

Presentation at ITU ETSI IEEE Joint SDOs Brainstorming Workshop on Testbeds Federations for 5G & Beyond: Interoperability, Standardization, Reference Model & APIs Workshop

ITU-ETSI-IEEE joint SDOs
brainstorming workshop
**Testbeds federations for 5G
and beyond: interoperability,
standardization, reference
model and APIs**

Free | Virtual
15-16 March 2021
14:00 to 17:30 CET

<http://itu.int/go/BTF4-5G>

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Presentation/Discussions on the Reference Model, Associated Reference Points/APIs and the Key Players for Testbeds Federations for 5G & Beyond — being Standardized by ITU-T SG11 & ETSI TC INT

15th March 2021

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The Standards People



This is Joint Work of ETSI TC INT and ITU-T SG11

Reference Work Items in ITU-T SG11 and ETSI TC INT contributing to this Work:

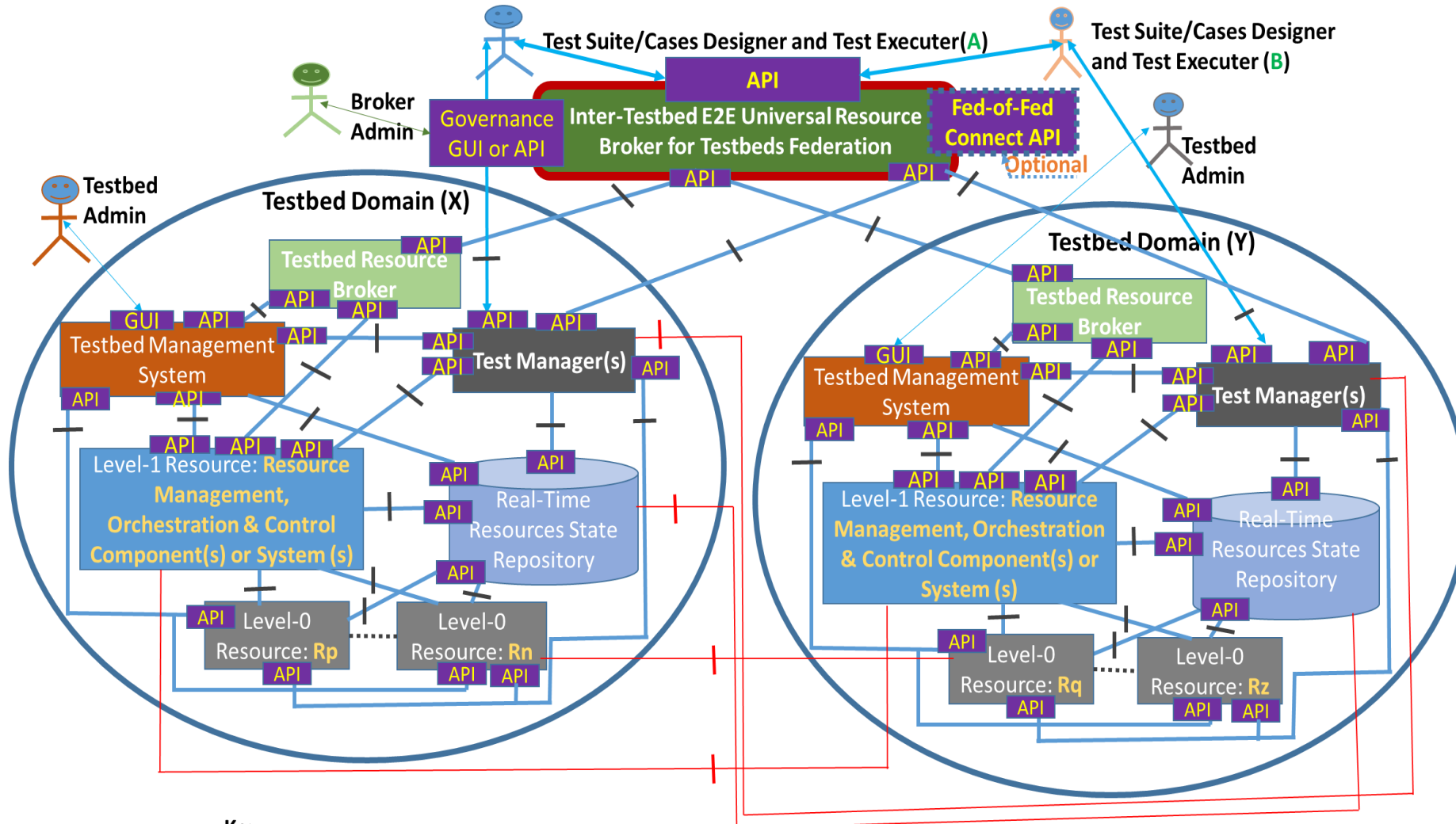
- *ITU-T SG11 Q.API4TB on Open APIs for Interoperable Testbed Federations: https://www.itu.int/ITU-T/workprog/wp_item.aspx?isn=16511*
- *ETSI TC INT: Test Requirements and Approach for E2E Federated Testbeds, with an Example Use Case of Testing Federated Autonomic Management and Control (AMC) operations (e.g. by GANA) Components Within and Across Multiple 5G Network Operators (https://portal.etsi.org/webapp/WorkProgram/Report_WorkItem.asp?WKI_ID=59577)*

