CORBA Component Model Tutorial

OMG CCM Implementers Group,
MARS PTC & Telecom DTC
OMG Meeting, Orlando, USA,
June 25th, 2002

OMG TC Document ccm/2002-06-01

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With support from the European IST COACH project
Tutorial Objectives

- A guided tour of the CORBA Component Model
  - How to design, implement, package, deploy, execute, and use CORBA components
  - Putting the CCM to work

- Illustrated with a concrete example
  - Well-known Dining Philosophers
  - Demonstrated on various OS, ORB, CCM platforms, and programming languages (C++, Java, OMG IDLscript)

Agenda

- What is the CORBA Component Model?
- Defining CORBA components
- Programming CORBA component clients
- Implementing CORBA components
- Putting CORBA containers to work
- Packaging CORBA components
- Deploying CORBA component applications
- Summary
What is the CORBA Component Model?

- From CORBA 2.x to the CCM
- Comparison with EJB, COM, and .NET
- CCM Technologies
- Typical Use Case

Why Software Components?

- Time to market
  - Improved application productivity
  - Reduced complexity
  - Reuse of existing code

- Programming by assembly (manufacturing) rather than development (engineering)
  - Reduced skills requirements
  - Focus expertise on domain problems
  - Improving software quality

- Key benefit with client side & server side development
From CORBA 2 . . .

- A distributed object-oriented model
  - Heterogeneity: OMG Interface Definition Language (OMG IDL)
  - Portability: Standardized language mappings
  - Interoperability: GIOP / IIOP
  - Various invocation models: SII, DII, and AMI
  - Middleware: ORB, POA, etc.
    - minimum, real-time, and fault-tolerance profiles

- No standard packaging and deployment facilities !!!

- Explicit programming of non functional properties !!!
  - lifecycle, (de)activation, naming, trading, notification, persistence, transactions, security, real-time, fault-tolerance, ...

- No vision of software architecture

... to the CORBA Component Model

- A distributed component-oriented model
  - An architecture for defining components and their interactions
    - From client-side (GUI) to server-side (business) components
  - A packaging technology for deploying binary multi-lingual executables
  - A container framework for injecting lifecycle, (de)activation, security, transactions, persistence, and events
  - Interoperability with Enterprise Java Beans (EJB)

- The Industry’s First Multi-Language Component Standard
  - Multi-languages, multi-OSs, multi-ORBs, multi-vendors, etc.
  - Versus the Java-centric EJB component model
  - Versus the MS-centric .NET component model
CCM Compared to EJB, COM and .NET

- Like SUN Microsystems’s Enterprise Java Beans (EJB)
  - CORBA components created and managed by homes
  - Run in containers managing system services transparently
  - Hosted by application component servers

- Like Microsoft’s Component Object Model (COM)
  - Have several input and output interfaces
    - Both synchronous operations and asynchronous events
  - Navigation and introspection capabilities

- Like Microsoft’s .NET Framework
  - Could be written in different programming languages
  - Could be packaged in order to be distributed

But with CCM

- A CCM application is “really’’ distributed
  - Could be deployed and run on several distributed nodes simultaneously

- A CORBA component could be segmented into several classes
What is the CCM Specification?

- Abstract Component Model
  - Extensions to IDL and the object model

- Component Implementation Framework
  - Component Implementation Definition Language (CIDL)

- Component Container Programming Model
  - Component implementer and client view
  - Integration with Security, Persistence, Transactions, and Events

What is the CCM Specification?

- Packaging and deployment facilities

- Interoperability with EJB 1.1

- Component Metadata & Metamodel
  - Interface Repository and MOF extensions
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

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CCM User Roles

- Component designers
- Component clients
- Composition designers
  (~ component implementation designers)
- Component implementers
- Component packagers
- Component deployers
- Component end-users
**Component Designers**

- Define component and home types via OMG IDL 3.0 extensions

- Output
  - OMG IDL 3.0 files
  - Client-side OMG IDL mapping
  - Client-side stubs
  - Interface Repository entries

**Component Clients**

- CCM designed for CORBA-2 compliance
  - Component clients could run “legacy” ORBs

- View components and homes via the client-side OMG IDL mapping

- Use client-side stubs

- Could navigate and introspect components via the generic `CCMObject` and `CCMHome` interfaces
Composition Designers

- Specify platform and language independent features required to facilitate code generation
  - Component Implementation Definition Language (CIDL)
  - Persistence State Definition Language (PSDL)

- Output
  - Local server-side OMG IDL mapping
  - Component skeletons
  - Component metadata as XML descriptors

Component Implementers

- Implement business logic operations
  - Defined by local server-side OMG IDL interfaces
  - Could inherit from generated CIDL skeletons
  - Could implement local container callback interfaces
  - Could invoke local container interfaces

- Output
  - Component binaries
  - XML component descriptors enriched
From CORBA Component Design to Packaging

Component Designer

OMG IDL, PSDL & CIDL

Local server-side OMG IDL

Component Implementer

Component Executor Code

Programming Language Tools

Stubs, Skeletons

Component Client

Client-side OMG IDL

Component Packager

OMG IDL PSDL & CIDL Compiler

XML Component Descriptor

Binary Component

Component Packagers

- Produce component packages containing
  - Component binaries
  - Software & component XML descriptors
  - Default property XML descriptors
  - Probably done using an interactive visual tool

- Output - component archive file (zip file)

- If “no further assembly required”, skip to deployment
Component Assemblers

- Produce assembly packages containing
  - Customized component packages
  - Assembly XML descriptors
    - Component instances and interconnections
    - Logical distribution partitioning
  - Probably done using an interactive visual tool

- Output - component assembly archive file

- Process may be iterated further

Component Deployers

- Deployment/installation tool takes deployer input + component and assembly archives

- Attach virtual component locations to physical nodes

- Start the deployment process
  - Installs components and assemblies to particular nodes on the network

- Output - instantiated and configured components and assemblies now available
  - CCM applications deployed in CCM containers
The CCM Big Picture

Next Tutorial Steps

- Defining CORBA component types
  - Abstract Component Model and OMG IDL 3.0 extensions
- Programming CORBA component clients
  - Client-side OMG IDL mapping
- Implementing CORBA components
  - Component Implementation Framework (CIF)
  - Local server-side OMG IDL mapping
  - Component Implementation Definition Language (CIDL)
- Putting CORBA containers to work
- Packaging CORBA components
  - Associated XML DTDs
- Deploying CORBA component applications
  - Component deployment objects and "basic" process
Defining CORBA Components

- The Abstract Component Model
- OMG IDL 3.0 Extensions
- The Dining Philosophers Example

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

Component Features

- *Attributes* = configurable properties
- *Facets* = offered operation interfaces
- *Receptacles* = required operation interfaces
- *Event sources* = produced events
- *Event sinks* = consumed events

Navigation and introspection supported
A CORBA Component

My Business Component

- Component interface
- Facets
- Event sinks
- Attributes
- Offered
- Receptacles
- Event sources
- Required

Building CCM Applications = Assembling CORBA Component Instances
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

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 \texttt{eventtype} meta-type
  - \texttt{valuetype} specialization for component events
Component Event Sources

- Named connection points for event production
  - Push a specified event type

- Two kinds: Publisher & Emitter
  - \textit{publishes} = multiple client subscribers
  - \textit{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
What is a CORBA Component Home?

