Security Technologies for SoCs

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Security Technologies for SoCs

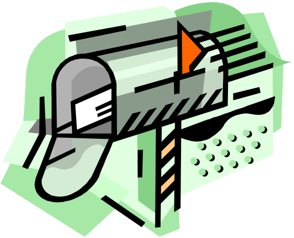
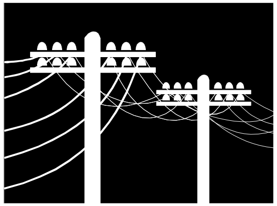
- SoC and Social Information Infrastructures
- Security and SoC Design
- Technical Challenges
- QuPID
- Conclusion

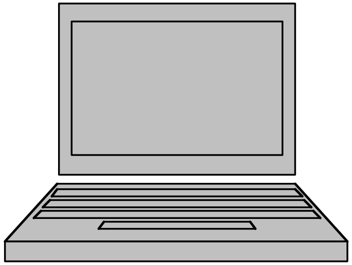
MPSoC Challenges

- Challenges to Physical Barriers
  - PTV variability, Reliability, High-Performance, Power Consumption, Interconnect, Clock Distribution, Modeling, Simulation…
- Challenges to Logical Complexity
  - New Applications, NoC, Platform, OS, System Description, QoS, Semantic Gaps, Algorithms, Verification…
- Challenges to Social Problems
  - Security, Smart Card, Quality, Reliability…

IT as a Basis of Social Infrastructure

- In the 20th century, many information and communication technologies were developed and introduced in various social infrastructures.
- Governmental services, economical activities, energy supplies, transportation services and communication services are provided based on the information technology.

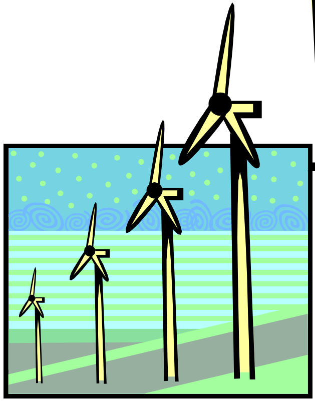


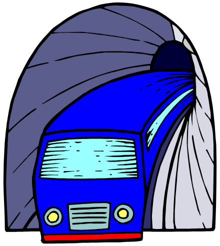
Rapid Progress of IT Changed Time Constants

- Time of information transfer and processing has been shortened drastically by IT.(x10^{-6}-10^{-9})
- Basic design of social systems was not supposed the speed-up of information spreading. Time constants of the systems are completely changed and the stability of the systems is not guaranteed.
  - Stock and foreign exchange markets
  - e-commerce, e-government, e-education,…

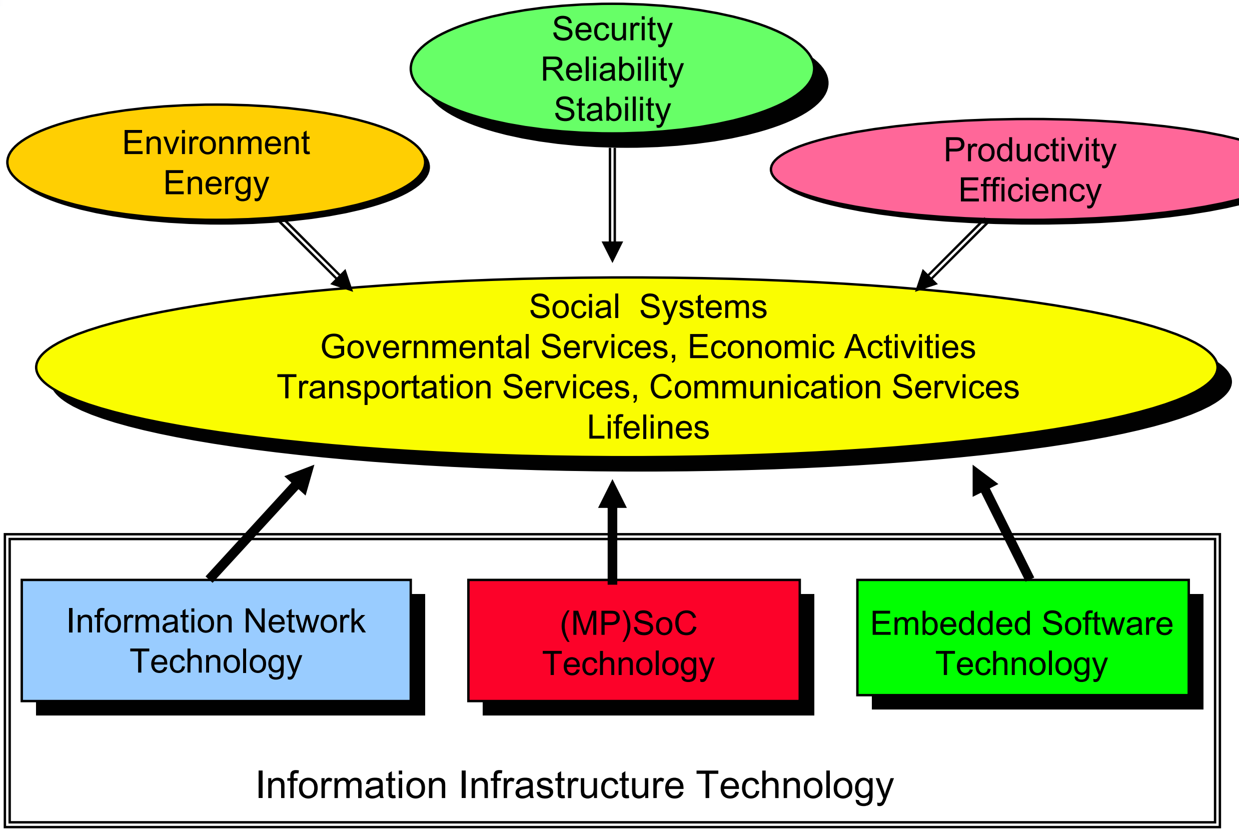
Needs for Reconstruction of Social Infrastructures

