Let's Focus on Autonomous Networks

ITU-T FG-AN, an overview.

9th SG13 Regional Workshop for Africa on
Standardization of Future Networks and Emerging Network Technologies:
African perspectives, 19-20 September 2023

10th Meeting of ITU-T Study Group 13 Regional Group for Africa,
21-22 September 2023

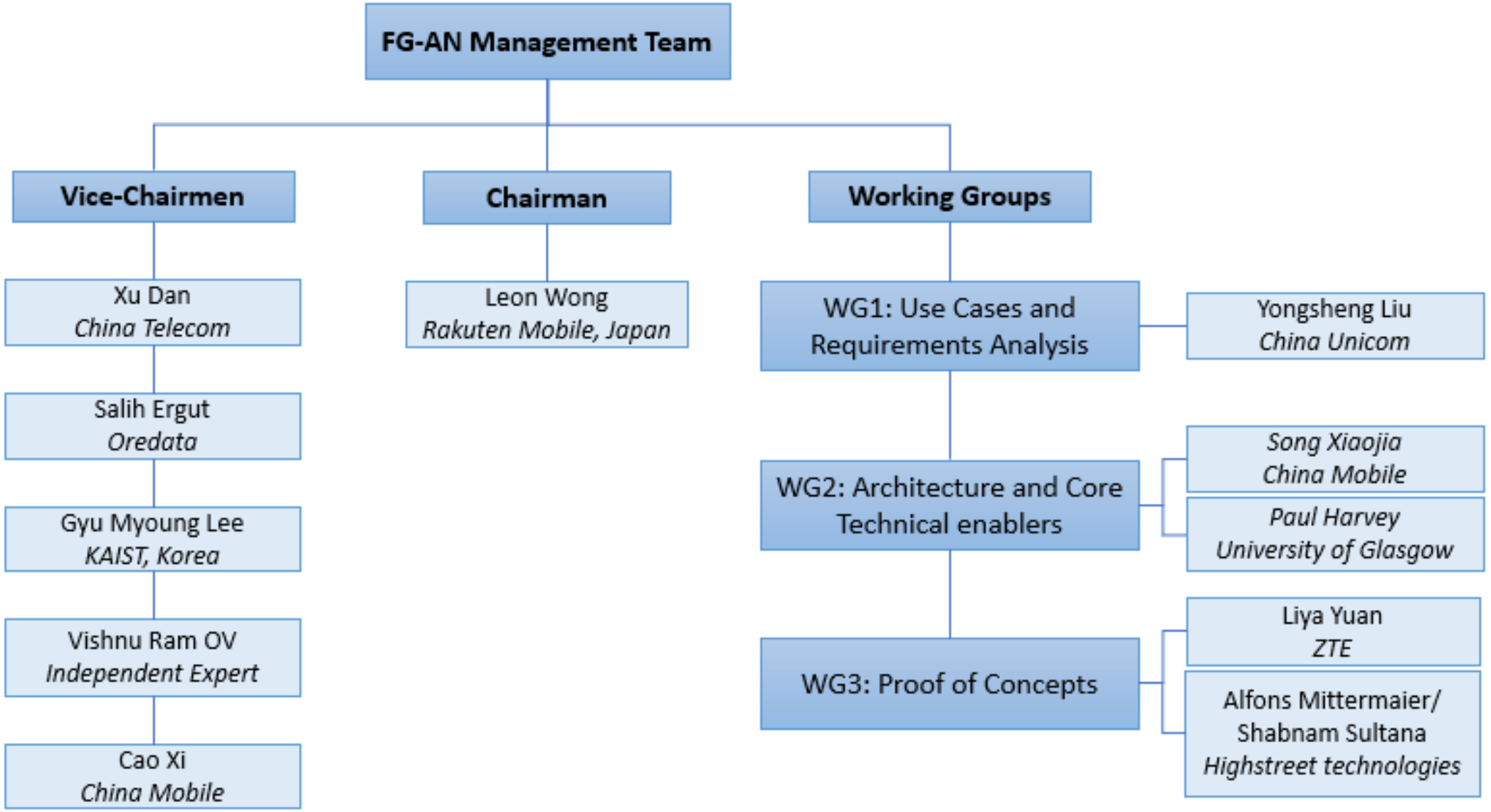
FG-AN: Overview

- ITU-T Focus Group on Autonomous Networks was established by ITU-T Study Group 13 at its virtual meeting, 17 December 2020.

- The Focus Group will draft **technical reports and specifications** for autonomous networks, including exploratory evolution in future networks, real-time responsive experimentation, dynamic adaptation to future environments, technologies, and use cases.
- The Focus Group will also identify relevant gaps in the standardization of autonomous networks.

The primary objective of the Focus Group is to provide an open platform to perform pre-standards activities related to AN.

FG-AN: Overview



FG-AN: Progress

FG AN Meetings:

- 1st Virtual meeting, 2-4 Feb 2021
- 2nd Virtual meeting, 13-16 Apr 2021
- 3rd Virtual meeting, 15-17 Jun 2021
- 4th Virtual meeting, 1-3 Sept 2021
- 5th Virtual meeting, 3-5 Nov 2021
- 6th Virtual meeting, 26-28 Jan 2022
- 7th Virtual meeting, 30 Mar - 1 Apr 2022
- 8th Virtual meeting, 1-3 Jun 2022
- 9th Virtual meeting, 31 Aug – 2 Sep 2022
- 10th Virtual meeting, 1-2 Feb 2023
- 11th Virtual meeting, 19-22 Apr 2023
- 12th Virtual meeting, 13-15 Jul 2023
- 13th Virtual meeting, 28-29 Sep 2023

FG-AN: Progress

Build-a-thon 2022:

Build-a-thon Workshop Kickoff, 3 Jun 2022
Build-a-thon Workshop 2.0, 2 Sep 2022
Build-a-thon Workshop 3.0, 7 Nov 2022

Build-a-thon 2023:

Build-a-thon Workshop Kickoff, 3 Feb 2023
Build-a-thon Workshop 2.0, 22 Apr 2023
Build-a-thon Workshop 3.0, 15 Jul 2023
Build-a-thon Workshop 4.0, 29 Sep 2023

