T-SYSTEMS WHITE PAPER
FUTURE IN CONNECTIVITY FOR OIL & GAS

T · · Systems ·

Let's power
higher performance

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Introduction

The World Economic Forum in 2017 concluded a commissioned study titled Digital Transformation Initiative for Oil and Gas. The intent of this System Initiative was focused on shaping the future of the digital economy and society. It's aim is to contribute to an ongoing initiative intended to serve as the focal point at the Forum for new opportunities and themes arising from latest developments in the digitization of business and society as whole as well as to support the [Economic] Forum's broader activity around the theme of the Fourth Industrial Revolution again with a focus on the industry of Oil & Gas.

Digital transformation (aka: digitization) is quickly emerging as a driver of sweeping change in the industrial world around us. With this, connectivity has shown the potential to empower industry as never seen before all the while providing businesses with unparalleled opportunities for value creation and capture. Since the start of the industrial revolution, Oil & Gas has played a key role in the economic transformation of the world. Providing the fuel needed for heat, light and mobility required by business.

Yet today the Oil and Gas industry faces new opportunities as well as demands to redefine its boundaries through the rise of digitization. The business climate changes post a period of rapidly falling crude prices coupled with frequent budget and schedule overruns compounded with greater societal demands of increased climate accountability. The Oil & Gas industry can now provide practical solutions to these problems though "digitization" as a change enabler as well as provide extended value to all its stakeholders at the same time.

The potential of digitization to the Oil & Gas vertical is viewed as being around $1.6 trillion which could increase further to $2.5 trillion if existing organizational/ operational constraints are relaxed, and the impact of "futuristic" technologies related to digitization are implemented. In short, these are significant numbers for the industry and telegraphs a swing from business as usual to that of a competitive intent which will reshape an industry which has spent several decades of simply repeating the same.

Driving down into the concepts of "digitization" (see figure 1.), we quickly see that the figure 1 investment categorization from 2017 to 2025 first three years of projection includes (1) Big Data/Analytics, (2) IoT, (3) Mobile Devices, (4) Cloud and as we set now almost three years into the projection, the accuracy has been now been established. So to look forward phase II emerges which looks past five years and will encompass technological shifts such as (5) Robotics/Drones, (6) Artificial Intelligence, (7) Wearables, and (8) Collaboration. Here the interesting parallelism become clear as phase I (1, 2, 3, 4) are actually enablers of phase II (5, 6, 7, 8) providing the basis for the drive to 2025. As Big Data, IoT, Mobile Devices and the Cloud all worked together to collect and process the "data" into "value" which will feed Robots/Drones, AI, Wearables (from an application perspective) and collaboration.

Yet as already mentioned, all of these facets to unlock $2.5 trillion in value depend on an ever growing underlay of [network] "connectivity". However this rapid growth to meet the insatiable demands of data movement required is presenting its own set of challenges in form of both cost as well as manageability. To address this impending bottle neck, a new form technology has begun to emerge under the banner of Software Defined Networking (SDN). In short, it is impossible to discuss the applied concepts of digitization without first also understanding how the redefinition of network connectivity will enable Phase I of all of these activities.

Over the remaining course of this paper, the goal will be to expand upon the applied concepts of SDN as it relates to the new age of connectivity and how this will be a critical enabler for digitization in the Oil & Gas space moving forward.

O&G Investments in digital technologies to 2025

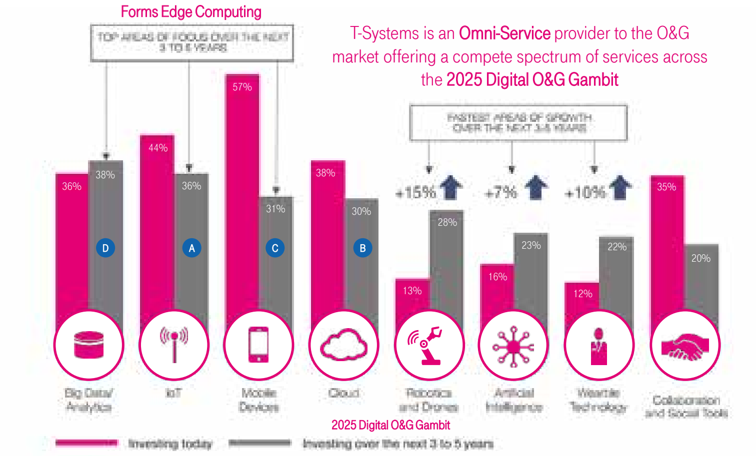


Figure 1 investment categorization from 2017 to 2025

Source: World Economic Form Digital Transformation Initiative Oil and Gas Industry

Technology trend/description

Most of today's corporate networks have a complex mix of proprietary hardware that require manually configuration as well as management. Not only is this kind of infrastructure woefully inefficient to meet the demands of the evolving world of digitization, but it also fails to deliver the flexibility and agility that organizations need to support big data and keep up with the ever growing pace of business. This is where Software-defined networking (SDN) enters the stage to offer a fresh approach to network design and management which promises to overcome these obstacles.

