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Training

ANSAwise - The Engineering Model [CNET]

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Abstract

Organizations wishing to understand how to design and build distributed systems need to appreciate engineering concepts to enable them to make trade-offs in these systems.

This module of the ANSAwise training programme describes the ANSA/ODP Engineering Model, covering each construct and concept briefly, from the top down. It compares and contrasts it with the Computational Model.

It does not describe applications of these features; these are covered in other modules of the training programme. Similar, quality-of-service issues (for example, performance) are not covered here.

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Briefing Note

Distribution:
Supersedes:
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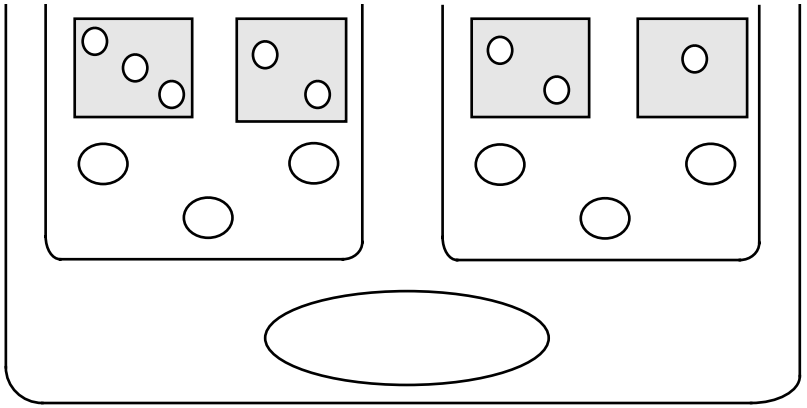
The Engineering Model



In this session

- ***Explain the concepts in the Engineering Model***
- ***Explain the various types of transparency mechanisms***
- ***Compare the Engineering and Computational Models***

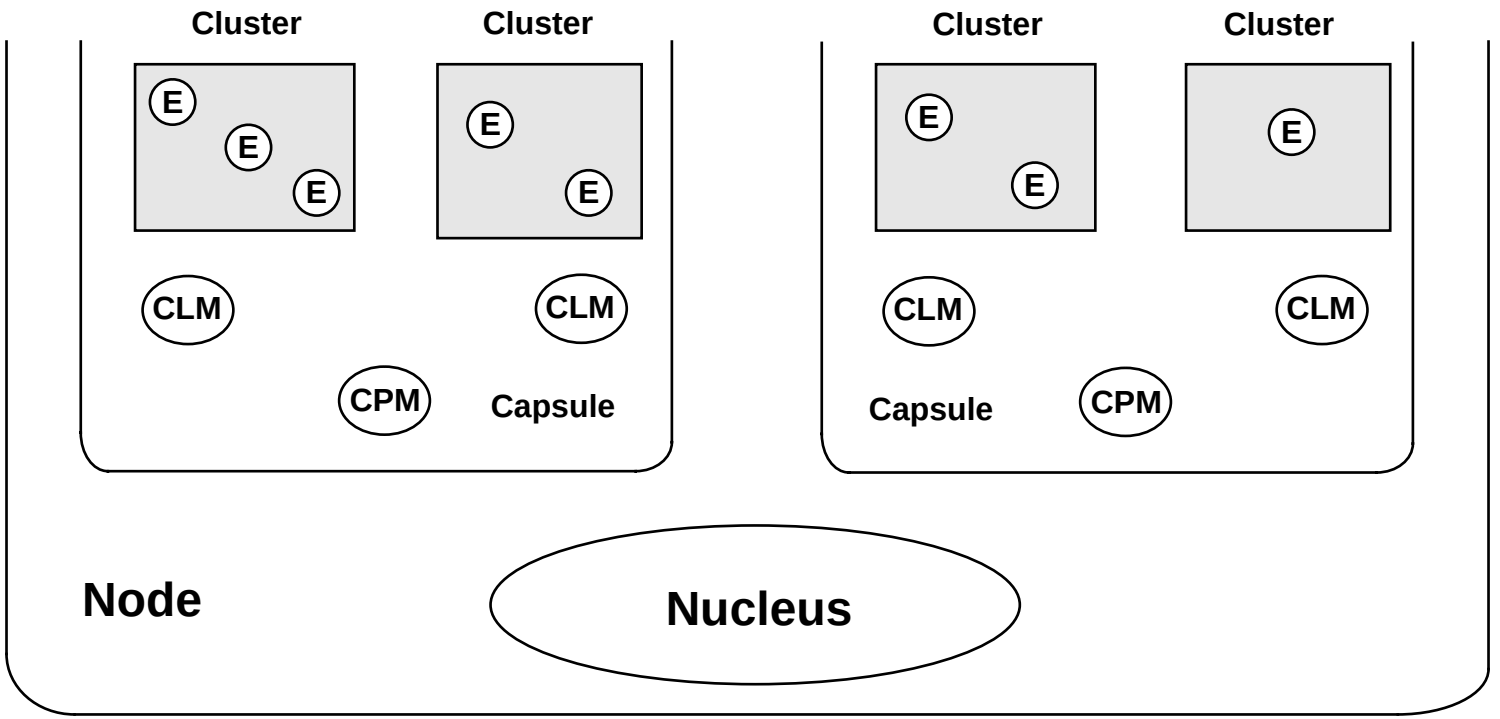
What is the Engineering Model for?

