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Training

ANSAwise - The ODP Computational Model [Eurocontrol]

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Abstract

This presentation is a module of the ANSAwise training program.

It describes the following concepts in the ODP/ANSA Computational Model.

Objects
Encapsulation
Shared state
Multiple interfaces
Service configurations
Operations and Terminations
Interface types
Type conformance

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Briefing Note

Distribution:
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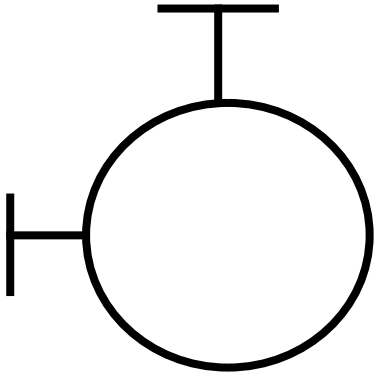
The Computational Model



In this session

- **Explain the concepts of the Computational Model**
- **Explain the rules that are imposed, and their importance**
- **Explain how objects and interfaces are used**

What is the Computational Model?

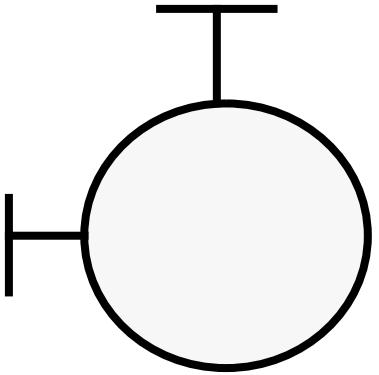
- It is a model for specifying service provision and use
  - Objects may provide multiple services to other objects
  - Objects may use multiple services from other objects
- Objects and their services may be created and destroyed dynamically
- The ability to use a service may be passed from one object to another
- The Computational Model is based on interacting *distributed objects*
  - It makes no assumptions about where the objects are located

What is meant by ‘object’?

- **Nowadays all software is supposed to be ‘object-oriented’**
  - **OOA/OOD (analysis and design methods)**
  - **OOL (programming languages)**
  - **OODBMS (databases)**
  - **... and many more**
- **All these have one key concept in common...**

Encapsulation - the key concept

- **Objects are encapsulated**
  - **every object provides a service via interfaces**
  - **the interface is public; the implementation is private and hidden**
  - **encapsulation forms a boundary; the only access to an object is via its interfaces**

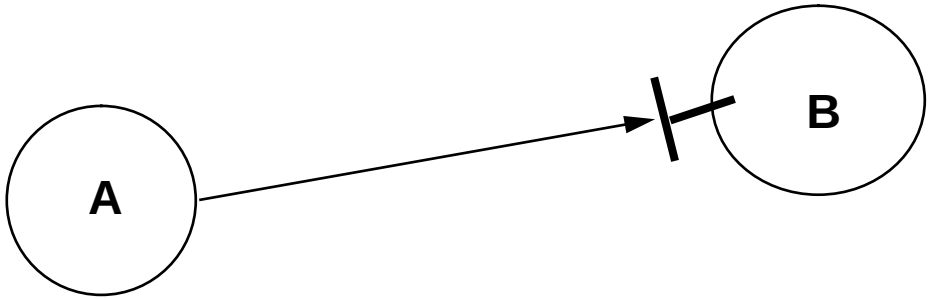


Encapsulation hides data representation

- **The boundary hides the data representation used by the object**
  - **Diversity: different objects use different representations**
  - **In a distributed system, different representations are used in different places**
  - **One object cannot manipulate another's data (only via the interface)**
  - **Data representations cannot be transferred between objects**

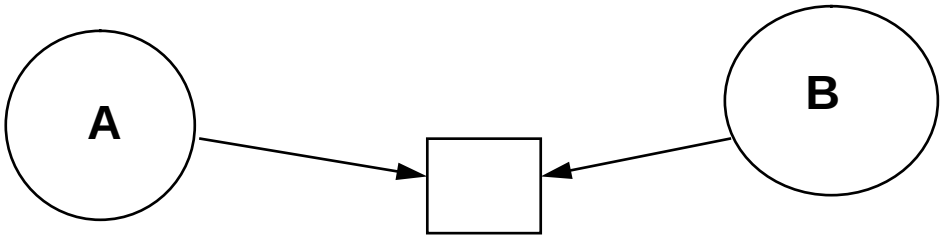
Encapsulation for distributed objects

- **We cannot assume anything about the location of distributed objects**
  - **Objects A and B could be on the same machine, or in different countries**

