

AI, IoT & Device Management: the Indispensable Collaboration

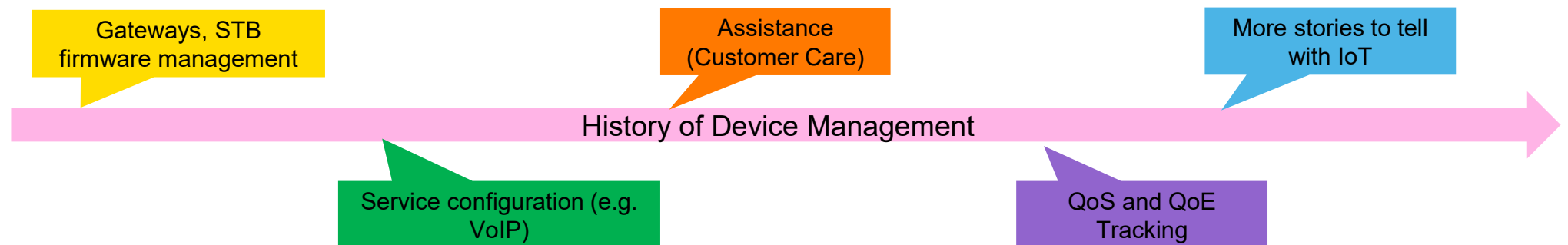
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14/10/2022



Device Management

Definition: Remote administration of connected objects

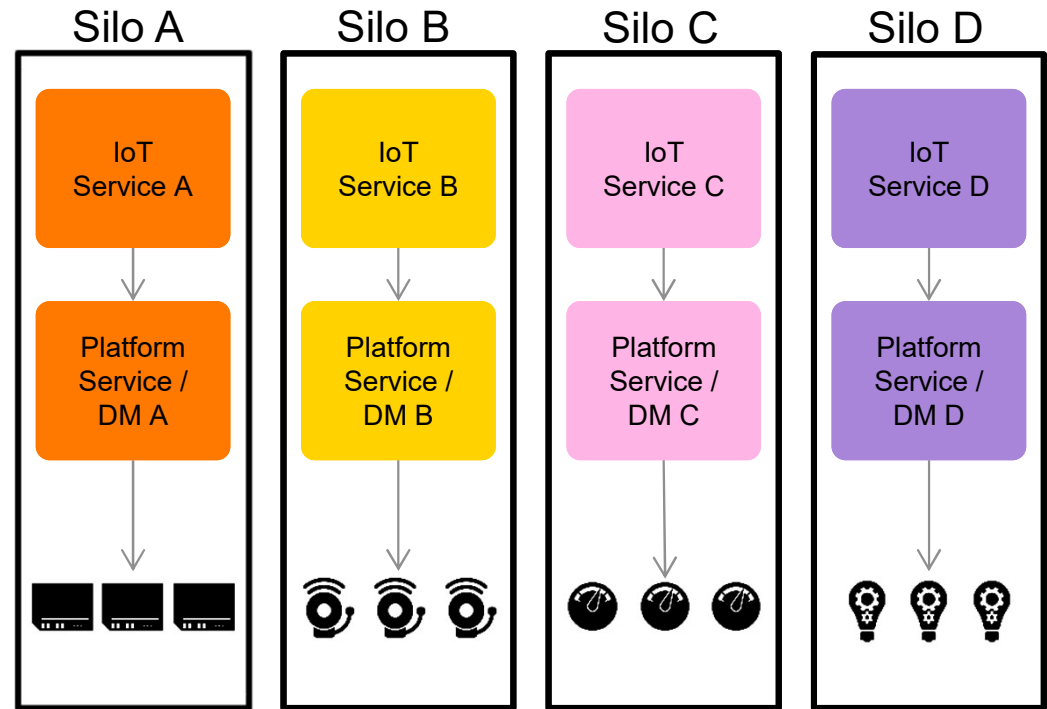


Silos in IoT

With already well known issues

Heterogeneity
(protocols,
datamodels,
lifecycles)

Scaling (e.g.
number of
devices)



