FactoryDC: Network and Resource Planning for Emerging Applications in Future Factories

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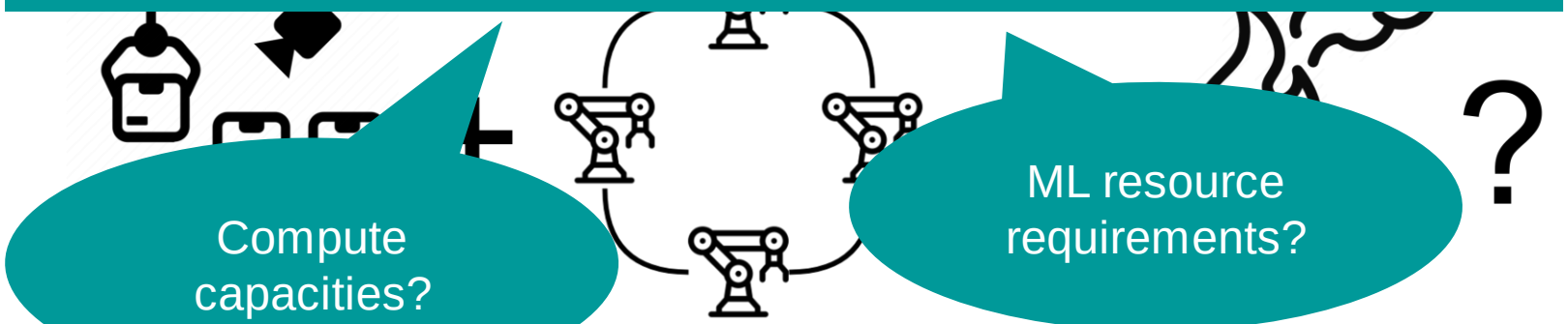
Never Change a Running System! …or Should we?

- IT & OT are merg
- Paradigm change in factories caus by “Build to order”
- Machine learni

Network dimensioning?

ML performance?

How to ac Planning! changes?



Compute capacities?

ML resource requirements?

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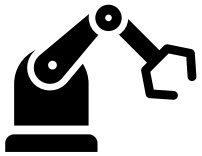
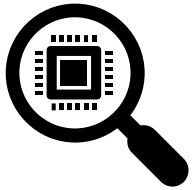
Proper Planning needs a Plan

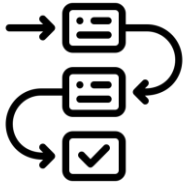
Evaluate ML-centric use cases in the factory



