

# The Distributed Car – Motivating a Comprehensive, Service-Oriented Engineering Approach For Cyber-Physical Systems

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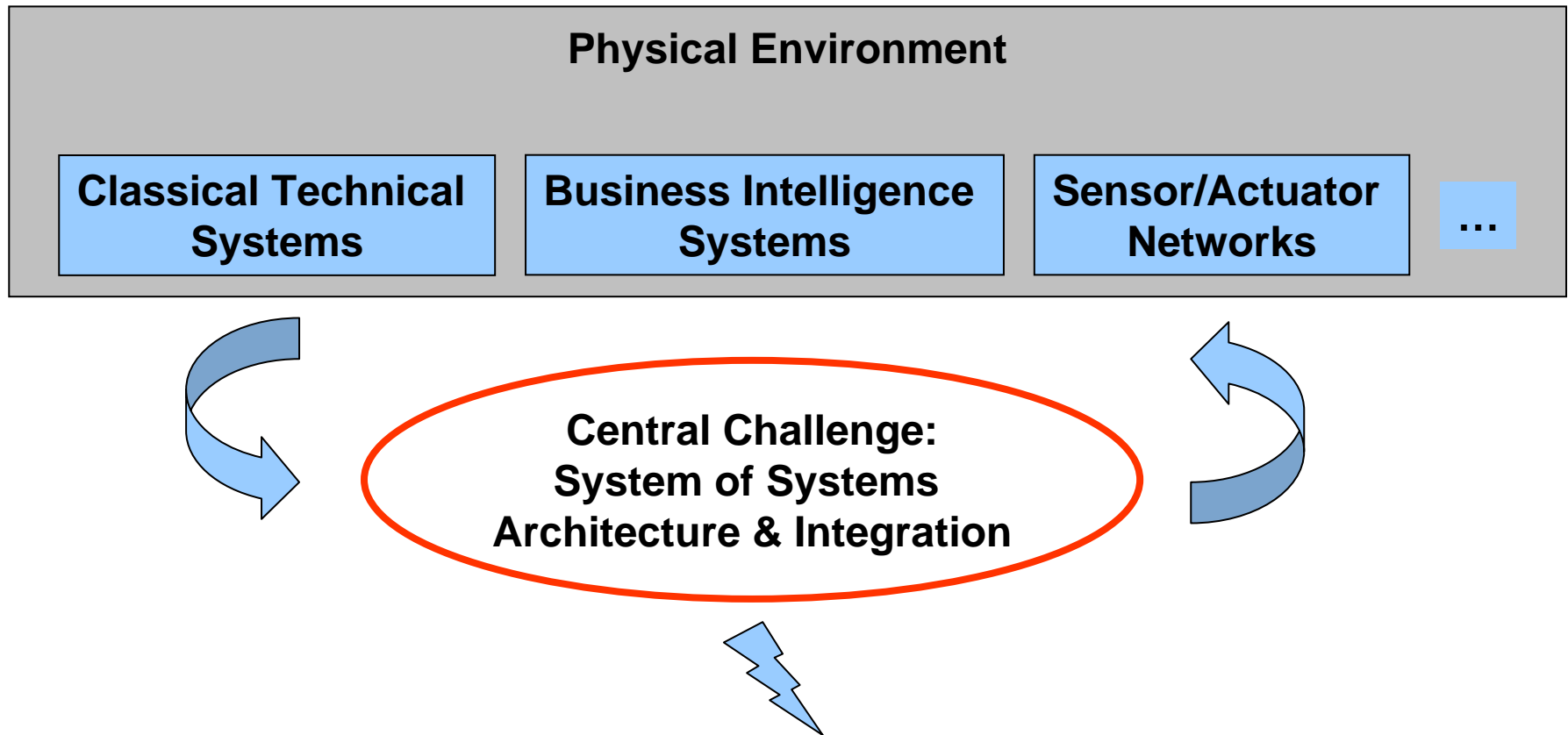
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# Cyber-Physical Systems (CPS)

