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5G IQ NWDAF

3GPP Network Data Analytics Function (NWDAF)
The Cornerstone for Autonomous 5G Networks

eBook

Executive Summary

5G networks are ushering in an era of gigabit-speed, low-latency, ultra-reliable wireless services, unleashing a wave of application innovation for consumer and enterprise use cases. Yet 5G networks are operationally complex, challenging network operators to ensure service quality while relying on the operator-centric tools employed to manage 4G/LTE networks.

5G networks require autonomous operations, underpinned by network analytics and AI/ML that generate the real-time operational intelligence needed to inform all aspects of network operations and service orchestration. Consequently, the 3GPP defined Network Data Analytics Function, or NWDAF is a new standard for real-time network analytics that drives the automation of network functions in the 5G Core. A standard approach to network data analytics is critical for multi-vendor interoperability in 5G networks that incorporate products from multiple suppliers.

Guavus has developed an open, standards-based, vendor-agnostic network data analytics product designed for autonomous operations in multi-vendor 5G networks. **5G-IQ NWDAF** is full-featured, supporting a wide range of use cases, incorporates an efficient streaming analytics engine that ensures high performance, can be flexibly deployed in cloud native environments to ensure scalability and supports AI/ML plug-ins, allowing operators to utilize third party or custom-developed analytics algorithms.

5G is Not "Just Another G"

5G networks are significantly different from today's 4G/LTE networks. New services will support gigabit speeds, massive machine-to-machine communications and ultra-reliable, low-latency connections for mission-critical applications. In addition to billions of human users in new industry verticals, 5G will add billions more non-human users in the form of IoT devices, smart machines and autonomous vehicles.

5G New Radio achieves gigabit speeds by incorporating advanced RF technology such as Massive MIMO and beam forming antennas, while operating in new high-frequency spectrum bands: Mid-Band at 1-6 GHz and mmWave at 24-40 GHz. Large-scale deployments of 5G small cells for both indoor and outdoor use cases will drive network densification to support the massive number of high-bandwidth connections.

Network operators will deploy 5G on a new generation of cloud native platforms that will span the 5G edge and core, applying the power of edge computing to the 5G RAN and cloud computing to the 5G Core. Cloud native infrastructure is critical for supporting the real-time network visibility, streaming analytics and AI/ML technologies that provide the foundation for autonomous network operations.

The vast power of 5G comes at the cost of increased complexity across multiple operational domains.

Monitoring and managing the delivery of multiple services with stringent SLAs introduces a level of complexity – and the need to take action in real time – that operators do not contend with in 4G/LTE networks. A new approach is required that removes human decision making from the critical path for network operations.

5G Complexity Drives the Need for Autonomous Operations

Piloting a modern jet aircraft is analogous to operating a 4G/LTE network.

Jets incorporate extensive telemetry and sophisticated avionics that utilize telemetry data, and even though they can fly on autopilot, human pilots are still quite capable of flying jet aircraft in a wide range of conditions. In fact, humans are so essential to safe in-flight operations that there are always two pilots on board.

4G/LTE networks require human 'pilots'. While operators rely on extensive network telemetry data, sophisticated monitoring and analytics systems, human decision making is integral to operational workflows. The people in the network operations centre (NOC) are always in control and the NOC must always be staffed to handle both routine service operations and to take action in response to faults, anomalies and unexpected events.

5G networks are more like today's state-of-the-art spacecraft, which can take off, maneuver into orbit, re-enter the atmosphere and land on the same launch pad, all under the automatic control of onboard computers. Flight control or astronauts on board might initiate certain actions, but once under way, telemetry-driven avionics direct flight operations. In fact, some maneuvers are so complicated they are beyond the ability of humans to pilot the spacecraft and zero-touch automation is imperative.

In autonomous 5G networks, personnel in the NOC are like ground-based flight control or astronauts on board for the ride. They serve as passive observers who may occasionally direct the network to carry out a certain function, but otherwise the network runs autonomously, driven by operational intelligence derived from the continuous collection and analysis of real-time telemetry data.

Exponential difference between 4G and 5G complexity

AI/ML Powers the Shift from Operator-Centric to Autonomous Networks

Mobile network operators have relied on network monitoring and analytics for years to feed dashboards and visualizations in the NOC. 4G/LTE networks are operator-centric, with the role of analytics largely confined to informing human decision making for routine service operations and to take remedial actions whenever problems arise.

