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: Combine Out-of-band monitoring with AI and big data for datacenter automation

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EU H2020 FETHPC
project ANTAREX
(g.a. 671623)

EU FP7 ERC Project
MULTITHERMAN
(g.a.291125)

The University of Bologna

THE BIRTH OF THE UNIVERSITY
The Studium in Bologna is the first home of free teaching, independent from ecclesiastic schools. Irnerio's law school marks the birth of Western universities.

FREEDOM OF RESEARCH
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the University as
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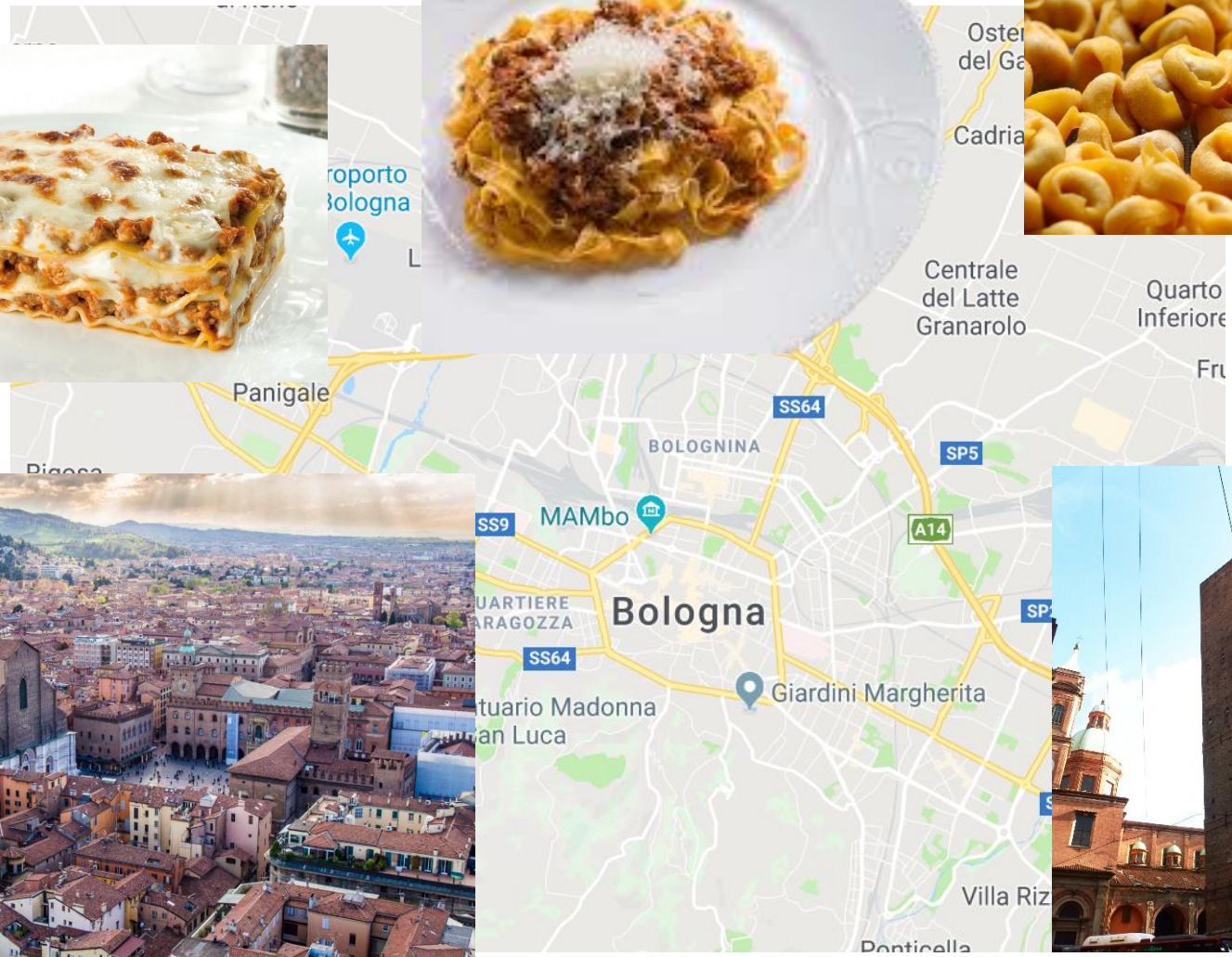
Alma Mater Studiorum
Università di Bologna
is a multi-campus
university based in Bologna,
Cesena, Forlì, Ravenna, and
Rimini.

University Statute, Constituent
Principles, Art. 1 para. 2

Bologna the city of …



Bologna the city of …

…Datacentres.

