Common Object Request Broker Architecture

An overview of the
OMG way in Component Software

Matteo Matteucci
matteucc@elet.polimi.it

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Component Programming

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  - Standard interface (contractual)
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  - User:
    - Integration of component independently developed
    - Reuse of common features
    - Wrapping of user applications (legacy)
  - Developer:
    - Modularization of application
    - Incremental developement
    - Reuse

Object Management Group

- OMG (Object Management Group)
  - No-profit consortium of several hundred members founded in 1989 to promote the development and diffusion of object-oriented software
  - Definition of an extensible infrastructure to support services:
    - Interoperability
    - Security
    - Concurrency
    - ...
- Object-oriented and Component Programming
  - Objects or components as production, distribution and management units
  - The objects became also deployment units
  - Objects interoperate using a software bus sending requests and results in a distributed system

OMA and CORBA

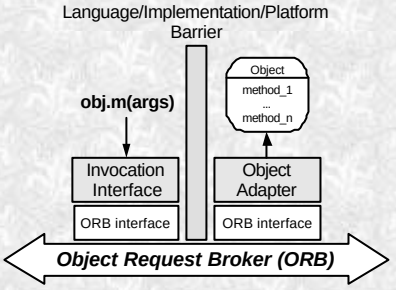
- The problem to face:

  "How can distributed object-oriented systems implemented in different languages and running on different platforms interact?"

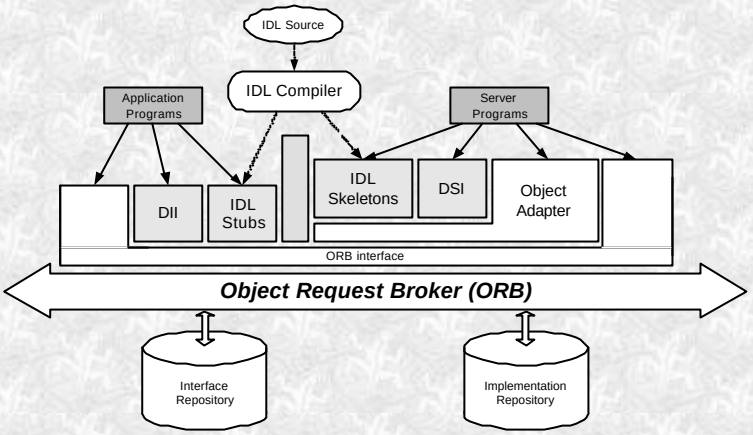
- The OMG solution
  - OMA (1992)
    - Reference architecture to guarantee component reuse and interoperability
  - CORBA (1995)
    - Open interconnection of languages implementations and platforms
    - Bus software for component wiring
    - Interface definition language

CORBA

- Reference architecture to ORB implementation
  - Specification of architecture
  - No implementation defined
- Middleware Object Oriented
  - Marshaling
  - Implementation hiding
  - References management
  - Localization hiding
  - OO RPC
- Object Request Broker
  - Communication infrastructure
  - Platform independent primitives
  - Implementation independent primitives



Object Request Broker

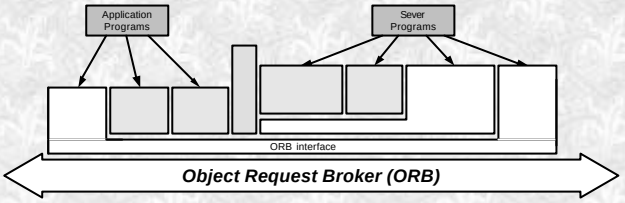


ORB: Client and Services

- Client Application
  - Written in a language with a *binding* to IDL
  - Not necessarily an object oriented language (es. VB, 4GL, …)
  - Client does not know the location of an object implementation
  - An object can act as a client and as a server at the same time
  - The client can call a method of a remote object by its reference and knowing its interface
- Object Reference
  - Identify univocally an object in distributed system based on an ORB
  - CORBA specifies the standard of IOR (Interoperable Object Reference) but not its implementation
  - How to map Object Reference is defined by the binding of IDL to a specific language (pointers in C++, object references in SmallTalk, …)

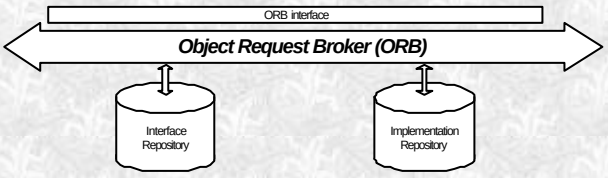
ORB: ORB Interface

- API to services implemented by the ORB used by the client and by the server
  - Allow operations on Object References
    - `get_interface`: to obtain the description of the interface of an object
    - `get_implementation`: to obtain the description of the object implementation of an object
    - `is_nil`: to verify if the Object Reference really identify an object



