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**

ANSA Phase III

Interoperability and Distributed Application Platform Design (conf slides)

Yigal Hoffner

Abstract

Interoperability is concerned with enabling co-operation between objects which reside in different domains. Interception is the process which creates and inserts the appropriate gateways when a binding between a client and a server is created across domain boundaries. One of the major problems of interception concerns how to propagate the necessary gateways to subsequent bindings across the same boundaries. The inserted gateways can perform the required transformations in the case of technical differences, the checking and vetting in cases where administrative boundaries are necessary, and the monitoring where auditing is required.

The talk will introduce a model of interception and use it to describe a number of different interception strategies. One application of interception, namely that of passing interface references through domain boundaries will then be considered in detail.
The impact of interception on the structure of interface references and the role of binding in the interception process will be explained and used to show how distributed application platforms may provide for different strategies.

This paper was accepteed for the ICDP ’96 IFIP/IEEE International Conference on Distributed Platforms, Dresden, Germany, February 27 - March 1, 1996

APM.1575.00.02 **Draft** 11th October 1995

Request for Comments

Distribution:
Supersedes:
Superseded by:

1 Inter-operability and distributed application platform design

1.1 Introduction

1.1.1 Background

Computing facilities in offices, departments, organizations and multinational companies are being connected together. This coupled with the diversity and proliferation of information systems, and the need to rapidly adjust to business changes, requires responsive dynamic systems that can:

- facilitate the interaction between different systems where this becomes desirable
- restrict or prevent interaction between them where this is or becomes undesirable
- audit the interactions between different systems.

Administrative boundaries demarcate differences between the authorities in charge of systems, their policies and management procedures. These boundaries do not necessarily coincide with technical boundaries and must therefore be erected where necessary. Administrative boundaries are where monitoring takes place for auditing, billing and accounting purposes.

Technical boundaries are caused by differences among distributed application development platforms such as CORBA, DCE and ANSAware. Such differences have to be overcome where interaction between them is desirable.

Technical boundaries can be bridged by agreement on common protocols, for example through standardisation initiatives such as the CORBA Universal Network Object (UNO) proposal, or by the use of gateways (also called transformers, bridges, wrappers or fire-walls) which perform the required transformations.

In spite of such standardization initiatives, gateways will still be necessary:

- to erect and maintain administrative boundaries
- to cater for systems which do not support common protocols such as CORBA UNO, either for legacy or other technical/political reasons
- to adjust or modify the interface of an application.

1.1.2 Interception

Interoperability is concerned with enabling co-operation between objects which reside in different domains.

Interception is the process which creates and inserts the appropriate gateways when a binding between a client and a server is created across domain boundaries. One of the major problems of interception concerns how to

propagate the necessary gateways to subsequent bindings across the same boundaries. The inserted gateways can perform the required transformations in the case of technical differences, the checking and vetting in cases where administrative boundaries are necessary, and the monitoring where auditing is required.

A model of the process of interception is a useful tool for explaining the issues and outlining the options which will be available to system and application integrators. Options differ in terms of the point in time and the manner in which gateways are created, in the resource allocated to them and in the quality of service guarantees which can be made about the bindings between clients and servers going through the created gateways.

1.1.3 The talk

The talk will set the background to the work by talking about relations between enterprises and enterprise computer systems.

A model of interception will be introduced and used to describe a number of different interception strategies.

One application of interception, namely that of passing interface references through domain boundaries will then be considered in detail.

The impact of interception on the structure of interface references and the role of binding in the interception process will be explained and used to show how distributed application platforms may provide for different interception strategies.

Interoperability and Distributed Application Platform Design

ICDP '96:
IFIP/IEEE INTERNATIONAL CONFERENCE
ON DISTRIBUTED PLATFORMS
Dresden, Germany, February 27 - March 1, 1996

Yigal Hoffner (yh@ansa.co.uk)

The Advanced Networked Systems Architecture
ANSA Project

1995

Overview

- Relations between enterprises and enterprise computer systems
- A lineal model of interception
- The phases of the interception process
- Passing references to interfaces across domain boundaries
- Implications for distributed application platform designers
- Using the interception model to explain architectural issues

Enterprises and their computer systems

- Complex relations and processes inside and between enterprises manifest themselves in their information systems
- There is a need to overcome boundaries which exist in terms of:
  - the different way things are done in enterprises
  - the different way things are done in computer systems
- There is a need to implement physical boundaries to reflect organizational issues of:
  - responsibility, liability
  - monitoring, security, remuneration

Types of boundaries

- **Technology boundaries:**
  - can objects interact
  - can objects interact safely
- **Administrative boundaries (authority/policy):**
  - are objects allowed to interact
  - do objects want to interact (an object does not have to interact if it does not want to)
  - how are objects allowed to interact
- **The types of boundaries have implications on how the crossing is handled**
- **Can the same means used to overcome technology boundaries be used to implement administrative boundaries !?!**

Gateways and transformations

- **Gateways are needed in order to:**
  - **facilitate the interaction between different systems where this becomes desirable**
  - **restrict or prevent interaction between them where this is or becomes undesirable**
  - **audit the interactions between different systems**
- **In spite of standardization initiatives, gateways will still be necessary:**
  - **to administer and maintain boundaries between authorities**
  - **to cater for systems which do not support common protocols such as CORBA UNO, either for legacy or other technical/political reasons**
  - **to adjust or modify the interface of an application**

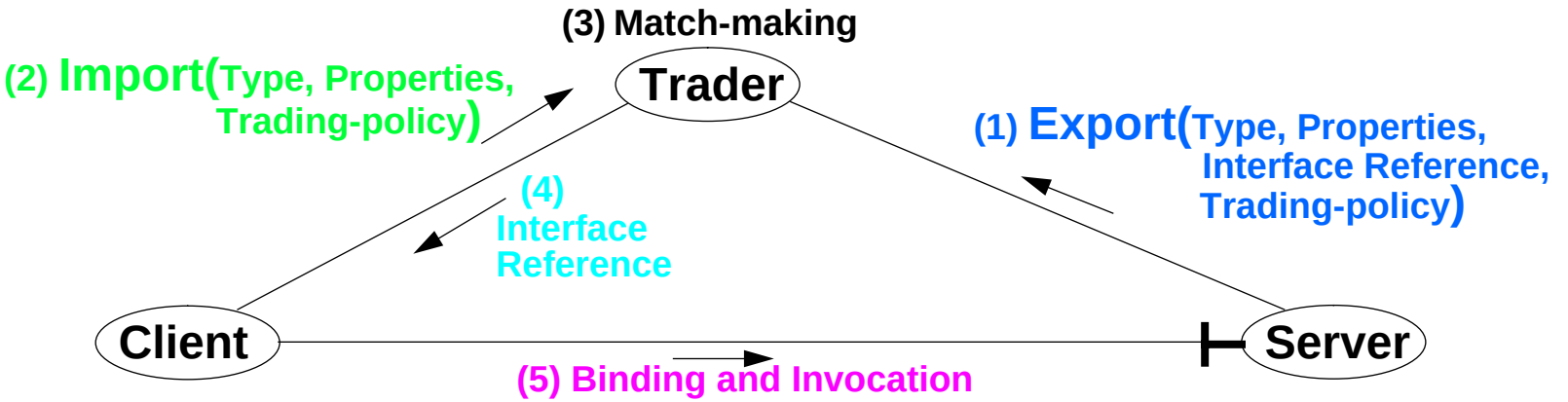
Interoperability and Interception

- **Interoperability is concerned with enabling co-operation between objects residing in different domains**
- **Interception is about...**
  - **creating bindings across domain boundaries**
  - **Interception (resolution) strategies**
  - **passing interface references**

