CORBA Component Model Tutorial

OMG CCM Implementers Group,
MARS PTC & Telecom DTC
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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?

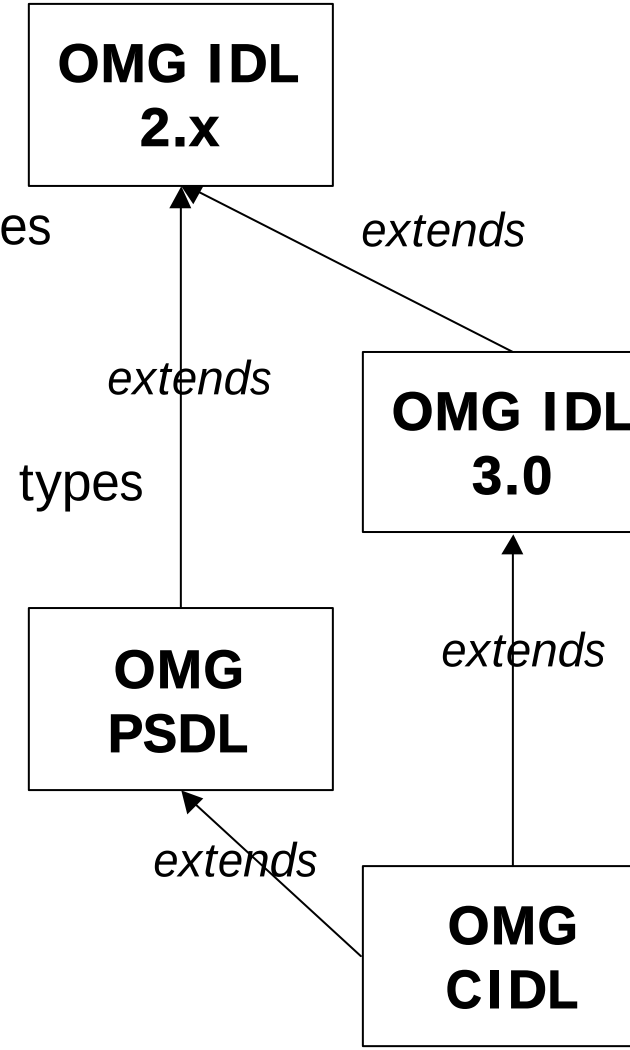
- Abstract Component Model
  - Extensions to IDL and the object model
- Component Implementation Framework
  - Component Implementation Definition Language (CIDL)
- Component Container Programming Model
  - Component implementer and client view
  - Integration with Security, Persistence, Transactions, and Events

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

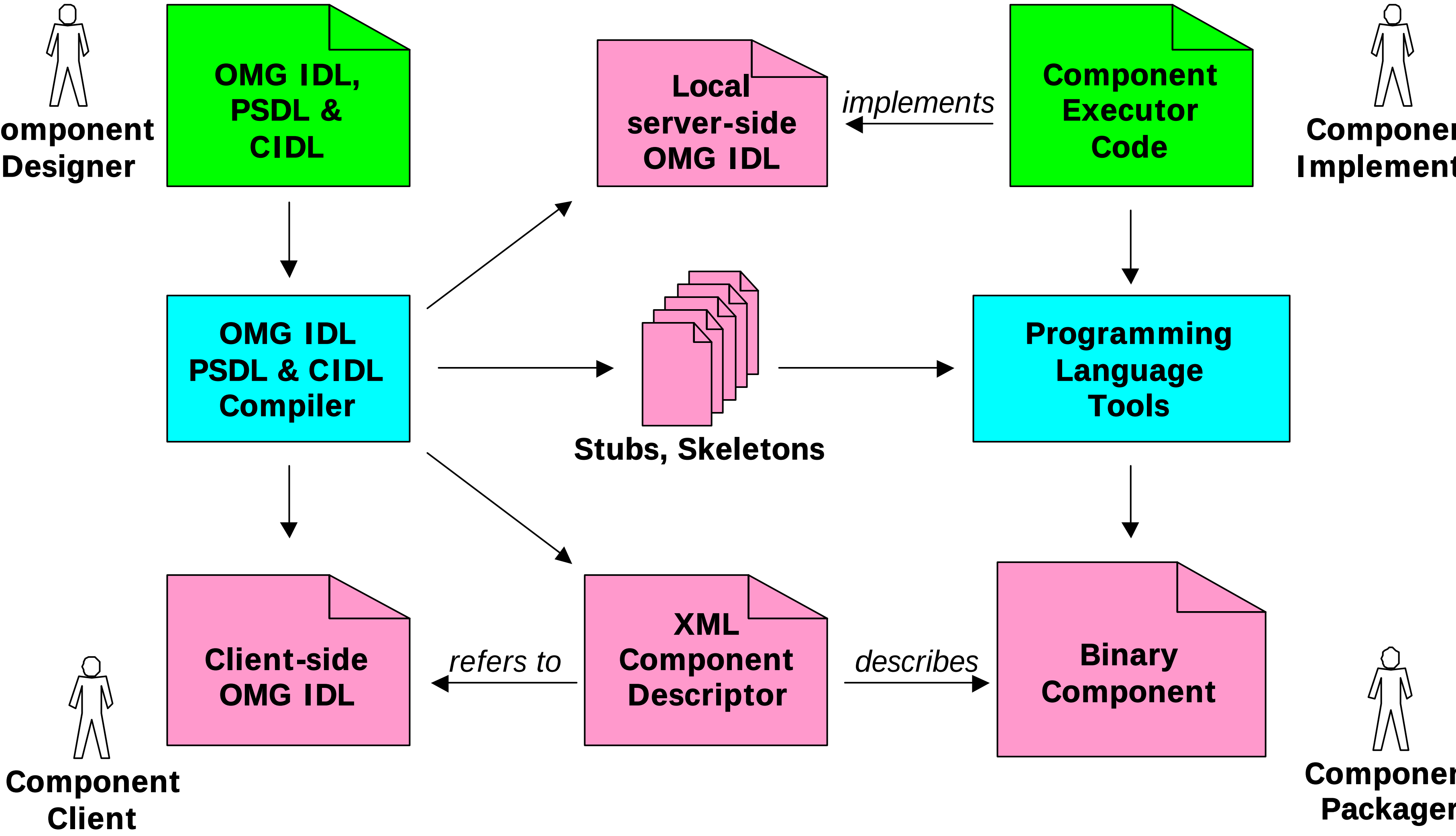
- Specify platform and language independent features required to facilitate code generation
  - Component Implementation Definition Language (CIDL)
  - Persistence State Definition Language (PSDL)

- 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



omponent
Designer

OMG IDL,
PSDL &
CIDL

Local
server-side
OMG IDL

implements

Component
Executor
Code

Componen
Implement

OMG IDL
PSDL & CIDL
Compiler

Stubs, Skeletons

Programming
Language
Tools

Client-side
OMG IDL

refers to

XML
Component
Descriptor

describes

Binary
Component

Component
Client

Componen
Packager

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

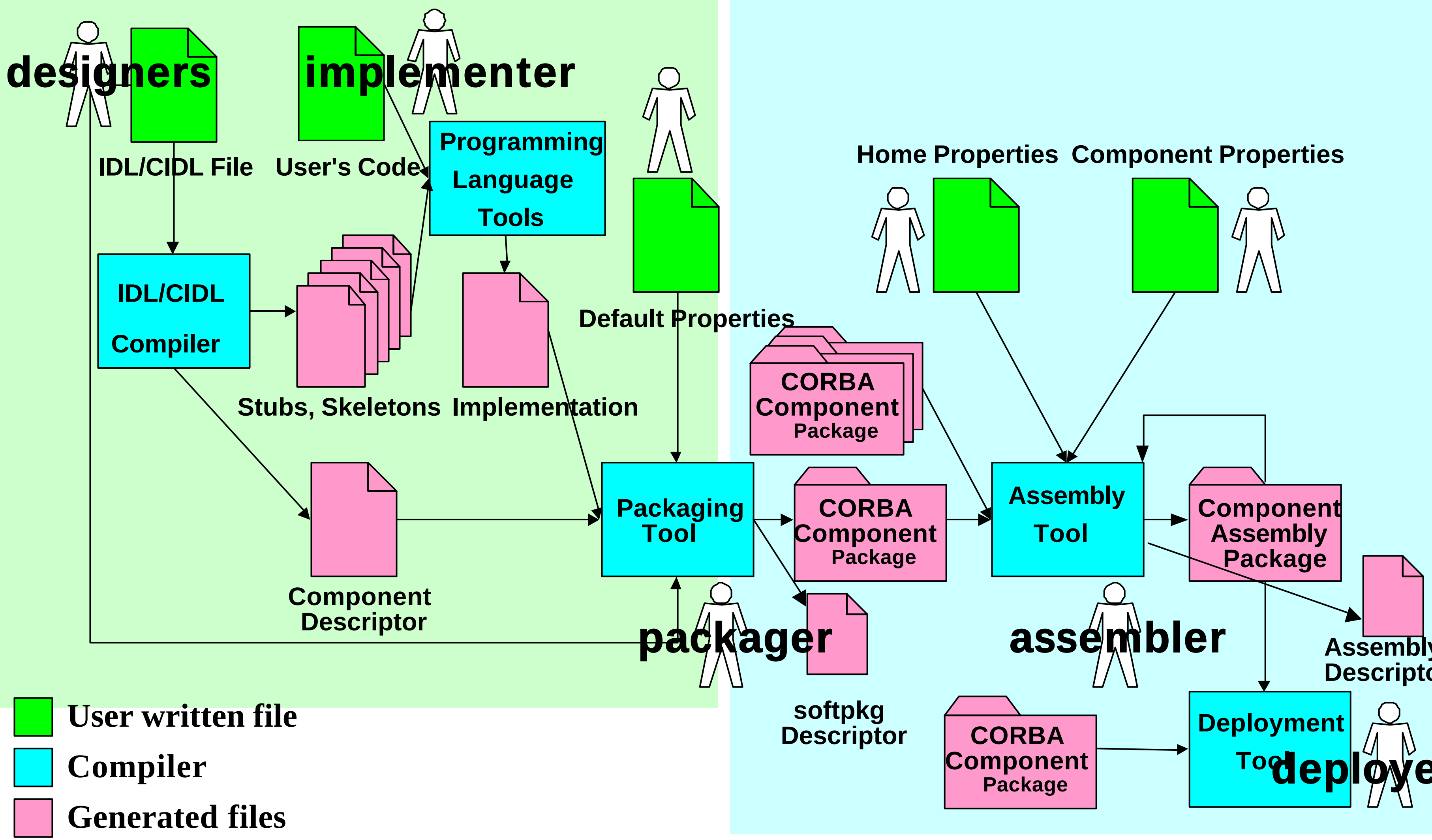
Component Assemblers

- 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 locations to physical hosts
- Start the deployment process
  - Installs components and assemblies to particular machines on the network
- Output - instantiated and configured components and assemblies now available
  - CCM applications deployed in CCM containers

The CCM Big Picture



🟩 User written file

🟦 Compiler

🟪 Generated files

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?

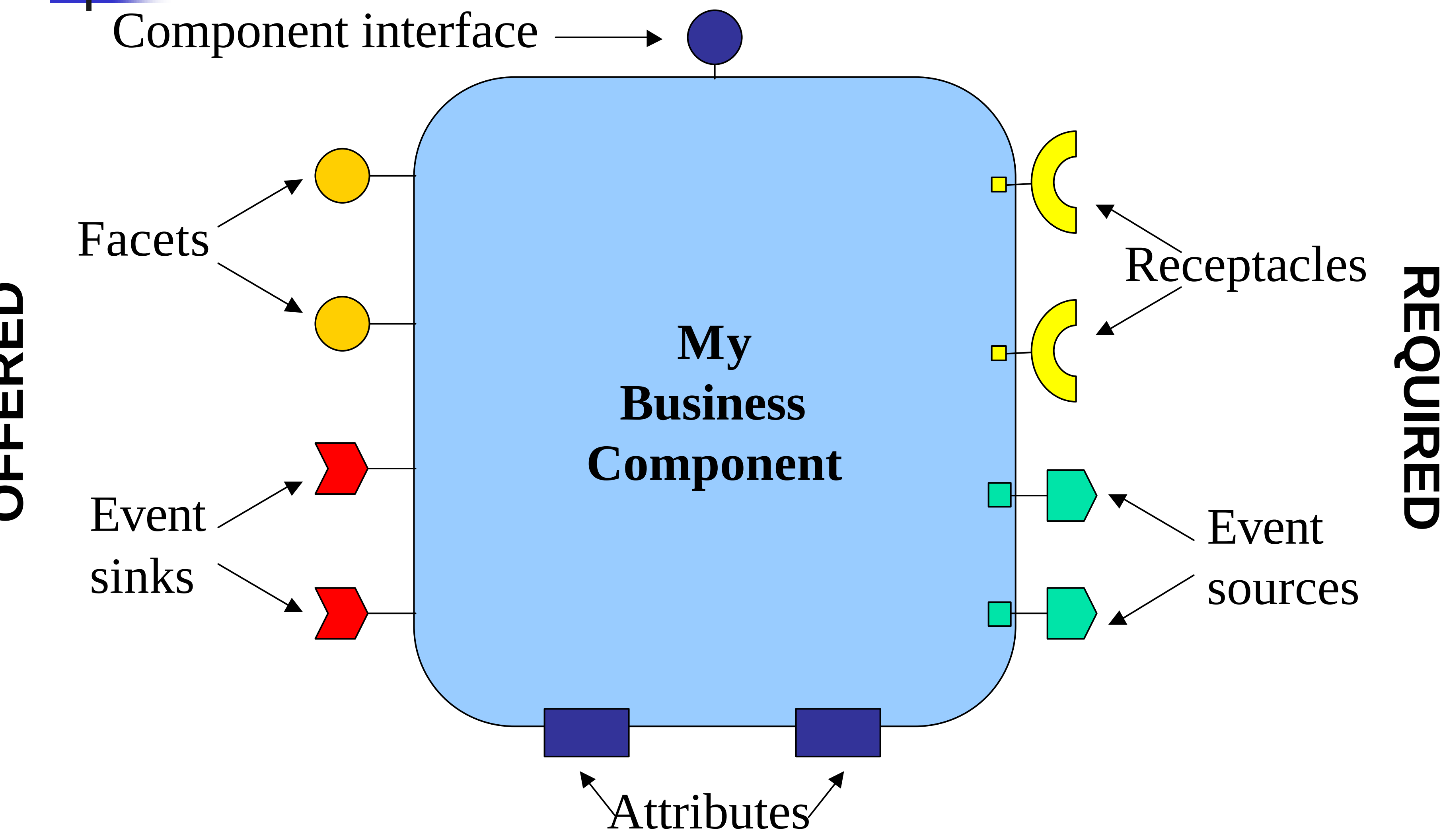
- component is a new CORBA meta-type
  - Extension of Object (with some constraints)
  - Has an interface, and an object reference
  - Also, a stylized use of CORBA interfaces/objects
- Provides component features (also named *ports*)
- Could inherit from a single component type
- Could *`supports`*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

Component Features

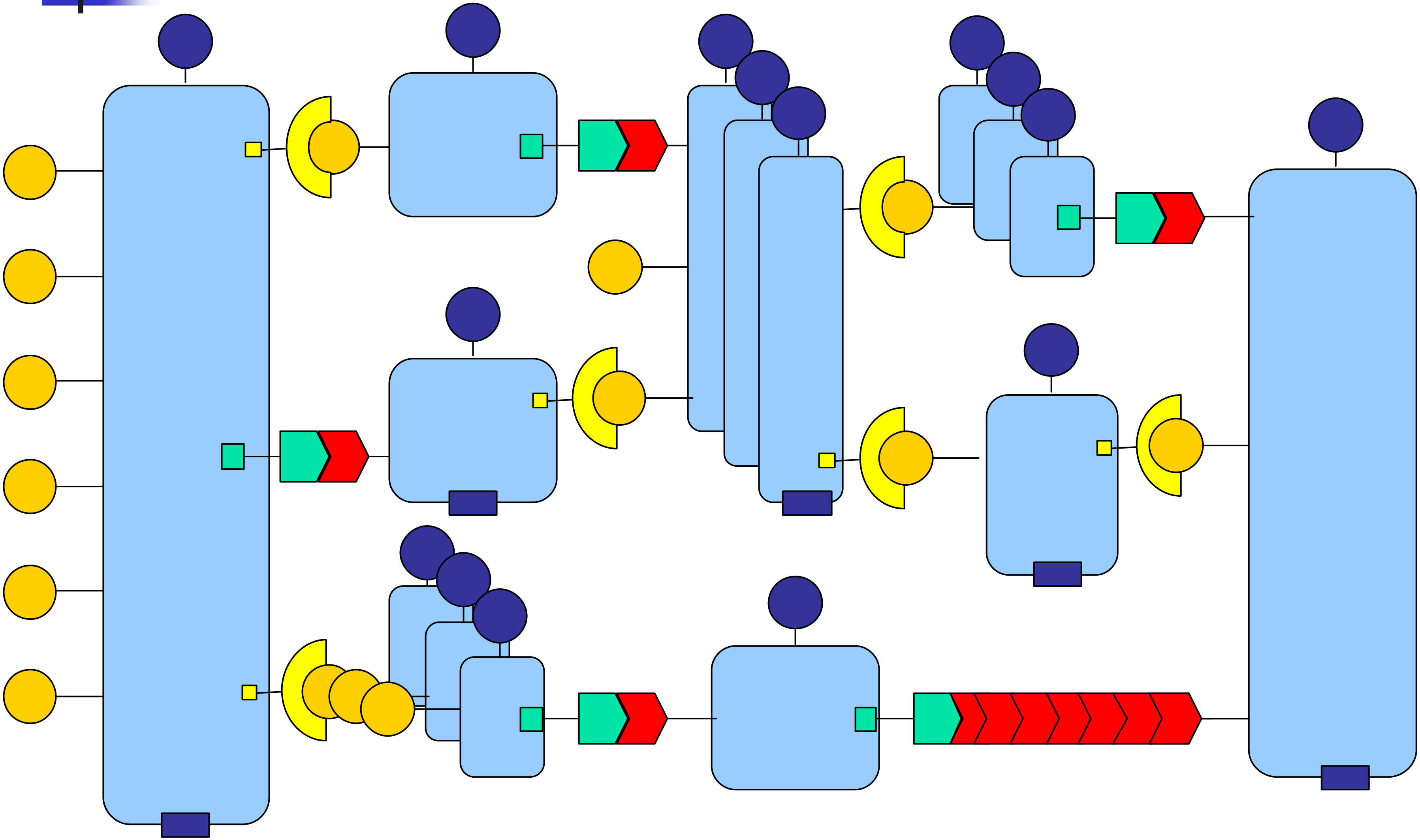
- *Attributes* = configurable properties
- *Facets* = offered operation interfaces
- *Receptacles* = required operation interfaces
- *Event sources* = produced events
- *Event sinks* = consumed events

- Navigation and introspection supported

A CORBA Component



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 read only 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
  - `valuetype` specialization for component events

Component Event Sources

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

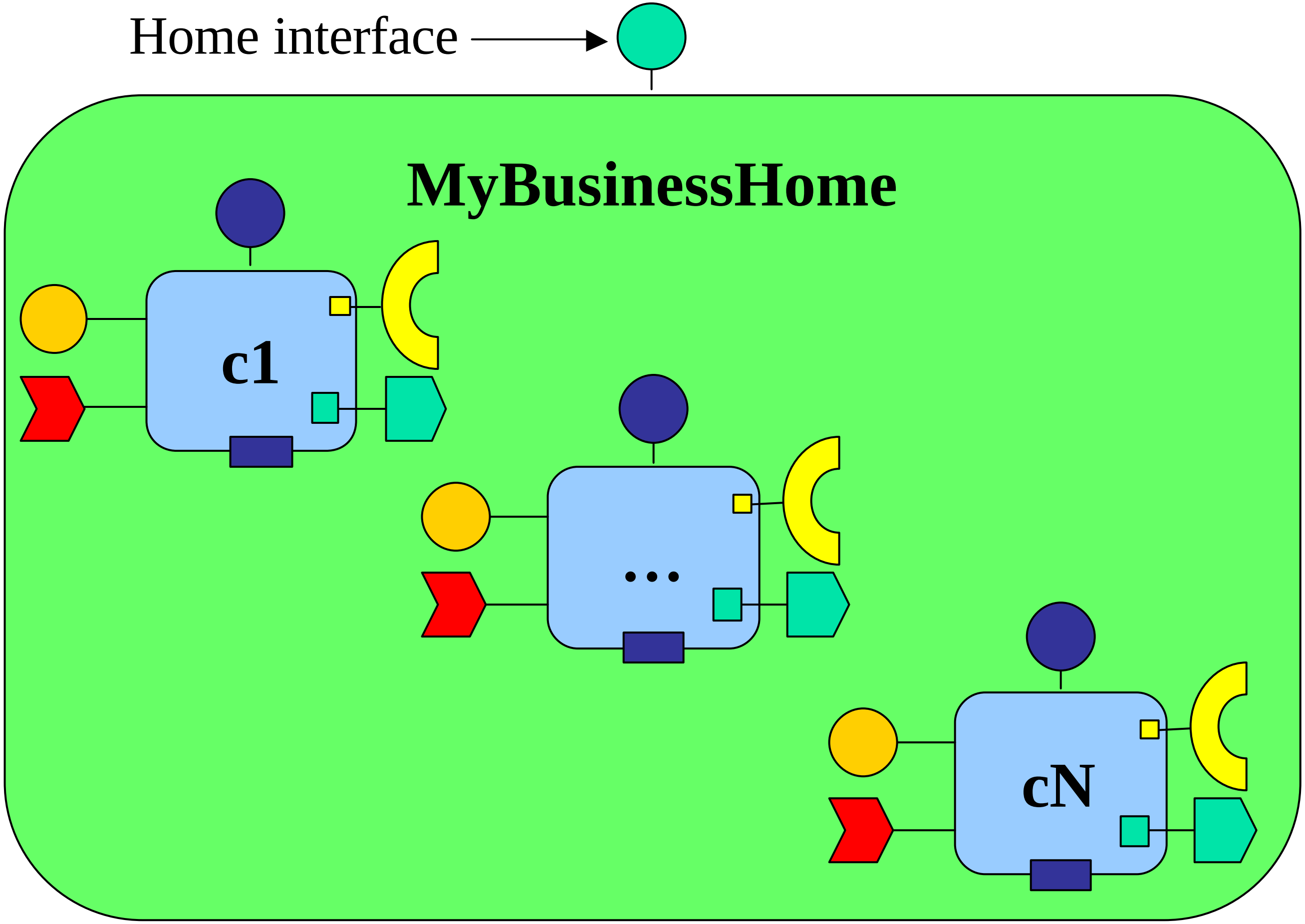
Component Event Sinks

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

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

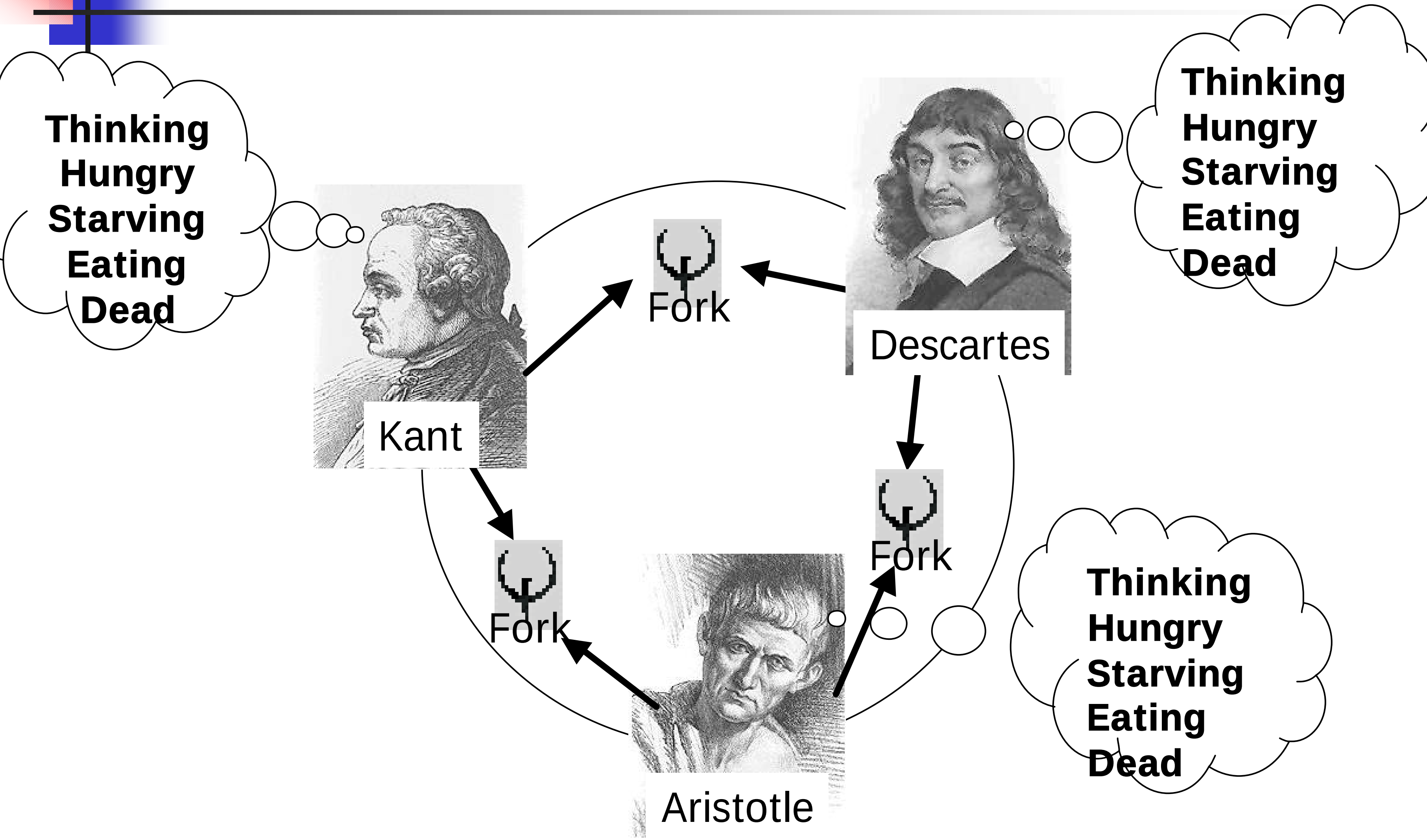
- Values exposed to clients to create, find, and destroy component instances
  - Uniquely identifies a component instance within a home
  - Assigned at creation time, or in pre-existing database
  - Must be a value type derived from Components::PrimaryKeyBase (empty, abstract)

