Building Autonomous Networks, One Step at a time (Standards, Research, Prototypes)

Benoit Claise, Intelligent Operations & Management CTO

benoit.claise@huawei.com

HUAWEI

It’ s always the Network Fault, right?

- And not the application?
- And not the server?
- And not the cloud?
- Or the end user environment?

New « network » definition ?

- « Is it my area? »
- The different silo views don’t work any longer

2

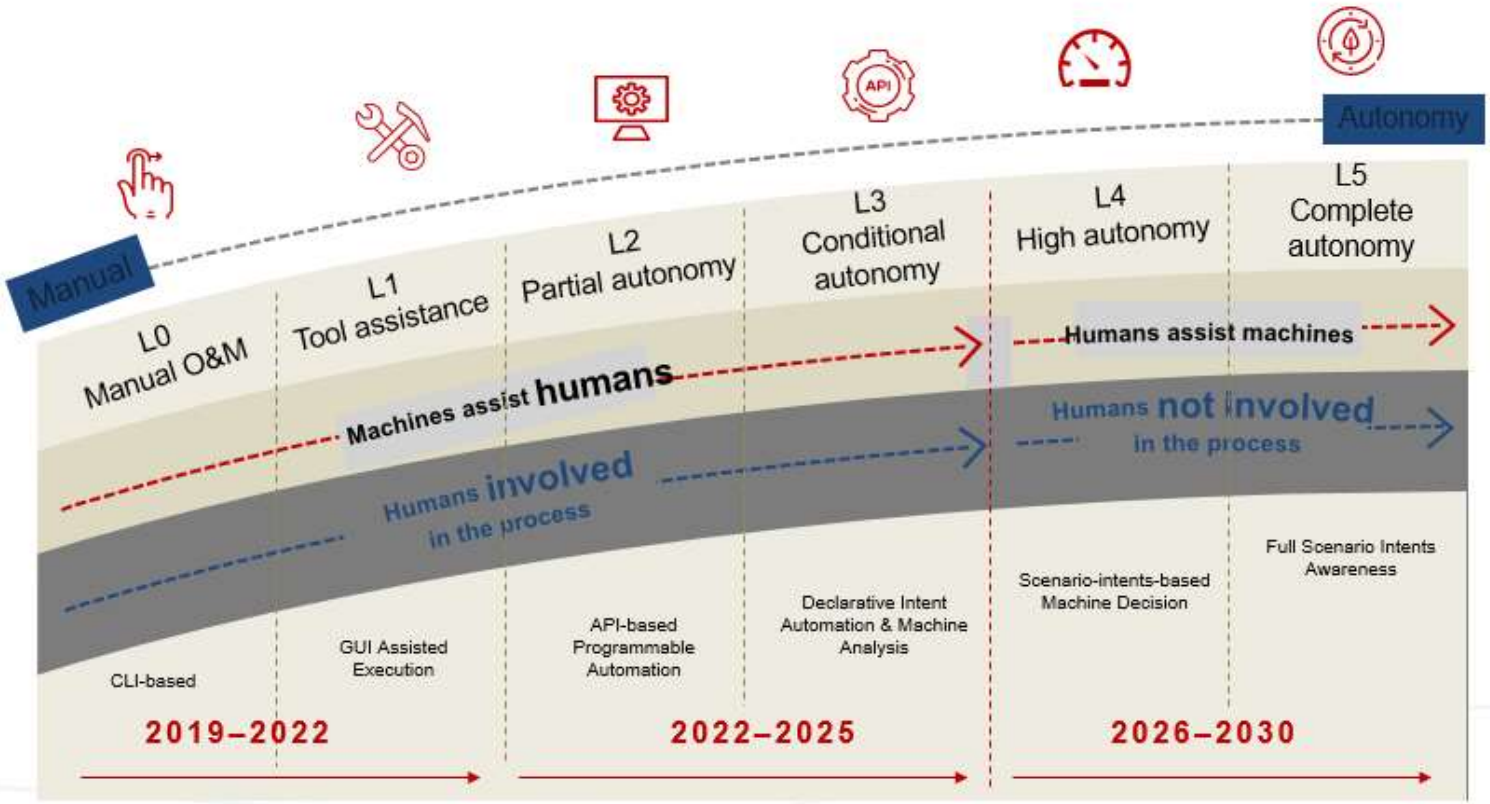
Networks are too Expensive to Operate

The (network) complexity (we loved) is (on the verge of) turning against us

- Business issue: ratio of OPEX/CAPEX
  - Automation is a compulsory transformation
  - Difficulty: multi-vendor, old/new devices, different capabilities
  - « if a feature can’t be automated, it doesn’t exist! »

3

Autonomous Network Vision



Autonomous (Driving) Network Vision: Where is Industry Today?

