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Design of distributed applications

use of Software Engineering concepts, methods and tools to design and development distributed applications

- software development cycle is divided into phases
  - requirements analysis, specification, design, implementation, test and integration, maintenance
- for details see Software Engineering courses

Open Distributed Processing (ODP)

Model Driven Architecture (MDA)

AutoFocus

introduced by ISO with the goal of defining a reference model for distributed applications

- integrating a wide range of standards for distributed systems, e.g. ISO/OSI reference model

Reduction of complexity by specifying different levels of abstractions of the distributed system ("viewpoints").

- Enterprise viewpoint: deals with the overall goals that the distributed system should reach within the organization.
- Information viewpoint: focus on aspects of the structure, the control of and the access to information
- Computation viewpoint: aspects of the logical distribution of data and subsystems.
- Engineering viewpoint: physical distribution of data and subsystems
- Technology viewpoint: the different physical and technical subsystems, e.g. network, hardware platforms.

Model Driven Architecture (MDA)

concept for structured and documented software development

- OMG standard (Object Management Group)
- use of architectural models

Models

Definition: A **model** is a description of (part of) a system written in a well-defined language.

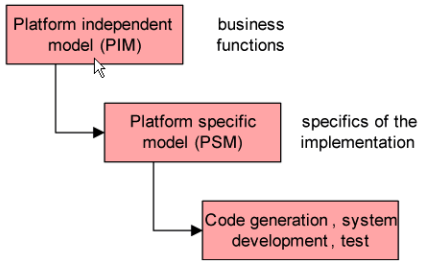
Definition: A **well-defined language** is a language with well-defined form (syntax), and meaning (semantics), which is suitable for automated interpretation by a computer

MDA Concept

consists of 3 steps

- development of platform independent models (PIMs)
- mapping to platform dependent models (PSMs)
- implementation, integration and test

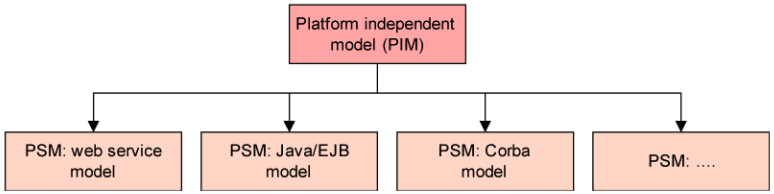
transformation between models (PIM → PSM, PSM → code)



1. Step: development of PIM
2. Step: mapping to PSM
3. Step: code generation

2. Step: mapping to PSM

mapping of PIM to platform specific models PSMs

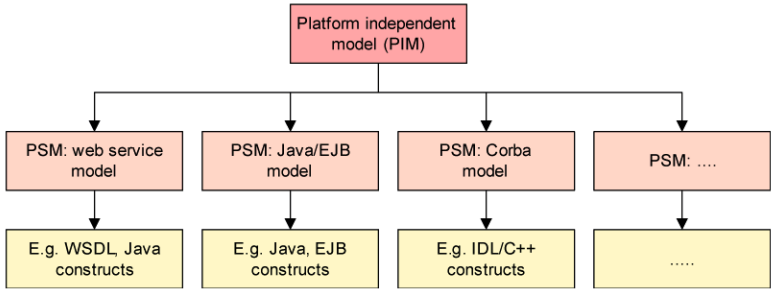


- PSM models realization of software solution in UML
- Example: software components are Web services and communication via SOAP

3. Step: code generation

generation of specific technological constructs, e.g. Java packages

- implementation of system functionality
- use of tools for automatic code generation



AutoFocus is a platform to specify distributed systems

developed by the group of Prof. Broy, TU München

based on formal methods of systems engineering

integrates hierarchical description techniques

allows distributed and platform independent development

project advanced to AutoFocus 2 supporting the following functionality

requirement analysis tool (AutoRAID), such as use-cases and scenarios, business and application requirements

Design modelling views and editors, such as system structure diagram, state transition diagram, message sequence charts

interactive simulation environment, code generation, consistency maintenance support,

Design - Development environment

use of Software Engineering concepts, methods and tools to design and development distributed applications

software development cycle is divided into phases

requirements analysis, specification, design, implementation, test and integration, maintenance

for details see Software Engineering courses

Open Distributed Processing (ODP)

Model Driven Architecture (MDA)

AutoFocus

Ideas and proposals emerged to transfer the service approach to the design and modeling of software systems.

Definition: Service-oriented modeling (SOM) is the discipline of modeling business and systems, for the purpose of designing and specifying service-oriented business systems within SOA.

create models that provide a comprehensive view for the analysis, design, and architecture of all software components in an organization.

envision the coexistence of services in an interoperable computing environment.

