# Managing Future Networks Requires a Digital Twin

The launch of next-generation networks such as 5G and 6G will continue to increase the complexity of operator networks, requiring evolution in network inventory and infrastructure management. This is due to the increasing virtualization of network functions, and the growth of new RAN (Radio Access Network) such as 5G small cells.

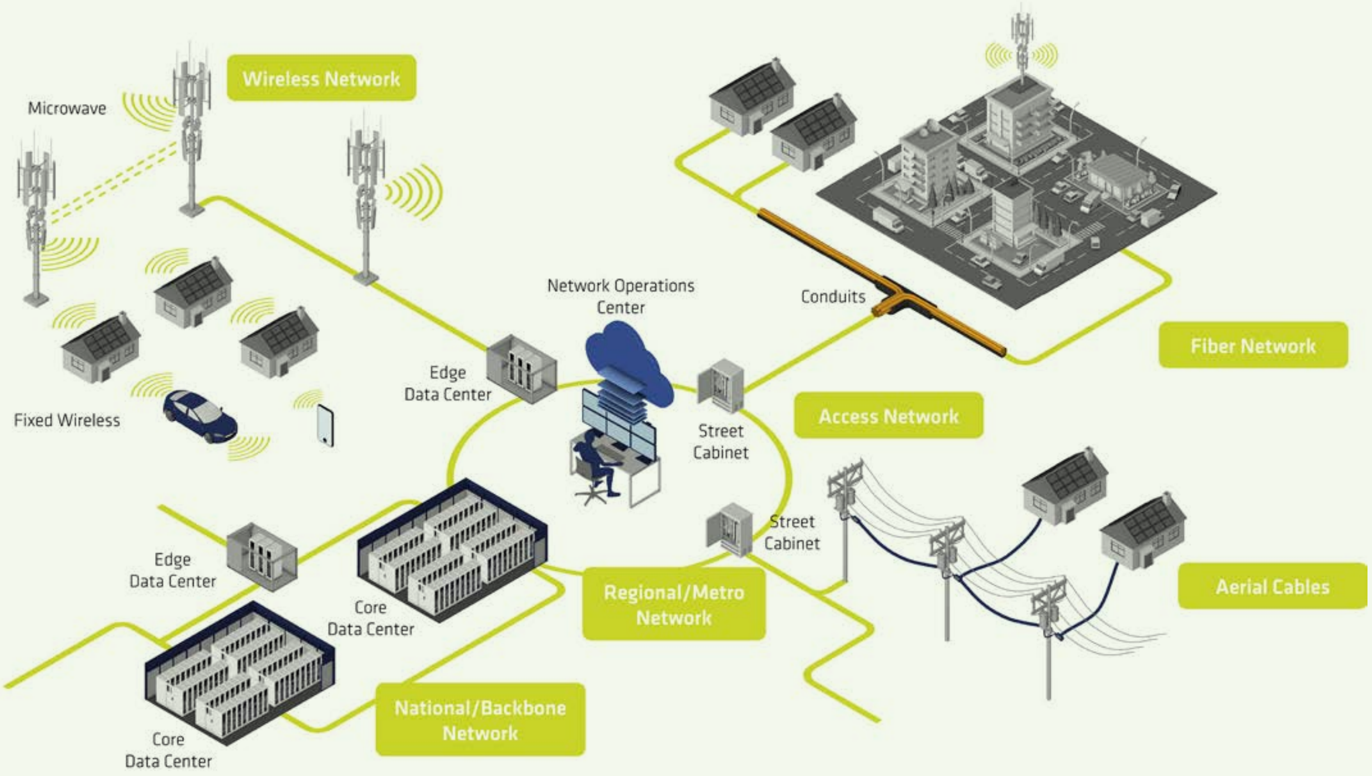


**Figure 1: Operator Network Components** Source: FNT

An innovative approach to network management is digital twins, which digitally replicate something such as an entity, process, system, network, or geographic area. Digital twins span the physical, virtual, and logical world and are synchronized with the original in real-time. This acts as a consolidated single source of truth and provides operators with greater insight into their networks in real time.

# What Is a Network Digital Twin?

A significant use case of digital twins will be replicating operators' networks. Network digital twins represent an operator's hybrid network infrastructure, representing the physical, virtual, and logical components of a network. A hybrid infrastructure is formed of a mix of physical and virtual components, crossing different technologies and network domains such as the cloud, and on-site data centers.

The physical component of an operator's network's infrastructure consists of RAN, such as base stations and antenna sites, as well as the location of data center and other PoPs (Points of Presence). Whilst operators are increasingly virtualizing physical functionality, other physical infrastructure is becoming increasingly important, such as edge data centers which enable operators to bring data processing and storage closer to the network edge.