Entreprise => ?
- Primary focus: reduce IT costs

Data Center => 2.5? 3.1?
- Advantages: greenfield, clean topology, single vendor, reduced number of platforms/OS
- Therefore, ML/AI is applicable

Cloud => 3 or 3.5?
- Hyperscalers: "if we see a problem twice, we code it"
- Cloud native applications

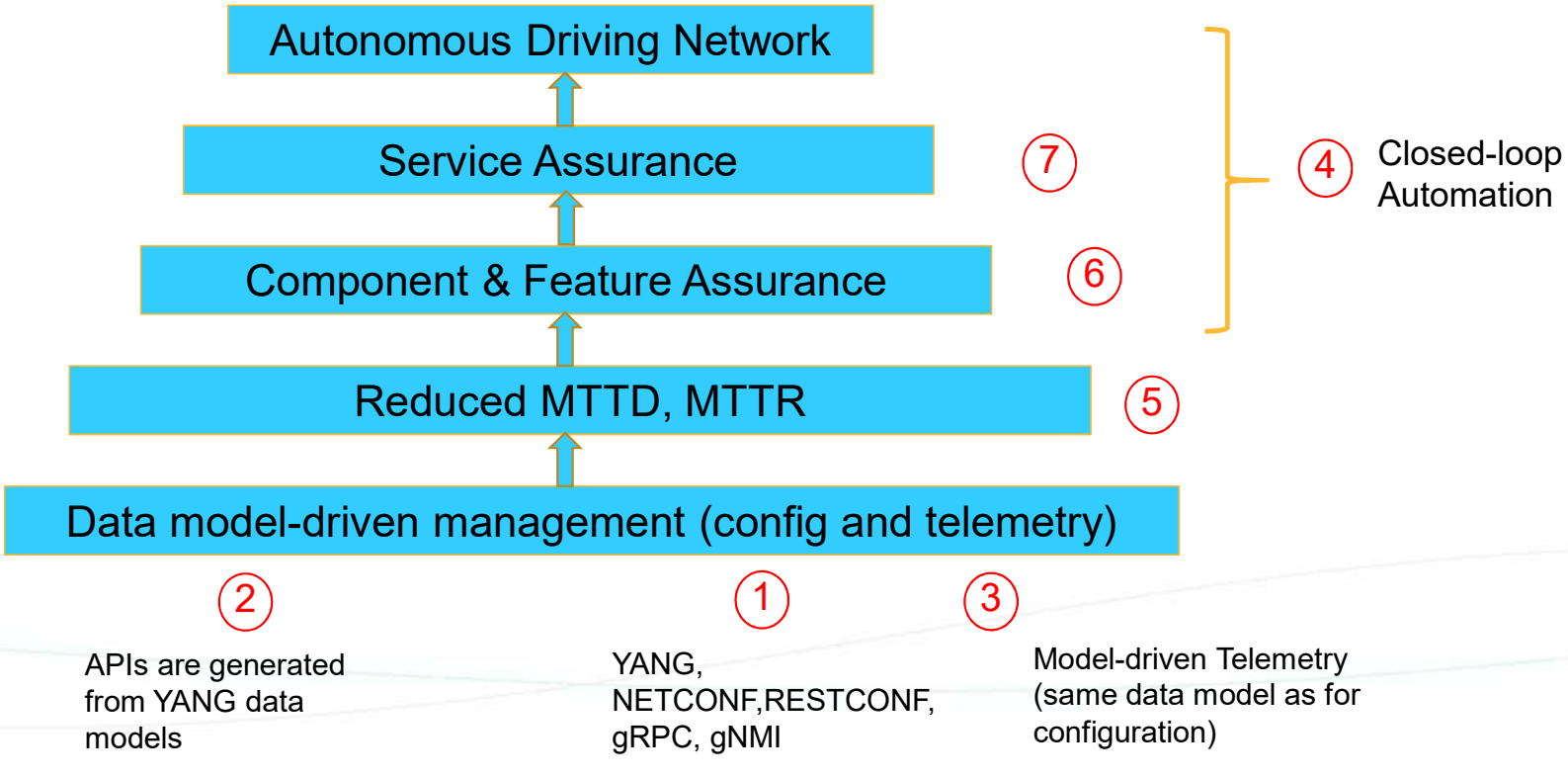
Autonomous Levels	L0: Manual Operation & Maintenance	L1: Assisted Operation & Maintenance	L2: Partial Autonomous Networks	L3: Conditional Autonomous Networks	L4: High Autonomous Networks	L5: Full Autonomous Networks
Execution	P	P/S	S	S	S	S
Awareness	P	P/S	P/S	S	S	S
Analysis	P	P	P/S	P/S	S	S
Decision	P	P	P	P/S	S	S
Intent/Experience*	P	P	P	P	P/S	S
Applicability	N/A	Select scenarios				All scenarios

P : People (manual) ; S : Systems (autonomous)

Service Provider => 1.5?
- Most complex scenarios: multi-vendor, old/new devices, silo organization, mixed of core, access, metro, cloud, DC, etc.

