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Beyond bit-pipes — new opportunities on the 6G platform

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The 6G platform will enable communication service providers to take a major step toward delivering more than best-effort communication. By enabling fast and easy introduction of new exposed services, 6G will be a powerful platform for developers to realize advanced use cases such as immersive communication.

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In the digital context, a platform is a product that enables other products or services to be built on top of it. Platform businesses typically enable others to share information, build applications or content, or run services tailored specifically for them. The 6G platform aims to expand the scope of networks beyond communication services to enable the delivery of broad support for applications, which are at the center of the digital transformation.

Enhanced access to network capabilities through service application programming interfaces (APIs) available in the 6G platform will make it easier to meet the high demands of applications on communications and other capabilities from underlying infrastructure. For communication service providers (CSPs), this will create opportunities to offer new services and create relationships with new customers that can be monetized based on service differentiation. With the 6G platform the opportunities for new monetization established in 5G will be further enhanced.

The mobile communication ecosystem today

Mobile communication exists in a wide and flourishing ecosystem that consists of several stakeholders who fulfill different roles. Two of the most important ones are CSPs and application service providers (ASPs). ASPs deliver services to private or enterprise consumers through software functionality (applications) in devices and in the internet domain. Applications are developed and made available to consumers on application platforms (Google Play, for example) that serve as marketplaces, also allowing third-party enterprises to reach consumers with advertisements and other types of content. CSPs deliver a best-effort mobile broadband (MBB) data connection (also known as a bit-pipe) between consumer devices and the internet domain. The current business model for CSPs is based on consumer subscriptions, with applications relying on generic MBB.

Looking ahead, both current and future applications will require enhanced communication services and services beyond communication that enable application differentiation and the ability to improve user experience. For example, information services can help applications optimize for the user's position and current network conditions. Quality of service (QoS) can significantly improve user experience, helping the application move from best effort toward service differentiation.

While the traditional ASP and CSP roles are likely to persist into the 2030s, relationships between them will need to evolve to overcome emerging challenges. For example, both ASPs and CSPs already face limitations to their ability to innovate: ASPs because they are forced to adjust their services to an MBB bit-pipe and CSPs because of a lack of established business with the ASPs. Further, ASPs that want to use more than an MBB bit-pipe need to manage interactions with many CSPs.

Terms and abbreviations

3GPP – 3rd Generation Partnership Project | **AI** – Artificial Intelligence | **API** – Application Programming Interface | **AR** – Augmented Reality | **ASP** – Application Service Provider | **CSP** – Communication Service Provider | **GNSS** – Global Navigation Satellite System | **HMD** – Head-Mounted Display | **MBB** – Mobile Broadband | **MLOps** – Machine Learning Operations | **MR** – Mixed Reality | **NEF** – Network Exposure Function | **NW** – Network | **QoE** – Quality of Experience | **QoS** – Quality of Service | **SCEF** – Service Capability Exposure Function | **SDK** – Software Development Kit | **SLA** – Service Level Agreement | **URSP** – UE Route Selection Policy

