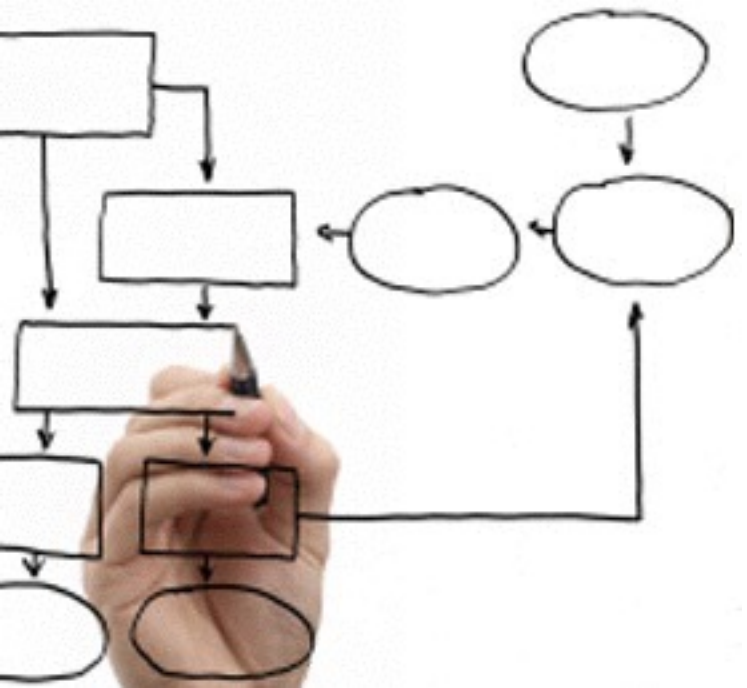
Methods for the specification and verification of business processes

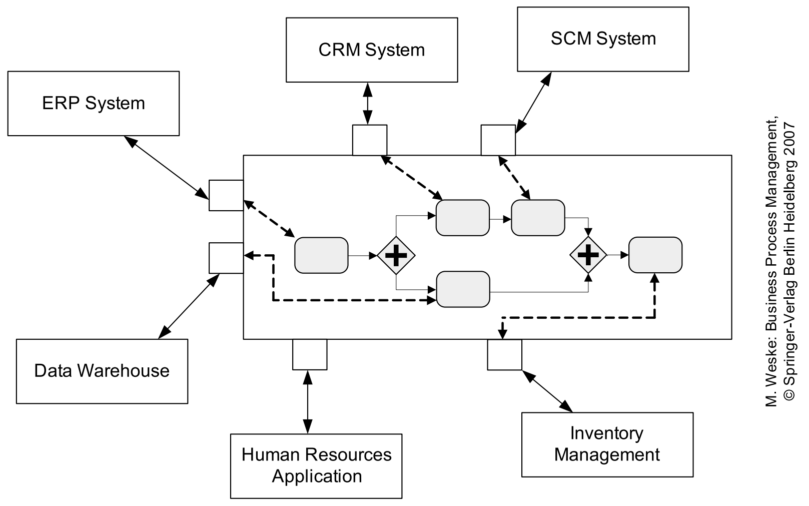
MPB (6 cfu, 295AA)

Roberto Bruni
http://www.di.unipi.it/~bruni

06 - Evolution



Object


CRM System
SCM System
ERP System
Data Warehouse
Human Resources Application
Inventory Management
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Overview of the evolution of (Information Systems inside) Enterprise Systems Architectures

Guiding principles

Separation of Concerns (SoC)
(to separate a system into distinct features that overlap in functionality as little as possible)

Modularity and information hiding
(encapsulation, interfaces, reuse, maintainability, response to change)

Edsger W. Dijkstra 1974

11 May 1930
6 August 2002
http://www.cs.utexas.edu/users/EWD/

Let me try to explain to you, what to my taste is ***characteristic for all intelligent thinking****.*

It is, that one is willing to study in depth an aspect of one's subject matter ***in isolation for the sake of its own consistency****, all the time knowing that one is occupying oneself only with one of the aspects.*

Edsger W. Dijkstra 1974

...
We know that a program must be ***correct*** *and we can study it from that viewpoint only;*
we also know that it should be ***efficient*** *and we can study its efficiency on another day, so to speak.*
In another mood we may ask ourselves whether, and if so: why, the program is ***desirable****.*

But nothing is gained —on the contrary!— by tackling these various aspects simultaneously.

Edsger W. Dijkstra 1974

...
*It is what I sometimes have called **"the separation of concerns"**, which, even if not perfectly possible, is yet the only available technique for effective ordering of one's thoughts, that I know of.*

This is what I mean by "focussing one's attention upon some aspect": it does not mean ignoring the other aspects, it is just doing justice to the fact that
from this aspect's point of view, the other is irrelevant.

Edsger W. Dijkstra 1974

Business data processing systems are sufficiently complicated to require such a separation of concerns

and the suggestion that in that part of the computing world "scientific thought is a non-applicable luxury" puts the cart before the horse: the mess they are in has been caused by ***too much unscientific thought****....*

SoC: an example

HyperText Markup Language (HTML):
organization of webpage content

Cascading Style Sheets (CSS):
definition of content presentation style

JavaScript (JS):
user interactions

SoC: another example

Model–view–controller (MVC) sw architecture

Controller: send commands to the model to update the model's state or to its associated view to change the view's presentation of the model

Model: notifies its associated views and controllers when there has been a state change (the views update their output, the controllers change the available set of commands).

View: requests information from the model to generate an output representation to the user

Software Architecture

Definition: A **software architecture** defines a structure that organizes the software elements and the resources of a software system (outside view).

Software elements and resources are represented by subsystems, with specific responsibilities and relationships (inside view).

Early systems (architectures)

Applications developed from scratch

Porting required redevelopment

Data dependency and consistency issues

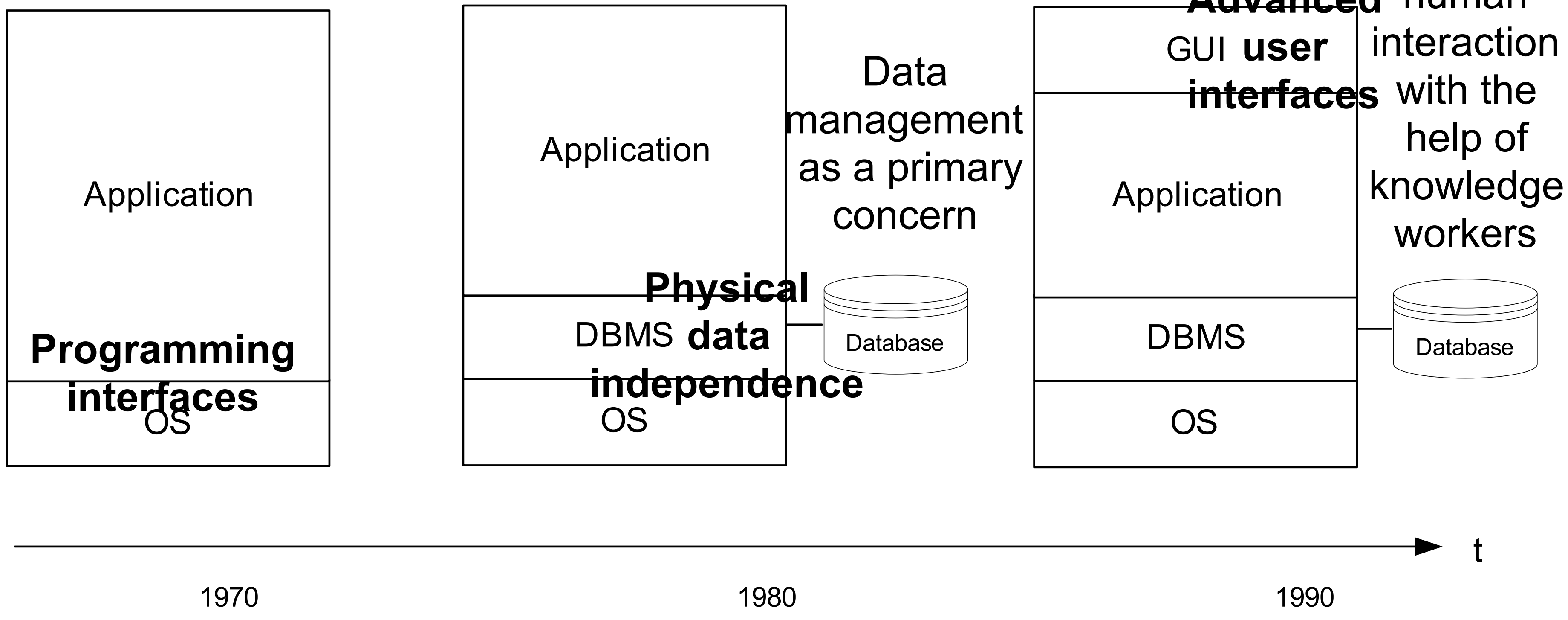
Programming interfaces

Physical data independence

Data management as a primary concern

Advanced user interfaces

ease human interaction with the help of knowledge workers



Enterprise Scenario

Early stages
mainframe, assembler language, monolithic applications (including data and textual user interface)

DBMS
application code and (textual, form-based) user interface still entangled

Lowering cost of hw
more separated applications available (different applications in different departments, but hosting related data: redundancy, dependencies)

Enterprise Applications

OS + DBMS + GUI + Networking capabilities =
more and more elaborate information systems could be engineered

Typically hosting enterprise applications (customers, personnel, products, resources)

Next steps:
from individual to multiple information systems (needs integration)

Changes

Changes were hard to implement!

Hard to track data dependency and replication

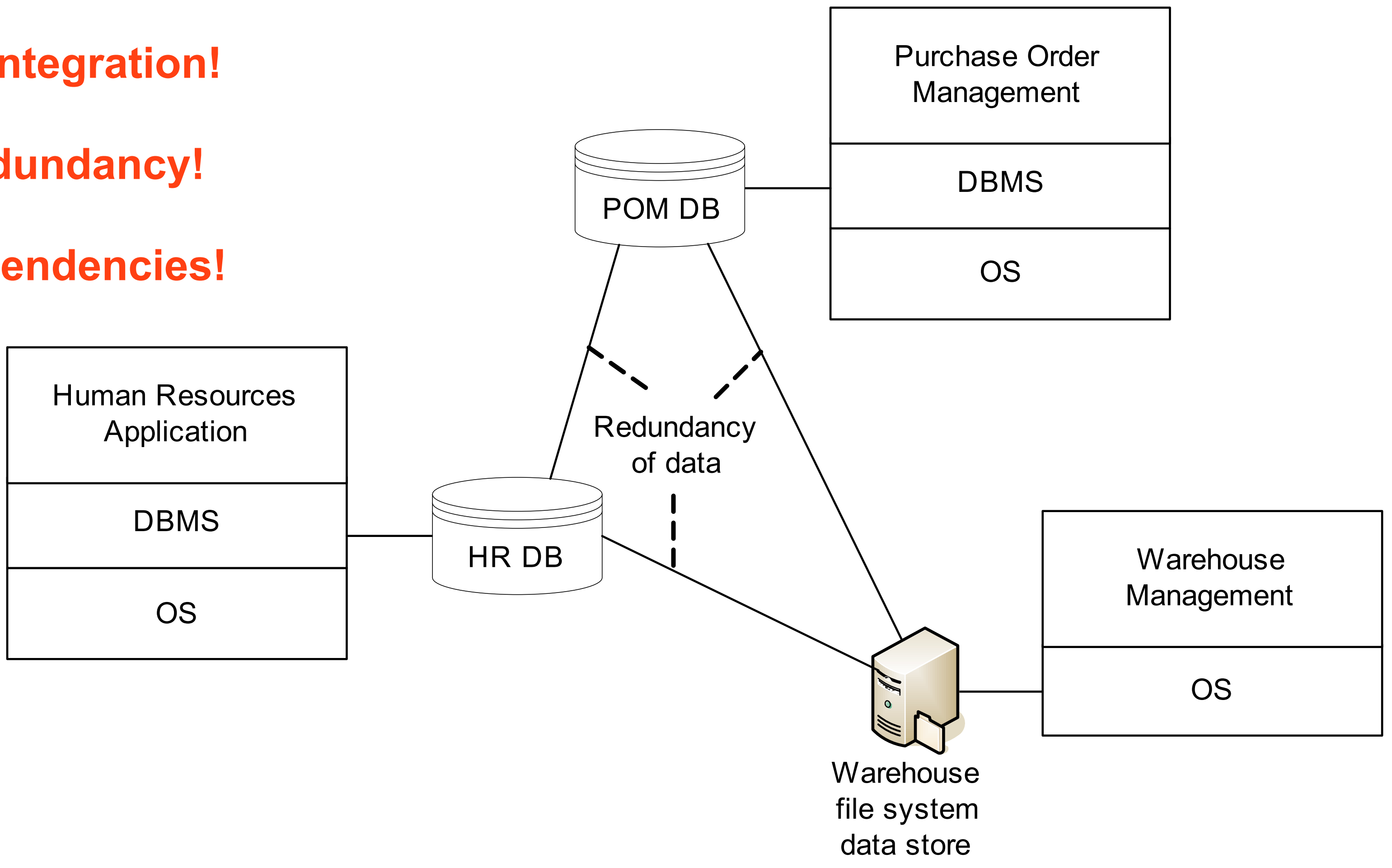
Any modification of an application was a complex and error-prone activity, with domino effect (e.g. change of customer address format)

Individual enterprise application

Lack of Integration!

