Orchestrating a brighter world NEC

Data Week 2023

Urban Digital Twins based on NGSI-LD

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Table of Content

1. Digital Twin Concept
2. NGSI-LD: Standard, Design and Digital Twin Modelling
3. Smart Data Models for NGSI-LD
4. Uptake, Summary and Impact

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Empowering innovators to grow and solve societal challenges through research excellence

Open innovation of core technologies

- AI Innovation
- Biomedical AI
- Graph Machine Learning/NLP
- Human-Centric AI

- Security (Trust, System)
- 6G Networks

- System Platforms for AI and Data Ecosystems (Data Spaces)

Heidelberg, Germany:
~ 80 researchers from across the globe, + 20 other staff

Collaboration with top European universities and research institutes

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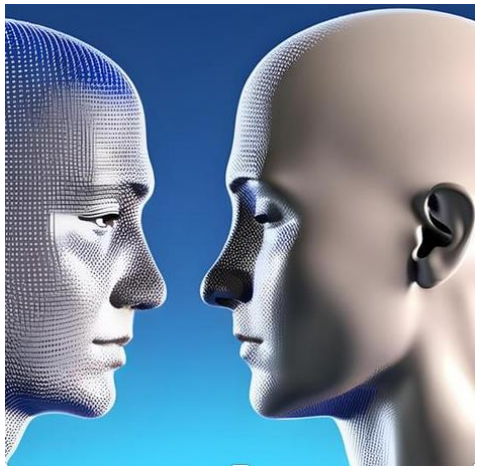
Digital Twin Concept

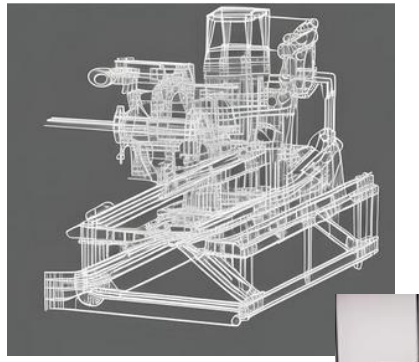
Digital Twins



- **Digital Twin** = Digital representation of a real-world asset …
  - Characterized by attributes
    - Properties
    - Relationships
  - Values of attributes may change over time (or not)
  - Typically have a location (but it is not a must requirement)

  … & Capabilities

- **Cornerstone for the development** of interoperable and replicable (portable) Smart Solutions:
  - Standard API for getting access to Digital Twin data (context)
  - Common Data Models associated to Digital Twin classes



Pictures are AI-generated on https://www.canva.com

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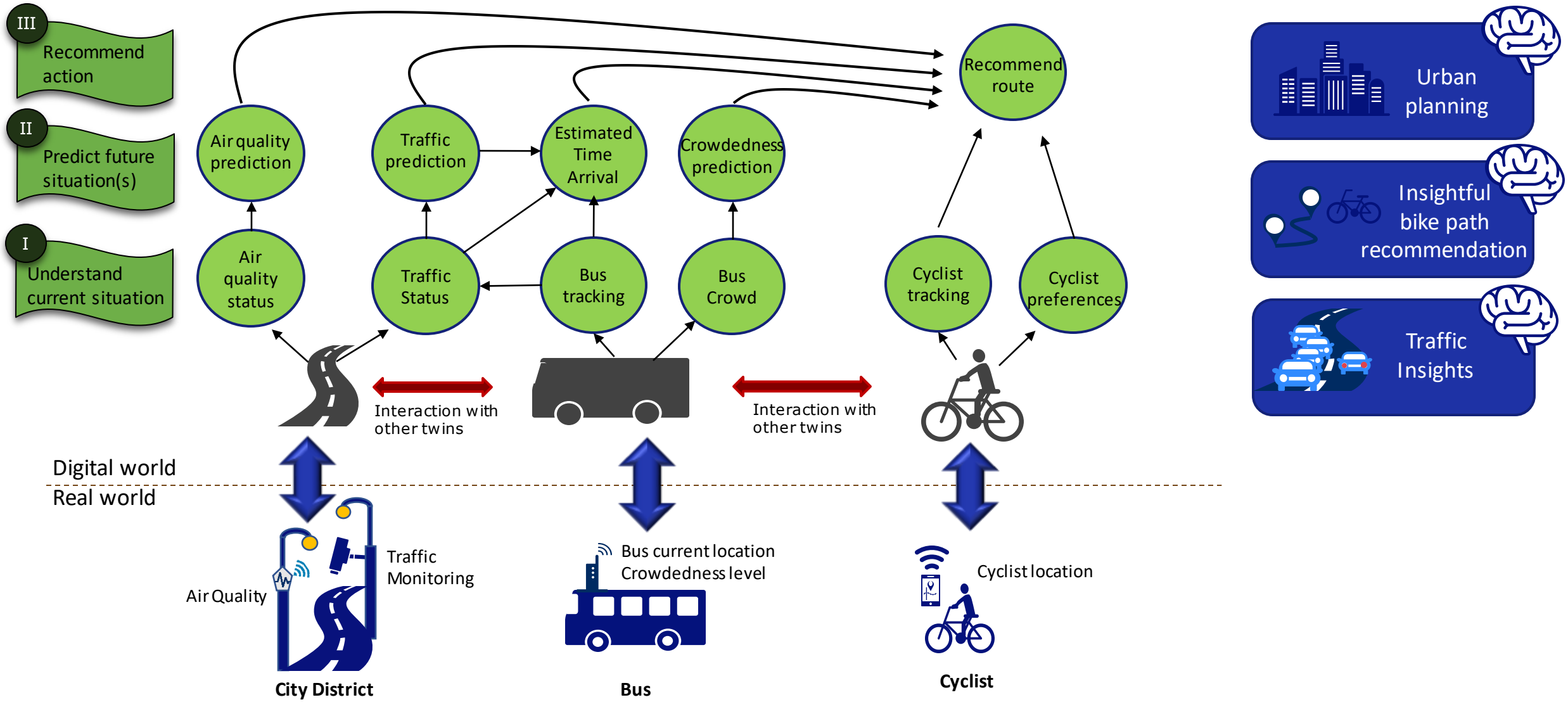
Implementing Use Cases with Urban Digital Twins



