EN
English

Universidad de Oviedo

School of Computer Science

# Software architecture and enterprises

SOFTWARE ARCHITECTURE

2024-25

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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.

Source: Software architecture for developers, Simon Brown, 2014

# 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,...



Source: TOGAF (IA

# Enterprise architecture

- Enterprise architecture
  - Structure and behaviors of a business
  - Business roles and processes
  - It comprises IT and organization design
- 2 main approaches
  - Zachman framework: Model driven
  - TOGAF: Initiative driven

# Zachman framework

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

### Classification scheme for enterprise descriptions

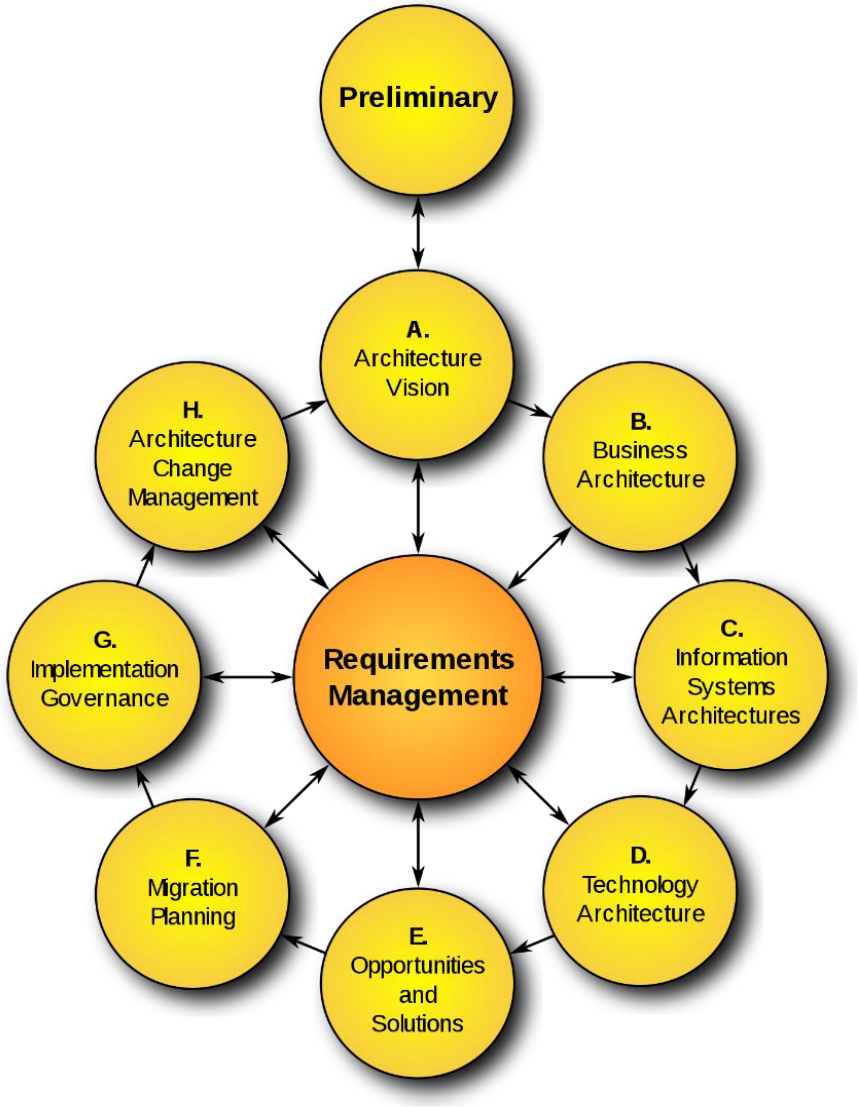
| | WHAT | HOW | WHERE | WHO | WHEN | WHY | |
|---|---|---|---|---|---|---|---|
| SCOPE CONTEXTS | Inventory Identification<br>Inventory Types | Process Identification<br>Process Types | Network Identification<br>Network Types | Organization Identification<br>Organization Types | Timing Identification<br>Timing Types | Motivation Identification<br>Motivation Types | STRATEGISTS AS THEORISTS |
| BUSINESS CONCEPTS | Inventory Definition<br>Business Entity<br>Business Relationship | Process Definition<br>Business Transform<br>Business Input | Network Definition<br>Business Location<br>Business Connection | Organization Definition<br>Business Role<br>Business Work | Timing Definition<br>Business Cycle<br>Business Moment | Motivation Definition<br>Business End<br>Business Means | EXECUTIVE LEADERS AS OWNERS |
| SYSTEM LOGIC | Inventory Representation<br>System Entity<br>System Relationship | Process Representation<br>System Transform<br>System Input | Network Representation<br>System Location<br>System Connection | Organization Representation<br>System Role<br>System Work | Timing Representation<br>System Cycle<br>System Moment | Motivation Representation<br>System End<br>System Means | ARCHITECTS AS DESIGNERS |
| TECHNOLOGY PHYSICS | Inventory Specification<br>Technology Entity<br>Technology Relationship | Process Specification<br>Technology Transform<br>Technology Input | Network Specification<br>Technology Location<br>Technology Connection | Organization Specification<br>Technology Role<br>Technology Work | Timing Specification<br>Technology Cycle<br>Technology Moment | Motivation Specification<br>Technology End<br>Technology Means | ENGINEERS AS BUILDERS |
| COMPONENT ASSEMBLIES | Inventory Configuration<br>Component Entity<br>Component Relationship | Process Configuration<br>Component Transform<br>Component Input | Network Configuration<br>Component Location<br>Component Connection | Organization Configuration<br>Component Role<br>Component Work | Timing Configuration<br>Component Cycle<br>Component Moment | Motivation Configuration<br>Component End<br>Component Means | TECHNICIANS AS IMPLEMENTERS |
| OPERATIONS CLASSES | Inventory Instantiation<br>Operations Entity<br>Operations Relationship | Process Instantiation<br>Operations Transform<br>Operations Input | Network Instantiation<br>Operations Location<br>Operations Connection | Organization Instantiation<br>Operations Role<br>Operations Work | Timing Instantiation<br>Operations Cycle<br>Operations Moment | Motivation Instantiation<br>Operations End<br>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

