Final report

Operator benefits from the automation of IP networks

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RESEARCH

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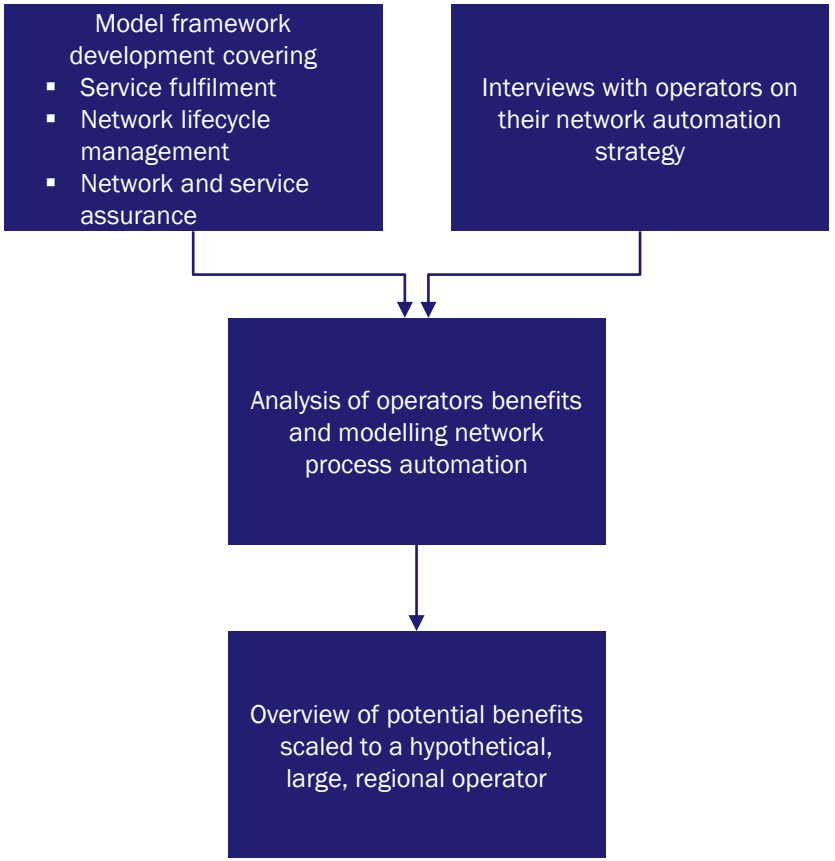
This project collected over 60 data points on operators' network automation strategy to develop a model of the benefits scaled to a large, regional operator

- The objective of this project was to develop a model of the benefits from network automation at the domain controller layer for an operator providing IP services.
- This model focuses on network automation implemented for the operator's service fulfilment, network lifecycle management, and network and service assurance processes in the Nokia Network Services Platform (NSP) or an equivalent domain controller/orchestrator.
- We conducted 5 interviews with operators on their network automation strategy and collected over 60 data points on the achieved or expected benefits from their network automation journeys.
  - Operators expected the largest benefits from automating the service fulfilment processes, and many had prioritised this as part of their automation journey.
  - Detailed findings from these interviews are included in the methodology.
- This data has been analysed and normalised across the operators to account for differences between the operators' network strategy and architecture. The findings from this data was then input to the model and applied to the network operations of hypothetical large, regional operator profile to estimate the general benefits of network automation.

Overview of project methodology



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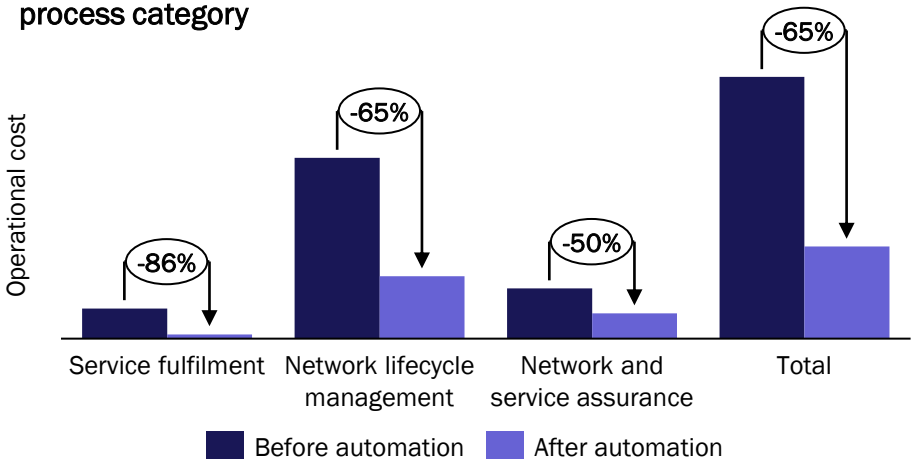
Network automation at the domain controller layer drives significant benefits to operators and enable future, network slicing based business models

- Our model estimates that a large regional operator may expect significant cost avoidance benefits at the domain controller layer of up to 65% of operational costs.
  - Operators reported significant benefits for service fulfilment using templates and standard scenarios.
  - Automated provisioning and upgrade of network equipment drive the benefits under network lifecycle management. Zero touch provisioning capabilities at the domain controller are key.
  - Enabling employees to identify and correlate faults and alarms, and implement the resolution significantly faster drives the benefits under network and service assurance.
- The cost avoidance factors in multiple benefits such as process automation reducing the labour time requirement for manual workloads, standardised scenarios reducing the frequency of order fallout, and greater process reliability, reducing human error.
- Other benefits to the operator may include:
  - A faster time to revenue (TTR) for IP services through automated service provisioning at the domain controller
  - A faster mean time to repair (MTTR) for network issues by automating the fault correlation and resolution workloads.

Final cost avoidance expected from network automation, by process category



Other KPI benefits for IP network automation across all process categories

- 68% reduction in labour time
- 85% reduction in errors (i.e. order fallout, human error)
- 88% faster TTR with automated service fulfilment
- 71% faster MTTR with automated network and service assurance

Network automation can further expose the base capabilities to the northbound stack for multilayer SDN control. In turn, this will enable future network-as-a-service and network slicing based business models.

Recommendations for operators

1

Operators should automate the network management processes for their IP services.

There are clear benefits to operations from network automation at the domain layer. Our model estimates that a large, regional operator can avoid up to a 65% of costs across service fulfilment, network lifecycle management and network and service assurance processes. This benefit was driven by the reducing labour time on repetitive manual processes and the frequency of human error and errors from order fallout that require repeated work. Network automation would also benefit the operator by improving its business flexibility with faster TTR and MTTR.

2

Operators may look to implement network automation in a staggered approach to realise the immediate benefits.

Our results demonstrate how an operator may realise these benefits over a three-year period as they gradually implement network automation. Our interviews support this as operators' take different strategies in implementing network automation, typically as starting with specific use cases first – one such operator focused on automated troubleshooting and triage, as part of automating the network and service assurance processes.

3

Operators should look for a network automation platform with a clear roadmap for future network slice-based services.

The network automation platform should be built to automating the operator's existing IP services but also provide a clear roadmap for enabling the efficient and automated management and control of network slice-based services and enable the future network-as-a-service business model.

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- A key challenge in the concept of promoting network automation is quantifying the benefits, in terms of both cost avoidance and indirect effects on the mean time to repair (MTTR), time to revenue (TTR), manual workloads of operational staff and processing errors.
  - Manual workloads are slow and prone to frequent order fallout and/or human errors, and may rely on inconsistent data sources and processes across different platforms, making it difficult to accurately define the end-to-end benefits from automation.
  - Automated processes and dashboards or KPI reports can address these challenges, however it can be difficult for an operator at the start of their automation journey to accurately predict the impact or benefits they may expect.
- Analysys Mason has been requested by Nokia to develop an Excel-based model of the benefits from automation for an operator providing IP services. The model focuses on network automation implemented for the operator's service fulfilment, network lifecycle management, and network and service assurance processes in the Nokia Network Services Platform (NSP) or an equivalent domain controller/orchestrator.
- This model is based on the inputs from 5 operator interviews, collecting data on the achieved or expected benefits from their network automation journeys. We have then analysed and normalised these operator inputs and applied them to a hypothetical operator profile to estimate the general benefits of network automation. The objective of this study is to illustrate the potential benefits achieved by an operator deploying network automation over a three-year period.
- This report provides:
  - The methodology for this network automation study.
  - Summary of benefits from network automation across three process categories (service fulfilment, network lifecycle management and network and service assurance).

