ETISALAT- 2020 Landscape

WHITE PAPER

etisalat

About This White Paper

Software Define Networking and Network Function Virtualization are two major disruptive technology innovations that are shaping the Telecom industry. Etisalat is very keen to harness the benefits promised by these technologies.

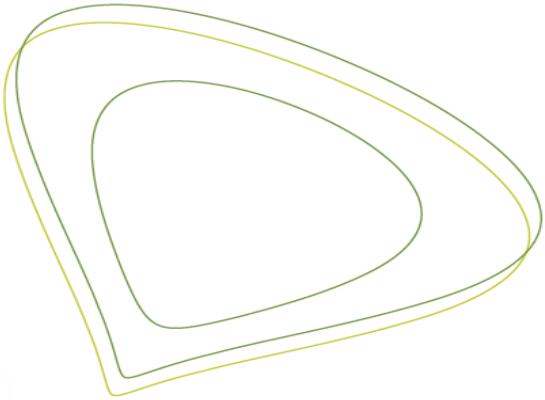
With this whitepaper, Etisalat would like to highlight their vision and intent of aggressive persuasion of key industry advancements that will bolster the use of SDN and NFV technologies. This approach will practically allow Etisalat to pave the road-map of necessary business growth areas for the next generation Communication, Content+ and IOT Services.

The structure of this whitepaper is a theme based format. Starting with Etisalat' Service vision 2020. These focus areas highlights key Network and Operations challenges which will be used as basis to analyze the details of adoption of SDN and NFV. The discussion will take into consideration a 5 year road-map of maximizing the use of SDN and NFV and show how Etisalat will achieve business benefits not only from cost savings perspective but also to be able to create an agile network environment that is necessary for futuristic services and differentiated user experience.

CONTENT

Mr. Hatem Bamatraf, CTO Etisalat Group

"Virtualisation offers a unique opportunity for Etisalat Group to meet the challenges to address the needs of our diverse customers and create services in an efficient manner with agility and faster turn around time. Etisalat group is committed to working towards this and has created number of initiatives to ensure a leading role."



Mr. Khaled Ismaeel AlBelooshi

VP, Core & IP Networks, Etisalat Group

"SDN, NFV and Orchestration are the key pillars to address future technological challenges for telcos and hence Etisalat has initiated number of trials and limited deployments for various aspects of the network to benefit from these opportunities. We have aggressive plans to adopt the strategy of "Whatever can be virualised will be virtualised".

Executive Summary

Etisalat has always been and will continue to aspire forward to stay at forefront to offer innovative and breakthrough technologies and services for its customers.

Etisalat strategy for "2020" network transformation is driven by **rising customer experience requirements and business growth obligations** for its Operational companies located in developing and emerging markets.

Forthcoming services based on super rich content and IoT, have stringent requirements of ultra low latency, extremely high bandwidth, seamless mobility and personalized online subscription efficiency. All of these imperatives have shaped **'cloud"** as the **"de-facto'** technology for future Telco networks.

Through this paper, Etisalat is illustrating fundamental changes in future networks along with tailored roadmap formulation of SDN/NFV deployment to realize **following objectives:**

- **Excellence in Customer Experience:**
  - Excellence in Customer Experience with provision of online, on-demand and real time experience across various channels/touch points for all legacy and new services
- **Efficient Operations:**
  - Simplified and Agile Operations to reduce Total Cost of Ownership
  - Improve time to deploy, modernize and scale of new and existing network elements and services
- **Create new Revenue Streams:**
  - Monetize APIs potential with Open Architecture to delve into emerging ICT business models and eco systems
  - Offer our customers new product & Services which will become possible through virtualization
  - Reach new customers and markets through cloud service environment

Etisalat believes "SDN/NFV driven network transformation" is by far the **most disruptive technology** for telecom service providers, which eventually will transform all key aspects of networks and operations. Ironically, at the same time, fast emerging ICT ecosystem necessitates it **to be adapted at a faster rate than its predecessors**. Hence this has been considered while charting out our virtualization journey plan.

To enable virtualization, and achieve shorter time to deploy and market; de-coupling of software and hardware is mandatory. Hence network infrastructure will transform to be **DC (Data Center) Centric**. Simultaneously, end-to-end network architecture transformation will take **AC (Agile and Cloud) Centric** approach. A distributed DC architecture with multi-tenancy for various application and functions support will be at core of future network.

Etisalat deems it necessary to aim for maximum virtualization of existing networks functions to realize utmost benefits from NFV technology; therefore, an ambitious approach of **'whatever can be virtualized will be virtualized'** is to be followed for network transformation.

Nevertheless, it is worth mentioning here that certain Access network functions may remain 'physical' or will take longer time towards virtualization. However, it is vital that future network architecture is open, agile and flexible enough to adapt to any new access network medium that may be deployed in last mile.

A five year roadmap of Etisalat SDN/NFV deployment is drafted based on above mentioned guidelines. Certain SDN/NFV use cases (vEPC, vCPE, vUDC, vIMS, Service Chaining, DC Inter-Connectivity) are already mature and are already under trial and will be commercially deployed soon across Etisalat OpCos based on appropriate business case. Etisalat has set a goal to achieve **60% virtualization** of network functions by year 2020.

Establishment of **'Regional Cloud factory'** is one particular strategic opportunity identified by Etisalat Group. Cloud Factory refers to amalgamation of certain network/IT services, application and functions from a number of Etisalat Operational Companies into one unified and converged Cloud platform. "Regional Cloud Factories" can significantly reduce TCO with operational efficiencies and offer unified service experience for customers of Etisalat operational companies, especially in less developed markets of Asia and Africa.

Last but not least, SDN/NFV impact on operations and subsequently on Etisalat organization is inevitable. **'Self-healing'** and **'automation across domains'** are integral part of next generation operational framework. Big data based analytics also will play a central role in future network and marketing operations. Etisalat also has set a target of **70% reduction in time to market** for overall product and service development lifecycle.

End to End Orchestration across CT and IT domains is critical for noteworthy service agility and operational efficiency enhancements. Although unification of IT and CT automated process is a challenge today; Etisalat believes that ultimately deploying a **unified orchestration (ICT-O)** is the most favorable approach to realize its objectives from SDN/NFV transformation.

Finally, SDN/NFV driven new processes across physical and virtual network operations across different domains mandate a **new organization model** based on dev/ops concept. Telco Organization of future may have to consolidate certain IT and CT roles. At the same time new skills in areas of virtualization, APIs and Dev/Ops Operations must be learned and acquired.

Etisalat Network Concept 2020

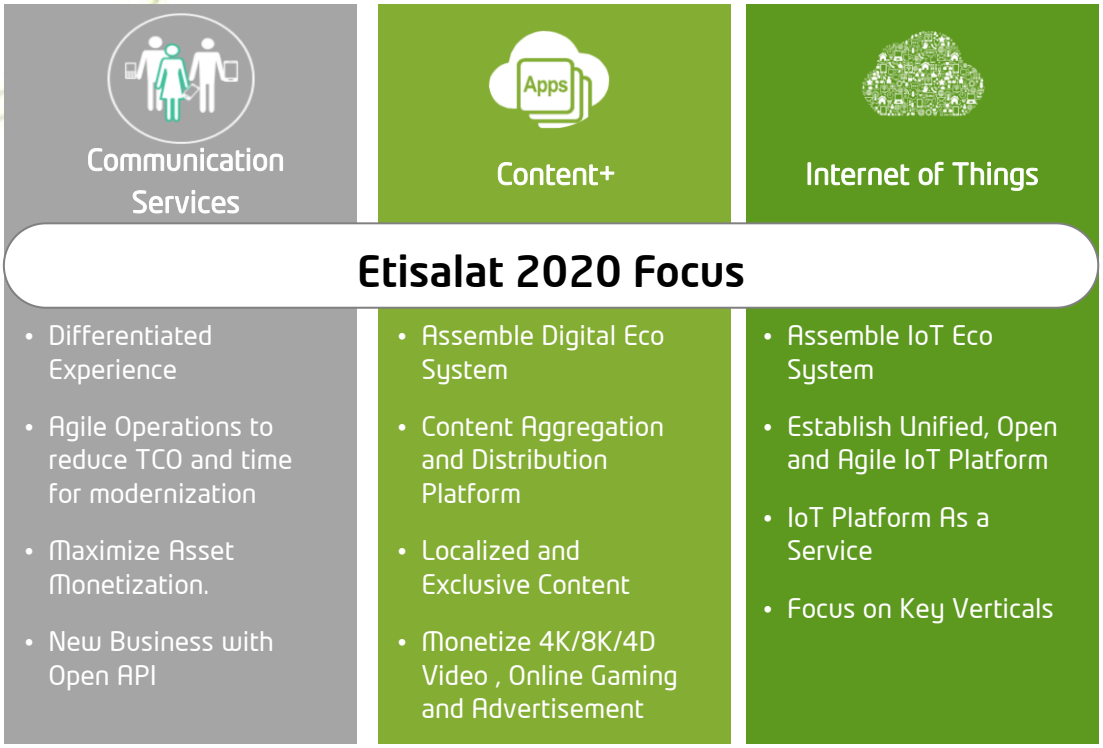
In this chapter we are showcasing key services forecast in year 2020 for Etisalat future business development. Additionally, impact on network operations because of future innovative services and experience expectations is also highlighted. Network of future should enable Etisalat to offer enhanced servcies and experience with ease and minimum disruption.

Services Outlook 2020:

Future Services are bundled in three major categories as follows:

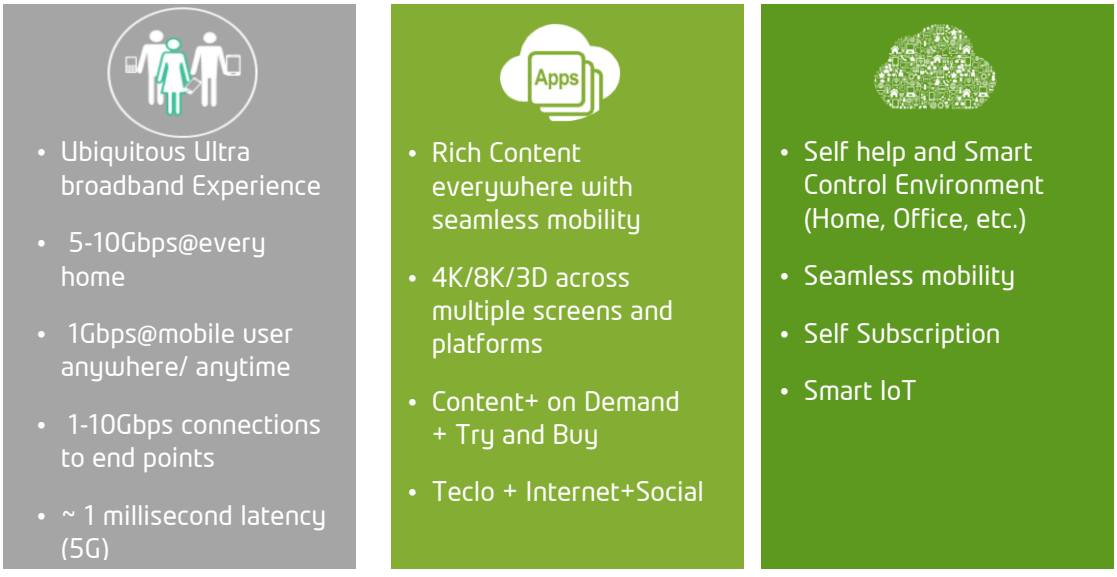
- **Communication Services**: The exponential growth in connected devices and bandwidth will still remain a major driving factor in the Middle East, Asia, and Africa, while consumers expect to have a significantly enhanced differentiated user experience.
- **Content+ Services:** Content+ will be at the core of future digital services. These services include all rich content oriented new services and business models, such as, 4K/8K video, online gaming, Virtual Reality, etc.
- **IOT Services:** IOT Services is another area where Etisalat will bring innovations within various industry segments it serves with pre-packaged vertical solutions.

Considering above services landscape; Etisalat key focus would be to establish and develop new partnerships to leverage revenue potential from emerging eco systems. While still deploying state of art technology for best customer experinece for communication services.



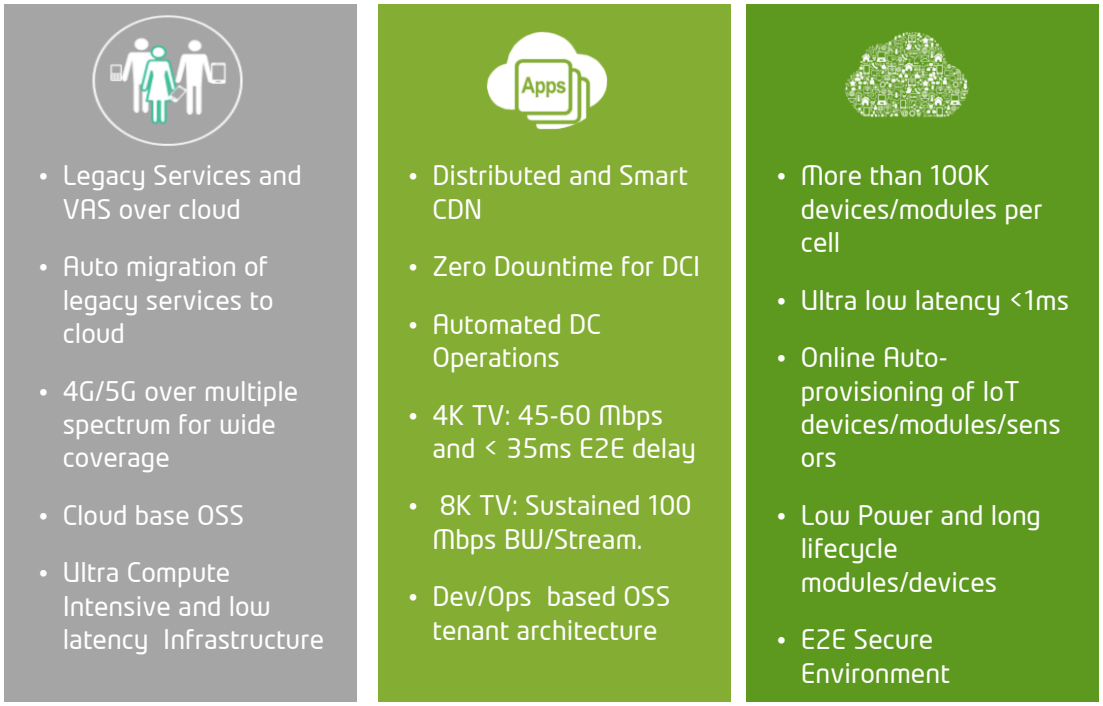
Service Experience Requisites:

Evolving service scenarios with popularity of internet based experience over smart devices present a new challenge for telecommunication service providers. Etisalat considers it imperative that future customer services and network should offer agile, on demand and internet based experinece.



