

# Resilience of digital infrastructures to resource fluctuations



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2026-07-09, Paris

*Inria*

# Critical infrastructures

Societies rely on digital infrastructures (ICT)

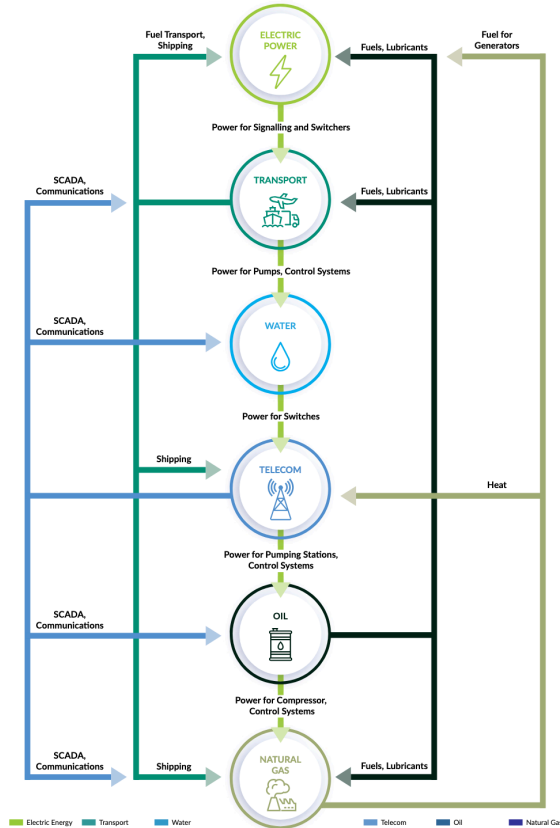


**CISA**  
CYBER+INFRASTRUCTURE

Critical Infrastructure Sectors

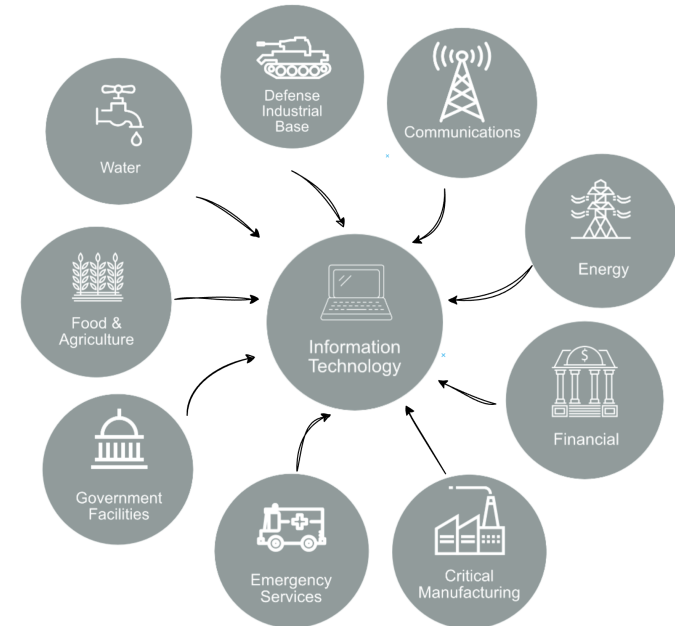
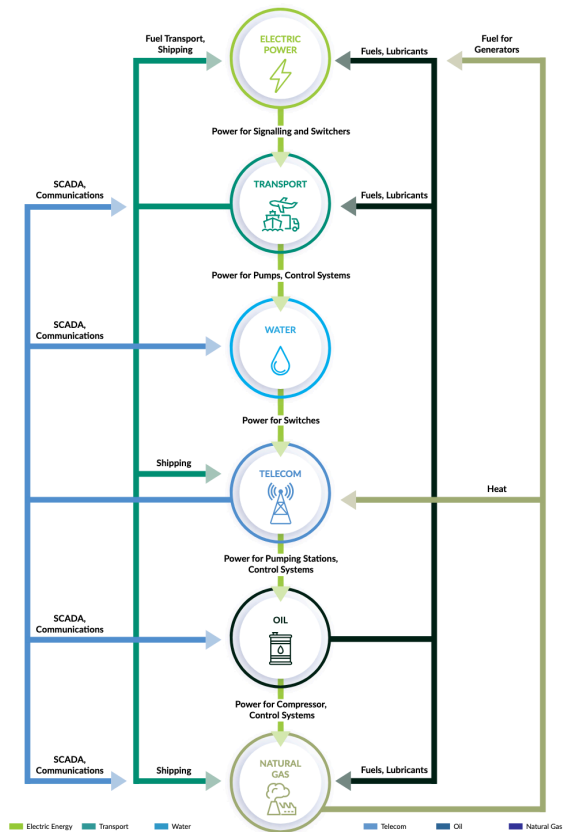


