



AI/ML-enabled automation in Open Optical Networks

Netnod Tech Meeting 2022

Sai Kireet Patri, 2022-10-13

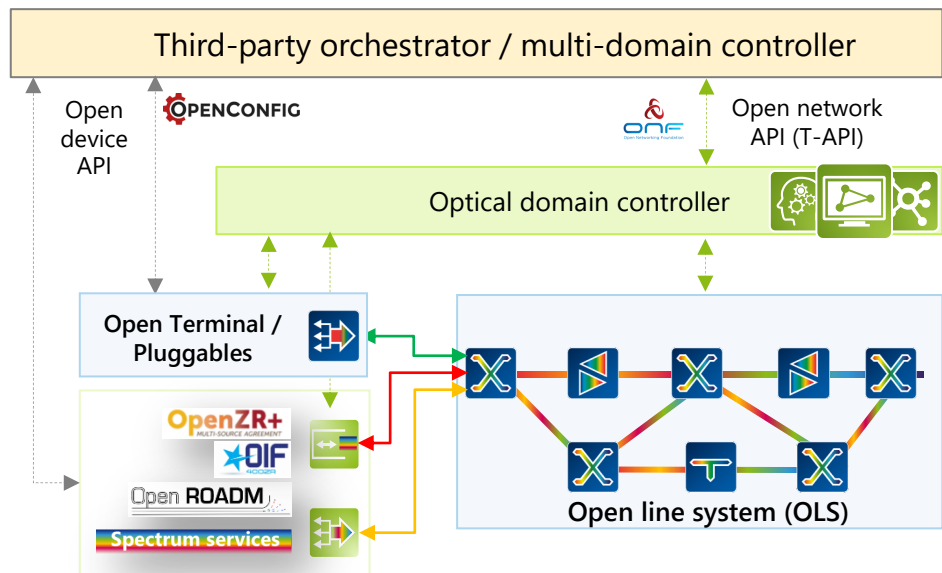
Open optical networking

Giving network operators freedom of choice

Open optical system

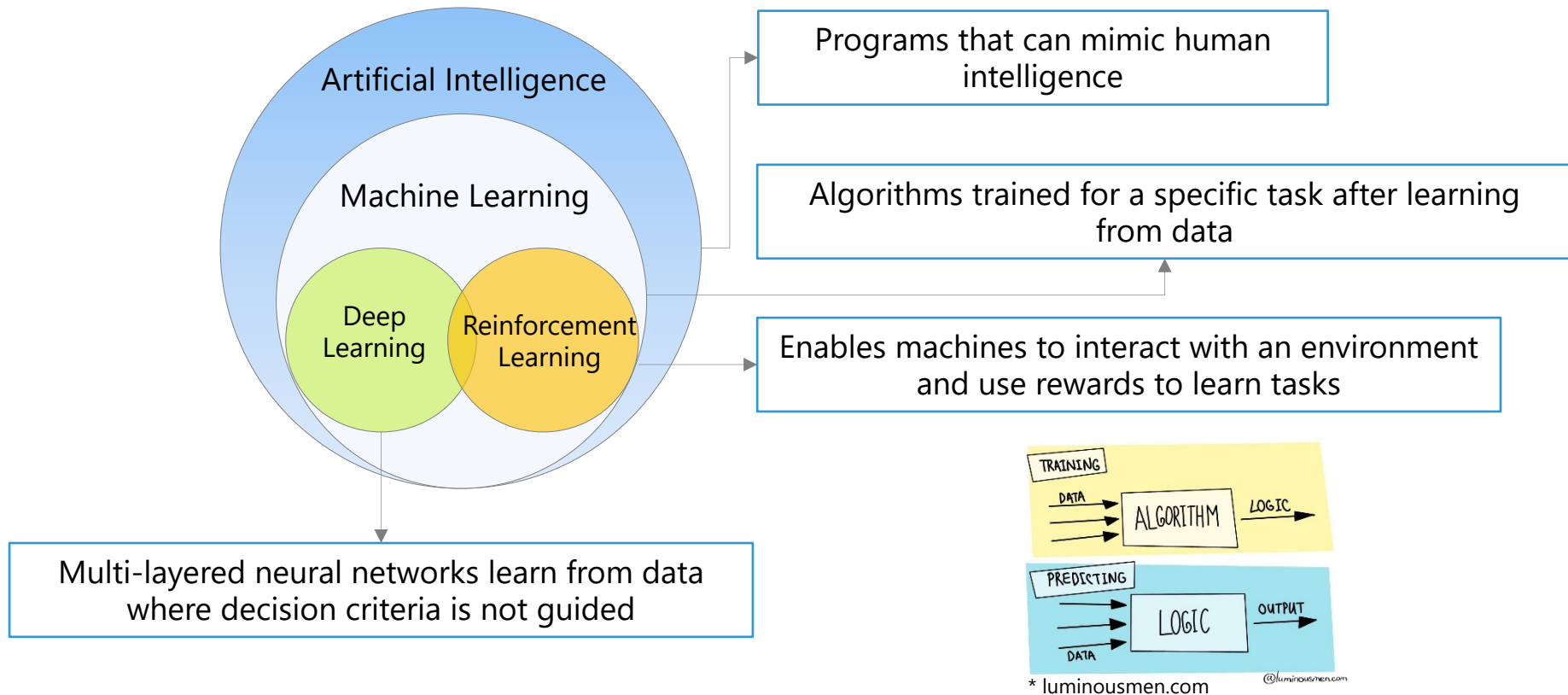
- Open and **partially disaggregated** hardware (terminals + OLS)
- Hardware configurable via **standardized data models** and APIs
- **Open commercial model** enabling network planning with third-party wavelengths