- We have to redesign and reconstruct the Social Infrastructures and Social Systems based on the advanced information technology. (e-JAPAN Project)





Information Infrastructure Technologies



Security
Reliability
Stability

Environment
Energy

Productivity
Efficiency

Social Systems
Governmental Services, Economic Activities
Transportation Services, Communication Services
Lifelines

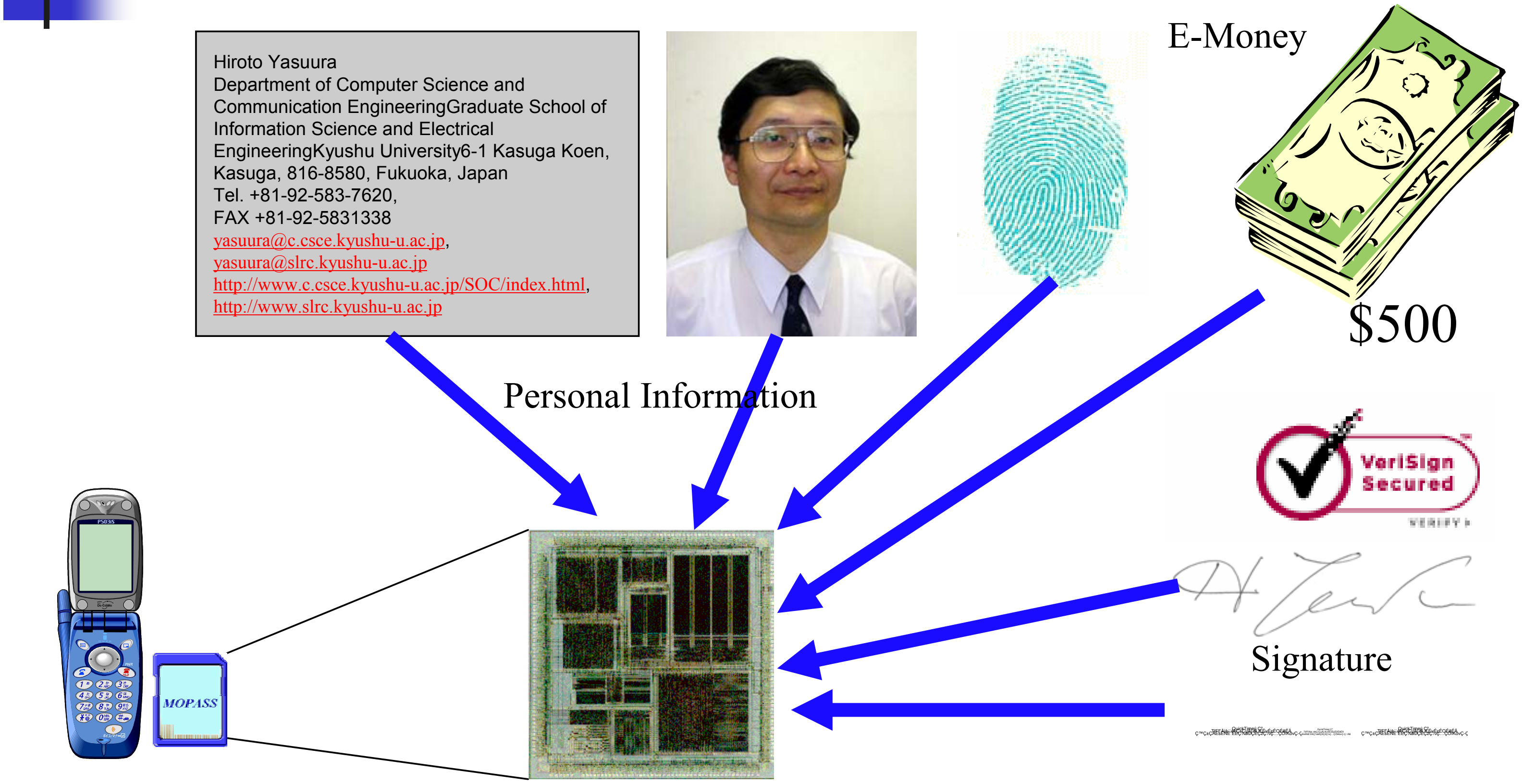
Information Network Technology

(MP)SoC Technology

Embedded Software Technology

Information Infrastructure Technology

Values on a Chip



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Personal Information

E-Money

$500

Signature

Credit Cards

$200

$30/Chip

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Major Problem?

- How to handle Credit, Value and Property on SoC.
- 1,000$ on a 10$ chip.

