ENEA | 5G DATA MANAGEMENT

# UNIFIED DATA MANAGEMENT

## CRITICAL TO 5G SUCCESS

SPRING 2020

# 1

# UNIFIED DATA MANAGEMENT AND THE 5G NETWORK CORE

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**The shift from 4G to 5G has resulted in an architectural overhaul of the network, requiring network operators to rethink how they manage the data coming, going, and moving through the network.**

To do this, network engineers have developed unified data management (UDM). The technology is the equivalent of the 4G networks' home subscriber server (HSS). UDM communicates with different network layers and functions to share user data across the network, creating a platform through which different parts of the network can draw from one, centralized data source.

## What is UDM?

UDM works in tandem with other network functions and supplies relevant information to the system. It is abstracted from hardware so that it can be scaled and updated without the need for manual configuration. It can be stateless or stateful, depending on the network architecture.

A stateful UDM stores data locally; a stateless UDM stores data externally in the user data repository (UDR).

In a stateless architecture, multiple nodes can't update the same points of information at once (which can cause lags in the network), says Ron Parker, chief architect for Affirmed Networks.

Microservices orchestrate communication between the user plane of the network and the control plane where the UDM is situated, and are more commutable in a stateless architecture. In a stateless UDM, subscriber data is separate from the functions it supports, in order to keep database access separate from the operation of the network.

In a stateful architecture, data is shared among the microservices, meaning they must be taken off the network in bulk when issues arise, instead of independently, Parker says.

## A SEPARATE DATABASE... MEANS RELIABILITY AND PERFORMANCE

"You lose autonomy of the microservices as soon as you let them share the data," Parker said.

A stateless UDM offers flexibility and stability, says Mario Ruprecht, senior product manager, policy and access control at Enea. The UDM and UDR can be mixed and matched from different providers, so long as they are interoperable and chosen with the network structure in mind.

"A separate database... means reliability and performance. UDM heavily relies on the capabilities of the underlying media, so both should be very carefully selected," Ruprecht said.

"UDR needs to be designed with a cloud-native approach in mind, but it also needs to be robust, because the key element [of the] requirements is the storage. The unit itself is basically the deciding point to allow operators to start a best-of-breed architecture, otherwise they will be stuck with a single vendor forever," Ruprecht said.

## What Does UDM do?

The UDM will send data to network functions for verification, no matter the architecture. Both the UDM and UDR are capable of sending and storing the information, depending on how the network is built.

### User Data Repository Management

In a stateless network, while user information is stored in the UDR, it's the job of the UDM function to retrieve the data, send it to other network functions, and generally manage it.

The function of the UDM is then abstracted from the UDR, allowing it to be applied evenly throughout several UDRs in the mobile network. Overall, the UDM manages data for access authorization, user registration, and data network profiles . This subscriber data is provided to the session management function (SMF) — which allocates IP addresses and manages user sessions on the network.

### Access and Mobility Management

The access and mobility management function (AMF) receives user information sent through the network. This information is forwarded to the SMF and used to determine what session manager would be best assigned to the user.

The SMF serves as a gateway from the User Plane Function (UPF) on the user plane, to the control plane of the network.

## Creating a New UDM

In 4G, the home subscriber server (HSS) fills a similar function to the UDR. It stores customer profile data and authentication information, and provides keys for encryption for the mobile management entity (MME).

The UDM comes from a split in the HSS. In the 5G network, the functions of the HSS are broken up in the authentication server function (AUSF) and the UDM. The AUSF authenticates the servers and provides keys for encryption, and the UDM stores and manages the data itself, becoming an abstracted software on the network.

This abstraction separates the storage from the management function and gives the UDM accessibility to functions across the network.

In a stateless architecture, this function is further broken out into the UDR, separating it from the authentication function and the storage and management data into AUSF and UDM.

This increases scalability and flexibility in the network, says Oliver Korfmacher, VP of product management, policy and access control at Enea.

"By separating data and function, [UDM] is the best way for the operator to manage both significant capex savings. Even more so... the likeliness of inconsistency is basically totally gone in a 5G network because the data itself is stored only in one location," Korfmacher says. "The various functions that access the data, the most prominent one being the UDM, no longer require complex provisioning and reconciliation."