# Soft skills

## Leadership and negotiation

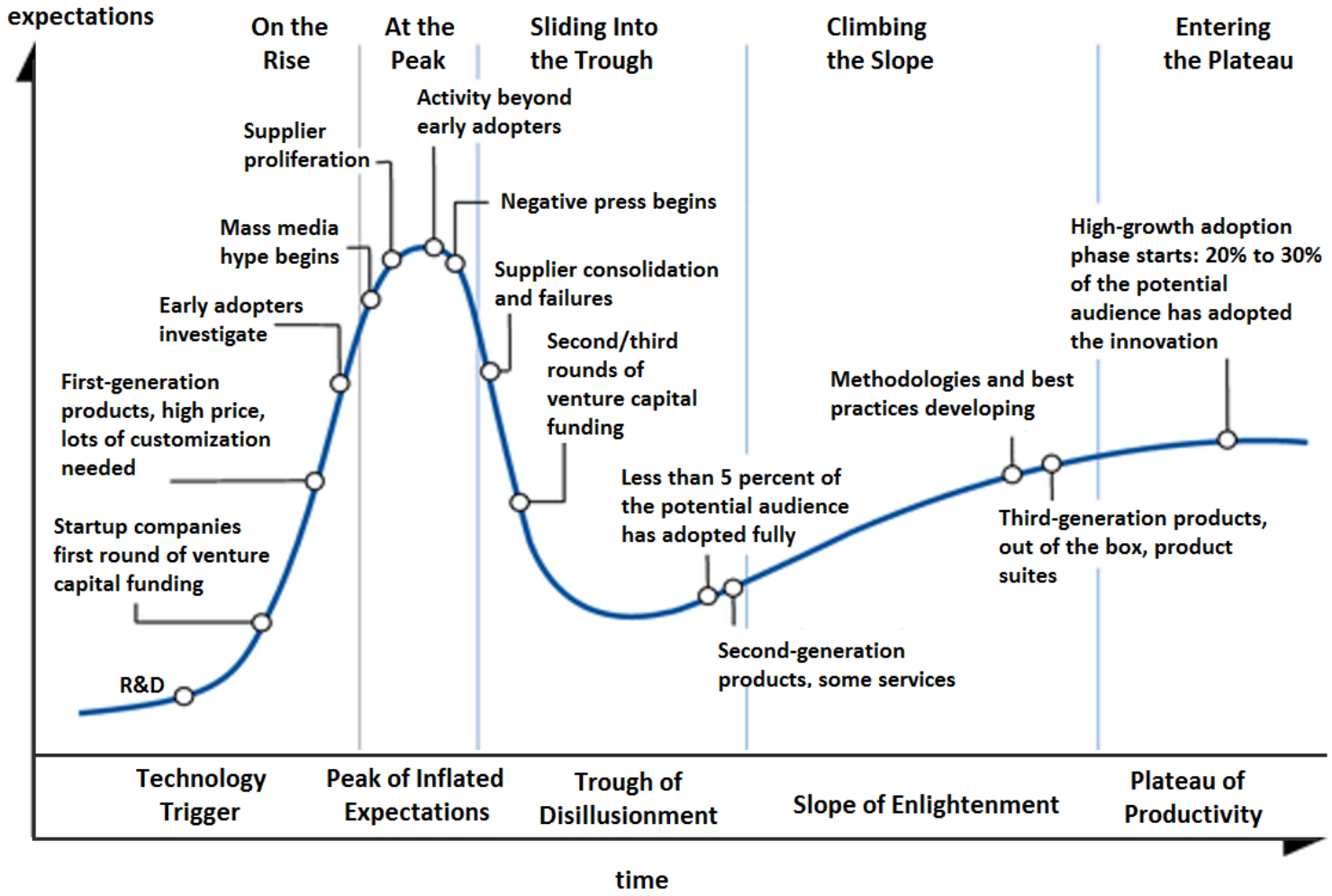
## Some negotiation tips

- 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

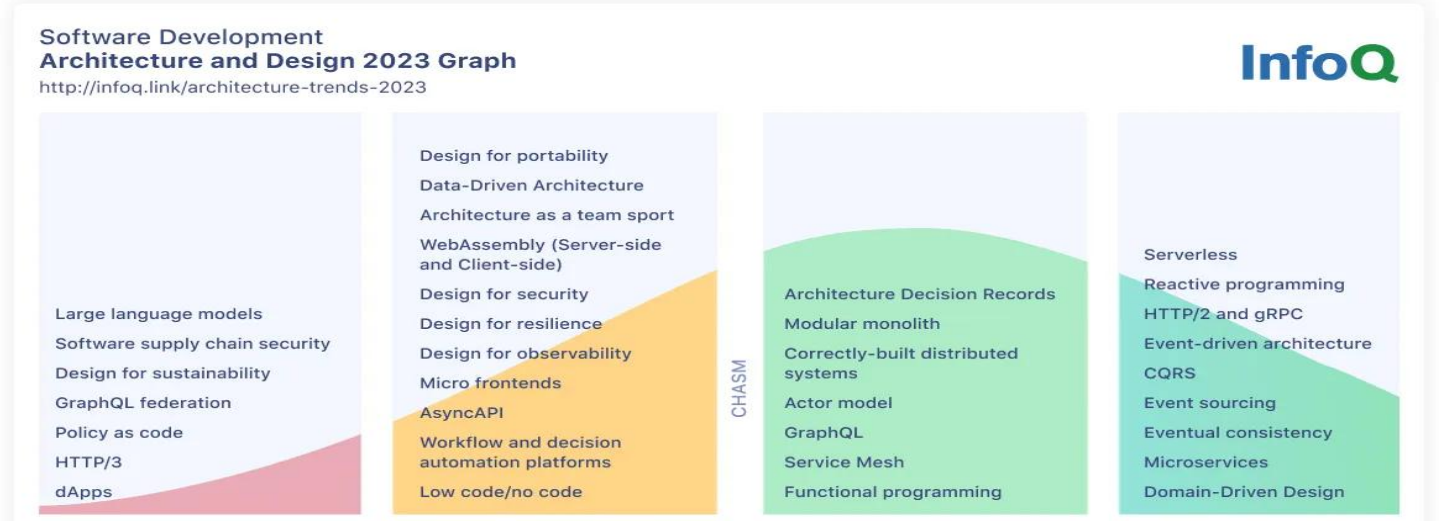
Tip: devote time to keep up to date

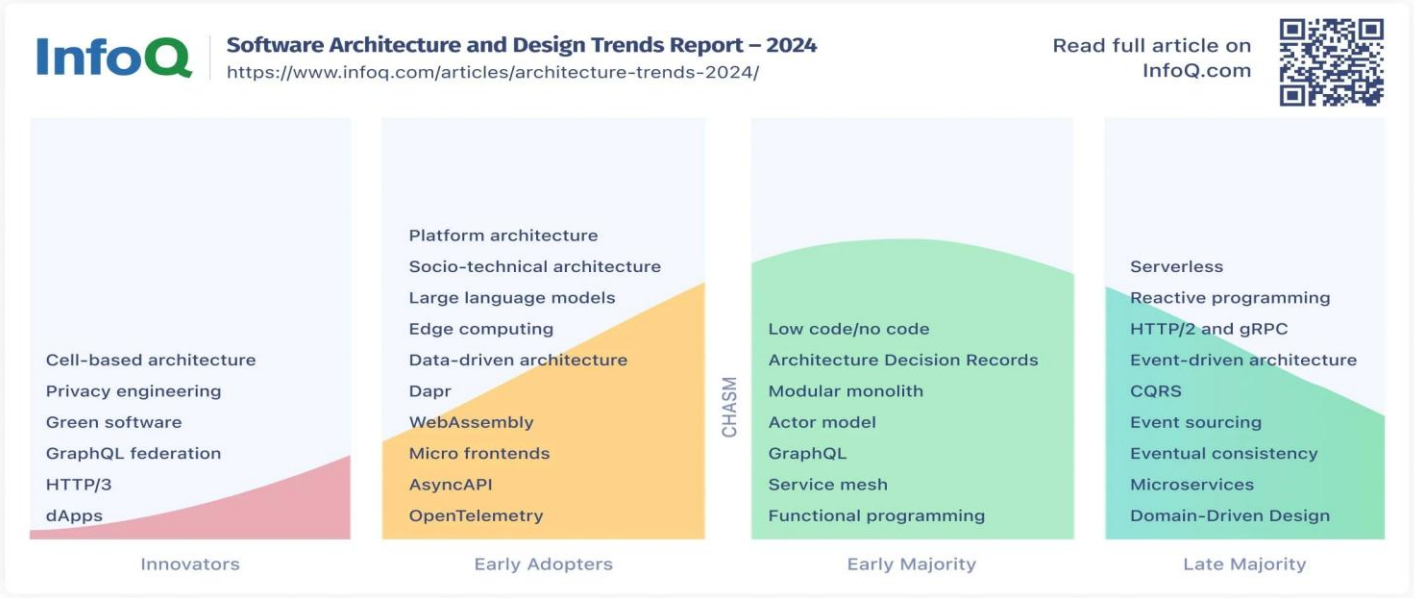
Recommendation 20 minutes every day to learn something new

