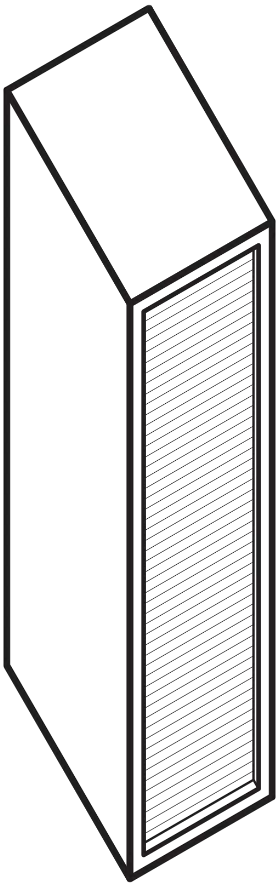
Data Centers

Archetype or a Typology.
Stories of a digital time.



Philip Scott Marcantonio

Fall 2021 - Winter 2022

Master Thesis Studio | Arch 5100 - 5200
Masters Thesis Supplement | Arch 5110 - 5210
Studio Advisor : Wladek Fuchs, PhD

Figure 01 - (cover) Data Rack

ACKNOWLEDGEMENT

Thank you to all whom have helped me along the way.

TABLE OF CONTENTS

ABSTRACT

Throughout the turn of the 20th century humanity saw a shift in its way of life as technology evolved ever so rapidly. This technological integration, having lasted for already over a half of a century, has crossed disciplinary lines and has surfaced in the field of architecture as an issue of locating both near and far from humans as well as consumption of resources. In this present moment Data Centers are predicted to become an even more integral part of human life as the need for increased digital storage capacity will potentially outweigh the current demand. This thesis draws on the collective knowledge of what makes Data Centers run as well as special topics surrounding the materials in which it stores, and potential novel adaptations to a new model of data storage. In order to accomplish these goals, there is a need to look outside the current deployed means and methods for storage. Through this study new emerging ideas can be discovered by using the specific byproducts of digital storage to which can then facilitate a new model of small scale deployed data centers, which then can offset the need for additional storage needs and spur additional benefits.

FANTASIES
REVALATIONS
CONVERSATIONS

Keywords - Oxford Definitions

Big [adjective] - Of considerable size, extent, or intensity. // Of considerable importance or seriousness.
Data [noun] - The quantities, characters, or symbols on which operations are performed by a computer, being stored and transmitted in the form of electrical signals and recorded on magnetic, optical, or mechanical recording media. // Things known or assumed as facts, making the basis of reasoning or calculation.

Big Data - Quantity
Big Data Technology - Hardware
Big Data Ecosystem - Entirety
Big Data Architecture - Housing

INTRODUCTION

BUT SOME DATA CENTERS ARE IN CITIES,

SOME IN TOWNS,

& SOME NEXT TO COWS

Figure 03 - Data Server

Data centers are inherently unrecognizable, yet are composed of complicated systems that advise and alter our perception of the modern world. These structures provide for and are not limited to commerce, entertainment, research, discourse and security. Deemed 'critical' infrastructure, these facilities are primarily composed of computer systems, mechanical hardware, telecommunication, data storage equipment, and cooling systems. Collectively, this equipment connects, processes and provides digital storage for the several billions of people and entities around the world. However, the science behind these facilities outside of engineering and computer science are extremely off putting to what the general public knows about them. Rather their visual appearance, or architecture is the most approachable form of its existence. Having said all, data centers are typically sited in remote areas, far from the public, built using big box store rhetoric and lauded for their consumption of resources. But, behind all these descriptors, the most captivating conversation about a data center is how new and relevant they are to today's time. They also act as the main ethos of what can be considered as a body of work and/or knowledge that not only represents the 21-st century, but also the future. It is exciting to point out that this idea of representing a time is not a new phenomena, nor has it not been talked about in the canon of architecture in years past. If we can go back in time briefly, we can study similar generational and time capturing ideas by the works of artists, theoreticians, and architects. All of whom were pioneers in both their respective fields as well as offering a new and inventive way of looking at the world, society, and the present time, their time and beyond.

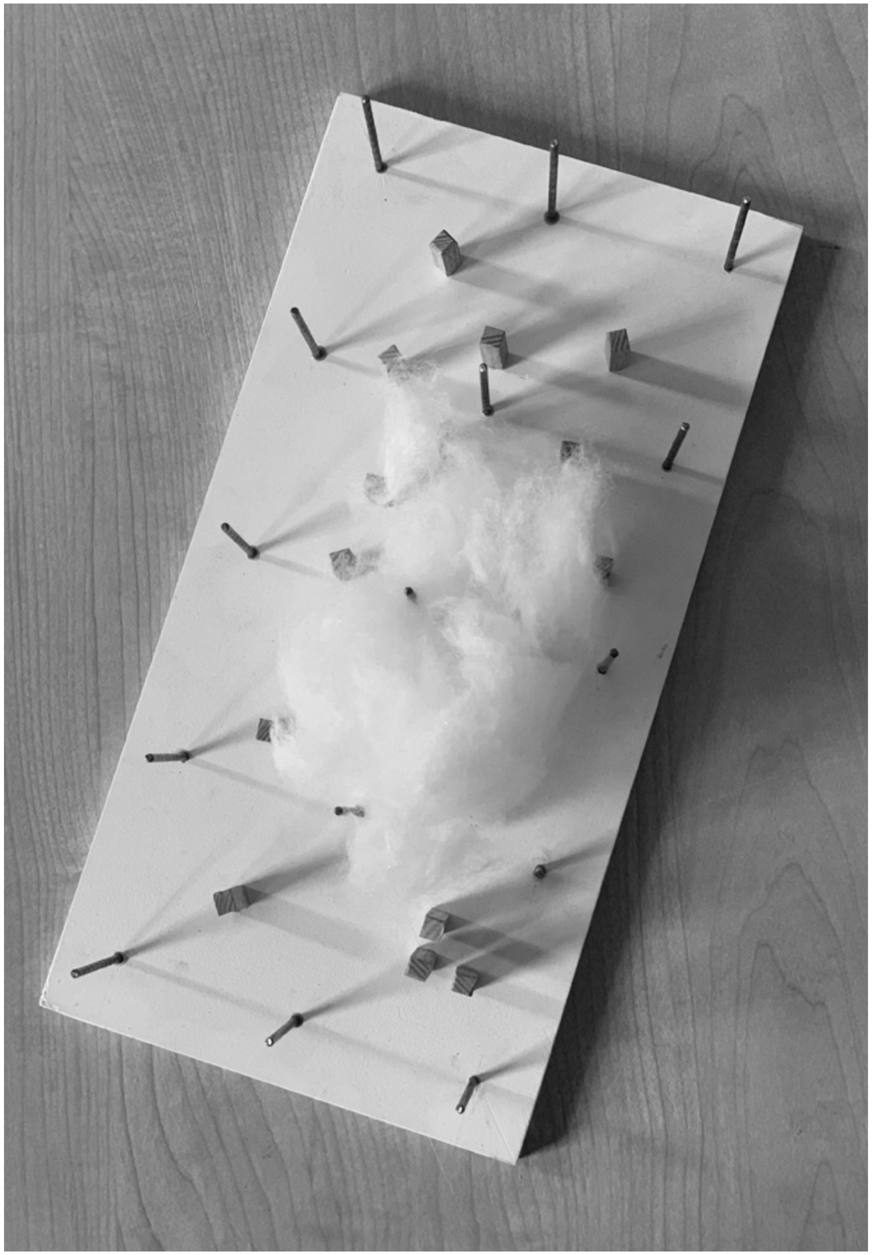


Figure 04 - Spatial Conditions Model

THE TOPIC

Big Data Architecture remains among the least studied areas of digital culture, with cloud computing producing a layer of abstraction that masks the physical infrastructure. The Big Data Ecosystem is generally out of sight and out of mind, However generally there is equal access to knowledge and ideas. Over the last several decades Data production and storage has increased and has outpaced Moore's law. Simultaneously, storage capacity has gone down in price of unit production. With this said, will we ever be able to catch up to usage and production of data?

RELEVANCE

As a relatively new typology the relevancy of researching Big Data Architecture in today's data driven society is that there is always an increasing need for digital storage. As population increases and digital trends move to the wayside, demands outgrow their current set limits. What this thesis hopes to contribute to the field of architecture is new novel ways of how we store the summation of modern day digital society. What might it look like as data centers continue to multiple and scatter the landscape? Are there different approaches to collecting and storing Big Data?

QUESTIONS

- ~~Examining how the user communicates with the data center. Via Socially, politically, educationally, Monetarily?~~
- ~~How are social spaces used in a digital world?~~
- ~~Who are included and excluded in these spaces?~~
- ~~How is information collected and dispersed?~~
- ~~How can a data center provide a place for social physical discourse?~~
- ~~Can data be accessible through a physical form?~~
- ~~How does the digital environment affect culture and society as a whole?~~
- ~~IS A DATA CENTER AN ARCHITECTURE?~~

BACKGROUND

Before it is classified special innate qualities are experienced, the unpredictable nature of its original conversation prevents it from proceeding directly towards an aim or having to be useful from the start. It allows recognition to take place. In an emotional way maybe for some and an intellectual way for others this work would stretch this architecture in the capacity for the people who see it or think about it to understand in a more open way or in a different way for what the possibilities are. This may be very Utopian actually or very naive but on the other hand you don't have to touch everybody you just have to touch a few who will touch a few other people, because there is always a discussion about who is in the discussion, who are you talking to? [Such is the nature of the data] _ [the datum of the Internet] and if you really go back and understand who is asking the question, what should an architecture be? People who don't belong to architecture all have a say in what the current state of being is… Whether it is a lawyer or doctor in a city, or even scientists, politicians and sociologists. There are all roles in which people have to offer. This discussion is one of architecture to not sign on and support what exists but to offer other ways of thinking, unless you are okay with how the world operates as it exists or what you think what it is; is what it will always remain. The world does get different. I wouldn't say that the world gets better. This thesis is a push for the reconciliation of the ideas of what others, the ones I mentioned earlier, can think, do and participate in to spur contemporary modern ideas past what the formal agenda is, using architecture as a catalyst. The building obligates the people and vice versa.

Figure 05 - White Space

OBSITCLES

OBSTICLE ONE:

My research thus has been widely eye opening as I started to unpack what constitutes a data center. It has been burdensome to be tasked at studying the equipment which alone is incredibly complex and is on the engineering side of the fence. Furthermore the infrastructure which powers, cools and connects to entities is equally burdensome. For the sake of this discussion it is fair to say that these are issues that are out of my control, nor would I want to tackle such a vast aspect of the research. They can certainly inform me on the position of my thesis however, at this time they are taken at face value as factual information. All together data centers are massive. There is an economy of scale that attributes to their scale as well as the owner operators scale. This thought made me think of a Walter Vanstiphout interview where he is quoted as saying "I can solve problems, but I'm not to blame if I cause a problem". The way I interpreted this is as a problem is solved a new problem is created. For example, if you solve an energy issue with data centers by locating in a renewable energy rich region, every data center provider will want to build their facilities in that region. A potential cause and effect. It is potent to note that I alone can not solve a specific issue architecturally but historically there have been multiple people before me asking questions and making solutions. Therefore at the global scale I can see policy, planning, investing and consultants all to name a few to be at the table as the supply and demand curve continues to rocket North.

OBSTICLE TWO:

Activism in the research. Everyone has stuff. The clothes you wear, the books you read, the expired can of food in the back of your pantry and so on. All physical, which means these things take up space. Now what about the other space? Data space. How many songs do you have on your laptop, and pictures and documents ect, all things that take up space. You see the similarity of physical space and data space is that they are both finite. You need to allocate more space to hold more things. Again a cause and effect. However, the beauty of the internet and streaming services is you can access any and all information you want and not have to store it yourself. But where is all this data stored? Alas the advent of data centers. Industries, organizations and individuals are in constant growth and flux, but the digital trace and data that is left behind is for what we currently know is 'forever'. So how would activism and awareness cure this so-called left over or expired data? Can data expire just as a can of food would? Would reminding individuals of a "spring cleaning" of digital content assist as a long term approach to help offset the need to constantly expand and build storage facilities? Could this be a constructive way? How much does your data weigh?

CHAPTER ONE

HOW DID WE GET HERE?

Humans have been collecting, gathering and storing items since the inception of their existence. Therefore it is fair to opine that storage is nothing new, however, through the chronicle of time humans have devised inventive ways to continually change the way in which things are stored. Space therefore can be distilled down to a linear line to which it is viewed as a timeline of events in which human concerns, human creations and human systems are gathered. What quantifies all these different spaces of storage is a formal structure, or architecture that houses said items. For the sake of this historical understanding of storage we must look at past contemporary precedents of storage spaces. To which an understanding of why they were created and how their creation led to further development of society. Thus a typological investigation is needed.

A typology in architecture can be defined as

The invention of the automobile and its production led to a major shift in the mobility of the contemporary world. Prior to its creation ships and trains were the main avenue of transportation of both humans and goods. Albeit, these modes of transportation were scarce and reserved for the very few that could afford the means to participate on. Therefore the automobile catapulted mobility to the masses on such a massive scale that new economies such as jobs, towns and services were created. However, this invention did have its shortcomings. There are various scale reasons why the automobile is the size it is. The human scale is just one to consider, the relative size of existing town streets is another, additionally its predecessor the horse carriage is another.

However, at the forefront of this shortcoming is how the automobile can be stored when not in use. With the influx of new workers and the transportation of building materials towns grew and their town limits diminished. Workers drove in torves to their workplace and a need to store all these automobiles was needed. Alas the parking garage was now a method created to temporarily store an automobile.

Figure 1.x | xxx

Figure 1.x | xxx

CHAPTER TWO

WHERE ARE THEY?

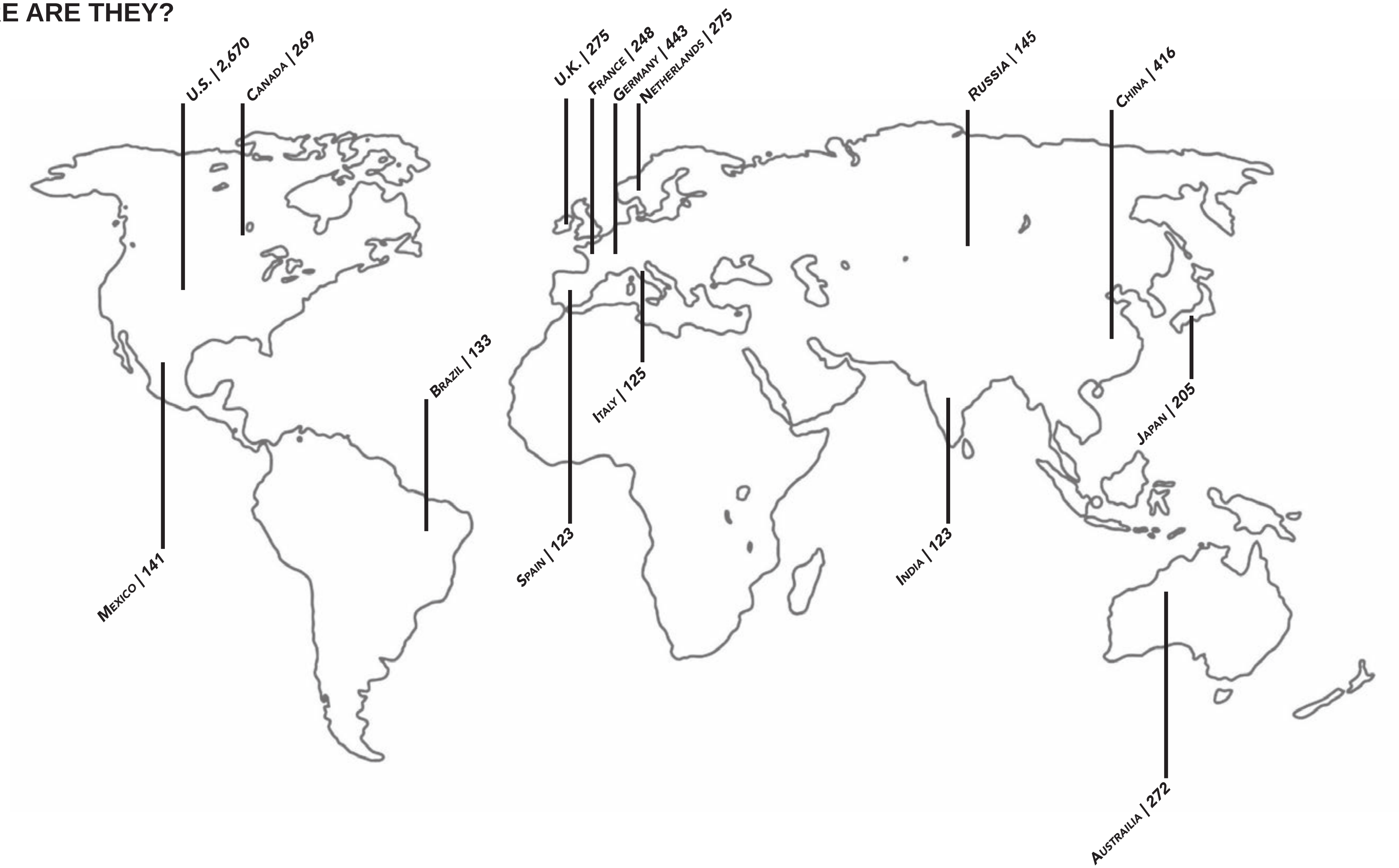


Figure 04 - Global Data Locations

To understand exactly what bigdata stands for outside of its initial definition of quantity of stored data, and its various capacities in how it is stored. It is important to note that the data itself is structured in a combination of ways in its machinery that stores it through the means of three structuring models. Industry standard is devised through the means of structured, semistructured and well as unstructured big data. These structure standards that machinery and systems use to process the data use a variety of methods to do such tasks and collectively operate and are categorized through three methods. Methods being its volume, variety and velocity. Commonly known as the three "V's" where first identified at the start of the twenty-first century by analyst Doug Laney at consulting firm Meta Group Inc. These three "V's will be defined at a later point.

