White Paper

Cisco 5G Vision Series: Vertical Value Creation

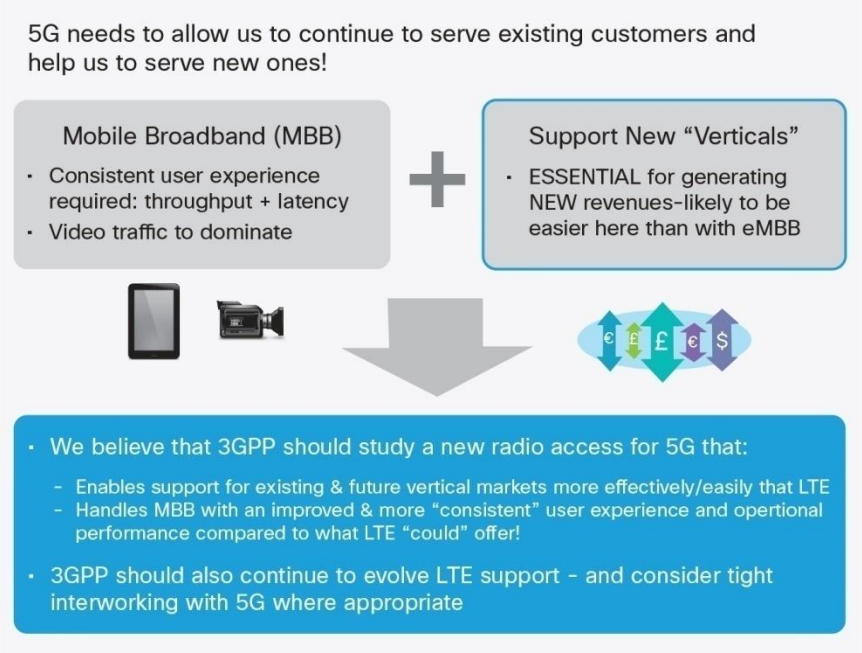
What You Will Learn

5G networks must be designed with new capabilities addressing the needs of new vertical markets. Current mobile standards lack well-defined interfaces to the service layer. Without them, expensive, proprietary solutions are required. For vertical use cases such as the Internet of Things (IoT) and machine-to-machine (M2M) interface, which are expected to be a major focus of 5G networks, more than basic connectivity is required. Enablement platforms and vertical applications must also be supported. These new capabilities will be crucial to 5G value-added services addressing verticals. This white paper in the Cisco® 5G Vision Series explores 5G value-added service requirements, capabilities, and architectures.

Vertical Value Chains and Value Creation by API Exposure

In addition to supporting the evolution of established mobile broadband use cases, 5G needs to support a set of capabilities that enable mobile networks to more effectively serve vertical markets, as illustrated by Vodafone in Figure 1.

Figure 1. Vodafone's Expectations for 5G

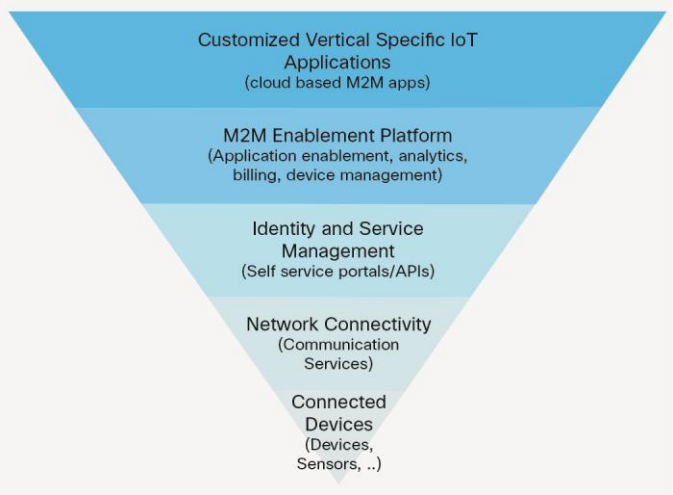


This sentiment is echoed by the Next Generation Mobile Networks (NGMN) Alliance in its February 2015 5G white paper. It describes how the 4G system design that was focused primarily on supporting mobile broadband services is ill equipped to address new services that do not cleanly fit in this connectivity-focused service category. The NGMN Alliance highlights the lack of well-defined interfaces to the service layer as a specific deficiency, which results in expensive, proprietary solutions required to launch new services.

