Network Automation

Start Your Automation Journey in the Core Network

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Introduction

Communication Service Providers (CSPs) needed a radically different way to build networks and deliver services to compete with agile, web-scale rivals and to cope with ever-increasing traffic demand and sluggish revenue growth.

Network Functions Virtualization (NFV) was born out of economic necessity. Communication Service Providers (CSPs) needed a radically different way to build networks and deliver services to compete with agile, web-scale rivals and to cope with ever-increasing traffic demand and sluggish revenue growth. By replacing proprietary physical network appliances with software-based virtual network functions (VNFs) or cloud native network functions (CNFs) that run on generic hardware "in the cloud," CSPs have sought more flexible networks that not only drive growth through rapid service innovation, but also deliver significant cost savings from commodity hardware and operational efficiency.

However, so far, current NFV implementations have yet to deliver the necessary scale of cost savings and new revenues. Simply deploying VNFs is not enough.

CSPs must adopt automation and orchestration to fully realize the promise of NFV.

Operationalizing NFV with the right amount of orchestration and automation is one of the most challenging aspects of network virtualization.

There are many hurdles hindering CSP progress towards introducing automation into their legacy operations environments, such as:

- Lack of industry consensus on orchestration requirements
- Slow adoption of new and emerging specifications among traditional suppliers
- Difficulty navigating numerous, fragmented industry initiatives and tools, such as the Open Network Automation Platform (ONAP), ETSI's NFV Industry Standards Group and Open Source MANO (OSM), and MEF's Lifecycle Service Orchestration
- Convincing operations teams to embrace automation and rely on orchestration
- Reorganizing departments to take advantage of agile and DevOps methodologies
- Retraining staff on the latest cloud technologies and hiring new skills
- Transforming traditionally risk-averse network operations cultures that create reluctance to embracing change or putting too much trust in new tools

Even for CSPs who see the need for transformation and take up the challenge, one of the biggest impediments can be not knowing where and how to move forward. A common and enticing trap is to attempt to automate the entire end-to-end network operations all at once and deliver on all the business goals. However, taking a boil-the-ocean approach is a sure way to stymie not just the network automation project, but the delivery of the services themselves by prolonging an already complex process and delaying cost savings.

Current NFV implementations have yet to deliver the necessary scale of cost savings and new revenues.

Grand, top-down visions require very large, complex projects to implement. Attempting to transform everything from service design through to VNF management at once is a significant challenge to any business. The responsibilities of different roles in the organization – and even the roles themselves – can radically change. This is business process re-engineering on a large scale. For those CSPs that do not have the time or teams of already cloud-skilled resources, or risk appetite to attempt such a large single step forward, a different, more pragmatic step-by-step approach is needed that focuses on empowering the operations teams and builds up from the reality of managing and operating a network. This is business process automation.

This white paper recaps the fundamental drivers for automation and presents a simple, step-by-step framework for building a network automation strategy that overcomes the challenges of getting started and helps CSPs to align their automation strategy with their business needs. Implementation projects can leverage many use cases, with edge projects typically highlighted in industry discussion. There are pros and cons to any choice and so we examine the case for CSPs to start their automation journey in the core network to illustrate the method. Using this, CSPs can build a foundation for network automation in the core that delivers cost savings and learnings today and can be readily expanded to other parts of the network as well as support 5G in future.

Network Transformation Drives Demand for Automation

Network functions are being re-engineered as software-based VNFs and CNFs to be deployed in cloud environments to reduce costs and deliver new revenue generating services to market faster.

Given the economic constraints on traditional CSPs, the industry's direction of change is clear: network functions are being re-engineered as software-based VNFs and CNFs to be deployed in cloud environments to reduce costs and deliver new revenue generating services to market faster. And there is growing recognition that cloud software design principles (microservice architectures, stateless scaling, automation by design etc.) are key to realizing the full cost savings and efficiency benefits of NFV. Eventually, CSPs will have to adopt virtualized or cloud native network functions and update their network operations to avoid being left behind the market and have the agility necessary for developing innovative services.

But a cloud network brings complexity and scale that necessitates a radically different operational approach. With orders of magnitude more instances of VNF components, the high-touch, traditional operations procedures and methods cannot cost-effectively scale to cope with virtualized functions. Enter automation.

