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Perspective

CSPs can futureproof their analytics strategies by taking a platform-based approach to NWDAF implementation

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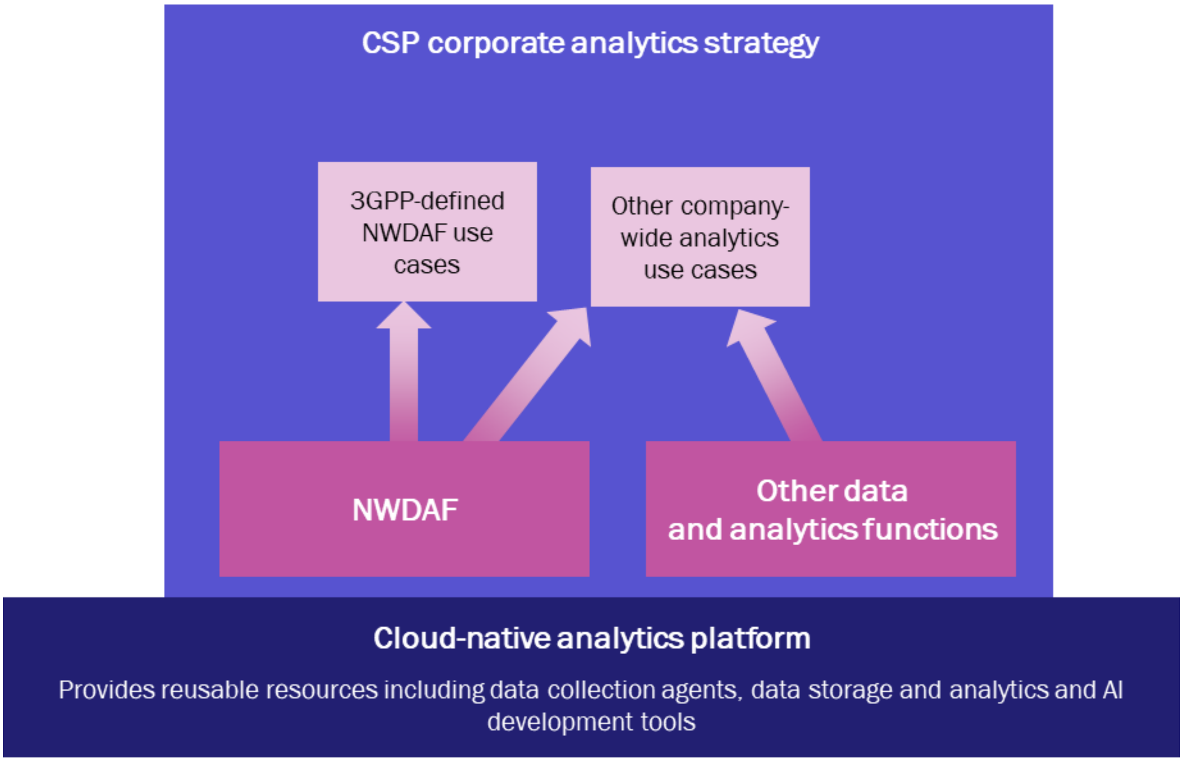
1. Executive summary

Communications service providers (CSPs) are implementing 5G standalone (SA) core networks to generate new revenue and streamline operational processes. Data analytics will provide insights that will be key to the discovery and management of new 5G-enabled opportunities. However, CSPs' current analytics offerings use non-standardized interfaces for the collection and delivery of network data and insights. To mitigate the challenges associated with this, 3GPP has defined the network data analytics function (NWDAF), a network function for the 5G core that standardizes the operations of interfaces that support analytics workflows.

In this perspective, we make the case that CSPs should view the implementation of the NWDAF in a broader analytics context rather than simply deploying it as a silo to fulfil the 3GPP specification (see Figure 1.1). The NWDAF should be part of a CSP's journey to fulfil a company-wide vision for analytics. CSPs should look beyond 3GPP's pre-defined NWDAF use cases to discover others that the NWDAF might support, such as using user equipment (UE) mobility data insights to increase footfall for retailers. The NWDAF's disaggregated architecture is key to realising these additional use cases because individual NWDAF components can co-exist with, and contribute to, CSPs' broader analytics architecture. The NWDAF can also become a key data source within such architecture, and can consolidate 5G core network data so that it can be easily accessed using standard interfaces. This will reduce the time and effort required by data practitioners to access and integrate network data with other data sets to drive company-wide analytics objectives.

