North Sea: Landscapes of Coexistence
Transitional Territories Studio 2019-2020

Research Report

Zuzanna Rosinska

Archive Fever
Introducing Data Storage in the city of Hamburg

Index

Abstract

The project emerges from the acknowledgement of the growing phenomena of archive fever (Derrida, 1995). Driven by the need, obligation, desire or simply possibility to store a growing amount of both - physical objects and digital data, and encouraged with a constantly increasing capacity of digital media storage - we keep on gathering more. Often unconsciously or with little curation of the collected content, we keep on creating a limitless cloud archive, that has an overwhelming physical presence that takes over hectare after hectare of land. Huge, anonymous, dark and hot space, placed in a remote location – that is a typical data centre. Blending into the neighbouring storage halls is easily omitted and stays hidden from the public sight.

Data storage came a long way from the representative architecture of banks, archives and city halls to a unit defined storage facility. Therefore, one may say that data centre is a continuation of the typology of storing and archiving. And a storage type that emerges is an opaque container defined by the size of a stored unit - server. These content defined buildings, technical as they are, allow for almost no human presence, but do potentially manage through their sheer size to organize and control the context they inhabit, the territory. One cannot underestimate their urban impact.

Current trends in technology, among others, the Internet of Things and a growing amount of latency dependent applications will generate a need to introduce data into the cities. That gives a unique opportunity to redefine existing data centre typology. Even though data is already fully integrated and present in our lives, we rarely acknowledge it. What is more, due to a lack of understanding of data flows we are often excluded from the discussion on the degree of its presence in our lives or surveillance.

The proposed project, is a gesture that brings data, technology, citizens and urban context together, emphasizing interconnections and interdependence of all aforementioned. This way introducing one of the most significant elements of our infrastructure physically into the culture, giving digital data a physical weight and interface. Creating friction between public and private, human and machine – that are completely dependent on each other and cannot function without the other.

Keywords: data, archive fever, storage, unit defined

Territory

1. Territory: North Sea

1.1. Identity - Historical Precedents

"From antiquity to the present, and with an exponential impetus, we have been obsessed with systematically collecting and reorganizing what in effect already exists, in its own kind of order, or disorder. This desire for control and centralisation of our environment has no doubt aided us in the past and present. Nevertheless, some think that ***archives have reached such epidemic proportions that, not only has the digital revolution not been able to solve the problem, but it has in fact aggravated it****. All of this, of course, occupies space, an increasingly huge amount of space."*

Peter Cook
Introduction text to MAP 003 Archive, by David Garcia Studio

Act of memorising is fundamental not only for knowledge development but is primarily a very basic element allowing society to form and function. The common history and experiences allow a group of people to identify with each other and fight for a common aim. Until the 18th century memorising was perceived as art and story was its main medium. However, with the development of print and commonly accessible manuals, encyclopaedias, guides and archives the tradition started to vanish. What was once stored mentally and related orally with often with imprecision and some detail loss, was now written down and could last for years.

Nowadays, thanks to digital data and web repositories, there is no need to memorise all the information for professional daily work. It is enough to remember a source where we may find a valid piece of information when it is actually needed.

Within the resent years marketing of the Cloud – made us believe that data has no weight and that when it comes to data storage – the sky is the limit. However, the physical infrastructure of the Internet is tangible. Nonetheless, often hidden from the sight – underground or under the surface of the sea. Where millions of kilometres of fibre optic cable occupy the seabed, connect with ICT coast stations and through fibre optics reach our houses.

How a growing amount of data is affecting the North Sea territory? That is housing over 60% of all data centres in Europe and what are the spatial consequences of the growing phenomena of the Archive Fever?

1.2. Territorial Analysis

During the group research, we commenced our research under the topic of the "*Pervasive ecology of flows*" within and around the North Sea region[2]. The ramifications (conditions) of this thematic include energy, fisheries, logistics, data and migration. Through a deep overview of these flows within the European context and in an attempt to give a clear direction to our research, we chose migration as the lens through which to assemble our collection of findings due to its principal consideration of the flow of people. As the principal cause of change in our Anthropocene era, the flow (movement, growth, shrinkage and stagnation) of individuals and groups drives and accelerates the alteration of territories. Henceforth, this flow forms the binding matter throughout the analysed conditions. It furthermore remains a consistent point of reference as the boundaries between the conditions blur due to their strong inter-relations.

2. Group comprised: Ian Omumbwa, Zuzanna Rosinska and Jun Chen

Therefore, we centred our probe on how the overall conditions for logistics, energy, data and fisheries - through trends in population migration - influence, affect and change the Greater North Sea region's territory?

To control and manage the territory, populations and flows, the infrastructure, collection and surveillance of produced data has been paramount. Disregarding tangible borders (physical, geopolitical) and moving through intangible borders (firewalls, private information), international surveillance programmes have been maintained and expanded from post-war and Cold-War coalitions between groups of allies. With the development of ICT and an increase in access to connected networks and production of data, information entirely changes the way people and governing institution interact with one another. In 2015, the EU adopted the digital single market aimed at growing the European economy and industry via the digital economy. Furthermore, the rise of social media and e-commerce via content providers results in increased data production, traffic and surveillance. Relative to migration, access to data is a game-changer. Technological transition has the resource constraints on mobility – the threshold amounts of wealth required to move around – by lowering transportation and communication costs, this resulted in increased access to ICT to all population segments including migrants. Data changed the way the crisis is lived (by the migrants having access to information) and controlled (by host countries delivering/manipulating information). The advent of Brexit and Euro-scepticism, extremism, populism and national security result in heavy manipulation and tracking of information. This attains all sectors including the fishing industry where data starts to be implemented to track fishing stocks, levels of pollution and documentation of the sea's resources for each sovereign nation-state under EU policy.

These pervasive instances of heavy information collection beg the question as to who or which entity owns it and where it is stored. The physicality of data has resulted in new infrastructure (including optic fibre cables, DSL lines, data centres, servers, internet providers, etc.). In turn, these factors agglomerated and created a data economy where information has become a valuable commodity especially relative to the flow of people and the socio-economic interest related to this flow. When considering the North Sea, we can observe it as a palette of public, private, human and natural stakeholders forming an ecosystem with varying degrees of ownership (physical and data) and tension. Here, ownership and access to stock, commodities and information are heavily regulated by sovereign states, the EU and the fishing, energy, and transport industries.

Our research has observed that migration will remain a defining issue for the EU in the coming, influencing politics and policy-making across the North Sea region and the European continent. Access to data, social media and in general greater connectivity to networks (ICT) is influencing migration flows and its diversification. Therefore, focusing further on my research I decided to take a closer look at the growing regions (according to the predictions for the coming years) to focus on the source of data flow.

1. Territory: North Sea

Following the group inquiry, I focused on digital data - fascinated by the dual nature of it and its immateriality. While mentioned before copper and fibre optic cables and ICT points enable transfer, Data Centres are storing and processing data. These huge, anonymous, dark and hot spaces are placed in remote locations, hidden from the public site – and they keep on growing.

Data storage came a long way from representative architecture of Banks, Archives and City Halls to a unit defined storage facility. Therefore, one may say that data centre is a continuation of the typology of storing and archiving. And a storage type that emerges is an opaque container defined by the size of a stored unit - server.

Infrastructure that responds to archive fever

On a daily basis, we create a cloud of data, which in our imagination is not limited by any physical frames, but in fact, it has a huge impact on a physical space.
These automated warehouses, almost do not require human presence - which is limited to the short moments of lightness when an IT technician is visiting a server room. However, through their tremendous footprint influence and dominate the context they inhabit.

While data centres became a critical infrastructure essential in everyday life, is there a chance for an innovative approach to their design and development of new typologies?

Existing typology

In purpuse to deal with digitalisation and the generated silos of data and bandwidth requirements, increasing amount of companies - throughout all industries - are shifting server rooms to data centres out of their premises, opening advantages such as technological flexibility, reliability, enhanced frameworks, mobility, simplicity of access to cloud services and summary lower expense.

A typical data centre in Europe has approximately 5,000 sqm, although a new record will be set at 600,000 sqm by a data centre that will be constructed in Finland within coming years. The north location is intentional, in the process of design the climate is remarkably important - the lower the temperatures outside, the lower the energy demand for cooling the servers will be. As a matter of fact, air conditioning and overheating protection consume the biggest portion of data centre electricity demand.

Usually powered by a municipal network and on-site generators, strongly affecting a local grid. Therefore, data centres are most often located on the site with access to inexpensive energy supply. In recent years, there is a trend for the use of renewable energy - with Google, Facebook, Amazon and Microsoft as the largest buyers. In total, the amount of renewable energy purchased by technology giants in the last year corresponds to energy demand for Poland for the same period.

Due to before-mentioned huge energy consumption, out of which 90% is realised by servers in the form of heat, there is a growing amount of projects that use this side effect. In Finland, Telia data centre, built in 2018, with 5,000 server racks in use, provides heat throughout the year to 20,000 apartments in Helsinki. Another example is the IBM & GIB-Services data centre in Uitikon, Switzerland, which uses an old bunker for a headquarters, and water heated by servers heats the school pool. Another example is Snøhetta design for MIRIS, (in collaboration with Skanska, Nokia and Asplan Viak) the Spark concept is based on a data centre operating as a local centre providing heat for a community and creation of a local data centre storage, supporting self-sufficiency.

Dave Greer, *The Internet*

Underground fiber optic cable marker, New Jersey

Dave Greer, *The Internet*

Facebook data center, Des Moines IA

Submarine Cables Landings

A particularity regarding data is that is it both tangible and untangible. The physicality of data results in new infrastructure (including optic fibre cables, DSL lines, data centres, servers, internet providers, etc.) - these are the tangibe entities of data. However, information traffic moves through through space and borders, be they geopolitical or digital (e.g. firewalls) and is in most cases invisible by being hidden in infrastructure underground, or underwater. The adjacent catalogue depics locations spread out through the North Sea's shors where submarine cables arrive on land. As described, these are completely invisible and are usually placed under the surface upon arrival on the mainland up to a landing station due to their high value.

Karsto, NOR
Tampnet

Torquay, UK
Channel Islands-9
UK-Channel Islands-7

Créances, FR
INGRID
UK-Channel Islands-8

Aberdeen, SCOT
Tampnet

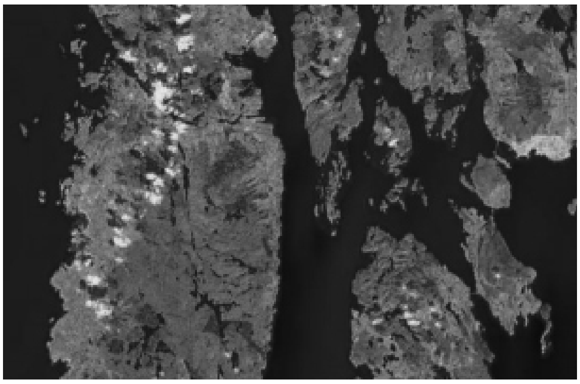
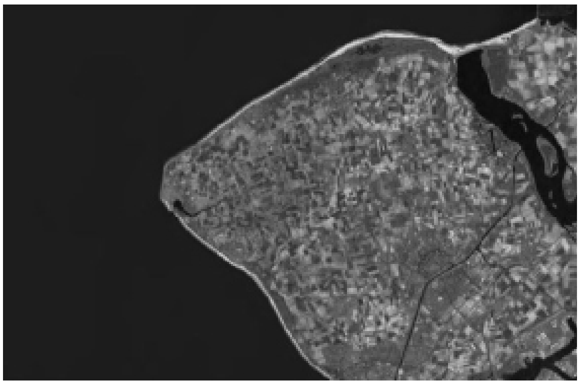
Middelburg, NL
Farland North

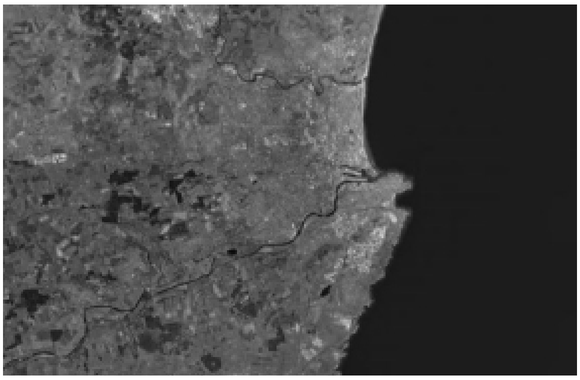
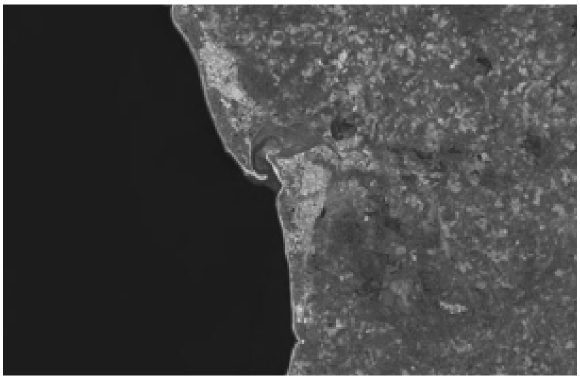
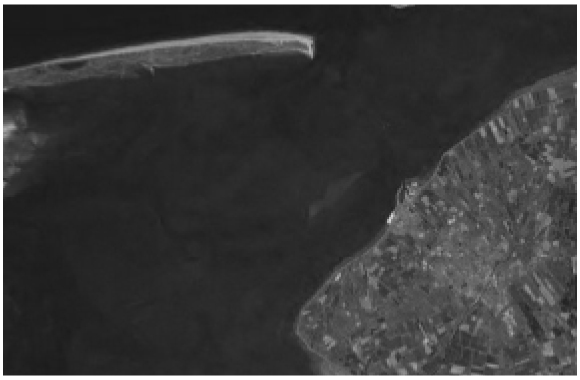
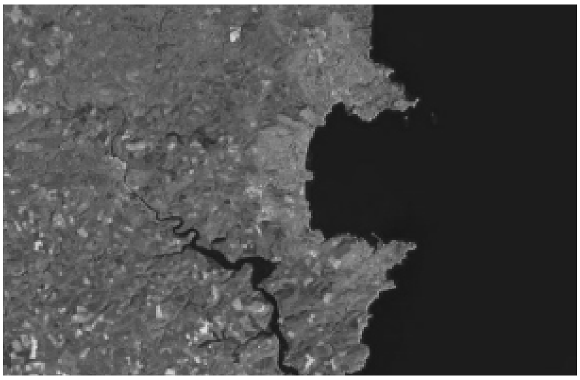
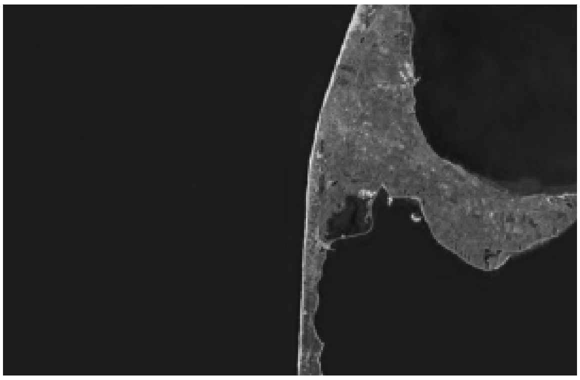
Margate, UK
Tangerine
PanEuropean Crossing

Norden, GER
TAT-14
SeaMeWe-3

Sylt, GER
Atlantic Crossing-1

Sources: Zoom Earth Satellite Imagery via Microsoft Bing, 2019.

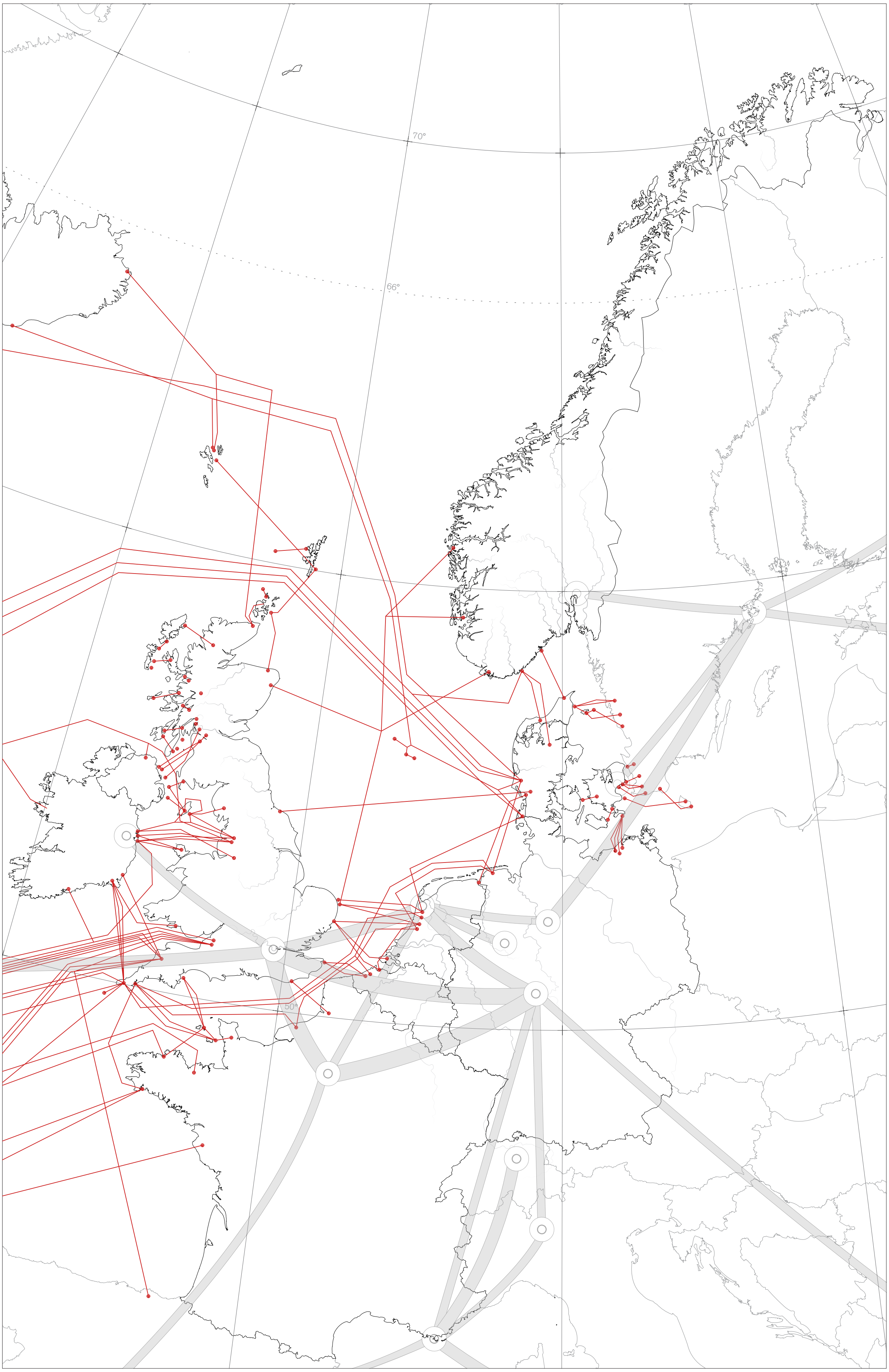






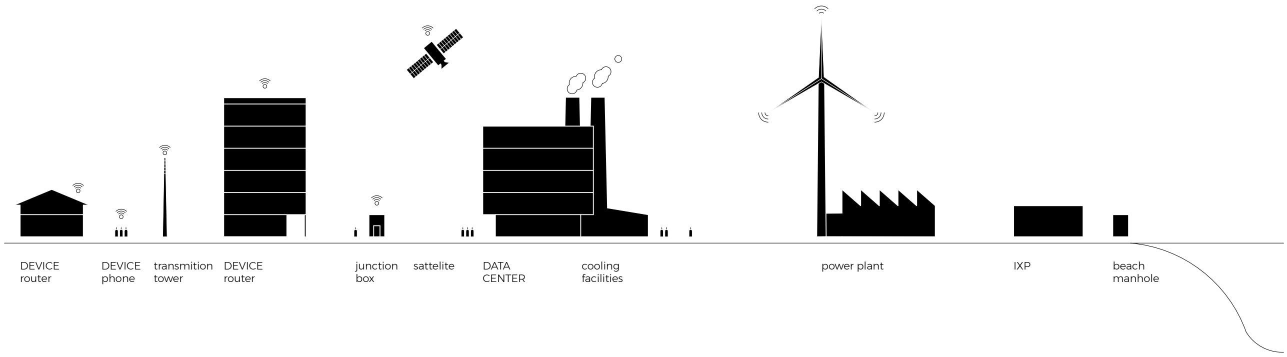
Data Infrastructure

The removal of barriers in intra-European mobility, the end of the Cold War and advent of globalisation shrunk time/space for information flow. The growth of capitalism, neo-liberalism and the effects of the third industrial revolution (computerisation and automation of processes) increased information flow. With telephone and telegram lines and radio/satellite signals already forming a basis for communication between countries and continents, the development of the internet, private and public networks at the end of the millenia induced the need to create a backbone of infrastructure to serve the needs of inforamtion flow. Firstly using cable and then optic fibre cables as they were developed, underwater lines have become the norm and backbone to our global networked connectivity (along with satellites). The adjacent map depicts underwater lines prinarily in the North Sea region (cables in other regions e.g. Mediterranean are not shown).
Parallel to this are the top hub cities (as ranked by international capacity in Gbps) and their highest capacity links. The cities with the highest capacity in Europe are Frankfurt, London, Amsterdam, London (global leaders) followed by Stockholm and Marseille. The thickness of the line indicates the size of capacity, therefore, the London-Amsterdam line depict that both are hubs but the London-Dublin line show that Dublin is a spoke (city with a lower capacity link).

Sources: Telegeoography Global Internet Map, 2018; Telegeography Submarine Cable Map 2019.

Submarine Optic Fibre Cables
Capacity Traffic (in Gbps)
Data Traffic Node


70°
66°
50°

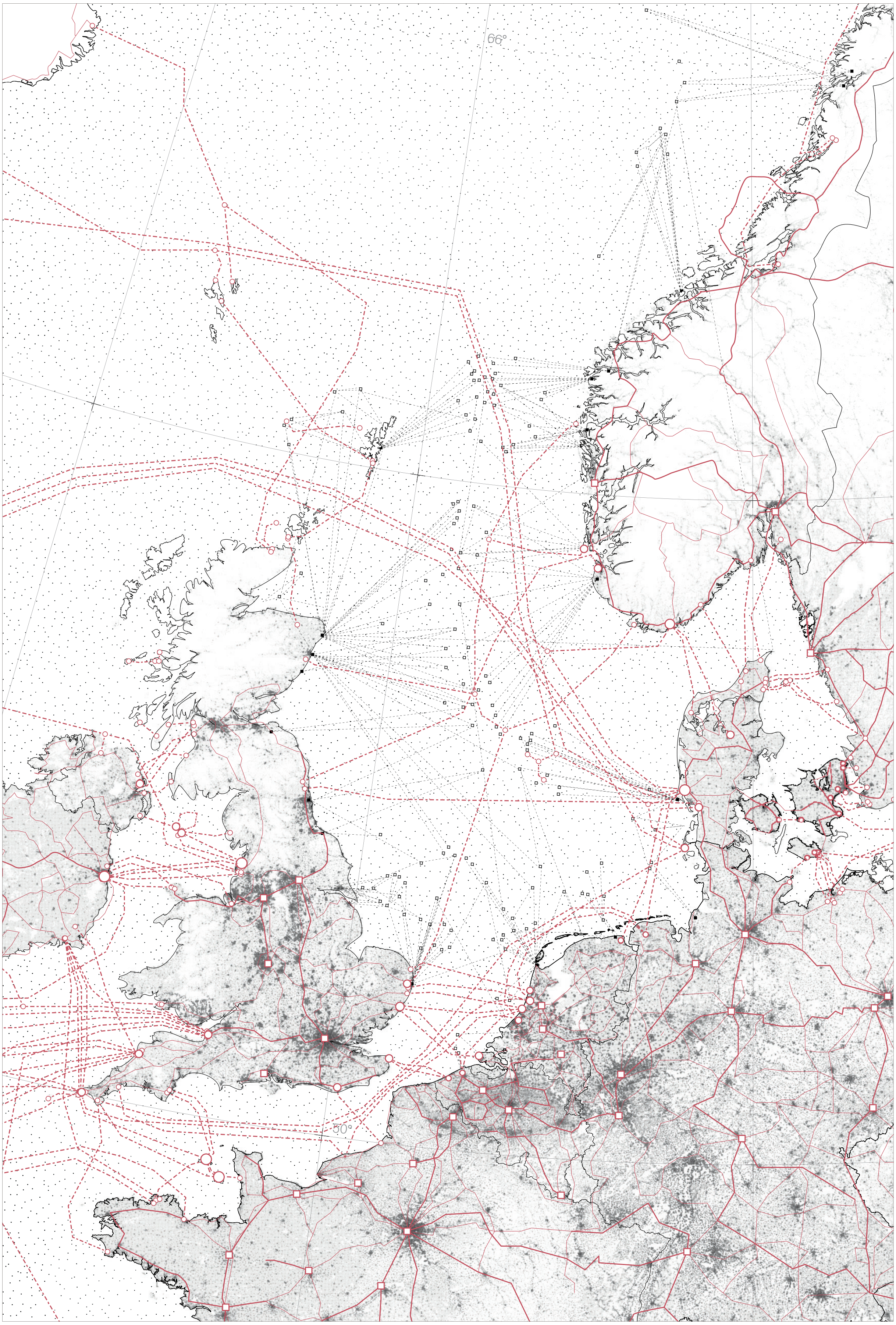


Physical Infrastructure of the Internet

diagram by author

Submarine Sea Cables and
Fibre Optic network on land

drawing by Sebastian Schulte, TT, 2019


66°
50°

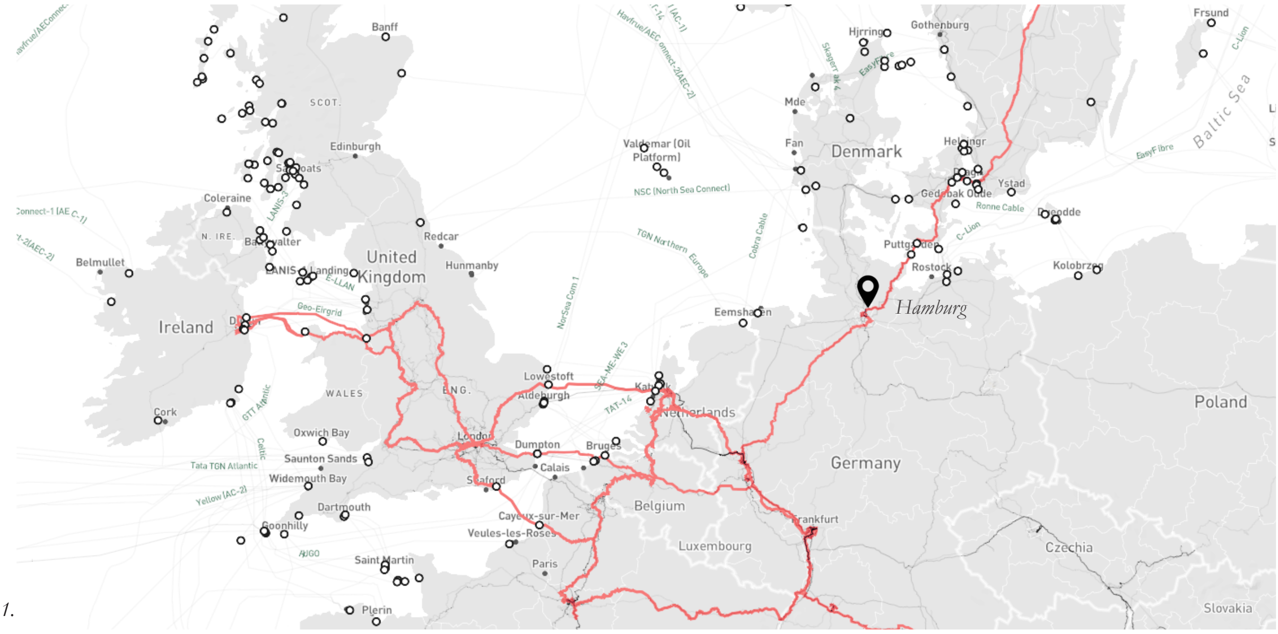
Hamburg Site in the context of the
Data Infrastructure

1. Intra-European Connection
Eunetworks fibre optic connection
length about 13 000 km

2. Hamburg in Intra-European network

3. Site St. Annenplatz in Hamburg
in Intra-European network context

source: www.infrapedia.com/app


Banff
SCOT.
Edinburgh
Coleraine
N. IRE.
Belmullet
Ireland
Cork
WALES
ENG.
United Kingdom
Redcar
Hunmanby
Lowestoft
Aldeburgh
Oxwich Bay
Saunton Sands
Widemouth Bay
Dartmouth
Goonhilly
London
Dumpton
Calais
Bruges
Seaford
Cayeux-sur-Mer
Veules-les-Roses
Paris
Saint Martin
Plerin
Valdemar (Oil Platform)
NSC (North Sea Connect)
TGN Northern Europe
Hjrring
Gothenburg
Mde
Fan
Denmark
Helsingr
Ystad
Gedbak Odde
Puttgarden
Rostock
Kolobrzeg
Hamburg
Eemshaven
Netherlands
Belgium
Luxembourg
Germany
Frankfurt
Poland
Czechia
Slovakia
Baltic Sea
Frsund
Tata TGN Atlantic
Yellow (AC-2)
Geo-Eirgrid
TAT-14
Rønne Cable
Cobra Cable
EasyFibre
1.


