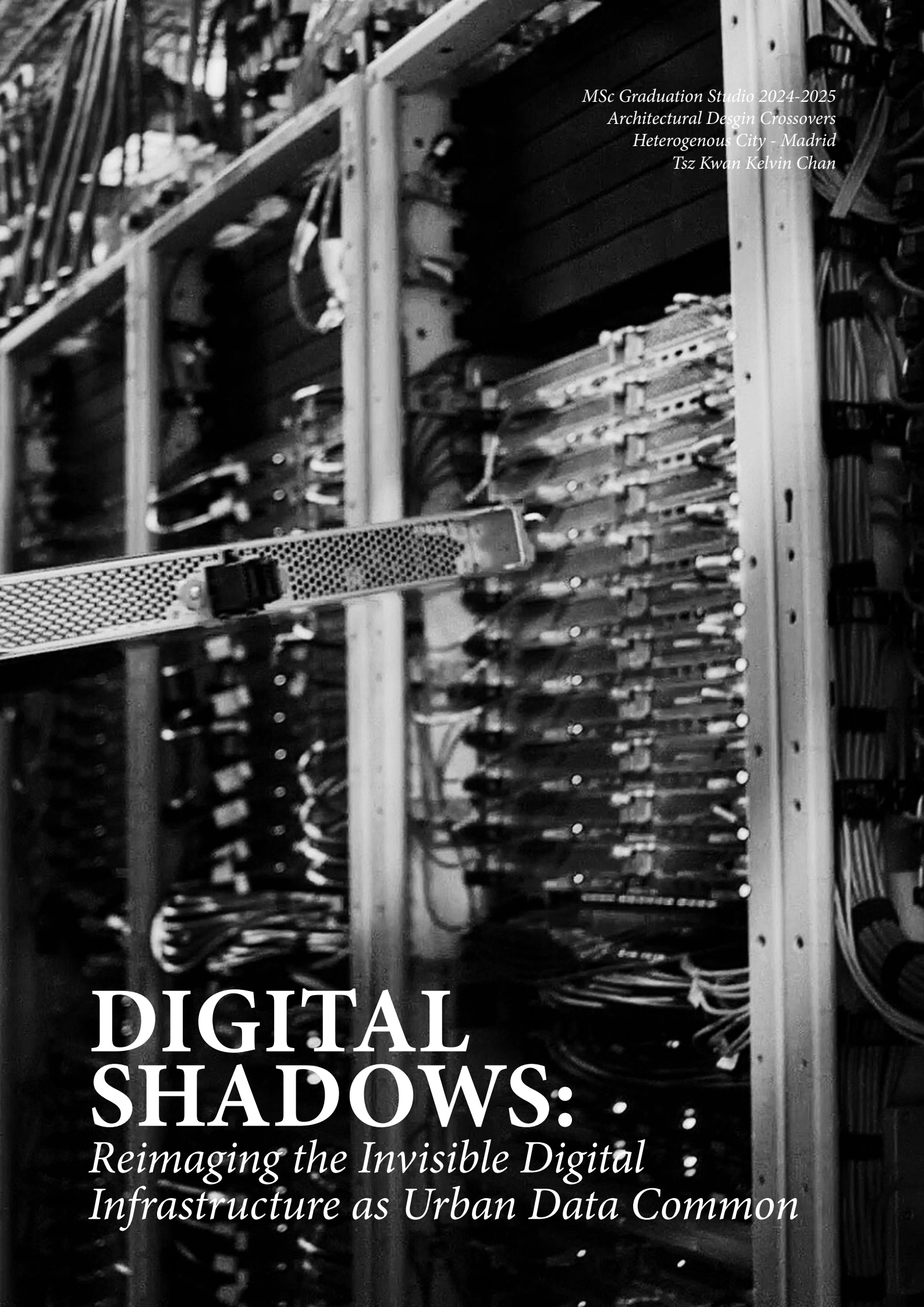

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DIGITAL SHADOWS:

Reimaging the Invisible Digital Infrastructure as Urban Data Common

> *We are constructing an architecture without people. This is not a 'posthuman' condition... they are more accurately extra-human in that they are outside us, totally indifferent to us, where we are no longer part of the equation at all.*
>
> *(Young, 2019.)*

Image 1 / Merlin Data Center / Getafe / Madrid / Spain /

KEYWORDS

/ Initial Fascination / Interests / Phenomenon /

Data Commons

"Who owns the Data?"

Data Sovereignty

Maak, N., "Server Manifesto"

Data Growth

"Every two years, the volume of data across the world doubles in size."

Data Center

Post-Anthropocene Architecture

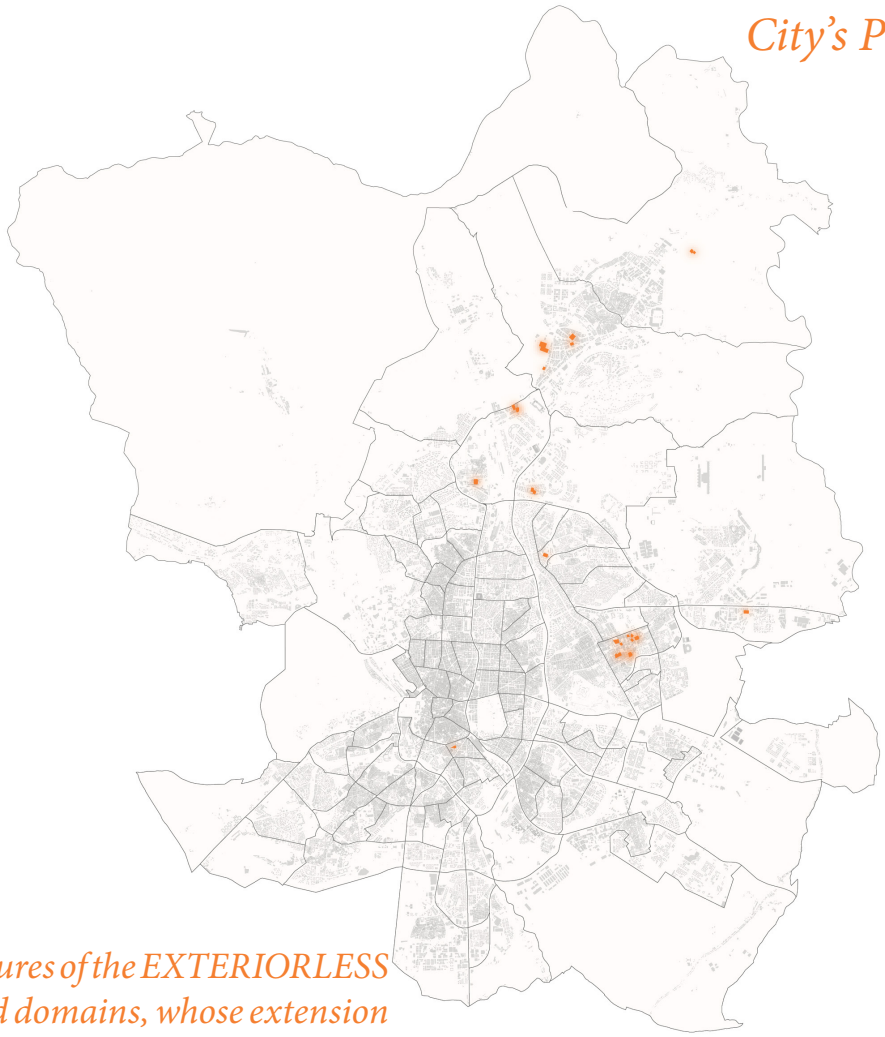
Exteriorless Architecture

Corbo, S.

Infrastructure Network

The backend of Data Center

Data Center that hidden in the City's Periphery.



"…..the architectures of the EXTERIORLESS act as expanded domains, whose extension and influence reach beyond their physical boundaries.

