Novel Semiconductor Business Model –

Engineering Chain for the Semiconductor Industry

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Outline

- Introduction
- Current Issues in Engineering-Chain Management
- Key Requirements of ECMS
- ECMS Framework
- EC Workflow Scenario
- Conclusions

Introduction

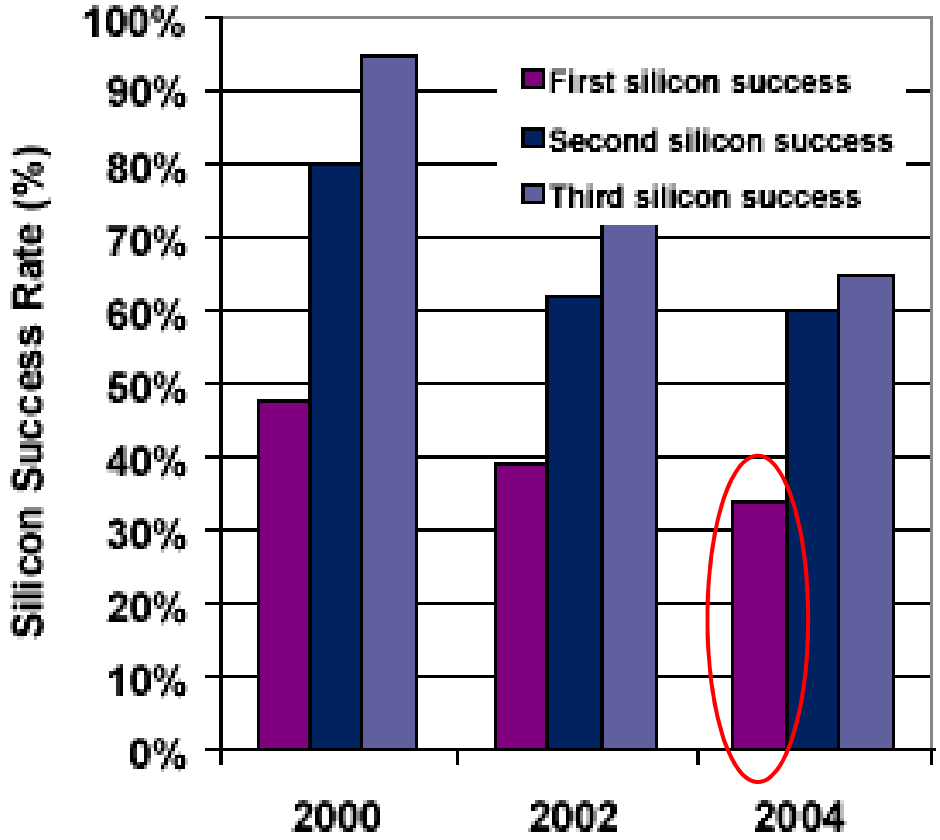
Three Trends Exist in the Semiconductor Industry

- **Faster IC design is required to support shorter life cycle of IC products when IC is assembled in end-products and the end-product life cycle is getting shorter.**
- **Moore's law holds that IC function capacity doubles every 18 months, therefore the whole semiconductor industry is striving to carry this trend of increasing IC function capacity.**
- **Owing to the large investment necessary to establish an IC manufacturing factory, specialization in the semiconductor industry has also become a trend.**

Source: G. E. Moore, “Cramming More Components onto Integrated Circuits, Electronics”, April 19, 1965. [Online]. Available: ftp://download.intel.com/research/silicon/moorespaper.pdf

IC Design Success Rates

- In 2004, only 34% of first IC designs can be successfully released for mass production
- A new business model is required (with a framework) to increase first design success rates



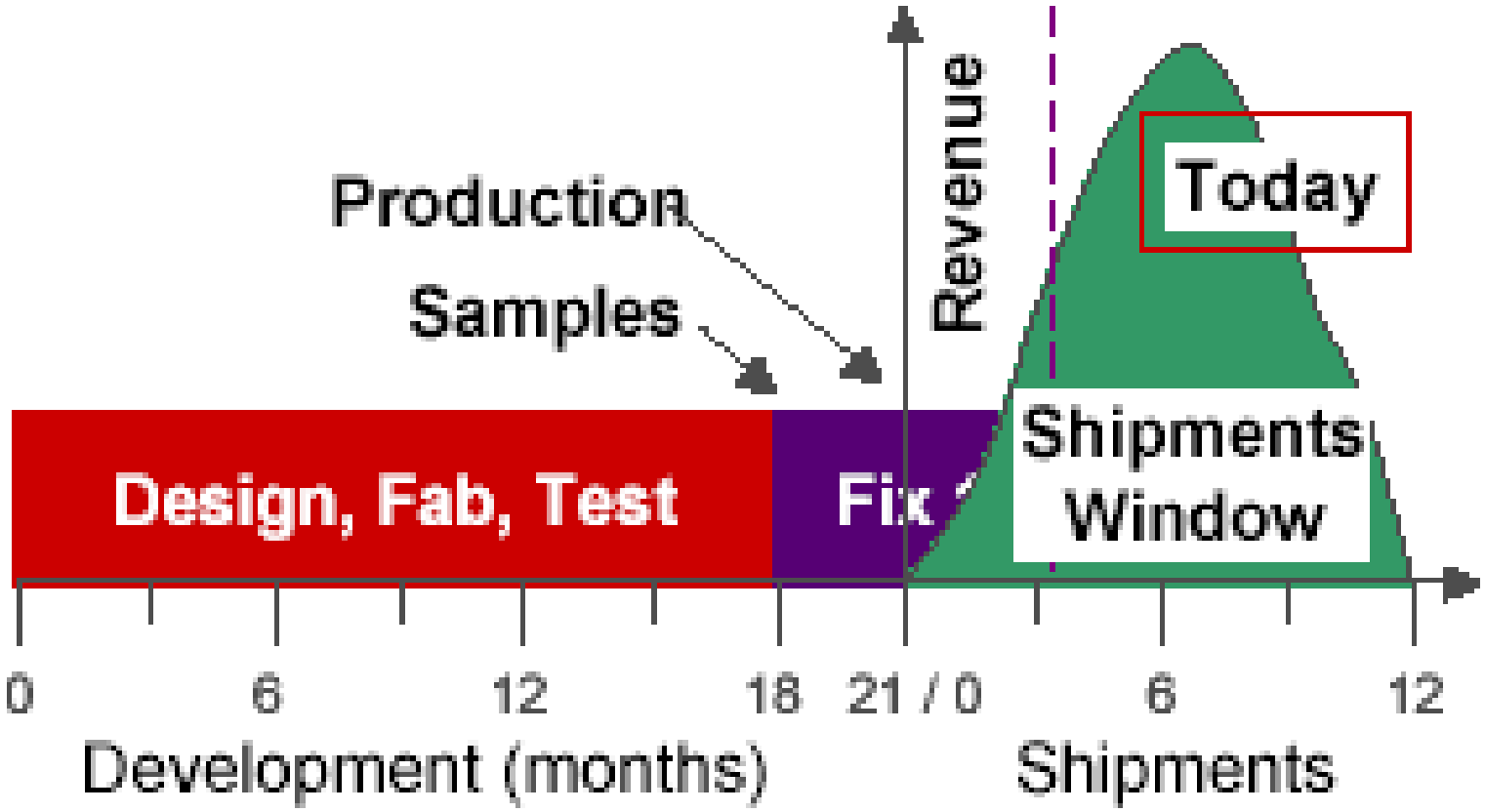
Increasing First Design Success Rate

- **Most IC design companies believe the greatest challenges in the IC design cycle are cost and cycle time.**
- **In the next generation of process technology, mask cost will increase 100%.**
- **The IC design company must pay reworking costs and the new project is left idle while waiting for second and even third rework results.**
- **Increasing first design success rate not only reduces design costs and IC design cycle time, but also increases revenue via earlier market entry.**

Source: K. Jou, “IC Design House Survey 2004”, EE Times. [Online]. Available: http://www.eetasia.com/SURVEYS/EETT_ICD_TW04.PPT

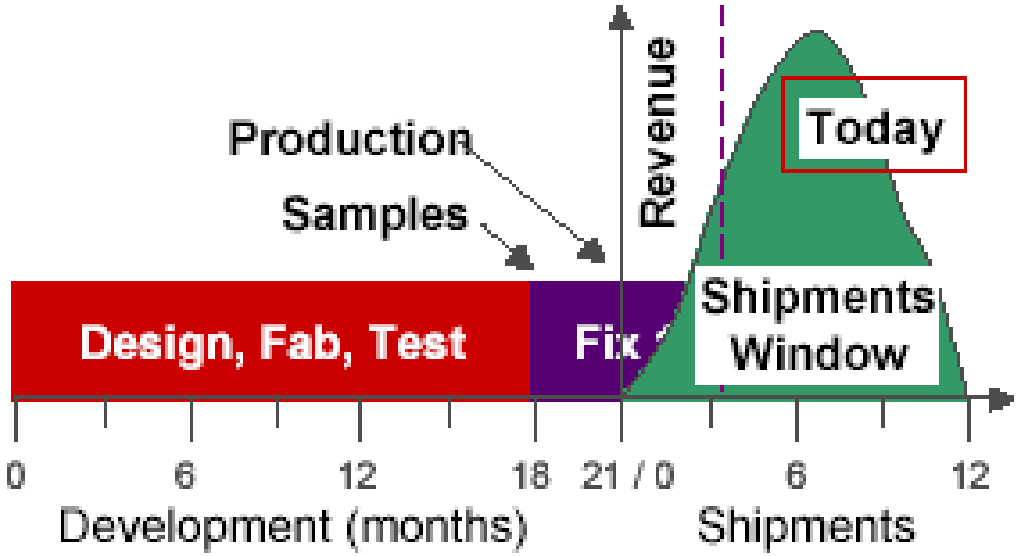
R. Madhavan, “Changing Economics of Chip Design”, FSA Presentation, 2004.