Network and Operations Essentials:

Above mentioned emerging end user experinece mandates a new architecture and functional requirements from future network and business support system operations. The following outlines fundemantal pre-requisites of future networks and support systems.

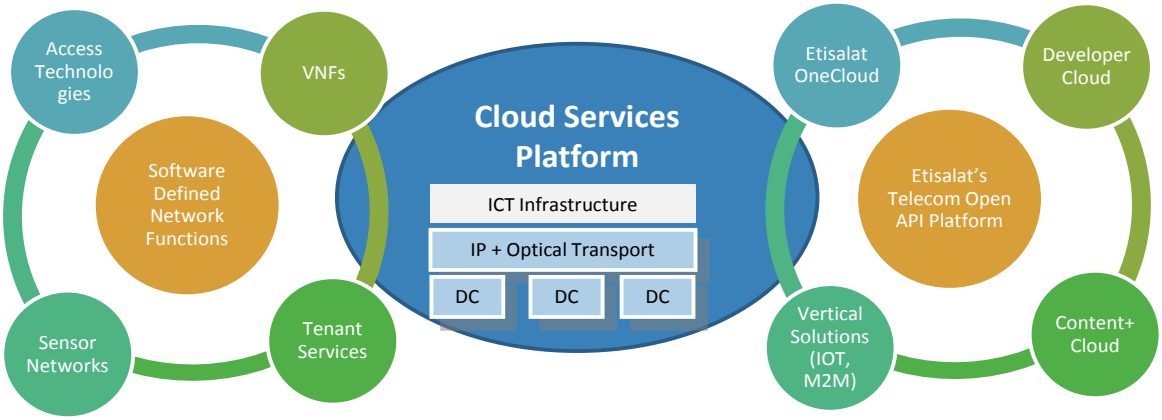


Our future Architecture will be of a cloud based infrastructure. The implication behind such approach is to appropriately mirror how data is distributed across data centers across geographic regions. By doing this, the management and transport of information are optimally accessed and thereby eliminating network inefficiencies.

Therefore, Future network concept is driven by openness, agility and future services. This network should be agile and open to adapt to different ICT ecosystems. This will eventually help Etisalat to extend their portfolio beyond connectity and become a significant key player in prevailing ICT value chains. One more critical design criteria for future network is "adopting IT technologies" as an enabler for rapid new service launches.

Traditional infrastructure gradually transformed to adoptive infrastructures, such as "Agile Core" to quickly respond to customer demand of new services and requirements which is discussed in details in subsequent sections.

This concept is illustrated in the diagram below:



Etisalat believes that above mentioned concept of future network architecture is fundemantal in shaping future service operations and business plans. There are three key pillars of future network architecture which emerge from this concept and hence are prime focus for Etisalat 2020 transformation. These building blocks are:

- Software driven and Data Center based **platform.**
- Virtualized **network functions** and Application
- Agile and orchestrated **operations.**

In following chapters; we have eloborated impact on and from these fundemental building blocks on Etisalat 2020 network transformation journey and objectives.

Platform

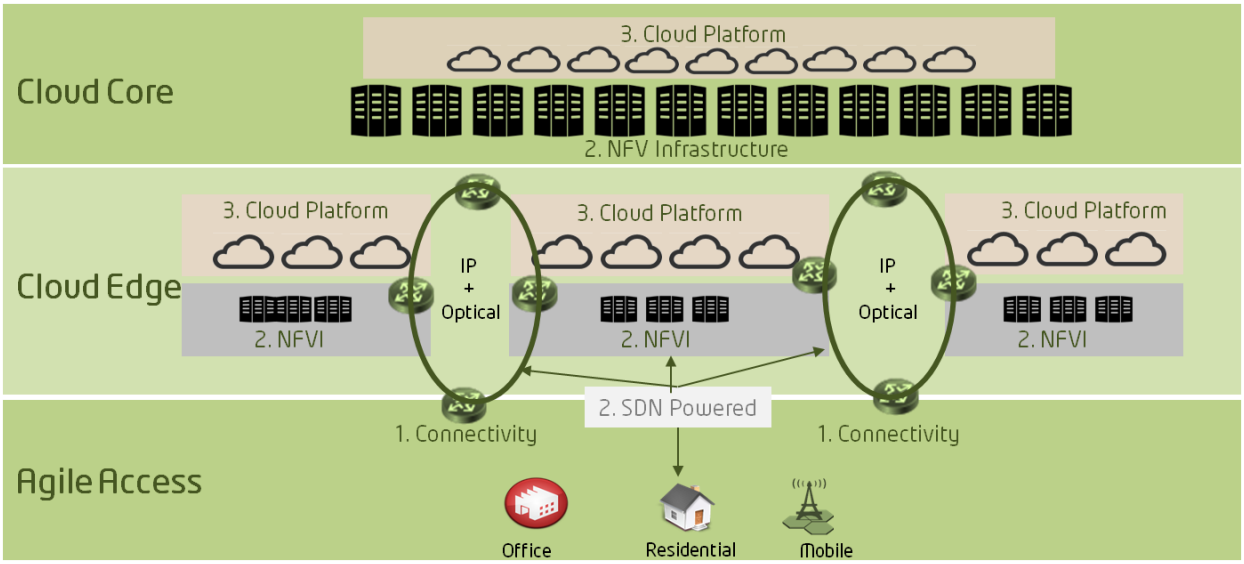
Etisalat foresee one of the most fundamental and visible shifts emerging across telecommunication network infrastructure and connectivity layout. With transformation focus towards ICT continues to grow, Etisalat is increasingly focusing on improving Network Infrastructure, particularly with efficiency, agility and open principles.

With the term "Platform", we want to focus on three key areas that will work in synergy to achieve the stated objectives above:

1. Emphasis on the **Connectivity Architecture** where the underlying IP and Optical networks will be enabler for delivery of the future services
2. Embarking on the full potential use of **Software Defined Networking (SDN)** and **Network Functions Virtualization (NFV)** technologies
3. Underpinning these objectives to initially focus on deployment of a Scalable Open **Cloud Infrastructure**

Telco of the future must be able to increase the capacity at ease. It must introduce significant network efficiencies and Service Agility, while lowering TCO at the same time. A programmable, scalable, virtualized and open platform is mandatory for future services.

Figure 1: Future Platform Concept



Connectivity Reference Architecture

The evolution of whole telecommunications industry and the Connectivity Layer towards Cloudification and Virtualization of technologies and solutions will demand redefining the Telco Infrastructure hierarchy in terms of understanding the evolving role of each of the domains in play. Table below shows Etisalat's evolving Domain Terminologies:

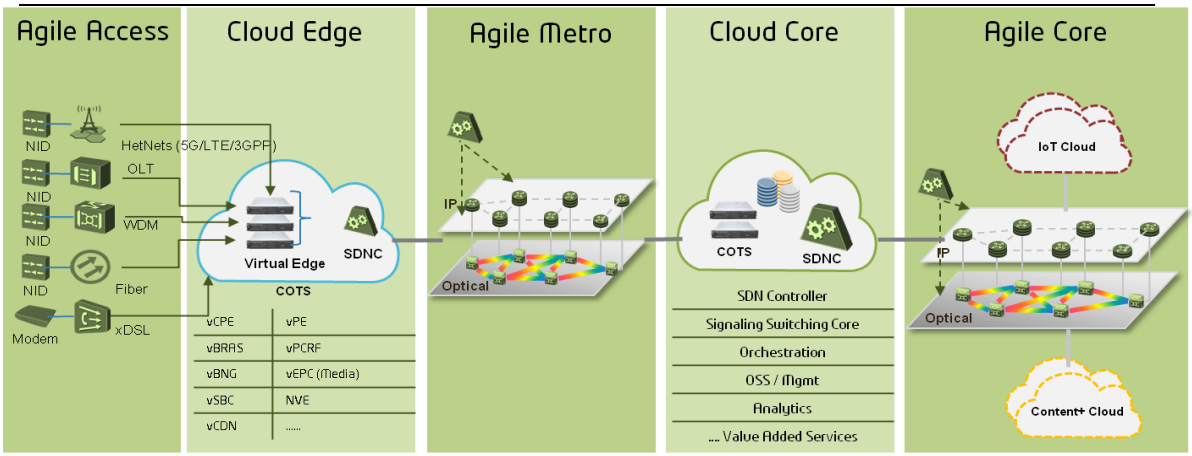
EVOLVING TERMS OF CARRIER NETWORKS

Traditional	Future
IP CORE NETWORKS	AGILE CORE
CENTRAL OFFICE	CLOUD CORE
DATA CENTER	CLOUD CORE
REGIONAL POP	CLOUD EDGE
METRO NETWORK	AGILE METRO
ACCESS NETWORK	AGILE ACCESS

Traditional **Core Network** is becoming **Agile Core** adding more flexibility and innovation speed to Core technologies. Traditional **Regional POPs** and **Central Offices** are becoming **Cloud Edge** converting all regional PoPs to DC-based virtual infrastructure virtualizing dedicated hardware appliances and network functions, traditionally located in Central Offices. **Metro Network** is becoming **Agile Metro** giving better service quality and user experience.

Traditional **Access Network** is becoming **Agile Access** whereby virtual-izing physical high speed access technologies such as Gigabit Passive Optical Network (GPON) and copper-based G.fast.

Figure 2: Etisalat Connectivity Reference Architecture



The above diagram shows how Etisalat's connectivity architecture will evolve. As noted earlier NFV and SDN will be heavily utilized where it makes sense. In the later sections The details of various use cases are covered. The architecture above shows an extensive use of Cloud and Virtualization technologies at the Cloud Edge and Cloud Core layers. These two layers will become Telco function aggregation point and Telco Services aggregation point respectively.

The Cloud Edge layer will have various types of access technologies terminating on a virtual Edge platform. This virtual edge could be an aggregation of network links, a Virtual CPE (vCPE), a Virtual BNG (vBNG) or a Virtual CDN (vCDN). In other words Virtual Edge will host most of the Virtual Network Functions (VNFs). In addition there are numerous other functions that can be virtualized which is covered in next section. The main driving factors besides splitting the location of Virtualized Network Functions (VNF) and Virtual Network Services (VNS) is because of user-experience needs and also demands from technologies such as 5G or 4KTV etc. Content Location proximity to End users will become mandatory due to very high Bandwidth and ultra-low latency requirements.

The Cloud Core can host Virtual Network Services (VNS) such as Value Added Services (VAS), Orchestrator, OSS, BSS, Analytics etc. type of Networks and Management Services.

Interconnecting to the Cloud Core and Cloud Edge is the Connectivity Layer which consists of IP and Optical environment. In future, Etisalat will further leverage Bandwidth on Demand (BoD), Bandwidth Calendaring (BC) etc. type of SDN applications. This architecture allows us to bring necessary efficiencies by intelligently utilizing the IP + Optical bandwidth with SDN and NFV. This future architecture will allow higher efficiency usage of the network without compromising the redundancy levels and quality.

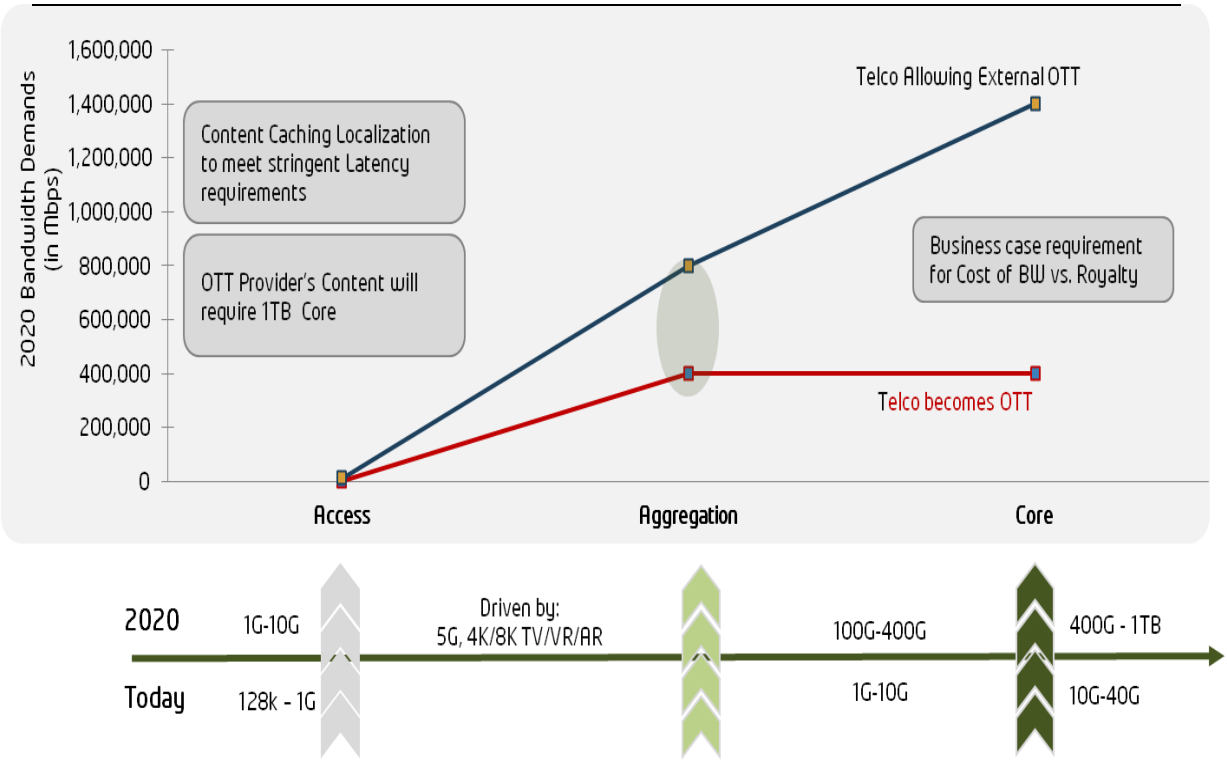
The Agile Core will also become a key enabler for Interconnecting various external Cloud Services such as (but not limited) to Community (or Developer) Cloud, Partner Cloud or Content Provider. These external Cloud interconnection will be an important aspect of growth and scaling the Business.

Industry vertical solutions can also be integrated seamlessly to provide end to end services over Etisalat's future platform. Some of the examples include (but not limited to): IOT, M2M, Autonomous Vehicles, Smart Homes and Smart City etc.

Bandwidth Shifts

In the future due to enhancements in the Access Technologies that will also allow Operators to provide superior customer experience will result in shifts in Bandwidth ratios.

Figure 3: Future Bandwidth Impact



The Access, Aggregation and Core BW requirements will be changing impacting the traditional ratios. The Aggregation layer will become more and more bulky because of BW increase as well as new Technologies such as 4K TV, 5G demanding ultra-low latency. That means localization of content is going to be an important shift by 2020.

