Holonic Supply Chain System for e-Manufacturing

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- Introduction
- Basic Foundations
- Development Procedure
- Development of Generic Holon
- Development of Exchange Holon & HIES
- Development of Communication Holon & HICS
- Conclusions

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Vision of e-Manufacturing

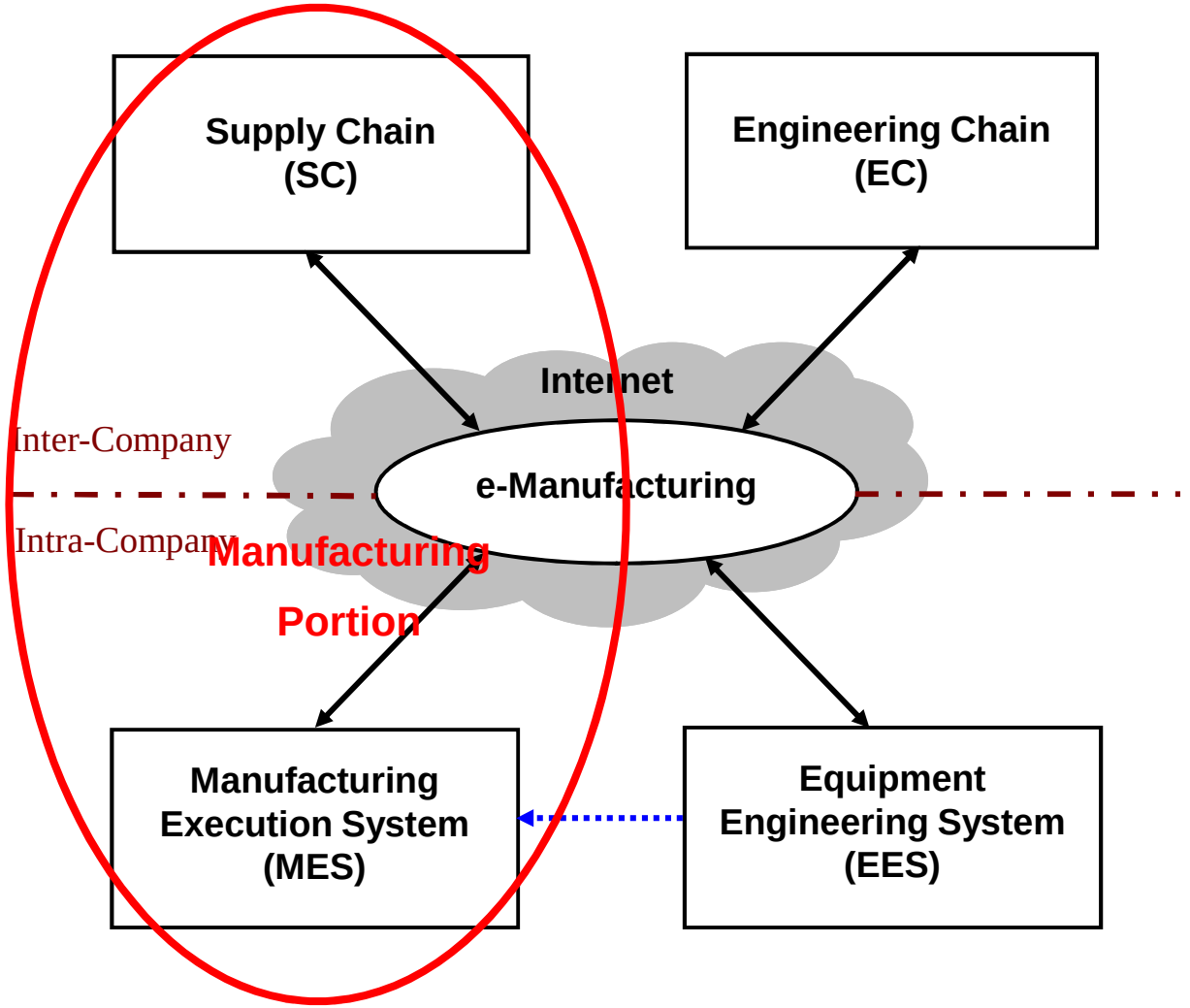
- Definition of e-Manufacturing

  Advanced manufacturing utilizing Information and Internet Technology to improve agility, efficiency, decision-making, etc.

- Goals of e-Manufacturing

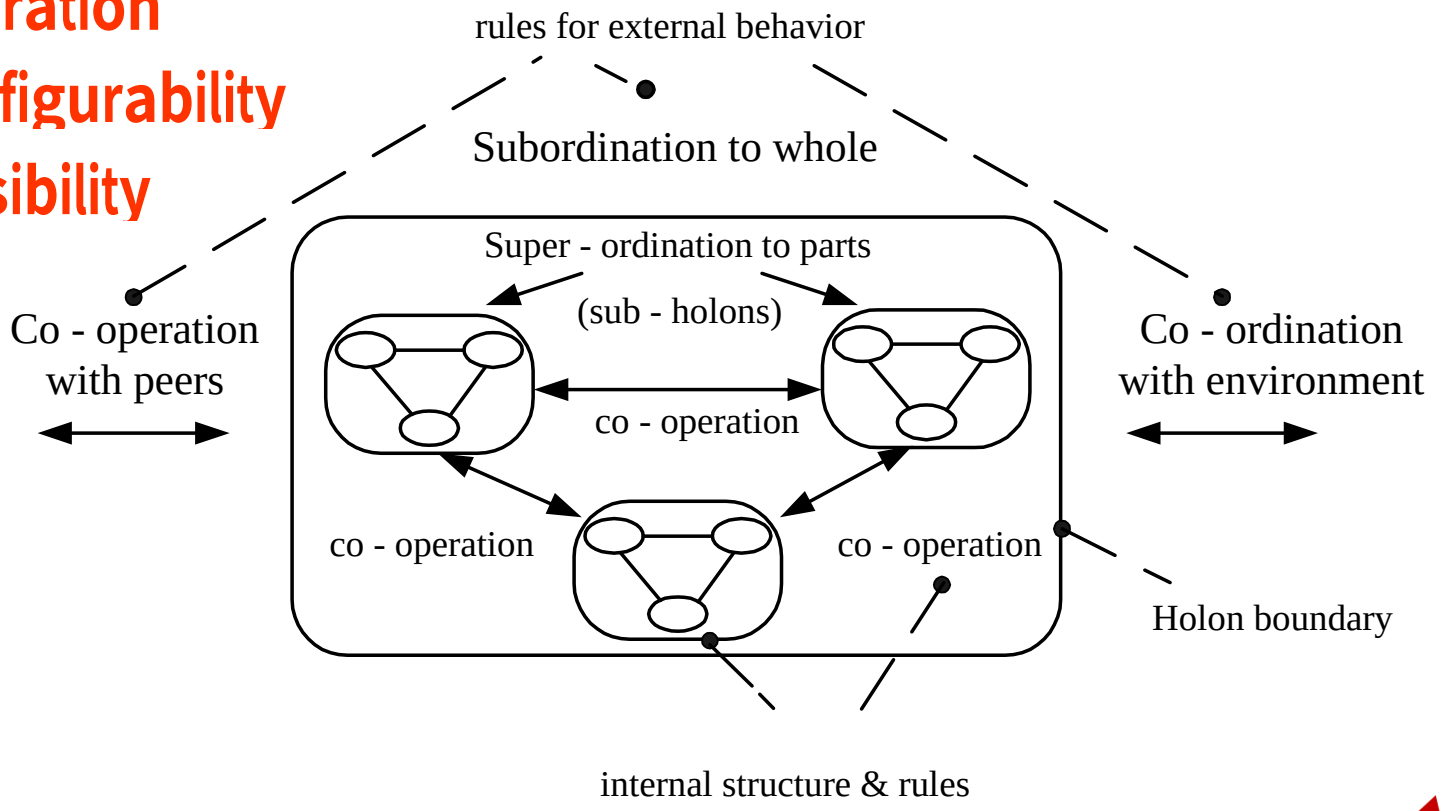
  - Reduce the overall production cost.
  - Provide fast responses to customers' requests.
  - Deliver correct information to the right people at right time.