Supporting Vertical Value Chains

No area highlights how service requirements have changed more than the vertical focus of the IoT, which has been identified by many in the mobile industry as the major focus of the next wave of mobile communications. With IoT, networks connect people, processes, data, and things. However, IoT and M2M applications are disrupting the classical cellular value chains because the M2M stack necessitates moving beyond basic connectivity to enablement platforms and customized, vertical-specific IoT applications, as illustrated in Figure 2. The 5G architecture needs to enable value creation by enhancing overall service delivery functionality. This will be provided by defining standard APIs through which partner applications and business models can utilize the 5G network's value creation capabilities.

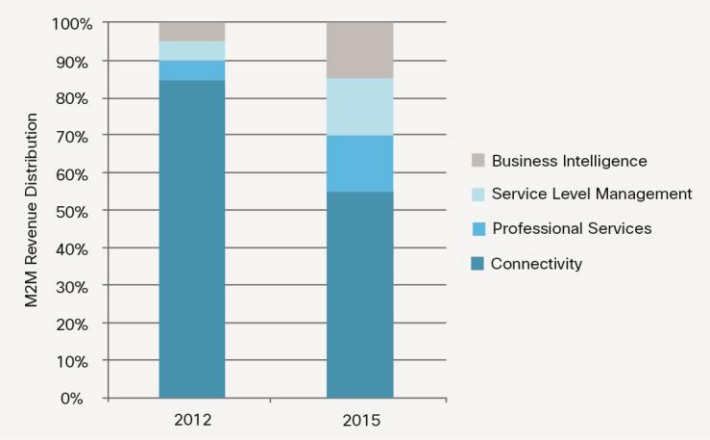
Figure 2. The M2M Stack



This broadening of the stack will see the revenue distribution shift, with Informa predicting that over the last three years, the revenue associated with M2M network connectivity has decreased from 85 percent of total M2M revenue to 55 percent, as illustrated in Figure 3. This continued shift in revenue and value will drive different approaches compared with how today's operators serve the emerging M2M and IoT market opportunities.

Figure 3. Value Shift in M2M Communications

Source: Information from Informa

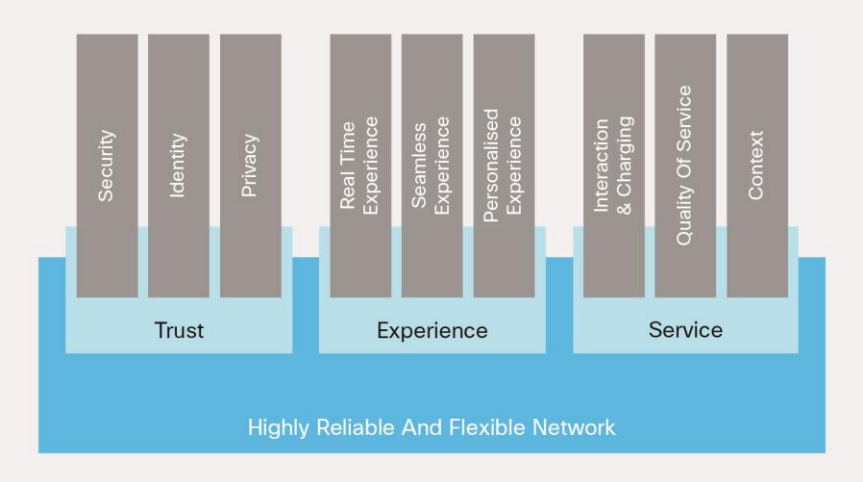


With operator value continuing to shift away from basic connectivity services, the 5G mobile architecture needs to enable operators to use their networking assets to quickly and efficiently support new value-added services. These services will be supported by a range of different business models. The 5G architecture must make the collection, storage, processing, and exposure of information associated with value creation as simple as possible. As the NGMN Alliance has stated in its 5G white paper, appropriate APIs for various parts of the end-to-end architecture—including the radio access network (RAN)—should be exposed and standardized. This will enable access to the APIs by vertical system integrators supporting agile service realization and using different x-as-a-service (XaaS) business models.

For 5G value creation, the NGMN Alliance has identified nine categories of capabilities under the categories of trust, experience, and service, as illustrated in Figure 4.

