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Scenarios, Use Cases and Requirements for Autonomic/Self-Managing Future Internet

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Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Network Technologies (NTECH).

Modal verbs terminology

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1 Scope

The present document contains a description of scenarios, use cases, and definition of requirements for the autonomic/self-managing future internet. Scenarios and use cases selected in the present document reflect real-world problems which can benefit from the application of autonomic/self-management principles. Two types of high-level requirements are covered:

1) basic requirements that enable to derive an architectural reference model for introducing Autonomic Management & Control (AMC) of networks (resources, protocols, parameters) and services in various reference network architectures; and

2) specific requirements pertaining to aspects requiring "automation" and "behaviour" in a particular network/service management problem.

2 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 reference document (including any amendments) applies.

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2.1 Normative references

The following referenced documents are necessary for the application of the present document.

Not applicable.

2.2 Informative references

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

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3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

automated management: automation of the processes involved in the creation of network configuration input using specialized Task Automation Tools, e.g. scripts, network planning tools, policy generators for conflict-free policies

Autonomic Behaviour (AB): process which understands how desired Managed Entity (ME) element's behaviours are learned, influenced or changed, and how, in turn, these affect other elements, groups and network [i.13]

NOTE: Managed Entity can be physical or logical resource.

autonomic manager element: functional entity that drives a control-loop meant to configure and adapt (i.e. regulate) the behaviour of a managed entity

NOTE: E.g. a protocol module or some other type of a managed entity such as a component, processing sensory information from the managed resource and from other types of required information sources and reacting to observed conditions by effecting a change in the behaviour of the managed resource to achieve some goal.

autonomic networking: networking paradigm enabling network devices and the overall network architecture to exhibit the so-called self-managing properties, namely: auto-discovery, self-configuration (auto-configration), self-diagnosing, self-repair (self-healing), self-optimization, etc.

NOTE: The term autonomic comes from the autonomic nervous system, which controls many organs and muscles in the human body. Usually, human are unaware of its workings because it functions in an involuntary, reflexive manner – for example, human do not notice when their heart beats faster or their blood vessels change size in response to temperature, posture, food intake, stressful experiences and other changes to which human are exposed. And their autonomic nervous system is always working [i.2].

context awareness: property of an autonomic application/system that enables it to be aware of its execution environment and be able to react to changes in the environment [i.1]

Decision Element (DE): functional entity designed and assigned to autonomically manage and control some Managed Entities (Mes)

NOTE 1: Decision-Making-Elements (DMEs) [i.15] referred in short as Decision Elements (Des) that fulfil the role of Autonomic Manager Elements.

NOTE 2: In accordance with note 1, an ME can be a protocol or a mechanism implemented by some functional entity. A Decision Element (DE) in an Autonomic Manager Element implements the logic that drives a control-loop over the management interfaces of its assigned Managed Entities (Mes). Therefore, self-* functionalities are functionalities implemented by Decision Element(s).

NOTE 3: Mes and their associated configurable parameters are assigned to be managed and controlled by a concrete DE such that an ME parameter is mapped to one DE.

future internet: framework Interoperating Multi-Service Self-Managing Future Networks that evolve from today's networking models, paradigms and protocols, and will also include newly designed networking models that succeed to be "deployed"

NOTE: The motivation behind Future Internet is to address deficiencies in current networks such as Scalability, and lack of "Network Intelligence (through Autonomics and Cognition)", and also incorporate missing capabilities such as Self-Management Capabilities. Future Internet includes all sorts of Fixed(Wired) / Mobile / Wireless / Sensor Networks. The Future Internet will interconnect and inter-operate IP(v4&v6) and any Post-IP Networks that emerge and get deployed as some other types of "islands" within the global space of the "Future Internet". As the Future Internet evolves, some "islands" identified by old technology will disappear and new "islands" identified by new technology will appear in the picture.

