CLOUD COMPUTING APPLICATIONS

Cloud Computing Glue: Communication

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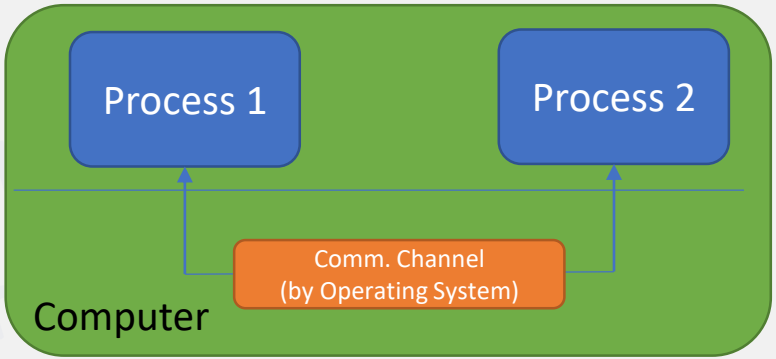
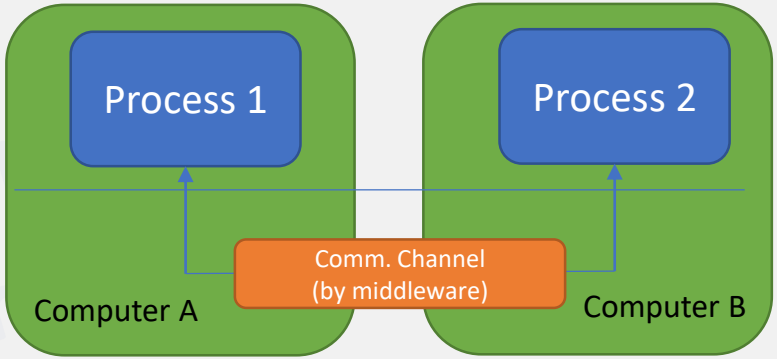
Communication in a single machine

- Communication Channel provided by the Operating System
- Shared memory block
- Shared File System
- Signal
- POSIX Socket, aka. Berkeley Socket
  - Port numbers
  - *SOCK_STREAM (compare to TCP)*
  - *SOCK_DGRAM (compare to UDP)*
- Remote Method Invocation (RMI)
  - Method invocations between objects *in different processes (processes may be on the same or different host)*
  - *From one JVM to another*
- Message Queue
- Message Passing
  - Unix Pipe
  - *Actor Model*
  - *Pi Calculus*

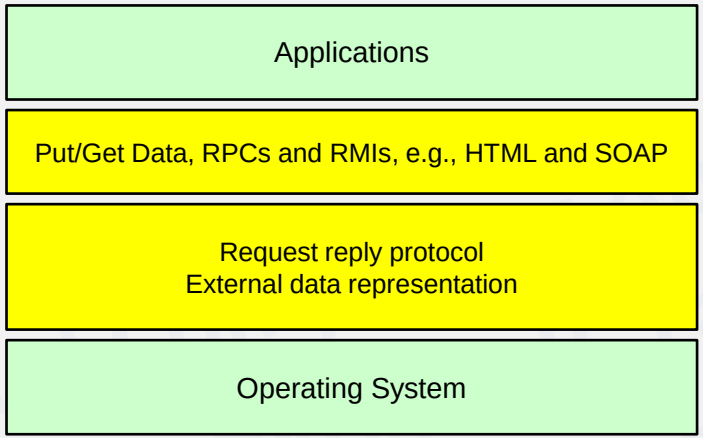


Middleware Layer Definition

- *Software that provides services to applications beyond those generally available at the operating system*
- Middleware implements functionalities that are common across many different applications
  - No need to reinvent the wheel (e.g., message parsing) every time you need to do something
- A Middleware Layer can provide the same abstractions to distributed applications!
  - Building distributed systems while maintaining our code is not very different from a single-node program



Middleware Layers



Middleware layers

Provide support to the application

Run at all servers at user level

RMI = Remote Method Invocation
CORBA = Common Object Request Brokerage Architecture
SOAP = Simple Object Access Protocol

Communication in a local network

- Scientific Computing
  - Message Passing Interface (MPI)
  - Simple model: Send() and Receive()
  - No native support for fault tolerance
  - Programming interface is complicated
    - Race, deadlock, etc.
- Business Sector
  - Remote Procedure Calls
    - RPC Semantics (behavior in presence of network failures)
    - RPC Implementation
  - Remote Method Invocation (RMI)
    - Between two JVMs on a network

Communication in Big Data Deployments

- Need scaling from the start
  - Sometimes many 10s of thousands of nodes on the network
  - Ad hoc solutions do not work
- RPC Frameworks
  - Google Protocol Buffer
    - You define the functions that will be called remotely
    - Then Compile
    - The system automatically generates interfaces functioning as communication stubs in your choice of programming language
      - Many languages are supported: C++. C#, Objective C, Java, Python, etc.
    - You import the generated header / code files into your project
    - At run-time, your program just calls the function locally. The auto-generated code takes care of serialization and marshalling of the function parameters, making the network calls (handling any network errors), and transferring the function call in the target system.
  - Apache Thrift
    - Apache HDFS, Hadoop, Spark, Storm, etc. extensively use Thrift
- Consistency
  - Paxos
  - Zookeeper