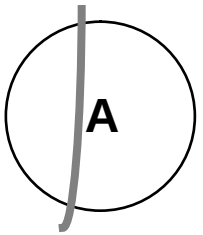


Encapsulation rules

- **Objects cannot share state directly (only access it via interfaces)**
  - ***this is not allowed***

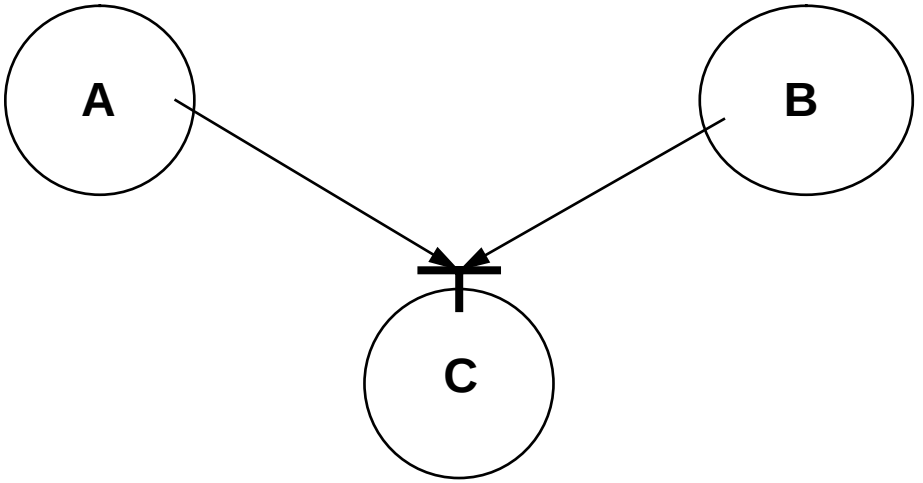


- **An object cannot be distributed in pieces; it must all be in one place**
  - ***this is not allowed***



Sharing state via an object

- No back door is needed; use an interface to a shared object instead
  - Both A and B can access their shared state stored in C

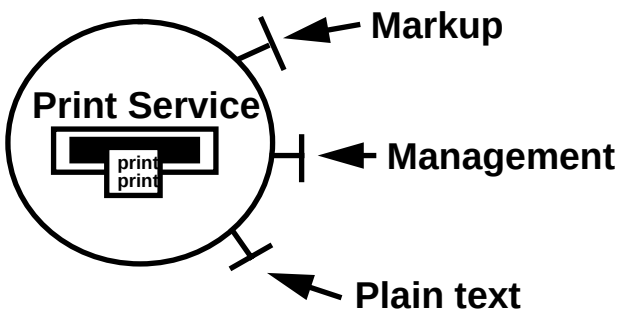


Multiple interfaces to an object

- Multiple interfaces allow flexible configurations...
- ... Consider a service for printing documents
- It must print two kinds of document
  - plain text documents
  - documents in some markup language, for example PostScript (TM)
- It must also have a management interface for
  - starting and stopping a print queue
  - delete print jobs
  - other administrative tasks

A print service with multiple interfaces

- **One object with plain text, markup, and management interfaces**



Objects and Interfaces - summary so far

- **Objects encapsulate state**
  - **and must take full responsibility for it**
- **Interfaces provide the service access points**
- **Objects can have multiple interfaces**
- **[Object-oriented programming languages:**
  - **use one construct for both encapsulation and service provision**
  - **provide only a single interface]**

with their shared state

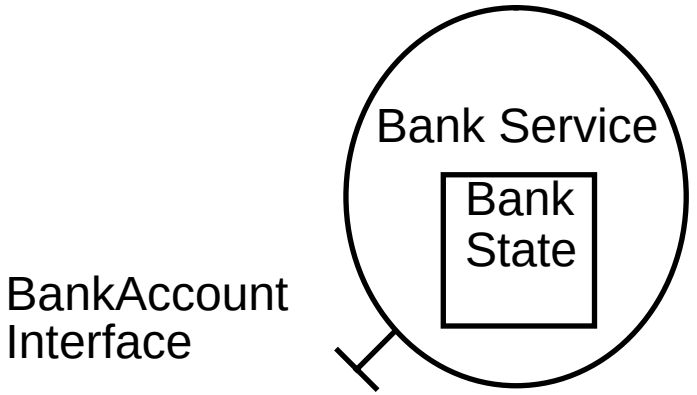
Operations - the actions in an interface