Schleswig-Holstein
Wadden Sea National Park
Speicherstadt,
Hamburg
2.


Zollkanal
Wandrahmsfleet
Holländischer Brook
Brooksfleet
Am Sandtorkai
Brooktorhafen
St. Annenplatz
3.

Data: The Power of Access

The Data research is relative to the information society in the European Union and focusses on the availability of information and communication technologies and their use by individuals and institutions. The research covers the topics of access, surveillance, censorship, information ownership and data infrastructure and its ownership.

As a starting point, the adjacent diagrams illustrate the total internet users, total cellular mobile subscriptions and number of data centres per country bordering the North Sea. These figures on one hand illustrate the proportion of the respective populations connected to the internet (creating and consuming data), therefore the relative penetration of internet and on the other the comparison between the former figures and the amount of data centres present in these countries available to handle the collected and transiting information.

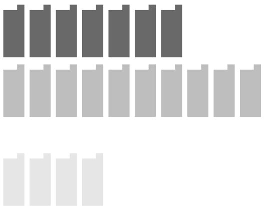
When considering the economy of data (part of the digital economy), we notice that the advent of globalisation has resulted in more connected societies. Therefore, countries with a higher instance of interent penetration have more developed infrastructure like Norway or the Netherlands have a more connected society and therefore a higher ration of data centres to handle the data traffic relative to their population.

Sources: CIA World Factbook, CIA; Eurostat, European Commission.

Total internet users (in millions)

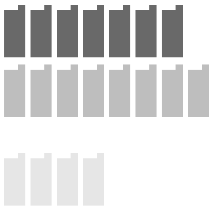
Total cellular mobile subscriptions (in millions)

Number of datacentres per country (in hundreads)



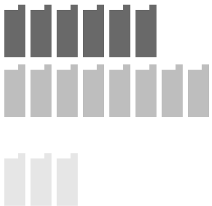
Germany

72 million internet users
106 million mobile subscriptions
417 data centers



United Kingdom

70 million internet users
80 million mobile subscriptions
415 data centers



France

57 million internet users
70 million mobile subscriptions
249 data centers

Norway

5 million internet users
6 million mobile subscriptions
36 data centers

Denmark

5 million internet users
7 million mobile subscriptions
43 data centers

Belgium

10 million internet users
12 million mobile subscriptions
65 data centers

Netherlands

15 million internet users
20 million mobile subscriptions
247 data centers

Data and Surveillance

In a move to control and manage the territory, populations and flows, the infrastructure, collection and surveillance of produced data has been paramount.

International surveillance programmes have been maintained and expanded from post-war and Cold-War coalitions between groups of allies. With the development of ICT and increase in access to connected networks and production of data, information entirely changes the way people and governing institution interact with one another. In 2015, the EU adopted the digital single market aimed at growing the European economy and industry via the digital economy. Furthermore, the rise of social media and e/m-commerce via content providers resulted in increased data production, traffic and surveillance.

Thus, with the advent of open networks, the threats prone to it and the desire for information and control from certain parties; local, national and global surveillance has become omnipresent. Various countries have national bureaus or form international coalitions and treaties to oversee these networks, which has caused security, scandal and uproar from different parties – especially with the increasing rate of whilstleblowers e.g. Edward Snowden. Thus the importance of data is given a relatively high value.

Hereby, the following map illustrates an overview of surveillance in Europe. This includes data traffic hubs, surveillance hubs with national bureaus dealling with information collection, surveillance programmes and a collection of the world's leading technology firms (information technology, service providers and content providers) implanted within Europe. Only the offices in the countries bordering the North Sea have been selected, however these represent the majority of these firms' EU locations. A correlation can then be drawn when comparing the implantation of these firms and the relatively high instance of data centers and data flow in their repective countries.

The represented firms include: Google, Microsoft, Apple, Amazon, Facebook, IBM and Huawei.

North Sea region National and international surveillance parties:

- NSA/National Security Agency (USA)
- The Five Eyes network /FVEY (Australia, Canada, New Zealand, United Kingdom & USA) – emerging from the Atlantic Charter of 1941
- ECHELON: a global system for the interception of private and commercial communications (mass surveillance)
- GCHQ – Government communication Headquarters (UK)
- Secret Intelligence Service (UK)
- Security Service (UK)
- Defence intelligence (UK)
- German Foreign Intelligence Service/BND (Germany)
- PET/FE (Denmark)
- DGSE/DGSI (Frhh
- AIVD (Netherlands)NIS (Norway)

Illustrated surveillance programmes:

PRISM: UK, NL, USA, AUS, Google, Microsoft, Facebook, Apple
XKeyscore: DE, USA, SWE, CAN, NZ, JP
Tempora: UK, USA, BT, Vodafone, Verizon
MUSCULAR: UK, USA
Project 6: DE, USA
Lustre: FR, USA, UK, AUS, CAN, NZ,
FVEY/ECHELON: UK, USA, CAN, AUS, NZ
INDECT: EU

Sources: Wikimedia, 2019; Freedom House, 2018; Big Brother Watch, 2018; European Comission, 2019; Facebook, 2019; Huawei, 2019; Google, 2019; Amazon, 2019; Micrisoft, 2019; IBM, 2019.

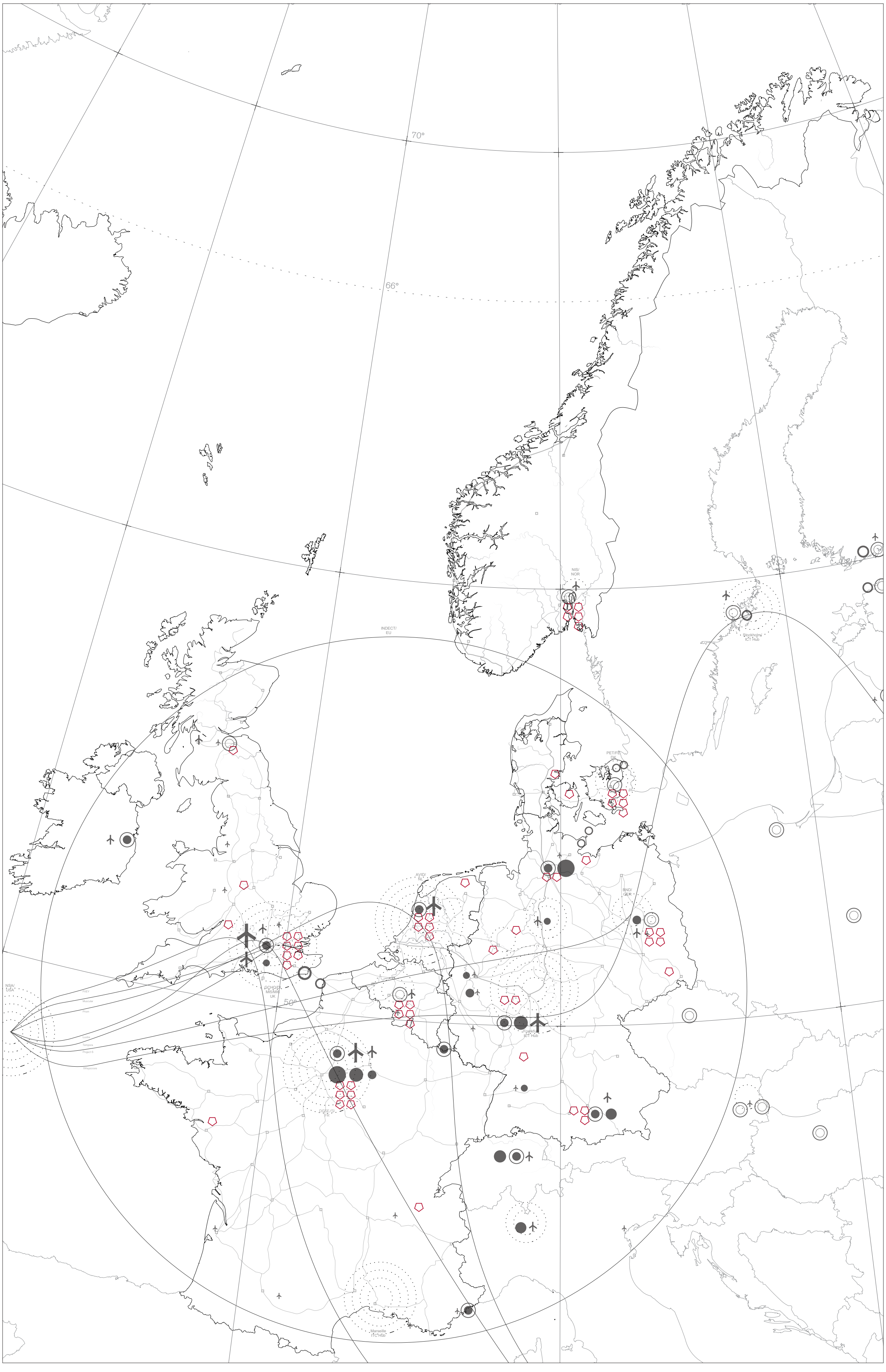
Data Traffic & Surveillance Hub

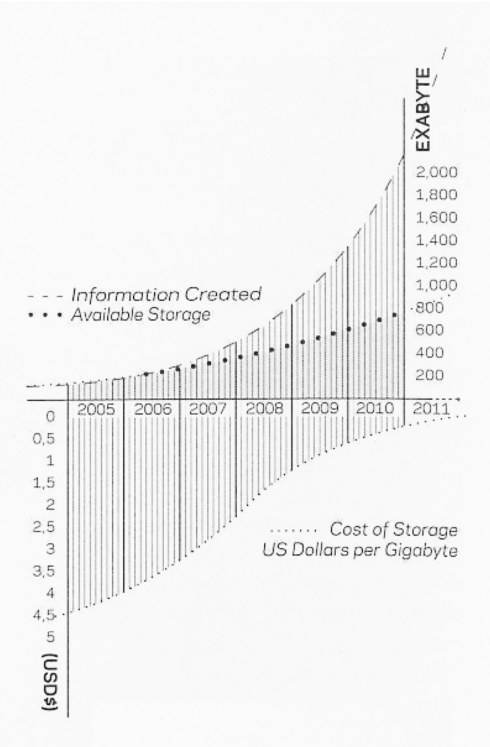
Tech Firms

Surveillance Programme Link

Rail Traffic Node

Air Traffic Node


70°
66°
50°
NIS/
NOR
INDECT/
EU
Stockholm/
ICT Hub
PET/FE
DK
AVID/
NL
BND/
GER
NSA/
USA
FVEY
Muscular
Prism
Lustre
Tempora
Project 6
XKeyscrore
GCHQ/DI
MI5/MI6
UK
DGSE/SI
FR
ICT Hub
Marseille
ITC Hub



The amount of information created, captured or replicated exceeded storage for the first time in 2007. By 2011 almost half of the digital universe will not have a permanent home.

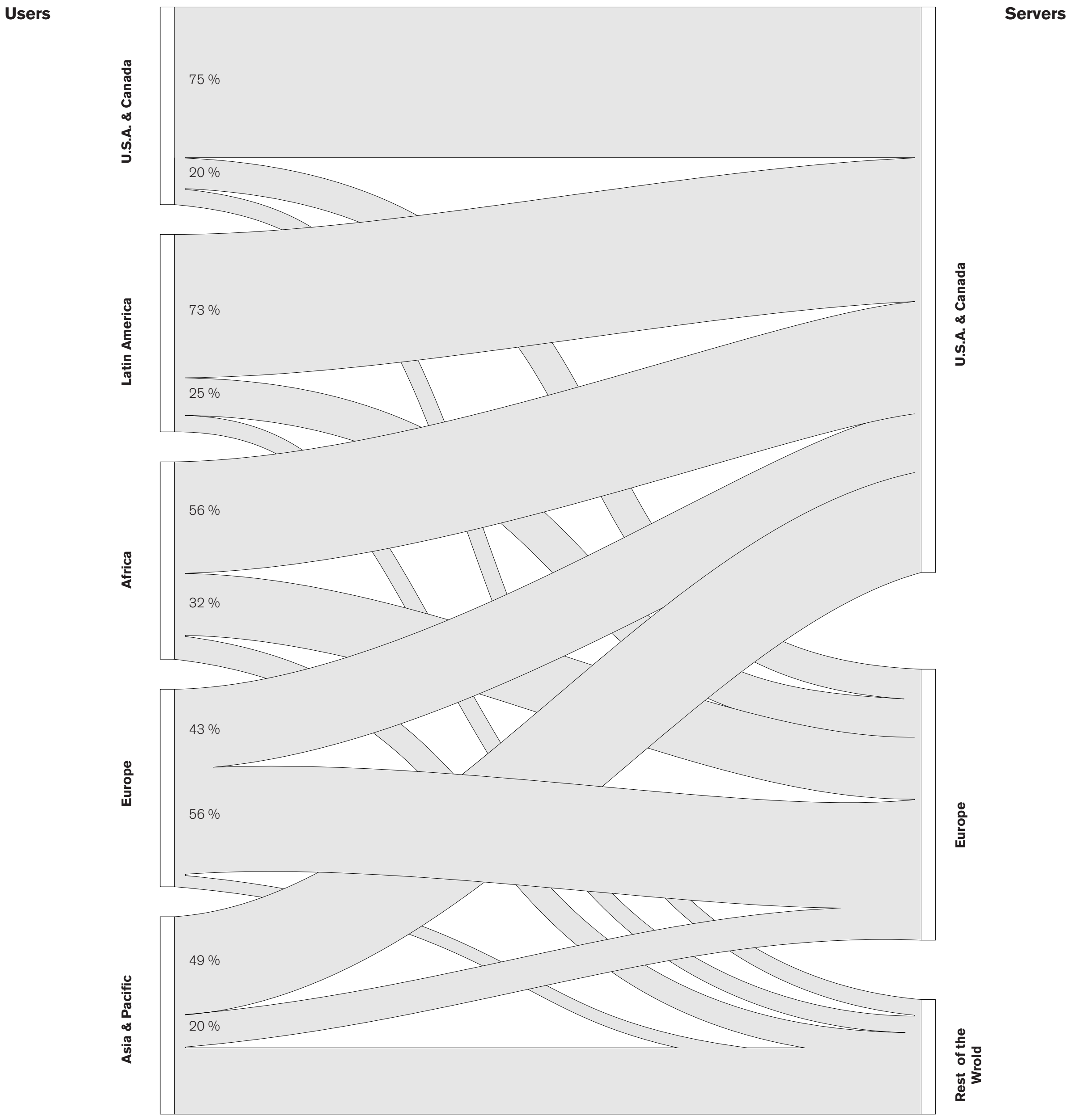
source: Garcia, D., 2010. MAP 003. Archive, David Garcia Studio; text sourced from The Diverse and Exploding Digital Universe - IDC Whitepaper, March 2008.

Data Infrastructure: Servers vs Users

This page's diagram depicts server locations (as a percentage of top webistes requested by users in each region) compared to the amounts of users of the servers' services. Europe is observed to be the second provider of servers after the North American region.

As the North Sea region is an information flow hub, it is no surpirse that Frankfurt, Amserdam, London and Paris are the world's top capacity hubs in terms of Gigabites per Second (Gbps) and are situated within the countries with the most data centres in Europe. The cities shown below the capacity hubs are the locations ith which they share the highest capacity links.

Sources: Telegeography Global Internet Map, 2018.



Capacity Hubs
Gbps

Frankfurt - 73, 079		London - 55, 666		Amsterdam - 48, 405		Paris - 47, 757		Stockholm - 21, 299	
Paris	15%	Amsterdam	21%	London	24%	Frankfurt	24%	Helsinki	15%
Amsterdam	12%	New York	15%	Frankfurt	17%	London	17%	Copenhagen	14%
London	8%	Paris	14%	Paris	10%	Madrid	12%	Oslo	10%
Milan	8%	Frankfurt	11%	Düsseldorf	8%	Amsterdam	10%	Moscow	10%
Istanbul	5%	Dublin	3%	Hamburg	7%	Paris	8%	Hamburg	10%

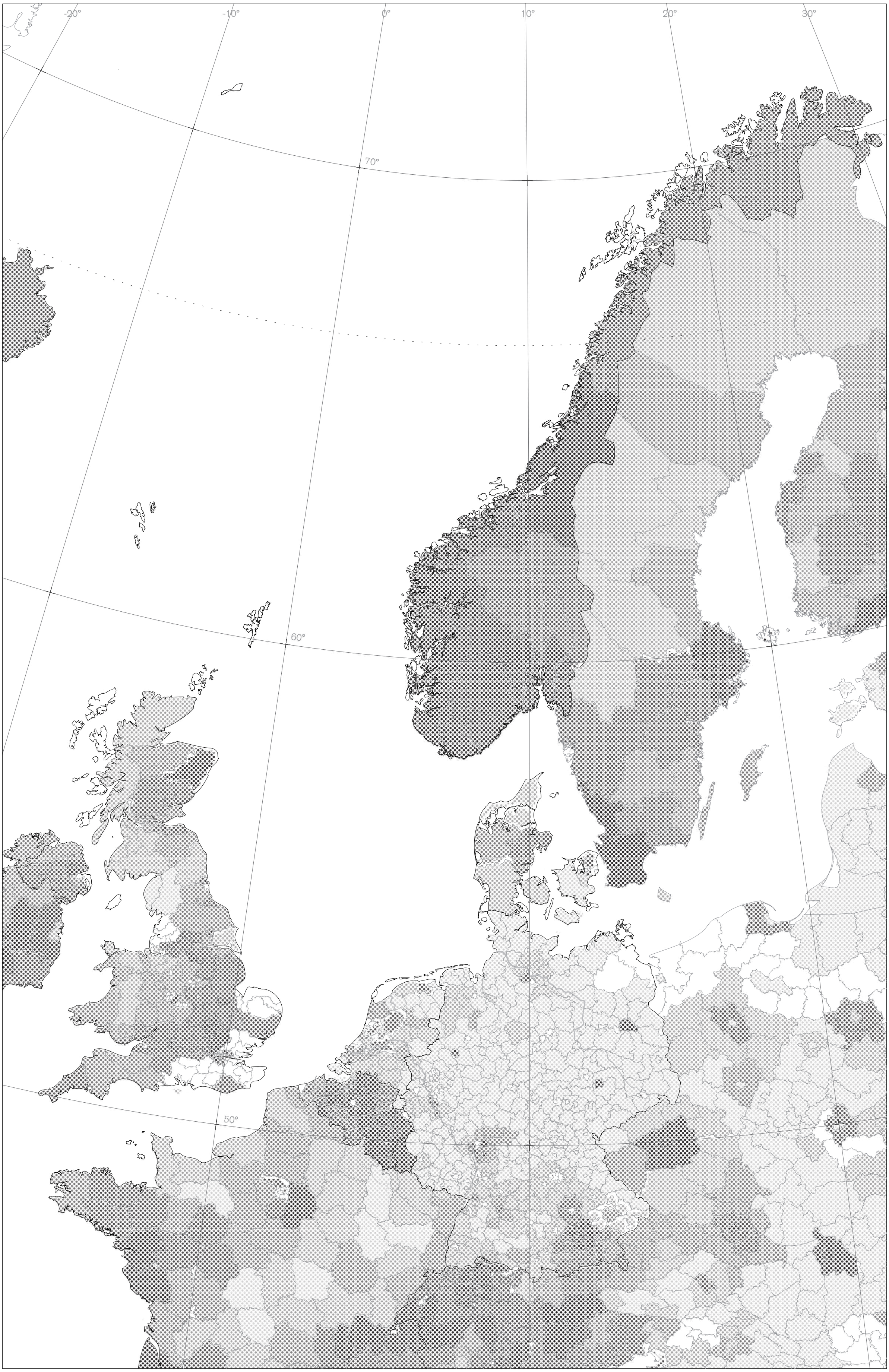
Why focus on the urban?

Within the project, I decided to focus on the urban in purpose to address the source of the archive fever. A city that is a producer of data, stored in the remote landscapes, far away from the sight. Even though the arguments to place unpleasant infrastructure away from the cities are rational, this decision embraces the idea of the weightless cloud. By bringing part of data infrastructure into the city one could become aware that data storage or online activity has an impact on the space. Growing regions are here a point of focus. In particular harbour cities that were once a breadbasket of Europe and now are becoming a data-baskets – housing in the coastal region over 60% of data centres on the continent.

Projected precentage change of the population in 2015-50

The EU population is projected to increase by 3.4 % between 2015 and 2050. The population future projrctions are showing that EU-28's population will grow steadly until reaching a number of 525.6 milion in 2048. Then in the next two years it is projected to drop slightly.

- <-10 %
- -10<0 %
- 0<10 %
- 10<25 %
- >25 %

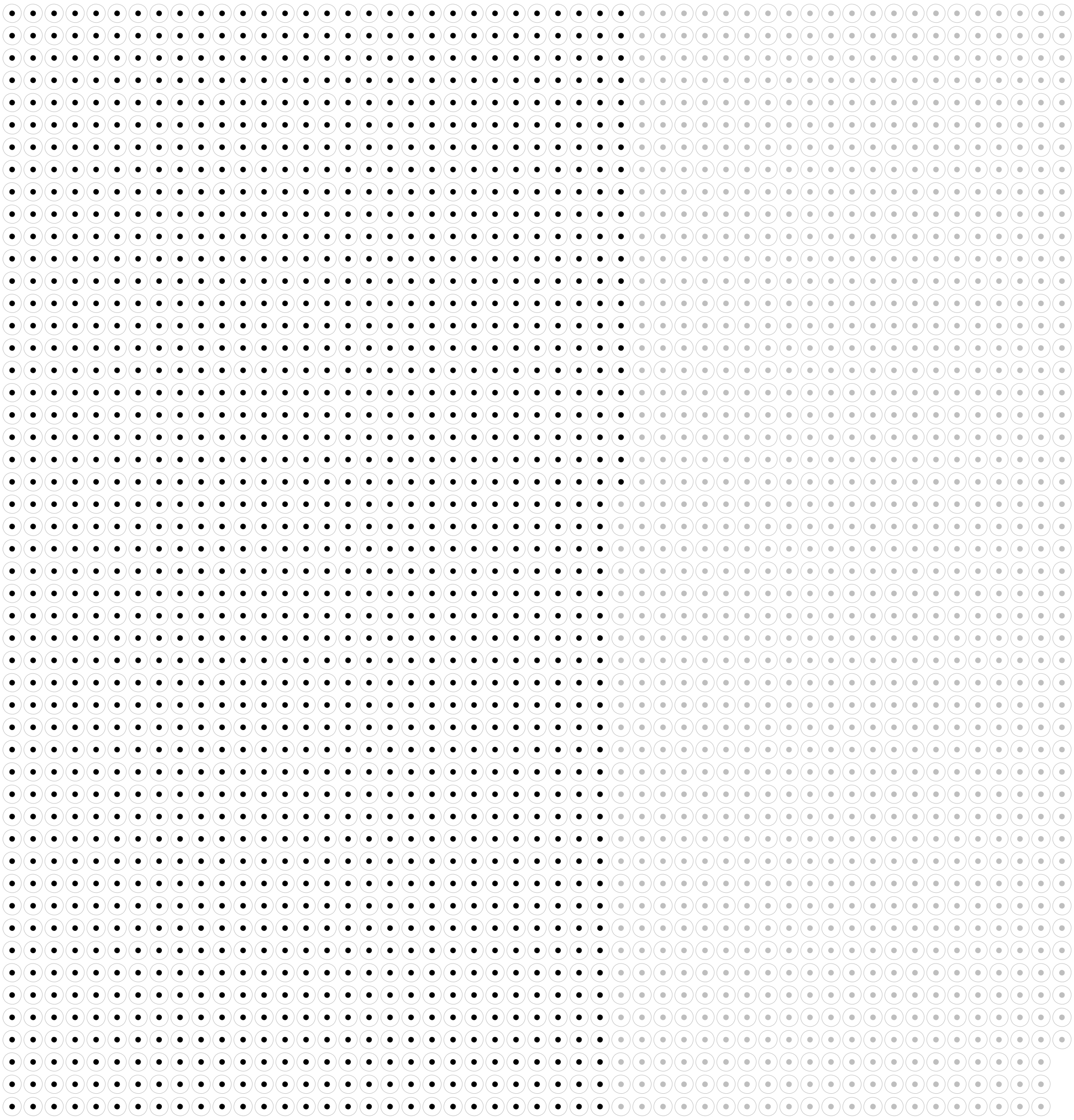

-20°
-10°
0°
10°
20°
30°
70°
60°
50°

Data Infrastructure: Data Centres

Continuing on the physicality of data, the proliferation and increased access to the internet and commodification of data has resulted in an increase of infrastructure to handle its traffic. To clarify terminologies, a server is a form of powerful computer or device affiliated to a network which handles network resources. A data centre is infrastructure (e.g. a building) containing and supporting a vast amount of computing hardware. This page depicts the number of data centres in Europe (2,547). The number of data centres in countries around the North Sea (1,055) is highlighted to show the region's importance relative to the flow of information.