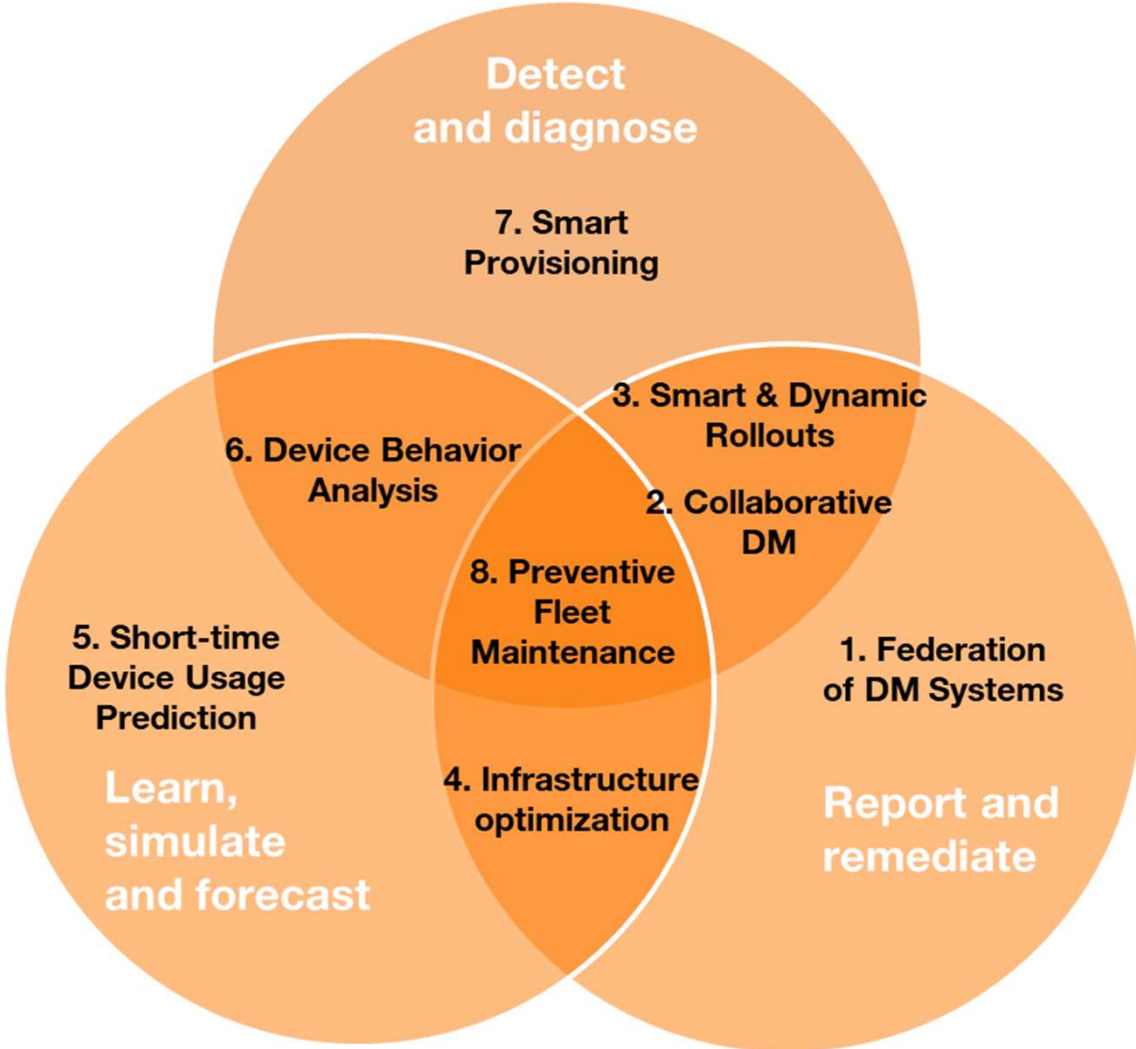
New challenges and issues brought by IoT Device Management

Static
Dependencies
(firmware or
configuration)