Interface References

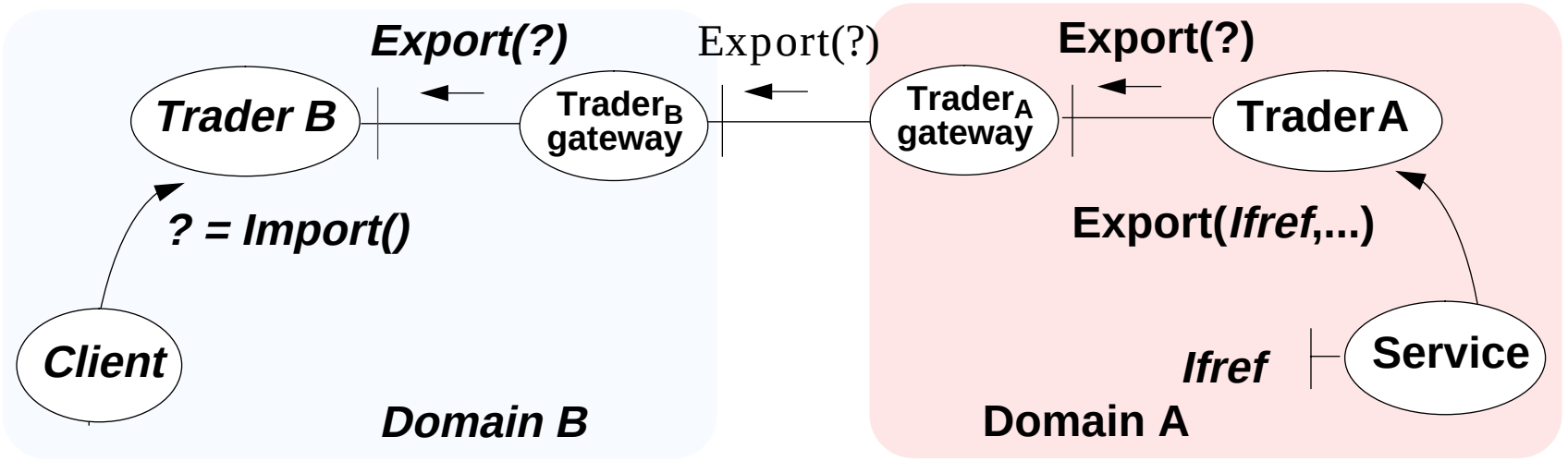
- An Interface Reference contains the engineering information needed to establish a connection between a client object and a server object
- Interface References (Ifrefs) can be:
  - DCE Binding Handles
  - CORBA Object References
  - ANSAware Interface References
- In ANSAware, for example, Ifrefs also include End-to-end binding integrity check, QoS and Group information

Trading



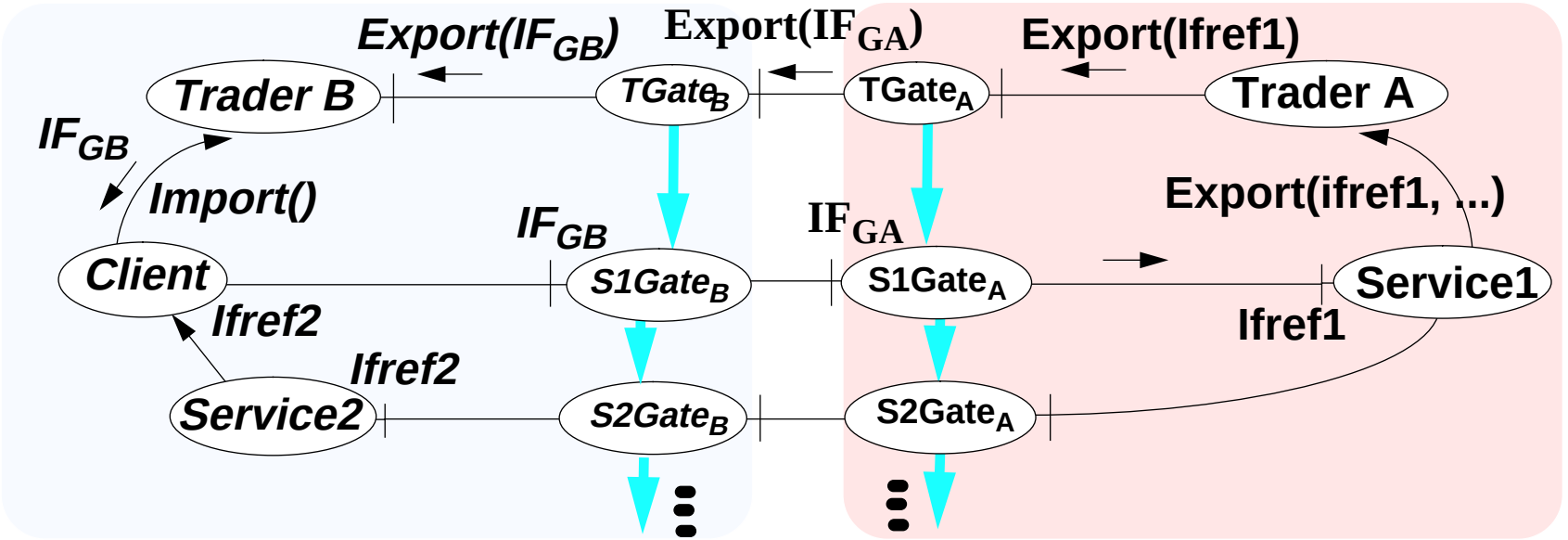
- Discovering an interface of a service that provides the required service
- Emphasis in match-making is on conformance, not equivalence

Creating bindings across domain boundaries



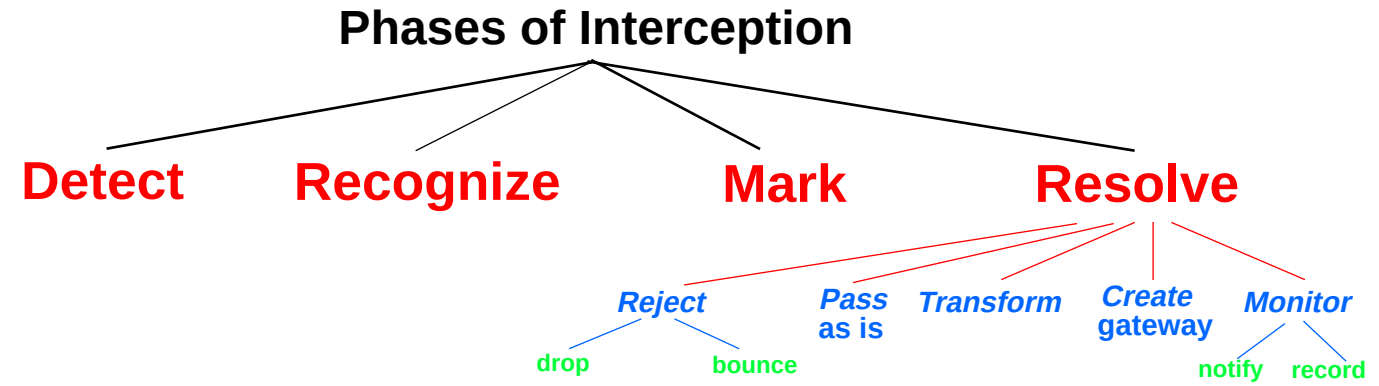
- Relationship between Domain$_A$ and Domain$_B$ is preserved by gateways
- The relationship should be preserved by subsequent bindings