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Automation and Orchestration Meet CSP Business Needs

Orchestration is the coordination of automated tasks in a workflow across multiple software and hardware network elements to achieve the desired outcome, such as deploying or upgrading a service.

First, what do we mean by orchestration and automation? Orchestration is the coordination of automated tasks in a workflow across multiple software and hardware network elements to achieve the desired outcome, such as deploying or upgrading a service. Traditional physical network appliances require tailored, manual procedures for setup, provisioning and management. Implementing network functions in the cloud as VNFs or CNFs enables CSPs to automate operational processes and place network elements into a common operations environment.

Rather than having unique, specialized operation procedures for each hardware appliance in the network, CSPs need to transition to a common operations environment that handles multiple workloads -- and the multi-tenancy nature of the cloud in general. This is the catalyst for delivering the necessary outcomes of significant OPEX savings and increased business agility.

What does such a common operations environment look like? It is composed of automated tasks orchestrated in a workflow to achieve the desired

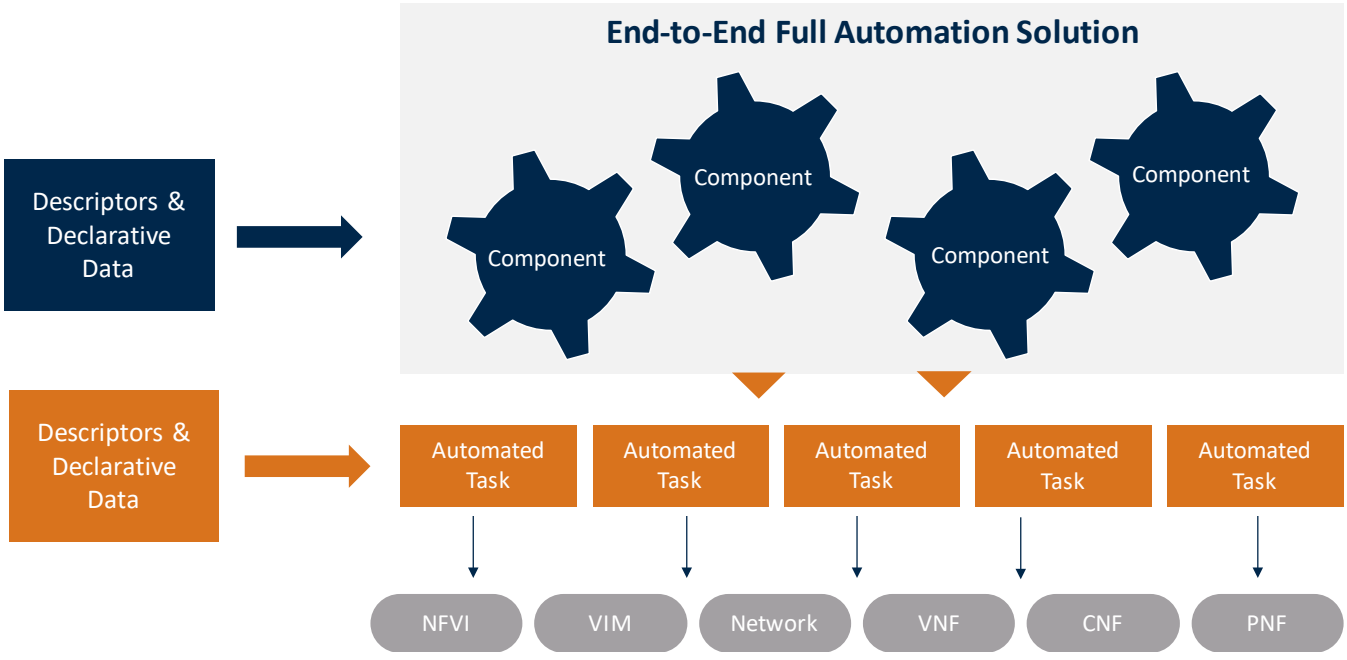


Figure 1

outcome, such as deploying a service. In all cases, automation should begin with a descriptor of the entity being managed, such as a service or VNF and the declarative data representing the desired state. Both the descriptor and data are defined in a domain specific language to support the execution environment. A system of functional components then collectively operates on this data to initiate tasks that act on the network, the cloud environment and potentially external physical components. This can be conceptually illustrated as displayed previously in Figure 1.