Data redundancy!

Data dependencies!



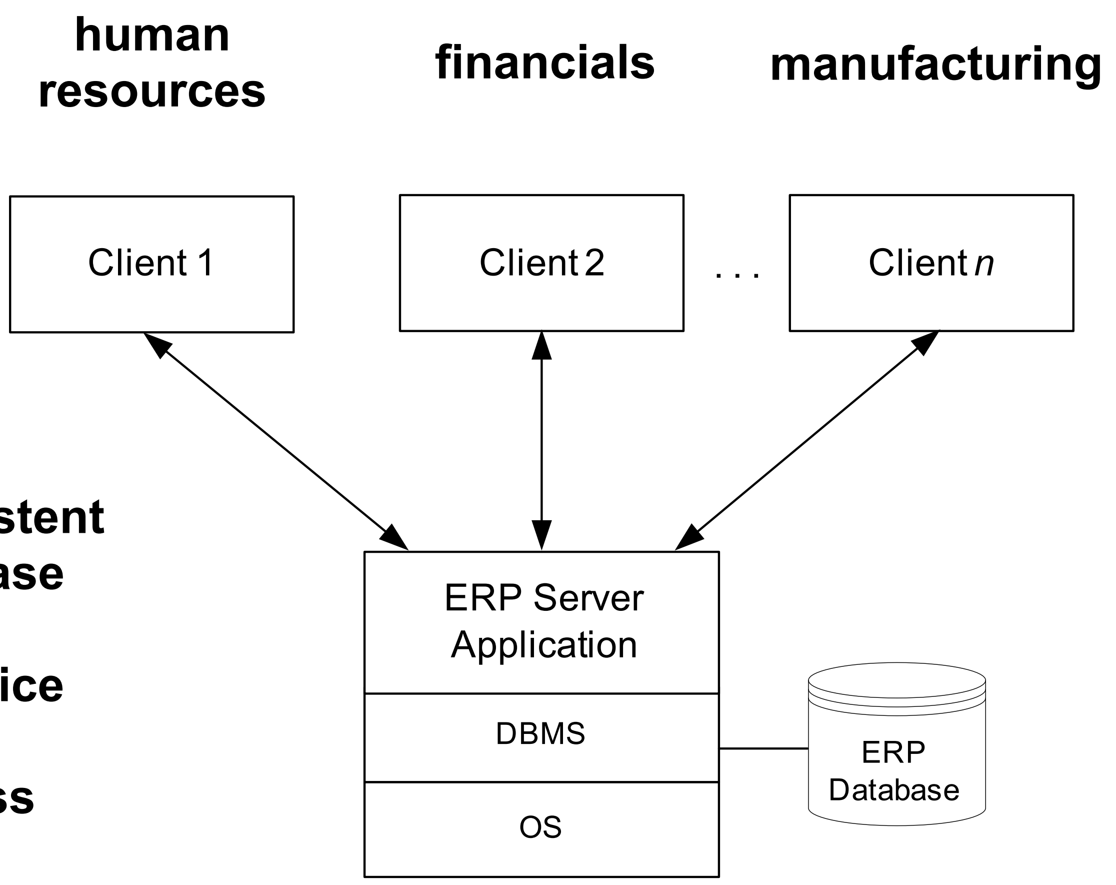
Purchase Order Management
DBMS
OS
POM DB
Redundancy of data
Human Resources Application
DBMS
OS
HR DB
Warehouse Management
OS
Warehouse file system data store

ERP

Enterprise Resource Planning (**ERP**) systems were developed to deal with the increasing complexity of changes

Basic idea
integrated database that spans most applications, separated modules provide desired functionalities, accessed by client applications

Enterprise resource planning systems



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Integrated and consistent (centralized) database

Two-tier client-service

remote data access

ERP

CRM and SCM

New types of sw entered the market around 2000

Customer Relationship Management (**CRM**) systems
Supply Chain Management (**SCM**) systems

Goal
to support the planning, operation, and control of supply chains, including inventory management, warehouse management, management of suppliers and distributors, and demand planning

Problem: different vendors, separately developed

Siloed enterprise applications

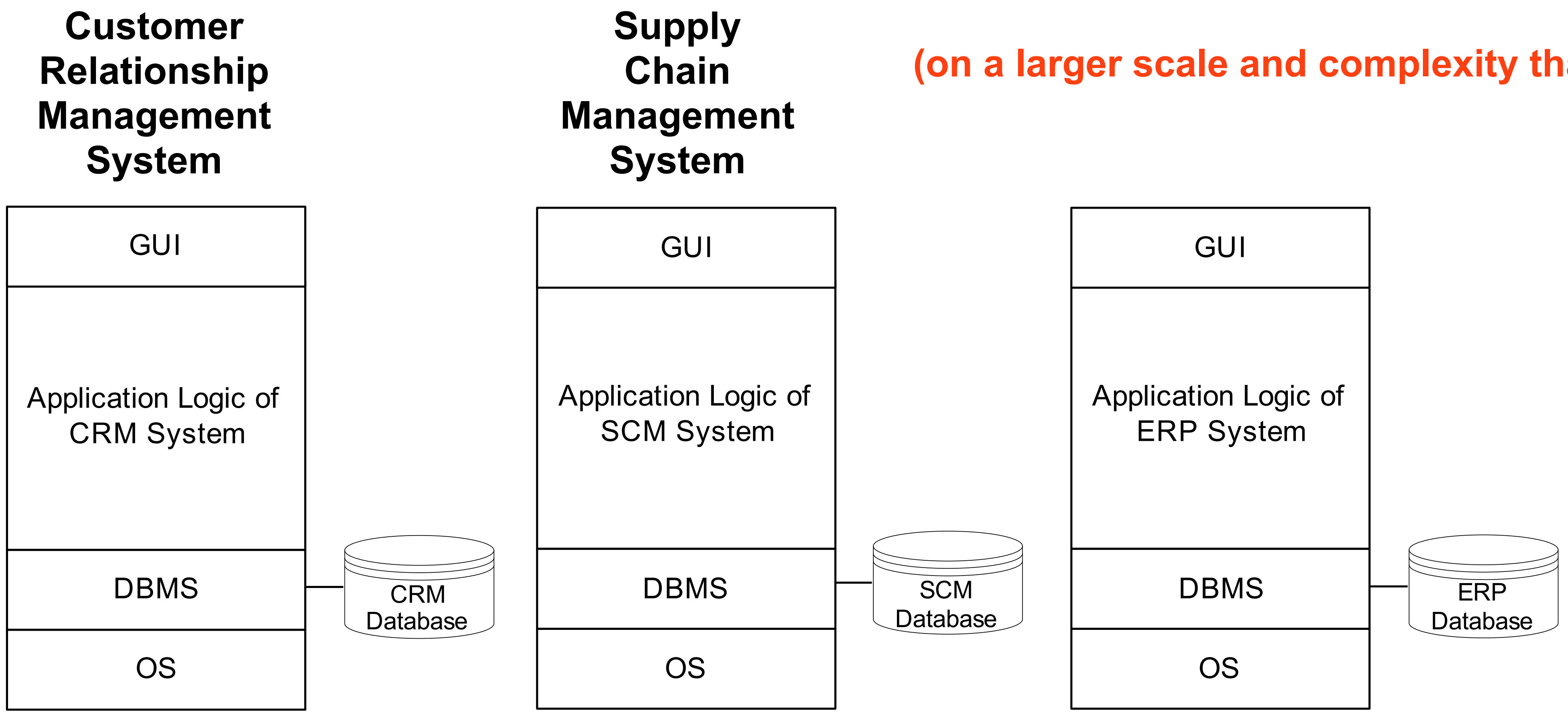
Lack of Integration!

Data redundancy!

Data dependencies!

(on a larger scale and complexity than before)

Data Integration would provide valuable information


Customer Relationship Management System
GUI
Application Logic of CRM System
DBMS
OS
CRM Database
Supply Chain Management System
GUI
Application Logic of SCM System
DBMS
OS
SCM Database
GUI
Application Logic of ERP System
DBMS
OS
ERP Database

Connected on local network, but not logically integrated

A sample scenario

Customer calls

Call centre personnel can only access the information stored in one system

Call centre personnel is not aware of the full status of the customer

Customer (doesn’t care about siloed structure)
does not feel well served,
becomes upset,
expects a better service

Heterogeneity

Heterogeneous information technology landscape
has grown in an evolutionary way for years:
Heterogeneity of data and their attributes
(syntax and semantics difficulties)
calls for Data Integration

Examples
corresponding data fields with different names
(e.g., CustAddr vs CAstreet),
fields with the same name but different meaning
(e.g. Price, with or without taxes?, unitary?)

Integration

Manual integration is possible, but:

it consumes considerable resources

it is error-prone

cannot foreseen all applications in advance
(reimplementing functionalities in an integrated way
would just postpone the problem)

Solution
Enterprise Application Integration systems
as a new middleware

Enterprise Application Integration

Definition: **Enterprise Application Integration** (**EAI**) is defined as the use of software and computer systems architectural principles to integrate a set of enterprise computer applications.

