RADCOM's Network Data Analytics Function (NWDAF)

Data analytics and containerized service assurance for 5G

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Introduction

Network Data Analytics Function (NWDAF) is a new Network Function (NF) introduced as part of the 3GPP standards for the 5G Core (5GC), as defined in TS 29.520[1]. It's a network analytics capability built into the general framework of the network architecture and is an evolution of the RAN Congestion Awareness Function (RCAF) from previous 3GPP releases. Its purpose is for centralized data collection/analytics. Although this function is still in the "early stages" of standardization, it could become a more critical function for analytics in future iterations of the 5GC.

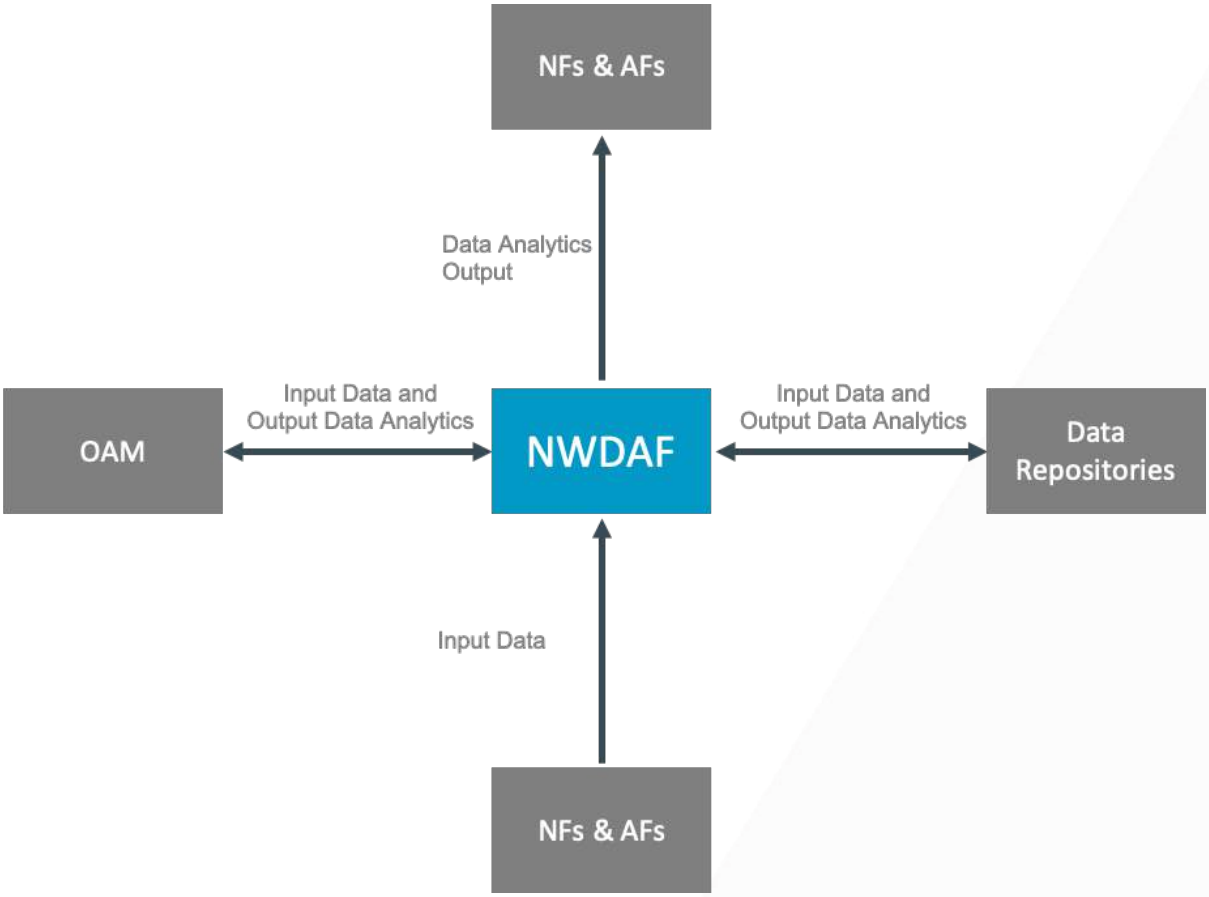

Figure 1 - Network Data Analytics Function as defined in TS 29.520

As defined in Release 15, the NWDAF provides load level information for a network slice. So, the NWDAF collects and analyzes the aggregated data per slice and aids in network optimization. Thus, the Network Slice Selection Function (NSSF) and the Policy Control Function (PCF) are considered as potential "consumers" of the NWDAF. Currently, some interfaces are defined between the NWDAF and the NSSF and PCF, (mainly the northbound ones), but the southbound interfaces and the way KPIs are calculated is not defined.