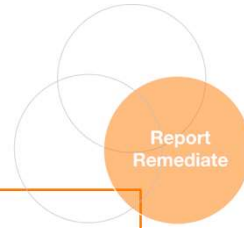
Dynamic
Dependencies
between devices

Provisioning of
services on multi-
devices

8 DM use cases related to the three meta use-cases of AI



Use cases 1/4



1. Federation of DM systems

Description:

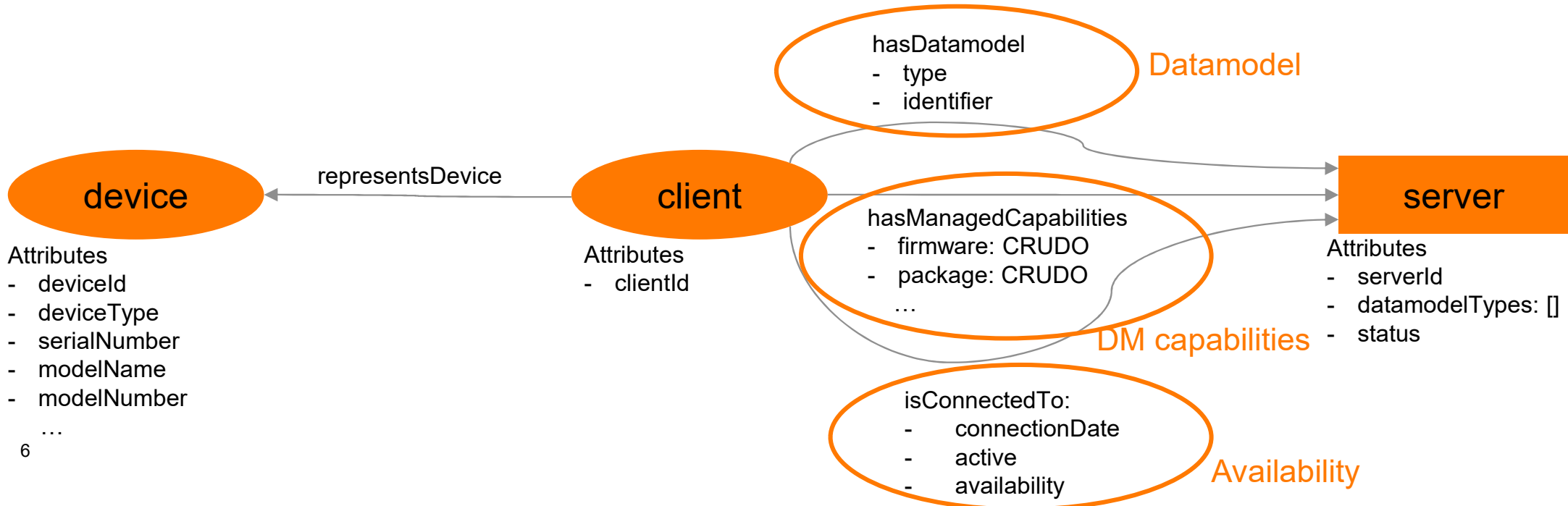
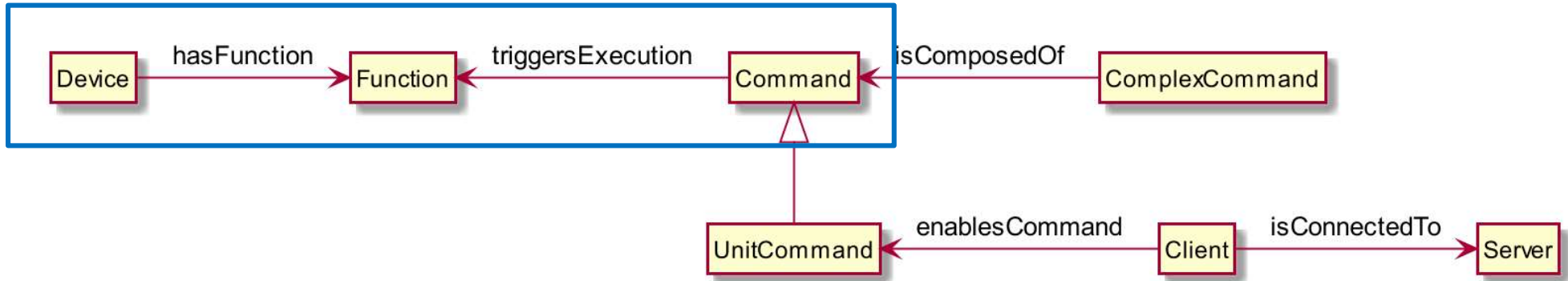
- Federation of **heterogeneous DM systems** and devices under a **single access point**
- **Modelization** of DM business, offering a **generic API**, however a device is managed

