CORBA Component Model Tutorial

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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

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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

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

- 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 overload local container callback interfaces
  - Could invoke local container interfaces

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

- OMG IDL, PSDL & CIDL
- OMG IDL, PSDL & CIDL Compiler
- OMG IDL
- Component Designer
- Local server-side OMG IDL
- Component Implementer
- Component Executor Code
- Client-side OMG IDL
- Stubs, Skeletons
- Component Client
- XML Component Descriptor
- Component Packager
- Programming Language Tools
- 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 \textit{ports})
- Could inherit from a single component type
- Could \textit{supports} multiple interfaces
- Each component instance is created and managed by a unique component home

Component Features

- \textit{Attributes} = configurable properties
- \textit{Facets} = offered operation interfaces
- \textit{Receptacles} = required operation interfaces
- \textit{Event sources} = produced events
- \textit{Event sinks} = consumed events
- Navigation and introspection supported
A CORBA Component

Component interface

Facets

Event sinks

Attributes

OFFERED

My Business Component

REQUIRED

Receptacles

Event sources

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 eventtype meta-type
  - valuertype 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
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`

The Dining Philosophers Example
Dining Philosophers as CORBA Components

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.
    typeprefix 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

```c
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

```c
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;
};

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

```plaintext
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

```plaintext
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 {};
The Observer Home

```java
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
The Client-Side OMG IDL Mapping

- 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

```cpp
component ForkManager
{
  provides Fork the_fork;
};
```

Is mapped to

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

Client-Side Mapping for Fork Home

```cpp
home ForkHome
  manages ForkManager {};
```

Is mapped to

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

```
home ObserverHome
manages Observer {};

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

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

Client-Side Mapping for Philosopher Component

```
component Philosopher {
  attribute string name;
  uses Fork left;
  uses Fork right;
  publishes StatusInfo info;
}

interface Philosopher :
  ::Components::CCMObject {
    attribute string name;
    ...
  }
```

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Client-Side Mapping for Philosopher Component

```java
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(...);
};
```

Philosopher name = XXX

Client-Side Mapping for Philosopher Home

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

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/implementation visibility
Using CORBA Components with OMG IDLscript

# 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

# 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
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

- Main component executor interface
- Facet or event sink executor interface
- SessionComponent or EntityComponent

A Segmented Component Executor

- Main segment
- Seg2, Seg3, Seg4

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The Server-Side OMG IDL Mapping

- 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 in Java

- Dining Philosophers Example

Local Server-Side Mapping for ForkManager Component

```java
// Executor interface for the the_fork facet.
local interface CCM_Fork : Fork {};

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

// Monolithic executor interface.
local interface CCM_ForkManager :
   CCM_ForkManager_Executor {
   // Requested by container.
   CCM_Fork get_the_fork();
   }
```
Local Server-Side Mapping for ForkManager Component

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

Different ForkManager Implementations

- Fork facet implementation
  - class ForkImpl

- Monolithic executor approach
  - By inheritance: MonolithicForkManager_1_Impl
  - By delegation: MonolithicForkManager_2_Impl

- Executor locator approach
  - One segment: SegmentedForkManager_1_Impl
  - Two segments: SegmentedForkManager_2_Impl
Fork Facet Implementation: Just Business Operations

```java
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;
    }
}
```

Monolithic ForkManager Executor: Facet Implementation By Inheritance

```java
public class MonolithicForkManager_1_Impl extends ForkImpl // Fork implementation implements CCM_ForkManager, // as 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;
    }
}
```
Monolithic ForkManager Executor:
Facet Implementation By Delegation

```java
public class MonolithicForkManager_2_Impl
    extends org.omg.CORBA.LocalObject
    implements CCM_ForkManager, // as monolithic
              // Is a session executor
        org.omg.Components.SessionComponent
{
    private ForkImpl the_fork_ = new ForkImpl();

    // Required by CCM_ForkManager interface.
    public CCM_Fork get_the_fork()
    {
        // The delegate for the facet.
        return the_fork_;
    }
```