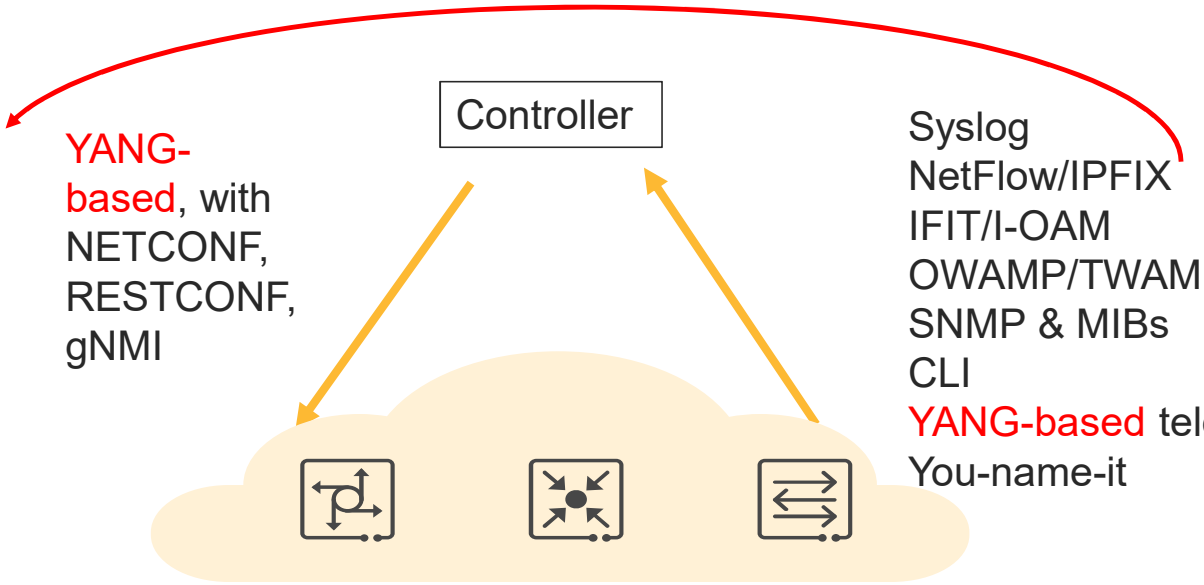
Consumer => between 1.5 to 2?
- For point product
- Higher with cloud-based solutions

How to Decompose the Autonomous Network Vision? The Maslow Pyramid of Needs for ADN



