A Distributed Systems Perspective on Industrial IoT

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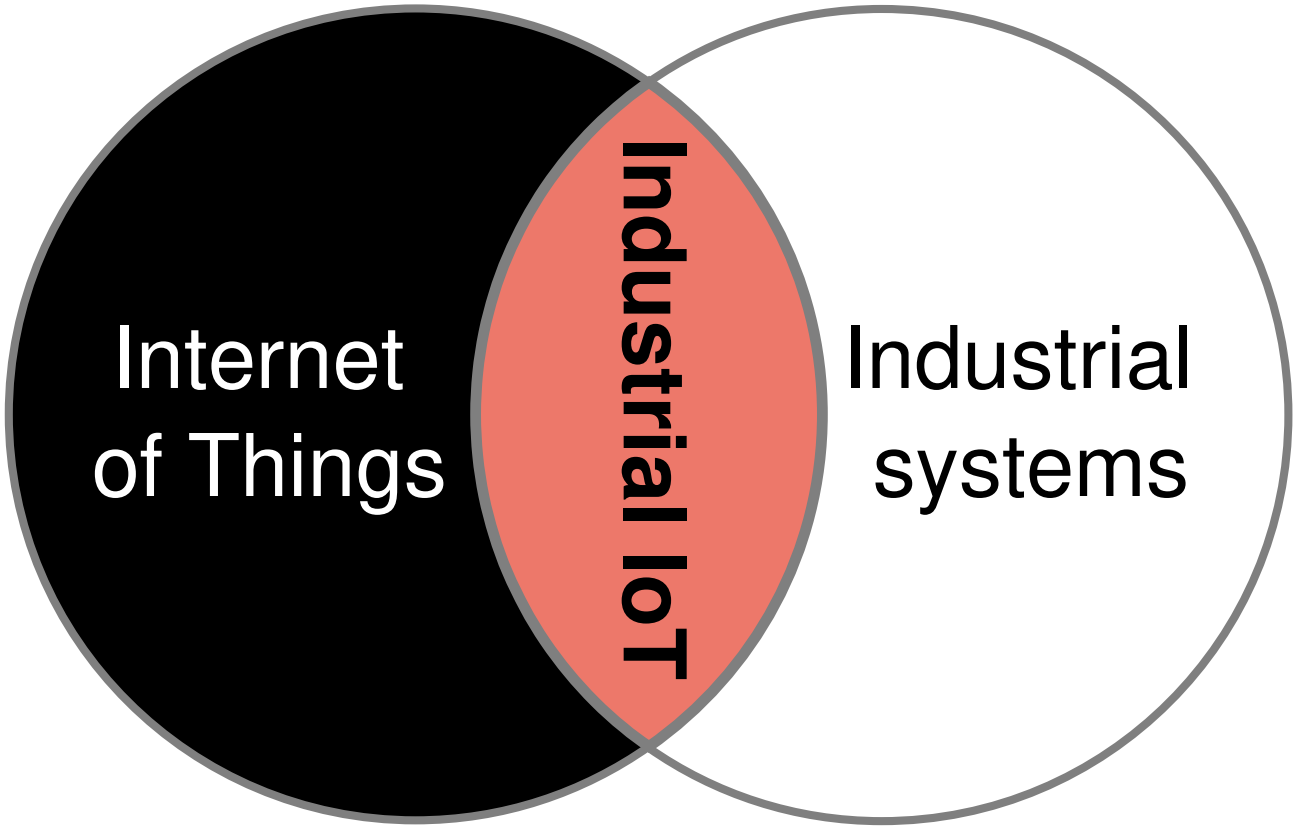
Industrial IoT



Industrial IoT

The adoption of IIoT has lagged compared to the adoption of consumer-oriented IoT gadgets.

IIoT is about distributed systems...

An industrial IoT system is a collection of largely independent interconnected computing elements that monitor or control some physical resources in a way that appears to the users of the system as an operation of a single facility realizing a certain business process.

