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System architecture and ecosystem interoperability enabling AI-driven solutions

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Background

- Main work experience
  - Assistant Professor (tenure track), Tampere University, February 2018-
    - Software Engineering
    - Industry4.0 applications focusing on software and system architectures
  - Researcher, Teaching Associate, Postdoc, Academy Postdoctoral Researcher positions since 2007 at Tampere University of Technology
    - Industrial systems, data-driven solutions and analytics based services
- Education and background
  - D.Sc. (Tech.), Tampere University of Technology, 2013
  - M.Sc. (Tech.), Tampere University of Technology, 2007

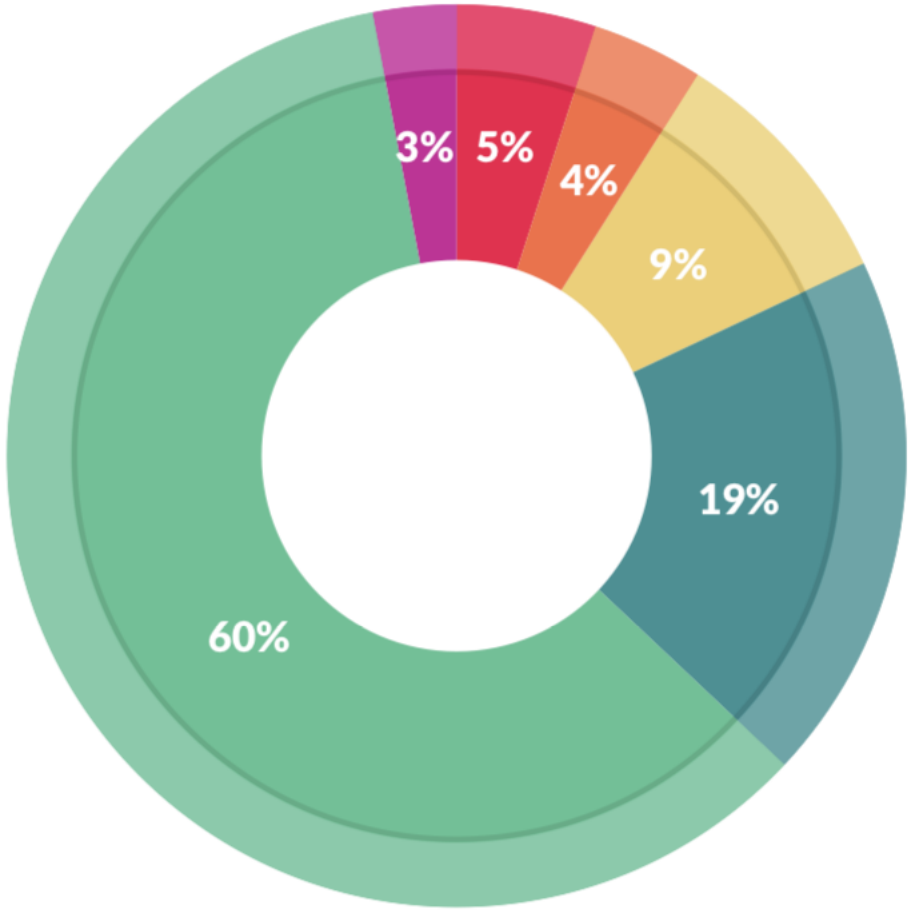
Content

- Motivation and challenge
- Architecture, interoperability
- A few examples striving for
  - Scalability and loose coupling
  - Local (distributed) reasoning
  - Flexible and continuously evolving system
- Conclusion

Typical challenges

- The data is not of sufficient quality, it is not representative
- There is not enough data
- Data is in different formats, not comparable. It is accessed differently from various systems.
- Data ownership sets limits to easily share to new use cases
- Data-driven solutions are not agile
- …

Data is not efficiently utilized



What data scientists spend the most time doing

- *Building training sets: 3%*
- *Cleaning and organizing data: 60%*
- *Collecting data sets; 19%*
- *Mining data for patterns: 9%*
- *Refining algorithms: 4%*
- *Other: 5%*

Source: Data Science Report, CrowdFlower, 2016

Getting ready for AI (data-driven solutions)