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 2023-24



# Enterprise software

IT Software taxonomy

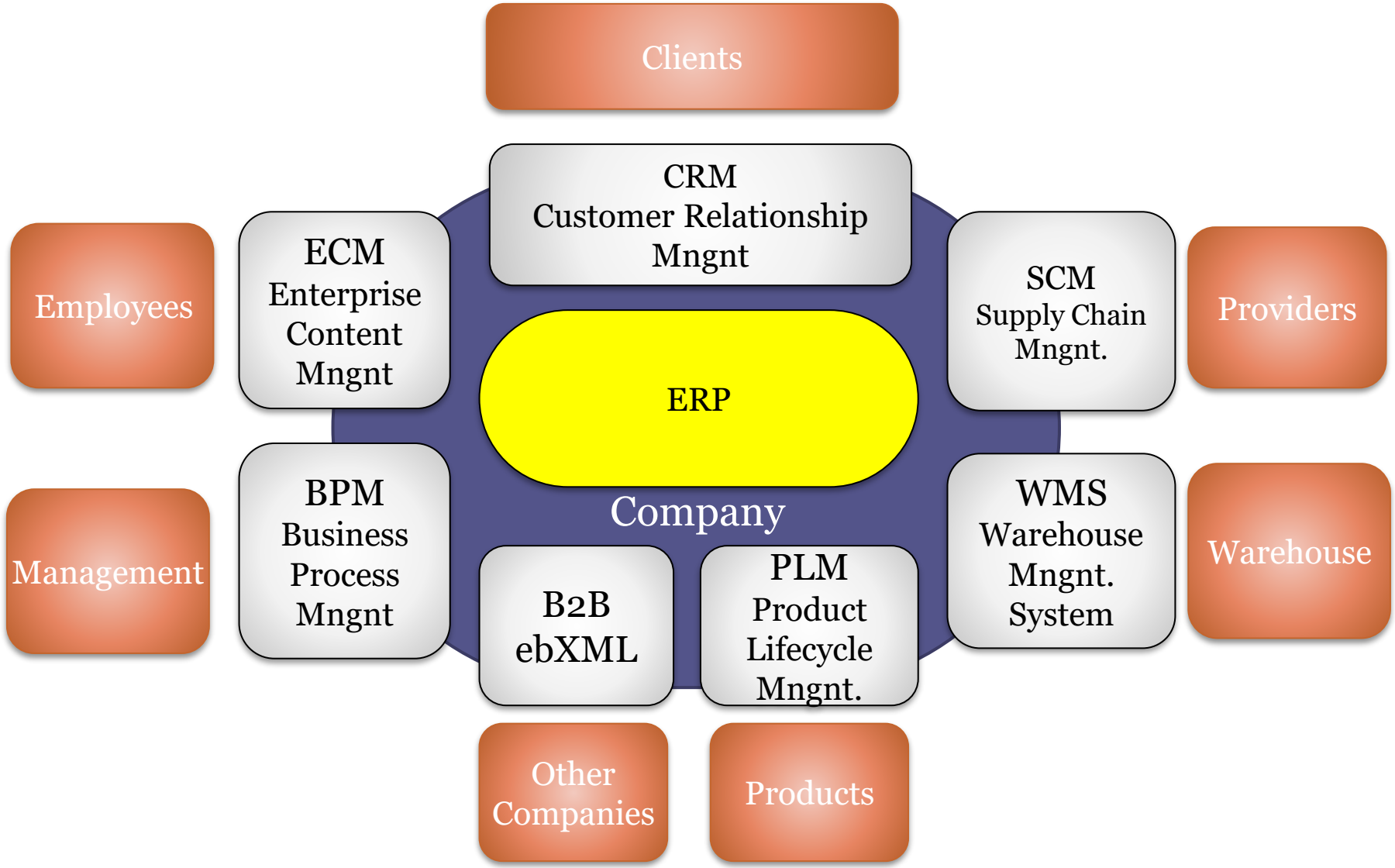
# Enterprise Software

## 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

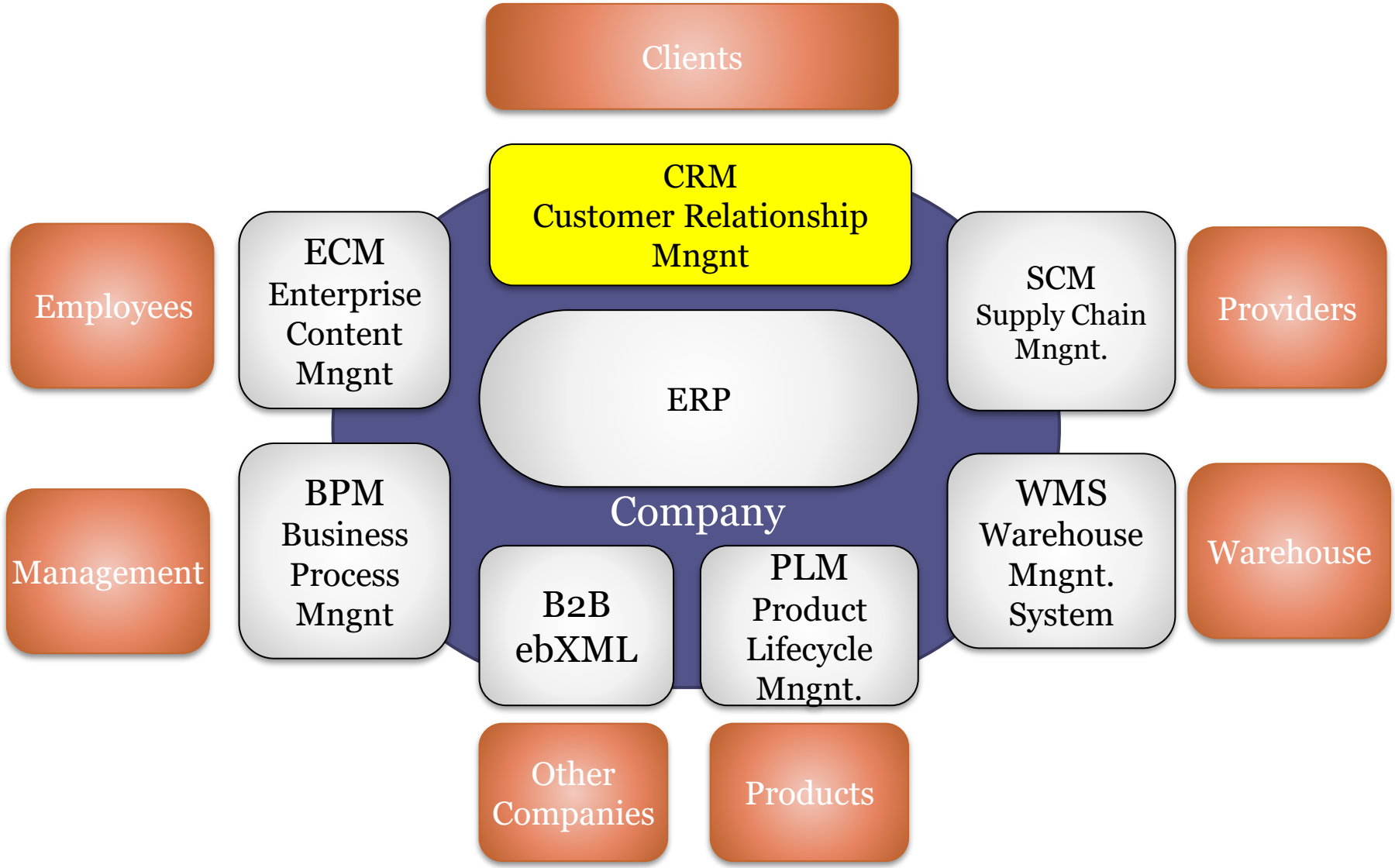
# ERP

## Applications

- SAP R/3
  - 3 layers client/server architecture
  - Based on a domain-specific language: ABAP
    - ABAP: Advanced Business Application Programming
  - SAP = bigggest european software company
- Other systems:
  - Comercial:
    - Oracle Fusion, Microsoft Dynamics NAV, SAGE, ...
  - Open source:
    - OpenERP, webERP, ...

http://en.wikipedia.org/wiki/Comparison_of_ERP_software

# 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

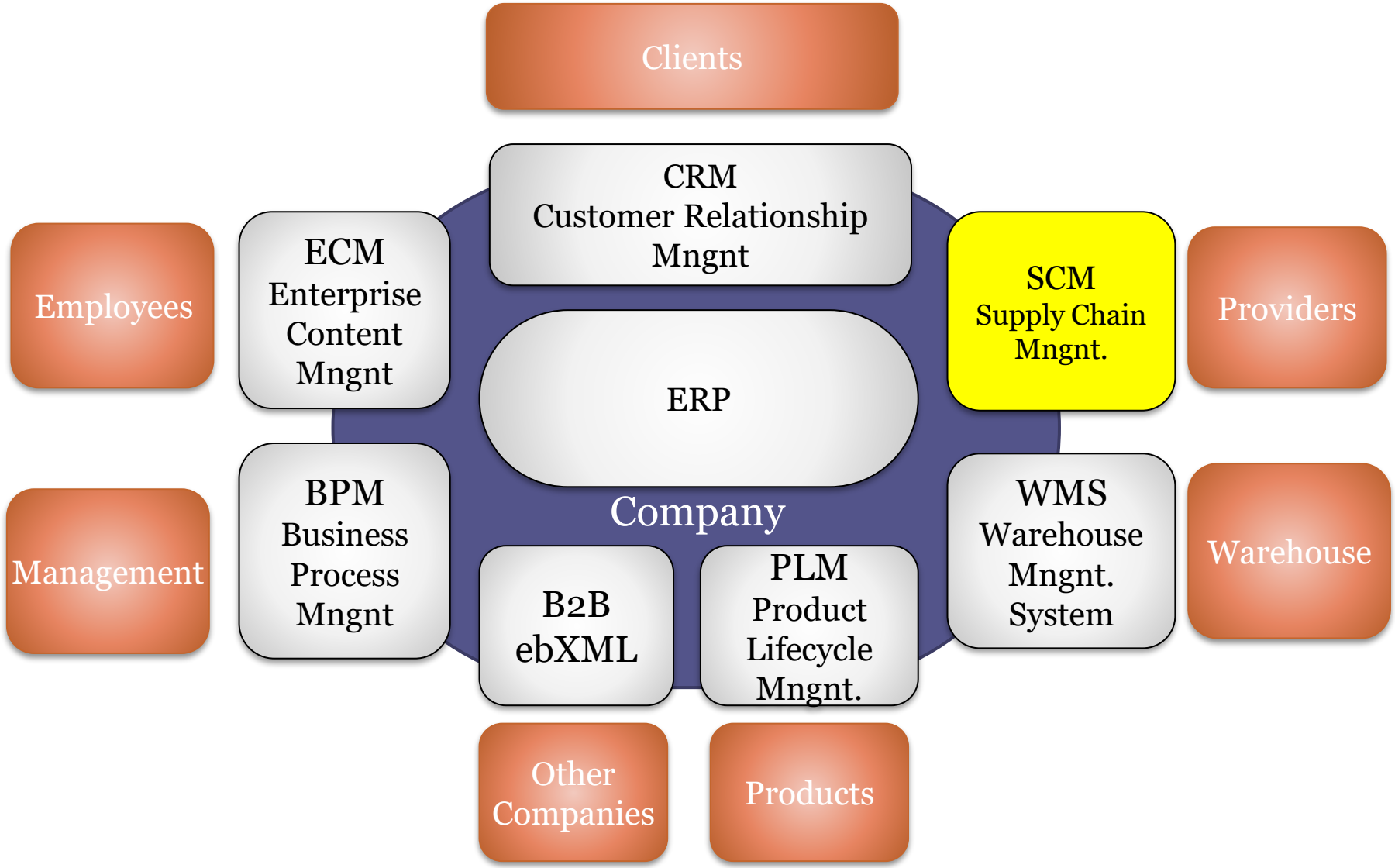
- Client satisfaction
- Labor cost reduction
  - Geographical and temporal diversity
- Profile management and privacy
- Social client and user communities
  - Combination with social networks (twitter, facebook,...)
  - Product reviews (Amazon, Booking,...)