Figure 1.1: Overview of how the NWDAF fits into CSPs' broader analytics strategies



Source: Analysys Mason

A platform-based approach to the implementation of the NWDAF will be critical to achieving these benefits. Such an approach enables multiple analytics applications that address different use cases to be delivered within a common and shared technical and business framework. Common resources provided by the platform include data collection agents, a data and analytics repository, AI and analytics development tools and execution environments and interfaces that enable analytics applications to share data and insights. The benefits associated with adopting a platform-based approach include the accelerated development of the NWDAF and associated use cases and a consistent environment for the development and management of the NWDAF and other analytics applications.

CSPs should assess the cloud-native credentials of the analytics platforms into which they will integrate the NWDAF. They should also consider how well these platforms align with 3GPP standards for the NWDAF and their ability to accelerate the development of NWDAF and other analytics applications.

2. The NWDAF is a key component of CSPs' broader analytics vision

2.1 What is the NWDAF?

The NWDAF is a 3GPP-defined 5G analytics network function for the 5G core (5GC). It standardizes and streamlines how data is collected and how the analytical insights drawn from the network are consumed and distributed to support operations. 3GPP has defined standard interfaces for 5G core network functions to deliver and receive performance data and other data sets to and from the NWDAF using a publish/subscribe or request/response model.

The NWDAF will be key to achieving the analytics-driven, closed-loop automation of network functions and network slice lifecycle management that is required to assure a high quality of experience (QoE) and meet service-level agreements (SLAs). The data held within the NWDAF can also be used for preventive network maintenance and proactive operations in order to facilitate advanced technologies such as machine learning (ML). The 5G core network data can be used to train ML models to predict network anomalies, identify root causes and recommend corrective actions to resolve network issues.

Many CSPs are already applying analytics tools to their networks. However, the deployment of these tools can be complex due to their inconsistent approaches to collecting and transmitting data and insights to network functions via non-standardized proprietary interfaces. Consequently, the level of intelligence that can be gleaned from, and applied back to, the network and other parts of the business is limited. This has an impact on the pace at which CSPs can achieve their strategic objectives.

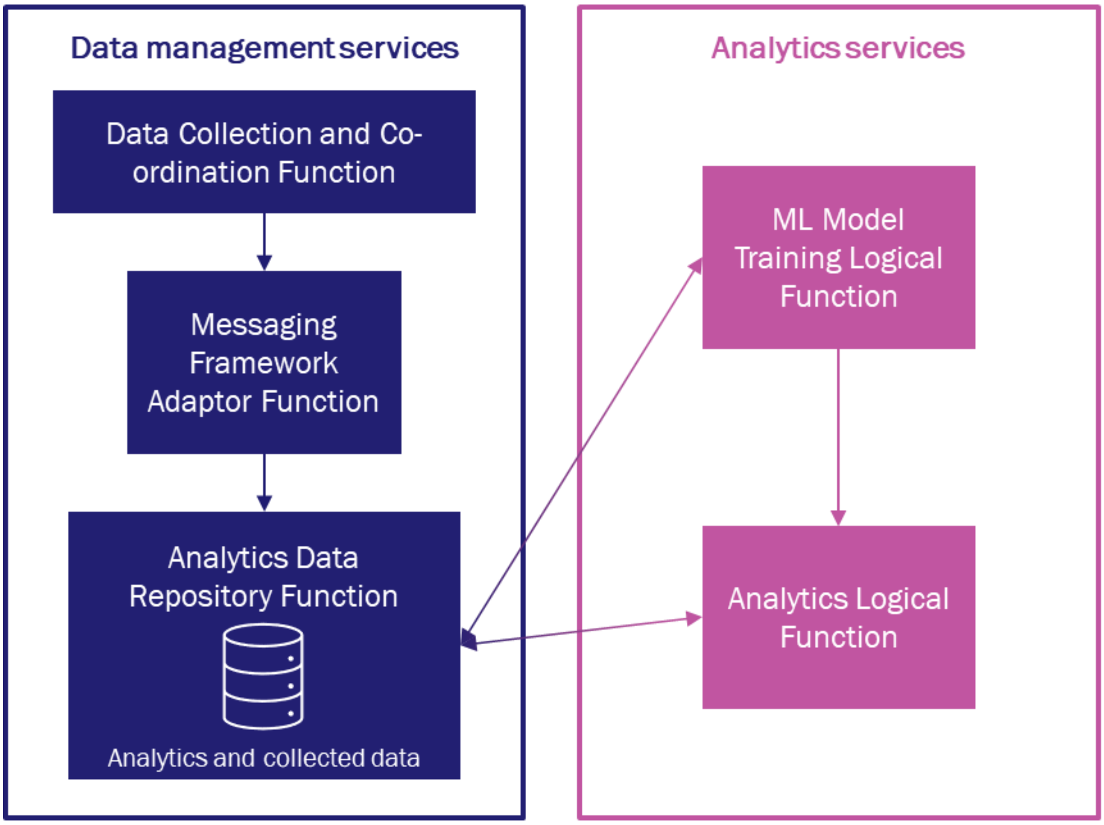
These analytics solutions were also developed as centralized functions. 5G core network functions such as the user plane function (UPF) are moving to the edge and the continuous performance monitoring of these functions is critical to their operation. This means that there is a need for distributed analytics architecture that enables analytics functions to run where the data is generated.

