



Universidad de Oviedo



Software architecture and enterprises



SOFTWARE
ARCHITECTURE

2025-26

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Role of software architect



Architectural drivers

Understanding the goals
Capturing, refining and
challenging
requirements and constraints

Designing Software

Creating the technical
strategy, vision and
roadmap

Technical Risks

Identifying, mitigating and
owning the technical risks to
ensure that the architecture
"works"

Architecture evolution

Continuous technical
leadership and ownership of
the architecture throughout
The software delivery

Coding

Involvement in the
hands-on elements of
the software delivery

Quality Assurance

Introduction and adherence
to standards, guidelines,
principles, etc.

Role of software architect (review)



Expectations of an architect

Make architectural decisions

Continually analyse the architecture

Keep current with existing trends

Ensure compliance with existing decisions

Diverse exposure and experience

Have business domain knowledge

Possess interpersonal skills

Understand and navigate politics

Software architect is a role, not a rank



Understand and navigate politics

Understand the political climate of the organization and be able to navigate the politics

Architectural decisions affect stakeholders

Product owners, project managers, business stakeholders, developers...

Almost every decision an architect makes will be challenged

Negotiation skills are required

Present and defend the architecture

The software architect's elevator

Communication with the different layers



Some types of companies

Product-based companies in software

- Develop some software product

- The software can itself consist of a service like Google

- The whole company is software driven

Product-based companies in other domains

- Domains like steel, textile design, logistics...

- IT department inside those companies

- Trade-off: internal IT, in-house, outsourced, offshore

Consulting or service-based companies

- Provide IT services to other companies

- From Small/local companies to International companies

Startups and entrepreneurs

- Small companies developing some product or idea

- Usually funded by angel investors or venture capitalists

- Risk in an uncertain and volatile environment



Other architects...

Enterprise architect

Support organization's business strategy with IT solutions and information

Solutions architect

Focuses on the ongoing projects and works in designing IT solutions based on requirements from the organization business

Business architect

Focuses on the organizational business needs and understands in details how the organization works

Software architect

Focuses on the ongoing project similarly to solution architects. They have a deeper knowledge in technology

Others: Data architect, application architect, technology architect,...

Enterprise architecture

Enterprise architecture

Structure and behaviors of a business

Business roles and processes

It comprises IT and organization design

Some approaches

Zachman framework: Model driven

TOGAF: Initiative driven

UAF: Unified Architecture Framework





































SysML: Systems Modeling Language



Zachman framework

Model driven approach (created by J. Zachman, 1987)

Classification scheme for enterprise descriptions

	WHAT	HOW	WHERE	WHO	WHEN	WHY	
SCOPE CONTEXTS	Inventory Identification  Inventory Types	Process Identification  Process Types	Network Identification  Network Types	Organization Identification  Organization Types	Timing Identification  Timing Types	Motivation Identification  Motivation Types	STRATEGISTS AS THEORISTS
BUSINESS CONCEPTS	Inventory Definition  Business Entity Business Relationship	Process Definition  Business Transform Business Input	Network Definition  Business Location Business Connection	Organization Definition  Business Role Business Work	Timing Definition  Business Cycle Business Moment	Motivation Definition  Business End Business Means	EXECUTIVE LEADERS AS OWNERS
SYSTEM LOGIC	Inventory Representation  System Entity System Relationship	Process Representation  System Transform System Input	Network Representation  System Location System Connection	Organization Representation  System Role System Work	Timing Representation  System Cycle System Moment	Motivation Representation  System End System Means	ARCHITECTS AS DESIGNERS
TECHNOLOGY PHYSICS	Inventory Specification  Technology Entity Technology Relationship	Process Specification  Technology Transform Technology Input	Network Specification  Technology Location Technology Connection	Organization Specification  Technology Role Technology Work	Timing Specification  Technology Cycle Technology Moment	Motivation Specification  Technology End Technology Means	ENGINEERS AS BUILDERS
COMPONENT ASSEMBLIES	Inventory Configuration  Component Entity Component Relationship	Process Configuration  Component Transform Component Input	Network Configuration  Component Location Component Connection	Organization Configuration  Component Role Component Work	Timing Configuration  Component Cycle Component Moment	Motivation Configuration  Component End Component Means	TECHNICIANS AS IMPLEMENTERS
OPERATIONS CLASSES	Inventory Instantiation  Operations Entity Operations Relationship	Process Instantiation  Operations Transform Operations Input	Network Instantiation  Operations Location Operations Connection	Organization Instantiation  Operations Role Operations Work	Timing Instantiation  Operations Cycle Operations Moment	Motivation Instantiation  Operations End Operations Means	WORKERS AS PARTICIPANTS
	INVENTORY SETS	PROCESS TRANSFORMATIONS	NETWORK NODES	ORGANIZATION GROUPS	TIMING PERIODS	MOTIVATION REASONS	

Source: Visual-paradigm web page

TOGAF (The Open Group Architecture Framework)

Initiative driven approach

Framework and methodology

First published in 1995, Dpt. Defense USA

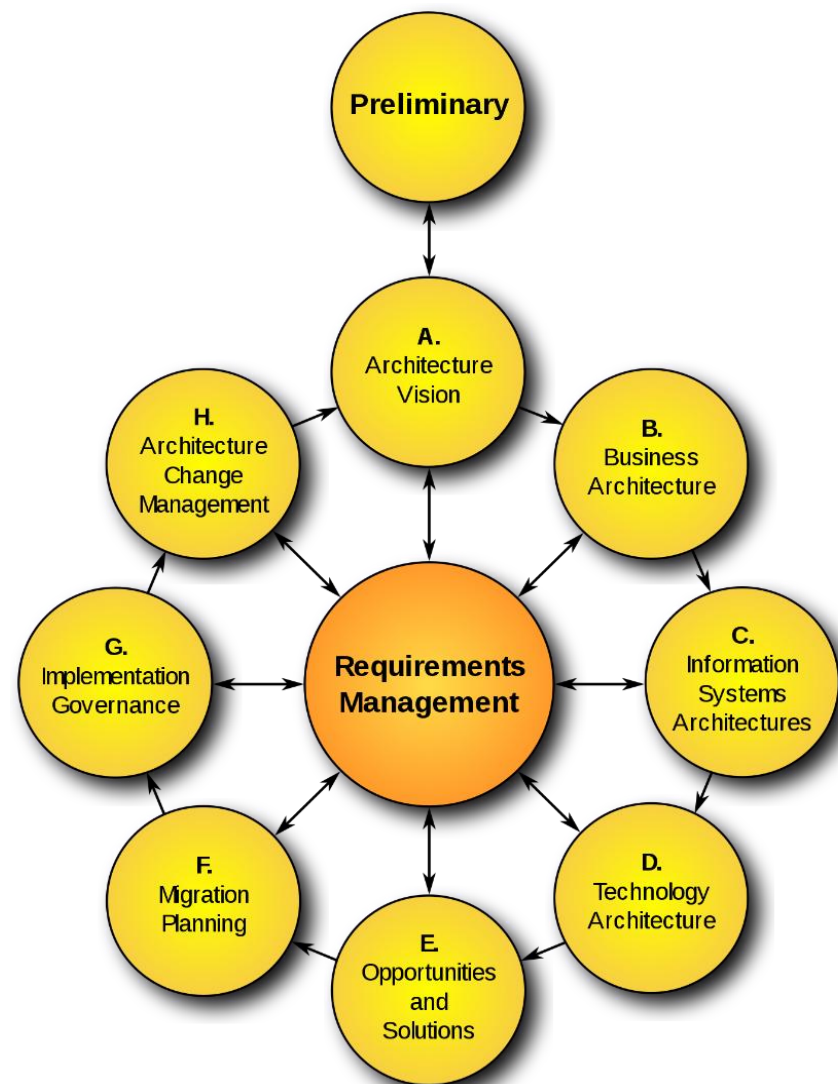
4 architecture domains

Business architecture

Data architecture

Applications architecture

Technical architecture



Source: Wikimedia commons

UAF: Unified Architecture Framework

Developed by Object Management Group (OMG):

Based on UML and SysML

Unifies defense and commercial systems

Graphical notation and tools

Can model systems of systems

UML describes a software system

UAF describes how software fits in global enterprise



<https://www.omg.org/uaf/>

SysML

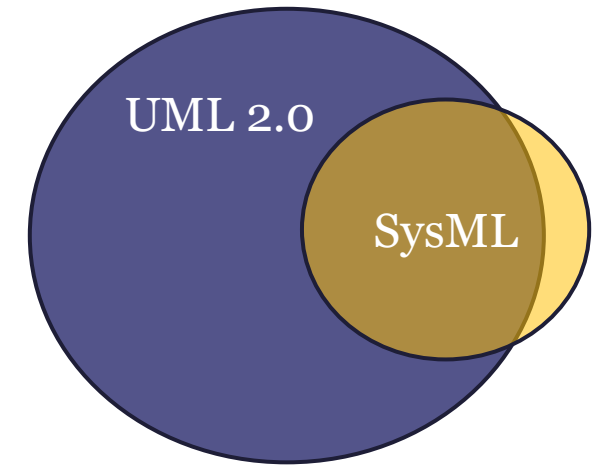
Developed by Object Management Group
Similar to UML but can be used for hardware,
Goal: Model based Systems Engineering

Single source of truth

Adds two diagrams:

