*"Organizational and operational transformation plans should be evolutionary rather than revolutionary."*

**Digital Transformation Telco Playbook Overview**

ACG Research Paper

ACG RESEARCH

Hewlett Packard Enterprise

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# INTRODUCTION

The service providers' industry is undergoing a profound disruption, which is driving increased competitive dynamics and causing tepid revenue growth, shrinking margins and high churn. Their businesses are increasingly challenged by nimble competitors, such as webscalers, that operate in an environment that is not hampered by legacy infrastructure, entrenched methods and procedures, a methodical and deliberate go-to-market approach that lacks agility and the ability to iterate the product to make sure it meets the customer's needs.

Service providers need to become deft to compete in a digital marketplace, to drive new revenue, and to bring their expenses more in line with their revenue.



Figure 1. Benefits of Transformation, Source: TM Forum[1]

The examples are plentiful. The multichannel video programming distributors (for example, Comcast, AT&T), have been dealing with competition from Netflix, YouTube, content providers going directly (HBO Now), and other over-the-top providers offering bundles over IP, for example, Sony Vue. The wireless industry is maturing and churn is increasing. Operators are offering more bandwidth for less, and some such as T-Mobile and Sprint have gone the unlimited data route. In a possible race to the bottom, Verizon Wireless, long thought to be the premier provider, announced on February 13, 2017, its intention to offer unlimited data plans. One has only to consider the latest mergers (Charter/Time Warner Cable) to recognize that the industry increasingly sees scale as an answer to the problem, albeit a short-term one.

At the same time, changes in technology (cloud, virtualization), as well as the importance of connectivity in most industry verticals, added to the service providers' woes, have created the impetus for change. Many service providers have embarked on a journey to transform themselves to continue to be relevant in the digital economy.

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[1] https://inform.tmforum.org/internet-of-everything/2017/02/infographic-transformers-age-digital-telco/
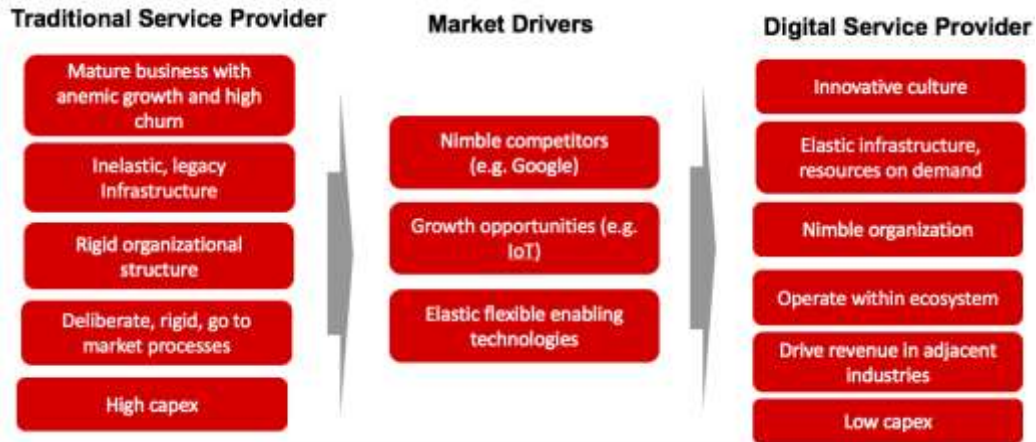
Figure 2. Market Drivers, Source: ACG

## INTRODUCING THE DIGITAL SERVICE PROVIDER

There is not one definition of a digital service provider (DSP). However, there are several characteristics that the service provider needs to consider as it plans its transformation. What each operator chooses to do is very much a factor of its core competencies, its size, its position in the market place and the competitive environment. The following are the high-level characteristics of a digital service provider:

- An intense focus on the customer, which drives its strategy.
- A culture of innovation, where creativity is encouraged, and failure tolerated.
- An ability to thrive within an ecosystem, which can include other service providers, customers, vendors, and sometimes competitors.
- A nimble infrastructure that supports the ability to iterate and continuously improve its offerings.
- The ability to work with government and standards bodies for the advancement of its cause but also of the industry.



Figure 3. Digital Service Providers, Source: ACG

# CULTURE OF INNOVATION

To thrive in a highly competitive landscape, service providers need to fundamentally rethink their culture. Many of those companies were born as monopolies, and although they have evolved, they are behind webscalers and other innovative companies. Therefore, a fundamental change in their culture is an essential ingredient for their long-term competitiveness:

- Create an environment where innovation and creativity are encouraged and supported rather than subjected to the frameworks of the existing business.
- Evolve the business support environment and operations to support a more pioneering and agile environment.
- Create incentives to reward innovation. Tolerate failure as an opportunity to learn and improve.
- Create the appropriate financial strategy and metrics that will support innovation, as well as an elastic infrastructure and agile go to market strategy.
- Establish the appropriate incentives and rewards for innovation.

## T-Mobile: The "Un-Carrier"[23]



Figure 4. T-Mobile Profile, Source T-Mobile

The competitive market is largely dominated by Verizon and AT&T. However, over the past three years T-Mobile has managed to become the most innovative telecommunications carrier and is now publicly listed. At the heart of this transformation is T-Mobile's Un-Carriier strategy put in place in 2013 by CEO John Legere.

The main components of T-Mobile's strategy[4]:

- **Hiring rebellious and smart:** The team that John Legere has formed around him is unquestioningly one of the key factors driving T-Mobile's current market success.

- **Building a culture not processes:** In the past, to manage corporate growth, there has been significant emphasis on creating processes to enable corporations to scale quickly. Today, with the successes of Google and other tech companies, greater emphasis has been placed on building the right culture with the right people rather than processes alone.

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[2] https://goo.gl/9u7tPf.

[3] https://goo.gl/g99AtR.

[4] http://www.huffingtonpost.ca/eric-quonlee-/tmobile-uncarrier-strategy_b_10007240.html.

- **Having a holistic plan:** If T-Mobile USA had only changed its advertising style, the changes at T-Mobile USA would have been insignificant. Indeed, it would be dismissed as just another "changing the lipstick color on a pig" attempt of an industry player to gain market share without addressing key customer pain points. Marketing is a key component but so are new "no contract" plans and the spectrum purchases to boost signal strength. T-Mobile, just like an increasing number of individuals and corporations, are realizing that it is critical to connect the dots and build a holistic plan to succeed in the hypercompetitive business environment today.

- **Willing to take smart risks:** In an industry characterized by tradition, T-Mobile adopted a rebellious position and did away with many of the sacred cows of the industry: pink color palette, introducing the concept of unlimited data when the industry was metering data, and rewarding customers with shares. T-Mobile became a "cool" company in an industry that is staid, still attached to its monopolistic roots and conservative culture. Un-Carrier was not simply a marketing campaign but was tied in with other internal changes that truly demonstrated this was an organization transformed.

- **Changing the consumer conversation:** One of the biggest reasons T-Mobile USA has been so successful was its ability to change the industry conversation in their favor. From discontinuing contracts to disconnecting the linkage between wireless plans and phones, T-Mobile changed the conversation in the wireless industry.

- **Addressing long held customers' pain points:** From inattentive customer service, complex bills and hidden fees, the pain points in the wireless industry were an open secret that have been around for decades. T-Mobile, not only changed the game for itself, but forced its competitors to follow suit.

What T-Mobile did for its customers[5]:

- Greatly simplified products and pricing.
- Improved the customer experience through transparency and simplicity.
- Broke ways with industry standards by eliminating contracts and data caps, which customers disliked.
- Created a centralized digital order orchestration infrastructure.
- Activated new customers and services quickly.
- Initiated an easier path to integrate partner products.
- Delivered speedier time to market for new products.

The results of this strategy have been remarkable. T-Mobile's stock has appreciated, and it has gained significant share from its competitors[6].

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[5] Source: IBM, ACG, and T-Mobile.
[6] https://finance.yahoo.com/quote/tmus?ltr=1.

Figure 5. T-Mobile's Stock

**Altice: Bucking the cable DOCSIS trend**

Altice, the French operator, which recently acquired Cablevision and SuddenLink cable operators, announced it was going to forgo DOCSIS 3.1 and pursue a fiber to the home (FTTH) plan in the last mile, leveraging technology it has developed in its labs. This technology is, according to Altice, higher performing and less expensive than the traditional FTTH technologies. Altice's announcement is relatively recent (November 2016), so it is early to assess the implications of this announcement. It is to be noted that DOCSIS has been the mainstay of the cable technology for offering high-speed service and more recently IP video service. Although its peers have made a huge bet on DOCSIS 3.1 for gigabit services and for IP video Altice has chosen the FTTH route, which is likely quite capital-expense intensive, but also will move it away from its cable heritage. It remains to be seen how Altice will deal with the organizational challenges associated with this technology bet, for example, the fate of QAM and DOCSIS expertise in the company.

## CUSTOMER CENTRICITY

In an environment where customers face abundant options and increasingly rely on social media to express their views of the companies with which they do business, it is imperative that the service providers rethink carefully about their strategy to make the customer the focal point of their activities and initiatives. Service providers should make the end-to-end customer's experience the guiding principal for defining strategy, products and services, marketing, and all systems and capabilities.

Focus on job to be done for the customer and bring together all the required capabilities to support that mission:

- Deliver a superior customer experience.
- Provide multiple touch points. Leverage technology to offer self-care and other capabilities that enhance the customer's experience.
- Use data for better targeting and customization of product and customer's experience.
- Provide a seamless experience across multiple devices, channels and touchpoints.
- Adopt an agile product development approach to enable introduction and continuous improvement.
- Focus on the customer; it is an imperative for service providers and more specifically Internet and television service providers, considering that they typically rank at the bottom of customers' satisfaction.

Historically, service providers have typically had poor customer ratings[7].

