

Ubiquitous Computing (CS60055)

Introduction

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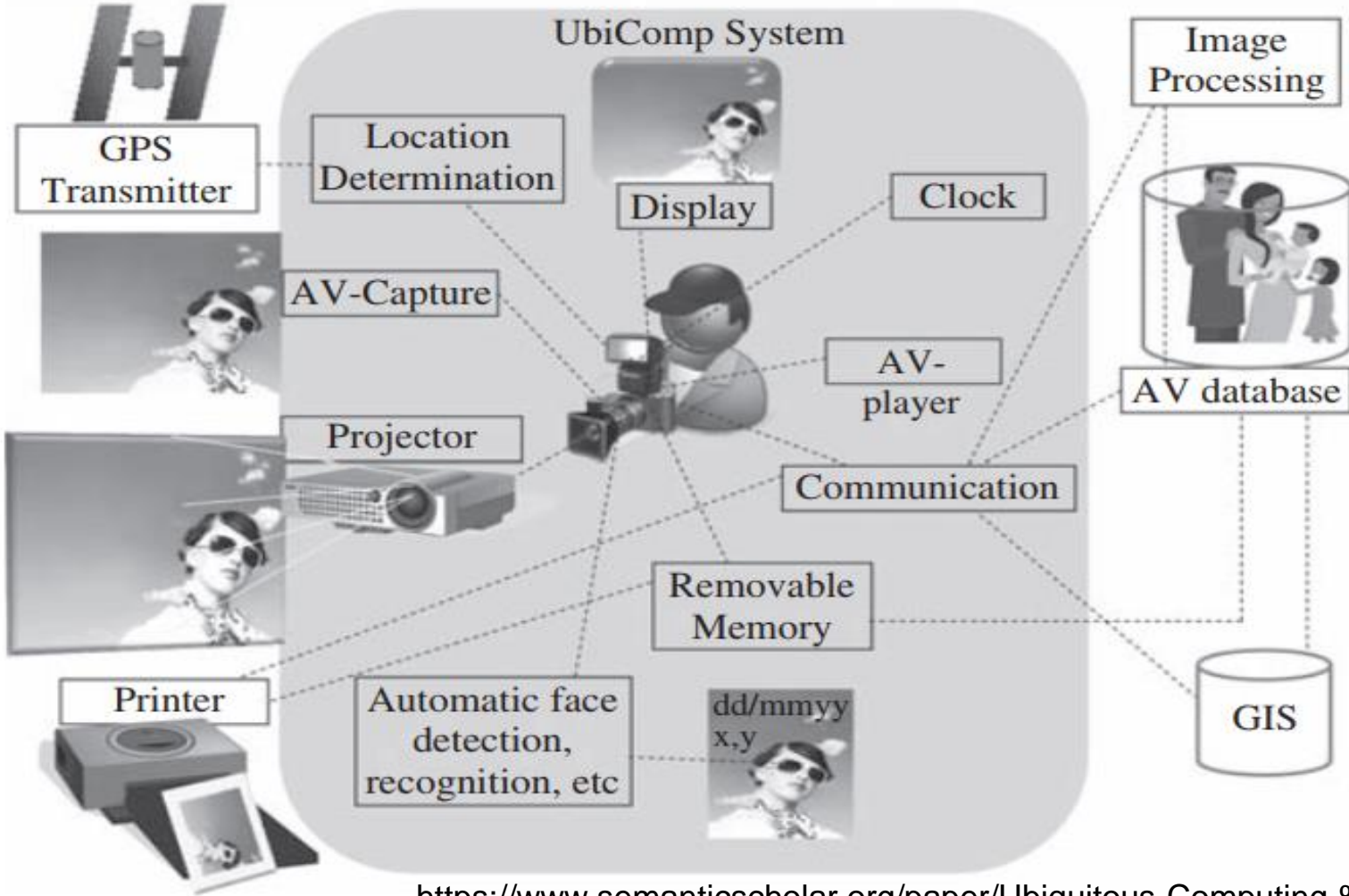


Ubiquitous Computing

- ❑ Ubiquitous computing is the method of enhancing computer use by making many computers available throughout the physical environment, but making them effectively invisible to the user.
– **Mark Weiser** (*Father of Ubicomp*)

- ❑ Ubiquitous computing, or calm technology, is a paradigm shift where technology becomes virtually invisible in our lives.
- **Marcia Riley** (*Georgia Institute of Technology, Atlanta.*)

Cont...