Scope & Elements of e-Manufacturing

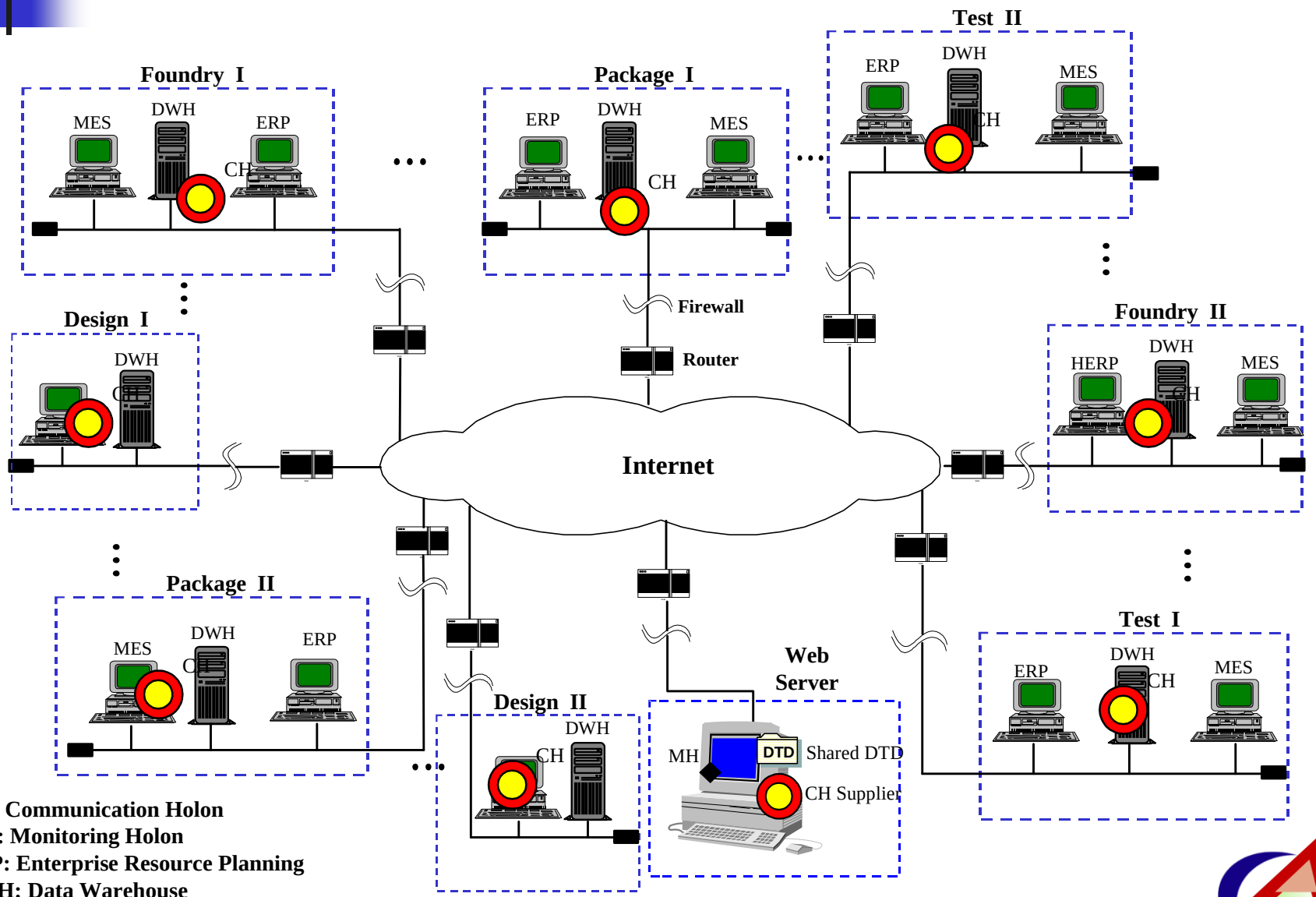


The Concept of Holon

- Intelligence
- Autonomy
- Cooperation
- Reconfigurability
- Extensibility

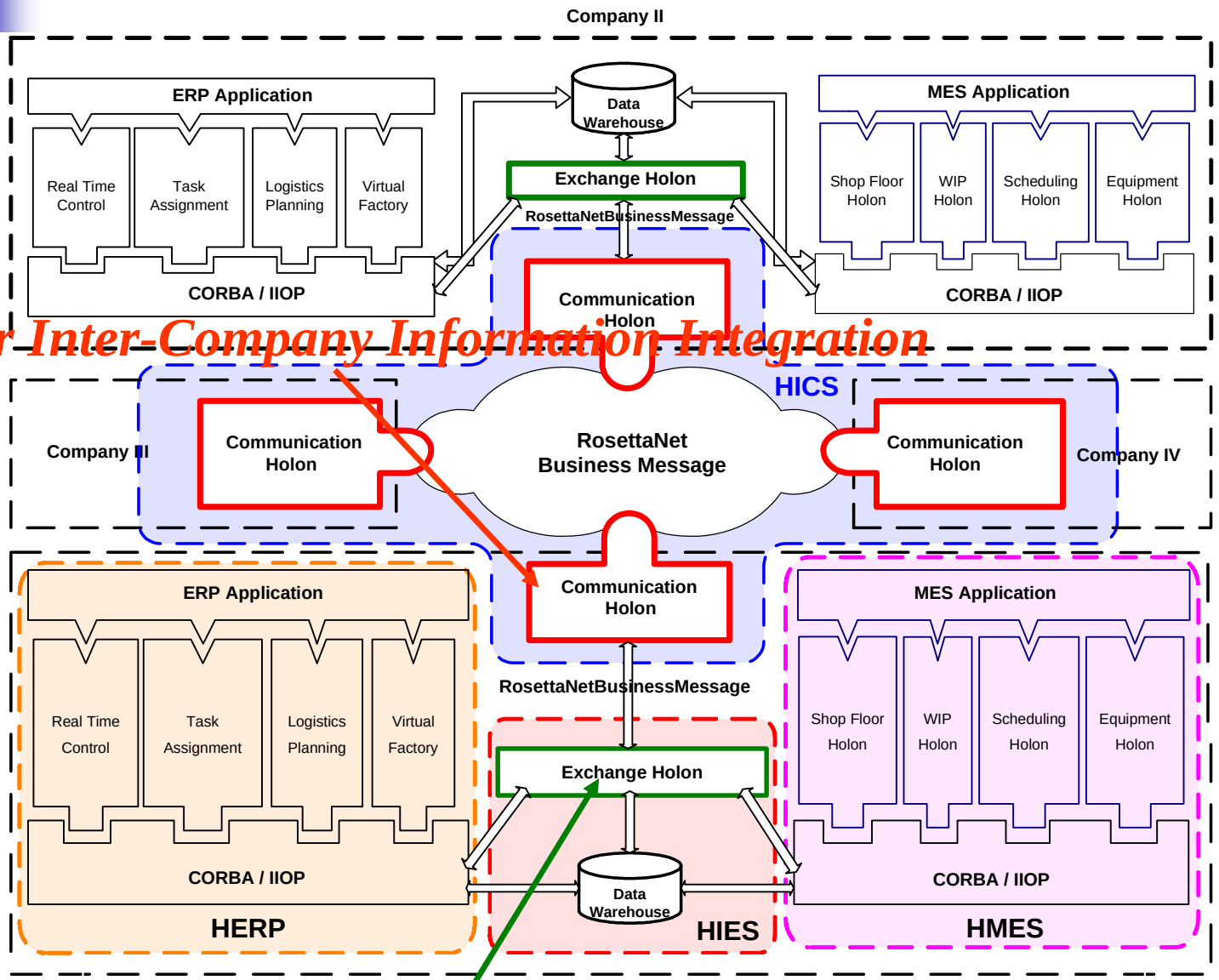


Semiconductor Supply Chain System



CH: Communication Holon
MH: Monitoring Holon
ERP: Enterprise Resource Planning
DWH: Data Warehouse
MES: Manufacturing Execution System
DTD: Document Type Declaration

Semiconductor Holonic Supply Chain System



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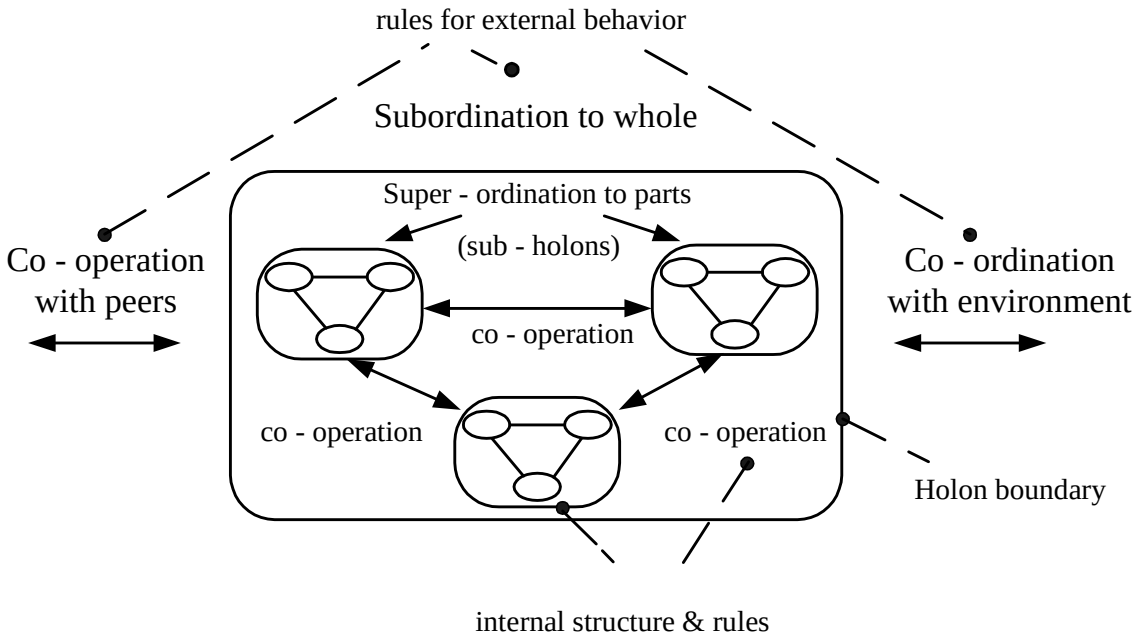
Basic Foundations

- Holon
- UML
- CORBA
- XML
- RosettaNet
- Network Security
- Distributed & Object-Oriented Systems

Basic Foundations (cont.)

Holon

- Intelligence
- Autonomy
- Cooperation
- Reconfigurability
- Extensibility



Basic Foundations (cont.)

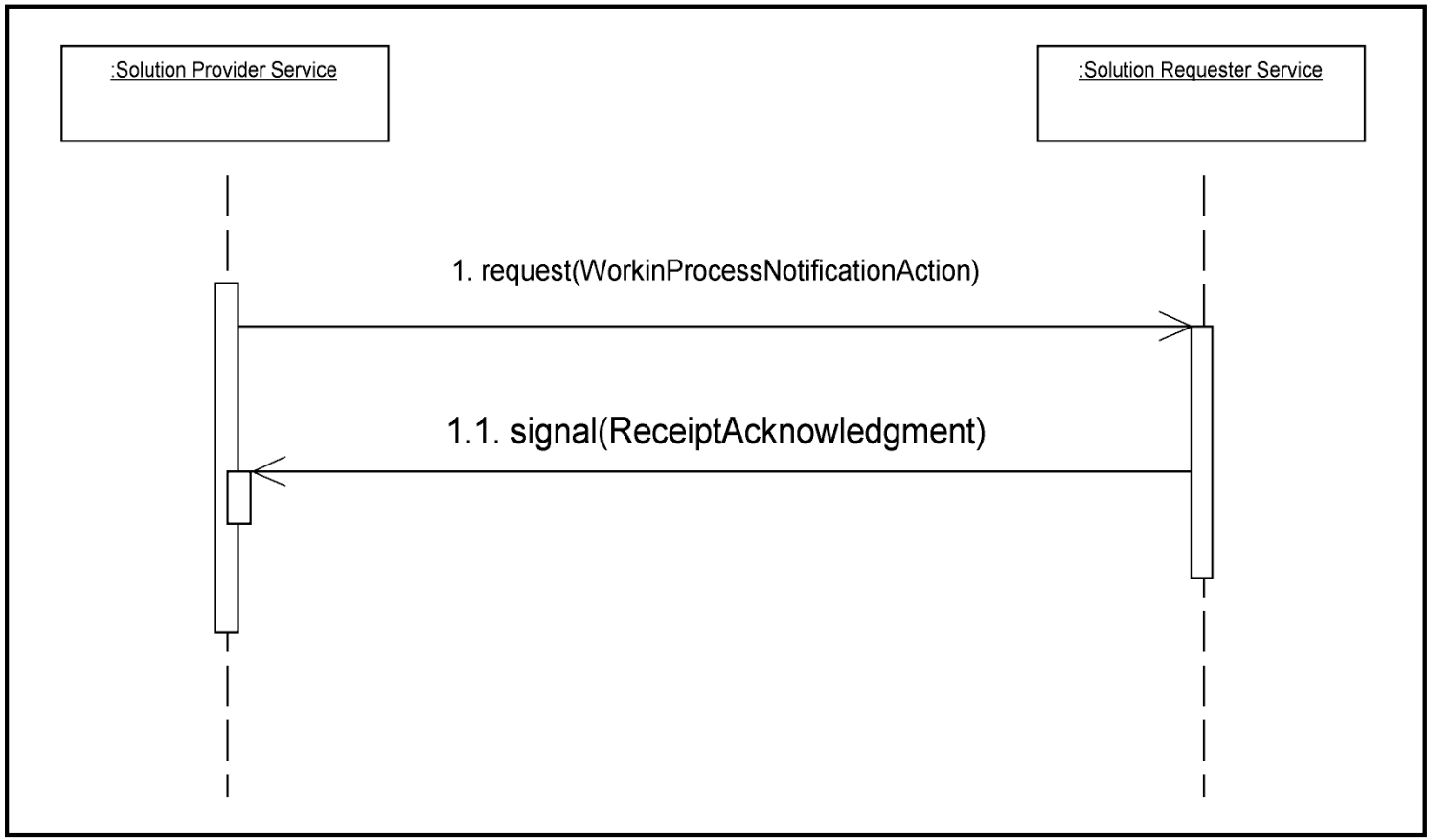
RosettaNet: PIPs (Partner Interface Processes)

Source: RosettaNet Overview, http://www.rosettanettaiwan.org.tw/

Basic Foundations (cont.)

RosettaNet: PIPs (cont.)

- PIP3D8 Distribute Work In Process (One-Action Activity)

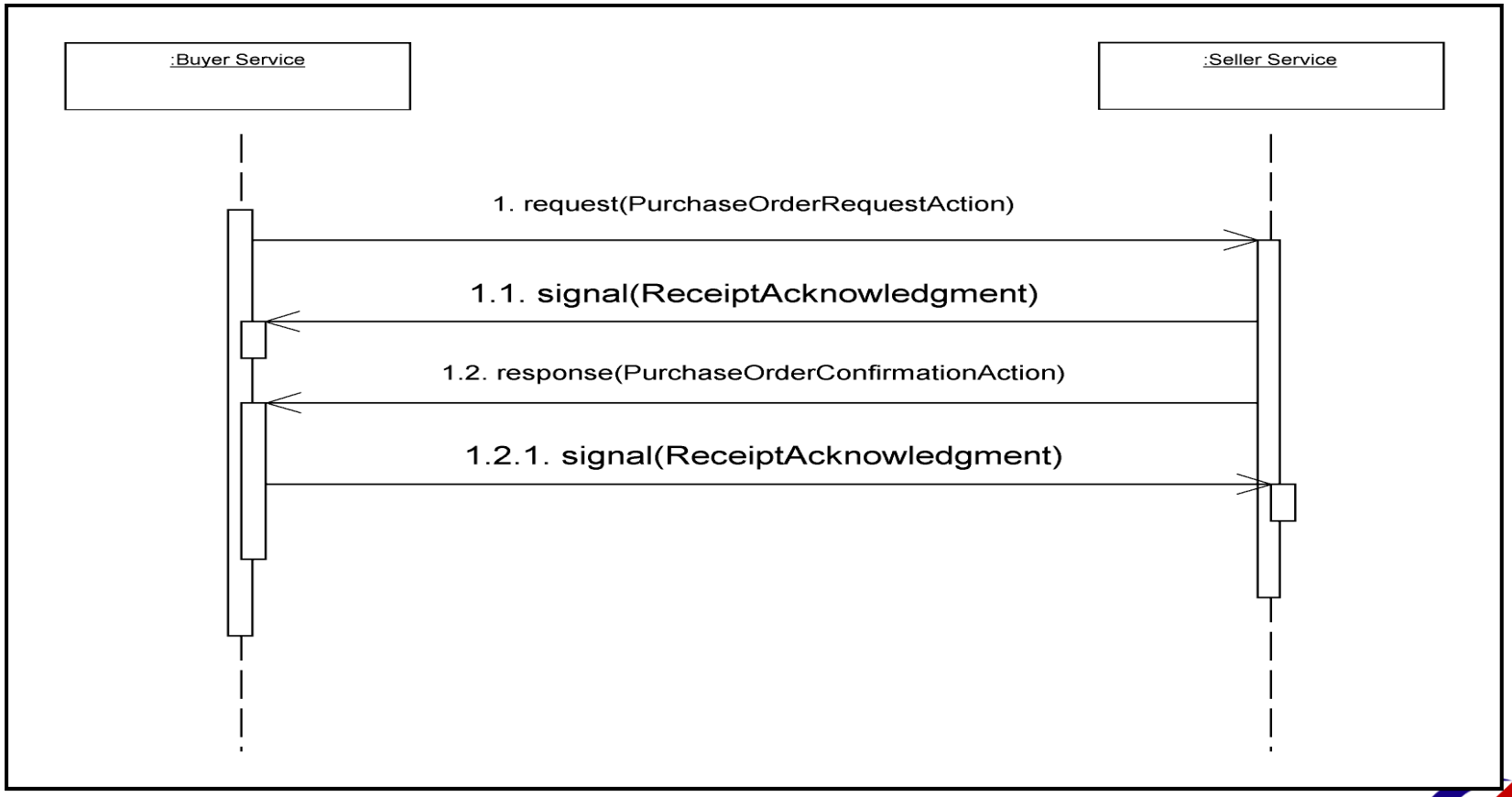


Source: RosettaNet, "RosettaNet PIP Specification", Cluster 3: Order Management, Segment D: Product Configuration, PIP3D8: Distribute Work In Process, http://www.rosettanet.org/ /

Basic Foundations (cont.)

