CSC9006 Real-Time Systems

Pattern-Based C++ Network Programming
Part 1: Revisiting CORBA and TAO

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Agenda

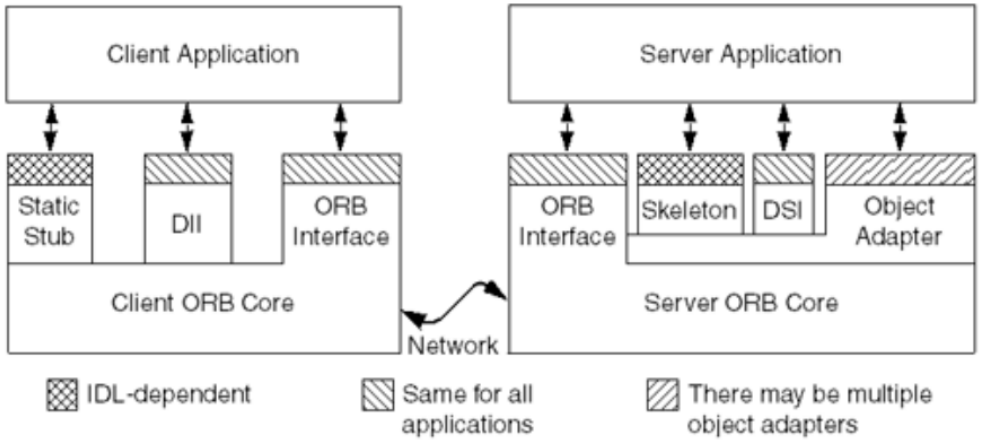
Links to the video recording for this presentation and demo:

- click here for the first half (download for a high resolution version)
- click here for the second half (download for a high resolution version)

1. Revisiting CORBA basics
   - Terminology and Basic Concepts
   - Naming Service
   - Event Service
2. Revisiting TAO and TAO's Real-Time Event Service
3. Demonstrating TAO and TAO's Real-Time Event Service
4. References

CORBA Terminology

- CORBA: Common Object Request Broker Architecture
- A server application contains several CORBA objects, each of which provides some specified operations.
- A client application at run-time may request some operations on a CORBA object.



(Figure 2.3 in [1])

CORBA Terminology (cont.)

- An object reference is a handle for a client to direct its request to a CORBA object.
  - Each object reference refers to an unique CORBA object
  - A CORBA object may have several object references
- A servant is a program implementation of one or more CORBA objects. A servant is part of the server application.
- The following terms will be covered in the next couple slides
  - IDL (Interface Definition Language), Stub, and Skeleton
  - DII (Dynamic Invocation Interface) and DSI (Dynamic Skeleton Interface)
  - Object Adapter and POA (Portable Object Adapter)
  - IOR (Interoperable Object Reference)

Interface Definition Language (IDL)

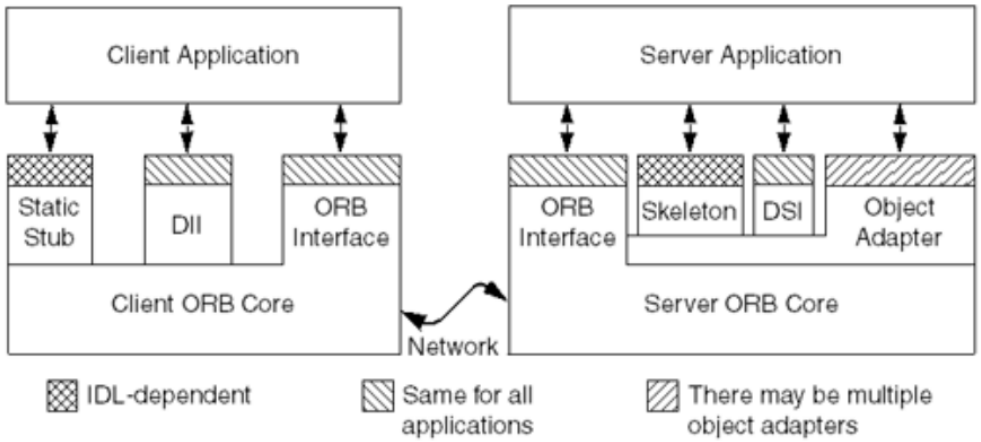
- Goal: enable *interoperability* among applications implemented in different programming languages.
- Approach:
  - First, define object interfaces and their operations in a way that is *independent* of any particular programming language.
  - Then, *compile* the IDL definitions into the code of the specified programming language (C++, for example).