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[7] https://experiencematters.blog/2016/05/25/tv-and-internet-service-providers-deliver-the-worst-customer-experience-according-to-temkin-group-research/
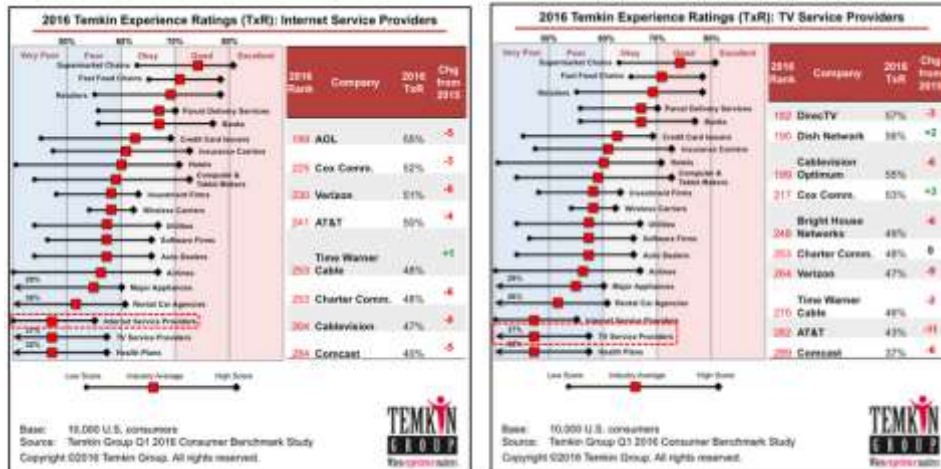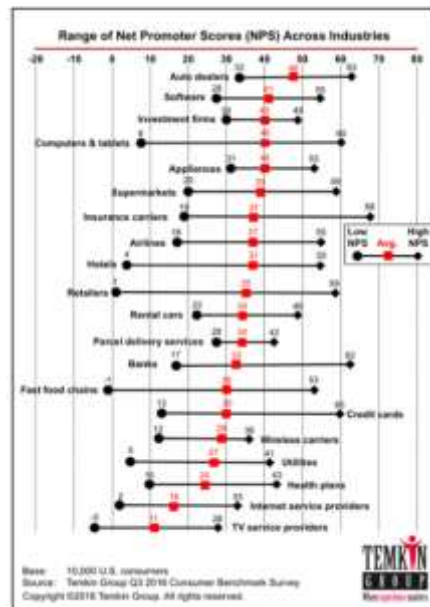
Figure 6. Temkin Experience Rating



Figure 7. NPS across Industries

Service providers face an uphill battle in improving customers' perception and satisfaction, but many of them have embarked on a journey to improve the situation, and are beginning to make some headway, as is exemplified by Comcast bucking the cable companies' trend of losing video subscribers every quarter, starting in 3Q 2016.

How is Comcast improving customer satisfaction[8]?

Comcast is rolling out Net Promoter System (NPS) across the entire company, tying all decisions to feedback from customers. This includes customers' callbacks across all levels of the company to gather customers' feedback after they interact with the company. Feedback is then discussed to determine action.

The company has:

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- Leveraged technology to monitor services to fix trouble quickly and update the My Account platform to enable better self-service, including adding the option schedule a call with us, which proved popular.
- Introduced voice recognition to control the TV remote and to manage My Account.
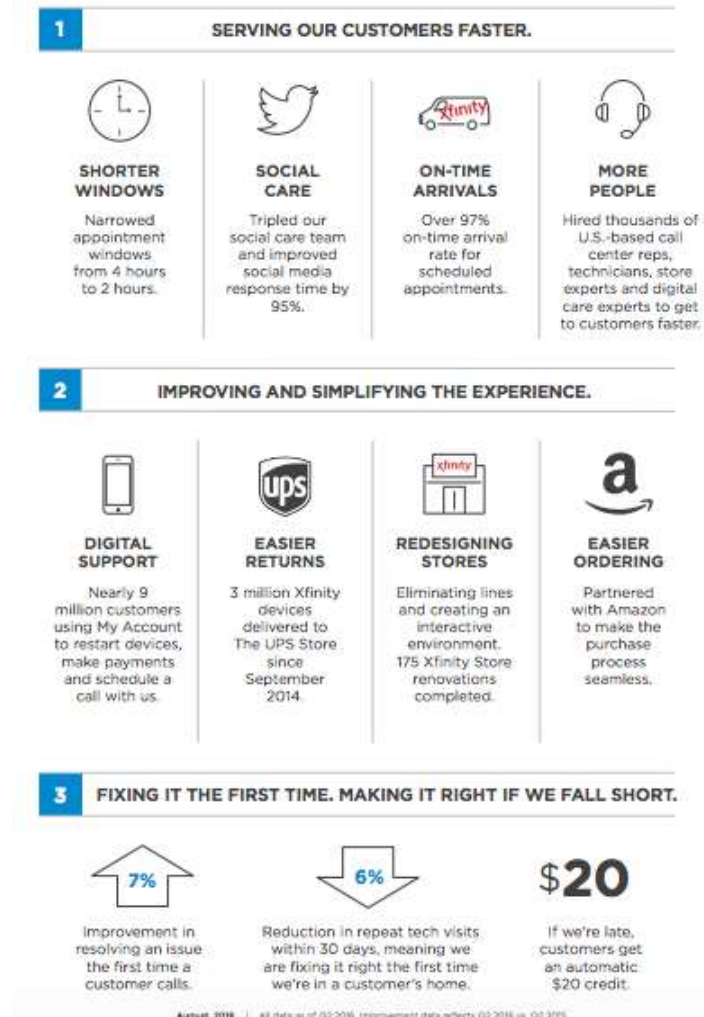- Redesigning the stores to make them more customer friendly.



Figure 8. Comcast Customer Service, Source: Comcast

## Customer centricity at Cellcom, Malaysia

In 2014, Cellcom embarked on an initiative to improve its customers' service. The company developed an innovative customer relationship management (CRM) platform, which provided information in a single view and resulted in faster and accurate service across Celcom's channels of communication, including online, call centers and retail stores. This increased Celcom's operations efficiency and reduced operating cost.

In the words of CEO Dato' Sri Shazalli Ramly, "As Celcom aims to scale even greater heights in the coming years, we will do our very best to create a unique customer universe that emphasizes the importance of understanding our customers' needs and meeting their expectations from the very beginning to the end. This effort can bring tremendous value to our customer experience and hopefully it will attract our customers to keep coming back for more as we move towards becoming a true customer-centric organization."

The following are results the company achieved through this transformation[9]:

- Improved system flow-through capabilities from retail sales to network provisioning.
- Increased to 99% of daily prepaid customers activating services in less than two minutes.
- Enabled 50% of prepaid customers to activate services in less than 15 seconds.
- Reported that up to 99% of mobile Internet activation is in less than 60 seconds.
- Decreased 20% in customers' complaint rate per million.

## Overhauling the customer experience at Rogers, Canada[10]

In 2014 Rogers announced Rogers 3.0, a multi-year plan to "radically improve the customer experience while laying the groundwork to reaccelerate revenue and cash flow growth." Rogers' plan reorganized around their customers with all customer experience units reporting directly to the CEO.

"The mix of assets, the culture of innovation and depth of employee pride is extraordinary. But we've neglected our customers, and we've let our legacy of growth and innovation slip. The plan I've laid out will significantly improve the experience for our customers and re-establish our growth by better leveraging our assets and consistently executing as One Rogers," says Guy Laurence, president and CEO of Rogers[11].



Figure 9. Rogers 3.0, Source: Rogers

Rogers 3.0 is based on seven strategic priorities:

- Be a strong Canadian growth company.
- Overhaul the customers' experience.
- Drive meaningful growth in the business market.
- Invest in and develop its people.
- Deliver compelling content anywhere.
- Focus on innovation and network leadership.
- Go to market as One Rogers.

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[9] Source: Cellcom.
[10] Source: Rogers.
[11] https://goo.gl/Xu7igJ.

The turnaround plan has started to deliver results. In 2015, Rogers gained a net 95,000 customers in two quarters, after losing customers in past quarters. In July 2016, Rogers reported improved earnings. All four of the company's business segments delivered stable or improving results due in part to contributions from Rogers 3.0 plan[12].

## Telstra's Digital First strategy

In 2014, Telstra announced "Digital First," a major initiative to extensively change the way it interacts with its customers, making a significant investment in new digital technology. A company-wide program, the goal of Digital First is to improve the customers' experience by giving them greater control over accounts, services, technical appointments, support options and product features[13].

Telstra CEO David Thodey said Telstra was accelerating its move to become a Digital First company, extending its digital agenda beyond sales, service and marketing to all parts of the business. "We have listened to our customers and know many of them want the convenience of dealing with us on their terms in their own time. Improving and simplifying our online relationship with them will help to deliver this," says Mr. Thodey. "We are challenging the way we do things to make life simpler and more convenient for our customers, giving them greater control in managing their telecommunications needs whether that be through our Telstra stores, contact centers or digitally. We are building a company that is more responsive, customer-focused and innovative by digitizing every part of our business. To do that, we are investing in new digital capabilities that balance scope, cost and complexity to create a brilliant digital future. We look forward to the journey ahead."



Figure 10. Digital First, Source: Telstra[14]

Under this initiative, Telstra looks at each product or service to assess whether it can be delivered digitally. For example, under Digital First, Telstra reviews ways to improve field-force customer engagement. This includes initiatives to better automate job allocation and integrated mapping to get technicians to jobs quicker and more efficiently while keeping customers updated on the estimated arrival time.

Early results point to the success of the Digital First initiative.

[12] https://www.fool.com/investing/2016/07/21/rogers-communications-incs-earnings-buoyed-by-soli.aspx.
[13] https://inform.tmforum.org/news/2014/03/telstra-announces-digital-first-strategy/.
[14] https://www.telstra.com.au/content/dam/tcom/business-enterprise/digital-media/pdf/digital_first_discussion_paper.pdf.

Figure 11. Telstra Stock, Source: Yahoo Finance[15]

## EMBRACE THE ECOSYSTEM

The traditional model of service providers operating independently and offering connectivity services—something at which they excel—is quickly becoming obsolete. Increasingly, digital service providers must play within an ecosystem that includes familiar components such as vendors, industry bodies and regulators, but increasingly will include competitors, other service providers, and in some cases customers.



Figure 12. Digital Service Providers, Source: ACG Research

### Comcast partners with Netflix

Traditionally, MVPDs have operated in a complex ecosystem where they acquired the rights to content from content providers and sold it to its subscribers in a bundled offering. A few years ago, Netflix emerged as a competitor to MVPDs, offering a large menu of on demand offerings for a fixed small monthly fee. Netflix's relationship with MVPDs was very contentious, as Netflix was accusing service providers of being discriminatory towards its services (lack of network neutrality). In the fall of 2016, Comcast and Netflix elected partner; Comcast would add Netflix to its user guide on the X1 box.

Comcast sees such an agreement as a template for future agreements as the future will demand tight partnerships among former competitors to offer compelling user friendly services.

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[15] https://au.finance.yahoo.com/echarts?s=TLS.AX#symbol=TLS.AX;range=2y

### AT&T ECOMP: An ecosystem to drive innovation

Enhanced Control, Orchestration, Management and Policy (ECOMP) is the software platform AT&T created to power its new network. ECOMP, which consists of eight subsystems and over eight million lines of code, lets service providers quickly add features to drive down operations costs. It provides a framework for real-time, policy-driven software automation of network management functions.

AT&T took the uncharacteristic step of putting its ECOMP platform into open source and opening it for use by other service providers. So far, Orange and BCE have signed on to use ECOMP. More service provider announcements are forthcoming.

Opening ECOMP to the development community has enabled AT&T to benefit from the ecosystem. "Without having the brainpower, the developer ecosystem, across these providers and service integrators, we are all working together, we can't get there," said Mazin Gilbert, Vice President of Advanced Technologies, AT&T Labs.

