MANAGEMENT OF INFORMATION SYSTEMS
PROCESS-ORIENTED INFORMATION SYSTEMS

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GENERAL INFORMATION

- Title: Management Information Systems
- Credit hours: 3.0
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- Lecture time: Tuesday 2:30 pm – 4:00 Hall 262
  Thursday 11:15 am – 12:45 pm Hall 7
- Grading
  - 60% final exam
  - *10 % Mid-term exam*
  - *10% Quizzes*
  - *20% Assignments*

OUTLINE

- Introduction
- Information Systems
  - Types
  - Architecture
- Business Process Management
- Process Modeling Techniques
- Business Process Modeling Languages
  - Petri nets
  - BPMN
  - EPCs
- Correctness Criteria of Business Process Models
- Data and Processes
- Data Anomalies

1. INTRODUCTION

- Competence in today's businesses is mainly driven by technology.
  - Plants: support for the production process
  - Retailers: order processing
- Maturity with technology allows companies to better respond to market changes.
  - Planning new products: Less time to market
  - Mass customization vrs. Mass production
  - Collecting user feedback: Facebook

RESPONSE TO CHANGE

Why Learn About Information Systems in Organizations?

- Information systems (ISs) can cut costs and increase profits
- Students in most fields need to know ISs
  - Management major might be hired to design a system to improve productivity
  - Biochemistry major might be hired to conduct drug research using computer techniques
  - Engineering major might be hired to model and simulate reality using computer techniques

DEFINITION

- **Information system (IS)**
  - Set of interrelated components: collect, manipulate, store, and disseminate data and information
  - Provides feedback to meet an objective
  - Examples: ATMs, airline reservation systems, course reservation systems
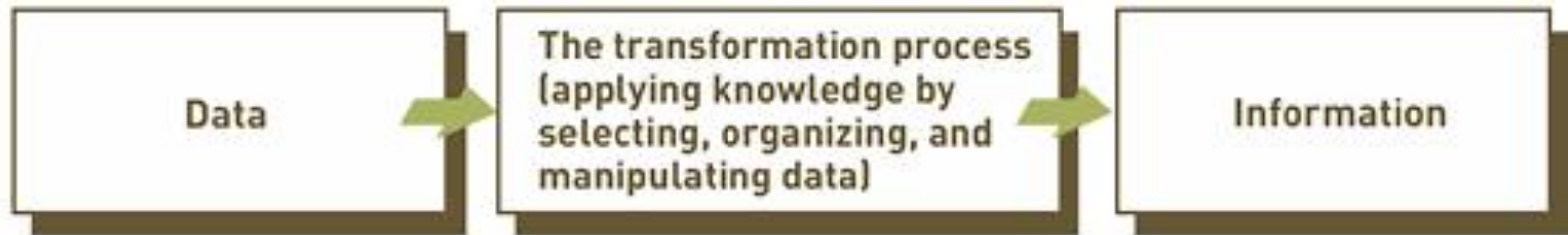
Information Concepts: Data, Information, and Knowledge

- **Data:** raw facts
  - Alphanumeric, image, audio, and video
- **Information:** collection of facts organized in such a way that they have additional value beyond the value of the facts themselves

Data, Information, and Knowledge (continued)

| Data	→	The transformation process (applying knowledge by selecting, organizing, and manipulating data)	→	Information

INFORMATION SYSTEMS TO SUPPORT ORGANIZATIONS

- Support routine operations/strategies
- Enhance productivity
- Offer new ways of communication: intra- and intercommunication
- Decision support on various levels
  - First level management: Transaction Processing Systems
  - Middle management: Management Information Systems
  - Top level: Decision Support Systems
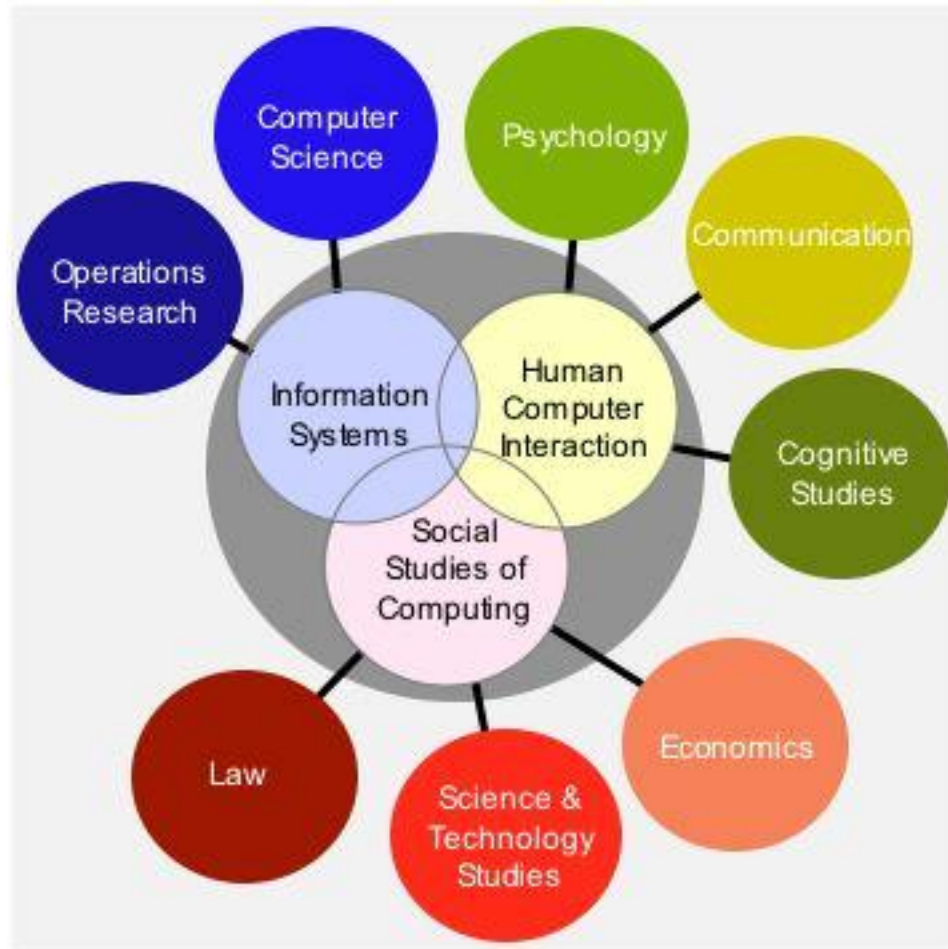
What Is an Information System?
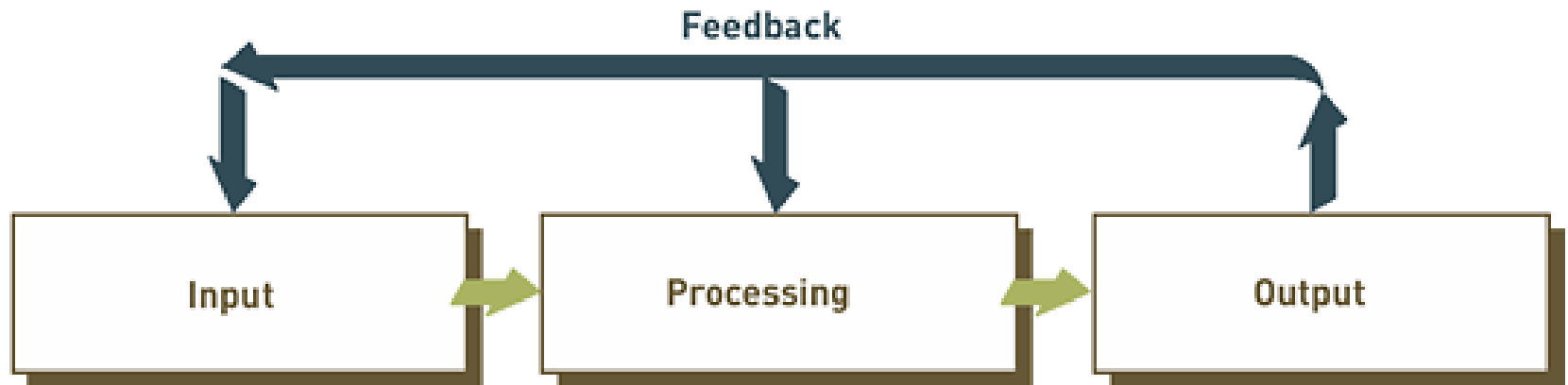
MANUAL AND COMPUTERIZED INFORMATION SYSTEMS

- An information system can be:
  - Manual
    - Example: developing patterns and trends on graph paper for stock analysis
  - Computerized
    - Example: using program trading to track the market and trade large blocks of stocks when discrepancies occur