Unified SDN control and management



Allowing seamless integration into multi-vendor environments

A quick introduction to AI/ML



A quick introduction to AI/ML

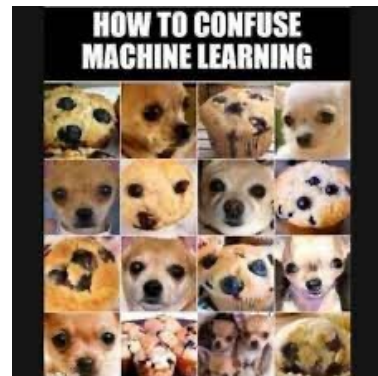
Hype Cycle for Artificial Intelligence, 2022



gartner.com

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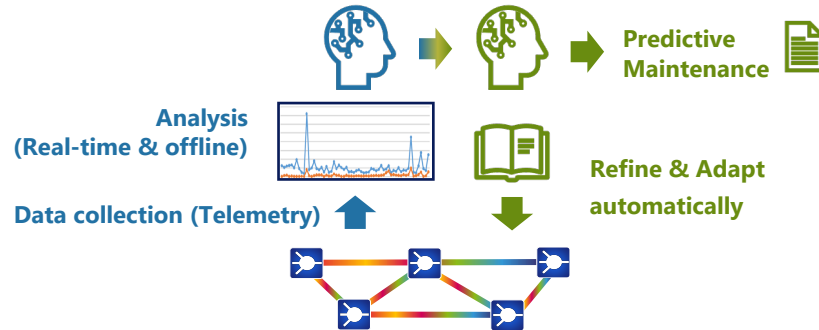
* reddit.com (u/Nesher86)



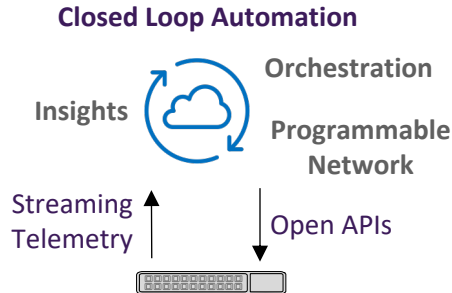
* 9gag.com (alvinfsc)

* gartner.com

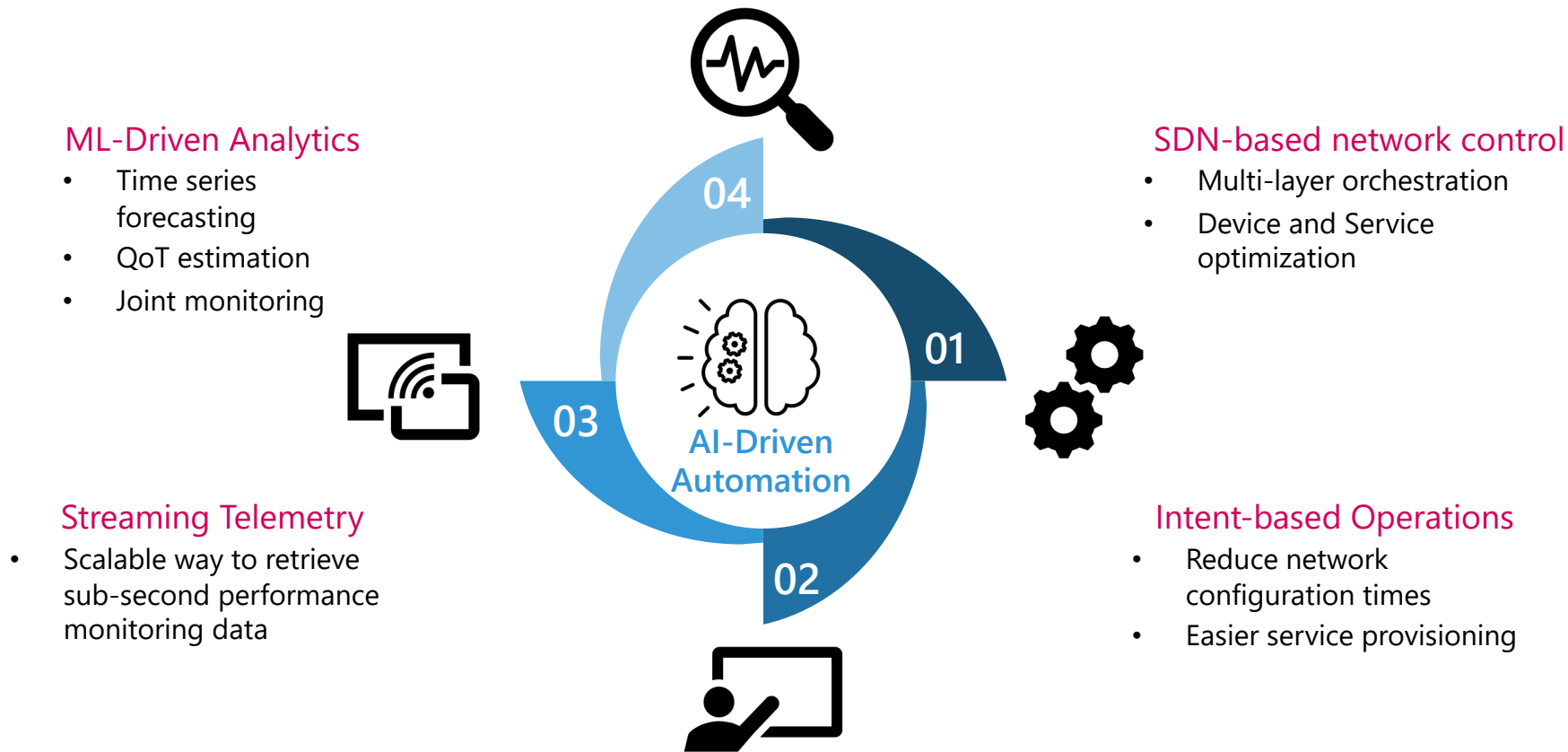
AI/ML for network automation and optimization



Turning **data into actionable insights** to optimize network and service performance