Example

```
interface Time {
  long current_time (); // First operation
  long count_requests (); // Second operation
  oneway void shutdown (); // Third operation
};
```

Static Invocation vs. Dynamic Invocation

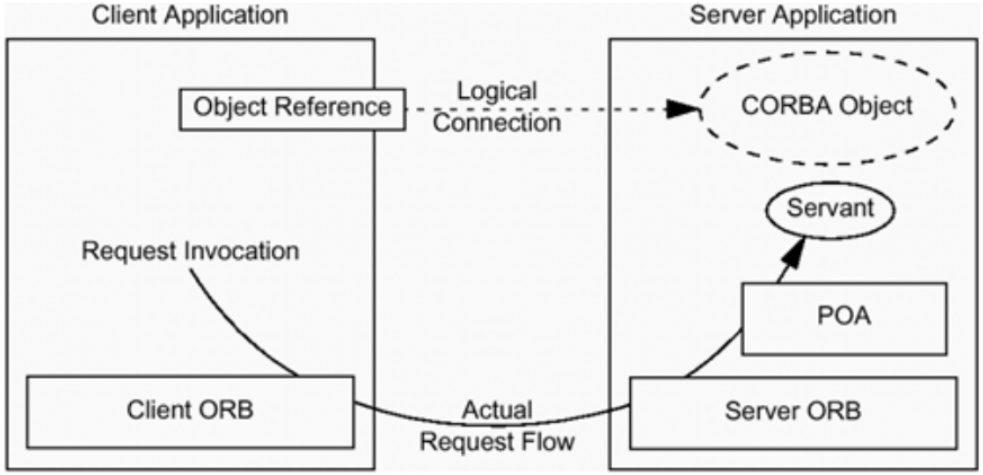
- Static invocation and dispatch
  - The IDL compiler translates the IDL definitions into client-side functions (i.e., stub) and server-side functions (i.e., skeleton), which will be complied into applications.
- Dynamic invocation and dispatch
  - Both the construction and dispatch of CORBA requests are made at run-time. At client-side it is made possible through DII; at server-side, DSI. In this course we do not use dynamic invocation and dispatch.



(Figure 2.3 in [1])

Object Adapter and POA

- Adapter is a classic design pattern[1].
- The object adapter glues the ORB and the servant, so that the ORB may invoke request on an object without knowing the object's true interface.
- POA stands for the portable object adapter and it replaced the obsolete basic object adapter; see Section 2.4.5 and Chapter 11 in [1] for more detail.



(Figure 11.2 in [1])

[1] See the description from Wikipedia (link)

Interoperable Object Reference (IOR)

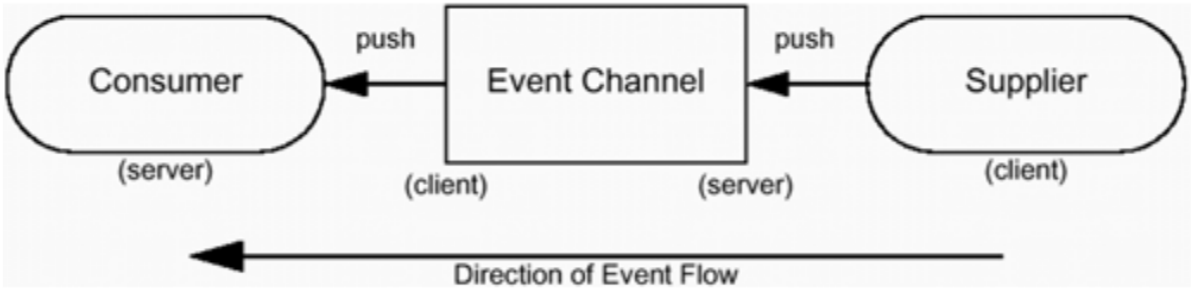
- It is essential for remote ORB applications to communicate with each other, and for different ORB vendor to operate with each other. The General Inter-ORB Protocol (GIOP) is an abstract protocol for this purpose.
- The Internet Inter-ORB Protocol (IIOP) specifies how GIOP is implemented over TCP/IP.
- Interoperable Object Reference (IOR) is the standard object reference format, which contains information for ORBs to establish communications between clients and target objects.
- An IOR for IIOP contains a host name, a TCP/IP port number, and an object key that identifies the target object.