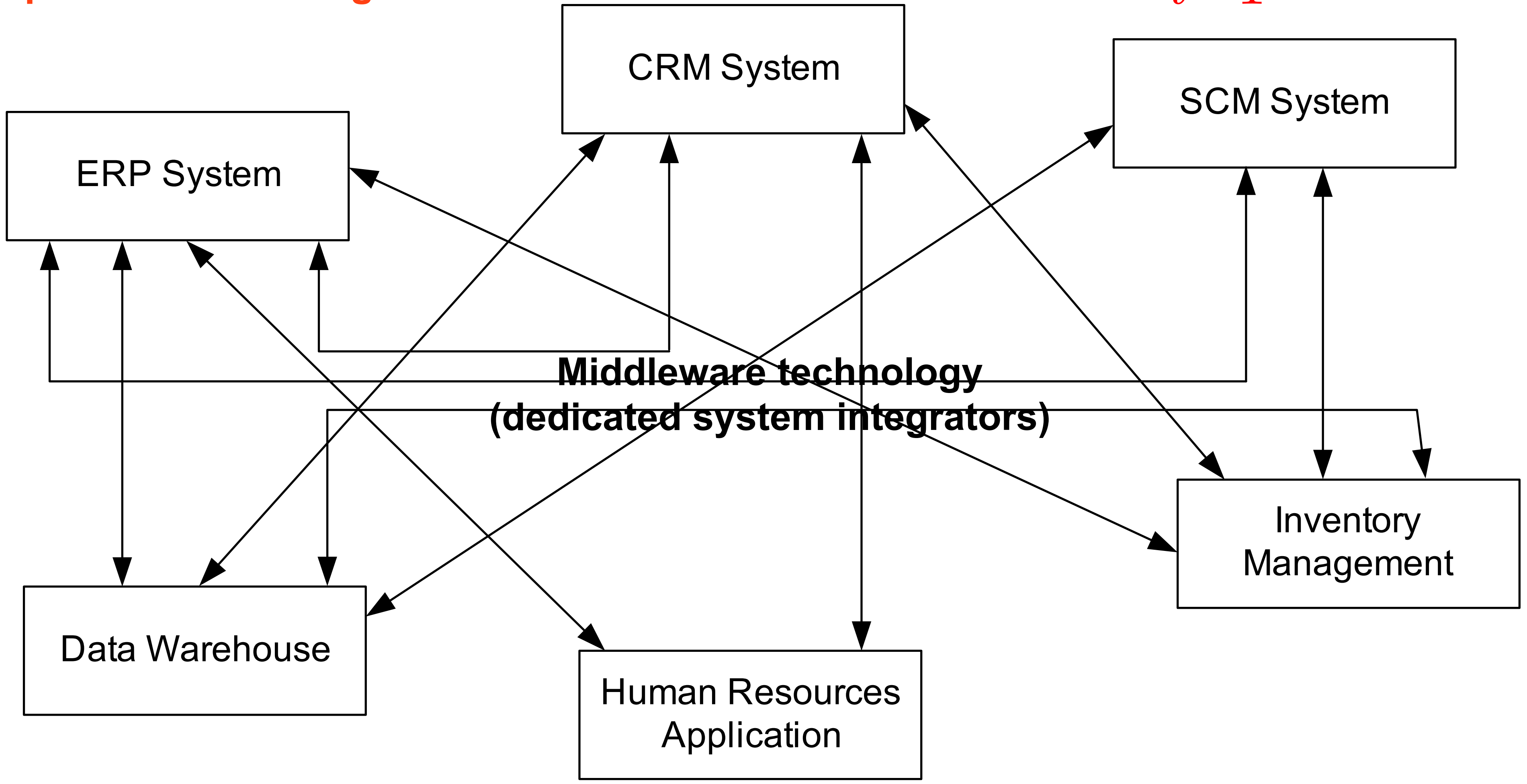
Point-to-point integration (of silos)

N x N hard-wiring problem!

Too many interfaces to develop!

Does not respond well to changes!

$$\sum_{i=1}^{N-1} i = \frac{N(N-1)}{2}$$



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Support Changes, efficiently, effectively

The point-to-point approach opposes some resistance to fluent changes

Hard-wiring of interfaces (and their numbers) is the main limit

Reprogramming an interface requires considerable resources, typically

Alternative
Move to message-oriented middleware

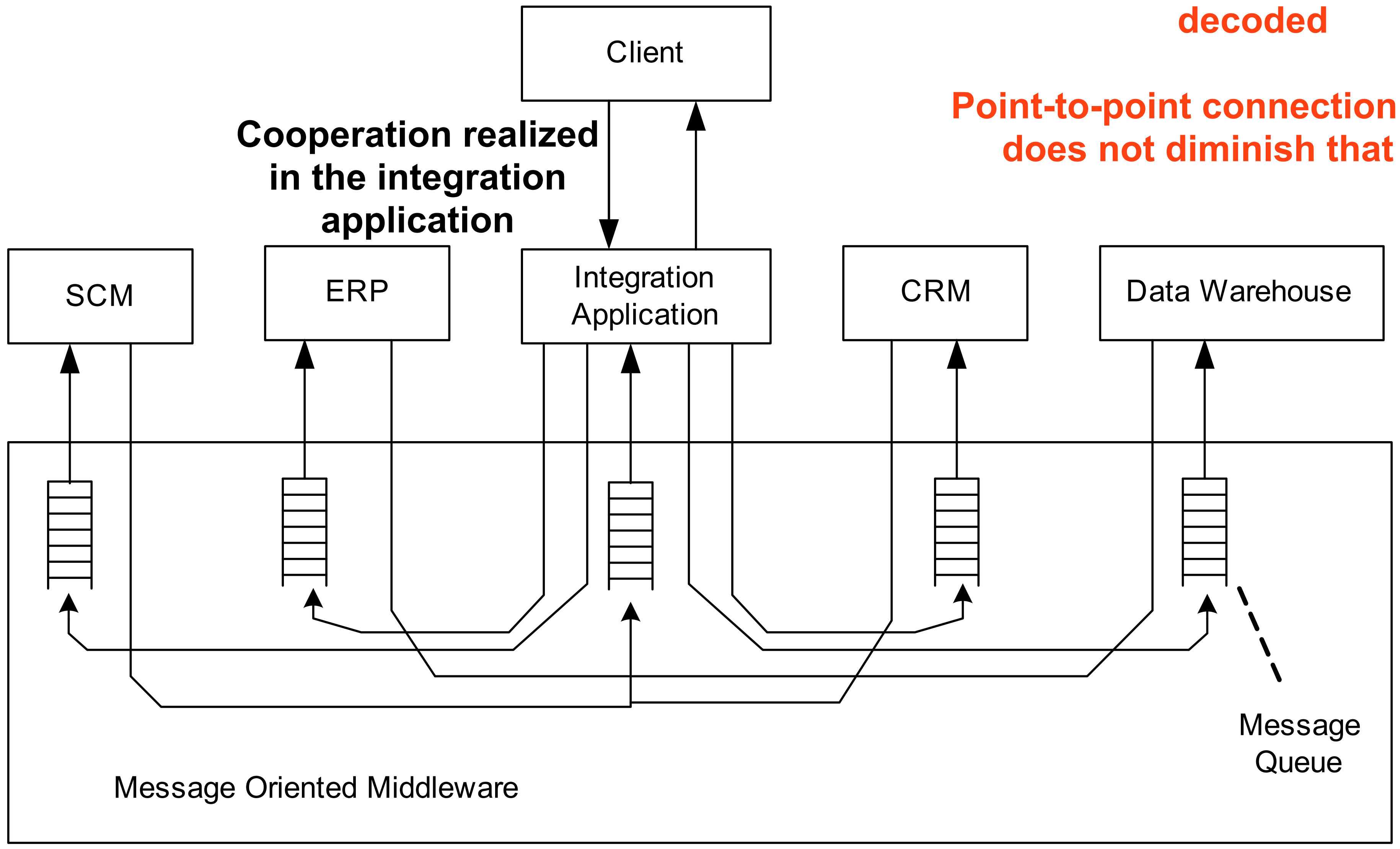
Message Oriented Middleware

Message-Oriented Middleware offers some execution guarantees, such as message delivery (e.g. persistent message queues are used)

Still, the main problem remains:
changes in the application landscape require changes in the communication structure

The Client exploits an **Integration Application** to operate on all systems

Message-oriented middleware


Client
Cooperation realized in the integration application
SCM
ERP
Integration Application
CRM
Data Warehouse
Message Queue
Message Oriented Middleware

Messages must be encoded and decoded

Point-to-point connection problem does not diminish that much

Response to Change

Message-oriented middleware reduces in part integration efforts and gives important run-time guarantees

Still cooperation is hardwired in a particular application (the Integration Application)

No explicit process model that can be documented, communicated, and changed when necessary

In the end, response to change is not improved

Hub-and-Spoke

The **Hub-and-Spoke** paradigm is based on a central hub and a number of spokes attached to it

The Application Integration middleware represents the hub, and the applications to be integrated represents the spokes

Interactions between any two applications must pass through the hub

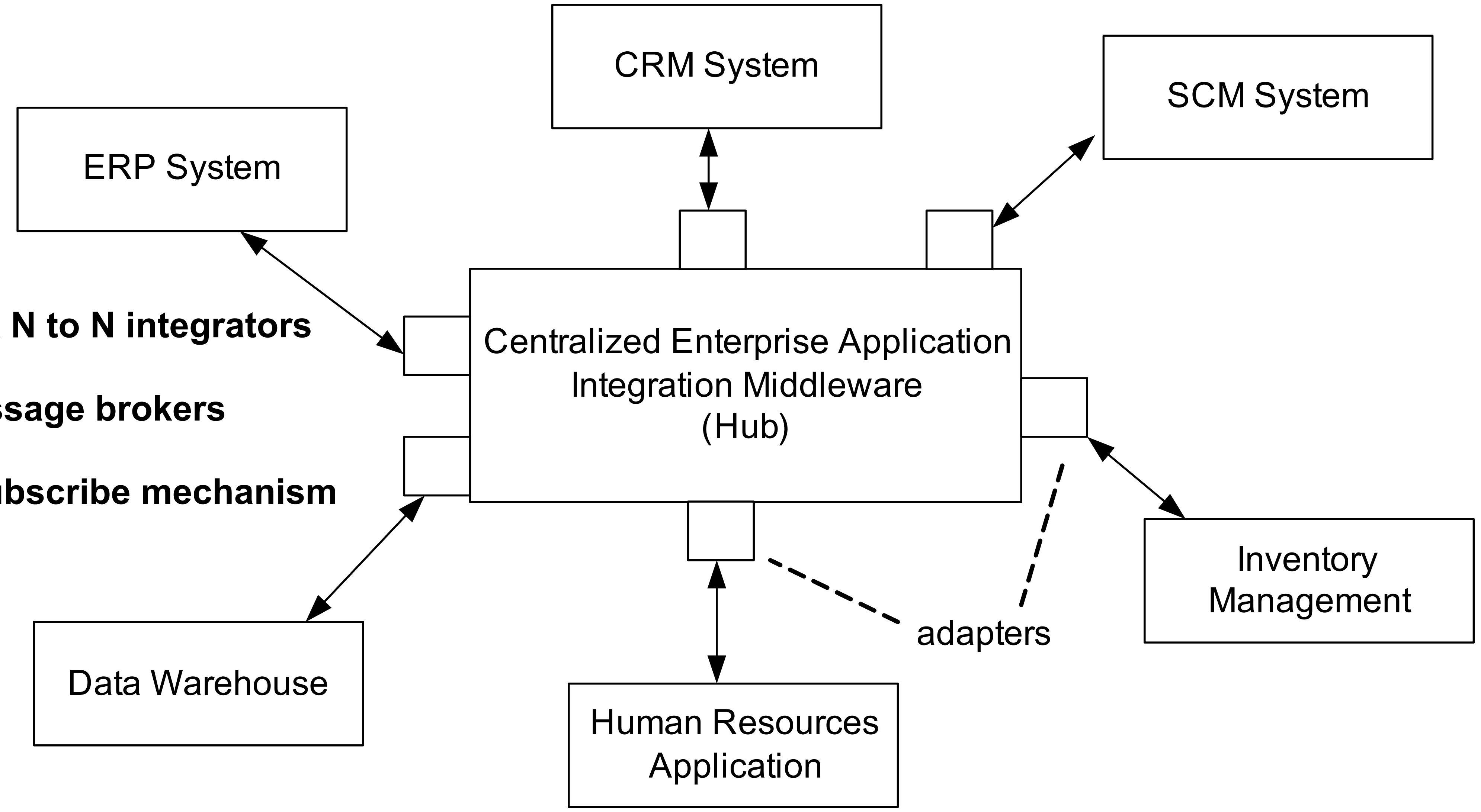
Hub-and-spoke integration

Configuration and management of adapters and message brokers can become cumbersome