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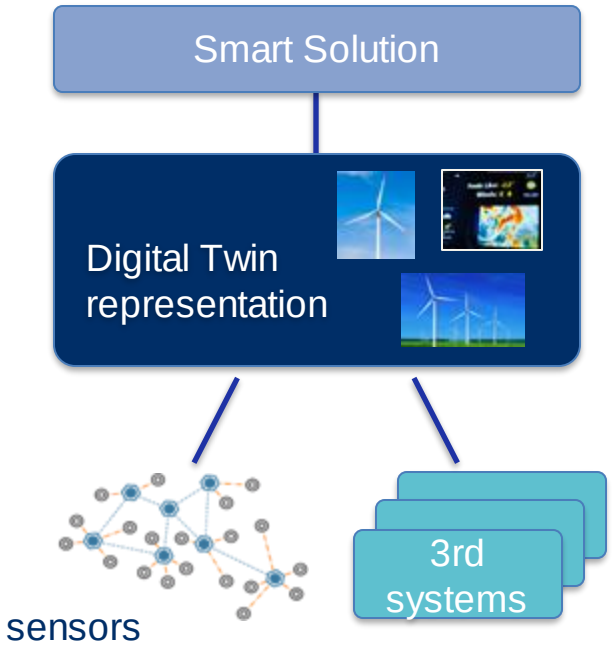
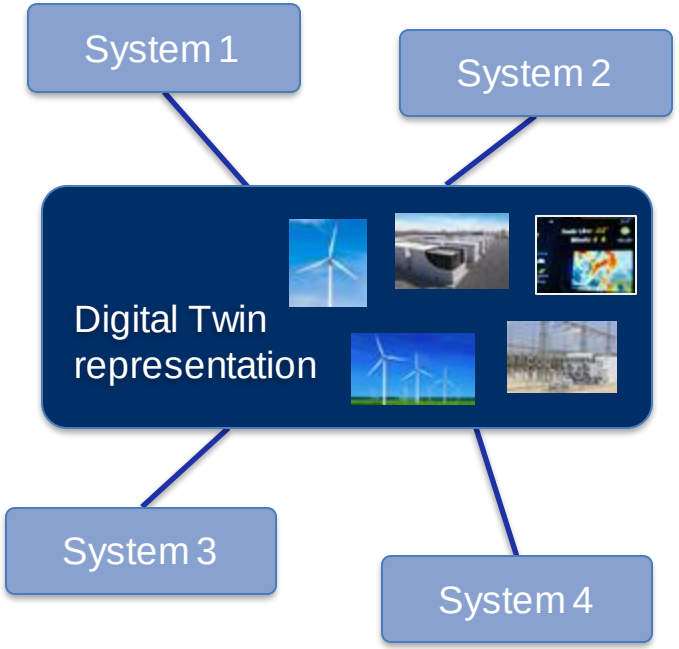
Digital Twins: an approach for integration at multiple levels