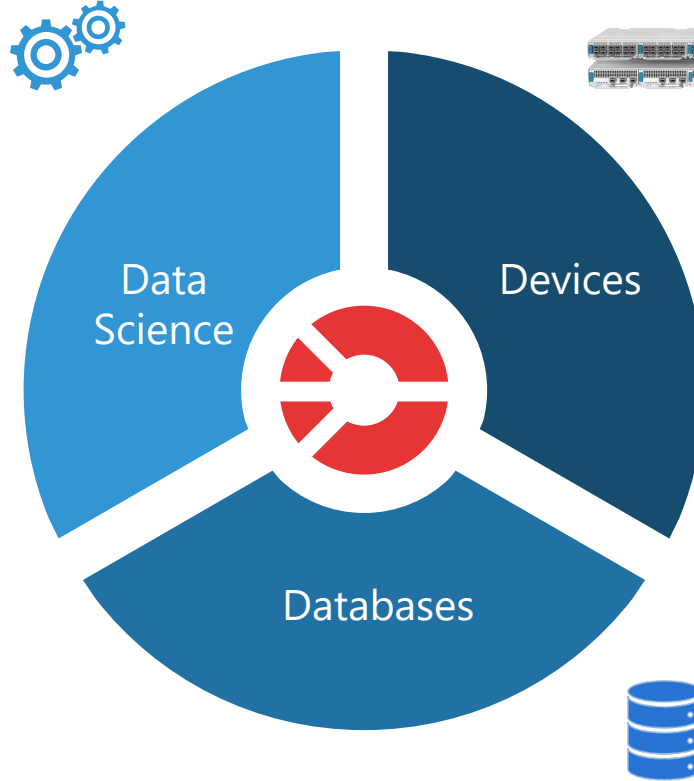
The evolution towards AI/ML for network automation



Building blocks for AI/ML driven network automation

Data Science & Applied ML

- Data Analytics
- Choice of ML algorithms to solve specific problems
- Algorithm marketplace
- Leverage data to optimize network operations



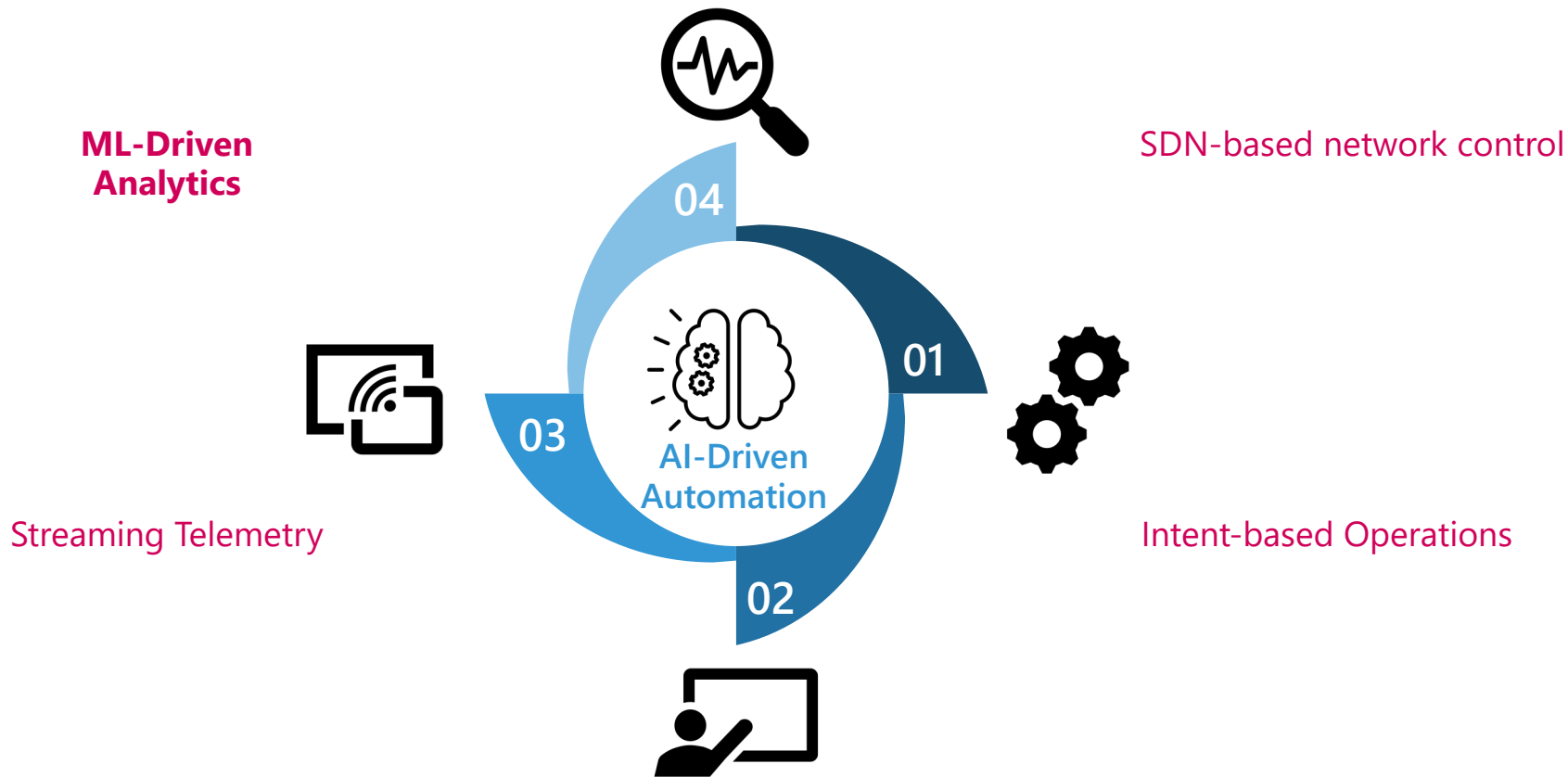
Choice of Devices

- Open APIs
- Standardized Data Models
- Zero-Touch Provisioning
- Streaming Telemetry