SDN separates the control plane **(overlay)** from the data plane **(underlay)** so both can be optimized based upon business needs. Hardware such as switches and routers (i.e. the underlay) no longer determines how traffic should be routed or how resources should be allocated. Instead of configuring physical devices one by one according to vendor protocols, network policies and applications are centrally programmed and managed through a single controller. The SDN model embraces the trend of moving away from hardware-focused infrastructure in order to create more customized, and agile networks to cost effectively meet ever evolving competitive business drivers.

SDN offers a number of business benefits, such as:

Simplified management

Is achieved by providing IT with end-to-end visibility of the network through a single interface. Here all physical and virtual devices can be centrally managed, and the provisioning and configuration of network resources are automated via the control plane software. This ability greatly reduces the chance of human error as well as frees staff to focus on strategic business initiatives reducing cost as well extending value creation.

Greater network agility

SDN provides a platform for more intelligent, automated network capabilities accelerating the delivery of services and the deployment of applications within the enterprise. This in turn enables organizations to respond quickly to changing market conditions maintaining a competitive advantage over the competition which is not possible in legacy network deployments.

Reduced capital and operational costs

SDN controllers should be viewed as being vendor-neutral, enabling IT to use inexpensive, commodity hardware or repurposed equipment already owned. Centralized management and control, higher resource utilization, and the elimination of proprietary protocols bring administrative efficiency and operational savings to the corporate bottom-line.

Improved security

Here SDN provides the enterprise with a central security hub for consistently applying security policies across the complete enterprise with minimal effort and quickly addressing questionable traffic or activities in near real time.

While it is still early days for SDN, there has been much excitement about the potential of this emerging technology and many experts are predicting that 2020 will be the year in which SDN truly begins to see wider-spread adoption. International Data Corp. (IDC) expects that oil and gas, and healthcare, are expected to lead the shift towards SDN. Gaming and entertainment companies see SDN as a way to affordably support high volumes of traffic produced by their businesses. Even if an organization isn't ready to make the step to SDN now, they still should make IT purchasing decisions with SDN in mind as it will becomes not a matter of **"if"** but **"when"** the step is made.

General enterprise use cases for SDN

While there are many use cases for SDN, there are several which should notably be considered as starting points for the enterprise to establish quick wins for the deployment of Software Defined Net owing Technology:

Network operations and monitoring

SDN technologies can abstract what tend to be the most critical layers within the enterprise estate because the networks today have architectures that are much more complex than in the past. Additionally, they must also handle far more data than before at ever increasing rates. In short, it is of importance to understand what is flowing through enterprise network. As it is possible to alleviate many challenges when a solid understanding of the network layer is easily available. More importantly an agile SDN installation will assist in the monitoring and management of network traffic between your data centers, field locations and cloud ecosystems.

Security

As the size of the physical network increases (i.e. the underlay), the surface becomes greater for threats. With SDN it is now possible to incorporate Network Function Virtualization (NFV) into the platform. Doing so creates a truly proactive network security environment capable of both reducing risk and responding to incidents quickly. When a network is compromised, time is critical in either stopping or minimizing the extent of the attack. Important too is the ability to identify the attack vector and ensure that other components like network components are also safe. As in the digitized business model, the network layer becomes ever more critical. Additionally, assuredly with the growing sophistication of Bad Actors, there will be a growing number of attacks as well as persistent threats. Therefore the SDN layer enables the creation of a proactive environment which is capable of dynamically responding to challenge and attack dynamically.

Compliance/Regulated applications and data

Compliance bound workloads can provide a challenge to the enterprise. Yet now the ability to extend architectures and data sets which were originally limited due to regulations exists. As SD-WAN can now assist in ensuring that compliance: regulation bound workloads are persistently secured and monitored. As SDN can track network traffic traversing between switches, network points and even hypervisors—all of this can be controlled by the SDN overlay architecture, because this layer abstracts all functions as well as hardware controls. Additionally, the overlay can span various locations, virtualized instances, along with public cloud regions opening up opportunities here that technology didn't allow before.