Once individual tasks and processes are automated, operations teams can then consider how best to orchestrate them, so they collectively provide full end-to-end operational automation.

So why go to all this effort? Automation not only benefits the bottom line but also makes operations more efficient and valuable while empowering operations staff with more strategic responsibilities, as follows:

CSP Business Requirement	Relevance of Automation
Do more with less	▸ Replace manual MOPs with automated processes that are repeatable at scale and executed in parallel across all lifecycle management tasks ▸ Reduce time to complete network-wide operations from months to hours or days. ▸ Lower running costs by dynamic scaling of workloads and managing cloud capacity in aggregate, through closed-loop, real-time analytics and policy decisions.
Improve customer experience / deliver on SLA obligations	▸ Reduce service faults by >60% with automated MOPs that create fewer chances for human errors. ▸ Minimize downtime and service degradation after any fault through rapid, automated recovery or redeployment of failed nodes. ▸ Dramatically reduce mean time to repair and catch faults before they affect services with AI/ML advanced analytics.
Increase time-to-market / seize new revenue opportunity	▸ Common operational environment vastly reduces the amount of service-specific integration needed within IT and operations ▸ Common deployment workflow with automated regression testing enables rapid delivery of features and upgrades into network ▸ Prepare for 5G Service-Based Architecture (SBA) that is inherently designed for, and will require, automated operations and orchestration ▸ Offer operations staff to take on more strategic tasks by minimizing tedious, repetitive processes and middle-of-the-night maintenance windows
Empower operations team	▸ Leverage automation and analytics to mitigate increasingly sophisticated security attacks and meet data protection and privacy regulations ▸ Provide staff opportunities to develop skills on new, cutting-edge cloud technologies and reorganize around a DevOps mindset

Which Functions and Components Can Be Automated?

With the right software and cloud environment automation can be applied to almost every aspect of deploying and managing a network.

The following lists the various components that make up a complete automation environment. Some components and corresponding tasks are often present and can be directly mapped to the existing manual operational environments today and documented as methods of procedure (MOPs). In other cases, we define logical functions that exist in some form but not necessarily as distinct components today.

VNF/CNF Lifecycle Management Automation

Workflows for automated VNF lifecycle management include deploying, scaling, healing and upgrades. Implementation can be staged by first defining a common data model for representing the VNF properties and then selecting LCM events with the greatest ROI such as deploy and upgrade.

VNF/CNF/PNF Provisioning and Configuration

Workflows for automation of “Day 1” and “Day 2” deployment and service provisioning for virtual, cloud native or physical network functions. Virtualized network functions do not differ a lot from their PNF counterparts. Although automating configuration is easier with newer cloud native VNFs with support for declarative data such as NETCONF/RESTCONF. This component is often a good starting point to automate existing configuration tasks with the goal of orchestrating the tasks in a larger workflow as more tasks are automated and the end-to-end solution takes shape.

Service Orchestration

Services such as VoLTE and core network functions like vIMS and vEPC are orchestrated in a single workflow. Service orchestration leverages existing automated tasks and LCM events across multiple VNFs/CNFs to provide a single orchestrated workflow defined in a data model.

SDN Control

This component controls the network connectivity between VNFs as well as between VNFs and PNFs. SDN control can follow the same phased-in approach by starting with automating manually SDN control tasks and then integrating the automated task into components such as cloud platform control and Services Orchestrators.

Cloud Platform Control

This capability enables cloud resources to be reserved, requested and controlled, such as VMs, containers, storage and networking. Although cloud platform task can be executed manually, they are often the first to automate and then subsequently integrate into VNF LCM events.

Data Collection & Analytics

Logs, events, alarms network and performance management are collected in central repositories and analyzed. Integrating automated data collection and analysis tasks with tasks that take corrective actions allows for the implementation of an orchestrated workflow for closed-loop automation.

Artificial Intelligence/Machine Learning

Leverages data collection and analytics to discover patterns, which enable faster detection of faults and proactive automated actions. AI/ML is still in the experimental stages but investment and improvements in the technology are driving toward the goal of autonomous networks.