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GANA (Generic Autonomic Network Architecture): conceptual architectural reference model for autonomic network engineering, cognition and self-management

NOTE 1: GANA purpose is to serve as a "blueprint model" that prescribes design and operational principles of autonomic decision-making manager elements responsible for autonomic and cognitive management and control of resources (e.g. individual protocols, stacks and mechanisms).

NOTE 2: GANA is a functional architecture and not an implementation architecture [i.15].

knowledge plane: pervasive system within the network that builds and maintains high-level models of what the network is supposed to do, in order to provide services and advice to other elements of the network [i.19]

NOTE: It is a distributed and decentralized construct within the Internet to gather, aggregate and act upon information about network behaviour and operation [i.20]. The subject of the kind of functional entities (mainly GANA Network-Level-DEs) that realize the Knowledge Plane, is covered in clause 9.13 of the GS AFI 002 [i.15]: "Cognition and Knowledge Plane as part of the GANA Decision Plane".

Managed Entity (ME): physical or logical resource that can be managed by an Autonomic Manager Element (i.e. a Decision Element) in terms of its orchestration, configuration and re-configuration through parameter settings

overlay: logical network that runs on top of another network

EXAMPLE: Peer-to-peer networks are overlay networks on the Internet. They use their own addressing system for determining how files are distributed and accessed, which provides a layer on top of the Internet's IP addressing.

self-advertise: ability to advertise its self-model, capability description model, or to send some information signalling message [i.18] to the network in order to allow communication with it or to allow other entities to know whatever is being advertised

self-adaptation: ability of a system or component to change its state of operation e.g. by changing its configuration, in response to context changes that define the service(s) it is supposed to provide to the outside world, or changes in workload, or in response to internal and external challenges (e.g. manifestation of faults, errors and failures)

NOTE: Self-features of a system or component, such as self-optimization and self-healing are special cases of self-* adaptation.

Self awareness: ability to "know itself" and be aware of its state and its behaviours [i.1]

NOTE: Knowledge about "self" is described by a "self-model".

self-care services: ability of a system (e.g. network) to promote and provide an interface for external users to request and consume its services without intervention of the system-administrator, and to update services available to users of such services

self configuration: ability to configure and reconfigure itself under varying and unpredictable conditions [i.1]

self-descriptive: able to provide a description of its self-model, capabilities and internal state [i.3]

self-diagnosis: ability of a system or component to perform fault-diagnosis (also called fault-localization or fault-isolation) procedures by employing various methods to determine the root cause of a failure or malfunction, without external intervention [i.21]

NOTE: Identifying abnormal behaviour (symptom) of a running system or component based on values received by the sensors, by launching some testing (e.g. to discriminate remaining ambiguities), or using the information available in its system or component model and its analysis knowledge-base (e.g. the use of model-based techniques for fault-diagnosis/localization/isolation).

self healing: able to detect and recover from potential problems and continue to function smoothly [i.1]

self-monitoring: able to observe its internal state [i.3]

EXAMPLE: Observation of internal state can be quality-of-service metrics such as reliability, precision, rapidity, or throughput.

self optimization: ability to detect suboptimal behaviours and optimize itself to improve its execution [i.1]

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self organizing: able to organize itself with minimum manual intervention **[**i.12**]**

self partioning: introducing level of automation within the partioning process

self protecting: able to detect and protect its resources from both internal and external attacks and maintain overall system security and integrity [i.1]

self-regulation: ability to regulate its internal parameters so as to assure a quality-of-service metric such as reliability, precision, rapidity, or throughput [i.3]

self services: ability to promote and update services available to public

self-testing: ability to test the conformance of its systems

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

3GPP	3rd Generation Partnership Project
AB	Autonomic Behaviour
ABGet	Available Bandwidth Get
AC	Admission Control
AC_ME	Admission Control Managed Entity
AF	Autonomic Function
AFI	Autonomic network engineering for the self-managing Future Internet
AMC	Autonomic Management & Control of Networks and Services
AP	Access Point
API	Application Programming Interface
App_DE	Application Decision Element
BBF	Broadband Forum
BS	Base Station
BSS	Business Support System
CaaS	Communication as a Service
CHOP	Configuration-Healing-Optimization-Protection

NOTE: For implying Self-* features of an autonomic system, namely: Self-Configuration; Self-Healing; Self-Optimization and Self-Protection.