- 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



Thinking
Hungry
Starving
Eating
Dead

Kant

Fork

Descartes

Thinking
Hungry
Starving
Eating
Dead

Fork

Fork

Aristotle

Thinking
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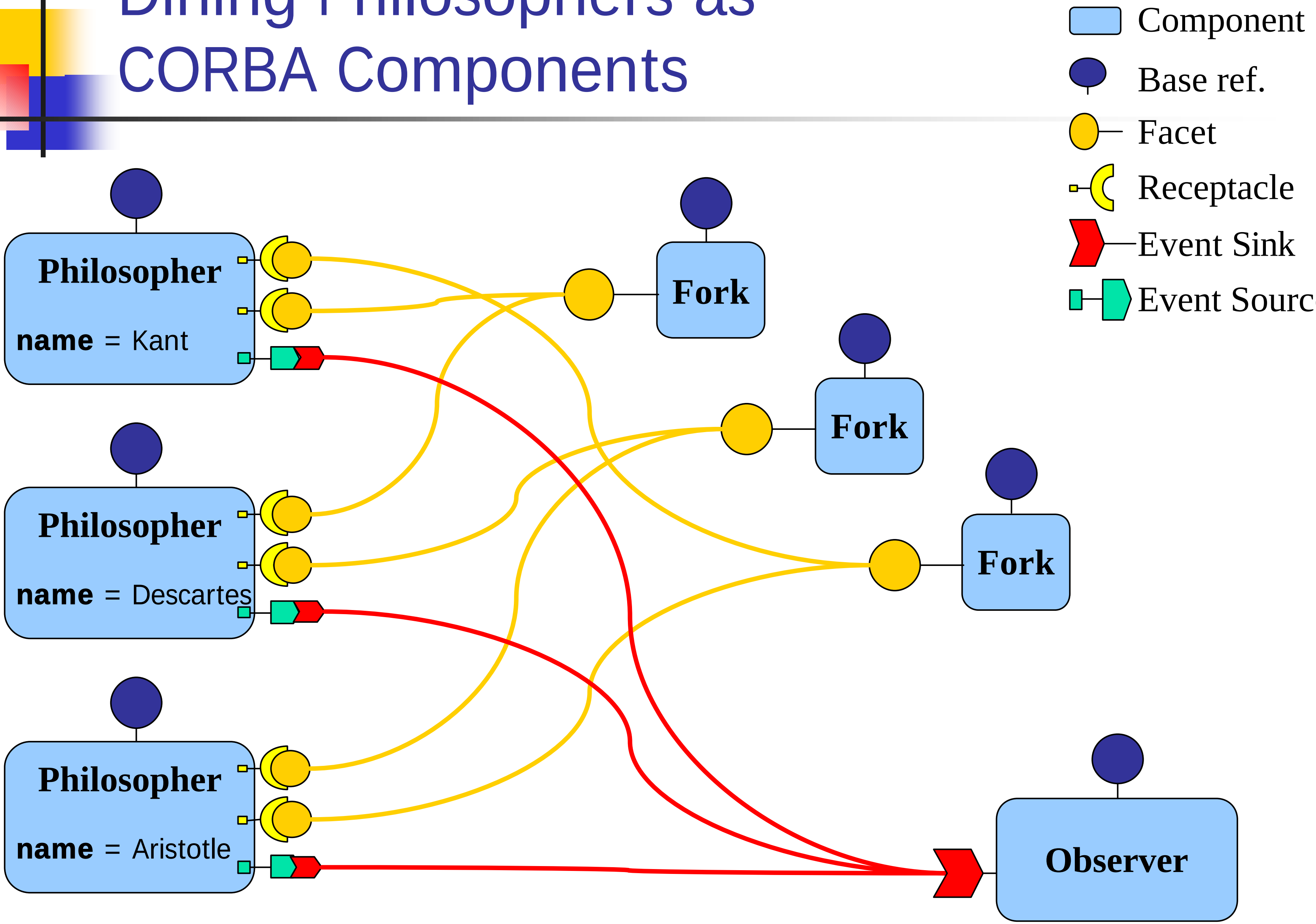
Dining Philosophers as CORBA Components



Component

Base ref.

Facet

Receptacle

Event Sink

Event Sourc

Philosopher

name = Kant

Philosopher

name = Descartes

Philosopher

name = Aristotle

Fork

Fork

Fork

Observer

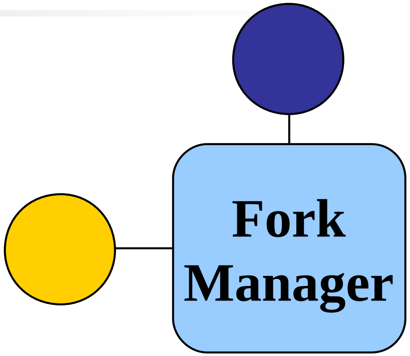
OMG IDL 3.0 for Dining Philosophers

```
// 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.
   typeprefix DiningPhilosophers "omg.org";

  . . .
};
```

The Fork Interface



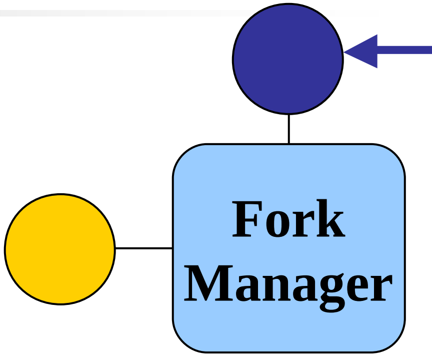
```
exception InUse {};

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



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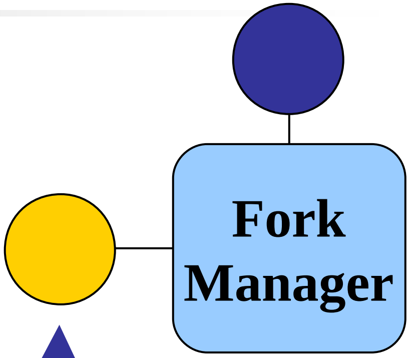
The Fork Manager Component Facet



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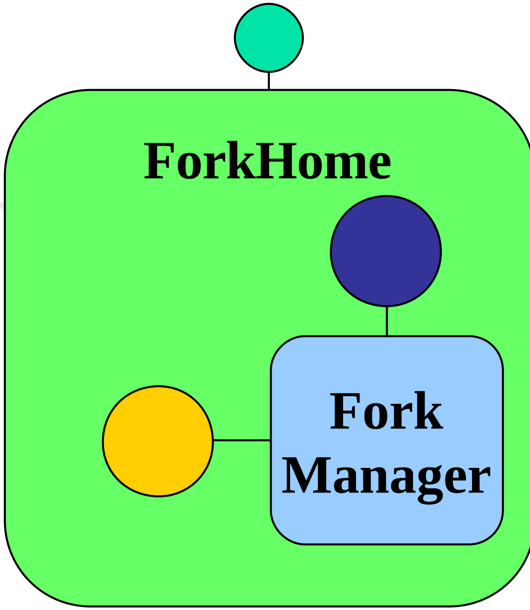
The Fork Manager Home



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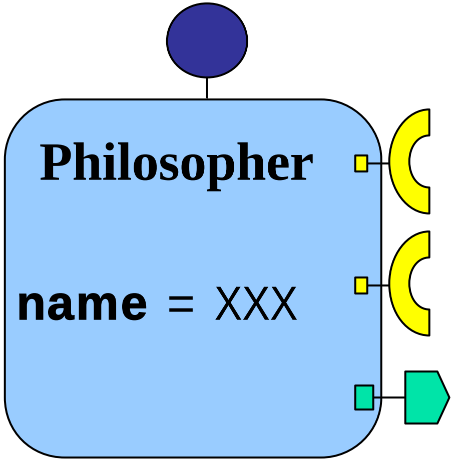
The Philosopher State Types



```
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

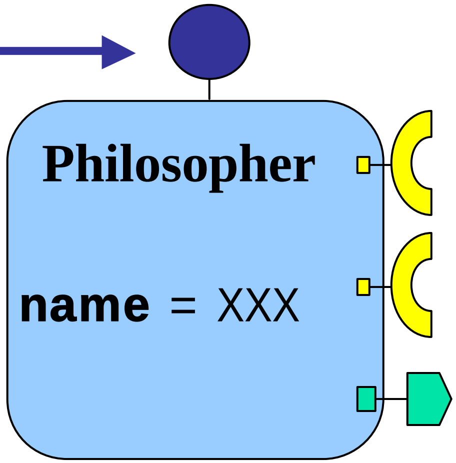
```
component Philosopher
{
   attribute string name;

   // The left fork receptacle.
   uses Fork left;

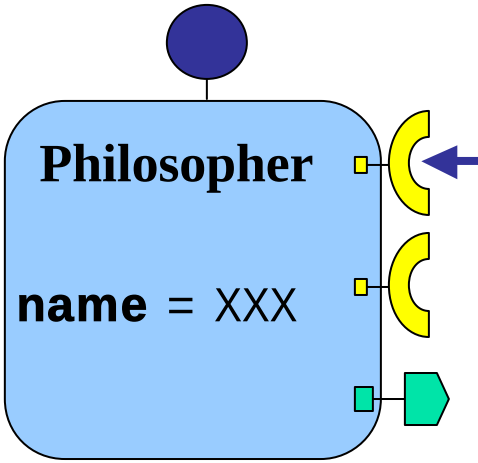
   // The right fork receptacle.
   uses Fork right;

   // The status info event source.
   publishes StatusInfo info;
};

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



The Philosopher Component Receptacles



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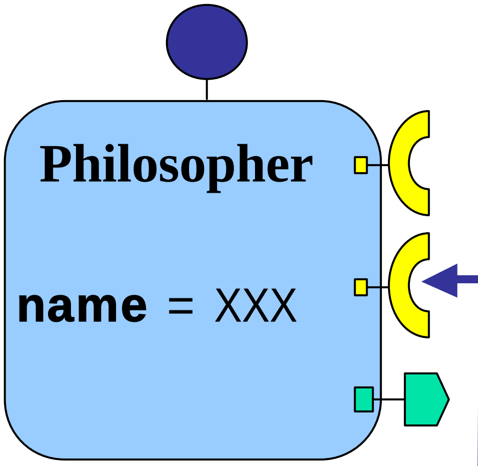

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The Philosopher Component Event Source

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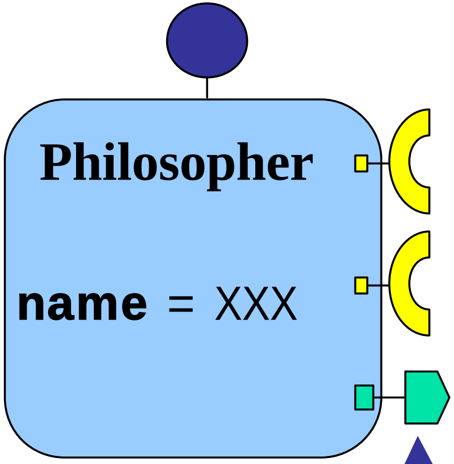
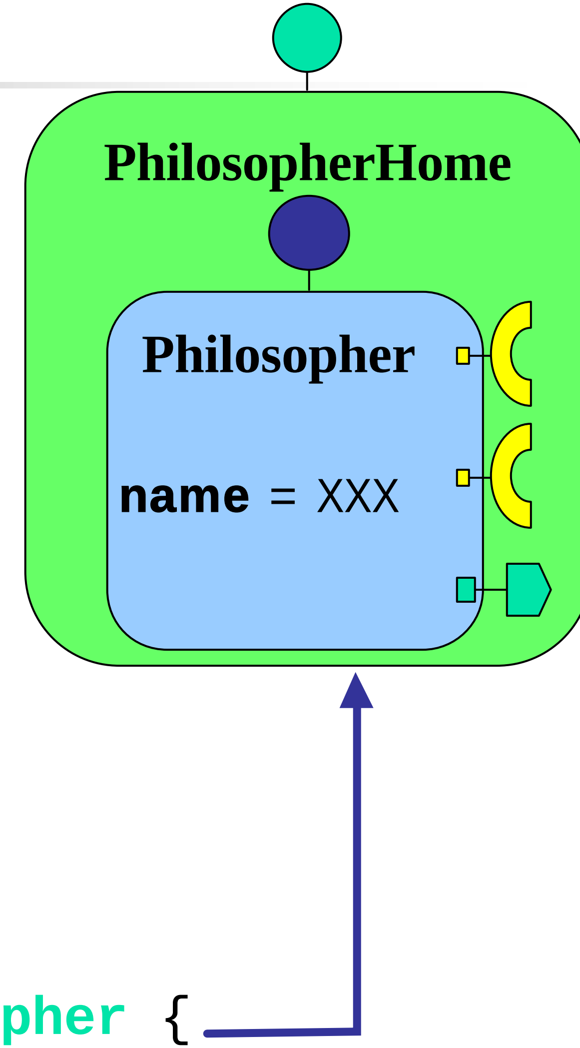


The Philosopher Home



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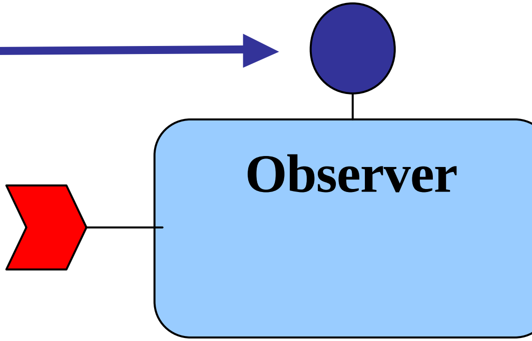
The Observer Component



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

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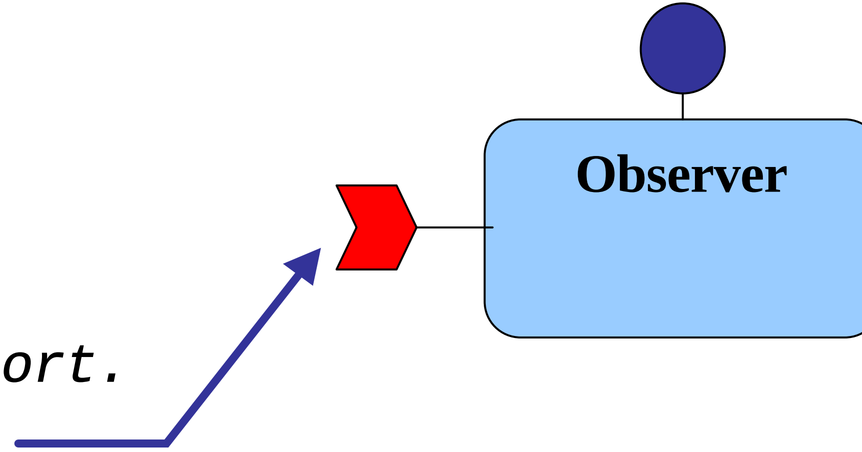

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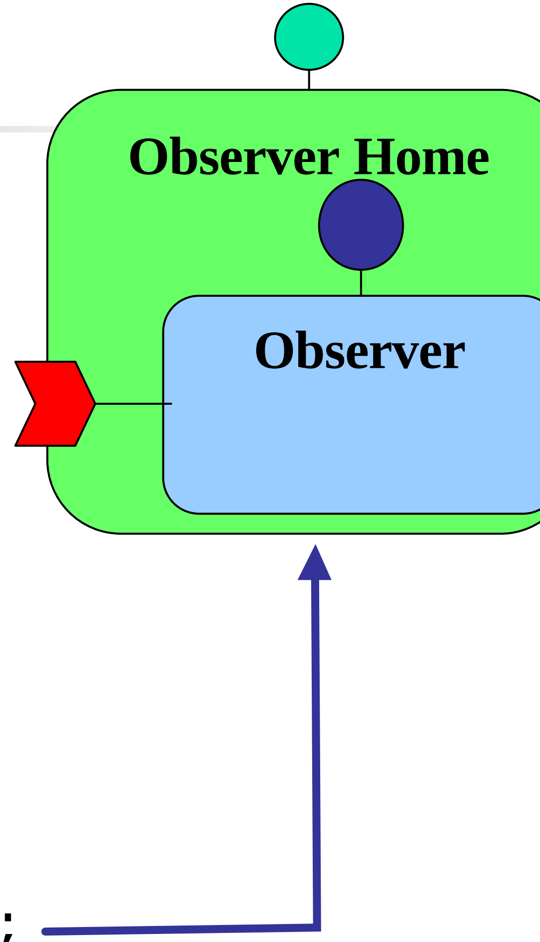


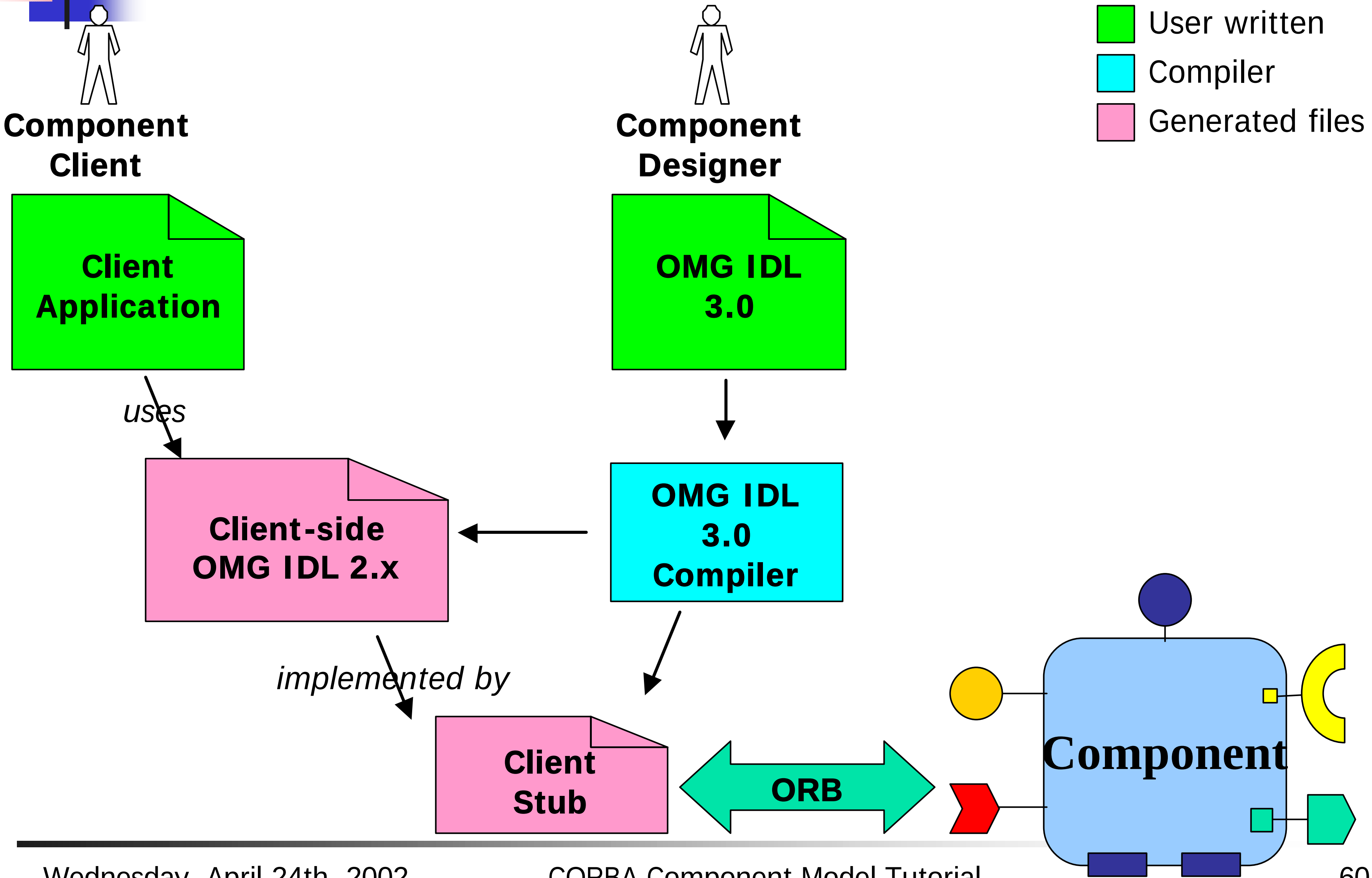
Programming CORBA Component Clients

- 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

The Client-Side OMG IDL Mapping



🟩 User written
🟦 Compiler
🟪 Generated files

Component Client

Component Designer

Client Application

OMG IDL 3.0

uses

OMG IDL 3.0 Compiler

Client-side OMG IDL 2.x

implemented by

Client Stub

ORB

Component

Main Client-Side OMG IDL Mapping Rules

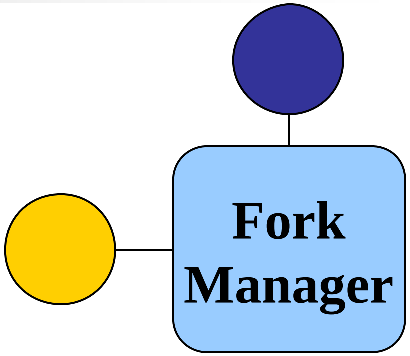
- A component type is mapped to an interface inheriting from `Components::CCMObject`
- Facets and event sinks are mapped to an operation for obtaining the associated reference
- Receptacles are mapped to operations for connecting, disconnecting, and getting the associated reference(s)
- Event sources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

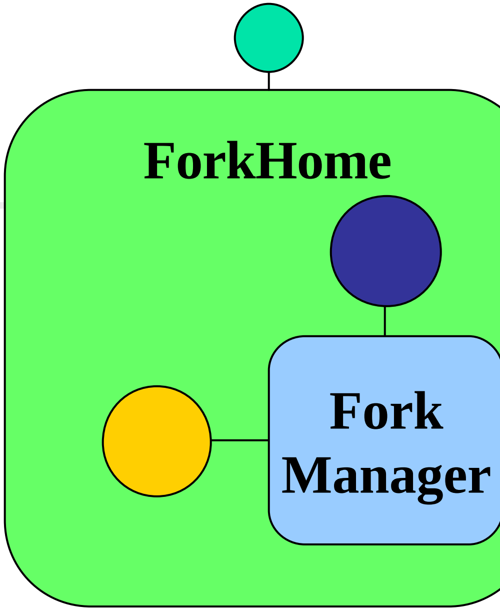
```
component ForkManager
{
  provides Fork the_fork;
};
```



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 {};
```

Client-Side Mapping for StatusInfo Event Type

```
eventtype StatusInfo {. . .};
```

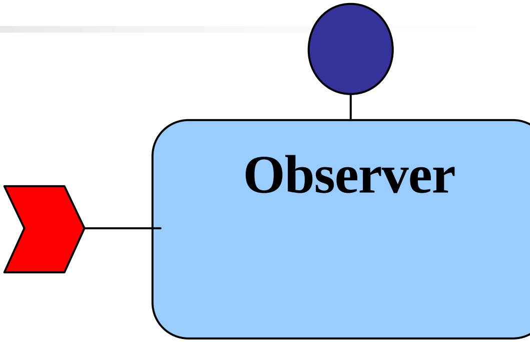
Is mapped to

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

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

Client-Side Mapping for Observer Component

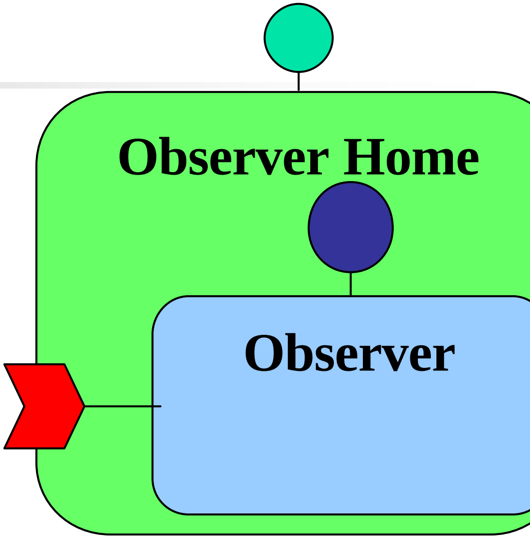
```
component Observer {
  consumes StatusInfo info;
};
```



Is mapped to

```
interface Observer :
          ::Components::CCMObject {
  StatusInfoConsumer get_consumer_info();
};
```

Client-Side Mapping for Observer Home



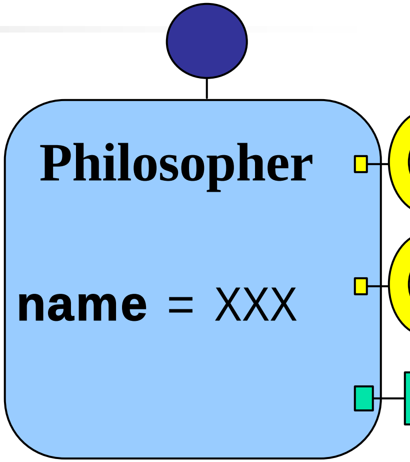
```
home ObserverHome
        manages Observer {};
```