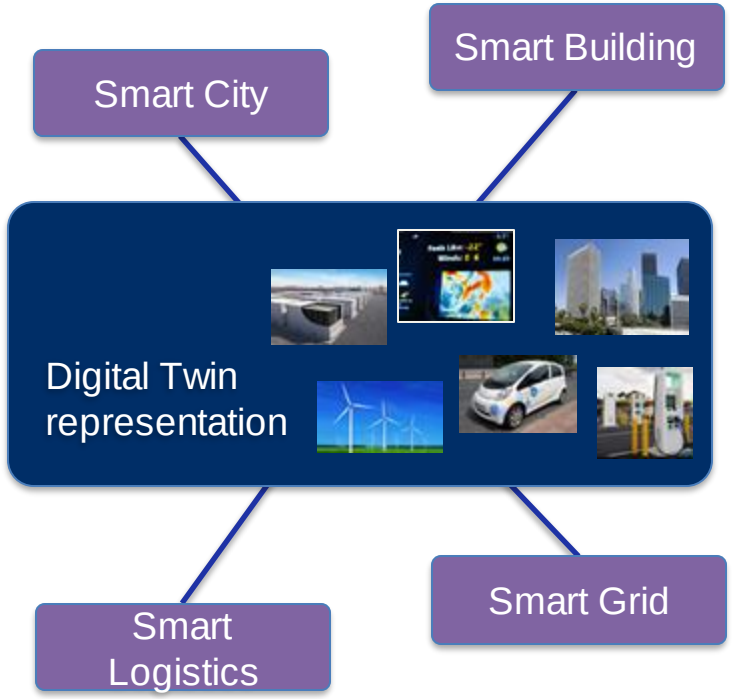
Architecting Smart Solutions



Integrating systems and data within organizations (system of systems)



Sharing Data across organizations (Data Spaces)



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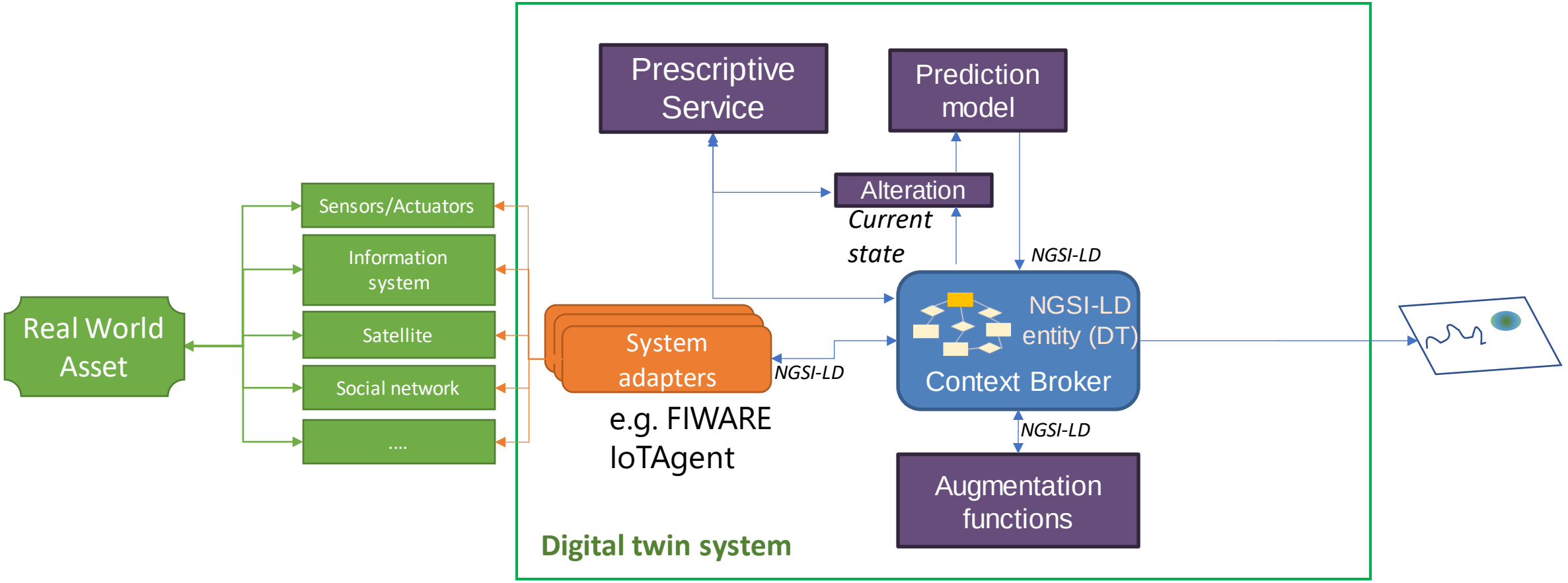
NGSI-LD:
Standard, Design and Digital Twin modelling