Agile Access (Access Layer)

The traditional Bandwidth availability per user or enterprise ranged anywhere from 128kbps to 1 Gbps. By 2020, the bandwidth at the access layer will reach in the range of 1Gbps to 10 Gbps. This is due to the enhancements in the access technologies namely Mobile 5G, Ultra Broad-band, IEEE 802.11ax Wi-Fi standards. The users experience requirements are also playing a major role in enhancing the end user bandwidth. Due to this access technology evolution the entire network architecture has to be carefully planned to meet the following goals: a) Increase the aggregation and Core bandwidth, b) Reduce the number of hops to reach the content and c) Reduce the latency to access Key services

Agile Metro (Aggregation Layer)

The traditional Bandwidth availability at the aggregation layer ranged anywhere from 1 Gbps to 10 Gbps. By 2020, the bandwidth requirement at the aggregation layer will reach in the range of 100 Gbps to 400 Gbps. This BW requirement is due to the rapid growth in number of connected devices and flattening of the traditional Telco layers.

Agile Core (Core Layer)

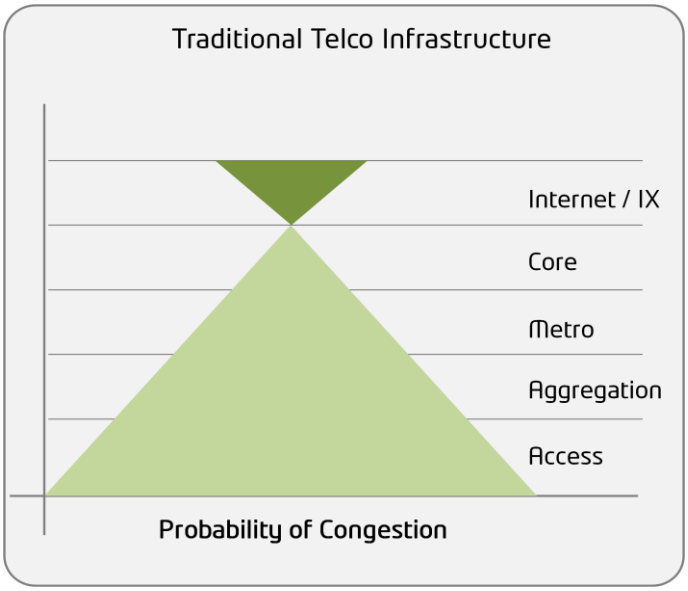
The traditional Bandwidth availability at the core layer ranged anywhere from 10 Gbps to multiples of 10 Gbps. By 2020, the bandwidth requirement at the core layer will reach in the range of 400 Gbps to 1 Tbps This BW requirement is due to Centralized and Virtualized Network Functions, enhancements in bandwidth consuming applications and content.

Another angle to look at deviation of the Core BW requirement is whether the Telco is an Over the Top (OTT) provider too. If the Telco is an OTT provider too, then the Core Bandwidth requirements will be much less as the content localization scenario will bring Bandwidth savings. But if the Telco allows external OTT providers to utilize their backbone infrastructure, the Bandwidth requirements in the core will be 3 times higher.

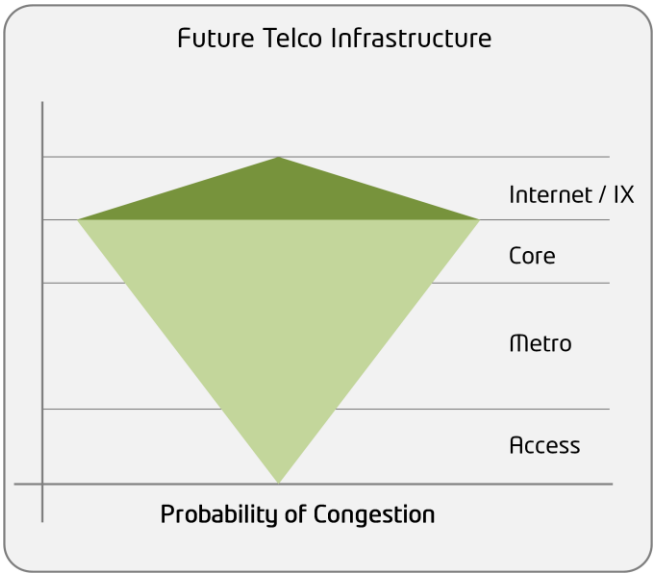
Due to massive growth in connected devices and this Bandwidth ratio shifts it is important to look at type of efficiency, needed to operate the underlying network elements. How to deal with the scale while addressing performance, security and agility concerns in today's networks. This is where Etisalat is banking heavily on the SDN and NFV based technological evolution.

Evolving Choke points

Despite the growth in the core network and Internet backbone traffic, it is always perceived that Access layer is a source of congestion. As such traditionally - the Probability of congestion was high in the Access layer and the Internet Edge. This resulted in network capacity planning teams efforts more focused towards access network traffic planning. However this may change with new emerging network architecture based on SDN/NFV concepts. With advancement in access technologies, multi-Gigabit speed accesses will need to be aggregated and probability of choke points will be shifting more into the Core Networks.



The core network upgrades are often very costly and its highly unlikely that any technology will fully address Core network virtualization needs. Hence Etisalat considers it critical to utilize the power of SDN to improve backbone efficiency and productivity. Though SDN technology will provide automated control and proactive approach towards capacity planning, however, it does make network traffic engineering operations more complex. This also makes prevention of congestion more critical, since it may impact a large geographical area than before and makes business impact of congestion more serious.



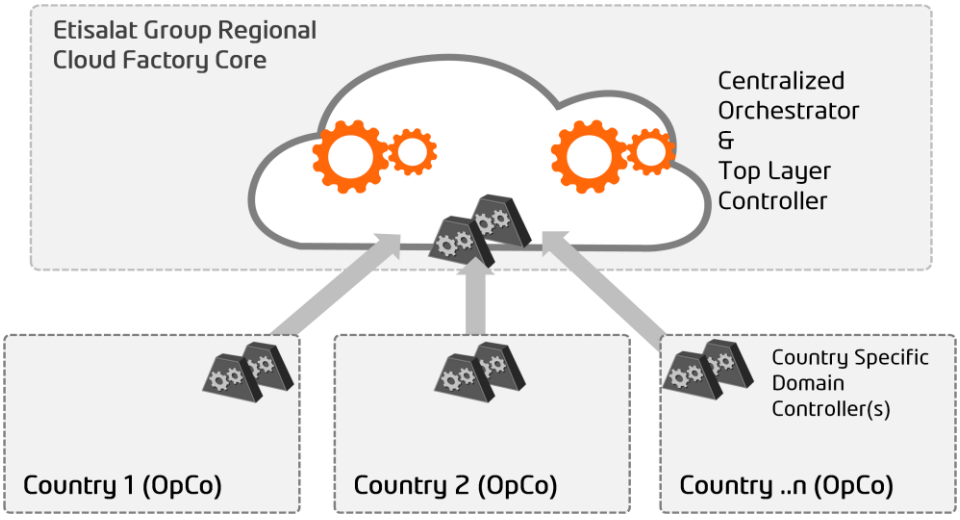
Banking on SDN and NFV

As Etisalat foresee the SDN maturity will come in the three phases. Timelines for the phases of SDN evolution will be tied to industry readiness and organizational needs.

SDN enabled Network Domains

Etisalat's intention is to centralize resources as much as possible to reduce financial and operational burden on Operational Companies (OpCos). However due to latency reasons, it is important that some of the domain specific Controllers are deployed in a distributed fashion (specific to OpCo environments). To balance the economic and technological constraints, the SDN deployment will be hierarchical in nature.

Figure 4: Etisalat Cloud Factory Concept



Hierarchy will help overcome scaling issues and eliminating a massive East-West Cross-controller communication between each domain. This East-West cross controller communication could get very complicated from development as well as operational point of view.

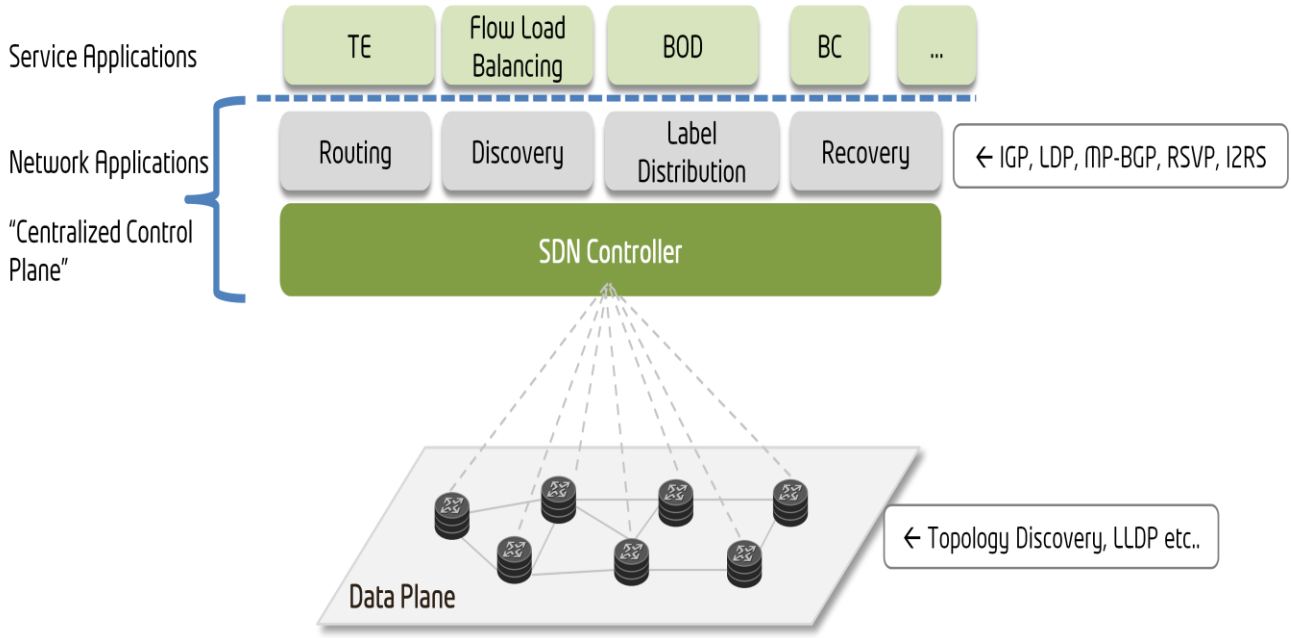
As such a hierarchical Controller system can help overcoming these challenges. This distributed Controller architecture can be hosted at the Cloud Edge as per the general architecture direction.

The Centralized Controller cluster and Orchestration function however required at the Cloud Core layer to get an end to end visibility and cross-domain provisioning capabilities.

SDN in MPLS Networks

The SDN controller will be responsible for computation of the control plane information and program individual network elements with the flow information and actions aka flow rules.

Figure 5: SDN and Network Functions



As shown in the diagram, Centralization of Control plane on the SDN controller means no routing protocols like MPLS, IGP, TE, RSVP, MP-BGP on the MPLS routers.

The controller provides the network abstraction view to the upper layer (North Bound – NB) applications and/or Orchestrator. Examples of such applications could be Traffic Engineering, Flow

based Load-balancing, Discriminative traffic steering, Bandwidth on Demand, Bandwidth Calendaring etc.

As many benefits SDN bring, Etisalat also shares the industry concerns and challenges. Moreover, some specific challenges related to emerging markets where it operates. SDN is positioned for Service agility but in Etisalat's view point SDN along with an Orchestrator can bring the true Service Agility. Traditionally there have been many attempts by the networking vendors and system integrators to develop a provisioning system but never become very attractive in the Telco industry. Due to lack of not having a dependable provisioning system and lack of standard body's involvement, the automated provisioning systems remain a distant reality

This SDN induced transition is a unique opportunity for Vendors and Telco's to work collectively to ensure the success of developing a dependable Orchestrator that can be used as an automated provisioning system without it true service agility will not be achievable.

Another aspect to look into evolution of the current MPLS networks due to NFV. As the boundary between Networks and compute functions are fading, it is possible that in the future there will be Virtual PE functions running on the COTS hardware. Requirements for that could be multi-tenancy or segmentation or regulatory compliance.

That means the infrastructure needs to support a vast number of PE devices on the MPLS network. Etisalat is mind-full of the required scaling, performance and efficiency from the MPLS networks. Moreover, Etisalat's view point is that traditional separation of Network and Applications need to be bridged. The Applications need to have a very clear view of what network can offer, what path is best for the required quality of Service, on the other side the network also need to have a clear understanding of what applications are running on it and what their requirements are. Traditional Hop-by-Hop QoS deployments served us good but with the power of SDN, Etisalat is very keen to see these wide gaps between Applications and Networks narrowing or eliminating.

SDN and NFV implications on the Security Architecture

- Traditionally the security features are fully distributed with layers of security provided with varying degree of operational complexities
- In the SDN and NFV world, some of this security functions will be centralized. In addition, how Edge devices will get virtualized will bring more centralized security boundaries that could

result in lowering the OPEX. The following is a quick highlights of how the traditional security functions will be impacted due to SDN and NFV:

	Traditional Security	NFV and SDN Era
DEVICE HARDENING	Entire Device Hardening	No need for Device Hardening, no user access to Thin-CPE
ACCESS ENCRYPTION	IPSec from CPE to Aggregation PE	Encrypted VxLAN from Thin CPE to vCPE
ACCESS LAYER FIREWALL	Added protection but policies have to be individually applied to the Firewalls	In addition to Encrypted VxLAN overlay, Virtualized FW can be an additional Value Added Service. Reduced CAPEX and OPEX
SERVICE LAYER FIREWALL	Centralized but symmetric traffic is a requirement due to statefulness	Centralized and SDN policies can help with asymmetric traffic shunting or state transfers
INTERNET GW FIREWALL	Centralized but symmetric traffic is a requirement due to statefulness	Centralized and SDN policies can help with asymmetric traffic shunting or state transfers
DEEP PACKET INSPECTION	Centralized but symmetric traffic is a requirement due to statefulness	Distributed and SDN policies can help with asymmetric traffic shunting or state transfers
URL FILTERING	Centralized Proxy : Latency induction	Cloud based Proxy: SaaS, Geographic Load sharing
WEB PROXY	Centralized Proxy : Latency induction	Cloud based Proxy: SaaS, Geographic Load sharing
IPSEC OVERLAY VPN	IPSec configuration, key management, Tunnel End point management results in high OPEX, plus waste of bandwidth	SDN aware IP Sec VPN provisioning, key management
CONTROL PLANE POLICING	Device specific	Not needed, DDoS Mitigation will address this Control Plane protection
DDOS MITIGATION	Centralized, RTBH	Centralized – SDN enabled BGP Flow-spec

As it is evident that some of the traditional way of security functions will change it brings unique set of benefits and challenges to Etisalat. For example, the centralization of the security functions, and being able to virtualize, will be a considerable financial benefit both from a CAPEX as well as OPEX perspective. Having centralized functions will result in better operational efficiency and enhancements in security policy enforcement. But more importantly Etisalat will be able to offer more value added security services that were before cost prohibitive or not feasible.

