It would be reducing it to an architecture, when in truth it is a system developed by a discipline that has little to do with spatial management. It is only in recent decades that computer science has been forced to deal with logical spatial elements by borrowing from the discipline of architecture. The collection of 'Avvenimenti' is therefore inspired by Bacci's work precisely because it attempts to represent the subject from non-logical points of view, but from different perspectives of the phenomenon itself.

Part of the 'Avvenimenti' deal with space and the movements that the system makes and allows it to make, intercepting its positioning, but also its directions. Thus, how Wikipedia works or how the move of the Italian stock exchange takes place become clear examples of the possibilities of position and movement, adding complexity to the classic notion of tactical centralisation of the system.

Through the 'Avvenimenti', the absence of limits in the functioning of the system also emerges; something that underlines the refined study of the components that break through territorial limits by settling on practically any type of environment. A case in point is 'Avvenimento 10', when the research requirements are outlined with funds provided by the European Union to study how data centres can be placed in space. Or 'Avvenimento 1', where the Natick project explores the possibility of installing data centres under cold ocean waters.

The question of volume, which most closely relates to the classical architectural language, is certainly not forgotten, but in the data center system it is a secondary issue if we consider that its scale and modularity is totally overtaken as a classical design topic, as it is a system with theoretically infinite potential.

Contemporary narratives on the subject usually report territorial occupation and thus volume as one of the most noticeable and important characteristics, mainly investigating its ability to compose itself in huge spaces while consuming large amounts of energy. Believing this narrative to be exhaustive in describing the complexity of the system, reduces the possibilities of fully understanding the data center and its characteristics. From a spatial point of view, the manifestations are different; the large industrial shed is the most visible and the one that won the capitalist system, but the different 'Avvenimenti' attempt to delve into its complexity of composition and modes of use.

The collection of 'Avvenimenti' is therefore proposed as a tool that defines the point of view of the research. By adopting this approach to the object of study, it

offers reflection points to delve even deeper into the complex construction of its spaces. This collection pushes research beyond space to study its main designers: the programmers. Professional figures who are no longer only the main actors of a digitalised space, but also designers - programmers of real, physical spaces.

Name:	Project Natick
Where:	Phase 1 - San Luis Obispo (105 days, 11 metres deep). Phase 2 - Orkney Islands (2 years, 36 metres deep).
Status:	Microsoft is currently working on Project Natick 3
Dimensions:	12,2 x 3,2 m
Description:	

The idea originated with a US Navy veteran in 2013. In 2015, the first phase of the Natick project led by Microsoft began. The project team tested the immersion for 105 days in the Pacific Ocean constantly monitored to check the workability of the project. The phase 1 capsule submerged in California measures 3x2 metres. Having studied the project's feasibility and confirmed the strength of the servers inside the capsule, Microsoft hired Naval Group, one of Europe's leading naval defence system designers. After assembly by the French company, it was submerged 193 km away from the Orkney Islands in Scotland on 8 June 2018.

The idea was born to try to build server spaces that power and regulate themselves totally autonomously, adapting technologies usually employed for submarines, such as cooling: a system of passing water that cools the back of the servers and then circulates back into the ocean. While for the energy used, Microsoft collaborated with EMEC (the European Marine Energy Centre LDT), which researches and develops methods to obtain energy from tides and waves.

Inside the Phase 2 capsule, there are 12 racks with 864 servers and 27.6 petabytes of storage and there is no oxygen inside, the environment is sealed, reducing the possibility of dust production and deterioration of electronic components.

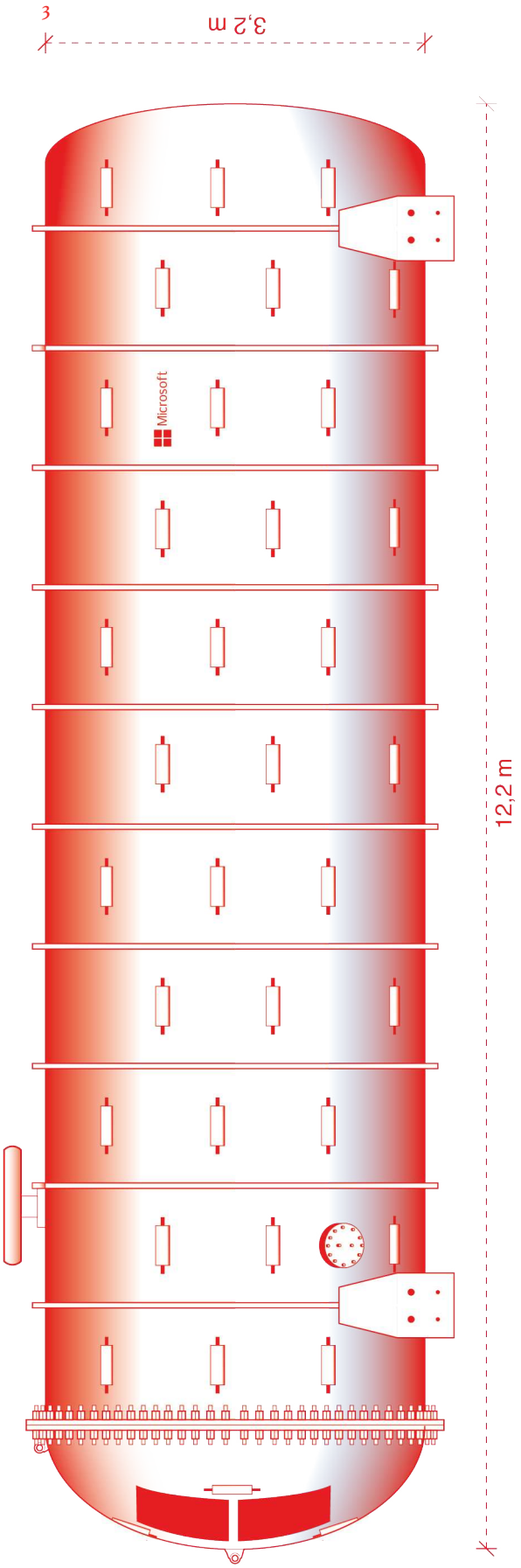
The immersion of the capsule lasted 2 years and the confirmations of the project's success are overwhelming: the risk of infrastructure failure is greatly reduced, temperature control is much simpler and cheaper, and the absence of oxygen extends the life of the electronic components.

1. Natick_France_017.jpg: Engineers slide racks of Microsoft servers and associated cooling system infrastructure into Project Natick's Northern Isles datacenter at a Naval Group facility in Brest, France. The datacenter has about the same dimensions as a 40-foot long ISO shipping container seen on ships, trains and trucks. Photo by Frank Betermin.

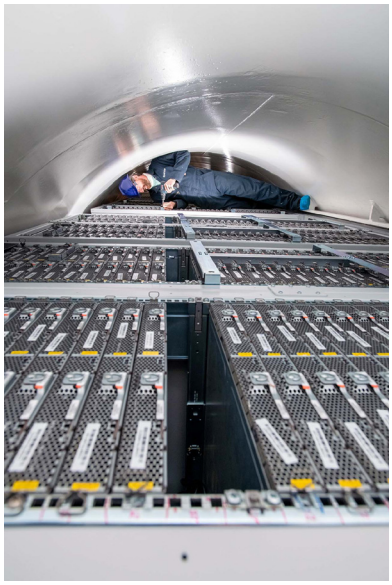
2. Natick_Scotland_75.jpg: Spencer Fowers, senior member of technical staff for Microsoft's special projects research group, prepares Project Natick's Northern Isles datacenter for deployment off the coast of the Orkney Islands in Scotland. The datacenter is secured to a ballast-filled triangular base that rests on the seafloor. Photo by Scott Eklund/Red Box Pictures.

3. The front of Natick 2.

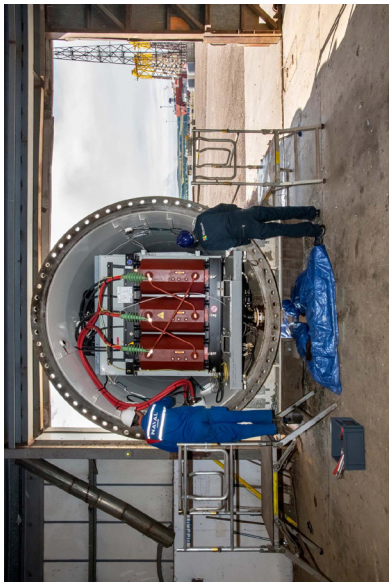
3



2



1



Name:	Borsa Italiana S. p. A.
Where:	2007 Slough (UK), bought by London Stock Exchange Group, located in the data centre: Equinix LD4 6 June 2022, Ponte San Pietro (BG), sold to Euronext for EUR 4.325 billion, located in the data centre: Data Centre IT3
Status:	Currently working in Ponte San Pietro (BG)
Dimensions:	8,050 square metres of data hall
Description:	

The data of the Italian Stock Exchange was relocated in June 2022. In 2007 London Stock Exchange Group, bought Borsa Italiana S.p.A. and until 2021 its data was stored in the LD4 data center in Slough, stored together with the data of the London Stock Exchange, all owned by the London Stock Exchange Group which controlled 100% of the company. Equidistant from Equinix LD4, on the opposite side of the City, is another important data center belonging to Euronext, which contains the European outpost of the New York Stock Exchange. Euronext is the leading European financial market based in Amsterdam, which encompasses many of the pan-European markets and in 2021 completes a multi-billion dollar financial transaction to buy Borsa Italiana. This takeover takes place at a decisive historical and political moment for the United Kingdom, which decided to leave the European Union. In this way, the holding company Euronext chose to transfer the core data center in Basildon to European territory, taking the Borsa Italiana with it. Wanting to migrate to a qualitative better place, the company chose the Aruba campus not far from Bergamo, Italy's largest and most efficient campus, powered by 100% renewable energy. The decision to move was made both after the purchase of Borsa Italiana, and after the consequences that could persist in the UK after Brexit. The move focused on the core of the data center, i.e the equipment that holds and supports the data, setting up in the Global Cloud Data Center (IT3) in Ponte San Pietro. The details of the move are not fully described by Euronext, what they claim is that:

"To make the Core Data Centre relocation happen, with as minimal disruption as possible, Euronext worked closely with clients throughout the 14-month period. "This was a very complex, technical migration, and it involved a lot of work for our internal teams and our clients. We had over 800 calls with our clients, dozens of webinars, three dress rehearsals and a migration weekend," relates Nicole Agopian. "We needed to test every inch of the installation, and all of this happened in parallel to running day-to-day trading."

This was accomplished after 14 months of planning, several internal tests and only two days of actual moving, which lasted one weekend when the stock exchanges are usually closed.

1. Equinix LD4, the data center that housed the Italian stock exchange's data until 2022.

2. By buying Borsa Italiana, Euronext decided to move its data to the IT3 Data Centre at the Aruba campus in Ponte San Pietro in the province of Bergamo.
The pictures frame the entrance to two structures representing totally different technological eras. Ten years later, the London data center has become 'old' to hold valuable data such as financial data.

1

2

Name:	Hamina Google Data Center
Where:	Ensontie 1, 49420 Hamina, Finlandia. 1953 paper mill designed by *Alvar Aalto*
Status:	Currently working
Dimensions:	
Description:	

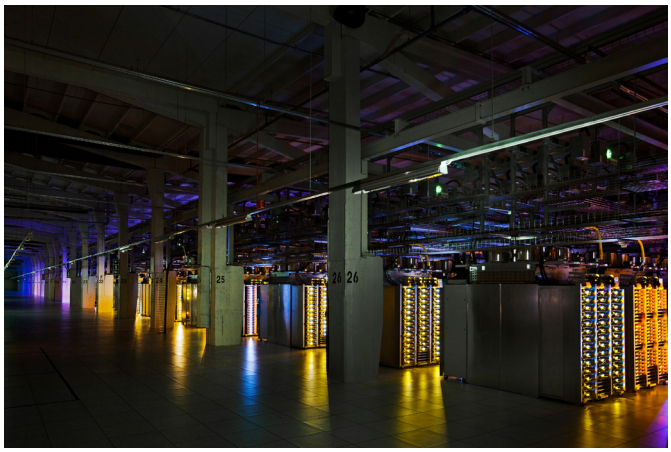
The Summa paper mill and the nearby residential area, Petkele, were designed by Alvar Aalto at various periods 1951-1953, 1957, 1970-1972. The area is located outside the centre of Hamina and the design included residences for the workers in addition to the paper mill itself. Production began in 1955 and by the 1970s there were three machines in operation while paper production at Summa Mill ended in January 2008. Google buys the assets of Stora Enso, a paper, packaging and forest products company that has always looked to the printing industry, for around EUR 40 million. The sale closed in the first quarter of 2009. This was one of Google's first outposts in Europe. Interestingly, the company took advantage of spatial and design choices made by one of the masters of European architectural modernism. For the paper mill, proximity to water was also fundamental, a fundamental characteristic for Google as well, in fact today the Hamina plant pumps cold water from the Baltic, thus replacing its local cooling units.
The spatial reuse used by this technological system continues to be a popular design approach. This is one of the first major cases in which the reuse of space has taken place for this system, and coincidentally, the new function is the one that has helped to weaken or replace the use of paper.

1. *'Server rooms like these require a lot of space and energy efficiency to run the entire Google product family worldwide. Here in Hamina, Finland, we decided to renovate an old paper mill to take advantage of the building's existing infrastructure and its proximity to the cooling waters of the Gulf of Finland."*
2. *'An overhead view of our cooling facilities in Hamina, where the cooling of the data center is done entirely with seawater from the Gulf of Finland."*
3. *'Hamina, Finland, is home to one of our data centres in Europe. Previously, this facility housed the Stora Enso paper mill."*
4. Master plan of the Summa industrial estate, 1954. Planimetry. Pencil and coloured pencil on print, 157x89.

3

4

1



2

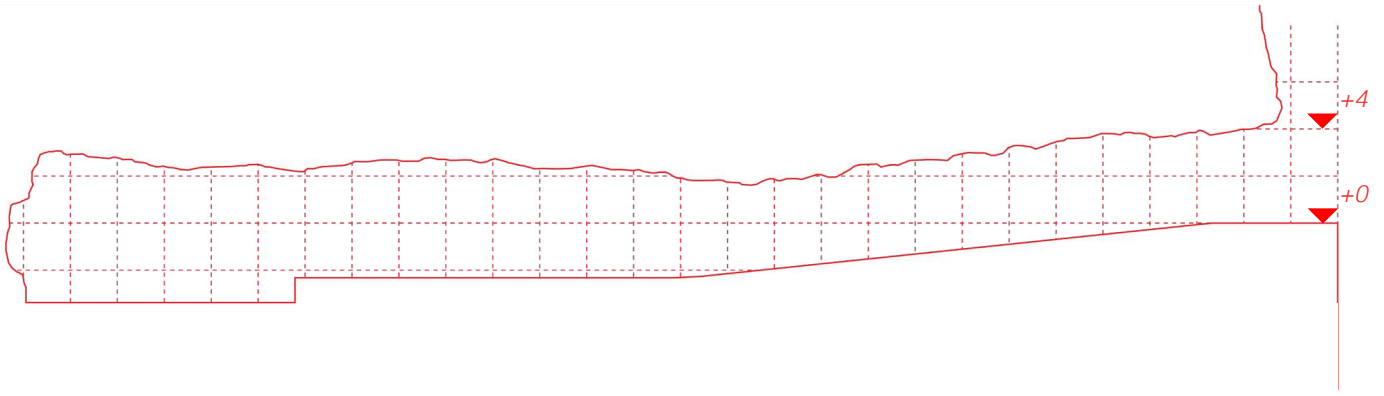
Name:	Pionen White Mountains DC
Where:	Stoccolma, Svezia, 2008
Status:	Currently working
Dimensions:	1200-1800 mq
Description:	

The space was built in 1943 as a civil defence centre, a nuclear shelter in the centre of Stockholm. The conversion project was carried out in 2008 by Albert France Lanord Architects in which they planned server and office spaces. The imagery on which the studio worked is that of science-fiction cinema, making the nature-technology dualism coexist in a brutal way, leaving completely raw spaces in which the form is given by the old cave hollowed out underground, flanked by completely artificial spaces through materials such as glass and aluminium to create an alien structure within the cavernous space. The contrasts are increased by the interior presence of fountains, greenhouses and even an aquarium.
In addition to its spatial conformation, this data center also made the news for hosting on its servers the Wikileaks site, a non-profit media organisation founded by Julian Assange, an Australian activist who recently challenged US extradition to London and became a free man.

1. Contrast between the sharp lines of the servers and the coarse lines of the cave. Pionen - White Mountain, Albert France-Lanord Architects, 2008, Stockholm, ph. Åke E:son Lindman.
2. Suspended meeting room whose floor represents an image of the moon. Pionen - White Mountain, Albert France-Lanord Architects, 2008, Stockholm, ph. : Åke E:son Lindman.
3. Section of the bunker free of elements. Modular grid 2x2m applied to the interior.

1

2



3

Name:	HP Performance Optimized Datacenter (POD) 20ce
Where:	Minimum required length: 8.59 m Minimum required width: 4.76 m Minimum required height: 3.1 m
Status:	Fuori produzione
Dimensions:	Length: 6,7 m Width: 2,644 m Height: 3,1 m Server racks: 8 Ru available per rack: 46U Total RU in POD: 368U

Description:

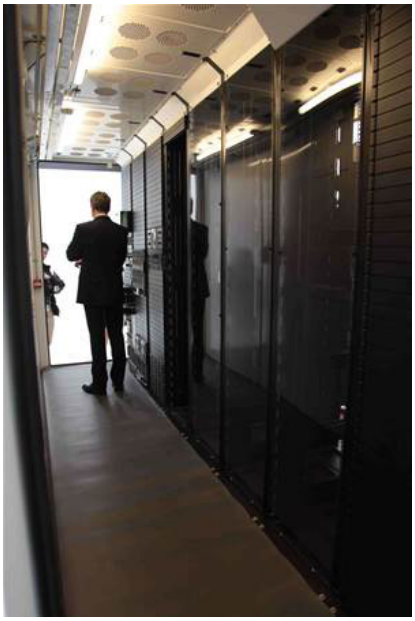
"The HP Performance-Optimized Data Center (HP POD) is a containerized datacenter equipped with power infrastructure, cooling and IT power distribution. The HP POD can be deployed within weeks instead of months or years typically associated with brick-and-mortar datacenters and offers advanced cooling infrastructure that is more energy-efficient than typical datacenter build-outs."

Between about 2005 and 2012, there was a lot of experimentation with modular server spaces. One of the first companies to think about this was Google, which claims to have been thinking about it since 2005. The first POD in HP's series, on the other hand, came onto the market in 2008.
This example is from HP, which in 2010 made available this stand-alone infrastructure skeleton, the smallest produced by the company itself. The one presented here is the HP POD 20c, but in 2008 the HP POD 40c was also presented, and in 2011 the HP POD 240a, thus a clear spatial experimentation, given that the sizes are not increasing in the succession of output, which would mean a technical impossibility in dealing with certain spaces.
The first years of formalisation of the infrastructure was a period of spatial experimentation whose tendency was towards a portable, compact modularity comprising all the components necessary for operation. This type of data center entered the market mainly in order to halve the installation time, as data centres designed specifically for a space can take up to years.
Although these steps have not been successful, some companies still produce transportable modules with this kind of agility.

1. View of HP Performance Optimised Datacenter (POD) 20ce from the inside. The line of racks occupying one side of the module is visible from this photo.

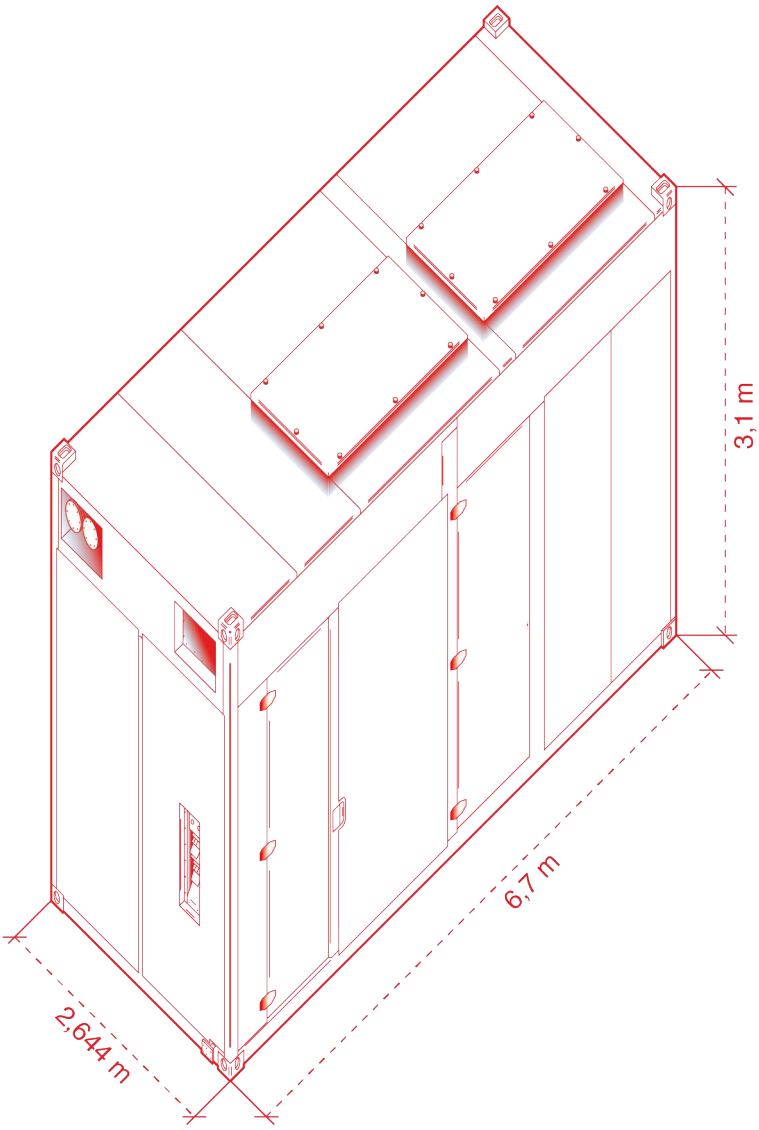
2. View of HP Performance Optimised Datacenter (POD) 20ce from the outside installed in an indoor environment during a presentation.

3. Axonometric view of the volume of the HP Performance Optimised Datacenter (POD) 20ce.



1

3



2

Name:	Wikipedia hardware
Where:	The non-profit foundation has several server clusters located all over the world.
Status:	Currently working with the main servers in the USA and various cache servers spread around the world.
Dimensions:	xxx
Description:	

Wikipedia is one of the most visited websites in the world and belongs to the *Wikimedia Foundation, Inc* (WMF), founded in St. Petersburg, Florida with headquarters in San Francisco, California. In the early years, all its material was crammed into one server. In 2009, Wikipedia was running on less than 300 servers in a single data centre in Tampa, Florida and servers in Amsterdam in AMS-IX, also a non-profit peering point. In 2013, the Wikimedia Foundation switched to an Equinix infrastructure in Virginia for connection reliability and more stable weather conditions. In 2015, the total number of servers amounted to 520.
Gradually, the foundation began to expand spatially, such as to Singapore in 2017 through a cache cluster also in an Equinix infrastructure and other spaces around the world.
On the Wikipedia page dedicated to servers they write:

"A list of servers and their functions used to be available at the server roles page; no such list is currently maintained publicly (perhaps the private racktables tool has one). It used to be possible to see a compact table of all servers grouped by type on *icinga*, but this is no longer publicly available. However, the puppet configuration provides a pretty good reference for the software that each server runs."

The spatial example of the Wikimedia Foundation is crucial to understand how the presence of a website on the web goes hand in hand with a spatial presence across the globe. Wikimedia does not have its own hardware infrastructure, but relates to other companies such as Equinix, which specialise in data center production.
The core of Wikipedia is thus split up and relocated all over the world to make information more easily accessible, a constellation of servers geographically distributed over the earth's surface.

1. Photo of the Wikimedia Foundation servers in September 2004.

2. One of the other infrastructures used by the Wikimedia Foundation when it started expanding its 'server territory', 2015.

1

2

Name:	xxx
Where:	Tibetan and Qiang Autonomous Prefecture of Ngawa
Status:	Probably still working
Dimensions:	Deliberately kept secret by the photographer at the request of the mine owner.
Description:	

Between 2016 and 2017, photographer Xingzhe Liu published a photo report of a bitcoin mine in China. Even today, the Republic of China, despite its government restrictions, remains one of the countries most involved in bitcoin mining. At the time, there were few relevant restrictions and the factory he visited combined all the features needed to create huge profits through cryptocurrency mining. Generally, the production centre of the Chinese state is considered to be the coast, the interior of the country is barely inhabited and there is little productive activity, but for cryptocurrencies, in addition to low-cost labour, the presence of electricity, consumed in large volumes by this type of data centre, is necessary. The 'mine' is in fact located next to a hydroelectric power station and through his photos Liu, gives us a contemporary way of life, adapted to the conditions of Chinese exploitation. While in Gondo (Switzerland)[1] the opportunities and characteristics are similar, what changes is the classist approach to the subject. In Liu's reportage, server spaces are seen that seem to come straight out of despotic sci-fi movies, spaces in which technological decadence takes a back seat to the usual aseptic feel of data centers.
This type of data centre also tends to be deliberately hidden, but if for the more common ones the secrecy of the location is set as a general protection, in this case, the protection of the owner of the space photographed by Liu is seen as a defence against the Chinese state.

1 For more on the subject of Gondo, see the publication: M. Domman, H. Rickli, M. Stadler, *Data Centers Edges of a Wired Nation*, Lars Müller Publishers, Baden 2021

1. A Bitcoin "mine" with a blue tin roof sits next to a hydroelectric power plant in Ngawa (Aba) Tibetan and Qiang Autonomous Prefecture, Sichuan province, September 27, 2016. Located at the eastern edge of the Tibetan Plateau, the area has abundant hydropower, a key factor in making energy intensive mines cost effective. Electricity typically accounts for 60-70 percent of a bitcoin mine's expenses. Ph. : Xingzhe Liu.
2. Goats from a nearby village walk among cooling fans at the mine, September 28, 2016. Ph. : Xingzhe Liu.
3. Miners can check a machine's condition and operations using phones and personal computers. For most issues, they can simply restart a machine. Ph. : Xingzhe Liu.
4. Employees use their phones at the Bitcoin mine, September 26, 2016. The mine has 550 "mining machines" running continuously. Seven employees work in shifts monitoring the machines to keep the mine running 24 hours a day. Ph. : Xingzhe Liu.

3

4

2

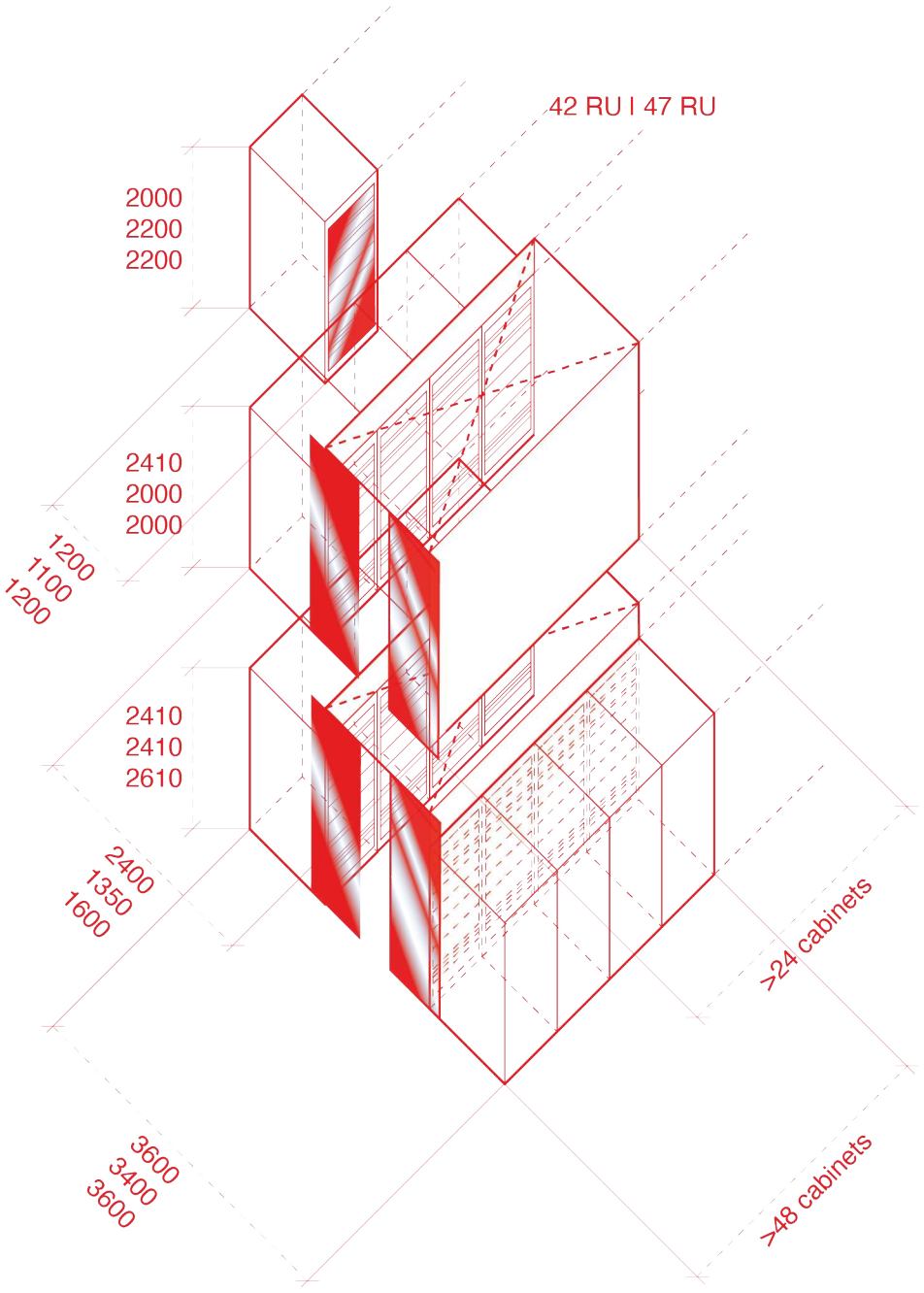
1

Name:	Huawei FusionModule2000
Where:	Potentially in any interior with a minimum height of 2.6 m.
Status:	under production
Dimensions:	(see type illustrations)
Description:	

The Huawei data center is a modular indoor data centre that combines cabinet, power supply and distribution, cooling, cabling and management system software. This system claims itself to be set up in record time. In Huawei's YouTube channel, they show in time lapse the installation, which can be done in just 8 hours with 2 supervisors, 5 workers and 3 transporters. In addition to cutting down on typical planning times, the convenience of this system is that it can add power to an existing infrastructure, thus playing on the addition dictated by possibility and necessity.
The product data sheet illustrates the possible options: the single row of servers, which closely resembles a typical data centre design, and the parallel double row enclosed in the middle that creates a room within a room. The versatility of choice and the ease of construction place this data centre system in the annexation and emergency market, acting as an instant fail-safe to solve imminent problems.
What the *FusionModule2000* enables is to establish a dialogue between the speed of connection and the speed of demand for instant infrastructure, fully equipped and functioning.

1 | 2. Frame of the official installation video in which the company counts down the time and watches the movements required to fully install the Huawei FusionModule2000. In 8 hours the customer can start using his module.

3. Axonometry and measurements of the different possibilities the company offers the market. In addition to selling single racks, Huawei arranges modules from a single row of racks, up to a maximum of 24 up to a double row consisting of a total of 48 racks.


42 RU I 47 RU
2000
2200
2200
2410
2000
2000
1200
1100
1200
2410
2410
2610
2400
1350
1600
3600
3400
3600
>24 cabinets
>48 cabinets

3

1


Wiring
58:01
7h

2

Name:	Switch TAHOE RENO - The Citadel Campus
Where:	1 Superloop Circle, Sparks, NV 89437, USA (Storey County)
Status:	in action
Dimensions:	1,300,000 square feet (120,774 sqm); 30,000 sqm of server space, currently built
Description:	

This structure belongs to the SWITCH company owned by Rob Roy. The entrepreneur is the owner and founder of the Switch company, which was founded in January 2000.
The data centre in discussion is part of the famous Tahoe Reno campus, a 400-hectare campus with 670,000 square metres of storage space. The campus itself is part of a system of super-connected campuses in the United States, a system privately set up to build a network of five hubs carefully spread across the US territory to achieve high-speed connectivity and collaboration.
The Switch company has become so powerful in recent years that it no longer follows the recognised standards of the Uptime Institute, but has created its own. In addition to being Tier IV certified, Switch has added Tier 5 Platinum with new performance standards[1].
In 2017, the company opened the site's first data centre in the area: the Tahoe Reno 1. The presentation on the official website, describes it as designed to house theft-proof, high-intensity data, described as a technological fortress surrounded by a 20-foot (6 metre) high wall. This structure falls under the categorisation called a hyperscale data centre. This characteristic manifests itself in an agility of components, replacements and expansions of the data space. In fact, as can be seen, the building currently occupies little more than half of the lot enclosed by the perimeter wall, a space ready to be occupied when the need arises.
The campus has been mentioned in the exhibition 'Countryside, The Future' by architect Rem Koolhaas at the Guggenheim in New York as one of the world's largest logistics centres. In fact, the campus not only contains data centers that store important data such as medical data, but also has immense spaces dedicated to the distribution logistics of companies such as Walmart and Tesla's car manufacturing.

1 UI groups data centres according to different possibilities that determine their efficiency. The hierarchy proposed by the Uptime Institute considers Tier IV to be the maximum performance that can be achieved by a data center.

1. The entire project designed by Rob Roy involves 7 roofed structures. So far, little more than half a module of one of the 7 volumes has been created on campus.

2. Photo taken from Google Maps comments. A user shows the view from inside the enclosure. The small wall parallel to the frame is the limit of the volume built to date, hardly noticeable in the photo.

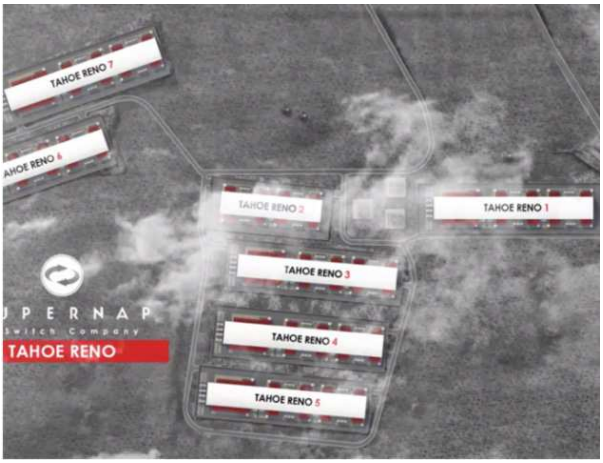
3. Detail of the roof of the structure. Double roof to ensure maximum protection of the machines against the Nevada winds.

4. Graphic reworking of the built volume. The square grid applied above the drawing measures 25x25 m modules.

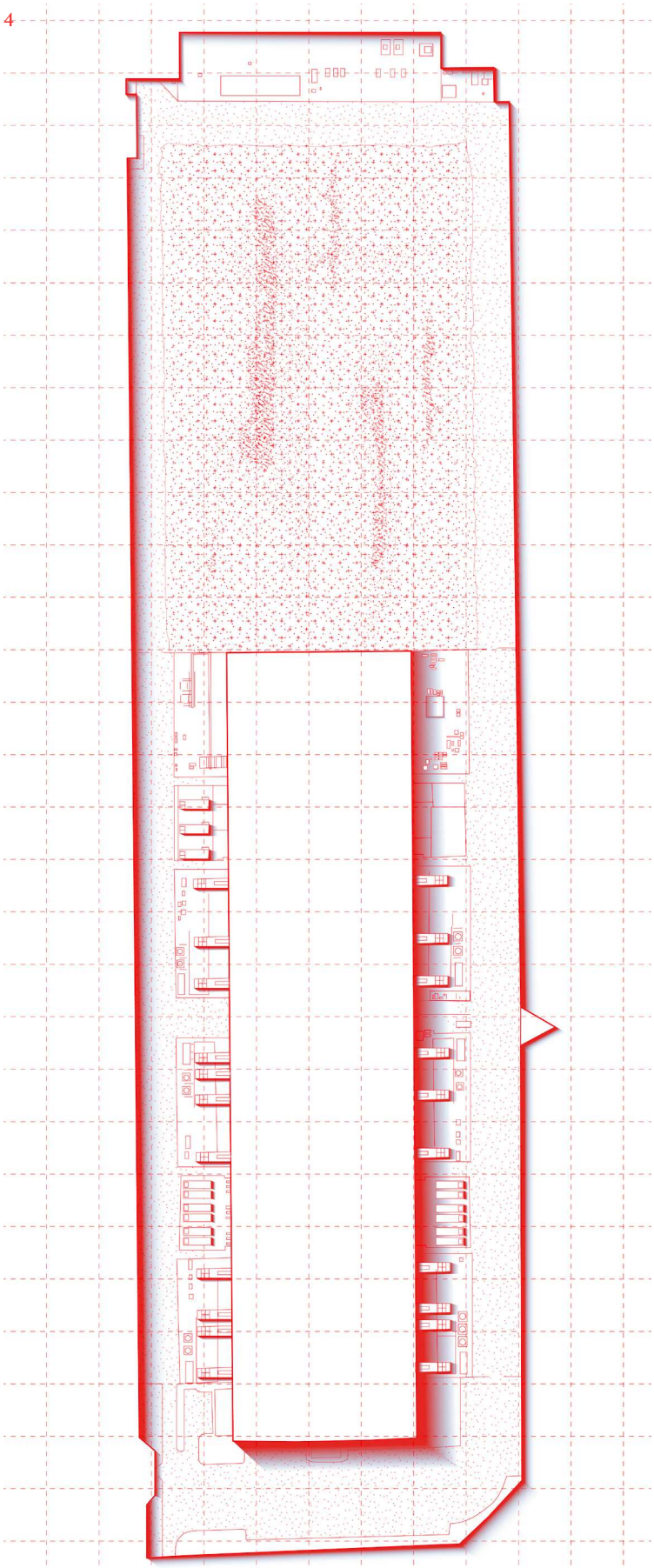
3

2

1


TAHOE RENO 7
TAHOE RENO 6
TAHOE RENO 2
TAHOE RENO 1
TAHOE RENO 3
TAHOE RENO 4
TAHOE RENO 5
TAHOE RENO

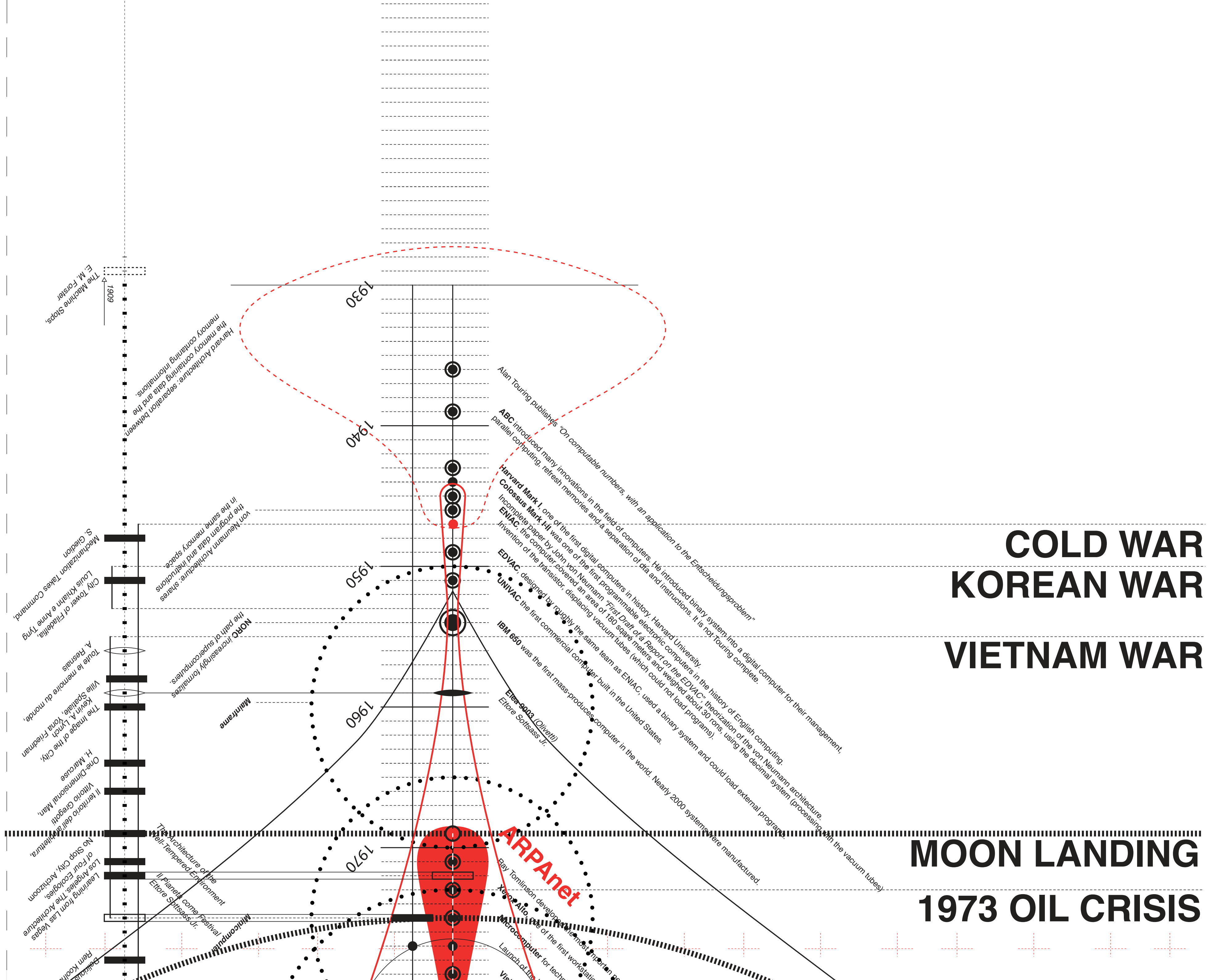
4

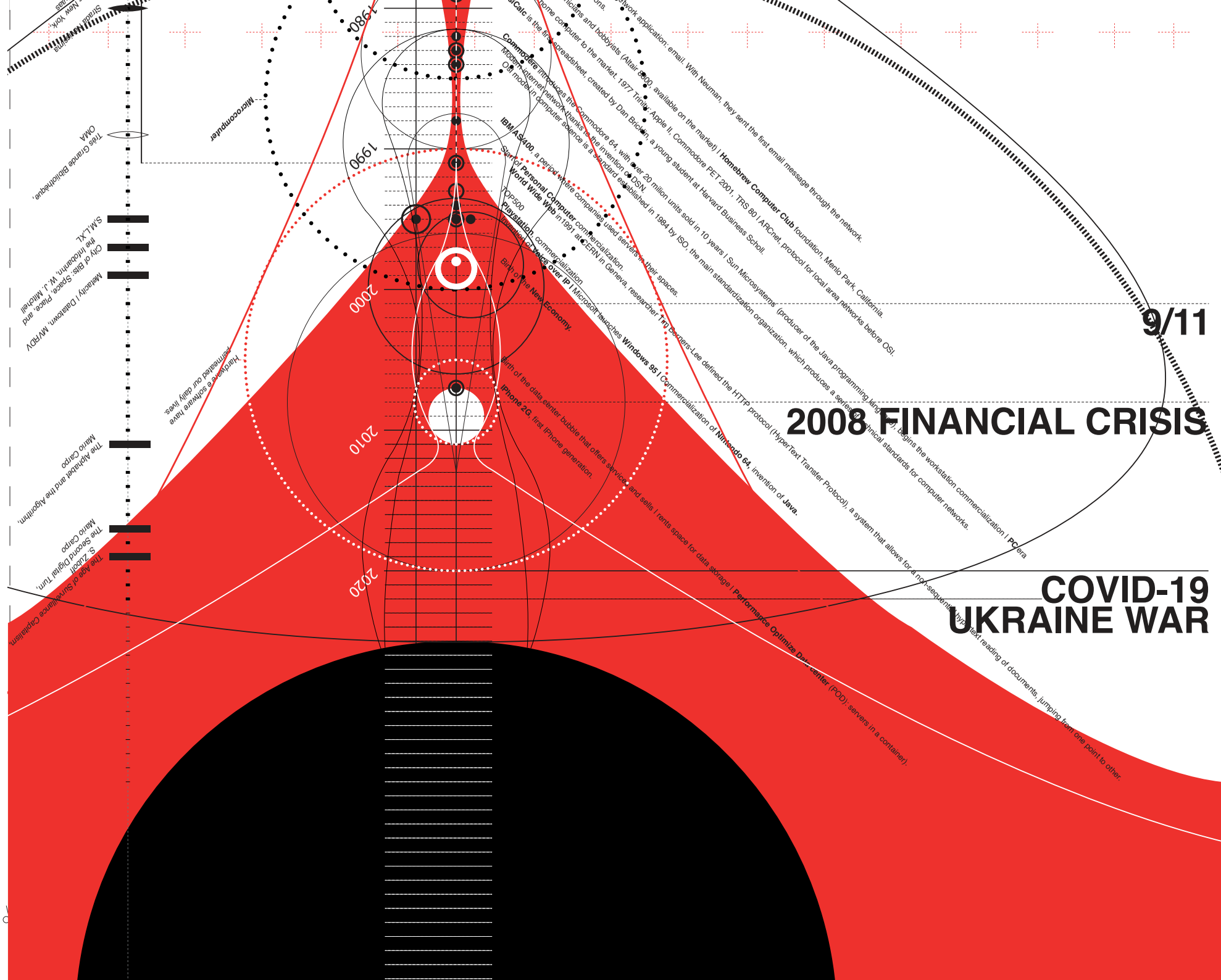


Name:	ASCEND (Advanced Space Cloud for European Net zero emission and Data sovereignty)
Where:	In space
Status:	In the development phase
Dimensions:	There is no information of this kind
Description:	