- *To allow trade-offs*
  - flexibility versus performance
  - time versus space
  - ... and many others
- **But without affecting the Computational Model**

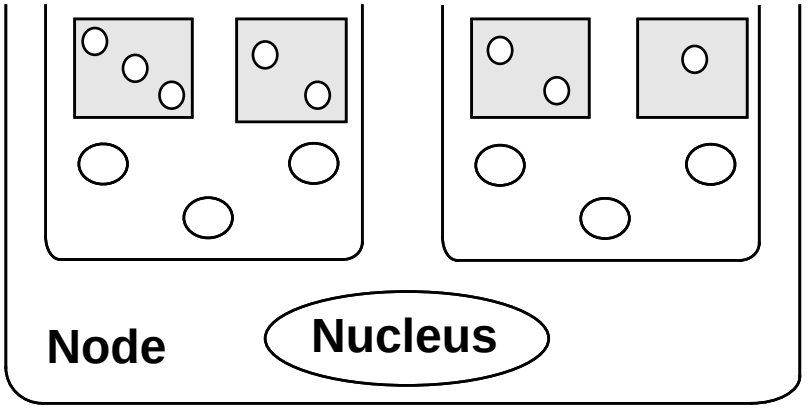
Engineering is infrastructure

- ***Provides infrastructure for encapsulation***
  - ***capsules*** **for resource allocation and protection**
  - ***clusters*** **for collective activation, deactivation, and migration**
  - ***nodes*** **for network addressing**
- ***Provides channels for communication***
  - **point-to-point (simple client-server)**
  - **point-to-multipoint**
  - **streams**
- ***Provides concurrency mechanisms***
  - ***threads*** **for concurrent execution**
- ***Provides transparency mechanisms***