Distributed application control

One of the larger benefits of SDN is its capability to extend across the entire data centers well as distributed sites, and even cloud installations for the entire organization. Here SDN is the gate keeper allowing critical network traffic to pass between varying sites, independent of the type of underlying network structure. This is achieved by abstracting critical network services which allows for the simplified movement of data between say the corporate data center and cloud regions. Since SDN is a powerful form of virtualization based upon advanced APIs, it not only can integrate with numerous cloud providers. It too can control specific local physical networking services as well. This enables a granular approach to the management of workloads while maintaining an agile stance.

High-performance applications

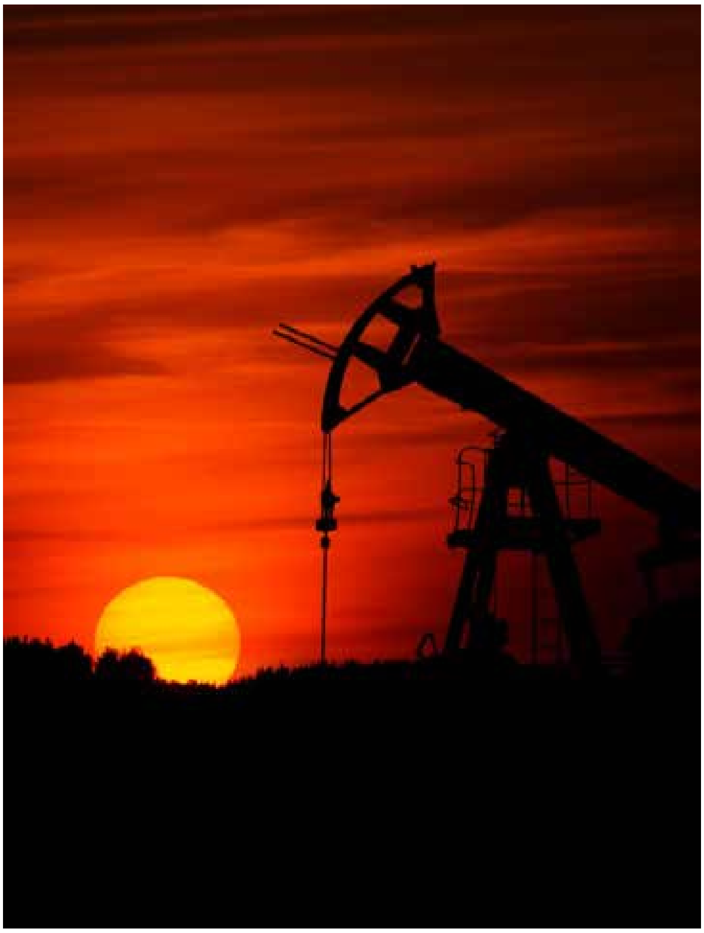
As a competitive trend, high performance apps, whether cloud native or located in a corporate data center, are becoming the new norm. In a conventional setting, these workloads typically required bare metal infrastructure with dedicated connections. However, at the network layer with the integration of SDN, it is now possible to enable application control and by creating sophisticated QoS policies, segmenting heavy traffic, and dynamically managing bottlenecks. With SDN in fact support high-performance applications can now be delivered via virtualization services. See more in appendix A regarding application orchestration.

Again, while there are many more detailed opportunities for the applied use of SDN, these categories are intended to offer high level hand rails for quick value realization for new deployments.

Agile governance structure for SDN

The basis for SDN as discussed in this paper is that of an ecosystem whereas there are many intrinsic players in the model which must work in a coordinated approach to assure reaching a common goal. Yet ecosystems have historically been cumber-some organizational constructs which are slow to respond to change and quickly become out of sync with business demands. So to maintain a highly effective ecosystem organization in an agile fashion means the paradigms must be left behind and new ones developed which can both operate in an agile fashion as well as scale.

To that end, T-Systems recommends the "Spotify Model" because as many know Spotify has become a popular music delivery platform well known for offering original and a limitless collections of music content to listeners. Launched in 2008, it steadily increased in both size and complexity. Spotify owes their success to their deeply rooted agile methodologies and the utilization of the agile scaling in their own way.



This method is typically referred to as the "Spotify Tribe" model. Here Spotify adapted a unique agile scaling method that not only assisted them in achieve their goals faster however also built a shift in the mindsets of the people (both internal as well as external) in it. And can be deployed across basically ecosystems for value creation.

The basis of the model is structured as follows Squads, Tribes, Chapter, Guilds, and Alliance. Worth note this is the basic model design and there are many hybrids. However, the intent of this section is to share concepts and generalized inner workings as applied to the deployment of SDN in a large enterprise in a DevOps fashion.

