Parity

Hamza Hasan

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PARITY

Hamza Hasan
Parity, or,

*The Closed System of a Redundant Architecture*

Thesis Proposal
Hamza Hasan

Thesis Committee: Amber Bartosh (primary), Gregory Corso, & Lawrence Davis
Final Review Committee: Amber Bartosh, Lawrence Davis, Julie Larsen, & Yutaka Sho

Syracuse University
School of Architecture
Fall 2015

Front cover image: Google’s patent for a water-based data center.
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Fig 1. Google's patent for a 'server sandwich' assembly, where two motherboards are attached to one liquid-cooled heat sink. Note the use of the scale figure within an abstract model of a data center.

ON DATA CENTERS

Digital data contributes to an increasingly alienated aspect of our infrastructure. The complex practices of the Internet produce highly specified, engineered objects. Though their forms are ‘optimized,’ their intentions are not: the two primary considerations for the development of the infrastructure of the Internet are energy and security. Each category presents its own deliberations, but both often produce non-architectural, infrastructural elements beyond public visibility. The hidden infrastructure of data storage and mining (the indexing and analysis of data and traffic) produces spaces outside the agency of normative architectural discourse.

The key consideration for the design of the Internet is redundancy, which operates in four ways: the redundancy of storage, the redundancy of energy supply, the redundancy of security, and the redundancy of data flow and connectivity. All data is ‘backed up’ twice, on two separate hard
drives somewhere in physical space. All data centers receive multiple power supplies and have their own uninterrupted power supply (UPS). Multiple physical security measures control the physical access to data centers at their exteriors and within their interiors. Multiple routes exist from one node in a network to another node in another network, eliminating the blockage of information from one computer to another.

This thesis challenges the infrastructure of the Internet and its key element, the data center. Whereas the data center is the ultimate node for connectivity (it is where our data is hosted), the formal, ecological, and political implications of its architecture are largely ignored. By addressing the conceptual and material problem of redundancy, architecture can reenter the discourse of data center design, which is currently dominated by engineering principles of ‘efficiency’ and ‘optimization’. More broadly, we can begin to question the architecture of redundancy as a theoretical framework with formal and material implications. The issues of energy and security present a specific problem
within a paradigm of redundancy in data storage and connectivity. Moreover, when viewing the data center as the machine (not just its components), one must consider another discourse: closed ecological systems within the larger framework of cybernetics. Though the data center may the telos of this project, the question remains: what is a homeostatic architecture, where building, machine, and organism coalesce into one?

THE TYPICAL CONDITION

EXISTING DATA HALL CONDITION

SCALE 1:25

0 1.25 2.5 5 METERS
STRUCTURE

- Raised plenum (12" cavity)
- Dropped ceiling (18" cavity)
- Open web steel joist truss
- Reinforced concrete with steel decking
- Air diffuser (supply)
- Air return

DATA HALL

SINGLE AISLE

COOL AISLE

HOT AISLE

POWER SUPPLY
CONTESTION

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“THE WORLD INSIDE THE SCREEN SEEMED TO HAVE NO PHYSICAL REALITY OF ITS OWN [...] IF YOU WENT AND LOOKED FOR IMAGES OF THE INTERNET, THIS WAS ALL THAT YOU FOUND: THIS FAMOUS IMAGE BY OPTE, OF THE INTERNET AS THE MILKY WAY, AS THIS EXpanse WHERE WE DON’T SEEM TO BE ANYWHERE ON IT, WE NEVER SEEM TO GRASP IT IN ITS TOTALITY. IT’S ALWAYS REMINDED ME OF THE APOLLO IMAGE OF THE EARTH, THE BLUE MARBLE PICTURE. AND IT’S SIMILARLY MEANT TO SUGGEST THAT WE CAN’T REALLY UNDERSTAND IT AS A WHOLE, WE’RE ALWAYS SORT OF SMALL IN THE FACE OF ITS EXpanse.”

