
F5G OpenLab at HHI: from Vision to Solutions

A Vendor-neutral Infrastructure for Technology Testing and Validation

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NGON & DCI
World

Workshop:

Overview of Recent Developments for Optical Network Standards

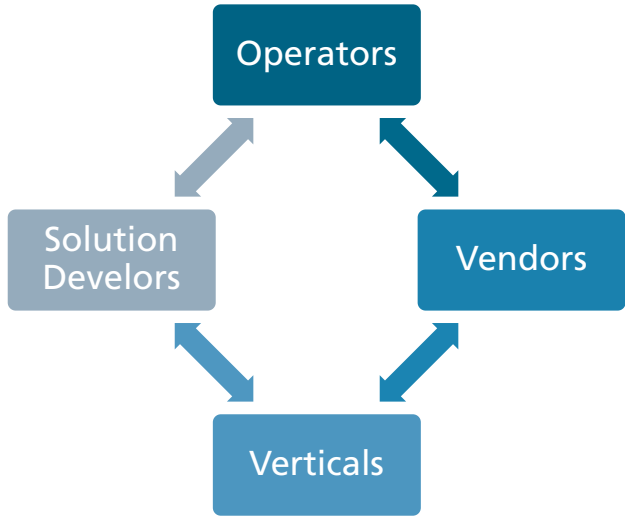


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 - Precise Traffic Monitoring and Telemetry Streaming for Prediction and Analysis

Vision of F5G OpenLab

Roadmap



F5G Alliance

Ecosystem Development
Raise and Verify Use-cases
Participate in Trade Shows

F5G OpenLab – Development and Demonstrations

Investigates Use-cases, Demonstrate F5G Technologies,
Showcase F5G PoCs

ETSI ISG F5G – F5G Standards Development

Generation Definition, Use-case Documentation, Architecture Definition, E2E Management,

Vision of F5G OpenLab

Develop, Test, and Validation of the Specifications and Use-cases of F5G

Enhanced Traffic
Monitoring and
Network Control in
Access Networks

PON for Industrial
Manufacturing

Edge/Cloud-based
Control of AGVs

Edge/Cloud-based
Visual Inspection for
Automatic Quality
Assessment in
Production

Cloud Virtual Reality

High Quality Private
Line

PON on Premise

Passive Optical LAN

Using PON for City
Public Service

XR-based Virtual
Presence

Cloudification of
Medical Imaging

AI-based PON optical
Path Diagnosis

Vision of F5G OpenLab

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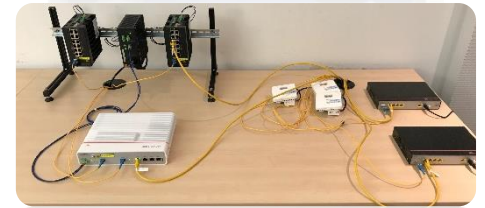
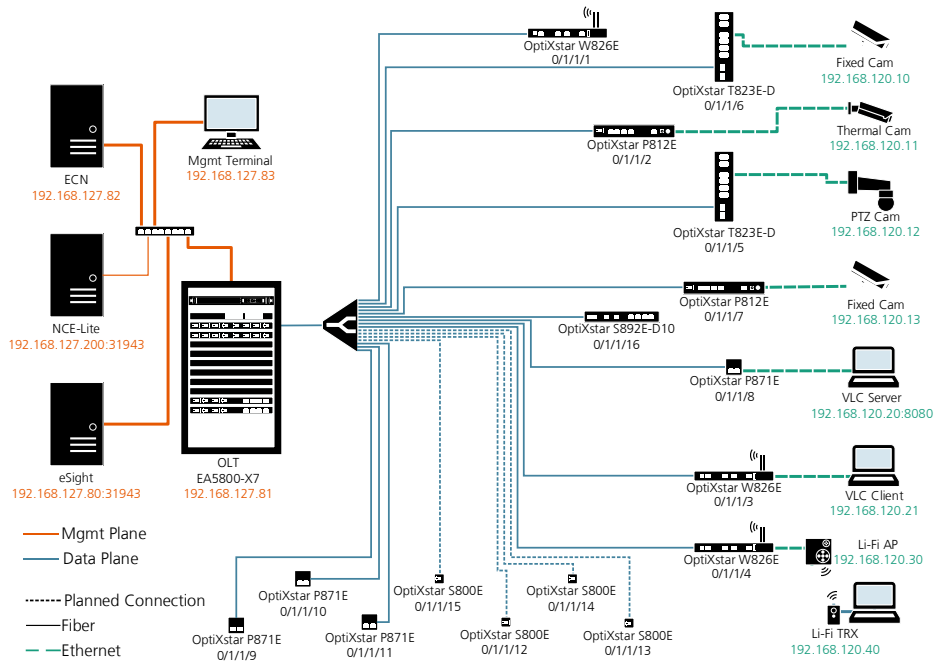
XR-based Virtual Presence