Taxonomy and scope

Process categories	Description and scope
Overall	▪ All processes and benefits focus on the time and costs associated with tasks completed at the domain control layer. ▪ A margin for human error is estimated across all processes, requiring the process to be repeated.
Service fulfilment	▪ The lifecycle management of IP services (i.e. C-line, E-line, E-LAN, Layer 3 VPN, Internet Enhanced Service, Bandwidth on Demand services and Composite services). This includes three distinct processes to the service management lifecycle: provisioning (creation and activation), modification and deletion. ▪ **Order fallout** is when a service order fails during processing due to missing or incorrect information, or a failure occurring in the domain controller. These failed orders require an engineer or customer service representative to manually resolve them.
Network lifecycle management	▪ The provisioning, configuration and maintenance of network equipment (i.e. customer edge and provider edge routers), after the physical installation of the hardware. This includes 4 distinct processes – Provisioning (Day 0-2), backup, upgrade, and service migration. ▪ **Provisioning (Day 0-2)** refers to the deployment, configuration and management of the network equipment, specifically: – Day 0 is the deployment of new equipment, including equipment commissioning, discovery and the base configuration. – Day 1 is the configuration of equipment after initial commissioning, including the interfaces (IGP, BGP, IP/MPLS) and the base services infrastructure (e.g. adding one or more end points on a node). – Day 2 is the configuration of managed objects (e.g. cards, ports, SAPS), including new card insertions, binding new ports, creating LAG and assigning ports, creating new SSH users, password resets, deploying new protocols and bulk operations. ▪ **Backup** refers to the backup and restoration of the software and configuration of network equipment. ▪ **Upgrade** refers to the upgrade or update of software on network equipment. ▪ **Service migration** refers to transferring services from a port, LAG or card to another on the same equipment, or on different equipment, or transferring services from LDP to RSVP-TE &/or SR-TE tunnels.
Network and service assurance	▪ The assurance of the network and services, including fault management with alarm correlation and root-cause analysis: – **Custom alarm correlation** includes the efforts required to identify and correlate faults and alarms to a common issue in the network. – **Root cause analysis** refers to the efforts required to identify and resolve the main cause for a service outage or performance degradation. This activity includes any truck rolls that may be required for the resolution.

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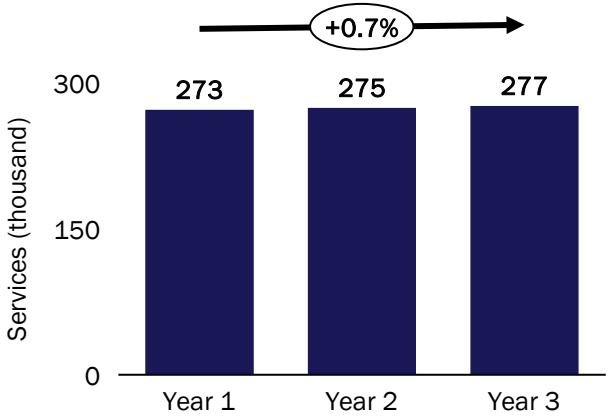
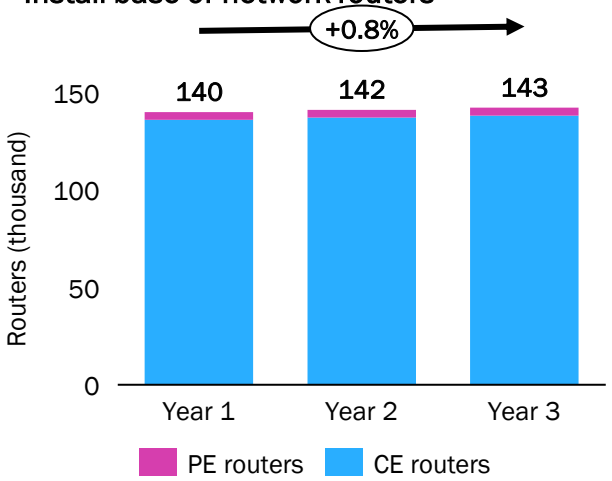
Operator profile: We have developed an operator profile in terms of the number of services, network routers and alarms and faults

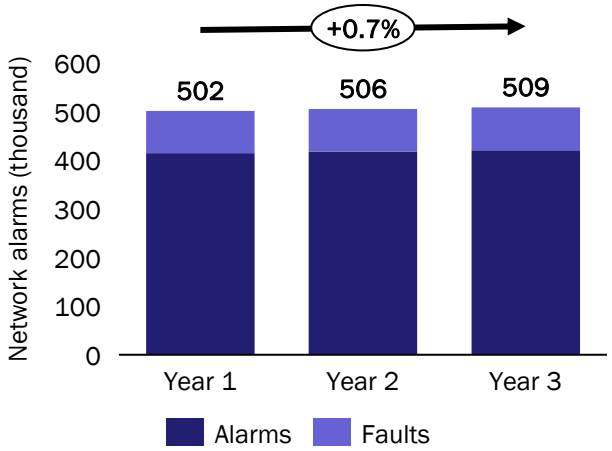
IP services maintained



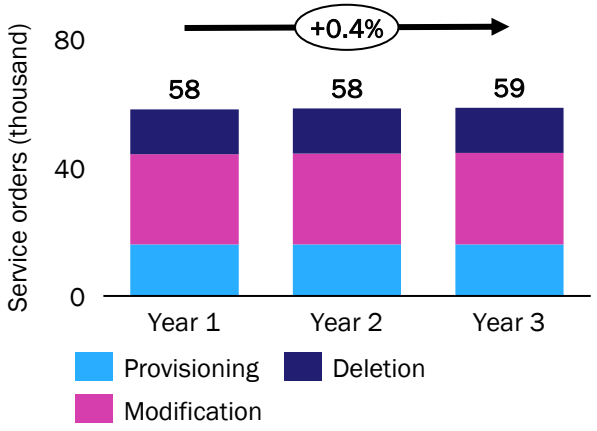
Install base of network routers



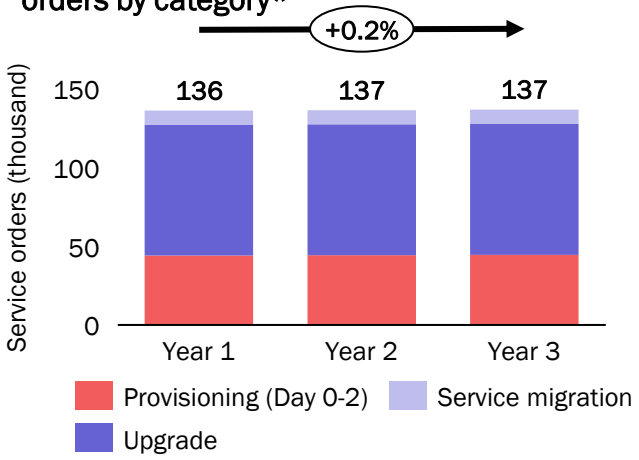
Number of alarms and faults occurring



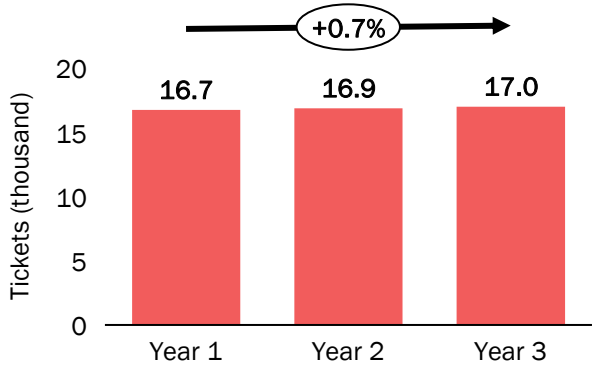
Domain controller service fulfilment orders by category



Domain controller network operations orders by category*



Number of tickets created



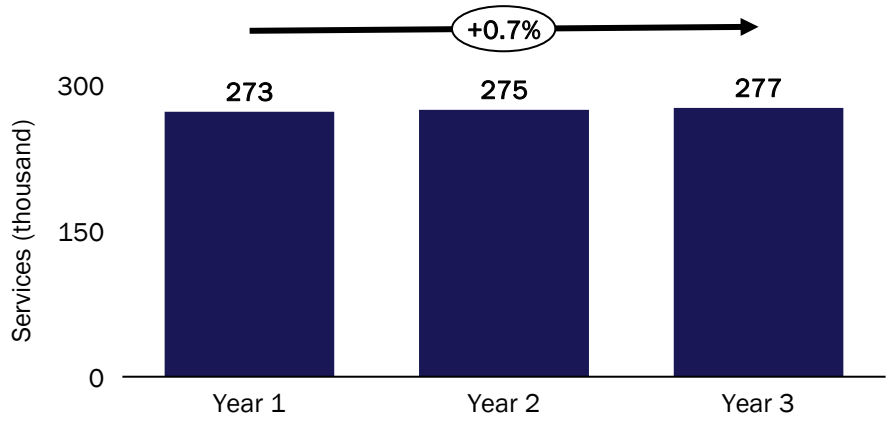
* Network equipment backup not shown due to the high volume of daily backups.

Operator profile: We forecast a flat growth of IP services and service fulfilment orders because of the uptake of SD-WAN

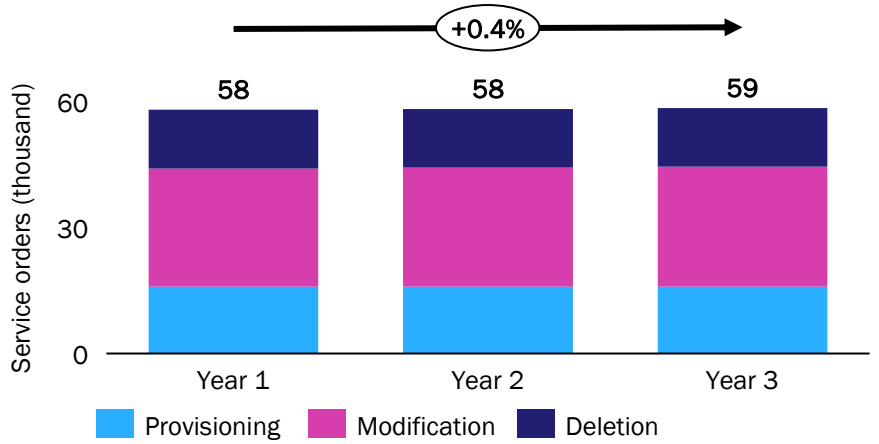
Key assumptions

- This profile assumes the operator is already using all service types covered for mobile and fixed network backhaul, and enterprise services.
  - Growth in total service volume is assumed flat in an established market. Some interviewed operators reported a high growth rate, however this was due to the launch of new service types or enterprise services.
  - Growth has been modelled as constant across the three-year forecast, as function of the gross adds and deletions.
- The total number of services is sized approximate market share and breakdown of total IP services reported by operators and scaled to the Western European market.*
- The install base, and growth, of IP services then drives the volume of service fulfilment orders:
  - Provisioning orders are driven by the gross number of new IP services.
  - The annual modification rate of the install base is 15%.
  - The annual deletion rate of the install base is 5%.
- The automation benefits for service fulfilment are consistent across all different IP service types (e.g. C-line, E-line), based on operators' inputs.