A lineal model of interception



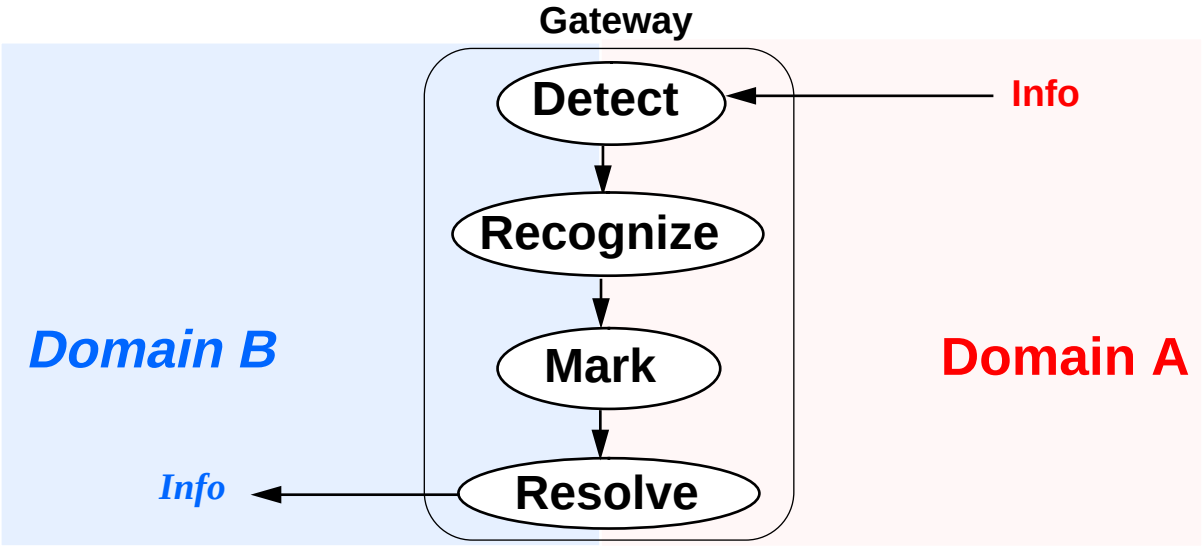
- Gateways detect the crossing of interface references and create gateways if necessary
- These may detect the crossing of interface references and create subsequent gateways if necessary. Which in turn ...

The phases of the interception process (I)



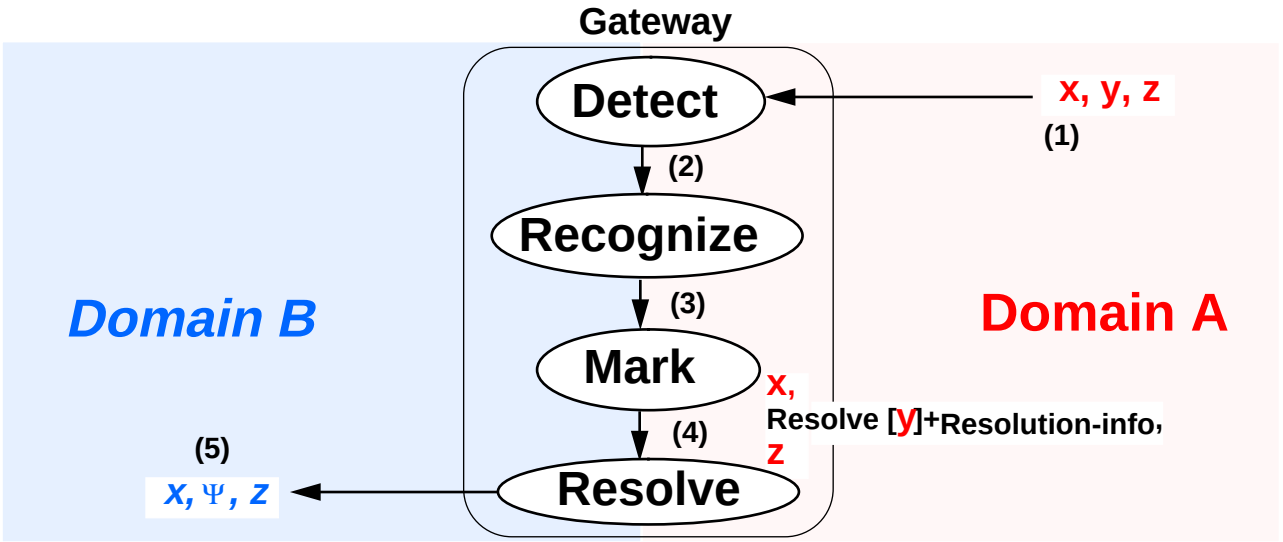
- DETECT: crossing of the domain boundary
- RECOGNIZE: information which should effect or be affected by the crossing
- MARK: recognized information for resolution
- RESOLVE: act according to or on the marked information

The phases of the interception process (II)



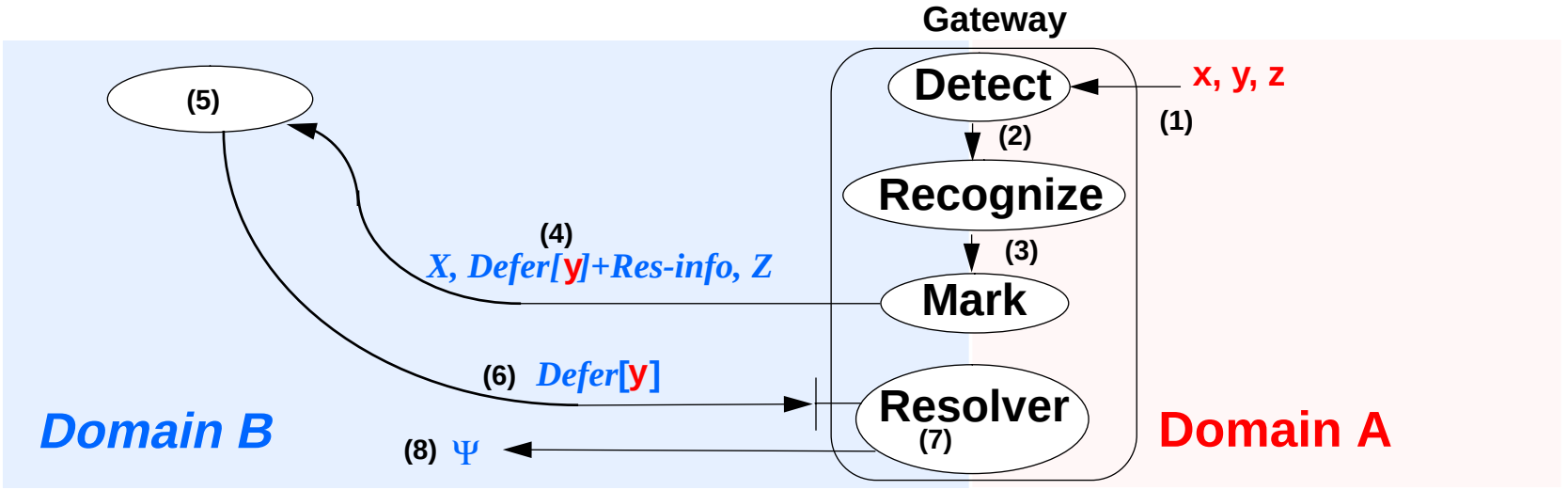
- **Separating Marking and Resolution - distribution in time and space:**
  - **how much to resolve immediately or how much to leave for later**
  - **how much information to keep in gateway or how much to forward**
- **Resource utilization and performance options**

The Immediate resolution strategy



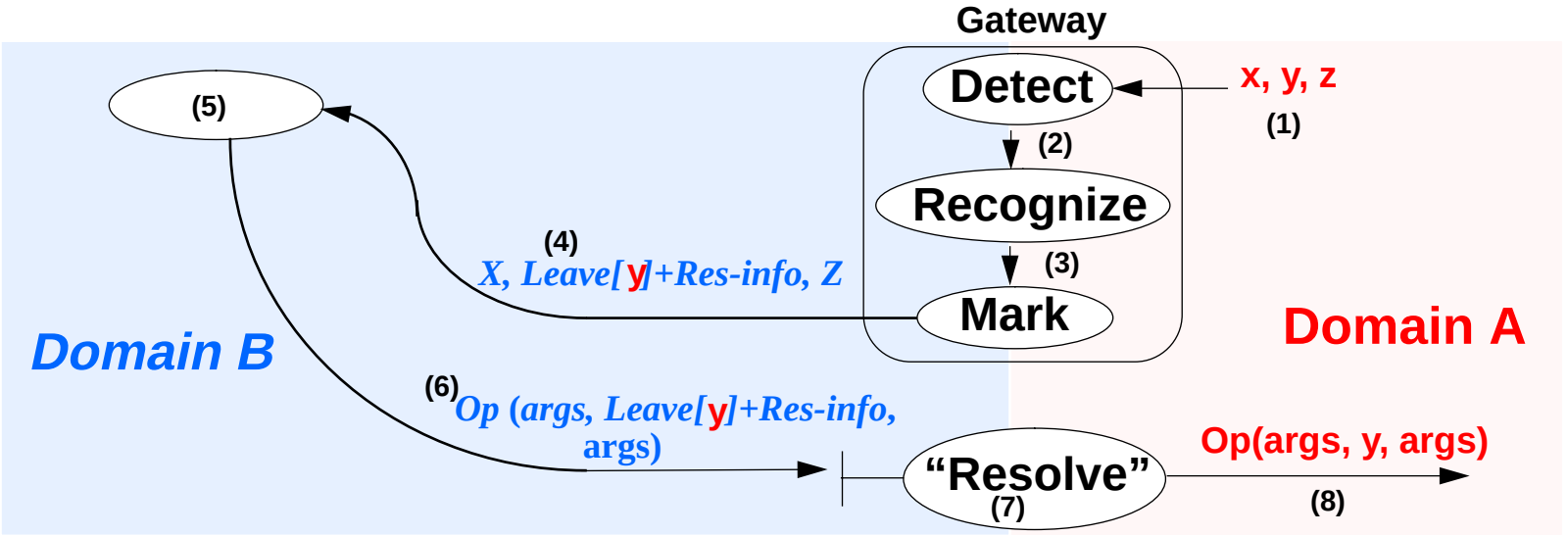
- Requires resolution to be carried out regardless of need
- Recipient in $Domain_B$ always gets immediately usable information
- All action takes place in Gateway -> no need to change anything in $Domain_A$ or $Domain_B$