Sources: Data Centres in EU: CloudScene, 2019.

- Data centres in North Sea countries (EU)
- Data Centers outside of North Sea countries (EU)



Data Centres in Europe

United Kingdom	**(415)**	Ireland	(44)	Georgia	(2)
Germany	**(417)**	**Denmark (43)**		Iceland	(4)
Spain	(96)	Portugal	(16)	Serbia	(6)
Netherlands	**(247)**	Ukraine	(46)	Belarus	(2)
France	**(249)**	Slovakia	(14)	Gibraltar	(1)
Austria	(59)	Hungary	(12)	Malta	(4)
Sweden	(90)	Croatia	(6)	Cyprus	(5)
Poland	(116)	**Norway**	**(36)**	Slovenia	(10)
Belgium	**(65)**	Luxembourg	(23)	Bosnia & Herzeg.	(1)
Bulgaria	(21)	Turkey	(28)	Monaco	(1)
Italy	(115)	Greece	(11)	Moldova	(3)
Romania	(21)	Finland	(34)	Liechtenstein	(1)
Russia	(117)	Latvia	(14)	Azerbaijan	(1)
Switzerland	(98)	Lithuania	(13)	Guernsey	(1)
Czech Republic	(37)	Macedonia	(2)		

Data Centres with the most data traffic and number of service providers

Equinix FR5
Frankfurt, GER
Service Providers: 244

TeleHouse London Docklands North
London, UK
Service Providers: 374

Equinix AM7
Amsterdam, NL
Service Providers: 234

Growing Storage

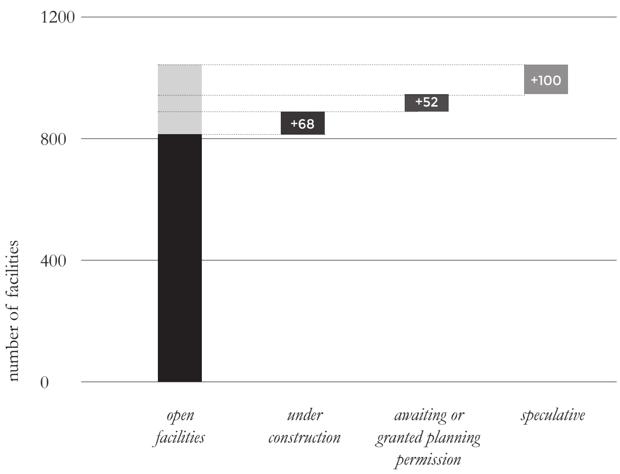
The growing archive goes beyond the digital data. The physical storage grows as well in recent years - as visualised on the map and diagram below.

With increasingly mobile populations, more people living in cities, shorter rental leases and smaller living spaces becoming the norm across Europe, high-tech self-storage facilities are set to feature more in modern living in years to come.

80% of facilities in Europe are located in six countries - out of which five is located around the North Sea.

In 2019 there are 4 290 self-storage facilities offering 9.9 million sq m of space in Europe.

31% of the facilities included in the survey had occupancy levels of between 85-90%.



Self storage development pipeline

source: FEDESSA/JLL, 2019

Number of Self Storage enterprises per country

source: FEDESSA/JLL, 2019

- 15 600
- 10 200
- 9 500
- 5 500
- 3 200 - 3 700
- 1 400


60°
50°

2.3. Problem Statement

1. *Operational Landscapes: Towards an Alternative Cartography of World Urbanization*, Neil Brenner, 2015

For ages, the North Sea was a territory of exchange, the Hanseatic League is one of the symbols of its long trade history and power relation between the North Europe countries. In the Network Society information is new capital and its only physical and tangible presence is embodied in the infrastructure. The submarine network of cables occupies the seabed and enables communication. Referring to Neil Brenner the sea becomes one of the *Operational Landscapes*[1] essential for urban existence.

Digital data flows have this characteristic dual nature – immaterial and tangible, that is embodied in the infrastructure that occupies a growing amount of space.
Due to the remote location and anonymous storage architecture of data centres – its growth is easily omitted or ignored.

Remote data centres keep on growing – especially now in the COVID-19 pandemic – it became, in particular, a critical infrastructure – crucial not only for the economy but also education, medicine and daily information exchange. The need to extend data centres facilities to provide the required amount of processing power to cope with the online work, video streaming etc. grew dramatically.

Until server farms will stay only remote storage it will be easier to ignore or unconsciously overlook its impact on the landscape, energy grid and surveillance.
Can we fight archive fever? Start to reduce and curate our archives and repositories. Moreover, that way also include a wider public in the discussion on where and how our data is stored?

1.4. Research Question

How a growing amount of data is affecting the North Sea territory?

What are the spatial consequences of the growing phenomena of the Archive Fever?

Julian Rosefeldt,
Archive of Archives

(Storehouse of Asiatic antiques dealer) [nr.7], 1995

Archive Fever

2. Problem Analysis | Archive Fever

2.1. Framework | Defining Archive Fever

1. Jacques Derrida, *Archive Fever: A Freudian Impression*, 1996

Jacques Derrida situates the beginnings of archiving at a time of gradual loss of the tradition of spoken memory, making it a "prosthesis" of human memory[1]. At the same time, he emphasizes that the archiving process is imperfect and incomplete, creates an event only to the extent that it records it. He also notes that it is impossible to examine what was left outside the archive. Perhaps this is where our need for accurate documentation of our lives has its source - and with time is building the most powerful archive in history.

The rationalist obsession to systematically collect and reorganize what exists. Followed by the desire for control and centralise our environment lead to almost epidemic proportions of the archives and storage spaces. How did this archive epidemic start? What was its source and how does it actually affect our space?

2.2. Subjects | Data segregation

The storage act could be divided into two main categories, depending on the purpose: storage in the aim of protection (due to value and assurance against undesired access - in case of a secret or private data) and temporary storage.

Value protection can be classified due to the main preservation role:
- preserving heritage and identity (museums, galleries, archives, etc.),
- knowledge (libraries),
- financial value (banks, archives, vaults),
- property rights (archives, banks, vaults) and
- protection against unwanted access (archives, data centres).

Archives of public institutions, museums, libraries, banks - are all shelters securing stored objects and documents. Therefore, the representative character of their architecture is a representation of the values that these institutions embody, to name few - authority, respect and trust. Impressive porticoes and entrance halls were ensuring the public and visiting clients that their data, documents and information are secure and safely stored. In those buildings data was stored until recently.

WHY DO WE STORE?

to collect

to understand

to build identity

to learn

to insure
commodities, investments,
heritage, history

to preserve
knowledge, capital, memory, data

to remember

to archive we:
systematize, organize, interlink

WHAT DO WE STORE?

RECORDS

DATA

INFORMATION

documents

- birth and adoption certificates
- marriage certificates
- copies of power of attorney, wills, driver's licenses and passports
- citizenship papers
- insurance information
- household inventories
- bank and credit card account information
- pet ID information
- diplomas
- transcripts
- social security cards
- military records
- immunization records
- tax records

business information

- business records
- important contracts

other items that one believes are irreplaceable (or would be difficult or expensive to replace)

- hard drives and flash drives with

important data

state data - census

COMMODITIES

A STORE OF VALUE

PRECIOUS AND
SENTIMENTAL OBJECTS

collectibles

art

books

a store of value

money, currency

cryptocurrency

investment information

real estate deeds

real estate warranties

stock certificates and bonds

photos and negatives

FOOD

(SEMI-) PRODUCTS

VEHICLES

WEAPON

COSTUMES

SCENOGRAPHY

MACHINES

TEXTILE

2.2. Subjects

- Digitalisation & Media
- Digital Data Storage
- Architectural Typology of Storage
- Development of storage spaces (Art storage, Storage of goods)
- Storage on Display
- Data Migration
- Representative character of unit-defined architecture

| Digitalisation & Media

The transition from analogue to digital is almost complete - it aimed to preserve data permanently and become a remedy for so imperfect memory. However, digital media rapidly deteriorates in comparison to analogue. With software and hardware updated every 18 to 24 months, it becomes difficult to keep up the pace. According to Moore's law – every 12-24 months the capacity of digital media doubles, we are now able to store the equivalent of 290 000 books, that could be stored on over 500 sqm, now can fit on single 1TB drive. However, to keep up the pace, data storage facilities grow enormously, taking over hectare after hectare of land. Moreover, proper archival-quality digitalization requires the use of large uncompressed files, storage of these are expensive as digital media with a large capacity are essential. We keep on creating a limitless cloud archive, that has an overwhelming physical presence.

In reality of a constantly increasing capacity of digital storage, we keep on gathering more, often unconsciously or with little curation of the collected content. In fact, since 2011 almost half of the digital universe doesn't have a permanent storage place. There are 2.5 quintillion bytes of data created each day at our current pace, but that pace is only accelerating with the growth of the Internet of Things (IoT). According to Forbes only over the last two years 90 per cent of the data in the world was generated[1].

1. Bernard Marr, *How Much Data Do We Create Every Day? The Mind-Blowing Stats Everyone Should Read*, Forbes, May 2018, source: www.forbes.com/sites/bernardmarr/2018/05/21/how-much-data-do-we-create-every-day-the-mind-blowing-stats-everyone-should-read/#642ea3dd60ba, 2.02.2020

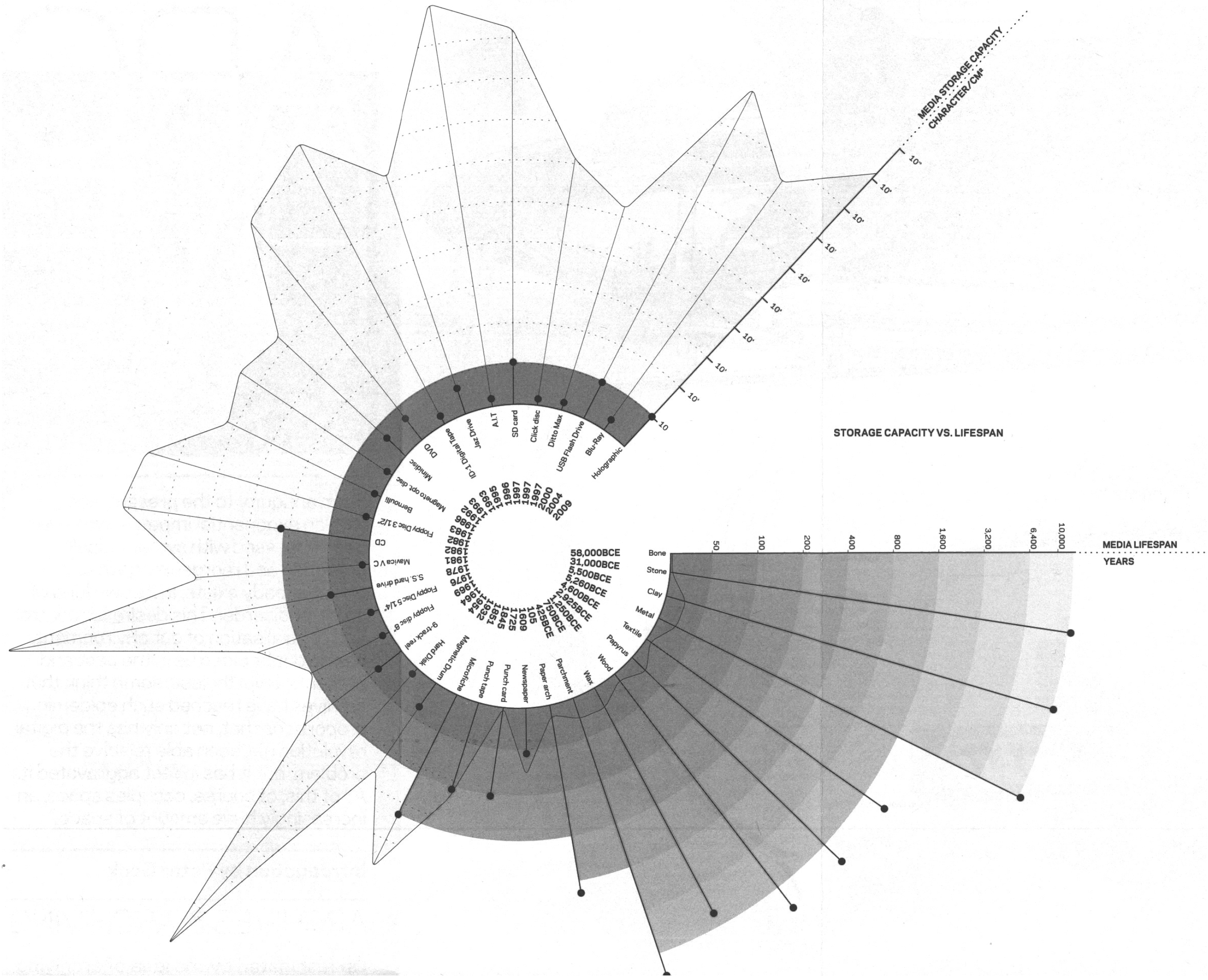
Storage Capacity vs. Lifespan

Medium vs Durability and capacity - from stone with highest durability and small capacity, papirus, paper, CD to hard drive with very small durability but high capacity.

source: Garcia, D., 2010. MAP 003. Archive, David Garcia Studio.

Types of Media

Traditional and New Media



DIFFERENT TYPES OF MEDIA

physical

traditional media

broadcast

television

radio

music

movies

print

newspapers

magazines

books

signs

billboards

digital

new media

web sites

apps

email

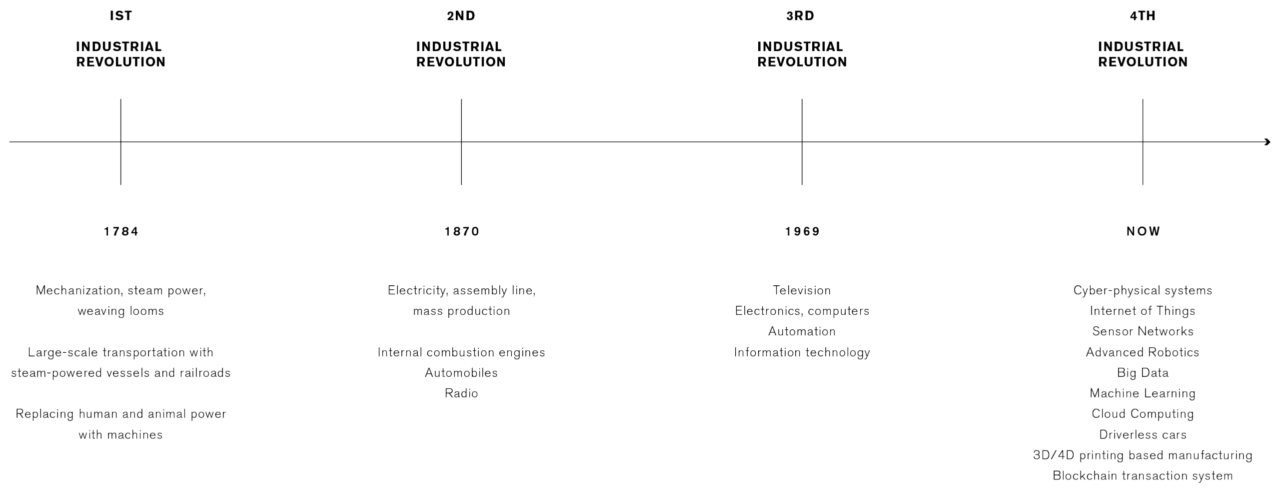
podcasts

blogs

ebooks

social networks

streaming video and music



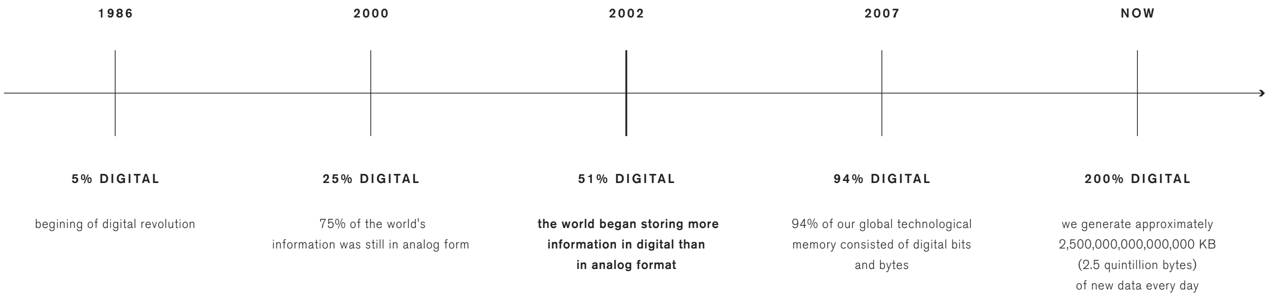
01

Digitalisation

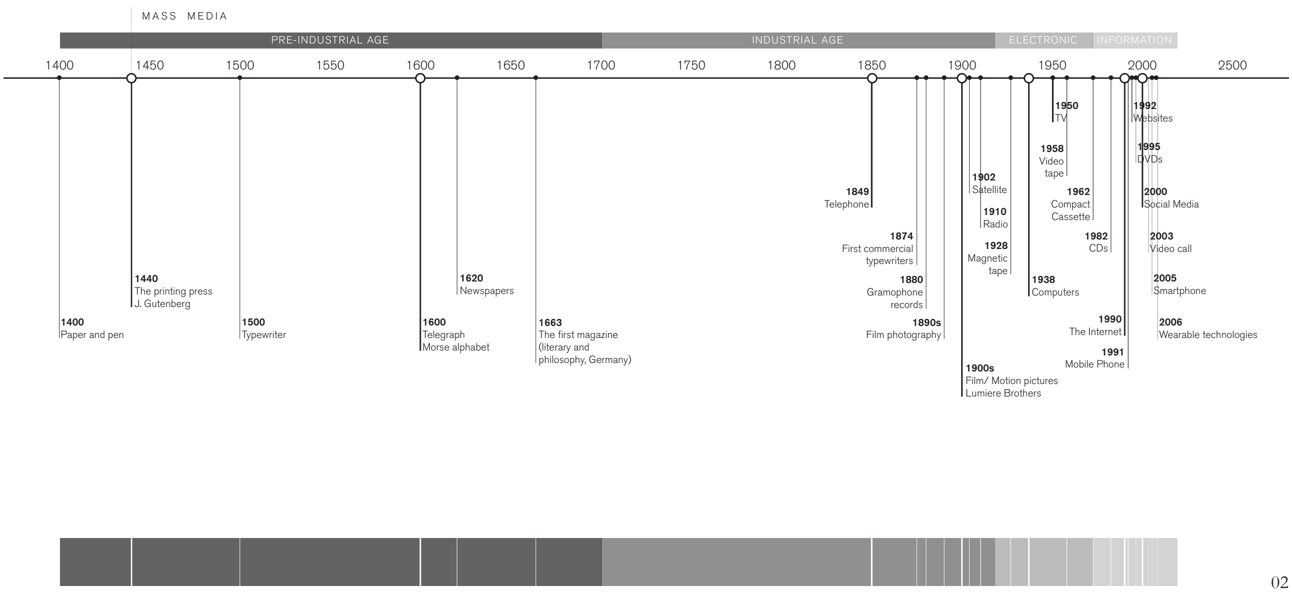
Shift from analogue to digital

01 Industrial Revolutions
02 Evolution from Traditional to New Media | Density Gradient
03 Digital Revolution | Tipping Point in 2002

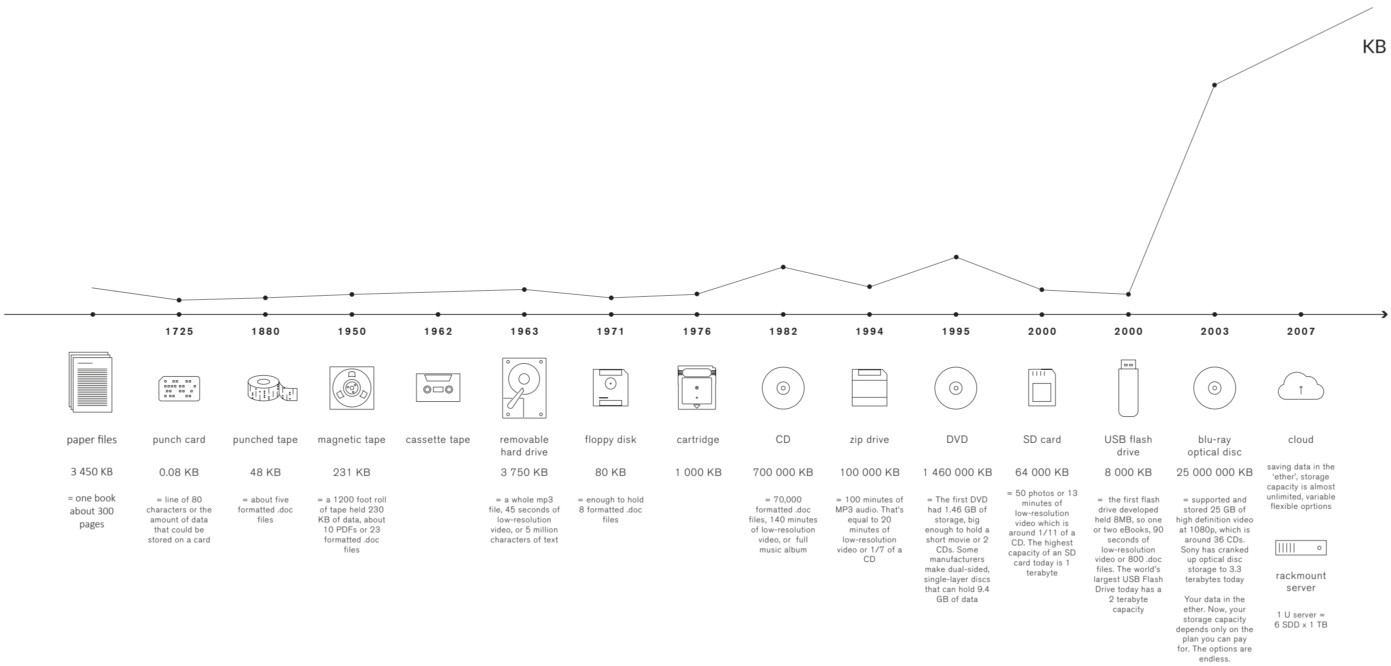
information source: www.frontierinternet.com/gateway/data-storage-timeline/


1986
2000
2002
2007
NOW
5% DIGITAL
begining of digital revolution
25% DIGITAL
75% of the world's information was still in analog form
51% DIGITAL
the world began storing more information in digital than in analog format
94% DIGITAL
94% of our global technological memory consisted of digital bits and bytes
200% DIGITAL
we generate approximately 2,500,000,000,000,000 KB (2.5 quintillion bytes) of new data every day

03


MASS MEDIA
PRE-INDUSTRIAL AGE
INDUSTRIAL AGE
ELECTRONIC
INFORMATION
1400
1450
1500
1550
1600
1650
1700
1750
1800
1850
1900
1950
2000
2500
1400 Paper and pen
1440 The printing press J. Gutenberg
1500 Typewriter
1600 Telegraph Morse alphabet
1620 Newspapers
1663 The first magazine (literary and philosophy, Germany)
1849 Telephone
1874 First commercial typewriters
1880 Gramophone records
1890s Film photography
1900s Film/ Motion pictures Lumiere Brothers
1902 Satellite
1910 Radio
1928 Magnetic tape
1938 Computers
1950 TV
1958 Video tape
1962 Compact Cassette
1982 CDs
1990 The Internet
1991 Mobile Phone
1992 Websites
1995 DVDs
2000 Social Media
2003 Video call
2005 Smartphone
2006 Wearable technologies

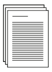
02

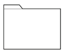


Development of Digital Data Storage

Time vs Capacity of storage devices

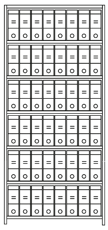
Devices and Medium needed to read data





book (300p)

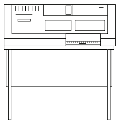
3 450 KB



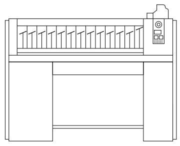
punch card

0.08 KB

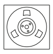
= line of 80
characters or the
amount of data
that could be
stored on a card



Punchcard key
punch machine



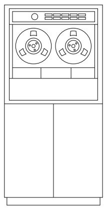
sorting machine,
reproduction machine and
collator and merger machine



magnetic tape

231 KB

= a 1200 foot roll
of tape held 230
KB of data, about
10 PDFs or 23
formatted .doc
files

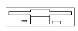


magnetic tape
unit (drive)

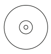
floppy disk

80 KB

= enough to hold
8 formatted .doc
files



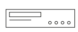
floppy disk
drive



CD

700 000 KB

= 70,000
formatted .doc
files, 140 minutes
of low-resolution
video, or full
music album

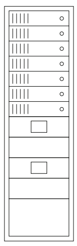


CD player/
discman

rackmount
server

1 U server =
4-10 SDD x 1TB

2U = 20 x 1TB SSD



full rack

42 U = 420 TB

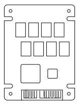
1000 B Bytes	= 1 kB Kilobyte
1000 KB Kilobytes	= 1 MB Megabyte
1000 MB Megabytes	= 1 GB Gigabyte
1000 GB Gigabytes	= 1 TB Terabyte
1000 TB Terabytes	= 1 PB Petabyte
1000 PB Petabytes	= 1 EB Exabyte
1000 EB Exabytes	= 1 ZB Zettabyte
1000 ZB Zettabytes	= 1 YB Yottabyte

Shrinking Size of Digital Data Storage

Equivalent of 1TB in different storage divces

Comparison of the amount of each media needed to save 1TB of digital data

Future possibilities for long-term digital data storage



SSD drive

1TB

1 TB = 1 000 GB = 1 000 000 MB = 1 000 000 000 KB

= 85,899,345 pages of Word documents = 286 331 x 300p books (1 book/month = 23 860 years to read all)

=200,000 songs or 17,000 hours of music = CD (80min) x 13 080 = Phonograph record 12" vinyl record (44min) x 24 286

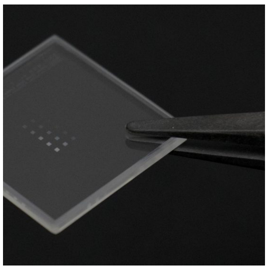
= 250 movies (500 h of movies (120min long each))

= 310,000 photos

book	punch card	magnetic tape	removable hard drive	floppy disk	12'' Phonograph record	CD	DVD
300 pages	0.08 KB	231 KB	3 750 KB	80 KB	420 000 KB	700 000 KB	1 460 000 KB
x 286 331 = 1TB	= 0.0069 page x 12,449,180,435	= 20 pages x 4,294,960	= 324 pages x 265,120	= 12 pages x 7,158,280	= Phonograph record 12" vinyl record (44min) x 24 286	= 200,000 songs or 17,000 hours of music = CD (80min) x 13 080	= 200,000 songs or 17,000 hours of music = DVD (166min) x 6,258
	3 1/4 by 7 3⁄8 inches (82.6 by 187.3 mm) became the standard card size	10.5 inches (267 mm)					

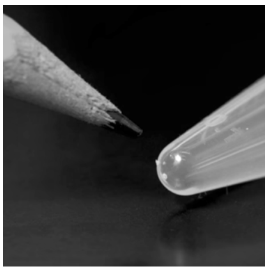
Further development possibilities for long-term storage

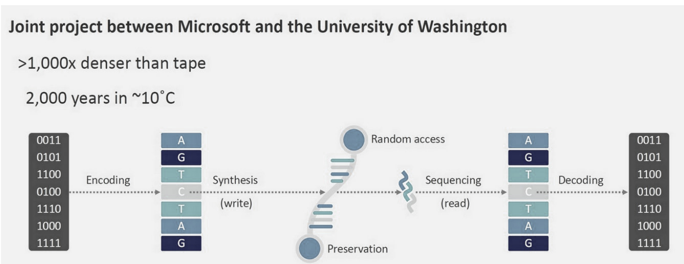
Laser engrave in glass



Project Silca, Microsoft

DNA





Project Palix - 10TB of data | DNA, Microsoft

2.2. Subjects

| Architectural Typology of Storage

Storage practice may be divided depending on the aim on: preservation and storing. While the first one aims to preserve the heritage, identity, knowledge or simply value and right of ownership, the latter is embodied in a temporal depot where objects are placed till the next use.