- 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
- home is a new CORBA meta-type
  - Home definition is distinct from component one
  - Has an interface, and an object reference
- Could inherit from a single home type
- Could supports multiple interfaces
- Is instantiated at deployment time

A CORBA Component Home
# Component Home Features

- 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
Other OMG IDL 3.0 Extensions

- The new `import` keyword
  - Importation of OMG IDL scopes
  - To replace `#include`

- The new `typeprefix` keyword
  - To replace `#pragma prefix`

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The Dining Philosophers Example

- Kant
  - Fork
  - Thinking
  - Hungry
  - Starving
  - Eating
  - Dead

- Descartes
  - Fork
  - Thinking
  - Hungry
  - Starving
  - Eating
  - Dead

- Aristotle
  - Fork
  - Thinking
  - Hungry
  - Starving
  - Eating
  - Dead
Dining Philosophers as CORBA Components

Philosopher
name = Kant

Philosopher
name = Aristotle

Philosopher
name = Descartes

Fork

Fork

Fork

Observer

OMG IDL 3.0 for Dining Philosophers

// Importation of the Components module
// when access to OMG IDL definitions contained
// into the CCM’s Components module is required.
import Components;

module DiningPhilosophers
{
    // Sets the prefix of all these OMG IDL definitions.
    // Prefix generated Java mapping classes.
    typedefprefix DiningPhilosophers "omg.org";

    ...
}
The Fork Interface

```java
exception InUse {};
interface Fork {
    void get() raises (InUse);
    void release();
};
// The fork component.
component ForkManager {
    // The fork facet used by philosophers.
    provides Fork the_fork;
};
// Home for instantiating ForkManager components.
home ForkHome manages ForkManager {};
```

The Fork Manager Component

```java
exception InUse {};
interface Fork {
    void get() raises (InUse);
    void release();
};
// The fork component.
component ForkManager {
    // The fork facet used by philosophers.
    provides Fork the_fork;
};
// Home for instantiating ForkManager components.
home ForkHome manages ForkManager {};
```
The Fork Manager Component Facet

exception InUse {}; 
interface Fork 
{ 
    void get() raises (InUse); 
    void release(); 
}; 
// The fork component. 
component ForkManager 
{ 
    // The fork facet used by philosophers. 
    provides Fork the_fork; 
}; 
// Home for instantiating ForkManager components. 
home ForkHome manages ForkManager();

The Fork Manager Home

exception InUse {}; 
interface Fork 
{ 
    void get() raises (InUse); 
    void release(); 
}; 
// The fork component. 
component ForkManager 
{ 
    // The fork facet used by philosophers. 
    provides Fork the_fork; 
}; 
// Home for instantiating ForkManager components. 
home ForkHome manages ForkManager();
The Philosopher State Types

```java
enum PhilosopherState {
    EATING, THINKING, HUNGRY,
    STARVING, DEAD
};

eventtype StatusInfo {
    public string name;
    public PhilosopherState state;
    public unsigned long ticks_since_last_meal;
    public boolean has_left_fork;
    public boolean has_right_fork;
};
```

The Philosopher Component

```java
component Philosopher {
    attribute string name;
    // The left fork receptacle.
    uses Fork left;
    // The right fork receptacle.
    uses Fork right;
    // The status info event source.
    publishes StatusInfo info;
};

home PhilosopherHome manages Philosopher {
    factory new(in string name);
};
```
The Philosopher Component Receptacles

component Philosopher
{
    attribute string name;
    // The left fork receptacle.
    uses Fork left;
    // The right fork receptacle.
    uses Fork right;
    // The status info event source.
    publishes StatusInfo info;
};

data StatusInfo
{
    attribute String info;
};

timeout Fork left
{
    value String left;
    type String;
};

data Fork right
{
    value String right;
    type String;
};

data StatusInfo info
{
    value String info;
};

home PhilosopherHome manages Philosopher
{
    factory new (in string name);
};
The Philosopher Component Event Source

component Philosopher
{
    attribute string name;
    // The left fork receptacle.
    uses Fork left;
    // The right fork receptacle.
    uses Fork right;
    // The status info event source.
    publishes StatusInfo info;
};

home PhilosopherHome manages Philosopher {
    factory new(in string name);
};

The Philosopher Home

component Philosopher
{
    attribute string name;
    // The left fork receptacle.
    uses Fork left;
    // The right fork receptacle.
    uses Fork right;
    // The status info event source.
    publishes StatusInfo info;
};

home PhilosopherHome manages Philosopher {
    factory new(in string name);
};
The Observer Component

component Observer
{
    // The status info sink port.
    consumes StatusInfo info;
};

// Home for instantiating observers.
home ObserverHome manages Observer {};

Observer
The Observer Home

component Observer
{
    // The status info sink port.
    consumes StatusInfo info;
};

// Home for instantiating observers.
home ObserverHome manages Observer {};

Programming CORBA Component Clients

- The Client-Side OMG IDL Mapping
- The Client Programming Model
- Client Use Examples
Each OMG IDL 3.0 construction has an equivalent in terms of OMG IDL 2.

Component and home types are viewed by clients through the CCM client-side OMG IDL mapping.

Permits no change in client programming language mapping:
- Clients still use their favorite IDL-oriented tools like CORBA stub generators, etc.

Clients do NOT have to be “component-aware”:
- They just invoke interface operations.
Main Client-Side OMG IDL Mapping Rules

- A component type is mapped to an interface inheriting from `Components::CCMObject`
- Facets and event sinks are mapped to an operation for obtaining the associated reference
- Receptacles are mapped to operations for connecting, disconnecting, and getting the associated reference(s)
- Event sources are mapped to operations for subscribing and unsubscribing to produced events

Main Client-Side OMG IDL Mapping Rules

- An event type is mapped to
  - A value type inheriting from `Components::EventBase`
  - A consumer interface inheriting from `Components::EventConsumerBase`
- A home type is mapped to three interfaces
  - One for explicit operations user-defined inheriting from `Components::CCMHome`
  - One for implicit operations generated
  - One inheriting from both previous interfaces
Client-Side Mapping for ForkManager Component

component ForkManager
{
    provides Fork the_fork;
};

Is mapped to

interface ForkManager :
    ::Components::CCMObject
{
    Fork provide_the_fork();
};

Client-Side Mapping for Fork Home

home ForkHome
    manages ForkManager {};

Is mapped to

interface ForkHomeExplicit :
    ::Components::CCMHome {};
interface ForkHomeImplicit :
    ::Components::KeylessCCMHome {
    ForkManager create();
};
interface ForkHome :
    ForkHomeExplicit,
    ForkHomeImplicit {};

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Client-Side Mapping for StatusInfo Event Type

eventtype StatusInfo { . . . };

Is mapped to

valuetype StatusInfo :
    ::Components::EventBase { . . . };

interface StatusInfoConsumer :
    ::Components::EventConsumerBase {
    void push_StatusInfo(in StatusInfo the_StatusInfo);
};

