stc Saudi Arabia

Cloud Infrastructure Department

Building Large Enterprise Smart Campus & SME Shared MEC-on-demand

Oct, 2022

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EXECUTIVE SUMMARY

Executive Summary

The Saudi Kingdom has taken qualitative steps toward ensuring the speedy development of digital transformation to achieve the Vision 2030 target, and 5G will be one of its key enablers. For consumers, digitalization provides the promise of more ubiquitous, convenient, and personalized access to these services, while fostering innovation and the development of new products. For enterprises, new digital services based on artificial intelligence, analytics, virtual reality, industrial Internet of Things, and drones are expected to produce long-term gains in efficiency and productivity.

To adapt to differentiated service requirements like enhanced mobile broadband, ultra-reliable low-latency communication, and massive machine-type communications, stc Cloud infrastructure & 5G Stand-Alone (5G SA) investment features new capabilities of MEC edge computing and a network slicing technology. Edge Computing capability plays an important role for new applications that need not only connectivity but also other capabilities such as latency, information security, and quality of service managed by the service provider. From massive data processing in enterprise campus scenarios, real-time data processing in industrial control and autonomous driving, to massive IoT use cases requiring analytics localization and finally better user experience for AR/VR/cloud gaming consumer use case – the edge is where services aggregate and is the natural extension of operator's cloud computing.

This whitepaper explores edge computing driving forces, and global industry key discussed scenarios and reviews Saudi market key requirements on the value of telco edge. Furthermore, the paper develops stc KSA specific understanding of MEC network construction objectives and guides future MEC construction objectives. In partnership with the most prominent industry names, stc develops the regional first comprehensive proof of concept of 3GPP Rel-16 capable edge computing with applications for Oil&Gas and petrochemical industry verticals. Key findings are presented in the final chapters.

MULTI-ACCESS EDGE COMPUTING AND ITS ROLE IN DIGITALIZATION

Saudi Market Vision and 5G Industry Development

To meet Saudi Vision 2030, the Saudi private sector is keen to develop the telecommunications and information technology infrastructure, especially high-speed broadband, expanding its coverage and capacity within and around cities and improving its quality with the goal to exceed 90 percent housing coverage in densely populated cities and 66 percent in other urban zones. Furthermore, the Saudi government aims to strengthen the governance of digital transformation through a national council, to establish an effective partnership with telecom operators to better develop this critical infrastructure.

The KSA ICT market is the biggest in the Middle East in terms of capital value and volume of spending and accounts for more than 70% of all ICT markets in the Cooperation Council for the Arabic States of the Gulf (GCC). A few so-called Smart cities are planned e.g. King Abdullah Economic City which will house 2 million people and be completed in 2035. A sophisticated digital infrastructure is integral to today's advanced industrial activities as it attracts investors and enhances the fundamental competitiveness of the Saudi economy.

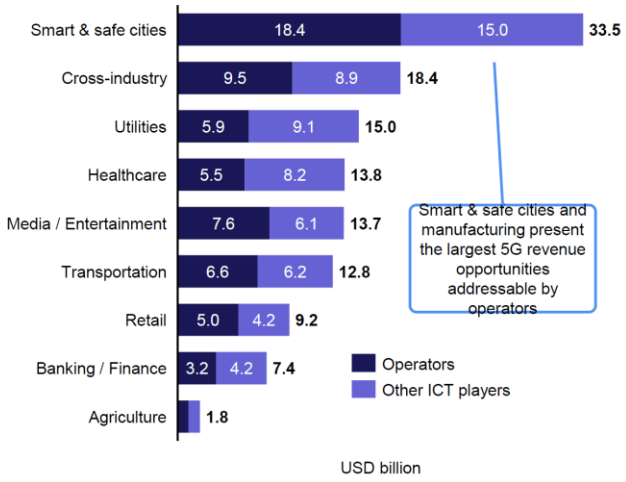
The fifth generation of wireless technologies, known as 5G, is expected to have a profound impact on people's lifestyles, societies, and economies globally, stretching far beyond the telecoms industry and its users. 5G networks offer an unprecedented leap in bandwidth speeds in comparison to previous mobile networks. 5G provides an opportunity to reduce latency and improves overall network efficiency. This allows 5G to offer enhanced mobile broadband, ultra-reliable low-latency communication, and massive machine type communication. 5G technology further delivers an attractive business model through means of provisioning of a wide variety of new services for varied customers with different service level needs and performance requirements.

MULTI-ACCESS EDGE COMPUTING AND ITS ROLE IN DIGITALIZATION

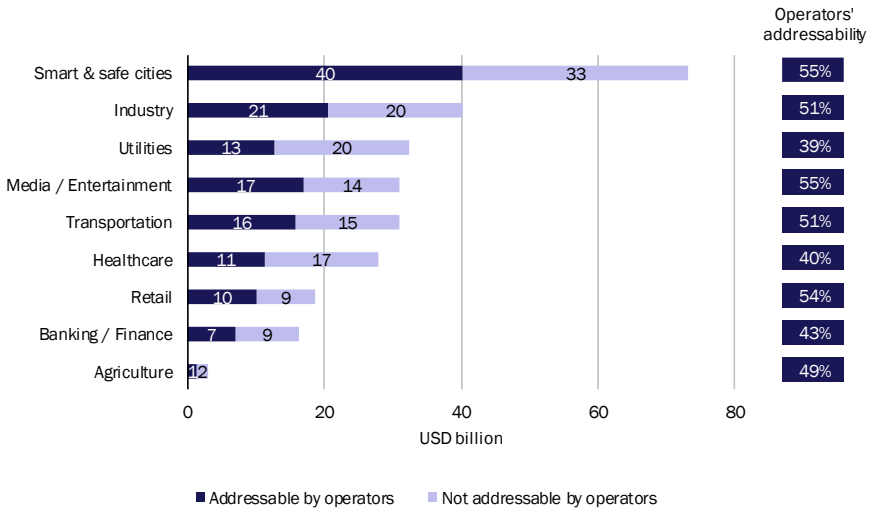
Telecoms investing in cloud technologies are poised to transform themselves into digital service platform providers, offering a range of new services that can directly be supporting digital transformation in all those industries and the Saudi government's new initiatives. These new services present a 10-year cumulative revenue opportunity of USD126 billion in the Saudi market, about 50% of which will be addressable by operators.