Squads

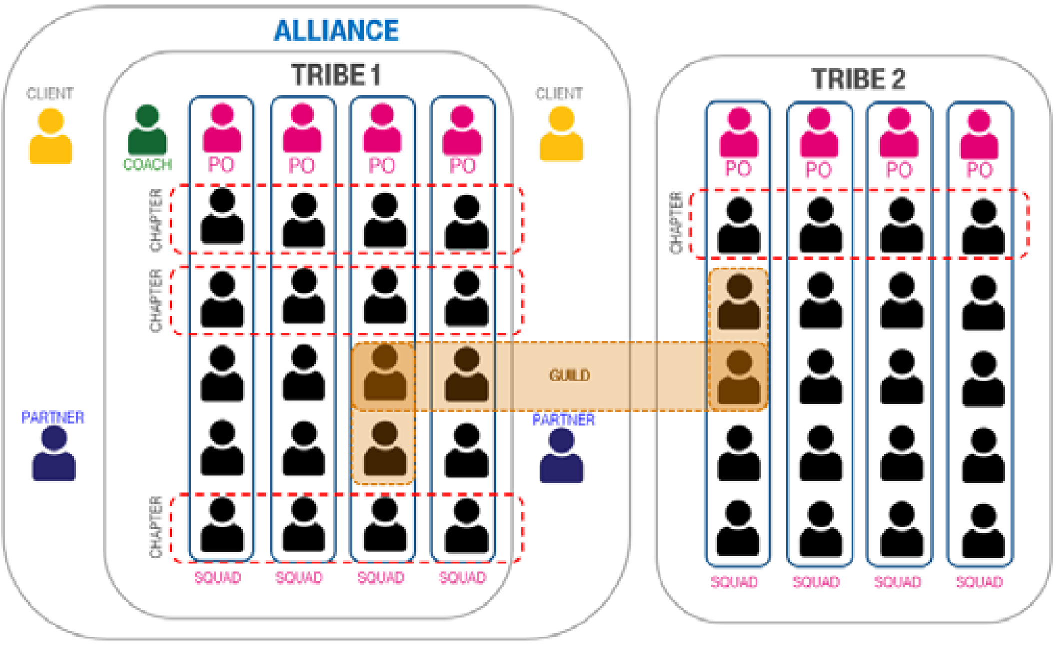
... are similar to scrum teams and in an organization, there can be multiple squads consisting of six to twelve people each dedicated to work on one feature area. Squads are an autono-mous, self-organizing and self-managing pods of people. Each squad has a mission to accomplish and is free to choose an agile methodology and may follow a mix of agile approaches to carry out their goal. In general to release early and often, squads apply the minimum viable product (MVP) technique.

Squads also have an agile coach who assists them in improving their ways of working. There is also a product owner who defines the vision of the feature area for the squad. The agile coach also conducts retrospectives while sprint planning meetings are considered optional. However, it's important to note that each squad has direct contact with stakeholders.

Here Dev and Ops work in such a way that the operations do not interfere with the work of the developers. Instead the operations activity paves the way for the developers to release the work for themselves shortening the delivery cycles. This is achieved by creating an environment in infrastructure and support to allow the developers to launch their own work. In addition, face to face communication is encouraged over documentation and opera-tions is a separate squad to help other dev squads.

Tribes

... multiple "squads" who work on related feature areas comprise a tribe. Here a tribe may consist of 40–150 people however preferably, a tribe should have a maximum of only 100 people (this is based upon the Dunbar number). In a tribe there is a tribe lead who is responsible for creating both a productive and an innovative environment for the squads. Also worth note is that the tribe lead may be part of a squad as well.



While Connectivity is at the heart of industrial IoT, there is not a single digital ecosystem
Each is unique to each company and to each market. A digital ecosystem is an interdependent group of actors, including enterprises, customers, IoT devices, and other stakeholders. They share **standardized digital platforms** to achieve mutual benefit. To create a **"best fit"** ecosystem for our clients, T-Systems has the ability to productize its wide range of partner-ships and platforms into productive ecosystems using the **Spotify Squad Framework** ensuring both agility and scalability.
The **ecosystem** will ultimately become the **competitive** unit yet there are complex undertakings which require many interconnected factors to be balanced by a seasoned integrator.

Extending the SDN model into production

The other aspect of an SDN deployment is the operationalization of the model for controlled delivery. Below is a stack of the assemble tiers from a logical operational view point. The delivery services are abstracted into seven tiers combining the traditional Overlay/Underlay model into a complete stack approach.

This graphic demonstrates the complexity which is associated with an SDN deployment as there are complex dependencies throughout the stack which must be addressed for a successful implementation. As for practical example the overlay is actually an insertion layer into the complete application even if only indented to operate a limit piece of the underlay, it can pose a large risk to the overall estate.