The virtual component of an operator network consists of digitalized network infrastructure such as vRAN (Virtual RAN), C-RAN (Cloud RAN), Transport and Core VNFs (Virtual Network Functions).

vRAN enables operators to run baseband functions as software, enabling RAN functions to run on standard servers, instead of on proprietary hardware. Meanwhile, C-RAN is a centralized cloud computing-based architecture for RAN, providing collaborative radio technology support and real-time virtualization capabilities.

The virtual component to operator networks is becoming increasingly important, as it provides greater network flexibility, scalability, and security. For example, operators can leverage virtual base stations to perform real-time baseband processing and allocate baseband resources. This enables operators to improve network efficiency, eliminating the need to over-provision base stations to meet peak demand.

However, the increasing number of virtual components will continue to complicate operator network management, as operators must manage more integrations with physical and logical network components, configurations, and security challenges. As a result, solutions such as digital twins, which can provide detailed insight and automated management for these virtual network components, are essential to future network management.

The logical network component determines the logical transmission paths between sources and destinations. It includes links and connections between active network nodes and resources, as well as logical entities such as virtual private networks, and logical circuits. By replicating these logical entities, operators can simulate alternative configurations of network nodes, resources, and logical entities, providing insight into how changes will impact network availability.

# Why Network Digital Twins Are Critical to Future Network Management

Historically, operators have managed their network resources through a combination of network hardware and software, which collects data about the network, resources, surroundings, and available routing. This data is then used to ensure connectivity for customers, identify issues such as network bottlenecks, and plan future alternations to network resources and configurations.

However, this approach to network resource management is becoming increasingly strained and inefficient, as the diversity and complexity of operator networks and associated data increases.

Research by Juniper Research has found that the portion of global SIMs that are 5G will increase from 23.2% in 2024 to 57.8% in 2028. The growing role of 5G networks in cellular connectivity will require continued expansions to operator 5G networks, increasing the extent of network virtualization, and thus complexity in network management. In turn, this will drive demand for digital twin deployments.

The complexity of network management will be increased by the launch of 6G networks in 2029. 6G connectivity will be provided by an unprecedented number of base stations, with the high throughput required limiting transmission distance, and interference by objects due to the use of higher-frequency spectrum. As a result, operators must manage a greater number of base stations, as well as accompanying deployments, such as reconfigurable intelligent surfaces. Operators must manage an increasing number of components to their networks, including these components' integrations and connections with other network components, further increasing the complexity of operator network management.

Moreover, 6G networks will further accelerate the virtualization of operator networks, with 6G networks leveraging virtualization for use cases such as integration between ground and non terrestrial networks. Consequentially, 6G networks will further expand the number and diversity of network resources operators must manage, increasing complexity and the potential for mismanagement and inefficiency.

## How Do Network Digital Twins Differ from Alternatives?

Network digital twins are distinguished from other types of digital twins by their focus on the virtual and logical world. Different forms of digital twins focus extensively on the physical world, such as production digital twins, which replicate manufacturing equipment and IoT devices in production lines. Consequentially, network digital twins require more advanced data input processes and more comprehensive data models.

## What Is the First Step to Deploying a Digital Twin?

Network digital twins will be critical in enabling operators to manage the diversity and complexity of 5G and 6G networks, as they provide the means for operators to efficiency process and act on the volume and variety of the data generated.

The first step for operators when deploying a digital twin solution is data population, which forms the backbone of the model. Operators must collect network data from their cellular networks, network testbeds, or simulation tools on a continuous basis for synchronization. Furthermore, data collection also requires operators to input passive assets in the network, such as racks and cellular towers, requiring the deployment of AI and machine learning technologies which leverage machine vision and image recognition. This process is complex with data quality controls, formatting, and collection speed all affecting the viability of the resultant data model.

Furthermore, operators must also ensure that this data can be efficiently integrated with the data model, a process complicated by data collection being reliant on legacy systems that were not designed to communicate with one another. By simplifying integration, solutions such as the FNT IntegrationCenter ensure that operators can efficiently populate their data models, protecting against delays in synchronization, missing data, and unbalanced data models.

