u-Science & u-Engineering for u-Things

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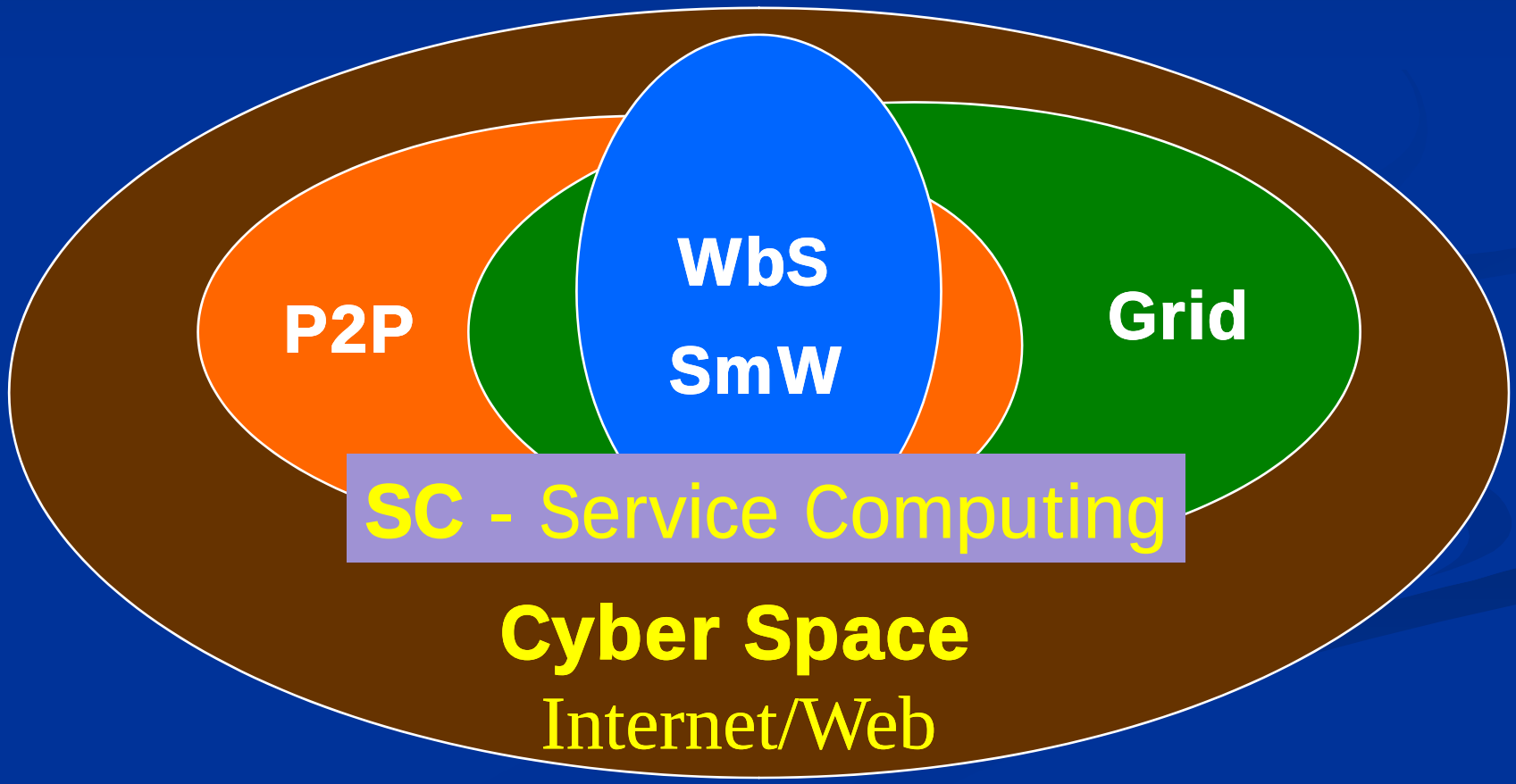
  - Conversion of computing from e-Things to u-Things
- CU2 – Challenge for U-Intelligence
  - Complexity in Smart u-Things and Ubiquitous Intelligence
- CU3 – Conjecture for U-Science
  - Consideration to u-Science and u-Engineering
- CU4 – Cooperation for U-Research
  - Collaboration on u-x exploration and study

Computing on Cyber Space

- Cyber/Web/Internet Computing, Service Computing (SC)
  - Cross/intersection of Web Services, Semantic Web, P2P, Grid, etc.