- **An interface defines one or more *operations***
- **Operations are the actions that the user of the interface can invoke**
  - **Similar to "methods" in object-oriented languages**
- **Because of encapsulation, the defined operations are the only way to act on the object**
  - **No “back door” [not even for management or debugging]**

Operations - a Simple Bank example

- Consider a bank account service...
- Each bank account has state
  - account balance
  - name of customer
  - ... and others
- Each bank account has actions that affect this state
  - Credit: depositing money, increases the balance
  - Debit: writing a cheque, decreases the balance
  - Show: enquires the account balance
- These actions are the only way of manipulating the bank account; these actions are the *operations*

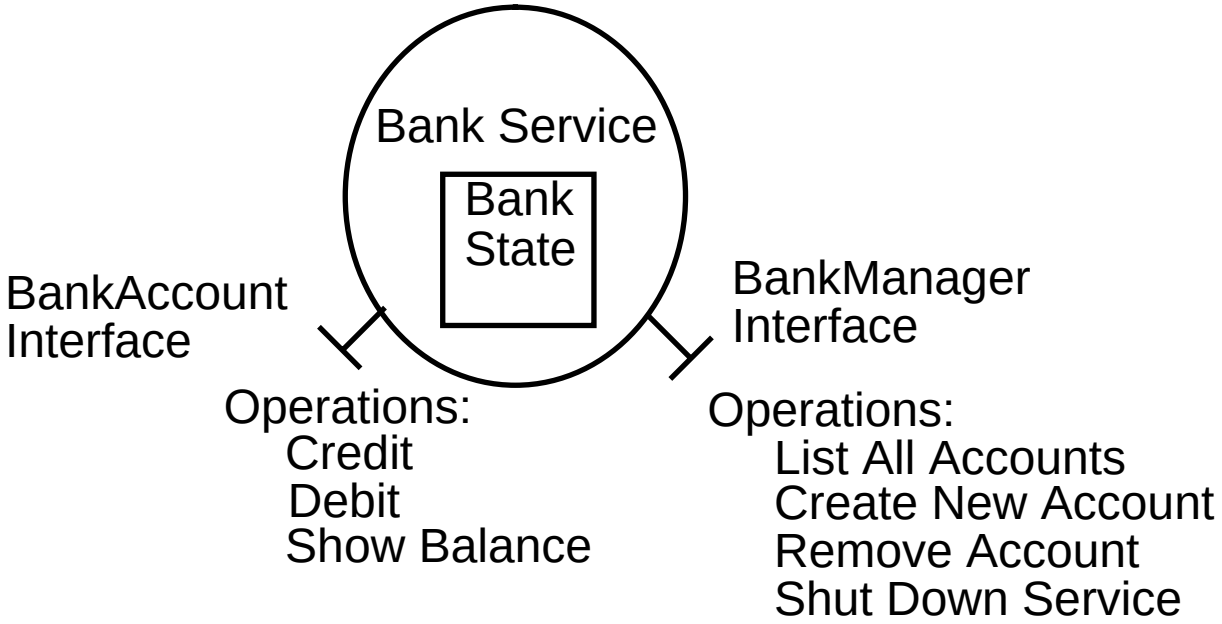
Simple Bank - Service, interface, and operations



Operations:
- Credit
- Debit
- ShowBalance

Simple Bank - Operations in multiple interfaces

- **A service can have more than one interface**
- **Each interface has its own operations**



Operations and Arguments

- **Each operation has a name, input arguments, and output arguments**
  - **for example, the Credit operation returns the new balance**

    Credit (amount : Integer) -> (newBalance : Integer)
  - **amount is a input argument; newBalance is an output argument (result)**
- **Each operation can have multiple input and output arguments**
  - **this example only has one of each**

Operations and Terminations

- **An operation can have more than one possible outcome**
- **Consider operations on the BankAccount:**

  Credit (amount : Integer) -> (newBalance : Integer)

  Debit (amount : Integer) -> (newBalance : Integer)

  - **... but the balance may be insufficient! - so**
  - Debit (amount : Integer) -> (newBalance : Integer) ->InsufficientFunds()

- **There is one Debit operation with two possible outcomes; two separate *terminations***

