ECONOMIC BENEFITS OF NETWORK AUTOMATION

Executive Summary

Communications Service Providers (CSPs) are making significant investments in network and business automation through digital reengineering as software changes every part of their network, business, and customer interfaces.

The benefits of network automation are overwhelming, as is the magnitude of the task of automating a complex, diverse set of technologies and services. Simple strategies of increasing levels of automation from simple task automation to complex cross-domain orchestration have been shown to be feasible today with significant business benefits in cost, agility, and operations speed.

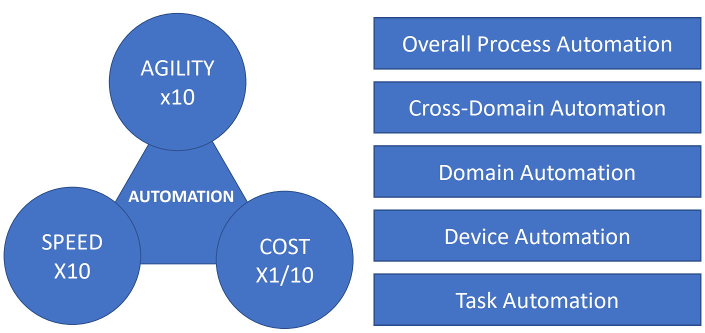

Figure 1. Goals of CSP Operations Automation and the Automation Hierarchy (Source: ACG Research, 2020)

This paper presents the benefits of network automation, from CSP interviews, real-world automation use cases, and economic models from ACG Research and Cisco.

Report Highlights

Automation seeks to increase business agility and speed and to reduce operations costs by x10. Today, we can get over halfway there.

Current automation technology has the potential to automate nearly 3/4 of the overall manual effort and cut service provisioning times by an order of magnitude.

A hierarchy of today's network automation of individual tasks (24%), devices (22%), domains (25%), and cross-domain processes (9%) can provide more than half of the desired reductions.

Automation with SDN enabled and virtualized network functions presents the opportunity to reengineer processes to introduce new services at over six times the current rate with commensurate business benefits.

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INTRODUCTION

The automation of network operations has been proceeding for over 50 years, from the early days of remote equipment alarms for centralized fault management in the 1970s, through the introduction of service-level monitoring and flow-through automated service provisioning in the 1990s, and the service-level management of the 2010s. This has enabled network operations costs as a fraction of revenue to be reduced continuously, even as the services have become increasingly complex and varied and the customers' expectations for fast service delivery of new, secure, reliable services has increased by several orders of magnitude.

In the 2020s, network engineering and IT organizations of communications service providers (CSPs) are now faced with both a new series of challenges as well as a new set of opportunities to meet the growing business needs:

- 5G technology will enable CSPs to support a host of new services with extremely varying characteristics of low latency, ultra-reliability, high bandwidth and very large numbers of endpoints. However, this will come at the cost of having much more complex networks and associated operations. Automation will be critical in maintaining visibility and control of the network to respond to users' requirements. Network slicing that will (virtually) assign network resources for specialized needs will further complicate the operations, making end-to-end, scalable automation a necessity.

- Complex enterprise services such as SD-WAN will continue to evolve. These service sets intrinsically require comprehensive, simpler network management by both the CSP and directly by the enterprise customers. Automation is the only answer that provides the simplicity and comprehensive management of these networks by multiple parties.

- Network equipment enabled with Software Defined Networking (SDN) capabilities will be more flexible but more complex to configure, assure and secure.

- New Network Function Virtualization (NFV) equipment offerings will be instantaneously deployable for automated provisioning, replacing the logistics-bound physical equipment in many cases and speeding the introduction and provisioning of new services. This can only be done through massive automation.

- Richer network status and usage information is available from the new generation of modern (physical and virtual) equipment. Automation using big-data analytics and artificial intelligence automation is the only way to gather, process and evaluate this onslaught of data,.

These challenges and opportunities extend to the entire operations infrastructure of a CSP, both the business and network sides. Here, however, we focus on the network aspects of the issue while putting it in the larger context of business and network operations automation as well as overall digital transformation.