10-year cumulative revenue opportunity from 5G-enabled solutions, Saudi Arabia (2020-2030)

10-year cumulative revenue opportunity from 5G-enabled solutions by vertical, Saudi Arabia (2020-2030)



As per Anaysys Mason study, Saudi telcos will be in a position to monetize more than 20 different digital services in the next 10 years, in addition to the base eMBB use case.



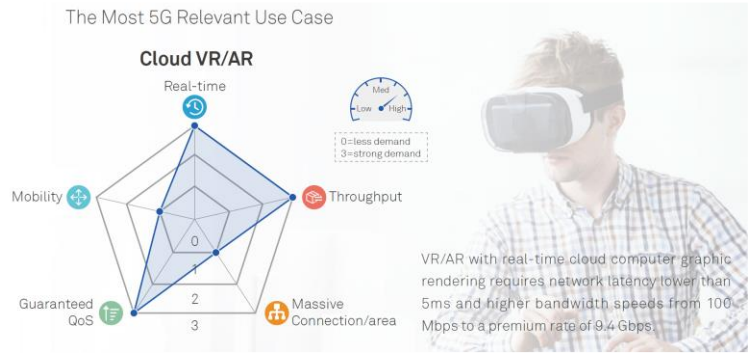
MULTI-ACCESS EDGE COMPUTING AND ITS ROLE IN DIGITALIZATION

Apart from essential Smart City applications, four vertical industries identified as important for the Saudi market are industrial manufacturing, smart healthcare, smart education, and smart logistics.

SMART CITY

City video surveillance is an invaluable tool that not only enhances security but also energizes the productivity of businesses and civic institutions. Video surveillance systems are invaluable for monitoring: Busy public places (squares, activity centers, schools, and hospitals), Business areas (banks, shopping centers, and plazas), Transportation centers (stations, docks), Major intersections, High-crime areas, Institutions and residential areas, Flood prevention (canals, rivers), Critical Infrastructure (energy grid, telecom data centers, and pumping stations). Demand for video surveillance is primed by the innovation in video camera technology, the cloud storage that supports data collection and analytics and by price competition.

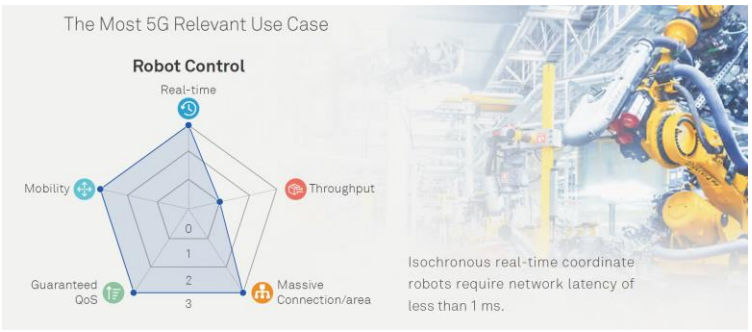
CLOUD VIRTUAL & AUGMENTED REALITY



Virtual reality (VR) and augmented reality (AR) are transformative technologies poised to revolutionize the consumption of content in both the consumer and the enterprise sectors. VR/AR require significant data transfer, storage, and computing capabilities. These data- and compute intensive tasks will therefore move to the cloud, which provides abundant data storage and can provide the necessary high-speed computing capability.

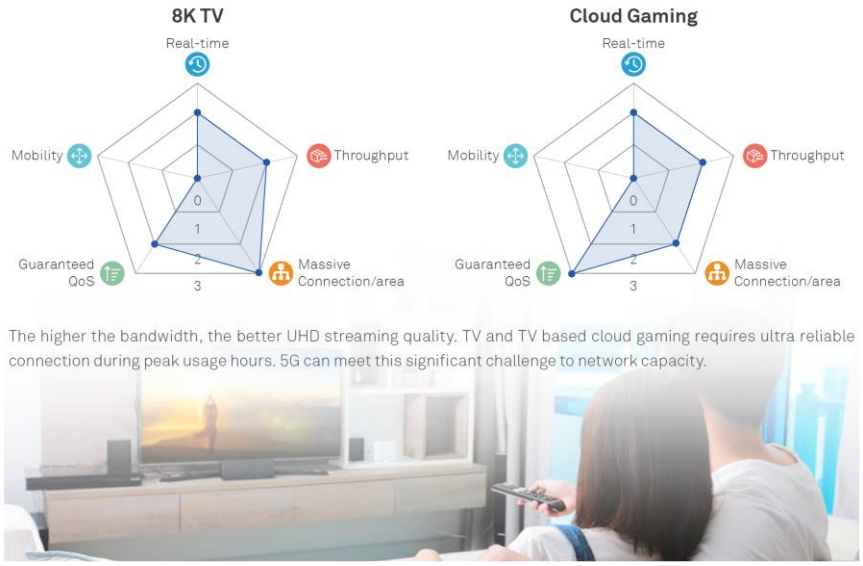
MULTI-ACCESS EDGE COMPUTING AND ITS ROLE IN DIGITALIZATION

SMART MANUFACTURING



Innovation is at the heart of manufacturing. Major developments include the moves toward lean manufacturing, digitalization, and greater flexibility in work processes and production. Recent times have also seen a strong shift in favor of the industrial Internet of things (IoT). Historically, manufacturers have relied on wired technologies for their connected applications. Wireless solutions such as Wi-Fi, and Bluetooth have taken a foothold in the manufacturing workplace, but these wireless solutions face limitations in security and reliable bandwidth.

UHD 8K VIDEO & CLOUD GAMING



The higher the bandwidth, the better UHD streaming quality. TV and TV based cloud gaming requires ultra-reliable connection during peak usage hours. 5G can meet this significant challenge to network capacity. Cloud gaming requires less from end-user devices – all the processing will be on the cloud. Users' interactions will be transmitted to and processed in the cloud in real-time to ensure high-quality game streaming experiences.

MULTI-ACCESS EDGE COMPUTING AND ITS ROLE IN DIGITALIZATION

SMART HEALTH

The healthcare industry has the opportunity to develop a fully personalized medical advisory service that is complemented by doctor-driven AI medical systems connected by 5G. These AI medical systems can be embedded into hospital call-in centers, home medical advisory assistants, local doctor clinics, and even traveling out-station clinics that lack on-site medical staff. Healthcare professionals have begun to integrate solutions such as remote audio/video diagnosis, remote surgery, resource databases, and remote health monitoring using wearables/portable devices.