Candidate AI Technologies:

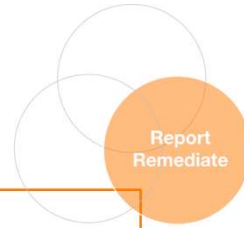
- Semantic model of DM, ETSI SAREF
- Graph models, reasoning, SHACL
- Generic API

A semantic model for DM

ETSI Saref



Use cases 1/4



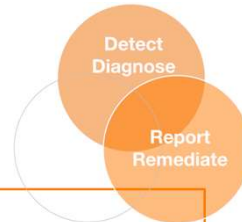
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2. Collaborative DM

Description:

- **Multi-actor** environment makes **error handling** a complex task with **implicit device dependencies**
- Ensure the **sharing of information/knowledge** to establish the collaboration between the actors

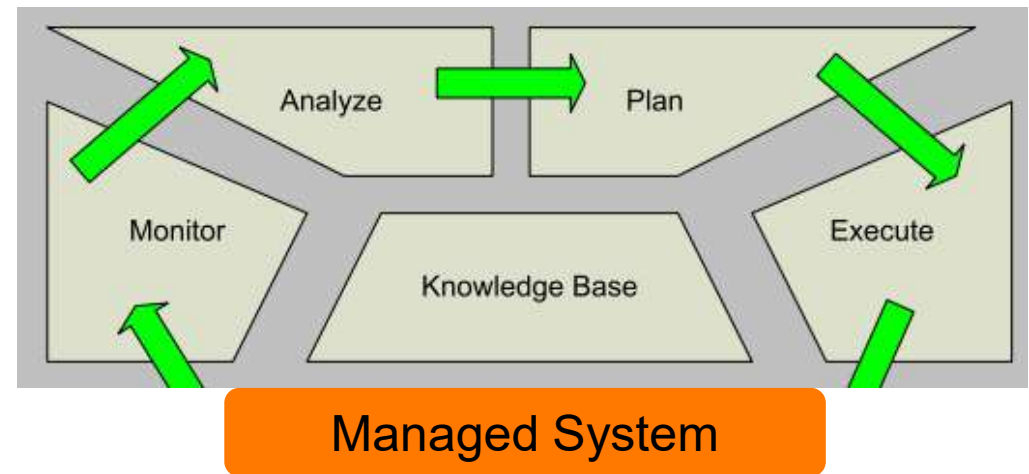
Candidate AI Technologies:

- Semantic web modeling, ontology
- Graph reasoning

Adapt to change

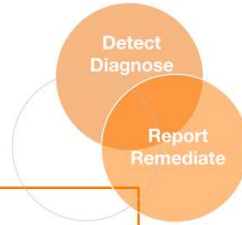
Autonomic Computing Modeling : MAPE-K

- **Monitor** : get sensors/context data.
- **Analyze** : select the correct state.
- **Plan** : target the transition plan to the desired state.
- **Execute** : execute the transition.



Autonomic manager representation.

Use cases 2/4



3. Smart and Dynamic Rollouts

Description:

- Autonomic management of **configuration campaign** for a **device fleet**
- **Reacting to external events** (knowledge base) such as ratio of errors, new firmwares, new devices...
- Multiple applications: adapting migration rate, automatically detect a new campaign, automatic migration for new devices...