From N x N to N integrators

Message brokers

Publish/subscribe mechanism


CRM System
SCM System
ERP System
Centralized Enterprise Application Integration Middleware (Hub)
Inventory Management
Data Warehouse
Human Resources Application
adapters

EAI implementation pitfalls

70% of all EAI projects fail (2003).
Most of these failures are not due to technical difficulties, but due to management issues:

Constant change

Shortage of EAI experts

Competing standards

Loss of detail: Information unimportant at an earlier stage may become crucial later

Conflicting and emerging requirements

Data protectionism

From (data-models and)
data-integration

To (process-models and)
process-integration

Value Chains and Process Orientation

Two major factors fuelled business process management

Value chains

as a means to functionally break down the activities a company performs and to analyze their contribution to the commercial success of the company

Process orientation

as the way to organize the activities of enterprises

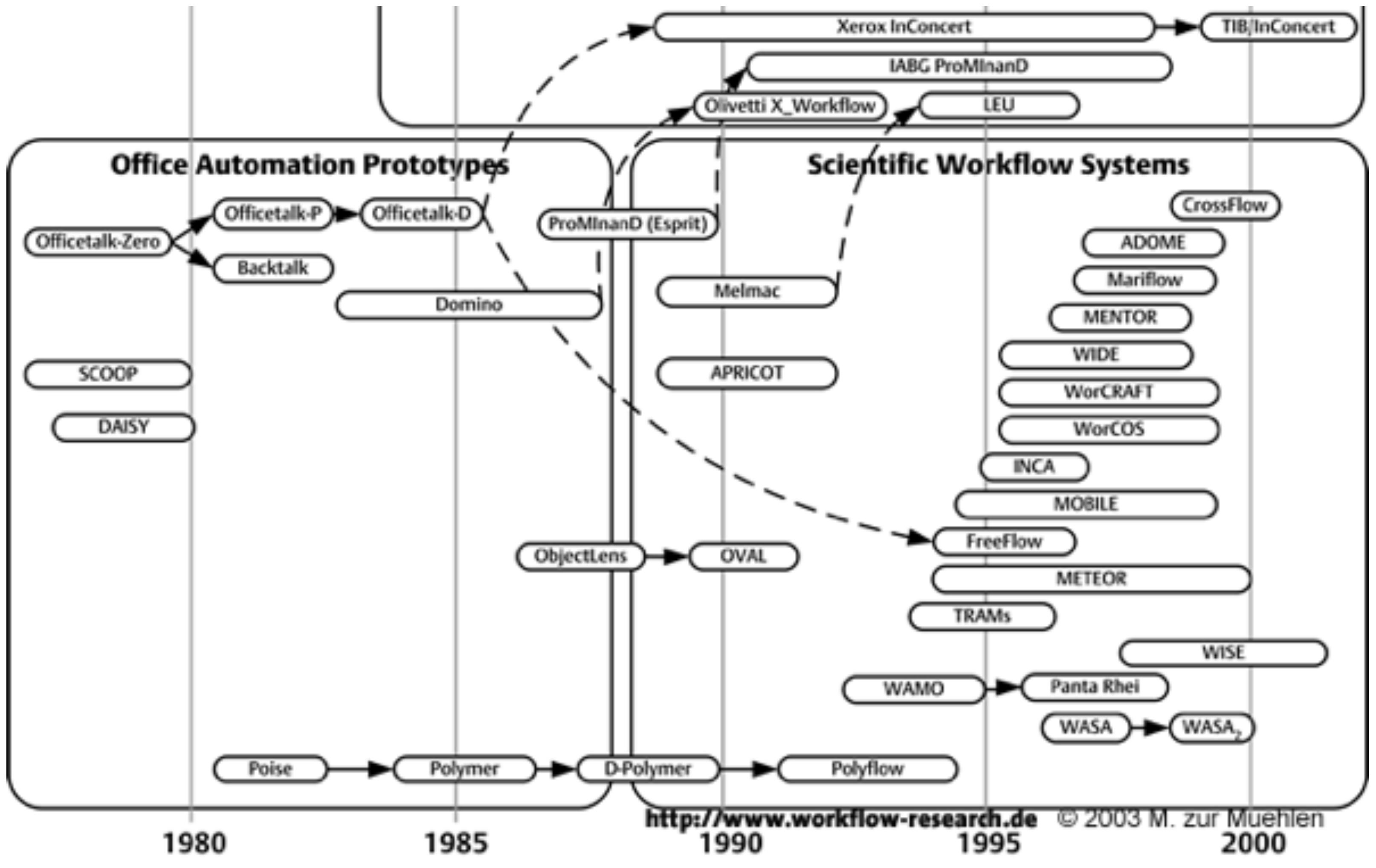
Workflow re-birth

Born as rational organization of work in manufacturing:
optimization of throughput and resource utilization

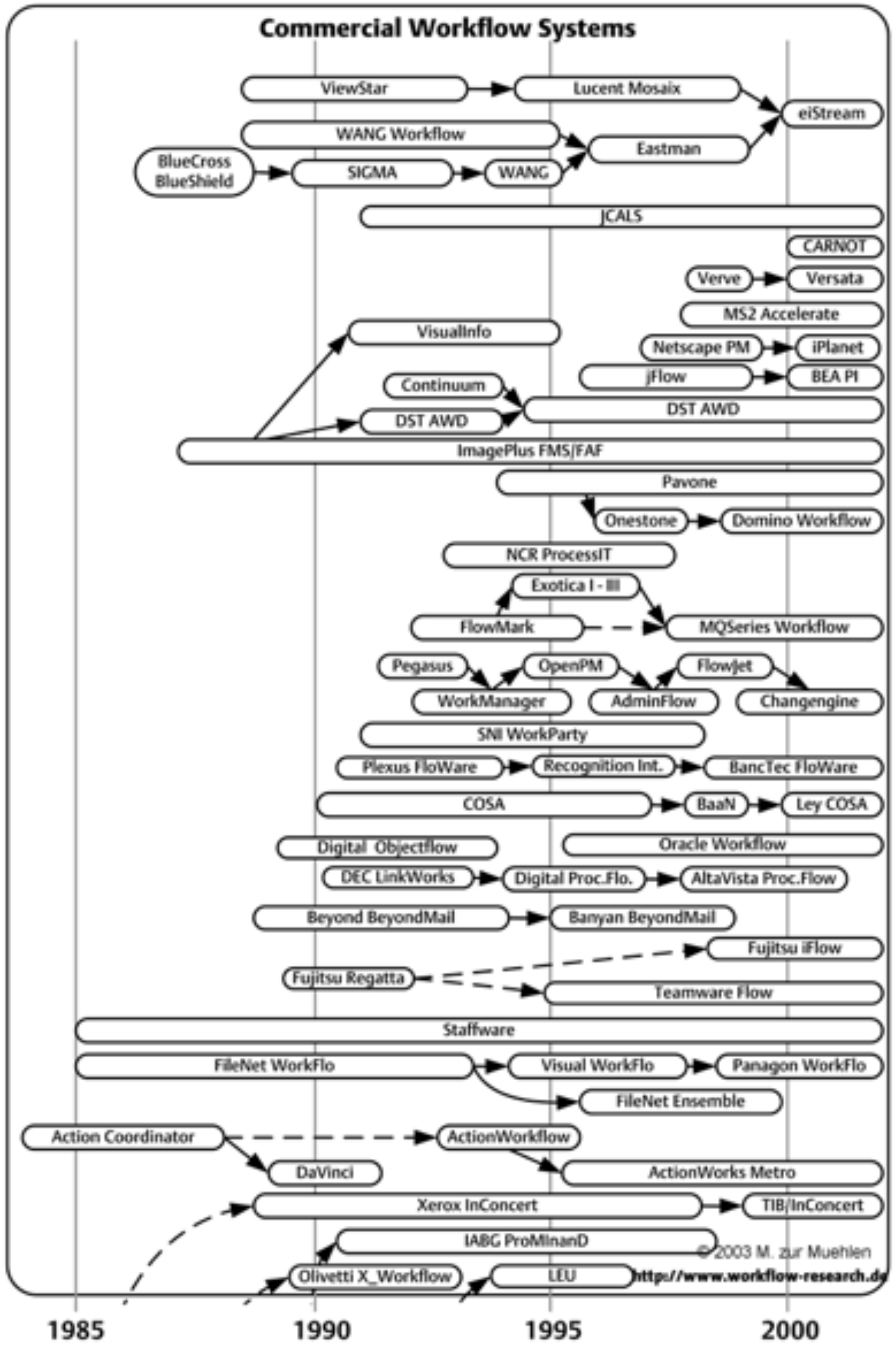
Re-born in ICT:
flexibility, adaptability, modularity, distribution