(Corbo, 2023)"

Image 2 / Mapping of Data Center Location /

PROBLEM STATMENT

The power coursing through Madrid's data centers – a massive 613 MW – could heat over 456,000 Madrid apartments for an entire year.[1] This staggering amount of energy, almost enough to warm a quarter of the capital's residential buildings, isn't keeping families cozy; instead, it's fueling Madrid's transformation into Europe's next digital powerhouse. By 2026, these energy-intensive facilities will catapult Madrid's data center capacity to 70% of established tech hubs like Paris or Amsterdam.[2] These digital fortresses remain strategically **hidden in the city's periphery**, their locations determined by essential infrastructural needs:

1. *Access to cheap and abundant power*
2. *Availability of water for cooling systems*
3. *Room for scalability and expansion*
4. *Lower land costs*
5. *Proximity to telecom network*

This strategic invisibility presents a striking architectural paradox. Unlike their historical predecessors – civic buildings that proudly displayed their importance through grand design – modern data centers actively resist architectural expression. As Niklas Maak aptly noted:

"…(data center) are meant to be the opposite of architecture: saying nothing, betraying nothing, offering no surface for attack." [4]

This intentional concealment creates a profound **disconnect between citizens and the infrastructure** that increasingly governs their lives.

The impact of these facilities **extends far beyond their physical boundaries,** exemplifying what Stefano Corbo terms **"EXTERIORLESS architecture."**[3] Data centers exert unprecedented influence on urban infrastructure networks. **They strain power grids with massive energy demands, challenge water systems through substantial cooling requirements, and generate heat that could potentially serve district heating applications.** Additionally, their operational needs shape telecommunications development and local transportation systems through regular hardware replacements and connectivity requirements.

These unprecedented infrastructural demands signal a fundamental transformation in how our cities store and manage information. **This evolution of information storage marks a profound shift from tangible civic knowledge bases to abstract digital repositories**. Historically, knowledge storage infrastructure manifested

1 **Madrid Data Center Power Consumption Equivalency Analysis**

Annual Energy
= 613 MW × 8,760 h
= 5,369,880 MWh/year
Apartment Need for Heat
= 121.2 kWh/m² × 97 m²
= 11,756.4 kWh/year
Equivalent Apartments
= 5,369,880,000 ÷ 11,756.4
= 456,760

Hernández Aja, *"Energy Needs and Vulnerability Estimation at an Urban Scale for Residential Neighbourhoods Heating in Madrid (Spain),"* (2016), 1415.

2 Galindo, "Madrid To Increase Data Centre Capacity Over 300% by 2026," *CoStar Analytics*, July 10, 2023, https://www.costar.com/article/270239180/madrid-to-increase-data-centre-capacity-over-300-by-2026.

3 ***EXTERIORLESS Architecture*** manifests through three key characteristics: Interface - platforms favoring horizontal organization with generic aesthetics rooted in 1960s utopianism; Expanded Domains - isolated spaces exerting far-reaching influence through logistics and data networks; and Forms of Urbanity - new urban environments that challenge traditional city concepts while concentrating global capital and social contradictions.

4 Niklas Maak, "Server Manifesto: Data Center Architecture and the Future of Democracy," in *Server Manifesto: Data Center, Architecture and the Future of Democracy* (Berlin: Hatje Cantz, 2022), 21.

through libraries and archives, serving as prominent urban landmarks with clear architectural identities. These traditional repositories, while **requiring extensive physical infrastructure - from climate-controlled archival rooms to public reading spaces - remained fundamentally accessible to citizens**.[5] Contemporary libraries reflect this transition, strategically reducing physical storage in favor of digital access points and flexible, technology-enabled environments. Yet paradoxically, as these spaces evolve, **modern data centers vanish from public consciousness despite their massive infrastructural demands, their identity deliberately obscured behind generic facades.**

This evolution of information infrastructure marks not just a shift in storage paradigms, but raises a critical urban challenge: **how to reveal and articulate the vast infrastructure networks that enable contemporary digital storage systems**. Unlike traditional repositories, where the infrastructure of digital storage - from reading rooms to archive facilities - was visibly integrated into civic architecture, today's digital infrastructure networks operate in deliberate obscurity. Data centers, while serving as modern equivalents to historical archives, represent nodes in a far more complex web of urban systems. Their operations generate **unprecedented infrastructure networks: power distribution strained by massive energy demands, water systems adapted for cooling and reclamation, potential heat redistribution networks from thermal output, and sophisticated electronic waste management systems**. Yet these vital infrastructural connections, which far exceed the relatively straightforward systems of traditional knowledge institutions, remain largely invisible to the public. This systematic concealment of increasingly critical urban networks raises fundamental questions about civic legibility and public understanding. While historical knowledge repositories demonstrated their civic role through architectural expression and public accessibility, we now face the challenge of **how to meaningfully reveal and articulate these complex, interconnected systems of digital infrastructure.** The tension between operational concealment and civic comprehension emerges as a defining challenge in the evolution of urban knowledge infrastructure.

PROBLEMATIZATION.

5 David E. Coleman, "Evolution of a Library: Information Storage to Information Use," *Journal of Hospital Librarianship* 17, no. 3 (July 3, 2017): 201–8, https://doi.org/10.1080/15323269.2017.1328569.

RESEARCH QUESTION

WHAT IF Madrid's invisible Digital Infrastructure became an integrated Urban Data Common ?

Parque Eólico de Maranchón (Wind)
208 MW
Central Nuclear de Trillo (Nuclear)
1003 MW
Parque Eólico La Plata (Wind)
21.25 MW
Planta Solar Fotovoltaica Solaria-Añover I
(Photovoltaic) 759 MW
Aceca Power Plant (Combustion)
759 MW
Central hidroeléctrica de Azután (Hydroelectric)
200 MW
SSubestación eléctrica de Grijota (Wind Farm)
Subestación de La Mudarra (Wind Farm)
Polígono Industrial Valportillo
Polígono Industrial Julián Camarillo
13884m
7657m
Plaza Mayor
El Pardo Reservoir
System of Data Center
Data Center
Data Center
Industrial Zone
Water Related
Reservoir
Water
Green Park
(Pond Harvesting System)
Forest
Waterway
Rainwater Storage
36 Rainwater Tanks
Power Related
Electrical Substation
Above Head Power Line
Underground Power Line
Building
Buildings
Distance

POSITION & RELEVANCE

◀ Image 3 / **Mapping of Madrid's data center locations** in relation to urban infrastructure networks, highlighting the intersection between digital facilities and the city's water harvesting system through green spaces. While sustainable energy production occurs outside the city limits, the analysis explores how data centers could better integrate with existing green infrastructure to enhance their visibility and connection to urban life.

This project stems from a fascination with the intersection of digital infrastructure and urban design, specifically focusing on the complex relationship between data centers and city life. As our lives become increasingly digitized, **the architecture that supports this transformation remains largely hidden and poorly understood by the general public.** This research aims to bridge that gap, making visible the invisible structures of our digital society while exploring the potential synergies between traditional and digital forms of data storage.

The relevance of this work lies in its potential to address four critical issues (right). By exploring these issues through the lens of architecture and urban design, this research aims to contribute to a new social contract for the digital society, one that **uses technology to attain both social and environmental sustainability.** This work is particularly timely for Madrid as it expands its digital infrastructure, offering an opportunity to develop models that other cities could adapt for their own digital transitions.

/ Data / Commons

"A data commons is a shared resource that enables citizens to contribute, access, and use data - for instance, on air quality, mobility, or health - as a common good, without restrictions related to intellectual property right" [6]

Digital / Sovereignty /

"Digital sovereignty means that as a society we should be able to set the direction of technological progress and put technology and data at the service of the people" [8]

/ Operational / Sustainability

".....operational sustainability approach addresses five key areas of impact: energy efficiency, renewable energy, water conservation, Scope 1 emissions and the circular economy." [7]

Hybrid / Morphology /

"Infrastructure, architecture, and landscape amalgamate to become one complex. Instead of accentuating their differences and treating them as separate entities, the possibility of their convergence is proposed" [9]

6 Francesca Bria, "This is a historic moment: Why we need new public spaces to experiment with and reclaim digital sovereignty for the people," in *Server Manifesto: Data Center, Architecture and the Future of Democracy* (Berlin: Hatje Cantz, 2022), 11.