Analyse ML applications w.r.t their performance behaviour



Dimension/Plan with ML applications in mind



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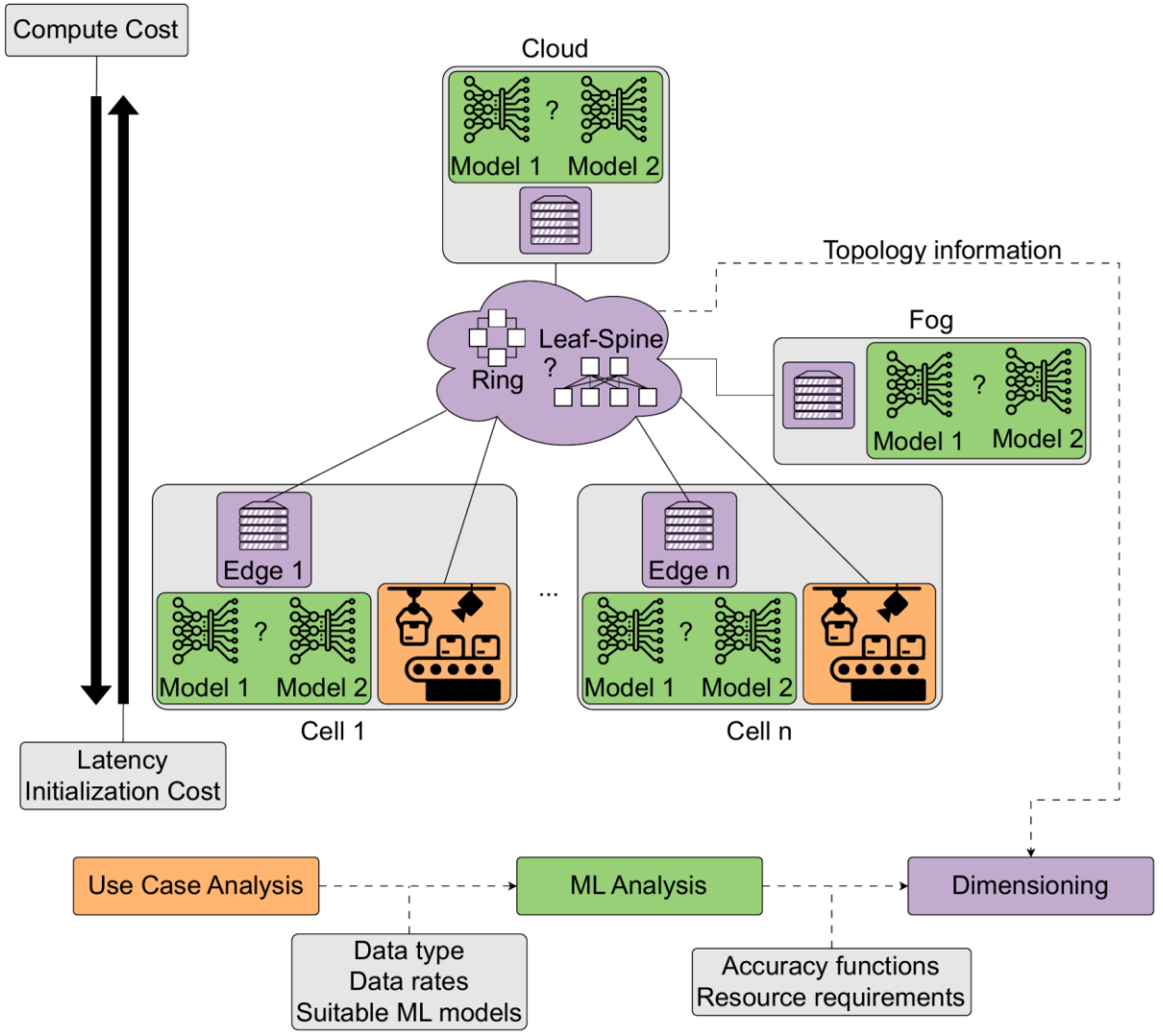
FactoryDC Pipeline – From Use Case to Dimensioning



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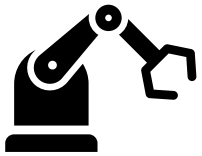
Proper Planning needs a Plan

Omitted for this presentation

Evaluate ML-centric use cases in the factory



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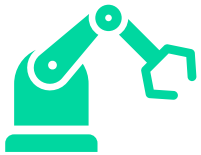

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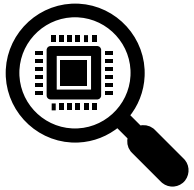


Dimension/Plan with ML applications in mind

Machine Learning Analysis – How does it behave?