Choice of Database

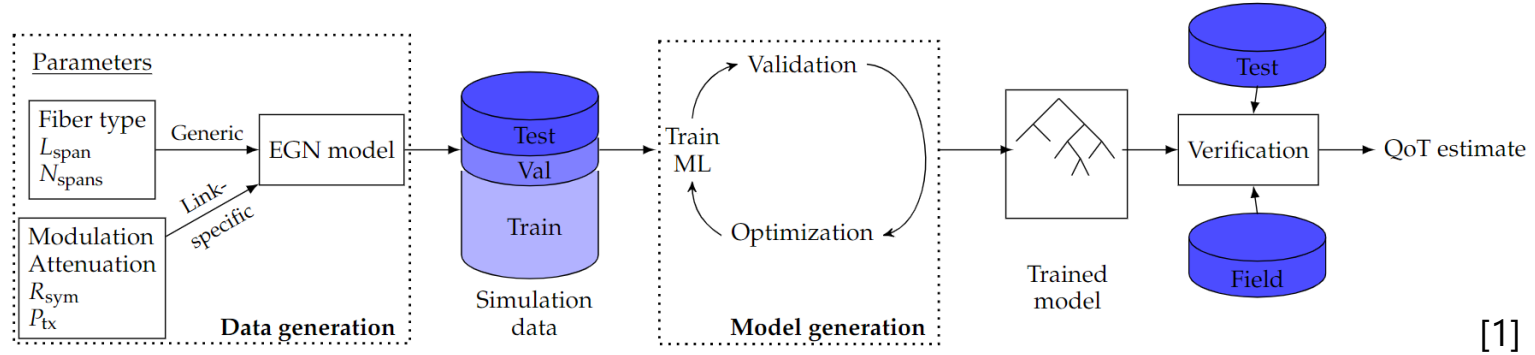
- Scalable common data collection framework
- Easy to store and archive data
- Light and quick DB ops

Can we work with the data we already have?



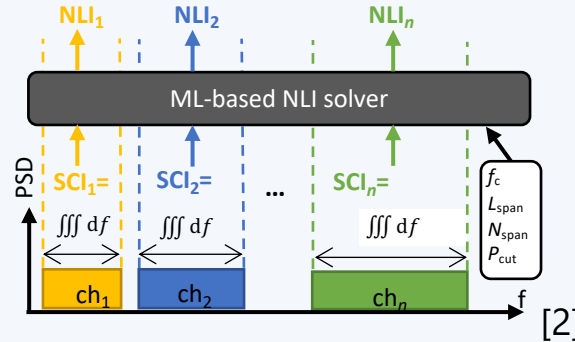
Research highlights: Planning new services

Fast and accurate ML-based QoT Estimator



ML-based NLI solver

$$SNR = \underbrace{\frac{P_s}{P_{ASE} + P_{SCI}}}_{\text{physical}} + \underbrace{P_{XCI}}_{\text{ML}}$$