Cloudification of Medical Imaging

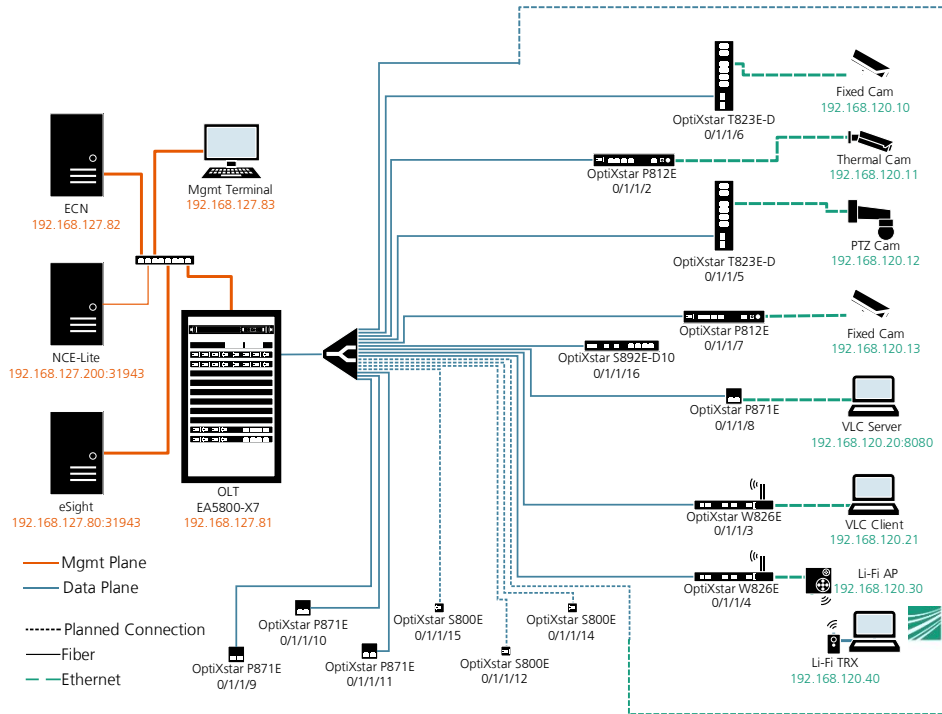
AI-based PON optical Path Diagnosis

Architecture of the F5G OpenLab

Available Equipment and Software Solutions



