Middleware for synchronous requests

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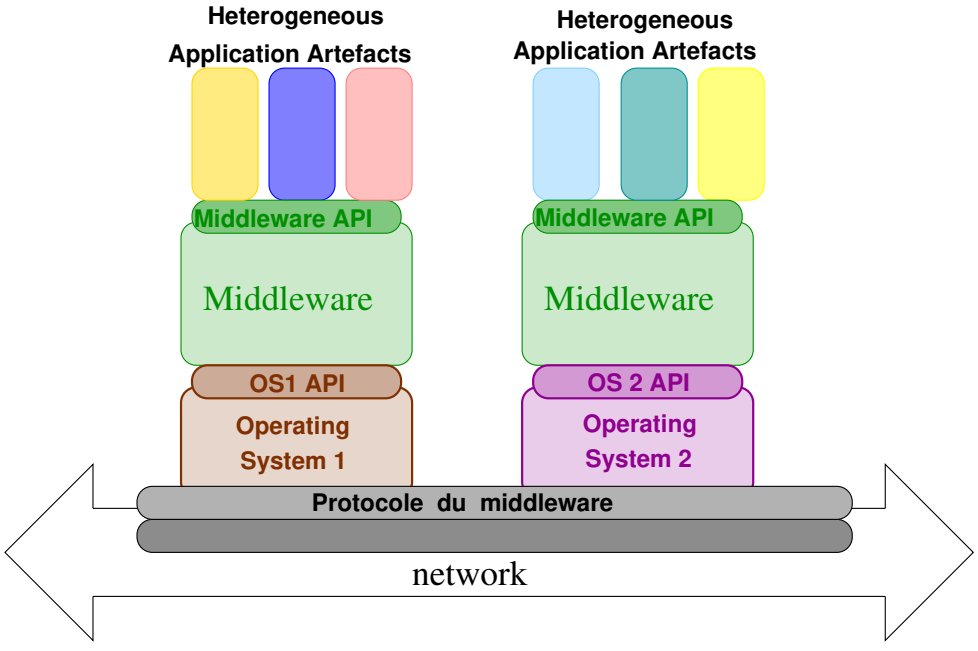
1 Introduction

1.1 Middleware for distribution



- **Middleware** is a software layer which provides :
  - Programming interfaces (common API)
  - Protocol for interoperability
    - With data exchange format

. . . to support distribution and heterogeneity.

1.2 Goal : interoperability

- Existing *"legacy code"*,
- Numerous languages,
- Several operating systems,
- Various hardware (e.g., little endian, big endian),
- Several network protocols

$\Rightarrow$ need for interoperability!

1.3 Distribution models

- Point to point message
- Point to multipoint message
- Event/action
- Publish/subscribe
- **Client/server**
- Mobile code
- Virtual shared memory

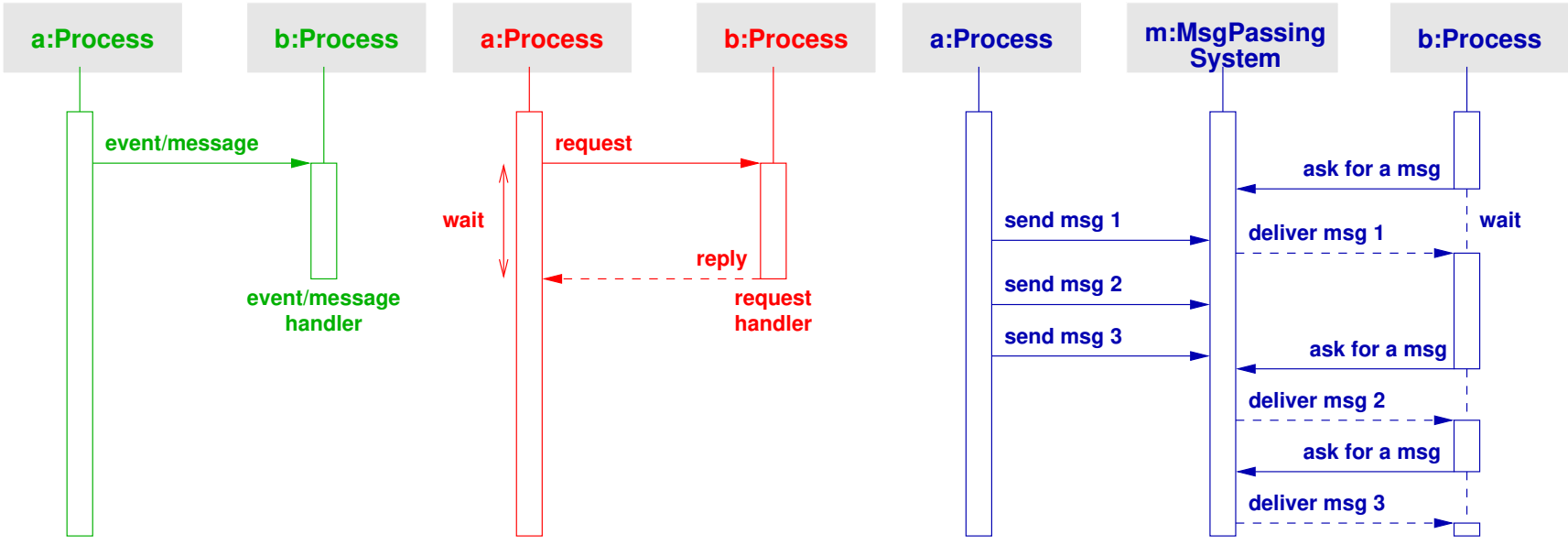
1.4 Client-server models

- **Procedural**
  - Remote Procedure Call - RPC
- **Object-oriented**
  - Remote Method Invocation (Java RMI, Common Object Request Broker Architecture CORBA)
- **Data-oriented**
  - SQL requests
  - REST (Representational State Transfer)- create, read, update, delete over HTTP
- Traditionnal **Web** (HTTP requests)
- **Web Services** (SOAP over HTTP)

