Guest Lectures

- Guess Lectures
  - Feb 7: Kumar
  - Feb 16: Klara
  - Mar 2: Indy
  - Mar 9: YY
  - Mar 30: Jiawei
  - Apr 4: Kevin
  - Apr 13: Tarek

Course Objective

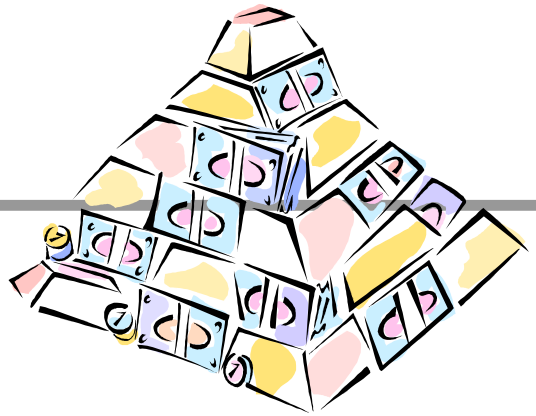
Course Objective: This is a course designed to help improve your research skills in the following areas.

- How to be abreast of research trends and identify critical issues,
- How to estimate the value of potential research topics, and create a coherent set of research problems (thesis)
- How to give presentations and write papers,
- How to establish a personalized creative process,
- How to create a well structured research agenda,

in the context of creating the scientific foundation for cyber physical systems: the convergence of computing, communication and control.

Next Steps

- Revise your presentation on trends and challenges, present them BRIEFLY (5 min)
- List and then characterize the different features and attributes of the challenges
- Analyze the nature of each challenge (engineering/research)
- Estimate the impacts and the nature of difficulties
  - (See pages 5,6,7 in Chen & Sha)
- Useful heuristic: Build a system description table



Summary: Creativity Process - structured and learnable

Kuan-Ling Chen (NTU Student)

Lui Sha

Creativity Process

- **Identify potential research topics**
  - Position the research focus on the intersection of your ***gifts***, your ***interests***, and ***societal needs***.
  - All the ideas and contributions should be recognized and acknowledged explicitly. This is key to successful collaboration..
- **Examine the Trends**
  - Examine the candidate topics' relation to the current research trends
  - Identify the contributions and limitations of related works
  - Spot opportunities that may create new trends
- **Look deeper into the Challenges**
  - What can be solved by current technology?
  - What needs to be invented?
  - What is the estimated effort?
  - What is the ***key factor*** that makes a result significant?

Creativity Process

- **Estimate the Impacts**
  - What are the categories of research and their risks/impacts?
    - new directions, unification/integration, broad applicability, incremental improvements.
- **Look ahead into the Future**
  - What are the new and exciting application scenarios that established technologies stop working?
  - What will the future technology enable?
  - What is impossible, and what can be formulated into a similar and solvable problem?
    - understand the true nature of constraints and separate the hard constraints from the soft ones.

Creativity Process

- **Expand to a a Family of solutions**
  - A group of solutions where each member is complemented and reinforced with each other .
    - What are their ***intrinsic characteristics***?
    - What are their strength and limitations?
- **Layout an elegant Architecture**
  - Optimally use the advantages of each member.
- **Implementation**
  - Publish papers and file patents.
  - Create new architectures, protocols,…
  - Prototype demonstration and identify industrial partners.

End Products

- From incremental improvements along the line of existing ideas
- To the creation of a new direction
  - Structurally different from the existing ones
  - Enabled by emerging technologies
  - Enable new and exciting applications that were not possible before

Play without Plug (PWP)
A New Product Line

Jen-Wei Hsieh & Yu-Kai Huang (NTU Students)
With Contribution by Neil, Johnson, and Kuan-Ling
Advised by Professor Lui Sha

26 October 2005

Outline

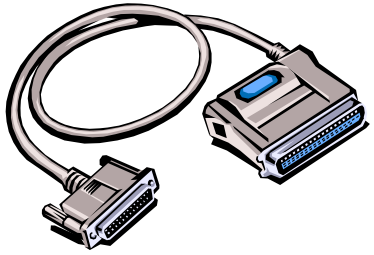
- The Emerging Trends
- Play without Plug*
- Killer Applications
- Evaluation
- The Challenges
- Conclusions
- Key Related Works
- The Candidate Conferences / Workshops

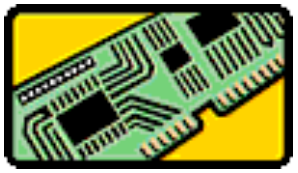
* This fantastic name is created by Neil Perng.

