ENGINEERING 5G DIGITAL ECOSYSTEM FOR ACCELERATED ADOPTION

A few years back, a profound and farsighted Qualcomm report stated, "5G will enable 13.2 trillion global economic output by 2035." The size of this economy is almost equivalent to the total consumer spending of the US in 2018. However, the question is whether we are still on track for this promise. This paper explores the challenges beyond bringing up 5G infrastructure and how it can be better enabled for monetization. Further, discussions on 5G advanced will also start soon, implying that whatever framework we build now must also cater to the next generation. In addition, all these must be done considering sustainability. This paper attempts to factor in these aspects and explore a way forward.

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Challenges beyond standing up a 5G network

While most assume that the adoption of 5G ends when the network is deployed and commissioned for connectivity, we believe the real challenge of adoption and monetization only starts there. The secret sauce of adoption lies in making the 5G network usable for B2B through a series of software defined solutions and automation which enable a dynamic ecosystem integration. Here are some of the stumbling blocks towards this journey.

1. **Single pane of glass for visibility and management**
   With disaggregation and cloud native architecture of 5G, managing end-to-end 5G networks consisting of RAN, Core, and the hosting infrastructure requires a rethink. While each of the equipment providers has its network management system, there is uncertainty regarding who and how the end-to-end operations, SLA/KPI and maintenance will be achieved with distributed deployment, especially in the case of private networks and mobile private networks.

2. **Multitenancy for catering to multiple use cases and end customer segments**
   For the B2B monetization of 5G, it is essential to have multitenancy awareness in the network and edge infrastructure where applications are hosted. The multitenancy must be vertically sliced so that the service provider can have a complete view of all tenancies in their network and manage them separately. For the consuming side, the application, data and network properties should be preserved within their tenancy and not leaked to a shared network and edge.

3. **End-to-end slicing**
   The multitenancy requirement establishes the need for end-to-end slicing by the network. While RAN slicing is still maturing, and core and transport network slices are possible through configurations, end-to-end slicing by linking the application to the network and ensuring the network is application aware remains a challenge.