Install base of IP services maintained



Domain controller service fulfilment orders by category



* Based on Analysys Mason's dedicated internet access forecasts.

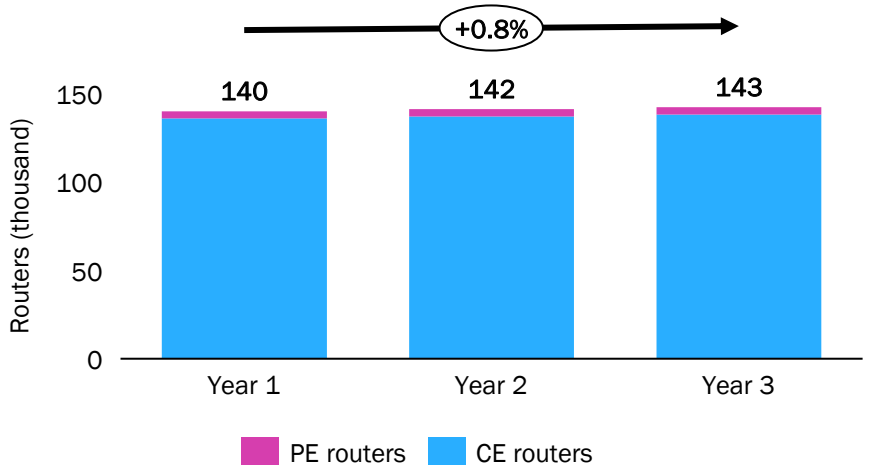
Source: Operator interviews

Operator profile: We have assumed a large install base of routers required for the delivery of these IP services

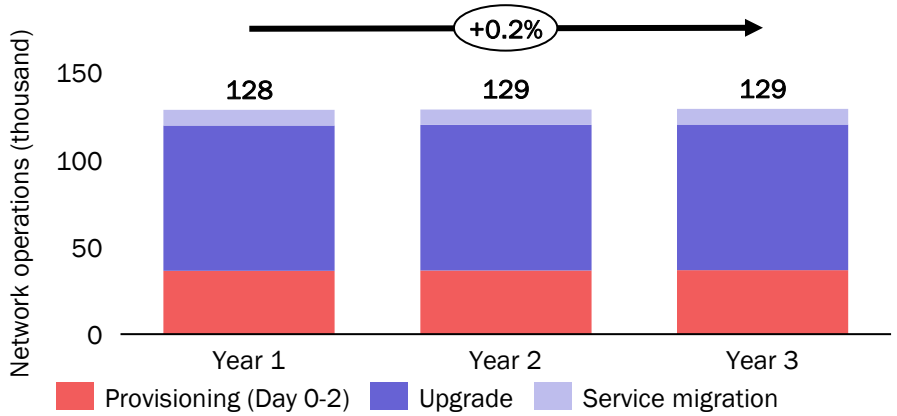
Key assumptions

- The profile includes customer edge (CE) and provider edge (PE) routers among the operator's network equipment.
- The install base of CE and PE varies greatly between operators depending on the scale of enterprise IP services and backhaul networks, and the operator's network architecture.
  - The install base of CE routers is assumed to scale with an average of 2 IP services to 1 CE router.
  - The install base of PE routers in the network is scaled at a ratio of 30 CE routers to 1 PE router.
- The new equipment and install base of CE and PE routers then drives the volume of network operations:
  - Provisioning (Day 0-1) operations are required for the gross number of routers installed. The annual rate of subsequent configuration changes, requiring a Provisioning (Day 2) operation, is assumed to be 20% of the install base.
  - The annual upgrade rate of the install base is assumed at 60% for CE routers and 40% for PE routers.
  - The annual rate for service migrations is assumed at 50% for PE routers and 5% for CE routers.
  - Most operators reported equipment back ups (not shown) occurred daily and was already highly automated.

Install base of network equipment by router type



Domain controller network operations by category*



* Network equipment backup not shown due to the high volume of actions from daily backups.

Source: Operator interviews

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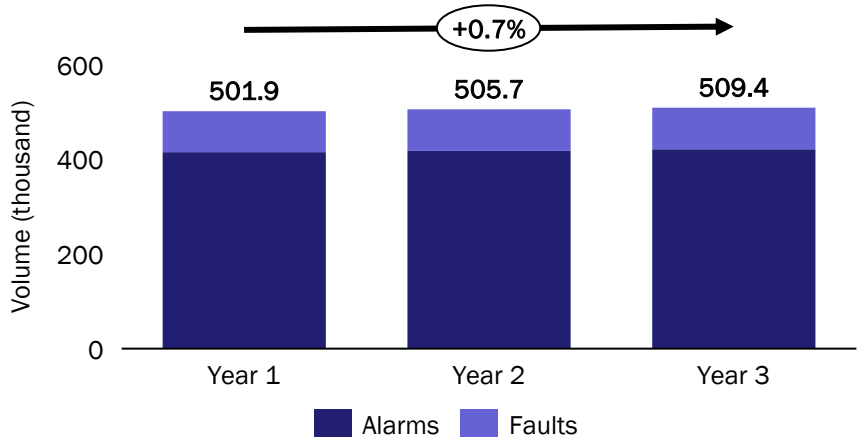
Operator profile: The volume of network alarms and faults, and subsequent tickets, is assumed to scale with the volume of services and routers on network

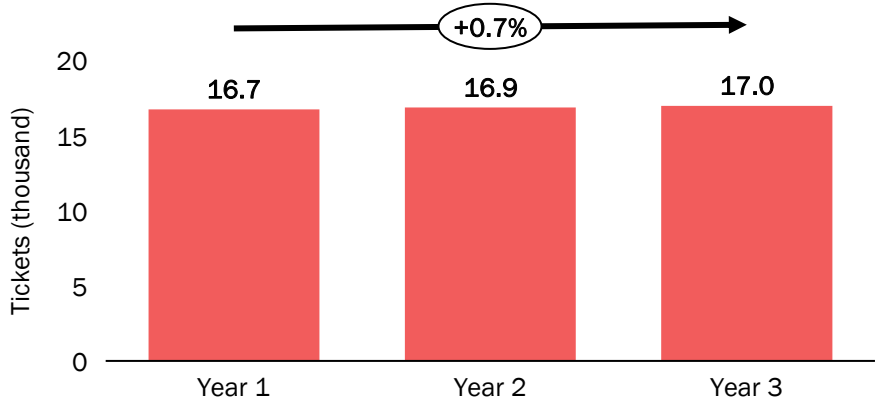
Key assumptions

- The profile includes unsuppressed faults and alarms generated by the volume of services and routers maintained on the operator's network.
  - This volume is assumed constant with regard to the install base of services and routers.
- The volume of faults and alarms from the network then drives the volume of tickets generated to the domain controller:
  - The average rate of tickets created is assumed to be 1 ticket for every 30 faults and alarms.

