A Reference Architecture for Web Servers

Ahmed Hassan and Richard Holt

Software Architecture Group
University of Waterloo
CANADA
Reference Architecture

- Architecture template for software systems in a domain
- A product architecture is an instantiation of the reference arch
- Defines the fundamental components and the relations between them
- Well known for mature domain (eg. Compilers, Operating Systems)
Compiler Ref. Arch.

Reference Architecture Benefits

- Documents existing well-proven designs
- Helps build complex systems
- Provides a common vocabulary
- Aids in the comparison of different architectures in the same domain
- Improves code reuse
Paper Overview

• We present:
  – A process to derive a reference architecture by non-domain experts
  – A reference architecture for web servers
  – Mapping it to different product architectures
The Web Server Domain
Web Servers

- Apache
- Microsoft - IIS
- Netscape - iPlanet Server
- AOL Server
- Jigsaw
Summary: 3 Servers

<table>
<thead>
<tr>
<th>Web Server</th>
<th>Main arch.</th>
<th>Dev type</th>
<th>1st release</th>
<th>Code size (KLOC)</th>
<th>Lang.</th>
<th>Arch. stable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apache</td>
<td>Robert Thau</td>
<td>Open source</td>
<td>April 1995</td>
<td>80</td>
<td>C</td>
<td>5 yrs</td>
</tr>
<tr>
<td>AOL Server</td>
<td>-</td>
<td>Commercial</td>
<td>May 1995</td>
<td>164</td>
<td>C &amp; TCL</td>
<td>-</td>
</tr>
<tr>
<td>Jigsaw</td>
<td>Yves Lafon</td>
<td>Experimental</td>
<td>May 1996</td>
<td>106</td>
<td>Java</td>
<td>2.5 yrs</td>
</tr>
</tbody>
</table>
Conceptual vs. Concrete Architecture

- **Conceptual Architecture:**
  - Resides in the head(s) of the developer(s)
  - Mental model: incomplete, inaccurate, ideal

- **Concrete Architecture:**
  - Extracted from the system’s implementation
  - Many mismatches with the conceptual architecture
Process for Deriving Ref. Arch.

Reference Architecture for Web Servers

- Conceptual Architecture
  - Concrete Architecture
    - Apache

- Conceptual Architecture
  - Concrete Architecture
    - AOLServer

- Conceptual Architecture
  - Concrete Architecture
    - Jigsaw
Web Server Reference Architecture
Reception

- Request Analysis
- Access Control
- Util

- Record Transaction
- Resource Handler

Operating System Abstraction Layer

Web Server Reference Architecture

All depend on

Control flow
Mapping the Reference Architecture to a Web Server
The Apache Web Server
Apache: Conceptual Architecture

- Req. Analysis
  - Translation
  - Access Ctrl
    - Authentication
    - Authorization
- Core
- Request Trans
  - Logging
  - Req. Handler
    - MIME type
    - Response
- Util
- OS Layer

Apache Conceptual Architecture mapping
The AOL Web Server
AOLServer: Conceptual Architecture

- Recep. & Req. Analysis
- Communication
  - Driver
- Request Trans.
- Access Ctrl.
  - NSPerm
- Daemon - Core
- Req. Handler.
  - URL Handle
- Util.
  - Timer
  - Database Interface
  - Util
  - TCL Interpreter
- OSAL.
  - NSLog
  - NSThread
Mapping Summary

- Conceptual arch. of 3 servers maps nicely to ref. arch.
- Main differences are splitting and merging of subsystems
- The derived architecture is independent of development methodology
Conclusions

• Ref. arch.: Framework to assist in forward and reverse engineering

• Conceptual arch: Each server maps nicely to the derived reference architecture

• Needs more validation
Reference Architectures for Web Browsers

A Case Study in Architectural Analysis: The Evolution of the Modern Web Browser

Alan Grosskurth and Michael W. Godfrey
History of Web Browsers

Legend
- Open-source
- Closed-source
- Hybrid

- Opera
- Nokia S60 Browser
- Safari
- Konqueror
- Epiphany
- Galeon
- Firefox
- Mozilla
- Netscape
- Mosaic
- Internet Explorer
- Lynx

- W3C founded: 1992
- 1998–03–31

- 1.0
- 2.0
- 3.0
- 4.0
- 5.0
- 6.0
- 7.0
- 8.0

- 1992
- 1993
- 1994
- 1995
- 1996
- 1997
- 1998
- 1999
- 2000
- 2001
- 2002
- 2003
- 2004
- 2005
- 2006

- 2.4
- 2.0
- 1.0
- 0.5
- 0.4
- 0.8
- 1.0
- 1.2
- 1.0
- 1.8
- 2.0
- 1.7
- 1.5
- 1.0
- 0.5
- 0.4
- 0.8
- 1.0
- 1.2
- 1.0
Reference Architecture

- User Interface
  - Browser Engine
    - Rendering Engine
      - Networking
      - JavaScript Interpreter
      - XML Parser
      - Display Backend

- Data Persistence
## Studied Browsers

<table>
<thead>
<tr>
<th>Project</th>
<th>Version</th>
<th>Language</th>
<th>Files</th>
<th>kLOC</th>
<th>Start</th>
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<tbody>
<tr>
<td>Mozilla</td>
<td>1.7.3</td>
<td>C++, C</td>
<td>10,700</td>
<td>2,400</td>
<td>1998</td>
</tr>
<tr>
<td>Konqueror</td>
<td>3.3.2</td>
<td>C++</td>
<td>3,150</td>
<td>600</td>
<td>1996</td>
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<tr>
<td>Epiphany</td>
<td>1.4.6</td>
<td>C++, C</td>
<td>7,230</td>
<td>1,540</td>
<td>2000</td>
</tr>
<tr>
<td>Safari</td>
<td>1.2</td>
<td>C++, Obj C</td>
<td>&gt; 1,550</td>
<td>&gt;230</td>
<td>2003</td>
</tr>
<tr>
<td>Lynx</td>
<td>2.8.5</td>
<td>C</td>
<td>200</td>
<td>120</td>
<td>1989</td>
</tr>
<tr>
<td>Mosaic</td>
<td>2.7b6</td>
<td>C</td>
<td>295</td>
<td>88</td>
<td>1993</td>
</tr>
<tr>
<td>Firefox</td>
<td>1.0</td>
<td>C++, C</td>
<td>10,700</td>
<td>2,400</td>
<td>2002</td>
</tr>
</tbody>
</table>
Mozilla

User Interface

UI Toolkit (XPFE)

User Interface

Browser Engine

Gecko

Rendering Engine

User, Secure, & Engine Persistence

Data Persistence

Necko

Security (NSS/PSM)

Networking

Spider-Monkey

JavaScript Interpreter

GTK+ Adapter

GTK+ / X11 Libraries

Display Backend

Expat

XML Parser
Konqueror

User Interface

KHTMLPart

Browser Engine

KIO

KJS

PCRE

Rendering Engine

Networking

Data Persistence

User Persistence

Secure Persistence (KWallet)

Engine Persistence

XML Parser

Display Backend

Qt / X11 Libraries

JavaScript Interpreter
Epiphany
Mosaic

Diagram showing the components and structure of the Mosaic browser.