Cost of Time


Production
Samples
Revenue
Today
Design, Fab, Test
Fix
Shipments
Window
0
6
12
18
21 / 0
6
12
Development (months)
Shipments

Increasing First Design Success Rate

- **Increasing first design success rate not only reduces design costs and IC design cycle time, but also increases revenue via earlier market entry.**



Source: K. Jou, "IC Design House Survey 2004", EE Times. [Online]. Available: http://www.eetasia.com/SURVEYS/EETT_ICD_TW04.PPT
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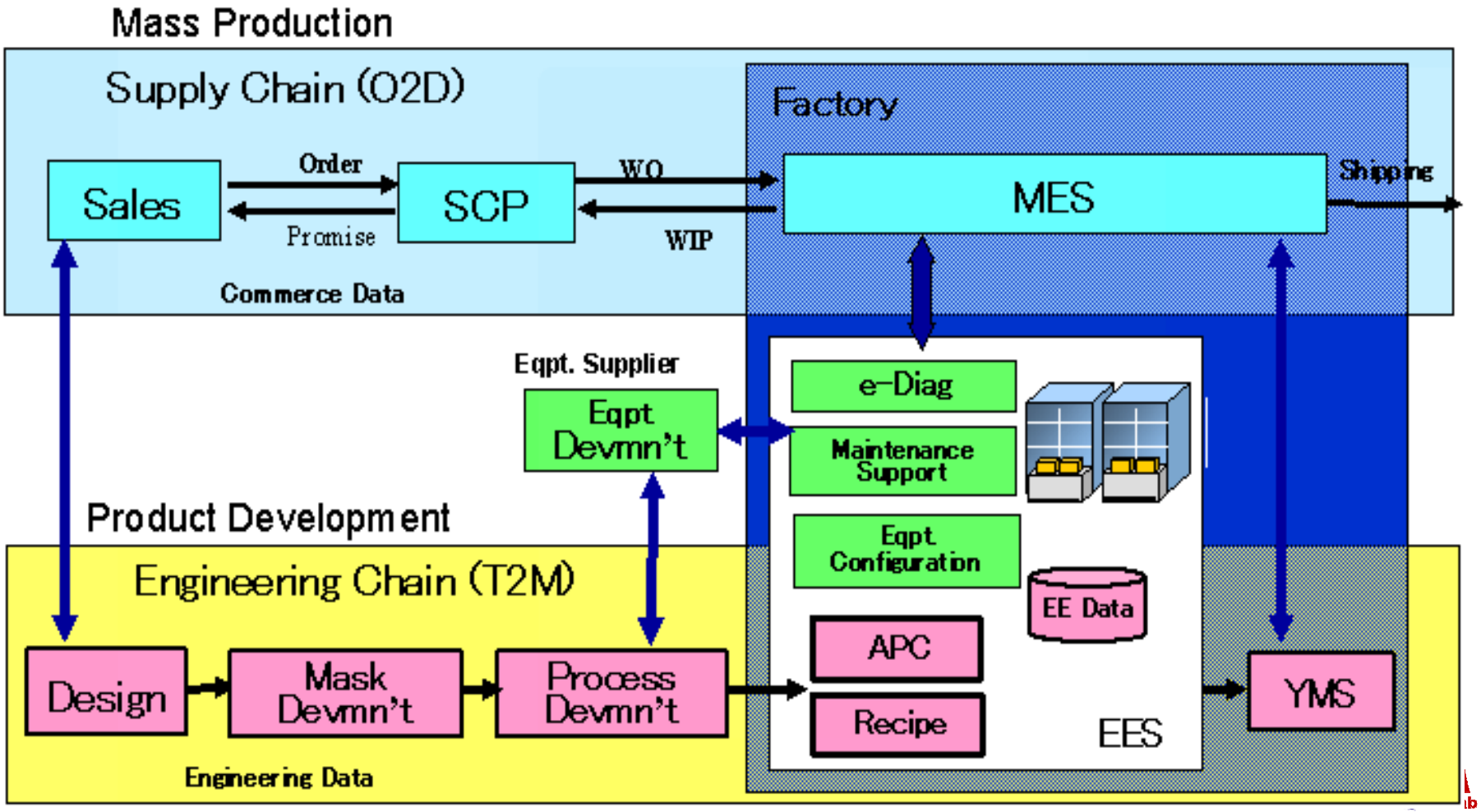
Comparison of Supply Chain and Engineering Chain

- ITRS proposed the Engineering-Chain (EC) idea to cope with design collaboration in the semiconductor industry.
- During the product-development phase, EC plays the role of managing IC design operation from IC design to the release of mass production.

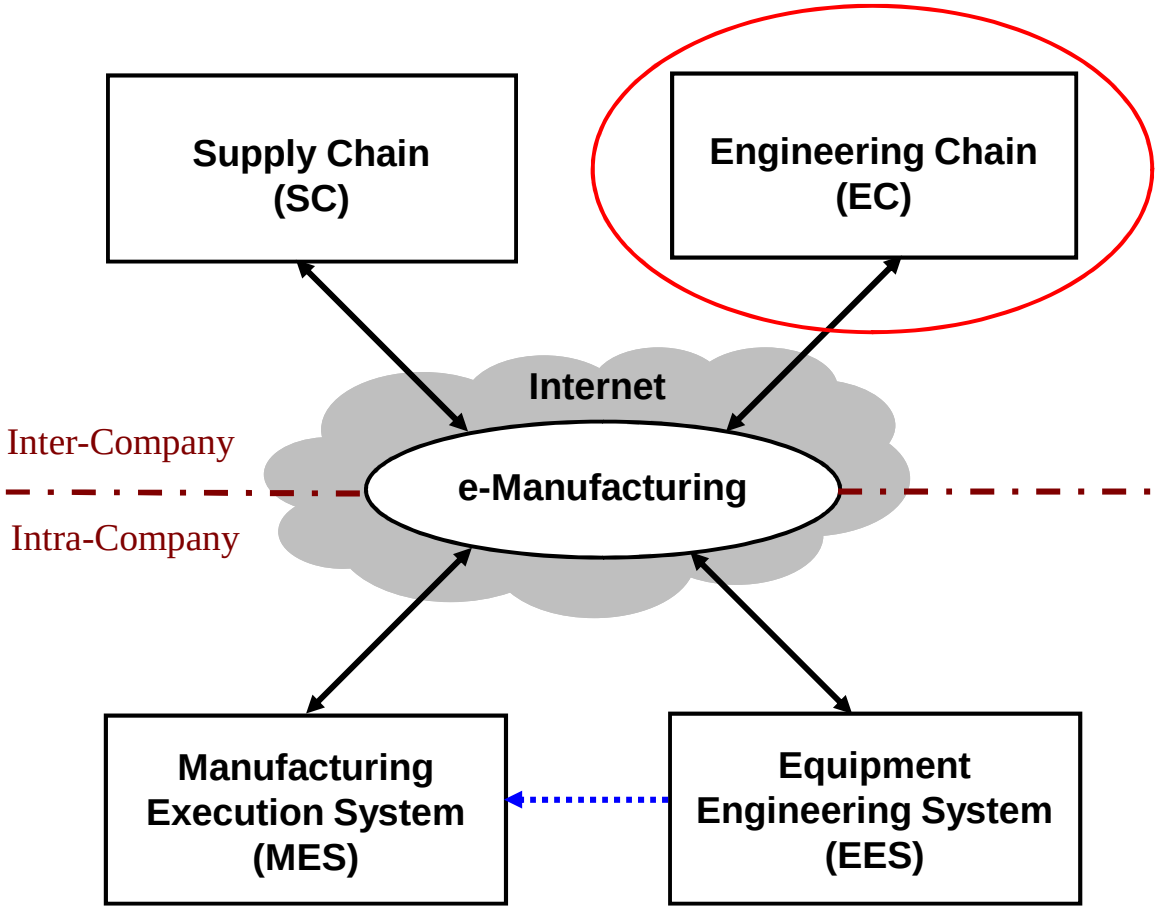


e-Manufacturing

- **Semiconductor e-Manufacturing idea focuses not only on SC "order-to-delivery" for timely and economical delivery of needed products;**
- **but also emphases e-Manufacturing support to a fast design cycle to reduce EC "time-to-market" because some IC design cycles are longer than their matching mass-production cycles.**

Source:
•R. Ganeshan and T. P. Harrison, “An Introduction to Supply Chain Management”, Penn State University, [Online]. Available: http://silmaril.smeal.psu.edu/misc/supply_chain_intro.html
•Performance Indicators in Logistics, IFS Publications / Springer-Verlag, NEVEM-workgroup, 1989.

e-Manufacturing



- **Goals of e-Manufacturing:**
  - Reduce the overall production cost.
  - Provide fast responses to customers' requests.
  - Deliver correct information to the right people at right time.