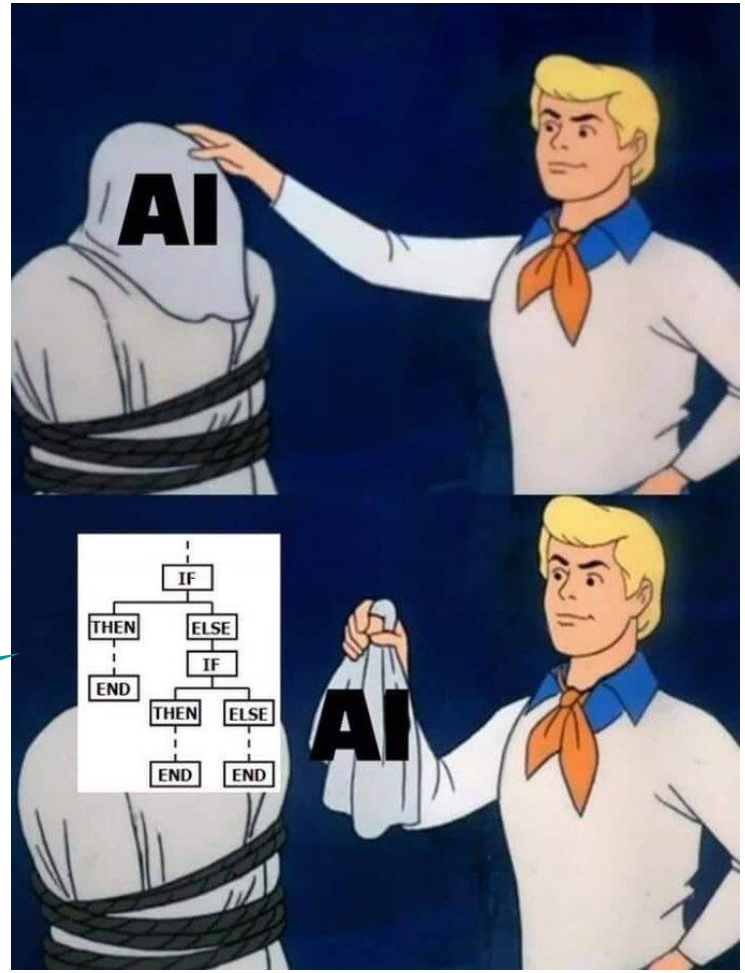
ML Influences

Data quality

Data type

ML model selected

Bitrate



ML Metrics

Accuracy

Resource requirements

➔ When does garbage in become garbage out?!

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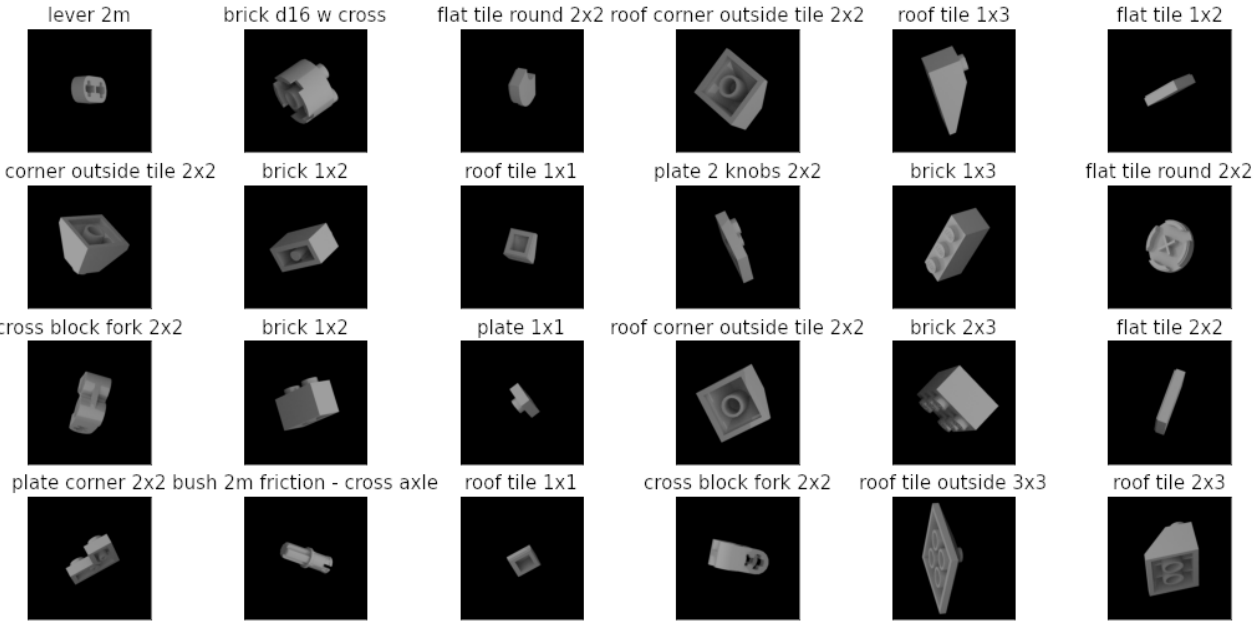
Machine Learning Analysis - Evaluation

Test Setup

- 40000 images of lego bricks
- 50 classes of bricks
- 100/50/25/10/1% JPEG compression
- ResNet models trained to every compression stage