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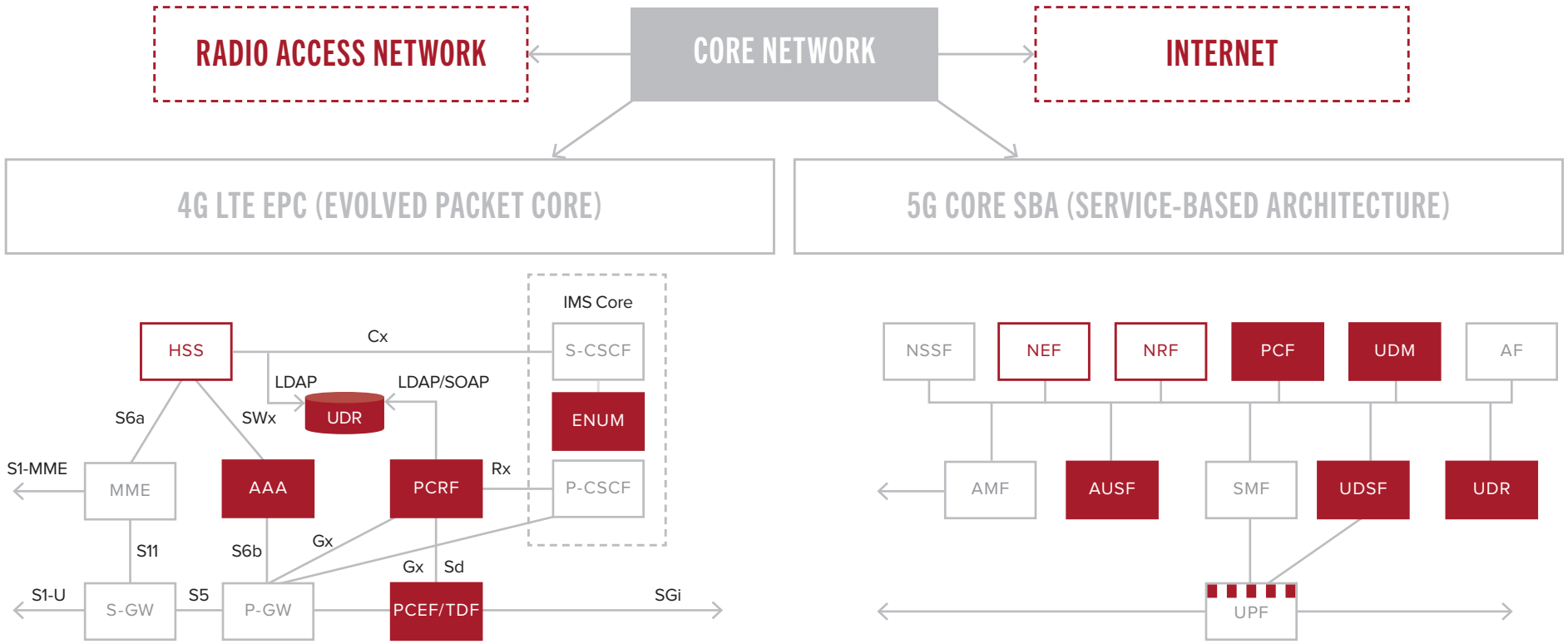


Both 4G LTE, and 5G's service-based architecture, can include UDR, which works with the UDM/HSS to act as a data repository for user subscriber information.

Image Source: Enea Policy and Access Control Portfolio

UDM can also be incorporated into the cloud. As 5G network compute is predicted to be hosted nearly entirely on the cloud, having functions that can operate within a cloud environment is critical.

Having a subscriber management system that is both adapted to a service-based architecture and accessible to non-operators is a crucial element of the 5G network, says Sue Rudd, director of service provider analysis at Strategy Analytics.

"[UDR] is now in 5G. It's a database that allows real-time events to access subscriber data, and act as a database for third-party apps," she said.