P_s signal power

P_{ASE} amplified spontaneous emission power

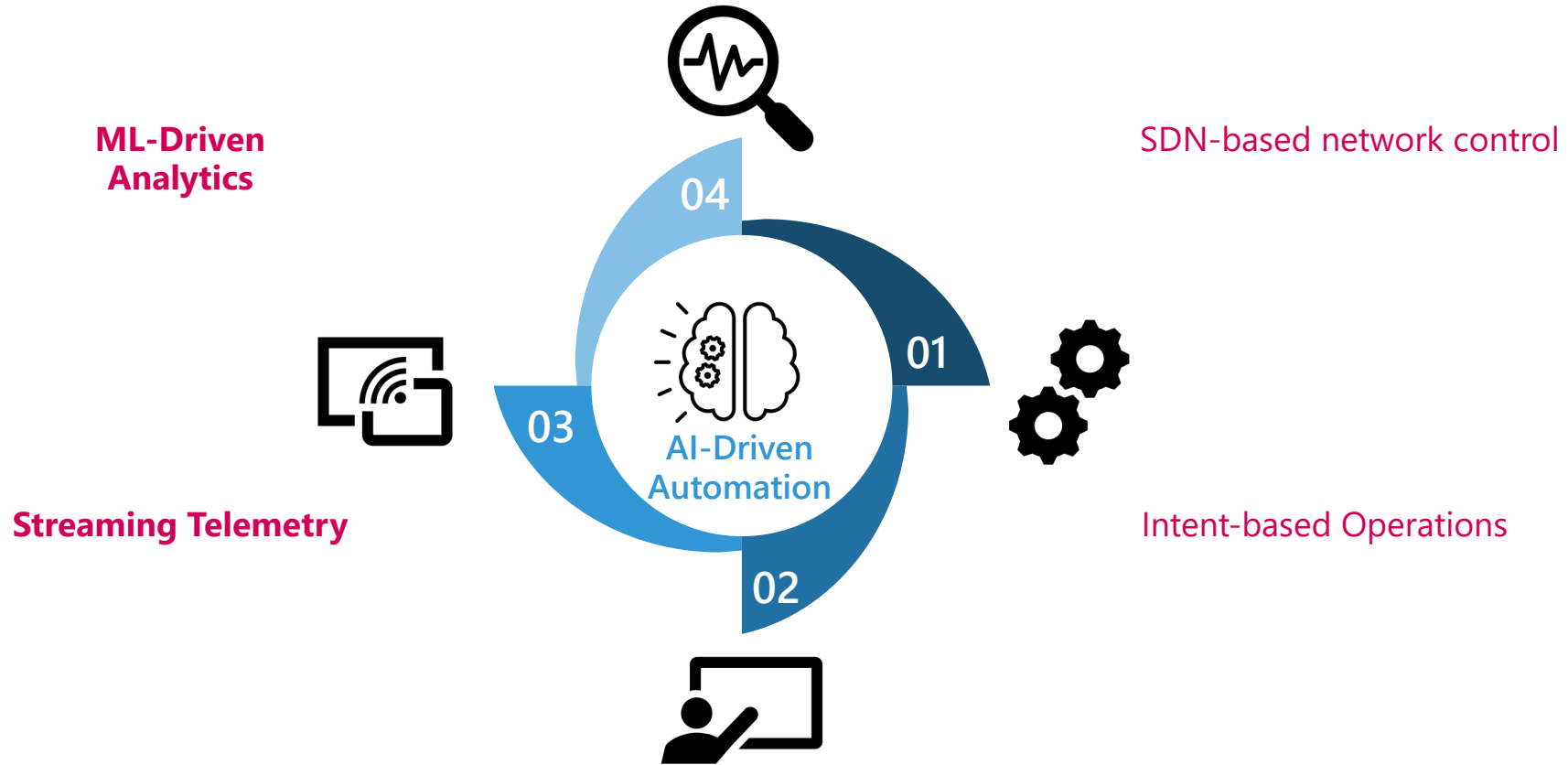
P_{SCI} self-channel-interference power

P_{XCI} cross-channel-interference power

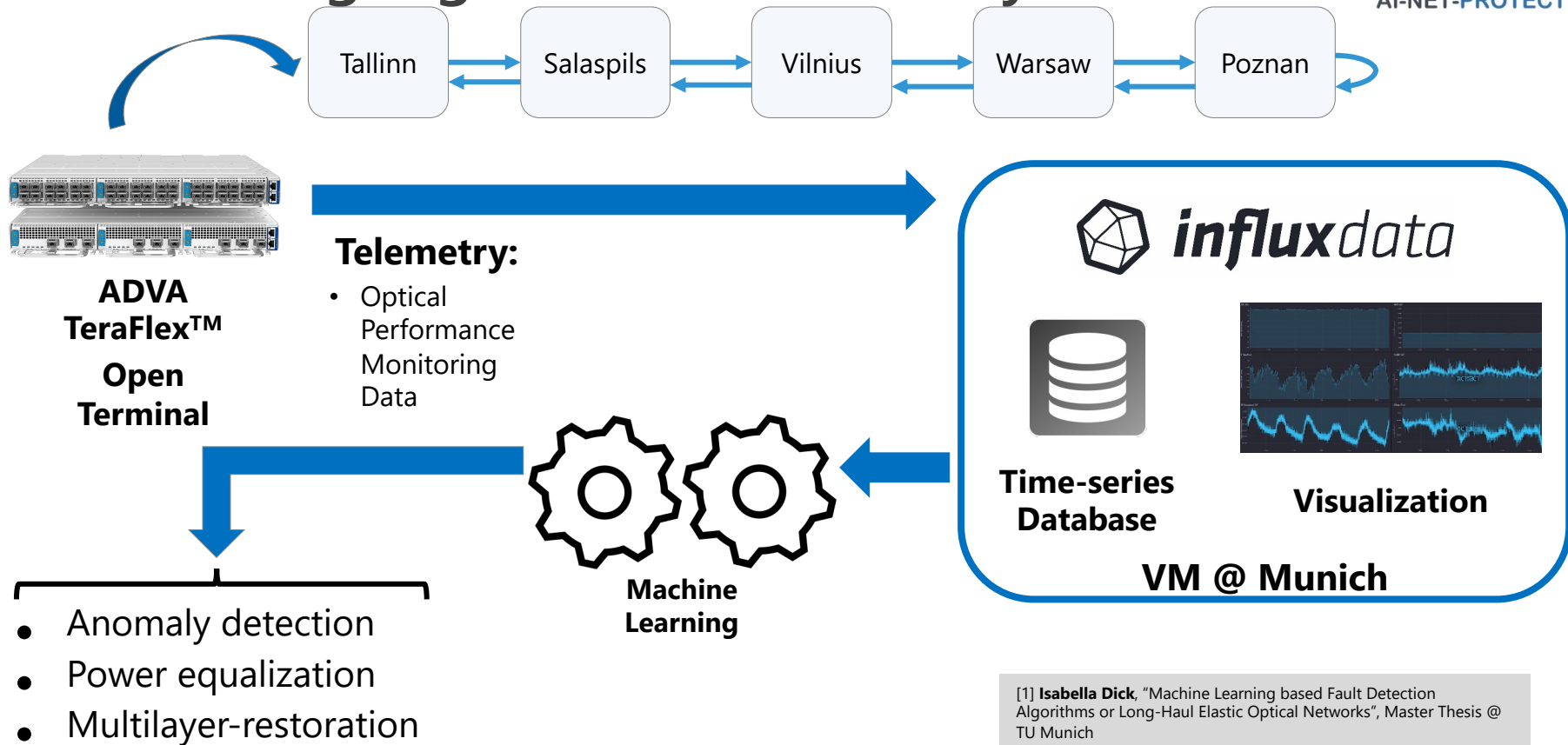
[1] J. Müller et al., "ML-based QoT Estimation: From Simulations to Application in a Live Production Network, submitted to JOCN

[2] J. Müller et al., "A QoT Estimation Method using EGN-assisted Machine Learning for Network Planning Applications", ECOC, 2021