The standards-based definition of the NWDAF is expected to address these challenges. It will also enable distributed architecture, which means that the NWDAF can be co-located with other network functions to provide real-time analytics at the edge, while also supporting non-real-time analytics using aggregated data in the core network.

2.2 The disaggregation of NWDAF components

The NWDAF is made up of five components and its core functions are data collection and storage, model training and analytics (Figure 2.1). These five components are disaggregated into two logical functions providing data management and analytics services, respectively. 3GPP has not defined standards for all of the components of the NWDAF.

Figure 2.1: Key components of the NWDAF



Source: Analysys Mason

- **Data Collection and Co-ordination Function (DCCF).** This controls data collection and triggers data delivery to the NWDAF data consumers. It may support multiple data sources, consumers and message frameworks. However, each data source is associated with only one DCCF to avoid duplicating data collection.

- **Messaging Framework Adaptor Function (MFAF).** This contains messaging infrastructure that carries event data (such as streaming and notifications) from data sources to consumers using the publish/subscribe model, for example. The MFAF may contain one or more adaptors to translate between 3GPP and non-3GPP protocols. 3GPP does not specify standards for the MFAF.

- **Analytics Data Repository Function (ADRF).** This function stores and retrieves analytics data for the initial training and retraining of machine learning and for analytics. The data management framework defined by 3GPP supports both a 3GPP-defined ADRF for ML/analytics and data repositories that are not defined by 3GPP.

- **ML Model Training Logical Function (MTLF).** This is used for initial ML model training and updating trained ML models. The initial models can be provided by an external product referred to as a model designer. The specifications of the model designer are not defined by 3GPP.

- **Analytics Logical Function (AnLF).** This function receives trained ML models with related analytics IDs that can be registered with the network resource function (NRF).

2.3 Benefits of the disaggregated NWDAF architecture

The disaggregation of the NWDAF functions presents multiple benefits. These include:

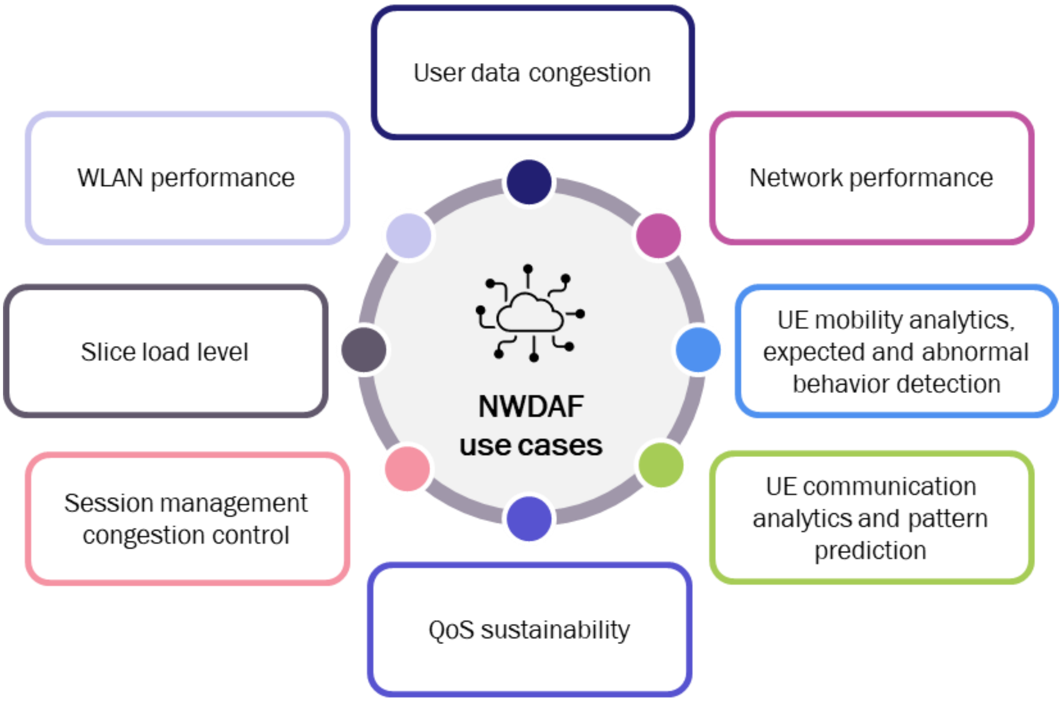
- giving CSPs the flexibility to choose which products or architecture to use when implementing NWDAF components
- providing CSPs the opportunity to reuse pre-existing analytics components, thereby reducing the time and cost to implement the NWDAF
- creating the potential for the NWDAF to co-exist and contribute to CSPs' broader vision for analytics
- reducing current barriers faced by data practitioners regarding data access and preparation
- driving network monetization by exposing network data and insights to enable third-party developers to create new services.