NOTE: IEEE INGR Testbeds WG is Adopting this Work and Collaborating with ITU-T & ETSI on this Work

Agenda Outlook

1. **Reference Model for Testbeds Federation: Generic Federated Testbed Model**
2. **Specializations of the Testbed Domain Concept**
3. **"Federations of Federations", a level above the level of the Universal E2E Resource Broker**
4. **Abstraction Levels for Resources in a Testbed, and how individual Resources may take part in a Test Scenario**
5. **Types of APIs for Testbed Federations based on the Testbeds Reference Model; and APIs Specifications, Implementation Invocations Approaches**
6. **Examples of Testbeds Federation APIs Requirements**
7. **Roles of Various Stakeholders to the Emerging Ecosystem around the Testbeds Federation Reference Model, its APIs and its Instantiations using various Testbeds that get federated**
8. **Summary of the Objectives of this Workshop w.r.t Stakeholders Engagement around the Testbeds Federation Reference Model and associated Ecosystem to emerge**

Reference Model for Testbeds Federation: Generic Federated Testbed Model

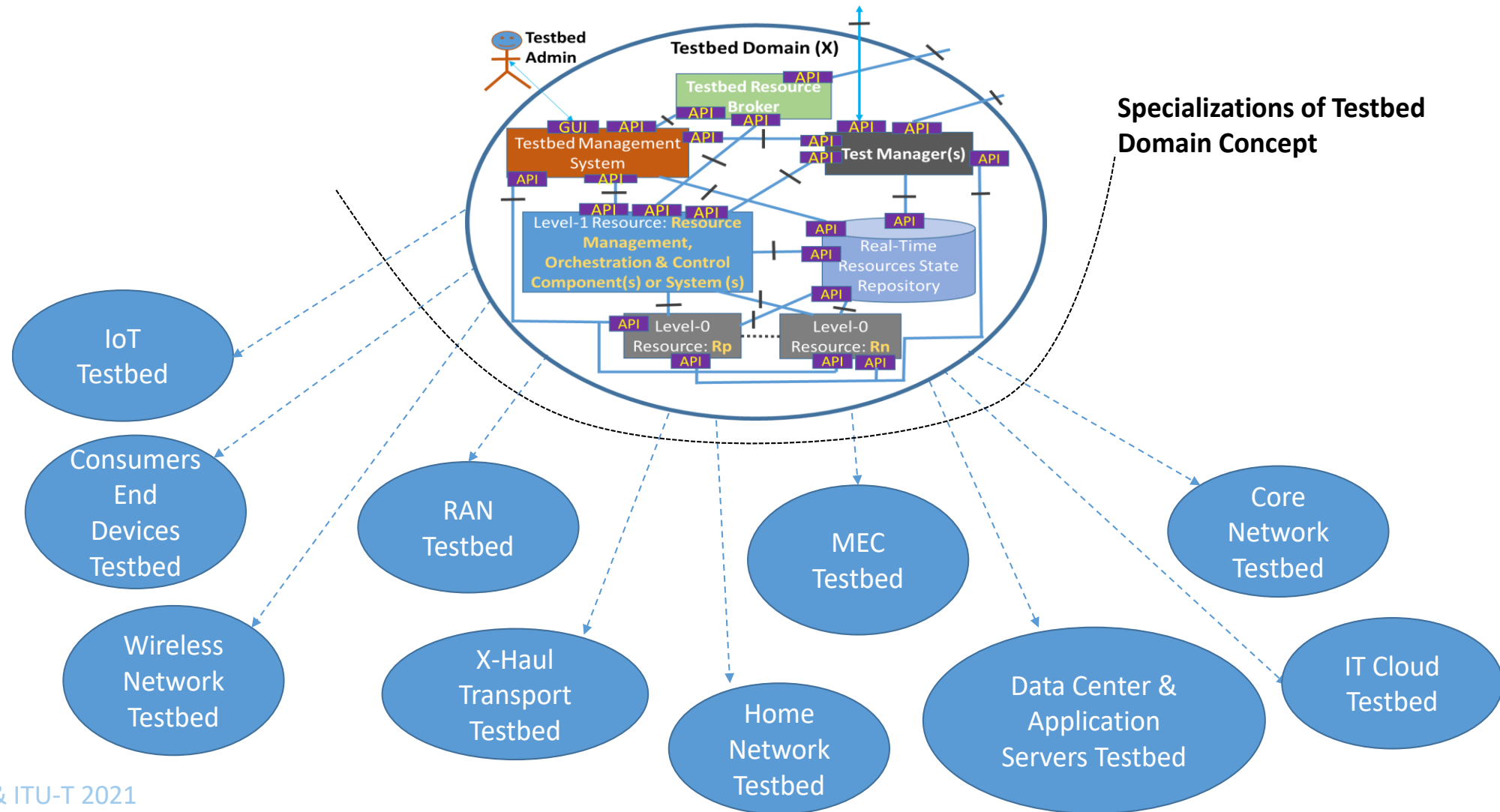


NOTE: The APIs shall be named (to have a way to distinguish them) and we shall start describing the APIs and how the Generic APIs get extended (specialized) by Testbed Type specific APIs and how Generic APIs make calls to the Testbed Type specific APIs