NGSI-LD Architecture for Digital Twin Systems



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NGSI-LD – Evolution and specification in ETSI ISG CIM

2010 OMA NGSI
Context API in Open Mobile Alliance (OMA)

→

2012-2016: NGSI v1/v2
FIWARE project develops binding and evolves OMA NGSI
(not standardized)

→

2019: NGSI-LD
Evolution as ETSI ISG CIM specification based on JSON-LD

- ETSI ISG for cross-cutting Context Information Management (ETSI ISG CIM)
  - Established in 2017 – extended until 2025
  - Currently about 30 supporting organizations
  - **Evolution of NGSI Context Interfaces →NGSI-LD**

  https://www.etsi.org/deliver/etsi_gs/CIM/001_099/009/01.06.01_60/gs_CIM009v010601p.pdf

- European Telecommunications Standards Institute (ETSI)
  - ETSI produces globally-applicable standards for Information and Communications Technologies (ICT)
  - It is officially recognized by the European Commission as a European Standards Organization
  - Industry Specification Groups (ISG): low standardization barriers and allowing participation of non-ETSI-members

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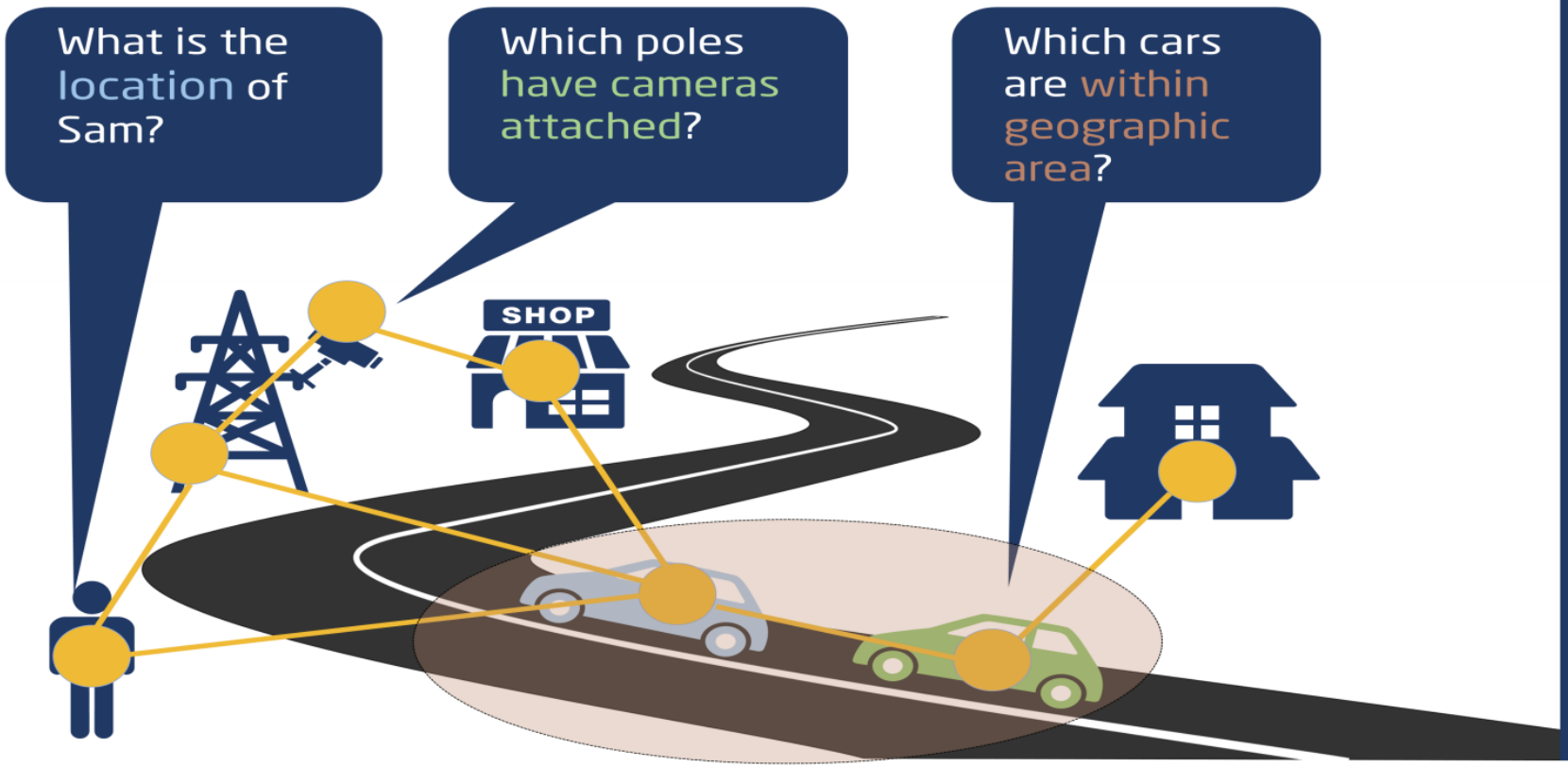
NGSI-LD API



