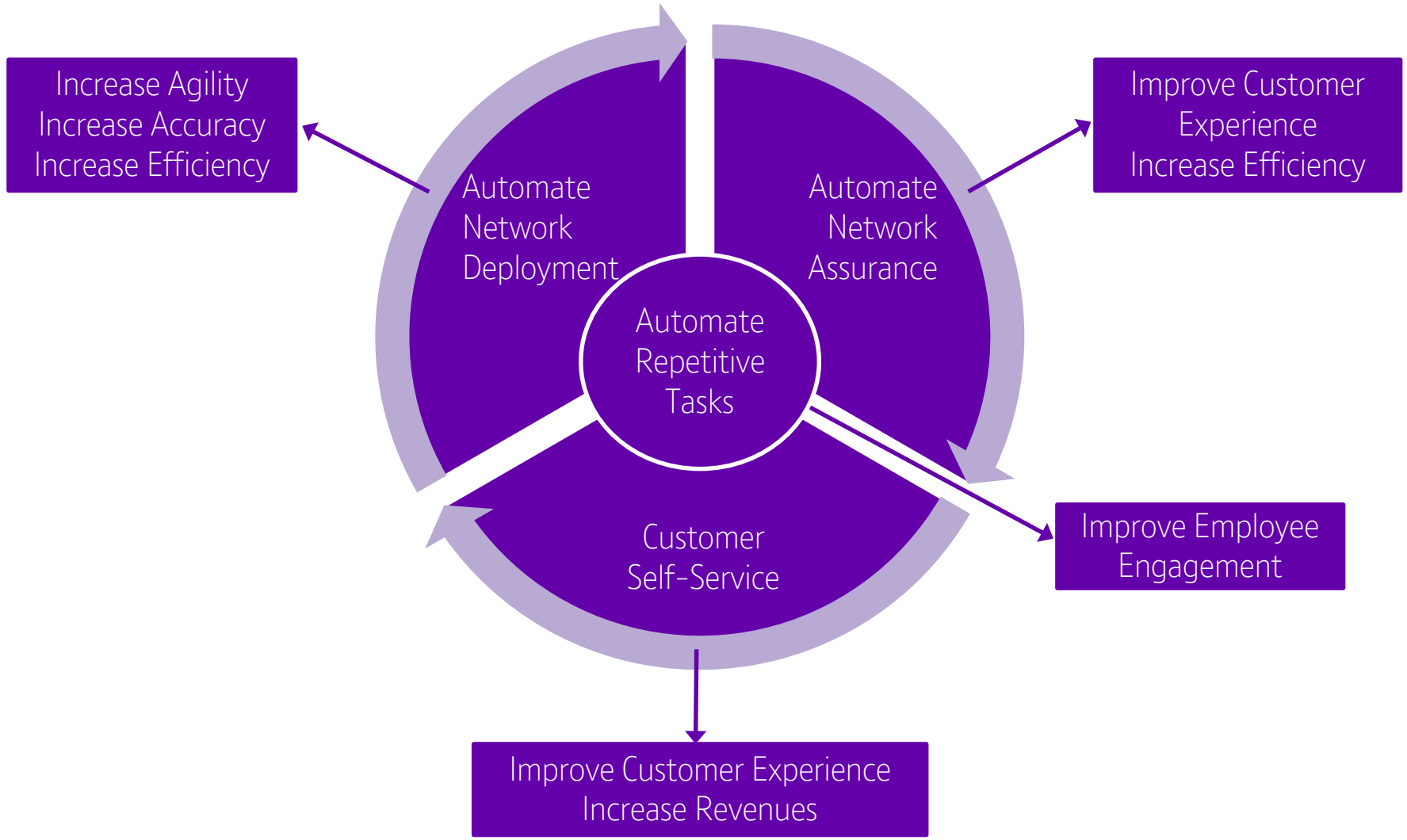
BT's journey to Automation

June 2020

Network Automation Benefits



Enabling Technologies – Network Automation Tools

- There is a wide range of tools available to support all aspects of Network Automation. Many of these tools are Open Source.
- Below is a very brief list of some of the most popular tools – all of these tools are in use within BT today.

