Hype Cycle for CSP Networks Infrastructure, 2023

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Initiatives: CSP Digital Transformation and Innovation

CSP networks infrastructure requires constant change, planning and investment due to new cellular generations, open/disaggregated architecture and business process changes. CSP CIOs can use this research to identify the most essential technologies for network modernization and transformation.

More on This Topic

This is part of an in-depth collection of research. See the collection:

- 2023 Hype Cycles: Deglobalization, AI at the Cusp and Operational Sustainability

Analysis

What You Need to Know

Communications service provider (CSP) networks infrastructure must align with new business models and end-user product changes. Not doing so undermines investments' outcomes and values. The disruptive challenges from initiatives like network disaggregation and cloud-native technology utilization, as well as the inconsistent outcomes of early digital transformation projects, show this.

Traditional connectivity services (e.g., voice, messaging, etc.) that CSPs used to govern the market and enjoy high barriers to entry of others have been disrupted by digital giants and dragons, including public cloud providers and newer startups. Furthermore, some of the network infrastructure that underlies connectivity will no longer be a core competence or differentiator for many CSPs. CSP CIOs must decide whether to use the same business model as before — focus more on providing new services by changing business models or move into other industries.

This Hype Cycle highlights the most essential technologies and capabilities for CSPs' network modernization. CSP networks infrastructure and its transformation encompass scores of technologies and capabilities, many of which are continually evolving, such as cellular networks, open multivendor networks, sustainable network initiatives, data intelligence and monetization, technology sourcing and integration. These changes call for continued investments in key capabilities that are essential for success.

The Hype Cycle

CSPs (particularly those that are network-based) are undergoing significant changes. There are disruptive forces from new types of CSPs (such as DISH Network, Reliance Jio and Rakuten Mobile), IT and systems integrator companies, as well as players from other industries. New cloud-native CSPs are ambitious with their market, technology services scope and operating model. In such a scenario, incumbent CSPs in particular need a well-structured approach to continue modernizing their networks. Delaying or resisting changes over networks infrastructure transformation including hardware, software, related services, and operations and business models will limit competitiveness and differentiating value creation.

CSP CIOs should use this Hype Cycle to:

- Identify the required technologies and capabilities to enable their network vision and support the broader business strategy.

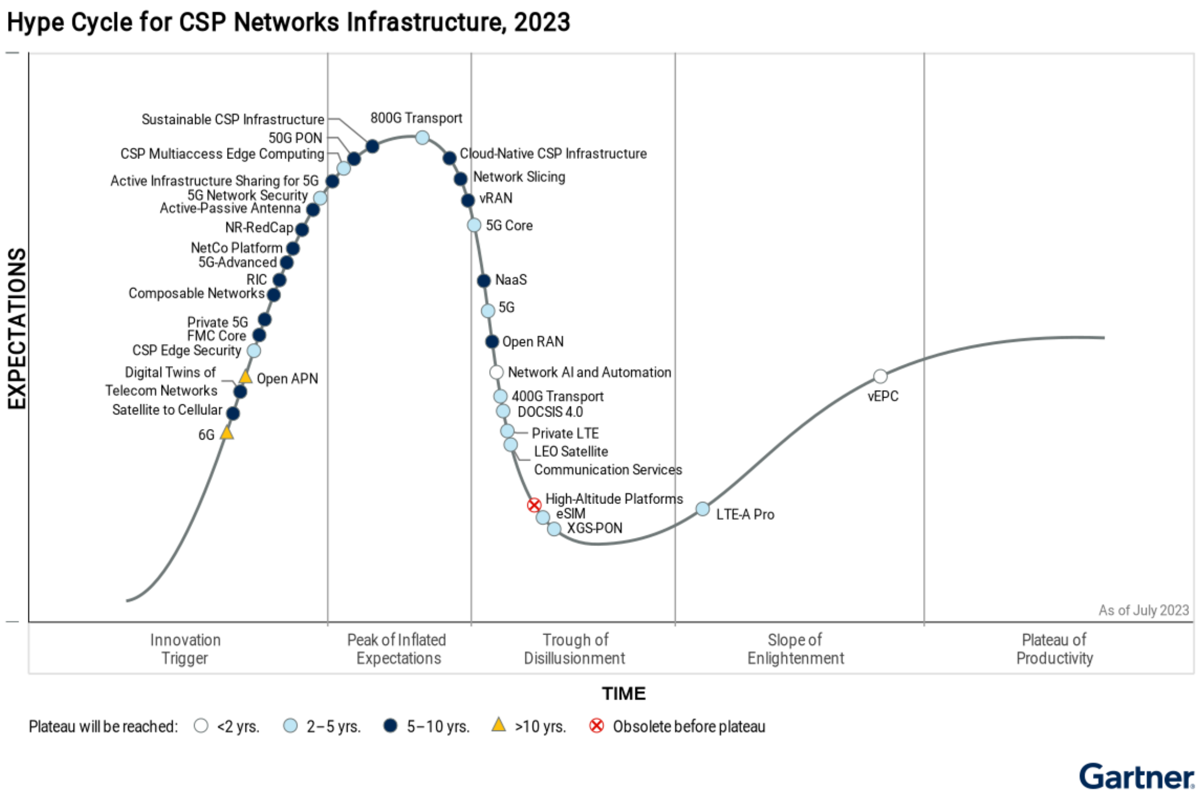
- Develop consensus with business leaders, product and infrastructure teams on which technologies, features and capabilities to introduce and when.
- Validate if they are investing in all the key capabilities.
- Plan investments in necessary technologies- and process-related capabilities, including workforce skills development.

Several innovations have been added to this Hype Cycle. This is achieved by utilizing a framework that focuses on network architecture revolution (e.g., cellular, open and disaggregated network), value creation (e.g., sustainability and new business revenue) and underlying networks (e.g., wireless, core, fixed, edge and cloud):

- CSP edge security
- DOCSIS 4.0
- NetCo platform
- Satellite to cellular

CSPs looking for guidance about operation capabilities should consult Hype Cycle for Communications Service Provider Operations, 2023.

Figure 1: Hype Cycle for CSP Networks Infrastructure, 2023



The Priority Matrix

The Priority Matrix indicates the need for strategic, long-term and sustained investments for capability improvement. Among scores of technologies and capabilities, we have focused on a set that is critically important and has potential for significant impact. Most capabilities will take more than two years for mainstream adoption, and in some cases, five years or more, except vEPC, network AI and automation. It is important for CSPs to carefully select technologies and capabilities in line with their business strategy and invest early with the aim to affect operational and network architecture changes.

For many of the innovations in the Priority Matrix, the predominant focus on technology and process capabilities will not suffice to deliver CSPs' intended outcomes. CSPs require an active strategic orientation toward culture, mindset and structural changes. For example, capabilities such as CSP multiaccess edge computing, sustainable CSP infrastructure, 5G network security and open RAN will have significant impact over the next three to five years, as they affect multiple dimensions of the organization.

One point to note is the need for dedicated and executive sponsorship for transformational capabilities such as 6G, RIC, NetCo platform, network slicing and cloud-native CSP infrastructure. Deploying/evolving these capabilities may require sourcing of specific skills from outside the organization.

Table 1: Priority Matrix for CSP Networks Infrastructure, 2023

(Enlarged table in Appendix)

Benefit	*Years to Mainstream Adoption*			
↓	*Less Than 2 Years* ↓	*2 - 5 Years* ↓	*5 - 10 Years* ↓	*More Than 10 Years* ↓
Transformational		eSIM	Cloud-Native CSP Infrastructure Composable Networks NetCo Platform Network Slicing RIC	
High	Network AI and Automation vEPC	5G CSP Edge Security CSP Multiaccess Edge Computing DOCSIS 4.0 LTE-A Pro Private LTE XGS-PON	5G-Advanced Active Infrastructure Sharing for 5G NR-RedCap Private 5G Sustainable CSP Infrastructure	6G Open APN
Moderate		400G Transport 5G Core 5G Network Security 800G Transport LEO Satellite Communication Services	50G PON Active-Passive Antenna Digital Twins of Telecom Networks FMC Core Open RAN Satellite to Cellular vRAN	
Low			NaaS	

Source: Gartner (July 2023)

Off the Hype Cycle

The following innovations were removed or replaced with one that aligns better with CSP networks infrastructure:

- Public cloud for mobile edge and CSP edge cloud platform have been removed as they are combined with other superordinate innovations: CSP edge security and CSP multiaccess edge computing.
- LPWA has been removed as LPWA was commercially deployed gradually as IoT. IoT was put to practical use and LPWA became more mature.

On the Rise

6G

Analysis By: Kosei Takiishi

Benefit Rating: High

Market Penetration: Less than 1% of target audience

Maturity: Embryonic

Definition:

6G is the generic name for the next-generation cellular wireless, also called Beyond 5G. In 2023, the features and timetable for 6G are not clearly defined, although it's expected to be commercialized in 2028 by some communications service provider (CSP) pioneers. 6G will enhance 5G capabilities and is intended to provide higher peak data rate (e.g., 100 Gbps to 1 Tbps), lower latency (e.g., 0.1 ms) and much more connection density and energy efficiency (e.g., 10 times more efficient).

Why This Is Important

The U.N.'s 2030 Agenda for Sustainable Development, including 17 goals, is heavily impacted by the mobile industry. Many of these social issues and ambitious goals will result in technologies that will become a part of 5G or future 6G cellular deployments. Design and research for 6G is already underway by many industrial associations and academic and commercial organizations. 5G can solve some of these challenges; however, 6G is indispensable for continuous growth and problem solving in the 2030s.

Business Impact

6G will enable end users, including consumers and enterprises, to transfer and process large volumes of data in real time, which enables true immersive experiences as well as more mission-critical human machine communications. Much richer and advanced connectivity of the physical world with the digital world — digital-physical fusion — is expected. There is no clear 6G definition, but 6G is aiming to improve 5G capabilities by adding one generation every 10 years (same as before).

Drivers

- Different from 4G and current 5G, 6G will become a sort of national network supported or impacted by countries and national policies. Some leading countries have started their initiatives, which will drive further research and discussions. In February 2023, the South Korean Minister for Science and ICT unveiled the K-Network 2030 plan, calling for South Korean tech firms to lead the way in developing world-class 6G technologies and software-based networks. The Chinese government has nominated 6G as one of its priority projects for 2023. In March 2023, the Beyond 5G Promotion Consortium in Japan published its B5G White Paper 2.0.

- Academics and commercial organizations want to be part of the 6G process, and active research has already begun. Working group one6G in Europe hosted a summit and held related open webinars in 2022. In February 2023, NTT DOCOMO hosted Open House'23, where 6G was one of the main topics. In November 2022, NTT DOCOMO published the 6G White Paper 5.0.

- Many commercial organizations and academic institutions have started their 6G research to be a part of the future 6G patent pool.

Obstacles

- The 5G journey is still in its early years, and its best practices and monetization are not clear. Success or failure of 5G to drive revenue and new business opportunities will have a major impact on 6G commercialization and business.

- The telecommunications industry has formulated its own specifications and standardization (such as 2G, 3G, 4G and 5G). It is unclear whether 6G will be able to incorporate external opinions, extending the start provided by some other industries' participation in developing 5G standards.

- Some 6G technologies, such as THz wireless, may not prove to be technically viable or cost-effective for most cellular users' needs.

User Recommendations

- Monitor discussion of the currently emerging 6G carefully.

- Prepare early trials and proofs of concept (POCs) in the late 2020s with vendors to learn more about the capabilities of 6G and early use cases, and begin building skill sets.

- Support your regulators and government to create their new national policy for 5G-Advanced and 6G. Technology innovation and strategy leaders should look at evolving 6G standards to get an early idea of future networking technologies.

Sample Vendors

Ericsson; Huawei; Nokia; NTT DOCOMO; Qualcomm; Samsung Electronics; SK Telecom

Gartner Recommended Reading

Emerging Tech Impact Radar: Communications

Digital Twins of Telecom Networks

Analysis By: Pulkit Pandey, Peter Liu

Benefit Rating: Moderate

Market Penetration: 5% to 20% of target audience

Maturity: Emerging

Definition:

A digital twin of a telecom network is a virtual representation of the telecom network, which encapsulates logical models with true data structure to emulate real behavior. These real-time representations are used to improve network performance, asset maintenance, planning, base station information modeling and other use cases. A digital twin of a telecom network can be of a physical network component, single base station or the end-to-end network.

Why This Is Important

Digital twins of telecom networks can be leveraged to assess a situation and predict outcome-based scenarios for planning, monitoring and optimizing the network. They can also assess and identify scope of improvement in network operations through simulations. Finally, they can model processes to improve network performance in terms of better customer service/experience or reduced operating costs.

Business Impact

Digital twins of telecom networks:

- Enable CSP CIOs to enrich decisions — for example, to plan network capacity and deployment scenarios in a better way, or to lower maintenance and operational costs while improving network performance as well as customer experience.
- Test the prototypes of network elements to reduce product defects, thus shortening the time to market.
- Optimize processes such as monitoring, managing and maintaining the supply chain.

Drivers

Adopting digital twins of telecom networks can support a broad variety of business outcomes:

- Reduce infrastructure maintenance costs through asset management and real-time remote monitoring.
- Optimize resource allocation and planning through prediction and simulation based on real-time information.
- Optimize equipment and processes by aligning asset digital twins into a range of solutions, such as predictive analytics and field service management.
- Increase and speed up experimentation of new business and operating models for different industry verticals.
- Provide effective data-driven decision making and testing of various scenarios in a virtual environment with less risk and cost.

Obstacles

- There are underlying challenges with understanding business objectives and applicability for how digital twins can really enhance overall network performance and improve the bottom line.
- Few vendors have a viable go-to-market strategy to build a digital twin business, creating market confusion and excess hype.
- While consortium and standards bodies are emerging, they are all generally immature, with many vendors pushing proprietary formats. There is a lack of standards for a broad range of digital twin integration, evolution and other technical issues.

User Recommendations

- Strengthen the data collection capabilities of critical processes as a way to set the foundation for the introduction of digital twin models by adopting a data-driven network architecture.
- Engage with business unit peers to ensure the business case has clear metrics that the IT organization can support.
- Identify IT gaps and build a roadmap to drive IT organization learning opportunities, its investment plan for internal skills and partner selection strategy.
- Consider digital twin capabilities when selecting vendors for network rollouts.
- Take a holistic view of digital twin network planning and implementation. Go beyond digital twins for individual physical objects, and loop in processes and process-related personnel.

Sample Vendors

Ericsson; Huawei; Nokia; NTT

Satellite to Cellular

Analysis By: Kosei Takiishi

Benefit Rating: Moderate

Market Penetration: Less than 1% of target audience

Maturity: Embryonic

Definition:

Satellite to cellular is a new emerging technology that increases connectivity coverage by integrating cellular and satellite networks. As satellite networks coverage, such as geostationary (GEO) and low Earth orbit (LEO), become more widely available, communications service providers (CSPs) have been integrating satellite communication capabilities into cellular devices to extend service range beyond cellular network coverage.

Why This Is Important

Latest flagship smartphones, such as Apple's iPhone 14 series and Huawei's Mate 50, equip satellite communication capability to send SOS messages. With the arrival of 5G-Advanced and 6G, the integration of cellular networks and satellite networks will be further enhanced by CSPs. It is useful in emergencies such as large-scale disasters and network accidents, and in areas that are sparsely populated or where cellular networks on the ground do not reach (e.g., communication on ships).

Business Impact

Advanced CSPs have been planning satellite to cellular solutions, including T-Mobile's partnership with SpaceX, and the joint project between AST SpaceMobile and Rakuten Mobile. These aim at not only supporting SMS communication, but also voice and data communication in the future. It is difficult for existing 4G/5G networks to cover the entire surface of the earth, and both consumers and enterprise users have expectations for universally available communication services.

Drivers

- Cellular communication over LEO and other high-altitude platform stations (HAPs) is becoming a reality, and the vendor ecosystem is beginning to mature.
- Latest flagship commercial devices (e.g., Apple iPhone 14 series and Huawei Mate 50) have been equipping basic satellite communication capability, and this could spread further.
- 3rd Generation Partnership Project (3GPP) has been doing feasibility studies about satellite and cellular integration for 5G and future 6G. This standardization activity can contribute to enhance further integration, including satellite to cellular.

Obstacles

- Radio spectrum coordination, and harmonization between satellite and cellular community.
- Reuse of cellular radio bandwidths in satellite, which AST SpaceMobile is attempting.
- The risk that satellite communication and cellular communication will interfere greatly, and that coordination would not proceed.
- The coordination between existing systems (e.g., broadcast, fixed satellite), and LEO's service-link and feeder-link that newly acquire shared radio bandwidths.

User Recommendations

- Select partner candidates by investigating what kind of players in your territory have plans to offer, and commercialize LEO and the progress of frequency acquisition plans.
- Formulate a strategy for how to coordinate and integrate cellular network and satellite network, in anticipation of 5G-Advanced and 6G.

Sample Vendors

AST SpaceMobile; OneWeb; Qualcomm Technologies; SpaceX

Gartner Recommended Reading

CSPs: Define the Role of LEO Satellites in Your Future Networks

Open APN

Analysis By: Kosei Takiishi, Peter Kjeldsen

Benefit Rating: High

Market Penetration: Less than 1% of target audience

Maturity: Embryonic

Definition:

Open all photonics network (APN) is one of the fundamental technologies defined by Innovative Optical and Wireless Network (IOWN) Global Forum. Open APN is an optical wide-area network that dynamically creates connections between endpoints achieving guaranteed bandwidth, deterministic latency, and high energy efficiency. Use cases include data center interconnection, mobile fronthaul, and high-definition video transport. Although it aims to mature by 2030, early adoption has already started.

Why This Is Important

While the evolution of mobile networks and cloud computing will create opportunities to develop high-bandwidth and low-latency cyber-physical applications, infrastructures should significantly reduce their carbon emissions to address the global sustainability issue. Current IP-based networks lead to increased latency and energy consumption because of the probabilistic packet loss and unpredictable latency. Open APN will address this problem by dynamically creating optical paths between endpoints.

Business Impact

Open APN will contribute to developing new service applications, leveraging the latest AI platform on the cloud and the cyber-physical connectivity by the latest mobile networks while maintaining their confidential data in the sovereign clouds or on their premises. While “cloud first” practice is forcing customers to centralize their assets to a few mega clouds, open APN will enable customers to build their own hybrid/multicloud infrastructure as virtual private availability zones.