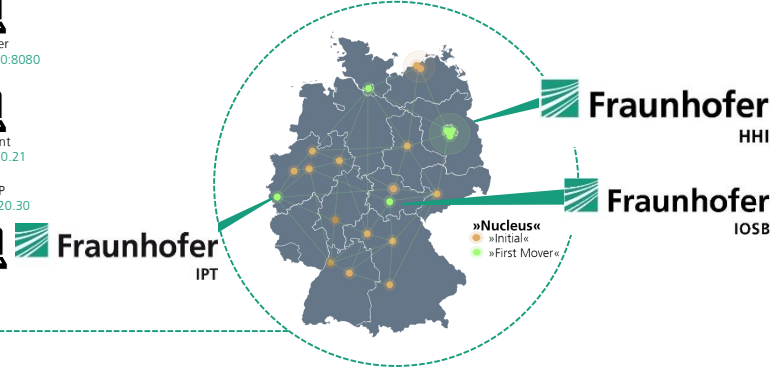
F5G OpenLab Extension



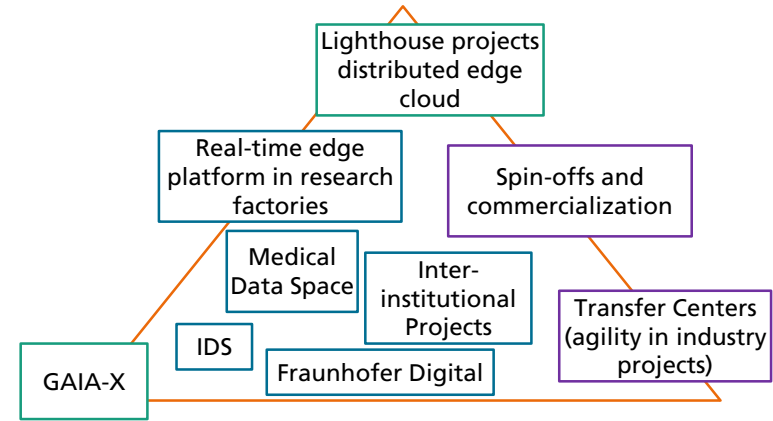
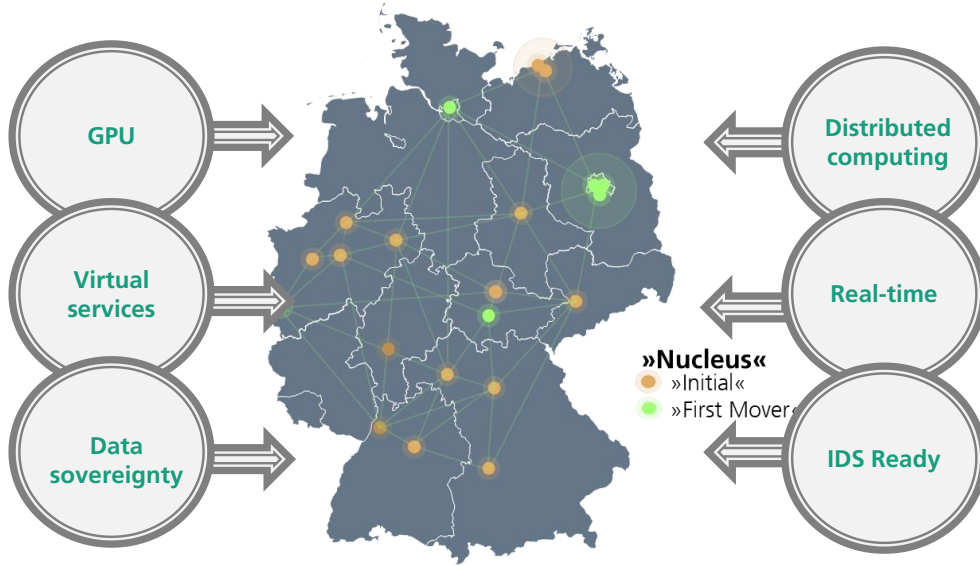
Manufacturing Sites



Fraunhofer Edge Cloud (FEC)