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… but peculiar ones

Tight coupling between IIoT systems and the physical objects they monitor and control.

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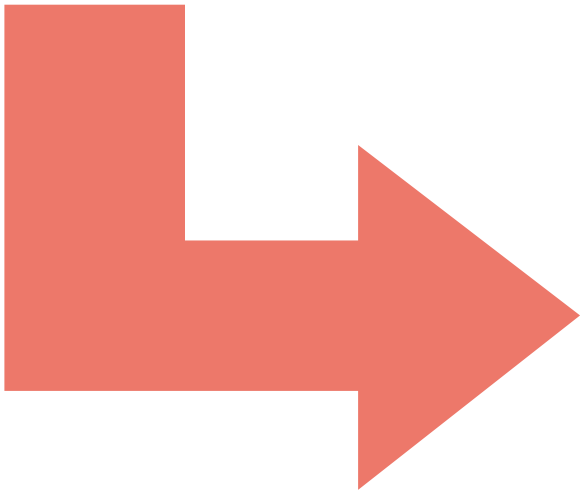
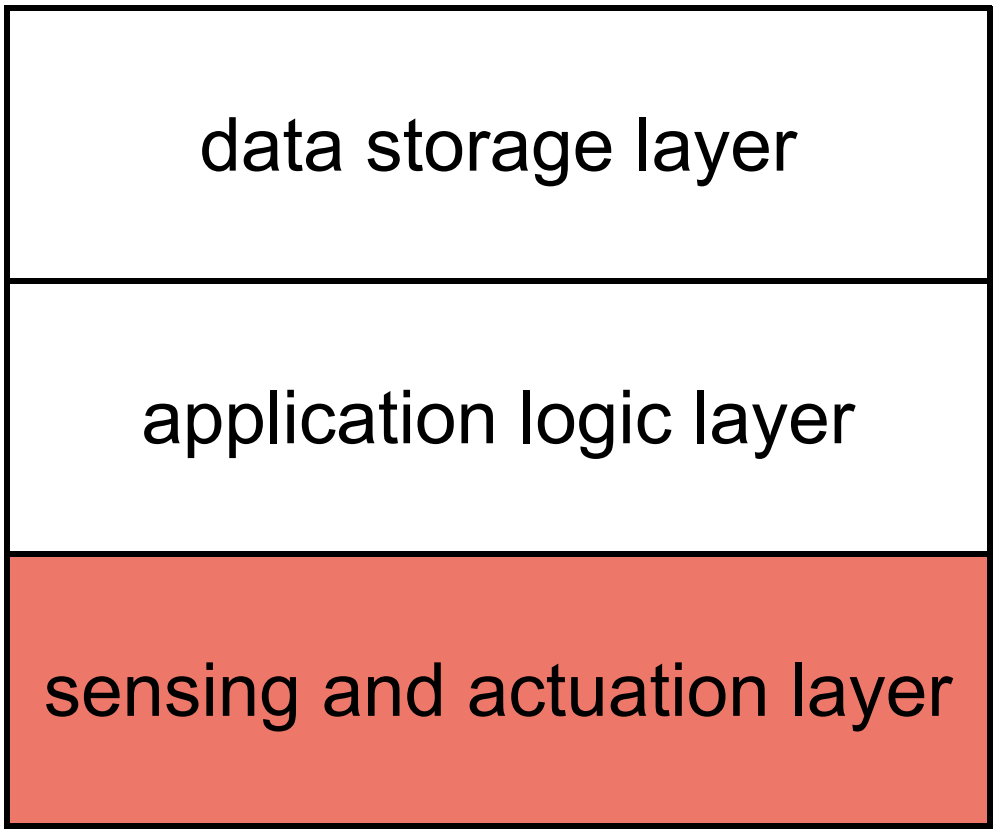
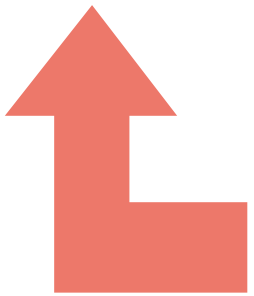
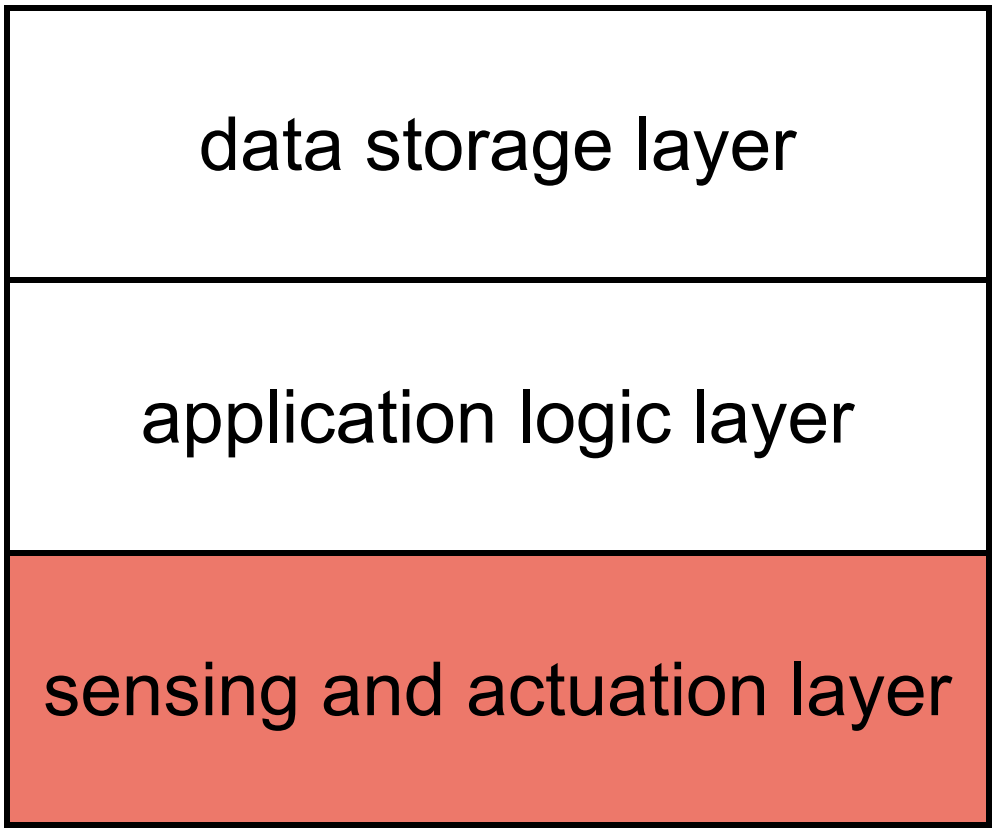