RosettaNet: PIPs (cont.)

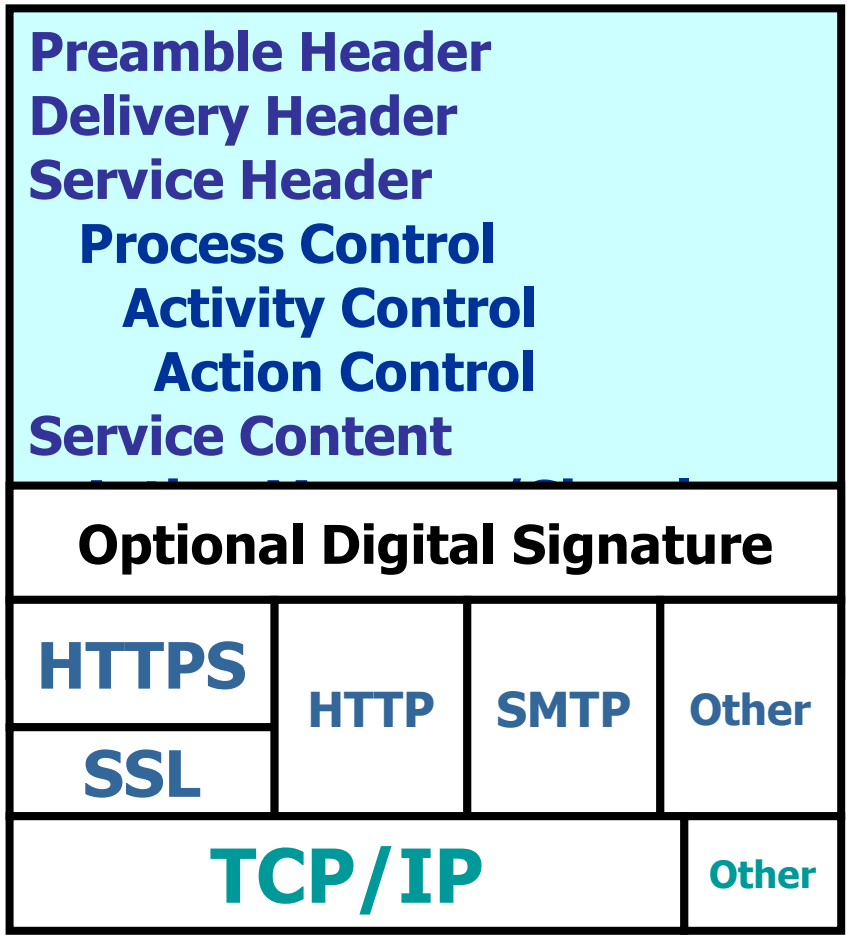
- PIP3A4 Request Purchase Order (Two-Action Activity)



Source: RosettaNet, "RosettaNet PIP Specification", Cluster 3: Order Management, Segment A: Quote and order entry, PIP 3A4: Manage and purchase Order, http://www.rosettanet.org/

Basic Foundations (cont.)

RosettaNet: PIPs (cont.)



RosettaNet Business Message in MIME/S-MIME message formats

Source: http://www.rosettanettaiwan.org.tw/

Source: RosettaNet,
"RosettaNet Implementation Framework",
Specification Status:
Version: Release 2.00.00, 3 January 2001

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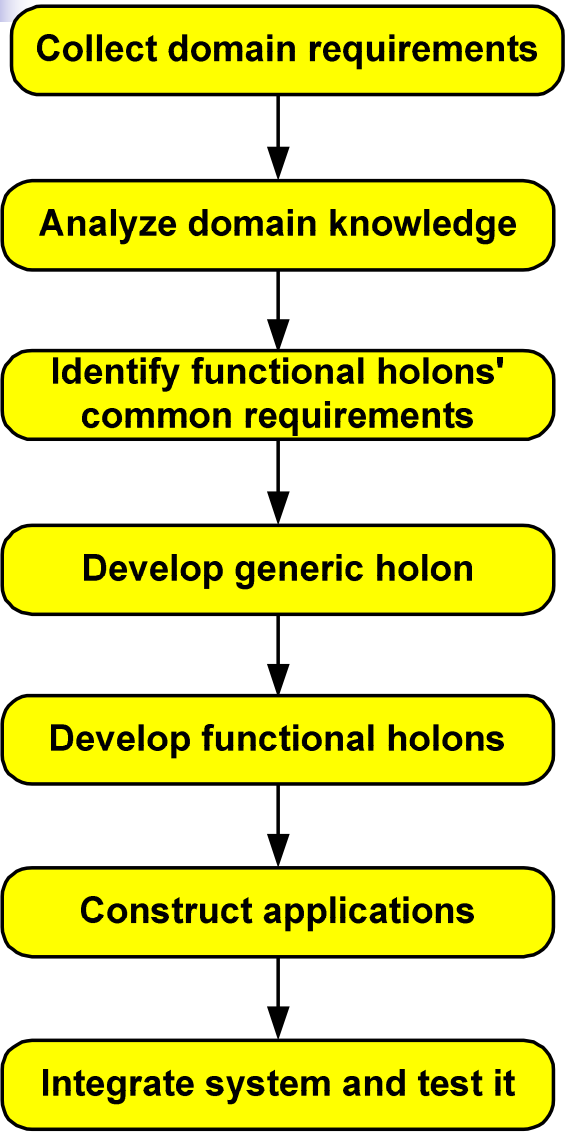
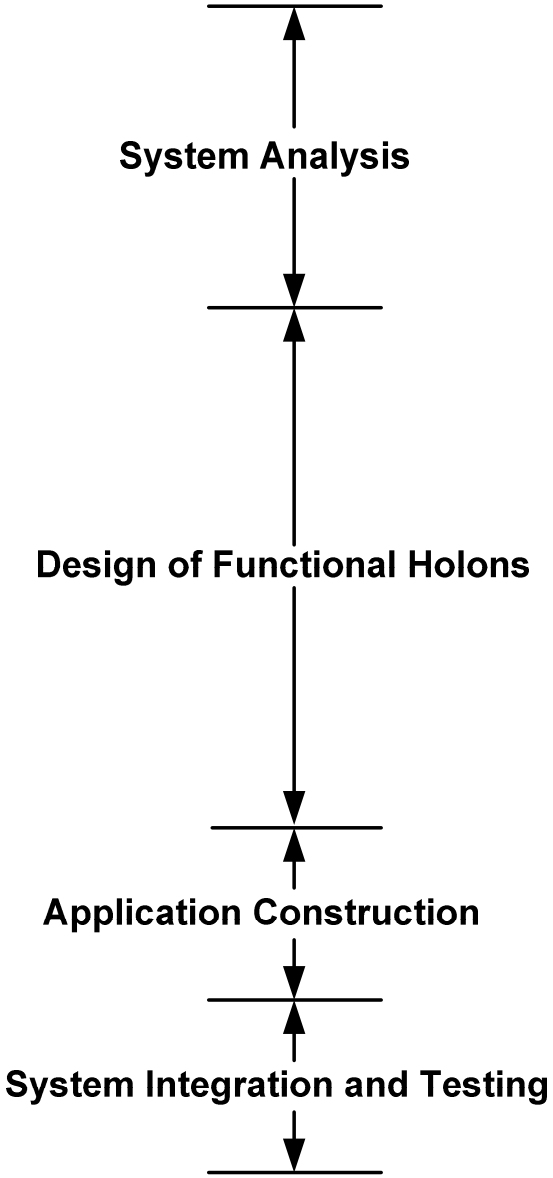
Development Procedure





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Development of Generic Holon

Functional Holons' Common Characteristics

- Intelligence
- Autonomy
- Cooperation
- Reconfigurability
- Extensibility
- Error Detection & Diagnosis
- Security

Development of Generic Holon (cont.)

Requirements of Generic Holon

Intelligence Mechanism

- **Error Diagnosis**

Search Mechanism

- **Collaboration**
- **Reconfigurability**

Security Mechanism

- **Security Check** (Authentication & Authorization)
- **Data Encryption**
- **Data Decryption**

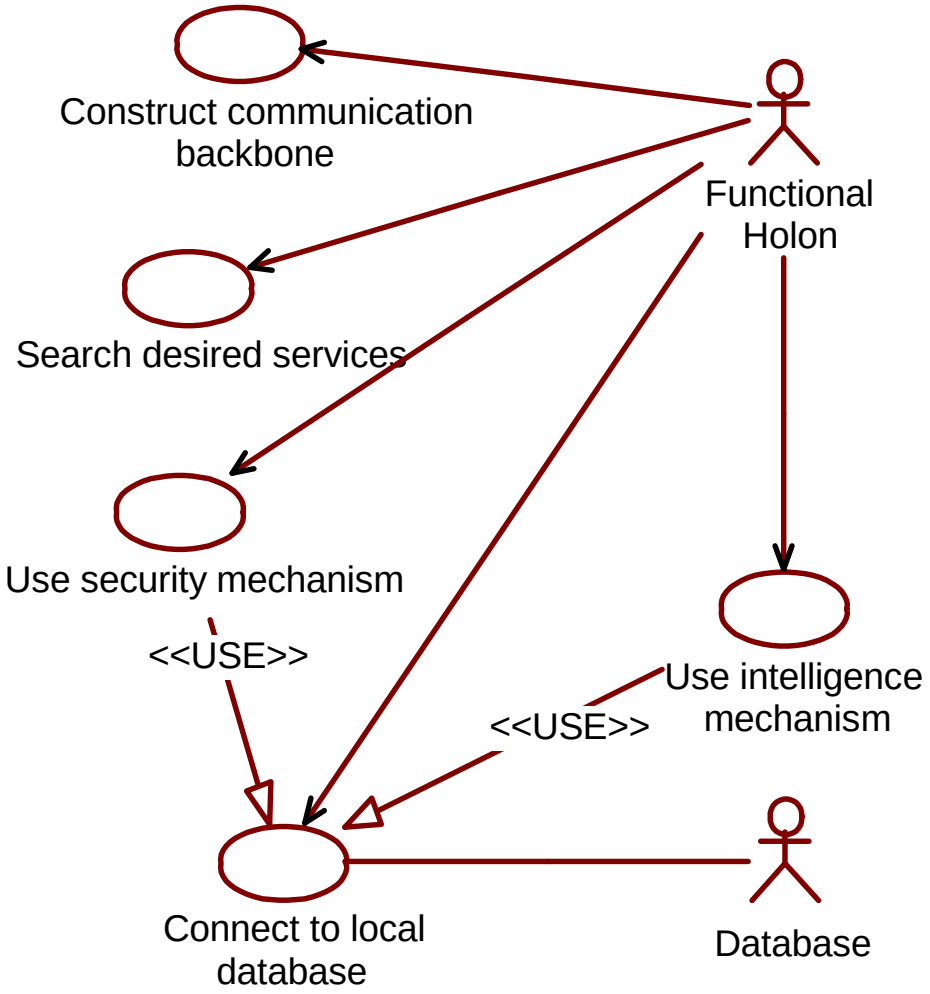
Development of Generic Holon (cont.)

Requirements of Generic Holon

- It establishes a communication backbone for the purposes of extensibility, collaboration, and communication.
- It provides an intelligence mechanism for diagnosing exceptions.
- It provides a search mechanism for the purposes of collaboration and reconfigurability.
- It provides a security mechanism for security check and encryption/decryption.
- It establishes a database service for information storage.

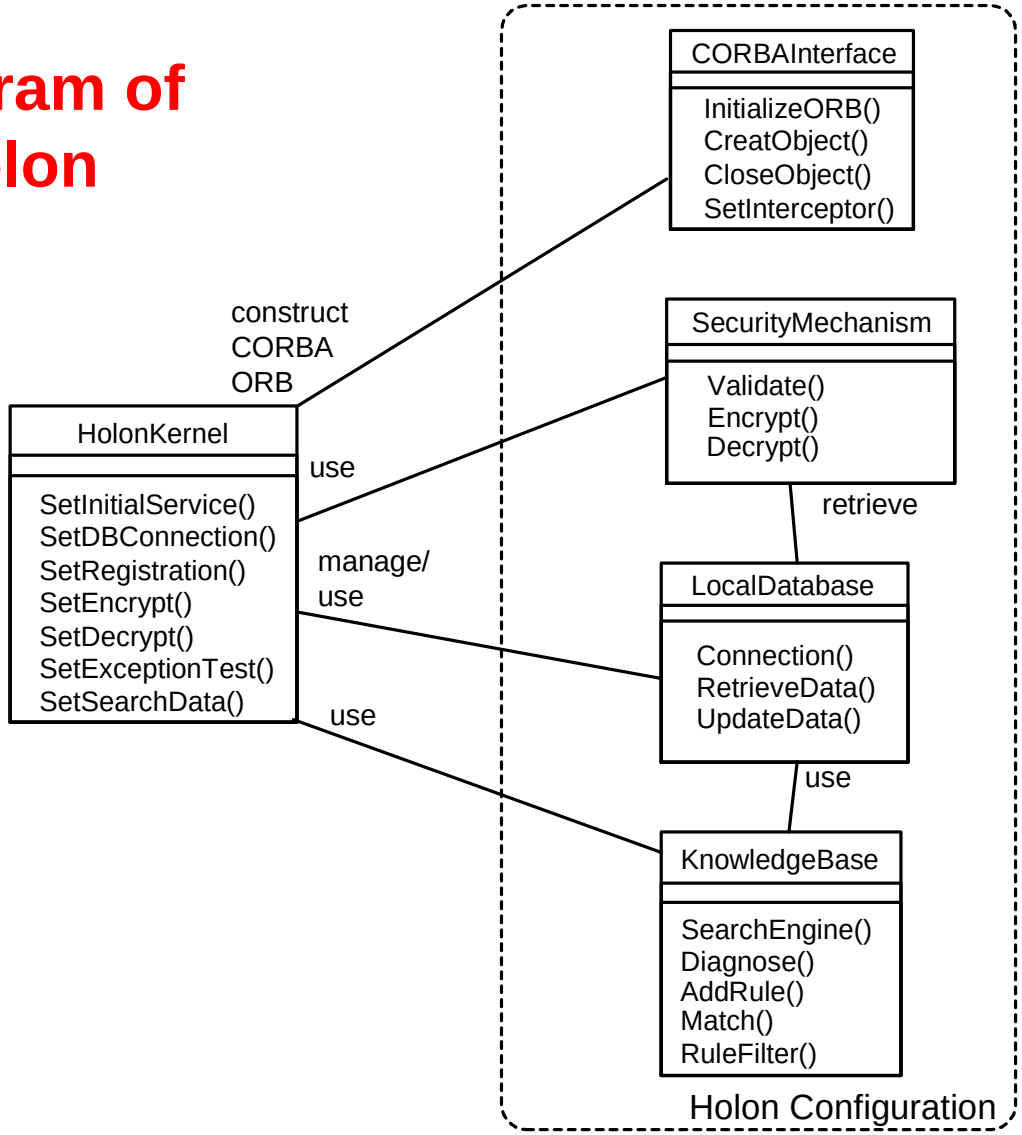
Development of Generic Holon (cont.)