Active Inventory

Provides inventory and topology management by keeping track of all resources, services and their relationships with each other.

Service Design and Creation

This is a design-time component whose primary role is to create the required artifacts used at runtime to instantiate and automatically operate a service. This environment is often the last to be added, but care must be taken to define the data and descriptors to be compatible with the design time environment when it is added to the solution.

Onboarding and Validation

Governs the workflow pipeline for receiving, testing and deploying new software releases. This often leverages Continuous Delivery/Continuous Integration (CI/CD) principles, methods and tools to automate what has historically been a very costly and time-consuming activity.

Policy Framework

Defines and controls policies which when implemented by various controllers impact the automated actions of each controller such as placement, healing and scaling. A phased-in approach to centrally managing these automated actions can be implemented along with the orchestrated workflows.

Artificial Intelligence/Machine Learning

As with analytics, AI/ML can be applied to enhance the value of the Policy Framework. Here specifically, discovered or learned patterns can lead to advanced or “aware” control policies that can help the network adapt to demands and increase resiliency (e.g., by proactively scaling capacity and deploying additional geo-redundancy ahead of a perceived increase in demand).

How to Build a Network Automation Strategy

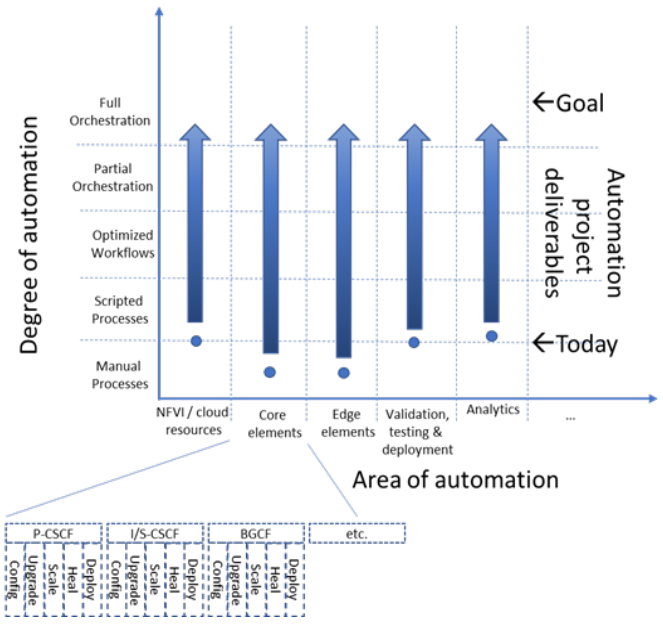
The number of functions that can be automated seems overwhelming (and the list above is just a subset). But the good news is CSPs should not attempt to implement all of these or to automate every element at once. Indeed, trying to automate too much, too soon is the biggest trap that CSPs can fall into along their cloud transformation journeys.

It is far better to start small, test implementations and apply learnings to the next project to steadily build a foundation for network automation. It's also important to remember that realizing the entire strategy is a long-term project -- measured in years not months. After all, all the legacy systems and processes cannot simply be replaced overnight.

