

ARTIFICIAL INTELLIGENCE (AI) IN TEST SYSTEMS, TESTING AI MODELS AND THE ETSI GANA MODEL'S COGNITIVE DECISION ELEMENTS (DES)

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Agenda

- ETSI TC INT → Activities on « Autonomic Management & Control of Networks and Services»: Technical, Operational & Regulation Challenges towards Industry Consensus
- ETSI 5G PoC Program under TC INT AFI WG
- ETSI GANA → Multi-Layer Artificial Intelligence (AI) Framework for Implementing AI Models for Autonomic Management & Control (AMC) of Networks and Services
- □ AI in Performance Test Systems
- Testing AI Models for Closed-Loop (Autonomic) Network Automation
- AI Generic Test Framework for Testing ETSI GANA Multi-Layer Autonomics & their AI Algorithms for Closed-Loop Network Automation









ABOUT ETSI TC INT AFI WG

Core Network and Interoperability Testing (INT)/

AFI WG = Autonomic Management and Control Intelligence for Self-Managed Fixed & Mobile Integrated Networks









ETSI GANA Multi-Layer AI & Autonomics Framework; Key Liaisons and Deliverables



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ETSI TC INT WI: Scenarios, Use Cases & Requirements for Autonomic Networks ETSI TS 103 194

ETSI GANA Cross-Layer Autonomic & Cognitive "Business-Service-Network" Framework, and Benefits and Value Creation it brings

ETSI TC INT AMC standalone & **2** Federated AMC Framework ETSI TS 103 195-2

5G Systems (supporting highly disaggregated and modularized capabilities) must evolve to "Smart Networks of the future" operated on principles of dynamically adaptive Autonomic Management & Control (AMC) powered with Al capabilities, meeting Regulation requirements (e.g. Accountability, Audit, Ethics) ETSI TC INT WI on Testing 3 AMC / AI Systems (5G use caes)

5G Autonomic Networks and embedded AMC / Al Models, must be assessed under Programmable Training, Testing, Monitoring, Intentbased Orchestration and Service & Security Assurance through Test Systems powered with Al capabilities

ETSI TC INT 5G PoCs on Autonomic 5G Network Slicing Mgnt & Control

5G Network Slices Creation, Autonomic & Cognitive Management and E2E Orchestration; with Closed-Loop(Autonomic) Service & Security Assurance of Network Slices <u>https://intwiki.etsi.org/index.php?title=Accepted_PoC_proposals</u>







THE ETSI 5G POC (PROOF-OF-CONCEPT) PROJECT UNDER TC INT AFI WG

Operationalizing the ETSI GANA Framework for Autonomic Management & Control (AMC) of Networks and Services

https://intwiki.etsi.org/index.php?title=Accepted_PoC_proposals (For White Papers Downloads)









Topics & Demos being carried out to Expose Gaps in **Standards and Address Industry Challenges**













AFI Proof of Concept

ETSI GANA Reference Model and Instantiations

ETSI TS 103 195-2









Federated GANA Knowledge Planes for RAN-, Backhaul- and 3GPP Core Networks complemented by low level autonomics











Federation of GANA Knowledge Planes for E2E Autonomic (Closed-Loop) Service & Security Assurance of 5G Slices











Multi-Layer Autonomics and ETSI GANA Knowledge Plane(KP) Integration with other Systems (Integration APIs)





ETSI 5G POC WHITE PAPER NO.5 [THE FOCUS HERE]

Artificial Intelligence (AI) in Test Systems, Testing AI Models and the ETSI GANA Model's Cognitive Decision Elements (DEs) via a Generic Test Framework for Testing ETSI GANA Multi-Layer Autonomics & their AI Algorithms for Closed-Loop Network Automation







Key Takeaways of the White Paper No.5

- Benefits of AI in Test Systems
- Approaches to Testing AI Models in general
- Standardizing a Generic Test Framework for Testing GANA Components for Autonomics
- Test Solutions that play a role in Enabling Autonomic Management & Control of 5G Slices
- Invitations for Contributions to the Newly launched Work Item in ETSI TC INT: AI in Test Systems and Testing AI Models





THE BENEFITS AI BRINGS TO TEST SYSTEMS (EMBEDDING AI IN A TEST SYSTEM/COMPONENT)

Al in Performance Test Systems







Al in Performance Test Systems

Why does AI fit especially well in performance testing? Over 95% of all performance measurements are regression tests! Implications: Performance regression tests is a learning process in the behavior of the tested system! This can be handled particularly well by AI in a system performance testing tool. Results would be less and more focused measurements of the most critical system characteristics. Frequent performance tests produce huge amounts of measurement data! This can also be handled particularly well by AI in a system performance testing tool. Results would be faster and better analysis of behavior trends of the tested system indicating potential future performance problems at an early state. softwell