# CRM - Customer Relationship Management

- Applications
  - Lots of CRM are integrated with ERP systems
    - SAP, Oracle, Microsoft CRM
  - Others:
    - Salesforce.com
    - webCRM
    - ...

http://en.wikipedia.org/wiki/Comparison_of_CRM_systems

# 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

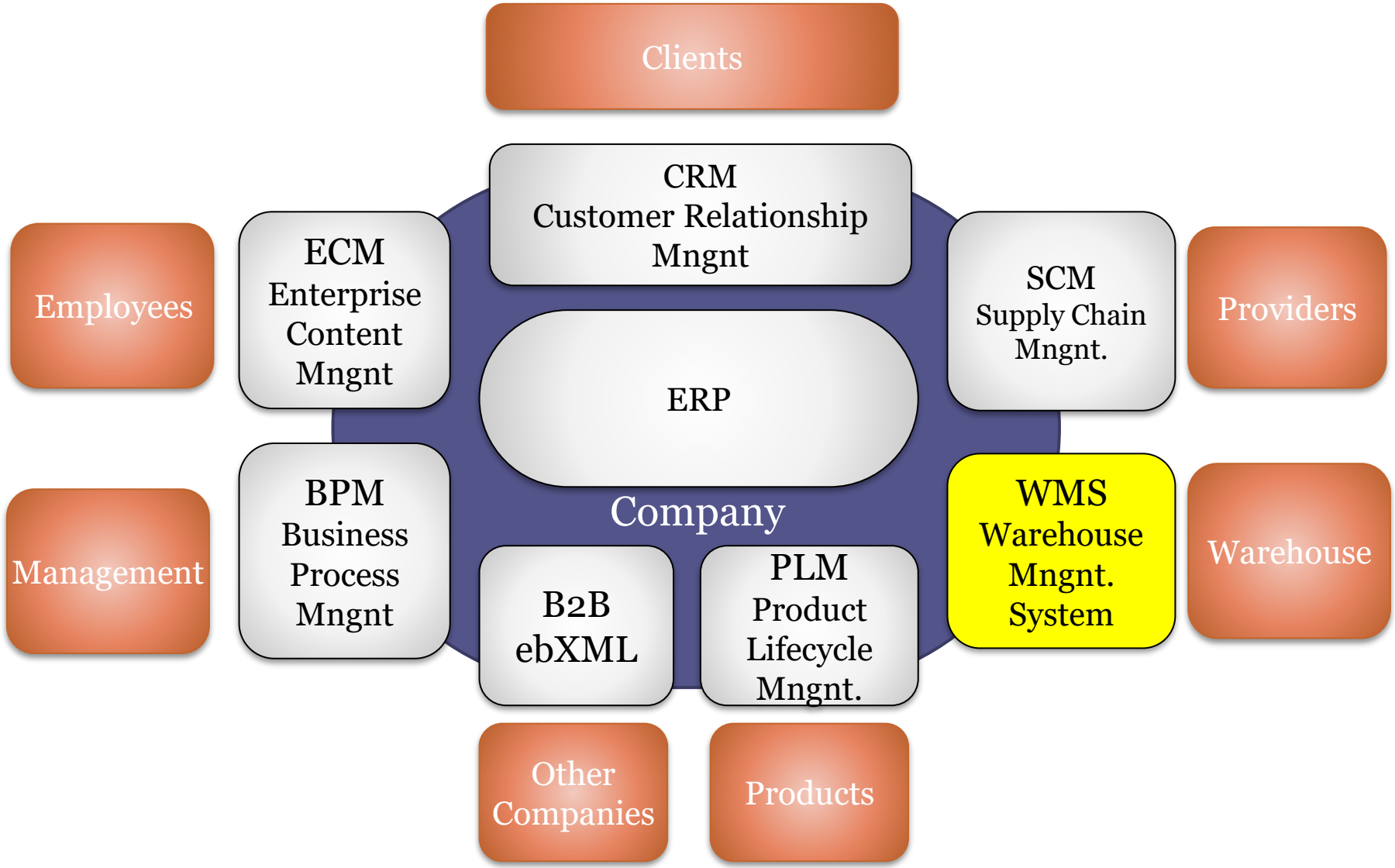
## Advantages

- 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

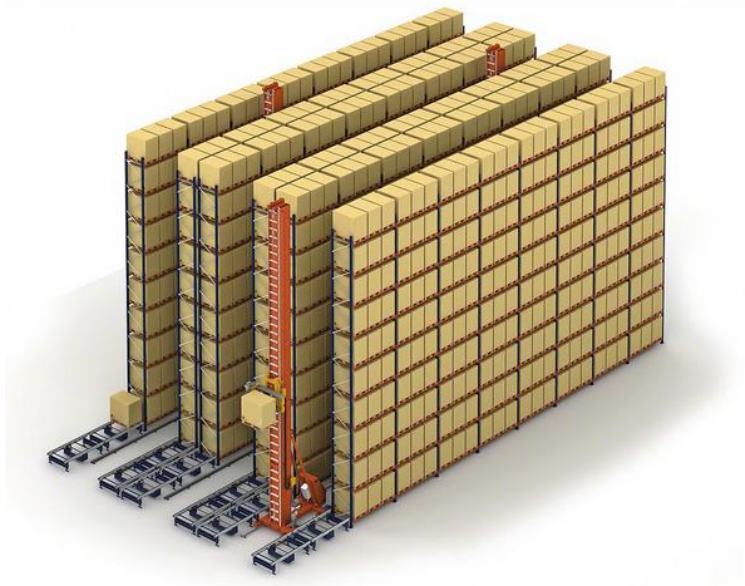
# Enterprise information systems



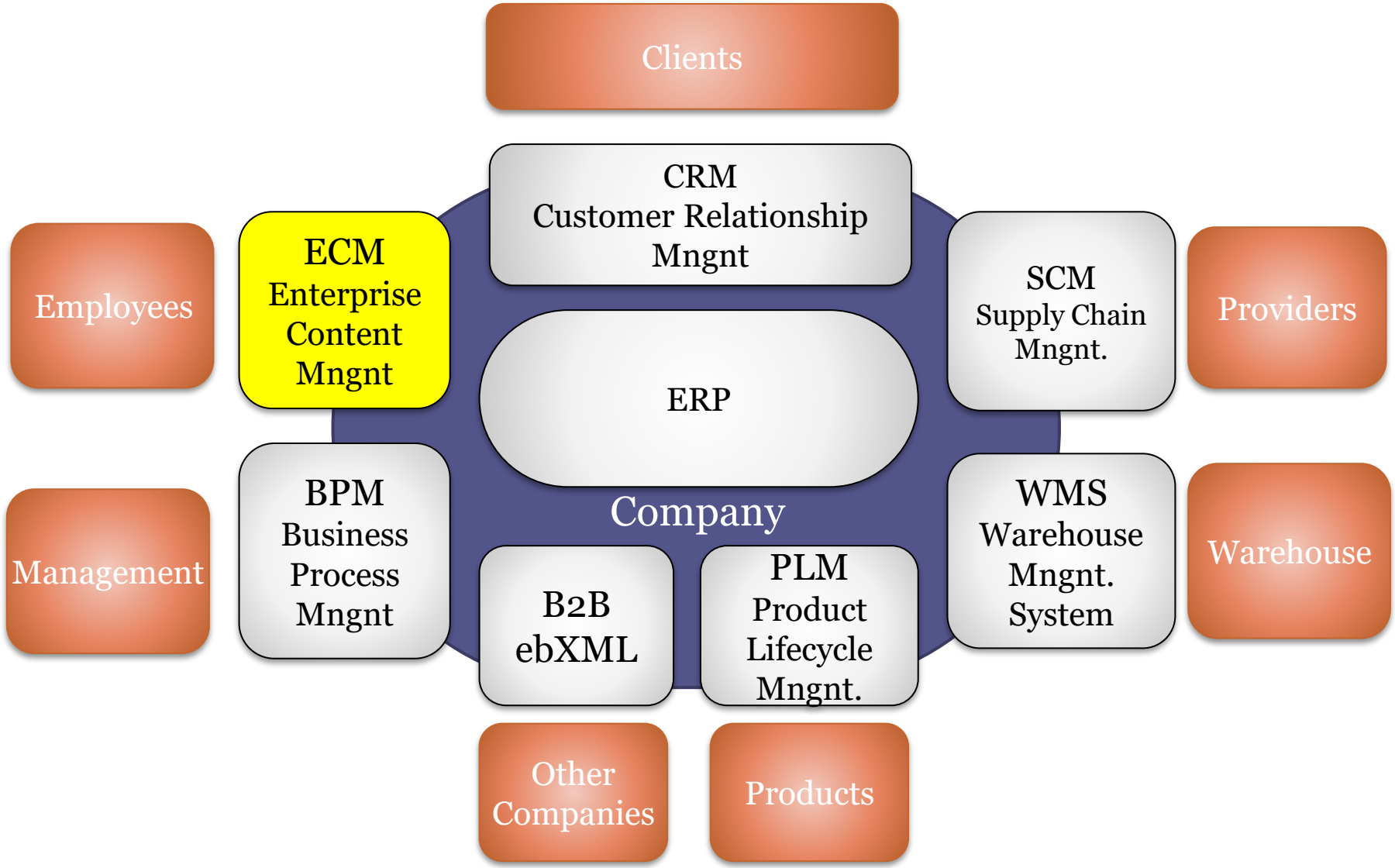
# WMS - Warehouse Management Software

## Warehouse Management Software

- Product control in warehouses
- Technology for identifying products
  - Picking, barcode scanners, RFID, etc.
- Automated warehouses
  - Stacker cranes, *miniloads*
- Examples:
  - Mecalux EasyWMS