Future of Connectivity—T-Systems/DTAG Production Model

Figure 2 production model
Source: T-Systems

Additionally challenges that large enterprises will face the deployment and productionization of SDN will be a lack of carrier-grade software that ideally has the following characteristics:

- Robust software, with features and functions large enterprises require
- Support for resiliency (especially when deployed in the OT domain)
- Compatibility with future versions
- Easy installed with efficient operations ability (i.e. limited staff training).
- Load balancing and firewalls

Yet with these changes and emerging requirements, MPLS network operators can still support legacy applications while fully emulating TDM and SONET/SDH-based network stability, security and reliability. As MPLS provides a full suite of VPN service capabilities to provision connectivity for next-generation applications via SDN. It is also transmission media and physical layer-agnostic, for optimum network architectural flexibility as MPLS can run seamlessly over various transmission mediums, such as fiber, microwave, satellite and copper, rendering a unified end-to-end, service oriented view to operators. With this being the case and the application of SDN, MPLS can become an asset when building converged, mission-critical networks. But for the most part SDN architecture has yet to reach this point, which requires enterprises to adapt and customize the software in order to fit their environment and it is this immaturity which makes it impossible for enterprise to simply "buy" [SDN] off the shelf, install, operate, even automate or be able to update easily.

This is why it is critical to seek experienced consultation for any enterprise deployment as there are many moving parts to the scheme and complex application topologies will pose an ever present source of delivery risk.

Emerging connectivity technologies and trends related to SDN

Enterprises have to consider a bundle of connectivity trends arising in 2019. First of which is the arrival of 5G networks in the world's major markets. Telecommunication providers will invest heavily in the next generation mobile telephone network to get fast and wide coverage. As the major benefit driving 5G is it will be the "wire killer" with its abilities now to move data at the same rates and latencies as wired lines.

Beyond 5G where will be the replacement of MPLS, the rise of Wi-Fi 6, Fiber improvements, IPv6, as well as the before-mentioned software defined anything and virtualized network functions (VNF) which round out the connectivity topics of relevance for enterprises.

Also worth note is that all of these emerging technologies exist in what is considered the "underlay" space of the SDN model. In that they provide for the physical transport of the packet and exist in the "data plane". Therefore understanding these changes is important when considering the future of an SDN deployment. It will be these attributes which will come under management of "data plane". While simply obvious, it is important to keep in mind that no matter the capabilities of the control plane (overlay), it cannot achieve anything which is im possible by the data plane (underlay).

Why MPLS is not sufficient alone any longer

Historically, most enterprises used MPLS-based virtual private network solutions, typically delivered as a managed service. While a properly engineered and operated MPLS-based service delivers high availability, it is static. Enterprises cannot change dimensioning, endpoints or Quality of Service (QoS) parameters on the fly. For global enterprises, private MPLS-based network solutions typically offer a few centralized Internet access points. With the broad move to public clouds, this is no longer sufficient.

The changes in the application landscape trigger a new set of requirements for connectivity, this includes:

- Real-time configuration changes, e.g. on QoS assignments
- Real-time analytics
- Access flexibility, e.g. support of redundant local Internet connections, support of LTE and 5G for backup and in some cases for primary site connectivity
- Automation
- End-to-end connectivity and security management

5G boosts mobile network performance

Traditionally, operators implemented different strategies for fixed and mobile access. 5G was designed to be a true revolution for mobile communications—fixed mobile convergence will finally become reality.

5G delivers one network supporting:

- Massive broadband with bit-rates per end-system of 10 or more Gb/s, and a capacity of 10 Tb/s per km^2
- Massive machine communication with a million connected devices per km^2, e.g. for devices like sensors, designed for ultra-long battery lifetimes up to 10 years, sending only limited amount of data
- Mission critical communications with strict latency (< 10 ms) and high availability (99.999 %) requirements

For the foreseeable future, there likely won't be devices capable of 10 Gb/s with 1 ms latency and a battery lifetime of ten years. Yet one of 5G's major advantages is that it is designed to deliver networks in slices. Operators are planning to set up one massive broadband slice, one slice optimized for billions of devices delivering a few packets every hour and having ultra-long battery lifetime, and one slice offering ultra-low latency, or slices delivering SLAs enterprise customers need to support their business.

5G will enable private, high-performance campus networks that can tackle a host of challenges and innovation subjects like automated guided vehicles, virtual and augmented reality, asset tracking, machine control as well as massive sensors. In addition, given the massive number of [wireless] "connections" possible with 5G means the importance of SDN will be of key importance to the effective management of this space—especially for mission critical machine to machine services which are evolving in the Operation Technology (OT) space today.