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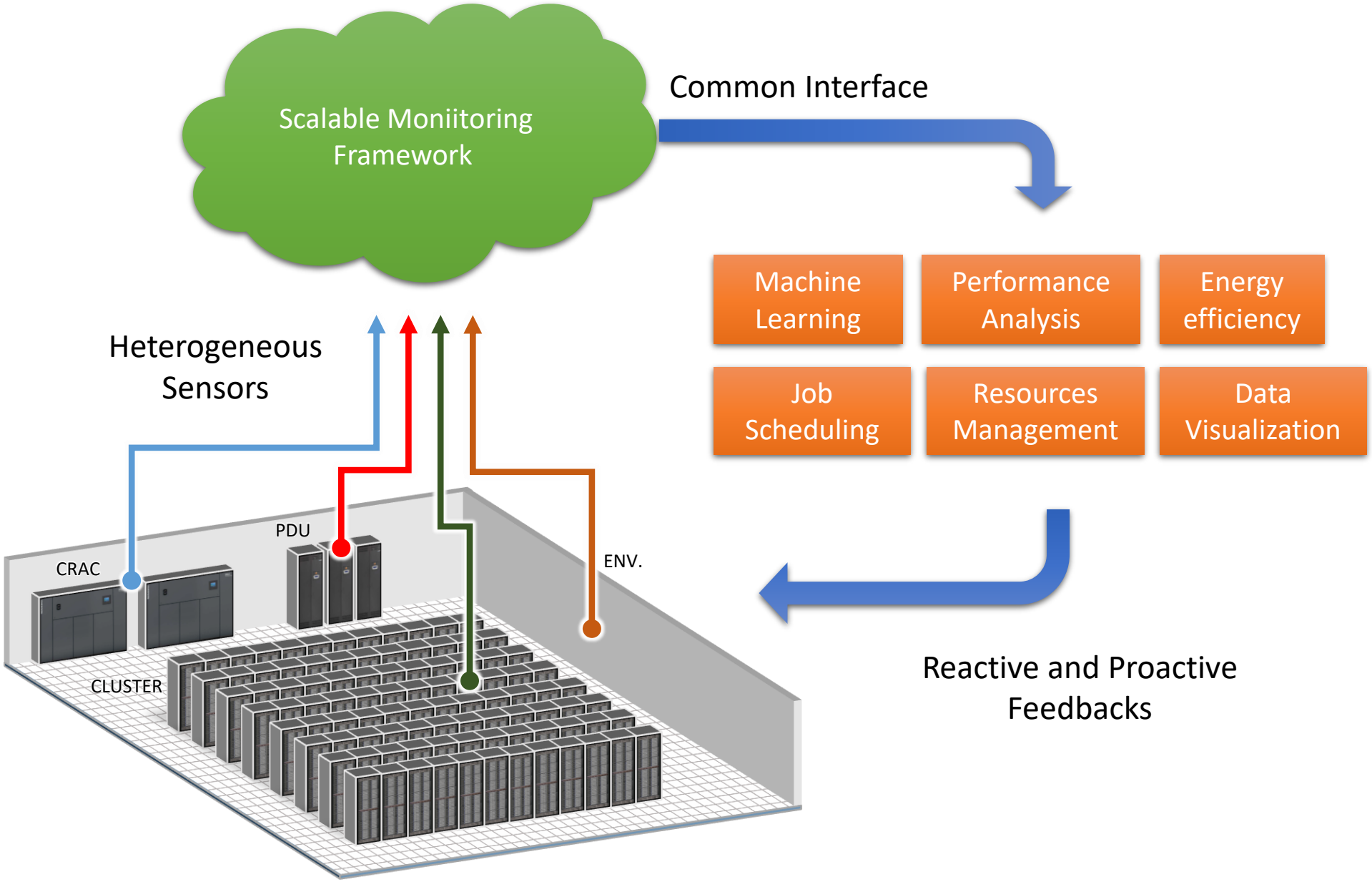
A New Trend: Datacentre Automation



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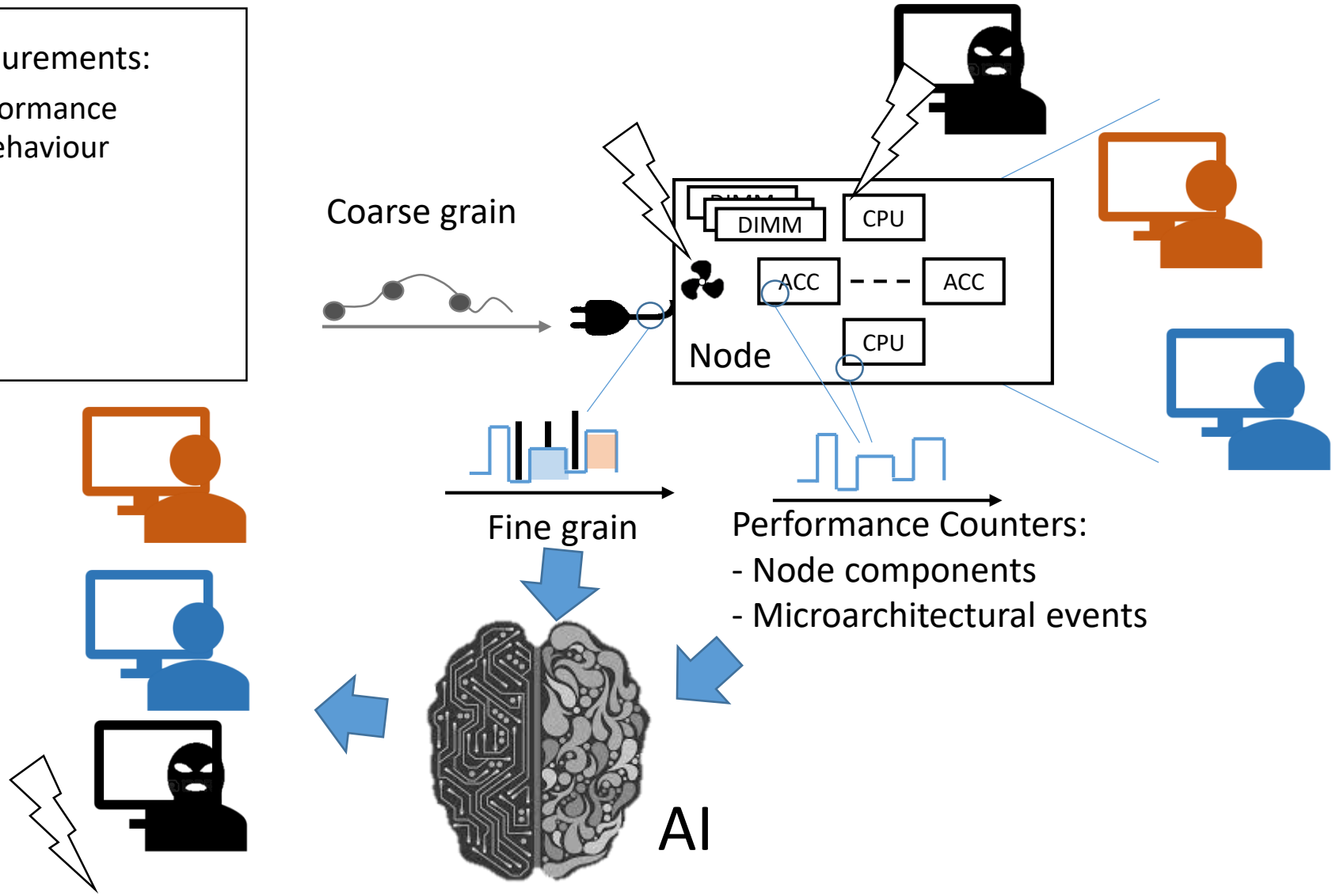
Usage Scenarios