The limited information about this project comes from the website of the company Thales Alenia Space, which explains on 14 November 2022:

"Thales Alenia Space, the joint company between Thales (67%) and Leonardo (33%), has been chosen by the European Commission to lead the ASCEND (Advanced Space Cloud for European Net zero emission and Data sovereignty) feasibility study for data centers in orbit, as part of Europe's vast Horizon Europe research program.
Digital technology's expanding environmental footprint is becoming a major challenge: the burgeoning need for digitalization means that data centers in Europe and around the world are growing at an exponential pace, which in turn has a critical energy and environmental impact.
A consortium led by Thales Alenia Space has been set up to find an ambitious solution for Europe, namely to install data center stations in orbit, powered by solar power plants generating several hundred megawatts. This project could help meet Europe's Green Deal goal of achieving carbon neutrality by 2050 and would also be an unprecedented development in the European space and digital ecosystem.
This concept makes direct use of the energy produced in space outside of the earth atmosphere: the only link with the ground would be high-throughput Internet connections based on optical communications, a technique for which Europe has mastered the underlying technologies.
For the ASCEND feasibility study, Thales Alenia Space is leading a consortium of companies with complementary areas of expertise spanning the environment (Carbone 4, VITO), cloud computing (Orange, CloudFerro, Hewlett Packard Enterprise Belgium), launch vehicles (ArianeGroup) and orbital systems (German aerospace center DLR, Airbus Defence and Space and Thales Alenia Space).
The first objective of this study will be to assess if the carbon emissions from the production and launch of these space infrastructures will be significantly lower than the emissions generated by ground-based data centers, therefore contributing to the achievement of global carbon neutrality. The second objective will be to prove that it is possible to develop the required launch solution and to ensure the deployment and operability of these spaceborne data centers using robotic assistance technologies currently being developed in Europe, such as the EROSS IOD demonstrator.
This project is expected to demonstrate to which extent space-based data centers would limit the energy and environmental impact of their ground counterparts, thus allowing major investments within the scope of Europe's Green Deal, possibly justifying the development of a more climate-friendly, reusable heavy launch vehicle. Europe could thus regain its leadership in space transport and space logistics, as well as the assembly and operations of large infrastructures in orbit."
La società in questione è la più grande produttrice di satelliti europei specializzata nella produzione aerospaziale, spaziale e di difesa. Stiamo parlando di quella società che il 9 settembre 2023 ha compiuto il lancio della missione Euclid, un satellite che esplorerà e indagherà i*n orbita, l'origine dell'universo cercando di mappare diverse miliardi di galassie in tre dimensioni.*


COLD WAR
KOREAN WAR
VIETNAM WAR
MOON LANDING
1973 OIL CRISIS
1930
1940
1950
1960
1970
Alan Touring publishes "On computable numbers, with an application to the Entscheidungsproblem"
ABC introduced many innovations in the field of computers. He introduced binary system into a digital computer for their management, parallel computing, refresh memories and a separation of data and instructions. It is not Touring complete.
Harvard Mark I, one of the first digital computers in history. Harvard University.
Colossus Mark I-II was one of the first programmable electronic computers in the history of English computing.
Incomplete paper by John von Neumann "First Draft of a Report on the EDVAC" theorization of the von Neumann architecture.
ENIAC, the computer covered an area of 180 square meters and weighed about 30 rons, using the decimal system (processing with the vacuum tubes)
Invention of the transistor, displacing vacuum tubes (which could not load programs).
EDVAC, designed by roughly the same team as ENIAC, used a binary system and could load external programs.
UNIVAC the first commercial computer built in the United States.
IBM 650 was the first mass-produces computer in the world. Nearly 2000 systems were manufactured.
Elea 9003 (Olivetti)
Ettore Sottsass Jr.
ARPAnet
Ray Tomlinson develops
Xerox Alto, one of the first workstations
Microcomputer for tech
Launch of the
Harvard Architecture: separation between the memory containing data and the memory containing informations.
von Neumann Architecture: shares the program data and instructions in the same memory space.
NORC increasingly formalizes the path of supercomputers.
Mainframe
Minicomputer
The Architecture of the Well-Tempered Environment
Il Pianeta come Festival
Ettore Sottsass Jr.
1909
The Machine Stops,
E. M. Forster
Mechanization Takes Command,
S. Giedion
City Tower of Filadelfia,
Louis Khiahn e Anne Tyng
Toute le memoire du monde,
A. Resnais
Ville Spatiale, Yona Friedman
The Image of the City,
Kevin A. Lynch
One-Dimensional Man,
H. Marcuse
Il territorio dell'architettura,
Vittorio Gregotti
No Stop City, Archizoom
Los Angeles. The Architecture of Four Ecologies,
Learning from Las Vegas
Delirious
Rem Koolhaas


1980
1990
2000
2010
2020
9/11
2008 FINANCIAL CRISIS
COVID-19
UKRAINE WAR
Microcomputer
Homebrew Computer Club foundation, Menlo Park, California.
Commodore introduces the Commodore 64, with over 20 million units sold in 10 years | Sun Microsystems' (producer of the Java programming language), begins the workstation commercialization | PC era
IBM AS/400, a period where companies used servers in their spaces.
Birth of the New Economy.
Birth of the dotcom bubble that offers services and sells | rents space for data storage | Performance Optimized Datacenter (POD) servers in a container).
IPhone 2G, first iPhone generation.
Commercialization of Nintendo 64, invention of Java.
Haptic reading of documents, jumping from one point to other.

Harvard Mark I, 1943
Designed by Howard Aiken, this electromechanical computer, more than 50 feet (15 metres) long and containing some 750,000 components, was used to make ballistics calculations during World War II.

2.1 Caption of the Timeline

In its complexity, the diagram attempts to chronologically highlight the stages of computer science as it evolved from both hardware and software to the discipline of architecture in order to relate the various meeting points between the two.
In order to guide those consulting the graph, well-known events have been chosen that certainly influenced the development of computing. The Cold War, the Korean War, the war in Vietnam, the Moon landing, the 1973 oil crisis, the fall of the Twin Towers, the 2008 crisis, covid-19 and the war in Ukraine, are events that shook the entire planet and that computer science and architecture have internalised in their developments.
The progressive materiality of the graph highlights the pervasiveness of the discipline in everyday life. The large red spot starting from 1969 represents the network connection between devices, which takes on important roles in different seasons. Before that date, which coincides with the landing of man on the Moon, the development of information technology visually and mentally occupied enclosed and circumscribed spaces, with ever more insistent drives for action on the territories. It is precisely the beginning of the Internet connection that is the real cause of the visual-spatial dispersion of information technology and its pervasiveness into the territory.
In 1950-51, the first marketable computer, the Univac I, was born in the United States, marking an expendable season for computer science in the business systems sales scene. Reading the business manual of the computer in question, the main structure looks like a small pavilion with a rounded corner plan that externally resembles a simple metal cabinet. The development of the discipline after 1969, however, begins to think in terms of a wider audience, broadening its field of influence and losing the initial centralisation seen in the production of the first computers. The web expands the imaginative and potential aspect of the computer, which after the consolidation of the internet begins to reflect on the presence|absence of infrastructure and devices accessible to all.

2.1.1 Pre 1969

Beginning from the 1940s there followed the assembly of early calculators such as ENIAC which had an area of 180 square meters with a weight of 30 tons. At that time in 1946, ENIAC still operated with thermionic valves which prevented the use of programs in the machine, and this made ENIAC only a large-scale calculator. It was not until 1947 that a small but significant invention took place, the transi-

stors whose potential made calculators more high-performance and functional.[1].
The same ENIAC working group also elaborates EDVAC which supported the binary system and could load external programs making the machine more versatile in its use.
It was only in 1951 that the concept of computers began to be linked with utility in companies and thus for computers for commercial purposes. UNIVAC in fact opens the season to the first computers sold to the public. It only in 1955 with the IBM 650 computer that the first commercialization with mass-produced computers is accomplished; more than 2,000 IBM 650 systems are sold.
Experimentation in such a young discipline also found favorable seasons outside the United States. In fact, in 1959, Olivetti produces the Elea 9003, which finds as its main actor Mario Chu, a Chinese engineer who, called by Olivetti, allows its realization.
The design of the computer in question is elaborated by Ettore Sottsass, who disegns cabinets that can be opened and composed thanks to wheels. This is the first real contact between the disciplines, an experience that will mark developments in the architect's imagination. Future elaboration can be seen in Preliminary Project for Microenvironment, Element for Landscape Home. With this modular project, the architect expertly uses the design experience of Elea 9003 to create new relationships between humans and the built environment. The radical gesture subverts the idea of built architecture; the modules subdivide the space by housing the kitchen, bookcase, cabinets, shower, etc.. The element that structures everything is one and is drawn in its details in an exploded view that identifies its elements. The wheels are precisely the element that determines the project; taking up the idea of Elea, Sottsass develops a module containing other functions for living everyday life. Unconsciously, the design brings the human being closer to the spatiality of the data center, which is composed of an orderly cabinetry that relates to humans out of need for maintenance. If in the computer the human serves for the machine, in Preliminary Project for Microenvironment, Element for Landscape Home, the machine serves for the human.
The evolution of computer performance goes through seasons that also confront the advent of the network, internet. Changes continue with the idea of making the computer permeant in people's lives. Small internal components begin to change the spaces of the computer, which increasingly tends to become a terminal with memory elsewhere. With the years at the turn of 1969, the divergence begins between machine and terminal for communicating with human beings, but this occurs after the Arpanet project.

2.1.2 1969-2005

At the time the first connection takes place, a project directed by DARPA, a government agency of the U.S. Department of Defense, the first in a long series of RFCs (Request For Comments) is published. In the form of a simple A4 document, the RFCs are intended as a moment dedicated to describing how the Internet works, documents that using word and diagram explain the complexity of the network. These documents continue to this day to be published and made public online.

1 This small but great discovery contributes to the development of infrastructure. It slowly begins the road to investment in millimetre design and begins to ease the tension in urban design.

Are all RFCs Internet standards documents?
In a word, "NO!". Many RFCs have Informational or Experimental status and do not represent any kind of standard. They contain information that may be useful or important to retain in this archival document series. This is important to understand, because unscrupulous marketeers and a careless trade press sometimes falsely suggest that every RFC represents a standard, or that all standards have equal weight. The relationship among Internet technical specifications is often complex.

In addition to being a conspicuous record of the evolution of the network, the legacy of these documents can be considered the greatest theoretical contribution that illustrates and constantly updates the functions of the Internet and its protocols.

The RFC Series
The RFC Series (ISSN 2070-1721) contains technical and organizational documents about the Internet, including the specifications and policy documents produced by five streams: the Internet Engineering Task Force (IETF), the Internet Research Task Force (IRTF), the Internet Architecture Board (IAB), Independent Submissions, and Editorial.

By its own precise protections and publication processes, the RFC-Editor is an open-access platform where anyone can upload a text, first entered as a "draft" and then passed through the screening of the various oversight bodies, before it becomes in effect an RFC. Any person is invited to write an RFC, all are authors if they can help with the theoretical and functional implementation of the network.

"The RFC series has a long history. The series was originated in 1969 by Steve Crocker of UCLA, to organize the working notes of the new ARPAnet research program. Online data access (e.g., FTP) was defined in early RFCs, and the RFC series itself became the first online publication series. For 28 years, this RFC series was managed and edited by the Internet pioneer Jon Postel.
The RFC Editor operation was funded by the Defense Advanced Research Projects Agency (DARPA) of the US government until 1998. From 1998 – 2018, the RFC Editor was funded by a contract with the Internet Society, to continue to edit, publish, and catalog RFCs. The RFC Editor was a project at the USC Information Sciences Institute in Marina del Rey, California, through 2009. Currently, the RFC Production Center and Publisher functions are provided by Association Management Solutions, LLC (AMS)."

The RFCs are intended to be a container that also deals with its own history. There are three RFCs entitled: "30 years of RFCs," "40 years of RFCs," and "50 years of RFCs."@nota) To understand the behaviors, functions, sometimes even future projections, these documents remain to this day the only primary source to delve into the network. These celebratory RFCs, do not add new technologies or standards, but are reflections that help to understand the centrality of these documents throughout the life of the Internet.
After 1974, the military project is abandoned, and these are precisely the years when universities and computer scientists have enormous potential on their hands to develop.
People's Computer Company and *Homebrew Computer Club*, two spontaneous organizations that sprang up at that time, begin timidly to optimize hardware for a home-use computer that was not yet connected to the network. During hardware development and early software design, software writing was included within the federal copyright law in 1980. This episode thus contributes to spatial definition through privatization. In addition to effectively empowering software writers, it veers the development of the future network toward privatization, a totally oppo-

site view from groups such as People's Computer Company that dreamed of an accessible, limitless network for anyone(nota la reillere).
At this time the Commodore 64 comes out and sells 20 million computers in 10 years, the OSI model is adopted as the network transmission protocol, and the branch of software that will develop hardware dedicated to gaming begins-the first consoles are born[2]. RFC 822 opens the way for electronic mail. In 1991 the World Wide Web[3] thought of and developed by Timothy John Berners-Lee was invented, describing the logic with which we use the Internet today to navigate and search for informationi[4]: now the connection space between networked computers had an interface in a screen, the current way we interact with the network.
Having reached this point, all the elements for the composition of the data center were present and mature. Between the two millennia, the Internet infrastructure was already in place and functioning, but the key players in this story had not yet built an infrastructural hierarchy to optimize its use. Spatial organization arose as a necessity and method for conveying data and bringing order to a flux of information that had not yet reached a rational and well-organized form.

2.1.3 Post 2005

At that time memory, service, and device lived three distinct processes in the logic of space. The device had become a domestic one and had become embedded in everyday logic, many homes had a PC that held memory to run the machine and for personal use, while services were physically plug-ins sold to the user to enhance his or her machine.
With the rise of the Internet, a process of physiological discovery by companies like Google takes place. Together with other infrastructure-owning tech companies, they subvert the logic of terms by implementing the spatial factor.
To keep its search service free, Google has begun selling data on user preferences to third-party companies to place ad hoc advertisements. With this shrewd move, Google kicks off a series of services sold through the network.
To keep its search service free, Google has begun selling data on user preferences to third-party companies to place ad hoc advertisements. With this shrewd move, Google kicks off a series of services sold through the network.@confusion
In a first economy related to the sale of devices, which took place before 2005, an economy made up of services now begins. This new type of behavior initiated a fast but precise development of a large network-connected memory infrastructure in order to sell its services.
In 2005 came the first response from an American national standards association, accredited by ANSI, which published the first manual for building a data center[5],

2 The first gaming consoles were inspired by the commodore 64 hardware. From now on, the gaming console and the personal computer began to run parallel, but never divergent, development tracks.

3 The World Wide Web (WWW) was invented by Tim Berners-Lee in 1989 while working at CERN. Berners-Lee developed the concept of the World Wide Web as a way to share and access information through a network of connected computers. He created the first specifications and software for the World Wide Web, including the first web browser (called 'WorldWideWeb') and the first web server, which enabled the creation of the first website in 1991.

4 This way of surfing the net is the one that persists to this day. Most probably, with the advent of artificial intelligence, the ways of using the net will change. If the user is now the author of the search he does through links, the way he uses it will most likely change by asking explicit questions and getting a complete answer to our question.

5 Cf. the following chapter develops an analysis of the standard mentioned here, TIA-942.

document that brings together notions of the different professions involved in designing a data center.
Infrastructural direction is taken by creating large storage spaces. This logical-spatial choice, has led to two important consequences. While the size of our devices began to shrink[6], data centers began to change the spatiality of the city and what is outside. The territory has since begun to fill with spaces that have organized the network system according to the value of quantity. Data centers are the keepers of data, architectural structures owned by different companies that are absorbing the different services of the city[7], including financial markets. Most actions performed nowadays use the data center as a spatial medium, invisible to the user. This buildings are camouflaged in urbanized locations within structures not so distant from those we are used to seeing with the advent of the factory after the industrial revolution. Since 2005, the network infrastructure has begun an extensive space conquest operation to obtain more data, hence more money. Thus began the structuring of a specific chain of material production companies and companies that use the infrastructure to then sell services to users. The three players play in a strict and clear hierarchy that becomes a necessary principle for success.
The network system had infinite ways to develop, given the vast possibilities offered by its composition, but to date the direction seems to be tending towards a centralisation of infrastructure, which corresponds to the large presence of this part of the digital infrastructure in the territory.
The red spot representing the network in the graph overlooks the black circle representing the future. So far, it seems that the only actor definitely present in the near future is the Internet.

2.2 Data Center

After the discovery of the behavioural surplus, the data centre infrastructure began its spatial invasion. Before the formalisation, their presence was simply not so structured. All the components of a data center were already perfectly in use even before 2005, but now a spatial reconfiguration was needed to confine them in one place; a spatial configuration to make the machines coexist with each other. Architecture comes into play when the system requires the assembly of its parts. The grouping of servers in one place has required implementing what were previously small gestures of expediency with new spaces. The power supply is no longer the plug connected to the electrical system and the ventilation is no longer a ventilated environment: all elements acquire a mass and spatial presence. Ensuring an active service day and night to a large number of servers implies high performance auxiliary spaces. Furthermore, the amount of data the infrastructure holds increases the fragility of the system, which can be digitally or physically undermined. This is where security, energy and ventilation become the most frequently discussed topics in the news, for economic as well as environmental reasons. For the most part, the external construction logics still belong to twentieth-century logic, so at first glance they may appear as simple factories, but what makes it a different

6 It should be noted that the technology devices popular in the 1990s were PCs consisting of a monitor, tower with components, keyboard and mouse. In 2024, the main devices for the general public are smartphones. The way people use the Internet changes over the years, and the evolution of the device they use bears witness to this.

7 Cf. chapter Programmed architecture: architectural language of the data center. The feeling expressed by Mitchell publishing the screenshot of Apple's e.World continues to become reality, data centres convey information that was previously accessible through different kinds of urban spaces.

space is the degree of cleanliness and the internal temperature maintained. The data centre is designed to prevent in any way the entry and accumulation of dust, which is harmful to any kind of electrical component. In addition, the temperature inside the room housing the storage servers is controlled and ranges from 20 to 25 degrees. The space assembled to house the servers is aseptic, almost surgery-like pervaded by LEDs that monitor their operating status.
It is in the heart of the structure that all efforts for precise and efficient design are concentrated: in the server rooms, consistency and control must be absolute, any errors must be quickly reported and resolved.

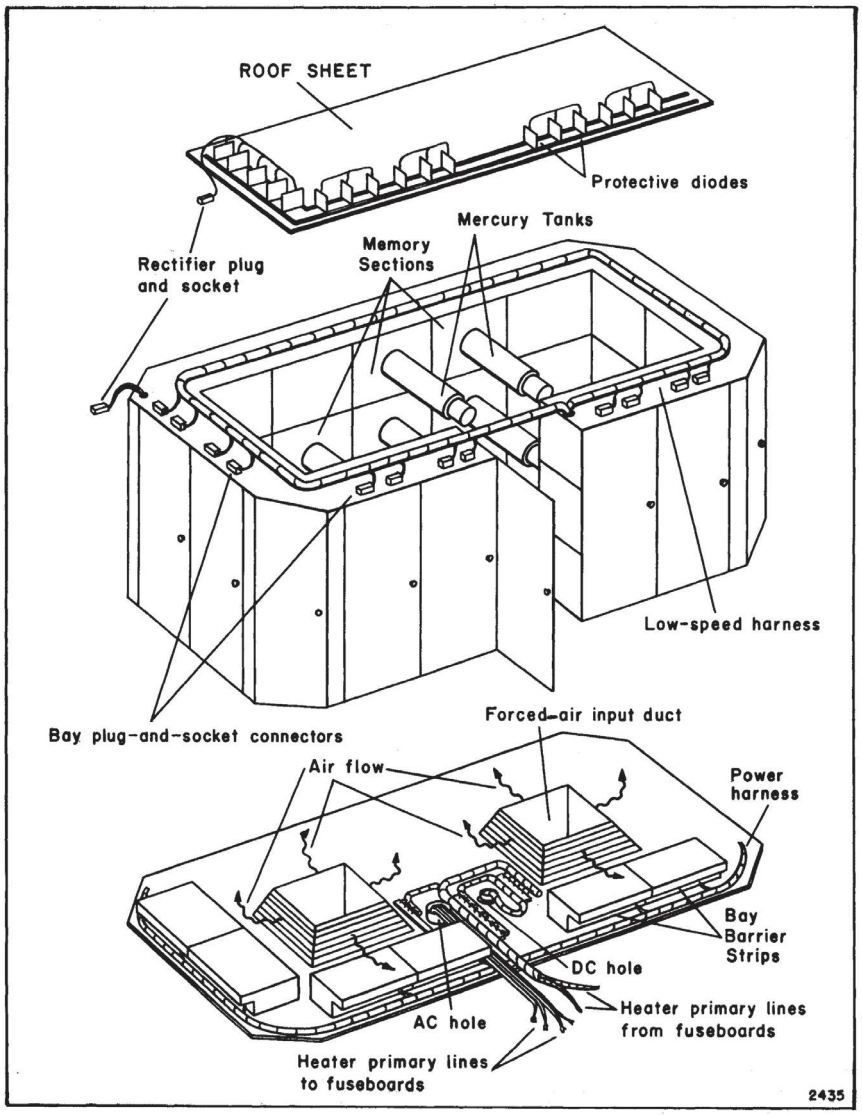
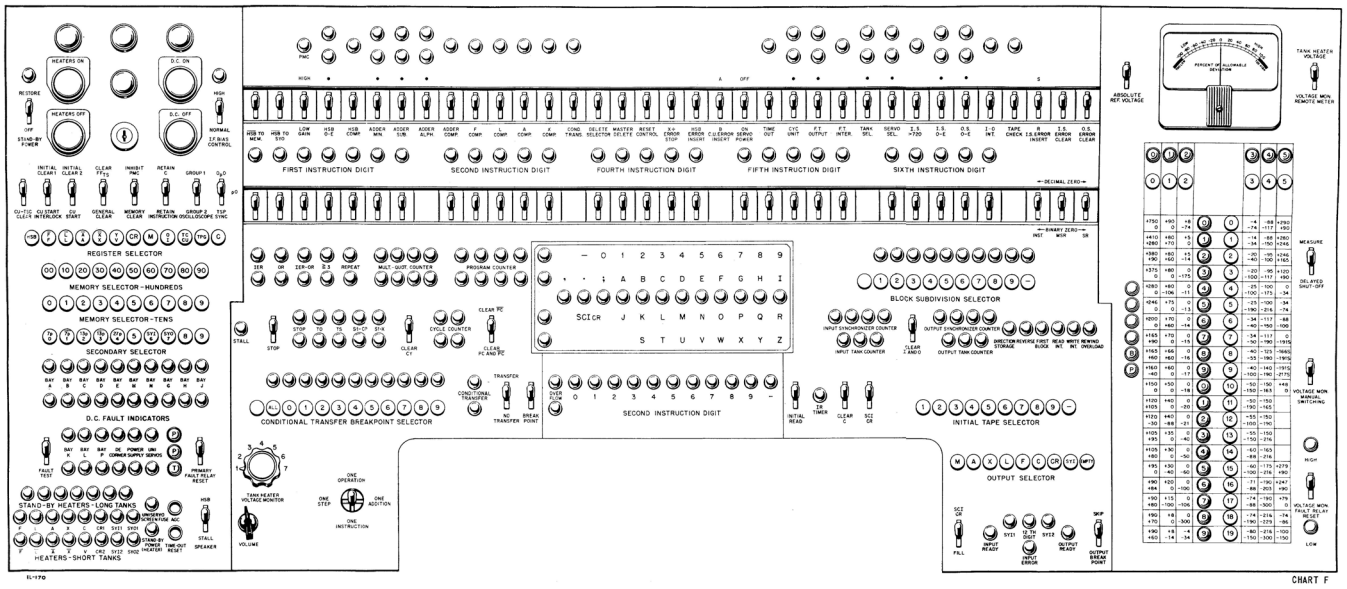


Figure 1-1. Exploded View of Univac I Central Computer

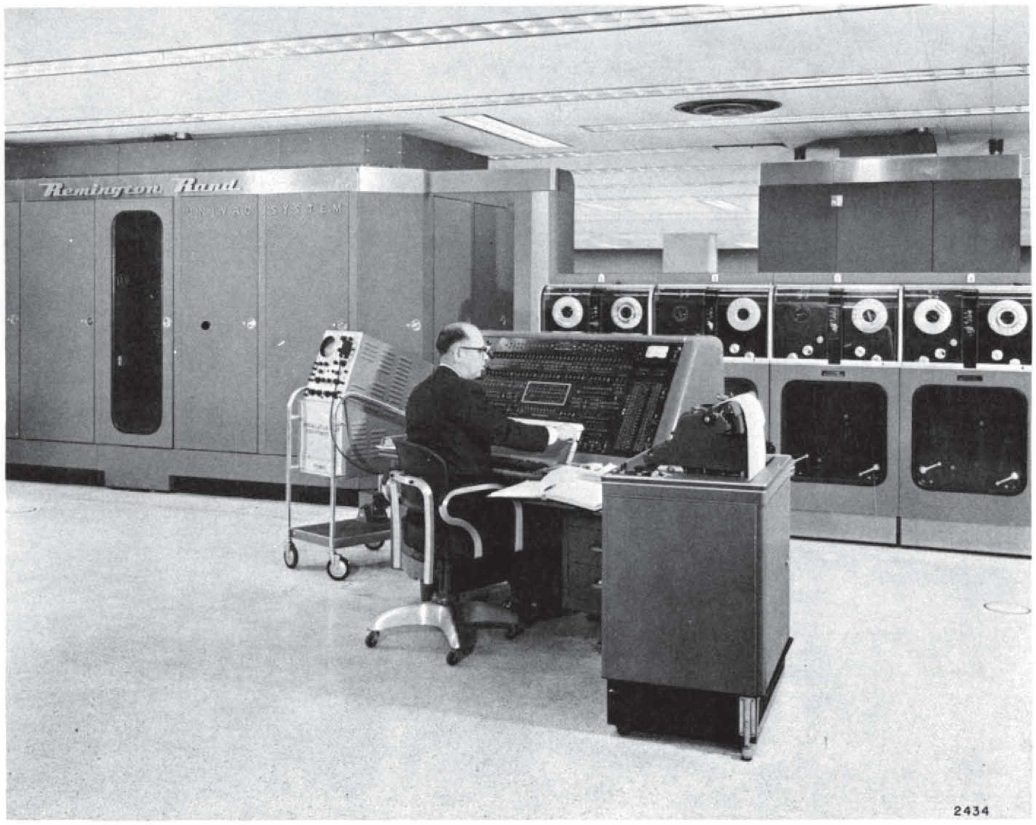
UNIVAC 1
Axonometric exploded view of the UNIVAC 1 computer, in *Maintenance Manual for Univac 1 Central Computer Group*, January 1958.
A computer that is spatially related to its environment, so much so that a human being can literally enter it, given its components and measurements.



UNIVAC 1

UNIVAC 1 computer control panel, in *Maintenance Manual for Univac 1 Central Computer Group*, January 1958.

Console independent of the main machine, one of the first communication tools between man and computer that most closely resembles a keyboard.



INTRODUCTION

Remington Rand's Univac® I electronic data-automation system includes two major groups of equipment, the Central Computer and the input-output auxiliaries.

The Central Computer group comprises the computer and its power supply, the supervisory control console, and up to ten Uniservos.

The input auxiliaries accept typewritten, punched card, or punched paper tape information and place it on a magnetic tape.

The output auxiliaries translate data from the magnetic tape into whatever form the user wishes: typewritten, punched card, or punched paper tape.

Magnetized areas on magnetic tape are the only direct means of communication into and out of the Central Computer. The computer controls the flow of information in both directions.

A Univac I system installation is shown in the frontispiece. Although each system is individually installed, there are characteristics common to all. These include: the grouping of the supervisory control console group into the control panel and keyboard, the monitor oscilloscope, and the control printer; placement of an overhead wiring conduit from the right side of the computer to the group of Uniservos; access to the electronic components of the computer through the casework doors; and in most models placement of the power supply lines from the top of the computer down to the power distribution area in the false floor.

This manual gives details of the physical aspects of the Univac I system (Section I), built-in servicing aids (Section II), external servicing aids (Section III), maintenance (Section IV), and system analysis (Section V).

UNIVAC 1
Set-up space of UNIVAC 1, in *Maintenance Manual for Univac 1 Central Computer Group*, January 1958.
The photo clarifies the size of the computer in relation to the human presence; it is still a computer that creates space with its standardised modules through its elements.

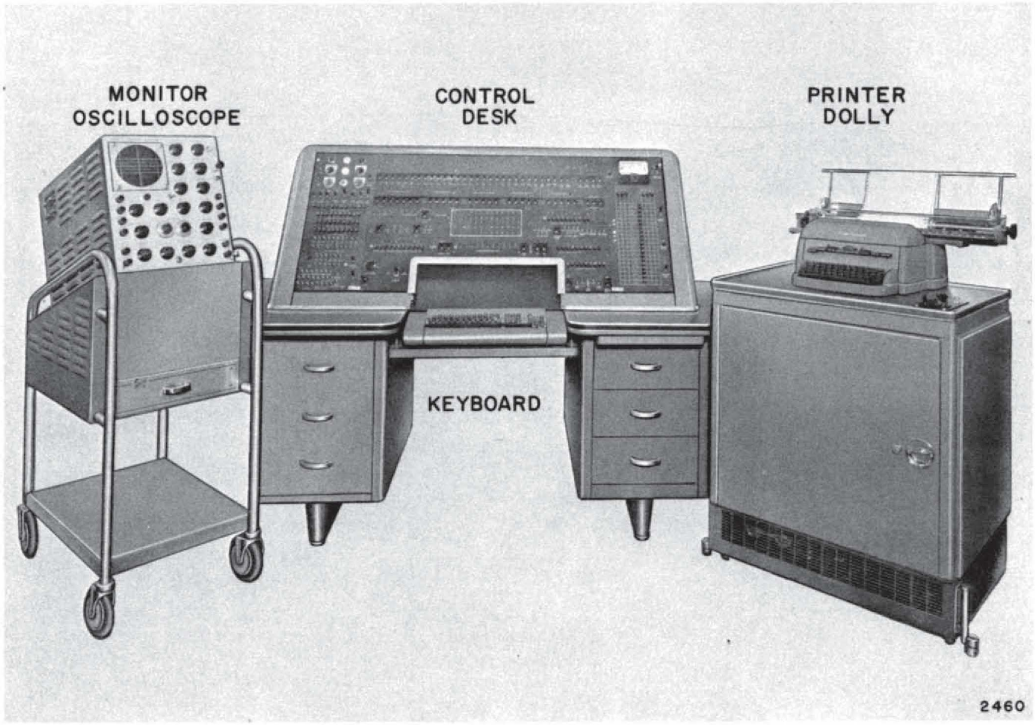
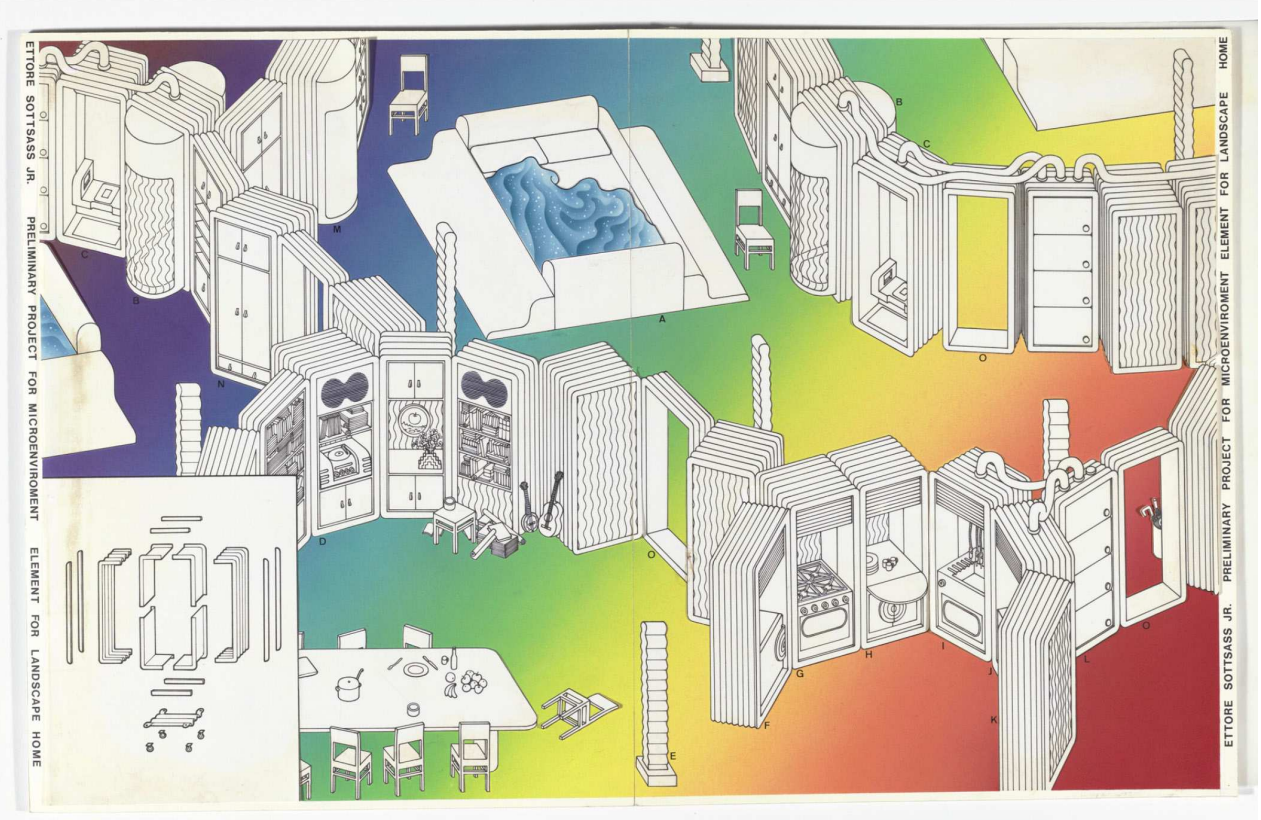


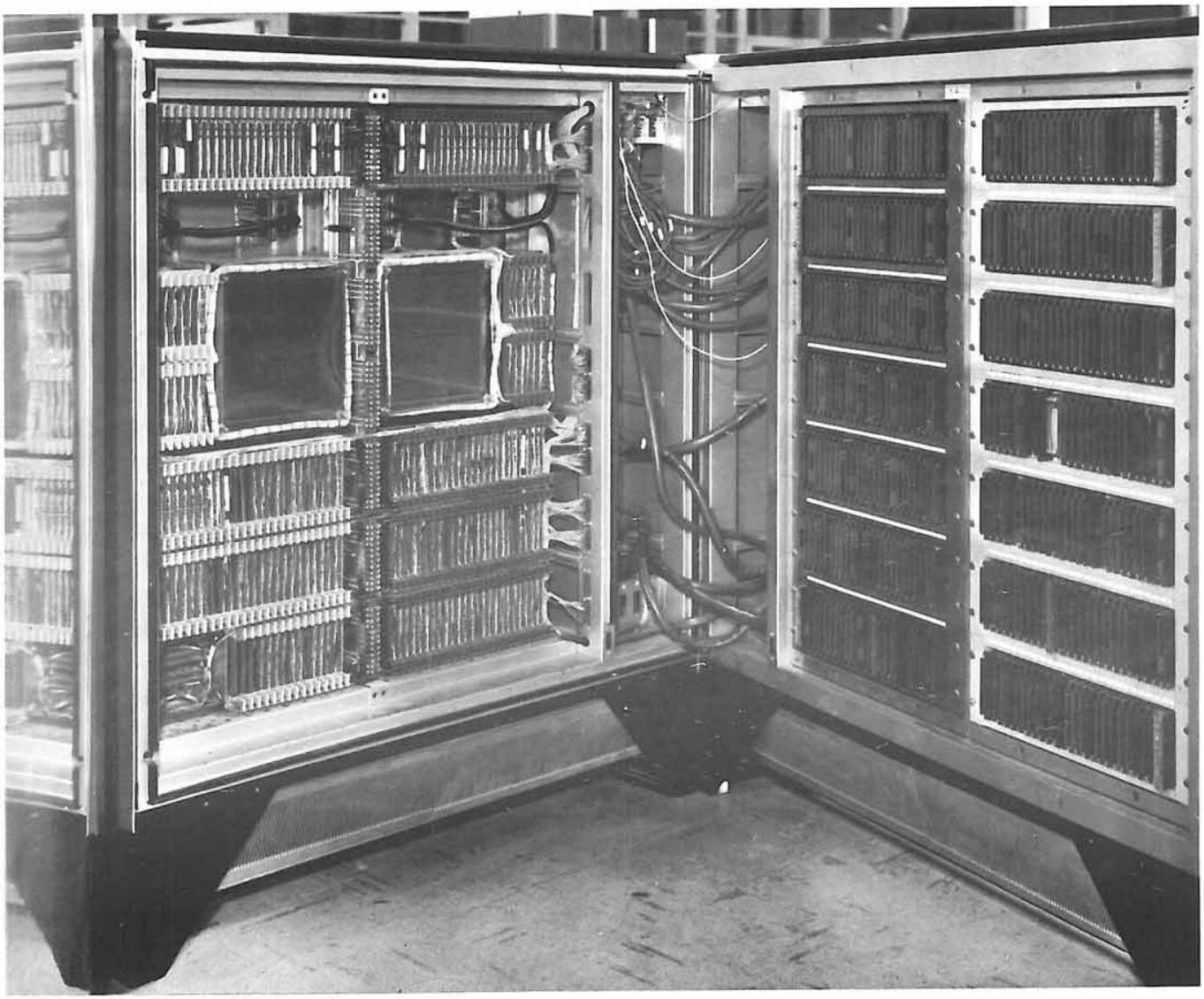
Figure 1-26. Supervisory Control Console Group

1-29

UNIVAC 1
Auxiliary components for the use of UNIVAC 1, in *Maintenance Manual for Univac 1 Central Computer Group*, Jenuary 1958.
The oscilloscope monitor, the control desk with also a keyboard (QUERTY) and the output printer.