SMART TRANSPORTATION

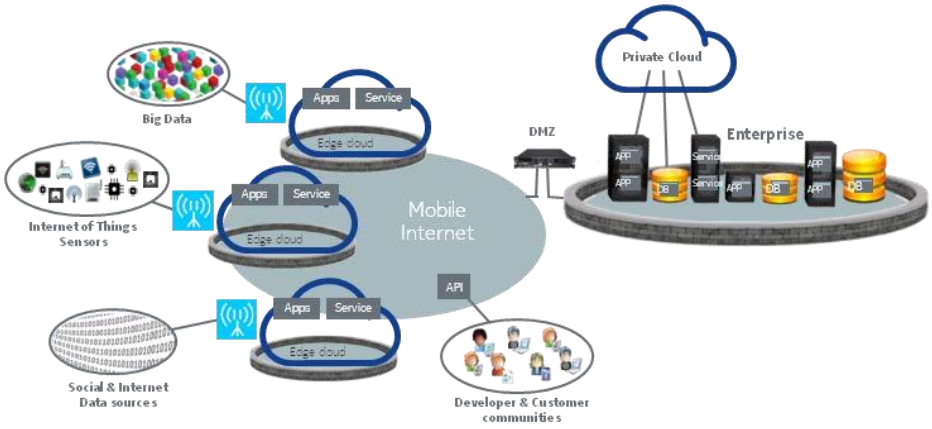
The transportation industry used to manually monitor and maintain roads using a backhaul of images and videos. Now, the industry is looking for ways to digitalize and automate operations and management. MEC is an ideal solution for this.

The MEP accelerates the backhaul of HD images and videos in multiple channels to almost real-time. Moreover, it draws on AI-driven technologies, such as video content analysis and machine vision, to dynamically analyze the collected data and quickly make decisions to handle faults or initiate alarms. This ensures that the system will not miss any key status, performance indicator, or loss, quickly diagnosing any issues.

MULTI-ACCESS EDGE COMPUTING AND ITS ROLE IN DIGITALIZATION

Edge Computing Technology

The worlds of IT and Telecommunications Networking are converging bringing with them new possibilities and capabilities that can be deployed into the network. A key 5G transformation has been the ability to run IT based servers at the network edge, applying the concepts of cloud computing, defined as Multi-access Edge Computing (MEC). MEC can be seen as a cloud server running at the edge of a mobile network and performing specific tasks that could not be achieved with traditional network infrastructure.



This environment is characterized by ultra-low latency and high bandwidth as well as real-time access to radio network information that can be leveraged by applications. By deploying various services and caching content at the network edge, Mobile core networks are alleviated further congestion and can efficiently serve local purposes. Furthermore, operators can open their network edge to authorized third parties, allowing them to flexibly and rapidly deploy innovative applications and services towards mobile subscribers, enterprises, and vertical segments.

IMPROVED USER EXPERIENCE

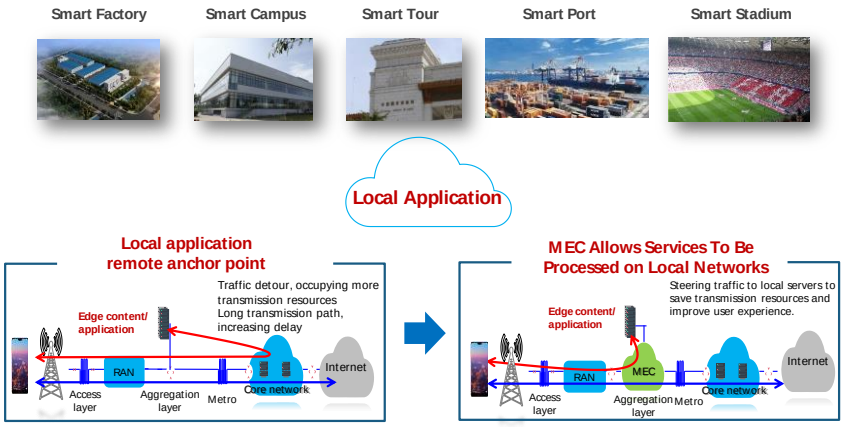
stc strives for improving user experience and relies on enhanced user experience to attract and retain customers and improve brand value. On the network side, a shorter end-to-end (E2E) service access delay brings a better user experience. In this way, the service access delay can be shortened if content servers are deployed as close to the users as possible.

Servers like CDNs and Gaming caching are good examples of applications whose end-customer experience is directly dependent on connectivity related quality parameters like network latency, and jitter.

MULTI-ACCESS EDGE COMPUTING AND ITS ROLE IN DIGITALIZATION

PROCESSING SERVICES ON LOCAL NETWORKS

In scenarios such as enterprise campuses, factories, ports, stadiums, and industrial Internet, services are deployed locally to provide services for dedicated devices and employees of local organizations. These services feature that the service providers and users are in the same region, and sensitive data, such as industrial production and enterprise operation data is transmitted during the services. It is expected that users can access local servers and use services provided by the local servers. This helps improve access efficiency and ensure service security and reliability.



Capabilities Needed to Meet Industry Requirements

DIFFERENTIATED AND DETERMINISTIC CONNECTIVITY

stc considers that edge MECs construct connection capabilities to achieve highly differentiated connection requirements. Deterministic connection capabilities are mandatory capabilities provided by edge solutions and are also high-priority scenarios. MEC needs to provide ULCL and LBO, 5G LAN, Uplink lossless compression, and deterministic latency TSN technology.

ULCL LBO - The flexible traffic distribution capability is a basic capability. It implements flexible traffic distribution based on location information, subscriber attributes, and service requirements.

5G LAN - The 5G LAN Layer 2 networking capability directly applies 5G connections to industrial scenarios. It also supports industrial Ethernet networking to facilitate access and interconnection of traditional factory devices.

UPLINK LOSSLESS COMPRESSION - Uplink lossless compression supports the integration of the lossless compression SDK on the device side to perform lossless compression on images collected by industrial cameras. The compressed data is sent uplink through the 5G network, reducing the pressure on 5G air interface bandwidth for image upload and improving device access density.

THE DETERMINISTIC LATENCY TSN TECHNOLOGY - The deterministic latency TSN technology combines 5G LANs with high-precision clock synchronization capabilities to meet the low latency and deterministic requirements of industrial Ethernet and TSN on 5G networks.

FROM CONNECTIVITY TO COMPUTE

Provides one-stop deployment of connection and computing based on MEC, and provides capability sets and ecosystems that are closely related to diversified computing capabilities and connections. Pre-integrated industry solutions can help carriers expand the industry market. Focus on key project scenarios, focus on scenarios with strong connection relevance, and prioritize high-precision projects. Indoor positioning and Streaming media processing.