Requirements diagram: traceability

Parametric diagram: constraints and equations



Soft skills

Leadership and negotiation

Some negotiation tips

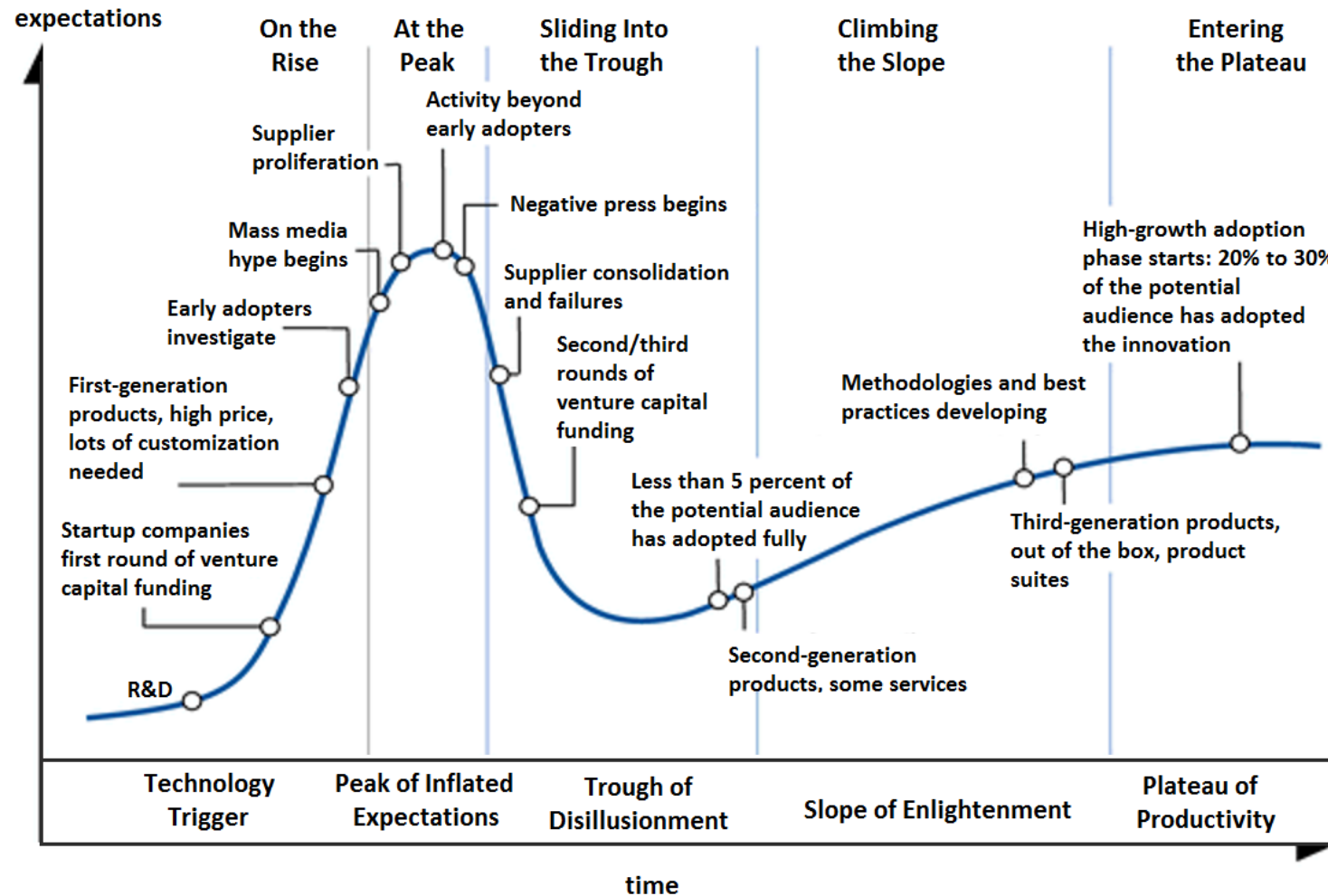
- Know when to fight for something and know when to 'let it go'
- Demonstration defeats discussion
- Leverage the divide and conquer rule to avoid absolutes or '*all-or-nothing*' situations
- Focus the conversation on business value
- Involve developers in your architecture decisions
- Turn the negotiation into terms of qualified cost and value

<https://www.youtube.com/watch?v=nNwTNRb9HQQ&t=201s>



Software architecture and trends

Hype cycle_ Proposed by Gartner, first published in 1995



Software architecture and trends

Tip: devote time to keep up to date

Recommendation 20 minutes every day to learn something new

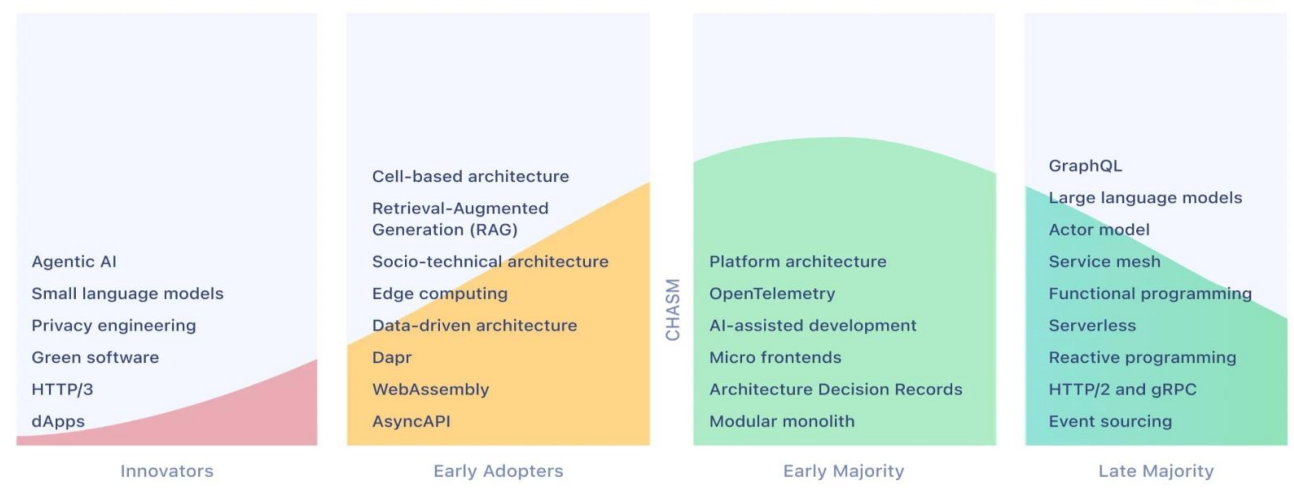
Review some places:

- InfoQ: <https://www.infoq.com/articles/architecture-trends-2023/>
- ThoughtWorks: technology radar: <https://www.thoughtworks.com/radar>
- Dzone refcardz: <https://dzone.com/refcardz>
- Software engineering radio: <https://www.se-radio.net/>
- ...

InfoQ Software architecture trends

InfoQ | **Software Architecture and Design Trends Report - 2025**
<https://www.infoq.com/articles/architecture-trends-2025/>

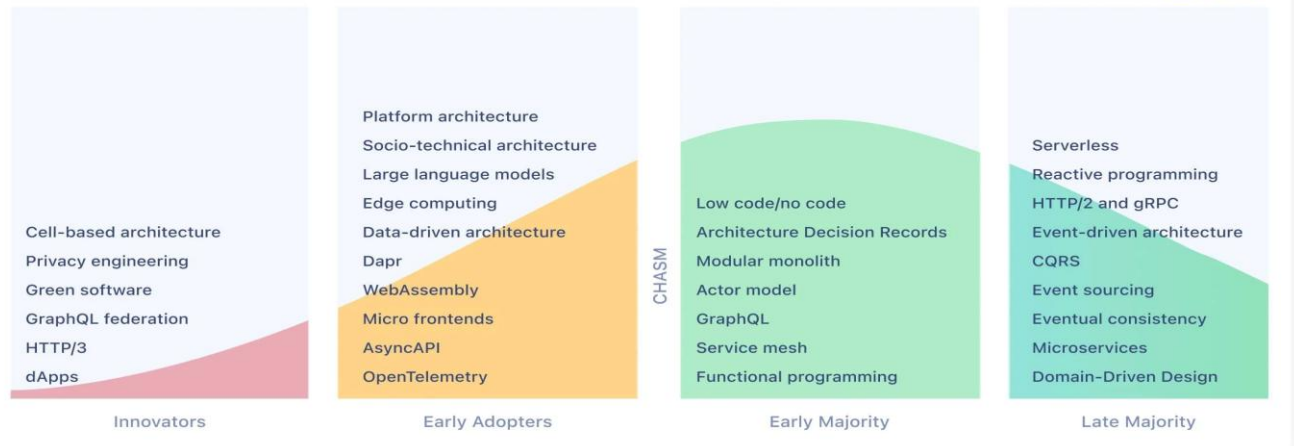
Read full article on [InfoQ.com](https://www.infoq.com)

2025

InfoQ | **Software Architecture and Design Trends Report - 2024**
<https://www.infoq.com/articles/architecture-trends-2024/>

Read full article on [InfoQ.com](https://www.infoq.com)