The Deferred resolution strategy



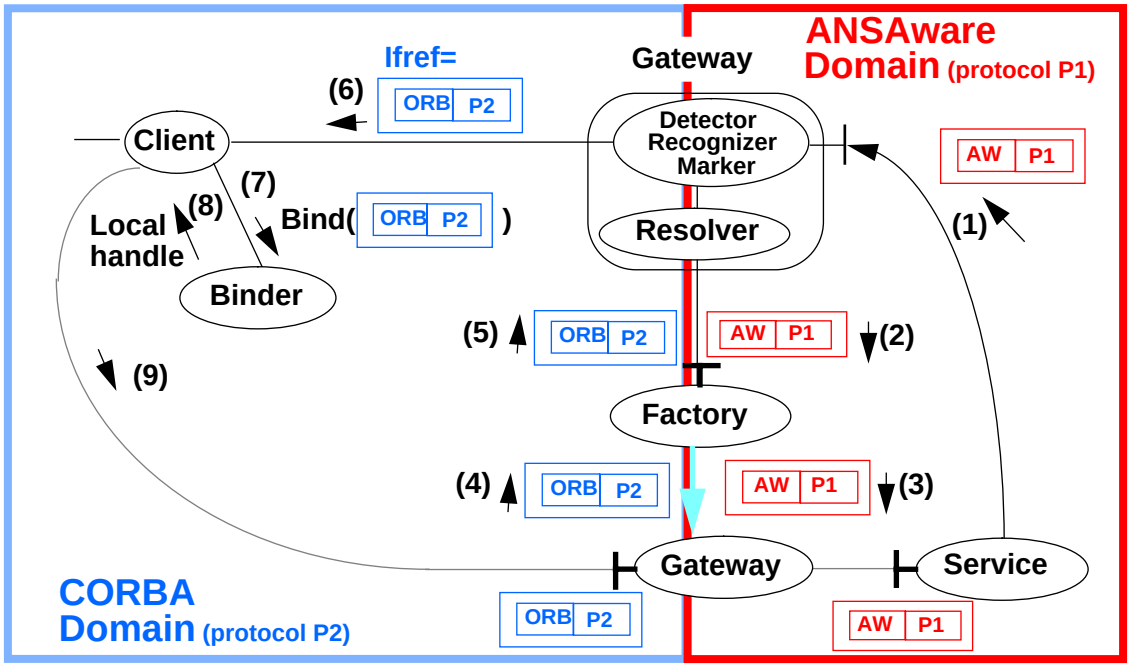
- Allows resolution to be carried out when needed
- Requires the gateway to mark information and add information for resolution
- Requires recipient in $Domain_B$ to deal with marked information

The “Leave-Unresolved” resolution strategy

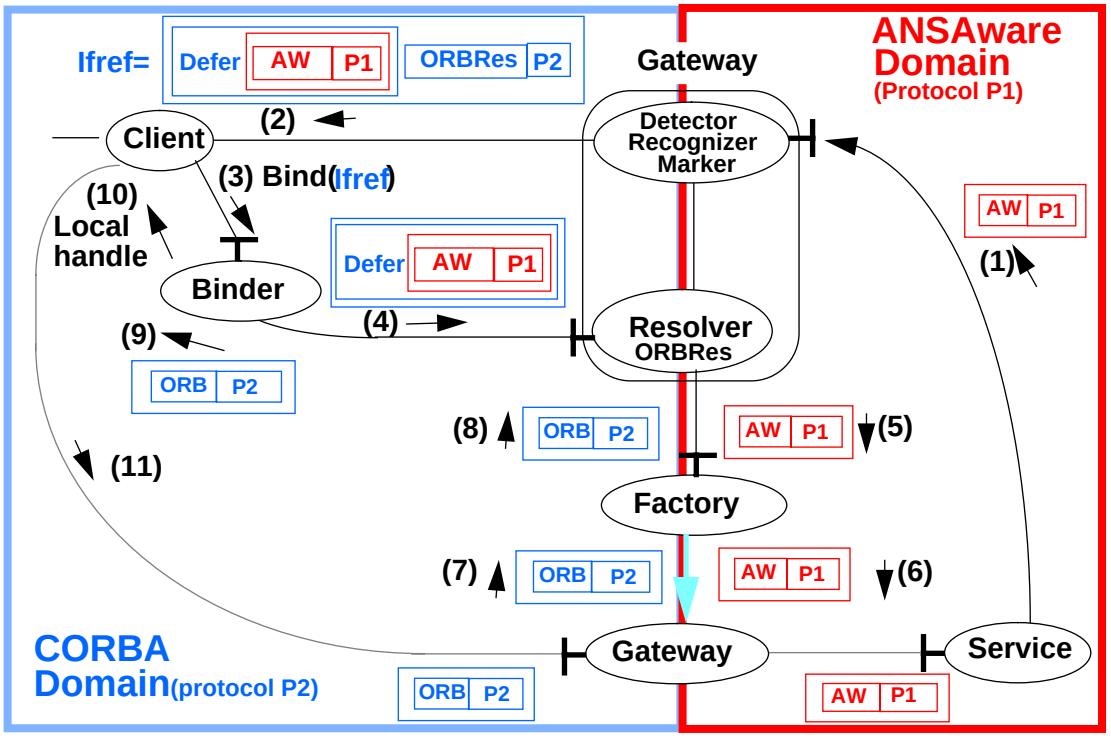


- Requires the gateway to mark information and add information for resolution
- Requires recipient in $Domain_B$ to be able to deal with marked information