CIM	Common Information Model
CLI	Command-Line Interface
CM	Consistency Manager
DE	Decision Element
DHT	Distributed Hash Tables
DME	Decision Making Element
DMTF	Distributed Management Task Force
E2E	End to End
EMS	Element Management System
EPC	Evolved Packet Core
GANA	Generic Autonomic Network Architecture
GS	Group Specification
GUI	Graphical User Interface
HAN	Home Area Network
IaaS	Infrastructure as a Service
IANA	Implementable Autonomic Network Architecture
IB	Information Base
IDS	Intrusion Detection Systems
IMS	IP Multimedia SubSystem
IP	Internet Protocol
Ipv4/Ipv6	Internet Protocol version 4 or 6
IRP	Integration Reference point
ISP	Internet Service Provider
ISV	Independent Software Vendor

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IT	Information Technology
ITU-T	International Telecommunication Union
KPI	Knowledge Plane Information
LTE	Long Term Evolution
M2M	Machine to Machine
MAC	Medium Access Control
MANET	Mobile Ad-hoc NETworks
ME	Managed Entity
MM	Monitoring Module
MVNE	Mobile Virtual Network Enabler
MVNO	Mobile Virtual Network Operator
NaaS	Network as a Service
NE	Network Element
NGN	Next Generation Network
NGOSS	New Generation Operations System and Software
NMS	Network Management System
NO	Network Operator
OAM	Operating And Maintenance
OPEX	Operation Expediture
OSS	Operation Support System
OTT	Over The Top
OVN	Overlay Virtual Network
P2P	Peer to Peer
PC	Personal Computer
QoE	Quality of Experience
QoS	Quality of Services
QoS_DE	Quality of Service Decision Element
RAN	Radio Access Network
RFID	Radio-Frequency IDentification
RQ	Requirement
Saas	Service as a service
SDN	Software Defined / Driven Network
SDO	Standardization Organization
SID	Shared Information Data/Model
SLA	Service Level Agreement
SMS	Short Message Service
SOHO	Small Office Home Office
SON	Self Organizing Network
TCP	Transmission Control Protocol
TISPAN	Telecoms and Internet converged Services and Protocols for Advanced Networks
TMF	Tele Management Forum
TSPEC	Traffic Specification
TV	Television
UE	User Equipment
VNO	Virtual Network Operator
WMP	Wireless Media Access Control (MAC) Processors

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4 Main drivers towards Autonomic Management and Control (AMC) of Networks and Services

4.1 Global background and general requirements on the need for autonomics

As network operators need to address numerous issues such as deregulated markets, open competition, explosion of digital services, converged fixed-mobile services, converged IT-Network (virtualisation, Clouds) and operation efficiency, they are facing new business and technical challenges. Consequently, they are striving to build a new ecosystem comprising end-to-end solutions, created through strategic alliances within the telecommunications sector including third parties (e.g. Mobile Virtual Network Operator (MVNO) / Mobile Virtual Network Enabler (MVNE), competitors becoming partners (Radio infrastructure sharing or "Radio Access Network (RAN) Sharing" agreement, for instance), Clouds Services Providers, Virtual Network Providers, consumers becoming content producers, outsourcing partners, integrators. For this reason the networks they are operating and the associated 'Operations Support System' (OSS) need to be intelligent, agile, open, secure, flexible and autonomic (i.e. operating with minimum human intervention).

As driving forces from the network evolution perspective, industries can highlight the deployment of key emerging technologies such as IP Multimedia Subsystem (IMS) / Next Generation Network (NGN), Long Term Evolution (LTE)/Evolved Packet Core (EPC), Future Internet, Internet of Things, Machine to Machine (M2M), Infrastructure / Network / Communication as a Service (IaaS/NaaS/CaaS), etc. The underlying network architectures, so called "flat architecture" will increase the amount of equipments required while at the same time the major operators' requirement is to lower operating costs (OPEX).