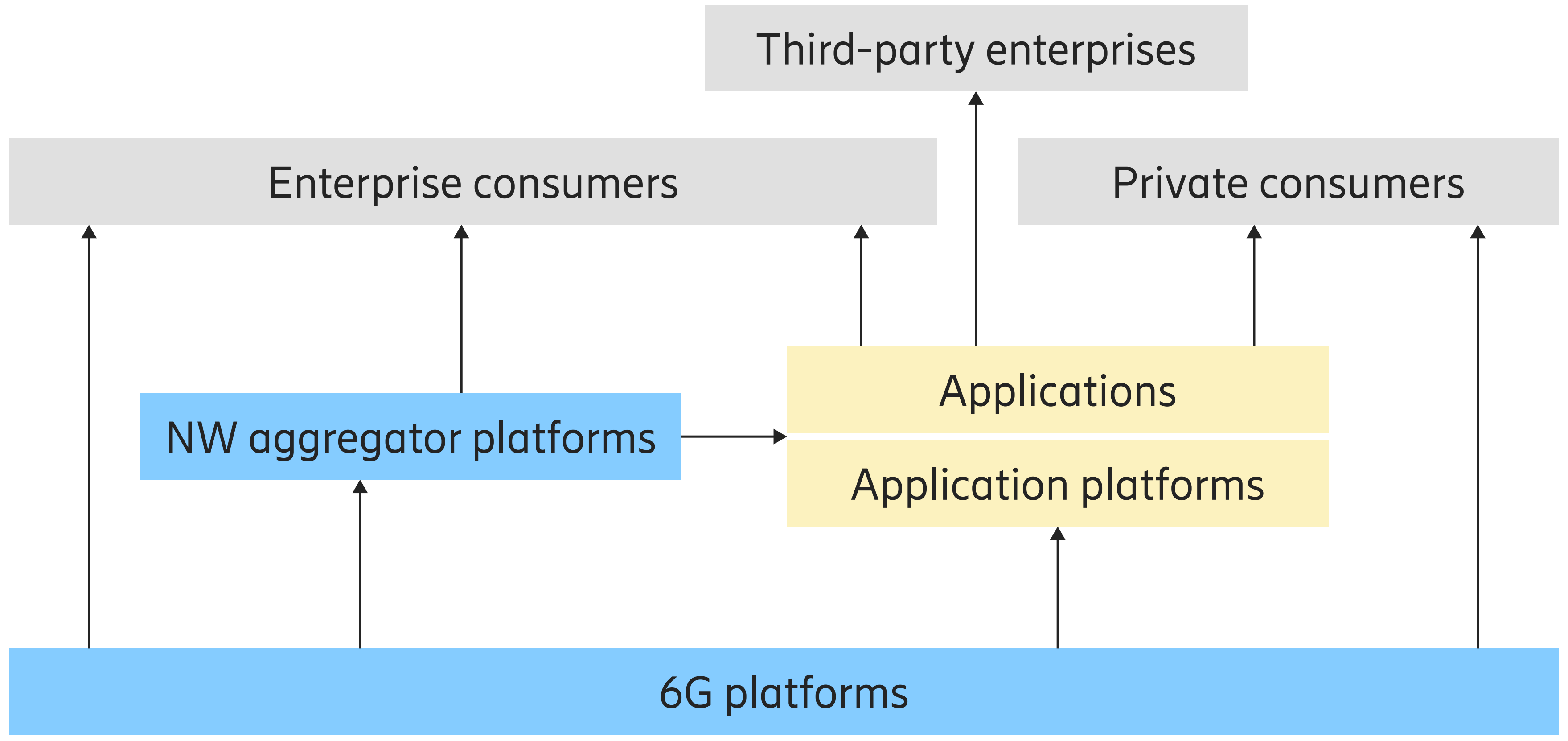

Figure 1: Interactions on the 6G platform

The best way to overcome these challenges is for CSPs to offer differentiable add-on services both directly to ASPs as well as through aggregator and application platforms, in addition to the MBB bit-pipe they offer to enterprise and private consumers. **Figure 1** shows how the 6G platform will incorporate service relationships with new stakeholders (applications and application platforms, in light yellow) next to those that already exist in 5G (with network aggregator platforms and directly with enterprise and private consumers). The offering for ASPs must be adapted to their roles in the ecosystem and be based on a solid understanding of their specific needs. To prevent fragmentation, it will be necessary to have a developer-friendly global interface that is coupled with attractive business agreements.

New service offerings on the 6G platform

The 2030s will be a decade of cyber-physical interactions – that is, the connections between the physical domain of things and actions and the digital domain of data and intelligence will intensify. Networks will serve as the key link between these domains, and we expect to see many new use cases that exploit these interactions.

Figure 2 illustrates a network platform built on 6G technology and services. Based on the network assets – that is, a set of available enabler technologies – this platform has capabilities of service assurance and enhanced external interactions for ASPs and enterprises. Such a platform enables a variety of new business possibilities.

The top of figure 2 highlights a selection of the foreseen 6G platform use cases, all of which require improved performance, advanced services, efficiency and sustainability, based on new services offered to consumers through ASPs. Many of these use cases will benefit from the 6G network's ability to offer capabilities beyond communication such as positioning, physical environment sensing and compute. These capabilities reuse existing communication assets for add-on services to data connectivity.

