Middleware definitions and overview

Revision: 545

Chantal Taconet

September 2020
Overview

1. Which middleware?
2. Middleware for separation of concerns
3. Which middleware family
4. Architecture
5. Synthesis
A wide number of middleware technologies are hidden under those acronyms!

💡 To master the complexity: Understand the abstractions, classify the middleware
Several definitions ¹

- **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 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 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)**

Which middleware?

Middleware as a universal adapter to build high level applications?
2 Middleware for separation of concerns

1. Which middleware?

2. Middleware for separation of concerns
   2.1 Middleware: several concerns
   2.2 Separation of concerns and middleware
   2.3 Levels of heterogeneity addressed by middleware
   2.4 Middleware for several levels of distribution
   2.5 Examples of software distribution

3. Which middleware family

4. Architecture

5. Synthesis
2.1 Middleware: several concerns

Middleware definitions and overview
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
  - 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

1. Which middleware?
2. Middleware for separation of concerns
3. Which middleware family
   3.1 Families of middleware
   3.2 Main family history
   3.3 Interaction styles: synchronous call
   3.4 Interaction styles: publish/subscribe
   3.5 Object/Service/Component lifecycle: servers and containers
   3.6 Data management
   3.7 Presentation middleware
4. Architecture
5. Synthesis
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

Databases | Message buses | RPC | Markup languages, Web

Families

MQTT
RabbitMQ (2007)

EJB & JTA (1999)

BEA Tuxedo
IBM Encina

OMG OTS−1994

Arjuna−R−1989
Recoverability−R−1988

Field−R−1987

Nested transaction−R−1980

BEA MQ
DEC MQ
DEC FUSE

TIBCO TIB
InformationBus−R−1992

RPC Systems
ORC
CORBA

Orca−R−1989
Emerald−R−1987

Field Interconnection Language−R−1978

module

RMI

RMI−R−1998

Network Objects−R−1993

REST WebServices (2000)

SOAP & WSDL

XML

SGML−R−1986

GML−R−1981
Scribe−R−1981

RPC−R−1981

RMI−R−1998

Cedar RPC−R−1984

RPC Systems

Mesa−R−1979

Module Interconnection Language−R−1976
### 3.3 Interaction styles: synchronous call

- 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)
3.4 Interaction styles: publish/subscribe

- Middleware for **publish/subscribe** (interaction layer)

- **MQTT** For the IoT
- **JMS** LAN
- **AMQP, RabbitMQ**
3.5 **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):

![Diagram](image-url)
3.6 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)
3.7 Presentation middleware

- **Presentation middleware**: handles presentation of information (presentation layer)

- **Struts**: Web presentation of components through the MVC approach (Model View Controller)
4 Architecture

1. Which middleware?
2. Middleware for separation of concerns
3. Which middleware family
4. Architecture
   4.1 3 tiers Architecture
   4.2 Component based Architecture
   4.3 Service Oriented Architecture
   4.4 Microservice architecture
5. Synthesis
4.1 3 tiers Architecture

Presentation

Application logic

Persistency
4.2 Component based Architecture

- Component abstraction
- Component Assembly (*e.g.* SCA Service Component Architecture, Fractal components, CORBA Component Model)
4.3 Service Oriented Architecture (for sequence of services)

- Service abstraction
- Service Orchestration

2. Source de la figure
4.4 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
5 Synthesis

1. Which middleware?
2. Middleware for separation of concerns
3. Which middleware family
4. Architecture
5. Synthesis
   5.1 Layer view
   5.2 Conclusion
5.1 Layer view

Structural Compositions
- SCA

Activity Orchestrations
- BPEL

Application servers
- Life cycle (instantiate)
- Persistency

JavaEE

Publish/Subscribe
- RabbitMQ

WebServices/JavaRMI
- Synchronous Call

sockets
- TCP/UDP
5.2 Conclusion

- In the design of a distributed application, you first choose the middleware family, you choose the middleware itself later on (e.g. you first choose Synchronous interaction style and then Java RMI or REST WebService).

- Middleware connect pieces of software implemented separately (by different companies, developers . . . ) 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.