… but peculiar ones

- Highly constrained resources and heterogeneity.
- Fixed physical placement.
- Operating conditions different from “sterile” data centers.





Interoperability

- IIoT systems aim to transform business processes but:
  - Existing infrastructure is hardly ever entirely replaced.
  - Various IIoT solutions are heterogeneous.

Interoperability

with legacy systems

with other IIoT solutions

Interoperability

- Solution: standardization
  - necessary in many cases...
  - ...but does not address all issues (e.g., legacy components).
- Possible complementary solution: middleware
  - leverage the experience from enterprise application integration.

Scalability

- IIoT systems are often deployed incrementally:
  - small tests
  - gradual rollout

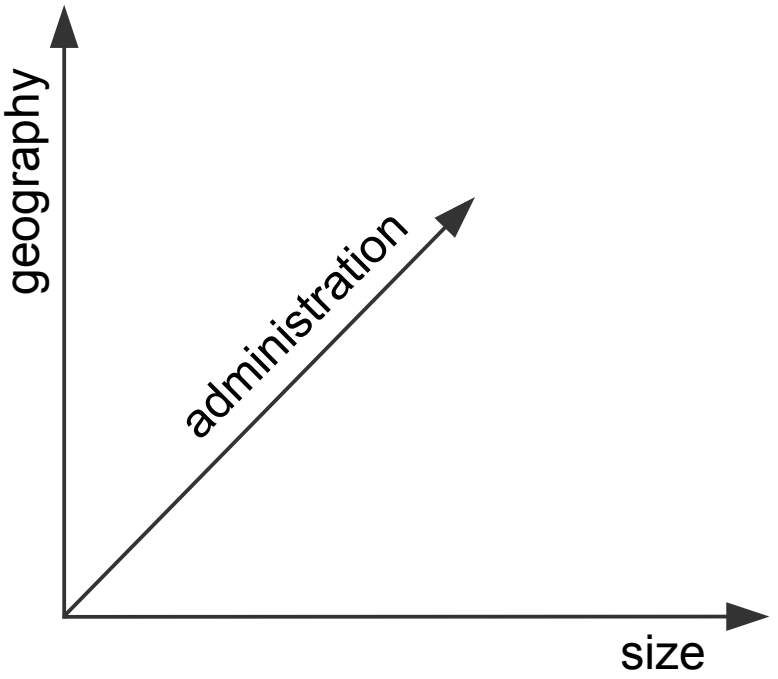
Pros:

- Minimal disruption to business processes
- Smaller risk of calamities

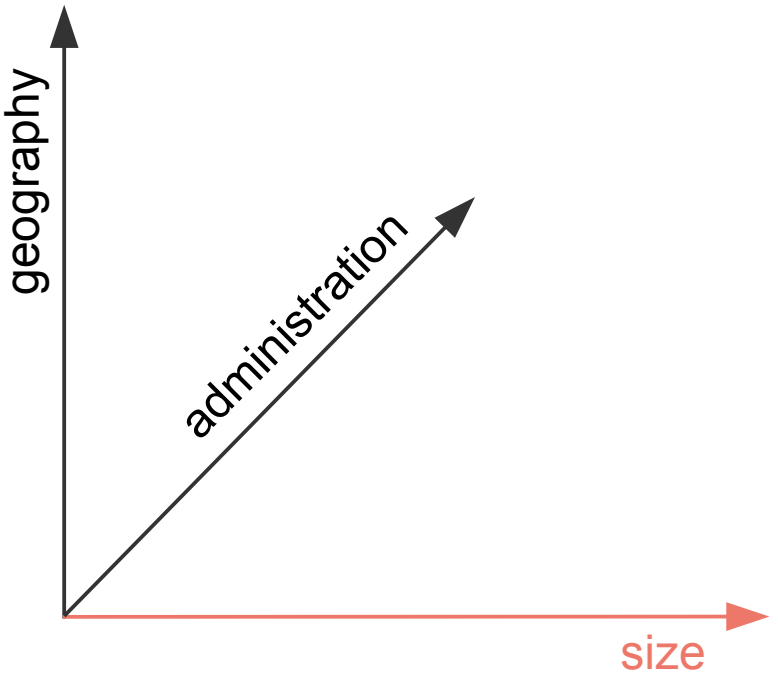
Cons:

- A system has to tolerate a growth of a few orders of magnitude.
- Initial overprovisioning may not be an option.