# Emterprise 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

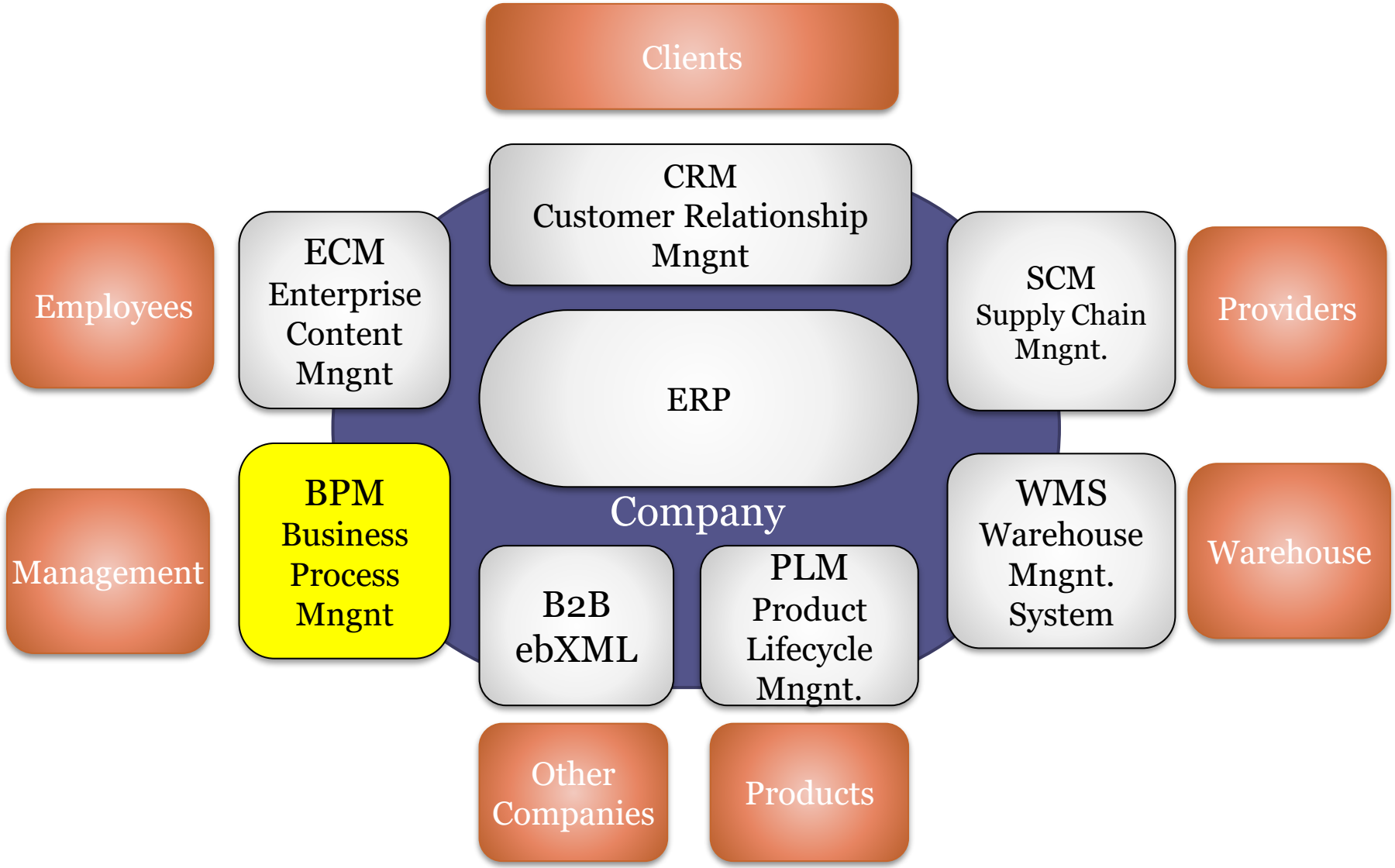
# ECM - Enterprise Content Management

- 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 though 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

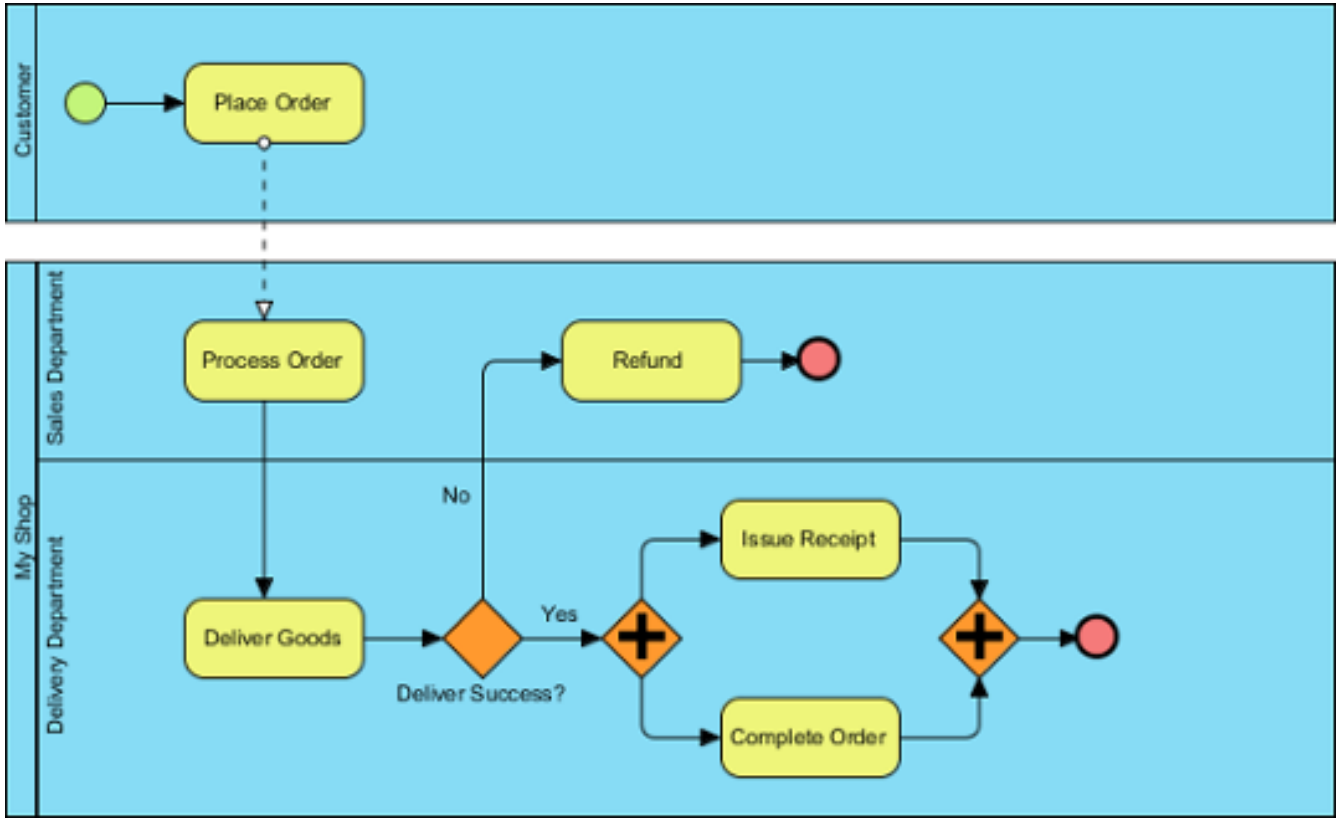
## Notations

- 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

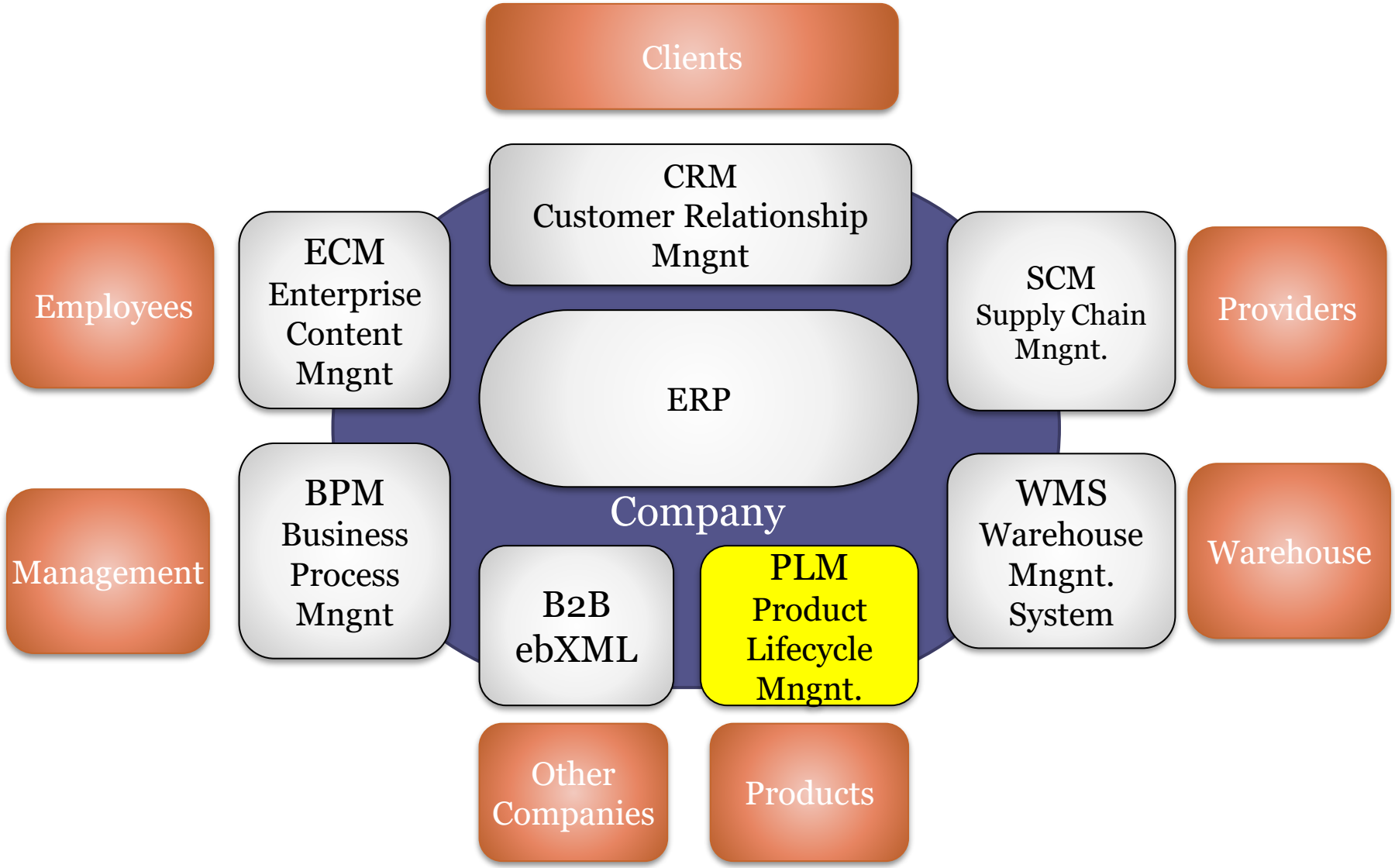
# BPMN example

## BPMN elements

- Events (start/intermediate/end)
- Activities
- Gateways
- Connections
- Swim lanes