HSS doesn't have the capability to act in that capacity. Third-party apps can't access it, Rudd said. "It's only for the network operator, nobody else can touch it," she said.

5G is a service-based architecture, Rudd said, and its network functions must follow suit. As a cloud-native, shared-data environment, UDR needs to rapidly incorporate static information and keep up with real- time events in the network.

"We have to move into a database that can be accessed by multiple third parties, and that's cloud-accessible," Rudd said.

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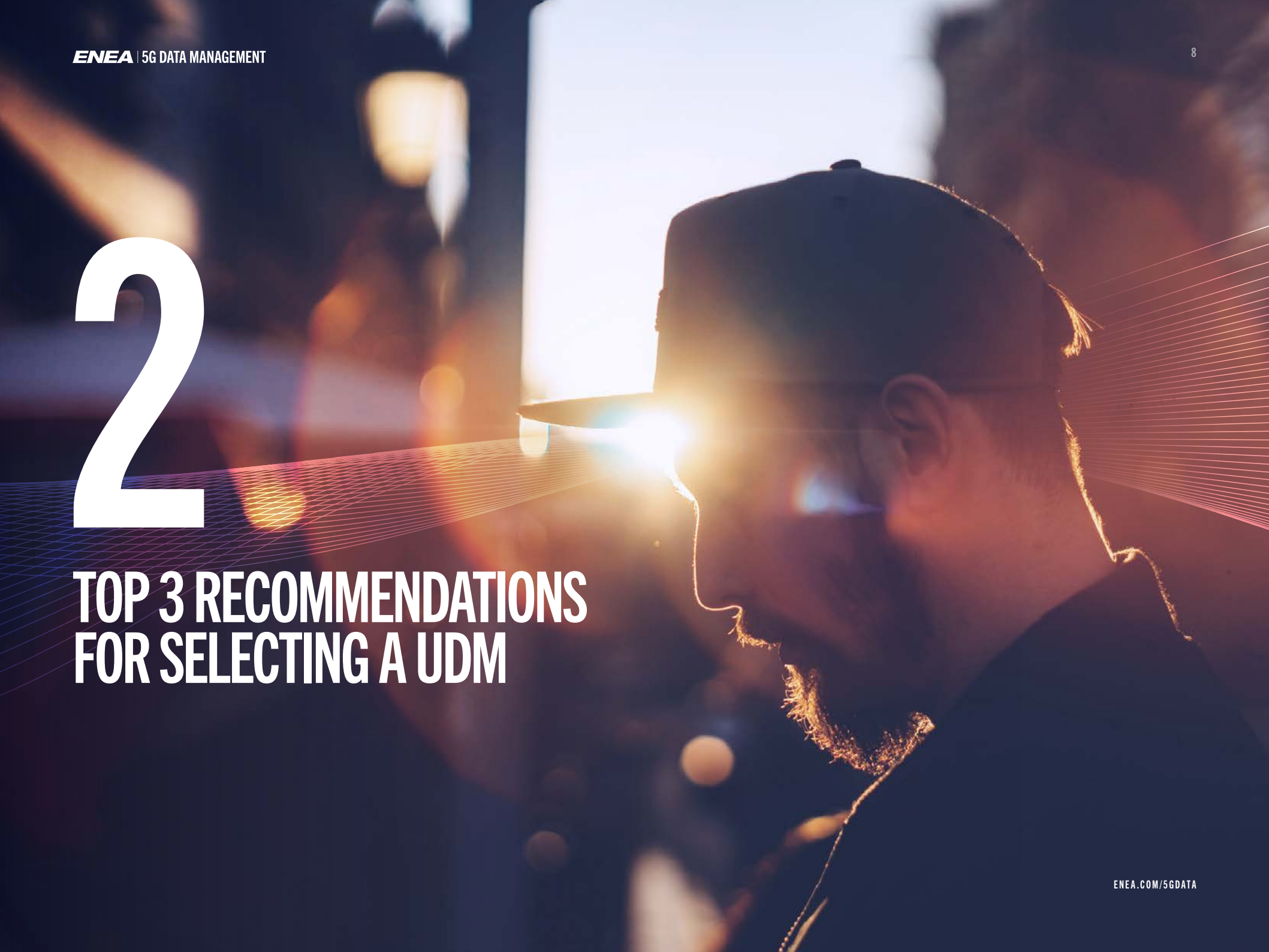

