Digital Twins for Augmented Network Operations

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Agenda

- **Digital Twins**

- **Network Digital Twins**

- **Thing'in, a graph-based Digital Twin Platform**

- **Use cases within Orange**

- **Conclusion**

Digital Twins

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Digital twins are used to model and interact with complex systems
A digital twin is not a 3D model or a mockup, it is about data!

"A digital twin is a virtual representation of real-world entities and processes, synchronized at a specified frequency and fidelity." Digital Twin Consortium , December 2020

- Structured digital information
- Synchronization between digital and physical entities
- Arbitrary synchronization frequency
- Arbitrary precision/fidelity
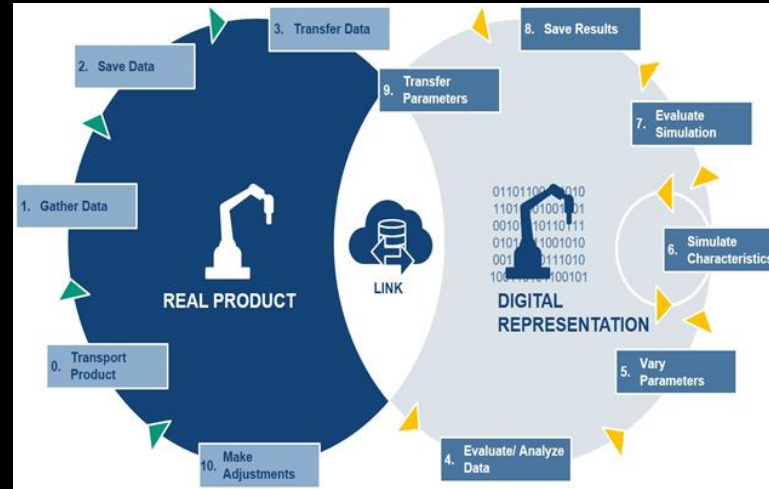
Source : Digital Twins in Logistics – DHL

Digital twins come in very various shapes for very various usages

Digital Twins are not just about 3D models, simulations, databases…
but very much about data modeling, data aggregation/homogenization/synchronization/historization, data enrichment (semantics), data inference/intelligence

Full applicative Digital Twins are generally not built from scratch but thanks to a Digital Twin solution
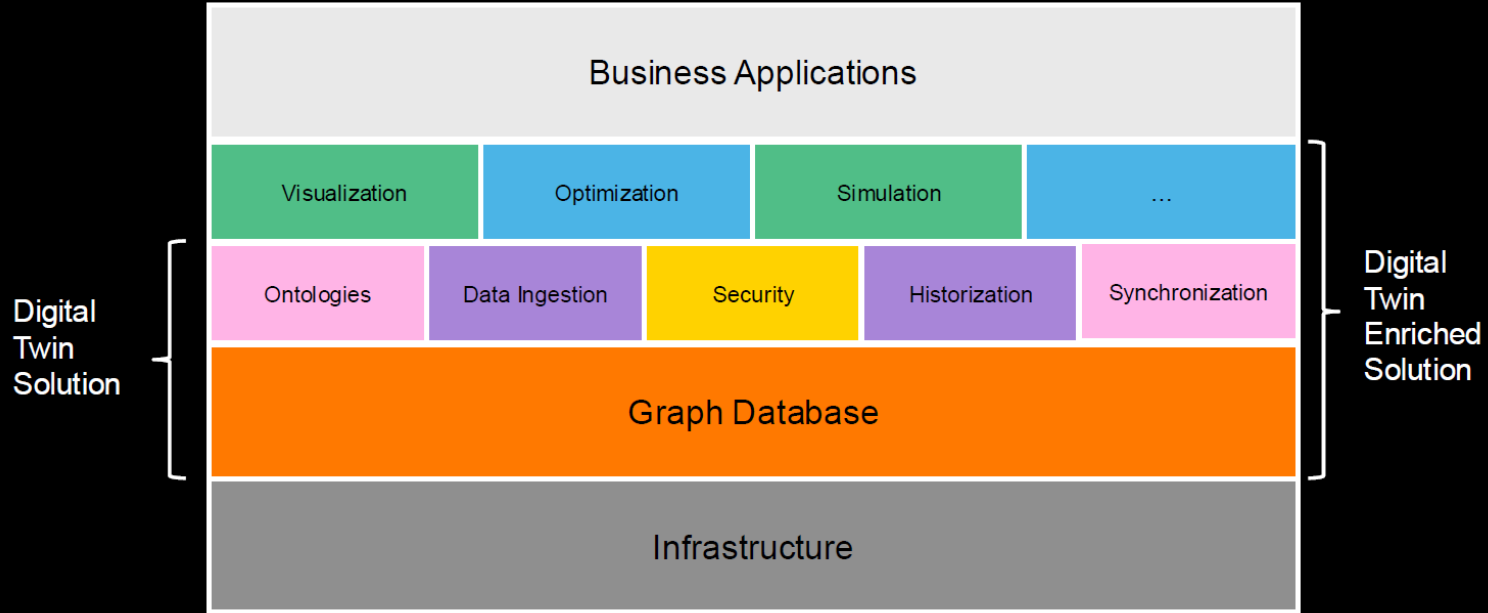