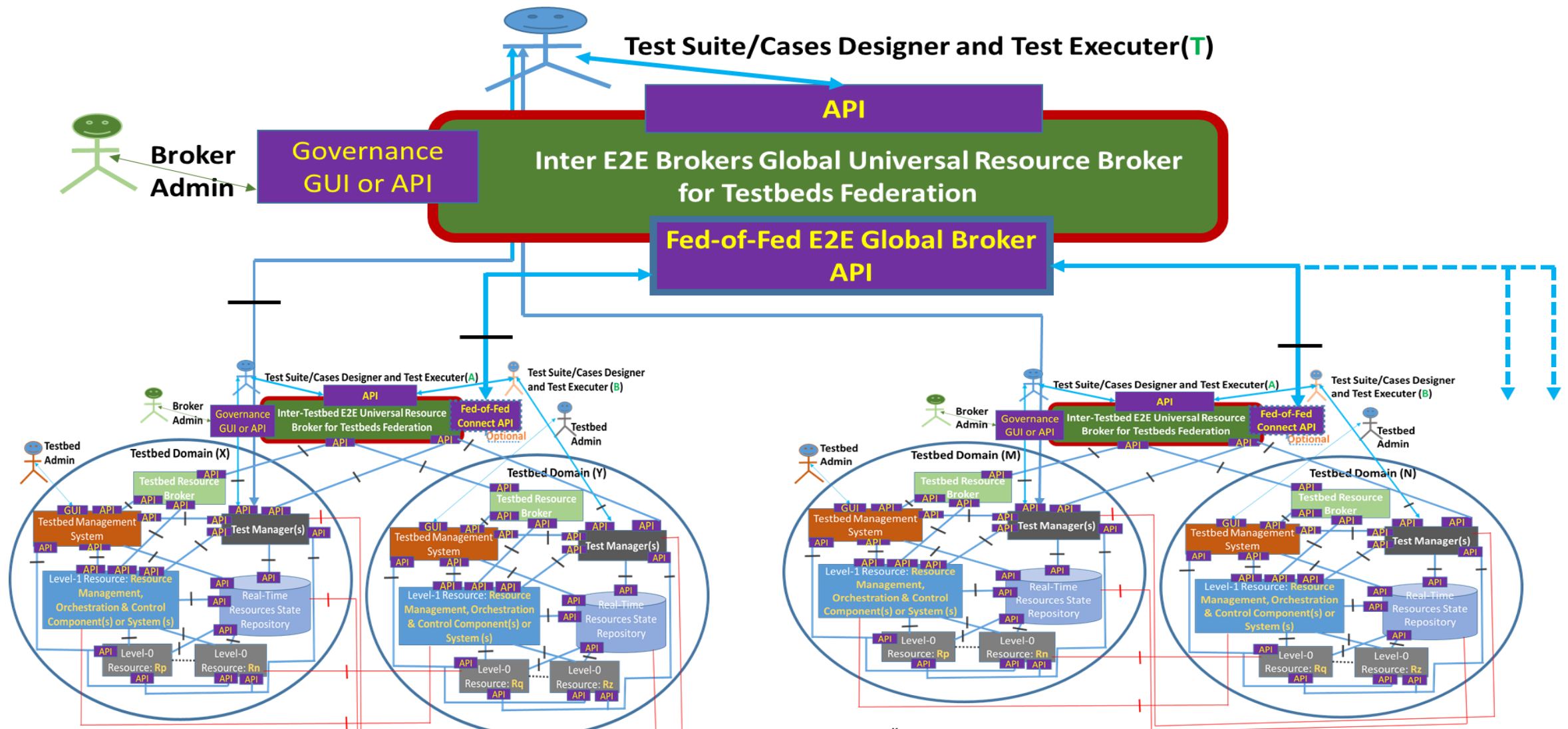
Key: There may be established Horizontal and/or Hierarchical/Vertical Federations of Assets/Components or Resources at specific Levels across Federated Testbeds

Specializations of the Testbed Domain Concept

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"Federations of Federations", a level above the level of the Universal E2E Resource Broker



Key: There may be established Horizontal and/or Hierarchical/Vertical Federations of Assets/Components or Resources at specific Levels across Federated Testbeds

Examples of Abstraction Level-1 Resource which could be used within a Test Scenario



Level-1 Resource: **Resource Management, Orchestration & Control Component(s) or System (s)**

Embedded Test Agent

Level-1 Resource: **Resource Management, Orchestration & Control Component(s) or System (s)**

No Embedded Test Agent

- ETSI GANA Knowledge Plane (KP) Platform as whole (with KP Decision Elements (DEs), MBTS, an ONIX System of Federated Information Servers)
- OSS/BSS
- E2E Service Universal Orchestrator
- Domain Controller
- SDN Controller
- MANO Stack
- Big Data Analytics Platform
- GANA ONIX as Standalone System
- Performance Monitoring Component or System
- EMS/NMS
- Fault Management System
- Configuration Manager Component
- Security Management System

NOTE: In some Test Scenario a Resource may itself be considered as a Component Under Test (CUT) or System Under Test (SUT) or may simply be required to participate in a Test Scenario

Examples of Abstraction Level-0 Resource which could be used within a Test Scenario



Level-0 Resource: **Rp**

Embedded Test Agent

Level-0 Resource: **Rp**

No Embedded Test Agent

Examples of Level-0 Resource:

- Protocol
- Network Element/Function (NE/NF) – PNF or VNF in general
- Protocol Stack or Stacks as a whole
- Network Switch
- Router
- Base Station
- RRU
- BBU
- DU
- CU
- RU
- Bridge
- Signaling Gateway

NOTE: In some Test Scenario a Resource may itself be considered as a Component Under Test (CUT) or System Under Test (SUT) or may simply be required to participate in a Test Scenario

Examples of Abstraction Level-0 Resource which could be used within a Test Scenario(Cntd...)