Tool	Purpose
Python	Coding/Scripting
Git / GitHub	Version Control
GitLab / Git Lab Runner	DevOps / Test Automation
Ansible	Software & Config Deployment
Puppet/ Chef	Software & Config Deployment
Salt / SaltStack	Server Automation
Jinja	Config Management
MAAS	Server Automation
Juju / Charms	Software Modelling
Jenkins	Test Automation & DevOps

Tool	Purpose
ElasticSearch	Big Data Search
Logstash / Beats	Log / Data Collection
Kibana	Analytics/Visualization
Greylog	Log Management
Nagios	Server Monitoring
Prometheus	System Monitoring & Alerting
Grafana	Analytics/Visualisation
Splunk	Analytics/Visualisation
Appformix	Analytics & Cloud Ops

Network Automation – Key Principles & Technologies

Network Deployment Themes

- Workflow Automation
- Configuration Management & Validation
- Network Virtualization
- Software & Service Orchestration
- Test & Upgrade Automation

Network Assurance Themes

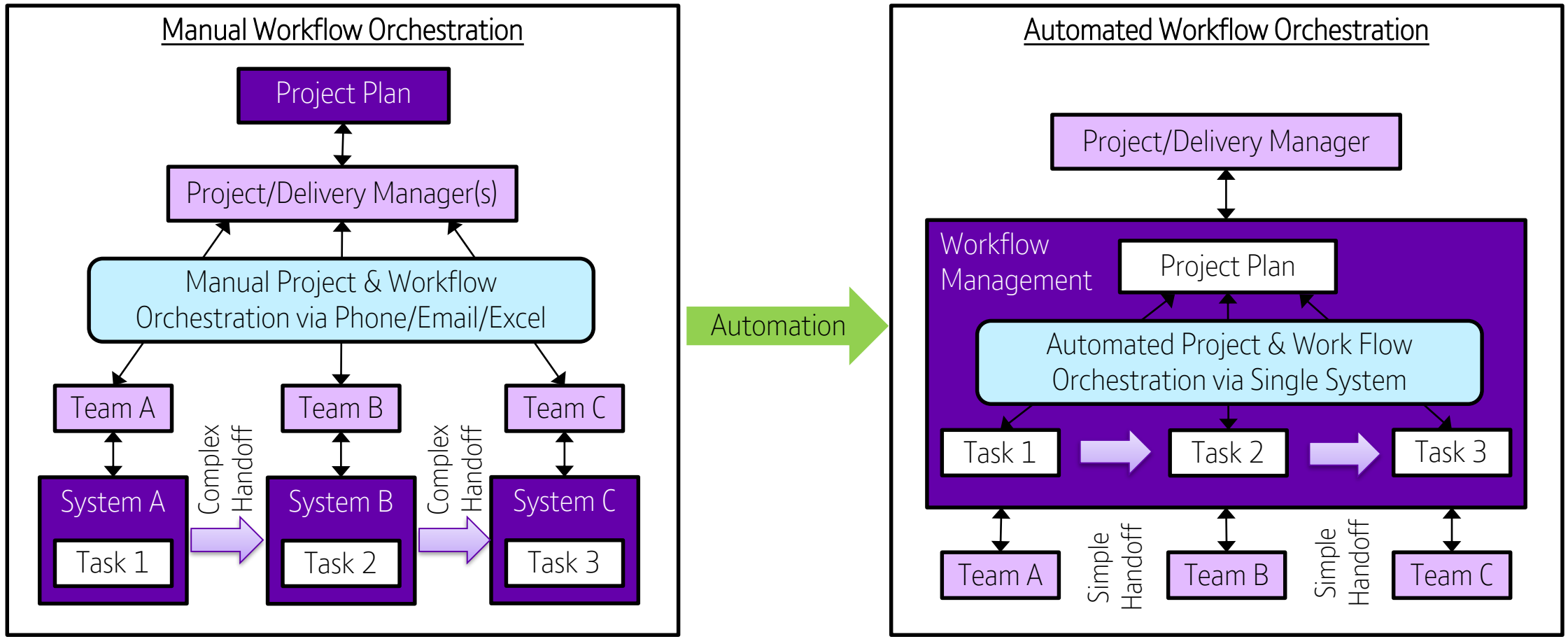
- Capacity & Network Planning
- Fault/Event Management
- Performance Monitoring & Network Optimization
- QoE & Service Monitoring
- Security Monitoring

Enabling Technologies

- Data Architecture & Analytics
- Artificial Intelligence & Machine Learning
- Network Automation Tools

