Poseidon House
Castle Park
Cambridge CB3 0RD
United Kingdom

TELEPHONE: **Cambridge (01223) 515010**
INTERNATIONAL: **+44 1223 515010**
FAX: **+44 1223 359779**
E-MAIL: **apm@ansa.co.uk**

Training

ANSAwise - Objects in Distributed Systems

Chris Mayers

Abstract

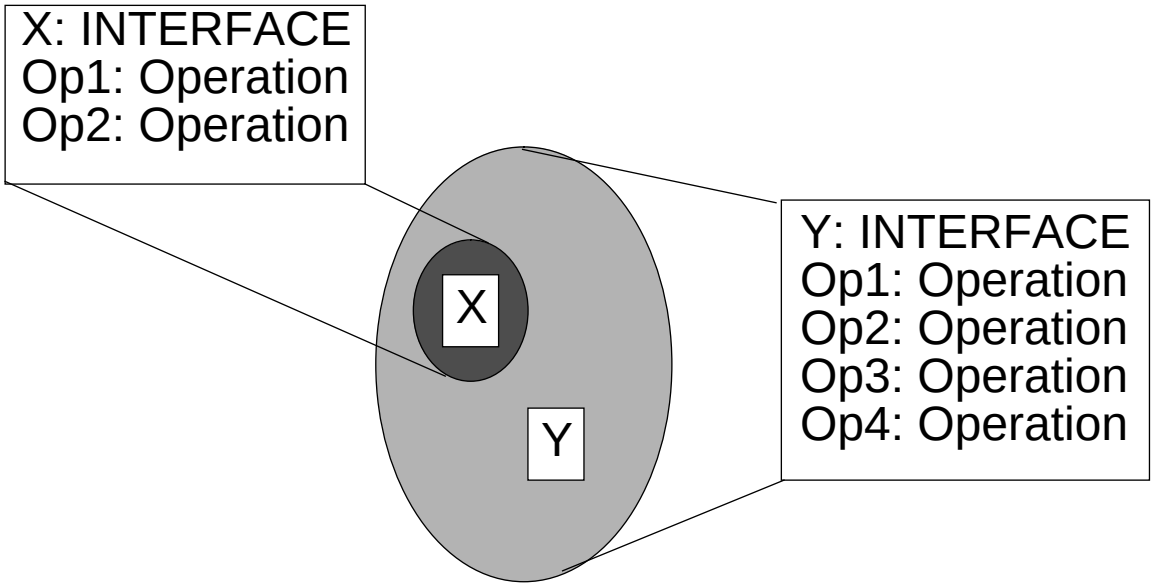
Organizations will be aware of object technology, and have a picture of the benefits it can bring, but may be unaware of the state of the market, and the pitfalls.

This module of the ANSAwise training programme discusses “objects in general”, compares how the ideas of encapsulation, polymorphism, and inheritance are applied in various object technologies, and explains why distributed objects require a specific approach to be successful.

APM.1350.02 **Approved** 27th March 1996
Briefing Note

Distribution:
Supersedes:
Superseded by:

Objects in Distributed Systems



In this session

- **Explain the basic ideas of object technology**
- **Show how these ideas are applied in programming languages**
- **Clarify what is different about objects in distributed systems**

Problems with existing software

- Changing software is difficult
- Changing software can have unanticipated side-effects
- Upgrading software to new versions is difficult
- The consequences are
  - Application backlogs
  - Low productivity and administrative overheads
  - Low quality

Why object technology?