Named Terminations

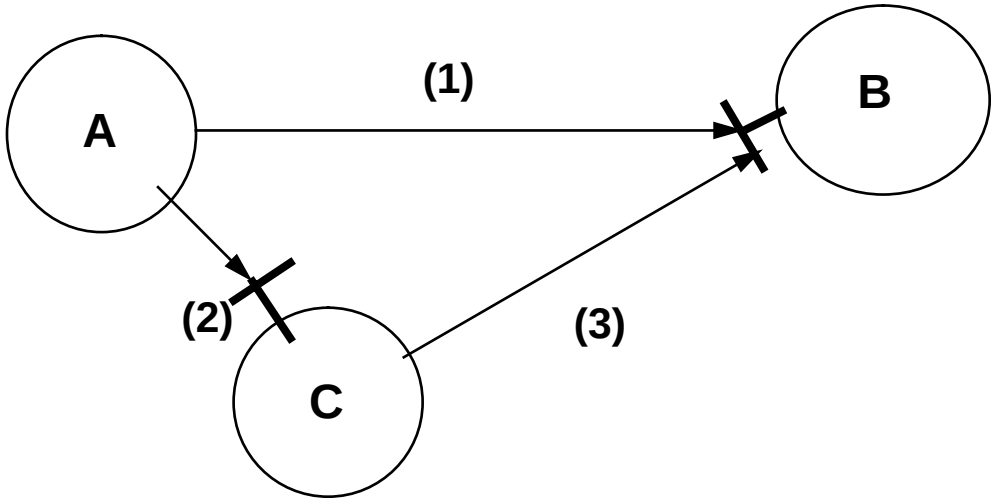
- **The InsufficientFunds outcome is called a *Named Termination***
  - **the normal outcome is an unnamed (anonymous) termination**
  - **one termination of an operation may be anonymous**
- **Each termination may return multiple results**
- **The invoker of an operation distinguishes between the different terminations by their names**

Operations, Arguments, and Terminations - summary

- An *operation* is the unit of interaction. It has:
  - a name
  - a signature (list of input arguments)
  - a set of *terminations* (possible outcomes)
- A termination has:
  - a name
  - a signature (list of output arguments)
- Terminations make operations more powerful than ‘functions’ or ‘methods’

Using Interfaces

- Object A is using one of object B's interfaces
- Suppose it needs to tell C to use the same interface



- It must be possible to pass a binding to B's interface between A and C

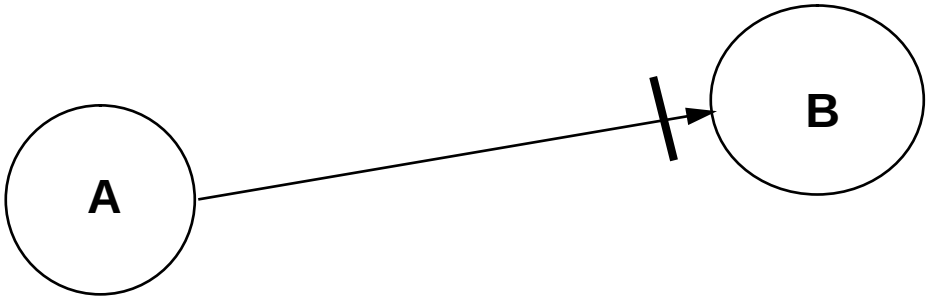
Interface Bindings

- **Interfaces are identified by *interface bindings*; these can be passed to other objects as arguments (or results)**
  - **for example, when A passes B's interface binding to C, it calls...**

    C_op (b: TypeOfInterfaceToB) ->()
  - **... with B's interface binding as the argument**
- **Only the binding is passed, not the interface...**
- **... In fact, all operations are invoked via interface bindings**

The right interface?

- Suppose object A has a binding for an interface of B...
- ... how does object A know that B has the right kind of interface?
  - it can't inspect the object itself
  - objects A and B could be on the same machine, or in different countries



