Chapter 2: Middleware

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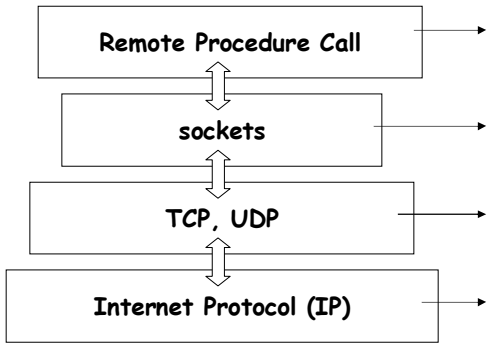
Programming abstractions

- Programming languages and almost any form of software system evolve always towards higher levels of abstraction
  - hiding hardware and platform details
  - more powerful primitives and interfaces
  - leaving difficult task to intermediaries (compilers, optimizers, automatic load balancing, automatic data partitioning and allocation, etc.)
  - reducing the number of programming errors
  - reducing the development and maintenance cost of the applications developed by facilitating their portability
- Middleware is primarily a set of programming abstractions developed to facilitate the development of complex distributed systems
  - to understand a middleware platform one needs to understand its programming model
  - from the programming model the limitations, general performance, and applicability of a given type of middleware can be determined in a first approximation
  - the underlying programming model also determines how the platform will evolve and fare when new technologies evolve

RPC as a programming abstraction



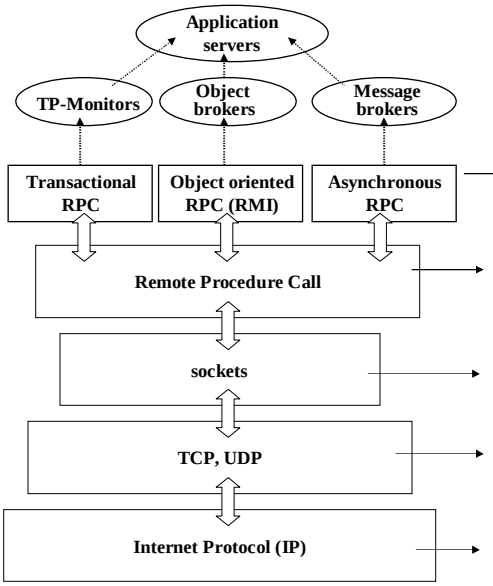
Remote Procedure Call:
hides communication details behind a procedure call and helps bridge heterogeneous platforms

sockets:
operating system level interface to the underlying communication protocols

TCP, UDP:
User Datagram Protocol (UDP) transports data packets without guarantees
Transmission Control Protocol (TCP) verifies correct delivery of data streams

Internet Protocol (IP):
moves a packet of data from one node to another

The genealogy of middleware



Specialized forms of RPC, typically with additional functionality or properties but almost always running on RPC platforms

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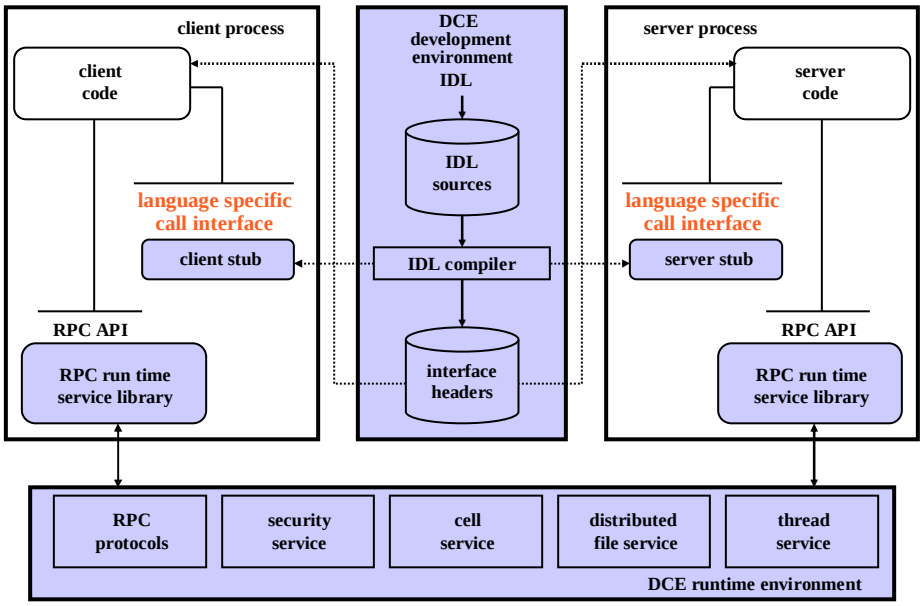
And the Internet? And Java?

- Programming abstractions are a key part of middleware but not the only one:
  - a programming abstraction without good supporting infrastructure (i.e., a good implementation and support system underneath) does not help
- Programming abstractions, in fact, appear I many cases in reaction to changes in the underlying hardware or the nature of the systems being developed
- Java is a programming language that abstracts the underlying hardware: programmers see only the Java Virtual Machine regardless of what computer they use
  - code portability (not the same as code mobility)
  - the first step towards standardizing middleware abstractions (since now the can be based on a virtual platform everybody agrees upon)
- The Internet is a different type of network that requires one more specialization of existing abstractions:
  - The Simple Object Access Protocol (SOAP) of Web services is RPC wrapped in XML and mapped to HTML for easy transport through the Internet

Middleware as infrastructure



Infrastructure

- As the programming abstractions reach higher and higher levels, the underlying infrastructure implementing the abstractions must grow accordingly
  - Additional functionality is almost always implemented through additional software layers
  - The additional software layers increase the size and complexity of the infrastructure necessary to use the new abstractions
- The infrastructure is also intended to support additional functionality that makes development, maintenance, and monitoring easier and less costly
  - RPC => transactional RPC => logging, recovery, advanced transaction models, language primitives for transactional demarcation, transactional file system, etc.
  - The infrastructure is also there to take care of all the non-functional properties typically ignored by data models, programming models, and programming languages: performance, availability, recovery, instrumentation, maintenance, resource management, etc.

Understanding middleware

To understand middleware, one needs to understand its dual role as programming abstraction and as infrastructure

PROGRAMMING ABSTRACTION

- Intended to hide low level details of hardware, networks, and distribution
- Trend is towards increasingly more powerful primitives that, without changing the basic concept of RPC, have additional properties or allow more flexibility in the use of the concept
- Evolution and appearance to the programmer is dictated by the trends in programming languages (RPC and C, CORBA and C++, RMI and Java, Web services and SOAP-XML)

INFRASTRUCTURE

- Intended to provide a comprehensive platform for developing and running complex distributed systems
- Trend is towards service oriented architectures at a global scale and standardization of interfaces
- Another important trend is towards single vendor software stacks to minimize complexity and streamline interaction
- Evolution is towards integration of platforms and flexibility in the configuration (plus autonomic behavior)

Next topics

- RPC
- TP Monitors
- Object brokers