CSPS' VIEW OF AUTOMATION: NECESSARY AND GROWING

In a survey of CSPs, ACG Research found that CSPs are committed to automation in their business and network operations, with 30% growth in annual spending for automation projects.[1] The key reasons for engaging in these projects is[2]:

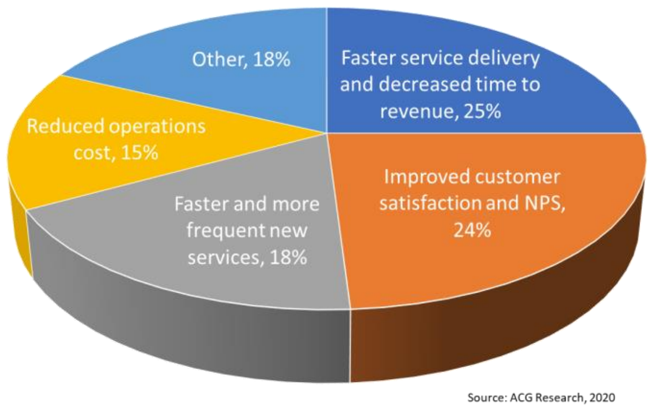

Figure 2. CSPs' Reasons for Initiating Automation Projects (Source: ACG Research, 2020)

ACG Research's experience is that business cases for these projects generally consider all these four key benefits. The first three provide the major motivation for prioritizing these automation projects. However, many CSPs insist that they still must pay for themselves from reduced operations cost.

Automation Is the Goal of All of the Stakeholders

But what does it mean for a CSP's operations to be automated?

From a consumer's view: It means having a rich digital experience when interacting with the CSP, being able to get immediately any information using a self-care service model and having service requests immediately fulfilled.

From a CSP's business view: It means minimal involvement of people in the operations except in exceptional circumstances during provisioning, repair or inquiries, along with full visibility of the process.[3]

In the CSP's network operations: It means simplification in service provisioning, service changes and terminations, diagnosis and repair services. It means minimal elapsed time for these processes. It also

[1] CSPs' reasons for automating operations, from 2018-2021, based on 208 CSPs surveyed, worldwide. See *Automation in the Adaptive Network: A survey of trends, opportunities, and challenges facing network providers.* ACG Research, 2019.

[2] The Other category consists of faster troubleshoot and service restoration (8%), more agile business operations (5%), improve visibility and proactive service intelligence (3%) and capital expense reduction (2%).

[3] This is often called a platform-based business model.

includes engineering work prior to service provisioning: capacity estimates, engineering plans, equipment ordering, and equipment installation and configuration. Today, the latter is less amenable to full automation. It will require a re-engineering of the equipment resource provisioning process in the future.

Three Major Benefits of Network Automation

These provides three major benefits, each with an aspirational goal of an order-of-magnitude reduction over the next several years:

- Operations Cost: The total cost of the process, dominated by the labor cost. The goal is to reduce these by 10% of the costs today.
- Operations Speed: The total time from the beginning of a process until its resolution. The goal is to reduce this time by 90%.
- Business Agility: The ability of a CSP to quickly introduce many new services or modify existing services. The goal is to reduce the time required to introduce a new service by 90%, not to decrease costs as much as allowing 10 times the number of services to be quickly introduced and the successful ones quickly scaled.

AUTOMATION HIERARCHY

Automation is a general term applied to many different situations. Here, we describe the hierarchy of automation approaches and techniques from the bottom-up, Figure 3. Task automation becomes the atoms of the process (the various tasks that otherwise would need to be done manually). An example is the configuration of the network equipment devices to the next level (bringing together all of the tasks necessary to automate a process for a particular device), domains above that (a collection of devices that are managed together) with cross-domain automation (often called orchestration[4]) applied for processes that cross domains. Finally, at the top is the overall process automation that involves not only the network processes, but also the OSS and BSS systems that support the network and business, respectively.