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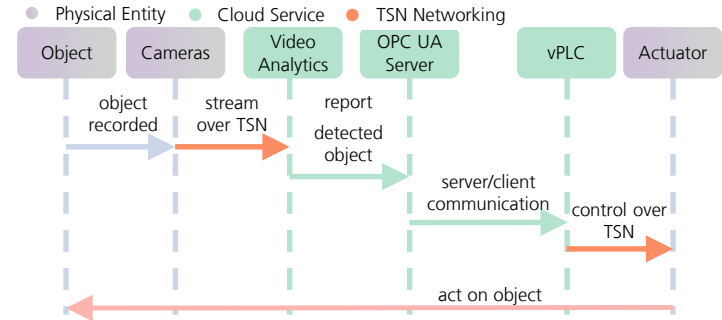
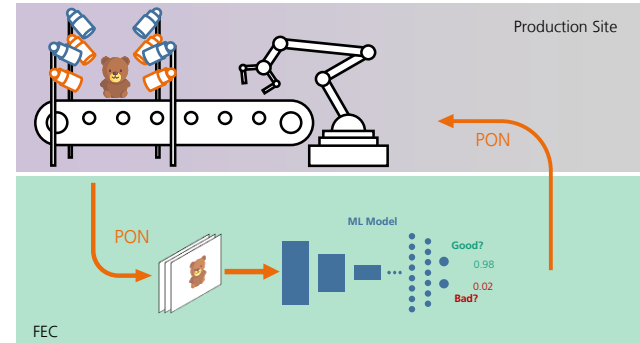
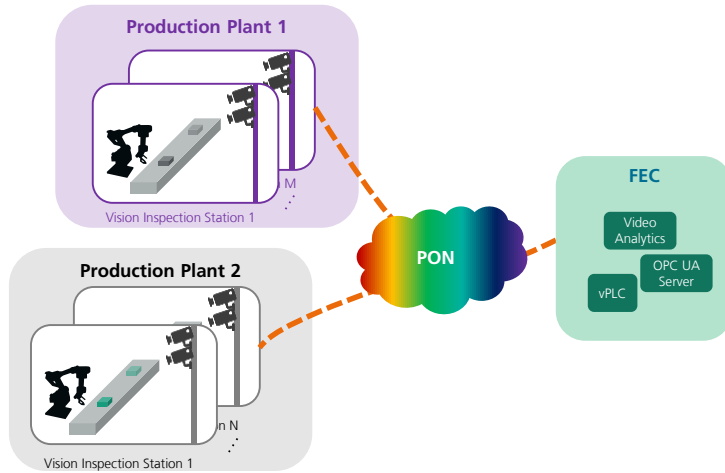
Creation of an edge cloud in Germany for networked and adaptive solutions of the future



FEC as a Research Platform

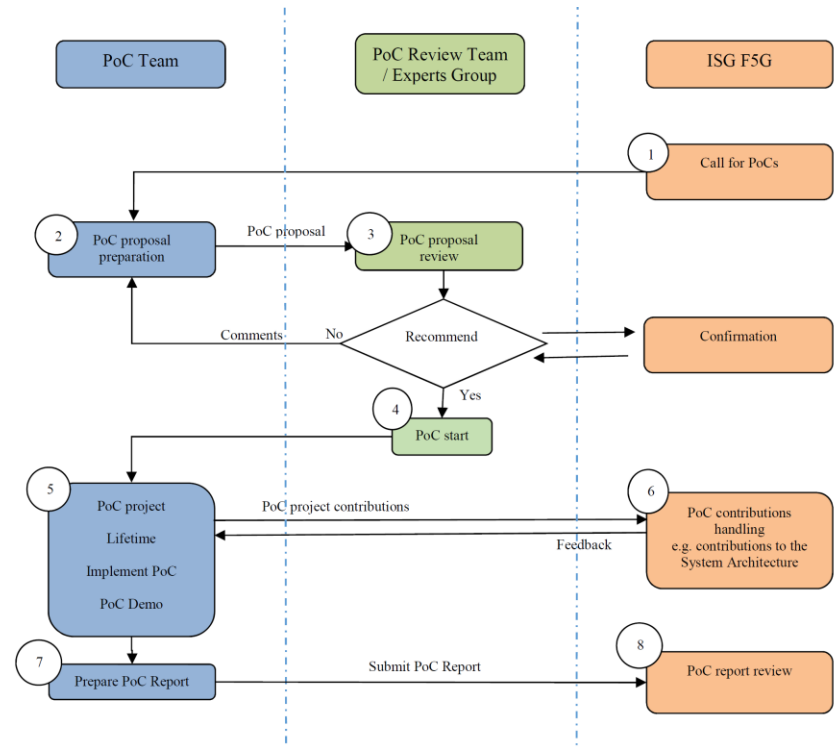
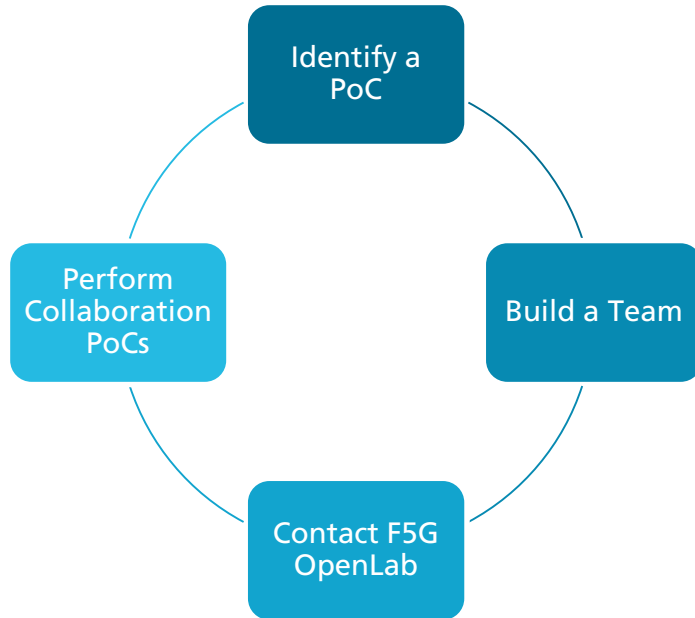
OpenLab Extension to FEC and Manufacturing Sites