- **Object technology enables systems to be built out of modular components**

- **These systems offer**

  - **Greater productivity through reuse**

  - **Better quality through proven components**

  - **Lower costs through reduced maintenance overheads**

Influence of object technology

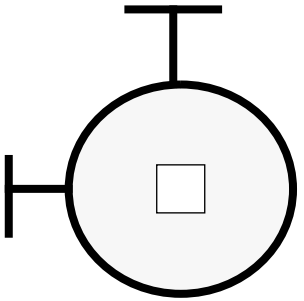
- **Now affecting all areas**
  - operating systems
  - programming languages
  - databases
  - user interfaces
- **Products and standards are emerging in all of these**
  - but at different levels of maturity...
  - ...with patchy support from development methods and tools
  - ...and with important technical differences
- **Not all of these products and standards are ‘open’**
  - this poses a challenge to those building systems with object technology

Objects - beyond modular programming

- Object programming is ‘modular programming’ that scales
  - to very large and complex systems
- Object technology has three common concepts
  - encapsulation
  - polymorphism
  - inheritance
- In distributed systems these concepts need to be examined again

Encapsulation - the key to reuse

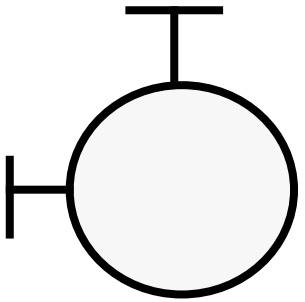
- **Data needs to be encapsulated together with the program...**



- **...forming an object**

Encapsulation for objects

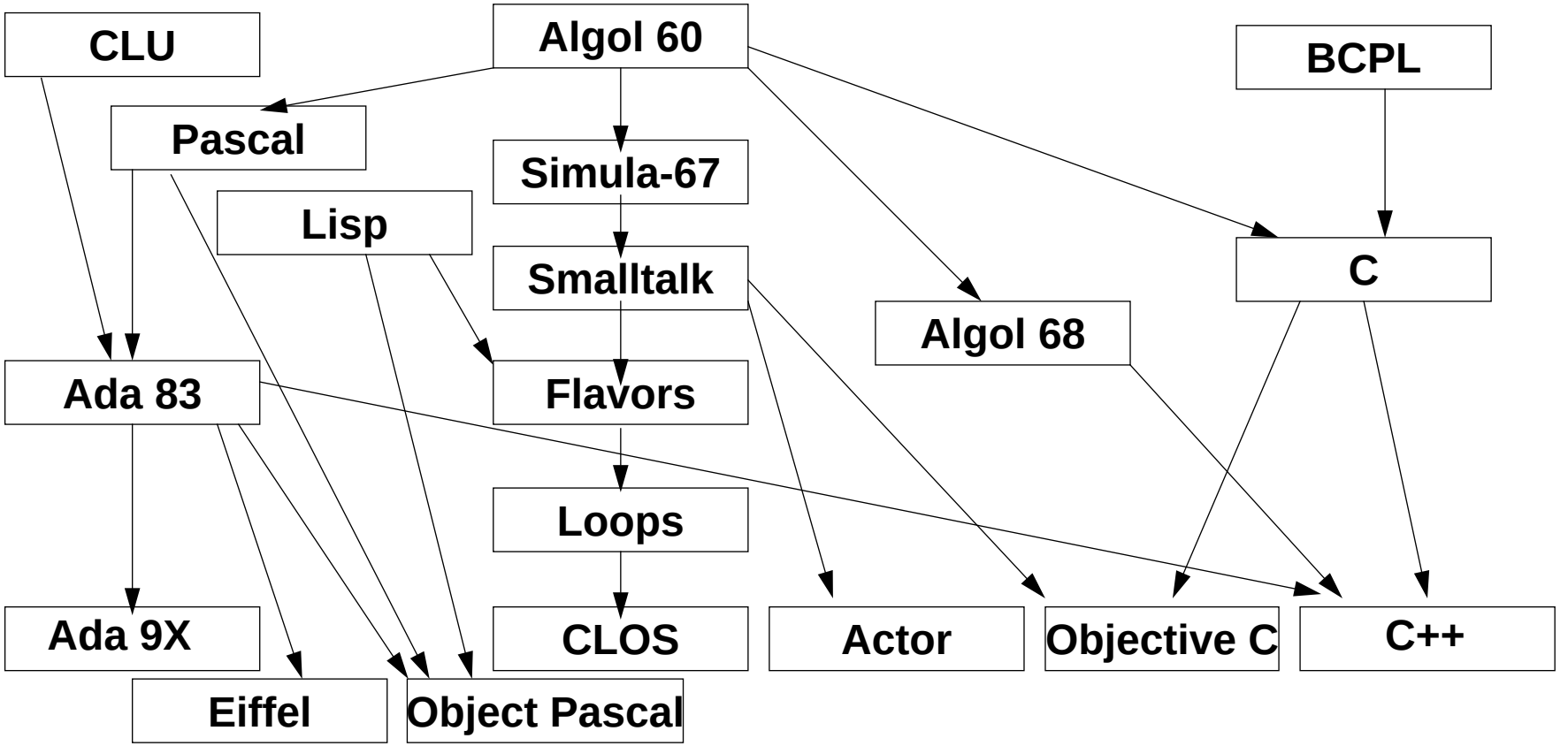
- **Objects are encapsulated**
  - **every object provides a service via interfaces**
  - **the interface is public; the implementation is private and hidden**
  - **encapsulation forms a boundary; the only access to an object is via its interfaces**