2,000 years

1,000 years

Metal Coins
(before BC 10th C)

•Value: Metal
•Conservation: Metal
the law of the indestructibility of matter

Paper Bill (10th C)

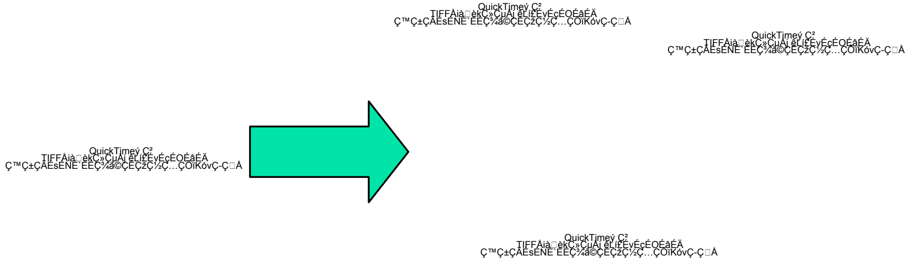
•Value: Printed information guaranteed by governments and/or banks.
•Conservation: Paper

Electric Money
(21st C)

•Value: Digital Information.
•Conservation: Digital Information?

Kids know the problems

- Can we securely treat “values” as copy-free digital information?
- In the game world
  - Illegal copy of PIKACHU
  - Virtual money in online games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Social Problems

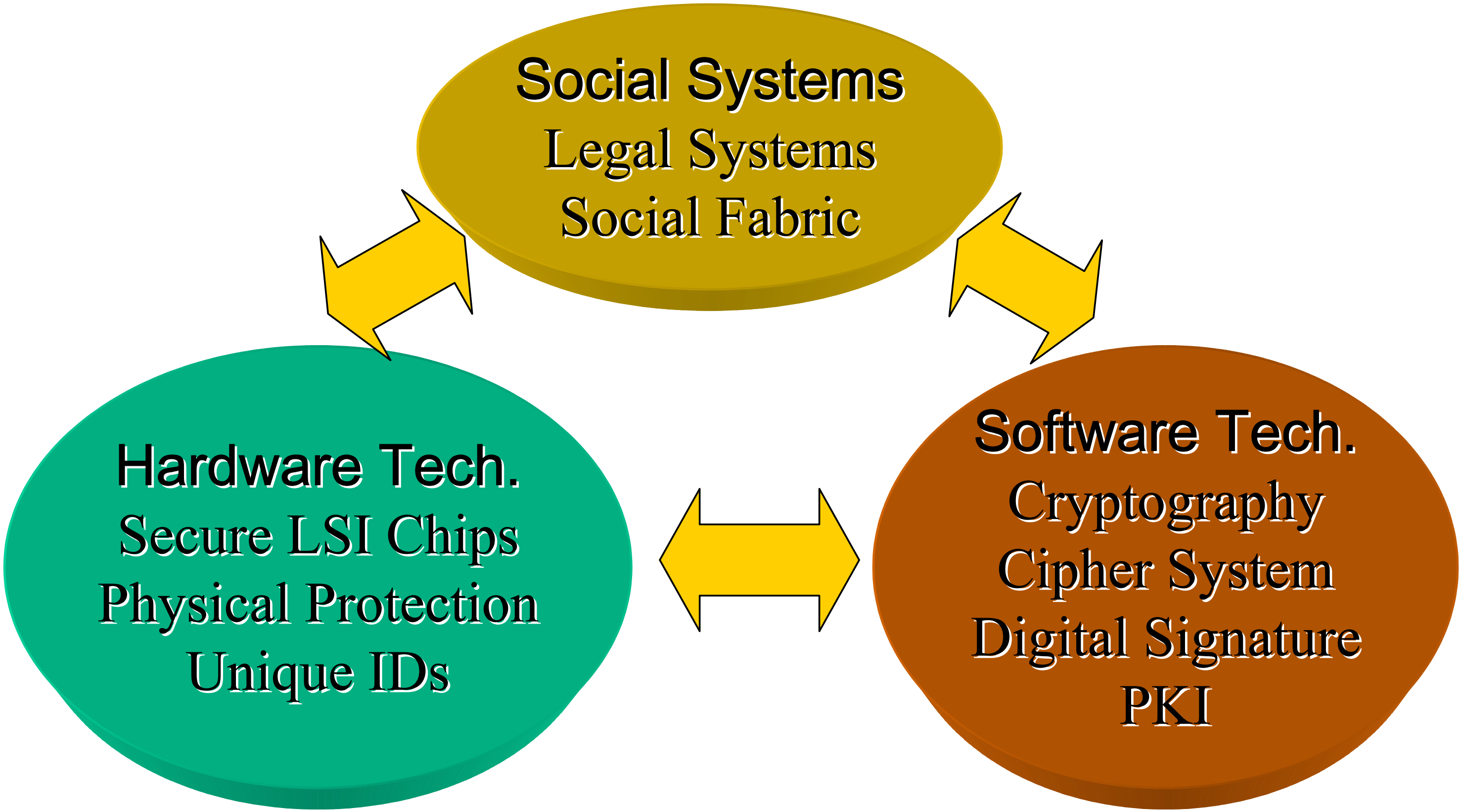
- Diversification of Issuers of Money
  - Private Money
    - Mileage of Airlines, Points of Credit Cards, etc.
  - Foreign currency (US $, Euro, Yen, etc.)
- Influences upon National Fiscal System
  - Tax Collection
    - Tax for Electric Commerce
    - Tax for Trade of Private Money
    - How to Trap and Verify Them
- New Social Systems and Technologies for Them
  - Information Technology for Value and Credit
  - Private Property Management
  - New Systems for Value Circulation
- Security and Trustworthiness Technologies
  - Crime Prevention
  - Copy Management of the Value and Credit