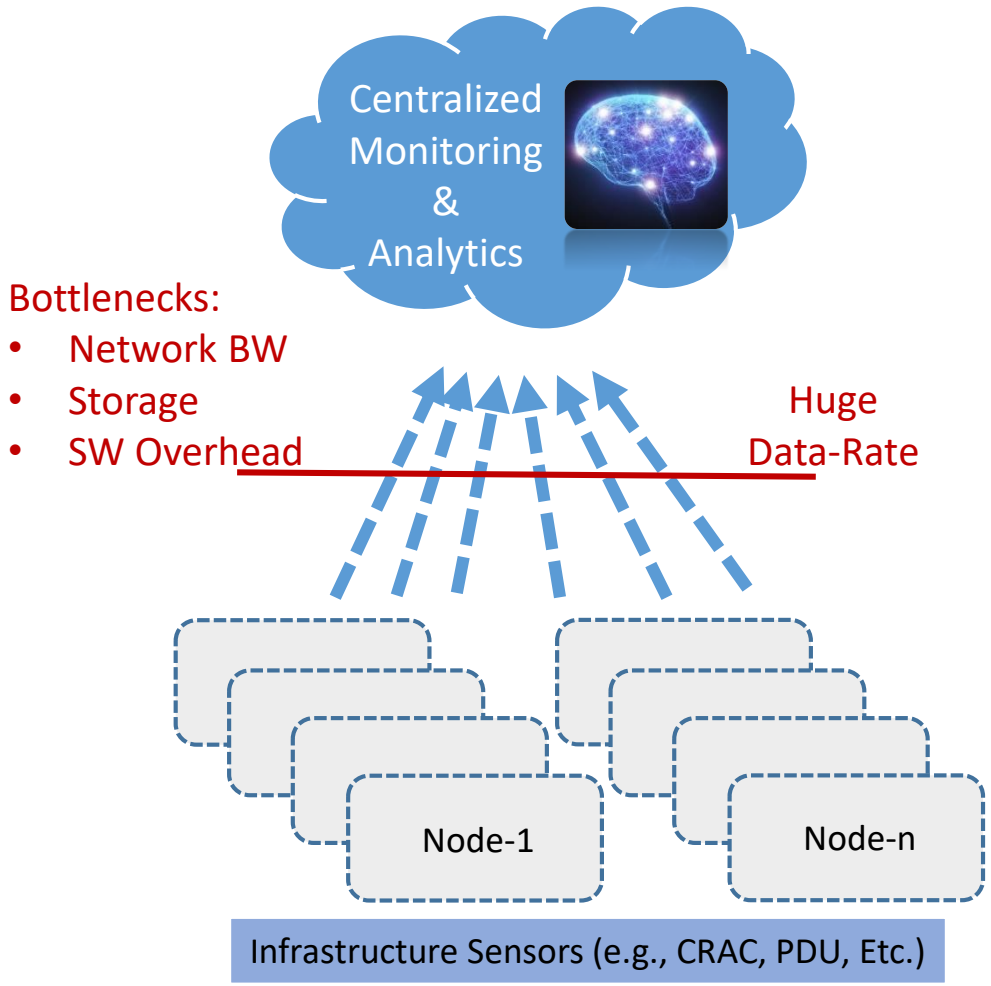
Fine Grain Power and Performance Measurements:

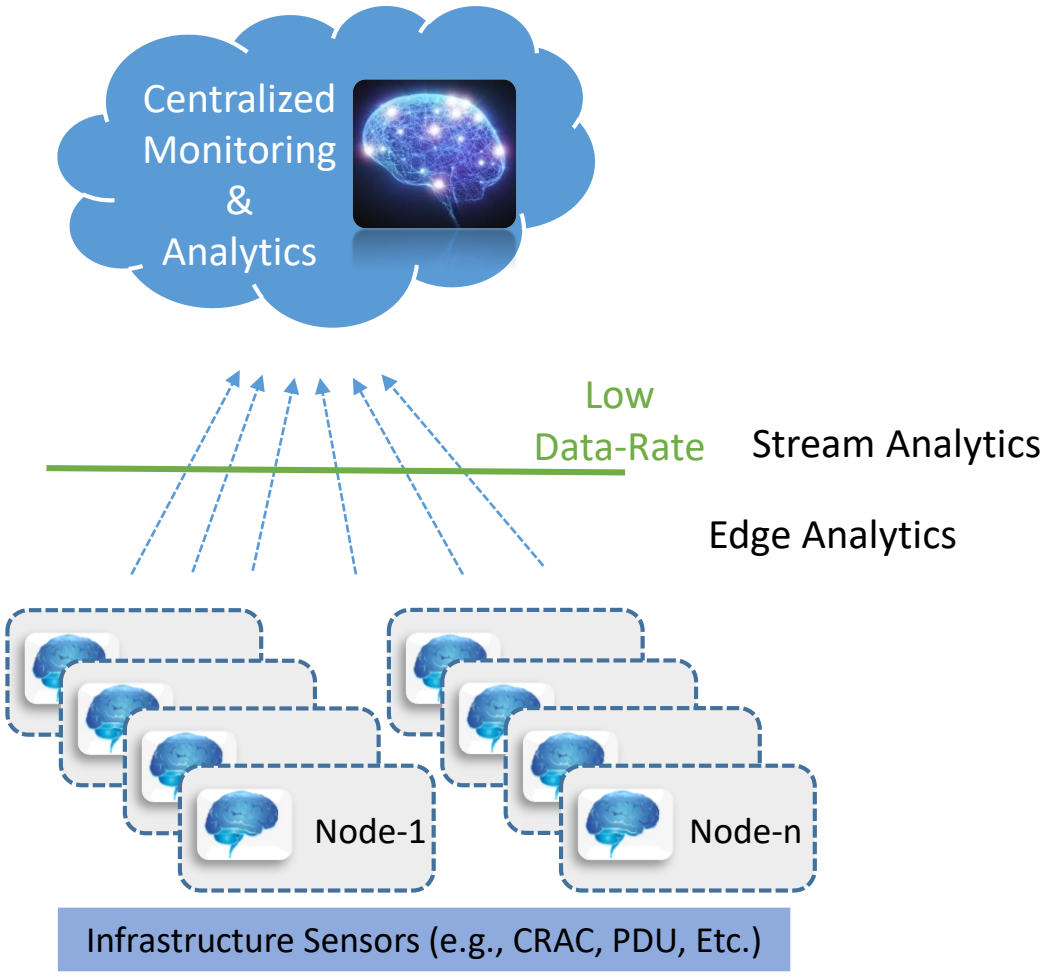
- Verify and classify node performance
  - In spec / out of spec behaviour
  - Miss configuration
  - Aging and wear out
- Detect security hazards
- Predictive maintenance



Datacenter Automation Design and Bottlenecks

[DAAC18] Libri et al. 2018. **DiG: Enabling Out-of-Band Scalable High-Resolution Monitoring for Data-Center Analytics, Automation and Control**





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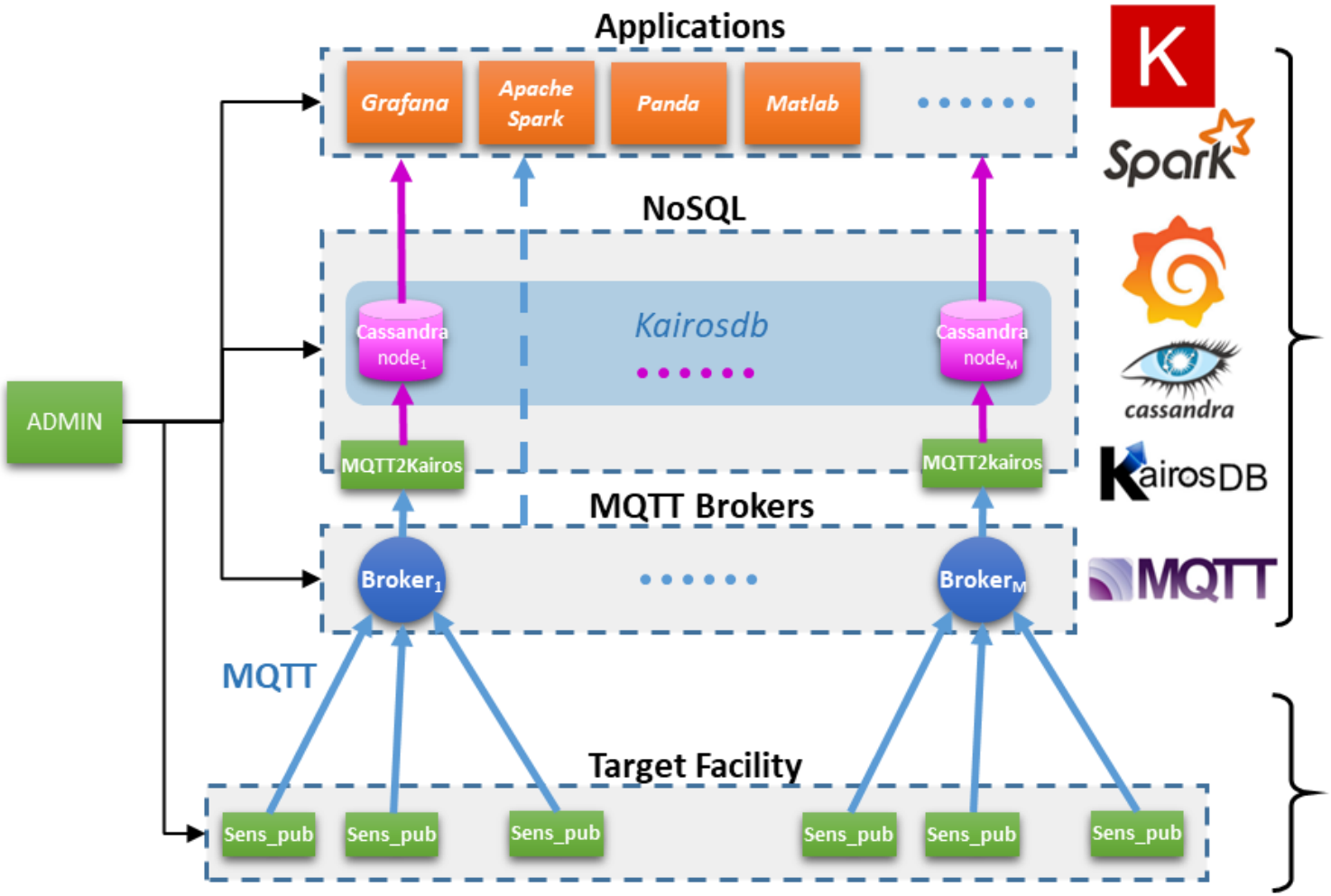
Scalable Data Collection, Analytics