Candidate AI Technologies:

- Autonomic computing



4. Infrastructure Optimization

Description:

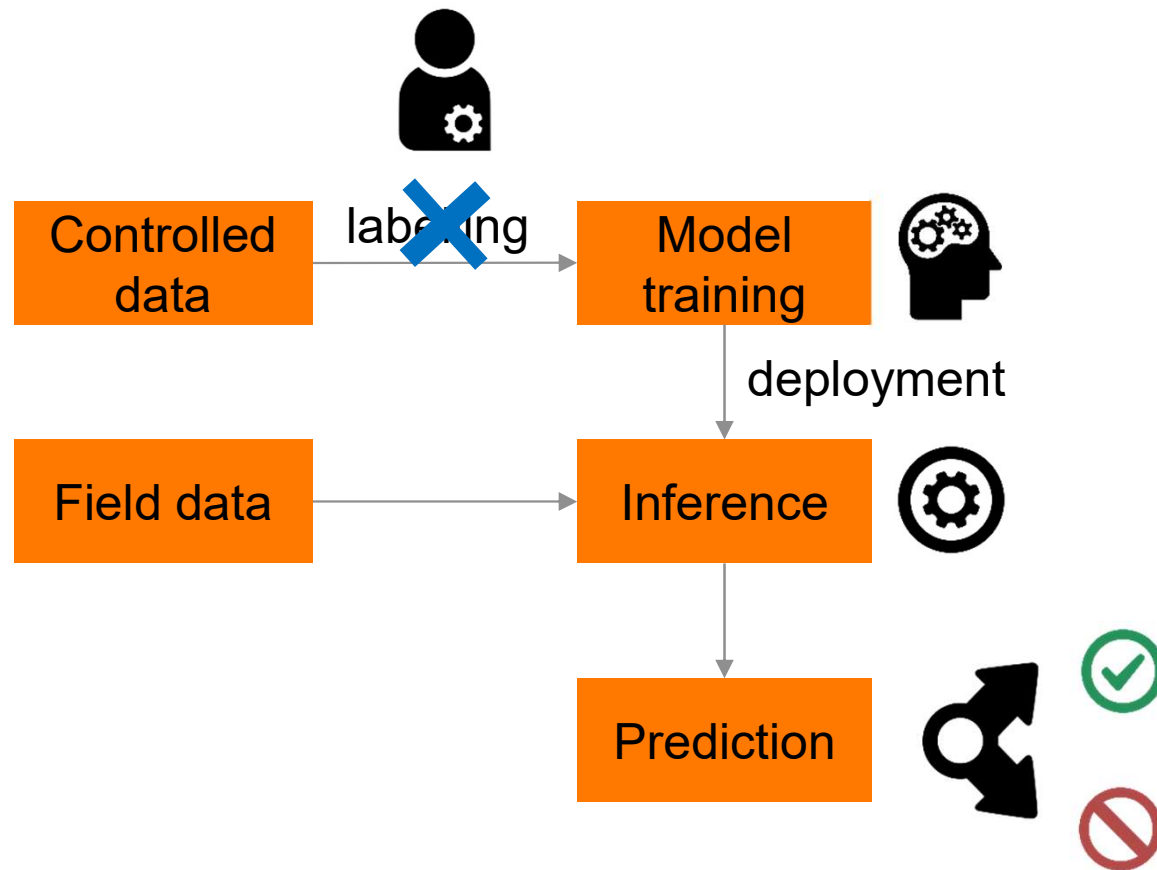
- Automatically compute a **deployment target** for a **DM infrastructure**, in reaction to events (new campaign, new server...)
- Consider **multiple constraints**: RAM/CPU optimization, privacy...

