



## White Paper

# Driving Network Agility Through a Service Orchestration Approach

Prepared by

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on behalf of

The logo for tail-f, featuring the lowercase letters "tail-f" in a bold, dark blue, sans-serif font. The "f" is stylized with a horizontal bar that extends to the right and ends in a small vertical tick mark.

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## Executive Summary

There is widespread market consensus that it takes too long both to introduce new services into telecom networks and to deploy services to customers. Yet telcos operate in an on-demand age, in which customers are increasingly intolerant of the slow pace of network service delivery compared to the rapid availability of IT services. At the same time, telcos can see that their high cost of network operations contrasts with the automated and streamlined operational capabilities of their Internet rivals.

The reasons for telco shortcomings are well understood and operators agree that fulfillment is a top culprit. Inadequate provisioning processes where services are either configured manually or hard-coded in operations support systems (OSS), the proliferation and maintenance of expensive network adapters, inconsistent configuration data sets due to siloed and manual operations and a "fire and forget" approach to provisioning all contribute to the difficulties of implementing and delivering services in a timely and cost-efficient way.

Software-defined networking (SDN) and network functions virtualization (NFV) promise to address operator challenges around service agility and operational cost. But they will take time to deploy because of the extensive organizational, OSS and network changes they entail. Many operators would like a means to achieve these benefits today, with minimal disruption to their operations.

There is growing telco interest in a network service orchestration layer that sits between existing and well-established business support systems (BSS)/OSS and network devices. Such a service orchestration layer replaces and automates the siloed sprawl of provisioning and activation approaches that characterize networks today. It uses the property of transactionality to address data inconsistency issues, and standardized service and device models to overcome the problems of hard coding and proprietary adapters. This layer supports the continuous reconfiguration of the network in near real time, enabling operators to rapidly respond to the changing service needs of their customers.

This white paper explores the drivers and requirements for a well-behaved network service orchestration layer and the part it can play in increasing the agility and "programmability" of today's networks, ahead of the adoption of SDN and NFV. Such a layer provides a measure of network abstraction that should support the migration to these new technologies over time.

**Section II** looks at the drivers for more agile and cost-effective provisioning and activation of the network, and discusses how this can be introduced with minimum disruption for existing operational stacks and network equipment.

**Section III** describes the concept of network services orchestration, which supports network "programmability" through the transactional, near-real-time and continuous reconfiguration of network equipment. It explores the characteristics of a well-behaved service orchestration layer that can coexist with today's B/OSS stacks.

# The Need for Streamlined Network Operations

## Service Agility Is a Top Priority

The key reason operators cite for their interest in NFV and SDN is service agility, according to the latest *Heavy Reading* research. In the digital age, over-the-top (OTT) competitors of all kinds, from cloud providers to app developers, measure the time it takes to add new features and deploy new services in hours and days. Operators, on the other hand, take weeks and months to enhance or roll out network services.

End users across the world are adjusting to life at digital speed. They expect, as a matter of course, the continual release of new capabilities, instant response to their demands and flexible business models that support their preferred mode of service consumption. These IT consumerization trends are shaking up enterprise customer expectations of telco business services and especially of connectivity solutions, such as IP/virtual private networks (VPNs), on which their companies critically depend.

NFV and SDN may provide an eventual answer to operators' service agility challenges, but it will take time for these technologies to become ubiquitous in telco networks. Operators' existing networks and associated management systems will remain in play for a long time due to the large investment they represent. The business case for extensive network technology change is limited, while telco equipment lifecycles have yet to run their course.

Operators need a way to inject two dimensions of agility into service delivery today across their current networks:

- **Design agility**, which enables them to introduce new services quickly into their portfolios. This entails having a flexible way of adding services/service features instead of hard-coded, rigid service structures. The latter require small armies of programmers to toil for months to add new features to OSS systems, extend service topologies or add support for new vendors, so operators typically opt to leave them alone.
- **Operational agility**, which allows operators to deliver services to customers more quickly. This means finding ways to minimize the barriers to rapid service delivery, such as manual processes and order fallout, and to modify service instances on demand, for example, flexing bandwidth and/or quality of service (QoS) for a specific time-period.