Encapsulation in programming languages

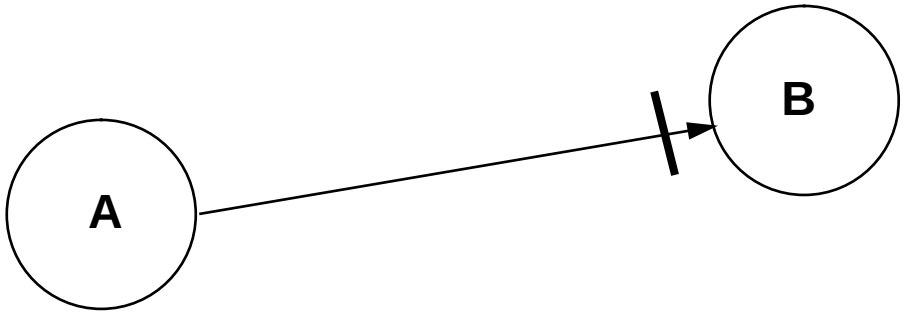
- Access only via explicit interfaces
  - C++ class
  - Smalltalk class
  - Ada package
- Hide the implementation
  - the data structures
  - the algorithms
  - the state
- Keep the data with the code

Evolution of OO programming languages



Encapsulation in distributed system

- In a distributed system, encapsulation must be strict
  - no shared state between objects
  - no ‘back doors’
- Objects A and B could be on the same machine today...
- ... in different countries tomorrow



Polymorphism

- There are more kinds of objects than kinds of operations...

	Save	Edit	Print	Delete	...
Report					
Spreadsheet					
Diagram					
Graph					
Diary					
Plan					
...					

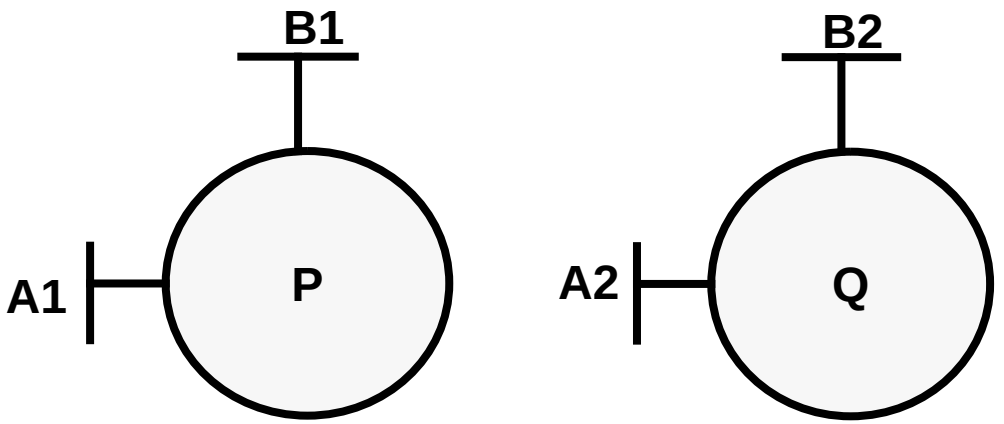
- ... so each object should handle each kind of ‘polymorphic’ operation