2024

Enterprise software

IT Software taxonomy

Enterprise Software

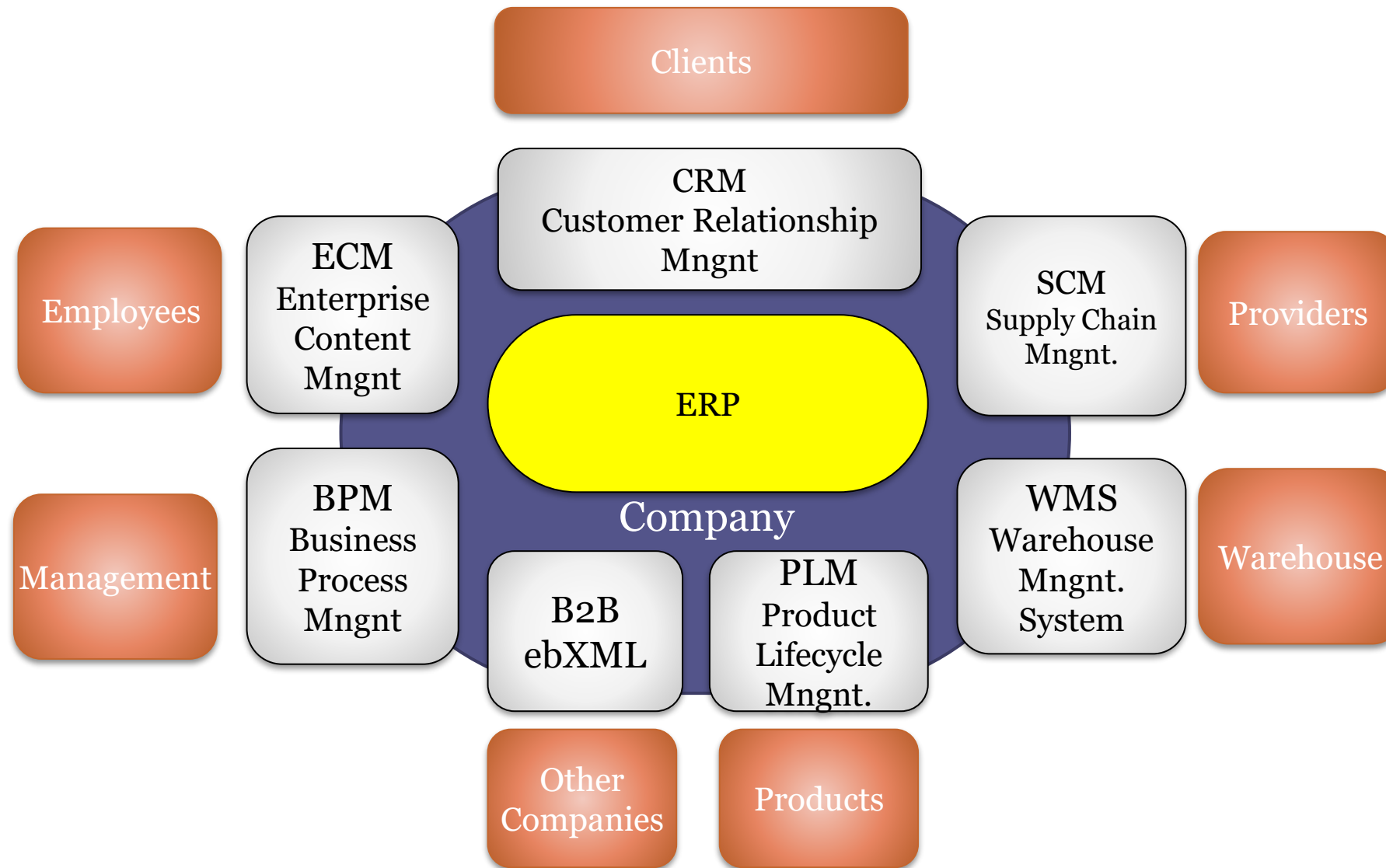
IT software taxonomy

System Classification:

CRM, ERP, SCM, ECM, PLM, EAI...



Enterprise information systems



ERP

ERP (Enterprise Resource Planning)

Appeared at the end 90s

2000 year increased its adoption

Enterprise Technological Structure

Central data base

Real time access

Centralized management of production, logistics, inventory, accounting, billing...

ERP

Advantages

Performance and quality

Reuse established business best practices

Process continuity

Information uniformity

Concept of unique and single data

Continuous technological update

Decision-making support

Challenges

Complexity: Customization, Deployment, Training, ...etc.

Involve people

Adapt existing processes

Overestimate software benefits

Too much dependency on some specific software

High costs to change to other software

Adapting existing processes to provided processes

ERP

Applications

SAP R/3

3 layers client/server architecture

Based on a domain-specific language: ABAP

ABAP: Advanced Business Application Programming

SAP = biggest european software company

Other systems:

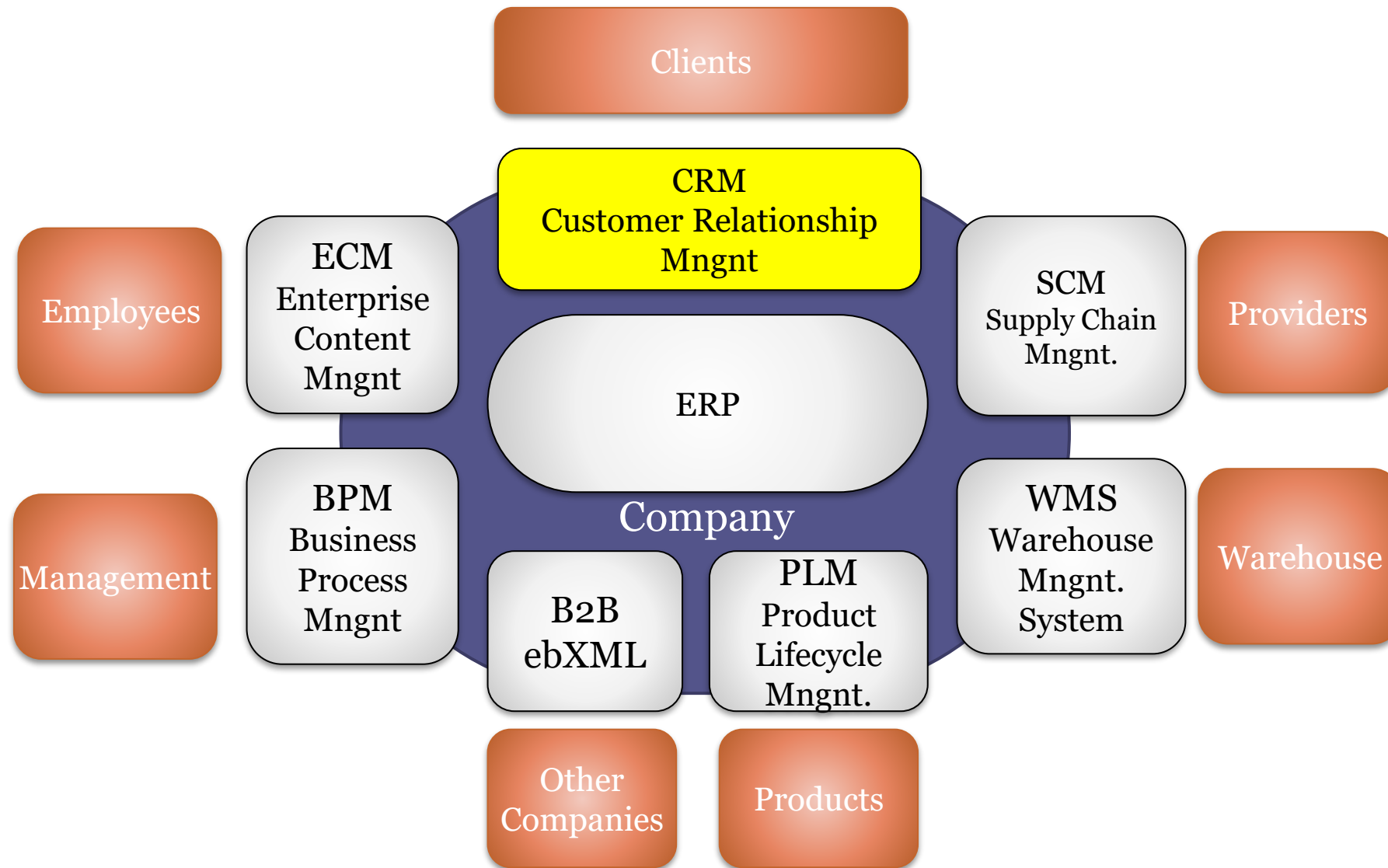
Comercial:

Oracle Fusion, Microsoft Dynamics NAV, SAGE, ...

Open source:

OpenERP, webERP, ...

Enterprise information systems



CRM - Customer Relationship Management

CRM - Customer Relationship Management

Manage relationships between Company and clients

Client lifecycle

Acquisition - Improve - Retain

Manages interactions with current and future clients

Involves:

Sales

Marketing

Client service

Call-centers

Technical support



CRM - Customer Relationship Management

Advantages

Helps identify best clients

Adapt products to client needs

Anticipate needs

Keeps track of client's contacts

Challenges

Client satisfaction

Labor cost reduction

Geographical and temporal diversity

Profile management and privacy

Social client and user communities

Combination with social networks (twitter, facebook,...)

Product reviews (Amazon, Booking,...)