Archives, museums, libraries and banks – are all serving as preservation shelters and also have a crucial – representative function, embodied in the special arrangement and sequence. Depending on the user and aim of one's visit one would have a different experience, building the respect and authority of the institution – this is where data used to been stored (city halls, archives).
On the other hand, a utilitarian aspect of the storage was always a catalyst for development and fast application of new technologies that could bring profit or lead to outrunning the competition. Purely functional logistics centre – this is where data is stored currently. Most of these spaces look like an automated landscape with endless repetitive layout reminding the No-stop City drawings by Archizoom.

| Storage on Display

Museums as cultural institutions that are established to care for (conserve), collect and research a collection of artefacts and other objects of artistic, cultural, historical, or scientific importance. These collections are constantly expanding and due too lack of space new items are often stored in archives. However, about 90% of museums' collections remain in magazines and have never seen daylight. As a matter of fact, the percentage of digital data use is comparable, up to 90% after saving is never processed (that is why it is called dark data).

In 2008, in England, the museums' budgets publication started a discussion. Millions of pounds, from the public budget, were spent on storage and conservation of works that have never been presented to the public. The question emerged - if it is still valid to acquire new objects to the existing collection, while it already generates huge maintenance costs? What is more, the institutions have neither the place nor the possibility of displaying new acquisitions?

Fortunately, this approach is changing within recent years and more and more museums make decisions to open their archives and make them available to the public. The projects of Depot Boijmans Van Beuningen in Rotterdam (planned to open in 2021) by MVRDV, or built in 2006 by SANAA - Louvre Lens, are good examples of experimentation with a new typology of placing storage on display.

The base starting point in these projects is a resignation or minimization of a curator role in exhibitions - when exhibiting over 151,000 artefacts (as in the case of Depot) it is difficult to talk about building a narrative of the shown collection. From the outside, the building has an unusual shape of a reflective bowl, but the interior is designed like any warehouse - optimized to accommodate the largest possible number of objects on the smallest possible surface. The novelty is that there will be a public path that runs through the building, which will allow visitors to immerse themselves in the world behind the scenes of the daily museum's work and discover the previously invisible artefacts and see what maintaining and caring for an invaluable art collection actually entails - conservation and restoration processes, as well as packaging and transportation of works of art.

1. EDF Archives Centre / LAN Architecture
2. Kunsthaus Bregenz, Zumthor
3. Beinecke Rare Book & Manuscript Library
4. Covilha Data Center, Portugal

5. Bank of England, London
6. Post office, Amsterdam

7. Venetian Arsenal
8. Hangar
9. National Theatre costume storage, London
10. Microsoft Data Center, near Amsterdam

WHERE WE STORE AND WHY?

STORAGE

PASSIVE

IN-USE

CULTURAL HERITAGE

identity, knowledge, preserving,

Archives
Museums
Library
Data Center (as an archive)

A STORE OF VALUE

preserving value, statement of ownership, investments

Bank, Post, Private Deposit boxes / Vaults

in-room safes, in-floor safes,
time-delay safes, time-lock safes

Data Center (with highest security levels)

Repository

STORING TILL USE

part of the economy

physical

armory, arsenal
boathouse
depository
depot
garage
granary, silo
hangar
outbuilding
pantry
shed

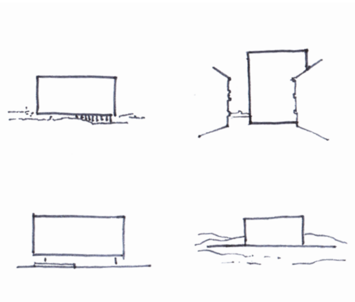
physical/ digital

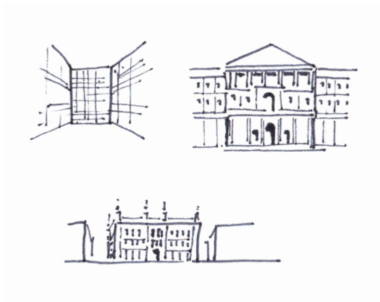
store
container
storage

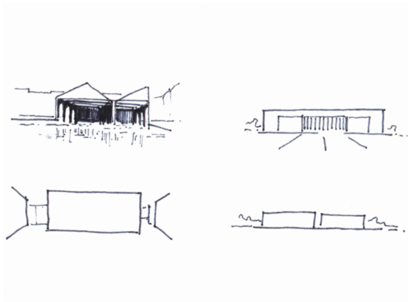
Warehouse

Data Center

digital





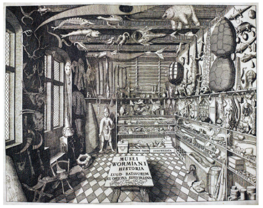


Development of storage spaces

Museums
are used to educate, showcase heritage to public, also as archive is used to create value from processing data and creating information - often in non-obvious way (cross domain etc.)

WUNDERKAMMER & CABINETS OF CURIOSITY

1600



"Musei Wormiani Historia", the frontispiece from the Museum Wormianum depicting Ole Worm's cabinet of curiosities.

These cabinets date back to Renaissance Europe, when private collectors began accumulating exotic, wondrous, fantastic, or bizarre objects via travels, scientific experiments and investigations, and other collecting methods. The organization and display of such collections were attempts to rationalize and categorize a vast bounty of information, and today's museums can be understood as an outgrowth of them.

THE EARLY MUSEUM

1800-60

Nineteenth-century museums introduces new ideas and new more structuralised view of the world. They taught visitors to respect the artifacts (therefore museum and the authority it represented), to look and not touch.

Exposition universelle: Section egyptienne, 1867, Daumier, National Gallery of Art, Washington, D.C.

WORLD'S FAIR

1880

McNeven, J., The Foreign Department, viewed towards the transept, coloured lithograph, 1851, Ackermann (printer), V&A. The interior of the Crystal Palace in London during the Great Exhibition of 1851.

A large international exhibition aiming to showcase achievements of nations. They vary in character and are held in different parts of the world at a specific site for a period of time, temporarily from three to six months. The idea originated in the French tradition of national exhibitions. The best-known 'first World Expo' was held in The Crystal Palace in Hyde Park, London, UK, in 1851, under the title "Great Exhibition of the Works of Industry of All Nations". First time for such a great scale and with modern approach.

EDUCATION IN PROGRESSIVE MUSEUM

1890

Introduction of new methods for display focused on telling stories with artifacts. Museums became spaces for active learning.

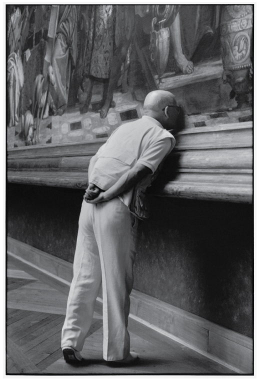
An illustration of the Children's Room in the Smithsonian Castle. Annual Report of the Board of Regents of the Smithsonian Institution, 1901. Smithsonian Libraries.

ERA OF PROFESSIONALIZATION

1910

Scientists and art historians took on curatorial roles. Museum directors received business and academic training. Educators brought skills from schools and libraries. Idea of the White Box.

5216, Paolo Caliari (1528-1588), known as Veronese, The Wedding Feast at Cana, 1562-1563. Louvre Museum, Paris, 1993, © Alécio de Andrade, ADAGP, Paris



COMMUNITY MUSEUM MOVEMENT

1980-95

Change of political climate. These new spaces, often founded to serve ethnic and racial groups, promoted community pride and served local interests.

THE EXPERIENCE REVOLUTION

2000-17

Reaching new audiences, use of digital technologies to engage visitors.

Henri Matisse, The Swimming Pool (1952)
Museum of Modern Art, New York

Henri Matisse's The Swimming Pool installed at MoMA (Corbis)

The undulating ultramarine waves and swimmers of Henri Matisse's The Swimming Pool, a large paper installation made for the artist's dining room in Nice, are in fact currently on view in the exhibition **Henri Matisse: The Cut-Outs** until February 10 at New York's Museum of Modern Art. But the work, acquired by MoMA in 1975, was out of sight for nearly 20 years. Its burlap backing had become discoloured and brittle; the white paper frieze on which the blue cut-outs were mounted was stained. The long process of the work's restoration was indeed the impetus behind this highly acclaimed exhibition that represents Matisse's last major work series; after the exhibition closes, the work will be unpinned and returned to customised, climatised storage cases. But the situation behind its temporary retirement isn't completely unusual – often, an artwork needing restoration will wait months, even years for an update.

Storage costs for art in British Museums is costing over a million pounds per year. A Freedom of Information request put in by the BBC resulted in the finding.

“The British Museum spent £86,280 in 2009 and 2010, mothballing 99% of its collection, in storage.” Many museums in the capital keep an average of 90% of their collections stored away with a mere 10% on view.

Albrecht Dürer, Young Hare (1502)
Albertina Museum, Vienna

Albrecht Dürer, Young Hare, 1502 (Corbis)

Dürer's famous watercolour and gouache drawing Young Hare is a masterpiece in observation; its impeccable rendering served as benchmark for centuries thereafter. As 'Vienna's unofficial mascot', the work on paper is also the Albertina's prize possession, but it's not often on show. After a maximum of three months, Young Hare needs five years in dark storage with a humidity level of less than 50% for the paper to adequately rest. It was on view briefly in 2014 after a break of ten years, and will appear again for a short time in 2018, before it goes back into hiding. The museum holds millions of works on paper, and is thus able to show “less than 1% – maybe even 0.1% – of our collection,” according to deputy director Christian Benedik, but, as mandated by the museum's original owners (part of the Habsburg royal family) every graphic work has a facsimile that can be viewed more readily, including one of Young Hare. A **Google Cultural Institute Gigapixel image** of the Hare is digitally viewable – the better to see the reflections in the bunny's eyes with.

Urgency to place storage on display

screenshots source: bbc.com/news/uk-england-london-12214145, 19.01.2011

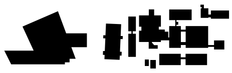
Procentage of the collected items on public display

information source: Garcia, D., 2010. MAP 003. Archive, David Garcia Studio

THE BRITISH MUSEUM EXHIBITS
1%
OF ITS TOTAL COLLECTION OF
7 MILLION ITEMS

THE SMITHSONIAN EXHIBITS
1%
OF ITS TOTAL COLLECTION OF
137 MILLION ITEMS

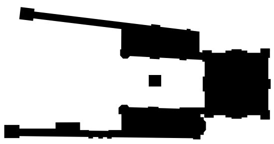
THE BRITISH LIBRARY EXHIBITS
3%
OF ITS TOTAL COLLECTION OF
14 MILLION ITEMS



THE IMPERIAL WAR MUSEUM EXHIBITS
5%
OF ITS TOTAL COLLECTION OF
10.7 MILLION ITEMS

THE HERMITAGE EXHIBITS
5%
OF ITS TOTAL COLLECTION OF
3 MILLION ITEMS

THE LOUVRE EXHIBITS
12%
OF ITS TOTAL COLLECTION OF
380 000 ITEMS



THE MOMA EXHIBITS
15%
OF ITS TOTAL COLLECTION OF
150 000 ITEMS

DATA CENTRE		USE / VALUE CREATION		TYPES	STOCK	*highly restricted access, only by the owner*
		used to create value from processing data, storing and creating information		*academic, private - service provider, cloud, business (for profit), e-commerce, government non-profit institutions - hospital*	MEDIA INTERACTION	*available from anywhere via Internet network*
ACCESS	*highly restricted access*					
USERS	*staff and potential clients*	DATA OWNERSHIP	*private, public*	RESPONSE TIME	*immediate, machine-dependent*	

ARCHIVE		USE / VALUE CREATION		TYPES	STOCK	*restricted access, visitor needs to ask for exact item from catalogue*
		used to create value from processing data and creating information - often in non-obvious way (cross domain etc.)		*academic business (for profit) government non-profit, and other*	MEDIA INTERACTION	*reading, viewing, listening (depending on collection) in study room; digital access in archive*
ACCESS	*might be public, limited access*					
USERS	*citizens*	DATA OWNERSHIP	*public*	RESPONSE TIME	*waiting time (from few minutes to few days)*	

LIBRARY		USE / VALUE CREATION		TYPES	STOCK	*visible, restricted access, visitor needs to ask for exact item from catalogue*
		used to popularise knowledge; is also used to create value from processing data and creating information - often in non-obvious way (cross domain etc.)		*academic, children's, national, public, reference, research, digital, special*	MEDIA INTERACTION	*reading, viewing, listening (depending on collection) in study room; digital access in archive*
ACCESS	*public, limited access to collection*					
USERS	*students, academics, wider public*	DATA OWNERSHIP	*public*	RESPONSE TIME	*waiting time (from few minutes to few days)*	

WAREHOUSE		USE / VALUE CREATION		TYPES	STOCK	*restricted access, only staff*
		part of economical chain, creates a value through receiving, stockpiling and despatching goods; exposing goods for clients; repacking, reviewing and labelling and unpacking them		*canal, railway retail, cool storage overseas packing, self-storage*	MEDIA INTERACTION	*digital catalogue overview*
ACCESS	*private, limited access*					
USERS	*staff, clients*	GOODS OWNERSHIP	*private*	RESPONSE TIME	*waiting time (from few minutes to few days)*	

DATA CENTRE		USE / VALUE CREATION		TYPES	STOCK	*highly restricted access, only by the owner*
		used to create value from processing data, storing and creating information		*academic, private - service provider, cloud, business (for profit), e-commerce, government non-profit institutions - hospital*	MEDIA INTERACTION	*available from anywhere via Internet network*
ACCESS	*highly restricted access*					
USERS	*staff and potential clients*	DATA OWNERSHIP	*private, public*	RESPONSE TIME	*immediate, machine-dependent*	

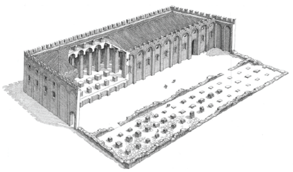
Development of storage spaces

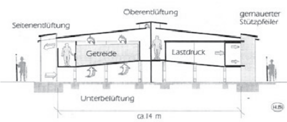
Warehouses
are used as part of the value chain,
often were built in the vicinity of
harbors and commercial centers
to house large-scale trade

images source: Wikimedia Commons

Warehouse

Horreum





The great Horrea Galbae were used in Rome to store **grain as well as olive oil, foodstuffs, wine, clothing, even building materials like marble.**

XIII Fondaco dei Tedeschi

Multifunctional

A quarter belonged to German traders located in Venice, it combined many functions including: dwelling, warehouse, market and rooms for travellers.

A Sust, a Middle Ages type of warehouse, in Horgen, Switzerland

Characteristic European gabled timber roofs, are dated as late Middle Ages.

Warehouses On An Amsterdam Canal On Uilenburg, Seventeenth-century warehouses in Amsterdam, Netherlands

Canal Warehouse

This type of warehouse derived from coastal predecessors, had unique features: it had internal water filled canal arms that entered the building, it was multi-storey with canal access at one level and road and even rail egress at another, and has a hoist system powered by a water wheel or at later stages steam. Canal warehouses were transshipment warehouses, holding goods until they could be shipped out to their next recipient.

19th century, Watts Warehouse, Manchester

Warehouses also fulfil a range of commercial functions besides simple storage, exemplified by Manchester's cotton warehouses and Australian wool stores: receiving, stockpiling and despatching goods; displaying goods for commercial buyers; packing, checking and labelling orders, and dispatching them.

Historic Atlantic Dock warehouse in Brooklyn in the 1800s

Technological innovations of the early 19th century changed the shape of warehouses and the work performed inside them: cast iron columns and later, moulded steel posts; saw-tooth roofs; and steam power. All (except steel) were adopted quickly and were in common use by the middle of the 19th century.

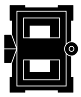
Pakhuis het Veem, 1898, seen from Diemenkade during the 1930s.

After 1585, Amsterdam grew to become a powerful and rich city of international significance. Over a period of a hundred years Amsterdam was the world's central warehouse. Here goods from around the globe were brought in, stored, traded and transported onwards. Warehouses and storehouses, particularly along the Prinsengracht and Brouwersgracht, still serve as reminders.

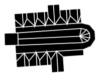
Territorial impact of Data Storage moving away from the city

Document storage
Moving away from the city center

Amsterdam City Archive
source: Google Maps



1 Amsterdam City Hall, *Koninklijk Paleis*, 1808, footprint 4 330 sq m

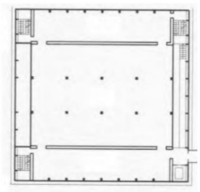


2 Oude Kerk, Amsterdam, *Iron Chapel,* Middle Ages, footprint 3 700 sq m

3 Amsterdam City Archives, 1914, footprint 2 810 sq m

4 Archiefdepot Noord, 2019, footprint 1 790 sq m

Data Center



Typical data center program:

1. hall/circulation
2. room for data archives/magnetic tape
3. room for servers
4. service platform/coolth recovery equipment
5. ventilation plant, fire extinguishing system
6. electricity/emergency power
7. services, ventilation, argon fire-suppression system
8. transformer
9. main entrance/reception
10. administration offices
11. control room
12. services & facilities area for personnel
13. covered loading area
14. parking

Remarks: the power supply can't go off, the communications lines can't break down, the space must be kept under high security, the data rooms need to be kept cool

Architecture Without Content

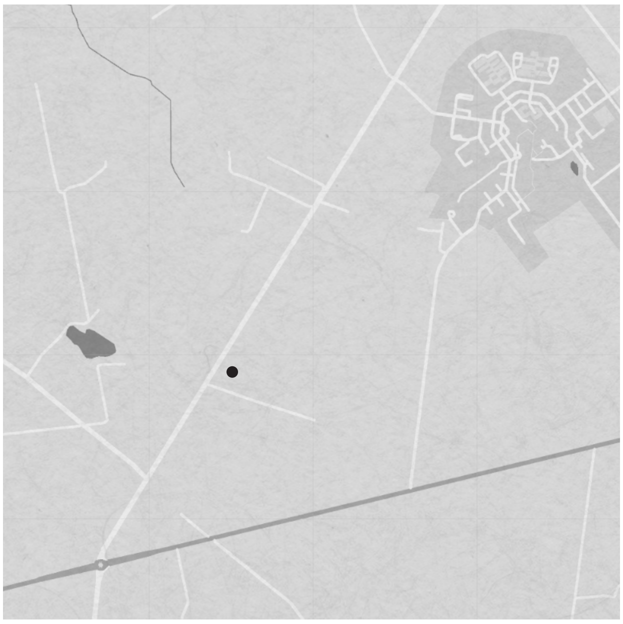
source: publication by Atelier OFFICE, Kersten Geers & David van Severen, Carola Daldoss, Andrea Zanderigo, 2011, arch.usi.ch

Territorial impact of storage moving away from the city - Data Centres are located in remote, often rural or industrial areas.

Data Center Locations

Urban Analysis

01 rural
02 nearby academic center
03 port
04 urban



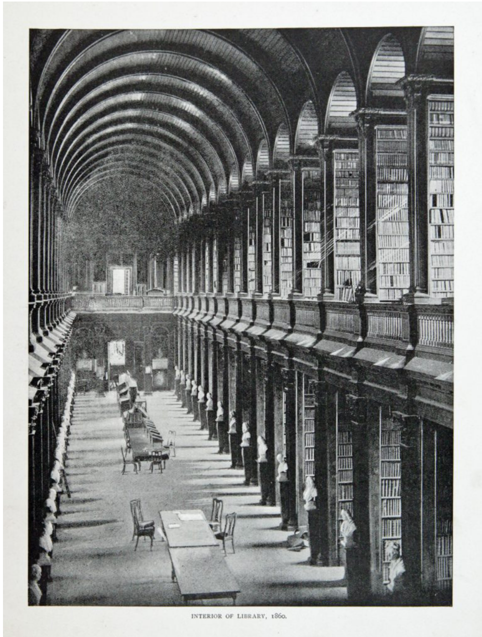
Trinity College Library, Thomas Burgh

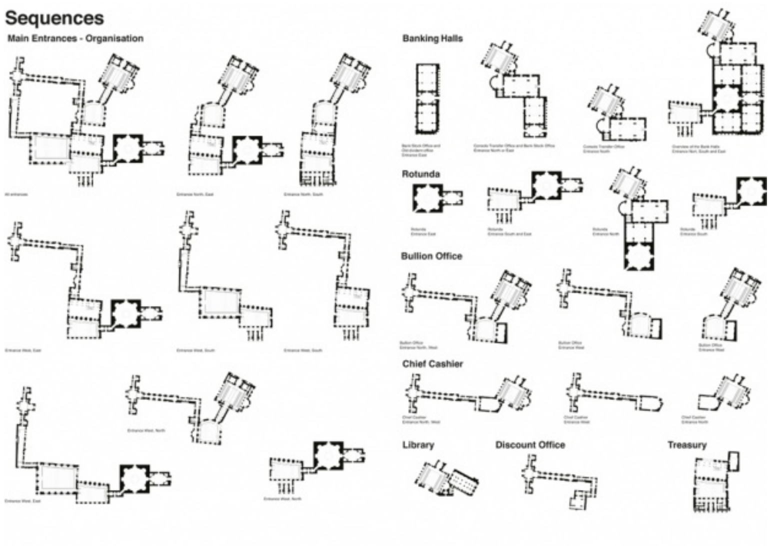
founded in 1592, image: Wikipedia commons

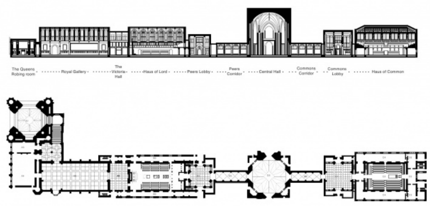
Bank of England, London

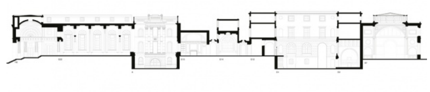
different spatial sequence - depending on the visitor's aim or role

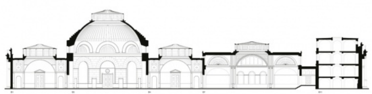
image source: Caruso Studio, ETH, FS 2013, caruso.arch.ethz.ch/archive/references/project/194

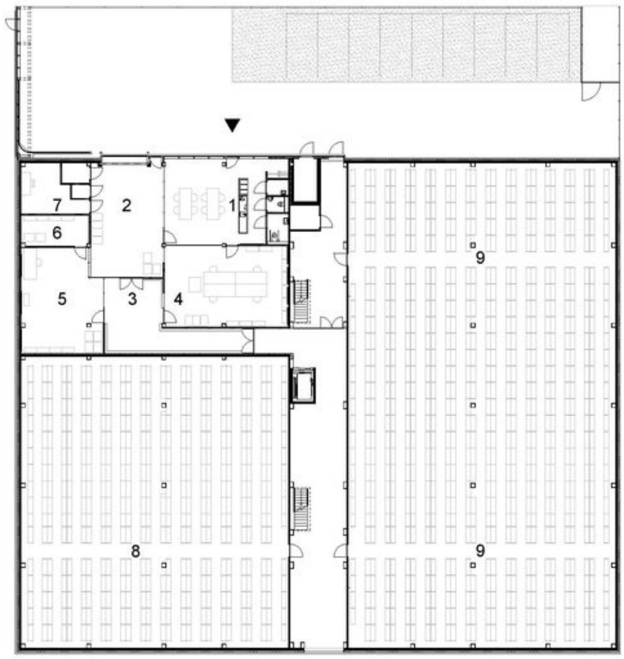

INTERIOR OF LIBRARY, 1860.