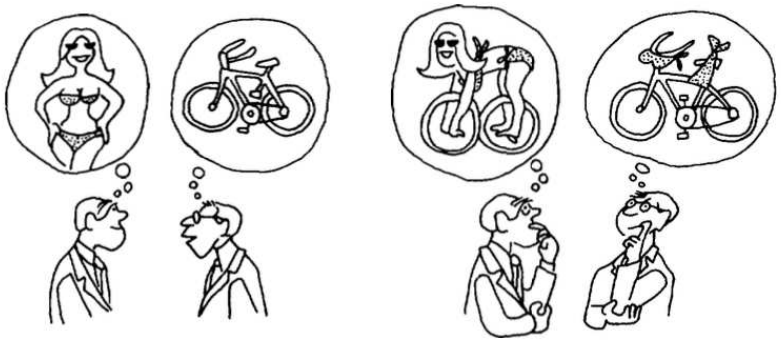


Ettore Sottsass, Preliminary Project for Microenvironment, Element for Landscape Home, 1970.
I shall exhibit a system of plastic "containers" for furnishing the home. These containers make it possible to create a domestic environment that can be adapted at any moment to the needs of the inhabitants. The idea is that their needs "furnish" the home, in as much as they create the spaces of the home.
In other words, while the stage for the domestic drama or comedy has so far been static (as in Greek theatre), now it can easily be transformed as the action changes. This potential for changing the scene may modify, or make it possible to modify (I believe), also the actual substance of the domestic drama or comedy or ritual.
(Interview with Beverly Russel 1971).
There is a Planet. Exhibition Catalogue. Triennale Design Museum, a cura di B. Radice, Mondadori Electa, Milano 2017

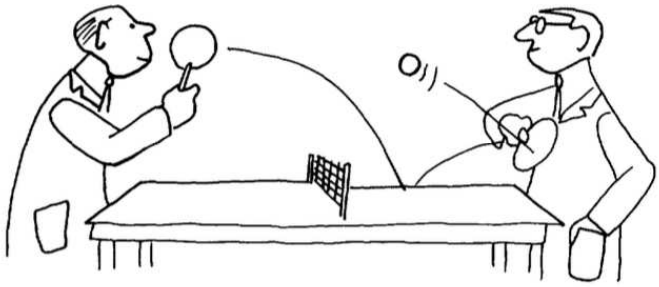


LA MEMORIA DI LAVORO IN UN ARMADIO .—

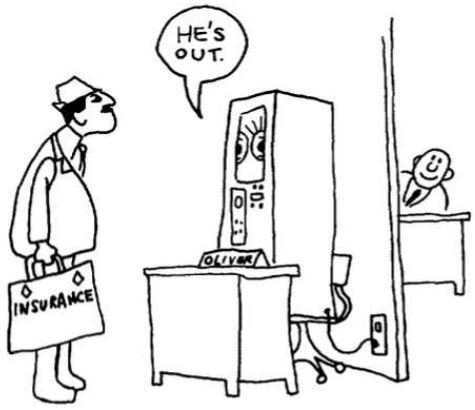
Ettore Sottsass, Elea 9003, 1959.
The formal similarity is no accident. The author seems to use the spatial principles of Elea 9003 for Olivetti when working on Preliminary Project for Microenvironment, Element for Landscape Home.



When mental models are dissimilar, the achievement of communication might be signaled by changes in the structure of one of the models, or both of them.

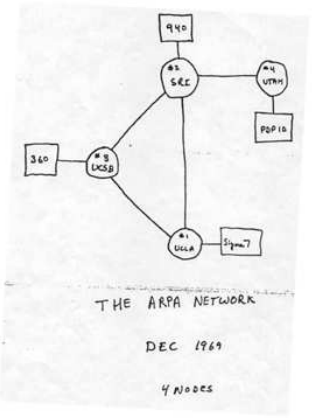


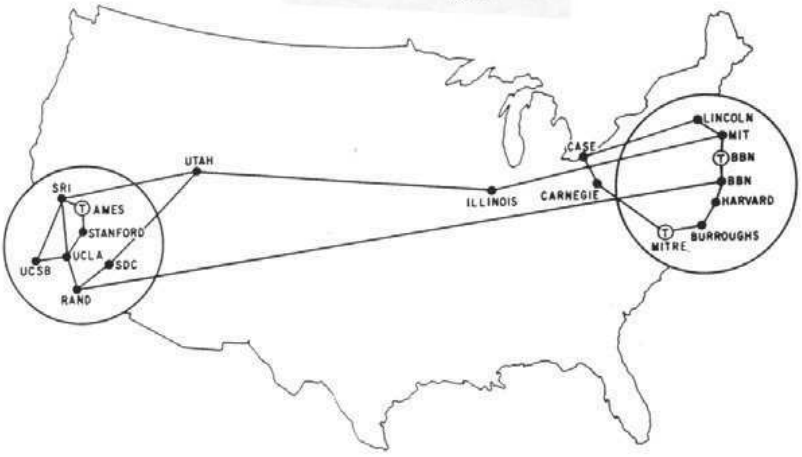
Interactive communication consists of short spurts of dialog . . . . .



Your computer will know who is prestigious in your eyes and buffer you from a demanding world.

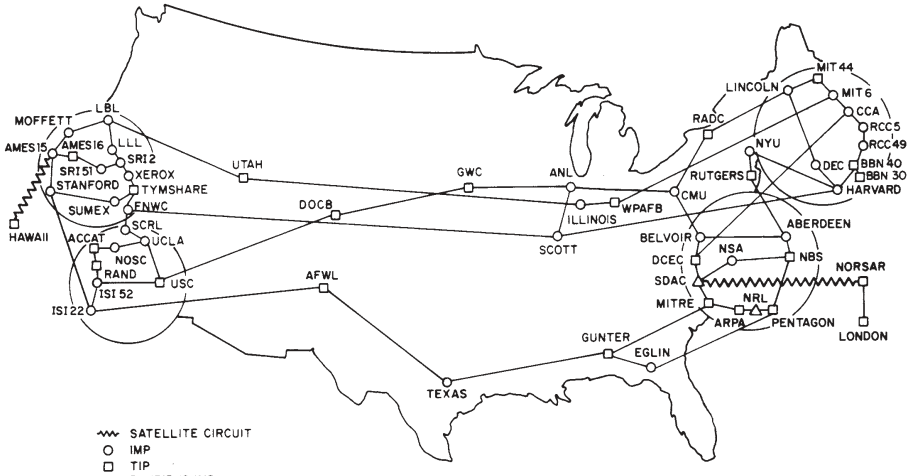
J. C. R. Licklider R. W. Taylor, *The Computer as a Communication Device*, Science and Technology, April 1968.
Licklider, a psychologist and computer scientist, was in charge of the ARPA project in 1962, the one that led to the ARPAnet division in 1969. The article, published in Science and Technology, investigates the possibilities that a computer can give with its use. The illustrations use a very ordinary representational language, making comparisons with the communication and interactivity provided by computers.





MAP 4 September 1971

ARPANET GEOGRAPHIC MAP, MAY 1977



ARPANET, ARPANET_file.pdf, https://www.darpa.mil/about-us/advancing-national-security-through-fundamental-research
At that time, the government agency was called ARPA and its logo remains conceptually unchanged to this day. The PDF downloaded from the site says:
" What was needed was a means to get messages to their destination in a way that did not depend on any single node. This is the challenge that spawned the concept of packet switching. By moving packets of data that dynamically worked their way through a network to the destination where they would reassemble themselves, it became possible to avoid losing data even if one or more nodes went down. A common communications protocol between computers was also necessary, because the computers involved were not always compatible. Building a protocol and the software that would allow different computers to communicate and “internetwork” was a significant challenge."
Having found the technical way to connect, as the years went by the nodes grew larger and larger. The pictures show the nodes in 1969 - UCLA, UCSB, SRI, UTAH - the connections in 1971 and 1977. The ARPAnet project was abandoned in 1989, but it was not until 2016 that the US federal government relinquished direct control over key Internet issues. ICANN, which supervised IANA in the management of IP addresses, passed from the US Department of Commerce to private organisations on 1 October 2016.

Network Working Group
Request for Comments: 2555
Category: Informational

RFC Editor, et al.
USC/ISI
7 April 1999

30 Years of RFCs

Status of this Memo

This memo provides information for the Internet community. It does not specify an Internet standard of any kind. Distribution of this memo is unlimited.

Copyright Notice

Table of Contents

3. The First Pebble: Pubblication of RFC 1

RFC 1, "Host Software", issued thirty years ago on April 7, 1969 outlined some thoughts and initial experiments. It was a modest and entirely forgettable memo, but it has significance because it was part of a broad initiative whose impact is still with us today.

At the time RFC 1 was written, the ARPANET was still under design. Bolt, Beranek and Newman had won the all-important contract to build and operate the Interface Message Processors or "IMPs", the forerunners of the modern routers. They were each the size of a refrigerator and cost about $100,000 in 1969 dollars.

The network was scheduled to be deployed among the research sites supported by ARPA's Information Processing Techniques Office (IPTO). The first four nodes were to be at UCLA, SRI, University of California, Santa Barbara and University of Utah. The first installation, at UCLA, was set for September 1, 1969.

Although there had been considerable planning of the topology, leased lines, modems and IMPs, there was little organization or planning

regarding network applications. It was assumed the research sites would figure it out. This turned out to be a brilliant management decision at ARPA.
Previously, in the summer of 1968, a handful of graduate students and staff members from the four sites were called together to discuss the forthcoming network. There was only a basic outline. BBN had not yet won the contract, and there was no technical specification for the network's operation. At the first meeting, we scheduled future meetings at each of the other laboratories, thus setting the stage for today's thrice yearly movable feast. Over the next couple of years, the group grew substantially and we found ourselves with overflow crowds of fifty to a hundred people at Network Working Group meetings. Compared to modern IETF meetings all over the world with attendance in excess of 1,000 people and several dozen active working groups, the early Network Working Groups were small and tame, but they seemed large and only barely manageable at the time. One tradition that doesn't seem to have changed at all is the spirit of unrestrained participation in working group meetings.

Our initial group met a handful of times in the summer and fall of 1968 and winter 1969. Our earliest meetings were unhampered by knowledge of what the network would look like or how it would interact with the hosts. Depending on your point of view, this either allowed us or forced us to think about broader and grander topics. We recognized we would eventually have to get around to dealing with message formats and other specific details of low-level protocols, but our first thoughts focused on what applications the network might support. In our view, the 50 kilobit per second communication lines being used for the ARPANET seemed slow, and we worried that it might be hard to provide high-quality interactive service across the network. I wish we had not been so accurate!

When BBN issued its Host-IMP specification in spring 1969, our freedom to wander over broad and grand topics ended. Before then, however, we tried to consider the most general designs and the most exciting applications. One thought that captured our imagination was the idea of downloading a small interpretative program at the beginning of a session. The downloaded program could then control the interactions and make efficient use of the narrow bandwidth between the user's local machine and the back-end system the user was interacting with. Jeff Rulifson at SRI was the prime mover of this line of thinking, and he took a crack at designing a Decode-Encode Language (DEL) [RFC 5]. Michel Elie, visiting at UCLA from France, worked on this idea further and published Proposal for a Network Interchange Language (NIL) [RFC 51]. The emergence of Java and ActiveX in the last few years finally brings those early ideas to fruition, and we're not done yet. I think we will continue to see striking advances in combining communication and computing.

I have already suggested that the early RFCs and the associated Network Working Group laid the foundation for the Internet Engineering Task Force. Two all-important aspects of the early work deserve mention, although they're completely evident to anyone who participates in the process today. First, the technical direction we chose from the beginning was an open architecture based on multiple layers of protocol. We were frankly too scared to imagine that we could define an all-inclusive set of protocols that would serve indefinitely. We envisioned a continual process of evolution and addition, and obviously this is what's happened.

The RFCs themselves also represented a certain sense of fear. After several months of meetings, we felt obliged to write down our thoughts. We parceled out the work and wrote the initial batch of memos. In addition to participating in the technical design, I took on the administrative function of setting up a simple scheme for numbering and distributing the notes. Mindful that our group was informal, junior and unchartered, I wanted to emphasize these notes were the beginning of a dialog and not an assertion of control.

It's now been thirty years since the first RFCs were issued. At the time, I believed the notes were temporary and the entire series would die off in a year or so once the network was running. Thanks to the spectacular efforts of the entire community and the perseverance and dedication of Jon Postel, Joyce Reynolds and their crew, the humble series of Requests for Comments evolved and thrived. It became the mainstay for sharing technical designs in the Internet community and the archetype for other communities as well. Like the Sorcerer's Apprentice, we succeeded beyond our wildest dreams and our worst fears.

Network Working Group
Request for Comments: 5540
Category: Informational

RFC Editor
USC/ISI
7 April 2009

40 Years of RFCs

Status of This Memo

This memo provides information for the Internet community. It does not specify an Internet standard of any kind. Distribution of this memo is unlimited.

Copyright Notice

Abstract

This RFC marks the 40th anniversary of the RFC document series.

1. RFCs and Jon Postel

Forty years ago today, the first Request for Comments document, RFC 1, was published at UCLA [RFC1]. This was the first of a series that currently contains more than 5400 documents (roughly 160,000 pages) on computer networking in general and on the Internet protocols in particular. The RFC series emerged from the US government-funded research efforts that created the ARPANET and later the Internet. When the IETF was formed in the mid-1980s, RFCs became the primary publication vehicle for IETF standards, and thus became centered on the vendor and user communities.

For the first 29 years, Jon Postel [Postel] was *the* RFC Editor, until his untimely death in October 1998. Postel, with substantial help from Joyce K. Reynolds, was responsible for the collection, editing, online publication, and archiving of the RFC documents. From 1978 until 1998, Postel was a research scientist at the USC Information Sciences Institute (USC/ISI) in Marina del Rey, California. Postel was also the original IANA as well as Director of the Computer Networks Division at ISI.

Request for Comments 5540, *40 Years of RFCs*, 2009.
On the 40th anniversary of the first RFC, the technical changes for the production of these documents after the passing of Jon Postel, the first RFC editor and author, who passed away in 1998, are mentioned in RFC 2468, I Remember IANA. That RFC is a tribute to the great work Postel did for the network.

Upon the occasion of the 30th anniversary of RFC 1 and as a tribute to the massive contribution of Jon Postel, the RFC Editor published RFC 2555 [RFC2555] on April 7, 1999. This RFC contained recollections from three networking pioneers: Steve Crocker who wrote RFC 1, Vint Cerf whose long-range vision continues to guide us, and Jake Feinler who played a key role in the middle years of the RFC series.

Ten more years have now passed, and we have reached the 40th anniversary of the RFC series. The series has more than doubled in size during the last ten years, and it is expected to continue far into the future. All the good things said in RFC 2555 still hold true ten years later.

We should, however, note some changes that have occurred over the past ten years.

- After Jon passed away, Joyce Reynolds and Bob Braden put together a small organization at USC/ISI to continue the RFC Editor function. This was motivated by a desire to honor Postel by continuing his remarkable effort and to provide a service to the Internet community.

- Funding of the RFC Editor, which had been supported by the US government until 1998, was taken over by the Internet Society. During 1998-2006, ISOC funded the RFC Editor under a series of annual contracts and extensions. ISOC put the function out for competitive bid for 2007 (USC/ISI was selected to provide RFC Editor services from 2007-2009), and the contract will be put out to bid again for post-2009.

  During 2009 there will be a significant transition for the RFC Editor function, as some new organization or set of organizations takes over this service that has been performed at USC/ISI continuously since 1978.

- Many improvements have increased the efficiency and transparency of the RFC editorial process [RFCed09].

- The RFC Editor formed an RFC Editorial Board, a group of people with broad and deep knowledge of the Internet and networking. One of its major functions is to assist the RFC Editor by reviewing RFCs in the Independent Submission stream.

- An email list, rfc-interest@rfc-editor.org, was created to obtain community input on the RFC Editor functions.

Stream: Internet Architecture Board (IAB)
RFC: 8700
Updates: 2555, 5540
Category: Informational
Published: December 2019
ISSN: 2070-1721
Author: H. Flanagan, Ed.
RFC Editor

RFC 8700
Fifty Years of RFCs

Abstract

This RFC marks the fiftieth anniversary for the RFC Series. It includes both retrospective material from individuals involved at key inflection points as well as a review of the current state of affairs. It concludes with thoughts on possibilities for the next fifty years for the Series. This document updates the perspectives offered in RFCs 2555 and 5540.

Status of This Memo

This document is not an Internet Standards Track specification; it is published for informational purposes.

This document is a product of the Internet Architecture Board (IAB) and represents information that the IAB has deemed valuable to provide for permanent record. It represents the consensus of the Internet Architecture Board (IAB). Documents approved for publication by the IAB are not candidates for any level of Internet Standard; see Section 2 of RFC 7841.

Information about the current status of this document, any errata, and how to provide feedback on it may be obtained at https://www.rfc-editor.org/info/rfc8700.

4. The Next Fifty Years of RFCs

As Steve Crocker mentioned, the Series began with goals of communication over formality and openness over structure. As the Internet has grown and become a pervasive, global construct, we still aim for openness and communication, but recognize that for protocols and other information to support interoperability, there must be points of stability to build from. Everyone, from small-time app developers to multi-billion dollar companies, is on the same footing. Anyone should be able to look back at a point in time and understand what was done and why.

While the informality has given way to increased structure, the openness and solid foundation that the Series provides must continue. With that in mind, what does the future hold for the next fifty years of RFCs?

4.3. Stream Structure

In the eyes of many, particularly within the IETF, the RFC Series is synonymous with the IETF. While the Series itself predates the IETF by eighteen years, over time, the IETF has become the source of the majority of documents submitted for publication to the RFC Editor. The policies developed for IETF Stream drafts tend to apply across all four document streams, and publication-related tools tend to focus on the IETF as the primary audience for their use. It is difficult for people to see how, or even why, there is a distinction between the Series and the IETF.

We are in the midst of that question now more than ever. What is the future of the Series? If people cannot tell where the IETF ends and the Series starts, should we consider this an artificial distinction and declare them to be the same entity?

Ultimately, this will be something the community decides, and conversations are underway to consider the ramifications of possible changes.

5. Conclusion

As the Internet evolves, expectations and possibilities evolve, too. Over the next fifty years, the Series will continue to demonstrate a balance between the need to stay true to the original mission of publication and preservation, while also staying relevant to the needs of the authors and consumers of RFCs. The tension in balancing those needs rests on the RFC Editor and the community to resolve. We will not run short of challenges.

6. IANA Considerations

This document has no IANA actions.

7. Security Considerations

This document has no security considerations.

8. Informative References

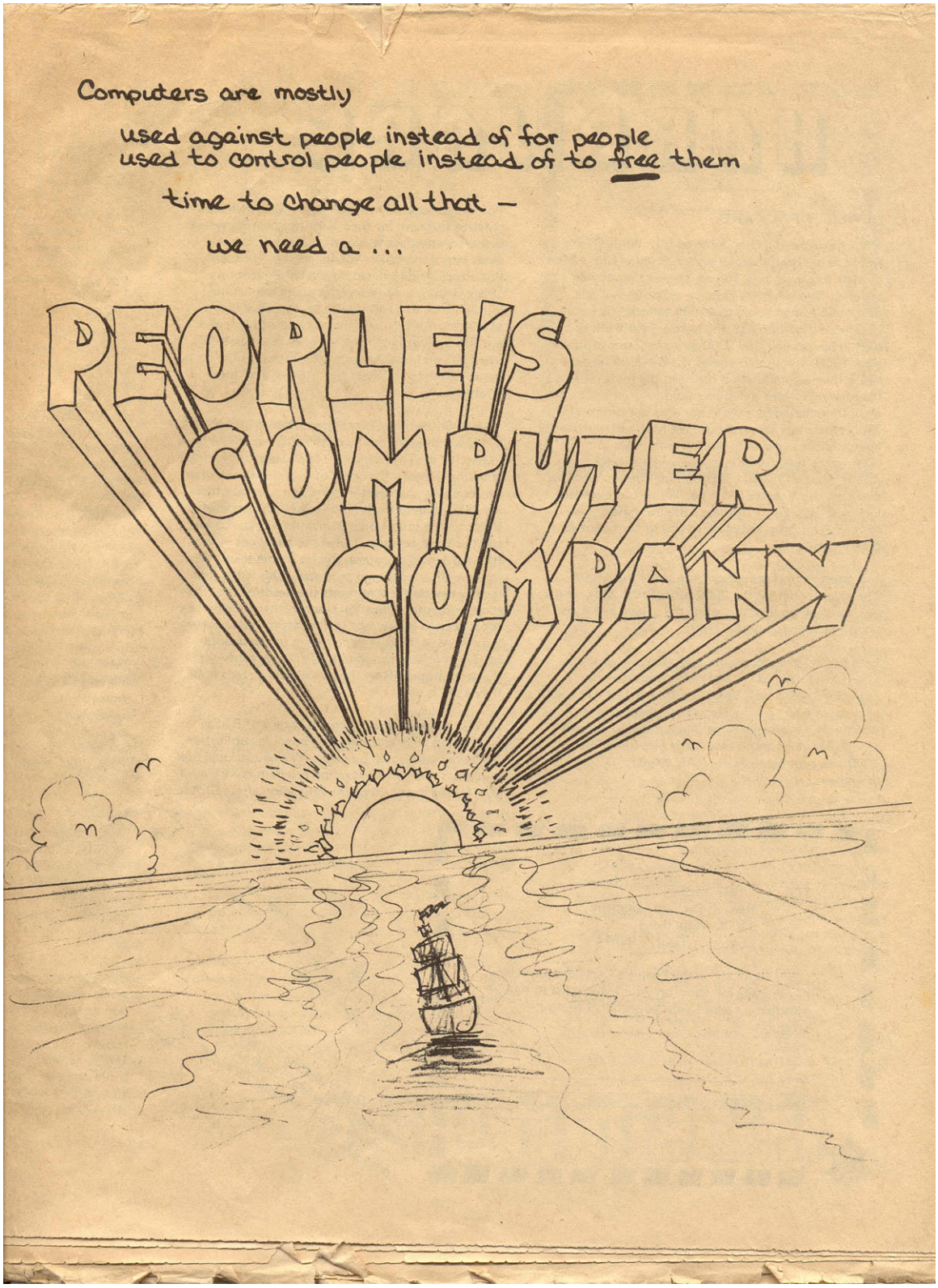
[APPRENTICE] Wikipedia, "The Sorcerer's Apprentice", December 2019, <https://en.wikipedia.org/w/index.php?title=The_Sorcerer%27s_Apprentice&oldid=925824658>.

[DATATRACKER] Internet Engineering Task Force, "IETF Datatracker", <https://datatracker.ietf.org>.

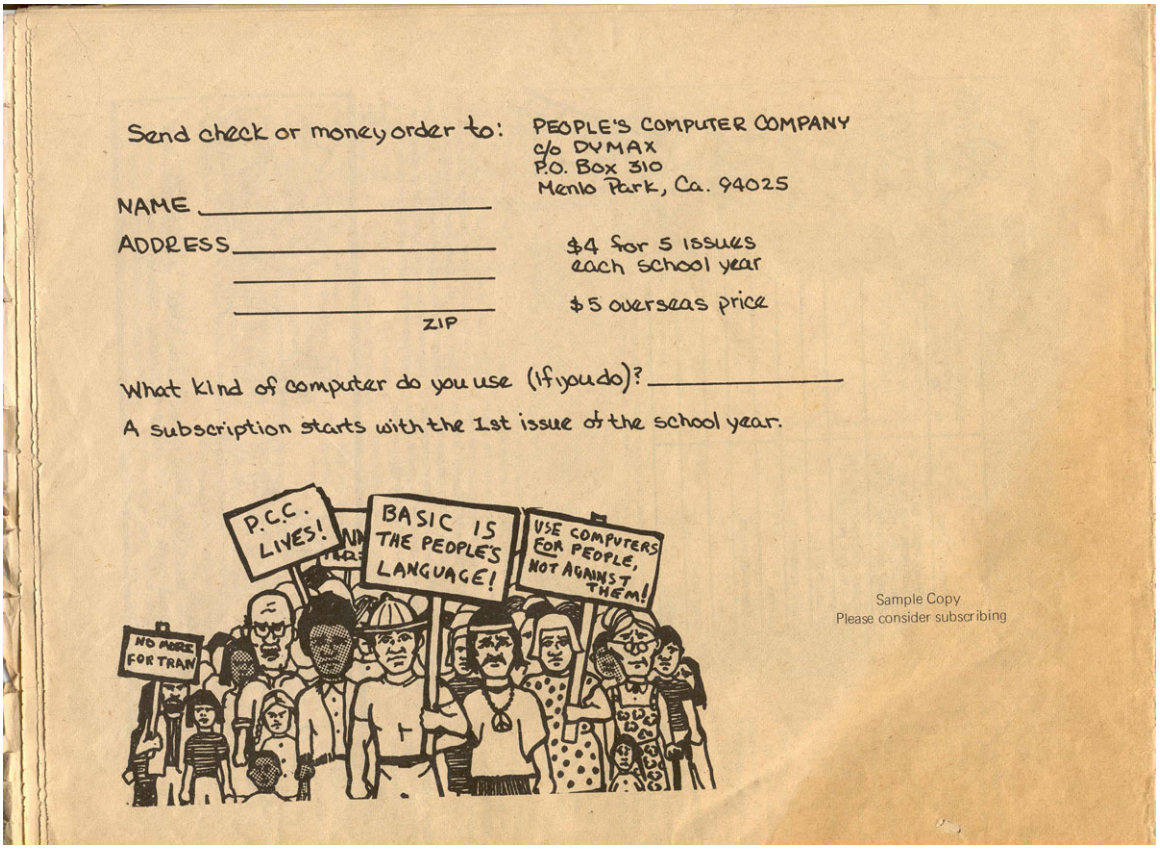
[IAB-19880712] IAB, "IAB Minutes 1988-07-12", July 1988, <https://www.iab.org/documents/minutes/minutes-1988/iab-minutes-1988-07-12/>.

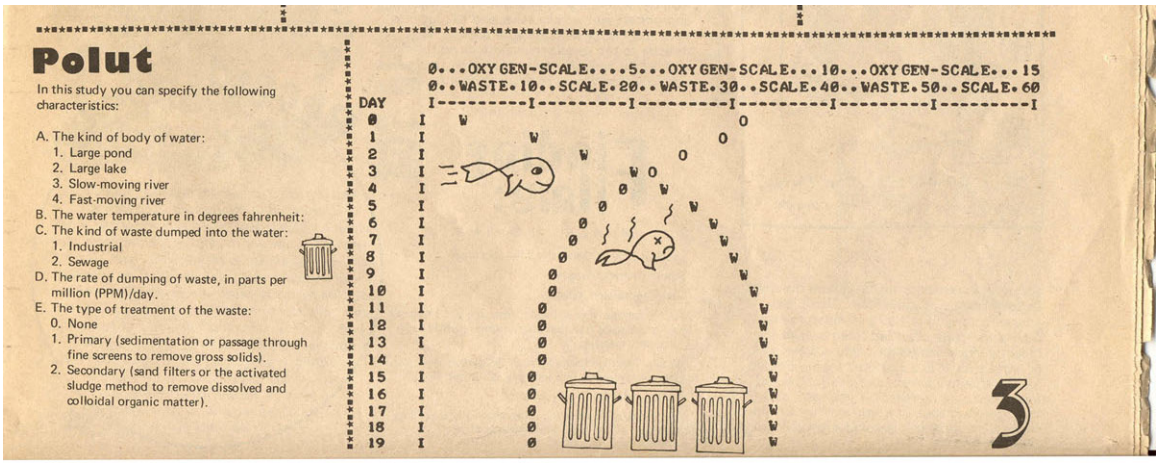
[IETF1]

Request for Comments 8700, *50 Years of RFCs*, 2019.
Even in the conclusions of this RFC, the tool is set to be collaborative and resistant to the challenges of the future, after the recent important structure that the Internet has acquired.

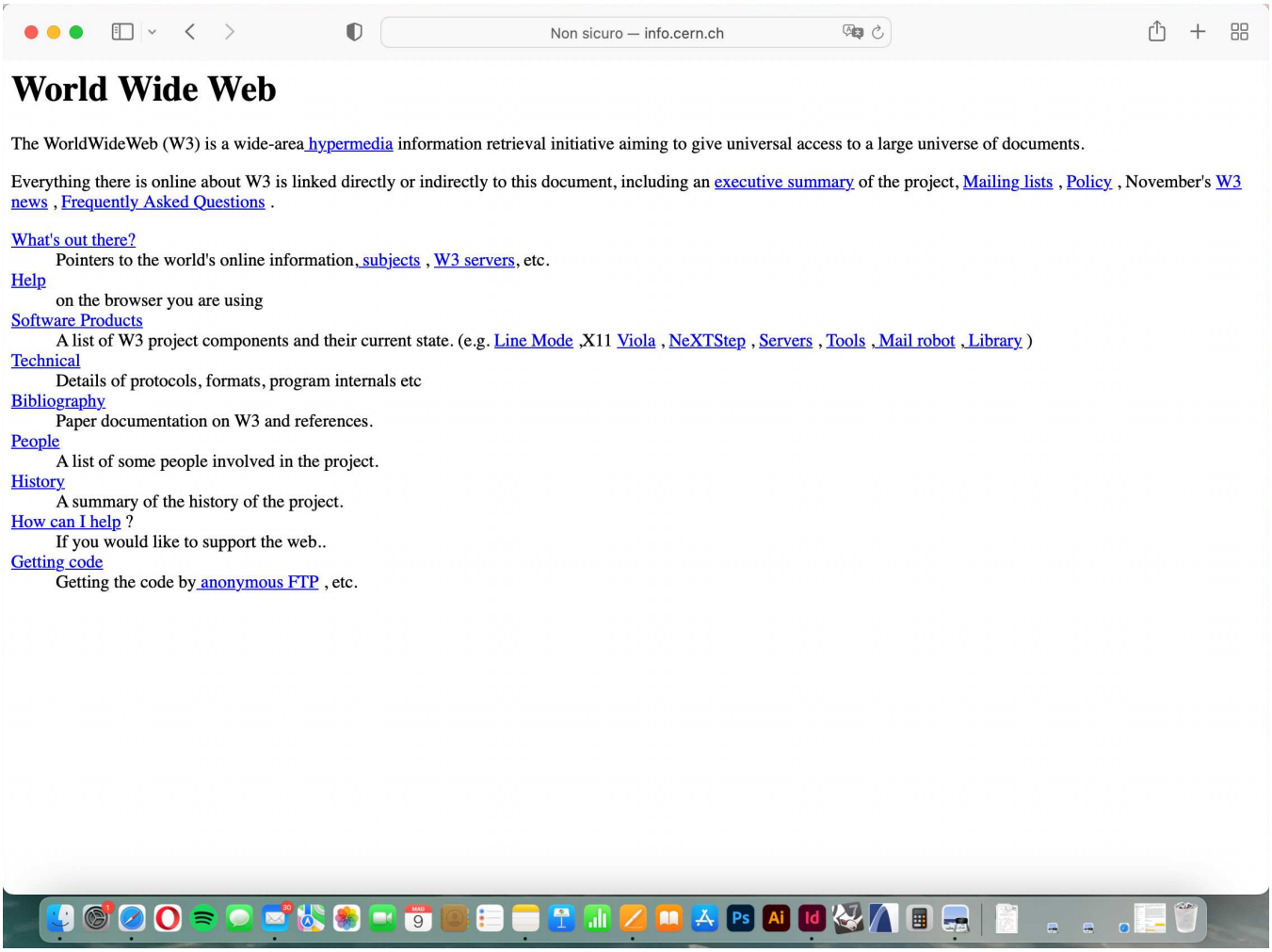


D. Allison, B. Albrecht e G. Firedrake, first newsletter People's Computer Company (PCC), Menlo Park, 1972.
DARPA's ARPAnet project was losing its military relevance and the network began to demonstrate its potential for the common man. The PCC is among the digital pioneers who perceived the importance of the network not for military purposes.





D. Allison, B. Albrecht e G. Firedrake, first newsletter People's Computer Company (PCC), Menlo Park, 1972.
On the back of the first newsletter, the network's audience seems to be depicted: a cultural melting pot that transcends ages. In the form of a protest, the net is stolen from the warring aims to be handed over to the people.



Schermata del primo sito caricato online
Still present on the web, the first searchable site with the concept of hypertext is described in RFC 1945, entitled 'Hypertext Transfer Protocol - HTTP/1.0' published in May 1996. The text is written by the inventor T. Berners Lee and R. Fielding and H. Frystyk. In fact, this RFC describes how the protocol works to move from one network space to another, creating the concept of Internet browsing.

Network Working Group L. Masinter
Request for Comments: 2324 1 April 1998
Category: Informational

Hyper Text Coffee Pot Control Protocol (HTCPCP/1.0)

Status of this Memo

This memo provides information for the Internet community. It does not specify an Internet standard of any kind. Distribution of this memo is unlimited.

Copyright Notice

Abstract

This document describes HTCPCP, a protocol for controlling, monitoring, and diagnosing coffee pots.

1. Rationale and Scope

There is coffee all over the world. Increasingly, in a world in which computing is ubiquitous, the computists want to make coffee. Coffee brewing is an art, but the distributed intelligence of the web-connected world transcends art. Thus, there is a strong, dark, rich requirement for a protocol designed espressoly for the brewing of coffee. Coffee is brewed using coffee pots. Networked coffee pots require a control protocol if they are to be controlled.

Increasingly, home and consumer devices are being connected to the Internet. Early networking experiments demonstrated vending devices connected to the Internet for status monitoring [COKE]. One of the first remotely _operated_ machine to be hooked up to the Internet, the Internet Toaster, (controlled via SNMP) was debuted in 1990 [RFC2235].

The demand for ubiquitous appliance connectivity that is causing the consumption of the IPv4 address space. Consumers want remote control of devices such as coffee pots so that they may wake up to freshly brewed coffee, or cause coffee to be prepared at a precise time after the completion of dinner preparations.

RFC 2324

In April 1998, 'Hyper Text Coffee Pot Control Protocol (HTCPCP/1.0)' was published. It is published as 'April Fools' RFC' and describes the protocol for controlling coffee pots via the Internet. Intentionally ironic and joking, years later it was realised with the Internet of Things. In this sense, the drafting of the RFC can be defined as a theoretical and imaginative space in which Internet authors experiment with the possibilities of the network, even in absurd ways.

"We are mutating into another species–from Aquaria to the Terrarium, and now we're moving into Cyberia. We are creatures crawling to the center of the cybernetic world. But cybernetics are the stuff of which the world is made. Matter is simply frozen information. . . . The critics of the information age see everything in the negative, as if the quantity of information can lead to a loss of meaning. They said the same thing about Gutenberg. . . . Never before has the individual been so empowered. But in the information age you do have to get the signals out. Popularization means making it available to the people. Today the role of the philosopher is to personalize, popularize, and humanize computer ideas so that people can feel comfortable with them. . . . The fact is that a few of us saw what was happening and we wrestled the power of LSD away from the CIA, and now the power of computers away from IBM, just as we rescued psychology away from the doctors and analysts. In every generation I've been part of a group of people who, like Prometheus, have wrestled with the power in order to hand it back to the individual."

–TIMOTHY LEARY, PATAPHYSICS MAGAZINE (1990)

T. Leary, *Chaos & Cyber Culture*, Ronin Publishing, Berkeley, California 94701, 1994.
In the 1990s, the narrative created around the net, its potential and its evanescent form, led to the emergence of characters that became pop in US culture. Timothy Leary, in his book, writes how the web will make the human species leap forward, linking the arrival of the web as a biological process that will change the species. He frames the net as a new environment in which the species must learn to move. From Aquaria to Terrarium to Cyberia.

If you have a desk, you need a Macintosh.

Macintosh was designed for anyone who handles, collects, distributes, interprets, organizes, files, comprehends, generates, duplicates, or otherwise works with information.

Any information.

Whether it's words, numbers or pictures.

We've narrowed it down to anyone who sits at a desk.

If, for example, your desk is in a dormitory, Macintosh isn't just a tool, but a learning tool. For doing everything from problem sets in Astrophysics 538 to term papers in Art Appreciation 101. Not to mention perfecting skills in programming languages like Macintosh BASIC and Macintosh Pascal. Which explains why colleges and universities across the country are ordering Macintoshes by the campus-full.

If you own your own business, owning your own Macintosh personal computer could mean the difference between getting home before dark, and getting home before Christmas. With software programs like MacWrite,™ MacPaint,™ MacTerminal,™ MacProject,™ and MacDraw,™ as well as data-base managers, business graphics programs and other personal productivity tools available from leading software developers, you can spend more time running your business, and less time chasing after it.

And even if you work for a company big enough to have its own mainframe or minicomputer, Macintosh can fit right in. With additional hardware, it can talk to IBM®mainframes in their very own 3278 protocols. It's also fluent in DEC®VT100,™ VT52™ and plain old TTY.

If your company has a subsidiary abroad, your colleagues there can use all the same tools. Because Macintosh will be available in several international versions with local conventions (alphabets, currencies, dates, and more).

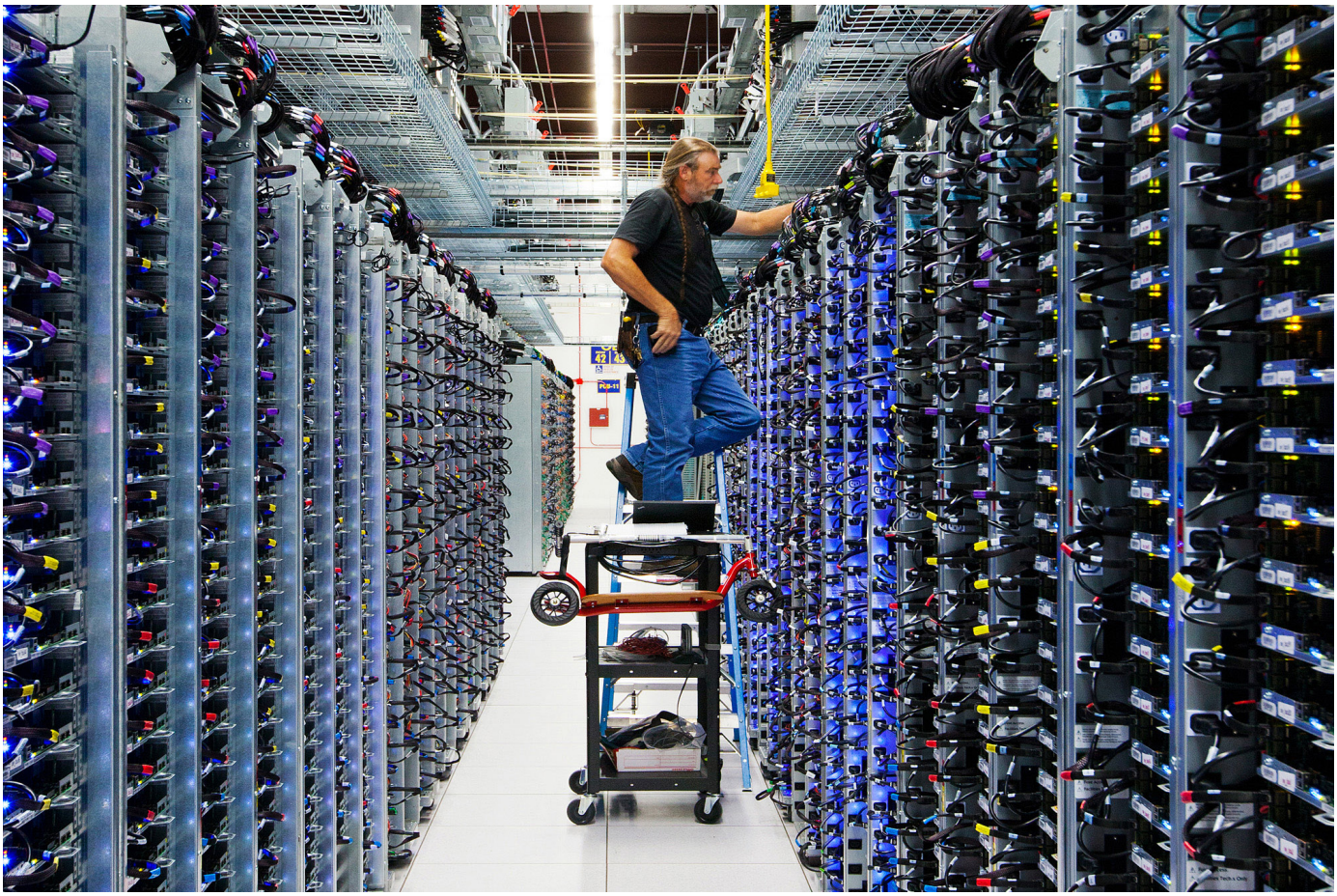
In other words, wherever there's a desk, there's a need for a Macintosh.

And the less you can see of your desktop, the more you could use one.

Apple Macintosh, Brochuse, December 1983.
The 1980s and 1990s were years of software but also hardware experimentation. The formal evolution of computers caused them to lose volume and enter the domestic. Now the ideal surface for using computers has become the home desk. Step by step, the elements that led to the contemporary use of the network through personal terminals and shared hardware in data centers began to be linked together.

Google
The original caption of the photo taken in the Google section dedicated to their data centres: 'The network room in Council Bluffs || The network room spaces in our data centre in Council Bluffs, Iowa, are divided with plastic curtains. In this room, the cold air is distributed through the floor and the transparent plastic curtains help to keep the cold air in while keeping the hot air out.'

Blake Gowriluk, 2014.
Helicopter survey of the Google Data Farm ar Pryor Creek, Oklahoma.



Google
The original caption of the photo taken in Google's section on their data centres: 'Roger in Mayes County || Roger looks after the infrastructure of our data centre in Mayes County, Oklahoma, "which allows Google to do the things it does", he says.'

Google
The original caption of the photo taken in Google's section on their data centres: 'Aisle with a row of servers in Meyes County || An unusual look behind the server aisle of our data centre in Mayes County. Here hundreds of fans channel hot air from the server racks to a cooling unit for recirculation. The green lights are the status LEDs of the servers reflected on their fronts.'