# Enterprise information systems

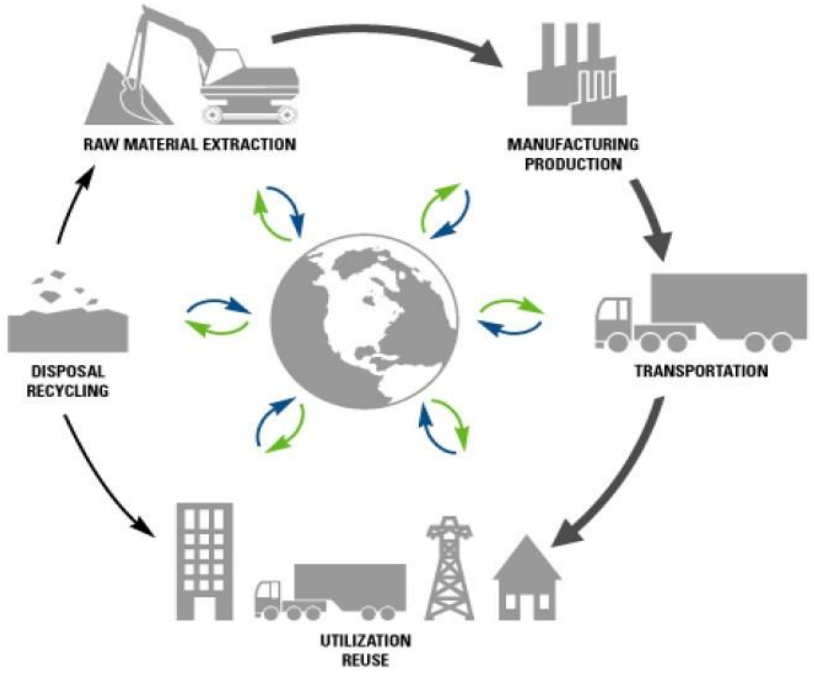


# PLM - Product Lifecycle Management

Integral product lifecycle management

Phases

- Conceive
- Design
  - CAD tools (Computer Aided Design)
- Realize
  - CAE (Computer Aided Engineering)
- Service
  - Repair and maintenance

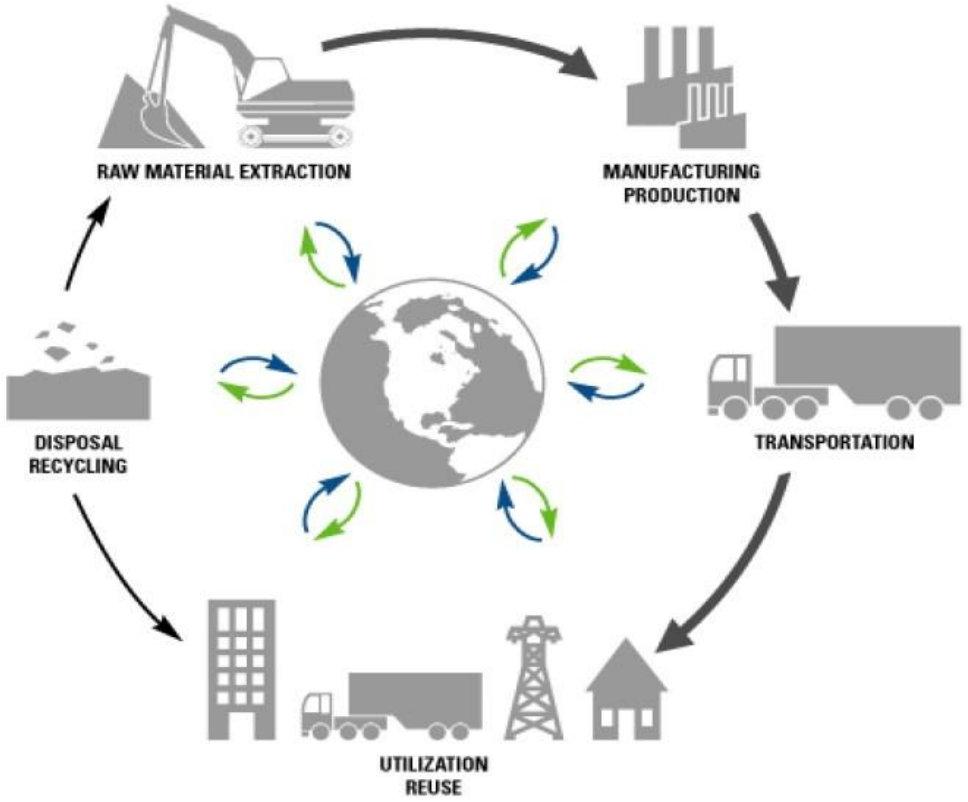



Source: Wikipedia
http://en.wikipedia.org/wiki/Product_lifecycle_management

# PLM - Product Lifecycle Management

Solutions :

- Siemens TeamCenter
- SAP PLM
- Sopheon
- ...