## Taming the Cost of Operations

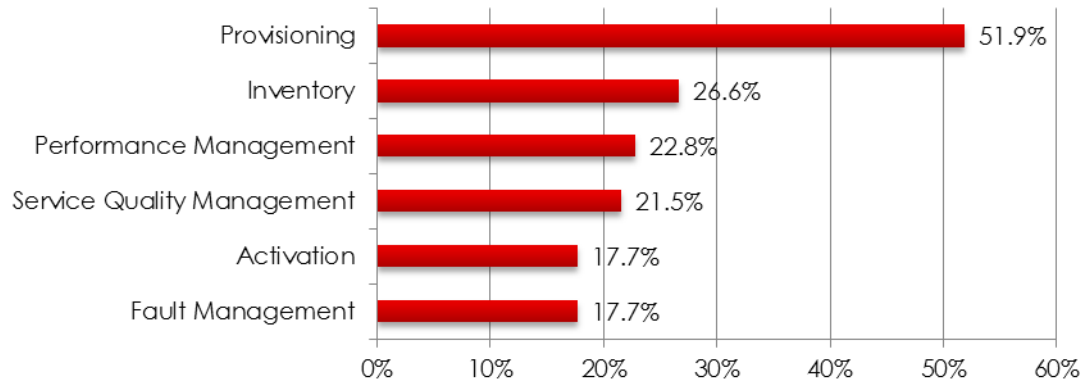
The cost of operating networks is soaring, pushing this inconvenient truth higher up the telco agenda. As the price of network equipment falls, it is exposing the high price operators are paying to manage and make changes to it. Telco opex contrasts starkly with that of Internet companies, which use high levels of automation to manage infrastructure complexity and keep operational headcount low.

Again, the automation associated with SDN and NFV is touted as the future solution to the telco opex crunch. But operators need to drive management overhead out of their networks today. Telcos can potentially realize large cost reductions if they clean up the greatest sources of expense in their current network. But this hygiene exercise will only deliver if it can be carried out with minimal disturbance to an operator's existing investments.

## Existing Service Fulfillment Challenges

Operators have taken a long, hard look at their operational costs and lack of agility, and they agree that service fulfillment is a top culprit. **Figure 1** shows that provisioning is by far the leading target for telco OSS investment.

**Figure 1: Top Priorities for OSS Investment**



Source: Heavy Reading survey of 85 communications service providers worldwide

There are several reasons why the provisioning and activation of network services are slow and expensive to carry out, listed below.

### ***Inadequate approaches to service delivery***

Some operators use spreadsheets and scripting to provision services. This enables network engineers to implement services flexibly, but as a manual approach, which relies on specialists in the proprietary command line interfaces (CLIs) of individual vendor equipment typing configuration changes into boxes or launching scripts, it doesn't scale. Other operators implement services that have been hard coded in their OSS. This approach supports automation, but is inflexible. When service definitions need to be modified or new network elements added, operators need to call on their OSS vendor each time to make the change(s).

Even when provisioning and activation tools are used, providing a measure of automated activation, each vendor often supplies its own management tools "for free" as part of an equipment deal. Coordinating the provisioning of an end-to-end, hard-coded service across the resulting OSS silos is time consuming and expensive.

### ***Adapter proliferation***

Multi-vendor OSSs, whether commercial off-the-shelf (COTS) or homegrown, overcome the silo problem and provide a higher level abstraction of the network. But in order to drive programmatically the activation of individual devices, they use an adapter layer that translates between the high level OSS and specific vendor CLIs. The creation of a new adapter typically requires a new software project. Adapters are proprietary, take time to develop for new equipment, need updating to reflect new features in existing equipment and their complexity means that OSS vendors need to charge high prices for their development and maintenance, to the detriment of operators.

### **Data inconsistency leading to order fallout**

Whether service fulfillment is carried out manually or with the support of tools, operators typically lack a near real-time view of the configured state of the network. Some multi-vendor OSS systems may provide an automated mechanism for passing configuration changes up to their centralized repository of network data: the inventory system. Or operators may have built such a process themselves. But such mechanisms are typically designed for the "fire and forget" era of network service delivery, where enterprise customers didn't demand rapid and frequent changes to their services. Therefore, they do not synchronize local device and inventory configuration data in near real-time.

Lack of strong governance over network configuration in a complex and fast-changing network environment is leading to inconsistencies between local and centralized network data. This situation results in order fallout and provisioning delays that are expensive to redress.

### **Provisioning mindset**

Operators' current provisioning processes still assume that telcos have the luxury of time. Enterprise customers used to accept long lead times for service provisioning because their planning cycles were long, too. Once services were in place, enterprises expected they would remain there, unchanged, for extended periods.

But globalization, the digital/cloud revolution and the growing availability of low-cost VPN services are changing the enterprise mindset. Enterprises now assume that virtual network services can be delivered as quickly and flexibly as virtual IT services: that is, when the enterprise wants them, where it needs them and with the ability to adapt them to faster business cycles. Service fulfillment is no longer a series of one-off provisioning and activation activities; it has to support a continuous process of service change. And VPN services involve changes to many more moving parts in the network than the simpler connectivity solutions of the past.