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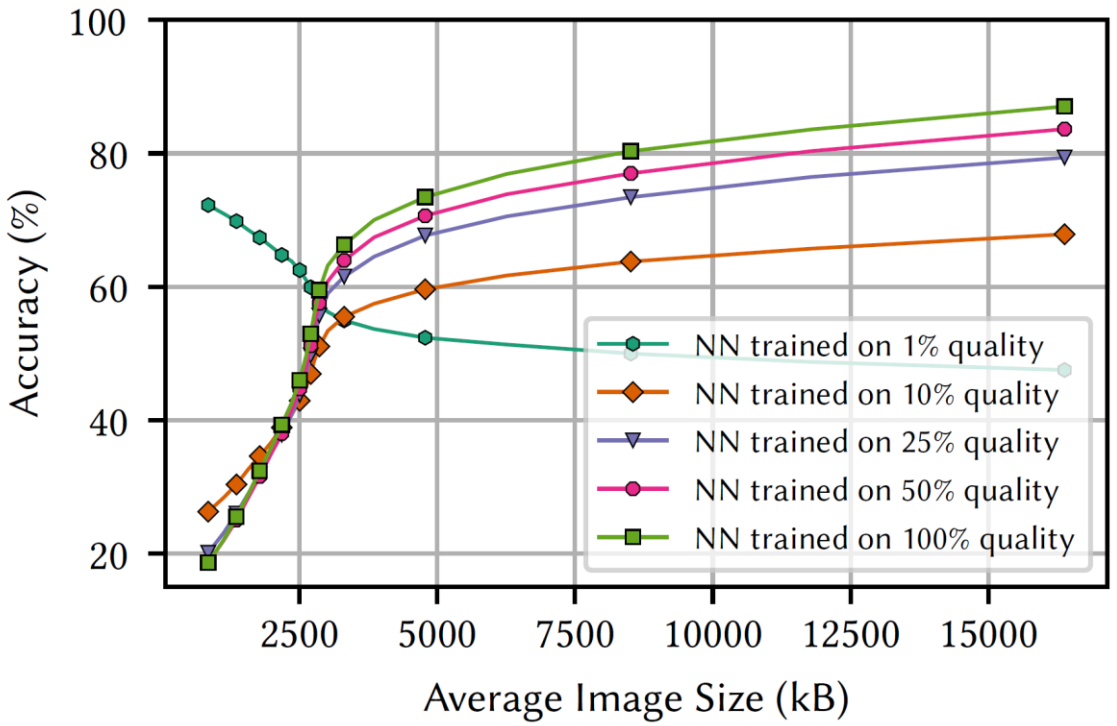
Machine Learning Analysis - Evaluation

Evaluation

- Mixing bad (1%) and good (100%) images
  - Increasing mixing level from all bad to all good
  - Inference on all models for each mixing level
- Record accuracy over average image size of mix



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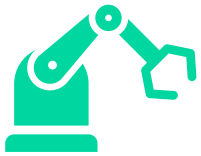
Proper Planning needs a Plan

Evaluate ML-centric use cases in the factory



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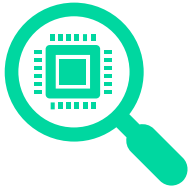
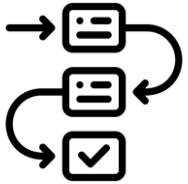


Dimension/Plan with ML applications in mind



Topology Dimensioning & Planning - Introduction

- MIP to place ML applications on compute resources
  - Edge
  - FOG/Industrial datacenter
  - Cloud
- Multi-objective path-flow model between clients (Robots, AGVs, ect.) and compute nodes
  - Latency
  - Overall datarate
  - Compute cost
  - Initialization cost
- Input: ML analysis
  - Suitable ML models
  - Performance
  - Resource requirements
  - => **Weniger Bulletpoints / Grafik**

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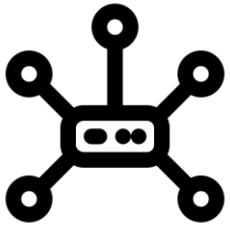
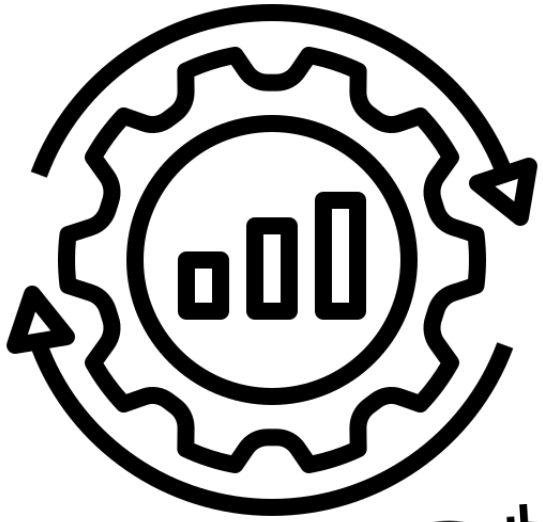
Topology Dimensioning & Planning - Introduction



Network Topology

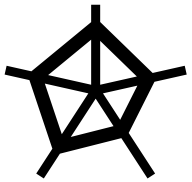
- Clients
- Compute resources
- Client paths