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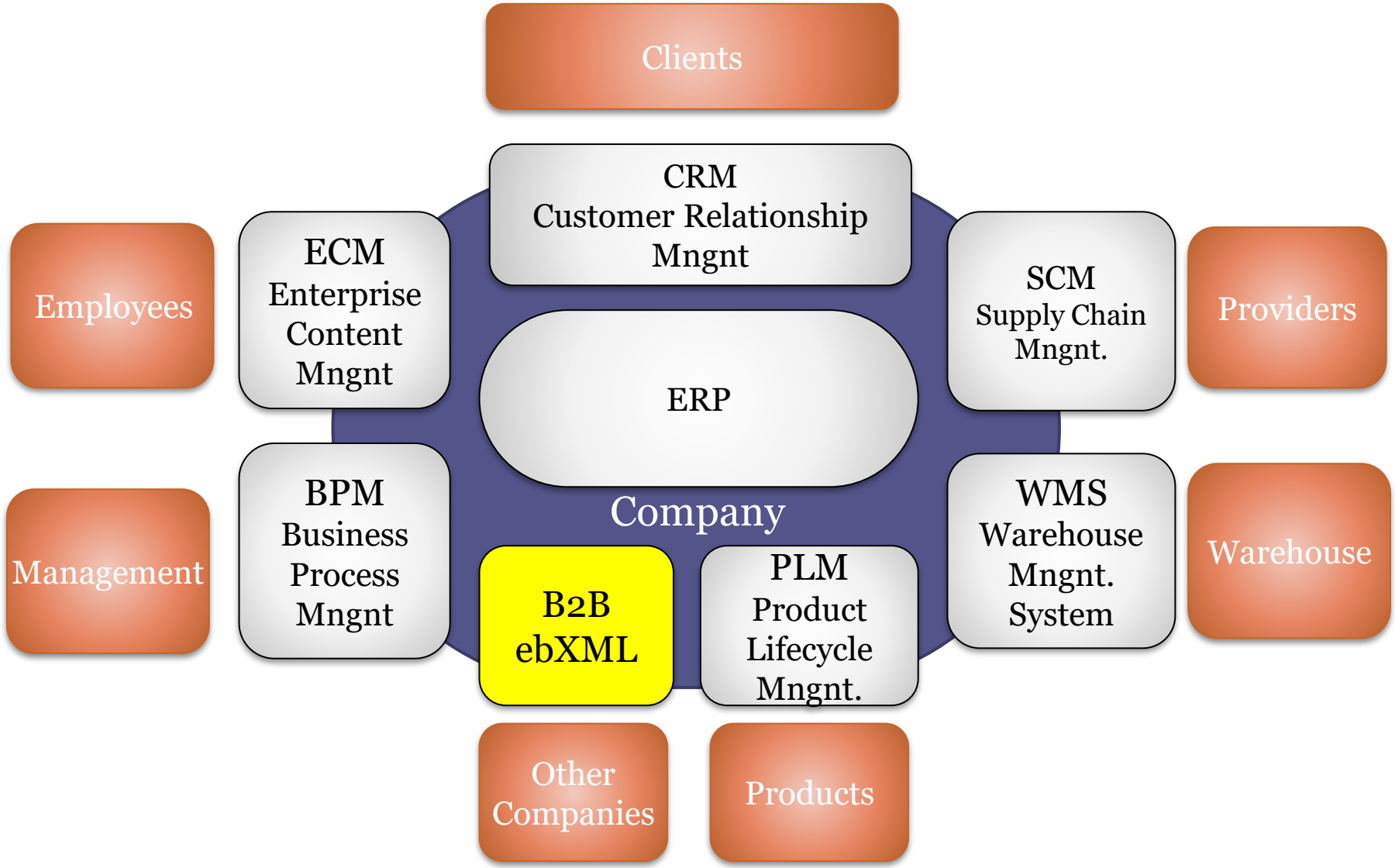
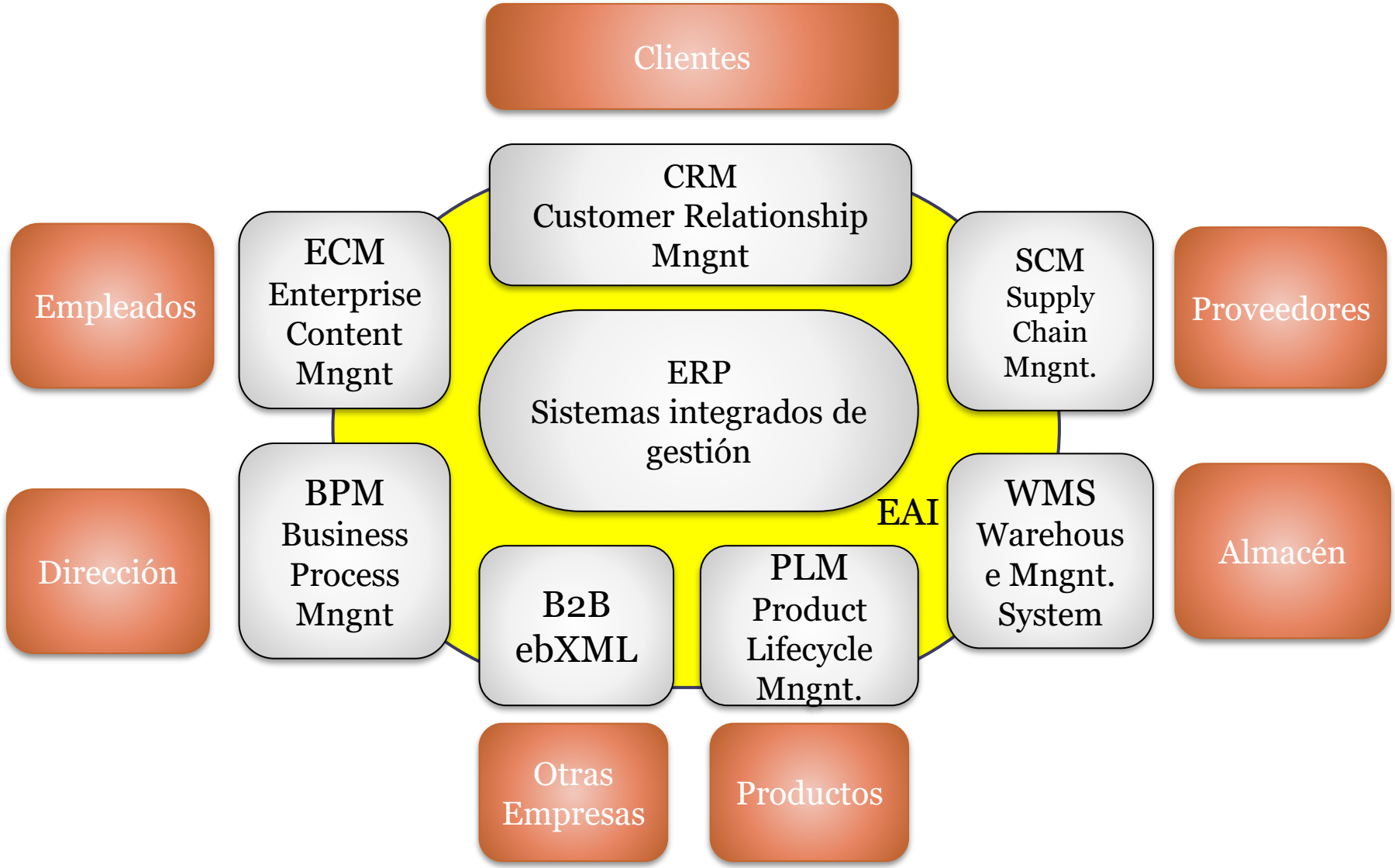
# Enterprise Information Systems



# 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

Sercice 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.



https://landing.google.com/sre/sre-book/chapters/service-level-objectives/

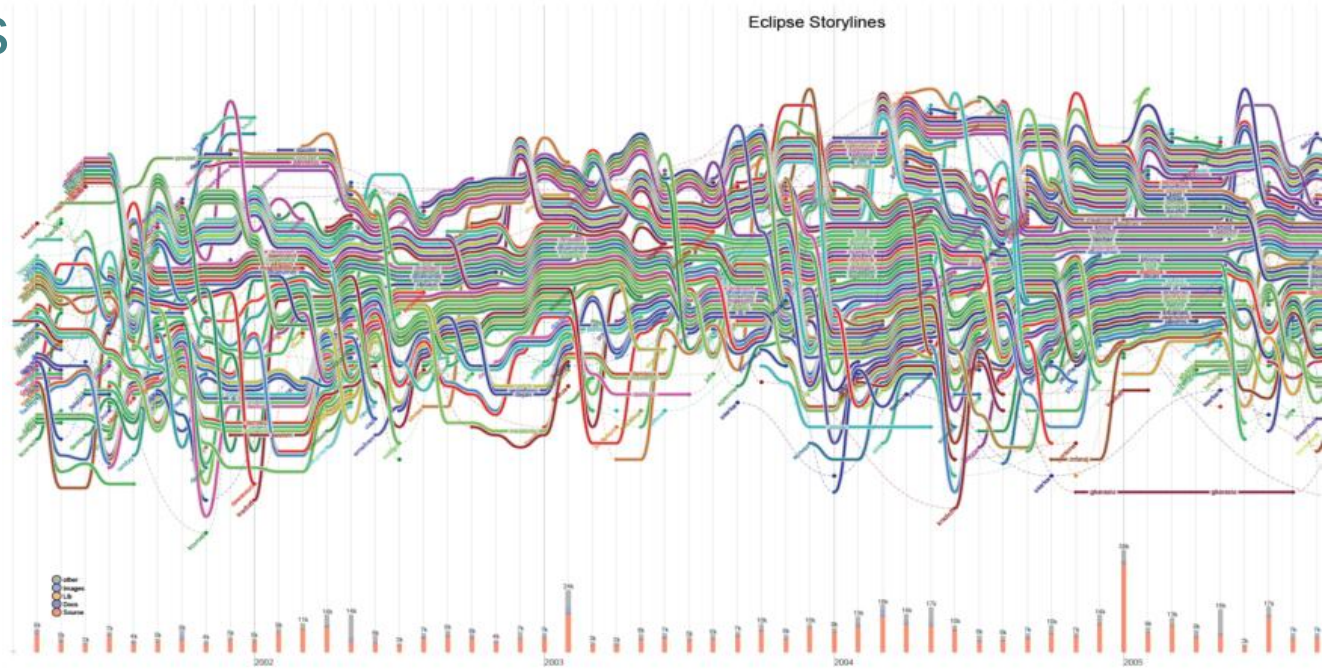
# Service governance

- 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




Software evolution storyline, Michael Ogawa

# Lehman's laws of software evolution

Manny Lehman
Fuente Wikidata

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

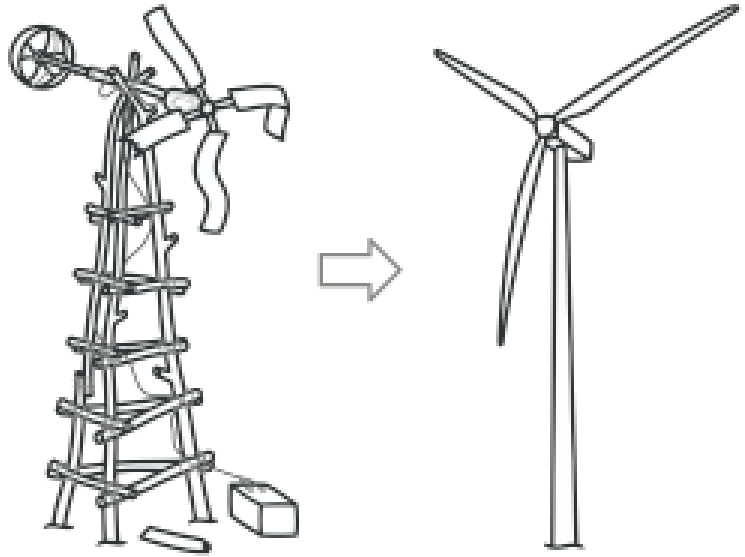
Conservation of familiarity

. . .