Polymorphic operations

- The same operation can apply to different types of object
  - you can print a text file, a structured document, and a bitmap
- Each object can be expected to “know how to print itself”
  - it has a standard interface for printing
  - the object determines *how* to “print itself”

Inheritance for objects

- Consider two similar objects



- They can have similar interfaces A and B
- They can have similar implementations P and Q
- ...these are quite separate properties

Views of inheritance

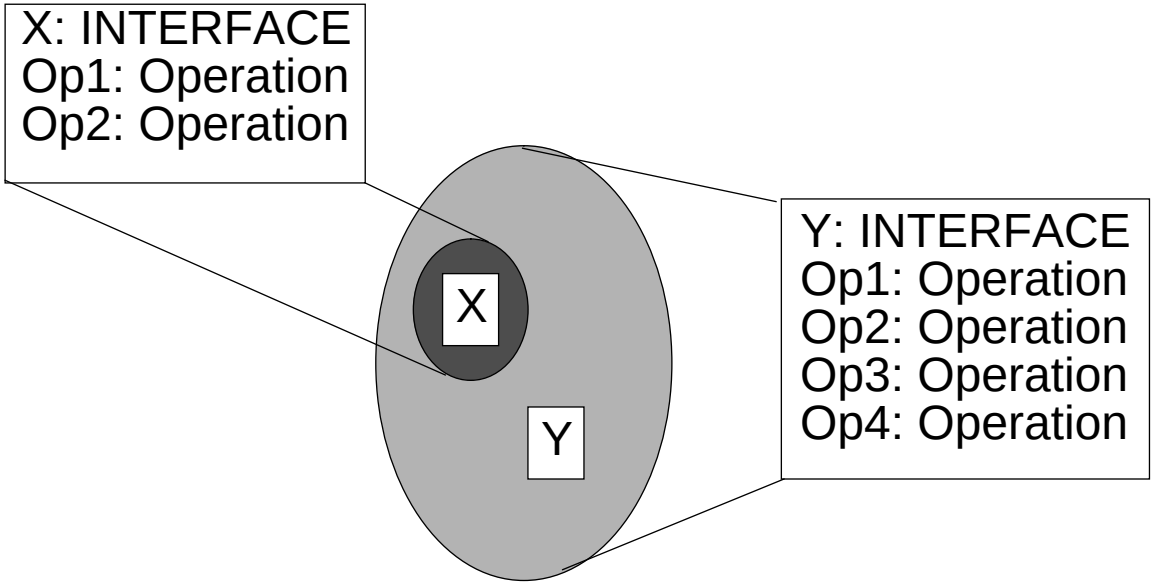
- In non-distributed object systems we may be interested in similar implementations
  - sharing or reusing some of the code...
  - ... for example the code for the A interface
- In a distributed system this is not relevant
  - sharing any code between distributed objects is impossible
- The important thing is compatibility of interfaces
  - type conformance (*substitutability)*
- Some programming languages try to use ‘class’ for both ideas

Technical benefits of objects

- **Encapsulation benefits client and server**
  - **by decoupling them**
- **Polymorphism benefits the client**
  - **client does not need to know the type of the server**
- **Inheritance would benefit the server**
  - **by sharing code...**
  - **... but this is not possible in distributed systems**