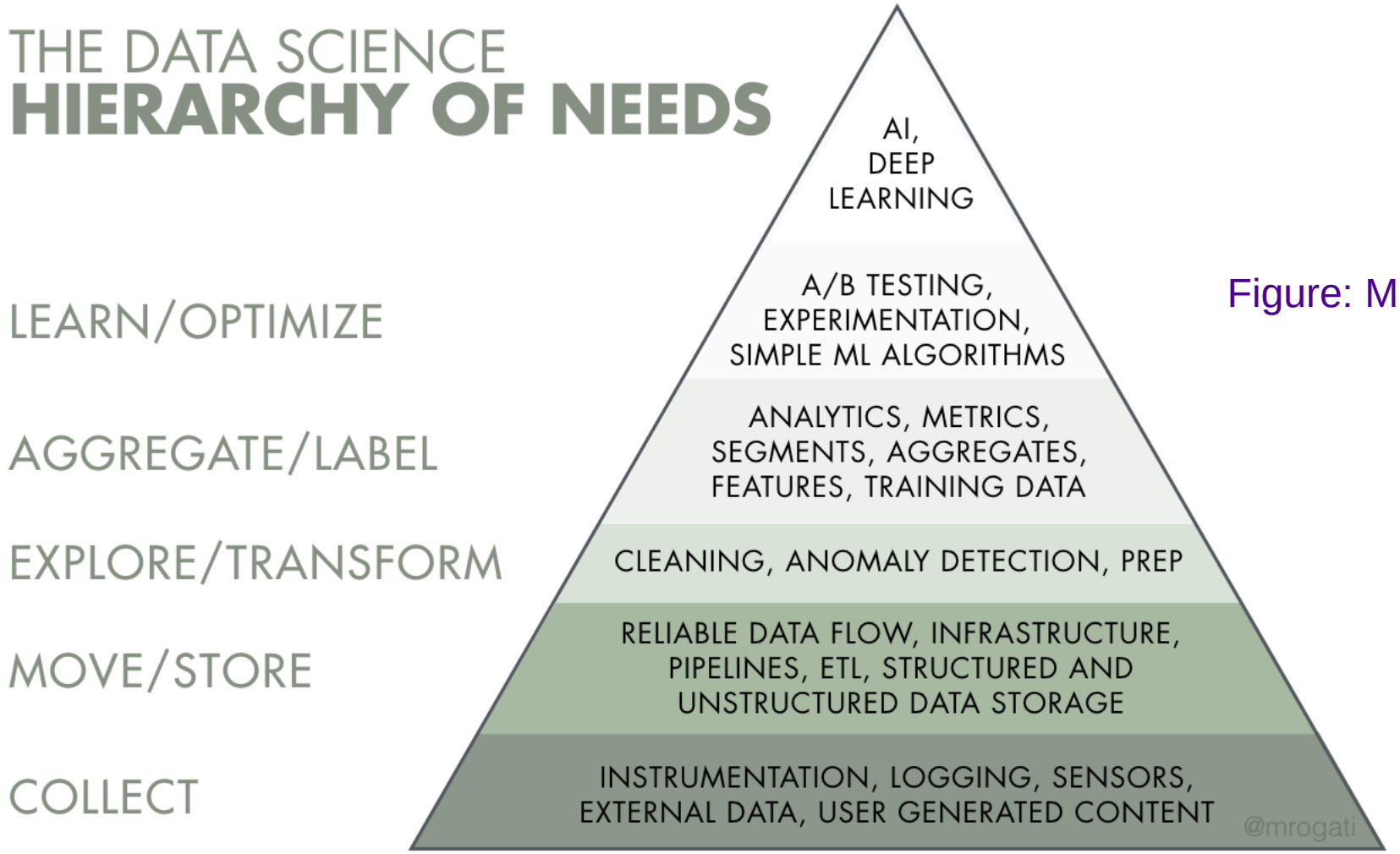


Figure: Monica Rogati

What architecture? What interoperability?