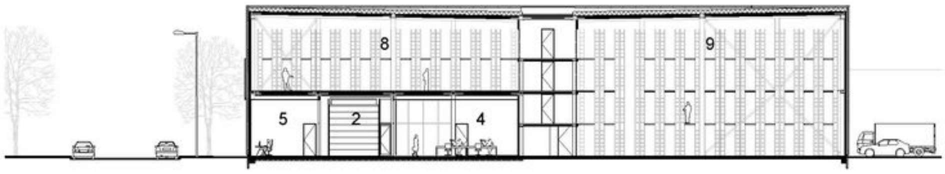








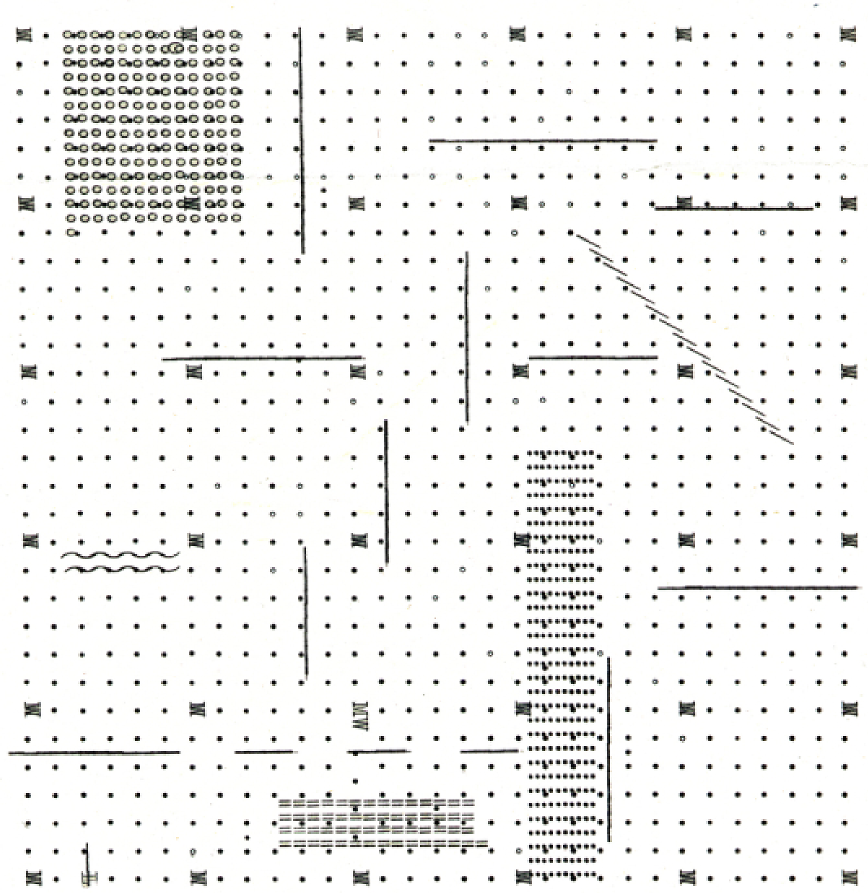
ground floor



longitudinal section

Logistics takes over the representative aspect of the archive

Archiefdepot Noord, 2019, plan and section by BAM Bouw en Techniek

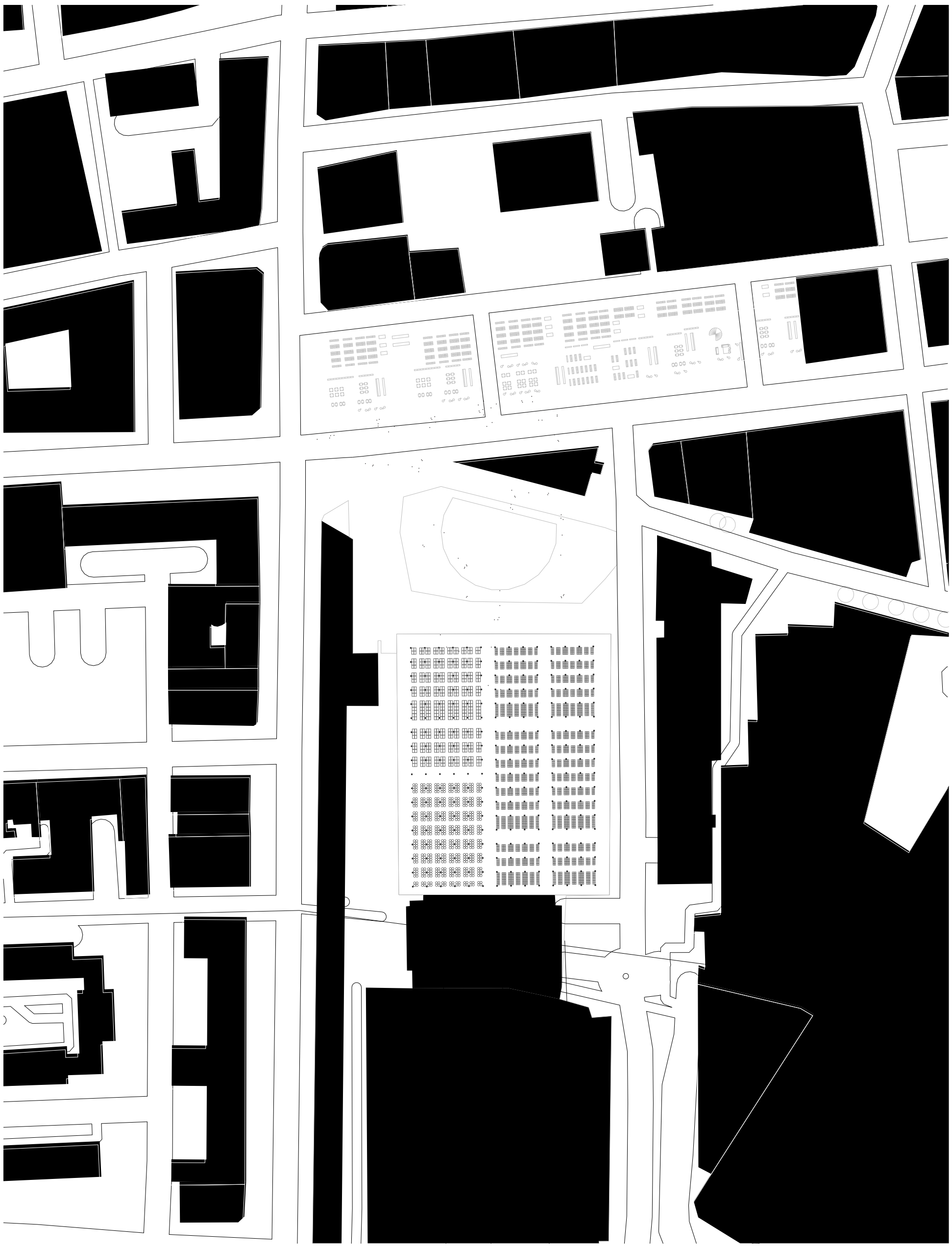


Unit-defined architecture
No-Stop City

by Archizoom

Unit-defined architecture

The Great Northern Warehouse
currently used as a shopping mall, Manchaster, UK



Canal Warehouse, Amsterdam footprint 415 m 2

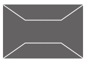
Watts Warehouse, Manchester footprint 2 400 m 2

Behrens Warehouse, Manchester footprint 2 840 m2

Great Northern Railway Company's Goods Warehouse, Manchester footprint 5 550 m 2

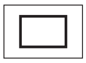
Zalando Warehouse, Germany footprint 101 500 m 2

ARCHITECTURAL TYPOLOGY OF STORAGE



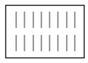
DARK SPACES

protection from sun exposure in most cases the light is either harmful for the collection or not needed in most rooms (data center)



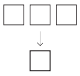
BOX IN BOX

protecting shell and treasure box hidden within



COMPRESSED VOLUME/PLAN

layout with maximal efficiency for storage, office spaces with more daylight and more spacious



MONO-FUNCTIONAL NOW= MULTI-FUNCTIONAL IN THE PAST

many start to provide some additional services to attract the market (warehouses-transport, label, packaging; data centers- 24h support service, additional security; archive- institutes, exhibitions, study centers, school lessons, research, cross-domain cooperation)

MODULAR

repetitive amount of shelfs, racks, servers, lockers, rooms etc

REACH OPTIMIZATION

human reach - lower shelfs and space height; while automated spaces are - as high as possible, using the full room hight

RESTRICTED ACCESS

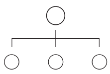
in a part or most of the building area

SECURITY

defines layout, affects both physical and digital network access

CLIMATE CONTROL

creating perfect climate (taking into account humidity, temperature, UV light protection, air quality etc.)



META-DATA, STRUCTURE AND HIERARCHY

need to create catalogue, systematic hierarchy and overview of stored objects - amount is overwhelming

DORMANT VALUE

hidden potential that is embedded in stored data/ objects; atmosphere of mystery, aura

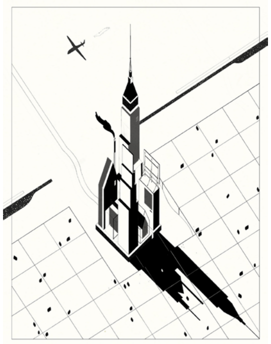
Anonymous Architecture of Data Centres

collage by author

2. Problem Analysis | Archive Fever

2.3. Problem Statement

Conclusion



Interface Towards the City
Drifting City, 2013, Bruna Canepa

In reality of a constantly increasing capacity of digital storage, we keep on gathering more, often unconsciously or with little curation of the collected content. We keep on creating a limitless cloud archive, that has an overwhelming physical presence that takes over hectare after hectare of land. Regardless of the content, a storage type that emerges is an opaque container defined by the size of a stored unit. All these content defined buildings, technical as they are, allow for almost no human presence, but do potentially manage through their sheer size to organize and control the context they inhabit, the territory. One cannot underestimate their urban impact in the coming future. However, the storage - once building the city (like Amsterdam canal warehouses, Hamburg Speicherstadt) - now moves away from it and becomes a servant to pure logistics and automation. There is an urgency to place storage on display and explore its dormant potential. Growing Internet of Things will require to reintroduce data units within the city. How it could be done and how data infrastructure could serve for the benefit of the city?

Introducing data into the culture
Thereupon, what are the spacial consequences of an act of placing data centre in the city? How the building could communicate with the public and the city?

Data Temples
Due to the Internet of Things and a growing number of metropolitan residents, it will be beneficial in the coming years to introduce smaller data centres into cities. Therefore it is worth to rethink data centre model and the role they could play in the urban tissue. Taking historical warehouse architecture - Amsterdam's merchant houses along the canals, Speicherstadt harbour district of Hamburg - or representative buildings of libraries, banks or archives, could data centres become more than just infrastructure in the urban context?

Rem Koolhaas, OMA, *Museum in the Countryside, Machine Landscapes: Architectures of the Post Anthropocene*, 2019, p.60

Quoting Rem Koolhaas '*At a moment when our collective history is digital, the data centre is becoming one of our most significant cultural typologies*' should it remain an anonymous magazine located on the periphery?

Studying history of architecture, libraries were also designed basing on the module of a book, however, considering its representative character - architects using the same unit created beautiful, magnificent rooms that were a place of admiration of the collection and proudly represented the institution. A reader, standing in such a delightful space, could have a feeling of being part of the history in front of him, something great and impressive.

Similarly, a data user, standing in a server room, can have this romantic impression, the pride of the possibilities and achievements of man. In a room dived in the darkness, warm and stifling, one stands in front of an infinite number of cabinets, cables and servers sparkling with blue lights. Irresistibly reminiscent of stained glass windows in gothic cathedrals and it is difficult to disagree with the accompanying analogy ... a place where incomprehensible things happen, difficult to explain, which we entrust and are depended on our everyday life ... this is where our data is housed.

2.4. Research Question - Architectural scale

1. What is the relation of a data storage as an architectural object to the city?

2. In the New Dark Ages, the media storage development only allowed us to store more is there a possibility to influence people to limit the amount they collect by explaining the unknown digital forces standing behind data flow?

BOOKS
x 290 000
(480 SHELFS)

AREA 520 M^2

12"PHONOGRAPH RECORDS
x 24 286

AREA 32 M^2

CD
x 13 080

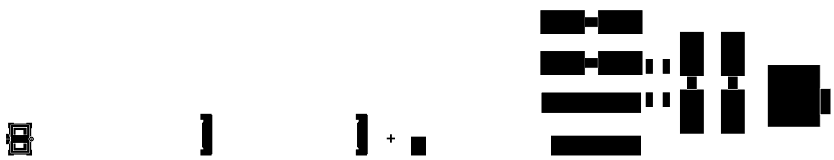
AREA 4 M^2

DVD
x 6 258

AREA 2 M^2

SSD DRIVE 1TB
x 1

AREA 0.1 M^2

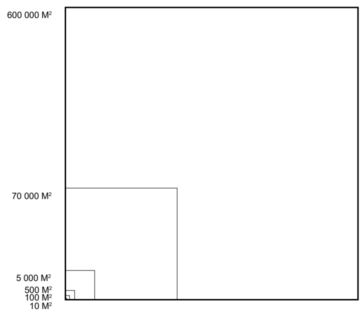


Amsterdam City Hall, NL
footprint 4 330 m^2

Amsterdam City Archive, NL
footprint 2 810 m^2

Archiefdepot Noord, 1 790 m^2
+ Amsterdam City Archive 2 810 m^2
= 4 600 m^2

Microsoft Government Data Center, Middenmeer, NL
footprint 100 850 m 2



Growth of Data Centers in Europe

2. Problem Analysis

2.5. Research Framework

Research Methods - Analysis Methods

The trans-scalar approach of the studio integrates investigation from the level of territory of the North Sea region up to the ground and body scale. Coming from the wider context to one's project-specific research subject. This approach proposes a variety of research methods and techniques. The foundation lies in the collective phase that combines theory and visual representation is an act of mapping, which is a conscious act of heuristic research. This phase allows for the study of the North Sea from various perspectives lenses (geological, ecological, political, and social) and the translation of scientific data into maps documenting the current state and future projections. The wide spectrum of topics as well as the formulation of the future scenarios broadened deeper understanding of studied trends and their impact. The aim to create collectively an atlas became a tool for research as well as representation of the assembled conclusions.

Moving to the scale of the individual project the focus shifts from the territorial scale into the site-specific analysis. The collected data about Hamburg is informed by literature and will be extended by an on-site inquiry. At this stage, different means and methods come into research relevant to the investigation scale. These include mapping, drawing and collage, text and photography.

Considering the vast amount of information on the area of interest, the research may be difficult to manage. Therefore, the combination of multiple techniques allows for dynamic change of the method depending on the needs of the research. Such strategy enables gathering of both raw data and the ephemeral attributes, temporal dynamics and atmospheres, and is, therefore, a value means for phenomenological inquiry. Along the first research steps, a literary inquiry about data, storage and archiving, content defined architecture is undertaken. The undertaken review of the literature broadens the knowledge, historical development and theory of the subject. What is more, it forms the foundation for a heuristic *research by design* approach. Within the broader context of global trends, I gave particular attention to the *Archive Fever* defined by J. Derrida, as well as a growing amount of digital data. A complementary research method is moreover provided by case-study analysis. Multiple examples (listed in the bibliography below) illustrate the various storage typologies, from museum to warehouses. By reinterpreting the storage spaces, I was able to get a better grip of the type and its common physical materialization, their components, function and finally their stories. This wide overview offers a look at what the project could become in the further steps.

Research by Design – an inquiry in which design is an essential part of the research process – is applied as a common strategy. It relies on continual reflection and reframing to be made throughout the design process, perpetually testing and adapting to new potential solutions. Therefore, according to the needs, the research is extended along the design.

Site

3. Site: Speicherstadt, Hamburg

3.1. Identity - Historical Precedents

The city of Hamburg has a strong historical connection with the North Sea region and harbour cities – which is indicated even in its official name: the Free and Hanseatic City of Hamburg (German: Freie und Hansestadt Hamburg; Low Saxon: Friee un Hansestadt Hamborg). The official name enhence Hamburg's long tradition of self-governmence. The city is considered the hub of European coffee culture, every year 700 000 tones of beans are coming through the city's port. There are about 200 commercial rosters, 60 coffee houses. As the second-largest city in Germany and 8th largest city in the European Union (with a population approx. 1.85 million) and Europe's third-largest port, it is a strongly growing region. As a matter of fact, HafenCity is expanding the city's land by 40%. This aspect indicates that data storage is and will be an important aspect for the developing city.

Speicherstadt

1. source of information: Unesco World Heritage website

Both districts of Speicherstadt and the nearby Kontorhaus are densely built urban areas in the city centre of Hamburg. The Warehouse District initially developed between 1885 and 1927, on an archipelago of narrow islands (1.1 km-long) in the Elbe River. After World War II it was partially rebuilt from 1949 to 1967. In 2015 Speicherstadt was awarded a UNESCO World Heritage Site Award, due to the unique size of the unified historic port warehouse complexes[1]. It is among the largest consistent port districts with warehouses (300,000 sq m) in the world. It contains 15 storage blocks connected with canals. The nearby district of Kontorhaus is a coherent, densely built area with eight office complexes built between the 1920s and the 1950s.

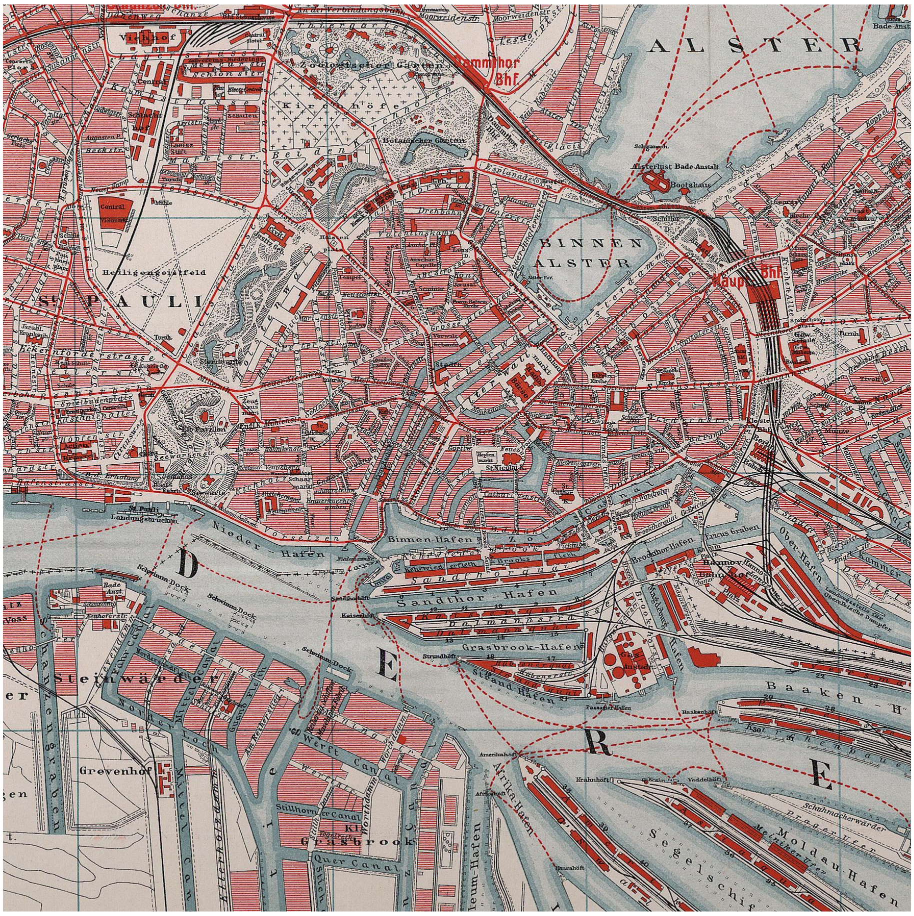
Combined these two districts are an example of an urban arrangement influenced directly by the form of port activities. Warehouses besides the historical facades were designed following modern technical solutions – all connected with rail, road and canal network. Tied by the emblematic Chilehaus, the vast office buildings of the Kontorhaus area have unique modernist brick-cladding that enhances a unified function. Accelerated growth of international trade at the end of the 19th century and beginning of the 20th century are illustrated through the architecture of the Speicherstadt, that was listed in 1991.

The future protection of the district is requiring preservation of the historic buildings and character of the area. Maintenance or improvement of the quality of life of the residents of Hamburg is advised as a direction of preservation.

The free zone is the main reason for the port's success. In 1871, Hamburg became part of the German Empire, however, still was able to maintain its tax and customs regulations. This opportunity remained till 1881 when a new customs union was established. From this period only the free harbour zone along the Elbe river was excluded from import sales taxes and customs. The final annexation of Hamburg by the German Empire was planned for 1888, giving the city almost 7 years to build needed storage buildings within new free port borders. For this reason, around 24 000 people had to be evicted and around 1 100 houses torn down, to make room for the new construction to take place. Five years later, in 1888, Emperor Wilhelm II inaugurated Speicherstadt. Interrupted by World War I, the district was finalised in 1927. In the time of World War II, during Operation Gomorrha the western part of Speicherstadt was destroyed. Restorations were concluded in 1967. And on 1 January 2013, an era came to a finish line when the free economic zone of Speicherstadt, which covered almost a fifth of Hamburg's entire port area, was dissolved.

Hamburg, 1853

Source: iiif.lib.harvard.edu/manifests/view/ids:8543928



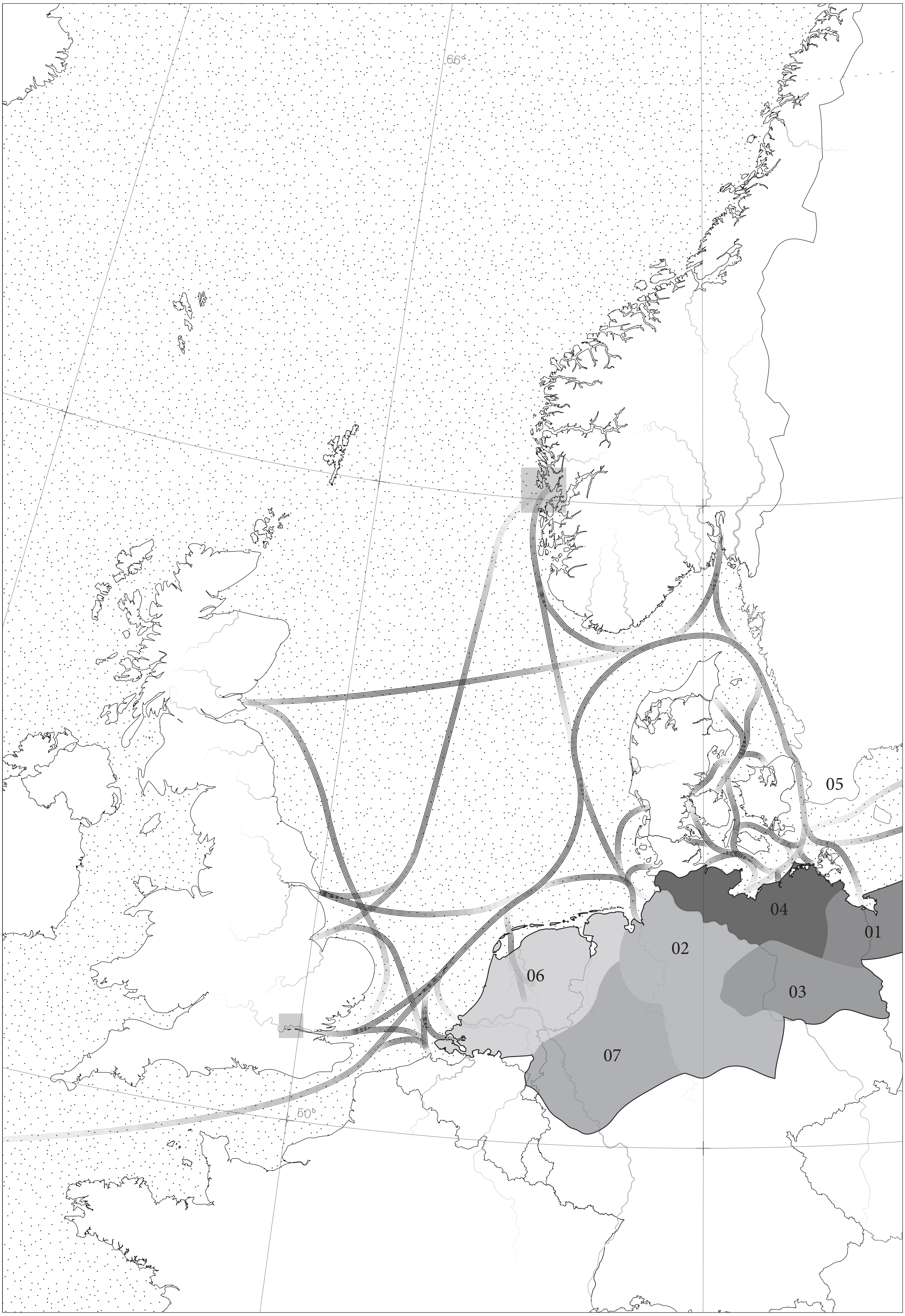
Hamburg, 1900

Source: Universitats und Landsbibliothek Darmstadt

Hanseatic League

Scale 1:10 000 000
Source https://www.britannica.com, map by Martin Kolev, TT 2019

01 Wend. and Pomm. Cities
02 Sächsisch Cities
03 Märkishe
04 Prusiche Cities
05 Swedish Cities
06 Dutch Cities
07 Westfalische Cities
≡ Shipping Flows - Density
□ Hanseatic Ports


66°
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3.2. Site Analysis

1. source of information: Hamburger Hafen und Logistik AG (HHLA)

2. source of information: Wikipedia

Architectural heritage

The brick façades in neo-Gothic style are described as characteristic for the "Hanoverian School"[1].

One of the organisation students - Franz Andreas Meyer, in 1885, was employed in a role of an advisor in Hamburger Freihafen-Lagerhaus-Gesellschaft (today HHLA), the owner of the warehouses. Franz Andreas Meyer evaluated all prepared plans for the new construction of Speicherstadt from not only technical, but also conceptual and design perspective. That is the reason why the district has such a high level of uniformity. Enhenced also through unified material and height of approx. 20 meters.

Current function

The Speicherstadt became a main tourist attraction in Hamburg. Around the district there are spread various museums like the Customs Museum, Miniatur Wunderland and museum of Speicherstadt. Many of the preserved buildings are still being used as warehouses. In 2005 the companies located in the area handled one-third of the world's carpet production, as well as other goods such as cocoa nuts, coffee beans, tea, spices, maritime equipment, and lastly electronics [2].

While the port is moving away from the city abandoning the land and buildings they partially change function. It is becoming a part of the city centre and HafenCity district. This transition shows the changing interface of the city. Shift from the storage and harbour district – from transition zone into a destination.

History of the Speicherstadt

Source: hhla.de/en/history/speicherstadt/history.html

25 May 1881

Hamburg signed the treaty with the German Empire regarding its duty-free trading, but kept its customs authority status and the right to establish a free port.

1883

The Kehrwieder and Wandrahm districts chosen for the construction of the Speicherstadt.

1885

The HFLG (Hamburger Freihafen-Lagerhaus Gesellschaft) shipping company was founded for the construction and neutral and transparent rental of the warehouses under uniform direction.

1888

Hamburg implemented its customs-free zone and Kaiser Wilhelm II came to perform a formal ceremony on 29 October.

1885-1927

Construction of the Speicherstadt, was split in tree phases.

1927

24 warehouse units with around 300,000 square metres of warehouse space were completed and bridge gates marked the free port borders and created a striking "Warehouse City" skyline.

1943/44

During World War II over 50 percent of Speicherstadt was destroyed.

1946-67

Under the architects Werner Kallmorgen and HHLA's building supervision, however, the bulk of the warehouses were preserved and restored, but in some cases that applied only to the facades (Block M).

1960

Until the introduction of the container in the 1950s and the restructuring of the harbour, quartermasters and ship's chandlers determined the scene in Speicherstadt.

1980

A substantial structural transformation. Container revolutionized the port and storage logistics. In the 1980s Speicherstadt developed into the world's largest storage and trading centre for Oriental carpets.

1991

3.3 hectares are removed from the port area and privatized. The remaining area of Speicherstadt is listed for protection as a historic monument.

1997

Hamburg Mayor H. Voscherau presents the HafenCity Project (by Architect Volkwin Marg and Peter Dietrich).

1999

The Hamburg Dungeon became the first permanent tourist attraction in the Speicherstadt historical warehouse district.

1 January 2003

Speicherstadt is relieved of its Freeport status.

