TELECOM INFRA PROJECT

MACHINE LEARNING & ARTIFICIAL INTELLIGENCE

This Project Group Charter establishes the scope, intellectual property and copyright terms used to develop the materials identified in this Project Group. Only Participants that execute this Working Group Charter will be bound by its terms and be permitted to participate in this Project Group and shall be considered "Contributors" in the Project Group as defined in the **Telecom Infra Project IPR Policy document.**

TIP Board of Directors Approval Date: 10/4/2017

1. PROJECT GROUP NAME

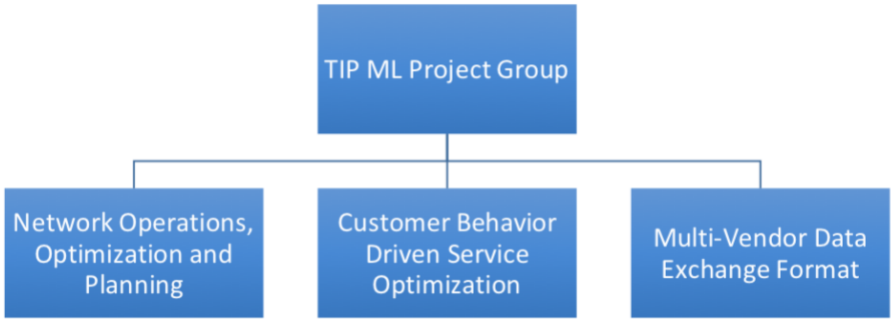
Machine Learning & Artificial Intelligence (Improving network operations and customer experience using Machine Learning and Artificial Intelligence)

2. PURPOSE

The complexity of networks and customer interactions will continue to increase in the future with the expanded deployment of diverse devices and new services. As a result, it is essential to enhance intelligence in network operations areas including network operations, planning, and optimization, as well as customer behavior areas with a focus on enhancing the overall customer experience. The application of machine intelligence will be central to automating network operations and to optimizing the experience for the users of present and future networks.

The objective of this Project Group is to define what customer and technical requirements, practices and infrastructure will be required to enable Machine Learning and AI to improve network operations and the customer experience.

3. PROJECT GROUP SCOPE



i. ML-Based network operation, optimization and planning
   a. ML-based monitoring and analysis to predict faults before they occur and accelerate the detection of faults to minimize customer experience impacts
      i. Anomaly/Fault Prediction and Detection
      ii. Autonomous anomaly and fault handling (Event/Incident Management)
   b. ML-based Fault Analysis and Recovery assistance
      i. Root cause analysis
      ii. Machine-guided recovery operations
      iii. Autonomous recovery actions
   c. ML-based network optimization and management to enhance network utilization and customer satisfaction through dynamic resource allocation and proactive maintenance via autonomous scheduling and configuration, including:
      i. Traffic and load prediction
      ii. Capacity utilization and performance optimization
      iii. Cell planning and real-time optimization
   d. **Customer behavior-driven service optimization** Goal is to develop ML- and AI- based recipes to:
      i. Predict customer behavior to optimize the network for improved customer experience, including operator-provided and over-the-top services.
      ii. Project best practices in bandwidth-intensive, latency-sensitive and/or data- heavy AI and ML apps (i.e., virtual assistants, augmented and virtual reality, robotics and autonomous vehicles.)
      iii. Provide a customer-centric approach that analyzes needs by customer segment (SMBs, Road Warriors, Gamers, Drones, etc.)
   e. **Vendor Data Exchange Formats Selection** of multi-vendor data exchange and interoperability formats that support the Network Operations and Customer Behavior ML/AI use cases implemented in work streams A and B above.

4. PROJECT GROUP DELIVERABLES

i. General Deliverables
   a. Common approaches, tools and sharable implementations in support of ML/AI based solutions for network operations and customer behavior including:

      i. Data definition and normalization practices
      ii. Feature definition and training models
      iii. Processing pipelines and optimization methods
      iv. Methods for optimized ML/AI processing related to distributed edge processing and autonomous decision making across the network
      v. Approaches and practices to enable an implementation focused ecosystem for network ML/AI solutions

ii. ML-based network operations, optimization, and planning
   a. Phase 1 [Target for Q4`17]: *Define initial use cases*
      i. Identify the requirements for ML based intelligent network operations
      ii. Define initial set of automated network operations use cases
      iii. Output: Contribute baseline requirements, initial use cases and learnings
   b. Phase 2 [Target for Q1`18]: First Prototype(s)
      i. Select common data model and sharing approach for solution development within the project group
      ii. Identify, select and assess ML algorithms and solutions regarding their applicability to the defined automated operations use cases
         1. Covering topics like Entropy Filtering, Clustering, etc.
         2. Select and prepare functions for dimension reduction based e.g. on Principle Component Reduction (PCA) or t-distributed stochastic neighbor embedding (t-SNE)
         3. Output: Demonstrate first prototypes and examples
      iii. Output: Contribute a control plane based, common data model supporting the initial network operations use cases
      iv. Output: Contribute initial practices, algorithms and prototype results
   c. Phase 3 [Target for Q2`18]: *Validation of Use Cases* o
      i. PoC of initial use cases
      ii. Evaluate ML capabilities for the addressed scope regarding automated decision making, learning and knowledge management
      iii. Output: Contribution of PoC results, technical architecture, data normalization methodology, algorithms, and models as applied in one or more PoC projects
   d. Phase 4 [Target for Q4`18]: Production Pilots with Shared Implementation
      i. Production pilots of selected use cases that demonstrate ML capabilities of automated operations

ii. Output: Contribution of Production pilot results, technical architecture, data normalization methodology, algorithms, models, pipeline specifications and Interface/API specification as applied in one or more production projects
iii. Output: Contribute a deployable implementation based on production pilots (Stretch goal - needs to be agreed by the project group membership)
iv. Output: Business case results (customer experience impacts, cost savings, operations scalability, etc.)