Flexibility, increased pace of innovation and the avoidance of vendor lock-in are key drivers for disaggregating network functions, including the NWDAF. Disaggregation also enables CSPs to swap out components easily when required and to reuse pre-existing analytics components such as data lakes or analytics engines. Some CSPs are planning to implement the NWDAF using existing data lakes as a message bus to provide the DCCF, MFAF and ADRF. The NWDAF can connect to the message bus to collect the 3GPP-defined data sets that support relevant use cases. The NWDAF then performs the required analysis and returns the results to the message bus. This approach may be best-suited to non-real-time analytics use cases, but real-time use cases can also use the NWDAF to collect data directly from 5G network functions, analyze the data and deliver insights directly back.

Another outcome of disaggregating the NWDAF is that the logical separation of the NWDAF components creates the opportunity for the NWDAF to co-exist with, and contribute to, CSPs' broader analytics strategies. For example, by separating the DCCF from the AnLF, the data and analytical insights that are held in the DCCF can be reused to support other analytics use cases or other applications that need to access the same information. In addition, CSPs can use their existing analytics toolsets to support the implementation of the NWDAF.

3GPP is primarily concerned with use cases that improve the internal operations of the core network. Figure 2.2 provides some examples of the NWDAF use cases that were defined by 3GPP in releases 16 and 17.

Figure 2.2: Examples of NWDAF use cases defined by 3GPP



Source: Analysys Mason

However, this view limits the value of the NWDAF to CSPs because it can enable other use cases, both within and outside the network domain. For example, data sets used in the session management function's (SMF's) routing decisions can be collected and analyzed within the NWDAF to determine how to route traffic to the right destination. The 5G Access Traffic Steering, Switching and Splitting (ATSSS) technique, controlled by the policy control function (PCF), is another potential use case that the NWDAF can enable; the NWDAF can support the definition and activation of rules that determine how devices use 3GPP and non-3GPP access networks when sending uplink traffic. The same functionality can be provided to the UPF to determine which access network should be used by a device for downlink traffic flow.

The network insights generated by the NWDAF can also be extended to support non-network-related use cases such as consumer experience and enterprise digital transformation. In these use cases, network insights from the NWDAF can be correlated with insights from other data sets across the CSP's business and/or those of its enterprise customers. For example, UE mobility analytics from the NWDAF can be correlated with data insights regarding customer footfall in a retail store to determine which products appeal most to customers in order to better showcase them. A1 Austria (with A1 Mobility Insights), O2 UK (with O2 Motion), Telefónica Group (with LUCA) and SK Telecom (with DataSpark) are examples of CSPs that are currently using mobility analytics to enrich the insights that are delivered to enterprise customers based on aggregated and anonymized population movement. The disaggregation of NWDAF components makes these additional use cases possible.

The NWDAF can therefore be considered to be one of the many data sources that are supporting the development of a multitude of use cases beyond the operations of the 5G network itself. Consequently, investment in the NWDAF needs to be considered not only in the context of the 5G core network, but also in terms of supporting CSPs' broader analytics vision. This approach presents benefits, including the possibility of accelerating the implementation of the NWDAF by using pre-existing analytics resources such as data lakes and ML algorithms. As a result, the cost of implementing the NWDAF is reduced.

Furthermore, the standard interfaces of the NWDAF can help CSPs to reduce the effort and time required for data engineers and scientists to access network data and integrate it with other data sets to drive company-wide objectives. Verizon's Chief Data Officer and Senior Vice President, Linda Avery, reported, at Digital Transformation World 2021, that data scientists spend around 70% of their time accessing and preparing data for analysis. The use of proprietary interfaces to network assets is a key factor in this. The NWDAF can therefore be positioned as an important data and analytics repository with standard interfaces that can store and expose information to support higher-level analytics use cases. These standard interfaces can also be exposed to third-party developers to enable them to create new services to increase revenue and customer stickiness. This allows CSPs to shift from being just connectivity providers to being value-added service creators for enterprise customers.