For the sake of this discussion it is important to note that although bigdata is defined in a quantifiable number it is important to note that the deployment of bigdata often involves the various sizes the industry uses when describing data. Examples include the standard model of bytes, which are scalable units of storage of digital information and can then be enlarged based on its physical hardware needs. We will learn more of the industry standards on sizing of data furthermore in this chapter. However it is important to note that when speaking of the three V's to be aware of the differences.

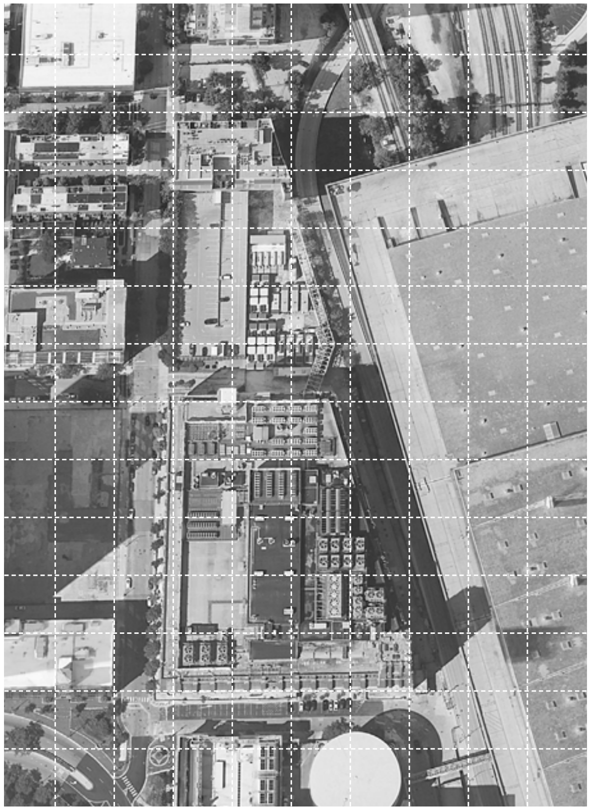
At this point you might be asking yourself why is big data so important and needed to be discussed? It is important to note that big data can be viewed in the lens of the great oil boom of the early part of the 20th century, or furthermore the California gold rush of the mid eighteenth century. All familiarly industrial time period events that spurred economic development and helped build that vast network of the United States. With that said, big data is used by both private as well as public companies to improve their operations in order to increase both profits and revenues.

URBAN

Located in Chicago, Illinois the Digital Realty data center is one of the largest privately owned facilities in the country and some critics argue it is the largest in the world with an estimated capacity spanning over one million square feet among its 8 floors. Prior to its repurposing to a data facility the building's original use was a printing press for both Sears Roebuck as well as Yellow Book Catalogs.

SUBURBAN

Facebook



RURAL

~~NSA~~

URBAN

DRT IL DATACENTER

100'

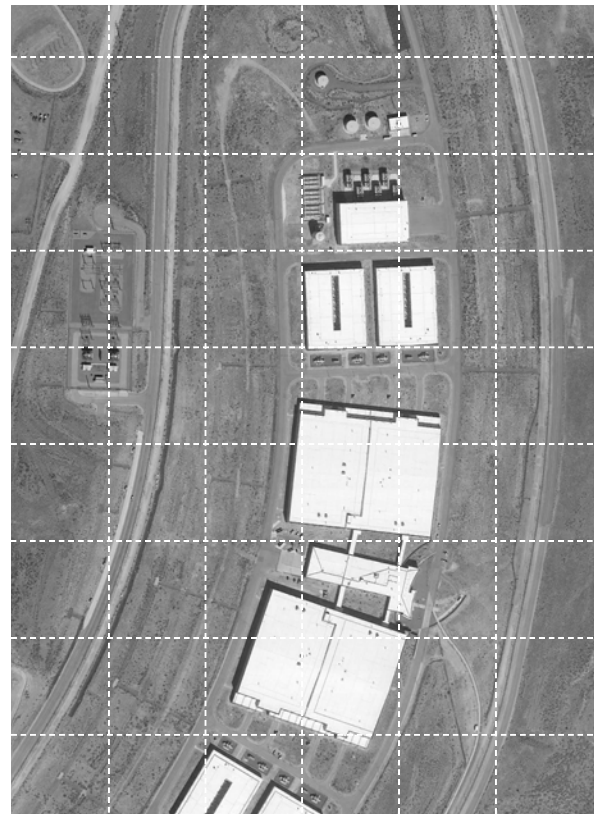
Figure 05 - White Space

SUBURBAN

FACEBOOK NC DATACENTER

600′

Figure 04 - Global Data Locations



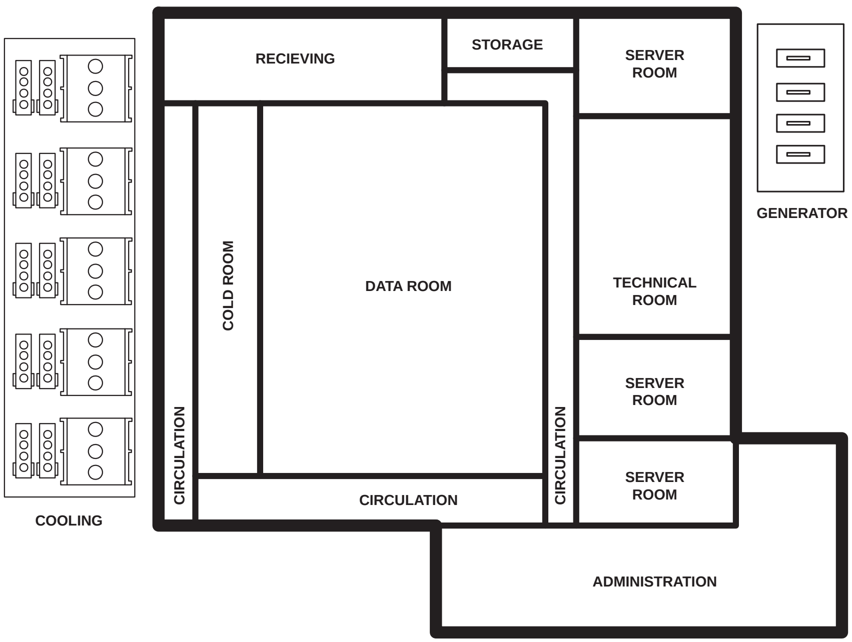
RURAL

NSA UT DATACENTER

600′

Figure 05 - White Space

HOW ARE THEY SPATIALLY ORGANIZED?



To understand exactly what bigdata stands for outside of its initial definition of quantity of stored data, and its various capacities in how it is stored. It is important to note that the data itself is structured in a combination of ways in its machinery that stores it through the means of three structuring models. Industry standard is devised through the means of structured, semistructured and well as unstructured big data. These structure standards that machinery and systems use to process the data use a variety of methods to do such tasks and collectively operate and are categorized through three methods. Methods being its volume, variety and velocity. Commonly known as the three "V's" where first identified at the start of the twenty-first century by analyst Doug Laney at consulting firm Meta Group Inc. These three "V's will be defined at a later point.

For the sake of this discussion it is important to note that although bigdata is defined in a quantifiable number it is important to note that the deployment of bigdata often involves the various sizes the industry uses when describing data. Examples include the standard model of bytes, which are scalable units of storage of digital information and can then be enlarged based on its physical hardware needs. We will learn more of the industry standards on sizing of data furthermore in this chapter. However it is important to note that when speaking of the three V's to be aware of the differences.

At this point you might be asking yourself why is big data so important and needed to be discussed? It is important to note that big data can be viewed in the lens of the great oil boom of the early part of the 20th century, or furthermore the California gold rush of the mid eighteenth century. All familiarly industrial time period events that spurred economic development and helped build that vast network of the United States. With that said, big data is used by both private as well as public companies to improve their operations in order to increase both profits and revenues.

Figure 04 - Global Data Locations

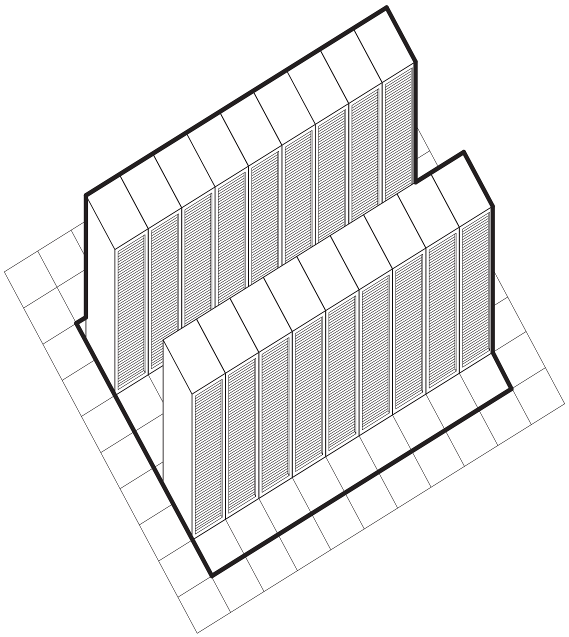


Figure 04 - Global Data Locations

Decision criteria:
- **Labor markets**
- **Staff retention/defection issues**
- **Public incentives**
- **Communication infrastructure**
- **Electrical services**
- **Taxes (personal property)**
- **Proximity to public transit**
- **Real estate markets**
- **Proximity to services/suppliers**
- **Quality of life**
- **Security and public safety**
- **Operational considerations**

HOW ARE THEY TECHNICALLY ORGANIZED?

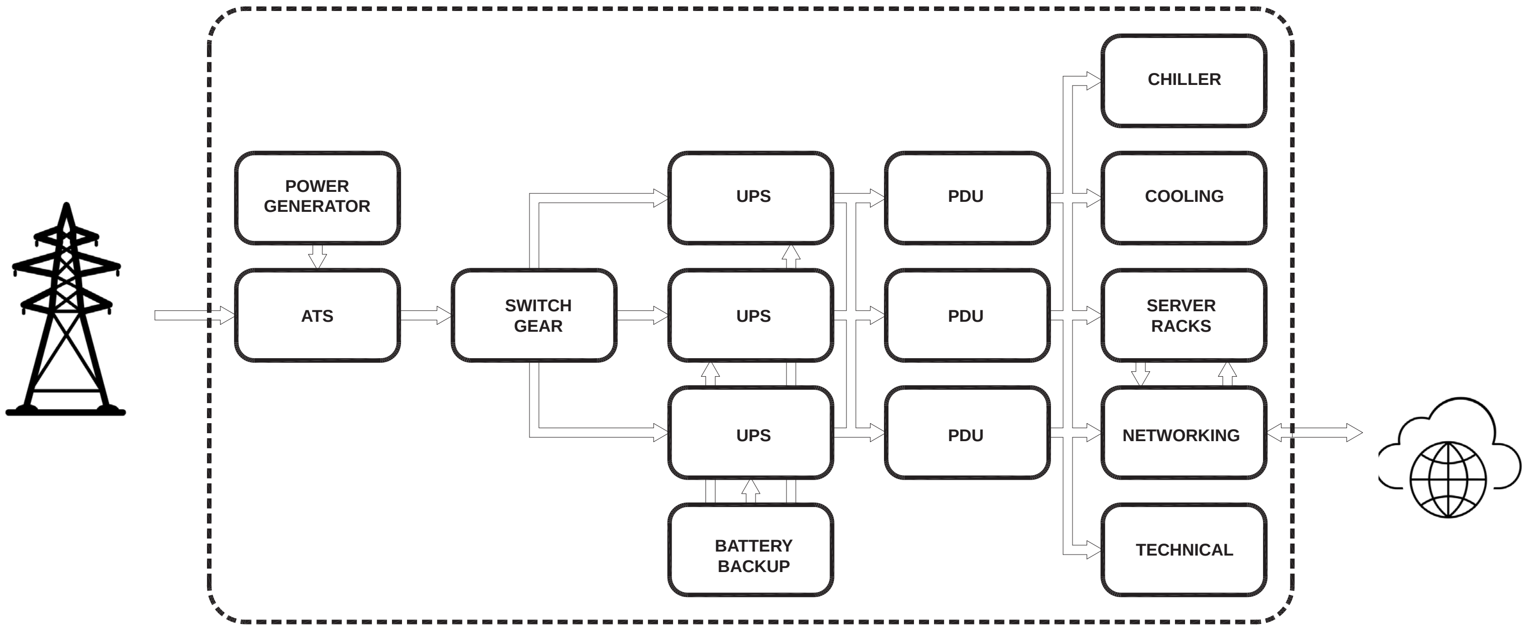


Figure 04 - Global Data Locations

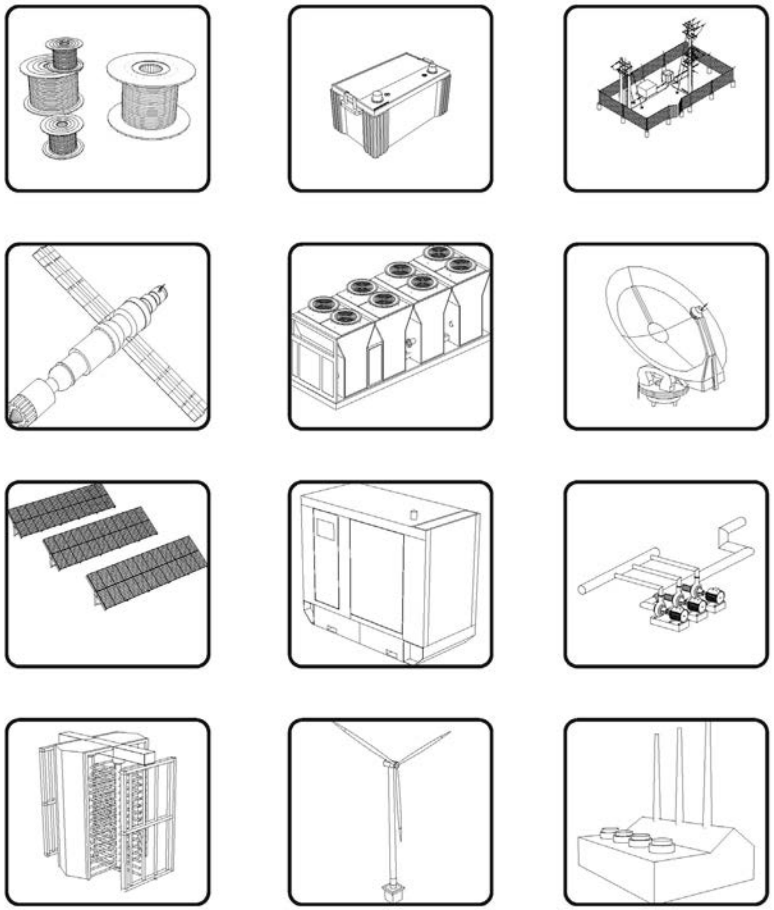


Figure 04 - Global Data Locations

To understand exactly what bigdata stands for outside of its initial definition of quantity of stored data, and its various capacities in how it is stored. It is important to note that the data itself is structured in a combination of ways in its machinery that stores it through the means of three structuring models. Industry standard is devised through the means of structured, semistructured and well as unstructured big data. These structure standards that machinery and systems use to process the data use a variety of methods to do such tasks and collectively operate and are categorized through three methods. Methods being its volume, variety and velocity. Commonly known as the three "V's" where first identified at the start of the twenty-first century by analyst Doug Laney at consulting firm Meta Group Inc. These three "V's will be defined at a later point.

For the sake of this discussion it is important to note that although bigdata is defined in a quantifiable number it is important to note that the deployment of bigdata often involves the various sizes the industry uses when describing data. Examples include the standard model of bytes, which are scalable units of storage of digital information and can then be enlarged based on its physical hardware needs. We will learn more of the industry standards on sizing of data furthermore in this chapter. However it is important to note that when speaking of the three V's to be aware of the differences.

At this point you might be asking yourself why is big data so important and needed to be discussed? It is important to note that big data can be viewed in the lens of the great oil boom of the early part of the 20th century, or furthermore the California gold rush of the mid eighteenth century. All familiarly industrial time period events that spurred economic development and helped build that vast network of the United States. With that said, big data is used by both private as well as public companies to improve their operations in order to increase both profits and revenues.

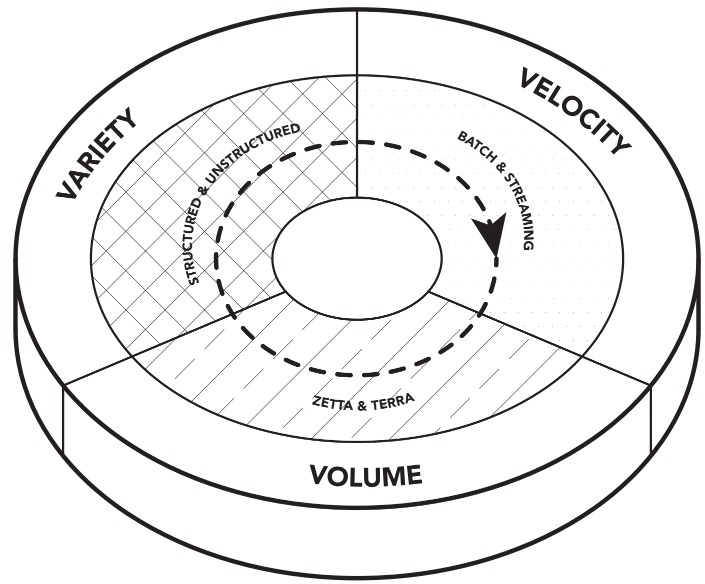
CHAPTER THREE

WHAT IS BIGDATA?

To understand exactly what bigdata stands for outside of its initial definition of quantity of stored data, and its various capacities in how it is stored. It is important to note that the data itself is structured in a combination of ways in its machinery that stores it through the means of three structuring models. Industry standard is devised through the means of structured, semistructured and well as unstructured big data. These structure standards that machinery and systems use to process the data use a variety of methods to do such tasks and collectively operate and are categorized through three methods. Methods being its volume, variety and velocity. Commonly known as the three "V's" where first identified at the start of the twenty-first century by analyst Doug Laney at consulting firm Meta Group Inc. These three "V's will be defined at a later point.

