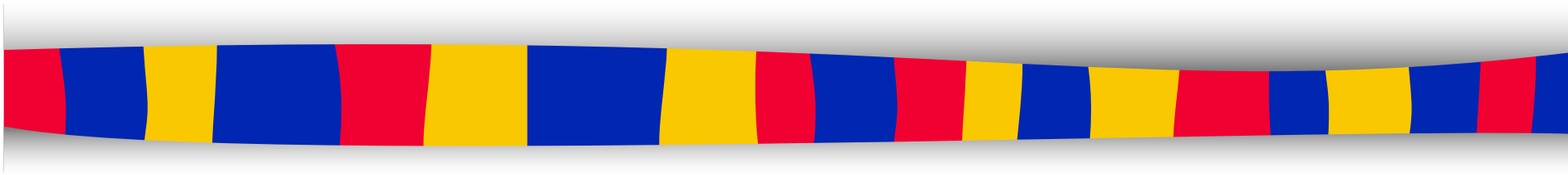
CISC 322
Software/Game Architecture



Module 5: Reference Architectures (Web Servers and Web Browsers)

Ahmed E. Hassan

A Reference Architecture for Web Servers

Ahmed Hassan and Richard Holt

Software Architecture Group

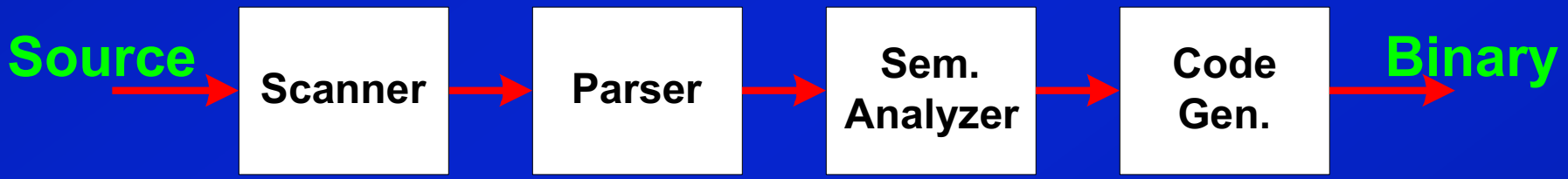
University of Waterloo

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.



