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Title: Proposal for a "Build-a-thon" for ITU AI/ML in 5G Challenge (second edition, 2021), aligned with FGAN WG3

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Abstract: This contribution proposes a build-a-thon aligned with the ITU AI/ML in 5G Challenge and calls for collaborative approach from FG-AN and partners to participate in the build-a-thon. Advantages to the FG-AN community in this participation is discussed, an outline of the proposal is given along with a problem statement.

Editor note: The clauses till Clause 3, will be useful only to FG AN, and not particularly useful to discuss in ITU AI/ML Challenge.

1 Introduction

As discussed in [FGAN-I-006] and [ITU Challenge URL], ITU AI/ML in 5G Challenge is an opportunity for students, professionals and industry from around the globe to work together and study the practical application of artificial intelligence (AI) and machine learning (ML) in emerging and future networks. A compilation of problem statements and resources for the first edition of the Challenge [ML5G-I-237-R5] was discussed during ITU FG ML5G (focus group machine learning in 5G and future networks). In the 2020 edition, the Challenge welcomed over 1300 participants from 62 countries, forming 911 teams. Among these were problem statements in the "enablers" track which included developing reference implementations based on FG specifications.

The collaboration between different organizations enabled a win-win situation for the participants and technologists aimed at overall technology development in the following manner:

- **Create a distributed eco-system**: ITU AI/ML in 5G Challenge enabled participants to connect with new partners in industry and academia — and new tools and data resources — to solve real-world problems based on the ITU specifications. This was supported by 26 webinars with leading researchers around the world, round-table discussions with participants and experts, and using open source and open data.

NOTE- This enables FGAN to take advantage of the state of the art, discussions, code and Sandbox from this distributed eco-system of industry, academia and other experts to advance the work in WG3 PoC, specifically related to the key concepts in the [FG-AN ToR].

- **Diverse participation**: A mix of participants (not only data scientists) from various backgrounds came together to solve problems, and students were provided mentoring by experts. Prizes and certificates were offered, refer to [FGAN-I-006] for details. But the real value was the diverse points-of-view offered from across the world.

  NOTE- This enables FGAN to collaborate and work closely with other entities as mentioned in clause 5 of [FG-AN ToR], in the spirit of open group.

- **Create practical implementations**: “enablers” track included problem statements which worked on creating reference implementations, using open source, demonstrating concepts from ITU specifications. Thus, the challenge was more than just predictions and inferences, but also about coding and proving the concepts in FG specifications.

  NOTE- This enables FGAN to collaborate towards reference implementations as mentioned in [FG-AN ToR].

Recognising the importance of such initiatives as an instrument for pre-standard research and spreading awareness and attracting diverse talent to the pool, this contribution proposes to create a “build-a-thon” proposal aligned with WG3 of PoC and the key concepts defined in the [FG-AN ToR].

The build-a-thon is proposed as a track in ITU AI/ML in 5G Challenge. It aims to demonstrate and validate important use cases for autonomous networks, creating proof of concept implementations and tools in the process. As an open platform, FG AN is well-poised to enable access to experts, students and industry, collaborate with other external events such as plugfests and hackathons and to set the stage for collaboration in open-source projects, other PoC (proof of concept) and standardization work.

2 Proposal for build-a-thon in Autonomous Networks

What is a build-a-thon?

In essence, a build-a-thon is a common, open platform for like-minded people to come together (remotely) and build something to prove a point. In the case of FG AN we define it as below:

1. Build-a-thon is a PoC development activity, to build upon a key concept in FG AN, especially intended to prove the concept practically with code, test setup and demo setup.

2. Build-a-thon is not intended to create a product, nor would the code created as part of Build-a-thon be considered as product quality software.

3. Build-a-thon would create well-documented artefacts and opensource code.

NOTE- In case there are project specific restrictions on opening the code to open source, other forms of license may be applied based on discussions among participants.

4. It is done collaboratively in teams, may last for several months, especially intense towards the end, culminating in a demo or presentation. The primary output would be well-documented, working code. By-products could be use case documentation, design docs and test code.

5. Completeness of the code is expected only to be judged by the definition of scope in the accompanying documentation. Correctness of the code is expected only to be judged by the definition of test scenarios in the accompanying documentation.