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Advantages of AI in performance test tools

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Al in Performance Test Systems









Al in Performance Test Systems





TESTING AI MODELS FOR AUTONOMIC AND COGNITIVE MANAGEMENT & CONTROL OF NETWORK RESOURCES, PARAMETERS AND SERVICES

Testing AI Models for Closed-Loop (Autonomic) Network Automation









The Main Aspects in Testing AI Models/Systems in General

- Key stakeholders, their roles and responsibility demarcation
- Data Validation
- Algorithms Testing and Model Validation
- Non-Functional Testing (e.g. Performance Testing and Security Testing)
- Integration Testing







ETSI GANA / AMC Cognitive c/d DEs (AI / ML Models) life cycle and Stakeholders:

Development – Training – Testing – Certification – Deployment - Auditing





of AI Models Test and Certification and associated stakeholders







Stakeholders in Test and Certification of GANA Cognitive DEs and **GANA Knowledge Planes**







Designing the Test Systems/Components for Testing Autonomics AI Models, and Challenges in AI Models

- □ Time it may take for an AI Model for autonomic management and control to meaningfully be applicable and be able to keep pace with dynamics of the network
- □ Time it may take for an AI Model embedded in a Test Component/System to meaningfully be applicable and be able to keep pace with dynamics of the network
- Verdicts Passing in Testing AI Models, and How Suppliers of AI Models (e.g. Cognitive GANA DEs) to be Tested and Certified can produce "Claims Specifications of Measurable Metrics/KPIs and certain observable and verifiable outputs" on what the AI Model can achieve under certain conditions during its operation
- Idea of using the concept of a "Qualified Automated Test Component(s) or System" that exhibits best quality AI capabilities, in testing comparable capabilities of AI Component(s)/System Under Test











Standardizable Metrics for Measurements and Assessments in Testing and Certification of AI Models of Autonomic Components/Systems

- Stability of the AI Model
- Speed of Learning of the AI Model
- Speed of Decision-making cycle of the AI Model after receiving triggering inputs
- Speed of Convergence of multiple interacting AI Models/components in a larger AI System
- Quality of Decision-Making of the AI Model







STANDARDIZING THE TEST FRAMEWORK FOR ETSI GANA COMPONENTS

A Generic Test Framework for Testing ETSI GANA Multi-Layer Autonomics & their AI Algorithms for Closed-Loop Network Automation







Key Aspects and Status of the Framework

- Design Principles for Test Components/Systems for Testing GANA Multi-Layer Autonomics Components
- Conformance Testing of GANA Functional Blocks (FBs) and Reference Points
 - Conformance Testing of the GANA Knowledge Plane (KP) DEs and their Reference Points, and Test Data
 - Conformance Testing of the GANA Knowledge Plane (KP) ONIX system and its associated Reference Points, and Test Data
 - Conformance Testing of the **GANA Knowledge Plane (KP) MBTS** and its associated Reference Points, and Test Data
 - Conformance Testing of the GANA Levels 2 and 3 DEs and their Reference Points, and Test Data
- □ Integration Testing of GANA FBs
- Performance Testing of individual GANA FBs
- □ Status of Standardization: TR will be produced in 2020/2021 to extend the early Draft Generic Test Framework in ETSI EG 203 341 V1.1.1







Types of testing and associated deployment phases of DEs

Type of Testing	Validation phase of an AF	Trustworthine ss building phase	Certificatio n Phase for the AF	Test Network Deployme nt Phase	AF deployme nt and activation Phase	Test Network Operatio n phase	Test Network Optimizatio n Phase
AF Testing and Validation	X	X	X				
Conformance Testing			X	X	X		
Interoperability Testing			X	X	X		
Integration and User Acceptance Testing of an Adaptive Network as a whole				X	X	X	X









The GANA MetaModel is an Assest to DE Implementers and Test **Developers**



User Conference on Advanced Automated Testing

to a specific network domain and is specific to a

AFI Proof of Concept

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AFI Proof of Concept

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The GANA MetaModel is an Assest to DE Implementers and Test Developers







INVITATION TO CONTRIBUTE TO A NEW WORK ITEM LAUNCHED IN ETSI TC INT

Name of the Work Item: AI in Test Systems and Testing AI Models







Scope & Expected Deliverables of the Newly Launched Work Item in ETSI TC INT

Artificial Intelligence (AI) in Test Systems,

- Testing AI Models in General and the Testing ETSI GANA Model's Cognitive Decision Elements (DEs)
- Generic Test Framework for Testing ETSI GANA Multi-Layer Autonomics & their AI Algorithms for Closed-Loop Network Automation

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ETSI INT 5G PoC wiki: http://ntechwiki.etsi.org/; https://intwiki.etsi.org/index.php?title=Accepted_PoC_proposals