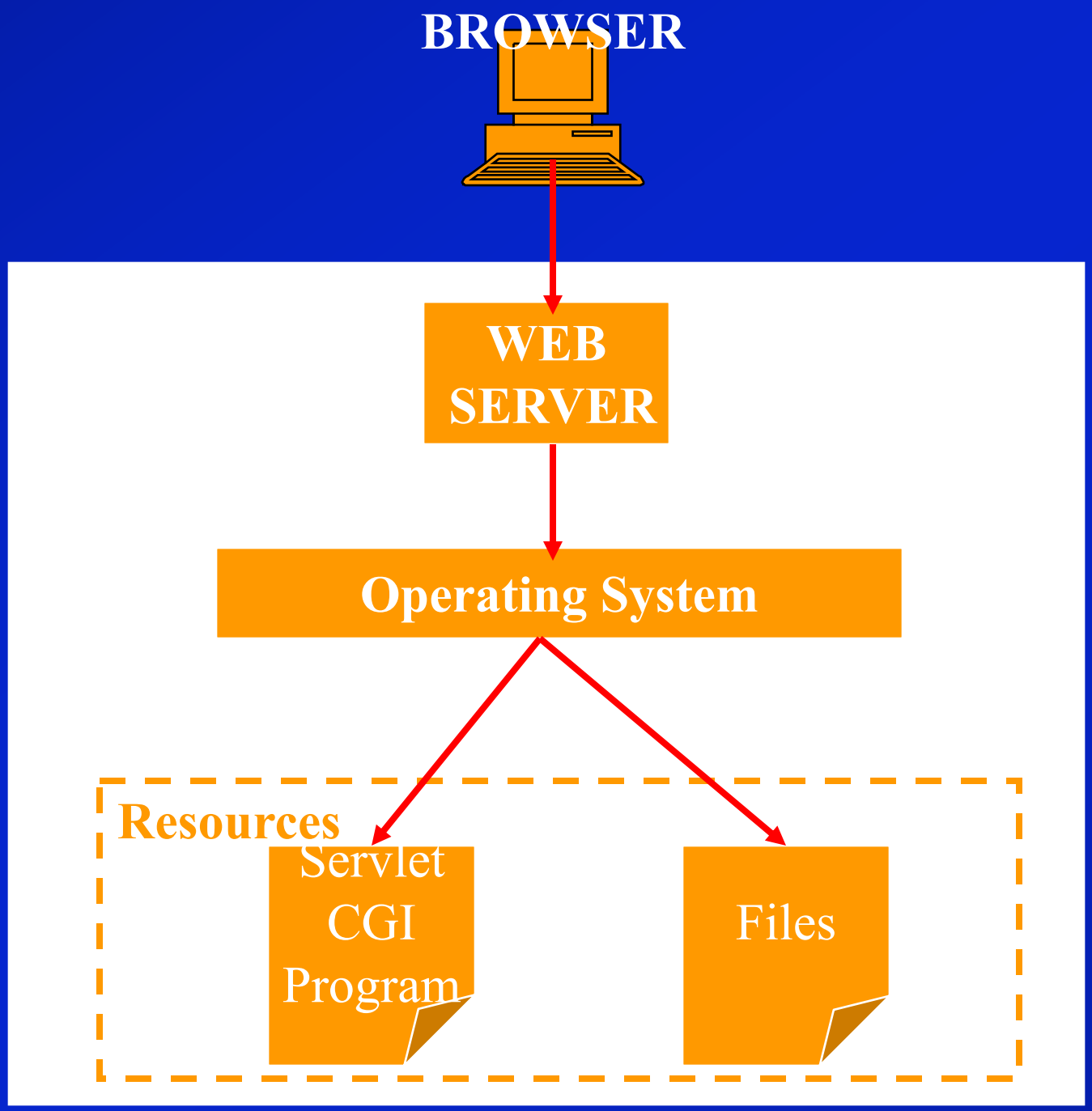
Reference Architecture Benefits

- 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


BROWSER
WEB SERVER
Operating System
Resources
Servlet CGI Program
Files

Web Servers

- Apache
- Microsoft - IIS
- Netscape - iPlanet Server
- AOL Server
- Jigsaw

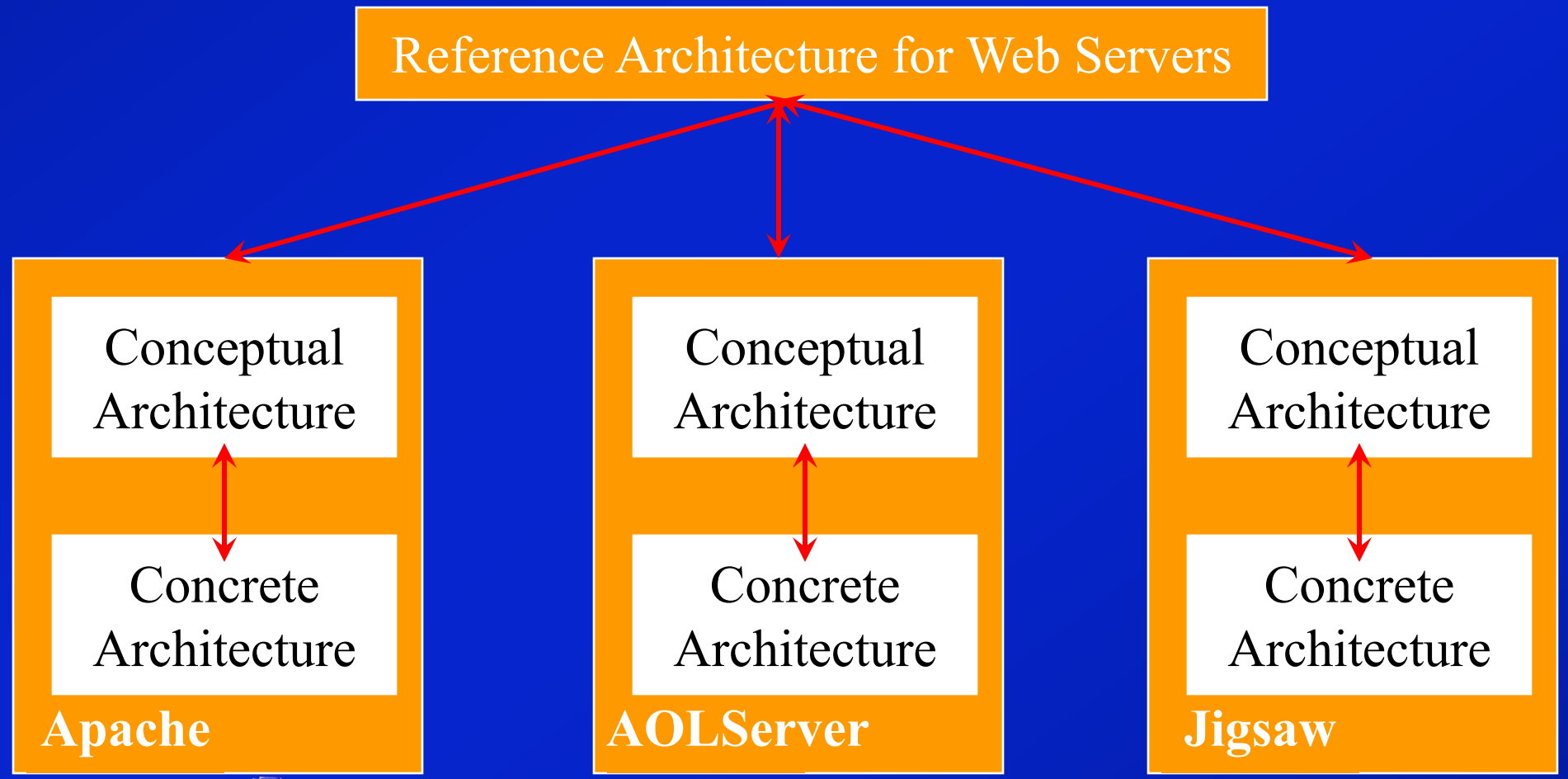
Summary: 3 Servers

Web Server	Main arch.	Dev type	1st release	Code size (KLOC)	Lang.	Arch. stable
Apache	Robert Thau	Open source	April 1995	80	C	5 yrs
AOL Server	-	Commercial	May 1995	164	C & TCL	-
Jigsaw	Yves Lafon	Experimental	May 1996	106	Java	2.5 yrs