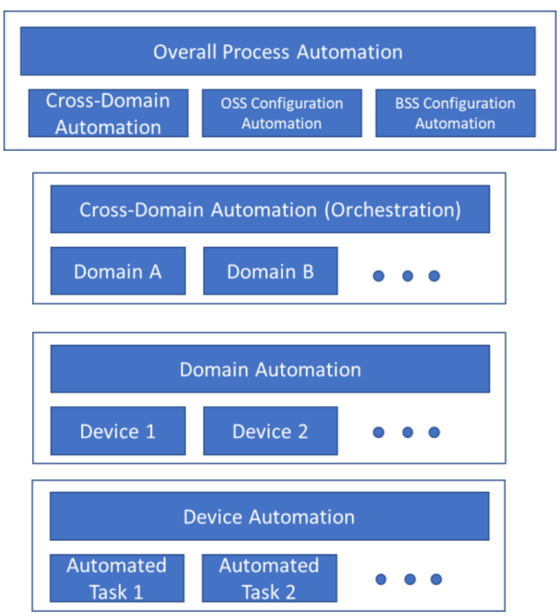

Figure 4. Hierarchy of Automation Types (Source: ACG Research, 2020)

The general strategy is to apply a healthy dose of automation at the lower levels, building it up to the domain level. Cross-domain automation is then implemented in critical domains such as SD-WAN, 5G xHaul, and core routing.

[4] The term orchestration is used freely in the industry, often just replacing the term automation. ACG Research reserves the term for when an automated process requires a process to cross domain boundaries.

Task Automation

The automation of individual tasks that otherwise would be performed by people using command line interfaces represents a major opportunity for automation today. Standardized scripts (sometimes also called playbooks) or processes using Robotic Process Automation (RPA) software packages are usually employed[5]. These scripts are specifically designed for many different kinds of processes for the myriad of individual device types (whether virtual or physical) and often further customized by manufacturer and version. Task automation processes are usually relatively simple with few decision points and very limited error condition handling.

Device Automation

A set of scripts can be pulled together to automate a multiple-step process, thereby automating a process for an entire device. The automation software here can, again, be RPA or more sophisticated process flow software with branches, loops, and error conditions.

Domain Automation

A set of devices that are considered a part of a larger whole are all withing one domain. The definition of a domain is dependent upon the policies of the CSP. They can be technological (for example, core routing, mobile core or SD-WAN), geographic (regional work groups) or by manufacturer. The domains follow the organizational boundaries of the CSP's network organization structure. Increasingly, a domain controller is deployed to automate all the work in a domain[6].

Cross-Domain Automation (Orchestration)

Work across multiple domains has usually been done manually, when necessary, via interrelated work orders and then tracked by project management software. New orchestration techniques are allowing these to be standardized and automated much more than in the past.

Overall Process Automation

With cross-domain automation in place, overall process automation can be applied to complete the picture. This involves the configuration of not only the network, but also the Operations Support Systems (OSS) and Business Support Systems (BSS).

[5] Ansible is one open-source example of RPA technology being widely deployed today for task automation, replacing manually entered commands or technician-created ad hoc scripts.

[6] The domain controllers can be considered the next generation of Element Management Systems (EMSs) and Network Management Systems (NMS). These have traditionally been provided by the manufacturers of the equipment with some abilities to manage other manufacturers' equipment also. The modern domain controllers have more multivendor capabilities, greater automation, and often incorporate both service provisioning and service assurance functions much more powerful than the EMS and NMS systems of the past. ACG Research has initiated a research program titled *Domain Control and Orchestration (DCO)* to track the evolution of this increasingly important area. See https://www.acgcc.com/domain-control-and-orchestration-for-the-future-automated-network/.

NETWORK MANAGEMENT PROCESSES TO BE AUTOMATED

What are the major network management processes that need to be automated? A summary is shown in Figure 5. These processes are standardized in each CSP but vary considerably among them. Each of these demands their own automation but can share a common set of tools for automation.