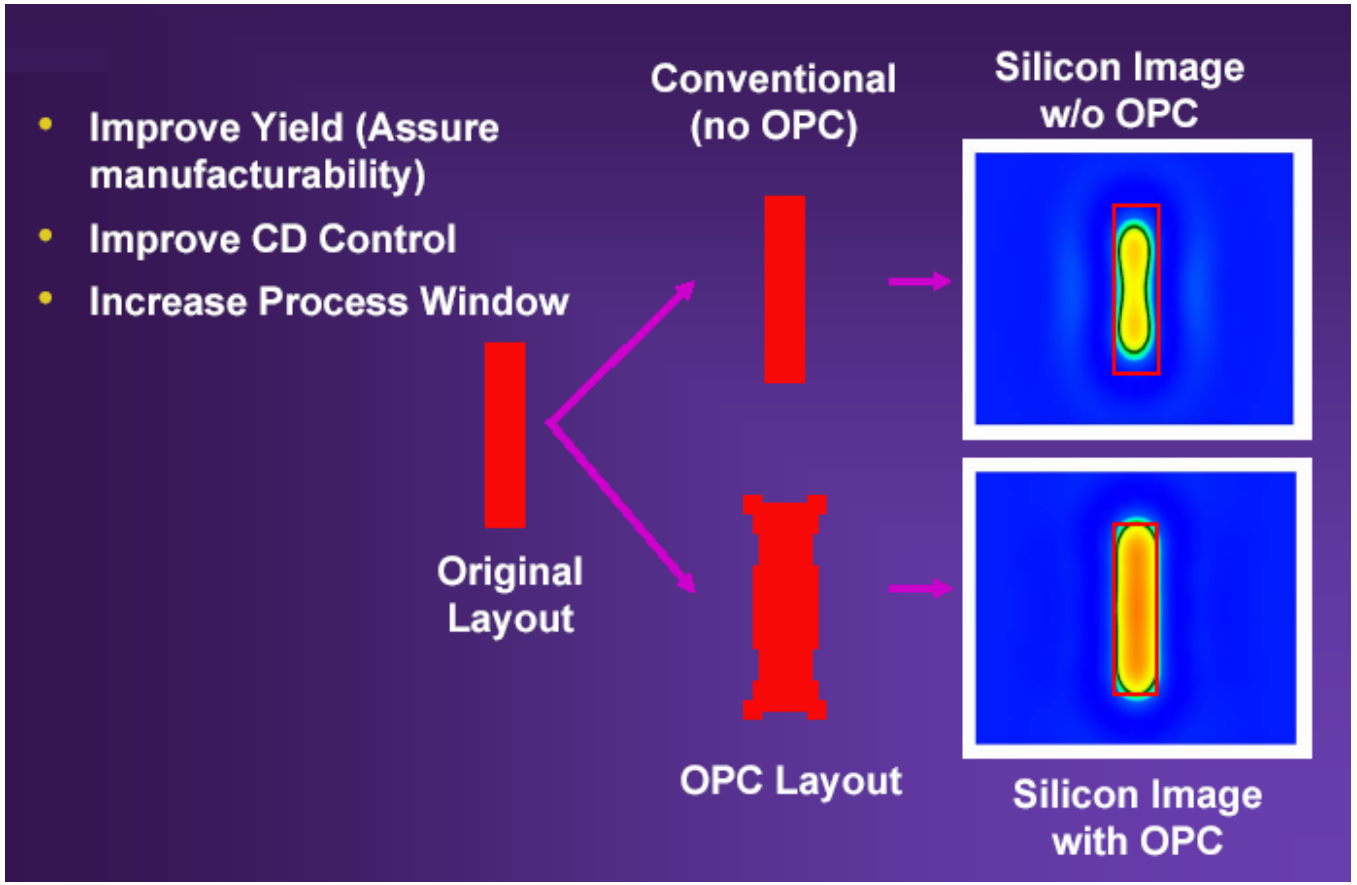
Current Issues in Engineering-Chain Management

- **In the present new digital consumer era, which is characterized by short product life cycle and advanced process technologies, the current IC mass-production cycles may even be shorter than their design cycles.**

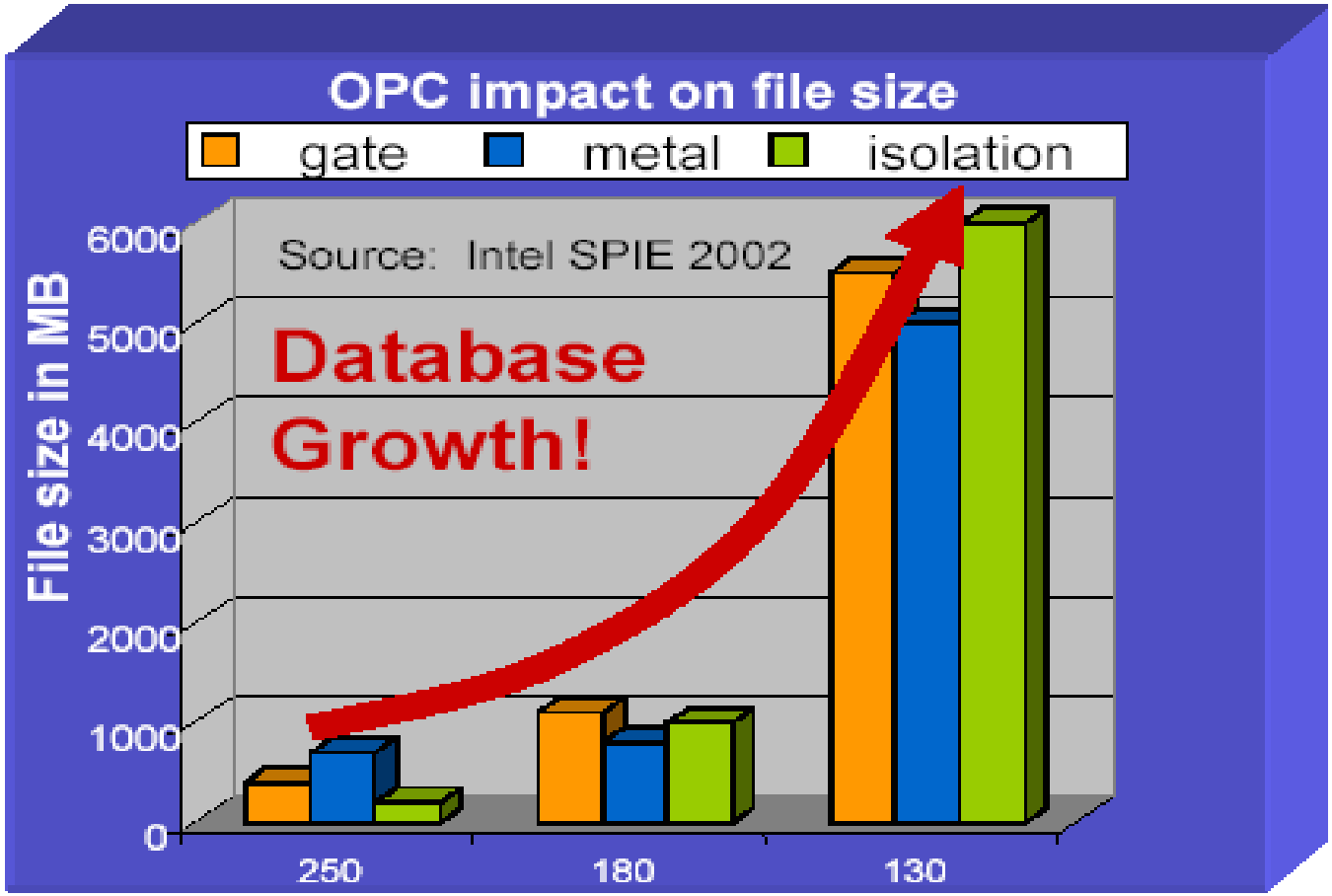
- **The importance of first IC design success is more crucial than before because IC design failure can easily spoil an entire project due to the market becoming unprofitable.**