7 "Operational Sustainability," Equinix Sustainability, June 18, 2024, https://sustainability.equinix.com/environment/operational-sustainability/.

8 Francesca, "This is a historic moment", 8.

9 Anna Klingmann and Marc Angélil, "Hybrid Morphologies, Infrastructure, Architecture, Landscape," *Daidalos*, no. 73 (1999): 16–25.

THEORECTICAL FRAMEWORKS

The Stack

This research builds upon Benjamin H. Bratton's conceptual framework from *"The Stack: On Software and Sovereignty,"* adapting his model of **planetary-scale computation as a megastructure**.[10] While Bratton's original framework encompasses six vertical layers[11], this study concentrates on four fundamental layers crucial to architectural design and urban integration: **Earth, Cloud, City, and User**, with particular attention to the Earth layer as a foundation for addressing broader systemic challenges.

"any one instance of such a stack works only in combination with another." [12]

By examining these layers as intersecting rather than purely hierarchical, this research seeks to uncover what Bratton terms "peculiar new spaces" and "fractured enclaves" that emerge from their interaction. This approach facilitates the analysis of **how heterogeneous layers operate within a complex system, exhibiting varying degrees of resilience and adaptability,** especially when considering data center integration with traditional urban topologies.

Critically, this research posits that **addressing fundamental issues at the Earth layer - including water distribution, energy consumption, and material lifecycle management - is essential for achieving higher-level objectives such as data commons and data sovereignty**. By resolving these foundational challenges, we can create more sustainable and equitable frameworks that support both physical infrastructure and digital rights management.

10 Benjamin H. Bratton, The Stack: On Software and Sovereignty (Cambridge, Massachusetts: The MIT Press, 2016).

11 The six layers in Bratton's original framework include Earth, Cloud, City, Address, Interface, and User.

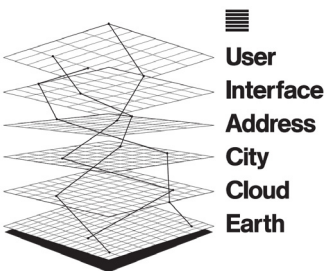
12 Benjamin, 67.

13 Benjamin, 75-105.

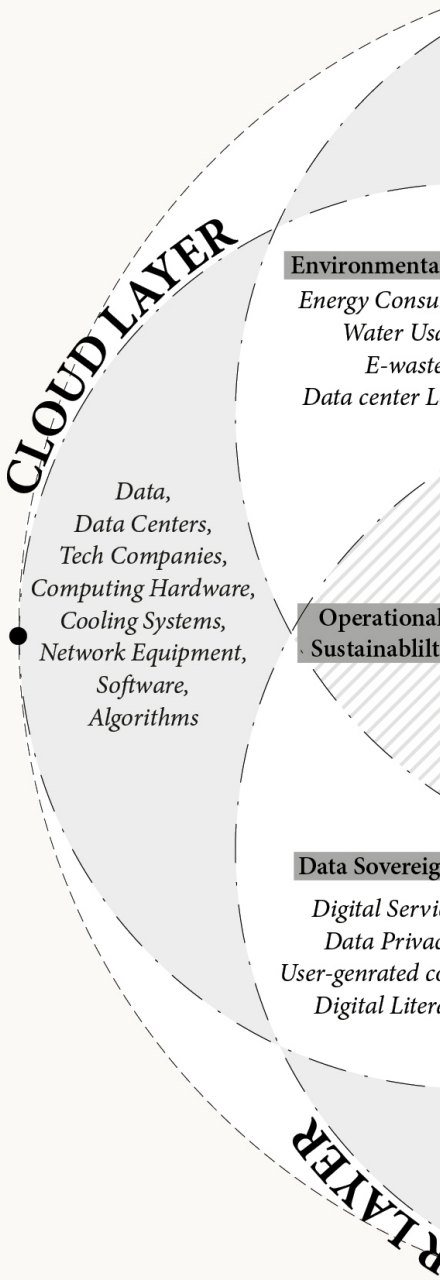
14 Benjamin, 111-141.

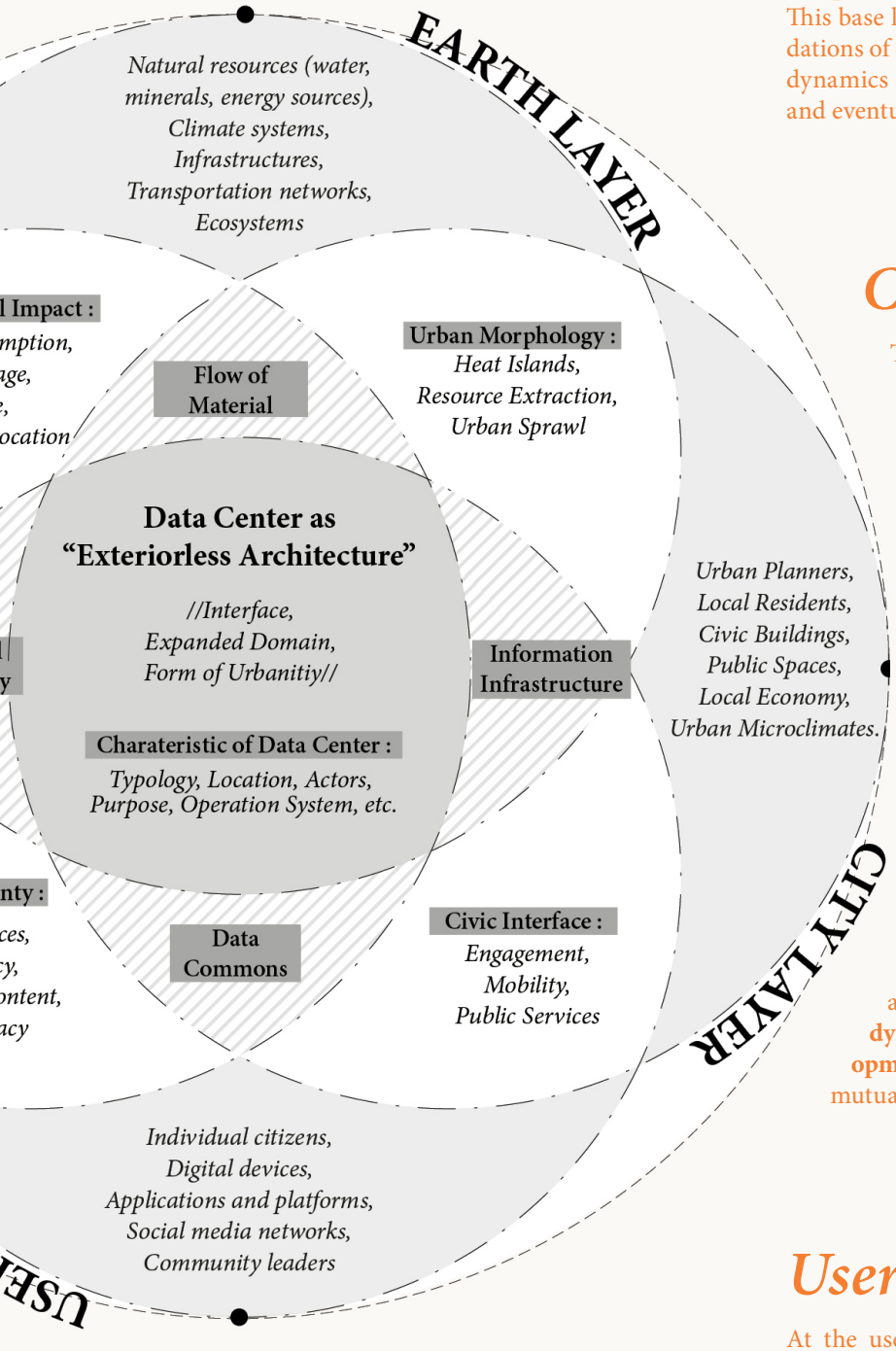
15 Benjamin, 149-183.