Mixed reality (MR) [1] is a good example of a demanding use case. In MR, digital content is seamlessly integrated into a user's view, bringing to life distant places and making it possible to interact with others as if they were in the same physical space. This use case requires high-quality image rendering with low latency and precise spatial mapping of digital objects. At the same time, the user device should be lightweight and affordable, with good battery performance. To achieve this, the 6G platform can support devices and ASPs at multiple levels: communication with quality guarantees, localization and mapping support, and offload services for computational tasks and artificial intelligence (AI).

The role of network platforms

Communication is a cornerstone of all forms of digital business, with networking capabilities setting the boundaries for what can be achieved. Beyond serving as communication tools, today's networks can also provide:

- Tailored and engineered connectivity services, such as QoS guarantees
- Information services from traditional positioning information to potential network-based radio-sensing services [2], the ability to understand the communication status and predicted performance
- Value-adding auxiliary services such as computational device offloading [3] or AI as a service [4], services for distributing large amounts of data, or supporting digital twins.

These services have already been adopted in multiple ways, including CPaaS (communication platform as a service), which is used by large application developer communities to integrate different communication services to applications. These platforms offer APIs and integrated development environments that simplify the integration of communications capabilities (voice, messaging and video, for example) into applications and business processes.

Network platforms can exist at many levels. An operator's network is a network platform that offers communication and other services. In many cases, there is also a need for global coordination, however, to provide ASPs with a single interface to a network service regardless of where the users of that application are located. This is particularly important for services that are independent of communications. Capabilities exposed from multiple network platforms can be aggregated into monetizable, globally available services for developers and enterprises. A platform like this acts as a network aggregator, as shown in Figure 1.

Network platforms are also related to other platforms in the mobile and information communications technology ecosystem, such as operating system platforms that expose underlying capabilities in phones; application platforms that focus on the distributing, governing and monetizing application distribution; and cloud compute and content delivery network platforms that enable flexible compute and content services.

Monetization and business support
Current expectations looking toward 2030 suggest a disconnect between the overall strong growth of the digital economy and the revenues of connectivity-centric telecom services. Creating a bridge between the connectivity and application business ecosystems will therefore be a key objective for 6G. Scaling 6G-empowered applications through distribution channels that have global reach (such as application platforms) would create synergy effects both for telecommunications and the application economy – covering application and application platforms, third-party ads and so on – spurring further growth in both sectors.

Creating a bridge between the connectivity and application business ecosystems is a key objective for 6G.

New services provided by the 6G platform must be designed to allow CSPs to increase and diversify their customer base. The new customers are expected to primarily consist of ASPs, verticals, application platform providers and other enterprises, and will enable CSPs to build API-based revenue streams. This will allow CSPs to create and capture new value connected to the digital, internet and application ecosystems as well as supporting a fast-paced digitalization through network buildout and densification.

In addition, for services beyond connectivity, CSPs can fully differentiate their offering based on the value delivered and type of consumer. This will lead to opportunities to increase revenues and profitability, which in turn can support a positive spiral of investments in CSP service and infrastructure evolution.

Digitalization is not only a crucial factor for future economic growth, but also a key enabler for a more sustainable society. According to the climate exponential roadmap, digital services have the potential to enable a reduction in global emissions by 30-50 percent in the next decade [5]. A delay in network investment could endanger the transition toward a digital and more sustainable economy.

APIs are the means for the 6G platform to expose its capabilities to application developers, which is already established in 5G. By employing APIs, telecom infrastructure functionality can be integrated at application level, allowing for value-based charging models instead of the connectivity subscription model that is prevalent today. APIs for QoS, positioning, network compute offload and so on can add high value to the experienced quality of the applications, and it should therefore be possible to monetize them based on their value. This could be done by API access involving quality of experience (QoE) guarantees paid by the ASP, which in turn is monetized by application sales/subscriptions, third-party enterprise ads or by in-application purchases, for example. In addition, application distribution in mobile ecosystems today is dominated by application platforms tied to specific operating systems, notably Apple's App Store and Google Play. There are indications that application developers would prefer to access network APIs through existing channels and integrate network API costs into application or in-application sales. Application platforms are already equipped to handle purchases that are consumed gradually, as well as subscriptions.