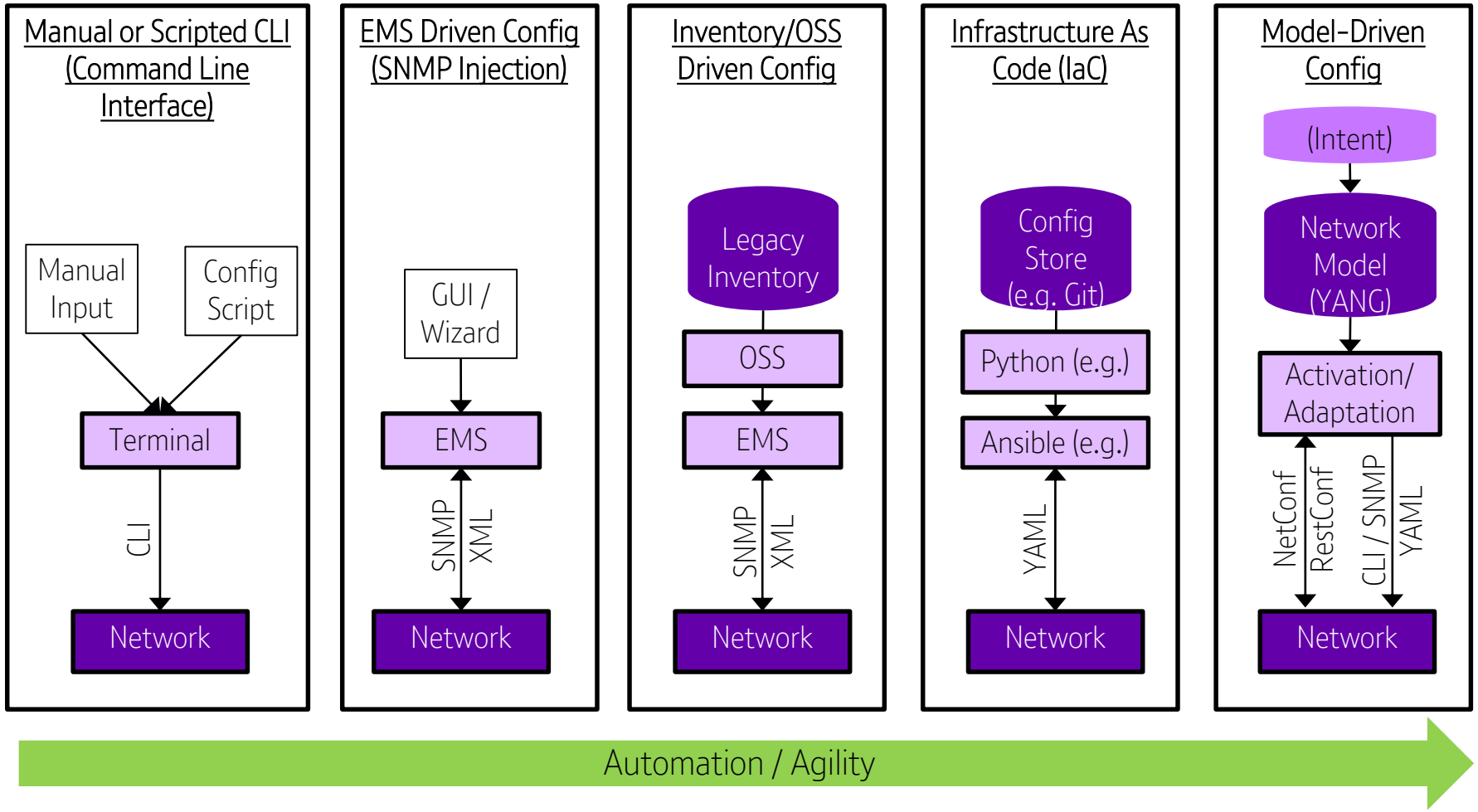
Workflow Automation

Deploying network equipment and managing complex network change requires the interaction of many different teams in network operators such as BT. Historically this has been managed in a very manual way, with complex hand-offs between teams. Workflow Automation can deliver significant reduction in cost / effort / time. It increases agility and reliability and frees up teams to work on other tasks.