Digital Twin solutions offer **APIs and tools for managing digital twins**: creation (connectors, injectors)/update/deletion, visualization, navigation, synchronization…

Network Digital Twins

Digital Twins are both challenging use cases for Networks and a cornerstone for Network operations

Digital Twins as a typical uses case of future networks

Generalization of Digital Twins may challenge —or motivate — future networks (6G)
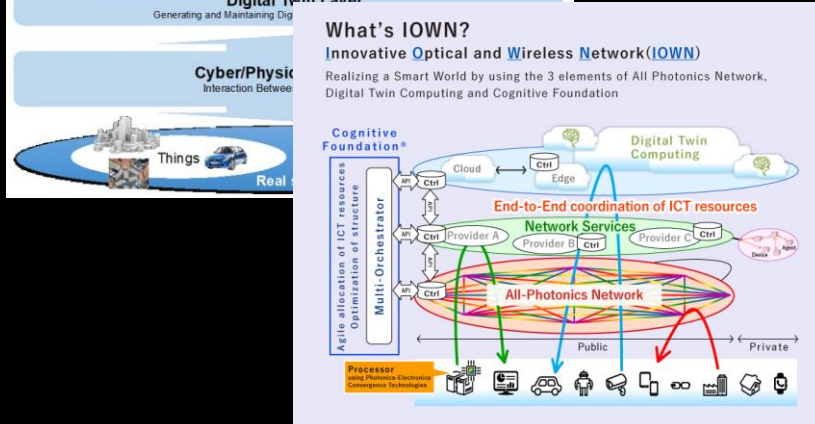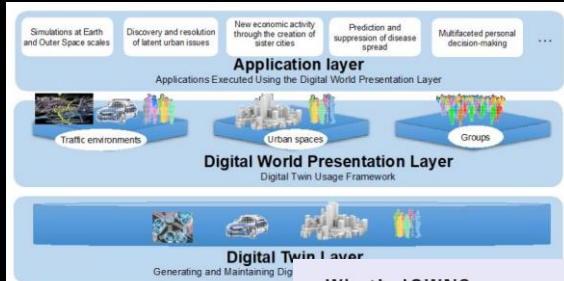
Digital Twins as a building block of future networks

- A framework to help mastering complexity in addition to other technologies: automation, AI…

- Envisioned usages:

  - **Telco sites supervision and operation** on the field

  - **Simulation**: network devops sandbox and What-if scenarios

  - **Data aggregation and homogenization** for network modeling, deployment, supervision, management and operation

  - Support for **data intelligence (AI)** and **automation**
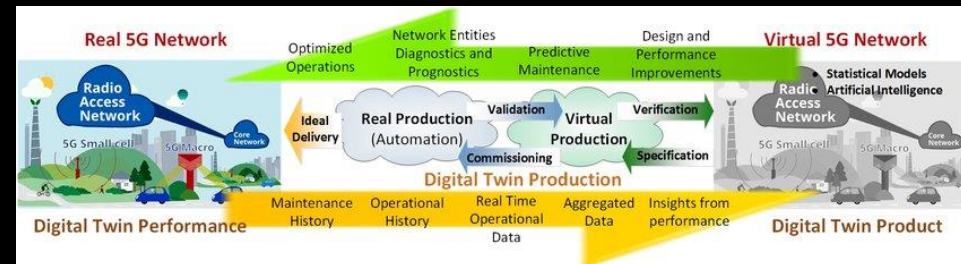
Network Digital Twin for Autonomous Networks