Drivers

- Growing pressures against organizations’ carbon emissions.
- Evolution of AI or data analysis applications leading to the demands for high-volume and high-velocity data flows.
- Emergence of commercial-level products. The IOWN Global Forum released starter packs including open APN, in January 2022. NTT launched commercial APN IOWN 1.0 service in Japan in March 2023, which reduces end-to-end delay by 1/200. Its monthly tariff plan is 1.98 Million Japanese yen. Enterprises using this service with commercial contracts are 12 companies and organizations including Oracle, Amazon Web Services Japan (AWS Japan), NVIDIA, Google Cloud Japan, Shibuya Ward and Yoshimoto Kogyo.

Obstacles

- Low industry awareness, not a mature ecosystem and still limited participating members. There are still many wait-and-see companies.
- Unclear position of the IOWN Global Forum in the industry, especially about the division of roles and cooperation with standardization bodies (e.g., ITU-T, 3GPP, IEEE).
- It is questionable how many players other than the NTT Group will sympathize with the IOWN and open APN vision and commercialize components and related solutions. There are cases of Japanese-developed solutions/technologies including i-mode, ISDN and NGN, which were led by the NTT Group but were not spread overseas.
- Open APN is a kind of virtualization of fiber optics, which may be of interest to data center providers, but currently, only a few hyperscalers participate in the IOWN alliance.

User Recommendations

- Develop your long-term network infrastructure strategy by referring to IOWN and open APN initiatives.
- Estimate the timing to adopt open APN by researching your network infrastructure's data consumption and power consumption.

Sample Vendors

Fujitsu; Intel; NEC; NTT; Sony Group

Gartner Recommended Reading

Emerging Tech Impact Radar: Communications

CSP Edge Security

Analysis By: Sylvain Fabre

Benefit Rating: High

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Definition:

CSPs deploy edge to facilitate applications and content closer to users and devices to improve performance and latency. The topology includes edge cloud federation and edge devices in IoT deployments, adding complexity, multiple vendors, suppliers and stakeholders in hardware and software infrastructure. CSP edge, using multiaccess edge computing (MEC), raises security, trust, and privacy issues that require an end-to-end approach with relevant existing standards.

Why This Is Important

MEC brings cloud to the edge of CSP networks, supporting functions including RAN, core network, network slicing and third-party applications running on a mix of container and virtual machine-based deployments, increasing zero-day attack risk. The physical location of MEC components, such as remote cell sites, increases vulnerability to physical attacks. Open collaboration in MEC ecosystems allows developers to create and deploy applications, but increases risk as attackers can exploit vulnerabilities.

Business Impact

MEC security supports 5G chargeable features, such as guaranteed low latency and monetization of ISG MEC defined APIs (both IaaS management APIs and PaaS service exposure APIs) and ETSI MEC standardized service APIs requested by telco players (e.g., radio access network [RAN] info, location APIs) or for vertical market (e.g., V2X API). New third-party APIs compliant with MEC API design guidelines can be added and exposed, enabling new applications. Different stakeholders own, manage and secure portions of the software stack.

Drivers

- MEC has an essential role in the 5G infrastructure since edge computing can be an enabler for solutions, identify gaps, and produce recommendations for various 5G usage scenarios (i.e., eMBB, URLLC, mMTC).
- ETSI published GR MEC 031 regarding MEC integration into 3GPP 5G system.
- 3GPP TS 23.558 provides application layer architecture and related procedures for enabling edge applications over 3GPP networks (see specification TS23.558), from the security point of view, the new functional elements introduced by the synergized architecture together with the introduction of third-party applications at the edge of the RAN may considerably extend the surface attack.
- MEC security requirements definition based on use cases defined in ETSI GS MEC 002 ENISA '5G threat landscape' Report.
- Based on the type of virtualization and containerization used, the MEC system can be susceptible to a number of threats emerging from these technologies, such as possible contamination of shared hardware resources, abuse of privilege, elevation of containers with higher levels of privileges, use of open-source APIs, and so on. Vulnerabilities in the MEC virtualization platform can include compromise of the underlying system (firewall, boot loader, host OS/hypervisor), inadequate isolation of resources in OS/container layers and vulnerabilities specific to cloud technologies used in MEC implementation.
- 5G network slicing applied to MEC needs to be secure to protect user data and privacy. This can be a challenge, as the number of network slices and MEC nodes increases, and the attack surface becomes larger.

Obstacles

- CSPs often do not have the internal staff to properly design, implement and operate a secure edge network.
- Edge computing and MEC involve the use of mobile devices, which can be vulnerable to malware, viruses and other security threats.
- Edge computing and MEC require the storage and processing of data on mobile devices and in the cloud. It is important for mobile operators to ensure that customer data is protected from unauthorized access.
- Mobile operators must comply with various regulations, such as GDPR, regarding data privacy and security when using edge computing and MEC.

User Recommendations

- Secure RAN and core network functions
- Secure MEC gateways that interface with devices such as base stations, IoT devices and RAN equipment
- Safeguard IoT specific network protocols like NB-IoT and LoRaWAN
- Protect RAN edge against DOS/DDoS attacks
- Provide high availability and resilient systems with secure routing protocols and traffic prioritization
- Harden physical security of MEC nodes
- Implement security controls for third-party applications
- Implement a security governance framework
- Address inadequate isolation by delivering network microsegmentation, resource separation, data segregation, software and network attestation, etc.
- Harden MEC components to address risk of unrestricted reachability for services, unused software/functions/components, improper separation of traffic, etc.
- Ensure hardening of default configurations are appropriately set, including OS software, firmware and applications, with a referenceable configuration for later verification
- Implement countermeasures such as packet filtering for the target site under attack, restriction of communication port used for DoS/DDoS attacks, and reduction or suspension of operation of targeted telecommunications facilities
- Secure vulnerabilities in MEC applications that can be used as an entry point to exploit other MEC components and internal interfaces to gain unauthorized access to data, elevation of privileges and cloud intrusion
- Implement regular security testing, including red team and perpetual purple team

Sample Vendors

Akamai Technologies; Check Point Software Technologies; Cisco; Imperva; Ivanti; Palo Alto Networks; PerimeterX; SentinelOne; Trend Micro; VMware; Xage Security

Gartner Recommended Reading

CSP Tech Supplier Insight: Securing the CSP Edge

Emerging Tech Impact Radar: Communications

FMC Core

Analysis By: Kosei Takiishi

Benefit Rating: Moderate

Market Penetration: Less than 1% of target audience

Maturity: Embryonic

Definition:

Fixed-mobile convergence (FMC) core refers to core network functions that are common across wired access (for example, fiber to the home [FTTH]) and wireless access (for example, 5G) and tend to be integrated for unified support and management. This concept spans the wireless and fixed access networks, which have been standardized and deployed completely separately, and will be accelerated by virtualizing the communication service provider (CSP) network and deploying the FMC core as software.

Why This Is Important

CSP networks consist of many subnetworks, such as the voice and telephony networks, the wired and wireless access networks, and the Internet network. Since each of these networks is composed of different communications equipment, even the control of voice call sessions of services that are available for both fixed and mobile communications is performed differently. The convergence of communication services is very important, and FMC core can help achieve it by simplifying infrastructure and eliminating duplication.

Business Impact

- FMC solutions can provide fixed and mobile communications users with unified voice, data and video services to improve the quality of experience.
- Seamless connections between different equipment and network layers enable effective transportation of diverse applications between different network platforms.
- Further network cost reduction can be achieved by unifying different network components for fixed and wireless communication, including C-plane and U-plane management, subscriber data management, and billing functions.

Drivers

- The 3rd Generation Partnership Project (3GPP) specifications standardized access to the Evolved Packet Core (EPC) via non-3GPP access networks, including Wi-Fi, previously on the 4G Long Term Evolution (LTE). Implementing these converged capabilities requires evolved Packet Data Gateway (ePDG). While non-3GPP signals are transmitted through a different path as compared with LTE signals, 3GPP further advanced its standardization on 5G core. Non-3GPP access can be achieved on the same N2 (for C-plane) and N3 (for U-plane) interface as 5G New Radio (NR) and LTE data.
- Service-based architecture developed for 5G core's C-plane management can define each network function as a service using the same protocol: HTTP/2. As a result, even if a new network function is added, access to the existing network function can use the already defined procedure as it is.
- The Broadband Forum and 3GPP have jointly started to standardize 5G Wireless and Wireline Convergence (5G WWC) to accommodate both fixed and wireless access in a unified core network. 3GPP Release 18 has related feasibility studies and WWC Phase 2 technical specification updates.

Obstacles

- Existing legacy infrastructure of nonvirtualized and cloudified purpose-built equipment in particular could delay new deployment and integration of FMC core.
- Ongoing incomplete standardization activities between multiple stakeholders addressing distinct network domains and access technologies, such as 3GPP and the Broadband Forum, could present an obstacle to FMC core implementation.
- CSP organizations often run fixed and mobile networks as separate divisions. This could result in unexpectedly tough internal negotiations.

User Recommendations

CSP CTIOs:

- Develop a plan to integrate fixed and mobile infrastructure in the medium term to long term by managing the deployed network equipment life cycle.
- Determine which vendors are your primary partners by reviewing their roadmaps and milestones, and prioritize them.
- Prepare your organizational structure and processes to implement and manage FMC core, by bringing together wireline and wireless core functions, creating joint working processes.

Sample Vendors

Ericsson; Huawei; Nokia

Gartner Recommended Reading

Magic Quadrant for 5G Network Infrastructure for Communications Service Providers

Private 5G

Analysis By: Sylvain Fabre

Benefit Rating: High

Market Penetration: 1% to 5% of target audience

Maturity: Adolescent

Definition:

A private 5G network is based on 3rd Generation Partnership Project (3GPP) standard R15 or above to provide unified connectivity, optimized services and security for enterprises. A 5G private mobile network (PMN) is specific to the enterprise and used to interconnect people and things. Deployments can be entirely on-premises, with local breakout, or linked to a public cloud or local telco.

Why This Is Important

Multiple verticals will require 5G PMN deployments to realize the full effect of their digital transformation initiatives. Adopting new 5G standards earlier than communications service providers (CSPs) can offer on their public infrastructure can provide access to additional functionality. Distinct from the public network, private 5G supports voice, video, messaging, data and Internet of Things (IoT) with higher performance requirements. It can optimize cost or connectivity (for example, less expensive than Wi-Fi for large area coverage).

Business Impact

Private 5G enables transformational digital use cases for industry, especially in conjunction with other technologies, such as factory digital twin or edge AI for computer vision. 5G PMN can offer enterprises improved security, independence and enable efficiency gains; for example, complete 5G coverage in factories, with speeds over 1 Gbps, and support for edge and AI use cases with guaranteed performance levels.

Drivers

- Applicability and vertical specific integration are increasing. Beyond 3GPP, other bodies are now contributing, such as 5G Alliance for Connected Industries and Automation (5G-ACIA) or 5G Automotive Association (5GAA).
- Liberalization of the radio spectrum has opened up standard radio bands, often around 3.5 GHz, for use by private 5G networks.
- Requirement for full, reliable network coverage for machines, sensors and equipment, including indoor, outdoor, office and large industrial areas at lower cost than Wi-Fi.
- Performance profile for demanding industrial use cases, in particular when low-latency, high-bandwidth (especially uplink), and reliability are required and exceed the capabilities of the shared public infrastructure.
- Private 5G has another class of use cases, not focused on mobility initially, but requiring a high-performance backbone where wiring is complex and costly — such as in a factory deployment.
- Interest from telecommunications service providers (TSPs) that can offer 5G PMN to various verticals, such as I4.0 factory automation, mining, oil, utility and railroad companies. IoT providers, universities, stadiums and so on are thereby expanding into industries and generating new revenue.
- Alternative provider types beyond the CSPs, such as integrators, infrastructure vendors and hyperscalers, are driving new deployments and proofs of concept.
- Some enterprises deploy private networks because they want to run their network more independently, as their own infrastructure, with limited outside dependency. One example is long-term commitment from public network operators; also, data privacy can be a key concern, with data loss prevention security controls in place to ensure sensitive information does not leave the enterprise perimeter.
- Some defense and government clients have indicated a wish to have more control and visibility into the vendors involved in the mobile services provision, which can be an issue over a shared public network built and managed by a CSP.
- Low-latency applications using processing embedded in network infrastructure are logistically easier if the application, and infrastructure are owned by the same entity.

Obstacles

- Unclear business models and value justification vs. alternatives (e.g., 4G PMN).
- Perception that real value begins from 3GPP R16, and that maturity and availability of R16 solutions are still a work in progress; for example, with network slicing.
- Complex deployment and operation.
- Limited availability and cost of equipment designed to use the radio bands available for private network use.
- Module availability and pricing for R16 and up.
- Lack of outcome-based pricing models.
- Spectrum availability and/or cost in some countries.
- Perception of risk regarding timing and relevance of private 5G.
- Feedback from some industrial clients mentioned that the majority of their use cases could be serviced by a 4G private network, and/or NarrowBand-Internet of Things (NB-IoT) and other low-power wide-area networks (LPWA networks), such as LoRaWAN.

User Recommendations

- Differentiate from other providers, like large equipment vendors, systems integrators (SIs), resellers, smaller specialist network vendors and hyperscalers, by integrating PMN with other functions like supplier information management (SIM), IoT platforms, edge computing, design and managed services, and national roaming.
- Co-create networks by partnering with SIs and consultancies that have the required industry skills for design, deployment, and managed services engineering headcount and evaluation test bed environments. For example, build manufacturing 5G PMN with connectivity, security and AI capabilities.
- Design licensed and unlicensed/shared spectrum options where available.
- Supplement your engineering teams by working with IT service providers. Do not expect or plan on public 5G replacing WLAN in large portions of your environment. Instead, IT leaders should select private 5G for specialized use cases with large coverage areas and known application performance requirements.
- Identify use cases and their requirements to establish where 5G can be implemented — for example, in applications using HD wireless cameras.

Sample Vendors

AT&T; Celona; China Mobile; Ericsson; HPE (Athonet); Huawei; Nokia; T-Mobile; Verizon; Vodafone

Gartner Recommended Reading

Infographic: 5 Steps for Vendors to Scope and Run Successful POCs for Enterprise 5G PMNs

Market Guide for 4G and 5G Private Mobile Networks

3 Go-to-Market Strategies for Product Leaders in Private Mobile Networks

Research Roundup: How to Build Winning Propositions in 5G Private Mobile Networks

Quick Answer: What Metrics Can TSPs Consider for Their Private Mobile Network Solution Development?

Composable Networks

Analysis By: Susan Welsh de Grimaldo

Benefit Rating: Transformational

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Definition:

Composable networks are built with modular, automatable components to support the dynamic requirements of a digital business. These components are disaggregated, reusable network functions and elements that can be easily and automatically integrated in near real time and that serve as shared pools of resources. The required modularity in telecommunications network technology is provided through microservices based on containers. Open APIs enable the integration of interoperable components.

Why This Is Important

Communications service providers (CSPs) can create a more agile, cost-effective network with a fluid set of resources that can be dynamically composited to meet the unique needs of any service. Implementing composable networks supports broader composable business thinking for efficient utilization of network investments and faster response to external changes. By using modular component architecture, composable networks enable the best service performance, while reducing underutilization and provisioning.

Business Impact

Composable networks provide CSPs:

- The ability to adopt an open and disaggregated infrastructure where network components can be provided by different players in the supply chain.
- Ease of innovation and faster upgrades that can occur in specific areas, as R&D occurs per function.
- Improved efficiency and optimization of network utilization, resources and investments.
- The ability to rapidly seize market opportunities and respond to disruption, by assembling elements to the composable network.

Drivers

- Need of agility and flexibility to address customer requirements, react to competitive offers, respond to uncertainty, and pivot as needed with less risk and faster time to market.
- Adoption of cloud-native architectures, with use of microservices and disaggregation of network functions.
- API-enabled architecture and broader adoption of open APIs (e.g., TM Forum APIs, GSMA Open Gateway framework launched at MWC 2023), facilitating discovery, orchestration and automation.
- Increasing levels of composability evolving over time as products mature and as the vendor community further adopts open frameworks, microservices/containerized solutions and open APIs.
- Increasing commercial deployments of 5G stand-alone (5G SA), providing a native service-based architecture for the 5G core.
- Introduction of 5G network slicing, which enables increased agility for customer-centric service delivery by creating a mechanism for composable services across network domains and elements.
- Using automated processes driven by slice templates to deliver desired service parameters that can be quantified in an SLA.
- Competition with hyperscalers and more digital competitors, and consequential shifts favoring new business models for on-demand, consumption-based delivery and more digital experiences (solutions that deliver business outcomes, not one-off products).
- CSPs increasingly participating in digital ecosystems to find new and differentiating value, and finding that their traditional technical capabilities are barriers to such participation.

Obstacles

- Challenges with orchestration and automation across components and processes, especially in a distributed multivendor network environment requiring interoperability with high reliability.
- Slow movement toward cloud-native architectures and 5G SA, all of which will enable increased network composability.
- Slow progress on open APIs standardization and challenges with interoperability and implementation.
- Challenges with management of CI/CD pipelines across a wide range of modular network elements from multiple vendors.
- Siloed organizational structures at CSPs, with separate teams addressing IT and OT as well as network domains.
- Lack of comprehensive and consolidated real-time network inventories and discoverability of network elements.
- Monolithic legacy network components with proprietary setup that make integration and interoperability complex.
- Lack of ample software engineering skills in network teams.

User Recommendations

- Plan your network roadmap with concrete steps to move toward composable networks, focusing on interoperability, adoption and automation of enabling technologies, e.g., standard open APIs, cloud-native/microservices, 5G SA and real-time consolidated network inventory.
- Evaluate the unique value propositions of emerging technologies and vendor solutions to aid in developing a composable network. Select vendors that plan to support increasing levels of network composability, collaborative work and integration of composable elements into your existing network environment.
- Assess what aspects of your organizational structure, governance, processes and mindset need to change to support a move toward a composable network; this may include a need for better integration of IT and network organizations.
- Conduct a comprehensive analysis of your available and required skills (business and technical) needed to design and operate composable networks. Identify gaps, and upskill where necessary.