ITU-T FG-AN Workshop:

ITU Workshop on "Advances in Evolutionary Autonomous Networks: Use Cases, Architecture and PoC" 15 Nov 2022

ITU Workshop on "Advances in Autonomous Networks: 2023 and beyond" 24 Oct 2023

FG-AN: Progress

Weekly Meeting every **Thursday 8:00 CET**

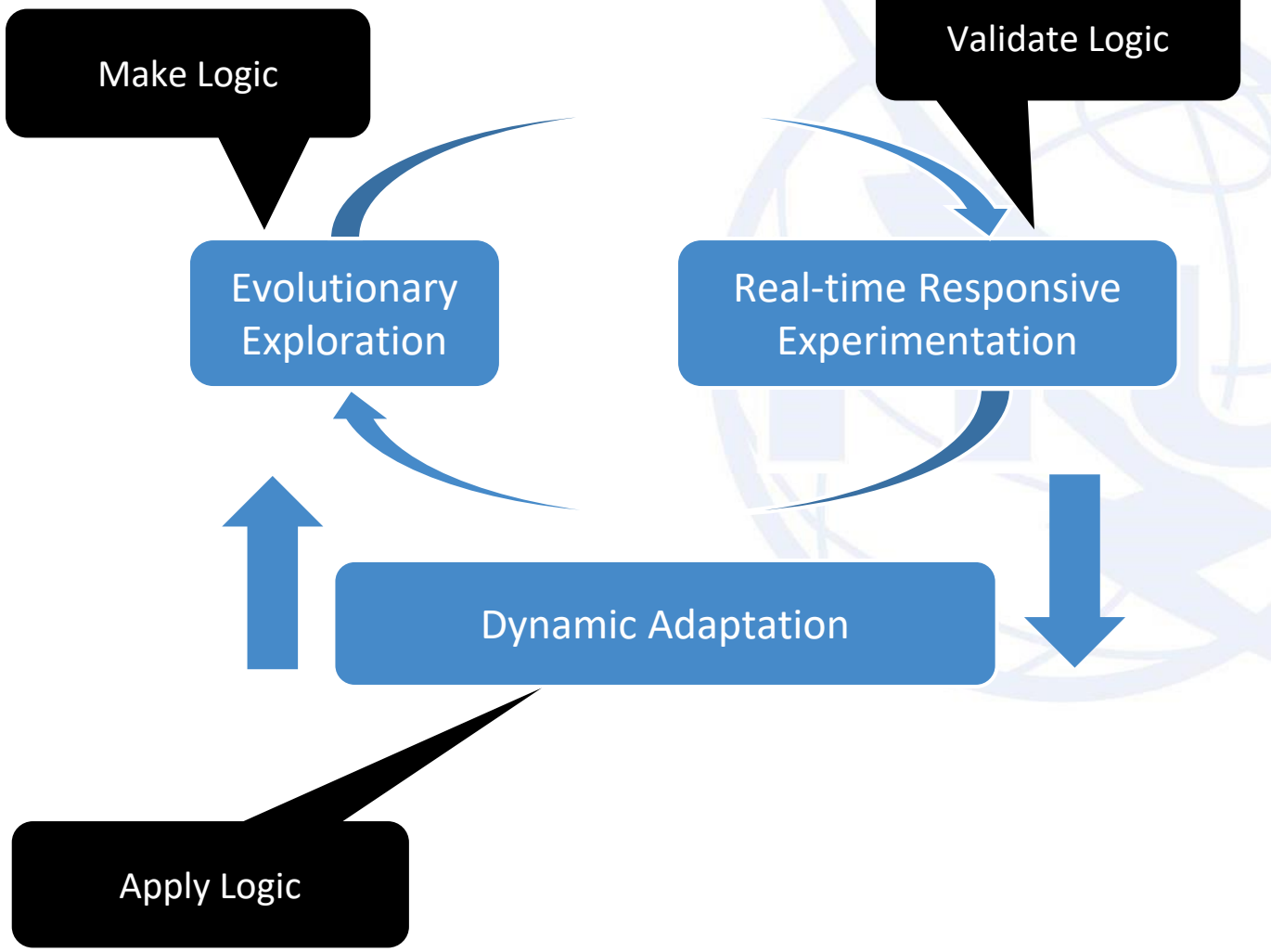
Weekly / Bi-Weekly **Editing sessions** for progressing deliverables

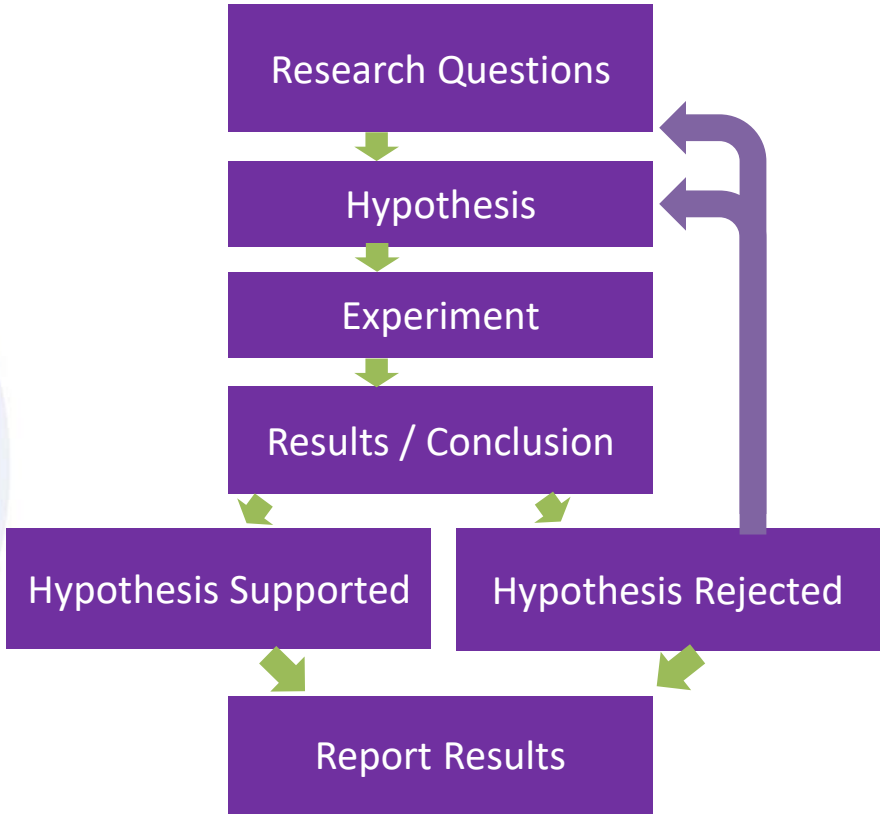
Meetings will cover:

Use cases document + use case requirements + mappings to other deliverables

- Architecture framework
- Trust in Autonomous Networks
- PoC
- Standards gap analysis
- Discussion with experts from industry & academia

Key Concepts



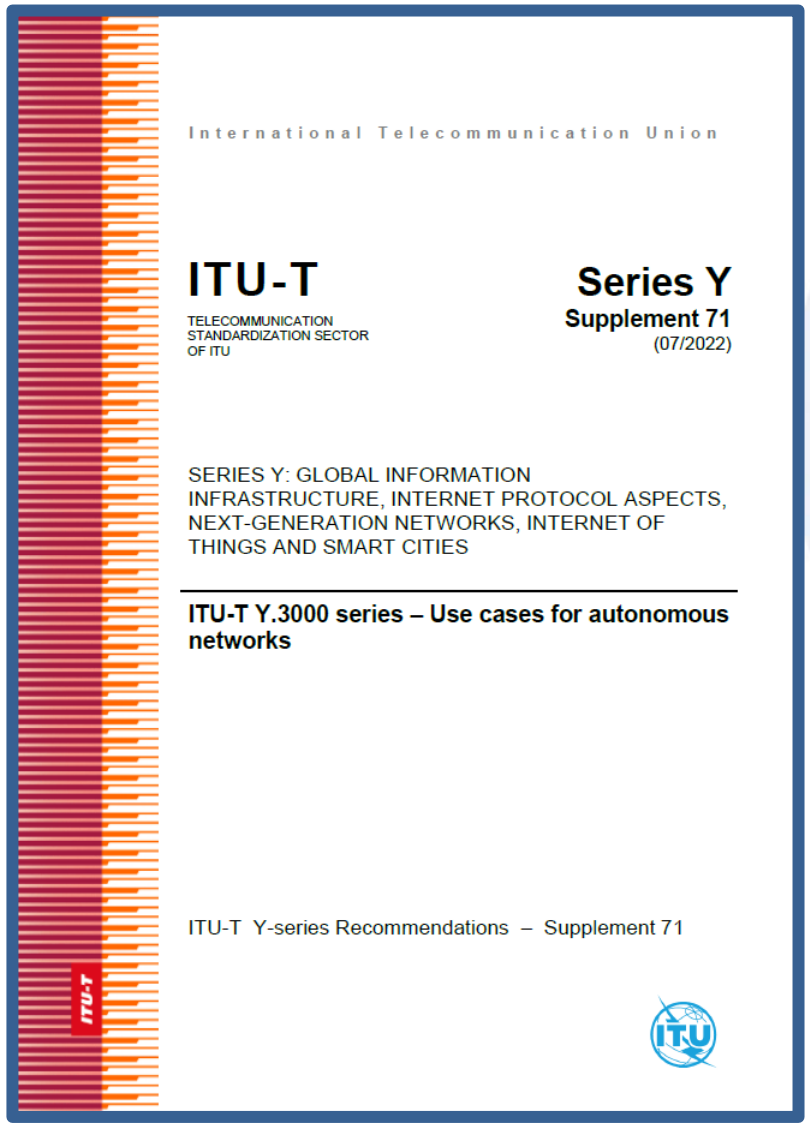


The Interface

FG-AN: Deliverables

FG-AN Deliverables	
Use Case & Requirements for Autonomous Networks	Submitted to SG13 Published as Supplement 71 to Y.3000 series
Concepts and Principles of Trust for Autonomous Networks	Submitted to SG13 Y.3060 Autonomous Networks – Overview on Trust
Architecture Framework for Autonomous Networks	Submitted to SG13 Work item created in Q20/13 (Y.AN-Arch-fw)
Trustworthiness evaluation for autonomous networks	Submitted to SG13. Work item created in Q16/13 (Y.TiAN.eval)
PoC Report	Submitted to SG13 Mar 2023 as Technical Report T22-SG13-230313-SG13-TD133/GEN
Glossary, Gap Analysis	In Progress

FG-AN: Deliverables



Use Cases for Autonomous Networks

FG-AN output document (FGAN-O-013-R1)

A collection of use cases presented and elaborated during FG-AN meetings.

These use cases were published as a Technical Specification and a draft use case deliverable submitted to ITU-T SG13.

Approved during ITU-T SG13 July 2022 meeting as "Y.Sup71 : ITU-T Y.3000 series - Use cases for autonomous networks"
https://www.itu.int/rec/T-REC-Y.Sup71/en

FG-AN: Deliverables

7.9 Network resource allocation for emergency management based on closed loop analysis

Use case ID	FG-AN-usecase-9
Use case description	Telecommunication systems are a critical pillar of emergency management. A set of hierarchical AI/ML based CLs could be used to intelligently deploy and manage slice for emergency responders in the affected area. A higher CL in the operational support system (OSS) can be used for detecting which area is affected by the emergency and deploy a slice for emergency responders to that area. It can then set a resource arbitration policy for the lower CL in RAN. The lower loop can use this policy to intelligently share RAN resources between the public and emergency responder slice. It can also intelligently manage ML pipelines across the edge and emergency responder devices by using split AI/ML models or offloading of inference tasks from the devices to the edge. NOTE 1 – An instance of open RAN architecture is explained in [b-O-RAN.WG1.O-RAN-Arch], including near-RT RICs and non-RT RICs which host applications designed to run with different latency requirements (e.g., xApps and rApps). The applications may be implemented independent of the RIC implementations and may be provided by any third party. The following are related steps in this use case scenario: 1) The mobile network operator (MNO) may instruct the OSS to detect a certain set of emergencies and provide connectivity to emergency responders according to a predefined SLA. NOTE 2 – For example, this input may be provided using an operator intent.