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# TOP 3 RECOMMENDATIONS FOR SELECTING A UDM

# DEPLOYING 5G CORE AND SELECTING A UDM

**Service providers are starting the process of deploying 5G core networks. While early deployments re-use the 4G core network in non-standalone (NSA) mode, it is becoming clear that the full benefits of 5G will only be realized when deploying a 5G core in standalone (SA) mode.**

The 5G core includes several functions that interact through new interfaces. HTTP-versioned APIs are now used to communicate between interfaces, making multi-vendor element integration easier. The deployment of a best-of-breed network requires operators to select products from different vendors for each function, taking into consideration their individual design and capabilities.

The Unified Data Management (UDM) element is key because it manages all subscriber and device data, and makes data available to other functions. Each vendor has an individual approach to UDM. Some have created a 5G core from scratch, in favour of evolving their HSS solutions into UDMs. Some deploy stateful UDMs and others advocate the benefits of state-less implementations.

## WHAT DOES CLOUD NATIVE MEAN?

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|---|---|
| **Microservices and Containers** | Software is designed in composable, loosely coupled pieces which implement complete functions that can be maintained separately and are delivered in containers. |
| **Standard versioned and secured APIs and API register** | Communication between services happens using secure APIs which are versioned for easier integration and service register is available to find the adequate element. |
| **CI/CD and DevOps principles** | Software blocks are developed and delivered individually where integration and testing relies on automated processes. |
| **Stateless design** | Data processing is separated from the storage of both structured/unstructured data and state. |
| **Service Mesh** | The microservices communicate with each other through a configurable networking layer to reduce complexity. |

**Three general recommendations for selecting a UDM:**

# 1 CONSIDER THE UDR AND DIRECT PEERS

The most advanced and flexible UDM architecture uses a stateless front end and a data store back-end called UDR (Unified Data Repository).

The UDM selection will also condition the AUSF choice, because the AUSF depends on the UDM for its operation. More specifically, the UDM handles all data, including security-related data, while the authentication is executed in the AUSF.

Large operators typically have integrated their own database back-end systems, which means they will prioritize a compatible UDM. Smaller operators may select a UDM/ UDR combination from the same vendor.

**WHY?**

- UDR is the actual network store for all subscriber and profile data
- UDM depends on UDR for performance and reliability
- AUSF depends operationally on UDM

**BENEFITS**

- Operational advantages of decoupled UDM/UDR (primarily by avoiding database inconsistencies)
- Re-use of existing UDR and provisioning
- Savings made when UDR, UDM and AUSF have common operational approach

# 2 MAKE A CLOUD NATIVE CHOICE

The 5G core has been designed for cloud deployment, with all the tools and features of a telco-grade cloud. Not deploying cloud-based functions will lower the value and performance of the overall system. The UDM must make use of basic cloud concepts like stateless design to scale effectively, and achieve high availability.

**WHY?**

- The UDM is critical because it holds all the data and only a cloud-native UDM will perform correctly in a cloud deployment
- Only a cloud-native UDM will scale to manage the data from billions of connected 5G devices
- A cloud-native UDM can be managed with the same tools as the rest of the 5G core

**BENEFITS**

- Increased scalability, reliability, and resiliency
- Reduced operational costs through automation

# 3 TAKE ADVANTAGE OF A FLEXIBLE UDM

When choosing a 5G UDM it is important to ensure that it can interwork with an existing 4G HSS. Replacing an existing 4G HSS has not shown to be practical, since service providers have usually added business logic to their HSS. As the UDM essentially replaces the HSS in 5G, it is therefore another candidate for adding non- standard functionality and new business logic. This makes it essential to prioritize flexibility.