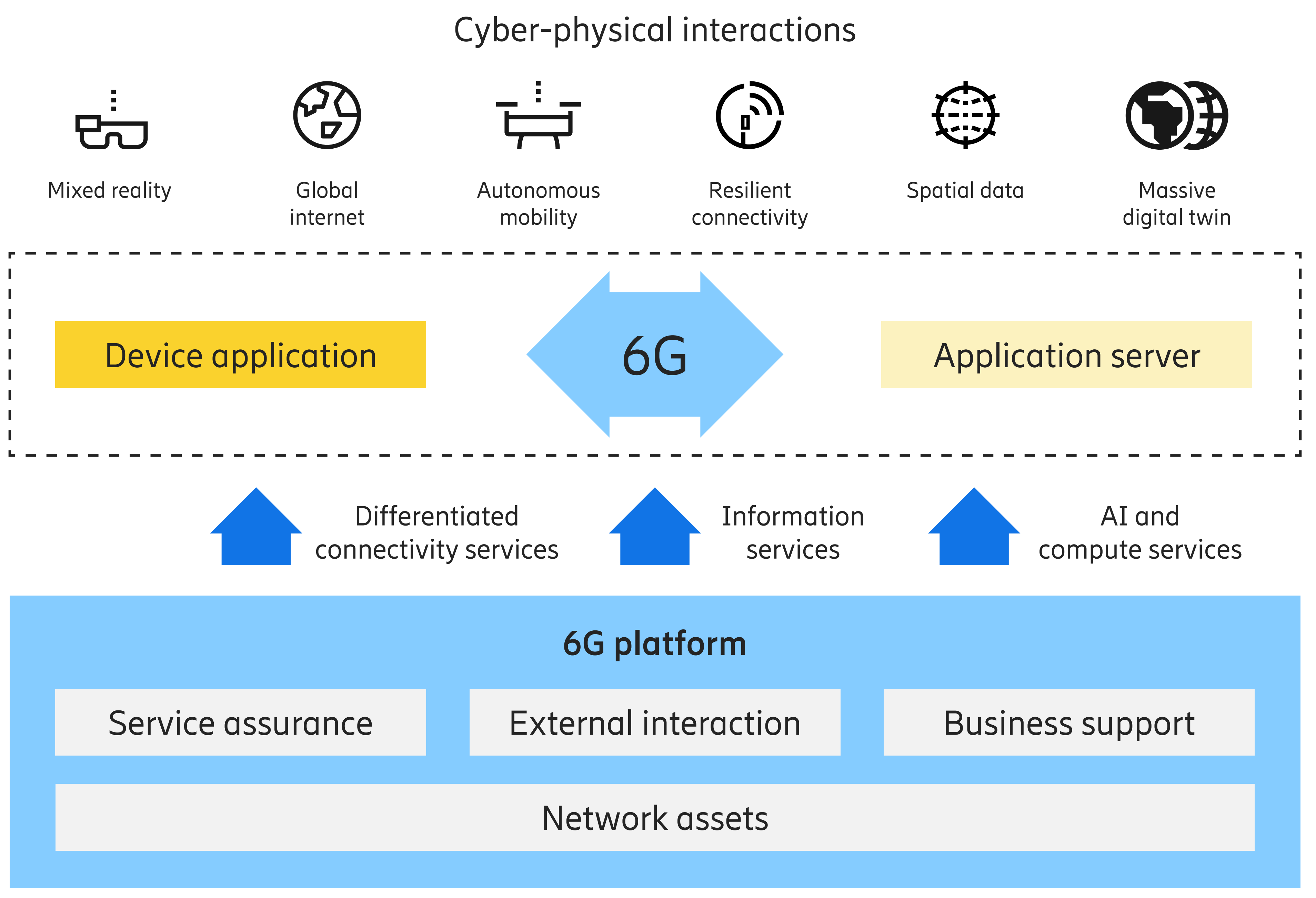

Figure 2: Advanced use cases expected to be supported by services from the 6G platform

CSPs are in a good position to offer these new services in their current local markets, but reaching a global market has historically proved challenging. Utilizing a network aggregator platform, however, CSPs can bootstrap into a global developer base.