Client-Side Mapping for Observer Component

component Observer {
    consumes StatusInfo info;
};

Is mapped to

interface Observer :
    ::Components::CCMObject {
    StatusInfoConsumer get_consumer_info();
};
Client-Side Mapping for Observer Home

```c++
home ObserverHome
    manages Observer {};
    Is mapped to

interface ObserverHomeExplicit :
    ::Components::CCMHome {};
interface ObserverHomeImplicit :
    ::Components::KeylessCCMHome {
    Observer create();
};

interface ObserverHome :
    ObserverHomeExplicit,
    ObserverHomeImplicit {};
```

Client-Side Mapping for Philosopher Component

```c++
component Philosopher {
    attribute string name;
    uses Fork left;
    uses Fork right;
    publishes StatusInfo info;
};
    Is mapped to

interface Philosopher :
    ::Components::CCMObject {
    attribute string name;
    .../...
```
### Client-Side Mapping for Philosopher Component

```plaintext
void connect_left(in Fork cnx) raises(...);
Fork disconnect_left() raises(...);
Fork get_connection_left();

void connect_right(in Fork cnx) raises (...);
Fork disconnect_right() raises (...);
Fork get_connection_right();

Components::Cookie subscribe_info(
    in StatusInfoConsumer consumer) raises(...);
StatusInfoConsumer unsubscribe_info(
    in Components::Cookie ck) raises(...);
```

---

### Client-Side Mapping for Philosopher Home

```plaintext
home PhilosopherHome
manages Philosopher {
    factory new(in string name);
}

Is mapped to

interface PhilosopherHomeExplicit : ::Components::CCMHome {
    Philosopher new(in string name);
};

interface PhilosopherHomeImplicit : ::Components::KeylessCCMHome {
    Philosopher create();
};

interface PhilosopherHome : PhilosopherHomeExplicit,
                           PhilosopherHomeImplicit {};
```
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

CORBA Component Home Finder

- A brokerage of homes to clients
  - Home implementations register with home finder
  - Clients request homes from home finder

- Home finder makes determination of what is the “best” home for a client, based on the client’s request and any available environmental or configuration data

- A home finder constitutes a domain of home/container/implementaion visibility
Using CORBA Components with OMG IDLscript

```plaintext
# Obtains the component home finder.
chf = CORBA.ORB.resolve_initial_references
    ("ComponentHomeFinder")

# Finds a home by its home type.
forkHome = chf.find_home_by_type(ForkHome.id())

# Creates a fork manager component.
forkManager = forkHome.create()

# Obtains the fork facet.
fork = forkManager.provide_the_fork()

# Uses the fork facet.
fork.get()
    ........
fork.release()
```

Connecting CORBA Components with OMG IDLscript

```plaintext
# Obtaining CORBA components to be interconnected.
kant = Philosopher("corbaname:...")
observer = Observer("corbaname:...")

# Connects kant and observer.
ck = kant.subscribe_info(observer.get_consumer_info())
        ........
# Disconnects kant and observer.
kant.unsubscribe_info(ck)
```
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

Implementing CORBA Components

- Component Implementation Framework (CIF)
- Local Server-Side OMG IDL Mapping
Component Implementation Framework

- CIF defines a programming model for constructing component implementations
  - How components should be implemented

- 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

OMG IDL 3.0
OMG CIDL

Server-Side Mapping
Skeletons managing ports, life cycle, persistency, etc. + GIOP/IIOP

Component executor

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Executors and Home Executors

- Programming artifacts implementing a component’s or component home’s behavior
  - Local CORBA objects with interfaces defined by the local server-side OMG IDL mapping

- Component executors could be monolithic
  - All component attributes, supported interfaces, facet operations, and event sinks implemented by one class

- Component executors could also be segmented
  - Component features split into several classes
  - Implements ExecutorLocator interface

- Home executors are always monolithic

Executors Are Hosted by Container

- Container intercepts invocations on executors for managing activation, security, transactions, persistency, and so

- Component executors must implement a local callback lifecycle interface used by the container
  - SessionComponent for transient components
  - EntityComponent for persistent components

- Component executors could interact with their containers and connected components through a local context interface
A Monolithic Component Executor

A Segmented Component Executor
Monolithic versus Segmented Approach

- Monolithic approach
  - Poor life cycle control of facet executors
  - But simplicity of implementation
  - Should be used for hand-coded implementation

- Segmented approach
  - Fine grain life cycle control of facet executors
  - But complexity of implementation
  - Should be used for CIDL based implementation

The Server-Side OMG IDL Mapping
Main Server-Side OMG IDL Mapping Rules

- A component type is mapped to three local interfaces
  - The main component executor interface
    - Inheriting from `Components::EnterpriseComponent`
  - The monolithic component executor interface
    - Operations to obtain facet executors and receive events
  - The component specific context interface
    - Operations to access component receptacles and event sources

- A home type is mapped to three local interfaces
  - One for explicit operations user-defined
    - Inheriting from `Components::HomeExecutorBase`
  - One for implicit operations generated
  - One inheriting from both previous interfaces

Implementing CORBA Components

- Dining Philosophers Example
- In Java
- In C++
Implementation Rules

- General
  - Local server-side equivalent IDL interfaces are implemented according to the used language mapping
  - Choice between monolithic and locator implementation
  - entry point = factory for each home type

- Java specific
  - Executor classes inherit from `org.omg.CORBA.LocalObject`
  - Entry points = static methods of home executor classes

- C++ specific
  - Entry points = extern "C" functions that can be found in shared library

Local Server-Side Equivalent IDL for ForkManager Component

- Executor
  - Depends on used strategy
  - SessionComponent
  - CCM_ForkManager_Context
  - SessionContext

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Local Server-Side Equivalent IDL for ForkManager Component

// Executor interface for the the_fork facet.
local interface CCM_Fork : Fork
{
    // No declarations added.
};

// Component-specific context interface.
local interface CCM_ForkManager_Context :
    // Container context interface.
    Components::CCMContext
{
    // Empty because no receptacles or event sources.
};

Fork Facet Implementation in Java: Just Business Operations

public class ForkImpl
    extends org.omg.CORBA.LocalObject
implements CCM_Fork
{
    private boolean available_ = true;

    public void get() throws InUse {
        // Check if there is no current philosopher.
        if (!available_) throw new InUse();
        available_ = false;
    }

    public void release() {
        available_ = true;
    }
}
Fork Facet Implementation in C++:
Just Business Operations

class Fork_impl : virtual public CCM_Fork
{
  bool available_
public:
  Fork_impl() { available_ = true; }
  void get() {
    if (!available_) throw InUse();
    available_ = false;
  }
  void release() {
    available_ = true;
  }
};

Local Server-Side Equivalent IDL
for ForkManager Component

Monolithic executor
Local Server-Side Equivalent IDL for ForkManager Component

```idl
// Monolithic executor interface.
local interface CCM_ForkManager :
   // Executors base interface.
   ::Components::EnterpriseComponent
{
   // Requested by container.
   CCM_Fork get_the_fork();

   // No attributes.
};
```