COMPUTER-BASED INFORMATION SYSTEMS

- **Computer-based information system (CBIS):** single set of hardware, software, databases, telecommunications, people, and procedures configured to collect, manipulate, store, and process data into information
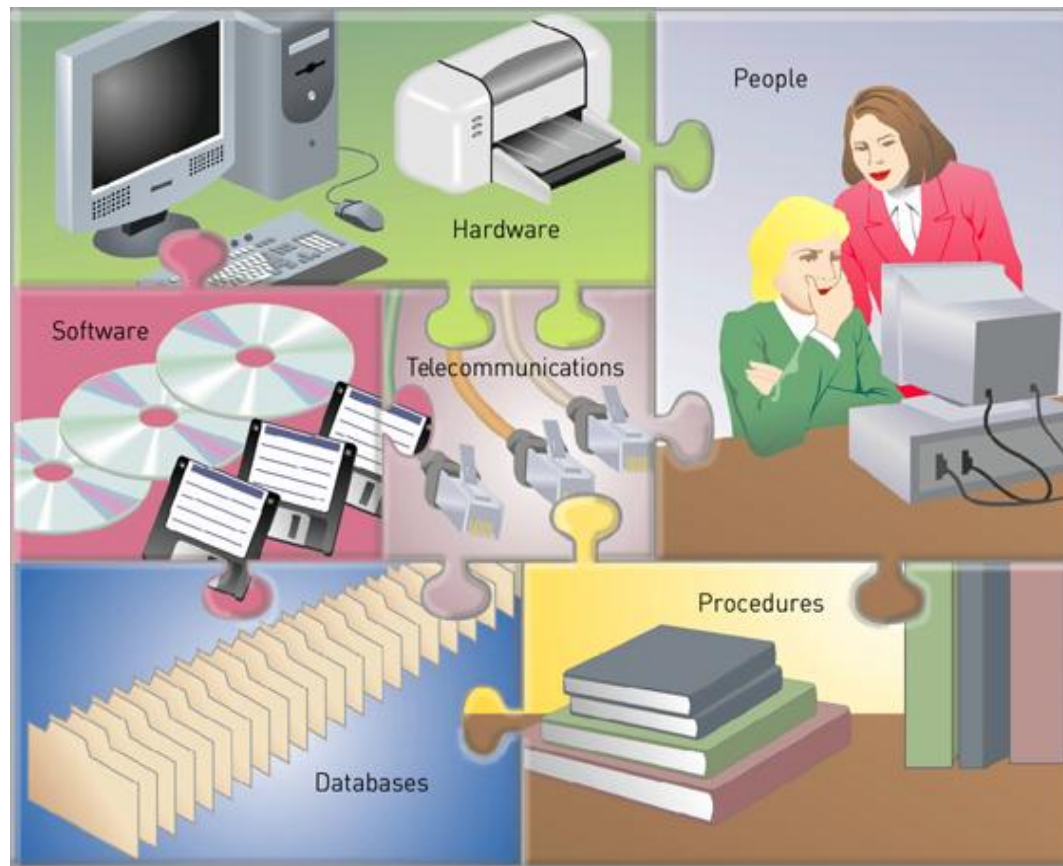
COMPUTER-BASED INFORMATION SYSTEMS (CONTINUED)

Figure 1.4: The Components of a Computer-Based Information System

Computer-Based Information Systems (continued)

- CBIS components
  - Hardware: computer equipment used to perform input, processing, and output activities
  - Software: computer programs that govern the operation of the computer
  - Database: organized collection of facts and information
  - Telecommunications: electronic transmission of signals for communications
  - Networks: connect computers and equipment in a building, around the country, and around the world

Computer-Based Information Systems (continued)

- CBIS components (continued)
  - Internet: world's largest computer network
  - People: manage, run, program, and maintain the system
 - Procedures: strategies, policies, methods, and rules for using a CBIS

Enterprise Systems: Transaction Processing Systems and Enterprise Resource Planning

- **Transaction:** business-related exchange
  - Payments to employees
  - Sales to customers
  - Payments to suppliers
- **Transaction processing system (TPS):** organized collection of people, procedures, software, databases, and devices used to record completed business transactions

TRANSACTION PROCESSING SYSTEMS (CONTINUED)
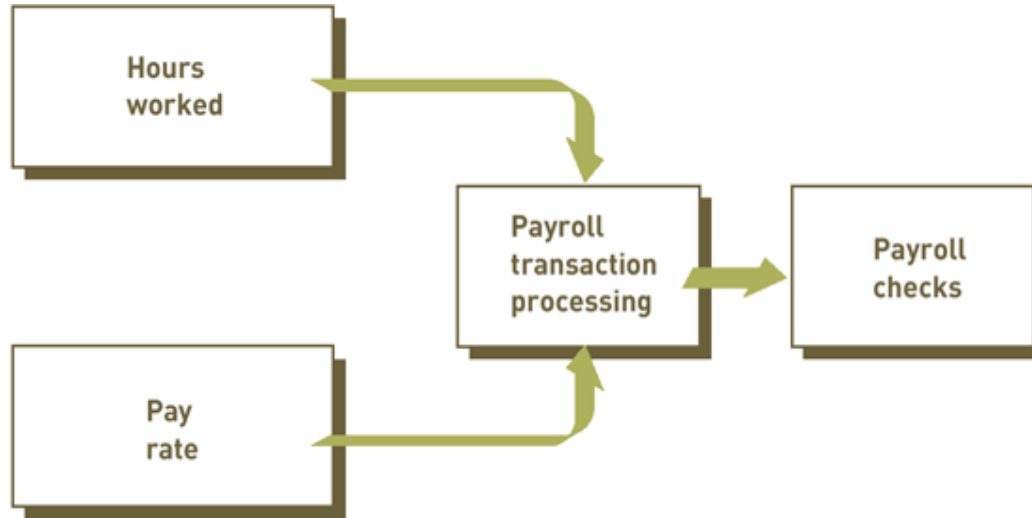
Enterprise Resource Planning

- Integrated programs capable of managing a company's vital business operations for an entire multisite organization
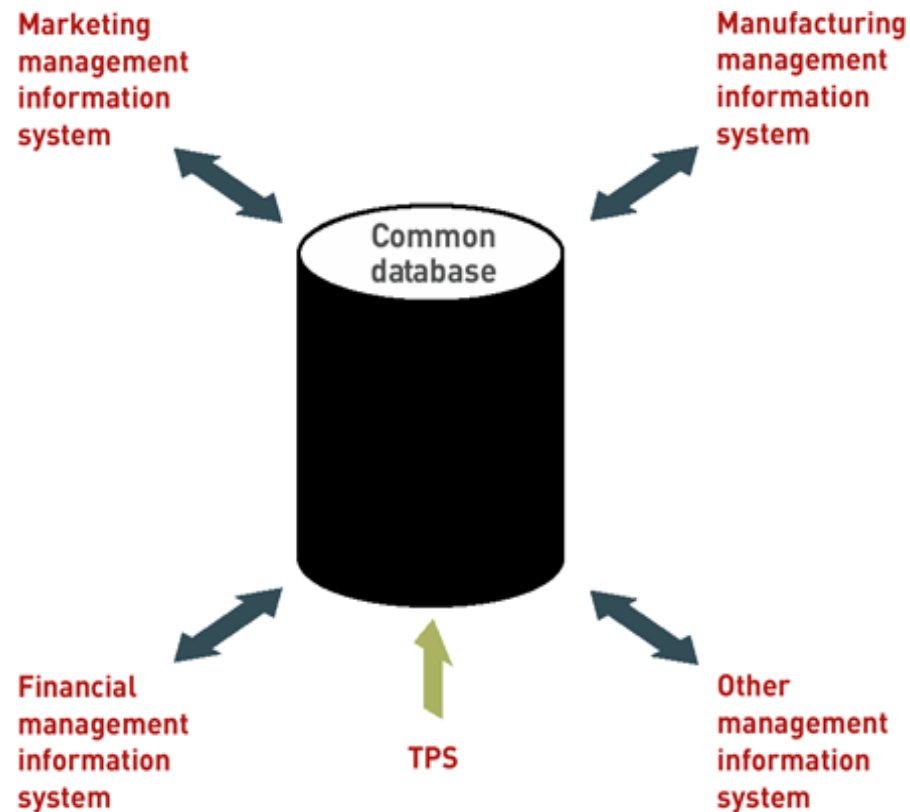- Coordinate planning, inventory control, production, and ordering

