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The Importance of Distributed Data Platforms for 5G

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Summary

5G deployments are starting to mature, and several mobile operators are considering the next wave of their network evolution, including advanced 5G features and enterprise business models. These require radical upgrades to established deployment processes and underlying technologies, especially on the core network. As the brain of the cellular network, the new Service Based Architecture (SBA) offers new ways to create services and maintain the network while ensuring future compatibility.

However, all these new introductions require a mindset change in underlying platforms, the most important of which is the data platform used throughout the network. The current deployment mode is centralized databases, but these will not scale for the distributed nature of 5G networks, especially when enterprise business models reach critical mass. For these reasons, ABI Research expects that distributed data platforms will be necessary to power the next wave of business evolution for mobile operators and 5G.

The 5G market in 2021

The 5G market is rapidly expanding in 2021, with hundreds of networks being launched and a variety of smartphones available to subscribers below the US$200 average selling price mark. This means that 5G is fully commercialized with some markets entering the large-scale adoption phase, after graduating from the early adopter phase. Some mobile operators are already optimizing their existing deployments (e.g., China Mobile) while others are still planning more effective strategies for rolling out 5G nationwide (e.g., US carriers with their recent C-band auction investments). In the consumer domain, 5G technology development has already been “frozen” and several operators are deploying this equipment with 3GPP Release 15.

The next phase of 5G development will be enterprise deployments, where carriers, vendors, and new entrants will aim to deploy equipment developed with 3GPP Release 16, which introduces significant improvements for enterprise 5G: support for deterministic networking, enterprise use cases, mission-critical applications, Control and User Plane Separation (CUPS), network slicing, and much more. Release 16 also introduced the Service Based Architecture (SBA) for the core network, another revolutionary approach, which redesigns the network for micro-services, agility, and rapid innovation. Release 17 will build further on this foundation to introduce additional functionality, including industrial IoT improvements, positioning enhancements, the next phase of network slicing, including RAN, and other practical improvements that indicate the maturity of 5G technology development.

Mobile operators are currently are trying to understand what functionality enterprise verticals will require from their networks, including completely private network functionality and applications delivered through public networks through network slicing or a hybrid model, which is named Public Network Integrated-Non-Public Networks (PNI-NPN). As such, mobile operators are now planning their deployment strategies and assessing the platforms they need to cater for enterprise needs, as well as future consumer requirements. Apart from the necessary radio networks to deliver these services, the most important part of the network is the core.

The revolutionary nature of 5G core networks

The 5G core network is designed from the onset to natively introduce three new significant advancements: a service-based architecture (SBA), native support for networks slicing, and control-plane/user-plane split. The underlying pillar of 5G core is the SBA architecture, a fine-grained arrangement of loosely coupled and autonomous components intended to fully utilize the efficiency and flexibility of virtualization and cloud technologies. In the SBA architecture, services interact with other services in a light-weight fashion across application programing interfaces (APIs). The underlying premise of SBA is service atomicity, the ability for services to run in isolation from concurrent processes but at the same time, promote a flexible operational model where key core network elements (e.g., the Network Repository Function (NRF)) allow the seamless discovery of adjacent network functionality for all network elements. By extension, SBA is conducive to a 5G network that is reduced to being more granular and decoupled, all of which is associated with the following benefits:

- **Network agility:** Network services can efficiently be exposed to third-party providers.

- **Elastic and modular components:** Accessible and agile applications and services, which can grow and shrink on demand.
- **Open and disaggregated network:** A service-centric delivery calls for data, functionality, and APIs exposure to external entities (e.g., enterprise front ends) without a cumbersome protocol/process conversion.

Network functions that are connected to the Service Bus which can access the services (consumers) that other network functions offer (producers), while a network function can be both. As such, network functions are now classified in these two groups: consumers and producers that connect through APIs in a consistent interface bus.