### Power of the ecosystem, Verizon ThingSpace

ThingSpace is Verizon's Internet of things (IoT) development environment, the cornerstone of its IoT strategy. The ThingSpace portal allows developers to manage their Intenet of things (IoT) environments and related data.  In late 2015, Verizon provides the API and support environment for free to the development community and nonVerizon customers but receives a revenue share from developers that succeed in monetizing their applications. This strategy enables Verizon to be at the forefront of IoT roadmaps and to work with industry innovators. Many key industry players have integrated their IoT platform with ThingSpace, and 4,000 developers have signed up to use the platform, growing the ecosystem and giving Verizon the benefit of data analytics on a larger scale.

"We believe ThingSpace brings all of the elements necessary to execute in the IoT space," says Mike Lanman, SVP of Enterprise and IoT Products at Verizon.

## ALIGN THE ORGANIZATION STRUCTURE

Service providers need to recognize that the organization structure that served them well in the past may no longer be suited to the new hyper-competitive marketplace. A realignment of the corporate structure, key stakeholders, and type of skills may be needed.

A change of this magnitude needs to start at the top, where the most senior leaders create a vision, which is shared widely across the company, and seek buy in by clearly spelling out the drivers, objectives and goals. Some of the changes that need to be considered:

- Move away from the silo model, typically along functional lines, to one focused on the job to be done.
- Create new capabilities that are needed for the new framework.
- Incentivize team work and align rewards with the quality of the customer's experience.
- Provide targeted training company wide.
- Recognize that the current workforce may not have the right skills, and in some cases new talent should be acquired, and some workers let go.

The following are some of the questions service provider leaders need to consider organization realignment:
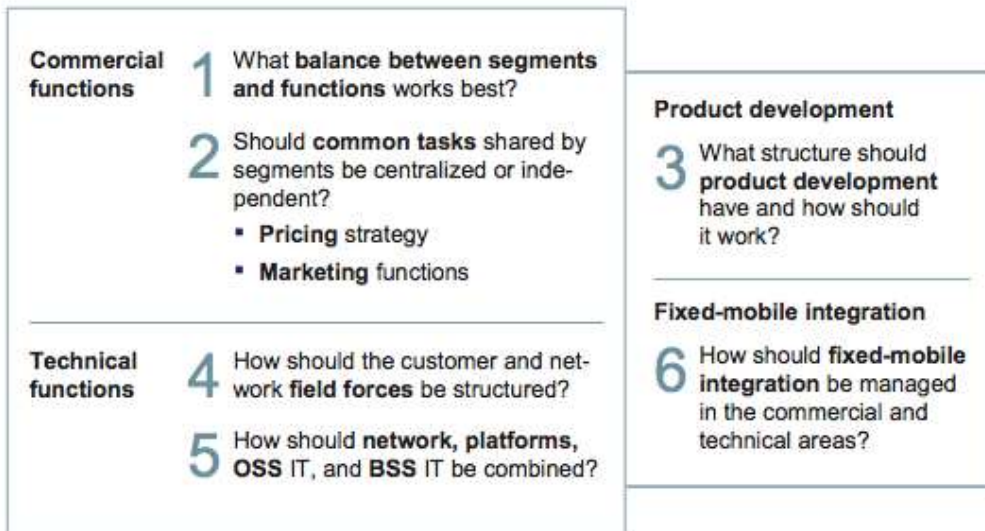
Figure 13. Questions for Organizational Alignment, Source: McKinsey & Co

## Organizational transformation at AT&T[16,17]

In 2013, AT&T recognized the need to prepare its workforce to address an evolving market. It embarked on a major corporate wide initiative called Workforce 2020 or WF2020, which "rapidly retrains all current employees while striving to engender a culture of perpetual learning."



Figure 14. WF020, Source: AT&T[18]

AT&T had 280,000 employees with an average tenure of 12–22 years. Since 2013, the company has spent $250 million annually on education and professional development and $30 million in tuition assistance to train 140,000 for new roles. The company also consolidated 250 roles across the company into 80, thereby increasing job mobility and interchangeable skills. In information technology, 17 existing roles spanning design, development, and testing evolved into the job of software engineer, who previously only tested equipment, write software that keeps systems operational.

This broadening of roles makes AT&T's resources more flexible and the company more agile. AT&T simplified performance metrics to focus more directly on how individuals contributed to business goals. The company also

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[16] HBR Oct 2016, "AT&T's Talent Overhaul," John Donovan and Cathy Benko.

[17] AT&T.

[18] https://goo.gl/iZNnAa.

redesigned compensation plans, de-emphasized seniority, added more variable compensation to motivate high performers, and gave weight to the in-demand skills. It shifted from corporate-ladder to corporate-lattice thinking, where individuals actively own their development, which fundamentally changes the social contract between employer and employee.

"The question for all of us becomes, Do I make this pivot or do I retire when the company retires the technology that I'm an expert on?" AT&T employee

In addition to the retraining initiative, AT&T redefined workspaces to make them more collaborative and more conducive to creativity. The transformation has begun to show results. In the past 18 months AT&T has reduced its product-development cycle time by 40% and accelerated time to revenue by 32%.

## SERVICE DIVERSIFICATION

As their traditional business matures, service providers are increasingly moving to offer services in adjacent industries, leveraging their superior ability to deliver connectivity solutions and tapping into value creation opportunities at the application level. Pursuing adjacent industries necessitates that the service provider adopts the right framework:

- Cohesive ecosystems, tight and agile partnerships, and depth in industry verticals.
- Agile service development and deployment model.
- Ability to forge new business relationships with customers, competitors, co-opetitors, and other players.
- Active engagement in adjacent industry verticals



Source: TM Forum, 2016

Figure 15: IoT

Examples of service diversification are plentiful. Many service providers have become major players in IoT. IoT holds significant promise for service providers in terms of new revenue; it relies at their deep expertise in connectivity, but enables them to create major businesses in adjacent industry verticals.

**Verizon IoT**

Verizon has established a strong beachhead in IoT. As indicated previously, it has developed its own platform (ThingSpace) and its development ecosystem. It has also made major acquisitions: in August 2016, it acquired

[19] https://www.tmforum.org/resources/research-and-analysis/roadmap-options-monetizing-managing-ioe-services/.

Fleematics, which provides software as a service fleet management, for $2.4 billion; in September 2016, it acquired Sensity, a leader in the smart city space. Verizon's IoT revenue in 3Q 2016 was $217 million, a 24% increase year over year. It is rapidly approaching a billion dollars in revenue.

**Vodafone's M-Pesa**

Vodafone transformed the banking landscape in many African countries by introducing M-Pesa, its mobile money service, in Kenya. M-Pesa is now the world's most successful money transfer service. It enables millions of people who have access to a mobile phone but do not have or have limited access to a bank account to send and receive money, top-up airtime and make bill payments[20].

**Comcast/NBCU**

In 2009, Comcast acquired NBC Universal, becoming a major content player. NBCU's properties include broadcast networks, cable networks, filmed entertainment, and parks and resorts. Comcast's goal is to own some of the content it is already distributing in a bid for vertical integration. Although typically such mergers do not end well (for example, the ill-fated AOL Time Warner), to its credit, Comcast has kept the two units separate with little synergy sought between them.

Other industry players are seeking to mimic this strategy. AT&T, which already owns DirecTV, is seeking to acquire Time Warner, whose properties include HBO, Turner and CNN.

## DATA ANALYTICS

At an operational level, service providers routinely collect massive amounts network operations data, which are typically used for diagnostics and other measures. Recently, service providers have come to realize the importance of data for predicting potential faults, and in some cases remediating the issues before they occur.

At a customer level, service providers are realizing that they hold troves of highly valuable data. Although they have begun to explore how to use the data, they are far from realizing the full potential of it. Some of the benefits, and use cases:

- Forecasting demand for use in network planning and operations, based on usage patterns and trends.
- Predicting and solving potential service issues, improving the customers' experience and reducing churn.
- Gathering insight about what services or what features customers are using and when provides valuable insight that can be used for product improvement.

With most products and services being consumed online or on a mobile device, service providers have a unique opportunity to learn about behavior on a user level. One example is video consumption. Previously, television viewing was consumed and measured on a household level with no insight into who was watching what. Now that content is being consumed online, video providers have a unique ability to pinpoint viewing habits at a very granular level, creating enormous opportunities for highly targeted and ultimately personalized content.

Increasingly, customers' data is being used, with excellent results, in improving customer service. When a customer contacts the service provider for help, detailed data on the customer's services, usage of services and prior issues, significantly improves the customer's service experience and may provide ample opportunities for upselling.

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[20] http://www.vodafone.com/content/index/what/m-pesa.html#.

IoT, which many service providers have embraced, is driving massive needs for data analytics. It is increasingly recognized that the value in IoT is at the application level, where the data being collected by the sensors is used for preventing errors, improving performance, and other business needs.



Figure 16. Data Analytics, Source: ACG

## Comcast harnessing customer data[21]

In 2015, Comcast created an initiative to harness viewing data from set-top boxes and streaming applications to create products it can license to other companies. Comcast's plan was to create organize data into dashboards that advertisers, content providers and other companies could use to target specific customer segments. For instance, a TV network could use viewing data with third-party data to find out what proportion of viewers are also shopping for a car. The company is also interested in data to gain insight about the success of its programming, for example, whether a show is building up an audience.

## Verizon's business intelligence unit

The business intelligence unit serves the marketing, finance and IT organizations. It provides data for more actionable targeting to ensure the offers are desirable to the customer and within financially sound boundaries.

"With business intelligence, we help the business identify new business opportunities or make course corrections to operate the business in a more cost-effective way. We support decision-makers with the most relevant information to improve the competitive advantage of Verizon," says Grace Hwang, executive director of financial performance and analytics, B[22].

Recently, Verizon announced its intention to open its analytics capability to the users of its ThingSpace IoT platform.

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[21] https://www.wsj.com/articles/comcast-seeks-to-harness-trove-of-tv-data-1445333401.

[22] http://blogs.teradata.com/customers/verizon-using-advanced-analytics-deliver-digital-promise-help-customers-innovate-lifestyle/.

# DIGITAL MOBILITY

Mobility is at the center of digital life. Digital mobility means facilitating digital information seamlessly anytime, anywhere, on any device and on any network. Whether someone uses a laptop, a mobile tablet or a smartphone or any network (Wi-Fi or cellular network) people want to access their favorite sites, read books, shop, and play games.