ForkManager Executor Monolithic in Java

```java
public class MonolithicForkManagerImpl
   extends ForkImpl       // Fork implementation.
   implements CCM_ForkManager, // Is monolithic.
      // Is a session executor
   org.omg.Components.SessionComponent
{
   // Required by CCM_ForkManager interface.
   public CCM_Fork get_the_fork() {
      // Itself as it extends ForkImpl.
      return this;
   }

   // Also SessionComponent operations.
}
```
### ForkManager Executor

**Monolithic in C++**

```cpp
// IDL implied by the IDL to C++ mapping.
local interface MyFork :
    CCM_ForkManager, CCM_Fork,
    Components::SessionComponent
{};

// C++
class ForkManager_impl :
    virtual public MyFork,
    virtual public Fork_impl
{
    public:
        // Required by CCM_ForkManager interface.
        CCM_Fork_ptr get_the_fork() {
            return CCM_Fork::_duplicate(this);
        }
        // Also SessionComponent operations.
};
```

---

### Local Server-Side Equivalent IDL for ForkManager Component

```
Main segment

ForkManager

CCM_ForkManager_Executor ExecutorLocator SessionComponent

Fork

CCM_Fork

Seg2

SessionContext

CCM_ForkManager_Context
```
Local Server-Side Equivalent IDL for ForkManager Component

// Main component executor interface.
local interface CCM_ForkManager_Executor:
    // Executors base interface.
    ::Components::EnterpriseComponent
{
    // Empty because no attributes.
};

Segmented ForkManager Executor With Two Segments in Java

public class MainSegForkManagerImpl
extends org.omg.CORBA.LocalObject
implements CCM_ForkManager_Executor,
    org.omg.Components.SessionComponent
{
    // SessionComponent to implement.
}
Segmented ForkManager Executor
With Two Segments in C++

class MainSegForkManager_impl :
    virtual public CCM_ForkManager_Executor,
    virtual public Components::SessionComponent
{
    // SessionComponent to implement.
};

Local Server-Side Equivalent IDL
for ForkManager Component

// Container callback implemented by the main segment.
local interface ExecutorLocator :
    ::Components::EnterpriseComponent
{
    // Obtain the specified port executor segment.
    Object obtain_executor(in string name)
        raises(CCMException);
    // Release a port executor.
    void release_executor(in Object obj)
        raises(CCMException);
    // Notify configuration completion.
    void configuration_complete() raises(CCMException);
};
Segmented ForkManager Executor Locator in Java

```java
public class ForkManagerExecutorLocatorImpl extends org.omg.CORBA.LocalObject implements ExecutorLocator {
    private CCM_Fork fork_;  
    private CCM_ForkManager_Executor mgr_;  

    public ForkManagerExecutorLocatorImpl() { 
        fork_ = new ForkImpl();  
        mgr_ = new MainSegForkManagerImpl();  
    }
}
```

Segmented ForkManager Executor Locator in Java (contd)

```java
public org.omg.CORBA.Object obtain_executor(String name) 
    throws org.omg.Components.CCMException { 
    if (name.equals("ForkManager")) return mgr_;  
    if (name.equals("the_fork")) return fork_;  
    throw new org.omg.Components.CCMException();  
}
public void release_executor(org.omg.CORBA.Object obj) 
    throws org.omg.Components.CCMException { 
    // Nothing to do.  
}
public void configuration_complete() 
    throws org.omg.Components.CCMException { 
    // Nothing to do. 
}
```
Segmented ForkManager Executor Locator in C++

```c++
class ForkManagerExecutorLocator_impl :
    virtual public ExecutorLocator
{
    CCM_Fork_var fork_; 
    CCM_ForkManager_Executor_var mgr_; 

    public:
    ForkManagerExecutorLocator_impl() {
        fork_ = new Fork_impl;
        mgr_ = new MainSegForkManager_impl;
    }

    CORBA::Object_ptr obtain_executor(const char* name) {
        if (strcmp(name, "ForkManager") == 0)
            return CORBA::Object::_duplicate(mgr_);
        else if (strcmp(name, "the_fork") == 0)
            return CORBA::Object::_duplicate(fork_);
        throw Components::CCMException();
    }

    void release_executor(CORBA::Object_ptr obj) {
        // Nothing to do.
    }

    void configuration_complete() {
        // Nothing to do.
    }
};
```
Local Server-Side Equivalent IDL for ForkHome Home

local interface CCM_ForkHomeExplicit :
   // Base home executors interface
   ::Components::HomeExecutorBase
   {
      // Empty as no user-defined home operations.
   };

local interface CCM_ForkHomeImplicit
   {
      ::Components::EnterpriseComponent create()
      raises(::Components::CreateFailure);
   };

local interface CCM_ForkHome :
   CCM_ForkHomeExplicit,
   CCM_ForkHomeImplicit
   {};

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ForkHome Executor in Java

```java
public class ForkHomeImpl extends org.omg.CORBA.LocalObject implements CCM_ForkHome {
    // Required by CCM_ForkHome interface.
    public org.omg.Components.EnterpriseComponent create() {
        // Return locator or monolithic instance.
        return new ...ForkManager...Impl();
    }

    // Called at deployment time.
    public static org.omg.Components.HomeExecutorBase create_home() {
        return new ForkHomeImpl();
    }
}
```

ForkHome Executor in C++

```cpp
class ForkHome_impl : virtual public CCM_ForkHome {
    // Required by CCM_ForkHome interface.
    Components::EnterpriseComponent_ptr create() {
        // Return locator or monolithic instance.
        return new ...ForkManager..._impl;
    }
};

extern "C" {
    Components::HomeExecutorBase_ptr create_ForkHome() {
        return new ForkHome_impl;
    }
}
```
Local Server-Side Equivalent IDL for Observer Component

// Container callback implemented by the component
local interface SessionComponent :
    ::Components::EnterpriseComponent
{
    // The context is fixed by the container.
    void set_session_context(SessionContext ctx) raises(CCMException);
    // Called when component is activated.
    void ccm_activate() raises(CCMException);
    // Called when component is deactivated.
    void ccm_passivate() raises(CCMException);
    // Called when component is removed.
    void ccm_remove() raises(CCMException);
};
Local Server-Side Equivalent IDL for Observer Component

// Info event sink executor interface.
local interface CCM_StatusInfoConsumer {
    void push(in StatusInfo ev);
};

// Main component executor interface.
local interface CCM_Observer_Executor :
    ::Components::EnterpriseComponent {
};

// Monolithic executor interface.
local interface CCM_Observer :
    CCM_Observer_Executor {
        void push_info(in StatusInfo ev);
    };

// Component-specific context interface.
local interface CCM_Observer_Context :
    ::Components::CCMContext {
};

Observer Executor
Monolithic in Java

public class ObserverImpl
    extends org.omg.CORBA.LocalObject
    implements CCM_Observer,
                org.omg.Components.SessionComponent
{
    // Required for monolithic interface.
    public void push_info(StatusInfo event) {
        ... update GUI ...
    }
}
Observer Executor
Monolithic in Java (contd)