# Sofware 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

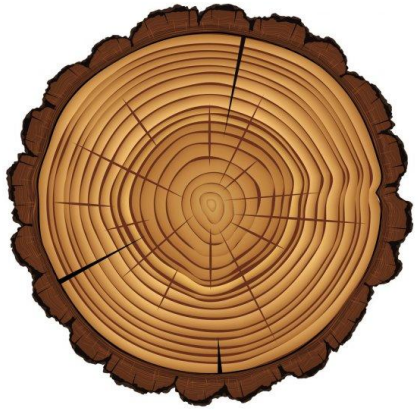
Valuable software that you are afraid to change

Some reasons

- Unfamiliarity
  - Developed by someone else/some time ago
- No tests
- No documentation/outdated documentation
- Reliance on external resources
- Short deadlines

More info:

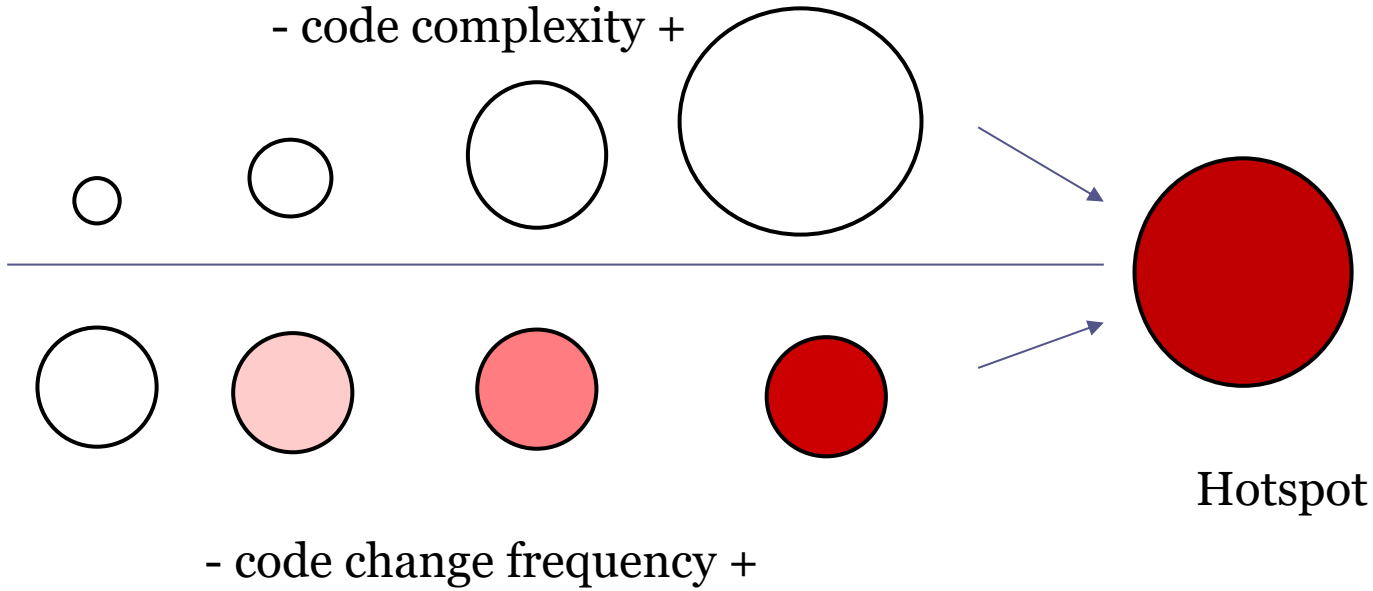
- https://understandlegacycode.com/



# Behavioral code analysis

## Identify system hotspots

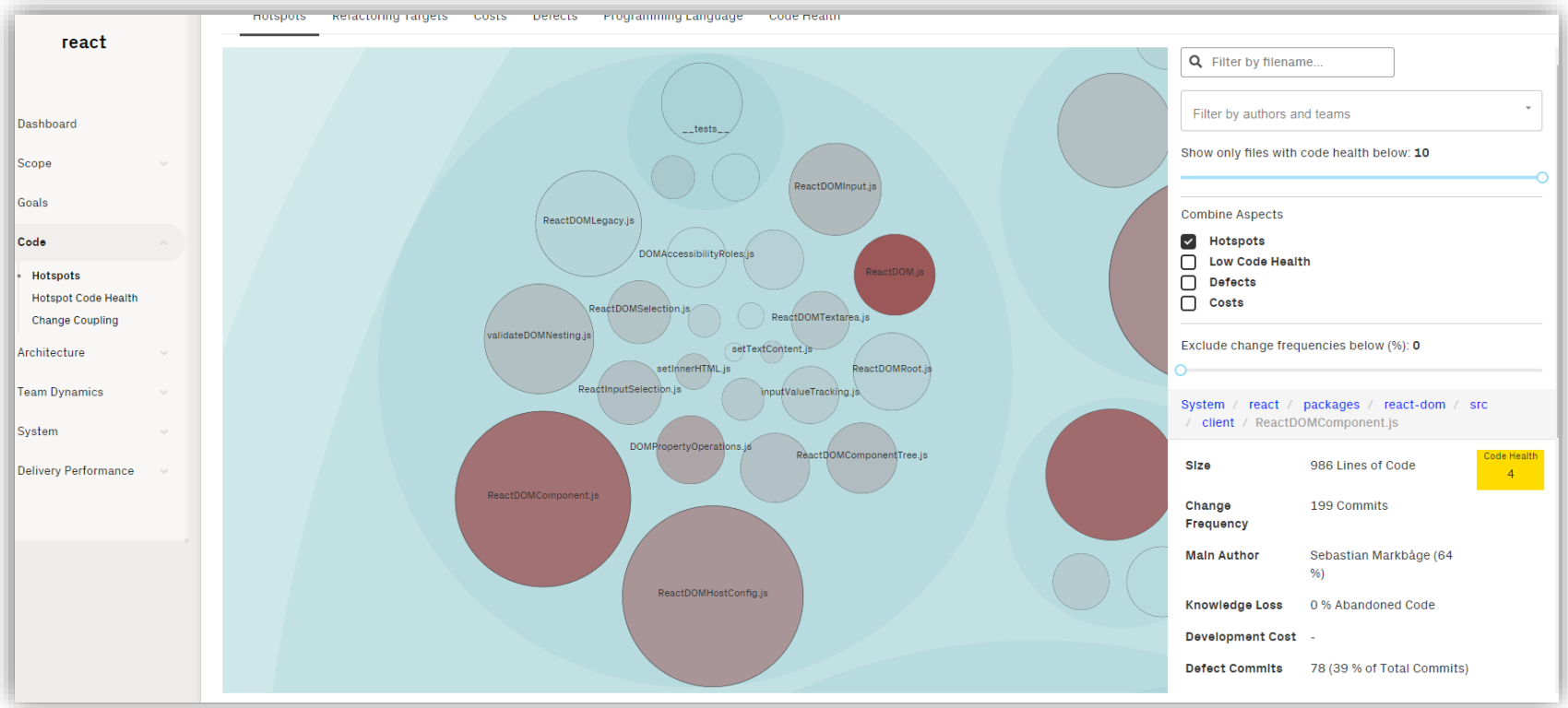
- Complex components that change frequently
- Good candidates for refactoring



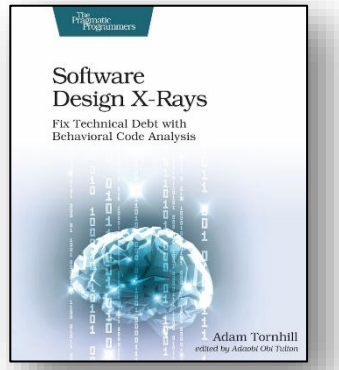
# Behavioral code analysis

CodeScene tool: https://codescene.io/

Includes several tools for behavioral code analysis




More information: Book (Software design X-Rays, Adam Tornhill)

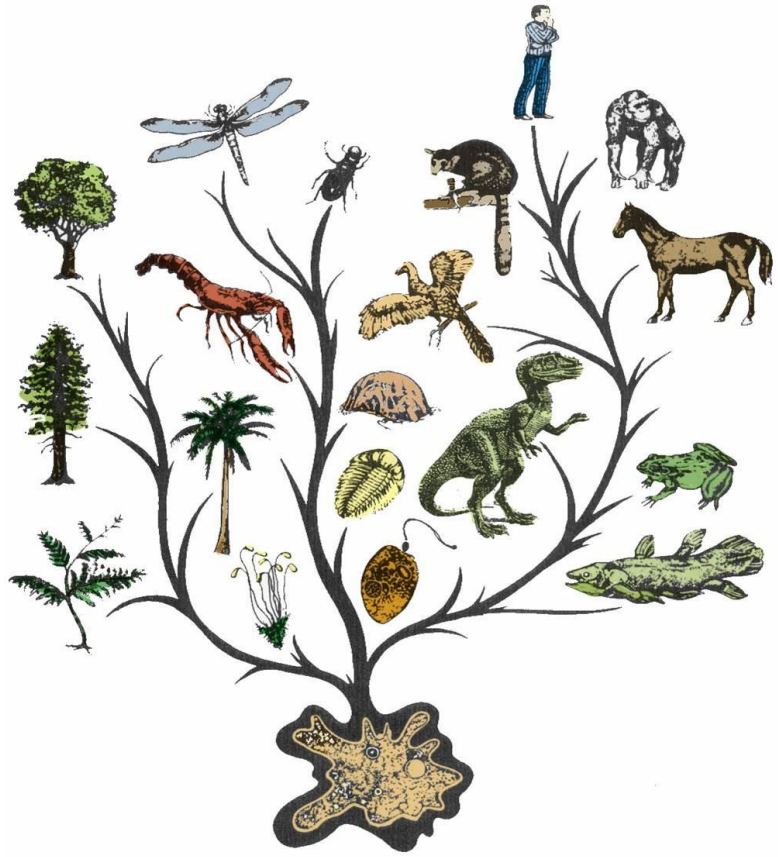


# Evolutionary architectures

Main quality attribute: evolvability

- Incremental, guided change as a first principle

Adoption of fitness function



# End of presentation