# Dependencies between critical infrastructures



Source: National Strategy on the  
Resilience of Critical Entities 2026-2029

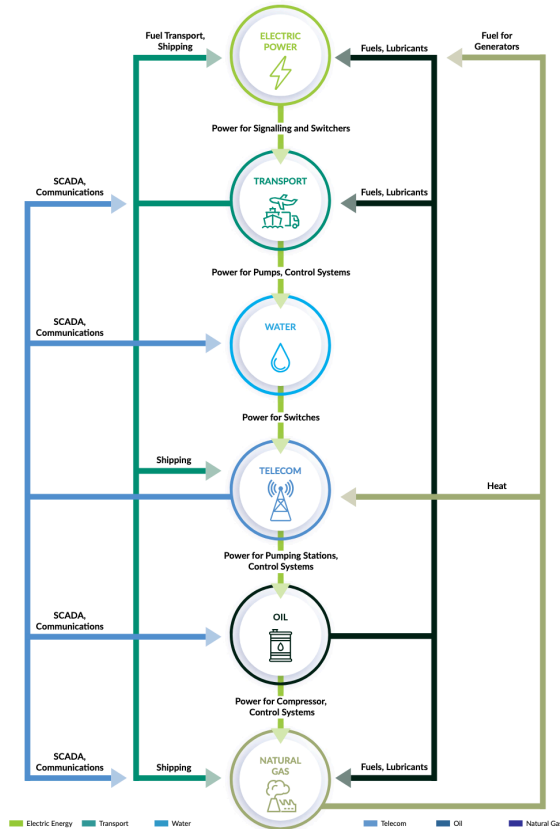
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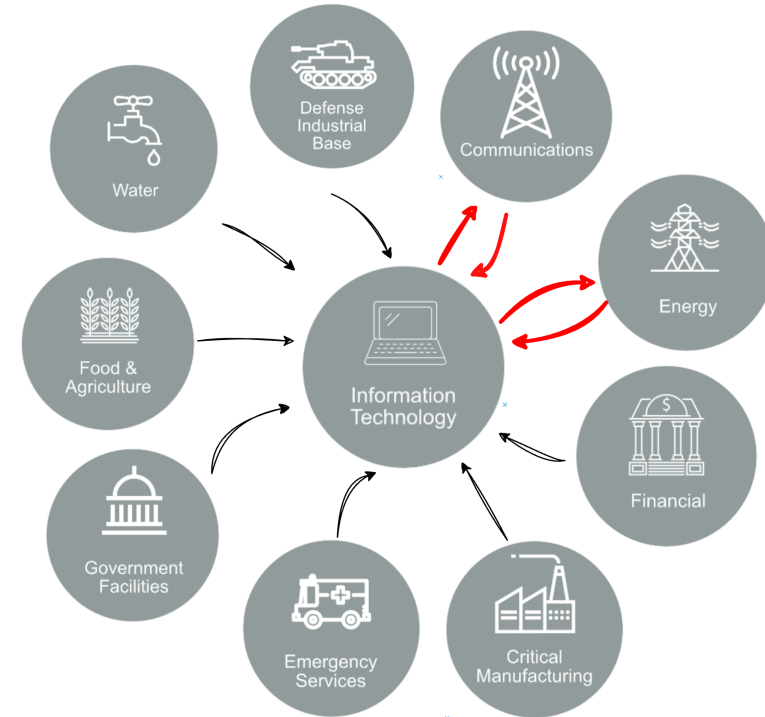
Source: National Strategy on the Resilience of Critical Entities 2026-2029