For the sake of this discussion it is important to note that although bigdata is defined in a quantifiable number it is important to note that the deployment of bigdata often involves the various sizes the industry uses when describing data. Examples include the standard model of bytes, which are scalable units of storage of digital information and can then be enlarged based on its physical hardware needs. We will learn more of the industry standards on sizing of data furthermore in this chapter. However it is important to note that when speaking of the three V's to be aware of the differences.

At this point you might be asking yourself why is big data so important and needed to be discussed? It is important to note that big data can be viewed in the lens of the great oil boom of the early part of the 20th century, or furthermore the California gold rush of the mid eighteenth century. All familiarly industrial time period events that spurred economic development and helped build that vast network of the United States. With that said, big data is used by both private as well as public companies to improve their operations in order to increase both profits and revenues.



Companies that have stakes in bigdata are shown to have a competitive edge due to the ability to gain valuable insights on their users and/or customers. In the present moment we can see the likes of the largest stakeholders of bigdata as the "big four" having the most control.

The "big four" technology companies as known collectively are; Facebook, Google, Amazon, and Microsoft. Control and have the most users and buying capacity to harness the ultimate stake of bigdata and its various benefits. However, outside of the monetization of bigdata there are several benefits and discoveries which have occurred in the science and medical fields using this data to help discover new medical treatments and risk factors. The Covid-19 response and tracking would not have been obtainable prior to bigdata implementation.

Figure 05 - White Space

Examples of bigdata and its sources vary widely and some examples which are used by individual users can be and are not limited to; emails, financial markets, medical records, images, videos, weather, social media usage, and other external sources.

Challenges of bigdata management vary by location based upon resources, the amount of participants in the pool of bigdata as well as the overall specialized technical components needed to run. There is no point A to point B formula when discovering the power of bigdata which has led to larger companies such as the “big four” to control a major share in the world’s bigdata. Behind some of the world’s largest humanless data centers require such large human teams to collectively run the operation.

But, could there be alternative ways to harness the power of the three “V’s” and their various quirks to spur a contemporary idea of a distributed network of big data? Perhaps a modular system that can be added or subtracted to? Having the ability to change and adapt to changes in technology and maybe offset byproducts of bigdata.

METHODS

VARIETY

The type of Data. Typically characterized by its subcategorized types. Structured data is information that is as it sounds. Easy to track and organized such as financial and medical records. Unstructured data is information such as text messages, computer desktop files and multimedia files. Lastly, semistructured data can be viewed as streaming services such as netflix or internet web hosting servers.

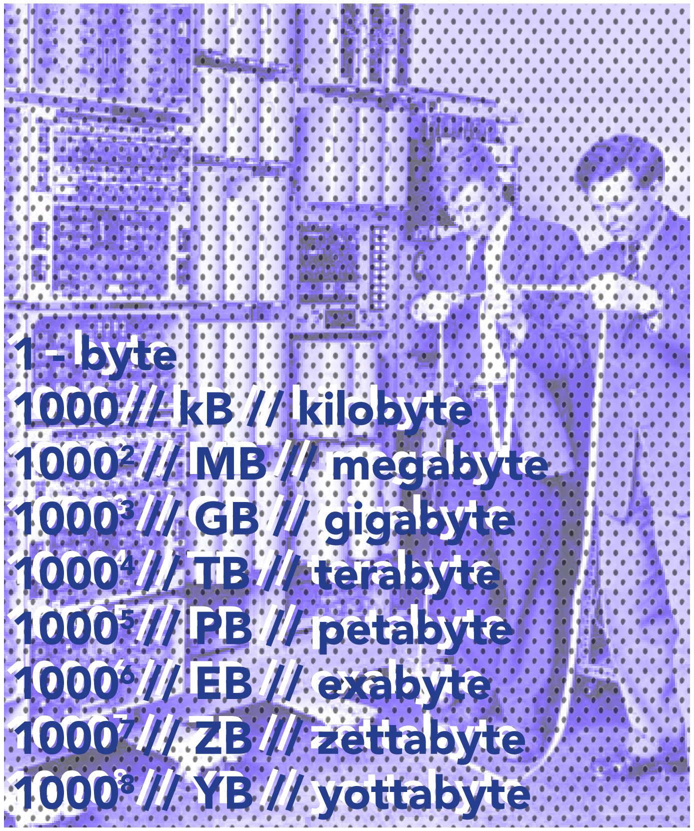
VELOCITY

The speed of data. Both in the way it is created as well as managed. Models can be generated at on-time or “instant basis” or can be scheduled at specific time intervals. Hardware challenges are generally the indicator of speed. Velocity is important to finding patterns in the data flowing. Such patterns lead to advancement in machine learning simulations.

VOLUME

The amount of data. Ranging from small to large data sets. This data typically comes from various sources. The larger the volume of data the more burdensome to handle and categorize. Larger and more specialized equipment is required to process such big data.

SIZE YOUR DATA



Historically and presently, byte units are sized based on the power of ten. However, today we scale and more commonly use the scalability terms used in the metric system. By definition, byte has become popularized by its notion of how one scales the amount of data they have. In other words the object such as a flash drive has been decoded and re-appropriated as the way one stores their data. Moreover the unit of measurement. From a historical perspective of computation development we have also seen data storage techniques follow this same phenomena. Dating back to 1965, IBM announced they had created an eight silicon disk storage device that had a industry leading storage capacity that relished the competition at a whopping 200mb capacity. Nicknamed the "pizza oven" to its pizza sized disks as well as the sheer size of the appliance, this device had the size that took up an entire large conference room and had a price tag to purchase the entire office building.

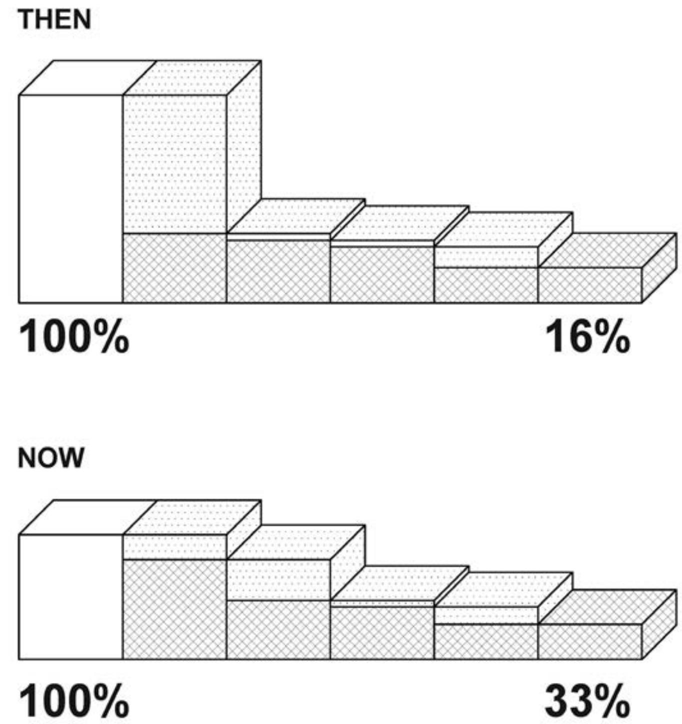
Figure 04 - Global Data Locations

Figure 1.x | xxx

Figure 05 - White Space

It was at this moment in the same year that the infamous Moore's law was introduced to the world by one of IBM's rivals of research and development, fairchild semiconductor companies very own, Gordon Moore. The term law had been picked out of its cynical take on the murphy law concept. However, this is no law by means of scientific standards. Rather it was an observation that Moore had stated computer chips with its various circuits and transistors would double its capacity every two years. With this speculation, Moore also opined that the cost of said computation components as well as housings would begin to drop in price as well. Soon after stating the famous words the world quickly discovered the truthfulness of such radical thinking. The relevance of Moore's law by today's standards could very well arguably be a law by physical science standards. Fast forwarding to today, roughly six decades, humanity saw a shift in room size, to desk size, to pocket size, to fingernail size computational data storage.

Additionally, at this point the global economy as well as its technology sectors began to develop faster, thanks to the power of the relatively free market. But, as the world economy began to grow, so has the need for the amount of data it produces and needs to be stored. Much like the amount of data produced in today's standard of "gigabyte," It can be argued that Moore's law has been outpaced by the doubling of data storage production. So much so that over the last decade humanity has shifted away from its pocket sized personal data devices and have since moved itself back to its origins of the conference room sized storage facilities. Alas, you can store much more data than its humble "pizza oven" beginning in 1965. This shift from personal size to large size does come with its own benefits of scalability, economies, as well as operations, however one issue that becomes the most difficult is the need to house and take care of such sensitive equipment. It was at this moment in the same year that the infamous Moore's law was introduced to the world by one of IBM's rivals of research and development, fairchild semiconductor companies very own, Gordon Moore.



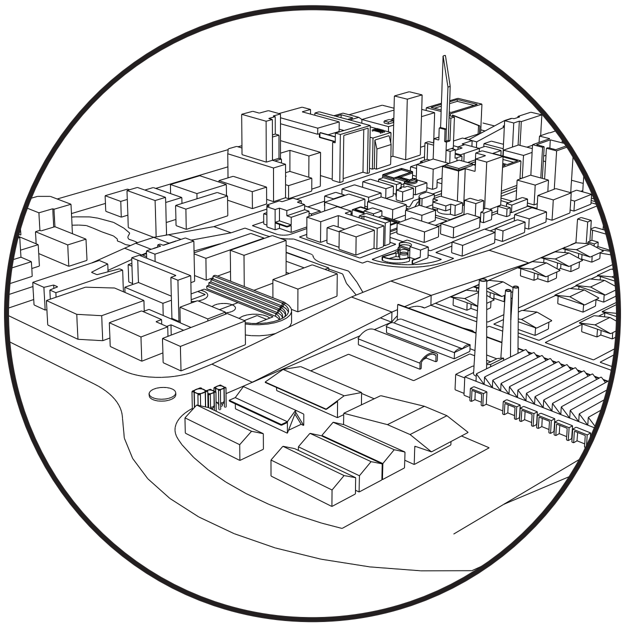
The term law had been picked out of its cynical take on the murphy law concept. However, this is no law by means of scientific standards. Rather it was an observation that Moore had stated computer chips with its various circuits and transistors would double its capacity every two years. With this speculation, Moore also opined that the cost of said computation components as well as housings would begin to drop in price as well. Soon after stating the famous words the world quickly discovered the truthfulness of such radical thinking. The relevance of Moore's law by today's standards could very well arguably be a law by physical science standards. Fast forwarding to today, roughly six decades, humanity saw a shift in room size, to desk size, to pocket size, to fingernail size computational data storage.

Figure 05 - White Space

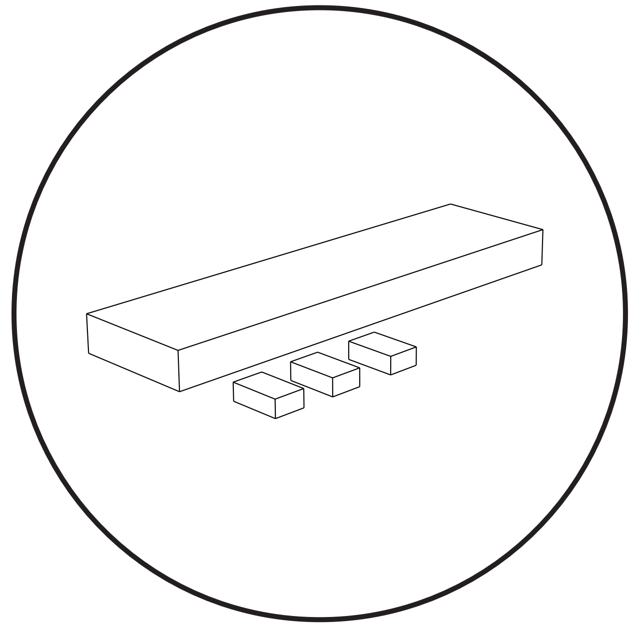
Additionally, at this point the global economy as well as its technology sectors began to develop faster, thanks to the power of the relatively free market. But, as the world economy began to grow, so has the need for the amount of data it produces and needs to be stored. Much like the amount of data produced in today's standard of "gigabyte," It can be argued that Moore's law has been outpaced by the doubling of data storage production. So much so that over the last decade humanity has shifted away from its pocket sized personal data devices and have since moved itself back to its origins of the conference room sized storage facilities. Alas, you can store much more data than its humble "pizza oven" beginning in 1965. This shift from personal size to large size does come with its own benefits of scalability, economies, as well as operations, however one issue that becomes the most difficult is the need to house and take care of such sensitive equipment. At this point the architects and engineers had to go to the drafting board and come up with solutions for its sensitive clients needs.

Thus, bigdata architecture was created, collectively named data centers by industry standards. A new architecture with its very own program for its speechless, and rather picky clients. These picky clients, considered lifeless from a biological perspective, have just as many "wishes" as a client with life. However, they get very hot, are incredibly thirsty, and need to eat as much electricity just to stay at a homeostatic level. What came to be as a solution for housing this equipment, has first handedly caused additional issues as scalability was introduced. Today, large scale facilities are spreading across the built environment with opposition and notoriously being a threat to its surroundings. Simply put, big data architecture is dirty. These facilities are a drain on resources from the standpoint of water consumption, electricity as well as space. By today's standard the average industry leading data center uses only eighteen percent of its floor area, strictly for its intended purpose. Yet, they use enough resources for a municipality of twenty-five hundred people.

Figure 05 - White Space



~~HEAT~~
~~POWER~~
~~WATER~~



MANY **ONE**

Figure 05 - White Space

VERTICAL INTEGRATION

33 Thomas - New York, NY

FLOOR AREAS

36 rows per floor, ca. 120 sq.ft. each = 4,320 sq.ft.

Total floor area of each floor = 27,862 sq.ft.

4,320 sq.ft. / 27,862 sq.ft. = 15%

HEIGHTS

Height of the building = 550.00'

Stripped height of standard 52U rack
52 x 1.75" = 7.625'

Hypothetical height of all racks
7.625' x 29 floors = 221.00'

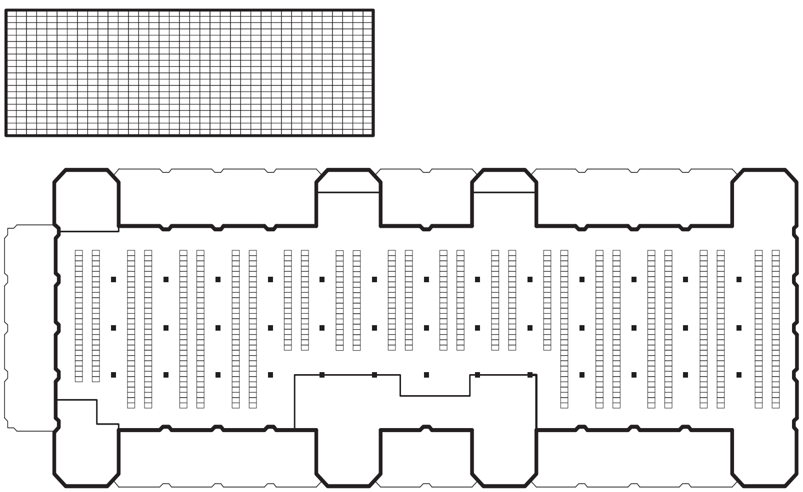
VOLUMES

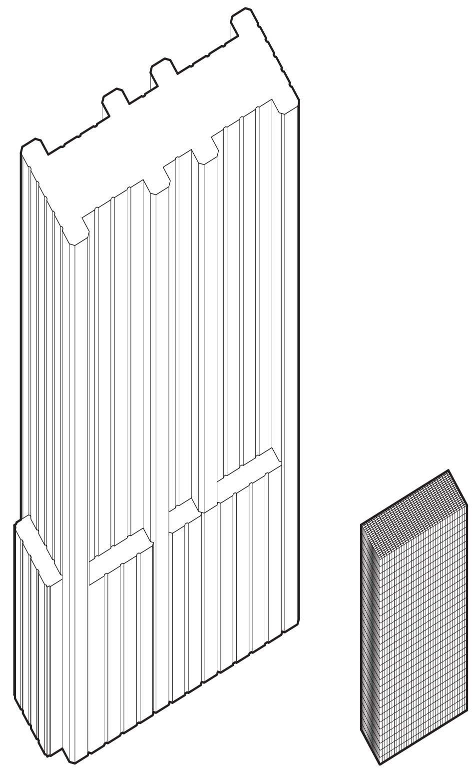
Total volume of the equipment
221.00' x 4,320 sq.ft. = 954,720 cb.ft.

Total volume of the building
550.00" x 27,862 sq.ft. = 15,324,100 cb.ft.

954,720 cb.ft. / 15,324,100 cb.ft. = 6%

15%





06%

Figure 04 - Global Data Locations

HORIZONTAL INTEGRATION

Yahoo - Lockport, NY

FLOOR AREAS

40 rows per floor, ca. 156 sq.ft. each = 6,240 sq.ft.

Total floor area of each floor = 33,750 sq.ft.