ORB: Repositories

- Interface Repository
  - Contains the description of the interfaces defined in the system
  - Can be queried to obtain information about interfaces, methods and parameters
  - Information can be used to dynamically compose the requests (DII)
  - Its services are described using IDL
- Implementation Repository
  - Contains information on the object implementation, object instances, identifiers and management information

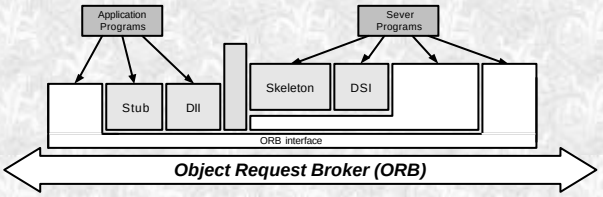


ORB: IDL Stubs and DII (1)

- Stub (static)
  - Represents operations of the server that the client can invoke using its implementation language
  - It is compiled from the IDL description of the interface to the specific implementation language
  - From client point of view it is a local procedure call
  - The Stub codifies the parameters (marshaling), de-codifies the results and re-raises exception from the server
- Dynamic Invocation Interface
  - The client may know the interface of an object during the execution
  - The client can built dynamically the request for a service
  - Server cannot distinguish if the request came from a static stub or a dynamic invocation

ORB: IDL Stubs and DII (2)

- Stubs (static)
  - Can be used only if methods are known a-priori (compile time)
  - They are totally transparent to the programmer
  - They allow static type checking
  - They are efficient
- Dynamic Invocation Interface
  - They do not require to know objects' methods (interface) before execution
  - Allow to write generic code

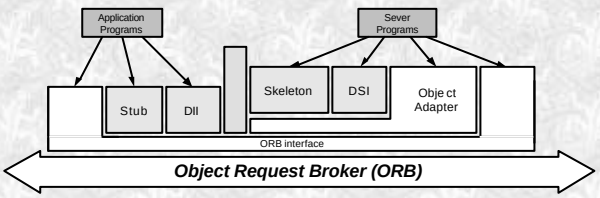


ORB: IDL Skeletons and DSI

- Skeleton (static)
  - Analogous to the Stub but from the server side
  - It is compiled from the IDL description of the interface to the specific implementation language
  - The Skeleton de-codifies the parameters (marshaling) passing them to the invoked method
  - Once executed the method, codifies the results and exceptions sending them to the client
- Dynamic Skeleton Interface
  - The server may know the interface of an object during the execution
  - The server receive the request also if it has not yet compiled the IDL interface
  - Client cannot distinguish if the result came from a static skeleton or a dynamic skeleton

ORB: Object Adapter (1)

- Layer between the ORB and the object implementation
  - Supply common operations on the objects (IDL)
    - Instances of new objects
    - Management of Object References
    - Routing of requests
    - Registration in the Implementation Repository
- CORBA defines BOA a standard object adapter (Basic Object Adapter)

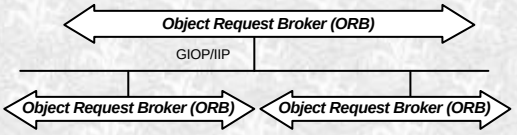


ORB: Object Adapter (2)

- Examples of adapters
  - *Basic Object Adapter (BOA):*generation and management of object references, invocation of methods, request delivery, registration …
  - *Library Object Adapter (LOA):* can substitute BOA if client and server belong to the same process (ORB == Library), few services but optimized for the particular use (in-process)
  - *Object-Oriented Database Adapter (OODA):* implements a connection to an object-oriented database
- Different types of BOA
  - *Shared server:* actives the server when requested and manages more objects
  - *Unshared server:* a different server for each object when requested
  - *Server-per-method:* a server for each request
  - *Persistent server:* a shared sever not managed by BOA

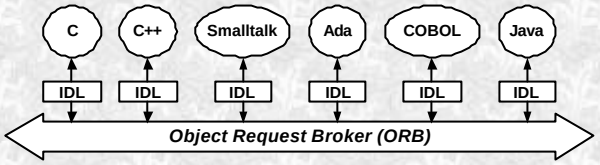
ORB: ORB Interoperability

- CORBA 2.0 defines a standard to connect ORB on different (sub)systems by different developer
  - General Inter-ORB Protocol (GIOP)
    - Defines the exchange format
    - Defines a common format for the data (Common Data Representation)
  - Internet Inter-ORB Protocol (IIOP)
    - Specifies messages of GIOP on TCP/IP
    - Allow to connect different ORBs using Internet
  - Environment Specific Inter-ORB Protocol (ESIOP)
    - Allow the use of different transport protocols