Figure 4. 5G Value Creation Opportunities

Source: NGMN 5G white paper, February 2015

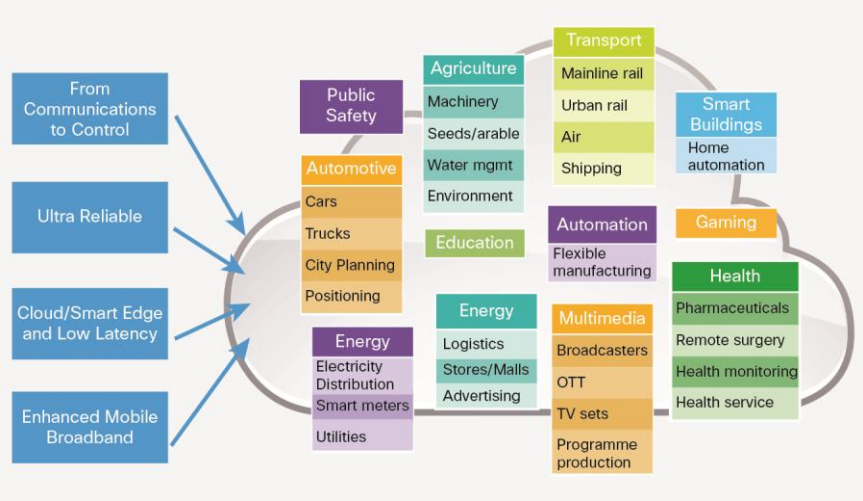


- **Security:** Provide state-of-the art security for all communication, connectivity, and cloud storage purposes
- **Context:** Utilize contextual information assets to improve network operations and to enrich service offerings to end customers and partners
- **Privacy:** Safeguard sensitive data while making sure of their full transparent handling
- **Real-time experience:** Enable real-time connectivity to allow for instantaneous remote interaction
- **Seamless experience:** Hide the complexity involved in delivering services in a highly heterogeneous environment (for example, multiple access technologies and devices, roaming, and so on)
- **Personalized experience**: Dynamically customize the service experience based on customer context and a differentiated, customer-configurable product portfolio
- **Responsive interaction:** Identify events in real time and apply the required business process in real time (for example, real-time charging)
- **Quality of experience:** Guarantee an agreed quality of service (QoS), reliability, and connectivity levels to end customers and partners over time and across the service coverage area
- **Identity:** Provide trusted partner for one master identity, providing for secured, hassle-free, single sign-on and user profile management to fit all communication and interaction demands

It is evident that these capabilities will affect the definition of the 5G RAN (for example, enabling standardized exposure of context, experience, and security information derived from the RAN). Some of the vertical markets, use cases, and 5G enabling technologies that Vodafone envisions are shown in Figure 5.

Figure 5. Some of the Verticals Envisioned for 5G and Their Enablers

Source: Vodafone Group, September 2015



Vertical Requirements for Network Slicing

One approach being defined by the industry to better support vertical requirements is network slicing. Network slicing enables multiple logical networks to be supported as virtually independent business operations on a common physical infrastructure. Any form of branded and specialized service can be including services for IoT, Narrow-Band IoT (NB-IoT), mobile broadband (MBB), the enterprise, and the mobile virtual network operator (MVNO). Associated with this concept is the cost-effective resource allocation where every resource is right-sized to its precise requirements for the service set.

In the future it will be possible for an enterprise vertical to have its own mobile network defined as a slice similar to how MVNOs are currently supported.

Vertical Requirements for Multioperator/Neutral Host

One feature that is increasingly emerging as a requirement to enable 5G to address vertical markets is the ability to support multiple operators on a shared infrastructure. When the operator of the shared infrastructure is a third party, this is often termed a neutral host deployment.