4. **Agile use case onboarding**
   It is well-known that the right B2B and B2C use cases will be the game changer for monetization. Every use case has a value chain and will involve an ecosystem of supplier, provider and consumer. Let's take the example of a Metaverse use case where immersive media streaming is done over a 5G network. Here, the supplier ecosystem includes the content, the VR software running in edge, the client, and the VR equipment. As expected, the content and software key for the experience will keep evolving. The use case provider must perform the backend certification, validation, and security checks and complete the onboarding process extremely agilely to ensure that the consumers get access to the latest experience and new applications with high quality.
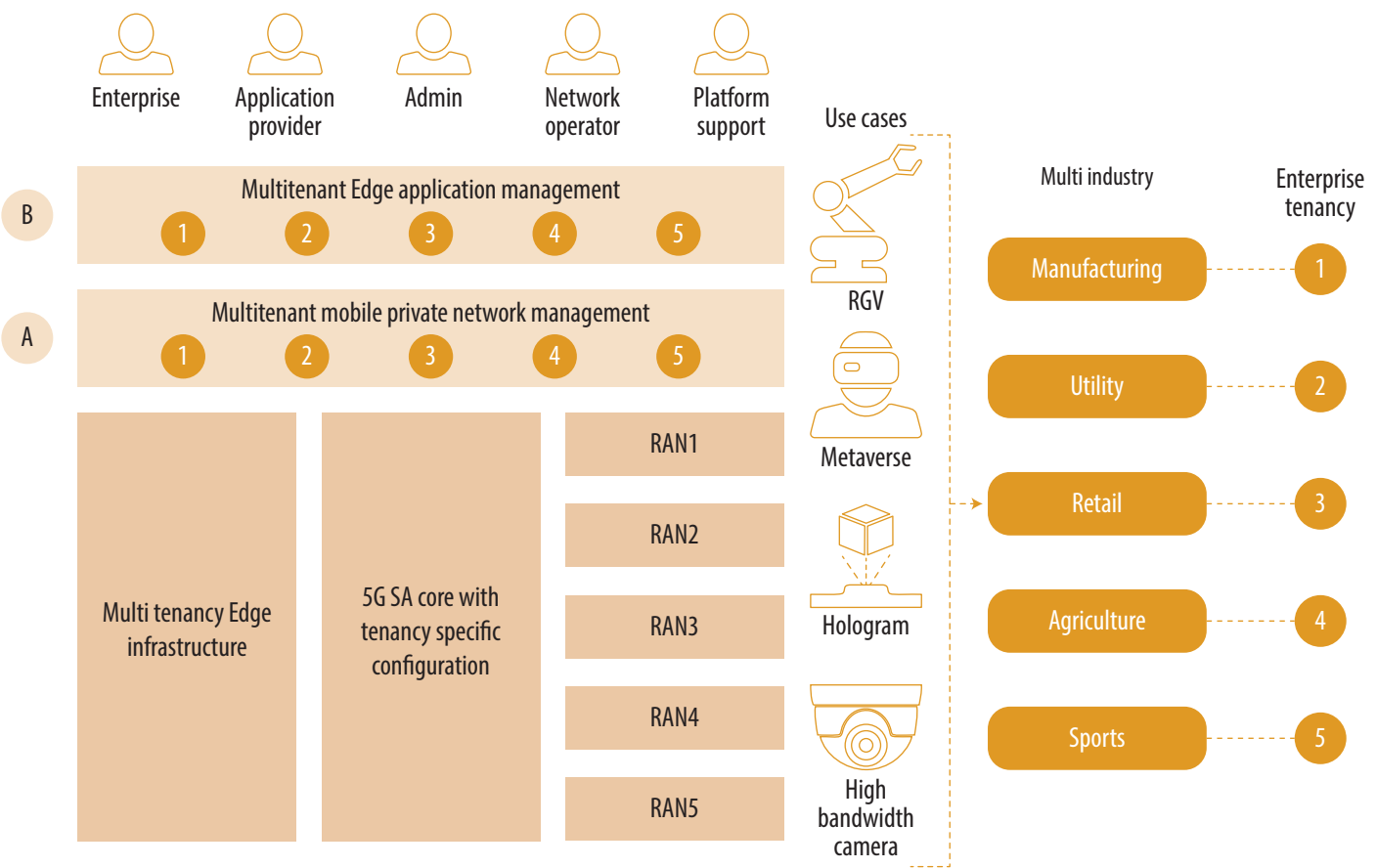
5. **Dynamic lifecycle management of use cases**
   The release, consumption and control of use cases must be dynamic in the future 5G economy. Dynamic implies the entire lifecycle of the use case, including bring-up, start and stop, deletion and dynamic scaling. This requires complicated orchestration between the edge and application workloads.

Approach for dynamic 5G ecosystem enablement

Infosys proposes a vendor agnostic approach that integrates with the network and cloud infrastructure to address the above challenges. This approach enables service providers to deliver enterprise services in a multitenancy way yet centrally manage all operations.