6,240 sq.ft. / 33,750 sq.ft. = 18%

HEIGHTS

Height of the building = 35.00’

Stripped height of standard 52U rack
52 x 1.75” = 7.625’

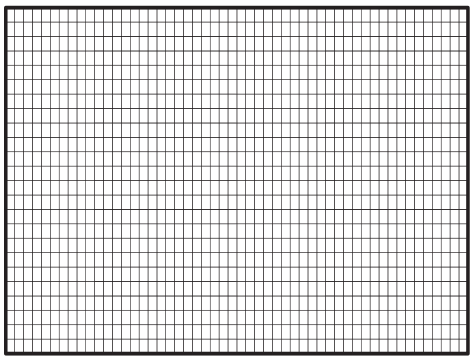
Hypothetical height of all racks
= 7.625’

VOLUMES

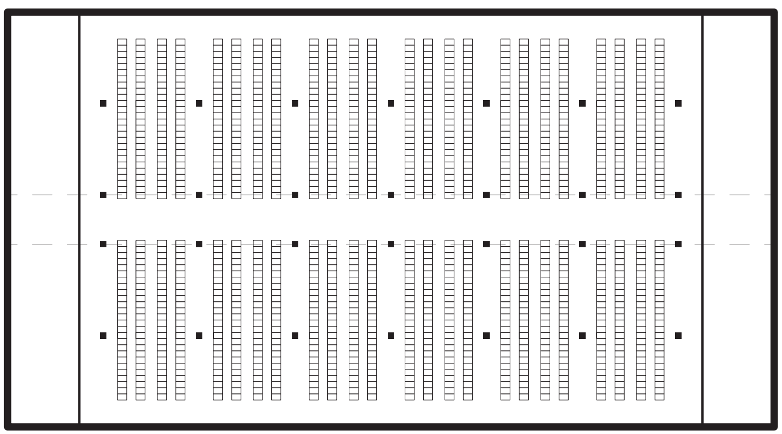
Total volume of the equipment
7.625’ x 6,240 sq.ft. = 47,580 cb.ft.

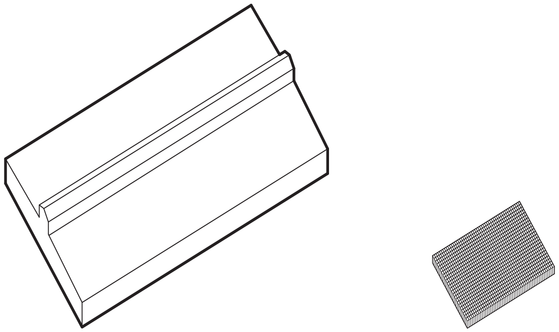
Total volume of the building
35.00’ x 33,750 sq.ft. = 1,181,250 cb.ft.

47,580 cb.ft. / 1,181,250 cb.ft. = 4%



18%





04%

Figure 04 - Global Data Locations

CHAPTER FOUR

ENERGY CONSUMPTION

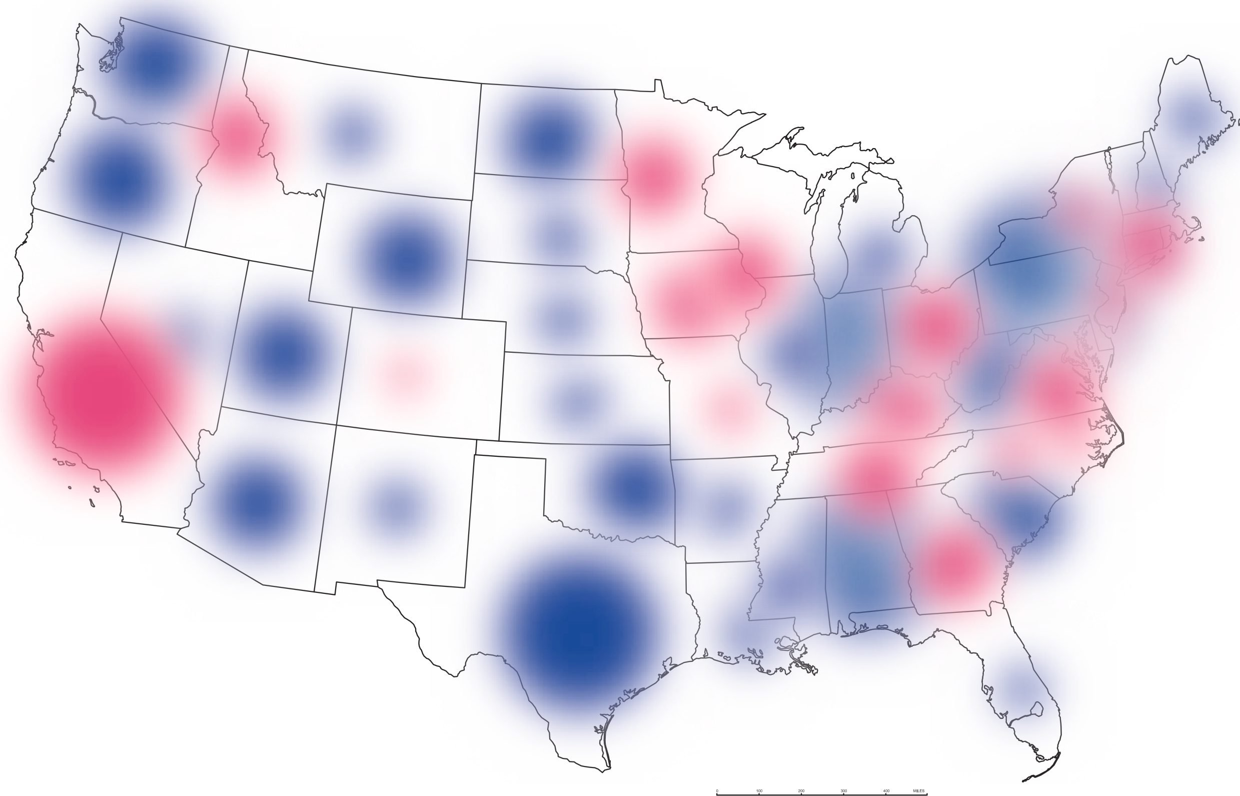
Fossil fuels (total)	2,427	60.6%
Natural gas	1,624	40.5%
Coal	773	19.3%
Petroleum (total)	17	0.4%
Petroleum liquids	10	0.2%
Petroleum coke	8	0.2%
Other gases	11	0.3%
Nuclear	790	19.7%
Renewables (total)	792	19.8%
Wind	338	8.4%
Hydropower	291	7.3%
Solar (total)	91	2.3%
Photovoltaic	88	2.2%
Solar thermal	3	0.1%
Biomass (total)	56	1.4%
Wood	37	0.9%
Landfill gas	10	0.3%
Municipal solid waste (biogenic)	6	0.2%
Other biomass waste	2	0.1%
Geothermal	17	0.4%
Pumped storage hydropower	-5	-0.1%
Other sources	13	0.3%

Figure 04 - Global Data Locations

When selecting a site for a prospective data center, one of the first areas of concern should be how to power the facility. Specifically where that power comes from and how that power was generated. There are various tax incentives for using renewable resources, however presently the majority of power demand used by data centers are generated from market rate power. In addition to using market rate power, facilities additionally require a source of onsite power in the event of a black or brown out occurrence.

On average data centers use enough electricity equivalent to three percent of the world's energy output. This number is spread out through the various components of a data center and the largest draw is the individual storage drives that store information. Industry standard drives used for storing data have historically been with hard drive disks commonly known as (HDD). These drives per volume of data accounts for the most electricity for a typical server rack. Within the last decade solid state drives (SSD) have been introduced to both increase the volume of storage but also to decrease the amount of energy. Projected figures of decreased energy consumption are currently at twenty-five percent. There is a cost to this change to SSD in facility storage. First, these drives cost more than the traditional HDD drives and secondly they do have a shorter rack lifespan which means they will need to be replaced more frequently.

One metric used to gain an effective insight on how energy efficient these facilities are is to use the power usage effectiveness, or PUE for short. This metric is a ratio that the industry uses to indicate how much energy is being consumed to run the physical hardware of the facility and how much is used to cool, light, and provide for additional building functions. The most effective PUE is equivalent to one, whereas any number above one iis where energy is being wasted. The most efficient data centers have a PUE from one and half to two.



NET GAIN / LOSS @ MWh

Alabama +54 Alaska +1 Arizona +28 Arkansas +9 California -57 Colorado -2 Connecticut +14 Delaware -6 D.C. -6 Florida +8 Georgia -13
Hawaii +1.5 Idaho -7 Illinois +41 Indiana +7 Iowa -9 Kansas +15 Kentucky -8 Louisiana +1 Maine +1 Maryland -21 Massachusetts -50
Michigan +9 Minnesota -8 Mississippi +20 Missouri -3 Montana +9 Nebraska +5 Nevada +2 New Hampshire +6 New Jersey -10
New Mexico +10 New York - 11 North Carolina -6 North Dakota +24 Ohio -22 Oklahoma +20 Oregon +12 Pennsylvania +91 Rhode Island +2
South Carolina +22 South Dakota +2 Tennessee -15 Texas +47 Utah +6 Vermont -3 Virginia -14 Washington +30 West Virginia +21
Wisconsin -6 Wyoming +27

Figure 04 - Global Data Locations

One way of mitigating PUE from a locational standpoint is studying current energy production in the United States at the state level. There are various forms of energy production and most states are able to generate power by both traditional means vis-a-vis fossil fuel generation but also ecological methods such as regenerative energy. When these two means are used together there is a greater chance for energy reduction as well as reduction in carbon dioxide emissions. Privatized data center facilities, specifically of the “big four” have been mitigating their PUE by providing onsite green regenerative energy sources such as wind, and solar farms.

But, are there alternatives with the energy that is already being produced? Taking United States current state energy production into account there are currently numerous States that produce more energy than their population demands. At the megawatt per hour calculations, more than half of the country produces a net gain. These figures are skewed in some states where density is more often than not the culprit has a net loss of energy. For example the tri-state area of New York, New Jersey, and Connecticut have higher densities of people as well as larger manufacturing sectors yet of the three states Connecticut actually has a net gain. Based on this information it can be noted that the state is selling and producing more energy to its neighboring states.

Zooming in by region, the central midwest states in climate zones five and four, which are Michigan, Indiana, and Illinois produce more net gain energy per year combined totalling 57 megawatt per hour than any other region in the country. These numbers are staggering based on the surrounding states with a net loss in energy production. But could this surplus in already produced energy be used to power data centers?

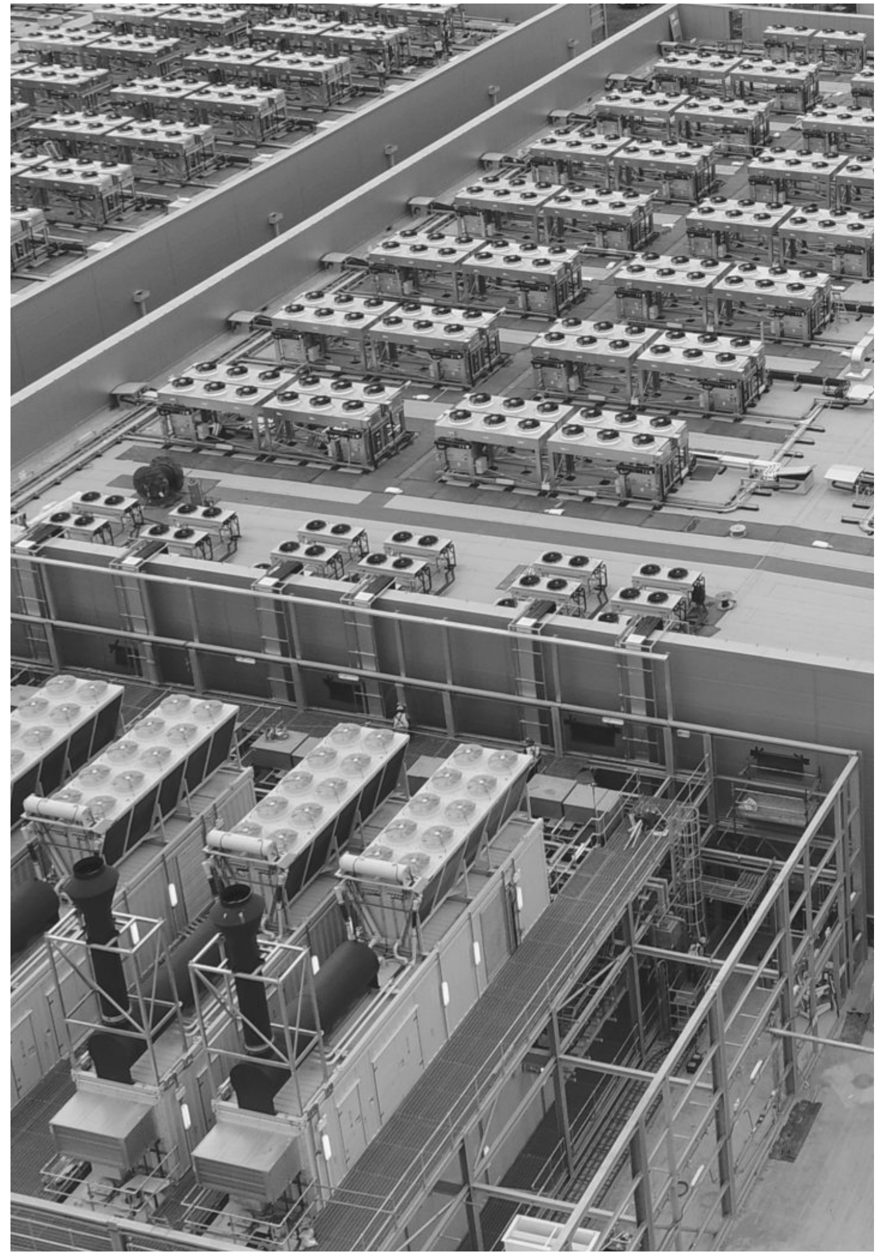


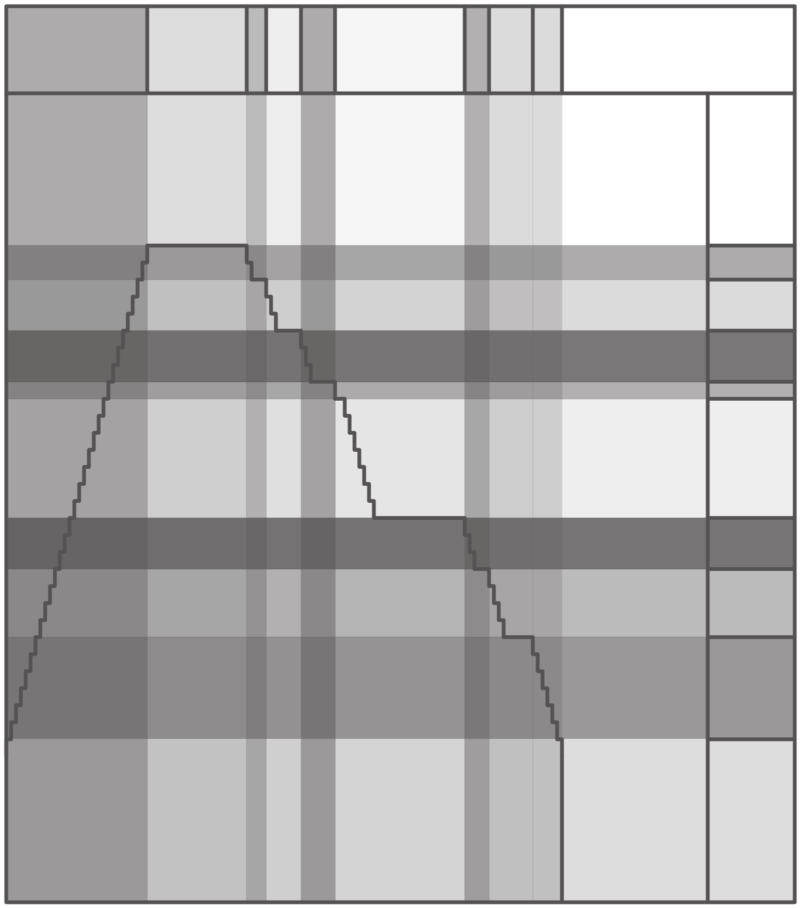
Figure 05 - White Space

WHATS BEING TALKED ABOUT

	LOCATION	STRUCTURES	ENERGY	RENEWABLES	STORAGE
TODAY	NEAR FIBER NETWORKS DATA CENTERS ARE CONSTRUCTED IN AREAS WITH DENSE FIBER NETWORKS	CLOUD & ON-PREMISE HYBRID-CLOUD, THE MIX OF CLOUD AND ON-PREMISE SOLUTIONS, WITNESS WIDESPREAD ADOPTION	AIR & WATER COOLING COLD AND HOT AIR ARE REDIRECTED TO KEEP EQUIPMENT AT THE RIGHT TEMPERATURE	PLUGGED IN & REC'S MANY DATA CENTERS ARE PLUGGED INTO THE GRID, BALANCING DIRTY ENERGY WITH RENEWABLE ENERGY CREDITS	HARD DISK DRIVES OVER 90% OF STORAGE DEVICE SHIPMENTS TO ENTERPRISES ARE HDD'S
TOMMORROW	STABLE CLIMATES CLIMATES, LIKE THE NORDIC REGION, ALLOW DATA CENTERS TO COOL EFFICIENTLY AND SAVE ENERGY	SMALLER & LARGER MEGA DATA CENTERS BENEFIT FROM ECONOMIES OF SCALE, MICRO DATA CENTERS BENEFIT LATENCY AND PORTABILITY	AUTOMATION NEW COOLING MATERIALS AND AI-ASSITANCE EMERGES	RENEWABLES LARGE PROVIDERS SUCH AS FACEBOOK, GOOGLE, AMAZON, MICROSOFT, ECT. CAN BUY LARGE AMOUTS OF RENAQABLE ENERGY CREDITS FOR ITS CENTERS	SOLID STATE DRIVES SSD'S BECOME MORE PREVALENT IN DATA CENTERS AS PRICES PER UNIT FALL
FUTURE	SMALL & OFF-SHORE SMALL, OFF-SHORE DATA CENTERS ADD NEW CAPACITY QUICKLY	NO CENTERS AT ALL DATA STORAGE AND COMPUTATIONAL RESOURCES ARE CROWD SOURCED THROUGH PEER-TO-PEER DEVICE NETWORKS	RECYCLING HEAT RESIDUAL HEAT IS RECYCLED AND REDIRECTED TO COMMUNITIES	RE FARMS TECH HELPS SMALLER BUYERS AND PRODUCERS CONNECT	MORE WITH LESS INNOVATION SUCH AS LIQUID-STATE STORAGE PROVIDES GREATER CAPACITY AT LOWER COST