# Dependencies between critical infrastructures



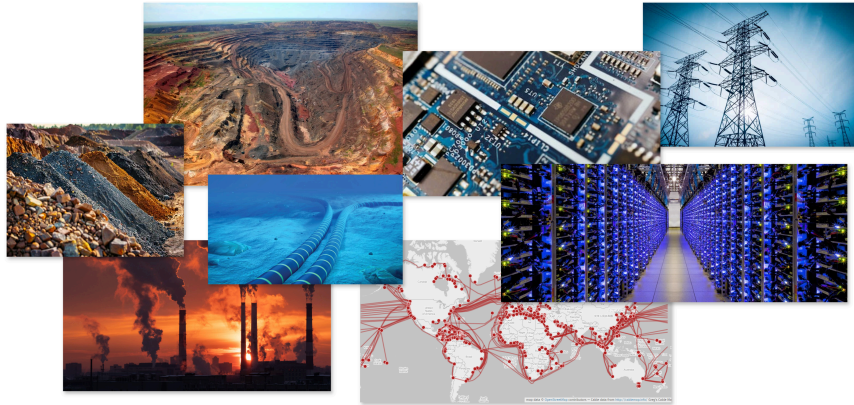
## ⚠ Loops



Source: National Strategy on the Resilience of Critical Entities 2026-2029

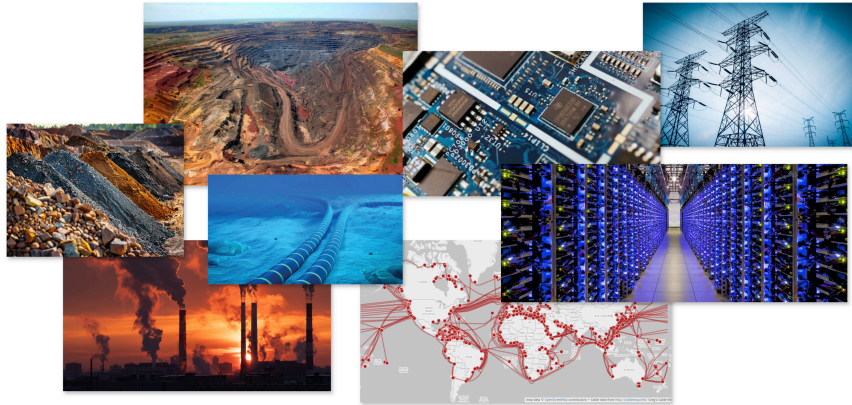
# Service-Oriented Digital Infrastructure

**Definition:** A service-oriented digital infrastructure is a set of hardware or software components/services required to offer higher-level services.



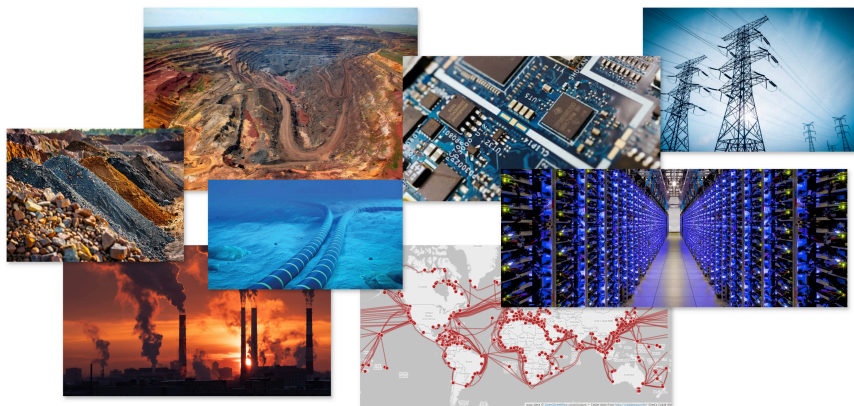
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⇒ *Graph of interdependent services*