<https://www.semanticscholar.org/paper/Ubiquitous-Computing-%3A-Basics-and-Vision-1-.-1-in-a/8ddeadc4c0b40fc1f43ce5e44a49cb79d29cd2c?hcb=1>

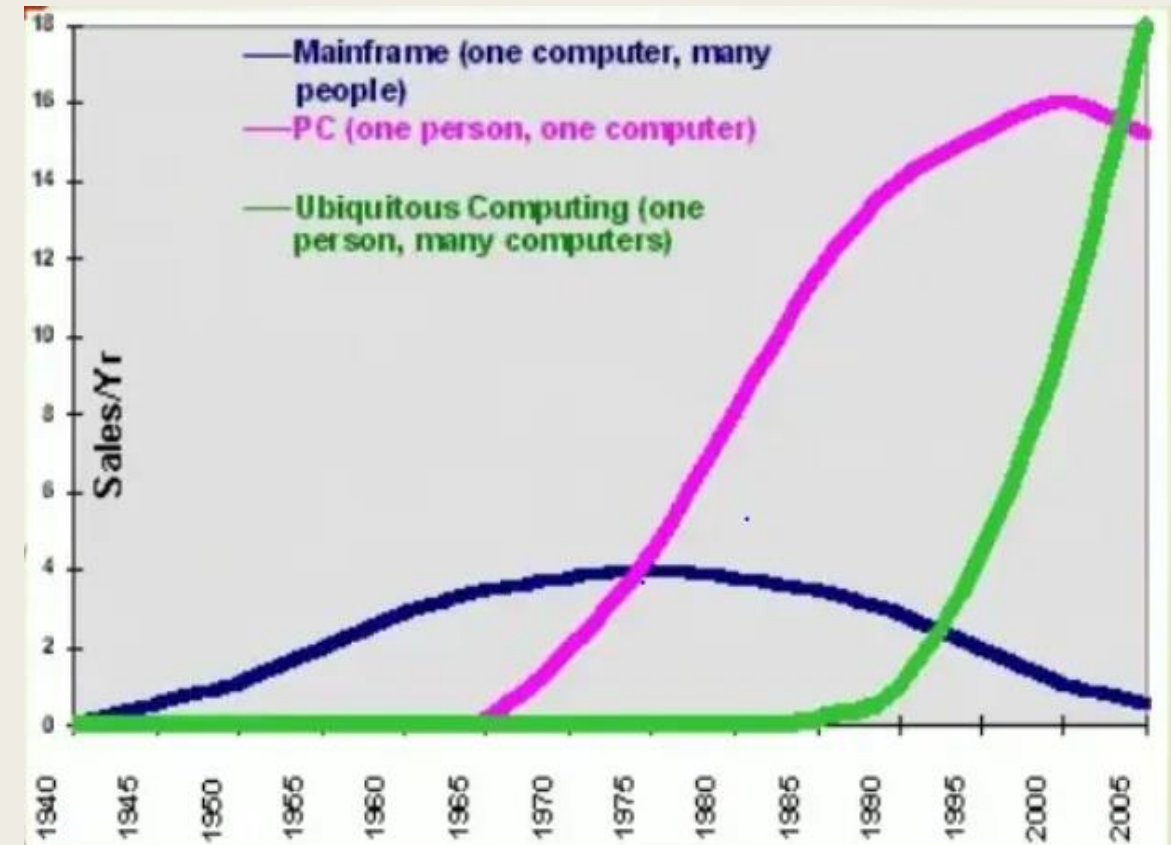


Three Waves of Computing

- ❑ **Mainframe computing era**
 - massive computers to execute big data processing applications.
 - very few computers in the world.
- ❑ **Desktop computing era**
 - one computer at every desk to help in business related activities.
 - computers connected in intranets to a massive global network (internet), all wired.

Cont...

- Ubiquitous computing era
 - tens/hundreds of computing devices in every room/person, becoming “invisible” and part of the environment.



https://www.researchgate.net/figure/The-major-trends-of-ubiquitous-computing-since-introduced-by-Mark-Weiser-1988-until_fig1_224078082

Key Elements of Ubiquitous Computing



- ❑ **Processing**
cheaper, faster, smaller, more energy efficient
- ❑ **Storage**
Big, fast and small in size.
- ❑ **Networking**
global, local, ad-hoc, low-power, high bandwidth, low latencies
- ❑ **Sensors**
- ❑ **Displays**



Properties of Ubiquitous Computing

- ❑ Computers need to be **networked, distributed and transparently accessible.**
- ❑ Human computer interaction needs to be **hidden more.**
- ❑ Computers need to be **context aware** in order to optimize their operation in their environment.