Principles for Design of Information Infrastructure

- Protecting privacy and properties of individuals as well as security of systems and societies
  - Security technologies
  - Simple and comprehensive mechanisms for easy understanding
- Economical and technological feasibility
  - Reliability and stability
  - Flexibility and extensibility against rapid progress of technologies
  - Resistibility and recoverability to attacks and crisis
  - No more Energy for new services

→ Challenges of Information Technology

Technologies for Security



Social Systems
Legal Systems
Social Fabric

Hardware Tech.
Secure LSI Chips
Physical Protection
Unique IDs

Software Tech.
Cryptography
Cipher System
Digital Signature
PKI

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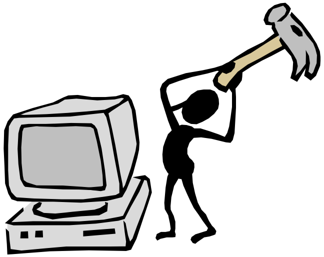
Technological Challenges

- What are the basic Technologies for treating “Credit, Value and Property”?
  - Authentication
    - How to authenticate your business partner
    - How to authenticate yourself
  - Value Assurance
    - How to assure the value trading
    - How to believe security of your property on IT

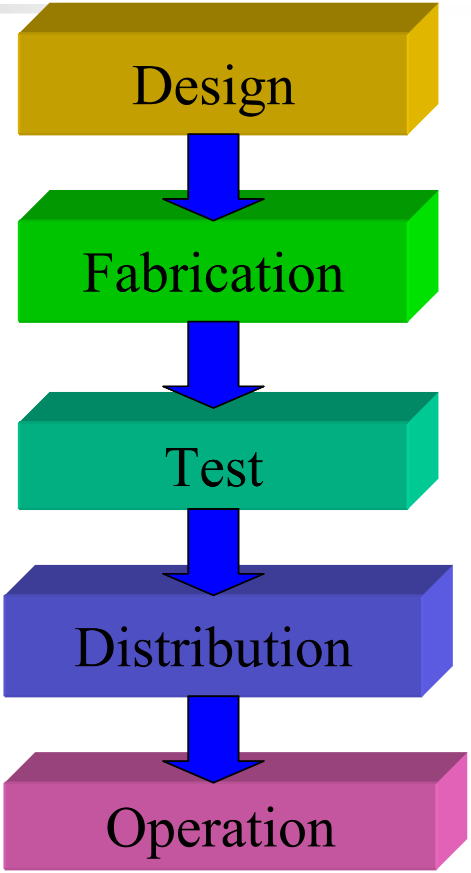
Researches on Security in IT

- Cryptography
  - Public key system (RSA, Elliptic Curve etc.)
  - Design and Analysis
  - Applications and Standardization
- Secure Information System
  - Protection from attacks (Fire walls, Network structure)
- Security in Communication
  - Secure Protocols
- Security for Software
  - Protections from virus and warms
- Security for Hardware
  - Anti-tampering
  - Side Channel Attack

Possible Attacks for LSIs

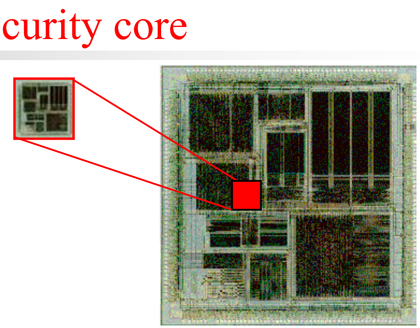


- What is attacked?
  - Information on LSIs
  - Circuit and system in LSIs
  - Social systems and/or personal properties
- When LSIs are attacked?
  - In design and fabrication stages
  - In test stage
  - During operation
- Why are LSIs attacked?
  - Get some benefit (Silent and invisible attack)
  - Destroy systems (Terrorism)



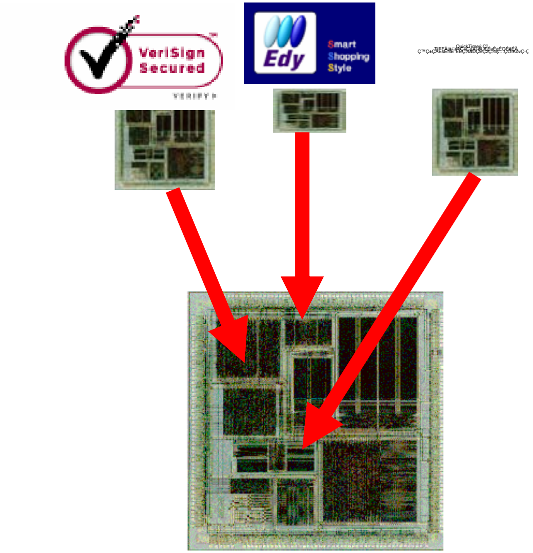
Technical Problems in SoC

- New functions in LSIs for security
  - Cryptography, Authentication, Watermark
  - Security Core IP
  - Resistance to attacking and tampering
- Design, verification and test techniques
  - Secure Design and Test scheme
  - Performance, cost and power consumption for security
- Fabrication
  - Secure Fabrication
  - New devices and/or materials
  - Embedded security core
- Operation and Distribution
  - Prevention and detection
  - Recovery
  - Wireless communication
  - Human and social factors