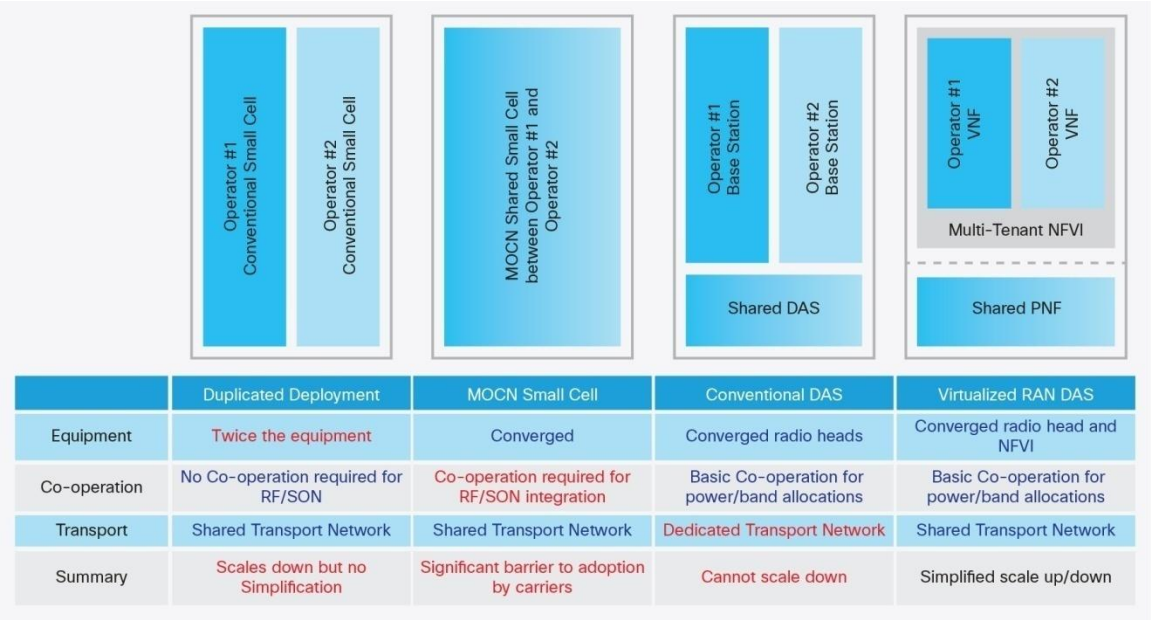
In its recent recommendations on how to accelerate the commercialization of 5G systems to address vertical opportunities, the Small Cell Forum describes the significant demand for multioperator and neutral host (MO-NH) solutions by vertical markets. Although long-term evolution (LTE) systems inherently include techniques for network sharing (for example, with 3GPP-defined multioperator core network [MOCN] capabilities), such approaches typically create a high barrier to RAN sharing, which has thus far seen only limited deployments of such approaches.

The move to virtualization in the RAN should help to address these MO-NH requirements. There is a growing consensus that the definition of 5G mobile technology needs to standardize alternative interfaces to support RAN virtualization. These interfaces should be able to be deployed with nonideal transport networks between physical network functions (PNFs) implementing the RF and lower baseband functions and virtual network functions (VNFs) implementing the upper baseband functions. Because such capabilities are designed to be deployed on a multitenant network function virtualization (NFV) infrastructure, different VNF instances can be used to support multiple operators.

This transition is then anticipated to see a blurring of the boundaries between conventional neutral host distributed antenna systems (DASs) and new virtualized RAN architectures.

Figure 6 contrasts the alternative approaches to multioperator support.

Figure 6. Different Approaches to Multioperator Support



	Duplicated Deployment	MOCN Small Cell	Conventional DAS	Virtualized RAN DAS
Equipment	Twice the equipment	Converged	Converged radio heads	Converged radio head and NFVI
Co-operation	No Co-operation required for RF/SON	Co-operation required for RF/SON integration	Basic Co-operation for power/band allocations	Basic Co-operation for power/band allocations
Transport	Shared Transport Network	Shared Transport Network	Dedicated Transport Network	Shared Transport Network
Summary	Scales down but no Simplification	Significant barrier to adoption by carriers	Cannot scale down	Simplified scale up/down

- **Option A** illustrates an approach to multioperator where each operator installs its own equipment to address the vertical customer's requirements. While limiting any coordination between operators, the approach duplicates equipment.
- **Option B** illustrates a conventional MOCN approach whereby a common base station is shared between operators. While addressing the vertical requirements for multioperator support on a common infrastructure, deployment of the system will typically require close cooperation between operators.
- **Option C** represents the classical DAS solution to MO-NH environments that enables a common physical radio head to be shared between multiple operators. The cooperation between operators is minimal, although the scalability of DAS means it can only be used to address deployments in large venues.
- **Option D** is a shared virtualized RAN. It can be seen as an evolution of the conventional DAS model. A standardized multivendor interface to the shared PNF enables multiple operators to be hosted on a common NFV infrastructure (NFVI). The drive to realize a small cell PNF by organizations such as the Small Cell Forum should make sure that the shared virtualized RAN model can address the full range of deployment scenarios.

5G Focus on Vertical: Learning the Lessons from Wi-Fi

The evolution of the mobile value chain to date has primarily been driven by the adoption of Wi-Fi-based technologies. In particular, the use of unlicensed spectrum enables Wi-Fi to easily address a broad range of multioperator use cases. This includes enabling a vertical customer to operate as the neutral host provider by using a shared Wi-Fi infrastructure to support its own vertical-specific requirements and multiple Wi-Fi operators.

Separate wireless LAN (WLAN) service set identifiers (SSIDs) are used to partition traffic with tunnels. Virtual LANs (VLANs) are used to make sure of isolation between the different providers operating on the shared infrastructure. Enhanced configuration can be used to make sure radio resources are allocated on a per-SSID, per-operator basis. This offers the neutral host provider better control over how resources are shared. With these capabilities, it is evident why today's Wi-Fi is often considered the default choice for addressing the wireless needs of many vertical markets.