Operators' current provisioning approaches are not coping well with these new demands. To increase the speed of manual fulfillment, for example, operators would have to add new staff at unacceptable cost.

### **Fixing Fulfillment: Issues to Consider**

Operators realize they need to fix fulfillment, but *Heavy Reading* research confirms they don't want to rip and replace existing B/OSS stacks. Operators have large investments in BSS, including established customer-facing portals for order capture, product catalogs and order management systems. Over the past few years, automation of the order-to-cash process has been a key focus of operators' BSS transformation programs, and many have best-practice implementations here.

Operators have also invested in inventory systems, which support a raft of further systems, from network planning to workforce management. And they don't necessarily want to replace stable fulfillment processes and tools supporting their customers' existing services on day one.

Any new approach to provisioning and activation will need to work with the northbound stack of B/OSS already in place and side by side with existing fulfillment practices, so that operators can migrate current services to the new paradigm at their own pace.

# The Network Service Orchestration Paradigm

## Network Service Orchestration Replaces Legacy Provisioning

The term "**network service orchestration**" is emerging to replace the concept of provisioning in the digital/cloud age. Network service orchestration coordinates the configuration of complex network services end-to-end across a heterogeneous network. It both automates this end-to-end process and carries out all the equipment configurations needed to activate or change a service dynamically in near real time. Service orchestration is not just about the initial provisioning of a service: It continues to manage all in-life configuration changes to the service, so it is responsive to the dynamic nature of enterprise customer demand.

Network service orchestration in a provisioning context is not the same as business process management or workflow management. These concepts come from the IT world and presuppose both the presence of manual steps and a long duration.

A network service orchestration is a modeled, automated transaction that takes place over a relatively short period of time (near real time). Service orchestration:

- Knows about the current configured state of the services and devices – intelligence that is not available to a generic workflow engine
- Understands what to do if it encounters an exception that prevents the completion of the transaction
- Resolves exceptions automatically or by requesting human intervention, but humans are not routinely involved in the way they are in a workflow

Network service orchestration can be implemented as a new layer of technology that sits between an operator's existing order-to-cash and inventory systems and the network. Operators implementing network service orchestration systems eventually expect them to replace their existing provisioning methods/systems, but a well-behaved network service orchestration layer should be able to coexist alongside these systems for as long as the operator chooses.

A network service orchestration system also needs to look to an SDN- and NFV-based future. It should support equipment configuration standards and service modeling languages being adopted by these technologies to provide a smooth operational transition for operators as they bring SDN and NFV into their networks.

## Requirements for a Network Service Orchestration Layer

The sections below summarize the key requirements for a network service orchestration system that address service fulfillment challenges. These characteristics enable operators to gain confidence with automated, programmatic configuration changes and to benefit from the speed and cost advantages they bring.

### ***Model-driven view of services and their required configurations***

Service models provide a means of specifying service configurations at a level that is abstracted away from their implementation in individual vendor devices (resources). This makes it easier and faster to design new services, as well as to change and extend existing services without impact at network level, supporting **design agility**.

When a service is provisioned into the network, the network service orchestration layer decomposes its service model into constituent resources. It orchestrates the translation of the service's high-level configuration requirements into each device's specific set of configuration commands, end to end across vendors and devices.

The network service orchestration layer not only initially provisions service instances but maintains and modifies their configuration throughout their lifecycle. It can re-program devices, supporting service instances in minutes rather than months and continuously, rather than in "fire and forget" mode. This supports **operational agility**.

### **Model-driven view of devices**

In order to translate between the service model's and device-specific configuration views, it is helpful if the configuration needs of services and devices are modeled using the same language – preferably a standards-based language like YANG to which major operators and device vendors have pledged their support.

YANG eliminates the need for expensive and proprietary adapters. Its native mapping between services and devices guarantees rigor in the translation process. YANG device models use the NETCONF configuration protocol to support the programmatic configuration of devices, replacing the manual or fragile script manipulation of CLIs. The network service orchestration layer can use YANG and NETCONF to automate service provisioning and activation transactions.

### **Transactionality**

The network service orchestration layer should orchestrate the simultaneous and programmatic configuration of all the devices supporting a network service as a *single atomic transaction*. If an attempt to configure even a single device fails, the entire service is compromised. If configurations that have already taken place are not completely rolled back in the event of such a failure, the network is left in an inconsistent state.