Use Case Diagram for Generic Holon



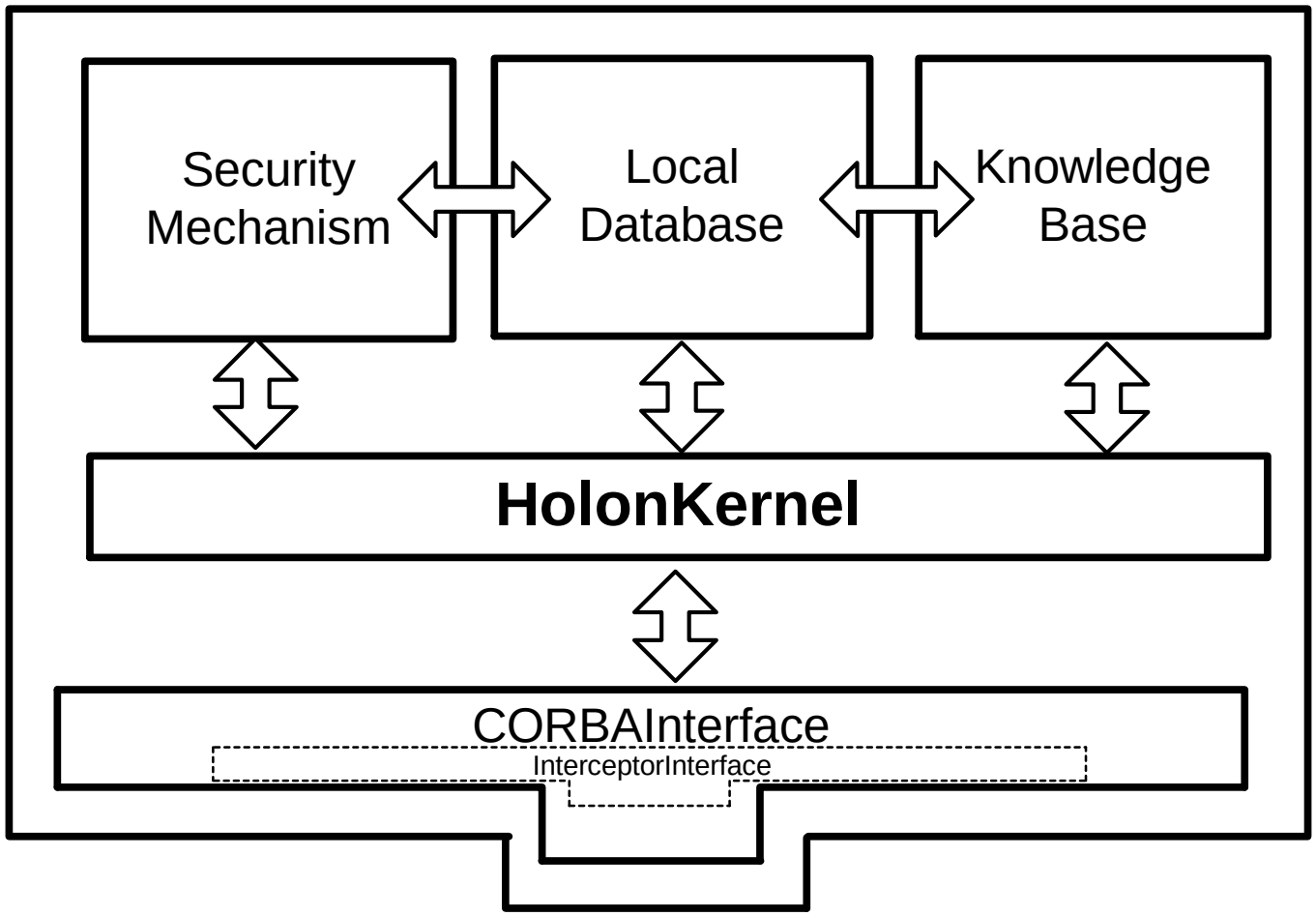
Development of Generic Holon (cont.)

Class Diagram of Generic Holon



Development of Generic Holon (cont.)

Generic Holon Internal Architecture



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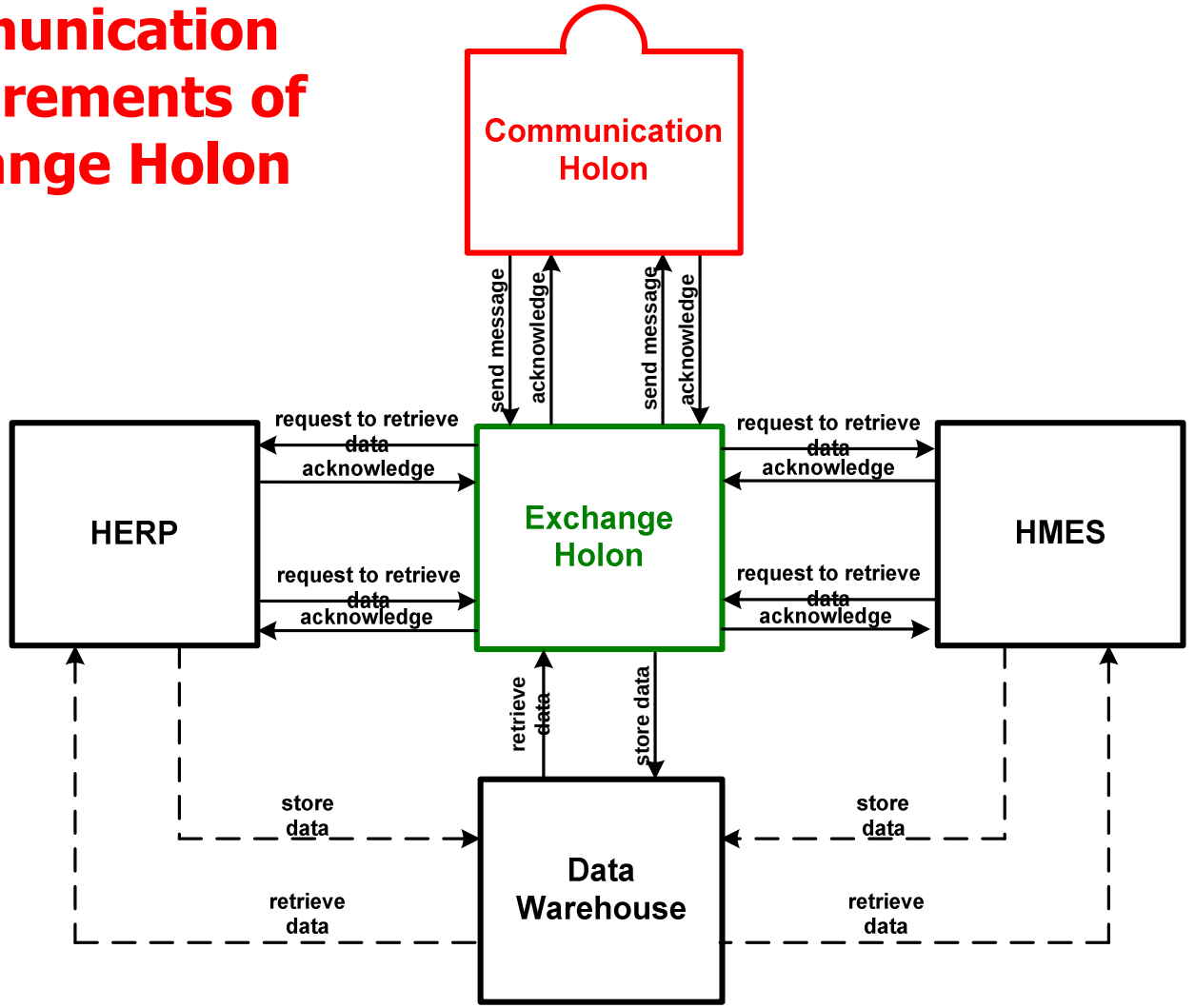
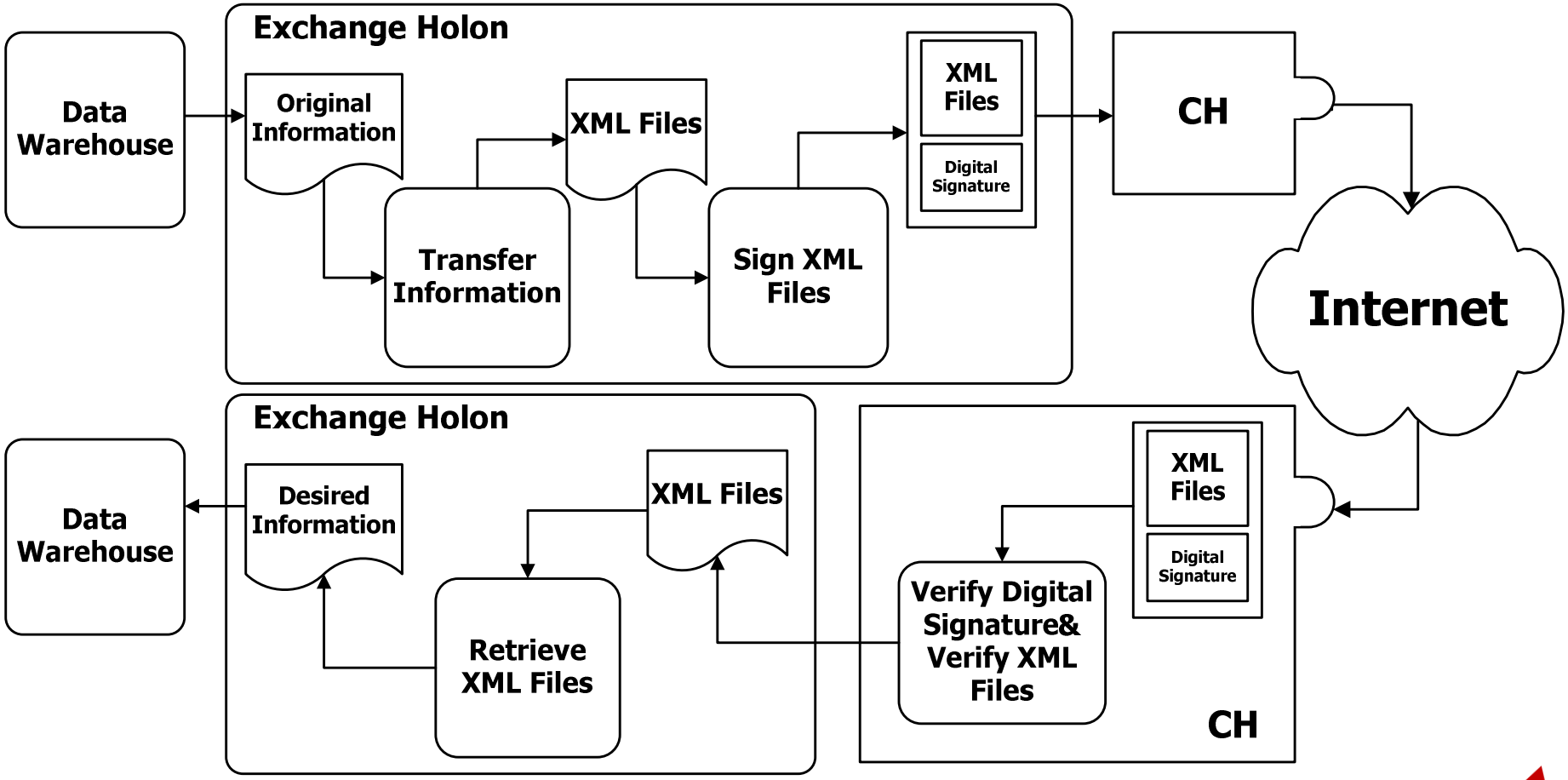
Development of Exchange Holon