Security Cores

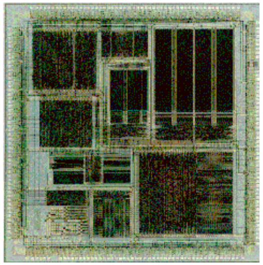
- Core for Security Functions
  - Authentication and Value Assurance
  - Cryptography: Algorithms and Key information
  - Anti-tampering
- How to implement
  - Software: processors and memories
  - IP: Secure design flow
  - Chip: SiP (System in Package)
- How to design and fabricate
  - Design tools
  - Fabrication lines
  - Test methods
- Interfaces and Protocols to the security cores



Who trusts whom and how?

Chip Designers

Application Programs



IP Providers
CPU, Memory, NoC

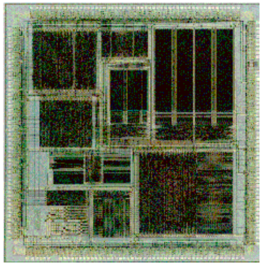
Operating System

EDA Tools

Test Engineers

Service Providers

Who trusts whom and how?



Chip Designers

IP Providers

EDA Tools

Test Engineers

Application
P ns

Operating System

Service Providers

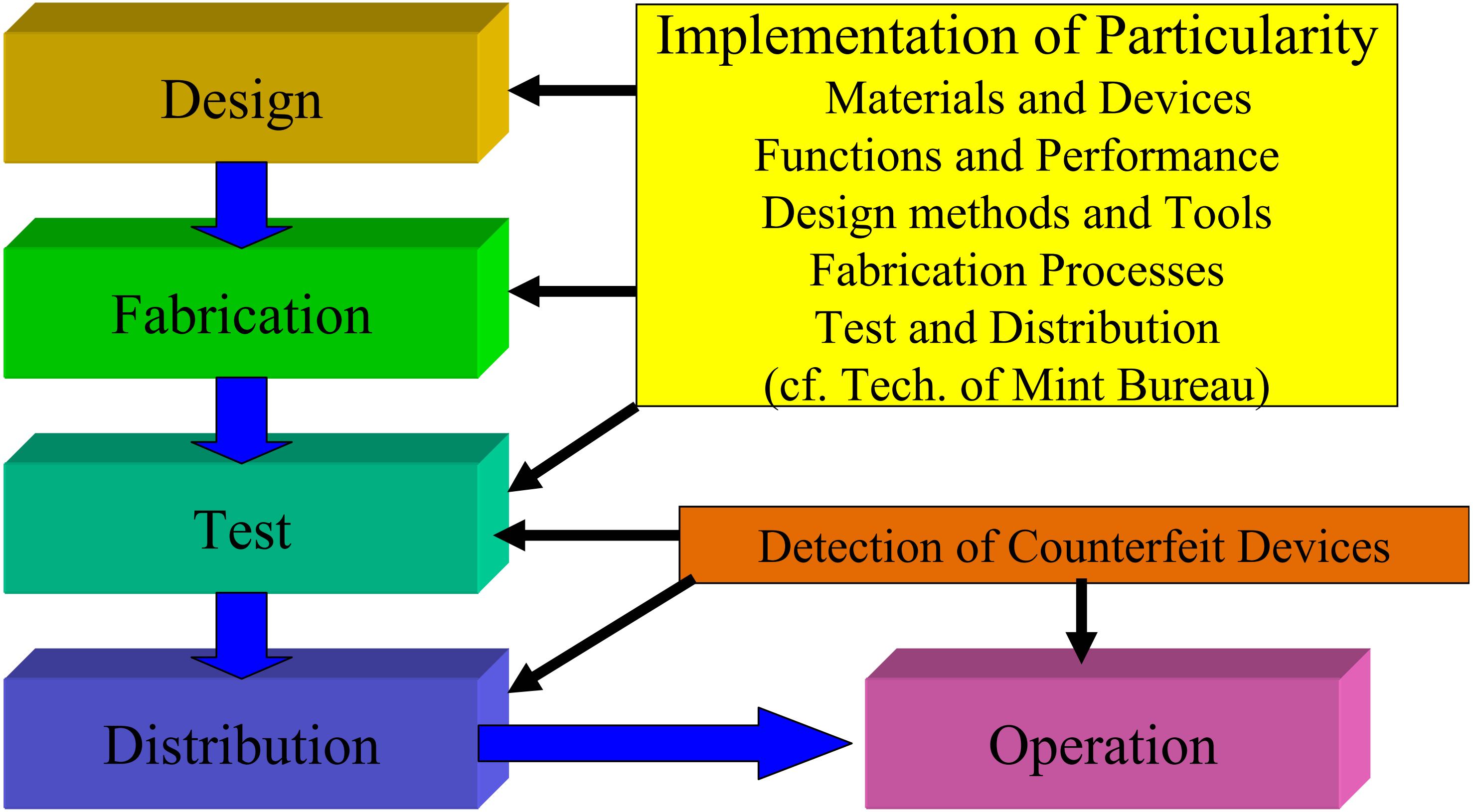
Design Problems of SoC

- Power and Performance
  - Extra computation for security
- Test
  - DFT introduces some risks
  - Special test methods
- Anti-Tampering technology
  - Prevent from side channel attacks
- Anti-Counterfeit technology
  - Unique ID for a chip

