Next Generation Internet of Things and Smart Systems

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IDSE : Intelligence-Driven IoT and Smart Systems Research Group

What We Achieved and Looking Forward

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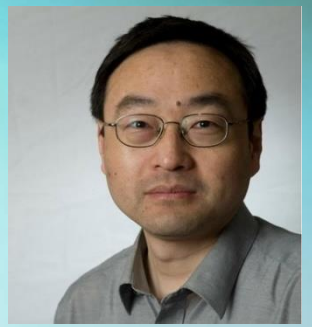


Current Research Focus

- Smart pervasive systems – intelligence-driven IoT based systems and CPS
- Deep learning and knowledge-based systems
- Semantic data modelling
- Microservice-Oriented Architecture
- Cloud-Edge-IoT continuum
- Software evolution

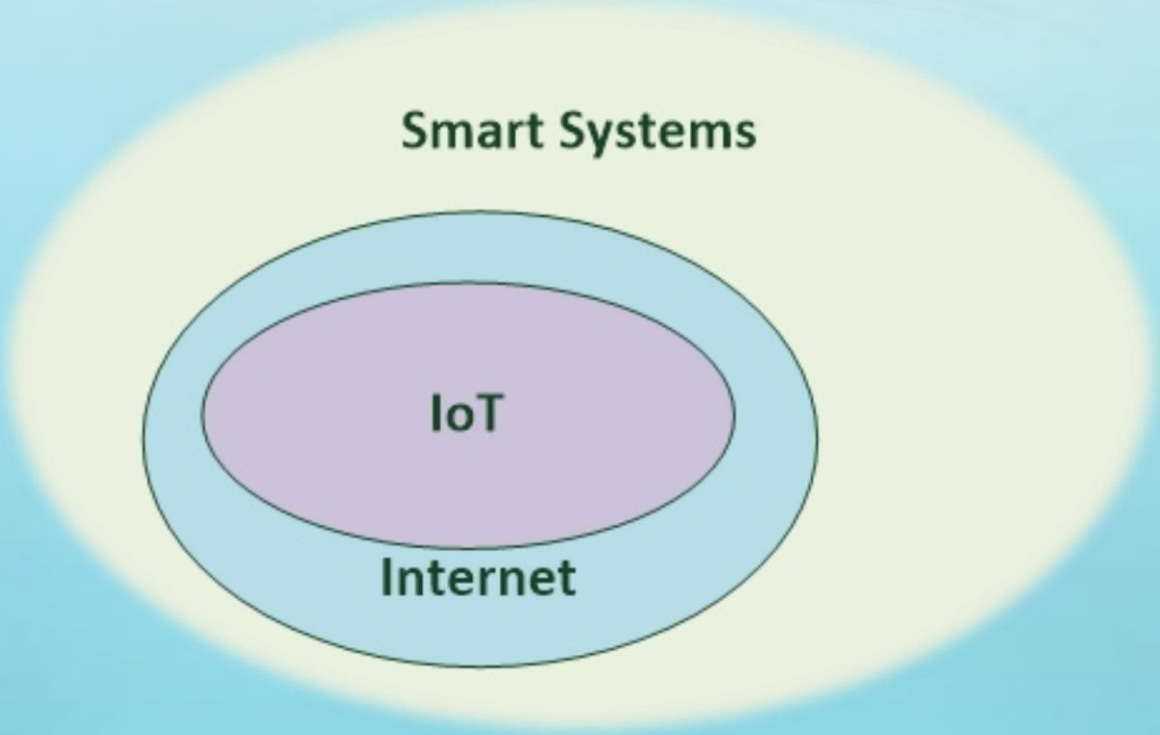
Overall Research Aim

- Focus on the new approaches, models and architectures to improve the engineering of emerging software-driven systems

- Towards a new theme of “Intelligence-Driven Software Engineering”

Internet, IoT and Smart Systems

- Pillars for emerging computing systems
- Any links or overlapping?