7.9.1 Use case requirements

Critical requirements

- AN-UC09-REQ-001: It is critical that the AN allow interaction between CLs via high level intents.

NOTE 1 – CLs may create new CLs in other network domains without human intervention.

- AN-UC09-REQ-002: It is critical that the AN allow each CL to evolve independently, using different analytical, optimization mechanisms including ML models and ML pipelines as required.

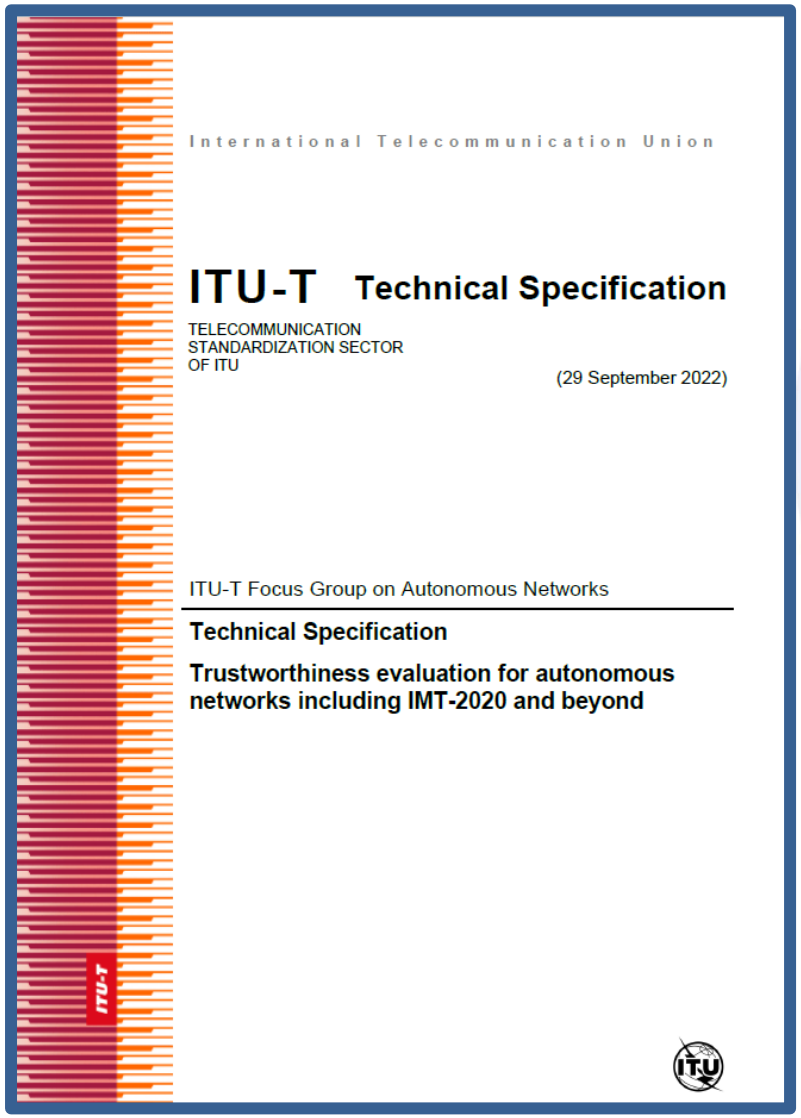
NOTE 2 – Each CL may move up or down the autonomy levels as defined in [ITU-T Y.3173]

Expected requirements

- AN-UC09-REQ-003: It is expected that CLs have the ability to provision or recommend AI/ML models to other CLs in automated fashion.
- AN-UC09-REQ-004: It is expected that CLs in the edge domain may be autonomous, in order to enable lower orchestration delay and better privacy and flexibility for verticals (e.g., industrial campus networks).
- AN-UC09-REQ-005: It is expected that higher CLs use the knowledge base available to them to optimize and generalize lower CLs using high-level intent.

NOTE 3 –This increases the efficiency of lower CLs while preserving their autonomy. (e.g., the higher loop might know certain kind of ML models are good for cyclone emergency management based on previous cyclones.)

FG-AN: Deliverables



Evaluation of Trustworthiness of Autonomous Networks

FG-AN output document (FGAN-O-024)

Provides the concepts, basic principles, metrics of evaluation, methodology for evaluation and evaluation models and use cases for trust in autonomous network.

The technical specification derived from this work has been transmitted to parent ITU-T SG13 as TD64/GEN:

https://www.itu.int/md/T22-SG13-221114-TD-GEN-0064/en

FG-AN: Deliverables

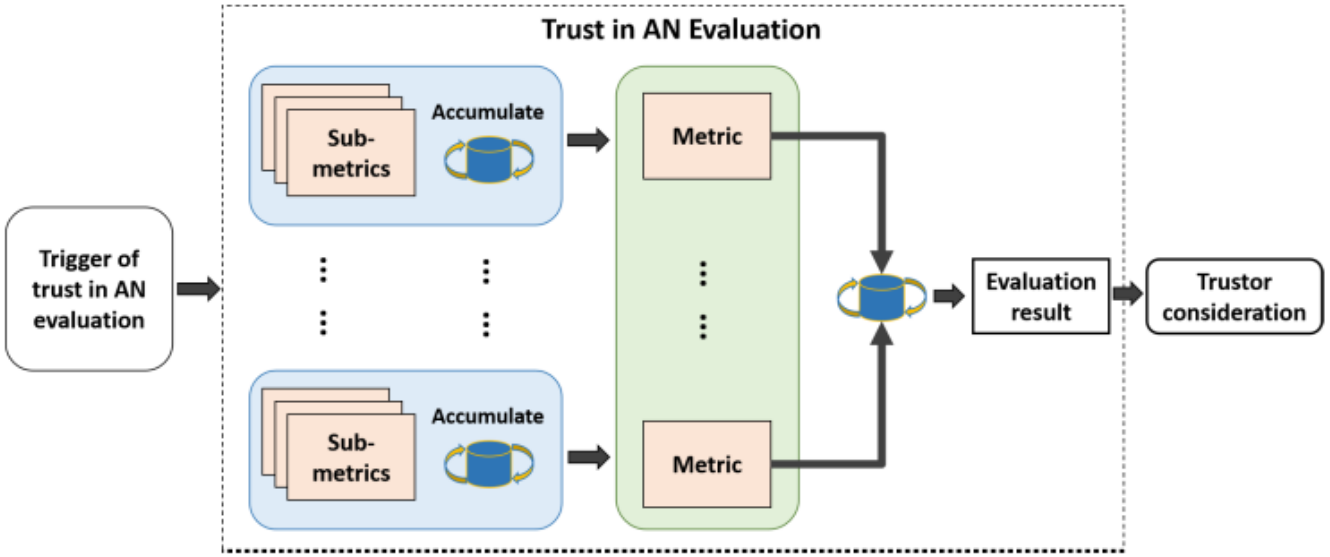
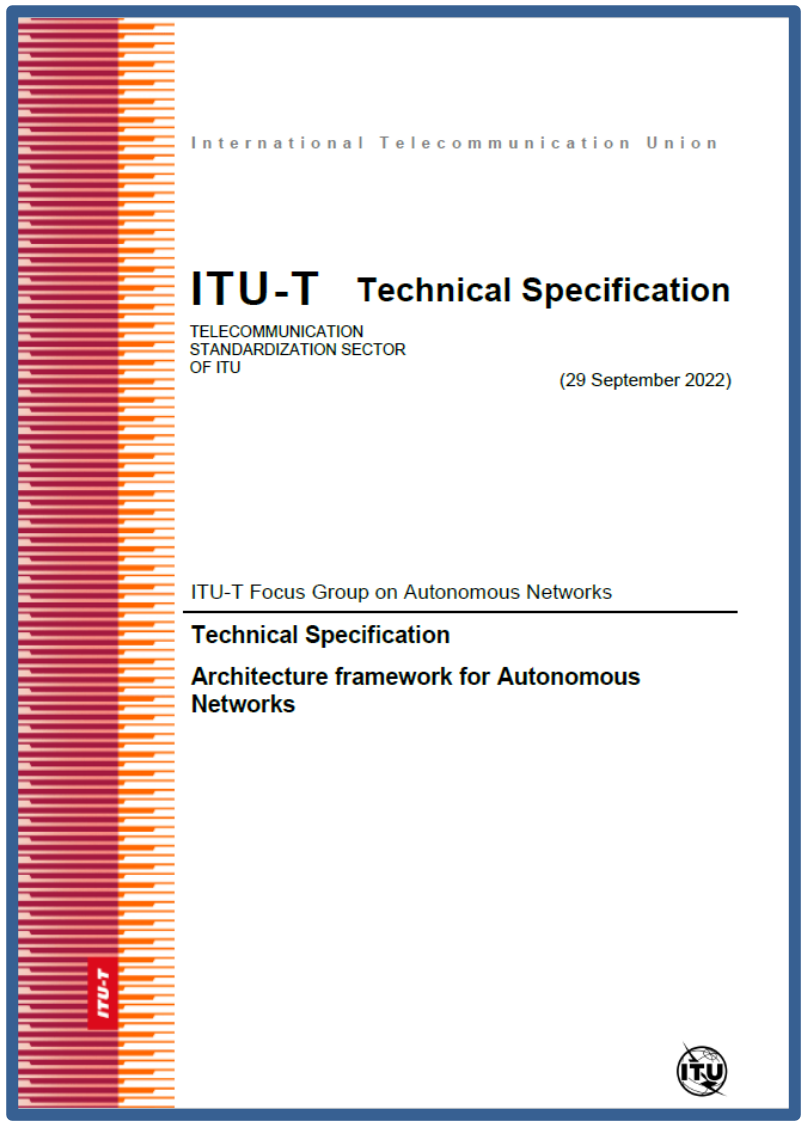


Figure 1 - General process of TiAN evaluation

Metric	Sub-metric	General Description of sub-metric
Accuracy	Reproducibility	Interactions in which the trustee reproduces the process of execution by trustee(s) across various interactions with the trustor, i.e. interactions which the trustee reproduces the same process and the same result(s)/action(s)/decision(s)/etc, using the same parameter(s)/input(s)/method(s)/algorithm(s)/knowledge/etc and other relevant conditions, in TiAN evaluation. $\frac{num\ of\ the\ same\ reproduced\ results\ with\ executions}{num\ of\ all\ reproduced\ results}$
	Precision	Interactions which the trustee produces precise result(s) during execution of the process(es)/step(s) by trustee(s), in TiAN evaluation. $\frac{number\ of\ interactions\ with\ accurate\ results}{total\ number\ of\ interactions}$
	Timeliness	Action(s)/reaction(s)/feedback(s)/decision(s) produced by the trustee **within specific time duration** for TiAN evaluation. $\frac{num\ of\ action(s) within\ the\ specified\ time\ duration}{total\ number\ of\ actions\ produced\ in\ the\ whole\ evalation}$ *NOTE - above formula should be specified with evaluating time duration for evaluation.*

FG-AN: Deliverables



Architecture Framework of Autonomous Networks

FG-AN output document (FGAN-O-023)

Autonomous Networks (AN) architecture framework in relation to AN concepts.
The scope of this document includes:

- Requirements for the architecture
- Description of the architecture components
- Description of the architecture
- Sequence diagrams explaining the interactions between the architecture components

The technical specification derived from this work has been transmitted to parent ITU-T SG13 as TD63/GEN :
https://www.itu.int/md/T22-SG13-221114-TD-GEN-0063/en