Enable Validation of F5G Features for Industry 4.0 Ecosystem



[ref] P. Safari, et al., "Edge Cloud based Visual Inspection for Automatic Quality Assurance in Production," in Proc. CSNDSP 2022, Porto, Portugal, Jul 2022.

F5G OpenLab for PoC Demonstrations

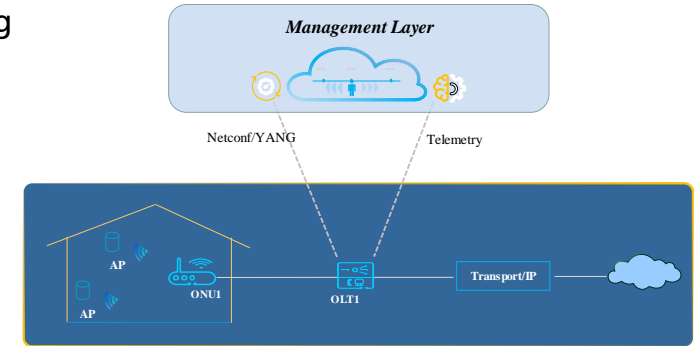
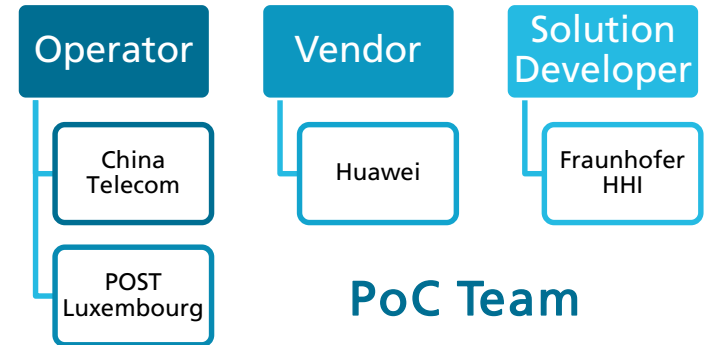


[ref] ETSI ISG F5G, "Fifth Generation Fixed Network (F5G): Proof of Concept Framework," V1.1.1, Jun 2021.

First PoC Demonstration in the F5G OpenLab

Precise Traffic Monitoring and Telemetry Streaming for Prediction and Analysis

- Operator driven use-case for:
 - improved service experience, and
 - improved operation and maintenance, and reduce OPEX.
- The identified use-case requires:
 - Telemetry Streaming: real-time, end-to-end, and precise traffic monitoring.
 - Big Data Analytics: traffic monitoring data analysis and processing
 - Machine Learning: to realize the network automation.
- Pre-conditions
 - SDN framework and interface should be supported by the OLT.
 - Telemetry interface and model should be supported by the OLT.