Naming Service

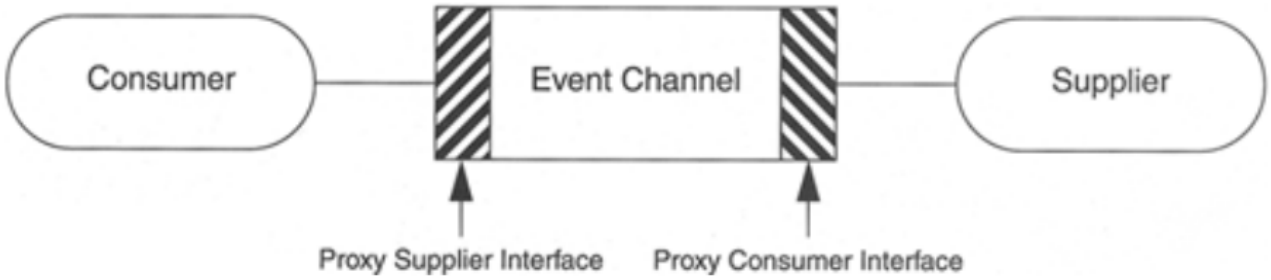
- Motivation: Use a meaningful name instead of the opaque object reference string for object request invocation.
- Approach: Similar to how the Internet Domain Name Service (DNS) provides a mapping from domain names to IP addresses, the naming service provides a mapping from names to object references.
- Applications can use the naming service to lookup the object reference of a certain name.

Event Service (a.k.a. Event Channel)

- Motivation: as described in [3]
- Approach: Event channel acts as a middleman, taking requests from suppliers and, accordingly, issuing requests to consumers.



(Figure 20.1 in [1])



(Figure 20.8 in [1])

TAO, The ACE ORB

- TAO[2] is a mature, widely used C++ implementation of CORBA. It is built upon ACE[3], the adaptive communication environment.
- TAO's IDL compiler creates C++ stubs and skeletons from an IDL file.

Example output of TAO's IDL compiler

(assuming Messenger.idl)

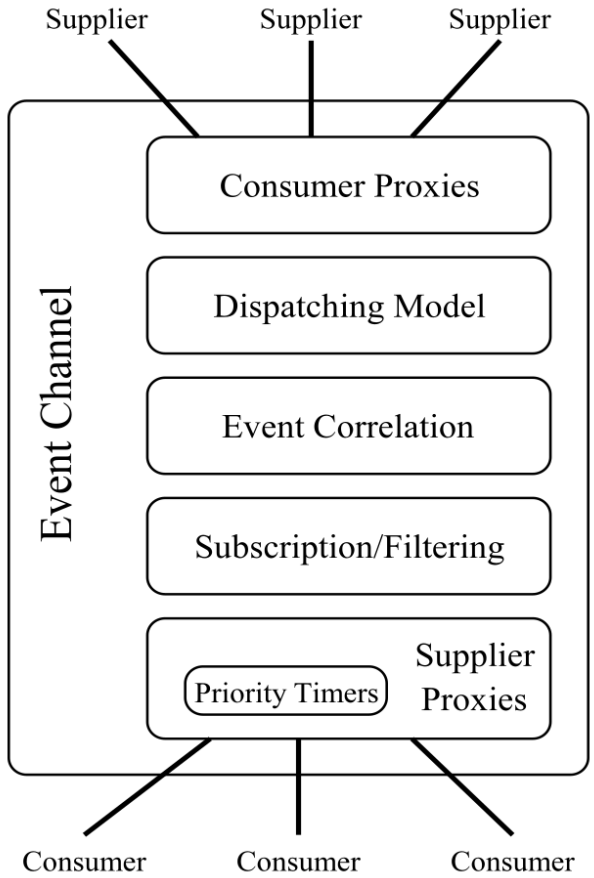
File Name	Contents
`MessengerC.h`	Stub class definitions.
`MessengerC.inl`	Inline stub member function definitions.
`MessengerC.cpp`	Stub member function definitions.
`MessengerS.h`	Skeleton class definitions.
`MessengerS.inl`	Inline skeleton member function definitions.
`MessengerS.cpp`	Skeleton member function definitions.

(Table 4-1 in [2])

[2] http://www.dre.vanderbilt.edu/∼schmidt/TAO.html
[3] http://www.dre.vanderbilt.edu/∼schmidt/ACE.html

TAO's Real-Time Event Service

- See the figure on the right. Notice how the names for proxies differ from those in [3]. The version here aligns with the class names in the code.



(Fig 24-1 in [3])

Demonstrating Some Usage of TAO

- Example folder: `$TAO_ROOT/examples/Simple`
- See the demo in the video clip for this presentation (click the link to the first-half of the recording on page 2)

Demonstrating TAO Real-Time Event Service

- Example folder: `$TAO_ROOT/orbsvcs/examples/RtEC/Simple`
- See the demo in the video clip for this presentation (click the link to the second-half of the recording on page 2)

References

[1] Henning, Michi, and Vinoski Steve. Advanced CORBA programming with C++. Wesley Longman, 1999.

[2] The TAO Developer's Guide, from Object Computing, Inc. https://objectcomputing.com/products/tao/tao-developers-guide

[3] T. Harrison, D. Levine, and D.C. Schmidt, The Design and Performance of a Real-time CORBA Event Service, ACM Conference on Object-Oriented Programming, Systems, Languages, and Applications, October 1997.