3 ARCHITECTURE OF THE STANDARDS: ARCHITECTURAL LANGUAGE OF THE DATA CENTER

3.1 Data center: Standards and Protocol Spaces

> Other search engines in the 1990s had the chance to do the same, but did not pursue it. Around 2000 Yahoo! saw the potential, but nothing came of the idea. It was Google that recognised the gold dust in the detritus of its interactions with its users and took the trouble to collect it up. [...] One example is Google's search engine, which is partly guided by the number of clicks on an item to help determine its relevance to a search query.
>
> Kenneth Cukier, *Data, Data Everywhere*, The Economist, 25 febbraio 2010

In 1997, Mitchell cleverly identified the laying of fibre optic cables as a drastic change that took place not even ten years later. The digital highways were already laid, the Internet had already entered the homes of the world's population and the amount of connections continued to grow without stopping.
With the beginning of the new millennium, the network discovered in 1969 by a military programme, began to fully embrace the logic of capital. The first company that discovers this trick is Google, which accumulates the behavioural surplus given by the waste information left by users and decides to make a personal profit out of it. The company discovers that this mass of surplus data could be sold to third party companies to place advertisements of their products according to the searches that users make. Thus began the targeting and profiling of users. If Google had initially set up its search engine as a portal to search for information for the sole purpose of circulating knowledge, around 2002-2004, it was discovered that this data could make a lot of money[1].
It was precisely in this period of the development of the Internet infrastructure that the structure of the data centres was formalised in a more organic and coherent form. Everything was already in place, the mechanical, electronic and electro-technical components were already available, what was needed was a coherent reorganisation of the material to accompany the companies in building the infrastructure system in the most flexible way.
Servers were already widely used in the IT world, cabinets to organise servers

[1] Cf. S. Zuboff, *Il capitalismo della sorveglianza*, LUISS University Press, Roma 2019.
In the text, the author traces the steps and reasons that have led the big tech companies (Google, Meta, Apple, etc.) to equip themselves with such an important infrastructure that occupies scarcely visible areas of our cities. Of course, the issue of behavioural surplus is only one of the needs that led to the investment in hardware infrastructure by tech companies, but it is perhaps the most representative of the direction that the infrastructure itself is now taking.

according to rack unity (RU) had already been extensively described in standards released decades earlier[2]. The classical elements for the assembly of a data centre were already all there, the mature IT issue was shaken up in the years 2000 to 2005, years in which the standards association community noticed and at the same time foresaw a large investment in this type of infrastructure. Between 2005 and 2015, standards began to be written by organisations such as TIA and Bicsi that comprehensively describe the installation of a data centre. The discovery of what Shoshanna Zuboff calls behavioural surplus coincides with the beginning of the infrastructural expansion of the network. What the sociologist is talking about occupies a space, although used with different logics to which the human eye and mind is accustomed, but it begins to persist in the territory, continuing to expand its mass until today.

If the story initially in the 1970s was more about the aspect of possibilities questioning the use of the network accompanied by a feeling of freedom and liberation, the infrastructure of the digital in the 2000s develops its hardware part in a way never seen before.

Authors such as J. C. R. Licklider or computer scientists such as Steve Crocker made their contribution to the conceptual and protocol development of the infrastructure, to the arché; on the other hand, organisations such as TIA and Bicsi contributed to the organisational tectonics of the physical structure. Thus, IP protocols[3] ound greater circulation with the discovery that Google made around the 2000s.

The etymology of the word architecture is re-built through its generating principle: the arché of the data transmission protocol and the tectonics of its physical composition.

Mitchell a few years earlier made remarks on the change of cities with the advance of this infrastructure. The similarity with the new meaning of the word architecture can be seen when the author juxtaposes the Nolli map of Rome and Apple's e.World display[4]. Although anchored in a visual imagery that still dialogues with human perception, the author understands that the new contemporary landscape is the screen, the one that gives information about the world and connects people with each other. Obviously this service is what will later evolve into today's operating systems that have totally abandoned urban reference as imagery. Mitchell's lucidity will soon be rewarded in the years following the release of his essay, although it all begins to dialogue much more with capital than with the human being as the author himself tried to elaborate.

[2] For example the EIA-RS-310 standard that was approved in 1968. This Electronic Industries Association document describes the precise pitch of the bolts in the metal bar to allow an orderly elevation when stacking servers within a rack or cabinet. Standard obviously also adopted in later TIA and Bicsi for the organisation of a data center.

[3] Introduced in 1981 in RFC 971.
This document specifies the DoD Standard Internet Protocol. This document is based on six earlier editions of the ARPA Internet Protocol Specification, and the present text draws heavily from them. There have been many contributors to this work both in terms of concepts and in terms of text. This edition revises aspects of addressing, error handling, option codes, and the security, precedence, compartments, and handling restriction features of the internet protocol.
This is what is written in the preface of the RFC 971 document by editor Jon Postel. in particular, this RFC explains which protocol and how it is used in the transmission of data over the network: application method of the ISO/OSI theoretical model.

[4] e.World was an online service provider offered by Apple. The communication between user and terminal was a cartoonish representation of a city with its most representative buildings that grouped service functions, messaging and more.

These cumbersome architectural structures are impregnable, sealed and guarded 24 hours a day all year round. The visual material available on the web does not differ much from the reality of the facts, but certainly does not provide a complete overview to understand their complex functioning. Much more immersive and engaging are the drafts of the first standards released, useful for traversing the forbidden spaces of the data centre. First of all, there is the one released by TIA (Telecommunications Industry Association), recognised by the US organisation ANSI (American National Standards Institute).
In 2005, the development of digital infrastructure began the first necessary steps for a space organisation and it was necessary for the first tech industries to address the space issue, knowing that the growth of these spaces could potentially be infinite[5].
TIA and BICSI were the first two organisations involved in drafting documents to help build the structure. While the first edition of the standard is the one made by TIA in 2005, for BICSI we have to wait until 2011.
Both texts follow the same structure and state from the outset that:

> "1.3 Categories of criteria
> Two categories of criteria are specified—mandatory and advisory.
> _Mandatory criteria generally apply to protection, performance, administration and compatibility; they specify the absolute minimum acceptable requirements.
> _Advisory or desirable criteria are presented when their attainment will enhance the general performance of the data center infrastructure in all its contemplated applications.
>
> Mandatory requirements are designated by the word shall; advisory recommendations are designated by the words should, may, or desirable, which are used interchangeably in this standard. Where possible, requirements and recommendations were separated to aid in clarity.
> Notes, cautions and warnings found in the text, tables, or figures are used for emphasis or for offering informative suggestions." (BICSI)

In addition to giving clear indications on how to read the text, both standards consist of chapters and annexes, where the chapters concretely represent the part of the text that addresses the issue of spatial organisation, while the annexes provide additional information, guidelines, and detailed examples that are useful but not essential to the construction of the data centre:

> Annexes A, B, C, D, E, F, G and H are informative and not considered to be requirements of this Standard except when specifically referenced within the main document. (TIA)

The structure of the text is proposed as a guide to be consulted according to the needs of the different professionals to whom it is addressed, and this is noticeable because a lot of technical information is given in a pedantic manner in many chapters.
As is reported in the first chapter:

5 Professionals in the field were already aware that they were talking about a system and as such it had to be spatially regulated.

1 SCOPE

1.1 General

This Standard specifies the minimum requirements for telecommunications infrastructure of data centers and computer rooms including single tenant enterprise data centers and multi-tenant Internet hosting data centers. The topology proposed in this document is intended to be applicable to any size data center. (TIA)

The standard therefore insists that the data centre is a system and that its construction at any scale will be described. Moreover, what you read in the text are not instructions that, step by step, accompany you in the construction of a structure, but the main purpose of the standard is to highlight the different parts of which it is composed and the different issues that need to be addressed during construction. This means that anyone who wants to build a data centre by consulting the standards must then turn to the different professionals involved and competent to make the system work.
The standards have within them all the other standards used to produce the manual, ensuring that more than 60 organisations in the telecommunications industry contributed to the drafting.
Although both are standards for building a data centre, the difference between the two is that TIA addresses cabling, power, environment, security and space management, while Bicsi is focused on best practices for building a system. This makes TIA-942 the best-known and most recognised standard to today, with the difference that now, this type of manual is no longer consulted as the companies that produce it have more than 10 years of consolidated know-how in system construction and installation. The current focus is more on energy and safety, topics that are constantly developing.
Therefore, the general spatial expression is described in the TIA standard, which after the initial notes, the glossary of terms and acronyms used in the text, includes a diagram representing the relationships between the spaces that compose a data centre. He precedes the description of the minimal spatial characteristics by coordinating with the architect and engineers the preliminary plan of the project. This will be one of only two occasions in the entire text where the profession of the architect is named (note: in the singular, as if there is the idea that the architect is one and alone contains the necessary knowledge, a twentieth-century view of the profession, while the other professions are always written in the plural, as if to represent the discipline rather than the person), the only other time, the architect is named for the question of lighting, where, almost optionally, the option of approaching him for the lighting plan is suggested.

The steps in the design process described below apply to the design of a new data center or the expansion of an existing data center. It is essential for either case that the design of the telecommunications cabling system, equipment floor plan, electrical plans, architectural plan, HVAC, security, and lighting systems be coordinated. Ideally, the process should be:
[...]
c) Coordinate preliminary data center space plans from architect and engineers. Suggest changes as required. (TIA)

The distribution diagram of the spaces speaks for itself (p. 141): everything is at the service of the Computer Room, while the rest of the spaces are necessary to make the whole system work. The protagonist and true inhabitant of these rooms is the cable, which runs through various spaces to connect to the Computer Room's

numerous servers to make the connection work. The diagram in fact shows the Entrance Room, but it is not considered the access for humans, rather it is the landing place for all the necessary external cabling that then branches off inside the Computer Room. The diagram does not really represent the spaces, but the places where the cables and their accessory spaces reside; man is no longer the protagonist of the project, but becomes a necessary tool for its operation.
The standard then proceeds to describe the minimum requirements of the Computer Room by saying that the minimum height of the room must be 2.6 m from the finished floor to any obstacle such as lighting or sprinklers. Floors, walls and ceiling must be sealed and painted with materials that minimise dust, the great enemy of electrotechnical equipment. Doors must be at least 1 m wide and 2.13 m high with hinges that open outwards, all without thresholds to facilitate the movement of material. Speaking of the Entrance Room, the text suggests creating the cabling access with the same distribution as is used in the Computer Room, to minimise the length of cables[6], pointing out that human access to this space must be strictly controlled by the data centre owner or space manager.
Confirming the fact that the cable is the true logical-spatial actor, the standard groups the entire cabled component into different zones according to logical proximity to the computer room[7]. So there is the MDA (main distribution area) which can be considered the grouping of incoming cables, the HDA (horizontal distribution area) which is the horizontal distribution area that extends throughout the data centre, the ZDA (zone distribution area) which coincides with the cabling of different zones within the data centre - the different Computer Rooms and the EDA (equipment distribution area) part of the cabling that connects to the servers.
The protagonist is the cable and the treasure to be defended are the servers in the Computer Room. The cables enter in an orderly sequence through cable trays with a maximum depth of 150 mm and connect to the servers, which consequently produce the heat from the operation of the machines.
The scheme of hot and cold aisles (p. 142) represents the best orientation of the racks to prevent overheating in the room. By dividing the space into hot and cold zones, it will be easier to concentrate heat in certain areas and then cool it down with HVAC systems running 24 hours a day, every day of the year. The standard repeatedly describes the ideal temperature for data centre operation:

> -dry Bulb Temperature: 200 C (680 F) to 250 C (770 F);
> -relative Humidity: 40% to 55%;
> -maximum Dew Point: 210 C (69.80 F);
> -maximum Rate of Change: 50 C (90 F) per hour;
> -humidification and dehumidification equipment may be required depending upon local environmental conditions.
> (TIA)

If the temperatures were to change, the functioning of the system could be compromised, which is why all data centres provide cooling of the spaces with various systems present that are designed specifically for this purpose. The standard

[6] At this point, the manual tends to bring more notions and efforts for an optimal floating floor distribution and only for lighting and sprinklers, use different suspended electrical circuits.

[7] Note that the cable subdivision does not always correspond to a specific space, but the manual physically divides the cable according to the distance from the arrival at the Entrance Room to the physical connection to the server. Sometimes, some subdivisions may coincide spatially; this depends on the complexity of the structure.

recommends these temperatures, but does not go into the specifics of cooling, as well as the specifics of structural safety and fire safety, which will be discussed with the relevant professionals.
If the main text in the chapters gives us a general overview of the logical-spatial issues, it is in the annexes where there are more tangible explanations and representations. The diagram (p. 145) in annex B shows the generic plan of a Server Room with the typical floating flooring modulated according to the 60x60 cm measurement, inside which all the cabling coming from the Entrance Room passes. The flooring becomes functional for the positioning of the racks, which can then be identified by means of a simple grid diagram with assigned nomenclature to quickly identify any errors or malfunctions[8]. This diagram differs little from the plan (p. 147) in annex H (INFORMATIVE) DATA CENTER DESIGN EXAMPLES. An example layout for a generic Computer Room is presented on page 131 of the standard. This is one of the first times that a Computer Room including accessory spaces has been officially published. The racks lying in the floor, the hot and cold zones, even the air vents for the floating floor are drawn; now the layout becomes more projected in the reality of the building. On the sides of the racks, the accesses to the structure and the accessory components to the functioning of the infrastructure are visible. Were it not for these useful graphics for orientation, the system of racks on the floor would still be a diagram with infinite potential for expansion.

3.3 Server Room: Programmed Architecture

Archizoom's first reflections on Non-Stop City! were made by the group of architects in late 1969. The first typed drawings reflected on the hypothesis of a non-figurative architectural language. The different drawings, through the use of Currier fonts, composed plans of a hypothetical structural diagram, radically changing the approach to the representative tools of the architectural discipline. The plan they invented was awaiting human occupation and the limitations of the design are given by the action space of the typewriter. It was from the limits set by the paper that the radical group subsequently developed their theory of the city, which clashed strongly with the classical theories circulating at that time. Imagining an architecture formed by an inexpressive structure with an adaptive capacity that crosses territories, Non-Stop City! was the first theory on the city that considered architecture, objects and spatial design in general, no longer part of a unitary path with a totalising strategy. With this theoretical project, Archizoom proposes itself as a precursor to thinking architecture not as a superior discipline, but as an accessory and pervasive framework for experiencing space.
Similar reflections, with totally different outputs, can be found in the spatial development of information technology. As explained in the previous chapter, the RFCs (Request for Comments) can be described as a primary theoretical input on how the network works. The authors themselves had already noted the versatility of the tool, so much so that we have confirmation in the RFCs themselves, as in 2321, which jokingly describes an imaginary character named RITA who acts as a personal assistant to solve network problems. This humour, combined with the shrewdness of someone who knows the territory and tools of the discipline, is also the keeper of the formalisation of the data centre and an outpost for future network perspectives.

8 The standard explains in detail the reasoning behind the adoption of the floating floor. As well as being a storage container for the cabling, the size of the flooring dialogues with the racks to allow the agility of opening the floor for any maintenance.

The first RFC entitled Host Software is published on 7 April 1969; the document describes the first network connection with the first protocols used and the connection that took place between UCLA (University of California, Los Angeles) and SRI (Stanford Research Institute).
In the same year that Archizoom starts thinking about Non-Stop City! RFC-1 is published[9]. The first of the theoretical documents on how the internet works is also typed in the Currier font, and if one looks at the document by adopting the logical shift offered by Archizoom in their diagrams of non-figurative architectural language hypotheses, one can see the first spatialisation of the digital infrastructure. Perhaps due to a lack of other tools or perhaps for formal coherence, on page 9 of RFC-1 there is the diagram describing how the signal started from the terminal at the University of Los Angeles and how, through the network connection with its protocols, the signal quickly travelled across the territory of the United States until it reached the terminal at Stanford University (page 140).
From this first document published by Steve Crocker, others would follow to the present day; a myriad of RFCs, which maintain the kind of representation that is formally blurred with text.
RFC-791 published in September 1981, on the other hand, describes the operation of the IP protocol, a technical application protocol of the OSI conceptual model, which describes the standard mode of communication between two network devices. Page 11 of this RFC contains the datagram representing the minimum unit of data sent over the network, which includes actual data and control information necessary for its delivery.
The first spatial representation of the digital infrastructure uses the same graphical language to illustrate the matter travelling through the network: the spatial diagram and the IP protocol datagram share the language, form and structure of representation. The representation of content and the container talk to each other in a clear and coherent manner with the notable difference that one is faced with a space no longer built for man, but for the machine. Architecture does not address man directly, but acts as a spatial medium for the human being, useful for experiencing the territory in a new key.
The example of the floor plan of a generic data centre presented in the TIA-942 standard clearly reveals the distinctive features of a spatial technical design. The closer the eye gets to the edges of the drawing, the clearer the architectural representation becomes. The doors, the glass panes, the load-bearing and non-load-bearing structure give a metric scale and a position to the contents of the server room, but if these representative and orientative spatial elements were removed, one would be faced with a diagram consisting of the 60x60 cm floating floor and the custodian racks of the servers, placed neatly according to the rules of hot and cold aisle. The floor plan would thus lose contact with reality, and a potentially infinitely replicable diagram would emerge.
The re-elaboration of the plan (p. 143) using the font Currier, underlines how the design seeds of a future spatial organisation of the digital infrastructure, were already established as early as the first RFC. The diagram was skilfully translated into space by a discipline that had to make use of architecture to achieve its aims. This is where the real encounter between computer science and architecture takes place, i.e. when the data center system had to develop a spatial theory, given the increase in data over the last twenty years.
Architecture emerged from a keyboard by formally organising both its content

9 In both cases, the paper becomes an important design and reflection tool.

and structure. With a logical, coherent and hyper-rational method, the creation of the first space of the digital infrastructure takes place in which human presence is barely tolerated for purely control and management issues.
As is clear from the various diagrams, diagrams, but also from simple online imagery, the constitutive principle adopted is one and is replicated at different scales. The grid as an organisational and conceptual method is also rigidly applied to the architectural form.

3.4 Grid

The use of the grid, a classic design method for spatial production that spans the entire history of architecture, is not interesting in its application, but in its obsession and repetition at every scale.
This constructive principle also governs the contemporary spatialisation of the data centre system, which, by synthesising the whole of space, resumes its insistence on all the territories of the globe.

3.4.1 Macro- 1:1000000

The territory in which the story develops has a long tradition steeped in control, conquest and national defence. The United States has long been a land of colonisation, developing unique territorial strategies that differ profoundly from European spatial theories. Banham in his production speaks clearly about the sense of movement that created a different architecture and a different mode of territorial expansion, and Lynch considers the difficulty of human beings to create for themselves a suitable environmental image in order to consolidate a strong relationship between people and space. The United States has been an area where the classical principles of architecture are first questioned and then profoundly altered.
The major cities of the East Coast adopted the typical grid expansion that proved fortunate for their development. While 19th century American railways designed less orderly and more spontaneous routes, with the rise of the automobile as the main medium for traversing the land, we see a more orderly and regular infrastructural design. As early as 1938, President Roosevelt[10] personally drew the hypothesis of the 8 grid highways, which would gain in value soon after the end of the Second World War, intensifying as time went on. Thanks to this infrastructure, full control of the democratised territory is taken over through the use of the grid conveyed by the medium of the automobile.
In addition to the horizontal conquest, the same tension pervades the unexplored celestial vault, the design of the sky, with the chase to build the tallest skyscraper. New urban policies and design tensions have contributed to the ascent to the sky. The attempt came with the Empire State Building, when the floor housing the observatory was designed for the docking of zeppelins, thus trying to complete the thirst for conquest in both directions. The completion is achieved in 1969, when Apollo 11 lands on the Moon and when the first network connection is made with the ARPAnet project. Through different modes of conquest, the American colonising dream comes true and is revealed.
Vertical extension and its fulfilment occurs on the east coast and the culmination of horizontal extension occurs on the west coast. For the pioneers, there is no more horizontal territory to conquer, process and control. To cope with the hunger for conquest, it seems that expansionist aims must proceed with the construction of a new space first, to be conquered later. The pioneers therefore arrive on the west

10 Cf. opening image of Chapter 2 Prelude to Space.

coast of the federal state and continue to conquer new spaces by creating the Internet, once again applying the grid system.

3.4.2 Meso- 1:100

> Why not set a higher value on dispersal? Instead of living in just one place, and trying in vain to gather yourself together there, why not have five or six rooms dotted about Paris? I'd go and sleep in Denfert, I'd write in the Place Voltaire, I'd listen to music in the Place Clichy, I'd make love at the Poterne des Peupliers (a leafy spot in the 13th arrondissement), I'd eat in the Rue de la Tombe-Issoire, I'd read by the Parc Monceau, etc.
>
> G. Perec, *Species of Spaces and Other Pieces*, Penguin Selected Writings, London 1974
> G. Perec, *Specie di spazi*, Bollati Boringhieri, Torino 1989

Perec's quotation offers the image that the data centre and the entire information infrastructure has been trying to achieve. The system infiltrates the urban landscape tracing the pace of infrastructures we have been accustomed to in the last 70 years or earlier but, unlike the author's dream, the digital's infrastructure acts on space maintaining the same output as the quotation, but proceeding with illusory protocols that do not involve the movement of the body: space goes towards the individual through its pervasive infrastructure and its terminals.
The classical spatial rhythms of architecture undergo an inversion by conditioning the project. Leaving aside the possibility of experiments in the coexistence of the two disciplines (architecture and IT) in a coherent and complex urban system, so far modest in its attempts[11], the tension of the project seems to detach itself from the urban context. An infrastructure that permeates centuries of design, but unlike other technologies with similar formal characteristics, it heavily affects the compression and expansion of space by playing with the classical rhythms of architecture.
At various scales it silently changes the positions of places of geopolitical interest, and at the urban scale it tends to empty existing structures of value.
Thus Mazara del Vallo suddenly becomes a globally important landing point for fibre optic cables[12]. A small town in the province of Trapani with just over 50000 inhabitants quietly becomes an outpost for the digital issue. It is there that most of the cables that touch the Italian coasts land, also absorbing all the fragility of the system.
By now, in all urban contexts, we are occultly suffering the spatial consequences of this infrastructure that empties the content of architecture, that content that gave form and value to the built project. Already in Learning from Las Vegas, Venturi perceived the formal detachment of the symbol from the structure: architecture is composed of the billboard that qualifies the existence of the lived space, in addition to the architectural structure. This type of approach clearly reflects the adoption of the automobile as a medium to travel the territory. Humans and architecture have had to find a new common language to achieve their coexistence through haighways, and with the medium of the automobile, a new way of experiencing the built environment begins.
Today, another medium has been introduced: the data center, which with its infrastructure begins to insist on the urbanised environment, remixing the subjects

11 Embedding the issue of the data center within the architecture project seems to be an unexplored theme. Contemporary projects continue to develop the envelope by pursuing the usual formal issue of the structure.

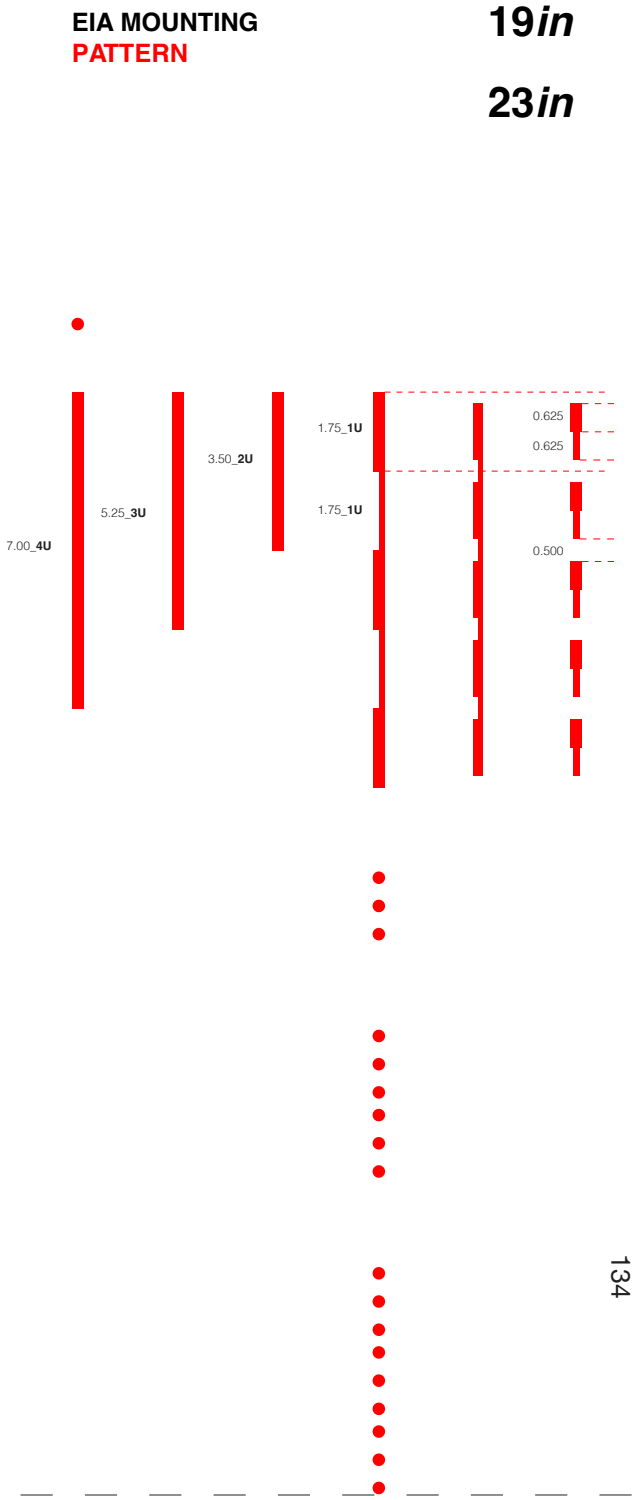
12 Cf. Annex A.

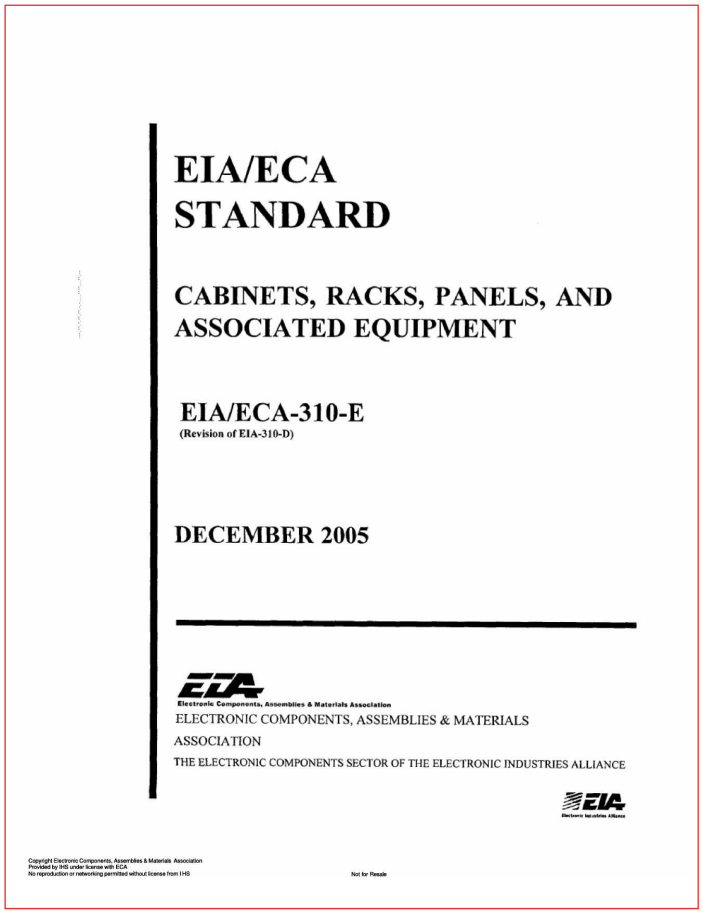
studied by Venturi.
With the pervasiveness of the system, architecture today suffers a violent disruption that produces a total emptying of content. What remains is the appearance, the exterior image of the architecture, with the content synthesised in servers stored between different data centers.
As of now, infrastructure creeps into cities maintaining the formal urban status quo, approaching the narrative of Potemkin villages, fake realities where everything seems to work, but the reality is instead all an acting mockup. This, however, is not a new subject on US territory. The westward rush for gold has in fact left examples of the 'Western false front architecture', villages built by pioneers advancing westward, consisted of urban agglomerations in which the main façade had to show relevance to those passing by. The shape and proportion of the façades on the street front did not correspond to the building behind, so that the former were built with more valuable materials than the latter.
Relegating the representative function to the urban context and in fact leaving it floating in the absence of content, this historical moment sees the data center as an a-symbolic architecture filled with content in which the highest security standards are applied. Consequently, the new digitised territory emerges that fully lives through the medium of the data centre.

3.4.3 Micro- 100:1

At the end of each calendar year, the Uptime Institute (UI) publishes its forecasts for the following year, trying to anticipate relevant issues affecting the digital infrastructure. The report of the forecasts for 2024 speaks for itself: the infrastructure to this point is essentially limited by chip production. Especially with the great demand to support artificial intelligence, in 2024 the UI research department reveals that there will be no further upheaval in the infrastructure because the amount of chips produced is related to the human capacity to manufacture the components. Once again, the system clashes with human time and logic.
The world's major investments are now placed in millimetric design, contributing to a vacuum in the design of spaces in urban contexts. Investments are made to increase the infrastructure that acts as a plug-in for the built territories. If the 1969 Archizoom No-Stop City! project played with fluid and interchangeable spatial modularity, today's action of the data center as a plugin for the built environment acts as an additional software component that extends or adds functionality to buildings. The data center acts as a seamless extension component that silently integrates into the building infrastructure speaking the language of binary code. In the software context, plugin is the seamless integration that does not disrupt the main application and does not cause interruptions to the user experience.
The new medium that connects architecture and the human being is composed of small, expensive chips that at first act imperceptibly on the building, but gradually empty the spaces of content by housing it in data centers. Thus the Cartesian micro-design synthesises the different design scales to itself, acquiring the spatiality of the project and significantly influencing the global context: the grid goes beyond the physical limits of the project and pervades everything.

Vertical expansion of a server room
The diagram summarises the standardised measures for composing servers within a standard rack. With just a few measures and a few rules, the server room is built with a modular system.
The diagram summarises what is described in the EIS/ECA-310-E standard.





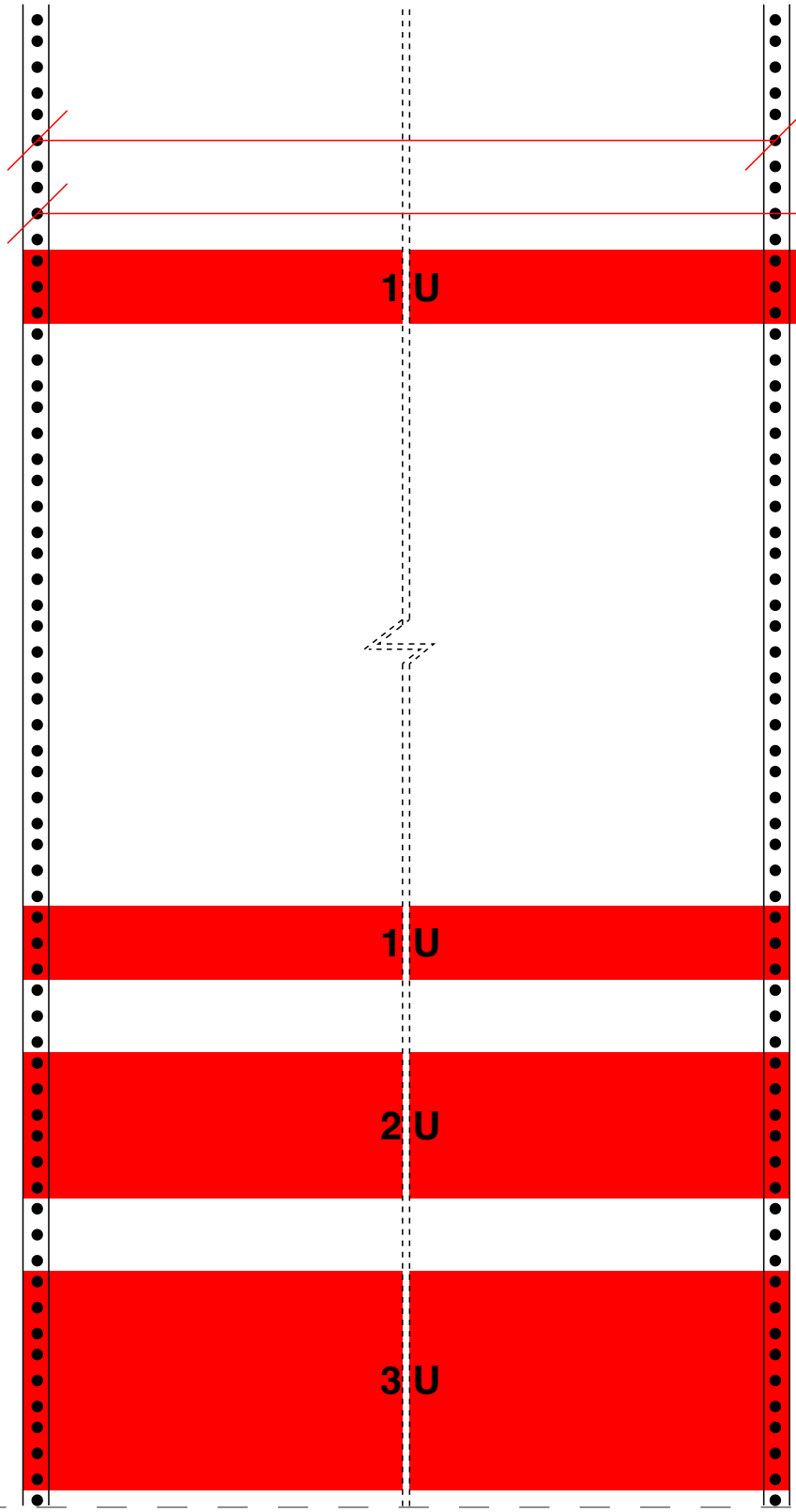
EIA/ECA
STANDARD

CABINETS, RACKS, PANELS, AND
ASSOCIATED EQUIPMENT

EIA/ECA-310-E
(Revision of EIA-310-D)

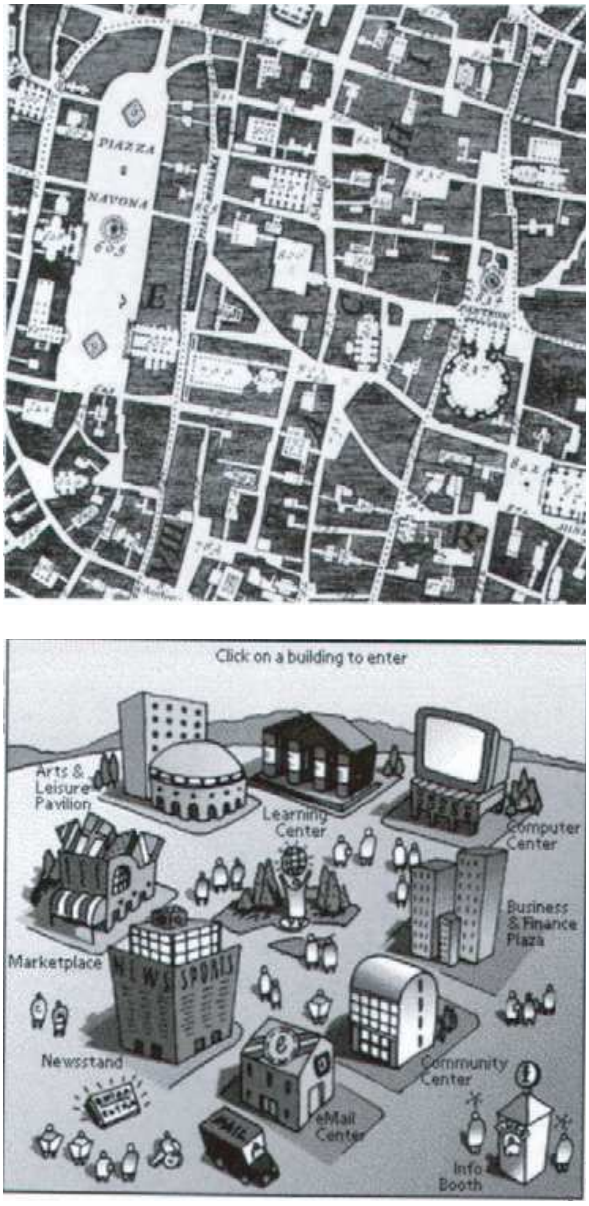
DECEMBER 2005

Electronic Components, Assemblies & Materials Association
ELECTRONIC COMPONENTS, ASSEMBLIES & MATERIALS
ASSOCIATION
THE ELECTRONIC COMPONENTS SECTOR OF THE ELECTRONIC INDUSTRIES ALLIANCE



Definition of units

EIA Unit	Nominal Height	Max. Acutal Height
1 U	1.75'' (44,45 mm)	1.72 [43,69 mm]
2 U	3.50'' (88,90 mm)	3.57'' [88,14 mm]
3 U	5.25'' (133,35 mm)	5.22'' [132,59 mm]
N Units	N UnitsX1.75'' [44.45]	N UnitsX1.75''-.03''



Map of Rome, G. B. Nolli and Apple's eWorld screen.
The two representations are juxtaposed by Mitchell in the essay The City of Bits. The author juxtaposes two ways of seeing public space. The form of the city is synthesised in the screen. The images are two different ways of representing the city.

RFC: 791

INTERNET PROTOCOL

DARPA INTERNET PROGRAM

PROTOCOL SPECIFICATION

September 1981

prepared for

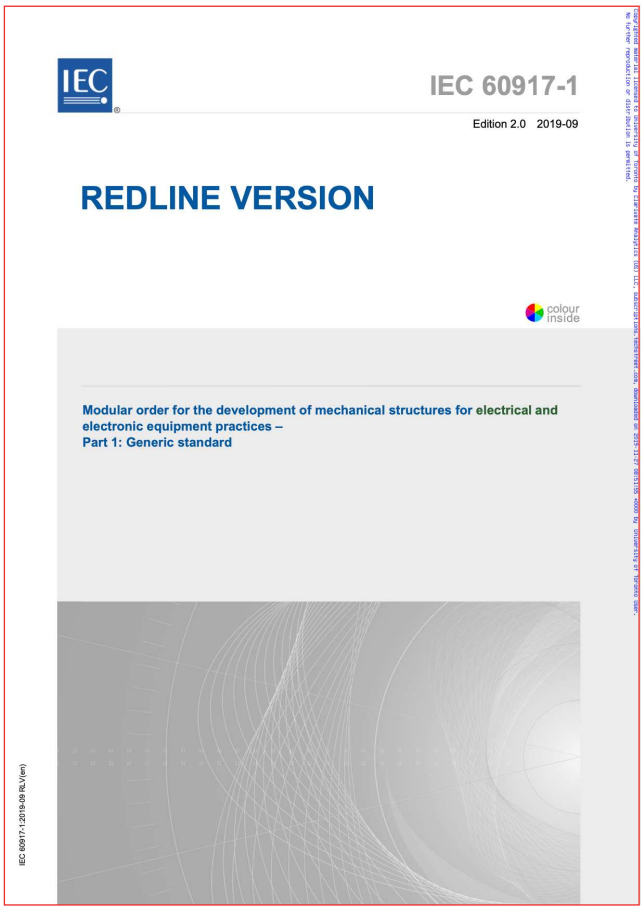
Defense Advanced Research Projects Agency
Information Processing Techniques Office
1400 Wilson Boulevard
Arlington, Virginia 22209

by

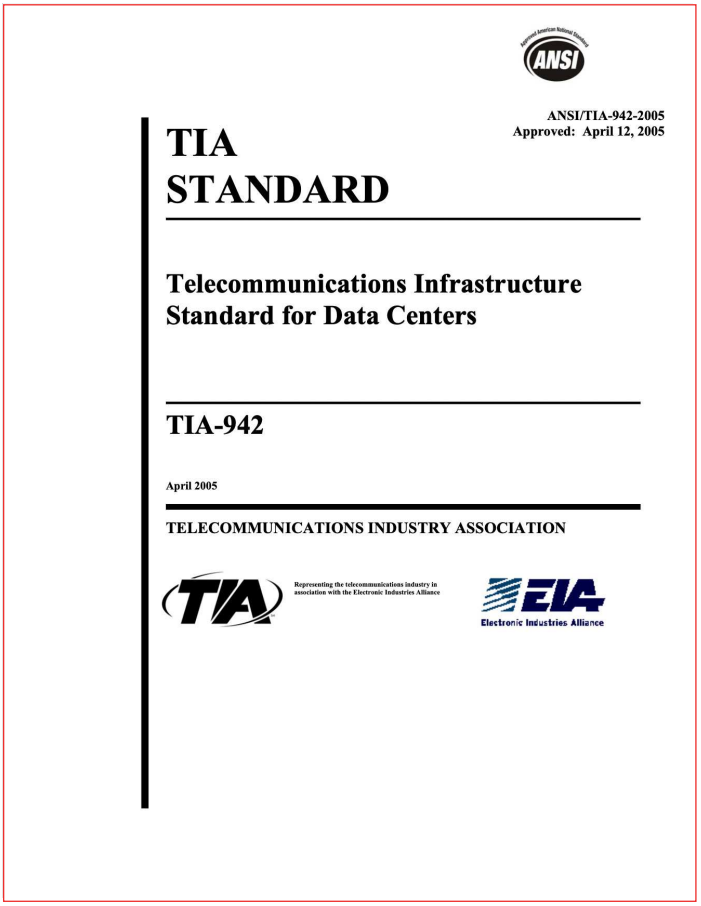
Information Sciences Institute
University of Southern California
4676 Admiralty Way
Marina del Rey, California 90291

RFC-791

In 1981, Jon Postel published this RFC in which he describes the technical specifications within an IP (Internet Protocol) network. Explaining how the IP protocol works is the knowledge base for crossing information in a network. If the image used by Mitchell of the Apple screen, is merely a visual representation of a way of conceiving the network, with RFC-791 we get into the technical spatial issue by describing what lives and how material circulates within the network.



IEC 60917-1 | ANSI/TIA-942-2005 | ANSI/BICSI 002-2011
The IEC standard introduces the modular order for the composition of mechanical structures electrical and electrotechnical equipment. The standard explains how all components are proportioned from the smallest millimetre scale to the spatial scale, to maintain consistency and fluency in design.
The other two images present the two main standards for designing a data centre.