1.5 Synchronous vs asynchronous mode

- Two entities (*e.g.*, processus) communicate
  - In **synchronous** mode: the two entities (client and server) are active at the same time, after a request, client is waiting for server response.
  - In *asynchronous* mode: entities send messages, they don't wait for responses, they don't know when the message will be delivered

1.6 Asynchronous call, synchronous call, buffered message

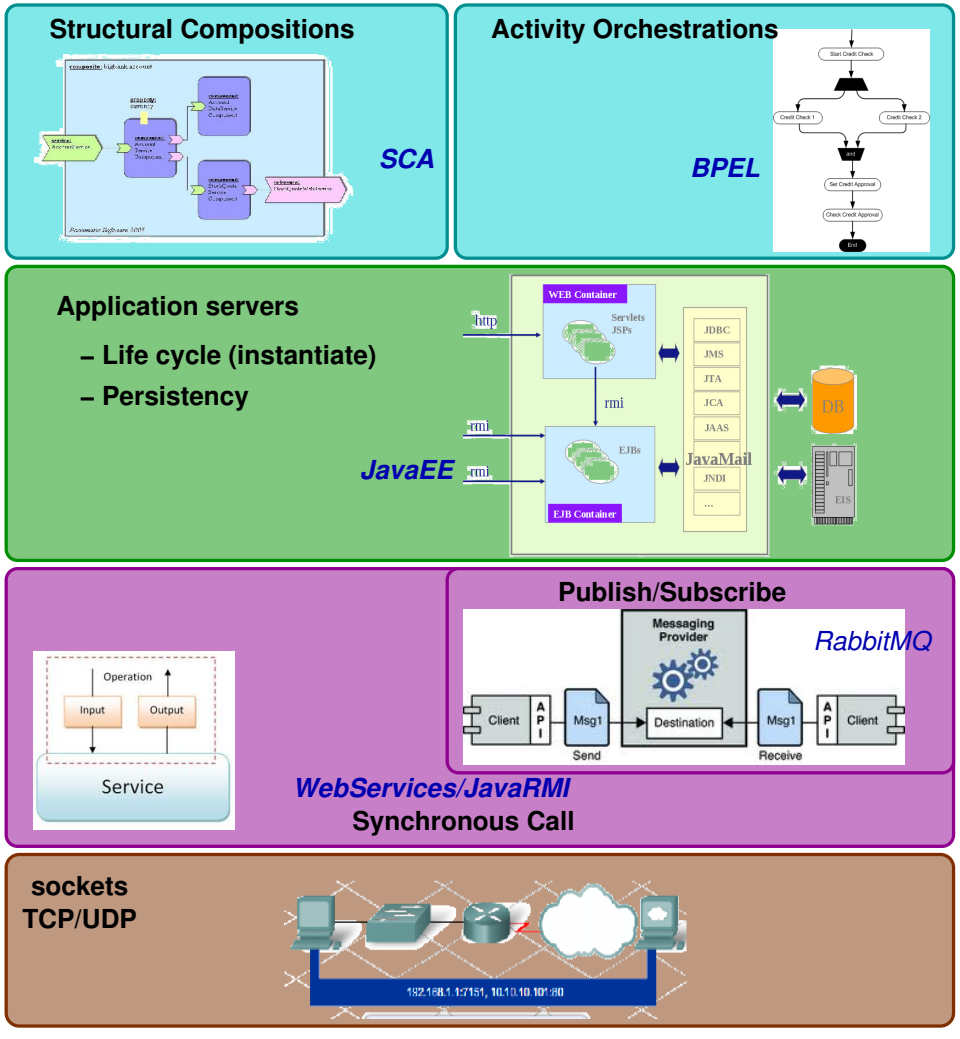


Asynchronous event (push)

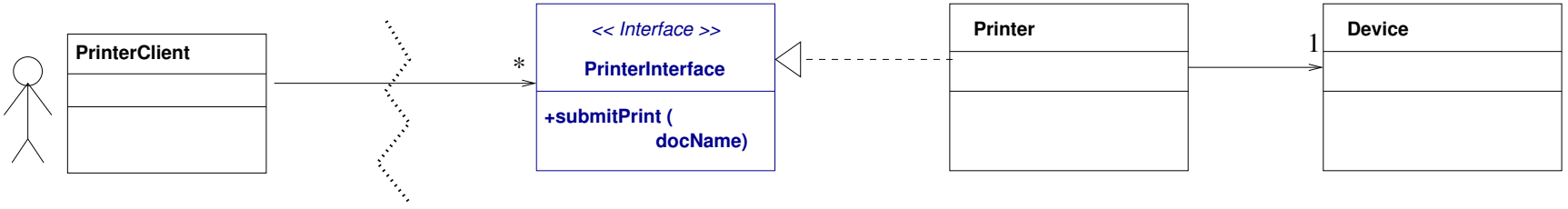
Synchronous call

Buffered messages (pull)