[1] Policy and Charging Control Framework for the 5G System; Stage 2 - 3GPP TS 23.503

Network slicing will enable an operator to provide many virtual network services over the same physical infrastructure. So, an operator could provide very high-speed connectivity for mobile gaming over one slice and a low-latency service for factory automation on another with both slices being reliant on the same underlying network.

However, automation is one of the keys to unlocking the potential of network slices. It will allow operators to manage them on a more granular level that will take full advantage of a cloud-native, fully virtualized network. So, a network slice could be very dynamic and perhaps last for only five minutes. The NWDAF could provide an essential part of this drive to automating network slice management.

Evolving NWDAF use cases

As described, in Release 15 the initial use case for the NWDAF was defined as network slicing. Now as part of Release 16 the following consumers of NWDAF data have been added alongside the PCF and NSSF:

- Access and Mobility Management Function (AMF)
- Session Management Function (SMF)
- Network Exposure Function (NEF)
- Unified Data Management (UDM)
- Application Function (AF)
- Operation, Administration, and Maintenance (OAM)

Additional closed loop use cases can be implemented based on NWDAF data such as:

- Load level information
- Service experience
- NF load
- Network performance
- Abnormal behaviour
- UE mobility
- UE communication
- User data congestion
- QoS sustainability

In addition to 3GPP-defined use cases, proprietary automated closed loop use cases may be implemented based on the NWDAF which can be extended above and beyond 3GPP defined interfaces and APIs. For more information, refer to the Additional NWDAF use cases section.

RADCOM's NWDAF solution is an open platform so as well as adopting 3GPP standards, RADCOM can implement additional use cases that are not standardized by 3GPP. If necessary, this means that proprietary NWDAF interfaces can be integrated into RADCOM's solution alongside the 3GPP-defined NWDAF interfaces.

RADCOM's NWDAF Solution

At the heart of RADCOM's NWDAF solution is RADCOM's next-generation solution for 5G assurance - RADCOM ACE – that identifies the network slice instance and creates the slice utilization KPI's that are provided to the PCF and NSSF per network slice instance. RADCOM's NWDAF allows an NF consumer to subscribe to and unsubscribe from periodic notifications of the KPIs and to subscribe to and unsubscribe to notifications when a threshold is exceeded.

Figure 2 – An NF service consumer subscribes to NWDAF notifications

- RADCOM's NWDAF identifies each network slice by the Single Network Slice Selection Identifier (S-NSSAI), which includes the following components: Slice/Service Type (SST) and an optional Slice Differentiator (SD).