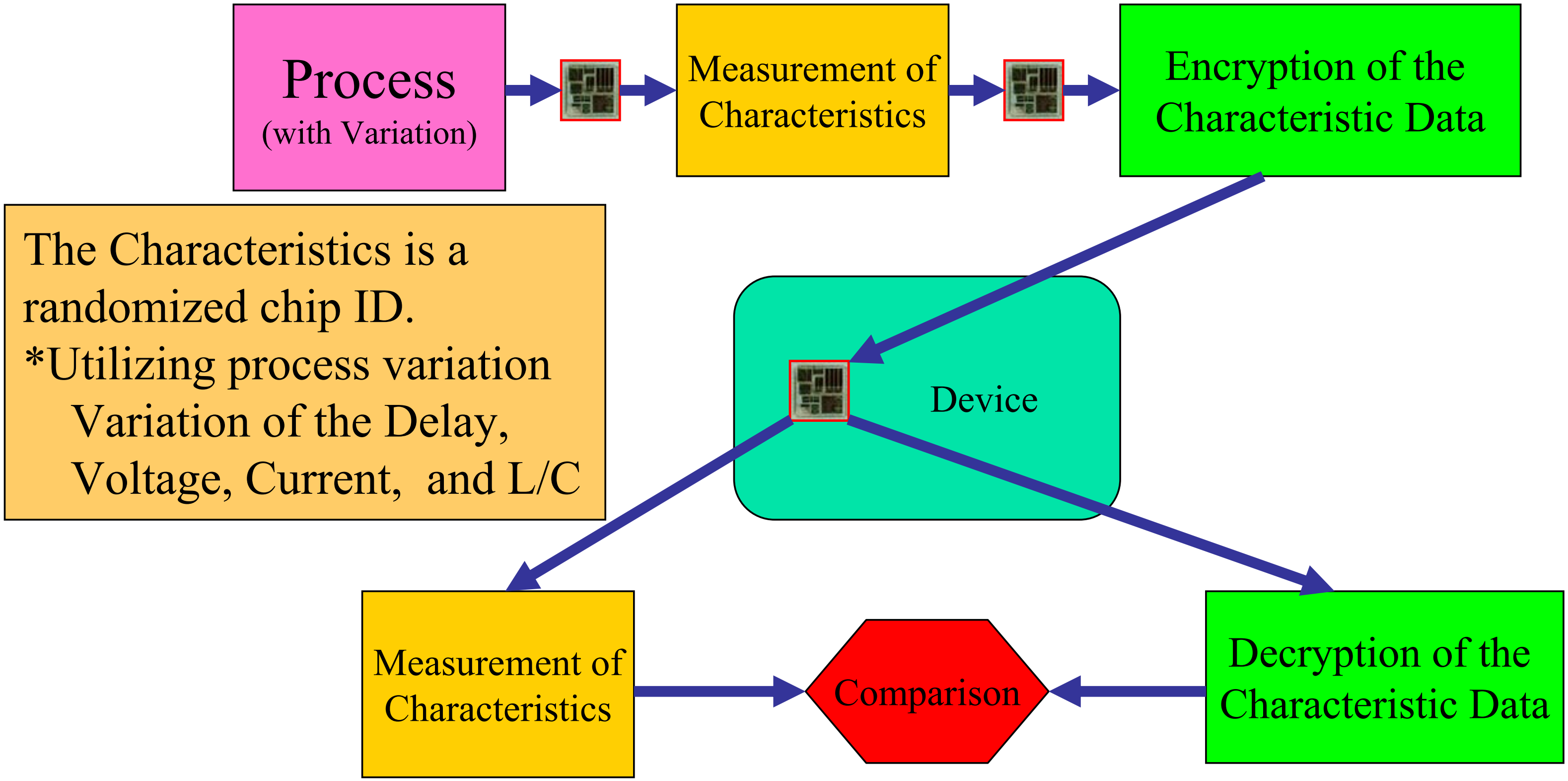
Threat of Counterfeit

- Examples
  - Counterfeit note (e-money)
  - Illegal ROM for Pachinco
  - Counterfeit of certifications (passports, drivers licenses and credit cards)
- Is the SoC a purse or money?

Countermeasures for Counterfeit



Detection of Counterfeit Devices



Process

(with Variation)

Measurement of Characteristics

Encryption of the Characteristic Data

The Characteristics is a randomized chip ID.