- Software and system architectures are easily overlooked when building a new system or solution in an ”agile” fashion
  - Division and structure of modules, extendability
  - Interplay of components
  - Scalability, performance
  - …
- Interoperability spans from data encoding to communication patterns between systems of systems
  - On an ecosystem level you could basically negotiate contracts on the go

Large-scale data exchange for evolving needs

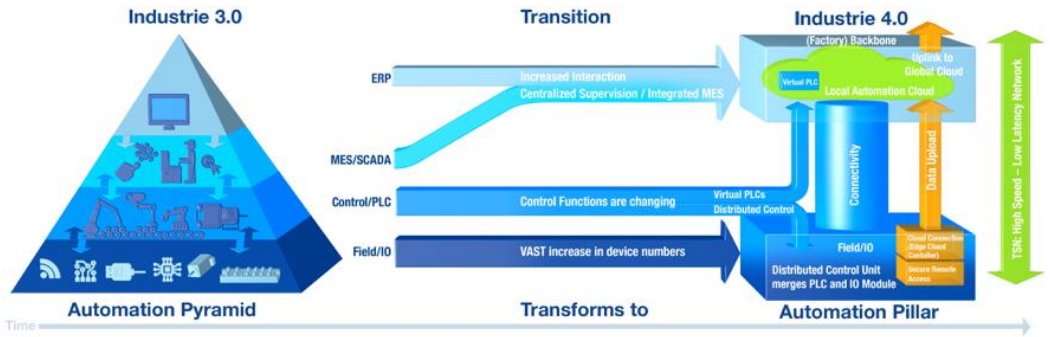
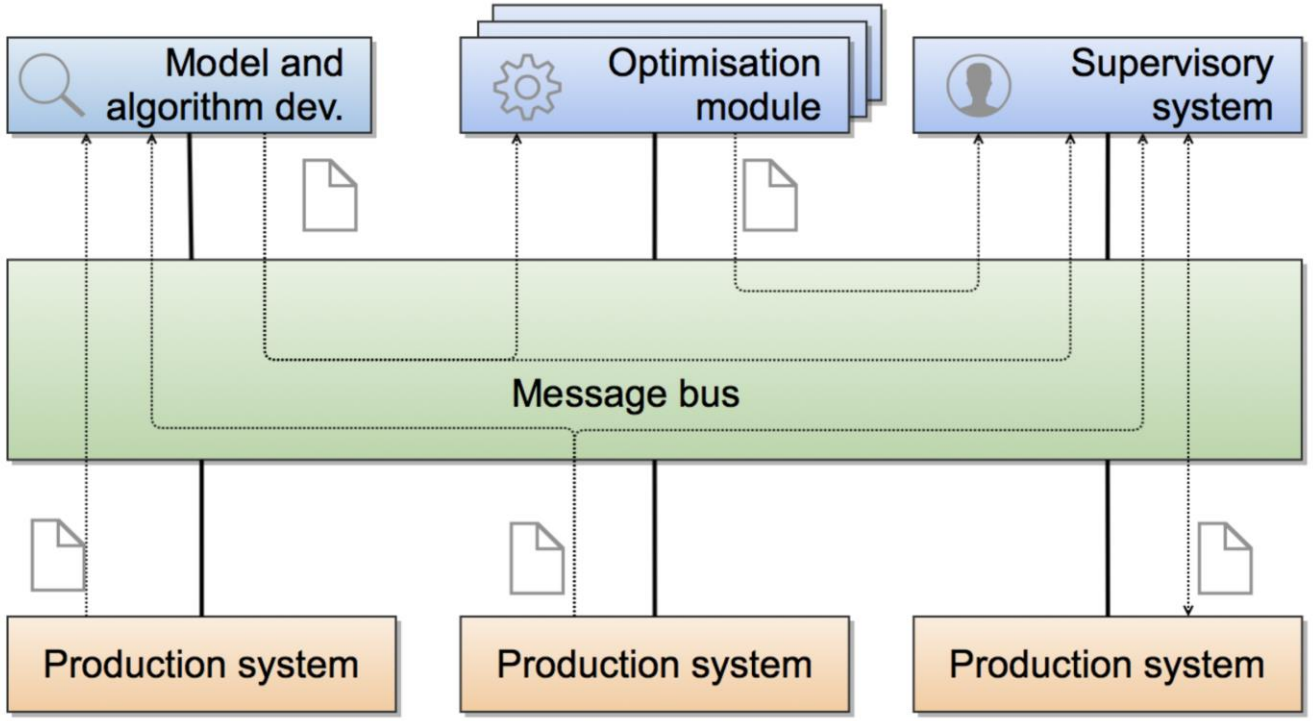
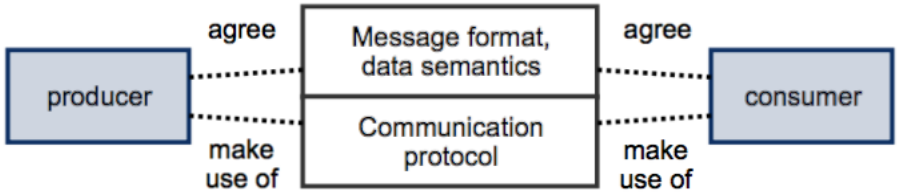