Another revolutionary aspect of the implementation of 5G core networks is Control and User Plane Separation (CUPS), first introduced as part of the 3GPP Release 14 specification but deployed in subsequent Release networks, predominantly Release 16 implementations. The utility of CUPS lies in the separation between the control and user plane, where the latter can be scaled independently of the former. Control planes can be hosted in a centralized function, whereas the latter can be placed close to edge locations. CUPS enables the following benefits:

- **Distributed architecture:** Deployment of 5G core elements across distributed environments to cater for new services.
- **Cloud platform compatibility:** Network elements can be hosted in multiple cloud platforms, such as hyperscalers, vendors' own clouds, or a hybrid cloud.
- **Centralized and simplified O&M:** CUPS is conducive of a centralized OM configuration, where one control plane resource pool configures and controls several user plane pools, in turn simplifying network configuration.

CUPS, and many other 5G features, will create the opportunity for more applications while lowering the overall burden for the core network. In any cases, 5G core network infrastructure becomes critical to the carrier-grade operation of the network, especially when enterprise and new use cases are considered.

Centralized vs Distributed Data Platforms for 5G

Many of the innovations that 5G introduces depend on distributed processing and network capabilities. This will be further accentuated when Artificial Intelligence and Machine Learning (AI/ML) algorithms are utilized to automate the network to a much greater extent, while enabling new use cases without a waterfall development approach. Future networks will no longer be tied to specific services (e.g., voice, SMS, and data), but will be open to develop and commercialize any type of new service.

These networks will essentially become distributed connected computing platforms, but their functionality will depend on the underlying data platforms that collect subscriber, network, policy, and other data to feed business, network, process, and AI/ML algorithms. A key aspect of making this architecture work is the data management strategy, as data generated will have a life beyond the domain it will be generated in. For example, data generated by a network function will be stored, manipulated, reused, harvested for analytics, used to train AI algorithms, profiled for other use cases, shared across network slices, and much more. The complexity and distributed nature of 5G use cases require a consistent data platform strategy that will enable new functionality across many new network and process layers.

Distributed connected computing presents several challenges when it comes to integrating data sources across a distributed technology footprint. Ultimately, a data-centric model applied to mobile network operations should encourage the control and unification of the underlying data repositories. The ability to store this data effectively will be a defining feature of the future telecoms' data infrastructure, as will be the ability to store and process diverse data types (e.g., structured, unstructured, etc.). Moreover, broader network implications create significant impact in data platforms, e.g., backhaul or transport network latency will affect data collection, especially when there are synchronization issues involved. Moreover, not all data need to be at all locations and not every subscriber or network function need access to all data. These challenges are considered as foundational challenges to consider before moving to a fully distributed architecture, for example, a large-scale CUPS deployment.

Traditional telco data platforms have been centralized to a high degree in order to ensure that network and subscriber data remains always atomic, consistent, isolated, and durable (ACID). Previous cellular generation network elements (namely HLR for 3G, and HSS for 4G) have been the most centralized and protected network elements in every operator network since these databases collect sensitive information and need to be accessible from every part of the organization for different purposes. However, the distributed and service-oriented nature of the 5G network and the Service Based Architecture—which includes additional features such as CUPS and enterprise deployment—may not be a good fit for the centralized approach traditional data platforms have been utilizing. For example, cost will be a major consideration when data from hundreds or even thousands of CUPS end points will need to be consolidated to a large centralized database. Moreover, the backhaul cost for transferring this data will also be considerable and may "choke" the core network if a centralized database is considered. An additional challenge will be transport network latency, which may result in data not being consistent between network control points. Finally, flexible data platforms will be able to foster innovation, especially for enterprise use case, and this will likely stimulate the creation of new use cases.

Going forward, data platforms need to fulfill new requirements, as illustrated in the comparison below between centralized and distributed options.