	Provisioning	Maintenance	Governance
Resources	Installing new network resources and configuring them	Diagnosing alarms and violations of normal behavior	Ensuring configuration compliance
Services	Allocating and configuring resources for the service	Diagnosing and fixing service-level SLA violations	Ensuring security compliance

Figure 6. Network Management Processes to be Automated (Source: ACG Research, 2020)

Resource Provisioning

The resource provisioning process includes the engineering work to determine the network capacity increases that will be required to meet future demand and then ordering, installing, and configuring the equipment to make it ready for use as a part of the network. The first step of the process is normally done by the CSP, but the physical installation steps of this process are often done by a network equipment manufacturer or systems integrator. The process lead times are long, and the installation and configuration operations are complex and expensive. Automation of this process is being accomplished via the introduction of virtualized network functions (VNFs) with software running on general-purpose computing and storage hardware (usually located in data centers[7]) instead of special-purpose physical equipment. Today, much of the work in selecting and configuring the computing and storage hardware is done manually. However, technologies such as OpenStack are beginning to automate this process. The further job of configuring the VNFs, loading them with the right information for proper information, has been done manually but, increasingly, using RPA software for automating the multiple tasks.

Service Provisioning

Once the equipment is in place, it is either used immediately as a part of the network (if it is a shared resource) or made available for engineering to allocate it to use[8]. The service provisioning process starts with the creation of a validated customer service order[9], for instance, a Layer 2 VPN and proceeds

[7] Increasingly, distributed in offices closer to the edge of the network.

[8] Examples are wavelengths in an optical transport system, ports and wire pairs on a DSL system or bandwidth in a packet transport system.

[9] Prior to this, there are major business processes to support the customer in selecting the service, checking the prerequisites, engineering the services (if needed), and validating and pricing the service. These are outside the current discussion.

through engineering and allocation of resources (if needed), changes to assignable inventories, and configuration and test of the network equipment for customer use.

Resource Maintenance

The network resources are monitored for proper function using service assurance systems and diagnosed and repaired if necessary. Some also require scheduled maintenance. Automation is used to help collect the data, run the diagnostics, determine the issues, and take corrective action. Artificial intelligence-powered automation is often used for diagnosis, as well as for optimizing proactive maintenance.

Service Maintenance

Service level agreement violations for customer services or internal Key Product Index violations trigger the service maintenance process, requiring network diagnosis, configuration changes, and repair. Automation is particularly important in this area to react quickly, gathering large volumes of data and processing it through big data analytics and artificial intelligence software.

Resource Governance

Resource governance processes involve the auditing of the network elements and the network configuration for conformance to corporate standards for functionality and security. It primarily involves the auditing of network element parameters and network configuration, often on a scheduled basis. These processes are highly amenable to simple RPA automation techniques, with analytics applied to the results gathered. Massive IoT systems can also benefit greatly by resource governance automation because of the security concerns.

Service Governance

Service governance processes look at the key performance indicators at the service level, monitoring and flagging problems or perceived nascent problems. They require the processing of large volumes of data from the network, piecing together the service characteristics, reporting results to customers and the CSP's product managers, and flagging weak areas for further analysis and mitigation through manual, assisted or, ultimately, closed-loop automated processes.

NETWORK AUTOMATION BENEFITS

The benefits of network automation extend to all three of the areas: business agility, operations speed, and operation expense (OPEX) operations cost reduction. Current technologies, well-implemented, can achieve much of the order-of-magnitude aspirational goals of automation.

Business Agility

For CSPs, business agility is the ability to create, implement, and scale new services quickly. In the past, the push for operations speed and efficiency conflicted directly with the quest for business agility, because they required standardization of the processes, which meant any new services for which an IT project had to be created, dealing with the usual funding issues, implementation, and test times. However, the rise of very flexible automation platforms, NFV and SDN can reduce that significantly.

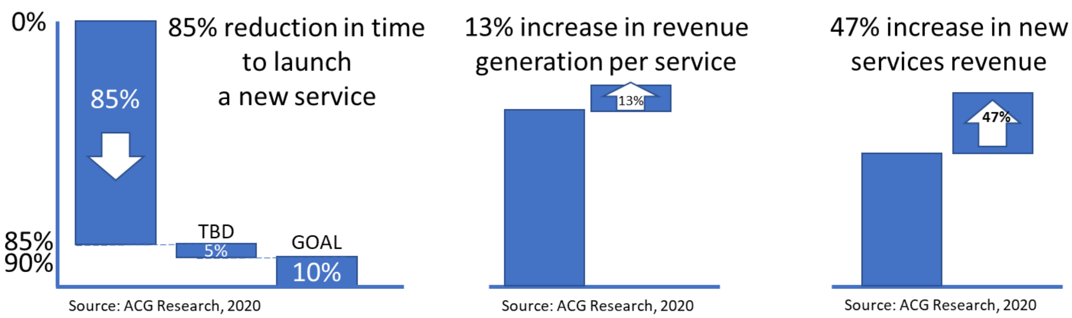

Figure 7. Agility Benefits of Network Automation (Source: ACG Research, 2020)