Is mapped to

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

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

Client-Side Mapping for Philosopher Component



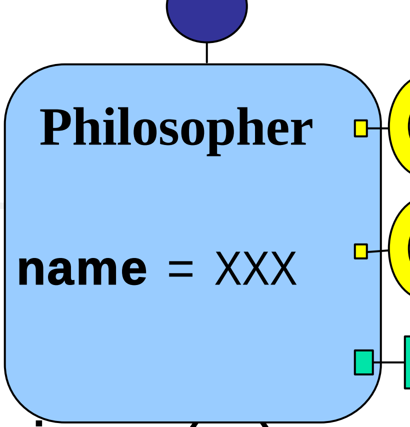
```
component Philosopher {
  attribute string name;
  uses Fork left;
  uses Fork right;
  publishes StatusInfo info;
};
```

Is mapped to

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

  .../...
```

Client-Side Mapping for Philosopher Component

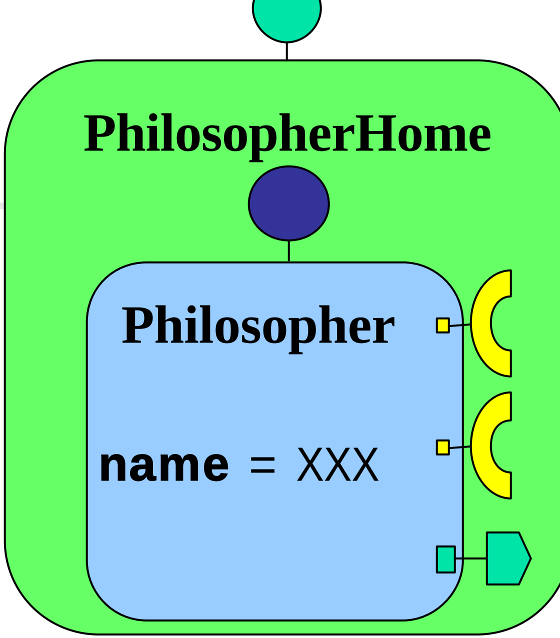


```
  void connect_left(in Fork cnx) raises(…);
  Fork disconnect_left() raises(…);
  Fork get_connection_left();

  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



```
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

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())

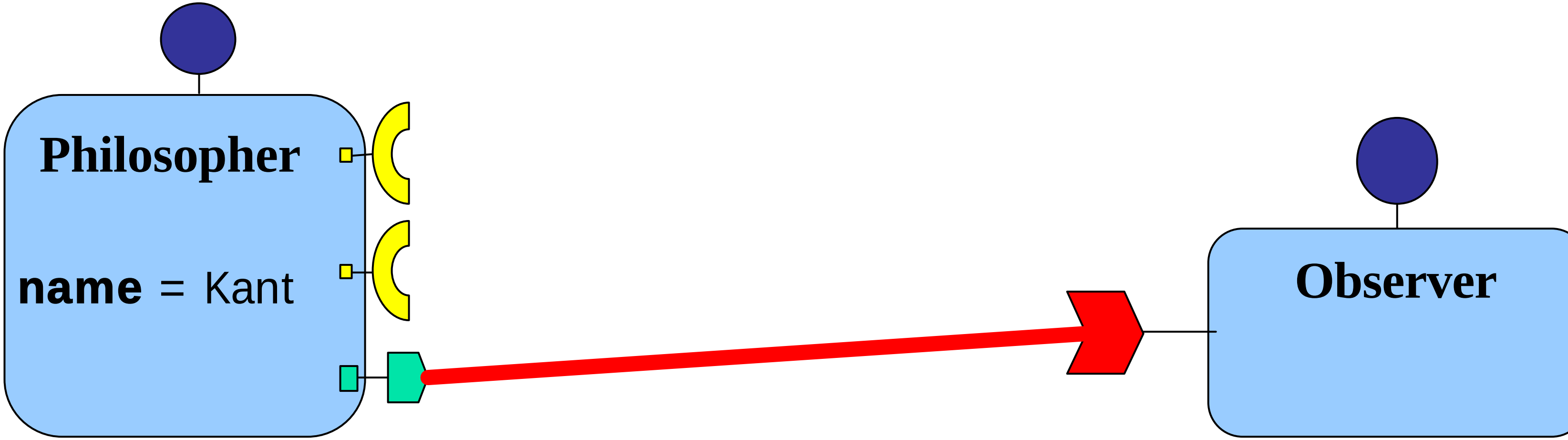
# Creates a fork manager component.
forkManager = forkHome.create()

# 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

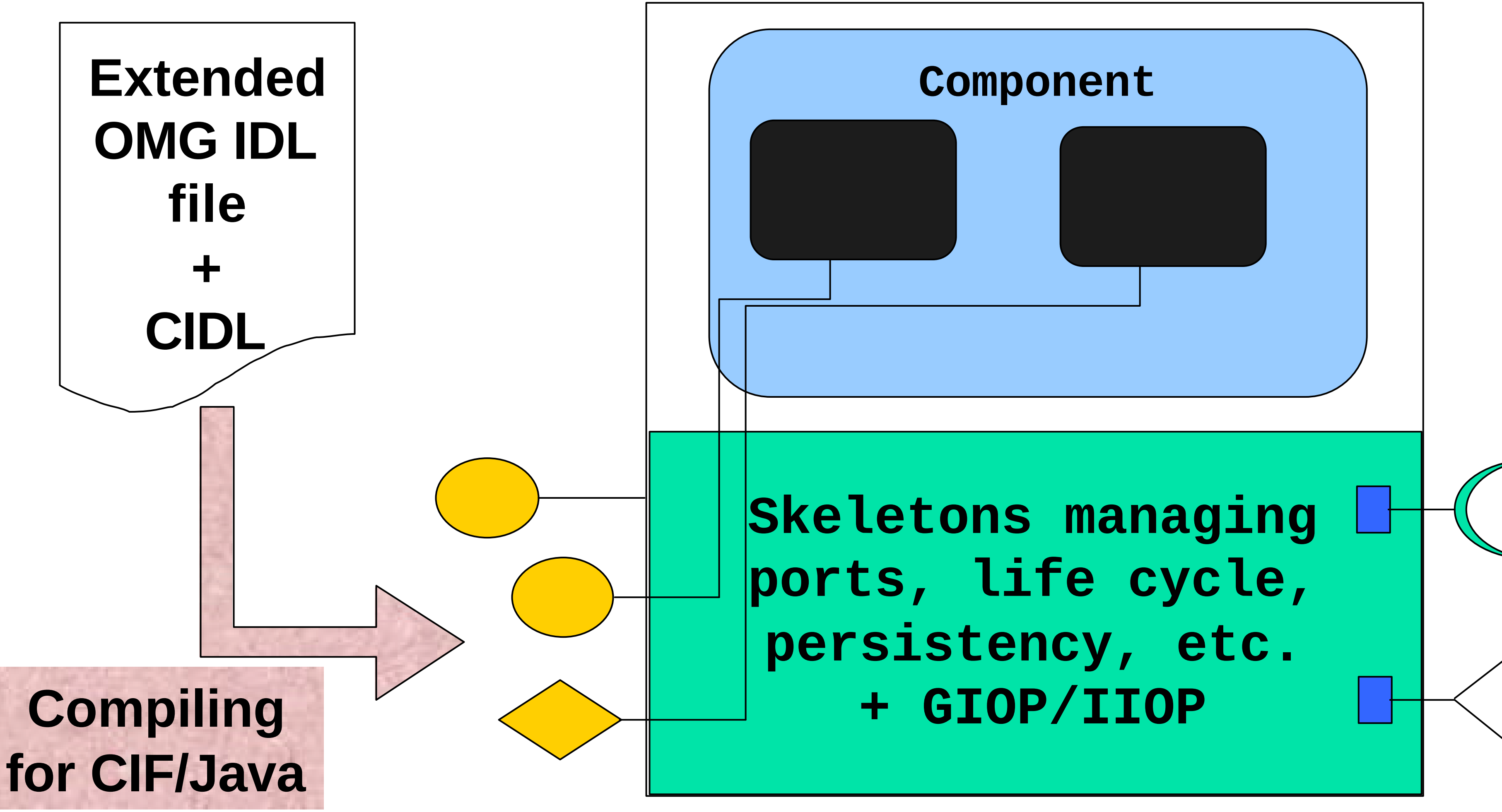
- Facilitates component implementation
  - “only” business logic should be implemented
    - Not activation, identify, port management and introspection

  => Local server-side OMG IDL mapping
    - Interactions between implementations and containers

- Manages segmentation and persistency

  => Component Implementation Definition Language

Component Implementation Framework to Component Skeleton Generation



Extended OMG IDL file + CIDL

Compiling for CIF/Java

Skeletons managing ports, life cycle, persistency, etc. + GIOP/IIOP

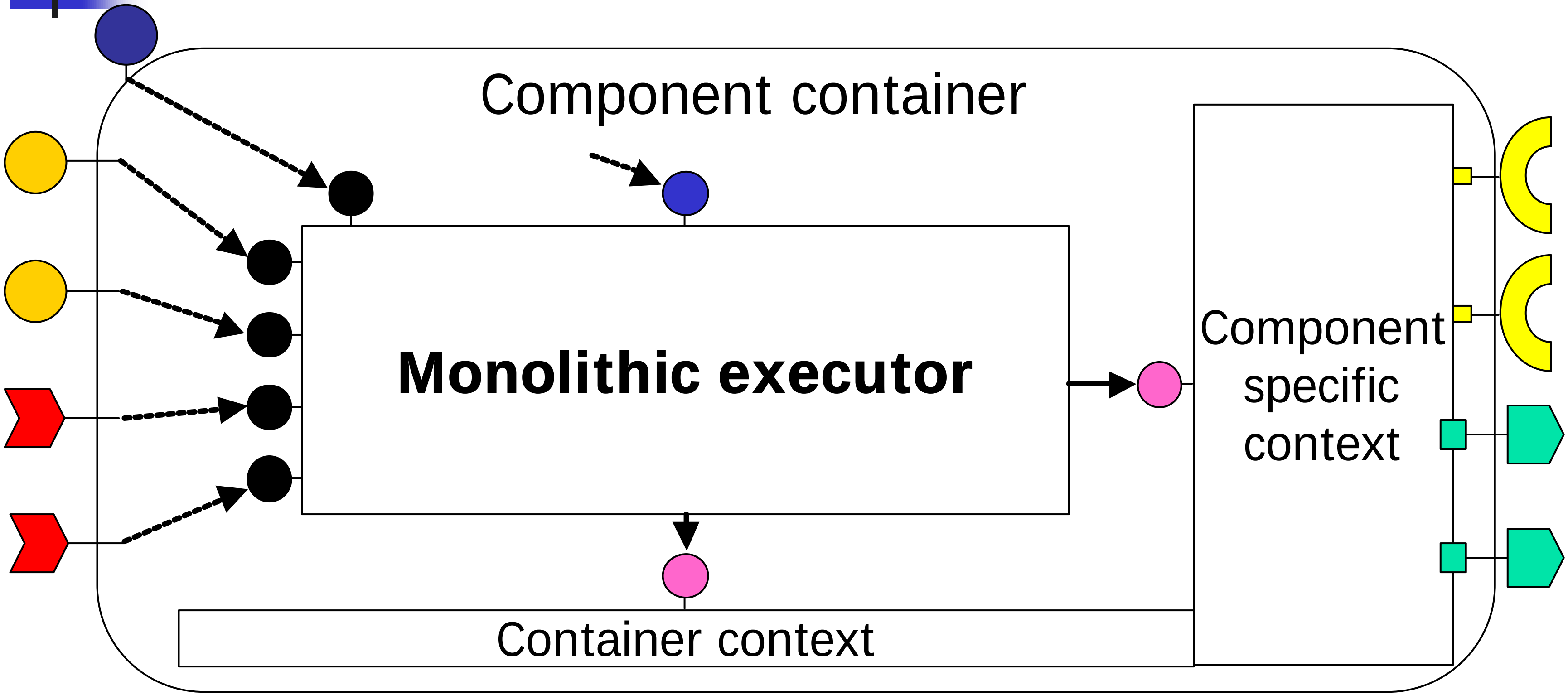
Executors and Home Executors

- 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



Component container

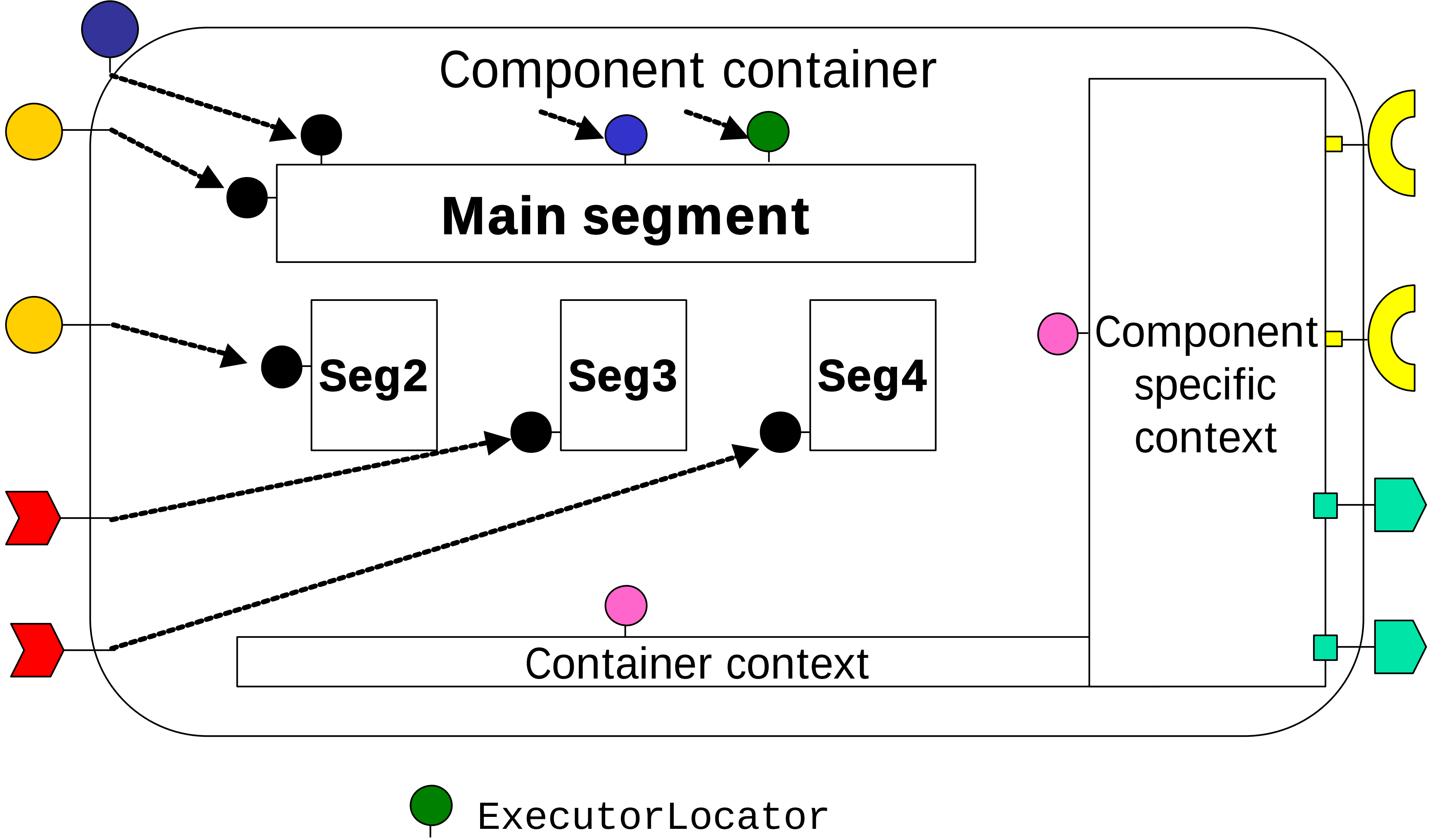
Monolithic executor

Component specific context

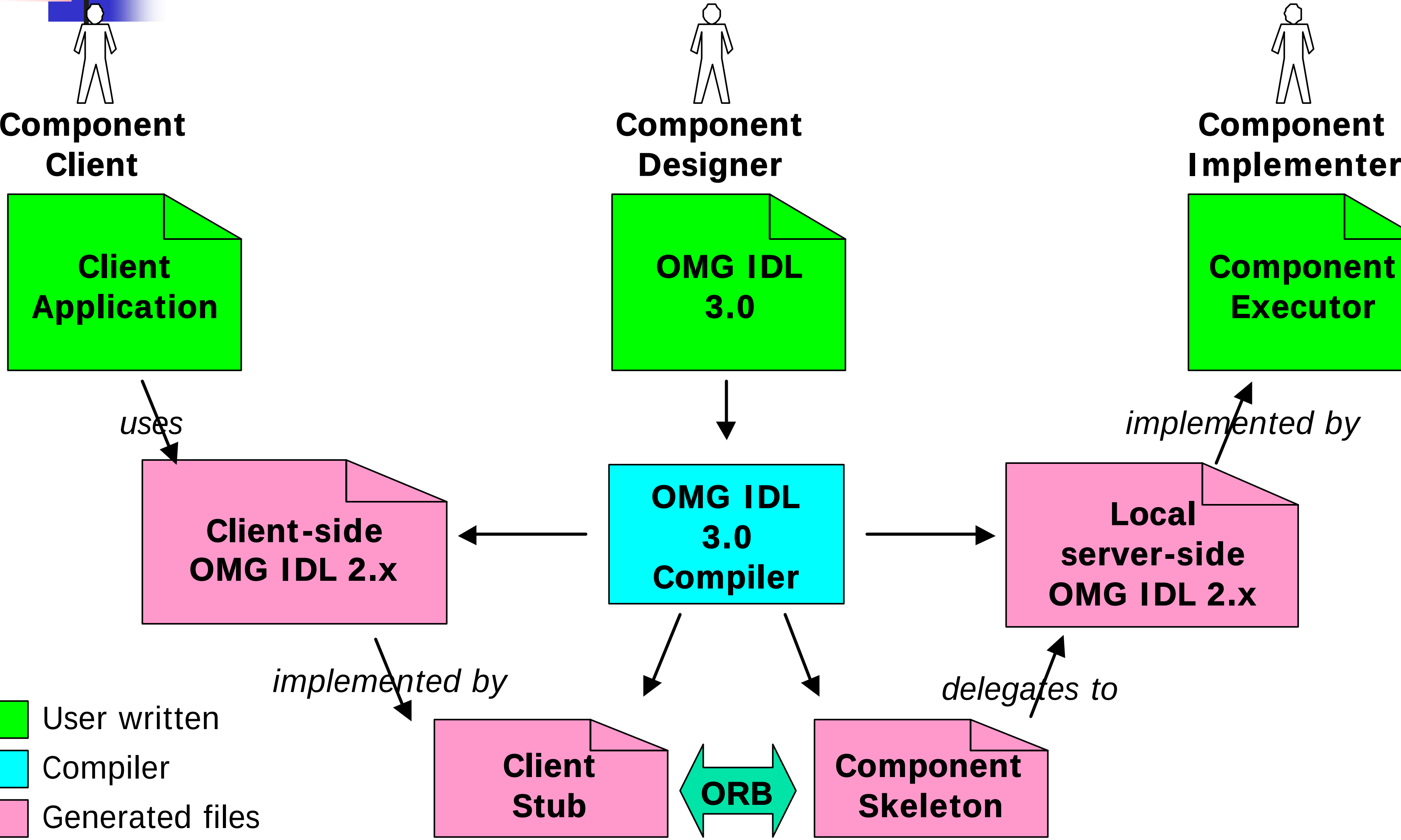
Container context

- ● Main component executor interface
- ● Facet or event sink executor interface
- ● `SessionComponent` or `EntityComponent`
- ● Component-oriented context interface
- ● Container-oriented context interface
- → Context use
- ⇢ Container interposition

A Segmented Component Executor



The Server-Side OMG IDL Mapping



Component Client

Component Designer

Component Implementer

Client Application

OMG IDL 3.0

Component Executor

uses

implemented by

Client-side OMG IDL 2.x

OMG IDL 3.0 Compiler

Local server-side OMG IDL 2.x

implemented by

delegates to

Client Stub

ORB

Component Skeleton

🟩 User written

🟦 Compiler

🟪 Generated files

Main Server-Side OMG IDL Mapping Rules

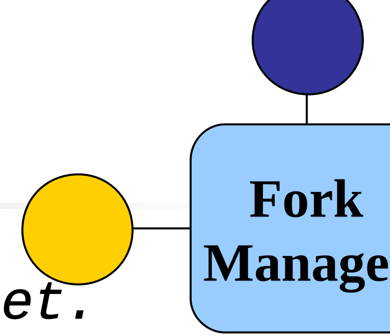
- A component type is mapped to three local interfaces
  - The main component executor interface
    - Inheriting from `Components::EnterpriseComponent`
  - The monolithic component executor interface
    - Operations to obtain facet executors and receive events
  - The component specific context interface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

- Dining Philosophers Example

Local Server-Side Mapping for ForkManager Component

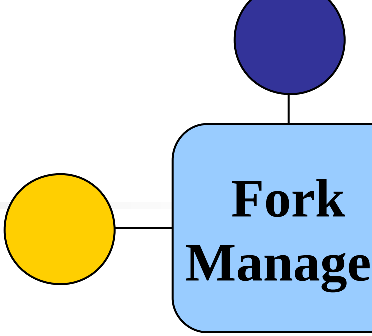


```
// Executor interface for the the_fork facet.
local interface CCM_Fork : Fork {};

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

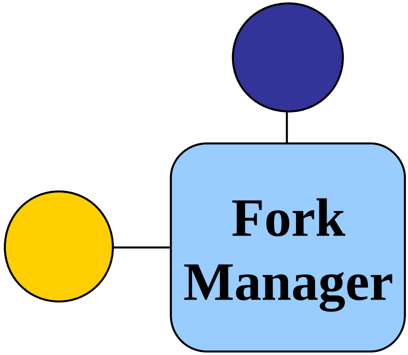
// Monolithic executor interface.
local interface CCM_ForkManager :
                CCM_ForkManager_Executor {
  // Requested by container.
  CCM_Fork get_the_fork();
};
```

Local Server-Side Mapping for ForkManager Component



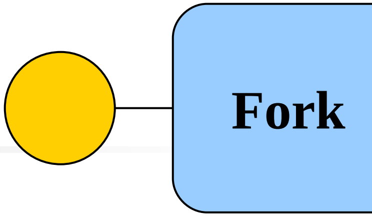
```
// Component-specific context interface.
local interface CCM_ForkManager_Context :
                // Container context interface.
                ::Components::CCMContext
{
  // Empty because no receptacles or event sources.
};
```

Different ForkManager Implementations



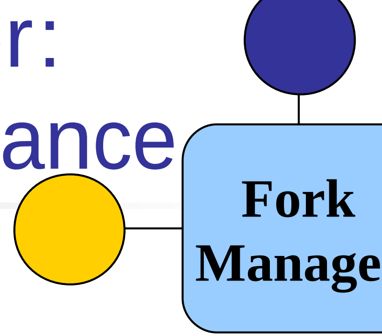
- Fork facet implementation
  - class **ForkImpl**
- Monolithic executor approach
  - By inheritance: **MonolithicForkManager_1_Impl**
  - By delegation: **MonolithicForkManager_2_Impl**
- Executor locator approach
  - One segment: **SegmentedForkManager_1_Impl**
  - Two segments: **SegmentedForkManager_2_Impl**

Fork Facet Implementation: Just Business Operations



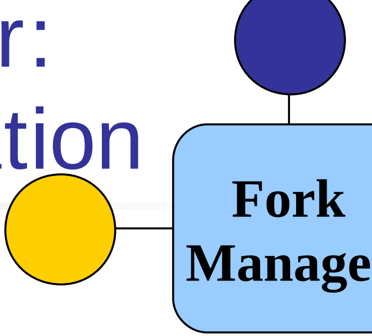
```
public class ForkImpl
     extends org.omg.CORBA.LocalObject
  implements CCM_Fork
{
  private boolean available_ = true;
  public void get() throws InUse
  {
    // Check if there is no current philosopher.
    if (!available_) throw new InUse();
    available_ = false;
  }
  public void release()
  {
    available_ = true;
} }
```

Monolithic ForkManager Executor: Facet Implementation By Inheritance



```
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;
  }
```

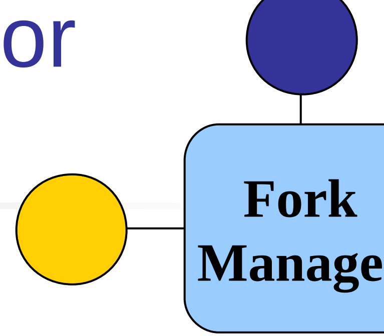
Monolithic ForkManager Executor: Facet Implementation By Delegation



```
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_;
  }
```

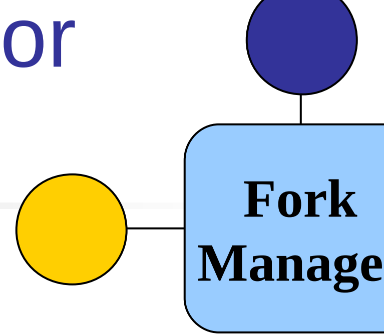
Segmented ForkManager Executor With One Segment



```
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();
  }

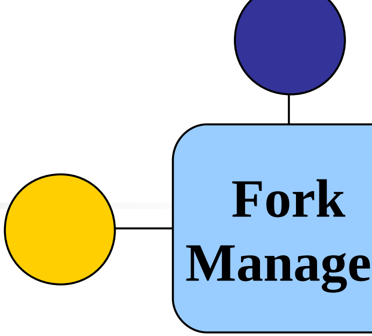
   public void release_executor(org.omg.CORBA.Object exc)
               throws org.omg.Components.CCMException {...}
   public void configuration_complete()
      throws org.omg.Components.InvalidConfiguration {...}
```

Segmented ForkManager Executor With Two Segments