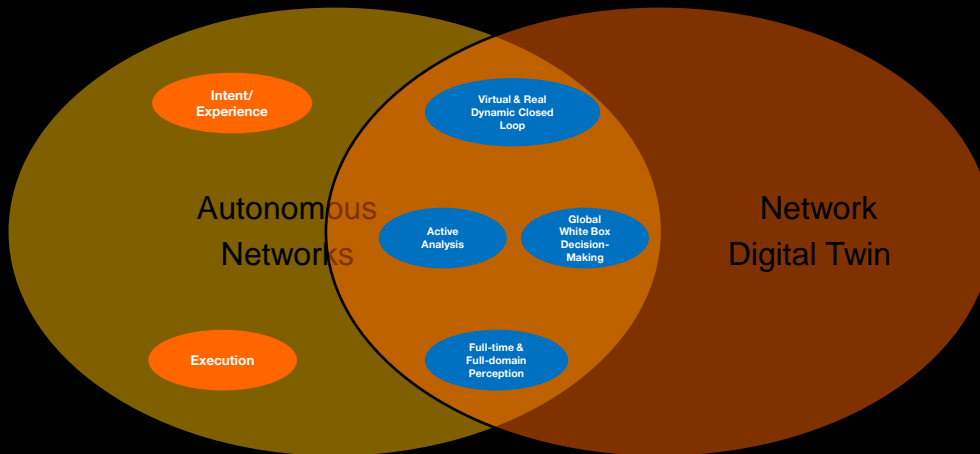Autonomous networks (AN) is defined in the Autonomous Networks Project by TM Forum aims to create fully automated, innovative network and ICT services for vertical industries

Orange is one of the founding members of TM Forum's AN project, and has committed to achieving Level 4 Autonomous Networks (AN) by 2025

Network Digital Twin is cornerstone for implementing L4, in terms of satisfying the autonomous closed-loop requirements of L4

Intent/Experience

Virtual & Real Dynamic Closed Loop

Autonomous Networks

Active Analysis

Global White Box Decision-Making

Network Digital Twin

Full-time & Full-domain Perception

Execution

Relationship between NDT & AN L4

Autonomous Levels	L0: Manual Operation & Maintenance	L1: Assisted Operation & Maintenance	L2: Partial Autonomous Networks	L3: Conditional Autonomous Networks	L4: High Autonomous Networks	L5: Full Autonomous Networks
Execution	P	P/S	S	S	S	S
Awareness	P	P/S	P/S	S	S	S
Analysis	P	P	P/S	P/S	S	S
Decision	P	P	P	P/S	S	S
Intent/Experience	P	P	P	P	P/S	S
Applicability	N/A	Select scenarios				All scenarios

Autonomous Network Levels(ANL) from TM Forum

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Network Digital Twin use cases in a Network Lifecycle

Non exhaustive list

Continuous Improvement
- Implementing lessons learned

Testing New Technologies
- Simulating new services

Network Planning and Optimization
- Capacity planning
- Network design

Network Planning and Simulation
- What-if analysis
- Fault simulation
- Impact Analysis

Decommissioning planning
- Assessing the impact of retiring components
- Planning of replacements

Data migration
- Ensuring smooth transition of services from old to new systems

Installation simulation
- Testing deployment strategies and configurations before physical implementation

Integration testing
- Ensuring new components work seamlessly with existing infrastructure

Predictive Maintenance
- Anticipating failures

Performance tuning
- Adjusting network parameters based on simulated scenarios

Field Operations
- Optimizing Field Interventions

Performance Monitoring
- Real-time analytics
- Anomaly detection

Root Cause Analysis
- Alarms correlation
- Investigating issues

Resilience
- Disaster Recovery

Threat Detection and Response
- Identifying security threats

Planning

Deployment

Operation

Maintenance

Retirement

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Thing'in, a graph-based Digital Twin Platform

Why graph representations?