ANSI/TIA-942-2005
Approved: April 12, 2005

TIA STANDARD

Telecommunications Infrastructure Standard for Data Centers

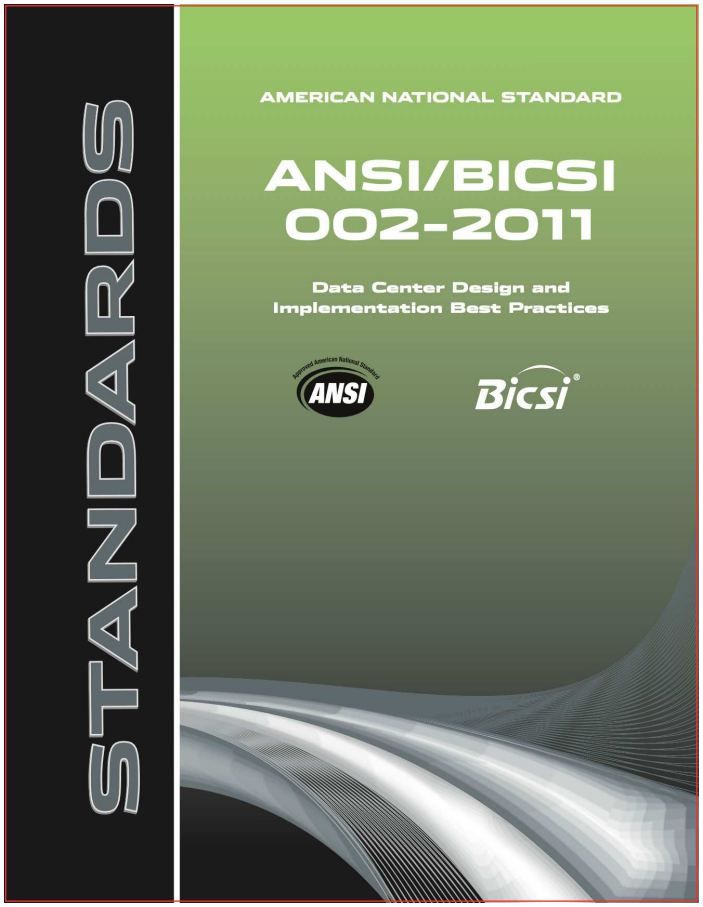
TIA-942

April 2005

TELECOMMUNICATIONS INDUSTRY ASSOCIATION

Representing the telecommunications industry in association with the Electronic Industries Alliance

Electronic Industries Alliance



NOTICE

TIA Engineering Standards and Publications are designed to serve the public interest through eliminating misunderstandings between manufacturers and purchasers, facilitating interchangeability and improvement of products, and assisting the purchaser in selecting and obtaining with minimum delay the proper product for their particular need. The existence of such Standards and Publications shall not in any respect preclude any member or non-member of TIA from manufacturing or selling products not conforming to such Standards and Publications. Neither shall the existence of such Standards and Publications preclude their voluntary use by Non-TIA members, either domestically or internationally.

Standards and Publications are adopted by TIA in accordance with the American National Standards Institute (ANSI) patent policy. By such action, TIA does not assume any liability to any patent owner, nor does it assume any obligation whatever to parties adopting the Standard or Publication.

This Standard does not purport to address all safety problems associated with its use or all applicable regulatory requirements. It is the responsibility of the user of this Standard to establish appropriate safety and health practices and to determine the applicability of regulatory limitations before its use.

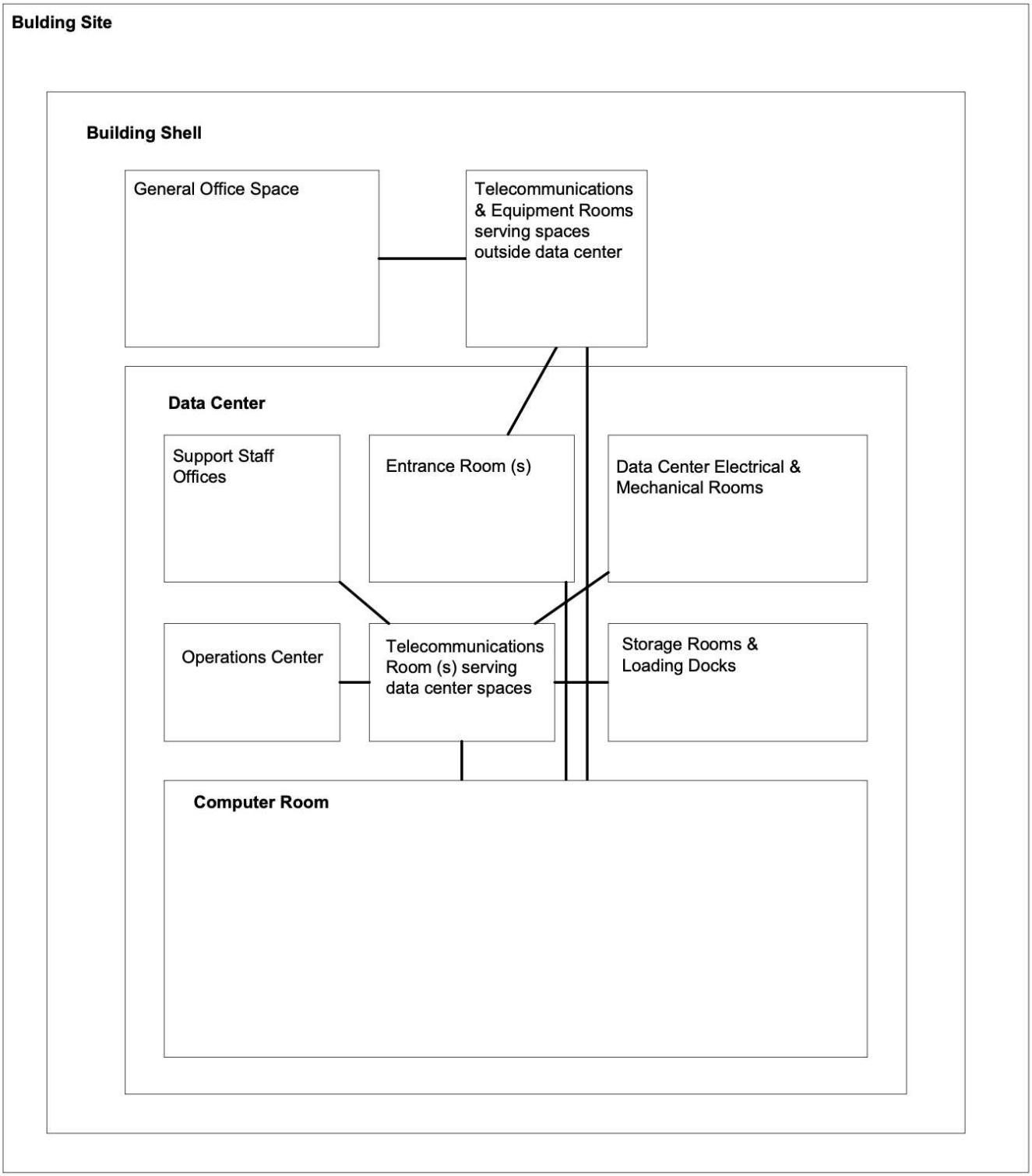
(From Standards Proposal No. 3-0092-C-1, formulated under the cognizance of the TIA TR-42.1, Subcommittee on Commercial Building Telecommunications Cabling).

Published by

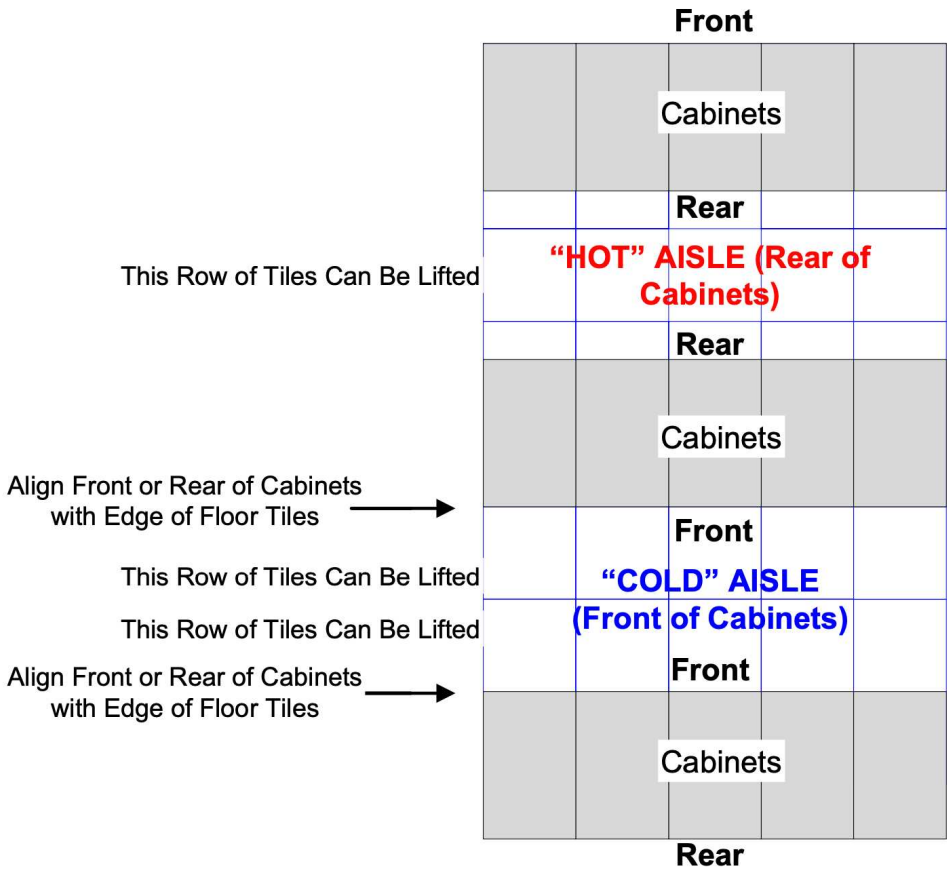
©TELECOMMUNICATIONS INDUSTRY ASSOCIATION
Standards and Technology Department
2500 Wilson Boulevard
Arlington, VA 22201 U.S.A.

PRICE: Please refer to current Catalog of
TIA TELECOMMUNICATIONS INDUSTRY ASSOCIATION STANDARDS AND ENGINEERING PUBLICATIONS
or call Global Engineering Documents, USA and Canada
(1-800-854-7179) International (303-397-7956)
or search online at http://www.tiaonline.org/standards/search_n_order.cfm

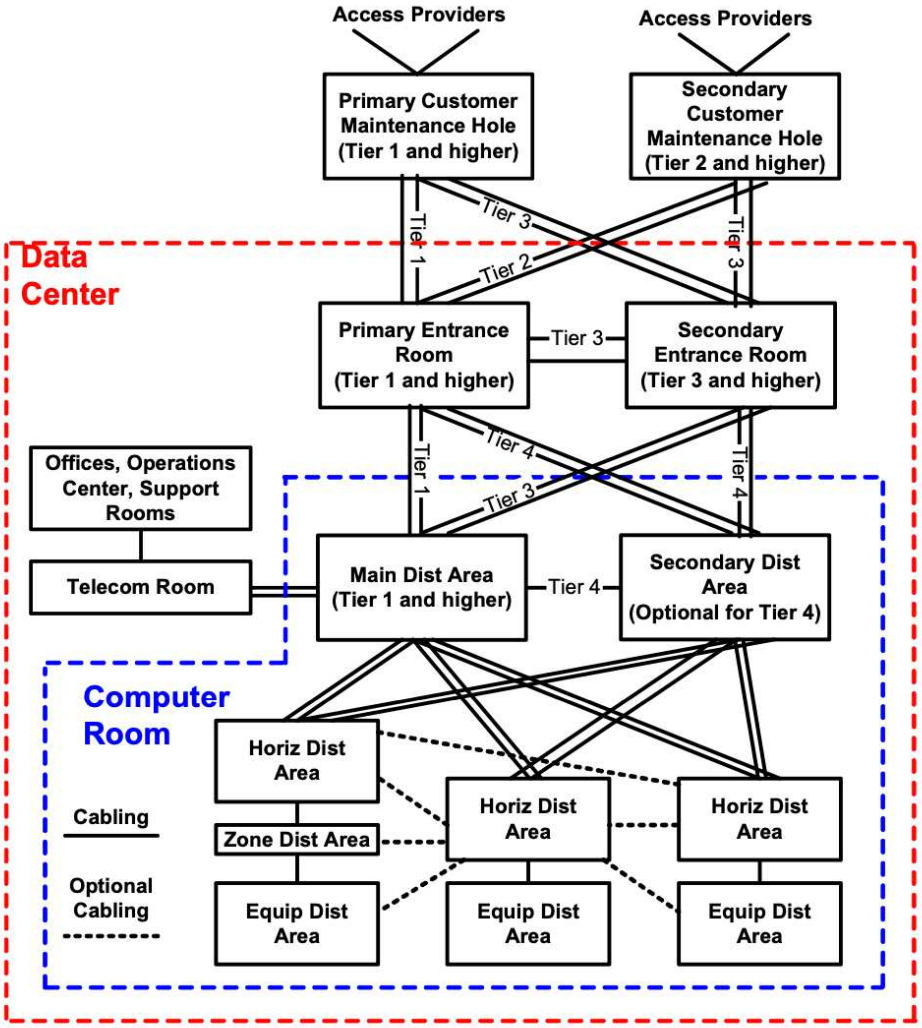
ANSI/TIA-942-2005.
The document is the first page of the Tia standard where it is expressly stated that the standard serves as a mediation between the manufacturer and the purchaser.
It is interesting to note the expectations that the document sets for it when it speaks of itself as "designed to serve the public interest". At this point, the standard seems to use language that veers towards political necessity.



Relationship of spaces in a data center – TIA-942.
Scheme that attempts to spatially trace the rooms required in a data centre. The enclosure construction admits the central importance of the Computer Room, the safe which must be protected and which must have a certain type of contact with the outside world, fully registered and regulated.

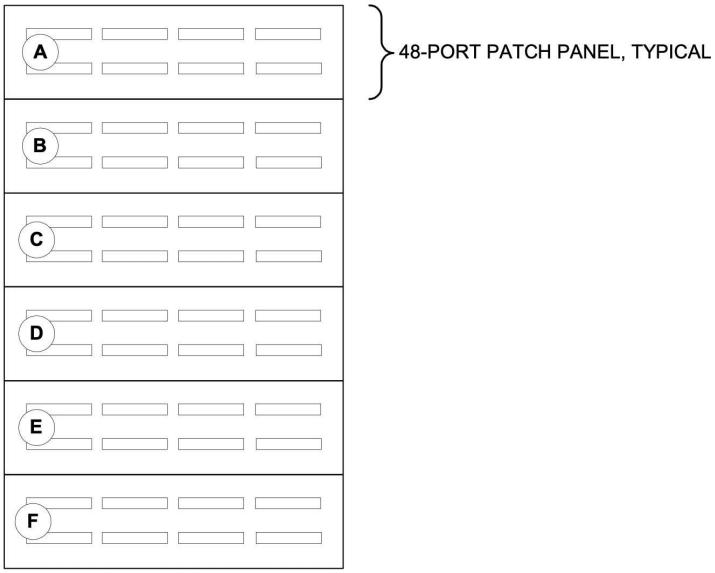


Example of "hot" aisles, "cold" aisles and cabinet placement – TIA-942
The floating floor matches the pitch of the cabinets. The cold aisles are 120 cm wide with a removable floor for servicing the cables underneath. The hot aisles are a result to adapt the space to the different widths of the cabinets. Everything is well calculated, the front and back looking at each other in a potential and endless repetitive pattern to more easily dissipate the heat produced by the machines.

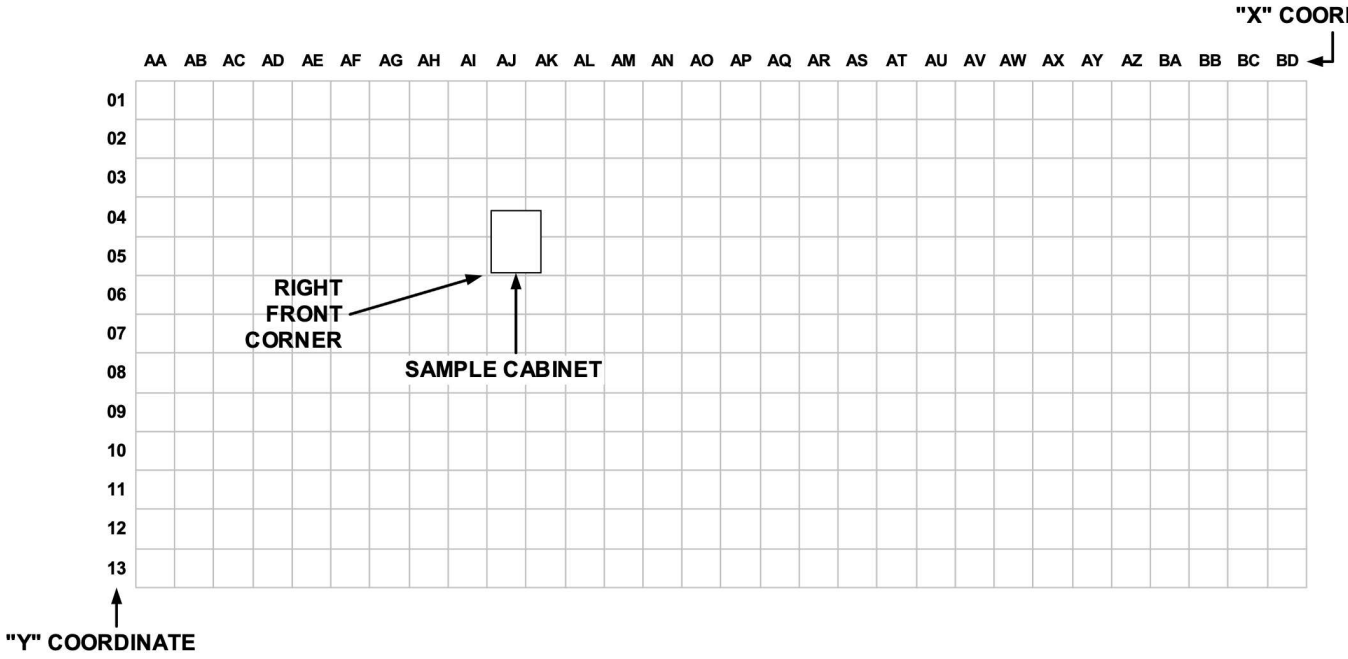


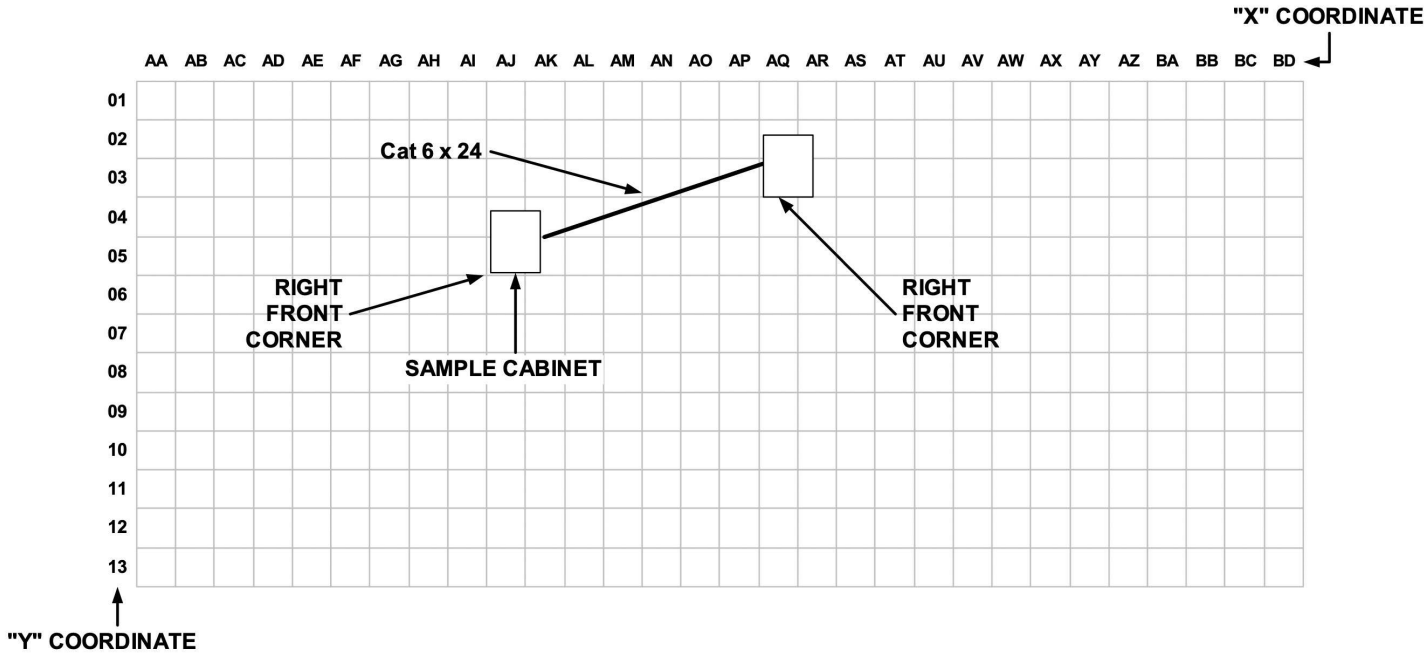
Telecommunications infrastracture redundancy – TIA-942

Another important feature for a well-functioning data centre is redundancy. The cable is double to ensure constant functionality if a connection is damaged. The data centre is nothing more than an intricate geometry of cables that enables the connection and storage of data contained in servers - for an example refer to ANNEX B.

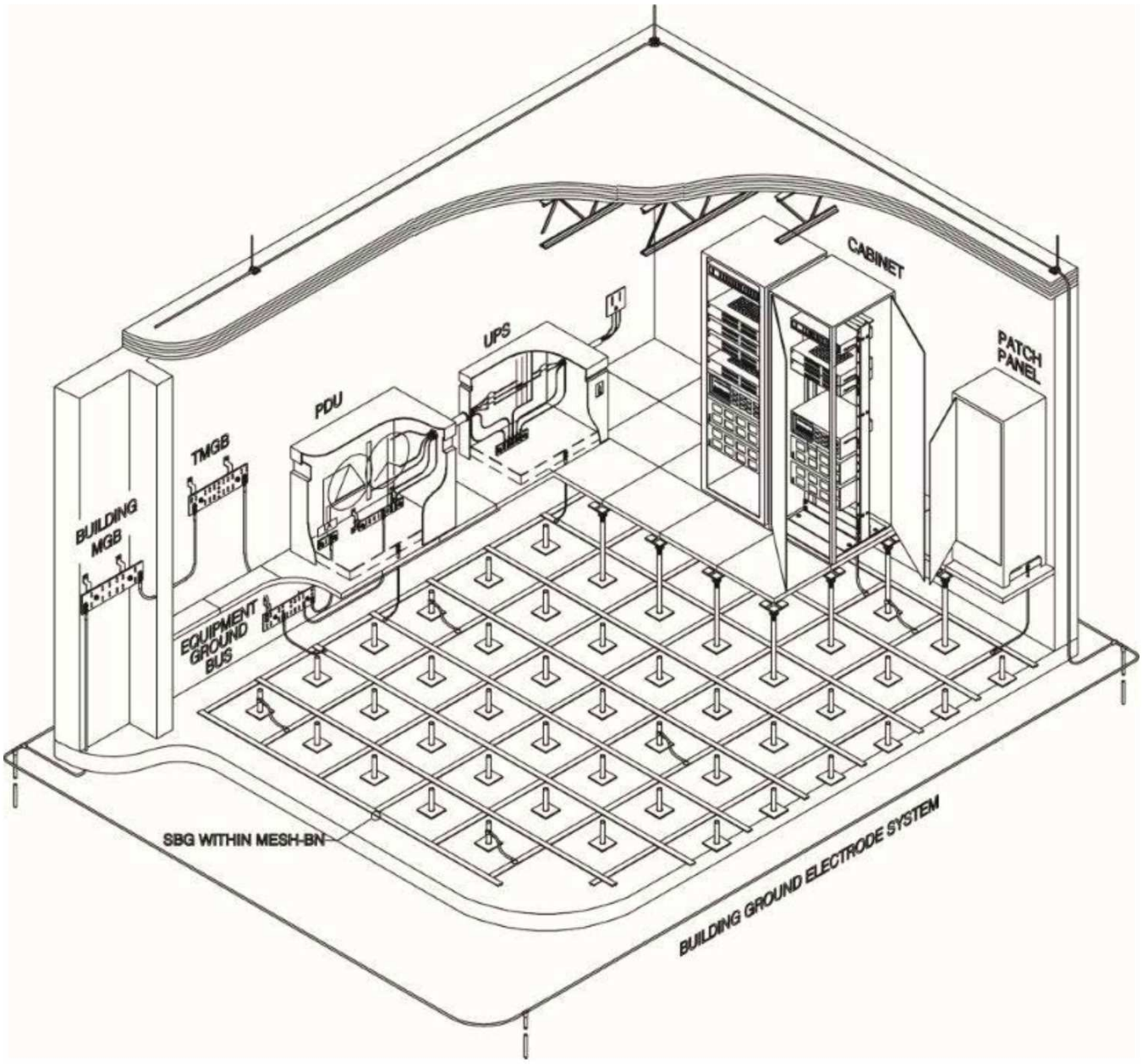


Sample copper patch panel identification schema – 942
The diagram is illustrated in the Tia-942 standard to explain how servers are installed inside the rack or cabinet by developing its mass in height.

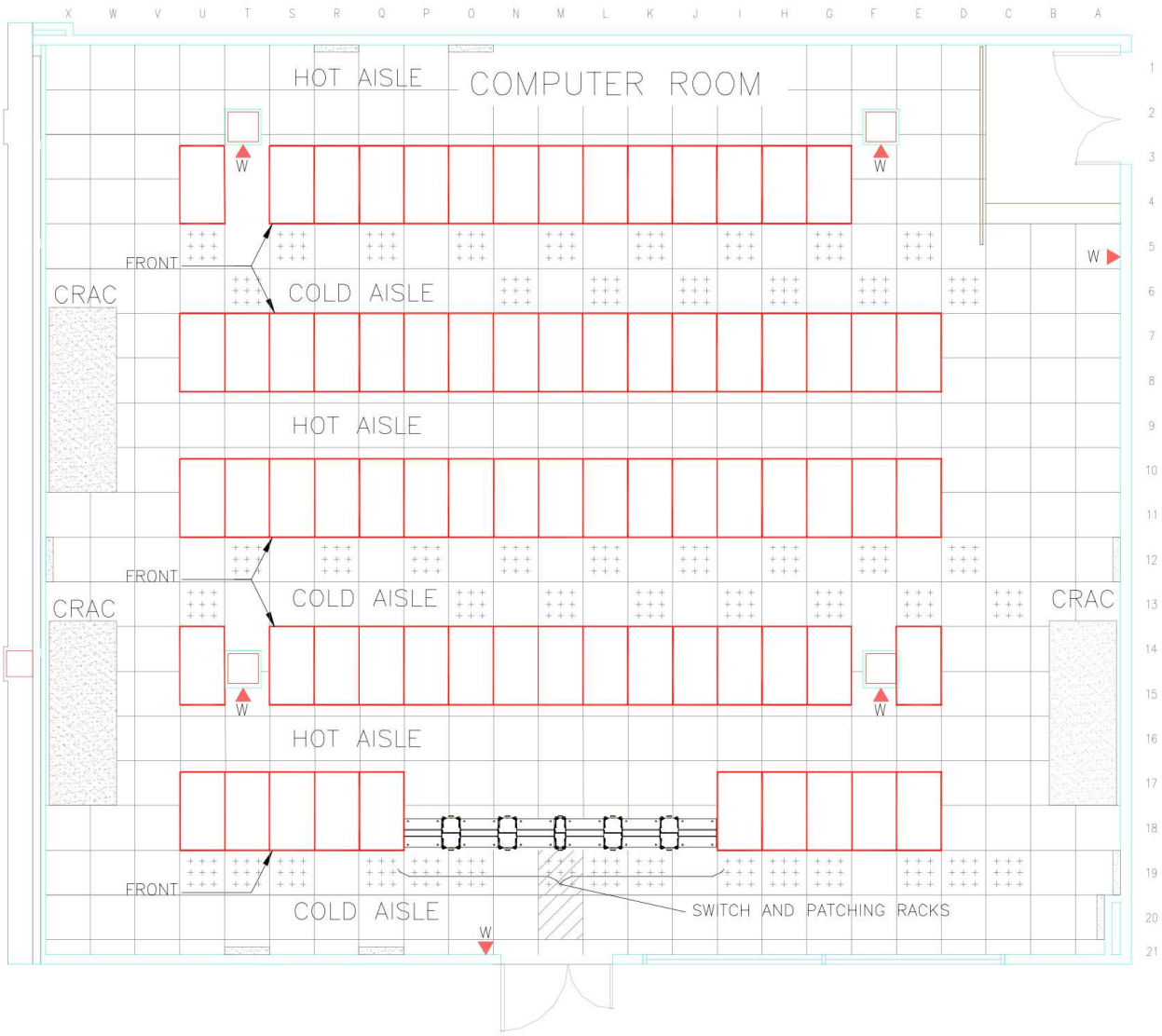




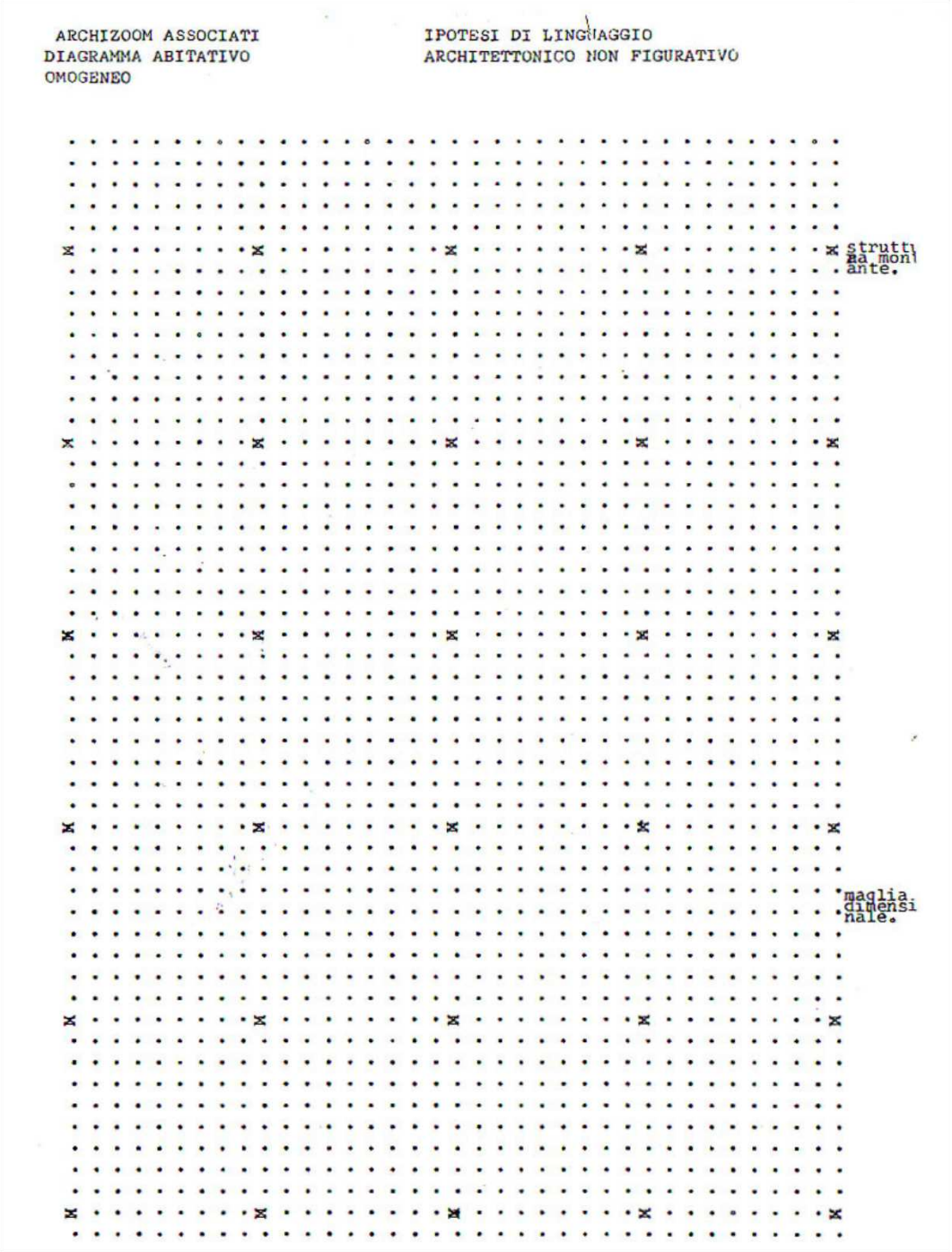
Sample rack/cabinet identifier | Sample 8-position modular patch panel labeling – TIA-942
These diagrams shown in Tia-942 represent the typical layout of a Server Room and how the racks/cabinets should be placed. The layout must be well calculated and planned in order to quickly detect any failures. As in a battleship, the racks are identified via the x-axis and y-axis. The nomenclature continues within the rack itself by meticulously numbering all installed servers and all input and output ports. The rigid and functional design is useful to give perfect functional continuity to the system.



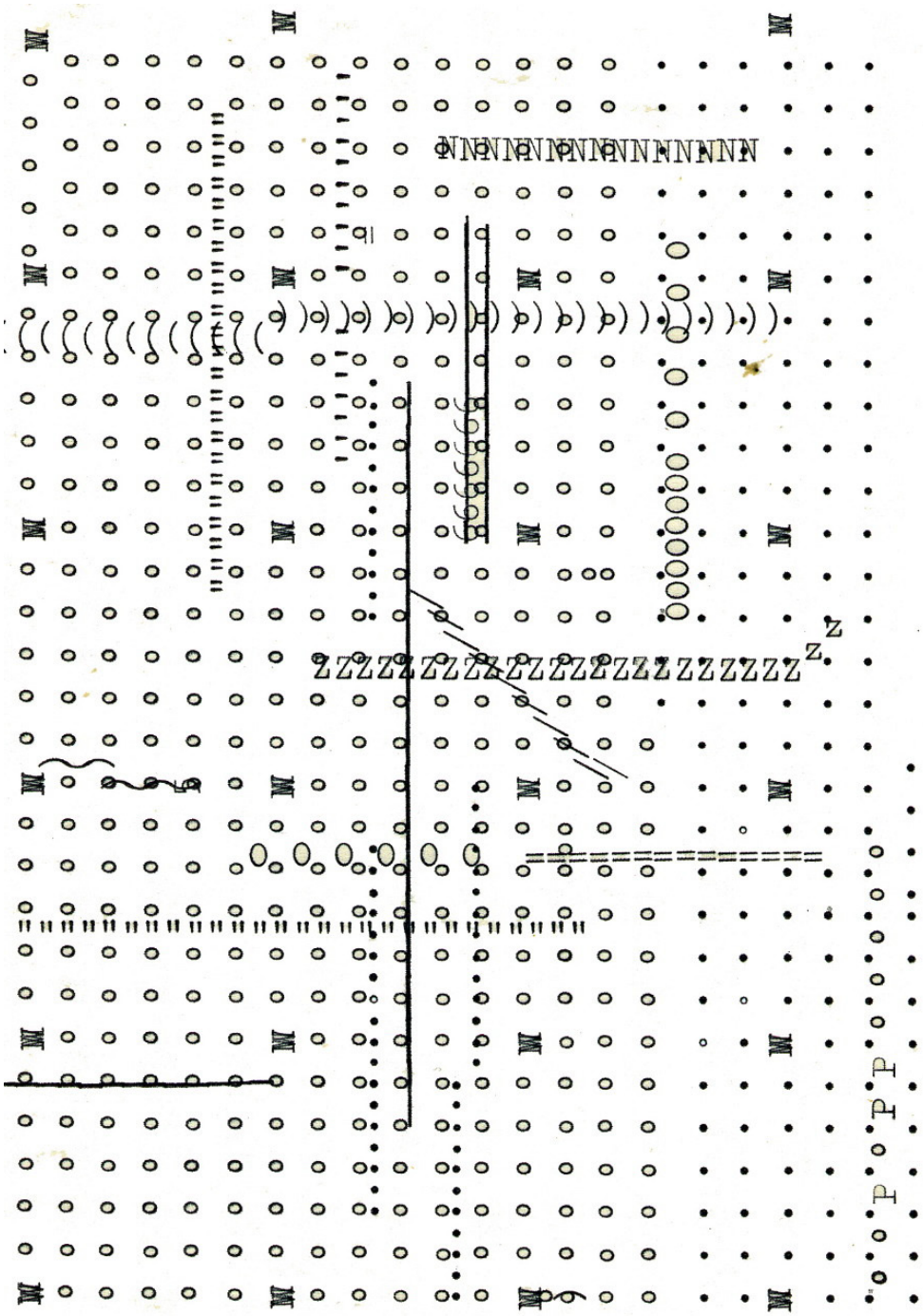
Data Center Grounging Schematic – BICSI-002-2011
The axonometry in the Bicsi standard shows a axonometric cutaway of the composition of a Computer Room, showing the floating floor where above will be the flooring with the cabinets and below the cabling that runs through and holds all the servers.



Computer room layout showing "hot" and "cold" aisles – TIA-942
image on p. 131 of TIA-942-2005.



Archizoom, No Stop City, plan 1969-1970
Using a typewriter, Archizoom drew the floor plan of No Stop City! in the same years as the first in a long series of RFCs that continues to this day.



Archizoom, No Stop City, plan 1969-1970.

b. After Link Establishment and Log-in

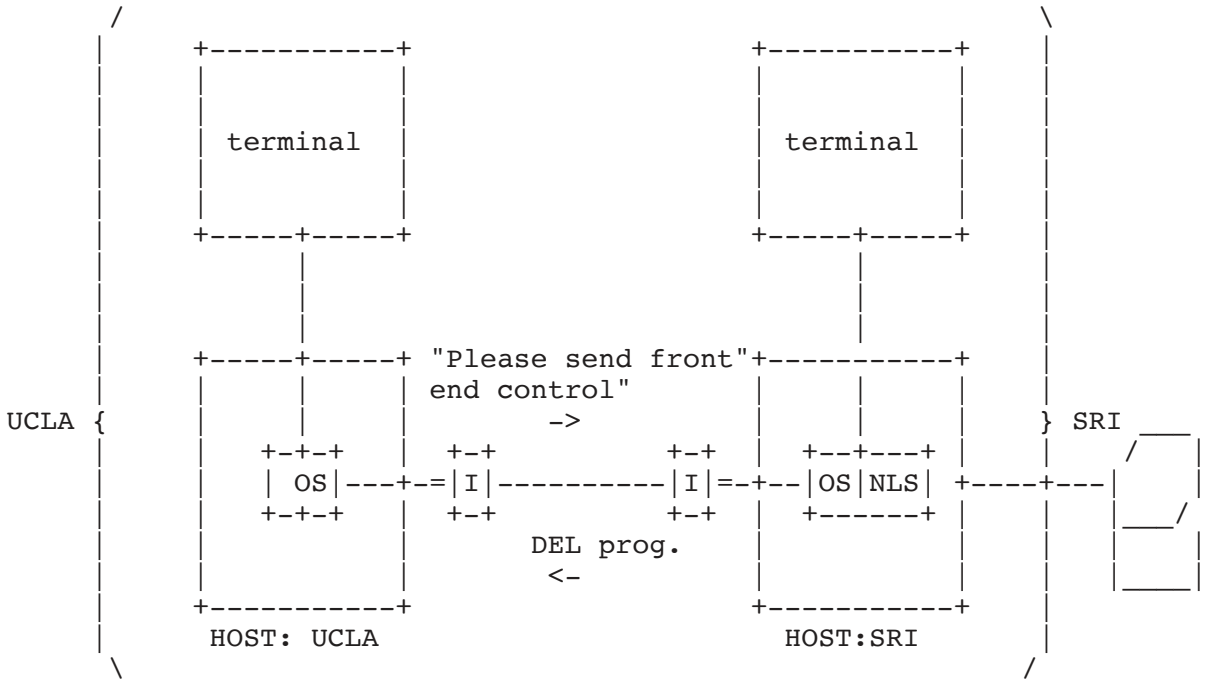
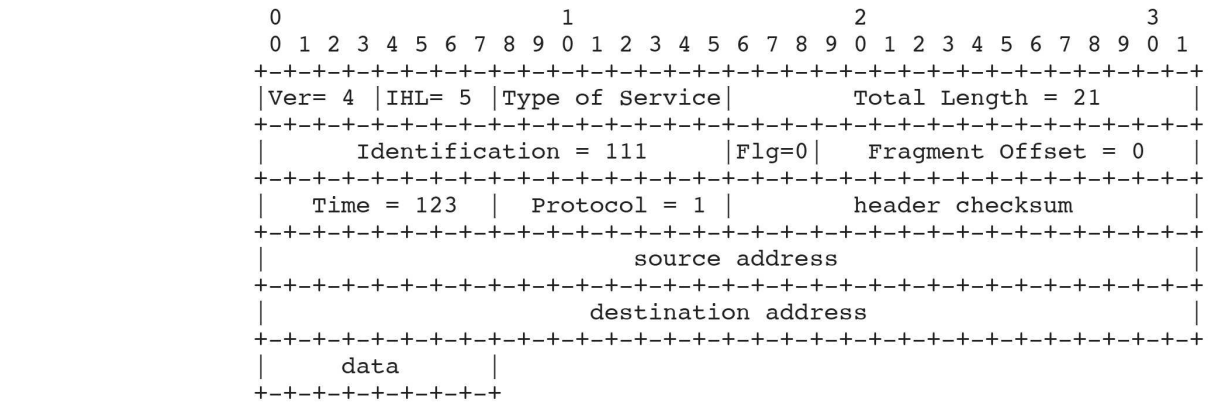


Diagramma *"b. After Link Establishment and Log-in"* in Request for Comments: 1 *"Host Software"*
One of the diagrams of the connection process between computer terminals via the network: connection request steps, actual connection established.
The diagram was developed by Steve Crocker through the composition of punctuation marks of the Courier font, the typical font of the typewriter. It can be defined as the first represented spatialisation of the network.