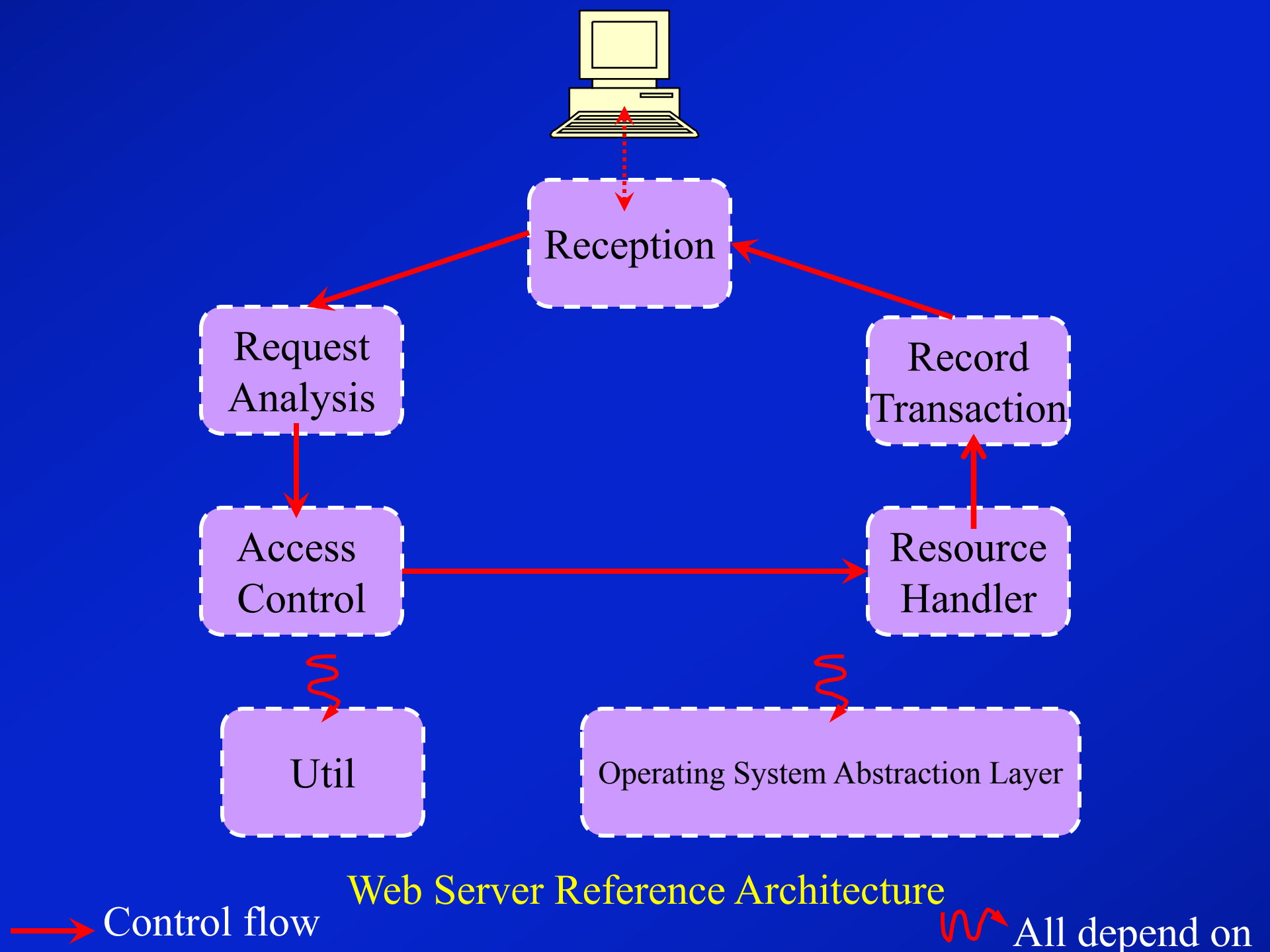
Conceptual vs. Concrete Architecture

- 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.

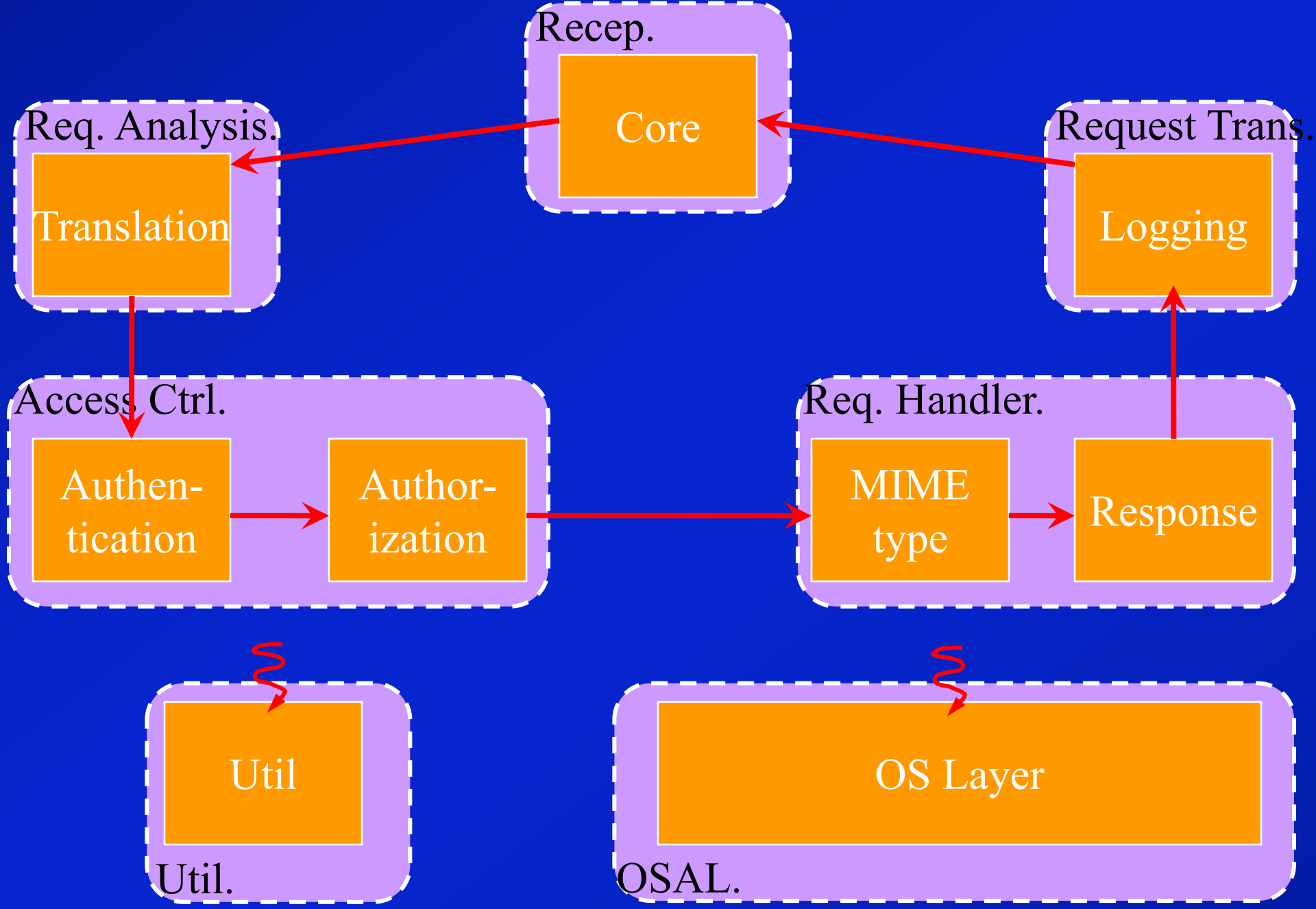


Web Server Reference Architecture


Reception
Request Analysis
Record Transaction
Access Control
Resource Handler
Util
Operating System Abstraction Layer
Web Server Reference Architecture
Control flow
All depend on

