Terms of Reference:
ITU-T Focus Group on "Autonomous Networks" (FG-AN)

1. Rationale and Scope

Current and future communication networks are the infrastructure at the heart of everyday life, supporting all forms of interaction from study to commerce and leisure to emergency services. As the demand and expectation of communication networks has grown through increased user subscription and new service expectation, operators must find new ways to address these pressures while at the same time controlling operational cost. Through digital transformation to software virtualization operators now have increasingly unified and simplified telecom infrastructure, presenting the *mechanism* to manage the network. However, the *control* of these mechanism is still mainly performed by human operators or well-defined automated process. Human operators do not have the required capacity to provide timely response in the face of the above pressures, and pre-defined automation does not have the ability to adapt to the ever-changing environment nor problems sets found within a modern telco-software network. Hence, the necessity exists for future networks to become *autonomous networks*.

Autonomous networks are those that possess the ability to monitor, operate, recover, heal, protect, optimize, and reconfigure themselves; these are commonly known as the self-* properties. The impact of autonomy on the network will be in all areas including planning, security, audit, inventory, optimisation, orchestration, and quality of experience. At the same time, autonomy raises questions about accountability for non-human decision that affect customers.

Advances in virtualization and cloud technologies in the Telco domain have paved the way for autonomous software control. Network architectures enabled by cloud-computing technologies and software virtualization are more amenable to integration of machine learning technologies, culminating in their autonomous behaviour. The work done in SG13 regarding the use cases, requirements, and architecture of cloud computing and AI/ML integration in future networks including 5G, are well-aligned with the proposal for a Focus Group on Autonomous Networks (FG AN).

Given the scale of the challenge, this Focus Group will serve as an open platform for pre-standard study on autonomous networks enabling collaboration between experts in the ITU, other SDOs, industry, and academia, allowing synergy of the right talent, knowledge, and experience to address the autonomy in future networks in a timely manner. The Focus Group will explore creative intelligence techniques that leverage online evolution mechanisms, enabling adaptation as a catalyst to achieve autonomous networks. The Focus Group will explore and study approaches such as exploratory evolution, emergent behaviour, and real-time responsive experimentation to enable an autonomous network. Collectively, these will provide a new layer of abstraction, introducing an evolution mechanism as a catalyst to autonomy. Both intentionally and necessarily, this effort is intended to be complimentary and interoperable with existing works by SDOs, academia, open source groups, and industry researchers.

2. Objectives of the FG-AN

The primary objective of the Focus Group is to provide an open platform to perform pre-standards activities related to this topic and leverage the technologies of others where appropriate.

The key concepts of Autonomous Networks are:

- Exploratory Evolution
- Real-time responsive experimentation
- Dynamic Adaptation

More concretely, this includes:

- **Study the meaning and characteristics of autonomous networks:**
  - Especially focusing on the definitions of concepts around creativity in autonomous networks, closed-loops or "controllers" as enablers for autonomy in future networks (including IMT-2020), exploration, experimentation, and adaptation in the context of autonomous networks, and any other integral concepts developed as part of the study in the focus group for autonomous networks.
    - NOTE – There are many different names for closed loop, cognitive loop, Monitor-Analyze-Plan-Execute over a shared Knowledge (MAPE-K), observe–orient–decide–act (OODA), etc.
  - Study these human or machine crafted taxonomies or ontologies used by the technology enablers to achieve the key concepts.
  - Produce a deliverable on the overview of autonomous networks in the context of self-adaptation which may include topics such as:
    - Appropriateness of existing approaches and techniques
    - Clear concepts
    - Key features
    - Characteristics
    - Design Principles
- **Study and propose technical enablers for <u>evolution</u> in autonomous networks**:
  - Given the work done in other groups, identify the gaps in achieving autonomous networks in future networks.
  - Study the possible reuse of existing solutions from other groups and the corresponding gaps based on the key concepts for autonomy in future networks. The key concepts include but not limited to, <u>exploratory evolution</u>, <u>real-time responsive experimentation</u>, <u>dynamic adaptation to future environments, technologies and use cases</u>.
  - Based on the above, propose technical enablers for autonomy in the network.

- **Provide guidelines to enable higher levels of autonomy through <u>real-time responsive experimentation</u>:**
    - Produce proof of concepts or guidelines of such architecture concepts that are able to:
        - Accept evolved artifacts (the output of the above evolutions)
        - Construct new real-time responsive experimentation to suitably verify these evolved artifacts.
        - Validate the evolved artifacts
    - Report on leverage existing efforts to achieve real-time responsive experimentation, such as simulation, sanity checking, or robustness, in concert with ITU standardized technologies such as ML Sandbox.
    - Study architecture mechanisms which will enable not only *automating* real-time responsive experimentation but also to analyze the need for new experiments.
    - Report on the specification languages/representations required to document such experimentation.