APPENDIX A: Examples & Scenarios

Example 1:

This is an example of the minimal data carrying internet datagram:



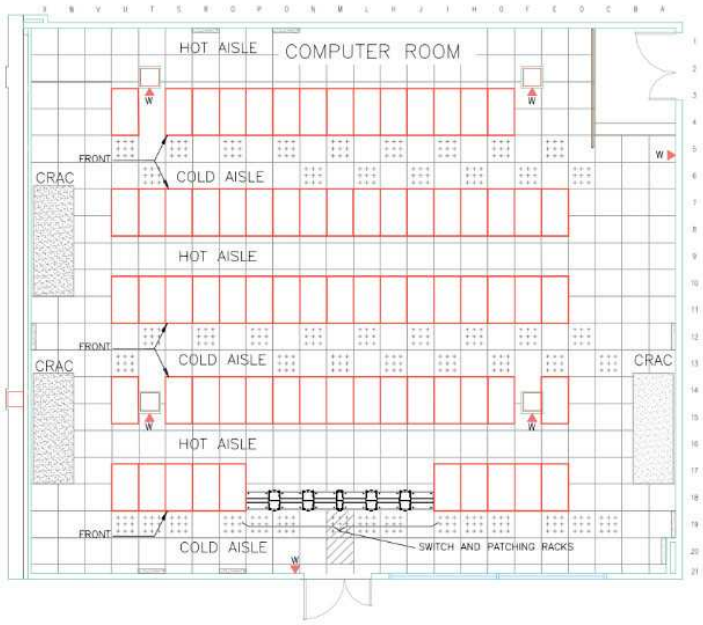
Example Internet Datagram

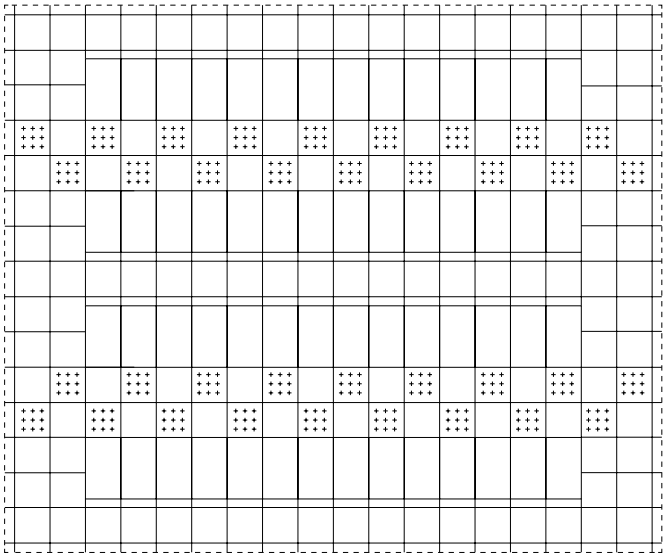
Figure 5.

Note that each tick mark represents one bit position.

This is a internet datagram in version 4 of internet protocol; the internet header consists of five 32 bit words, and the total length of the datagram is 21 octets. This datagram is a complete datagram (not a fragment).

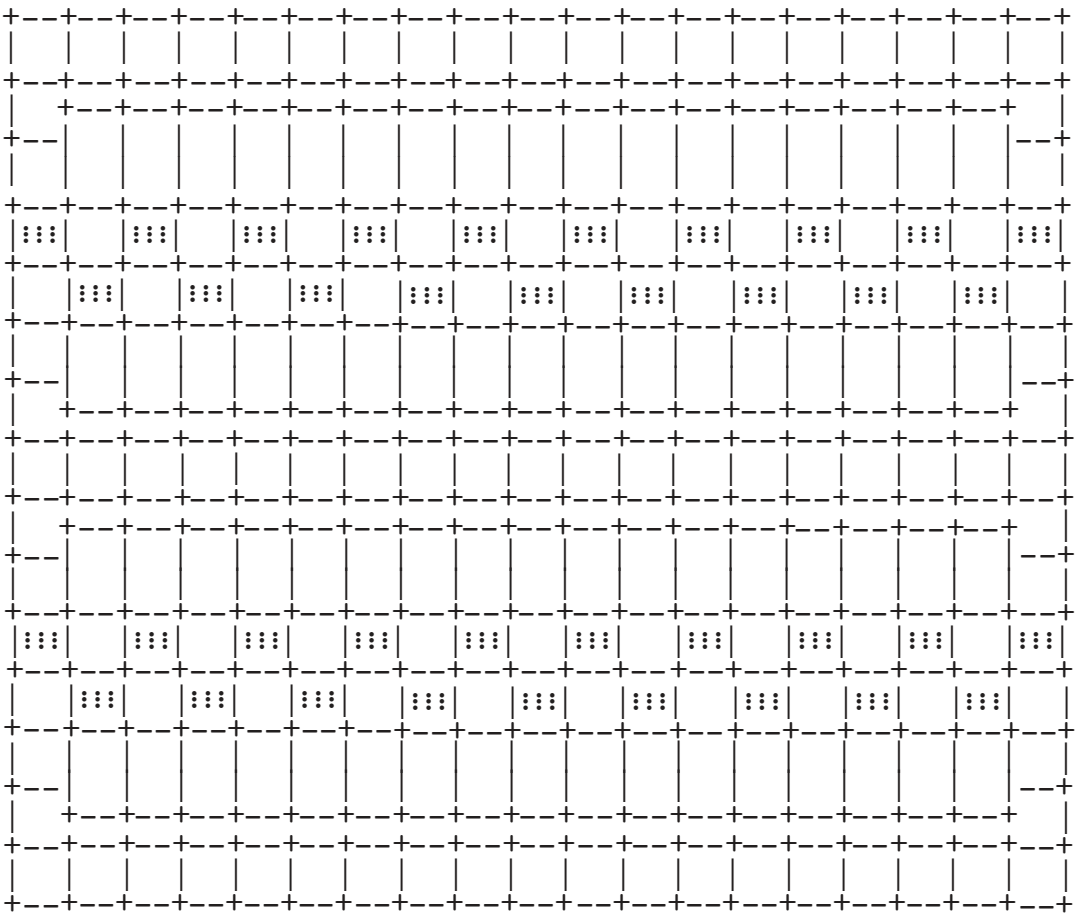
J. Postel, *Internet Protocol. Darpa Internet Program Protocol Specification*, Request for Comments: 791, ISI | USC, September 1981
The RFC page in this case represents the datagram that is essential for a connection. A datagram is a unit of data sent over a network, here using the IP protocol. A datagram is a self-contained packet of actual data and control information required for its delivery. In 1981, the same language is used as in the first RFC to explain the spatialisation of the network, here to bring order to the information stuff that flows through the network.



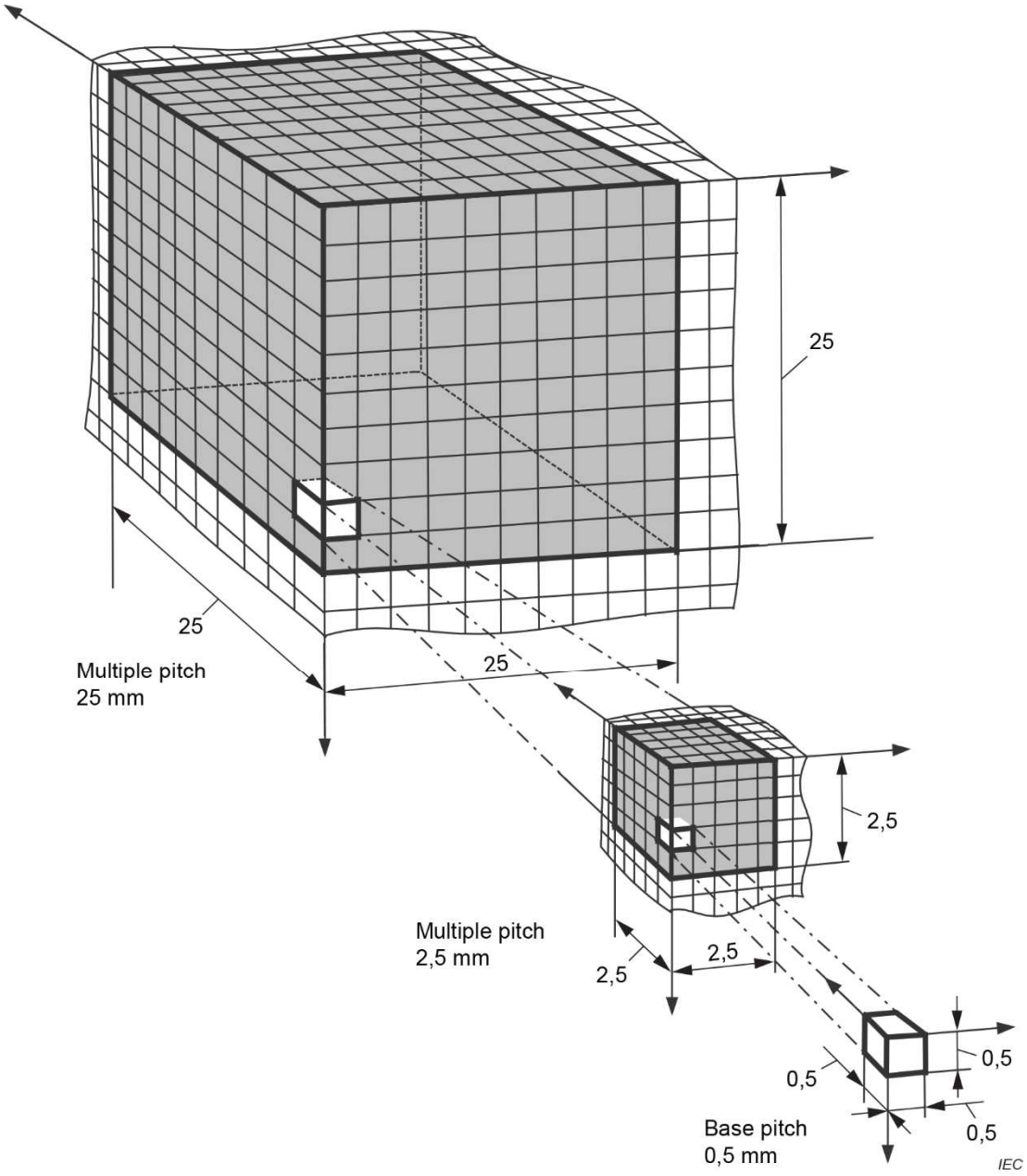


1 TIA-942, *Computer room layout showing "hot" and "cold" aisles*, 2005.

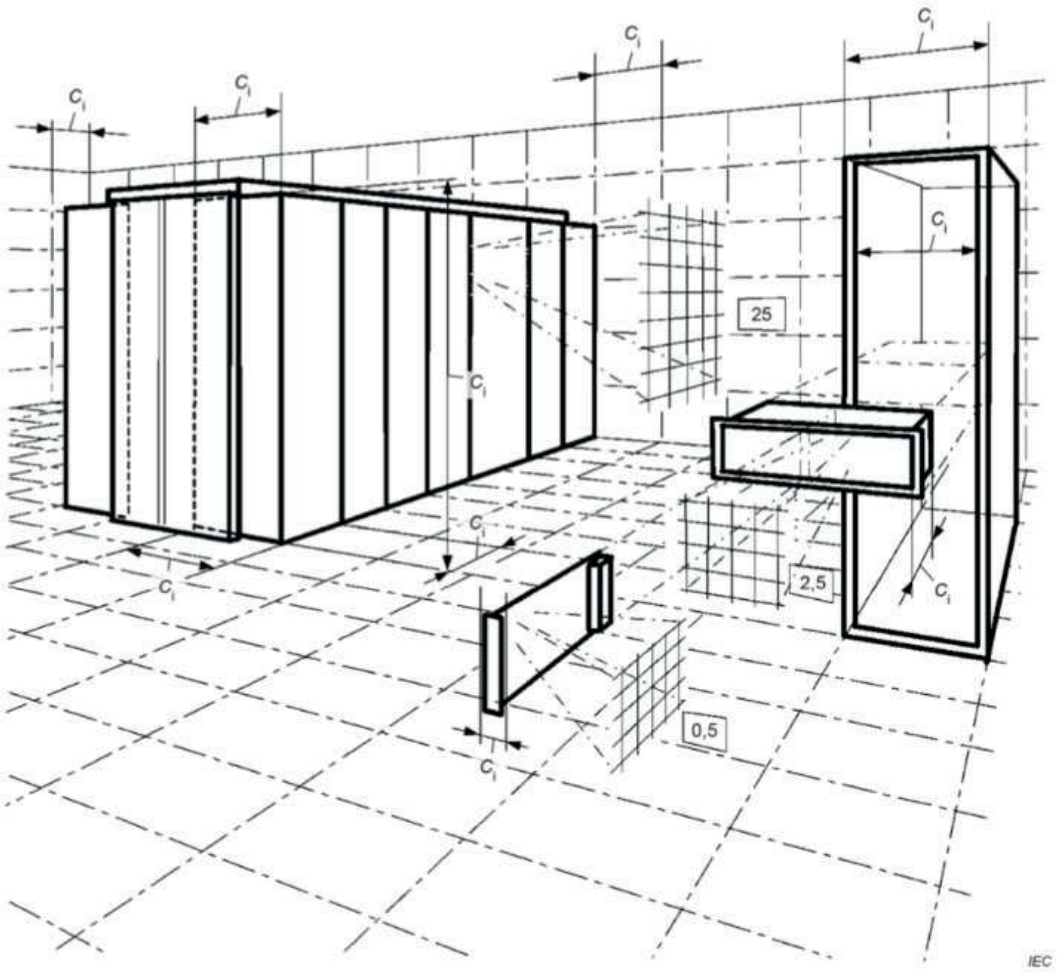
2. Attempted diagram taken from the plan published in the TIA-942 standard.



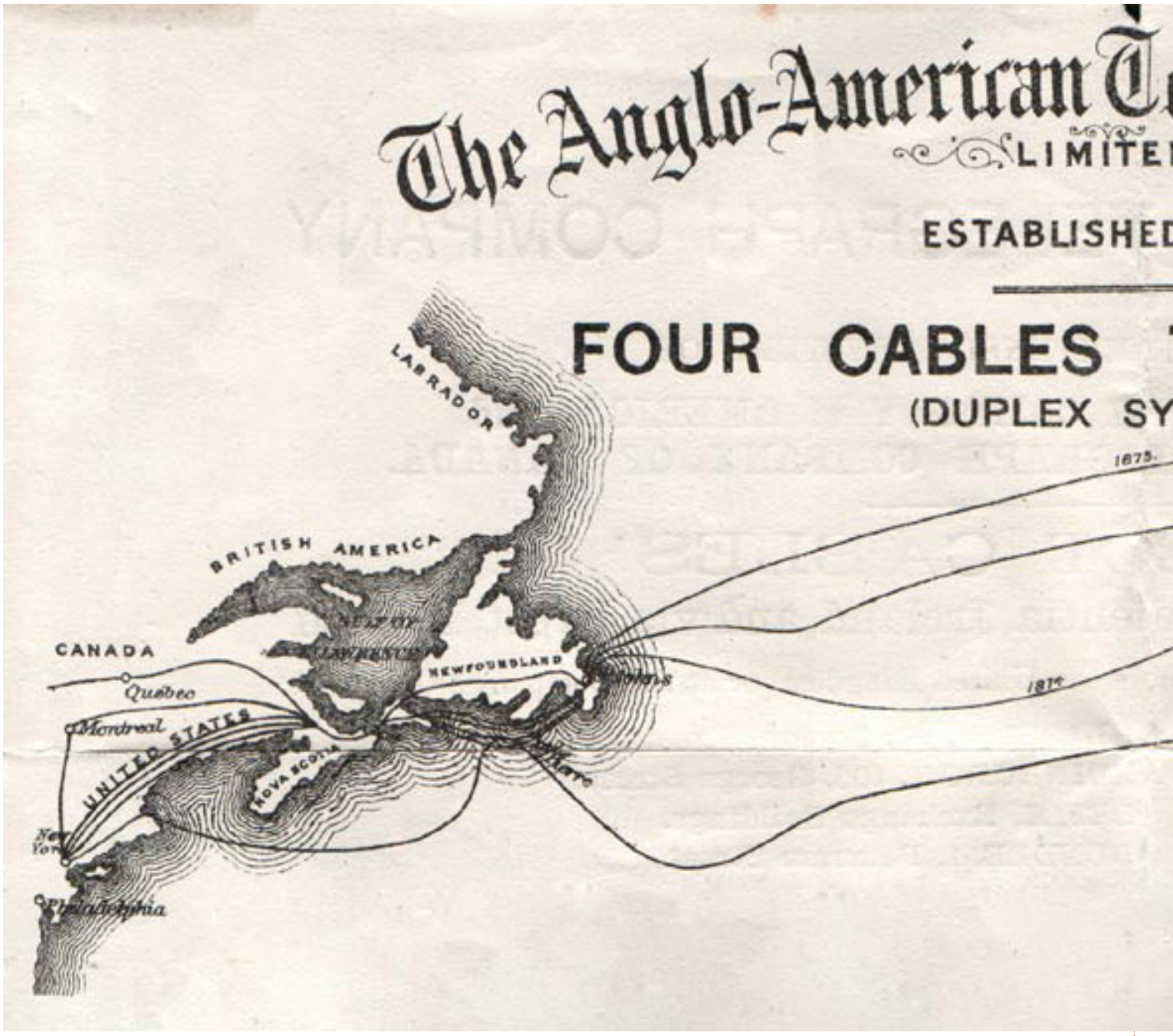
Data centre plan drawn up in TIA-942
Courier font punctuation marks are used to confirm the heritage and the relationship of today's structure of a server room with the first representation of the digital infrastructure in RFC 1.

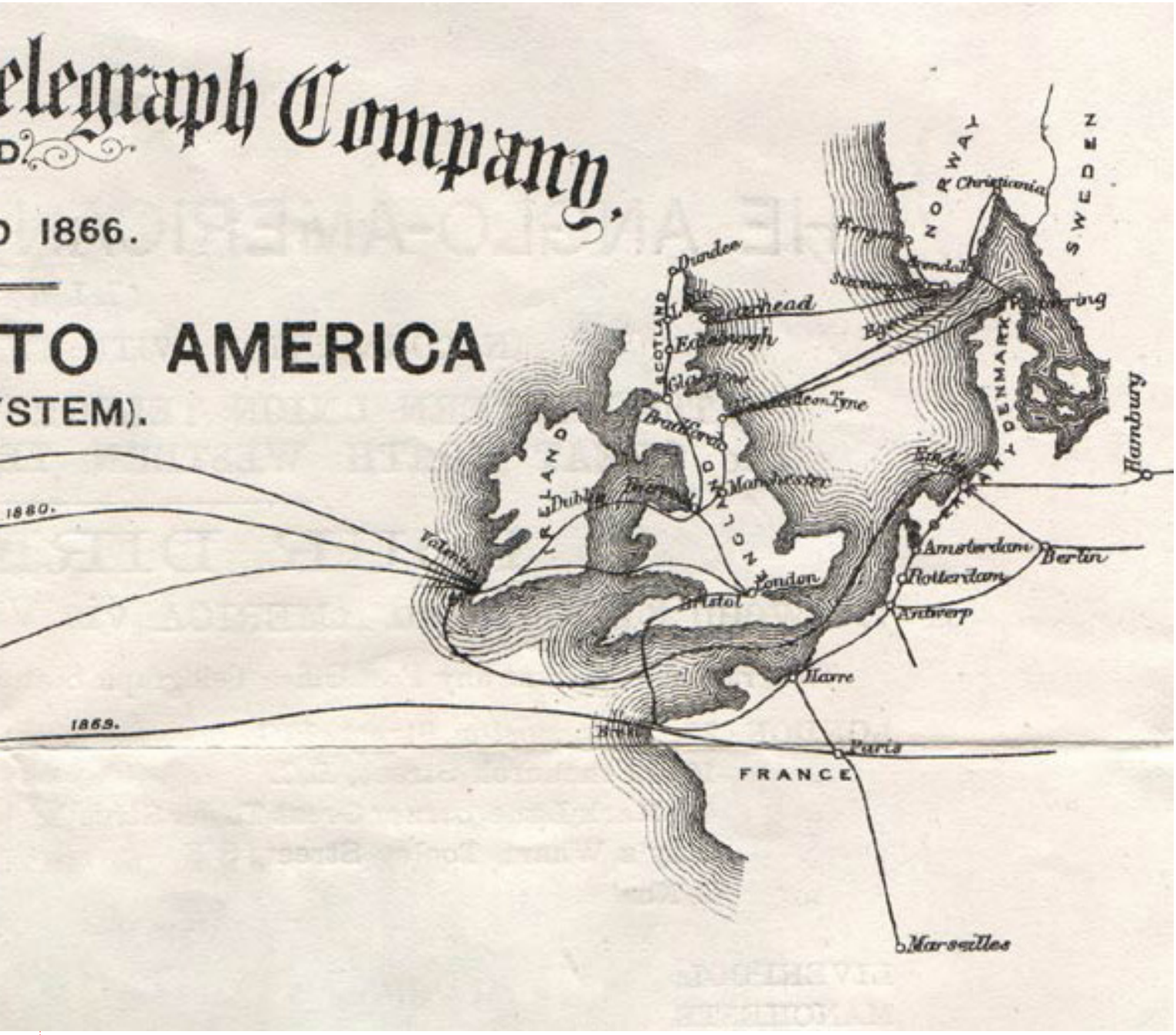


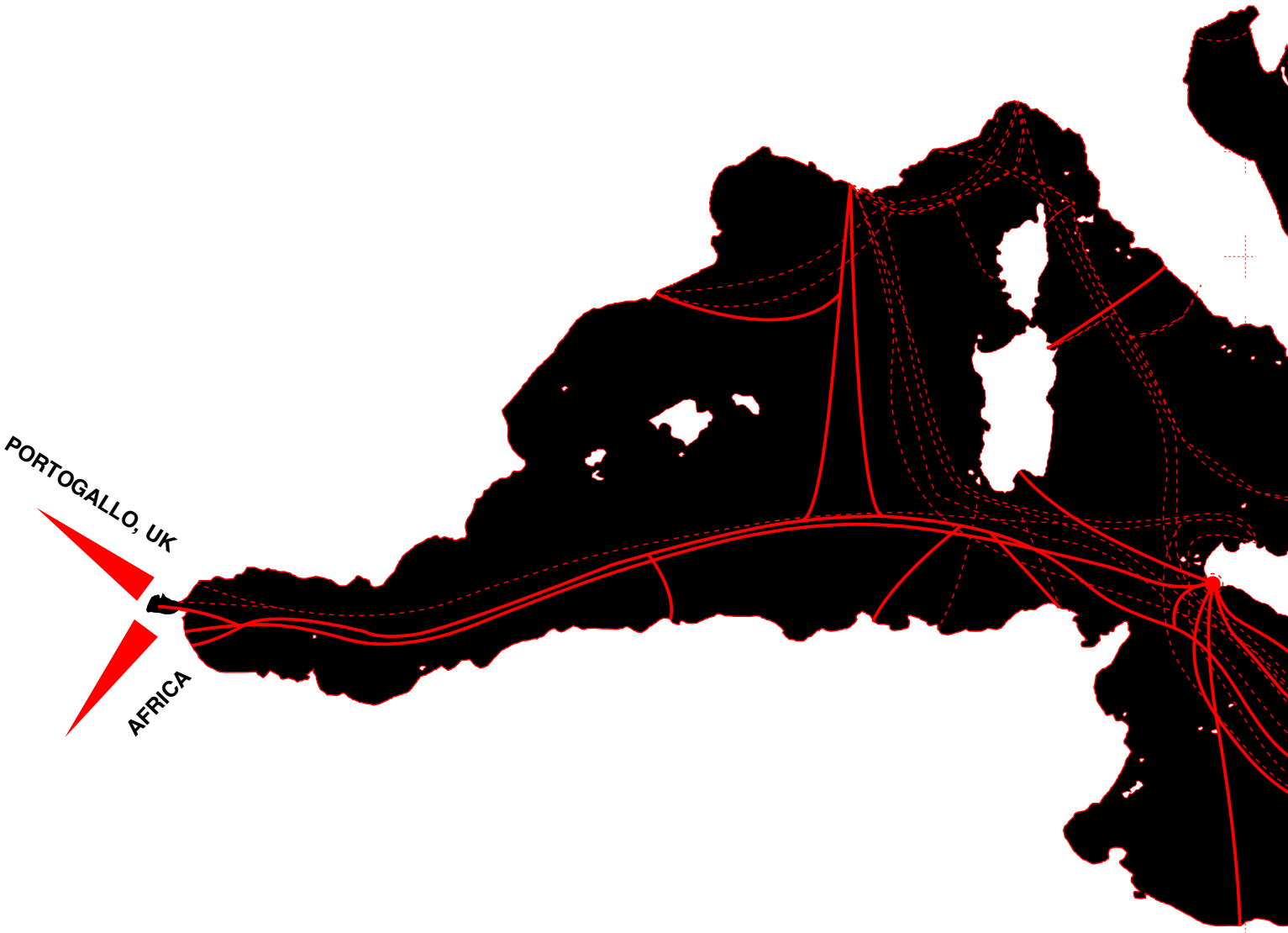
Modular grid – IEC 60917-1
Spatial representation of the modularity found in all electrotechnical material, which is useful for creating a standardised scalarity by facilitating the construction of space even in the server room. The system depicted adopts the grid as a dynamic scalar method for undefined growth.



Examples of the application of the modular order – IEC 60917-1
Spatial representation of an environment created to accommodate electrotechnical elements.
All elements at all sizes are perfectly positioned in the grid. The entire grid is proportioned according to an initially given measurement.

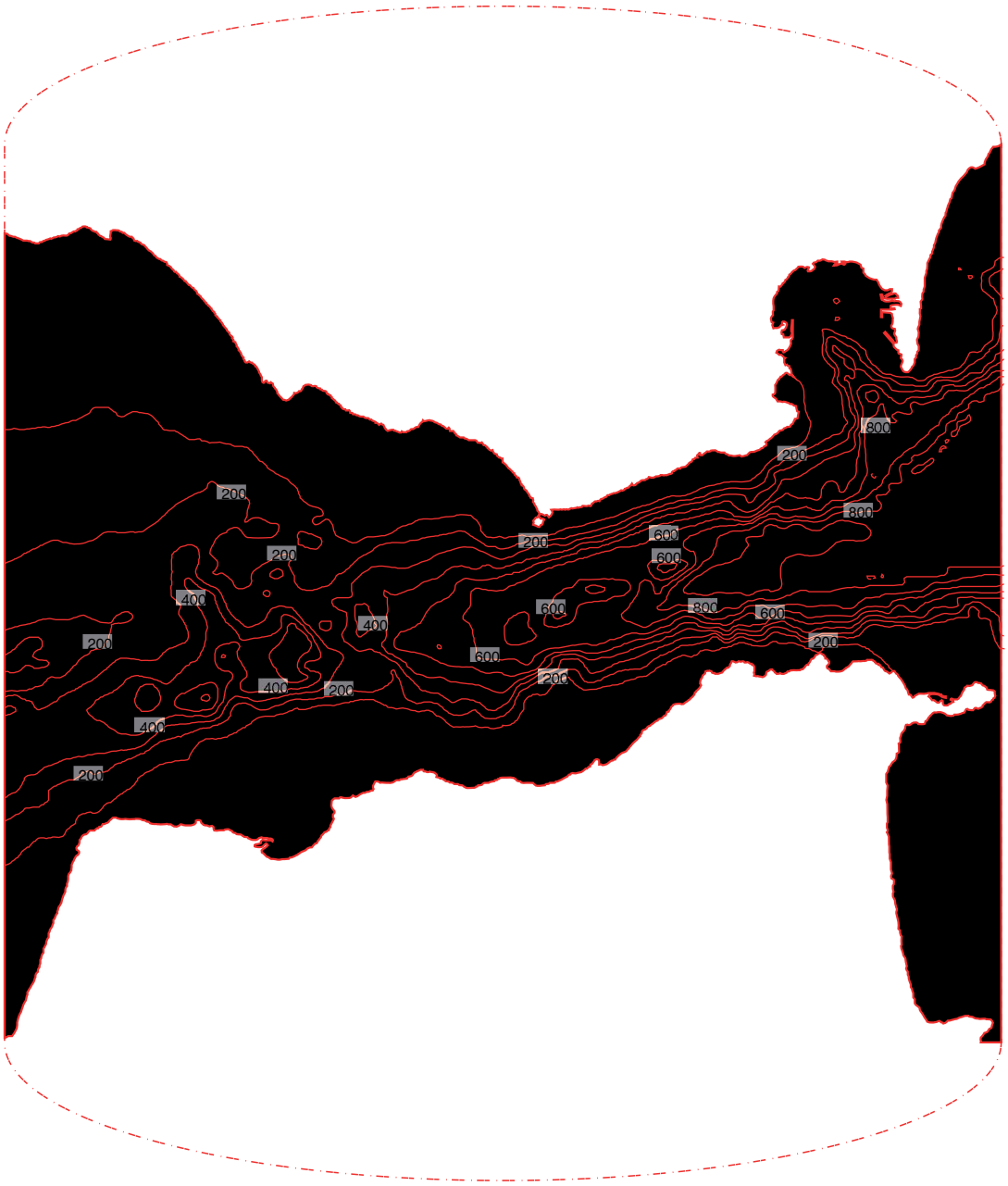

The Anglo-American
LIMITE
ESTABLISHED
FOUR CABLES
(DUPLEX SY
1875.
1874
LABRADOR
BRITISH AMERICA
CANADA
Quebec
Montreal
UNITED STATES
NEWFOUNDLAND
NOVA SCOTIA
Philadelphia


elegraph Company.
D.
0 1866.
TO AMERICA
STEM).
1860.
1863.
Dundee
Greenhead
Edinburgh
Glasgow
Newcastle on Tyne
Bradford
Manchester
Liverpool
Dublin
Valentia
IRELAND
SCOTLAND
ENGLAND
London
Bristol
Havre
Paris
FRANCE
Marseilles
Antwerp
Rotterdam
Amsterdam
Berlin
Hamburg
DENMARK
SWEDEN
NORWAY
Christiania
Bergen
Arendal
Stavanger



Fibre optic cables in the Italian coasts, Mediterranean.
Shown in red are the fibre optic cables that land on the Italian coast. Those shown with a continuous line are the cables arriving in Mazara del Vallo. Nine cables arrive that pass through a sorting facility that allows data to circulate throughout the territory through an infrastructure that ends at our terminal devices - smatphones, tablets, PCs including household appliances and cars.


SUEZ
SUEZ
ZAFARANA



Strait of Gibraltar.
The bathymetric map of the strait highlights the shallow depth of the seabed. This is also a very sensitive geographical point for many types of transit including that of fibre optic cables. The low seabed and high sea traffic make this area one of the most fragile points for digital infrastructure. Cable damage is a higher risk in this area. Fragility brings out the shape of the infrastructure, which seems to be materialising at this point.

Fiber Optic Cables

Sicilia:
Mazara del Vallo (9 cavi in data luglio 2023 + 2)

Name	Length	Active from:
COLUMBUS III	9900 km	December 1992
Didon	170 km	May 2014
GO1 Mediterranean Cable System	290 km	December 2008
HANNIBAL System	178 km	October 2009
Italy-Libya	570 km	March 2000
Janna	634 km	March 1999
Lev Submarine System	2600 km	March 1999
Medusa Submarine Cable System	8760 km	Project
Middle East North Africa (MENA) Cable System/Gulf Bridge Intenational (GBI) Cable System	8000 km	December 2014
SEA-ME-WE-3/SeaMeWe-3/SMW-3	39000 km	September 1999
SEA-ME-WE-6/SeaMeWe-6/SMW-6	19200 km	Project

Catania	(5 cables - two of them for Malta)
Palermo	(4 cables)
Trapani	(2 cables in the Tunisian direction)
Marina di Ragusa	(1 cable - Malta)
Pozzallo	(1 cable - Malta)
-	
Marsilia	14 cables on July 2023

The data center system is part of a global infrastructure whose most obvious connection is controlled by submarine fibre optic cables. Through cables, more than 90 per cent of digital information passes globally. Mitchell already mentioned this in his 1996 essay and now, this type of technology has continued to proliferate, drawing a dense network of cables in the seas of the globe. Of course, the global design synthesises the new political and economic powers and balances, even if, in the various free portals that can be found online, they are not all present. In fact, those that usually appear in these portals, are civil cables, which serve to manage the digital traffic that we can imagine and use, but there are other cables that are not reported in these portals because they are for military use and dedicated to the intelligence of the various states. To date, it is impossible to draw a complete and

exhaustive picture of this cable network.
Apart from the information that can be found, it is very interesting how this infrastructure silently changes the balance of entire territories, going totally unnoticed.
The Italian peninsula has always held a geographically crucial position for movements in the Mediterranean. A bridge between Europe and North Africa from north to south, but also an obligatory crossing point on the route from east to west, the peninsula even during digitisation retains its strategic position.
The illustration (p. 158-159) represents all the cables passing through the Mediterranean that touch the Italian coast. The drawing highlights more those that touch the coasts of Mazara del Vallo in the province of Trapani. A small town on the coast overlooking North Africa, Mazara del Vallo has for years been the Mediterranean location with the highest landing of submarine cables and continues to be the first Italian municipality with this record. No cables of little importance or for connections to nearby locations land on its coasts. Mazara del Vallo is home to the Sea-Me-We-3 cable, which until 2022 was the longest submarine cable in the world, running from Germany, through the United Kingdom, across the Mediterranean and the Suez Canal to Australia via India, China and Japan - and many other states. For decades, this small village has been a crossroads of data that has silently left nothing to the territory, except a fragility added to a part of Italy more depressed for historical-political reasons. Formally, it has gained neither benefit nor advantage. Its period of European, sometimes world and certainly Italian supremacy, still remains in the shadows of the local news, which in articles on the web denounce this situation, asking questions that over the years have never found answers, confirmations or denials.
This infrastructural network traverses the territories in a mathematical way, aiming only at the minimum effort without a critical approach to the territory it invades, but it settles with silent arrogance, abandoning it in the same way.
In 2023, 2Africa, a 45,000 km long cable, will finish being laid and will pass through Genoa, which will hold the world's longest cable. A cable that will connect 3.2 billion people, almost half the world's population. Of course, this infrastructure is being installed by unions of various companies, in particular 2Africa has: China Mobile International, Equinix, Facebook, MTN GlobalConnect, Orange, Sta, Telecom Egypt, Vodafone and WIOCC who assigned the laying to Alcatel Submarine Networks ('ASN').
For Mazara del Vallo this means an end to the primacy, not least because for a few years now, the Mediterranean location with the largest cable port has been Marsilia, with its 14 cables.
Perhaps the first infrastructure conceived and produced by man that invades a territory and with the same sneaky silence with which it has invaded it, leaves, without violating the view.

The Opte[1]: Algorithmic Representation of Digital Information

The first Internet connection took place via ARPANET on 29 October 1969 between the University of California (UCLA) and the Institute of Computer Science at Stanford University. The first message sent from Los Angeles and received at Stanford was 'lo', the first syllable of the word 'login', which did not all arrive due to a failure caused by the great technological effort required by the first connections. The project was developed at the height of the Cold War at the request of the US Department of Defence with the collaboration of various American universities in order to build a communication network that could survive a large-scale nuclear attack: a secure military network for the exchange of information at unprecedented speeds. After 1974, with the advent of the TCP/IP transmission standard[2], the network project was called the Internet, and it was with the advent of personal computers that this type of network spontaneously gave rise to e-mail, effectively creating a network of human connections. In the 1990s, after the ARPANET project had totally lost its relevance from a military point of view, the first attempts at commercialisation took place. Thanks to a series of services offered to companies, the Internet boomed, in the same years in which Tim Berners-Lee was working on the World Wide Web[3] project at CERN in Geneva.

The image in question (p. 170-171) is the latest and finest graphic representation of the Internet network we possess, a project called The Opte started in 2003 by Barret Lyon. The IT author's need arose precisely when the quantity of connections began to become numerically beyond the possibilities of human conception. The study seeks to represent in graphic form the vastness and complexity of the Internet connection, composed of connection nodes joined by lines that highlight their connections with other networks. The outcome is the result of the use of a type of algorithms called force-directed graph drawing algorithms. This particular version, developed by Lyon, is not in the public domain, so one cannot know exactly how it works and how it develops the image in detail.

To write the legend for this type of representation by stopping at the different

[1] "The Opte Projet" https://www.opte.org

[2] The general OSI theoretical model led to the creation of network protocols, such as TCP. As its name implies, Transmission Control Protocol, is a protocol at the transport level of the ISO/OSI model. Its main task is the secure transmission of data, the management of data flow and the control of network congestion. TCP is an example of a protocol that fits the ISO/OSI model. At the software level, it is implemented on operating systems and network devices such as routers, switches, firewalls; it is a fundamental software component for the functioning of the Internet along with the IP protocol, whose main action is the addressing of data and the splitting of data into packets for transmission across the network, without any guarantee of delivery or flow control (an issue addressed by the TCP protocol).

3 The birth is commonly referred to as 6 August 1991, the day when computer scientist Tim Berners-Lee first published a publicly accessible website. The development started two years earlier by Berners-Lee himself at CERN in Geneva and the first site featured the actual description of the WWW project. From here began the expansion of this hypertext system that now invades everyone's daily life. This system allows documents and resources to be linked together by hypertext links, allowing users non-linear navigation. This search mode allows users to access related information and move easily from one resource to another.

After two years in which the system was used by the scientific community, CERN decided on 30 April 1993 to make the WWW protocol available to everyone by releasing its source code and putting it in the public domain.

The Web is an electronic and digital space on the Internet for publishing multimedia content, so it is only one part of the services that the Internet offers and has helped to change the way we approach research and information retrieval.

http://info.cern.ch/hypertext/WWW/TheProject.html

colours present[4], would be reductive as the image is produced by an algorithm that uses logical schemes different from human ones.
To better understand the reading of this image, it may help to list what information the algorithm takes into consideration to process this representation.
1- Quantity. The infrastructure of the Internet is physical, the algorithm takes into account the quantity of servers, routers, switches, switch distributions[5] and the network backbones[6] that connect the infrastructure.
2- Connection. Which parts of the infrastructure are interconnected? The algorithm identifies the physical paths that data packets travel as they move between the various devices.
3- Distance. The physical distance between elements alters the production of the image; the positioning of the different infrastructure elements on the earth's surface influences the connection forces detected by the algorithm.
4- Hops. The algorithm takes into account "hops"[7], which in computer science are the steps a packet of information makes from one device to another. The hops count depends on the routing protocols and usually the more hops there are between the source and destination, the more the real-time performance suffers.
5- Regions. The colour assignment is not random, in fact it serves to distinguish different blocks of IP addresses divided by the NRO (Number Resource Organisation)[8].

The image is totally developed digitally through the use of the algorithm, making the work of the computer programmer a tool for representation. Reasoning about the interpretation of these types of maps and how they are created is useful to understand the complexity of the Internet infrastructure that continues its, seemingly random, expansion day after day.
The directions that the infrastructure has been taking since 2020 would seem to produce a different kind of design. As an alternative to the typical physical connection via earth through fibre optic cables, with SpaceLink, Elon Musk changes the connection vector. By launching particular satellites into orbit at a calculated height, the company is betting on an overhead connection. Until recently, this type of connection had never been considered because the satellite as a vector has always been slower than the typical cable connection, but now with SpaceX's stu-

[4] ARPNIC corresponds to the Asia Pacific area (red)
ARIN corresponds to North America (blue)
LACNIC corresponds to Latin America and the Caribbean (pink)
RIPE NCC corresponds to the territory of Europe, Middle East and Central Asia (green)
AfriNIC corresponds to African territory (yellow)
US Military (brown)
Backbone (white)

[5] Servers, routers, switches are among the fundamental components of a data center. These buildings represent a new contemporary architectural typology. Inside them reside the data that travels through the internet infrastructure and arrives in our devices. They are the spaces that contain the data that circulates through the Internet connection. Servers, routers and switches are necessary components for its operation.

[6] Network backbones or backbones are cables of various sizes that transport data from the most diverse places. For instance, in 2021, Google completed the laying of its fourth proprietary cable called the Grace Hopper. A cable approximately 7,000 kilometres long running from New York to the coast of Buda UK, with a split involving Bilbao (Spain). See Undersea Cable the work of Trevor Paglen with photographs of cables in the Atlantic and Pacific Ocean investigating their positions and landings in the coasts. https://paglen.studio/2020/05/22/undersea-cables/

[7] Cf. lemma no. 42 Hops in Definition of Terms.

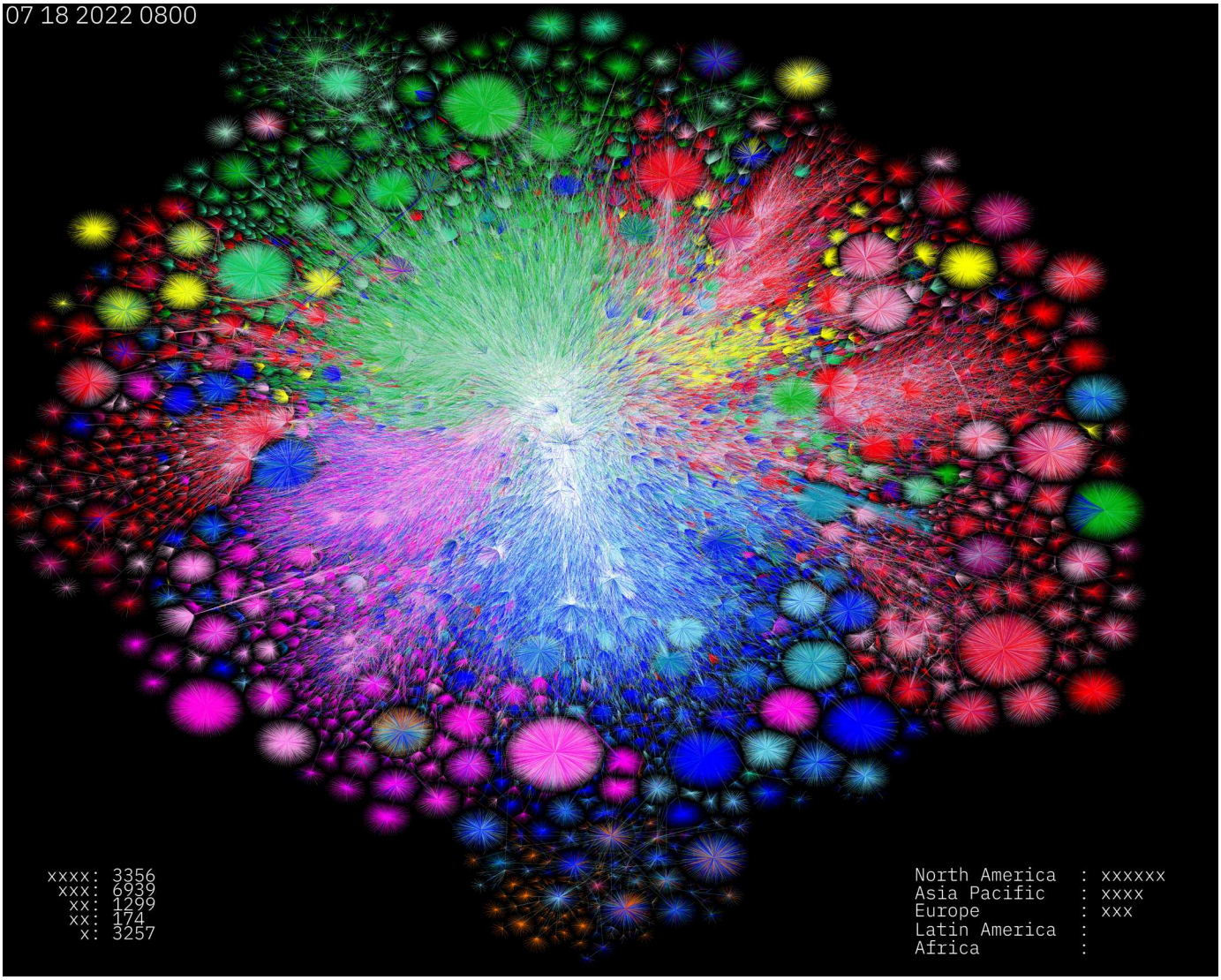
[8] Cf. lemma no. 32 NRO (Number Resource Organization) RIR (Regional Internet Registry) NRO in Definition of Terms.

dies, by organising the satellites in 3 levels in the sky, it designs an aerial network that wraps the globe. In this way, SpaceX ensures connection in any part of the earth: from the open sea to the highest mountain peaks on the planet.
As it evolves, the Internet opens up the design and drawing of different territories that span the globe. The Opte Project so far remains the only abstract representation of the Internet, but with the advent of new technologies, new methods of representing it may emerge.