2 Synchronous middleware and the big picture

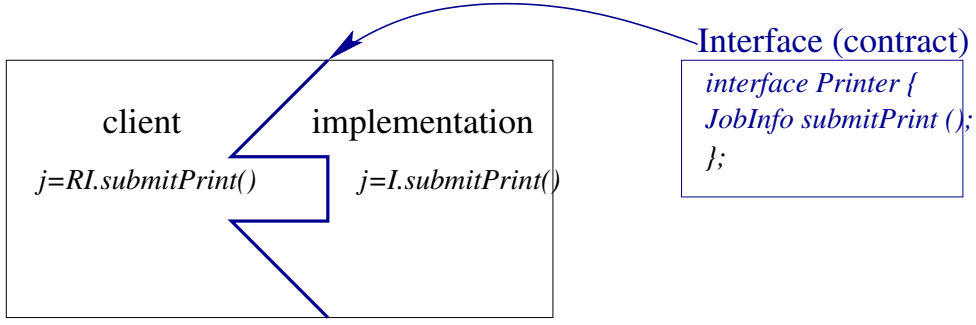


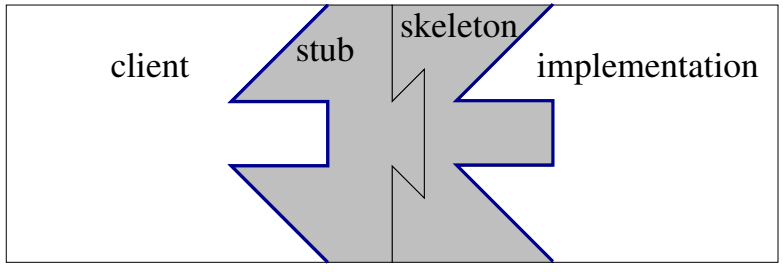
2.1 Introduction of the distributed example



- Which distribution ?
- Which abstractions (service, object) ?
- Which middleware ?

