

Programming Ubiquitous Things 2024/25 - Spring 2025 - UiO

Fundamental Challenges and Definitions

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Introduction

- Evolution
- Where do we want to go?
- Challenges
- Basic Definitions:
  - Mobile Computing
  - Ubiquitous Computing
  - Pervasive Computing
  - Localized Scalability and Smart Spaces

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Evolution

- Hardware evolution
- Ubiquity of devices
- Ubiquity nightmare
- Invisible computing
- Some examples











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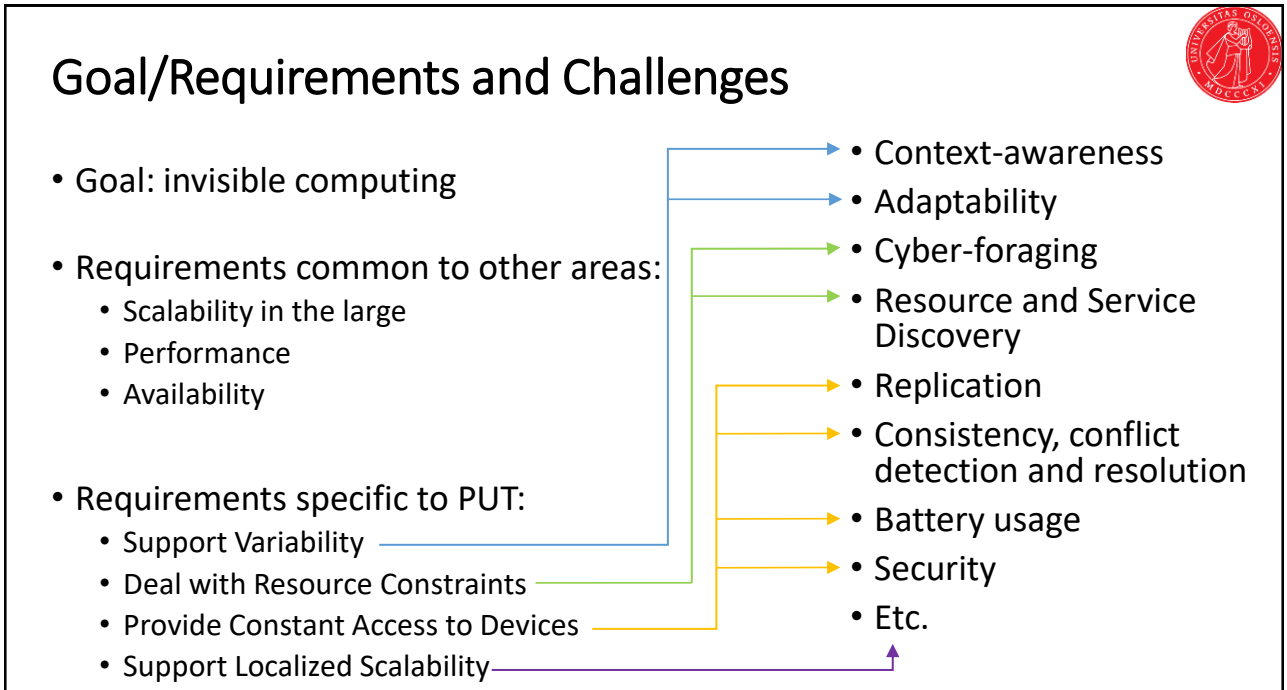
Where do We Want to Go ?

"The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it… Today's multimedia machines makes the computer screen into a demanding focus of attention rather that allowing it to fade into the background."

Vision: invisible computing

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Goal/Requirements and Challenges



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Basic Definitions

- Differences to classical distributed systems
- Fundamental concepts

- Mobile computing
- Ubiquitous computing
- Pervasive computing

- Localized scalability
- Smart spaces

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Mobile Computing



- Mobile computing is a computer science and engineering domain that deals with:
  - computing and communication software and hardware aspects
  - related to the use of mobile devices (e.g., smartphones, tablets, laptops, etc.)
- This domain includes several areas:
  - we are concerned with software (hardware is out of the scope)
- Thus, in the scope of this course, we refer to mobile computing to:
  - designate all system-level software issues related to the architectural design of solutions, including applications, middleware and operating systems,
  - which allow a mobile device to run mobile applications efficiently, while being scalable and secure

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Ubiquitous Computing



- Sometimes also designated as pervasive computing:
  - in this course we differentiate both
- Hardware evolution has made possible the development of a large number of devices with a large variety in sizes, characteristics, processing power, etc. (e.g. tablets, laptops, smart-watches, etc.):
  - thus, contributing to the ubiquity of computing and communication devices in our current and future world
- Specifically, ubiquitous computing is a computer science and engineering domain that deals with:
  - all computing and communication software and hardware aspects
  - related to the use of ubiquitous devices
- Given that most of such ubiquitous devices are mobile, it is clear that there is an overlap between these two fundamental concepts, but:
  - in some cases, we may be in presence of an ubiquitous system in which the devices are not mobile
  - thus, we can have an ubiquitous system that is not mobile and, on the other way around, a mobile system which is not ubiquitous

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Pervasive Computing



- In the literature, normally there is no distinction between ubiquitous and pervasive computing:
  - in this course we differentiate both
- Pervasive computing implies the embedding of computing devices into everyday "stupid" objects:
  - e.g., a smart-mug that changes its color according to the temperature of the liquid it contains
  - e.g., a smart-chair that senses when someone sits on it
- One could be in a pervasive computing environment which is not ubiquitous:
  - unless, there are several "stupid" objects, with increased embedded computing capabilities, all over

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Mobile, Ubiquitous, and Pervasive Computing



- The concepts underlying mobile, ubiquitous and pervasive computing are mostly related to the properties of:
  - mobility (i.e., devices can be easily moved from one place to another by the user),
  - ubiquity (i.e., devices are everywhere), and
  - pervasiveness (i.e., "stupid" everyday objects with embedded computing devices), respectively
- The most interesting scenarios are those in which all these properties exist
- The challenges being addressed, previously mentioned, apply to all such cases as they all share a common view:
  - "information at your fingertips anywhere, anytime"

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Localized Scalability and Smart Spaces



- It is the equivalent to the concept of scalability when applied to classic distributed systems:
  - the difference is that we are concerned with the large number of devices that may co-exist in a small space (e.g., in a room)
- Localized scalability means that a system must scale in the local space:
  - i.e., it must be able to handle a growing amount of devices and the resulting interaction
- Such a room is also called a smart-space:
  - its “smartness” results from the existence of a large number of computing devices that, while being invisible, perform the work needed

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Conclusion



- We have seen:
  - Differences to classical distributed systems
  - Fundamental concepts:
    - Mobile computing
    - Ubiquitous computing
    - Pervasive computing
  - Localized scalability
  - Smart spaces

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