*Utilizing process variation

Variation of the Delay, Voltage, Current, and L/C

Device

Measurement of Characteristics

Comparison

Decryption of the Characteristic Data

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Project Q : QuPID

- Experiments for New Social Information Infrastructures in moderately unrestricted society
- Campus Card with QuPID
  - IDs for students, staff with multiple usage
  - Keys to buildings, facilities, and parking
  - Access control to campus information
  - E-money
  - E-administration
  - Services to Students
  - NTT, Panasonic etc.
- RFID Tags to Equipments
  - Library
  - Equipments management
  - Hazard identification
  - Moving to the new campus

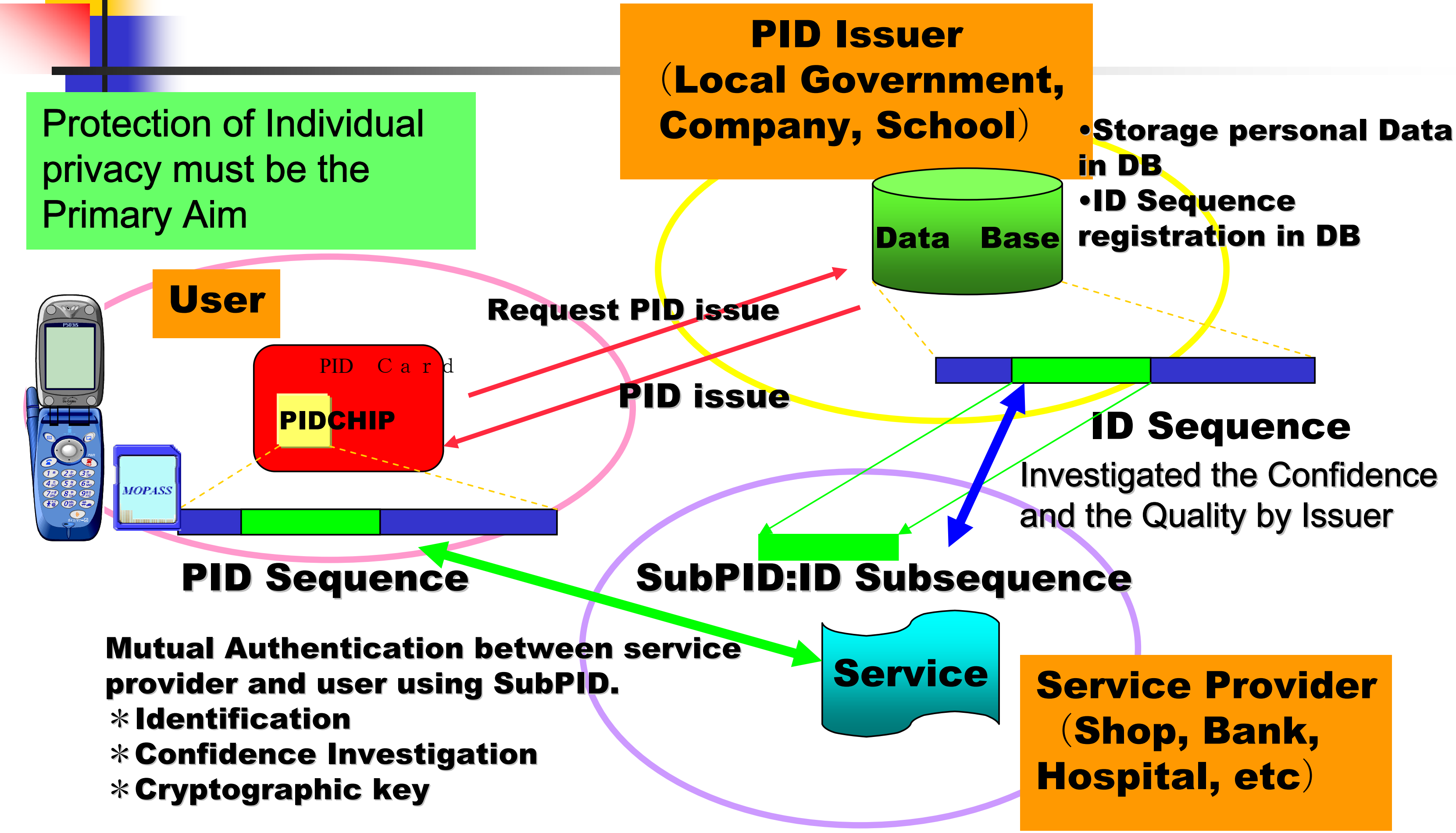
NTT

Panasonic
ideas for life

New campus of
Kyushu University
Open in 2005.