```
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



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

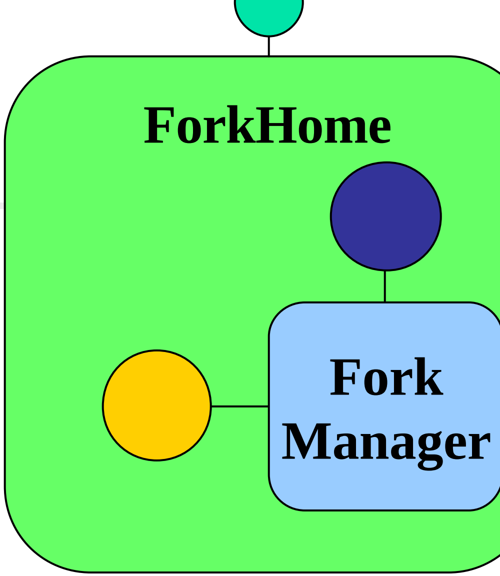
// The context is fixed by the container.
public void set_session_context(SessionContext ctx)
            throws CCMException {...}

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

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

// Called by container when component is removed.
public void ccm_remove() throws CCMException {...}
```

Local Server-Side Mapping for Fork Home

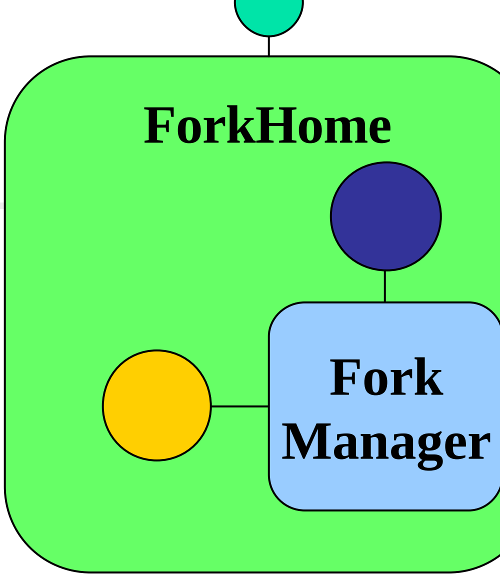


```
local interface CCM_ForkHomeExplicit :
      ::Components::HomeExecutorBase {
 // Empty as no user-defined home operations.
};

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

local interface CCM_ForkHome :
                CCM_ForkHomeExplicit,
                CCM_ForkHomeImplicit {};
```

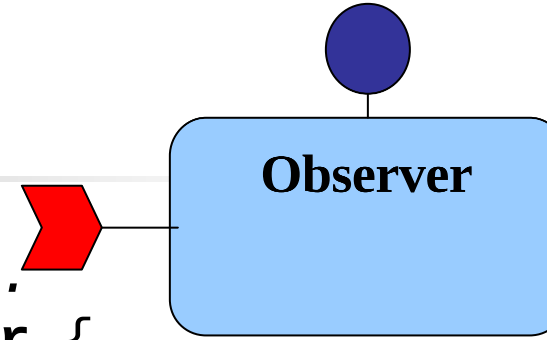
Fork Home Executor



```
public class ForkHomeImpl
     extends org.omg.CORBA.LocalObject
  implements CCM_ForkHome
{
  //  Called at deployment time.
  public static org.omg.Components.HomeExecutorBase
  create_home() {
    return new ForkHomeImpl();
  }

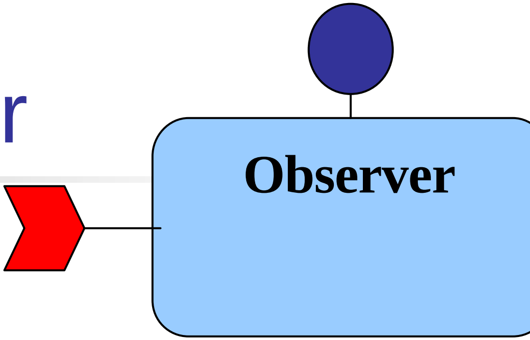
  //  Required by CCM_ForkHome interface.
  public org.omg.Components.EnterpriseComponent
  create() {
    // This home executor class manages a specific
    // component executor class.
    return new ...ForkManager...Impl();
} }
```

Local Server-Side Mapping for Observer Component



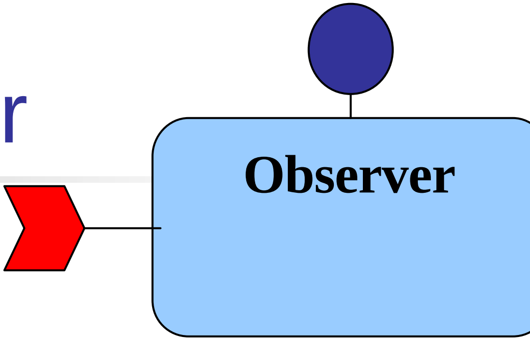
```
// info event sink executor interface.
local interface CCM_StatusInfoConsumer {
  void push(in StatusInfo ev);
};
// Main component executor interface.
local interface CCM_Observer_Executor :
  ::Components::EnterpriseComponent {
};
// Monolithic executor interface.
local interface CCM_Observer :
                CCM_Observer_Executor {
  void push_info(in StatusInfo ev);
};
// Component-specific context interface.
local interface CCM_Observer_Context :
                ::Components::CCMContext {};
```

Monolithic Observer Executor



```
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



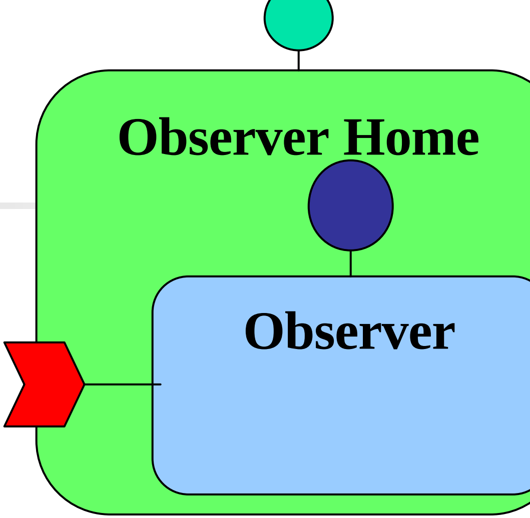
```
  public void set_session_context(SessionContext ctx)
   throws CCMException {...}

  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

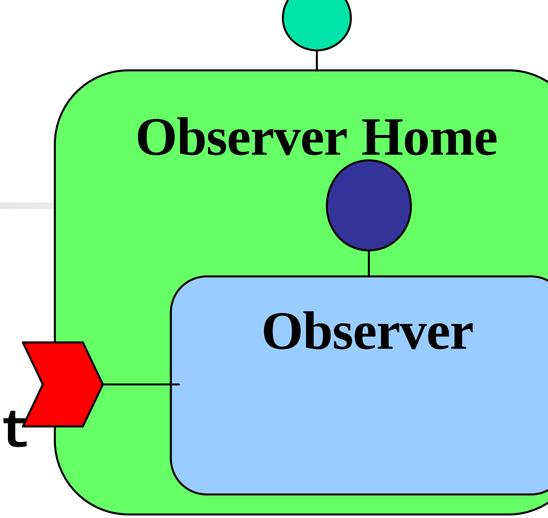


```
local interface
      CCM_ObserverHomeExplicit :
      ::Components::HomeExecutorBase {};

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

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

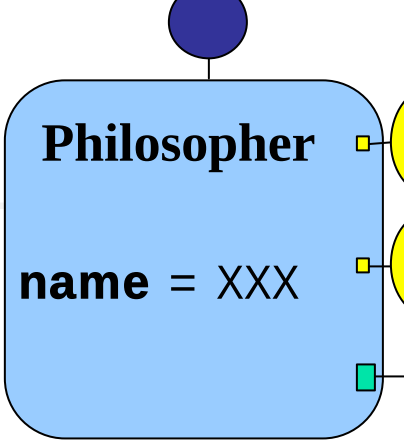
Observer Home Executor



```
public class ObserverHomeImpl
     extends org.omg.CORBA.LocalObject
  implements CCM_ObserverHome
{
  //  Called at deployment time.
  public static org.omg.Components.HomeExecutorBase
  create_home()
  { return new ObserverHomeImpl(); }

  //  Required by CCM_ObserverHome interface.
  public org.omg.Components.EnterpriseComponent
  create()
  { return new ObserverImpl(); }
}
```

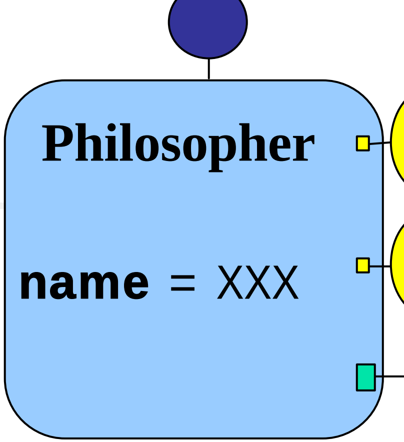
Local Server-Side Mapping for Philosopher Component



```
// 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 Mapping for Philosopher Context

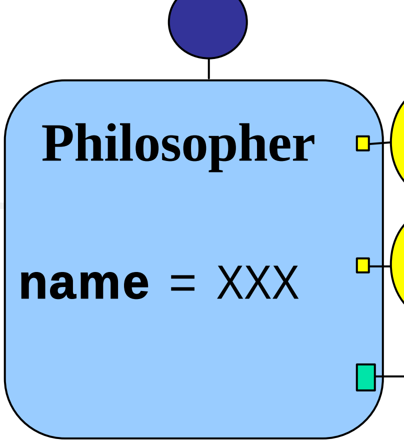


```
local interface CCM_Philosopher_Context :
                ::Components::CCMContext
{
  // To obtain the connected left fork
  Fork get_connection_left();

  // To obtain the connected right fork
  Fork get_connection_right();

  // To push an info event to all subscribers
  void push_info(in StatusInfo ev);
};
```

Monolithic Philosopher Executor

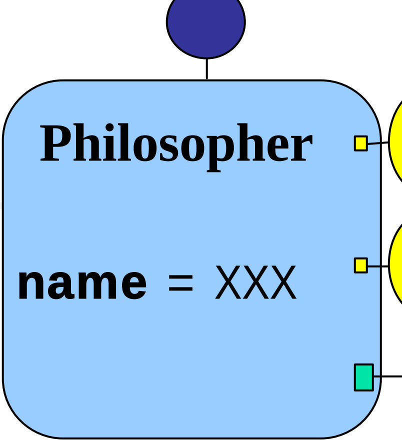


```
public class PhilosopherImpl
     extends org.omg.CORBA.LocalObject
  implements CCM_Philosopher,
             SessionComponent,
             java.lang.Runnable
{ // Constructor.
  public PhilosopherImpl(String n) { name_ = n; }

  // Transient state.
  private String name_;

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

Monolithic Philosopher Executor



```
// The philosopher behavior state machine.
private java.lang.Thread behavior_;

// The philosopher CCM context.
private CCM_Philosopher_Context the_context_;

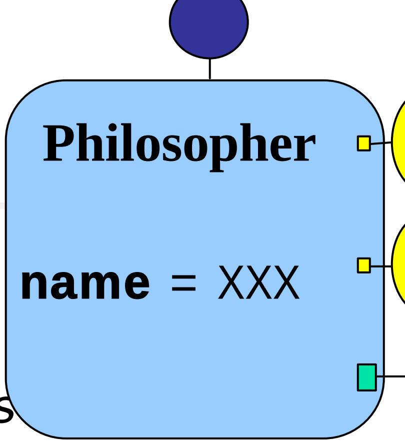
public void set_session_context(SessionContext ctx)
            throws CCMException
{ the_context_ = (CCM_Philosopher_Context)ctx; }

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

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

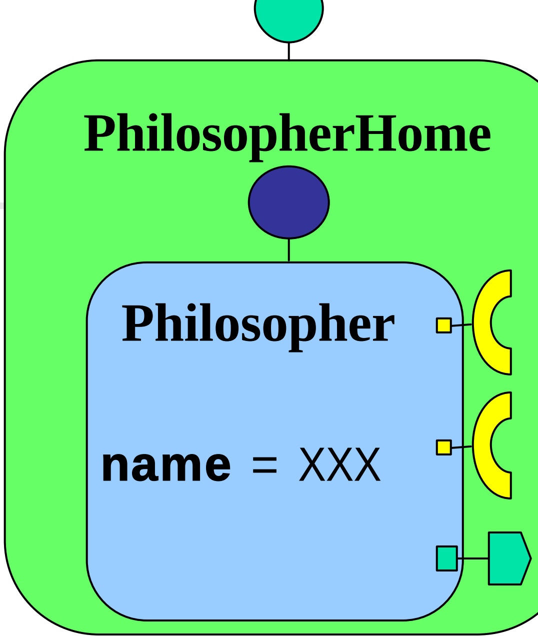
public void ccm_remove() throws CCMException {...}
```

Monolithic Philosopher Executor



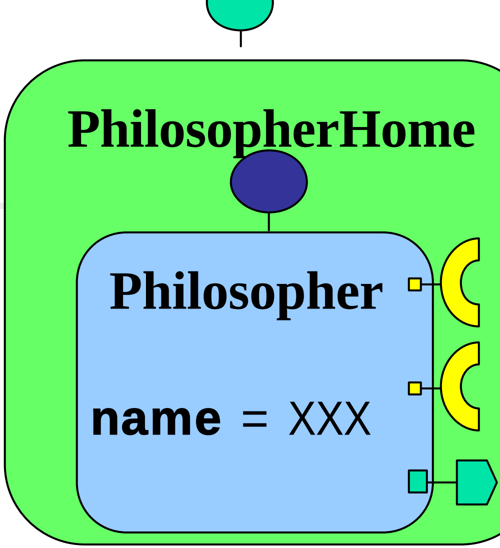
```
public void run() { // The state machine.
  ...
  // Pushes the current status to all observers
  the_context_.push_info(...);
  ...
  // Takes the left fork.
  the_context_.get_connection_left().get();
  ...
  // Takes the right fork.
  the_context_.get_connection_right().get();
  ...
  // Releases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



```
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



```
public class PhilosopherHomeImpl
      extends org.omg.CORBA.LocalObject
  implements CCM_PhilosopherHome
{
  // Called at deployment time.
  public static org.omg.Components.HomeExecutorBase
  create_home() { return new PhilosopherHomeImpl(); }

  // 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);
} }
```

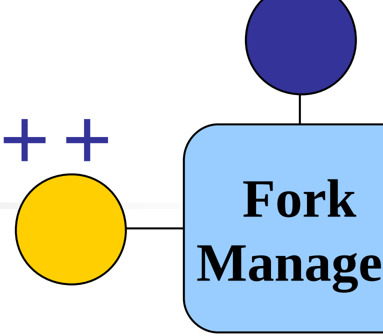
Implementing CORBA Components in C++

- 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++

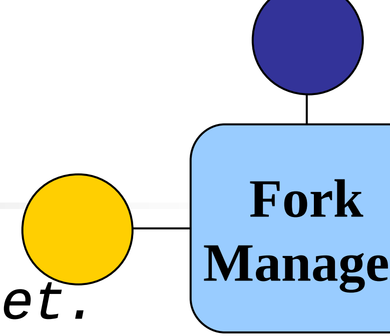


```
exception InUse {};

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

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

Server Side equivalent IDL for ForkManager

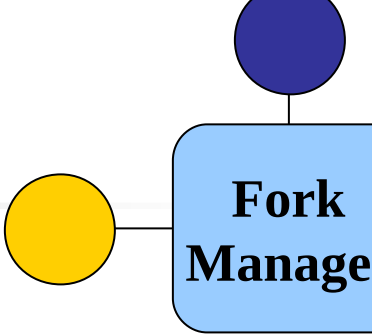


```
// Executor interface for the the_fork facet.
local interface CCM_Fork : Fork {};

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

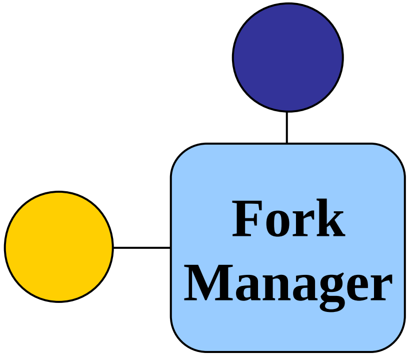
// Monolithic executor interface.
local interface CCM_ForkManager :
                CCM_ForkManager_Executor {
  // Requested by container.
  CCM_Fork get_the_fork();
};
```

Server Side equivalent IDL for ForkManager



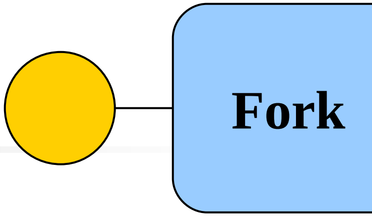
```
// Component-specific context interface.
local interface CCM_ForkManager_Context :
                ::Components::CCMContext
{
  // Empty because no receptacles or event sources.
};
```

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



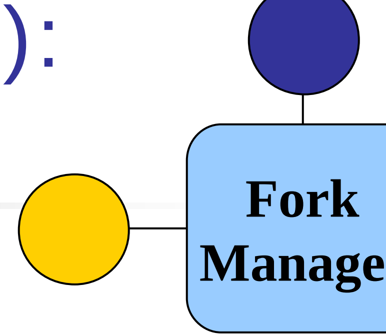
```
class Fork_impl : virtual public CCM_Fork
{ bool available_;
public:
  Fork_impl () { available_ = true; }

  public void get()
  {
    if (!available_) throw InUse();

    available_ = false;
  }

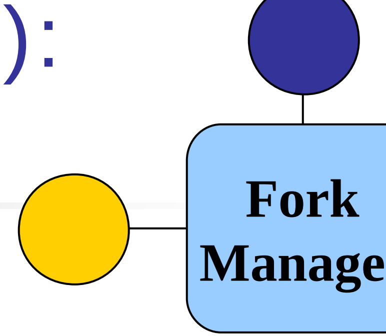
  public void release()
  {
    available_ = true;
  }
};
```

ForkManager Implementation (1): Monolithic, Inheritance of Facet



```
// IDL
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);
   }
};
```

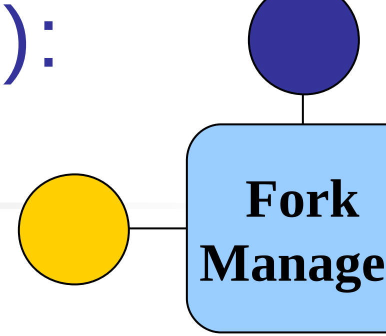
ForkManager Implementation (2): Monolithic, Delegation of Facet



```
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_);
  }
};
```

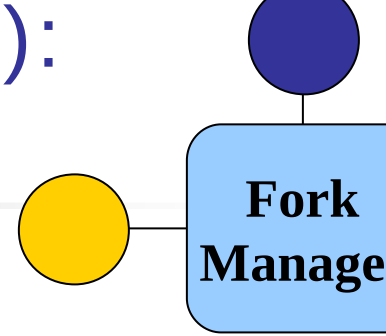
ForkManager Implementation (3): Locator based



```
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)



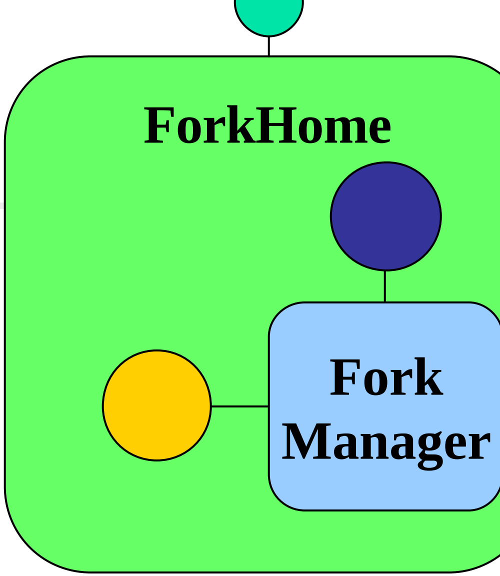
```
/* MyFork_3_Locator_impl continued */

  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

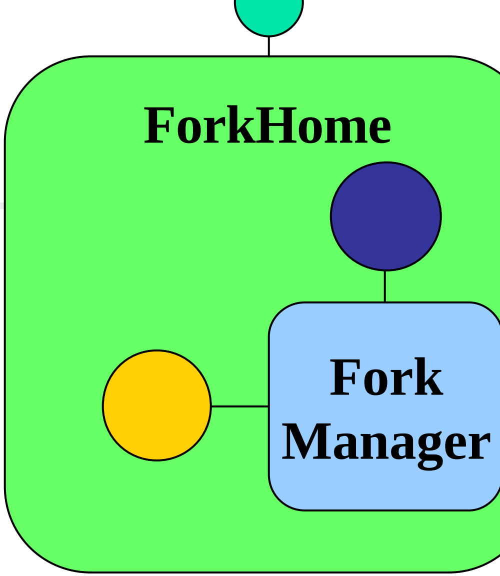


```
local interface CCM_ForkHomeExplicit :
      ::Components::HomeExecutorBase {
 // Empty
};

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

local interface CCM_ForkHome :
                CCM_ForkHomeExplicit,
                CCM_ForkHomeImplicit {};
```

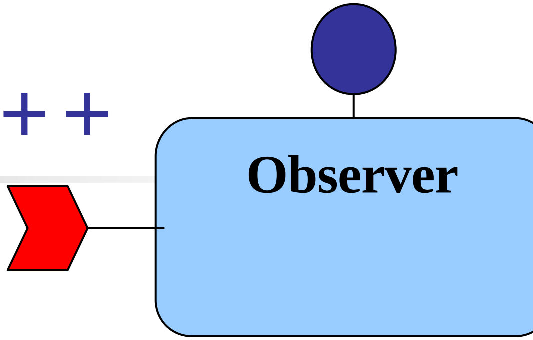
ForkHome Executor



```
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 { ... };

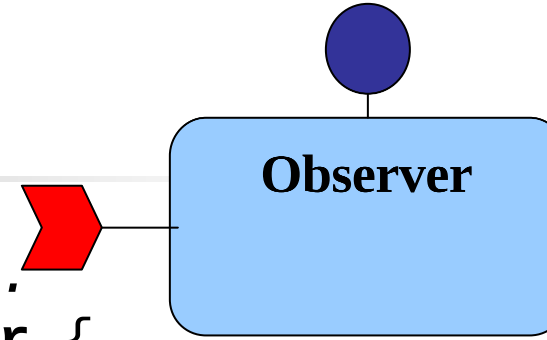
component Observer {
  consumes StatusInfo info;
};

home ObserverHome manages Observer {};

// to be notified of activation and passivation

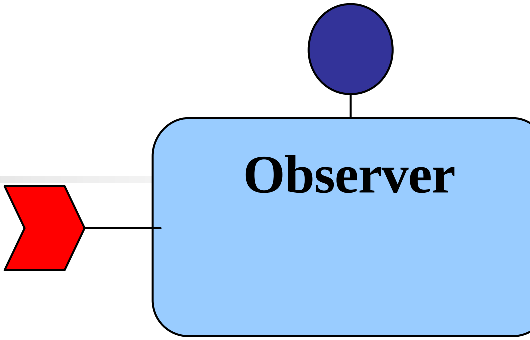
local interface MyObserver :
   CCM_Observer,
   Components::SessionComponent
{};
```

Server Side equivalent IDL for Observer



```
// 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 {};
```

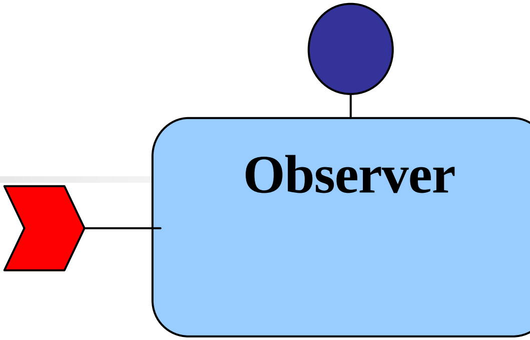
Observer Implementation Monolithic



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

  void push_info (StatusInfo * event)
  {
    … update GUI …
  }
```

Observer Implementation Monolithic (2)



```
  // from SessionComponent interface

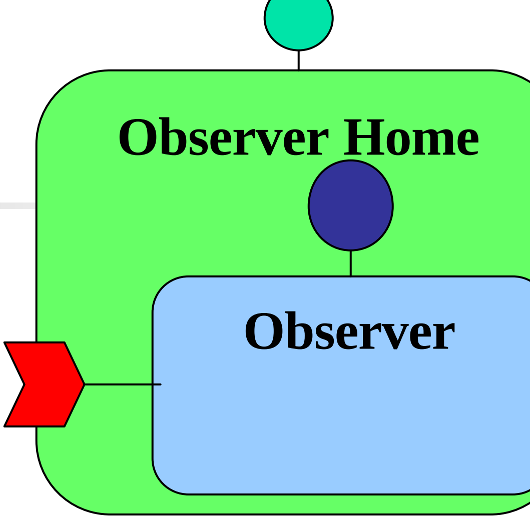
  void set_session_context
    (Components::SessionContext_ptr ctx)
  { /* empty */ }

  void ccm_activate ()
  { … display GUI … }

  void ccm_passivate ()
  { … hide GUI … }

  void ccm_remove ()
  { … free GUI … }
};
```