The primary reason for this is that monitoring and analytics solutions grafted onto 4G/LTE networks and the Big Data analytics solutions commonly deployed have hindered the ability of operators to gain visibility into changes in network state and perform actions in real time. The humans are always involved in the decision making process, and also there is no way to support autonomous network operations when it is impossible to generate the necessary operational intelligence in real time.

Recent advances in Artificial Intelligence (AI) / Machine Learning (ML) enable operators to overcome these challenges. Real-time streaming analytics, machine learning algorithms and predictive analytics are providing the foundation for a major paradigm shift from operator-centric to fully autonomous network operations.

AI/ML can now generate the requisite machine intelligence, in real time, to automate 5G network operations and service orchestration, without the direct involvement of NOC operators.

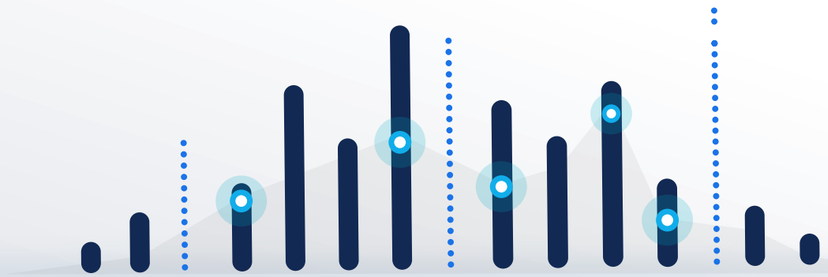
This dramatic shift will not occur overnight, and at first, machine intelligence will be employed to augment human intelligence, with NOC operators still in the decision-making process until they fully trust the abilities of the underlying AI/ML. But ultimately, machines are destined to supplant the role of humans in the NOC, completing the transition to fully autonomous 5G operations.

Open Standards Simplify Multi-Vendor Interoperability for 5G Network Automation

5G networks will be built on disaggregated cloud-native platforms utilizing the framework provided by the 3GPP's 5G Service Based Architecture (SBA). Disaggregation allows Mobile Network Operators (MNOs) to break out of proprietary supplier silos and selectively deploy best-of-breed products, fostering the development of a more diverse vendor ecosystem compared to existing 4G/LTE networks, which are fairly homogenous.

Network automation involving software components sourced from different suppliers places a premium on interoperability. Historically, telco Operations Support System (OSS) / Business Support System (BSS) have been plagued by a lack of standards, resulting in a proliferation of middleware and data mediation solutions employed by system integrators to glue together components from different suppliers. The standards specified in the 3GPP's 5G SBA simplify multi-vendor integration in 5G networks, eliminating the need for complex custom integration projects, which have proven costly and difficult to maintain in 4G/LTE networks.

Standards are particularly critical for network automation and service orchestration in the 5G Core, which requires interaction among more than a dozen network functions supplied by multiple vendors. In the 5G SBA, the 3GPP is embedding data analytics and AI/ML in the 5G Core to drive network automation, which required defining an entirely new standard for analytics that has no parallel in the standards for 4G/LTE networks – NWDAF. But before we dive into NWDAF, let's first examine the key elements of 5G network automation.



Four Pillars of Autonomous 5G Networks

Driving automation in the 5G Core with machine intelligence powered by AI/ML requires four key elements that form the pillars underpinning autonomous 5G networks.

Architectural Framework

An open standard framework that encompasses all the required components.

Operational Models

The definition of precise operational models for each automation use case.