Mapping the Reference Architecture to a Web Server

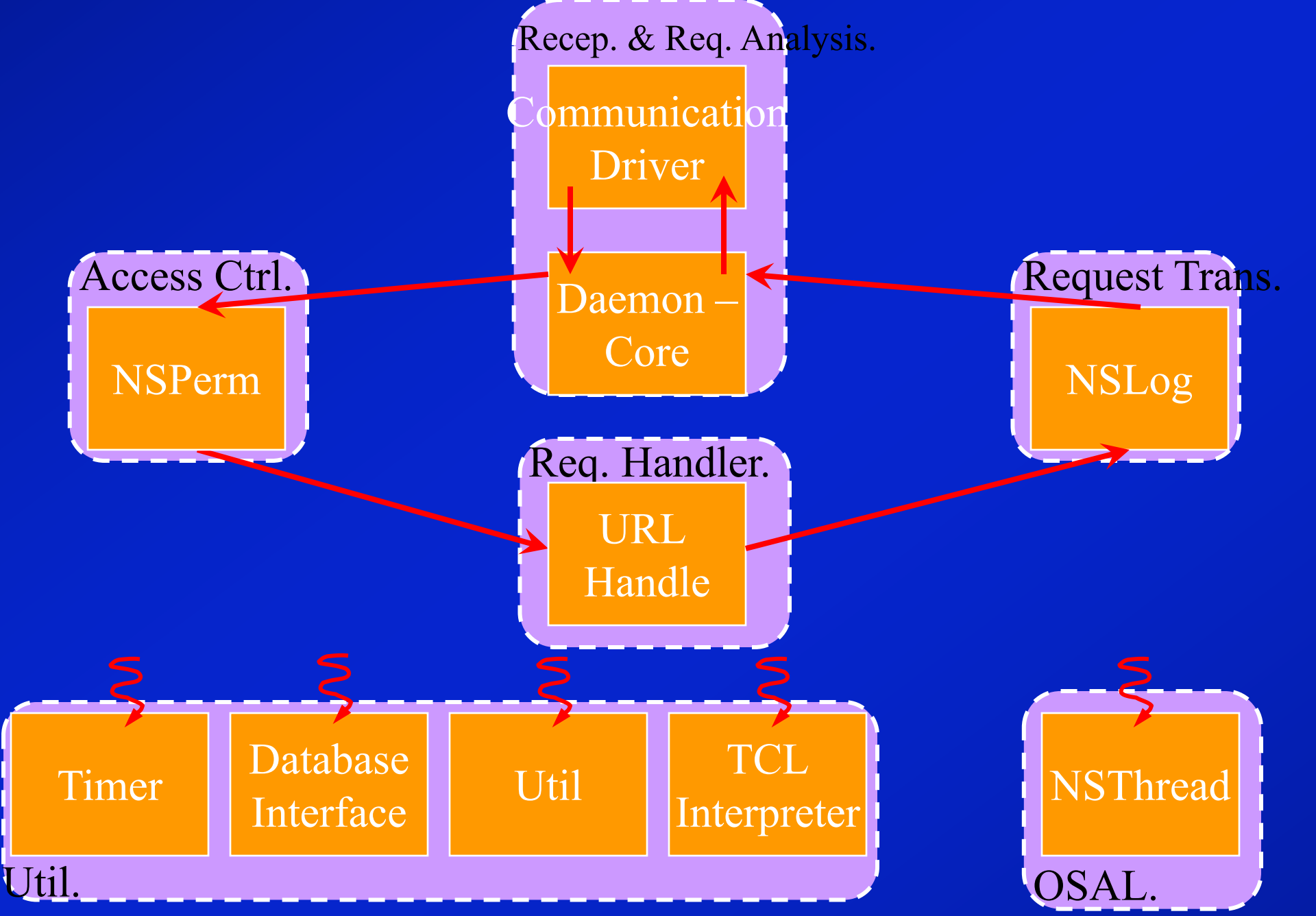
The Apache Web Server



Apache: A conceptual Architecture

Apache: Conceptual Architecture mapping

The AOL Web Server



AOLServer Conceptual Architecture mapping

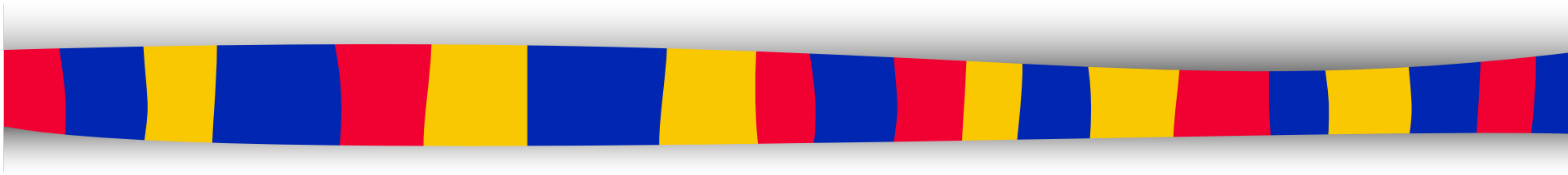