③

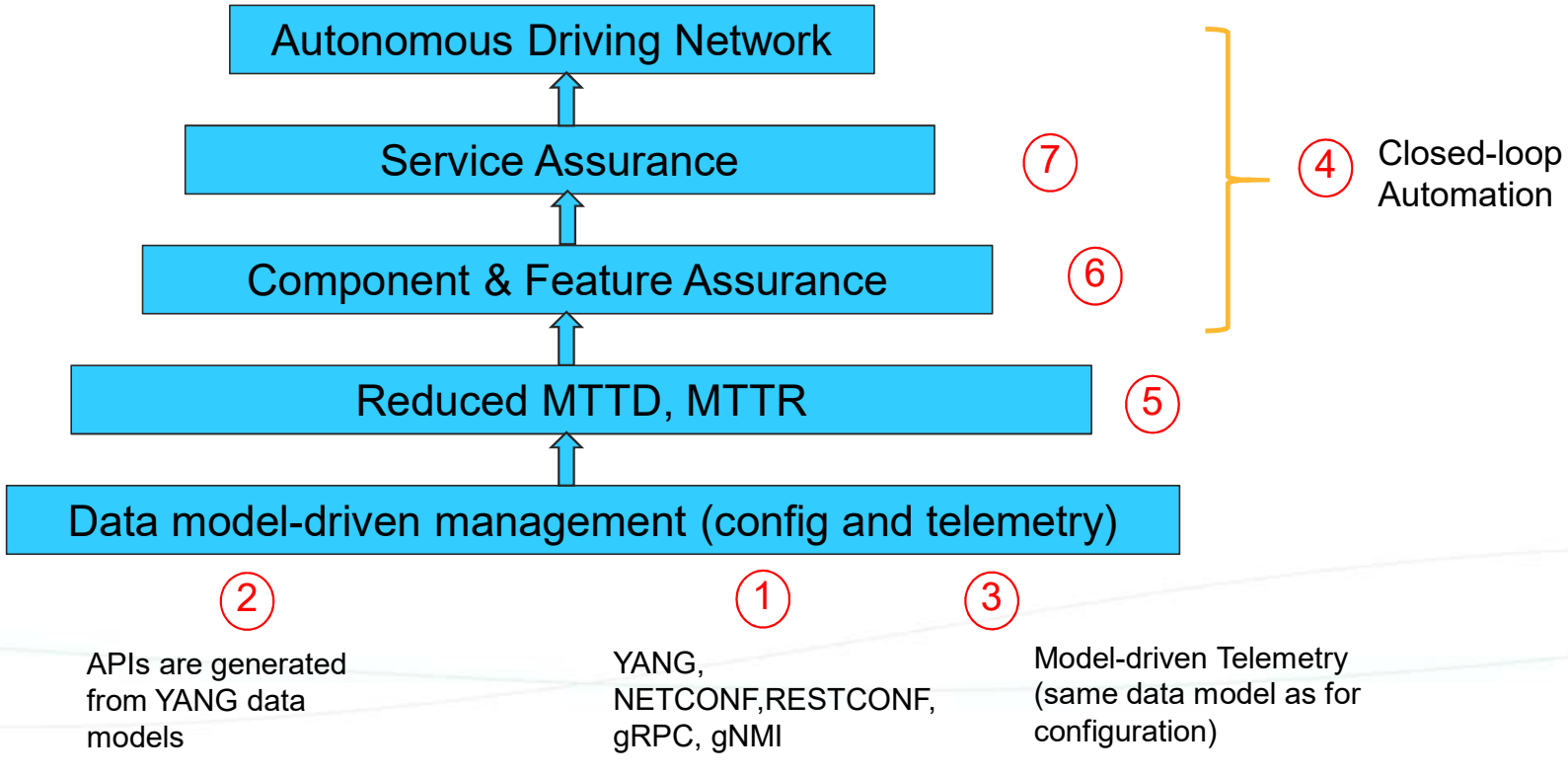
Model-driven Telemetry



- Autonomous Networks (assurance) needs closed loop automation
- Closed loop automation needs model-driven telemetry … since the configuration is done with YANG
- It's a question of (avoiding the mappings of different) data models

7

How to Decompose the Autonomous Network Vision? The Maslow Pyramid of Needs for ADN



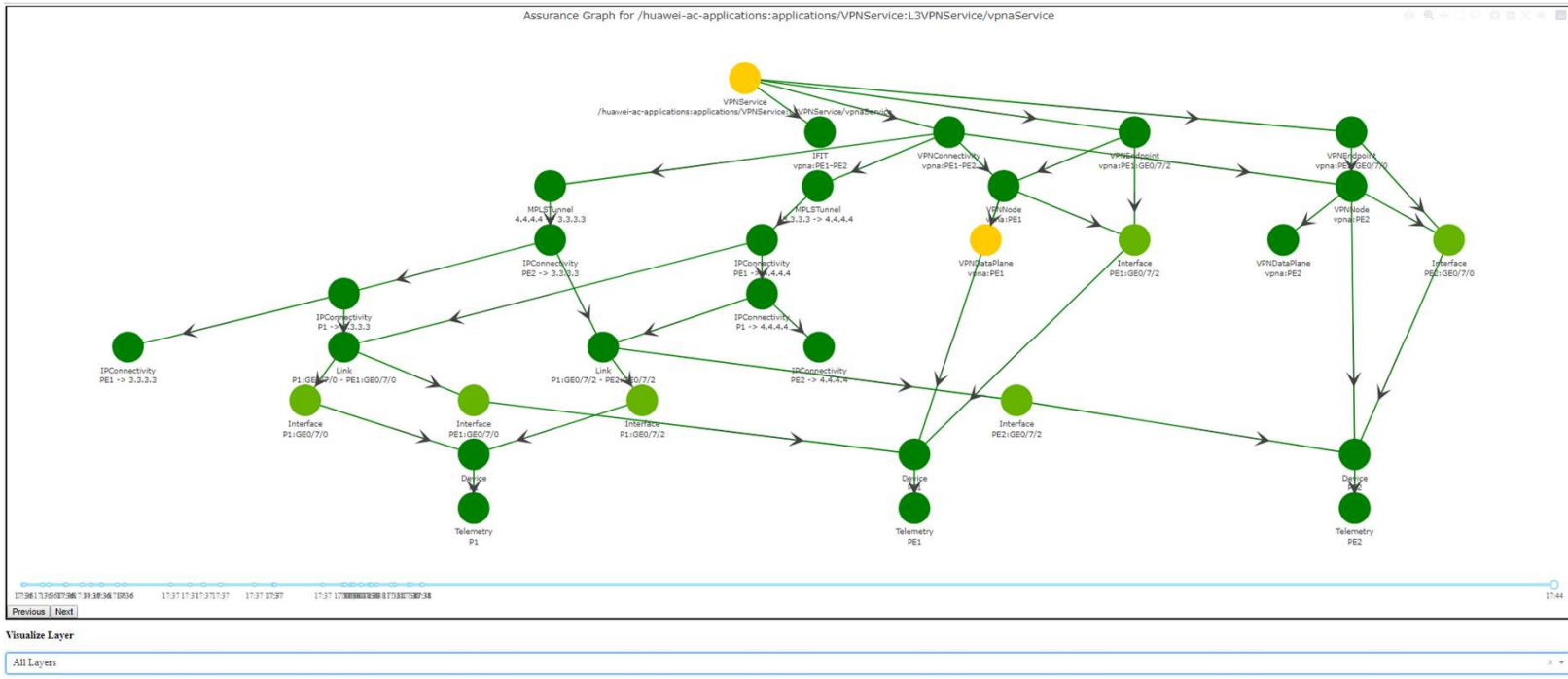
Intent Assurance Prototype

Key challenge:

- How to map between the intent/service and collected metric?
- AI/ML difficult to apply: transferability, not enough data, no clean data, no syntax/semantic behind the data

Value:

- When a service degrades, where are the faults, what are the symptoms?
- 2) What services are impacted by a network fault?