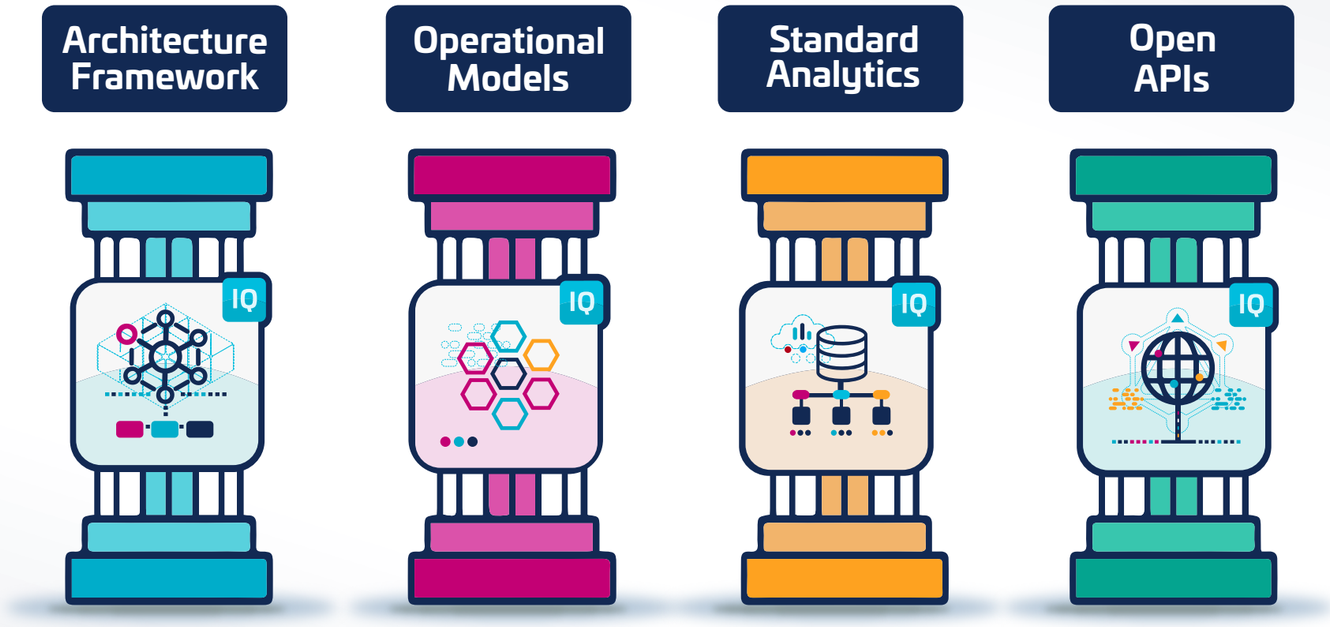
Standard Analytics

Based on formal specifications for all data types, formats and semantics.

Open APIs

Relevant programming interfaces between all network functions in the 5G Core.

The 3GPP's 5G SBA and NWDAF define standards for each of these key elements, which will be further extended in each subsequent 3GPP release to include capabilities supporting a broader range of operational use cases.