ML Pipeline for AI-assisted Network Automation

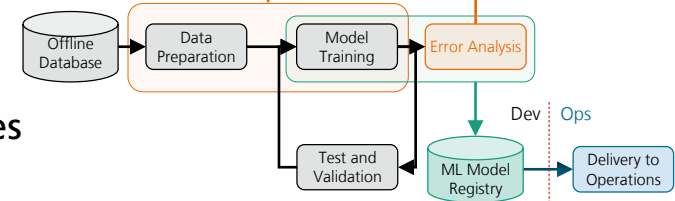
Unified Principles for Access/Metro/Core Transport Networks

Identified Requirements:

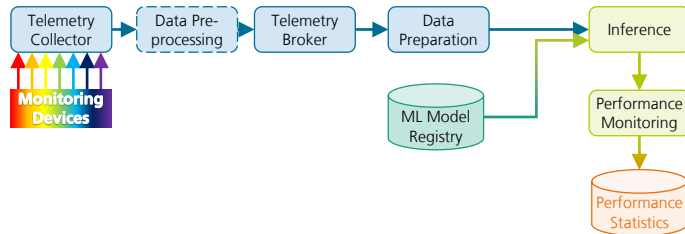
- Telemetry Retrieval Granularity
- Telemetry Storage Overhead
- Computation Requirements for Data Analysis
- Telemetry Collectors, Brokers, and Time-Series Databases
- Cross-interface and Cross-terminal Telemetry Sharing



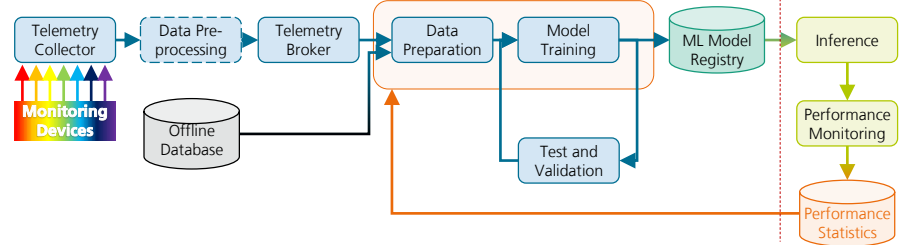
(a) ML pipeline for R&D phase



(c) ML pipeline for operation phase → Inference mode

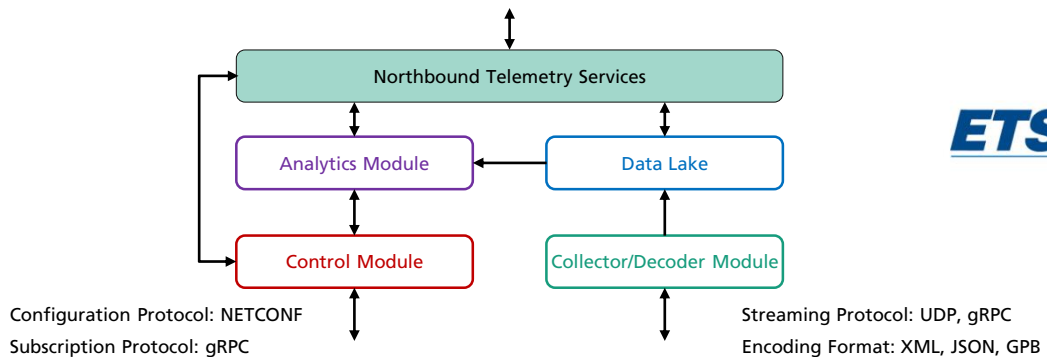
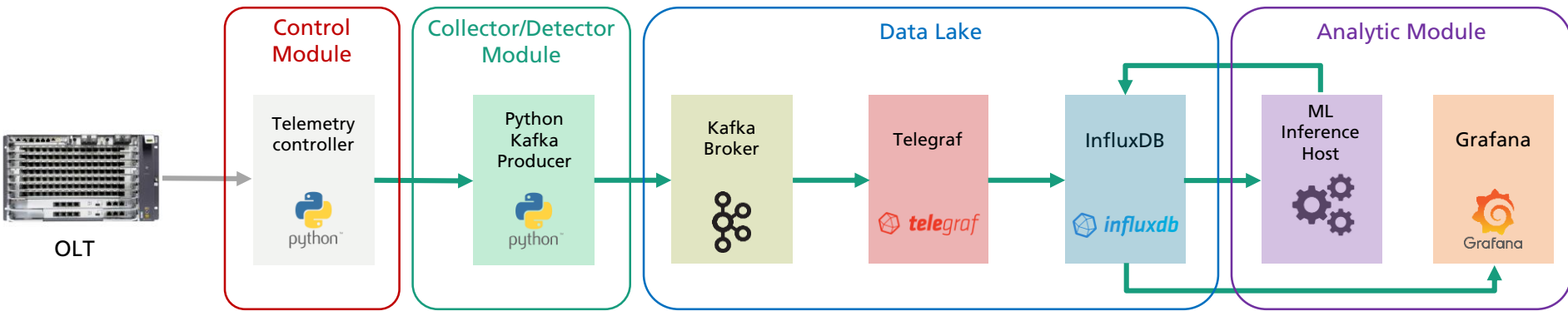


