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▶ CSP NEED FOR NEW NETWORK ARCHITECTURE CREATES 'VIRTUOUS CYCLE'



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THE NEW NETWORK ARCHITECTURE

Technological advancement is ushering in a new era, commonly referred to as the Fourth Industrial Revolution or Industry 4.0. This era is characterized by the coalescence of digitalization, IoT, ubiquitous and instantaneous network connectivity, automation and AI, which, when combined, can improve outcomes such as increased productivity. It is widely expected that during this era entire industries will be fundamentally transformed, people's lives will be greatly enhanced, and productivity will enter a new phase of sustained growth, all of which will contribute to an economic boom and improved standard of living.

Communication service providers (CSPs) have a golden opportunity to play a critical role in this era by providing not only ubiquitous, intelligent connectivity, but also value-added services such as content creation, data analytics, and financial services that participate in and enable this economic development.

CSPs will require a fundamentally new network architecture to realize the full benefits of this era. The key benefits this architecture will provide CSPs include the ability to enable and support new network services to drive profitable revenue growth as well as more cost-effectively support traditional network services including voice and internet connectivity. Some of the use cases the evolved network will be able to support include AR/VR gaming, drone package delivery and remote machine control. The primary role in charge of overseeing this network transformation at the CSP is typically the CTO, though CIOs also play a role from an IT and data management perspective.

The new network will be cloud-native, virtualized, automated, highly distributed at the edge, and able to dynamically and intelligently enable and support use cases in real time. Virtualization (NFV/SDN), edge computing, optical transport and 5G are key technologies that will comprise this evolved network.

The end-to-end and complex nature of implementing and operationalizing this new network architecture, while concurrently transforming the business model to be more value- and outcome-driven rather than usage-based, is a massive undertaking. It is widely expected that CSPs will encounter a myriad challenges as their migration progresses. Some of these challenges include:

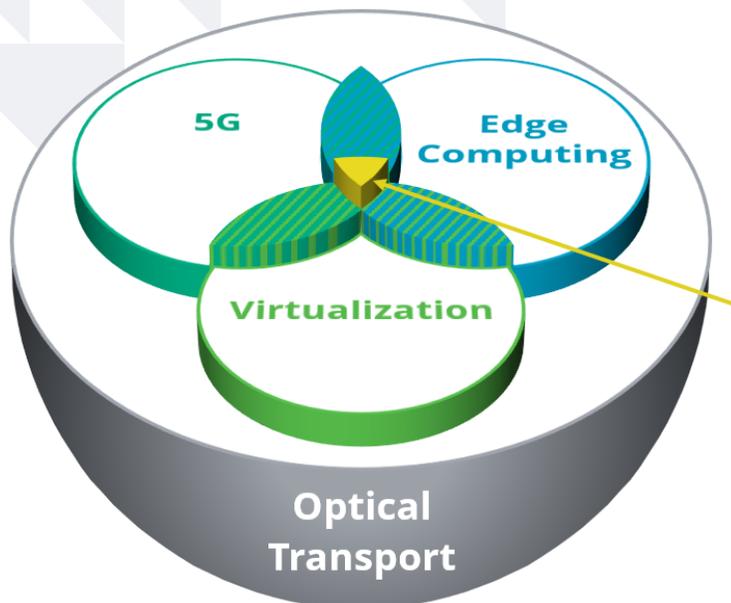
- Achieving sustained low latency — target is sub-10 ms for mission-critical workloads such as autonomous driving
- Network resilience — ensuring uptime of five nines or higher
- Bandwidth constraints in the local area network (LAN) and wide area network (WAN)
- Scale — challenges pertaining to the large-scale rollout of new technology across the network
- System complexity — migrating from the traditional network architecture to a software-centric, microservices-based, cloud-native network is a complex endeavor
- Shortage of skilled labor resources





To address these challenges, CSPs are turning to information and communications technology (ICT) solution providers to help them complete their evolution. ICT solution providers that possess the skills and scale to address the technology domains of the new architecture are best positioned to fulfil these complex requirements. The resource augmentation and expertise these ICT solution companies provide is important because most CSPs do not possess the full scope of resources internally to tackle the breadth of these transformations.