CRM - Customer Relationship Management

Applications

Lots of CRM are integrated with ERP systems

SAP, Oracle, Microsoft CRM

Others:

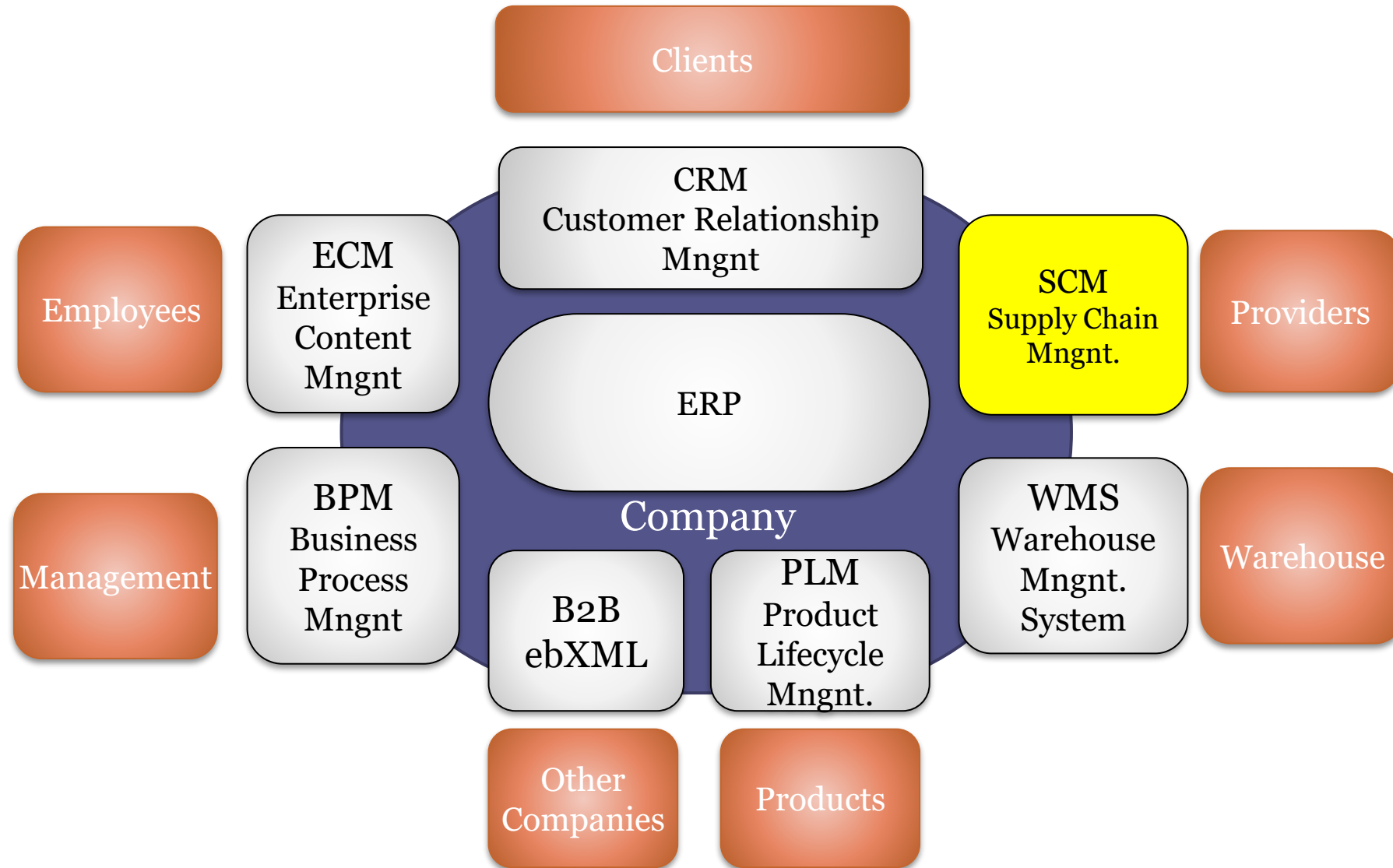
Salesforce.com

webCRM

...



Enterprise information systems



SCM - Supply Chain Management

SCM - Supply Chain Management

Processing client requirements

Purchase orders management

Inventory management

Goods reception and storage

Supplies and stocks management



SCM - Supply Chain Management

Advantages

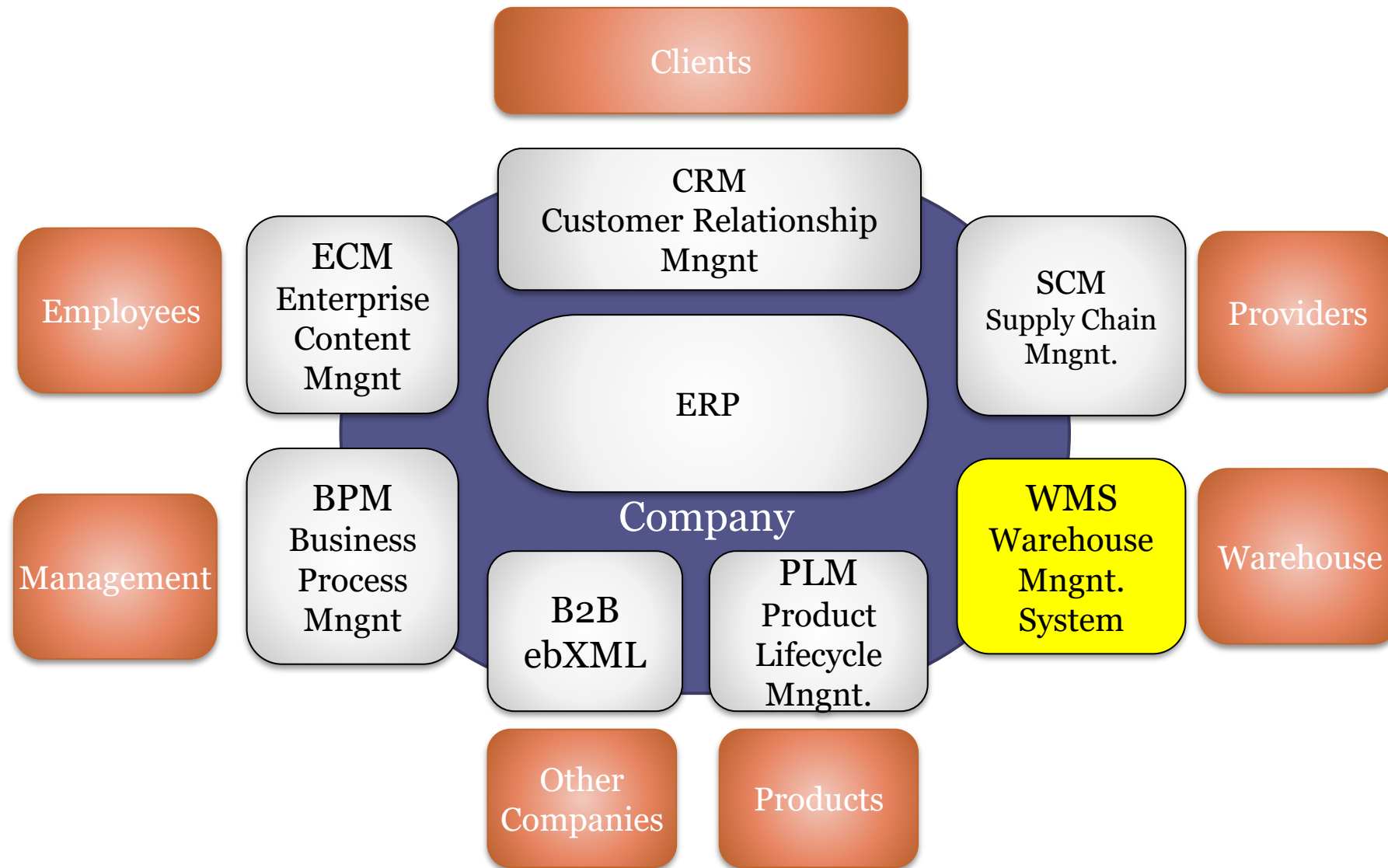
- Forecast future demands
- Inventory control
- Improve business relationships
- Feedback and state of each element in supply chain

Challenges

- Planning
 - Lack of knowledge
- Inaccurate forecasting demands
- Lack of collaboration



Enterprise information systems



WMS - Warehouse Management Software

Warehouse Management Software

Product control in warehouses

Technology for identifying products

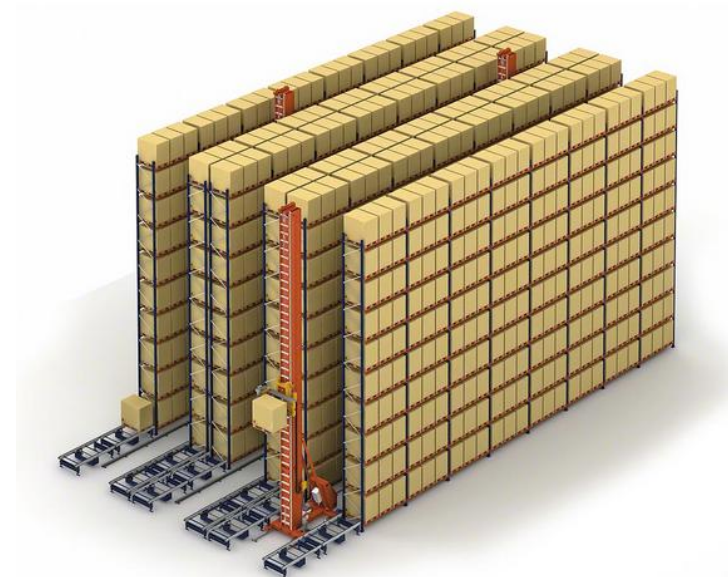
Picking, barcode scanners, RFID, etc.