EXAMON



Front-end

- **MQTT** Brokers
- Data **Visualization**
- **NoSQL** Storage
- **Big Data** Analytics

Back-end

- MQTT–enabled sensor collectors

https://github.com/EEESlab/examon

[DATE17] F. Beneventi et al., “Continuous learning of HPC infrastructure models using big data analytics and in-memory processing tools”
[BigDAW18] A. Bartolini et al, “The DAVIDE Big-Data-Powered Fine-Grain Power and Performance Monitoring Support”

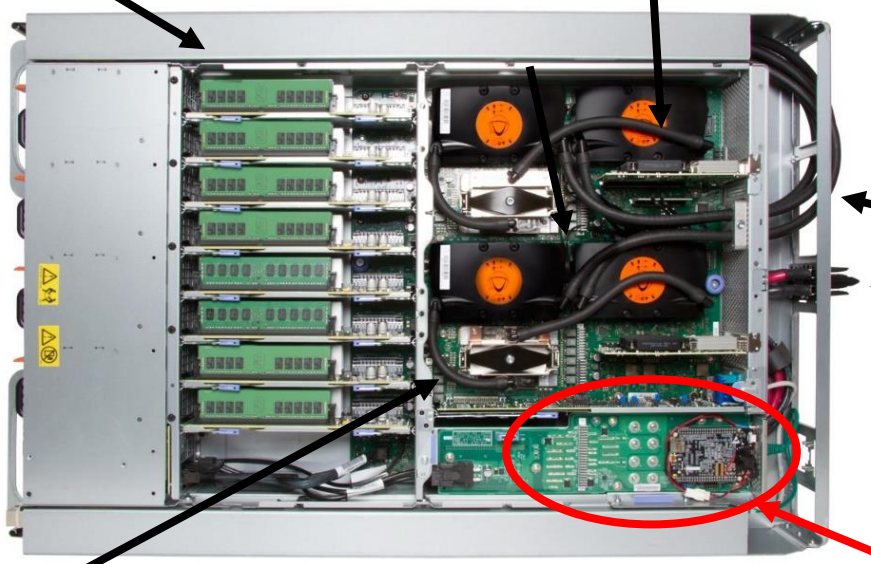
[DAAC18] https://arxiv.org/abs/1806.02698

DiG = High Frequency Monitoring on D.A.V.I.D.E.

OCP form factor compute node based on IBM Minsky

4x NVIDIA Tesla P100 HSMX2

2 x IBM POWER8 with NVLink



2xIB EDR

BusBar

DiG

ETH Zurich / Univ. of Bologna
SoA out-of-band
High Resolution Power
and Performance Monitoring