A piece of history

Research

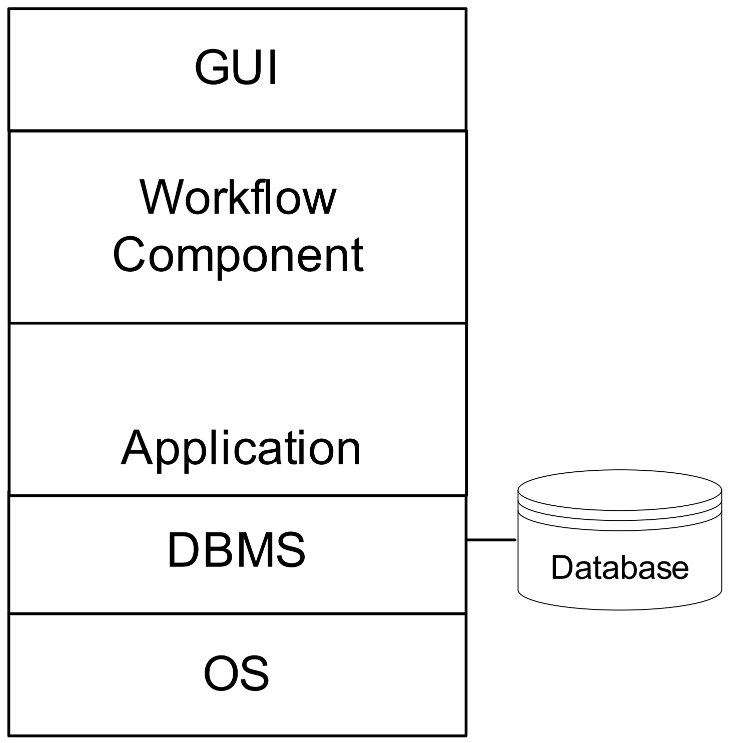


Systems



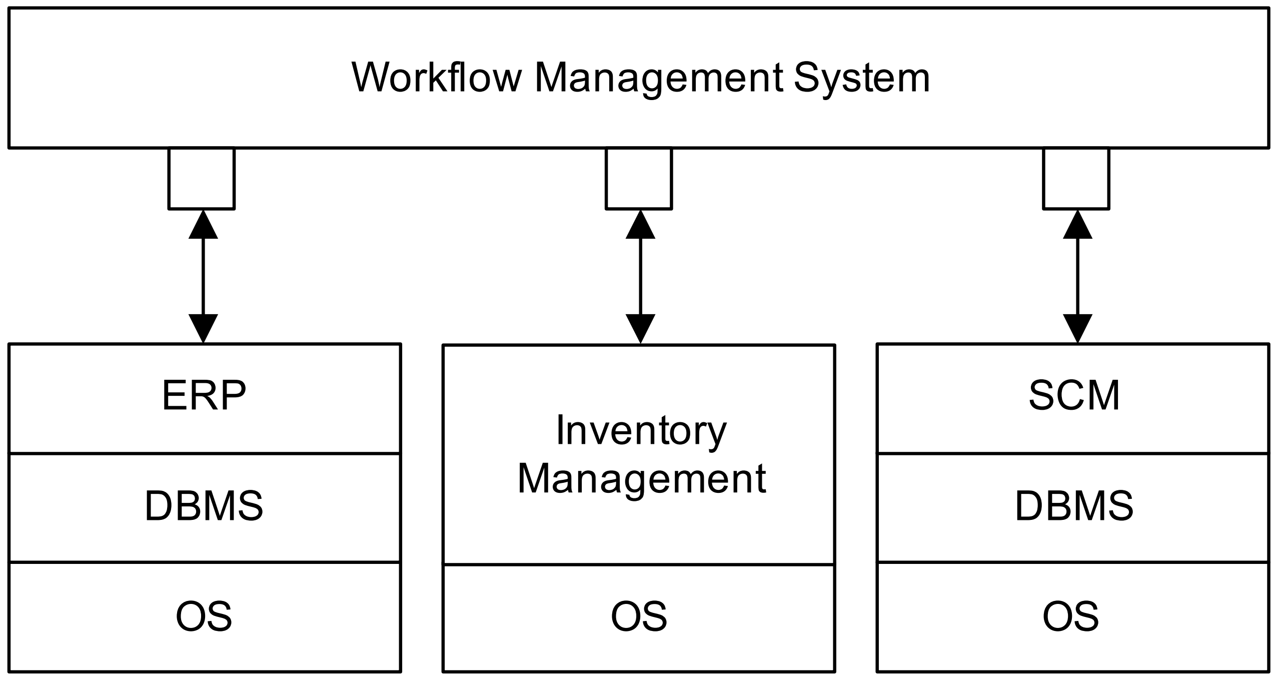
Workflow component

Definition: a **single-application workflow** consists of activities and their causal and temporal ordering that are realized by one common application system.



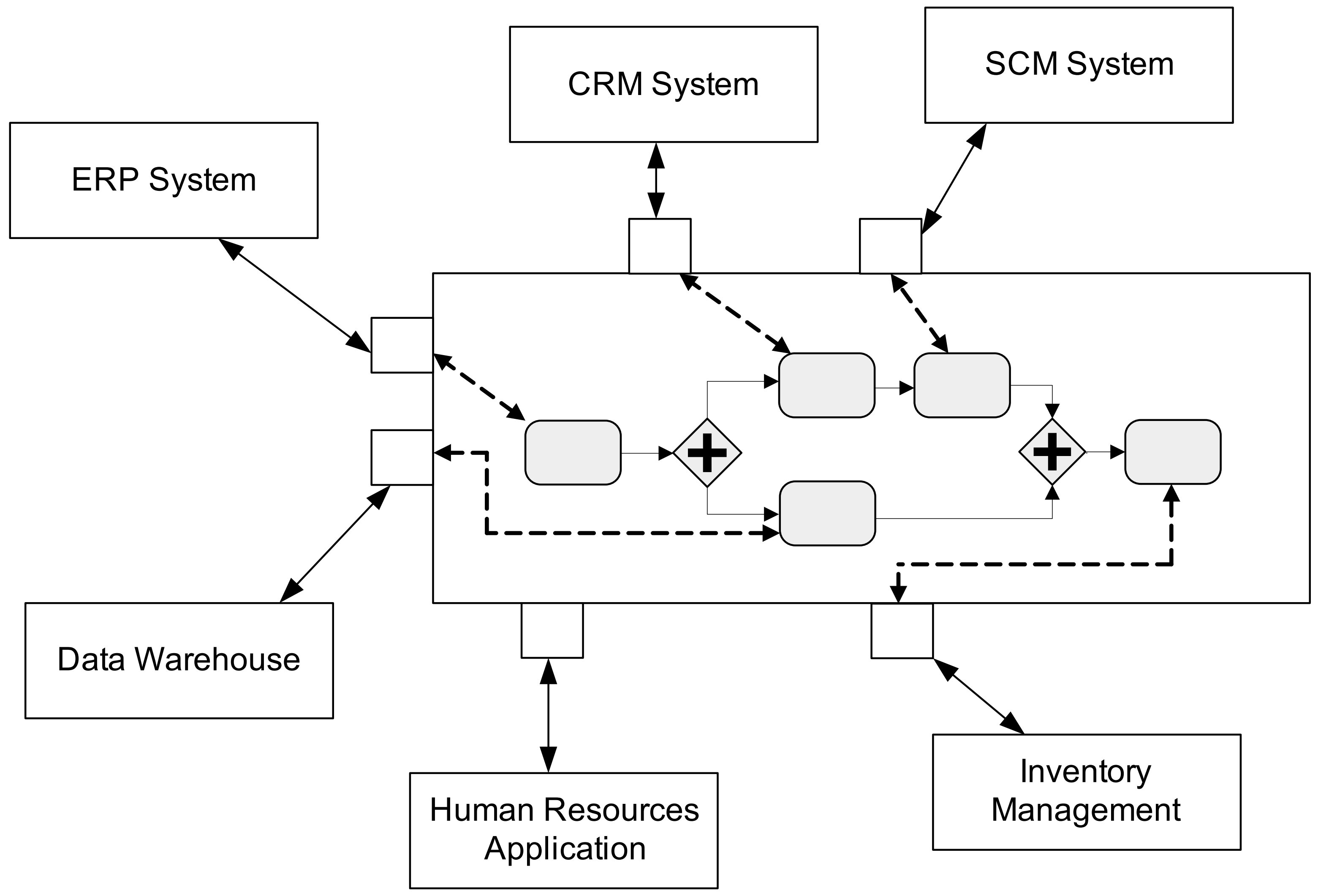
Multiple-application workflow system

Definition: a **multiple-application workflow** contains activities that are realized by multiple application systems, providing an integration of these systems.

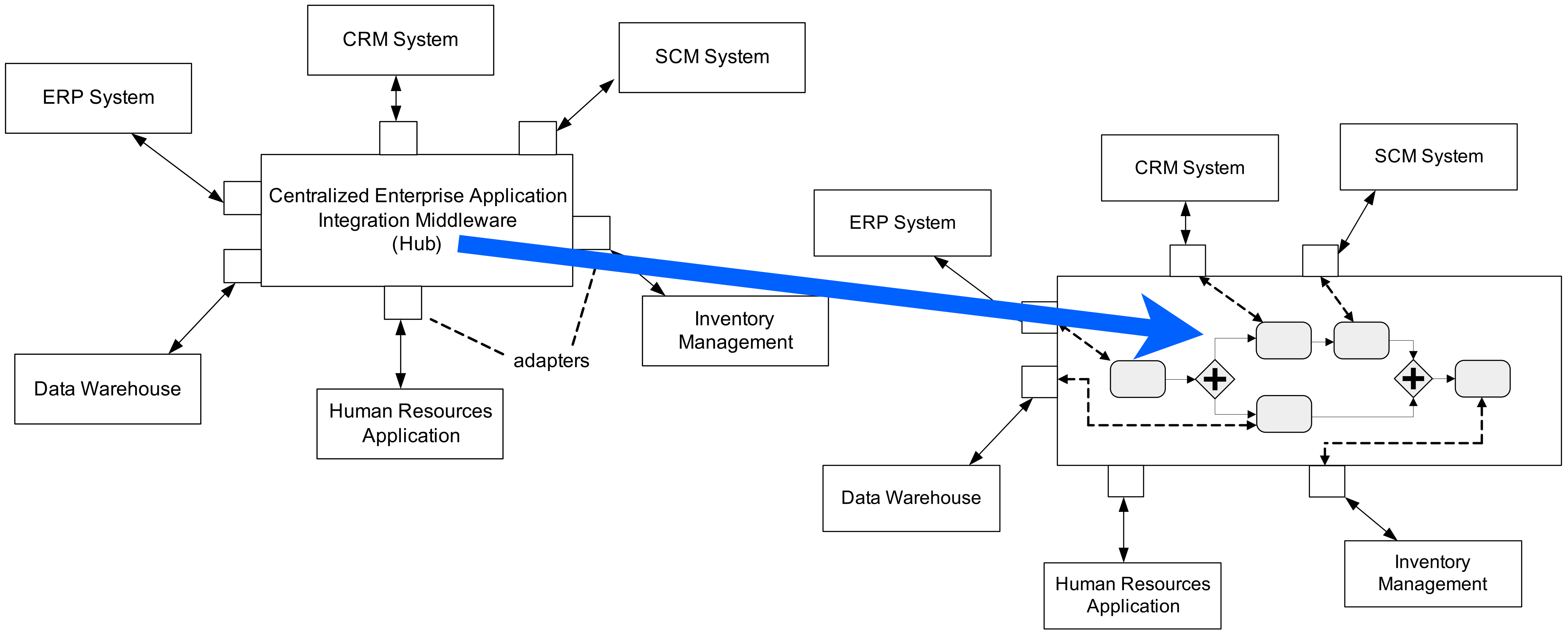


System workflow

Definition: a **system workflow** consists of activities that are implemented by software systems without any user involvement.



Do you remind hub-and-spokes EAI?



Limitations in workflow management

Technical integration problems:

Scarcely documented applications

Different levels of granularity

Tight coupling of applications
(direct invocation)

Enterprise service computing

Main idea:

Business functionalities exposed as services

Services are equipped with usage information

Customers can find services and use them

Services

Definition: **Services** are loosely-coupled computing tasks that can be dynamically **discovered** and **invoked** over the network.

Each service comes with a **service description** that can be published in **service registries** by the **service provider**.

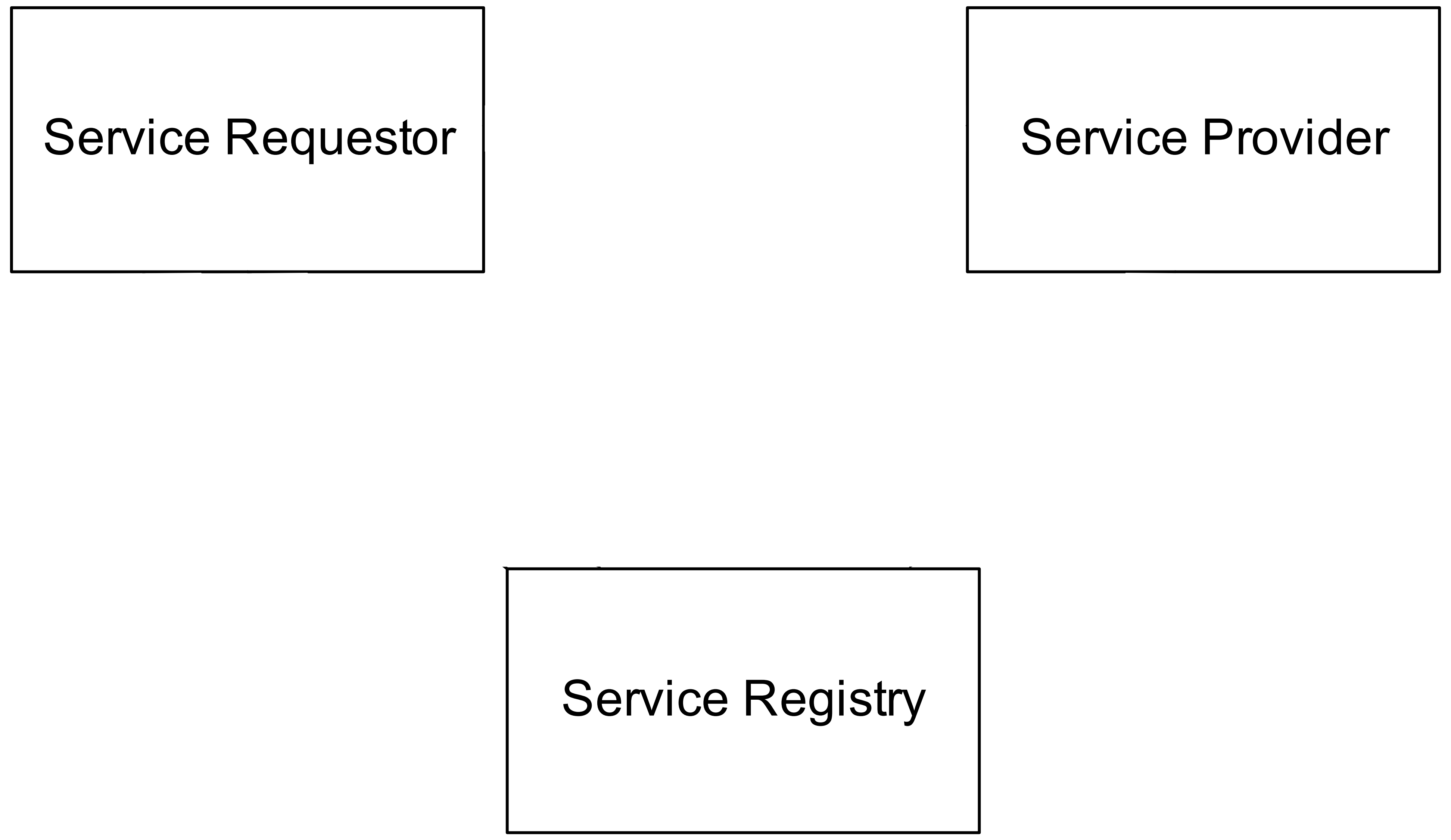
Service registries can be **queried** by **service requestors**.