Level-0 Resource: **Rp**

Embedded Test Agent

Level-0 Resource: **Rp**

No Embedded Test Agent

Examples of Level-0 Resource:

- DataBase
- IP Host with a Client Application Part
- NFVI Host Platform
- Network (presenting itself as single logical entity)
- Application in general
- Application Server
- LoadBalancer
- Firewall or Security Gateway, IPS, IDS, etc.
- Passive Monitoring Probe
- Active Monitoring Probe

NOTE: In some Test Scenario a Resource may itself be considered as a Component Under Test (CUT) or System Under Test (SUT) or may simply be required to participate in a Test Scenario

The Types of APIs required:

1. **Federation Generic APIs:** These capture Common Methods (Procedures) and Attributes that would be seen as being extended by some APIs at "concrete Testbed and resource level" (e.g. for RAN Testbed, Core Network Testbed). **Common Methods and Attributes of the Federation Generic APIs** are **agnostic to the Type of Testbed**. The work on specifying the Generic APIs should also be inspired by any already existing APIs and implementation experiences from the various Testbeds R&D Projects (past, present and future) to help capture "common methods and attributes" that should be agnostic to Testbed Type while leaving out the Methods and Attributes that are Testbed-specific for Specialized APIs in specific Testbeds Types that are then expected to get invoked by the Generic APIs.
2. **Testbed-specific specialized APIs in specific Testbeds Types:** These extend the Federation Generic APIs by inheriting the Generic APIs and their Common Methods (Procedures) and adding additional Methods and Attributes that are specific to the Type of Testbed, or they simply get invoked by the Generic APIs.

APIs Invocations Approaches:

- **The Generic APIs** should invoke **Testbed-specific specialized APIs in specific Testbeds Types** during execution of Use Cases for Testbeds and Testbeds Federations

Examples of Testbeds Federation APIs Requirements

Examples of requirements for the Testbeds Federation API are described below:

- **Management of the testbeds and their resources towards the testbed federation:** the API should be able to manage each testbed and the associated resources in a well-defined manner. Each component of the API architecture should have a clear role and expose its capabilities through the API. This permits the global management of all the resources distributed among the testbeds.
- **Data encryption:** the data exchanged between all the entities must be encrypted to ensure security and data protection.
- **Authentication and authorization:** the users must be authenticated and authorized to access the resources of the testbeds and to manipulate them through the methods exposed by the open API for interoperable testbed federations.
- **Mandatory and optional arguments passed in the methods:** the open API provides operations with mandatory and optional arguments. This permits to use the methods in different configurations and independently in the different federated testbeds. In the end, it will facilitate the integration of new testbeds in the federation.
- **Versioning of the API:** it will guarantee a part of the testbed interoperability. Indeed, in the initial phase of transactions between the federation entities, each component of the federation architecture will be able to check its possibilities of communication and to adapt them if it is necessary.

NOTE: Following the Generic Testbed Model with multiple APIs as requirements we will need to say which API exactly and if these Requirements are common for all APIs that are yet to be fully defined by the Generic Model. The APIs in the Generic Model will be Named

Examples of Testbeds Federation APIs Requirements (Cntd...)



Examples to requirements for the Testbeds Federation API are described below:

- **Extensibility of the API:** the API should be able to be extended to cover future needs which are not yet defined.
- **Portability:** the API should be portable in two directions. The first direction concerns the source code and the API source code should not be dependent on any programming language. Secondly, the API can be used in different environments without depending on the system interfaces. The application logic should not be linked to any system interface.
- **Unique identifiers used across the API:** this allows to identify each resource of the testbed federation in a unique way without any confusion. Clear identification of all the resources permits to use the resources in all the entities registered in the testbed federation.
- **Standardized communication protocol:** the protocol is used for the communication between the server and the client, and at the end, between the different components of the API architecture. A common communication protocol is requested to manage correctly the testbed federation and should be understandable for each component involved in the testbed and resources control. This protocol should be available on both sides and ideally, the implementation of the protocol should not be dependent on a specific programming language.