This will be a new area Etisalat will provide better security coverage to the end users providing a more robust threat defense system.

Along with any set of benefits with new technology adaption, there are challenges too, and SDN and NFV is not an exception. For example, the Deep Packet Inspection (DPI) that has a set of functions will get distributed when virtualized. Those functions will need to work together in a service chaining fashion but importantly will require collection of telemetry data for forensics purposes from many points in the network. All in all, Etisalat is very open to the benefits and at the same time mindful in how to effectively manage the challenges of changes in security functions.

Realistic Expectations from SDN and NFV

There is hype in the industry about SDN & NFV, however Etisalat has taken a pragmatic approach with careful evaluation while charting out its expectations and objectives from SDN and NFV.

Efficiency Gains from SDN	SDN/NFV impact on Lifecycle Management
• Efficient Resource (link BW, Path) utilization by means of Custom and Granular policy management • IP and Optical planes creating true synergy • Operational Efficiency -reducing manual provisioning • Faster TTM by reducing and automating provisioning steps • Reduction in Fault management process • Efficient Capacity management	• PNF : Follow tradition 3-5 Y lifespan • VNF: De-Couple Lifecycle management from Technology Evolution • COTS Hardware and Software lifespan will be shortened due to rapid changes in the Server and Virtualization Technology • Technology Refresh and migration will be much smoother, incremental and rapid.

Etisalat clearly understands that SDN will bring a level of complexity in terms of integration and changing the traditional Telecommunication practices. But the positive trade off of taking on this new set of complexity is in light of leveraging SDN to bring true agility and programmability. The benefits will be in operating network loads in a much more efficient way.

On the other hand, Etisalat is very well aware that by reducing the purpose built hardware and adopting the COTS hardware will actually shorten the equipment lifecycle that can be economically viewed as drawback.

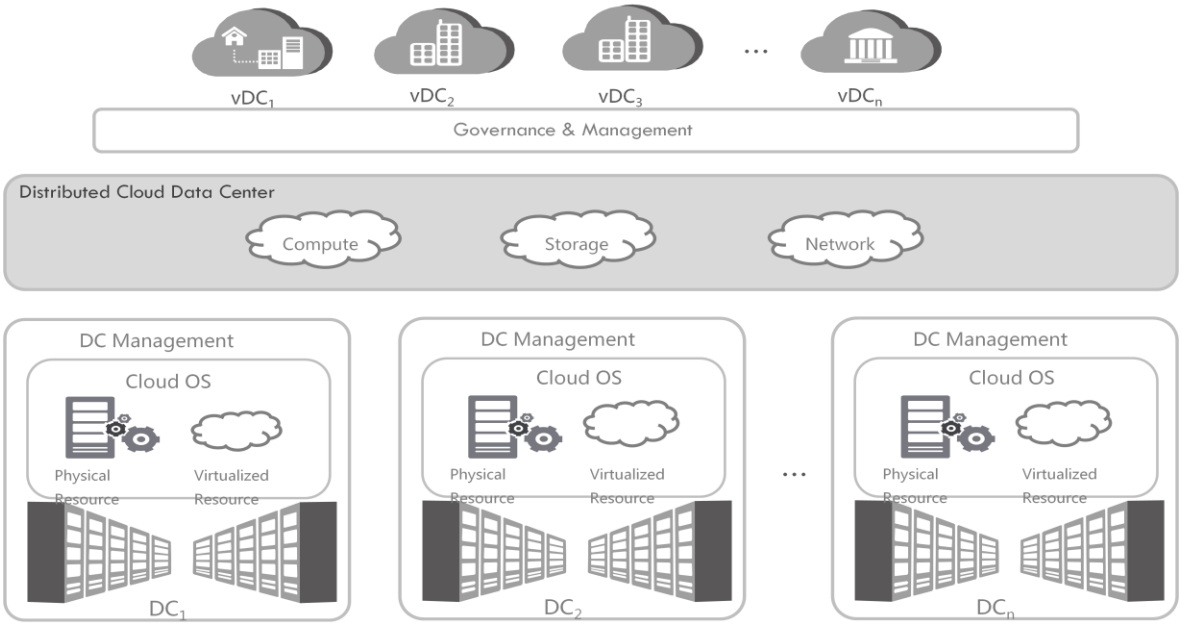
However, the fact that technology is evolving very fast and the future services has to follow that change process in tandem, the benefit of Speed of Technology integration is an essential requirement for Etisalat.

Cloud Infrastructure Reference Architecture

Elasticity is one of the main features of Cloud. Resources in the data center are allocated and assigned to a particular service or tenant from a pool of compute, storage and network resources and therefore form an optimum use of resources in the data center.

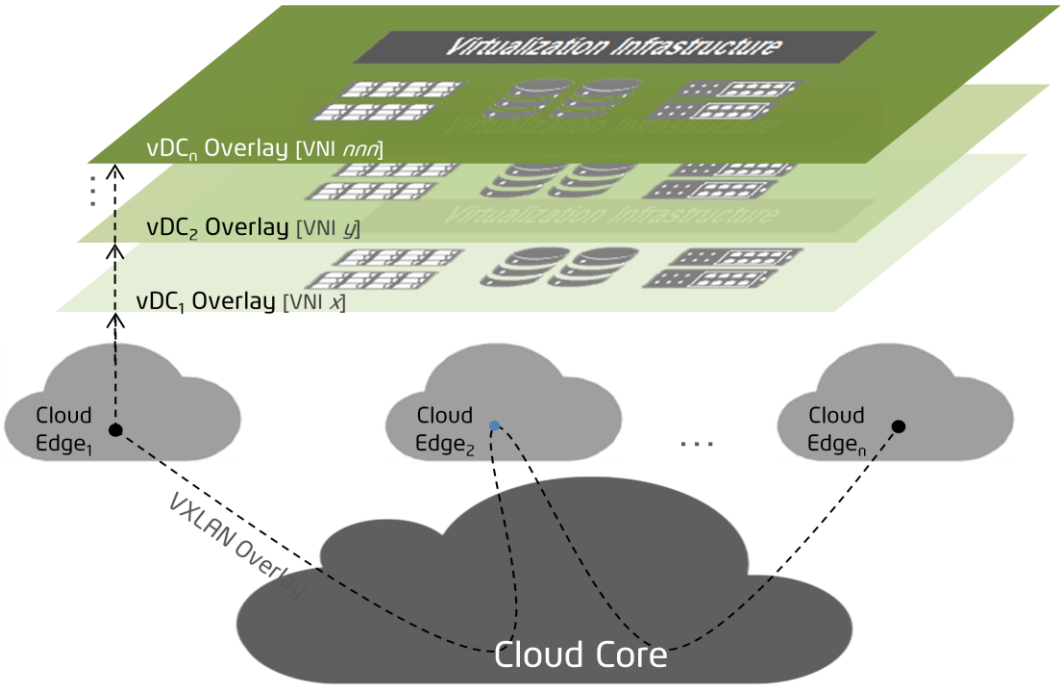
In the case of multiple cloud DCs, administrators traditionally move workloads manually from highly utilized DCs into less utilized ones. In a carrier network environment however, manual workload portability is completely impractical. Carriers are gradually moving towards distributed cloud architecture as a way to optimize the use of multi-cloud DC resources. The implementation of distributed cloud is gaining strong recognition and expected to be the future mainstream cloud implementation.

Figure 6: Distributed Datacenter Architecture



In Distributed Cloud architecture, a DC abstraction layer is formed where all DCs are treated like a single DC and resources are all combined in the Distributed Cloud DC abstraction layer as shown in figure above. A Governance and Management layer is necessary to manage resource allocation, SLAs, and provision services to tenants.

Figure 7: Multi Tenancy in Distributed DC Architecture



The location of tenant resources may very well be distributed among different DCs and accordingly tenant resources need to be joined together to form a single isolated overlay from other tenants in the network. VxLAN is commonly used to perform this task. Each tenant is separated by a unique VxLAN Network Identifier (VNI) to form a separate overlay as shown in figure above. Each of the overlays shown in the diagram above represents a group of resources dispersed among the edge clouds and the cloud core and joined all together to form a virtual data center for a specific tenant.

Evolving Industry Challenges for Cloud

Transitioning from a traditional model into an NFVI has many advantages as we described earlier, but carriers are not expected to transition overnight. There are some considerations and challenges to watch for and plan mitigation. The following are some of the challenges a typical transition may go through.

a. Network Simplicity; Or Not

Although NFVI simplifies service provisioning and orchestration, it still poses some architectural challenges, especially in multi-vendor environments. The interoperability of VNFs developed by different vendors with different hypervisors, hardware, orchestration and automation cause operators to face integration difficulties, potential performance challenges, and intermittent failures.

To mitigate the risk of operational complexity, the following should be considered:

- A clear certification process will need to be carried out by the operator before moving new workflows, hardware and/or VNFs into production.
- In service chaining, VNFs share session data within the workflow lifespan defined by the orchestrator. It is therefore necessary to have a clear mapping between the service to be provisioned, set of VNFs to be deployed, integration points between each VNF, the underlying architecture, and the hardware components. The mapping information is should then be integrated within a thorough verification and testing process prior to any service deployment to ensure smooth interoperability of the VNF elements and proper service delivery.

b. The Cascading Effect

With the growth of virtualization, service density increases; however, despite the positive impact of service density on operational efficiency, a single failure in one of the network components can have a major impact on provisioned services.

Service provisioning in the virtualized infrastructure entails executing complex workflows that would be impractical to run without the use of orchestration and automation tools. Developing orchestration workflows and automation scripts follow a typical development cycle including quality control, code validation, and defect/bug tracking. A single workflow defect during execution can have dire consequences that would create cascading failures in the subsystems or service chain that would be hard to control or troubleshoot.

As a mitigation strategy, operators have to follow a rigorous development quality control cycles, deployment tests and verification processes, especially in the initial phases of the transition where many parts of the network are in motion.

c. Shifts from Traditional Enterprise-style IT to Telco IT Architectures

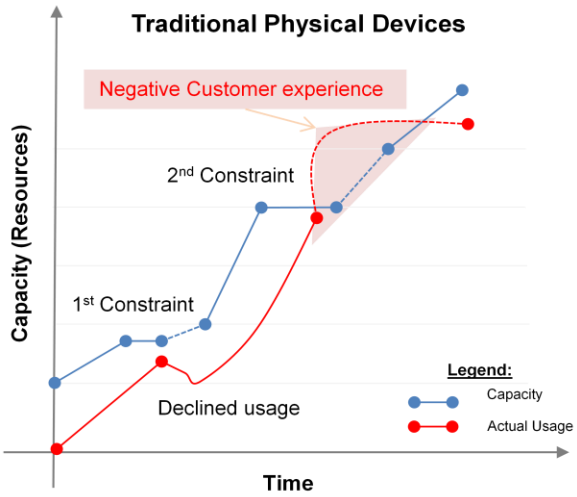
The need to build a carrier infrastructure that combines both CT features and capabilities with those of IT have never been higher. The transformation and merge between both CT and IT worlds to form the new Information Communication Technology (ICT) infrastructure is therefore rapidly growing and is expected to continue to grow and mature over the next few years.

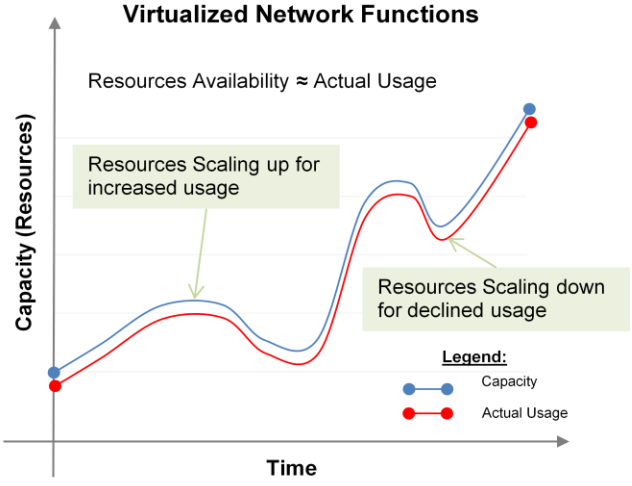
With the accompanied growth in needs, applications, and carrier services of a typical Telco infrastructure, a traditional enterprise IT becomes incapable of coping with Telco service delivery requirements and a great limitation that reins down any carrier cloud potential future capability.

As Telco transition to ICT architecture, a great deal of refreshes, builds, and customizations may be needed to blend and scale the Telco's existing service delivery platforms with existing IT infrastructure. Domain expertise in the different service platforms, applications, business process, and IT infrastructure should be acquired in advance to ensure seamless transition. Solid transition project management skills are also needed to avoid silo-type and lethargic cloud operation.

Benefits of Cloud Technology in Telco Networking

The obvious benefits of the Cloud Technology in the Data Center space are apparent but in Telco Networking it makes a big impact.





The traditional networking devices a total replacement when a new technology comes out or need hardware upgrades when more capacity is needed. Any upgrades done in the past are also susceptible to un-used spare capacity if that demand tapers off.

For any upgrades, the time consumed to add the necessary capacity and budget impact are known problems but more impact is the negative customer experience. Typically the capacity upgrades takes several weeks to months. With the help of Virtualization technology, the Cloud infrastructure scaling up or down can be tightly couple with the actual demand at that time.

Carrier Grade KPIs

One of the main challenges slowing down operators' adaption of SDN and NFV technologies is the limited IT infrastructure performance compared to CT performance. Operators always seek carrier grade systems in terms of availability, performance, security and manageability. For example, low-latency sub-millisecond response time is necessary for many of the carrier's applications. Without this level of performance, delivering an acceptable level of service and complying with contracted SLAs is very difficult to attain.

The following are examples of Key Performance Indicators (KPIs) that need to be met to have the required level of network performance.