TECHNOLOGY COALESCENCE OF THE NEW ARCHITECTURE



ICT solution providers that are able to address the technology domains of the new network architecture are in the sweet spot and best positioned to help CSPs.

Deploying this next-generation network will require concurrent and sustained investment in new technologies, especially virtualization, edge computing, optical transport and 5G. Investing in one technology area necessitates investment in others, creating a self-sustaining cycle. For example, enabling virtual RAN (vRAN), a critical technology that will be utilized at the access layer of the network in the new architecture, requires 5G for the radio interface, edge computing infrastructure to house and run the virtual baseband unit (vBBU), and optical transport for fronthaul and backhaul. CSPs must invest in all four technology areas concurrently to enable a vRAN environment.

Another example of the virtuous cycle pertains to the telco central office, which is being re-architected as an edge data center (aka CORD). In this scenario, legacy, purpose-built network appliances, such as routers and switches, in CSPs' existing central offices and related network sites are decommissioned and replaced with data center infrastructure that runs virtual network functions, such as the vBBU for 5G vRAN. These CORD implementations are examples of edge computing environments because they are "mini" data centers running virtualized infrastructure and are interconnected with the broader network via optical transport.

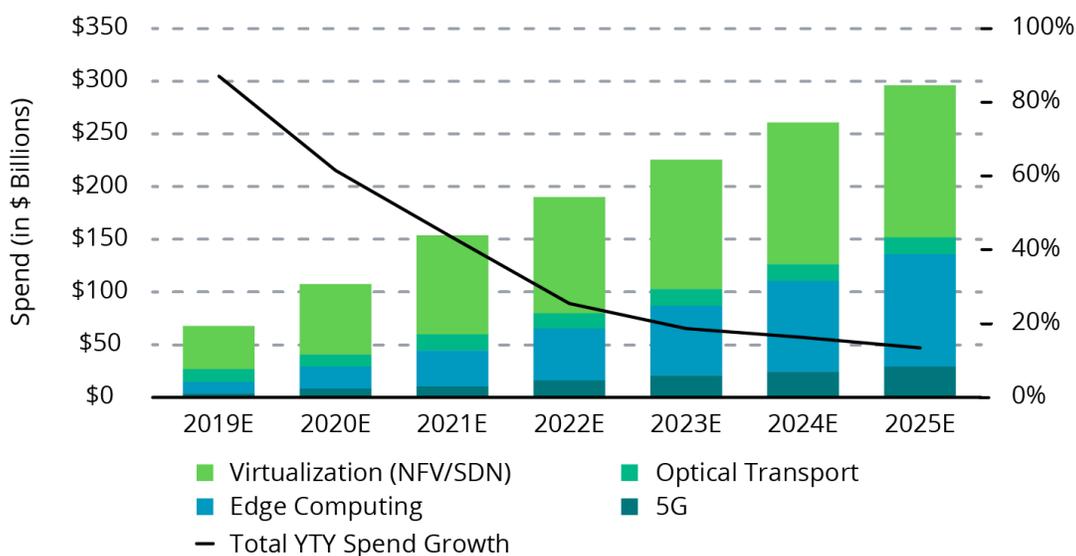


THE VIRTUOUS CYCLE: A CODEPENDENT, POSITIVE FEEDBACK LOOP OF NETWORK INFRASTRUCTURE INVESTMENT



TBR estimates that CSPs will invest nearly \$300 billion annually on virtuous cycle-related technologies by 2025, up from an estimated \$66 billion in 2019. This significant increase (a 28.4% CAGR) is indicative of the need to concurrently invest in multiple technology domains on a global scale.

CSP SPEND ON VIRTUOUS CYCLE



SOURCE: TBR ESTIMATES





Deploying this new architecture is a multiyear journey, and CSPs will need significant assistance from ICT solution providers to help them through the process, especially as CSPs will concurrently operate legacy and next-generation environments as they transition fully to the new network architecture.