THE PHYSICAL INTERNET

The Internet is the common inter-network of all the digitally connected networks on the World Wide Web. There are many intranets (a network spanning within a clearly defined organization of computers and devices) but there is only one Internet. By following the correct protocols for data exchange, any single intranet can become part of the larger system.

The Internet is commonly thought of as an immaterial system, one that exists solely in virtual space; the term ‘cloud computing’ reinforces this notion. In reality, the Internet takes place on a vast physical infrastructure from one computer to another. To understand the depths of this infrastructure, one must understand the components:

1) The client: Any computer, mobile device, or terminal used to access data for the end user
2) The router: The device that handles data exchange over a network
3) The Internet Service Provider: ISPs are the organizations that connect a local network (such as a residential network) to its infrastructure. ISPs share data with one another to create the World Wide Web.

4) The Internet Exchange Point: IXPs are the locations where multiple ISPs exchange data with one another.

5) The fiber optic network: The physical medium by which data is primarily exchanged. Fiber optic cables transmit light at high speeds throughout the network of the ISP, and connect at IXPs.

6) The data center: The facilities that store information on the Internet.

7) The server: The server exists to save and upload data to the end user. Because they are not typical computers, they do not have monitors and graphical interfaces, and are slim, efficiently stacked machines that usually exist in high quantities alongside one another. A data server is a single machine that takes up one slot in a server rack.

These physical components create the essential
infrastructure of the Internet. Conceptually the Internet is the exchange of many networks. Physically it is an expansive infrastructure that meets at material endpoints (computers that store and process information) through material means (fiber optic cables, landing stations, internet exchange points, telecom lines, routers, Ethernet, and Wi-Fi).
DIGITAL MATERIALISM

“In reality, the cloud is giant buildings full of computers and diesel generators,” Manos says. “There’s not really anything white or fluffy about it.”

Data centers are a crucial development in contemporary infrastructure. They are the storehouses of information that we access when we use the Internet. While “the cloud” may reduce the information we have to store on hand (on our personal hard drives and flash memory), that data still has to be stored somewhere. Every time we access any piece of information—the weather, sports scores, e-mails—we have requested access to a piece of information being stored on a hard drive somewhere in physical space. According to Thomas Lozada, a professor at NYIT,

Data center design has been virtually ignored in traditional architectural discourse. Big-box warehouses full of servers but devoid of any

discernable architectural features, data centers have thus far eluded critical scrutiny from the design community. They are essentially autonomous machines that not only don’t require architects to function, they hardly need any humans at all.  

He goes on to ask:

So where is the opportunity for creative expression? Architects and designers must now grapple with two compelling questions: what can the data center become, and, at a broader scale, how can humans interact more meaningfully with their essential infrastructures?”

And provides the ultimatum:

Data centers represent our increasing ability to efficiently organize information, but now it is up to architects and designers to determine how that information will, in turn, organize us.

This thesis will attempt to look at the two primary design considerations of data center
design—energy and security—and challenge the assumptions that govern the presumed autonomy of data center sites. By looking at two extremes—the urban, as is the case with 375 Pearl St in New York, and the rural, as is the case with Verne Global’s Facility in Keflavik, Iceland—we can develop a two-faced project, one that creates the nodes in two locations, and a network embedded in the physical fiber optic infrastructures of the global information exchange society.

An advertisement from CtrlS, a cloud computing company headquartered in India, informs us of the condition of contemporary data center design. Their flagship facility in Mumbai is the largest data center in Asia and falls under the Tier IV category, the largest and most secure type of data center. CtrlS Mumbai is purpose built, in opposition to a “bank-vault or a bunker,” and “it is built for business.” The advertisement argues that the “data center does not just hide or protect data [...] every detail of data—the way it’s stored, used, accessed, and maintained—is designed to deliver the best business value.” The comparison to the
bank-vault and the bunker continues as the narrator describes the eight levels of security, some of which include blast-proof gates, turnstiles, mantraps, and biometric scanners. If these measures seem inhuman, consider this: “All elements of the data center—the grid, the floor, the tile space, the rack size—have been derived from the dimensions of the data center rack.”  