**WHY?**

- The UDM may have to interwork with the 4G HSS and a variety of interworking options need to be supported
- The UDM can be customized and additional business logic can create competitive advantage

**BENEFITS**

- A flexible UDM lets operators keep their 4G HSS and experience smooth interworking between 5G and 4G
- With proprietary business logic it is possible to differentiate 5G offerings

# 3

# UDM AND THE SHIFT FROM 4G TO 5G

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**Unified data management (UDM) is part of the split function from 4G's home subscriber server (HSS). Like the 4G function, UDM stores customer profile and authentication information, provides keys for encryption of the information, and supplies it to other functions that manage mobile network sessions and connections. In fact, UDM functionally isn't all that different from HSS.**

The key difference between UDM and HSS is the non-functional.

The architecture of UDM is software-defined, cloud-native, and often stateless; storage is abstracted to the user data repository (UDR), and the function is run by microservices.

UDM can coexist with the HSS, however, by adapting the 4G function. When the two are interoperable, the HSS and UDM can authenticate users and sessions over the 4G and 5G networks, even as the user switches between them. Network hopping won't be uncommon as 5G gains its footing, meaning interoperability will play a key role in the network shift.

Many companies are adapting their 4G networks as the backbone for 5G, as 4G is expected to bear the brunt of mobile traffic well into 2022, and that mobile traffic is expected to burgeon in the coming years, according to the Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2017–2022 white paper.

Mario Ruprecht, senior product manager, policy and access control at Enea, says that the shift in major networks necessitates UDM and HSS interoperability.

> "You cannot immediately switch your whole subscriber base to a new technology. You need devices to support that," Ruprecht said. "You need to make sure that 4G and 5G can coexist and inter-work with each other... But of course, this is only for a limited period of time, in order to allow a smooth migration for the existing customer base."

As such, UDM plays a key role in the mobile network shift, offering a backwards bridge from 5G to 4G, flexibility, adaptability, and a more logical data route through the network for authentication information, saving on capex when 5G comes to truly dominate the market.

## How HSS and UDM Work in Tandem

Functionally, HSS and UDM are "comparable," Ruprecht says. Both serve as an entry point to the subscriber data in a mobile network.

UDM differs in its architecture and its protocol; it's service-based, and the management function of the UDM is separated from the data storage of the UDR, making the protocol for UDM different from HSS. UDM also gives external network functions access to subscriber data, which is a key part of 5G's cloud-based architecture.

What a 4G network needs that an HSS can't offer is scalability and abstracted data access through the UDR, which are both necessary for the 5G network to operate, says Sue Rudd, director of service provider analysis at Strategy Analytics.

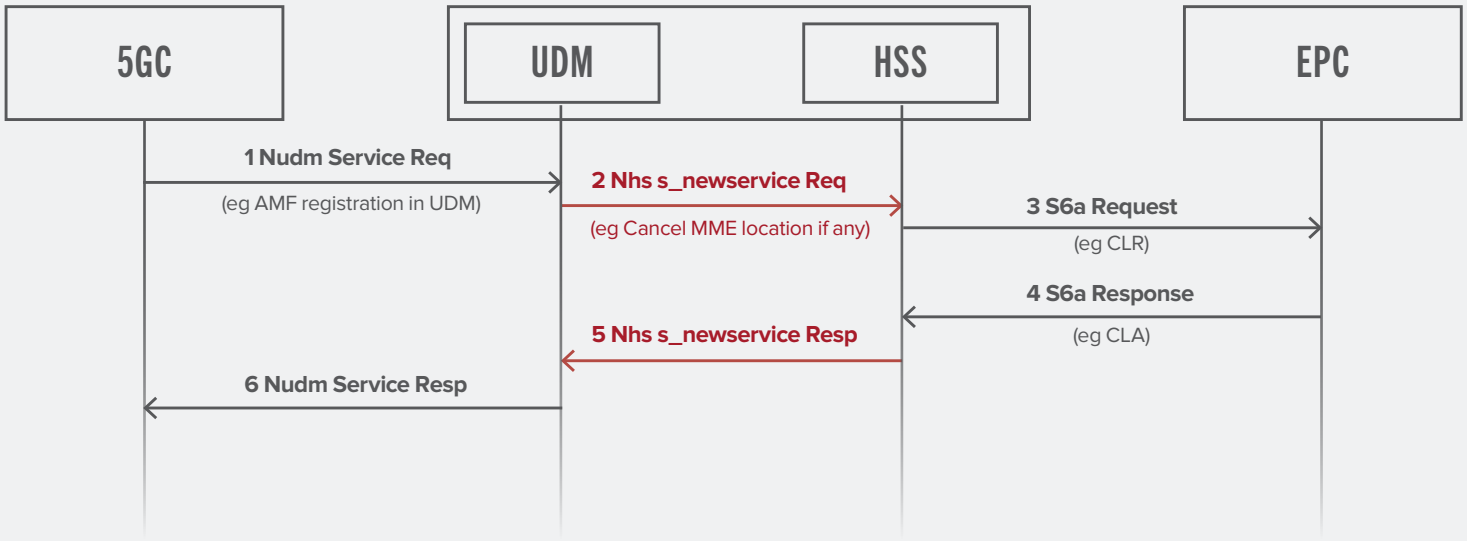
"HSS... is a real-time database," Rudd said. "In order to allow third-party apps [in], you need to access a database that doesn't affect the network operation."