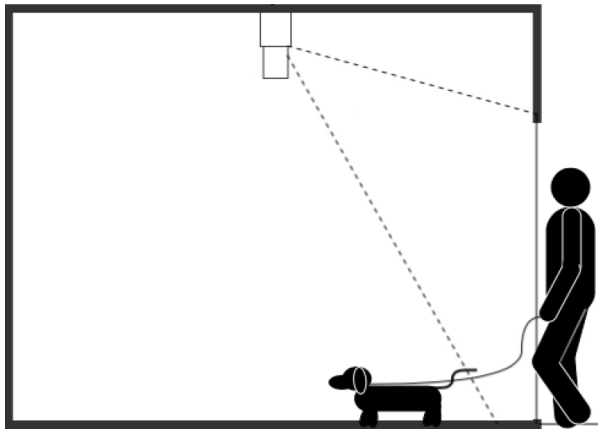
Figure: AutomationWorld

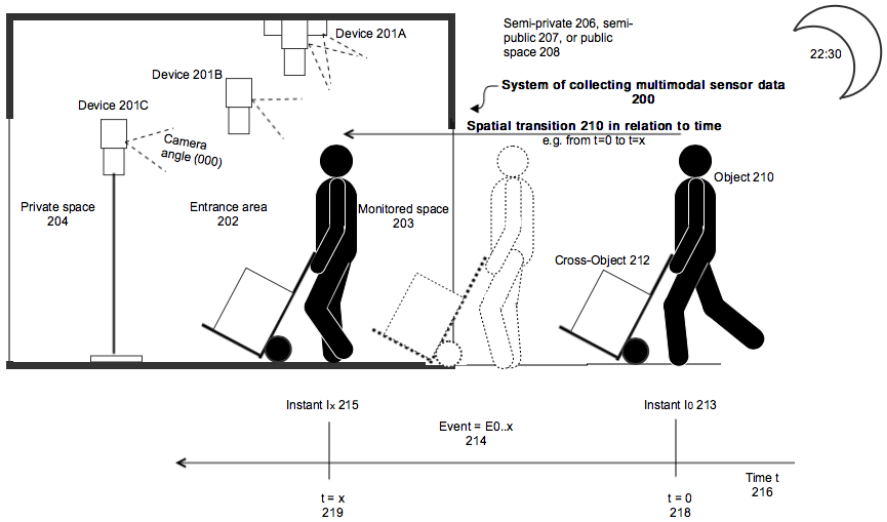
Source: Data-driven and Event-driven Integration Architecture for Plant-wide Industrial Process Monitoring and Control, Hästbacka, D., Kannisto, P. & Vilkko, M., IECON 2018 - 44th Annual Conference of the IEEE Industrial Electronics Society