Definition: The **service-oriented modeling framework** (SOMF) is a service-oriented development life cycle methodology that provides practices, disciplines and a universal language to provide tactical and strategic solutions to enterprise problems

Service Evolution

Life Cycle Structure

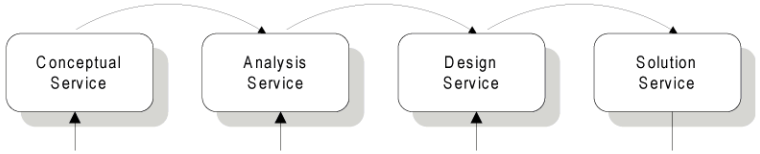
Life Cycle Modeling

SOM Framework

Other SOA Design Methodologies

Service Evolution

SOM advocates the transformation of a service through 4 states.



1. conceptual service: in its inception, a service appears merely as an idea or concept.
2. analysis service: it becomes a unit of analysis.
3. design service: it evolves into a design entity.
4. solution service: it ends in a physical solution that is ready to be deployed in the production environment.

identifies the elements for service development and operations. It consists of 4 major components.

timeline : defines the life span of a service.

events : 2 types of events during the service life span.

predicted and scheduled events, e.g. milestone, planning stage or deployment stage.

unexpected events, e.g. stock market crash, trading volume exceeds capacity of trading service.

events have beginnings and may last for a while.

seasons : services live through 2 major life cycle seasons.

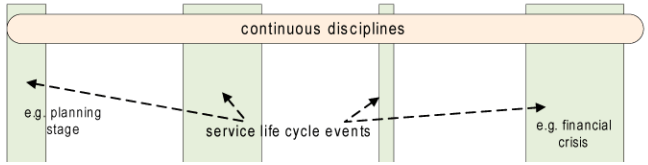
design-time season: services are conceptualized, analyzed, designed, constructed and tested.

run-time season: services are managed, monitored, and controlled to ensure proper performance.

disciplines : identify modeling and nonmodeling best practices and standards to be pursued throughout the service life cycle.

season disciplines: e.g. service-oriented conceptualization, business integration or construction.

continuous disciplines: e.g. service portfolio management, service governance.



Life Cycle Structure

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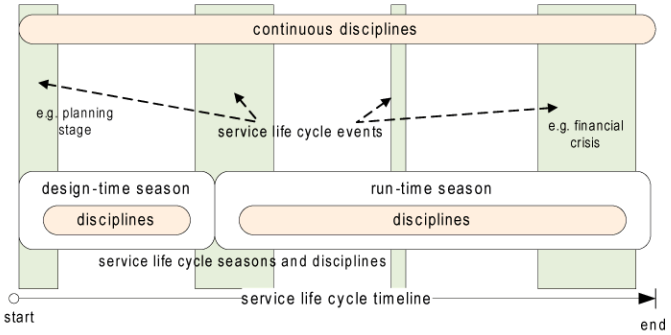
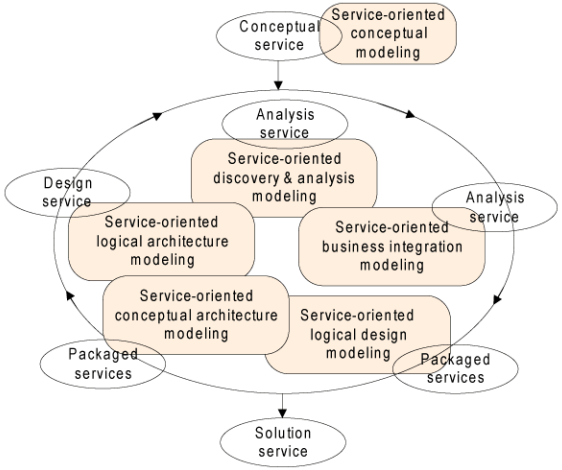


The following core processes can be identified in which business and IT personnel must be engaged to produce design and solution artifacts.

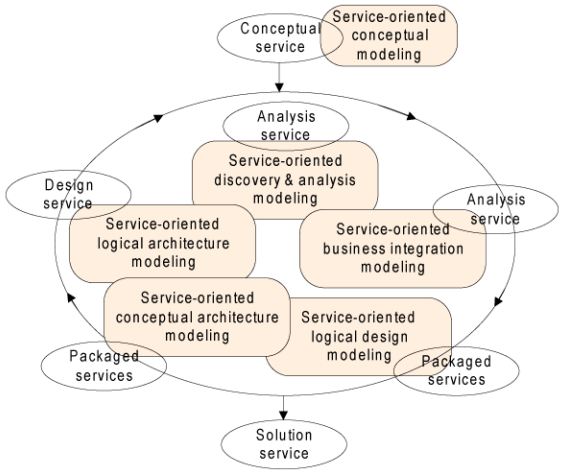


Conceptual modeling : identify driving concepts behind future solution services.

Discovery & analysis modeling : discover and analyze services for granularity, reusability, interoperability, loose-coupling, and identify consolidation opportunities for the existing software assets.