Fiber remains viable for the coming decades

For enterprise requirements, 5G is not expected to replace fiber as access technology for large sites requiring Gb/s or higher connectivity—this is caused by limited spectrum and the cost of densifying the network.

On the fiber side, coherent technologies and advances in silicon are enabling the delivery of cost-efficient 100 Gb/s connections over distances of up to 1,500 km. For 2020, we are expecting the availability of the first cost-efficient 400 Gb/s long-haul interfaces supporting distances of up to 600 km; for 2024, we are expecting the first affordable Tb/s interfaces supporting distances of several hundred km.

Optical networks evolve within the emerging advanced technologies space. Their sizes and functionalities grow with every passing year meaning these complexities cannot be handled through the traditional framework for network control and management. Here SDN has been proposed for the control and management of these networks. SDN provides a number of advantages for the control, operation and management of large scale optical networks. By offering flexibility and agility at every level of the network, it (SDN) will become a staple for future fiber traffic management.

Next generation Wi-Fi arrives

Wi-Fi 6 (IEEE 802.11ax) has adopted many of the underlying technologies from LTE, and many analysts see it as the standard solution for indoor connectivity while 5G is seen as the standard solution for outdoor connectivity.

The T-Systems view is that this has to be differentiated. For a pure indoor office environment, Wi-Fi 6 will likely be the most cost-efficient solution for the next three years as an average. Today, chipsets supporting Wi-Fi 6 cost roughly 50 percent of 5G chipsets. With further advances on silicon and more competition in the 5G chipset market, we are expecting that prices over time will

be very similar. In addition, as the consumer market for LTE is starting to near its end. Wireless service providers to maintain growth will need to seek entry into new modalities such as Wi-Fi to replace and with lower chipset cost, T-Systems also sees competitive LTE to Wi-Fi operating models emerging over the next couple of years.

Also for similar consideration for indoor production environments, cost is not the only factor. Can an enterprise accept the fact that a perfectly legal device can disturb Wi-Fi communications or bring communications to a complete halt? Again, where will be major trade-offs seen in the Wi-Fi versus LTE space such as security as attack vector areas grow substantially? Is this an acceptable risk for the enterprise?

From an SDN standpoint, the management of access point are an obvious first point of control (from an SD-LAN point of view). However also there is the emergence of managing the "handoff" between Wi-Fi access points. This is becoming a critical aspect when deployed in an industrial environment and there is a requirement for an unbroken connection as a device or worker moves through a large plant (worth note that is yet another driving point in favor of LTE).

New security concepts

Traditional single or dual trust boundary controls are not able to secure and enable the growing number of applications and the need for direct cloud access. Security perimeters are vanishing, hard to maintain and just not scalable.

Users now can fundamentally change the way of seamless mobile access by shifting away from IP addresses towards application segmentation and user identities to support a zero-trust boundary environment e.g. with a software defined perimeter (SDP).

The SDP functions as a broker between a user and the application with the concept to enforce the principle of least privilege at the application level and provide seamless connectivity whether the services are in a multi-cloud environment or in a private data center. This is supporting to determine granular policies, reduce the attack surface and providing more visibility into network and cloud environment.

How the Oil and Gas industry benefits from future connectivity (SDN)

Rapidly advancing connectivity technology will offer significant advantages for the Oil and Gas industry to create a new set of value creation propositions. These opportunities will be focused around two primary areas:

1. The design and set-up of innovative use cases for added value, in the establishment of new revenue streams and competitive differentiation.
2. Manageability and governance by improved orchestration and automation for increasingly complex infrastructures. This will reduce both cost as well as risk. Also important to keep in mind: The manageability improvements will not only cover the area of TC/connectivity however IT also, and may lead to an integrated view of ICT with additional potential for synergies.

Innovation

Advanced connectivity technologies (SDN) will enable the generation of analytics approaches. Data is collected via sensors, analysis can be done with a combination of edge and cloud computing utilizing artificial intelligence and/or digital twins. In this scenario, IoT will be employed to collect data used to optimize the production processes (e.g. improving production as well as offering greater environment protection at a lower cost of ownership).

Sensors and mobile devices can also be used to improve personnel safety and protection as well as collaboration capabilities up to the usage of AR/VR for maintenance. As campus networks based on 5G will become the foundation for improved network capabilities in both industrial and campus settings. This massive ability to connect will drive the growth of edge computing at a similar rate allowing for the greater deployment of robot and drone technology (in line with the World Forum projections) across the enterprise landscape.

It is also important to note retail operation will see significate value from the deployment of 5G technology: Users of autonomous (full/part) vehicles could utilize recharging/refilling times to perform software updates. Consume media (via direct consumption or download). In fact this channel will offer the legacy Oil and Gas operator the ability to enter into the content creation and delivery market.