Engineering Encapsulation Infrastructure

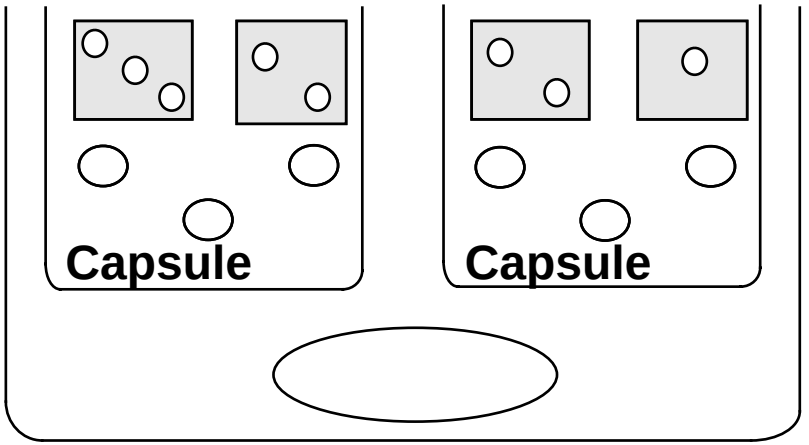


Node and Nucleus



- *A node is the unit of network addressing*
- *The nucleus handles communications between nodes and capsules*
  - it may be part of the operating system (if there is one), or a layer on top of it

Capsules



- *Capsules contain objects*
  - objects must be encapsulated
  - every object is contained in a capsule
  - different capsules separate the objects

Capsules can contain more than one object

- *Objects of the same type, or of different types*
- *Put more than one object in a capsule to*
  - share resources
  - share state information

Capsules and Shared Memory

- ***In a distributed system, two objects cannot usually share memory***
  - **the objects could be distributed anywhere in the world!**
  - **but if particular objects do, their implementation may be more efficient**
  - **... for example, you might keep objects of the same type together in the same capsule**
- ***Objects in the same capsule can share memory for efficiency - but then there is no protection boundary between them***
  - **resources: they compete for the same resources (physical and virtual memory)**
  - **robustness: object failure within the capsule can cause the whole capsule to fail**
  - **security: there is no security between objects in the same capsule**
- ***Sharing memory between different capsules is not permitted***

Capsules and Objects

- ***So, the Computational and Engineering Models of an object are different:***

  - **in the Computational Model, every object is separately encapsulated; objects cannot share state**

  - **in the Engineering Model, objects can share a capsule, and share state**

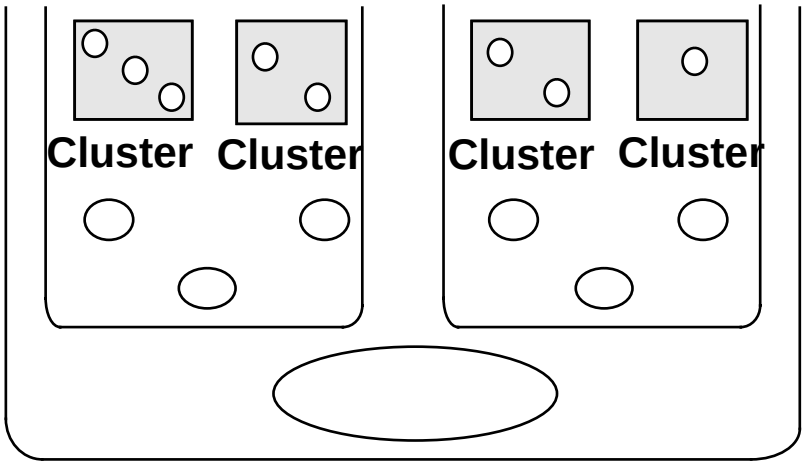
Capsules and Interfaces

- ***Objects in the same capsule can still invoke each other's interfaces***
  - **you are not compelled to use shared memory within a capsule**
- ***Object interfaces are invoked in the same way...***
  - **within a capsule**
  - **between two capsules on the same node**
  - **between two nodes**
- ***...the infrastructure will optimize communications between objects on the same node***

Nodes and Capsules

- ***Most systems can support more than one capsule per node***
  - **using the multi-tasking and memory protection features of the operating system**
  - **Unix can...**
  - **...DOS can’t (only one capsule per node)**

Clusters



- ***A cluster is a collection of objects that must be 'kept together'***
  - **if an object moves (*migrates*) between capsules, objects that share memory must move together with that object**
  - **if an object fails, you might want to shut down other objects automatically**
  - **when starting up one object, you might want to start up other objects automatically**