ACG Research's estimates are that a reduction of the time to launch a new service can be reduced by 85%, approaching the goal of 90% reduction. This reduction is estimated to provide a competitive advantage leading to a 13% differential in revenue generation per service launched based on a faster time-to-market and a 47% increase in revenue level based on a factor of six increase in the of number of services that can be launched. [10]

OPEX Operations Cost Reduction

ACG Research's estimated results of the benefits of network automation achievable with the technologies today are shown in Figure 6[11]. Network automation can reduce the overall OPEX by 55%, with task, device, and domain automation giving 50% and cross-domain orchestration contributing 5%. To get to the desired goal of a 90% reduction would take an additional 35% (shown as TBD on the diagram).

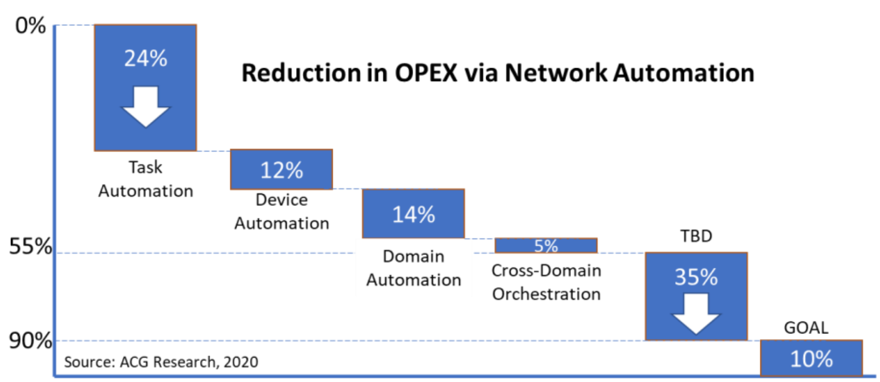

Figure 6. Cost Benefits of Network Automation (Source: ACG Research, 2020)

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[10] Haim, Robert, *The Business Value of Agility*, ACG Research. See https://www.acgcc.com/the-business-value-of-agility/

[11] This analysis is based on several studies, consolidating and validating the data from most notably: Cisco, *The Business Benefits of Automation and Orchestration*, Cisco, 2019; Doiron, Tim, *Trends, Opportunities and Challenges in Autonomous Networking (A Survey of Service Providers and Large Enterprises),* ACG Research, 2018; Fetterolf, Peter, *The Requirements and Economics of Core Routing Networks*, ACG Research, 2019; Fetterolf, Peter, *TCO Benefits of Converged 5G Ready IP Transport*, ACG Research, 2020; Haim, Robert, *The Business Value of Agility*, ACG Research, 2018.

Of the 35% shown as TBD, 18% can be achieved by BSS automation (primarily via automated self-serve care and automated support for customer service representatives). Additional reductions will take further technology (such as AI advanced real-time analytics and more predictive actions) and operational process changes (process re-engineering and closed-loop automation processes) to achieve the aspirational goal of a 90% reduction in overall OPEX.

Operations Speed

Automating a process has another major benefit beyond efficiency (for example, cost reduction), and that is the operations speed, defined as the total elapsed time that a process takes from initiation until completion. Moving from a manual to an automated execution of a process, of course, itself increases the operations speed. More importantly, it decreases the queuing time for a process. When a person must get involved in a process, there is often a queue of work awaiting attention. This is usually significant (if there are not queues, then often reduced resources are put on that work for the sake of efficiency). When a process is handed off from one automated step to another, those queues go from hours or minutes to seconds or less, increasing operations speed. However, to achieve significant speed advantages, all manual steps need to be replaced by automation[12]. Otherwise, there is still a queue somewhere in the process, and to complete the manual step, the person often needs to take additional time to review all of the information gathered during the automated and manual steps up to that point. This slows the process and eats into the benefits of the automation.