Segmented ForkManager Executor
With One Segment

```java
public class SegmentedForkManager_1_Impl
    extends ForkImpl
    implements CCM_ForkManager_Executor,
              SessionComponent, ExecutorLocator
{
    // Required by ExecutorLocator interface.
    public org.omg.CORBA.Object obtain_executor(String name)
        throws org.omg.Components.CCMException
    {
        if ( name.equals("ForkManager")
            || name.equals("the_fork") )
            return this;
        throw new org.omg.Components.CCMException();
    }

    public void release_executor(org.omg.CORBA.Object exc)
        throws org.omg.Components.CCMException {...}

    public void configuration_complete()
        throws org.omg.Components.InvalidConfiguration {...}
```
### Segmented ForkManager Executor With Two Segments

```java
public class SegmentedForkManager_2_Impl
    extends org.omg.CORBA.LocalObject
    implements CCM_ForkManager_Executor,
                SessionComponent, ExecutorLocator
{
    private ForkImpl the_fork_ = new ForkImpl();
    // Required by ExecutorLocator interface.
    public org.omg.CORBA.Object obtain_executor(String name)
        throws org.omg.Components.CCMException
    {
        if (name.equals("ForkManager"))
            return this;
        if (name.equals("the_fork"))
            return the_fork_;
        throw new org.omg.Components.CCMException();
    }
    // Also release_executor and configuration_complete operations.
```

### SessionComponent Callback Implementation

```java
// import org.omg.Components.*;

// The context is fixed by the container.
public void set_session_context(SessionContext ctx)
    throws CCMEException {...}

// Called by container when component is activated.
public void ccm_activate() throws CCMEException {...}

// Called by container when component is deactivated.
public void ccm_passivate() throws CCMEException {...}

// Called by container when component is removed.
public void ccm_remove() throws CCMEException {...}
```
Local Server-Side Mapping for Fork Home

```java
public class ForkHomeImpl extends org.omg.CORBA.LocalObject implements CCM_ForkHome {
    // Required by CCM_ForkHome interface.
    public org.omg.Components.EnterpriseComponent create() {
        // This home executor class manages a specific
        // component executor class.
        return new ...ForkManager...Impl();
    }
    // Called at deployment time.
    public static org.omg.Components.HomeExecutorBase create_home() {
        return new ForkHomeImpl();
    }
}
```

Fork Home Executor
Local Server-Side Mapping for Observer Component

```java
// 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 {};
```

Monolithic Observer Executor

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

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 ... }

Local Server-Side Mapping for Observer Home

local interface

  CCM_ObserverHomeExplicit : ::Components::HomeExecutorBase {};

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

local interface CCM_ObserverHome :

  CCM_ObserverHomeExplicit,
  CCM_ObserverHomeImplicit {};

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Observer Home Executor

```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(); }
}
```

Local Server-Side Mapping for Philosopher Component

```java
// 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 Mapping for Philosopher Context

```java
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);
};
```

Monolithic Philosopher Executor

```java
public class PhilosopherImpl
    extends org.omg.CORBA.LocalObject
    implements CCM_Philosopher,
                   SessionComponent,
                   java.lang.Runnable
{
    // Constructor.
    public PhilosopherImpl(String n) { name_ = n; }
    // Transient state.
    private String name_;
    // Required by the CCM_Philosopher_Executor interface.
    public void name(String n) { name_ = n; }
    public String name() { return name_; }
}
```
// 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 {...}

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();
    ...
}
Local Server-Side Mapping for Philosopher Home

```java
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

```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(); }
}
```
Implementing CORBA Components in C++

- Dining Philosophers Example

C++ Component Implementation

- As before:
  - Based on Server-Side equivalent IDL
  - Components and Homes are mapped to local interfaces
  - Equivalent local interfaces are implemented according to C++ language mapping
  - Choice between monolithic and locator implementation
  - Optionally aided by CIDL generated code
- C++ specific:
  - *entry point*: factory for each home type
  - extern "C" so that entry point can be found in shared library
Implementing ForkManager in C++

```cpp
exception InUse {};

interface Fork {
    void get () raises (InUse);
    void release ();
};

component ForkManager {
    provides Fork the_fork;
};
```

Server Side equivalent IDL for ForkManager

```idl
// Executor interface for the the_fork facet.
local interface CCM_Fork : Fork {};

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

// Monolithic executor interface.
local interface CCM_ForkManager :
    CCM_ForkManager_Executor {
    // Requested by container.
    CCM_Fork get_the_fork();
};
```
Server Side equivalent IDL for ForkManager

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

Different ForkManager Implementations

- Fork facet implementation
  - class Fork_impl

- Monolithic approach
  - By inheritance: ForkManager_1_impl
  - By delegation: ForkManager_2_impl

- Executor locator approach
  - Segmented: ForkManager_3_Executor_impl
  and ForkManager_3_Locator_impl
Fork Facet Implementation

class Fork_impl : virtual public CCM_Fork
{
    bool available_; 