Mobility is largely driven by the extensive use of smartphones and tablets. More websites run on smartphone and tablets than on the desktops. Internet usage by mobile and tablet devices exceeded desktop worldwide for the first time in October according to Statcounter, which finds that mobile and tablet devices accounted for 51.3% of Internet usage worldwide in October compared to 48.7% by desktop[23].
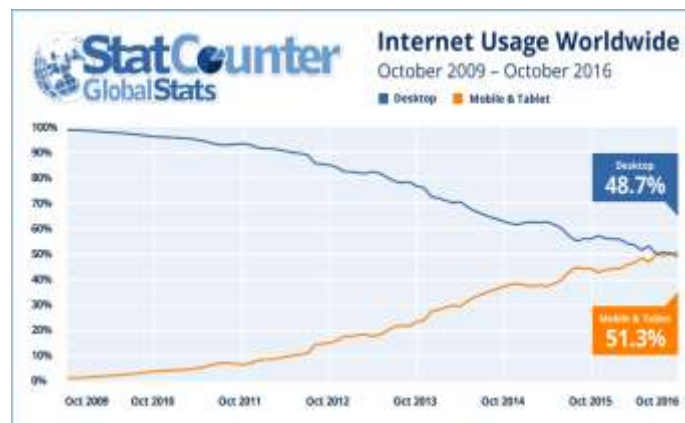


Figure 17. Global Internet Usage, Source: Stat Counter[23]

Digital mobility is driving service providers to take their services to where the customers are and to tap into location data to offer richer services and leverage the ecosystem for value-added services.

# CABLE COMPANIES: TV EVERYWHERE INITIATIVE

Cable companies have seen the effect of mobility on their subscriber base. Increasingly, their customers started demanding the ability to watch content on mobile devices at a time and location of their choice. However, to do that, cable companies needed to ensure compliance with digital rights management and needed to be sure they satisfied and in most cases renegotiate their contractual obligations with the content providers. This resulted in TV Everywhere or TVE. Although the success has been mixed thus far (awareness and authentication remain challenges), the industry has made significant progress in this endeavor.

# INFRASTRUCTURE TRANSFORMATION

The traditional siloed networks that characterized most operators (wireline, wireless, cable, etc.), no longer serve them well in a dynamic environment; such networks tend to be rigid, slow and cumbersome to update and maintain. Service providers need to innovate quickly, introduce new services, and fine tune these services based on market response. To do this they need an infrastructure that is flexible, scalable and dynamically managed. They need to reduce capital expenses and operational expenses to bring their spending more in line with their revenue. Advances in cloud technology and the continued evolution of Network Functions Virtualization (NFV) and Software Defined Network (SDN) offer service providers the opportunity to virtualize key network functions and

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[23] http://gs.statcounter.com/press/mobile-and-tablet-internet-usage-exceeds-desktop-for-first-time-worldwide.

other operational infrastructure and to separate network control logic from hardware, paving the way for a resource on demand model.

## Virtualization/Automation: SDN, NFV and Cloud

Capital expenses and operational expenses for the service providers are high and service agility is severely impacted with their current siloed network architecture and purpose-built hardware. Virtualization will, therefore, play a major role in a service provider's transformation and be the foundation on which the other customer-centric enablers will be built. Virtualization includes everything that constitutes the cloudification of the network:

- NFV includes virtualizing network functions on Commercial Off the Shelf (COTS) x86 servers thus reducing capital expenses and operational expenses significantly.
- SDN includes eliminating the control from network elements to central policy controller giving effective and flexible control over networking the resources.
- Cloud computing enables shifting the traditional computing to cloud-based model, enabling new business service opportunities such as IAAS, PAAS, and SAAS.

Automation will enable the virtualization to effectively achieve the flexibility and agility. One of the earliest drivers for virtualization adoption was reducing capital expenses and operational expenses. A recent survey shows that service agility is now the top driver for virtualization. Virtualization can help a digital service provider react to the market dynamics quickly. It can introduce customized as well as innovative solutions to address larger market segments.
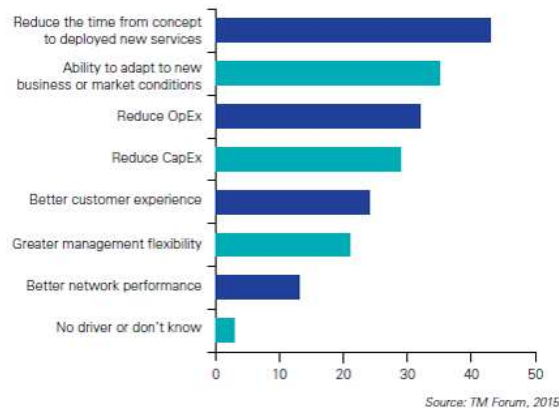


Figure 18. Benefits of Virtualization[24]

**AT&T network virtualization[25]**
AT&T plans to virtualize 75% of its network by 2020 under Domain 2.0. AT&T ended 2015 with 5% of its virtualization goal. By late 2016, AT&T had virtualized about one-third of its network. Domain 2.0 includes implementing SDN, which enables the service provider to automate infrastructure management and service delivery, and NFV, which enables it to replace expensive dedicated hardware appliances for services such as firewalls and VPNs with virtual functions that can run on regular servers. AT&T says the effort is a response to a massive increase in data traffic on its wireless network over the last eight years, driven primarily by video.

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[24] https://inform.tmforum.org/features-and-analysis/2015/09/if-you-want-to-be-agile-learn-to-fail/.

[25] http://www.datacenterknowledge.com/archives/2017/01/05/one-third-atts-network-now-virtualized/.

"The hardest part of how big-scale projects go is you have a year of planning, a year at five percent and a year at 30% and a year that takes you to 50%, and then you start to burn down the tail," says John Donovan.

**CenturyLink's Virtualization Strategy[26]**
CenturyLink has recently announced a plan to virtualize 100% of its points of presence (POPs) to reap capital and operational benefits. "We plan to have 100% of those [POPs] virtualized by the end of 2019," "We also have almost 50% of our network capabilities currently controlled through our SDN network," says Glenn Post, CEO, during the company's fourth quarter 2016 earnings.

Virtualization of the SDN, NFV network will save over $200 million a year in capital expense and will result in major operational savings. Implementing SDN and NFV will also enable CenturyLink to gain new revenue opportunities by offering new capabilities such as network on demand, and to reach a broader array of business customers, including outside its serving area. For example, CenturyLink can now reach 4.8 million businesses it could not reach before.

Virtualization enables CenturyLink to allow its customers to distribute their own bandwidth where it is needed. Last year, CenturyLink launched its SD-WAN service, which resulted in increased levels of automation and customer self-service.

## Security
Security is a key technical foundation that should be addressed throughout the network and services life-cycle, especially with such significant web access, big data, applications running in the cloud and the emergence of a new breed of hackers that threaten the foundations of the structure on which digital transformation is erected.

Organizations racing towards digital transformation should not forget the importance of security. Many organizations still view innovation and security as opposing forces[27]. Many would consider security as barrier to fast development of new products. However the truth is that it is the security that enables a sound and stable foundation for the products and lead to networks that sustain. In fact, if the security or network resilience of networks is compromised, this can create hurdles for the economic activities, lead to financial losses, bring down network but above all can damage the brand of a service provider. A culture of risk management including security assessment and implementation of security measures should be the top priority of a service provider.

A study from ENISA[28] has highlighted several threats to networks running in software.

- Threats related to servers running virtualized network functions (virtualized host abuse).
- Threats to data center hosting SDN operations (data center threats).
- controller software/firmware exploits.
- SDN applications software/firmware exploits.
- API exploitations.

Therefore, Service providers need to build a formal security framework that includes comprehensive internal and external security functions to thwart any potential threat. They need to implement end-to-end security life-cycle

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[26] http://www.service providertransformation.com/author.asp?section_id=396&doc_id=730209&.

[27] http://www.cio.com/article/3105274/cyber-attacks-espionage/hacked-companies-still-prioritize-innovation-over-cybersecurity.html.

[28] Threat landscape and good practice for SDN, www.enisa.europa.eu.

management and use analytics to identify any unusual behavior. Service provider should follow the security guidelines issued by different standard bodies such as ETSI and CSA.

## Transformation continuum

Given the complexity of the undertaking, it is expected that digital transformation is an ongoing process and the operator will be in a hybrid mode during the transition.
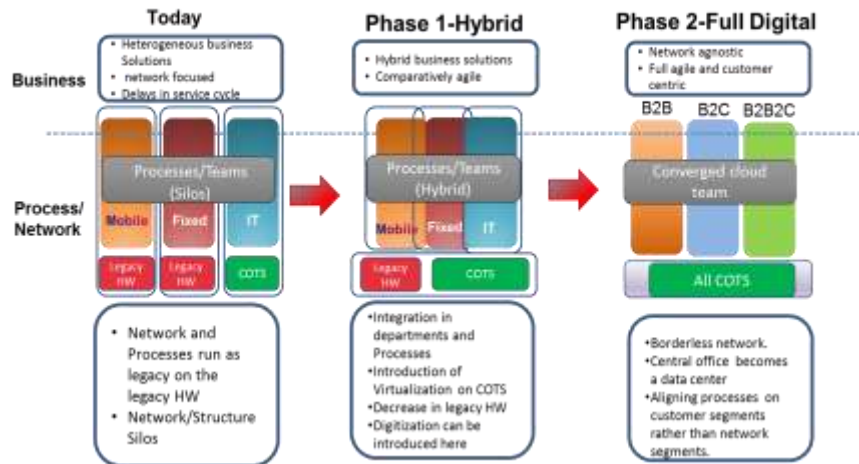


Figure 19. Transformation Process

## Phases of Organizational Transformation

The current structure of a service provider is a big, fat organization with large teams divided into technology units. There are different teams for mobile, fixed and IT and are subdivided into subgroups. There are separate planning, implementation and operation group for each unit. The result is a hierarchal organization with a lot of redundancies and communication issues between departments as each technology unit works in silo.

It is common to see technology redundancies as the network is built in silos. Bringing up a simple service take a significant amount of time as implementation and provisioning is handled by multiple teams with strict processes. The effect is customer churn and loss of business.

**Phase 1: Hybrid**

Phase 1 is an intermediate stage in which the organization is integrated by convergence of teams and processes. As virtualization starts to gain footprint in the organization. More and more legacy, purpose-built and proprietary hardware will be replaced with virtual COTs hardware.

**Example of organization convergence**

A service provider needs to introduce more convergence in the fixed network by bringing IP and optical domains together through SDN in both IP and optical domains and introducing an IP and optical domain orchestrator on top of IP and optical SDN controller. Opportunity for the service provider:

- Does not need to keep two teams to provision a service that goes through IP and optical domain. An MPLS service can be provisioned by the same team that can provision the DWDM team.
- More integration in the IP and optical systems and integration in IP and optical operation teams, reducing expenses.

- Major impact in operation because of integration of the provisioning teams, reducing the time to provision a service.

**Phase 2: Full Digital**

Going Full digital should be the ultimate target as the systems become virtual, enabling central offices to become data centers running on COTS server and thus phasing out purpose-built hardware. For example, one such initiative of transforming central offices to data centers is CORD[29]. When this stage is reached, there will be less need for hardware engineers as an organization is completely transformed to run its business on software applications. A high-converged cloud team would treat the network as just flexible hardware resources and focus on software applications that run on top of the hardware.

The business focus of such organization is network agnostic, which does not care about a mobile or fixed/IT network ( i.e. network becomes a resource pool) but about how to serve different business segments such as B2B, B2C or B2C2B. Internally there are separate teams for B2B, B2C and B2B2C that can create, design and provision agile and innovative solutions for its segment whether the service starts from a GSM phone and ends up on a fixed line.