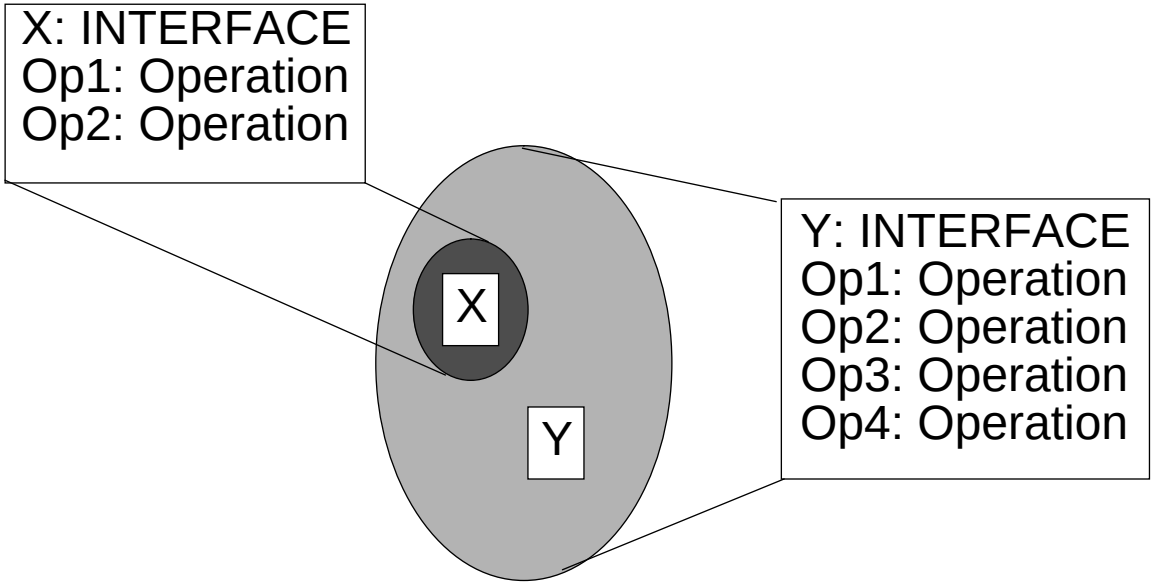
- It can tell, because interfaces have an *interface type*

Interface types

- **The interface type consists of the set of its operations**
  - **Plus all their signatures and terminations**
- **Object A can use an interface of object B, provided that the interface provided by B *conforms* with that expected by A**
- **This means that object A must state what interface type it expects**

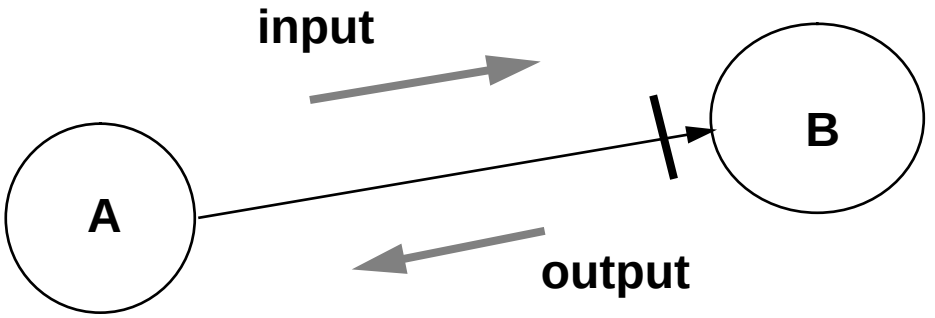
Type Conformance

- **Conforming interface types do not have to be identical...**
- **...Interface type Y *conforms to* interface type X**



Type Conformance Has Two Sides

- To conform, B must provide at least the operations expected by A...



- ...but also, A must handle at least the terminations given by B
  - same idea, but the ‘at least’ rule is the other way round for terminations
- To conform, both of these must be checked... [a two-sided *contract*]
  - B must not receive unknown operations
  - A must not receive unknown terminations

Summary

- **Objects enforce strict encapsulation**
  - **state cannot be shared between objects**
  - **only whole objects can be re-configured (*part* of an object cannot be)**
- **Interfaces provide the points of service provision**
  - **objects may have multiple interfaces**
  - **interfaces are typed**
- **Interfaces are composed of operations**
  - **operations can have multiple terminations with multiple results**
- **For more information:**
  - **for object-oriented concepts, see *Distributing Objects* (TR.018.01)**
  - **for a formal description, see *The ANSA Computational Model* (AR.001.01)**

Computational Model - topics not covered

- **Concurrency**
  - **threads and sub-threads, enforcing tree-structured concurrency**
- **Streams - continuous (possibly bi-directional) information flows, for example:**
  - **speech, in telephony and voice processing: an audio stream**
  - **video, in multimedia: a video stream**
  - **sensor data, in telemetry: a data stream**
- **Synchronous programming constructs**
  - **reactive systems, bounded execution paths**
  - **testing, receiving, waiting for and transmitting signals**
  - **watchdogs**