16 Benjamin, 254 - 284



▲ Image 5 / **The Stack's six-layer structure visualized by Metahaven /**





▲ *Image 6 / Venn Diagram show the relationship between Earth, Cloud, City & User layer. /*

Earth Layer:

Digital infrastructure is grounded in **tangible elements - from raw materials and energy sources to physical components** - that sustain data center functionality. This base layer analyzes both the environmental foundations of computing hardware and the complex global dynamics of how resources are extracted, consumed, and eventually discarded. [13]

Cloud Layer:

The distributed network of computing facilities encompasses multiple components **- from data storage centers and power infrastructure to communication cables and software applications** - forming an integrated technical framework that powers modern digital services. This interconnected system creates the foundational architecture that enables pervasive computational operations. [14]

City Layer:

Modern cities emerge as segmented metropolitan regions linked by complex networks, where human habitation and mobility exist simultaneously in tangible and virtual spheres. This layer explores the **dynamic interplay between urban development and data infrastructure**, revealing their mutual impact on spatial organization. [15]

User Layer:

At the user level, conventional distinctions between people and machines become increasingly indistinct, as both operate as interlinked nodes that simultaneously create and analyze data, establishing a seamless flow of interactions that bridge physical and digital domains. [16]

Three key historical perspectives:

Techno-Socio-Material Entanglements & Scale

Operation System & Flow of Material

Beyond the spatial hybridity described by Klingmann and Angelil, Mattern reveals how **technical systems, social practices, and urban form have been intertwined throughout history.** This helps us understand data centers not just as contemporary hybrid forms, but as evolved manifestations of long-standing urban communication infrastructure. Her multi-scalar approach shows how **digital infrastructure simultaneously operates at architectural, urban, and global scales**, expanding traditional morphological analysis.

Path Dependency & Networked Histories

Hybrid Morphologies & Information Infrastructure

While hybrid morphologies focus on current spatial convergences, Mattern's framework reveals **how these relationships follow historically established patterns**. Data centers' integration into urban fabric isn't just about present-day spatial relationships - it's shaped by centuries of information infrastructure development. This historical perspective enriches morphological analysis by **revealing the temporal dimension of infrastructure-architecture-landscape relationships.**

People as Infrastructure & Shadow Development

Civic Interface & Digital Commons

Mattern's framework **extends beyond physical form to include human actors and informal practices**, revealing how digital infrastructure, despite its technical nature, remains embedded in social practices and unofficial networks. This social dimension adds crucial depth to hybrid morphological analysis, showing how urban form evolves through both formal and informal processes.

Deep Time of Media Infrastructure & Hybrid Morphologies

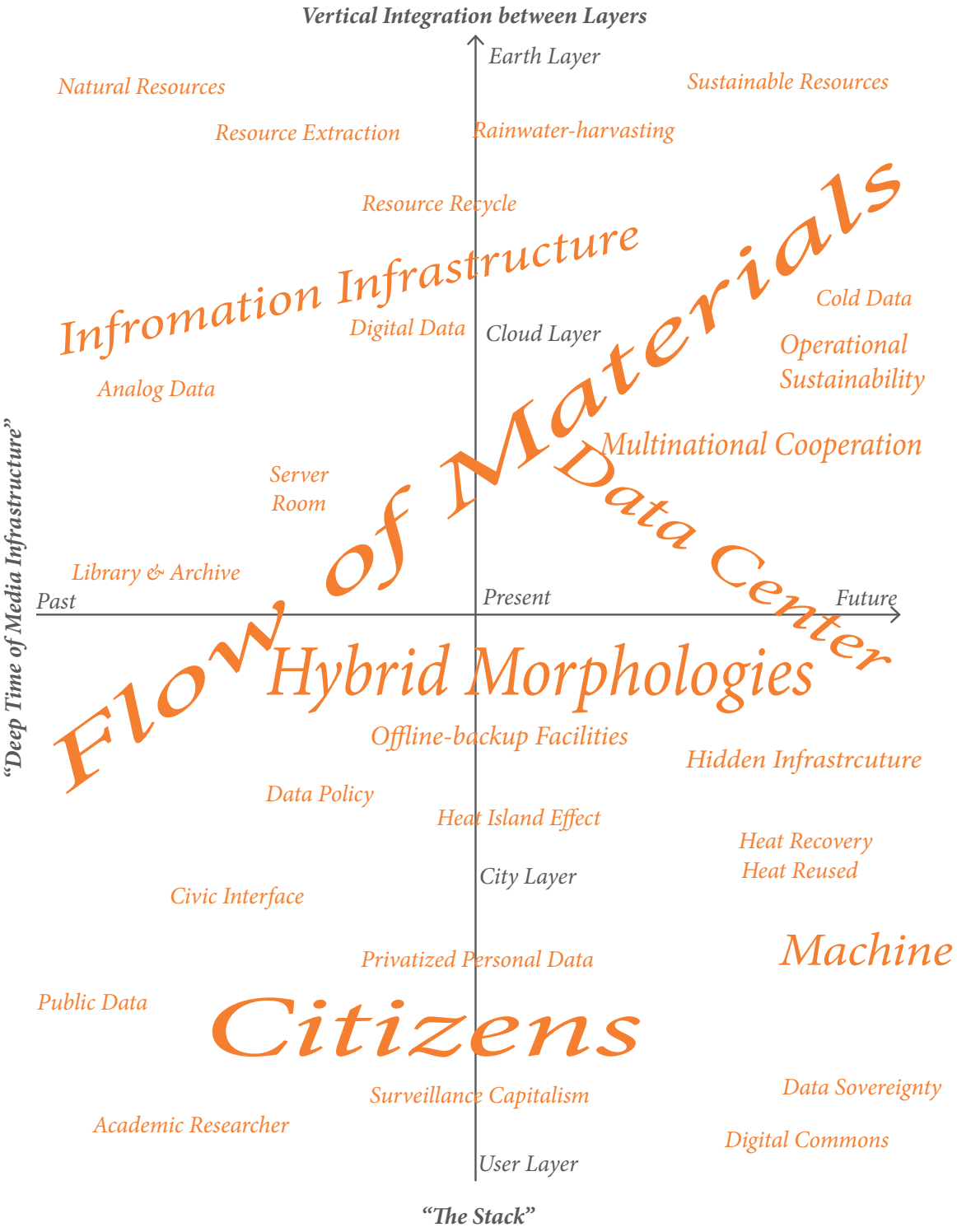
While Bratton's Stack provides a macro-scale theoretical framework for planetary computation, and Klingmann and Angelil's *"Hybrid Morphologies"* offers insights into the physical integration of architecture, infrastructure, and landscape, there remains **a crucial gap in understanding how digital technologies evolve within and shape urban form.** Mattern's *"Deep Time of Media Infrastructure"* fills this gap by providing **a historical-technological framework that connects urban morphological evolution with media infrastructure development**.[17]

While hybrid morphologies effectively describe how *"architecture is declared as landscape, infrastructure as architecture, and landscape as infrastructure,"*[18] it **lacks the temporal dimension needed to understand how digital systems transform these relationships.** Mattern bridges this through three key perspectives (left):

17 Shannon Mattern, Deep Time of Media Infrastructure, The Geopolitics of Information 1 (University of Illinois Press, 2017), 102-108

18 Marc Angelil and Anna Klingmann, "Hybrid Morphologies: Infrastructure, Architecture, Landscape" Daidalos: Architecture, Art, Culture, no. 73 (1999): 20.

▼ *Image 7 / Merging historical and spatial frameworks to analyze digital infrastructure development*



OPERATIVE QUESTIONS

1. **WHICH** urban infrastructures intersect with Madrid's digital networks?

2. **WHERE** do digital infrastructure byproducts currently flow within the city?