Cont...

- ❑ Computers can operate **autonomously**, without human intervention, be self governed, in contrast to pure human computer interaction.
- ❑ Computers can handle a multiplicity of dynamic actions and interactions, governed by **intelligent decision making and intelligent organizational interaction**.



Myths About Ubiquitous Computing

- ❑ There is a **single definition** which accurately characterizes ubiquitous computing.
- ❑ The ideal type of ubiquitous computing is where **all the properties of ubiquitous must be fully supported**.
- ❑ Ubiquitous computing means **making computing services accessible everywhere**.
- ❑ Ubiquitous computing is **boundless computing**.
- ❑ Ubiquitous computing is just about **Human Computer Interaction (HCI)**.



Cont...

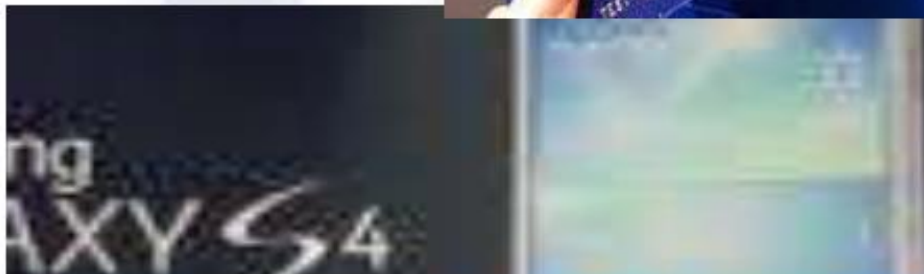
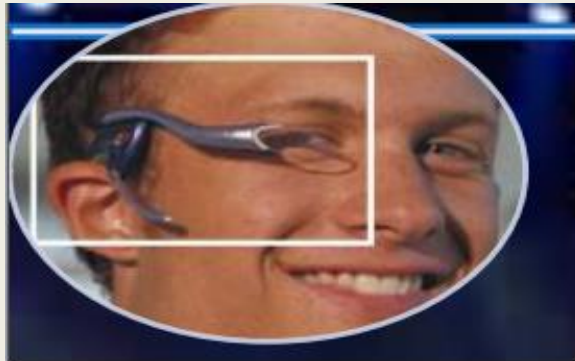
- ❑ Ubiquitous computing is just about **augmenting reality**.
- ❑ Ubiquitous computing is just about **smart environments**.
- ❑ Ubiquitous computing **need to be highly autonomous systems**.
- ❑ Ubiquitous computing is just about **physical world context awareness**.
- ❑ Ubiquitous computing systems can **operate effectively in all kinds of environments**.
- ❑ Ubiquitous computing is just **distributed intelligence**.



Applications

- ❑ **Smarter Phones**
- ❑ **Health care**
- ❑ **Home care (smarter homes)**
- ❑ **Intelligent Transportation Systems**
- ❑ **Natural disaster-specific warning purposes**
- ❑ **Interactive Wallpaper**
- ❑ **Remote Eyes , active badge**
- ❑ **Goggle Glasses**
- ❑ **Ubiquitous City(U-City)**

Examples





Challenges of Ubiquitous Computing

❑ Distributed

- Synchronizing local cached data with remote, possibly centralized data.
- Bigger chance of unauthorized remote access, disclosure, decreased privacy & security.
- Ad hoc interactions can be difficult to control and manage.
- Distribution computation and communication costs outweigh gains.
- Less clearly defined system boundary.



Cont...

❑ Human-Computer Interaction (HCI)

- System takes away control from the user.
- Disruptions can occur from unrecognized and nonsensical sources.
- Ambiguous user intentions lead to incorrect system interpretation.
- Loss of privacy & control because of an increasing indirect tracking capability.
- Loss of presence in physical real world because of continuous virtual interaction.



Cont...

□ Context Aware

- No omnipresence
- Uneven or patchy sensed environment events and context
- Incomplete, wrongly inferred, ambiguous, unwanted, context adaptation by system

□ Autonomous

- Unanticipated, undesired and uncontrollable macro level behavior emerges from microlevel interaction.