Communication Requirements of Exchange Holon



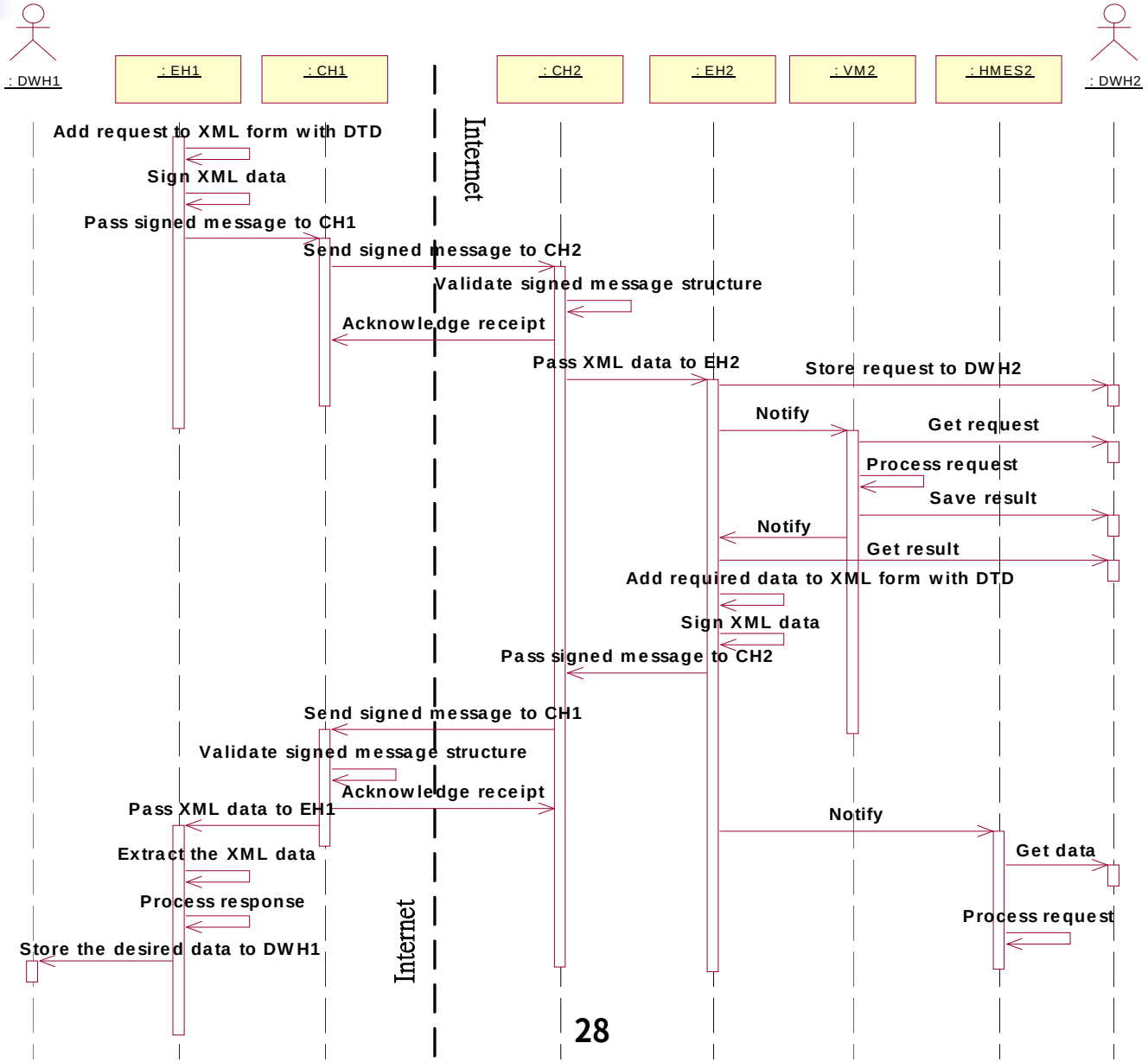
Development of Exchange Holon (cont.)

Digital Signature & XML Transformation



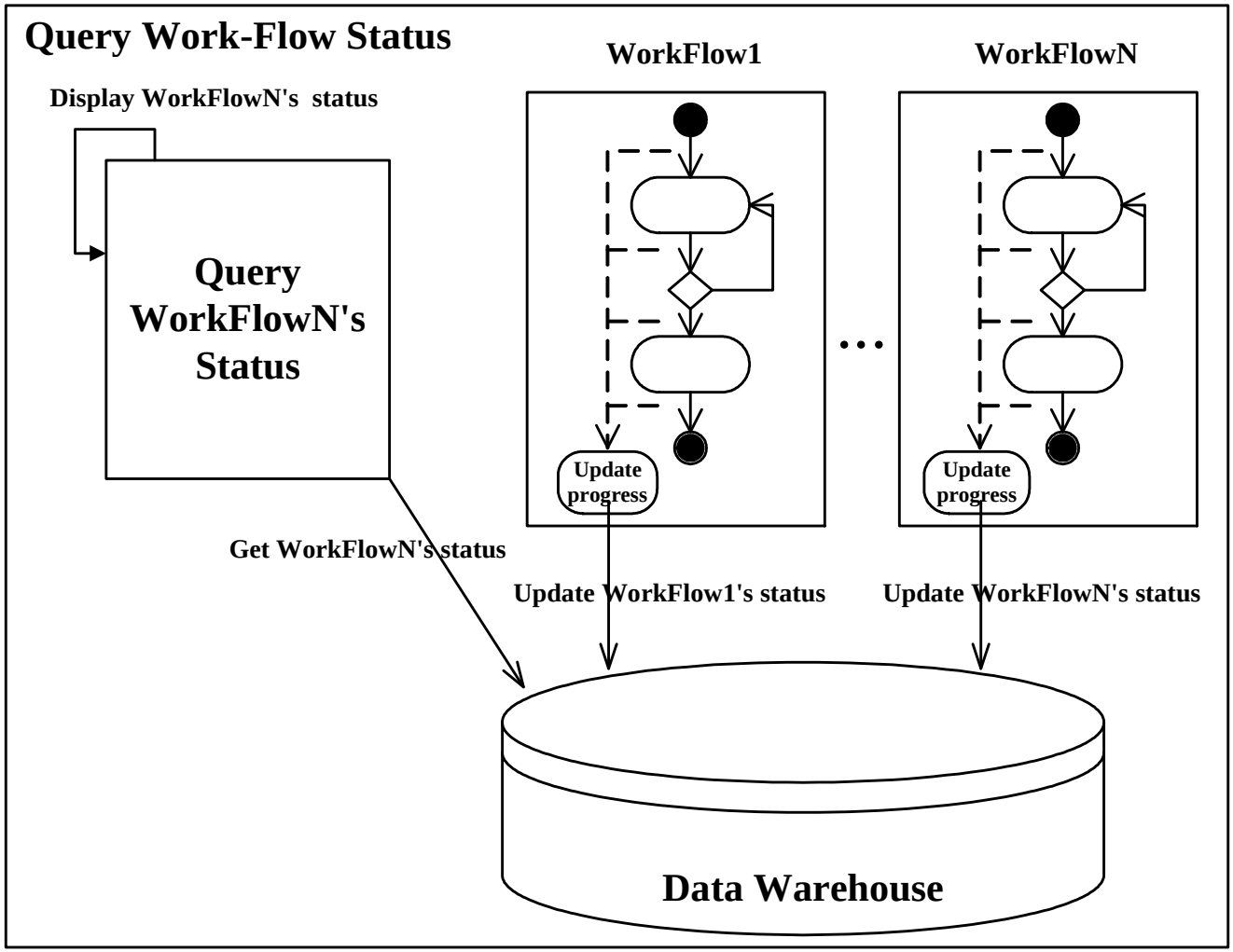
Development of Exchange Holon (cont.)

Two-Action Information Exchange Process: PIP3A4 Request Purchase Order

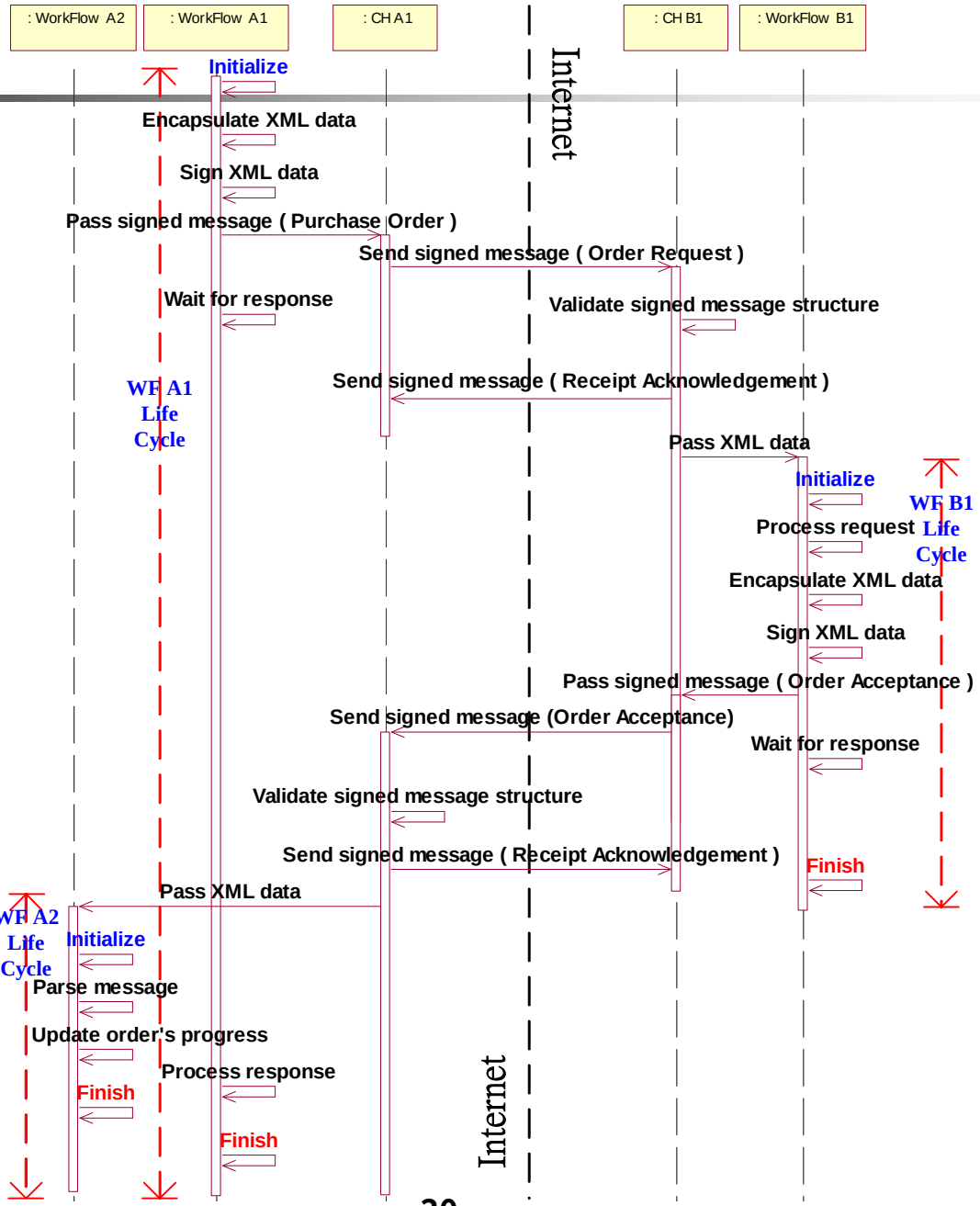


Development of Exchange Holon (cont.)