Number of alarms and faults occurring



Number of Network and service assurance tickets created to the domain controller



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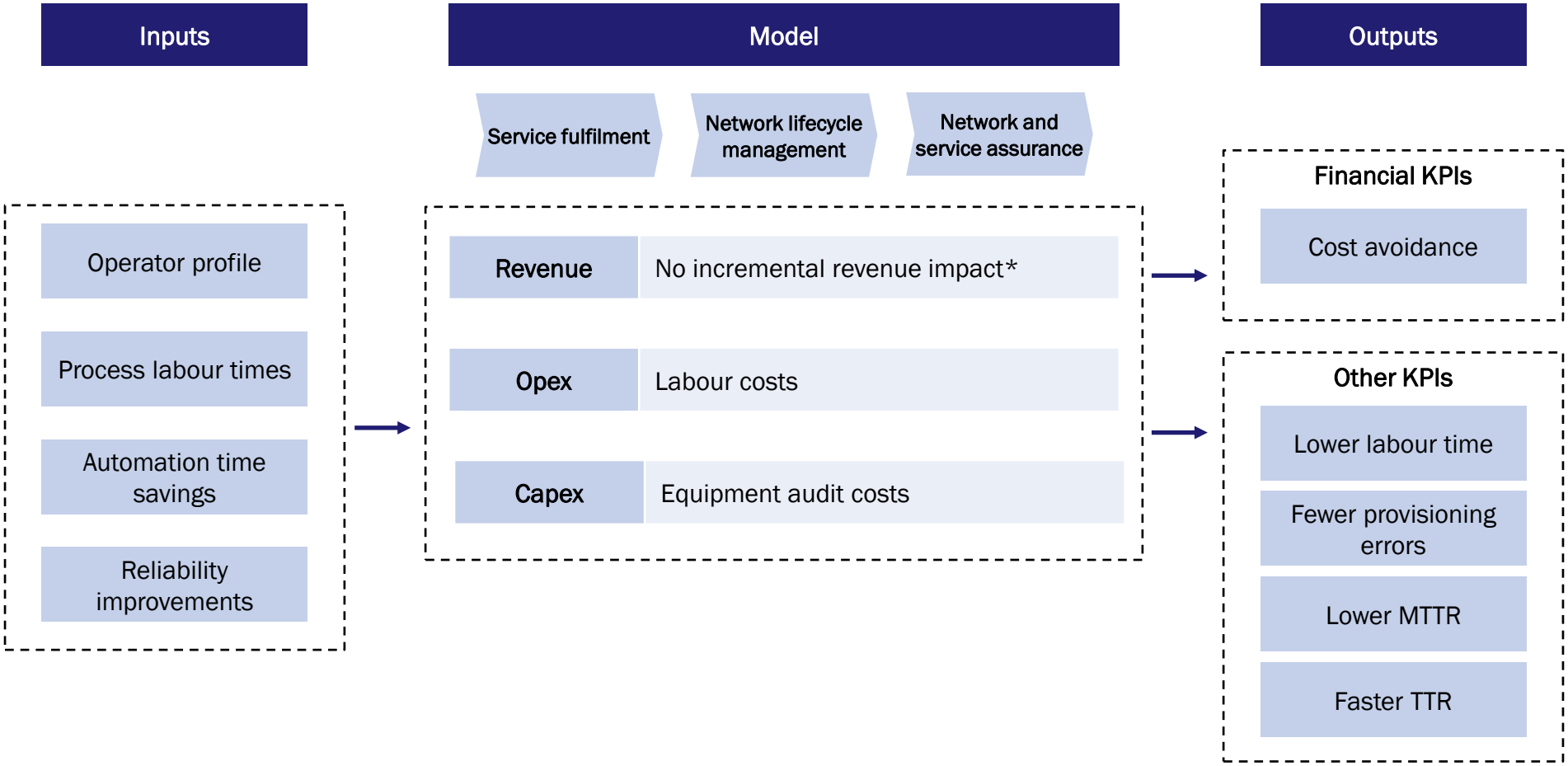
We developed a simple model to quantify the labour time and cost savings with network automation for the following categories and processes

Process category	Processes	Base driver and key variables
Service fulfilment	Provisioning	Number, and growth, of IP services maintained
	Modification	Labour time spent on service fulfilment, per service
	Deletion	Frequency of, and repeated labour time, for correcting order fallout
Network lifecycle management	Provisioning (Day 0, 1, 2)	Number, and growth, of network PE and CE routers maintained
	Equipment backup	Frequency of, and labour time per router, for network operations
	Equipment upgrade	
	Equipment migration	
Network and service assurance	Custom alarm correlation	Number, and growth, of network faults, alarms and tickets managed
	Root cause analysis	Frequency of, and labour time per ticket, for manual correlation
		Labour time per ticket, and escalation rate for root cause analysis

Key: Network-specific Benefit from network automation

* Higher revenue benefit calculated in terms of time-to-revenue only.

The model uses the basic workflow below to estimate the benefits in terms of labour time reduction, cost avoidance and other KPIs



*In terms of revenue, only the time to revenue (TTR) has been considered.

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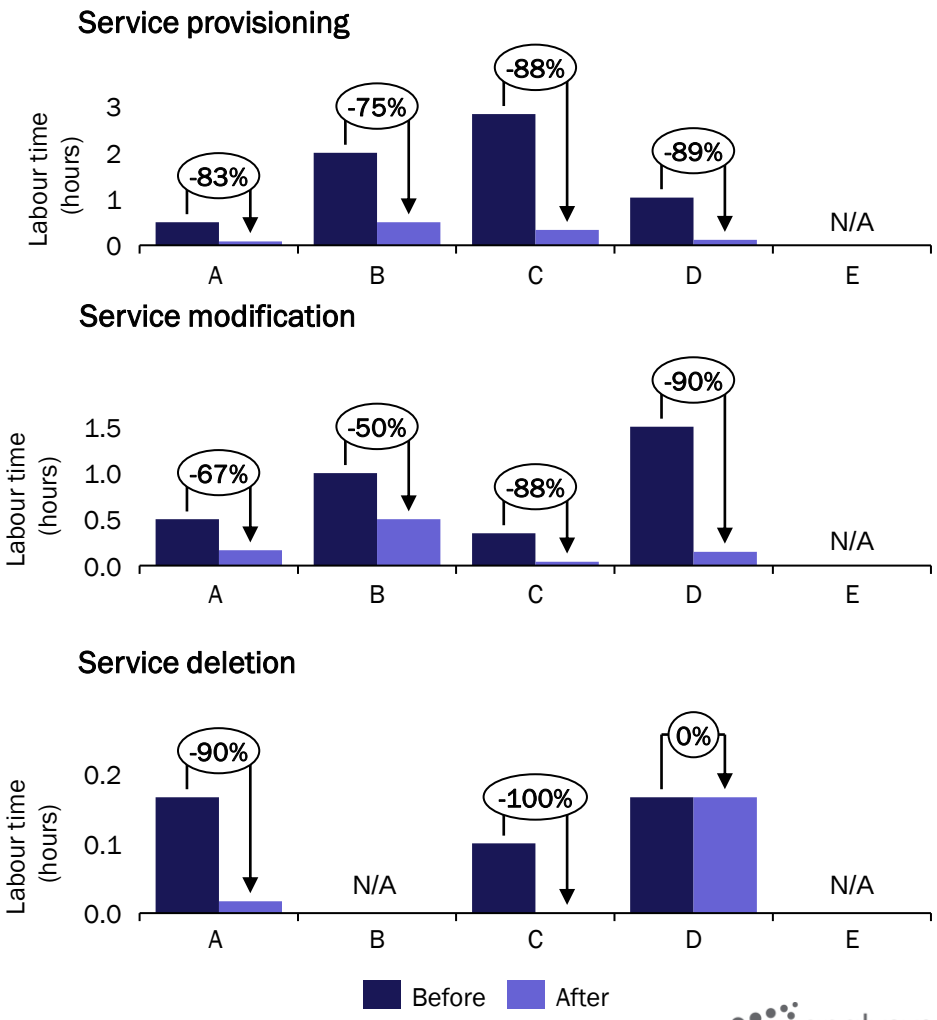
Service fulfilment: Operators reported significant reductions in labour time for automated fulfilment processes

- Most operators expected a large reduction in labour time on the service provisioning processes of 75% or higher.
  - Operators were less consistent on the benefits to service modification and deletion processes, with one operator suggesting no impact on service deletion.
  - These benefits are driven by process automation. However one operator suggested an improved user interface and access to information was the key driver to these benefits.
- No significant differences were reported in the labour times for any service fulfilment processes between the different types of IP services.
- Automation may also improve asset utilisation of network resources and offer capex avoidance.
  - One operator reported 20% of network ports today were still active on discontinued services because the service was not deleted correctly. The operator then had to conduct an audit to identify and resolve these errors.
- Many other operators reported automation may reduce order fallout by up to 80% by using standardised templates, scenarios or customer journeys.
- Not all operators responses are directly comparable, however these results show all operators expect a reduction of 75% or more to the labour time for service provisioning.

Reported labour time before and after automation:

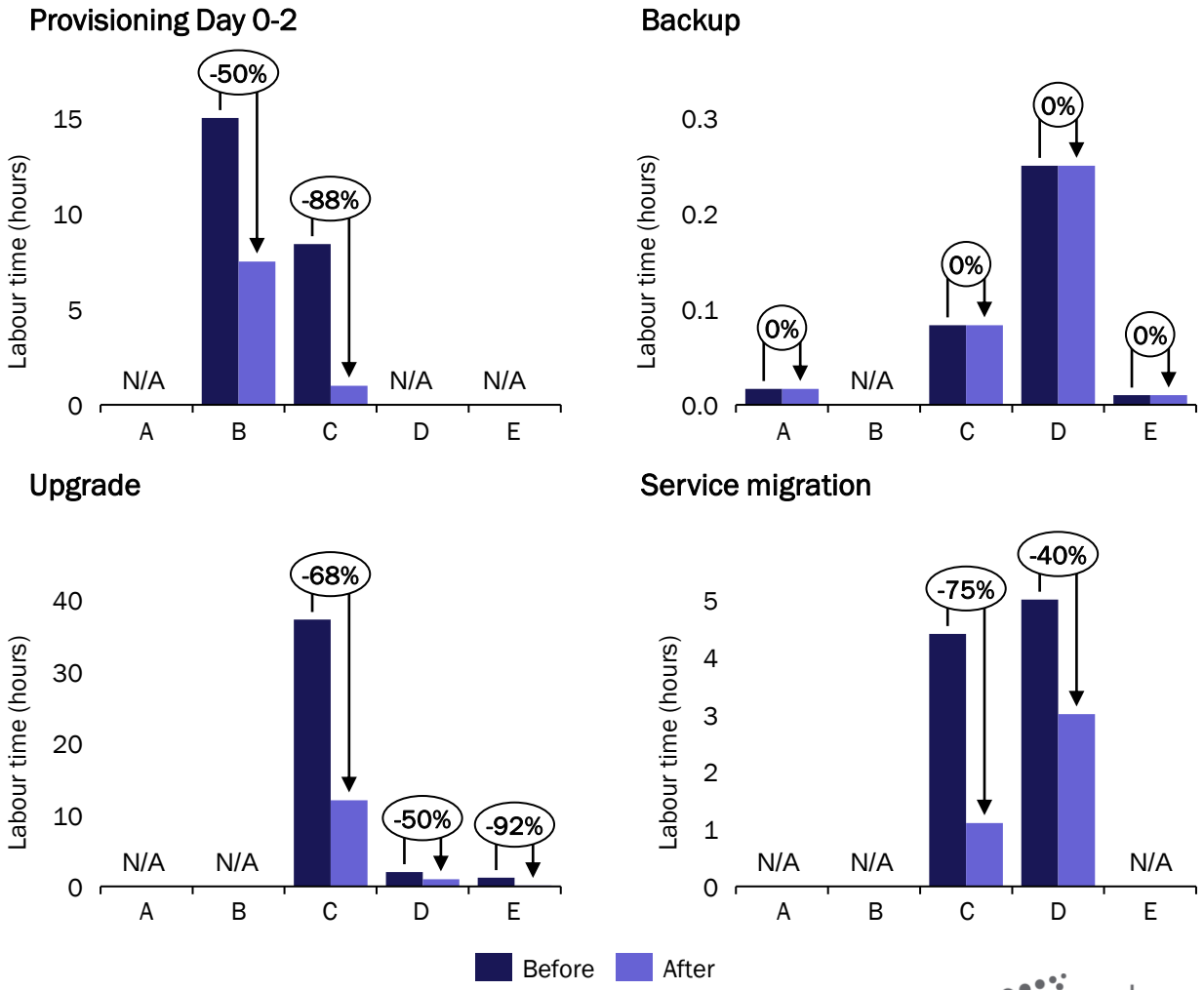


Source: operator interviews

Network lifecycle management: Different markets, network deployments and services drive differences in the network operations and benefits from automation

- Automation benefits to network operations vary significantly, and only a single operator interviewed was able to comment on all network operations concerned:
  - Automating equipment provisioning was reported to have the most significant impact among operators implementing automation in this area.
  - Equipment backup is already highly automated by all operators.
  - Service migration across equipment may pose significant benefits, but varies between scenarios (i.e. router to router, LDP to RSVP-TE).
- Similar improvements were reported for CE routers.
- These results will be normalised factoring in the network deployment and operator type, as well as other factors from the interview (e.g. network upgrades with newer routers).

Reported labour time for PE routers before and after automation:

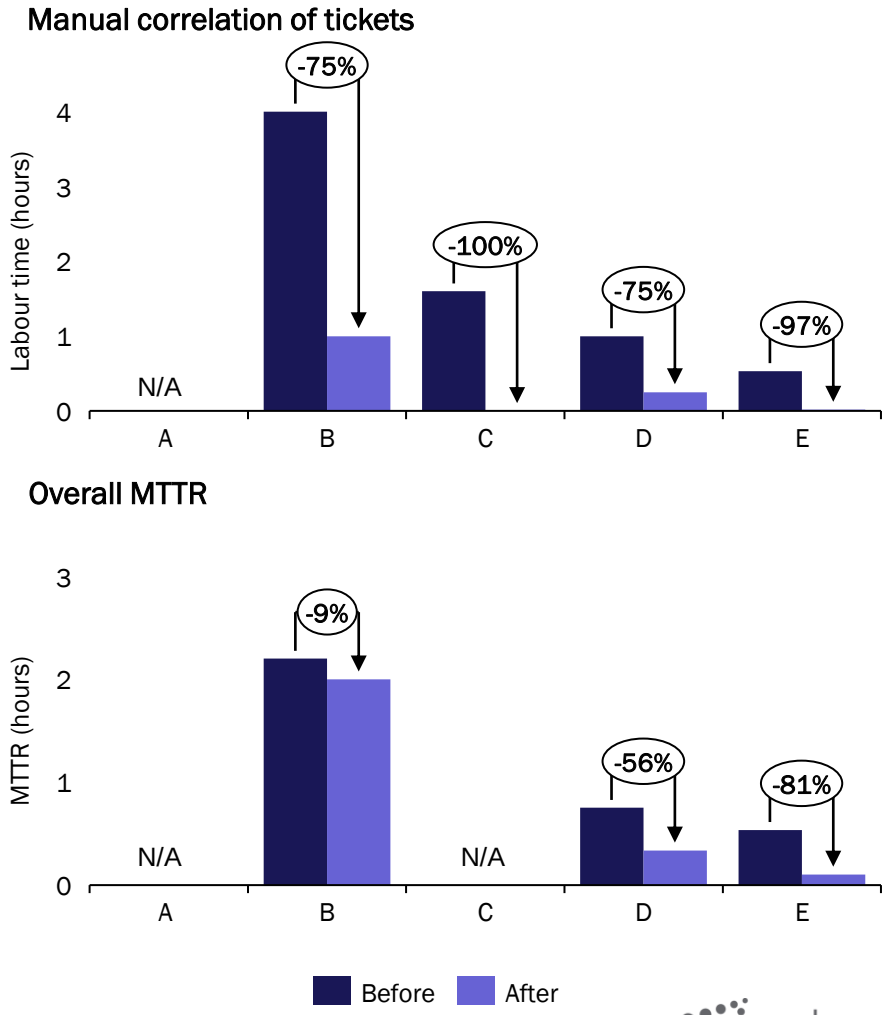


Source: operator interviews

Network and service assurance: Automation will significantly reduce the time required for manual correlation of tickets for root cause analysis

- Operators expect 75% or more reduction in labour time by automating the manual correlation processes for the root cause analysis of tickets. This will be driven by automating the correlation between network faults and alarms and the underlying network equipment to create the tickets.
- Further benefits come from automatic root cause analysis. One operator reported a 100% reduction to the labour time for manual correlation as the automated IP network will complete root cause analysis instantaneously.
- The expected benefit to the MTTR varied much more significantly, likely as a result of the different types of common issues between operators and some operators may have only reported the benefits after the manual correlation is completed.

Reported labour time before and after automation:



Source: operator interviews

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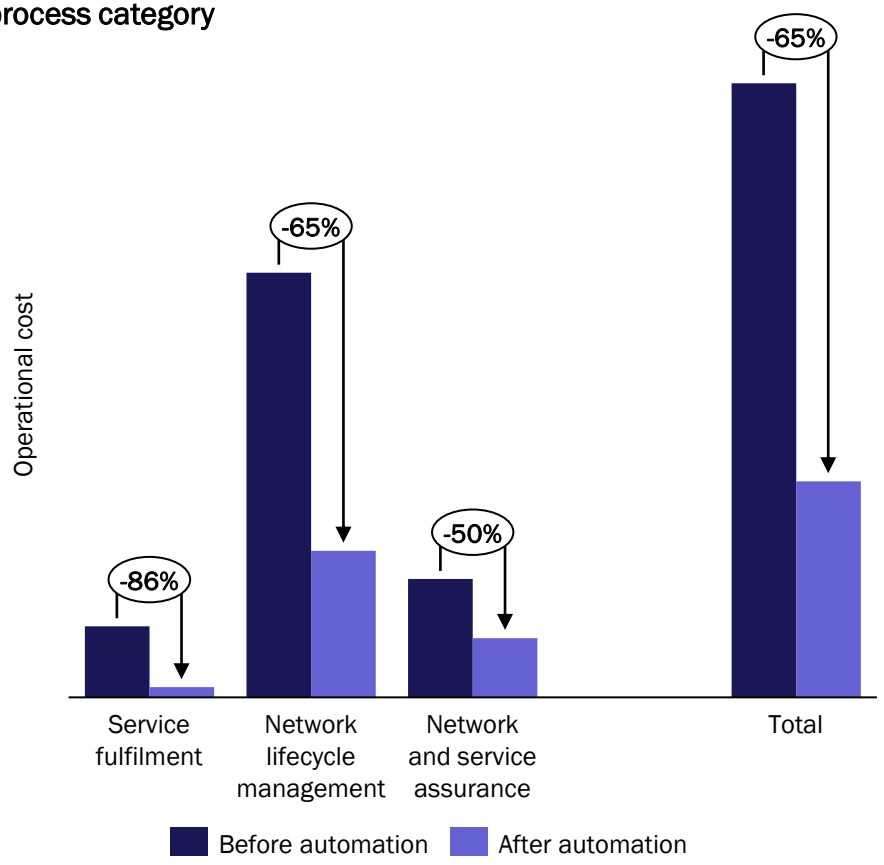
Overall network automation: Operators can expect up to a 65% cost avoidance after implementing automation across all operations categories