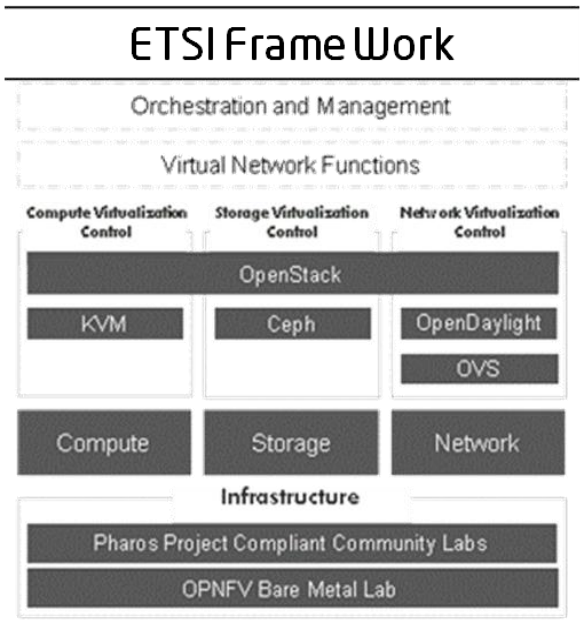
CRITERIA	KPI OR MINIMUM REQUIREMENT[1]
AVAILABILITY	• Six 9s Availability • In-service Upgrades • Network Recovery < 50ms • VM Redundancy within 500km • VM Infrastructure Recovery < 500ms
SCALABILITY	• Both Control & Data Plane • Scale-up & Scale-out • Ability to Scale in VM & Hardware • High Number of VNFs
PERFORMANCE	• High Port Throughput: Supports 100Gbps • Low Latency Network Level: 10 µs • Low Latency IT Level: 100ms, VM Migration < 150ms, 1M flow ops/s
SECURITY	• Data Plane Encryption • Multi-tenant isolation • Intrusion detection • OpenStack Spoofing protection • Hypervisor protection • User-level, system-level, etc.
OPENNESS & MANAGEABILITY	• Open Architecture & Northbound API Support • Avoid at all cost proprietary protocols or implementations • Hitless Upgrades • SLA Monitoring & fulfillment: BW allocation, latency, compute load, storage load, faults & detection

[1] TL9000 Standards & Metrics and ON.Lab's ONOS

OPNFV Test Platforms

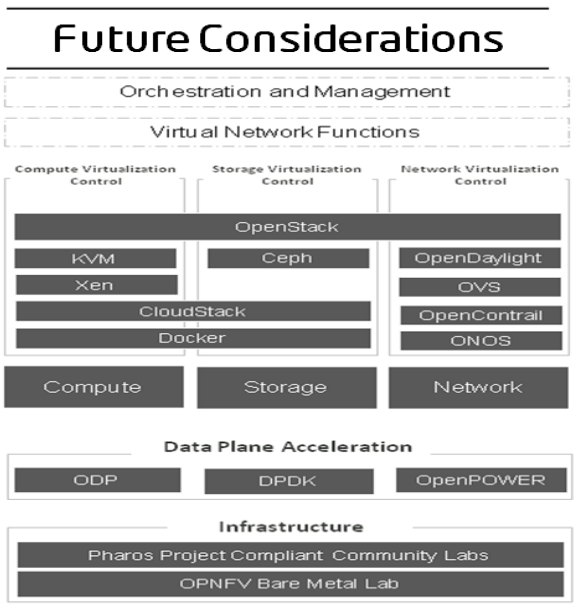
To encourage VNF development and accelerate the introduction of new NFV products and services, OPNFV released river themed builds of NFVI as defined in the ETSI NFV architecture. OPNFV also initiated the Pharos Project to help create a test platform for NFVI components through community hosted OPNFV test labs. At the time of writing of this Whitepaper, there are a total of eleven OPNFV test labs worldwide hosted in USA, Canada, China and France; and the list is expected to increase every month.

While diagram on the left shows a general overview of the OPNFV first released build Arno. As shown in the diagram, aside from the general OpenStack support, additional supported components include, KVM as a hypervisor, Ceph for storage and OpenDaylight and OVS for network overlays.



With the large install base of Xen and CloudStack, OPNFV is considering the integration of these components in future releases.

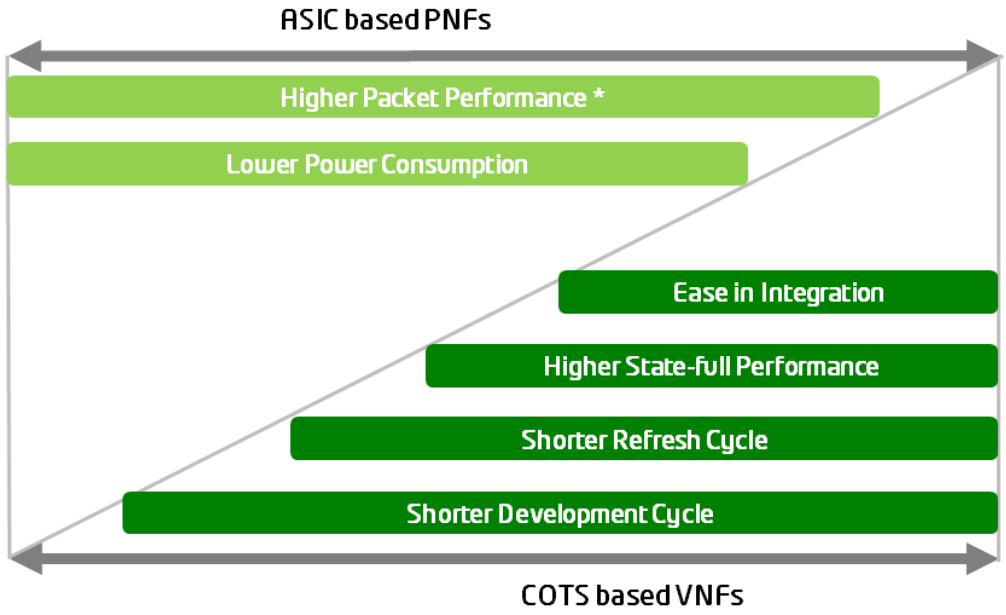
Containers are also gaining considerable attention in the market and adapting Docker may be necessary for future OPNFV integration framework. With carrier-grade deployments in mind, the Data Plane Acceleration becomes another essential piece in the framework that would help provide high performance infrastructure as well as the Open Network Operating System (ONOS) as an SDN controller.



Network Functions

As discussed earlier due to various business reasons, Etisalat is looking at capitalizing on the Virtualization technology. In this section, we would like to share our Virtualization journey along with business justification that helps us take informed and more realistic decisions on Network Functions Virtualization. But before we dive into the Virtualization Journey, we want to quickly highlight the realistic expectation of what we could virtualize and what can be left on physical Hardware. Below is a criteria on what to and what not to virtualize.

Figure 8: Criteria of Virtualization



[2]

Etisalat believes that the traditional hardware optimization technologies developed will remain for some time. ASIC based performance improvements are very well known in the industry and there is no denial that these performances can be further improved as technology advances. In a near term future the COTS technology cannot offer an equivalent match of an ASIC based performances and Technology Interface capabilities.

[2] * In addition to Hardware improvements, Future Development in Protocol Oblivious Forwarding (POF) and P4 promises to improve HW performance.

Carefully looking at this fact, Etisalat views that any function that requires very High Packet Performance (Data Plane) or if it requires lower power consumption for number of Bits transferred, we will still rely on the ASIC based Physical Network Elements. However, the future innovations such as COTS hardware improvements, Protocol Oblivious Forwarding or the new P4 Language can help us bridge the performance gaps. The key question for adopting appropriate hardware will be "whether it provides an acceptable level of performance".

On the other hand, any Network Functions that requires ease in Integration or have a very High state-full performance requirements AND a shorter deployment cycle will be considered for Virtual Network Functions on COTS hardware. In addition, Etisalat would like to see the future Telco Network Services developed in an application form independent from any underlying hardware requirements.

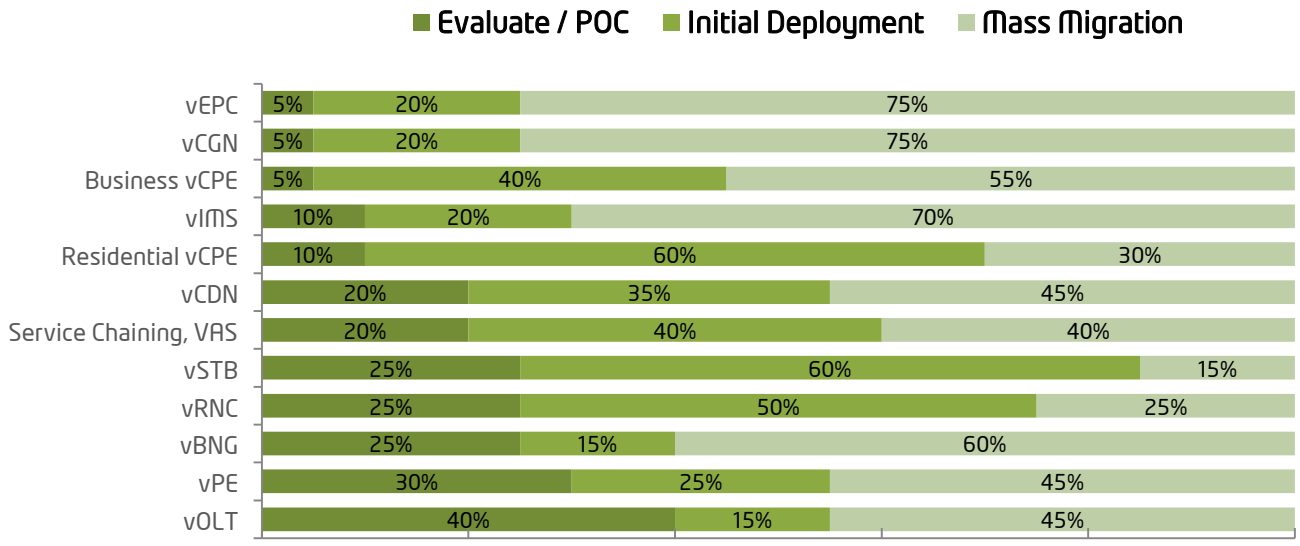
The following table enlists few of the Physical and Virtual Network Functions tied at various Telco Domains. This is NOT an exhaustive list but instead it's a starting point.

Figure 9: Matrix of Physical and Virtual Functions

	Agile Access	Agile Metro	Cloud Edge	Cloud Core	Agile Core
Physical	Thin CPE CPE Data Plane	Optical Transponders Switches (Interfaces)	MPLS "P" Devices Switches (Interfaces)	MPLS "P" Devices Switches (Interfaces)	Optical Transponders MPLS "P" Devices Switches (Interfaces)
Virtual	CPE Control Plane NAT Firewall DPI Encryption Compression / Optimization …	Control Plane Intelligent Protection	NVE vCPE vEPC (S/P- GW) Control Plane vSTB, vParental Control vCDN, vCache vBRAS, vBNG vDPI, vFW, vNAT	vPE Control Plane vIMS vPCRF vEPC (Sig) vAAA vHLR/vHSS vDPI M2M/IOT/vVAS	Control Plane vRoute Reflectors vRoute Server vCGN

Etisalat Virtualization Journey

Following table showcase an anticipation of Etisalat virtualization journey. The use cases listed here are not an exhaustive list but are selected based on their maturity and importance to Etisalat at the initial stage.



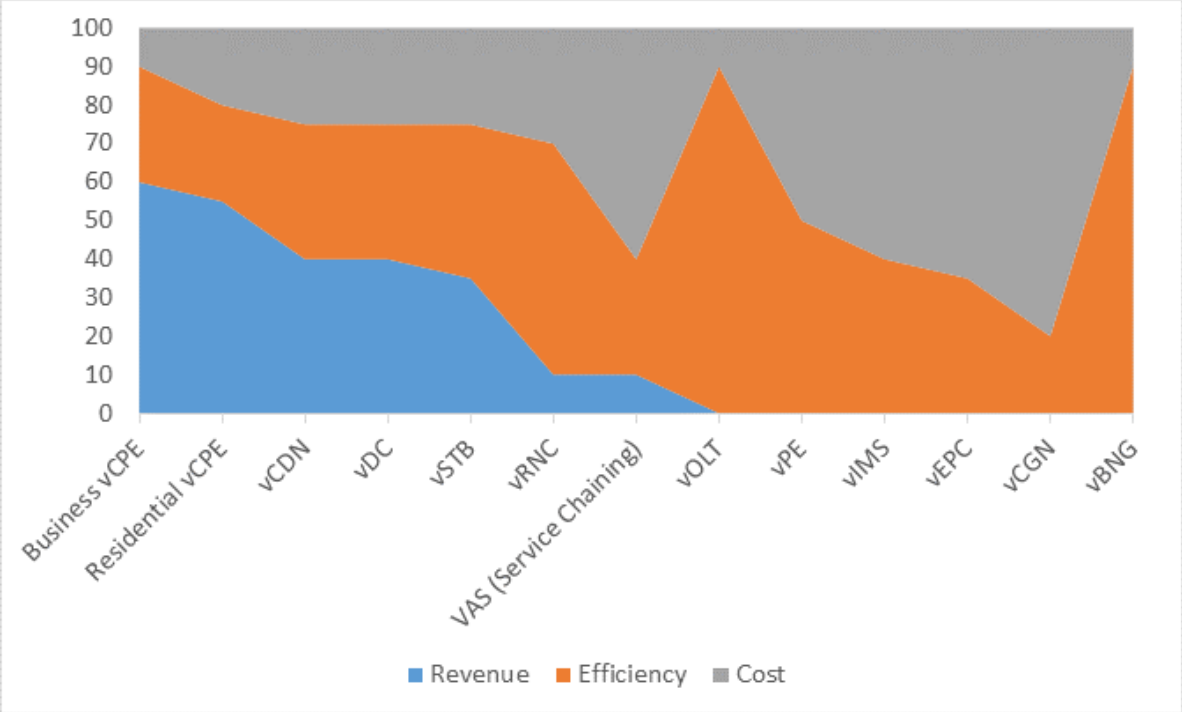
Since specific technical details of these use-cases is beyond the scope of this whitepaper and hence not covered in details.

vDC	Virtualized Data Center	VAS	Value Added Services – Service Chaining
vEPC	Virtualized Evolved Packet Core	vSTB	Virtual Set-Top Box
vCGN	Virtual Carrier Grade NAT	vRNC	Virtual Radio Network Controller
B-vCPE	Business Virtual CPE	vBNG	Virtual Broadband Network Gateway
vIMS	Virtual IP Multimedia Sub-System	vPE	Virtual Provider Edge
R-vCPE	Residential Virtual CPE	vOLT	Virtual Optical Line Termination
vCDN	Virtual Content Distribution Network		

Business Benefits to Etisalat

Etisalat has conducted a comprehensive study and categorizes the virtualization use-cases in a three dimensional business benefits. These business benefits dimensions are new revenue generation, Efficiency gain (both Architecture and Operations) and cost savings. Each of these use-cases have a varying degree of business impact of the three dimensions and the following graph shows the possible impact.