Dilemma

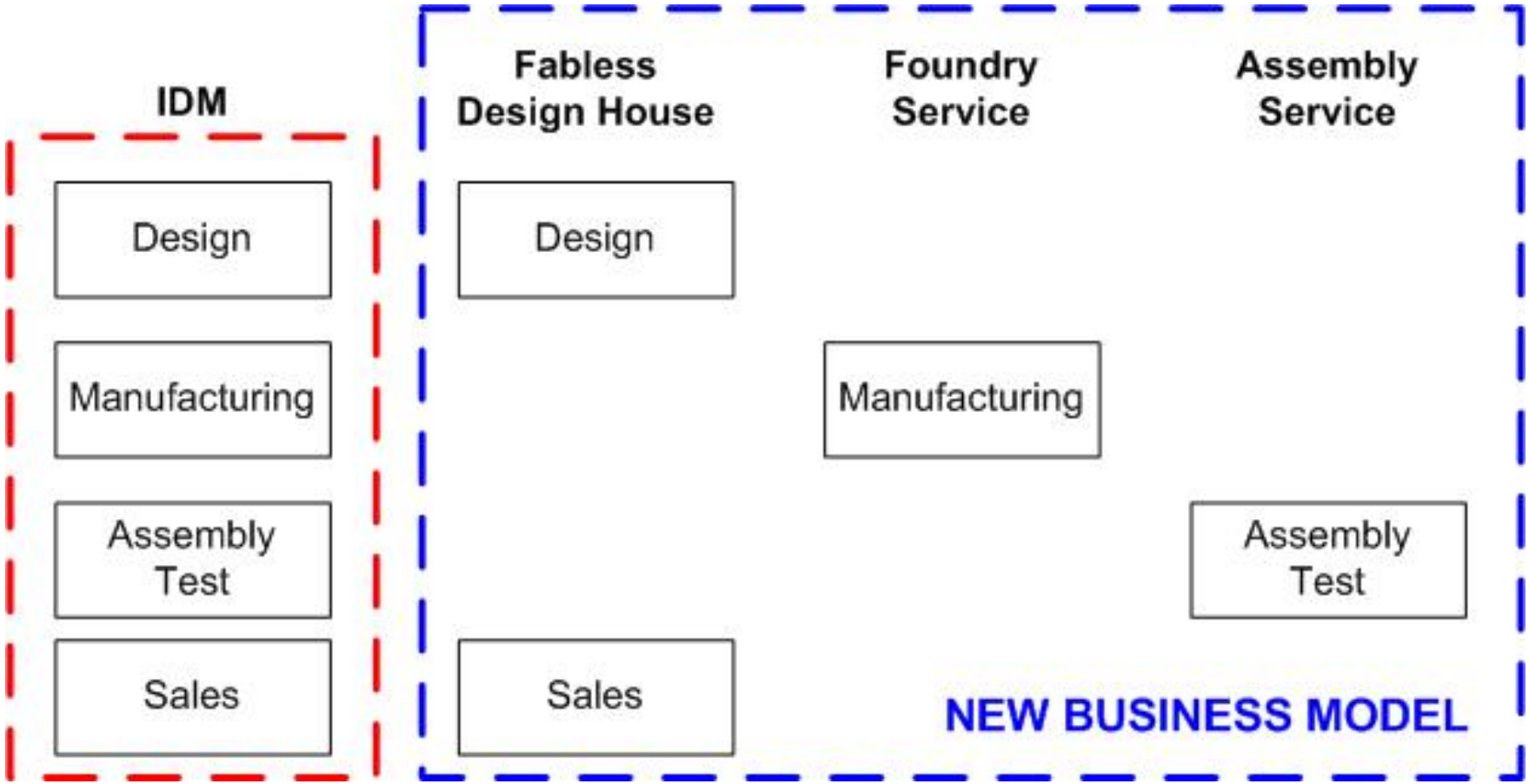
- Without OPC (Optical Proximity Correction) operation, a circuit cannot perform as expected for delivering the plan function.
- After the adoption of OPC design technology in IC design, IC design data size has been significantly increased.



More Data Supporting OPC Operation in Advanced Processes



New Semiconductor Business Model



IDM: integrated design and manufacturing

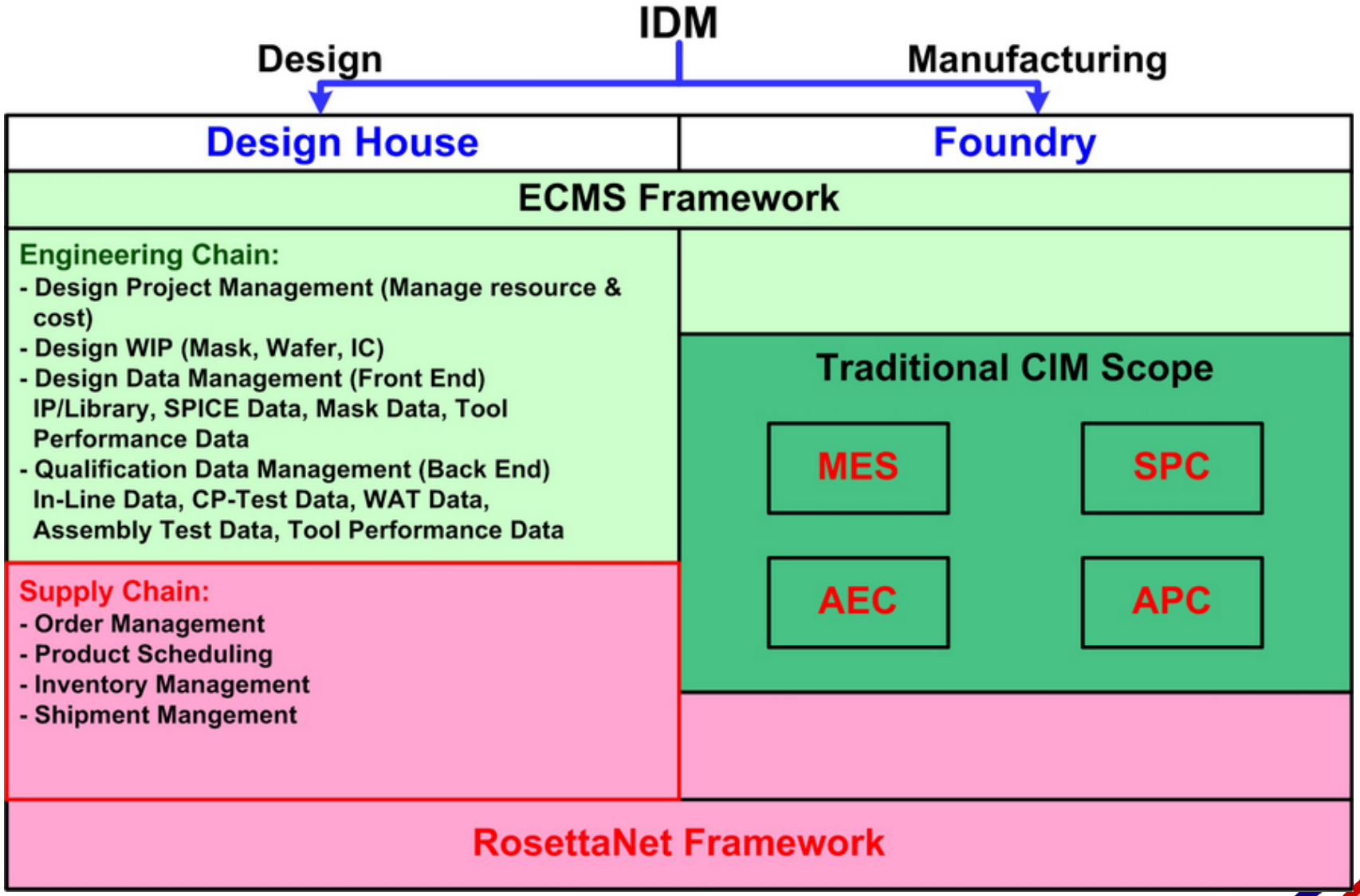
Motivation and Purpose

- To evolve the new business model, different from IDM's operations, current IC design, wafer manufacturing, IC assembly and test are handled by a new collaborative working team -- fabless design house, foundry service provider, and assembly service provider.

- The traditional CIM scope needs to be enhanced for including the supply chain management system (using RosettaNet framework for example) and the Engineering Chain Management System (ECMS) to produce a new comprehensive CIM architecture for supporting this e-Manufacturing operation.

- This study follows the same methodology of establishing the CIM framework to develop the ECMS framework.

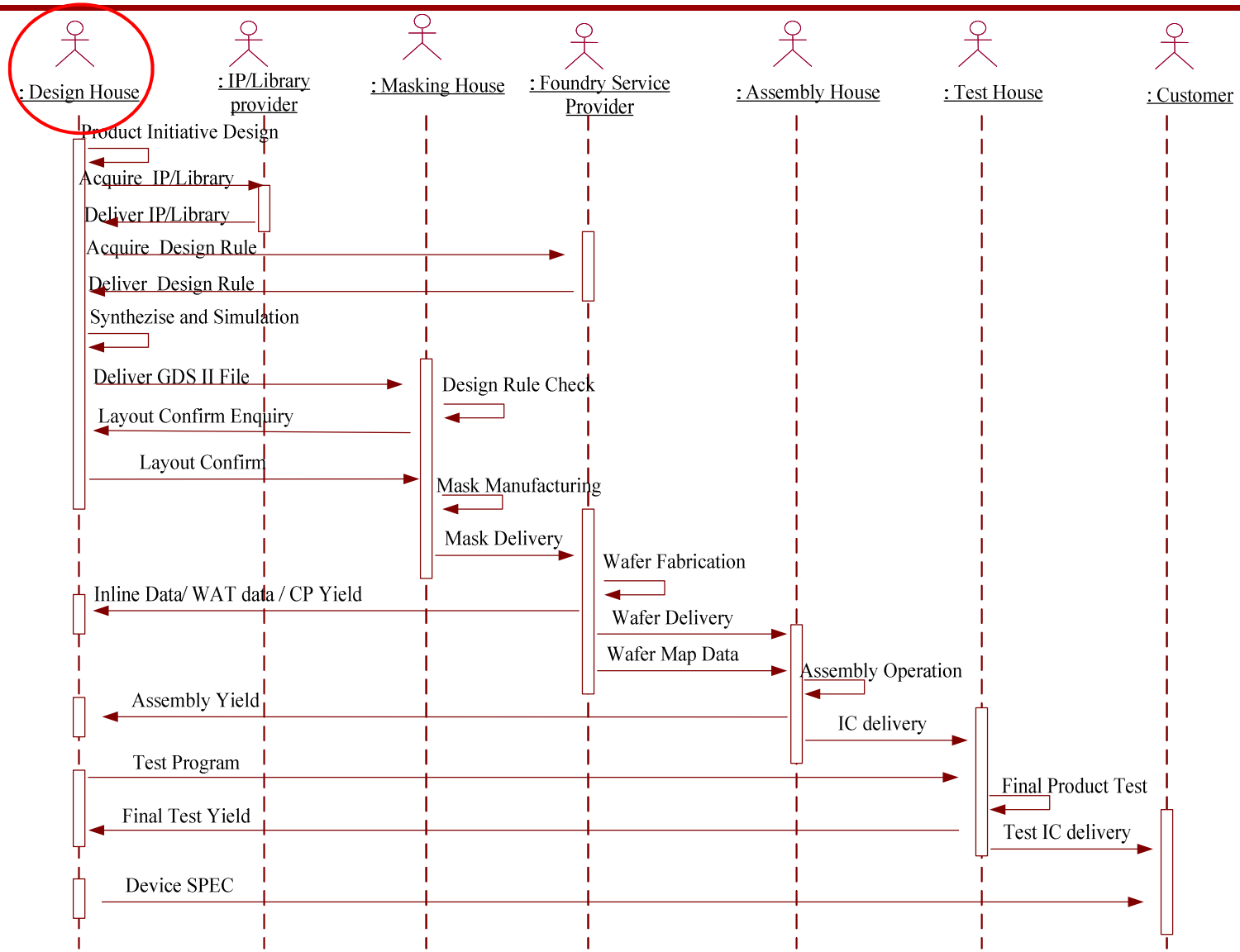
New CIM Scope to Support Engineering Chain