Computing on Real Space

Weiser's Vision *(1990):*

Ubiquitous Computing *(UC, **Ubicomp**)*

„In the 21st century the technology revolution will move into the everyday, the small and the invisible..."

Mark Weiser (1952 – 1999), XEROX PARC

"Ubiquitous Computing enhances computer use by making computers available throughout the physical environment, while making them effectively invisible to the user"

Industry Vision *(1999, IBM, etc.):*

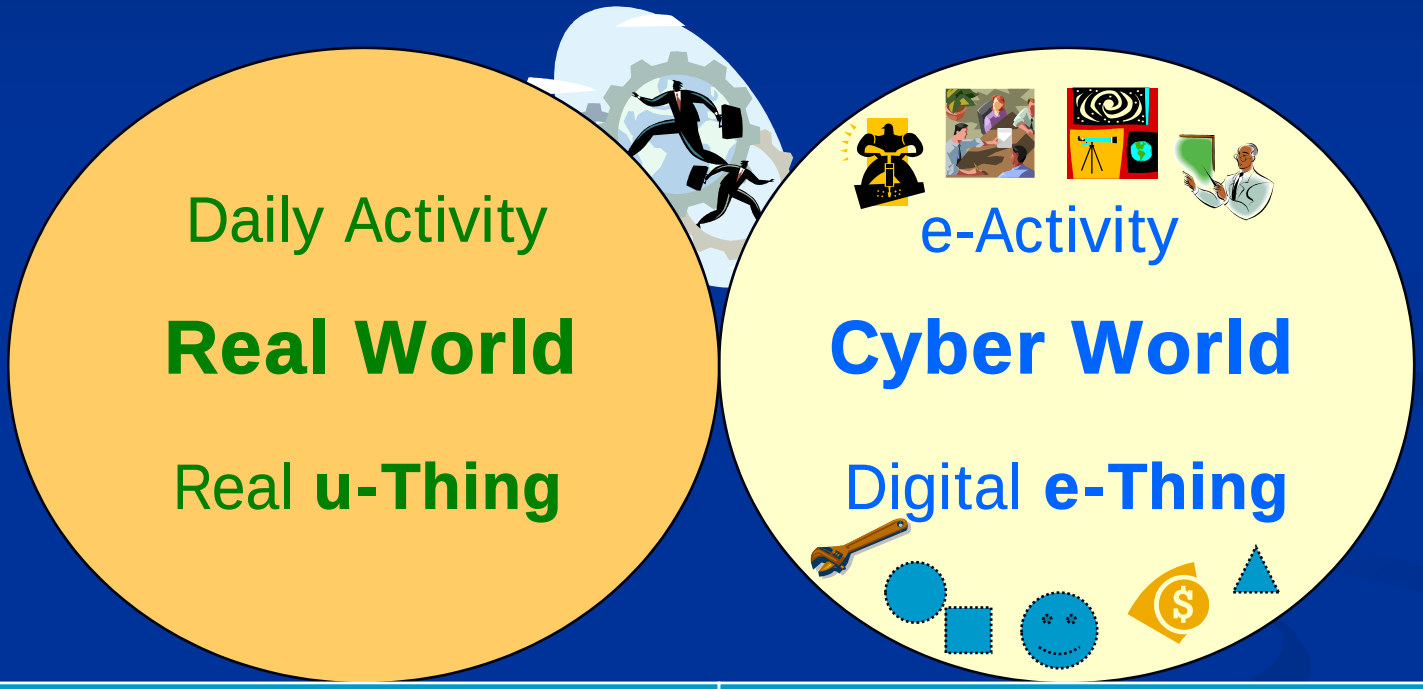
Pervasive Computing *(**Percomp**)*

EU's Vision *(2001):*

Ambient Intelligence *(**AmI**)*

Cyber/Web Computing → e-Things in Cyber World

Ubicomp/Percomp/AmI → u-Things in Real World



UC, ID, Context, Emb. Sys., etc.	Web, WbS, SmW, Grid, P2P, Agent, etc.
Sensor/M/NEMS, Comps & Per. Nets	Computers & Networks/Internet

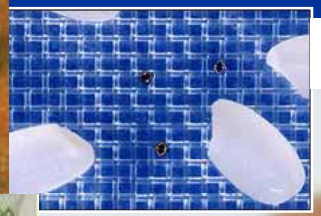
Computing for u-Things

→ **u-Things**: Real things with some kind of **A**ttachment, **E**mbedment, **B**lending