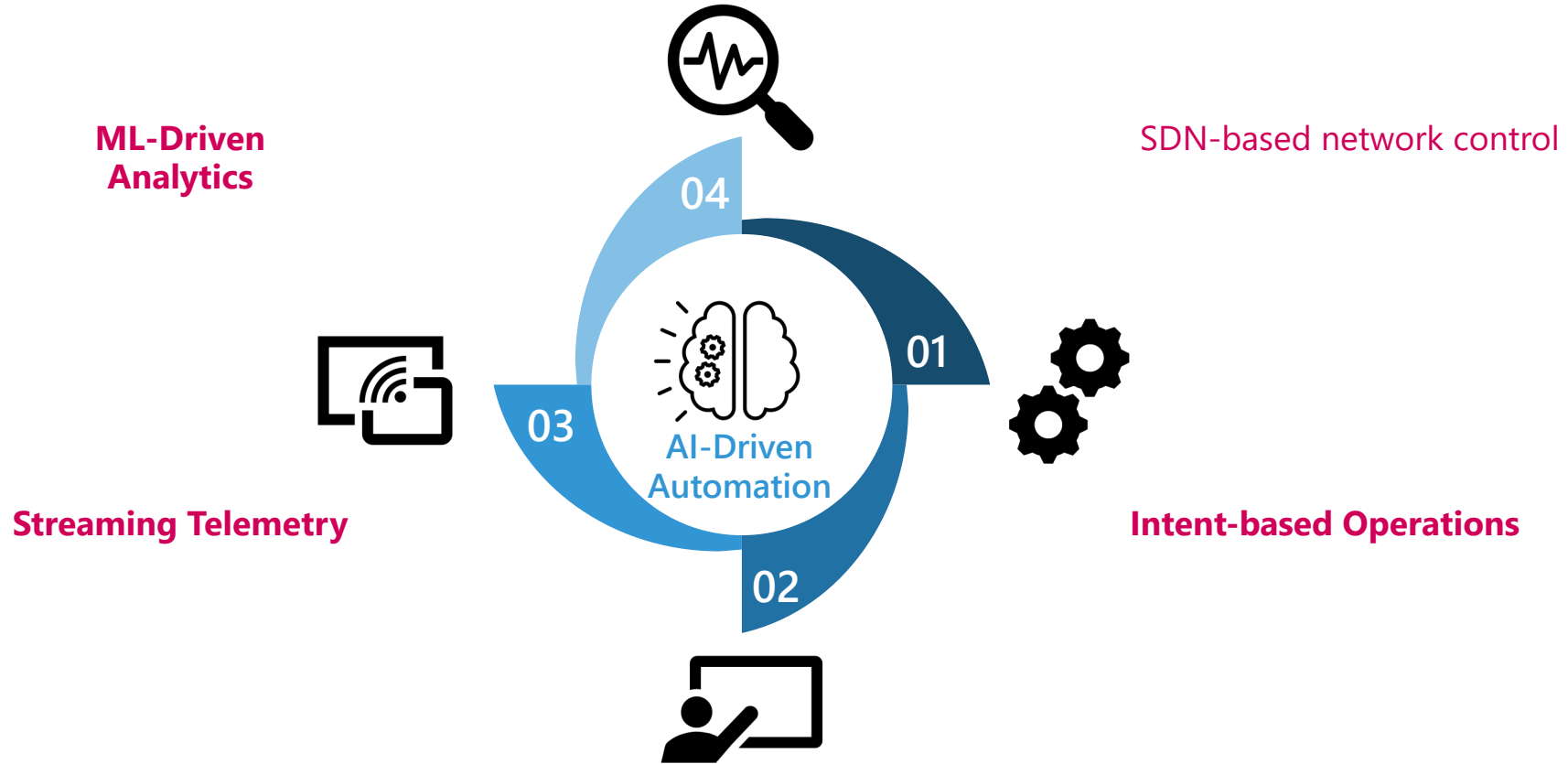
Can we extract real-time data for ML models?



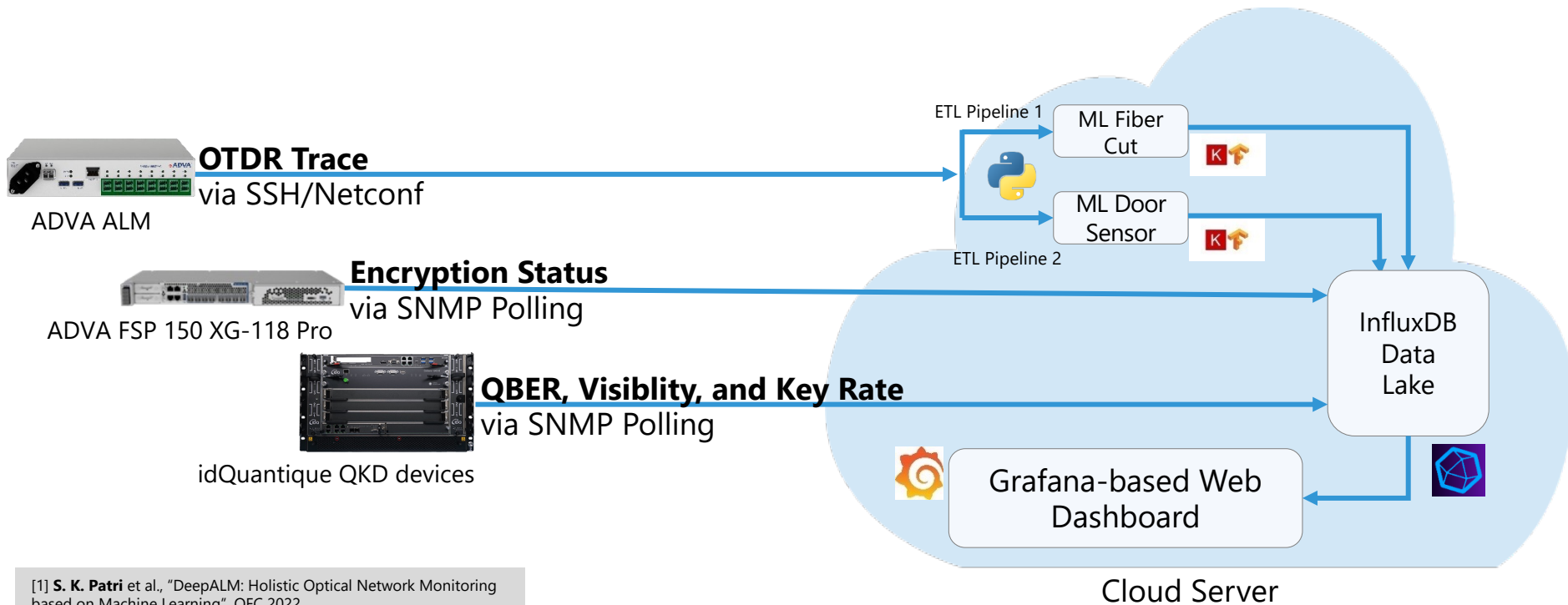
Research highlights: Network Analytics



Can we add relevant use-cases to our ML+data setup?