Mapping Summary

- 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

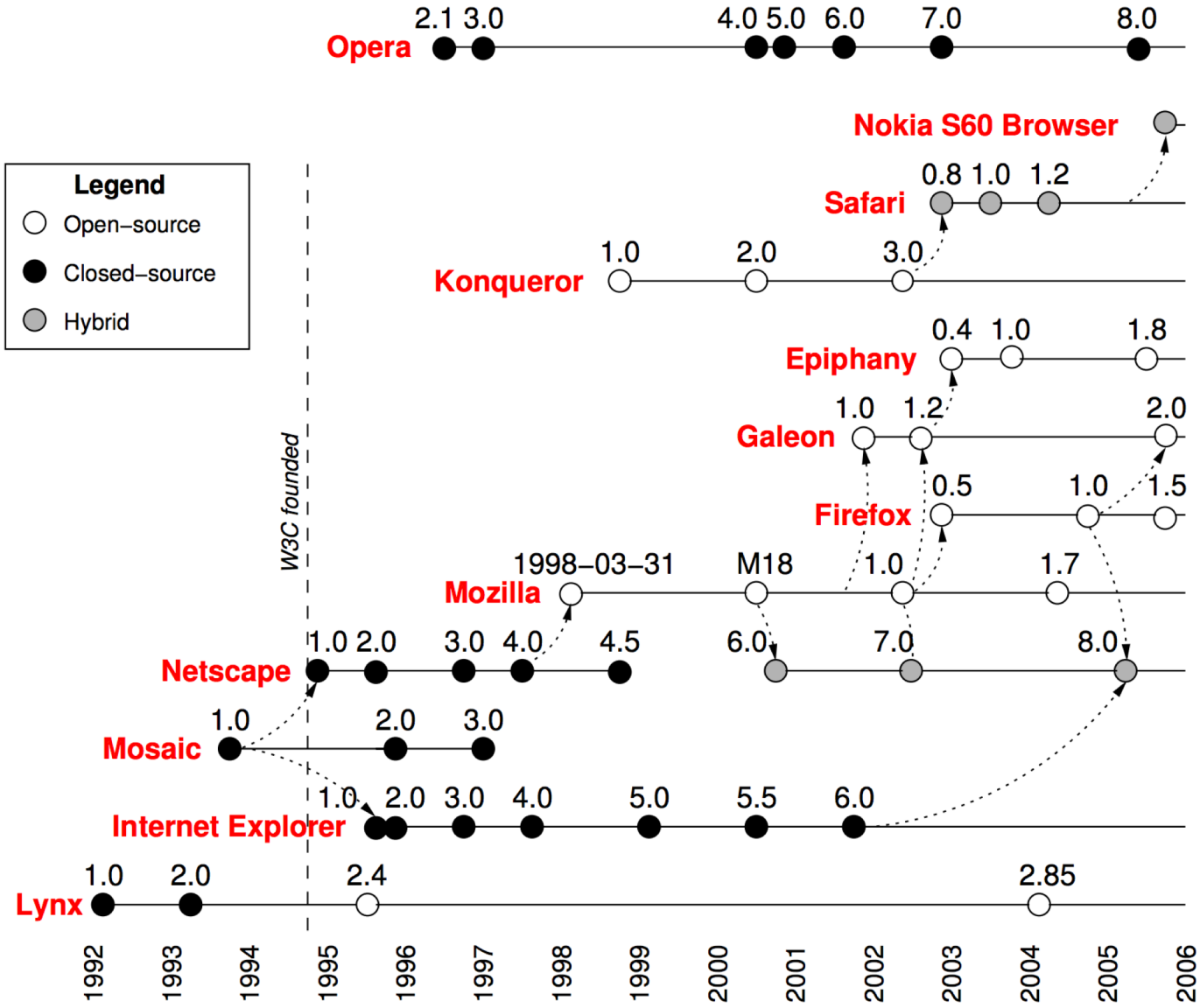
Reference Architectures for Web Browsers



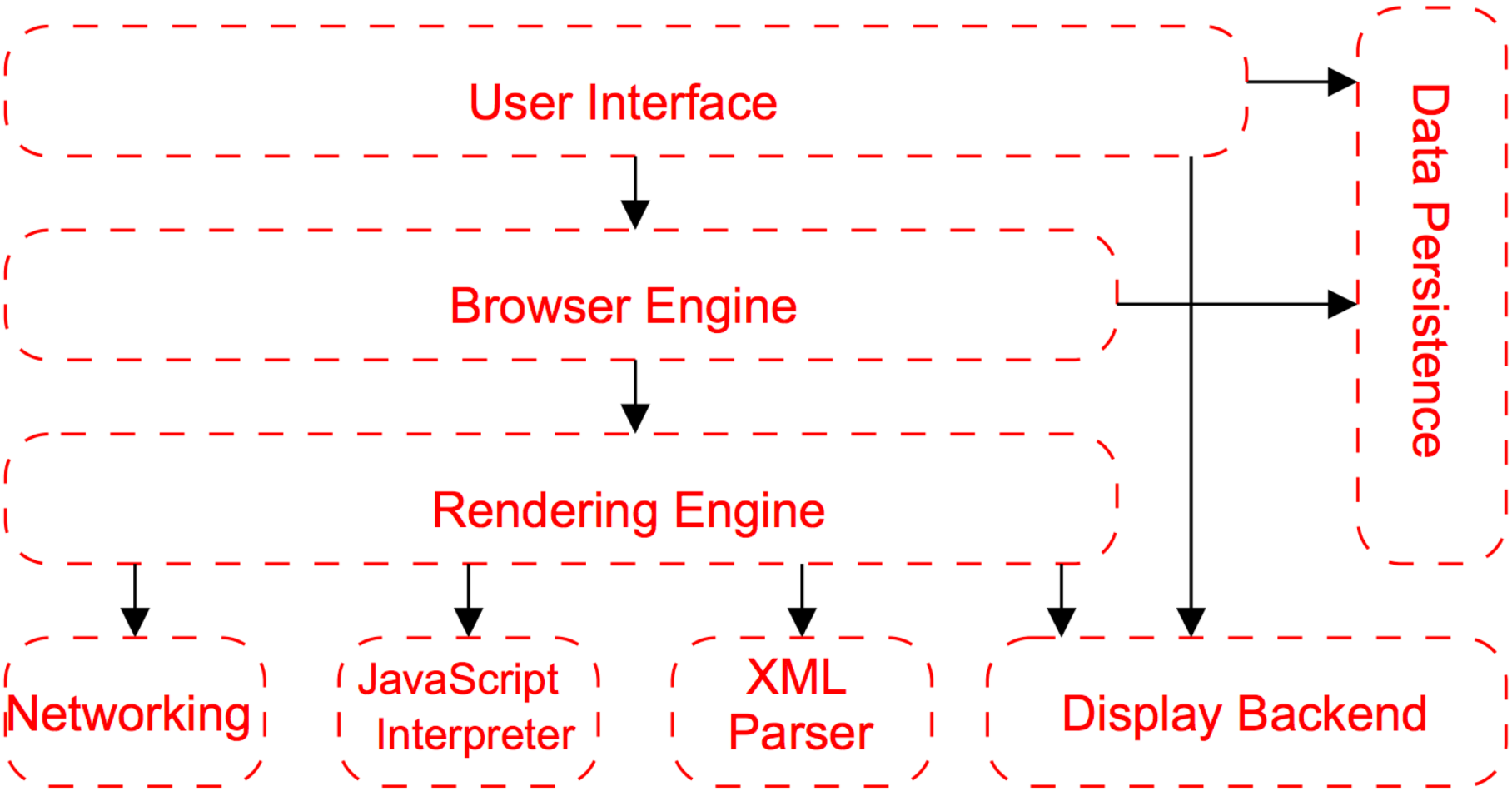
A Case Study in Architectural Analysis: The Evolution of the Modern Web Browser