MANAGEMENT INFORMATION SYSTEMS

- **Management information system (MIS)**
  - Organized collection of people, procedures, software, databases, and devices
  - **Provides routine information to managers/decision makers**
- Primary focus is **operational efficiency**

MANAGEMENT INFORMATION SYSTEMS (CONTINUED)

Information and Decision Support Systems

- An effective TPS provides a number of benefits to a company
- A TPS can speed business activities and reduce clerical costs
- Data stored in TPSs is used to help managers make better decisions

DECISION SUPPORT SYSTEMS

- **Decision support system (DSS)**
  - Organized collection of people, procedures, software, databases, and devices
  - Supports problem-specific decision making
- Focus is on decision-making effectiveness

DECISION SUPPORT SYSTEMS (CONTINUED)
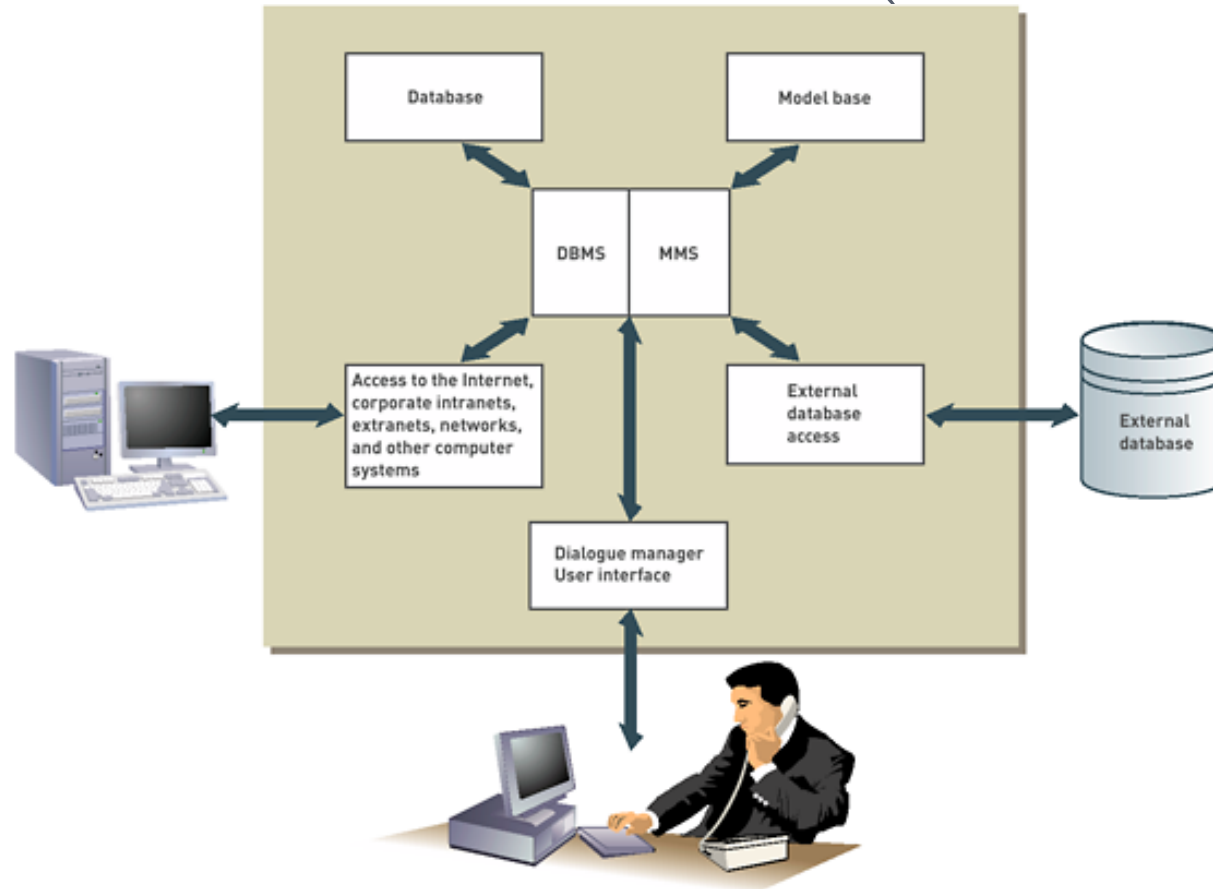
Figure 1.11: Essential DSS Elements

INFORMATION SYSTEMS TRIAD

Operational
Database

Data Warehouse
Data Mart

Enterprise
Workflow

OLAP
Online
Analytical
Processing

MIS
BI
DSS

OLTP
Online Transaction
Processing

Data

Information

Business
Process
Workflow

Messaging Systems

Knowledge

Workflow, Collaboration, Groupware
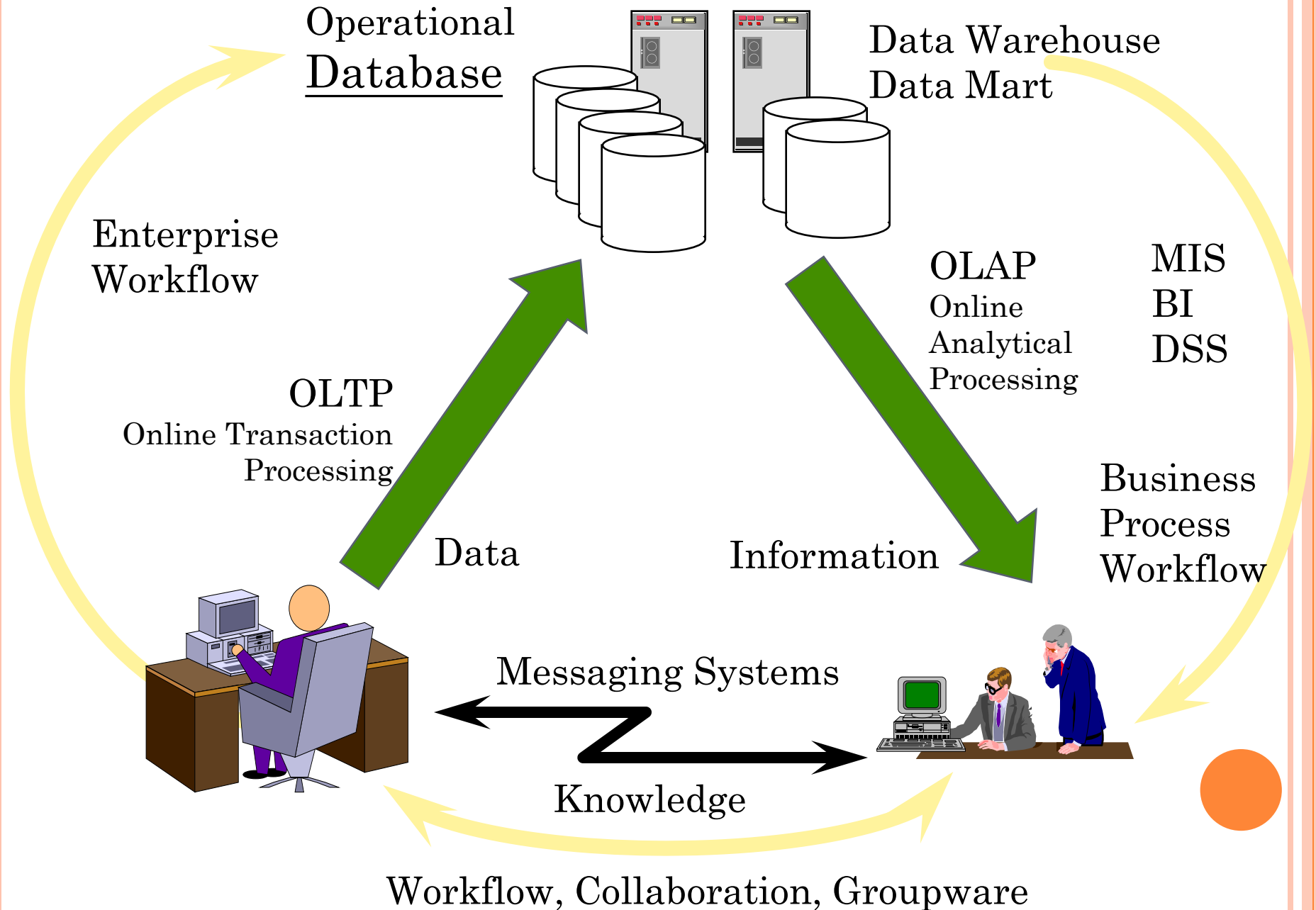
HISTORY: CLASSIFICATION OF INFORMATION SYSTEMS ARCHITECTURES