NGSI-LD Features

- Knowledge graph: Entities have Properties and Relationships
- Annotated Properties and Relationships
- Synchronous query and asynchronous subscription/ notification interaction
- Filtering & paging
- Geographic scoping
- Temporal queries
- Support for centralized, distributed and federated architectures

- Key aspects of NGSI-LD
  - NGSI-LD has a *knowledge graph* as its information model
  - NGSI-LD provides an *API* for retrieving and managing information
  - NGSI-LD supports different *architectural models* (central, distributed, federated)

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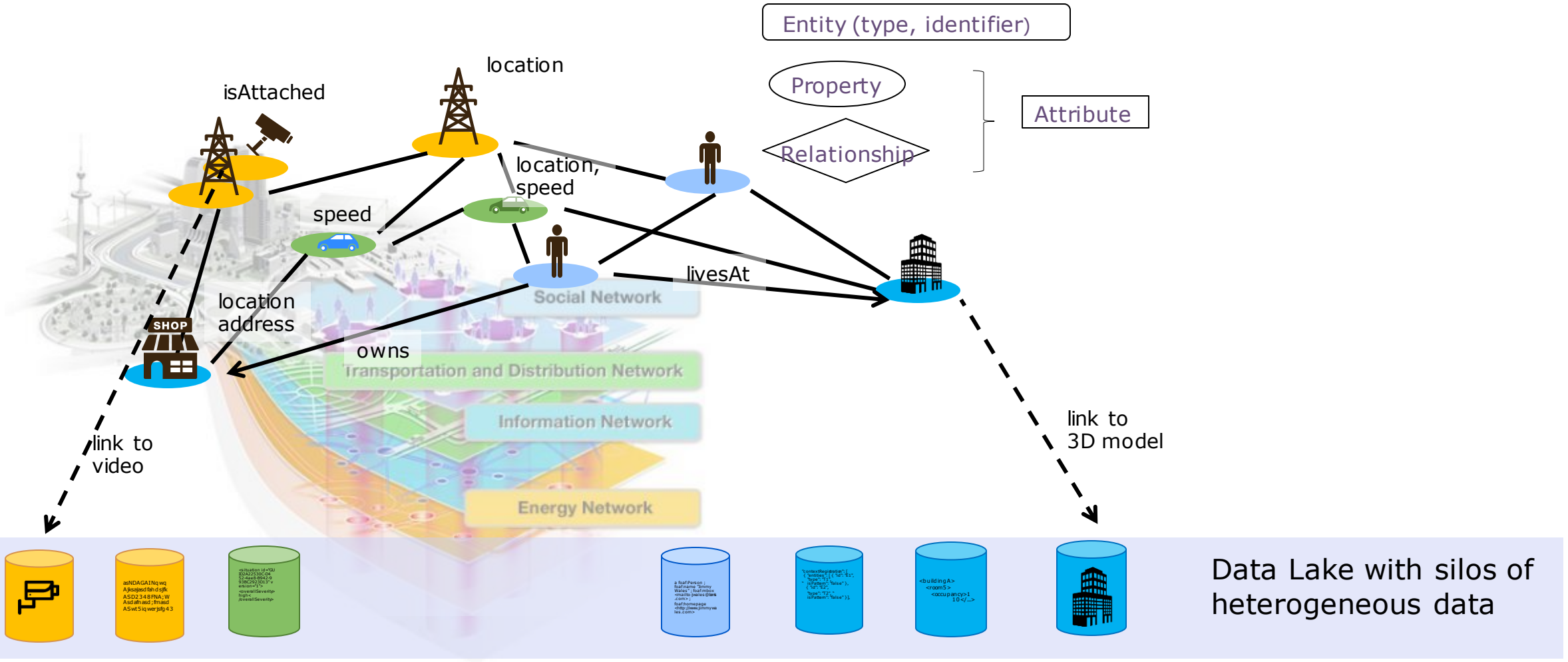
NGSI-LD Information Model (Property Graph)