The machine is now replacing Le Modulor.

The problem of energy in data center design has created much more awareness about the cost of data access and exchange. Several reports in the New York Times have examined the environmental effect of data centers. Data centers are designed with redundancy to provide the most continuous access possible. The Uptime Institute, a data center research and consulting group, determined the Tier system. In a Tier I system, the most basic kind, there is a 99.671 percent availability. In a Tier IV system, such as CtrlS, there is a 99.995 percent availability. While these differences seem minute, they are quite large: in a year, a Tier I system allows for 29 hours of downtime, and a Tier IV system

allows for 27 minutes. This notion of continuous supply affects us in multiple ways.

Firstly, data centers now use 2 percent of the electricity supply in the US, and over 1 percent in the world. Each data center requires more than one supply of electricity. Often times these come from the non-renewable sources on the grid, but increasingly companies locate to remote sites near a body of water to harness hydroelectric energy (or in the case of Verne Global, harness both hydroelectric and geothermal). The UPS, or uninterrupted power supply, requires diesel generators and massive arrays of batteries should a disruption occur in energy generation from outside sources. Contemporary discussions on sustainability become challenged when the notion of redundancy—having more power than you need as a failsafe—becomes necessary in a work of architecture.

There are other possibilities in this underdeveloped discourse on the architecture of data centers: Internet Exchange Points (IXPs). IXPs are locations where Internet Service Providers exchange broadband communication. Though their
primary purpose is not to serve as a data center, they usually provide colocation data centers (henceforth called colos) to provide small to medium sized business with their own servers without having to build their own data center. Several examples exist, such as One Wilshire in Los Angeles, 111 Eighth Avenue, 60 Hudson Street, and 375 Pearl Street. These exchange points are almost always in urban centers, and mostly occur in repurposed buildings.

In my explorations, I am looking at both rural and urban conditions. Several precedents fuel speculation on the future of data centers within the discourse of urban design. History speaks to the urbanization of the data center. According to Tom Vanderbilt:

*Data centers were not always unmarked, unassuming and highly restricted places. In the 1960s, in fact, huge I.B.M. mainframe computers commanded pride of place in corporate headquarters. “It was called the glasshouse,” says Kenneth Brill, founder of the Uptime Institute, a data-center research and consulting group. “It was located near the executive suite. Here you’d*
spent $15 to 30 million on this thing — the executives wanted to show it off. 11

The future of commodities trading also indicates the reurbanization of data centers:

Firms initially linked from their own centers, but that added precious fractions of milliseconds. So they moved into the data center itself. “If you’re in the facility, you’re eliminating that wire.” The specter of infinitesimal delay is why, when the Philadelphia Stock Exchange, the nation’s oldest, upgraded its trading platform in 2006, it decided to locate the bulk of its trading engines 80 miles — and three milliseconds — from Philadelphia, and into NJ2, where, as Thomas notes, the time to communicate between servers is down to a millionth of a second. 12

This thesis aims to challenge the hyper-engineered rhetoric of data centers, and address two issues that determine the siting and design of those facilities: energy and security. By challenging the models that support a LEED certified data center
(that exists well outside urban, efficacious systems), one can develop an architectural discourse on the Information Age that codevelops with the politics of internet ownership and governance. To end with a passage from Vanderbilt:

It seemed heretical to think of Karl Marx. But looking at the roomful of computers running automated trading models that themselves scan custom-formatted machine-readable financial news stories to help make decisions, you didn’t have to be a Marxisht to appreciate his observation that industry will strive to “produce machines by means of machines”—as well as his prediction that the “more developed the capital,” the more it would seek the “annihilation of space by time.”

Several levels of classification exist for data center precedents. The first classification is that of site: urban or rural. The second classification is the type of data center: a proprietary facility for one company or a shared facility known as a colocation center. The third classification is less straightforward; it deals with the ‘architectural merit’ of a facility. Though there are many data centers in the world, few are mentioned inside architectural discourse. For example, a simple search on ArchDaily\(^{14}\) yields only 8 entries for buildings whose primary program is data storage and/or processing. The next few pages will include some of those works, and a few other significant projects that address architecture as a machine.

