

# Development of Holonic Information Coordination Systems With Failure-Recovery Considerations

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**Abstract**—A holonic manufacturing system, designed to realize agile manufacturing, must (be able to) integrate the entire range of manufacturing activities from ordering, through design, modeling, production, to delivery. These activities are performed at many distributed sites. In order to effectively integrate these distributed sites, this work adopts distributed object and mobile object technologies, RosettaNet implementation framework, as well as holon and holarchy concepts derived from studying social organizations and living organisms to develop a holonic information coordination system (HICS). The generic holon is first developed by adopting the technologies of the distributed object-oriented approach with common object request broker architecture infrastructure,  $n$ -tier client/server architecture, a knowledge base, and data warehousing to achieve the properties of holon, error recovery, and security certification. The communication holon (CH) is then generated by inheriting the generic holon. Finally, CHs are employed to establish HICS. The CH exhibits basic holonic attributes, such as intelligence, autonomy, and cooperation. Furthermore, the CH can handle partner interface processes, and data exchange by various data formats following the standards of RosettaNet business messages. The failure recovery mechanism of the CH causes HICS to be more reliable than legacy systems. As such, HICS can meet the future requirements of supply-chain information integration of virtual enterprises.

**Note to Practitioners**—An HICS that handles the information flow of the supply chain is proposed in this work. HICS is composed of many communication holons (CHs). Any company that would like to use HICS to exchange information for enterprise integration may possess a CH. The CH is implemented with the Java web-start technology. Therefore, any company can download a CH from the web server via a web browser. The company is, then, able to communicate with other members throughout the supply chain. Accordingly, CHs are scattered throughout the Internet/intranet and each CH can act as both an information supplier and an information consumer. Further, because the CH adopts the RosettaNet implementation framework (RNIF), any company that has the capability of RNIF can also communicate with the members in the HICS framework via RosettaNet business messages.

**Index Terms**—Communication holon (CH), holonic information coordination systems (HICSs), holonic manufacturing systems (HMSs), supply-chain information systems (SCISs).

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## ABBREVIATION LIST

AC	Agent component.
CH	Communication holon.
CORBA	Common object request broker architecture.
DTD	Document type definition.
DWH	Data warehouse.
EH	Exchange holon.
HICS	Holonic information coordination system.
HERP	Holonic enterprise resource planning.
HMES	Holonic manufacturing execution system.
HMS	Holonic manufacturing system.
HTTP	Hypertext transmission protocol.
HTTPS	Hypertext transfer protocol over secure socket layer.
ICC	Information coordinator component.
IDL	Interface definition language.
IIOIP	Internet inter-ORB protocol.
ISO	International Organization for Standardization.
JDBC	Java database connectivity.
MES	Manufacturing execution system.
OMG	Object management group.
OMT	Object modeling technique.
ORB	Object request broker.
PIP	Partner interface process.
RMI	Remote method invocation.
RNIF	RosettaNet implementation framework.
SCIS	Supply-chain information system.
SOAP	Simple object access protocol.
SSL	Secure socket layer.
UDDI	Universal description discovery and integration.
UMC	United Microelectronics Corporation.
UML	Unified modeling language.
VM	Virtual manufacturing.
WIP	Work in process.
WSDL	Web services description language.
XML	Extensible markup language.
XSL	Extensible stylesheet language.

## I. INTRODUCTION

**I**N THE CURRENT environment of advanced cooperation and competition, most manufacturing companies cannot easily and completely produce products alone. Each company is specialized in one manufacturing segment and works closely with other companies that are specialized in other segments. The Internet has surrounded enterprises with new trading paradigms on both the seller and the buyer sides. The global electronic marketplace has placed even more power in the hands