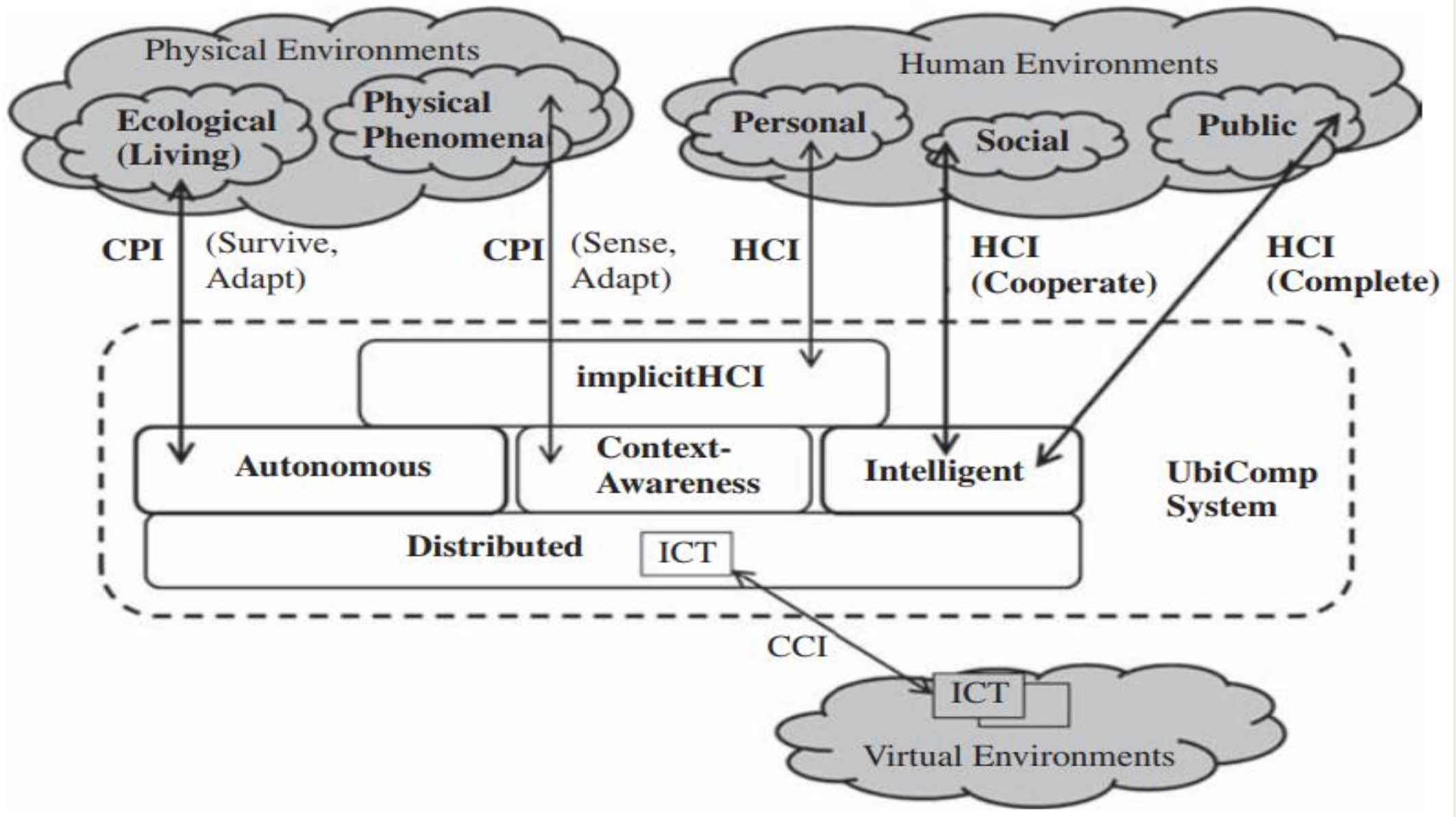


Cont...

❑ Intelligent

- System infers state, knowledge, context, etc. incorrectly.
- Greater reliance and dependencies on systems of systems, interactions to operate.
- Systems learn to operate outside its safe limits or conflicts with user intentions.
- Systems exceed normal human behavior limits, causing physical and mental damage.
- Virtual organization can masquerade as real organizations.