Alan Grosskurth and Michael W. Godfrey

History of Web Browsers



Reference Architecture

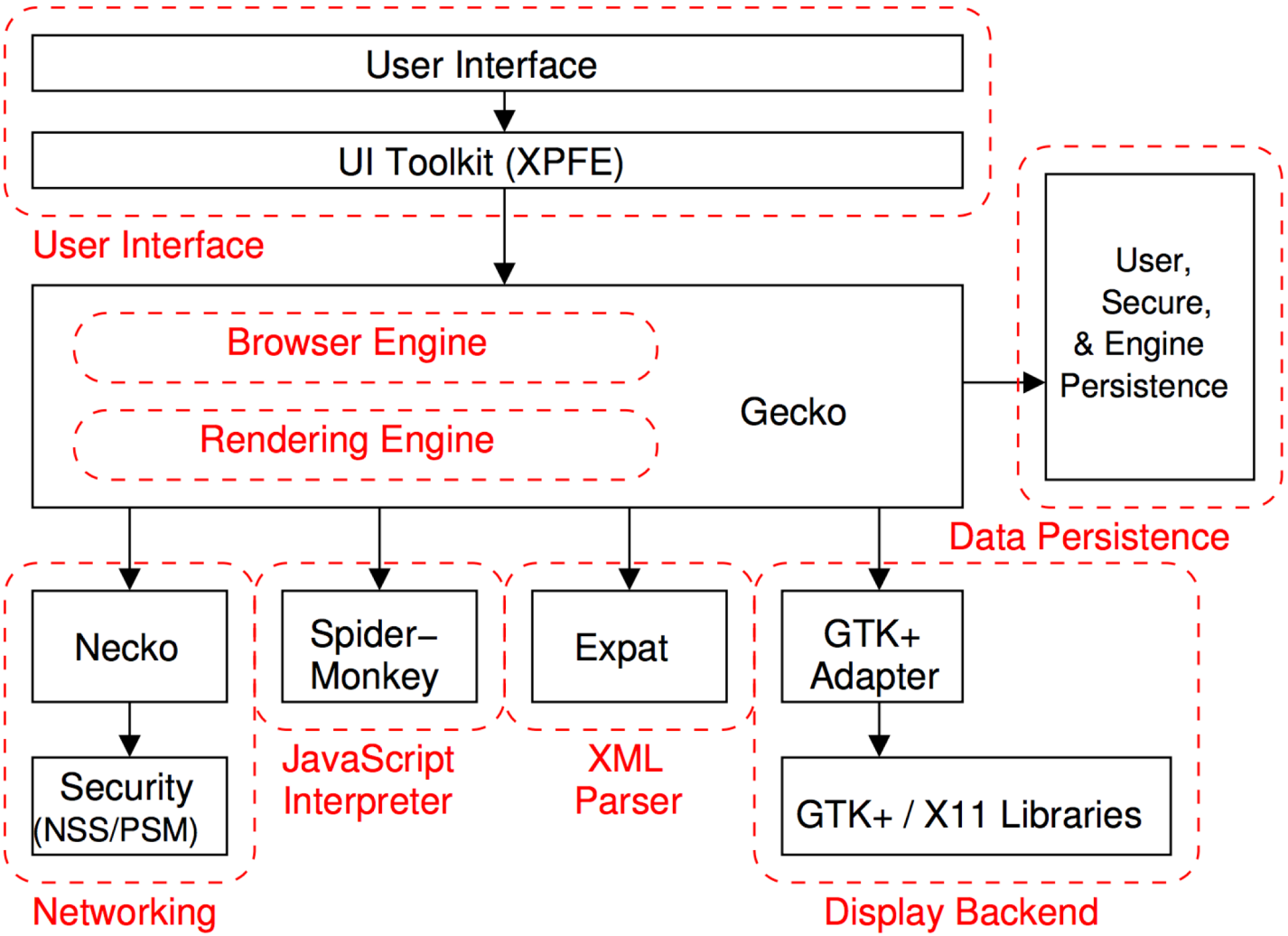


Studied Browsers

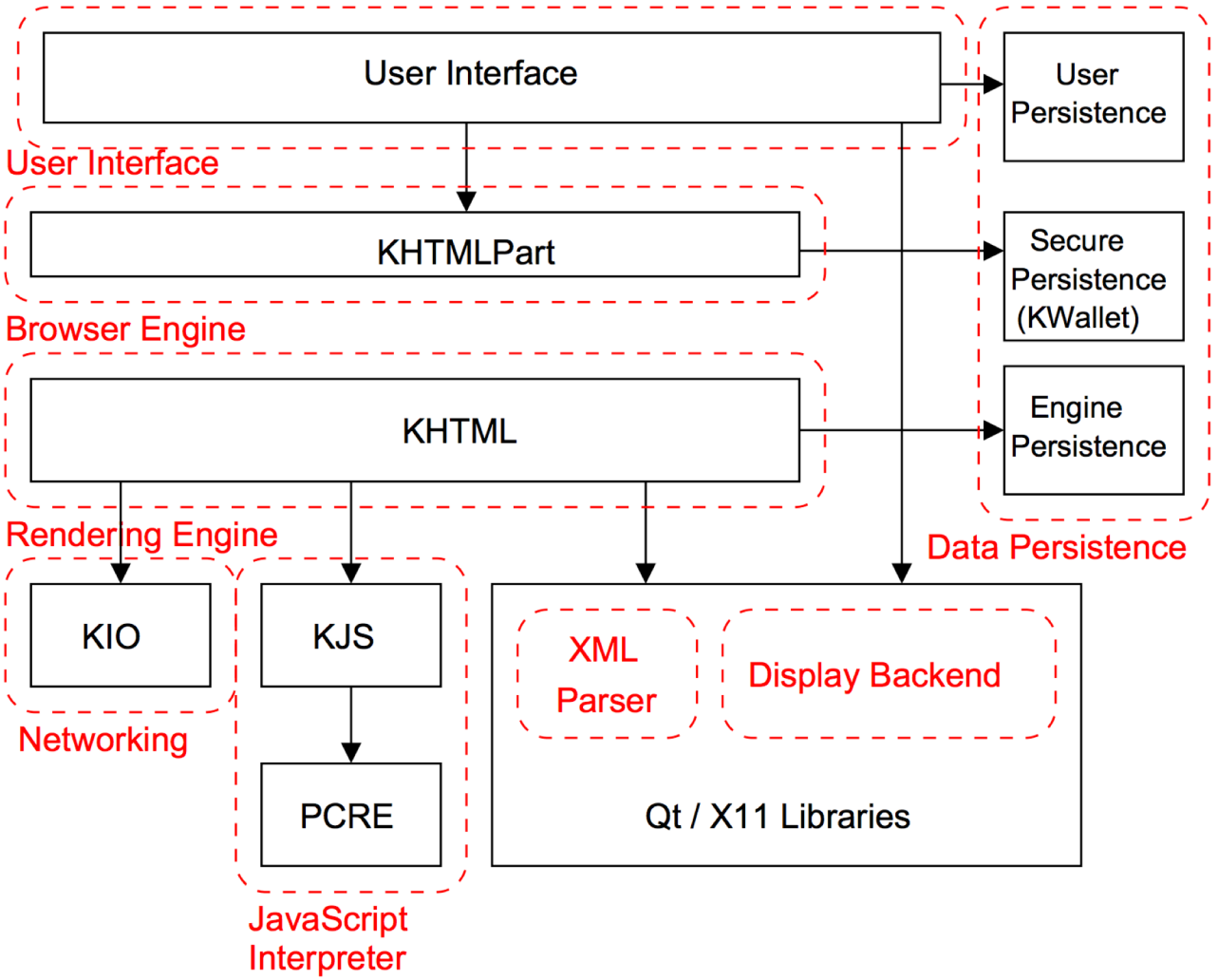
Table 1: Approximate web browser statistics