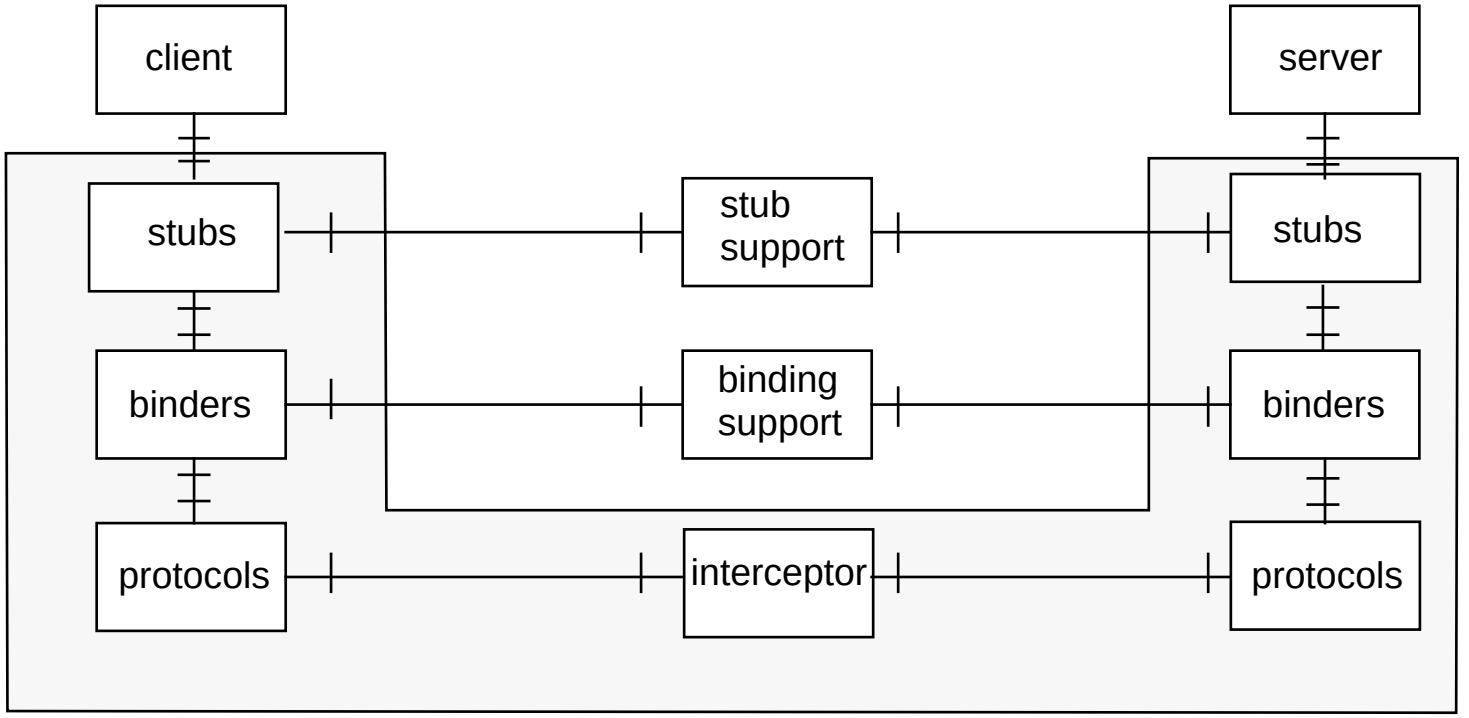
Clusters and Capsules

- ***A capsule can support multiple clusters***
- ***A Cluster Manager handles this for each cluster***
  - **it coordinates *checkpoints* for the cluster (snapshots of its state)**
- ***If there are no clusters, no Cluster Manager is needed***

Channels

- ***Channels are communication paths between objects***
- ***Channels may be:***
  - **1 to 1 (point-to-point)**
  - **1 to many (point-to-multipoint)**
- ***Channels may be:***
  - **operational**
  - **stream**
- ***Channels are layered:***
  - **built from *stubs*, *binders*, and *protocol objects***
  - **there may be multiple protocols in a particular infrastructure...**
  - **...layering hides the diversity from the application**