ACG Research created a model based on these concepts and mapped it onto the types of automation in a model CSP operation where the majority of the individual tasks are automated, strung together for devices, automated across the domain, then applied to overall process automation. The results are shown in Figure 7.[13]

Simple task and device automation provide reasonable speed advantages, because there are so many, although simpler, tasks that are moved from manual to automated. As the complexity of the process increases as one moves into domain and cross-domain processes, the speed benefits increase. Domain-level processes present the largest opportunity to boost the operations speed, followed by the much more complex cross-domain orchestration.

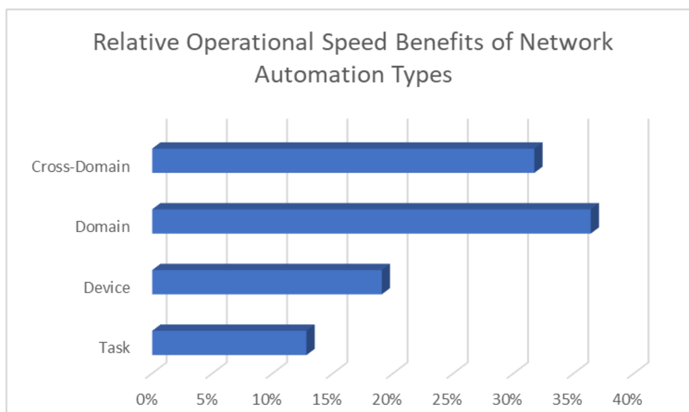

Figure 7. Relative Operational Speed Benefits of Network Automation Types (Source: ACG Research, 2020)

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[12] This is known as the reverse 80/20 rule that states that 80% of a process needs to be automated to get the first 20% of the speed increase.

[13] There are other business processes not included in the model that do not involve the network that would not be affected by network automation. Examples include billing enquiries, research on available services, and technical support for end-user devices.

Figure 8 shows the convolution of both efficiency and speed as a CSP proceeds from task automation to overall process automation. The sweet spot is in network domain automation, which has the potential of both large efficiency as well as speed gains. Effective network domain automation depends upon having good task and device automation in place.[14]

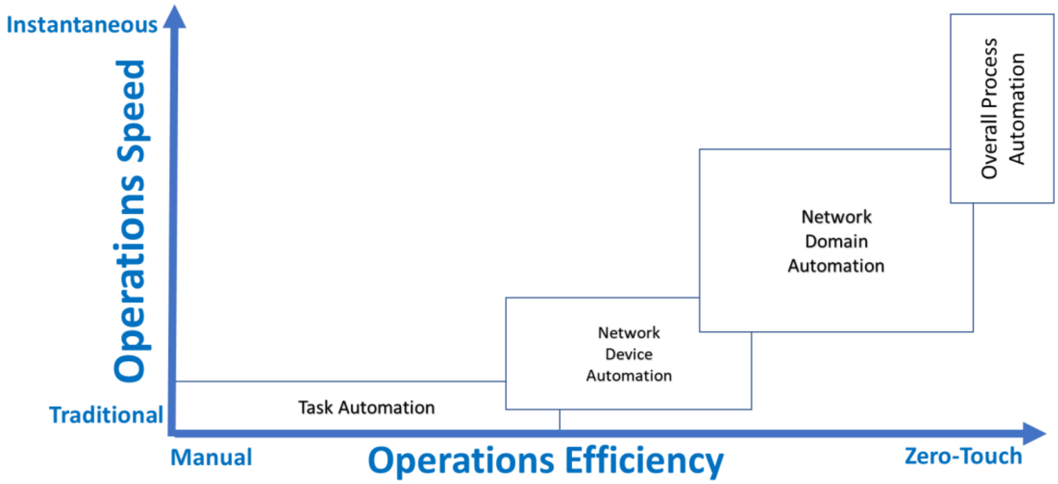

Figure 8. Operations Speed and Efficiency through Network Automation Hierarchy (Source: ACG Research, 2020)

Of course, the largest speed gains are realized when not only the network processes are automated (from task through network domain automation), but when the entire process, including OSS and BSS systems, are automated in an overall end-to-end process. Only this will bring CSPs into an era of instantaneous service and zero-touch provisioning.