## Once Populated, How Will Operators Use Digital Twins?

Once populated operators can begin to leverage digital twins for a wide range of applications, such as:

- **AI Plug-ins** – Through AI plug-ins, operators can connect their digital twin with other network management processes, systems, and solutions. This allows operators to leverage insight and analysis provided by the digital twin automatically. For example, work orders for repairs and maintenance can be automatically generated for operators based on the understanding of physical network resource's health provided by the digital twin.
- **Anomaly Detection** – The digital twin provides operators with a visual representation of 'normal' operations, which can be cross-referenced with 'actual' network operations to identify anomalous behavior.
- **Planning** – The digital representation of network resources provided can be used by operators to identify and plan future network resource expansions. These plans can then be tested out through simulations in the digital twin, enabling operators to identify and correct potential issues more efficiently than with previous approaches.
- **Troubleshooting** – Operators can use a digital twin to replicate previous network failures, which can then be studied to identify specific configuration, and other network errors which can lead to failure.
- **Hypothetical Scenario Analysis** – A digital twin can be applied as a sandbox for operators to experiment with potential network configurations and analyze how networks will cope with change in user behavior.

# Positioning FNT as a Leader in Digital Twin

## Who Are FNT?

FNT specializes in simplifying the complexity of digital infrastructure management for operators, enterprises, and public authorities. Its solutions serve over 500 customers, with more than 25,000 users, spanning cable management, CMDB (Configuration Management Database), DCIM (Data Centre Infrastructure Management), Telecom Network Inventory, IT asset management, and IT infrastructure management.

## FNT's Digital Twin Solution for Operators

FNT's digital twin solution is highly versatile and flexible, enabling operators to replicate physical, virtual, and logical resources deployed in their hybrid networks. It is part of FNT's broader hybrid infrastructure management solutions, which are provided through the FNT Command Platform.

By deploying FNT's digital twin solution, operators can access extensive insight into their network operations, with a highly configurable and extendable data model. This is accompanied by a library of over 75,000 components and extensive planning capabilities, based on accurate live network documentation. As a result, operators are able to model every device and resource from the beginning, simplifying the first steps for deploying a digital twin. This simplification is expanded on by the solutions' process automation, provided by its BPMN (Business Process Modelling and Notation)-compliant workflow engine.

FNT's digital twin solution provides operators with the tools and capabilities to design, plan, and operate their network infrastructures. It includes a highly configurable and extendable data model that covers physical, virtual, and logical network resources, with a partner-ready integration framework, which includes generative open APIs (Application Programming Interface), ETL (Extract, Transform, and Load) reconciliation, and notification functions.

Operators can access digital representations of their data through fully integrated schematic and geo-referenced visualizations on 2D and 3D maps, as well as mobile platform applications.

The solution is supported by the FNT IntegrationCenter, a software integration framework for the FNT Command Platform with external systems. The center is a combination of different pre-integrated functional blocks and tools, including the FNT StagingArea, FNT ReconciliationEngine, FNT EventEngine, and FNT Platform APIs. This enables operators to populate their digital twins in a simplified process, with data being migrated from legacy systems using its components.

Alongside the IntegrationCenter FNT's professional services and the option of using an existing system integrator are available to operators, providing further integration in the population and integration process. As a result, operators are provided with the flexibility to determine the best approach for them, ensuring an efficient and effective process. FNT's digital twin solution enables operators to manage the planning and engineering, service fulfilment, and service assurance for telco active inventory, and cable and outside plant management.

# Telco Active Inventory Management

FNT's telco active inventory management digital twin solution provides flexible support for transport and access technologies, as well as enabling multi-vendor and multi-technology active network planning and documentation. The solution also enables operators to manage network fulfilment via resource availability checks, and reservations, as well as integration with provisioning to supply configured service data. Further network fulfillment services are provided to operators through cross-domain auto- routing capabilities. This enables operators to automate the network engineering process, increasing efficiency.

FNT's digital twin solution also provides extensive integration for service assurance. Operators can integrate their digital twin with fault management and monitoring to create advanced alarms, as well as integrating with ticketing to supply affected customers with information about network resources and services. This integration is critical in providing operators a simplified process for applying the insight of FNT's digital twin solution to their wider network operations and processes.

Furthermore, operators can engage in instant impact analysis across their hybrid network infrastructure. This enables operators to quickly and efficiently gain insight into network issues, allowing swift responses, in turn protecting the quality of service provided to customers.

# Cable & Outside Plant Management

Operators who deploy FNT's digital twin solution in cable and outside plant management are provided with a flexible solution for the creation of fiber plans, and signal auto-routing capabilities on the duct and fiber layer. Moreover, the solution's planning capabilities enable operators to create detailed work orders automatically. This enables operators to improve the efficiency of the management and maintenance process, without significantly increasing the complexity of the process.

The digital twin's service fulfilment capabilities and services enable the creation of fiber plans and automated work orders in concert with its planning capabilities. Further automation is provided through signal auto-routing for the duct and fiber layer. Operators are then able to assure quality of service through reports on services affected by planned maintenance and instant impact analysis in the case of passive infrastructure failure. This enables operators to keep customers apprised of the status of their services.