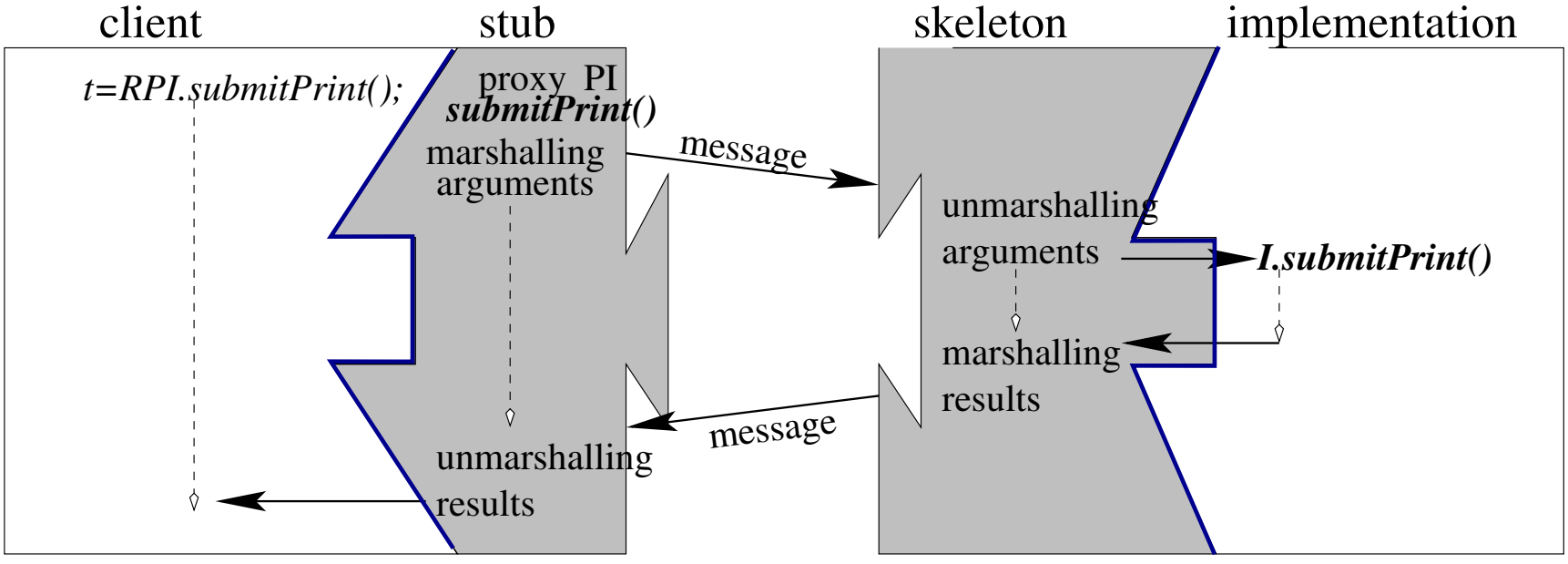
2.2 Principle of distributed objects





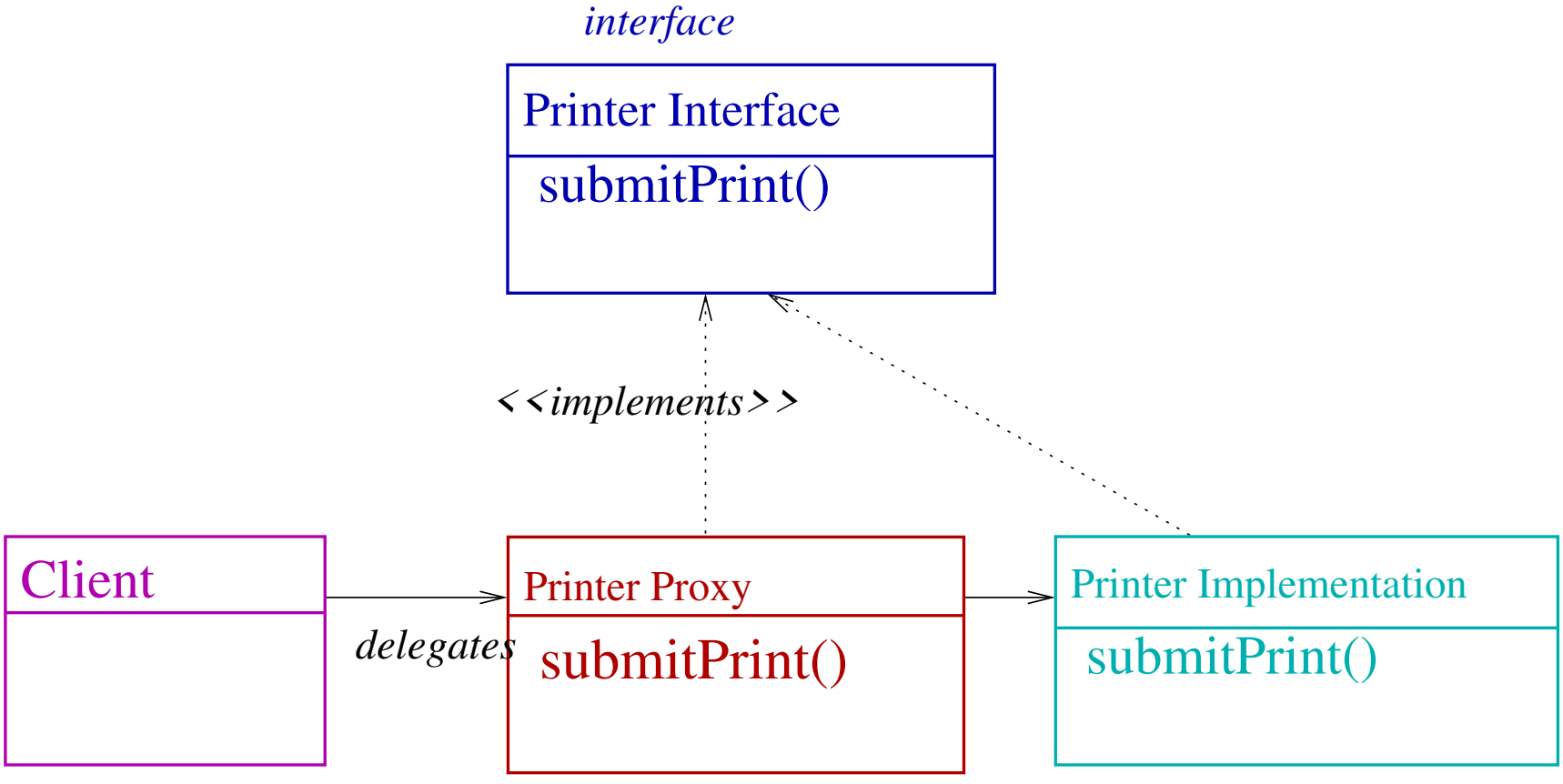
Automatic generation
stub and skeleton

2.3 The stub and the skeleton



2.4 Proxy Object and inheritance tree

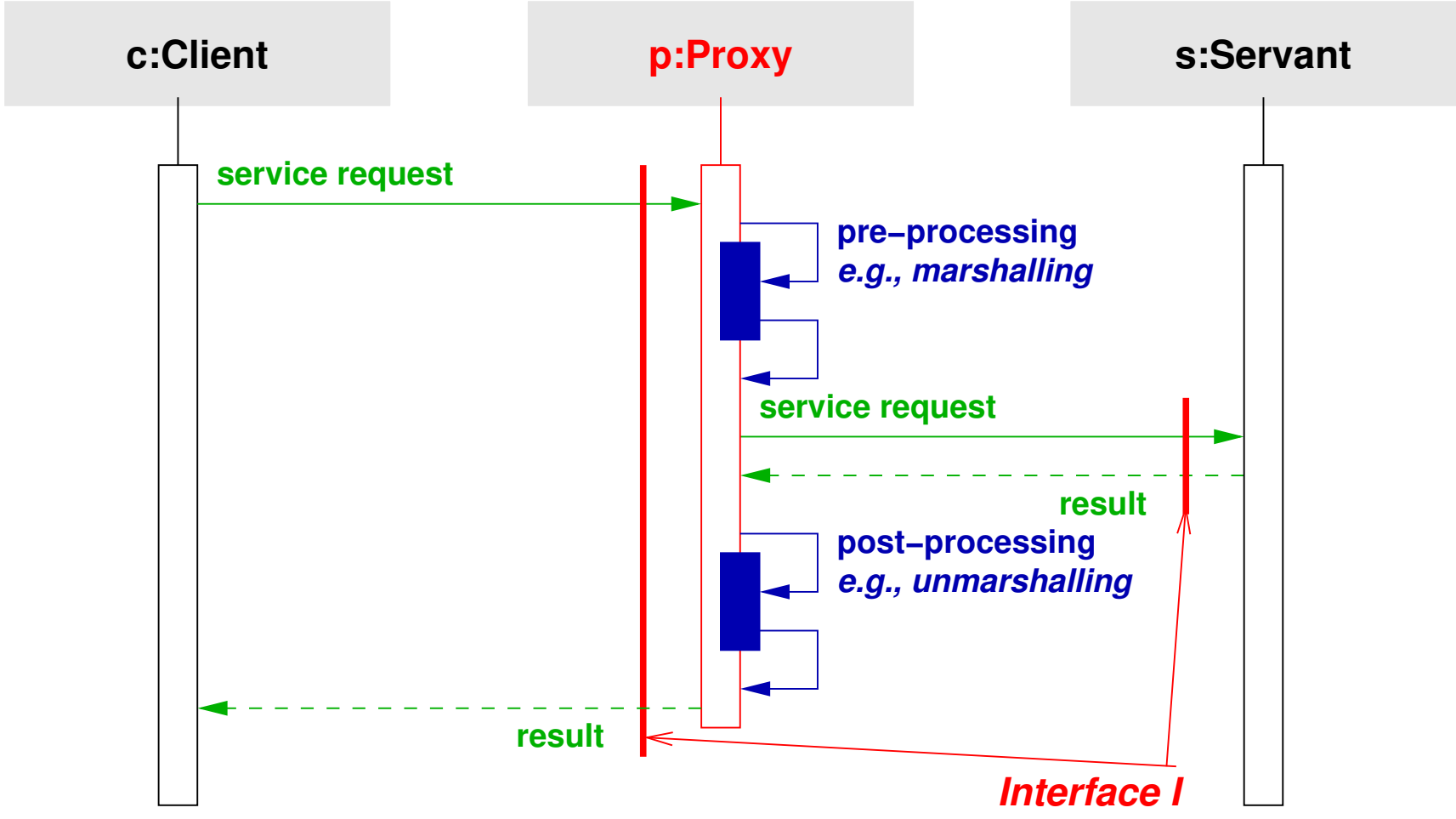
- Proxy: Representative for remote access



2.5 Proxy design pattern

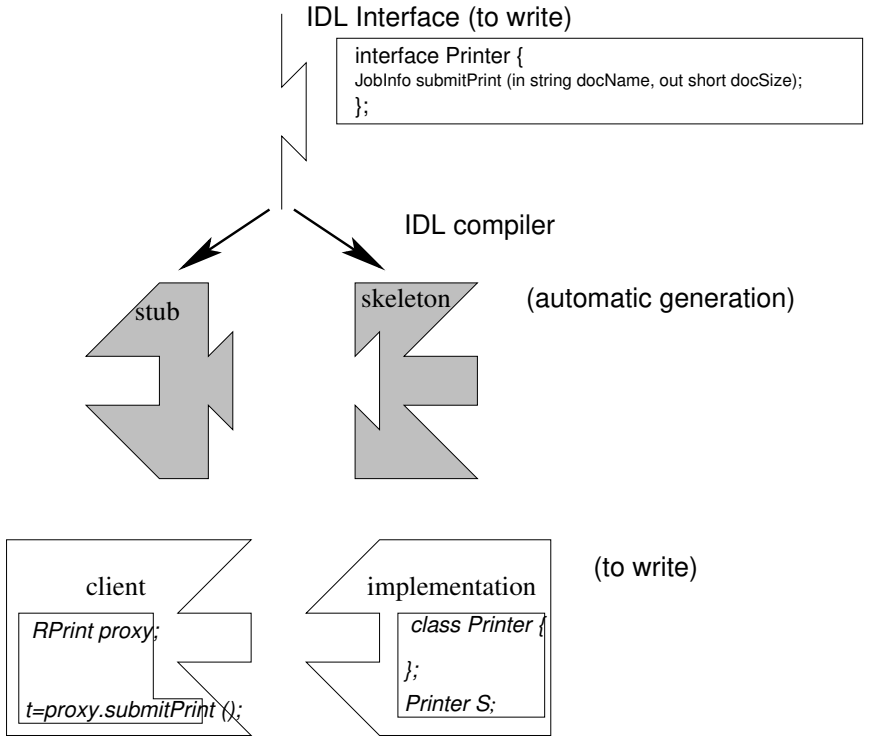
- *Context*: A **client** needs access to a **remote service** provided by some entity
- *Problem*
  - Define an access mechanism that does not involve
    - Hard-coding the **location** of the remote service in the client code
    - Deep knowledge of the communication **protocols** by the client
  - **Desirable properties**
    - Access should be **efficient** at run-time and **secure**
    - **Programming** should be **simple**: No difference between local and remote access
  - *Constraints*: Distributed environment (no single address space)
- *Solutions*
  - Use a **proxy** i.e. a local representative of the server on the **client** side that isolates the client from the communication system and the remote service
  - Keep the **same interface** for the representative as for the servant
  - Define a uniform proxy structure to facilitate automatic generation

