ETSI GR ZSM 005 V1.1.1 (2020-05)

Zero-touch network and Service Management (ZSM); Means of Automation

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Reference

DGR/ZSM-005ed111_Autom

Keywords

automation, management, model, network, orchestration, service

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Foreword

This Group Report (GR) has been produced by ETSI Industry Specification Group (ISG) Zero touch network and Service Management (ZSM).

Modal verbs terminology

In the present document "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

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Introduction

The automation of network management and service delivery is becoming critical. All major industries are rapidly digitizing and automating their businesses, relying on state-of-the-art cloud platforms and connectivity services supporting a similar level of business agility and flexibility. CSP (Communications Service Provider) service delivery and network management automation is thus becoming critical for handling the increase in overall complexity and scale of operations created by the transformation of networks into a programmable, software-driven, service-based architecture. Going forward, unprecedented operational agility will be required to support new business opportunities enabled by technologies, such as network slicing and artificial intelligence.

The goal is to have all operational processes and tasks (e.g. service creation, fulfilment, assurance, and optimization) executed automatically and enabled at scale and at a required TCO.

The present document explores and introduces different means and approaches to automate particular aspects of these functionalities, operational processes and tasks.

Towards the automation continuum

In its simplest form, **automation** is the action of making a task executable without human intervention. It is realized by introducing new automatic functions or by replacing, modifying or augmenting manual functions with automation artifacts (e.g. a script executing a series of commands).

Automation applies to different granularities: from tasks (or function) and processes up to the entire management and operation of digital infrastructures, i.e. to the entire Life Cycle Management (LCM) of networks and services.

Communication networks and services are already well but fragmentary automated systems.

Individual functions usually exhibit high-level automation. For example, Interior Gateway Protocols (IGP) such as OSPF or IS-IS can automatically discover peers, advertise capabilities, share topology information, compute routing paths and react to failures, independently of external control or human supervision [i.1].

Automation also applies to the network or service life cycle management covering phases such as installation, configuration, provisioning, and termination; and coping with additional level of flexibility introduced by the decoupling of control and data planes and virtualisation techniques. The essential challenge arising from this advanced capability is the ability to develop integrated solutions (or systems) out of the composable components with the right levels of performance, robustness, extensibility, reconfigurability; stressing even further the need for standardized interfaces, models and mechanisms.

Yet, building a comprehensive **automation solution** remains an open problem. A comprehensive automation solution consists in chaining automated functions, with the following properties:

- Vertically end-to-end, i.e. across the protocol stack or from the service-layer to the physical-layer.
- Horizontally end-to-end, i.e. across different technologies or administrative domains.
- Repeatable and reusable in different contexts, i.e. relies on standardized or best current practices for interfaces and models.
- Provisioning dynamically, customizable "control or touch points" in the end-to-end automation loop for human supervision.

Therefore, a comprehensive automation provides an approach for combining **function automation** with **process automation**; in line with the approach of Continuous Provisioning (CP), as an additional step of the Continuous Integration (CI)/Continuous Delivery (CD) model.

Automation challenges

Realizing the automation continuum faces certain challenges.

Automation pros: machine-based automation is useful for repetitive, intensive and/or error-prone tasks. Where a human will fatigue and introduce errors, a program will run relentlessly and without departing from the normative work flow of its operations. There is no contest that in front of repetitive and intensive actions, machines outperform human capabilities by far. Automation can be applied virtually anywhere in the digital infrastructure chain of operation, from functional level to inter-functions, to processes and life-cycle.

Automation cons: Pure automation techniques show rapidly their limitations limits in front of heterogeneity, changing context/conditions of the problem at hand, i.e. they are not **adaptive**. These techniques will require:

- either advanced level of customization or fine tuning, which will make the automation solution specialized and lower the automation gain;
- or human intervention to adapt to the new context (technology, domain, operation), which works against the initial goal of automating tasks.

Tackling the automation challenge is necessary but not sufficient. Automation alone can only adapt within the function pre-defined scope and settings. Higher levels of **autonomy** can be reached by combining the automatic, **aware** and **adaptive** properties [i.2].

