Feature Interaction Problems in Middleware Services

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Agenda

- Proliferation of Middleware
  - From the perspective of feature interaction problems
- Middleware Services
  - Cases of feature interaction problems
  - A preliminary solution
- Future Work
  - Key Project of National Natural Science Foundations in China
  - Consulting Project for Value-Added Services in Mobile Comm.
- Conclusion

Middleware: Why

- Interoperability
  - The ability of two or more systems or components to exchange information and to use the information that has been exchanged
  - The ability of systems, units, or forces to provide services to and accept services from other systems, units or forces and to use the services so exchanged to enable them to operate effectively together
    - U.S. Federal Standard: Glossary of Telecommunication
- Middleware
  - is the popular infrastructure for interoperability in computer based systems
  - Such as DCE, CORBA, Java RMI, COM, Web Services …

Middleware: What

Middleware is proliferating and brings challenges to interactions

Middleware: Proliferation

1. Provide plentiful Interoperability protocols
2. Guarantee plentiful quality of service
3. Support much more complex interactions

Middleware proliferation makes the development of distributed systems easier and faster as well as brings new problems to interactions

Middleware: Challenge

- Extremely Open and Dynamic Internet
  - Makes everything in middleware enabled interactions changeable
  - Such changes may lead to unexpected behaviors
- Q: If a component is changed, does the interaction work well?
  A: we define a component update model, which guarantee deadlock free, client transparency and state consistency (ESEC/FSE 2005)
  We implement reflective framework for monitor and adapt middleware based systems at runtime (J-ASE, IJSPM…)
- Q: If the middleware behaves incorrectly, does the interaction work well?
  A: we study how to automatically recover correlated faults of middleware services (COMPSAC2005)
  We also study the incorrect configuration of middleware services in this paper, and the incorrect usage of data base meta data in middleware in the next paper
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Middleware V.S. Telecom (1/3)

- Architecture
  - Similarities
    - middleware consists of the middleware core and a set of pluggable and relatively independent services
    - value-added functions of middleware are provided as pluggable services
    - both middleware and telecom have to provide any functions to multiple and different users
  - Differences
    - Telecom: features/services for functionalities
    - Middleware: services for both functionalities and non-functional requirements

Middleware V.S. Telecom (2/3)

- Development
  - Similarities
    - middleware services are developed and deployed in a parallel, independent and incremental manner.
    - open, flexible and dynamic architecture enables new services to be introduced to current middleware rapidly
    - customers can add, change or remove services in terms of application specific requirements
  - Differences
    - Distribution makes interactions in middleware much more complex and diverse

Middleware V.S. Telecom (3/3)

- Maintenance
  - Similarities:
    - Software As a Service
    - High availability (24x7 days)
    - Impossible to redesign completely
  - Differences
    - Bigger challenge for maintaining middleware based systems
    - Security, Cost, ...

- Conceptually
  - Middleware will suffer the same problem in telecom
    - Feature Interactions !!!
  - A real case in a J2EE application server

Interceptor Order may cause FIP like problems

- Some services have to be invoked before/after some other services
- Otherwise, unexpected behaviors/results will occur
Feature Interaction: a Case

**In this configuration**

- If a request with high priority is coming, it cannot be processed by CI until some threads are released. Then, PI cannot do anything until CI allocates a thread to a request. Therefore, the function of PI is invalid.

**Direct reason:** Resource competition

**Intrinsic reason:** Conflict in requirements

Allocate threads for requests without any special considerations

Allocate threads for requests in terms of priorities

Feature Model Analysis for Interceptors

- It is very difficult to find such conflicts

**ServantTheo**

**Access**

**Priority**

**Concurrency**

**Interceptor**

**Specialized**

**Optional**

Conflict between two policies

**FIP in the whole lifecycle of software systems**

- Based on our sophisticated methods and tools, which cover the whole lifecycle of software

**Real World**

**Feature Model**

**Software Architecture**

**Solutions of Feature Interactions in Software**

**Sources of Feature Interactions in Software**

**Limited Techniques**

**Resource competition**

**Implementation**

**Runtime**

**Research Map**

FIP in Chinese Mobile Communications

**Value added services in mobile comm.**

- Value added services will become the main profit, especially in 3G, in China.

**Headache of the largest mobile operator**

- Why we have to use so many different IP protocols
  - Performance testing in different applications
- Why it is so difficult to add a new service
  - Feature interaction problems
- Can we define a standard framework/architecture for adding new services in an easy-to-use, time-to-market, interaction-free manner
  - Based on our previous study on middleware

Almost all of these value added services are supported by middleware: CORBA, J2EE, Web Services, LDAP, …

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**Conclusion**

- In this paper
  - Try to prove that feature interaction problems exist in middleware based systems by
    - A conceptual comparison of the architecture, development and maintenance between middleware based systems and telecoms
    - A real case in interceptor based configuration of middleware services

- Future
  - Study feature interaction problems in the whole software lifecycle
  - Investigate feature interactions in Chinese Mobile Comm.

- More materials can be found at [http://sei.pku.edu.cn](http://sei.pku.edu.cn)
Thanks

Campus of PKU