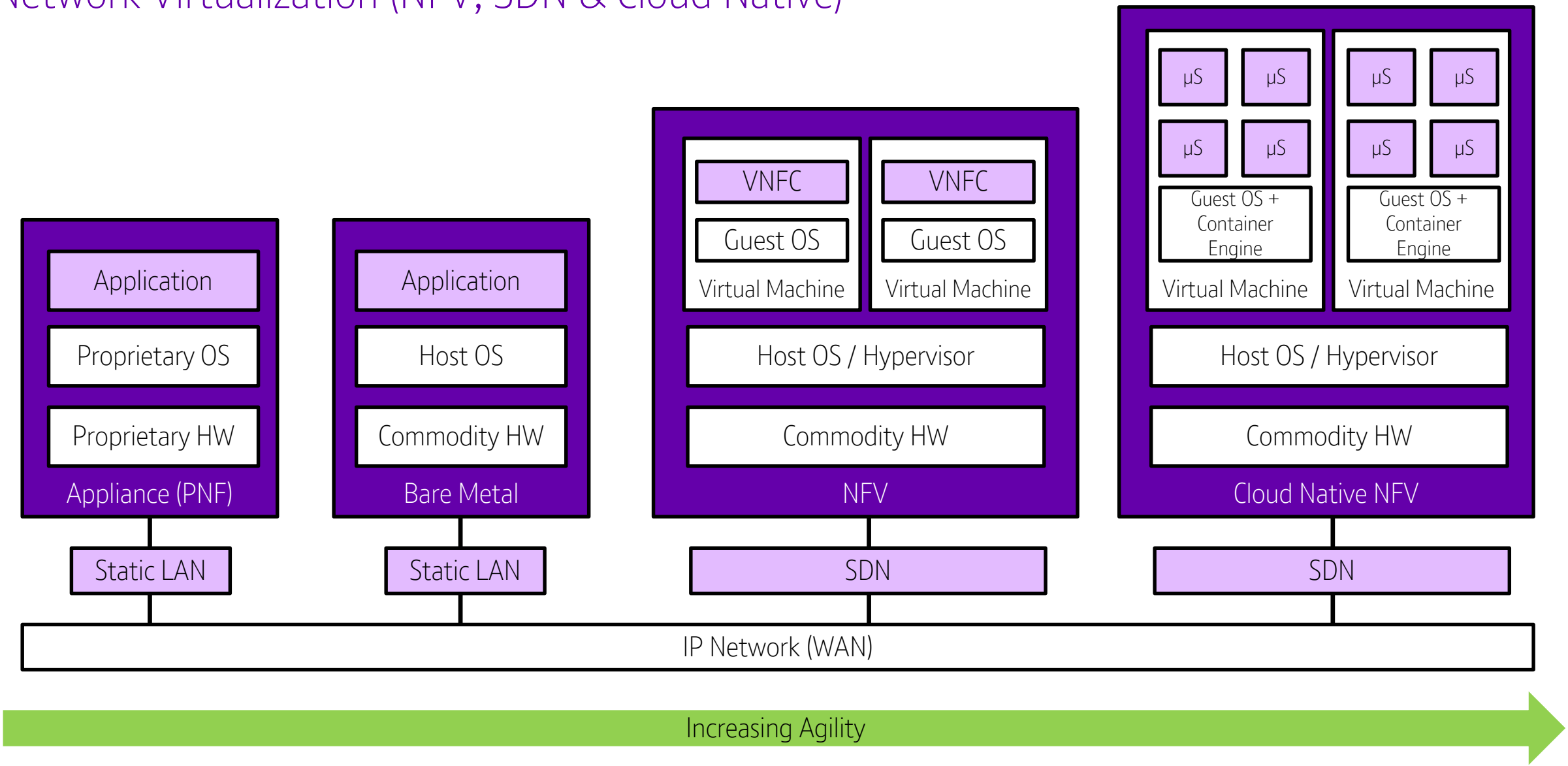


Configuration Management (& Validation)