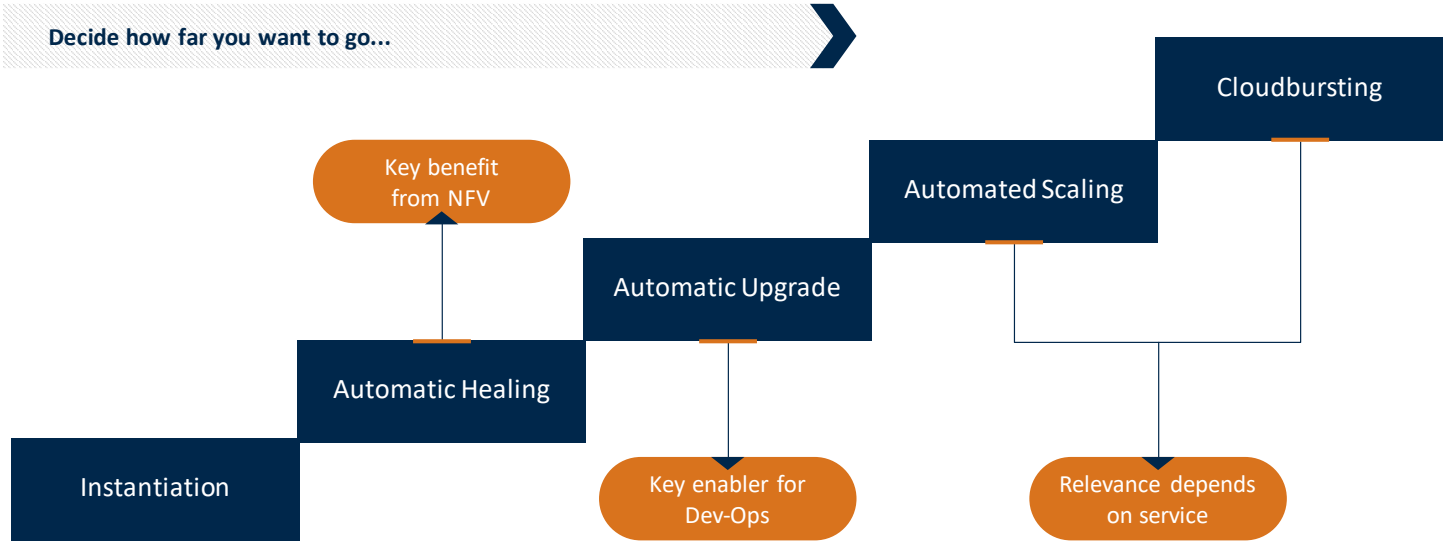
Fortunately, the high-level, big picture is emerging for automation and orchestration requirements through the work of industry initiatives such as ONAP, MEF's Lifecycle Service Orchestration and ETSI. These projects provide a reference architecture describing the components, functions and interfaces in a completely automated telco solution.

With an understanding of the big picture, operations departments can start to build an automation environment by breaking down the project into manageable parts and taking an iterative step-by-step approach that is aligned with the business goals. Each CSP will have a different mix of VNFs, CNFs and physical network functions, as well as unique service strategy goals and cost reduction targets; so there is not a one-size-fits-all path for automation.

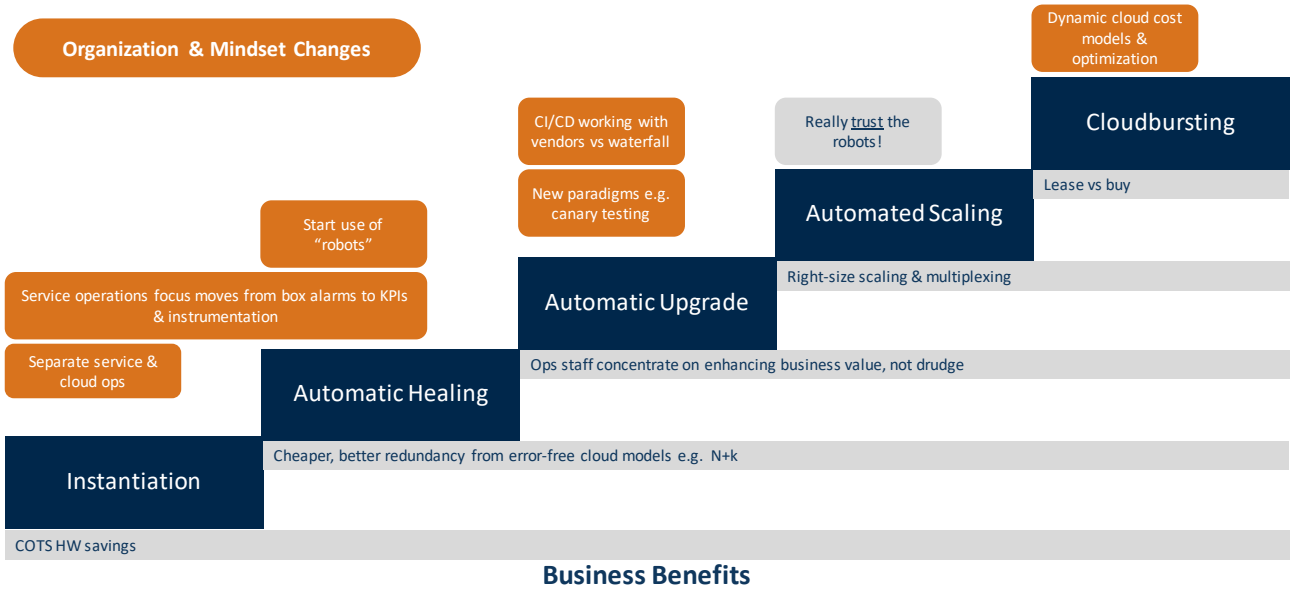
The graph below illustrates the process. The starting point for most CSPs is in varying degrees of manual and scripted processes across the network and very little automation components applied to few network elements. For a CSP, determining how far up the graph they want to go (that is, how much automation they want to apply to how much of the network) will depend on their individual business needs, ROI goals and building confidence and trust each step of the way. And the implementation path to get there will be unique for every CSP.