3. **HOW** can infrastructure, architecture, and landscape converge into unified urban forms in the case of digital infrastructure?

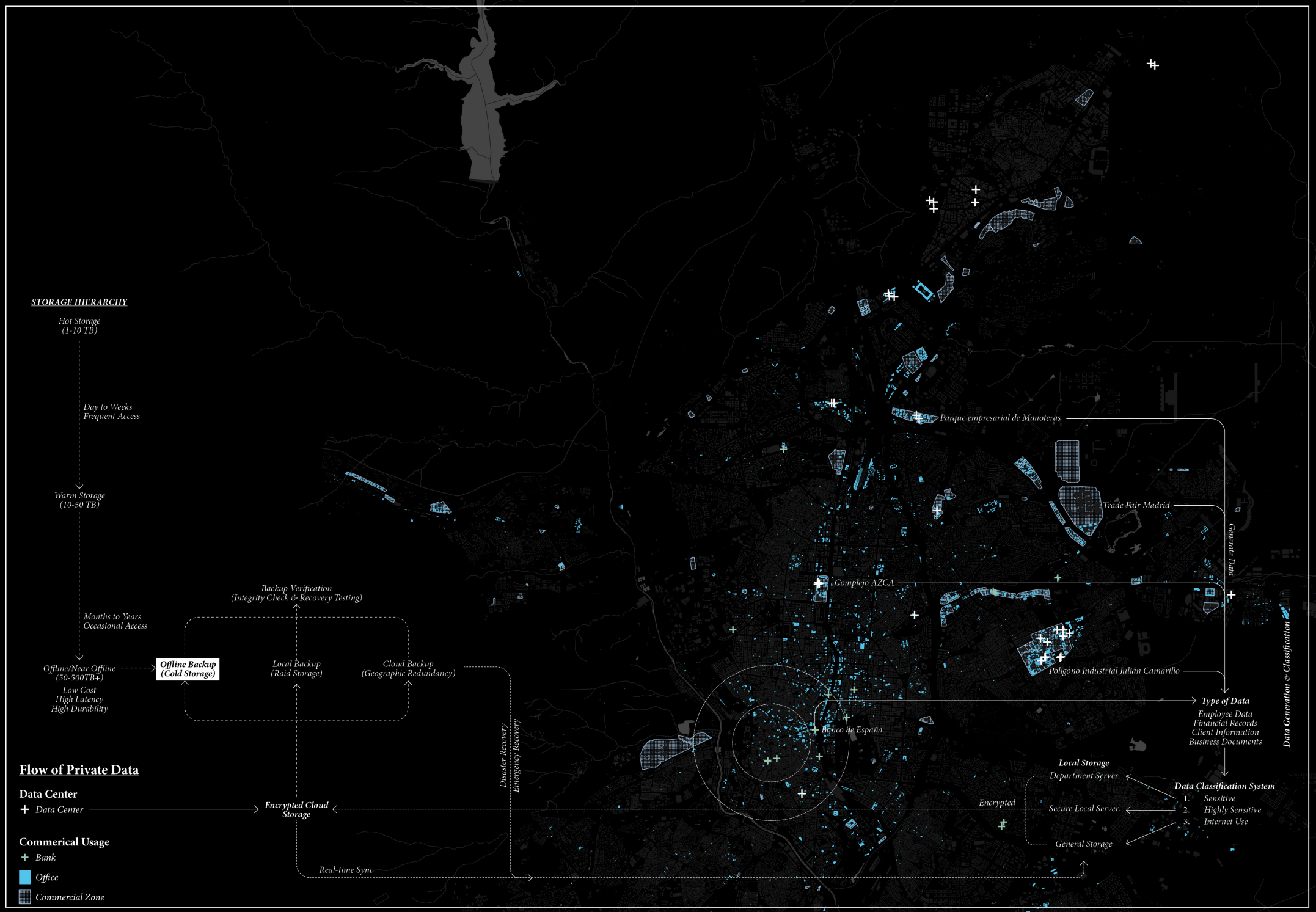
4. Besides data centers, **WHAT** are Madrid's data storage facilities and major data producers?

5. **WHAT IF** the hidden network of digital infrastructure were made visible and integrated into the city's landscape?

6. **WHERE** are the potential zones for integrating digital infrastructure into Madrid's civic space?

7. **WHAT** new urban conditions might emerge from making digital networks visible?

Image 9 / A Hierarchical Network Analysis illustrating data storage architecture for confidential and protected information, highlighting regions necessitating robust private data facilities. The network diagram examines storage stratification based on data retrieval patterns and access intensity levels.


STORAGE HIERARCHY
Hot Storage
(1-10 TB)
Day to Weeks
Frequent Access
Warm Storage
(10-50 TB)
Months to Years
Occasional Access
Offline/Near Offline
(50-500TB+)
Low Cost
High Latency
High Durability
Offline Backup
(Cold Storage)
Backup Verification
(Integrity Check & Recovery Testing)
Local Backup
(Raid Storage)
Cloud Backup
(Geographic Redundancy)
Disaster Recovery
Emergency Recovery
Flow of Private Data
Data Center
Data Center
Encrypted Cloud
Storage
Commerical Usage
Bank
Office
Commercial Zone
Real-time Sync
Parque empresarial de Manoteras
Trade Fair Madrid
Complejo AZCA
Poligono Industrial Julián Camarillo
Generate Data
Data Generation & Classification
Type of Data
Employee Data
Financial Records
Client Information
Business Documents
Banco de España
Local Storage
Department Server
Encrypted
Secure Local Server
General Storage
Data Classification System
1. Sensitive
2. Highly Sensitive
3. Internet Use

METHODOLOGIES

This research employs a multi-layered methodological approach to bridge the divide between Madrid's digital infrastructure and its citizens. Central to this approach is **Actor Network Theory (ANT)**, which **allows us to trace associations between heterogeneous elements - both human and non-human actors - across different layers of *The Stack framework*.** As Latour emphasizes, ANT helps us move beyond traditional 'social explanations' to understand how various actors assemble and reassemble into new configurations.[19] This approach is particularly valuable for understanding how different layers interact and influence each other through their various actors.

SPATIAL MAPPING form the foundation for identifying where digital infrastructure byproducts flow and which urban infrastructures intersect with digital networks. Through **layered mapping techniques with GIS software, the research traces connections between different actors across infrastructure network**: from physical data centers to green spaces, water systems, and energy networks. This multi-layer analysis reveals how actors at different levels influence and shape each other's behaviors and relationships.

ACTOR NETWORK MAPPING AND SYSTEMIC DIAGRAM explore how infrastructure, architecture, and landscape can converge into unified urban forms. **Using ANT as a tool, the relationships between human actors (citizens, operators, policymakers), non-human actors (data centers, infrastructure networks, environmental**

19 Bruno Latour, "Introduction: How to Resume the Task of Tracing Associations*," in Reassembling the Social, by Bruno Latour (Oxford University PressOxford, 2005), 1–2, https://doi.org/10.1093/oso/9780199256044.003.0001.

