Komponenttiväliohjelmistot

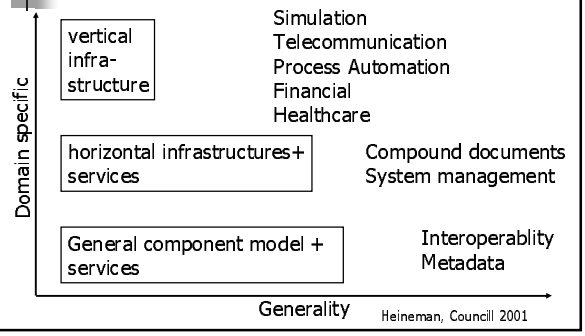
Teemat

- Järjestelmämallin tarpeet
- Palvelut ja rajapinnat
- Sisärakenteet
  - networking and interoperability
  - server control
  - system administration infrastructure
- Sovellustilanteen arkkitehtuurimallikkeita
- Realisaatioita
- Laajennustrendit

Components

- Components are entities running in a standardized environment that provides
  - transactions, security, event-handling, persistence, and
  - component model services (horizontal and vertical infrastructure services)
    - COTS: Operating systems, compilers, network managers, database systems, CASE tools; aircraft navigation algorithms, banking transaction handlers
- Examples in CCM, EJB, DCOM

Komponenttijärjestelmät



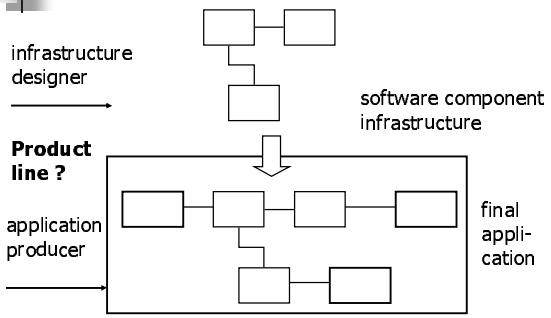
Components

- Independently deployed; Component transfer and deployment is standardized.
- Subject to third-party composition
- In the global software component markets; packaging and licencing
  - Downloadable packages
  - Deployment descriptor provides information about the contents of the package; used for installing and configuring the component properly
- Components are produced using declarative languages.

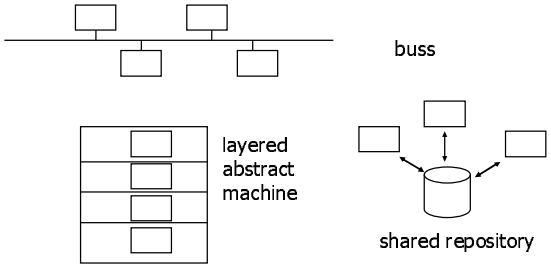
Component system production

- Tranditionally coordination among components by a skeletal software infrastructure
  - Invokes each component
  - Handles communication
  - Handles coordination -> architectural styles
    - Set of component types
    - Topological layout of components indicating their interealtionships
    - Set of interaction mechanims

Component system production



Mismatch of architectural styles



Tuumaustauko …

- Object factory and product line (Oliver Simms)
- Product line: set of products that share reqs and reused plans
- Business object: composed object across EAI n-tier model tiers
- Availability of different kind of middleware at each tier (GUI mw, J2EE, .NET, database mw) + "standard" deployment model and object architecture

CORBA-komponenttimalli CCM

- abstrakti komponenttimalli
- komponenttien suoritusaikainen ympäristö
  - Component container programming model
- komponenttien toteutus
  - Component Implementation Framework CIF + Component implementation language CIDL
- Komponenttien pakkaaminen ja käyttöönsaatto

The Abstract Component Model

- Allows component designers to capture how CORBA components are viewed by other components and clients
  - What a component **offers** to other components
  - What a component **requires** from other components
  - What collaboration modes are used between components
    - Synchronous via operation invocation
    - Asynchronous via event notification
  - Which component **properties** are configurable
  - What the business life cycle operations are (i.e. **home**)
- Expressed via OMG IDL 3.0 extensions
  - Syntactic construction for well known design patterns
  - Mapped to OMG IDL interfaces for clients and implementers

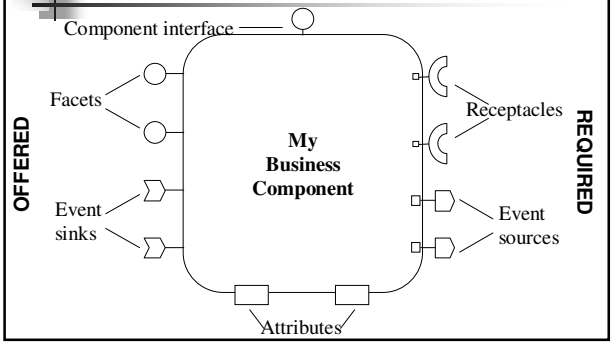
What is a CORBA Component?