Figure 1: Multitenant mobile private network management through Infosys private network management
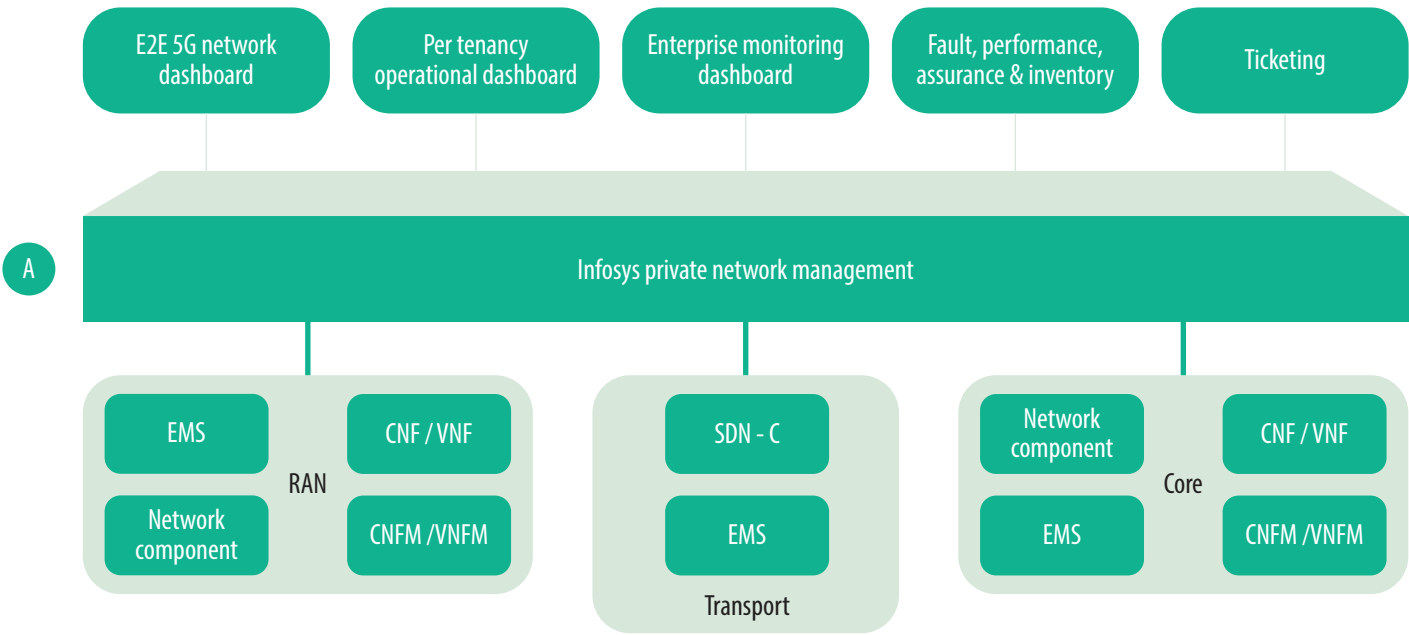
Infosys Private Network Management is a **cloud native and modular** solution for mobile private network operators to enable end-to-end network visibility and provide network management and operations **for multi-vendor based private 5G networks.** This provides a single pane of glass for the provider to manage and operate an entire network and operate each tenancy separately.