Generate Intent Assurance Graph

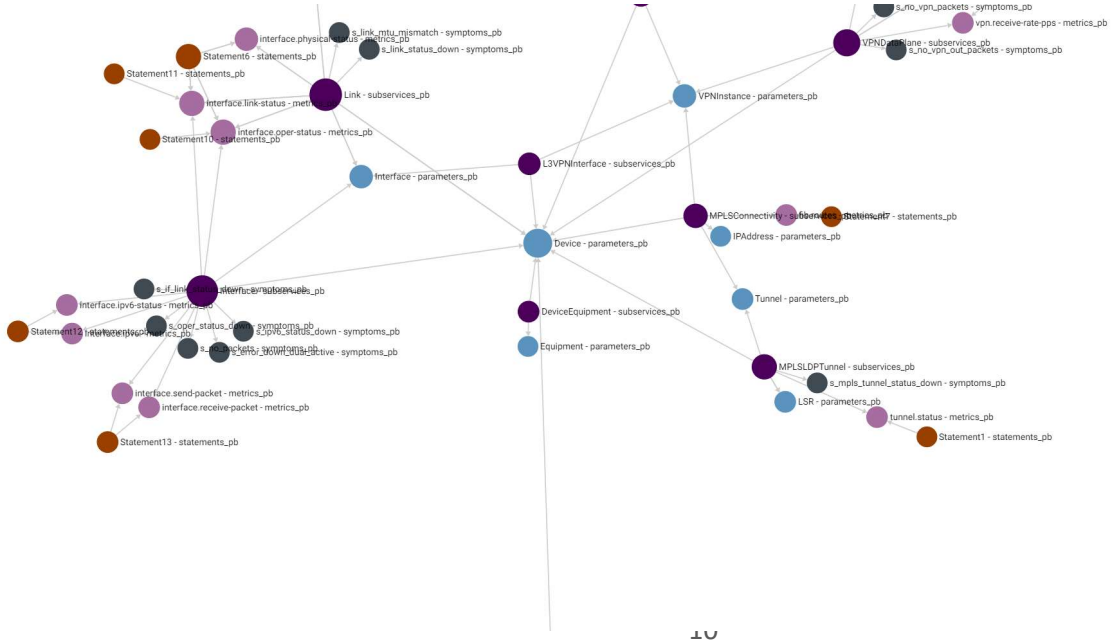
- static intent assurance graph generated from info from controller(s) + domain knowledge
- dynamic part generated from info from the network + domain knowledge

9

Knowledge Graph and Digital Maps

- Generate subservice health score and symptoms and service inferred health
  - generated from the network info + domain knowledge
- Digital Maps (part of Digital Twin)
  - Filtered information from this knowledge graph (ex: physical view)
  - Filtered instances (ex: service view)

Digital Maps:
6. …
5. Service SLA
4. Service
3. Overlay
2. Underlay
1. Physical



Service Assurance for Intent-based Networking: Architecture

- Flexible architecture
  - Physical and virtual devices
  - Multi-vendor
  - Multi-domains (interconnected)
- IETF specifications, with clear interfaces:
  - Service Assurance for Intent-based Networking Architecture : draft-ietf-opsawg-service-assurance-architecture
  - YANG Module for Service Assurance: draft-ietf-opsawg-service-assurance-yang
- Prototype
- Community:
  - Opensource code (Liège university) & tools
  - Working with operators

11

Standards (IETF) and TMF Levels

Autonomous Levels	L0: Manual Operation & Maintenance	L1: Assisted Operation & Maintenance	L2: Partial Autonomous Networks	L3: Conditional Autonomous Networks	L4: High Autonomous Networks	L5: Full Autonomous Networks
Execution	P	P/S	S	S	S	S
Awareness	P	P/S	P/S	S	S	S
Analysis	P	P	P/S	P/S	S	S
Decision	P	P	P	P/S	S	S
Intent/Experience♦	P	P	P	P	P/S	S
Applicability	N/A	Select scenarios				All scenarios

P : People (manual) ; S : Systems (autonomous)

Standards (IETF)

Autonomous Levels	L0: Manual Operation & Maintenance	L1: Assisted Operation & Maintenance	L2: Partial Autonomous Networks	L3: Conditional Autonomous Networks	L4: High Autonomous Networks	L5: Full Autonomous Networks
Execution	P				S	S
Awareness	P	P/S	P/S	S	S	S
Analysis	P				S	S
Decision	P	P	P	P/S	S	S
Intent/Experience♦	P	P	P	P	P/S	S
Applicability	N/A	Select scenarios				All scenarios

P : People (manual) ; S : Systems (autonomous)