- component is a new CORBA meta-type
  - Extension of Object (with some constraints)
  - Has an interface, and an object reference
  - Also, a stylized use of CORBA interfaces/objects
- Provides component features (also named *ports)*
- Could inherit from a single component type
- Could `supports` multiple interfaces
- Each component instance is created and managed by a unique component home

CORBA components

- extends and specializes object type (server side!)
- ports
  - Facets – interfaces provided to clients
  - Receptacles – named connection points, required operation interfaces
  - Event sources – named points that send events
  - Event sinks – named points to which events are pushed
  - Attributes – named values with set/get, for configuration; can raise exceptions
- Equivalent interface
  - Navigation
  - Modifying port states

A CORBA Component



Component runtime support

- Component home
  - Controls a set of components using the component equivalent interface
  - Provides component factory facilities
    - Specializations
- Container
  - Defines the environment for supporting dynamic collections of components
  - The core of the CCM is the container: a running piece of code that you buy from a vendor and install on your server machine. The container includes an ORB with a POA. Corba components are server-side objects; your system administrator installs components into the container, which takes charge of them when they run.

Component Facets

- Distinct named interfaces that provide the component's application functionality to clients
- Each facet embodies a view of the component, corresponds to a role in which a client may act relatively to the component
- A facet represents the component itself, not a separate thing contained by the component
- Facets have independent object references

Component Receptacles

- Distinct named connection points for potential connectivity
  - Ability to specialize by delegation, compose functions
  - The bottom of the Lego, if you will
- Store a simple reference or multiple references
  - But not intended as a relationship service
- Configuration
  - Statically during initialization stage or assembly stage
  - Dynamically managed at runtime to offer interactions with clients or other components (e.g. callback)

Component Events

- Simple publish / subscribe event model
  - "push" mode only
  - Sources (2 kinds) and sinks
- Events are value types
  - Defined with the new **`eventtype`** meta-type
  - `valuetype` specialization for component events

Component Event Sources

- Named connection points for event production
  - Push a specified eventtype
- Two kinds: *Publisher* & *Emitter*
  - `publishes` – multiple client subscribers
  - `emits` – only one client connected
- Client subscribes or connects to directly component event source
- Container mediates access to CosNotification channels
  - scalability, quality of service, transactional, etc.

Component Event Sinks

- Named connection points into which events of a specific type may be pushed
- Subscription to event sources
  - Potentially multiple (n to 1)
- No distinction between emitter and publisher
  - Both push in event sinks

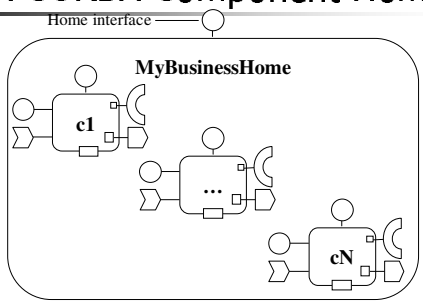
Component Attributes

- Named configurable properties
  - Vital key for successful re-usability
  - Intended for component configuration
    - e.g., optional behaviors, modality, resource hints, etc.
  - Could raise exceptions
  - Exposed through accessors and mutators
- Could be configured
  - By visual property sheet mechanisms in assembly or deployment environments
  - By homes or during implementation initialization
  - Potentially readonly thereafter

Navigation and Introspection

- Navigation from any facet to component base reference with `CORBA::Object::get_component`()
  - Returns nil if target isn't a component facet
  - Returns component reference otherwise
- Navigation from component base reference to any facet via generated facet-specific operations
- Navigation and introspection capabilities provided by `CCMObject`
  - Via the `Navigation` interface for facets
  - Via the `Receptacles` interface for receptacles
  - Via the `Events` interface for event ports

A CORBA Component Home



Component Home

- Is instantiated at deployment time
- Manages a unique component type
  - More than one home type can manage the same component type
  - But a component instance is managed by a single home instance
- Allows life cycle characteristics or key type to vary/evolve without changing component definition
- Optional use of *`primarykey`* for business component identity and persistency primary key
- Standard *`factory`* and *`finder`* business logic operations
- Extensible with arbitrary user-defined business logic operations