2.5.1 Sequence diagram of Proxy

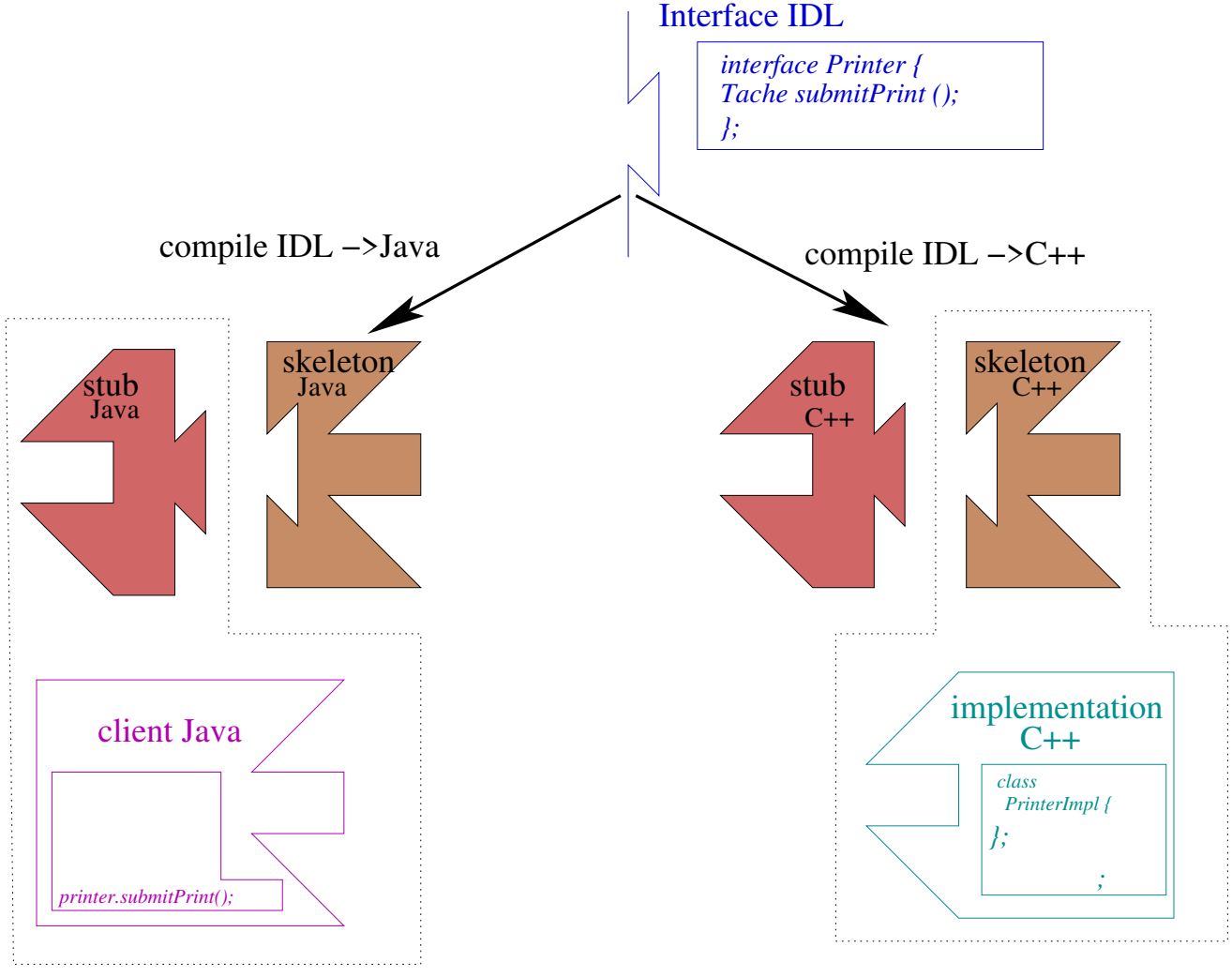


2.6 Distribution Implementation Process

1. Description of the interface in **IDL**
2. IDL compiler creates the stub and the skeleton
3. Write both **client and server implementations**