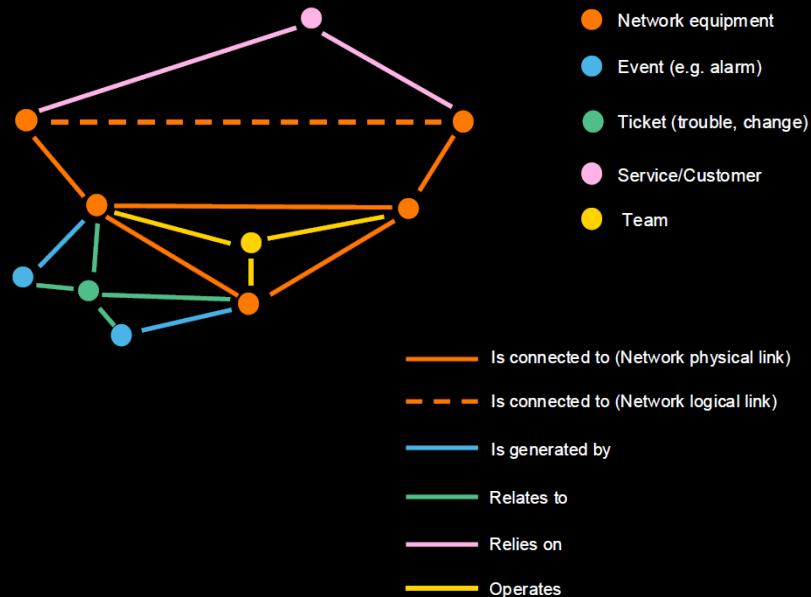**Graphs are the most universal, versatile and adaptable way to structure information**

- **Graphs do not enforce any other rigid a priori structuration**

Graphs capture multi-scale & multi-level "systems of systems" composition

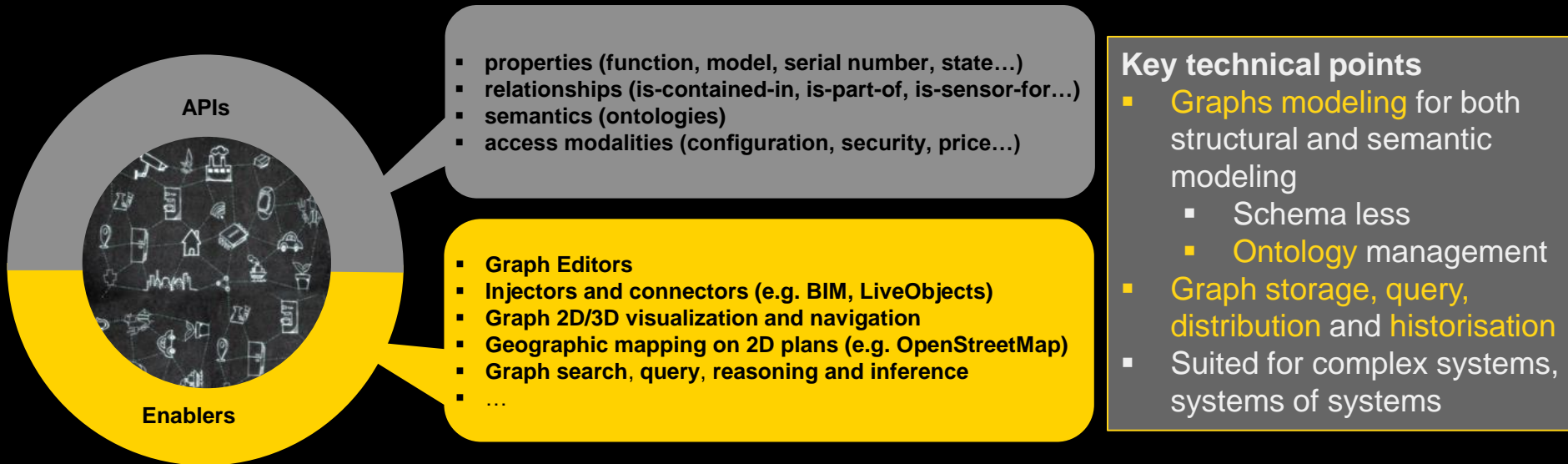**Graphs build up incrementally and become richer with each added link**