Scalability

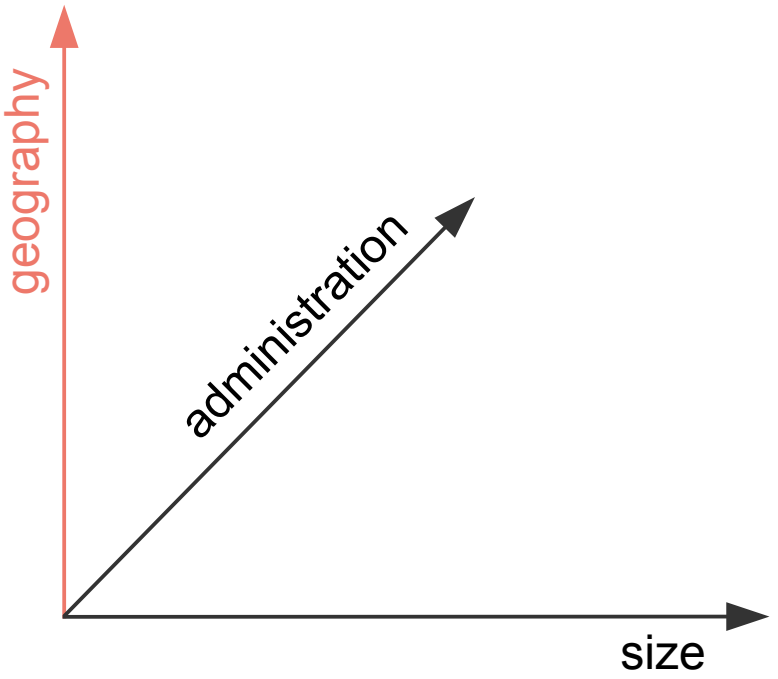


Scalability



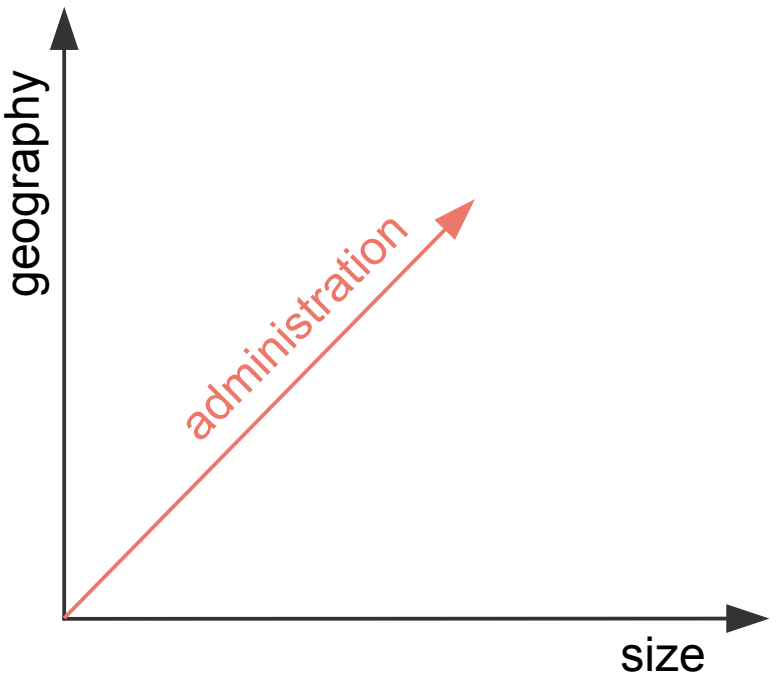
- provisioning more resources often infeasible
- replication and load balancing of limited use
- software architecture usually tightly coupled with system architecture

Scalability



- energy-latency trade-off
- traffic depends on exact placement of sensing and actuation points

Scalability



- sharing physical spaces => conflicts, e.g.:
  - wireless medium
  - sensing and actuation points

Dependability

IIoT must be dependable.

Dependability

- reliability
- safety
- availability
- maintainability
- security

Concluding remarks

- From a distributed systems perspective, IIoT poses a number of challenges, notably in:
  - interoperability,
  - scalability,
  - dependability.
- However, this requires collaboration with industrial partners.

Thank you

Q&A during the panel.

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Dependability

- reliability
- safety
- availability
- maintainability
- security

- Continuity of correct behavior.
- Maximized by:
  - individual components
  - redundancy

Dependability

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- Something wrong does not lead to a catastrophe.
  - Need not be binary!

Dependability

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- Readiness for usage.
  - Relevance of the CAP theorem.

Dependability

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- Ease of changing a system's configuration.
  - Lot of work done
  - There are still some open problems

Dependability

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- maintainability
- security

- Difficult to attack.
  - The “s” in “IoT” stands for security.
  - In IIoT the situation is somewhat better.