Many of these use cases have cost savings and efficiency benefits however some are likely to provide an additional revenue streams which will allow Etisalat to strengthen their service portfolios further. Whereas Efficiency gain is referred to the level of Service Agility improvement along with Operations efficiency gains that has a direct positive impact on the customer experience.



For Etisalat, Virtual CPE is the most targeted use-cases for revenue generation whereas vOLT and vBNG are the mostly targeted use-cases for Efficiency improvement. As for VAS Service Chaining, vEPC, vIMS and vCGN are expected to provide higher level of cost efficiencies. These functions are traditionally deployed on specialized hardware but Etisalat would like to get cost efficiencies as part of the technology refresh initiatives.

Technology Value Summary

Foundation Cloud Data Center

The vDC is the starting point as other use cases are hosted as in instances of the vDC. Besides being a foundation use case, it also has revenue potential where enterprises can subscribe into the platform as their own vDC. This allows enterprises to form a hybrid private cloud with distributed data centers using their existing enterprise data center along with the Telco cloud data center.

Enterprise focus

Software defined networking and software-defined data centers together form a new enterprise service market. This is largely known as vDC. It allows enterprise to self-service their network and IT needs. The virtualized network and IT can be combined with enterprise data centers to build a truly scalable data processing platform with on-demand capabilities.

Enterprise use-cases like vCPE allows Etisalat to transform their networking services and help enterprise become more efficient with vCPE. It can create a larger share of wallet for Telcos in the enterprise space, promote the branding and reduce cost of deployment in enterprise services. Combined with vDC, there is great revenue potential and foster a better brand for Telco in Enterprise services.

SDN

SDN capabilities are required for many of the enterprise use cases with high revenue opportunity and cost savings potentials. It is a good quick win. On top of vDC use case, the next best use case is CDN which is very important for new services for media, entertainment and 4K/8K videos.

NFV

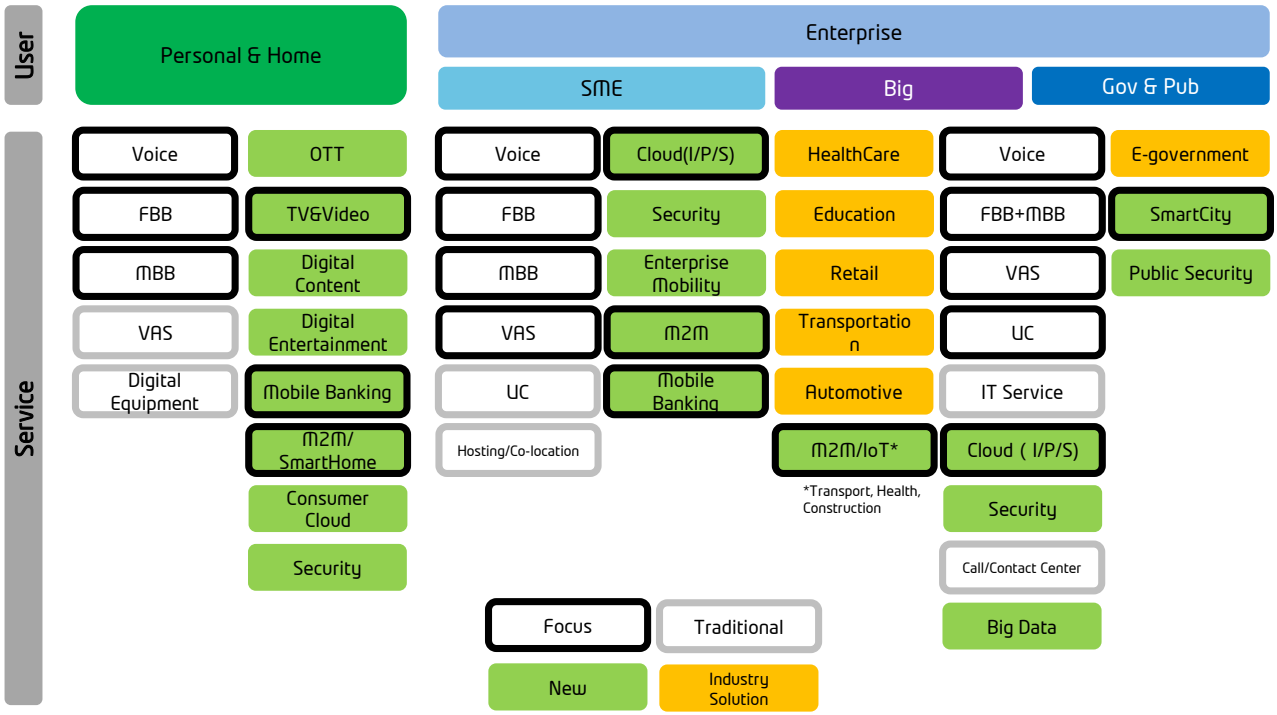
Supplementing the quick win phase of cloud DC and SDN, the incremental cost of supporting NFV is likely to be efficient and hence worthwhile an investment. NFV will allow operators to sustain a growth market by utilizing virtualized platform without increasing operational costs at the same ratio.

Operations

Etisalat see large number of new Content+ Services as a fundamental future requirement from its customers. Content+ Services are focused on rich content with Internet presence and transactions over digital media of e-commerce. Some of the services are listed in the following figure highlighting future focused services for various market segments.

The rise of Content+ Services ensuring a superior experience is profoundly changing the landscape for operators already. The key areas to focus on are operational efficiency, cost reduction and time to market.

Figure 10: Different Services with different Operational Focus



To enable rapid service innovation and participation from our partners, we need simplified OSS systems with open and flexible architecture that support standard API and allow adapting to Dev/Ops model. We need to identify areas where we have skills gap and put aggressive training plans to re-skill quickly.

New OSS systems need to rapidly and dynamically support user self-care needs and manage Real-time Interaction between Users, Partners, Network, and OSS/BSS capabilities. OSS system needs to allow our partners and users to be self-sufficient in fulfillment and service assurance as much as feasible. We must have centralized management across physical, virtual, cloud resources and avoid new management silos.

Being responsive to our customers and providing service assurance in real-time is a key requirement. This means we should have adequate network instrumentation and real-time analysis capabilities in place to detect customer experience degradation, service quality exception and have ability of network to self-heal in case of network problems.

SDN/NFV Impact on OSS

Virtualized SDN/NFV networks management brings following new challenges to OSS systems:

- Support of dynamic, policy-driven (near) real-time processes
    - Mapping of virtual to physical resources and tracking their statuses
    - Configuration, capacity-on-demand, scaling in/out and up/down
    - Service chaining
    - Root-cause and customer impact analysis
- Tight connection between assurance and fulfillment processes
- Intuitive and user-friendly service creation environment
- Integrated analytics – based on real-time traffic measurement, customer behavior, customer usage, etc.
- Service exposure via open APIs, creation of open business partner ecosystem
- Support of automated operations for both Physical and Virtualized resources with limited (or without) human involvement

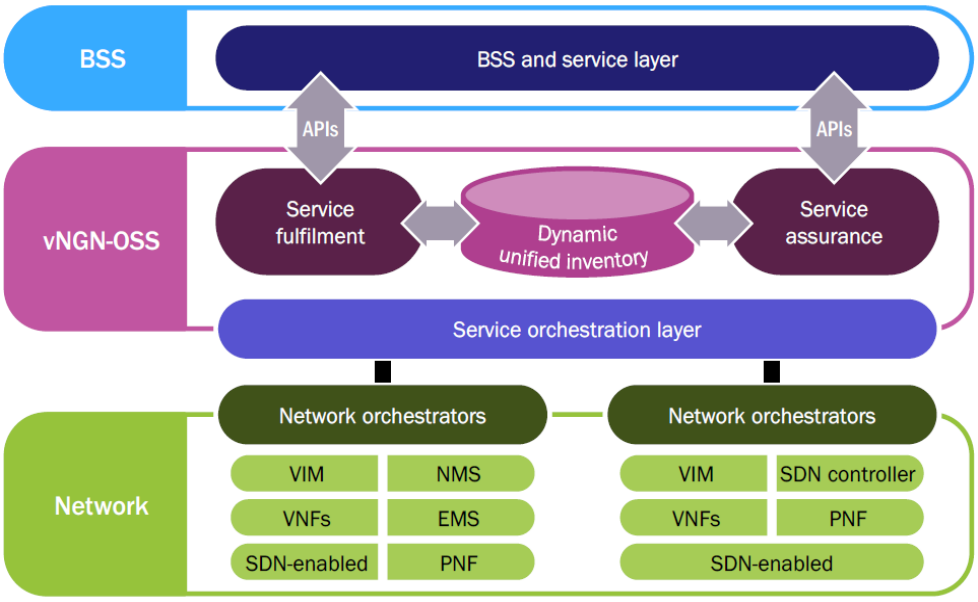
With a network composed of physical resources hop-by-hop troubleshooting has its challenges but is relatively easy, however, with virtualized resources troubleshooting task becomes even more challenging, primarily because the physical to virtual mapping can change in real time. Future troubleshooting activity will need appropriate tools to ensure real-time mapping of virtualized functions and associated physical resources is available. These tools should take into account service chaining and impact of full or partial movement of VNFs across data centers. OSS

needs to have capabilities to detect mal-functioning of Orchestrator(s) and take corrective action automatically without impacting service delivery.

Telco OSS Architecture

Operators and OSS vendors agree that to realize the benefits of using virtualized networks, the operational flexibility and service agility, the present OSS systems has to change. After taking input from multiple operators and OSS vendors, Analysis Mason high level view of the Next-generation OSS functional architecture is referenced as follows:

Figure 11: Analysis Mason[3] View on future OSS Architecture



Analysis Mason View[3]

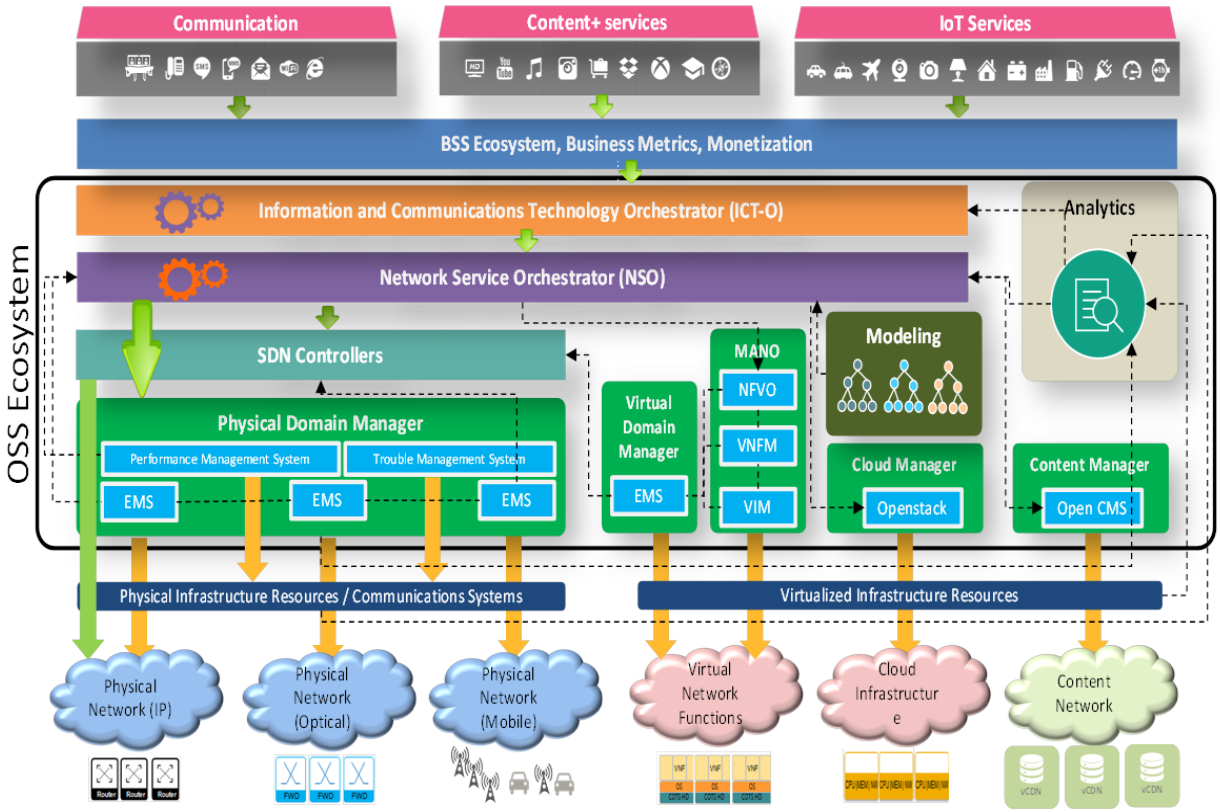
The key point to note is that OSS system must support end to end orchestration of multi-domain, multi-vendor networks and can manage both physical and virtualized networks. There should be two layers of Orchestration - Service Orchestration layer which communicates with multiple domain specific Network Orchestrators. This separation is needed to managed service fulfillment complexity and ease of extending the network or making changes to a specific part of network for a specific domain. There is strong connection between the service fulfillment and Service Assurance functions, both having a common view of dynamically changing inventory.

[3] Source: Analysis Mason July 2015, What Network Function Virtualization (NFV) will mean for service fulfillment.

Additionally, Network Analysis will play a key role to support rapid on-demand service creation in a constantly changing environment.

Based on above theme and to support capabilities and challenges outlined in above sections Etisalat believes that the following functional architecture for next generation Telco OSS is most likely to emerge. The various components like Information and Communication Technology Orchestrator (ICTO), Network Services Orchestrator (NSO), and SDN Controllers are used to orchestrate, configure and deliver network functions and services. SDN controller will interact directly with SDN enabled devices i.e., Openflow enabled devices. EMS's and VNF Managers (VNFM) will be used to manage physical and virtualized resources respectively. Cloud Infrastructure is managed by cloud infrastructure manager, e.g. Openstack. A Content Manager like OpenCMS manages content.

Figure 12: ICT-O based OSS Architecture



During SDN 2.0 phase, Orchestration is a key functionality needed for the necessary service agility. That orchestration function is provided by NSO. In the near future there will be a hierarchical orchestrator model will emerge. The diagram above shows a two layer Orchestration – one is the NSO and another one is ICTO those are essential to create that hierarchy.

Eventually, these two layers will merge to form a unified ICT-O; however they may co-exist for some time in near future. Etisalat also foresees Network Orchestration at country and regional level (Eg. Africa, Asia, Middle East etc.). Etisalat is also targeting to deploy a unified ICT-O in its proposed cloud factory by 2020.