\(^{14}\) As of May 4\(^{th}\), 2015.
PIONEN-WHITE MOUNTAIN

Bahnhof AB, one of Sweden’s largest internet service providers, approached Albert France-Landord Architects to design an elite colocation facility in a former World War II bunker. The clients and architects selected “references straight from science fiction films, mostly ‘Silent Running’ and a bunch of Bond films.” Though the building is underground, its location in Stockholm classifies it as an urban data center.

This data center is also notable because it hosted two Wikileaks servers.

Figures 6 & 7: Interior images of the facility. The upper image is the main approach into the facility, with the diesel backup generators in the blue light, and the exposed blasted stone to the right. The lower image is the meeting room suspended above the main circulation path.

Figures 8 & 9: The two floor plans to the right show the largely mechanical/technical facilities on plan 1 and the service and occupiable spaces (such as bathrooms) on plan 2. The section on the bottom right shows the entry sequence and the two levels of the project. Notice the unfinished blasted stone as a black poché.
‘EXPOSING THE DATA CENTER’

Ivan Sergejev’s Master’s thesis at Virginia Polytechnic Institute and State University proposes to challenge the conventional notions of data center design, exposed the physicality of the internet’s infrastructure, and propose a new architectural language for the data center typology.¹³

This project qualifies as an urban data center, a colocation facility, and a discourse-intensive project.

Fig. 10: An exterior render of Sergejev’s thesis project. The data center takes place within an existing building on Broadway in New York City.

Fig. 11-14: The plan and section of the project (upper-left and bottom-left) show the structural framework Sergejev considered for the development. Sergejev conceded that ‘they could be anything’ with regards to the section of the bottom-right (hence, the roof skate park). In the textual diagram on the top-right, he compares the bank to the cloud, arguing that bank securities are made immaterial through digitization, and actuality of the digital world is stored in the computer “in a paradoxical way.”


---

Bank

1) gathers & stores money
2) uses money it holds for its own investments
3) to generate more money for itself

Cloud

1) gathers & stores information
2) uses the information to generate more information for its own use
3) marketing, analytics, money
4) updates, sec., info., peer info., etc...

If you blow up a bank, you blow up, effectively, only people (the DHS archives, Facebook pages, etc.)

(Because the money is all virtualized.

It’s the data, and not the physical resource...

IN A PARADOXICAL WAY!

What we thought was immaterial is the new, material.)

---

CTRLS

CtrlS provides Asia’s largest Tier IV facilities. These two buildings exemplify the ‘black box’ interface of the data center.

These two facilities are considered urban. Though neither is discourse-intensive (in fact, no information on the architect or contractor could be found for either), their monolithic stature offers a possibility for the formal typology of such facilities. Both examples serve as colocation facilities.

Note the name of the company is wordplay: CtrlS comes from the Windows hotkey control + S, whose function is save a file.

Fig. 15 & 16: The upper image on the right is the Tier IV facility in Mumbai and the bottom image is the facility in Hyderabad. Notice the mass is largely the same, but the cladding is different. This signifies another aspect of “the black box” as a data center.

Image Credits:
http://www.ctrls.in/gallery.php
60 Hudson Street is not primarily a data center. It is one of a few internet exchange points (IXP), a location where many different networks physically meet together to exchange network traffic. The reuse of the old Western Union Building, an example of Art Deco styling, shows that the black box can exist in almost anything. It is an urban building with a small colocation facility, and an example of discourse-intensive architecture. The architects were Voorhees, Gmelin and Walker.

Fig. 17: An exterior view of 60 Hudson Street in Tribeca.