Query Work-Flow Status

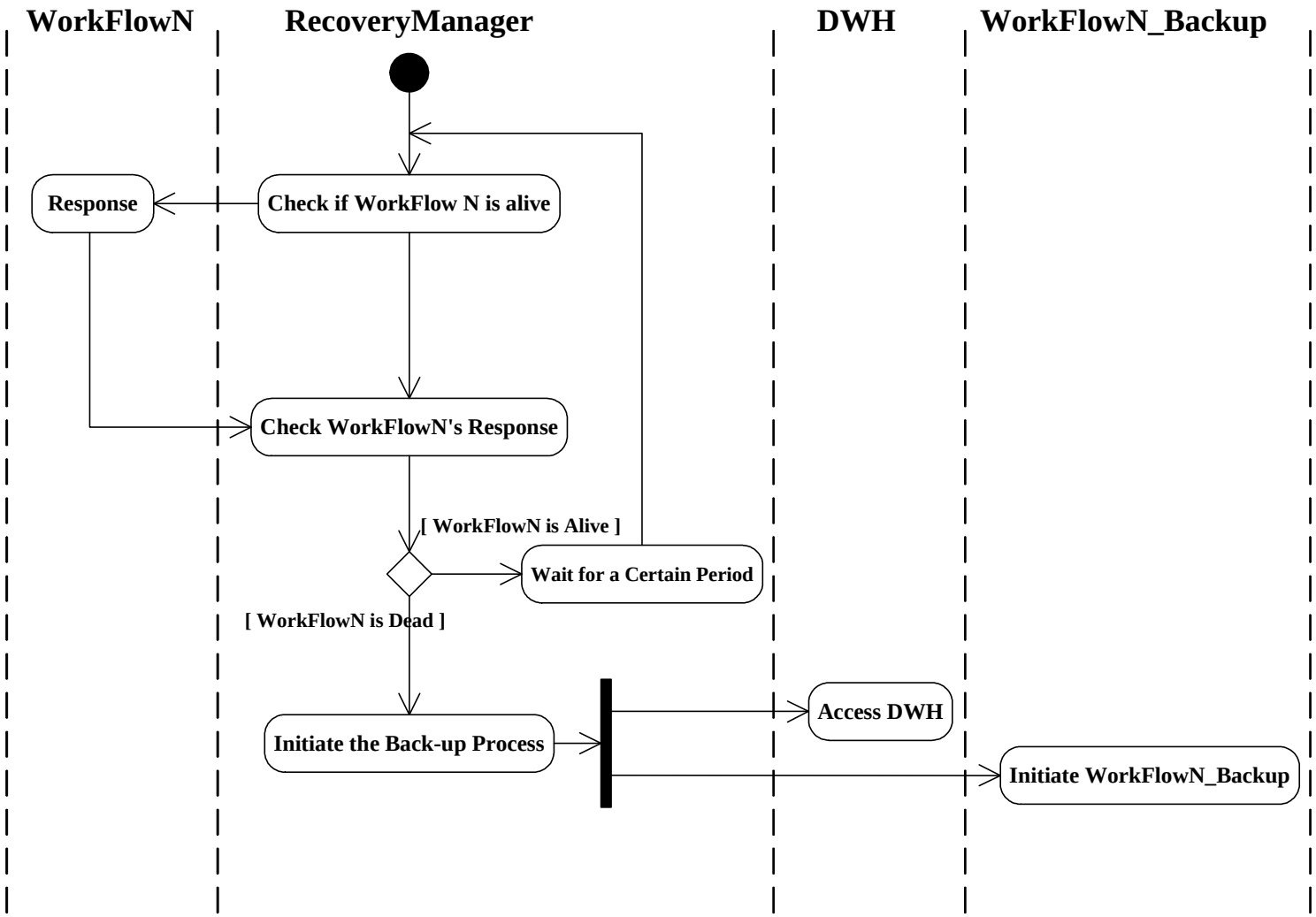


Life Cycles of WorkFlows: Two-Action Activity (Take PIP3A4 as the Example)



Development of Exchange Holon (cont.)

Error Detection and Recovery



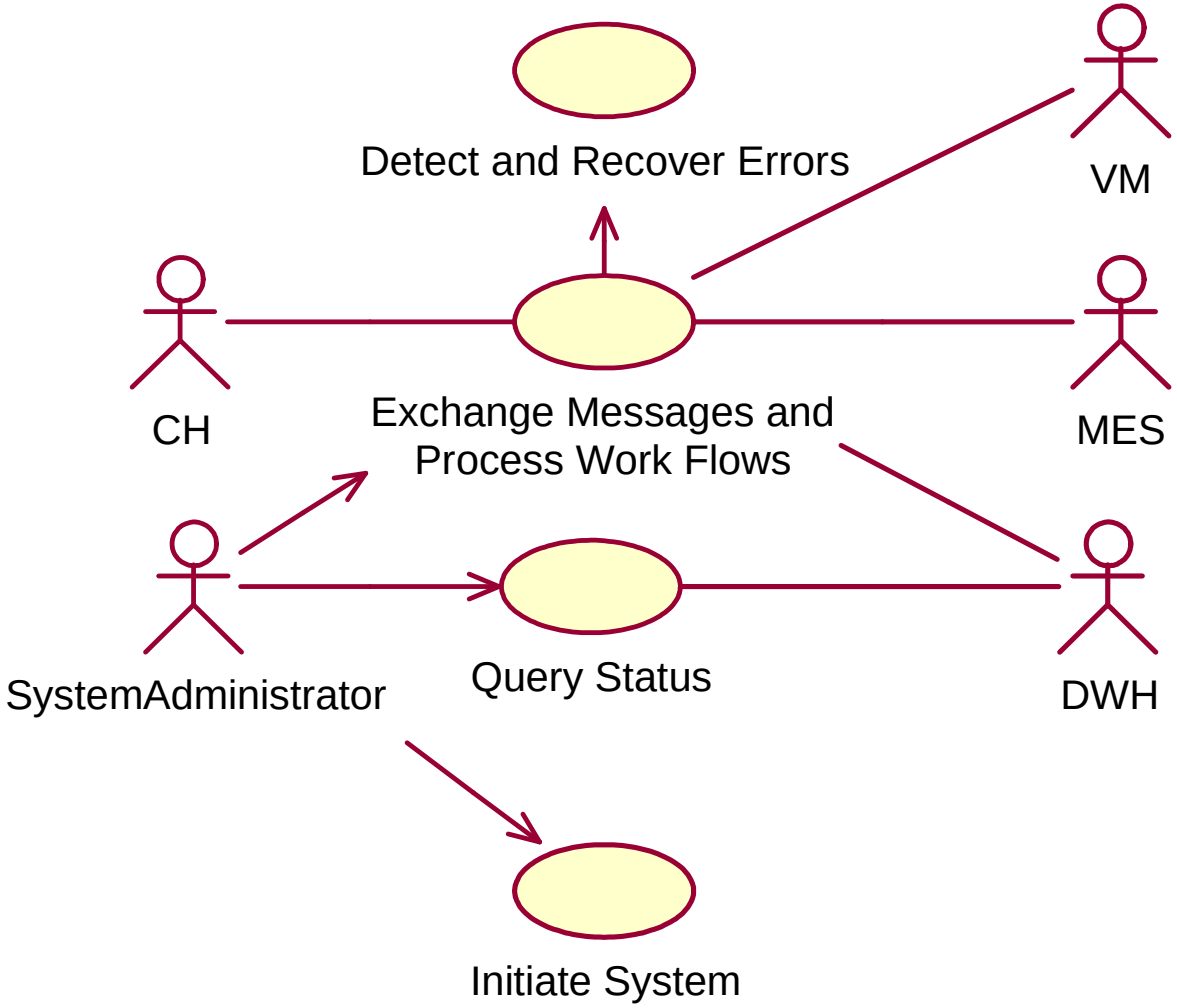
Development of Exchange Holon (cont.)

Requirements of Exchange Holon

- It exchanges and dispatches information to the Communication Holon, DWH, HMES, and HERP.
- It refers to RNIF specifications to transform exchanged information to RosettaNet business message.
- It establishes a communication backbone for the purposes of extensibility, collaboration, and communication.
- It provides an intelligence mechanism for diagnosing exceptions.
- It provides a search mechanism for the purposes of collaboration and reconfigurability.
- It provides a security mechanism for security check and encryption/decryption.
- It establishes a database service for information storage.
- It has capabilities of work-flow processing.
- It has capabilities of querying message flow status.

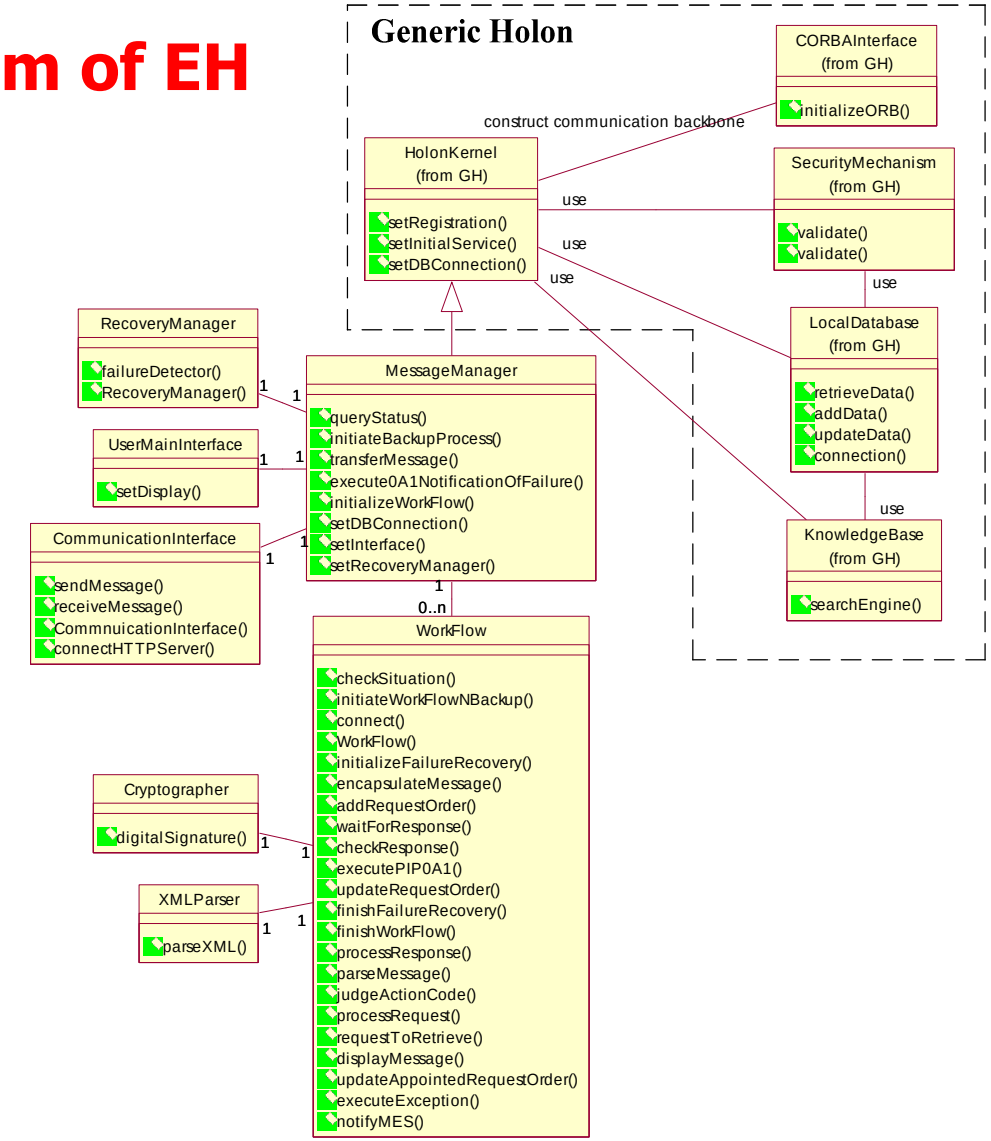
Development of Exchange Holon (cont.)

Use Case Diagram of EH



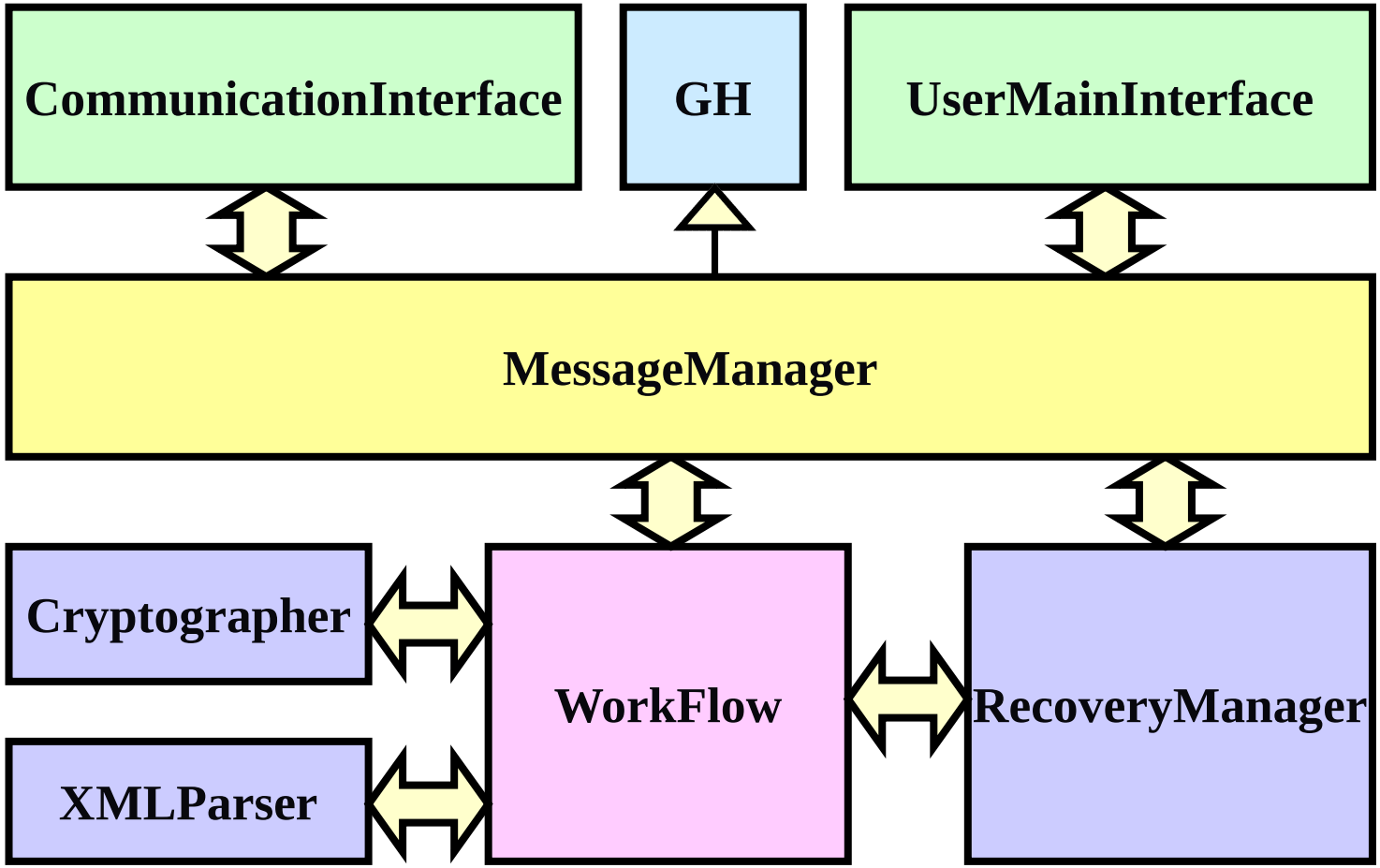
Development of Exchange Holon (cont.)