FG-AN: Deliverables

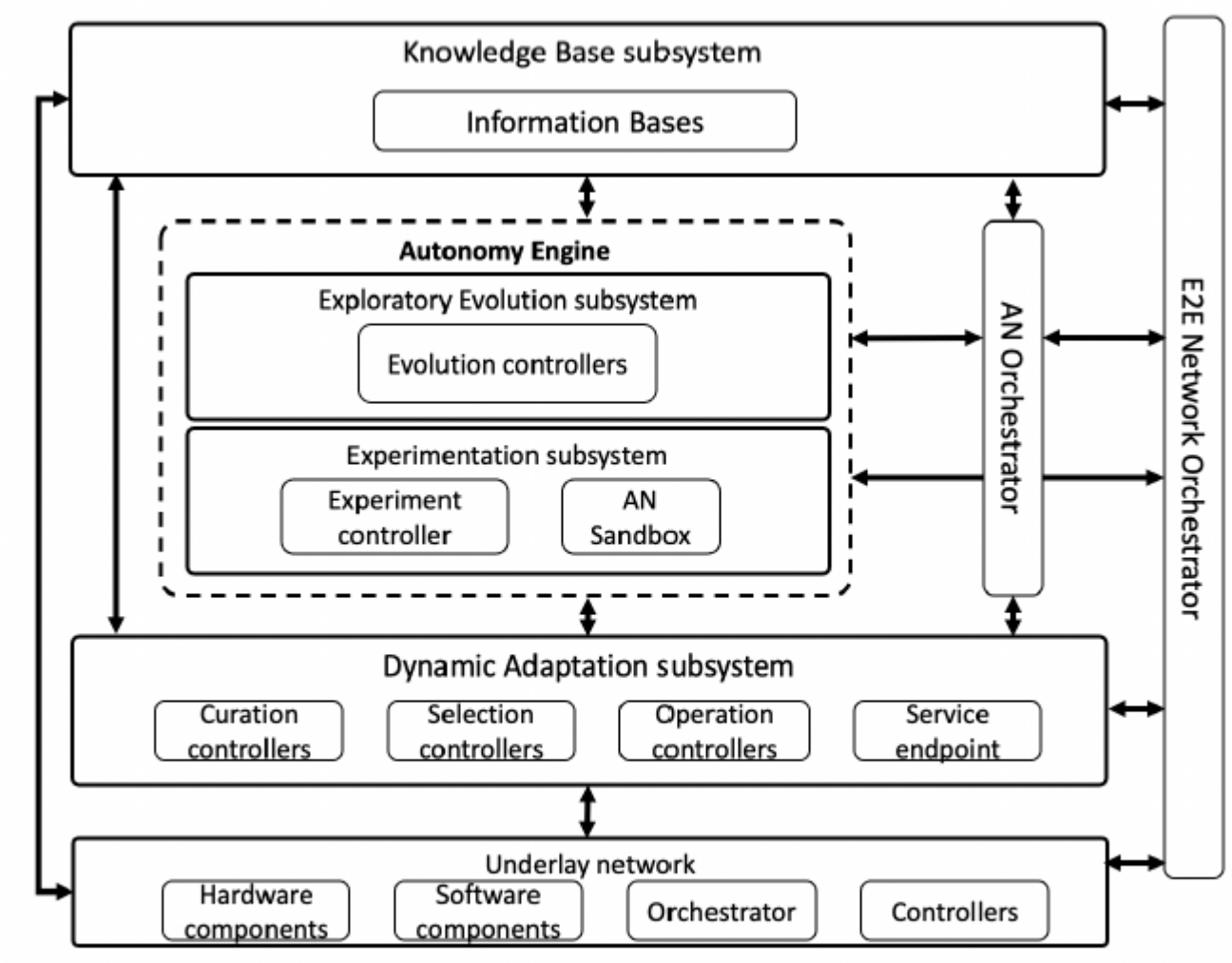
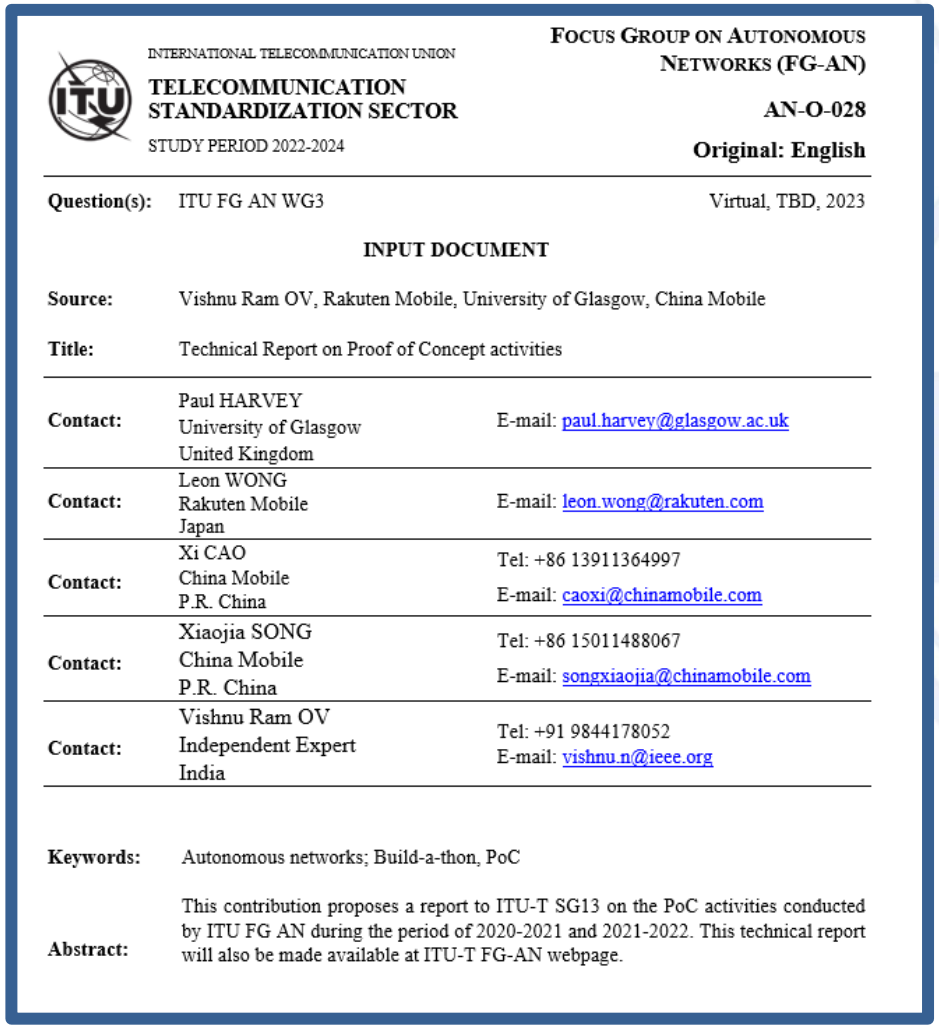