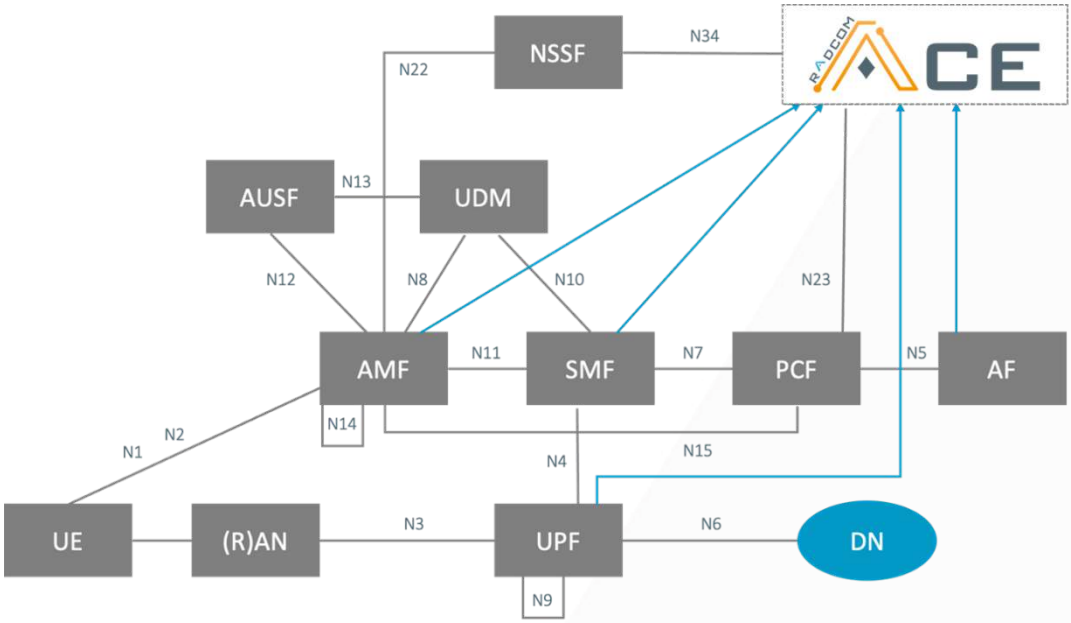

Figure 3 - RADCOM's NWDAF solution provides load KPIs to the PCF and NSSF

The PCF takes the input from RADCOM's NWDAF solution to assign more resources or steer traffic policies, which helps the operator run their network slices more dynamically, while the NSSF takes the load level information provided by RADCOM's NWDAF for slice selection. The user plane and control plane transactions are associated with the SST, and SD and KPIs are aggregated by the SST and SD (exposed via the 3GPP standard interfaces).

RADCOM's NWDAF supported services:

- N23 interface: a reference point between PCF (Policy Control Function) and the NWDAF
- N34 interface: a reference point between NSSF (Network Slice Selection Function) and the NWDAF
- Nnwdaf_EventsSubscription which enables the NF service consumers to subscribe/unsubscribe for network slice specific congestion events notification from the NWDAF
- Nnwdaf_AnalyticsInfo which allows the NF to service consumers to request and acquire analytics from the NWDAF

RADCOM's NWDAF provides operators with the ability to capture data from both non-SBI interfaces (N1, N2, N3, N4, N6, N9) and SBI interfaces (N5, N7, N8, N10, N11, N12, N13, N14, N15) so that as 5G services roll out, RADCOM's NWDAF ensures a smooth transition to the new core architecture; delivering a central point for network analytics.

Additional use cases

Use case	Description
5G edge computing	The NWDAF is used to aid in SMF routing decisions
Access Traffic Steering, Switching and Splitting (ATSSS) schemes support	The output of the NWDAF will feed new network functions related to Access Traffic Steering, Switching, and Splitting schemes (ATSSS). The three primary operations supported by the ATSSS are: • Access Traffic Steering: selects an access network for new data flow and transfers the traffic of this data flow over the access network chosen • Access Traffic Switching: The procedure that moves all traffic of ongoing data flow from one access network to another in a way that maintains the continuity of the data flow • Access Traffic Splitting: The procedure that splits the traffic of data flow across multiple access networks. When traffic splitting is applied to a data flow, some traffic of the data flow is transferred via one access, and some other traffic of the same data flow is transferred via another access system
Customize mobility management	The NWDAF can mine the collected network information to precisely predict UE's mobility

Use case	Description
	pattern and the associated UE track, e.g., gNB list or cell list per time of day. Then provide feedback on the gathered analytics, allowing the AMF to page the UE via, e.g., gNB list or cell list, and therefore bring down the paging load in gNB and saving corresponding processing resources in gNB.
Determination of Policy	The NWDAF provides data analytics to the PCF and assists in policy management.
Determining areas with fluctuating network conditions	By correlating and analyzing information coming from the network functions with data from the application functions (like MOS), RADCOM's NWDAF can provide statistical information that enables operators to change network deployment and configuration to improve E2E QoS. Examples of improvements that can be triggered are: • RADCOM's NWDAF will correlate service data with data provided by the NFs to find out why the service experience is low. • The AF can be informed when a UE is approaching a potentially overloaded area so that the AF can know that there is a higher chance of service fluctuation in these network conditions.
Management of Massive IoT (MIoT) infrastructure	In some vertical industries, service behaviors, data traffic (frequency, size), and locations probably have apparent regularity. However, for MIoT, the use cases are diversified, and the behaviors of MIoT terminals may vary a lot for different use cases, so requirements for quality of service and power saving are different. By utilizing both the NWDAF and NSSF, the expected UE behavioral information can be sent to the UDM to help supervise MIoT terminals.
Prevention of security attacks/anti-fraud	The NWDAF is used together with real-time machine learning to execute fraud prediction and prevent security attacks on the network.