NOTE: Following the Generic Testbed Model with multiple APIs as requirements, we will need to say which API exactly and if these Requirements are common for all APIs that are yet to be fully defined by the Generic Model. The APIs in the Generic Model will be Named

Examples of Testbeds Federation APIs Requirements (Cntd...)



Examples of requirements for the Testbeds Federation API are described below:

- **Interoperability:** the Testbed Federation API should ensure the interoperability between the components of its architecture. A client component should be able to communicate and exchange data with the server components in a well-defined manner and without any ambiguity. Clients and servers should understand the data exchanged between them.
- **Abstraction of the heterogeneous technologies and communication protocols under test:** the API defined in this document should abstract the technologies and protocols under test. Indeed, the API is completely independent of each technology and protocol under evaluation and there is no interference between this API managing the testbed federation and the objects under evaluation.
- **Openness of the API:** this API should be compliant within the criteria defining the openness of an API. It means that the API is interoperable, portable and extensible.
- **Scalability:** the API should be scalable. By definition, it means that the Testbed Federation API is extensible and is applying demand balancing for the requests done by the callers. This API should be designed by scalability since the beginning of its inception and in all its future releases.

NOTE: Following the Generic Testbed Model with multiple APIs as requirements, we will need to say which API exactly and if these Requirements are common for all APIs that are yet to be fully defined by the Generic Model. The APIs in the Generic Model will be Named

Roles of Various Stakeholders to the Emerging Ecosystem around the Testbeds Federation Reference Model



Looking at the following aspects for Consideration:

1. Stakeholders that need to be engaged to play specific in the Emerging Ecosystem around the Testbeds Federation Reference Model, its APIs and its Instantiations using various Testbeds that get federated
2. Summary of the Objectives of this Workshop w.r.t Stakeholders Engagement around the Testbeds Federation Reference Model and associated Ecosystem to emerge

Stakeholders to be engaged:

- **SDOs/Fora, Research Communities/Researchers on 5G and Beyond, Industry Users of Testbeds, Testbeds Suppliers for 5G Testbeds and other Testbeds, CSPs & Enterprises, Infrastructure Vendors/Suppliers for ICT and Verticals, ISVs, Open Source & Open Hardware Projects, Regulators, Owners of Existing Testbeds and Platforms for 5G& Beyond, and any other interested parties**

Roles of Various Stakeholders to the Emerging Ecosystem around the Testbeds Federation Reference Model (Cntd....)



Examples of Potential Roles of certain Stakeholders (Objectives on why engaging the various Stakeholders at this First Joint SDOs/Fora Workshop) :

- **SDOs/Fora:** Can potentially share the burden on APIs Standardization and on Roadmaps in a harmonized and collaborative way
- **ALL Stakeholders:** Help contribute to capturing Requirements to be fulfilled by the Testbeds Federations APIs
- **Testbeds Suppliers, CSPs, Enterprises, Infrastructure Vendors, ISVs:** Help contribute to Derivation of Potential New Business Models for Testbeds Suppliers that derive from the Testbeds Federations Reference Model
- **5G& Beyond Research/R&D Communities:** Bring experiences to the discussions of the Reference Model and APIs Specifications and contribute what may have been achieved already in this area of Testbeds Federations—with respect to existing API implementations by Research communities and by the Industry as well
- **Owners of Existing Testbeds and Platforms for 5G& Beyond:** Embark on Transformation or Evolution of Existing Testbeds (Industry and Potential Research Testbeds as well) and Federation APIs to meet the Requirements of the Testbeds Federation Model being standardized. Make Efforts on the Instantiations of the Reference Model in Building Industry-Grade New Testbeds and/or Transformations of Existing Testbeds
- **Open Source & Open Hardware Projects:** Help contribute to the Building of Open Networking Platforms (ONPs) Testbeds that conform to the Testbeds Federation Reference Model and its associated APIs. Also make efforts on the Instantiations of the Reference Model

**Come and Join in Contributing to
this Joint Vision by ITU-T & ETSI**

Thank You