Service descriptions provide a level of detail that facilitates service requestors to **bind** and **invoke** them.

Service-oriented architectures

Definition: **Service-oriented architectures** (**SOA**) are software architectures that provide an environment for describing and finding software services, and for binding to services.

Service-oriented architectures



Advantages of SOA

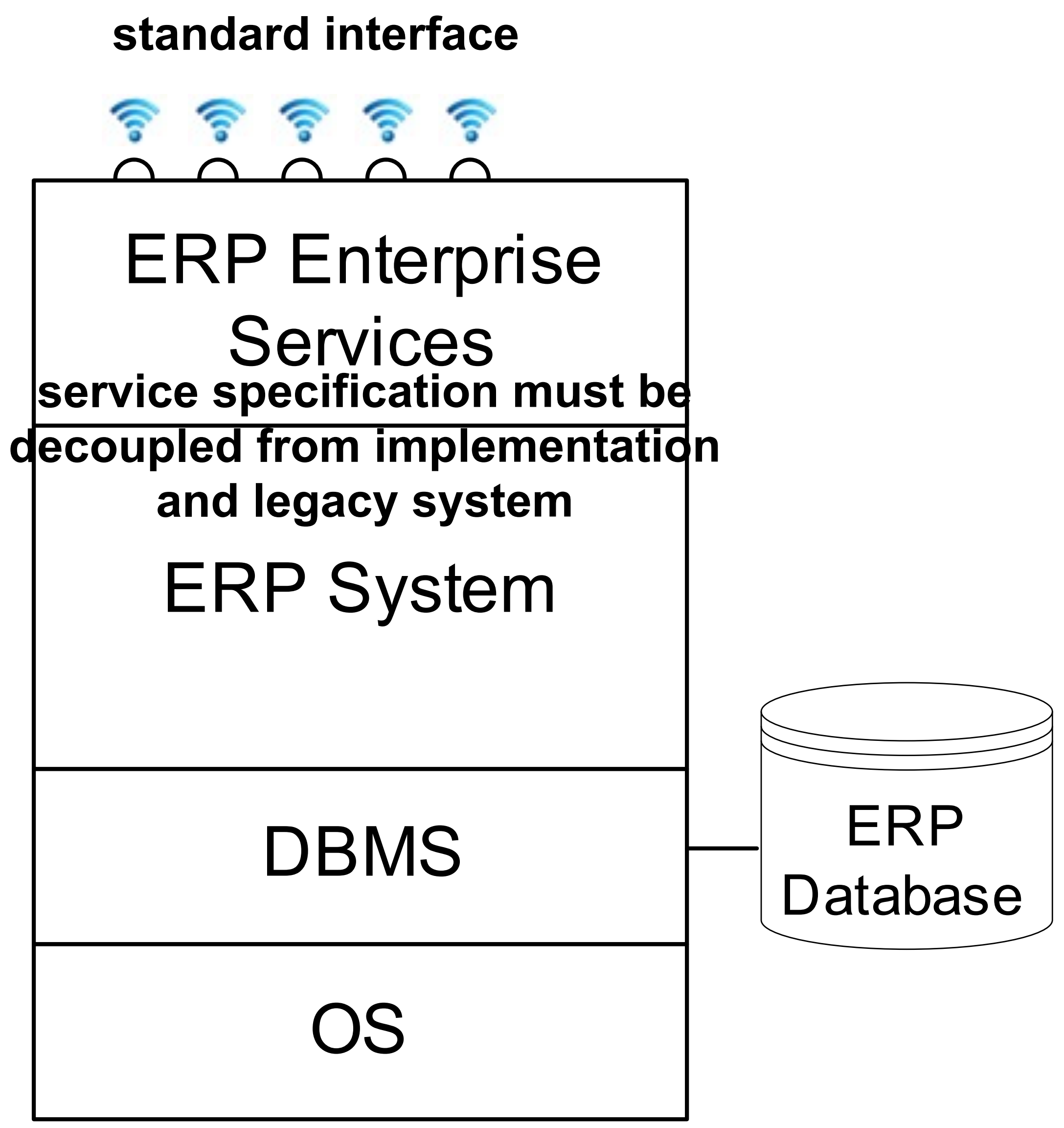
Reuse of functionality at coarse level of granularity

New applications can be built with less effort

Existing applications can be efficiently adapted to changing requirements

Reduced maintenance and development costs

Service enabled application system


standard interface
ERP Enterprise Services
service specification must be decoupled from implementation and legacy system
ERP System
DBMS
OS
ERP Database

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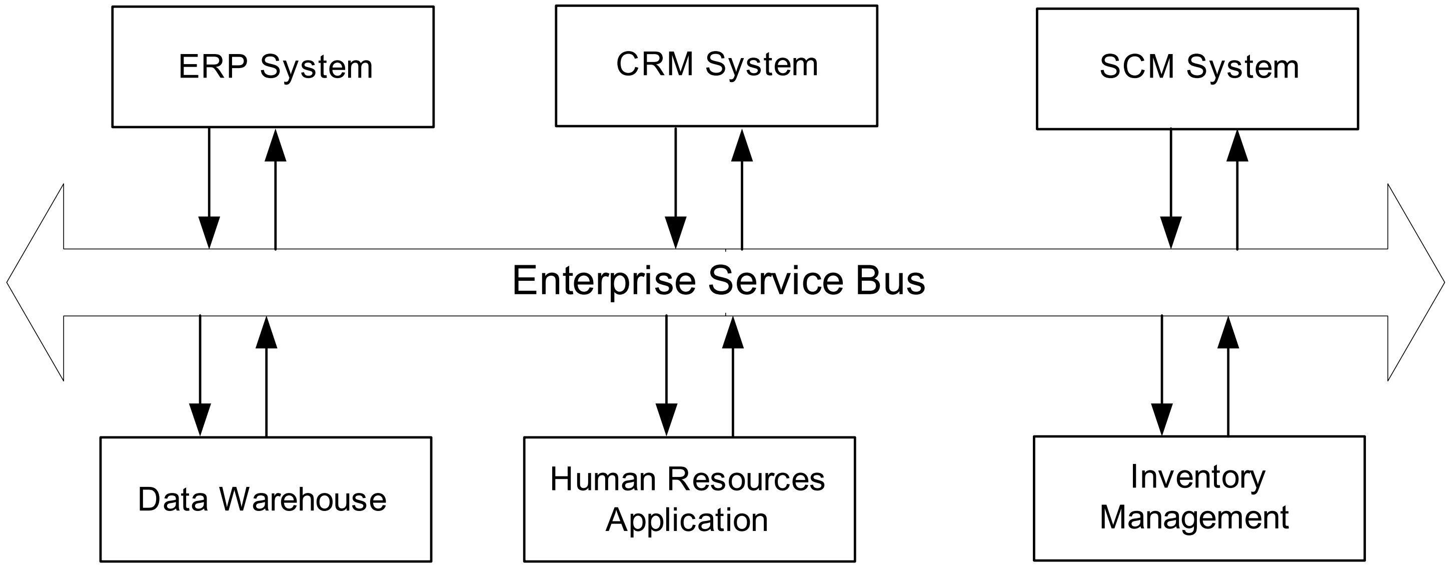
Enterprise service bus

Centralized component that integrates all applications

Hides heterogeneity by introducing service interfaces



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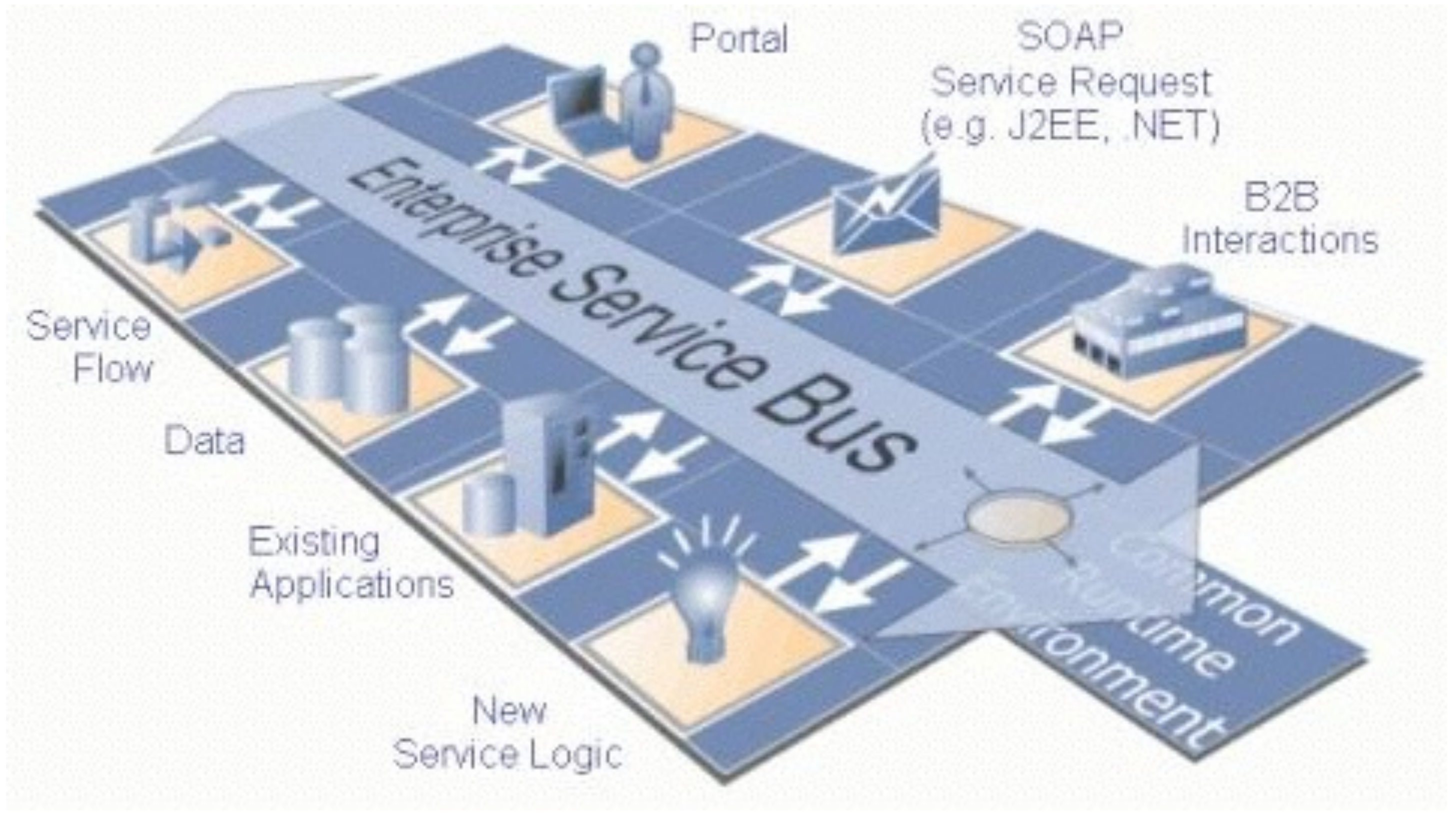
Local registry