(b) ML pipeline for operation phase → In-operation model re(training) mode



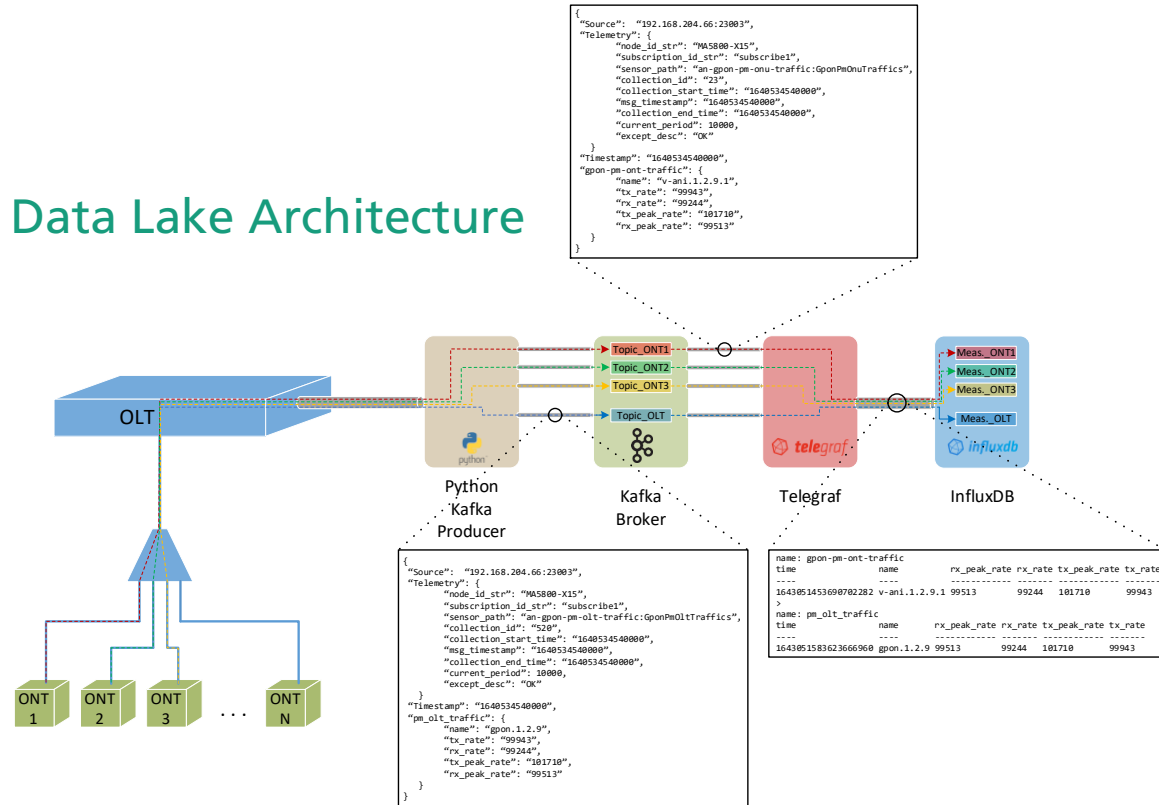
Real-time ML Pipeline for F5G Optical Access Networks