// Required for SessionComponent interface.
public void set_session_context(SessionContext ctx)
    throws CCMException
{
    ...
}

public void ccm_activate() throws CCMException
{
    ... display GUI ...
}

public void ccm_passivate() throws CCMException
{
    ... hide GUI ...
}

public void ccm_remove() throws CCMException
{
    ... free GUI ...
}

Observer Executor
Monolithic in C++

// IDL implied by the IDL to C++ mapping.
local interface MyObserver :
    CCM_Observer,
    Components::SessionComponent {};

class Observer_impl :
    virtual public MyObserver
{
    public:
        // Required for monolithic interface.
        void push_info(StatusInfo * event) {
            ... update GUI ...
        }
    }

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Observer Executor
Monolithic in C++ (contd)

```cpp
// Required for SessionComponent interface.
void set_session_context(
    Components::SessionContext_ptr ctx)
{
    ...
}

void ccm_activate()
{
    ... display GUI ...
}

void ccm_passivate()
{
    ... hide GUI ...
}

void ccm_remove()
{
    ... free GUI ...
}
```

Local Server-Side Equivalent IDL for ObserverHome Home

Observer Home

Observer

CCM_ObserverHome

Monolithic executor
Local Server-Side Equivalent IDL for ObserverHome Home

```plaintext
local interface CCM_ObserverHomeExplicit :
    ::Components::HomeExecutorBase
{};

local interface CCM_ObserverHomeImplicit
{
    ::Components::EnterpriseComponent create()
    raises(::Components::CreateFailure);
};

local interface CCM_ObserverHome :
    CCM_ObserverHomeExplicit,
    CCM_ObserverHomeImplicit
{};
```

ObserverHome Executor In Java

```java
public class ObserverHomeImpl
    extends org.omg.CORBA.LocalObject
    implements CCM_ObserverHome
{
    // Required by CCM_ObserverHome interface.
    public org.omg.Components.EnterpriseComponent create()
    { return new ObserverImpl(); }

    // Called at deployment time.
    public static org.omg.Components.HomeExecutorBase create_home()
    { return new ObserverHomeImpl(); }
}
```
ObserverHome Executor
In C++

class ObserverHome_impl :
  virtual public CCM_ObserverHome
{
  Components::EnterpriseComponent_ptr create () {
    return new Observer_impl;
  }
};

extern "C" {
  Components::HomeExecutorBase_ptr create_ObserverHome () {
    return new ObserverHome_impl;
  }
}

Local Server-Side Equivalent IDL
for Philosopher Component

Monolithic Executor
Local Server-Side Equivalent IDL for Philosopher Component

// Main component executor interface.
local interface CCM_Philosopher_Executor :
   ::Components::EnterpriseComponent
{
    attribute string name;
};

// Monolithic executor interface.
local interface CCM_Philosopher :
   CCM_Philosopher_Executor
{
};

Local Server-Side Equivalent IDL for Philosopher Context

local interface CCM_Philosopher_Context :
   ::Components::CCMContext
{
   // To obtain the connected left fork.
   Fork get_connection_left();
   // To obtain the connected right fork.
   Fork get_connection_right();
   // To push an info event to all subscribers.
   void push_info(in StatusInfo ev);
};
Philosopher Executor
Monolithic in Java

```java
public class PhilosopherImpl
    extends org.omg.CORBA.LocalObject
    implements CCM_Philosopher,
               org.omg.CORBA.SessionComponent,
               java.lang.Runnable
{
    // Transient state.
    private String name_; // Constructor.
    public PhilosopherImpl(String n) { name_ = n; }

    // Required by the CCM_Philosopher Executor interface.
    public void name(String n) { name_ = n; }
    public String name() { return name_; }
}
```

Philosopher Executor
Monolithic in Java (2)

```java
// The philosopher behavior state machine.
private java.lang.Thread behavior_; // The philosopher CCM context.
private CCM_Philosopher_Context the_context_;

public void set_session_context(SessionContext ctx)
    throws CCMException
{ the_context_ = (CCM_Philosopher_Context)ctx; }

public void ccm_activate() throws CCMException
{ behavior_ = new Thread(this); behavior_.start(); }

public void ccm_passivate() throws CCMException
{ behavior_.stop(); }

public void ccm_remove() throws CCMException {...}
```
Philosopher Executor
Monolithic in Java (3)

```java
public void run() {
    // The state machine.
    ...
    // Pushes the current status to all observers.
    the_context_.push_info(...);
    ...
    // Takes the left fork.
    the_context_.get_connection_left().get();
    ...
    // Takes the right fork.
    the_context_.get_connection_right().get();
    ...
    // Releases the left fork.
    the_context_.get_connection_left().release();
    ...
    // Releases the right fork.
    the_context_.get_connection_right().release();
    ...
}
```

Philosopher Executor
Monolithic in C++

```cpp
// IDL implied by the IDL to C++ mapping.
live interface MyPhilosopher :
   CCM_Philosopher,
   Components::SessionComponent {};

// C++
class Philosopher_impl : virtual public MyPhilosopher
{
    CCM_Philosopher_Context_var ctx_; 
    CORBA::String_var name_; 
    public:
    // Constructor.
    Philosopher_impl(const char* nn) { name_ = nn; }
    void name(const char* nn) { name_ = nn; }
    char* name() { return CORBA::string_dup(name_); }
}
```
Philosopher Executor
Monolithic in C++ (2)

```cpp
void set_session_context(
    Components::SessionContext_ptr ctx)
{ ctx_ = CCM_Philosopher_Context::_narrow (ctx); }

void ccm_activate()
{ ... start philosopher thread ... }

void ccm_passivate()
{ ... stop philosopher thread ... }

void ccm_remove()
{ ... }
```

Philosopher Executor
Monolithic in C++ (3)

```cpp
void timer() { // The state machine.
    ...
    ctx_->push_info(...);
    ...
    ctx_->get_connection_left()->get();
    ...
    ctx_->get_connection_right()->get();
    ...
    ctx_->get_connection_left()->release();
    ...
    ctx_->get_connection_right()->release();
    ...
}
```
Local Server-Side Equivalent IDL for PhilosopherHome Home

local interface CCM_PhilosopherHomeExplicit :
::Components::HomeExecutorBase
{
   ::Components::EnterpriseComponent
   new(in string name);
};

local interface CCM_PhilosopherHomeImplicit
{
   ::Components::EnterpriseComponent create()
   raises(Components::CreateFailure);
};

local interface CCM_PhilosopherHome :
   CCM_PhilosopherHomeExplicit,
   CCM_PhilosopherHomeImplicit {};
Philosopher Home Executor
in Java

```java
public class PhilosopherHomeImpl
extends org.omg.CORBA.LocalObject
implements CCM_PhilosopherHome
{
    // Required by CCM_PhilosopherHomeImplicit interface.
    public org.omg.Components.EnterpriseComponent
    create() { return new PhilosopherImpl(""); }

    // Required by CCM_PhilosopherHomeExplicit interface.
    public org.omg.Components.EnterpriseComponent
    _new(String name) {
        return new PhilosopherImpl(name);
    }

    // Called at deployment time.
    public static org.omg.Components.HomeExecutorBase
    create_home() { return new PhilosopherHomeImpl(); }
}
```