NG-IoT Challenge 1: multiple disciplines

- Internet of Things is being revolutionized nowadays.
- Solutions must come from multiple disciplines integrally.
- Non-technically:
  - Psychology
  - Cognition
  - Interaction
- Technically:
  - System architecture
  - System intelligence
  - System communication
  - Security and privacy

NG-IoT Challenge 2: desired features

- Supporting the key values of
  - More human-centric
  - Openness
  - Cooperation across borders
  - Decentralisation
  - Inclusiveness
  - Protection of privacy
  - Autonomous and meanwhile winning user trust
- Provide services which enjoy
  - More transparency
  - More intelligence
  - Greater involvement and participation
  - Leading towards an autonomous Internet that is more open, robust and dependable, more interoperable and more supportive of social innovation

Enabling technologies for NT-IoT

- Must be engaged seamlessly and integrally
- From multiple disciplines
- 5G/6G networks
- Machine learning
- Knowledge engineering
- Dynamically adaptive software architecture such as microservice-oriented architecture
- Cloud, Fog and Edge Computing
- Emerging digital media and interaction
- Blockchains

Software Defined NG-IoT – an inevitable direction

- The complexity and high intelligence of NG-IoT
- Software models and services critically needed in the realisation of the NG-IoT
- Need seamless co-design with emerging hardware and networks