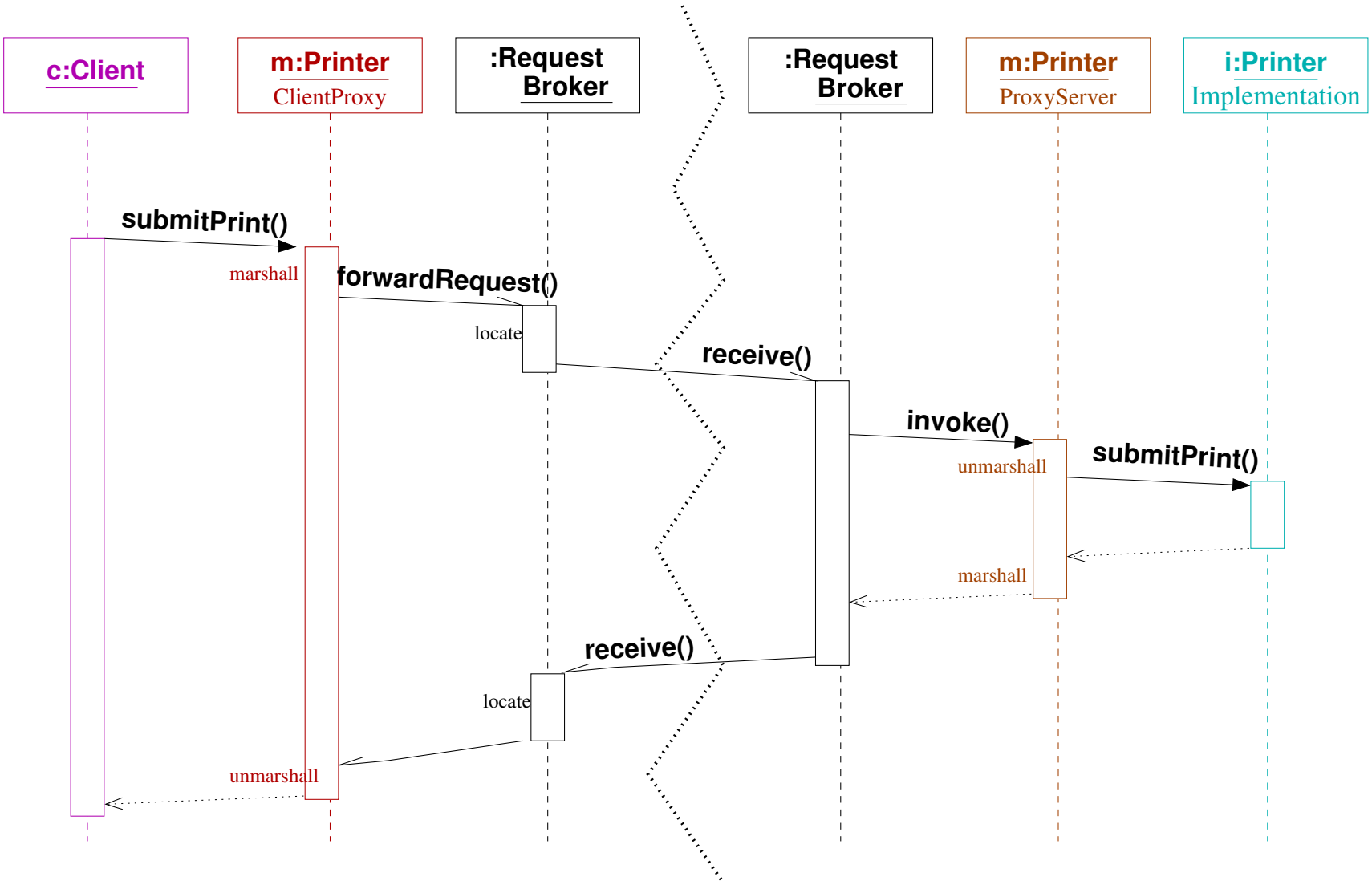
2.7 Multi-languages (or multi-ORBs, or multi-OSs)