This platform allows providers to optimize their networking resources and offer affordable solutions while gaining economies of scale. While the infrastructure might be distributed to provide the required security, Infosys Private Network Management brings the control together without compromising security and isolation.
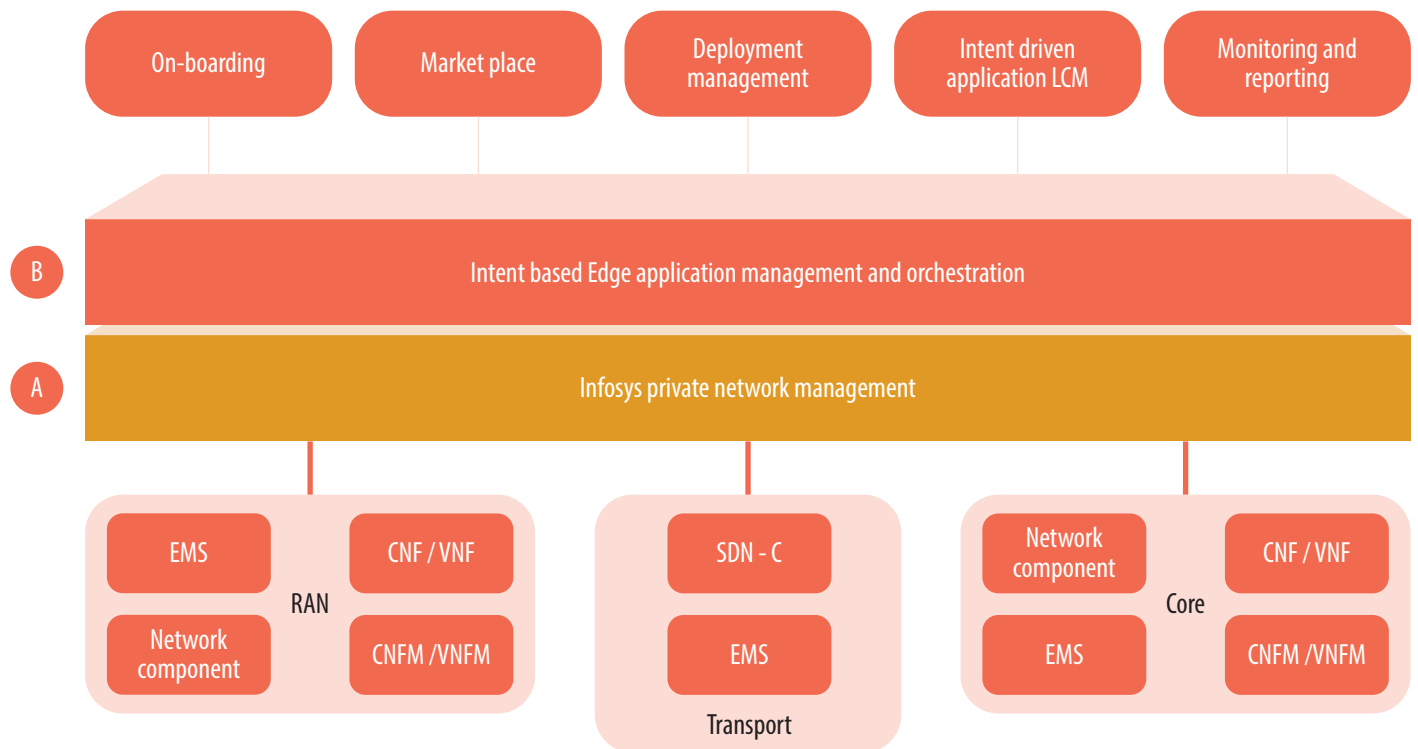
The key platform features include the following:

- Single-pane visualization, E2E management with active and proactive monitoring and tool actions.
- Role based access and multitenancy with easily customizable views.
- Setup NOC anywhere (On Premise, Cloud, Central DC, SaaS)
- Interface exposure through TMF APIs, O-RAN & 3GGP standards
- Pre-integrated with ML based assurance solution Infosys Smart Network Assurance for predictive decisions
- Avoids vendor lock-in with diverse adaptor layers.

Figure 2: Infosys private network management

Infosys proposes an intent based Edge application management framework that helps dynamically manage, scale and run applications on edge cloud. This approach not only provides functions to manage the Edge application lifecycle, but it also provides the required functionality for the use case providers to dynamically publish the applications to Edge cloud.

Figure 3: Edge application management through an intent based framework and orchestration
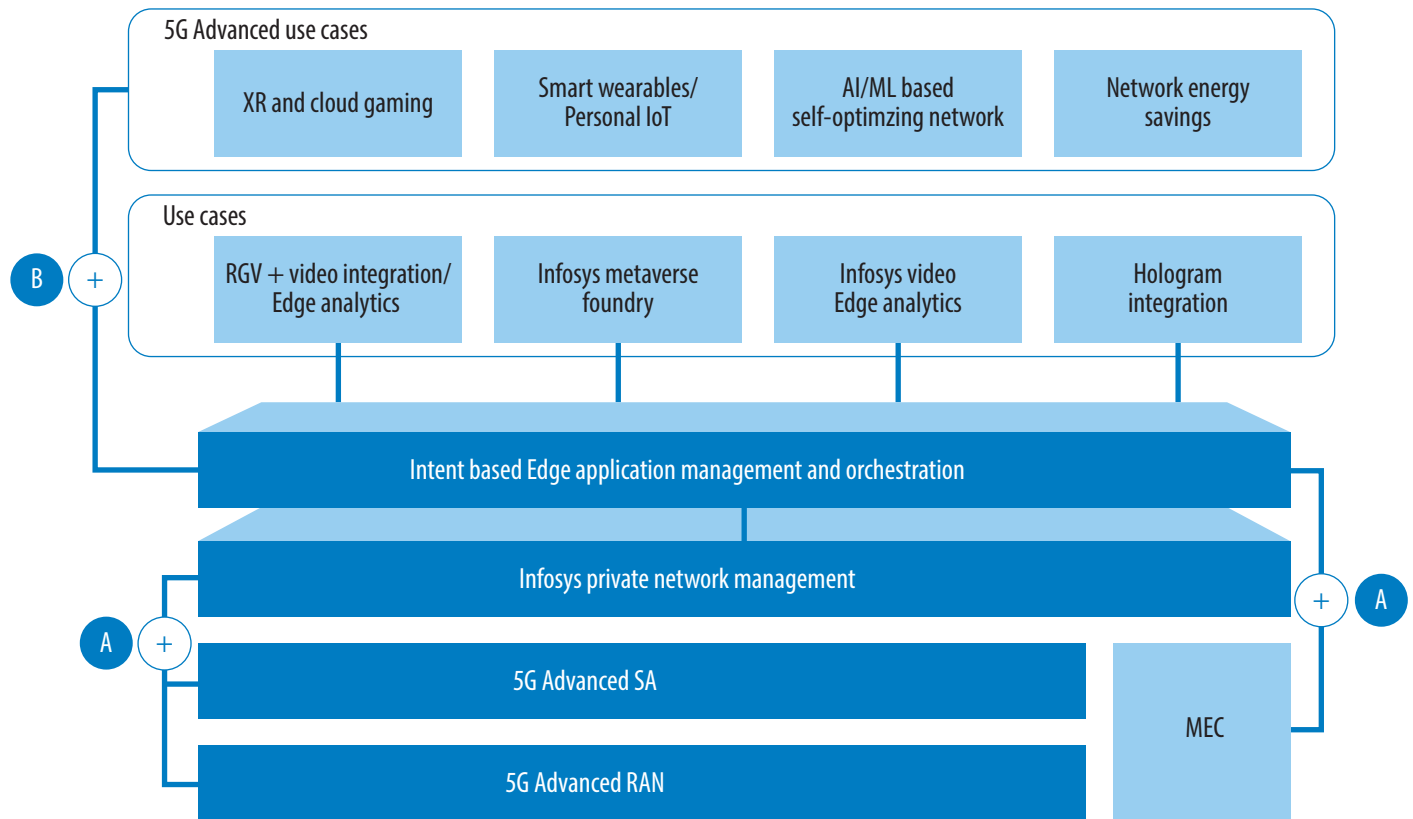

The key functionalities of this approach include the following,

- **Agile use case onboarding:** Providing an interface for the use case providers to dynamically onboard a use case application into edge cloud. Some of the sub-features of this function are

  - **Onboarding workflow:** Workflow to hand hold use case provider right from collecting relevant details till it is published into edge application Marketplace.

  - **Package validation:** Validates completeness and compatibility of the application package with Edge cloud and the network infrastructure.

  - **Certification:** Enables use case providers to perform required certifications in a sandbox and model before publishing in the marketplace.

  - **Updates:** Use case providers can deliver incremental updates to the application package already published in the marketplace.

- **Edge marketplace:** Enterprises can see a list of published applications and deploy the selected application in their respective edge platform.

- **Dynamic lifecycle management:** Lifecycle management functions like start, stop and uninstall are required to dynamically manage deployed applications.

- **Intent driven orchestration:** Intent driven way to orchestrate applications onto the Edge cloud, in which the user expresses their intents through objectives (e.g., as required latency, throughput), and the platform itself determines what resources in the infrastructure are required to fulfill the objectives.

- **Dynamic provision of network services:** Based on the intent and application dependencies, the platform determines and provisions appropriate slices and other network services for the application.

Integrating the future

A key expectation from the digital solution enablers of the new era is their ability to integrate and embrace emerging technology advancements. And this is not an exception for the solution that does dynamic enablement for the 5G ecosystem. Hence it becomes important to understand the future of the 5G ecosystem, which includes 5G-Advanced network and innovative future use cases.