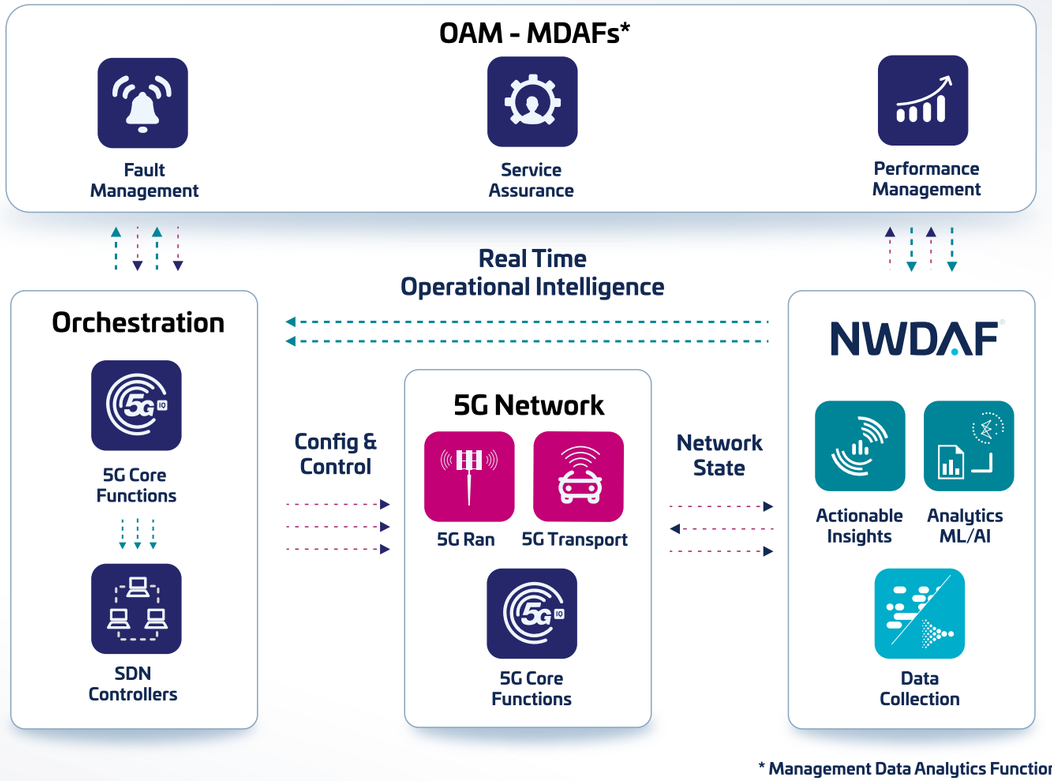


Pillars of 5G Network Automation

NWDAF – the 3GPP Standard for 5G Network Data Analytics

NWDAF is the 3GPP standard network function that leverages the power of network data analytics and AI/ML to generate the real-time operational intelligence driving network automation and service orchestration in the 5G Core.

NWDAF enables closed-loop automation for zero-touch autonomous 5G networks by providing the machine intelligence needed to remove NOC operators from time-critical analysis and decision making processes.



* Management Data Analytics Functions

NWDAF Powers 5G Orchestration & Automation

The Role of NWDAF in the 5G Core

NWDAF performs a vital set of functions in the 5G Core.

Data Collection

NWDAF continuously collects local data from Network Functions (NFs) and Application Functions (AFs) in the 5G Core. It can also collect management data from functions in the Operations, Administration and Management (OAM) layer, such as Management Data Analytics Functions (MDAF), which do not process network data.

Data Standardization

The NWDAF standard overcomes the vexing challenge of data normalization in complex telco environments by requiring formal specifications for all of the data it collects, including the exact format and semantics for each data type.

Real-Time Analytics

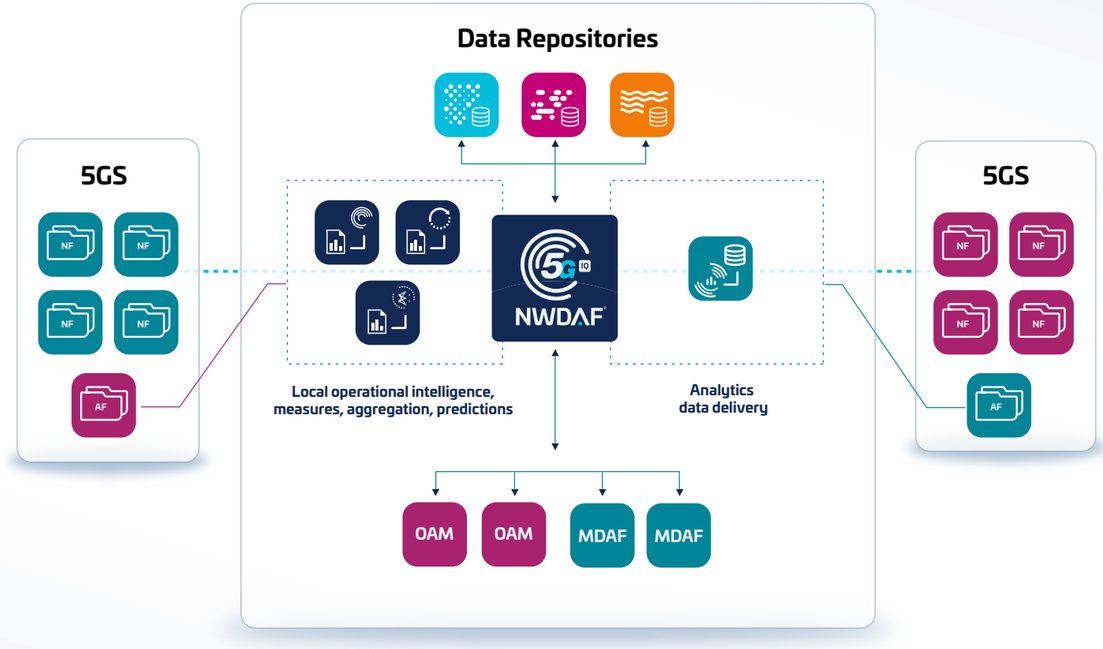
NWDAF analyses data in real time to produce the operational intelligence required to drive the automation of network functions in the 5G Core. Like collected data, the resulting analytics outputs are also standardized by type, including format and semantics.