Examples: Public and private clouds, Multi-clouds, edge, continuum, on-premise infrastructures, *Cyber Physical Systems*



# Fragilities

Complex evolving Systems with many dependencies

⇒ ***Internal and worldwide cascading outages***



# Fragilities

Complex evolving Systems with many dependencies

⇒ **Internal and worldwide cascading outages**

- 1. Network config
- 2. Undersea cable cuts
- 3. Incompatible metadata in CDN



Jan. 2025, 50h  
Sept. 2025  
Oct. 2025, , 10h

*Bad automated update  
quota check system*



Google Cloud Platform

June 2025, 3h

*Race condition in  
Amazon's DynamoDB's DNS*



Oct. 2025, 15h

*Larger than expected file  
replication*



Nov. 2025, 8h



# Resilience

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Resilience is used as an integrative concept that encompasses system robustness, survivability, recovery, and adaptability

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**BUT** they rely on the following strong **hypothesis**

- **Rare** and **isolated** (local) problems
- **Inifinte resources** (computing, storage, energy, water, etc.)
- **Stability** of external services (electricity, hardware supply etc.)

# Polycrises increase fragilities

## Which crises?

- climate change
- natural resource scarcity
- geopolitical instability

⇒ **Hypothesis**



## Fluctuation

An **irregular** rising and falling in number or amount

# Examples of fluctuations

**New Texas law allows  
ERCOT to disconnect  
data centers during peak  
events**

# Examples of fluctuations

**New Texas law allows**

**ERC  
data  
even**

*Feature*

How Agriculture and Data Centers  
Compete for the Great Lakes' Most  
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*Feature*

How Agriculture and Data Centers

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**How the April 28, 2025, power outage in Portugal and Spain impacted Internet traffic and connectivity**

2025-04-28

# Examples of fluctuations

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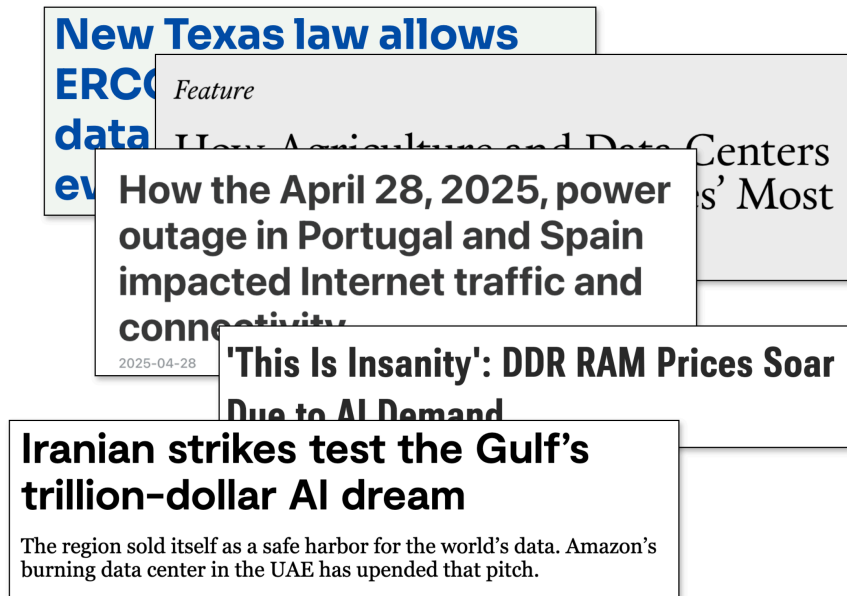
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**How the April 28, 2025, power outage in Portugal and Spain impacted Internet traffic and connectivity**  
2025-04-28

**'This Is Insanity': DDR RAM Prices Soar Due to AI Demand**



# Examples of fluctuations



- Fluctuations in access to water
- Temperature fluctuations
- Electrical fluctuations
- Fluctuations on hardware supply
- Fluctuation in network quality or connectivity
- Fluctuations to access data, software, services, applications
- etc.