- **Self-reinforcing information percolation within the graph**

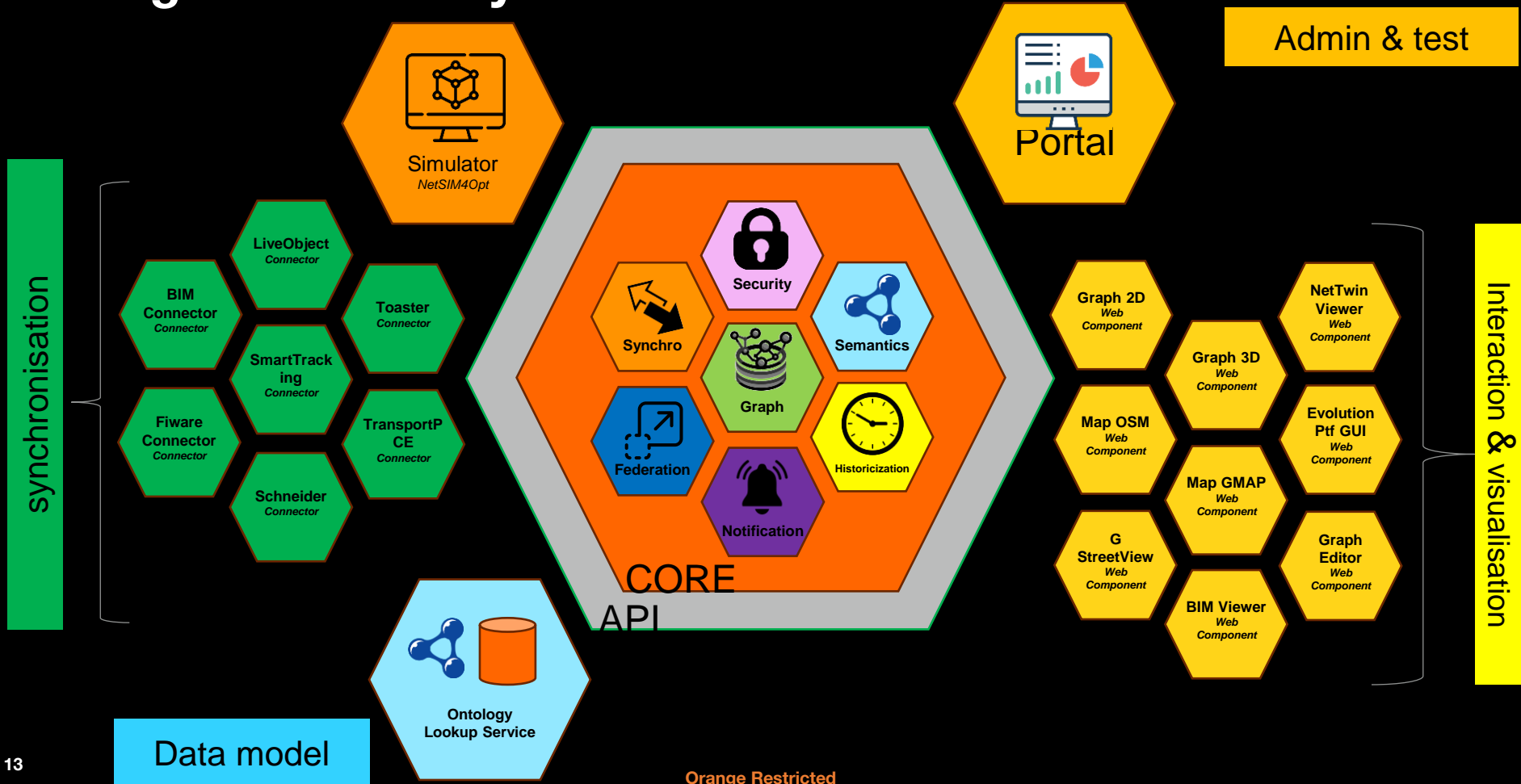**Graph databases are extensively used: they *scale*!**

Network equipment

Event (e.g. alarm)

Ticket (trouble, change)

Service/Customer

Team

Is connected to (Network physical link)

Is connected to (Network logical link)

Is generated by

Relates to

Relies on

Operates

Thing'in Digital Twin Platform

A core **graph of digital twins** + a catalog of generic and domain specific tools/enablers

APIs

Enablers

- properties (function, model, serial number, state…)
- relationships (is-contained-in, is-part-of, is-sensor-for…)
- semantics (ontologies)
- access modalities (configuration, security, price…)

- Graph Editors
- Injectors and connectors (e.g. BIM, LiveObjects)
- Graph 2D/3D visualization and navigation
- Geographic mapping on 2D plans (e.g. OpenStreetMap)
- Graph search, query, reasoning and inference
- …