Aims of the proposal for build-a-thon in Autonomous Networks are as follows:

- To take advantage of the momentum and energy created by the "AI/ML in 5G Challenge", create a "track" for autonomous networks. Bring the community of experts to the Challenge platform to fashion practical "proof of concept" problems from the **use cases** proposed in FG AN.
- To build proof of concepts and demos which can prove the feasibility (or the lack of it) of **architecture concepts**, collaborate and study the gaps of existing prototypes and standards.
- To build opensource solutions and collaborate with existing opensource projects in this domain, aligned with other potential **PoC (proof of concept)** projects in FG-AN.

  NOTE- If there are project specific restrictions on open source, other forms of license may be applied based on discussions among participants and classifying the problem statement as "restricted".
- To consolidate the learnings from the exercises above, feed the learning to the deliverables of FG-AN.

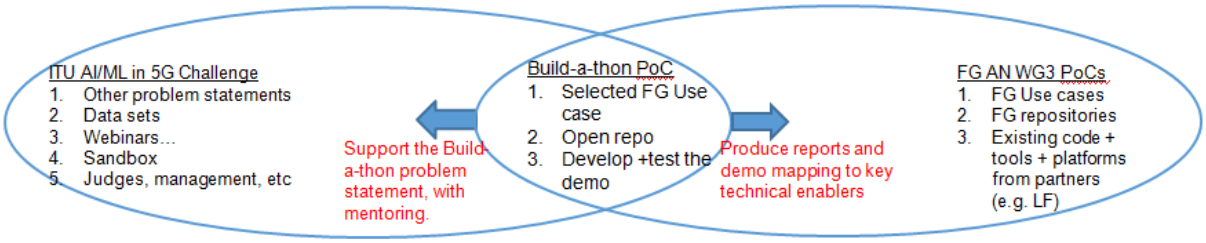

Figure 1: Relationship between ITU AI/ML in 5G Challenge with the proposed Build-a-thon and the FG AN.

As shown in figure 1 above, ITU AI/ML in 5G Challenge includes many problem statements, corresponding datasets, along with an ecosystem of webinars, sandbox, challenge management etc described in [ITU Challenge URL]. ITU-T FG AN working group 3 is discussing proof of concepts related to [FG-AN ToR]. This document proposes to collaborate with the ITU AI/ML in 5G Challenge (see clause 2 above) to create PoC in areas of common interest, by triggering a "build-a-thon" track in the Challenge.

The Build-a-thon, reusing the challenge platform, will build PoC, based on selected use cases (described below). Build-a-thon problem statement will be an "open" problem statement under the Challenge where as FG AN may run other PoC which are unrelated to the Challenge.

2.a Outline of the proposal is as follows:

NOTE- timeline of the steps below will follow the timeline of the Challenge 2021 (to be announced in [ITU Challenge URL])

1. From the use case contributions received at the first meeting of FG-AN, and contributions from partners of ITU, call for collaboration to fashion problem statements to demonstrate key concepts of AN (Autonomous networks) [FG-AN ToR] which can form relevant PoCs.

2. Submit the problem statements to ITU AI/ML in 5G Challenge 2.0, as per instructions in [FGAN-I-006]. Problem statements should propose FG-AN as the host, clearly state what

needs to be built/implemented from the AN use cases, refer to any papers or other references, point out any tools or resources and suggest scoring mechanisms.

3. Nominate judges, experts (from among FG AN participants) for mentoring and scoring of submissions to the build-a-thon.

4. Support the round tables and periodic meetings with registered participants of the build-a-thon.

5. Score the entries and publish results (winners) from the build-a-thon.

6. Support the "Challenge Grand Finale" (refer [FGAN-I-006]), felicitate the winners.

7. Follow-up with discussions with open source and other partners and inputs to FG-AN deliverables based on the learnings from the build-a-thon.

8. Collaboratively publish papers (e.g. conference papers, ITU journal etc), articles, technical reports and technical specifications integrating the results from the build-a-thon.

NOTE: Build-a-thon will use 5G Berlin testbed as an testing and evaluation platform. Collaboration with other partners (like O-RAN) for a joint demo using the O-RAN components in the testbed will be explored.

Editor note: The clauses from here on, will be discussed in AI/ML in 5G Challenge.