- Classification of IS in the context of software architectures for enterprise information systems
- Paradigms
  - *Separation of Concerns, focusing one's attention upon some aspect* [Dijkstra 1982]
  - Development of subsystems for encapsulating functionality, thereby re-implementation independent
  - *Information hiding, separation of interface to subsystems and its implementation* [Parnas 1972]
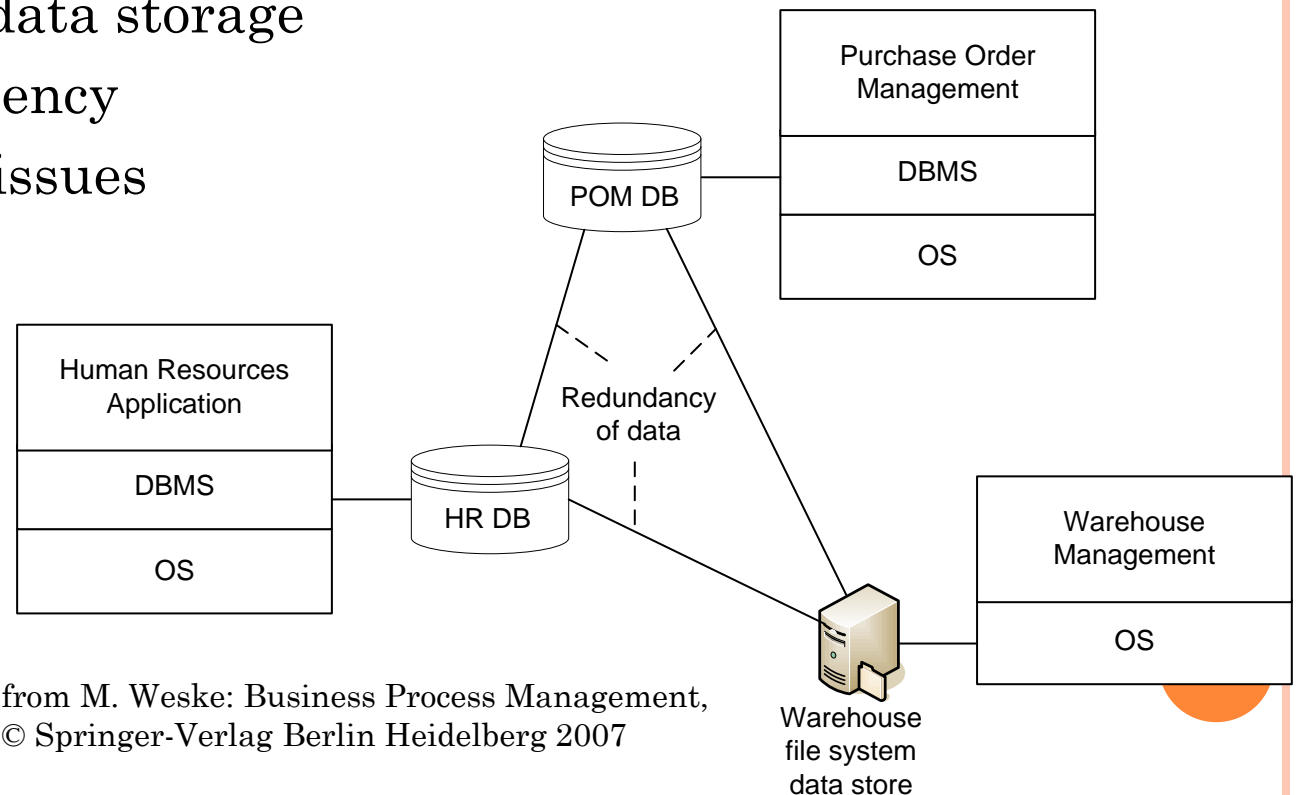
TRADITIONAL APPLICATION DEVELOPMENT

- Operating Systems: Encapsulating hardware properties
- Database Systems: For integrated data management
- Graphical user interface: Intuitive subsystem for the development of usable software

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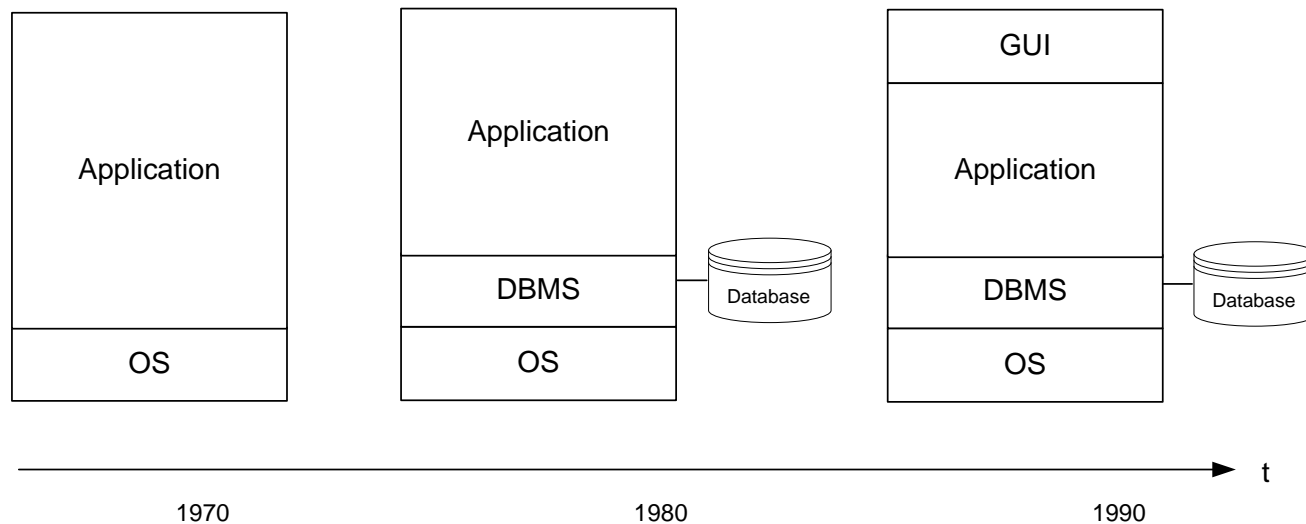
ENTERPRISE APPLICATIONS

- Technological change in communications and hardware allows wide use of IT in business (*Enterprise Applications*)

- Problems
  - Redundant data storage
  - Data consistency
  - Integration issues

| Purchase Order Management |
| DBMS |
| OS |

POM DB

| Human Resources Application |
| DBMS |
| OS |

HR DB

Redundancy of data

| Warehouse Management |
| OS |

Warehouse file system data store

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ENTERPRISE RESOURCE PLANNING

- Solution to the problem of integration by new type of enterprise software: Enterprise Resource Planning Systems
  - Integrated database with different modules for the tasks involved in a company
    - Human Resources, Financials, etc

Client 1	Client 2	. . .	Client *n*

ERP Server Application

DBMS

OS

ERP Database

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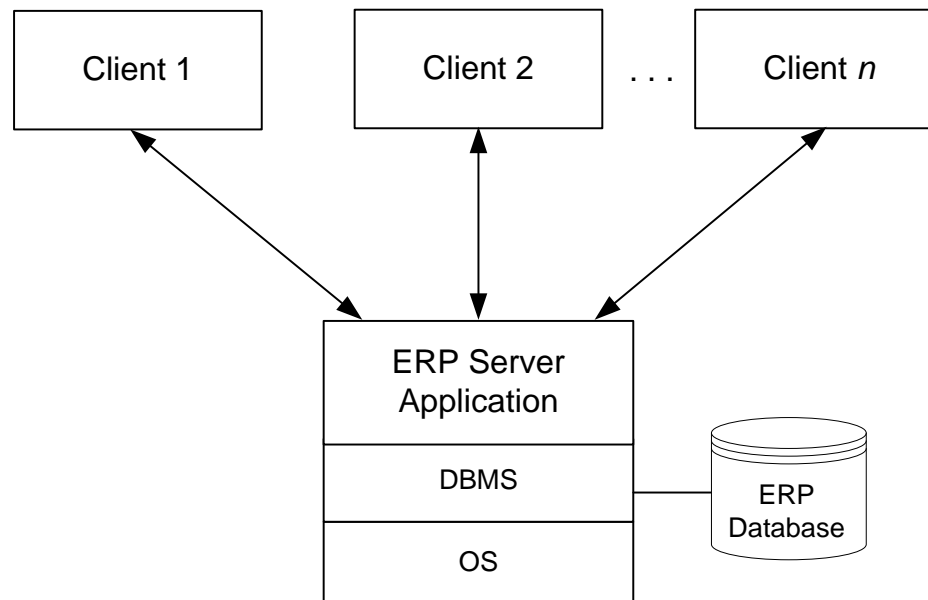
SILOED ENTERPRISE APPLICATIONS