Context-Active Resilience in CPS

Towards a new generation of Cyber Physical Systems

As a theme of Software-Defined Next Generation Internet of Things

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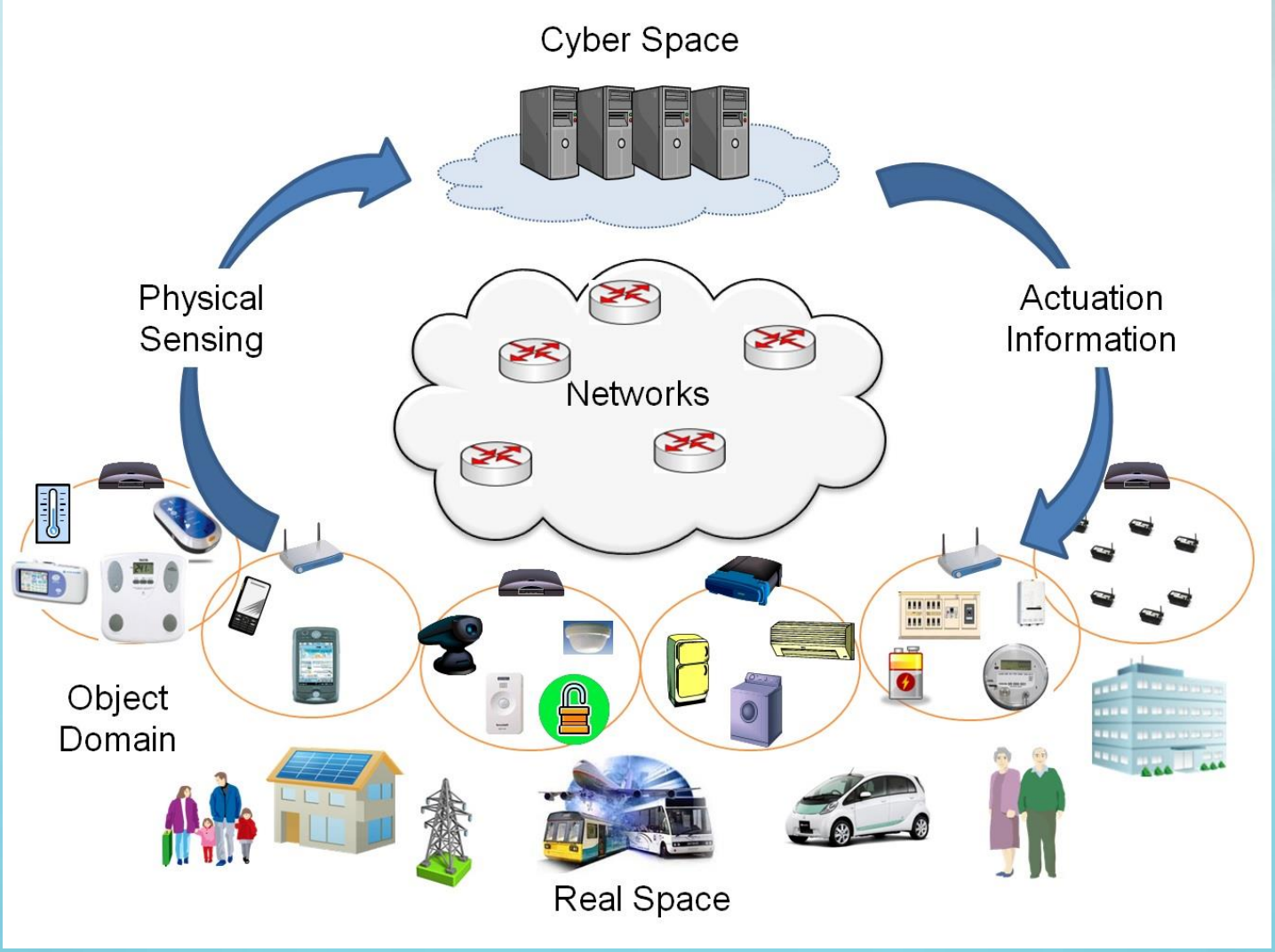
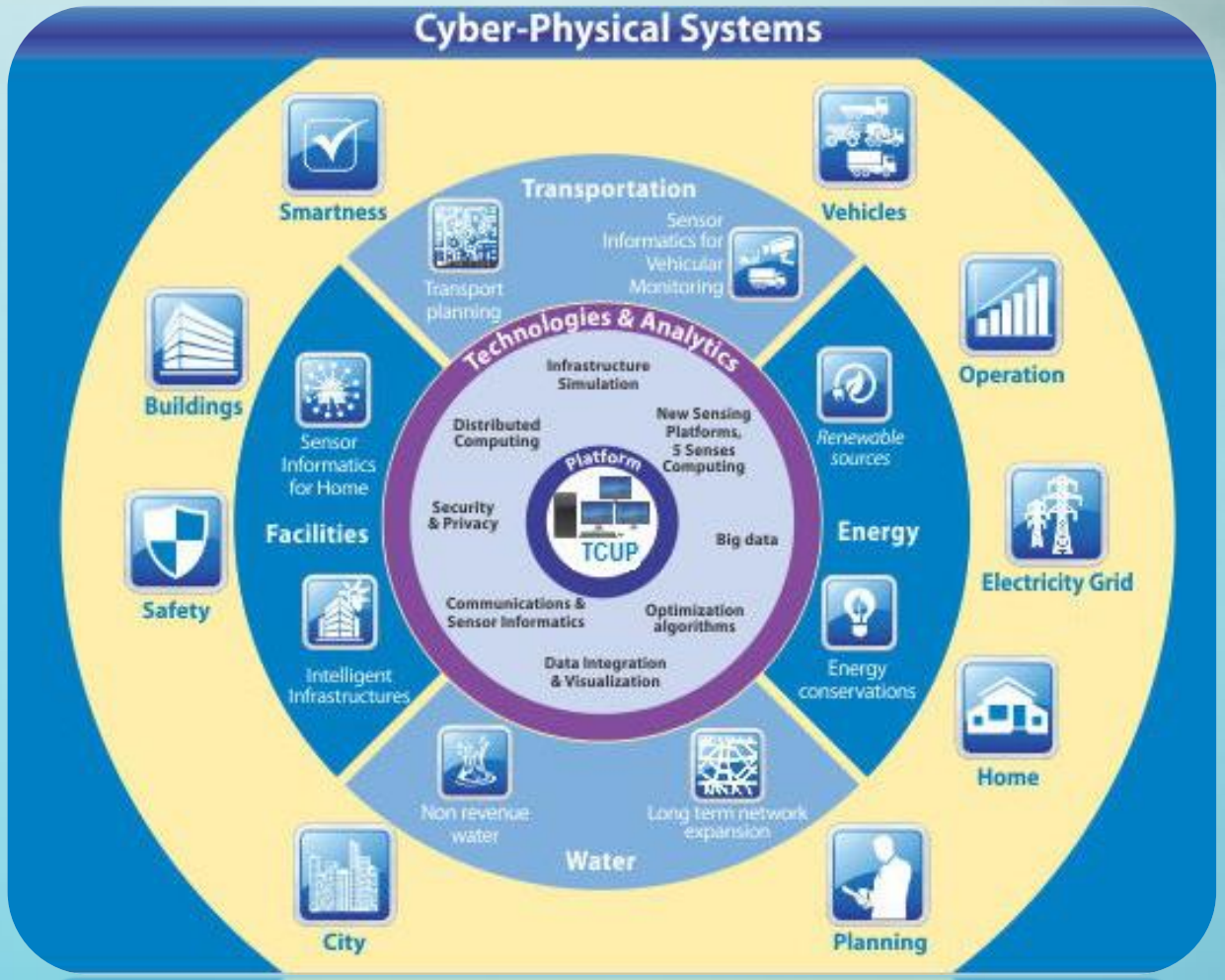
What is a CPS ? (from Sok pa Google)