Optimizer



Optimized Output

- ML latencies
- Datarates
- Compute node usage



ML Analysis

- Suitable ML models
- Performance
- Resource requirements

Objectives

- Latency
- Overall datarate
- Compute cost
- Initialization cost

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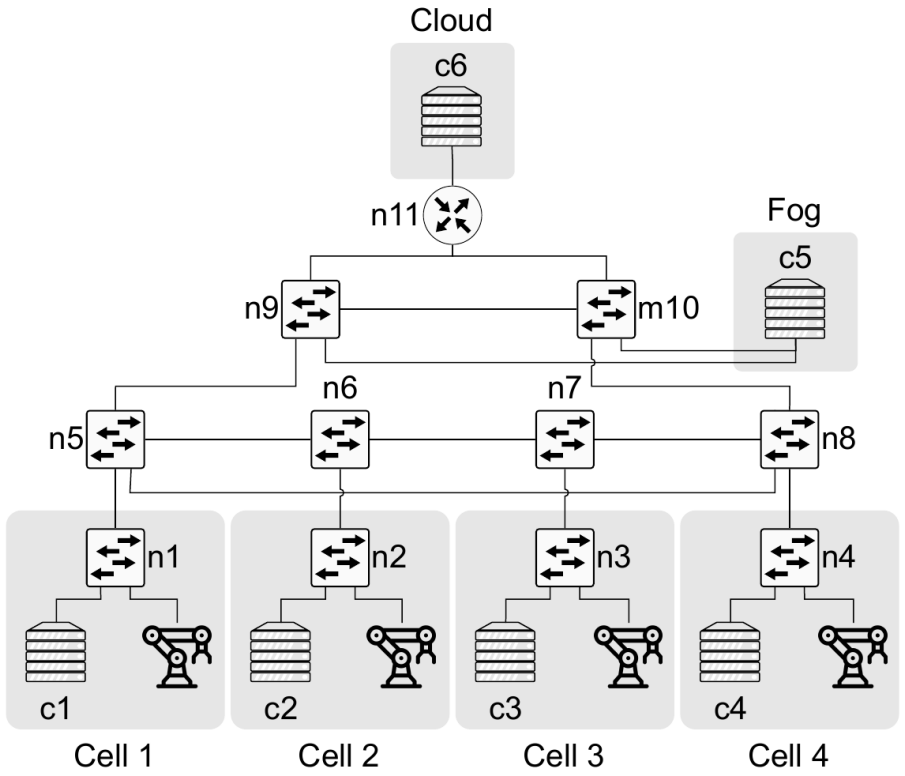
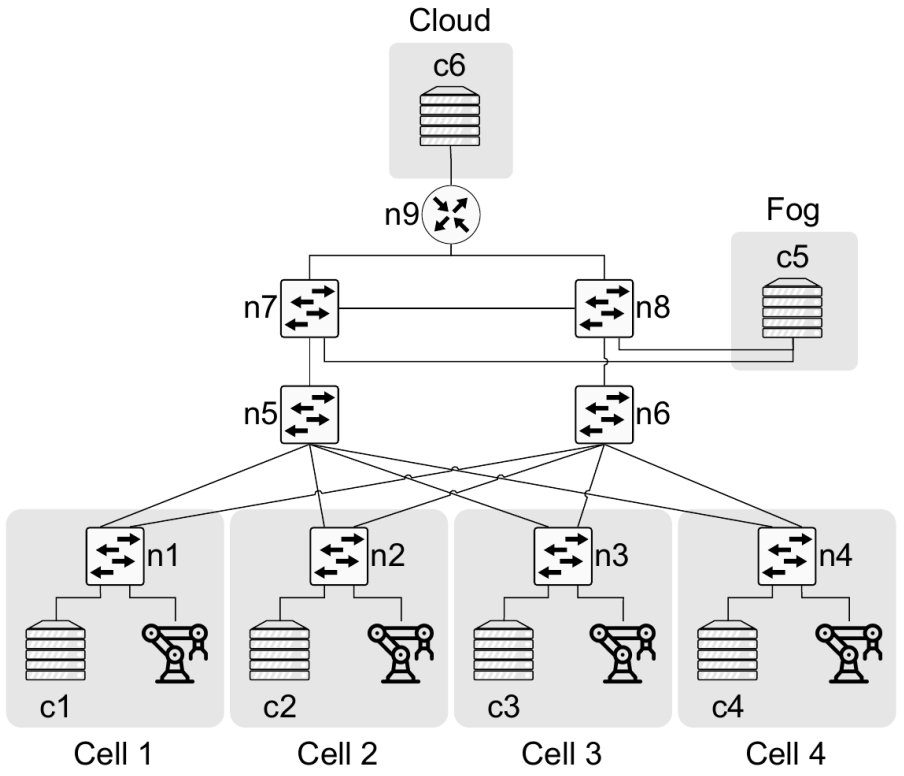
Topology Dimensioning & Planning – Test Setup