- Additional enterprise applications with high complexity (with local data storage)
  - Supply Chain Management Systems
  - Customer Relationship Management Systems
- Problems
  - Data integration and process integration required

GUI	GUI	GUI
Application Logic of CRM System	Application Logic of SCM System	Application Logic of ERP System
DBMS	DBMS	DBMS
OS	OS	OS

CRM Database

SCM Database

ERP Database

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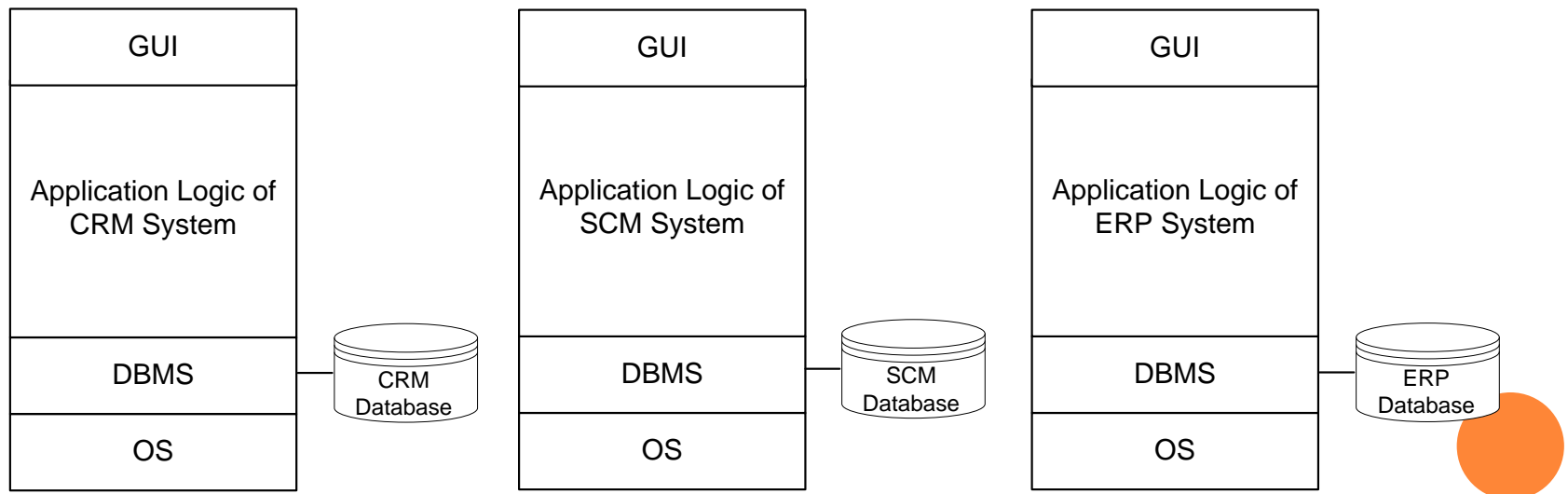
INTEGRATION OF ENTERPRISE APPLICATIONS

- Point-to-point Integration
 - Pairwise interfaces among applications are created
  - Disadvantage:
    - Large number of interfaces, high integration efforts
    - Little flexibility: Each change requires a modification in the system landscape of the corresponding interfaces

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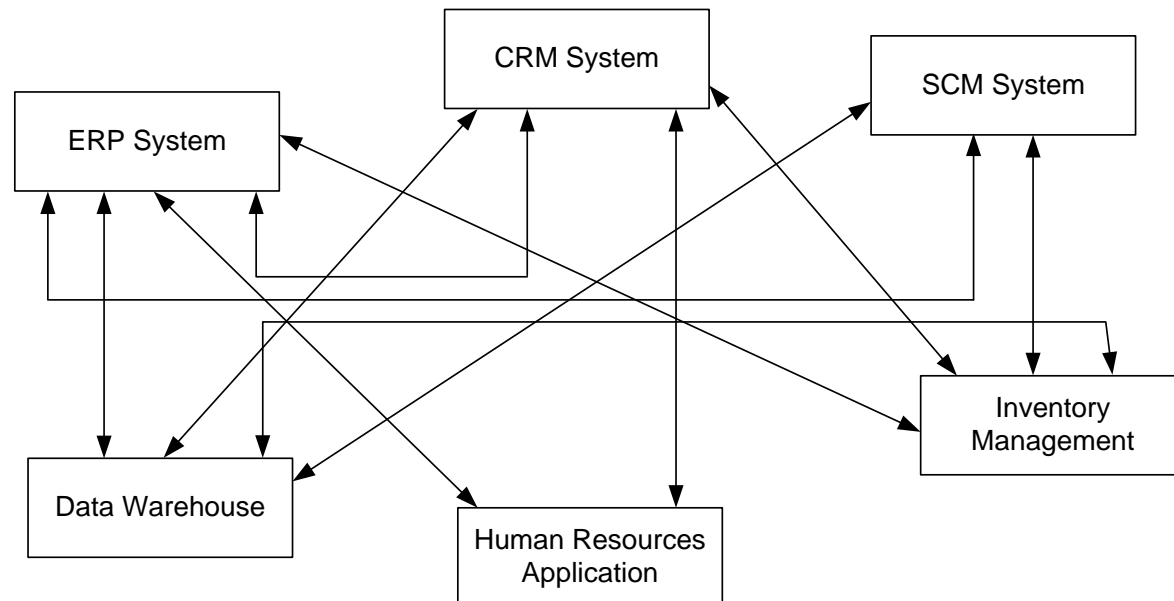
INTEGRATION OF ENTERPRISE APPLICATIONS

- Message-oriented Middleware
  - Applications communicate through messages
  - Presistent message queues