– **AEB** of computers, sensors, tags, networks, and/or other devices

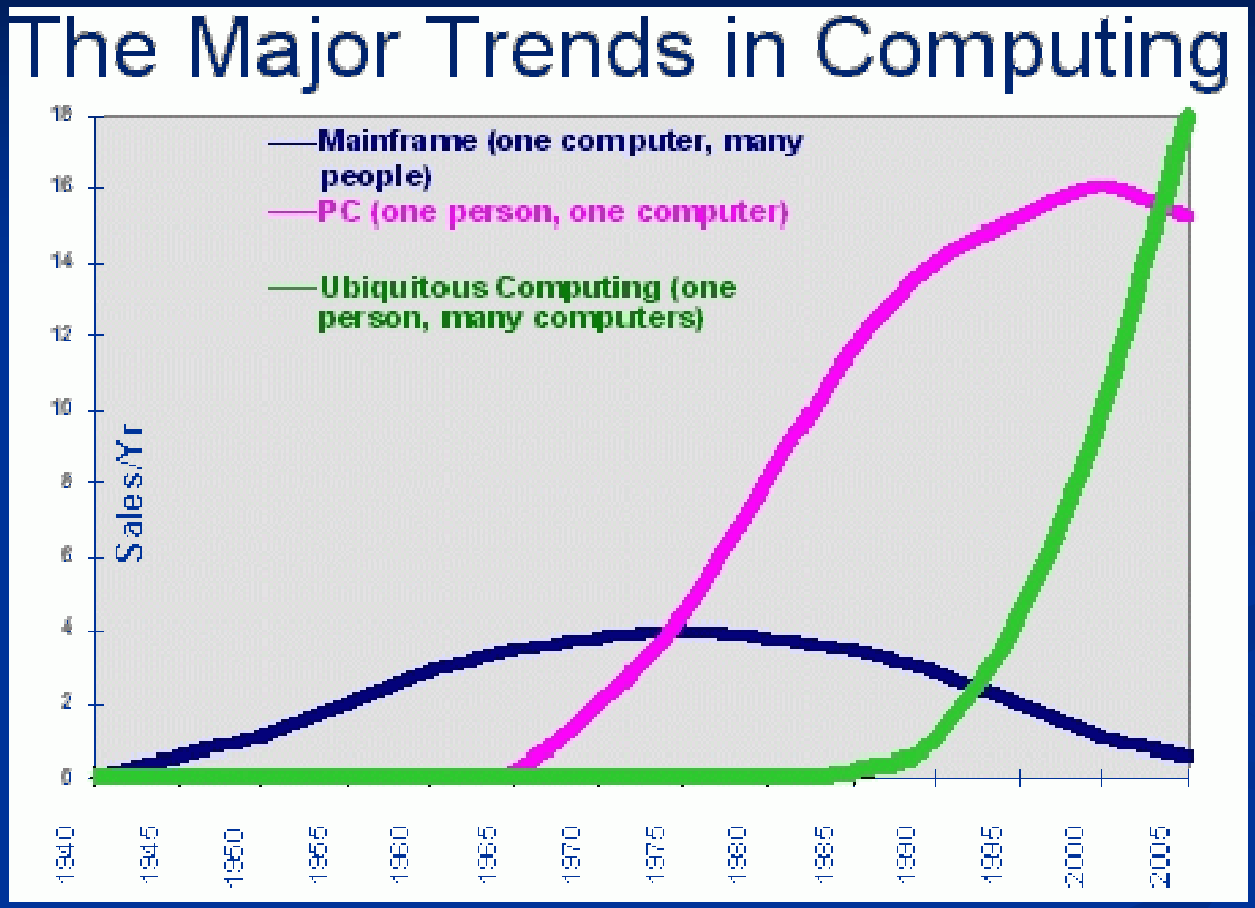
→ u-object, u-space, u-system → u-service, u-application, u-society, u-world

-- In "Smart u-Things and Ubiquitous Intelligence", ICESS2005 Keynote



0.15x0.15 mm, Hitachi/06

Computing: MC → PC → UC (u-Things)



Ubiquitous Computing Grand Challenge: Manifesto, UK, 2006, *EPSRC*, *UK-UbiNet*

e-Booming → u-Booming!! u-Korea, u-Japan, ...