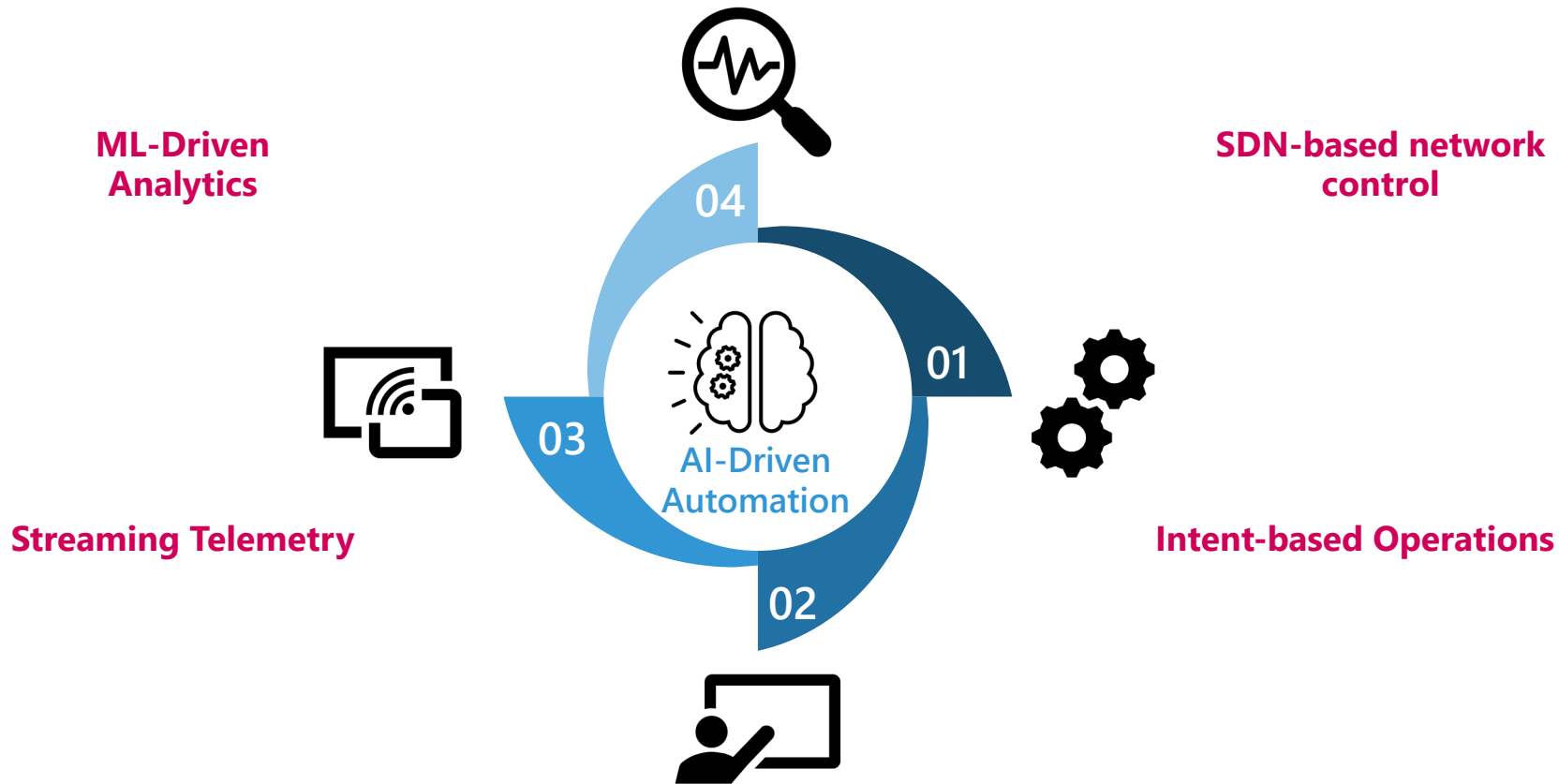
Research highlights: Joint Network Sensing ML-based Optical Network Monitoring for Security Use-Case



[1] **S. K. Patri** et al., "DeepALM: Holistic Optical Network Monitoring based on Machine Learning", OFC 2022

[2] **M. Wenning** et al., "Machine Learning based Optical and QKD Network Monitoring", TNC 2022

Can this be orchestrated on an SDN-based network?



Research highlights: Putting it together

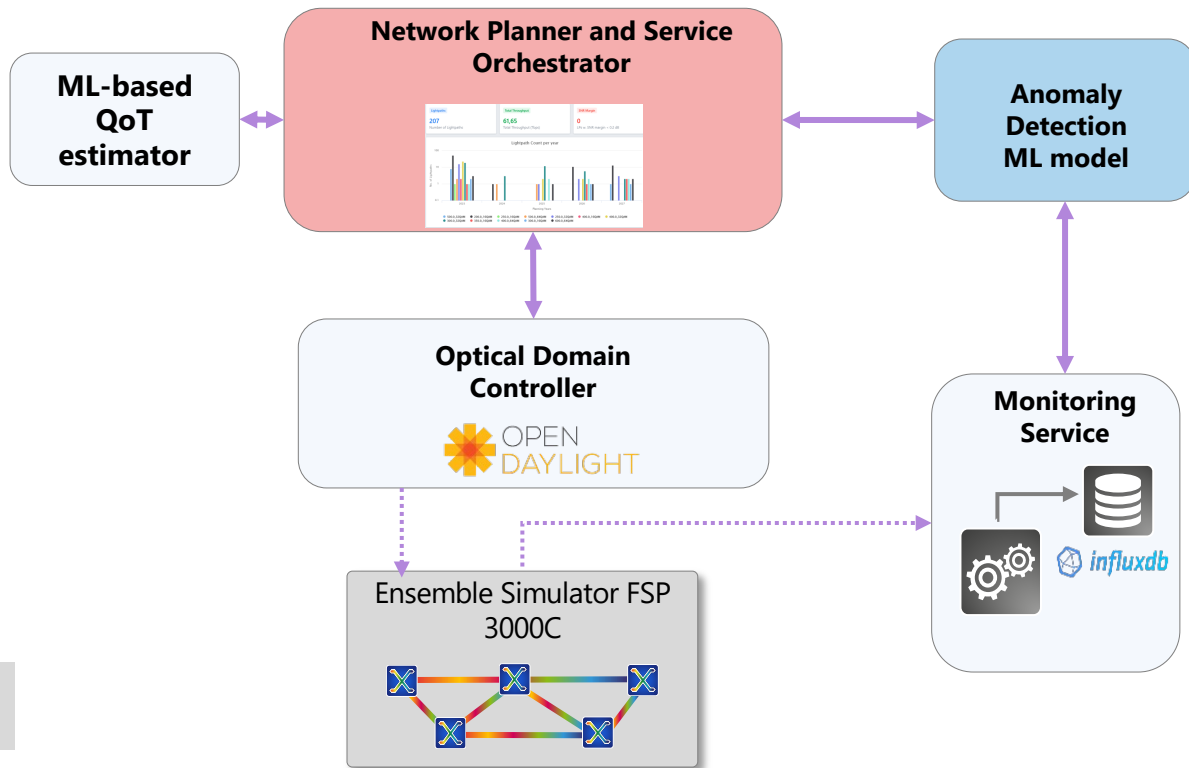
Towards ML-driven Zero Touch Operations in Partially Disaggregated Optical Networks