Philosopher Home Executor
In C++

```cpp
class PhilosopherHome_impl :
    virtual public CCM_PhilosopherHome
{
    Components::EnterpriseComponent_ptr
    create()
    { return new Philosopher_impl("unnamed"); }

    Components::EnterpriseComponent_ptr
    _cxx_new(const char * name)
    { return new Philosopher_impl(name); }
};
extern "C"
{
    Components::HomeExecutorBase_ptr
    create_PhilosopherHome()
    { return new PhilosopherHome_impl(); }
}
```
Implementing CORBA Components with CIDL

Component Implementation Definition Language (CIDL)

- Describes component composition
  - Aggregate entity which describes all the artifacts required to implement a component and its home

- Manages component persistence state
  - With OMG 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
Basic CIDL Composition Features

- Component lifecycle category
  - Service, session, process, entity

- Name of home executor skeleton to generate

- Component home type implemented
  - Implicitly the component type implemented

- Name of main executor skeleton to generate

CIDL Composition for Observer Component

```cpp
#include <philoi.idl>
// or import DiningPhilosophers;

composition service ObserverComposition
{
    home executor ObserverHomeServiceImpl
    {
        implements DiningPhilosophers::ObserverHome;
        manages ObserverServiceImpl;
    }
};
```
OMG CIDL Compilation Process

- Component Designer
- OMG IDL 3.0
- Local Server-side OMG IDL
- OMG IDL 3.0 Compiler
- Component Skeleton

- Composition Designer
- OMG CIDL
- OMG CIDL Compiler
- Component Executor
- Component Executor Skeleton

- Component Implementer

Advanced CIDL Composition Features

- Associated abstract storage home type for component persistency
- Multiple executor segments
  - Implement a subset of the component’s facets
  - Could have an associated abstract storage home
- Component features stored automatically
  - Attribute values, references connected to receptacles and event sources are delegated to storage
- Proxy homes
### CIDL Composition for ForkManager Component

```c++
#include <philo.idl>
// or import DiningPhilosophers;

composition session ForkManagerComposition
{
    home executor ForkHomeSessionImpl
    {
        implements DiningPhilosophers::ForkHome;
        manages ForkManagerSessionImpl
        {
            segment Seg
            {
                provides facet the_fork;
            }
        }
    }
};
```

### OMG PSDL for Dining Philosophers

```c++
#include <philo.idl>

abstract storagetype Person
{
    state string name;
    state DiningPhilosophers::PhilosopherState philosopher_state;
    ...
};

abstract storagehome PersonHome of Person
{
    factory create();
};

storagetype PersonBase implements Person();
storagehome PersonHomeBase of PersonBase
    implements PersonHome();
```
### CIDL Composition for Dining Philosophers

```
#include <philo.psdl>

composition process PhilosopherComposition
{
    home executor PhilosopherHomeProcessImpl
    {
        implements
            DiningPhilosophers::PhilosopherHome;
        bindsTo PersonHome;
        manages PhilosopherProcessImpl;
    };
};
```
Relationship Between Artifacts

component C  {};
home H manages C
{};

home executor HE
implements H;
bindsTo SH;
manages E;
}

abstract storagetype ST{);
abstract storagehome SH
manages ST {);
The Container Model

- A framework for component application servers
- Mostly built on the Portable Object Adaptor
  - Automatic activation / deactivation
  - Resource usage optimization
- Provides simplified interfaces for CORBA Services
  - Security, transactions, persistence, and events
- Uses callbacks for instance management
- Empty container for user-defined frameworks also

---

The Container Architecture

```
Client --> Home
```

```
CORBA Component
```

```
Container
```

```
POA
```

```
Callback API
```

```
Extended OMG IDL
external API
```

```
Transaction  Security  Persistency  Notification
```

```
ORB
```

---
Container View

- A container encapsulates one or several POAs
- A container manages one kind of component
  - entity: persistent, primary key, and explicit destruction
  - process: persistent, no key, and explicit destruction
  - session: exists during a session with the client
  - service: exists during an invocation
  - EJBSession, EJBentity: for EJBs
  - Empty: user-defined policy

- References are exported through Component HomeFinder, Naming, or Trader services

Component Categories

<table>
<thead>
<tr>
<th>COMPONENT CATEGORY</th>
<th>CONTAINER IMPL TYPE</th>
<th>CONTAINER TYPE</th>
<th>EXTERNAL TYPE</th>
<th>EJB BEAN EQUIVALENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service</td>
<td>Stateless</td>
<td>Session</td>
<td>Keyless</td>
<td>Session (stateless)</td>
</tr>
<tr>
<td>Session</td>
<td>Conv</td>
<td>Session</td>
<td>Keyless</td>
<td>Session (stateful)</td>
</tr>
<tr>
<td>Process</td>
<td>Durable</td>
<td>Entity</td>
<td>Keyless</td>
<td>-----</td>
</tr>
<tr>
<td>Entity</td>
<td>Durable</td>
<td>Entity</td>
<td>Keyfull</td>
<td>Entity</td>
</tr>
</tbody>
</table>
Container Managed Policies

- Specified by the deployer using an XML vocabulary
- Implemented by the container, not the component
- Policy declarations defined for:
  - Servant Lifetime
  - Transaction
  - Security
  - Events
  - Persistence

Servant Lifetime Policies

- **method** – valid for all categories
  - activated before each invocation
  - passivated after each invocation
- **transaction** – valid for all except service
  - activated on the first invocation of a new transaction
  - passivated after the last invocation of the transaction
- **component** – valid for all except service
  - activated before first invocation
  - passivated explicitly
- **container** – valid for all except service
  - activated on the first invocation
  - passivated when the container needs to reclaim memory
Transactions

- Container-managed at the operation level
  - NOT_SUPPORTED
  - REQUIRED
  - SUPPORTS
  - REQUIRES_NEW
  - MANDATORY
  - NEVER

- Self-managed using the `Components::Transaction::UserTransaction` API which is mapped to CORBA transactions

Security

- Most security is declarative using the component descriptors (`security` element)
- Container supports access to and testing of credentials at run time
- Security Permissions defined at the operation level
  - CLIENT_IDENTITY
  - SYSTEM_IDENTITY
  - SPECIFIED_IDENTITY (=userid)

- Based on CORBA Security V2
Events

- Subset of the CORBA Notification service
  - Events represented as valuetypes to components
  - Push Model
  - Container maps valuetypes to Structured Events
  - Container manages channel creation

- Quality of service properties left to configuration

- Event Policies declared in component descriptors
  - non-transactional
  - default
  - transactional

Persistence

- Supported for Entity container types only

- Container persistence policies:
  - Self managed
  - Container managed

- Both modes can use PSS or their own persistence mechanism
The Container Server Architecture

Container Manager

- Entity Container
  - POA1
- Session Container
  - POA2
- EJB Container
  - POA3
- Other Container
  - POA4

ORB
- Transactions
- Security
- Persistence
- Events

Packaging CORBA Components
A Day in the Life of a Component

- A component is specified
  - OMG IDL 3.0, PSDL, and CIDL
- A component is implemented
  - Component Implementation Framework
- A component must be packaged
- A component may be assembled with other components
- Components and assemblies are deployed