Figure 04 - Global Data Locations

FORCES OF CHANGE



NEW EQUIPMENT
CONSOLIDATIONS AND EXPANSIONS
NEW REDUNDANCY REQUIREMENTS
INCREMENTAL POWER REQUIREMENTS
INCREMENTAL COOLING DEMANDS
CONSTRAINED FLOOR SPACE
NEW SAFETY AND SECURITY REGULATIONS
CHANGES IN OPERATIONAL PROCEDURES
CHANGES IN MISSION
COST PRESSURES

Figure 04 - Global Data Locations

CHAPTER FIVE

INTERNET

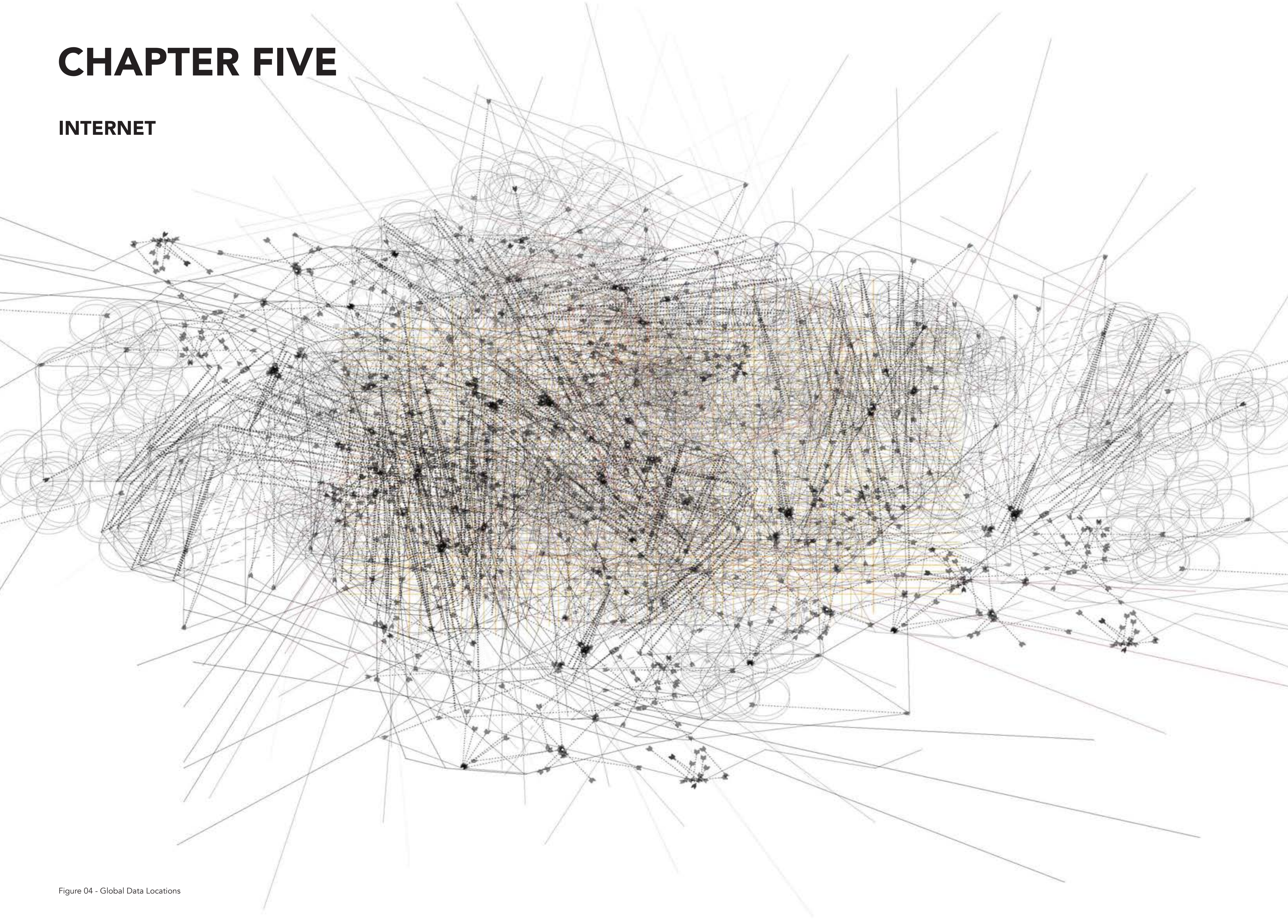


Figure 04 - Global Data Locations

Much to bigdata creation as well as need for data centers to control the shear volume, variety, and velocity pay's its due to the creation of the internet. Around the same time period of the first computer during the 1960's the internet first started out as a platform to share information between the United States, The United Kingdom and France.

It was not until the start of the year in 1983 when the internet as we know of it today was officially launched.

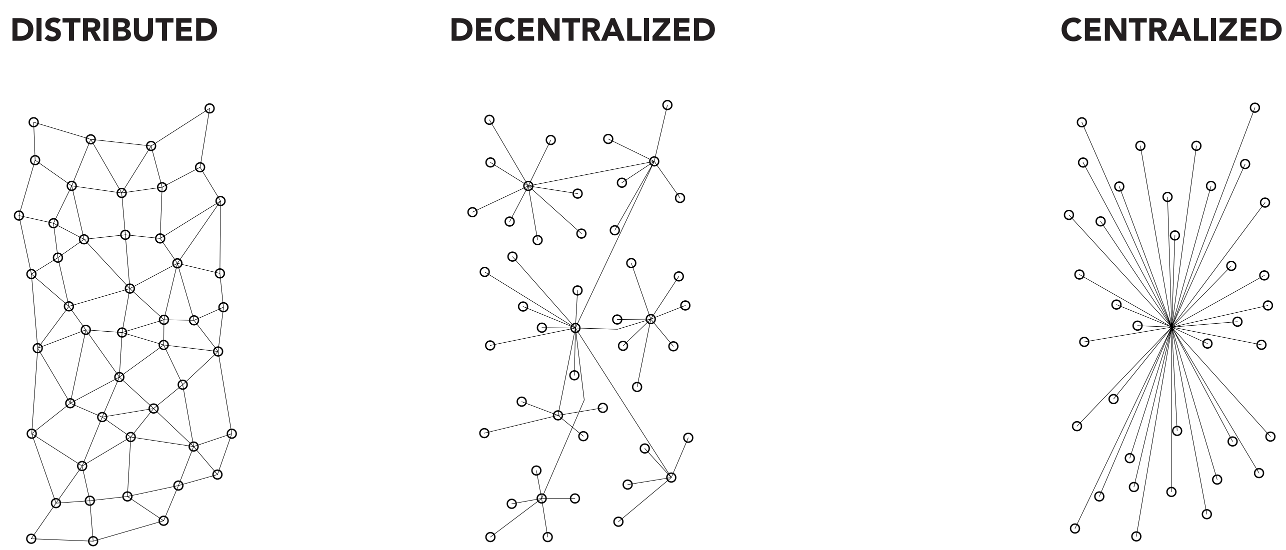


Figure 04 - Global Data Locations

CHAPTER SIX

INTERVENTION

The state of Michigan and its 3,288 miles of shore line has benefited greatly from its surrounding great lakes both for ecological as well as economic prosperity since its unionization in 1883. Yet, it wasn't until French explorers navigated their way through the St. Lawrence and other various rivers and lakes to be the first western society to capture the significance of what the fresh water peninsulas had to offer.

Moving into the age of the industrial revolution the network of five great lakes catapulted both the state of Michigan and surrounding shores into largest freshwater shipping terminals in the world. Raw goods such as Iron ore, coal, limestone and grain piloted their way to ports and into the various processing and manufacturing facilities. It was this boom of commercial success that caused the water ways to become congested as well as treacherous during 365 days of operations.

It wasn't until 1825 that the state of Michigan had a solution to help troubled navigating ships sail and find their way around the state. This not so new technology first arose at the entrance of the St. Clair river from Lake Huron at the Southern portion of the state's thumb. Often located in desolate areas which required these structures to be self sufficient and run on their own resources for power, water as well as heat.

The success of the first lighthouse in the state of Michigan convinced the United States Congress to begin approving funds for an additional 120 lighthouses to be built over the next century. Saving as well as navigating ships up and down the great lakes.

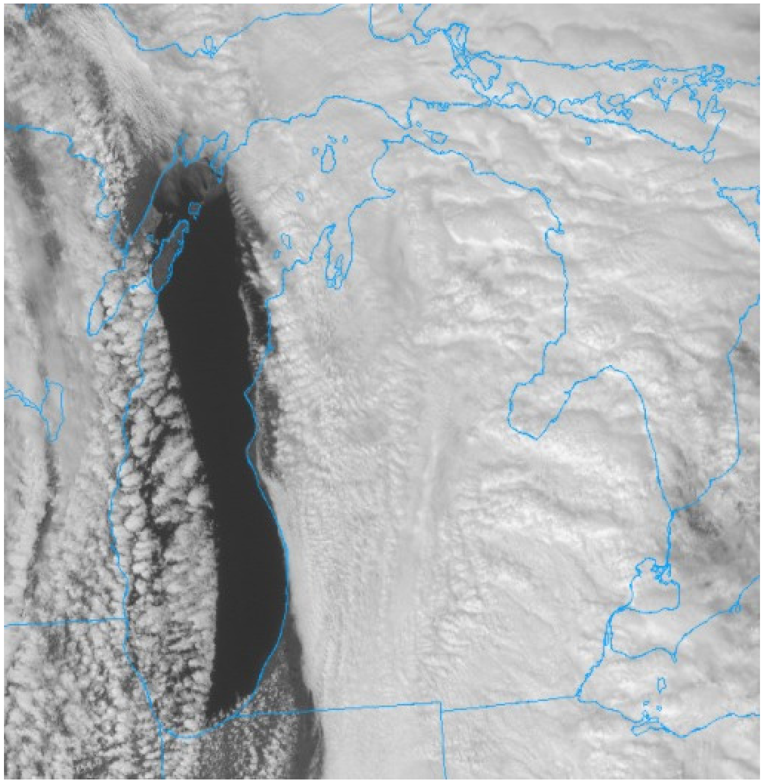


Figure 05 - White Space

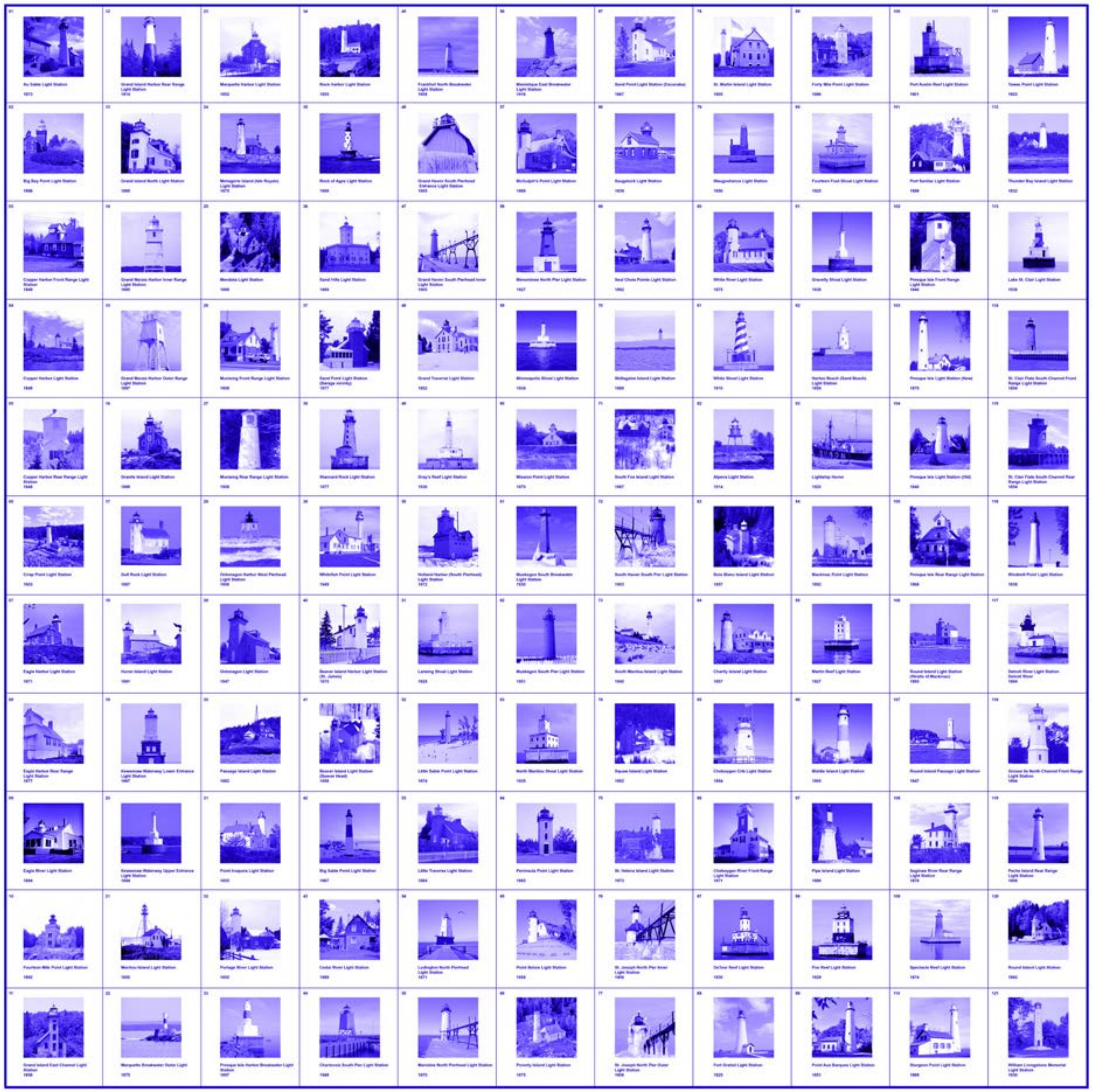


Figure 05 - White Space

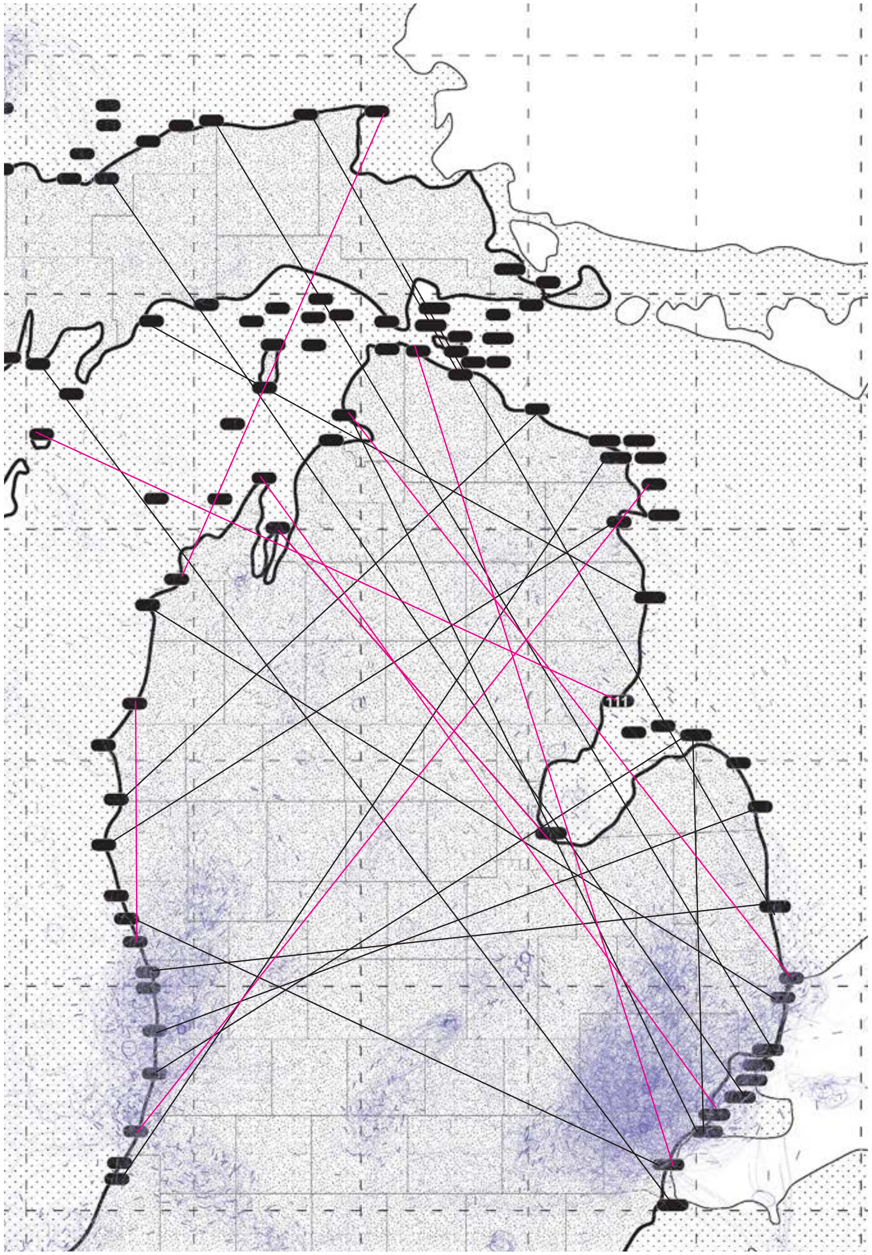
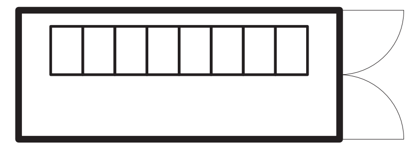
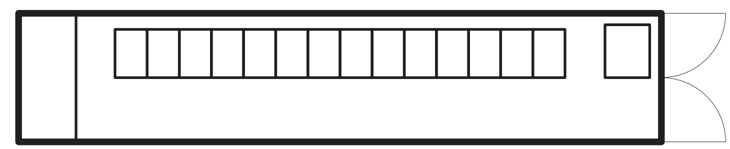