Both of these modalities require significate volumes of bandwidth to deliver a solid user experience (i.e. not waiting for hours to download). Petrol stations could thus become part of car manufacturers' ecosystems as well as content providers.

Improved manageability

With improved manageability, Oil and Gas industry can expect higher efficiency coupled with increased cost savings, e.g. reduced lead times, higher flexibility and better security level. This also needs to be considered across the complete scope up-stream, mid-stream and down-stream business operations.

Under this category it's important to note that SD WAN reduces the complexity in the end-to-end delivery model due to virtualization/VNF on an uCPE (universal customer premises equipment). uCPEs can easily be deployed onsite, managed remotely (e.g. for new features) and can be integrated into the local site infrastructures. No specialized field services nor proprietary hardware is needed. This allows more efficient, flexible infrastructures like compute power to use for storage, hosting, backup of these VNF applications.

SD-WAN uses a new generation of single universal CPEs in each company site that can easily be administrated from remote (e.g. a network center). SD-WAN uses significantly less hardware than traditional IP-VPNs due to the advanced virtualization of network functions (VNF) and components. Separate hardware for firewall or WAN optimization is no longer required.

SD-WAN creates a VNF layer across local sites, internet breakouts (via a local SD-WAN device) and applications in the private or public cloud. Access to private and public cloud services such as Amazon Web Services, Azure, Open Telekom Cloud or Sales-force can be implemented swiftly and securely. If computing resources in own data centers use SDN, these resources can easily be added to the VNF layer.

SD-WAN e.g. enables to dynamically setup firewalls, load balancing, micro segmentation, network-based security scanning, and network log analysis. Improved routing and application-level monitoring help to optimize network architectures for time-sensitive or mission-critical applications such as VoIP telephony, SAP or upstream applications. Using policy-based routing, the network dynamically adapts to the characteristics of each individual application ("bandwidth on demand"). Core functions and services use the highly available and therefore expensive network paths, while non-critical applications use lower-priced alternatives or receive less bandwidth.

All relevant security and WAN optimization functions such as next-generation firewall, IDS/IPS, DDoS prevention, packet de-duplication, caching or packet order correction are now available as virtualized appliances from most specialized providers. Today, the vast majority of these can be run on inexpensive standard hardware. That means that fast restoration and self-healing e.g. in the upstream world can rather easily be secured.
With a software-defined network approach corporate customers gain a global view and control of their network resources, reduces vendor lock-in, improves security level and receives not only cost control but cost saving opportunities. The deployment of licenses is simplified and the setup of an integrated tooling platform is possible that suits in-house operations as well as a co-managed approach with an external partner.

Steps to take towards a future-oriented setup for Oil and Gas

From a T-Systems point of view the next steps to Oil and Gas corporations' aspired targets should be (1) definition, (2) built and (3) realization of a minimum viable product (MVP) with ongoing extension and optimization:

- Embrace and maintain a best of breed carrier approach to introduce network aggregation. Between the carriers aggregation creates the foundation for the automation of the needed network-to-network-interfaces which will simplify the management of the corporate network topology as a whole as well drive the key formative decision moving forward in maturing the MVP.

- Introduce new technologies like Wi-Fi 6, 5G, next generation fiber, IPv6, edge computing, SD WAN, and VNF and balance the usage of public Internet vs. virtual private networks (e.g. MPLS). A new integrated connectivity landscape will improve security, enable application prioritizing and optimize load balancing. Based on this an effective new architecture of cloud security and identity management can be developed which will be future proof.

- Invest in the due diligence to select the toolset with the best fit and integrate it into your existing tool portfolio. Even if not all tooling cannot be completely integrated at the start, it again will lay a foundation for virtualization functions which maybe are still under development. The functions are introduced in a controlled manner in the MVP via cycle changes. This will build towards the goal of higher automation and will be the basis for a common management plane. In the end this provides users the opportunity for self service via various applied portals.

- Design a governance model to keep control and leverage provider capabilities to your best advantage. Here it is important to select an appropriate service provider who can deliver the necessary expert resources. In addition, both client and service need to align in an agile way to co-operate in the fast changing environment of IT/TC and insure the MVP develops at the right speed with the correct feature sets.

- Define the orchestration role up front including how to (co-)manage the complex environment of hybrid cloud in combination with multi-carrier and multi-service providers. Optimize your connectivity underlay by aggregation of the network, design and procurement of carrier services adding a thin service layer on top. Seek support for development and deployment of new services as well as monitoring, controlling and maintaining the run phase.