3 Proposed problem statement

Id	ITU-ML5G-Build-a-thon-PS-001
Title	Network resource allocation for emergency management based on closed loop analysis

Description	Develop a prototype implementation of the following use case: Telecommunication systems are critical pillar of emergency management. A set of hierarchical AI/ML based closed loops could be used to intelligently deploy and manage slice for emergency responders in the affected area. A higher closed loop in the 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 closed loop 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. Following are related steps in this use case scenario: 1. MNO may instruct OSS to detect certain set of emergencies and provide connectivity to emergency responders according to predefined SLA. NOTE- e.g. this input may be provided using an operator intent. 2. OSS might deploy a closed loop to achieve this. It might collect data from sources like network analytics data, social media scraping, input from emergency responders etc. NOTE- e.g. such inputs may be provided from nRT-RICs or other xNFs in the network. 3. OSS might use AI/ML models to detect emergency and deploy an ER slice to the location. It might also create high level strategy/policy to reallocate resources among the slices. NOTE- e.g. such closed loops may be hosted in non-RT RIC and may be used for predictive resource allocations to specific edge locations based on predicted needs, in turn based on detected emergency. NOTE- the policy to reallocate resources may depend, among other things, on the type of emergency e.g. a natural disaster, earth quake, a law and order situation, traffic accidents, etc.

Challenge Track	PoC
Expected output and Evaluation criteria	1. Well brought out relationship and mapping with discussions in FG AN use cases, and relationship with a focussed closed loop example(s). 2. Demonstration is focussed on a unique scenario (e.g. figure 1 below). 3. PoC (proof of concept) demonstrates the feasibility (or lack of it) of specific architecture approaches. 4. Quality of technical reports, papers and presentation of github code and demo. 5. Participation and engagement with mentors, regular and timely progress. Bonus points: for providing feedback to requirements/gaps: what are the impacts to existing reference points for enabling the AN key concepts?
Data source	Not applicable
Resources	1. Testbed and API description [FGAN-I-093] 2. Challenge resources [Build-a-thon resources]
Any controls or restrictions	The build-a-thon is open to all participants.
Specification/Paper reference	[ITU-T Y.3172], [ITU-T Y.3173], [FGAN-I-072], [FGAN-I-83-R2], [FGAN-I-088], [ETSI GS ZSM 001]
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3.1 Demo scenario-1: Network resource allocation for emergency management based on closed loop analysis

a. Demo precondition:

1. 5G testbed is operational, ML Marketplace (e.g. Acumos) and ONAP DCAE are integrated.
2. O-RAN or simulator-based underlay is available in the testbed.