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

ForkManager Implementation (1): Monolithic, Inheritance of Facet

// IDL implied by the IDL to C++ mapping.
local interface MyFork : CCM_ForkManager, CCM_Fork {};
// C++
class ForkManager_1_impl :
    virtual public MyFork, 
    virtual public Fork_impl
{
public:
    // facet implemented by myself
    CCM_Fork_ptr get_the_fork () {
        return CCM_Fork::_duplicate (this);
    }
};
ForkManager Implementation (2): Monolithic, Delegation of Facet

```cpp
class ForkManager_2_impl :
    virtual public CCM_ForkManager
{
    CCM_Fork_var the_fork_;

public:
    ForkManager_2_impl () {
        the_fork_ = new Fork_impl;
    }
    CCM_Fork_ptr get_the_fork () {
        return CCM_Fork::_duplicate (the_fork_);
    }
};
```

ForkManager Implementation (3): Locator based

```cpp
class ForkManager_3_Executor_impl :
    virtual public CCM_ForkManager_Executor
{ /* empty */};

class ForkManager_3_Locator_impl :
    virtual public Components::ExecutorLocator
{
    CCM_ForkManager_Executor_var _executor;
    CCM_Fork_var _the_fork;
public:
    ForkManager_3_Locator_impl ()
    {
        _executor = new ForkManager_3_Executor_impl;
        _the_fork = new Fork_impl;
    }
};
```
ForkManager Implementation (3):
Locator based (contd)

/* MyFork_3_Locator_impl continued */

CORBA::Object_ptr obtain_executor (const char * name) {
    if (strcmp (name, "ForkManager") == 0)
        return CORBA::Object::_duplicate (_executor);
    else
        return CORBA::Object::_duplicate (_the_fork);
}

void release_executor (CORBA::Object_ptr obj) {
    /* empty */
}

void configuration_complete () {
    /* empty */
};

Server Side equivalent IDL for ForkHome

local interface CCM_ForkHomeExplicit :
    ::Components::HomeExecutorBase {
    // Empty
};

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

local interface CCM_ForkHome :
    CCM_ForkHomeExplicit,
    CCM_ForkHomeImplicit {};
ForkHome Executor

class ForkHome_impl :
    virtual public CCM_ForkHome
{
    // from the implicit interface

    Components::EnterpriseComponent_ptr create ()
    {
        return new ForkManager_1_impl;
        // or: return new ForkManager_2_impl;
        // or: return new ForkManager_3_Locator_impl;
    }

    extern "C" {
        Components::HomeExecutorBase_ptr create_ForkHome ()
        { return new ForkHome_impl; }
    }
};

Implementing Observer in C++

eventtype StatusInfo { ... };

component Observer {
    consumes StatusInfo info;
};

home ObserverHome manages Observer {};

// to be notified of activation and passivation

local interface MyObserver :
    CCM_Observer,
    Components::SessionComponent
{};
### Server Side equivalent IDL for Observer

```idl
// 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 Implementation

```cpp
class Observer_impl :
    virtual public MyObserver {
public:
    // receive StatusInfo event

    void push_info (StatusInfo * event) {
        ... update GUI ...
    }
```
Observer Implementation
Monolithic (2)

// from SessionComponent interface

void set_session_context
(Components::SessionContext_ptr ctx)
{ /* empty */ }

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

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

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

Server Side Equivalent IDL
for ObserverHome

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

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

local interface CCM_ObserverHome :
CCM_ObserverHomeExplicit,
CCM_ObserverHomeImplicit {};

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ObserverHome Executor

class ObserverHome_impl :
    virtual public CCM_ObserverHome
{
    // from the implicit interface

    Components::EnterpriseComponent_ptr create ()
    {
        return new Observer_impl;
    }
};

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

Implementing Philosopher in C++

component Philosopher {
    attribute string name;
    uses Fork left;
    uses Fork right;
    publishes StatusInfo info;
};

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

local interface MyPhilosopher :
    CCM_Philosopher,
    Components::SessionComponent
{);
// 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 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);
  };

(c) Philippe Merle LIFL - INRIA 2002
class Philosopher_impl :
    virtual public MyPhilosopher
{
    CCM_Philosopher_Context_var _ctx;
    CORBA::String_var _name;

    public:
    // Philosopher interface
    Philosopher_impl (const char * nn) {
        _name = nn;
    }
    void name (const char * nn) { _name = nn; }
    char * name () { return CORBA::string_dup (_name); }

    // from SessionComponent interface
    void set_session_context
    (Components::SessionContext_ptr ctx)
    { _ctx = CCM_Philosopher_Context::_narrow (ctx); }

    void ccm_activate ()
    { ... start philosopher, start timer ... }

    void ccm_passivate ()
    { ... deep-freeze philosopher, stop timer ... }

    void ccm_remove ()
    { ... kill philosopher ... }
Philosopher Executor
Monolithic (3)

// timer callback
void timer ()
{
    // not the real code
    Fork_var left = _ctx->get_connection_left ();
    Fork_var right = _ctx->get_connection_right ();
    left->get ();  // acquire left fork
    right->get ();  // acquire right fork
    StatusInfo_var info = new StatusInfo_impl;
    // set event contents
    _ctx->push_info (info);
    right->release ();  // release right fork
    left->release ();  // release left fork
}

Server Side equivalent IDL for PhilosopherHome

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 {;
Implementing CORBA Components with CIDL