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Digital Twin Capabilities

- An NGSI-LD based Digital Twin system can get its capabilities incrementally increased

PrescriptiveTwin: Extends the prospective capability with suggested action(s) based on the analysis

Decision support systems

Prescriptive

Descriptive Twin:
- Current (and past) state of the real world asset - static and dynamic
- Bidirectional connection between real-world asset and the DT

Prospective

Prospective Twin: Extends the predictive twin capability with "what-if" analysis.

Predictive

Predictive Twin: Extends the descriptive twin capability by providing predictions on the way the real asset could evolve in the future.

Descriptive

ETSI NGSI-LD context information management

Diagnosis

Diagnosis Twin: Capability for evaluating what happened, especially in case of malfunction of the real asset.

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Smart Data Models

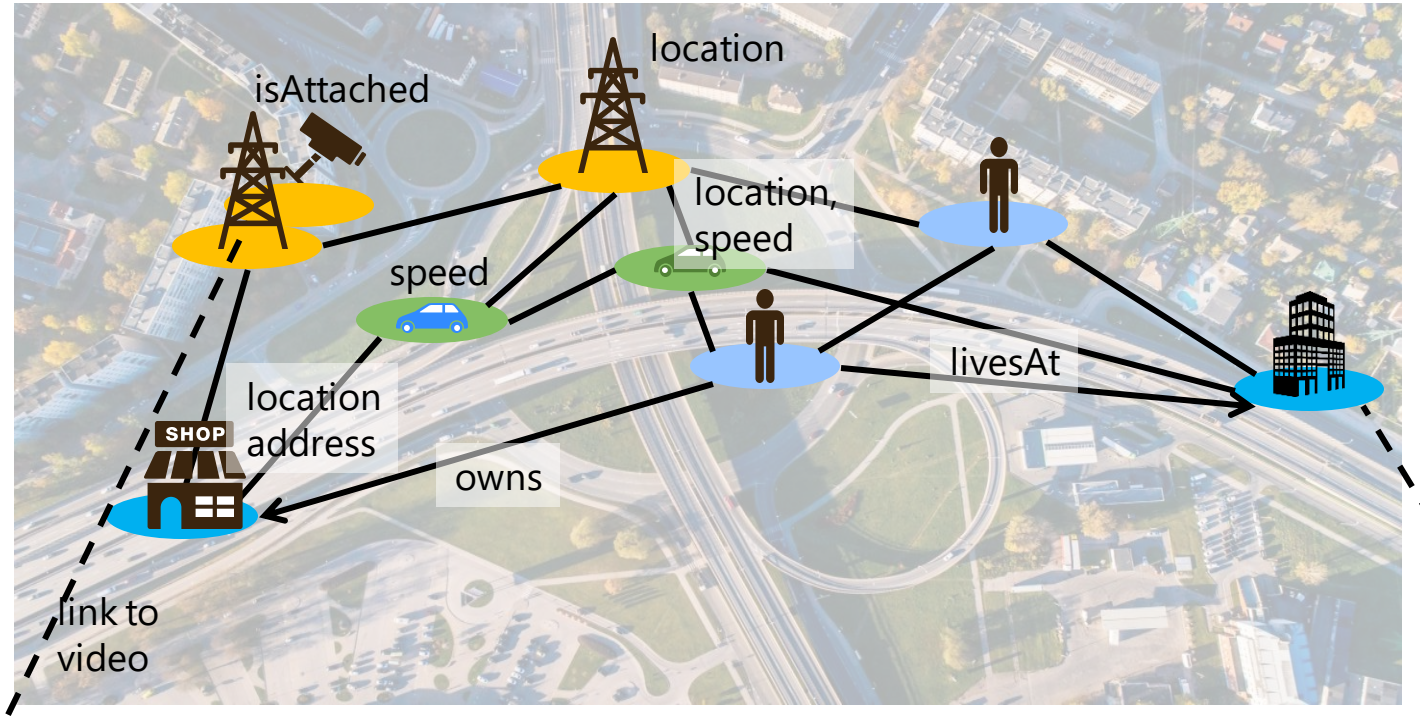
NGSI-LD-compatible Data Models for Digital Twins