Gartner Recommended Reading

Market Trend: Achieve CSPs' Business Agility Through a Composable Network

Emerging Tech Impact Radar: Communications

CSP CIOs Can Enable Growth and Efficiencies by Accelerating Disruptive Composability Practices

Cloud Creates New Opportunities in Composable Connectivity and Edge-Based Services

Invest Implications: Competitive Landscape: Emerging Providers of 5G Platform Infrastructure

RIC

Analysis By: Peter Liu

Benefit Rating: Transformational

Market Penetration: 5% to 20% of target audience

Maturity: Emerging

Definition:

RAN intelligent controller (RIC) is a logic function defined by the O-RAN alliance. It is responsible for controlling and optimizing RAN infrastructure. RIC serves as a platform for radio network and radio resources optimization and is split into non-real-time RIC (non-RT RIC), and near-RT RIC. RIC is accompanied by external applications (rApps and xApps), which serve as tailored algorithms for certain use cases including Radio Resource Management and (self-organizing networks) SON functions.

Why This Is Important

As a key element of “O-RAN alliance’s reference architecture,” RIC provides advanced control functionalities that leverage analytics and data-driven approaches to deliver increased efficiency and better radio resource management. In the short term, the RIC is an opportunity to increase energy efficiency and improve Open RAN quality of service. In the longer term, the RIC presents an opportunity to optimize and utilize radio access networks through new applications — xApps and rApps— and accelerate the innovation by introducing third-party developers.

Business Impact

Business benefits from RIC include:

- Enables radio access network (RAN) to evolve to an open and programmable infrastructure. This allows effective radio resources optimization and reduces total cost of ownership (TCO).
- Enables third-party applications (xAPPs and rAPPs), which maximize the radio network’s operational efficiency and accelerates RAN innovation by incorporating the benefits of AI and big data.
- Offers more automated and intelligent operations programmability to deliver optimal network performance.

Drivers

- **Open RAN adoption:** CSPs increasingly adopt Open RAN architecture aiming for agility, web-scale and innovation. The RIC is a critical piece of Open RAN disaggregation strategy, bringing multivendor interoperability and programmability to radio access networks.
- **Efficiency and automation:** With the advent of 5G, edge computing and dynamic customer needs, intelligent and automated radio control functions are crucial for enhancing efficiency and managing radio resources and spectrum effectively. The RIC enables CSPs to optmize resources and spectrum usage using AI/ML algorithms, leading to improved customer experience and spectral efficiency.
- **TCO reduction and sustainability:** The RAN infrastructure is the biggest cost and energy consumption component in CSPs' mobile network. To reduce the TCO and achieve sustainability targets, CSPs need a more effective and intelligent and optimal resources and energy management platform.
- **Accelerate Innovation:** CSPs are continuously seeking an innovation platform that can support broader ecosystem participation in their 5G RAN innovation, optimization and monetization. As an open platform, the RIC can drive innovation through new applications — xApps and rApps. These applications bring intelligence to the RAN and enable various use cases, such as assurance and real-time video optimization.

Obstacles

- The current RIC market is immature, with a range of vendors introducing early stage offerings and initial partners for xApps and rApps. Most CSPs' initiatives and projects are still in trial or proof-of-concept stages.
- Immature technology and early standardization stage limits RIC integration, interoperation and updates — particularly when legacy products, assets and equipment are involved.
- The introduction of new and additional touchpoints in O-RAN alliance reference architecture, the decoupling of hardware and software, and the involvement of third-party applications has the potential to expand the threat and attack surface.
- The various approaches in RIC frome different RAN vendors increase the interoperability complexity and limit the RIC implementation in scale.
- The success of RIC is not only dependent on the open RAN/vRAN adoption, but also on the developer community. However, as a new technology, the market lacks skilled resources and mind share of the developers.

User Recommendations

- Explore and evaluate the RIC technology through collaboration with vendors to conduct POC and pilot. Understand the readiness and initial use cases that RIC can introduce.
- Develop and trial solutions based on initiatives led by O-RAN alliance to further explore the readiness and near-term business benefits.
- Enhance flexibility and efficiency in leveraging developer community and their capabilities through standardized/open APIs and exposure of key functionalities.
- Be cautious and do not rush the commercial launch. Periodically assess and monitor the current level of adoption and standardization progress.
- Start experience with a focus on non-RT RIC because those specifications are farther along and less tightly coupled with the control of baseband scheduling, which is more complex and challenging.

Sample Vendors

Accelleran; Capgemini Engineering; Ericsson; Intel; Juniper Networks; Mavenir; NEC; Nokia; Parallel Wireless; Samsung Electronics; VMware

Gartner Recommended Reading

Magic Quadrant for 5G Network Infrastructure for Communications Service Providers

Communications Industry: 2023 Top Market Trends for CSP Tech Suppliers

Communications Industry: 2023 Top Tech Trends for CSP CIOs

Forecast Analysis: 5G Services Incremental Revenue Opportunity for CSPs

Forecast Analysis: Communications Service Provider Operational Technology, Worldwide

5G-Advanced

Analysis By: Kosei Takiishi

Benefit Rating: High

Market Penetration: Less than 1% of target audience

Maturity: Embryonic

Definition:

5G has been commercialized in many countries based on 3rd Generation Partnership Project (3GPP) Release 15 and later specifications. 3GPP decided to call the 5G successor technology 5G-Advanced as 3GPP Releases 18 and beyond will bridge the gap between current 5G and future 6G.

Why This Is Important

The completion of 5G-Advanced's first release, 3GPP Release 18, is scheduled for March 2024. This aims to expand the market reach of 5G by adding new big features such as XR and AI/ML and addressing additional requirements from CSPs and verticals. These requirements could include various enhancements of eMBB and URLLC, public-safety/mission-critical, satellite and IIoT/mMTC. This improvement will aid CSPs in more efficient use of the limited radio spectrum and provide new business opportunities.

Business Impact

5G-Advanced has two priorities, both of which can improve network and service capability for consumers and enterprise clients:

- Enhance the existing capability or cost reduction, such as multiple input/multiple output (MIMO), dynamic spectrum sharing, AI/ML and energy saving.
- Create new business, including extending terrestrial networks and vertical use cases supported by Sidelink NR positioning, nonterrestrial networks, AI/ML, AR/VR and IIoT/URLLC enhancement.

Drivers

- CSPs' interest in developing additional 5G monetization opportunities that require capabilities beyond 3GPP Release 17 is driving this technology.
- Standardization bodies and related consortia — such as 3GPP, ETSI, 5G-ACIA and 5GAA — have been promoting new features that can solve the challenges facing stakeholders.
- Developing new technologies and standards takes time, therefore this stepwise approach to adding more features and capabilities to 5G standards allows commercial equipment and deployment before the full vision of 5G is enabled. Iterative learning can then be incorporated into the standard process to address any gaps or further needs.

Obstacles

- Uncertain 5G ROI based on 5G monetization opportunities, coupled with heavy investments in initial 5G deployments and coverage expansion, could hamper willingness to invest significantly in 5G-Advanced.
- COVID-19 and other uncertainties related to standardization of work are concerns.
- There is increased complexity of coordination work due to the proliferation of technology-related standards organizations and industrial consortia, as well as increased dependency on other technical domains such as edge and cloud.

User Recommendations

- Develop a roadmap for what features to add to your 5G infrastructure while observing the progress of standardization activities.
- Collaborate with 5G-Advanced vendors to trial new capabilities to assess performance as well as potential business opportunities with leading enterprise and vertical market customers.
- Do not anticipate deploying 5G-Advanced commercially until 2024.

Sample Vendors

Ericsson; Huawei; Nokia; Samsung Electronics; ZTE

Gartner Recommended Reading

Magic Quadrant for 5G Network Infrastructure for Communications Service Providers

NetCo Platform

Analysis By: Amresh Nandan

Benefit Rating: Transformational

Market Penetration: 1% to 5% of target audience

Maturity: Adolescent

Definition:

A NetCo platform refers to an integrated system consisting of network and IT resources and management systems that a network operator or CSP can use to manage, maintain and expose network connectivity services to various service providers and enterprises. It refers to a decoupled architectural design to support network/connectivity business models as a separate business unit/department.

Why This Is Important

Network infrastructure and end-user services among communications service providers (CSPs) follow different investment cycles, amount of investment, innovation triggers and level of returns. The popularity of over-the-top (OTT) products has led to increasing decoupling of networks. A NetCo platform enables a CSP to manage these two different business paradigms (underlying network and IT resources, and its products and services) separately through creation of a NetCo-ServCo-like organization structure and direct monetization of network assets.

Business Impact

NetCos as a separate business entity have yielded better returns than traditional CSPs by allowing cost sharing and network monetization. This has been seen with many NetCos in the European region, delivering better returns on invested capital and earnings before interest, taxes, depreciation and amortization (EBITDA) margins. The concept when applied to other CSPs through a platform approach allows diversification of business model, better operational efficiency and technology change management through decoupled technology platforms.

Drivers

- Starting with TowerCos or national neutral carriers such as FiberCos, the business model has evolved to a full NetCo (supporting active network assets). When the same concept is used as a technology architecture by a CSP through a NetCo platform, it enables several business benefits.

- NetCo platform provides an architecture to a CSP with network assets to manage its asset-heavy operations (i.e., network operation) and asset-light operations (product/service operations for end users) separately supporting multiple lines of businesses (LOBs). The architecture decouples the LOB operations from network assets enabling cost sharing, separate evolution and monetization of the two.

- NetCo platform provides better monetization of network assets and investments and free capital to new investments, improvement of business models and creation of new business models through network slicing and network as a service.

- Greater adoption of the OTT approach for product development and delivery, even for connectivity products.

- Improvement of operational efficiency of network operations through decoupling service operations for end users.

Obstacles

Development of a NetCo platform and its operations is a large transformation program for a CSP because of many obstacles, including:

- The decision to invest in a NetCo platform and operation is a highly strategic and board-level decision that must be aligned with a longer-term vision of the company. If a CSP has a lack of clarity in vision, it is almost impossible to undertake a transformation for the NetCo platform.
- NetCo platform demands a restructuring of the organization structure and operating model. The platform breaks existing/traditional structures and therefore the move can face resistance from many.
- Investment in the NetCo platform is a technology transformation as well, demanding modernization of technology applications and systems to craft as a platform. It requires a high level of technology and architecture expertise to deliver a NetCo platform.

User Recommendations

- Crystallize the long-term vision for the enterprise and the role of a NetCo platform in it.
- Identify the business case of the NetCo platform in the context of the future business strategy of the enterprise. See Routes to the Future for CSP CIOs: Invest in Platform Capabilities to Shape Business for more on possible futures for CSPs.
- Evaluate the current technology transformation projects and roadmap, and how they will change if they adopt the idea of the NetCo platform.
- Focus on an adequate organizational structure that would suit the NetCo platform operations.
- Improve the design and architecture capabilities of the organization.
- Finalize the orchestration approach at various levels i.e., commercial order, end-to-end service orchestration, end-to-end resource orchestration and network domain orchestration.

Gartner Recommended Reading

Objectives and Principles for OSS Architecture Evolution in CSPs

NR-RedCap

Analysis By: Kosei Takiishi

Benefit Rating: High

Market Penetration: Less than 1% of target audience

Maturity: Embryonic

Definition:

NR-RedCap, also known as reduced capability new radio and NR-light before, is a 5G specification focusing on the IoT part of 3GPP Release 17 that was frozen in 2022. Release 16 for 3GPP covers high-performance (e.g., industrial) and low-complexity (i.e., LTE-M/NB-IoT) IoT, but with a gap between them. NR-RedCap aims to reduce power consumption, which is indispensable for IoT applications, with communication speeds of several Mbps to 100 Mbps and latency delays of tens to hundreds of ms.

Why This Is Important

While NB-IoT and LTE-M enhancements have been folded into the 5G specifications in 3GPP Releases 15 and 16, they are not very new and are just relatively minor improvements compared to other new functions. In contrast, NR-RedCap will enable a new class of devices that is more capable than LTE-M/NB-IoT but supports different features and smaller bandwidth than 5G NR eMBB/URLLC. NR-RedCap can be a suitable technology for use cases such as high-end wearables or industrial IoT cameras and sensors.

Business Impact

NR-RedCap is designed to bridge the capability and complexity gap in 5G, catering to midtier use cases. This optimized design addresses various applications such as wearables and industrial wireless sensors. This can satisfy communication service providers (CSPs) and enterprise clients that are trying to find devices with a balance of functionality and cost.

Drivers

- NR-RedCap can support new use cases and capabilities that have not been supported effectively by incumbent technologies, including reduced power consumption, affordable device pricing with communication speeds of several Mbps to 100 Mbps and latency delays of tens to hundreds of ms.
- The telecom industry is promoting 5G as a platform for vertical industries such as automotive and healthcare, and NR-RedCap capability will become a key component for the platform.
- Vertical industries, including the automotive industry (5G Automotive Association) and the manufacturing industry (5G Alliance for Connected Industries and Automation), are demanding NR-RedCap for their digital transformation.

Obstacles

- One or two years of preparation will be needed before NR-RedCap is ready for mass commercialization. This preparation includes vendor implementation, CSP deployment and device vendors' adoption.
- Unclear monetization models for use cases of NR-RedCap could delay its commercialization. Currently, most IoT-related use cases could be satisfied by either LTE-M/NB-IoT or 5G eMBB, while LTE (4G) networks provide a lower-cost alternative for applications requiring the kind of speeds that NR-RedCap is designed to deliver.
- Introducing another alternative for IoT communications risks confusing the market that needs to believe in the longevity of NB-IoT and LTE-M before investing in them.

User Recommendations

CSP CTIOs should:

- Estimate suitable use cases of NR-RedCap by observing and participating in related 3GPP standardization.
- Develop monetization strategy of NR-RedCap device and services by engaging with potential vertical industry customers.
- Adopt multi-IoT access technologies, including LTE-M, NB-IoT and NR-RedCap, to satisfy multiple demands from clients.

Sample Vendors

Ericsson; Huawei; Nokia; Qualcomm

Gartner Recommended Reading

Magic Quadrant for 5G Network Infrastructure for Communications Service Providers

5G Network Security

Analysis By: Sylvain Fabre, Peter Liu, Nat Smith

Benefit Rating: Moderate

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Definition:

5G network security mechanisms improve 4G security with enhancements such as new mutual authentication capabilities, enhanced subscriber identity protection, and addressing new threats from emerging technologies such as cloud-native architecture, network slicing and edge.

Why This Is Important

Securing 5G networks is a priority with the rise of private mobile networks (PMNs) deployments, vertical applications, cloud architecture and massive IoT connections in 5G are creating new vulnerabilities and challenges, such as DDoS attacks. 5G network security provides a unified authentication framework that is both open (e.g., with the support of EAP) and access-network-agnostic (e.g., supporting both 3GPP access networks, and non-3GPP access networks such as Wi-Fi and cable networks).

Business Impact

5G network security provides guaranteed security levels for more demanding applications. For example, the home control feature verifies device location when in a visited network, preventing some spoofing attacks. 5G mitigation against bidding down attacks prevents a fake base station from pretending not to support higher 5G security features (aka IMSI-catcher). Flexible security policies attached to other 5G chargeable features, such as slice as a service and guaranteed low latency, allow for premium security services.

Drivers

- With the wider ecosystem delivering industrial 5G use cases, better security tools that have varying security competencies and credentials are required in order to provide SLAs and service assurance (including end-to-end security).
- It can be part of liability exposure in enterprises looking to deploy private 5G.
- Regulations around user data privacy are increasing.
- Increased scrutiny on 5G infrastructure vendors, and heightened competition between them for perceived security levels, are also driving 5G network security.
- Legacy networks and new bearers such as satellite, as well as devices with lower security capabilities will interconnect with 5G networks, and need to be able to handle such connections safely.
- Cloud-based delivery of 5G network infrastructure and services — including packet core, network slicing and edge computing — requires cross-domain security.
- Demand for edge enterprise solutions will accelerate 5G security adoption.
- 5G service-based architecture (SBA) infrastructure virtualization, automation and orchestration, as well as multivendor solutions, increase risk exposure for CSPs and enterprises.
- CSPs can offer different security options, for example, using slicing.

Obstacles

- 5G end-to-end security presents new challenges many operators are not entirely prepared for, for example, based on some of the 5G hacks on misconfigured containers.
- Some security settings are optional, so implementation security levels may vary between.
- CISOs may not realize the need to secure their on-premises 5G private mobile networks, understand the additional threats in 3GPP-based infrastructure, and rely on their vendors, who tend to focus on performance and project delivery rather than security.
- Supply chain security concerns remain for 5G as open-source approaches add complexity. Not all network components are (yet) known and defense models may have to broaden as implementation progresses.
- Backward compatibility with 4G/LTE means some legacy security issues affect 5G (for example, GPRS Tunneling Protocol [GTP] attacks).
- 5G runs on commodity hardware and containerization, creating a larger attack surface compared to 4G, with most of the 5G hacks that have been demonstrated attacking those areas.
- Deployment scenarios for private 5G have different risk profiles and security needs.

User Recommendations

- Avoid overreliance on 5G security, solve all issues known in 4G and continue ongoing security initiatives, as many of 5G security features are designed to protect the network rather than secure user data.
- Assess and anticipate increased risk of attacks such as DDoS by improving the design of 5G network infrastructure and endpoints, as well as recovery procedures.
- Implement layered DDoS defense by using best-of-breed scrubbing, cloud web application firewall, bot mitigation, DNS protection, ISP and on-premises DDoS appliances.
- Initiate effective mitigation by correlating network traffic, application availability and server performance.
- Complement 5G infrastructure security with distributed AI/ML anomaly detection algorithms for zero days, covering newer domains such as core slicing.
- Implement edge protection concepts used in application security for elasticity, focused on app-layer protection.
- Implement 5G end-to-end security by managing algorithm strength, secret keys negotiation, confidentiality protection, cross-domain slice orchestration and heterogeneous network layers.

Sample Vendors

A10 Networks; Fortinet; Microsoft; Netcracker; Nokia; Palo Alto Networks; SentinelOne; Trend Micro; VIAVI Solutions; ZScaler

Gartner Recommended Reading

Infographic: 5 Steps for Vendors to Scope and Run Successful POCs for Enterprise 5G PMNs

Gartner Attractiveness Index for Private Mobile Networks Technologies

8 Critical Functionalities for Enterprise 5G Private Mobile Network Management and Orchestration

Active-Passive Antenna

Analysis By: Kosei Takiishi

Benefit Rating: Moderate

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Definition:

Active-passive antenna (APA) is an emerging antenna technology that integrates passive antennas and active antennas into a one-box solution. While passive antennas were commonly used for 4G, current 5G is rapidly adopting active antennas, including massive multiple input/multiple output (MIMO). APA has been adopted commercially to increase radio access network (RAN) capacity and modernize communications service provider's (CSP's) cellular network quickly and efficiently.