Interface Reference passing: Immediate resolution

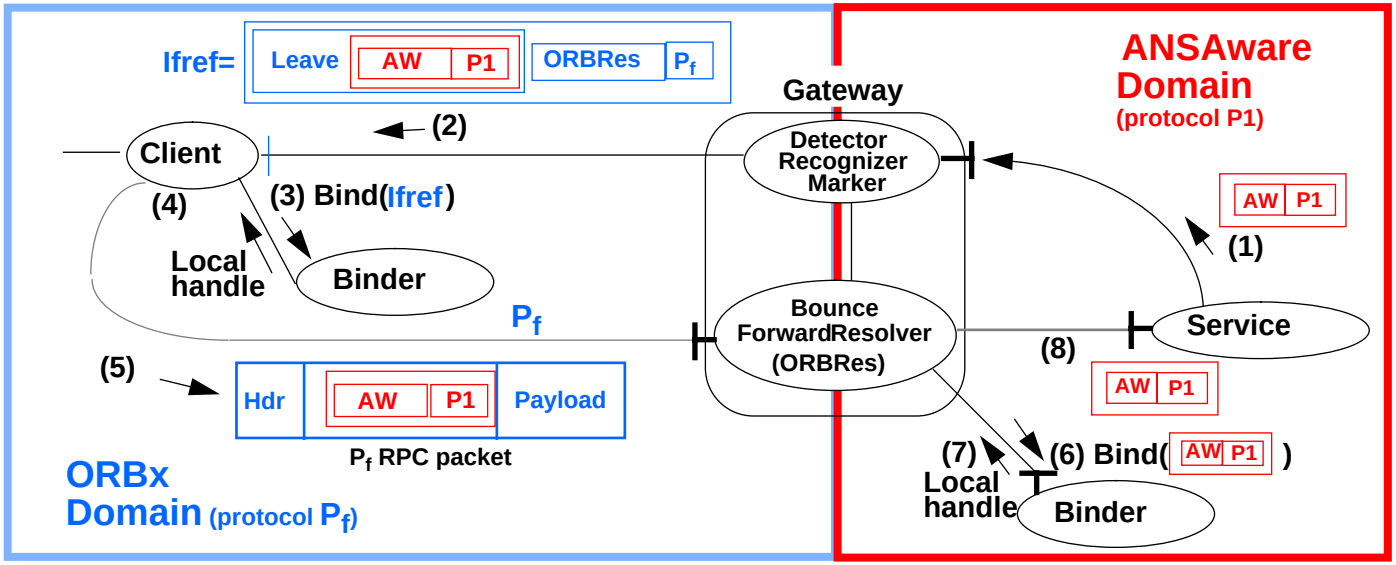


Interface Reference passing: Deferred resolution

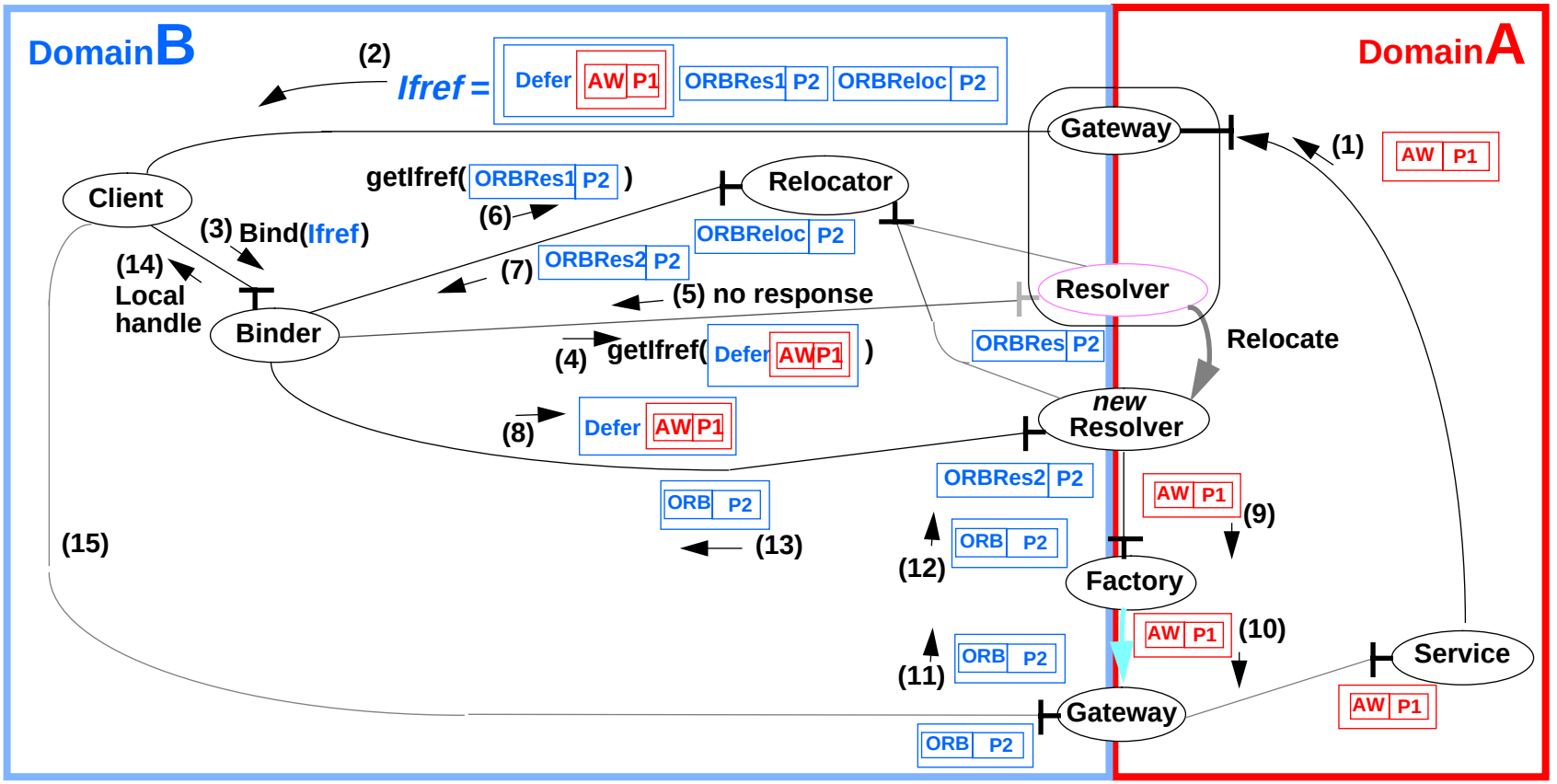


- One Interface Reference is marked and nested inside the other

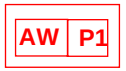
Interface Reference passing: “Leave-and-Forward” resolution