2Africa, Genova 2022
Le foto prese nel sito del comune di Genova mostrano l'arrivo del cavo 2Africa nelle coste di Genova. Dal mare emerge semplicemente un fascio di cavi che silenziosamente cambia la vita di milioni di persone.

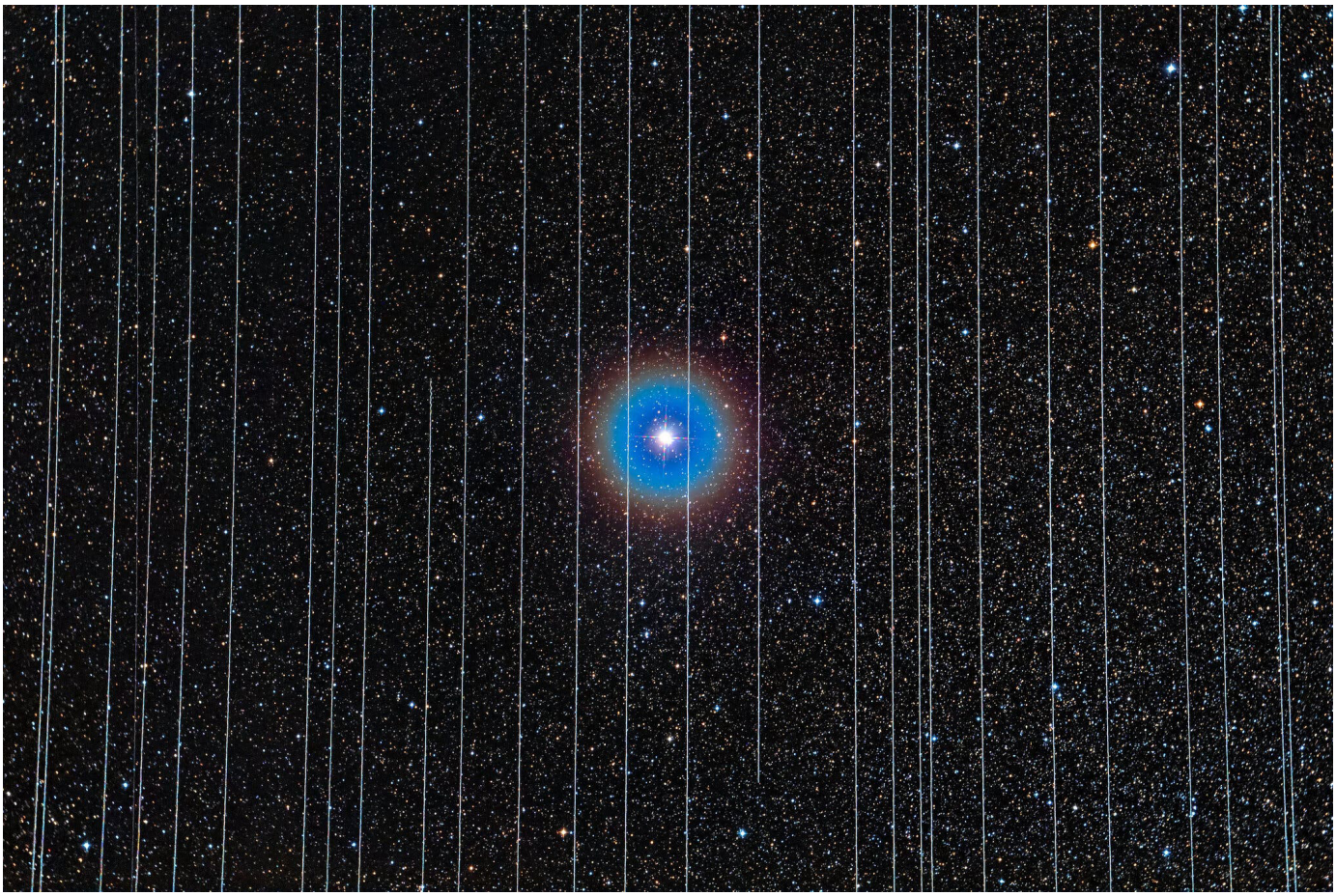
"Si sono svolte questa mattina sul litorale di Sturla le spettacolari operazioni di sistemazione sul fondale del primo dei due cavi sottomarini della partnership 2Africa, China Mobile International, Equinix, Facebook, MTN GlobalConnect, Orange, Stc, Telecom Egypt, Vodafone and WIOCC. Equinix, Inc. (Nasdaq: EQIX), azienda globale di infrastrutture digitali™, ha anche realizzato un nuovo data center denominato GN1.
L'operazione è stata curata dai tecnici a bordo della nave di Alcatel Submarine Network - una tra le imbarcazioni più tecnologiche e innovative al mondo in questo settore - che, dal litorale davanti a via del Tritone a Sturla, ha teso il cavo sottomarino e lo posato in trincea sul fondale.
Il cavo, a cui ne verrà affiancato tra circa 10 giorni un secondo, collega Genova, come testa di ponte per l'Europa, con Africa e Asia, mettendo in connessione circa 3,2 miliardi di persone, la metà degli abitanti dell'intero pianeta.
[...]
Con una lunghezza di 38.000km, 2Africa è uno dei più grandi progetti di cavi sottomarini, ha 21 approdi in 16 nazioni in Africa.
Verrà completamente attivato nel corso del 2023 con una capacità di 180 Tbps.
Vodafone, utilizzerà la struttura GN1 di Equinix come punto di interconnessione strategico per questo sistema di cavi sottomarini, creando una forte connettività in Europa e contribuendo a costruire una società digitale inclusiva per tutti. 2Africa è uno dei più grandi progetti al mondo di cavi sottomarini per le telecomunicazioni, guidato da un gruppo di aziende partner.
Il cavo circumnavigherà il continente africano, collegando direttamente 16 Paesi all'Europa e al Medio Oriente.
Questo fornirà l'indispensabile capacità e affidabilità di Internet, sostenendo l'ulteriore crescita del 4G, del 5G e dell'accesso a banda larga fissa per centinaia di milioni di persone. Il progetto guiderà anche la crescita di economie sempre più digitalizzate in tutta Europa, rafforzando la connettività tra i Paesi europei.
L'arrivo di 2Africa nel nuovo sito di Genova e la connessione diretta con Milano e l'Europa fa sì che GN1 offra una nuova opzione alternativa, complementare e diversificata, per l'area mediterranea.
Infatti, essendo il primo data center di Genova carrier-neutral, GN1 offrirà ai clienti servizi di colocation e interconnessione sicuri e resilienti.
GN1 fornirà una capacità di 150 cabinet equivalenti e uno spazio di colocation di circa 6.000 piedi quadrati (560 metri quadrati)."

https://smart.comune.genova.it/comunicati-stampa-articoli/innovazione-approda-sul-litorale-di-sturla-il-cavo-sottomarino-2africa

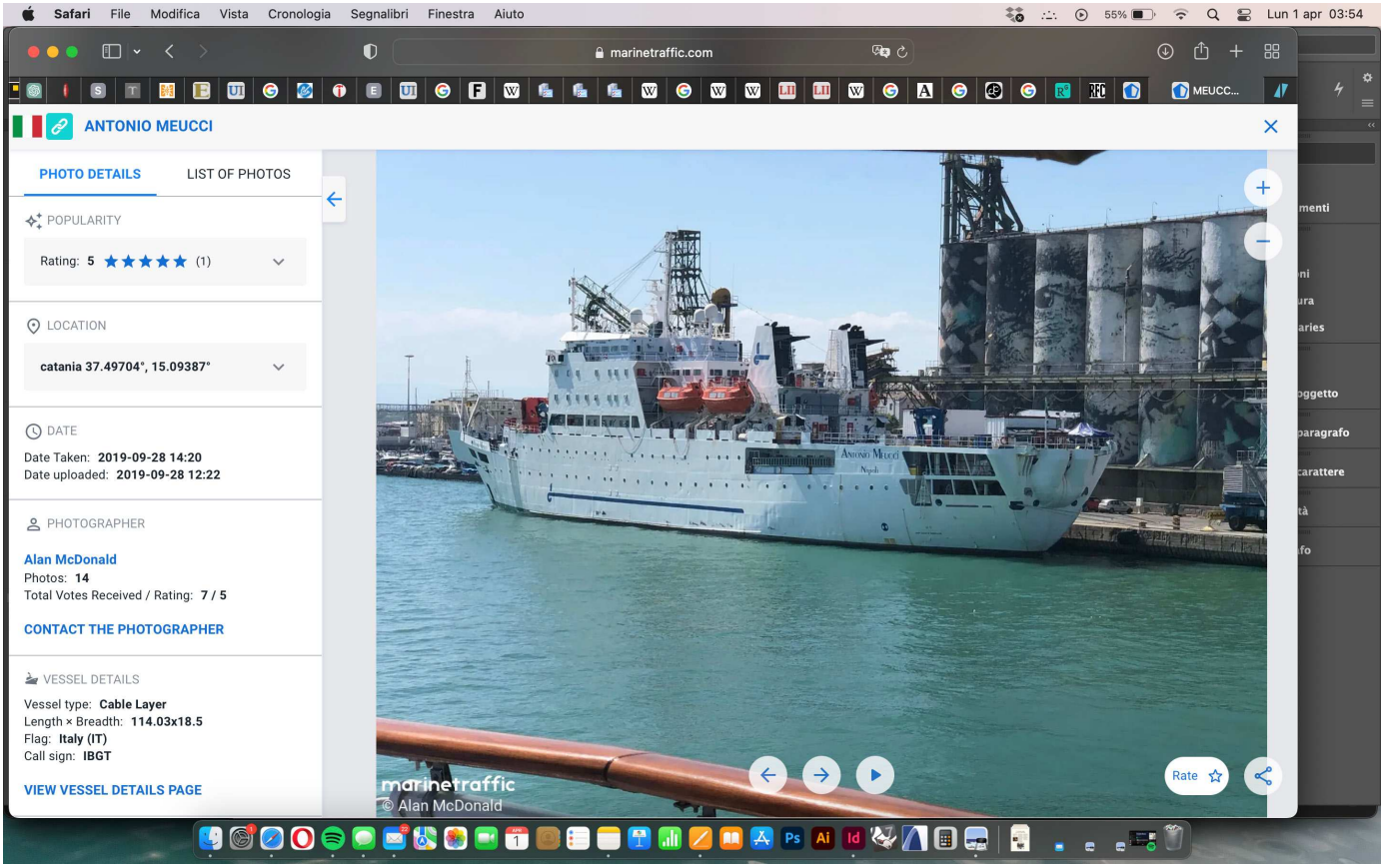


The Opte Project_07182022
Algorithmic representation of digital infrastructure connections.

The Opte Project_07182022
Algorithmic representation of digital infrastructure connections, a zoom.



Rafael Schmall, NOIRlab, National Science Foundation
"The background image shows the double star Albireo in Cygnus and was taken on 26 December 2019. Two out of ten 2.5-minute exposures recorded Starlink satellites moving across the field."
The photo's official description describes an overlay of information: in addition to the celestial vault, the photo features light beams from the passage of the Elon Musk-owned StarLink satellites. The presence of the satellites, visible to the naked eye, will add more layers of infrastructure, this time much closer to the earth's surface than the typical satellites.



Antonio Meucci, Cable Layer Ship
MISSION: telecom cable laying and associated trenching operations, telecom cable maintenance and ROV support.
With a crew of 68, the ship patrols the Mediterranean Sea, with a base in Catania, to lay fibre optic cables, but also to maintain the maintenance of the laid cables.

Ding Gang [x Caixin], Tibetan woman holding flowers, only they're not flowers they're cryptocurrency mining PSUs.
She is holding power supplies to help to supply the correct voltage to Bitcoin mining machines.
The author captures the woman holding a bouquet of digital flowers, giving back a barely altered image of the human condition after the advent of the digital revolution.

Outage [50 Instances]

Summary of the AWS Service Event in the Sydney Region
We'd like to share more detail about the AWS service disruption that occurred this past weekend in the AWS Sydney Region. The service disruption primarily affected EC2 instances and their associated Elastic Block Store ("EBS") volumes running in a single Availability Zone.
Loss of Power
At 10:25 PM PDT on June 4th, our utility provider suffered a loss of power at a regional substation as a result of severe weather in the area. This failure resulted in a total loss of utility power to multiple AWS facilities. In one of the facilities, our power redundancy didn't work as designed, and we lost power to a significant number of instances in that Availability Zone.
Normally, when utility power fails, electrical load is maintained by multiple layers of power redundancy. Every instance is served by two independent power delivery line-ups, each providing access to utility power, uninterruptable power supplies (UPSs), and back-up power from generators. If either of these independent power line-ups provides power, the instance will maintain availability. During this weekend's event, the instances that lost power lost access to both their primary and secondary power as several of our power delivery line-ups failed to transfer load to their generators. These particular power line-ups utilize a technology known as a diesel rotary uninterruptable power supply (DRUPS), which integrates a diesel generator and a mechanical UPS. Under normal operation, the DRUPS uses utility power to spin a flywheel which stores energy. If utility power is interrupted, the DRUPS uses this stored energy to continue to provide power to the datacenter while the integrated generator is turned on to continue to provide power until utility power is restored. The specific signature of this weekend's utility power failure resulted in an unusually long voltage sag (rather than a complete outage). Because of the unexpected nature of this voltage sag, a set of breakers responsible for isolating the DRUPS from utility power failed to open quickly enough. Normally, these breakers would assure that the DRUPS reserve power is used to support the datacenter load during the transition to generator power. Instead, the DRUPS system's energy reserve quickly drained into the degraded power grid.
The rapid, unexpected loss of power from DRUPS resulted in DRUPS shutting down, meaning the generators which had started up could not be engaged and connected to the datacenter racks. DRUPS shutting down this rapidly and in this fashion is unusual and required some inspection. Once our on-site technicians were able to determine it was safe to manually re-engage the power line-ups, power was restored at 11:46PM PDT.
[...]
In Closing
We apologize for any inconvenience this event caused. We know how critical our services are to our customers' businesses. We are never satisfied with operational performance that is anything less than perfect, and we will do everything we can to learn from this event and use it to drive improvement across our services.
-The AWS Team

https://aws.amazon.com/it/message/4372T8/

On the website, Amazon keeps track of all outages that have occurred in its data centre infrastructure in which it rents digital space[1]. The portal that manages infrastructure outage reporting, Service health, makes it possible to view outages

[1] Cfr. lemma no. 3 Cluod Data Center in Definition of Terms.

that have occurred over a 12-month period, but when a problem has had a more significant impact on customer service, the company aims to provide a post-event summary (PES), which will remain available for a minimum of five years. As of today 2024, there are 16 PESs present and they are located all over the earth: from Asia to the Americas and Australia.
On 4 June 2016, there were failures of Amazon data centres caused by weather events in the Sydney area. The report explains the severity of the situation as a malfunction of the power system that kicks in when there are electrical disruptions of various kinds and because the classical power redundancy system had not worked before. After explaining the extent of the damage, the company takes care to write down how the event led them to take meticulous action in all their facilities that might be exposed to the same kind of risk.
If Amazon reacts to the malfunctioning of its infrastructure by reassuring its users, there is a site on the other hand that collects reports from users notifying malfunctions. Downdetector[2] presents itself as an online service to keep up to date on the progress of the various online services used by users.
So we are dealing with a method of control that works if the infrastructure itself works.
Beyond the mode of operation and data collection, the fragility that affects the digital infrastructure mainly affects the fibre optic cables and the data centers themselves. Failures, however, can be physical in nature, such as the storm in Sydney in 2016 reported by Amazon, or failures given by digital hacking through viruses that affect the typical functioning of the infrastructure.
The complexity of the system makes the security factor increasingly important, a theme that is also developed in the standards addressed in Chapter 3.
Another useful system that periodically monitors the progress of the infrastructure are the reports of the Uptime Institute, which has entered the digital infrastructure market as the guardian of the system's progress.
Annually UI issues reports covering all aspects of the infrastructure. Interesting are the various reports dealing with connection disruptions, such as the one that has affected and continues to affect Amazon's infrastructure. As an impartial advisory organisation focused on improving the performance of critical business infrastructure, the data on which they rely is mainly high-profile public outages. In the 2020 report, it is explicitly mentioned that reporting and counting outages is a conundrum, given how little data is shared. This growing trend can be linked to the possibility of lawsuits that may affect these spaces, thus a protection for the companies themselves. As long as reporting forms are not mandatory, data will always be irregular and the analyses circulating will always be incomplete.
Reports group together all possible faults, but separating the digital and the physical-infrastructural type is useful to bring the whole system back to a more tangible reality. The IT discipline has been constantly prepared for attacks or failures of a digital nature, but the system is also made up of a physical structure, perhaps the only one subject to unpredictable events that are less controllable. The growth in the importance of such an infrastructure has not gone hand in hand with a spa-

[2] On the site they write: "Downdetector is powered by unbiased, transparent user reports and problem indicators from around the web. Downdetector helps people all over the world understand disruptions to vital services such as the internet, social media, web hosting platforms, banks, games, entertainment, and more. With insight into all the services and platforms that power connectivity, Downdetector empowers consumers and informs enterprises when customers are experiencing issues.
Downdetector is a part of Ookla®, a trusted global leader in connectivity intelligence and network insights. From measuring network performance with Speedtest® to identifying problems with Downdetector®, Ookla empowers consumers across the globe to understand and optimize their internet experience."

tial and structural evolution that would rework the physical security of the infrastructure; on the contrary, the choice being made is to hide the physicality of the infrastructure by even creating a language - that of the cloud - and a narrative that shifts the theme away from the spatial discourse. Today, we have an infrastructure that involves 90 per cent of the world's communications through cables laid on the seabed, an exposed network that suffers the vagaries of the weather, but also human tampering. The human issue is not to be underestimated as at least one person is needed to cut the cables with a simple shear. Fire, marine fauna, the human factor and weather events are the most palpable risks for an imminent infrastructure catastrophe.

DATA	LUOGO	DANNO	DESCRIZIONE	LINK
gennaio 2008	Cavi rotti 2008	Danneggiamento di 6 cavi sottomarini (medio oriente)	L'interruzione dei cavi sottomarini del 2008 si riferisce a tre incidenti separati di gravi danni ai cavi di comunicazione ottica sottomarini in tutto il mondo. Il primo incidente ha causato danni che hanno coinvolto fino a cinque cavi di comunicazione sottomarini Internet ad alta velocità nel Mar Mediterraneo e in Medio Oriente dal 23 gennaio al 4 febbraio 2008, causando interruzioni e rallentamenti di Internet per gli utenti in Medio Oriente e in India. L'incidente ha messo in dubbio la sicurezza della parte sottomarina del sistema via cavo Internet.	https://en.wikipedia.org/wiki/2008_submarine_cable_disruption
16 agosto 2013			Tutti i servizi Google in down per 5 minuti	https://www.cnet.com/tech/services-and-software/google-goes-down-for-5-minutes-internet-traffic-drops-40/ https://www.wired.co.uk/article/googledip
24 gennaio 2014			Gmail, Google+, Google Calendar e Google Docs in down per 25 minuti	https://blog.google/inside-google/company-announcements/todays-outage-for-several-google/
25 maggio 2018	Friuli Venezia Giulia	Problemi alla rete regionale Insiel (data center di Insiel) per 1h	Problemi alla rete regionale Insiel negli uffici regionali e nelle sedi che ne fanno uso. E' capitato oggi alle 11.25 fino alle 12.20. Fuori uso per quasi un'ora i collegamenti fra gli uffici regionali e gli enti che utilizzano il servizio intranet gestito dalla società in house della regione Fvg. Il piccolo disguido tecnico si è verificato inevitabilmente anche al Nue 112 di Jalmicco ma, come affermato dal direttore del Sores di Palmanova, Vittorio Antonaglia, 'il black out informatico non ha creato alcun problema di gestione sanitaria'. L'ultimo guasto si era verificato una settimana fa, ma anche allora, il problema era stato risolto in breve tempo - circa mezzo'ora - grazie al sistema di backup utilizzato da Insiel.	https://www.udinetoday.it/cronaca/rete-insiel-down-problemi-alla-rete-intranet-regionale.html
17 agosto 2018	Sardegna	Danneggiamento cavo Civitavecchia - Olbia	17 Agosto del cavo sottomarino che collega la Sardegna al resto del mondo, per quanto riguarda il mondo digitale e quello di internet. Nella giornata di ieri l'ennesimo incidente, e questa volta non si tratta dello stesso collegamento già danneggiato che da Civitavecchia va a Olbia (252.5 chilometri, fino a 1400 metri di profondità)	https://www.sardegnadigital.it/2018/08/28/cavi-sottomarini-la-sardegna-rischiava-di-rimanere-offline/
16 ottobre 2018			Dopo un'ora e due minuti di blocco, Youtube ritorna a funzionare	https://www.cnbc.com/2018/10/17/googles-youtube-outage-affected-users-in-us-australia-asia-europe.html https://www.fox13now.com/2018/10/16/youtube-down-major-outage-prompts-outcry-on-social-media https://twitter.com/TeamYouTube/status/1052373937839980544
28 gennaio 2019	Data center non dichiarato	Irruzione in un data center	Un cervo ha invaso un data center.	https://www.datacenterdynamics.com/en/news/deer-broke-data-center/
20 agosto 2020	Non reso pubblico	Danno non reso pubblico	Più di 6 ore di inattività per Gmail, Google Drive, Google Docs, Google Meet, Google Voice	https://news.sky.com/story/google-services-including-gmail-hit-by-serious-disruption-12052892 https://www.gadgets360.com/internet/news/gmail-google-drive-docs-meet-cloud-outage-issues-problems-2282388 https://www.forbes.com/sites/carlypage/2020/08/20/gmail-down-google-services-suffer-global-outage/?sh=12ca9b6d62f8 https://www.newindianexpress.com/business/2020/aug/20/gmail-services-being-restored-expect-resolution-for-all-users-in-near-future-google-2185988.html https://www.news.com.au/technology/online/google-suffers-gmail-and-drive-outage-worldwide-after-a-week-of-australian-controversy/news-story/2781e17551bc35e0c6465b00638b22d8 http://www.dailynews.lk/2020/08/20/world/226464/gmail-experiencing-worldwide-service-disruption
11 novembre 2020			Interruzione di YouTube, YouTube Music, YouTube TV, Google TV, Google Play	https://9to5google.com/2020/11/11/youtube-tv-down-2/ https://www.androidpolice.com/2020/11/11/its-not-just-you-youtube-is-down/ https://www.theverge.com/2020/11/11/21561764/youtube-down-outage-loading-videos
14 dicembre 2020				https://www.theguardian.com/technology/2020/dec/14/google-suffers-worldwide-outage-with-gmail-youtube-and-other-services-down
9 marzo 2021	Strasburgo	Data center Ovh	Ovh, società francese leader nel cloud con oltre 1,5 milioni di clienti, messo offline decine di migliaia di pagine web. Un grave incendio scoppiato nella notte tra il 9 e il 10 marzo ha colpito il **campus di Strasburgo di Ovh**, tra i principali fornitori europei di infrastrutture cloud, causando importanti disagi a chiunque dipenda dall'azienda per i suoi servizi in rete. L'imponente intervento dei vigili del fuoco francesi ha permesso di contenere i danni e attualmente **non sembra vi siano vittime**, anche se *"non è stato possibile controllare le fiamme in Sbg2"*, uno dei data center ospitati nel campus, ha twittato **il fondatore di Ovh**, Octave Klaba. *"L'intero sito è stato isolato e questo impatta su tutti i servizi (ospitati da) Sgb1-4"*, ha proseguito Klaba. *"Raccomandiamo (ai clienti) di attivare il vostro piano per il ripristino di emergenza"*. Anche il data center Sgb1 è stato parzialmente distrutto dalle fiamme.	https://www.wired.it/internet/web/2021/03/10/incendio-data-center-ovh-strasburgo/
8 giugno 2021		Errore 503. Inaccessibili molti siti molto frequentati	Problemi con Fastly. Fastly fornisce un servizio noto come CDN (Content Delivery Network) che permette di ridistribuire localmente i contenuti di un sito conservandone una memoria cache, utile soprattutto in caso di down o di problemi legati al server garantendo dunque la navigazione lato utente. Un servizio che se mal configurato potrebbe creare dei grossi problemi (Inps aprile 2020)	https://www.webforma.it/news/down-fastly-thevarnishcache-problemi-8-giugno-2021-twitch-vimeo-stackoverflow https://www.open.online/2021/06/08/internet-down-fastly/
7 dicembre 2021	US	Problemi al data center		https://www.smartworld.it/informatica/problemi-per-amazon-web-services-a-farne-le-spese-e-praticamente-tutto-internet.html
22 dicembre 2021	US	Problemi al data center	Il problema accorso sembra aver riguardato "*La connettività e l'alimentazione ad alcuni data center all'interno della zona di disponibilità interessata o ad altre zone di disponibilità all'interno della regione US-EAST-1. Continuiamo a lavorare per risolvere il problema e ripristinare l'alimentazione all'interno del data center interessato*" queste le dichiarazioni di **Amazon AWS** che dunque ammettono problemi di corrente nel data center della regione US-EAST-1.	https://www.hwupgrade.it/news/web/amazon-aws-mette-ancora-ko-internet-tantissimi-i-siti-web-down-ecco-cosa-sta-succedendo_103447.html
15 gennaio 2022	Tonga (Nuova Zelanda)	Cavo reciso da eruzione	Un cavo sottomarino in fibra ottica che collega Tonga al resto del mondo è stato reciso durante l'eruzione di un vulcano. Il ministero degli affari esteri della Nuova Zelanda afferma che potrebbe volerci più di un mese per riparare le pause nei 49.889 km (31.000 miglia) di cavo che servono il Pacifico meridionale. L'eruzione sottomarina - seguita da uno tsunami - ha portato alla interruzione delle 110.000 persone di Tonga. Una connessione wireless 2G è stata stabilita sull'isola principale, utilizzando una parabola satellitare dell'Università del Pacifico meridionale. Ma il servizio è irregolare e i servizi internet funzionano lentamente.	https://www.bbc.com/news/technology-60069066.amp
22 febbraio 2022				https://techprincess.it/aws-down-22-febbraio-2022/
3 maggio 2022	Toscana	Guasto ai sistemi del data center che servono la regione	Un guasto ai sistemi del data center regionale ha bloccato stamattina per circa un'ora l'erogazione di alcuni servizi. I tecnici informatici sono prontamente intervenuti e sono al lavoro per ripristinare il normale funzionamento. Lo comunica, in una nota, la Regione Toscana scusandosi per i disagi creati ai cittadini e alle cittadine.	https://www.lanazione.it/firenze/cronaca/guasto-informatico-regione-toscana-1.7630049
19 luglio 2022	Londra	Malfunzionamento data center di Google	Un data center di Google Cloud ha avuto dei malfunzionamenti a causa del caldo record che ha colpito Londra martedì. Lo status ha indicato "problemi di raffreddamento" come motivo del blackout, che pare abbia interessato un numero ridotto di utenti. Il problema ha riguardato solo uno dei tre data center londinesi di Google Cloud, ma ne hanno risentito ad esempio la banca Atom Bank e anche Oracle Cloud ha dovuto mettere in manutenzione i propri record a causa del caldo. Il Regno Unito sta sperimentando in questi giorni una delle estati più calde della sua storia, con il termometro che ha raggiunto i 40 gradi.	https://www.adnkronos.com/ischia-simoncini-stop-compromessi-tutela-suolo-con-i-21-mld-del-condono-di-38-anni-fa_3yTy6lrWH1xzFdMApEH5q7
4 agosto 2022	Bolzano	Guasto al cavo di collegamento, Roma	"L'esecuzione di operazioni bancarie presso il sistema Raiffeisen non è momentaneamente possibile - aveva avvertito la banca stamattina - a causa di un guasto al cavo di trasmissione principale del data center nei pressi di Roma. Ad esso sono collegati i sistemi Raiffeisen. Nonostante i molteplici dispositivi di sicurezza, il centro è attualmente isolato quindi non accessibile."	https://www.altoadige.it/cronaca/guasto-al-circuito-bancario-raiffeisen-risolto-il-problema-al-centro-dati-1.3281242
8 agosto 2022	Council Bluffs, Iowa	Google Data Center	L'8 agosto, un data center di Google situato a Council Bluffs, in Iowa (Stati Uniti), è stato protagonista di un incidente elettrico che ha causato tre feriti. I media locali hanno inizialmente parlato di una vera e propria esplosione registrata alle 11:59 ora locale (intorno alle 18:00 italiane), ma a quanto pare il problema ha provocato ingenti danni.	https://www.hdblog.it/google/articoli/n559835/google-data-center-esplosione-feriti-iowa-cronaca/ https://www.ceotech.it/google-subisce-un-incidente-che-interrompe-la-ricerca/

8 agosto 2022	Council Bluffs, Iowa	Google Data Center	L'8 agosto, un data center di Google situato a Council Bluffs, in Iowa (Stati Uniti), è stato protagonista di un incidente elettrico che ha causato tre feriti. I media locali hanno inizialmente parlato di una vera e propria esplosione registrata alle 11:59 ora locale (intorno alle 18:00 italiane), ma a quanto pare il problema ha provocato ingenti danni.	https://www.hdblog.it/google/articoli/n559835/google-data-center-esplosione-feriti-iowa-cronaca/ https://www.ceotech.it/google-subisce-un-incidente-che-interrompe-la-ricerca/
4 ottobre 2022	USA molto probabilmente	Probabilmente problemi tecnici in data centers	ripreso dal down più lungo di sempre. Secondo quanto riportato dal The New York Times, un team di ingegneri si era davvero recato in un data center statunitense in California per cercare di rimettere in piedi i servizi dell'azienda. Come riportato da diversi fonti poi, il down dell'ecosistema Facebook ha colpito anche gli uffici dell'azienda: gli impiegati non potevano utilizzare i loro badge per accedere agli edifici o alle sale riunioni. Bisogna capire a questo punto quale è stata la vera causa del disservizio, sempre che Facebook Inc. faccia chiarezza a riguardo nelle prossime ore.	https://www.smartworld.it/app/facebook-instagram-e-whatsapp-down-tutti-i-servizi-di-facebook-non-funzionano.html
16 ottobre 2022			Interruzione di Google Maps e Street View	https://volsiz.ru/en/news-en/2022/10/17/is-google-maps-down-10-16-2022-why-google-maps-is-not-working-today-whats-up-with-google-maps-now/
24 ottobre 2022	Scozia	Danneggiati 5 cavi sottomarini	Nelle ultime settimane cinque cavi sottomarini in fibra ottica per la trasmissione di dati internet nel Mare del Nord e nel Mar Mediterraneo sono stati sabotati. I Paesi più colpiti da questi danneggiamenti sono Scozia e Francia, nonostante anche Danimarca, Spagna e persino l'Italia abbiano riscontrato malfunzionamenti nella connessione a internet, anche se nel nostro caso i disagi riguardano quasi esclusivamente la città di Milano. Al momento resta ignota l'origine di questi sabotaggi, se di sabotaggi si tratta, ma sale la tensione e i vari Governi stanno iniziando a valutare possibili soluzioni per prevenire e limitare futuri attacchi.	https://www.geopop.it/cavi-sottomarini-danneggiati-avanza-lipotesi-di-sabotaggio-in-europa-ancora-ignote-le-cause/
30 ottobre 2022	Salerno	Data center del cloud provider	I servizi informatici del Comune di Salerno non sono stati garantiti.	https://www.salernotoday.it/cronaca/comune-salerno-guasto-servizi-informatici-30-ottobre-2022.html
4 ottobre 2021	Problemi ai software di vari servers.	Accesso impossibilitato	Il 4 ottobre 2021, alle 15:39 UTC, il social network Facebook e le sue filiali, Messenger, Instagram, WhatsApp, Mapillary e Oculus, sono diventati indisponibili a livello globale per un periodo da sei a sette ore. L'interruzione ha anche impedito a chiunque cercasse di utilizzare "Accedi con Facebook" di accedere a siti di terze parti. Durante l'interruzione, molti utenti si sono riversati su Twitter, Discord, Signal e Telegram, causando interruzioni sui server di queste app. L'interruzione è stata causata dalla perdita di percorsi IP ai server DNS (Facebook Domain Name System), che all'epoca erano tutti self-hosted. Il routing Border Gateway Protocol (BGP) è stato ripristinato per i prefissi interessati intorno alle 21:50 e i servizi DNS hanno iniziato ad essere di nuovo disponibili alle 22:05 UTC, con i servizi application-layer gradualmente ripristinati su Facebook, Instagram e WhatsApp nell'ora successiva, con il servizio generalmente ripristinato per gli utenti entro le 22:50.	https://www.wired.com/story/why-facebook-instagram-whatsapp-went-down-outage/
21 aprile 2011	Problema software	Blocco servizi cloud di Amazon	Alle 12:47 PDT del 21 aprile, un cambiamento di traffico non valido prima dell'aggiornamento della rete ha causato la perdita di connettività reciproca delle istanze con una zona di disponibilità della regione US-East-1. Una volta che gli errori sono stati localizzati in una sola zona di disponibilità, il ripristino EBS Questi errori di connettività hanno avuto un impatto sul volume EBS e sulle istanze EC2 in più zone di disponibilità e hanno causato problemi per i clienti fino al recupero completo alle 15:00 PDT del 24 aprile	https://money.cnn.com/2011/04/21/technology/amazon_server_outage/index.htm
7 agosto 2012	Dublino Data Center	Problemi di vario tipo: umani, soft, hardware	Lunedì scorso (8 agosto) Amazon ha affermato che un fulmine a Dublino, dove si trovano alcuni dei suoi server, ha fatto cadere l'alimentazione al centro dati. Ma oggi l'azienda ha detto che una serie di problemi derivanti dall'interruzione di corrente, la cui causa deve ancora essere determinata, e non un fulmine ha causato l'interruzione prolungata del servizio.	https://sociable.co/business/amazon-admits-lightening-didnt-strike-its-dublin-data-center-but-a-series-of-errors-did/
8 agosto 2011	US orientale	Bug software nel router	EC2 è sceso intorno alle 22:25. Orientale negli Stati Uniti dell'Amazzonia Regione Est. L'interruzione del cloud è durata circa 30 minuti, ma ha abbattuto i siti Web e i servizi di molti dei principali clienti del cloud Amazon, tra cui Netflix, Reddit e Foursquare. Il problema si è verificato nelle reti che collegano le zone di disponibilità a Internet ed è stato causato principalmente da un bug software nel router	https://www.cnn.com/news/cloud/231500023/amazon-offers-explanations-apologies-for-dual-cloud-outages.htm
29 giugno 2012	West Virginia	Danno per meteo avverso	La nostra regione US East-1 è composta da più di 10 data center strutturati in più zone di disponibilità. Queste zone di disponibilità si trovano in posizioni fisiche distinte e sono progettate per isolare i guasti l'uno dall'altro. Venerdì scorso, a causa degli avvisi meteorologici dell'avvicinarsi della tempesta, tutte le attività di cambiamento nella regione East-1 degli Stati Uniti erano state annullate e personale extra era stato chiamato nei data center per la sera.	https://aws.amazon.com/it/message/67457/
22 ottobre 2012	US	Bug con conseguente interruzione di cloud sevices	Si verifica una grave interruzione (a causa di un bug di perdita di memoria latente in un agente di raccolta dati operativo), che colpisce molti siti come Reddit, Foursquare, Pinterest e altri.	https://aws.amazon.com/it/message/680342/
24 dicembre 2012	Nord est US		AWS subisce un'interruzione, causando l'indisponibilità di siti web come i video istantanei di Netflix per i clienti nel nord-est degli Stati Uniti.	https://www.theverge.com/2012/12/24/3801978/netflix-streaming-down-on-some-devices-thanks-to-amazon-issues https://aws.amazon.com/it/message/680587/
13 settembre 2013	Nord Virginia	Struttura rallentata per stress di sovraccarico	Venerdì 13 non sta iniziando bene per i grandi Stati Uniti di Amazon. Regione orientale dove il servizio EC2 di Amazon mostra segni di stress. Dalle 7:54 AM alle 9:04 AM	https://old.gigaom.com/2013/09/13/uh-oh-amazon-u-s-east-is-in-trouble-again/
26 novembre 2014		|||||||	||||	https://www.theregister.com/2014/11/27/aws_cloudfront_wobbles_at_worst_possible_time/
20 settembre 2015	Nord Virginia	Interruzione del servizio	Nonostante sia gestito interamente dalla piattaforma cloud di AWS, il gigante dello streaming online Netflix segnala un rapido recupero dall'interruzione di domenica, dimostrando l'importanza del suo approccio di costruire sistemi basati su cloud per "fallimento".	https://www.techrepublic.com/article/aws-outage-how-netflix-weathered-the-storm-by-preparing-for-the-worst/
5 giugno 2016	Zona orientale dell'Australia	Interruzione del servizio	AWS Sydney subisce un'interruzione per diverse ore a causa di forti temporali nella regione che causano un'interruzione di corrente ai data center 6 ore di interruzione circa.	https://www.theregister.com/2016/06/05/aws_oz_downed_by_weather/ https://aws.amazon.com/it/message/4372T8/ https://www.itnews.com.au/news/failure-in-power-redundancy-triggered-aws-sydney-outage-420656
28 febbraio 2017	Virginia Settentrionale	Interruzione servizio	Il 2 marzo, AWS rivela che l'interruzione è stata causata da un parametro errato passato da un dipendente autorizzato durante l'esecuzione di un playbook stabilito, che ha finito per eliminare più istanze del previsto dal dipendente.	https://aws.amazon.com/message/41926/ https://venturebeat.com/business/aws-apologizes-for-february-28-outage-takes-steps-to-prevent-similar-events/
2 marzo 2018	Ashburn, Virginia	Degrado|interruzione del servizio AMAZON	4 ora di abbassamento di potenza di connessione	https://virtualizationreview.com/articles/2018/03/05/aws-outage.aspx
31 maggio 2018	||||||||	||||||||	30 minuti di diminuzione del traffico nei server Amazon	
23 agosto 2019	Tokyo	Interruzione servizio Amazon Cloud per surriscaldamento	Surriscaldamento sistema per malfunzionamento sistemi di raffreddamento.	https://aws.amazon.com/it/message/56489/
31 agosto 2019	Nord Virginia US-EAST-1	Interruzione di corrente con conseguente perdita di volume di dati	L'interruzione di corrente non dovrebbe essere un grosso problema per AWS come appare sulla carta. Con la garanzia dei generatori di backup in ogni centro dati, AWS assicura ai clienti la sicurezza dei loro dati. Ma il contrario è accaduto il 31 agosto 2019, quando il data center Amazon US-EAST-1 in North Virginia ha subito un'interruzione di corrente alle 4:33. I generatori di backup del centro dati non funzionavano e mostravano segni di guasto intorno alle 6:00 del mattino. Di conseguenza, quasi il 7,5% delle istanze EC2, così come i volumi EBS, non erano disponibili.	https://www.whizlabs.com/blog/amazon-aws-outage/
22 23 ottobre 2019	\\\	Virus informatico	Amazon Web Services è stato colpito da un attacco DDoS (distributed denial-of-service), con conseguente interruzione che ha colpito molti siti web. 10.30 to 18.30	https://www.cnn.com.au/news/aws-hit-by-ddos-attack-dragging-half-of-web-down-532842
25 novembre 2022	\\\	Inaccessibilità ai servizi.	Molte app, servizi e siti web hanno pubblicato su Twitter su come l'interruzione di AWS li ha colpiti, tra cui 1Password, Acorns, Adobe Spark, Anchor, Autodesk, Capital Gazette, Coinbase, DataCamp, Getaround, Glassdoor, Flickr, iRobot, The Philadelphia Inquirer, Pocket, RadioLab, Roku, RSS Podcasting, Tampa Bay Times, Vonage, Downdetector.com ha anche mostrato picchi nei rapporti degli utenti di problemi con molti servizi Amazon durante il giorno	https://www.theverge.com/2020/11/25/21719396/amazon-web-services-aws-outage-down-internet
15 dicembre 2021	Ovest stati uniti	Perdita di potenza elettrica	Regione irraggiungibile per 30 minuti	https://www.theregister.com/2021/12/22/aws_outage/
	La storia del canada e della sua interruzione di servizi			
	La storia di Crimea del BO del 2019 fisico | informatico			

	La storia di Crimea del BO del 2019 fisico | informatico			
	2016 botnet usa orientali attacco DSN			
	2000 Michael Calce DDos			
	Storia di stuxnet			
	Worms iloveyou 2000			
	Baltimora 2019 ransomeware			
	2017 spoofing navi guerra usa			
14 marzo 2017	Torino, Piemonte	Interruzione totale del servizio TOP-IX, anomalia backbone di rete 11.40 to 12.45	Il TOP:IX è composto da 86 membri consorziati, tra questi - oltre i maggiori carrier nazionali- vi sono anche alcune della principali realtà del mondo accademico e produttivo del nord ovest italiano: La Stampa, Politecnico di Torino, Intesa San Paolo, Fondazione Ugo Bordoni, il Traforo del Frejus, comune di Torino, Regione Piemonte, I?INrIM (ex istituto Ferraris). Reti connesse al consorzio sono circa 100.	https://www.key4biz.it/il-down-di-top-ix-ecco-cosa-e-successo-lo-scorso-14-marzo/185102/

Outage – 50 cases

The collection of these case studies is not intended to be exhaustive, but was used as a reason for awareness in the study of the infrastructure.