Orchestrator plans and provisions lightpaths into the simulated network using ML-based QoT estimator

Controller interacts with the orchestrator using RESTCONF and simulated devices using NETCONF.

Monitoring Service – Pushes PM data to a time-series DB. The anomaly detection model suggests services to be re-routed

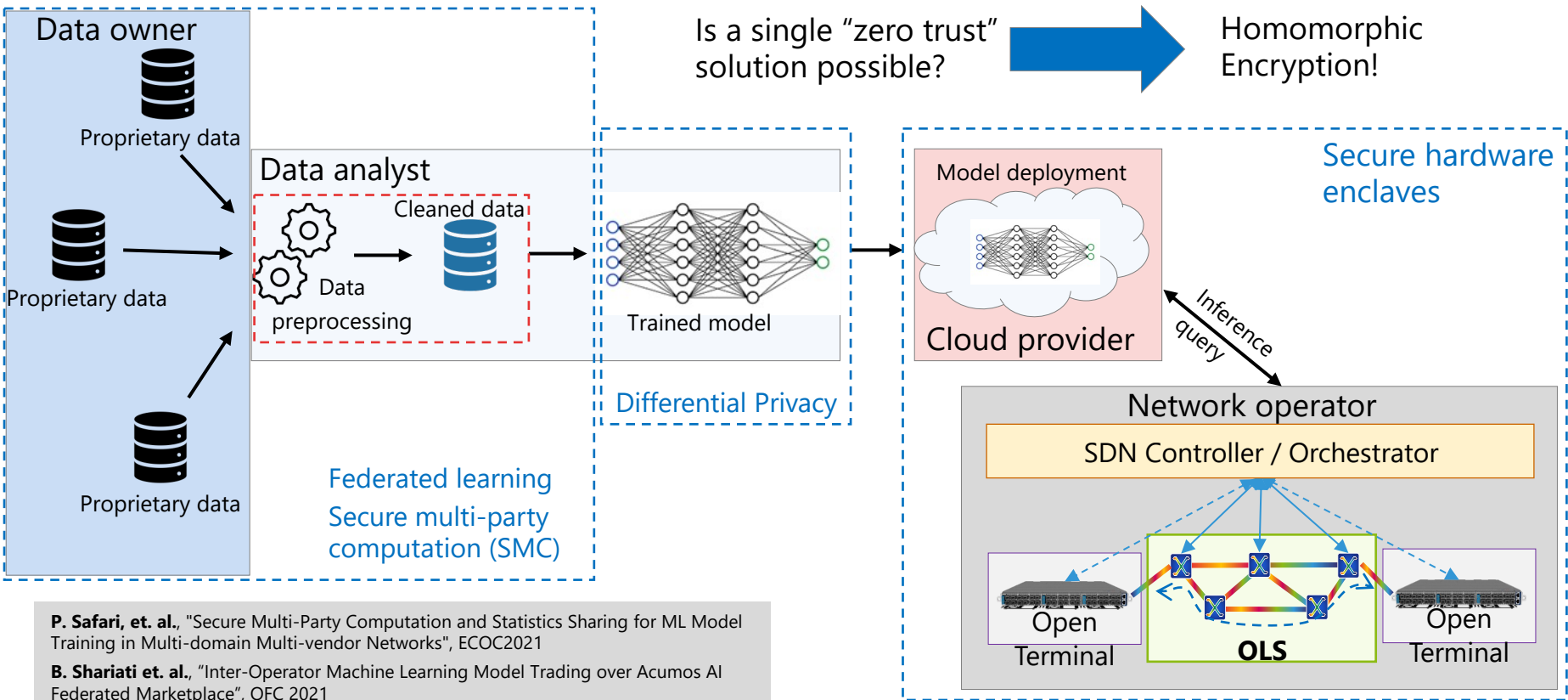
Application - Useful for managing end-to-end optical services in a partially disaggregated or multi-domain network environment.



[1] S. K. Patri et al., "Open-Source Service Management for a Fully Disaggregated Optical Network Simulation", to be presented at IEEE CNSM 2022

Looking ahead

Data security is the key to effective AI-driven automation



P. Safari, et. al., "Secure Multi-Party Computation and Statistics Sharing for ML Model Training in Multi-domain Multi-vendor Networks", ECOC2021

B. Shariati et. al., "Inter-Operator Machine Learning Model Trading over Acumos AI Federated Marketplace", OFC 2021

AI-ML driven automation in open optical networks

Takeaways

Partially Disaggregated optical networks will drive down deployment costs

Privacy-Preserving ML techniques and inter-operator model sharing are just around the corner



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Engineer Advanced Technology

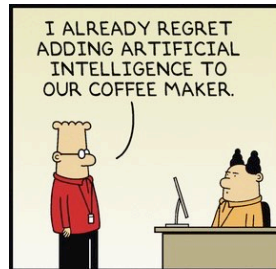
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Investing in **SDN, streaming telemetry, and ML analytics** provides you insights to improve and optimize network operations

Interested in our research?:



* dilbert.com (Scott Adams)