Transactionality ensures that either all the configurations associated with a service are committed or they are entirely rolled back, so it preserves data consistency within the network, reducing the likelihood of exceptions and order fallout.

### **Near-real-time view of the configured state of the network**

Transactionality critically depends on this, enabling the network service orchestration layer to restore the pre-transaction state if configuration fails. Since the service orchestration layer contains all the service models and their continuously maintained mapping to device models, it is the *de facto* real-time repository of network configuration data.

As a result, the network service orchestration layer can resolve data quality and subsequent order fallout issues that affect operators with inventory and provisioning systems not connected to network devices in real time.

For example, if a configuration change transaction fails due to a previous configuration that was made locally to a device, unaudited by the network service orchestration layer, the system should be able to flag this to the network operations center for resolution. Alternatively, the service orchestration layer could be allowed to override the rogue configuration automatically, synchronizing the device with its expected configuration.

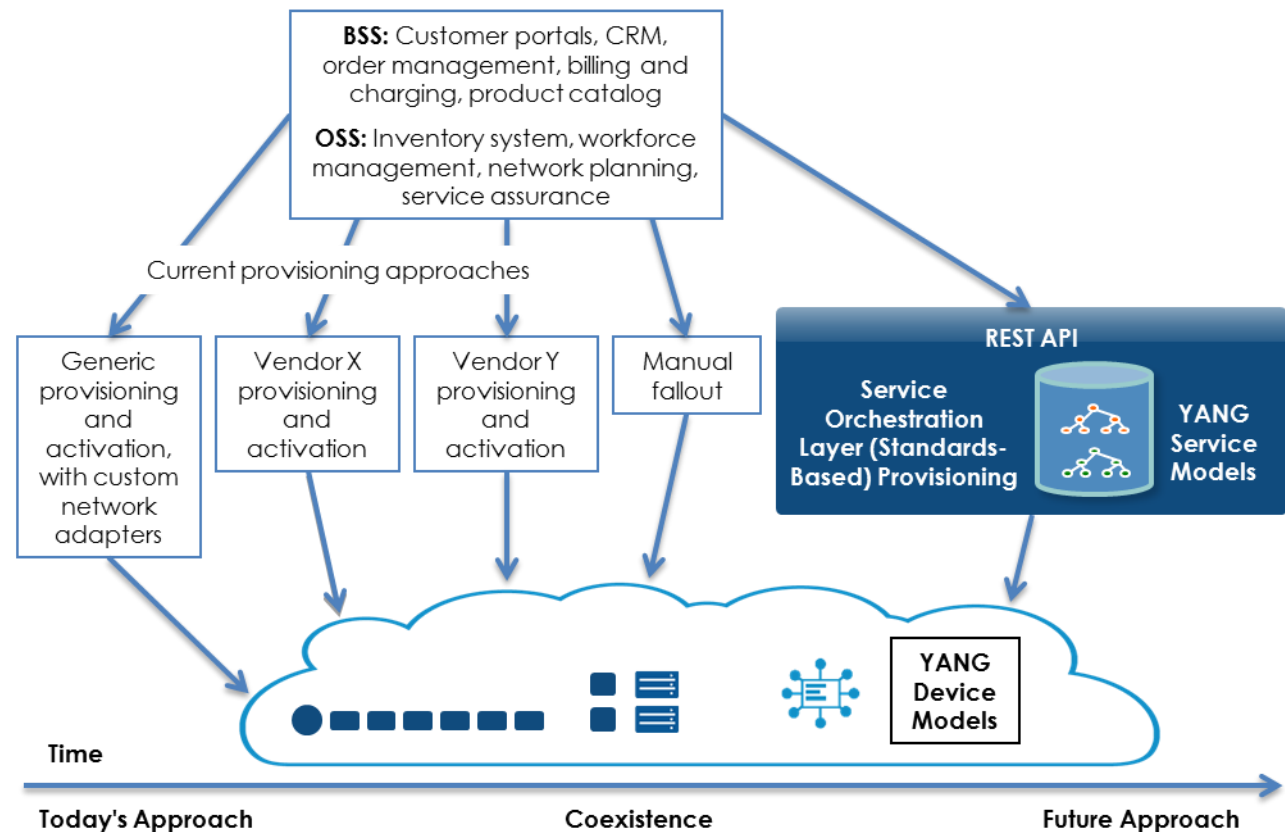
## Coexisting With Other Operational Systems

There is one more requirement for the network service orchestration layer: It should be able to **communicate with other systems** in the B/OSS stack. For example:

- The NOC may continue to use the **inventory system** as the master source of network configuration data and the service orchestration layer will need to pass across to it details of real-time configuration changes.
- The services defined in the service orchestration layer may themselves be components of larger product bundles, the fulfillment of which is under the control of the **order management system**. So this layer will need to get provisioning instructions from the order management layer of the stack.
- The service orchestration layer will also need to talk to the **assurance systems** that monitor the performance and health of services and devices, with the service orchestration layer playing an instrumental role in reconfiguring devices for performance reasons and/or to remediate faults.