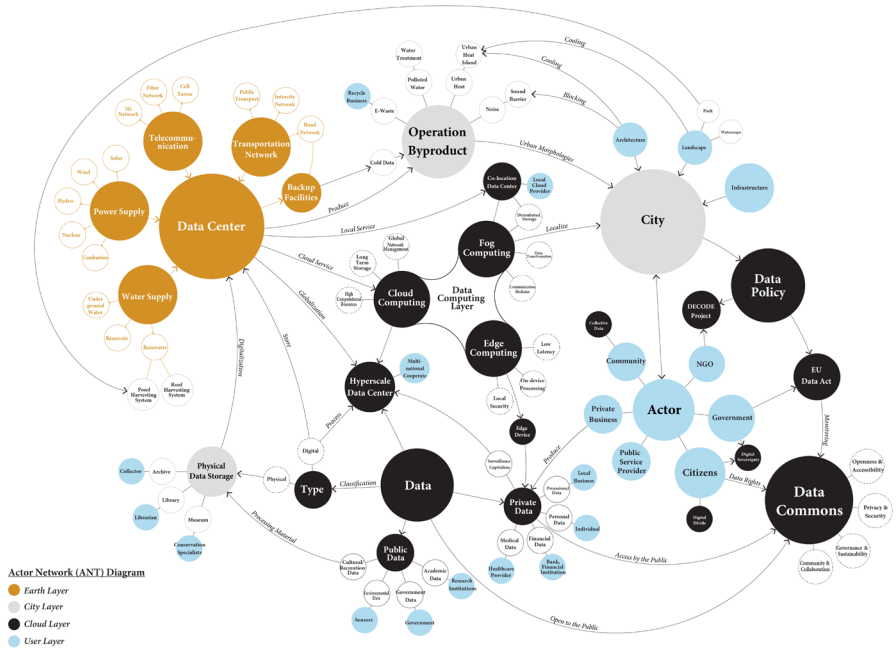
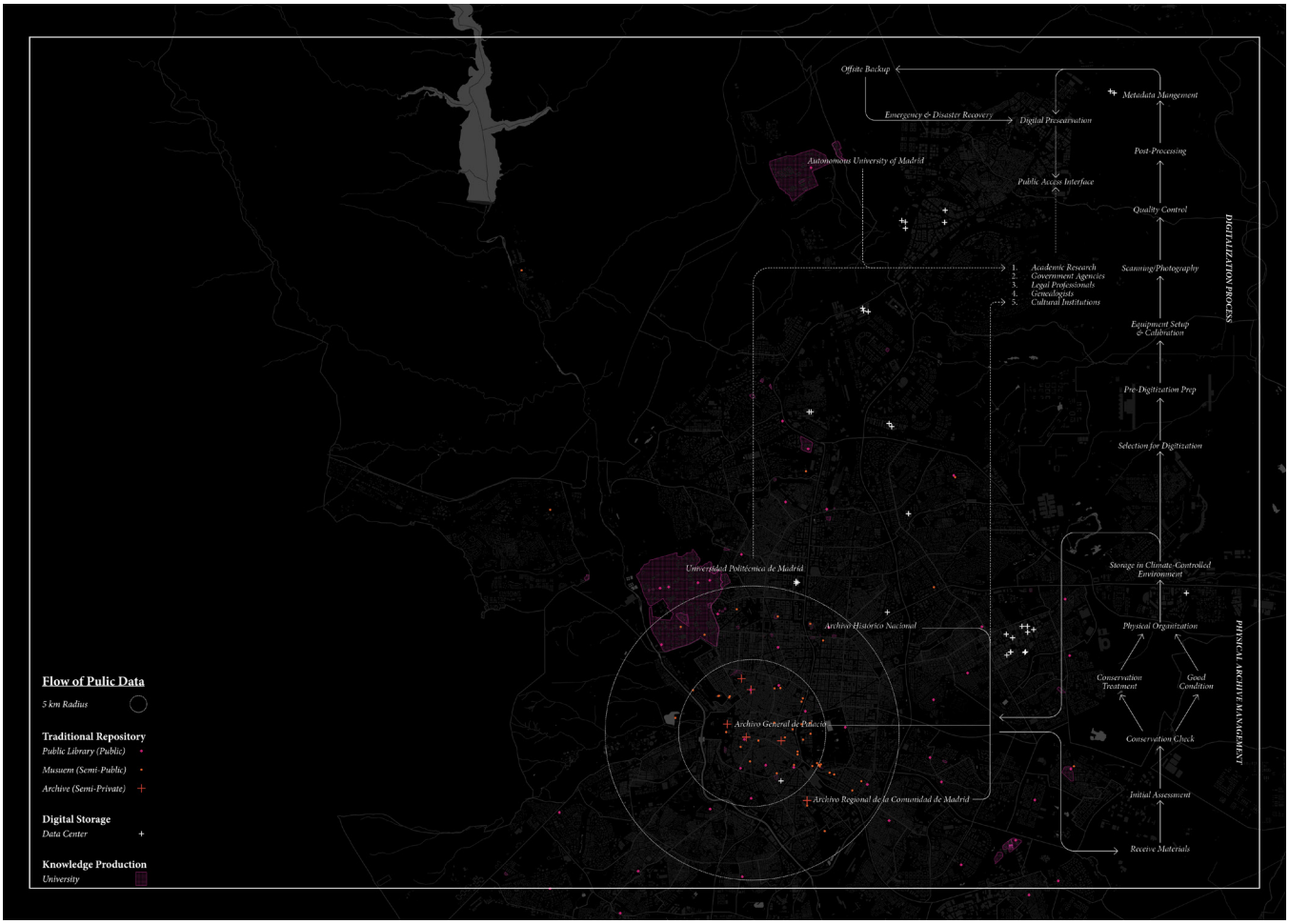


*Image 10 / **Actor Network Theory diagram** mapping relationships and flows between Madrid's infrastructural layers - from data centers to water systems, green spaces to power grids - revealing interdependencies and potential integration points between technical, environmental, and social actors.*

▼ *Image 11 / A visualization of conventional physical data repositories, including libraries, museums, and archives, examining the evolutionary journey of converting tangible records into digital formats and studying the digitization workflow.*