2012

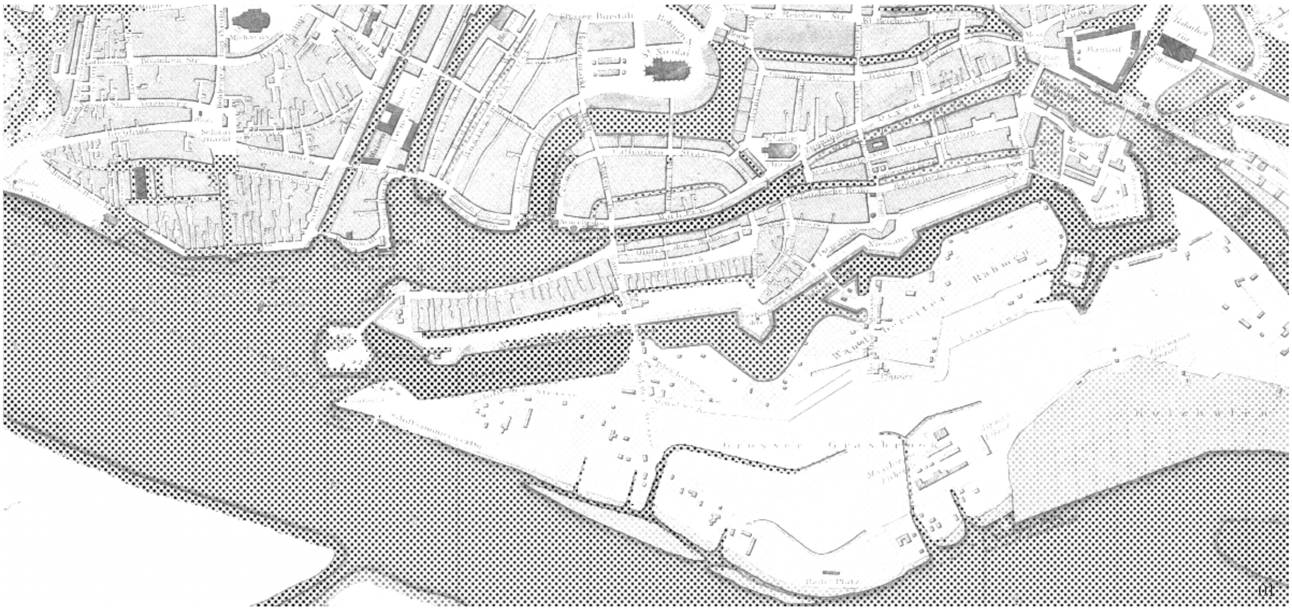
Speicherstadt is no longer part of the port. Hamburg's parliament shifts the boundaries and adopts a development scheme.

2015

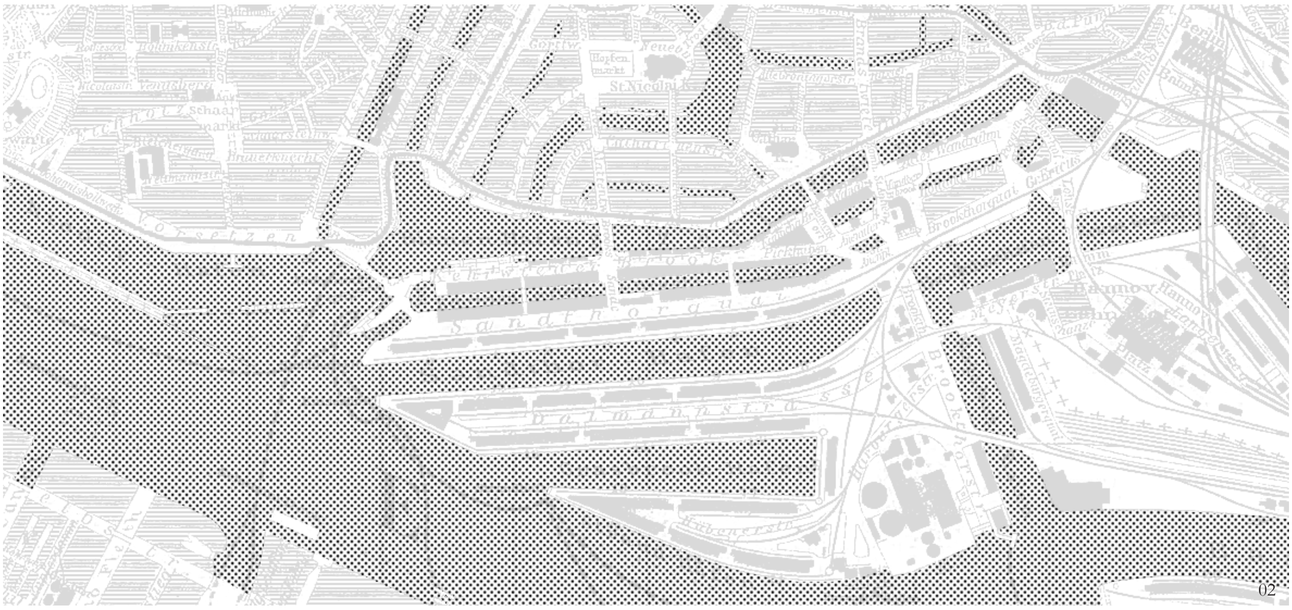
Hamburg's Speicherstadt designated along with the neighbouring Kontorhaus area as a UNESCO World Heritage Site.

History of the Speicherstadt

01 Hamburg, 1853
02 Hamburg, 1900
03 Hamburg, 1944



01



02

03

The selected site is located in Hamburg.

Territorial

1. It is the second-largest city in Germany after Berlin and 8th largest city in the European Union with a citizens around 1.84 million and Europe's third-largest port, it is a strongly growing region. Therefore, data storage is and will be an important aspect for the developing city.
Which is visible through the dense network of fibre optic cables and amount of data centers.

2. The city has a strong historical connection with the North Sea region and harbour cities – which is indicated even in its official name: the Free and Hanseatic City of Hamburg (German: Freie und Hansestadt Hamburg; Low Saxon: Friee un Hansestadt Hamborg).

Urban

3. It is the biggest coherent warehouse district in the world, protected by UNESCO. Designed as a unified part of the city, with architecture defined by the stored goods.

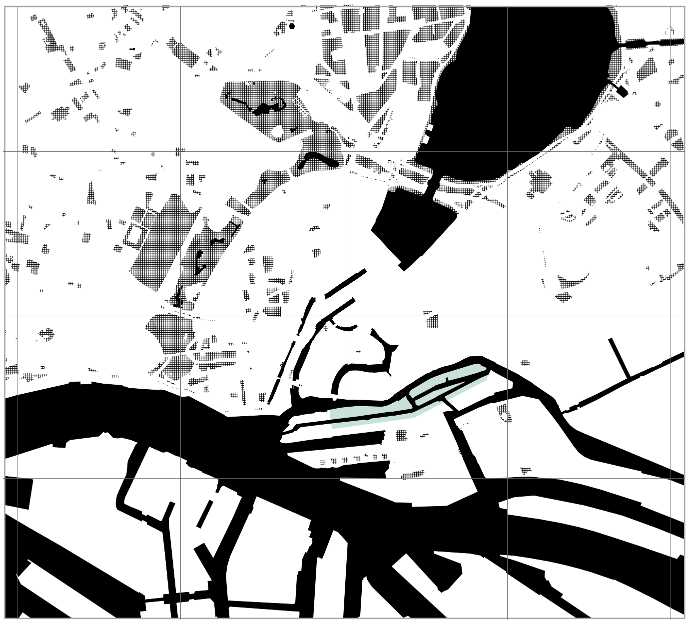
4. While the port is moving away from the city abandoning the land and buildings they partially change function. It is becoming a part of the city centre and HafenCity district.
This transition shows the changing interface of the city. Shift from the storage and harbour district – from transition zone into a destination.

HafenCity district lies on the periphery of the harbour and was an abandoned for years. It was divided from the Hamburg center through a border of a customs fence till the first decade of 21 century. The proposed master plan was based on the interaction between current and planned buildings, canals and public character and various functions.

Infrastructure

Urban Analysis

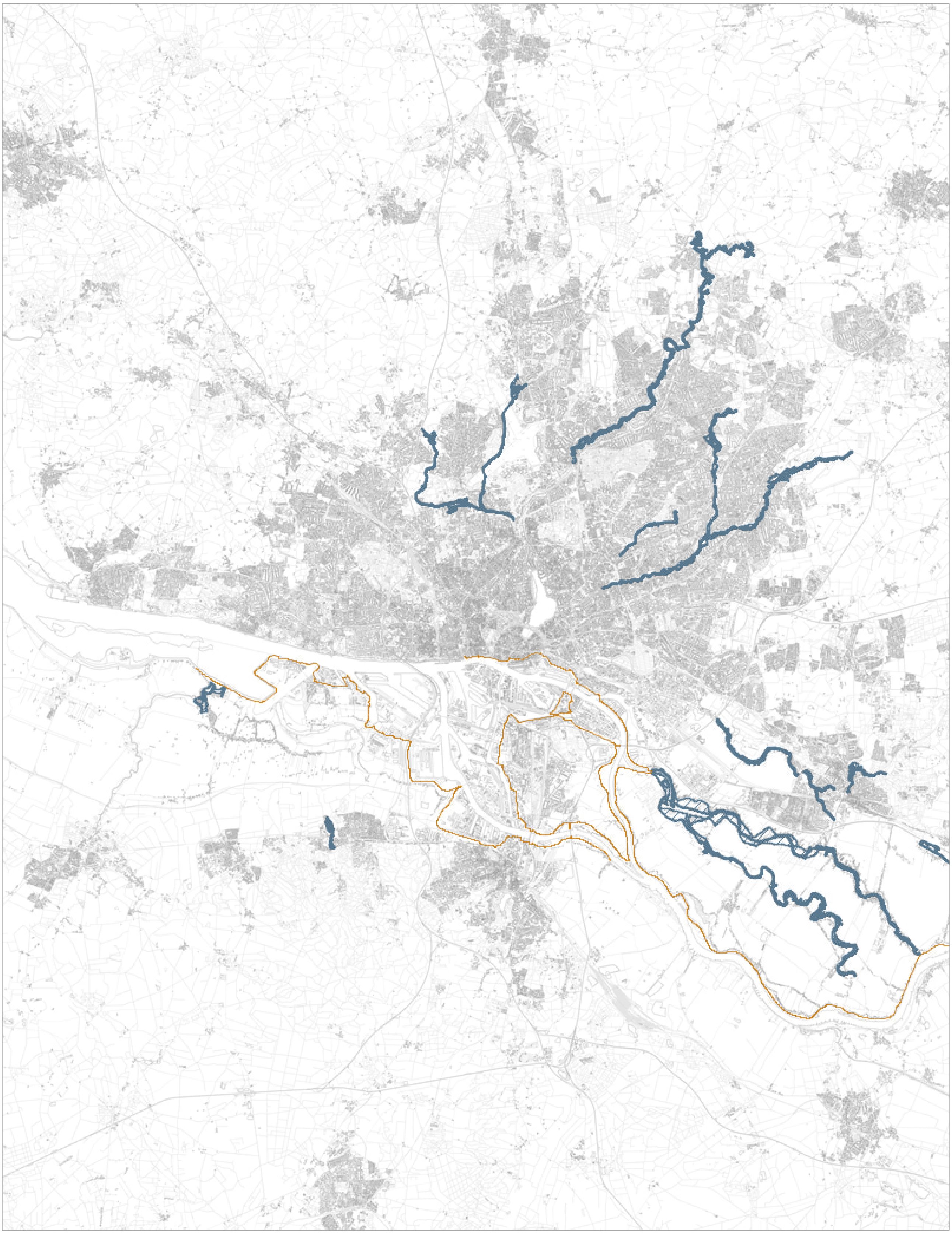
01 Waterscape and Green Spaces
02 Schwartzplan
03 Road Networks



Speicherstadt is in the area of flood risk as it is not protected by dikes and Elbe is a tidal river. HafenCity is built on the 4m plinth to avoid flooding due to sea level rise in the future.

Dikes and Floodplains in Hamburg
Source: geoportal-hamburg.de

- Dikes
- Floodplains



Future Data Centres

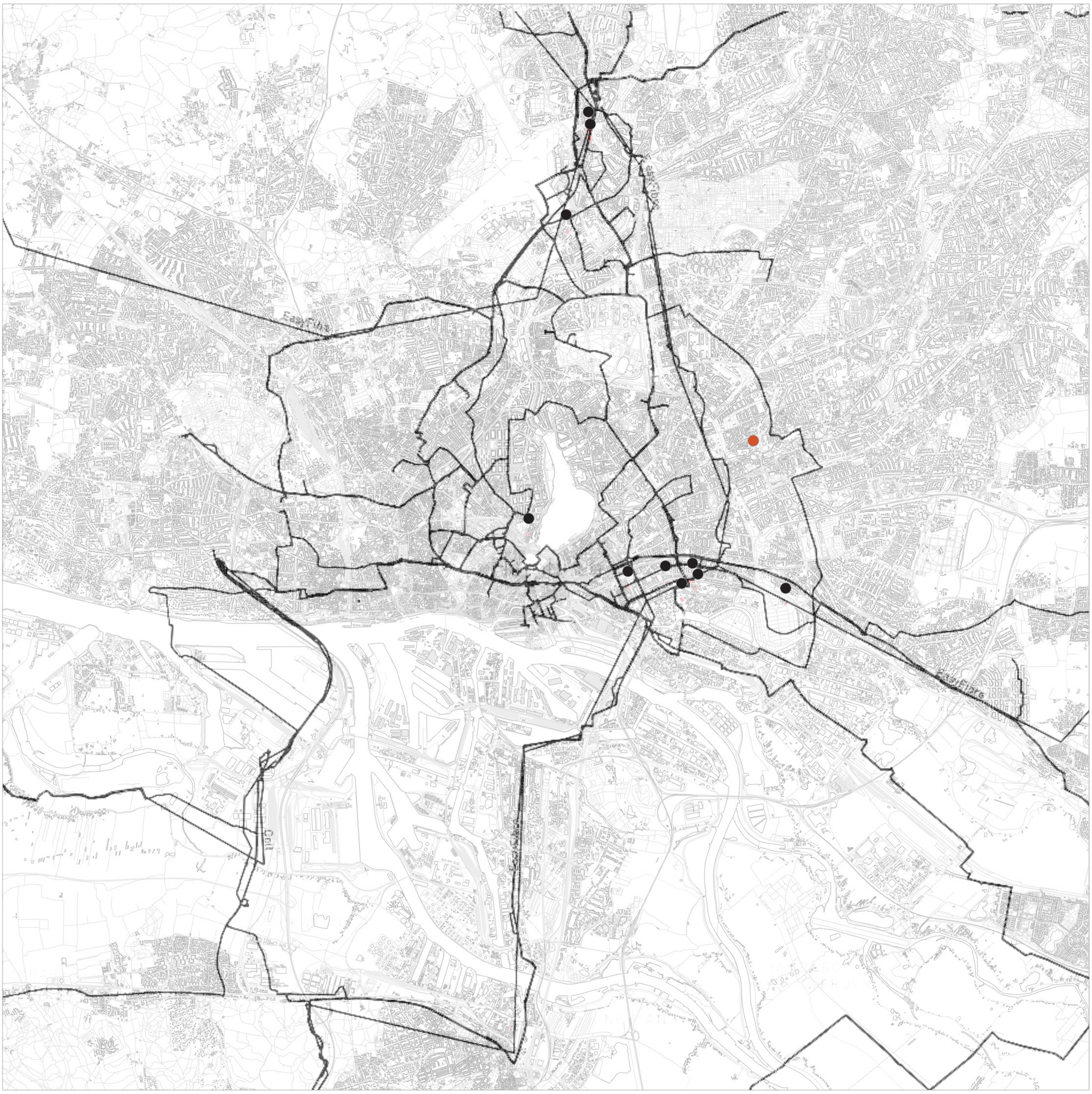
	LOCATION	STRUCTURES	ENERGY EFFICENCY	RENEWABLES	STORAGE
TODAY	*near dense fiber networks*	*cloud and on-premise hybrid cloud, the mix of cloud and on-premise solutions*	*air-based cooling cold and hot air needed to keep equipment at the right temperature*	*plugged into the grid*	*over 90% of storage device are HDDs (Hard Disk Drives)*
TOMOMRROW	*cool, stable climates for efficency and energy savings*	*mega DC benefit from economies of scale, micro DC benefit latency and portability*	*liquid and AI-assisted cooling*	*big tech buys renewables*	*SSDs (Solid State Drives) become more prevalent in DC - dropping prices per unit*
FUTURE	*smaller, close to the cities, add new capacity quickly, offshore technologies*	*no DC at all?* *data storage and computional resources are crowd sourced through P2P device networks*	*reusing excess heat heat is recycled and redirected to communities*	*RE farms and DC work together tech helps small buyers and producers connect*	*more with less innovations such as HAMR (Heat-Assisted Magnetic Recording, 400-500°, 100 TB by 2025 on one drive) and liquid-state storage (metal liquid, nanoparticles, 1 table spoon=1TB) provide greater capacity at lower cost*

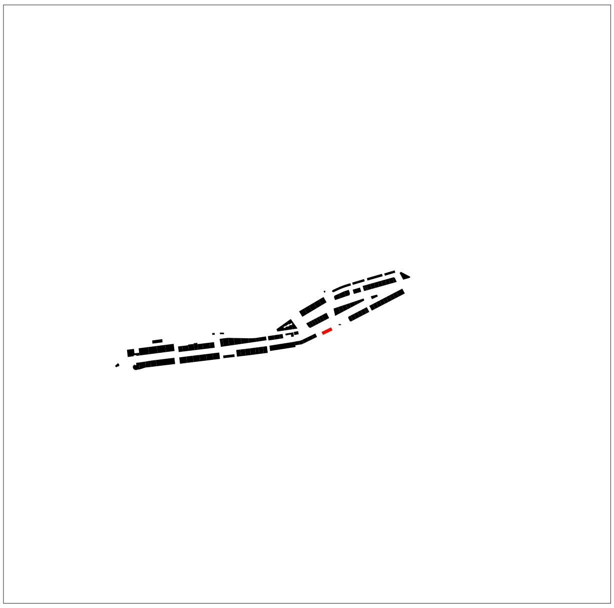
Hamburg is densely covered with fibre optic network, providing high quality connection. Currently there are 7 data centres on the East, 3 on the North (close to the airport) and one in the city centre close to business hub.
The city archive moved away from the old Town Hall and was located on the outskirts.

Data Centers and Fibre Optic cable network, Hamburg

Source: www.datacente.rs, fibre optic: live.infrapedia.com

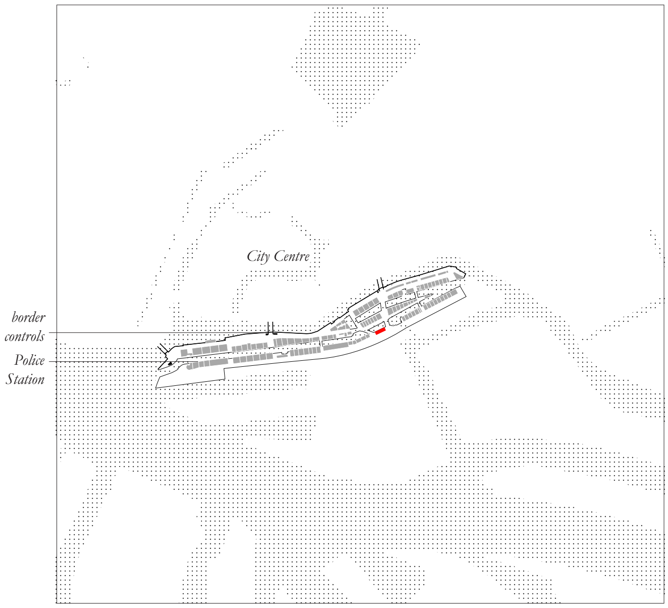
- ● Data Centers
- — Fibre Optic
- ● State Archives of the Free and Hanseatic City of Hamburg





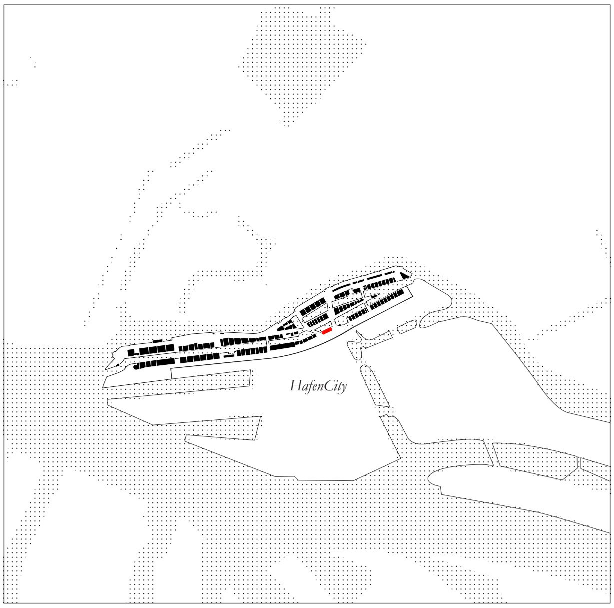
ENCLOSING STORAGE DISTRICT

Speicherstadt in relation to the site



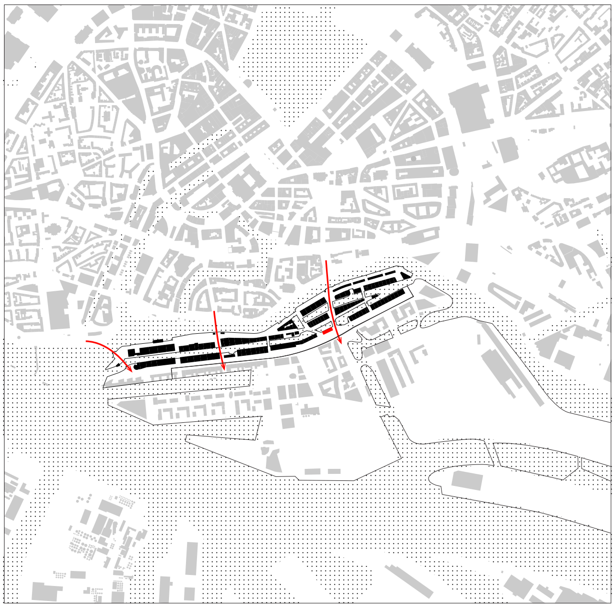
SPEICHERSTADT CHANGING CHARACTER

Fenced access to the port storage area, separated from the city



RECLAIMINED LAND

Port is moving away - new HafenCity district is emerging, extending Hamburg area by 40%



SPEICHERSTDT AS A BRIDGE

Speicherstadt becomes a connection, link between the city and the new district

Selected site in the urban context

DATA CENTER LOCATION

	URBAN	RURAL
ELECTRIC POWER	+ more stable and reliable power grid - higher costs	+ willing to negotiate power price or give tax breaks - reliability issues
PROXIMITY FACTORS	+ direct access to major Internet networks + better options for air and ground travel + easy access to the facility in case of disaster + gives staff possibility to fix small issues and do preventative maintenance - with no need to take a day off - avoiding serious issues with time + hardware maintenance - reliable delivery of spare parts in the expected amount of time + easier to take potential customers on a data centre tour, or get technical staff into meetings + faster access for mission-critical and response-time sensitive applications	- long distance from a major customer hub will decrease output for latency-sensitive application - data backups can take longer and raise operating costs - fewer modes of transport - it could be more difficult to get access to the facility after a disaster
WEATHER AND NATURAL RISK FACTORS	+ emergency resources + could be better prepared to react in case of disaster - but it will prioritize citizens over infrastructure + possibility to build vertical - might be safer	- lack of available emergency resources? - possibly lack of power, and fluent communication and transportation - the construction usually is built on the ground floor (exposition to flooding etc.)
INFRASTRUCTURE COST FACTORS	+ possibility to use third-parties to bring down your infrastructure and communication costs	+ can provide significant cost-savings in construction - but it might require higher investment in telecommunication + to extend the benefits to citizens, local governments might co-invest to help you update communication networks; one can take advantage of such opportunities to save money
EMPLOYEE RETENTION FACTORS Employs only a few hundred people to stay secure, and up and running. But really data centers are a symbol of a much larger scale of economic activity. For one, you have the sales, marketing, and operations staff.	+ IT employees are well-paid who prefer city life + housing, health, education, recreation and social conditions of the surrounding area + community in the city - benefit for the knowledge exchange - best practice gets exchanged and new partners found	- less attractive for top talents - atracting different age groups of the IT market - employee inflow might becomes an issue
POLITICAL FACTORS	+ political initiatives and strategic partnerships + legislation to attract DC - projects to each of which the local authorities are projected to contribute millions a year in revenues; over time , the economic effect of these ventures will be exposed as local governments seek to secure the creation of data centres of all types and sizes + typical data centre project may contribute about 30%-40% of its construction investments to the local economy + about 10 million euro yearly in revenues - through creaed jobs (directly and indirectly) + economic benefits from outsourced jobs + infusion of outsource revenue and spending example: Chicago's Data Center Express project	

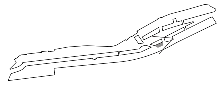
source: instor.com/blog/where-to-build-your-data-center-urban-vs-rural/
www.dartpoints.com/why-your-community-needs-a-data-center-and-how-to-attract-one/

St. Annenplatz

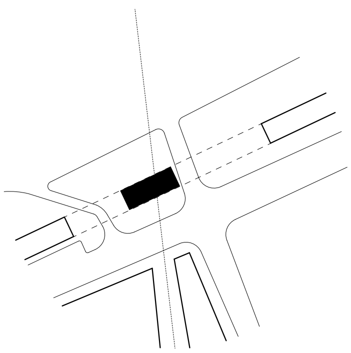
The plaza is located on the edge of the warehouse district. In the original design, this plot was designed as a storage building quarter, however, due to the WWII, the plan was never realised. Surrounded from all sides with streets and canal, the site is exposed and seen from all directions.

Currently St. Annenplatz is an empty space, where people are rare visitors and cars are being parked from time to time. The square is lacking a defining function and separation from the loud Am Sandtorkai street. Lastly, a connection between Speicherstadt and HafenCity is left open, enhanced only through boulevard pavement materiality.

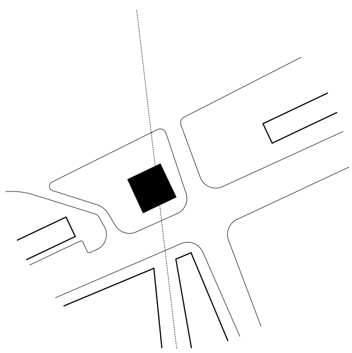
The Site
St. Annenplatz
photo by Patrick Noack



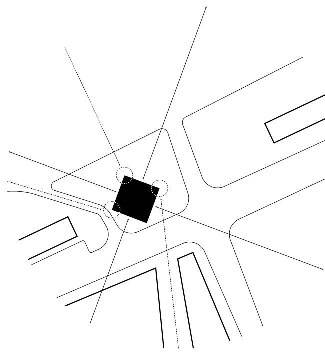
Positioning on the site



Building footprint proposed in the Speicherstadt Master plan on the boulevard axis



Data Centre footprint



Orientation towards the views

Speicherstadt as a Unit-Defined district

Speicherstadt is the largest warehouse district in the world. All buildings are constructed on timber-pile foundations. Designed as a unified part of the city, defined by the units of stored goods. It is an example of the largest unified historic areas of harbour grainers with area approximately 300,000 sq m. In the area 15 large storage blocks were built with a connection through canal network. Located in the port of Hamburg — in the borders of the HafenCity was constructed between 1883 to 1927. Fast growth is an example of the effect of successful international trade in the late 19th and early 20th centuries.

It is in particular interesting for the project due to the fact that it was designed as a storage district defined by the goods unit. Data storage could fit well in this particular context.