What is most evident from the case studies is that clarity on the technical aspect is always left out. There is a lack of connection, but the justifications are always vague and never direct and clear.

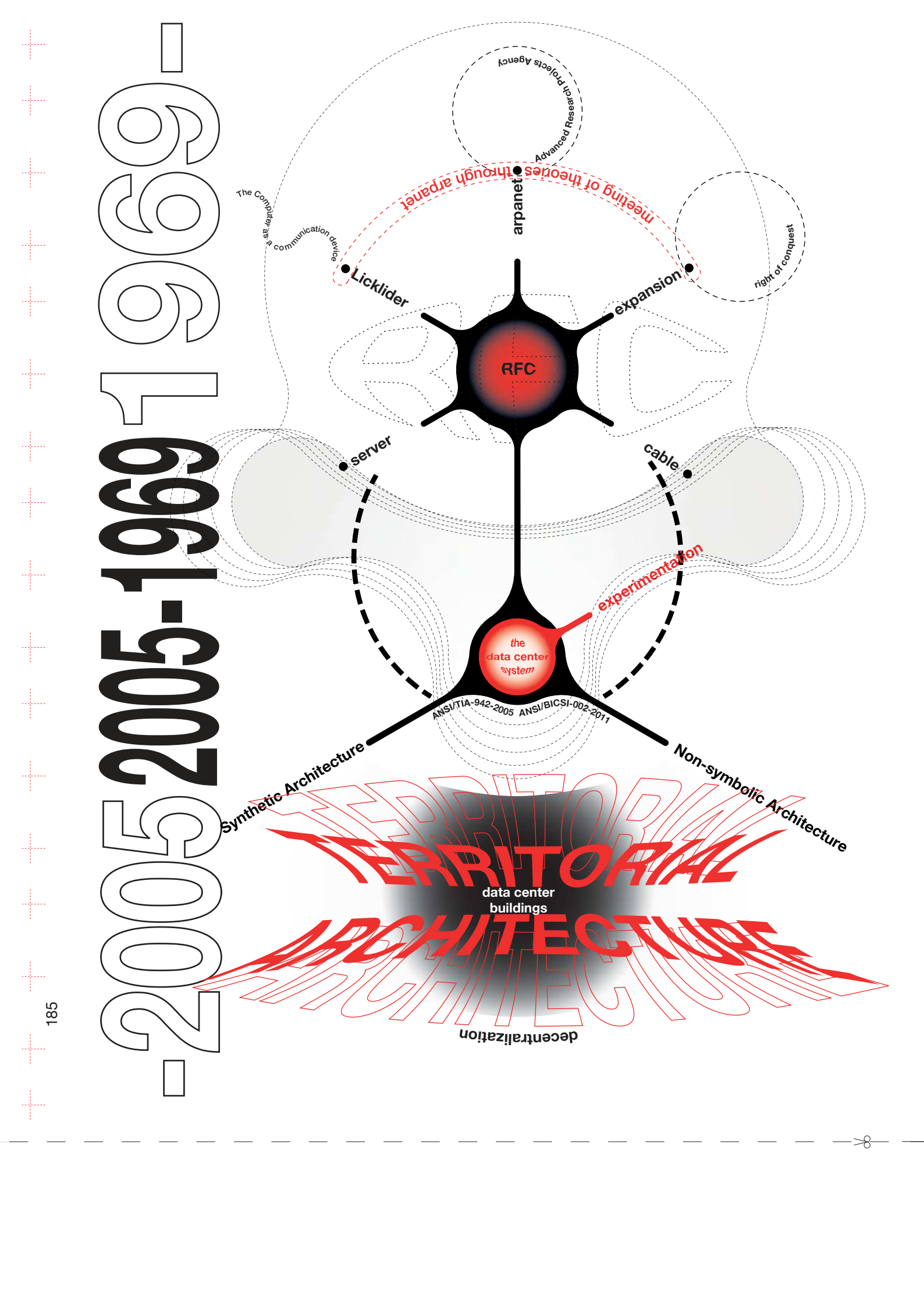
A shark bites a cable – 2014
In 2014, this video gained public notoriety by demonstrating the absurd fragilities of the fibre optic cable system and its multiple possibilities of being damaged.

Damaged cables, France, April 2022
The damaged cables are those connecting Paris to the cities of Lille, Lyon and Strasbourg.
'Internet cables have been cut in the Ile-de-France region, which is affecting the landline and mobile network. We are in touch with operators who are working to restore service,' the former French secretary of state for digital affairs said in a tweet. Occurring just days after a presidential election, the government rejects the idea of the attack as sabotage.
Ten internet companies were damaged in this coordinated attack that took place at different locations in the French capital. The CEO of Nasca Group, one of the affected companies stated that this was a professional job.
That it was an organised performance is not in doubt; one only has to realise how much these attacks need great professionals to carry out this kind of action. They take the form of a simple cut in places where cables of that importance are known to pass: near data centers, to convey the cabling that then connects to the servers.

The fire in Strasbourg (photo: Strasbourg fire brigade via Twitter|X)
In March 2021, a fire broke out on the Ovh campus in Strasbourg. A company that is one of Europe's leading owners of Iaas infrastructure (Crf. in Definition of Terms lemma 2 Cloud Computing), it hosts applications for one and a half million people in its data centres. This fire clarifies the false immortality of the cloud. Many servers were lost and some, due to a lack of systemic redundancy, lost their data completely.
Wired reports on how the digital spaces of the National Cybersecurity Laboratory (CINI - International Consortium for Informatics) were damaged, and complaints also came from online gaming platforms such as Minecraft whose servers were damaged.
Unveiling the fragility of the system also helps to physically embed it in urban logic. Clear signs of physical presence emerge from the damage, but so does the blind trust that human beings place in this infrastructure that seems to be unbreakable to the public opinion.

https://www.wired.it/internet/web/2021/03/10/incendio-data-center-ovh-strasburgo/

A deer in a data center – January 2019
It is unclear where this incident took place. In 2019, a video and pictures appeared online of a terrified deer that managed to enter a data center and reached the server room before animal protection arrived.
From the pictures one can recognise the server room, the floating floor with vents for the cables underneath, and the electrotechnical furniture arranged according to the flooring. Apparently this happened in a data center of little importance and it is clearly visible from the photos that the infrastructure is not comparable to a new one built at that time.
For this type of infrastructure, time is a factor that plays a different role than for most other infrastructures. Obsolescence follows a rapid rhythm if one thinks of the data center as an architecture.


-2005 2005-1969 1969-
Advanced Research Projects Agency
arpanet
meeting of theories through arpanet
The Computer as a communication device
Licklider
right of conquest
expansion
RFC
server
cable
experimentation
the data center system
ANSI/TIA-942-2005 ANSI/BICSI-002-2011
Synthetic Architecture
Non-symbolic Architecture
TERRITORIAL
data center buildings
ARCHITECTURE
decentralization

Synthetic Architecture for New Spatial Logics

The fields of technology are creating their own space autonomous from that of man, but it would be reductive to allude to a spatial peace between IT and architecture. This apparent independence, on the other hand, can become a key element in directing the view towards future design directions. Indeed, the thesis considers the study of the data center as a system[1] that brings with it various spatial compositions. By crossing the boundaries between the two disciplines, the research repositions the actors and elements that direct this phenomenon.
The great spatial revolution in computing came about thanks to the Arpa project and its research team. Also working under the same department was J. C. R. Licklider, a psychologist and computer scientist, who in 1968 published the article *The Computer as a Comminucation Device* in which the author, together with Robert Taylor, imagined the computer as a useful tool for the exchange of information between users, rather than just as a calculation system. It was he who from 1962 to 1964 influenced the direction of the project within ARPA by proposing a connection between computers, de facto imagining the logic of the Internet.
With this vision, the Internet lays the foundations for a decentralisation of information given mainly by its way of circulating it. The speed of connection, the first principle of the American project, will allow the centres of the digital infrastructure to be distributed across the globe.
Right from the beginning, the seeds were laid for the logical functioning of the network, which then led to the formalisation of the data center as the custodian of information connected through a cabled infrastructure system.
With the coming of the new millennium, in fact, we are experiencing a quantitative increase in digital spaces that will slowly replace the memory that every PC had. Now the network is accessible through devices - PCs, tablets and smartphones - that behave as highly connected terminals with the ability to reach the information contained in data centers. This logic is quantitatively different from the way the first computers were used. Initially, computers such as UNIVAC 1, EDVAC or ENIAC consisted of the actual computer, where the calculations actually took place, and the terminal, where the inputs were inserted and the outputs printed out. It sometimes happened that the two parts of the machine occupied different rooms in the same building. While previously decentralisation insisted on one building, now with the systemic and spatial organisation of the data center, decen-

The thesis starts from the assumption that the data center is not only an architecture, but a system that has made use of the discipline of architecture for quantitative issues.

tralisation acts across the entire globe.
The core of the digital infrastructure and the data centers themselves are the server rooms whose physical translation is the spatial transposition of the *diagram*.
Experiments within the boundaries of the architectural discipline were developed in the same years by Archizoom using the typewriter. The group of architects produced the first experiments of *No-Stop City!* using a typewriter to draw|write the general plan. In the same year, with the publication of the first RFC-*Host Software* edited by Steve Crocker, the functioning of the first Internet connection is schematically represented, using the font used by Archizoom.
The language and principles that diagrammatic representation brings with it are therefore those of synthesis. The IT discipline has always adopted synthesis as its founding principle and value, from its language to its physicality, and this also entails synthesis in the territory in which it operates. The structure in question increases its territory of influence compared to any past architecture that could only insist on more circumscribed territories. A synthetic architecture in a dual narrative aspect: as architectural language and as action on the territory.
The diagram, as the ages of computer development have passed, has continued to accompany disciplinary reasoning; as successive published RFCs demonstrate, coherence is never denied. It is easy to see how the plan of the data centre itself can be traced back to the character representation used in the RFCs. These publications prove to be a moment in the theory of the digital infrastructure, a narrative space in which the possibilities and ways of functioning of the infrastructure itself are examined.
When the need for space arose, the meeting between architecture and computer science was physiologically desired by the latter. In this event, the spatial question emerged as a non-derogable necessity, so much so that in the standards analysed, the presence of the architect is presented as useful, but not fundamental. If not for regulatory or other minor issues, he in no way enters into the heart of the design.
Infrastructural organisation had to be addressed in some way, and this led to a violent clash between the two disciplines, forcing information technology to absorb the more classic structural and formal issues from architecture.
Spatial formalisation creates regulations governing the need to install servers, seeking to propose a universal method adaptable to any territory. The data center thus becomes an architectural system that has no relationship with the outside world, but an architecture that seeks mediation with its surroundings for its sole purpose: to make its spaces performative through the operation of servers.
Despite the ordinary formal relevance of the design output, this is the first architectural structure produced by the digital infrastructure[2] as a medium for experiencing the global territory. The system's possibilities are complex and it is not impossible that it may generate other types of spaces, with other formative principles leading to new design tools. It certainly acts as a watershed and anticipates new futures for architectural design.
Data centers respond to strict regulations that leave no room for interpretation. Server rooms are true compositions of elements that lie in territories that can be urban, desert or glacial. Their composition follows a rigid diagram that interlocks all the necessary elements, delivering the spatial standard for any detail. Hyper-rationality in design accompanies the floor plan, the section and above all the environment itself, which is appropriately insulated from the outside through systems and instruments that regulate its internal characteristics. Cold aisles and hot aisles

2 Following on from Mario Carpo's thesis, the opening up of new approaches to design could involve the 3D printer, a tool and method that, according to the author, can subvert the entire supply chain.

give spatial rhythm to the built environment and rationally divide spaces which do not give off heat from those which do. The maniacal layout of each element follows the strict dictates of the standard that hardly seems to notice that it produces space.
One of the new features of this architecture is its relationship with the human being, who is almost non-existent here. The very careful care for the machine in fact comes at the cost of human presence. For now, the spatial conformation still dialogues with the human body in the security, installation and component maintenance phase. Apart from these aspects, server rooms do not need the human factor. Its usefulness to the system can be considered as much as the ventilation system and the electrical system, thus becoming an auxiliary element. The proportions, dimensions and construction systems do not take into consideration the presence of man, who must also adapt to the temperature required by the servers if he wants to approach their environment.
In its essence, it behaves like a synthetic architecture. Its action in the global territory is to store information that was until recently crammed into different pieces of the city. Many deposits of material are replaced by binary-encoded files that are absorbed by the data centre. As a result, the infrastructure empties many typically urban architectures of symbolic meaning. It synthesises within it entire urban systems and infrastructures that interfere with classical spatial logic. This aspect of it gives a new balance to spatial hierarchies by creating compressions and expansions, effectively redistributing the relevance of the territory equally between urban and non-urban. The city becomes lighter and the non-city acquires relevance, becoming ground for design.
This controlled design, however, does not escape a classic aspect of architecture, that of time. Even StarLink begins to question the classical modes of connection by laying the basis for a design of the sky with three different layers of satellites[3], demonstrating the elasticity in spatial experimentation of the discipline itself. In doing so, the system could produce dismantling or closure, expanses of roofed surfaces with which humans will perhaps come into physical contact.
Analysing the object of study as a system, one can now think of it as the main cause of the territorialisation of architecture. This system and the buildings it produces subvert the principles of finiteness in architecture that usually affect a circumscribed territory. It produces a system that insists on vast portions of territory as previously mentioned. Thus, the dialogue between architecture and territory is transcended, as they undergo a union of intent in where subjects blend into each other.
Looking at its theoretical development, the study of this infrastructural phenomenon introduces new design principles. A discipline built on input and output, accustomed to looking for the solution that gives it an answer, computer science has written language as its dominant tool. When, in 1980, the United States included the writing of software in the federal law protecting copyrights, the authority of the field of research was confirmed and it was not yet thought that those software, in time, would become spaces. Indeed, the architecture of data centers seems to be the concrete realisation of software in which writing corresponds to its materialisation.
The architectural episode seems to recuperate the written language as a design tool. The figure of the designer becomes an author who produces architecture through his words. Given the recent evolutions of the discipline through artificial

3 By mentioning this new form of connection that runs through the territories of the sky, it subverts the idea of linearity in the spatial evolution of infrastructure.

intelligence, it is not insignificant that we have come to be able to translate/illustrate/represent written texts that are then converted into design. The ability to be able to converse with the machine to extract new designs, previously only in written form, now becomes commonplace. Architecture expands the number of design tools by implementing new possibilities for the author. It is therefore up to the discipline of architecture to recognise the value of resources to compete as a central discipline in future urban developments.

> The space of a sheet of paper (regulation international size, as used in Government departments, on sale at all stationers) measures 623,7 sq. cm. You have to write a little over sixteen pages to take up one square meter. Assuming the average format of a book to be 21 by 29,7 cm, you could, if you were to pull apart all the printed books kept in the Bibliothèque Nationale and spread the page carefully out one beside the other, cover the whole, either of the island of St Helena or of Lake Trasimeno.
>
> G. Perec, *Species of Spaces and Other Pieces*, Penguin Selected Writings, London 1974
> G. Perec, *Specie di spazi*, Bollati Boringhieri, Torino 1989

G. C. Argan, *Progetto e destino*, Il Saggiatore, Milano 1965

B.H. Bratton, *The Stack: On software and Sovereignity*, The MIT Press, Cambridge 2016

G. Bachelard, *La poetica dello spazio*, Edizioni Dedalo, Bari 2006

J. Baudrillard, *Cyberfilosofia*, Mimesis, Milano 2010

R. Banham, *Architettura della seconda età della macchina. Scritti 1955 – 1988*, Mondadori Electa, Milano 2004

R. Banham, *Los Angeles. L'architettura di quattro ecologie*, Piccola Biblioteca Einaudi, Milano 2009

R. Banham, *Architettura della prima età della macchina*, Edizione Calderini Bologna, Bologna 1970

F. Berardi, *E: la congiunzione*, Produzioni Nero, Roma 2021

J. Briddle, *Nuova era oscura*, Produzioni Nero, Roma 2018

I. Burrington, *Networks of New York, an Illustrated Field Guide to Urban Internet Infrastructure*, Melville House, New York 2016

M. Carpo, *The Alphabet and the Algorithm*, The MIT Press, Cambridge 2011

M. Carpo, *The Second Digital Turn*, The MIT Press, Cambridge 2017

M. Carpo, *Beyond Digital. Design and Automation at the End of Modernity*, The MIT Press 2023

E. Cioran, *Sulla Francia*, Voland Srl, Roma 2014

M. Domman, H. Rickli, M. Stadler, *Data Centers Edges of a Wired Nation*, Lars Müller Publishers, Baden 2021

L. Floridi, *The Online Manifesto*, Being Human in a Hyperconnected Era, Springer

Open, London 2015

E. M. Forster, *La Macchina si ferma e altri racconti*, Mondadori, Milano 2020

E. L. Francalanci, *Del Ludico, dopo il sorriso delle avanguardie*, Mazzotta, Milano 1982

S. Giedion, *Le macchine prenderanno il comando. Un contributo ad una storia anonima*, Ghibli, Milano 2019

V. Gregotti, *Il territorio dell'architettura*, Feltrinelli, Milano 2014

A. Huxley, *Il mondo nuovo – Ritorno al mondo nuovo*, Mondadori, Milano 2011

K. Kelly, *Quello che la tecnologia vuole*, Codice Edizioni, Torino 2011

R. Kitchin M. Doudge, *Code/Space Software and Everyday Life*, The MIT Press, Cambridge 2011

R. Koolhaas, *Testi sulla (non più) città*, Quodlibet, Macerata 2010

A. Laumonier, *6|5 – La rivolta delle macchine*, Produzioni Nero, Roma 2018

T. Leary, *Chaos & Cyber Culture*, Ronin Publishing, Berkeley, California 94701, 1994.

G. Lee, *Cloud Networking. Understanding Cloud-based Data Center Networks*, Elsevier, Amsterdam 2014

D. Libeskind, *La linea del fuoco. Scritti, disegni, macchine*, Quodlibet, Macerata 2014

K. Lynch, *L'immagine della città*, Biblioteca Marsilio, Venezia 1964

Amnesia, *Def. //, Recycled Theory: Dizionario Illustrato / Illustraded Dictionary, a cura di Sara Marini e Giovanni Corbellini*, Quodlibet, 2016

W. McKenzie, *Il capitale è morto. Il peggio deve ancora venire*, Produzioni Nero 2021

N. Maak, *Server Manifesto: Data Center Architecture and the Future of Democracy*, Hatje Cantz, Belino 2019

E. Marcuse, *Uomo a una dimensione. L'ideologia della società industriale avanzata,* Einaudi Editore, Torino 1997

Y. Mingard, *Deposit – Yann Mingard*, a cura di Florian Ebner, Daniela Janser e Thomas Seeling, Steidl, Gottinga 2014

T. Morton, *Iperoggetti*, Produzioni Nero, Roma 2018

MVRDV, *Metacity Datatown*, 010 Publishers, Rotterdam 1999

E. Paniagua, *Error 404. Siete pronti per un mondo senza internet?*, Passaggi Einaudi, Torino 2022

G. Perec, *Specie di spazi*, Bollati Boringhieri, Torino 1989

P. Portoghesi, *Infanzia delle macchine*, Editori Laterza, Roma, 1981

P. Portoghesi, *Tecnica curiosa. Dall'infanzia delle macchine alle macchine inutili*, Edizioni Medusa, Milano 2014

B. Rudofsky, *Architettura senza architetti,* Editoriale Scientifica s.r.l., Napoli 1977

B. F. Skinner, *Walden due, utopia per una nuova società*, La nuova Italia, Scandicci 1995

M. C. Taylor, E. Saarinen, *Imagologies: Media Philosophy*, Routledge, Londra 1994

R. Venturi, D. Scott Brown, S. Izenour, *Imparare da Las Vegas*, Quodlibet, Macerata 2010

J. William Mitchell, *La città dei bits: spazi luoghi e autostrade informatiche*, Mondadori Electa, Milano 1997

E. Weizman, *Architettura dell'occupazione, spazio e controllo territoriale in Palestina e Israele*, saggi Bruno Mondadori, Milano 2007

S. Zuboff, *Il capitalismo della sorveglianza*, LUISS University Press, Roma 2019

RIVISTE, CATALOGHI, PUBBLICAZIONI

R. Hyde, *When Aalto Met Google*, in Harvard Design Magazine n. 43, 2016, pp. 153

E. Gardner, M. Mars, *Tracing Concepts*, in Volume, The Internet of the Things n. 28, 2011, pp. 26 (insert)

A.Angelidakis, *Democracy of Gold. (Click Autobiography of an Internet Architect),* in Vesper Journal n. 2 Materia-autore, 2020, pp. 16 - 22

Paradigma Ariadné, *Sylvan Interiors*, in Vesper Journal n. 3 Nella selva, 2020, pp. 60 - 63

J.C.R. Licklider, R.W. Taylor, *The Computer as a Communication Device*, in Science and Technology, 1968

AMO, R. Koolhaas, *Countryside a report*, Taschen, Colonia 2020

L. Young et al., *Machine Landscape: Architecture of the Post-Anthropocene*, in Architectural Design (the whole number), 2019

Architectural Design, *Architects in Cyberspace*, 1995

P. Cournet, N.S. Bensi, *Datapolis*, nai010 publishers, Rotterdam, 2023

M. Bedir, L. Groen, M. Kuijpers, V. Munoz Sanz, et al., *Automated Landscape*, Nieuwe Instituut publisher, Rotterdam, 2023

B. Radice a cura di, *There is a Planet. Exhibition Catalogue. Triennale Design Museum*, Mondadori Electa, Milano 2017

BIBLIOGRAFIA DIGITALE
Organizzazioni per controllo e mantenimento della rete e dei suoi protocolli

Internet Assigned Numbers Authority (IANA)	https://www.iana.org
Internet Corporation for Assigned Names and Numbers	https://www.icann.org
Internet Society	https://www.internetsociety.org
Internet Architecture Board	https://www.iab.org
Internet Engineering Task Force	https://www.ietf.org
Internet Research Task Force	https://irtf.org
Number Resource Organization	https://www.nro.net
The Internet Numbers Registry for Africa	https://www.afrinic.net
Asia-Pacific Network Information Centre	https://www.apnic.net
American Registry for Internet Numbers	https://www.arin.net
Latin America and Caribbean Network Information Centre	https://www.lacnic.net
Ripe Network Coordination Centre	https://www.ripe.net
The RFC Series	https://www.rfc-editor.org
The Opte	https://www.opte.org/the-internet
DigiBarn Computer Museum	https://www.digibarn.com

report UPTIME INSTITUTE

AA. VV., *Uptime Institute Global Data Center Survey 2022, Resiliency remains critical in a volatile world*, Uptime Institute Intelligence, 2022

AA. VV., *Uptime Institute Global Data Center Survey 2021, Growth stretches an evolving*

sector, Uptime Institute Intelligence, 2021

A.Lawrence, L. Simon, *Annual outages analysis 2023, The causes and impacts of IT and data center outage*, Uptime Institute Intelligence, 2023

A.Lawrence, *Annual outage analysis 2021, The causes and impacts of data center outages*, Uptime Institute Intelligence, 2021

A.Lawrence, R. Ascierto, *Annual outage analysis 2020,, The causes and impacts of publicly recorded IT service and data center outages from 2016-2019*, Uptime Institute Intelligence, 2020

AA. VV., *Annual Data Center Survey Results 2019*, Uptime Institute Intelligence, 2019

AA. VV., *Publicly Reported Outages 2018-19*, Uptime Institute Intelligence, 2019

A.Lawrence, *Uptime Institute data shows outages are common, costly, and preventable*, Uptime Institute Intelligence, 2018

Previsioni 2024 (da inserire)

RFC (Request for Comments)

S. Crocker, *Host Software*, Request for Comments: 1, UCLA, 7 April 1969

J. Postel, *Internet Protocol. Darpa Internet Program Protocol Specification*, Request for Comments: 791, ISI | USC, September 1981

J. Postel, *Transmission Control Protocol. Darpa Internet Program Protocol Specification,* Request for Comments: 793, ISI | USC, September 1981

D. H. Crocker, *Standard for the Format of Arpa Internet Text Messages*, Request for Comments: 822, Sept. of Electrical Engineering University of Delaware, Newark, DE 19711, 13 August 1982

P. Mockapetris, *Domain Names - Concepts and Facilities*, Request for Comments: 1034, ISI, November 1987

P. Mockapetris, *Domain Names - Implementation and Specification*, Request for Comments: 1035, ISI, November 1987

L. Masinter, *Hyper Text Coffee Pot Control Protocol (HTCPCP / 1.0)*, Request for Comment: 2324, Network Working Group, 1 Aprile 1998

V. Cerf, *I Remeber IANA*, Request for Comments: 2468, MCI, 17 October 1998

RFC Editor, et al., *30 Years of RFCs*, Request for Comments: 2555, USC | ISI, 7 April 1999

P. Resnick, *Internet Message Format*, Request for Comments: 2822, QUALCOMM

Incorporated, April 2001

RFC Editor, *40 Years of RFCs*, Request for Comments: 5540, USC | ISI, 7 April 2009

H. Flanagan, *Fifty Years of RFCs*, Request for Comments: 8700, Internet Architecture Board (IAB), December 2019

MAPPE, FOTO, VIDEO

C. Cerasoli, *L'oro di Gondo*, http://www.claudiocerasoli.com/gallery/loro-di-gondo/, (consultato 2021)

The Creators Project, *Trevor Paglen's Deep Web Dive | Behind the Scenes*, https://www.youtube.com/watch?v=h7guR5ei30Y, 2016

Marine Traffic, Antonio Meucci, https://www.marinetraffic.com/en/ais/details/ships/shipid:282083/mmsi:247349400/imo:8506062/vessel:ANTONIO_MEUCCI , (consultato Ottobre 2022)

M. Ernst Stockburger, *Cloud Atlas*, https://maxernststockburger.com/Cloud-Atlas , 2020

MVRDV, *Metacity Datatown,* https://youtu.be/JiMJpfsavME , 1999

Infrapedia, map, https://www.infrapedia.com/app , (consultato 2020)

ISO, iso.org, https://www.iso.org/home.html , (consultato Settembre 2022)

A. Resnais, *Toute la memoire du monde*, Parigi 1956

J. Rinaldi, *All the World's Memory*, https://cargocollective.com/jacoporinaldi/All-the-World-s-Memory ,

Telegeography, *Submarine Cable Map*, https://www.submarinecablemap.com/submarine-cable/seamewe-5 , (consultato 2021)

DATA4, *Storico finanziamento bancario per DATA4: 620 milioni di euro per la strategia di espansione in Europa*, https://www.data4group.com/it/notizie-data4/storico-finanziamento-bancario/, 2021

DATA4, *DATA4 CAMPUS DI DATACENTER MILANO*, https://www.youtube.com/watch?v=vxbVmrtb4kU , 2019

Google, *Informazioni sui data center di Google,* https://www.google.com/intl/it/about/datacenters/ , (consultato 2021)

MANUALI TECNICI, STANDARD, NORME

Maintenance Manual For Use With Univac I Central Computer, Remington Rand Univac, Jenuary 1958.

Manuale base di programmazione, Olivetti Elea 9003, (manuale strettamente riservato al personale Olivetti)

Telecommunications Infrastructure Standard for Data Centers, TIA-942, TELECOMMUNICATIONS INDUSTRY ASSOCIATION, Aprile 2005

ANSI/BICSI-002-2011, Data Center Design and Implementation Best Practices, Ansi, 2011

IEC 60917-1, *Modular order for the development of mechanical structures for electrical and electronic equipment practices – Part 1: Generic standard*, IEC, 2019

RS-310, EIA Standard, Electronic Industries Association, maggio 1965

ARTICOLI riviste online

M. Cooney, *In pictures: The (mostly) cool history of IBM mainframe,* https://www.arnnet.com.au/slideshow/541873/pictures-mostly-cool-history-ibm-mainframe/ , arnnet

I. Burrington, *Why Amazon's Data Centers Are Hidden in Spy Country*, https://www.theatlantic.com/technology/archive/2016/01/amazon-web-services-data-center/423147/ , The Atlantic, 8 Gennaio 2016

U. Eco, *The Holy War: Mac vs. Dos*, Espresso, 30 Settembre 1994

C. Harvey, *What is a Data Center? History, Design, Cooling & Types,* https://www.datamation.com/data-center/what-is-data-center/ , Datamation, 10 Luglio 2017

M. Hogan, *Data flows and water woes: The Utah Data Center,* https://journals.sagepub.com/doi/10.1177/2053951715592429, Big Data & Society, 2015

M. Hogan, *The Data Center Industrial Complex*, https://www.academia.edu/39043972/The_Data_Center_Industrial_Complex_2021_, 2020

R. Koolhaas, *The Cut: Where to from Here, When All the Horizon is in the Cloud?*, https://flaunt.com/content/art/rem-koolhaas FLAUNT, Los Angeles 6 Gennaio 2006

F. Sarcina, *I cavi sottomarini: la «spina dorsale» di Internet*, https://st.ilsole24ore.com/art/tecnologie/2016-05-27/i-cavi-sottomarini-spina-dorsale-internet-145231.shtml?uuid=ADaWJzQ&refresh_ce=1 , Il Sole 24 Ore, 28 Maggio 2016

R. Venturi, *L'arte di Trevor Paglen*, https://www.doppiozero.com/rubriche/21/201706/larte-di-trevor-paglen , Doppiozero, 2017

A.Vonderau, *Scaling the Cloud: Making State and Infrastructure in Sweden,* https://www.tandfonline.com/doi/full/10.1080/00141844.2018.1471513 , Ethnos Journal of Anthropology, n° 84, 2019

M. Hardy, *The Cryptocurrency Rush Transforming Old Swiss Gold Mines,* https://www.wired.com/story/cryptocurrency-gold-mines-gallery/, Wired, 2019

F. Pinna, *Cavi sottomarini: La Sardegna rischiava di rimanere offline*, https://www.sardegnadigital.it/2018/08/28/cavi-sottomarini-la-sardegna-rischiava-di-rimanere-offline/ , Sardegna Digital, 28 Agosto 2018

F. Pintarelli, *La biblioteca dentro Minecraft e il nostro futuro nel metaverso,* https://www.domusweb.it/it/notizie/gallery/2020/03/16/la-biblioteca-dentro-minecraft-e-il-nostro-futuro-nel-metaverso.html , in Domus web, 16 Marzo 2020

F. Pintarelli, *"Evadere dalla Megamacchina"*, https://not.neroeditions.com/archivi-datificazione-megamacchina/ in Not, 4 ottobre 2019

I. Sergejev, *Let's design data centers for people!,* https://www.datacenterdynamics.com/en/opinions/lets-design-data-centers-for-people/ , datacenterdynamics, 9 Febbraio 2016

||||

D. Monaco, *Il data center della Borsa più grande d'Europa sarà in provincia di Bergamo*, https://www.wired.it/economia/finanza/2021/04/30/borsa-data-center-bergamo/

Il "cervello" della Borsa è a Ponte San Pietro, https://www.rainews.it/tgr/lombardia/video/2022/10/lom-data-center-borsa-italiana-euronext-Inaugurato-ea29e-4be-590a-433c-ae17-63f204218eee.html

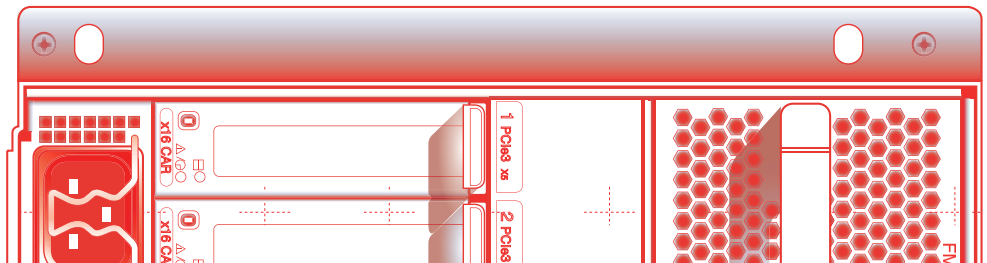
A. Annicchiarico, *Perché il cuore tecnologico di Euronext trasloca da Londra a Bergamo,* https://www.ilsole24ore.com/art/perche-cuore-tecnologico-euronext-trasloca-londra-bergamo-AE17tsE?refresh_ce=1

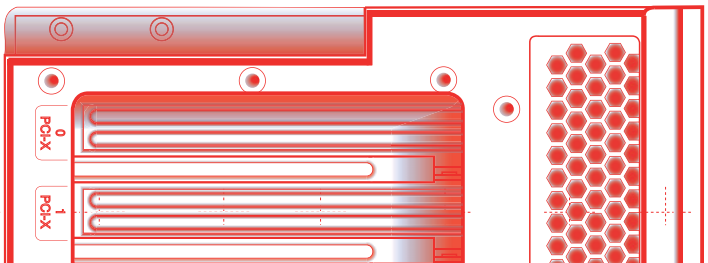
https://www.key4biz.it/il-cuore-di-borsa-italiana-nei-data-center-aruba-qui-passa-il-25-del-trading-azionario-europeo/422043/

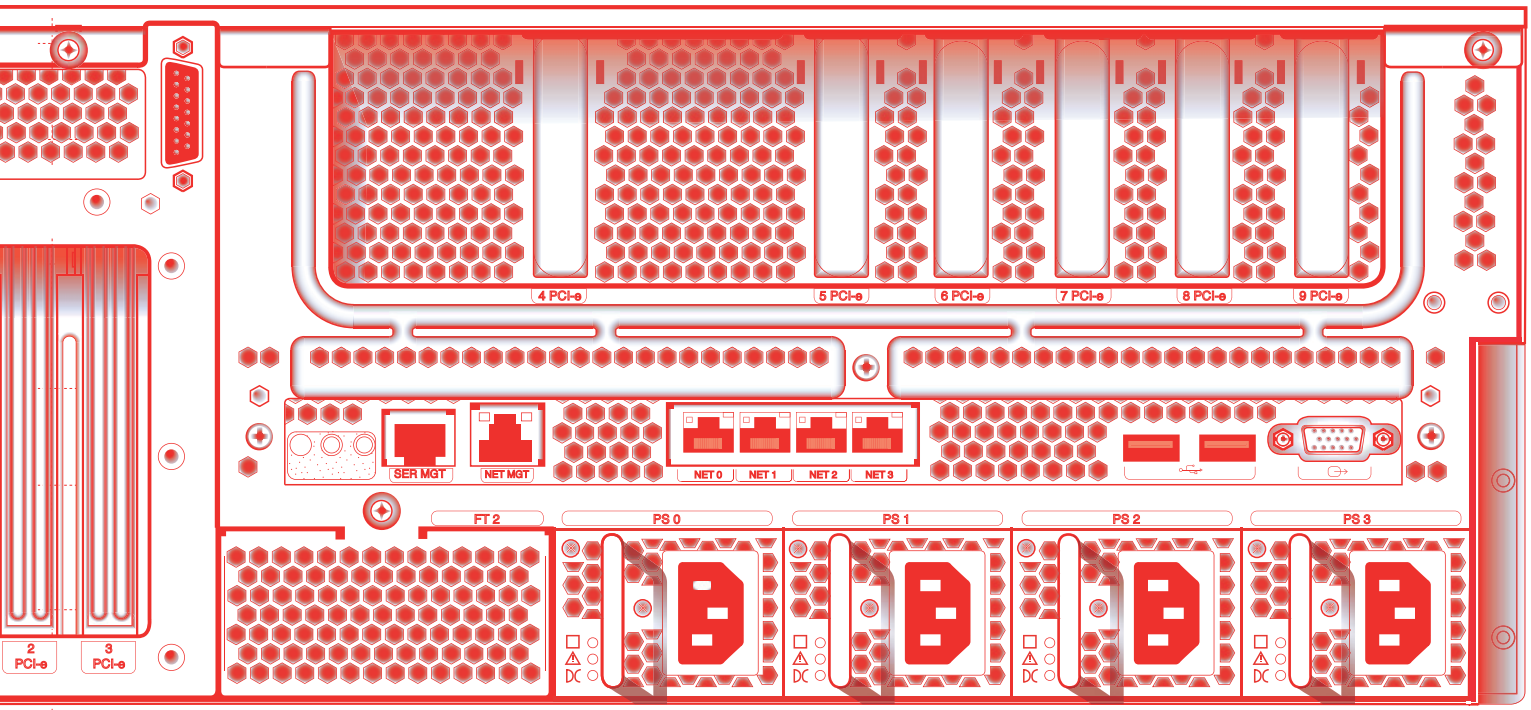
https://www.ilsole24ore.com/art/a-bergamo-cuore-verde-borsa-euronext-alza-velo-data-center-AEeaBoBC

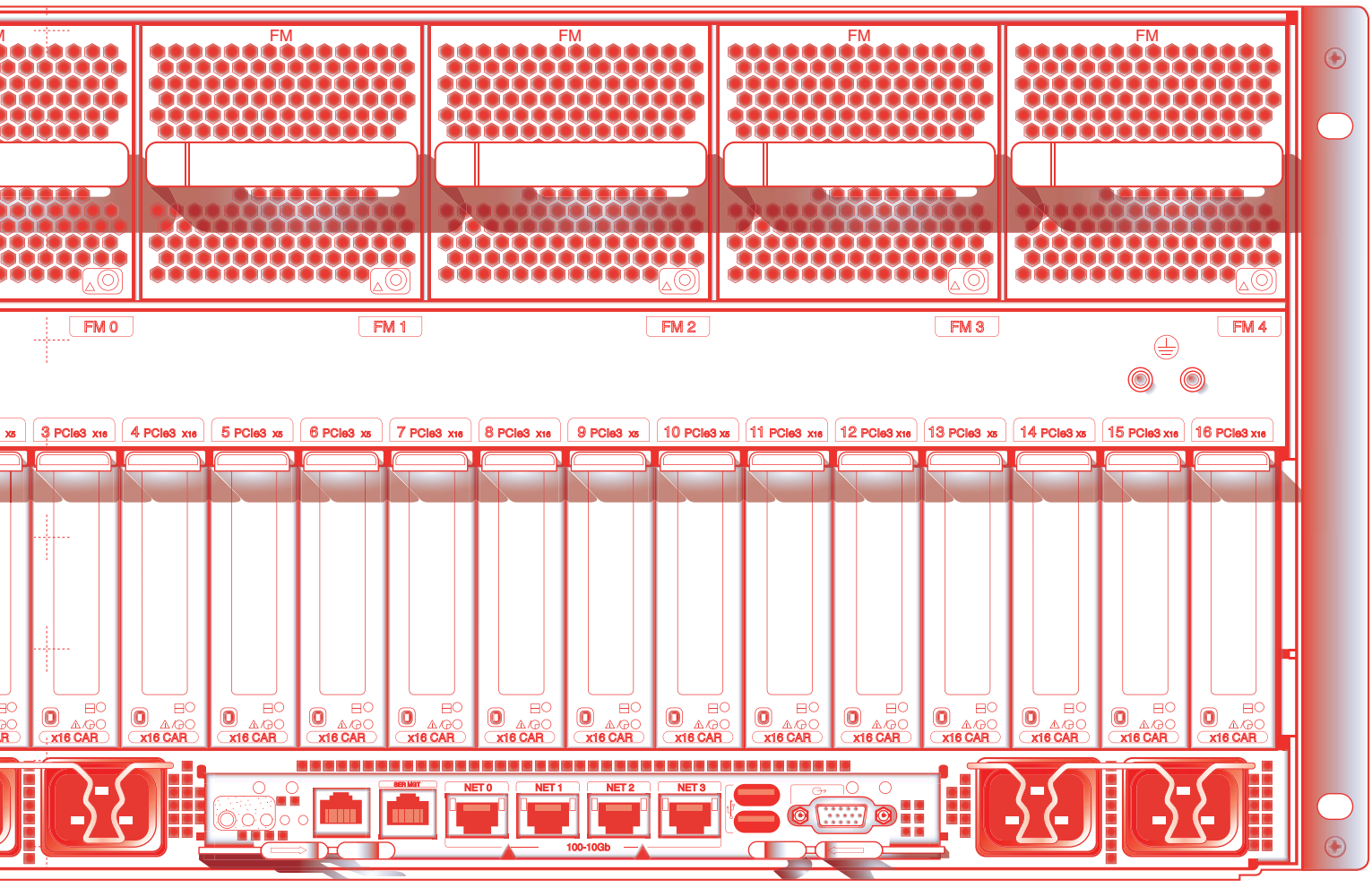
https://www.wired.it/economia/business/2021/01/20/olivetti-mario-tchou-elea-ibm/

Sun Netra X4450 (2007) – Oracle SPARC T8-4 Server (2017)
The two servers shown belong to the same company, which over time was acquired by Oracle. The two servers have a 10-year difference in design. Representing the back of this hyper-designed box, one can see that the differences are practically non-existent.
The one with the largest volume, the SPARC, occupies one RU (Rack Unity - see Definition of Terms - 05 'U' or 'RU') more than its predecessor Sun Netra. However, it remains within the modular measurements established by the rack unit, keeping within the vertical expansion logic of the infrastructure. The big difference between the two servers is the increasing scarcity of mechanical screw systems replaced by mechanical interlocking systems to install the different modular elements that make up the server.
In 10 years of strong development of the infrastructure, no volumetric changes have ever taken place, but rather the development consists of the millimetric design of the chips contained within.






4 PCI-e
5 PCI-e
6 PCI-e
7 PCI-e
8 PCI-e
9 PCI-e
SER MGT
NET MGT
NET 0
NET 1
NET 2
NET 3
FT 2
PS 0
PS 1
PS 2
PS 3
2 PCI-e
3 PCI-e


FM
FM 0
FM 1
FM 2
FM 3
FM 4
3 PCIe3 x16
4 PCIe3 x16
5 PCIe3 x8
6 PCIe3 x8
7 PCIe3 x16
8 PCIe3 x16
9 PCIe3 x8
10 PCIe3 x8
11 PCIe3 x16
12 PCIe3 x16
13 PCIe3 x8
14 PCIe3 x8
15 PCIe3 x16
16 PCIe3 x16
x16 CAR
SER MGT
NET 0
NET 1
NET 2
NET 3
100-10Gb