Advanced network slice optimization

In 5G services like URLLC and Vehicle to Everything (V2X) will require network-wide analysis to both validate and improve NF deployment and configuration. Operators will also be able to monitor network slices (for example, performance requirements for groups of UEs associated with a type of service). The NWDAF will help operators determine areas of fluctuations in the network conditions and ensure service levels match expectations.

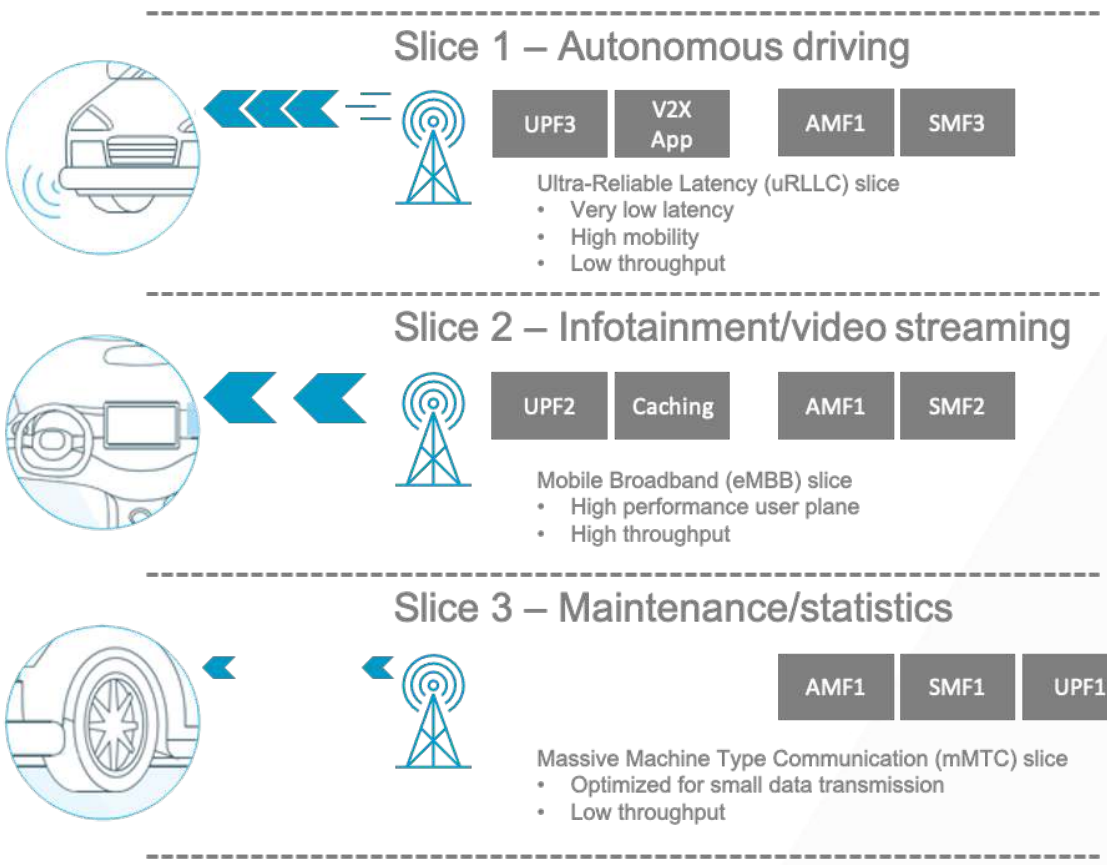

Figure 4 - Ensuring network slice performance for V2X

- Slice SLA assurance or predictable network performance

  3GPP defines basic network slice types such as eMBB, mMTC, and URLLC, where each network slice is designed for a group of services sharing comparable service requirements. However, some applications and services will require multiple service flows. These service flows can be implemented by using QoS flows (defined in 3GPP TS 23.50112), different PDU sessions, or even different network slices. For instance, in remote driving use cases, HD video requires high throughput, which is supported via the eMBB slice. However, the in-vehicle sensor data and vehicle control signaling require low latency and high reliability, which is backed by the URLLC slice. When a subscriber requests a service, the 5G network automatically assigns an identifier: 5QI (5G QoS Identifier) for each service with the required QoS (Quality of Service) and changes the technical parameters of the network to fulfill the requirements of each assigned 5QI. Monitoring these QoS flows will be an essential part of SLA assurance for network slices.