NGSI-LD-compatible Data Models

Entity (type, identifier)

Property

Relationship



What entity types are there?

What properties can instances of a certain entity type have?

What relationships can instances of a certain entity type have?

→ Data Models

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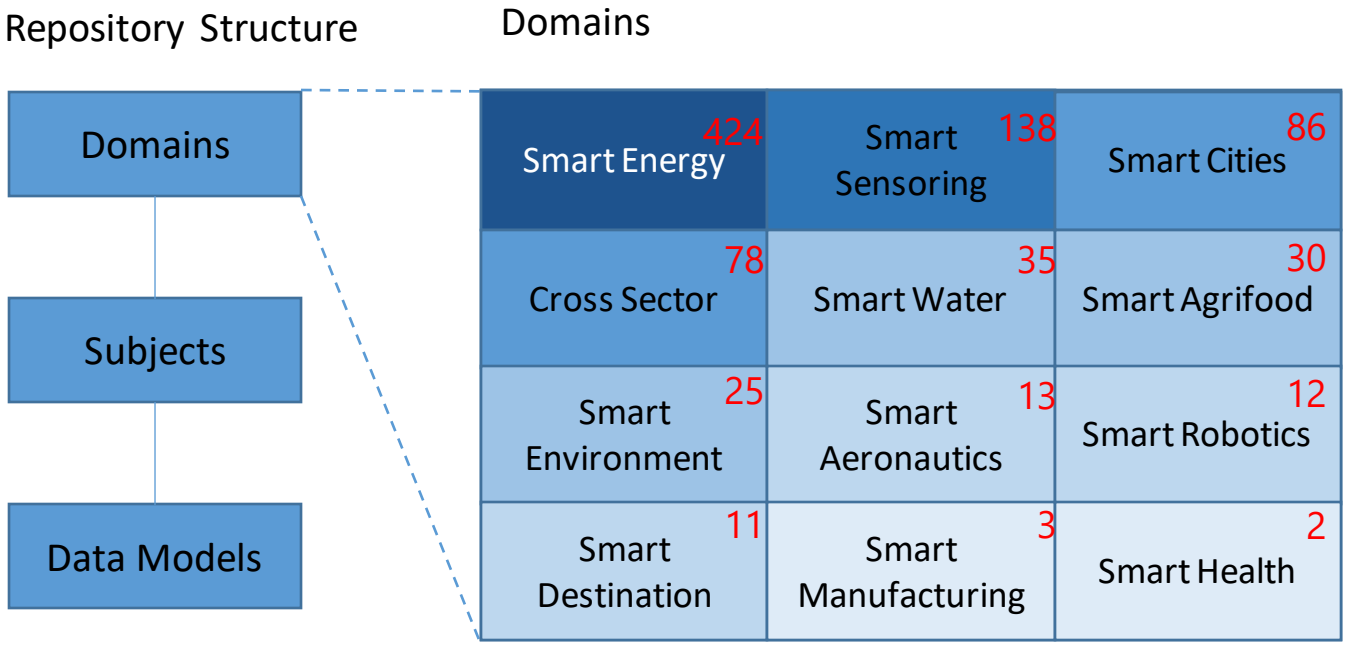
NGSI-LD Data Models

- NGSI-LD requires models defining entity types with their properties and relationships
- Existing NGSI-LD Data Models



- 811 official Smart Data Models from 77 different organizations
- 133 documented adopters