3. A platform-based implementation approach is required if the NWDAF is to be used as part of a broader corporate analytics strategy

3.1 NWDAF implementation is not a one-time activity but an on-going journey

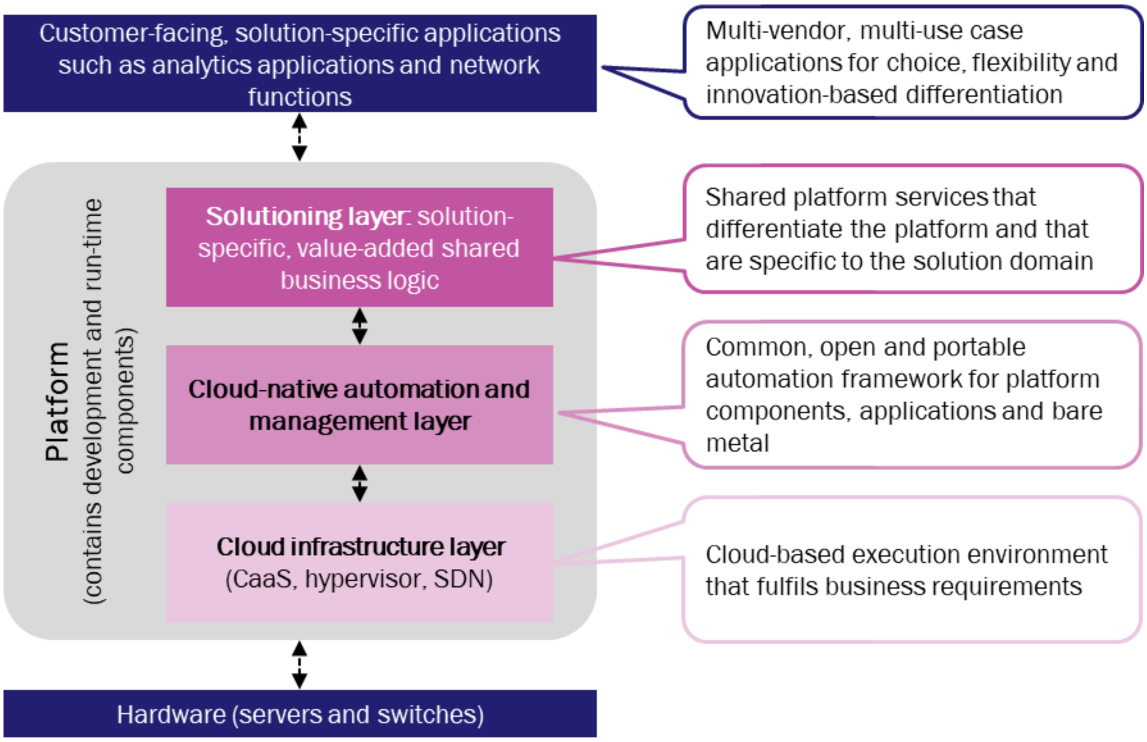
The implementation of the NWDAF needs to support the function's potential to contribute to current and future analytics use cases in order to enable CSPs to realise the full benefits that it can bring to their broader analytics strategies. As such, the NWDAF must not be deployed as a siloed analytics function. The implementation of the NWDAF should also not be considered as a one-time activity but as part of an on-going analytics deployment journey that will evolve over time. CSPs that are implementing the NWDAF will require a solution that is flexible enough to support this journey while providing the foundational capabilities needed to drive other analytics functions.

3.2 What is a platform?

Taking a platform-based approach to implementing the NWDAF provides CSPs with an opportunity to implement this network function as part of their broader analytics ecosystem.

Analysys Mason defines a platform as a structure that allows multiple applications participating in a 'solution' to be delivered within a common and shared technical and business framework. Platforms provide applications with access to shared assets, including common automation assets, thereby enabling the highly efficient development, deployment and lifecycle operation of software-based solutions. There are three key layers of functionality in a platform as shown in Figure 3.1.

Figure 3.1: The three layers of platform functionality



Source: Analysys Mason

The bottom two layers of a cloud-native platform use industry-standard, open-source components. The cloud infrastructure layer is based on Kubernetes and/or OpenStack, while the cloud-native automation and management layer contains Kubernetes-based tools developed by the Cloud Native Computing Foundation (CNCF). These include observability tools for monitoring, logging and auditing the cloud-native software components that are delivering the solution, as well as other components that enable operational automation (Day 1 and Day 2 configuration and management) to be built into the cloud-native applications that are running on the platform.