Awareness: Required for L1+, Barrier for L3

Per-node capability discovery

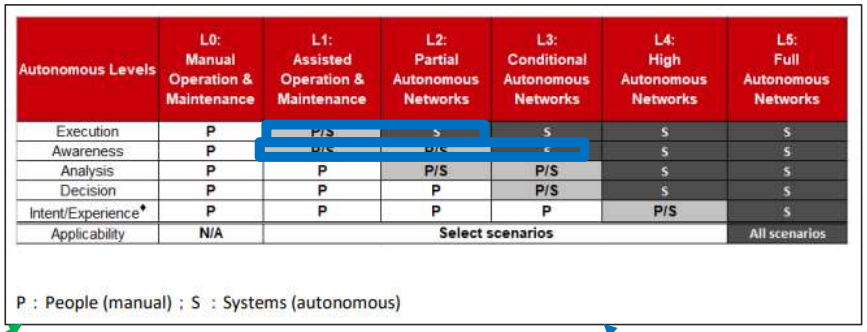
- **YANG Modules describing Capabilities for Systems and Datastore Update Notifications, RFC 9196**
- **YANG Instance Data File Format, RFC 9195**

=> EXPOSING ROUTERS CAPABILITIES DURING DESIGN AND IMPLEMENTATION TIMES

- **Per-Node Capabilities for Optimum Operational Data Collection , draft-claise-netconf-metadata-for-collection-02**

=> NEED A GENERIC CAPABILITY DISCOVERY MECHANISM

Standards (IETF)



Autonomous Levels	L0: Manual Operation & Maintenance	L1: Assisted Operation & Maintenance	L2: Partial Autonomous Networks	L3: Conditional Autonomous Networks	L4: High Autonomous Networks	L5: Full Autonomous Networks
Execution	P	P/S	S	S	S	S
Awareness	P	P/S	P/S	S	S	S
Analysis	P	P	P/S	P/S	S	S
Decision	P	P	P	P/S	S	S
Intent/Experience♦	P	P	P	P	P/S	S
Applicability	N/A	Select scenarios				All scenarios

P : People (manual) ; S : Systems (autonomous)

Awareness: Required for L1+, Barrier for L3

Awareness: Required for L1+, Barrier for L3
Execution: Required for L1+, Barrier for L2

Per-node capability discovery

- **YANG Modules describing Capabilities for Systems and Datastore Update Notifications, RFC 9196**
- **YANG Instance Data File Format, RFC 9195**

=> EXPOSING ROUTERS CAPABILITIES DURING DESIGN AND IMPLEMENTATION TIMES

- **Per-Node Capabilities for Optimum Operational Data Collection , draft-claise-netconf-metadata-for-collection-02**

=> NEED A GENERIC CAPABILITY DISCOVERY MECHANISM

Semantic versioning

- **YANG Semantic Versioning, draft-ietf-netmod-yang-semver**

Standards (IETF)

Autonomous Levels	L0: Manual Operation & Maintenance	L1: Assisted Operation & Maintenance	L2: Partial Autonomous Networks	L3: Conditional Autonomous Networks	L4: High Autonomous Networks	L5: Full Autonomous Networks
Execution	P	P/S	S	S	S	S
Awareness	P	P/S	P/S	S	S	S
Analysis	P	P	P/S	P/S	S	S
Decision	P	P	P	P/S	S	S
Intent/Experience*	P	P	P	P	P/S	S
Applicability	N/A	Select scenarios				All scenarios

P : People (manual) ; S : Systems (autonomous)

Awareness: Required for L1+, Barrier for L3 (??)

Streaming counters with UDP notification
- draft-ietf-netconf-udp-notif

Subscription to Distributed Notificaitons
- draft-ietf-netconf-distributed-notif

Awareness: Required for L1+, Barrier for L3

Per-node capability discovery
- YANG Modules describing Capabilities for Systems and Datastore Update Notifications, draft-ietf-netconf-notification-capabilities
- YANG Instance Data File Format, draft-ietf-netmod-yang-instance-file-format-08
- Per-Node Capabilities for Optimum Operational Data Collection , draft-claise-netconf-metadata-for-collection-01

=> NEED A GENERIC DISCOVERY MECHANISM

Awareness: Required for L1+, Barrier for L3
Execution: Required for L1+, Barrier for L2

Semantic versioning
- YANG Semantic Versioning, draft-ietf-netmod-yang-semver

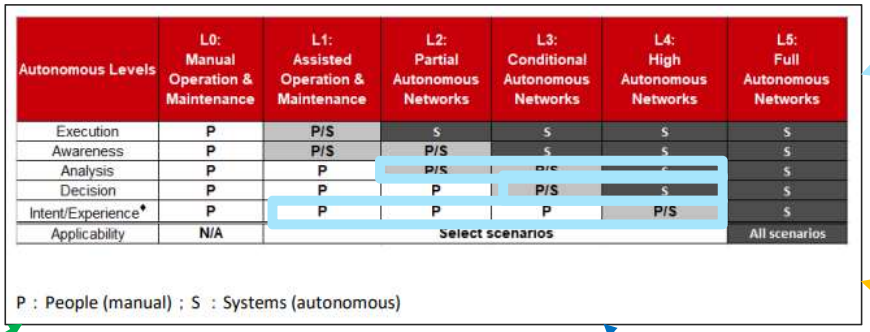
Standards (IETF)