Ring Topology



Leaf-Spine Topology

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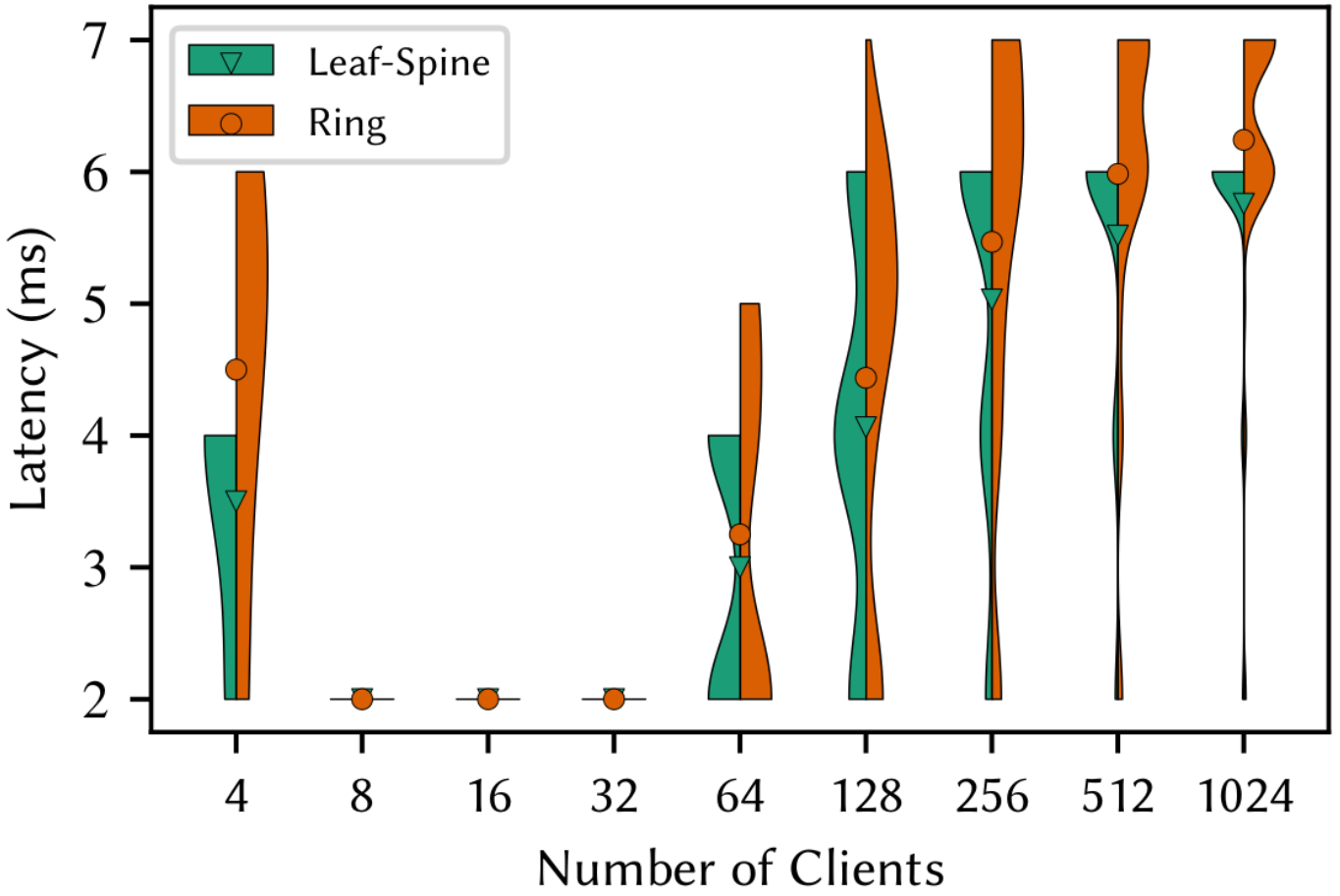
Topology Dimensioning & Planning – Evaluation



Latencies depending on number of clients and topolgy

➔ Higher latencies of legacy topologies indicate inability to cope with modern requirements