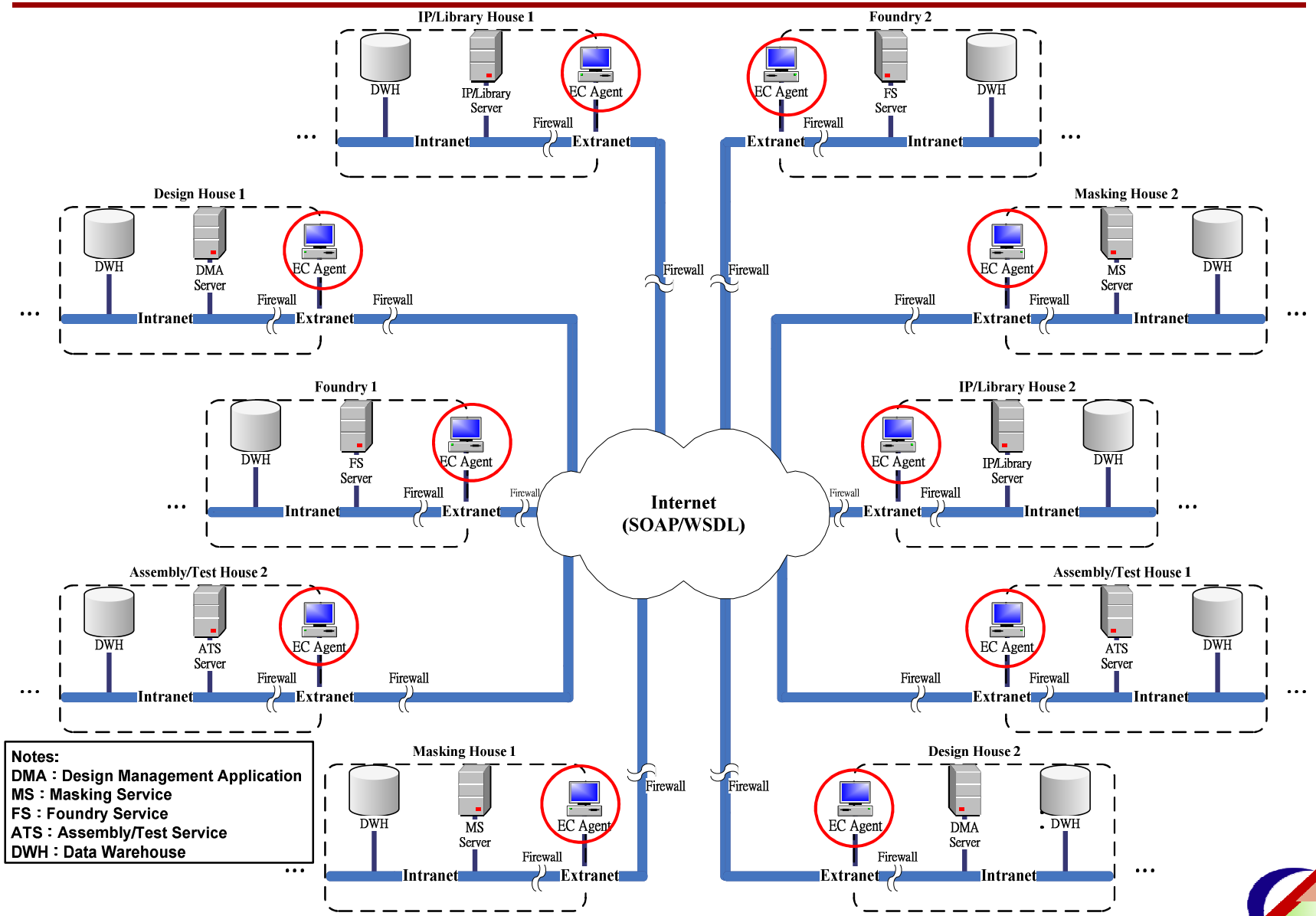
Key Requirements of ECMS

- Distributed Operation
- Security Control
- Efficient Data Exchange Mechanism
- Reliable Data Exchange Mechanism
- Real-time Co-work Capability
- Interoperability
- Product Life Cycle Management and Project Management Capability
- Cross-boundary Knowledge Management
- Design Performance Evaluation

Workflow of Engineering Chain



Vision of Global Engineering Chain System

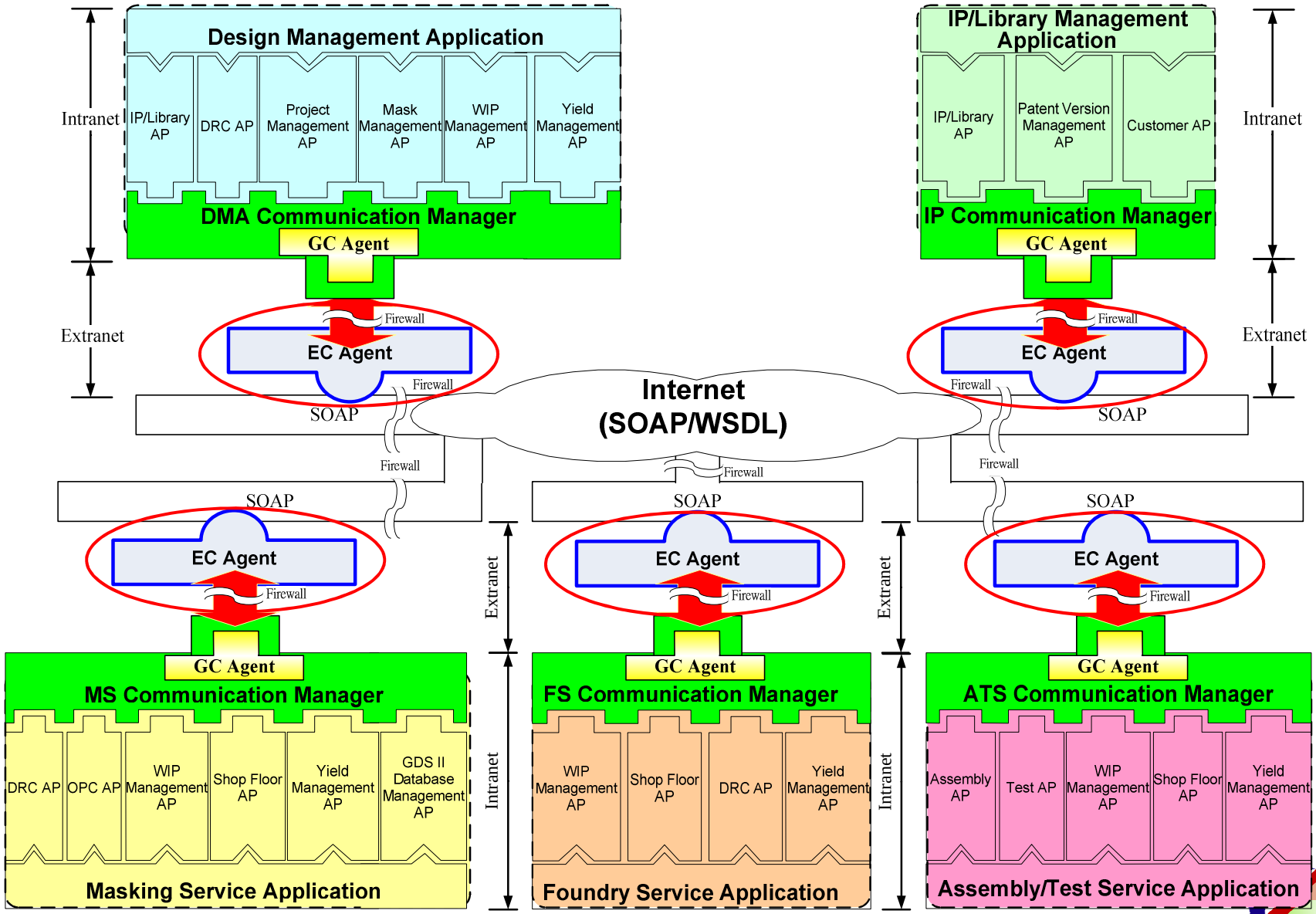


Several Possible Risks Need to be Resolved During Defining EC Operating Scenarios