Key technical points
- Graphs modeling for both structural and semantic modeling
  - Schema less
  - Ontology management
- Graph storage, query, distribution and historisation
- Suited for complex systems, systems of systems

https://www.thinginthefuture.com

Thing'in Modularity

Use cases within Orange

Orange is very active on Network Digital Twin, beyond research, with several ongoing projects with BU

Digital Twin Enabler project

- **Root Cause Analysis** for the Transmission Network
- **Change Management** for the New Mobile Core Network

Digital Twin for Optical Networks

- **IP/Optical multilayer fault detection and recovery** (IP and/or optical re-routing decisions) based on simulations
- Sequels (with IOWN) around All-Photonic Networks and Transport PCE

Fiber Network Digital Twins

- Alignment IS-real world: **Digital Twin as a source of truth**
- Links **Network Digital Twin and XR (augmented technician)** / supervision and field intervention

Cognitive Networks Operation project

- Targets transition to highly automated L3/4 Network Operations Centers (NOC)
- **Will leverage AI and Digital Twins**

Digital Twin for B2B *Evolution Platform*

- Simulation and evaluation of user-configured connectivity services **cost in Euros** and **Carbon Footprint**

Digital Twin for Home LAN Management to experiment Digital Twin benefits in the Home context

- Improve efficiency of **Home LAN exploitation teams and customer support**
- Contribute to improve **WiFi Quality of Experience**
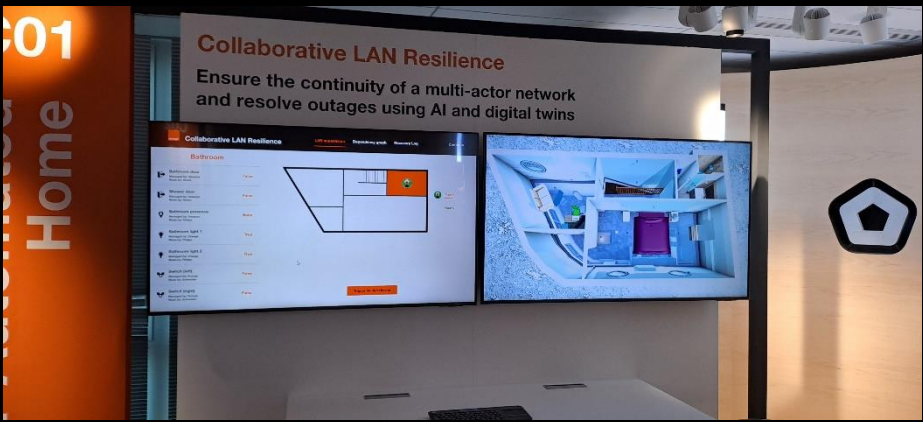- Manage **Home LAN resilience** in a Home LAN **open to third parties**