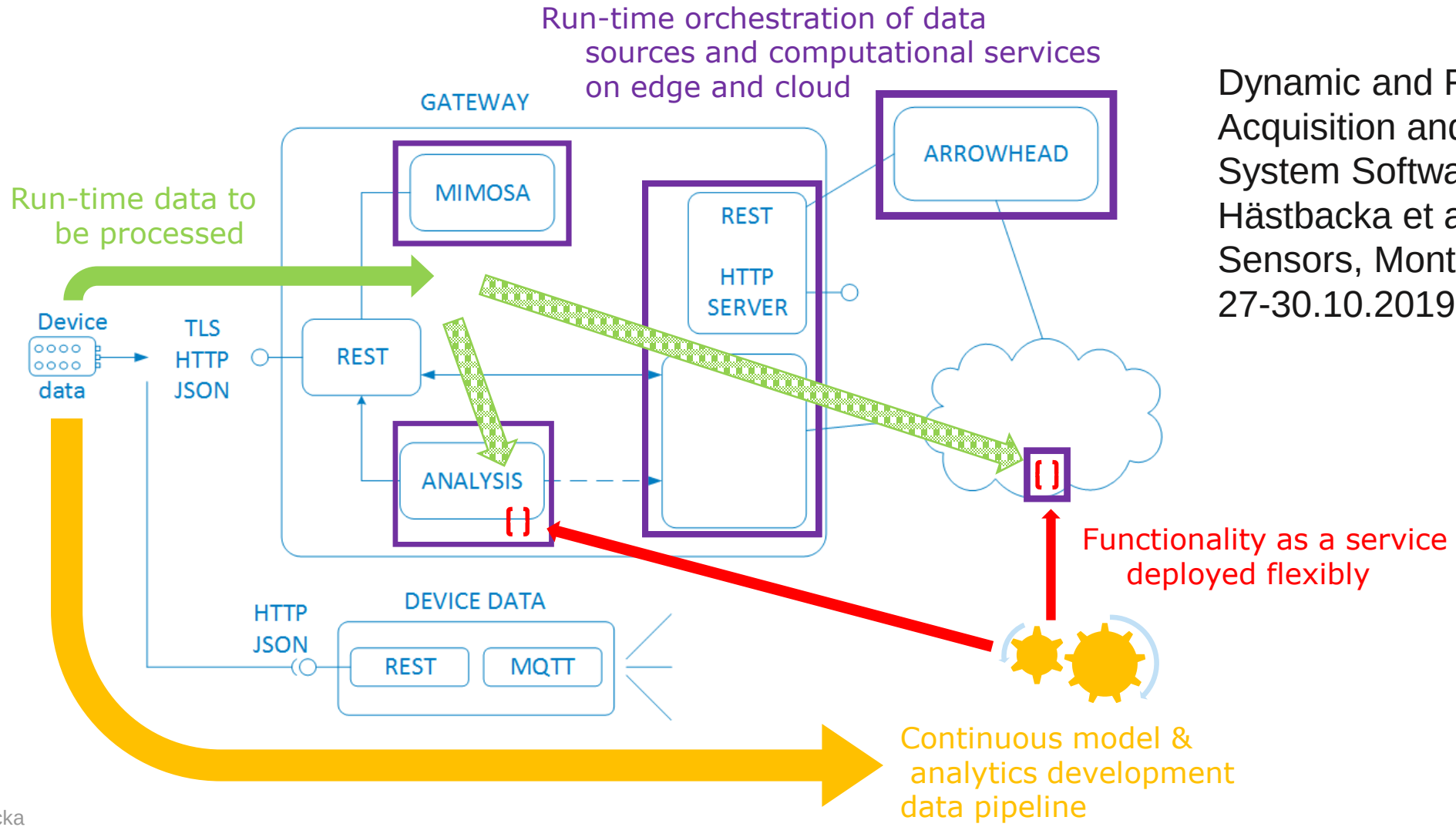
Local reasoning for control and forecasting





AIDOMUS non-intrusive sensoring for understanding use of space

Building a flexible, system architecture



Dynamic and Flexible Data Acquisition and Data Analytics System Software Architecture, Hästbacka et al., IEEE Sensors, Montreal, Canada, 27-30.10.2019

Conclusion

- AI based solutions need a solid architecture
  - Purposeful, scalable and extendable (open)
  - Physical (virtual) architecture ≠ logical architecture
- Ecosystem interoperability
  - Not only APIs – interoperability is needed on all levels of communication!
- Ideal future AI-driven solutions
  - Are capable of tapping into data in a plug and play manner
  - Evolve over time (i.e. a model is not only deployed and forgotten)
  - Support decentralised AI computation

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Thank you!

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