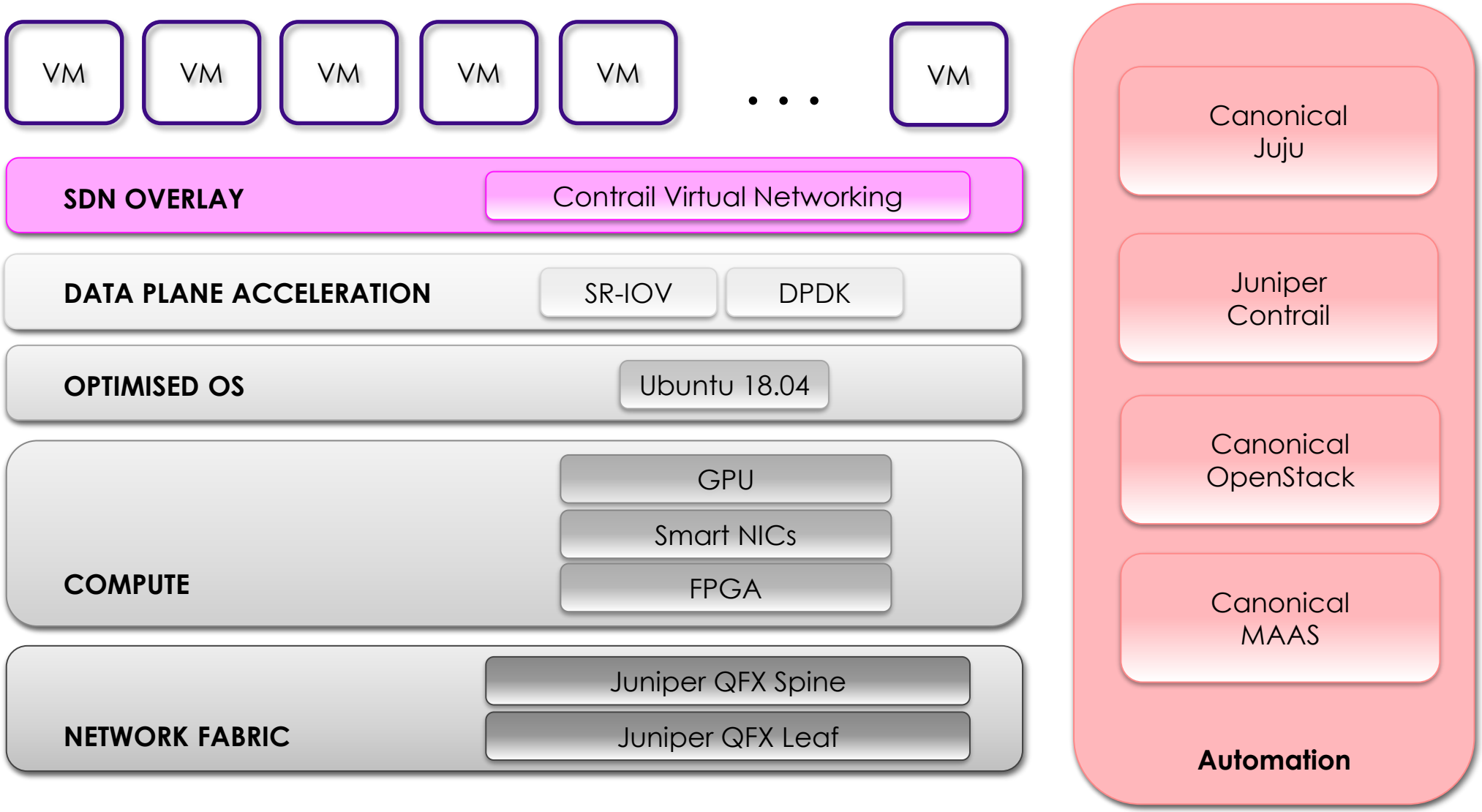
Automating Configuration Management (& Validation) increases accuracy and reduces time and effort to deploy network changes.
Ensuring integrity of network state vs design intent (and inventory data) is also vital to underpin wider network automation initiatives.



Network Virtualization (NFV, SDN & Cloud Native)