REENGINEERING THE RESOURCE PROVISIONING PROCESS: INTEGRATED DYNAMIC NETWORK PROVISIONING

This section describes an example of the kind of process changes that will be necessary to realize fully the aspirational goals. The introduction of operations automation working with a software defined network represents an opportunity for a completely re-engineered process for resource provisioning.[15] Here, we describe this potential re-engineered process.

Today's Resource Provisioning Process

Today, as shown in Figure 9, physical network resources (PNF) are pre-provisioned and pre-allocated to their engineered use. They are planned in forecasts and driven by engineering orders. The PNFs undergo a long network resource provisioning process as they are ordered, delivered, warehoused, distributed, installed, tested, and put into service. If they have SDN capabilities, they can be used in several different ways, depending upon the changing needs of the business. If they are VNFs, they can be quickly and

[14] The task, device, and domain automation may all be instantiated in a single domain control system.

[15] Mortensen, Mark H, *Hybrid Networks: Integrated Provisioning for Virtual and Physical Networks*, ACG Research, 2020.

automatically installed on in-place general-purpose computing hardware using automated orchestration software. Whether physical or virtual, they are then configured using either command-line or automated means[16]. Then, they are added to the list of network resources to be monitored by service assurance systems for proper operation (network assurance provisioning). Again, that final step is often automated for VNFs but manual for PNFs.

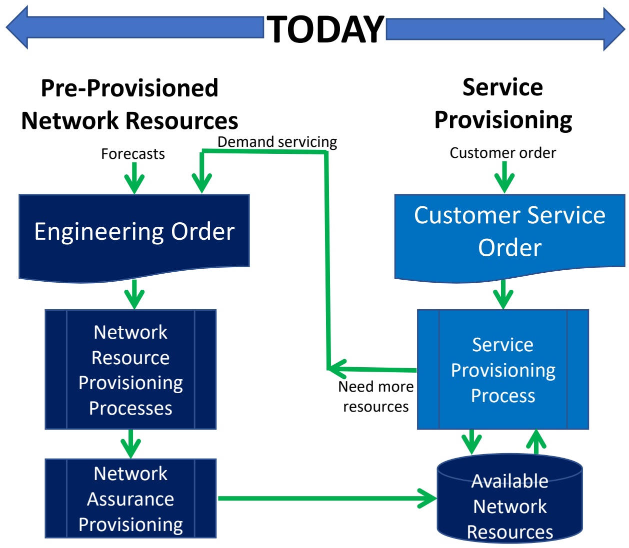

Figure 9. Current Resource and Service Provisioning Processes (Source: ACG Research, 2020)

The service provisioning process is initiated by a customer's order through a validated customer service order (as an example, an IP-VPN implemented on a converged SDN transport network). In the service provisioning process, available resources are checked. If they are available, those resources are used, configured to provide the required functions, and assigned to the customer's service, usually in a flow-through automated operation.[17] If the resources are not available, the entire process is stopped, an engineering work order created to put in place the required network resources, and the service provisioning rescheduled.

Future Integrated Provisioning Process

In the future, forecasts will be used to drive the procurement process of SDN PNFs and VNFs but not the network provisioning process, in most cases[18]. That will come after a service order is processed (Figure 10).

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[16] Most VNFs today are configured using the same systems and processes as PNFs, often using the same EMSs and NMSs as the physical elements. We call these virtual boxes, which do not provide the same benefits as when full automation is applied.

[17] Many enterprise services, such as IP-VPNs, SD-WANs or UCS, require complex engineering designs. They require engineering orders and, often, additional resources to be installed and configured.

[18] There still will be cases where forecasts, based on expected orders (such as a new major business facility put in place that will need service), will drive network additions.