Class Diagram of EH



Development of Exchange Holon (cont.)

Exchange Holon Internal Architecture



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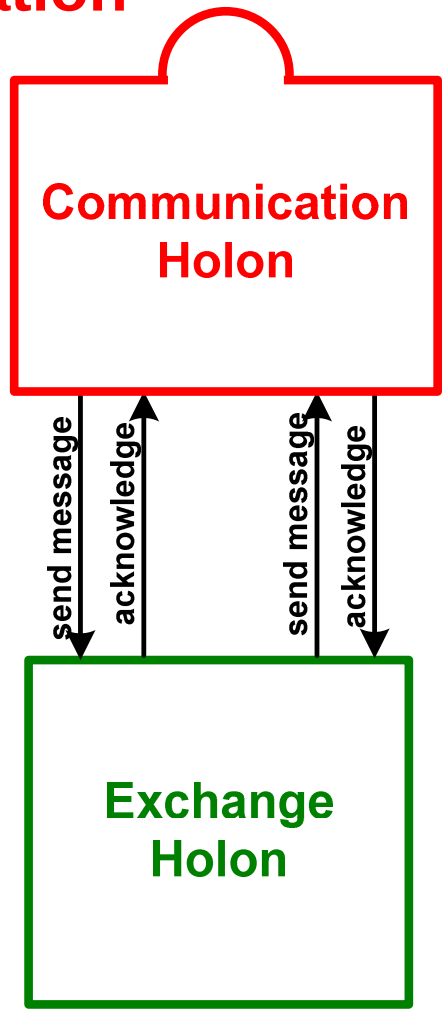
Development of Communication Holon (cont.)

Communication Model for Inter-Company Integration

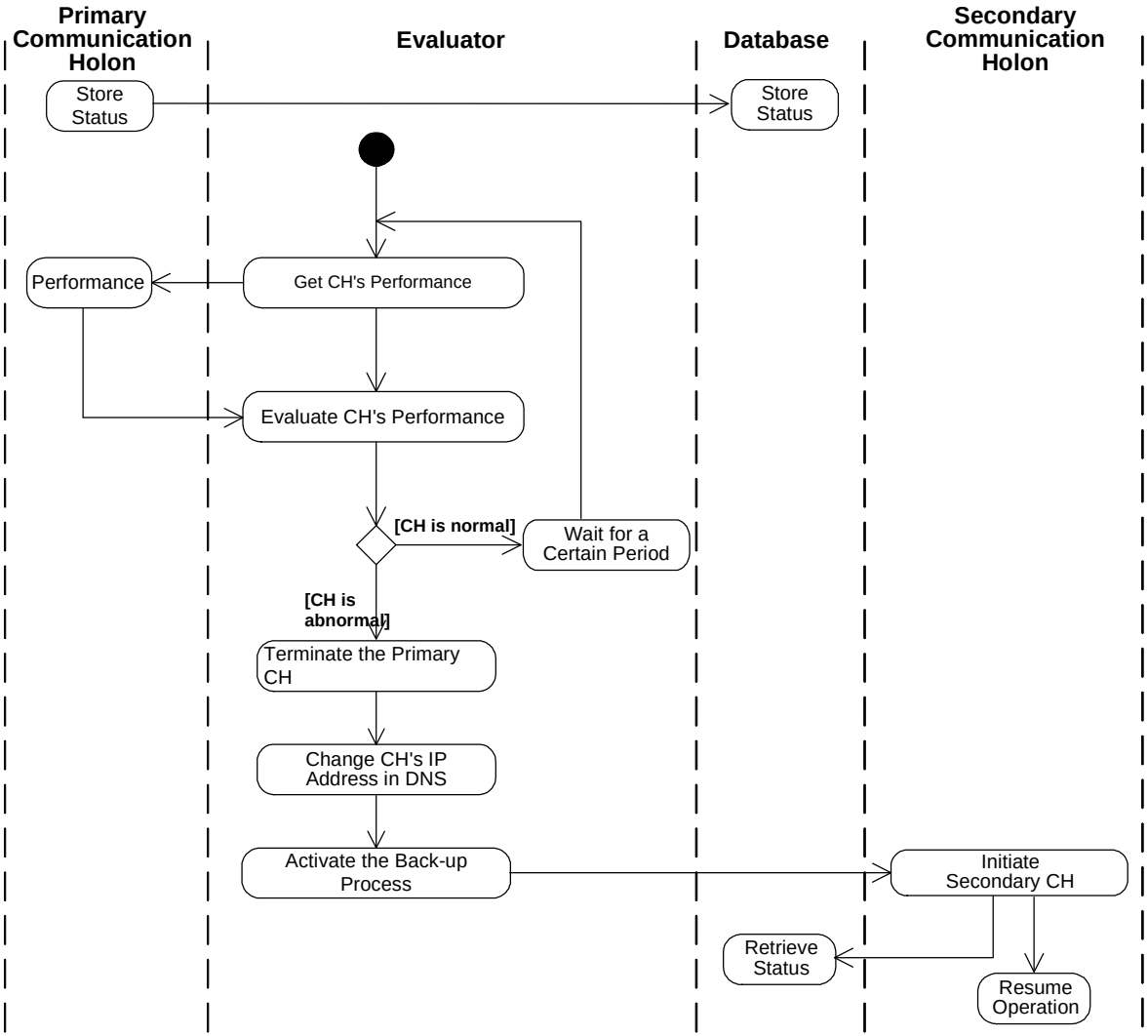
Development of Communication Holon (cont.)

Communication Model for Intra-Company Integration



Development of Communication Holon (cont.)

Error Recovery & Reconfiguration of CHs



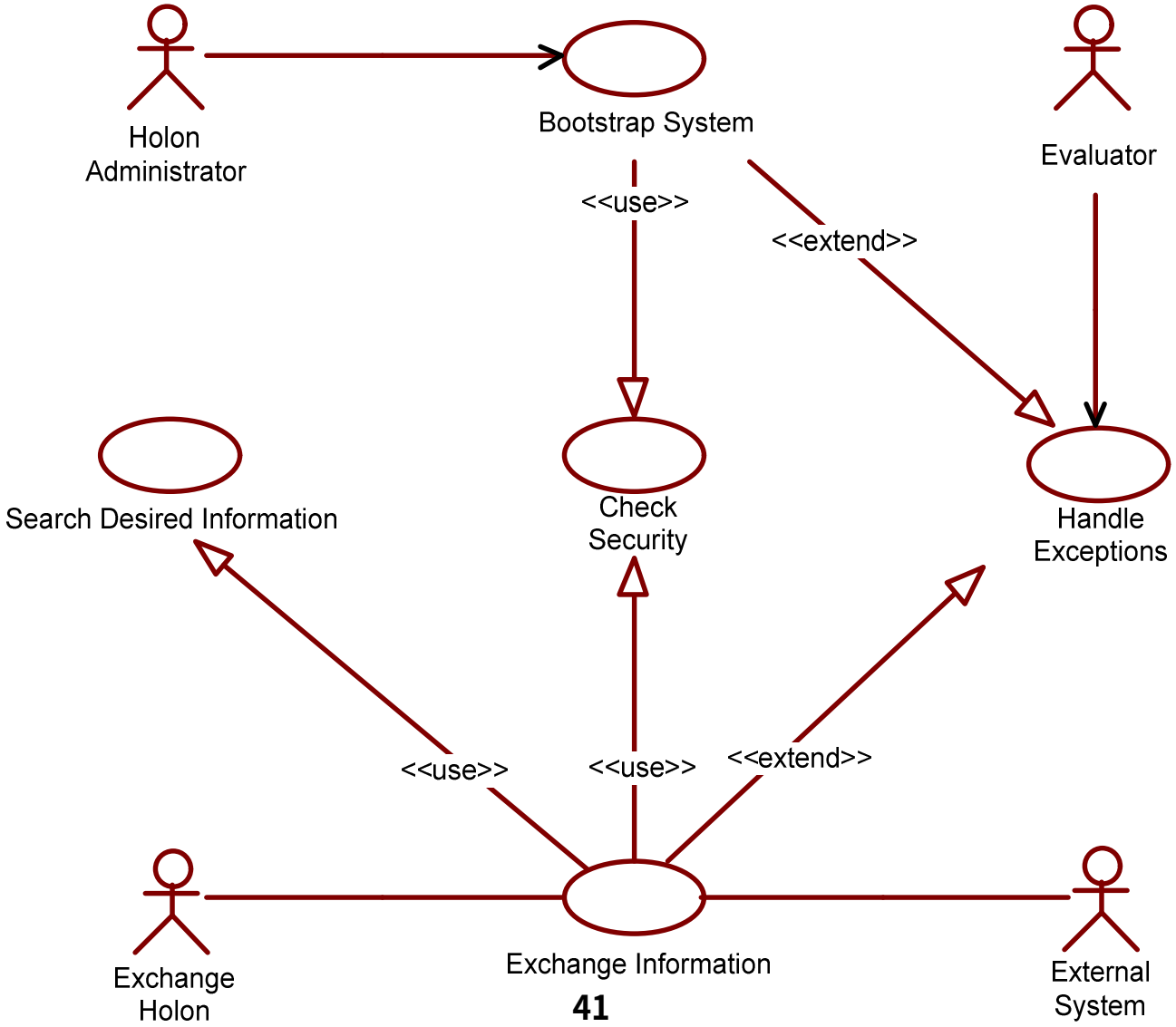
Development of Communication Holon (cont.)

Requirements of Communication Holon

- **It supports the generic communication model of RosettaNet implementation framework.**
- **It establishes a communication backbone for the purposes of extensibility, collaboration, and communication.**
- **It provides an intelligence mechanism for diagnosing exceptions.**
- **It provides a search mechanism for the purposes of collaboration and reconfigurability.**
- **It provides a security mechanism for security check and encryption/decryption.**
- **It establishes a database service for information storage.**
- **It supports the company internal data exchange for the intra-company integration.**

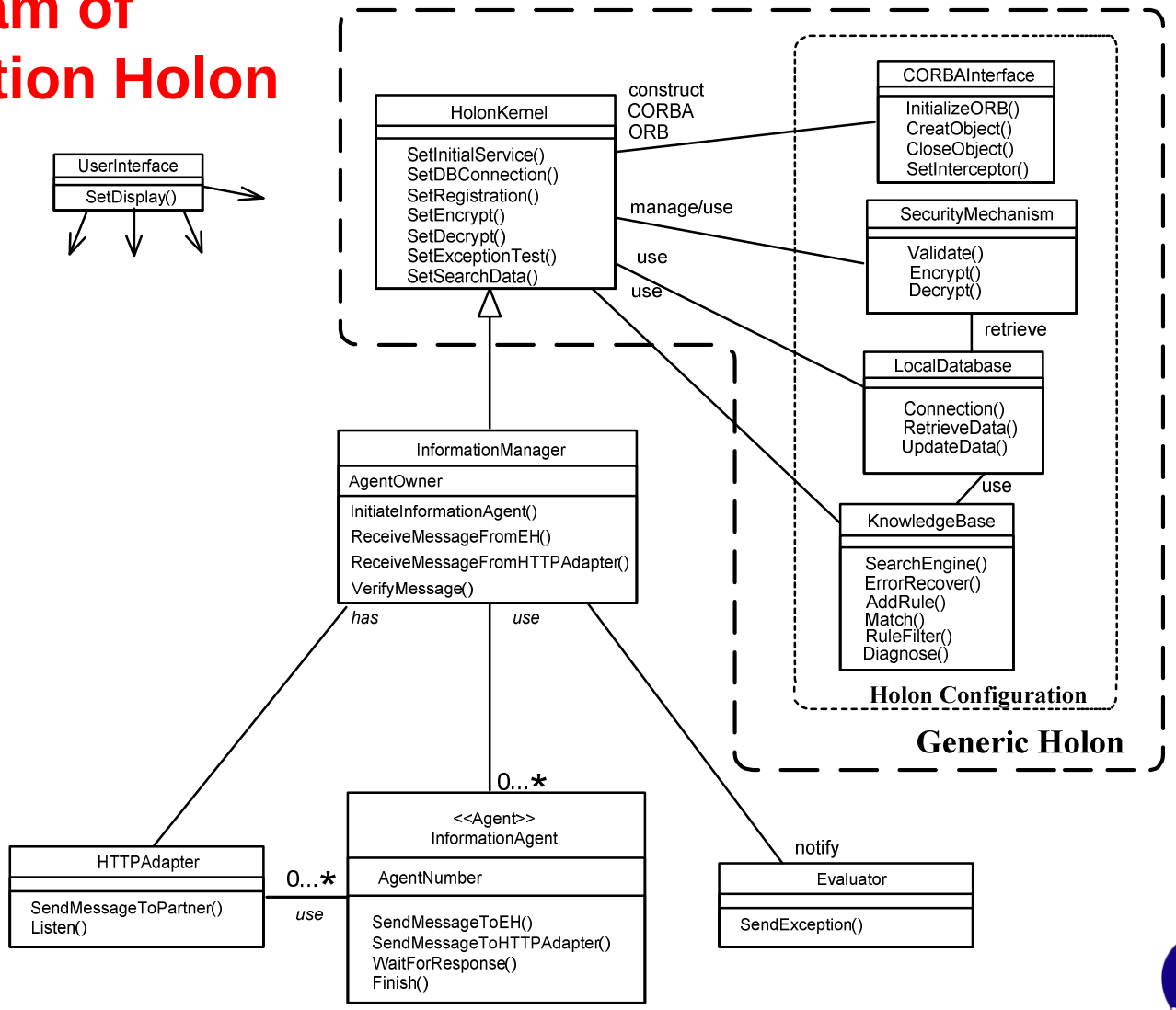
Development of Communication Holon (cont.)