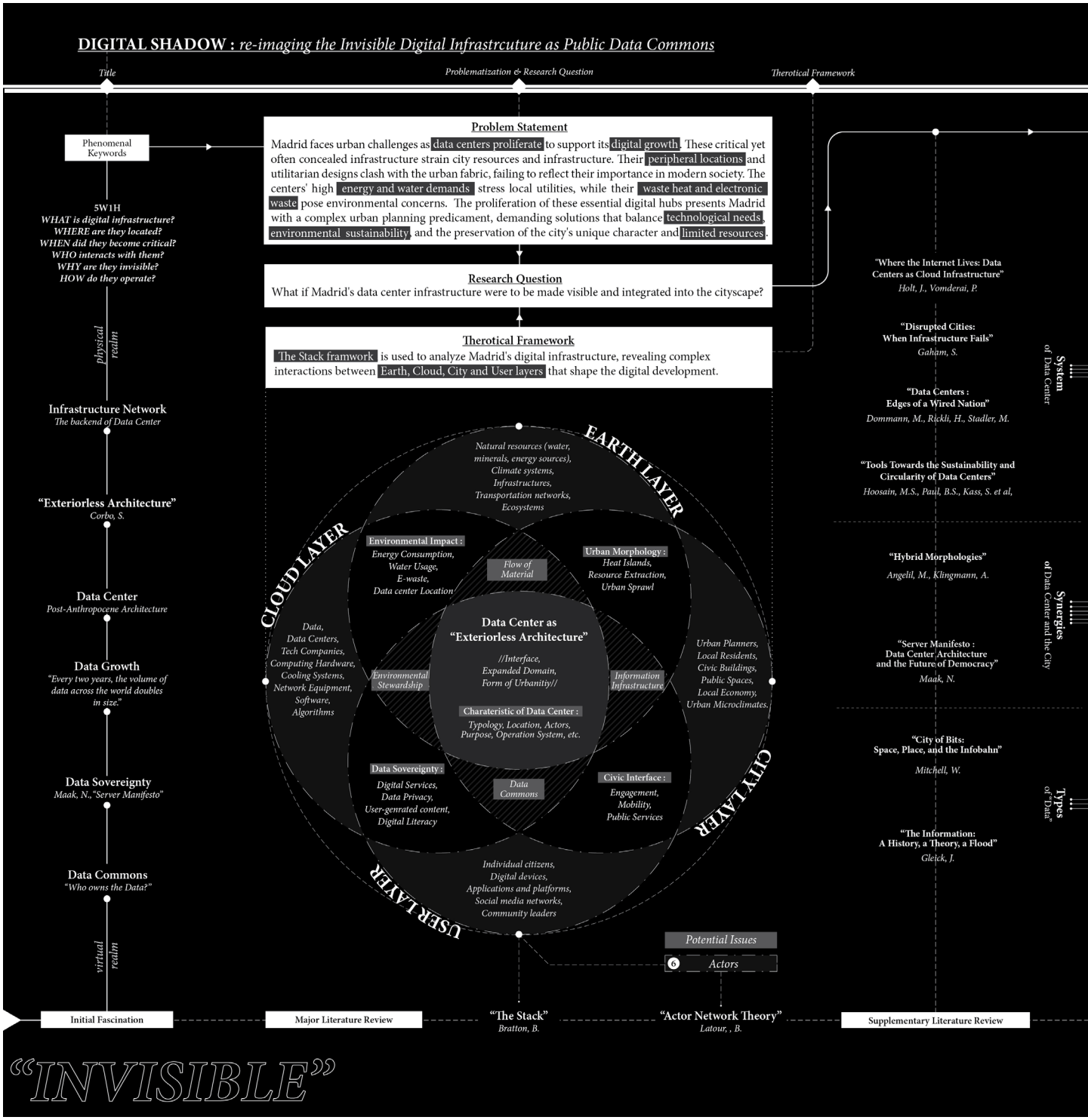


systems), and intermediaries (policies, technologies, spatial practices) across different layers will be mapped. This reveals not just vertical causation between layers, but also horizontal relationships within each layer, helping identify potential synergies and intervention points.

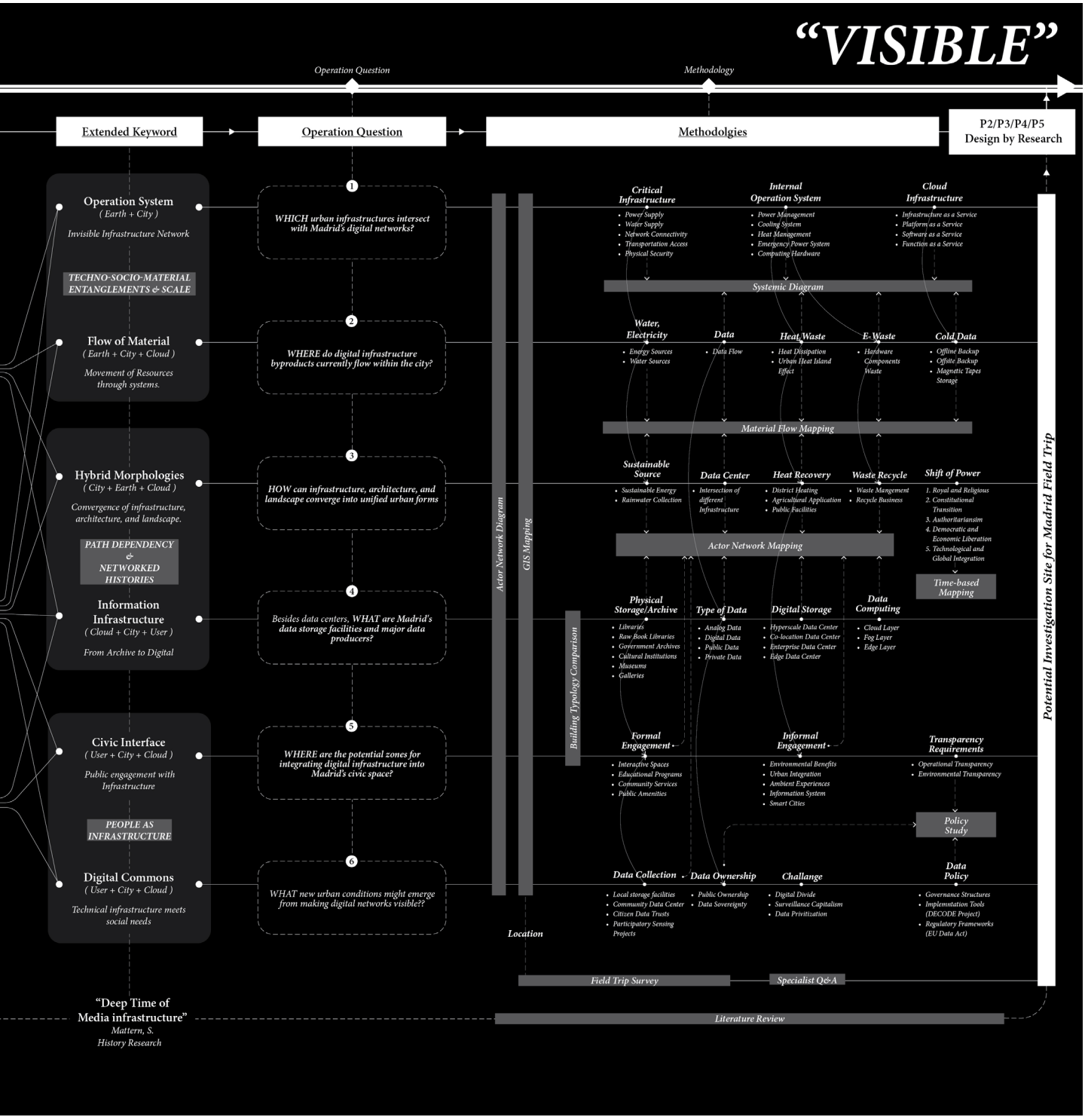
QUANTITATIVE ANALYSIS AND COMPARATIVE ANALYSIS examines Madrid's data storage evolution by **comparing traditional archives with modern data centers through their spatial organization, operational efficiency, and building scale.** This analysis reveals how data centers' massive computing capacity and energy demands contrast with traditional archives, informing strategies for civic integration.

FIELD OBSERVATION AND SITE SURVEY identify where potential zones exist for integrating digital infrastructure into Madrid's civic space. Through systematic **documentation of physical facilities and neighborhood relationships,** these methods reveal opportunities for vertical integration between layers and help visualize what new urban conditions might emerge when digital networks are made visible.

This comprehensive methodological framework, anchored by Actor Network Theory's emphasis on tracing associations, allows us to understand both vertical causation through infrastructure layers and horizontal relationships within layers. By mapping these complex webs of association, we can identify new opportunities for integration and transformation of Madrid's digital infrastructure into visible, meaningful components of the urban fabric. The resulting analysis will inform strategies that consider both technical requirements and community needs while acknowledging the complex interplay between different infrastructural layers and their various actors.