LIQUID COOLING

[DAAC18] Libri et al. 2018. DiG: Enabling Out-of-Band Scalable High-Resolution Monitoring for Data-Center Analytics, Automation and Control
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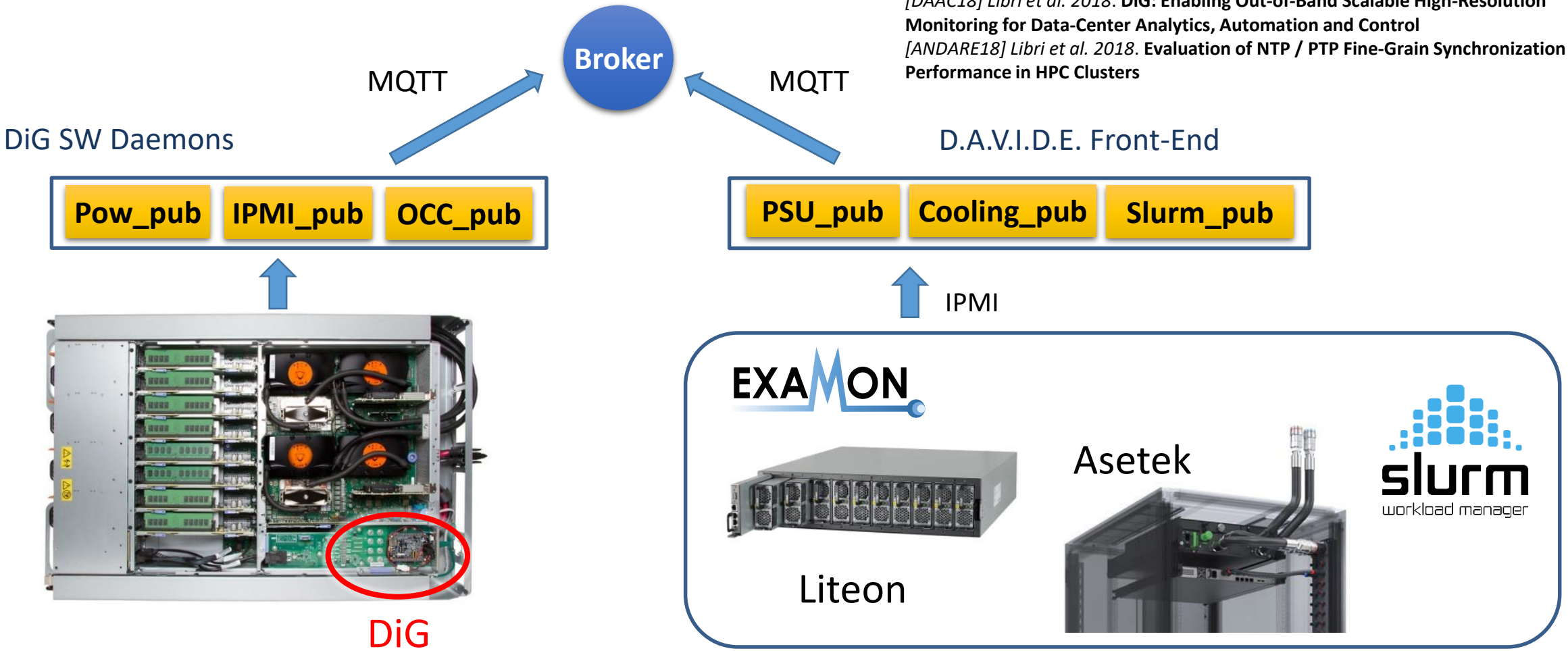
[DAAC18] Libri et al. 2018. **DiG: Enabling Out-of-Band Scalable High-Resolution Monitoring for Data-Center Analytics, Automation and Control**
[ANDARE18] Libri et al. 2018. **Evaluation of NTP / PTP Fine-Grain Synchronization Performance in HPC Clusters**



AI+Big Data on D.A.V.I.D.E.: Anomaly detection

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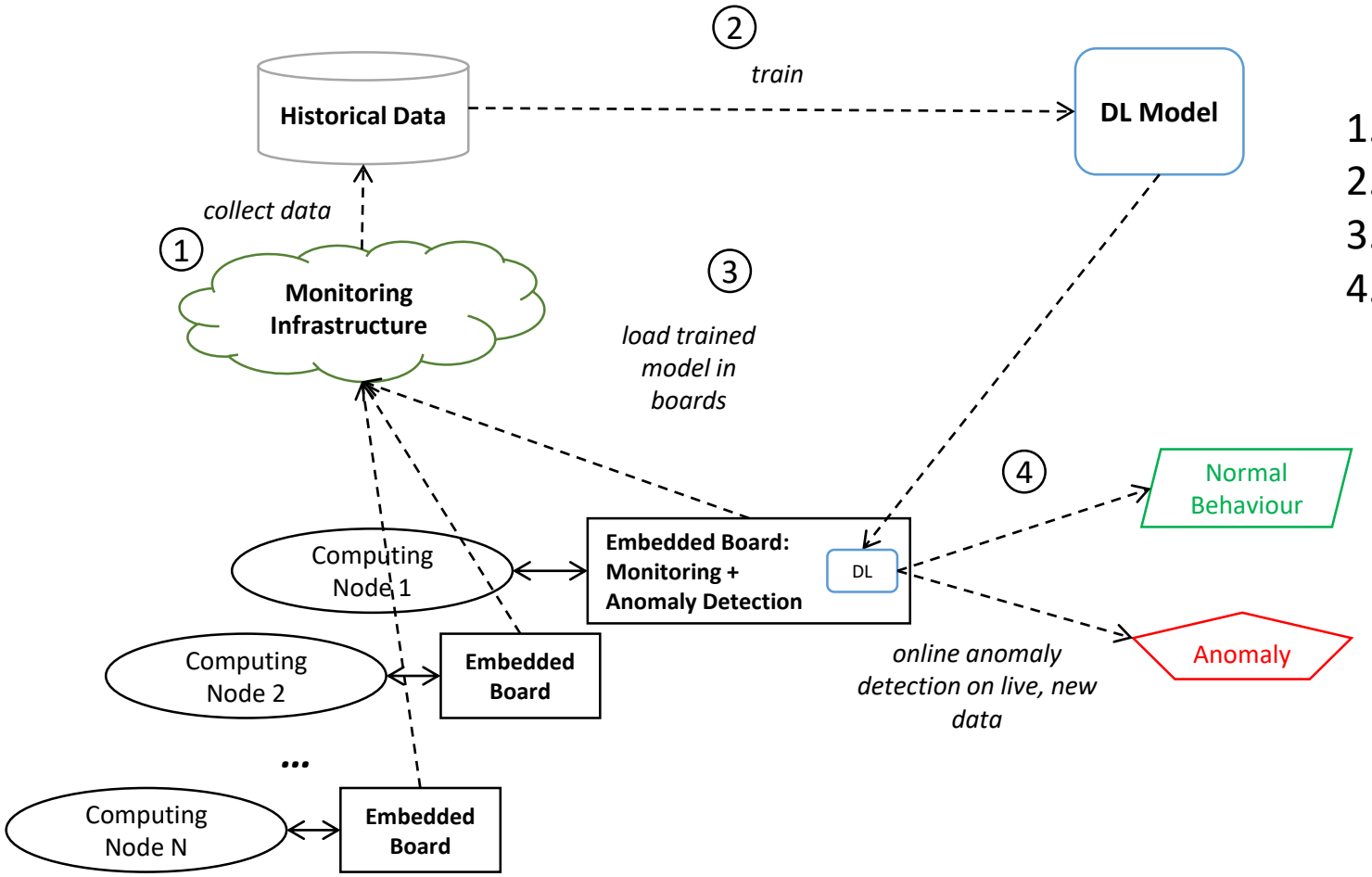