Point-to-Point Client-Server Channel



Stubs, Binders, and Protocol Objects

- *Stubs provide data conversion*
- *Binders manage end-to-end integrity and quality-of-service*
- *Protocol objects provide communication*
- *... Most application developers will only be aware of stubs*
  - and even these will probably be generated automatically

Concurrency

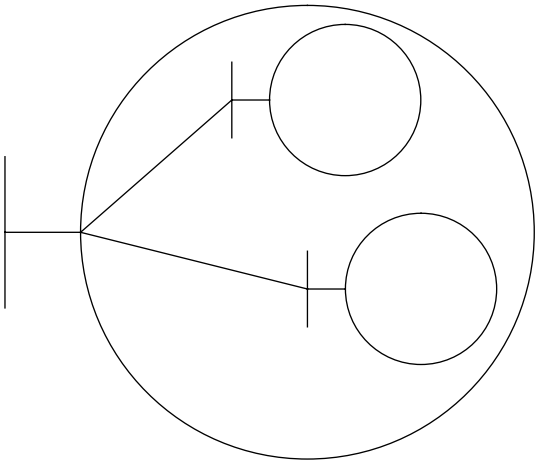
- ***Capsules on the same node run concurrently***
- ***Within a capsule, you can use threads to achieve concurrency***
  - **these may be supported by the operating system, or by the nucleus**
  - **... threads are always available, even under DOS!**
- ***On a multi-processor system, different threads in the same capsule can run simultaneously on different CPUs***

Relating Engineering Concepts to CORBA

- *The relation between the concepts of the engineering model and those of CORBA is non-trivial*
- *Some concepts translate directly, for example:*
  - stubs are described in the same way
  - ...and play the same role
  - ...but are more complex
- *Other concepts are complex to translate*
  - capsules are simple in the engineering model
  - ...but have no simple counterpart in CORBA

Engineering Concepts Present in CORBA

- ***Objects***
  - **CORBA objects are more like those in the Computational Model**
- ***Interfaces***
  - **CORBA interfaces like in engineering model**
- ***Capsules***
  - **not native CORBA objects**
  - **...can be represented by object wrappers**
  - **...objects that encapsulate other objects**



Stubs and Binders in CORBA

- *In CORBA, stubs are augmented with implementation information*
  - client side: IDL -> stubs + interface repository
  - server side: IDL -> skeletons
  - server side: implementation installation -> implementation repository
- *The binder role corresponds in CORBA to the functions performed by the interceptors*
  - Natural to put control over QoS, along with other end-to-end criteria (such as security), into the interceptors