- **Specify requirements and architectures for <u>adaptation</u> in future networks to enable autonomy:**
    - Understand the limitations of evolution with respect to the self-adaptation of multi-domain systems, especially using orchestration mechanisms, such as machine learning function orchestrator (MLFO).
    - Identify the relationship between autonomy and future networks with regards to interaction points, data sharing & rate, safe operational envelopes.
    - Enable creating interoperable interfaces to validate new use cases without human intervention.
- **Liaison with other organizations:**
    - Establish liaisons and relations with other organizations which could contribute to the standardization and open source activities related to autonomous networks, especially related to use cases, requirements, architecture and PoC. It would be also useful to discuss the components and concepts which could be reused from different other groups.
    - Study, review and survey existing technologies, open source projects, platforms, guidelines, and standards for autonomy in current and future networks

3. Structure

The FG-AN may establish sub-groups if needed.

4. Specific Tasks and Deliverables

Tasks and deliverables developed by FG-AN may include the following:

- **Gap analysis**: Study existing initiatives related to autonomous networks, identify existing standards in other SDOs, and call out the additional work needed to adopt the key concepts (evolution, creativity, adaptation and online exploration, etc.) in autonomous networks. Gap analysis will be done as a horizontal activity across all the sub-groups. It should include standards, industry bodies, and open source related to autonomous networks. This activity shall be continuous and updated regularly by technical report.

- **Definitions:** Promote harmonization of terminologies and taxonomies for autonomous networks and the relevant eco-system needed for standardization
- **Use case analysis**: Study and identify use cases for autonomous networks, with emphasis on the key concepts, in the context of future networks.

  NOTE- autonomous generation of new use cases is a specific use case in autonomous networks.
- **Requirements and architecture**: Study and specify possible requirements, architectures of autonomous networks.
  - Study and define key technical enablers for the realization of autonomous networks (for example: Evolution mechanism to achieve creativity, Sandbox/Real-Time Responsive Experimentation Engine, Modularity to enable adaptation):
    - Specifications of core technical enablers;
    - Real-time responsive experimentation guidelines;
    - Trustworthiness including certainty and robustness while selecting and applying the autonomous decisions;
    - Adoption and influencing of open source implementation - respecting dominant approaches in the community - to collaborate towards reference implementation of the focus group specifications, especially highlighting the integration with other groups and past work of ITU.
- **Active partnerships:**
  - Collaborate with standards bodies, open source, forums, consortia and other entities dealing with aspects of autonomous networks and liaise with organizations, which could contribute to the standardization activities for autonomous networks with a specific aim to understand the level of autonomy possible in those domains, and the requirements for technical enablers which would hasten the integration of autonomous capabilities to future networks.
  - Organize thematic workshops and forums on autonomous networks, which will bring together all stakeholders, and promote the FG-AN activities, encouraging both ITU members and non-ITU members to jointly contribute to FG-AN and its objectives

5. Relationships

This Focus Group will work closely with SG13, with co-located meetings encouraged when possible. FG-AN will collaborate (as required) with other relevant groups and entities, in accordance with Recommendation ITU-T A.7. These include municipalities, non-governmental organizations (NGOs), policy makers, SDOs, industry forums and consortia, companies, academic institutions, research institutions, open source bodies and other relevant organizations.

6. Parent group

The parent group of the FG- ANs is **ITU-T Study Group 13** “Future networks, with focus on IMT-2020, cloud computing and trusted network infrastructures”.

7. Leadership

See clause 2.3 of Recommendation ITU-T A.7.

8. Participation

See clause 3 of Recommendation ITU-T A.7. A list of participants will be maintained for reference purposes and reported to the parent group.

It is important to mention that the participation in this Focus Group has to be based on contributions and active participations.

9. Administrative support

See clause 5 of Recommendation ITU-T A.7.

10. General financing

See clauses 4 and 10.2 of Recommendation ITU-T A.7.

11. Meetings

The Focus Group will conduct regular meetings, which may be virtual. The frequency and locations of meetings will be determined by the Focus Group management. The overall meetings plan will be established at the first meeting of the Focus Group. The Focus Group will use remote collaboration tools to the maximum extent, and collocation with existing SG13 meetings is encouraged.

The meeting dates will be announced by electronic means (e.g., e-mail and website, etc.) at least four weeks in advance.

12. Technical contributions

See clause 8 of Recommendation ITU-T A.7.

13. Working language

The working language is English.

14. Approval of deliverables

Approval of deliverables shall be taken by consensus.

15. Working guidelines

Working procedures shall follow the procedures of Rapporteur meetings. No additional working guidelines are defined.

16. Progress reports

See clause 11 of Recommendation ITU-T A.7.

17. Announcement of Focus Group formation

The formation of the Focus Group will be announced via TSB Circular to all ITU membership, via the ITU-T Newslog, press releases and other means, including communication with the other involved organizations.

18. Milestones and duration of the Focus Group

The Focus Group lifetime is set for one year from the first meeting but extensible if necessary, by decision of the parent group. (see ITU-T A7, clause 2.2).

19. Patent policy

See clause 9 of Recommendation ITU-T A.7.