Interface Definition Language

- Separation among interface and implementation
- The language to define interfaces of OMA components
  - To use services implemented by an object a client application has to know its interface
  - Used to define objects in *CORBA-compliant* applications
- An interface specified by IDL can be implemented by different languages
  - CORBA specifies mapping to several languages



IDL: Main features

- Main features
  - Specification language (not programming)
  - Independent from implementation language
  - Multiple Inheritance
  - Static type checking for interfaces
  - Allow static and dynamic use
  - *C++ like* syntax
  - IDL compiler support pre-processing (#include)
  - An IDL specific includes
    - types
    - constants
    - exceptions
    - interfaces
    - modules

IDL: Interfaces (1)

- An interface defines types, constants, exceptions, attributes and operation supported by a server objects
- Any interface has a name and can be defined from one or more existing interfaces (multiple inheritance)
  - Derived interfaces can add new elements or redefine existing ones
  - It is not possible to derive from interface defining the same attributes or operations
  - Ambiguities are resolved by operator::
- Objects implements an interface if implements all the operations (may be more than one interface)
- The object reference supplied by the ORB and mapped on the specific implementation language feature

IDL: Interfaces (2)

- An example:

```
interface BASE
 {
        const int N;
        …
 }

interface  Derived: Base
 {
        const int N;
        typedef …
 }
```

IDL: Modules

- Modules implements modularization of programming languages (modules, namespaces, packages …)
- An example:

```
module Global
 {
        typedef ...;
        interface B ...
 }

Global::B ...
```


IDL: Types

- Built-in types:
  - `[unsigned]short, long, long long`
  - `float, double, long double`
  - `char`
  - `octet`
  - `string`
  - `boolean`
- It is possible to define C++ like types
  - `enum`
  - `struct, union`
  - `array`
  - `sequence`
- An example:

```
typedef sequence<sequence<long>> DblSeq;
```

IDL: Attributes

- It is possible to declare constants data
- Attributes are declared in the interfaces
  - `attribute` is the keyword to declare an attribute
  - `readonly` the client cannot modify the attribute
  - `const` also the server cannot modify the attribute
  - attribute are public, any other value is private
- An example:

```
const int MAX = MIN + LEN;
attribute float radius;
readonly attribute position_t position;
```


IDL: Exceptions & Operations

- Exceptions can be declared as structures
  - Can be raised by operation called by the caller
  - CORBA defines a set of standard exceptions
- An operation specifies a function in a C-like style
  - The operation syntax is:

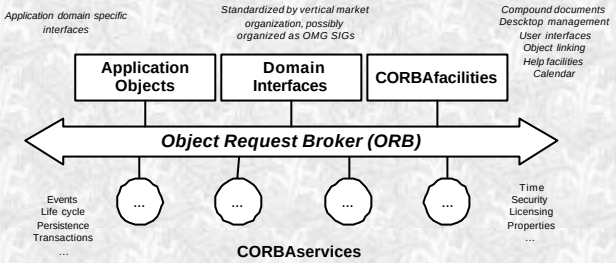
```
[oneway] <resultName> <opName> ([in|out|inout] par1, …)
        [raises(exception1, …)][context(c1, …)];
```

  - `oneway` specifies that the result is not used by the client
  - Overloading is non supported
- An example:

```
exception NotFound {string <N> what};
void search(in Code what, out Item el)
        raises(NOTFound);
```

Object Management Architecture

- OMA objects:
  - Encapsulate data and operations
  - Have a defined interface
  - Univocally identifiable
  - Execute services requested by a client (not necessary an object)



OMA: CORBAservices (1)

- Objects Services form the base to distributed applications
  - Creation of distributed objects
  - Access to object's methods and attributes
  - Security, transactions …
- CORBAservices
  - OMA specifies the interfaces of objects implementing the Object Services
  - OMA does not specify any implementation
- Object Services implementation is the base for any CORBA platform

OMA: CORBAservices (2)

- Naming Service
- Event Service
- Life Cycle Service
- Relationship Service
- Persistent Object Service
- Transaction Service
- Concurrency Service
- Externalization Service
- Licensing Service
- Query Service
- Property Service
- Security Service
- Time Service
- Collection Service
- Trader Service

OMA: Frameworks

- CORBAfacilities
  - Components that supply common application functionality
    - Distributed help
    - DBMS access
    - e-mail services
    - …
  - OMA defines their interfaces non the implementation (not necessary)
- Domain Interfaces
  - Specific services for particular domain
    - Medics
    - Finance
    - Manufactory
    - e-commerce
    - Telecommunications
    - …

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