Packaging and Deployment

- "Classic" CORBA: No standard means of ...
  - Configuration
  - Distribution
  - 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
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

The Packaging and Deployment Model

- Describes distributed CORBA component-based applications for automatic deployment

- Packaging technology
  - Self descriptive “ZIP” archives with XML descriptors
  - For heterogeneous components

- Allows interoperability between deployment tools and containers
  - Off-line by data exchange formats
  - On-line by OMG IDL interfaces
Component Package

- Archive (ZIP file) containing
  - One component, consisting of
    - One or more implementations
      - E.g. for different OSs, ORBs, processors, QoS, ...
    - OMG IDL file of the component, home and port types
    - CORBA Component Descriptor (.ccd) for required container policies
    - Property File Descriptor (.cpf) defining default attribute values
    - Software Package Descriptor (.csd) describing package contents

- Self-contained and self-descriptive, reusable unit
- Usually done by the component implementer
Component Assembly Package

- A component assembly is a template for a deployed set of interconnected components
- Described by an assembly descriptor in terms of component files, partitioning, and connections
- May be deployed as it as well as imported into a design tool to be reused or extended
- A “ZIP” archive containing descriptor, component archive files, and property files

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
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 Descriptor
- Software Package Descriptor
- CORBA Component Descriptor
- Component Property File Descriptor

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
Software Package Descriptor Example

```xml
<?xml version='1.0'?>
<!DOCTYPE softpkg>
<softpkg name="PhilosopherHome">
  <idl id="IDL:DiningPhilosophers/PhilosopherHome:1.0">
    <fileinarchive name="philo.idl"/>
  </idl>
  <implementation id="*">
    <code type="DLL">
      <fileinarchive name="philo.dll"/>
      <entrypoint>create_DiningPhilosophers_PhilosopherHome</entrypoint>
    </code>
  </implementation>
</softpkg>
```

Software Package Descriptor for Observer Component

```xml
<?xml version="1.0"?>
<!DOCTYPE softpkg SYSTEM "softpkg.dtd">
<softpkg name="Observer" version="1.0,0,0,0">
  <pkgtype>CORBA Component</pkgtype>
  <title>Observer</title>
  <author>
    <name>Philippe Merle</name>
    <company>INRIA</company>
    <webpage href="http://www.inria.fr"/>
  </author>
  <description>The CCM dining philosophers example</description>
</softpkg>
```
Software Package Descriptor for Observer Component

```xml
<license href="http://www.objectweb.org/license.html"/>
<idl id="IDL:DiningPhilosophers/Observer:1.0">
    <link href="http://www.objectweb.org/philo.idl"/>
</idl>
<descriptor type="CORBA Component">
    <fileinarchive name="observer.ccd"/>
</descriptor>
<propertyfile>
    <fileinarchive name="observer.cpf"/>
</propertyfile>
<implementation>
    <os name="WinNT" version="4,0,0,0"/>
    <os name="Linux" version="2,2,17,0"/>
    <processor name="x86"/>
    <compiler name="JDK"/>
    <programminglanguage name="Java"/>
    <code type="Java class">
        <fileinarchive name="ObserverHomeImpl.class"/>
        <entrypoint>ObserverHomeImpl.create_home</entrypoint>
    </code>
    <runtime name="Java VM" version="1,2,2,0"/>
    <runtime name="Java VM" version="1,3,0,0"/>
    <dependency>...</dependency>
</implementation>
```
Software Package Descriptor for Observer Component

```xml
<dependency type="ORB" action="assert">
  <name>OpenORB</name>
</dependency>

<dependency type="Java Class" action="install">
  <valuetypefactory
    repid="IDL:DiningPhilosophers/StatusInfo:1.0"
    valueentrypoint="DiningPhilosophers.StatusInfoDefaultFactory.create"
    factoryentrypoint="DiningPhilosophers.StatusInfoDefaultFactory">
    <fileinarchive
      name="DiningPhilosophers/StatusInfoDefaultFactory.class"/>
  </valuetypefactory>
</dependency>
```

Software Package Descriptor for Observer Component

```xml
<implementation id="observer_0x1">
  <os name="Win2000" />
  <processor name="x86" />
  <compiler name="VC++" />
  <programminglanguage name="C++" />
  <dependency type="DLL"><localfile name="jtc.dll"/></dependency>
  <dependency type="DLL"><localfile name="ob.dll"/></dependency>
  <descriptor type="CORBA Component">
    <fileinarchive name="observer.ccd"/>
  </descriptor>
  <code type="DLL">
    <fileinarchive name="PhilosophersExecutors.dll"/>
    <entrypoint>create_ObserverHome</entrypoint>
  </code>
</implementation>
```
CORBA Component Model Tutorial

Tuesday, June 25th, 2002

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

CORBA Component Descriptor Example

```xml
<corbacomponent>
  <corbaversion>3.0</corbaversion>
  <componentrepid>IDL:DiningPhilosophers/Philosopher:1.0</componentrepid>
  <homerepid>IDL:DiningPhilosophers/PhilosopherHome:1.0</homerepid>
  <componentkind><session><servant lifetime="component"/></session></componentkind>
  <threading policy="multithread"/>
  <configurationcomplete set="true"/>
  <homefeatures name="PhilosopherHome" repid="IDL:...PhilosopherHome:1.0"/>
  <componentfeatures name="Philosopher" repid="IDL:...Philosopher:1.0">
    <ports>
      <publishes publishesname="info" eventtype="IDL:DiningPhilosophers/StatusInfo:1.0">
        <eventpolicy/>
      </publishes>
      <uses usesname="left" repid="IDL:DiningPhilosophers/Fork:1.0"/>
      <uses usesname="right" repid="IDL:DiningPhilosophers/Fork:1.0"/>
    </ports>
  </componentfeatures>
</corbacomponent>
```
CORBA Component Model Tutorial
Orlando OMG Meeting

CORBA Component Descriptor
for Philosopher Component

```xml
<?xml version="1.0"?>
<!DOCTYPE corbacomponent SYSTEM "corbacomponent.dtd">
<corbacomponent>
  <corbaversion>3.0</corbaversion>
  <componentrepid repid="IDL:DiningPhilosophers/Philosopher:1.0"/>
  <homerepid repid="IDL:DiningPhilosophers/PhilosopherHome:1.0"/>
  <componentkind>
    <process><servant lifetime="container" /></process>
  </componentkind>
  <security rightsfamily="CORBA" rightscombinator="secanyrights" />
  <threading policy="multithread" />
  <configurationcomplete set="true" />
</corbacomponent>
```