# RIFT research team (under creation)

[R]esilience of digital [I]nfrastructures to resource [F]luc[T]uations

⇒ Following the current *STACK* research group of Adrien Lebre



Daniel Balouek



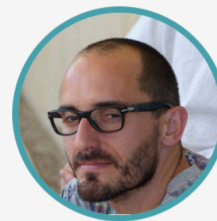
Carlos Gonzalez



Baptiste Jonglez



Remous Aris Koutsiamanis



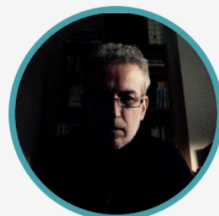
Adrien Lebre



Thomas Ledoux



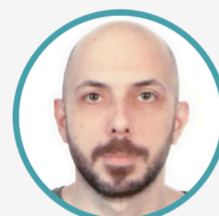
Jean-Marc Menaud



Jacques Noyé



Kandaraj Piamrat



Guillaume Rosinosky



Mario Südholt

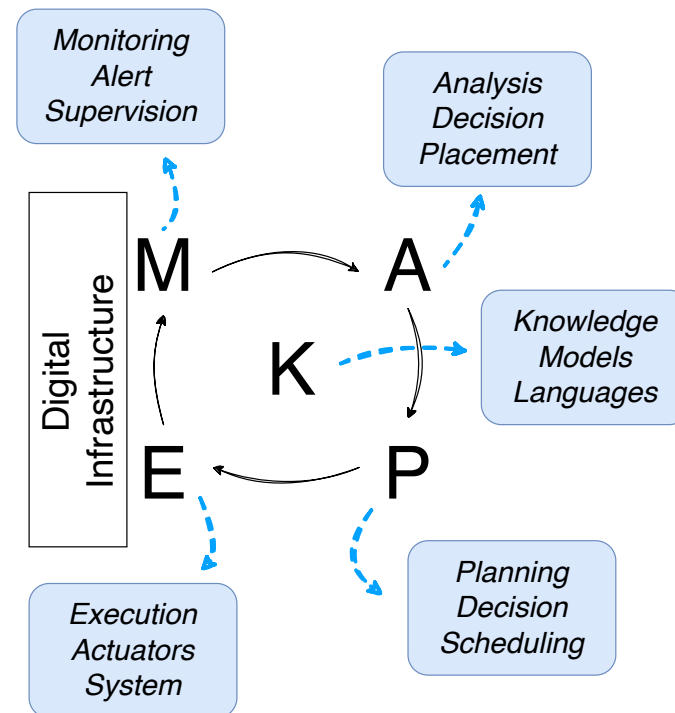
# Scope of the team

## Contributions

(Resilient) Software systems for ICT management and resilience.

**Examples:** *OpenStack, Kubernetes, OpenWISK, OpenFaaS, OpenFL, Sylva etc.*

- **Axis 1:** Considering limitations and degradations
- **Axis 2:** Handling the temporal scales of fluctuations
- **Axis 3:** Handling the spatial scales of fluctuations
- **Axis 4:** Evaluating resiliency



 Thank You!

**[R]esilience of digital [I]nfrastructures to  
resource [F]luc[T]uations**

Questions?



# Research program

- ◎ **Axis 1**: Considering limitations and degradations
  - ▶ Connectivity, energy, hardware
- ◎ **Axis 2**: Handling the temporal scales of fluctuations
  - ▶ urgency, high frequency, long-term permanent
- ◎ **Axis 3**: Handling the spatial scales of fluctuations
  - ▶ geography and territoriality, sovereignty
- ◎ **Axis 4** Evaluating resiliency
  - ▶ Metrics, benchmarks, resilience-oriented platforms