The Emerging Trends

- New Trends
  - Wired Devices vs. Wireless Devices
  - User-Friendly Interfaces (Auto-Configuration)
- New Enabling Technologies
  - Ultra Wideband (UWB, IEEE 802.15.3)
- Observation & Existing Limitations
  - Storage Redundancy
  - Synchronization Problem

Evolution of Infrastructure





Dedicated Devices

Plug and Play

Play without Plug

Killer Applications (1/3)

- *Personal / Home Storage® (Home)
  - People can carry about their personal data.
  - The storage can be accessed by numbers of intrinsically different devices, e.g., ear phone, display, projector, printer, etc.
    - Object could be “touched” from different dimensions
    - Coupled with a brand-new file system
  - Storage-less peripheral would emerge.

* The original idea of this product is proposed by Johnson Chang.

The Concept

Projector

Digital Imaging

Mobile PCs

Share and Exchange

PCs

Photo and Video Display

Printers

In Car Media Center

Potable Media Players

Mobile Phones

Killer Applications (2/3)

- *Instant Notes® (Work)
  - The download process could be done easily and simultaneously.
  - Applications
    - In Class: Students can get the latest lecture slides immediately.
    - In Conference: The protected data can only be distributed to the attendances.
    - In Company: The confidential data can only be accessed in company.

*This product is named by Professor Lui Sha.

Killer Applications (3/3)

- Personal Tourist Guide® (Vacation)
  - Provide tourists abundant suggestions and directions.
    - *Co-operate with search engine, e.g., google.
    - Overall roadmap can be downloaded from tourist office.
    - Detailed information can be updated wirelessly while approaching the spot.
    - Rich multimedia contents are provided.
  - **Interest-Oriented Information Sharing, not File-Oriented Sharing.

* Suggested by Johnson.

**Suggested by Professor Lui Sha & Kuan Lin.

Similar Products

- Bluetooth Products
  - No Similar Product
  - Limited Bandwidth
  - Lack of Many-to-Many Transmission Function
- PaPaGO! (GPS)
  - Location Inaccuracy
  - Relying on Existing Content in Devices
  - Lack of Flexibility, Updating Inconveniency

Evaluation (1/3)

- Attractive Features
  - **Play without Plug**
    - Devices can be used without complex setup
    - Content can be accessed by intrinsically different devices.
  - **Economy** – Dramatically reduction in total-weight in system, power consumption, and size
  - **Many-to-Many Transmission** – Information can be spread out quickly.

Evaluation (2/3)

- **Instant Update** – Suitable and the latest information can be retrieved naturally.
- **Interest-Oriented Information Sharing** – Desired information can be easily extracted.
- **Secure Enhancement** – Confidential information can only be accessed in the company.

Evaluation (3/3)