Through the B2B2C segment, the organization will also have to focus on developing ecosystem partners. To these partners it can open its network through open APIs, reaching a greater customer footprint than possible with its direct segments. Clearly, such an organization can provide digital services at a much higher scale with innovation.

## Operational Transformation

The current operating environment is often siloed. The following are drawbacks to the operator's digitization efforts:



Figure 20. Operational Transformation

- Operation Silos: Most operational structures today are walled structures with limited communication, too much hierarchy that could impede the move to a DSP.

- Service modifications and rollouts take time is a normal effect of having a multitude of technologies and multiple teams involved in provisioning that delays the service rollout.

- Waterfall methods of service innovation do not work with the agile requirements of new networks where software and service rollouts need to be fast and to adopt a DevOps methodology.

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[29] www.opencord.org.

**Challenges in moving to a cloud environment**

The migration to a cloud environment is not without challenges. Re-organization is often needed to bring IT and OT into alignment and requires people to change their work habits and often to acquire new skills. Such changes are often met with resistance and reluctance. Additionally, the organization often lacks the right skills. People typically need to be retrained, but in some cases, layoffs may be necessary as the companies seek to acquire more up to date skills.

**Three Prongs of Operational Transformation**

Moving forward we will discuss the three prongs of operation transformation which are
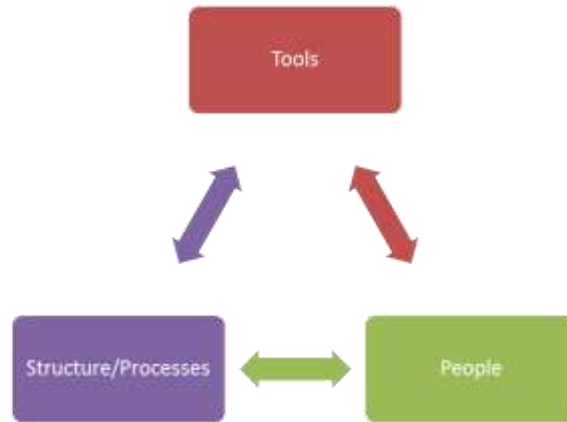
- Structure and Processes
- Tools
- People



Figure 21. Three Prongs of Operational Transformation

**Process Transformation: DevOps**

DevOps is an approach whereas the operations team is involved in the development process. This convergence of development and operation is at the heart of agile delivery. Software is continuously developed and tested against production-like systems, making product development more agile.
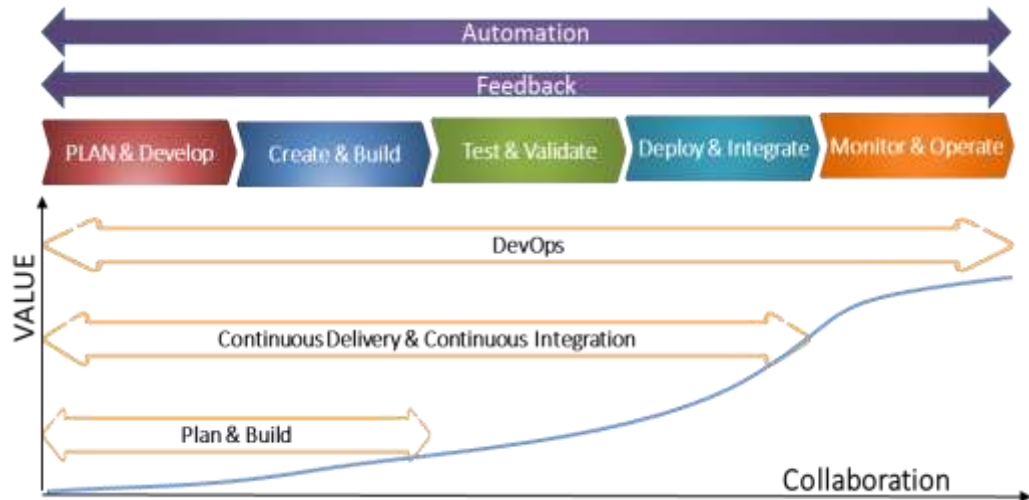


Figure 22. DevOpps Process

As shown in Figure 22 the process has different stages starting from planning and developing software to operating it. But two other factors are very important: automation and continuous feedback.

The following describes the main attributes of DevOps methods.

- Continuous integration (CI). The basic functionality of DevOps involves use of delivery pipeline that controls advancement of release artifacts from idea to production. The pipeline is like manufacturing production line with conveyer belts that facilitates components being assembled through stages until the final product is ready. Instead of the waterfall method, small incremental changes are applied and tested thoroughly (integration); therefore, any integration issues can be caught early, rectified and reapplied until they pass regression tests.

- Continuous delivery (CD) of new releases. This combination of CI and CD means that there is a confidence in the build and release process that supports a significantly faster end-to-end release.

- High degree of automation is applied to all steps in the delivery pipeline, including the generation of intermediate artifacts, packaging, testing and deployment. This ensures that the product gets out quickly.

- Continuous feedback and open communication at every stage (automatic and real world). Real production data is used to guide to development and operation practices and priorities. Operations team enable developers with frameworks and feedback that can help engineers test, fix, and ship code faster. By including customers' feedback, the product can be refined and customized at a faster pace. Real-world feedback can only thrive in an environment of open communication and requires culture changes in big siloed organizations.

- No rollback, only fail forward. In traditional large systems, a change that was not successful had to be rolled back completely. In DevOps working on incremental changes facilitate failing fast and failing early to allow catching the errors in the beginning, fixing them and then continuing forward, which results in much quicker time-to-release stable software applications.

**Automation leads to fast time-to-market (TTM)**

The result of automation with DevOps is faster time to market of new applications to customers. Digital transformation requires new digital products be released to customers often and fast. Traditional O&M needs six to 12 months to roll out a new service; DevOps may take less than a month because of the automation and feedback loop involved.
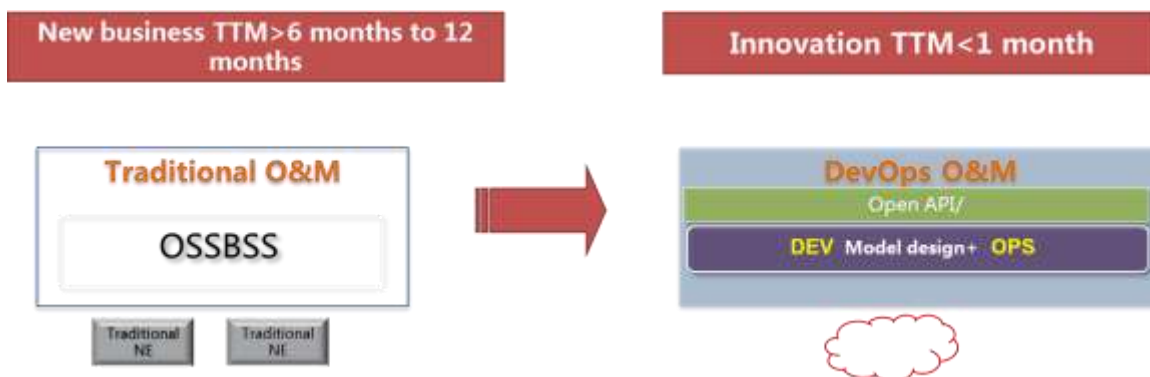


Figure 23. Challenges in Operation

**Model for DevOps; recommendation for service provider**

Many service providers have skillset issues to overcome before getting involved in development activities. The recommendation is a start-slow and gradual model with the assistance of vendors in development activities until it is capable to take on the development activities completely.

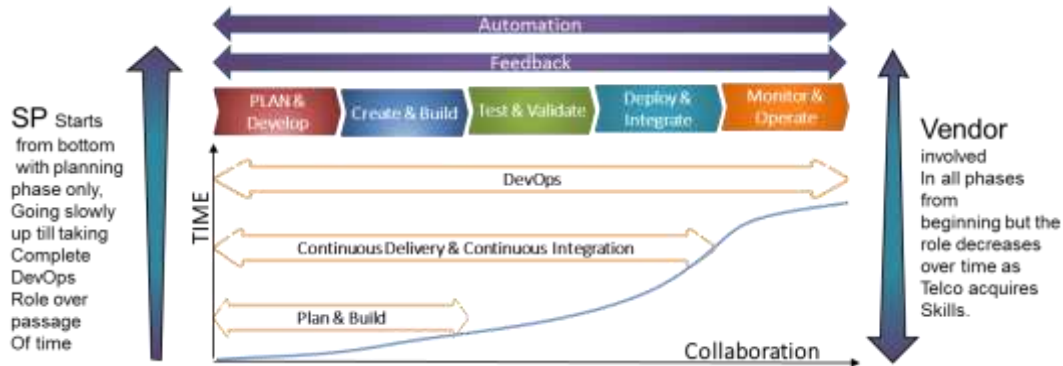The following shows one such approach:



Figure 24. Start-slow model for DevOps

Success of DevOps greatly depends on the collaboration between a service provider and a vendor. At an early stage of virtualization, a service provider is faced with the shortage of skills to carry out DevOps processes and development part of the DevOps. Initially, the service provider must be involved in the basic planning stage whenever a new service is planned. In the other stages, a vendor would assist the service provider in the complete DevOps process. Initially, a vendor is the owner of the DevOps cycle; however, as the service provider acquires DevOps skills and starts managing the DevOps cycle, the role of vendor decreases and the service provider manages the complete DevOps cycle.

**Operational structural transformation: Phase 1**

The operational structure should be slowly transitioned to a take the advantage of DevOps models:

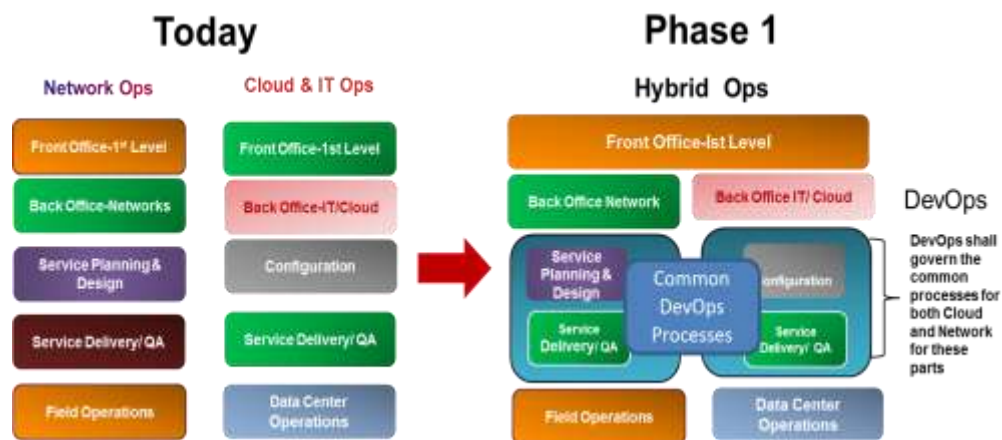

Figure 25. Phase 1 of Operation Structure Transformation

Figure 25 shows the hierarchal structures for networks and operation: the front office of the operation team, which is supported by the Level 2, the back office team. These two teams are then supported by a service planning team and service delivery team. There is one field operation team that takes care of field incidents.