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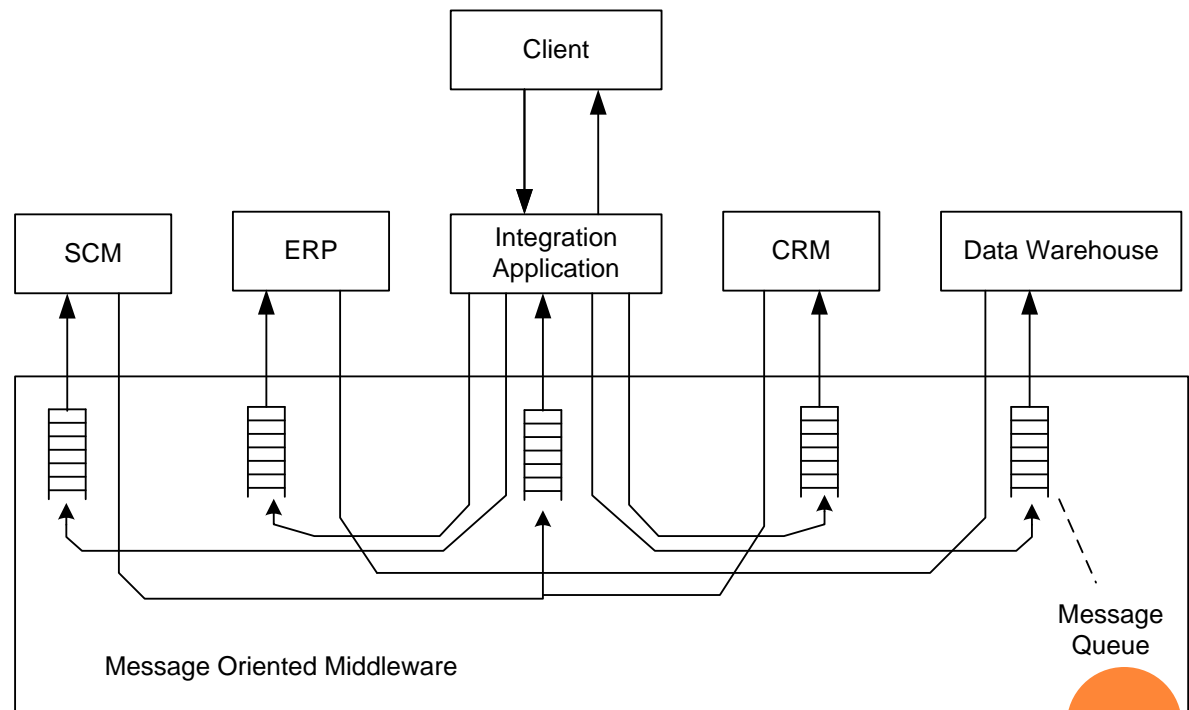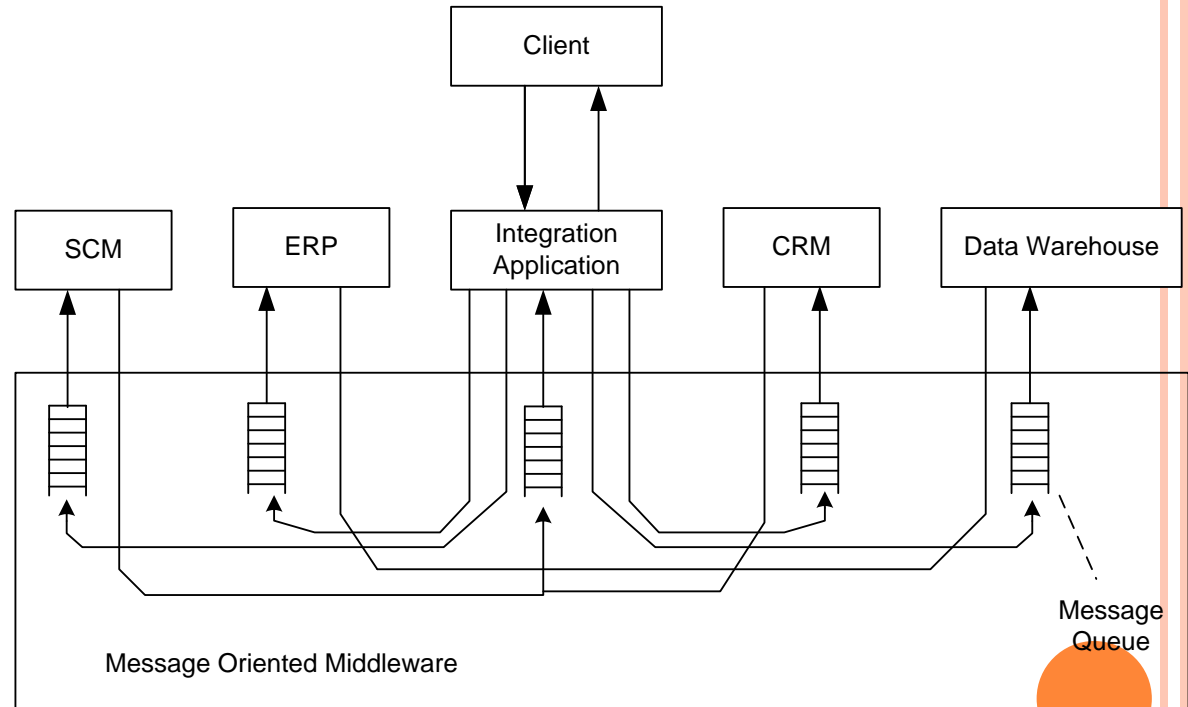
INTEGRATION OF ENTERPRISE APPLICATIONS

- Properties
  - Applications communicate using middleware
  - Messages are directly encoded from sender to receiver
  - Therefore, the integration logic is embedded in application code
- Result
  - little flexibility because "landscape changes in the system" require changes in the applications
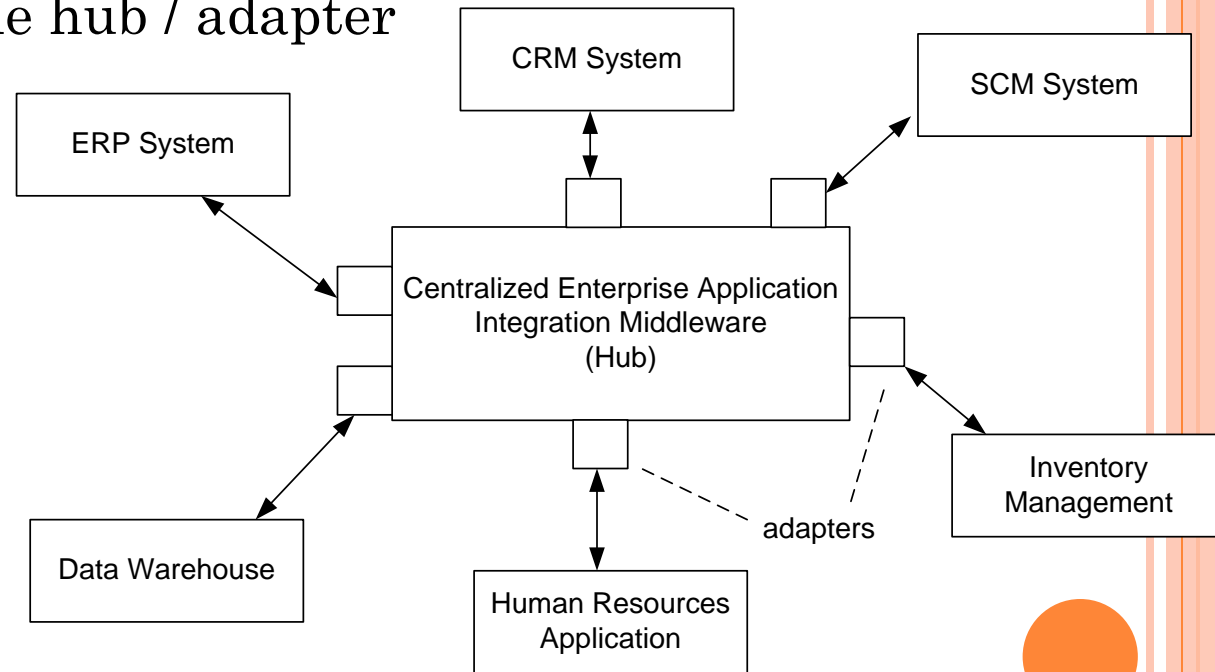
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INTEGRATION OF ENTERPRISE APPLICATIONS

- *Hub and Spoke* Integration
  - The central hub has the integration logic
- Result
  - more flexibility because changes are reflected only in the hub / adapter
  - Applications remain unchanged

CRM System

SCM System

ERP System

Centralized Enterprise Application
Integration Middleware
(Hub)

Inventory
Management

adapters

Data Warehouse

Human Resources
Application

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INTEGRATION OF ENTERPRISE APPLICATIONS

- Realization of hub and spoke through rule-based message broker
  - Message broker contains rules that are used for relaying messages
  - Rules use structure and content of the messages