b. Demo story

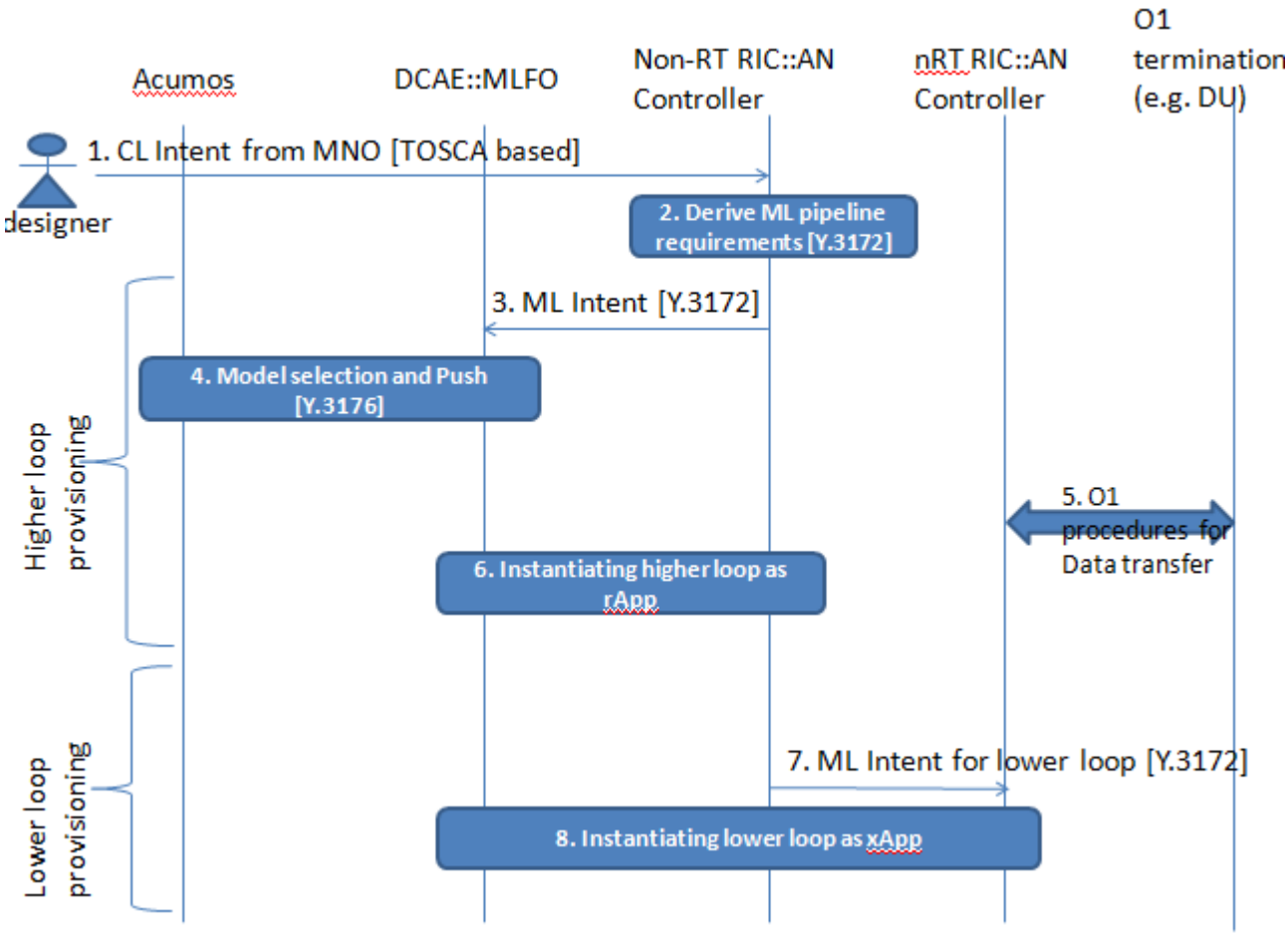

Figure 1: Demo sequence diagram

NOTE- refer to FG-AN-usecase-11 in [FGAN-I-082-R3] for corresponding use case description.

step-1: The MNO applies intent to SMO/Non-RT RIC which tells it to detect emergencies and maintain required SLA.

steps 2-4: The SMO/Non-RT RIC then creates a higher loop which monitors various parameters like network activity, 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 Acumos/DCAE/rApp.

step-5-6: Once the emergency is detected the loop then sends an intent over A1 interface to Near-RT RIC instructing it to handle the increased load for the corresponding RAN node.

NOTE: - Emergency responders (ERs) might use various devices which might need AI/ML inference in real time (e.g., Firefighter's Helmet mounted camera may use image recognition to detect humans in a burning building). However, the devices might not have enough compute and might need to offload the task to the network edge or use split AI/ML models for inference.

Step-7-8: 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 of the inference task. This loop could be realized using xApp.