Typical application areas of CPS

- CPS provide critical services in many emerging application domains such as:
  - Energy supply,
  - Health care
  - Traffic management
  - Manufacture

  Map from Pixel Solution:



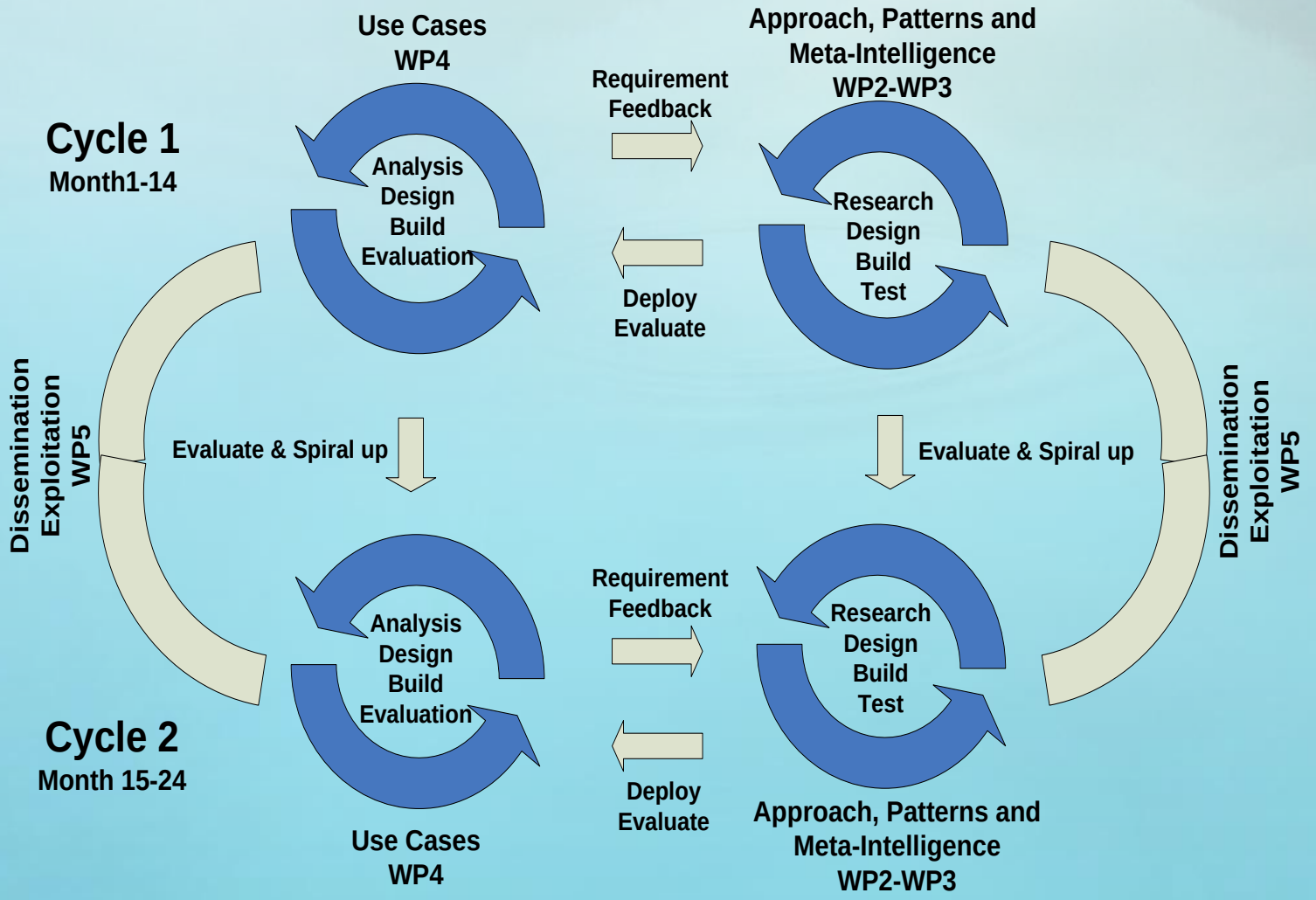
Resilient CPS

- A **resilient CPS system** is one that maintains state awareness and an acceptable level of operational normalcy in response to disturbances, including threats of an unexpected and malicious nature.

Context Active Resilience

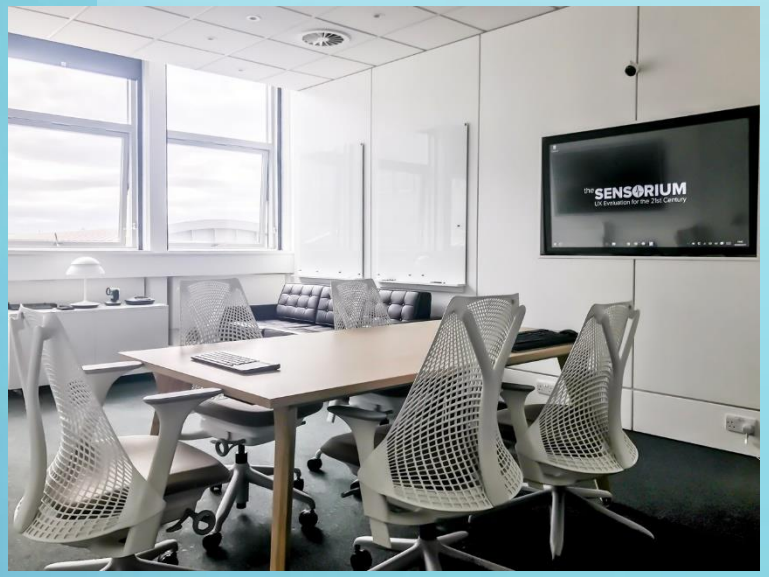
- Although resilience is critically desired in CPS, existing approaches are only able to support limited resilience in a non-dynamic manner
- I.e., fail to consider and respond to a comprehensive profile of the current states and needs of the devices and human users, which are always dynamically changing during the running of a CPS
- We define such a profile as the context of a CPS,
- We advocate that a CPS should adapt itself actively and even proactively for the optimal functions and Quality of Services (QoS) according to this dynamic context.
- This is a new level of resilience, which has not been aimed at by previous work, and we define it as “**Context-Active Resilience (CAR)”.**