Manual search (absence of dynamic matchmaking)



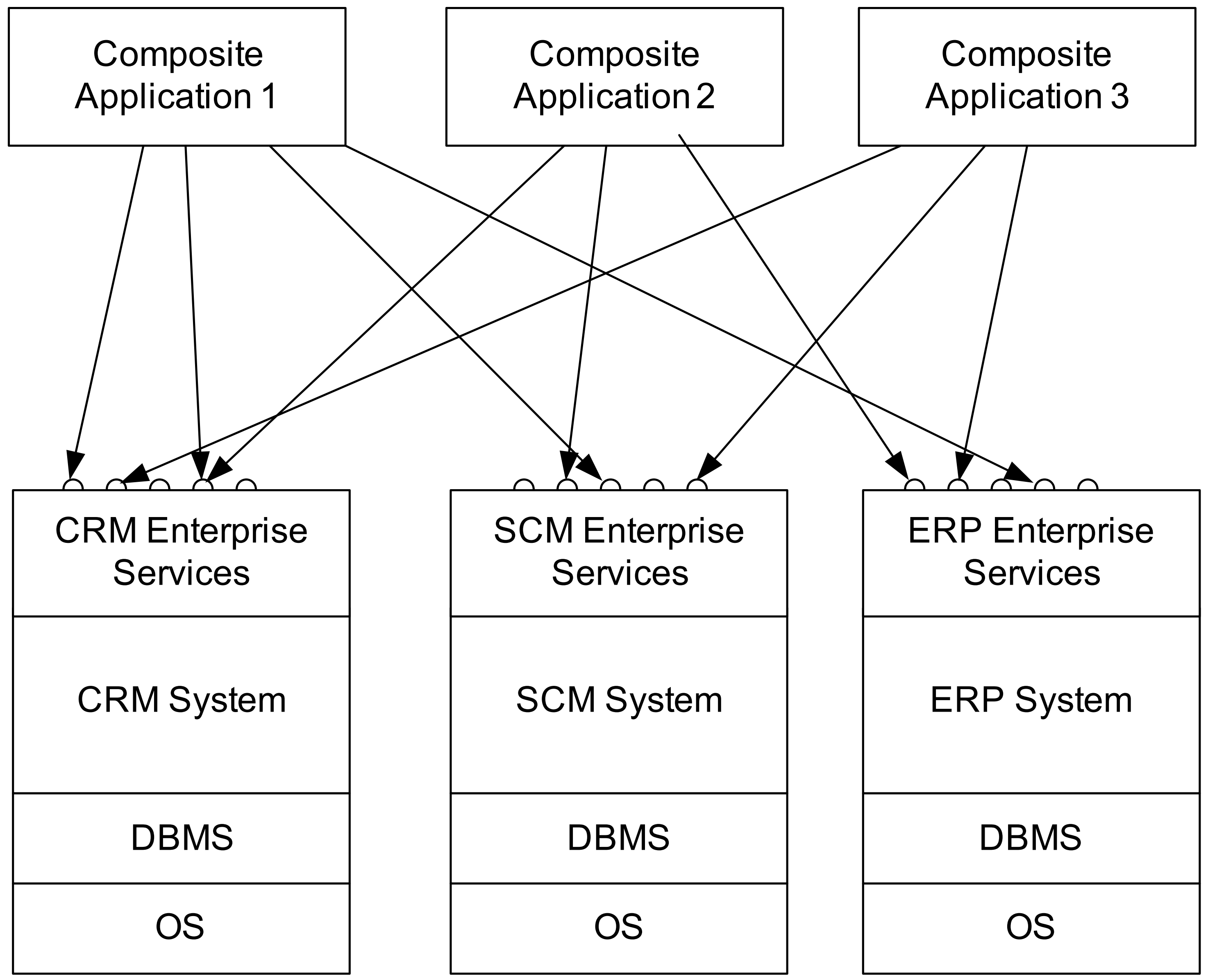
Composite service based application

Intra-company

well-expressed as business processes

Local registry

Manual search (absence of dynamic matchmaking)

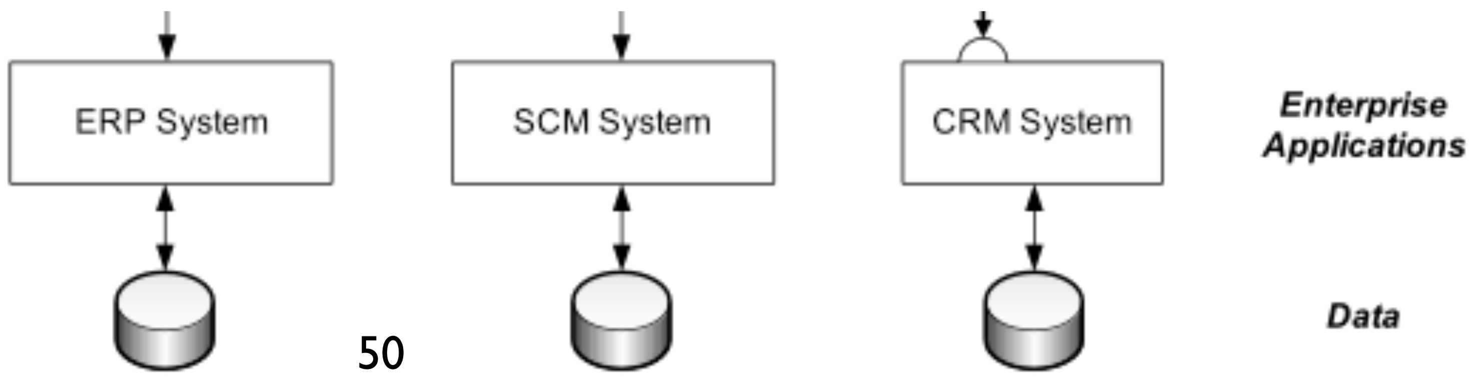


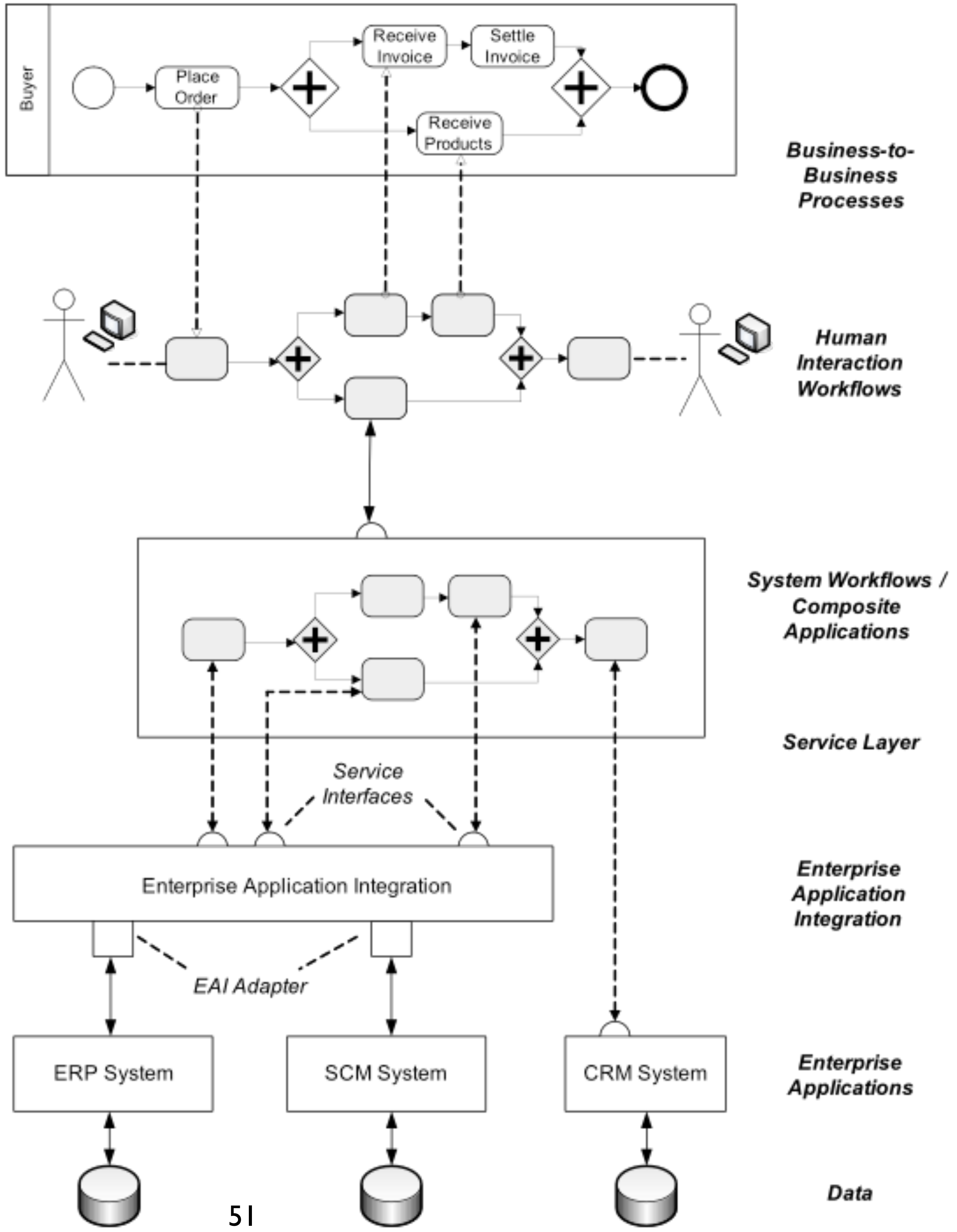
Products as services

Corporations are increasingly perceived by the set of services they provide

These services exposed to the market can be realized by enterprise services (provided by the back-end application system)

Also services provided by third parties can be integrated so that better end used services can be provided to the customer


ERP System
SCM System
CRM System
Enterprise Applications
Data


Buyer
Place Order
Receive Invoice
Settle Invoice
Receive Products
Business-to-Business Processes
Human Interaction Workflows
System Workflows / Composite Applications
Service Layer
Service Interfaces
Enterprise Application Integration
Enterprise Application Integration
EAI Adapter
ERP System
SCM System
CRM System
Enterprise Applications
Data