The work to be done and the areas in which it is to be achieved can be decomposed. The example above shows there are multiple layers to be considered when looking at network element automation – the domain (e.g., core vs. edge), the set of elements (e.g., P-CSCF, I-CSCF, S-CSCF, BGCF) and then the lifecycle operations themselves (e.g., deploy, heal, upgrade). Each can be a discrete, measurable project deliverable.



Hence, while an automation project may be ambitious, complex and daunting, the good news is it can be broken into small parts, ideally suited to an agile DevOps methodology, that deliver easy wins. The key is to ensure these are progressed in a cohesive way that can be reused elsewhere to propel towards the overall goal of a common operations environment across all areas – that's the automation strategy.



The strategy must explicitly consider five key elements to ensure the common goal is met and prevent fragmentation along the way.

Build vs. Buy

What is the right mix of in-house development combined with use of external product, tools and services? The end-state is the vision of the ultimate role of Operations and Engineering and the implementation path is decided more tactically by shorter-term priorities including budget, time and characteristics of internal organizations and skill-sets (since building will require a potentially significant retraining program). The choices here will help guide everything else.

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Tools and Technology

These decisions must align with the CSP business goals and vision. OpenStack is offered in numerous carrier-grade distributions; VMware has a long and rich set of robust, cloud workload features (and now themselves also offer OpenStack support through VIO); and container-based platforms managed via Kubernetes are rapidly proving their worth over traditional VM-based environments. But technology choices aren't just about the cloud platform. The technology needs to be accompanied by a solid, expandable set of common tooling for automation.

A core set of tools is crucial to promote reuse and allow focused training. For example, Ansible is a popular and solid automation framework, and there are many DevOps scripting and management tools (e.g., python and Git repositories) that can be easily brought into service to promote automation without introducing fragmentation. Ultimately, the choices here must be robust, come with a wide range of supporting libraries, be portable, automatable, and easy to control. Further, establishing a central ownership structure with a repository of standard tools and training is a great way to promote training, efficiency and reuse.

Orchestration

Even though it's not likely to be an early priority, CSPs do need to identify and evaluate some suitable orchestration choices (i.e., open source vs. proprietary, build vs buy) and ensure what is being built now can be adapted later. Use of common tools and a view of the standards (ETSI-SOL-003/004) will help with this.

VNF Management

This may come with your VNFs (i.e., S-VNFM) or there are generic options (i.e., G-VNFM). It's important to ensure that it can be integrated into your toolset now and is compatible with your choice of orchestrator down the line. Again, ensuring standards compliance (ETSI-SOL-002/003) or open, easily automatable APIs will help. Key considerations are usually deploy and upgrade flows.

Delivery Pipeline and Automated Testing

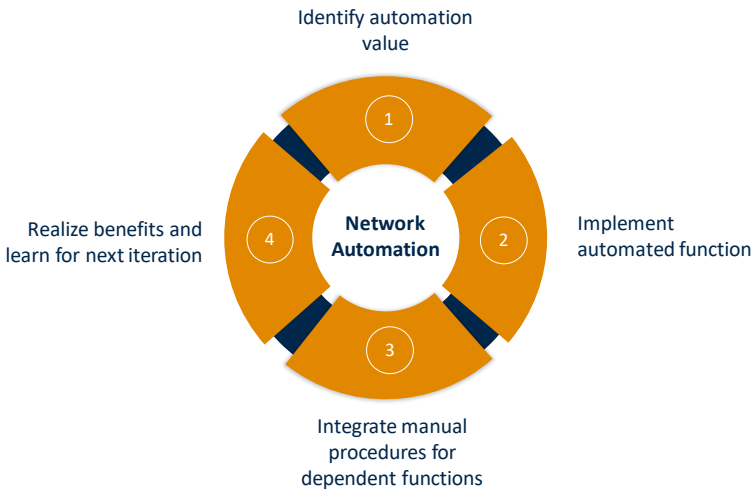
Ensure that you can quickly take updates and new deliveries, ingest, test, verify and deploy them. IT CI/CD frameworks like Jenkins can help with this, as do delivery and packaging standards like ETSI-SOL-001/004. Also, this is a good way (but not the only way) to take first steps in the broader realm of testing automation.