Expression language for operation workflow, data lake query, and actionable symptoms

Analysis: Required for L2+, Barrier for L4
Decision: Required for L3+, Barrier for L4
Intent/Experience: Required for L1+, Barrier for L4

Intent Assurance

- **Service Assurance for Intent-based Networking Architecture,** draft-ietf-opsawg-service-assurance-architecture
- **YANG Module for Service Assurance,** draft-ietf-opsawg-service-assurance-yang



Autonomous Levels	L0: Manual Operation & Maintenance	L1: Assisted Operation & Maintenance	L2: Partial Autonomous Networks	L3: Conditional Autonomous Networks	L4: High Autonomous Networks	L5: Full Autonomous Networks
Execution	P	P/S	S	S	S	S
Awareness	P	P/S	P/S	S	S	S
Analysis	P	P	P/S	P/S	S	S
Decision	P	P	P	P/S	S	S
Intent/Experience*	P	P	P	P	P/S	S
Applicability	N/A	Select scenarios				All scenarios

P : People (manual) ; S : Systems (autonomous)

Analysis: Required for L2+, Barrier for L4
Decision: Required for L3+, Barrier for L4
Intent/Experience: Required for L1+, Barrier for L4

Awareness: Required for L1+, Barrier for L3 (??)

Streaming counters with UDP notification

- draft-ietf-netconf-udp-notif

Subscription to Distributed Notificaitons

- draft-ietf-netconf-distributed-notif

Awareness: Required for L1+, Barrier for L3

Per-node capability discovery

- **YANG Modules describing Capabilities for Systems and Datastore Update Notifications,** draft-ietf-netconf-notification-capabilities
- **YANG Instance Data File Format,** draft-ietf-netmod-yang-instance-file-format-08
- **Per-Node Capabilities for Optimum Operational Data Collection ,** draft-claise-netconf-metadata-for-collection-01

=> NEED A GENERIC DISCOVERY MECHANISM

Awareness: Required for L1+, Barrier for L3
Execution: Required for L1+, Barrier for L2

Semantic versioning

- **YANG Semantic Versioning,** draft-ietf-netmod-yang-semver

More Visibility: Data Plane (IPFIX), Control Plane (BMP), Management Plane (YANG)

Autonomous Levels	L0: Manual Operation & Maintenance	L1: Assisted Operation & Maintenance	L2: Partial Autonomous Networks	L3: Conditional Autonomous Networks	L4: High Autonomous Networks	L5: Full Autonomous Networks
Execution	P	P/S	S	S	S	S
Awareness	P	P/S	P/S	S	S	S
Analysis	P	P	P/S	P/S	S	S
Decision	P	P	P	P/S	S	S
Intent/Experience♦	P	P	P	P	P/S	S
Applicability	N/A	Select scenarios				All scenarios

P : People (manual) ; S : Systems (autonomous)

- **SRv6 IPFIX Information Elements,**
  draft-tgraf-opsawg-ipfix-srv6-srh-02
  => DATA PLANE VISIBILITY
- **BMP YANG module**
  draft-cptb-grow-bmp-yang
  => CONTROL PLANE VISIBILITY

Data manifest for Contextualized Telemetry Data
draft-claise-opsawg-collected-data-manifest-02,
=> HOW THE DATA WERE ACTUALLY MEASURED
USEFULL IN ORDER TO TAKE A DECISION

Where is ML/AI in this ADN Story?

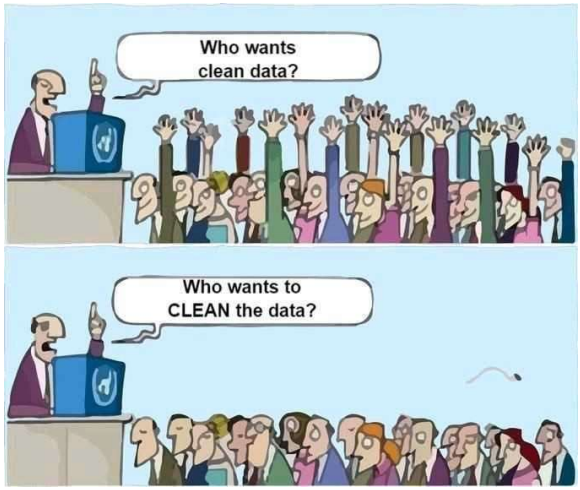
Problem 1: Getting data

- Data scientist needs data
- A lot of data
- Real time data
- High frequency data

This is not easy to stream all counters & state from networks … and to process them close to real-time

Problem 2: clean data

- Clear semantic
- Labeled data



Problem 3: no intent context

- "Spent 2 years doing ML/AI for assurance and we need to start again with structured data to model the network. It cannot be achieved without intent context"

=> Unsupervised learning helps but is not sufficient!