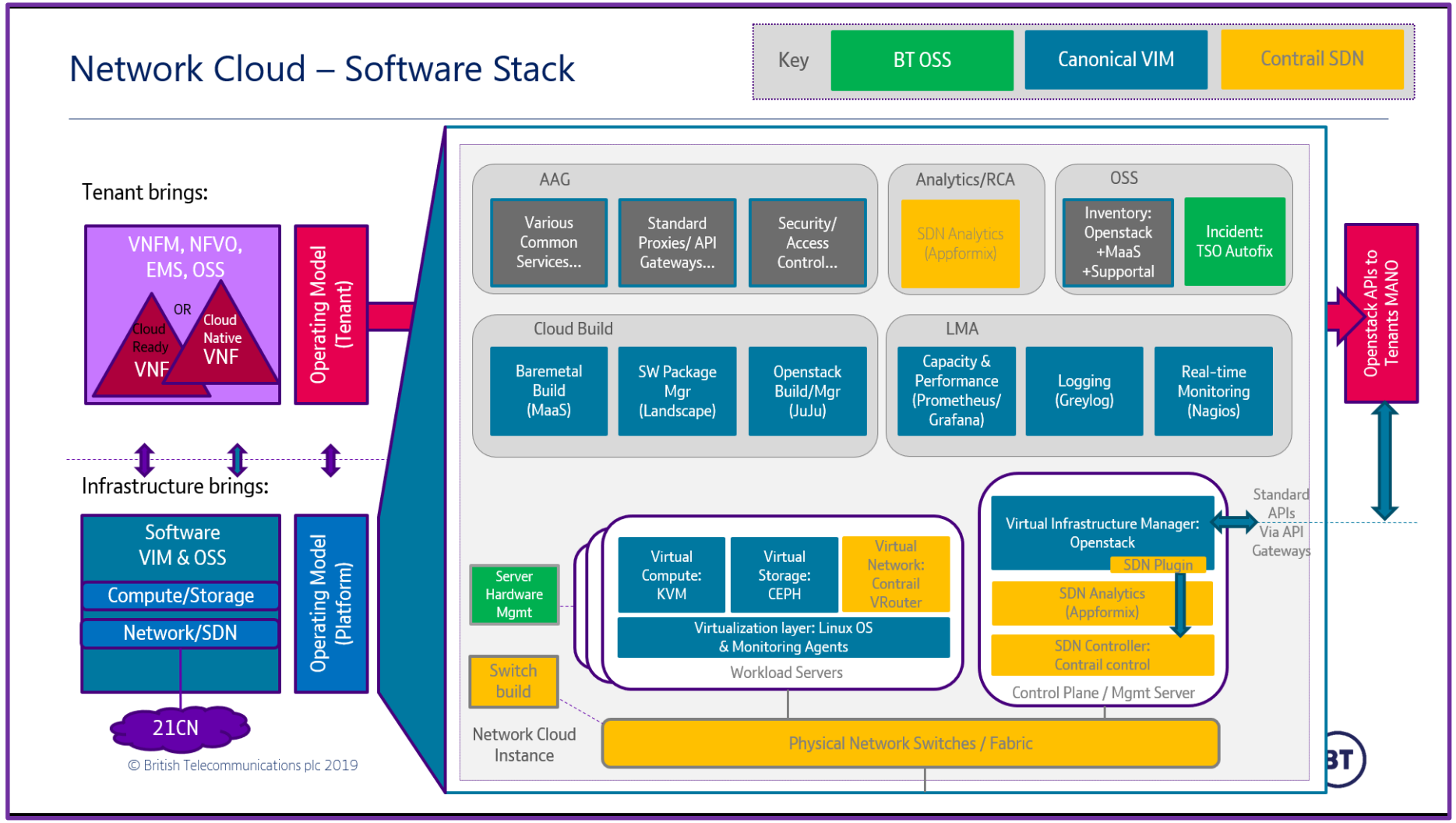
BT Network Cloud Architecture Overview



BT Network Cloud Tooling & Automation

BT Network Cloud is intended to be **highly automated from day one** and implements:

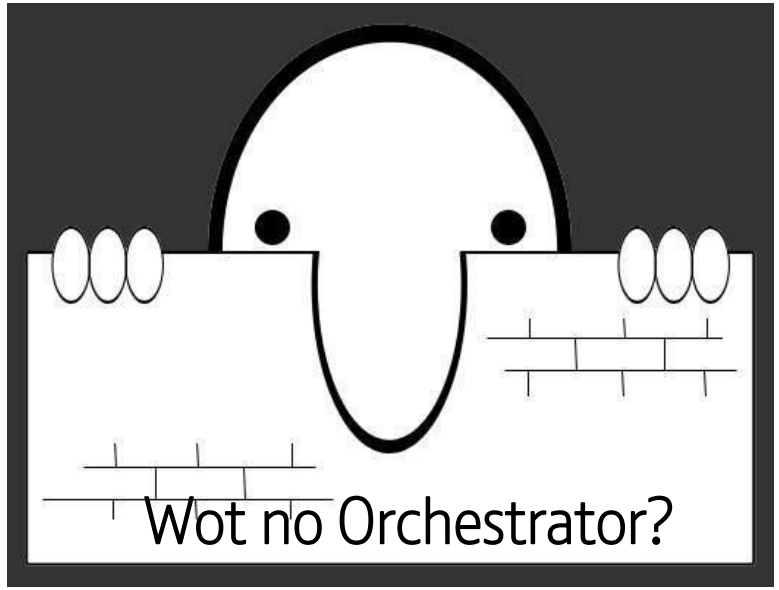
- **Automated Deployment** (via MAAS/Juju/Landscape).
- **Virtual Infrastructure Management** (via Canonical Openstack)
- **SDN** (via Juniper Contrail)
- **Tenant Software Orchestration** (following ETSI MANO principles).
- **Automated Assurance** (via Greylog/Nagios/Prometheus/ Grafana/Appformix)