Platform exposure through application programming interfaces
In the 6G time frame, the application developers, on both the server and client side, will have many more – and more diverse – APIs available to choose from than they have today that expose both network and connectivity capabilities, as well as new services beyond connectivity. The 5G exposure solution must evolve to better support the 6G platform requirements, handle many more APIs, and provide new, customized APIs more easily and rapidly.

A key challenge for future network platforms is finding the right level, format and mechanism of exposing different platform services to involved ecosystem partners, including private or enterprise developers, other platform providers and aggregators (network aggregators and application or cloud platforms), as well as device vendors. To other platforms and aggregators, network exposure through APIs evolving from current Service Capability Exposure Function/Network Exposure Function (SCEF/NEF) approaches will be suitable (as is already ongoing in the GSMA's (GSM Association's) telco global API alliance CAMARA or in the 3GPP's (3rd Generation Partnership Project's) SA6). To reach application developers, however, it will be crucial to offer bundles of relevant APIs abstracted in libraries made accessible to developers as part of application-specific software development kits (SDKs) such as OpenXR, the device SDKs for Android and iOS, and so on.

The service innovation, creation and life-cycle management of APIs will be made simpler and faster with new supportive tools. Tools to assist API implementation, generation of documentation and SDKs, and customized example code used by the application developers. Other tools will support the service innovation process with technical, legal and business analyses. Technical analysis can support feature requirements, performance and reliability, for example. This may be used to upgrade and dimension the platform and to define Service Level Agreements (SLAs). The legal analysis can answer questions about conformance to the applicable legislation. The business analysis can estimate invocation cost and propose service level objectives, for example. Tools are also needed for customer onboarding and management of consumers and applications. One expected evolution is that service composition will be more flexible and simpler to use to create new services.

The platform will expose many standardized APIs, such as CAMARA APIs, to simplify aggregation of multiple 6G platform providers. Today, REST is the dominant API stack (used by CAMARA APIs, for example) but we assume a more diverse situation with other stacks that have other characteristics, such as data query and manipulation language GraphQL and the cross-platform remote procedure call framework gRPC. Something more flexible and efficient for the exposure of data and data streams has yet to emerge.

Service setup and assurance

For services offered with performance and reliability commitments, there is also a need for mechanisms to assure fulfillment, both for the initial service setup and during the lifespan of the service. The CSP must be able to validate that the required resources are available, both for the new service and those already deployed. In case this cannot be done with sufficiently high confidence, service requirements must be adjusted to levels that can be fulfilled in the network. The process would vary depending on the customer. A large enterprise user could engage directly with the CSP to customize offerings and SLAs.

For common service types, an SLA portal may provide template SLAs that could be adjusted to specific enterprise needs. An ASP would define the requirements through the service API. On the other end, a private user who wants premium-performance gaming for an hour could use in-application purchases to request the add-on service realized by the application through the network API. Either way, the SLA would capture relevant requirements, such as a minimum throughput and a maximum latency, or a consumer QoE. For add-on services, it can also include positioning accuracy, sensing resolution, or processing capacity for compute offload.

Tools such as slicing, time-critical communication and QoS frameworks [6] will be used to configure the needed traffic flows in the network. On the device side, user equipment (UE) route selection policy (URSP) can be used to identify the desired application and map its traffic to the configured traffic flows. In addition, resources for beyond-communication services will be allocated. Once setup is complete, the dynamic network environment needs to be managed. Performance will be impacted both by the overall traffic situation with congestion points occurring at different places at different times. An individual user may be in a bad radio location, or a cell may need to serve more users than originally anticipated. To manage this, the 6G platform automatically instantiates assurance processes at different levels to adjust network resources to achieve the desired performance.

The introduction of intents provides a structured way of capturing both service and network requirements, and their relative importance.