Final cost avoidance expected from network automation, by process category



KPI benefits for IP network automation, by process category

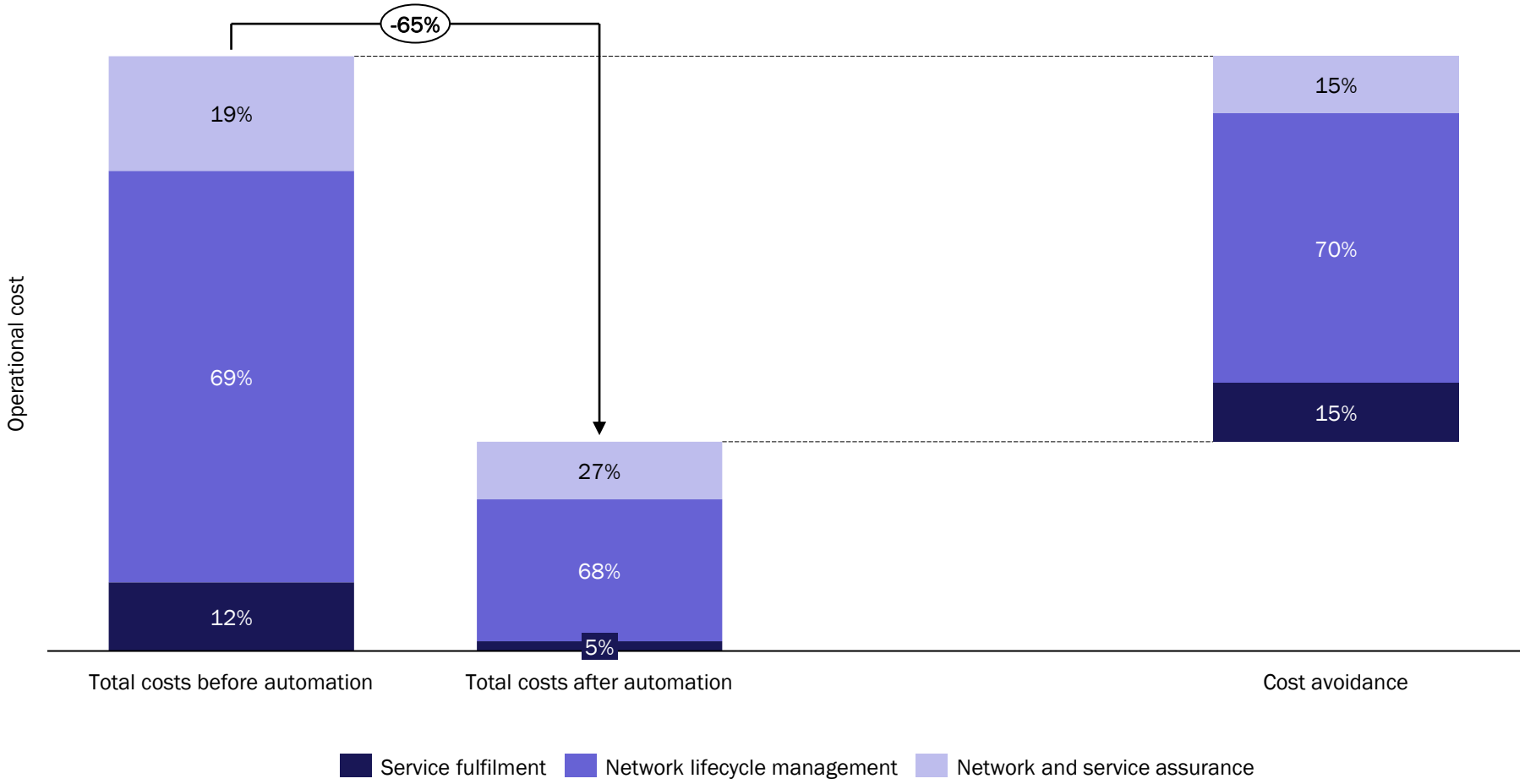
KPI	Service fulfilment	Network lifecycle management	Network and service assurance	Overall
Reduction in labour time	84%	65%	71%	**68%**
Reduction in processing errors*	87%	85%	70%	**85%**
Faster TTR	88%	-	-	**88%**
Faster MTTR	-	-	71%	**71%**

Cost avoidance includes the labour time and costs avoided by minimising manual tasks through process automation, and other associated costs (e.g. truck rolls, audits)

* Processing errors include order fallout that requires manual correction and issues requiring repeat work resulting from human error.

Overall network automation: Automation of the network lifecycle management contributes to 70% of the total cost avoidance

Distribution of the operational costs (and cost avoidance) between process categories, before and after implementing network automation



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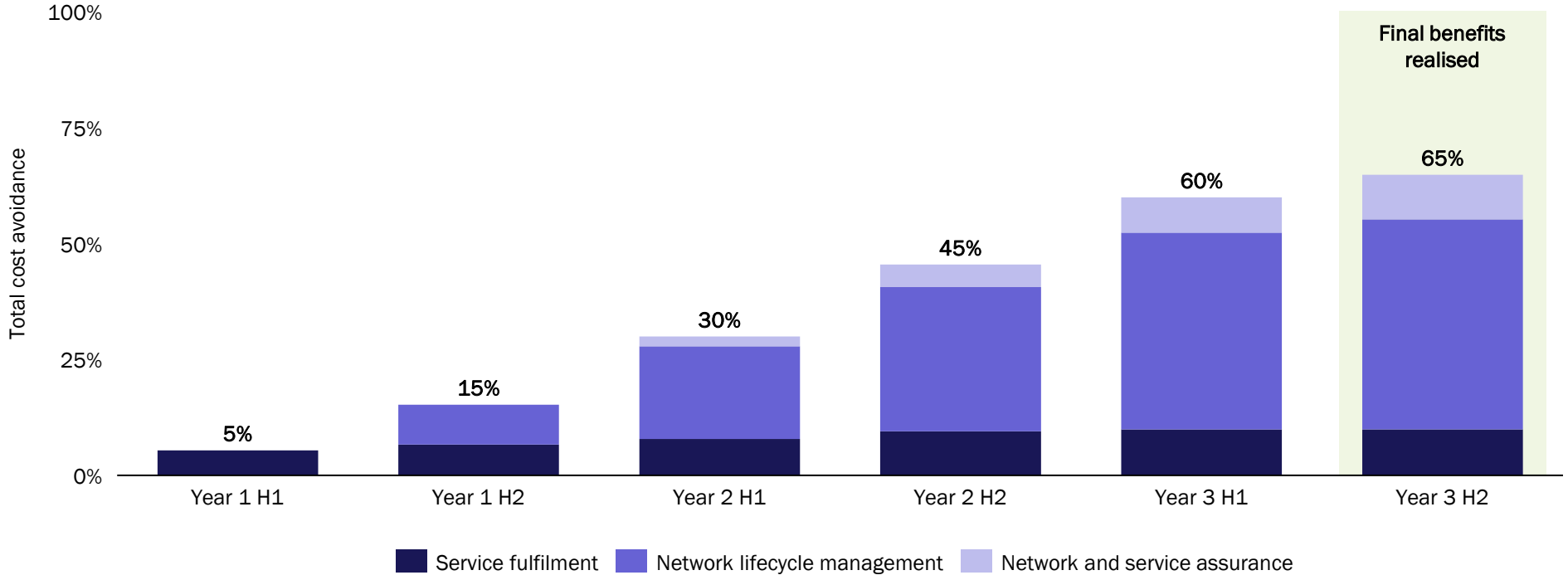
Overall network automation: Operators can expect this benefit to develop over time, as automation is implemented and the automated processes are refined

Total cumulative cost avoidance by implementing network automation over a three year period, by process category



- In the above scenario, the implementation network automation in each process category is staggered:
  - Service fulfilment begins implementation in Year 1 H1.
  - Network lifecycle management begins in Year 1 H2.
  - Network and service assurance begins in Year 2 H1.
- The full benefits from automation are then realised within the first two years after the implementation began.
- Operators may pick and choose where automation is deployed first, based on the expected benefits and ease of implementation. Our interviews suggested most operators began with service fulfilment.

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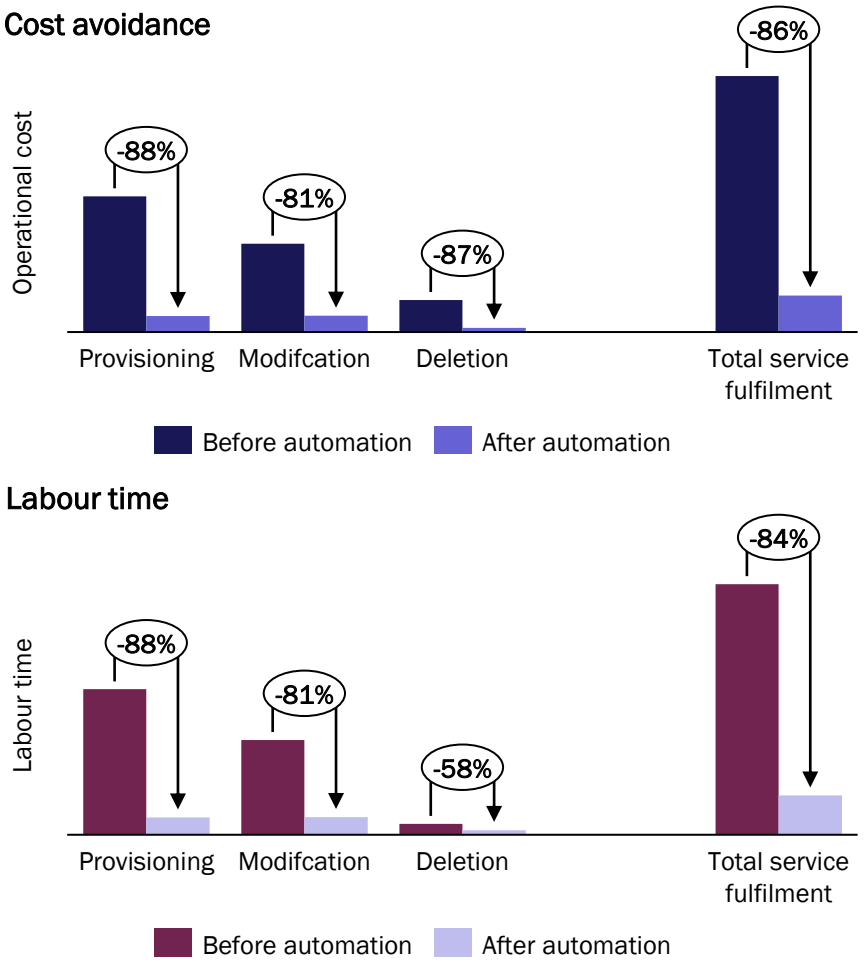
Service fulfilment: The provisioning processes can be highly automated and subsequently benefit typically labour intensive service modifications