That means, some level of the notion of being "autonomic" should be embedded into network equipment and OSS at a first phase for the configuration purpose.

Future Network infrastructure should incorporate more and more autonomic features in order to maintain operational costs under control when it comes to a large scale deployment phase.

The same should be also applicable during the "operation phase" and "optimization phase", all lifelong of the network. This needs embedding self-configuration, self-healing, self-optimization, self-protecting (Self CHOP) features.

In this context, requirements aiming at building trust and confidence on these self-functions, in one hand, and the coordination of interaction of various autonomics functions in the other hand, shall be implemented in order to ensure a global optimum while targeting a local optimum per autonomics function activated through the same optimization parameter.

Without this coordination, the operator could not prevent the fact that some parameters can lead to the optimization of one autonomics function while at the same time, it negatively impacts another autonomics function. This results in an unstable behaviour of the network.

That means, the coordination of interaction of autonomics functions deployed in a network is a major requirement as well from operators' perspective.

In case of failure of an Autonomics function, a process shall be specified and designed to allow the operator to keep control of the management of the network through its OSS and related tools by desactivating a given autonomics function as long as a solid trust and confidence has not being built.

Currently, there is a lot of work being carried out on autonomics, mostly conducted by the research community but from the operational point of view there is little common understanding on how autonomic technologies can help and how they will impact current operation models of the operators. There is a need to build a new management environment that can definitely contribute to the efficiency of business units and reduce OPEX. Autonomics and Self-Management related technologies are envisioned as the solution for a player to control its own environment and at the same time assuring the end to end view, which emerges from the individual behaviours of all the players.

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The present document focuses on the set of requirements for Autonomic and Self-Managing Future Networks to efficiently help the operator to face new market realities and on the definition of the operational requirements for operators to take advantage of such advanced infrastructure. The operational model is far beyond the classical centralized management approaches, looking for innovative methods for controlling and managing distributed decision making functions embedded in an autonomous and intelligent infrastructures.

The present document establishes a framework for "Scenarios, Use Cases and Requirements for the Self-Managing Future Networks" contributed by network operators and other players such as content providers, etc.

The starting point is capturing autonomic issues and global context from operators' requirements in order to shape the current and Future network vision. This serves as input to formulate operators' requirements from operation view point. The result is shaping AFI high level requirements.

4.2 Future network vision and expected further requirements for Autonomics and its interworking with other emerging paradigms

This clause is simply meant to provide useful insights into emerging trends in networking, in which autonomics, as a paradigm, is expected to play a role while also complementing other emerging networking paradigms such as Virtualization and Software-Driven/Defined Networking (SDN).

In the future, processing, storage and communication services will be highly pervasive, intertwined and strongly related to each other. What the future network vision expects is that people, smart objects, machines and the surrounding space will all be embedded with devices such as sensors, RFID tags, etc., defining highly decentralized dynamic network environments of virtual resources interconnected by wired and wireless connectivity. Overlay networks will be the major means to organize and aggregate these highly dynamic communication environments.

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Virtualization of resources (from networking to processing to storage, etc.) will be a key characteristic of Future Networks. As a consequence:

- autonomic features should support functions such as the creation and maintenance of overlay networks of virtual resources.

For instance autonomic features might be integrated with hypervisors' capabilities.

Therefore, networks will evolve towards a broader perspective to include not only connectivity resources but also other types of resources such as processing, storage and things (e.g. terminals, sensors, actuators, probes, etc.). This is a more holistic and future proof vision of the network environment (useful for analysing various scenarios/use-cases: from zero-configuration Home to Cloud Computing, to Content Delivery Networks, etc.).