Figure 04 - Global Data Locations

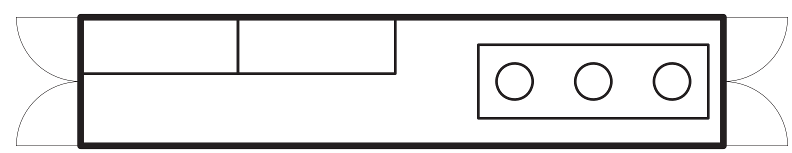
As with time, and advancement in technology With the average age of 135 years old



MINI = 160 SF = 3500 TERABYTES



BIG = 320 SF = 7000 TERABYTES



LIFE SUPPORT

Figure 05 - White Space

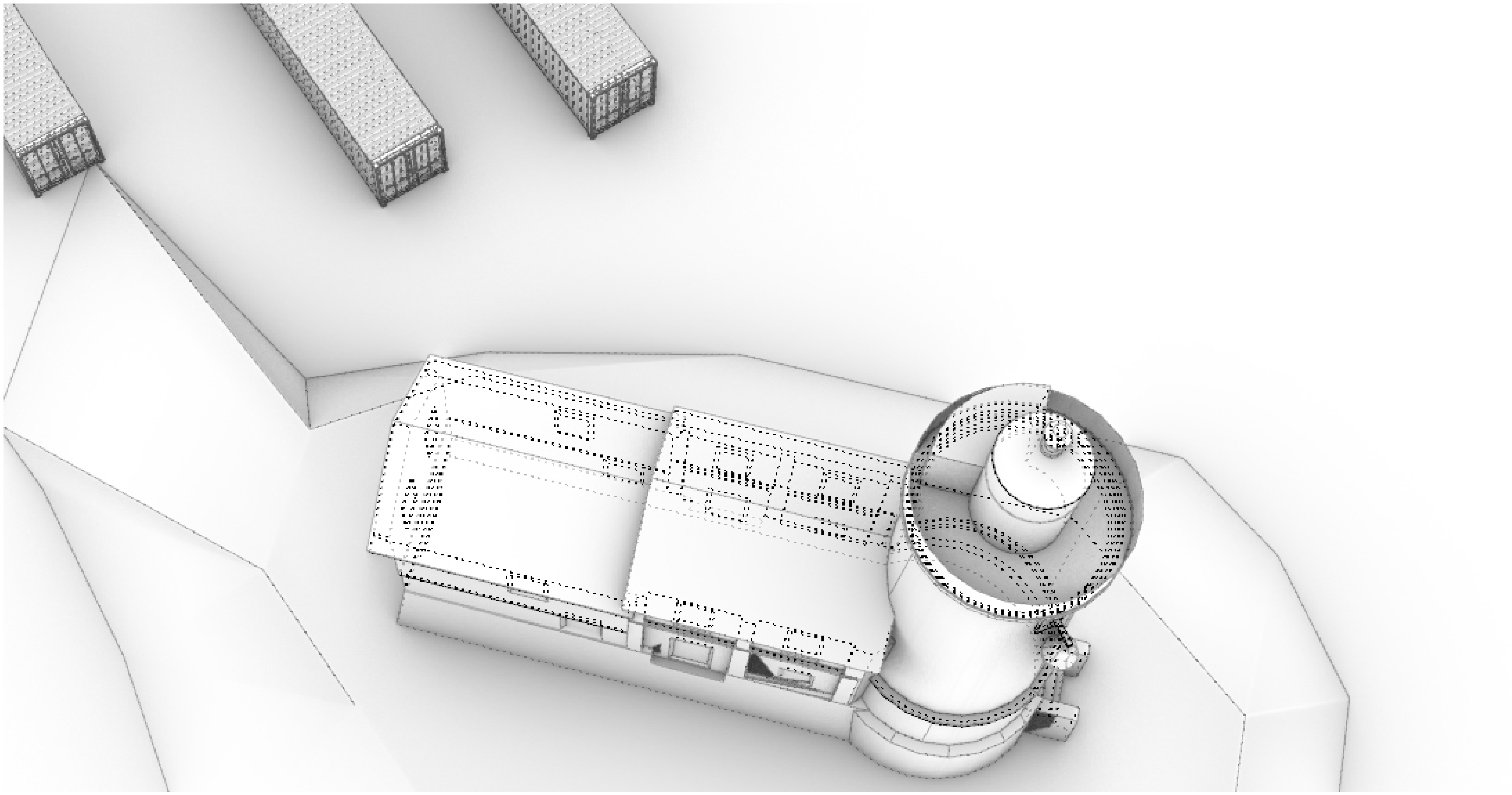


Figure 04 - Global Data Locations

ADDITIONAL HISTORIC STRUCTURES

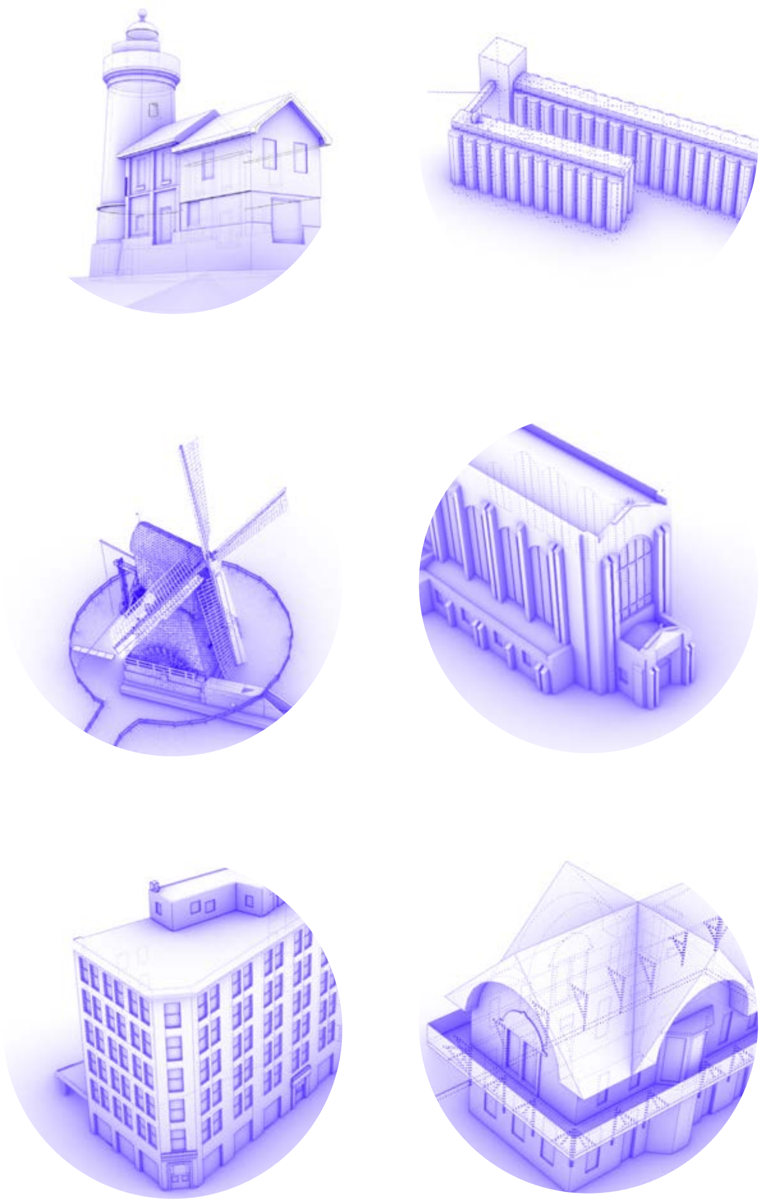


Figure 04 - Global Data Locations

CONCLUSION

The main objective of this thesis is to spur a conversation that can span the ever expanding development of data, specifically what data means at the individual level and how we use it, store it, and abuse it. Not one person can find a unanimous conclusion to these issues and stances. However, this conversation can start to develop outside of the discipline of architecture and engineering.

FIGURES

Figure xx - Lighthouse Matrix

01 - Unknown. "Au Sable Light Station." https://www.nps.gov/piro/learn/historyculture/ausablelightstation.htm
02 - Unknown. "Big Bay Point Light Station." https://www.gonomad.com/2644-lodging-michigan-s-big-bay-point-lighthouse-b-and-b
03 - Unknown. "Copper Harbor Front Range Light Station." https://www.lighthousefriends.com/light.asp?ID=225
04 - Unknown. "Copper Harbor Light Station." https://lakesuperiorcircletour.info/lake-superior-lighthouses/
05 - Unknown. "Copper Harbor Rear Range Light Station." https://www.lighthousefriends.com/light.asp?ID=225
06 - Unknown. "Crisp Point Light Station." https://www.crisppointlighthouse.org/
07 - Unknown. "Eagle Harbor Light Station." https://www.scenicusa.net/092111.html
08 - Unknown. "Eagle Harbor Rear Range Light Station." https://www.lighthousefriends.com/light.asp?ID=854
09 - Unknown. "Eagle River Light Station." https://en.wikipedia.org/wiki/Eagle_River_Light
10 - Unknown. "Fourteen Mile Point Light Station." https://lakesuperiorcircletour.info/location/fourteen-mile-point-lighthouse/
11 - Unknown. "Grand Island East Channel Light Station." https://www.lighthousefriends.com/light.asp?ID=726
12 - Unknown. "Grand Island Harbor Rear Range Light Station." https://lakesuperiorcircletour.info/location/grand-island-harbor-rear-range-lighthouse/
13 - Unknown. "Grand Island North Light Station." https://www.lighthousefriends.com/light.asp?ID=725
14 - Unknown. "Grand Marais Harbor Inner Range Light Station." https://www.lighthousefriends.com/light.asp?ID=723
15 - Unknown. "Grand Marais Harbor Outer Range Light Station." https://www.lighthousefriends.com/light.asp?ID=723
16 - Unknown. "Granite Island Light Station." https://www.lighthousefriends.com/light.asp?ID=727
17 - Unknown. "Gull Rock Light Station." https://www.lighthousefriends.com/light.asp?ID=730
18 - Unknown. "Huron Island Light Station." https://www.lighthousefriends.com/light.asp?ID=729
19 - Unknown. "Keweenaw Waterway Lower Entrance Light Station." https://www.lighthousefriends.com/light.asp?ID=229
20 - Unknown. "Keweenaw Waterway Upper Entrance Light Station ." https://www.lighthousefriends.com/light.asp?ID=221
21 - Unknown. "Manitou Island Light Station." https://www.lighthousefriends.com/light.asp?ID=731
22 - Unknown. "Marquette Breakwater Outer Light." https://www.lighthousefriends.com/light.asp?ID=571
23 - Unknown. "Marquette Harbor Light Station." https://www.lighthousefriends.com/light.asp?ID=572
24 - Unknown. "Menagerie Island (Isle Royale) Light Station." https://www.lighthousefriends.com/light.asp?ID=735
25 - Unknown. "Mendota Light Station." https://www.lighthousefriends.com/light.asp?ID=227
26 - Unknown. "Munising Front Range Light Station." https://www.lighthousefriends.com/light.asp?ID=569
27 - Unknown. "Munising Rear Range Light Station." https://www.lighthousefriends.com/light.asp?ID=569
28 - Unknown. "Ontonagon Harbor West Pierhead Light Station ." https://www.lighthousefriends.com/light.asp?ID=220
29 - Unknown. "Ontonagon Light Station." https://www.lighthousefriends.com/light.asp?ID=219
30 - Unknown. "Passage Island Light Station." https://www.lighthousefriends.com/light.asp?ID=733
31 - Unknown. "Point Iroquois Light Station." https://www.lighthousefriends.com/light.asp?ID=566
32 - Unknown. "Portage River Light Station." https://www.lighthousefriends.com/light.asp?ID=228
33 - Unknown. "Presque Isle Harbor Breakwater Light Station." https://www.lighthousefriends.com/light.asp?ID=573
34 - Unknown. "Rock Harbor Light Station." https://www.lighthousefriends.com/light.asp?ID=734
35 - Unknown. "Rock of Ages Light Station." https://www.lighthousefriends.com/light.asp?ID=736
36 - Unknown. "Sand Hills Light Station." https://www.lighthousefriends.com/light.asp?ID=222
37 - Unknown. "Sand Point Light Station (Baraga vicinity." https://www.lighthousefriends.com/light.asp?ID=230
38 - Unknown. "Stannard Rock Light Station." https://lighthousefriends.com/light.asp?ID=728
39 - Unknown. "Whitefish Point Light Station." https://www.lighthousefriends.com/light.asp?ID=567
40 - Unknown. "Beaver Island Harbor Light Station (St. James)." https://www.lighthousefriends.com/light.asp?ID=206
41 - Unknown. "Beaver Island Light Station (Beaver Head)." https://www.lighthousefriends.com/light.asp?ID=205
42 - Unknown. "Big Sable Point Light Station." https://www.lighthousefriends.com/light.asp?ID=196
43 - Unknown. "Cedar River Light Station." https://www.lighthousefriends.com/light.asp?ID=559
44 - Unknown. "Charlevoix South Pier Light Station." https://lighthousefriends.com/light.asp?ID=201
45 - Unknown. "Frankfort North Breakwater Light Station." https://www.lighthousefriends.com/light.asp?ID=198
46 - Unknown. "Grand Haven South Pierhead Entrance Light Station." https://www.lighthousefriends.com/light.asp?ID=189
47 - Unknown. "Grand Haven South Pierhead Inner Light Station." https://www.lighthousefriends.com/light.asp?ID=189
48 - Unknown. "Grand Traverse Light Station." https://www.lighthousefriends.com/light.asp?ID=711
49 - Unknown. "Gray's Reef Light Station." https://www.lighthousefriends.com/light.asp?ID=209
50 - Unknown. "Holland Harbor (South Pierhead) Light Station." https://www.lighthousefriends.com/light.asp?ID=188
51 - Unknown. "Lansing Shoal Light Station." https://www.lighthousefriends.com/light.asp?ID=208
52 - Unknown. "Little Sable Point Light Station." https://www.lighthousefriends.com/light.asp?ID=193
53 - Unknown. "Little Traverse Light Station." https://www.lighthousefriends.com/light.asp?ID=203
54 - Unknown. "Ludington North Pierhead Light Station." https://www.lighthousefriends.com/light.asp?ID=195
55 - Unknown. "Manistee North Pierhead Light Station." https://www.lighthousefriends.com/light.asp?ID=197
56 - Unknown. "Manistique East Breakwater Light Station." https://www.lighthousefriends.com/light.asp?ID=564
57 - Unknown. "McGulpin's Point Light Station." https://www.lighthousefriends.com/light.asp?ID=213
58 - Unknown. "Menominee North Pier Light Station." https://www.lighthousefriends.com/light.asp?ID=558
59 - Unknown. "Minneapolis Shoal Light Station." https://www.lighthousefriends.com/light.asp?ID=563
60 - Unknown. "Mission Point Light Station." https://www.lighthousefriends.com/light.asp?ID=713
61 - Unknown. "Muskegon South Breakwater Light Station." https://www.lighthousefriends.com/light.asp?ID=191