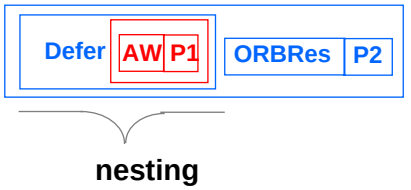


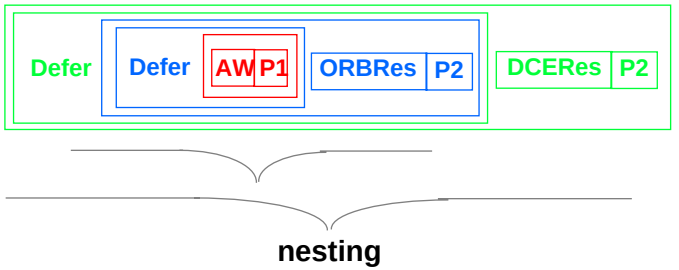
Deferred method and relocation



Gateways: Interface Reference nested structure

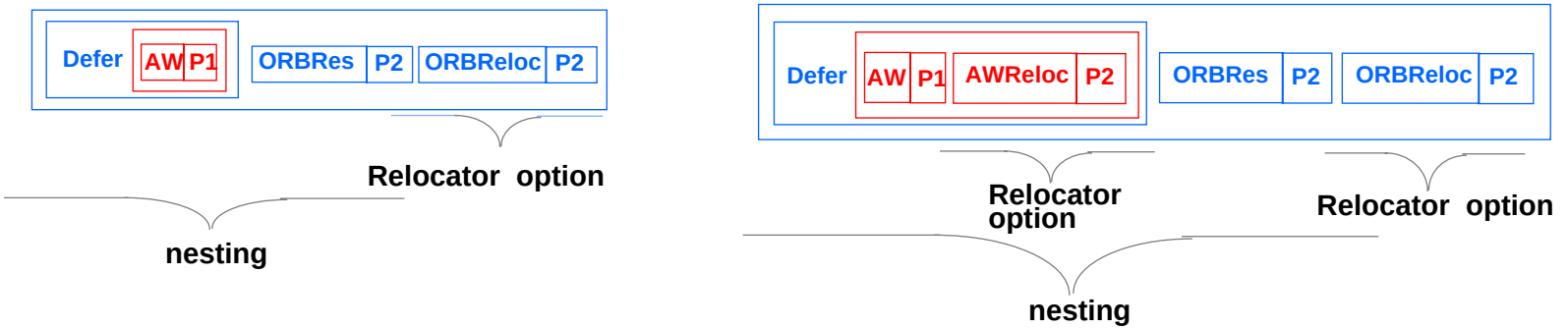






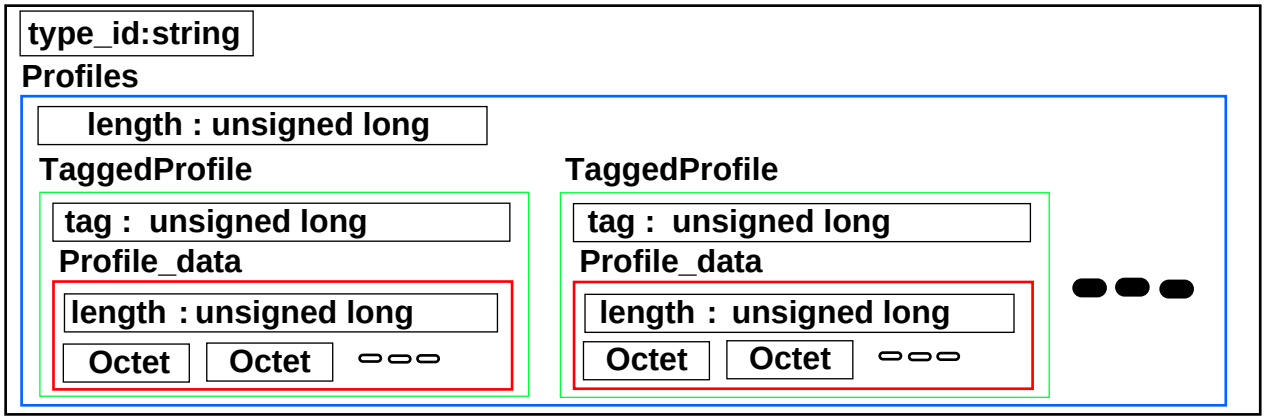
- **Gateways: marked, wrapped and nested Interface Reference records to represent a cascade of gateways**
- **Nested records may be seen as providing:**
  - **options: show the path by which an Interface Reference was obtained - short cuts are permissible (crossing technological boundaries)**
  - **imperative path: Binder must not jump a gateway (crossing administrative boundaries)**
- **Requires domain reserved words: Local, Defer, Resolver, Relocator**

Relocation: Interface Reference sequenced structure



- **Relocators: sequence of Interface Reference records to represent relocator options of increasing scope**
- **Binder will require policy concerning the order of interpretation of Interface Reference records**

Interoperable Object Reference (IOR)

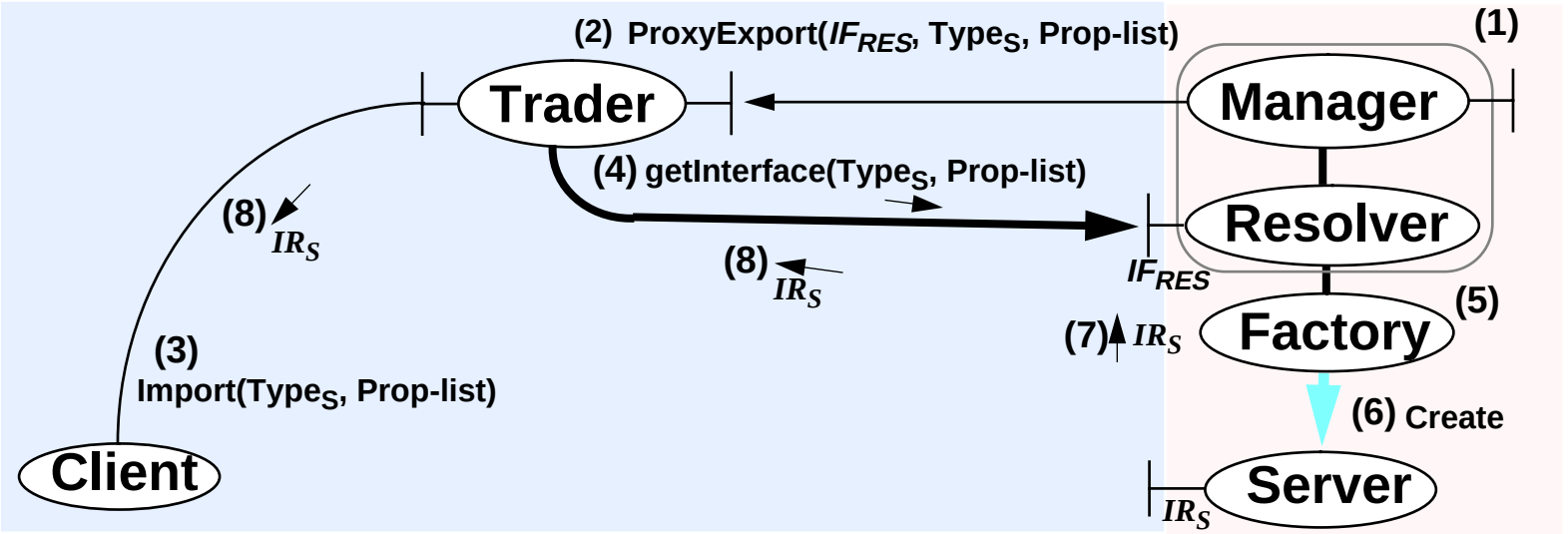


- **Extensions for interoperability can be specific to one platform or extended across platforms by agreement**
- **OMG CORBA Universal Networked Objects (UNO) proposal**
- **Tag should identify the type of the profile, e.g. 'CORBA/IIOP' or 'ANSAware'**
- **To minimise overheads of tag allocation, the tag may be divided into *tag-foundry* field and *tag-family* field**

Interoperability requirements for distributed platforms infrastructure

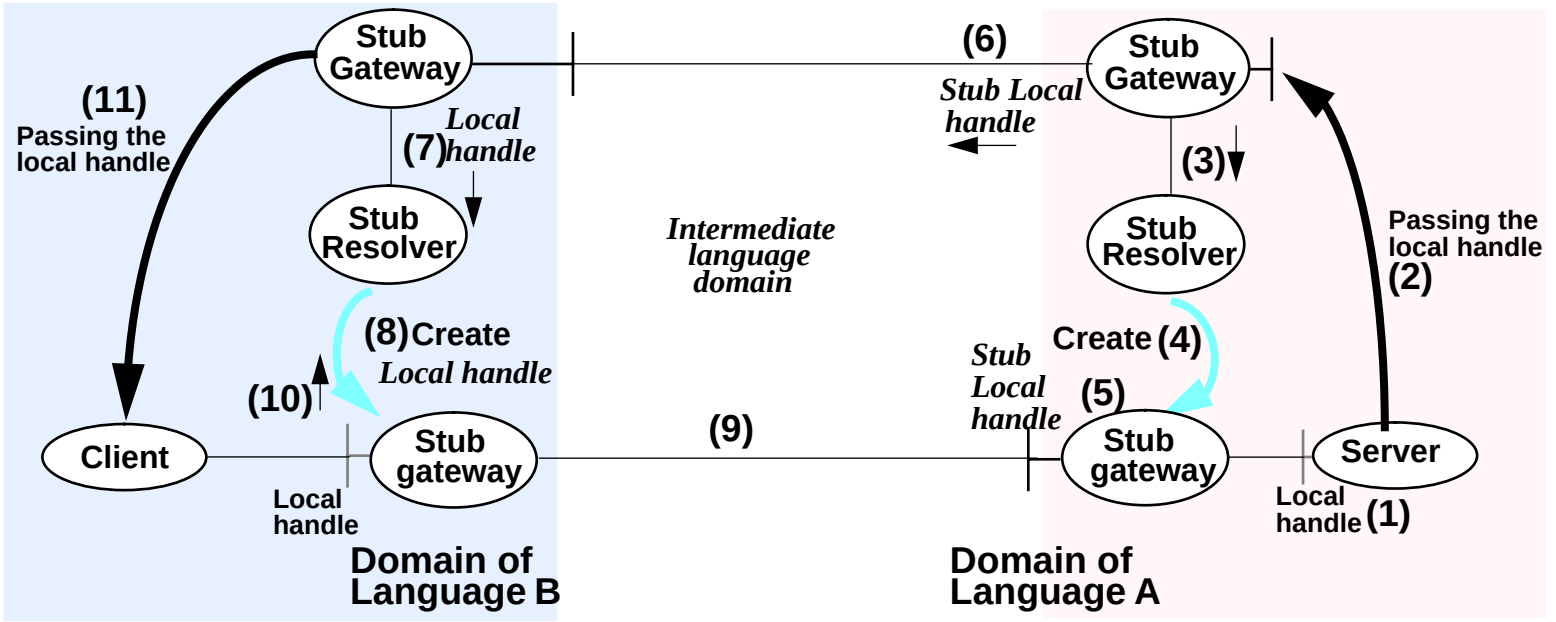
- **Extension to Interface references to allow:**
  - **inclusion of:**
    - ▲ **sequences of interface references records**
    - ▲ **nested interface references records**
    - ▲ **be able to incorporate foreign interface references**
  - **marking of: local, deferred and other cases**
- **Extensions to Binder to deal with:**
  - **relocation**
  - **gateways: defer/leave**
  - **other cases must fit the scheme:**
    - ▲ **passivation/activation**
    - ▲ **migration**