By creating a framework, CSPs can introduce automation incrementally in a way that is tailored to their strategic goals. Eventually, this foundation will enable the wholistic management of services across design-time, validation and runtime environments, rather than managing individual network elements in isolated silos.

Simple Steps to Network Automation and Rapid ROI

Our step-by-step process provides a template for CSPs to build a network automation strategy.

The aim is to identify individual components that when automated provide immediate return on investment (ROI) and can be used as justification to continue and reused as building blocks to create an end-to-end fully automated and orchestrated solution.



1 Identify the Functional Components and Tasks for Automation

What tasks do you want to automate? Depending on the function and component, the ROI is derived from faster mean time to repair, fewer human errors, or quicker onboarding, for example. Many times, existing manual procedures can be automated more or less as is, allowing for a quick win with the long-term benefits of being integrated into orchestrated workflows.

2 Implement Identified Tasks

Implement automated tasks and components as building blocks that may be initiated manually or integrated into end-to-end automated and orchestrated solution.

3 Integrate Manual Procedures for Dependent Tasks & Components

Some operations components and tasks have dependencies with others, which will require the solution to be augmented with manual procedures.

4 Realize the Benefits and Learn from the Process

Review the automation implementation, calculate the benefits and document the process so that learnings can be applied to the next iteration.

Putting Your Network Automation Plan into Action

There are many criteria that will determine which operations should be automated first, such as a CSP's current network setup and configurations, the services being delivered and the characteristics of the operations team.

Now that we have the process framework, how do we select the right functions and components to automate? First, decide which domain to automate – that is, the core network infrastructure or the edge or perhaps the service layer. Within that domain, select the network elements to be automated. There are many criteria that will determine which operations should be automated first, such as a CSP's current network setup and configurations, the services being delivered and the characteristics of the operations team.

The other hugely important factors in these early decisions are the CSPs' business priorities. Of course, the high-level objectives for network automation are cost savings and efficiency gains. But more specifically, the goal of the inaugural project could be to reduce repair times or minimize human errors or increase the speed of VNF/CNF onboarding or upgrades.

Based on CSPs' unique network criteria and business priorities, they can then select one or two tasks to automate and then gradually eliminate manual procedures by continuing to automate tasks and integrating them into an orchestrated workflow. An iterative implementation allows CSPs to arrive at the best strategy for their requirements. For example, an operator may want to start by automating the tasks in VNF/CNF lifecycle management -- i.e., deploying, scaling, healing and upgrades – to immediately lower OPEX by automating previously manual tasks. The CSP could also automate cloud platform control, which reduces human errors by integrating with lifecycle management events. All other operational functions will remain manual.

Another good place to start is to look at existing manual tasks in each component area to be considered for immediate automation. This leverages a known robust process and hence often provides a quick ROI and proof point for success. After initial translation to automate the "manual MOP" subsequent phases can refine and optimize the steps, as needed.

Once the new lifecycle management and cloud platform control procedures are in place and the CSP can quantify the reduction in OPEX and errors, the operator may want to introduce automated network function provisioning to further cut OPEX and streamline operations by creating a single workflow. Following that implementation, the operator can continue with adding service automation and then service creation and design, for example.

Based on CSPs' unique network criteria and business priorities, they can then select one or two tasks to automate and then gradually eliminate manual procedures by continuing to automate tasks and integrating them into an orchestrated workflow.