Why This Is Important

Mobile CSPs are in fierce 5G competition. They are demanded to offer 5G services with wide coverage, high data traffic at an affordable price, quickly. Active antennas can enlarge data throughput, but require space for new installation, and their deployment is time consuming and costly. APAs can replace incumbent antennas by supporting both active and passive antenna capabilities, including 5G massive MIMO and dynamic spectrum sharing (DSS) over 4G and 5G.

Business Impact

CSPs can deploy additional uplink or downlink capacity without time-consuming negotiations and expense to acquire new locations. It is a new antenna equipment and maintenance efficiency and visibility can be improved by integrating antennas for past generations and 5G.

Drivers

- 5G that leverages higher radio spectrum leads to cell densification, making it more difficult to find new locations for base station antennas. APAs can solve this issue to some extent.

- Total cost of ownership (TCO) could be reduced by purchasing unified antennas and reusing power supply, cabling and so on.

- Leading vendors have already developed APA products and commercialized them. Examples include Huawei 5G Blade AAU and Ericsson's Hybrid AIR and Interleaved AIR for Ericsson Radio System.

Obstacles

- Chronic lack of space for base station antenna deployment and power supply.
- Product limitation of supported frequency bands for active and passive antennas.
- Lack of range of vendors with commercial products.

User Recommendations

- Adopt APA by estimating its benefit through the comparison between current separated passive and active antenna deployment and APA.
- Reduce 2G/3G users and these networks' traffic by leveraging APA that can support multiple radio bands of 4G and 5G.

Sample Vendors

Ericsson; Huawei; Nokia; ZTE

Gartner Recommended Reading

Magic Quadrant for 5G Network Infrastructure for Communications Service Providers

Critical Capabilities for 5G Network Infrastructure for Communications Service Providers, Macrocell

At the Peak

Active Infrastructure Sharing for 5G

Analysis By: Kosei Takiishi

Benefit Rating: High

Market Penetration: 1% to 5% of target audience

Maturity: Adolescent

Definition:

Active infrastructure sharing for 5G across CSPs focuses on sharing electronic infrastructure equipment (RUs and BBUs) and resources (radio spectrum assets), which is different from passive infrastructure sharing. Active infrastructure sharing encompasses technologies like MORAN, MOCN, and GWCN. This aims at reducing and optimizing their 5G RAN investments and allows CSPs to reap the benefits of shared infrastructure while delivering efficient and high performance 5G services

Why This Is Important

Up to 4G, passive (nonelectronic) infrastructure sharing, including base station locations, masts and towers, antennas, power supplies and transport network, was the main focus. In 5G, active infrastructure sharing (not only passive) but also spectrum bandwidths, radio units, base band units and core network are targeted. This is due to high spectrum acquisition costs, use of higher spectrum bands (e.g., 3.8GHz), cell densification and revenue stagnation not scaling up in line with higher costs.

Business Impact

Active infrastructure sharing for 5G aims at further network components sharing, and this can result in TCO reduction for each CSP. The more CSPs share the infrastructure, the more cost savings CSPs will have. Flexible area development is also possible, such as active infrastructure sharing only in rural areas, while other areas are nonshared. Network coverage enhancement in unprofitable areas is indispensable for 5G, and can not be delivered profitably without active sharing.

Drivers

- Many CSPs have been spinning off their infrastructure to tower companies and these CSPs are now becoming service companies (servcos) whose focus moves from infrastructure or hardware to software or applications. Centralization of network assets by tower companies drives network sharing across multiple CSPs.
- Excessive expectations for 5G, including nationwide coverage, improved user experience and affordable tariff plans, which are uneconomical to provide by a single CSP.
- CSPs' aspirations to be lighter and agile servcos by evolving their mobile communications system into an industrial and social infrastructure, and platform.
- Green targets, including 5G networks aiming at sustainability and being carbon neutral.

Obstacles

- Reduction of marketing and differentiation opportunities from the network infrastructure layer.
- The complexity of shared network infrastructure and responsibility clarification between stakeholders.
- Regulations such as radio spectrum usages and network-sharing-related rules and obligations.

User Recommendations

- Clarify benefits by conducting partial 5G active network sharing trials, proof of concepts (POCs), etc. with partners including other CSPs.
- Manage the separation of network infrastructure, IT systems, processes and their workforce.
- Contribute to the formulation of your desired rules by communicating with regulators in advance.

Sample Vendors

American Tower; China Tower; Ericsson; Huawei; Nokia

Gartner Recommended Reading

5G Infrastructure Sharing: How Vendors Incorporate It Into Their Products

50G PON

Analysis By: Peter Kjeldsen

Benefit Rating: Moderate

Market Penetration: 5% to 20% of target audience

Maturity: Emerging

Definition:

50G PON is the new generation PON technology after XGS-PON and commercial products have been announced. It supports 50 Gbps uplink and downlink over a single optical wavelength, and provides a bandwidth five times faster than XGS-PON. It uses the time division multiplexing (TDM) PON mechanism, and supports the coexistence with XGS-PON and leveraging existing passive optical distribution networks.

Why This Is Important

Applications like video streaming, mixed reality, generative AI, gaming and video conferences are putting pressure on communications service providers' (CSPs') infrastructure. In addition, critical enterprise use cases and adoption of 5G bring more strict performance requirements. 50G PON is expected to become a preferred next generation PON technology considering it can coexist with XGS-PON and reuse the existing optical distribution network, which reduces the network construction cost.

Business Impact

Benefits of 50G PON are:

- 50G PON allows CSPs to offer internet speed up to 50 Gbps and deliver 5 to 10 Gbps services to end users supporting B2B use cases as well as future consumer use cases and applications like Metaverse, augmented reality/virtual reality (AR/VR), video.
- In addition, optimized clock synchronization and improved latency enable CSPs to support innovative services that pose strict requirements on SLA and performance.

Drivers

- Growth in cloud computing, B2B traffic, Metaverse, artificial intelligence (AI) and 5G has driven an increasing demand for access bandwidth that requires continuous improvement of the access network capacity. 50G PON provides larger shared bandwidth to support more users and more application delivery options.
- High-density small cells for 5G fixed wireless access (FWA) will require higher bandwidth for the backhaul transport, with 50G PON a potential technology option that could be used in a fixed mobile convergence scenario.
- 50G PON technology is expected to be a preferred choice that will be able to attract sufficient CSP interest and investments to accelerate the maturity, with the first commercial products being announced.

Obstacles

- XGS PON will continue to be deployed on a large scale and should be sufficient to meet the market demand for the next few years.
- While 50G PON offers a future-proof roadmap to migrate from XGS PON to 50G PON, the demand is not yet there to begin large-scale commercial roll out.
- Frequent upgrades to fiber access networks at short time intervals cannot be supported economically or operationally. 50G PON technology is expected to be commercially viable in three to five years.

User Recommendations

- Include 50G PON in your broadband access infrastructure roadmap as a natural step in the evolution of PON solutions. Focus on XGS PON for now and take a phased approach for your PON evolution, where the pace of the upgrade and roll-out is adjusted to match demand.
- Explore the technology through limited-scale 50G PON trials in areas that have strict requirements on latency and clock synchronization.
- Evaluate 50G PON for use in 5G hauling and enterprise scenarios instead of residential services.

Sample Vendors

Adtran; Calix; Cisco; DZS; FiberHome Telecommunication Technologies; Huawei Technologies; Nokia; ZTE

Gartner Recommended Reading

Predicts 2023: CSP Technology and Operations Strategies

Communications Industry: 2023 Top Market Trends for CSP Tech Suppliers

Communications Industry: 2023 Top Tech Trends for CSP CIOs

CSP Multiaccess Edge Computing

Analysis By: Sylvain Fabre

Benefit Rating: High

Market Penetration: 1% to 5% of target audience

Maturity: Adolescent

Definition:

Multiaccess edge computing for communication service providers (CSPs) complies with European Telecommunications Standards Institute Multiaccess Edge Computing Industry Specification Group (ETSI MEC ISG) specifications for edge computing in telecom environments. This infrastructure is deployed and leveraged in the CSP network, and can be a homegrown solution or based on an external partner, such as a hyperscale cloud provider (HCP).

Why This Is Important

CSP MEC integrates edge compute in the network infrastructure of CSPs, with computing resources and services are deployed at the edge of the network, enabling low-latency and high-bandwidth process, and storage capabilities. It follows a set of standards and specifications (ETSI MEC, OpenFog Consortium, GSMA Operator Platform Group) developed by various organizations and industry bodies. It can be a homegrown cloud-native edge solution or HCP cloud infrastructure.

Business Impact

CSP MEC allows cloud-like, mobile application development. Network and edge vendors have increased opportunities for providing MEC to CSPs. CSPs can reduce product work by leveraging HCPs' full spectrum of offerings such as AI, machine learning (ML) and applications. CSPs can apply CI/CD development, security, and automation workflows already applied to the rest of the CSP infrastructure, as MEC is a telecom network element. CSP MEC also complements next-generation 5G networks.

Drivers

- Some visionary CSPs would like to build an independent CSP edge computing, provided by them as a service.
- ETSI MEC as a telecom network element was specified before the HCP solutions started getting deployed. It has a longer track record in production, and is now part of 3rd Generation Partnership Project (3GPP) R17 (TS 23.558 v17.1.0, Architecture for Enabling Edge Applications, Release 17, September 2021).
- 5G MEC supports use cases where applications leverage local content and real-time information about radio access network (RAN) network conditions, while offloading mobile core networks.
- Content delivery networks (CDNs) are adding intelligent processing and improved proxy capabilities, causing CSPs to consider whether the CDN business is becoming more valuable and should be reentered. Multiaccess edge computing cloud gives them a way to test this without a heavy investment.
- The move to more distributed, cloud-native network functions that need compute at the edge is causing CSPs to look for additional monetization and host edge services there (their own or partners'/third parties') as a 5G platform.

Obstacles

- MEC for CSPs requires more commitment in technical headcount and skills, compared to the HCP outsourcing scenario.
- It is typically (but not only) provided by smaller vendors, so long-term viability could be a question for some specialist suppliers.
- Most CSP MEC nodes will share similarities to CDN nodes and micro data centers. The compute environment will support continuous, high-availability compute, but may not necessarily support scaling with the same elasticity that could be obtained with an HCP solution.

User Recommendations

- Evaluate "as a service" alternatives from systems integrators who can also supply managed services, security as a service and integration, above and beyond hardware.
- Factor in the trade-off related to the reduced access to ready-to-go ML/AI and Internet of Things (IoT) applications that could be obtained from HCPs, when using their MEC implementations.
- Implement the right tools and culture for container, asset management, provisioning and orchestration at scale at the 5G edge(s). These include hybrid, public and private scenarios; whether multiple hyperscaler clouds at the edge, telco and hyperscaler, or multiple hyperscalers.
- Support standards-based roaming and cross-settlement (for example, ETSI and other bodies, such as GSMA).
- Factor into your business case the channel opportunities — such as resale, operations and support of hyperscaler edge cloud platform offerings — that will not be readily available with homegrown CSP solutions.
- Consider CSP edge-in models as better fit with federation scenarios.

Sample Vendors

ADVA; Alef; Amdocs; Capgemini; Ciena; COMSovereign (Saguna Networks); Dell Technologies; DriveNets; Hewlett Packard Enterprise; Vapor IO

Gartner Recommended Reading

Research Roundup: How to Build Winning Propositions for CSPs in Edge Computing

Quick Answer: What Mistakes Must CSPs Avoid in the Edge Computing Business?

Top Technology Trends for CSPs in 2022: Edge Redefines CSP's Role in 5G Platforms

Sustainable CSP Infrastructure

Analysis By: Juha Korhonen, Susan Welsh de Grimaldo, Pulkit Pandey, Peter Kjeldsen

Benefit Rating: High

Market Penetration: 20% to 50% of target audience

Maturity: Early mainstream

Definition:

Sustainable communications service provider (CSP) infrastructure refers to telecommunications industry offerings to innovate, build, maintain and operate communications network infrastructure in a sustainable manner. These are focused on energy consumption, carbon emissions, sustainable materials, reusability and recycling of equipment and materials in line with the push for sustainability targets from greater society, shareholders, customers and regulators.

Why This Is Important

The Paris Agreement, adopted by 196 countries, set a goal to limit global warming below 2 degrees Celsius. Many countries and CSPs have since adopted sustainability goals. In February 2019, the GSMA board set an ambition for the communications industry to reach net-zero carbon emissions by 2050. Last year, the cost of energy became a critical driver for CSPs, especially in Europe. Sustainability focus is changing how network elements are being built, procured, designed and managed.

Business Impact

Environmental sustainability requirements for communication networks are fundamentally changing network elements, maintenance and operations, including procurement and business operations. Many governments, regulators, customers, employees and shareholders are expecting stricter commitments and more progress toward the sustainability targets. Sustainability has already impacted CSP buyer behavior, the procurement process, vendor selection and differentiation among vendors.

Drivers

- CSPs have to establish environmental sustainability strategy and measurements to be compliant with the requirements and regulations where they operate.
- Many investors require appropriate environmental, social and governance (ESG) transparency and performance from CSPs. Transparency requires definition of targets, commitment and KPI reporting of the progress.
- Customers are focused on the material environmental performance of their suppliers (including vendors, products and services), and, in particular, the associated energy and greenhouse gas (GHG) emission performance.
- Energy efficiency for operational savings has been a market driver for years, and now the trend is changing to include the materials used, water used and reusability of physical equipment. Concrete steps taken by leading CSPs include using upgradable antenna elements, artificial intelligence (AI) and machine learning (ML) to optimize energy consumption during low utilization, automatically repositioning antennas, and using 5G beams.
- Leading CSPs have chosen environmental sustainability as one of their core differentiators going forward and are now actively positioning sustainability with their brand. Examples are Elisa, KPN, Telia Company and Telstra with more aggressive carbon neutral and net-zero targets; 13 European operators founding the European Green Deal; and leading operators in the U.S. such as AT&T, T-Mobile and Verizon.
- The communications industry has the capability to impact society by enabling other industries to become more sustainable using IoT or real-time control and automation. For example, AT&T's Connected Climate Initiative aims to eliminate gigatons of global emissions by 2035, working together with Microsoft, universities and other ecosystem partners.

Obstacles

- Lack of transparency for a full-value-chain environmental impact, making it difficult to assess the impact of different communication industry components — for example, supply chain, recycling and reusing network components
- Slow change of mindset across organizations to take sustainability into account while deploying new technologies with a recycling and repurposing approach
- Lack of sufficient and constant renewable energy sources in the countries, requiring long-term planning from CSPs together with energy companies (including long-term commitments and contracts or even building their own energy production)
- Lack of industry standardization, slowing down development of best practices
- Unclear long-term roadmap from countries and regulators, making planning for new infrastructure projects difficult
- Conflict between the need to densify the network for additional capacity, edge computing requirements for compute and distributed equipment, and the need to reach sustainability goals

User Recommendations

- Set up an environmental strategy and goals for your network, and make sure that all the necessary teams are aware of the plan and impact. Assess financial impact.
- Establish KPIs to be used to follow the progress, and report both internally and externally to governments, shareholders, customers and employees (e.g., follow the GSMA Sustainability Assessment Framework).
- Ensure your sustainability requirements (including ecolabels, emissions, reusability and recycling materials, packaging, and shipping) are part of your procurement and vendor selection decision-making criteria and overall sustainability in the RFI/RFP phase.
- Create a roadmap with specific network modernization and optimization targets to incorporate higher energy efficiency while setting up short-, mid- and long-term goals.
- Work with various business unit teams (including corporate strategy, ESG, finance and product managers) to identify and assess your sustainability initiatives and better understand how sustainable CSP infrastructure can most effectively contribute.

Sample Vendors

Cisco; Ericsson; Hewlett Packard Enterprise; Huawei; Intel; Nokia

Gartner Recommended Reading

A Framework for Sustainable Technology

Top Technology Trends for CSPs in 2022: CSP-Driven Sustainability Impacts Society

Leverage Technology Ecosystems to Improve Sustainability Capabilities

Executive Leadership: Sustainability Primer for 2023

Unlock the Business Benefits of Sustainable IT Infrastructure

800G Transport

Analysis By: Peter Kjeldsen

Benefit Rating: Moderate

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Definition:

800G is a very high bandwidth optical transport technology. It delivers per wavelength data transmission rates of up to 800 Gbps. This is achieved through the use of advanced coherent modulation schemes operating at high baud rates (90-100G symbols/second).

Why This Is Important

800G technology is important because it can increase the capacity that can be provisioned per fiber. Moving to higher capacity per wavelength has traditionally proven itself as a cost-effective path to realizing lower cost per transport bit while bandwidth requirements increase over time — or “bit-wise economies-of-scale.” 800G transport is expected to do the same as the technology matures.

Business Impact

CSPs can benefit from 800G deployment:

- 800G transport offers an upgrade path for capacity exhausted 400G systems without requiring additional fibers.
- With 800G transport, CSPs can deliver higher data throughput per wavelength — at a lower cost per bit and with less energy required per bit.
- CSPs can offer higher bitrate connectivity services, reduce equipment footprint and lower energy consumption leading to a greener network infrastructure supporting the growing digital economy.

Drivers

- Network traffic will continue to increase sharply in the next ten years as new technologies and services such as 5G, cloud computing, big data, generative AI and AR/VR continue to drive demand.
- CSPs need to push the capacity of their networks beyond 400 Gbps per wavelength.
- New coherent digital signal processors (DSPs) represent significant technical achievements that make 800G cost-effective to deploy, allowing CSPs to push the wavelength capacities closer to the Shannon theoretical limits.

Obstacles

- 800G is still in a relatively early stage and the maturity of the 800G technology and standardization is a key issue for mass adoption by CSPs.
- 800G technology is still on a steep part of the learning curve, and cost relative to 400G is still a concern that impedes adoption, depending on the upgrade scenario at hand.
- Evolution path is another concern. 800G transport will have to prove itself cost-effective against 400G transport — not only at the link/node level but also at the overall network architecture level. 800G transport will likely also be pushed by even higher bitrate solutions, so it is not the end of the journey to higher capacity per wavelength. Transport networks have traditionally seen capacity jumps of a factor of 4 between the most commonly used line rates — and some network architects may see 800G as too small a jump from 400G.