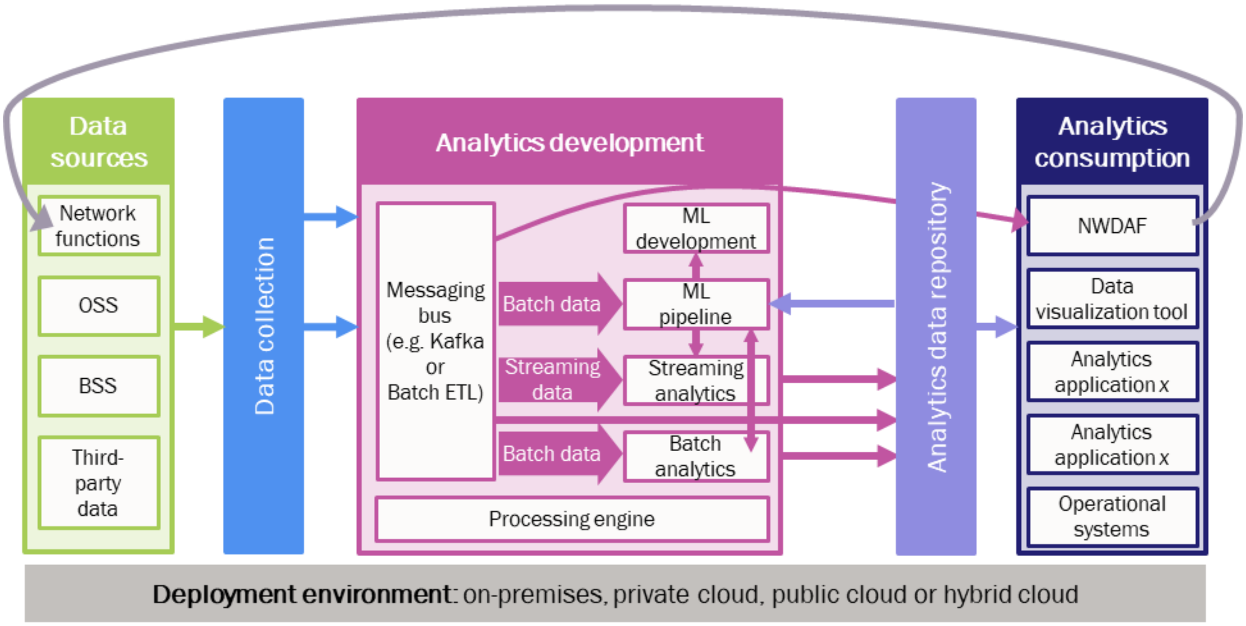
The top layer (the "solutioning layer") contains shared assets that we refer to as platform services. These are specific to the solution domain and include toolsets for data collection and management, AI/analytics and development. They can all be reused to develop specific business logic for applications within the same solution domain. They help to fast-track the development and upgrade of new applications, which is a necessary part of CSPs' on-going journeys with analytics.

3.3 Components of a platform-based analytics platform

A platform-based analytics solution is one that enables the creation and operation of multiple analytics applications using a combination of technologies in order to meet company-wide analytics needs. Technologies implemented within such an analytics platform support the end-to-end analytics lifecycle from data collection and storage to management, enabled by common data governance practices to provide full accountability of available data and assure its quality and accessibility.

The architecture of an analytics platform largely aligns with that shown in Figure 3.1; the only difference is that the solutioning layer is developed to support the common requirements of analytical applications. Several software components reside within the solutioning layer including data collection agents, data and analytics repositories, AI and analytics development and execution environments and interfaces for the consumption and delivery of data and insights between analytical products such as the NWDAF. These components are implemented as decoupled modules within the analytics platform (**Error! Reference source not found.**).

Figure 3.2: Key components of the solutioning layer of an analytics platform that supports NWDAF



Source: Analysys Mason

- **Data collection agents** retrieve data from 3GPP-defined network functions for NWDAF use cases. Data from non-3GPP-defined data sources such as network-related data sources from legacy 2G, 3G and 4G networks, customer data and third-party data can also be collected. CSPs continue to point out the need for an analytics platform that is open in order to collect and integrate information from multiple data sources, with a view to speed up the development of new analytics use cases.

- **Data and analytics repositories** store and manage data and can support the large volumes of data and high speeds that are required for streaming (or real-time) analytics use cases. These repositories must be able to store and deliver data and analytical insights to both 3GPP-defined network functions and non-3GPP-defined data consumers.

- **Analytics development and execution environments** contain the analytics engine and ML model lifecycle management functions.

  — **The analytics engine** creates and supports different levels of analytics use cases (real-time, near-real-time and non-real-time). Predictive analytics capabilities for functions such as anomaly detection are also supported to avoid events such as network function failure. Real-time analytics functions are crucial to reducing CSPs' reliance on complex batch analytics that take a long time to perform, thereby enabling them to adopt streaming analytics solutions that provide faster responses to events such as network failures and changes in service performance or customer behavior. Streaming analytics functions enable a large volume of data to be filtered, aggregated, correlated and analyzed in real time because these functions are driven by a highly automated data processing pipeline.