Figure 5: High-Level Framework for Autonomous Network

FG-AN: Deliverables



INTERNATIONAL TELECOMMUNICATION UNION

TELECOMMUNICATION STANDARDIZATION SECTOR

STUDY PERIOD 2022-2024

FOCUS GROUP ON AUTONOMOUS NETWORKS (FG-AN)

AN-O-028

Original: English

Question(s): ITU FG AN WG3 — Virtual, TBD, 2023

INPUT DOCUMENT

Source: Vishnu Ram OV, Rakuten Mobile, University of Glasgow, China Mobile

Title: Technical Report on Proof of Concept activities

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Keywords: Autonomous networks; Build-a-thon, PoC

Abstract: This contribution proposes a report to ITU-T SG13 on the PoC activities conducted by ITU FG AN during the period of 2020-2021 and 2021-2022. This technical report will also be made available at ITU-T FG-AN webpage.

Technical Report on Proof of Concept activities

FG-AN output document

Provides the technical report on the PoC activities conducted by ITU FG AN during the period.

The technical report is currently in the process of being published as FG AN deliverables and has been submitted to ITU-T SG13.

FG-AN: Deliverables

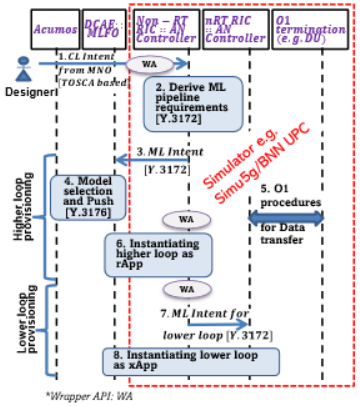
7 Requirements for the PoC

This clause describes the requirements for the PoC.

Requirement	Description
Gen-Build-a-thon-PoC-001	It is critical that PoC development activity, builds upon a key concept in FG AN, especially aims to prove the concept practically with code, test setup and demo setup.
Gen-Build-a-thon-PoC-002	It is critical that PoC development activity create well-documented artefacts and opensource code.
Gen-Build-a-thon-PoC-003	It is critical that the maturity of the PoC is evaluated using test scenarios in the accompanying documentation.
Gen-Build-a-thon-PoC-004	It is critical that the mapping with discussions in FG AN use cases, and relationship with a focussed closed loop example(s), is documented in the PoC.
Gen-Build-a-thon-PoC-005	It is critical that PoC (proof of concept) demonstrates the feasibility (or lack of it) of specific architecture approaches.
2021-Build-a-thon-PoC-006	It is critical that Demonstration is focussed on a unique scenario.
2021-Build-a-thon-PoC-007	It is expected that AI/ML based closed loops be used to intelligently deploy and manage slice for emergency responders in an emergency scenario.
2021-Build-a-thon-PoC-008	It is expected that A higher closed loop in the OSS be used for detecting which area is affected by the emergency and deploy a slice for emergency responders to that area.
2021-Build-a-thon-PoC-009	It is expected that The lower loop can use the policy derived by the higher loop to intelligently share RAN resources between the public and emergency responder slice.
2021-Build-a-thon-PoC-010	It is expected that the lower loop intelligently manage ML pipelines across the edge and emergency responder devices by using split AI/ML models or offloading of inference tasks from the devices to the edge.

8.7 Integration of the POC

This section describes the integration of the above implementation of closed-loops into P-RAN-based software platform ready to be tested in the 5G Berlin testbed [b-FGAN-I-197]. The operator inputs the declarative intent to the Service Management Orchestrator (SMO)/Non-RT RIC, which describes the use case to detect emergencies and maintain the required SLA as described in Section 2.1. Similar to the mechanism described in 2.1, SMO/Non-RT RIC then creates a higher loop that monitors various parameters like network activities, input from emergency responders (ER), social media trends, etc. to detect and locate the emergency (e.g., fire in a building). This can be realized using either a hosted model in Acumos or Open Network Automation Platform data collection analytics engine (ONAP DCAE) or O-RAN rApp, as discussed in sections 2.2 and 4. Once the emergency is detected, the higher loop sends an intent over the A1 interface to the Near-RT RIC, instructing it to handle the increased load for the corresponding RAN node. Real-time ML/AI inference might be needed by some of the ERs' devices; for firefighters a helmet-mounted camera may use image recognition to detect humans in a burning building. However, the devices might not have enough computing and might need to offload the task to the network edge or use split AI/ML models for inference. The Near-RT RIC receives the intent and creates a closed-loop which can monitor the network and compute resources of the edge and the ER device and maintains the SLA/QoS (quality of service) of the inference task as discussed in Section 3 above. This loop can be realized using xApp. Fig. 30 shows the simulator-based sequence for the integration of the activities.



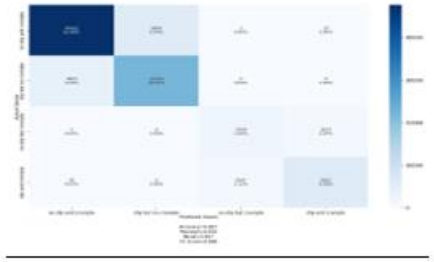


Figure 69: Confusion matrix for LSTM model for Case 1: slip detection

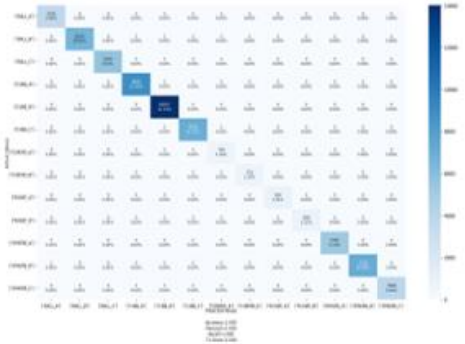


Figure 70: Confusion matrix for RF model for Case 2: object detection

Figure 52: Log messages of the Ey_Py docker container.