Figure 4: Integrating the future

5G to 5G-Advanced

The 5G technology standards evolution, which the Third Generation Partnership Project defines, also referred to as 3GPP, must first be understood. Two waves of innovation can characterize the standardization -

- In the first wave, 3GPP introduced 5G foundational capabilities and innovation enablement for industries with its Releases - 15, 16 and 17

- In the second wave, 3GPP enhanced 5G with its richest capabilities, termed "5G-Advanced" through Release 18 and beyond. This will set the stage for 6G in the coming decade.

The key capabilities introduced in **5G-Advanced RAN** include MIMO evolution, AI/ML capabilities for NR Air interface, NG-RAN, NR Sidelink evolution, NR coverage enhancements, XR enhancements for NR and IoT Non-Terrestrial Network.

Similarly, the key capabilities introduced in **5G-Advanced SA** include Extended/Mixed reality services (XRM), Network Resource utilization for AI/ML Operations, Ranging/Sidelink positioning, Deterministic Networking and Service Function Chaining.

Finally, the proliferation of such edge use cases will need Multi-Access Edge Computing with an enhanced capability set. In addition, the capabilities must support many requirements, ranging from low-latency support, intense compute capabilities, secure multitenancy, extended public cloud services and usage management.

5G-Advanced use cases

The key use cases that 5G-Advanced network capabilities will enable are:

- Extended Reality (XR) based applications for industrial automation, remote monitoring, and control
- Smart wearable /personal IoT
- AI/ML based self-optimizing network and operations
- Saving network energy costs with network resource monitoring and optimization
- Drones/UAV based advanced use cases
- Satellite backhauling connectivity

As a result, the dynamic 5G ecosystem enablement components, including Infosys Private Network Management and edge application management approach, are designed by considering the future integration requirements arising from network, edge, and use case layers. Hence, they play a crucial role in orchestrating the industry specific use cases for the 5G advanced ecosystem.

Sustainability considerations

Information and Communication Technology (ICT) globally contributes to approximately 2% of total GHG emissions. No wonder then that green in networks is a priority. However, 5G is being looked upon cautiously because of its potential to add more infrastructure, consume energy and add more truck rolls. Infosys has already published a point of view on how green in 5G can be improved through better integration.

This article on Green 5G, authored by Infosys SMEs, emphasizes the need for automation and agile methods for 5G deployments. The dynamic ecosystem enablement approach in the current discussion also integrates these sustainability considerations. For example, the zero touch method of end-to-end use case enablement and AI enabled operations can reduce the truck roll by at least 30%.

The faster adoption of MPN and Private Networks also enables enterprises to implement use cases like metaverse for virtual collaboration, remote guided vehicles and autonomous vehicles, thereby helping them achieve carbon goals in an accelerated way.

Enabling a double sided economy

Clearly, the dynamic 5G ecosystem enables service providers to be the bridge for a double sided economy.

Marketplace for the use case providers

The dynamic ecosystem enablement framework gives the use case providers an easy path to push their applications, validate across the service provider network and edge, and then publish for consumption. The agile nature of this framework makes this process faster, reducing the time to market. It also provides a wider and consolidated window of access for the end users, which is otherwise difficult to reach separately.

Upselling the connectivity and edge with use cases

Service providers can easily move up the value chain by upselling connectivity or edge or both in the case of Telcos by bundling the infrastructure and service with use cases. There are opportunities for newer as-a-service and subscription models for several use cases like immersive media, edge gaming and premium infrastructure services.

Conclusion

While the private network and Mobile Private Network (MPN) adoption is progressing, there are a few challenges. Operators need good orchestration and management solutions to make MPN service scalable. The key lies in providing end-to-end visibility, manageability and flexibility to operators and enterprises consuming this. AI plaWys an important role in bringing predictability and automation to operations. Enterprises are adopting private networks for vertical use cases beyond mere connectivity. The use case adoption will accelerate only when there is flexibility for

agile application management, extending to the application provider and service provider. This will, in turn, enable a double sided economy.

Meanwhile, technology is evolving fast. While we are amid 5G, talks on 5G advanced and 6G are progressing. So, any approach defined now must cater to 5G advanced, 6G and the next generation use cases. Last but not least, sustainability considerations must be embedded in the approach from the beginning for a greener tomorrow.

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