— **The ML model lifecycle management component** is responsible for the development and management of the ML models that are used to drive advanced analytics functions such as predictive analytics. This component could be embedded within the analytics engine or could be provided by an external system that integrates with the analytics engine. The ability to create and maintain ML models to consistently yield highly accurate results will be important to maintaining the integrity of the network and enabling CSPs to meet their QoE and SLA requirements.

- **Analytics consumption** occurs via 3GPP- and non-3GPP-defined interfaces for the NWDAF that deliver analytics results to other systems. The NWDAF can execute actions immediately for some use cases. The delivery of analytics results occurs in one of two ways.

  — Analytics results can be delivered as a **data source** to support decision-making processes before an action/operation is initiated. For example, the NWDAF can send UE mobility analytics information to another network function (NF) or group of NFs to enable an appropriate action to be taken. Analytical insights can also be delivered to end-user applications via dashboard interfaces such as those used in a network operations center (NOC). Intuitive and interactive dashboards can be written to flag anomalies to engineers in real time; this information can then be combined with other data to drive decisions. This feature will more easily enable CSPs to prevent issues from arising, which in turn will help them to deliver better experiences to customers and reduce costs.

  — Analytics results can also be delivered as a **key decision driver** that triggers immediate actions by the receiving network function or application. For example, if a slice load threshold defined by the policy control rules function (PCRF) is reached, the NWDAF can immediately recognise that the slice is congested and let another entity, namely a function related to the operations, administration and maintenance (OAM) domain, execute a slice lifecycle management operation to fix the issue.

3.3 Benefits of taking a platform-based approach to implementing the NWDAF

A platform-based approach to implementing the NWDAF delivers several benefits from both a commercial and technical point of view. An analytics-based platform enables CSPs to realise the advantages of the NWDAF's disaggregated architecture and its implementation alongside other analytics functions within a CSP's environment. The benefits of a platform-based approach to implementing the NWDAF include the following.

- **Accelerated and futureproofed NWDAF development**. An analytics platform has key features that can enable the NWDAF to support additional use cases in the future, in line with CSPs' corporate vision for analytics. These features include reusable components such as data repositories and AI and analytics tools that deliver common services to 3GPP-defined NWDAF use cases and other analytics applications. As a result, a platform-based NWDAF delivers speed, opex and capex benefits when CSPs create new analytics use cases.

- **Reduced time to develop and implement NWDAF use cases.** An analytics platform provides an integrated environment where data practitioners such as data engineers and data scientists can centrally access data. As a result, the time spent accessing and preparing data for model training and data analysis is reduced.

- **Consistent environment for analytics use case development.** Multiple capabilities can be integrated within a single unified environment when taking a platform-based approach. This integrated environment also enables data engineers and data scientists to collaborate during the ML model lifecycle process (which supports analytics development).

- **Ability to develop NWDAF components using cloud-native principles.** Components can be developed and deployed as decoupled microservices and then exposed using standard interfaces to deliver the advantages of flexibility, adaptability and agile development. The 5G core is cloud-native, so implementing core network functions using cloud-native platforms ensures that the NWDAF aligns with the standards specifications.

4. Key attributes of an analytics platform that can be used to support NWDAF implementation

4.1 What to consider when selecting an analytics platform to support NWDAF implementation

Various types of platforms can be used to implement the NWDAF: open-source platforms, vendor-proprietary platforms or a mix of both platform types.

The components of an open-source platform provide standard toolsets that support analytics workflows. However, adaptations are required to ensure that they align with company-wide analytics strategies. Nonetheless, several CSPs that possess the necessary expertise are using open-source toolsets to address their analytics needs.

CSPs that use vendor-proprietary solutions will have access to expertise from the vendor to support their analytics needs. Many vendors are now also including open-source tools within their proprietary solutions. This has been driven by CSPs' growing acceptance and use of open-source tools such as Apache Kafka and Spark and the ability of these tools to enable CSPs to switch more easily from one vendor-proprietary solution to another. Combining a vendor's expertise in adapting open-source tooling to CSPs' operational business needs with the additional capabilities offered by their proprietary solutions can further enhance the reliability and performance of analytics workflows.

There are key characteristics that the platform will need to have, regardless of the approach used, to ensure that it supports both the requirements of the NWDAF and the future analytics requirements of the business. These include the following.

- **Strong cloud-native credentials.** These credentials enable operational automation, agile delivery and API-based integration. The NWDAF should conform to cloud-native principles including the disaggregation of components into microservices, the ability to run within containers and Kubernetes-based orchestration to enable scalability and automation. The platform must support CI/CD processes to enable the continuous enhancement and testing of the NWDAF, other analytics functions and the analytics platform itself.