Digital Twins for interventions: bridging 3D, XR and Digital Twins
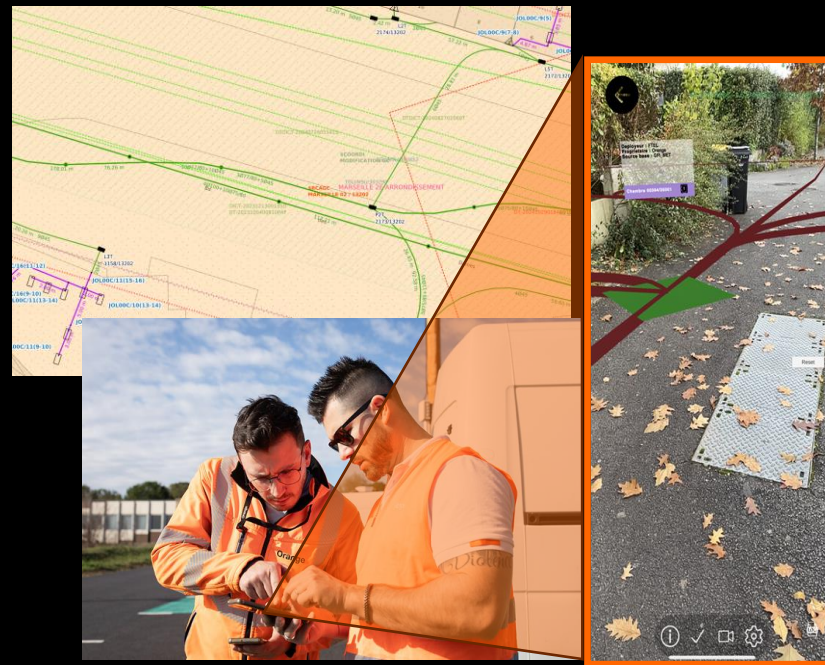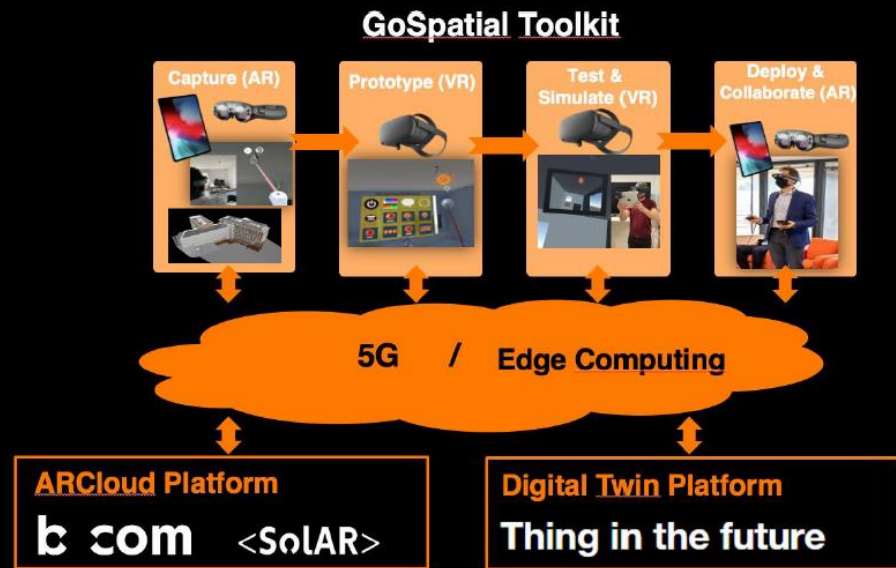
Make the Network Digital Twin the source of truth to save time **during interventions**
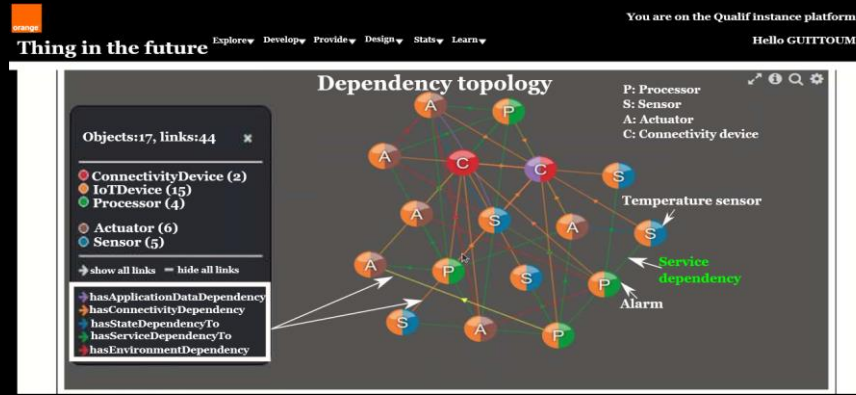
Digital Twins for Home LAN Management: bridging AI and Digital Twins

Managing cascading failures in Home LANs open to third parties

A Digital Twin of the Home LAN providing the dependencies between devices and services

AI technics to automatically infer dependencies (Semantic Reasoning) and automate failure resolution (Multi-Agent System)

Conclusion

Conclusion, take aways, next steps

- **Network Digital Twins**, combined with other technologies, are **the corner stone** for Network Augmented Operations and Automation all along the whole Network **lifecycle**

- **Digital Twin Solutions** bring **mutualized** features and tools to **capitalize** during various projects

- **Graph-based Digital Twins** offer a flexible and interoperable way to **model and structure** information for all network type, segment and layer

- **Real use cases** are implemented **today**

- **Next challenges (among others)**
  - Trusted Automation based on a "quality in, quality out" unified data layer
  - Cognitive Digital Twins by pursuing the combination of Digital Twins with AI technologies to fill the gap from reactive to proactive and predictive solutions

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Thanks

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