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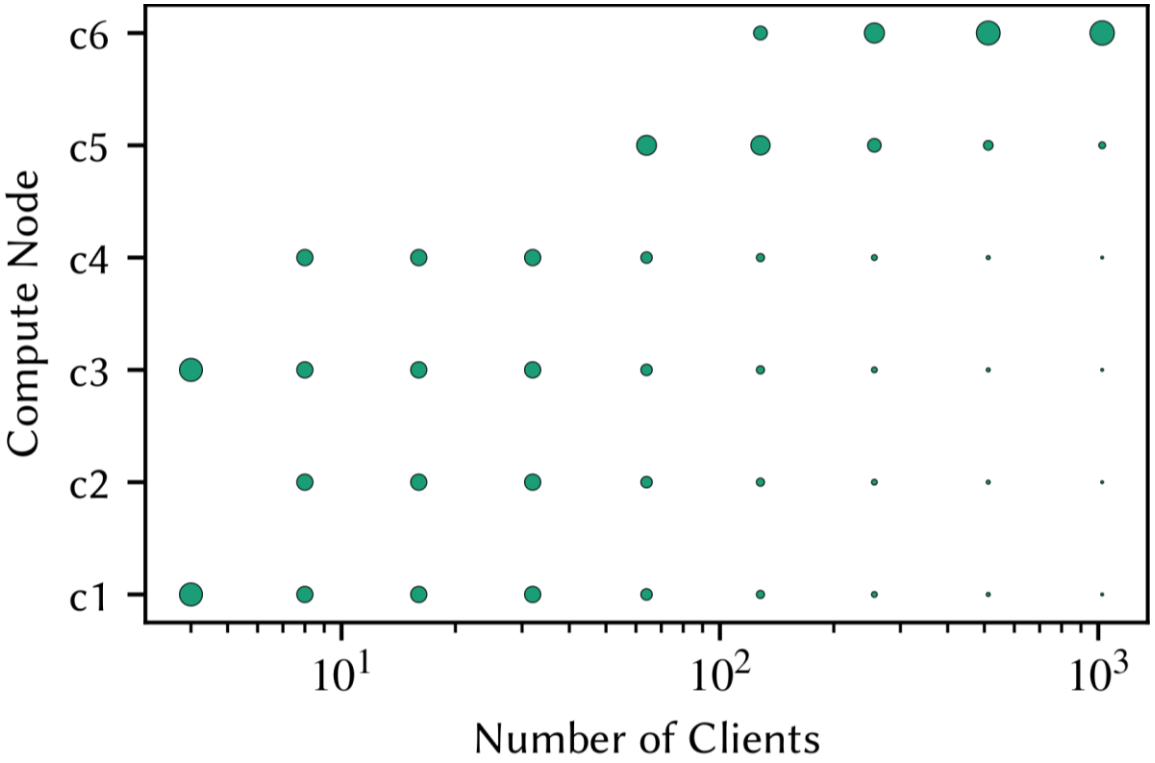
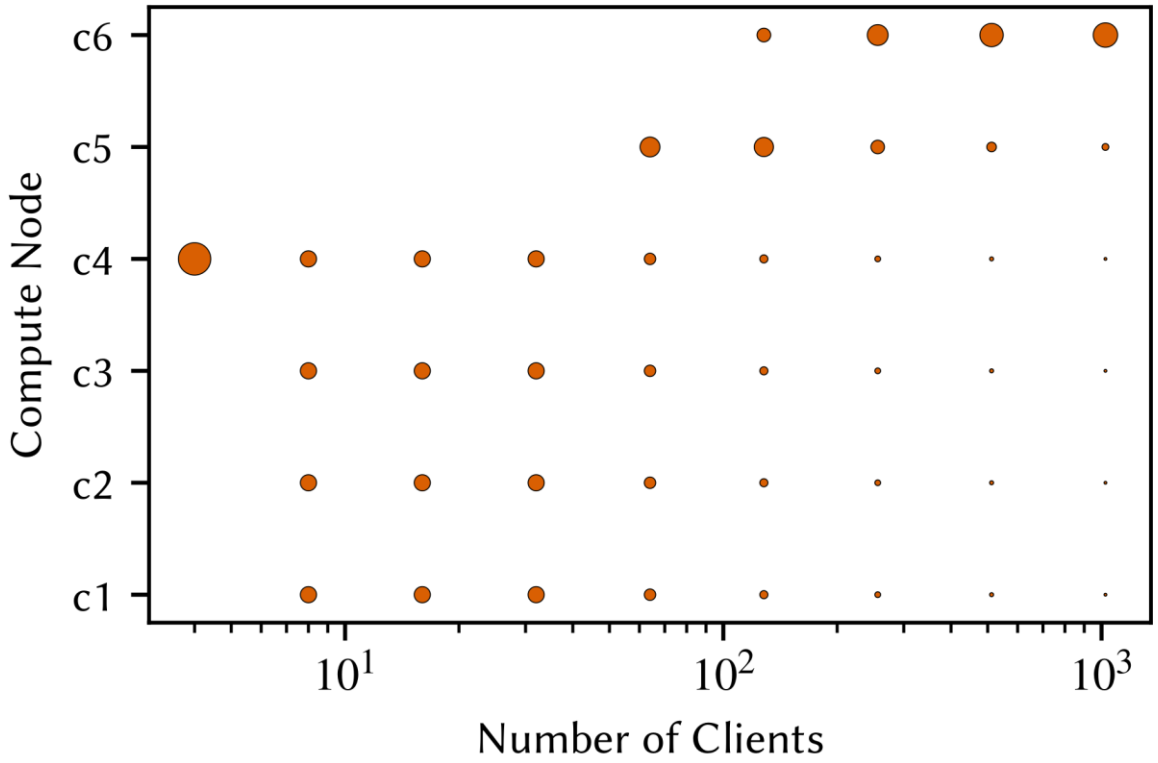
Topology Dimensioning & Planning – Evaluation



