Building the Infrastructure for a Harmonious Information Society

Jun Li
Tsinghua University
March 14, 2005
Outline

- Changing Landscape in Computing
- Emerging Opportunities in Industry
- Harmonious Information Society
  - A Smart Classroom Project as Example
- Research at Tsinghua University
Quick Look Back (I)

What has been done?
- A. Turing: Turing Machine
- J. von Neumann: von Neumann machines
- C. Shannon, N. Wiener, L. von Bertalanffy

Machine Computing
- Binary stored data and program
- Processor, memory, and I/O
- Numerical and logical computation
Quick Look Back (II)

- What is being done?
  - Moore’s Law:
    - In 1965, Gordon Moore stated, "The complexity for minimum component costs has increased at a rate of roughly a factor of two per year."
    - Number of transistors on an integrated chip doubles every 18 months.
  - Network Bandwidth
  - Network Efficiency
Quick Look Back (III)

- What has not been done or need to be done?
  - Binary data and Shannon's theory are all about coding, for storage, process and communication
    - How do we handle content?
    - Can or should knowledge be represented this way?

- Machine Intelligence
  - Failure of 5th Gen Computer
  - The old question: “Can machine think?”
Brave Look Forward (I)

- Make Machine Thinking
  - Mimic Human Intelligence
    - Is our way of thinking the only best way?
    - Even people don’t always “think” the same way!
    - In a harmonious society, we don’t all think the same way, we communicate
  - Content-aware
  - Context-aware
Brave Look Forward (II)

- Help People Thinking
  - Extend Human Intelligence
    - Global village
    - Massive/Multimedia data
    - Real-time/Instant communication
  - Yahoo, Google
  - Napster, Skype
Lay Out Nerves

- Nerves form a network of pathways for conducting information throughout the body
- Converging network
  - Date, voice, and video
  - Internet, phone/cellular, and broadcasting
Seamless Mobility

- Why Do We Work Around Computers?
  - They are tethered

- How Can We Have Computers Work Around Us?
  - Make them wireless and embedded: mobile
    - Power
    - Bandwidth
    - Security
    - ...
Smart Environment

- Work environments allowing people to perform tasks efficiently by offering unprecedented levels of access to information and assistance from computers
  - Augmented Reality
  - Natural User Experience
  - Spontaneous Interoperation
  - ...

Augmented Reality
Natural User Experience

Voice Communication via MA

Pen/Touch Interaction

Laser Pointer Interaction

Context-aware Interaction
Spontaneous Interoperation
Smart Space Testbed

Inter-module coordination
Coordination Model, Multi-Agent, Communication Language

Natural Human Computer Interface
Tangible Interfaces, Sensors, Perceptual technology

Eternity & Invisibility
Loose coupling, Embedded technology

Individual Smart Space

Open Smart Space

Smart Community

Cyber Foraging
Environment Discovery, Resource Management
Surrogate, Virtual Service, Proxies,
Hybrid Communication Method Support

Inter-Space Operation

Inter-Space Resource Management

Hierarchy Space Organization
The Smart Classroom Project

An augmented classroom where a teacher can instruct remote and local students at the same time and in a similar fashion.

http://media.cs.tsinghua.edu.cn/~pervasive
Tele-presence

Smart Cameraman

Overview

Writing on the Board

Showing a Model

Interface of Remote Clients

Student Board in the Classroom
Invisibility: Natural UI

- Pen-based writing

- Speech-capable virtual assistant

- Biometrics-based login authentication

The remote student’s image is highlighted as the teacher aims the laser pointer at it.

- Highlight remote student by laser pointer and voice command

A camera for Face-Recognition is installed behind the mirror.

- Virtual Assistant

Your Name, Please.

I am Weikai
Experience Capture

- Auto-record the synchronized multiple data streams
  - Lecture on mediaboard and its presentation progress
  - Writing and pointing on the boards
  - Live audio/video
  - Interaction with remote students

- Post-edit
- Playback
- Post-edit
- Post-edit
- Post-edit
- Post-edit
- Post-edit

- Video record
- Time record
- Event record
- Note record
- Video record
- Note record
- Writing record
- Control panel
Hardware Infrastructure for Smart Classroom
Ubiquitous or Pervasive

- **Seamless Mobility**
  - From stay in touch to seamless handover

- **Smart Environment**
  - From anytime, anywhere, any service to right time, right person, right service

- **Strengthen Human Intelligence**
  - Computer systems as human brain extension
  - Networked people with stronger thinking power
Related Effort (I)

- DTV
  - Broadcasting channel coding standard
  - UTI: “SIM” card for set-top boxes
  - DRM: Digital Right Management
  - CA: Conditional Access
  - EPG: Electronic Program Guide
  - GridMedia: IPTV broadcasting
  - Mobile and handheld DTV
  - SDR: Software defined radio DTV receiver
UTI
Wireless Overall

DVB

2G
3G

WLAN
PCS

WPAN
Bluetooth
UWB

xDSL

Hori. Roaming
Vert. Roaming
Uplink Request

Mobility
Coverage
Security

TDSCDMA
Related Effort (II)

- OS and SoC
  - Elastos
  - THUMP
  - NC: Network Computer
  - $100 laptop

CAR: Component Assembly Runtime

CAR module, binary code upgrading on-the-go, platform transparent
Elastos

OS Integrated Developing Environment
- System Modeling
- Hardware Emulation
- Code Generating
- Software Analysis
- Testing Tools

Key Tech.
- Secure Info.
- Middleware Standard
- Middleware
- Platform Transparency
- Network
- OS Core

Hardware Platform: X86, ARM7/9, MIPS (Tsinghua THUMP, Longxin, etc.)

Embedded Real-time OS Core
- Cell Phone
- Auto Electronics
- Digital TV

Middleware Standard
- System Modeling
- Hardware Emulation
- Code Generating
- Software Analysis
- Testing Tools
Related Effort (III)

- Security and Privacy
  - TCG & TNC
  - End-point security
  - Policy/compliance enforcement
  - SSO: Single Sign On
  - High-speed security algorithms
  - NPU based implementation
Conclusion

- On the way of revolution from machine computing to machine intelligence, we need symbiotic evolution.
- A harmonious information society requires seamless mobility and smart environment.
- Network convergence, natural interface, security and privacy are important research areas among others.
Thank You
junl@tsinghua.edu.cn