CORBA Component Descriptor
for Philosopher Component

```xml
<homefeatures name="PhilosopherHome" repid="IDL:DiningPhilosophers/PhilosopherHome:1.0"/>
<componentfeatures name="Philosopher" repid="IDL:DiningPhilosophers/Philosopher:1.0">
  <ports>
    <uses usesname="right" repid="IDL:DiningPhilosophers/Fork:1.0" />
    <uses usesname="left" repid="IDL:DiningPhilosophers/Fork:1.0" />
    <publishes emitsname="info" eventtype="StatusInfo">
      <eventpolicy policy="normal" />
    </publishes>
  </ports>
</componentfeatures>
<interface name="Fork" repid="IDL:DiningPhilosophers/Fork:1.0"/>
```
CORBA Component Descriptor for Philosopher Component

```
<segment name="philosopherseg" segmenttag="1">
  <segmentmember facettag="1" />
  <containermanagedpersistence>
    <storagehome id="PSDL:PersonHome:1.0"/>
    <pssimplementation id="OpenORB-PSS"/>
    <accessmode mode="READ_WRITE"/>
    <psstransaction policy="TRANSACTIONAL">
      <psstransactionisolationlevel level="SERIALIZABLE"/>
    </psstransaction>
    <params>
      <param name="x" value="1"/>
    </params>
  </containermanagedpersistence>
</segment>
</corbacomponent>
```

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
Property Files

Property File For Philosopher Kant

```xml
<?xml version="1.0"?>
<!DOCTYPE properties SYSTEM "properties.dtd">

<properties>
  <simple name="name" type="string">
    <description>Philosopher name</description>
    <value>Kant</value>
    <defaultvalue>Unknown</defaultvalue>
  </simple>
</properties>
```
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

Dining Philosophers as CORBA Components

*Philosopher* name = Kant

*Philosopher* name = Aristotle

*Philosopher* name = Descartes

Observer

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Component Assembly Descriptor for Dining Philosophers

```xml
<?xml version="1.0"?>
<!DOCTYPE componentassembly SYSTEM "componentassembly.dtd">

<componentassembly id="demophilo">
  <description>Dinner assembly descriptor</description>
  <componentfiles>
    <componentfile id="PhilosopherComponent">
      <fileinarchive name="philosopher.csd"/>
    </componentfile>
    <componentfile id="ObserverComponent">
      <fileinarchive name="observer.csd"/>
    </componentfile>
    <componentfile id="ForkManagerComponent">
      <fileinarchive name="forkmanager.csd"/>
    </componentfile>
  </componentfiles>
</componentassembly>
```

Assembly Descriptor Example (2)

```xml
<partitioning>
  <homeplacement id="ObserverHome">
    <componentfileref idref="ObserverComponent"/>
    <registerwithnaming name="Dinner/ObserverHome"/>
  </homeplacement>
  <homeplacement id="PhilosopherHome">
    <componentfileref idref="PhilosopherComponent"/>
    <registerwithnaming name="Dinner/PhilosopherHome"/>
  </homeplacement>
  <homeplacement id="ForkHome">
    <componentfileref idref="ForkComponent"/>
    <registerwithnaming name="Dinner/ForkHome"/>
  </homeplacement>
</partitioning>
```

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Component Assembly Descriptor
Partitioning for Dining Philosophers

<partitioning>
  <homeplacement id="ObserverHome">
    <componentfileref idref="ObserverComponent"/>
    <componentinstantiation id="Freud"/>
    <registerwithnaming name="Dinner/ObserverComponent"/>
  </homeplacement>

  <homeplacement id="ForkHome">
    <componentfileref idref="ForkManagerComponent"/>
    <componentinstantiation id="ForkManager1"/>
    <componentinstantiation id="ForkManager2"/>
    <componentinstantiation id="ForkManager3"/>
    <registerwithhomefinder name="ForkHome"/>
  </homeplacement>

  <homeplacement id="PhilosopherHome">
    <componentfileref idref="PhilosopherComponent"/>
    <componentinstantiation id="Kant">
      <componentproperties><fileinarchive name="Kant.cpf"/></componentproperties></componentinstantiation>
    <componentinstantiation id="Descartes">
      <componentproperties><fileinarchive name="Descartes.cpf"/></componentproperties></componentinstantiation>
    <componentinstantiation id="Aristotle">
      <componentproperties><fileinarchive name="Aristotle.cpf"/></componentproperties></componentinstantiation>
  </homeplacement>
</partitioning>
Component Packaging

- IDL
- User Code
- Generated Code
- Component Descriptor
- Default Properties
- Compiler
- Shared Library or Executable
- Packaging Tool
- Component Package .zip

Component Assembly

- Component Package
- Port Connections
- Assembly
- Assembly Archive .aar (ZIP)
- Deployment Tool
- Instance Creation
Deploying CORBA Component Applications

- Component Deployment Objects
- Component Deployment Process
- Deployment Scenario

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

[Diagram showing the deployment process]

- ZIP
- Assembly File
- Deployment App
- OMG IDL
The Component Deployment Process

Deployment Tool

AssemblyFactory

Assembly

ServerActivator

ComponentServer

Deployment Tool

ComponentInstallation

Container

CCMHome

CCMObject

Deployment API: Assembly

module Components {
    enum AssemblyState {
        INACTIVE, INSERVICE
    };
    exception CreateFailure {};
    exception RemoveFailure {};

    interface Assembly {
        void build () raises (CreateFailure);
        void tear_down () raises (RemoveFailure);
        AssemblyState get_state ();
    };
}
Deploying the Philosophers Example

- Run Deployment Application
  - Use ComponentInstallation to upload component implementations
  - Use AssemblyFactory to create an Assembly
  - Call build() operation on Assembly Interface
    - starts ComponentServers for each home
    - creates Containers and installs homes
    - creates component instances
    - interconnects component ports
    - calls configuration_complete
- One-step installation!

Deployment Scenario

- Deployment Tool
- Component Assembly Descriptor
- Deployer
- Component Assembly Descriptor
- with installation information
Deployment Scenario: Implementation UpLoading

Deployment Scenario: Assembly Creation
Deployment Scenario: Component Server Instantiation

Deployment Scenario: Container Instantiation
Deployment Scenario: Home Installation

- Component Assembly Descriptor +
- Home for A
  - Container
  - Code for Component A
- Assembly
- Home for B
  - Container
  - Code for Component B

Deployment Scenario: Component Instantiation

- Component Assembly Descriptor +
- Home for A
  - Assembly
  - A instance
- Home for B
  - B instance
Deployment Scenario:
Component Configuration

Component Assembly Descriptor +

Home for A

A instance

Assembly

Home for B

B instance

Summary
Conclusion

- 1st open standard for Distributed Component Computing
  - Component-based software engineering process
  - Advanced component model
  - Server-side container framework
  - Packaging and distributed deployment
  - EJB interworking
  - Component meta models

- Heart of CORBA 3.0
  - Available specification since the Yokohama meeting
  - ~ 500 pages added

Next CCM Steps at OMG

- Deployment and Configuration RFP
  - OMG TC Doc orbos/2002-01-19

- CORBA Component Model Revision Task Force
  - Chartered at Yokohama meeting (April 26th 2002)

- UML Profile for CCM RFP
  - In preparation / discussion
  - Revision of the UML Profile for CORBA for including IDL 3.0 extension, PSDL, and CIDL

- EDOC to CCM Mapping RFP
  - Should be prepared
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/

- CIF from Humboldt University
  - C++ on ORBacus 4.1
  - http://sourceforge.net/projects/cif

Commercial CCM Implementations

- Qedo from Fraunhofer FOKUS
  - C++ on MICO & ORBacus 4.1
  - http://qedo.berlios.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
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/