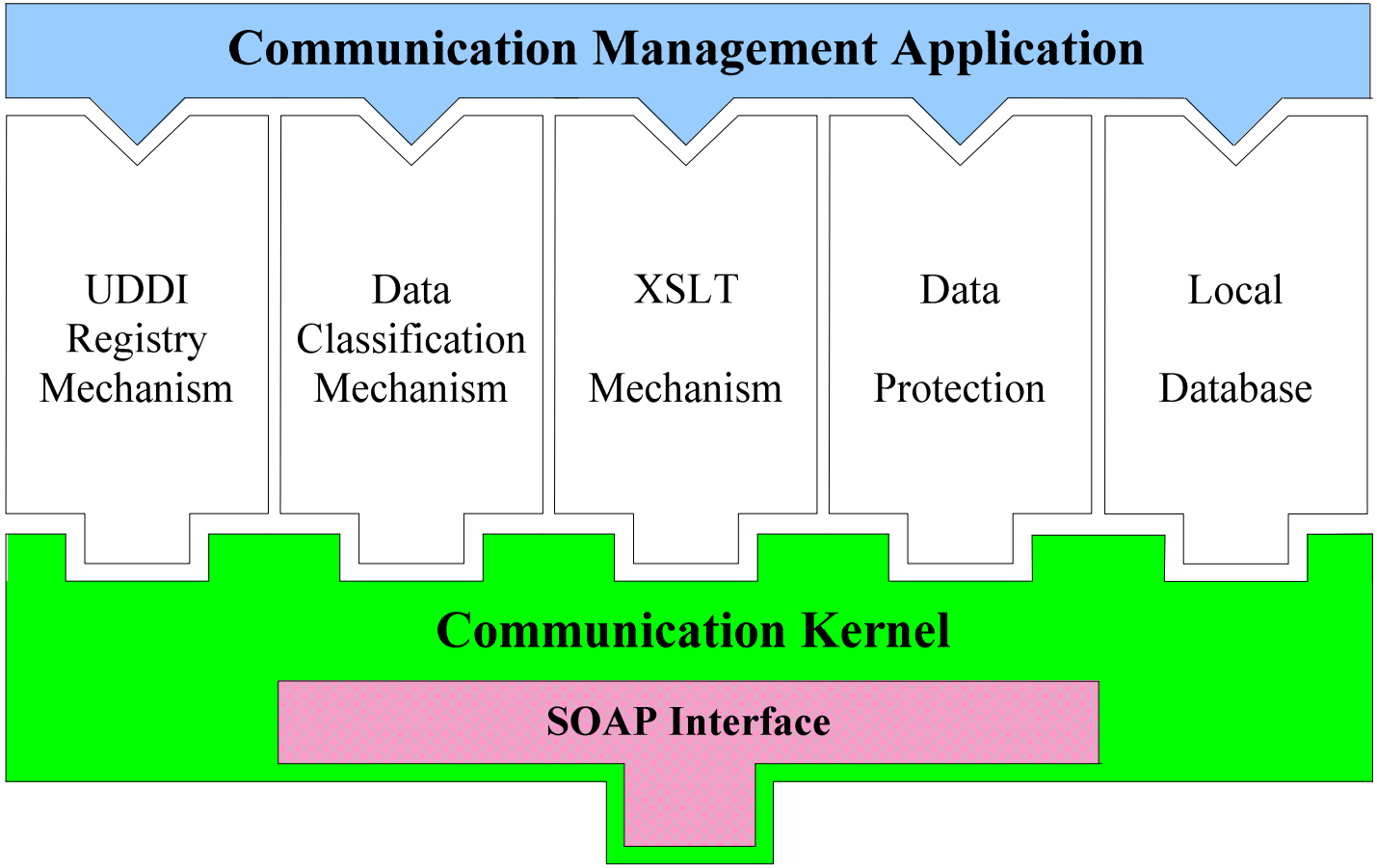
- Does the design house use the same process technology provided by the engaged foundry service provider? (design platform)
- Can the foundry service efficiently and effectively provide all the engineering data necessary for design improvement to the design house?
- Can the foundry service provider's wafer acceptance test (WAT) process and summary report address all potential product defects and respond to the design house in real time? (Key item)
- How can the production specification confirmed by the qualification process be successfully transferred to the mass-production phase to ensure compatible mass-production quality? (golden recipe and tool)

