Middleware definitions and overview

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A wide number of middleware technologies are hidden under those acronyms!

To master the complexity: Understand the abstractions, classify the middleware.
1.1 Middleware definitions

Several definitions

- Middleware is software glue.
- Middleware is the slash in Client/Server
- Software that mediates between an application program and a network.
- Middleware is computer software that connects software components or applications. It is used most often to support complex, distributed applications. It includes web servers, application servers, content management systems, and similar tools that support application development and delivery. Middleware is especially integral to modern information technology based on XML, SOAP, Web services, and service-oriented architecture. It goes on to say that it describes a piece of software that connects two or more software applications so that they can exchange data.
- Middleware is any software that allows other software to interact.

Middleware definitions and overview

1 Which middleware?

- Middleware is sometimes called plumbing because it connects application and passes data between them.
- Middleware is software used for coupling high level system components (application) with basic system components (data and network).
1.2 Middleware as a universal adapter to build high level applications?
2 Middleware for separation of concerns

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2.1 Middleware : several concerns

Middleware for separation of concerns

Persistency (JavaEE, Hibernate)
MVC (Struts)
Presentation Layer

Application
Logic

System 1

Data Storage Layer
Persistency (JavaEE, Hibernate)

Interaction Layer
Synchronous call: RPC, RMI,
Web Services (REST, SOAP)
Publish/subscribe: JMS, RabbitMQ

Middleware

Application
Logic

System 2

Presentation Layer
MVC (Struts)
2.2 Separation of concerns and middleware

Middleware is a solution for the separation of concern paradigm.

In computer science, separation of concerns (SoC) is a design principle for separating a computer program into distinct sections, such that each section addresses a separate concern.

- Separation of concern enables application designers to focus on their business preoccupations.
  - Use standard middleware components for handling non-business preoccupations.

Through middleware, separation of concern is reached for:

- Heterogeneity
- Distribution of pieces of software
- Persistency of components
- Security issues
- New middleware for new preoccupations (e.g., context-awareness)
2.3 Levels of heterogeneity addressed by middleware

Middleware may address several level of heterogeneity

- Hardware heterogeneity (e.g., Little Endian and Big Endian representation)
- Operating System heterogeneity (e.g., library availability)
- Language heterogeneity (e.g., one piece of software in C, another piece of software in java)
- Application logic heterogeneity (e.g., data transformation from one application to the other)
2.4 Middleware for several levels of distribution

- Pieces of software connected by middleware may be distributed on:
  - Several processes (in the same computer)
  - Several computers (in the same local area network)
  - Several networks (in the same company)
  - Several companies
2.5 Examples of software distribution
3 Which middleware family

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3.1 Families of middleware

- RPC middleware
- Object Middleware
- Message Oriented Middleware
- Component Middleware
- Service Middleware
- Database middleware
- Persistency middleware
3.2 Main family history

- OMG OTS (R-1994)
- JMS
- TIBCO TIB
- InformationBus (R-1992)
- Module Interconnection Language (R-1976)
- Nested transaction (R-1980)
- Recoverability (R-1988)
- Arjuna (R-1989)
- DEC MQ
- DEC FUSE
- Field (R-1987)
- BEA MQ
- BEA WLS
- IBM WebSphere
- JBoss AS
- EJB & JTA
- RMI
- RMI (R-1998)
- Network Objects (R-1993)
- Emerald (R-1987)
- Orca (R-1989)
- Field (R-1987)
- CBD
- CORBA
- Rpc Systems
- SGML (R-1986)
- GML (R-1981)
- Scribe (R-1981)
- ANSA
- OMC
- OnC
- Cedar RCP (R-1984)
- Mesa (R-1979)
- Module Interconnection Language (R-1976)
3.3 Interaction styles

- **Middleware for distributed synchronous calls** (interaction layer)
  - **RPC**: request broker,
  - **CORBA**: object request broker, multi-languages, Local Area Network (LAN)
  - **RMI**: object request broker, java, LAN
  - **Web services (synchronous messages)**: multi-languages, Wide Area Network
    - **REST** (microservice architecture)
    - **SOAP** (Service Oriented Architecture, service orchestration)

- **Middleware for publish/subscribe** (interaction layer)
  - **MQTT** For the IoT
  - **JMS** LAN
  - **AMQP, RabbitMQ**
  - **ESB** Enterprise Service Bus, WAN
3.4 Object/Service/Component lifecycle: servers and containers

- **Application server** manager: instantiation, containers
  - Application Servers
    - JavaEE (JBoss, glassfish, Websphere):
    - Light servers: Spring
  - Web container: Web Server (tomcat, jetty, LiteWebServer):
3.5 Data management

- **Data Oriented Middleware** (network and data layers)
  - EAI Enterprise Application Integration, data exchange, WAN
  - REST (Representational State Transfer)
  - DDS Data Distribution Service

- **Persistency middleware** handles persistency of data or objects (data layer)
  - JavaEE (EJB) includes persistency preoccupation (various technologies)
  - Hibernate is a persistency framework (from object to relational database paradigm)
3.6 Presentation middleware

- **Presentation middleware**: handles presentation of information (presentation layer)
  - ♦ **Struts** Web presentation of components through the MVC approach (Model View Controller)
4 Architecture

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4.1 Service Oriented Architecture

- **Service Oriented Architecture** (for sequence of services)
  - Service abstraction
  - Service Orchestration

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4.2 Component based Architecture

- Component abstraction
- Component Assembly (e.g. SCA Service Component Architecture, Fractal components, CORBA Component Model)
4.3 Microservice architecture

- A microservice is a software architectural style that structures an application as a collection of loosely coupled services.
- Advantages:
  - modularity
  - continuous delivery
  - better scalability

- Microservices interaction patterns
  - Services in a microservice architecture are often processes that communicate over a network
    - For synchronous interactions: REST over HTTP (one of the most popular)
    - For asynchronous interactions: AMQP and Akka actors are good candidates
4.4 3 tiers Architecture

Presentation  
Application logic  
Persistency
5 Synthesis

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5.1 Layer view

**Structural Compositions**

![SCA Diagram]

**Activity Orchestrations**

![BPEL Diagram]

**Application servers**

- Life cycle (instantiate)
- Persistency

![JavaEE Diagram]

**Publish/Subscribe**

![RabbitMQ Diagram]

**WebServices/JavaRMI**

Synchronous Call

**sockets**

TCP/UDP

![sockets Diagram]
5.2 Conclusion

- In a same family, the Choice of middleware may be decided lately when designing an application (e.g. Java RMI vs WebService).
- Middleware may connect pieces of software implemented separately and available on the network.
- Standardisation is essential to connect pieces of software.
- Universal adapter is of course not possible:
  - Many technologies are available with different characteristics (e.g., target platform, semantics, efficiency)
  - The basic of middleware is about distribution (RPC, RMI) sometimes called plumber solutions.
  - Above distribution, higher abstractions may be built: publish/subscribe, data distribution, persistency, presentation, naming, workflow, orchestration and composition.