1. Collect Data
2. AI Train
3. Edge
4. AI Inference

[IAAI19] Borghesi et al, https://arxiv.org/abs/1811.05269

AI+Big Data on D.A.V.I.D.E.: Anomaly detection

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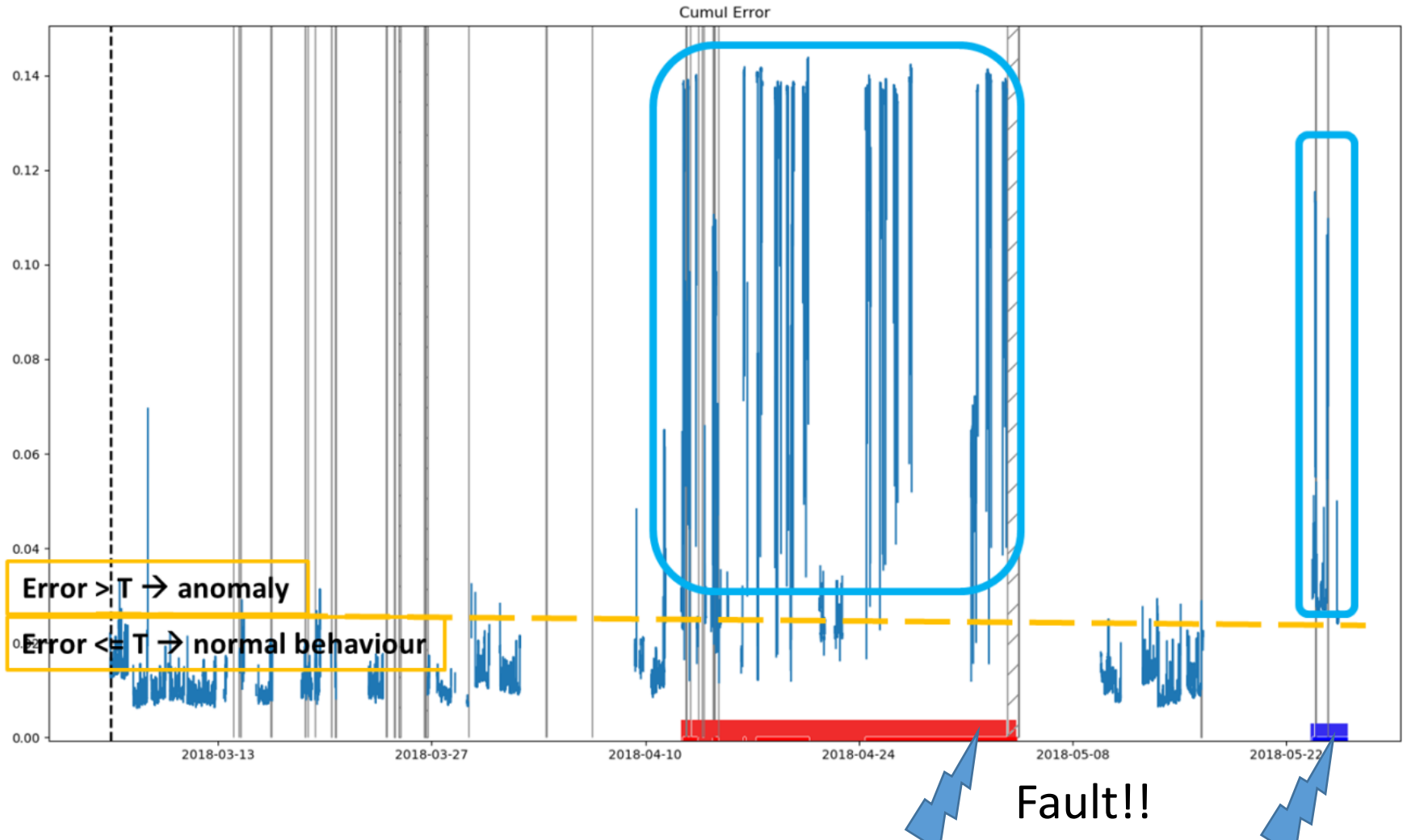