- Operators reported significant benefits from the automation of service fulfilment processes with the use of templates and standard scenarios for service fulfilment.
- The provisioning processes were expected to see the largest reduction in both labour time and operational costs.
  - These benefits are driven by a significant reduction in the manual labour time required to create and activate new services, and significantly fewer errors resulting from order fallout and human error.
- Service modification processes are expected to achieve a similar benefit,
  - Many operators reported that the modification process was very labour intensive, requiring employees to manually delete the service and then create & activate it with the new configuration.
- The deletion process has the smallest impact to the overall service fulfilment lifecycle with regard to the operational costs and labour time.
  - The labour time saving for service deletion is expected to be smaller than for provisioning and medication.
  - However, further costs can be avoided with automation by improving the accuracy of the process, alleviating the need for equipment audits to ensure services have been deleted correctly.

Final benefits expected from network automation, by process



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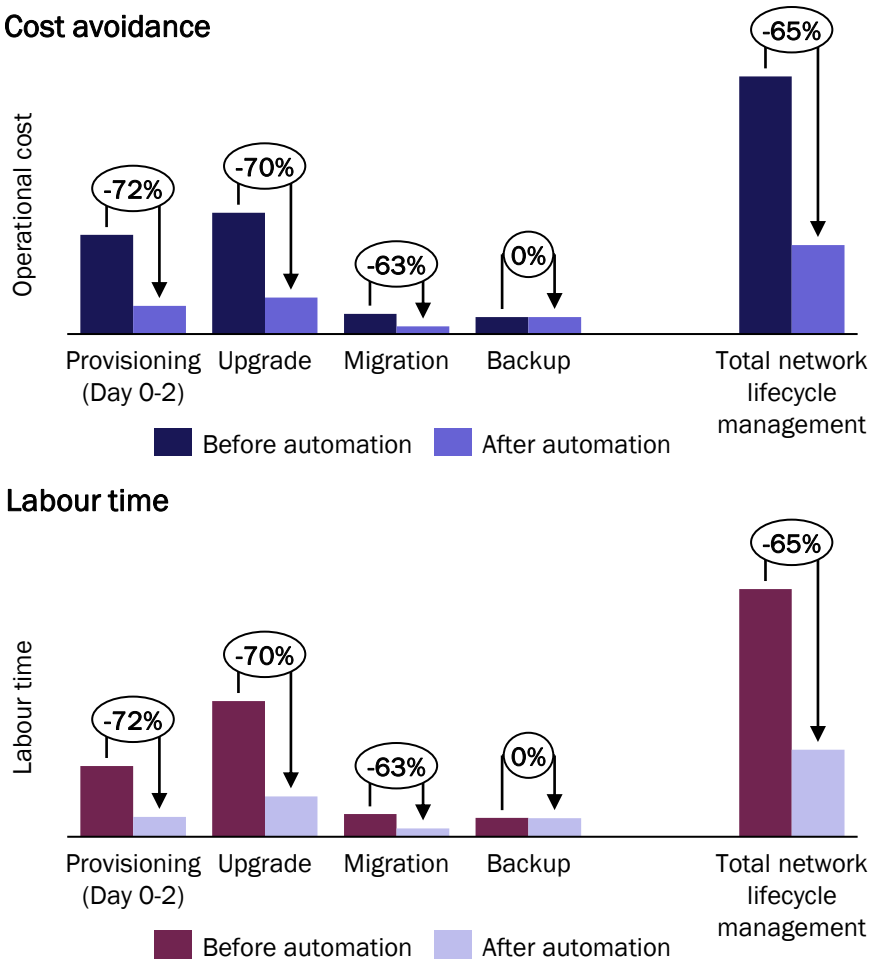
Network lifecycle management: Equipment provisioning and upgrades, and service migration can be highly automated

- Network lifecycle management processes related to the network equipment will significantly reduce the manual workloads for the provisioning and upgrade of equipment.
- The benefits of provisioning the equipment during the Day 0-2 stages are primarily achieved through the automation of network discovery processes, and automatic updates to the router base configuration and interface configurations.
  - Zero touch provisioning capabilities through the domain controller are a key driver for this automation.
- Automation of the PE router software upgrades also delivered significant benefits. This benefit is driven by the automation of the pre-check and post-check audits that are typically heavy on manual work.
- Service migrations are another area that operators can automate through the domain controller. This would involve the automation of the service provisioning at the destination and removal of the old configuration.
- The equipment backup processes include highly repetitive tasks that many operators have already automated, hence no further benefit has been evaluated at the domain controller.

Final benefits expected from network automation, by process



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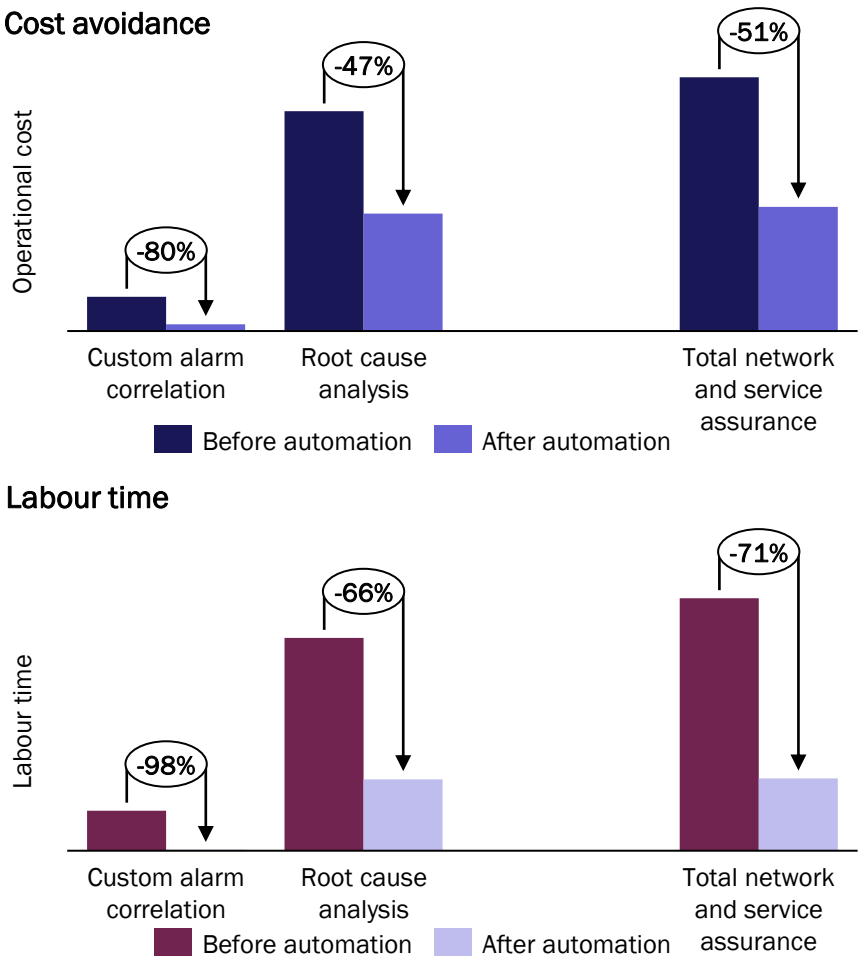
Network and service assurance: Labour intensive manual correlation processes for custom alarm correlation can be very highly automated

- Operators reported large benefits from the automation of network and service assurance processes by enabling employees to identify and correlate faults and alarms, and implement the resolution significantly faster.
- The labour time and costs required for alarm correlation processing are expected to be significantly reduced or effectively removed entirely. The driver for this benefit is two-fold:
  - Firstly, automation is expected to significantly reduce the number of tickets that will require a manual correlation.
  - Secondly, automatic grouping and assessment of alarms and faults may significantly reduce the time required and frequency of human error to complete manual correlations.
- The root cause analysis process is expected to have a significantly greater operational time and cost requirement and will also see a large benefit from automation. These benefits are driven by faster troubleshooting and triaging for issues that may be resolved remotely and those that require a truck roll.
  - The operational cost reduction for root cause analysis is less than that for labour time due to the inclusion of the fixed costs for truck roll outs, and operators did not expect the frequency of roll outs to be affected by automated solutions.