Server Side Equivalent IDL for ObserverHome

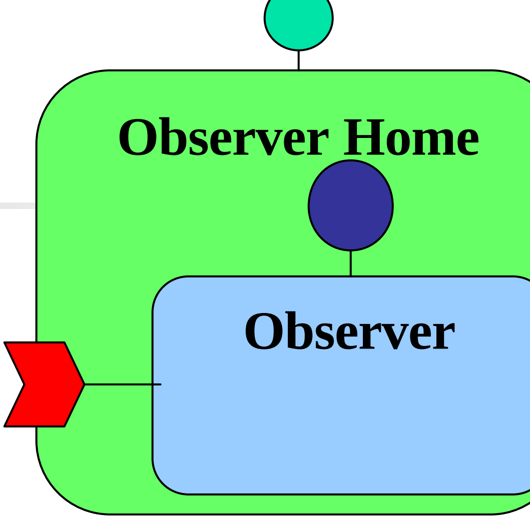


```
local interface
        CCM_ObserverHomeExplicit :
        ::Components::HomeExecutorBase {};

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

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

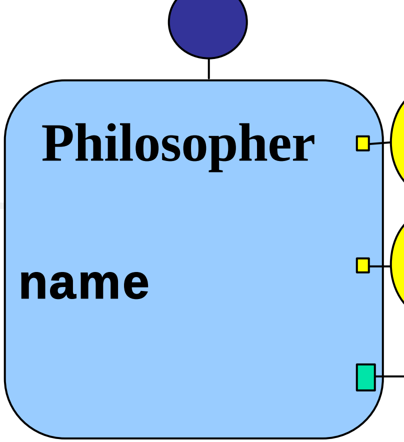
ObserverHome Executor



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

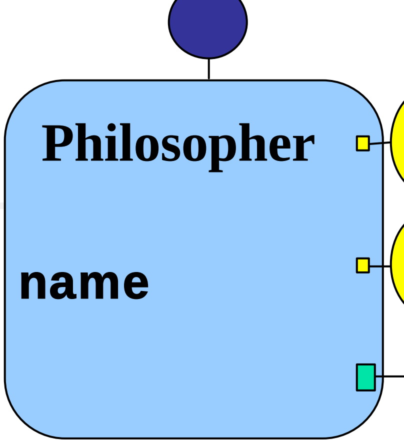
  Components::EnterpriseComponent_ptr create ()
  {
    return new Observer_impl;
  }
};
extern “C” {
  Components::HomeExecutorBase_ptr
  create_ObserverHome ()
  { return new ObserverHome_impl; }
}
```

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
{};
```

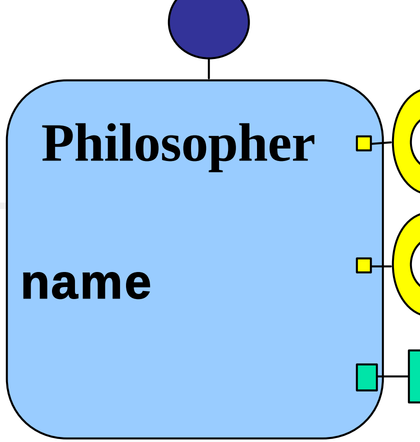
Server Side equivalent IDL for Philosopher



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

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

Server Side equivalent IDL for Philosopher

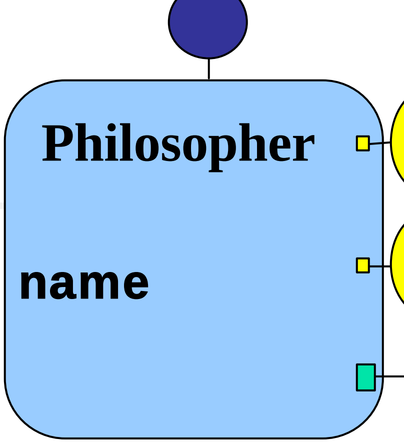


```
local interface CCM_Philosopher_Context :
                ::Components::CCMContext
{
  // To obtain the connected left fork
  Fork get_connection_left();

  // To obtain the connected right fork
  Fork get_connection_right();

  // To push an info event to all subscribers
  void push_info(in StatusInfo ev);
};
```

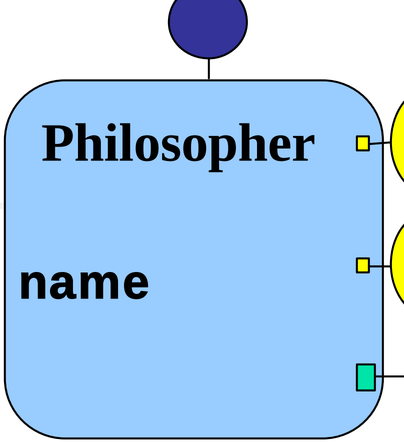
Philosopher Executor Monolithic



```
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); }
```

Philosopher Executor Monolithic (2)



```
// from SessionComponent interface

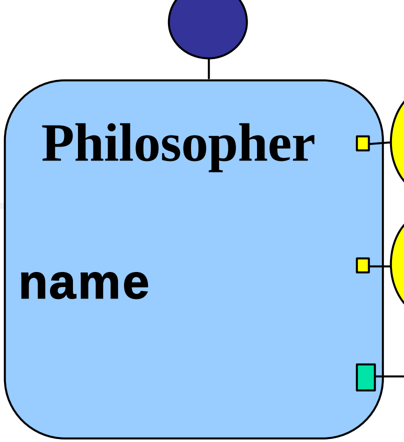
void set_session_context
  (Components::SessionContext_ptr ctx)
{ _ctx = CCM_Philosopher_Context::_narrow (ctx); }

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

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

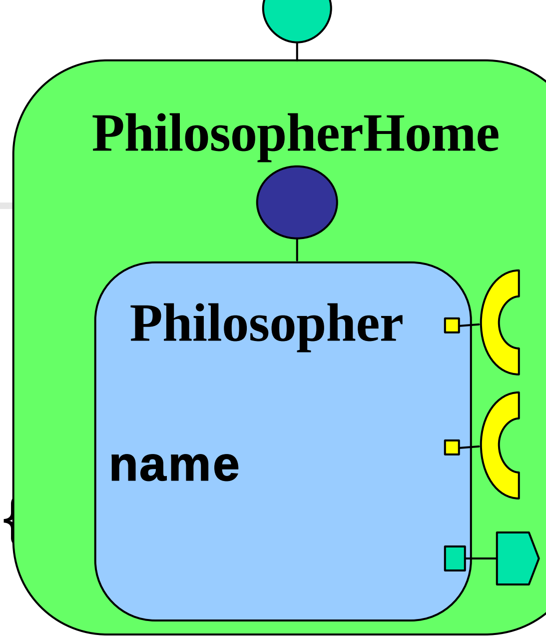
void ccm_remove ()
{ … kill philosopher … }
```

Philosopher Executor Monolithic (3)



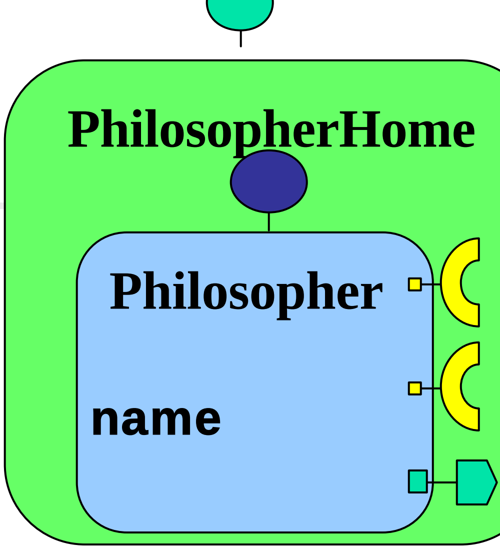
```
// timer callback
void timer ()
{
  // not the real code
  Fork_var left = _ctx->get_connection_left ();
  Fork_var right = _ctx->get_connection_right ();
  left->get ();       // acquire left fork
  right->get ();      // acquire right fork
  StatusInfo_var info = new StatusInfo_impl;
  // set event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

PhilosopherHome Executor



```
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

Advanced CIDL Composition Features

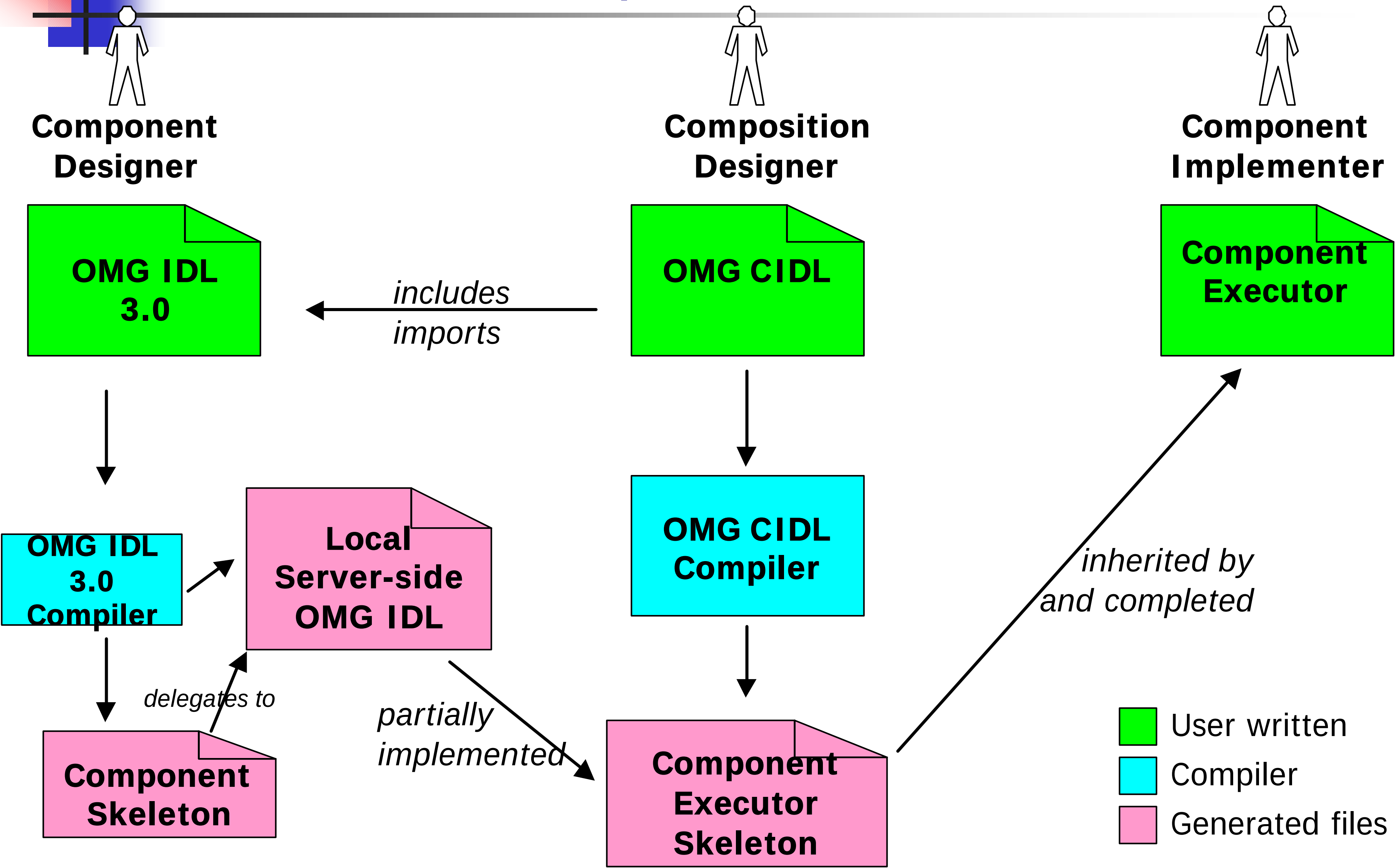
- Associated abstract storage home type for component persistency
- Multiple executor segments
  - Implement a subset of the component's facets
  - Could have an associated abstract storage home
- Component features stored automatically
- Proxy homes

CIDL Composition for Observer Component

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

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

OMG CIDL Compilation Process



Component Designer

Composition Designer

Component Implementer

OMG IDL 3.0

includes

imports

OMG CIDL

Component Executor

OMG IDL 3.0 Compiler

Local Server-side OMG IDL

OMG CIDL Compiler

inherited by and completed

delegates to

partially implemented

Component Skeleton

Component Executor Skeleton

🟩 User written

🟦 Compiler

🟪 Generated files

CIDL Composition for ForkManager Component

```
#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

```
#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 {};

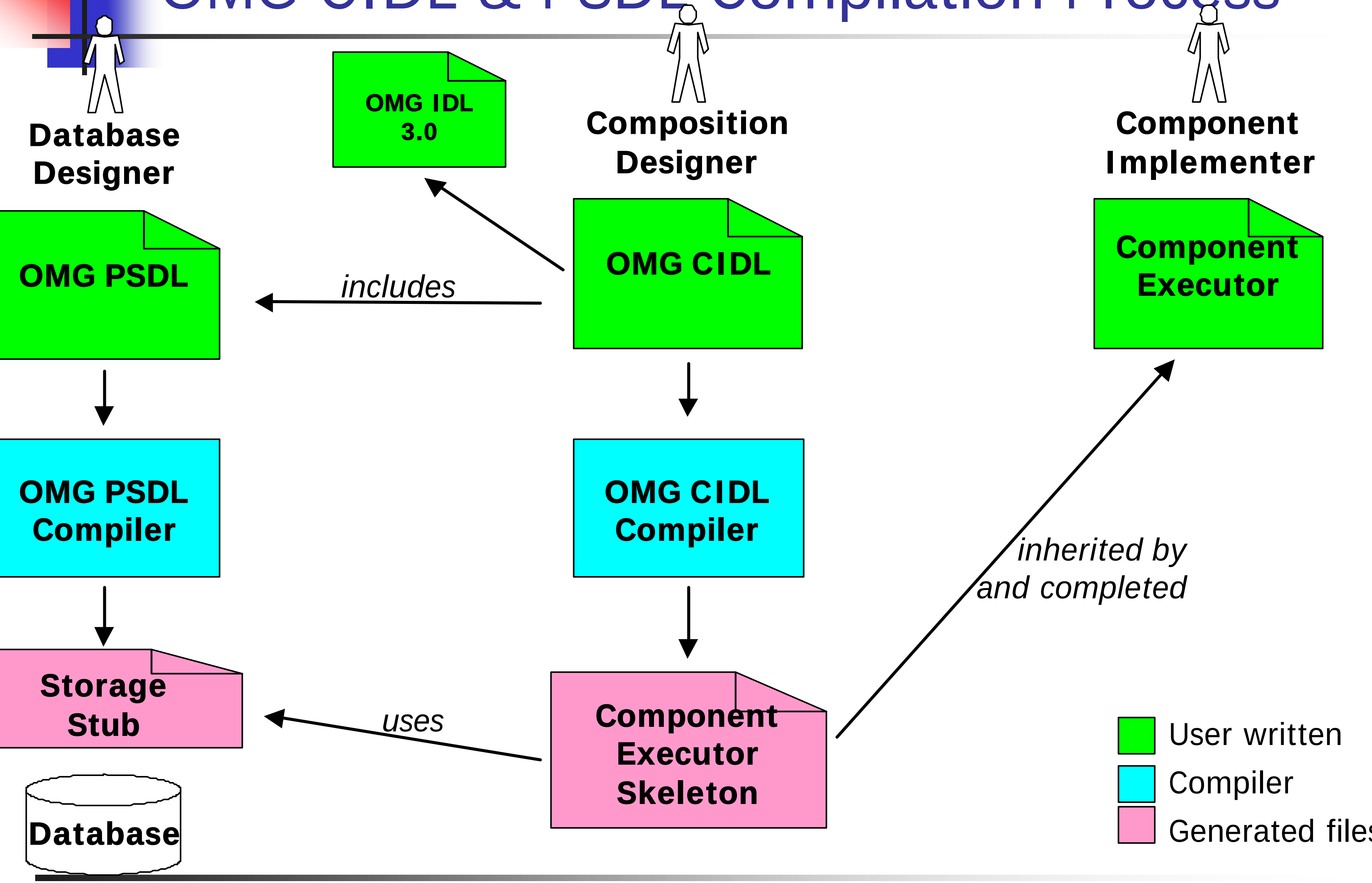
storagehome PersonHomeBase of PersonBase
            implements PersonHome {};
```

CIDL Composition for Dining Philosophers

```
#include <philo.psdl>

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

OMG CIDL & PSDL Compilation Process



Database Designer

OMG IDL 3.0

Composition Designer

Component Implementer

OMG PSDL

includes

OMG CIDL

Component Executor

OMG PSDL Compiler

OMG CIDL Compiler

inherited by and completed

Storage Stub

uses

Component Executor Skeleton

Database

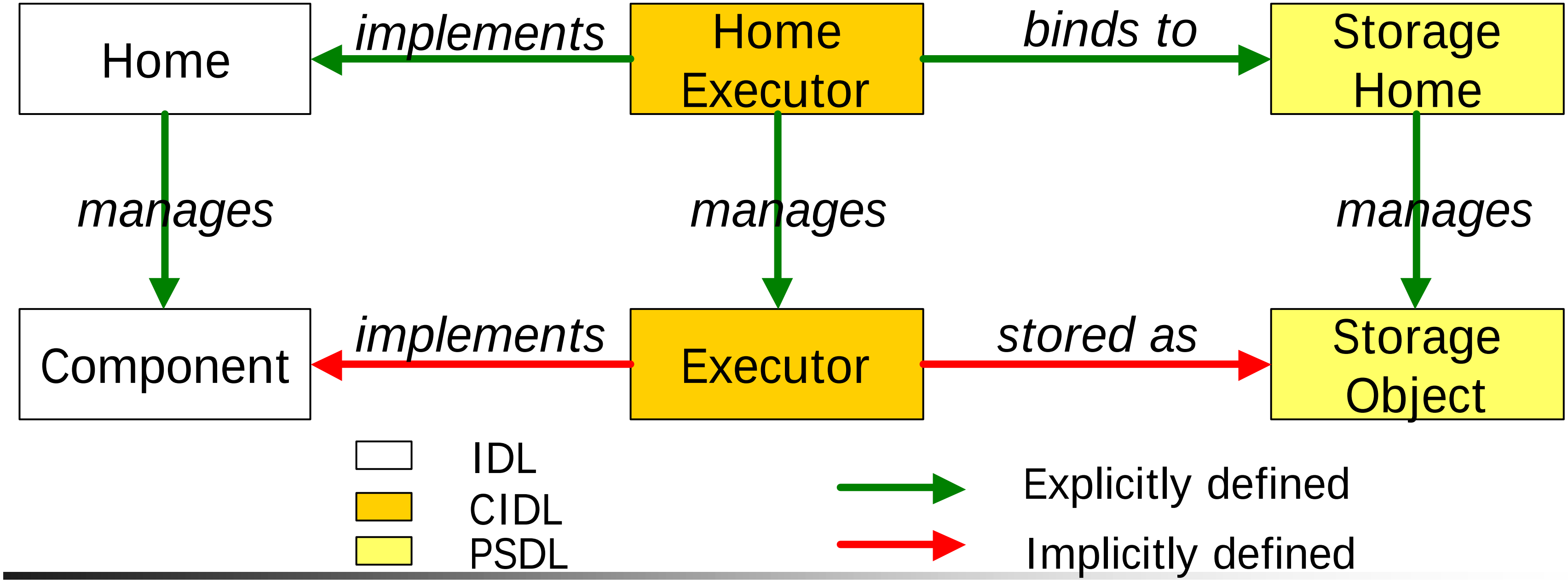
🟩 User written
🟦 Compiler
🟪 Generated files

Relationship Between Artifacts

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

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

```
abstract storagetype ST
bstract storagehome SH
              manages ST {};
```



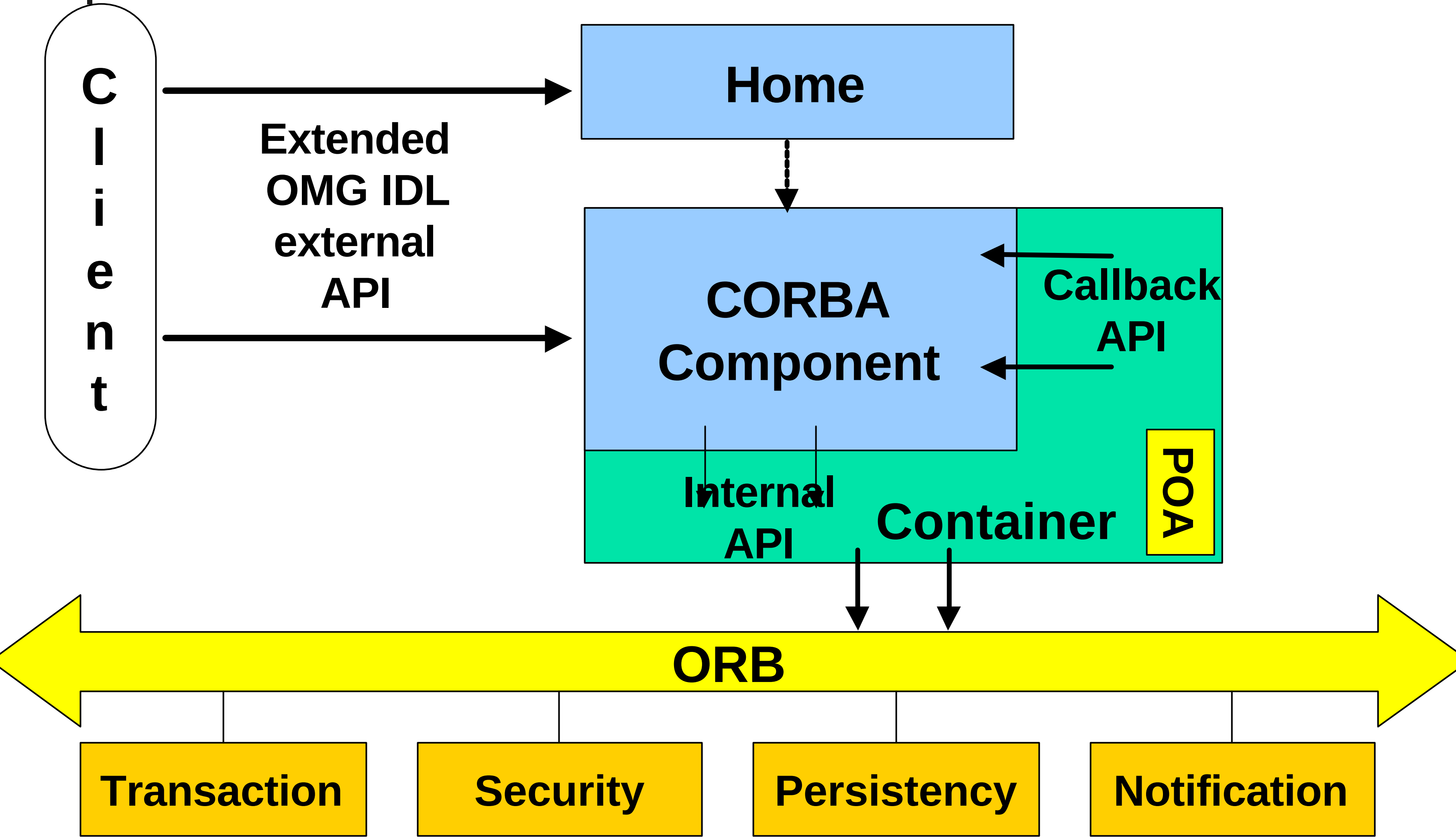
Putting CORBA Containers at Work

- 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



Client

Extended OMG IDL external API

Home

CORBA Component

Callback API

Internal API

Container

POA

ORB

Transaction

Security

Persistency

Notification

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 *FactoryFinder*, *Naming*, or *Trader* services

Component Categories

COMPONENT CATEGORY	*CONTAINER IMPL TYPE*	*CONTAINER TYPE*	*EXTERNAL TYPE*	*EJB BEAN EQUIVALENT*
Service	Stateless	Session	Keyless	Session (stateless)
Session	Conv	Session	Keyless	Session (stateful)
Process	Durable	Entity	Keyless	-----
Entity	Durable	Entity	Keyfull	Entity

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

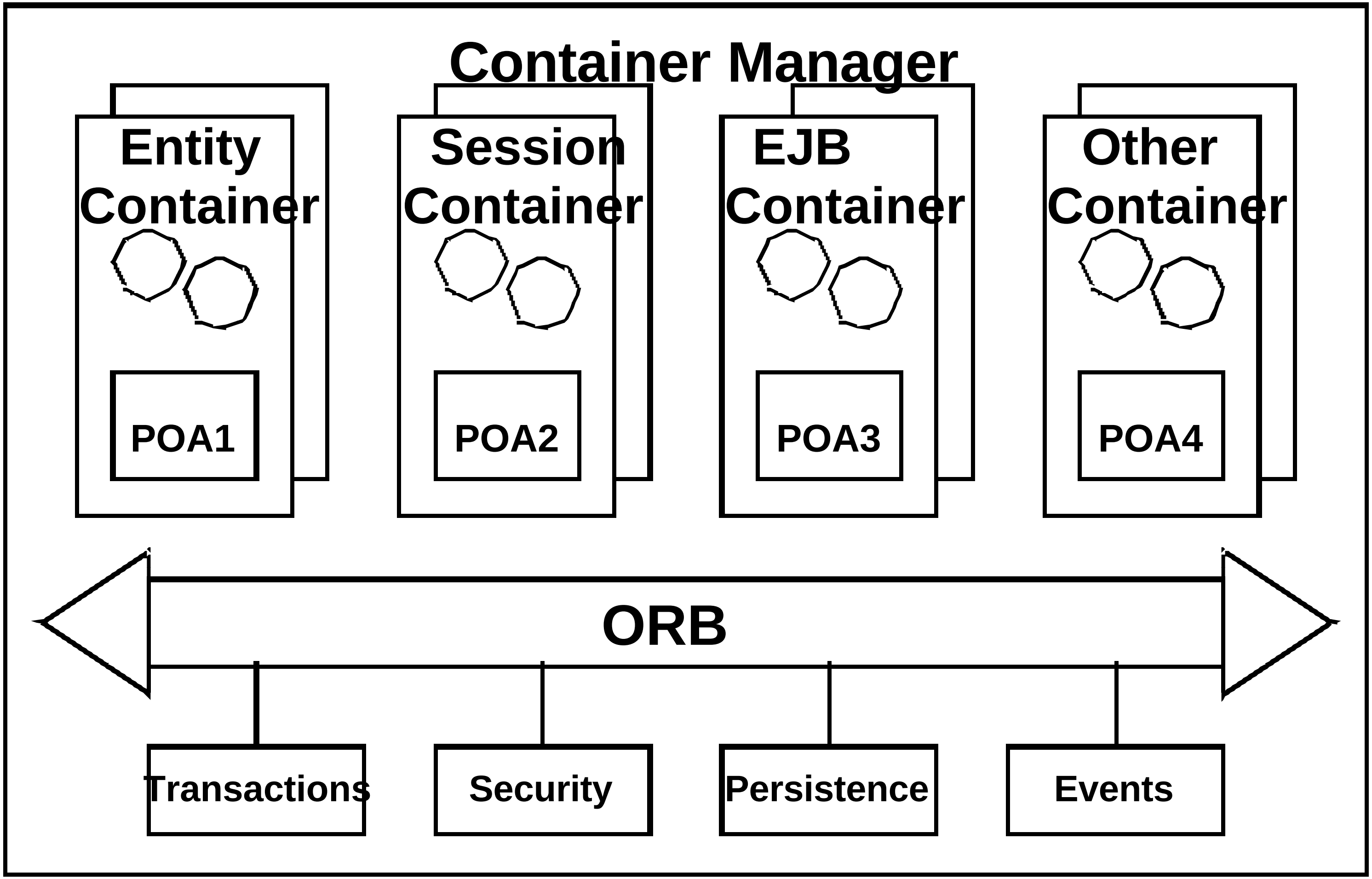
Events

- 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

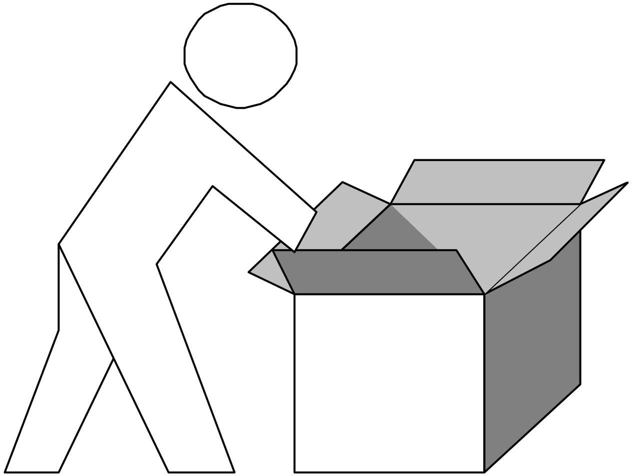
Transactions

Security

Persistence

Events

Packaging CORBA Components



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

Component Package

- Archive (ZIP file) containing
  - one component, consisting of
    - one or more implementations (e.g. for different OSs)
    - IDL file
    - CORBA Component Descriptor (.ccd)
  - 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 implementor

Component Assembly

- 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 policy values editable 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

Software Package Descriptor (.csd)

- Descriptive elements
  - title, author, company, webpage, license
- Link to IDL file
- Link to property file
- Implementation(s)
  - information about Implementation
    - Operating System, processor, language, compiler, ORB
    - dependencies on other libraries
  - link to implementation file
    - shared library, Java class, executable
  - entry point

Software Package Descriptor Example