AI+Big Data on D.A.V.I.D.E.: Anomaly detection

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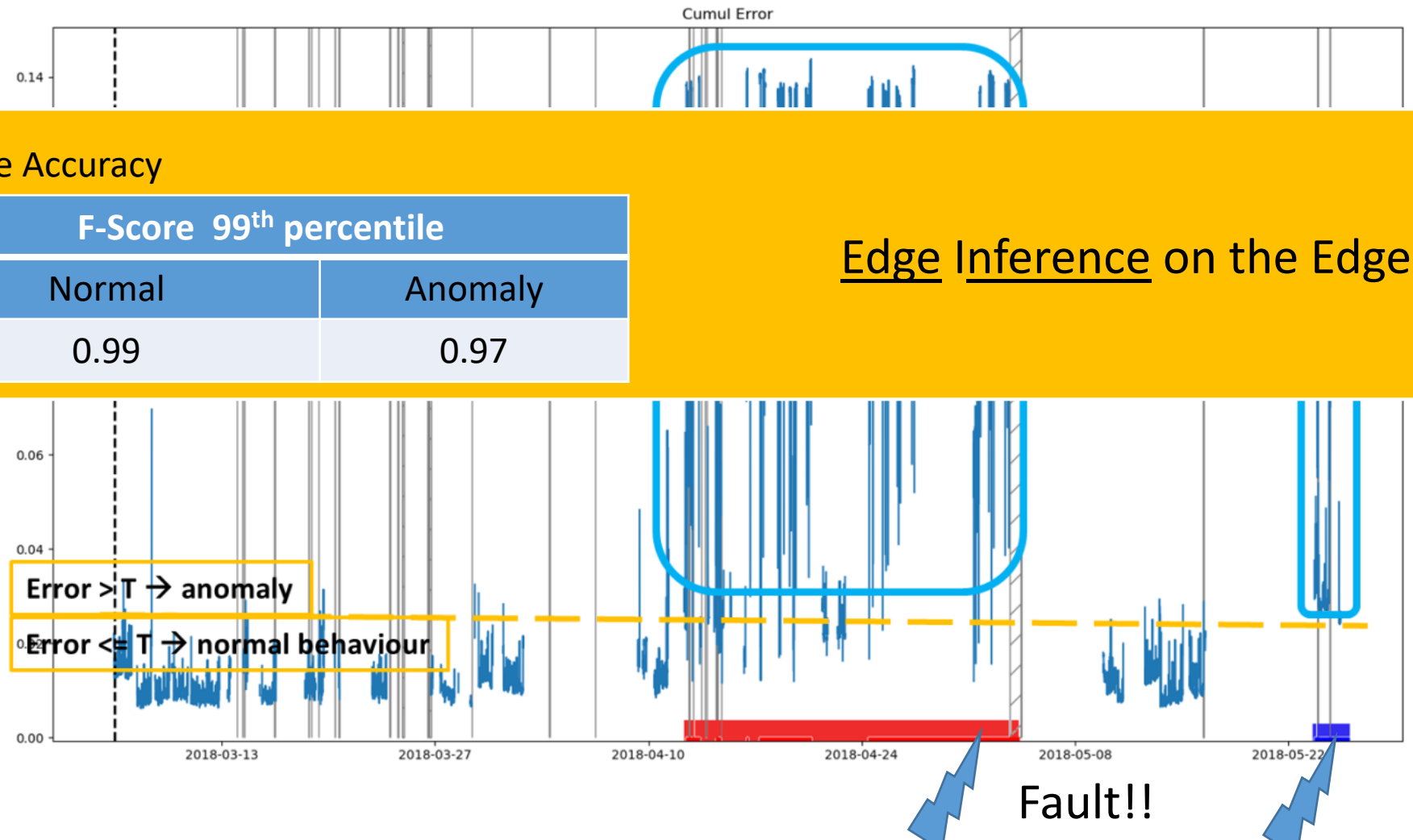
Inference Accuracy

F-Score 99th percentile	
Normal	Anomaly
0.99	0.97

Edge Inference on the Edge: (**11 ms**)



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Conclusion & Future Works

- Holistic and Fine Grain Monitoring feasible w. Open Source and Scalable of the shelf tools
- Challenge in the effective usage and knowledge extraction from the monitored data
- AI, ML and Predictive Control can leverage the infrastructure toward datacentre automation.
- Future Works:
  - Scale anomaly detection at the full datacentre level
  - HW design support for Datacenter Automation

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Multitherman

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E4:

- Cosimo Gianfreda, Fabrizio Magugliani, Daniele Gregori, Simone Tinti

EX 10^18

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ETH zürich

PRACE

CINECA

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COMPUTER
ENGINEERING

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- Borghesi, A., Bartolini, A., Lombardi, M., Milano, M., & Benini, L. (2018). **Anomaly Detection using Autoencoders in High Performance Computing Systems.** arXiv preprint arXiv:1811.05269. (to appear in IAAI19)