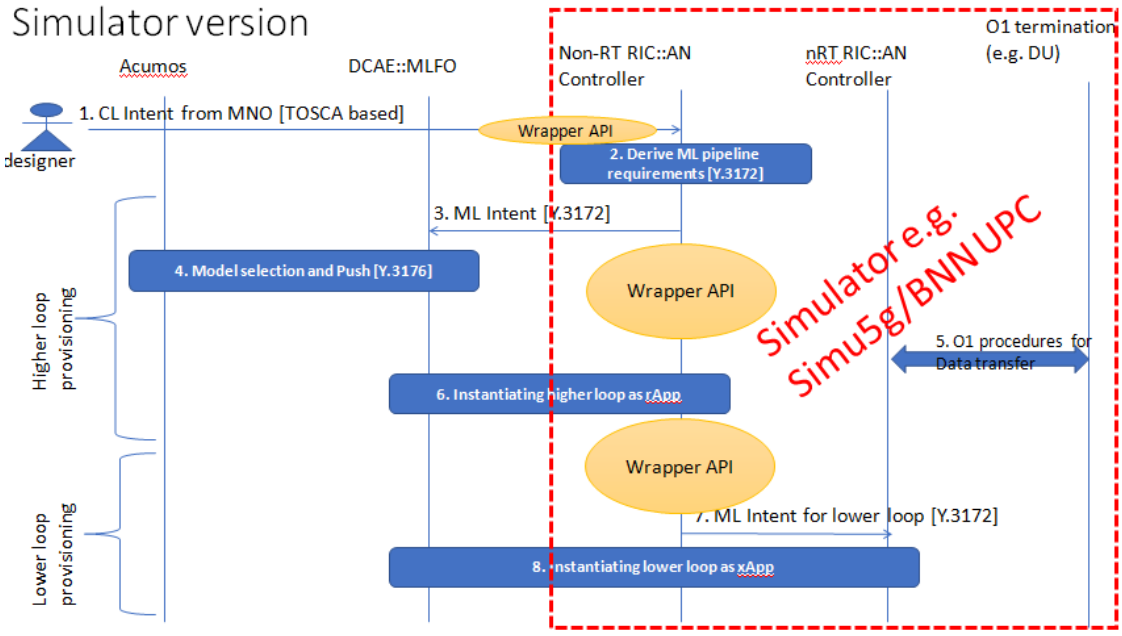

Figure 2 Simulator-based sequence

c. Demo post condition

- Intent based triggering of AN controllers is noted
- Management of ML pipelines for closed loops by AN controllers is noted.

d. Demo output for FG AN

- A demo report, especially focusing on Controller interface requirements with closed loops and ML pipelines is prepared and submitted to the FG AN.

Output report towards FG AN will address the following questions:

Activity-1) How to represent “controllers” (closed loops) in declarative fashion (intent)?

Editor note: Chris to help.

Team-1: FUT:

a. Model TOSCA nodes for controller (closed loop): SRC, SINK, Model metadata
b. successful parsing using orchestrator e.g. https://github.com/xlab-si/xopera-opera
c. write and demo “Toy” playbooks.

2) How to trigger “imperative actions” in the “underlay” based on the intent?

Team-x: xxx: must do this year. (Uc3m)

e.g. translating of intent to blueprint.

Editor note: Shabnam may help with this.

a. identify the existing cloudify blueprint template on DCAE blueprint repository which suits the use case.

b. Merging of input values into “DCAE bootstrap” e.g. specific urls.

c. Automated blueprint creation and integration from (1) above script/playbook to generate this blueprint.

[ref: https://wiki.onap.org/display/DW/DCAE+Service+Component+%28MS%29+Deployment+Options]

e.g. based on the blueprint, trigger the ML pipeline (Acumos+DCAE)

Editor note: Shabnam may help with this.

3) data pipeline setup

Team-3: SRM:

e.g. setup of data pipeline with simulators [SDNC – NTS sim], simu5g, …

Editor note: Shabnam, UoPisa, BNN UPC may help with this.

a. setup simulators, definition of yang, …

b. generation of data for particular use case

c. collection of relevant data and integration of data src with dmaap (or similar bus)

d. integration of SINK with some action APIs

e.g. installing and onboarding the “controllers” (closed loops) based on the use case requirement expressed in the intent.

4) The different types of scenarios which can be demonstrated with simulated vs. testbeds?

Team-4:TED??

e.g.

e.g. installing and onboarding controllers for evaluation.

e.g. Controller-controller interaction

Editor note: Chris + Abhishek - sub-intent derivation.

a. create a sub-intent (theoretical research).

Deploy controller for autonomy scenarios (O-RAN based lowerloop).

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e.g.[O-RAN nRT RIC may allow subscription of data +
      capability handling from E2 nodes]
Editor note:Qi Sun may help
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a. use an existing xApp to consume the sub-intent (from 4.a above)

b. trigger an existing closed loop?

c. create a new subscription?

NOTE – Teams may choose the scope of their implementation from the use case above. Not all teams may implement the complete use case. However the generic evaluation criteria is expected to be applied to all teams.

NOTE- Interim/early insights may be derived and incorporated into the FG AN reports.