Engineering Concepts Absent from CORBA

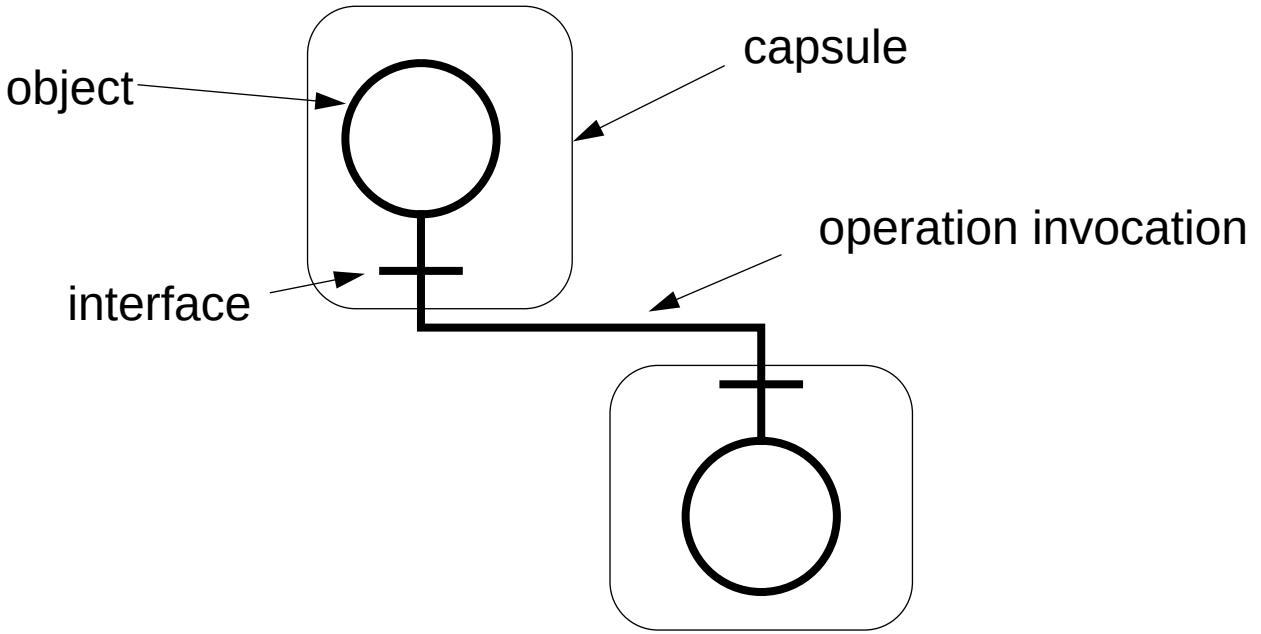
- *Nodes*
  - CORBA does not specify the level or granularity of distribution of objects
- *Nucleus*
  - CORBA expects most of the nucleus functions to be provided by the OS
- *Clusters*
  - these would be built using Common Facilities and Common Object Services

Transparencies - Simplifying distribution

- ***Remember that in a distributed system, traditional design assumptions must be reversed***
  - **for example, mobility: objects do not stay in one place, they can migrate**
- ***Must isolate the specification of transparencies from their design***
  - **Computational Model just assumes the transparencies are provided when needed**
  - **Engineering Model must show how transparencies are provided from engineering mechanisms**
- ***Applications developers simply state which transparencies they require***
  - **software tools construct them automatically from the engineering mechanisms**

Transparency examples

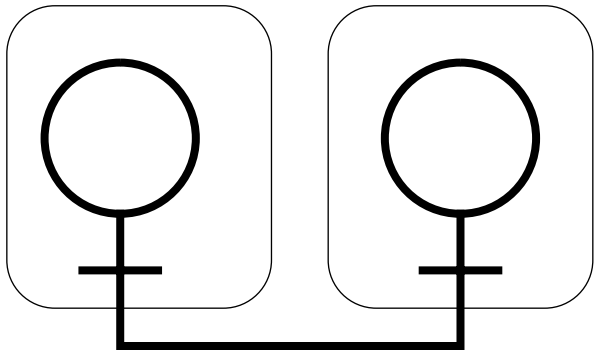
- ***In these examples the diagrams are slightly simplified***
- ***This shows an object invoking an operation from another capsule***



Selective Transparency Engineering - Location

- **Location Transparency**

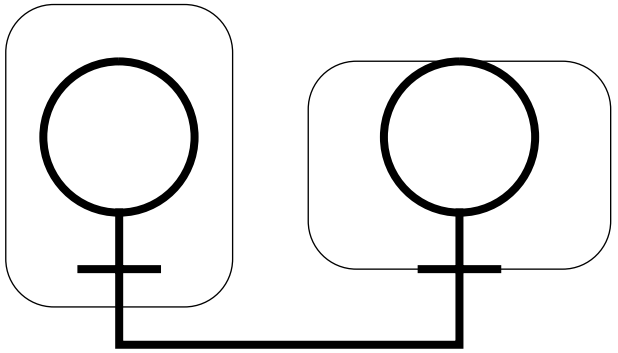
  - **application need not know where object is to use it**