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

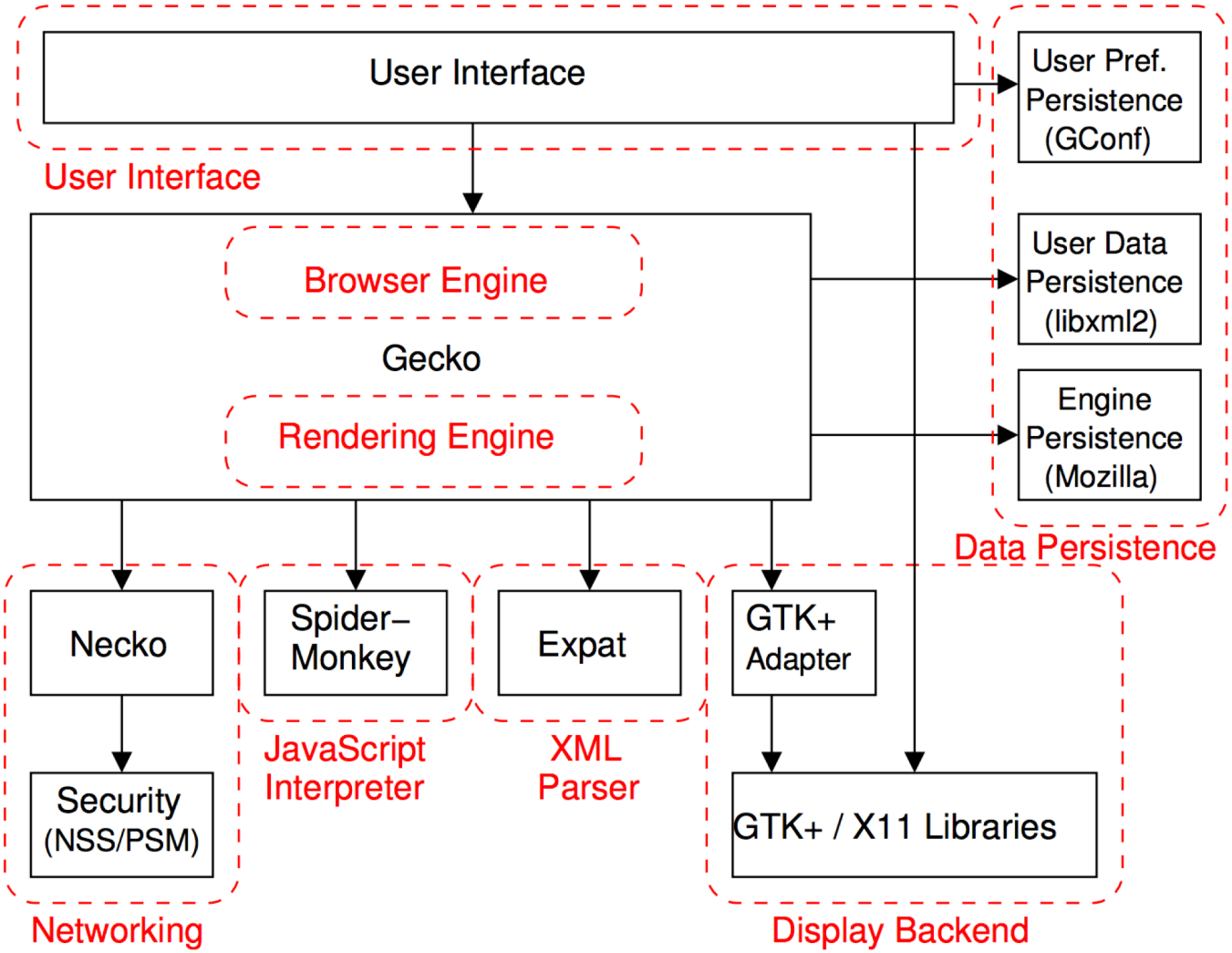
Mozilla


User Interface
UI Toolkit (XPFE)
User Interface
Browser Engine
Rendering Engine
Gecko
User, Secure, & Engine Persistence
Data Persistence
Necko
Security (NSS/PSM)
Networking
Spider–Monkey
JavaScript Interpreter
Expat
XML Parser
GTK+ Adapter