5G INDOOR POSITIONING - As one of the main 5G B2B application scenarios, precise positioning is widely required in the industrial Internet.

STREAMING MEDIA PROCESSING - Streaming media processing: In the 5G stadium live TV service scenario, the streaming media processing capability can stitch multiple channels of VR live TV videos (six 360-degree channels) before being presented to the user terminal to form one VR video stream, improving user experience and saving network bandwidth.

UNIFIED AND SIMPLIFIED O&M

The operation and O&M of edge solutions will bring new challenges. How can we simplify the network architecture and reduce OPEX for the deployment of a large number of edge sites in the future? Plug-and-play is the key to simplify edge delivery. In addition, a unified 2C/2B network O&M is beneficial to improve O&M efficiency. In addition, it is necessary to gradually integrate with the BSS/OSS and build self-service capabilities for enterprise customers.

MEC PLUG AND PLAY - Remote O&M and one-click deployment automation reduce manual involvement in service deployment. MEC edge applications are plug-and-play, and the network changes automatically as service requirements change.

UNIFIED ORCHESTRATOR AND ASSURANCE - MEAO/MEPM enables APP quick integration and deployment， focusing on the real-time monitoring of cross-layers O&M.

MEC SECURITY

Compared with the central 5GC, MEC (UPF and MEP) may be deployed in the carrier's enterprise equipment room or enterprise campus equipment room and on the network edge. It may face unauthorized physical intrusions. In addition, third-party apps can be deployed on MEC. If these apps have security risks, they may be exploited to threaten MEC and central 5GC.

Third-party apps may be attacked by other apps or MEC, causing data breaches and software tampering. In addition to building security capabilities of their own, third-party apps expect the MEC platform to provide an environment for resource isolation.

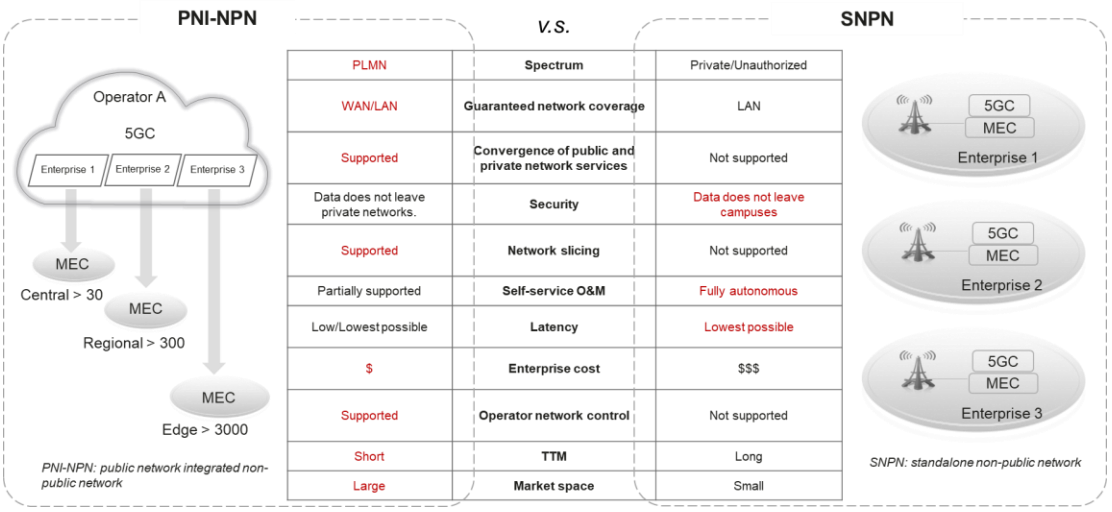
TELCO MANAGED PNI-NPN MEC VS. S-NPN PRIVATE CORE DEPLOYMENT

Large enterprises of Saudi Arabia's important industries like Oil&Gas often feature multi-campus setups with one central operation location. This often attracts consideration for Industry 4.0 style private network core option deployment, but there are some important advantages of telco managed MEC approach to be considered:

- MEC deployment offers several architecture options with the flexibility to have not only a user-plane, but also a dedicated control-plane (AMF, SMF) and data-plane (PCF, UDM) and fully isolated from public MNO
- Telco-managed MEC supports powerful feature of network slicing, essential for efficient resource management and premium SLA guarantee in multi-campus environments
- features such as 3gpp standardized voice, charging, lawful interception, and fast capacity expansion are not supported by S-NPN type small core networks

The benefits of the PNI-NPN MEC approach are further summarized here:

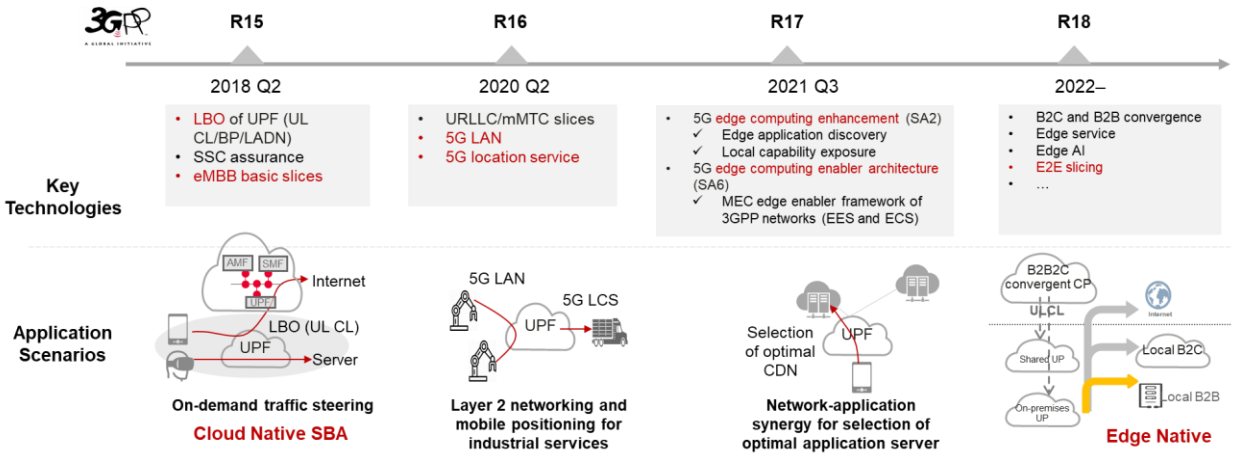
stc MEC VALUE PROPOSITION



Enterprises can choose any option based on internal priorities or use case requirements - Edge Native Transformation

Envisioned rapid development of all the key industry sectors of the Saudi market will have stc 5G MEC capability and relevant service offerings in the center of it. To achieve this, stc will have to treat every vertical as a high-priority industry with its own set of requirements. Through step-by-step development of new tech, stc will be able to serve mass markets of small to medium size enterprises to specialized industry application scenarios. stc will have to keep investing into new features like 5G LAN, security, intelligent routing, high-precision positioning, network slicing, deterministic latency, and others. As an elementary step, stc needs to adapt MEC platforms to 5G networks, ensuring that computing and networking are collaboratively implemented. Becoming Edge Native is the key in this process.