Automated warehouses

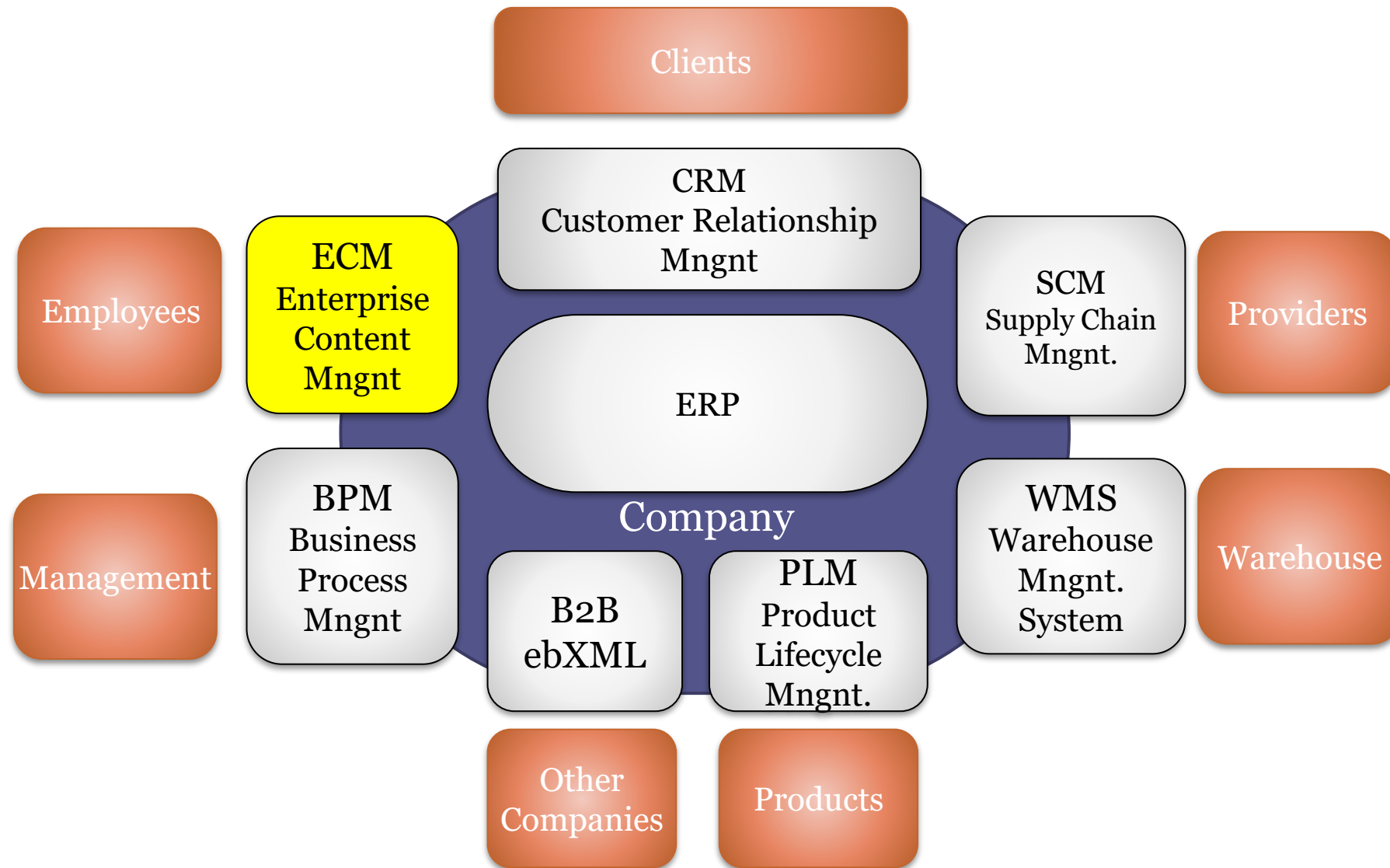
Stacker cranes, *miniloads*

Examples:

Mecalux EasyWMS



Enterprise information systems



ECM - Enterprise Content Management

Goal: Paperless office

Became popular in 2006

ECM - Enterprise Content Management

Components

Capture and recognition

- Scan and obtain documents

- Character recognition: OCR, HCR, etc.

Management:

- Document indexing

Storage

- Document management

Maintenance

- Security copies, archive, etc.

Sending

- Transformation and publishing

ECM - Enterprise Content Management

Systems

Microsoft Sharepoint

Oracle Content Management

EMC Documentum

Open source

Alfresco

LogicaDOC

Plone

...

ECM - Enterprise Content Management

Knowledge Management

Combines unstructured information sources

Groupware

Software for collaborative working groups

Example: Lotus Notes

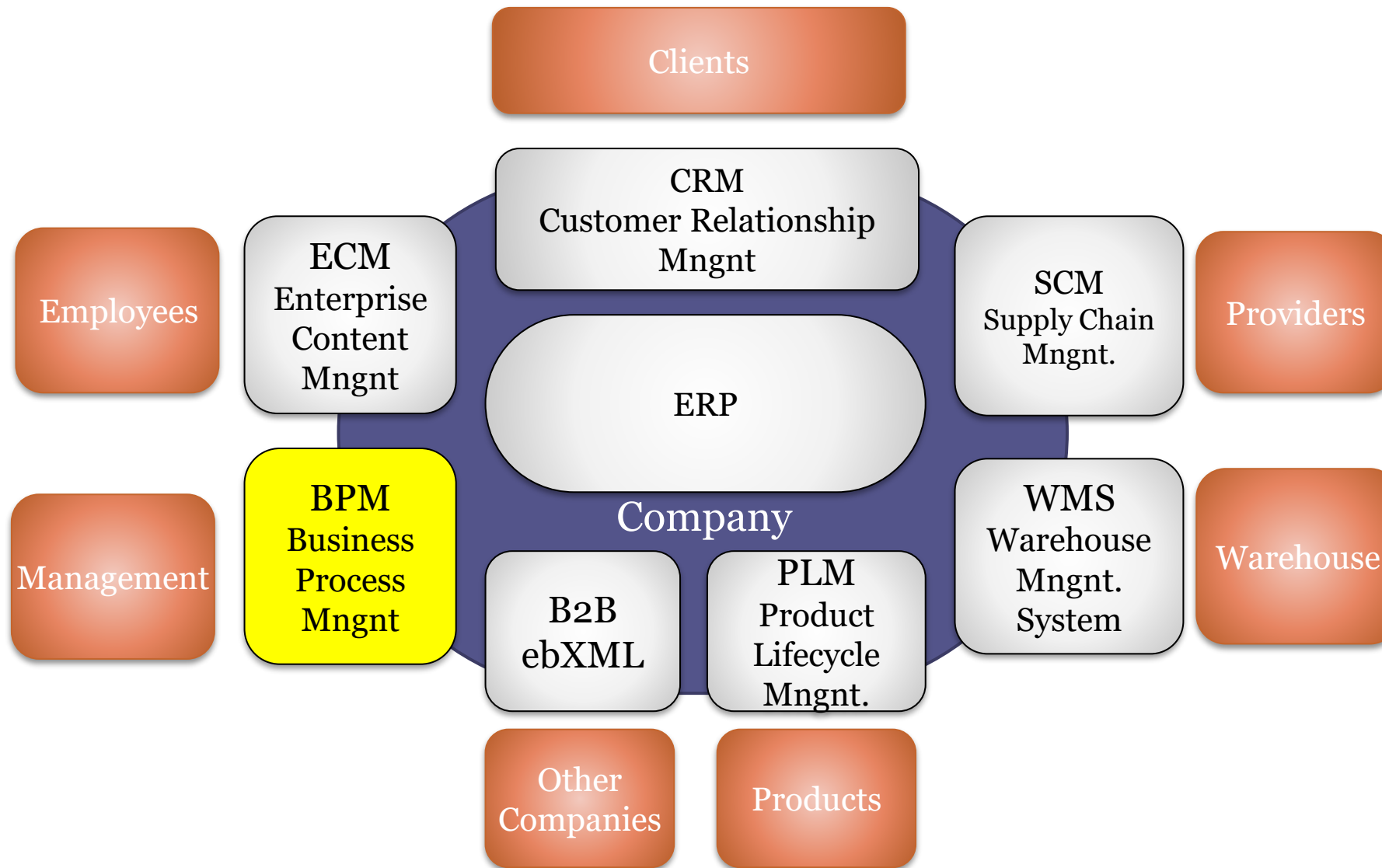
Enterprise Wikis

Example: Confluence

Document manager

Examples: LogicalDOC, Ricoh

Enterprise information systems



BPM - Business Process Management

Business process:

Set of procedures or activities with a business goal

Workflow:

Business workflow automation

BPM:

Business process lifecycle management through workflows

BPM - Business Process Management

Decision support systems

BI: Business Intelligence

Report creation

Data mining

Predictions and decision support

BPM - Business Process Management

OLAP (Online Analytical Processing) tools

Multidimensional analysis (OLAP Cube)

Enables to do operations

Sums, averages, etc. over groups of data

Solutions:

Microsoft, Oracle Business Objects,...

BPM - Business Process Management

Operational intelligence

Real-time monitoring

Balanced scorecard

Graphical visualizations of different metrics

Complex event processing

BPM - Business Process Management

Notations

BPEL (*Business Process Execution Language*)

Defined by OASIS

Defines relationships between web services (orchestration)

Integration with WS-* standards

More oriented to developers

BPMN (*Business Process Model and Notation*)