The agile spiral methodology



Work Environment

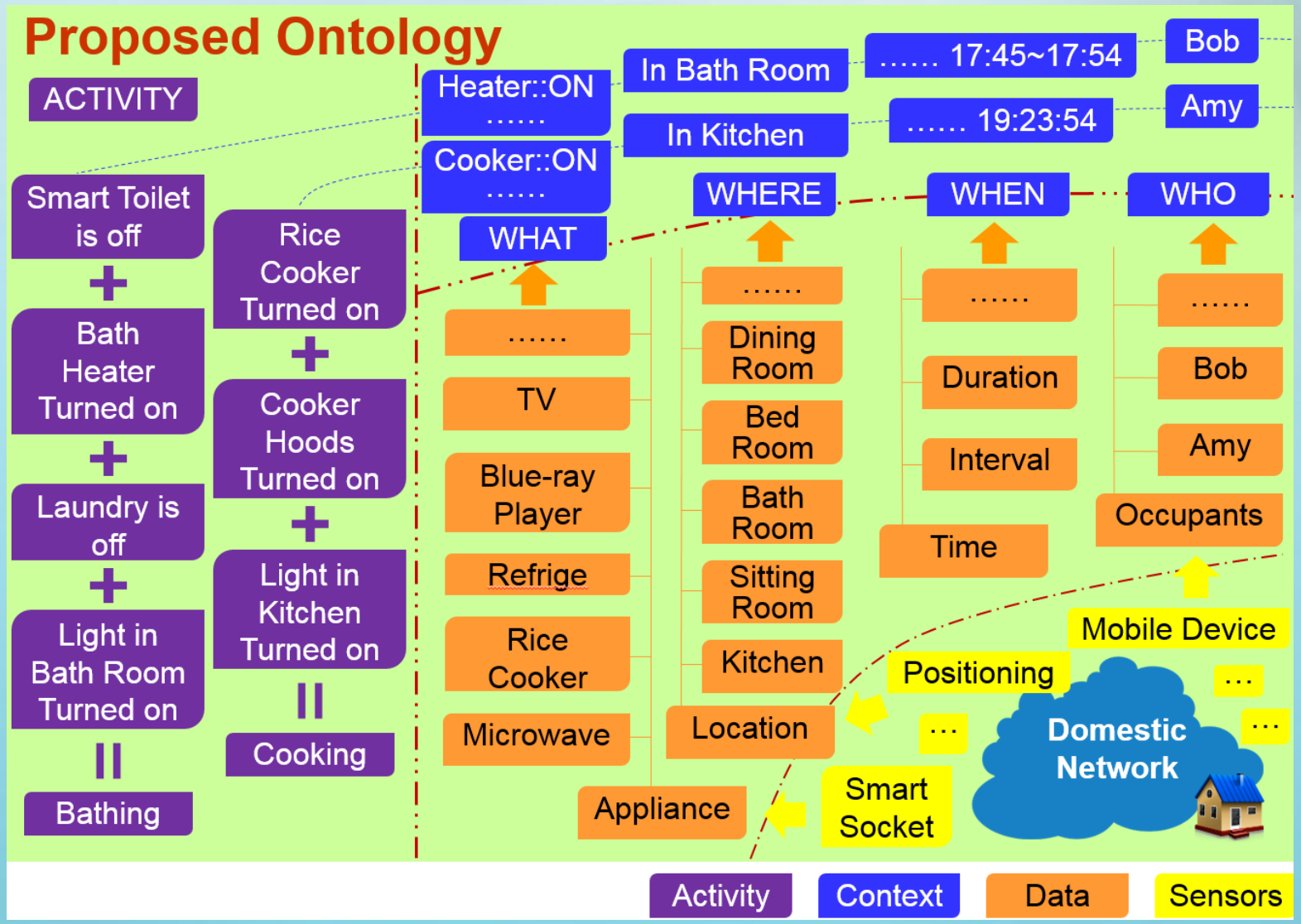
- Lab C78, Merchiston Campus, ENU
  - Sensorium Lab: Smart UX research and evaluation resources of SoC
  - Great environmental framework for possible integration of our work
    - Smart Sensors
    - Concept Models
    - Recognition & Control Algorithms