Edge Native strengthens edge capabilities, including service orchestration, AI, and enhanced security on the network edge; it effectively integrates computing and connectivity. Therefore, Edge Native will be the foundation for industry-oriented networks, those planned by the operators in the medium term.



Cloud Native was defined by the Cloud Native Computing Foundation (CNCF) as a paradigm that eliminates the underlying differences in technical implementation between various applications and allows these applications to leverage cloud features, such as elasticity and distributed layout. Under the Cloud Native architecture, applications can be quickly deployed, flexibly scaled, and guaranteed with zero downtime. This approach laid the foundations for Edge Native, which is expected to have greater reach thanks to its ability to adjust to varying industry needs.

As the ICT industry embraces edge services, Cloud Native encounters several challenges at the edge:

- Edge device data must be transferred to the central network first, and the resulting long round-trip time (RTT) degrades the user experience.
- The consumption and management of computing, storage, and network resources must be terminated on the central network.
- Costly data transmission and computing.
- Limited privacy protection and data security.

The advantages of Edge Native can overcome these challenges, as illustrated in next table.

Item	Cloud Native	Edge Native
Technology	Computing only	Computing and connectivity
Infrastructure Resources	• Medium- and large-size data centers • General-purpose hardware • Flexible scaling	• Lightweight edge node • Heterogeneous hardware • Limited or unavailable scaling capabilities

Application Deployment	Independent	Mutually dependent
Management and Orchestration	• Centralized, automatic management • Horizontal orchestration	• Remote management and edge autonomy • Cross-node orchestration
Networking	• Internet-oriented • Backbone network as the focus	• Access-oriented • 5G mobile access as the focus

Edge Native encompasses a new series of concepts for IT developers that are related to telecom network connectivity. These concepts, regardless of whether they are conveyed by 3GPP-defined attributes or reflected by the edge network architecture, parameters, and features, must be clearly paraphrased and presented to developers.

Edge Native is the ideal target network architecture for industries to carry out their digitalization strategies. Leveraging cutting-edge technologies will enable all industry stakeholders to efficiently build, run, maintain, and manage latency-sensitive applications at the network edge. These technologies include:

- 5G network capability openness at the network edge
- Cloud-edge collaboration and edge-edge collaboration
- Service orchestration across different network edges
- Multi-language and serverless design for edge autonomy
- Near-real-time preprocessing and analysis of massive raw data
- Authentication, encryption, and blockchain for a trustworthy edge
- Edge AI for heterogeneous hardware acceleration

stc MEC Deployment Strategy

CONSTRUCTION OPTIONS

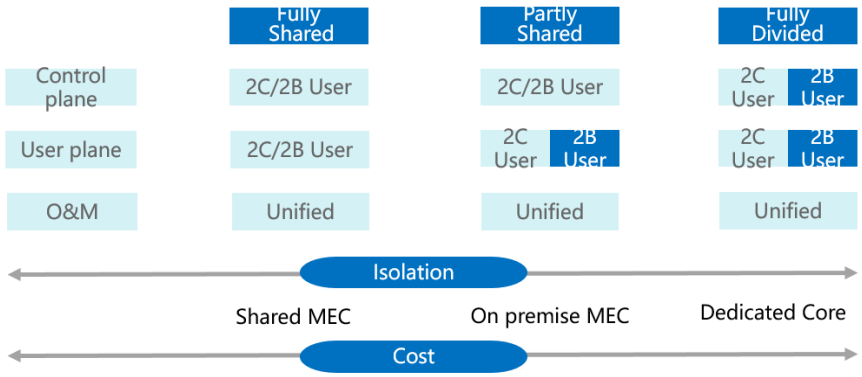
In B2C service scenarios, such as media entertainment and smart education, subscribers are spread across the entire network. Service development depends on 5G network coverage and high-priority processing of network access and resources. This type of customer wants "public and private networks", that is, share the radio access network, bearer network, and core network of a large network, and implement virtual private networks through logical isolation of network slices.

Some industry application scenarios have high requirements for data security and self-management. They will require an independent 5G network, including an independent access network, bearer network, and core network. A dedicated card number is used for subscriber access, and service authentication is performed locally. In this case, the services of the private network are completely

separated from those of the public network and are not affected by each other. This deployment mode applies to specific service scenarios, such as industrial Internet scenarios.

There is another type of service between the preceding two scenarios to achieve a balance between resource exclusive use and construction costs. For example, in most campus scenarios, enterprises require that data services cannot be transmitted out of the campus. Therefore, enterprises select the partially shared construction mode, that is, an independent core network user plane is deployed on the campus. However, the radio access network, bearer network, and core network control plane are shared with the large network.

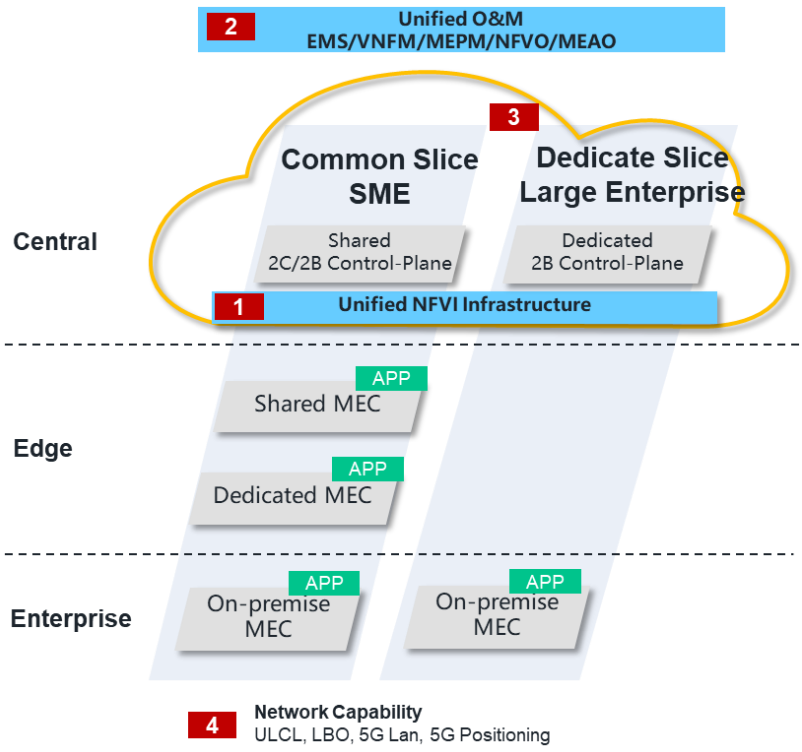
These modes differ greatly in terms of investment costs, service SLA assurance, and local maintenance capabilities of enterprises.