Engineering Chain Management System Framework

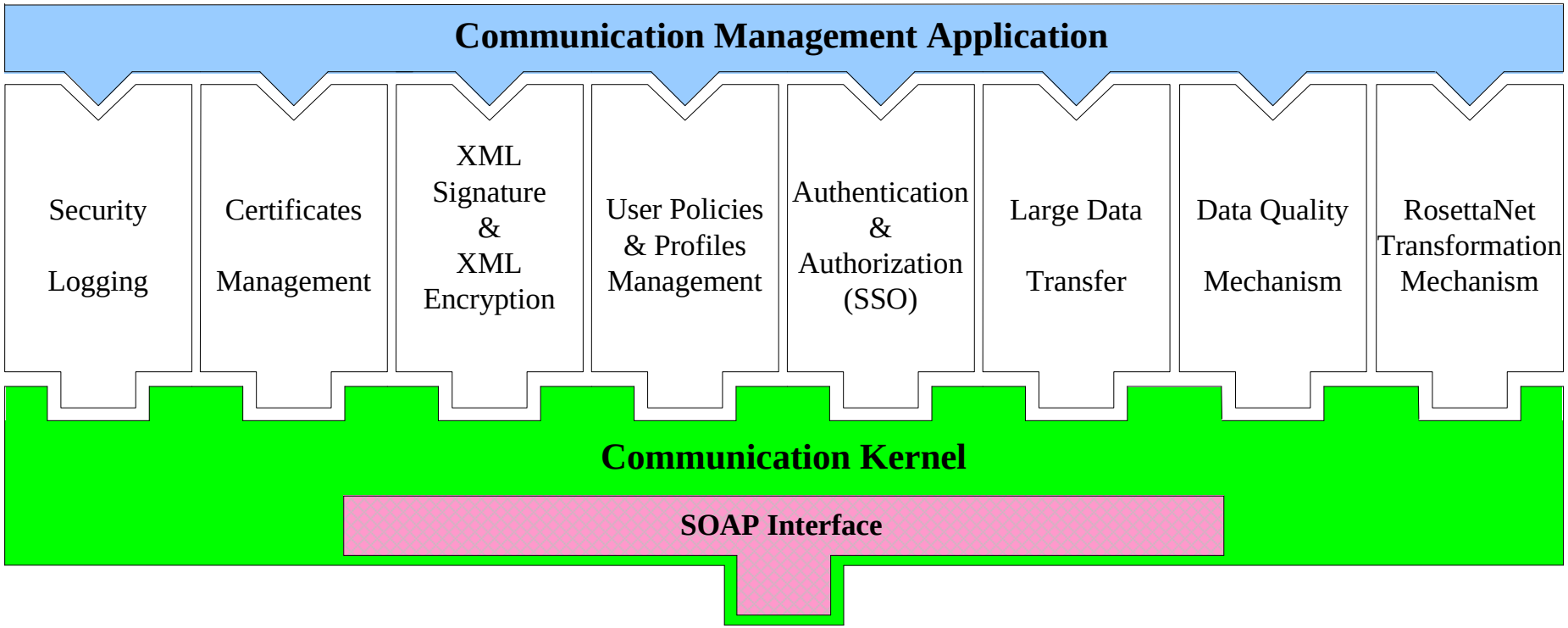
System Components of ECMS Framework



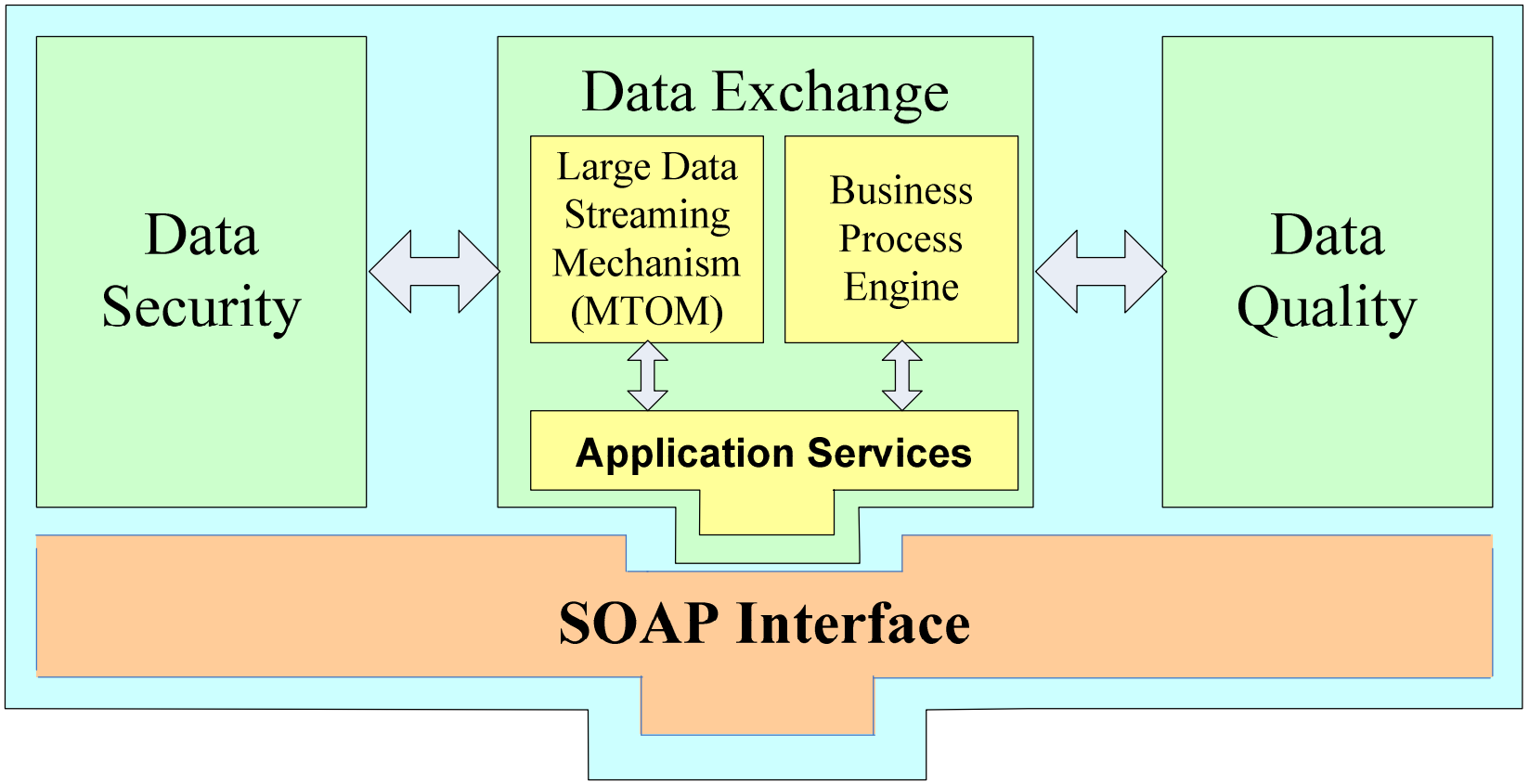
System Components of GC Agent



System Components of EC Agent

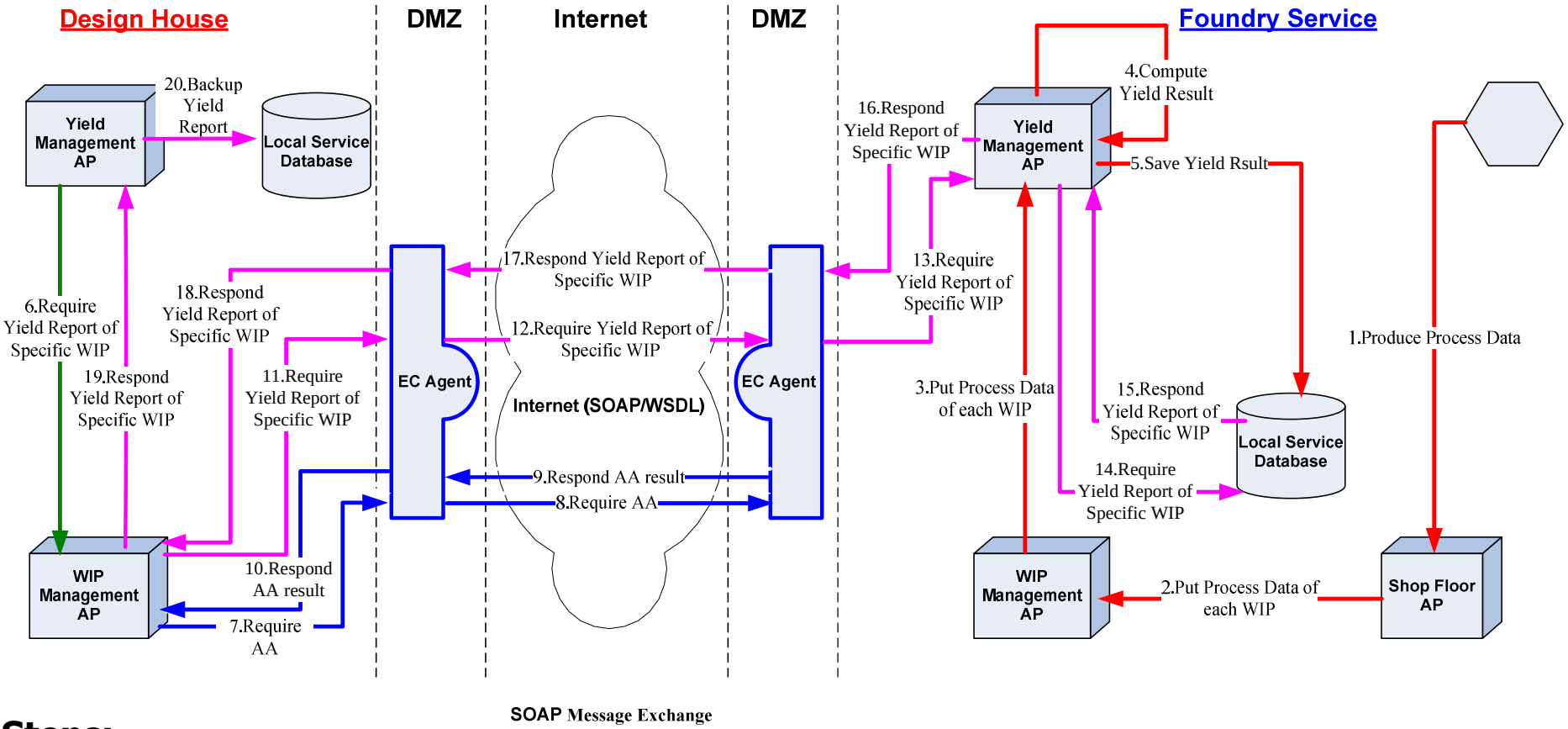


System Components of EC Agent



EC Workflow Scenario

Signal Flow for Design House Requesting Yield Report from Foundry Service



Steps:

1.Foundry Service collects process & yield data and store them in Database.

2.Design House requests a yield report from Foundry Service.

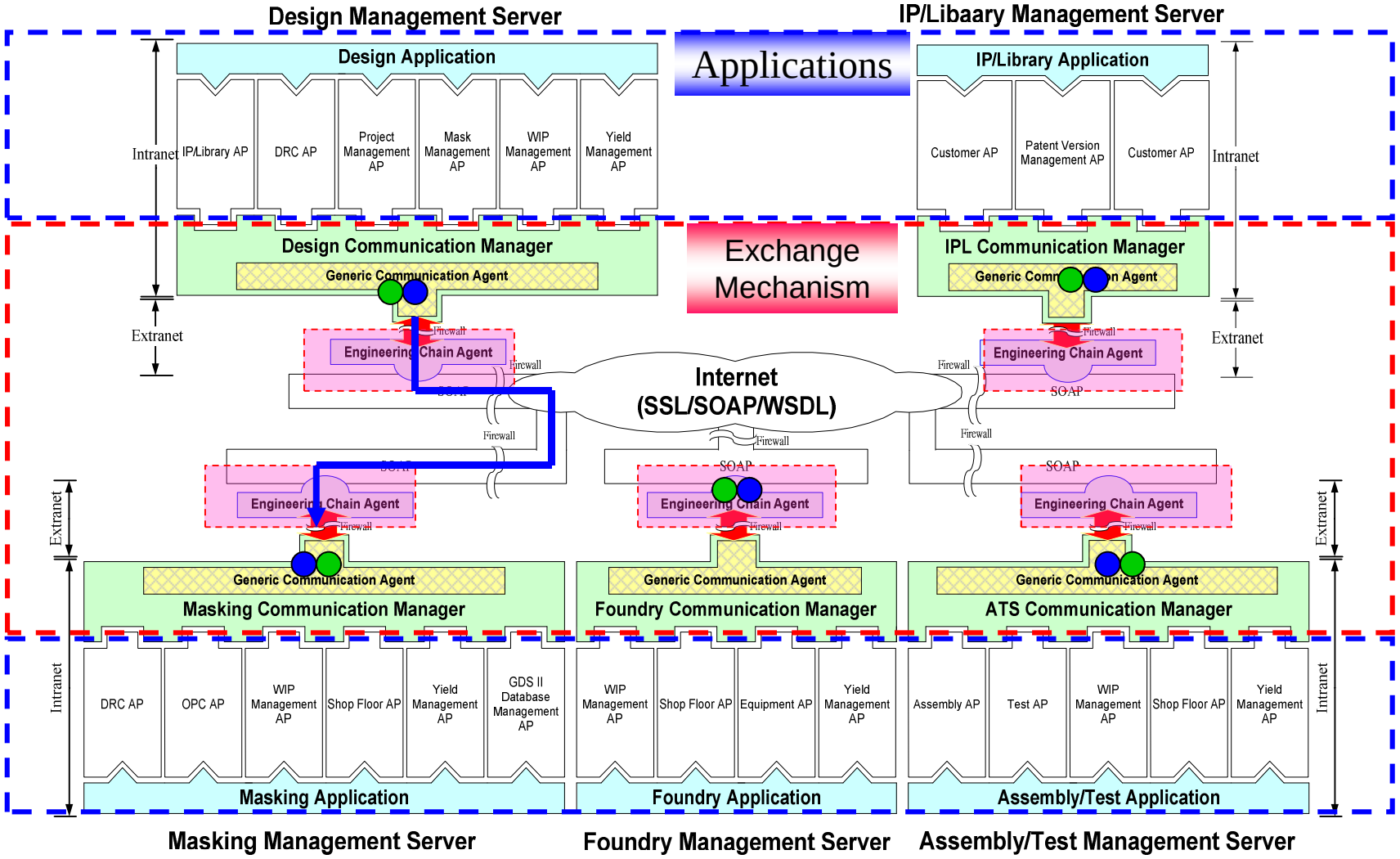
3.Design House must first obtain Authentication & Authorization from Foundry Service.