In parallel, there is a similar hierarchy for the IT team. As a first step, the DevOps can be implemented:

- Merge the planning team with the delivery team as a single DevOps team from the network side.
- Merge the configuration team with the delivery team in the IT as a single DevOps team.
- Implement shared DevOps process that the two teams formed earlier can follow. At this stage there is a convergence of processes and tools between IT and networks.

Some of DevOps tools that are used in the IT can be reused for the service provider's cloud applications:

| Tool Type for Virtualization | IT Examples (Open Source- DevOps Tools) |
| --- | --- |
| Repositories | GitHub, GitLab |
| Development Build & Automation | Ant, Maven, PyUnit |
| Continuous Integration and Continuous Delivery | Jenkins, Travis CI |
| Configuration Management & Automation | Puppet Enterprise, Chef, Ansible |

Table 1. Dev Ops Tools

These steps outline a much smarter integration on the networks and IT side and implement a shared DevOps processes among the teams.

**Operation structure transformation: Phase 2**
As the service provider moves to Phase 2, it moves its entire infrastructure to COTS hardware, converting the central office to a data center with x86 servers and almost no purpose-built hardware. However, there will still be for some time legacy equipment processes. Moving to Phase 2 will take a longer time depending on the maturity level of a service provider and how quickly a service provider adopts processes in Phase 1. Phase 2 might take from 7 to 10 years.

During Phase 2, the service provider moves to an integrated Ops model completely, merging its IT and network operations teams. When all the applications run on x86 servers, there will be no need to keep multiple specialized operation teams. There will be one data center field operation team, one integrated DevOps team and one front office. There might be some specialized back office teams to solve functional issues related to specialized applications. This will significantly reduce the operational structure, number of teams and effectively the operations expense of the service provider.
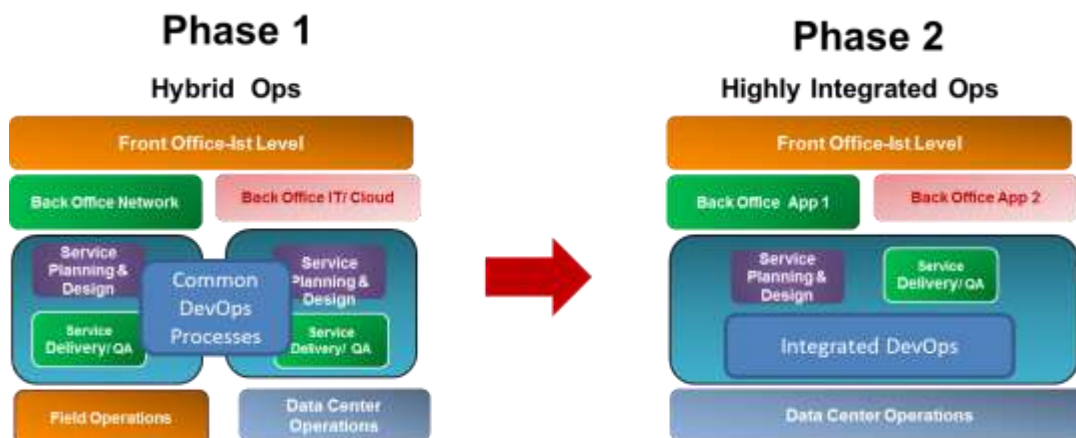
Figure 26. Phase 1 to Phase 2 Migration of Operation

## Tools Transformation

Tools transformation is the most important part of the new operational transformation. The digital transformation must have richer capabilities in the BSS/OSS, such as accommodating ecosystem developers, big data analytics, customer self-service portal. The recommendation is a phased approach of modifying the BSS/OSS structure incrementally instead of a fork lift upgrade.
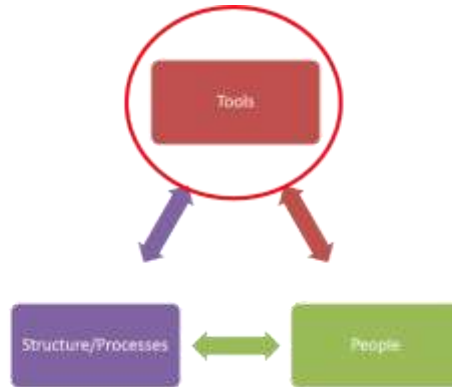


Fig: Second Step to Operation Transformation

The following are three examples of how AT&T, Verizon and SK Telekom are approaching their architecture and tools.

**AT&T ECOMP: Takeaways: Policy Control, Automation and Open APIs**

AT&T Domain 2.0 is focused on utilizing cloud technologies and network virtualization to offer services while reducing capital and operation expenses. The ECOMP is a software platform for the life-cycle management of the Domain 2.0 environment for carrier-grade real-time workloads. It consists of multiple software subsystems with focus on the rich design platform and execution time environment based on closed loop, policy driven automation. ECOMP is good example of a carrier plan to move to digital transformation.
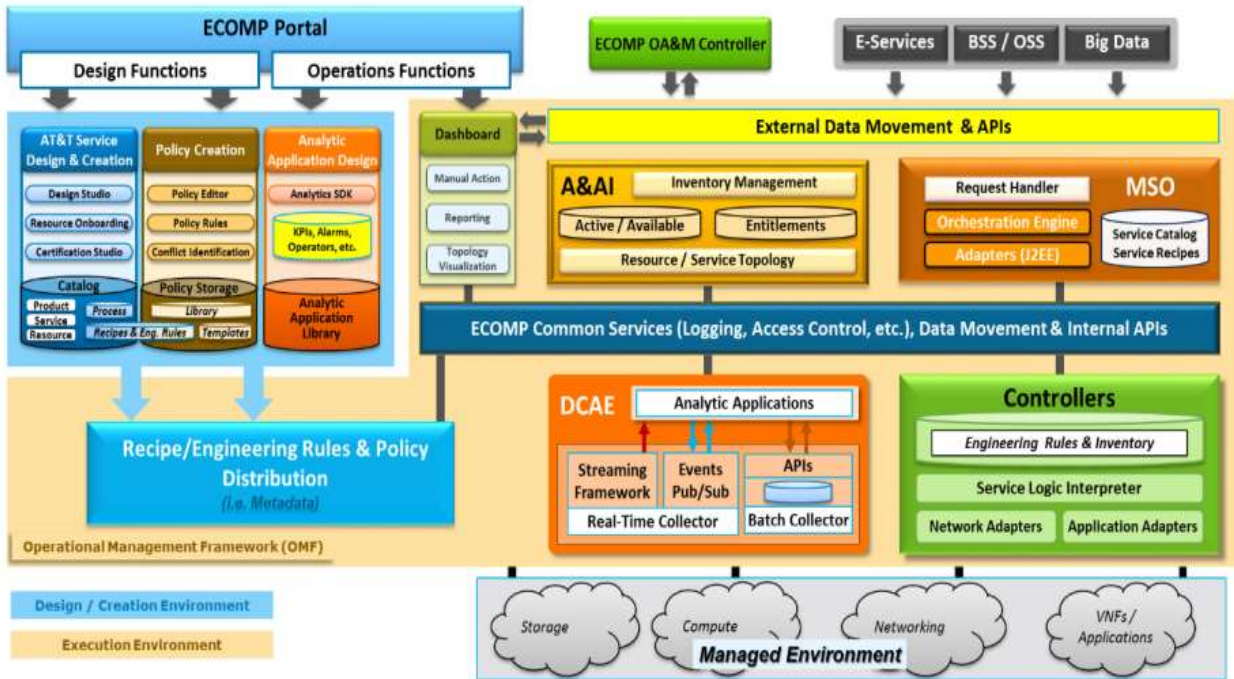
Figure 27. AT&T ECOMP Platform[30]

Some of the key take away from the ECOMP platform:

- The ECOMP platform supports integration with the legacy OSS to provide seamless customer's experience across both physical and virtual network elements.

- There is a clear focus on the design functions for applications development. The platform enables design factory-like concept as shown in the design module on the left with a certification studio. Once design is done, it can be certified quickly. There are design recipes from which a designer can choose to start immediately.

- There is an emphasis on using policies instead of manual controls (policy module on the left side). Policies are conditions or constraints that must be maintained or enforced for certain actions to take place. One example is the use of SDN for networking. SDN can be taken as policy-based networking by a central SDN controller.

- There is emphasis reusing the models for saving time and automation purposes. Common capabilities are developed once and reused many times. There are models for services, design and products.

- Close loop operations help in identifying and troubleshooting the issues automatically. This is the essence of DevOps: catching the errors at the early stage of development and deployment of applications.

- The platform integrates with big data platform and external OSS/BSS through APIs.

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[30] http://about.att.com/content/dam/snrdocs/ecomp.pdf.

- The E-portal gives access to third-party developers to develop and integrate their applications with AT&T ECOMP platform.

**Verizon Innovation Architecture: Takeaways: automation & end-to-end orchestration**

In a white paper[31] on the future migration to a cloud based architecture, Verizon asserts that transformation should be driven by the advent of cloud based technologies, agile software development such as DevOps, IT and web-application technologies. Verizon's high-level architecture consolidates and enhances SDN, NFV and orchestration into an operable framework.
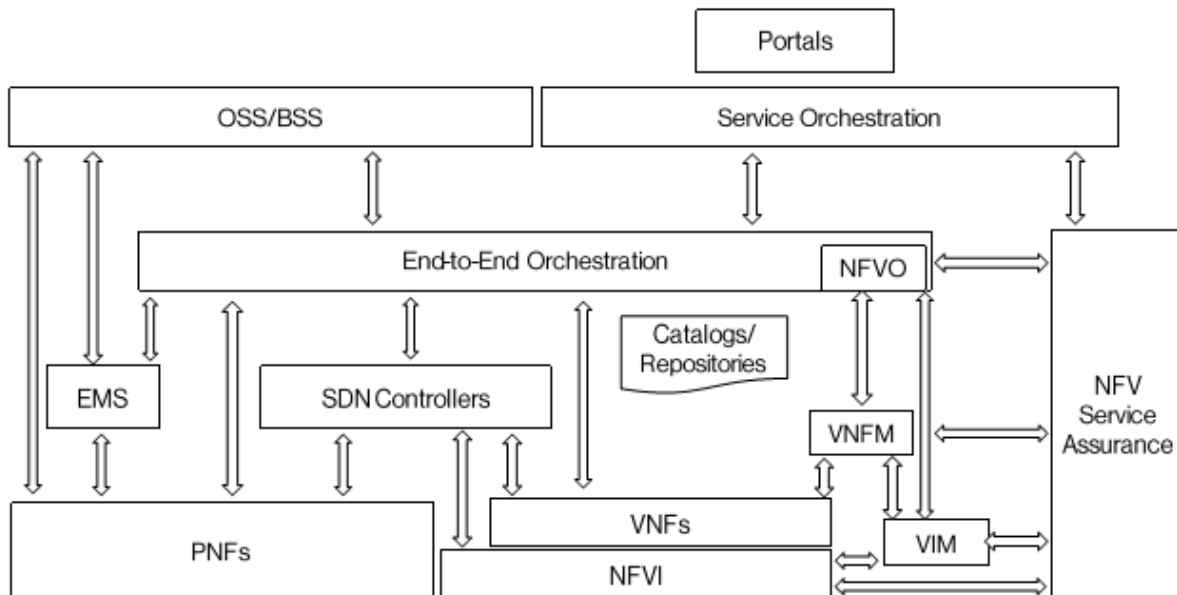


Figure 28. Verizon High-Level SDN/NFV Architecture[31]

Some of the key takeaway from the Verizon vision:

- The introduction of SDN/NFV does not imply wholesale replacement of OSS/BSS. Initially, the operator will continue to manage most services using existing systems and procedures.