User Recommendations

- Conduct detailed assessments of the network traffic pattern and utilization before adopting 800G. It's important to understand actual, realistic network performance that can be expected when using high-capacity wavelengths when planning a network's evolution.
- Work closely with vendors and standardized organizations to understand the technology progress trends and learn from best practices. Consider running POCs and tests 800G in labs or pilot environments.
- Define the long-term evolution path of your optical transport network and evaluate 800G as a possible milestone in your evolution journey.

Sample Vendors

Adtran; ADVA Optical Networking; Ciena; Cisco Systems; Fujitsu; Huawei Technologies; Infinera; ZTE

Gartner Recommended Reading

Predicts 2023: CSP Technology and Operations Strategies

Communications Industry: 2023 Top Market Trends for CSP Tech Suppliers

Communications Industry: 2023 Top Tech Trends for CSP CIOs

Cloud-Native CSP Infrastructure

Analysis By: Enrique Hernandez-Valencia, Susan Welsh de Grimaldo

Benefit Rating: Transformational

Market Penetration: 5% to 20% of target audience

Maturity: Early mainstream

Definition:

Cloud-native CSP infrastructure is built using the architectural and design principles of cloud computing. These include capabilities delivered on demand that are scalable and elastic, service-based, programmable (API-driven) and loosely coupled. Network functions that are written to take full advantage of the cloud computing capabilities on public, private or hybrid clouds are considered cloud-native.

Why This Is Important

Cloud service providers (CSPs) face increased competition from more agile, digital and cloud-centric companies, as well as a need to integrate more partner solutions in their offerings. CSPs and vendors of telecom network infrastructure are adopting cloud-native capabilities to drive composability and faster time to market with new services. They are focusing on service-based frameworks using microservices and containers, supported by CI/CD, API-driven infrastructure to increase CSP agility and partnerability.

Business Impact

A cloud-native approach promises a transformational impact on both CSP operations and business — offering a number of benefits such as openness, flexibility, agility, scalability, and improved products and feature velocity. Cloud-native infrastructure can enhance and simplify service orchestration, partner ecosystems, product innovation, and automation to offer improved services and efficiencies as well as an ability to pivot to meet new challenges.

Drivers

- More vendors have been increasing their commitment to cloud-native architecture frameworks for existing and new products, and have adopted an integrated platform approach to support this process.
- CSPs and vendors are participating in Cloud Native Computing Foundation, Open Networking Foundation, O-RAN Alliance and Telecom Infra Project, promoting and collaboratively developing cloud-native open source specifications specifically for telecom infrastructure.
- CSPs are motivated to adopt cloud-native frameworks to make their infrastructure and products more attractive to partners and customers. More open, scalable, elastic and programmable infrastructure technologies, consistent with service-based architecture models that leverage microservices, containers and open APIs as core technologies — especially for new workloads — allow CSPs to spend more effort on customers and service innovation, not infrastructure.
- Agile providers are leveraging the major cloud providers' infrastructure, showcasing best practices and driving attention to the benefits of cloud-native infrastructure by sharing performance metrics.
- Greenfield deployments by Rakuten Mobile and Dish Networks aim to showcase the potential of cloud-native infrastructures that enable more automated, lower headcount/opex to manage networks and enhance 5G network-slicing-ready advantages.
- Increasing deployments of multi-access edge computing by large CSPs are leveraging distributed cloud-native frameworks.
- The use of microservices in software development facilitates continuous integration and continuous delivery (CI/CD) efforts, reducing the development life cycle and the opportunity for human error with process automation.
- Modularity enables frequent software updates to accelerate incorporating R&D advances and lessons learned from existing deployments without taking services offline.

Obstacles

- Lack of transparency on how vendors incorporate cloud-native capabilities in commercial offerings, take steps to become more cloud-native and deliver benefits in their products
- Challenges with sourcing and integrating cloud-native infrastructure in multivendor and multicloud scenarios, given the lack of established industry standards
- Skills gaps managing a cloud-native environment, building CI/CD pipelines, supporting a mix of bare metal, container and VM-based infrastructure, particularly for new solutions, such as 5G core
- Technology debt from investments in reliable legacy infrastructure, given the complexity to transition processes and organizational structure in support of a large scale cloud native environment
- Concerns over the potential growth in opex as infrastructure hosted in public clouds grow, and overdependence on few hyperscalers increases

User Recommendations

- Identify areas that can adopt cloud-native solutions, and build knowledge and skills, sooner by working through details of use cases and network deployment roadmaps.
- Prioritize vendors that demonstrate ability to work as true partners on your cloud-native transition journey by offering: increased out-of-box functionality; standard open APIs; clear and transparent product roadmaps in terms of the cloud-native capabilities currently commercially available; and the features that will be enabled or developed during the project delivery time frame.
- Support shifts in processes and decision making, as well as KPIs, to understand performance, cost structures and workflows that moving to cloud-native infrastructure necessitates.
- Identify skills gaps that will limit your ability to move to a more cloud-native environment.

Sample Vendors

AWS; Azure; Ericsson; GPC; IBM; Nokia; Oracle (OCI); Rakuten Symphony; Red Hat; Samsung

Gartner Recommended Reading

Predicts 2023: CSP Technology and Operations Strategies

Communications Industry: 2023 Top Tech Trends for CSP CIOs

Market Trend: Achieve CSPs' Business Agility Through a Composable Network

Market Guide for CSP Revenue Management and Monetization Solutions

5G Providers Must Grasp the Scope of Hyperscalers' Announcements for CSP Network Infrastructure

Key Principles for the Design and Implementation of a Cloud-Native Telecom Infrastructure

Network Slicing

Analysis By: Susan Welsh de Grimaldo, Peter Liu

Benefit Rating: Transformational

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Definition:

Network slicing enables network-based CSPs to create multiple isolated end-to-end logical networks in the form of network slices on top of a common shared physical network infrastructure. Each slice can be customized to provide a specific service quality profile based on the requirements for distinct applications, driving revenue opportunities.

Why This Is Important

Network slicing creates multiple logical networks using a common shared physical network, enabling cost efficiencies and 5G monetization. Slices are tailored to meet specific needs of applications, services, devices, customers or operators. Slicing provides a mechanism to translate business needs of end customers into parameters that can be defined and measured (e.g., required bandwidth, speeds, latency and reliability) to deliver improved customer experience and revenue opportunities.

Business Impact

With network slicing, CSPs can run multiple independent business end services on a common physical infrastructure. This helps generate new business models, especially for vertical industries, and also increases infrastructure utilization and economic efficiency. With network slicing, business customers will be able to access highly customized network slices tailored to specific requirements in a cost-effective, timely and efficient way that are backed by an SLA.

Drivers

- CSPs seek increased agility and faster time to market for customer-centric service creation. Slicing offers a mechanism for composable services across network domains and elements, using automated processes driven by slice templates to deliver desired service parameters that can be quantified in an SLA.
- Vertical industries have specific requirements that drive a need for CSPs to deliver SLAs as they push further in their digital transformation efforts and integrate connectivity, cloud services and sensor data into their mission-critical operations. An example is for secure, reliable low-latency/high-bandwidth connectivity to AI on edge computing.
- Broader commercial deployments of 5G stand-alone (SA) with 5G core will serve as a catalyst for more rapid growth of network slicing in commercial service offerings.
- Advancements in trials and initial commercial deployments, for example with UE Route Selection Policy (URSP), slicing to support fixed wireless access (FWA), and slicing for live events use cases, are providing lessons to support commercial slicing use cases and deployments.
- Network slicing offers improved security and data traffic isolation, as each slice is isolated in operations to minimize potential interference with the traffic in other slices. This will enable slices on the public network to more cost-effectively deliver private networking services, bringing the benefits of network slicing downstream to smaller businesses through more affordable offers.
- Dynamic network slicing that can be quickly instantiated — and spun down when no longer needed — through automation will provide more agility to deliver required value propositions to customers. They can do this while reusing integratable and automatable network components to drive energy and resource efficiency.

Obstacles

- Capabilities such as comprehensive network inventory, automated data-driven operations, and test and assurance of SLAs are needed to commercialize network-slicing-related offerings, but are still in progress.
- Key areas such as dynamic orchestration for low-touch operations to support slicing at scale and manage subdomains/subnets also need further development. Multivendor environments add more complexity. Standards supporting dynamic, E2E slicing across network domains are still being developed.
- 5G SA commercial deployment is still limited, which will delay broader slicing implementation.
- Compelling monetization use cases for network slicing at scale have not been fully developed.
- For multidomain slicing, security policy coordination mechanisms among different domain infrastructures must be coordinated and managed.
- Private 4G/5G adoption by enterprises could satisfy some demands that can be achieved by public 5G's network slicing services, reducing demand.

User Recommendations

- Drive customer centricity by focusing on business outcomes. Work with product teams to translate how technology features can help solve problems or create opportunities for end customers.
- Prepare for slicing by addressing key enablers, e.g., SDN, cloud vRAN, edge computing, cloudification, real-time inventory and increased automation capabilities.
- Evaluate technologies and use cases by working with vendors and customers to co-develop solutions, identify performance gaps and measure business impact.
- Identify ways to deliver cost optimization while supporting revenue growth. Work with vendors to get the right out-of-box functionality, low-code solutions to support use by business units, flexible procurement for pay as you grow and licensing that fits the use cases.

Sample Vendors

Amdocs; Blue Planet (a division of Ciena); Ericsson; Google; Huawei; Intel; Juniper Networks; Nokia; ZTE

Gartner Recommended Reading

Create Value and Drive Revenue With 5G Network Slicing Phased Approach

Drive 5G Network Slicing From POC to Scale

Composable Solutions Are Main Drivers for CSPs Selling IoT and 5G to Enterprises

Market Guide for CSP Service Design and Orchestration Solutions

vRAN

Analysis By: Kosei Takiishi

Benefit Rating: Moderate

Market Penetration: 1% to 5% of target audience

Maturity: Early mainstream

Definition:

Virtualized radio access network (vRAN) decouples software and hardware by running baseband unit (BBU) over COTS servers, which is different from classic RAN that usually adopts vendors' own SoCs. This includes BBU containerization by microservice deployment on Kubernetes containers. While current distributed RAN (dRAN) and centralized RAN (cRAN) use dedicated purpose-built hardware, vRAN is a new architecture that can aggregate BBU functions to the server, cloud, for many radio access nodes.

Why This Is Important

vRAN focus on RAN programmability and efficiency through virtualization is intended to enable the best, most efficient RAN implementation for communication service providers (CSPs). Not only new disruptors with software backgrounds but also incumbent network equipment vendors are providing vRAN solutions. Key 5G use cases focused on providing the best, most efficient network for customers, could heavily rely on vRAN and other adjacent technologies (e.g., network slicing and orchestration).

Business Impact

By virtualizing and centralizing network functions, vRAN enables more efficient resource allocation, simplified network management, faster deployment of new features and greater adaptability to changing network demands. It also has the potential to reduce hardware and maintenance costs, enhance energy efficiency and allow for easier integration with cloud-based infrastructure.

Drivers

- New standardization, ecosystem creation and multivendor interoperability assurance led by the O-RAN ALLIANCE and Telecom Infra Project (TIP) based on 3rd Generation Partnership Project (3GPP) specifications.

- The software-based nature of vRAN is treated as a cost-effective approach to provide alternatives against the traditional, distributed RAN architecture to enable new serviceability and simplified deployment approach.

- Leading CSPs adopting vRAN could spur further adoption by other CSPs. In 2020, Verizon commercialized Samsung Electronics' fully virtualized 5G RAN solution, including virtualized Distributed Unit (vDU) and virtualized Central Unit (vCU). Rakuten Mobile, a "greenfield" CSP in Japan, has commercialized more than 52,000 4G base stations based on vRAN which integrate multiple vendor solutions, including RAN, core and cloud-native platform.

- Government and regulator efforts (e.g., Open RAN Policy Coalition and The Quad Open RAN Forum) to support more diversified and/or local supplier ecosystems.

Obstacles

- vRAN is still missing commercial best practices adopted by incumbent CSPs. So far, large-scale commercial adoption of vRAN has come through from only one incumbent CSP — Verizon in the U.S.

- vRAN may not perform as well as purpose solutions related to network capacity and power consumption, and requires new skills beyond RAN, including IT and cloud-native expertise.

- Complex external hardware accelerator adoption (e.g., look-aside, in-line) and missing industry consensus.

User Recommendations

CSP CIOs should:

- Implement best practices and future roadmap of vRAN by participating in O-RAN ALLIANCE and TIP and related interoperability testings.
- Prioritize new technologies that are most needed for sustainable development and operational efficiency. vRAN is one of the candidates.
- Evaluate bottlenecks, difficulties and immaturity before implementing this new technology. Discuss feasibility with your incumbent and possible partners to better understand their capabilities. For incumbent CSPs to follow Rakuten's large-scale commercial adoption example, a thorough understanding of vRAN adoption is crucial.

Sample Vendors

ASOCS; JMA Wireless; Mavenir; Parallel Wireless; Radisys; Rakuten Symphony; Samsung Electronics

Gartner Recommended Reading

Quick Answer: How Can Tech Suppliers Stimulate 5G Open RAN/vRAN Commercial Deployments at Scale?

Emerging Technologies: Revenue Opportunity Projection of Open RAN/vRAN

Sliding into the Trough

5G Core

Analysis By: Peter Liu

Benefit Rating: Moderate

Market Penetration: 5% to 20% of target audience

Maturity: Early mainstream

Definition:

5G core is the mobile core entity in the 5G stand-alone (SA) mobile network. Based on 3GPP specifications, it handles a wide variety of essential functions, such as connectivity and mobility management, authentication and authorization, subscriber data management and policy management. 5G core is a mandatory component in 5G SA architecture. Its functions are completely software-based and designed as cloud native, which allows higher deployment agility and flexibility.

Why This Is Important

With 5G SA (enabled by 5G core), CSPs are able to offer the full suite of 5G network capabilities beyond enhanced Mobile Broadband (eMBB) such as ultra-low latency, network slicing, IoT and TSN. These capabilities unleash the full potential of 5G, accelerating monetization for CSPs. Moreover, the cloud-native and service-based architectures (SBAs) of 5G core can add more benefits to the already enhanced service, including flexibility and fast deployment, with lower costs.

Business Impact

5G core adoption has myriad benefits, including:

- Allowing CSPs to unleash full 5G capabilities beyond eMBB such as zero latency and ultra-high reliability
- Enabling network slicing to become a reality; allowing operators to allocate dedicated portions of the network for specific services or industries; catering to diverse requirements with customized performance characteristics
- Opening opportunities for CSPs to introduce new services and business models; leveraging capabilities of 5G networks such as network slicing, edge computing and ultra-low latency

Drivers

- CSPs gradually deploy 5G SA architecture to offer services linked to new 5G capabilities such as network slicing, edge applications, fixed/mobile convergence and ultra-reliable low-latency communications (URLLC). 5G core is mandatory for the SA deployment.

- CSPs continuously seek a more flexible, composable and economic core architecture. 5G core microservices architecture allows new vendors to enter the ecosystem without the burden of providing end-to-end solutions. This increases competition and innovation, with either best-of-breed vendors for each network element, or selection of vendors for fit-for-purpose use-case deployments.

- 5G core is based on SBA and leverages open API. It is a cloud-native design that is introduced to enable a new operating model that is agile and efficient. By modernizing their 5G core network infrastructure, CSPs can achieve greater automation, new scaling and resiliency models, and new methods of orchestration.

- Increasing interest in 5G private mobile networks, which are normally based on SA architecture, create new growth opportunities and market for 5G core.

- CSPs are continuously investing in intelligent automation in their network operations. 5G core NWDAF will play an essential role in the monetization of 5G and the realization of autonomous networks. By leveraging NWDAF to standardize data for use and analysis by 5G applications, CSPs can proactively manage the level of service and improve the 5G experience for end users.

Obstacles

- Implementation of 5G core requires upgrades to the existing network infrastructure. This includes deploying new hardware, upgrading software systems, adopting new cloud-native environments and process/operating models like CI/CD, and ensuring compatibility with multigeneration technologies. CSPs may face challenges in managing these changes and ensuring a smooth transition.

- Adoption of a 5G core network involves substantial investments in terms of infrastructure, equipment and licenses. Without clear business justification and ROI, many CSPs may prefer a slow transition by starting with 5G NSA, which will impact the 5G core demand.

- SBA and cloud-native architecture provide the 5G core network with more flexibility, but also trigger new service security concerns.

User Recommendations

- Gain support from the Board for 5G SA and 5G core deployment by communicating relevant business drivers and expected business value.
- Plan and develop your 5G SA strategy and roadmap centered on the 5G core. Ensure that the selected 5G core solution is able to support a smooth migration from NSA or can work with existing LTE networks.
- Focus on open and disaggregated architecture for 5G core solutions. Ensure your vendors' solution supports microservices architecture and multivendor integration. Pay attention to the underlying cloud environment requirements and challenges, and work closely with vendors across the network stack for efficient deployment and operations.
- Evaluate and test 5G core from nonincumbent vendors in a more contained, limited environment such as PMN — where use cases are likely to be more advanced than the public network, but with less capacity requirement and simple deployment.
- Engage in continuous real time testing and assurance and CI/CD pipeline management across vendors also key for success.

Sample Vendors

Ericsson; HPE; Huawei; Mavenir; Microsoft; NEC; Nokia; Oracle; Samsung; ZTE

Gartner Recommended Reading

Magic Quadrant for 5G Network Infrastructure for Communications Service Providers

Cloud and Hyperscaler Strategy Playbook for CSPs' 5G Networks

Communications Industry: 2023 Top Market Trends for CSP Tech Suppliers

Communications Industry: 2023 Top Tech Trends for CSP CIOs

Forecast Analysis: Communications Service Provider Operational Technology, Worldwide

NaaS

Analysis By: Ted Corbett, Gaspar Valdivia, Jonathan Forest, Lisa Pierce

Benefit Rating: Low

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Definition:

Network as a service (NaaS) is a standardized and highly automated delivery model for networking functionality. It offers support for dynamic scaling up and down of network resources. The NaaS vendor primarily owns and operates NaaS offerings. Pricing is on a pay-for-use basis, or as a subscription based on usage metrics. Typically, self-service interfaces — including an API and a user portal — are exposed directly to customers.