```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; }
}
```
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 <philo.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
- Component Skeleton
- OMG IDL 3.0 Compiler
- includes
- Local Server-side OMG IDL
- Component Executor
- OMG CIDL Compiler
- delegates to
- partially implemented
- Component Skeleton
- inherited by and completed
- User written
- Compiler
- Generated files

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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**

```cpp
#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**

```cpp
#include <philo.pSDL>

composition process PhilosopherComposition {
  home executor PhilosopherHomeProcessImpl {
    implements DiningPhilosophers::PhilosopherHome;
    bindsTo PersonHome;
    manages PhilosopherProcessImpl;
  };
};
```
OMG CIDL & PSDL Compilation Process

- OMG IDL
  - COMPONET
  - EXECUTOR
  - IMPLMENTER
  - inherited by
  - and completed

- User written
- Compiler
- Generated files

Relationship Between Artifacts

- component C
- home H manages C
- abstract storagetype ST
- abstract storagehome SH
- manages ST

- Component
  - manages
  - implements

- Executor
  - implements
  - stored as
  - explicitly defined
  - implicitly defined

- Storage Object
  - manages
  - binds to

- Home
  - implements
  - manages

- Home Executor
  - binds to
  - manages

- Storage Home
  - manages
Putting CORBA Containers to Work

- The Container Model
- Container Managed Policies

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

- 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</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 Session</td>
<td>(stateless)</td>
</tr>
<tr>
<td>Session</td>
<td>Conv</td>
<td>Session</td>
<td>Keyless Session</td>
<td>(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 Entity</td>
<td></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

[Diagram showing the container server architecture with container manager, entity container, session container, EJB container, other container, POA1, POA2, POA3, 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 be 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

Component Assembly Artifacts

IDL/CIDL File

User's Code

Programming Language Tools

Proprietaries

Home Properties

Component Properties

Component Assembly Package

Assembly Tool

Deployment Tool

CORBA Component Package

Assembly Descriptor

Softpkg Descriptor
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='phiIo.idl'/>
  </idl>
  <implementation id='*'>
    <code type='DLL'>
      <fileinarchive name='phiIo.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">
  <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>
  <license href="http://www.objectweb.org/license.html"/>
  <idl id="IDL:DiningPhilosophers/Observer:1.0"
       link href="http://www.objectweb.org/philo.idl"/>
  <descriptor type="CORBA Component">
    <fileinarchive name="observer.ccd"/>
  </descriptor>
  <propertyfile>
    <fileinarchive name="observer.cpf"/>
  </propertyfile>
  <implementation>... </implementation>
</softpkg>
```
Software Package Descriptor for Observer Component