- End-to-end orchestration is necessary to create end-to-end services among physical and virtual elements. Initially, it will focus mainly on virtual services but will eventually include the physical services.

- The SDN controllers shown are for the DC, WAN and access services.

- There is a focus on catalogs, which enhance the current industry standards. In addition to the catalogs for VNFs and virtual services, it will have catalogs for SDN based services such as IP VPN and E LINE.

- Very important is the service orchestration layer that gives access to partners and DIY customer activation.

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[31] http://innovation.verizon.com/content/dam/vic/PDF/Verizon_SDN-NFV_Reference_Architecture.pdf.

**SK Telecom COSMOS and ATSCALE: Takeaways: automation, IOT and external APIs**

SK Telecom is South Korea's leading service provider and known worldwide for leading innovation initiatives. The company has published a white paper on Composable, Open, Scalable and Mobile-Oriented System (COSMOS)[32] and one on Scalability, Cognition, Automation, Lean and End-to-End (ATSCALE[32]). SK Telkom has put together an architecture as below that is really focused on moving it to the digital transformation.

COSMOS combines the IT and service provider's architecture into software defined data center. It is an open source platform not only for platform services such as multimedia, lifestyle and IOT but also service provider's services such as LTE and 5G. ATSCALE delivers not only software-based services but an open API based architecture to deliver high-quality experiences for customers and innovative services quickly and end-to-end.
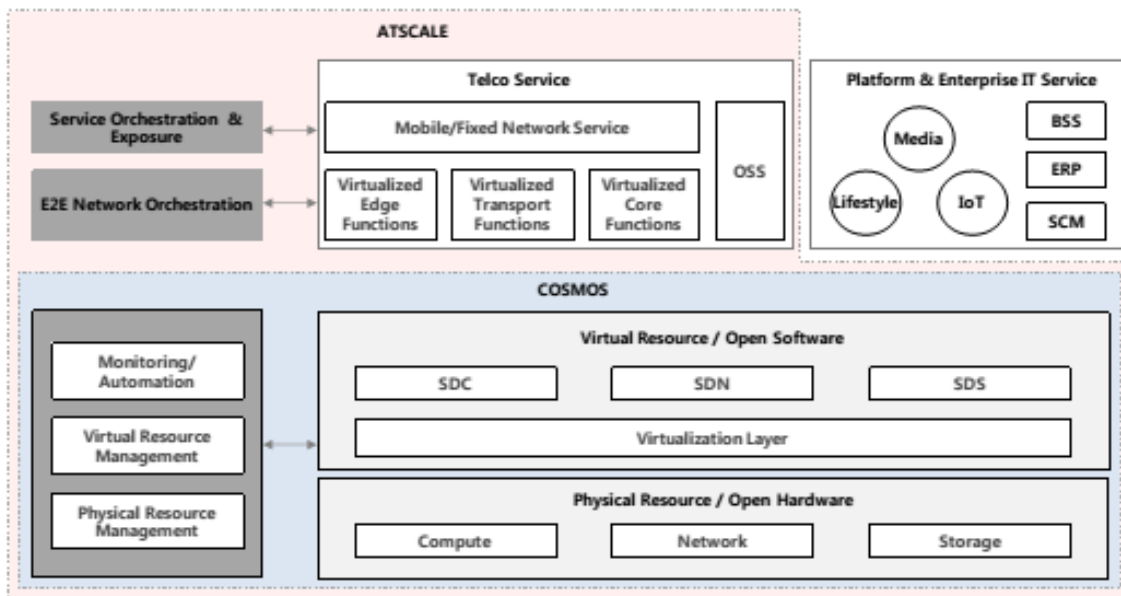


Figure 29. SK Telecom ATSCALE and COSMOS Architecture[32]

Key takeaways from the SK Telecom next generation architecture:

- The architecture is geared towards making a central office as a data center by combining the IT and service provider's networks on the COTS platform.

- High focus on external APIs for the partners' eco-system and expose the network for DIY customers.

- Focus on platform management module called Platform and Enterprise Service that covers IOT, media and lifestyle.

Therefore, the major focus areas of the above three leading service providers can be summarized as following:

- Highly degree of automation.
- Open source software and combining their IT and service provider's platforms
- End-to-end orchestration and assurance.
- Exposing networking with external APIs to ecosystem partners, customers and third-party developers.

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[32] https://developers.sktelecom.com/resource/document/#none.

- High focus on big data analytics integration.
- Reuse of existing OSS/BSS.

## Roadmap for OSS/BSS evolution

Every service provider has extensive deployment of OSS/BSS, and, therefore, it makes sense to reuse the existing infrastructure. The following diagram shows an architecture where a service provider wants to move to virtualization with minimum addition to the existing infrastructure:
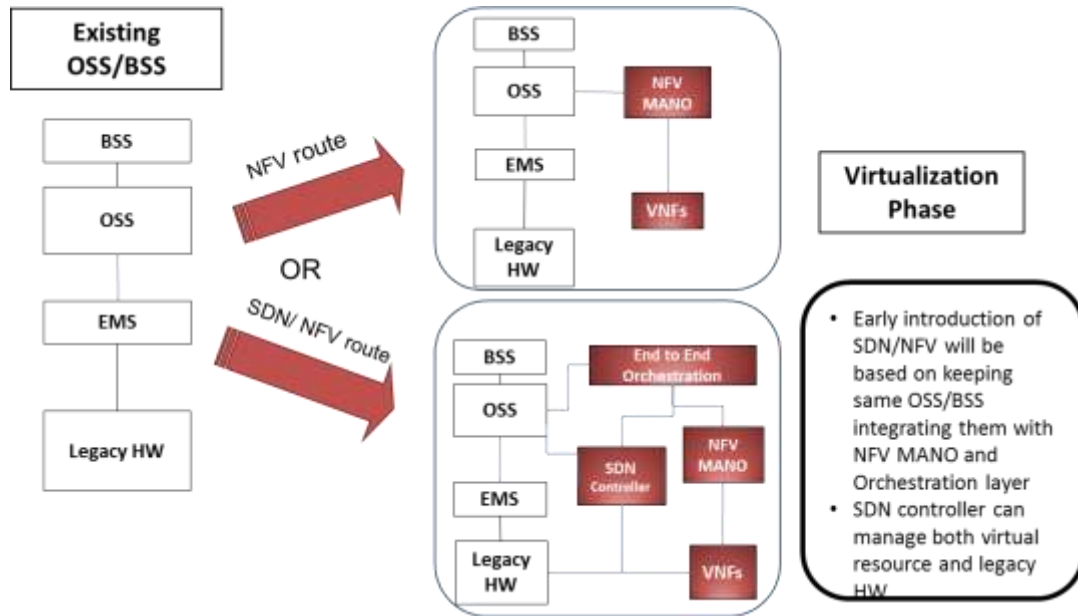


Figure 30. Phase 1: Virtualization Phase

The service provider can take either the NFV route or the SDN/NFV route, ending up with one of the models. The implementation is done by using NFV Management and Orchestration (MANO) and integrating it with the OSS. The SDN controller can also be integrated with NFV MANO and OSS through the end-to-end orchestration layer. The SDN controller can manage both the legacy and virtual hardware.

In both these models, there is no effect on the OSS/BSS as the same OSS/BSS can be used to integrate the new entities in the network. The addition of SDN would require a good end-to-end orchestration layer to create services seamlessly between from physical to virtual domain.

**From Virtualization Phase to Digital Phase**
Digital transformation needs much more than adding just service orchestration as in the virtualization phase. The notable additions in the digital transformation phase are big data analytics engine, next-generation BSS, customer DIY portal and partner's eco system management.
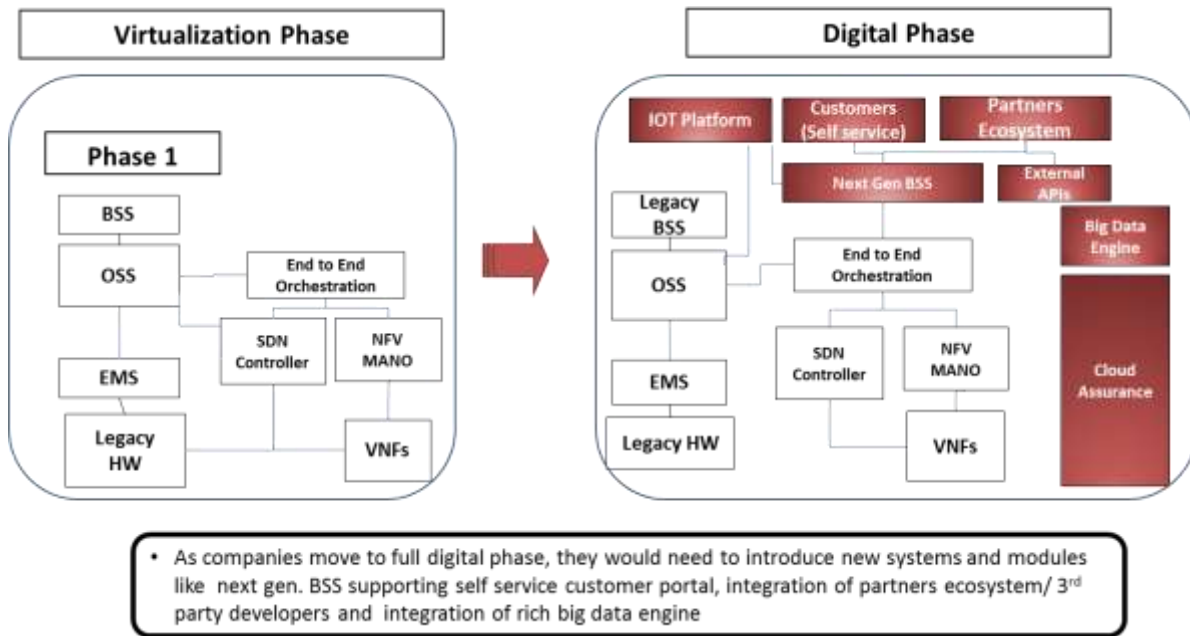
Figure 31. Virtualization Phase to Digital Phase

The notable exceptions with the digital phase are:

- The system should expose open APIs to external ecosystem partners and third-party developers. Partner's ecosystem module is therefore added.