Advanced AI/ML Algorithms

NWDAF incorporates advanced AI/ML algorithms that can perform predictive analytics for gaining real-time insights into the future operational state of the network, in addition to the information about current network state or historical analysis of past state.

Data Storage

NWDAF stores collected data and analytics outputs in one or more repositories that may be centralized or distributed within the 5G Core.



NWDAF in the 5G Core

NWDAF 3GPP Release 16 Use Cases

NWDAF in 3GPP Release 16 defines a set of use cases for network data analytics that encompass a range of 5G operational requirements, which can be logically grouped into three categories:

- Network Conditions
- Device Behavior
- Service Experience

Network operators need to know, in real time, how users and applications are impacting the 5G network, or how adverse network conditions or unusual device behavior are impacting users. Operators also need to constantly monitor user service experience metrics for each type of 5G service.

Network Conditions

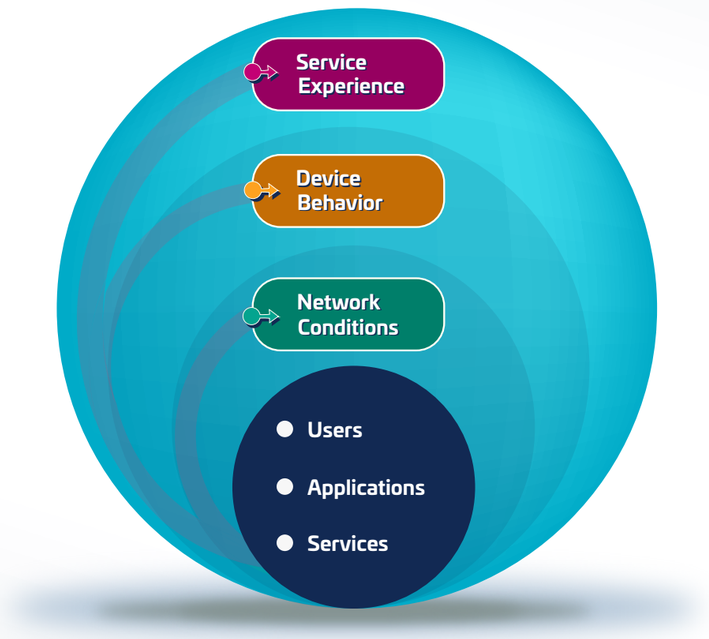
Real-time network monitoring is typically per slice and involves generating performance metrics such as throughput, latency, connection setup time and reliability. Operators also need to monitor network load and detect congestion conditions or other types of performance anomalies.

Device Behavior

Both human users and machines will be connected to the 5G network. 5G operations requires monitoring device connectivity, mobility and communications patterns. Abnormal device usage or unusual device behavior could have a negative impact on network performance and service quality.

Service Experience

MNOs need to measure and track service experience to ensure that the 5G network is meeting user expectations and stringent SLAs for performance, latency and reliability. NWDAF-generated metrics will measure service experience by user, application type, device group or geographic location as well as the standard calls for tracking QoS sustainability to monitor the current quality of service and predict future changes.



Guavus 5G-IQ NWDAF: Open NWDAF for Multi-Vendor 5G Networks

In 2021, Guavus introduced 5G-IQ NWDAF – a 3GPP-compliant, full-featured, vendor-agnostic NWDAF product designed for 5G networks in which multi-vendor interoperability, extensible data analytics and flexible deployment options are critical requirements. 5G-IQ NWDAF features the following capabilities:

Broad Use Case Support

A common network data collection and analytics engine in the 5G Core that supports a comprehensive range of 3GPP use cases to satisfy the MNO's operational requirements.

Distributed Modular Architecture

Allows operators to deploy NWDAF instances at proper points in the 5G network based on the location of data sources and the analytics processing required. 5G-IQ NWDAF can be deployed at the 5G edge, in an on-premise data centre or in the cloud, operating standalone or integrated with a cloud-based 5G Core.