Why This Is Important

Many network service providers (NSPs) and non-NSPs are creating NaaS offerings for enterprises seeking consumption-based spending for networking — similar to what cloud offers for compute. Enterprise network equipment market spending is projected to reach $94 billion in 2023. This reflects a 6.1% five-year CAGR through 2027. New entrants see growing enterprise spending, while many incumbents seek to hold on, invest in their NaaS strategy and grow amid emergent competition.

Business Impact

Currently, some enterprises pursue a flexible, consumption-based networking model — regardless of user or application location. NaaS seeks to provide enterprises with agility, service delivery quality, automation and end-to-end customer experience — with up/down scalability and adaptive billing based on usage amid all-opex spending. Emerging NaaS providers' goal is to disrupt current customer sourcing norms. Over time, this disruption may expand enterprise buyer options and pricing models.

Drivers

- Many enterprises envision a future where complete life cycle network operations are delivered via a consumption-based, predictable spending model. This future would include their end-to-end networking estate spanning LAN, wireless-LAN, data center and WAN edge, for both on-premises or cloud-based network functions — including private 5G and other emerging network services.
- Buyers increasingly seek full life cycle management of their network estate, not simply all-opex network product procurement where operational leases (rentals) have long served the purpose of amortizing payment for networking products.
- The key drivers for an all-opex model for the enterprise have evolved. Enterprise buyers seek a greater focus on end users and their applications for improved service delivery quality, automation and predictable customer experience from the market. Also, WAN services from NSPs have evolved from enterprise locations to virtually any cloud-based provider or hosted endpoint. These continue to drive enterprise objectives for increased agility, more flexible consumption models and a seamless experience across their network consumption life cycle.
- In response to evolving enterprise needs, non-NSPs are seeking to drive revenue by pursuing their own emergent offers for NaaS.

Obstacles

- Most NaaS offerings in the market are limited to pricing/licensing changes. This confuses and frustrates customers, limiting true adoption.
- Compared to traditional pricing models, positive ROI models for a NaaS proposition do not yet exist.
- Enterprises entering into NaaS agreements hand over control of their network design and face full replacement of NaaS product components upon early or end-of-term-based exit events.
- Current NaaS offerings (primarily from NSPs) are not comprehensive, focusing on the provider's points of presence, where many NaaS components such as gateways and cloud connectivity bandwidth on demand reside.
- All-opex procurement is complicated by refresh timing of different network product technologies.
- Most NaaS offerings include network hardware, but do not meet the definition of NaaS and are not different from the vendor's labeling of current offerings as new; these packages are not owned and operated by the network vendor in this case, and are not NaaS offerings.

User Recommendations

IT leaders:

- Exert caution with NaaS due to widespread confusion created by the provider community.
- Procure network products more traditionally with financial leasing methods to smooth spending.
- Retain network design control by separately procuring kit as an operations lease and add managed operations.
- Calculate before and after ROI by capturing all in-scope costs and uniformly comparing proposals to identify the differences.
- Choose NaaS to achieve operational, lease-based network product spending when this is the primary goal, and you have a predictable consumption pattern.

Technology service providers:

- Build NaaS capabilities by investing in consumption-based, commercial models across LAN, WAN and cloud connect services.
- Build trust in NaaS by providing itemized pricing, standardized service definitions, and scale-up and down commercial flexibility.
- Prove to prospective buyers the value of NaaS offers by disaggregating proposals and providing detailed comparisons against alternative options.

Sample Vendors

Nile

Gartner Recommended Reading

What Is NaaS, and Should I Adopt It?

Magic Quadrant for Managed Network Services

Magic Quadrant for Network Services, Global

Navigating Emerging Network-as-a-Service Promises and Challenges

Early NaaS Pricing Lessons to Drive Adoption

5G

Analysis By: Sylvain Fabre

Benefit Rating: High

Market Penetration: 20% to 50% of target audience

Maturity: Early mainstream

Definition:

5G is the fifth generation cellular technology standard by the 3rd Generation Partnership Project (3GPP). The standard targets maximum downlink and uplink throughputs of 20 Gbps and 10 Gbps, respectively. Latency is as low as 4 milliseconds in a mobile scenario and can be as low as 1 millisecond in ultra reliable low-latency communication scenarios, down to centimeter-level location accuracy indoors, and massive IoT scalability. New system architecture includes core slicing and wireless edge.

Why This Is Important

5G supports the 4th industrial revolution and IoT. Its fast and reliable real-time data transfer will benefit many industries. 5G supports eMBB, URLLC and MIoT — vital for enterprise transformation. 3GPP 5G standards releases deliver incremental functionality in: R15, extreme mobile broadband; R16, industrial IoT (massive IoT, slicing and security) — latest commercially available release; R17, MIMO enhancements, sidelink, DSS, IIoT/URLLC, bands up to 71GHz, nonterrestrial networks; and RedCap R18 is under definition with a planned freeze date in 1Q24.

Business Impact

- 5G enables three main technology deployments; each supports distinct new services for multiple industries and use cases of digital transformation, and possibly new business models (such as latency as a service). These are enhanced mobile broadband (eMBB) for HD video, mMTC for large IoT deployments, and URLLC for high-availability and very low-latency use cases, such as remote vehicle operations.

- Promising applications for 5G use include fixed wireless access, IoT support and private mobile networks.

Drivers

- Over 249 operators have rolled out 5G (see GSA), 30% of public mobile networks, and some form of 5G capability is penetrating lower cost smartphones in vendors' portfolios (with over nine versions of the technology depending on the band and the 3GPP release).
- Gartner estimates that 5G-capable handset penetration in 2025 will reach 54% worldwide, and 78% in Western Europe, with 5G-capable handset share of sales reaching 80% in 2023 in Western Europe from 51% in 2021. North America share will rise to close to 87%.
- 5G capability is starting to deliver value in emerging always-on wearables use cases.
- Increased data usage per user and device requires a more efficient infrastructure.
- Requirements from industrial users value 5G lower latency from ultra reliable and low-latency communications (URLLC) and expect 5G to outperform rivals in this area.
- Demand continues for massive machine-type communications (mMTC) to support scenarios of very dense deployments up to the 5G target of one million connected sensors per square kilometer. While diverse networks can offer adequate and cost-effective alternatives to 5G for many use cases (e.g., LPWA, NB-IoT, LoRa, Wi-SUN), overall total cost of ownership (TCO) and future proofness may not be as good.
- Availability has increased for industry-specific spectrum options (e.g., CBRS).
- Competitive pressures continue, for example, if one CSP launches 5G in the market others usually have to follow or risk losing market share — this includes both public as well as private 5G offerings.

Obstacles

- Issues with availability and cost of spectrum, in particular for industrial private networks, occur in some countries.
- Security concerns arise when using 5G in critical industrial scenarios.
- Availability and pricing of networks and modules for R16 and beyond solutions.
- Upgrade to 5G SA (stand-alone) core is needed for more advanced R16 releases (such as slicing), and commit to the continuous evolution of 5G releases over R17, R18 and beyond.
- Cost of radio network upgrades for 5G coverage and availability may require additional sites.
- Use of higher frequencies and massive capacity requires denser deployments with higher frequency reuse, which could raise network costs.
- Uncertainty exists about use cases and business models that may drive 5G for many CSPs, enterprises, and technology and service providers (TSPs).
- Feedback from some industrial clients mentioned that the majority of their use cases could be serviced by a 4G private network, Wi-Fi and/or NB-IoT, and other LPWA such as LoRa.

User Recommendations

- Enable R16 and above 5G for enterprise connectivity for mobile, nomadic and FWA secondary/tertiary use cases for branch location redundancy, as long as 5G is not the primary link for high-volume or mission-critical sites and unless there are no other options.
- Provide clear SLAs for network performance by testing installation quality for sufficient and consistent signal strength, signal-to-noise ratio, video experience, throughput and coverage for branch locations.
- Ensure backward compatibility to 4G devices and networks, so 5G devices can fall back to 4G infrastructure.
- Focus on architecture readiness — such as SDN, NFV, CSP edge computing and distributed cloud architectures, and end-to-end security — in preparation for 5G.
- Build an ecosystem of partners to target industry verticals more effectively with 5G before your competition.

Sample Vendors

Ericsson; Huawei; Mavenir; Nokia; Qualcomm; Rakuten Symphony; Samsung Electronics; ZTE

Gartner Recommended Reading

Emerging Tech: 5G mmWave at a Crossroads

Infographic: 5 Steps for Vendors to Scope and Run Successful POCs for Enterprise 5G PMNs

Invest Implications: Magic Quadrant for 5G Network Infrastructure for Communications Service Providers

Market Guide for 4G and 5G Private Mobile Networks

Quick Answer: What Vendor Product Leaders Need to Know About MWC Barcelona 2023

Open RAN

Analysis By: Kosei Takiishi

Benefit Rating: Moderate

Market Penetration: 1% to 5% of target audience

Maturity: Early mainstream

Definition:

Open RAN indicates disaggregated interoperable RAN using open interface specifications on 4G/5G infrastructure. Open RAN focuses on the multivendor integration that includes an open fronthaul interface between remote radio head (RRH) and baseband unit (BBU), standardized by the O-RAN ALLIANCE. Open RAN does not cover radio intelligent control (RIC) and vRAN. This also covers proprietary interoperable RAN by some Tier 1 communication service providers (CSPs) that have commercialized in the past.

Why This Is Important

With open RAN which aims at multivendor interoperable RAN, CSPs can source different RAN elements from different vendors. This theoretically can help them to avoid locking on a vendor’s proprietary solution, increase flexibility and optimize cost. While open RAN vendors are newly emerging, supported by the O-RAN ALLIANCE and Telecom Infra Project (TIP), they could become a potential rival against incumbent vendors and accelerate the infrastructure modernization and innovation.

Business Impact

Open interface can achieve best-of-breed vendor selection by balancing features and cost. Most 5G commercial deployments still lead to vendor lock-in due to difficulty of multivendor integration over 5G non-stand-alone (NSA) architecture that requires anchors on 4G network. Tier 1 CSPs, like NTT DOCOMO and Verizon, commercialized open fronthaul interfaces in a proprietary way, but the global adoption did not spread. Telecom industry now promotes standardized open RAN across all its components.

Drivers

- Standardization bodies and related consortiums with strong CSP participation, such as the O-RAN ALLIANCE and TIP, have been promoting open RAN by creating new specifications and accomplishing interoperability testing.
- Early commitment by greenfield CSPs, including Rakuten Mobile and DISH, can contribute to open RAN maturity and vendor ecosystem expansion.
- Governmental efforts to promote more diversified and/or local vendor ecosystems have considered open RAN as an area for potential support.

Obstacles

- Current open RAN solutions are not as mature as classic purpose-built base station equipment; and it might take at least two to three years to be useful (e.g., performance gap, total cost of ownership [TCO] reduction).
- Insufficient experience and poor integration power by CSPs related to open RAN. CSPs need to decide how to assure and promote the multivendor integration.
- Continuing work to address security concerns, particularly in open RAN interfaces.
- For CSPs with large legacy networks, transitioning to open RAN will be a lengthy process and limits early market scale, making large investments by incumbent vendors less attractive, particularly those hesitant to cannibalize their existing RAN equipment markets.

User Recommendations

- Define your open RAN adoption scenario by discussing the feasibility with your incumbent network vendors and as well as new vendor partners.
- Enrich your open RAN strategy by learning from vendors you have never selected or met before.

Sample Vendors

Airspan Networks Holdings; Baicells; Comba Telecom Systems Holdings; Fujitsu; Mavenir; MTI; NEC; Rakuten Symphony; Samsung Electronics; STL Tech

Gartner Recommended Reading

Quick Answer: How Can Tech Suppliers Stimulate 5G Open RAN/vRAN Commercial Deployments at Scale?

Emerging Technologies: Revenue Opportunity Projection of Open RAN/vRAN

Network AI and Automation

Analysis By: Pulkit Pandey

Benefit Rating: High

Market Penetration: More than 50% of target audience

Maturity: Mature mainstream

Definition:

Network AI and automation combine multiple technologies including but not limited to data analytics, artificial intelligence (AI), machine learning (ML), orchestration, robotic process automation (RPA) and artificial intelligence for IT operations (AIOps). Together, these technologies enable CSPs to use deep knowledge about the network to power the adaptive automation of their services and operations.

Why This Is Important

Network intelligence empowers rapid end-to-end business or operation process automation complemented by sophisticated algorithms, leading to better efficiency, faster response and improved productivity. In addition, it introduces scalability and flexibility to meet the diversified requirement of more complex and dynamic network technologies. It also enables the extraction of actionable insights to provide better customer experiences and support new businesses with precision and in adaptive ways.

Business Impact

Network AI and automation benefit CSPs in:

- Enabling real-time network optimization, predictive maintenance and more adaptive networks to support business agility.
- Improving the productivity of employees, minimizing repetitive tasks and enabling employees to focus on innovation and creativity.
- Improving operational efficiency and agility, lowering operating costs, and shortening the time of response.
- Gaining customer insight that might lead to improved customer satisfaction and revenue.

Drivers

- More network equipment vendors have started to embed “intelligent and automation” capabilities into their solutions. The emergence of the relevant algorithm, tools and technologies accelerates the adoption.
- The adoption of AI in networks is gaining speed, as CSPs are accepting a shift from a use-case-based approach to a more stable platform-based approach.
- CSPs’ network environment is growing increasingly complex with the introduction of such technologies as network function virtualization (NFV), software-defined networking (SDN) and cloud-native distributed architecture enabling the development of on-demand services and network slicing. Existing network management and operation systems lack the scale and flexibility to meet the requirements of these more dynamic network technologies.
- The COVID-19 pandemic and headwinds in the economy refocused network infrastructure on resilience, which for many resulted in accelerating the intelligent automation agenda.
- Maturing and expanding data science initiatives, better algorithms, more cost-effective computing power, and a substantial increase in available network data support the emergence of intelligent techniques.
- The use of intelligent automation will transform how IT and network infrastructure is delivered and supported, including delivering more agility to address resource demand, which is attractive for CSPs that are building next-generation operation and management platforms.
- The rise in connected endpoints driven by the IoT, as well as 5G, will also require automation to improve network KPIs and allow automation of maintenance tasks and energy savings.

Obstacles

- Although automation is not a new idea in the telcos, adding AI to the process cycle is a relatively new concept. Management and frontline employees sometimes have misconceptions about what they should expect as AI becomes part of their work lives.
- Lack of skills in either IT or telecom processes acts as a hurdle in the process.
- The accuracy of algorithm models is limited by the completeness and accuracy of the data being used. Fragmented data and data quality are always major concerns of successful intelligent-based automation adoption.
- The multivendor, multilayer and cross-domain environment challenges network automation and intelligent implementation.
- Most of today's network AI and automation projects have a tactical approach that is difficult to scale due to the lack of cross-domain orchestration and collaboration, thus creating internal-technology-based silos. In addition, data unification and lack of sufficient data is also a challenge among vendors and CSPs.

User Recommendations

- Select initiatives that align with your organization-level strategy by including BU heads to ensure transparency and accountability.
- Enhance network intelligence and automation capabilities through investments in advanced technologies like analytics, AI/ML, low-code platforms, API-centric SaaS and decision intelligence (DI) and generative AI.
- Improve the efficiency of the network automation process before introducing AI, because introducing intelligence on top of an inefficient automation process nearly always leads to a worse situation.
- Build a transformational mindset for AI and automation across the network operation and management team by accelerating AI skills and talent development.
- Establish an automation roadmap by requesting intelligent capabilities in vendors' products, or consider how to develop internal capabilities that can create this intelligent automation.
- Enhance context awareness by establishing cross-siloed visibility and a strong data foundation for intelligence.

Sample Vendors

Amdocs; AsiaInfo Technologies; Cisco Systems; Ericsson; Huawei; Juniper Networks; Netcracker; Nokia; P.I. Works; ZTE

Gartner Recommended Reading

Market Guide for AI Offerings in CSP Network Operations

How Can The Telecom Sector Be Successful With AI?

AI Vendors Selling to CSPs: Your Guide to an Effective Solution Packaging

400G Transport

Analysis By: Peter Kjeldsen

Benefit Rating: Moderate

Market Penetration: 20% to 50% of target audience

Maturity: Early mainstream

Definition:

400G transport is a long-distance networking solution typically implemented in combination with wavelength division multiplexing (WDM) optical infrastructure. The main incentives to upgrade from 100G to 400G wavelengths are lower total cost and energy consumption.

Why This Is Important

The exponential demand for connectivity and bandwidth, driven by cloud computing, video streaming, generative AI, Internet of Things (IoT) and 5G, are pushing the limits of existing 100G optical transport networks. Communication service providers (CSPs) are increasingly adopting 400G transport as a pragmatic solution to scale their optical transport networks in a cost-effective and energy-efficient way.

Business Impact

400G-capable transport solutions are suitable for high-volume CSPs, large data centers and enterprises with high traffic growth. 400G enables a new level of scale compared to 100G, reducing transport and operational costs with fewer transponders to deploy and delivering a significant reduction in footprint and energy consumption per bit.

Drivers

- Massive growth in cloud computing, video streaming, generative AI and 5G continues to drive an exponential demand for high-bandwidth, scalable solutions that require 400G techniques and architectures.
- CSPs like AT&T, Bell Canada, Colt Technology Services, Deutsche Telekom, Lumen Technologies and Telstra are deploying 400G transport solutions in their networks, both to cater to growth in aggregate traffic and to offer 400G wavelength services.
- Maturing and advancing 400G optical technologies in transmission, optical line amplification and reconfigurable optical add/drop multiplexer (ROADM) switching technologies are supporting the emergence of 400G transport adoption.
- There is significant demand for high-speed transport to support customer expectations for direct cloud connections and interconnections with increased usage of infrastructure as a service (IaaS), platform as a service (PaaS) and SaaS.

Obstacles

- Depending on distance and other factors the upgrade to 400G may require some redesign of the optical network infrastructure.
- There are lower channel bitrate alternatives to 400G, for example, 200G, which will not offer the same scalability but offer a more incremental upgrade path. These may delay the adoption of 400G.

User Recommendations

- Conduct an assessment of your existing transport network infrastructure and establish a 400G upgrade path with a 12- to 36-month adoption strategy, aiming to assess the potential economics and technical optimization over current 100G and lower-speed transports.
- Work closely with vendors and standardized organizations to understand the technology progress trends and learn from best practices. Consider running proof of concepts (POCs) and test 400G in lab or pilot environments.
- Define the long-term evolution path of your optical transport network and evaluate 400G as a possible milestone in your evolution journey.