The ability to observe relevant key performance indicators is instrumental. Metrics are gathered that directly or indirectly reflect the performance objectives. For instance, latency and throughput could be used to estimate the QoE. It could also be the case that an offloaded rendering process is hitting the capacity limit in the compute infrastructure. If we identify that QoE is degrading due to network congestion in the radio access network, the assurance process in the radio base station could adjust resource allocation or scheduling parameters to improve the needed performance metric. In doing so, we need to balance against requirements from other services and objectives on network operation at large, such as energy consumption.

The introduction of intents [7] provides a structured way of capturing both service and network requirements, and their relative importance. This makes it possible to effectively prioritize and ensure performance is optimized even in situations of congestion or failures. In most cases, intents would not be directly exposed to consumers. Instead, they would use an API or service portal, where the needed information would be captured and translated into intents that can be complemented with operator-specific objectives reflecting the commercial offering, the network deployment and operational priorities.

Example use case: exposed 6G platform services for mixed reality

To illustrate how the different 6G platform components will work together, we will use the example of an immersive MR application developed on an augmented reality (AR)/MR application platform. The MR application is experienced using a lightweight, mobile head-mounted display (HMD) supported by cameras and a variety of sensors. Through the HMD, digital representations of communication partners, virtually generated personas or digital objects are integrated into the user's view.

While such an immersive experience requires the complex interworking of many services, the user will judge the quality