Importance of coffee trade

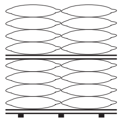
Coffee has played a substantial role in Hamburg history even before the German unification. In 1871 a customs free area Speicherstadt was created within the Hamburg harbour to enable the tax free wholesaling of imported coffee beans. Hamburg ever since has been the European entry point for the unroasted coffee beans. The tax free area known as the "Speicherstadt" (Storage City) is used to store and wholesaling products such as coffee, tobacco, tea and spices. The Speicherstadt was completed in 1883 and kept the status of a tax free area until 2003. However, Hamburg is still the hub for coffee in Europe. Kaffeeklappe (cafes) are very popular in the city. Raw coffee is imported from Brazil, Ethiopia, Vietnam to the port of Hamburg and distributed around European continent. Many of well known coffee companies are located in the area, including 200 commercial rosters, 60 coffee houses (way more than in Vienna - that is considered the hub of European coffee culture). Each year about 700 000 tones of beans are coming through port.

Speicherstadt, the port of Hamburg

Relation of the unit to definition of the warehouse architecture and district

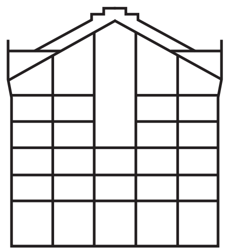
unit

sack of the coffee beans



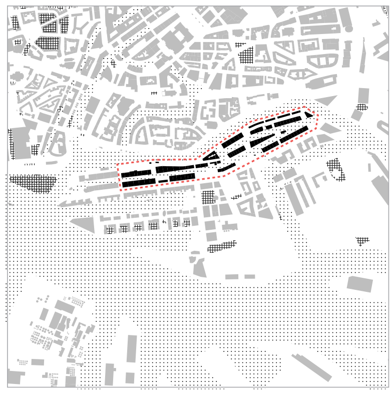
rack

sack of the coffee beans sacks,
storage unit



building

floors filled with racks
warehouse

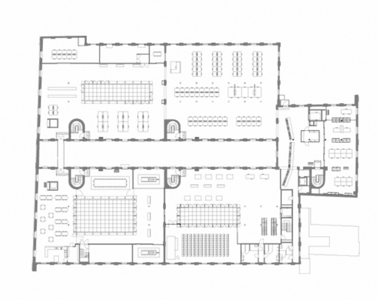


district - part of the city

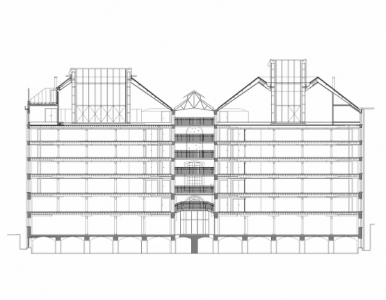
warehouses Speicherstadt,
the port of Hamburg

Reference |
Conversion of the warehouse into city archive

St-Felix Warehouse Antwerp, Belgium, 2006, Robbrecht en Daem architecten



Plan of the renovated Felix Archive, attic, reading rooms and lecture hall



Cross-section of the renovated Felix Archive

The Felix Archives are located in the Sint-Felix Warehouse of approximately 20,000 sq m, an iconic part of historical port in Antwerp.

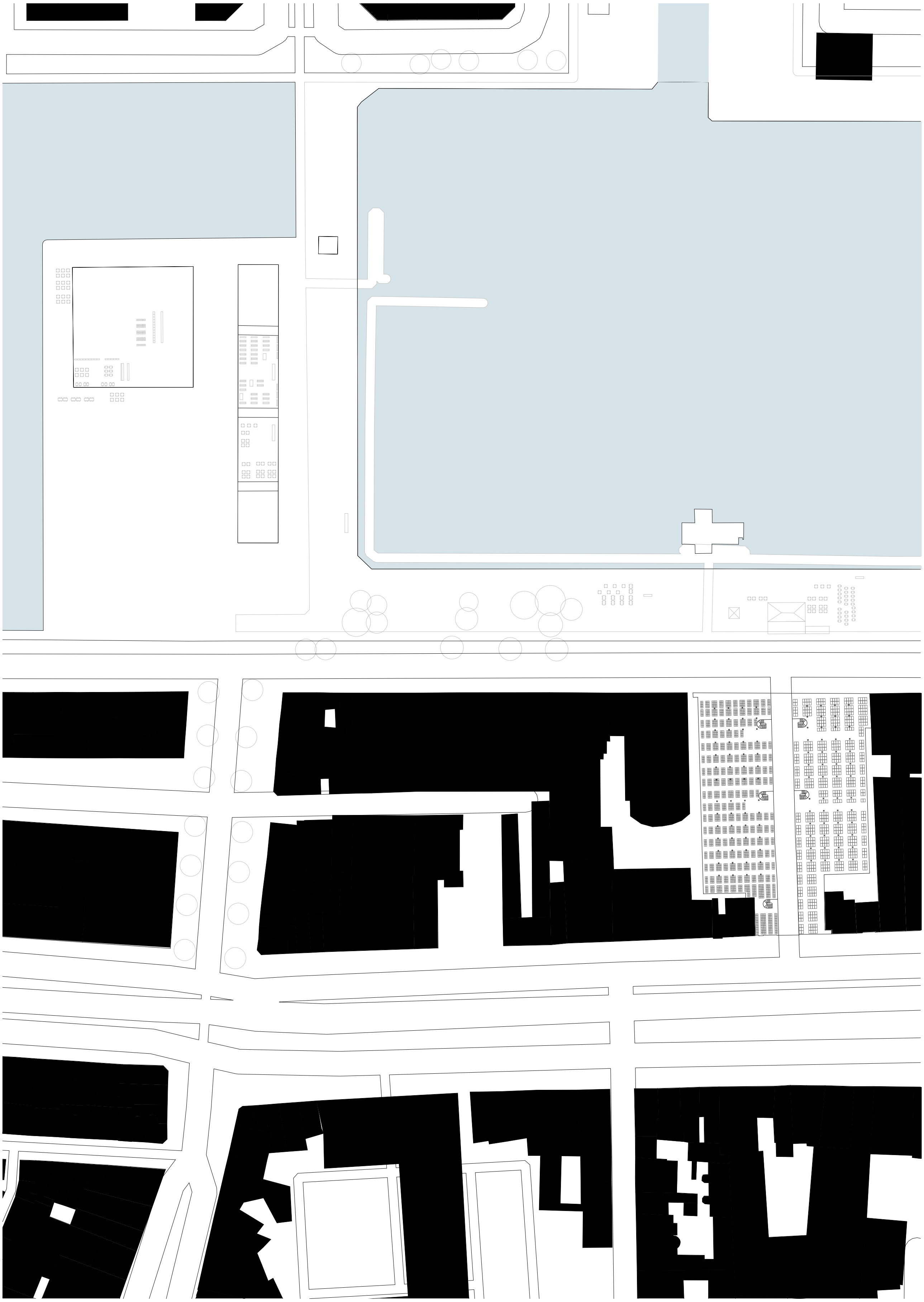
The top floor gained a new wooden roof structure which frames reading area and study rooms. The archive is currently accessible through a semi-public internal passage, that served as a fire division.

Semi-public internal street - the warehouse was divided for fire protection.

image source: www.robbrechtendaem.com/projects/libraries-archives/st.-felix-warehouse-antwerp

St-Felix Warehouse

Antwerp, Belgium, renovated in 2006



3. Problem Analysis

3.3. Problem Statement

Introducing Data Storage into the city

Aspects that work for the benefit of placing data centre within Speicherstadt, Hamburg is a dense fibre optic network. As a harbour city, it is also rich in tidal and wind energy that can be used efficiently as the main energy source. While land abandoned by the harbour is transformed into a new neighbourhood it creates ground for innovative design and new solutions like a reuse of excess heat produced by servers for district heating. Compression of a rural and urban potential location for server farm shows the benefits that in the nearest future will bring providers of the latency-critical services into the cities. The urban location provides security, limits infrastructure costs and opens access to the best IT employees on the market.
The crucial question is how to introducing Data Centre into the culture in a way to bring awareness and create a valuable part of the city?

Non-attractive plaza

The selected site in Speicherstadt – St. Annenplatz currently does not fulfil its public function as it is lacking function that would attract people and make them stay on the plaza for longer. It was originally intended as a built block, however, currently, such a footprint would interfere with HafenCity masterplan and promenade crossing the plaza. The emerging HafenCity is missing a market place, there are few small local shops, however, to reach any grocery shop there is a need to use a car or public transport. Another aspect is a flood risk that needs to be taken into account.

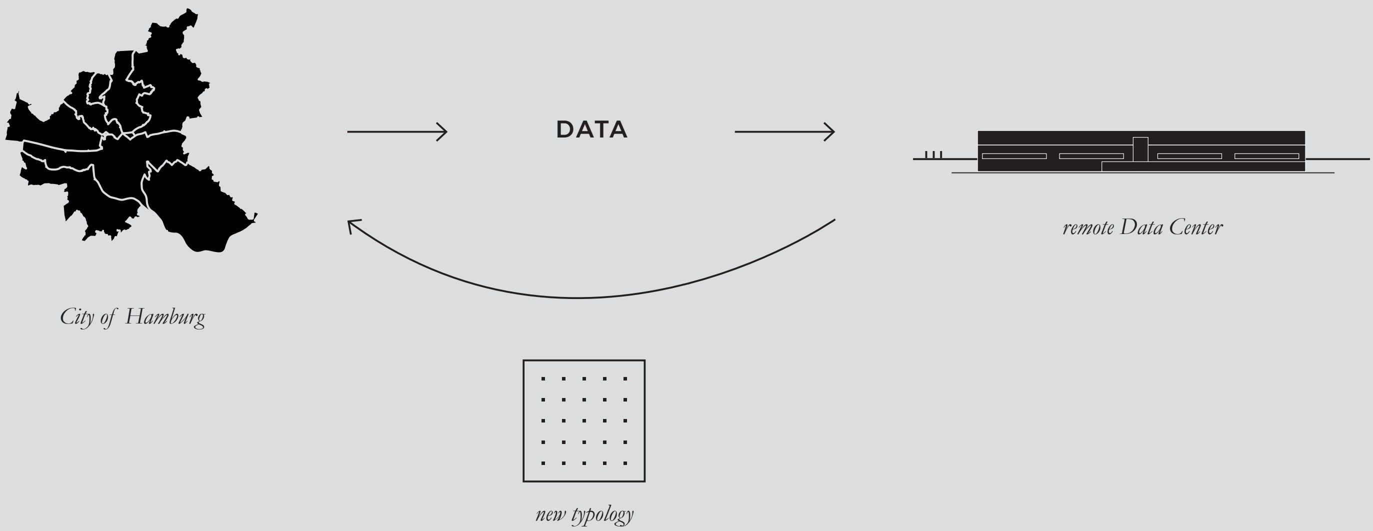
Creation of a node

Speicherstadt undoubtedly has high architectural value, however, designed as storage buildings are completely closed on the ground level and do not interact with street life in any way. Therefore, while crossing Speicherstadt islands, it seems to be enclosed and detached from the city's tissue. With city-centre, the warehouse district and new neighbourhood of HafenCity – there is a need emerging for connecting all these periods, functions and stories into one narration to enhance Hamburg's character.

The Cloud
representing intangible aspect of digital data

Concept Model by author, 2019

The Project


City of Hamburg
DATA
remote Data Center
new typology

4. The Project

4.1. Proposition

Act of placing a data centre within the city – is a statement, a physical representation of the digital cloud. However, it is based on the current trends in technology, among others, the Internet of Things and a growing amount of latency dependent applications will generate a need to introduce data into the cities. Having this shift on the horizon, I believe that it is a good moment to redefine existing data centre typology. Even though data is already fully integrated and present in our lives, we rarely acknowledge it. What is more, due to a lack of understanding of data flows we are often excluded from the discussion on the degree of its presence in our lives or surveillance.

Hereby, I would like to note that through this project I do not postulate that all data centres should be placed in the cities, nor that this is the best location for this infrastructure. The decision to place data storage is based on the extended research of the industry future predictions and foreseeing coming changes. On the other hand, it is a provocation, to face waste - the amount of data we produce and store so hastily.

The project aims to bring attention to the impact of the archive fever on the tangible space close to citizens of Hamburg. Lastly, quoting Rem Koolhaas: At a moment when our collective history is digital, the data centre is becoming one of our most significant cultural typologies. In this context, the spaces of data storage gain another dimension of importance.
What are the consequences of placing data centre storage in the city?

In the context of the ever-growing amount of data – architectural expansion stops to be relevant. Based on the history of storage – the ability to store more just makes us store more, trying to preserve as much as possible. On the one hand, it frees us from our imperfect memory – on the other hand, it has a malignant effect to get lost in data. The cloud makes data even more intangible, and if we will be represented that way it will dominate our landscape and cities before we realise.

The project is designed as a node, besides being a point of access to the European and world network, the project also aims to become a bonding element in the urban context. Bringing together different parts and characters of the city. Therefore, the proposed design assignment comprehends a data centre with a publicly accessible path, located in the Speicherstadt Warehouse District in Hamburg.

4.1. Proposition | Typology Analysis

Location

A proposal to place a Data Centre in the city besides being a statement – that brings a public attention to the impact data has on the physical space, the project also aims to transform the emerging issue into a benefit for the nearest neighbourhood and citizens. The proposition of a new typology explores the hidden potential of infrastructure.

Future Data Centres

On the technological level – by proposing a circular system - reusing heat waste to heat neighbouring houses in winter and tapped water in summer, this way making the most of the urban location. Using the potential that would be lost otherwise. To illustrate that - the proposed size of data centre has a potential to heat around 2000 apartments – a one third of all apartments in the new HafenCity district.

Typical design process

A Typical design process of a data centre starts from the estimation of the total energy capacity divided into halls – then into racks and aggregated into rows. MEP defines the section, TIER requirements define equipment. Then, architect comes in - to draw floor plans and design office space – usually attached to the DC as a separate unit. Within described process only the last two steps are design domain of an architect the rest is dominated by technology and engineering – what role architect may have beyond that?

Proposition: New Typology

DATA CENTRE
TYPICAL DESIGN PROCESS

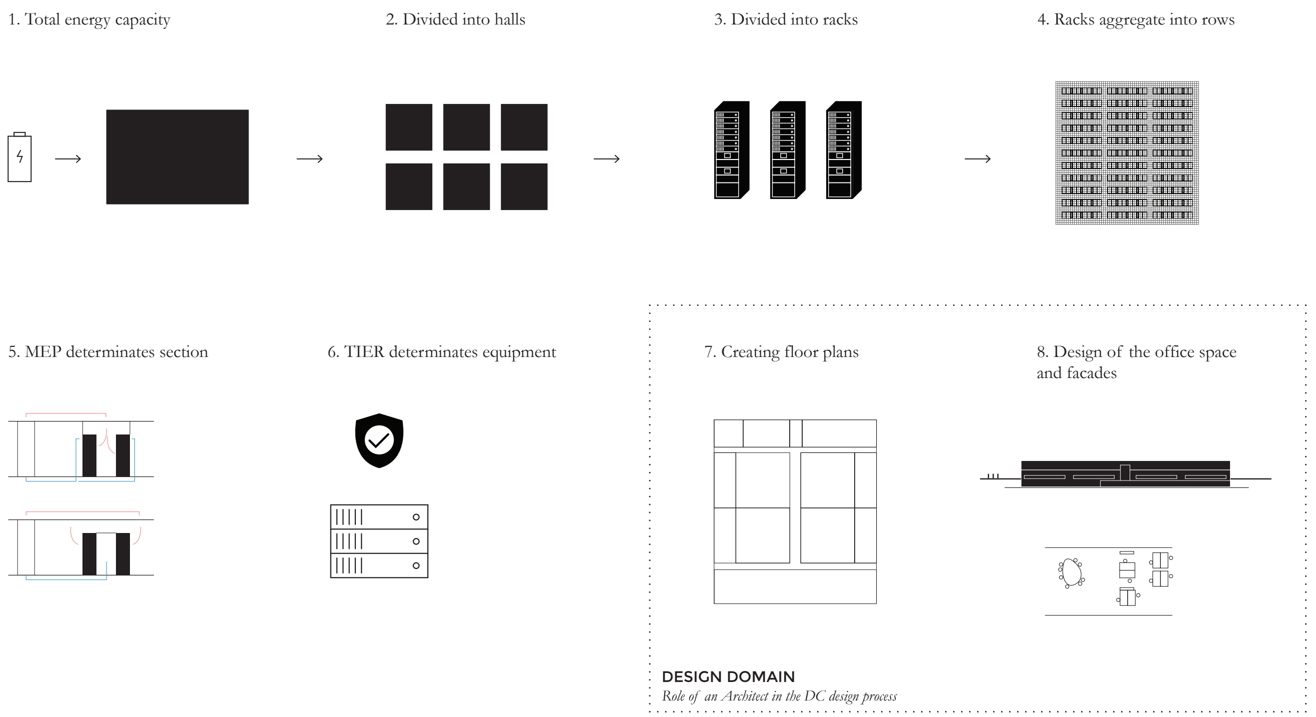


diagram by author is based on the lecture by Ippolito Pestellini Laparelli & Aleksandar Joksimovic (OMA) at *Data Centre Seminar* (*Automated Landscapes*, hosted by Het Nieuwe Instituut)

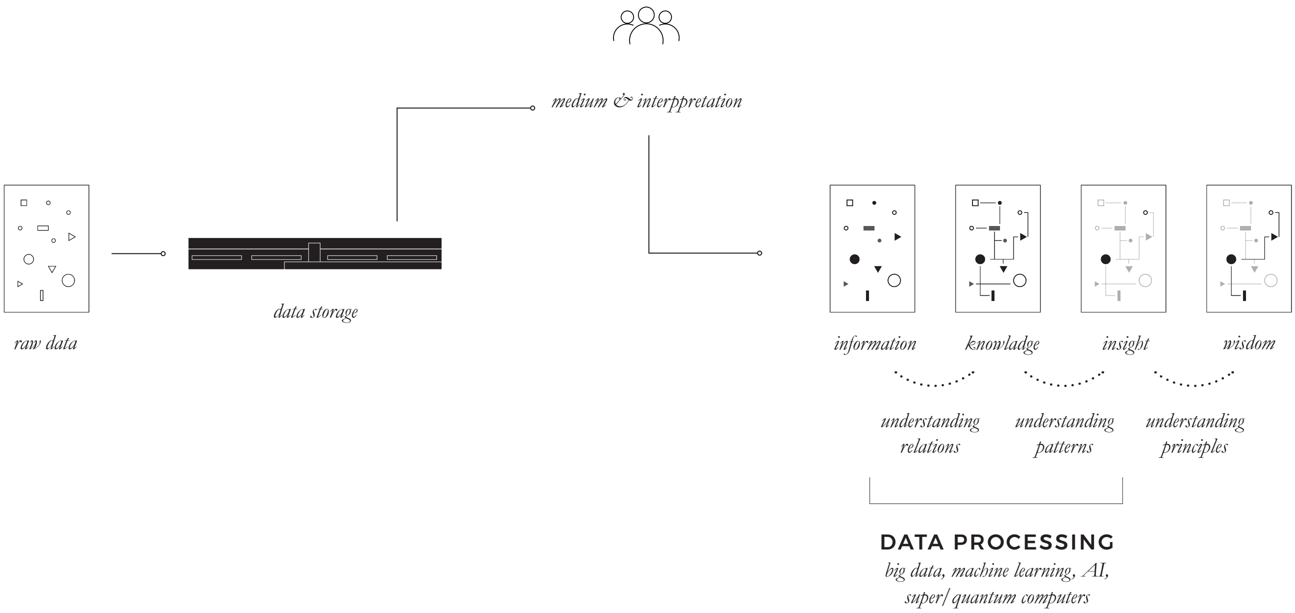
4. The Project

4.2. Objectives

It is important to acknowledge that Data is not information! To become one it has to be processed and interpreted – therefore I incorporate all data processing steps into the project.

The biggest data storage capacity is used by businesses – that store siloes of dark data, out of which over 90% is never used – due to the lack of processing power that would be capable to deal with big data. For this reason I introduced, to my project, a Quantum lab and training centre – benefitting from the urban location with access to IT employees and stuff interested in the subject. Those functions could be of service to the local businesses - offering a service of data processing and this way fight redundant data storage, that mostly enlarge the archive fever.

DATA IS NOT INFORMATION!



Reducing amount of stored data -
Proposed program fighting the source of Archive Fever

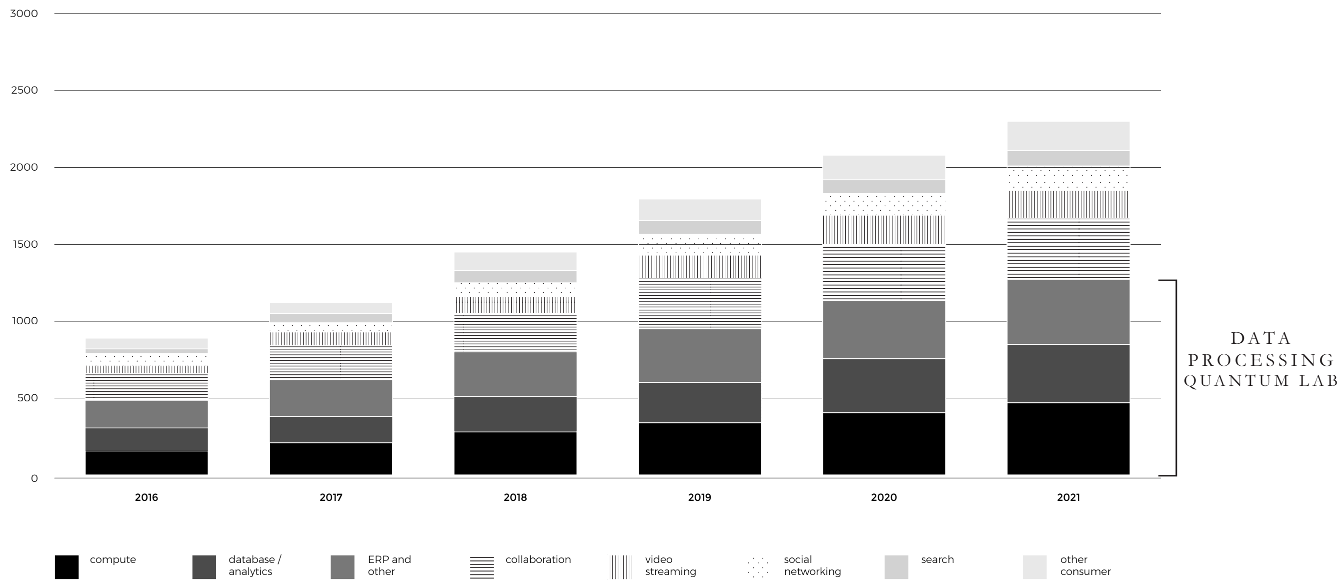
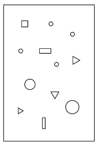


diagram by author

information source: www.statista.com/statistics/638593/worldwide-data-center-storage-capacity-cloud-vs-traditional

PROJECT PROPOSAL

DATA STORAGE
actual data centre



data

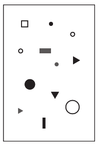
DATA BANK

safe and climate optimal storage for citizens (uploaded and physical) + service: upgrade of digital storage media to keep them up to date (avoiding data loss), backups, recovery

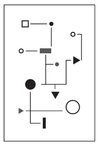
COLLOCATION DATA CENTRE

for local businesses

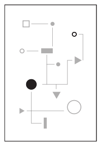
DATA PROCESSING
fighting archive fever



information



knowledge

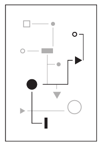


insight

SUPERCOMPUTER/ QUANTUM COMPUTER LAB

processing dark data (90% of stored business data), looking for patterns and relations, working with big data - decluttering digital space

INFORMATION EXCHANGE

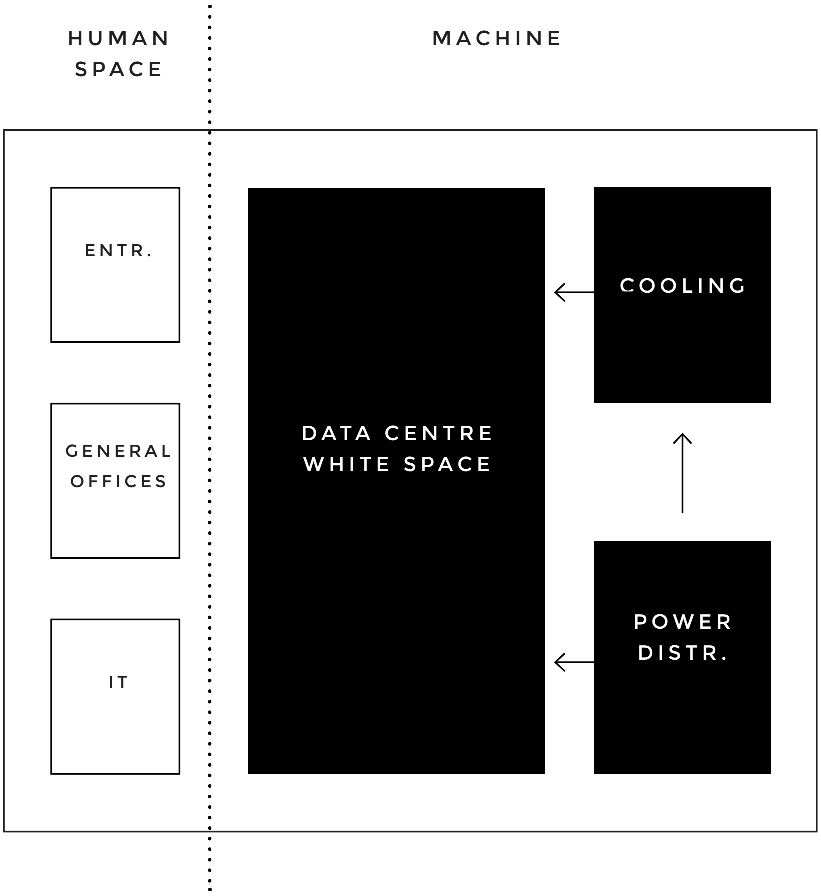


wisdom

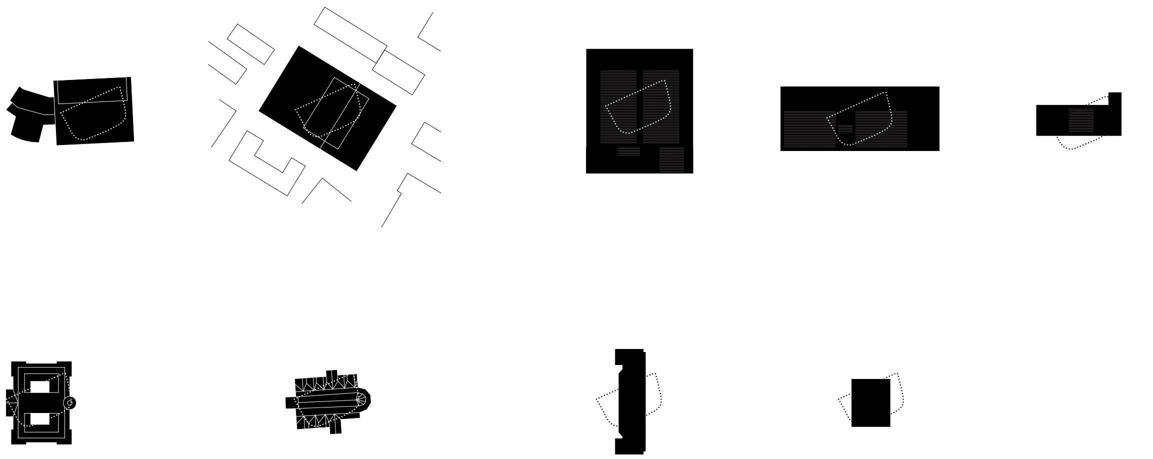
VISITOR PATH
insight, visual overview

TRAINING /CENTRE/

programming super/ quantum computer, work-flow, possibilities, big data processing


HUMAN
SPACE
MACHINE
ENTR.
GENERAL
OFFICES
IT
DATA CENTRE
WHITE SPACE
COOLING
POWER
DISTR.