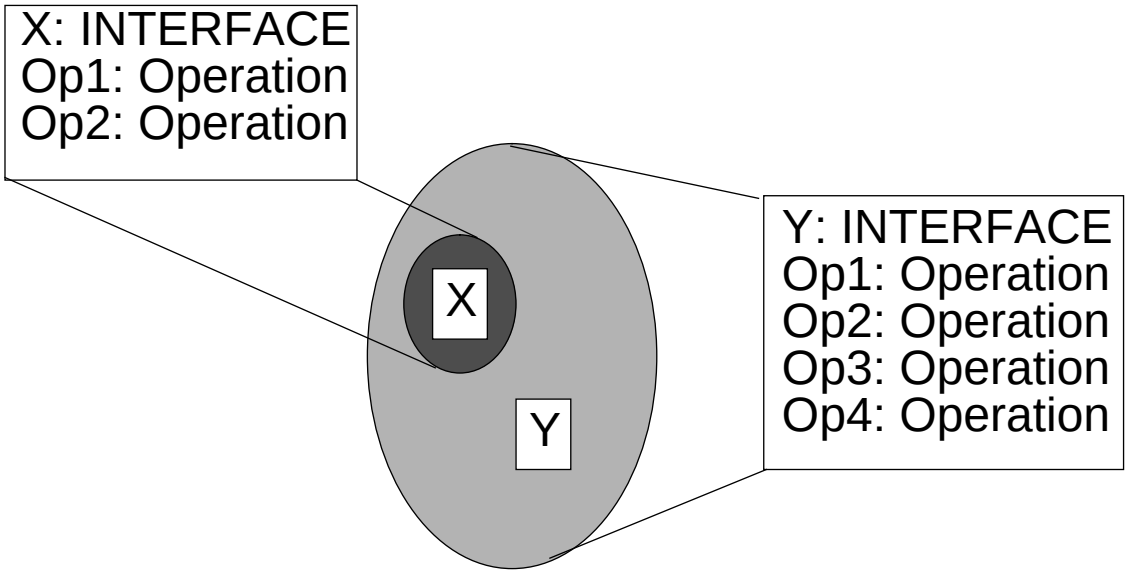
Type Conformance

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

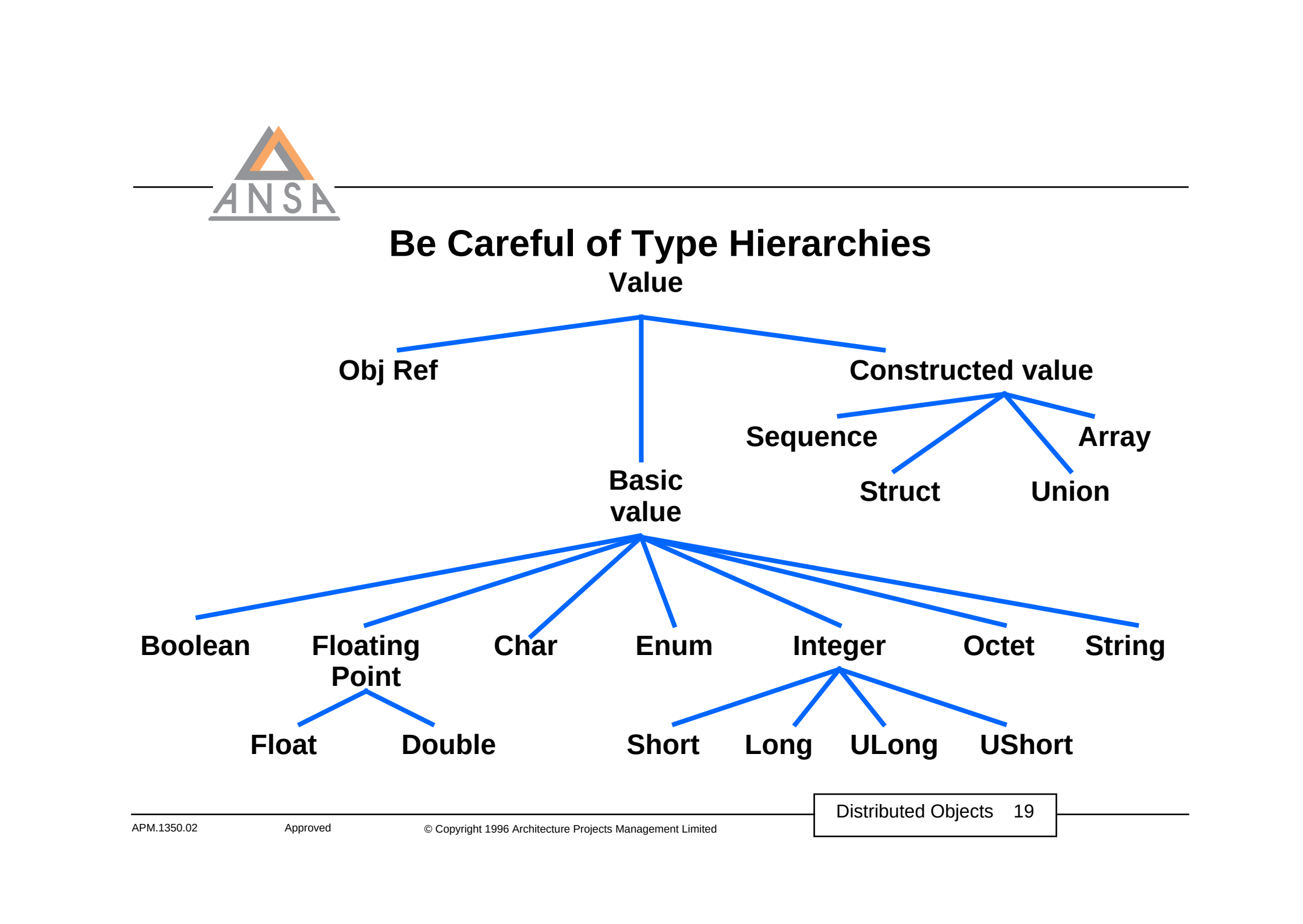


Type Conformance and Subtypes

- **Be careful when comparing types**



- **Y is a ‘subtype’ of X...**
  - **... but Y can ‘do more’ than X, not less!**



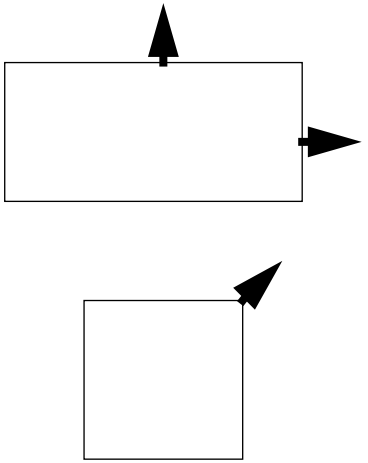