Visual notation defined by OMG

Represents business processes

More oriented to business people

BPMN example

BPMN elements

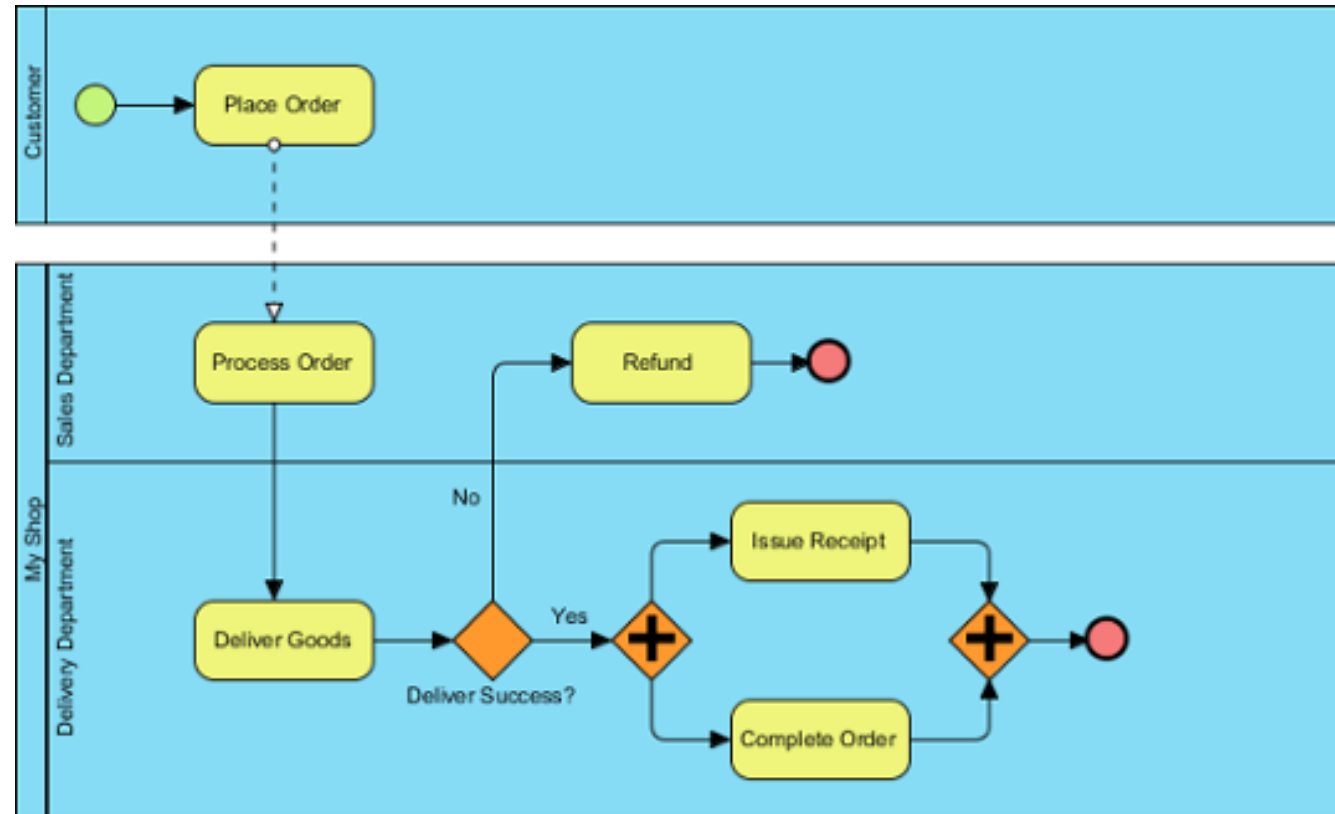
Events (start/intermediate/end)

Activities

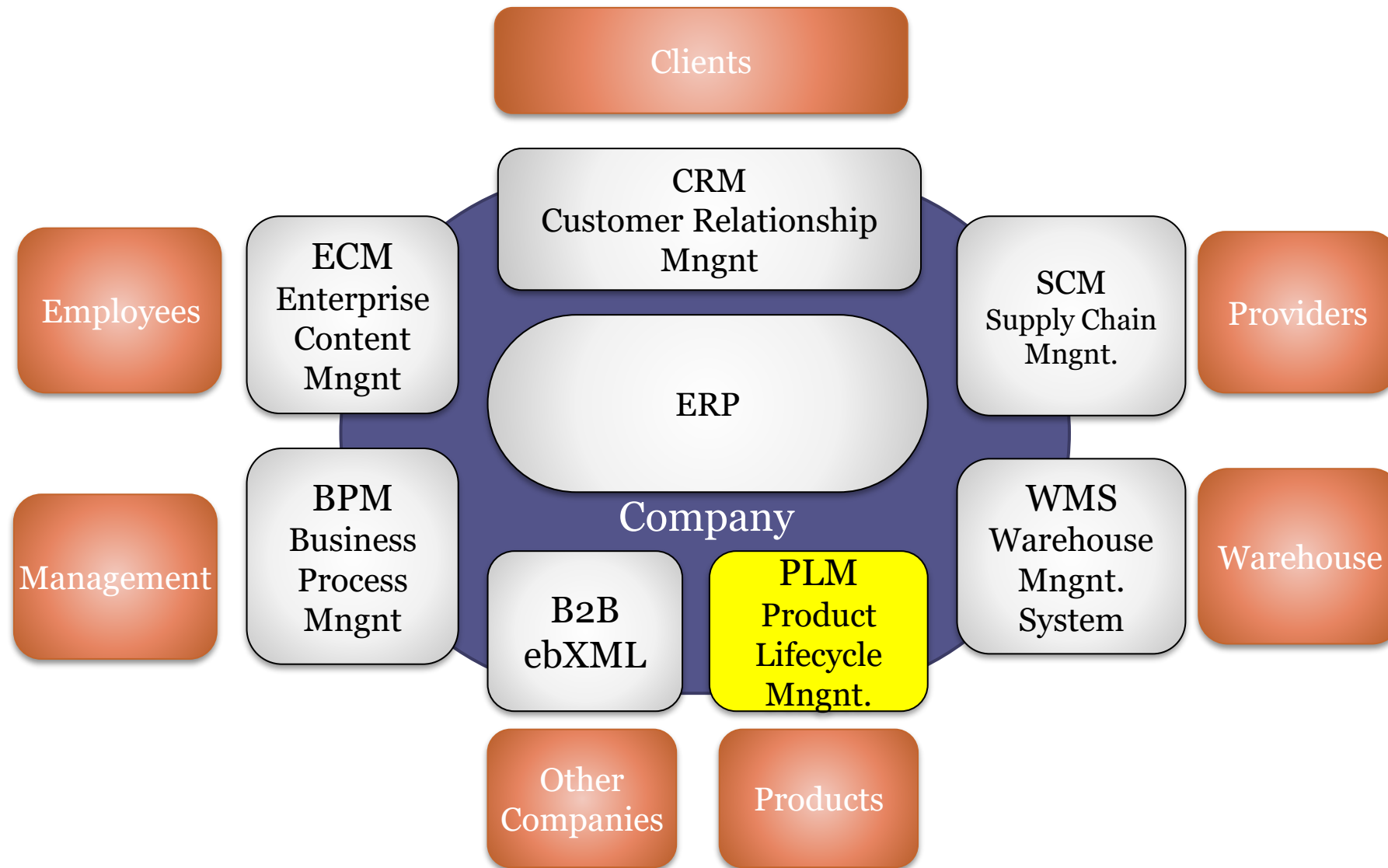
Gateways

Connections

Swim lanes



Enterprise information systems



PLM - Product Lifecycle Management

Integral product lifecycle management

Phases

Conceive

Design

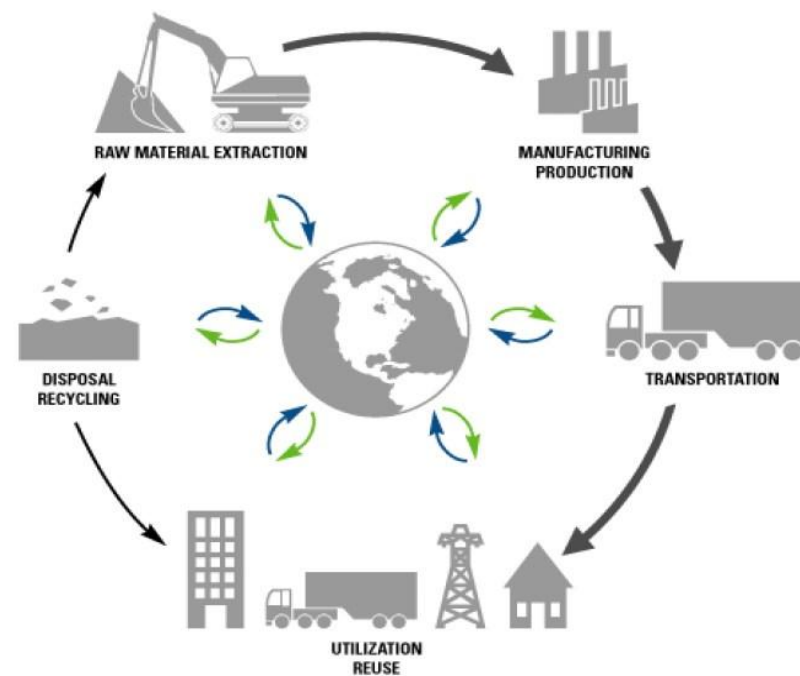
CAD tools (Computer Aided Design)

Realize

CAE (Computer Aided Engineering)