Efficient Streaming Analytics

Lightweight, hardware-efficient streaming analytics engine for high performance data ingestion, aggregation and scoring at the 5G edge, co-located with data sources.

Extensible Data Collection

Ability to collect and ingest data types which are not currently defined in the 3GPP 5G SBA, such as data sourced by application functions, OAM layer functions, monitoring probes and packet metadata extracted from the user plane.

Plug-in Algorithm Support

Provides an API for analytics plug-ins that gives operators the ability to extend NWDAF's built-in analytics with AI/ML algorithms developed by third parties or by the MNO's data scientists.

5G IQ NWDAF

Find Out More

NWDAF is the Cornerstone for Autonomous 5G Networks

Few question the conventional wisdom that 5G networks will be so complex that analytics powered by AI/ML will generate real-time machine intelligence that will be crucial for directing network automation functions. NOC operators will be alleviated of responsibility for the type of split-second analysis and decision making that human minds are not well-suited for in time-critical situations.

However, many do underestimate the importance of standards-based 5G analytics for realizing the industry vision of autonomous 5G networks. Standards promote multi-vendor interoperability, which will be a key requirement in networks running on disaggregated, cloud native platforms that will enable MNOs to easily deploy and integrate best-of-breed products from multiple suppliers.

The 3GPP's NWDAF standard is the first milestone on the path to standards-based 5G analytics and NWDAF is the cornerstone for building 5G networks which are capable of autonomous operation, with minimal operator intervention required.

Guavus 5G-IQ is an open approach to NWDAF that provides operators with the capabilities required to deploy network data analytics in complex 5G operational environments that demand performance, flexibility, extensibility and scalability.

Guavus NWDAF Resources

[Video] Introducing Guavus 5G-IQ NWDAF
- https://youtu.be/nMQ5XWkNR_c

[Web Page] 5G-IQ NWDAF - An Open NWDAF that enables Multi-Vendor 5G Network Automation
- https://www.guavus.com/guavus-iq/5g-iq-nwdaf/

[Web Page] NWDAF Use Cases
- https://www.guavus.com/communications-service-providers/nwdaf-use-cases/

[Webinar Replay] Deploying Cloud-Scale Analytics for AI/ML to Drive 5G Network Automation
- https://landing.guavus.com/webinar-deploying-cloud-scale-analytics-for-ai-ml-to-drive-5g-network-automation

[Press Article] Analytics-Driven Automation Is Critical for Mobile Network Operators to Master 5G Complexity at Scale
- https://www.futurenetworld.net/5g-automation-and-intelligent-edge/analytics-driven-automation-is-critical-for-mobile-network-operators-to-master-5g-complexity-at-scale/2021/05/

[Press Article] Guavus: AI-driven Analytics in the 5G Era
- https://telecomdrive.com/guavus-ai-driven-analytics-in-the-5g-era/

[Blog Series] 5G Analytics and NWDAF
- https://www.guavus.com/resources/blog/

About Guavus, a Thales company

Field-Proven, Carrier-Grade Telecom Analytics Experience

Guavus is a telecom analytics pioneer that is laser-focused on enabling 5G MNOs to realize business value by leveraging cloud-scale analytics and state-of-the-art AI/ML to increase operating efficiency, satisfy stringent 5G SLAs and ensure quality of service experience for users, machines and IoT devices.

The Guavus team combines in-depth telecom domain experience with data science and software engineering expertise to deliver high-performance, carrier-grade analytics solutions that the world's leading network operators are using to collect and analyze petabytes of data every day.

For over 15 years, Guavus has been at the forefront of applying Big Data, streaming analytics and AI/ML to solutions that enable telecom network operators to overcome critical business challenges impacting customer experience, service quality, operating efficiency, revenue and profitability.

Lean Innovator Inside a Multi-Billion Euro Technology Leader

A Thales company, Guavus is a lean innovator inside a global technology leader with 80,000 employees in 68 countries, revenue of 17 billion euros (in 2020) and a self-funded R&D budget of 1 billion euros. Guavus works closely with non-telecom Thales business units to provide analytics solutions for applications in industrial IoT, aerospace, transportation and digital security. Guavus also partners with leading network equipment vendors and cloud service providers to further extend its reach to customers around the world.

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