- **Open and based on standards.** The platform must be aligned to the NWDAF architecture, interface and use case standards as defined by 3GPP, while also providing the flexibility required to meet CSPs' analytics needs. For example, an NWDAF platform should integrate with non-3GPP-defined NWDAF interfaces to support non-3GPP-specified use cases or extend 3GPP-defined use cases.

- **Modular.** Data management components should be decoupled but interoperable with any analytics engine. This structure provides CSPs with the flexibility to reuse existing assets, such as data lakes, to support analytics use cases. It also gives CSPs the freedom to choose best-of-breed solutions for NWDAF components.

- **Flexible.** Both the deployment environment (where components of the analytics platform can run) and the data sources and use cases supported by the platform should be flexible.

- **Fast.** Speed will be particularly critical to real-time data processing and the development of high-quality ML models. For example, a significant amount of time is required to plan, develop and optimize ML models to ensure that they remain of a high quality. AutoML and pre-packaged ML models can be used to address these challenges. AutoML automates the time-consuming, iterative tasks involved in ML model development, including algorithm selection, training, testing and optimization, while enabling data practitioners to create high-quality ML models efficiently and at scale. AutoML can also run within the data repository to further speed up the model building process. Furthermore, it can be used to continuously adapt ML models as the network and business environment evolves, thereby ensuring that accurate results are consistently derived. One of the key advantages of pre-packaged ML models is that their implementation takes less time than developing a model from scratch. CSPs with limited AI/ML expertise can therefore accelerate the development and deployment of ML-based use cases within the NWDAF by utilizing these pre-packaged ML models.

- **Robust and efficient.** The platform must be robust enough to deal with the massive volume of data generated by the millions of mobile users on a CSP’s network. The speed and capabilities of the functions provided by the platform (such as data collection, processing, model training and retraining) will need to align with the requirements of the relevant use cases. The efficiency of data processing also becomes increasingly important as the amount of data increases. Hadoop-based big data platforms may be used, but the inefficiency of these platforms when handling large amounts of data and their lack of agility in scaling analytics processes (due to their monolithic architecture) makes these systems less appealing to CSPs. Instead, CSPs can adopt cloud-based big data services, such as those from the public cloud providers, thanks to their agile and scalable data architecture.

- **Adaptable.** The platform must be adaptable, especially with respect to customizing analytics applications to deliver unique experiences to end users. For example, dashboard applications should be adapted to enable any of the personas consuming the analytical insights to engage with and consume the data and insights in a way that is most relevant to their role. Consequently, the user experience of the NWDAF or other analytics applications should be considered continuously to improve and/or increase user adoption. This can also extend the relevance of the NWDAF beyond the internal operations of the network to a broader end-user community.

5. Conclusion

The NWDAF will play a critical role in enabling CSPs to meet their expectations regarding 5G investments. However, it is important that CSPs take a well-informed approach to implementing this network function. We provide the following recommendations for CSPs that are looking to make the most of their investments in the NWDAF.

- CSPs should view the implementation of the NWDAF in a broader analytics context rather than simply deploying this network function as a silo to fulfil the 3GPP specification. They should view the NWDAF as a means of fulfilling strategic, company-wide analytics objectives.

- CSPs should resist limiting their use of the NWDAF to 3GPP-defined use cases. The NWDAF can address many other use cases that can add value to CSPs' 5G deployments, including those that support operational efficiency, revenue generation and customer experience.

- CSPs should take advantage of the NWDAF's disaggregated architecture and reuse existing analytics components such as data lakes and analytics engines during deployment. They should also exploit the NWDAF's ability to co-exist with other analytics applications and provide relevant data and analytical insights.

- CSPs should invest in an analytics platform that can support the NWDAF's requirements, its associated use cases and the requirements of other analytics applications. This platform should provide features that enable all applications to co-exist with each other and to consume and share data and insights.

- CSPs should work with partners that provide the technical expertise needed to deliver an analytics platform and capabilities that enable CSPs to discover and develop new analytical use cases. These use cases can then use insights and data from the NWDAF and other pre-existing analytics applications to drive new revenue streams.

6. About the author

Adaora Okeleke (Principal Analyst) leads Analysys Mason's Data, AI and Development Platforms research programme. Her research focuses on service providers' adoption and use of data management, artificial intelligence, analytics and development tools to support the digital transformation of network, customer and other business operations. Adaora tracks vendor strategies for the telecoms industry to understand how they are evolving their product portfolios to include data, AI and development capabilities. She also provides key industry insights to operators and vendors on strategies for adopting these technologies.

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