Use Case Diagram of Communication Holon



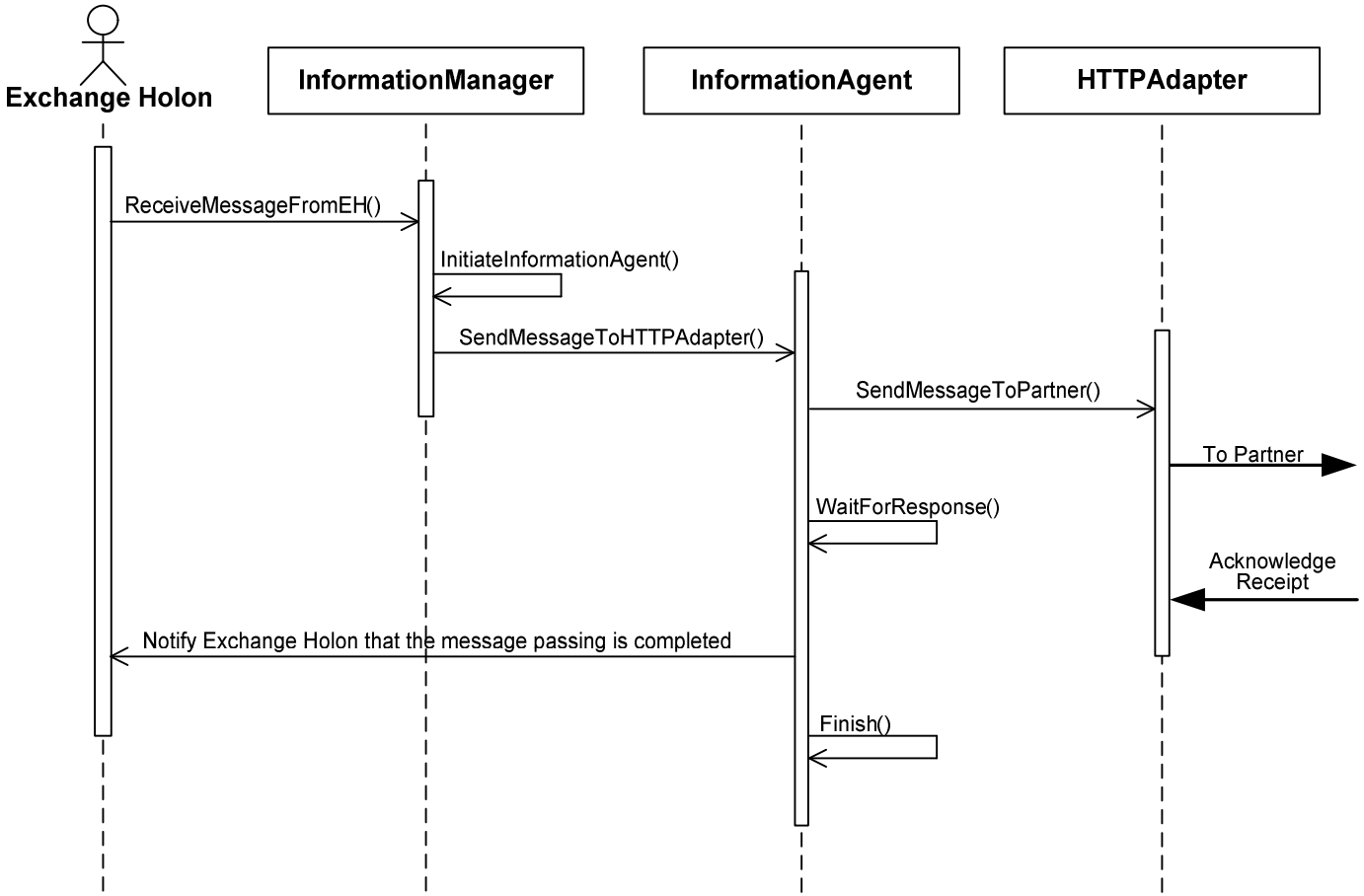
Development of Communication Holon (cont.)

Class Diagram of Communication Holon



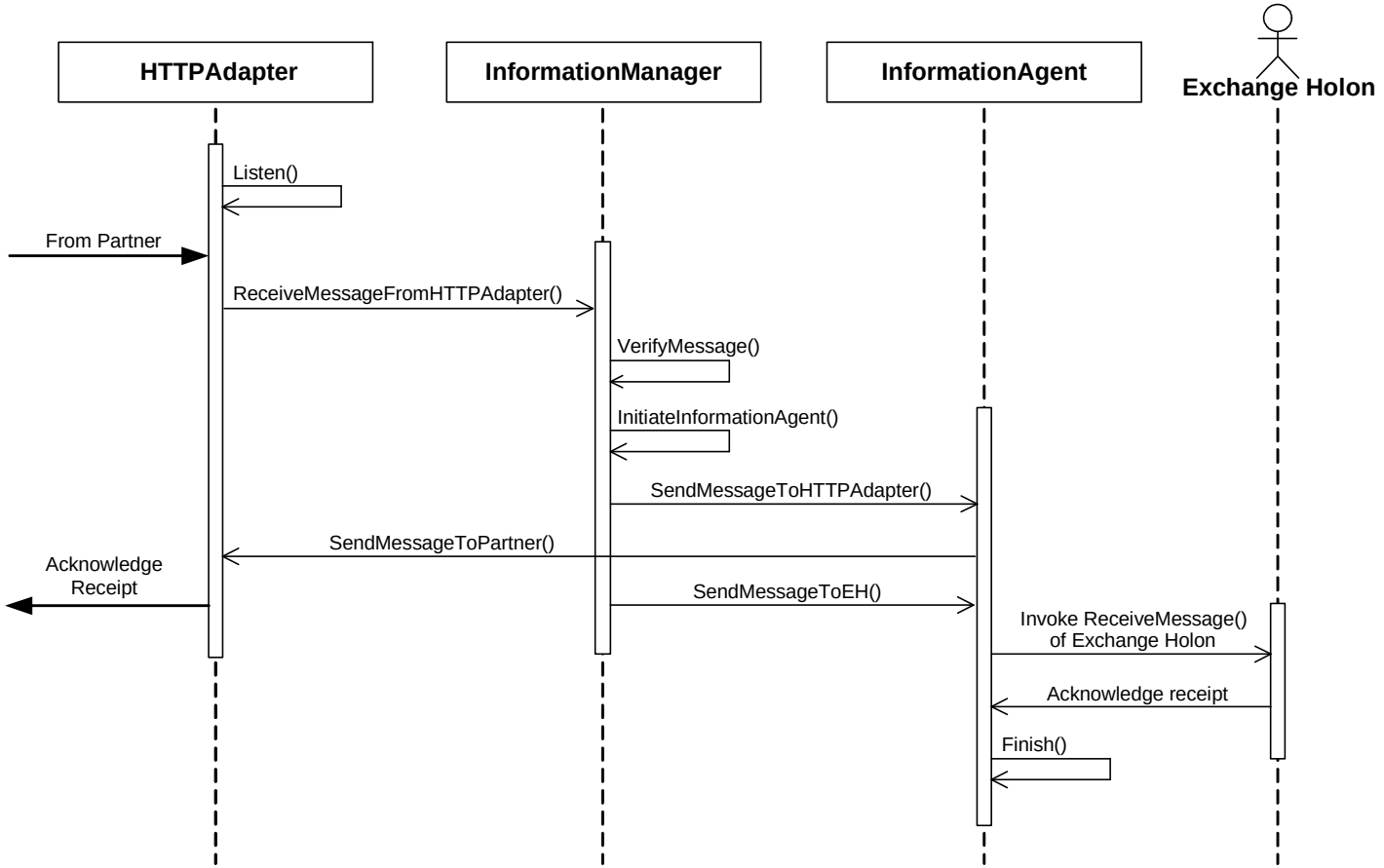
Development of Communication Holon (cont.)

Outgoing Process of Communication Holon



Development of Communication Holon (cont.)

Incoming Process of Communication Holon



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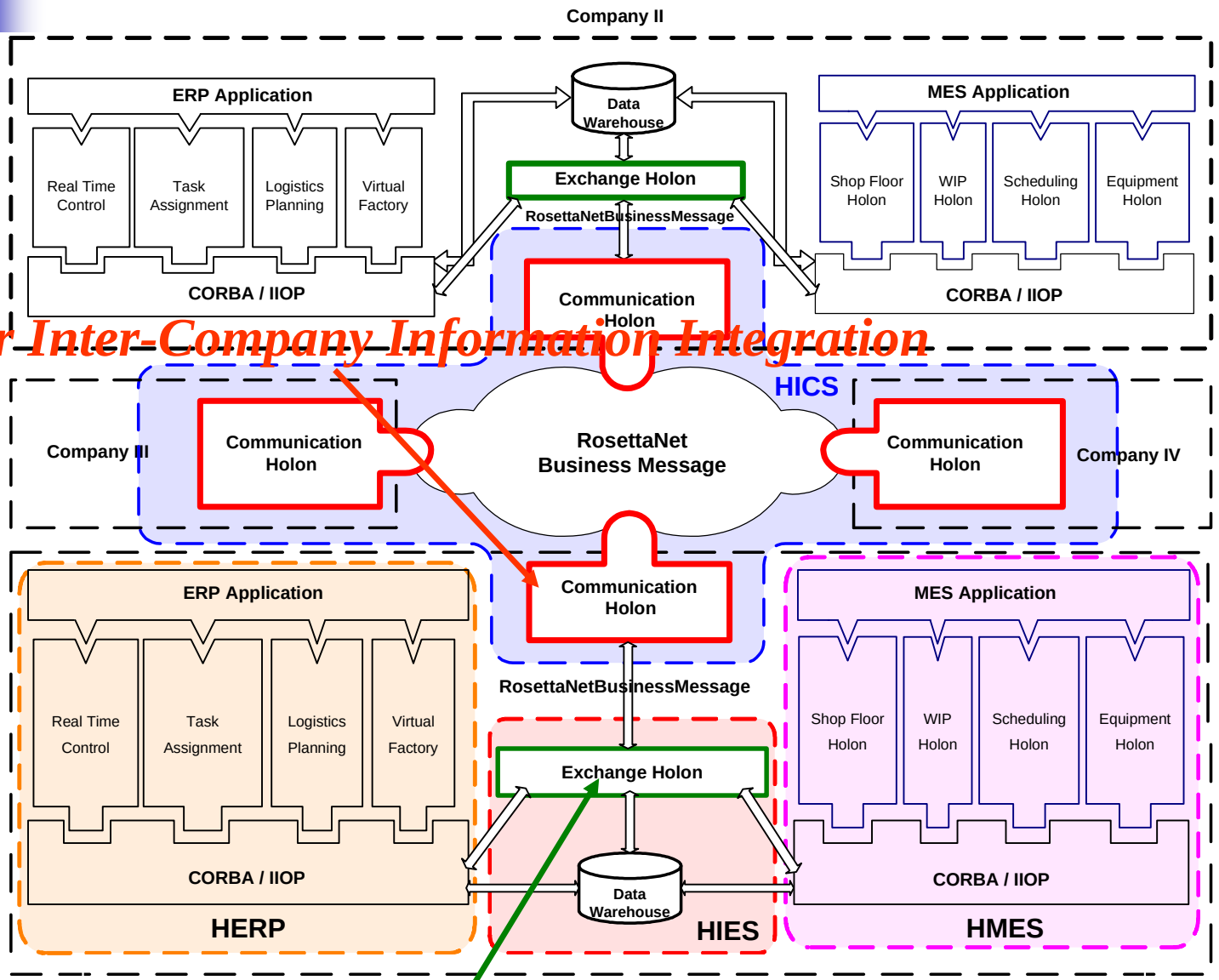
Semiconductor Holonic Supply Chain System



References

[1] F.-T. Cheng, H.-C. Yang, and J.-Y. Lin, "Development of Holonic Information Coordination Systems with Failure-Recovery Considerations," *IEEE Transactions on Automation Science and Engineering*, vol. 1, no. 1, pp. 58-72, July 2004.

[2] F.-T. Cheng and C.-T. Lin, "A Holonic Information Exchange System for e-Manufacturing," in *Proc. of The 30th Annual Conference of the IEEE Industrial Electronics Society (IECON 2004),* Busan, Korea, November 2004.