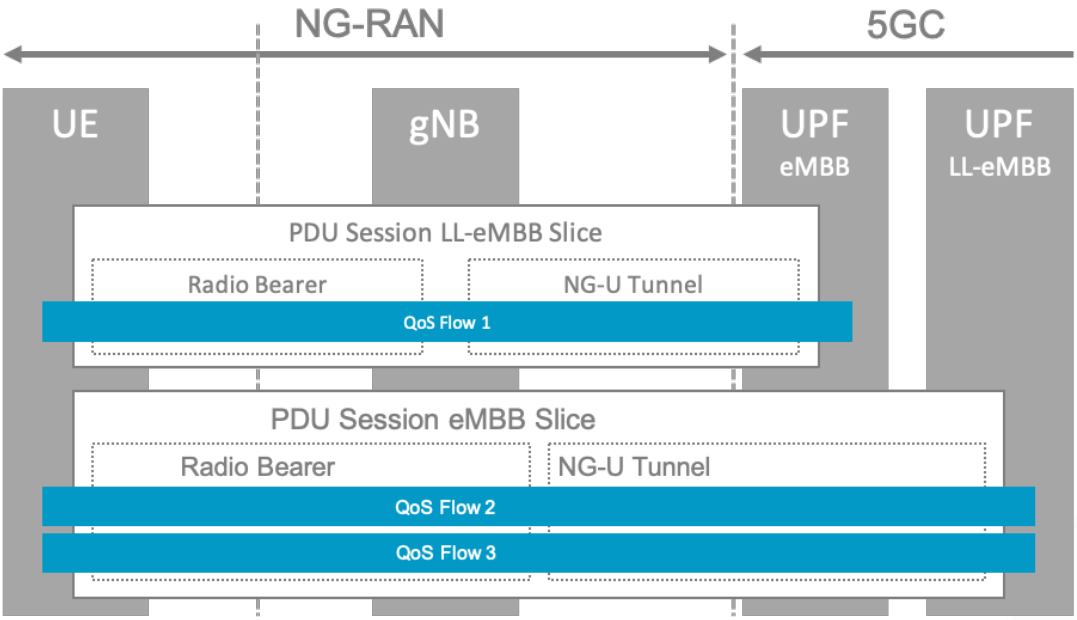

Figure 5 - QoS flows in different network slices

Automation with Artificial Intelligence (AI) and Machine Learning (ML)

Automation will play an essential part in unlocking the potential of network slices and 5G in general, and NWDAF will provide a critical role in helping operators make strides towards this goal and transition to zero-touch network management. This will mean the network adapting automatically to changing traffic conditions and demand without human intervention, empowering operators with a closed-loop approach to network operations and service quality monitoring.

This level of automation will be enabled with the power of NWDAF – a centralized analytics function – embedded into the 5G Core and aided by built-in AI and ML. The NWDAF with AI/ML capabilities will continually collect network data from the NFs and provide real-time analytics back to the NFs and the operator's BSS/OSS systems. This will give this continuous network analysis to help proactively manage the 5G network, essential for advanced 5G use cases.

Services will run on the network, and the NWDAF will constantly monitor service quality and react to any network degradations. So, the NWDAF will provide failure detection, load/capacity management, all enhanced by AI and ML to provide automated, data-driven adjustments, and insights not possible through manual network monitoring.

For network slicing, this will mean slices can be created dynamically with network resources allocated on-demand, and the service delivery policy set to match the required QoS. The slices will be monitored automatically for performance and resources adjusted to make sure the agreed SLA is delivered. AI and ML will be continually utilized to assist zero-touch slice management by forecasting resource utilization trends and proactively improving/configuring the network resources.