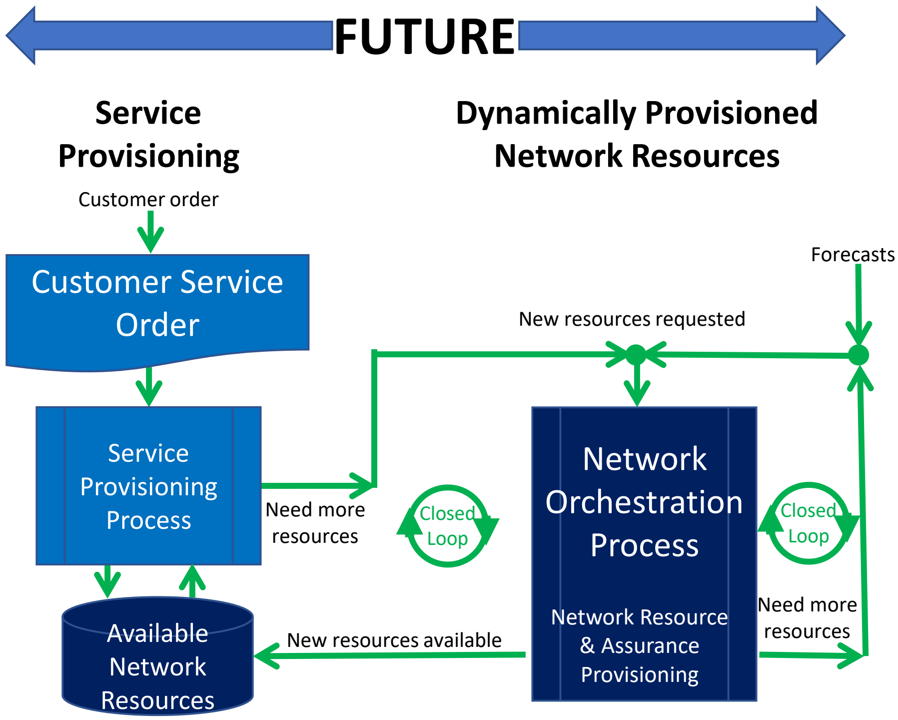

Figure 10. Future Integrated Provisioning Process (Source: ACG Research, 2020)

The result of this reengineered process is that network resources are quickly put in place only when they are needed. This decreases the total investment required (resources are not sitting idle ahead of forecasted usage) and increases business agility as it quickly puts in place and offers (and decommissions) new network and service capabilities.

ACG Research will be conducting total cost of ownership studies as CSPs' experiences deepen in reengineering the resource provisioning process in selected domains.

SUMMARY

Network automation is not new, but the technology has improved to allow unprecedented operations efficiency and speed while still supporting business agility. With a program of interlocking automation projects, from simple task automation through sophisticated cross-domain orchestration, CSPs can meet the increasing customers' expectations while moving toward the goal of 10 times the agility at 10 times the speed and one-tenth the cost of current operations. To realize the aspirational goal, further automation of the physical and virtual SDN network elements, along with reengineered processes will be needed.

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About the Author

Dr. Mark H Mortensen *is an acknowledged industry expert in communications software for the TMT sector, with over 40 years of experience in OSS and BSS specifications, software architecture, product marketing, and sales enablement. His work has spanned the gamut of technical work at Bell Labs, strategic product evolution at Telcordia, CMO positions at several software vendors, and as a research director at Analysys Mason. Most recently, Mark has focused on the technology and processes of digital transformation for Communications Service Providers and the growing automation and orchestration of network and business processes. He joined ACG Research in 2018 where he is responsible for Communications Software research.*

About Cisco Network Automation

Cisco's intent-based, closed-loop automation portfolio offers comprehensive solutions for full-lifecycle network management to improve agility, scalability, operational excellence, and customer experience. For more information, see: Cisco Crosswork Network Automation *and* Cisco NSO*.*

ACG Research delivers telecom market share/forecast reports, consulting services, business case analysis, product and service message testing. ACG provides you with accurate market share data, strategic and tactical advice, services and products, and timely answers to industry questions so that you can better understand market dynamics and grow your telecom operations more efficiently and profitably.