Implementation of F5G Telemetry Management Platform

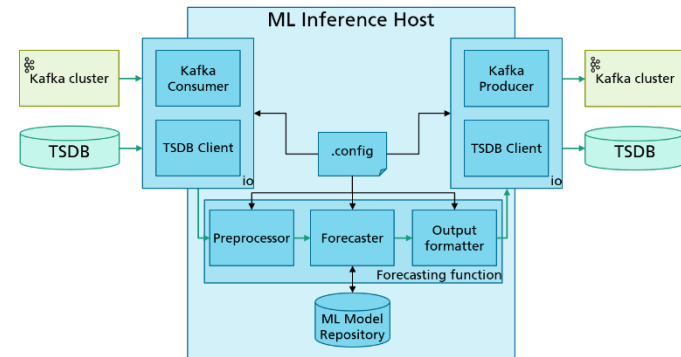


Real-time ML Pipeline for F5G Optical Access Networks

Data Lake Architecture

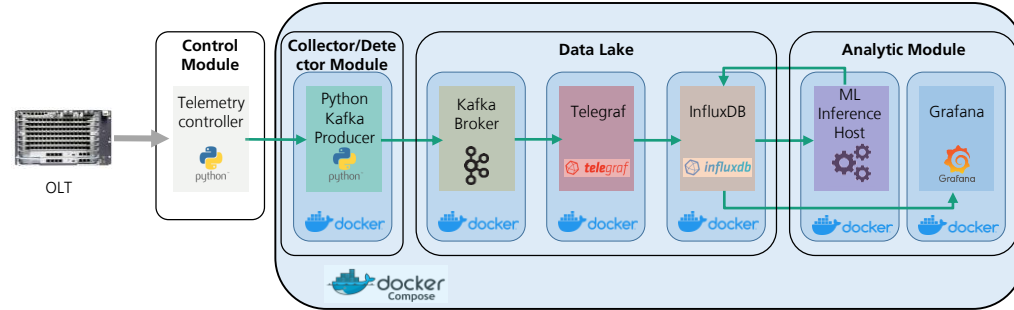


ML Inference Host



First PoC Demonstration in the F5G OpenLab

Precise Traffic Monitoring and Telemetry Streaming for Prediction and Analysis



Summary

- F5G OpenLab offers a unique opportunity to operators, vendors, and technology developers to test and validate their solutions.
- We carried out the first successful demonstration focused on real-time ML pipeline and telemetry streaming for traffic prediction and analysis in F5G optical access networks.
 - POST Luxembourg, China Telecom, Huawei, and Fraunhofer HHI
- F5G OpenLab is upgraded with an HHI-developed ML pipeline and is ready to host advanced PoCs in the context of AI-assisted network automation.
- HHI is coordinating the project 6G-RIC, which paves the way for F6G developments offering numerous possibility to the F5G OpenLab at HHI.

Fraunhofer-Institut für Nachrichtentechnik, Heinrich-Hertz-Institut, HHI

WE PUT SCIENCE INTO ACTION.

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Cluster



ML Model for Traffic Analysis

■ Traffic Forecast

- ML Model: Temporal Fusion Transformer ^[1]
- Forecast 10 samples into the horizon based on the last 50 samples retrieved from the OLT.

■ Traffic Pattern Recognition

- ML Model: ROCKET (RandOm Convolutional KErnel Transform) ^[2]
- Returns a class label based on the last 12 samples retrieved from the OLT.

■ Traffic Anomaly Detection

- ML Model: It is an ensemble of three models: ETS (Error, Trend, Seasonality) ^[3], ZMS ^[4], and Robust Random Cut Forest ^[5]
- Returns an anomaly score based on the last 2 samples retrieved from the OLT.

[1] B. Lim, et al., "Temporal Fusion Transformers for Interpretable Multi-horizon Time Series Forecasting," arXiv:1912.09363, Sep 2020.

[2] A. Dempster, et al., "ROCKET: Exceptionally fast and accurate time series classification using random convolutional kernels," arXiv:1910.13051, Oct 2019.

[3] C. C. Pegels, "Exponential forecasting: Some new variations," in Management Science, 1969.

[4] A. Bhatnagar and et al., "Merlion: A Machine Learning Library for Time Series," arXiv:2109.09265, 2021.

[5] S. Guha and et al., "Robust Random Cut Forest Based Anomaly Detection On Streams," in International Conference on Machine Learning, NY, USA, 2016.