Be Careful of Type Hierarchies

What type hierarchies can mean

- When someone shows you a picture like that, it could have several meanings
- Does it show
  - type conformance relationships?
  - implementation relationships?
  - something else?

‘Is-a’ relationships

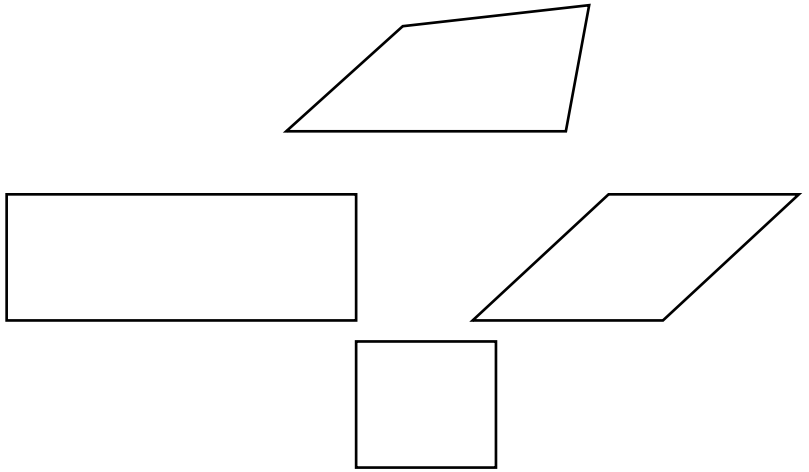
- A square ‘is a’ rectangle...