DEVISED DEPLOYMENT STRATEGY

To meet the requirements of different enterprises and scenarios, stc considers the overall network simplification principle to introduce edge solutions. The following figure shows the target architecture of 5GC and MEC deployment.

stc MEC VALUE PROPOSITION



Unified telco cloud deployment of control-plane

Centralized deployment of the B2B/B2C control plane simplifies the network architecture and greatly improves the utilization of telecom cloud resources. Cloud resources are planned and orchestrated in a unified manner.

Unified Network O&M

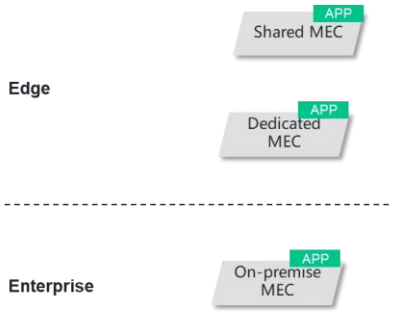
Unified Resource Orchestration - Based on the unified resource model, unified planning and centralized management are implemented, and global resource visualization is provided to improve resource usage efficiency.

Unified VNF/CNF Life-cycle orchestration (NFVO) - The NFV service orchestration system can orchestrate and schedule network services and resources in the NFV domain.

Unified APP life-cycle orchestration (MEAO) - Manages the upload of mobile edge application packages, orchestrates resources across edge DCs, selects appropriate mobile edge hosts for application instantiation based on conditions such as latency, available resources, and available services, and triggers application instantiation and termination.

Unified FCAPS management (MEPM) - Manages mobile network devices and auxiliary networking devices used in mobile networks in a centralized manner, and provides basic functions such as configuration management, performance management, fault management, security management, log management, topology management, software management, and system management.

Flexible deployment for different enterprise



Shared MEC

- **Typical Requirement**: LBO, 3rd APP collaboration
- **Deployment position**: Central/Edge DC
- **Possible Scenario**: Smart City/SME office…
- **Project**: MCIT

Dedicated MEC

- **Typical Requirement**: ULCL, low latency, high resource isolation
- **Deployment position**: Exchange sites
- **Possible Scenario**: Industry City/Remote Education…
- **Project**: MODON

On-premise MEC

- **Typical Requirement**: keep data processing on local, high security, high reliability
- **Deployment position**: Enterprise
- **Possible Scenario**: Manufacturing/5G Port…
- **Project**: Dammam Port

Many Large enterprises require independent networks for their digital experience. The production network and daily work network have high security isolation requirements. Therefore, independent network deployment modes need to be considered.

In addition to meeting SME network requirements, the overall network cost needs to be considered. For different SME requirements, the shared deployment of the control plane or user plane needs to be considered.

Furthermore, in-between options like a dedicated user-plane with a shared control plane provide for isolation of user-traffic while minimizing costs associated with dedicated control slice deployment.

ON-PROMISE MEC STRATEGY

Large enterprises in Saudi are following innovative government programs and going through a radical digital transformation which often involves complete campus infrastructure transformation. Here, stc on-demand dedicated MEC can provide large enterprise customers with managed localized smart connectivity and computing with applications on demand, thus driving enterprises to this attractive and inexpensive OPEX model.

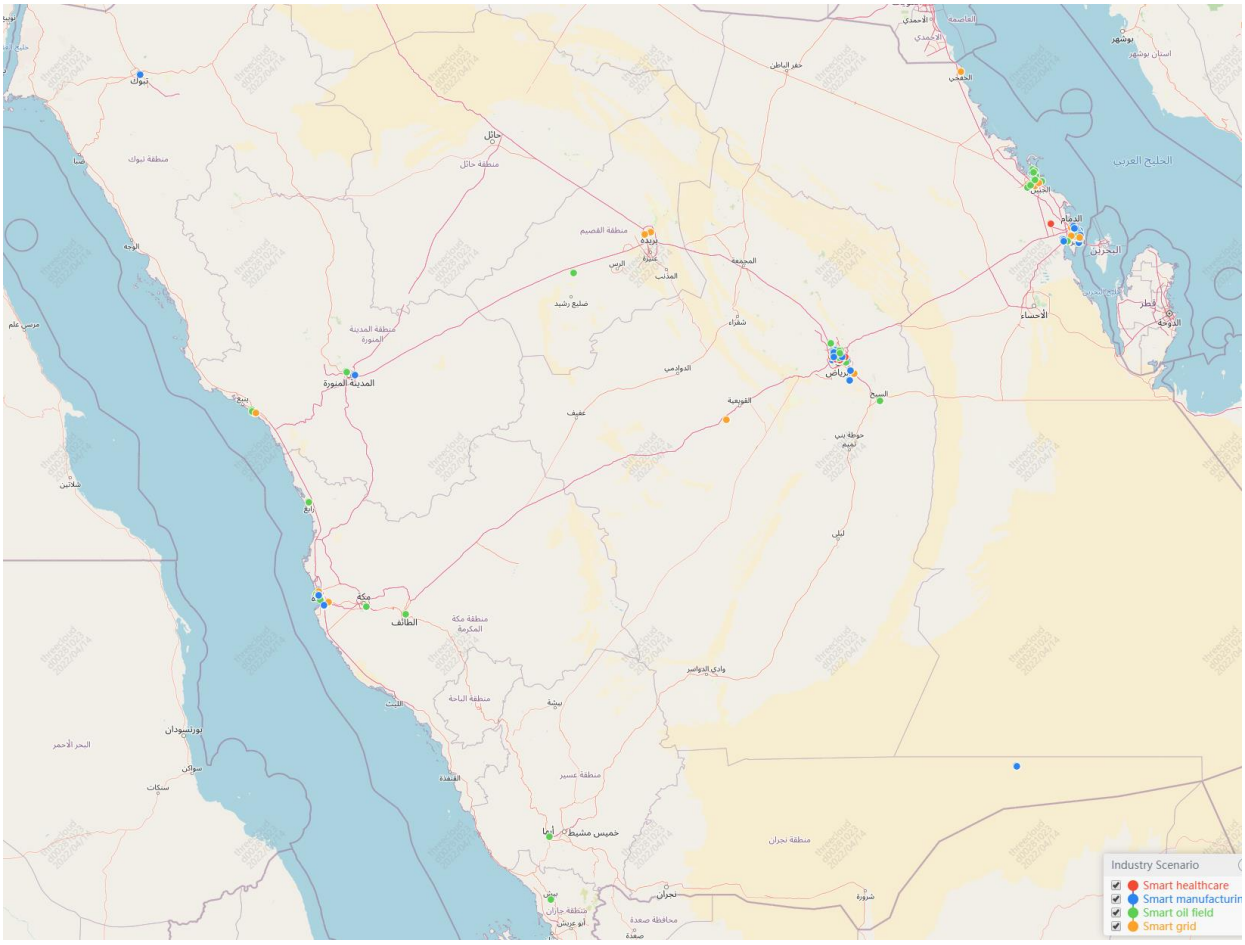
To assess the opportunity for a dedicated MEC deployment strategy in the Saudi market, we sourced data from all the companies in healthcare, education, Oil&Gas, petrochemical, manufacturing, public sector, communication, agriculture, energy, environment, biotech, tourism, aerospace, transport & logistics, etc. We also collected publicly available geographical locations of all companies' campuses, headquarters, and offices across the kingdom.