The service orchestration layer will therefore need rich, open application programming interfaces (APIs) northbound to support integration with the operational systems with which it needs to coexist.

**Figure 2: Service-Layer Orchestration Coexistence**



Source: Heavy Reading



## Flexible Approach to Cleaning Up Operations

The service orchestration layer can be introduced alongside existing provisioning processes and systems. Operators can continue to configure routers manually or through vendor-specific tools where existing services are concerned, while simultaneously programming the same routers through a service orchestration layer for new services. This minimizes disruption and allows network engineers time to adapt to the new approach.

Eventually, operators may want to migrate customers' established services to the new service orchestration paradigm to provide customers with a better experience/more features and to drive out operational cost. Of course, they will have to weigh these benefits against the effort required to recreate their service definitions/templates in the formal models used by the service orchestration layer. The advantage of coexistence is that operators can evaluate the business case for migrating services, customer by customer, or by class of service.

Service orchestration layers based on YANG and NETCONF can use NETCONF's ability to test candidate configurations offline to ensure they work before pushing them live. This is particularly useful in the case of service migration where operators want to ensure exactly the same service functionality before and after the move.

## Migrating to SDN & NFV

A network service orchestration layer is still needed in a network implemented with SDN and NFV. The ETSI NFV Management and Orchestration (MANO) stack makes provision for an orchestration layer that decomposes network services into individual virtual network functions (VNFs) that fulfill that service.

More critical as operators introduce NFV incrementally on a function by function basis into their networks, is a network service orchestration layer that can map services onto combinations of physical network functions (PNFs) and VNFs. Since the service models in a network service orchestration layer exist at a high level of abstraction, there is no reason why they can't be reused when the network is virtualized. The network service orchestration layer can then decompose the models into a mix of PNF and VNF resources. Similarly it can fulfill services that will be supported in the future by SDN-enabled devices.

The network service orchestration layer is therefore able to address current operational challenges and prepare operators for service delivery on top of future virtualized networks.

## Conclusion

When operators have invested heavily in existing network equipment and operational processes and tools, they may be disinclined to adopt disruptive SDN and NFV technologies at such an early stage of their development. Nevertheless, operators both want and need to become more agile at introducing new services onto their networks and delivering those services right to customers the first time. They are also keen to rein in service delivery costs, which are rising because current manual methods of managing increasingly complex networks don't scale.

Operators recognize that their lack of agility and high operational costs can in large part be traced to shortcomings in the provisioning and activation domain. They consistently flag configuration management as a top OSS priority to address. But they want any new solution here to coexist with their investments in other B/OSS so that they don't need to rip and replace complete operational stacks. At the same time, many operators are making strong demands for a standards-based approach to configuration.

A network service orchestration system that uses a model-based approach enables operators to programmatically drive changes into the network. Standards-based YANG models and NETCONF for southbound configuration of devices can reduce cost and complexity, but the orchestration layer needs to be able to handle non-standard interfaces to devices as well, enabling migration to standards over time.

A service orchestration layer applies new configurations to the network as an atomic transaction, rather than a workflow. Compared to workflows, transactions are carried out in near real time, automatically with little or no human intervention, and they guarantee consistency of network data since either all the configurations in a transaction are applied or the entire transaction is rolled back.

A well-behaved service orchestration layer can be introduced alongside existing methods of service provisioning, enabling operators to choose the pace at which they migrate over existing customers and services to the new approach. It should also have open APIs to plug northbound into established order management and other systems and the ability to provide a migration path for operators when they eventually want to adopt NFV and SDN technologies.

Operators implementing a network service orchestration layer gain a significantly more flexible level of control over their existing network, enabling them to realize many of the promised benefits of SDN and NFV today, with minimal disruption.

## About Tail-f Systems

[Tail-f Systems](#) is a leading provider of network service programmability solutions for traditional and software-defined networks (SDN). Headquartered in Stockholm, Sweden, Tail-f is a Red Herring Top 100 company, a Stratecast Global OSS/BSS 10 to Watch Company, and a Pipeline Network Innovations Award Finalist.