The service-based architecture enables 5G network functions to support thousands more transactions per minute than HSS, according to the Strategy Analytics white paper 5G Design Principles with Unstructured Data Storage Function (UDSF).

It also means that either the UDM/UDR, or the HSS, must be able to work together and exchange subscriber information.

3GPP has proposed a "single combo" of UDM and HSS, acting as a singular point of contact for the IP multimedia subsystem (IMS), which facilitates IP use for delivering communication services over IP networks.

UDM and HSS, in this way, can be adapted to work with one another. If the UDM is adapted to work with the HSS, then it can save on capex when the 4G network is phased out, says Oliver Korfmacher, VP of product management, policy and access control at Enea.



"We have a native 5G product that will only support the required 4G functionalities," Korfmacher said. "As soon as 4G is no longer needed, the customer can decommission that functionality."

While an HSS can be adapted to 5G, it's better to build a new UDM from scratch. While it's more expensive and time-consuming in terms of development, a natively- built, stateless UDM built with independent microservices is more adaptable, says Ron Parker, chief architect for Affirmed Networks.

"The advantage of in house is pretty profound," Parker said. "That advantage is in terms of agility, and the time it takes to develop a new feature. If a customer requests a new feature, the traditional way takes a long time to give that to the customer. In the microservices way, it takes a very short time, again, because of the autonomy and smallness of the code, and the independence of the code."

## UDM Beyond Mobile Networks

While UDM is a concrete network function with a solid foundation and purpose within 5G, its abilities — and the philosophy of creating a central, abstracted access point for data — can be applied to other systems linked to subscription data, such as cable and internet service, Korfmacher said.

"We're currently trying to use the very modern, very cloud-native architecture of a UDM, or the overall 5G universal data management approach, to also cover different network technologies," he said. "So the approach that we're taking is to integrate fixed networks, like cable, for example, but also WiFi, and maybe even satellite communication, using the very same data models and universal data management systems."

To do so would require state-of-the-art architecture able to run the latest services, support legacy technology, and that easily extends to future trends, Korfmacher said.

"It's a key requirement of product architecture and framework that is not limited to only the modern systems," he said. "One must also be able to support legacy protocols."

## UDM in the Future

Where 5G goes, UDM will follow; and, if the global flock to mobile use is any indication, it will grow with the network. Korfmacher predicts that while the function of UDM will stay the same, it will need to adapt as the rest of the network becomes more scalable and automated.

"The mobility, the flexibility, the liquidity of the network will definitely increase dramatically, and that is something that needs to be pretty much automatic," Korfmacher said. "[UDM] cannot be manually managed and maintained where a subscriber is managed. But this is something the network needs to learn and handle itself by itself."

Ultimately, UDM will need to be architectured and adapted to both 4G and 5G as the mobile-dependent population continues to grow, and the demand for data increases. While UDM was made for a software-defined, cloud-native, microservices-based 5G network, it can work with a 4G network, creating a unified way to manage subscription and authorization information across a widespread network.