Trading and ProxyExport() operation

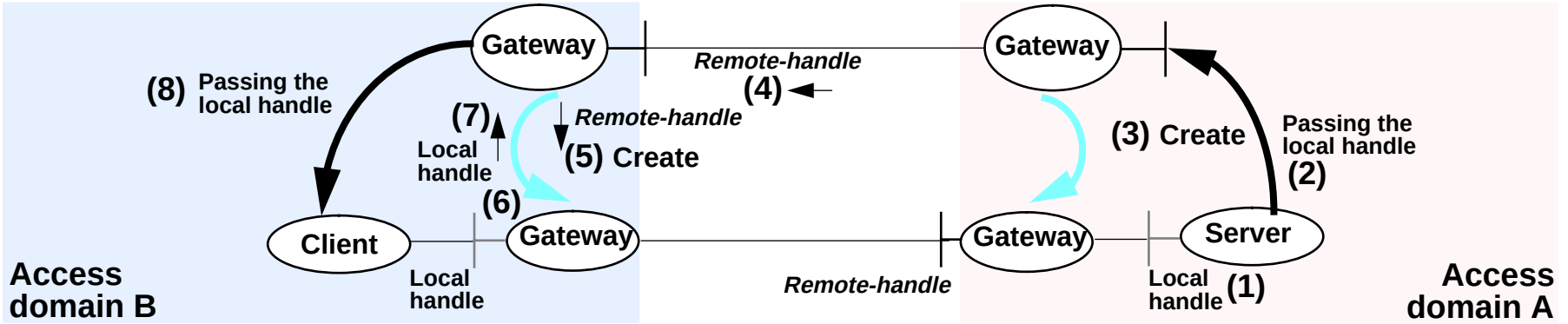


- ANSAware: NodeManager used ProxyExport() to defer creation of services
- In ORBIX Match-Maker: Interface references are properties. ProxyExport is distinguished by whether a property with name ObjRef or MonRef is available

Stubs and language domains

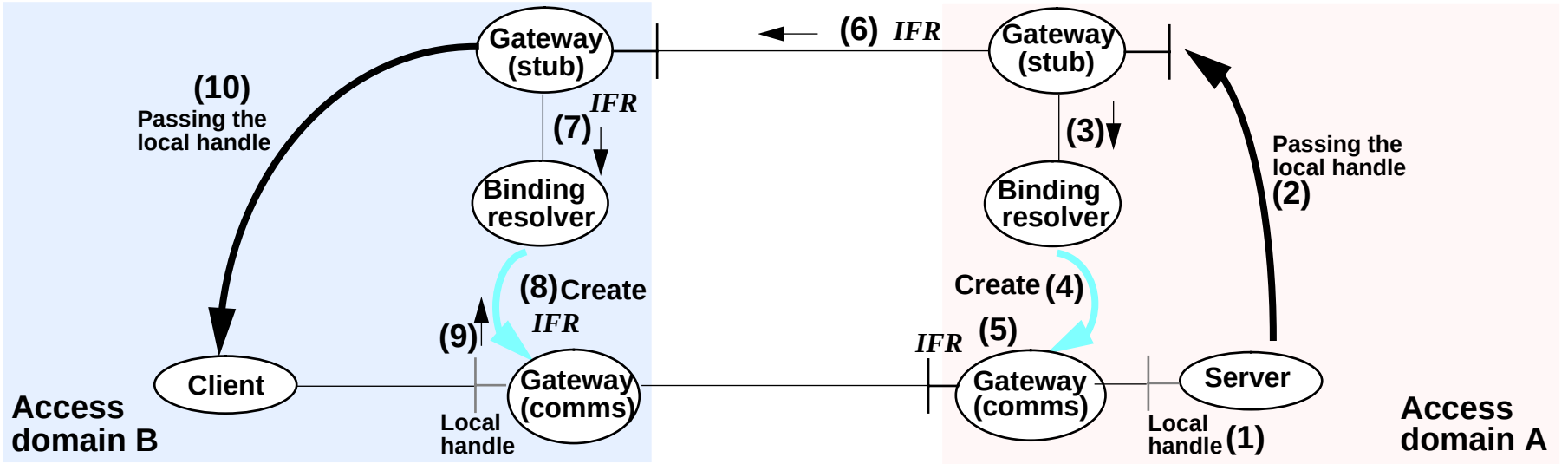


Crossing access domain boundaries



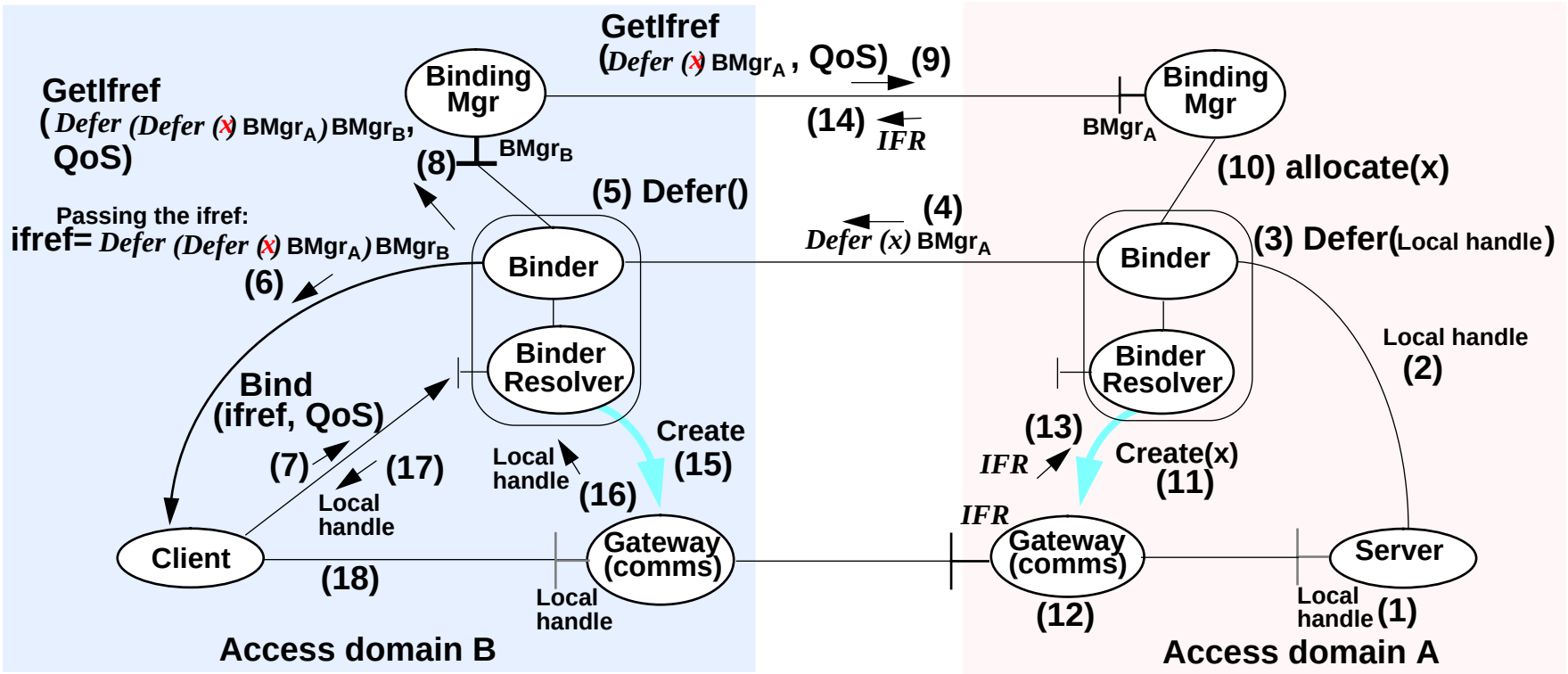
- **Immediate resolution method**
- **Access domains scope:**
  - **address space (subroutine)**
  - **capsule**
  - **node**
  - **LAN**
  - **WAN**