With the introduction of each automated function, CSPs follow the same four-step framework of identifying the value, implementing the automation, integrating manual processes and realizing the benefits. With this step-by-step strategy, operators avoid boiling the ocean and mitigate risk through iterative implementation.

Example Use Case: Automating the Network Core

The industry is abuzz about opportunities at the edge of the network, and edge use cases like vCPE, SD-WAN and vRAN are often targeted for first forays into automation.

The industry is abuzz about opportunities at the edge of the network, and edge use cases like vCPE, SD-WAN and vRAN are often targeted for first forays into automation. But an automation strategy that prioritizes core network functions — whether it's session border controllers (SBCs), IP Multimedia Subsystem (IMS) or Evolved Packet Core elements — can provide a solid foundation for network-wide operational efficiency.

While the decision for which domain is the best starting place will be aligned with an operator's business priorities, as noted above, the core network is an ideal use case for introducing automation.

Core Network Advantages	Core Network Challenges
Built-in redundancy	Lack of consensus on orchestration requirements
Less configuration required	Confusing array of industry initiatives
Tightly controlled maintenance events	Risk-averse cultures
Core network operations staff organized together in teams	Retraining staff and hiring new skills
High SLA penalties avoided due to fewer human errors	Slow adoption of new specifications among traditional suppliers

The built-in redundancy in the core provides an advantageous environment within which to work. It is also a less volatile environment and maintenance events are tightly controlled. The homogeneous nature of the core ensures that the initial automation investment will not need to factor in as many variations as in other parts of the network.

Furthermore, the level of service differentiation in the core and the amount of network, service and subscriber configuration is lower than in other networks.

From a personnel perspective, core network operations staff are usually organized together in the same team, which naturally presents a confined area for developing new processes without affecting other teams or business areas.

Automation of management and operations minimizes human errors, which are often culprits of network downtime.

Given the criticality of the core network, the stakes are high for CSPs. An outage caused by the loss of a core network function is likely to affect critical services and a large number of subscribers, whereas faults in edge networks will impact fewer customers. Automation of management and operations minimizes human errors, which are often culprits of network downtime.

Using our template, a CSP would select for automation the network element and the operations functions for that network element, which will quickly deliver on their business objectives. For example, an operator may opt to automate its vSBCs and have a high priority for faster upgrades, which traditionally can take months to roll out in the core network. Automated upgrades within lifecycle management tasks save huge amounts of time and employee resources, which all goes toward lowering OPEX.

Another operator might decide to automate its vSBCs, but it may have issues with taking too long to repair faults. In this case, the operator would want prioritize automated healing in lifecycle management to reduce the mean time to repair. For example, the CSP can apply automated healing in phases by starting with the access SBC. Once the implementation has been validated (and the operator has completed the four-step process), automated healing can then be applied to the interconnect SBC, and then the S-CSCF, and then the I-CSCF, and then the application servers, and so on.

While there are common themes, the precise answer for where to start with network automation is different for every operator. It's a complex decision process, but with the right template and thorough understanding of the business priorities, CSPs can implement the right strategy for network automation that will deliver the cost savings and agility promised by NFV.

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Conclusion

Network operators have pursued NFV for the last seven years in an effort to drive out operating costs and acquire the agility needed to rapidly innovate and survive in a fiercely competitive market. But so far, the results have not lived up to the promise.

With NFV presenting a very large transformation, the focus has typically been on establishing and proving the technology can work. However, a key missing ingredient in this has been how to successfully operationalize these technologies through network automation and orchestration. Only through an automated operations environment can CSPs fully realize the cost savings and business flexibility that NFV can deliver.

But knowing where and how to start is difficult. CSPs shouldn't try to automate the entire network at once. Rather, they should think big and start small when it comes to network automation. With the right framework and clear business objectives, CSPs can build an effective network automation strategy that is implemented iteratively over time to deliver rapid ROI and, finally, realize the full benefits of NFV.

The Metaswitch Difference

As the leading cloud native communications software provider, Metaswitch has been helping CSPs realize the benefits of NFV since the concept first emerged. Based on our direct experience with putting CNFs and VNFs into production networks for operators of all sizes, we've developed the tools to help operators operationalize NFV with the right amount of automation and orchestration. Our cloud consulting services guide CSPs through the stages from strategic idea to planning to implementation and measurement to achieve their network transformation goals.