4. After obtaining A & A, Design House can access the yield report from Foundry Service.

Data-Exchange Mechanism in Engineering-Chain-Management-System Framework

Engineering Chain Management System

3. Complicated Business Flow (GDS II File)



Design of Data-Exchange Mechanism

- Mechanism of data communication and integration
- Mechanism of data-transfer security
- Mechanism of large-data transfer
- Mechanism of business-process transaction

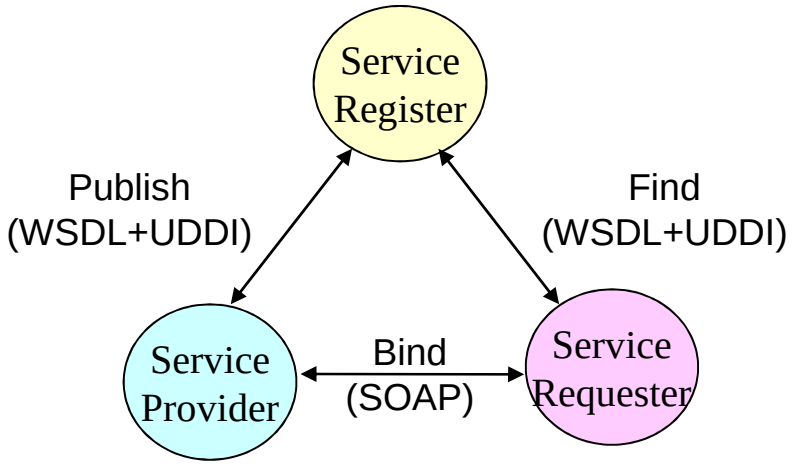
Mechanism of Data Communication and Integration

- **Issue:**
  - **It is not suitable for using some traditional-distributive-object technologies (e.g. DCOM, CORBA and RMI) into data exchange and integration in engineering chain.**
  - **There are some latent issues for those traditional technology, such as using dedicate connections and communication integration.**

Data Source：
G.-P. Lee - Web services design model.
L.-S. Su- Web Services- the next-generation web technology.
The Middleware Company - J2EE vs. Microsoft .NET A comparison of building XML-based web services.
Web Services A Technical Introduction. Upper Saddle River, New Jersey: PRENTICE HALL, 2003.

Mechanism of Data Communication and Integration (cont.)

- **Possible solution:**
  - **Adopting Web Services technology with SOA and XML base to develop data-exchange mechanism to solve the problem of data communication and protocol.**
  - **Adopting .NET as the development platform, because it possesses a development environment with high efficiency and high security.**



Mechanism of Data-transfer Security

- **Issue:**
  - **Security is a crucial issue for engineering-data exchange among IC related companies in engineering chain.**
- **Possible solutions:**
  - **Certificate management**
  - **System security: Authentication/ Authorization, Auditing and Administration**
  - **Security of data transfer: Secure Socket Layer**
  - **Security of message layer: XML Signature and Encryption**

Data Source：

T. S. Zhan and S. U. Wu – Technologies of Information and Network Security.
ITU-T (The International Telecommunication Union Telecommunication Standardization Sector) - X.800 Security Architecture for OSI.
Web Services Enhancements for Microsoft .NET.
IBM and Microsoft - Web Services Security (WS- Security), Technical report.

Mechanism of Large-data Transfer

- **Issue:**
  - **The more large size of GDS-II data file can be a crucial issue for traffic of data exchange for engineering-chain management.**

Data Source：
W3C - SOAP Message Transmission Optimization Mechanism
WSE 3.0 - What's New in Web Services Enhancements 3.0

Mechanism of Large-data Transfer (cont.)

- **Possible solutions:**
  - To solve large-data transfer, adopt Message Transmission Optimization Mechanism (MTOM) of Microsoft's WSE to provide efficiency data transfer with binary data encoding.
  - MTOM technology owns the SOAP base proposed by W3C, to replace with DIME (Direct Internet Message Encapsulation) and WS-Attachment

Mechanism of Business-Process Transaction

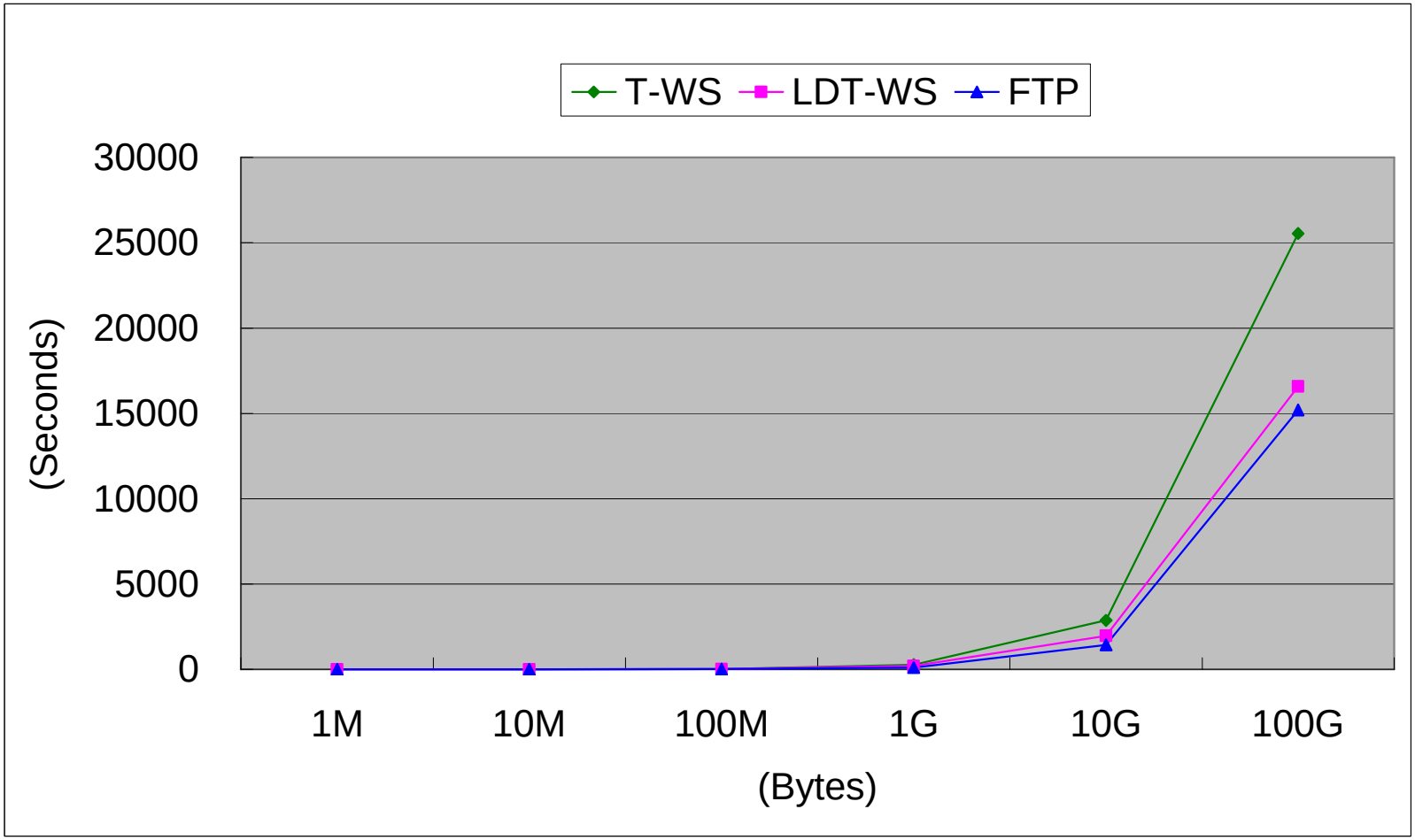
- **Issue:**
  - **The Web Services belongs to ‘stateless’ for message delivery between applications, which cannot be satisfied for business process**

Source:
G.-H. Huang -Development of a Web-Services Based dynamic and collaborative business process Application and Integration Framework, 2003.
S. Weerawarana and F. Curbera - Business Process with BPEL4WS-Understanding BPEL4WS Part 1, August 2002.

Mechanism of Business-Process Transaction (cont.)

- **Possible solution:**
  - **Adopting Microsoft BizTalk Server with the standard of Business Process Execution Language for Web Services (BPEL4WS) as the development tool, which can work with .NET closely.**

Comparison of Data Transmission Performance



T-WS: Traditional web-services method
LDT-WS: Our proposed large-data-transfer web-services method
FTP: File transfer protocol

Conclusions

- Novel semiconductor business model – Engineering Chain for the semiconductor industry is defined.
- Effective EC operation scenarios for improving the design productivity, through faster design cycle and higher product yield are proposed.
- The ECMS Framework is designed to support the coherent collaboration of the EC.
- The ECMS framework can be applied to develop any information communication platform involving all EC design partners, and to enhance the design productivity for the semiconductor and other industries.