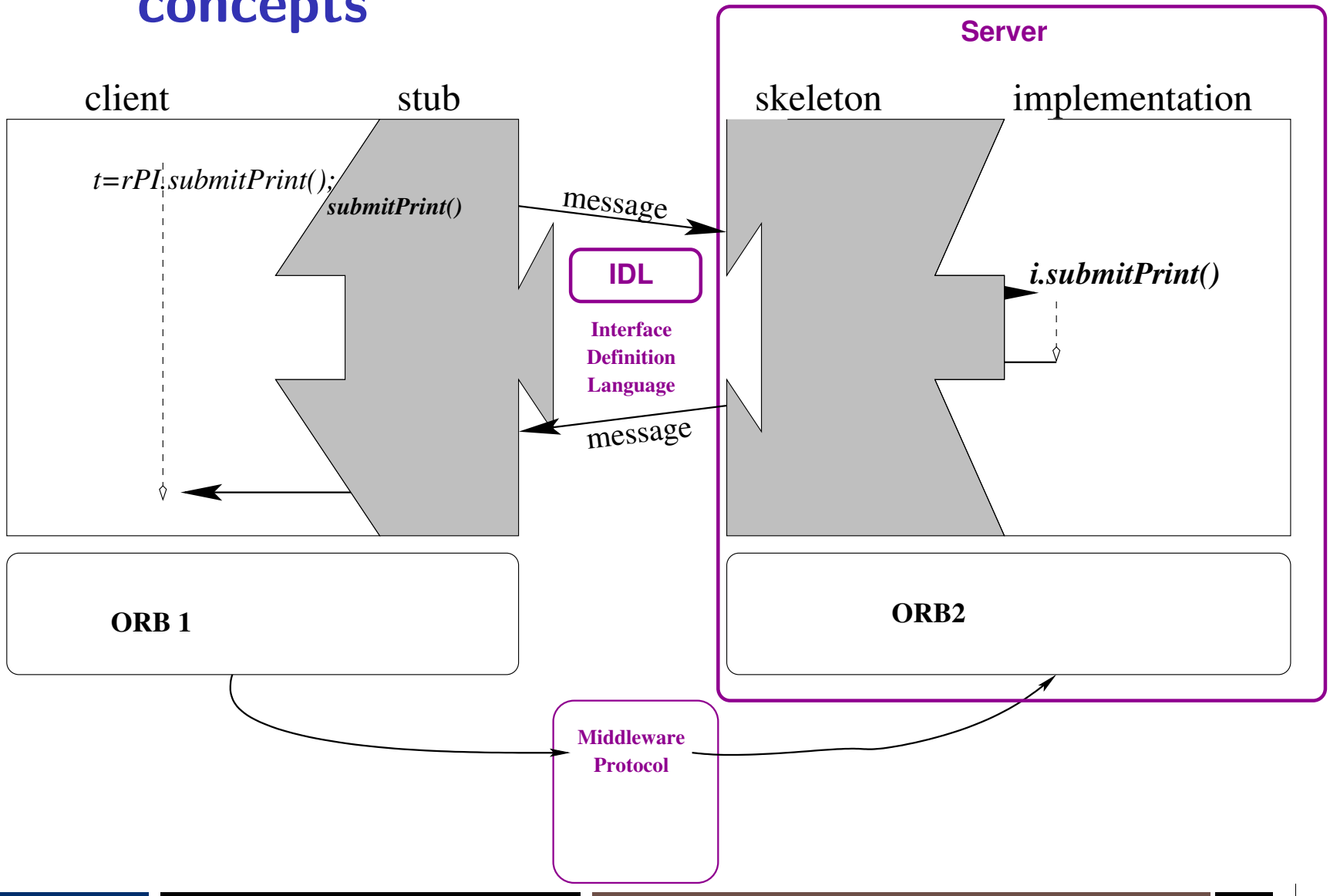
2.8 Distribution implications

- Objects/service implementation are in different spaces (not the same process, not the same computer . . .):
  - Assign a **unique identifier** to each object/service in different spaces
  - Localize objects/service implementations
  - Transports requests and replys
  - Use of a neutral network format for the data

2.9 Invocation sequence diagram



2.10 Middleware for synchronous requests : main concepts



2.11 Inherent complexity of distribution

*" **Distributed systems:** One on which I cannot get any work done, because some machine I have never heard of has crashed "*

Leslie Lamport

- **No global state**
- Poor **debugging** tools
- Partial **failures**, network partition
- Requests in parallel (**concurrency management**)
- Trusting the caller (**authentication**)

3 Conclusions

3.1 Main distributed object middleware

CORBA (OMG) 1991

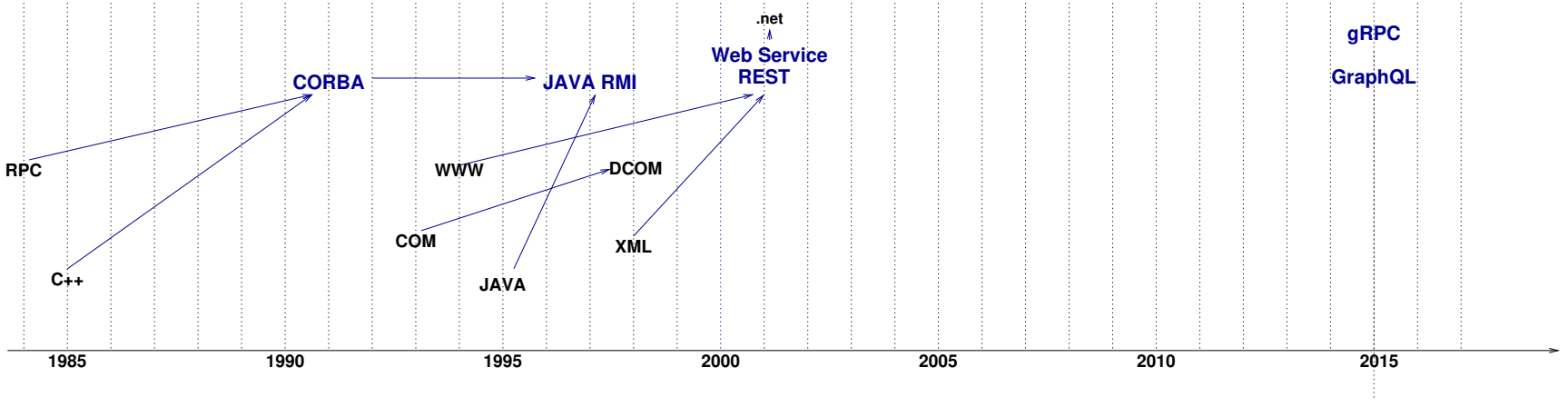
Java RMI (Sun) 1997

SOAP WebService (w3C) 2001

REST WebService (w3C) 2001

GoogleRPC (Google) 2015

GraphQL (Facebook) 2015



3.2 Comparison of historical synchronous middleware

	CORBA	RMI	SOAP	**REST**	gRPC	GraphQL
Origin	OMG	SUN	W3C	W3C	google	FaceBook
Prog. language	multi	**Java**	multi	multi	multi	multi
IDL (Interface Definition Language)	IDL CORBA	interface Java	WSDL	URIs	Protocol Buffer IDL	GraphQL Schema Definition Language (SDL).
data presentation	CDR/binary	serialisation/**binary**	SOAP Envelope/XML	**JSON/XML/text**	protobuf/binary	JSON
protocole	IIOP/TCP	IIOP/TCP	SOAP/HTTP Protocol	HTTP1	HTTP2	HTTP1
connexions	connected	connected	short connexions	**short connexions**	bi-directional	short connexions
object references	location independant	IP+port	URL	URI	URL	URL
naming service	NS, trading	RMI registry, JNDI	UDDI, WSIL	/	/	/
main advantages	services/efficiency	easy in java	SOA	simple	efficient message transmission	define views from several resources
main difficulties	complex to learn	Java/Java	complex	low level	maturity and low navigator support	complex to learn

3.3 Take away conclusion

- Synchonous vs asynchronous
- Proxy design pattern
- Complexity of distribution
- One concept: RPC Remote Procedure Call (1984), several family of solutions
  - Interface definition language, protocols, Data representation ...
- Synchronous request middleware is the necessary foundation to build higher level middleware
  - Application servers
  - Publish/subscribe
  - Compositions and orchestrations

References

Krakowiak, S. (2009).

Middleware Architecture with Patterns and Frameworks.

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