Service

Repair and maintenance



PLM - Product Lifecycle Management

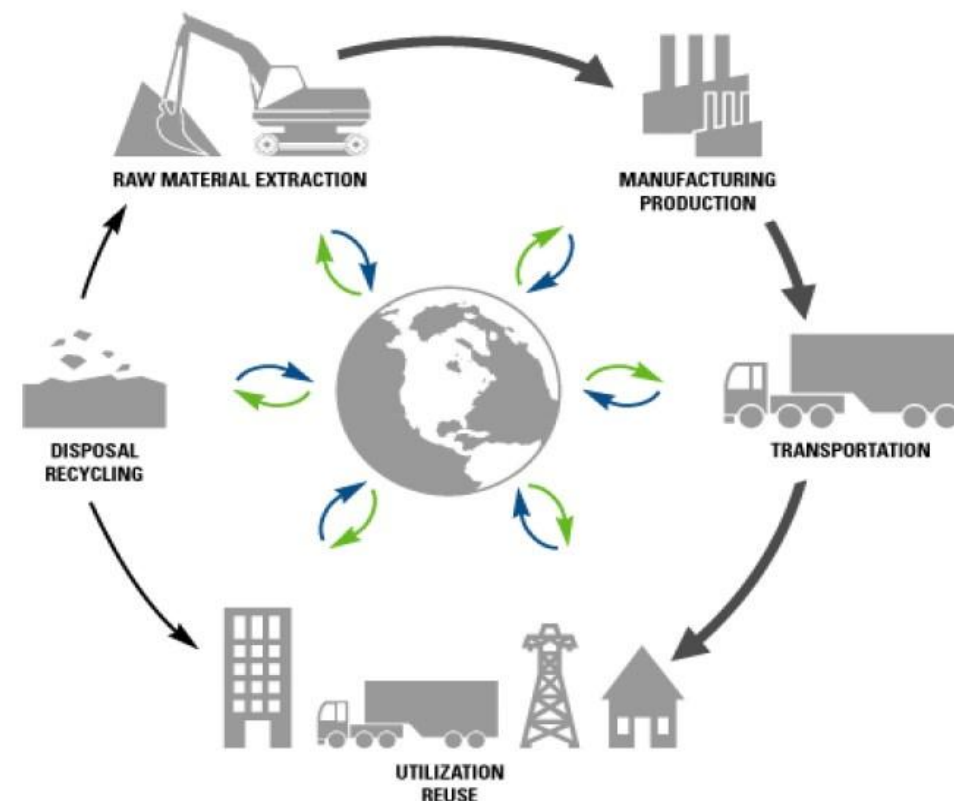
Solutions :

Siemens TeamCenter

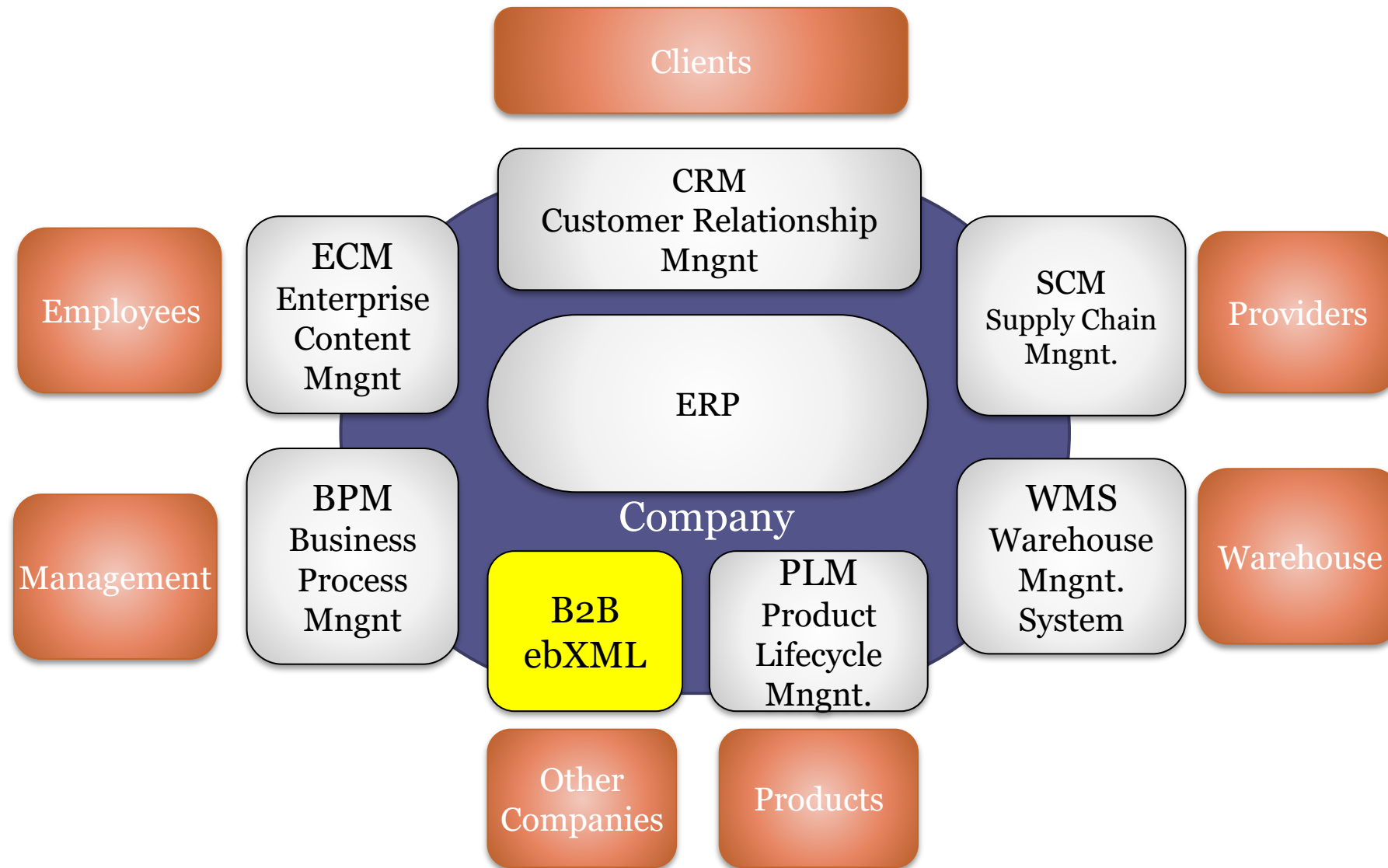
SAP PLM

Sopheon

...



Enterprise Information Systems



Relationship with external agents

Some common terms

B2B: Business-to-business

B2C: Business-to-consumer

C2C: Consumer-to-consumer

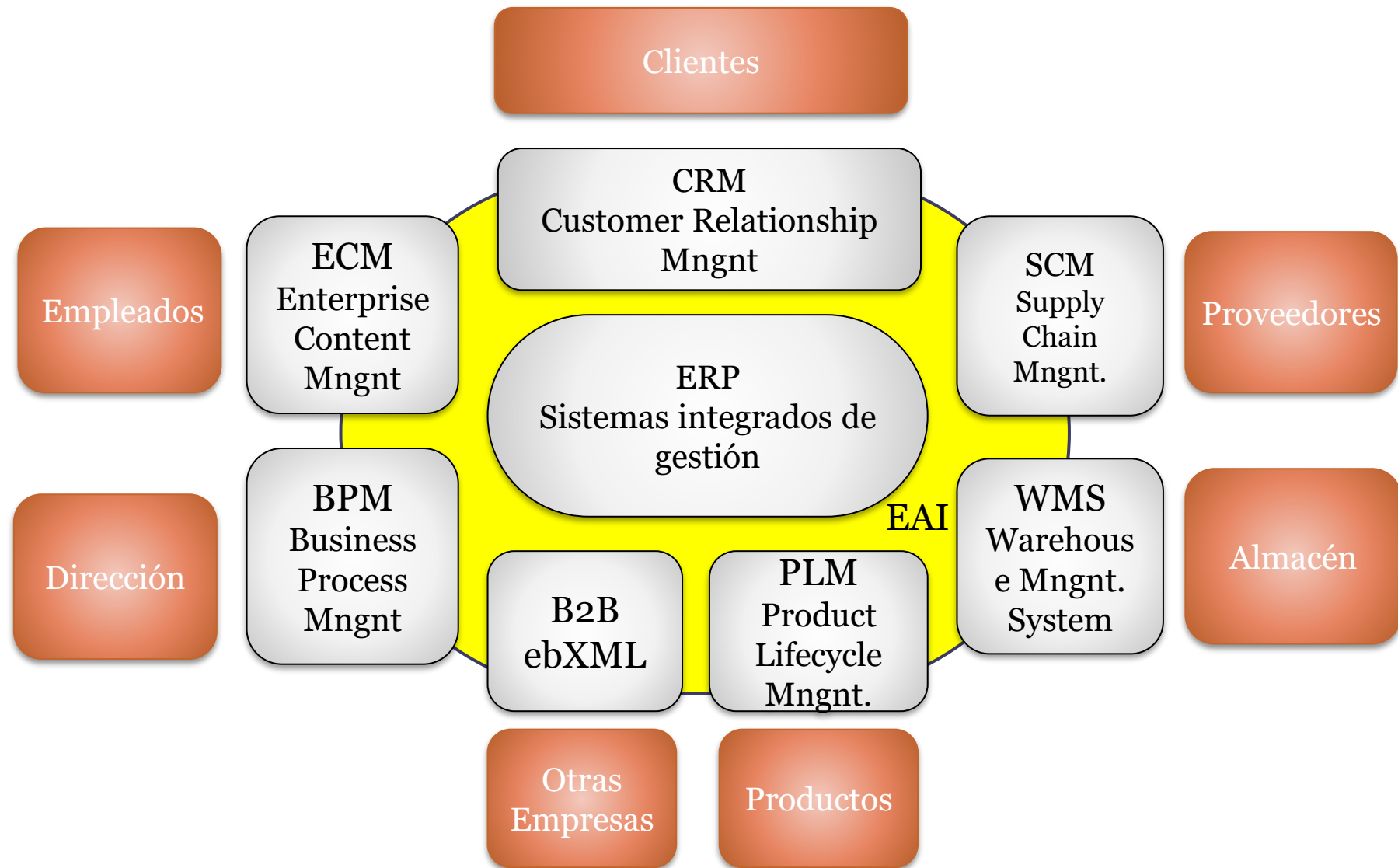
Most of e-commerce is B2B

Information exchange standards:

EDI (Electronic Data Interchange)

ebXML: XML based technologies for e-commerce

Enterprise Application Integration



EAI

EAI: Enterprise Application Integration

Glue between different systems

See:

Integration patterns (previous lesson)

Software product lines

Software product lines

Product line: products that share a set of functionalities to satisfy some given market segment

Goal:

Reduce development effort

Improve productivity

Evolve from a single product to a product line

Strategic reuse



Software product lines

Requirements

Identify generic solutions to common problems

Component based development

Generic Platforms

Software reuse

Generic architecture from which individual product architectures can be derived

Automatic system generation



Software and enterprise services

Towards services

Trend towards services

As a service family

Software as a service (SaaS)

Platform as a service (PaaS)

Infrastructure as a Service (IaaS)

Microservices

Service ecosystems

Service level terminology

Service Level Indicators (SLI)

Quantitative measure of some aspect of the level of service that is provided

Examples: error rate, system throughput, availability

Service Level Objective (SLO)

A target value or range of values for a service level that is measured by an SLI

Example: average search request latency should be less than 100 milliseconds

Service Level Agreement (SLA)

An explicit or implicit contract with your users that includes consequences of meeting (or missing) the SLOs they contain.