Category of Smart u-Things

- Smart u-Things
  - Smart ←→ Intelligent ←→ Life-like
  - *Sentient, Aware, Context-aware, Active, Reactive, Proactive, Assistive, Adaptive, Automated, Autonomic, Amorphous, Organic, Spray, Perceptual, Cognitive, Thinking, Self-x, …*
- Smart Object (Smart u-Object, Smartifact - *P. Saffo*)
  - A physical object with AEB devices and some smartness/intelligence
  - *Handheld, card, label, sensor, artifact, appliance, goods, furniture, textile, robot, ……*
- Smart Space/Environment (Smart u-Space/u-Environment)
  - A physical spatial environment integrating smart u-objects &/ usual devices
  - Smart u-Services via these objects/devices and their commun./cooperation
- Smart System (Smart u-System)
  - May be a real system/network for management, monitoring, emergence, …
  - May be a platform or middleware for a kind of smart u-objects/environments
  - May be a general one supporting a class of smart u-services/applications

USW-05: 1st Int'l Workshop on Ubiquitous Smart World (Taiwan, March 2005)

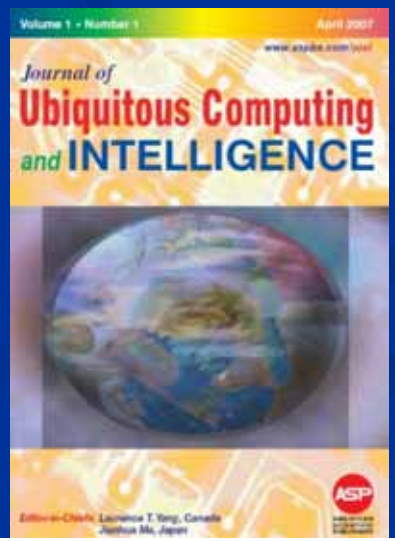
UISW-05: 2nd Int'l Sym. on Ubiquitous Intelligence & Smart World (Japan, Dec. 2005)

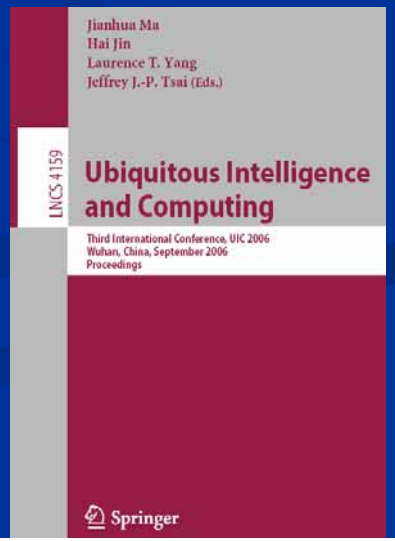
Coming of Ubiquitous Intelligence

- U-Intelligence (UI) or Pervasive Intelligence (π) from 2003, Ma-Yang, etc
- Residing in everyday objects, environments, systems, ourselves, plant, animal, ...
- Pervasive life-like smart real things able to sense, talk, think, act, ...
- *Real Things → u-Things → Smart/Intelligent u-Things → Smart Worlds*

➢ Information Explosion → Intelligence Pervasion !

- The Intelligence Revolution, Interview by Wise Media, ID People Magazine, Apr. 2005
- Ubiquitous Intelligence Summit 2005, A Think Tank, Oulu, Finland, June 15-17, 2005
- Journal of Ubiquitous Computing and Intelligence (EIC, Yang & Ma), American Sci. Pub.
- Int'l Conference on Ubiquitous Computing and Intelligence, (UIC06, UIC07, UIC08)
- Special Issue on u-Intelligence, IEEE Intelligent Computing Magazine (Editing, Yang-Ma)





Challenges for u-Intelligence (UI)

Ultimate Goals of UI

- To make u-Things **calm**, **trustworthy** with **context-/self-awareness**
- To offer u-Services from **ANY** place/time/means to **RIGHT** place/time/means

◆ Towards a Smart World and Ubiquitous Intelligence, JPCC., 1(1) March 2005.