Comparison of DC and document storage to the Hamburg Site

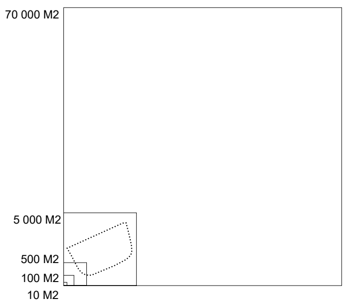


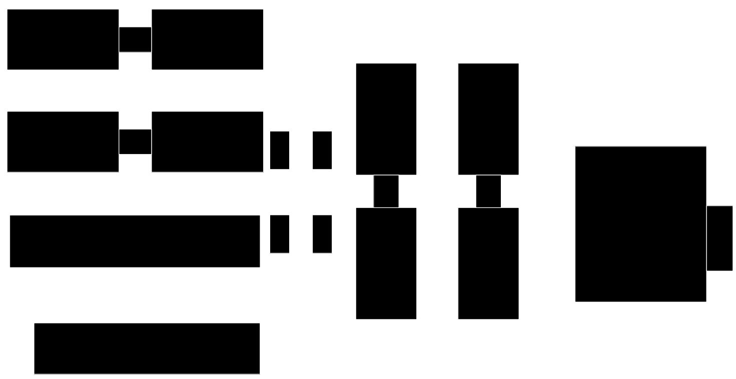
Amsterdam City Hall, NL
footprint 4 330 m 2

Oude Kerk, Amsterdam
footprint 3 700 m2

Amsterdam City Archive, NL
footprint 2 810 m 2

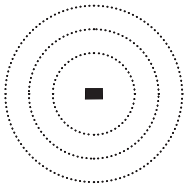
Archiefdepot Noord, Amsterdam, NL
footprint 1 790 m 2





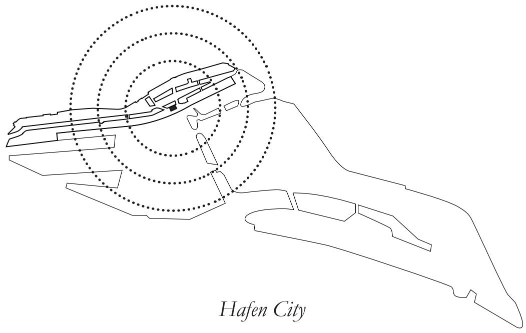
Microsoft Data Center, Middenmeer, NL
footprint 100 850 m 2

HEAT WASTE AS A DISTRICT HEATING

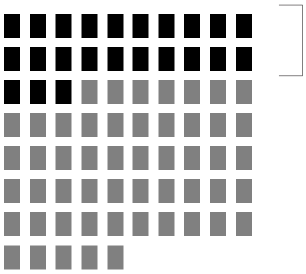


	DATA CENTER CAPACITY	RACKS	SQ M	HEATED FLATS	THERMAL ENERGY
Telia DC, Finland, 2015-18	24 MW	5 000	8 400 M²	20 000	200 000 MWh/ year
Yandex DC, Finland, 2018	10 MW	2 100	6 500 M²	8 400	84 000 MWh/ year
estimation for the Hamburg site	~2.8 MW	~580	~1 800 M²	~2 000	~23 300 MWh/ year

HEAT WASTE AS A DISTRICT HEATING



RESIDENTIAL PROJECTS



4. The Project

a. Configuration and Composition

The designed building is enclosing the storage district. That as a part of the port, was completely fenced off from the rest of the city. While the port is moving away from the city abandoning the land and buildings they partially change function. The Speicherstadt is becoming a part of the city centre and emerging HafenCity district. This transition shows the changing interface of the city. In this context, Speicherstadt becomes a bridge, connection, a link between the city and the new HafenCity district.

The building is designed as a vertical street, a local centre of gravity, an extension of the public space of the plaza, that penetrates and explores the machine. As in a typical data centre - a human being is only a visitor, a short moment of light in the dark automated machine.

The building is placed on the site in a way to relate with the views and boulevard connecting HafenCity with Speicherstadt. The path is overlaid with the surrounding to select the views along the way - that way visually connecting the old town with the warehouse district and new emerging neighbourhood.

b. Performance

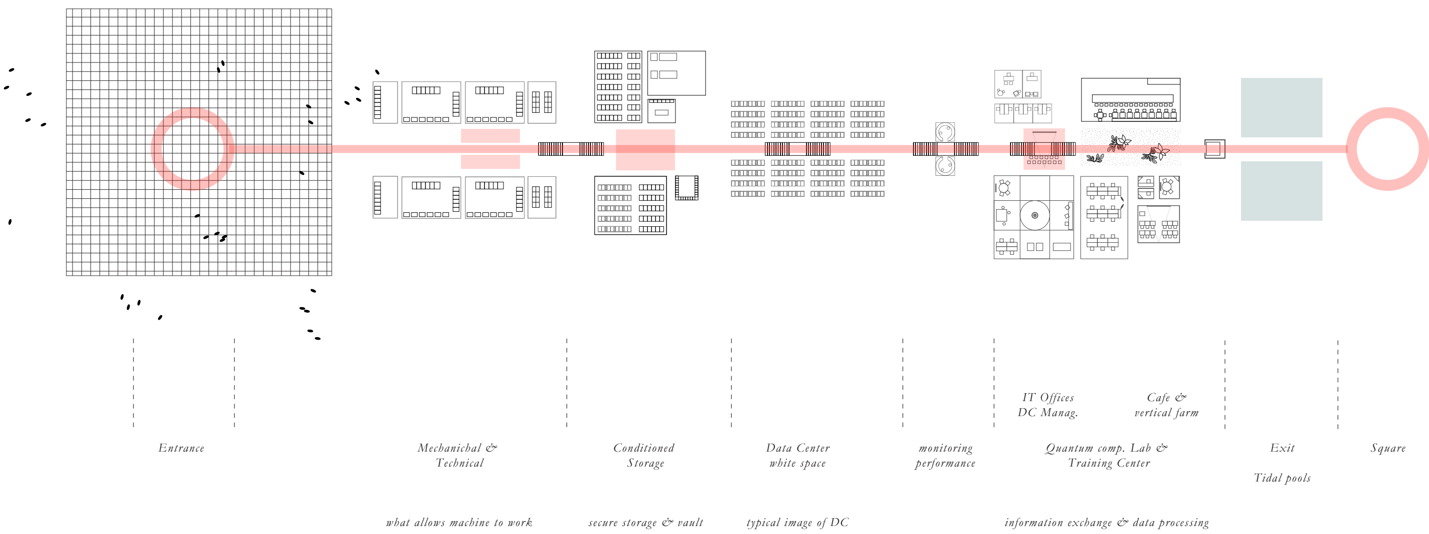
The project, therefore, is a gesture that brings data, technology, people and context together, emphasizing interconnections and interdependence of all. This way introducing one of the most significant elements of our infrastructure physically into a culture, giving the digital data - physical weight and interface. Creating friction between public and private, human and machine – that are completely dependent on each other and cannot function without the other. The path – is a separate and independent circulation from the data centre – however, it is challenging the surveillance and idea of security of our data, drawing attention to the fact that physical security is the minor problem for data centres compering with a real problem of cybersecurity.

c. Function and Program

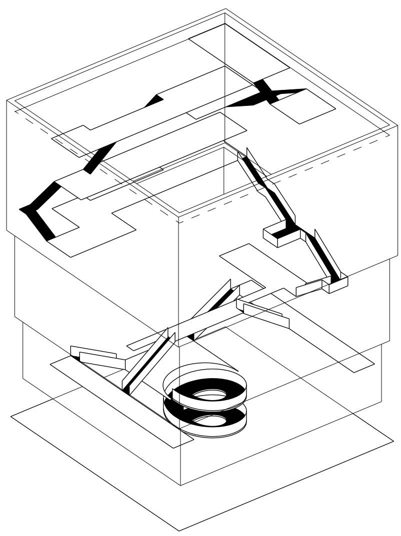
The path that leads through the building begins at the square and leads a visitor through all parts of the machine – technical spaces, conditioned storage, data centre white space, monitoring of the performance – up to the human-inhabited space with offices and quantum lab – finishing with the underground tidal pools, that store water to generate energy for the building. Therefore - the ramp ties the path – it is a beginning and the end of the path.

To allow the flow of people under the building and continuity of the views from the boulevard the building touches the ground only with ramp and 4 cores, that are also points of access for the employees. The building is defined by the server module that was a starting point for each plan.

Having in mind the archive fever study - that architectural expansion is irrelevant – therefore in the project – changes might happen within the parameter of the building – for example through optimizing servers due to technology advancement or stacking more within the same structure.



The Visitor Path in relation to program & volume



4. The Project

4.4. Relevance

In the context of ever growing amount of data – architectural expansion stops to be relevant. Based on the history of storage – the ability to store more just makes us store more, trying too preserve us much as possible. Which is - on the one hand incredible – as we don't have to relay on our imperfect memory – however, if we'll keep on thinking about data as cloud it will dominate our landscape and cities.

The design results are specific to the data technology and Hamburg site, however the project is, to some extent, possible to apply across typologies and locations. Especially harbour cities could apply similar approach to design of data centres, in the context of accessibility to cooling sea water and tidal energy.

As far as I am concerned, the proposed design solution is interesting to be applied in harbour cities – due to proposed technological solutions. I believe that my project is a good base for opening a discussion on the current role of a data centre and it's future potential in the urban context.

01. The relationship between research and design.

Working with intangible is in particular challenging, especially if one has to translate it into an actual physical space. Throughout my process, I tried to understand digital data and the phenomenon of storing endless memories in bits and bytes. I realized how little one understands, besides being a part of the Network Society about the infrastructure that enables the internet connection and data flows.

Basing the research on the territorial scale of the North Sea region, which houses over 60% of all data centres in Europe, I tried to examine the impact of data on the remote landscapes. From there, I decided to focus on the source of the data escalation – cities. In the typological part of my research, a data storage type emerges as an opaque container - defined by the size of a stored unit – a server rack. Even though being highly technological, data centre continues the typology of storage architecture. All content defined buildings, technical as they are, allow for almost no human presence, but do potentially manage through their sheer size to organize and control the context they inhabit, the territory. One cannot underestimate their territorial and urban impact. It was a truly challenging task to translate extensive research on digital data and storage practice into the urban and architectural scale. However, starting with such a broad overview and a variety of references enabled me to build a strong foundation for taking conscious decisions on the design stage of the project. Therefore, the Project gradually developed through exploration and application of theory into the applied design solutions. Finally, the project was informed by the parallel, back and forth design and testing.

Founding on the feedback given by my mentors I was able to push my limits and challenge my initial conclusions. The unique experience to develop a design preceded with extensive theoretical research was a completely new challenge to me and I appreciate the patience and constructive feedback I received along the way. I believe that it helped me to build a strong narrative and enrich project on many levels.
From my own work, I have learned the patience to allow the research to bring the conclusions rather than jumping into them in the early stages. Moreover, that unobvious typology study might bring an interesting and innovative approach to design like the storage typologies to data centres.

02. The relationship between your graduation (project) topic, the studio topic, your master track and your master program.

Interdisciplinary approach of the Transitional Territories studio establishes cross-field research. Within its framework, it is integrating, besides architecture and urbanism, also landscape design and water management. Therefore, the studio is coherent with the reflection of the profession at the faculty of Architecture and the Built Environment. As far as I am concerned, in professional life, the success and innovation of the design lie in a continual and parallel interdisciplinary coordination during the whole design process. Aforementioned constitutes a base of the studio approach.

Through my project, I am studying the way in which data could be reintroduced and integrated within a dynamically growing city, this topic inscribes in the studio's research framework. Starting from the impact of data flows and growing storage needs on a territorial scale of the North Sea region that lies in the studio interests, followed with the specified research in urban and architectural scale.

There is no doubt that information is a base and embodiment of the highest value in the Network Society. What is more, people keep on producing more data each year. In reality of a constantly increasing capacity of digital storage, we keep on gathering more. Created limitless 'cloud archive' has an overwhelming physical presence that takes over hectare after hectare of land. Data storage buildings manage through their sheer size to organize and control the territory they inhabit. One cannot underestimate their urban impact that will have a great impact on the processes of territorialisation in the North Sea region.

I consider architecture as relevant to planning, urban and landscape design as to other engineering fields. I hope as an architecture student I will be able to contribute to improving our cities by designing them with liveability, resilience and sustainability in mind. Especially by integrating the variety of disciplines within the approach to my research. Consequent to the studio, my project attempts to keep a cross-field approach and inform the design with knowledge from a variety of disciplines. Therefore, above mentioned the project has a non-hierarchical and dynamic structure.

03. Elaboration on research method and approach chosen by the student in relation to the graduation studio methodical line of inquiry, reflecting thereby upon the scientific relevance of the work.

- *Mapping*
- *Theoretical research*
- *Typological research*
- *A research on how data centre may be designed in the urban context*

The trans-scalar approach of the studio integrates investigation from the level of the territory of the North Sea region up to the ground and body scale. Coming from the wider context to one's project-specific research subject. This approach proposes a variety of research methods and techniques. The foundation lies in the collective phase that combines theory and visual representation, materializing in the act of mapping, which is a conscious act of heuristic research. This phase allows for the study of the North Sea from various perspectives (geological, ecological, political, and social) and the translation of scientific data into maps documenting past and current state, as well as the future projections. The wide spectrum of topics as well as the formulation of the future scenarios broadened a deeper understanding of the studied trends and their impact on the territory. The aim to create collectively an atlas became a tool for research likewise representation of the assembled conclusions.

Moving to the scale of the individual project the focus shifts from the territorial scale into the site-specific analysis. The collected data about Hamburg is informed by literature and extended by an on-site inquiry. At this stage, different means and methods come into research on the relevant investigation scale. These include mapping, drawing and collage, text and photography.

Considering the vast amount of information on the subject of interest, the research may be difficult to manage. Therefore, the combination of multiple techniques allows for dynamic change of the method depending on the current needs and state of the research. Such strategy enables gathering of both raw data and the ephemeral attributes, temporal dynamics and atmospheres, and is, therefore, a mean of value for phenomenological inquiry. Along with the first research steps, a literary inquiry about data, storage and archiving, content defined architecture was undertaken. The initiated review of the literature broadened the knowledge, historical development and theory of the subject. What is more, it forms the foundation for heuristic research by design approach. Within the broader context of global trends, I gave particular attention to the Archive Fever defined by J. Derrida, as well as a growing amount of digital data. Additionally, a complementary research method is provided by case-study analysis. Multiple examples illustrated the various storage typologies, from a museum to warehouses. By reinterpreting the storage spaces, I was able to get a better grip of the architectural type and the common physical aspects of materialization, their design components, function and finally their stories. This outlook gives a wide outlook to possible architectural intervention that the project could become. Research by Design – an inquiry in which design is an essential part of the research process – is applied as a common strategy. It relies on the continuous reflection and re-framing to be made throughout the design process, enduringly testing and adapting to new potential solutions. Therefore, according to the needs, the research is extended along with the design.

04. Elaboration on the relationship between the graduation project and the wider social, professional and scientific framework, touching upon the transferability of the project results.

My graduation work brings its relevance basing on two aspects. On the one hand, it has the ambition to integrate different fields and approaches, including architecture, planning, urbanism, landscape architecture and engineering. Taking into account different actors and stakeholders in purpose to build a comprehensive picture of the social aspects of defined archive fever and constantly growing storage. Growing repositories generate higher costs each year which indicates a need to place storage on display, face and acknowledge what and in which amount we actually produce and store.

Secondly, my project has its relevance due to current trends in technology, among others, the Internet of Things and growing amount of latency dependent applications, that generate a need to introduce data back into the city. Even though data is already fully integrated and present in our lives, we rarely acknowledge it. What is more, due to lack of understanding we are often excluded from the discussion on the degree of its presence in our lives. While data and communications gain a ubiquitous presence in Network Society the conducted research gains its relevance as well.

Lastly, considering that above mentioned technologies are mainly developed by engineers and technicians there is a growing need to review their architectural and urban impact on the cityscape, keeping in mind the importance of its social and political importance. My research fits into contemporary discourse by addressing these issues. Asking questions if we should create a separated world of service for serving us infrastructure, and therefore separate society from technology to the extent that we do with unpleasant technologies. Quoting Rem Koolhaas "*At a moment when our collective history is digital, the data centre is becoming one of our most significant cultural typologies.*" In this context should it become an anonymous part of the outskirts rather than a part of our urban landscape?

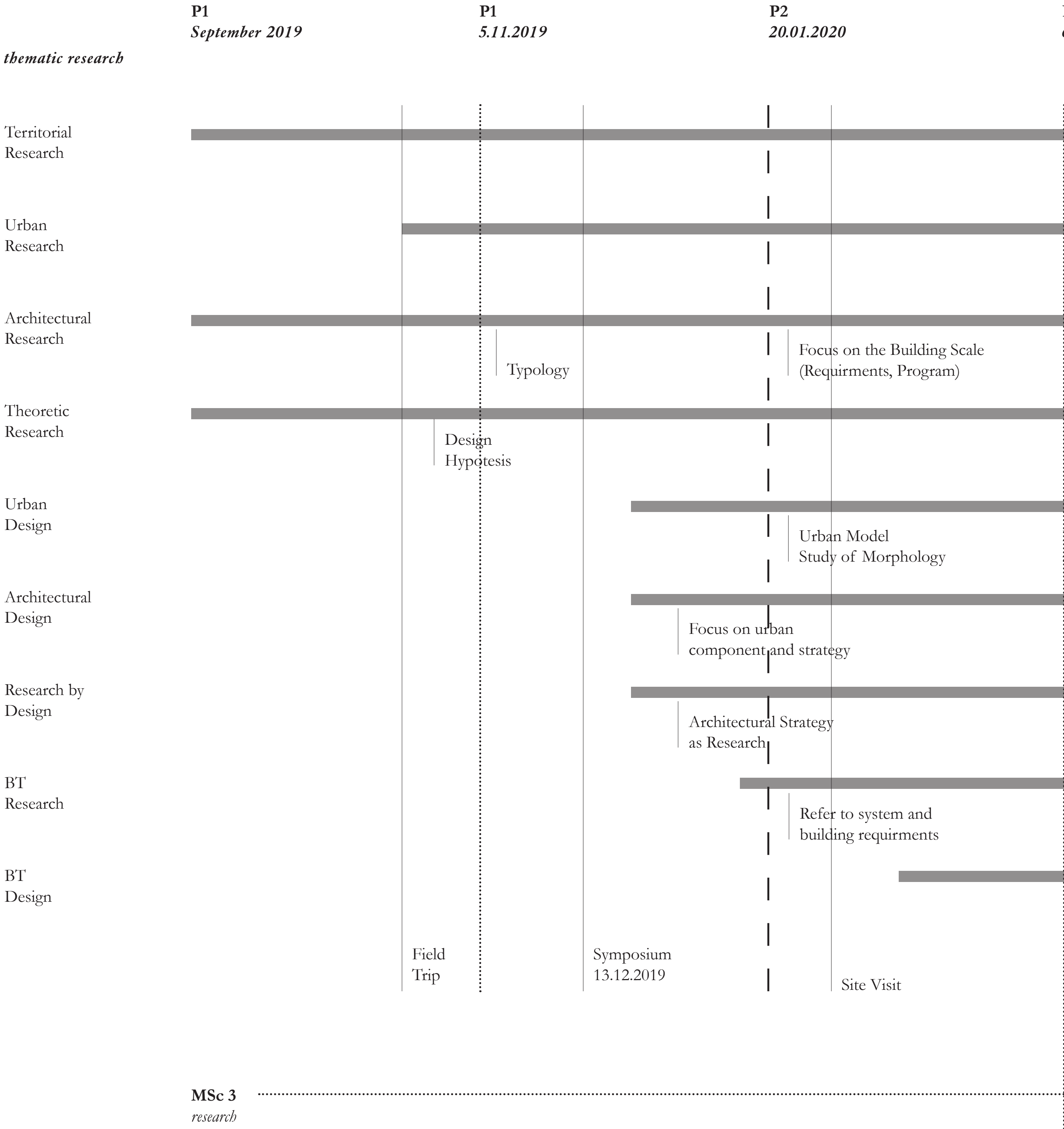
The design results are specific to the data technology and Hamburg site, however the project is, to some level, possible to apply across typologies and locations. Especially harbour cities could apply similar approach to design of data centres, in the context of accessibility to cooling sea water and tidal energy.

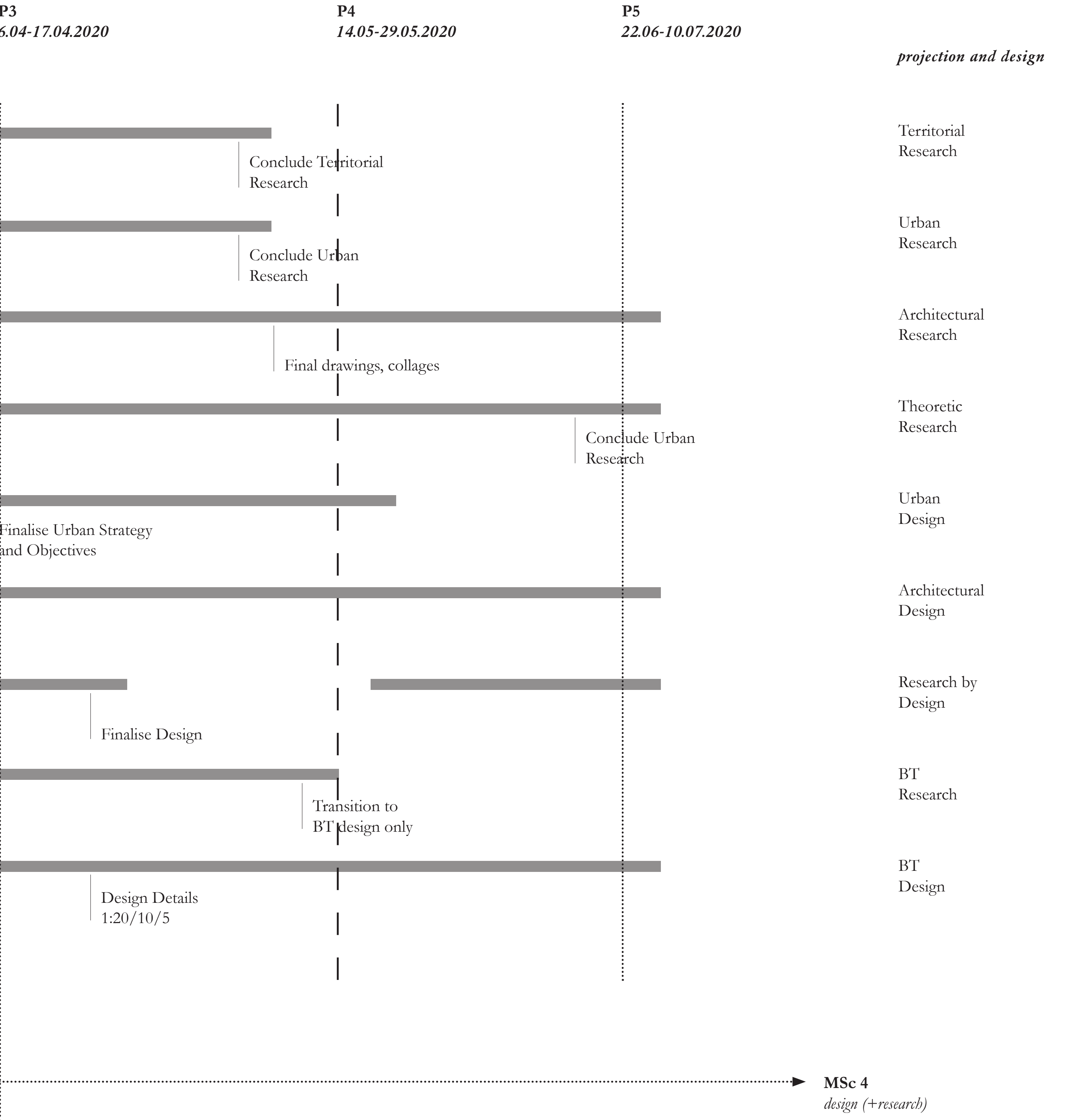
05. Discuss the ethical issues and dilemmas you may have encountered in (i) doing the research, (ii, if applicable) elaborating the design and (iii) potential applications of the results in practice.

The project combines the aforementioned scales, starting from the territorial network up to the scale of the site in Speicherstadt district and the human visiting the machine. A proposal to place a Data Centre in the city besides being a statement – that brings a public attention to the impact data has on the physical space, the project also aims to transform the emerging issue into a benefit for the nearest neighbourhood and citizens. The proposition of a new typology explores the hidden potential of infrastructure. The building is designed as a vertical street, an extension of the public space of the plaza, that penetrates and explores the machine. It is introducing one of the most significant elements of our infrastructure physically into a culture, giving the digital data a physical weight. The project is a gesture that brings data, technology, people and context together, emphasizing interconnections and interdependence of all. Moreover, the waste heat is reused for the district heating (potentially saving even up to 90% of used electricity by servers) and the tidal waters of Elbe are producing energy. Lastly, the data bank is challenging the surveillance and idea of security of our data, drawing attention to the fact that physical security is the minor problem for data centres comparing with cybersecurity.

As far as I am concerned, the proposed design solution is interesting to be applied in harbour cities – due to proposed technological solutions. I believe that my project is a good base for opening a discussion on the current role of a data centre and it's future potential in the urban context.

Timeline


P1
September 2019
P1
5.11.2019
P2
20.01.2020
thematic research
Territorial
Research
Urban
Research
Architectural
Research
Typology
Focus on the Building Scale
(Requirments, Program)
Theoretic
Research
Design
Hypotesis
Urban
Design
Urban Model
Study of Morphology
Architectural
Design
Focus on urban
component and strategy
Research by
Design
Architectural Strategy
as Research
BT
Research
Refer to system and
building requirments
BT
Design
Field
Trip
Symposium
13.12.2019
Site Visit
MSc 3
research


P3
6.04-17.04.2020
P4
14.05-29.05.2020
P5
22.06-10.07.2020
projection and design
Territorial Research
Conclude Territorial Research
Urban Research
Conclude Urban Research
Architectural Research
Final drawings, collages
Theoretic Research
Conclude Urban Research
Urban Design
Finalise Urban Strategy and Objectives
Architectural Design
Research by Design
Finalise Design
BT Research
Transition to BT design only
BT Design
Design Details 1:20/10/5
MSc 4
design (+research)