DIGITAL SHADOW : re-imaging the Invisible Digital Infrastrcuture as Public Data Commons
Title
Problematization & Research Question
Therotical Framework
Phenomenal Keywords
5W1H
WHAT is digital infrastructure?
WHERE are they located?
WHEN did they become critical?
WHO interacts with them?
WHY are they invisible?
HOW do they operate?
physical realm
Infrastructure Network
The backend of Data Center
"Exteriorless Architecture"
Corbo, S.
Data Center
Post-Anthropocene Architecture
Data Growth
"Every two years, the volume of data across the world doubles in size."
Data Sovereignty
Maak, N.,"Server Manifesto"
Data Commons
"Who owns the Data?"
virtual realm
Problem Statement
Madrid faces urban challenges as data centers proliferate to support its digital growth. These critical yet often concealed infrastructure strain city resources and infrastructure. Their peripheral locations and utilitarian designs clash with the urban fabric, failing to reflect their importance in modern society. The centers' high energy and water demands stress local utilities, while their waste heat and electronic waste pose environmental concerns. The proliferation of these essential digital hubs presents Madrid with a complex urban planning predicament, demanding solutions that balance technological needs, environmental sustainability, and the preservation of the city's unique character and limited resources.
Research Question
What if Madrid's data center infrastructure were to be made visible and integrated into the cityscape?
Therotical Framework
The Stack framwork is used to analyze Madrid's digital infrastructure, revealing complex interactions between Earth, Cloud, City and User layers that shape the digital development.
EARTH LAYER
Natural resources (water, minerals, energy sources), Climate systems, Infrastructures, Transportation networks, Ecosystems
CLOUD LAYER
Data, Data Centers, Tech Companies, Computing Hardware, Cooling Systems, Network Equipment, Software, Algorithms
CITY LAYER
Urban Planners, Local Residents, Civic Buildings, Public Spaces, Local Economy, Urban Microclimates.
USER LAYER
Individual citizens, Digital devices, Applications and platforms, Social media networks, Community leaders
Environmental Impact :
Energy Consumption, Water Usage, E-waste, Data center Location
Urban Morphology :
Heat Islands, Resource Extraction, Urban Sprawl
Flow of Material
Data Center as "Exteriorless Architecture"
//Interface, Expanded Domain, Form of Urbanity//
Environmental Stewardship
Information Infrastructure
Charateristic of Data Center :
Typology, Location, Actors, Purpose, Operation System, etc.
Data Sovereignty :
Digital Services, Data Privacy, User-genrated content, Digital Literacy
Data Commons
Civic Interface :
Engagement, Mobility, Public Services
Potential Issues
6
Actors
"Where the Internet Lives: Data Centers as Cloud Infrastructure"
Holt, J., Vomderai, P.
"Disrupted Cities: When Infrastructure Fails"
Gaham, S.
"Data Centers : Edges of a Wired Nation"
Dommann, M., Rickli, H., Stadler, M.
"Tools Towards the Sustainability and Circularity of Data Centers"
Hoosain, M.S., Paul, B.S., Kass, S. et al,
System of Data Center
"Hybrid Morphologies"
Angelil, M., Klingmann, A.
"Server Manifesto : Data Center Architecture and the Future of Democracy"
Maak, N.
Synergies of Data Center and the City
"City of Bits: Space, Place, and the Infobahn"
Mitchell, W.
"The Information: A History, a Theory, a Flood"
Gleick, J.
Types of "Data"
Initial Fascination
Major Literature Review
"The Stack"
Bratton, B.
"Actor Network Theory"
Latour, , B.
Supplementary Literature Review
"INVISIBLE"

▼ *Image 12 / Sequential research roadmap showing progression from inital fascinations to methodolgy.*



EXPECTED OUTCOME

The research plan aims to map a series of critical intersections in Madrid where digital infrastructure could potentially integrate with civic life. Through systematic field observations, we expect to develop a comprehensive survey methodology that traces the flows of energy, data, water, and electronic waste across the city's digital landscape.

Key investigation areas will include:

1. *Data centers' thermal output zones and their proximity to public facilities*
2. *E-waste collection points and recycling facilities that process server equipment*
3. *Traditional knowledge institutions adapting to digital transformation*
4. *Power substations and renewable energy infrastructure supporting data centers*
5. *Water systems utilized for cooling digital infrastructure*
6. *Telecommunication nodes and their urban integration points*

The field research guidelines will be structured around four layers of observation:

1. *Physical Infrastructure: Mapping visible technical facilities*
2. *Resource Networks: Tracing energy, water, and waste flows*
3. *Social Patterns: Documenting public interaction with digital spaces*
4. *Adaptive Reuse Potential: Identifying spaces for infrastructure integration*

This framework will create an open-ended research tool for exploring Madrid's digital ecosystem, establishing a methodology that can adapt to emerging technological needs while preserving the flexibility to discover unexpected integration opportunities between digital infrastructure and urban life.

Image 13 / Time-based mapping that show the Shift of Power during the urban sprawl

WHAT NEXT?

5. 1995 - Present
Technological and Global Integration
- Tech hub
- International Corporations
- Networked Insitutions

4. 1975-1995
Democratic and Economic liberation
- New Business District
- New Industrial District

3. 1939-1975
Centralized Authoritarianism
- Expansion of Government Ministries
- State Controlled Institutions

2. 1808-1939
Constitutional Transition
- Parliament
- Civic Institution

1. 1561-1808
Royal and Religious
- Royal Palance
- Church
- Monasteries

REFLECTION

Through this research plan, I've come to recognize the inherent limitations of architectural intervention in digital infrastructure. While architects can envision physical integrations of data centers with urban fabric, we must **acknowledge that critical aspects like data sovereignty and digital commons ultimately reside in the realm of policy and politics - areas beyond architectural control.**

However, these limitations haven't constrained the research; rather, they've helped **sharpen its focus towards a more profound question: how can architecture physically manifest 'data commons' when today's digital power structures deliberately resist traditional architectural expression?** Historically, civic buildings like palaces and government offices proclaimed their authority through central locations and monumental design.

Yet modern data centers - perhaps the most powerful infrastructure of our time - intentionally fade into peripheral industrial zones, hiding their influence behind anonymous facades. This investigation has taught me to work within constraints, finding meaningful architectural contributions even when larger systemic issues lie beyond our scope. Rather than mimicking historical monuments of power, perhaps the architecture of data commons requires a new language - one that **prioritizes transparency of resource flows and reveals the usually hidden processes of digital infrastructure.** Sometimes, limitations help define the most impactful path forward.

Core Keywords

Data Common

Digital Infrastructure

Machine Architecture

Infrastructure Network

Flow of Data

Hybrid Morphologies

Data Center

Theoretical Framework

The Stack

Earth Layer

Cloud Layer

City Layer

User Layer

Hybrid Morphologies

Exteriorless Architecture

Planetary-scale Computation

Megastructure

Techno-Socio-Material Entanglements

Scale

Path Dependency

Networked Histories

People as Infrastructure

Infrastructure & Technical

Server Farms

Databases

Energy Sources

Optical Cables

Wireless Transmission

Media

Distributed Applications

Power Grids

Water Systems

Telecommunications Networks

Network Infrastructure

Cooling Systems

Flow of Materials

Urban & Architectural

Civic Buildings

Civic Interface

Information Infrastructure

Urban Landscape

Urban Development

Urban Fabric

Urban Territory

Infrastructure Corridors

Peripheral Locations

Spatial Organizations

Operation

Resource Management

E-waste

Waste Heat

District Heating

Energy Consumption

Water Consumption

Hardware Replacements

Methodology

Time-based Mapping

GIS Mapping

Material Flow Mapping

Demographic Mapping

Actor Network Mapping

Cross-System Analysis

Actor Network Theory

Building Typological Comparison

Classification Analysis

Components of Analysis

Digital Hub

Digital Society

Digital Sovereignty

Infrastructural Complex

Knowledge Exchange

Technical Networks

Civic Landmarks

Technical Infrastructure

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FIELD TRIP SCHEDULE

Day 2 (6/11) - Traditional Knowledge Infrastructure

Morning: Biblioteca Nacional de España (National Library)
Afternoon: Archivo Histórico Nacional (National Historical Archive)
Evening: Digital documentation and reflection
Focus: Understanding traditional information storage systems and their transformation

Day 2 (7/11) - Personal Travel

Suggested: Toledo

Day 3 (8/11) - Personal Travel

Suggested: Segovia

Day 4 (9/11) - Digital Infrastructure Core

Morning: Polígono Industrial Julián Camarillo (Data Center District)
Afternoon: Getafe Industrial Area (Merlin Data Center)
Focus: Documenting exterior architecture and urban context of data centers

Day 5 (10/11) - Infrastructure Networks

Morning: El Pardo Reservoir (Water infrastructure)
Afternoon: Polígono Industrial Valportillo
Focus: Mapping connections between water systems and digital infrastructure

Day 6 (11/11) - Energy Systems

(Morning: Local power substations
Afternoon: District heating facilities
Focus: Understanding energy distribution networks)

Day 7 (12/11) - E-Waste and Circular Economy

(Morning: Electronic waste recycling facilities
Afternoon: Tech repair shops and informal e-waste collection points
Focus: Documenting material lifecycle of digital infrastructure)

Day 8 (13/11) - Urban Integration Points

(Morning: Plaza Mayor and surrounding digital access points
Afternoon: Modern libraries and cultural centers with digital facilities
Focus: Observing where digital infrastructure meets public space)

Day 9 (14/11) - Synthesis

(Morning: Follow-up visits to key sites
Afternoon: Documentation organization
Focus: Filling gaps in research and consolidating findings)

This schedule is only for reference.