  - **objects may be in the same capsule, different capsules, or different nodes**

Selective Transparency Engineering - Access

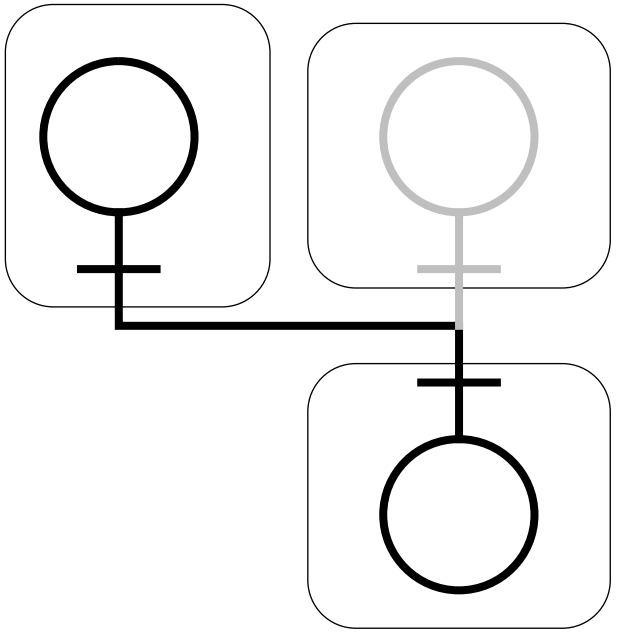
- **Access Transparency**
  - **application need not know the type of machine where the object is executing**



  - **objects may be in capsules on different operating systems, on different processor types (mainframe, workstation, or PC),...**

Selective Transparency Engineering - Migration

- **Migration Transparency**
  - **application need not know where the object has moved to**

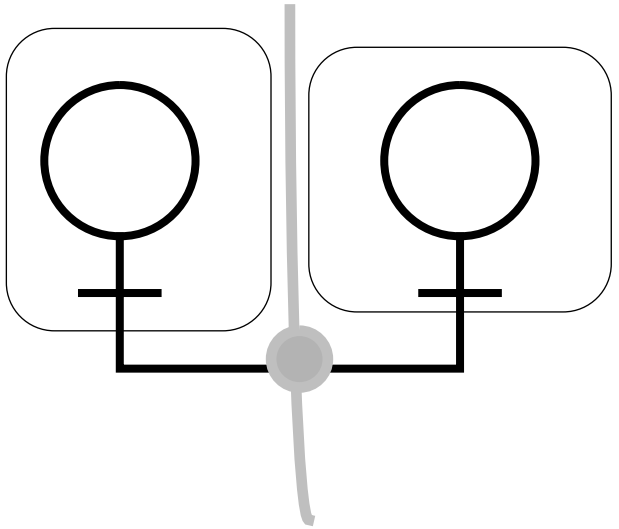


Migration Transparency

- ***Object migration needed:***
  - **when a node fails, and its capsules have to be moved to another node**
  - **for load-balancing between capsules**
- ***Like a stronger form of location transparency***
  - **relies on location transparency mechanism**

Selective Transparency Engineering - Federation

- **Federation Transparency**
  - **application need not know where administration boundaries are**



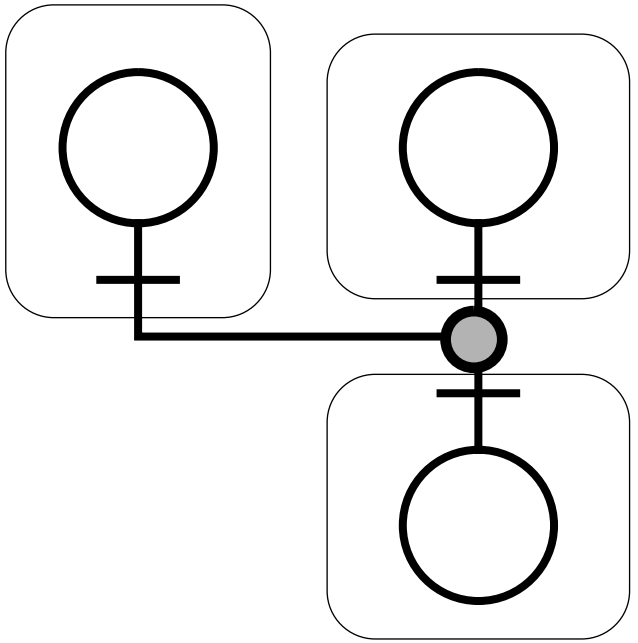
  - **interception may happen at the boundary, but this is not visible to the application**