BT's Orchestration Architecture / Strategy

Orchestrator Architecture

- Hierarchical with domain specific orchestrators.
- Generic Network Service Orchestration capability provides automation & visibility across E2E network services.
- Model driven.
- Standards based.
- Common TOSCA and YANG service and resource catalogues.



In BT Network Cloud

- Tenants bring their own Orchestrator e.g. 5G core tenant may use the 5G core vendor's orchestrator.
- Developing "Orchestration as a Service" concept for tenants that don't bring their own orchestrator.

Role of OSM in BT

- Complementary to BT's DIY "SRIMS" orchestrator and multiple proprietary domain specific orchestrators.
- Attractive because open and standards based.
- Subject of on-going R&D – Integrated into BT's Applied Research Network Automation platform.

BT's OSS Architecture / Strategy

Network Fulfilment

- Centralized service & resource catalogues.
- Model driven network orchestration.
- Single-truth network inventory driven by discovery/reconciliation.
- Multi-domain orchestration via exposure of modular microservices.

Network Assurance

- Evolve to pre-emptive assurance using AI and data analytics.
- Support Self-Healing Networks using data streaming architecture & Machine Learning tools.

NFV & Service Orchestration

- Generic Network Service Orchestration capability provides automation & visibility across E2E network services.
- Standards-based generic VNF Management supports rapid on-boarding of VNFs.
- Common TOSCA and YANG service and resource catalogues deliver service agility and reduces time to market.

BT's In-house Developments

- Diveboard – Performance Monitoring.
- NG-WFMT is an in-house Workflow Management Tool based on Open Source components (Autofix) which combines Project Delivery Orchestration and Task Automation. It has primarily been developed to automate Plan & Build workflows .
- SRIMS is a Catalogue & Model Driven Inventory System for Service & Resource Orchestration.
- The Next Gen Activation Engine (NGAE) provides the Network Abstraction layer.

Operational Architecture for Network Automation

The Operational Architecture innovates by enabling:

A hierarchical structure (as per TMF & ETSI ZSM automation architectures) with clear separation of roles including:

- A Dynamic Infrastructure layer (Dynamic Networks + Network Cloud Operations)
- A Service Platforms layer (Broadband, Voice, Mobile, TV Operations etc)
- An E2E Service Management layer (including exposure of Customer Portals and Data Analytics Portals).

Increasing automation of network deployment in each domain via Network Model / Service Catalogue based provisioning.

- Exposure of industry standard / vendor-independent APIs from each domain will enable cross-domain agile service orchestration & network activation.

Increasing automation of network assurance in each domain via aggregation of multiple network data sources (including Telemetry) and use of Analytics (including AI/ML) in each domain,

- Exposure of enriched Network Data between domains enables more effective co-operation and supports goals of data democratization, data sharing and analytics enablement.