```
<?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>
```

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
    - link to property files

CORBA Component Descriptor Example

```
<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>
```

Property File Descriptor (.cpf)

- 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 File Descriptor Example

```
<?xml version='1.0'?>
<!DOCTYPE properties>
<properties>
  <simple name="name" type="string">
    <value>Socrates</value>
  </simple>
</properties>
```

Component Assembly Descriptor (.cad)

- References one or more Component Software Descriptors
- Defines home instances and their collocation contraints
- Defines components to be instantiated
- Defines that homes, components or ports are to be registered in the Naming or Trading Service
- Defines connections to be made between component ports

Component Assembly Descriptor Example

```
<?xml version='1.0'?>
<!DOCTYPE componentassembly>
<componentassembly id="demophilo">
  <componentfiles>
    <componentfile id="ObserverHome">
      <fileinarchive name="ObserverHome.csd"/>
    </componentfile>
    <componentfile id="PhilosopherHome">
      <fileinarchive name="PhilosopherHome.csd"/>
    </componentfile>
    <componentfile id="ForkHome">
      <fileinarchive name="ForkHome.csd"/>
    </componentfile>
  </componentfiles>
```

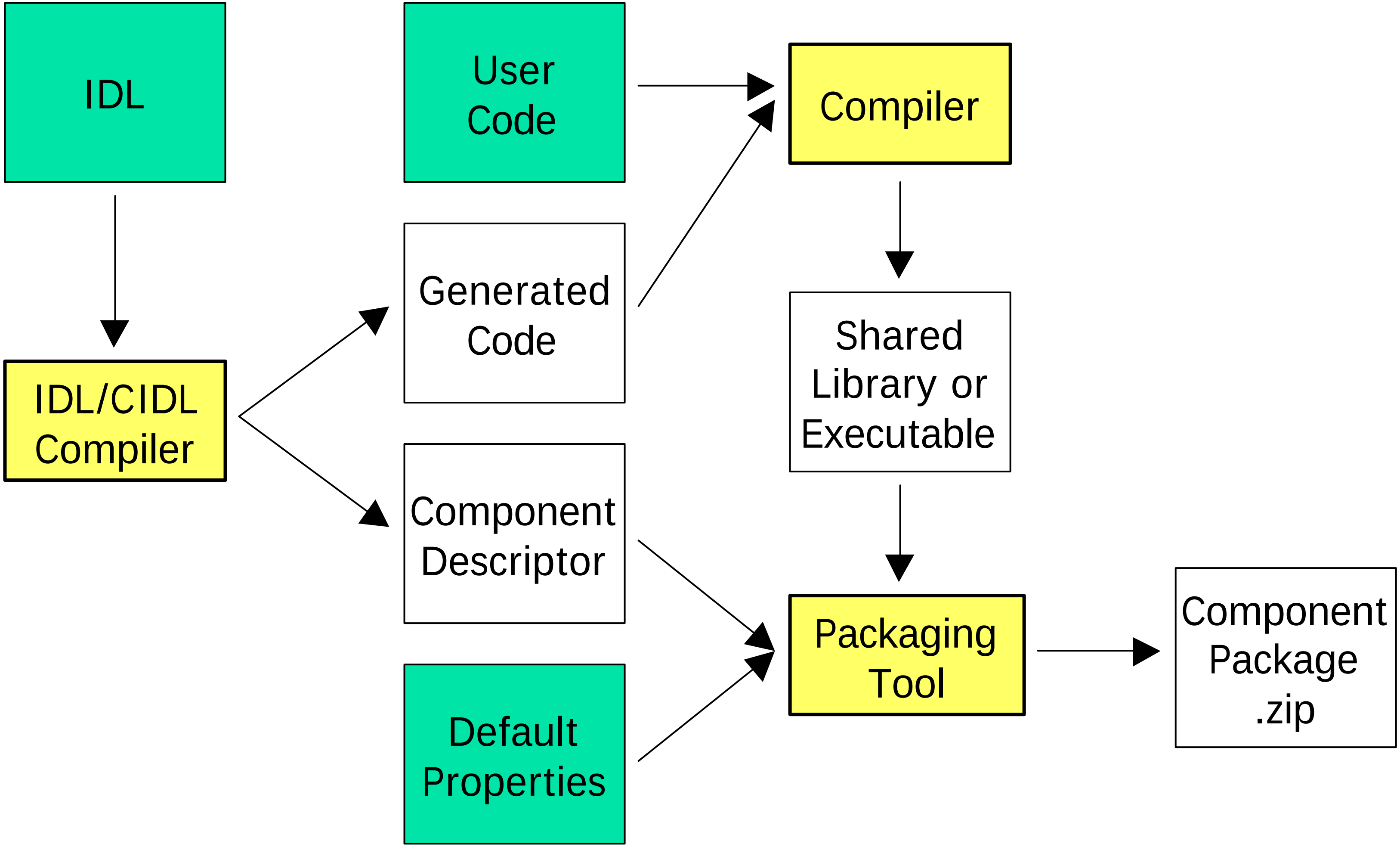
Assembly Descriptor Example (2)

```
<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><connections/></componentassembly>
```

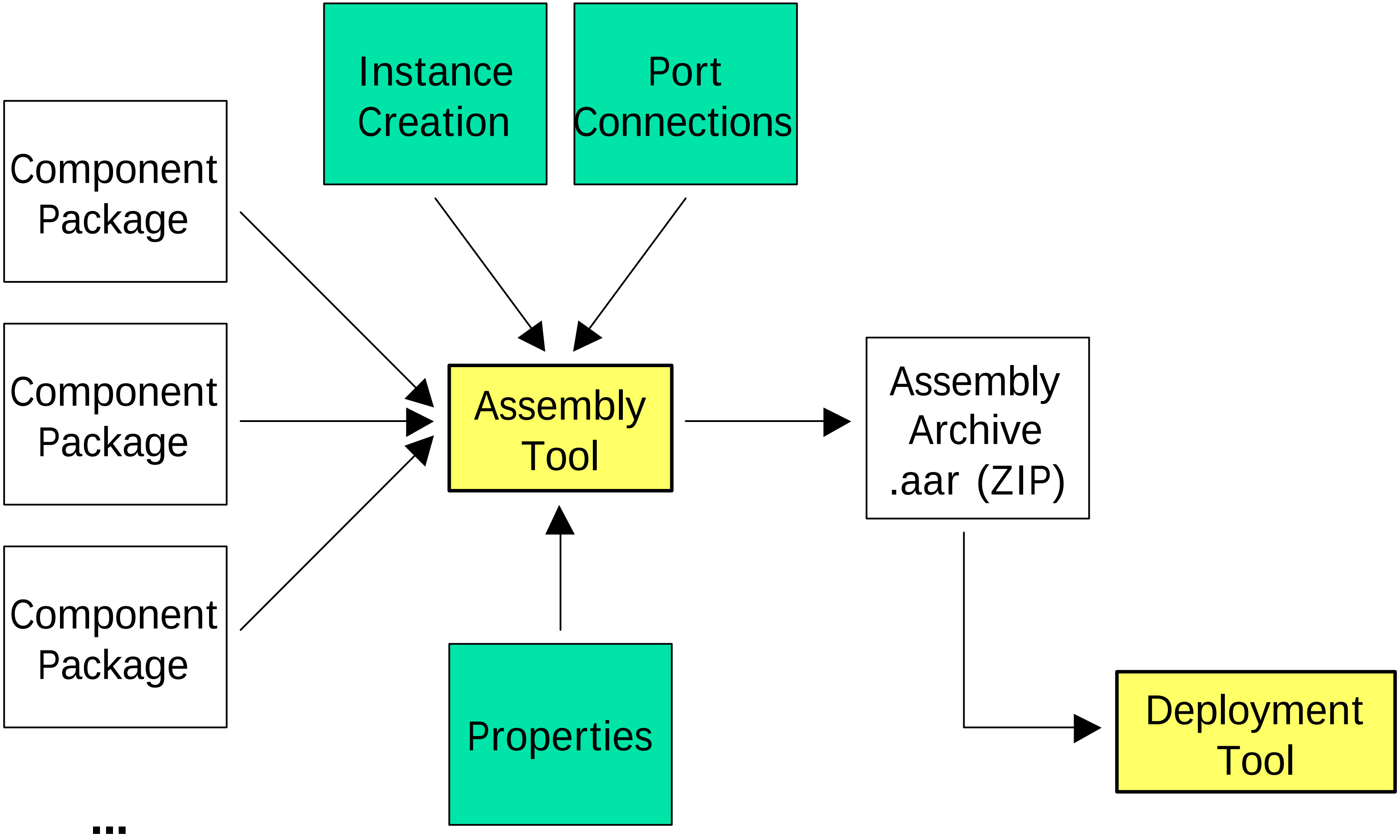
Assembly Descriptor Connection Example

```
<connectinterface>
  <usesport>
    <usesidentifier>left</usesidentifier>
    <componentinstantiationref idref="Philosopher (1)"/>
  </usesport>
  <providesport>
    <providesidentifier>the_fork</providesidentifier>
    <componentinstantiationref idref="ForkManager (1)"/>
  </providesport>
</connectinterface>
```

Component Packaging



Component Assembly



Instance Creation

Port Connections

Component Package

Component Package

Component Package

...

Assembly Tool

Properties

Assembly Archive .aar (ZIP)

Deployment Tool

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

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

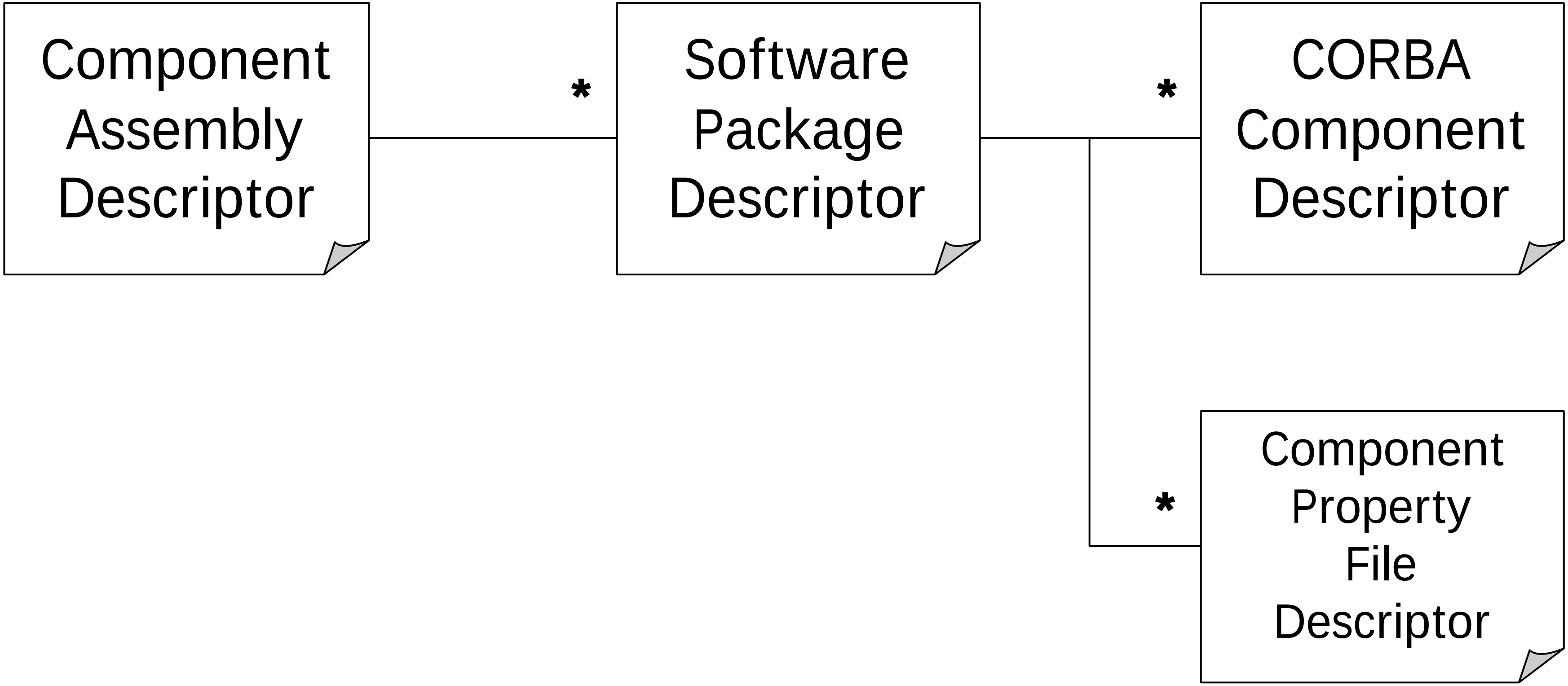
The Packaging and Deployment Model

- 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

Four CCM XML Descriptors

- Software Package Descriptor (.csd)
  - Describes a software package globally
  - Lists various implementations
- CORBA Component Descriptor (.ccd)
  - Technical information mainly generated from CIDL
  - Container managed policies filled by the user
- Component Assembly Descriptor (.cad)
  - Describes initial logical configurations
    - homes, component instances, and connections
- Component Property File Descriptor (.cpf)
  - Describes initial configurations for homes and instances

Relationship Between CCM XML Descriptors



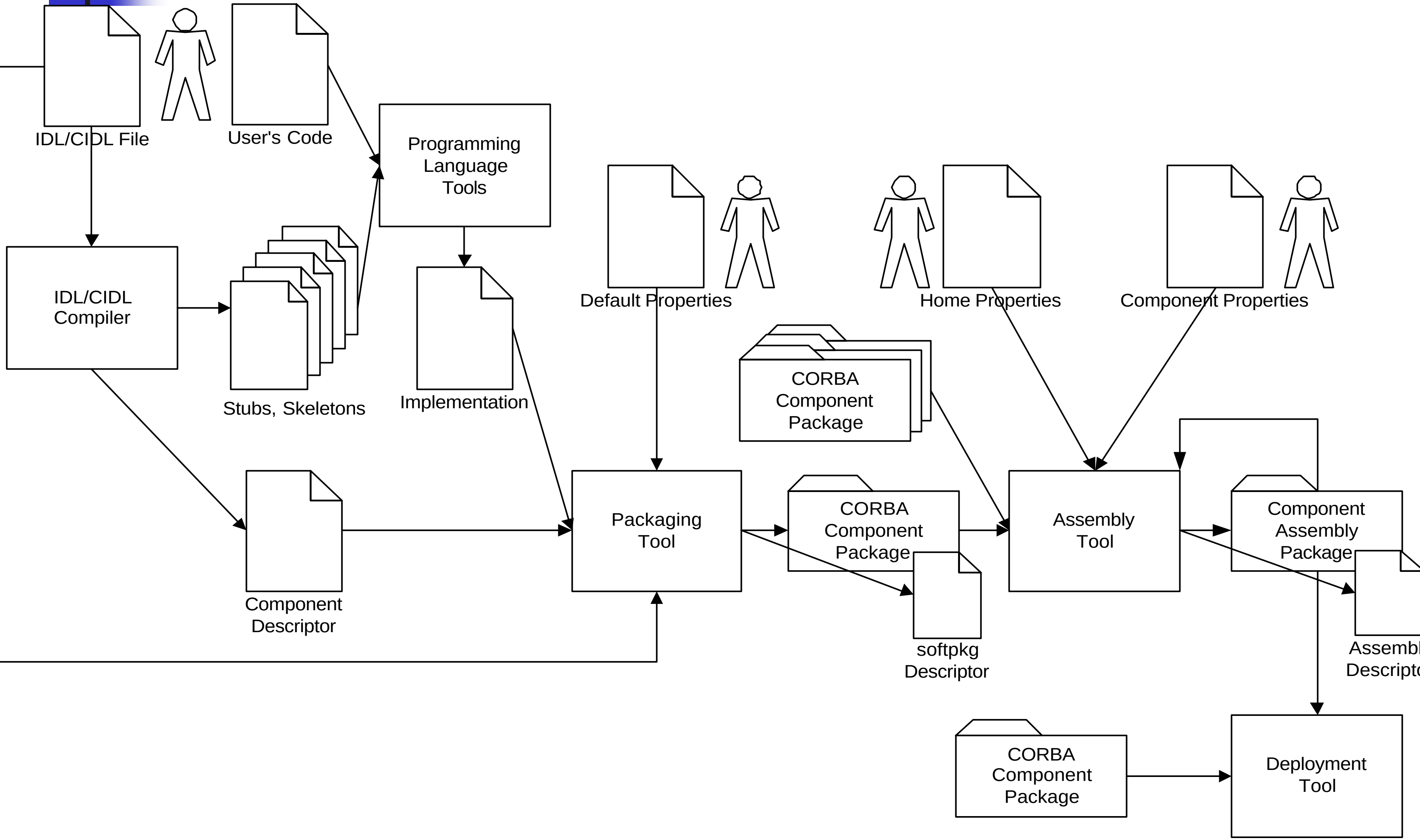
Component Assembly Descriptor

Software Package Descriptor

CORBA Component Descriptor

Component Property File Descriptor

The Big CCM Picture



IDL/CIDL File

User's Code

Programming Language Tools

IDL/CIDL Compiler

Stubs, Skeletons

Implementation

Default Properties

Home Properties

Component Properties

CORBA Component Package

Component Descriptor

Packaging Tool

CORBA Component Package

softpkg Descriptor

Assembly Tool

Component Assembly Package

Assembl Descripto

CORBA Component Package

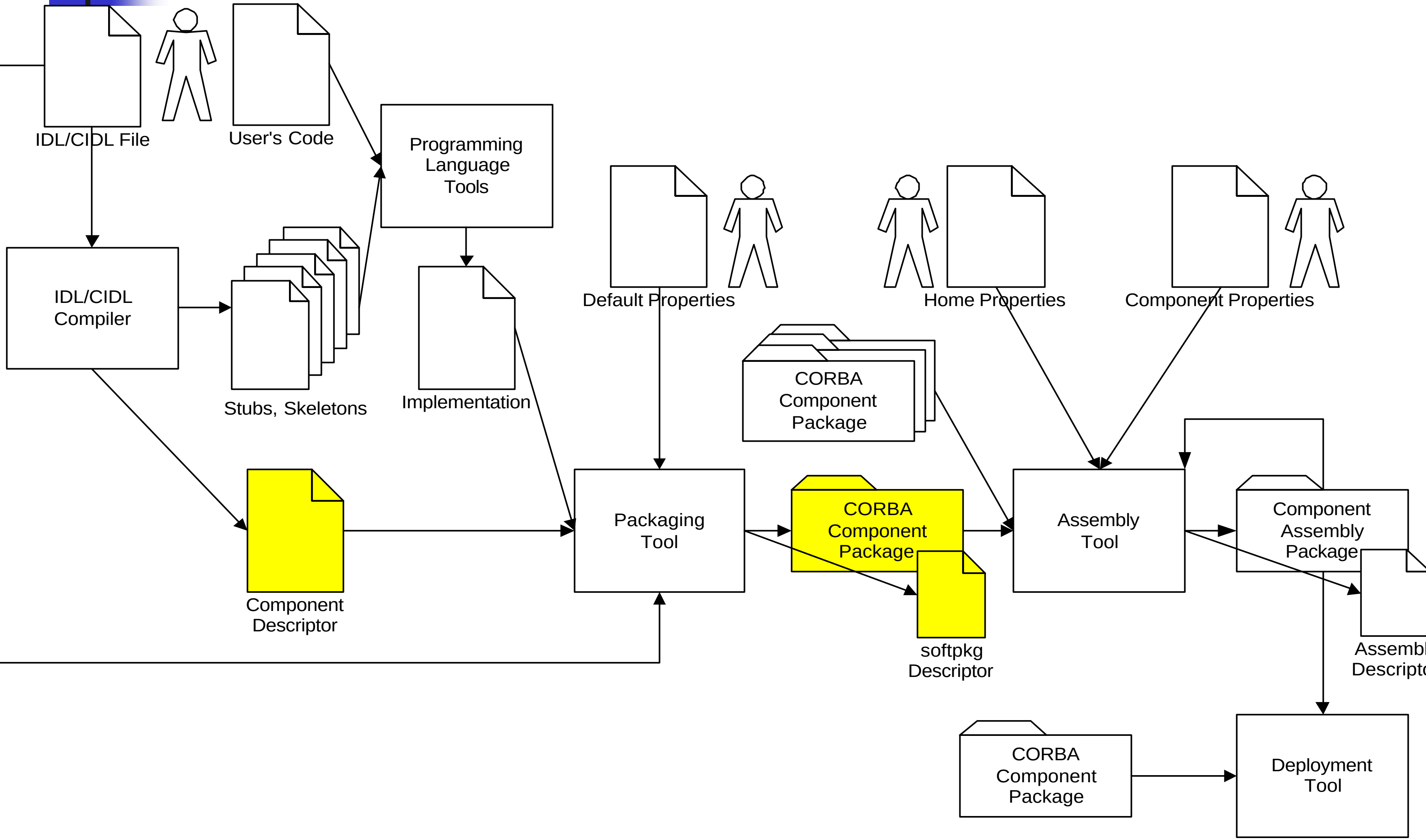
Deployment Tool

Component Package

- A component package is a deployment unit
  - for a CORBA component

- A package is a “ZIP” archive file including
  - A component software descriptor
  - One or more implementations of the component type
    - Various processor, OS, ORB, QoS, ...
    - A CORBA Component descriptor for container policies
  - Descriptors for the default property values
  - OMG IDL files of the component, home and port types

Component Packaging Artifacts



Software Package Descriptor

- Contains general information
  - Title, author, description
  - Links to license and OMG IDL files
  - Default property and CORBA component descriptors
  - Deployment dependencies

- Contains one or more implementation descriptions
  - Used compiler, programming language, human language
  - Operating system, processor, and runtime requirements
  - Customized property and CORBA component descriptor
  - Specific runtime dependencies
  - Link to binary code

Software Package Descriptor for Observer Component

```
<?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>
```

Software Package Descriptor for Observer Component

```
<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> . . . </implementation>
</softpkg>
```

Software Package Descriptor for Observer Component

```
<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

```
<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

```
<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 Descriptor

- Structural information generated from 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

- Component and home properties

CORBA Component Descriptor for Philosopher Component

```
<?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" />
```

CORBA Component Descriptor for Philosopher Component

```
<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"/>
```