Figure xx - Lighthouse Matrix

01 - Unknown. "Au Sable Light Station." https://www.nps.gov/piro/learn/historyculture/ausablelightstation.htm
02 - Unknown. "Big Bay Point Light Station." https://www.gonomad.com/2644-lodging-michigan-s-big-bay-point-lighthouse-b-and-b
03 - Unknown. "Copper Harbor Front Range Light Station." https://www.lighthousefriends.com/light.asp?ID=225
04 - Unknown. "Copper Harbor Light Station." https://lakesuperiorcircletour.info/lake-superior-lighthouses/
05 - Unknown. "Copper Harbor Rear Range Light Station." https://www.lighthousefriends.com/light.asp?ID=225
06 - Unknown. "Crisp Point Light Station." https://www.crisppointlighthouse.org/
07 - Unknown. "Eagle Harbor Light Station." https://www.scenicusa.net/092111.html
08 - Unknown. "Eagle Harbor Rear Range Light Station." https://www.lighthousefriends.com/light.asp?ID=854
09 - Unknown. "Eagle River Light Station." https://en.wikipedia.org/wiki/Eagle_River_Light
10 - Unknown. "Fourteen Mile Point Light Station." https://lakesuperiorcircletour.info/location/fourteen-mile-point-lighthouse/
11 - Unknown. "Grand Island East Channel Light Station." https://www.lighthousefriends.com/light.asp?ID=726
12 - Unknown. "Grand Island Harbor Rear Range Light Station." https://lakesuperiorcircletour.info/location/grand-island-harbor-rear-range-lighthouse/
13 - Unknown. "Grand Island North Light Station." https://www.lighthousefriends.com/light.asp?ID=725
14 - Unknown. "Grand Marais Harbor Inner Range Light Station." https://www.lighthousefriends.com/light.asp?ID=723
15 - Unknown. "Grand Marais Harbor Outer Range Light Station." https://www.lighthousefriends.com/light.asp?ID=723
16 - Unknown. "Granite Island Light Station." https://www.lighthousefriends.com/light.asp?ID=727
17 - Unknown. "Gull Rock Light Station." https://www.lighthousefriends.com/light.asp?ID=730
18 - Unknown. "Huron Island Light Station." https://www.lighthousefriends.com/light.asp?ID=729
19 - Unknown. "Keweenaw Waterway Lower Entrance Light Station." https://www.lighthousefriends.com/light.asp?ID=229
20 - Unknown. "Keweenaw Waterway Upper Entrance Light Station ." https://www.lighthousefriends.com/light.asp?ID=221
21 - Unknown. "Manitou Island Light Station." https://www.lighthousefriends.com/light.asp?ID=731
22 - Unknown. "Marquette Breakwater Outer Light." https://www.lighthousefriends.com/light.asp?ID=571
23 - Unknown. "Marquette Harbor Light Station." https://www.lighthousefriends.com/light.asp?ID=572
24 - Unknown. "Menagerie Island (Isle Royale) Light Station." https://www.lighthousefriends.com/light.asp?ID=735
25 - Unknown. "Mendota Light Station." https://www.lighthousefriends.com/light.asp?ID=227
26 - Unknown. "Munising Front Range Light Station." https://www.lighthousefriends.com/light.asp?ID=569
27 - Unknown. "Munising Rear Range Light Station." https://www.lighthousefriends.com/light.asp?ID=569
28 - Unknown. "Ontonagon Harbor West Pierhead Light Station ." https://www.lighthousefriends.com/light.asp?ID=220
29 - Unknown. "Ontonagon Light Station." https://www.lighthousefriends.com/light.asp?ID=219
30 - Unknown. "Passage Island Light Station." https://www.lighthousefriends.com/light.asp?ID=733
31 - Unknown. "Point Iroquois Light Station." https://www.lighthousefriends.com/light.asp?ID=566
32 - Unknown. "Portage River Light Station." https://www.lighthousefriends.com/light.asp?ID=228
33 - Unknown. "Presque Isle Harbor Breakwater Light Station." https://www.lighthousefriends.com/light.asp?ID=573
34 - Unknown. "Rock Harbor Light Station." https://www.lighthousefriends.com/light.asp?ID=734
35 - Unknown. "Rock of Ages Light Station." https://www.lighthousefriends.com/light.asp?ID=736
36 - Unknown. "Sand Hills Light Station." https://www.lighthousefriends.com/light.asp?ID=222
37 - Unknown. "Sand Point Light Station (Baraga vicinity." https://www.lighthousefriends.com/light.asp?ID=230
38 - Unknown. "Stannard Rock Light Station." https://lighthousefriends.com/light.asp?ID=728
39 - Unknown. "Whitefish Point Light Station." https://www.lighthousefriends.com/light.asp?ID=567
40 - Unknown. "Beaver Island Harbor Light Station (St. James)." https://www.lighthousefriends.com/light.asp?ID=206
41 - Unknown. "Beaver Island Light Station (Beaver Head)." https://www.lighthousefriends.com/light.asp?ID=205
42 - Unknown. "Big Sable Point Light Station." https://www.lighthousefriends.com/light.asp?ID=196
43 - Unknown. "Cedar River Light Station." https://www.lighthousefriends.com/light.asp?ID=559
44 - Unknown. "Charlevoix South Pier Light Station." https://lighthousefriends.com/light.asp?ID=201
45 - Unknown. "Frankfort North Breakwater Light Station." https://www.lighthousefriends.com/light.asp?ID=198
46 - Unknown. "Grand Haven South Pierhead Entrance Light Station." https://www.lighthousefriends.com/light.asp?ID=189
47 - Unknown. "Grand Haven South Pierhead Inner Light Station." https://www.lighthousefriends.com/light.asp?ID=189
48 - Unknown. "Grand Traverse Light Station." https://www.lighthousefriends.com/light.asp?ID=711
49 - Unknown. "Gray's Reef Light Station." https://www.lighthousefriends.com/light.asp?ID=209
50 - Unknown. "Holland Harbor (South Pierhead) Light Station." https://www.lighthousefriends.com/light.asp?ID=188
51 - Unknown. "Lansing Shoal Light Station." https://www.lighthousefriends.com/light.asp?ID=208
52 - Unknown. "Little Sable Point Light Station." https://www.lighthousefriends.com/light.asp?ID=193
53 - Unknown. "Little Traverse Light Station." https://www.lighthousefriends.com/light.asp?ID=203
54 - Unknown. "Ludington North Pierhead Light Station." https://www.lighthousefriends.com/light.asp?ID=195
55 - Unknown. "Manistee North Pierhead Light Station." https://www.lighthousefriends.com/light.asp?ID=197
56 - Unknown. "Manistique East Breakwater Light Station." https://www.lighthousefriends.com/light.asp?ID=564
57 - Unknown. "McGulpin's Point Light Station." https://www.lighthousefriends.com/light.asp?ID=213
58 - Unknown. "Menominee North Pier Light Station." https://www.lighthousefriends.com/light.asp?ID=558
59 - Unknown. "Minneapolis Shoal Light Station." https://www.lighthousefriends.com/light.asp?ID=563
60 - Unknown. "Mission Point Light Station." https://www.lighthousefriends.com/light.asp?ID=713
61 - Unknown. "Muskegon South Breakwater Light Station." https://www.lighthousefriends.com/light.asp?ID=191
62 - Unknown. "Muskegon South Pier Light Station." https://www.lighthousefriends.com/light.asp?ID=191
63 - Unknown. "North Manitou Shoal Light Station." https://www.lighthousefriends.com/light.asp?ID=714
64 - Unknown. "Peninsula Point Light Station." https://www.lighthousefriends.com/light.asp?ID=562
65 - Unknown. "Point Betsie Light Station." https://www.lighthousefriends.com/light.asp?ID=199
66 - Unknown. "Poverty Island Light Station." https://www.lighthousefriends.com/light.asp?ID=834
67 - Unknown. "Sand Point Light Station (Escanaba)." https://www.lighthousefriends.com/light.asp?ID=561
68 - Unknown. "Saugatuck Light Station." https://www.lighthousefriends.com/light.asp?ID=1773
69 - Unknown. "Seul Choix Pointe Light Station." https://www.lighthousefriends.com/light.asp?ID=565
70 - Unknown. "Skillagalee Island Light Station." https://www.lighthousefriends.com/light.asp?ID=207
71 - Unknown. "South Fox Island Light Station." https://www.lighthousefriends.com/light.asp?ID=204
72 - Unknown. "South Haven South Pier Light Station." https://www.lighthousefriends.com/light.asp?ID=187
73 - Unknown. "South Manitou Island Light Station." https://www.lighthousefriends.com/light.asp?ID=715
74 - Unknown. "Squaw Island Light Station." https://www.lighthousefriends.com/light.asp?ID=712
75 - Unknown. "St. Helena Island Light Station." https://www.lighthousefriends.com/light.asp?ID=214
76 - Unknown. "St. Joseph North Pier Inner Light Station." https://www.lighthousefriends.com/light.asp?ID=186
77 - Unknown. "St. Joseph North Pier Outer Light Station." https://www.lighthousefriends.com/light.asp?ID=186
78 - Unknown. "St. Martin Island Light Station." https://www.lighthousefriends.com/light.asp?ID=833
79 - Unknown. "Waugoshance Light Station." https://www.lighthousefriends.com/light.asp?ID=211
80 - Unknown. "White River Light Station." https://www.lighthousefriends.com/light.asp?ID=192
81 - Unknown. "White Shoal Light Station." https://www.lighthousefriends.com/light.asp?ID=210
82 - Unknown. "Alpena Light Station." https://www.lighthousefriends.com/light.asp?ID=177
83 - Unknown. "Bois Blanc Island Light Station." https://www.lighthousefriends.com/light.asp?ID=718
84 - Unknown. "Charity Island Light Station." https://www.lighthousefriends.com/light.asp?ID=707
85 - Unknown. "Cheboygan Crib Light Station." https://www.lighthousefriends.com/light.asp?ID=217
86 - Unknown. "Cheboygan River Front Range Light Station." https://www.lighthousefriends.com/light.asp?ID=216
87 - Unknown. "DeTour Reef Light Station." https://www.lighthousefriends.com/light.asp?ID=716
88 - Unknown. "Fort Gratiot Light Station." https://www.lighthousefriends.com/light.asp?ID=167
89 - Unknown. "Forty Mile Point Light Station." https://www.lighthousefriends.com/light.asp?ID=183
90 - Unknown. "Fourteen Foot Shoal Light Station." https://www.lighthousefriends.com/light.asp?ID=710
91 - Unknown. "Gravelly Shoal Light Station." https://www.lighthousefriends.com/light.asp?ID=174
92 - Unknown. "Harbor Beach (Sand Beach) Light Station." https://www.lighthousefriends.com/light.asp?ID=170
93 - Unknown. "Lightship Huron." https://www.lighthousefriends.com/light.asp?ID=166
94 - Unknown. "Mackinac Point Light Station." https://www.lighthousefriends.com/light.asp?ID=212
95 - Unknown. "Martin Reef Light Station." https://www.lighthousefriends.com/light.asp?ID=717
96 - Unknown. "Middle Island Light Station." https://www.lighthousefriends.com/light.asp?ID=179
97 - Unknown. "Pipe Island Light Station." https://www.lighthousefriends.com/light.asp?ID=719
98 - Unknown. "Poe Reef Light Station." https://www.lighthousefriends.com/light.asp?ID=709
99 - Unknown. "Point Aux Barques Light Station." https://www.lighthousefriends.com/light.asp?ID=171
100 - Unknown. "Port Austin Reef Light Station." https://www.lighthousefriends.com/light.asp?ID=172
101 - Unknown. "Port Sanilac Light Station." https://www.lighthousefriends.com/light.asp?ID=168
102 - Unknown. "Presque Isle Front Range Light Station." https://www.lighthousefriends.com/light.asp?ID=182
103 - Unknown. "Presque Isle Light Station (New)." https://www.lighthousefriends.com/light.asp?ID=181
104 - Unknown. "Presque Isle Light Station (Old)." https://www.lighthousefriends.com/light.asp?ID=180
105 - Unknown. "Presque Isle Rear Range Light Station." https://www.lighthousefriends.com/light.asp?ID=182
106 - Unknown. "Round Island Light Station (Straits of Mackinac)." https://www.lighthousefriends.com/light.asp?ID=215
107 - Unknown. "Round Island Passage Light Station." https://www.lighthousefriends.com/light.asp?ID=838
108 - Unknown. "Saginaw River Rear Range Light Station ." https://www.lighthousefriends.com/light.asp?ID=173
109 - Unknown. "Spectacle Reef Light Station." https://www.lighthousefriends.com/light.asp?ID=708
110 - Unknown. "Sturgeon Point Light Station." https://www.lighthousefriends.com/light.asp?ID=708
111 - Unknown. "Tawas Point Light Station." https://www.lighthousefriends.com/light.asp?ID=175
112 - Unknown. "Thunder Bay Island Light Station." https://www.lighthousefriends.com/light.asp?ID=178
113 - Unknown. "Lake St. Clair Light Station." https://www.lighthousefriends.com/light.asp?ID=705
114 - Unknown. "St. Clair Flats South Channel Front Range Light Station." https://www.lighthousefriends.com/light.asp?ID=706
115 - Unknown. "St. Clair Flats South Channel Rear Range Light Station." https://www.lighthousefriends.com/light.asp?ID=706
116 - Unknown. "Windmill Point Light Station." https://www.lighthousefriends.com/light.asp?ID=164
117 - Unknown. "Detroit River Light Station—Detroit River." https://lighthousefriends.com/light.asp?ID=160
118 - Unknown. "Grosse Ile North Channel Front Range Light Station—Detroit River." https://www.lighthousefriends.com/light.asp?ID=162
119 - Unknown. "Peche Island Rear Range Light Station—St. Clair River." https://www.lighthousefriends.com/light.asp?ID=165
120 - Unknown. "Round Island Light Station—St. Mary's River." https://www.lighthousefriends.com/light.asp?ID=720
121 - Unknown. "William Livingstone Memorial Light Station—Detroit River." https://www.lighthousefriends.com/light.asp?ID=163

REFERENCES

Mejias, U. A. (2013), Off the Network, Disrupting the Digital World. University of Minnesota Press.

Hu, T.-H. (2015). A Prehistory of The Cloud, MIT Press.

Ayomaya, B. A. (2017). Data Center for Beginners. B.A. Ayomaya

Blum, A. (2012). Tubes: A Journey to the Center of the Internet.

Banham, R. (1984). The Architecture of the Well-Tempered Environment. The University of Chicago Press.

Himmelsbach, S., & Mareis, C. (2015). Poetics and politics of data. Ambivalenz des Lebens in der Datengesellschaft. Christoph Merian Verlag.

Shepard, M. (2011). Sentient city : ubiquitous computing, architecture, and the future of urban space. MIT Press.

Hughes, T.P. (1983). Networks of power : electrification in Western society, 1880-1930. The Johns Hopkins University Press, Copyr.

Shaviro, M. (2011). Connected, or, What it means to live in the network society. University Of Minnesota Press.

National Centers for Environmental Information (NCEI) formerly known as National Climatic Data Center (NCDC) | NCEI offers access to the most significant archives of oceanic, atmospheric, geophysical and coastal data. (2012). Noaa.gov. https://www.ncdc.noaa.gov/.

Weather Data Center. (2019). Ashrae.org. https://www.ashrae.org/technical-resources/bookstore/weather-data-center.

Home | SEMCOG. (n.d.) https://semcog.org/.

Data Center Map - Colocation, Cloud, Managed Hosting etc. (n.d.) https://www.datacentermap.com/

How much data is there in the world? Bernard Marr. (2021, July 13). Retrieved September 20, 2021, from https://bernardmarr.com/how-much-data-is-there-in-the-world/.

Community cleverness required. (2008, September 03). Retrieved from https://www.nature.com/articles/455001a
Powers of Ten and the Relative Size of Things in the Universe. (2019, October 03). Retrieved from https://www.eamesoffice.com/the-work/powers-of-ten/

Intelligence, A. A. (2021, September 13). APAC Data Center Power Market Size by Investment to Reach USD 5,772.7 Million by 2026 - Arizton. Retrieved from https://www.prnewswire.com/news-releases/apac-data-center-power-market-size-by-investment-to-reach-usd-5-772-7-million-by-2026--arizton-301375264.html

McKendrick, J. (2021, September 14). Automation won't resolve the data center staffing crisis, at least not yet. Retrieved from https://www.zdnet.com/article/automation-wont-resolve-the-data-center-staffing-crisis-at-least-not-yet/

Data Center Solutions: Reducing the Risk of Change. (2021, September 14). Retrieved from https://www.datacenterdynamics.com/en/whitepapers/data-center-solutions-reducing-the-risk-of-change/

Jennewine, T. (2021, September 10). Why NVIDIA Will Dominate the Data Center by 2030. Retrieved from https://www.fool.com/investing/2021/09/10/why-nvidia-will-dominate-the-data-center-by-2030/
The Jakarta Post. (n.d.). ABB: Why are data centers more important than ever? Retrieved from https://www.thejakartapost.com/adv/2021/09/13/abb-why-are-data-centers-more-important-than-ever.html

Turner, A. B. (2021, May 18). Data Storage Units of Measurement Chart from Smallest to Largest. Retrieved from https://solutionsreview.com/data-storage/data-storage-units-of-measurement-chart-from-smallest-to-largest/

Madrigal, A. C. (2011, December 29). IBM's First 100 Years: A Heavily Illustrated Timeline. Retrieved from https://www.theatlantic.com/technology/archive/2011/06/ibms-first-100-years-a-heavily-illustrated-timeline/240502/

Press, G. (2019, July 17). A Very Short History Of Big Data. Retrieved from https://www.forbes.com/sites/gilpress/2013/05/09/a-very-short-history-of-big-data/?sh=69dfc69065a1

IBM Celebrates 20th Anniversary of Moving Atoms (w/ Video). (n.d.). Retrieved from https://phys.org/news/2009-09-ibm-celebrates-20th-anniversary-atoms.html

How Much Data Is Created Every Day? [27 Powerful Stats]. (2021, March 22). Retrieved from https://seedscientific.com/how-much-data-is-created-every-day/

Mearian, L. (2017, March 23). CW@50: Data storage goes from $1M to 2 cents per gigabyte (video). Retrieved from https://www.computerworld.com/article/3182207/cw50-data-storage-goes-from-1m-to-2-cents-per-gigabyte.html

CB Insights. (2020, August 17). The Future of Data Centers Industry l CB Insights. Retrieved from https://www.cbinsights.com/research/future-of-data-centers/

NVIDIA Modern Data Centers to Accelerate HPC Workloads. (n.d.). Retrieved from https://www.nvidia.com/en-sg/data-center/

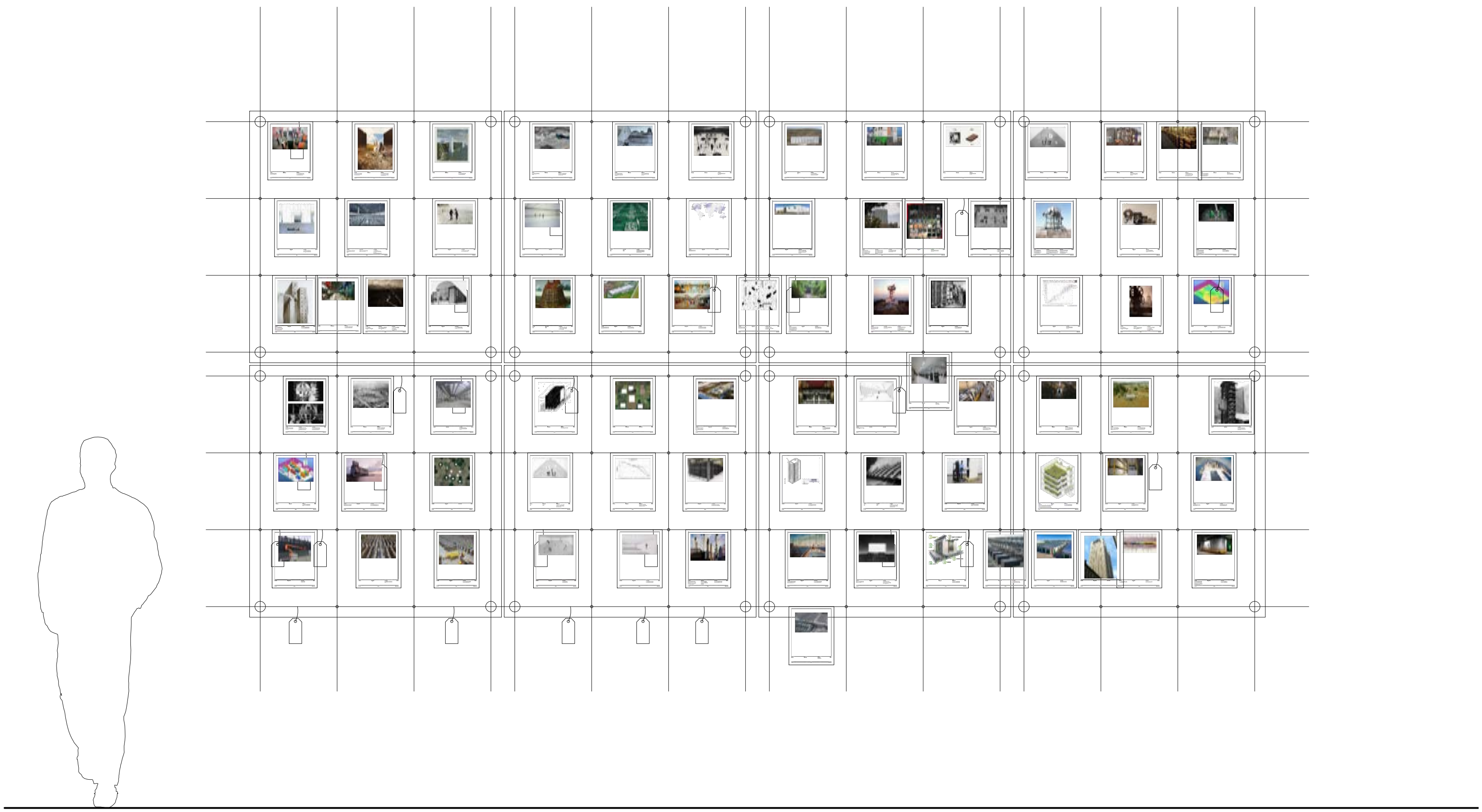
Roach, J. (2021, April 20). Microsoft's virtual datacenter grounds 'the cloud' in reality. Retrieved from https://news.microsoft.com/innovation-stories/microsofts-virtual-datacenter-grounds-the-cloud-in-reality/