Also, the NWDAF will utilize AI and machine learning for other use cases such as detecting network anomalies, predicting unusual network, and user behavior. This central repository of data analytics combined with AI and ML will enable operators to manage their networks efficiently and assure that QoS requirements are met even when rapid changes in the network traffic occur. This type of automation will be critical with such services as mission-critical communications or other latency-sensitive services are widely deployed on 5G.

Using NWDAF and built-in AI/ML will provide data for predictive analysis so operators can proactively manage their 5G services with minimal human intervention and rapidly react to changing network demands. So, for example, in network slices, the NWDAF can utilize slice load level information stored in its data repository to predict behavior based on day to day analysis and historical data to indicate possible spikes in traffic on say a holiday. Based on the NWDAF output, the NSSF can automatically allocate more network resources or even allocate a new slice even before the overload starts to ensure continued service quality; however, much the network traffic fluctuates. Predictive analytics provided by the NWDAF can also be used by operators to perform forecast analysis by the NWDAF and help teams plan infrastructure enhancement, thus preventing any customer-impacting service degradations.

Advanced ML algorithms will utilize the information collected by the NWDAF for tasks such as mobility prediction and optimization, anomaly detection, predictive QoS, and data correlation. Some of the use cases for future 5G standard releases and enhanced network automation using ML are:

- Network congestion data – current and predicted for a specific location
- NWDAF analytics exposure to applications, for example in Smart City applications such as alleviating urban traffic congestion
- NWDAF-assisted predictable network performance
- QoS sustainability (which requires predicting QoS changes)
- UE abnormal behavior/anomaly detection
- UE communication pattern prediction
- UE expected behavior prediction

RADCOM ACE: An enhanced NWDAF solution

As well as serving as an NWDAF, RADCOM ACE also offers an efficient and cost-effective, containerized service assurance solution. This provides end-to-end network troubleshooting, as well as complete service and customer experience visibility—empowering the operator with an enhanced, more agile NWDAF solution.

- **End-to-end call and session tracing and troubleshooting**
  Providing operators with a state-of-the-art, modern troubleshooting application-layer (call/session tracing and packet analysis) that utilizes the latest web-client principles of cloud-based applications for collaboration and ease of use, and industry-leading for tracing and packet analysis applications.

- **Network analytics and smart alarming**
  It is offering network analysis and alarming, which is interoperable with the troubleshooting applications, allowing for a seamless drill down from one application to another—for example, performing a drill from a KPI Reporting into session information and from there into packet information. This can also work in reverse by way of a "drill up" from a specific example to a broader view of the associated data, e.g., starting from a packet and viewing the entire session, which includes that particular packet.