The below table lists our understanding of most typical services used by particular industry sectors as well as our understanding of service specific SLA requirements and potential commercialization date.

stc MEC VALUE PROPOSITION

Service Category	Service	Commercial Us...	E2E Latency(ms)	Distance(km)	Downlink(Mbps)	Uplink(Mbps)	LBO Rate
Smart healthcare	4K+ tactile feedback endoscope	2022	10	10	50	50	90%
Smart healthcare	AI Vision Assisted Tactile Feedback Ultrasound	2024	10	10	23	23	90%
Smart healthcare	Healthcare robot (medical assistance)	2022	10	10	10	10	90%
Smart healthcare	Healthcare robot (telemedicine)	2022	10	10	10	10	90%
Smart healthcare	semiautomatic tactile feedback ultrasound	2022	10	10	15	15	90%
Smart healthcare	Wireless surgery demonstration	2020	50	50	15	15	90%
Smart healthcare	Remote surgery	2025	10	10	3072	3072	90%
Smart healthcare	Remote consultation/ambulance communication	2021	50	50	10	10	90%
Smart Education	Cloud AR, interactive teaching	2021	20	20	75	10	90%
Smart oil field	Security protection	2020	50	50	2	50	90%
Smart oil field	Production data collection and monitoring	2022	50	50	0.6	0.6	90%
Smart oilfield	Video surveillance	2020	50	50	0.6	50	90%
Smart oil field	Remote production control	2020	50	50	0.6	50	90%
Smart manufacturing	Cloud-based diagnosis and device control of industrial s...	2022	10	10	0.6	1	90%
Smart manufacturing	Cloud Diagnosis and Manipulator Control of Industrial C...	2023	10	10	0.6	100	90%
Smart manufacturing	Cloud-based control of automatic guided transport vehi...	2023	10	10	0.6	10	90%
Smart grid	Intelligent distributed power distribution automation	2022	10	10	0.2	2	90%

Next, the target is to devise the best MEC candidate locations to serve the needs of those enterprises as per the specific service profile / SLA of each company. The final result of the calculation gives us a total of **245 potential locations** for dedicated edge computing deployment.



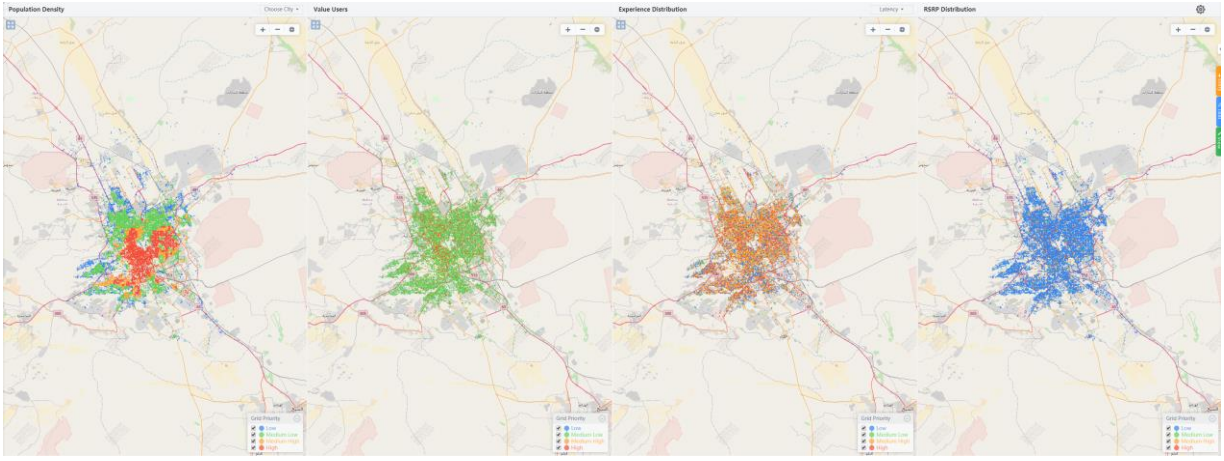
SHARED MEC STRATEGY

While the key to 5G success is B2B verticals, it is B2B2C that will play a major role in edge computing transformation first as its business model is more similar to telco traditional business and thus easier and more tangible. Also, it is expected that a typical small to medium size enterprise would be looking to outsource most of the non-business critical which will include supporting communication and cloud computing infrastructure, but also typical office applications. ETSI MEC standard envisions the same, where edge computing is a shared type of resource providing multi-tenancy, isolation, and security – all the typical public cloud experience but with the additional benefit of premium service SLA.