Leaf-Spine compute node usage



Ring compute node usage

➔ Worse compute distribution for less clients due to higher hop count

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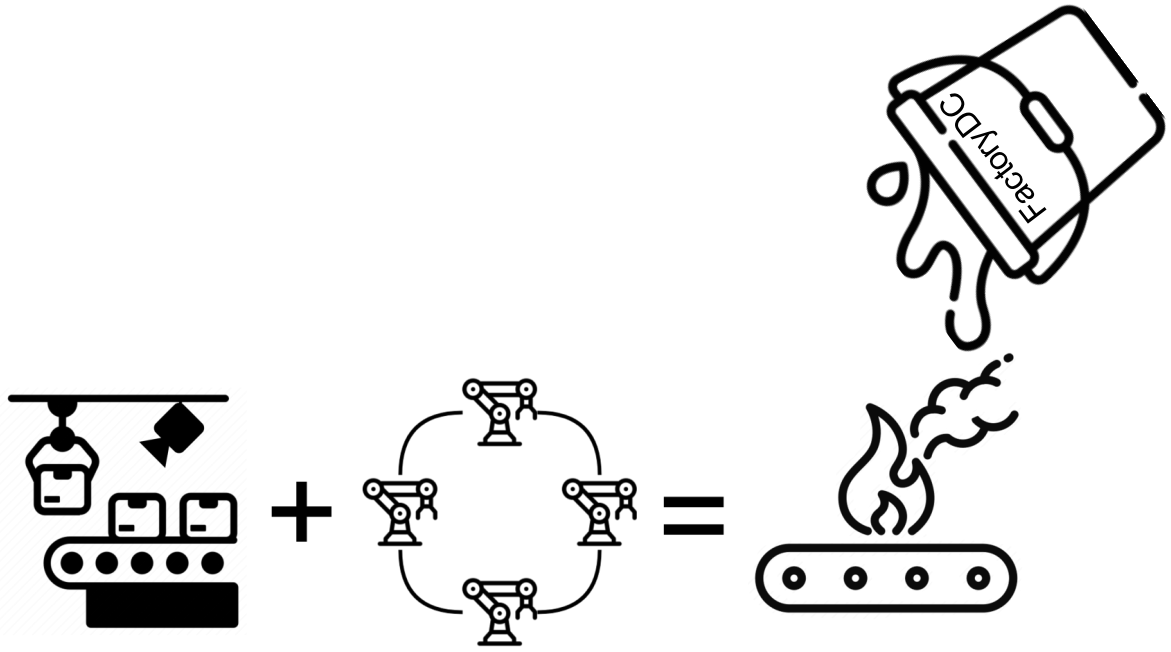
Conclusion

- ML-centric network planning essential for future factories
- New datacenter-like topologies outperform legacy networks
- Understanding ML application behaviours is key for proper planning
- Realistic dimensioning helps to save cost and improve efficiency



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Future Work

- Evaluate additional network topologies
- Consider further ML applications and demands
- Increase client amount for simulation
- Introduce hard-boundaries (latency) for time critical tasks

Acknowledgements

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Thank You

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