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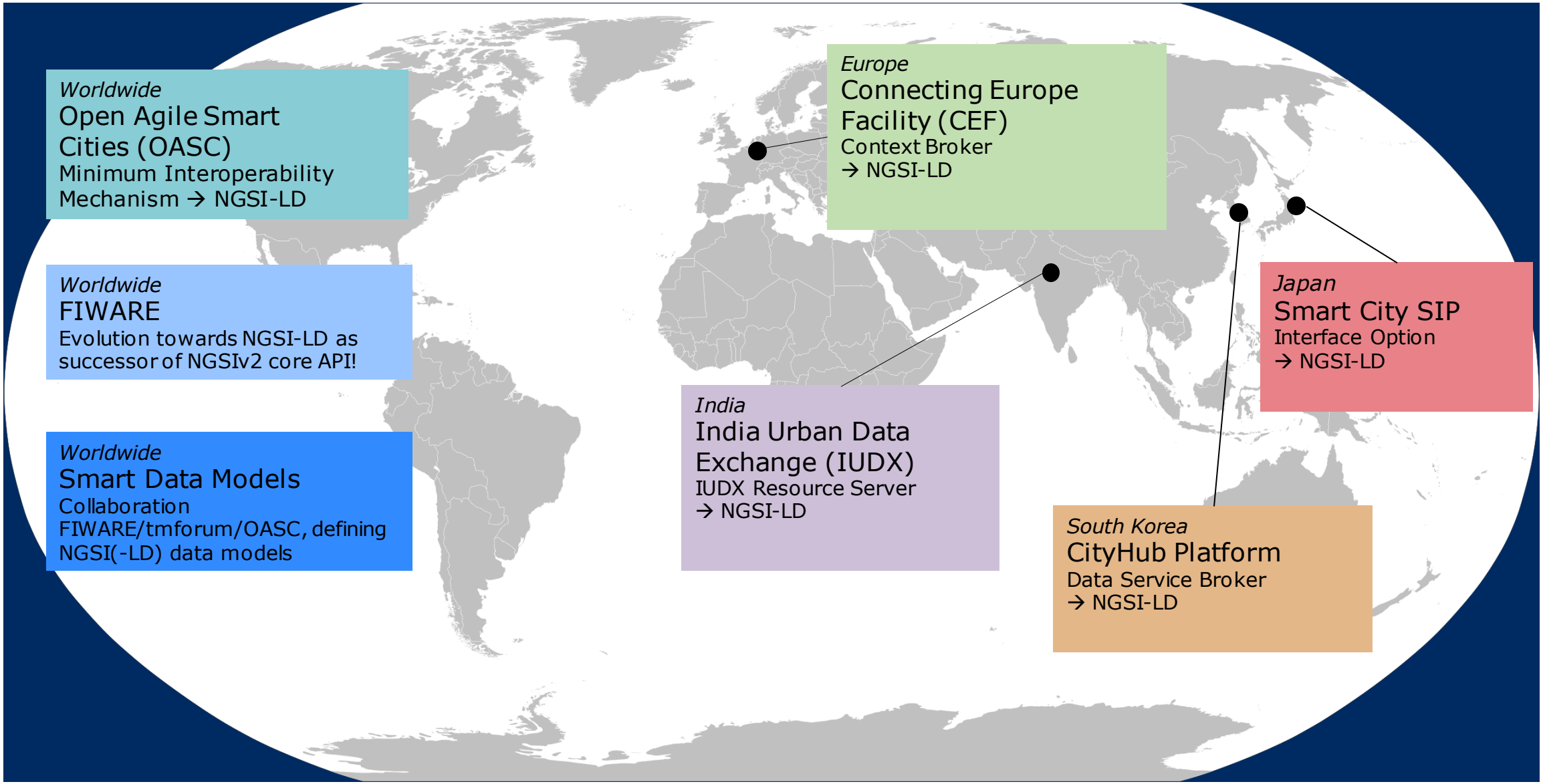
Uptake, Summary and Impact

NGSI-LD Uptake and Collaborations



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Summary / Future Impact

- Digital Twins: from passive ‘shadows’ to active ‘proxies’ of real world objects
- Common ‘standard’ language to ‘speak’ with DTs essential
- Must be ‘universal’ and taking pace with digitization
- NGSI-LD: enables an advanced Digital Twin concept
  - ✓ Standardized in ETSI ISG CIM (V1.7 to be published in these days)
  - ✓ NGSI-LD as API of DT to interact with real world, other DTs and applications
  - ✓ NGSI-LD focus makes it universal: e.g., smart data models to describe domains
  - ✓ Outlook: will include Actuation and Services Execution

Further Information:

- https://www.etsi.org/committee/cim
- Martin.Bauer@neclab.eu

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NEC creates the social values of safety, security,
fairness and efficiency to promote a more sustainable world
where everyone has the chance to reach their full potential.

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