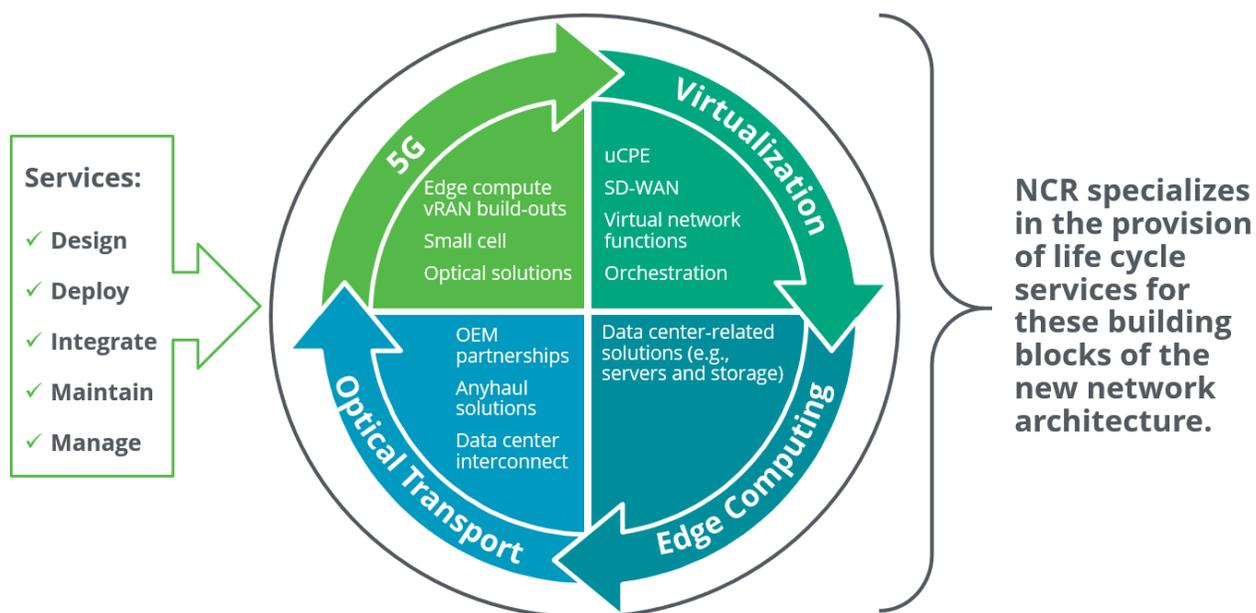
Recommended best practices for CSPs as they pursue network transformation include:

- Cap and shrink legacy infrastructure investment and transition capex and opex to next-generation technologies, such as virtualization (NFV/SDN), edge computing, optical transport and 5G.
- Reskill workforce to become proficient with software, data science and virtualization, all of which will be critical to support this new network.
- Partner with companies in the ecosystem, such as shared infrastructure owners (e.g., data center and tower REITs), cloud service providers (e.g., public cloud companies), and ICT solution providers (e.g., network equipment providers and IT services companies) that can help accelerate transformation-related endeavors.

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As a leading global ICT solution specialist, NCR Corporation’s Telecom & Technology business unit is in the vanguard of providers operating in the sweet spot of virtuous cycle technologies. Having supported leading CSPs around the world for decades, NCR is well equipped to help CSPs accelerate their network transformations. With capabilities in all aspects of the virtuous cycle, NCR can provide a full range of services for relevant technologies, from design, deploy and integrate to maintain and manage.

NCR’S CAPABILITIES ALIGNED TO THE VIRTUOUS CYCLE





PARTNERING FOR A BETTER FUTURE

CSPs are migrating to a new network architecture to capitalize on the enormous value that will be created during the Fourth Industrial Revolution. The nature of this architecture will spur a virtuous cycle of CSP investment in a range of enabling technologies. CSPs will undoubtedly encounter numerous challenges on this multiyear, evolutionary journey, and they will require help from ICT solution providers to meet their objectives.

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