Primary Keys

- Values exposed to clients to create, find, and destroy component instances
  - Uniquely identifies a component instance within a home
  - Assigned at creation time, or in pre-existing database
  - Must be a value type derived from Components::PrimaryKeyBase (empty, abstract)
- Association between a primary key and a component is defined and maintained by its home
  - Different home types may define different key types (or no key) for the same component type
  - Primary key is not necessarily a part of the component's state

CCM development project stages

1. Analysis/design
   - UML + business object profiles
2. Component declaration
   - Define component's methods and home with extended IDL and compile to produce
     - for clients: Operations, navigation operations, stubs
     - for servers: skeletons, IR entries, some code, packaging and deployment descriptors in XML

Esimerkki

```
component ShoppingCart {
    provides ShoppingCartIntf Cart1;
    uses CheckoutIntf CheckOut1;
}
home ShoppingCartHome manages
  ShoppingCart{};
```

CCM development project stages

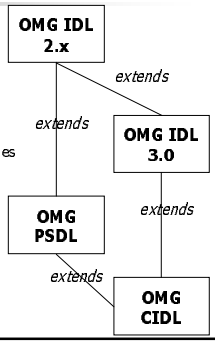
3. component implementation
   - declare component's persisent state in PSDL and some behaviour aspects in CIDL
   - compile to get skeletons; fill in with business logic; compile to joint result to get compiled libraries

Esimerkki

```
abstract storagetype CustomerState{
   state long AcctNum;
   state ...
}
storagetype PortableCustomerState implements CustomerState{};
typedef sequence <Customer> CustomerList;
abstract storagehome CustomerStorageHome of Customer {
      primary key AcctNum(AcctNum);
      factory create(AcctNum, Name, ...);
}
storagehome PortableCustomerStorageHome implements
   CustomerStateHome{};
```

Relations between OMG Definition Languages

- OMG IDL 2.x
  - Object-oriented collaboration
  - i.e. data types, interfaces, and value types
- OMG IDL 3.0
  - Component-oriented collaboration
  - i.e. component types, homes, and event types
- OMG PSDL
  - Persistent state definition
  - i.e. [abstract] storage types and homes
- OMG CIDL
  - Component implementation description
  - i.e. compositions and segments



Component usage patterns

- 7 component categories: 4 CCM, 2 EJB, 1 clustomizable
- servant lifetime policies: method, transaction, component, container

category	usage model	container API type	primary key
service	stateless	session	no
session	conversational	session	no
process	durable	entity	no
entity	durable	entity	yes

Composition

- Defined in CIDL
  - Category
  - Home executor
  - Executor
  - Bindings
  - State management (storage)

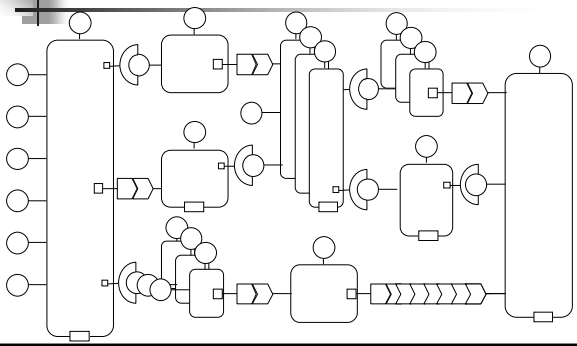
Esimerkki

```
composition entity CustomerImpl {
    implements Customer;
    home executor CustomerHomeImpl
      delegatesTo abstractstoragehome
      CustomerStateStorageHome;
}
```

CCM development project stages

4. component packaging
   - (use interactive tools to produce)/write component descriptor (in XML) to tell CCM runtime how to connect up and manage the implementation
   - package up implementation and component descriptor into a component archive file CAR
5. component assembly
   - An application or part composed of some components with predefined interaction pathways in an assembly archive file AAR
   - Customizes configuration, connections, partitioning to different computers

Building CCM Applications = Assembling CORBA Component Instances



CCM development project stages

6. component deployment and installation
   - Prior to this: system admin has installed and configured runtime environement
     - Installer program for CARs
   - Deploy component factories and managers
7. Runtime: component instance activation
   - Part of the application logic
   - Components are activated by the container POA