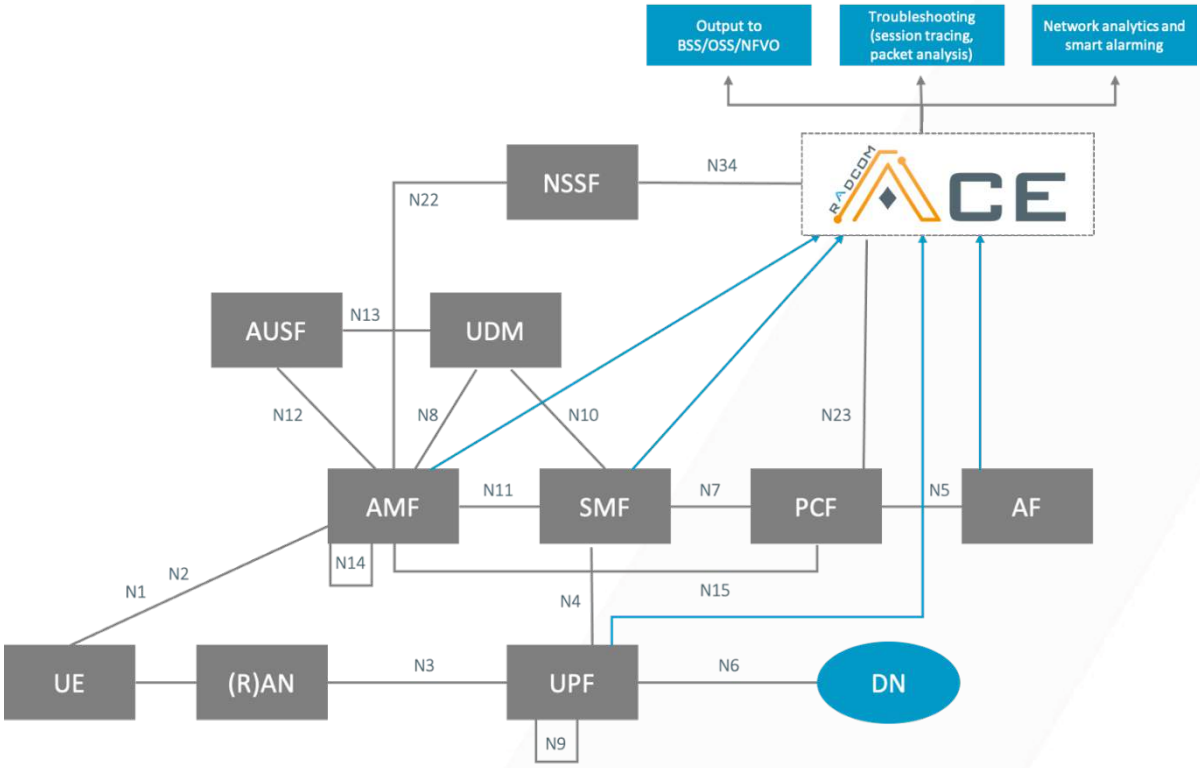

Figure 6 RADCOM ACE also provides end-to-end assurance with call tracing and packet analysis

Monitoring the 5GC SA requires a new approach to service assurance by enabling the processing of events streamed from the network elements in the SBI core and optionally combining information based on packet mirroring from the 5GC NFs.

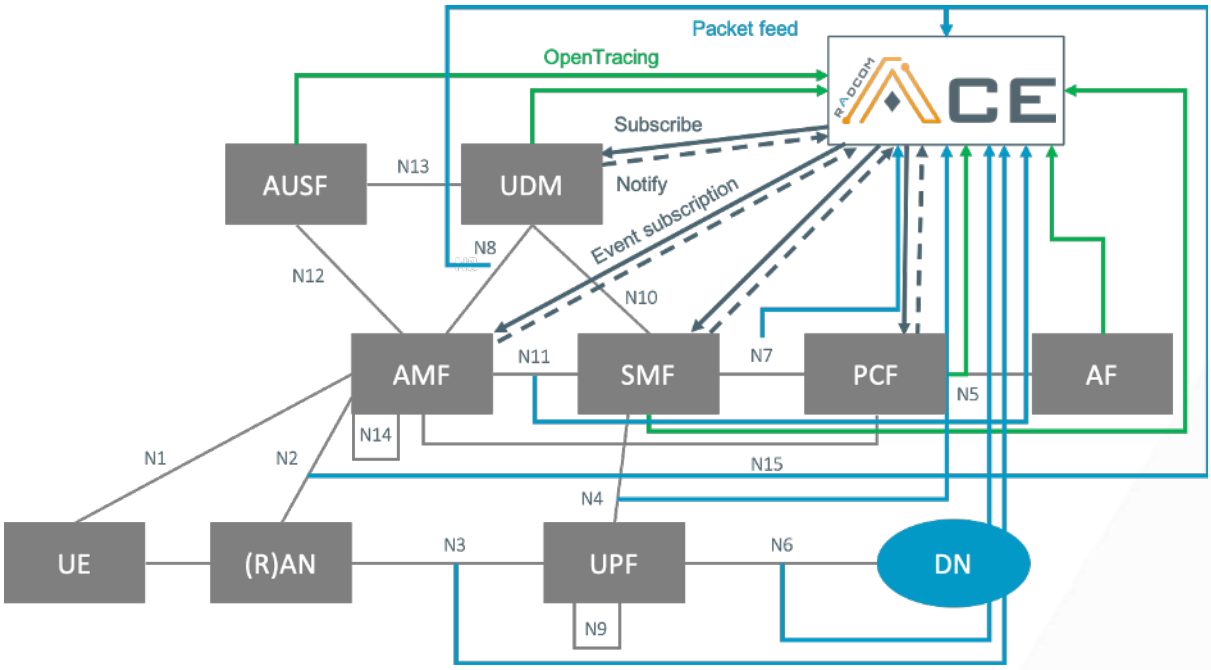

Figure 7 - RADCOM's solution correlates multiple data sources

Using containerized probes (cProbes), RADCOM captures and correlates the network packets and uses RADCOM I.C.O.N. to capture and process network events. RADCOM ACE takes data from multiple sources in the network (such as JSON, AVRO, Protobuf, raw packets, PCAP) and outputs the analytics in numerous formats (such as Kafka, TCP, REST, file, email). While also being flexible in exposing its services to other network functions and knowing which functions should benefit from them.