- "We looked at IBM Watson: these are the best ML/AI tools but it doesn't apply to telcos"

Full ML/AI Power on top Assurance Graph and Expert Knowledge

Input 1: Getting data

Key metrics to look at, per subservice type, with a clear semantic (based on YANG modules)

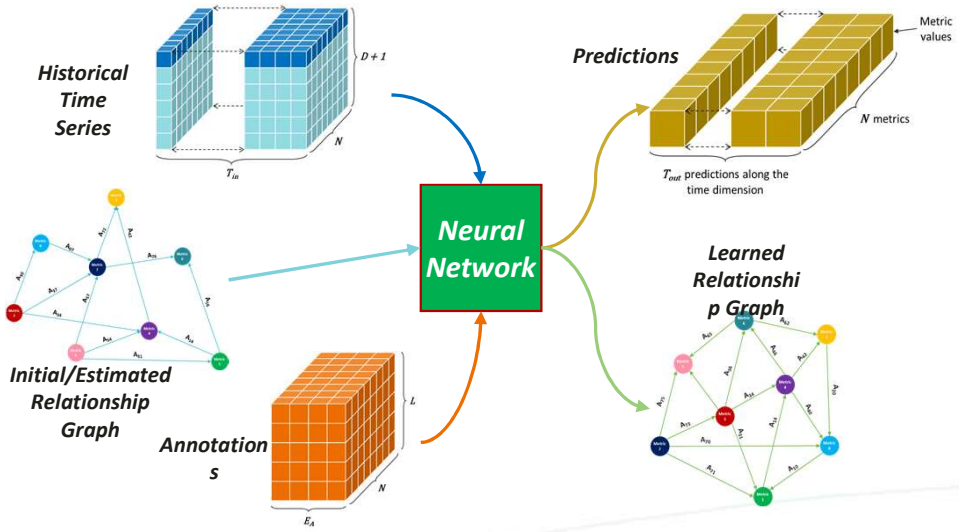
Input 2: clean data

Problem 3: intent context

Assurance graph

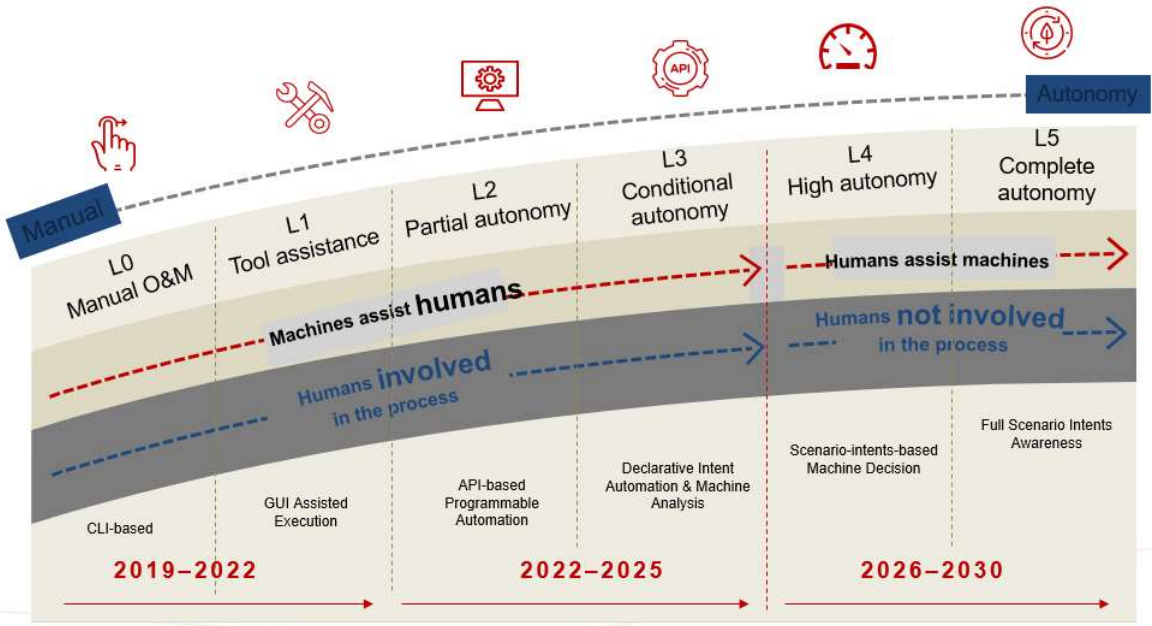
Help create or improve the expert knowledge:

1. Discover new impacting KPI for a subservice health
2. Combined with the real SLA measurements, deduce the weight/impact of each KPI in a subservice expression
3. Anomaly score based on the feature in the time series
4. Learn an initial relationship graph
5. Unsupervised learning might provide interesting symptoms



Conclusions

- How to simplify operations? How to make our equipments/products easier to manage?
- Decomposing the ADN vision into:
  - Research & Prototype
  - Standard
  - Product Implementation
- Starting with the Service Assurance for Intent-based Networking archticture
- Contact me
  - For interesting research topics
  - For more details



Thank You.