Service governance

Release management and deployment

Reliability and security

API management

Dependencies

Monitoring

Production support

Incidence response

On-call rotations

Cost model

Client onboarding

Documentation

Disaster recovery

Recommended books (free)
Site Reliability Engineering
<https://landing.google.com/sre/>

Software evolution

Software evolution

Timely updating the software

Reasons

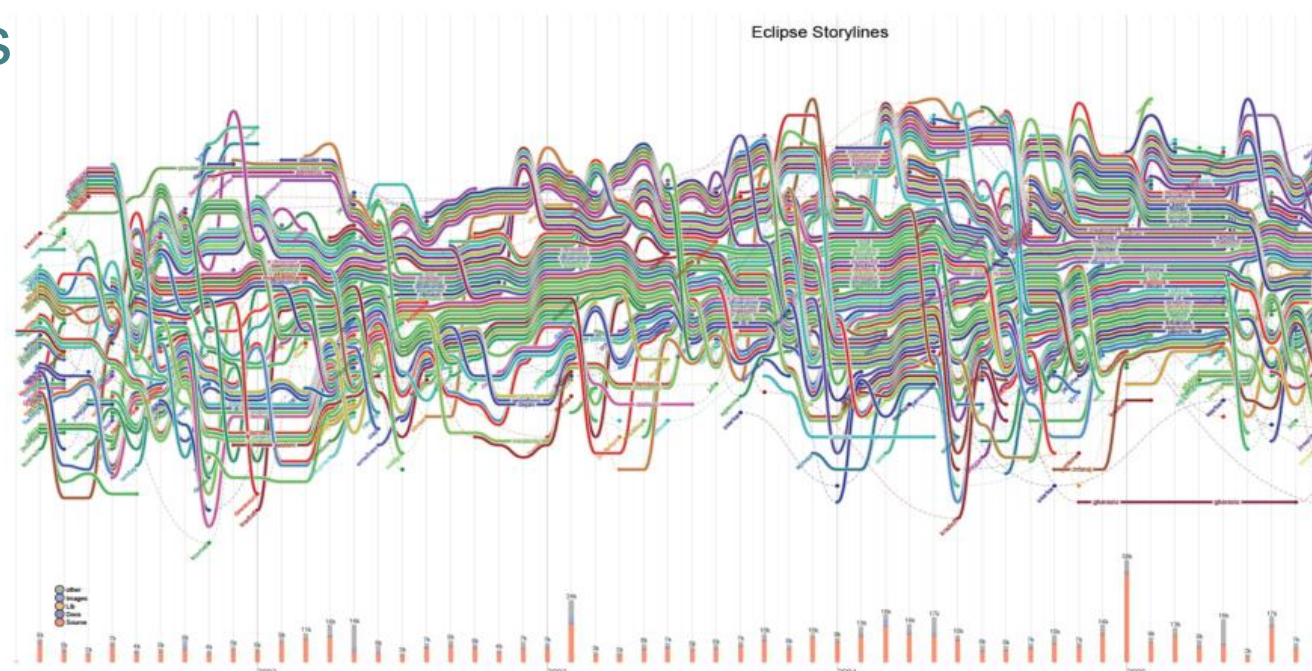
Changes in requisites with time

New functionalities or features

Changes in environment

Errors and bugs

Security risks



Lehman's laws of software evolution

Proposed in 1974 by Manny Lehman

Continuing Change

A system must be continually adapted or it becomes progressively less satisfactory

Increasing Complexity

As a system evolves, its complexity increases unless work is done to maintain or reduce it

Other laws from Lehman's:

Continuous growth

Conservation of familiarity

...



Manny Lehman
Fuente Wikidata



Software refactoring

Restructuring existing software without changing its external behaviour

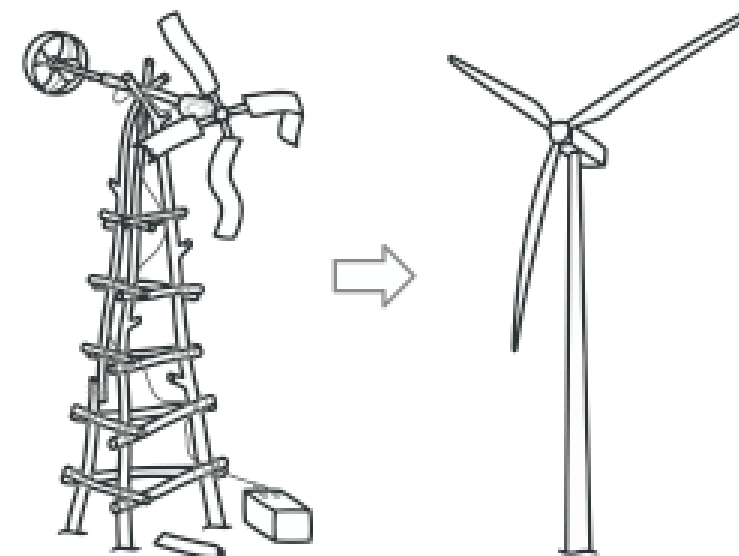
Keep functionality

Improve quality attributes

Goals

Avoid code smells

Pay technical debt



Legacy projects

Projects that are difficult to maintain or extend
Valuable software that you are afraid to change

Some reasons

Unfamiliarity

Developed by someone else/some time ago

No tests

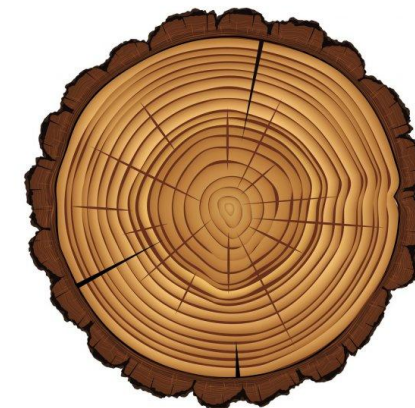
No documentation/outdated documentation

Reliance on external resources

Short deadlines

More info:

<https://understandlegacycode.com/>

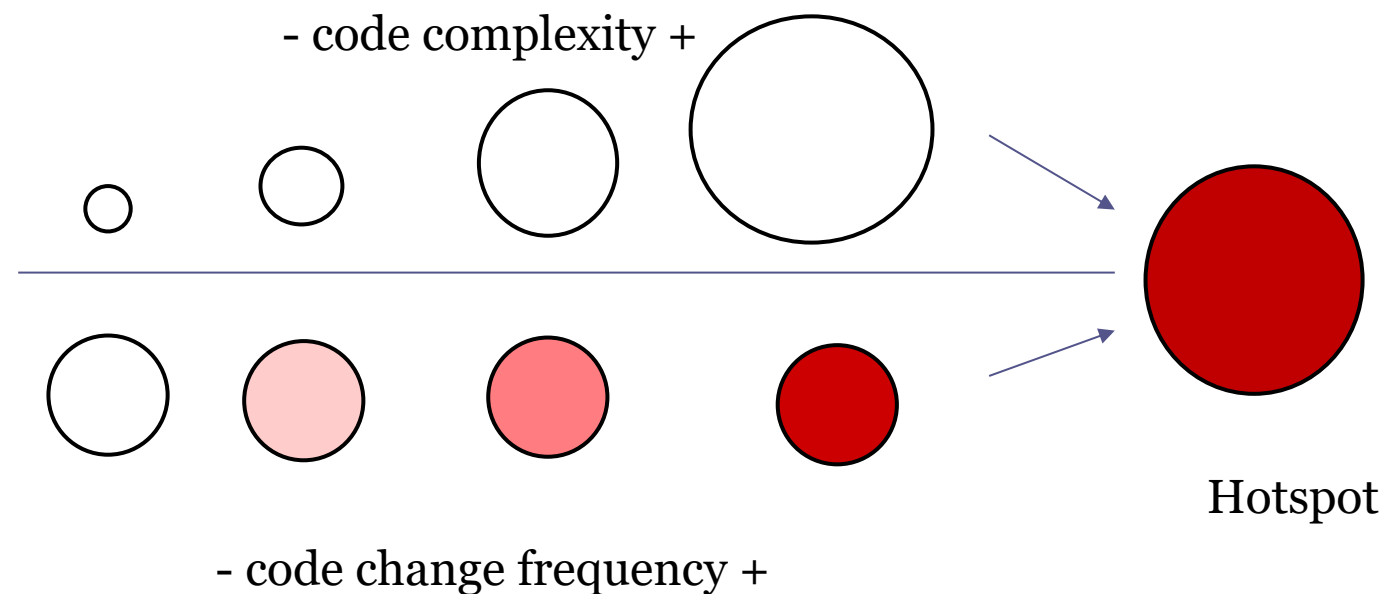


Behavioral code analysis

Identify system hotspots

Complex components that change frequently

Good candidates for refactoring



Evolutionary architectures

Main quality attribute: evolvability

Incremental, guided change as a first principle

Adoption of fitness function



End of presentation