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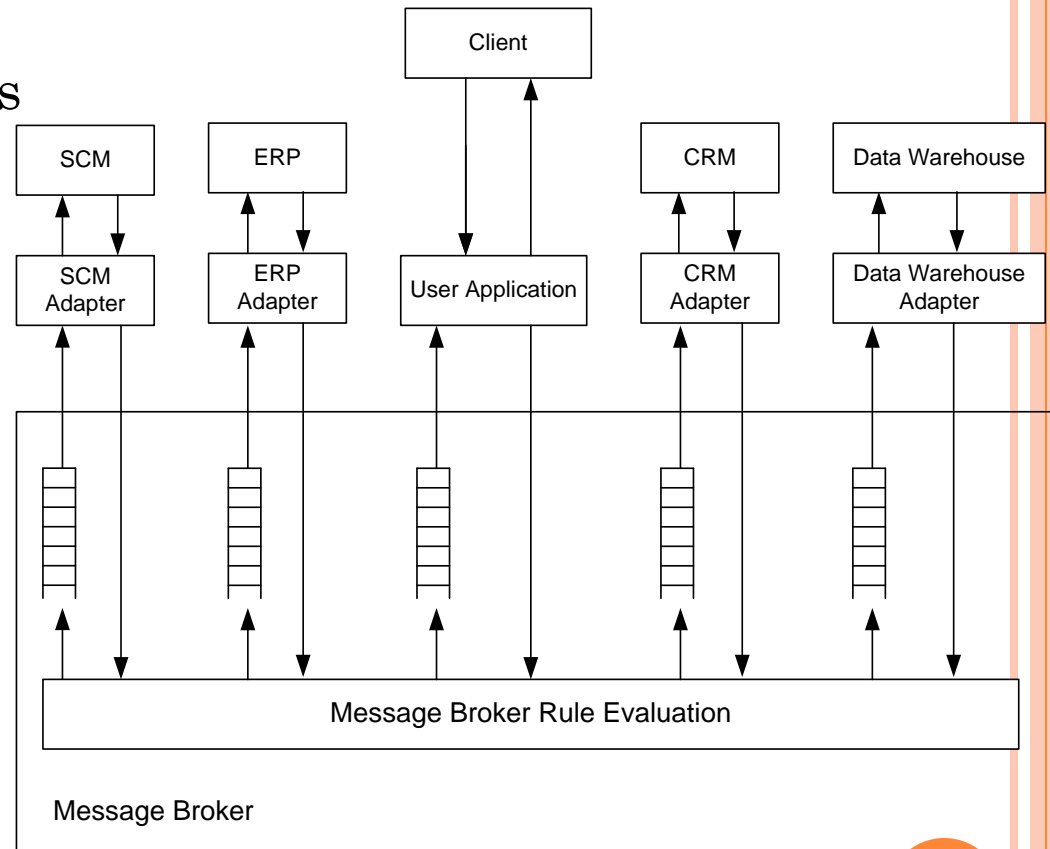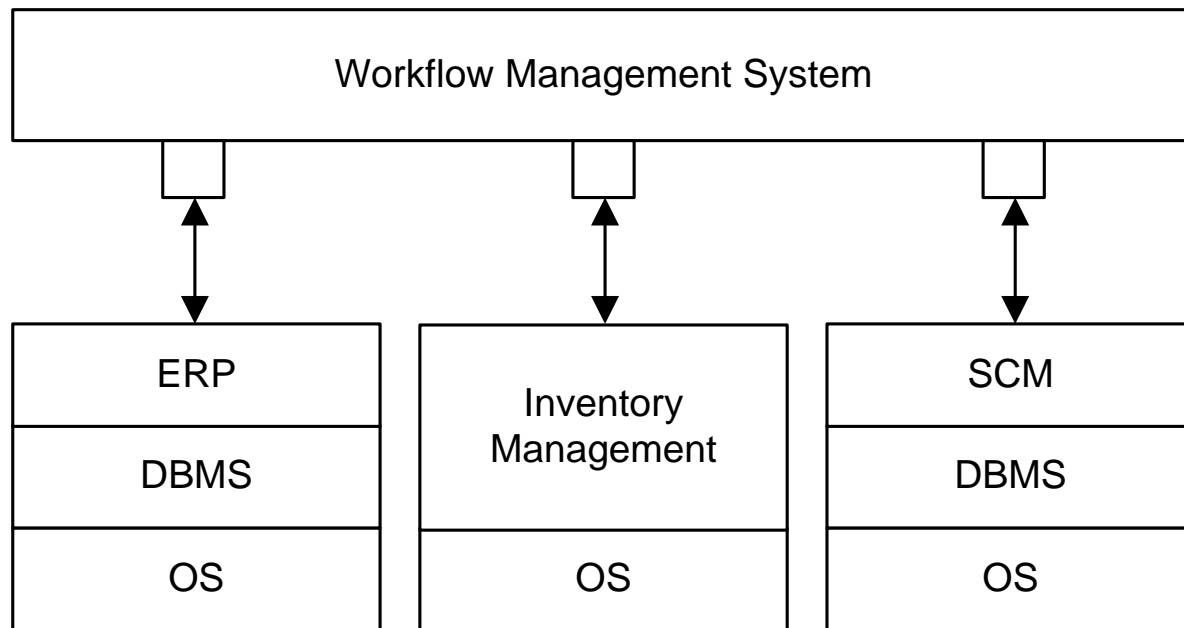
WORKFLOW MANAGEMENT SYSTEMS

- Idea: Explicit representation of active processes and process control
- Definition Workflow
  - *Workflow is the automation of a business process, in whole or in part, during which documents, information or tasks are passed from one participant to another for action, according to a set of procedural rules.*
- Definition Workflow Management System
  - *A workflow management system is a software system that defines, creates and manages the execution of workflows through the use of software, running on one or more workflow engines, which is able to interpret the process definition, interact with workflow participants and, where required, invoke the use of IT tools and applications.*

- Integration aspect of workflow management
  - Adapters create connections between enterprise applications and workflow management systems

- Remark
  - The next step in the evolution of software architectures

Workflow Management System

ERP
DBMS
OS

Inventory Management
OS

SCM
DBMS
OS

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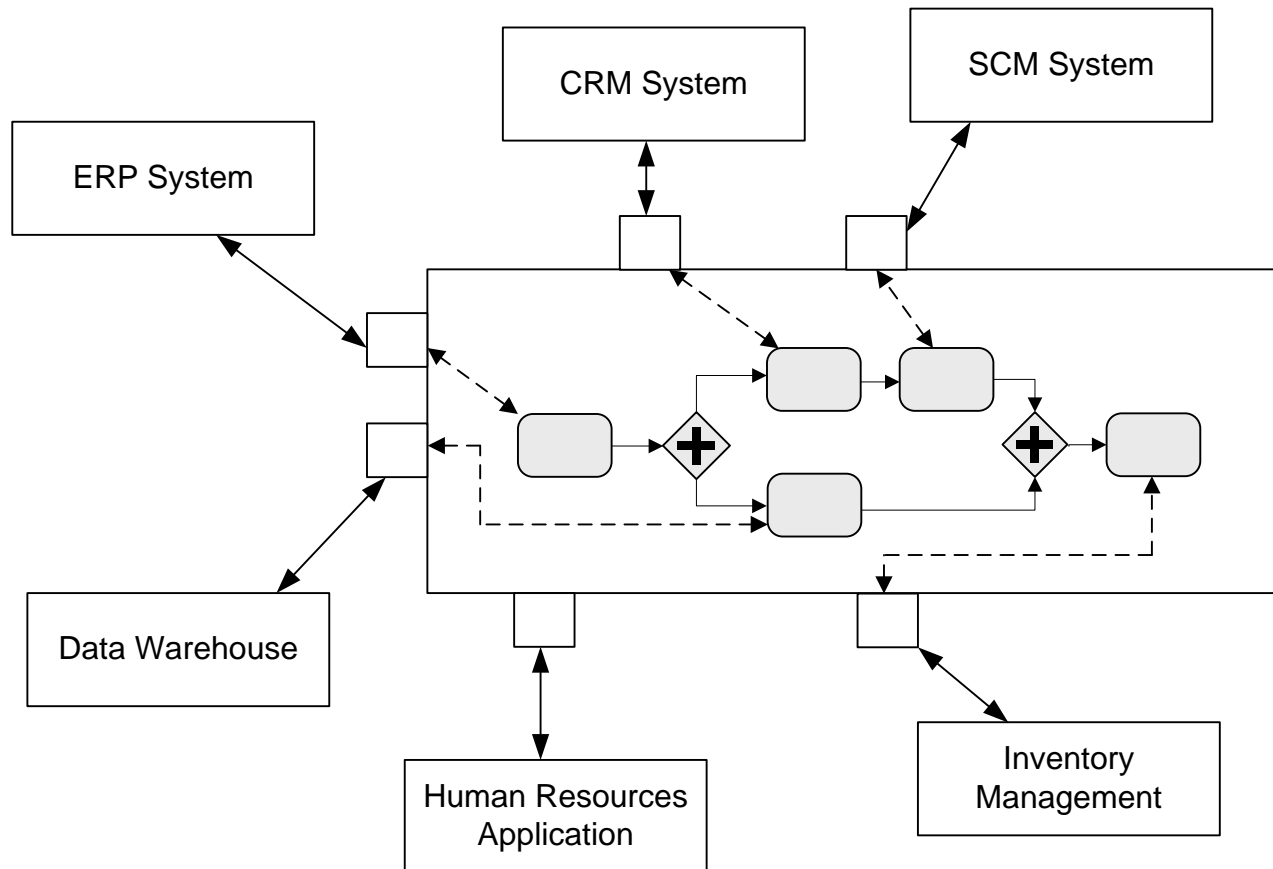
System Workflows

- Characterization
  - Process activities are realized through software systems
  - No user interactions
  - Workflow system can be understood as a realization of EAI, with explicit process modeling and execution control
- Approach
  - Use of application-specific adapters
  - Integration logic is implemented in a process model
  - The process model is used by WFMS for process control
  - Adapters are used to adjust data types (data mapping)

SYSTEM WORKFLOW: EXAMPLE

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HUMAN INTERACTION WORKFLOWS

- Characterization
 - User interaction during workflow execution
  - System activities are also provided
  - Active process controlled by interaction with the *Process Participants*
- Approach
  - As in system workflows; additionally
  - Modeling of organizational structures, i.e., Modeling of users with their tasks and skills
  - Providing specific interfaces (work list)
  - Integration of applications with user interface