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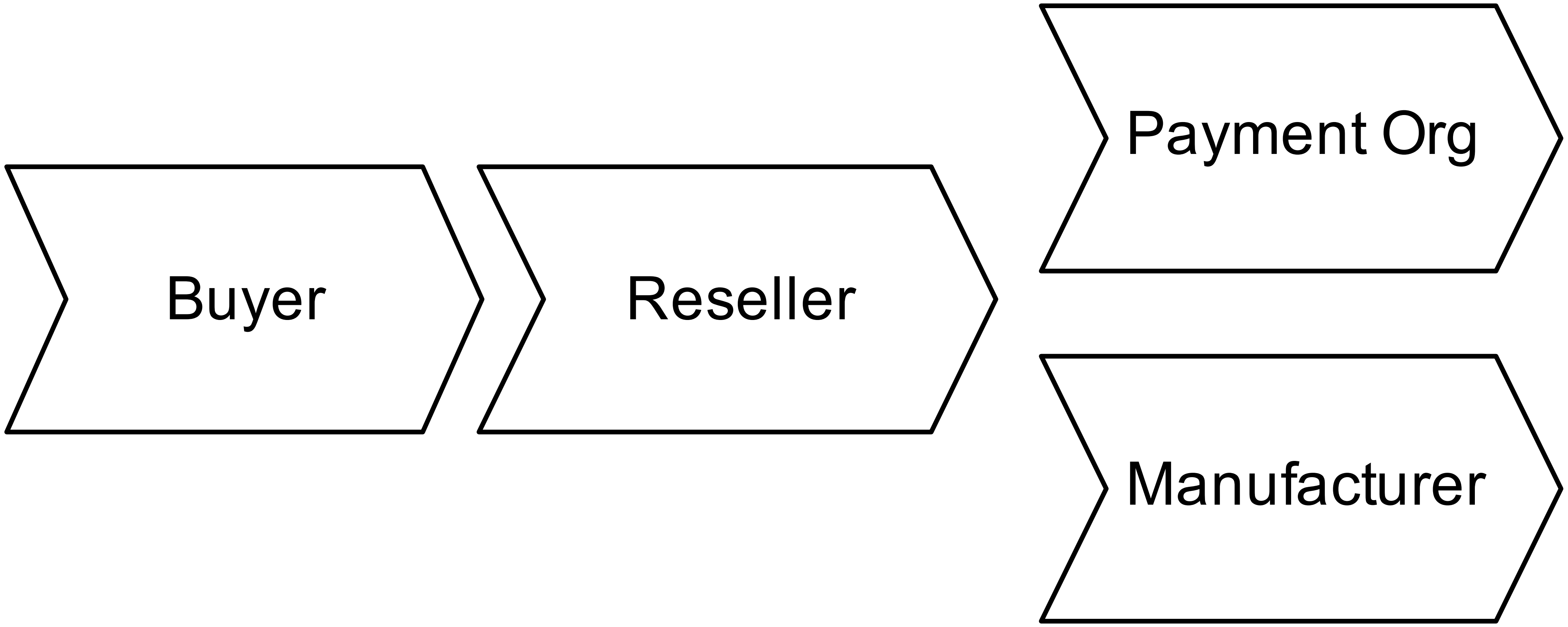
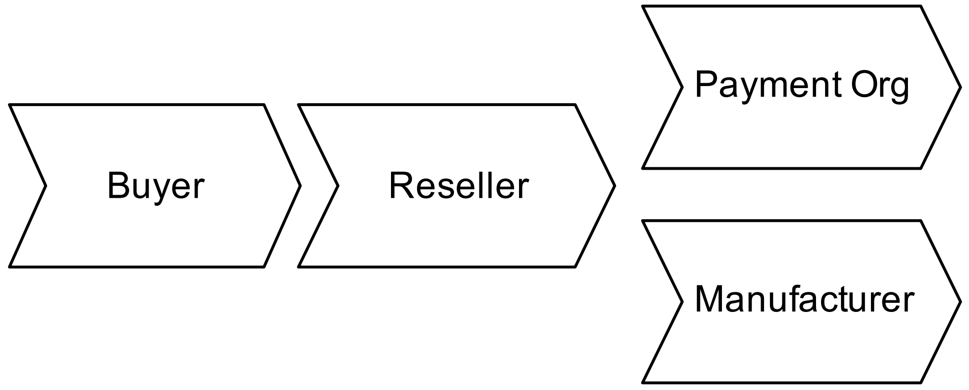
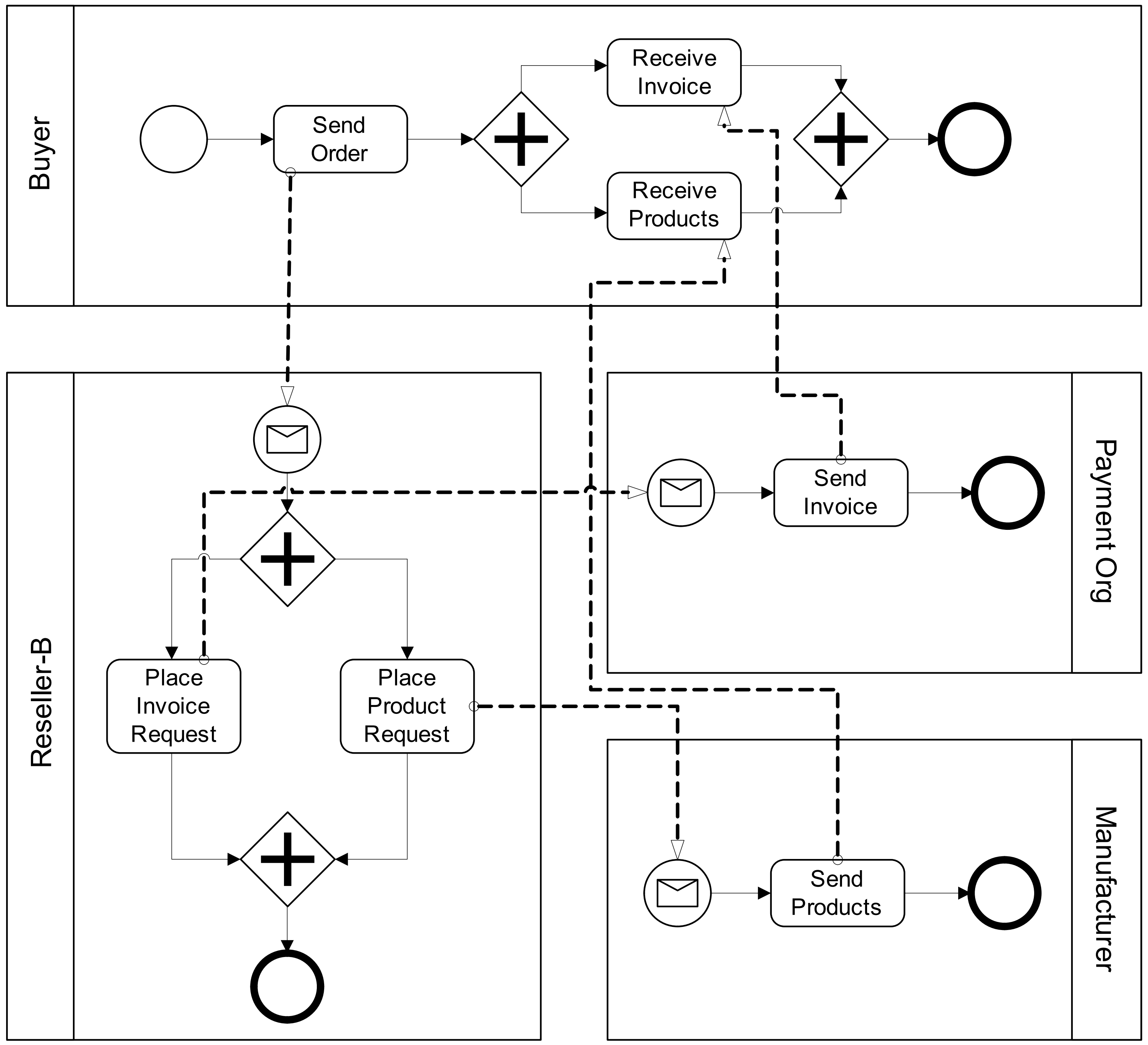
Business-to-business value system



Business-to-business processes





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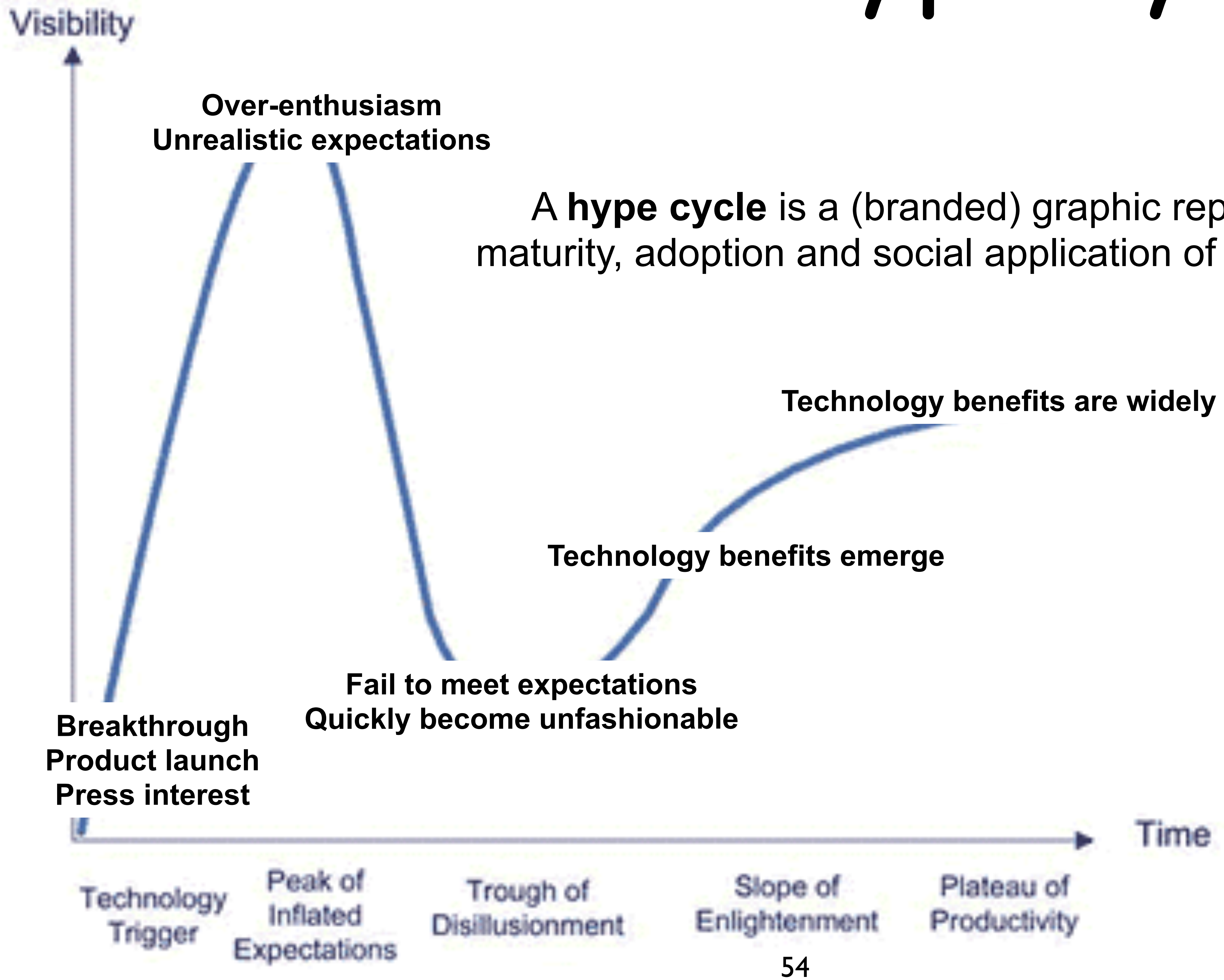
Gartner's hype cycle

A **hype cycle** is a (branded) graphic representation of the maturity, adoption and social application of specific technologies


Visibility
Over-enthusiasm
Unrealistic expectations
Technology benefits are widely accepted
Technology benefits emerge
Fail to meet expectations
Quickly become unfashionable
Breakthrough
Product launch
Press interest
Time
Technology Trigger
Peak of Inflated Expectations
Trough of Disillusionment
Slope of Enlightenment
Plateau of Productivity