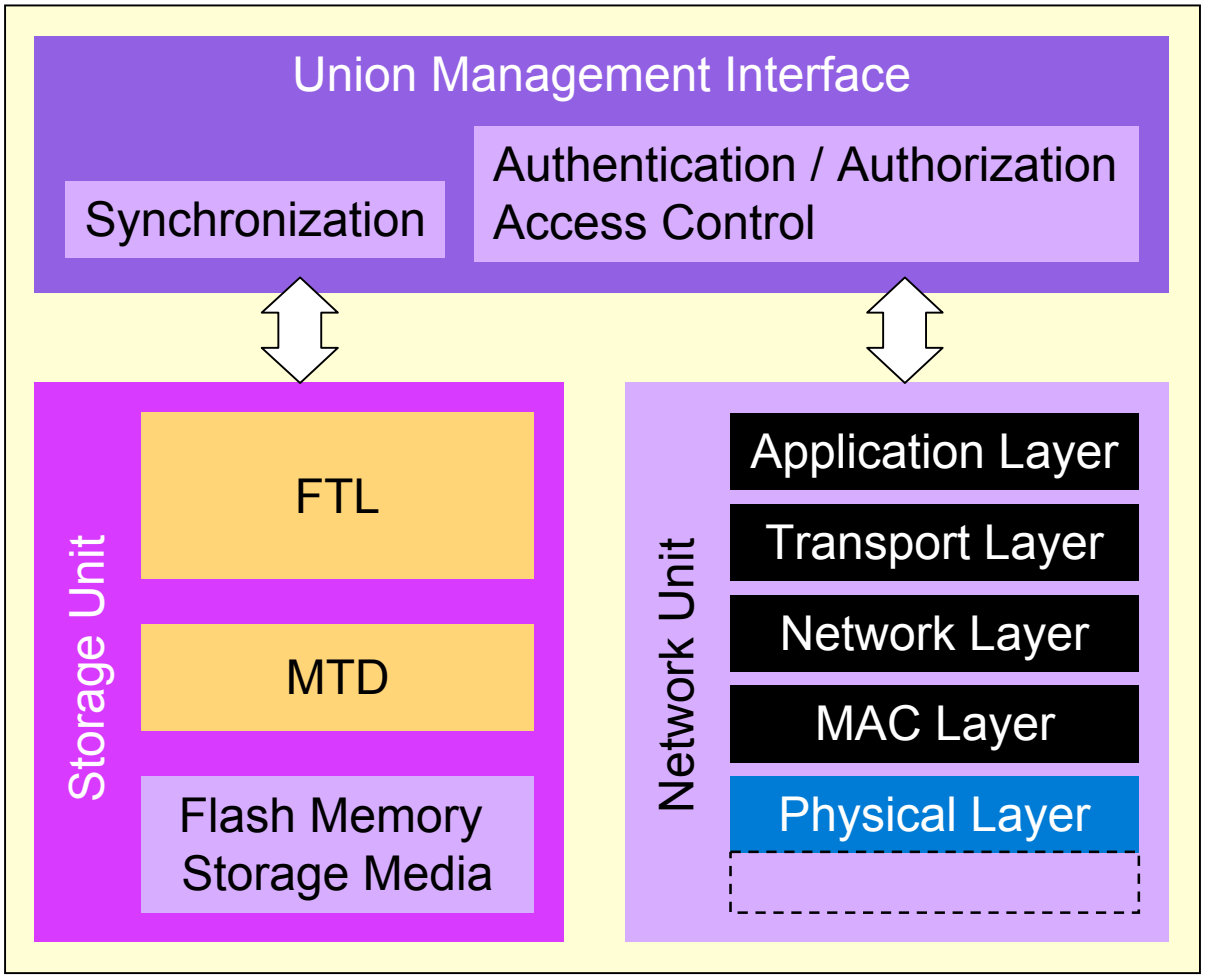
- Quality Attributes
  - **Transparency** – user/host is not aware of the difference while adopting this new product.
  - **Reliability** – data is available and correct anytime and anywhere.
  - **Inter-Operability** – the new product can be used over different platform.
  - **Performance** – the new product should be good enough, compared to the similar products.

System Description Table (SDT): Design, Trade-off

	Transparency	Reliability	Inter-Operability	Performance
Play without Plug	Adapter (L)	UWB (H)	FTL (M)	UWB (H)
Many-to-Many Transmission	Multicast / Broadcast (M)	UWB (H)	Layered Design (H)	P2P (H)
Instant Update	Daemon (H)	Synchronization (M)	Porting (H)	Hand-Off (M)
Secure Enhancement	Encryption / Decryption (H)	Authentication / Authorization (H)	Layered Design (M)	Hardware Circuits (H)

*Efforts: H: High, M: Medium, L: Low

Block Diagram for SDT



The Challenges (1/2)

	Play without Plug	Many-to-Many Transmission	Instant Update	Secure Enhancement
MTD	(D)	(D)	(D)	(R) Encrypt / Decrypt
FTL	(R) Rapid Booting	(R) Simultaneous Read / Write	(D)	(D)
UMI	(R) Transparency	(R) P2P Networking	(R) Version Control	(R) AAA Control
PHY	(D)	(D)	(D)	(D)
MAC	(D)	(R) QoS between Peers	(D)	(D)

*R: Research, D: Develop

The Challenges (2/2)

- Power Consumption
  - Power Sources* – Fuel Cells, Solar Cells, Heat, Vibration, Fusion
  - “How to save energy” is also a hot research topic, for example:

[1] Chin-Hsien Wu, Tei-Wei Kuo, and Chia-Lin Yang, 2004, "Energy-efficient flash-memory storage systems with an interrupt-emulation mechanism," IEEE/ACM/IFIP International Conference on Hardware/Software Codesign and System Synthesis, Stockholm, Sweden, September, 2004.