Ubiquitous System





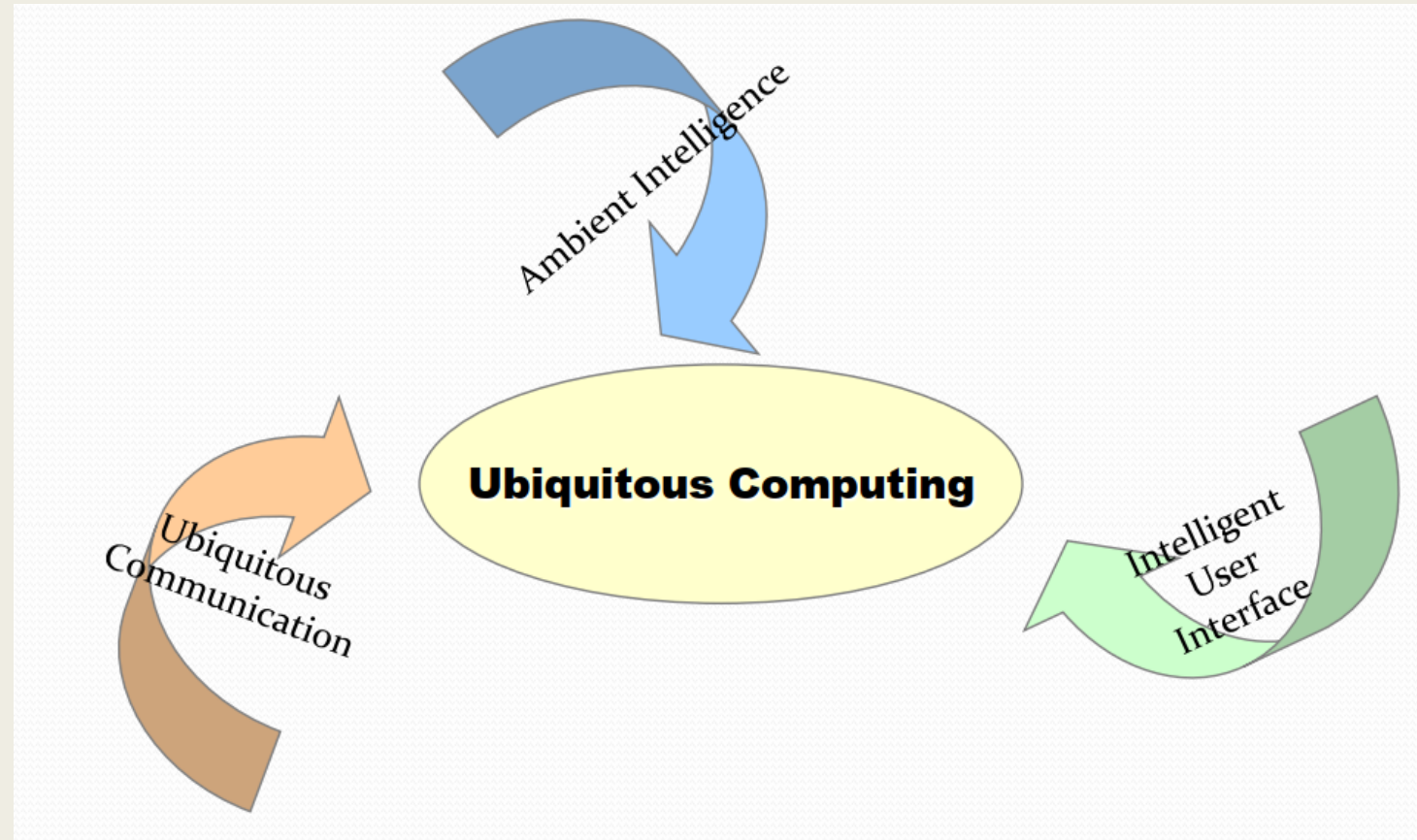
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- ❑ **Physical environment context:** pertaining to some physical world dimension or phenomena such as location, time, temperature, rainfall, light level, etc.
- ❑ **Human context:** interaction is usefully constrained by users: in terms of identity; preferences; task requirements; social context and other activities; user experience and prior knowledge and types of user
- ❑ **ICT context or virtual environment context:** a particular component in a distributed system is aware of the services that are available internally and externally, locally and remotely, in the distributed system.

Different Models of Ubiquitous Computing



- Smart Terminal
- Smart Infrastructure
- Smart Interaction



Device Trends

Increasing capability to manufacture low power, micro, more complex devices

Use more complex, multi-functional, mobile, personalised (& private) **smart devices** to ease access to & embody services rather than just to virtualise them
e.g., phone is also a camera, music player, is also a printer??

Increasing capability to embed devices in the physical environment

Use **smarter environments** to sense and react to events such as people, with mobile devices, entering & leaving controlled spaces
e.g., walls can sense camera is recording and modify lighting to improve recording

Increasing capability for more interoperable distributed mobile devices

Use more service access devices with simpler functions and allow them to interoperate — **smarter interaction** between devices
e.g., camera can interconnect to phone to share recordings, direct to printer to print

Ubiquitous Computing



Thank You!!!