Challenges & Risks of Network Automation

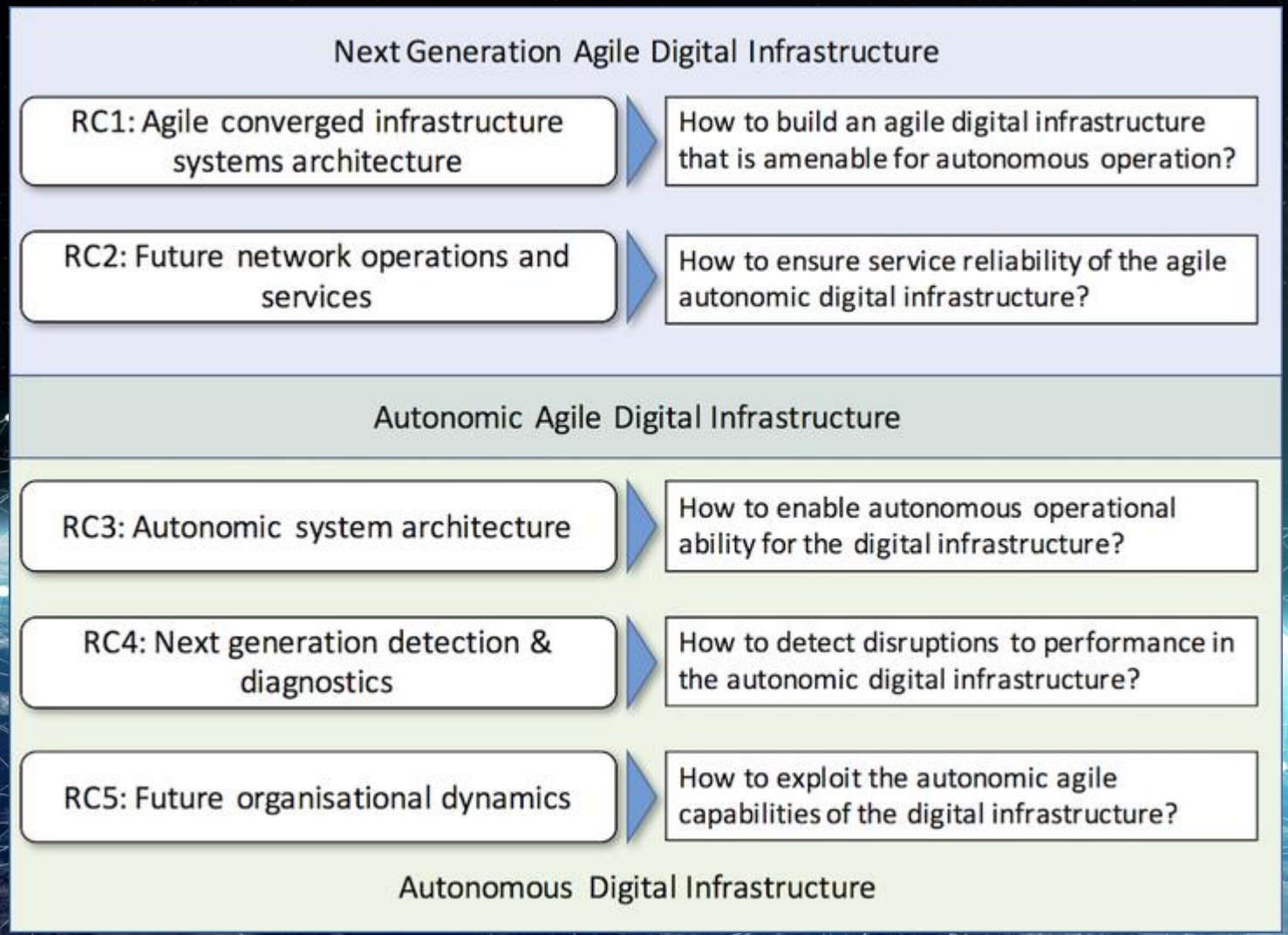
Challenges to implementing Network Automation

- Many layers of legacy networks – within incomplete support for required capabilities (Programable Interfaces, Streaming Telemetry etc)
- Many functions still deployed as physical appliances (typically harder to automated than software functions)
- Test Automation is more difficult in a complex infrastructure environment (involving radio interfaces, optical transmission, specialized hardware & consumer devices etc) than in a pure software environment.
- Data standards and formats must be agreed for exposing meaningful data between network domains (ensuring that the data is correctly structured and enriched).
- Automation primarily applies to known & repetitive tasks. In complex network environments, unique issues that have never been seen before will occur and these probably can't be automated. In other words, there are limits to Network Automation.

Risks inherent in Network Automation

- What happens if Automation tools / processes fail? What is the impact? What is the fallback? How quickly can we recover? Automation could enable errors to propagate faster.
- Safe Automation must operate within defined limits, with human oversight and with "failsafe" mechanisms to cope with potential failures.
- As more decisions are trusted to AI/ML algorithms, how do we know that these algorithms are behaving correctly? How do we monitor the outcomes?
- All AI/ML systems carry a risk of bias and/or error and a risk that performance degrades over time if they are not correctly maintained and updated.

Next Generation – Converged Digital Infrastructure



NG·CDI
NEXT GENERATION • CONVERGED DIGITAL INFRASTRUCTURE

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