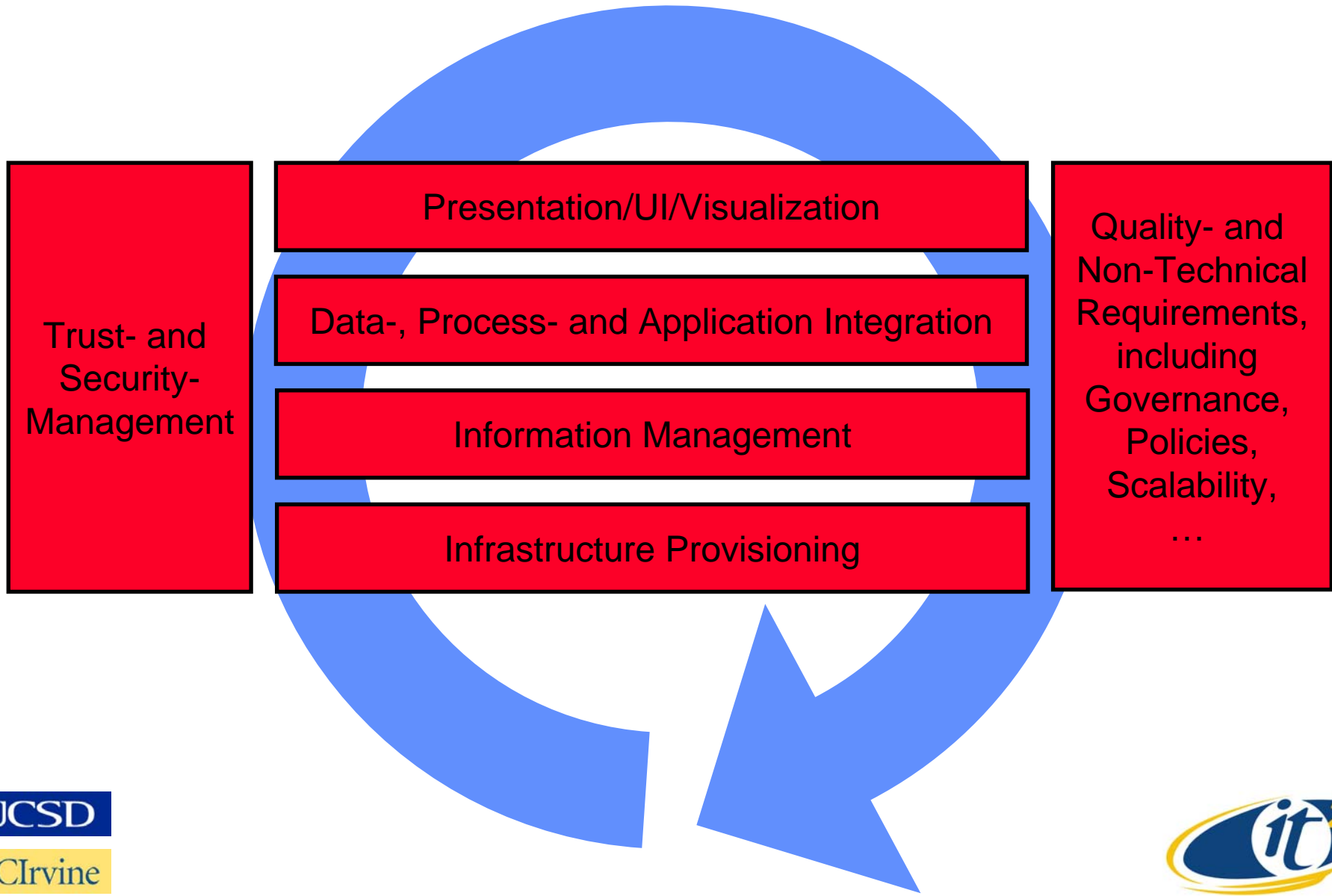
- Change the way we interact with the physical world
- Value proposition shifts from physical/chemical process control to software as enabling technology
- Examples: **automotive**, manufacturing, power-grid, oceanography, command and control, public safety, ...
- Forces:
  - Cost-reduction potentials,
  - Flexibility/agility demands,
  - Time-to-market,
  - Usability,
  - Increasingly challenging requirements at safety, security, trust, governance, policy, and dependability,
  - Environmental concerns, ...

# Challenges for Feature-Rich CPS



Adequate modeling notations, methodologies, and seamless tool-suites for precisely and adequately capturing integration solutions based on **partial** rather than **complete** knowledge, is a critical problem with tremendous impact on quality assurance

# Sample Layout of the Requirements Space



# Research Needs

- Comprehensive approach to management of system complexity at development *and* runtime
- **Service-orientation** has facilitated a paradigm shift in the development of business intelligence systems, **will be key enabler for CPS!**
- Need for an innovative, service-oriented software engineering approach
  - Services as first-class entities across **all** phases (not just deployment!)
  - Focus on interaction patterns as the defining elements of services to yield end-to-end complement to pure component-centricity
  - Disentanglement of *logical* and *deployment* architecture
  - Consequent use of model-driven architecture (MDA)
  - Elicit relevant & effective portions of the domain model as core architectural integration artifacts
- Example challenge area: **failure management**
  - Consider the cross-cutting nature of integrated functionality, failures and failure-mitigation opportunities
  - Rich potentials can be realized via comprehensive, domain-driven development

# Research Directions

- We propose to investigate a **comprehensive engineering approach for cyber-physical systems**, focusing on a **service-oriented integration** approach.
- Vision for an example application area: **Distributed Car**
  - Core idea: “explode” the car’s functionality (physical and software components) as services onto the cyber-infrastructure – to the degree possible
  - Removes the necessity of physical presence during automotive system development & operation
  - Create a geographically distributed collection of automotive systems
  - Establish full integration with other services present on the cyber-infrastructure
  - Engineering *and* societal impact
- **Benefits:**
  - Allows experimentation with model-based, service-oriented development techniques for cyber-physical systems
  - Perfect instrument for researching an ontology for model-based development of fail-safe automotive software systems
  - Touches all the challenge areas introduced above
  - Vast potentials for impact on interdisciplinary research, education and development