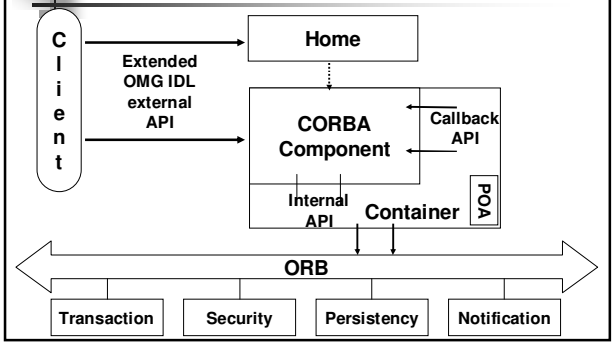
Esimerkki

```
<componentassembly id="374...2304">
<description>Assembly descr for example
</description>
<componentfiles>
<componentfile id="ShoppingChartFile">
<fileinarchive name="shoppingchar.car">
</componentfiles>
<partitioning>
<homeplacement id ="ShoppingCartHome">
<componentfileref idref="ShoppingCartFIle">
</homeplacement>
...
</partitioning>
<connections>
<connectinterface>
<usesport>
<usesidentifier>Check1</usesidentifier>
<homeplacementref idref="ShoppingChartHome">
...
```

Komponenttien suoritusaikainen ympstö

- component container model
  - Framework for component application servers
  - Mostly built on the POAs
    - Automatic activation/deactivation
    - Resource usage optimization
    - Provides simplified interfaces for corba services
    - Uses callbacks for instance management
  - Container encapsulates 1-N POAs
  - References exported thourhg component home finder, naming or trading

The Container Architecture



CCM Container model

- CORBA Usage Model
  - Describes the interaction between the container, the POA and the CORBA services, ie reference persistence and servant to ObjectID mapping
  - Types: stateless, conversational, durable
- Component categories
  - Combination of internal and external APIs

usage model	container API	comp.category	object ref	servant/OID
stateless	session	service	transient	1:N
conversational	session	session	transient	1:1
durable	entity	process	persistent	1:1
durable	entity	entity	persistent	1:1

CCM Container model

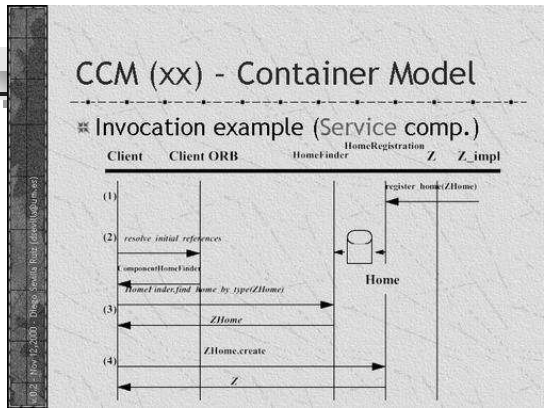
- Components define their runtime requirements through (in the deployment descriptor)
  - Usage model
  - Component category
  - Activation and servant lifetime management
  - Transaction policies
  - Security policies
  - Events
  - Persistence
  - Compoent level (basic-ejb-compat, extended)

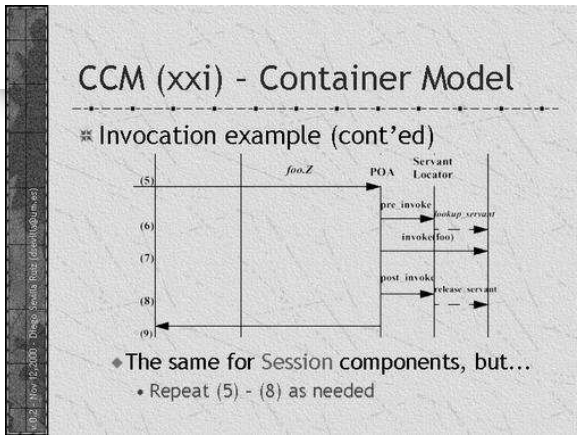
CCM container model

- component activation and servant lifetime management
  - Each container has a POA and servantLocator
  - Policies
    - Method: activate/passivate by method-basis
    - Transaction: lifetime tied to a transaction
    - Component: component decides itsef on deactivation
    - Container: lifetime tied to container's lifetime
  - Depends also on component category

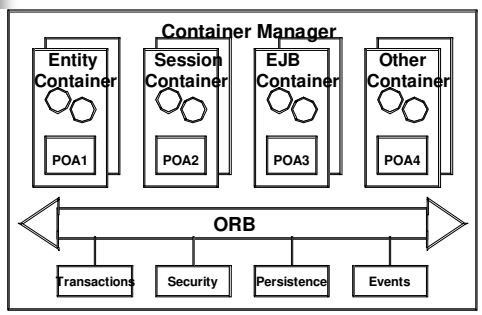
characteristics	property (service)
internal interface	session context (basic) or Session2Context (extended)
callback interface	session component
usage model	stateless
extenral API type	keyless
client design pattern	factory
servat lifetime mgmt	method (only)

characteristics	property (entity)
internal interface	entitycontext(basic) or entity2context(extended)
callback interface	EntityComponent
usage model	durable
extenral API type	keyfull
client design pattern	factory or finder
servat lifetime mgmt	any