QuPID: Personal ID (PID) System

Protection of Individual privacy must be the Primary Aim



PID Issuer （Local Government, Company, School）

•Storage personal Data in DB
•ID Sequence registration in DB

ID Sequence

Investigated the Confidence and the Quality by Issuer

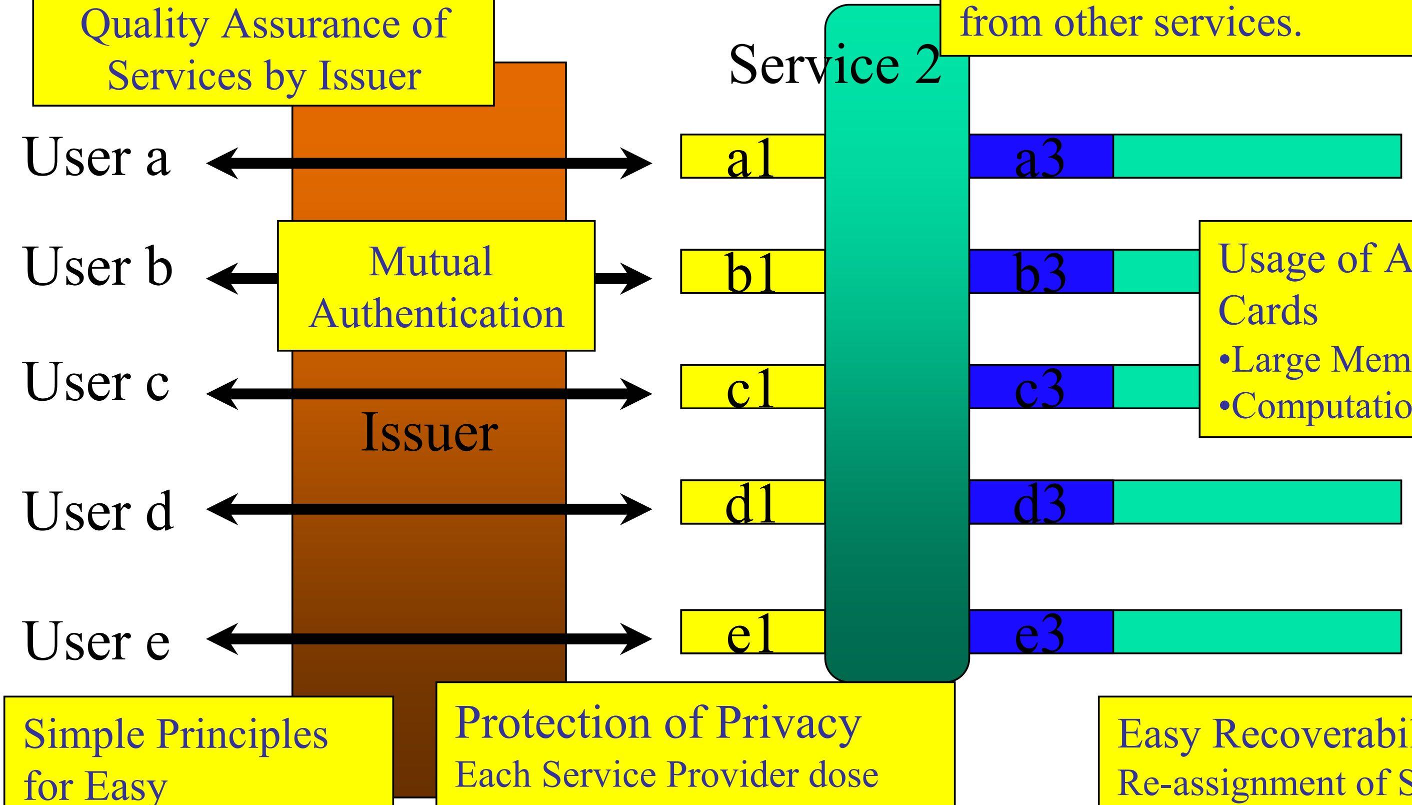
PID Sequence

SubPID:ID Subsequence

Mutual Authentication between service provider and user using SubPID.
＊Identification
＊Confidence Investigation
＊Cryptographic key

Service Provider （Shop, Bank, Hospital, etc）

Basic Structure of PID



Cost Reduction of Service Providers
Security of each service is independent from other services.

Quality Assurance of Services by Issuer

Mutual Authentication

Usage of Ability of IC Cards
- Large Memory Spaces
- Computation Power

Simple Principles for Easy Understanding

Protection of Privacy
Each Service Provider dose not have personal data for users.

Easy Recoverability
Re-assignment of Sub PID

Technical Challenges

- Mutual authentication for multiple services
- Multiple application system
  - Services on campus using PID system
  - Trial of e-money and e-commerce
  - PID on IC Cards, Mobile Phones and Back-end Systems
- LSI Architecture for Security and Privacy Protection
  - Resistance to tampering
  - Anti-counterfeit technology
  - Test and verification techniques
- Low Power RF and Cryptographic Computation
  - Hash and Cryptographic functions
  - Secure RF communications
- New Business Models
  - Fukuoka-Card (Local money and new services)

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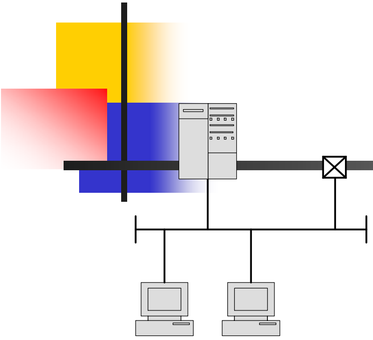
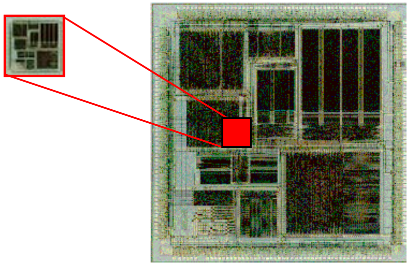
Conclusion

- New Application Area of LSI Technologies
  - Requirement of Standard Technologies
  - Collaboration with Communication and Software
  - Big Chance of New Business
  - Authentication, e-money and e-commerce
- New Social Infrastructure
  - Infrastructure of New Economic Systems
  - Basic Technology for Ubiquitous Computing Society
- National Security
  - Money System and Tax Collection
  - Secure and Safe Society
  - New Social Fabrics

Projects for Social Information Infrastructure



Security Core



Social System Level

Social Systems(Money, Tax, Commerce)
Laws, Economic Systems, Communication Networks

Information System Level

IC Card, mobile phone, PCs
Software, OS and Compiler
Cryptography, Privacy Protection
Embedded Software

Device and LSI Level

Security on an LSI Chip
Secure Design, Fabrication, and Test
Security IP Core
Counterfeit chip detection

Money as a link between the present and the uncertain future

-John Maynard Keynes