Fig. 18-20: Above, a specification sheet of how one might rent out the floors. Top-right, a diagrammatic section the ‘vertical infrastructure’ of the HVAC systems. Bottom-right, a parallel projection of the ‘megasuite’ inside the building, colored with different data halls.
Multiple configurations available on the 6th, 7th and 8th floors

Specifications

Size
- Up to 180,000 sq. ft.
- 60,000 sq. ft./floor
- Raised floor built-to-suit
- 22’ column spacing
- Slab to slab 13’6”

Deployment
- Turnkey build-to-suit
- Warm shell
- Custom floor configurations
375 PEARL STREET

Also known as Intergate.Manhattan, Sabey Corporation bought out the former Verizon building in 2011. Paul Goldberger thought the project “overwhelms the Brooklyn Bridge towers, thrusts a residential neighborhood into shadow and sets a tone of utter banality”⁴. Sabey is the largest owner of data center facilities in the U.S. Though the project ostensibly could be called modern, its discourse-intensivity is subject to argument. It is obviously urban and almost complete a colocation facility. It was designed by the architecture/engineering firm Rose, Beaton & Rose.

Fig. 21: A view of the monolithic facade looking downtown.

Fig. 22 & 23: Above, a sample floor plan of the colocation facility in the building. On the right, a functional section showing the zones of HVAC and their relationship to the data halls on each floor.
CITI DATA CENTRE

Arup’s data center in Frankfurt is the first project in Germany to be LEED certified and the first data center to receive a LEED Platinum award. The project is not in the urban core of Frankfurt and would not be considered within the discourse of architecture. Its green wall (precisely what kind, Arup do not tell us) masks Citi-owned proprietary data storage. It fits the rural, warehouse typology of most data centers.

Although this is one of few projects to transparently place ecology alongside data center usage, the critical potential of this strategy is yet to be realized.

Fig. 24: A front view of the facility with its ‘green wall.’

Fig. 25 & 26: Upper-right, Arup conveniently expose the functional and performative massing within the project. Bottom-right, show the solar building performance and the aesthetic effect on the facade.
SIGNAL BOX

body text
line two

Captions

BUFFALO GRAIN ELEVATORS

This is significant!

Captions

GREAT NORTHERN ELEVATOR

This is significant!

Captions

Inline notes; use endnotes, not footnotes this time.
THE SITE: TASIILAQ, GREENLAND
TASIILAQ, TORSUUQ TUNOQ SOUND
BIOCLIMATIC DATA: TASIILAQ

**PRECIPITATION**
MAX 120MM/MONTH

**WATER TEMPERATURE**
MAX 4°C/MIN -1°C

**DAYLIGHT**
MAX 970 HOURS/MONTH

**AVERAGE HUMIDITY**
MAX 4%/MIN 5%

**AVERAGE TEMPERATURE**
MAX 11°C/MIN -11°C

**RAINY DAYS**
MAX 12 DAYS/MONTH

**PRECIPITATION**
MAX 120MM/MONTH

**WATER TEMPERATURE**
MAX 4°C/MIN -1°C

**DAYLIGHT**
MAX 970 HOURS/MONTH

**AVERAGE HUMIDITY**
MAX 4%/MIN 5%

**AVERAGE TEMPERATURE**
MAX 11°C/MIN -11°C

**RAINY DAYS**
MAX 12 DAYS/MONTH
SITE PLAN: TASIILAQ
This is significant!
This is significant!
THE SERVER
SERVER RACK FLOWS
PARITY ENERGY CYCLE
GEOTHERMAL + HYDROELECTRIC SCHEMES
GEOTHERMAL PLAN
GEOTHERMAL SECTION
HYDROELECTRIC SECTION

HYDROELECTRIC UNIT SECTION
SCALE 1:100

0 10 20 50 100 200 METERS
MAINTENANCE BOTS
DATA HALL ‘FUNNEL’
FUNNEL COMPONENTS

CONNECTION TO COMMAND
CLADDING
ETHERNET LINES
DATA SERVERS
ELECTRICAL LINES

REGENERATIVE FAN
DESICCANT WHEEL
INTAKE FANS
GRILLE STRUCTURE
VENTILATION GRILLE

FUNNEL UNIT EXPLODED
SCALE 1:200
CREDITS

Bibliography

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