The Container Server Architecture



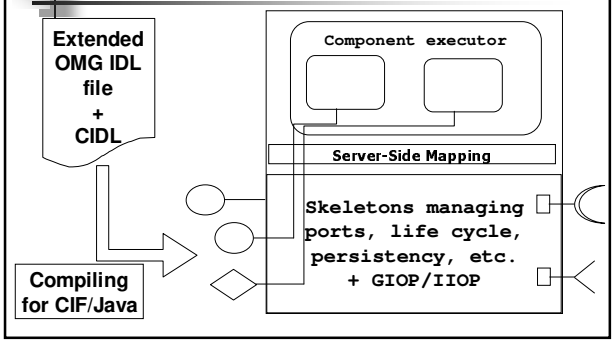
The Client Programming Model

- Component-aware and -unaware clients
- Clients see two design patterns
  - Factory – Client finds a home and uses it to create a new component instance
  - Finder - Client searches an existing component instance through Name Service, Trader Service, or home finder operations
- Optionally demarcation of transactions
- Could establish initial security credentials
- Invokes operations on component instances
  - Those defined by the client-side mapping

Cmponent Implementation Framework

- CIF defines a programming model for constructing component implementations
  - How components should be implemented
  - Generates executors: implementation of behavioural elements (homes, containers, ...)
- Facilitates component implementation
  - "only" business logic should be implemented
    - Not activation, identify, port management and introspection
  - -> Local server-side OMG IDL mapping
    - Interactions between implementations and containers
- Manages segmentation and persistency
  - -> Component Implementation Definition Language

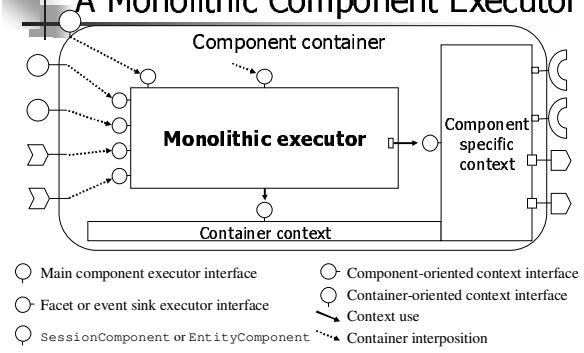
Component Implementation Framework to Component Skeleton Generation



Component Implementation Definition Language CIDL

- describes component composition
  - Aggregate artifacts required to implement a component and its home
- Manages component persistent state
  - Persistent state definition language PSDL
  - Links storage types to segmented executors
- Generates executor skeletons providing
  - Segmentation of component executors
  - Default implementations of callback operations
  - Component's state persistency

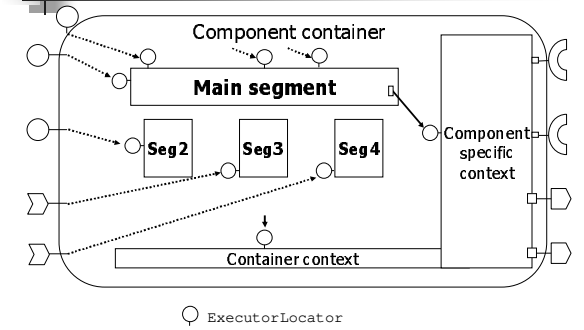
A Monolithic Component Executor



CIF

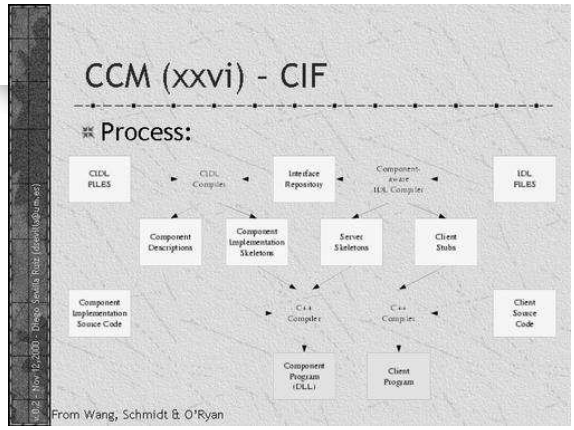
- implementations can be segmented
  - Segments are physical partitions of implementations
  - Can define independent state and can be independently activated
  - Help in managing, partitioning and sharing a high number of facet implementations
  - Only in process and entity categories

A Segmented Component Executor



CCM (xxvi) - CIF

Process:



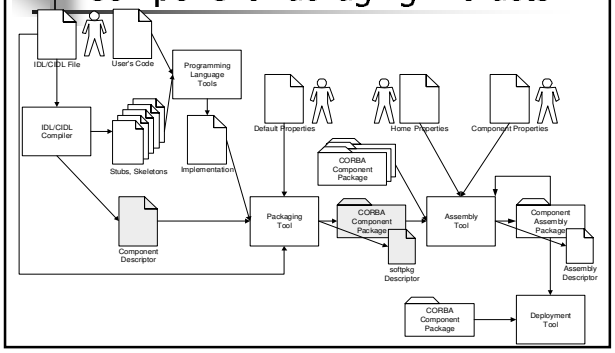
Packaging and Deployment

- Packaging and Deployment of Components
  - Components are packaged into a self-descriptive package
  - Packages can be assembled
  - Assemblies can be deployed
- Helped by XML descriptors
- Packaging and Deployment model Allows interoperability between deployment tools and containers

CCM Applications Deployment

- It is necessary for an application to
  - List component instances
  - Define logical location and partitioning
  - Specify connections between components
- It is necessary for a component to
  - Specify its elements
    - interfaces, implementations
  - Describe system requirements
    - OS, ORB, JVM, library releases, ...
  - Specify its initial configuration
- It is necessary for a connection to
  - Associate related component ports

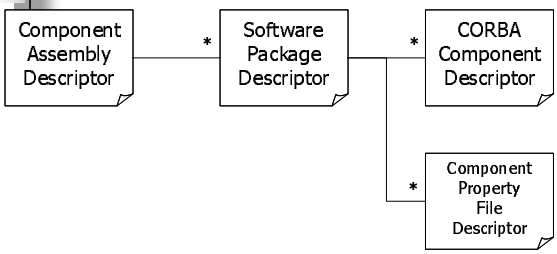
Component Packaging Artifacts



XML Descriptors Overview

- Software Package Descriptor (.csd)
  - Describes contents of a component software package
  - Lists one or more implementation(s)
- CORBA Component Descriptor (.ccd)
  - Technical information mainly generated from CIDL
  - Some container managed policies filled by user
- Component Assembly Descriptor (.cad)
  - Describes initial virtual configuration
    - homes, component instances, and connections
- Component Property File Descriptor (.cpf)
  - name/value pairs to configure attributes

Relationship Between CCM XML Descriptors



Component Assembly Package

- Archive (ZIP file) containing
  - One or more component packages, either
    - Including a package's contents
    - Including the original package
    - Referencing the package by URL
  - Property File Descriptors defining initial attribute values
  - Component Assembly Descriptor (.cad)
    - Defines home instances to be created
    - Defines component instances to be created
    - Defines connections between ports to be made
- Self-contained and self-descriptive unit
- For automatic and easy "one step" deployment
- No programming language experience necessary

Component Assembly Descriptor (.cad)

- References one or more Component Software Descriptors
- Defines home instances and their collocation and cardinality constraints
- Defines components to be instantiated
- Defines that homes, components or ports are to be registered in the ComponentHomeFinder, Naming or Trading Service
- Defines connections to be made between component ports, e.g. receptacles to facets and event sinks to event sources

Software Package Descriptor (.csd)

- Descriptive general elements
  - title, description, author, company, webpage, license
- Link to OMG IDL file
- Link to default property file
- Implementation(s)
  - Information about Implementation
    - Operating System, processor, language, compiler, ORB
    - Dependencies on other libraries and deployment requirements
    - Customized property and CORBA component descriptor
  - Link to implementation file
    - Shared library, Java class, executable
  - Entry point

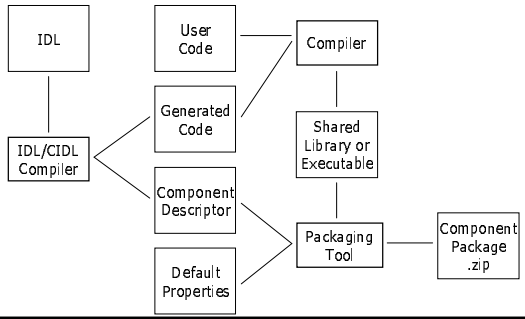
CORBA Component Descriptor (.ccd)

- Structural information generated by CIDL
  - Component / home types and features
  - Ports and supported interfaces
  - Component category and segments
- Container policies filled by the packager
  - Threading
  - Servant lifetime
  - Transactions
  - Security
  - Events
  - Persistence
  - Extended POA policies
- Link to component and home property files