Challenges for u-Intelligence and Smart u-Things

→ Ideal smart u-things are able to act adaptively and automatically according to

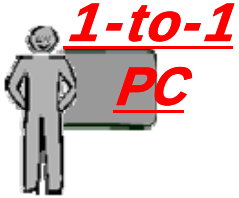
1. Surrounding Situations → Challenge 1: Situation Approximation
2. Users' Needs → Challenge 2: Knowing Users' Needs
3. Things' Relations → Challenge 3: Complex Things' Relations
4. Common Knowledge → Challenge 4: Knowledge Management/Growth
5. Own Goal, Role, Etc. → Challenge 5: Self Awareness
6. Error and Exception → Challenge 6: Looped Self Adjustment

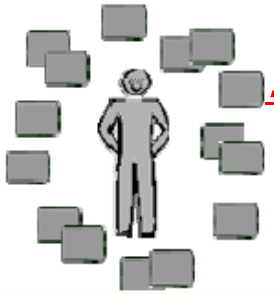
◆ Smart u-Things – Challenging Real World Complexity, IPSJ Symp., Ser.2005, No.19

Characteristics in 3 Computing Waves/Eras

Weiser's 3 Relations 3 Waves

The Place of computer technology in our lives...





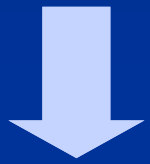
Comp Element	Mainframes	Personal Computers	**u-Things**
Size & Form	Large, Stationary	Small, Desk/Portable	**Unobtrusive, AEB**
User	Few	Many	**Universal**
Main Goal	Computation	Information	**u-Intelligence**
Proc. Content	Data	Media	**Context**
Basic Behavior	Passive	Interactive	**Active/Proactive/Smart Autonomic/Self-*/Life-like**
Theory/Tech	Comp Sci/Eng	Info Sci/Eng	**u-Sci/u-Eng**

Conjecture on u-Science

Conjectures are of great importance since they suggest useful lines of research. - A.M. Turing

Ubiquitous Computing - Ubicomp

→ Many other computing: Pervasive, AmI, embedded, invisible, context-aware, sentient, proactive, autonomic, amorphous, spray, organic, smart world, u-intelligence, ……



u-Things & u-Services

- → Real things with **AEB** computers, RFIDs, sensors, actuators, networks, etc.
- → Extra cyber dimensions newly added in physical/digital combined u-things
- → Smartness/intelligence from simple reactive function to complex life-like behavior

u-Science & u-Engineering

- → Systematic study of the u-things, theory, technologies, implementations, applications, etc.
- → Based on computer and information sciences, crossed with other disciplines: bio., soc., …
- → Coined by Yang-Ma to integrate all u-related computing and push interdisciplinary study

Congress on u-Science

- 2008 IEEE Congress on u-Science (u-Science2008)
  Palermo, Sicily, Italy, Dec. 1-3, 2008

Cooperation on u-*x* Research

- MUSE Lab (**M**ultimedia **U**biquitous **S**mart **E**nvironment)
  → u-Intelligence, Smart Hyperspace, UbicKids
  → Latest work: SS+Robot, Comet FW, Lifelog Analysis, HomeLog, Mob-Server, LocationCr, …
- Cooperation for united research
  - Apduhan (Kyushu Sangyo U), Huang (Hosei U)
  - Shiratori (Tohoku U): **人・社会・環境と情報システムが共生するためのネットワークコンピューティング技術A**
  - Sakurai (Kyushu U) & Yau (Arizona U): Strategic International Cooperative Program
    Information Protection based on Relationships of Trust among Agents in Ubiquitous/Pervasive Comp Environments
  - Namatame (National Defense Academy): **サービスサイエンス**(Service Science)**のためのサービス設計技術**
  - Zhang (Tsinghua U): Transparent Computing and Active Services
- Cooperation on ubisafe
  - Ubisafe coined in the brainstorm meeting, Okinawa, December, 2005
    Chaudhary (Buffalo U), *Zhao* (UoA), *Z. Cheng* (UoA), *J. Cheng* (Saitama U),
    Ibrahim & *Grill* (Johannes Kepler U), *Jin* (Waseda U), *Yang*, *Huang*, *Ma*
  - Ubisafe Computing (vision paper, 2006), UbiSafe-07 (Niagara Falls, 2007)
- Cooperation with union
  - IEEE Task Force on Intelligent Ubiquitous Computing (Duman, Yang, Ma)
  - IEEE Task Force on Autonomic and Trusted Computing (Ma & Yang)
  - Forum on Future Computing, **FFC2007** (Beijing, Zhang, Ma, Pan, Jin, Yang)