Besides, programmability and flexibility through SDN (Software Defined / Driven Network) are key enablers for networks (fixed and mobile) as well for data centres. (Reader may refer to SDN-oriented enablers are also mapped to GANA reference model [i.15]). It allows a close interaction of applications to networks which leads to delivering network services in an efficient manner via standardized and open Application Programming Interfaces (APIs).

4.3 Operator's requirements that enable derivation of a reference model for introducing AMC in networks

The scope in this clause is mainly focused on end to end services management from user perspective within an evolved network. Besides, some operators have to deal with the legacy network that is why an autonomic management and control specification needs to seek how to adapt Fixed (e.g. BBF), Mobile (e.g. 3GPP) and services (e.g. IMS) architectures in order to make the introduction of autonomic functions easier and smoother in physical, virtualized, distributed centralized resources. Therefore, in addition to user's requirements, a set of technical and management requirements for operators to deal with an autonomic network have also been captured.

First, a "knowledge plane" shall be introduced in the network taking into account the legacy network on the one hand, and services (e.g. IMS), access (e.g. Fixed and Mobile) and home access networks (e.g. Broadband Forum reference architecture, "Authone: Autonomic Home Networking" project [i.17], for instance), on the other hand.

- This knowledge plane shall take into account the constraints of all the actors and security concerns.

- Data in the knowledge plane shall be up to date and granted. Information from different actors could be shared by context defined by an ontology.

Autonomic features would decide locally based on knowledge retrieved from analysed information of the global network. Based on such knowledge, local decisions would be taken in respect of end to end or global views, e.g. configuration of network elements from end to end constraints actors view point, mobility control between different heterogeneous access network with different radio access technologies (e.g. WiFi, Wimax, 2G/3G/LTE), services adapted to user context.

The clause defines a set of operational requirements for an operator to control an Autonomic and Self-Managing Future Network. The requirements have implications on the operational principles of autonomic components of an autonomic network e.g. federation requirements, information sharing, and other types of desired behaviours in networks (as described later with figure 2) which illustrate a Policy Management framework.

In this context two views need to be highlighted: "cross layers autonomic views" within an operator's network in one hand, and "cross domain autonomic view" through various domains in the other hand. Domains mean here "players" as described later with figure 14.4.2 requirement framework for a policy- based management as input towards derivation of a reference model for introducing amc in networks. Indeed, from "cross layers autonomic views", an upper layer "cognition function" is able to retrieve from local views a situated view of its environment. At a lower layer which embeds an Autonomic Function it becomes possible to retrieve objectives from upper layers in order to make a decision locally with a global objective, to different layers (as described later with figure 3).

Regarding "cross domain autonomic view", the cognition functions are used here with the goal to disseminate the knowledge through various domains (as described later with fgure 4). Indeed, each "Autonomic Function" will use this "cognition function" to react locally with a *common* objective, to different domains.

- In order to manage end to end services autonomously if needed (players' agreements, regulation constraints, etc.) an horizontal autonomics architecture shall be defined.

iTeh STANDARD PREVIEW
(standards.iteh.ai)
Full standard:
https://standards.iteh.ai/catalog/standards/sist/f1885d...
7e93-4c4f-904d-de5378f8940/etsi-ts-103-194-v1.1.1-2014-10

4.4 Management requirements input to derivation to automated management workflow and architectural aspects of an autonomic network

This clause gathers the set of operational and management requirements for an operator to deal with an autonomic network. Starting from users' requirements, a set of operational and maintenance requirements are captured for an operator to fulfil the quality expectations of users. This work is aligned with the NGN management requirements that can be found in [i.6] and [i.5] where a first level of requirements (level 0) is composed by:

- Customer centric requirements.
- Business vision requirements.
- Technology requirements.
- Operational requirements.
- Regulatory requirements, only the Technology and Operational requirements are covered here.

The first set of requirements in Table 2 is user oriented. Users want to have access to adapted services that they choose with a guarantee of security and quality. This implies requirements from operators' perspective: Operating and Maintenance (OAM) requirements.