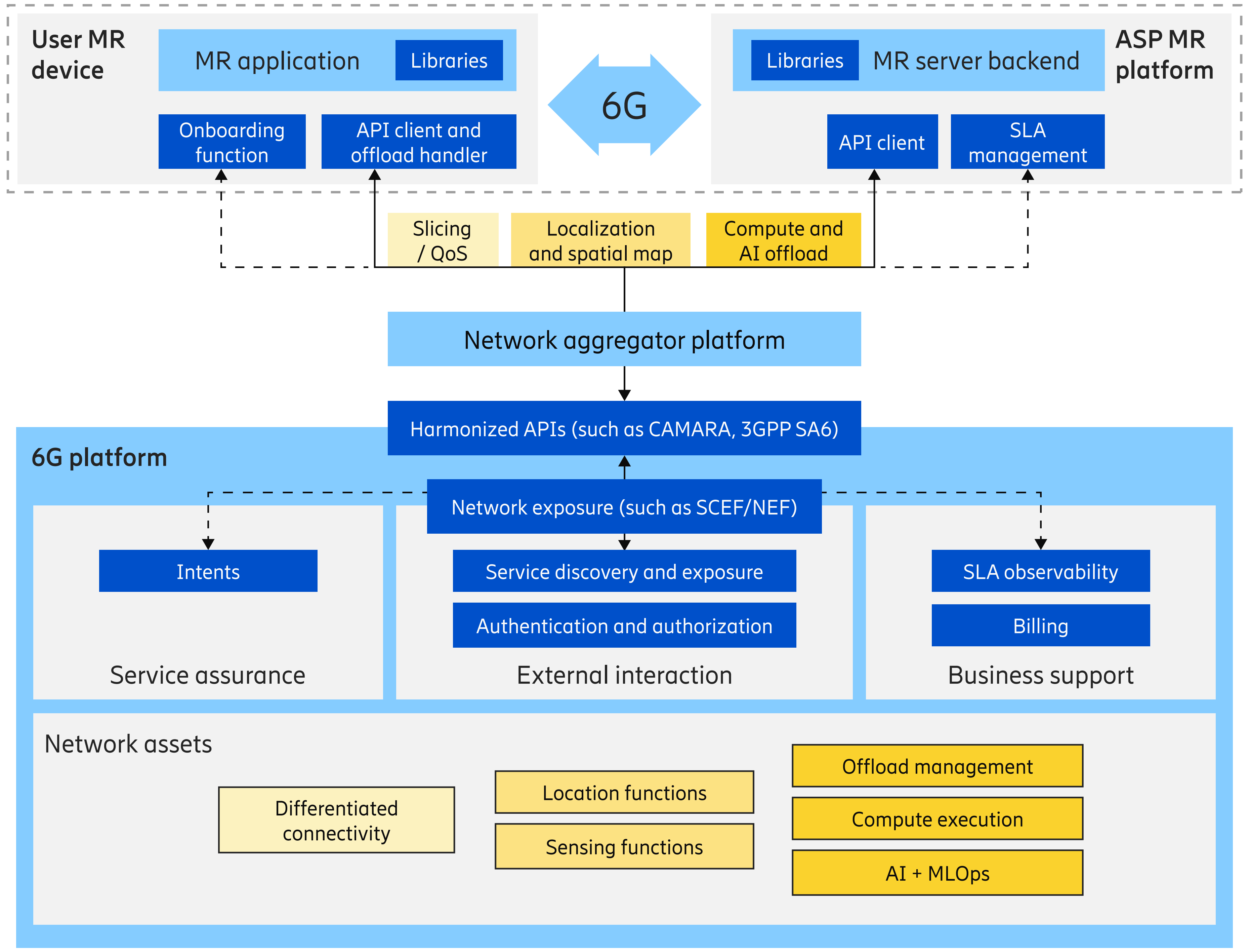

Figure 3: An MR application supported by services from the 6G platform

of the overall experience mostly by the steady, seamless integration and smooth interaction of the virtual objects with the real world and the fidelity of the graphics, as well as the convenience of wearing the HMD in a mobile scenario. Good QoE will reflect favorably on the ASP's offering. Both the ASP and the consumer have an incentive to use the best communication and other services to achieve the necessary QoE.

Figure 3 illustrates how an immersive MR application benefits from an appropriate bundle of 6G platform services to facilitate smooth application performance. The ASP initiates tailored connectivity with uplink/downlink capacity and latency that matches the requirements of the MR application [8]. To realize this in the networks, URSP is used to route the MR application traffic to a network slice that is dedicated for this purpose (as already demonstrated successfully in 5G [9]).

MR applications are heavily dependent on positioning and orientation information to accurately map digital content in relation to the real world. In our example, the MR application will be able to take advantage of the information services offered by the 6G platform, specifically (active) positioning and (passive) environmental sensing by the network. This information will enrich existing sensor data (for instance from gyroscopes, video, GNSS (Global Navigation Satellite System) and may be consumed in different grades of processing (raw data, a basic digital map around the user's location or a spatial mapping of objects within the digital map, for example) depending on the preferences of the AR/MR application. For instance, rough positioning by GNSS and a network positioning result could be complemented with a spatial map of the local environment, allowing the application to do quick and exact localization based on visual means.

The MR application can further benefit from a network-integrated compute service that offers the possibility to seamlessly offload and place processing-intensive tasks within the compute continuum stretching from the device via edge compute to the cloud. In the case of a typical MR application, this applies to tasks such as map optimization or object detection [10]. Based on the compute/heat/battery conditions of the HMD, radio conditions and the available remote compute capacities, an offloading service would determine when and where it is beneficial to dynamically offload some of these tasks for the benefit of optimized application and device experience. The optimization criteria would be based on policies set by the user, the ASP, the CSP and potentially even the device vendor. By adding a small offload handler to the device (either as an application, operating-system function or part of the network stack) and reusing network authentication and authorization mechanisms, the resulting dynamic computational offload service would be consumed alongside the connectivity-centric APIs of the network platform to ensure a richer experience for users.

Finally, the MR application uses the exposed service APIs to request the currently desired service characteristics and to learn what the available service is from the network in the current situation. The network then captures the agreed service in the form of intents, initiates the service, runs the needed assurance process, and so on. In short, the network platform strives to ensure a seamless application and device experience, and the application has the necessary information and support to tune its behavior for the best user experience.

Conclusion

The 6G platform will expand the scope of networks beyond communication services to support the services needed by applications, which are at the center of the digital transformation. Application service providers will have easy access to network capabilities and a wide range of service application programming interfaces. Consumers will benefit from enhanced quality of experience, while communication service providers gain the opportunity to expand their role in the ecosystem beyond bit-pipes, with new possibilities for monetization higher up in the value chain.

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Further reading

- Ericsson, Follow the journey to 6G ↗
- Ericsson white paper, Co-creating the cyber-physical world ↗
- Ericsson, Introduction to 6G ↗

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