Sample Vendors

Adtran Networks; Ciena; Cisco; Fujitsu; Huawei Technologies; Infinera; NEC Group; Nokia; ZTE

Gartner Recommended Reading

Predicts 2023: CSP Technology and Operations Strategies

Communications Industry: 2023 Top Market Trends for CSP Tech Suppliers

Communications Industry: 2023 Top Tech Trends for CSP CIOs

DOCSIS 4.0

Analysis By: Peter Kjeldsen

Benefit Rating: High

Market Penetration: 1% to 5% of target audience

Maturity: Adolescent

Definition:

DOCSIS 4.0 is the latest version of Data Over Cable Service Interface Specification standard published by CableLabs. Similar to prior versions, DOCSIS 4.0 is a hybrid fiber coax (HFC) technology that allows cable operators to extend the useful life span of their existing coax infrastructure and continue to compete in the fixed broadband access market. DOCSIS 4.0 offers downstream and upstream capacities of up to 10 Gbps and 6 Gbps, respectively.

Why This Is Important

- Cable operators need to respond to competition from fiber to the home (FTTH) and 5G fixed wireless access (FWA), and cater to increasing volumes of data from video, gaming and others.
- DOCSIS 4.0 offers cable operators with a logical upgrade path from DOCSIS 3.1.
- DOCSIS 4.0 increases the downstream and upstream capacities to 10 Gbps and 6 Gbps, respectively.
- Upgrading existing HFC infrastructure is less capital expenditure (capex) intensive and offers faster time to market than a full FTTH rollout, as it leverages existing cabling infrastructure.

Business Impact

Cable operators can benefit from DOCSIS 4.0:

- Provide cable operators with a cost-effective alternative to FTTH.
- Cable operators can leverage DOCSIS 4.0 to better support higher bandwidth services, with improved downstream and upstream capabilities supporting symmetrical services.
- It allows cable operators to protect existing average revenue per unit (ARPU) and prevent churn, as it can potentially unlock higher ARPU, such as through service offers targeting small and midsize businesses (SMBs).

Drivers

- DOCSIS 4.0 offers cable operators a natural upgrade path from DOCSIS 3.1 to revamp their existing coax infrastructure to compete against communication service providers (CSPs) deploying FTTH and 5G FWA.
- Upgrading existing HFC infrastructure reduces capex requirement compared to replacing the entire coax infrastructure with fiber.
- Growing interactive services, such as online gaming, video conferencing and cloud computing, are generating more symmetrical traffic. DOCSIS 4.0 is well-positioned for symmetrical and high-bandwidth upstream services.

Obstacles

- While DOCSIS 4.0 offers an upgrade path that leverages existing HFC infrastructure to compete against FTTH, the transmission properties of coax and fiber cables mean that coax cable infrastructure will offer less bandwidth scalability than fiber-based infrastructure.
- It is unclear what the DOCSIS technology roadmap will offer beyond DOCSIS 4.0. This is in contrast to 50G and 100G passive optical networks (PONs) which are already in the FTTH technology roadmap.
- The operating expenditure (opex) of DOCSIS 4.0 will be higher than for FTTH, due to the presence of active electrical components in DOCSIS 4.0 infrastructure compared to passive optical components in FTTH infrastructure.
- Hesitation from cable operators caused by uncertainties regarding the adoption of either Full Duplex (FDX) DOCSIS or Extended Spectrum (ESD) DOCSIS flavors of DOCSIS 4.0.
- Cable operators opting to become virtual network operators (VNOs) on wholesale fiber infrastructure instead of upgrading existing coax infrastructure.

User Recommendations

- Evaluate DOCSIS 4.0 as a possible upgrade path for DOCSIS 3.1 infrastructure — and compare it against an alternative investment in FTTH. Also consider that a DOCSIS 4.0 investment has potential as a possible stepping stone toward a later transition to FTTH since the fiber cables that are replacing part of the coax cables, when upgrading to DOCSIS 4.0, can possibly be leveraged later as part of an FTTH infrastructure.
- Make sure to evaluate both capex and opex aspects of the different choices, to ensure a full cost-of-ownership perspective when comparing DOCSIS 4.0 against FTTH and 5G FWA.

Sample Vendors

Casa Systems; Cisco; CommScope; Harmonic; Vecima Networks

Gartner Recommended Reading

Predicts 2023: CSP Technology and Operations Strategies

Communications Industry: 2023 Top Market Trends for CSP Tech Suppliers

LEO Satellite Communication Services

Analysis By: Bill Ray

Benefit Rating: Moderate

Market Penetration: 5% to 20% of target audience

Maturity: Emerging

Definition:

Low earth orbit (LEO) satellites operate at an altitude of less than 4% of the distance compared to a traditional communication satellite. Connecting to satellites in LEO uses significantly less power, supporting low latency and faster data. However, coverage requires a large number of satellites, most of which will have a limited life span. Several companies have launched LEO services for broadband internet access, while others are focused on low-speed (and low-power) IoT connectivity.

Why This Is Important

Innovations from the smartphone industry, along with lower launch costs, make LEO constellations economically viable. The orbit makes power consumption and latency comparable to terrestrial services. As of 2Q23, Starlink is providing internet access to a million customers and OneWeb is providing global connectivity to enterprises. Other operators (including Amazon) are still working toward commercial services.

Business Impact

LEO services make broadband internet and IoT data globally available. Companies and employees can assume that internet access and IoT sensing will always be available, which would remove network access as a limit on locations to work or live. Geography will cease to be a factor in recruiting the best staff and supporting the most profitable customers. This connectivity is extending to include airplanes, ships and sea platforms, creating a ubiquitous internet (and corporate intranet).

Drivers

- LEO satellite constellations are being launched to address two distinct markets: broadband internet access and low-power IoT connectivity. These markets are being addressed by different companies using different constellations, as the requirements are quite distinct. Other customers include airlines, ships and the military.

- Satellite broadband is relatively expensive (SpaceX's Starlink charges $99 per month, plus $499 for installation) and won't compete with already installed fiber to the cabinet or home. However, we have calculated that there are enough homes without connectivity to sustain the Starlink service with reasonable penetration.

- LEO satellites can also provide backhaul for cellular services — a single satellite uplink can provide connectivity to a cell tower providing 5G, 4G, Wi-Fi or any other local access technologies. This reduces the cost of network deployment for cellular operators, extending coverage into areas that have previously been economically impossible.

- As of 2Q23, Starlink and OneWeb are both offering commercial services. But these will need to compete with offerings from Amazon's Project Kuiper network, as well as competing projects such as E-Space, SATNet and Telesat.

- The 3rd Generation Partnership Project (3GPP) is creating standards for integrating LEO services with terrestrial networks, initially for narrowband (IoT and messaging), but in recognition that supplementary coverage from space (SCS) will become an increasingly important factor in providing global connectivity.

- IoT connectivity is a different market, focusing on low cost and low power to provide global asset monitoring and tracking. While asset tracking remains the primary application, condition and environmental monitoring will also be an important use case.

Obstacles

- To provide oceanic and remote region coverage (needed by military customers), satellite-to-satellite (intraconstellation) links are required. Starlink is testing such connections, but other constellations are still at the planning stage.
- Customer equipment currently costs more than $1,000, and subscription costs will vary widely between providers.
- Maintaining 30,000 satellites, with a life of five years, requires 500 new satellites per month. Current launch vehicles, such as SpaceX's Falcon 9, can launch 60 satellites at a time. This will not be sufficient, so larger launch vehicles (such as SpaceX's Starship or Blue Origin's New Glenn) will be needed.
- Satellite operators are required to avoid interfering with incumbent deployments, limiting the radio spectrum they can use. We expect that radio spectrum access will become a key point of negotiation, and perhaps litigation, in the next five years.

User Recommendations

- Exploit the rapid development of LEO services by adding satellite connectivity into strategic workforce and business planning.
- Prepare for international availability by liaising with local regulators and resellers. LEO services are inherently global, so these will spread internationally as quickly as regulators will allow.
- Protect investment by validating the technical and financial ability of your provider to launch and maintain its constellation.
- Mitigate against requirements for proprietary equipment by planning for a reinstallation in five years, allowing for updated equipment or a change of satellite service provider.

Sample Vendors

Astrocast; Myriota; OneWeb; SpaceX

Gartner Recommended Reading

Maverick* Research: LEO Satellites Will Trigger the Revolution That 5G Has Failed to Deliver

3 World-Changing Opportunities Emerged While You Were Fighting COVID-19

Private LTE

Analysis By: Sylvain Fabre

Benefit Rating: High

Market Penetration: 1% to 5% of target audience

Maturity: Adolescent

Definition:

Private LTE is a private wireless network based on 4G/Long Term Evolution (LTE) technology infrastructure, which interconnects people/things in an enterprise setting. It can use a licensed CSP spectrum or a shared spectrum independent of CSPs' networks. 4G/LTE can support voice, video, messaging, broadband data and IoT, typically only available to enterprises' own authorized SIM cards, thereby increasing security with predictable performance because the infrastructure is not publicly shared.

Why This Is Important

Enterprises can customize their own private LTE with specific SLAs, enabling networks for mission-critical, latency-sensitive applications. This can be implemented either using a licensed communications service provider (CSP) spectrum, or with a shared spectrum — to avoid interference and contention in the often-congested public wireless spectrum. Private LTE also enables wireless coverage in areas where CSPs do not provide adequate coverage from public infrastructure.

Business Impact

Industry verticals are seeking private connectivity on demand to support their premises and specialized applications. A private LTE network is perceived as one aspect of increasing productivity and reducing costs by providing cellular coverage in areas where it is not commercially available. Shared spectrum access allocations such as CBRS (in the U.S.), and dedicated spectrums such as Japan's sXGP and Australia's Band 3, are seeing CSPs and their suppliers compete directly, as CSPs no longer have exclusive, licensed ownership of spectrum resources.

Drivers

- Various industries have already deployed other wireless technologies such as Wi-Fi and non-3GPP low-power wide-area (LPWA) networks, but these cannot assure high data throughput, mobility and reliable communication like private LTE does.
- TSPs are developing private LTE solutions to offer directly to enterprise customers, in addition to selling through CSPs.
- Private LTE is shaping up as a viable option for enterprise mobility, especially since implementation does not require the CSP and can be implemented either by a service provider, a vendor, an SI or emerging competitors such as hyperscale cloud providers.
- Increasing availability of CBRS and dedicated spectrums such as Japan's sXGP and Australia's Band 3 increases the number of potential providers, because CSPs, their suppliers and SIs now compete directly since CSPs no longer have exclusive, licensed ownership of spectrum resources.

Obstacles

- Backhaul may still be needed from the remote implementation to the provider's network.
- There are concerns about coexistence with private 5G, and whether to launch private LTE over CBRS.
- There is a lack of private spectrum availability in some geographies.
- There is a lack of clarity on the business case for private LTE deployment.

User Recommendations

- Differentiate yourself against the widening choice of suppliers, such as vendors and integrators, by supporting national roaming in your private LTE offerings.
- Include voice over LTE (VoLTE), video, messaging and Rich Communication Services (RCS) in private LTE solutions.
- Differentiate as a CSP by bundling your offerings with other value-added technologies, such as agile and scalable network, SIM management, self-healing, closed loop automation and national roaming.
- Develop customized private LTE network configurations for various vertical industries by investing in an ecosystem of partners.
- Clarify your technology and coverage roadmap from 4G to 5G (4G/LTE is the generation prior to 5G) such that disruption is minimal and interference is managed in scenarios that include coexistence of these technologies in the same industrial campus.

Sample Vendors

AT&T; China Mobile; Druid Software; Ericsson; Hewlett Packard Enterprise (Athonet); Huawei; Nokia; Vodafone Group; ZTE

Gartner Recommended Reading

Quick Answer: What Metrics Can TSPs Consider for Their Private Mobile Network Solution Development?

Infographic: 5 Steps for Vendors to Scope and Run Successful POCs for Enterprise 5G PMNs

Market Guide for 4G and 5G Private Mobile Networks

Tool: Attractiveness Index for Private Mobile Networks Technologies

Gartner Attractiveness Index for Private Mobile Networks Technologies

eSIM

Analysis By: Pablo Arriandiaga

Benefit Rating: Transformational

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Definition:

The embedded SIM (also called eSIM or eUICC) is a programmable subscriber identity module (SIM) that is physically embedded into a mobile or IoT device. It is designed to remotely manage multiple CSPs profiles and be compliant with GSMA specifications. An eSIM is provisioned over the air (OTA) with operator credentials, giving users the ability to change providers. Dominant applications include international roaming and IoT connectivity.

Why This Is Important

Enterprises, OEMs and communication service providers (CSPs) need common standards for mobile and IoT connectivity that enable them to scale their business while reducing costs. More than 200 mobile network operators (MNOs) support eSIM. Leading smartphone and laptop manufacturers such as Apple and Samsung support eSIM in their new devices. Adoption is accelerating, mainly in consumer devices, driven by use cases such as wearables, where mobility and life cycle are important.

Business Impact

- **Smartphones, tablets and PCs —** eSIM enables the user to switch between mobile operators without removing the physical SIM from the device.
- **Wearable devices —** eSIM (and an embedded radio module) removes the dependence on smartphones as IoT gateways, making wearable devices always-connected IoT devices.
- **IoT —** eSIM enables industry transformation, standardizing the manufacturing process and simplifying device activation, no matter which country the product is delivered to.

Drivers

- Main device manufacturers like Apple and Samsung support eSIM both in their latest smartphones and wearables and vendors like Xiaomi or Oppo only have a few eSIM compatible phones. The U.S. model of Apple's iPhone 14 has no physical SIM slot, being entirely reliant on eSIM. eSIM shipments for 2022 were 382 million with a 13% year over year (YoY) increase as reported by the Trusted Connectivity Alliance (TCA).

- The eSIM is significantly smaller than removable SIMs, making it attractive in constrained devices including wearables and smartphones. It also removes the need for a hole in the product case, making eSIM devices more robust and easier to waterproof.

- For consumers and enterprises this is opening up new scenarios for travelers making access to local voice and data connectivity out of their home countries easier. Along with easily adding personal profiles to enterprise phones or offering an alternative to users that struggle with coverage problems in certain areas.

- In IoT, one of the main drivers is giving car manufacturers the ability to remotely swap the profiles simplifying the manufacturing process. In IoT, most use cases are still using eSIM as insurance to avoid future lock-in and improve future contract negotiations. Other industry-verticals such as utilities and logistics are also driving adoption as well, though reported eSIM connections by participants in Gartner's Magic Quadrant for Managed IoT Connectivity Services, Worldwide is still low.

- In IoT, multinationals are looking for a cost-effective way of integrating the IoT connectivity platform with other IoT and internal business systems and accessing local connectivity at the same time. Specialized providers that act as composable IoT connectivity hubs for CSPs and enterprises around the world could accelerate adoption if they are able to add as many local MNOs as possible, including commercial agreements, not just technical integration.

- For CSPs, facilitating digital transformation of SIM provisioning with eSIM, driving customer engagement and reducing SAC (subscriber acquisition cost).

Obstacles

- Consumers and enterprises have a lack of eSIM awareness and MNOs are not actively promoting eSIM benefits.
- Integration of eSIM across the back-office processes of MNOs for consumers is painful. Factors like device OS, or moving from physical to virtual SIM status, or integration with the MNO digital channels, is generating weak responses from MNO's customer support departments that generate frustration.
- The European standards still require a removable SIM in smartphones. This can be in addition to an eSIM (as seen in various models) but a physical SIM is still required until the standards are updated.
- In IoT, most managed IoT connectivity service providers are testing the new SPG.31 version of the standard released in 2022 by 3GPP, that is reusing most of the consumer architecture to simplify the current complexity of eSIM for IoT and also addresses some of the challenges regarding SMS and NB-IoT and battery constrained devices. GA releases if this new version will require some time to mature.

User Recommendations

Recommendations will vary, depending on the type of user:

- **Enterprises** — Evaluate the eSIM service CSPs or MVNOs offer acting as prime contractors by assessing MNOs supporting each by country including version of the standard supported, and interoperability with other eSIM subscription management platforms with special focus on NB-IoT support.
- **OEMs** — Promote eSIM in designs where its advantages are attractive (e.g., swapping cellular providers regularly across countries) and with big amounts of data by working with the GSMA and CSPs to present end users with a superior solution and a balanced playing field for new and innovative offers.
- **CSPs** — Leverage the flexibility of eSIM to attract new customers with superior service offerings that also motivate existing users to stay by, for example, eliminating per-device fees and instead bundling in content, wearables and more. eSIMs provided by CSPs to customers are particularly attractive for customers who regularly travel, allowing them to stay connected easily wherever they go.

Sample Vendors

Aeris Communications; Amdocs; Giesecke+Devrient; IDEMIA; Kigen; Pelion; Soracom; Thales; Truphone; Wireless Logic

Gartner Recommended Reading

Magic Quadrant for Managed IoT Connectivity Services, Worldwide

Critical Capabilities for Managed IoT Connectivity Services, Worldwide

Industry Insight: Composable IoT Connectivity Will Revolutionize Managed IoT Connectivity Business

Market Share: PCs, Tablets and Mobile Phones, All Countries, 1Q23 Update

Market Guide for IoT Mobile Virtual Network Enablers

High-Altitude Platforms

Analysis By: Bill Ray

Benefit Rating: Moderate

Market Penetration: Less than 1% of target audience

Maturity: Adolescent

Definition:

High-altitude platforms (HAPs) provide communication and, sometimes, observation services from the stratosphere (between 10 km and 50 km altitude). Platforms are generally (but not always) unmanned, requiring autonomous piloting and long flight times while operating in extremely cold conditions. Successful deployments are rare, despite significant investment, and the technology remains largely experimental.

Why This Is Important

Increasing demand for ubiquitous data services, and the transformative effect of global internet access, continue to generate investment in HAPs. The concept is deceptively simple, with balloons, blimps, airships or winged aircraft autonomously flying overhead while being rotated into service by a supporting ground crew. The return on investment is easily calculated and the social impact is enormous, enabling innovative companies to raise funds for experimental deployments.