Candidate AI Technologies:

- Constraint programming
- Autonomic computing

Predict from data

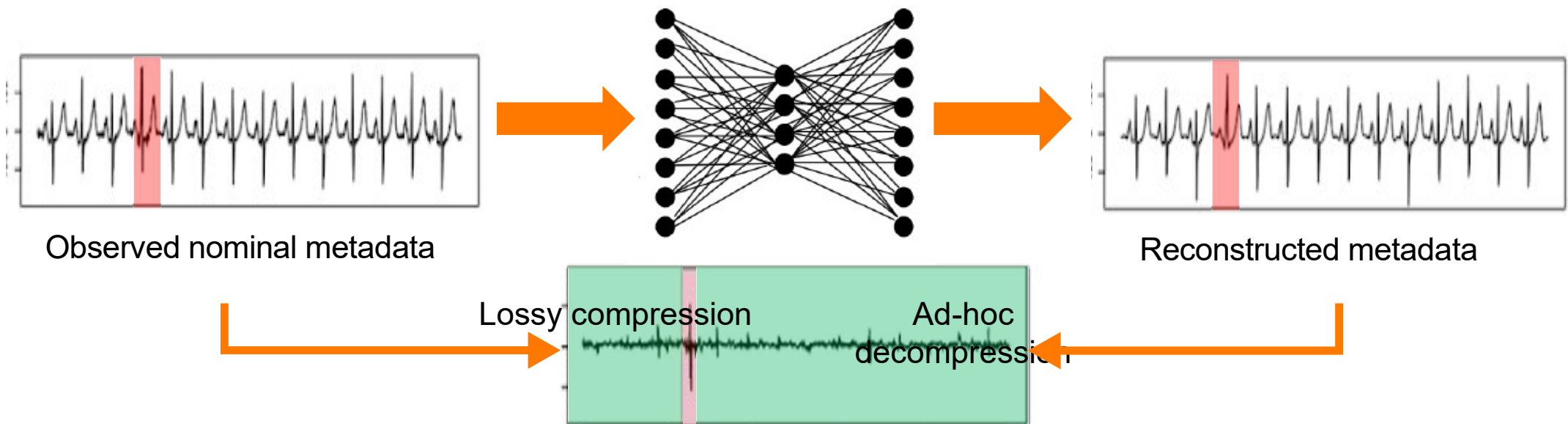
Supervised learning & unsupervised



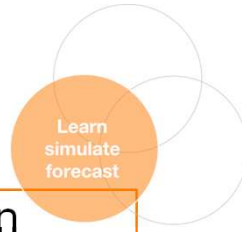
Unsupervised training example

Example of anomaly detection

- For normal data: train to reconstruct
 - For anomalies: lost information is not added back during decompression
- Corruption of observed data



Use cases 3/4



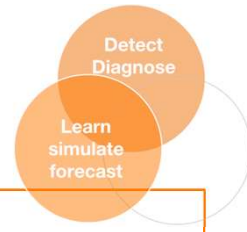
5. Short-time Device Usage Prediction

Description:

- Ensure QoE while performing DM operations. E.g., firmware upgrades trigger reboots and unavailability
- Need to estimate usage to schedule DM operations at the right time

Candidate AI Technologies:

- Machine Learning: Markov Models, neural networks



6. Device Behavior Analysis

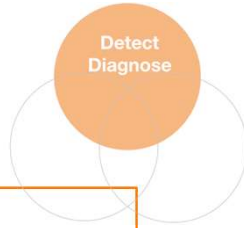
Description:

- Identify malfunctions, even on devices that Orange does not manage
- Rely on metadata: *description of network traffic*
- Model the normal device behavior: *what to expect*
- Anomalies: *expectation != observation*

Candidate AI Technologies:

- Machine Learning / Artificial neural networks: auto-encoders, transformers
- Self-supervised training

Use cases 4/4



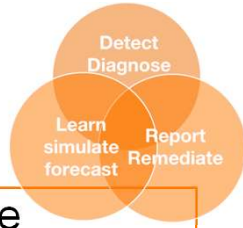
7. Smart Provisioning

Description:

- Context-aware device configuration
- Service configuration depending on the **user's devices and context**

Candidate AI Technologies:

- Context representation: Semantic modelling
- Adaptation to the user, and learn the previously used configurations: clustering, modelling...



8. Preventive Fleet Maintenance

Description:

- Analyze **past corrective operations** on a device fleet
- Automatically **compute a fix operation** on relevant devices
- **Create** the corresponding **campaign**

Candidate AI Technologies:

- Supervised and unsupervised modelling: clustering, classification...