Service Category	Service	Commercial Use Time	E2E Latency(ms)	Distance(km)	Downlink(Mbps)	Uplink(Mbps)	LBO Rate
AR/VR/holographic	VR games (12K 3D)	2023	10	10	220	50	90%
AR/VR/holographic	VR games (24K 3D)	2025	5	5	1500	50	90%
AR/VR/holographic	VR games (4K 2D)	2020	20	20	50	5	90%
AR/VR/holographic	VR games (8K 2D)	2021	20	20	75	10	90%
AR/VR/holographic	VR games (8K 3D)	2022	10	10	120	20	90%
AR/VR/holographic	VR live broadcast (12K 3D)	2023	10	10	220	50	90%
AR/VR/holographic	VR live TV (24K 3D)	2025	5	5	1500	50	90%
AR/VR/holographic	VR live TV (4K 2D)	2020	20	20	50	5	90%
AR/VR/holographic	VR live broadcast (8K 2D)	2021	20	20	75	10	90%
AR/VR/holographic	VR live broadcast (8K 3D)	2022	10	10	120	20	90%
Personal Entertainment	4K/8K live broadcast	2020	10	10	100	100	90%
Personal Entertainment	4K games	2020	10	10	50	50	90%
Personal Entertainment	4K social networking	2020	20	20	30	30	90%
Personal Entertainment	4K video	2020	20	20	50	0.2	90%

Services of interest include a range of consumer typical services like gaming and VR, but with premium SLA. Listed above are typical small/medium size enterprise use cases that we foresee being of interest to the Saudi market in the next five years. We list the expected service SLA (latency, throughput, local breakout) as well as the expected service commercialization year.

Next, we collect MBB consumer general data like population density, value-users map, experience distribution and RSRP distribution. Here is the sample study of Riyadh city:



Finally, we compare this data with existing stc facility information and plan the list of most suitable existing / new locations for shared MEC deployment to serve above listed services

CONCLUSION

stc MEC Trial and Commercial Practice

"ENTERPRISE A" SMART CAMPUS PRE-COMMERCIAL DEPLOYMENT

SAUDI enterprise A has partnered with stc to build a proof of concept of an Enterprise 5G Smart Network to explore 5G smart industrial uses case in the oil and gas sector.

The main use cases under the scope of this proof of concept are outlined as follows:

- Digital Helmet: documents navigation, visual assistance, remote collaboration with an expert.
- 3D Augmented Reality: for remote troubleshooting using the Digital Helmet.
- PPE Compliance: to monitor PPE equipment wearing habits in workplaces
- Scaffolding Compliance: to improve HSE monitoring and safety on construction sites
- Multi-vision Smart Surveillance: real-time and intelligent surveillance and monitoring
- Vehicle Surveillance: to provide various smart functions while patrolling with the security vehicle such as driver facial recognition and authorization checking, live streaming, and license plate recognition along the route
- Body worn camera: The body worn camera helps the security guard to initiate voice and video calls, and enables real-time visual and interactive events handling when the driver steps out of the security vehicle or during a foot patrol.
- Drone live video stream over 5G: to transfer the drone inspection video stream in real-time to OME Building using 5G high bandwidth and low latency connection.

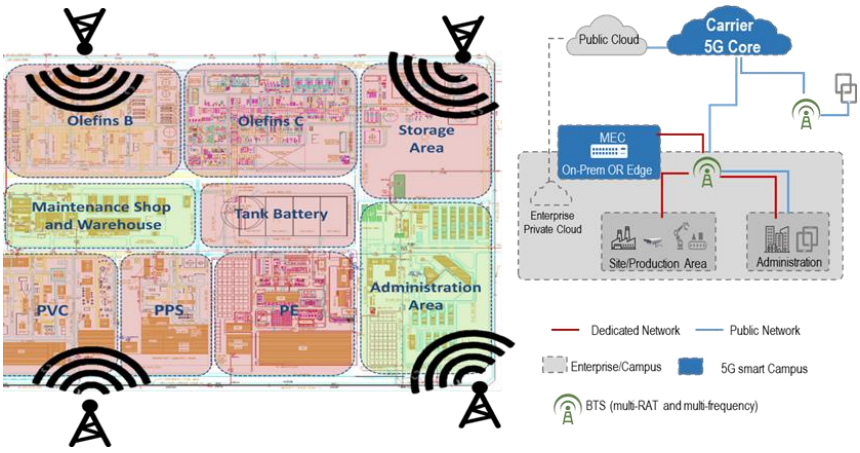
The MEC solution has been introduced in 5G Virtual Network to support low latency and high throughput use cases by isolating all local traffic inside the campus as well as steering traffic to either "Enterprise A" network or Application servers. In addition, the MEC platform integrates the User Plane Function (UPF) with application servers to have fast deployment and integration with third-party applications.

Initially envisioned objectives of this proof of concept were fully achieved: 1. Verification and solution adaptation of Enterprise 5G Virtual Network through latest technology means i.e. use of 3GPP 5G tech; 2. Exploration of Oil&Gas relevant use cases latest advancements in cooperation with the best of industry ecosystem; and 3. Successful showcase of PNI-NPN Managed (Leased) deployment model in cooperation. Proof of Concept's efforts and gained results are in line with key expectations of Industry 4.0 – superior connectivity coupled with more flexible operating and business models.

CONCLUSION

"ENTERPRISE B" PETROCHEMICAL INDUSTRY POC AND COMMERCIAL DEPLOYMENT

"Enterprise B", the largest petrochemical company in the region, hopes to improve production efficiency through ICT technologies. In 2017, "Enterprise B" began to discuss the digital transformation plan to reduce operating costs. In order to realize various industrial applications in the production plant area, "Enterprise B" conducted a pilot project in one of the plant areas to realize private network coverage in the area.



Based on the 5G campus solution, the campus mobile coverage is provided without traffic exiting the campus with big uplink, MEC, slicing and user self-service systems as key points. Applications explored: mobile inspection, campus security protection, and AR/VR, are introduced and gradually transferred to industrial applications.

Conclusion

This two-year long program started with the task to understand edge computing driving forces, exploring the Saudi market industry, and propose Saudi market specific set of recommendations. Achieved results provide answers to all the above, but also provide encouragement for stc to enroll into digital transformation programs.

This comprehensive work on telecom edge computing is culmination of stc multi-year private cloud infrastructure program through which stc reestablished the trust of Saudi enterprise market into local expertise and skill. Established partnership programs ensure continuous innovation in hands of Saudi customers, Saudi businesses, thus nurturing new generations of entrepreneurs forming the 2030 vision.