The hierarchical orchestration model is needed to differentiate the functions played by each layer and at the same time hide complexities within each domain too. NSO will be responsible for Service definition and Service policy management which in turn pushes the necessary policies to the SDN controller that further responsible for actual device configuration and will also configure the VNFs by communicating with NFV Management and Network Orchestrators (MANO). MANO manages all aspects of virtualized network. In addition, Etisalat foresee implementation of ICTO as the key cross domain and cross technology orchestration. However Etisalat expect that on the long run a major consolidation of the NSOs and ICTO's as technology matures.

In addition to providing traditional FCAPS functionality, MANO will provide lifecycle management of VNFs. VNF management functions will include support for operations like: Instantiate VNF, Scale VNF, Update and/or Upgrade VNF and Terminate VNF.

This architecture will support a shared model between fulfillment and service assurance capabilities. The model will get updated in near real time to capture the changes in network. The analytics engine gets real time feeds from various components - Physical & Virtualized Infrastructure resources, and EMS's Analytics engine uses these real time feeds to extract intelligence and with the help of a Policy Engine (not shown in the diagram for simplicity) sends corrective actions to NSO as well as to ICT-O. This mechanism of capturing real time data and computing actionable recommendations can be used to improve quality of service delivery or self-heal the network.

Eventually all OSS applications will be built with modular components with common capabilities. For the first phase, our goal is to implement ICTO & NSO with modular virtualized components. These components can be customized and will allow rapid assembly of new behavior in the OSS. Every component is self-contained from the point of data, configurable behavior (metadata, workflow), and functionality. This architecture allows designing software in logical, domain/expertise specific components and thus supports parallel work by multiple teams with different domain expertise and can support DevOps model.

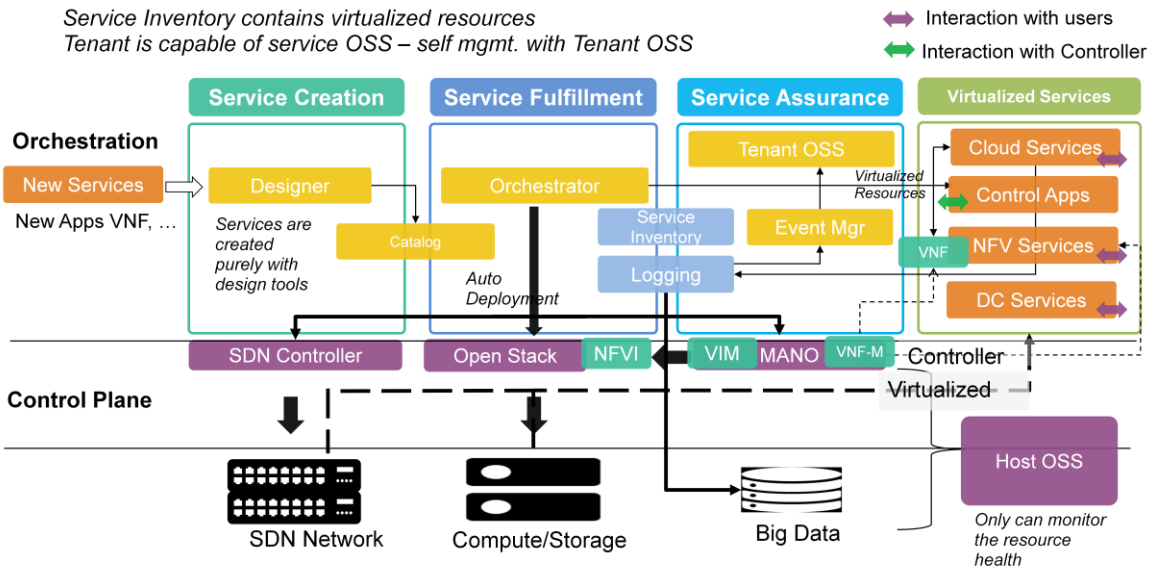
Evolving Role of the OSS

Role of orchestrator is very critical in delivering the real OSS value because of the following major functions:

1. End to End provisioning,
2. End to End Resource Management and
3. Supporting Service Models driven by Business Metrics.

In Future Mode Operations (FMO) Service orchestration is the heart of automating the service lifecycle management. Service orchestration capabilities will provide end to end capability to manage the service lifecycle. The orchestration engine is able to coordinate the activation of a SDN network across the transport layer and the data center network layer to form a virtualized and distributed network with DC processing capabilities across all connected locations.

Figure 13: Services Automation Flow



In FMO, the main change is that the orchestrator can now deploy the service by creating the virtualized data center and installing the entire software component that implements the service. The major activities for Service Creation, Service Fulfillment & Service Assurance for various virtualized services and their interactions are described in the figure above.

Service Creation is done by the service designer tool, however, the orchestrator will be integrated with service designer tool so that appropriate services can be described and modeled inside the

service catalog. The orchestrator will be capable of reading the catalog and deploying the service. Service Inventory is shared between fulfillment and assurance functions, so that real-time mapping of VNFs to VMs is available to assurance capabilities and event manager is able to correlate events to affected services. The Host OSS system has visibility to entire network. Tenant OSS provides fulfillment and assurance visibility to partners for their portion of the physical and virtualized resources and it interacts with Host OSS.

With the multitude of applications and domains (e.g., consumer, broadband, mobile backhaul, mobile packet core, and business VPNs), control cannot reside in a single monolithic software orchestrator or controller. To manage the complexity and specific domain expertise, tiered architecture is required with distributed NSOs sharing a global view of the services and network provided by ICTO. An NSO has the network intelligence necessary for its contained domain, such as mobile backhaul, transport network, IP VPN and content delivery networks (CDNs).

Analytics Role in Operations

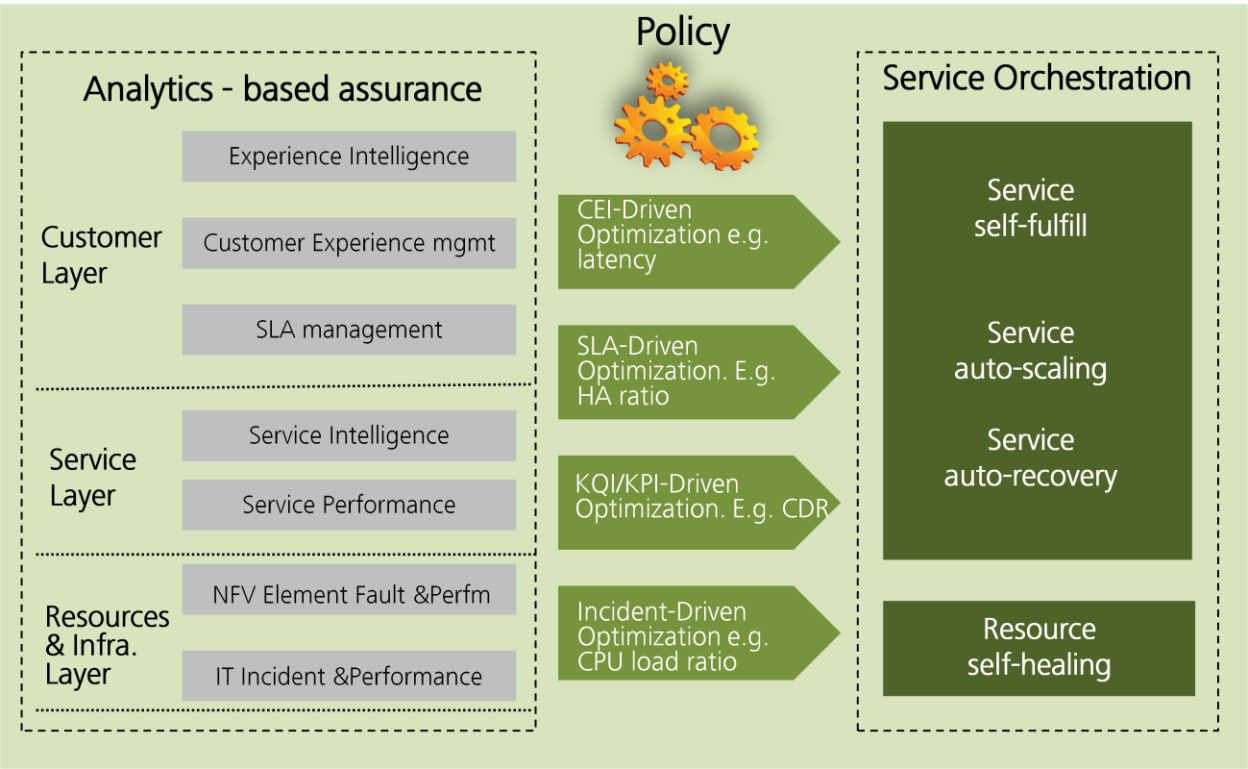
Etisalat is planning to build and monetize a Big Data platform using our ecosystem of customers and partners. This platform will capture data related to interaction from customers (B2C), from enterprises (B2B), from OTT players (B2B2C) and the developers of the services. One key source of data for the analytics is the operational logs generated by the virtualized services (VNF) and the OSS systems managing the virtualized environment.

The network must be instrumented in the data plane to track bulk and application traffic flow patterns as well as subscriber behavior to collect data. Two methods to collect the information and its impact are highlighted in the following table.

METHODS		WHAT IT IS?	IMPACT
PULL METHOD		Analytics Engine pulls the necessary analytics information from the nodes or part of network	Moderate BW impact, Moderate Device Sophistication impact, Passive devices can't be used for analytics
PUSH METHOD	Event driven	Devices send event driven data to the Analytics Engine	Less BW impact, High Device Sophistication impact, Passive devices can't be used for analytics
	Full Push	Devices send ALL data to the Analytics Engine, and rely on having a centralized processing	Very High BW implications but no device sophistication impact inclusive of Passive devices

Analytics engine can be deployed at the edge for time sensitive customer information and localized computation, i.e., detecting multiple dropped calls for a mobile customer who has travelled to a new country; or it can happen at a central place to mine customer sentiments about a CSP from data captured from multiple social sites. Ability to generate actionable events from collected data and the ability of system to act automatically on those events to improve customer experience or SLA is essential to realize business value. By applying data extraction & data mining techniques to collected data, triggers will be generated in real time. This information will go to policy engine to send policy directions back into the orchestration layers to self-regulate, self-optimize, and relay important network status changes. Etisalat plans to implement a closed loop between Assurance and Orchestration, along with a Policy Engine and Analysis capabilities. This will allow linking of operations with control and thus provide network to self-heal in case of some network problems.

Etisalat Real-time Analysis platform will work on four categories of triggers for optimizing and taking corrective actions as shown in the figure below.



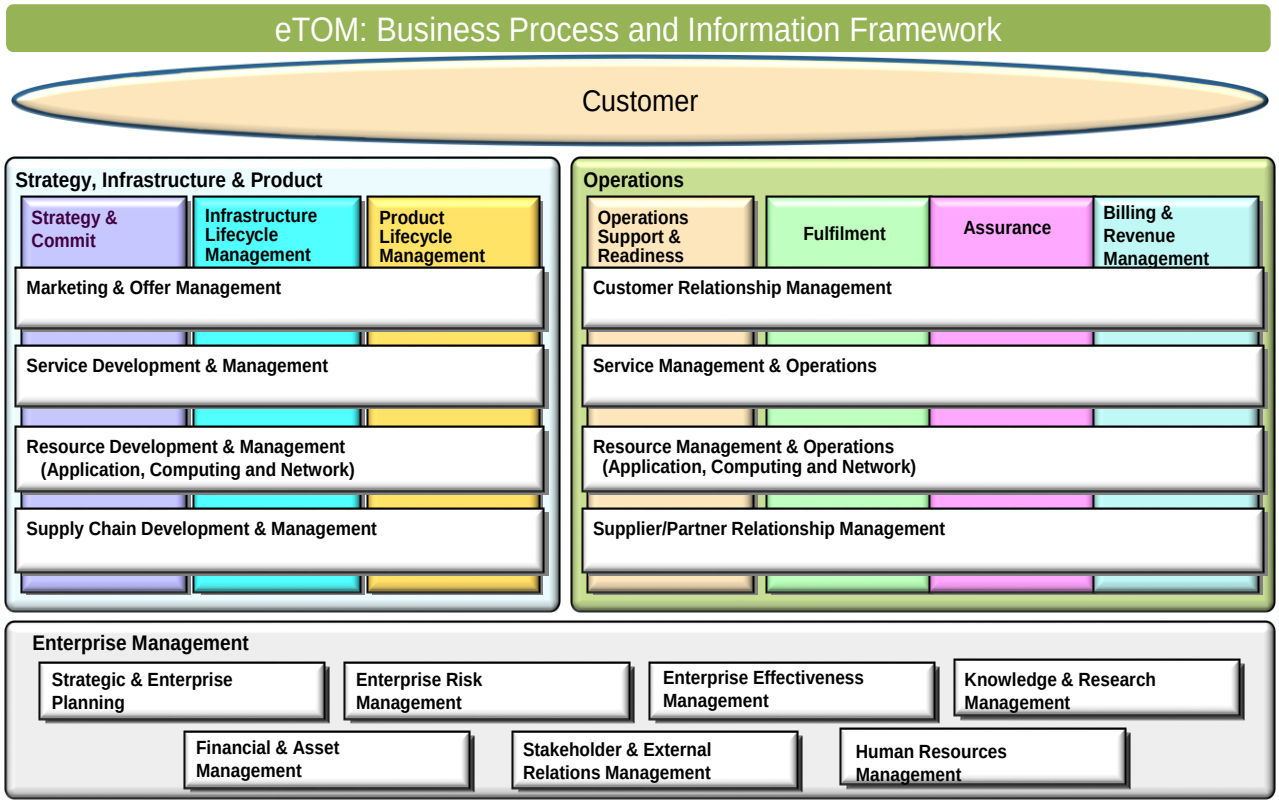
These are event/Incidents, KQI/KPI, SLA, and Customer Experience Intelligence per service and per account.

For example Intelligence about customer experience in Customer layer will allows us capability to auto-scale in case of bandwidth congestion or offer self-upgrade service options to customer. Similarly, incidents at resource and infrastructure layer can enable the OSS system to correct service problems based on some pre-defined policies and using stand by resources.

Key Operational benefits of real time analysis are enhanced Overall Decision Making, ability to take preventative action in Real Time and with predictive analysis capability to be more proactive than reactive. With SDN/NFV the data velocity, volume and variety increases, but more value is realized from better insight of Quality of Experience (QoE), customer management as well as end-to-end management. To be cost efficient, we will be selective in Real time interaction use cases and ensure each of them contribute to business value.

Service Management

The TMF eTOM Business Process and Information Framework (as shown below) has been helping the Telecom Industry define the Operations processes. Four major lifecycle processes exist inside the telecom operation; Customer Relationship Management, Service Management & Operations, Resource Management & Operations and Supplier/Partner Relationship Management.