- The BSS should support advanced customer management and billing functions. Customers should be able to provision do-it-yourself services and scale or terminate them. A self-service module and portal are therefore added.

- As the legacy BSS cannot support advanced customer and product management, it is recommended that the provider have a next-generation BSS supporting these functions.

- Both legacy and new BSS can function in parallel depending on whether legacy services are managed or are virtual services.

- Optionally, legacy BSS can be integrated with the new BSS using the new BSS as the only business support system.

- The existing OSS can still be utilized if it able to support the APIs exposed by the new systems.

- IOT platform is introduced and integrated with the BSS and OSS for providing IOT management.

- Big data analytics engine must be introduced as analytics will play a very important role in managing the big data generated by the IOT systems.

**People Transformation**

People transformation should start very early during the organizational transformation. The majority of today's service providers lack sufficient skillsets and capabilities to run networks in clouds. The virtualization and ultimately digital transformation is a big step that requires a detailed plan on upgrading the skillsets of employees.
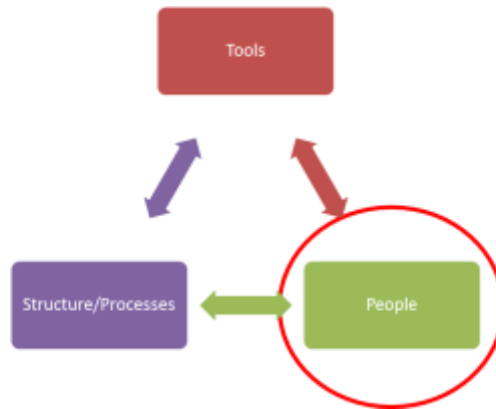
Figure 32. Third Step to Transformation

A paper by ACG[33] on the state of organizational readiness for virtualization technologies emphasizes that an organization should focus on a plan for up-skilling at a very early stage. The roadmap for developing DevOps strategy focuses on continuous skills development, and that phase starts even before the actual readiness plan for the organization is launched, Figure 34.
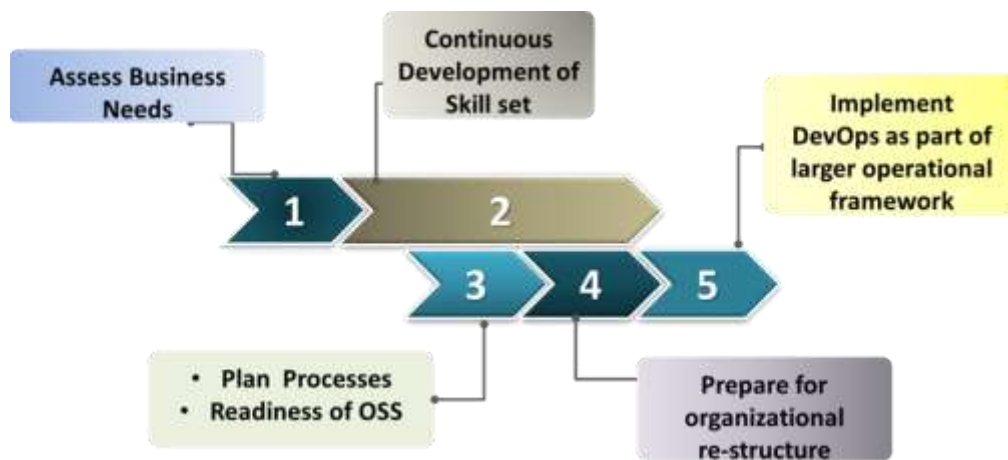


- Organizational DevOps implementation Plan including skillset phase

The skills certifications requirements will be much different than todays' vendor centric network certifications. What will be needed is a mix of IT and networking skills. Open source skills such as Linux and Openstack would be in high demand. Above all, skillsets related to automation are essential. For example, knowing Python helps in automating scripts to bring up a virtual router and configure it.

As the focus shifts from a vendor box to a COTS server, there will be a move away from vendor proprietary CLIs to a model-based configuration with open APIs such as RESTCONF and YANG.

**New Roles in Organization**
Some of the new roles in organization that are expected to emerge:

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[33] http://www.metaswitch.com/resources/acg-white-paper-sdn-and-nfv-the-missing-organizational-readiness-plan

- Cloud architect maintains and develops cloud service catalog, identifies market trends and anticipates business demands to create new services.

- Cloud orchestration engineer designs and deploys cloud orchestration workflows, cloud automation, responsible for automation of workflow activities based on DevOps.

- Virtual Infrastructure engineer is responsible for the virtual infrastructure including virtual machines and hypervisors.

- Data scientists analyze the data to conclude meaningful results, for example, improving customer experience.

- Mobile apps developers create mobile-centric apps for various platforms.

**Some recommended skillsets and trainings**

The following is recommended trainings that can prepare employees for the virtualization technologies:

- Software defined storage and networking
- Software defined data center infrastructure
- Cloud transformation and convergence of DevOps and NetOps
- Openstack administration
- Introduction to agile methodology
- Scripting skills in Bash, PHP, Ruby and Python
- Netconf and Yang
- DevOps tools and testing (Puppet/Chef/Ansible/CFEngine/SaltStack)
- Cloud computing
- Cloud security
- Services orchestration (onboarding, provisioning/activation, scaling decommissioning) introduction
- ONF Certified SDN Associate (OCSA)
- ONF Certified SDN Engineer (OCSE)

**Need to have mix of business and technical skills**

As service providers differentiate based on innovative business solutions, there will be a need for engineers with both business and technical skills with the ability to translate business requirement into technical requirement, as well as propose new and innovative solutions. Another engineer will create end-to-end architecture and give it to another person to design a service profile and create a service catalog.

**Security skills shortage and need for security engineers**

Running applications in the cloud means that applications must have extra security and be the top priority for any cloud deployments. Despite many advantages, NFV will introduce new security threats[34]. Since all virtual functions in NFV can be configured by an external controller, the whole network could be potentially at risk. For example, a hypervisor can dynamically load balance traffic between virtual machines; however, if a hypervisor is attacked, all network functions can be disabled completely.

Unfortunately, there is shortage of cyber security engineers. Intel Security and the Center for Strategic and International Studies published a security survey report[35], based on research from market research firm Vanson

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[34] http://seclab.skku.edu/wp-content/uploads/2013/05/FGCS_17_Mahdi.pdf.

[35] http://www.informationweek.com/strategic-cio/security-and-risk-strategy/cyber-security-skills-shortage-leaves-companies-vulnerable/d/d-id/1326463.

Bourne, which interviewed 775 IT decision-makers involved in cyber-security within their organizations. Respondents represented the US, UK, France, Germany, Australia, Japan, Mexico, and Israel. The majority of participants (82%) reported a lack of cyber-security skills within their organization. One in three say the shortage makes them prime hacking targets; one in four say it has led to reputational damage and the loss of proprietary data via cyber-attack.

Organizations should carefully study the security skillsets shortage in their organization and develop a plan to upgrade internal skillsets or bring on board external talent to cope with this shortage.

## CONCLUSION

There is no single definition of a digital service provider nor a unique path to achieve that status. Each service provider must chart a course that leverages its unique assets and competitive strengths and that considers the market competitiveness, its financial capabilities, the availability of an ecosystem it can tap into, its technical abilities, and its access to the vendors to help achieve its goals.

The following are some guiding principles the service providers need to consider:

- Start from the customer and make the customer the primary focus of the transformation strategy. Look at all initiatives and plans with a lens that zeros in on the needs of the customer. Focus on the job to be done for the customer[36].

- Start at the top. The most senior executive in the company should establish the vision, and communicate regularly and thoroughly, making the case for change and aligning the organization behind it.

- Ensure that there are sufficient resources earmarked for the effort.

- Put a detailed plan in place. A very important part of the plan is to ensure that the existing business will continue to operate without disruption, considering that the transformation process will take a long time, and that the organization will be in a hybrid environment during that process.

- Communicate with external stakeholders (shareholders) if the transformation will have an impact on immediate and near-term earnings. Communicate with investors to ensure their buy in and to impress upon them what the long-term upside will be by the transformation effort.

- Accept that things will not always go according to plan and be prepared to readjust and evolve.

The following are some architectural and operational transformation steps every service provider needs to take:

- Focus on IoT, big data and digital mobility as enablers for digital transformation.

- Include a roadmap on making the architecture flexible and elastic through virtualization and cloudification of network focus.

- The new borderless and networks that operate in clouds will generate new security threats. Include a comprehensive security plan in parallel to the technology transformation plans.

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[36] "Competing Against Luck," Clayton M. Christensen, Taddy Hall, Karen Dillon and David S. Duncan.

- Virtualizing network without automation leads to less flexibility and delays in service innovation and provisioning. DevOps model has the potential to introduce automation in the processes. The road to DevOps should be through phases introduced in this paper.

- Operational transformation will be most challenging as the current operational structures are based on silos and duplication of resources and processes. The transformation can start by consolidating and converging multiple operation teams through common DevOps processes. Merging IT and networks teams is the goal of the digital transformation.

- Service providers and vendors need to work closely and as partners during the transformation stages. The vendor initially helps the service provider in all phases through slow skills transfer until the service provider can run the process independently.

- The organizational and operational transformation plans should be evolutionary rather than revolutionary. The OSS/BSS should be migrated in phases instead of fork lift upgrade.

- Digital transformation puts the onus on new skill sets related to automation and virtualization and a mix of IT and networking skills. Developing skillset should be the top priority for any service provider. There should be a formal plan to develop such skills. This up-skilling should happen even before the technological transformation.

The digital transformation affects all aspects of service providers' organization. It requires a massive rearchitecture of their networks, infrastructure and operations, a fundamental change in mindset where the focus shifts to the customer, and customer centricity becomes the driver of strategy and goals across the firm. As their networks transform, their organization and the type of skills required to run the business fundamentally change as well. They are pursuing a mixture of hiring, massive retraining, and layoffs to align their core competencies with the needs of the evolving market. They are also instilling a new culture of innovation and risk tolerance, which in many cases is a departure from their traditional, slowly iterative mindset. In general, most service providers are in the early stages of this transformation; some have taken very aggressive steps, such as AT&T and T-Mobile, but the majority are either getting started or just beginning to recognize the need for change. To be sure, digital transformation is a long and hard process, full of pitfalls and challenges, but it is an essential transformation that will enable service providers to continue to be relevant and even thrive in the evolving, hyper competitive marketplace.