Achieving zero-touch networks with closed-loop automation

April 2023

Michelle Lam

The introduction of 5G is expected to generate large volumes of network data arising from new low-latency, mission-critical use cases. Closed-loop automation (CLA) is a strategic solution for communications service providers (CSPs) to simplify network management processes and improve service agility. This article highlights the benefits and challenges of implementing CLA in CSPs' network and service operations.

It is essential that CSPs should deploy closed-loop automation systems if they are to overcome the complexity of 5G

Network control systems have traditionally been designed in a domain-specific and proprietary manner, leading to data silos that hinder CSPs' ability to flexibly exchange data across different network domains. In addition, the control systems in legacy networks are either open-loop (no feedback among different modules in the system) or require costly human engineering procedures to close the loop. This lack of open exchange of information across the different domains reduces network visibility, which can lead to service interruptions and poor quality of service (QoS).

One of the most important factors to ensure the seamless delivery of 5G services is improving network reliability through real-time automation capabilities across network control and management, service assurance and fulfilment. CLA will enable CSPs to automate the network planning, configuration, management, optimisation and healing processes. These automated processes will be driven by feedback loops so that they can continuously adapt to changes in the network environment, which is foundational for fully autonomous networks which are self-organising, self-optimising and self-healing.

Advanced machine learning (ML) and artificial intelligence (AI) can also be implemented to optimise network resources, detect network anomalies before service disruption and automatically resolve issues within a continuous, highly automated framework. The use of AI/ML allows CSPs to reduce the need for human intervention, reduce operational expenditure and improve network reliability.

CLA introduces new capabilities in the following categories:

- **Data collection and monitoring.** CLA makes use of predictive analytics in active testing, where synthetic data is generated to emulate live network traffic and fed back into monitoring systems to assess the state of the network and generate actionable insights. Key performance indicators (KPIs) related to network performance, user quality of experience (QoE) and end-to-end service performance can be calculated based on the collected data.

- **Predictive maintenance**: ML-based prediction models for network behaviour will enable operators to proactively detect network faults and congestion that may lead to performance degradation. This minimises network downtime and maintenance costs, mitigates QoS violations and ensures minimal service interruptions.

- **Fault and performance management**. Once a network incident is detected, this triggers an alarm to execute troubleshooting workflows. CLA leverages complex analytics that uses AI to perform root-cause analysis, which then invokes the control and orchestration layers to carry out appropriate remediation actions to resolve the issue.

CSPs have a long journey to achieve zero-touch, autonomous networks

TM Forum has laid out the Autonomous Network Levels (ANL) evaluation methodology to measure CSPs' progress in their automation journey (Figure 1). Most CSPs are working on achieving L2 automation, whereas more advanced CSPs such as China Telecom have completed the construction of the L2 autonomous network and plan to reach L3 within 2 years. China Telecom aims to realise the L4 highly autonomous network between 2024 and 2025, and finally achieve L5 fully autonomous networks by 2030.

Figure 1: TM Forum's Autonomous Networks Levels

Autonomous network level	Description
Level 0: manual management	The system delivers assisted monitoring capabilities, which means all dynamic tasks have to be executed manually.
Level 1: assisted management	The system executes a certain repetitive sub-task based on pre-configured actions to increase execution efficiency.
Level 2: partial autonomous networks	The system enables partial automatic operations and maintenance (O&M) for certain units based on predefined rule/policy under certain external environments.
Level 3: conditional autonomous networks	Building on L2 capabilities, the system with awareness can sense real-time environmental changes, and in certain network domains, optimise and adjust itself to the external environment.
Level 4: high autonomous networks	Building on L3 capabilities, the system enables, in a more complicated cross-domain environment, analyses and makes decisions based on predictive or active closed-loop management of service and customer experience-driven networks.
Level 5: full autonomous networks	This level is the goal for telecoms network evolution. The system possesses closed-loop automation capabilities across multiple services, multiple domains, and the entire lifecycle.

Source: TM Forum

Most CSPs have stated that resource/network optimisation is their top use case for CLA, with the main objective being to improve customer experience, followed by supporting 5G, IoT or cloud edge services and reducing the total cost of ownership. In TM Forum's Autonomous Networks project, CSPs are using the autonomous Customer Experience Index (CEI+) to improve customer experience:

- The CEI+ solution has helped Hong Kong Telekom (HKT) to increase its 5G user base by 20% by the end of 2021 since its launch in April 2020, and reduce its churn rate from 0.9% per month to 0.7% per month between 2020 and 1H 2021). HKT plans to use CEI+ to support its autonomous digital enabling services in vertical industries.

- China Mobile has implemented CEI+ to enable real-time network awareness, zero-touch service provisioning and self-managing capabilities to achieve automatic provisioning of cloud-networking services for enterprise customers.

- Telekom Argentina is using CEI+ to unify its network, marketing and customer operations, and improve operational efficiency across monitoring, demarcation and root-cause analysis.

- STC is working with Huawei to develop a unified model for the customer lifecycle and implement CEI+ to provide real-time, customised experiences on a per-user basis for its 4G and 5G subscribers and improve customer experience and satisfaction.

CSPs and vendors are actively involved in standardising an end-to-end architecture for closed-loop automation

CSPs recognise the importance of implementing CLA to successfully achieve a fully autonomous network, however the adaptation to internal/legacy applications and ensuring interoperability across multi-vendor, multi-domain environments are some of the key challenges to more widespread adoption. The ultimate goal of achieving a fully autonomous network requires a new horizontal and vertical end-to-end architecture framework that is aligned to industrial standards and driven by high-level policies and rules.

ETSI has established the zero-touch network and service management (ZSM) group to define a future-proof, end-to-end operable framework for CLA. The ZSM group includes over 60 members and participants, including leading operators such as Deutsche Telekom, NTT Docomo, SK Telekom, Telefónica, Telstra and Verizon, as well as vendors such as Cisco, Ericsson, Hewlett Packard Enterprise (HPE), Huawei, IBM, Nokia and Oracle. The closed-loop anomaly detection and resolution automation (CLADRA) framework by TM Forum also provides a reference architecture for deploying AI-driven CLA to enable use cases such as traffic flow optimisation, identification and correlation alerts for remediation, and system performance prediction.

Active collaboration with telecoms standardisation bodies will be crucial for CSPs in enabling interoperable solutions for zero-touch automation. CSP must also work with external vendors to adopt new network technologies (such as cloud-native functions, digital twins, data-driven AI/ML algorithms, SDN, network slicing, intent-based networking) and best practices to accelerate their automation journey.