Federation Transparency

- ***Federation is an Enterprise issue***
  - **there are many different kinds of federation boundaries: administration, organizational, contractual, and so on**
  - **constructing the transparency requires Enterprise knowledge**
- ***Federation is an ANSA research area***
  - **how it relates to trading**
  - **part of ANSA Phase III**

Selective Transparency Engineering - Replication

- **Replication Transparency**
  - **application need not know how many copies**



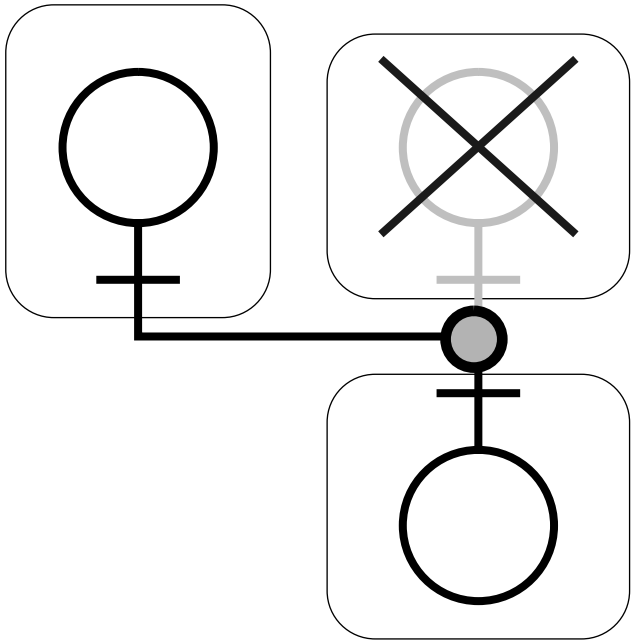
  - **application only sees a single interface**

Replication Transparency

- ***Server objects are members of a group***
  - **do not confuse with a cluster!**
- ***Replication transparency uses special mechanisms to make sure the group members are consistent***
  - **for instance, it may use multi-point channels and special protocols**
- ***Implementing replication transparency efficiently is difficult***
  - **it may need information from the application**
  - **it is under active research in the distributed systems community**

Selective Transparency Engineering - Failure

- **Failure Transparency**
  - **application need not know when an object fails**



  - **may use replication transparency to achieve this**

Other transparencies

- ***Security***
  - application need not be aware of security policy
- ***Concurrency***
  - application need not be aware of other concurrent operations
- ***Transaction***
  - applications need not be aware of inconsistent states

Computational and Engineering Models - comparison

- ***Computational Model is for specifying interfaces for distribution***
  - **interfaces consist of operations**
  - **operations have (multiple alternative) terminations**
  - **everything has a type**
- ***Engineering Model is the infrastructure for Computational Model***
  - **encapsulation using capsules, clusters, and nodes**
  - **communication using channels**
  - **concurrency using threads**
  - **transparency mechanisms**
- ***The Computational Model is pure...***
- ***... the Engineering Model supports trade-offs***

Summary

- ***This has described the Engineering Model***
  - **ANSAware implements some, but not all of the Engineering Model...**
  - **... and not always as described in the Engineering Model**
- ***For more information:***
  - **on transparency mechanisms, see *The Challenge of ODP* (TR.033.02)**
  - **on replication transparency and groups, see *A Model for Interface Groups* (AR.002.01)**
  - **on federation, see *The ANSA Model for Trading and Federation* (AR.005.00)**
  - **on streams, see *Integrating Multimedia into the ANSA Architecture* (TR.028.00)**