Key players

Standards & Telcos

- Use-case-driven working groups
- No actual standard on AI implementation yet

ETSI & oneM2M: architecture (tr_103674)

- AI & ML for the management and interpretation of IoT devices data
- interoperable, secure and manageable
- Multiple deployments models: Edge + cloud
- Examples of DM-relevant use cases:
 - Fault management and isolation for IoT field devices
 - Knowledge graphs and semantic reasoning

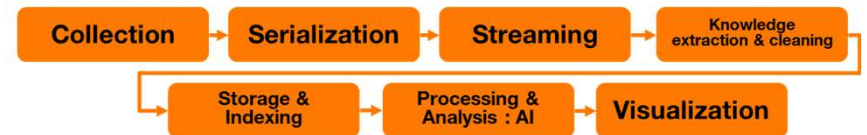
TMForum

- Catalyst Project to promote open APIs for AIOps
- Generic use cases:
 - Predicting and preventing poor customer experience
 - Performing preventive maintenance activities

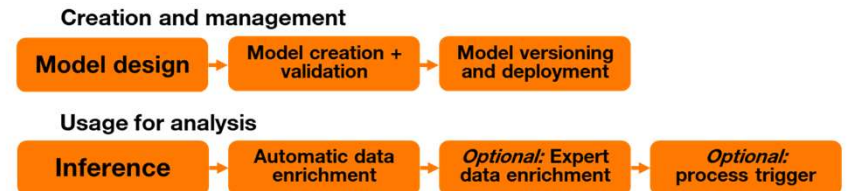
Open Source

- Main actor, *omnipresent*
- Ensures both Data & AI management
- Drives any implementation, tends to replace standards for data processing
- Does not address domain-specific requirements
 - Semantic models
 - Validation for inference models

The Flow of Data



The Flow of AI



Conclusion

DM is an opportunity of differentiation for IoT

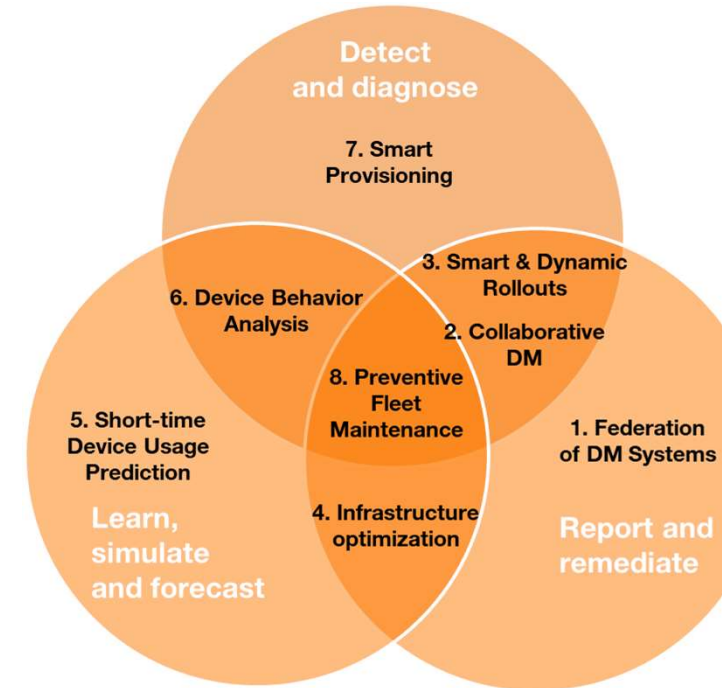
- Scalability, operability, end-user QoE are dependent on new features
- AI brings the technologies to develop these features

But AI development is complicated, with an important initial investment

- Business practices are costly to collect and model
- Need for real-scale experiments, with real data
- Complexity to experiment with new types of data
- Architecture for privacy, security, w/ edge computing

And the IoT market is highly fragmented

- Collaboration between actors will become key
- Shared representations, data, best practices and interoperable solutions become mandatory



The combination of DM, IoT and AI is a real opportunity for standards

Thank you

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