Business integration modeling : identify service integration and alignment opportunities with business

Life Cycle Modeling



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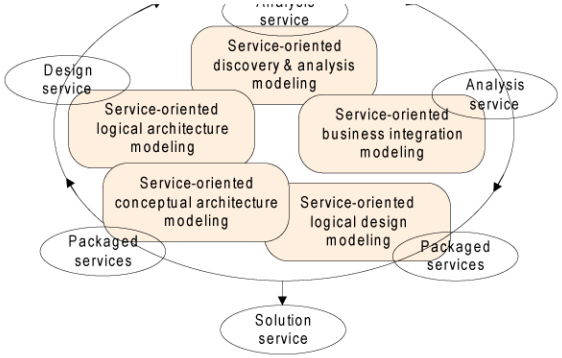
Logical design modeling : establish service relationships and message exchange paths; address service

Life Cycle Modeling



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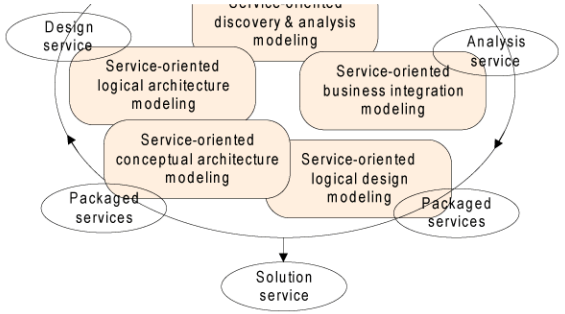
Logical design modeling : establish service relationships and message exchange paths; address service visibility, prepare service logical compositions; model service transactions.

Conceptual architecture modeling : establish an SOA architectural direction; select an SOA technological environment; establish an SOA technological stack; identify technological asset ownership.

Logical architecture modeling : integrate SOA software assets; establish SOA logical environment

Life Cycle Modeling



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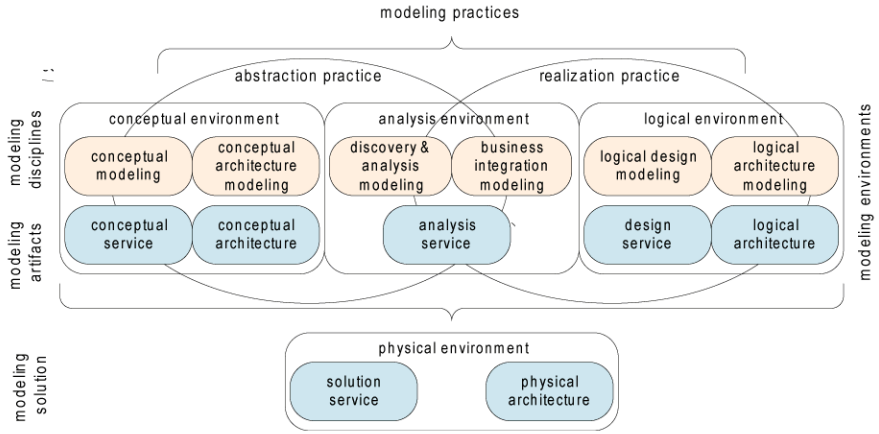
SOM Framework

Modeling components and disciplines are integrated into a SOM framework.



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Other SOA Design Methodologies

A brief overview of some other SOA design methodologies

Creating Service-Oriented Architectures (CSOA) by Barry & Associates

- focus is on technical aspects
- consist of the 5 phases
  - experiment with Web Services
  - adapt existing systems to use Web Services
  - remove intersystem dependencies
  - establish internal SOA
  - incorporate external services

Service-Oriented Transformation of Legacy Systems (SOTLS) by Nadhan

- targets the stepwise evolution of existing application systems towards service-oriented architectures
- focus is on technical aspects

Service-Oriented Design and Development (SOAD) by Papazoglou

- incorporates the perspectives of the service provider as well as the service consumer
- consist of the phases
  - planning, analysis, service design, service construction, service test, service deployment/execution and service management/monitoring

Design of distributed applications

Issues

This section introduces schemes for replication and concurrency control in the context of distributed file services.

What are the general characteristics of a distributed file service?

How to maintain consistency of replicated files?

What are voting schemes?

Presentation of the Coda file service.

Definitions

Definition: A **distributed file system** (e.g. Sun Network File System (NFS)) is characterized by:

a logical collection of files on different computers into a common file system, and

computers storing files are connected through a network.

Definition: A **distributed file service** is the set of services supported by a distributed file system. The services are provided by one or several file servers; a **file server** is the execution of file service software on a computer.

Definition: Allocation is the placement of files of a distributed file system on different computers.

Definition: Relocation changes file allocation within the distributed file system.

Definition: Replication

there exist multiple copies of the same file on several computers.

Replication degree REP_d of a file d: total number of copies of d within the distributed file system.

If replication transparency is supported, the user is unaware of whether a file is replicated or not.