Sep 20 How Much Does File Storage Really Cost? Contel Bradford. (2021, August 10). File Storage Cost, By The Numbers. Retrieved from https://blog.storagecraft.com/file-storage-cost-statistics/

Senthilvel, G. (2014, April 13). DotNet Programming using Cassandra. Retrieved from https://www.codeproject.com/Articles/758803/DotNet-Programming-using-Cassandra

APPENDIX

BENCHMARK II



BENCHMARK II - FIGURES

In no particular order

01 - Unknown, Winthrop Engineering Excellence. "data center facade construction." https://winthrop.ie/
02 - Unknown, Winthrop Engineering Excellence. "data center interior construction." https://winthrop.ie/
03 - Unknown, Winthrop Engineering Excellence. "data center roof construction." https://winthrop.ie/
04 - Unknown, Winthrop Engineering Excellence. "data center interior construction." https://winthrop.ie/
05 - Unkown, DataCenter Knowledge. "Google's Chillers." https://www.datacenterknowledge.com/archives/2009/07/15/googles-chiller-lessdata-center
06 - Admin, Data center Frontier. "Cooling Pipes - Chiller room." https://datacenterfrontier.com/opportunity-data-center-cooling/dft-chiller-room/
07 - Unkown, The Washington Post. "Fort Knox Gold." https://www.washingtonpost.com/national/after-40-years-fort-knox-opensvault-to-civilians/2017/08/21/f03eea2e-86b6-11e7-96a7-d178cf3524eb_story.html?utm_term=.83adba72850e
08 - Pierce, Gregory. "Optimal Pricing of Public Parking Garages." https://transfersmagazine.org/magazine-article/issue-1/optimal-pricing-of-public-parking-garages/
09 - Eames, Office. "Powers of Ten and the Relative Size of Things In the Universe." https://www.eamesoffice.com/the-work/powers-of-ten/
10 - Flamer, Keith. "Mysterious skyscraper at 33 Thomas Street." https://www.forbes.com/sites/keithflamer/2017/06/14/this-spyscraper-freaks-out-tom-hanks-11-reasons-why-it-should/?sh=6eb4cd154732
11 - Varnelis, Kazys. "025 mod." https://varnelis.net/projects/blue-monday/#jp-carousel-2080
12 - Branzi, Andrea. "Teatro Della Forma Premeditata." http://www.ecole.co/classics/branzi/
13 - Associati, Archizoom. "Residential Parking Lot - 1971." https://cyborges.tumblr.com/post/67690191381/archizoom-residential-parking-lot-1971
14 - Branzi, Andrea. "Non-Stop City." https://www.t-o-m-b-o-l-o.eu/beauregard/andrea-branzi-non-stop-city-archizoom/
15 - Branzi, Andrea. "Non-Stop City. - Representing the Chairs That People Can Sit On." https://medium.com/@jaechristinakim/archizoom-non-stop-city-84a2bef83140
16 - Branzi, Andrea. "Non-Stop City." https://www.t-o-m-b-o-l-o.eu/beauregard/andrea-branzi-non-stop-city-archizoom/
17 - Branzi, Andrea. "Non-Stop City." https://www.t-o-m-b-o-l-o.eu/beauregard/andrea-branzi-non-stop-city-archizoom/
18 - Associati, Archizoom. "The Neutral Surface." https://thetriumphofpostmodernismtumblr.com/post/136463843433/archizoom-associati-the-neutral-surface
19 - Associati, Archizoom. "Non Stop City Internal Landscape." https://medium.com/@jaechristinakim/archizoom-non-stop-city-84a2bef83140
20 - Dawson, Simon. "Amazon Facility - Getty Images." https://nymag.com/intelligencer/2014/10/amazon-is-not-a-monopoly.html
21- Morris, Paul. "Employees collect merchandise ordered by customers for shipment from the Amazon.com distribution center in Phoenix, Arizona, Nov. 26, 2012." https://time.com/3536400/amazon-centers/
22 - Shepperd, Jim. "Northland Mall. Photo received March 9, 1979." https://www.freep.com/picture-gallery/money/2015/03/28/northland-center-mall-through-the-years/70596214/
23 - Commons, Wikimedia. "The Cargill Pool grain elevator in Buffalo, 2012." https://www.frieze.com/article/what-modernism-learned-worlds-first-grain-elevator
24 - Mendelsohn, Erich. "Grain Elevator,bBuffalo, NY (detail), 1924." https://www.frieze.com/article/what-modernism-learned-worlds-first-grain-elevator
25 - Anjegdjj, Hochgeladen. "Interior View, May 2005. AEG Turbine Factory: Mileston of the Industrialization by Peter Behrens 1908-1910, Berlin Germany." https://www.metalocus.es/en/news/aeg-turbine-factory-milestone-industrialization
26 - Unknown. "Exterior View. AEG Turbine Factory." https://www.metalocus.es/en/news/aeg-turbine-factory-milestone-industrialization
27 - K.L. Security. "Data Centers & Racks DC-10x10x8." https://www.klsecurity.com/index.php/data-centers-racks-dc-10x10x8-1482.html
28 - Unkown, Server lift. "Server Lift." https://serverlift.com/why-us/rack-likea-pro/
29 - Sugimoto, Hiroshi. "Union City Drive-in, Union City, 1993." https://www.japantimes.co.jp/culture2016/04/23/books/book-reviews/hiroshi-sugimoto-black-box-ponders-representations-representations/
30 - Unknown, Sunbird. "Data Platform Diagram." https://www.sunbirddcim.com/product/data-center-environment-management
31 - Unknown, TileFlow. "Pressure distribution and airflow pattern under the raised floor." https://tileflow.com/tileflow/publications.html
32 - Unknown, TileFlow. "Rack Temperature Map." https://tileflow.com/tileflow/publications.html
33 - Unknown, Uknown. " Facebook singlet Rack v2 open rack." http://royspittleelectric.com/photo-gallery/av-data-rack/
34 - Marchon, Pitchford, Hsia, Gangopadhyay. "Historical variations of HMS versus bit length from." https://www.researchgate.net/figure/Historical-variations-of-HMS-versus-bit-length-from-6_fig5_258394857
35 - Unknown, Havi. "Evolution of hard disk drive HDD." https://www.havi.co/camp/news/evolution-of-hdd
36 - Unknown, Reddit. "Evolution of the hard drive." https://www.reddit.com/r/pics/comments/91h64q/evolution_of_the_hard_drive/
37 - Roser, Max. "Moore's Law - The number of Transistors on integrated circuit chips (1971-2016)." https://www.darrinqualman.com/moores-law/
38 - Unknown, Wired. "Gallery of Giant, Ancient Computers." https://www.wired.com/2009/12/gallery-of-giant-ancient-computers/

contunued.

39 - Unknown, AA Self Storage. " Jumbo Units." https://www.aa-ministorage.com/
40 - Unknown, Unknown. "Unkown." https://www.timeshighereducation.com/search?e=404&search=news%20switch%20to%20digital%20aims%20to%20bringthe%20arts%20out%20indiana%20jones%20storeroom%202014197%20article
41 - Unkown, Unknown. "car elevator - 1938." https://www.chicagomag.com/city-life/april-2012/a-chicago-car-elevator-mystery-and-the-man-who-invented-dialectical-materialism/
42 - Microsoft. "Modular Datacenter." https://www.businessinsider.com/microsoft-azure-modular-portable-data-center-connected-by-satellites-2020-10
43 - Unknown, Unknown. "underwater data center." https://www.businessinsider.com/microsoft-azure-modular-portable-data-center-connected-by-satellites-2020-10https://news.microsoft.com/features/under-the-sea-microsoft-tests-a-datacenter-thats-quick-to-deploy-could-provideinternet-connectivity-for-years
44 - Unknown, Unknown. "Data cage." https://cloud7.news/data-center/7-most-unusual-data-centers/
45 - Lefdal Mine. "data container." https://www.lefdalmine.com/colocation-containers/
46 - Vertiv. "data container." https://www.vertiv.com/en-emea/about/news-and-insights/articles/blog-posts/why-nearly-everything-you-thought-youknew-about-prefab-data-centers-is-afabrication/
47 - Unknown, Data center Knowledge. "Data container." https://www.datacenterknowledge.com/archives/2012/06/13/ovh-deploys-container-cube-data-center
48 - Unknown, Data center Knowledge. "Data container stacked." https://www.datacenterknowledge.com/archives/2012/06/13/ovh-deploys-container-cube-data-center
49 - Unknown, Unknown. "Data mine." https://cloud7.news/data-center/7-most-unusual-data-centers/
50 - Unknown, Unknown. "Data mine interior." https://cloud7.news/data-center/7-most-unusual-data-centers/
51 - Unknown, Unknown. "Arctic Data center." https://cloud7.news/data-center/7-most-unusual-data-centers/
52 - Unknown, Unknown. "Yahoo chicken coop." https://cloud7.news/data-center/7-most-unusual-data-centers/
53 - Unknown, Unknown. "CyberBunker." https://cloud7.news/data-center/7-most-unusual-data-centers/
54 - Unkown, theNBP. "INSTALACIONES DEL BARCELONA SUPERCOMPUTING CENTER." https://www.thenewbarcelonapost.com/en/supercomputation-and-the-information-revolution/
55 - Superstudio. "Supersurface." https://www.cristianotoraldodifrancia.it/supersurfaces/
56 - Superstudio. "Il monumento Continuo, 1969-1970." https://www.gazette-drouot.com/article/the-sublime-dystopin-visions-of-superstudio/21454
57 - Image created by Philip Marcantonio
58 - Image created by Philip Marcantonio
60 - Superstudio. "Supersurface."https://www.nytimes.com/2021/02/12/arts/design/superstudio-civa.html
61 - Superstudio. "Supersurface."https://www.nytimes.com/2021/02/12/arts/design/superstudio-civa.html
62 - Associati, Archizoom. "Autostrada Terra-Luna." https://www.frac-centre.fr/_en/biennales/walking-through-someone-else-dream/architects-and-artists/archizoom-associati-1018.html?article=2991
63 - Superstudio. "Supersurface."https://www.nytimes.com/2021/02/12/arts/design/superstudio-civa.html
64 - Superstudio. "Supersurface."https://www.nytimes.com/2021/02/12/arts/design/superstudio-civa.html
65 - Superstudio. "Supersurface."https://www.domusweb.it/it.html
66 - Unknown. "Telstar." https://www.smh.com.au/technology/still-in-orbit-telstar-the-50yearold-satellite-and-genesis-of-telecommunications-for-the-masses-20120711-21uhb.html
67 - Harding, Spencer. "the long lines." https://www.wired.com/2015/03/spencerharding-the-long-lines/
68 - Harding, Spencer. "the long lines." https://www.wired.com/2015/03/spencerharding-the-long-lines/
69 - Unkown. "NSA areial." https://www.nytimes.com/2015/08/16/us/politics/att-helped-nsa-spy-on-an-arrayof-internet-traffic.html
70 - Associati, Archizoom. "NO STOP CITY, 1970." https://underprospective.com/268
71 - Unkown. "Utah NSA." https://www.dallasnews.com/news/2015/11/28/nsa-s-bulk-collectionof-americans-phone-records-to-end/
72 - Zhou, Connie. "Google data center server." https://www.theverge.com/2013/6/27/4470442/nsa-surveillance-programs-bulk-collection-of-internet-metadata
73 - Unknown. "AFL Hyperscale." https://www.aflhyperscale.com/articles/techsplainers/what-is-a-meet-me-room/
74 - Unknown. "AFL Hyperscale." https://www.aflhyperscale.com/articles/techsplainers/what-is-a-meet-me-room/
75 - Coburn, Alvin. "Gravesend, 1907." https://www.atlasgallery.com/artists/alvin-langdon-coburn
76 - Coburn, Alvin. "St. Paul's and Cogs, 1905." https://www.atlasgallery.com/artists/alvin-langdon-coburn
77 - Sheeler, Charles. "Stacks in celebration, 1954." https://www.daytonartinstitute.org/exhibits/charles-sheeler-stacks-in-celebration/
78 - Coburn, Alvin. "Station Roofs, Pittsburgh, 1910." https://www.atlasgallery.com/artists/alvin-langdon-coburn
79 - Image created by Philip Marcantonio
80 - Bruegel, Pieter. "The Tower of Babel, 1563." https://www.khm.at/en/

SKETCH PROBLEM

My Initial inquiry to this sketch problem was to focus on the concept of how individuals interact with their content or what scientifically is defined as data. Now there are multiple ways to interact with data such as typing, clicking, tapping, and scrolling. However, for the sake of this assignment I chose to investigate the single most used method, which is scrolling. Scrolling is by no means a new method for how we interact with data. This technology was developed in the 1960's and has a rather fitting name to what was historically a physical means to store information in ancient times. However, with the advent of increasing connectivity through social media, news agencies, and content sharing platforms the scroll movement has become the gold standard way people in the 21st century interact with data.

So what is modern day scrolling? Scrolling is a gestural movement that primarily uses two bodily senses, tactility as well as vision. The connection or tool individuals use to gain access to the digital world is through an appliance… Plowing ahead on the making of the sketch problem. I had narrowed my focus on the appliance of a computer mouse. Computer mouses are ergonomically designed in order to allow the individual to perform their tasks and leisurely activities for extended periods of time.This made me think about how distorting, scaling or changing the materiality of a computer mouse can lead to a new experience. I sought to distort the mouse by creating another physical object, however this object would be very different.

The object is roughly; 12”x19”x7” constructed of plywood, foam, plaster, copper, and polyester cloth. It was intended to function as an operational mouse, however after much experimentation as well as an electrical failure the mouse did not work as intended. The result of this failure honestly did not have much effect on my overall goals of this sketch problem. In fact I believe it helped my cause because the user of this object had to make an interpretation based off of their own perception. Most users understood based on the mechanical movement as well as the abstracted materiality that the object was a computer mouse. However there is an alternative motive for the scroll.

This alternative motive is the paradigm of what I would like to describe as the endless scroll. Or the adverse effects of consuming too much, or unuseful content. It's no surprise to some and I think we are all able to agree that becoming trapped on the internet can be a wasteful use of time. With this said the main platforms that allow prey, as well as encourage this endless scroll are also at the posterchilds of data center owners and operators. This made me think about how distorting, scaling or changing the materiality of a computer mouse can lead to a new experience. I sought to distort the mouse by creating another physical object, however this object would be very different.

THESIS STATEMENT

Data centers are inherently unrecognizable, yet are composed of complicated systems that advise and alter our perception of the modern world. Deemed critical infrastructure, these facilities are primarily composed of computer systems, mechanical hardware, telecommunication and data storage equipment, as well as cooling systems. This equipment connects, processes and provides storage for the several billions of people and entities around the world. However, the science behind these facilities outside of engineering and computer science are far from what the public knows. Rather the visual appearance or architecture is the most approachable form of its existence.

Typically data centers are sited in remote areas, conveniently away from the public and built using big box store rhetoric. These facilities are especially lauded for their consumption of resources, such as electricity and water. Yet one of the least talked about concepts pertaining to these facilities is the data itself. Specifically how it is structured and the historical significance which led to the creation of a new building type.

The concept behind large scale facilities housing computer equipment goes all the way back to the origin of the computer itself. Typically forgotten about, yet having similar origins of being born in a rather large room itself. Presently, it is known that eventually data will become too burdensome to handle. Storage technology as well as its volume will soon overcome the physical hardware capacities. Technically speaking the data itself will soon outpace the material which stores it.

When considering this, it is important to consider questions while on this journey in understanding the volume of data is its relevance to today's time and also its scalability as a network. What might different volumes look like? Can we predict new volume techniques? Can volume be used in a new and novel way?

Limitations to this thesis is the very nature of the topic. Data centers are highly technical buildings that require a considerable knowledge in engineering and sciences. It is a building type that closely follows this dichotomy and therefore it is hard to justify what might eventually lead to advancements in storage and connectivity. Therefore critiques could be said that the research could be limited in scope and approach. However, using policies and theoretical frameworks of understanding on how data might be viewed at the individual level.

It is hard to justify what the future might hold in terms of advancements in technology and what data might mean in the future. It is an ever advancing field which centers itself around supply and demand. Given that there are numerous ways to approach this typology in the lens of ecological, scientific as well as political metrics. There are other practitioners working on these ideas and the vastness of this field limits the amount of time and study to the field. Therefore, I had to limit myself to focusing on what volume truly means in terms of its size and amount of data.

The main objective of this thesis is to spur a conversation that can span the ever expanding development of data, specifically what data means at the individual level and how we use it, store it, and abuse it. Not one person can find a unanimous conclusion to these issues and stances. However, this conversation can start to develop outside of the discipline of architecture and engineering.