RADCOM ACE provides a dynamic NWDAF and 5G service assurance solution with end-to-end tracing and advanced network troubleshooting with the following value proposition:

- **Designed with the 5GC architecture**
  Unique capability to receive and digest different inputs; Open API, OpenTracing, Kafka streams, raw packets, counters from Network Elements, DPDK, probes, Service-Based Interfaces (Subscribe/Notify, Request/Response methods). This is the only way to be able to provide end-to-end independent monitoring of 5GC. RADCOM ACE is designed for the 5GC architecture, being container-based, and acts as a producer and consumer of information.

- **Truly Real-Time Decision Making**
  The streaming architecture enables real-time streaming analysis with anomaly detection. Sitting on two architectural pillars; handles unbounded data streams and in-memory computations. This allows the real-time production of actionable output from a live stream of data, delivered to a user through a GUI or to a machine via a programmatic interface.

- **Making Closed-Loop Automation A Reality**
  RADCOM ACE becomes a producer of data needed by the operator and by the network itself. The Open API allows the the assurance components to be queried/subscribed to for feedback and actionable feedback that drives automation.

- **Operational Agility**
  Aggregations can be changed and applied on the fly with immediate results shown for a historical batch or a real-time stream. The same logic is used for both streamed computations and batched computations, enabling organizations to leverage the breakthrough benefits of a streaming architecture without any operational overhead.

- **Fault Tolerance**
  Individual RADCOM ACE clusters rely on failover resistance implemented at the virtualization layer. Also, independent RADCOM ACE clusters enable architecture fault resilience; given the fact that the processing is not performed on a single backend entity but distributed across multiple parallel clusters, a catastrophic failure of a cluster does not hinder the processing of other clusters.

- **Built-in Security**
  Data can be parsed, tagged, and delivered to a segregated RADCOM ACE cluster based on their nature (provenience, destination, ownership, object, etc.), where it is processed and stored. This architectural arrangement delivers correct traffic segregation with dedicated compute and storage resources, in a selected location, with ad-hoc security requirements.

- **Microservice Architecture with de-structured frontend and backend**
  Every RADCOM ACE deployment can ingest any data sources and, at the same time, output to any destination, meaning that the specialization between FE and BE disappears. Every RADCOM ACE component can be either FE, BE, or both at the same time. Or, more precisely, any RADCOM ACE component can be programmed to be either FE, BE, or both at the same time.

  This enables the introduction of new use scenarios:
  - Stand-alone FE and BE entity
  - Easier to expand and to integrate into existing ecosystems
  - Reduced resource requirements – deploy only the compute and storage resources required for the task
  - Minimal and surgical deployments to address a very narrow use case – no need for the whole solution deployment

Conclusion

Many operators have different analytics solutions deployed for a variety of use cases like quality assurance, marketing analytics, and network engineering. By implementing RADCOM's NWDAF solution, operators can unify multiple tools into a single, distributed, containerized solution.

RADCOM's NWDAF solution offers operators a significantly enhanced NWDAF that is a centralized data analytics function for the 5G Core but also delivers an entire assurance solution that is highly efficient, cost-efficient and is designed as a native 5G core function. Being container-based and using an SBA with a producer-consumer model. Whereby a service - that is authorized to – is offered data by an NF (Producer) and consumed by another NF (Consumer). This enables the operator to fully integrate end-to-end assurance into their 5G network while ensuring cloud efficiency and optimizing network resources.

With over 30 years in the telecom market, RADCOM's experts will provide guidance on what data sources are needed, and how to use the data to calculate KPIs and KQIs, to ensure a fully optimized network and a superior customer experience throughout an operator's 5G rollout.