With the advent of 5G, however, there will likely be a renewed focus on the unlicensed operation, not only to use the significant amounts of license-exempt spectrum above 6 GHz but also to address multioperator requirements from the verticals. The complexities of multioperator support in cellular systems stem from the complexities of managing a shared licensed RF environment and its integration into a—possibly dedicated—outdoor macro environment. Enabling 3GPP to operate purely in unlicensed bands addresses this limitation, and it has already been proposed by Qualcomm with its MuLTEfire technology, which is meant to deliver LTE-like performance with Wi-Fi-like simplicity that is suitable for neutral host deployments serving any device. As a consequence, it is anticipated that the ability to serve multiple operators will become a foundational 5G capability for new vertical markets.

5G Scaling Vertical Market Value Chains

Conventional cellular networks have looked to interface with third parties, exposing a limited set of core network capabilities and often using proprietary interfaces. But 5G requirements include the ability to accelerate integration of 5G connectivity services into a wide range of vertical systems. 5G needs to be able to support agile service realization and to use different XaaS business models. Additionally, when examining the nine value creation categories identified by the NGMN Alliance in Figure 4, it is evident that, in contrast to conventional core network-centric APIs, some of these will require exposure from the RAN.

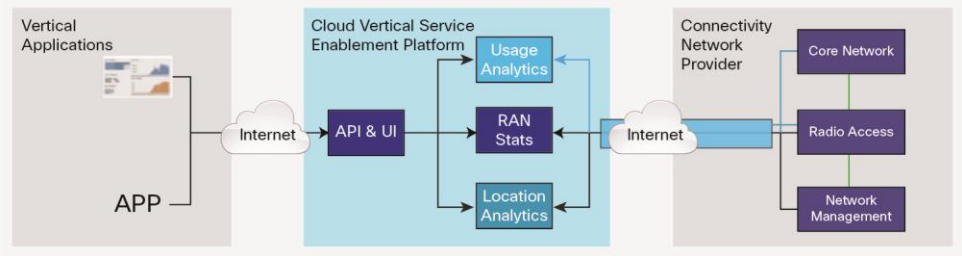
For example, context-based value creation is already a popular use case being championed by vertical solutions based on Wi-Fi; access network exposure of device hyperlocation is already being used by Wi-Fi systems to enable new vertical value chains to be supported. Various verticals identified as target 5G use cases by Vodafone in Figure 5 are already using location derived from the access network to support innovative vertical value chains:

- Airports are using Wi-Fi-derived location analytics to predict security queuing times.
- Shopping malls are using Wi-Fi location to provide personalized mobile shopping experiences as well as providing shop window conversion rates to retailers.
- Hotel operators are using Wi-Fi-derived location analytics to match front of desk staffing with visitor demand.

As a consequence, the vertical scaling challenges that are likely to be experienced by 5G are already being addressed by today's Wi-Fi-based systems. As the leader in carrier Wi-Fi, Cisco has already invested in a number of approaches that support Wi-Fi integration into vertical value chains. Hospitality, venue, and retail system integrators are able to obtain in real time actionable information about devices attached to the access network. They use this data to support business intelligence, as shown in Figure 7.

To facilitate the integration of such offerings into the widest range of vertical offers, Cisco has a range of data analytic cloud-based platforms that enables agile integration with vertical managed services offerings. The connectivity network provider interfaces to a cloud enablement platform, which then offers services that are consumed by vertical applications, as shown at left in Figure 8. These Data Analytics applications recognize the value chain migration highlighted previously and is able to interface to a variety of access networks, including Wi-Fi, 3G, and LTE.

Figure 7. Generalised Cisco Data Analytics Architecture



Conclusion

To serve the specific requirements of emerging vertical markets, 5G mobile standards must support a variety of use cases that demand well-defined interfaces to the service layer and support for enablement platforms and vertical applications. Additionally, an emerging requirement is support for multiple operators on a shared infrastructure. MO-NH solutions have been described by the Small Cell Forum, and the move to virtualization in the RAN is expected to help address these requirements. Various approaches to multioperator support have been proposed. Scaling 5G vertical market value chains easily and over a wide range of vertical systems is an exciting new capability.

For More Information

For more information about the topics discussed in this white paper, visit:

- Cisco Enterprise Mobility Services Platform: http://www.cisco.com/go/emsp
- Internet of Things: http://www.cisco.com/c/en/us/solutions/internet-of-things/overview.html
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