iii. ML-based customer behavior-driven service optimization
a. Phase 1 [Target for Q4`17]: Define initial use cases
i. Identify customer profiles / segments based on their specific needs. For example: SMB, Road Warriors, Gamers, Drones, etc.
ii. Select one customer segment for focused development high impact use cases
iii. Define initial set of intelligent customer behavior-driven use cases for the selected segment
iv. Define KPIs and data requirements for ML based intelligent customer behavior-driven service optimization across value and supply chain
v. Output: Contribute baseline requirements, initial use cases and learnings
b. Phase 2 [Target for Q1`18]: First Prototype(s)
i. Collaborate to design experiments to address each use case
ii. Identify, select and assess ML algorithms and solutions regarding their applicability to the initial customer behavior-driven service optimization use cases
iii. Output: Demonstrate first prototypes and examples
iv. Output: Contribute a user plane based, common data model supporting the initial customer behavior use cases
v. Output: Contribute initial practices, algorithms and prototype results
c. Phase 3 [Target for Q2`18]: Validation of Use Cases
i. Design and build a Proof-of-Concept (PoC) to test the initial use cases
ii. Evaluate ML capabilities for the addressed scope regarding automated decision making, learning and knowledge management
iii. Output: Contribute PoC results, technical architecture, data normalization methodology, algorithms, and models, as applied in one or more PoC projects
d. Phase 4 [Target for Q4`18]: Production Pilots with Shared Implementation
i. Production pilots of selected use cases that demonstrate ML capabilities for customer behavior-driven service optimization
ii. Output: Contribute production pilot results, technical architecture, data normalization methodology, algorithms, models, pipeline specifications and Interface/API specification as applied in one or more production projects

iii. Output: Contribute a deployable implementation based on production pilots (Stretch goal - needs to be agreed by the project group membership)
iv. Output: Business case results (customer experience impacts, cost savings, operations scalability, etc.)

iv. Multi-Vendor ML-AI Data Exchange Formats

To enable and ensure the AI/ML related topics mentioned above, an open, readable and common data exchange format is strongly required. To prevent handling of a number of different formats or even vendor specific data formats, the group will select and decide on one common and open data format used for this work.

While Network Operations/Planning/Optimization will probably find a data source in syslog messages, traps as well as the control plane data in general, the customer behavior driven service optimization will probably have a need to access user plan data.

a. Phase 1 [Target for Q1`18]: Initial Exchange Format(s)
    i. Output: Contribute an initial data exchange format that enable multi-vendor data aggregation and processing to implement the initial ML/AI network operations and customer behavior use cases
b. Phase 2 [Target for Q2`18]: Exchange Format Validation
    i. Output: Contribute an expanded control / user plane data exchange format that support implement of the ML/AI network operations and customer behavior use cases
    ii. Output: Contribute a multi-vendor sample data set used to validate interoperability of the exchange format (control plane and user plane)
    iii. Output: Contribute Proof of Concept (PoC) results that demonstrate the practical application and multi-vendor interoperability of the data exchange formats for of ML/AI based network operations and customer behavior driven service optimization
c. Phase 3 [Target for Q4`18]: Exchange Format Production Deployment
    i. Output: Contribute a production proven data exchange format that supports implement of the ML/AI network operations and customer behavior use cases
    ii. Output: Contribute a production proven multi-vendor sample data sets for community validation, experimentation and deployment

5. PATENT LICENSING

The patent license for all Contributions, Draft Specifications and Final Specifications within this Project Group shall be:

[Check one box]

x **RAND License Option**, as set forth in Section 5.2.1 of the Telecom Infra Project IPR Policy.

□ **Royalty-free License Option**, as set forth in Section 5.2.2 of the Telecom Infra Project IPR Policy.

6. FINAL DELIVERABLE COPYRIGHT LICENSING

Project Group agrees to grant the following copyright license for the Final Specification: *[Check one box]*

x **Creative Commons Copyright Attribution 4**, Each Project Group Contributor agrees that its Contributions are subject to the Creative Commons Attribution 4.0 International license - http://creativecommons.org/licenses/by/4.0/legalcode.

□ **Full Release of Copyright into the public domain**, Each Project Group Contributor agrees to release its Contributions to the public domain and waive all copyrights associated with them.

7. INITIAL PROJECT CHAMPIONS

DT, Telefonica, Facebook, SKT, Cisco, Avanseus

8. CHAIR AND(OR) CO-CHAIR OF PROJECT GROUP

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9. PARTICIPATION CRITERIA

i. Operators are required to contribute data from networks in an effort to normalize data for learning

Vendors are required to have their solution interface open and not proprietary to interact with network systems in an effort for open collaboration