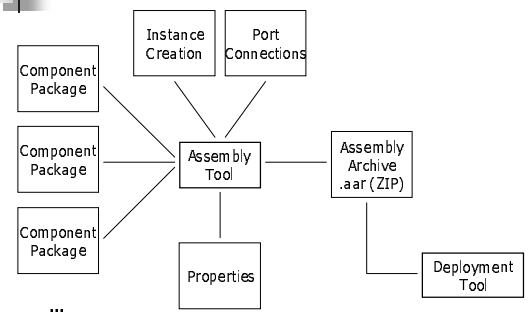
Property File Descriptor (.cpf)

- Used to set home and component properties
  - However, it could be used for anything
- Contains zero or more name/value pairs to configure attributes
- Referenced by…
  - Software Package Descriptors to define default values for component attributes
  - CORBA Component Descriptors to define default values for component or home attributes
  - Assembly Descriptors to configure initial values for home or component instances

Component Packaging



Component Assembly



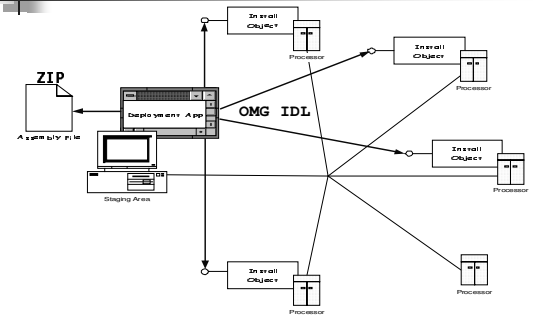
Deployment

- An Assembly Archive is deployed by a deployment tool
- The deployment tool might interact with the user to assign homes and components to hosts and processes
- The deployment application interacts with installation objects on each host

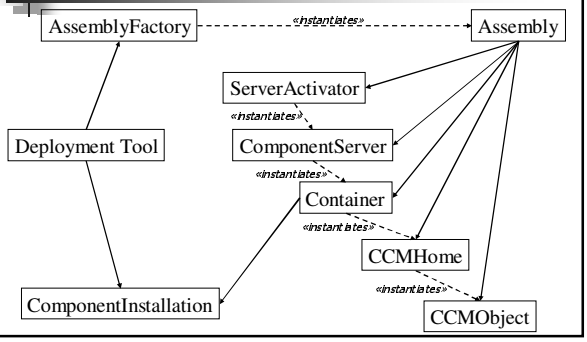
Deployment Objects

- `ComponentInstallation`
  - Singleton, installs component implementations
- `AssemblyFactory`
  - Singleton, creates `Assembly` objects
- `Assembly`
  - Represents an assembly instantiation
  - Coordinates the creation and destruction of component assemblies and components
- `ServerActivator`
  - Singleton by host, creates `ComponentServer` objects
- `ComponentServer`
  - Creates `Container` objects
- `Container`
  - Installs `CCMHome` objects

The Component Deployment Process



The Component Deployment Process



More Information

- CORBA 3.0: New Components Chapters
  - OMG TC Document ptc/2001-11-03
- CORBA 3 Fundamentals and Programming
  - Dr. John Siegel, published at John Wiley and Sons
- "The CCM Page", Diego Sevilla Ruiz
  - *http://www.ditec.um.es/~dsevilla/ccm/*

Kurssilukemisto

- Vinoski, S., New features for CORBA 3.
- Wang, Schmidt, O'Ryan: Overview of the CORBA Component Model

Muuta materiaalia

- CCM-spesifikaation intro
  - http://www.omg.org/cgi-bin/doc?formal/02-06-69
- Ohjelmointitutoriaaleja
  - http://www.cs.wustl.edu/~schmidt/ACE_wrappers/TAO/docs/tutorials/Quoter/
  - useimmilla toimittajilla omansa (Sun+Java+CORBA, etc)
- CORBA-sivustoja
  - http://www.cs.wustl.edu/~schmidt/corba.html
  - http://www.puder.org/corba/

Open Source CCM Implementations

- OpenCCM from LIFL & ObjectWeb
  - Java on ORBacus 4.1 & OpenORB 1.2.1
  - http://www.objectweb.org/OpenCCM/
- MicoCCM from FPX & Alcatel
  - C++ on MICO
  - http://www.fpx.de/MicoCCM/
- FreeCCM from Humboldt University
  - C++ on ORBacus 4.1
  - http://sourceforge.net/projects/cif

Commercial CCM Implementations

- EnagoCCM from IKV++/Fraunhofer FOKUS
  - C++ on MICO & ORBacus 4.1
  - ritter@fokus.gmd.de
- EJCCM from CPI Inc.
  - Java on OpenORB 1.3.x
  - http://www.ejccm.org
- K2 from ICMP
  - C++ on various ORBs
  - http://www.icmgworld.com