- But their ‘resize’ operations do not conform
  - rectangles have separate operations for resizing horizontally and vertically
  - squares have only one resize operation

Is-a relationships and type conformance

- Type conformance does not match is-a relationships



- There is no ‘natural’ type hierarchy
  - all that matters is conformance

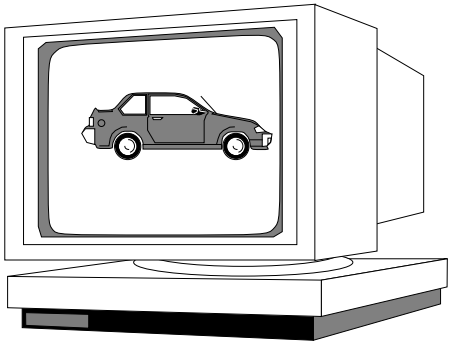
Object lifetime

- Objects outlive the processes that create them
  - conventional pointers are inadequate...
  - ... a more general kind of ‘handle’ is needed
- In a distributed system, it must be possible to pass these ‘handles’ around between machines
  - their representations must be mutually recognized

Object Identity

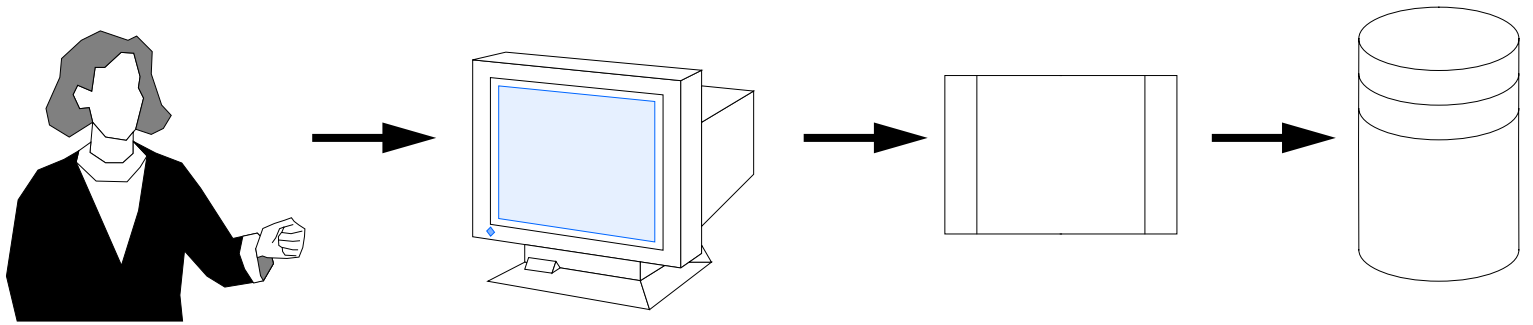
- An object can have more than one handle
- The infrastructure cannot automatically compare whether two handles refer to the same object
- Some systems have a global ‘unique id’ (UUID) for each object
  - this is not generally a good solution
- If a comparison operation is needed, the object itself should implement it

Seamless programming?

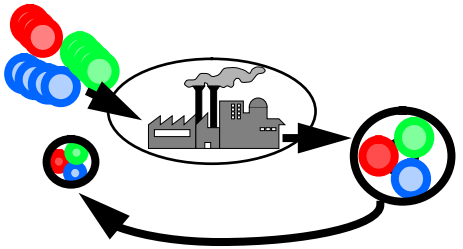


- In a car rental system, the car may be represented as
  - a user interface object, on the display
  - a distributed systems object, when accessed remotely
  - a database object, in the OODBMS
- These objects are programmed using different tools, maybe even in different programming languages by different people

Objects Everywhere



Reusable software



- Writing reusable software is more time-consuming
- Reusing software efficiently requires special software tools
- Reuse is primarily a strategy issue - a management issue
- The best form of reuse is to buy rather than build

Business Objects and Technology Objects

- **Business objects are derived from a top-down analysis of your organization's goals**
  - **derived from a strategic enterprise model**
  - **embodied in an operational model**
  - **... with associated business rules**
- **Business objects might be customers, products, orders...**
- **Technology objects are acquired bottom-up**
- **In the future, both business and technology objects may be bought and sold**
  - **supplied by third parties in horizontal and vertical markets**

Summary

- The key concepts are encapsulation and type conformance
- Distributed systems allow you choose freely the front-end and tools technology
  - Programming language
  - User interface/toolkit
  - Database
- You can use object systems without an object programming language
- Distributed systems development is possible without objects
  - but is harder work
- For more on this topic
  - see *Distributing Objects* (TR.018)