HUMAN INTERACTION WORKFLOW: EXMPLE
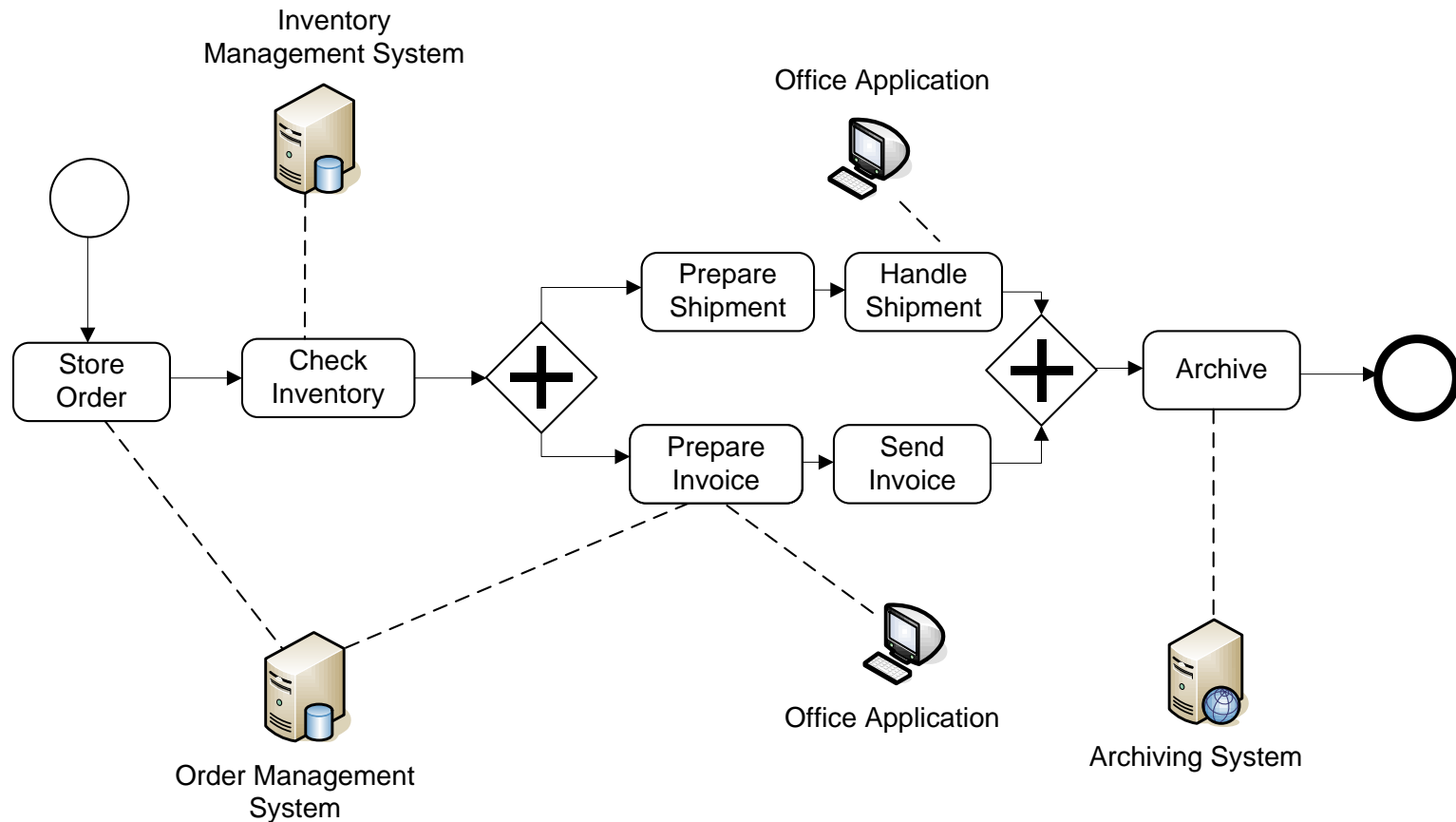
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INTRA- VERSUS INTER-SYSTEM

- Intra-system
  - All process activities are implemented by a specific software system
  - Explicit process modeling allows flexible composition of the functionality of the system
  - Little data integration problem
  - Remark: Enterprise software often has internal workflow component
- Inter-system
  - Process activities are implemented by different software systems
  - Data integration can be complex, heterogeneous system landscapes are necessary to integrate (as noted in EAI)

CRITICAL DISCUSSION OF WORKFLOW

- Interaction with users
  - Passive Roles of performers is problematic
  - Exceptional situations require decisions of performers, which are not captured in the process model
  - Remedy
    - Ad-hoc Workflow: Initiated by performers
    - Flexible Workflows: Structural changes at runtime
    - Data-dependent process control / Case Handling
- Technical integration issues
  - Heterogeneous interfaces require massive coding effort, as stated in EAI
  - Remedy
    - Service-oriented Architecture, SOA
    - System Workflows in SOA implemented via service-composition, Business Process Execution Language for Web Services, WS-BPEL

CRITICAL DISCUSSION OF WORKFLOW

- Processes without workflow management systems
  - Business processes can be implemented without workflow management systems
  - Examples:
    - Online trading (books, tickets, etc)
    - Wizard approach for configuration of software systems
  - System Workflows
    - If no changes are necessary to the process structure, the integration can be done by coding
    - Remark: In the context of a service-oriented approach, a graphical process model is developed, which is then transformed into an executable representation
  - Human Interaction Workflow
    - Close linkage to operational business processes, changes and user management are important advantages of WFMS

Service-oriented Architecture

- Service orientation
  - Providing a service by service-provider
  - Description of these services
  - Publish the description
  - Customers discover these descriptions
  - Customers invoke these services
- Software services
  - Providing the functionality of software components through services that are described in a uniform format
  - Service users will find these descriptions and use the services
- Objective
  - New applications can be created quickly and inexpensively and adapted to changing market situations.

SERVICE ORIENTED ARCHITECTURE

- Definition Service [Burbeck 2000]
  - *Services are loosely-coupled computing tasks communicating over the internet that play a growing part in business-to-business interactions. [...]*
  - *We reserve the term service-oriented for architectures that focus on how services are described and organized to support their dynamic, automated discovery and use. We do not address systems based on manually hardwired interactions, such as those used in EDI systems.*

SERVICE ORIENTED ARCHITECTURE

- Service Provider
  - Owns the service, provides description and publishes in a directory (Registry Service)
- Service Registry
  - Directory that provides search mechanisms so that service-requestor can find services
- Service Requestor
  - Service users, the service is in the directory, and finally calling it

```
Service Requestor  ──4: bind / invoke──▶  Service Provider
       ▲  │                                       │
   3: reply │ 2: request                    1: publish
        │  ▼                                       ▼
            Service Registry
```
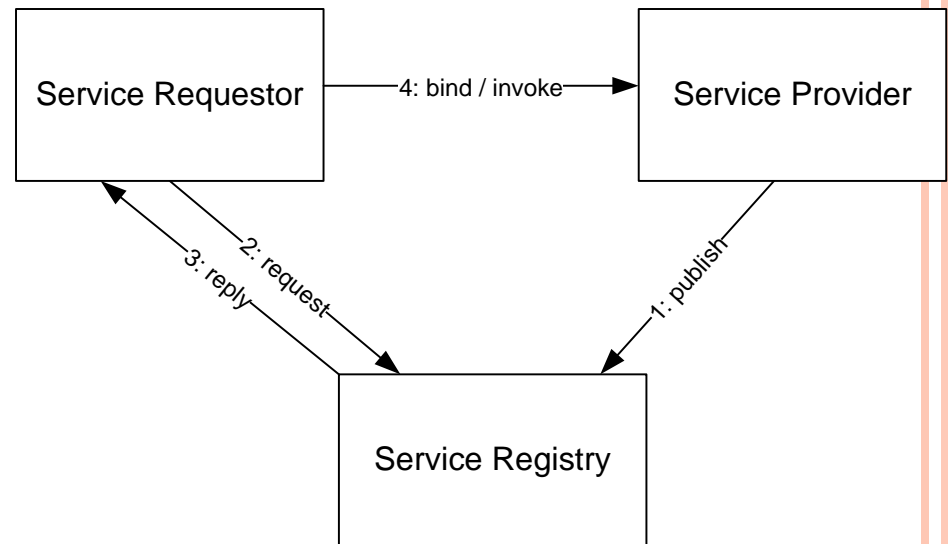
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OVERALL PICTURE

Business to Business Processes (Section 2.3)

Human Interaction Workflows (Section 2.4)

System Workflows / Composite Applications (Sections 2.4, 2.5)

Service Layer (Section 2.5)

Enterprise Application Integration (Sections 2.2, 2.5)

Enterprise Applications (Sections 2.1, 2.2)

Data

Buyer

Place Order

Receive Invoice

Settle Invoice

Receive Product

Service Interfaces

Enterprise Application Integration

EAI Adapter

ERP System

SCM System

CRM System

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