The introduction of SDN/NFV along with Orchestration capability has a major impact on the Service and Resource management & Operations. Orchestration technology allows the entire service lifecycle to be described in an information model. Virtualization of Infrastructure will allow us to provide a customized view of the part of the network that belongs to a Partner. With this view and the use of a Tenant OSS our partners will be able to support their customers. The table below shows the mapping of Service Lifecycle activities to eTOM Operations phases.

	ETOM MAPPING	
LIFECYCLE ACTIVITY	Strategy, Infrastructure and Product	Operations
SERVICE DESIGN	Service Development and Management	
SERVICE PROVISIONING	Resource Development and Management	Service Fulfillment
SERVICE CONTROL AND OPTIMIZATION		Service Assurance
SERVICE MONITORING AND PERFORMANCE MANAGEMENT		Service Assurance
SERVICE INVENTORY		Service Fulfillment
TROUBLE TICKETING		Service Assurance

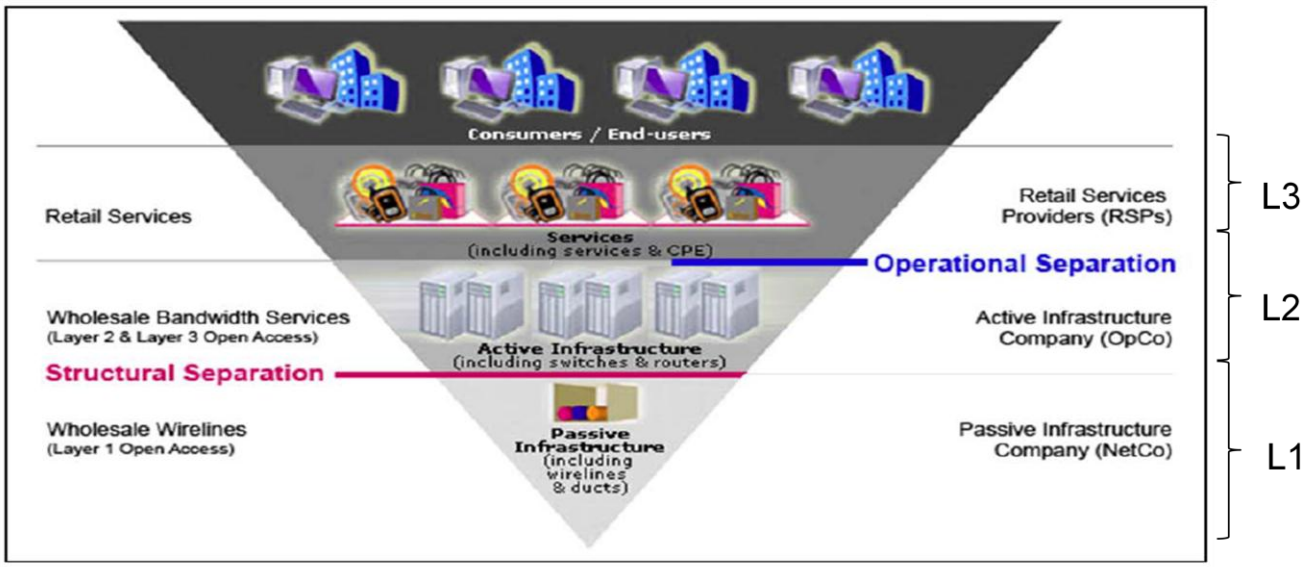
With orchestration technology for software-defined services, it will be possible to completely automate the service lifecycle management according to the eTOM model. In the future mode of operation (FMO), the designer will designs the service and the orchestrator is expected to automate the deployment of the service.

The service designer models a virtualized data center comprising processing locations (WAN Network) and the processing capacity required (VM, Storage).The designer associates the applications that will run inside each VM container. Each service will have a model comprising the virtualized data center resource requirements and the required applications to be deployed in each VM. The entire resource deployment is automated by the service orchestrator.

The service orchestrator reads the service model that is stored in the service catalog and creates the resource deployment template. The orchestrator creates the virtual resources and also loads the applications into the VM containers. The application loading will also include OSS applications to operate, monitor and control the service. To illustrate the changes in present mode of operation (PMO) to FMO, we describe operations in Retail/Wholesale use case below.

A Use Case Scenario Example: Operations in Retail/Wholesale

In most national broadband initiative, there is a wholesale/retail split for Operations as shown in the figure below. The wholesale infrastructure is owned and managed by the L1 organization i.e., the Infrastructure Owner - NetCo. The active virtualized infrastructure layer is managed by the L2 organization i.e., the Active Infrastructure Company - OpCo. The L3 organizations are the sales, marketing teams for the retail services and they are the front-end organizations supporting the customers.



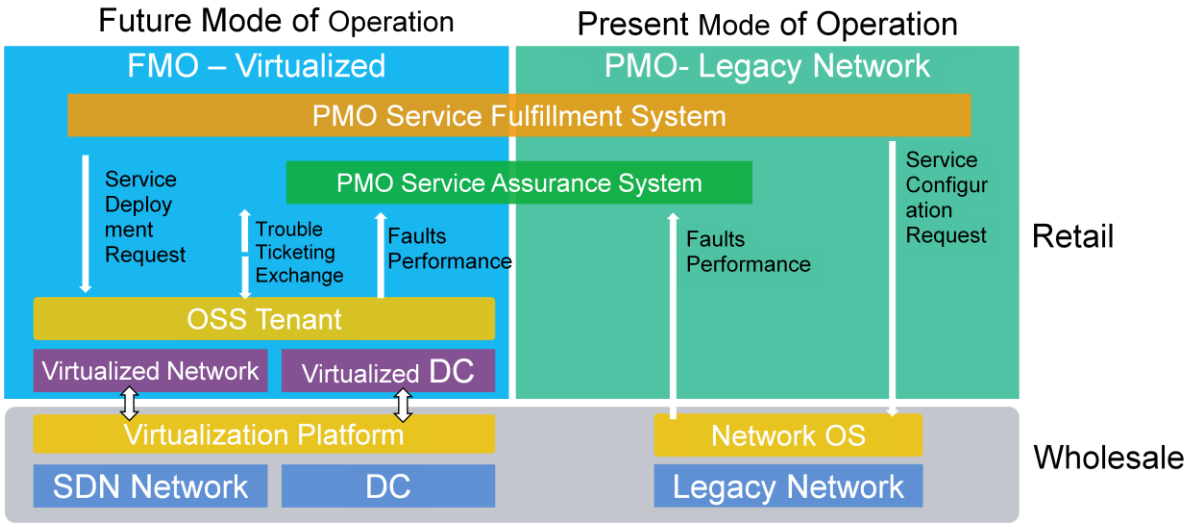
National Broadband Example

Prior to virtualized Infrastructure, there is only one operational unit and operational system at most operators. The OSS and the network belong to a single operator and a single Service assurance and Service fulfillment system. In the PMO to support a wholesale/retail split requires an order management system on both sides. The wholesale order system takes the order and converts it into a work order so that the order can be processed. The orchestrator in PMO can be used to provision the required service.

In the FMO, the retail/wholesale split will be implemented because the wholesale unit will manage the physical infrastructure (L1) and the virtualization platform (L2), as shown in the figure below. There could be multiple retail units for multiple service lines. All the business entities, the external OTT providers, the government entities and non-profit organization can subscribe to the infrastructure as virtual tenants and using the tenant OSS to self manage their operation. The OSS tenant application will provide them a view of only their portion of the virtualized network.

In the FMO, the SDN controller is used for the service provisioning. What is more important is that the retail operation can be completely self-service. It also removes the need of the wholesale entity to have an ordering and workflow system to manage the service fulfillment process. The greatest benefit of virtualization is the simplification of the service fulfillment process.

Figure 14: PMO and FMO

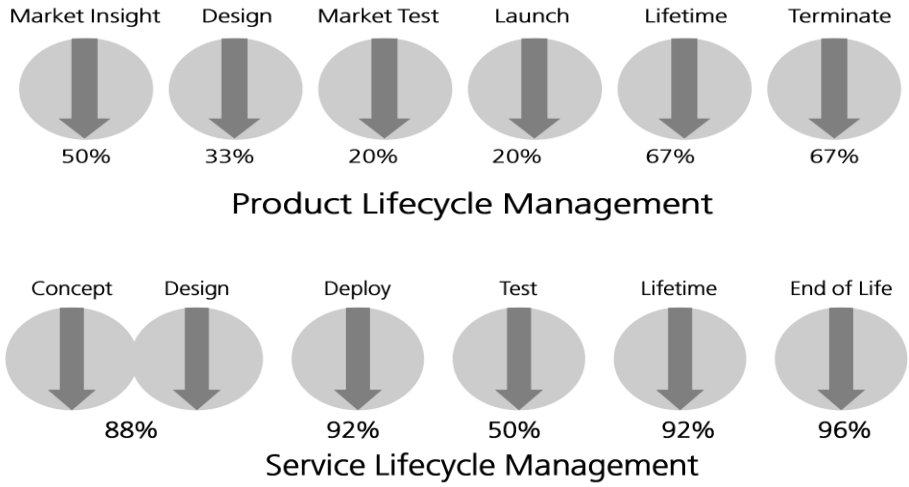


The alarms and OSS data from the OSS tenant can be forwarded to the existing retail-OSS so that the wholesale operation can manage the virtualized services through a central network operation center (NOC). Since there is a possibility of service management by distributed teams, the trouble-ticket exchange function is important. In PMO, the OSS events are monitored by L1 helpdesk and escalated to L2 and L3. There is a need to distinguish the event against hardware or software related issues. In the FMO, the distinction of hardware verses software failures can be easily determined by correlation engines. This means teams of L1, L2 and L3 will have to work in collaboration mode instead of escalation mode.

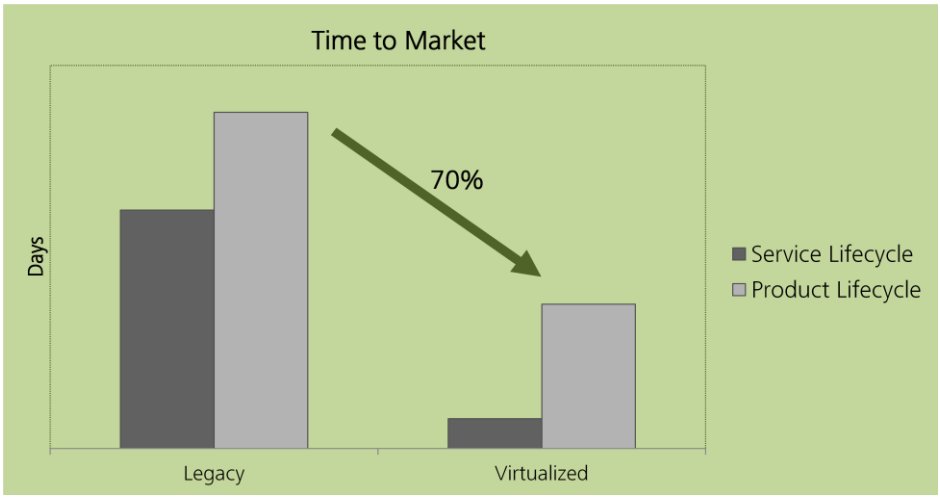
Reducing Time to Market

TTM (time to market) of Etisalat Telecom services is guided by 2 key processes in the new operating environment. The product lifecycle is guided by marketing and they involve presenting the services to each local market. This enables each service to support different local markets and is essential for global services marketing.

Main savings from product lifecycle perspective is the integration with Internet, Big Data Analytics and Social Media Integration, the service lifecycle is guided by the engineering team and the investment of orchestration that relies on ICT architecture will reduce service creation, deployment and problem resolution. The specific time reduction for each phase of product and service lifecycle is charted below.



Etisalat expects that, total reduction of TTM with full utilization of above mentioned networks and operational transformation could reach as much as 70%.



Conclusion

Etisalat understands that, to transform networks based on above mentioned architecture and guidelines; one of the key challenges in future is going to offer highly customized/personalized products/services with considerable reduction in time for product lifecycle.

In line with the Etisalat network and operations landscape for 2020, as explained in above chapters, following are key takeaways that we would like to convey across industry for all players.

- Significant Reduction in **time to market and deploy** is of most critical importance to Etisalat.
- Operators must **"prepare in advance"** for develop a comprehensive understanding of SDN/NFV technology and its full impact on existing networks, operations and organizations.
- **"Business Case"** with realistic targets and inputs should be arranged and followed by a practical **"roadmap"** of SDN/NFV deployment. Roadmap should be based on business case.
- Operators should ensure **current investments are future proof** with smooth roadmap of up gradation plan towards SDN/NFV adaption.
- **"Organization Transformation"** is inevitable for Operators. Hence, operators should start now and prepare in advance to grasp full understanding of SDN/NFV impact and requisites.
- **"Service Orchestration"** is critical for noteworthy service agility and operational efficiency; therefore standardization process needs to speed up. Operators should insist on acceleration of "Open and Unified " standard for Orchestration and Cloud OS
- **"Open Architecture"** is fundamental for success and smooth deployment of SDN/NFV; hence vendors should ensure solution developments around open solution. At the same time, operators should also start enforcing certification, quality lifecycle and rigorous integration testing. Operators should also ensure that their current investments are future-proofed with clear and smooth SDN/NFV migration plan in place.
- **"Vertical integration"** among different cloud components may come up as a new potential bottleneck to achieve quick deployment. This can be avoided with pre-deployment integration tests and stringent verification processes. System Integrator's (with IT and telco expertise) role will also be vital for swift deployment of Cloud based networks.

In conclusion, to enable new Communications, Content+ and IOT services Etisalat will ensure rapid technology innovation by our team and our partners, as we plan to implement a modular, pragmatic as well as a simplified approach.

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This white paper is prepared in collaboration with HUAWEI

About ETISALAT

Headquartered in Abu Dhabi, Etisalat was established almost four decades ago in the UAE as the country's first telecommunications service provider. An international blue-chip organization, Etisalat provides innovative solutions and services to 169 million subscribers in 18 countries across the Middle East, Asia and Africa.

Etisalat's mission is to provide a best-in-class total customer experience domestically and internationally, deliver attractive returns to shareholders while investing in the long-term future of the company, and supporting economic development in all the markets it operates in.

Aspiring to be the most admired telecom group in emerging markets, Etisalat strives to consistently foster innovation and deliver first-in-market technologies wherever it operates. This is evidenced by its expeditionary trials of 5G services in the UAE - the first-ever in the region - including coordinating the development, design and deployment of future ICT platforms for fifth generation mobile broadband. Abu Dhabi is the first capital in the world to be fully connected and has the highest speed fiber optic on the planet.

Such diverse technological expertise has helped Etisalat capture significant market share as it expands across Africa, Asia and the Middle East, most notably in Egypt and Saudi Arabia, where the introduction of mobile broadband services, including video call and mobile television, has changed market dynamics and provided affordable mobile internet access for millions of people.

For further information please visit www.etisalat.ae

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