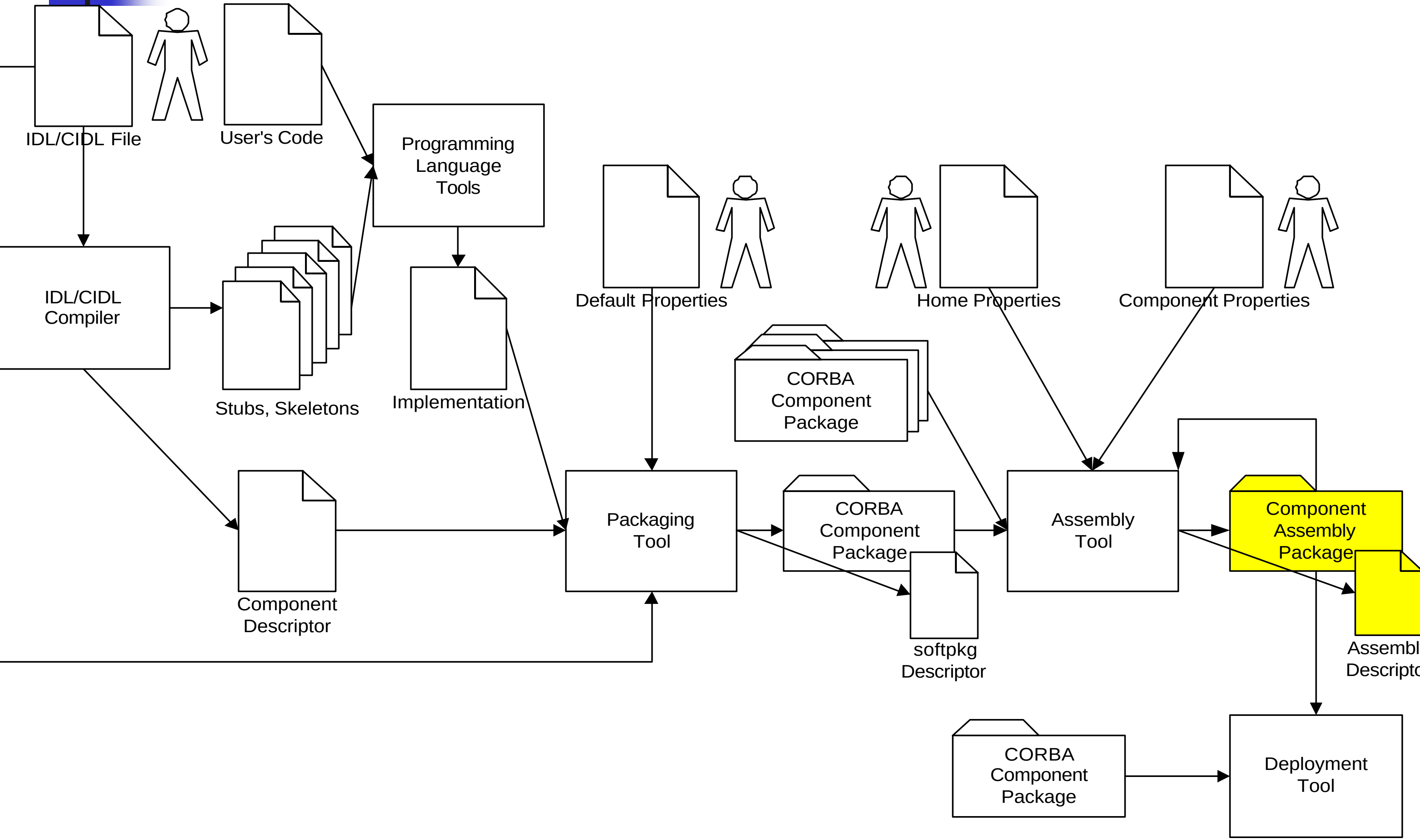
CORBA Component Descriptor for Philosopher Component

```
 <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>
```

Component Assembly Package

- A component assembly is a template for a deployed set of interconnected components
- Described by a 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 Artifacts

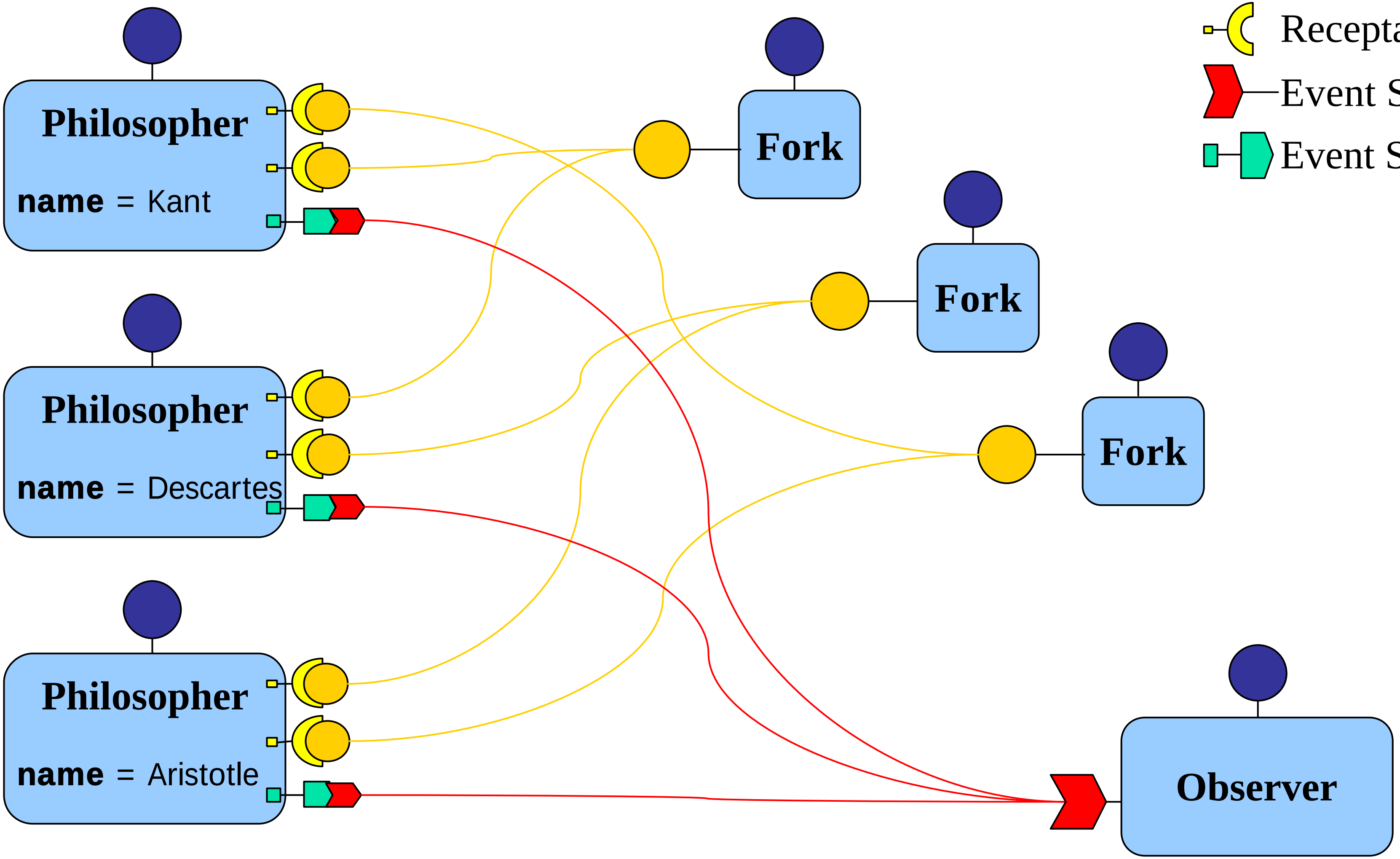


Component Assembly Descriptor

- Lists all used component archives
- Defines logical partitioning
  - Host and process collocation and cardinality
  - Executable and home placement
  - Component instantiation
  - HomeFinder, Naming, and Trader registration
- Describes connections between components
  - Which receptacles are connected to which facets
  - Which event sinks subscribe to which event sources

Dining Philosophers as CORBA Components

Component
Base ref.
Facet
Receptacle
Event Sink
Event Sourc



Component Assembly Descriptor for Dining Philosophers

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

<componentassembly id="dinner">
  <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>
```

Component Assembly Descriptor Partitioning for Dining Philosophers

```
<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>
```

Component Assembly Descriptor Partitioning for Dining Philosophers

```
 <homeplacement id="PhilosopherHome">
  <componentfileref idref="PhilosopherComponent"/>

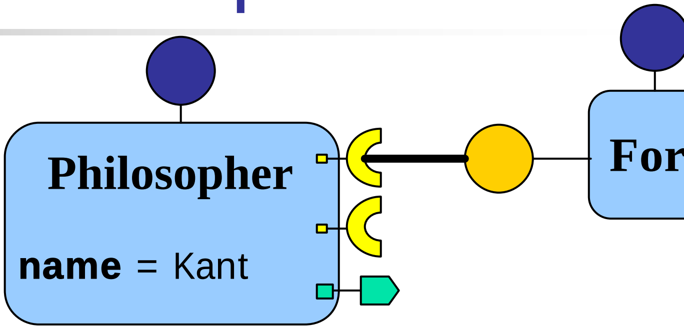
  <componentinstantiation id="Kant">
    <componentproperties><fileinarchive name="Kant.cpf"/>
   </componentproperties></componentinstantiation>

  <componentinstantiation id="Descartes">
    <componentproperties><fileinarchive name="Descartes.cpf"/>
   </componentproperties></componentinstantiation>

  <componentinstantiation id="Aristotle">
    <componentproperties><fileinarchive name="Aristotle.cpf"/>
   </componentproperties></componentinstantiation>

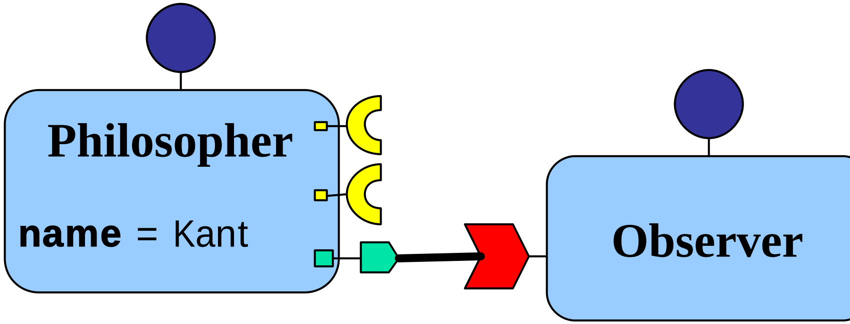
 </homeplacement>
</partitioning>
```

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>
```

Component Assembly Descriptor Connections for Dining Philosophers

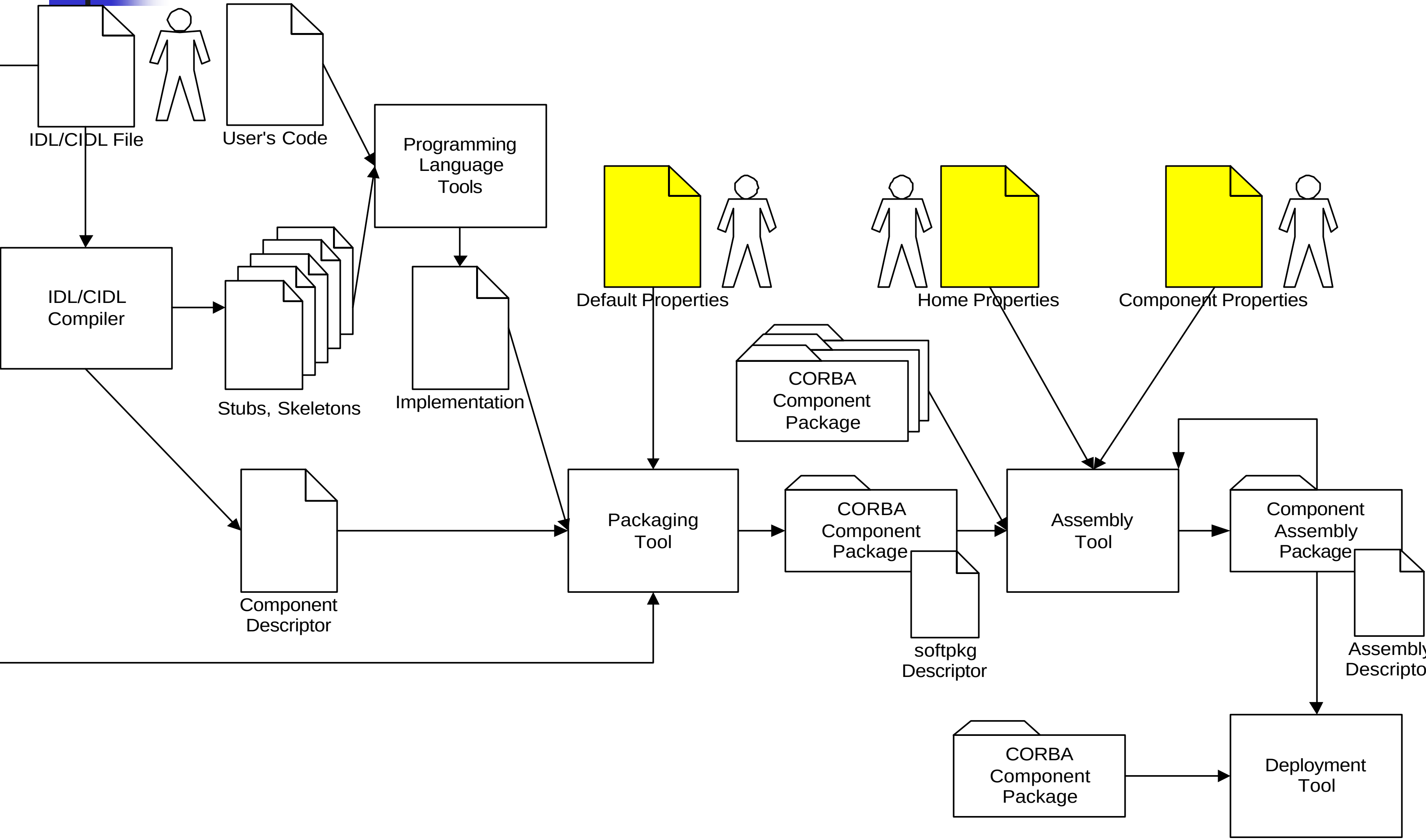


```
<connectevent>
  <publishesport>
    <publishesidentifier>info</publishesidentifier>
    <componentinstantiationref idref="Kant"/>
  </publishesport>
  <consumesport>
    <consumesidentifier>info</consumesidentifier>
    <componentinstantiationref idref="Freud"/>
  </consumesport>
</connectevent>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

Property Files

- A general property description is specified
- Used to set home and component properties
    - However, it could be used for anything
- Component properties can be applied to individual components or to a home which will apply the properties to all components it creates
- Homes may have their own properties

Property Files



Property File For Philosopher Kant

```
<?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>
```

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
- The deployment application interacts with installation objects on each machine

Deployment

- A component assembly is deployed by a deployment tool
- The deployment tool interacts with the user to assign individual and collocated components to actual hosts and processes
- The deployment application interacts with installation objects on each machine

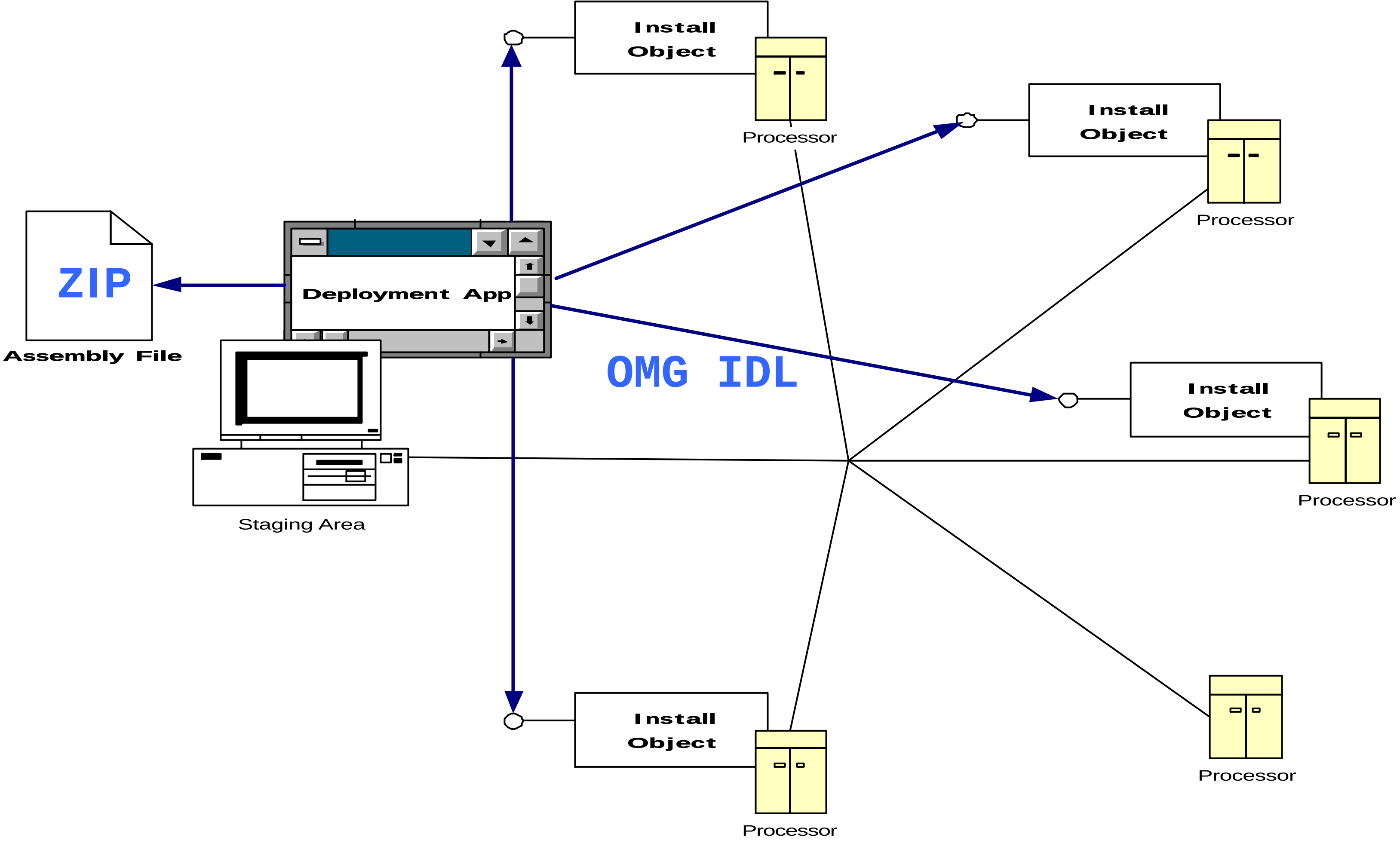
Deployment Objects

- `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, creates ComponentServer objects
- `ComponentServer`
  - creates Container objects
- `Container`
  - installs CCMHome objects

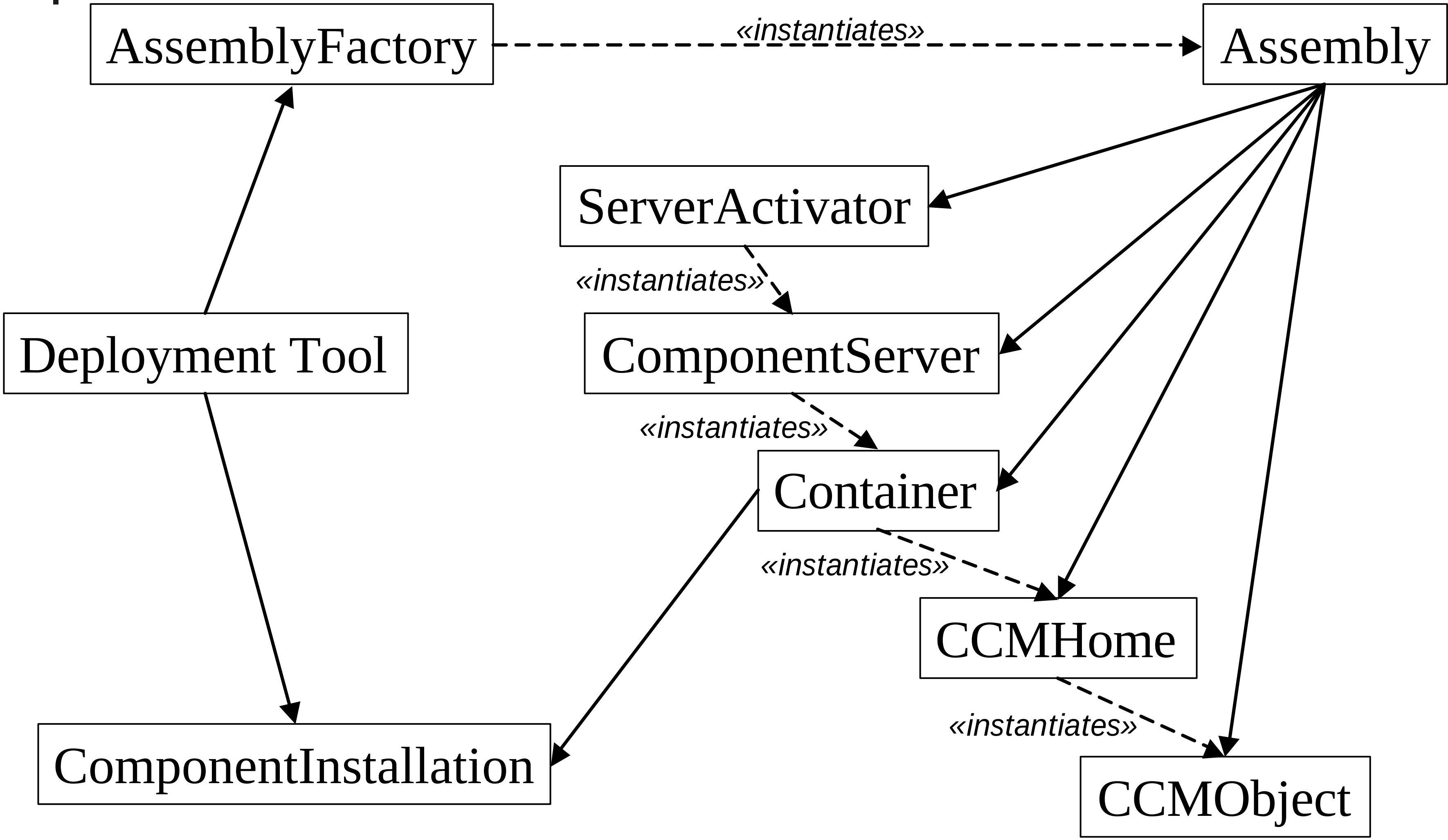
Deployment Objects

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

The Component Deployment Process



The Component Deployment Process



AssemblyFactory

«instantiates»

Assembly

ServerActivator

«instantiates»

Deployment Tool

ComponentServer

«instantiates»

Container

«instantiates»

CCMHome

«instantiates»

ComponentInstallation

CCMObject

Deployment API: Assembly

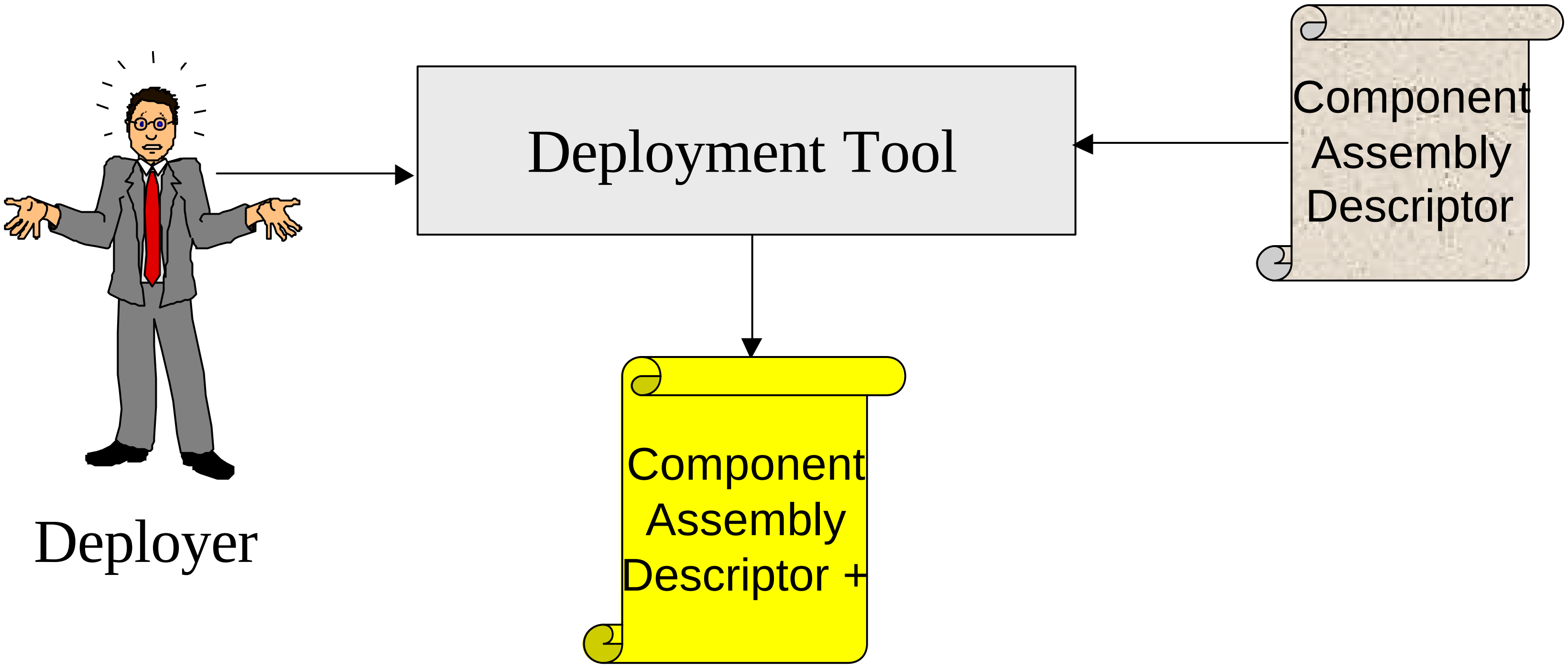
```
module Components {
  enum AssemblyState {
    INACTIVE, INSERVICE
  };
  exception CreateFailure {};
  exception RemoveFailure {};