[2] Li-Pin Chang, Tei-Wei Kuo, and Shi-Wu Lo, "A Dynamic-Voltage-Adjustment Mechanism in Reducing the Power Consumption of Flash Memory for Portable Devices," IEEE International Conference on Consumer Electronics, Los Angeles, USA, June 2001.

* http://www.trnmag.com/Stories/2005/061505/HIW_Power_sources_--_fuel_cells,_solar_cells,_heat,_vibration_and_fusion_061505.html

Rank the Proposed Topics

- Integration
- Power Consumption
- Quality of Service (QoS)
- Security

Conclusions

- A New Product line to improve quality of life.
- A well-organized, exciting set of research topics are proposed.

Key Related Works (1/3)

- Wireless Flash Memory

[1] http://www.intel.com/design/flash/wireless.htm

- Play without Plug

[2] http://www.ieee802.org/11/DocFiles/05/11-05-0788-00-000s-mna-5min-statement-to-tgs.ppt

- QoS for USB

[3] Chih-Yuan Huang, Tei-Wei Kuo, and Ai-Chun Pang, "QoS Support for USB 2.0 Periodic and Sporadic Device Requests," *the 25th IEEE Real-Time Systems Symposium* (*RTSS*), Lisbon, Portugal, December 2004.

[4] Chih-Yuan Huang, Li-Pin Chang, and Tei-Wei Kuo, "A Cyclic-Executive-Based QoS Guarantee over USB," *IEEE 9th Real-Time and Embedded Technology and Applications Symposium* (*RTAS*), Toronto, Canada, June 2003.

Key Related Works (2/3)

- Ultra-Wideband

[5] Xin Wang, Yong Ren, Jun Zhao, Zihua Guo, and R. Yao, "Comparison of IEEE 802.11e and IEEE 802.15.3 MAC," *Proceedings of the IEEE* 6th *Circuits and Systems Symposium*, 2004.

[6] Yu Cai, Zihua Guo, and R. Yao, "A novel design of IEEE 802.15.3 MAC over UWB," *Vehicular Technology Conference*, 2004.

[7] S. Datta, I. Seskar, M. Demirhan, Siun-Chuon Mau, and D. Raychaudhuri, "Ad-Hoc Extensions to the 802.15.3 MAC Protocol," *World of Wireless Mobile and Multimedia Networks*, 2005.

[8] http://www.uwb.org/

[9] IEEE standard for information technology - telecommunications and information exchange between systems - local and metropolitan area networks - specific requirements part 15.3: wireless medium access control (MAC) and physical layer (PHY) specifications for high rate wireless personal area networks (WPANs), IEEE Std 802.15.3-2003

Key Related Works (3/3)

[10] S. Roy, J. R. Foerster, V. S. Somayazulu, and D. G. Leeper, “Ultra-wideband radio design: the promise of high-speed, short-range wireless connectivity,” *Proceedings of the IEEE*, Volume 92, Issue 2, Feb 2004.

- Power Sources

[11] http://www.trnmag.com/Stories/2005/061505/HIW_Power_sources_--_fuel_cells,_solar_cells,_heat,_vibration_and_fusion_061505.html

- Power Consumption for Flash Memory

[12] Chin-Hsien Wu, Tei-Wei Kuo, and Chia-Lin Yang, 2004, "Energy-efficient flash-memory storage systems with an interrupt-emulation mechanism," IEEE/ACM/IFIP International Conference on Hardware/Software Codesign and System Synthesis, Stockholm, Sweden, September, 2004.

[13] Li-Pin Chang, Tei-Wei Kuo, and Shi-Wu Lo, "A Dynamic-Voltage- Adjustment Mechanism in Reducing the Power Consumption of Flash Memory for Portable Devices," IEEE International Conference on Consumer Electronics, Los Angeles, USA, June 2001.

The Candidate Conferences / Workshops

- RTAS 2006
  The 12th IEEE Real-Time and Embedded Technology and Applications Symposium
- SAC 2006
  The 21st Annual ACM Symposium on Applied Computing - Special Tracks on Embedded Systems
- AINA 2006
  The IEEE 20th International Conference on Advanced Information Networking and Applications
- NSDI 06
  The 3rd Symposium on Networked Systems Design and Implementation
- AuS Wireless 2006
  The 1st IEEE International Conference on Wireless Broadband and Ultra Wideband Communications
- ASWN 2006
  The 6th IEEE International Workshop on Applications and Services in Wireless Networks