Binding (immediate resolution)



- Gateway of Access domain A resolves the local-handle to an interface reference and allocates the resources for the gateway immediately
- Gateway of Access domain B resolves the interface reference to a local-handle and allocates the resources for the gateway immediately

Explicit Binding (deferred with Binding managers)



- I am ...
- from The Advanced Networked Systems Architecture --> ANSA Project in Cambridge in the United Kingdom
- We are a research and development organization which has been around for 10 years
- Our aim is to research distributed systems with a view towards developing an architecture that enables telecommunications services and computer applications to work together despite the diversity of programming languages, OS's, hardware, networks, comms protocols and policies.
- My talk is about:
  Interoperability and its implications on Distributed Application Platform Design - describing my work carried out over the last year
- Length of this talk is about ? minutes
- I will take questions during the talk but i reserve the right to defer answering to end of talk if i see it fit.

Overview

- I want to set the background and context of the work by talking about - Relations between enterprises and enterprise computer systems
- I want to present A lineal model of interception - to show how the relationship between enterprises/systems/domains can be preserved and propagated to any links between them
- i want to show how by dividing the interception process into distinct phases a number of interception strategies can be developed, providing designers and system integrators with options (this is in itself a topic of a whole talk)
- I want to show how all of the above can be used to deal with Passing references to interfaces across domain boundaries
- I will try and summarise this work by describing the Implications for distributed application platform designers
- An if there is enough time - or at question time i will demonstrate how to
- Use the interception model to explain architectural issues

Enterprises and their computer systems

- The general trend in IT systems is that more and more of the interactions between people and between enterprises are being subsumed by IT systems. Therefore
- Complex relations and processes inside and between enterprises manifest themselves in their information systems

- Immediate problems arise as a result:
- There is a need to overcome boundaries which exist in terms of:
  - the different way things are done in enterprises and in computer systems
- There is a need to implement physical boundaries to reflect organizational issues of:
  - responsibility, liability or ownership
  - monitoring, security, remuneration

This brings us to an important distinction between 2 general types of boundaries

- **Technology boundaries: CAN?**
  - can objects interact / can objects interact safely
- **Administrative boundaries (authority/policy): WANT/ALLOWED?**
  - are objects allowed to interact / do objects want to interact (object does not have to interact if it does not want to)
  - how are objects allowed to interact
- The types of boundaries have implications on how the crossing is handled
- Can the same means used to overcome technology boundaries be used to implement administrative boundaries !?!

Gateways and transformations

- In order to deal with technical and administrative boundaries it is necessary to perform some transformations at domain boundaries
- Gateways is one name given to agents which carry out these transformations

- **Gateways are needed ...**
  - Some standardization activities are aimed at enabling different systems/ domains to interact with each other,
  - For example, CORBA Universal networked Objects proposal
- **In spite of standardization initiatives, gateways will still be necessary:**

Interoperability and Interception

- **Interoperability is concerned with enabling co-operation between objects residing in different domains**
- **Interception is about...**
  - **creating bindings across domain boundaries**
  - **Interception (resolution) strategies**
  - **passing interface references**

Interface References

- **Before i dive into interception in technicolour detail i want to very briefly to clarify some terminology i will be using throughout**

- **ANSAware is the distributed application development platform designed and implemented at ANSA according to the architecture**

Trading

- A ubiquitous activity which takes place at all development epochs.
- At run time it's about:
  - Discovering an interface of a service that provides the required service
  - Emphasis in match-making is on conformance, not equivalence

Creating bindings across domain boundaries

- A good starting point for presenting the problem of interception is trading, as it involves passing of interface references
- What we have in this diagram are:
- 2 domains each with its own Trader
- Traders are connected together through gateways which perform the appropriate transformations at the domain boundaries
- It does not matter what type of boundary it is for this discussion!

- Question is: what happens as an export operation crosses a domain boundary --->
  How is the relationship between the two domains preserved

A lineal model of interception

- **Lineal: describes a relation among a series of causes such that the sequence does not come back to the starting point**
- **This is only a computational model - it does not imply that it has to be implemented in the same way**
  - **implementations may vary as to the degree of resources that gateways can share etc.**
- **None of the above discussion indicated the type of boundary crossed, so it applies to either type. In other words, the lineal model applies both to technical as well as administrative boundaries**

The phases of the interception process (I)

- Another angle of attack on the problem of interception is offered by looking at the interception process itself, and dividing it into distinct phases
-
-
- Different flavours of interception

The phases of the interception process (II)

- **Separating Marking and Resolution - distribution in time and space:**
  - **how much to resolve immediately or how much to leave for later**
  - **how much information to keep in gateway or how much to forward**
- **Resource utilization and performance options**

The Immediate resolution strategy

The Deferred resolution strategy

The “Leave-Unresolved” resolution strategy

- **This has an interesting implementation when the wrapping is implemented as part of the RPC protocol - more later**

Interface Reference passing: Immediate resolution

-
- **Let’s see what happens when you apply this to the lineal model of interception and look in detail at passing interface references through domain boundaries**

Interface Reference passing: Deferred resolution

Interface Reference passing: “Leave-and-Forward” resolution

-
-
-
- **Intermediate forms of all these resolutions trategies exist**

Deferred method and relocation

- Gives a flavour of the things designers can do with Interface references
- Has been implemented in ANSAware

Gateways: Interface Reference nested structure

-
-
- **Binders will have to be able to deal with such structures**

Relocation: Interface Reference sequenced structure

-
-
- **Binders will have to be able to deal with such structures**

Interoperable Object Reference (IOR)

- Extensions for interoperability can be specific to one platform or extended across platforms by agreement
- OMG CORBA Universal Networked Objects (UNO) proposal covers the nesting
- Also allows for tagging - agreement
- Tag should identify the type of the profile, e.g. 'CORBA/IIOP' or 'ANSAware'
- To minimise overheads of tag allocation, the tag may be divided into *tag-foundry* field and *tag-family* field

Interoperability requirements for distributed platforms infrastructure

- I have mentioned all of these points at some point or anotehr through out the talk but will repeat them briefly here.
-
-
- I hope i gave you a flavour also of some of the options which are open to system designers/integrators from the point of view of implementing interception. I have more material in a paper but could not cover it in the talk.

Trading and ProxyExport() operation

- ANSAware: NodeManager used ProxyExport() to defer creation of services
- In ORBIX Match-Maker: Interface references are properties. ProxyExport is distinguished by whether a property with name ObjRef or MonRef is available

Stubs and language domains

Crossing access domain boundaries

- Immediate resolution method
- Access domains scope:
  - address space (subroutine)
  - capsule
  - node
  - LAN
  - WAN

Binding (immediate resolution)

- Gateway of Access domain A resolves the local-handle to an interface reference and allocates the resources for the gateway immediately
- Gateway of Access domain B resolves the interface reference to a local-handle and allocates the resources for the gateway immediately

Explicit Binding (deferred with Binding managers)