  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

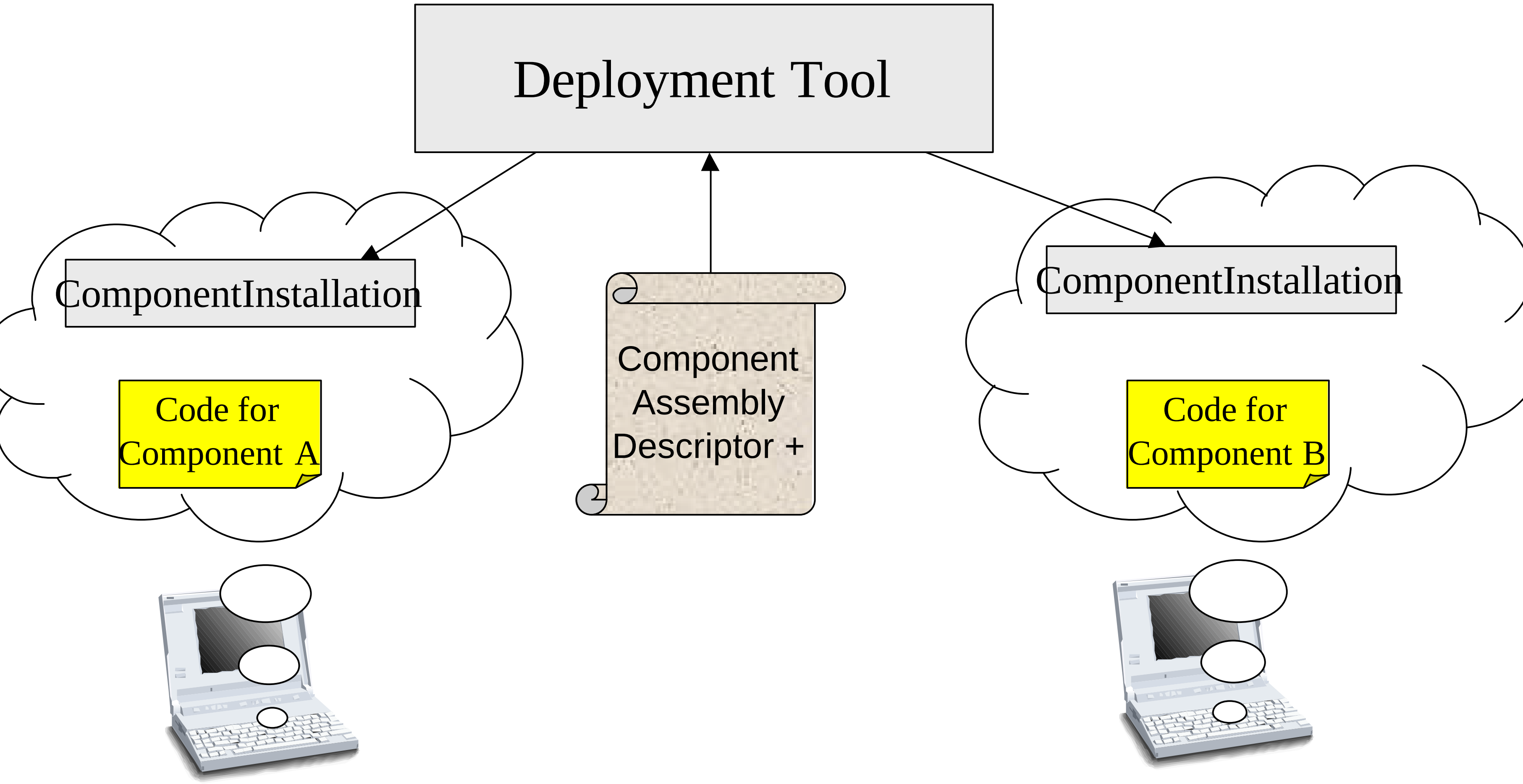
Component Assembly Descriptor

Deployer

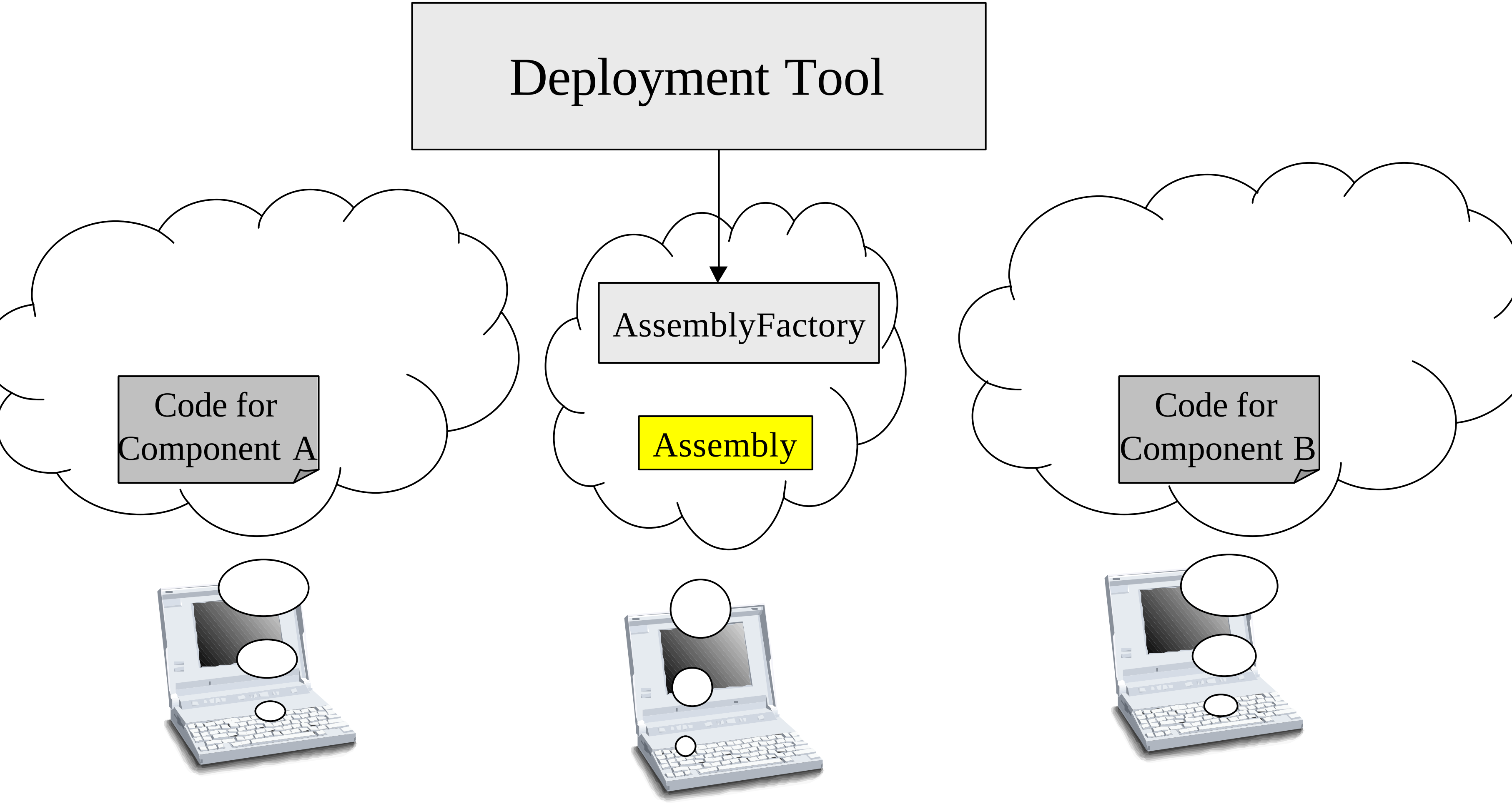
Component Assembly Descriptor +

with installation information

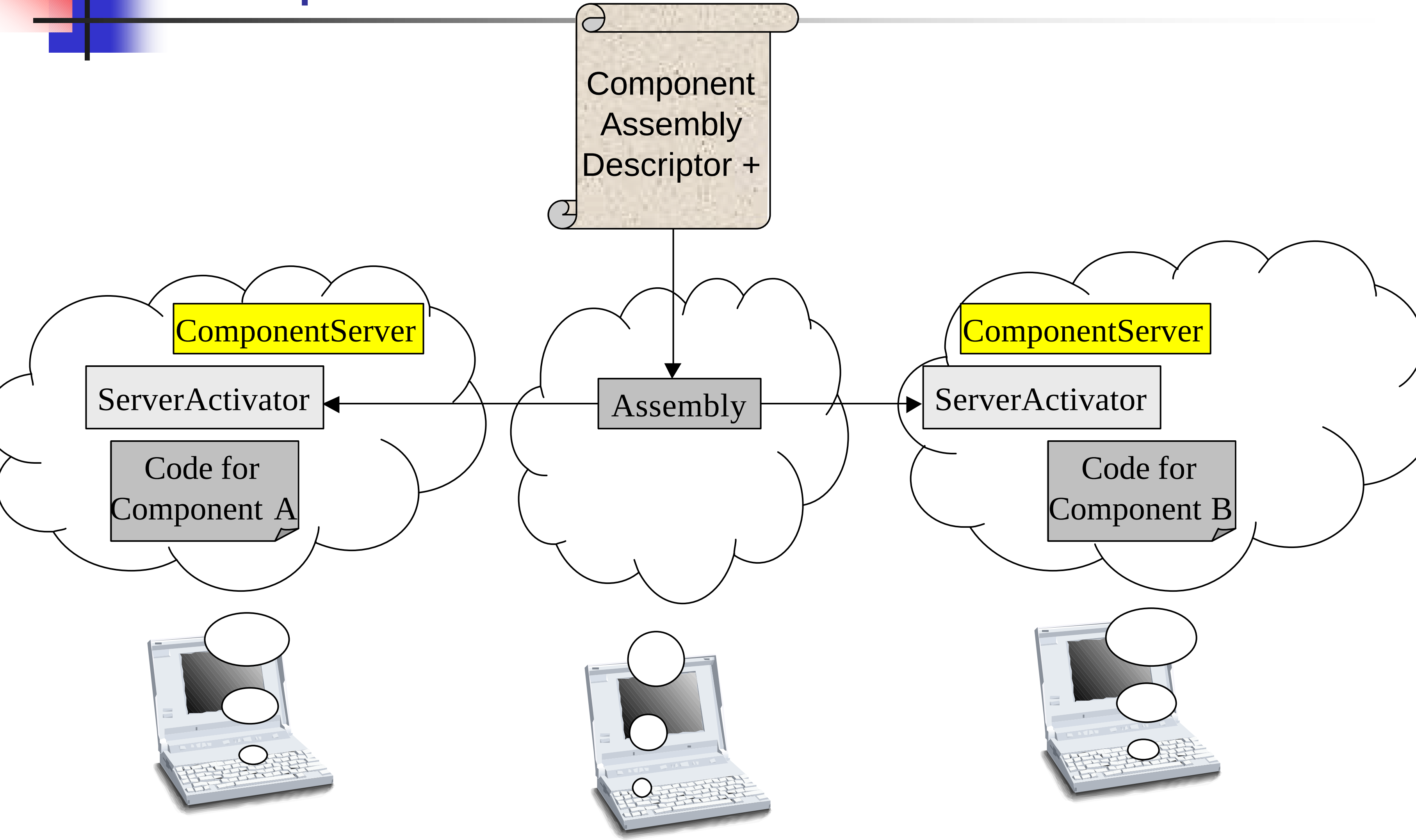
Deployment Scenario: Implementation UpLoading



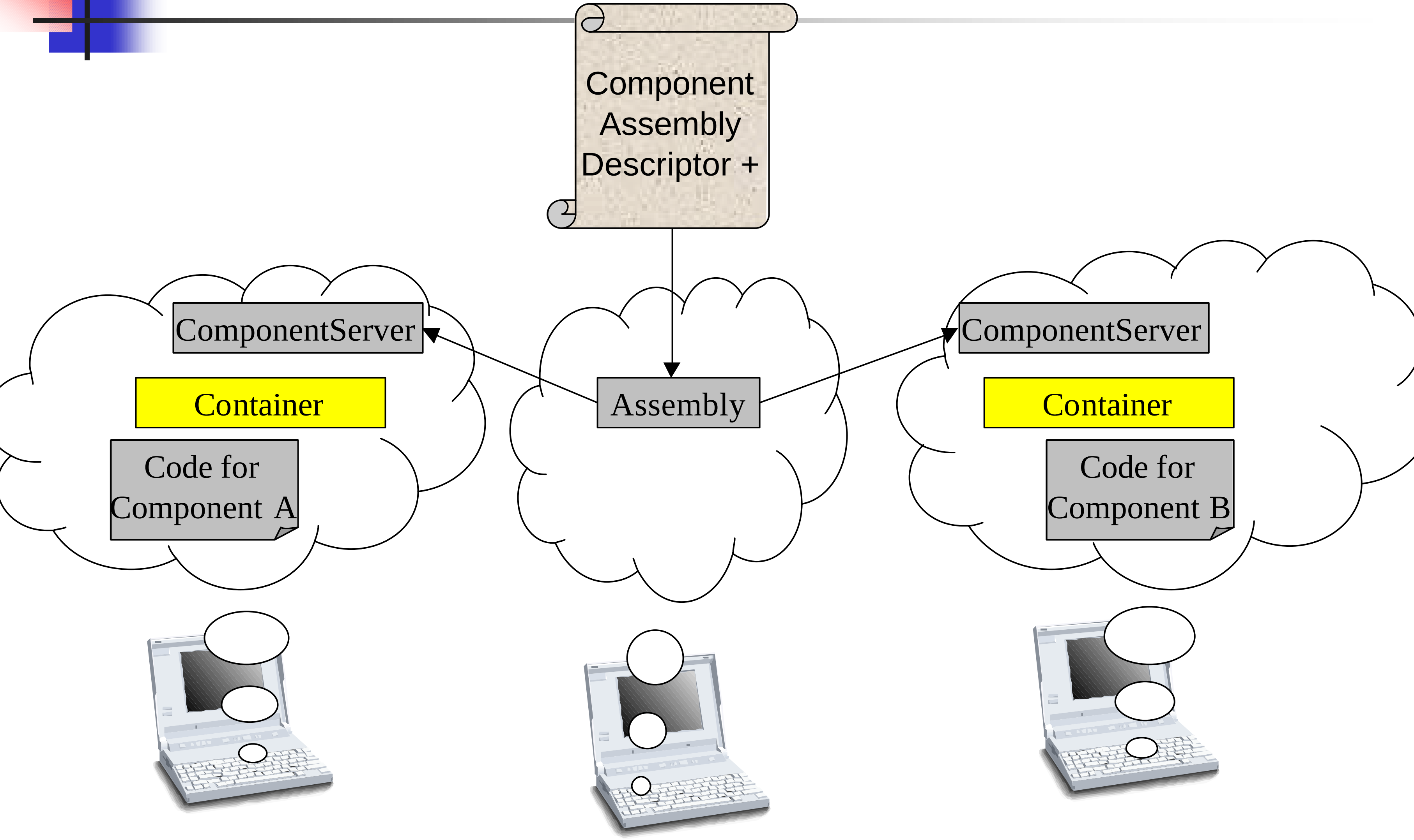
Deployment Scenario: Assembly Creation



Deployment Scenario: Component Server Instantiation



Deployment Scenario: Container Instantiation



Component Assembly Descriptor +

ComponentServer

Container

Code for Component A

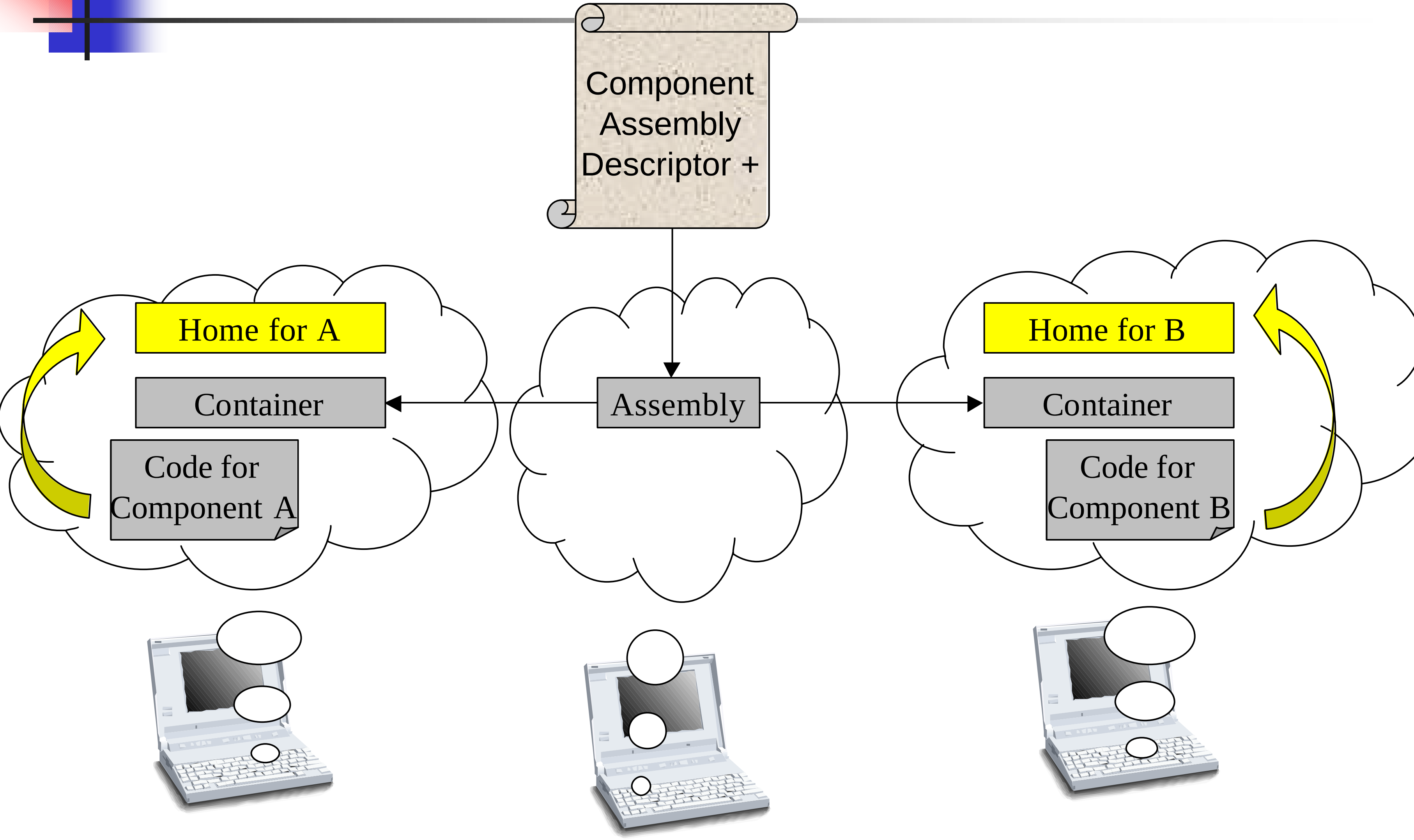
Assembly

ComponentServer

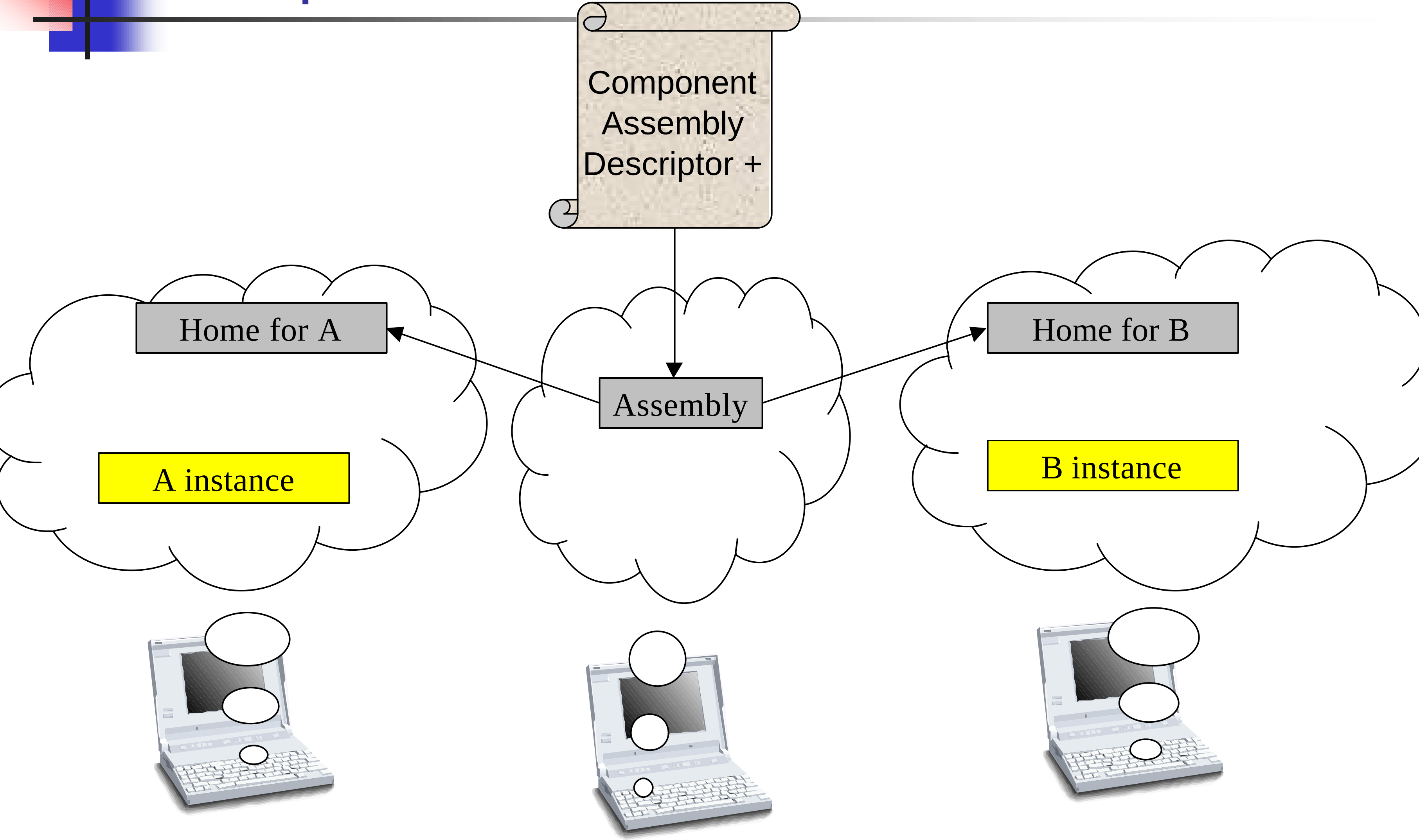
Container

Code for Component B

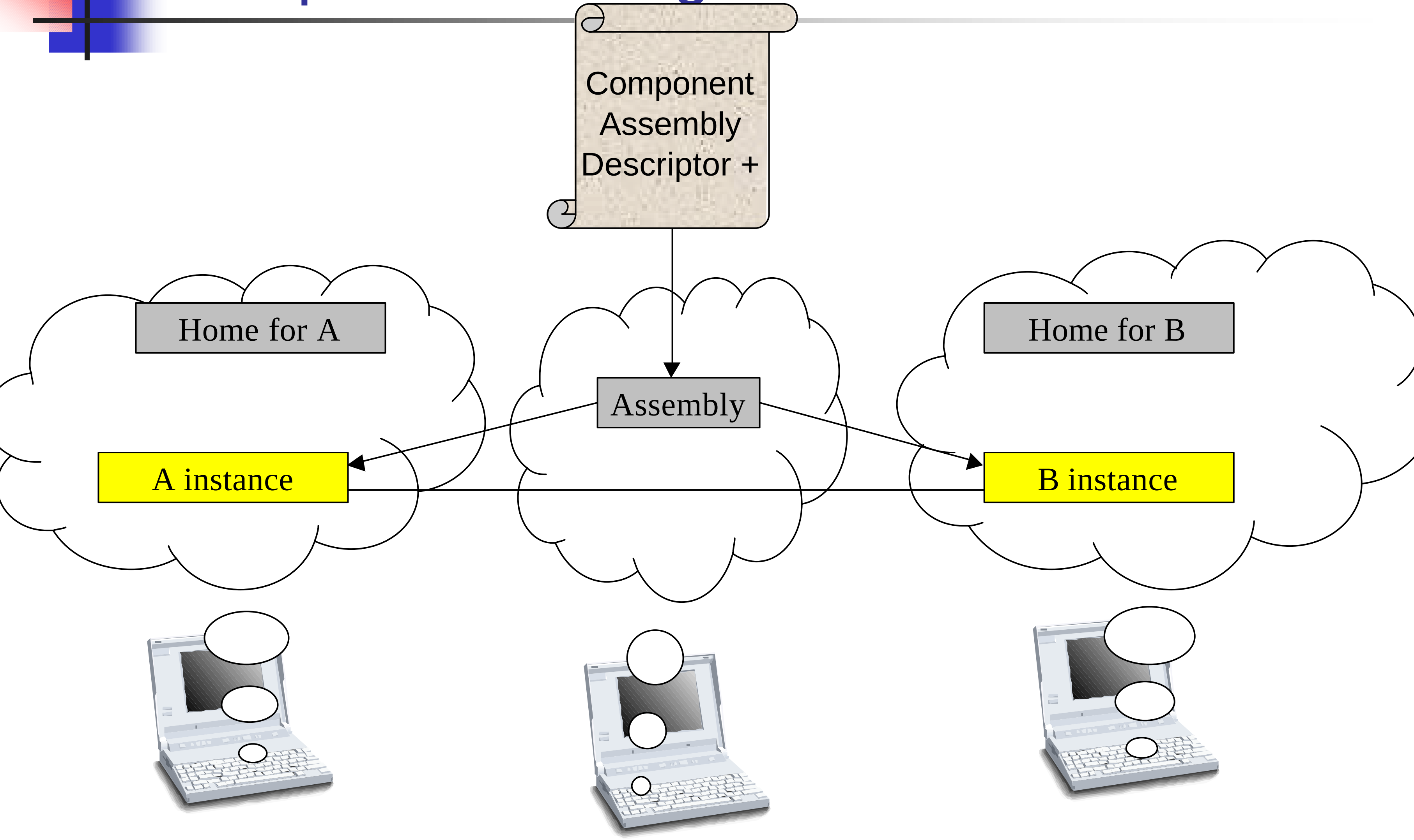
Deployment Scenario: Home Installation



Deployment Scenario: Component Instantiation



Deployment Scenario: Component Configuration



Component Assembly Descriptor +

Home for A

Assembly

Home for B

A instance

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
  - 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 ORBacus 4.1
    - Not available
- 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
- “The CCM Page”, Diego Sevilla Ruiz
  - *http://www.ditec.um.es/~dsevilla/ccm/*