



# Complex Ecosystem Management via Digital Twins Networks

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The Coherent WorkGroup

## Coherent Project Summary

The **Coherent project**, within the scope of S1 "Disruptive Architectures and Platforms" - SPOKE 6, aims to develop an integrated architecture from both technical and business perspectives, collaborating with RESTART initiatives such as S8, S9, and S14. It utilizes Digital Twins (DT) to allow new approaches to predictive network management in fast changing environments, ensuring dynamic behavior aligned with strategic goals, including ethical considerations measured through Key Values Indicators (KVI). Coherent adopts an innovative approach with serverless/deviceless solutions, emphasizing network autonomy and flexibility, effectively managing Key Values (KV) and their corresponding Key Value Indicators (KVI). The project promotes innovation with a proactive outlook, combining the latest technologies, especially in digital twins. It is committed to defining and managing KVs and KVIs within the network ecosystem, facilitating communication between different actors and domains, aiming to develop methodologies for achieving KVs at both local and global levels. Furthermore, it moves towards implementing serverless computing and deviceless operations, highlighting autonomy within the network.

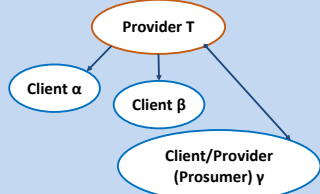
## Abstract

This poster explores the integration of **Digital Twin** and **Digital Twin Networks** to create a unified **ecosystem** for modeling **servers** and **clients**. By employing **Digital Twins**, both servers and clients are virtualized, allowing optimization through **Key Values** specific to each entity. This optimization ensures effective collaboration through creating a new approach in the relationship between servers and clients. Information exchange is facilitated through Digital Twins, utilizing **Key Value Indicators** to share essential data and enhance the overall efficiency of the interconnected system.

## Ecosystem and Domains

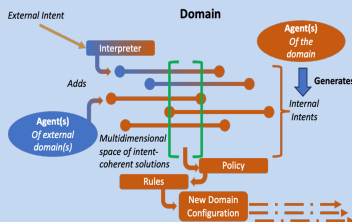
Ecosystem as compositions of Server and Client Domains:

- We define as **ecosystem** an environment composed by different main actors, as, telecommunications providers, smart cities, industries, connected assets and citizens, each one constitutes a separate functional **domain**.
- Each domain can provide a service, thus being a **provider**, and consume services, thus being a **consumer**. In more complex scenarios a domain can be at the same time a provider of some services and a client of some others, or, potentially the same, thus being name a **prosumer**.

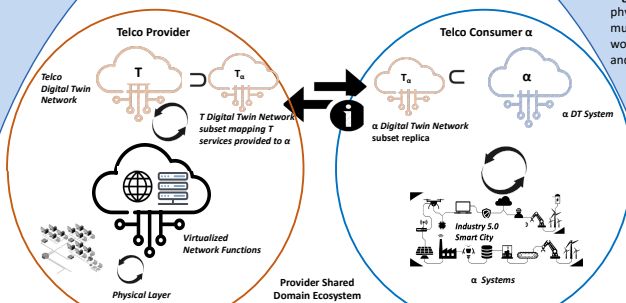


## Pursuing Domain Objectives within the ecosystem

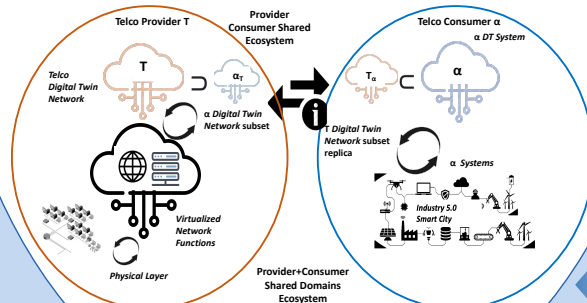
A new approach to **Coupling between client and server domains**: The use of Digital Twins as a mean of sharing information and services between **Consumers** and the **Providers** enables both parties to have a well-defined and dynamic communication system and the least amount of their respective subsystem's knowledge to function and work cooperatively pursuing ecosystem level KVs



## The role of DTNs within a complex ecosystem



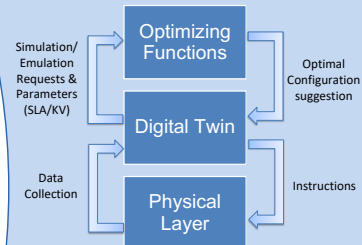
A sub-set of Telco DTN can be integrated within the consumer own DT system, thus allowing a more effective exchange of information, especially whereas low latency is essential (as in the use of MECs or when conflictive KV are present).  
A mutual exchange would further enhance such benefits, especially in Prosumer containing scenarios and ecosystems



## Digital Twin Network (DTN)

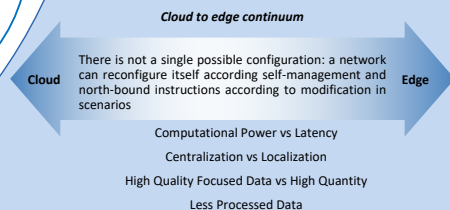
What is a Digital Twin Network:

- Digital Twin (DT)**: is a virtual representation part of a physical, digital of physical object, system, or process, which can be composed of a single or multiple assets. It's a computer-generated model that simulates the real-world counterpart in a way that allows for monitoring, analysis, simulation and manipulation of data in real-time or near-real-time.
- Digital Twin Network (DTN)**: is a composition of Digital Twins, distributed and connected, that represents telecommunication network, its structure, the services it provides, along with the attached SLA and KV requested by Consumer and the ones it consumes.



## Ecosystem Dynamic Optimal Equilibrium

**Digital Twins** can act as elements that allow global optima within ecosystem to be dynamically pursued in a faster and less resource costly way. This is especially relevant in fast-changing, complex scenario where latency time required to provide requested services is so low that optimal allocations of services and related resources is required across the *cloud-to-edge continuum*



## Future Work

- Designing an architecture that allows to create efficient representation of networks via Digital Twin and that allows digital twin views to be exchanged along with KV and SLA, providing an enriched service market within the ecosystem, while optimizing performance, costs and overall reliability
- Applying optimization techniques such as quantitative model analysis, operational research techniques, AI-ML approaches etc. to evaluate optimal configurations of Server and Client domains, to reach an optimal configuration for the whole ecosystem, in regard to KVIs and SLA satisfaction for all parties.

## References

Coherent aims to be compatible with current standards both in the domain of telecommunications and of digital twins

Currently Coherent is evolving several concepts expressed in:

- ITU-T Y.3090.02/2022 - Digital twin network – Requirements and architecture

At the same time Coherent is closely working with the concepts research in the domain of ethical networks, which represent a solid foundation to develop KV communication and optimization across complex and networked ecosystem. A relevant paper produced within Coherent is

- Toward the EthicNet: Challenges and Enablers for Ethics-Aware Networks. L. Atzori, C. Campolo, A. Iera, G. Morabito. Network softwarization and Management. 2023.