Our strategic bets

Our goal as T-Systems is to connect the industrial world, and see this as three fundamental market-trending topics we intend to apply our capabilities, history and experience.

1. Our goal is to enable Industrial 5G/EDGE use cases, that are powered by edge platforms and related services (cloud, IoT, security, apps, integration, operations), end-to-end with optional connectivity in a confined premise infrastructure.
2. As a vendor-independent provider we will establish a multi- and hybrid cloud management framework including cost control, cloud governance and value added services supporting public and private clouds. Therefore we use a best of breed approach for technology partners.
3. We will deliver future connectivity through integrated operation, with efficient cloud-based orchestration, fostering new secure network business models—along data center links, WAN, branch, LAN and campus to enable dynamic bandwidth, intelligent automation, network efficiency, application-driven performance and DevOps innovation.

Unique opportunity

Because of our telecommunication heritage, we are one of the few true ICT providers that can combine top-notch IT and TC to deliver end-to-end solutions. As such we differ from traditional IT providers and TC providers. We have a global delivery model for IT services in place that can easily be extended/transferred to connectivity services to offer the same results.
The provisioning of services out of one hand could result in a substantial advantage for integrated ICT operations, e.g. orchestration, governance and KPIs across IT and TC for a top end-to-end user experience. From a technical point of view this would also allow an unified orchestration from edge via uCPE, telco cloud, and private cloud to hyperscalers. Additionally within Deutsche Telekom group we have access to 5G frequency bands in several countries, e.g. the United States, Germany and the Netherlands.

Agile and reliable

As a provider who is experienced in the area of outsourcing as well as the new cloud universe we adopt agile methodologies and deliver our service with high reliability.

The service and delivery model of T-Systems follows agile concepts and key principles. The service processes, the delivery model and tools are consistently aligned with agile concepts and rituals; the handling has been optimized by applying numerous best practices and a continuous improvement cycle.

This agile approach/team is already implemented in several areas, e.g. T-Systems has already dedicated agile teams in place which already helped significantly to proactively improve the quality especially for clients' critical landscapes such as downstream retail, trading blueprint, global commercial and chemicals and as well for SAP services.

We are working with a Zero Outage maxim. The most important principle of Zero Outage is always that of comprehensive, proactive risk management, from businesses' point of view. It operates under the motto of “prevention, not reaction”. Great importance is thus placed on comprehensive quality assurance right from the planning phase for changes or projects, as well as on a generally high degree of standardization for processes and technology. Zero Outage includes specific rules and behavioural guidelines for various incidents, such as, in the case of defective system components, for network, power or VoIP outages, and even for incidents that arise while implementing a change. Active risk management serves as the basis for all Zero Outage initiatives: Every single risk cluster is monitored for risks, e.g. incidents, and the measures taken are constantly optimised and further developed.

Conclusion

As already mentioned, Software Defined Networking is still in its early day and due to the vast complexity, business risk and the cost of latent returns on invest means adoptions will be slow.
As the overlay control plane software matures the underlay IP transport also adjusts—conform with the still standards. However, even with these compound risks and challenges,
SDN will survive as an offering. The orchestration of workloads is a critical aspect for the future due to digitization movement’s rapidly growing needs to move data from the point of creation to the value creation engines in the compute space—be it public cloud or a private version.

It is also advisable to seek assistance for both the deployment as well as operate components of the SDN deployment as new ground will cut and experience with the legacy underlay will prove to be an invaluable assets for any SDN project. Furthermore, it will also require a long term management commitment for success as return on initial investments will assuredly be latent as the application landscapes will need to catch up with the overlay ability. Legacy applications don’t tend to be conducive to programmatic SDN adaptation, meaning the high value aspects of SDN (i.e. application orchestration) will be far more prevalent in new or highly refactored applications.

Current industry articles and publications addressing this topic:

1. World Economic Form Report
   http://reports.weforum.org/digital-transformation/wp-content/blogs.dir/94/mp/files/pages/files/dti-oil-and-gas-industry-white-paper.pdf
2. Wi-Fi 6 (IEEE 802.11ax)
   https://en.wikipedia.org/wiki/IEEE_802.11ax
3. Software Defined Networking
   https://en.wikipedia.org/wiki/Software-defined_networking
4. Software Defined-Wide Aera Network (SD-WAN)
   https://en.wikipedia.org/wiki/SD-WAN
5. SDN Overlay
   https://www.sdxcentral.com/networking/sdn/definitions/what-is-overlay-networking/
6. SDN Underlay
   https://ipwithease.com/difference-between-underlay-network-and-overlay-network/
7. Spotify Model
   https://blog.crisp.se/wp-content/uploads/2012/11/SpotifyScaling.pdf

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