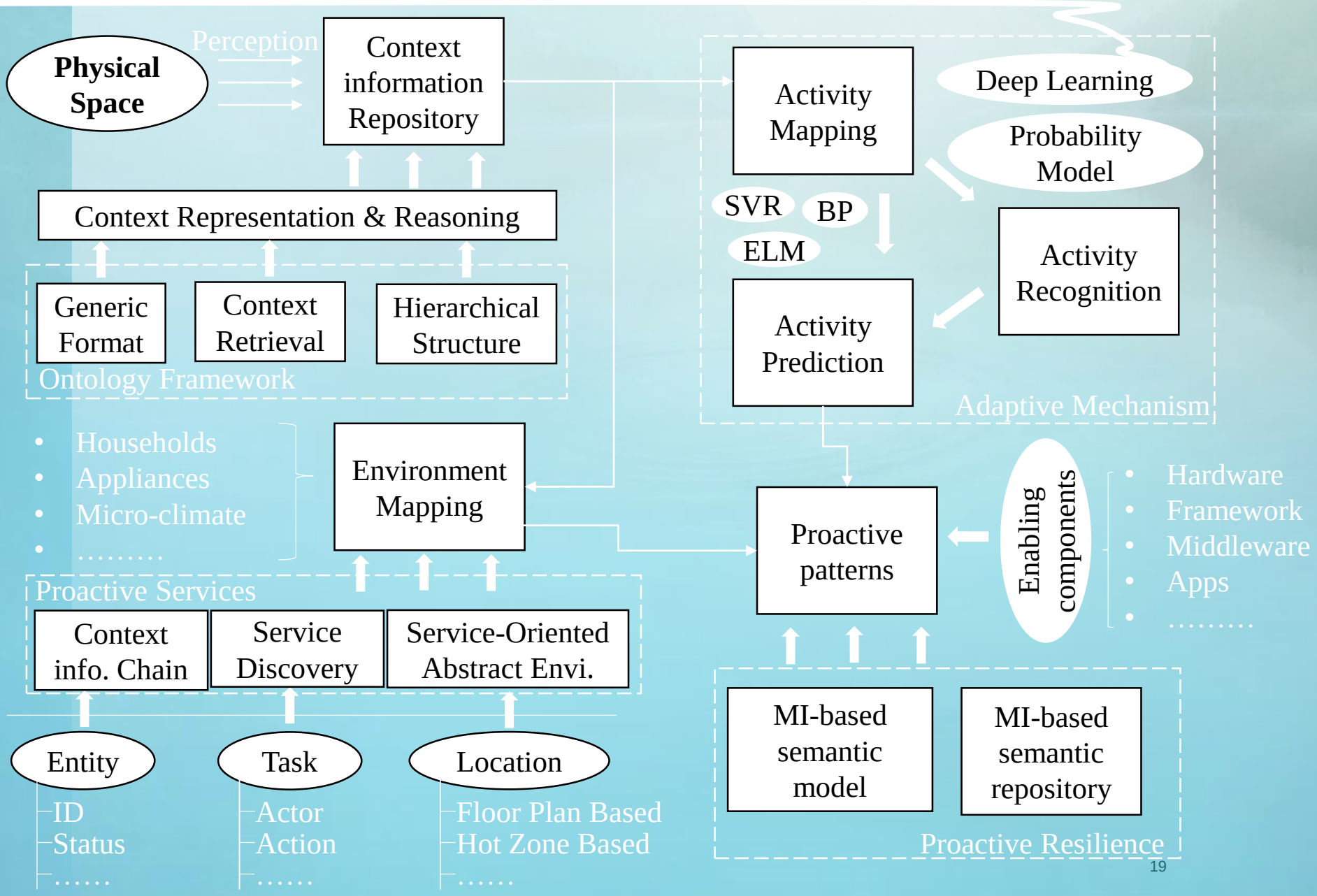
Research Activities in CAR Project

- WP1: Project Management
- WP2: Context-Active Resilience mechanism
- WP3: Context-Active Resilience Patterns
- WP4: Use Case: context-active smart home
- WP5: Dissemination and Exploitation

The Context Ontology



CAR Framework



Impact and Conclusion

- Enhancing the knowledge and skills for researching and developing **a future generation of CPS which enjoys the unique feature of context-active resilience**.
- Due to the wide and critical roles of CPS in industry and society and the novelty of context-active resilience, the project is both timely and significant.
- Acting as a bridge, the project simultaneously advance the theoretic approach and art of practice of this emerging topic, and benefit the society, living, economy and related research communities significantly.

Thank you for your interest

Questions?