Business Impact

HAPs can compete with terrestrial cellular services, though are often deployed by the same companies to provide extended network coverage. HAPs can also compete with satellite services, particularly the new generation of low Earth orbit (LEO) constellations focused on providing high-speed, low-latency communications. HAPs are much cheaper to deploy than satellites, and can be recovered and reused throughout their lifetime providing 4G, 5G or 6G network coverage. However, their operational costs are higher.

Drivers

- Military use of HAPs for temporary deployment over areas of interest to provide communications and observation is well understood. The Stratovision project broadcast (political propaganda) from high altitude in the 1940s and manned aircraft, such as the Proteus aircraft launched in 1998, can provide communication relays from high altitude.
- Modern military systems use disposable balloons and radio equipment for temporary network coverage. Civilian emergency deployments generally use low-altitude, tethered systems.
- Mobile coverage remains a significant challenge, despite the increased allocation of radio spectrum and huge investments from mobile network operators. Cell towers have limited reach and even the most developed markets have not-spots where network coverage is unavailable, particularly in rural areas.
- The objective of many HAPs projects is rural connectivity in developing countries, often supported by government subsidies.
- Internet access can quickly improve productivity while increasing opportunities for education and healthcare.

Obstacles

- While the HAPs concept is simple, the execution is not, and many systems fail in the detail with aspects such as wind patterns, intellectual property and hardware reliability, providing unexpected challenges.
- The thin atmosphere at stratospheric altitudes results in very cold conditions, but (conversely) also presents problems in heat dissipation similar to those experienced by a satellite in orbit.
- It is difficult to manage the cycling of aircraft that aren't designed to operate at low altitudes. HAPs must land, be refurbished and take off, which presents a huge challenge for gossamer-winged solar aircraft or billowing plastic balloons.
- Extended operational flight time is essential, and has proven to be the downfall of all the commercial systems so far attempted.
- The Loon project (a sibling of Google) provided a great deal of information on the technical challenge. The Loon Library should be required reading for anyone considering investment in HAPs including those listed above.

User Recommendations

- Calculate the value of new developments from the impact on operational flight time and costs, not data throughput, as data rates are relatively easy to increase.
- Examine companies offering highly autonomous operations, as staffing costs will be critical and the complexity of integrating those staff with existing operations must be considered.
- Avoid being seduced by high-profile investment in HAPs, even when accompanied by impressive graphics.
- Compare backhaul and data services to those available from LEO satellite constellations, as these could seriously undermine the HAPs' business model.

Sample Vendors

Airbus; Raven Aerostar; Stratospheric Platforms

XGS-PON

Analysis By: Peter Kjeldsen

Benefit Rating: High

Market Penetration: 20% to 50% of target audience

Maturity: Early mainstream

Definition:

XGS-PON is an International Telecommunication Union (ITU) standard for passive optical network (PON) that can support up to 10 Gbps symmetrical data transfer over a single wavelength. The support of higher bit rate symmetrical services opens new opportunities to increase average revenue per unit (ARPU), for example, by targeting small and midsize businesses (SMBs).

Why This Is Important

XGS-PON can support high ARPU opportunities for communications service providers (CSPs), enabling them to expand their addressable market from home-office/small-office customers to large enterprises that need symmetrical services. Cost-conscious CSPs are looking for a balance between near-term investment and long-term strategy. XGS-PON can coexist with existing gigabit passive optical network (GPON) solutions and support upgrades to future 50G PON solutions, making it a natural technology cycle in a longer PON evolution journey.

Business Impact

CSPs can benefit from XGS-PON:

- XGS-PON allows CSPs to provide higher bandwidth to premium subscribers, such as enterprises and high-end residential users which leads to a higher ARPU.
- CSPs can leverage XGS-PON to better support symmetrical and high-bandwidth upstream services, becoming one of the key marketing opportunities.
- XGS-PON can be used for mobile backhaul as well as the aggregation of remote access node traffic, which is key for 5G rollout.
- XGS-PON is a future-proof standard that can coexist with existing GPON.

Drivers

- Increasing investment in digital infrastructure assets and fiber broadband from government and CSPs further drive the PON market growth, and XGS-PON is a key beneficiary.
- Growing interactive services, such as online gaming, video conferencing, and cloud computing, as well as B2B use cases for SMBs, will generate more symmetrical traffic. It’s apparent that, in the long term, optical access will have to evolve toward symmetrical traffic transport. Therefore, XGS-PON, which provides symmetrical and high-bandwidth upstream services, increasingly becomes a crucial differentiator and an enabler for the next market opportunity.
- Declining XGS-PON equipment costs, the need to differentiate against competition and the promise of new revenue — for both residential and nonresidential applications — are leading many CSPs to deploy XGS-PON.

Obstacles

- The main obstacle in switching from legacy GPON technology to XGS-PON has been the cost of equipment. The XGS-PON technology itself is technically mature and standardized.
- GPON is considered sufficient for most of today’s residential use cases, and there is still hesitancy to upgrade from GPON to XGS-PON for some CSPs.
- Competition from other similar standards like IEEE’s 10G EPON and the ITU-T XGS-PON.

User Recommendations

- Evaluate XGS-PON as a possible upgrade to existing GPON deployments, as part of a coherent PON technology roadmap, that can address multiple business objectives as demand for fixed access bandwidth evolves.
- Take a stepwise approach and start with a limited deployment in areas that have strong network performance requirements by providing an XGS-PON broadband service and current GPON service simultaneously in the same network. This reuses existing network equipment and the optical distribution network, eliminating the need to change the existing fiber network or take up extra floor space.
- Explore using XGS-PON for 5G backhaul as part of a fixed mobile convergence strategy.
- Explore business opportunities in the enterprise market that are enabled by XGS-PON deployment.
- Expand from home-office/small-office customers to large enterprises that need symmetrical services.

Sample Vendors

Adtran; Calix; Ciena; CommScope; DZS; FiberHome Telecommunication Technologies; Huawei Technologies; Nokia; ZTE; Zyxel Networks

Gartner Recommended Reading

Predicts 2023: CSP Technology and Operations Strategies

Communications Industry: 2023 Top Market Trends for CSP Tech Suppliers

Communications Industry: 2023 Top Tech Trends for CSP CIOs

Climbing the Slope

LTE-A Pro

Analysis By: Kosei Takiishi

Benefit Rating: High

Market Penetration: 20% to 50% of target audience

Maturity: Early mainstream

Definition:

Long Term Evolution Advanced (LTE-A) Pro, defined by 3rd Generation Partnership Project (3GPP) Release 13 and later, was intended to mark the time when the LTE platform was dramatically enhanced to address new markets and add functionality to improve efficiency. This release 13 standardization was frozen in 2Q16. Its technical targets are at a peak rate of more than 3 Gbps with a delay of less than 2 ms.

Why This Is Important

As of December 2022, there are over 200 communication service providers (CSPs) investing in LTE-A Pro based on the Global mobile Suppliers Association (GSA). CSPs' LTE networks support 3GPP release 13 or 14 LTE-A Pro features, for example, those making use of carrier aggregation of large numbers of channels and 4x4 multiple input/multiple output (MIMO) to massive MIMO. LTE-A Pro can be utilized as a bridge between 4G LTE and 5G as 5G has been commercialized by most leading CSPs.

Business Impact

LTE-A pro offers higher uplink and downlink speeds and better capacity for existing smartphone users by aggregating many more frequency bands and deploying more antennas at base stations or devices. Improved user experience on 4G only devices as well as when 4G is a fall back from 5G, LTE-A pro can provide better competitive positioning and more spectral efficiency than earlier versions of 4G LTE.

Drivers

LTE-A pro provides a range of capabilities for CSPs to achieve network capacity increase and new business support by LTE-A pro with the completion of release 13 and 14 include:

- Machine-type communications enhancements, such as long-term evolution machine type communication (LTE-M) and narrowband Internet of Things (NB-IoT)

- Public safety features, such as device-to-device (D2D) and D2D proximity services (ProSe)
- Small cell dual connectivity and architecture
- Carrier aggregation enhancements
- Interworking with Wi-Fi and licensed assisted access (at 5 GHz)
- 3D/full dimension (FD) MIMO
- Indoor positioning
- Single-cell point to multipoint
- Latency reduction

Obstacles

- Hesitation in continuing to invest in previous generations including LTE-A pro amid shift to 5G investment.
- Chronic radio spectrum bandwidth shortages that satisfy increasing data traffic demand and service coverage by different cellular generations.

User Recommendations

- Upgrade 4G LTE to LTE-A pro alongside 5G non-stand-alone (NSA) to improve experience outside of 5G footprint.
- Acquire a new frequency asset for LTE-A pro by refarming 2G and 3G network and also negotiating with regulators and other stakeholders, and improve user experience continuously.

Sample Vendors

Ericsson; Huawei; NEC; Nokia; Samsung Electronics; ZTE

Gartner Recommended Reading

Magic Quadrant for 5G Network Infrastructure for Communications Service Providers

vEPC

Analysis By: Peter Liu

Benefit Rating: High

Market Penetration: More than 50% of target audience

Maturity: Mature mainstream

Definition:

Virtualized evolved packet core (vEPC) is a framework for virtualizing the Long Term Evolution (LTE) core network functions. vEPC enables CSPs to move core network components of LTE network from dedicated hardware to commercial off-the-shelf (COTS) servers. These components include mobility management entity (MME), serving gateway (SGW), packet data node gateway (PGW), home subscriber server (HSS), and policy and charging rules function (PCRF).

Why This Is Important

vEPC enables communication service providers (CSPs) to reduce capital expenditure (capex) and operational expenditure (opex) through moving from high-cost dedicated hardware to low-cost COTS servers. The software and disaggregated architecture of vEPC support elastically scalable network functions that bring more flexibility and agility in their LTE core implementation. vEPC also supports advanced features such as automation, programmability and seamless migration to 5G NG core.

Business Impact

- Greater scalability, elasticity, service velocity/agility
- Reduction of total cost of ownership
- Support for new business such as IoT and video in a cost-effective way — the programmability allowing for more agile and elastic deployment, resulting in reduced time to market
- Support for 5G NSA (non-stand-alone) architecture as well as seamless migration to 5G core through software upgrade, which reduces both capex and opex of 5G implementation

Drivers

- Economics scaling to meet the growing user traffic on LTE networks in an elastic and cost-effective way.
- CSPs commercially launching vEPC with different business purposes such as capacity on demand, cloud-based core, multitenant core to support "vEPC-as-a-service" or new business support (e.g., IoT, enterprise).
- Rising demand for commercialization of 5G network, new services deployment, need to reduce opex and capex, increasing scalability, and agile network.
- The maturity of the technology and standardization, which allow large-scale deployment without complex interoperability and integration effort.
- Evolution to 5G NSA and then 5G SA next generation core, since network slicing and the inclusion of very-low-latency applications will necessitate a virtual core network.

Obstacles

- While most legacy EPCs still function properly, some CSPs may not have the urgency to upgrade to a virtualized environment.
- Different vendors have different approaches for the migration path, which may incur additional integration and interoperability efforts.
- The challenges for CSPs to operate in a virtual and cloud-native environment may slow down adoption.
- Multiple deployment scenarios such as VM and container impact decision making and vendor selection.

User Recommendations

- Identify the lead use cases and a clear set of objectives for vEPC implementation that are in alignment with the intended business outcome. Make this central to your EPC virtualization strategy.
- Prioritize software-defined networking/network functions virtualization (SDN/NFV) or cloud-native infrastructure transformation, and position vEPC as a key component for the whole journey. Do not rush to containerized EPC solutions if you already started a virtual-machine-based transformation, but make sure the EPC solution itself is able to support both methodologies.
- Include investment in new orchestration architectures and management tools to achieve operational efficiency in the multivendor, heterogeneous network environment enabled by vEPC.
- Evaluate the organizational impact in terms of required skill set, initial goals and responsibilities. Create an open and cross-organizational structure that enables and champions the vEPC deployment.
- Access vEPC solutions that are able to support the evolution to cloud-native in the roadmap.

Sample Vendors

Athonet; Cisco; Ericsson; Huawei; Mavenir; Microsoft (Affirmed Networks); NEC; Nokia; Samsung Electronics; ZTE

Gartner Recommended Reading

Magic Quadrant for 5G Network Infrastructure for Communications Service Providers

Communications Industry: 2023 Top Market Trends for CSP Tech Suppliers

Communications Industry: 2023 Top Tech Trends for CSP CIOs

Forecast Analysis: 5G Services Incremental Revenue Opportunity for CSPs

Forecast Analysis: Communications Service Provider Operational Technology, Worldwide

Appendixes

See the previous Hype Cycle: Hype Cycle for CSP Networks Infrastructure, 2022

Hype Cycle Phases, Benefit Ratings and Maturity Levels

Table 2: Hype Cycle Phases

(Enlarged table in Appendix)

Phase	Definition
Innovation Trigger	A breakthrough, public demonstration, product launch or other event generates significant media and industry interest.
Peak of Inflated Expectations	During this phase of overenthusiasm and unrealistic projections, a flurry of well-publicized activity by technology leaders results in some successes, but more failures, as the innovation is pushed to its limits. The only enterprises making money are conference organizers and content publishers.
Trough of Disillusionment	Because the innovation does not live up to its overinflated expectations, it rapidly becomes unfashionable. Media interest wanes, except for a few cautionary tales.
Slope of Enlightenment	Focused experimentation and solid hard work by an increasingly diverse range of organizations lead to a true understanding of the innovation's applicability, risks and benefits. Commercial off-the-shelf methodologies and tools ease the development process.
Plateau of Productivity	The real-world benefits of the innovation are demonstrated and accepted. Tools and methodologies are increasingly stable as they enter their second and third generations. Growing numbers of organizations feel comfortable with the reduced level of risk; the rapid growth phase of adoption begins. Approximately 20% of the technology's target audience has adopted or is adopting the technology as it enters this phase.
Years to Mainstream Adoption	The time required for the innovation to reach the Plateau of Productivity.

Source: Gartner (July 2022)

Table 3: Benefit Ratings

Benefit Rating	*Definition*
Transformational	Enables new ways of doing business across industries that will result in major shifts in industry dynamics
High	Enables new ways of performing horizontal or vertical processes that will result in significantly increased revenue or cost savings for an enterprise
Moderate	Provides incremental improvements to established processes that will result in increased revenue or cost savings for an enterprise
Low	Slightly improves processes (for example, improved user experience) that will be difficult to translate into increased revenue or cost savings

Source: Gartner (July 2023)

Table 4: Maturity Levels

(Enlarged table in Appendix)

Maturity Levels ↓	Status ↓	Products/Vendors ↓
Embryonic	In labs	None
Emerging	Commercialization by vendors Pilots and deployments by industry leaders	First generation High price Much customization
Adolescent	Maturing technology capabilities and process understanding Uptake beyond early adopters	Second generation Less customization
Early mainstream	Proven technology Vendors, technology and adoption rapidly evolving	Third generation More out-of-box methodologies
Mature mainstream	Robust technology Not much evolution in vendors or technology	Several dominant vendors
Legacy	Not appropriate for new developments Cost of migration constrains replacement	Maintenance revenue focus
Obsolete	Rarely used	Used/resale market only

Source: Gartner (July 2023)

Document Revision History

Hype Cycle for CSP Networks Infrastructure, 2022 - 20 July 2022

Hype Cycle for the Future of CSP Networks Infrastructure, 2021 - 12 July 2021

Hype Cycle for the Future of CSP Networks Infrastructure, 2020 - 7 August 2020

Hype Cycle for the Future of CSP Wireless Networks Infrastructure, 2019 - 7 August 2019

Hype Cycle for the Future of CSP Wireless Networks Infrastructure, 2018 - 8 August 2018

Hype Cycle for the Future of CSP Wireless Networks Infrastructure, 2017 - 2 August 2017

Hype Cycle for Communications Service Provider Infrastructure, 2016 - 25 July 2016

Hype Cycle for Communications Service Provider Infrastructure, 2015 - 4 August 2015

Hype Cycle for Communications Service Provider Infrastructure, 2014 - 23 July 2014

Hype Cycle for Communications Service Provider Infrastructure, 2013 - 29 July 2013

Hype Cycle for Communications Service Provider Infrastructure, 2012 - 31 July 2012

Hype Cycle for Communications Service Provider Infrastructure, 2011 - 27 July 2011

Hype Cycle for Communications Service Provider Infrastructure, 2010 - 30 July 2010

Hype Cycle for Communications Service Provider Infrastructure, 2009 - 31 July 2009

Hype Cycle for Network Service Provider Infrastructure, 2008 - 9 July 2008

Hype Cycle for Network Service Provider Infrastructure, 2007 - 19 July 2007

Hype Cycle for Network Service Provider Infrastructure, 2006 - 18 July 2006

Recommended by the Author

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Understanding Gartner's Hype Cycles

Tool: Create Your Own Hype Cycle With Gartner's Hype Cycle Builder

Communications Industry: 2023 Top Tech Trends for CSP CIOs

2023 CIO and Technology Executive Agenda: Navigating the Triple Squeeze for CSPs

Infographic: Top Priorities, Technologies and Challenges in Telecom in 2023

CSP Digital Transformation and Innovation Primer for 2023

Quick Answer: Top Take-Aways From MWC Barcelona 2023 for CSP CIOs

Hype Cycle for Communications Service Provider Operations, 2023

Magic Quadrant for 5G Network Infrastructure for Communications Service Providers

Table 1: Priority Matrix for CSP Networks Infrastructure, 2023

Benefit	*Years to Mainstream Adoption*			
↓	***Less Than 2 Years*** ↓	***2 - 5 Years*** ↓	***5 - 10 Years*** ↓	***More Than 10 Years*** ↓
Transformational		eSIM	Cloud-Native CSP Infrastructure Composable Networks NetCo Platform Network Slicing RIC	
High	Network AI and Automation vEPC	5G CSP Edge Security CSP Multiaccess Edge Computing DOCSIS 4.0 LTE-A Pro Private LTE XGS-PON	5G-Advanced Active Infrastructure Sharing for 5G NR-RedCap Private 5G Sustainable CSP Infrastructure	6G Open APN

Benefit	*Years to Mainstream Adoption*			
↓	***Less Than 2 Years*** ↓	***2 - 5 Years*** ↓	***5 - 10 Years*** ↓	***More Than 10 Years*** ↓
Moderate		400G Transport 5G Core 5G Network Security 800G Transport LEO Satellite Communication Services	50G PON Active-Passive Antenna Digital Twins of Telecom Networks FMC Core Open RAN Satellite to Cellular vRAN	
Low			NaaS	

Source: Gartner (July 2023)

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