Komponenttimallien vertailua

Java component models

- applets – client side, downloadable lightweight component for augmenting websites display
- JavaBeans – focuses on supporting connection-oriented programming, for clients and servers
- Enterprise Java Beans, EJB – container-integrated services supporting components that request services using declarative attributes and deployment descriptors
- servlets – lightweight componetns instantiated by web server processing web pages
- application client components – uncontstrained Java application

EJB Overview

- EJB Architecture contracts
  - Client view contract between client and container
    - Client can be servlet or JSP, standalone Java application, applet, another EJB (same/different container), web services client
    - Provides development model for clients
  - Component contract between EJB component and its container
    - Runtime environment, development model

EJB Overview

- Client view contract is comprised of
  - Home interface
    - Methods for creating and locating beans
  - Remote interface
    - Business methods for clients
  - Object identity
  - Metadata interface
  - handle

EJB Overview

- component contract
  - Enables EJB method invocations from clients
  - Manages the life cycle of EJB bean instances
  - Implements home and remote interfaces
  - Provides persistence
  - Provides runtime context information
  - Manages transactions, security, exceptions, …
  - Implements callbacks

EJB Overview

- Deployment process defined
  - Deployment descriptor includes instructions for container on how to control transactions, security, lifecycle, state management, persistence, …
  - Describes structural and external dependencies of enterprise bean

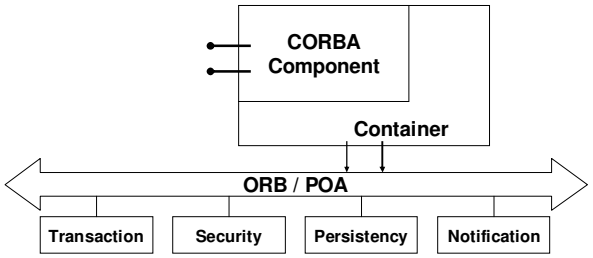
Component model comparison

- both CCM and EJB provide
  - component model with stateless and statefull sessions and entities
  - services for building scalable applications (load-balancing etc)
  - access to components via HTTP or distributed object protocol
  - Transaction support
  - Development tools

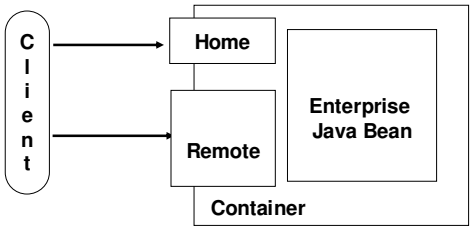
Component model comparison

- EJB interoperability is explicitly defined in the CCM specification
- CCM defines both ”container to component” and ”container to infrastructure contract”
- CCM’s container environment specification is a superset of EJB 1.1 containter environment specification

CCM Container Architecture



EJB Container Architecture



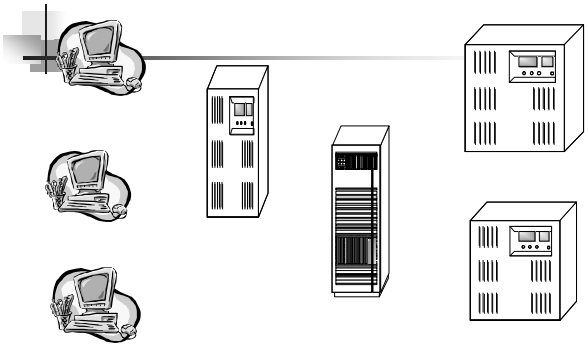
Component model comparison

- CCM
  - lookup and instantiation of objects on remote hosts
  - marchalling
  - security across mach. bound.
  - IIOP and GIOP
  - Objects handled via object reference
  - Error handling via exceptions
  - Multiple interfaces
  - Necessary services (in CACM):
    - Naming, transactions, events
- EJB
  - invocation of object methods, serialization
  - JRMP/IIOP
  - Server-side beans that process business logic,
  - Single interfaces only
  - Supports transactions
  - RMI – easy to use
  - Not language-independent
  - Better third-party market

Component container environments

- CCM container managed policies
  - Servant lifetime
  - Transaction: flat, operation level
  - Security
  - Notification/events
  - persistence
- EJB container manages
  - Component lifecycle, resource pooling, load balancing
- EJB component descriptor
  - Persistence
  - Transaction
  - security

Usability comparison

- why multi-tier architecture?
- flexibility
  - middle-tier business services accessible by many different types of clients
- scalability
  - Optimization of resource sharing in middle-tier
- Robustness
  - Interchangeable servers deliver business services

- A comparison framework