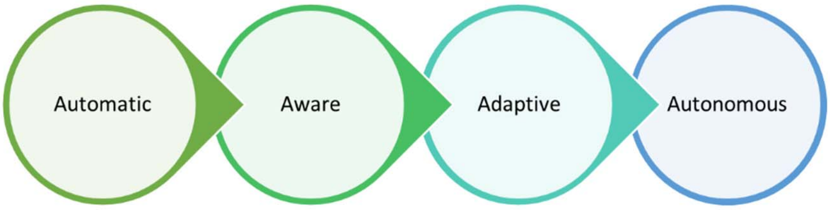

Figure 1: From Automatic to Autonomous - the "AAAA properties"

Collectively, the four properties qualify an **autonomous system**. Ultimately, this boils down to the essential coupling of automation with the **intelligence** that will drive it towards cognitive operation.

From automation to autonomous and cognitive management

Cognitive management automatically solves complex problems under uncertain (sometimes hostile) conditions to adjust and produce effective (re)action plans [i.3]. Cognitive management covers:

- Automation: ability to perform according to predetermined set of instructions.
- Complex: involve learning, inference and reasoning, causality analysis, expert knowledge.
- Uncertainty: epistemic (lack of knowledge) or aleatory (randomness/variability).
- Closed-loop: mainly adaptive (less often model-reference/predictive).

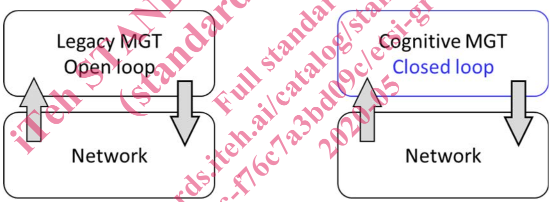

Figure 2: Legacy versus Cognitive Management - enabling a Closed Loop

Autonomous or cognitive systems relies on closed control loops for their base operation. Several types of closed control loops exist such as MAPE-K, OODA, MRACL [i.4] for the most used and well-known ones. Both individual functions and systems composed of functions can realize closed control loop operations. In the case of systems, it is the combination or chaining of the functions that collectively achieve the closed loop operation. It is therefore important to consider not only the functional-level design of the system but also the external properties of its functions or the system behaviour to assess whether the systems is autonomous (i.e. exhibits the AAAA properties).

Beyond the different types of control loops, 3 main pillars characterize cognitive system management: **measure, learn, decide.**

There is a gradient of autonomy levels for the combined management and managed systems. The share of autonomy of each part of the system can vary from case to case, from function to function and from domain to domain.

To reach a certain autonomy level, the composing parts of the system interact with each other: they discover capabilities, requirements and constraints supported by each, eventually negotiate or trade responsibilities and implications (e.g. areas of application, separation of concerns), define conditions of their interactions (escalation, delegation and coordination) to support the targeted autonomy level. This trading is dynamic. Most of the negotiation can be set at instantiation, but it should be possible to change the negotiated parameters over the life of the system. Such considerations and levels of flexibility should be considered in the design goals.

1 Scope

The present document explores different existing means or approaches to achieve automation. Such means may exist at different level of management and managed systems, e.g. at service and network management level, at managed network function level and at managed network level for autonomous optimization. All these means can have a value to achieve the ZSM goals.

The present document does not address a systematic survey of all standardization activities, open-source or other means to achieve automation. Rather it evaluates selected existing and proven means of automation at different levels of managed and management systems, provided by members of the ISG. That comprises for example:

- Alternatives for classic modelling such as intent vs. imperative vs. declarative modelling.
- Lessons learnt from 'model driven automation' of service and policy orchestration, including closed loop.
- Framework for self-managed VNFs based on cloud native network functions and implications.
- Delineate service modelling against 'machine learning'-inspired 'closed loop automation' modelling.
- Autonomous management of networks.

Means of automation may be single elements or composition of elements which enable service and network automation. They are made visible by this report, and may be considered by the ISG as elements in other work items for specifications.

2 References

2.1 Normative references

Normative references are not applicable in the present document.

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

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3 Definition of terms, symbols and abbreviations

3.1 Terms

Void.

3.2 Symbols

Void.