```xml
<implementation id="Observer_impl">
  <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"><localfilename="jtc.dll"/></dependency>
  <dependency type="DLL"><localfilename="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 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</componentKind>
  <servantLifetime>component</servantLifetime>
  <threadingPolicy>multithread</threadingPolicy>
  <configurationCompleteSet>true</configurationCompleteSet>
  <homeFeatures name="PhilosopherHome" repid="IDL:DiningPhilosophers/PhilosopherHome:1.0"/>
  <componentFeatures name="Philosopher" repid="IDL:DiningPhilosophers/Philosopher:1.0"/>
  <ports>
    <publishes publishName="info" eventType="IDL:DiningPhilosophers/StatusInfo:1.0"/>
    <uses useName="left" repid="IDL:DiningPhilosophers/Fork:1.0"/>
    <uses useName="right" repid="IDL:DiningPhilosophers/Fork:1.0"/>
  </ports>
</corbaComponent>
```

CORBA Component Descriptor for Philosopher Component

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

<corbaComponent>
  <corbaVersion>3.0</corbaVersion>
  <componentRepid>
    "IDL:DiningPhilosophers/Philosopher:1.0"
  </componentRepid>
  <homeRepid>
    "IDL:DiningPhilosophers/PhilosopherHome:1.0"
  </homeRepid>
  <componentKind>
    <process>
      <servant lifetime="container"/>
    </process>
  </componentKind>
  <security rightsFamily="CORBA"
    rightCombinator="secanyrights"/>
  <threadingPolicy>multithread</threadingPolicy>
  <configurationCompleteSet>true</configurationCompleteSet>
</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 emittname="info"
   eventtype="StatusInfo">
    <eventpolicy policy="normal" />
  </publishes>
</ports>

<interface name="Fork" repid="IDL:DiningPhilosophers/Fork:1.0"/>
```

CORBA Component Descriptor for Philosopher Component

```xml
<segment name="philosopherseg" segmenttag="1">
  <segmentmember facettag="1" />
  <containermanagedpersistence>
   <storagehome id="PSDL:PersonHome:1.0"/>
   <psimplemplementation id="OpenORB-PSS" />
   <accesmode 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

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="ObserverHome"/>
    <registerwithnaming name="ObserverHome"/>
  </homeplacement>
  <homeplacement id="PhilosopherHome">
    <componentfileref idref="PhilosopherHome"/>
    <registerwithnaming name="PhilosopherHome"/>
  </homeplacement>
  <homeplacement id="ForkHome">
    <componentfileref idref="ForkHome"/>
    <registerwithnaming name="ForkHome"/>
  </homeplacement>
</partitioning>
```

Component Assembly Descriptor
Partitioning for Dining Philosophers

```xml
<partitioning>
  <homeplacement id="ObserverHome">
    <componentfileref idref="ObserverComponent"/>
    <componentinstantiation id="Freud"/>
    <registerwithnaming name="corbaname: . . ."/>
  </homeplacement>

  <homeplacement id="ForkHome">
    <componentfileref idref="ForkManagerComponent"/>
    <componentinstantiation id="ForkManager1"/>
    <componentinstantiation id="ForkManager2"/>
    <componentinstantiation id="ForkManager3"/>
    <registerwithhomefinder name="ForkHome"/>
  </homeplacement>
</partitioning>
```
Component Assembly Descriptor
Partitioning for Dining Philosophers

<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>

Component Assembly Descriptor
Connections for Dining Philosophers

<connections>
  <connectinterface>
    <usesport>
      <usesidentifier>left</usesidentifier>
      <componentinstantiationref idref="Kant"/>
    </usesport>
    <providesport>
      <providesidentifier>the_fork</providesidentifier>
      <componentinstantiationref idref="ForkManager1"/>
    </providesport>
  </connectinterface>
</connections>
Component Assembly Descriptor
Connections for Dining Philosophers

```xml
<connectevent>
  <publishesport>
    <publishesidentifier>info</publishesidentifier>
    <componentinstantiationref idref="Kant"/>
  </publishesport>
  <consumesport>
    <consumesidentifier>info</consumesidentifier>
    <componentinstantiationref idref="Freud"/>
  </consumesport>
</connectevent>
```

Component Packaging

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

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

ZIP
Assembly File
Staging Area
Deployment App
OMG IDL
ServerActivator
ComponentServer
Container
CCMHome
CCMObject
ComponentInstallation
Deployment Tool
AssemblyFactory
Assembly
«instantiates»

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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 + with installation information

Deployer

Deployment Scenario:
Implementation UpLoading

Deployment Tool

Component Installation

Component installation

Code for Component A

Component Assembly Descriptor +

Code for Component B
Deployment Scenario: Assembly Creation

Deployment Tool

- AssemblyFactory
  - Assembly
  - Code for Component A
  - Code for Component B

Deployment Scenario: Component Server Instantiation

- Component Server
  - ServerActivator
  - Assembly
  - Code for Component A
  - Code for Component B
Deployment Scenario: Container Instantiation

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

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

Deployment Scenario:
Component Configuration
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
  - Final CCM specification approved begin 2002
  - ~ 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
  - Will be chartered this Friday, April 26th 2002
- UML Profile for CCM RFP
  - Should be prepared
  - 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/
- 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

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/