3.1 Corresponding PoC activities for participants

Activity-1: corresponding to steps 1, 2 and 3 in the sequence diagram,

Intent design, parsing, integration with the orchestrator => a working intent demo-able using a sample orchestrator. The orchestrator will successfully parse the intent and create the representation of the intent (e.g. Higher and lower loop intents). Includes derived-intent for higher loop and lower loop. [ONAP CL]

Activity-2: corresponding to steps 4 in the sequence diagram,

higher loop instantiation: (SMO/rApp) instantiation + integration with DCAE + Acumos. Use a trained model (to start with), apply it in rApp.

Activity-3: corresponding to steps 5 and 6 in the sequence diagram,

O1 integration (or simulated underlay).

Configure the data inputs, handle the data input in rApp, show inference.

Activity-4: corresponding to steps 7 and 8 in the sequence diagram,

Lower loop instantiation: (xApp) instantiation + integration with [O1/A1]. Use a trained model (to start with), apply it in xApp.

Activity-5: corresponding to steps 8 in the sequence diagram,

O1/E2 integration (or simulated underlay).

Configure the data inputs, handle the data input in xApp, show inference.

4 Conclusion

This contribution proposes a build-a-thon aligned with the ITU AI/ML in 5G Challenge and calls for collaborative approach from FG-AN and its partners to participate in the build-a-thon.

Advantages to the FG-AN community in this participation is discussed, an outline of the proposal is given along with a concrete problem statement.

We call for support for this proposal and request participants in FG-AN for resources and pointers for the build-a-thon.

5 References

[ETSI GS ZSM 001] Zero-touch network and Service Management (ZSM); Requirements based on documented scenarios

[FG-AN ToR] Terms of Reference: ITU-T Focus Group on "Autonomous Networks" (FG-AN) https://www.itu.int/en/ITU-T/focusgroups/an/Documents/FG-AN_Terms_of_Reference.pdf

[FGAN-I-006] ITU AI/ML in 5G Challenge (second edition, 2021)

[FGAN-I-072] O-RAN SC architecture and collaborative use cases deep dive

[FGAN-I-088] Proposed initial draft of use cases for Autonomous Networks

[FGAN-I-082-R3] Additional use cases for editing and discussion

[FGAN-I-083-R2] Use case and requirements for orchestration of AI/ML based closed loops to enable autonomous networks

[ITU Challenge URL] https://aiforgood.itu.int/ai-ml-in-5g-challenge/

[Testbed API] Testbed and API description TBD.

[ONAP CL] https://wiki.onap.org/display/DW/Defining+Control+Loops+in+TOSCA+for+CLAMP

Annex-I: Wrapper API definition

1. Accept the Intent
    a. Basic parsing.

2. Create higher loop
    {
        create blueprint – trigger the Acumos adaptor/DCAE -- incase of testbed.
        create blueprint/wrapper: configuration, trigger the app for Acumos/DCAE-- in case of simu5g
    }

3. create inter-controller
    {
        create inter-controller intents
    }

4. Create lower loop ()
    {
        Programmatic trigger data pipeline using existing simulation – in case of simu5g
        setup of data pipeline [SDNC – NTS sim] -- in case of testbed
        setup of data pipeline – in case of O-RAN based testbed – depends on availability
    }

Annex-II: Activity-1: How to represent “controllers” (closed loops) in declarative fashion (intent)?

1. For acumos: --- Model metadata
2. For DCAE: Dmaap and REST APIs – check blueprint and derive the contents for Intent.
3. For inter-controller: check what is needed for lower loop?? And derive the contents for intent.
4. For lower loop: generalize the simu5g simulation config.

1) what is a good service topology model to represent "Controllers"?

- what is a controller? what are the components?
- what is a declarative and imperative examples at each step?

2) what are the attribute values of "Controllers"?

3) how and what actions can be operated on the service models?

- what events are generated?
- what are the conditions?
- what are the actions?

4) how to use the substitution feature for cascading? ("they can propagate down from high-level abstract “intent” statements to low-level device reconfigurations, and they can escalate back up if necessary.")

5) Declarative policies are more suitable for top-level “intent” statements, but they need to be translated (by the orchestrator) into corresponding “imperative” policies in order to be actionable.