Final benefits expected from network automation, by process



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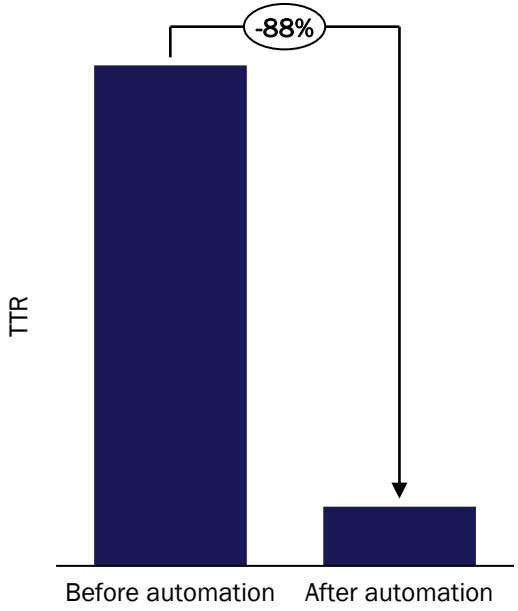
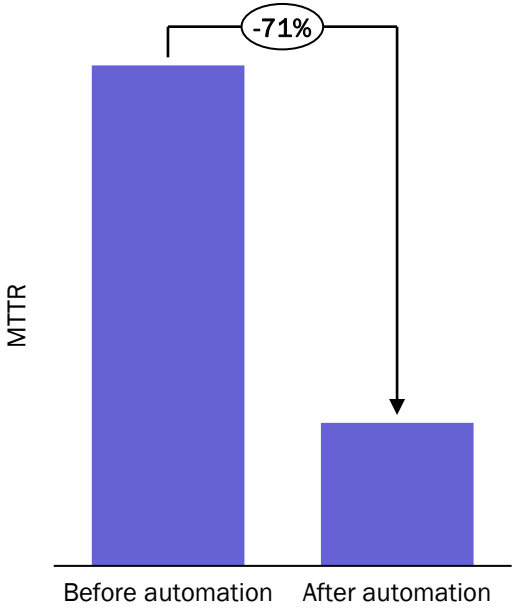
Overall benefits: Automation can further improve the time to revenue (TTR), mean time to repair (MTTR) and the total volume of errors

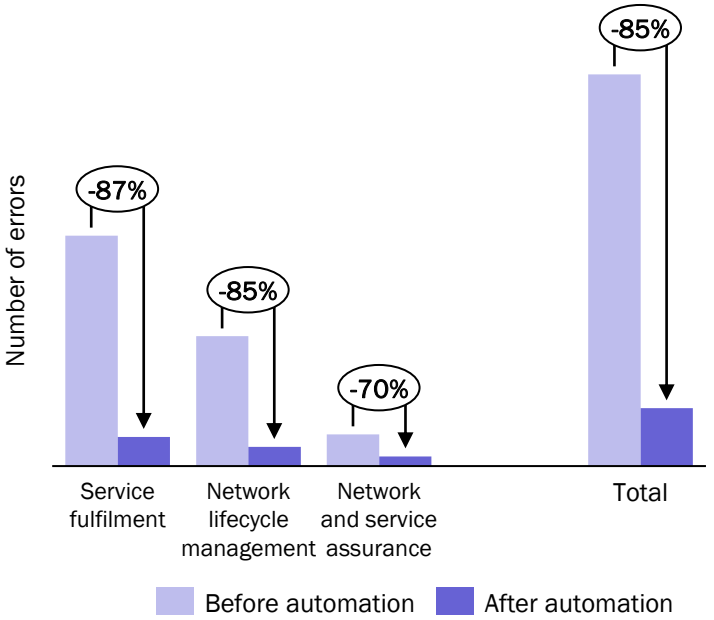
Final improvement in TTR



Final improvement in MTTR



Final annual reduction in processing errors

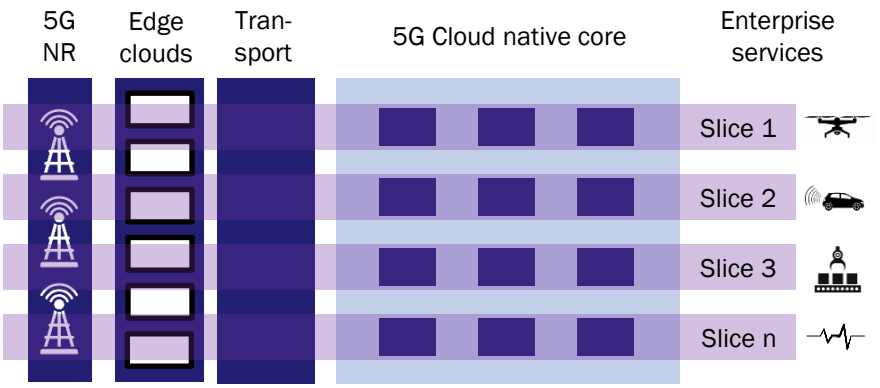


- Faster service provisioning processes for the provisioning of IP services may lead to a faster TTR. Assuming no additional lead time, the reduction of manual labour time required to complete these processes may translate in to an equivalent improvement to the TTR at the domain controller layer.
- Automating both the custom alarm correlation and root cause analysis processes may offer a significant improvement to the MTTR. Assuming no additional lead times, the labour intensive, highly repetitive workloads for correlating and resolving tickets may be significantly reduced.
- Less frequent order fallout across the service fulfilment lifecycle, greater process reliability and a lower likelihood of human errors in all process categories will drive a significant reduction in the volume of processing errors that will require repeat work.

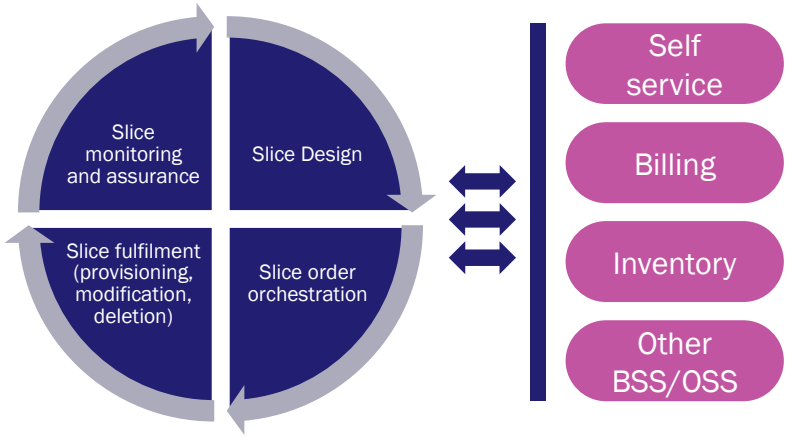
Network automation at the domain controller layer provides a strong foundation for automating the delivery and lifecycle management of network slice based services

- CSPs are looking to network slicing to deliver highly differentiated, on-demand services to enterprises. Each slice will have unique service characteristics, e.g.: ultra low latency for a manufacturing service, and can draw on underlying resources, such as networking, compute processing and storage, as required. Slicing enables the enterprise to control and manage their own network services enforced by strict SLAs and QoS requirements suited to the use case.
- As demand for slice-based networking services increases, CSPs will need an efficient and cost-effective way to manage the service lifecycle. Automation in each network domain will be critical for the operator to abstract underlying domain level complexity and achieve end-to-end network slicing at scale and speed. To deliver a seamless and responsive network-as-a-service experience to enterprises, the network must interoperate as a single, friction-less entity to enable lifecycle operations.
- To achieve this level of network slice lifecycle automation, operators will have to automate each of the functional elements including the end-to-end slice design, service order orchestration and fulfilment, and monitoring and assurance across network domains and on an end-to-end basis.

End-to-end network slices across network domains



Framework for network slice lifecycle management



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Nokia's Network Services Platform (NSP) overview

Nokia NSP is the domain controller for multi-vendor IP, optical and microwave networks enabling operators to automate a plethora of network management processes.

The NSP provides programmable multi-layer abstraction over transport networks making it easier for network engineering and operations departments to manage growing network complexity and aid the transition to autonomous networks in the 5G era. NSP is offered with 'out of the box' use cases for ease of implementation of network automation and orchestration capabilities.

NSP includes an SDN controller for intelligent network optimisation and real time traffic control. NSP has been developed as an open platform offering open northbound APIs for integrations with service orchestrators and other OSSs, allowing zero touch automation of fulfilment and assurance processes.

Some of the key use cases supported by NSP include equipment configuration, network service provisioning, assurance, path computation, unified IP-optical network visualisation and coordination, and cloud interconnect. NSP has also been enhanced to support network slicing across the transport and core network domains.

Overview of the characteristics of the NSP

SDN	The NSP is built around native SDN, and it enables programmatic, granular control of the network and network services. Furthermore the platform's advanced, virtualised architecture offers high-quality services and security.
Multi-domain control	The NSP enables operators to exercise control at every level of the network, both vertically and horizontally. This fine-grained control allows operators to create bespoke services, and automatically resolve service issues.
IP/optical	The NSP's multi-layer approach makes the handling of IP/optical convergence easier, as the process can be handled from a single platform. This feature is enhanced by the programmability of the NSP, allowing operators to deliver standardised and customised IP services.
Widely adopted platform	The NSP supports a wide range of applications and a modular architecture. This architecture allows operators already using the NSP to simply deploy new packages to deliver new functions and capabilities within their network, without the need to integrate a new system or platform.
Software Professional Services	The NSP's offering is comprehensive, and through the Network Resource Controller and Analytics & Assurance services, operators have access to a wide range of powerful tools.

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