Figure 53: Access to the JSON representation of a controller in the Marketplace via its CID. The Marketplace node that is being consulted is Exp_IPFS.

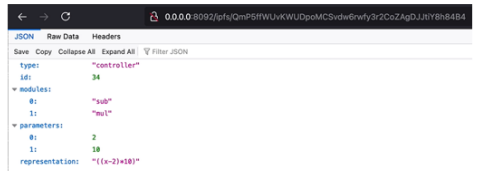


Figure 54: Access to a controller JSON representation in the Marketplace via its CID. The Marketplace node that is being consulted is DT_IPFS.

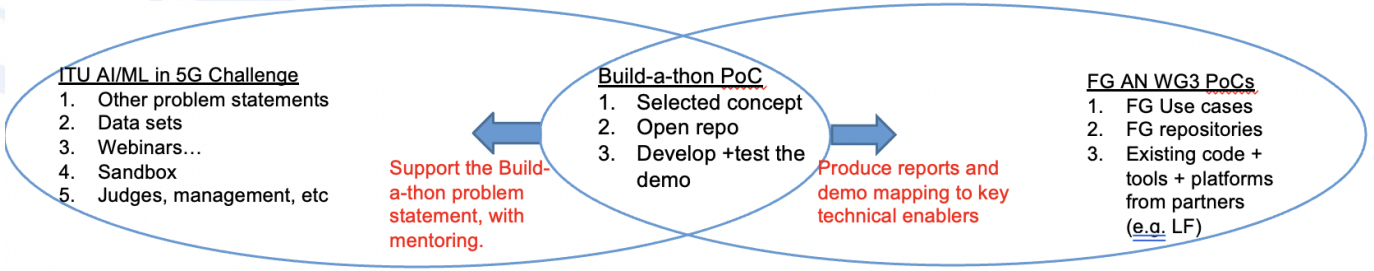
FG-AN: PoC activities

PoC / Build-a-thon 2021, 2022, 2023

Progressing proof of concept activities.
In conjunction with the ITU AI/ML in 5G Challenge under the Build-a-thon initiative.

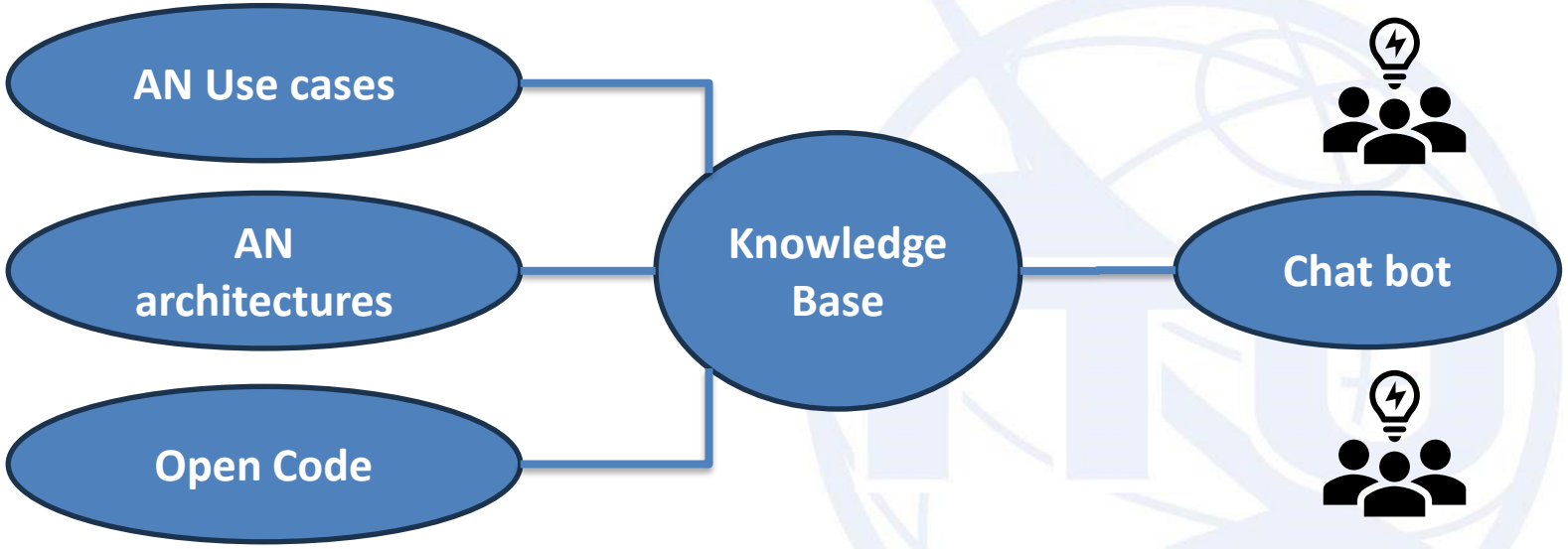
FG-AN input documents (FGAN-I-311)
Report and progress of the ongoing Build-a-thon activities.

Proving concepts **practically** with codes, test setup and demo setup



Call for collaboration: Build-a-thon 2023

[FGAN-O-030/LS11](#)
LS on ITU FG AN Build-a-thon 2023



Contributors and participants and Students

- ITU is conducting Autonomous Network Build-a-thon
- A chatbot is trained to assist contributors and participants

https://github.com/vrra/FGAN-Build-a-thon

FG-AN: Thank you and Invitation to all

- **Homepage**
  - https://www.itu.int/en/ITU-T/focusgroups/an/Pages/default.aspx
- **Weekly meeting**
  - Every Thursday (08:00 CET)
- **Mailing list**
  - fgan@lists.itu.int