5G Network Aspect	Centralized Data Platforms	Distributed Data Platforms
Stateless Network Functions	Data and service logic typically coupled	Shared data between network elements
Service Innovation	Depends on siloed service development approach	New services access data through consistent APIs from distributed data storage
Multi-Site Capabilities	Requires extension to data silo	Advanced replication mechanisms
API Exposure	Centrally managed	Distributed throughout control points

The Necessity of Distributed Data Platforms for the Future

Mobile network operators are just scratching the surface of what can be done with 5G networks and are currently deploying the platforms that will enable their next wave of profitability. Several operators are now evolving their data platform strategies and even integrating their own systems, for example, Telenor and Vodafone. Future networks will require additional functionality in the data platform layer for many reasons:

1) **Control and User Plane decoupling:** CUPS will allow operators to distribute user plane processing, in other words, allow for local or edge sites to process data and traffic. This will create new applications and use cases, but will also tax the control plane, especially when large amounts of data are generated by an application (e.g., a machine vision application). With a centralized data platform, vast amounts of data will need to be transferred to and from these edge sites, leading to unscalable control plane traffic. A distributed data platform will be necessary to share data throughout the network in a secure, scalable, and transparent manner.

2) **AI and ML algorithms:** These technologies will soon be the pinnacle of 5G and subsequent generations but will also create the need for the collection of vast amounts of data that will need to be transferred to a central location to train these models. Hyperscalers are already experiencing this data crunch and they are moving to distributed databases to ensure that AI/ML training and inference is also distributed. Telecom networks will need to follow the same path and distribute these algorithms as well.

3) **Hyperscaler-operator partnerships:** Some operators are already partnering with hyperscalers to improve their data platforms, some of which are aiming to shift their entire data storage and processing capability to the public cloud. Although this will certainly offer benefits, these operators may experience a form of vendor lock, in that it is not reversible. On the other hand, there are technologies and products in the market that allow for these distributed data platform model without moving data outside the telecom network.

4) **Cost and complexity of processing large amounts of data:** Last but not least, the complexity and cost of storing, processing, and managing these vast amounts of data in a centralized data platform will likely increase exponentially, in line with the exponential increase in data generated. Centralized data storage platforms are not designed for the extreme distributed nature 5G networks will soon come to adopt, and the established HLR/HSS, or even UDM deployment process, will not scale.

These are just a few examples why a distributed data processing platform is necessary to ensure the future of telecoms. Enterprise 5G, network slicing, and private-public network integrations are also a few examples where distributed data platforms are also necessary.

Several operators are currently in the process of evaluating and upgrading their data platform strategies. The following table illustrates a few examples where key operators are implementing significant upgrades to their data platform strategies.

AT&T	Started consolidating its network and subscriber data in 2017 into reusable data structures that can be used for analytics and AI algorithms.
Telenor	Implementing multi-vendor 5G core network, including a distributed data platform provided by ENEA.
Telefonica UK	Has selected Nokia's SDM platform to consolidate subscriber data into a centralized data platform.
DT and Orange	Assessing the creation of pan-European data platforms to be deployed across several country operating companies.
Vodafone	Partnership with Google Cloud to build a new distributed data platform based on the hyperscaler cloud platform.

Conclusions and Recommendations

The discussions above have argued that distributed data platforms are necessary for 5G and subsequent generations that include new enterprise business models. Mobile operators that are exploring active strategies in these domains need to put the necessary platforms in place to be able to take advantage of these opportunities, rather than wait until these markets are mature. These underlying platforms are the key differentiating points that will set telecoms apart, who now need to learn from hyperscaler experiences and distribute their networks, data platforms, and network processes accordingly.

ABI Research recommends that mobile operators start the process of evolving their centralized data platforms to distributed systems as one of the most important steps in their transformations, in line with their cloud-native strategies. Although hyperscaler partnerships are lucrative in the data platform and processing domains, ABI Research expects that there are advanced solutions in the market that can bring similar processes to the telecom cloud, setting the foundation for enterprise 5G and new applications.

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