GTK+ / X11 Libraries
Display Backend

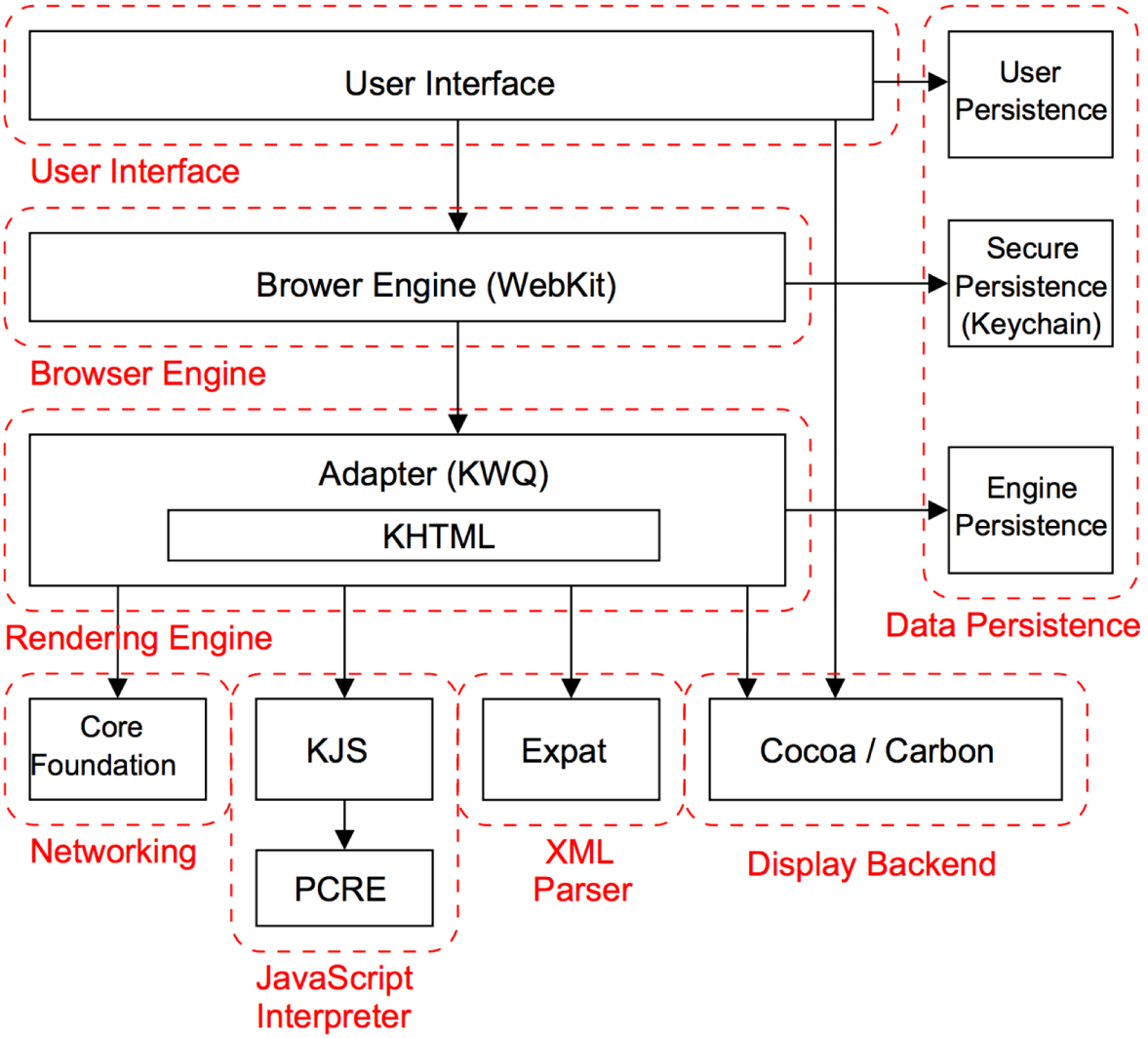
Konqueror


User Interface
User Persistence
User Interface
KHTMLPart
Secure Persistence (KWallet)
Browser Engine
KHTML
Engine Persistence
Rendering Engine
Data Persistence
KIO
KJS
XML Parser
Display Backend
Networking
PCRE
Qt / X11 Libraries
JavaScript Interpreter

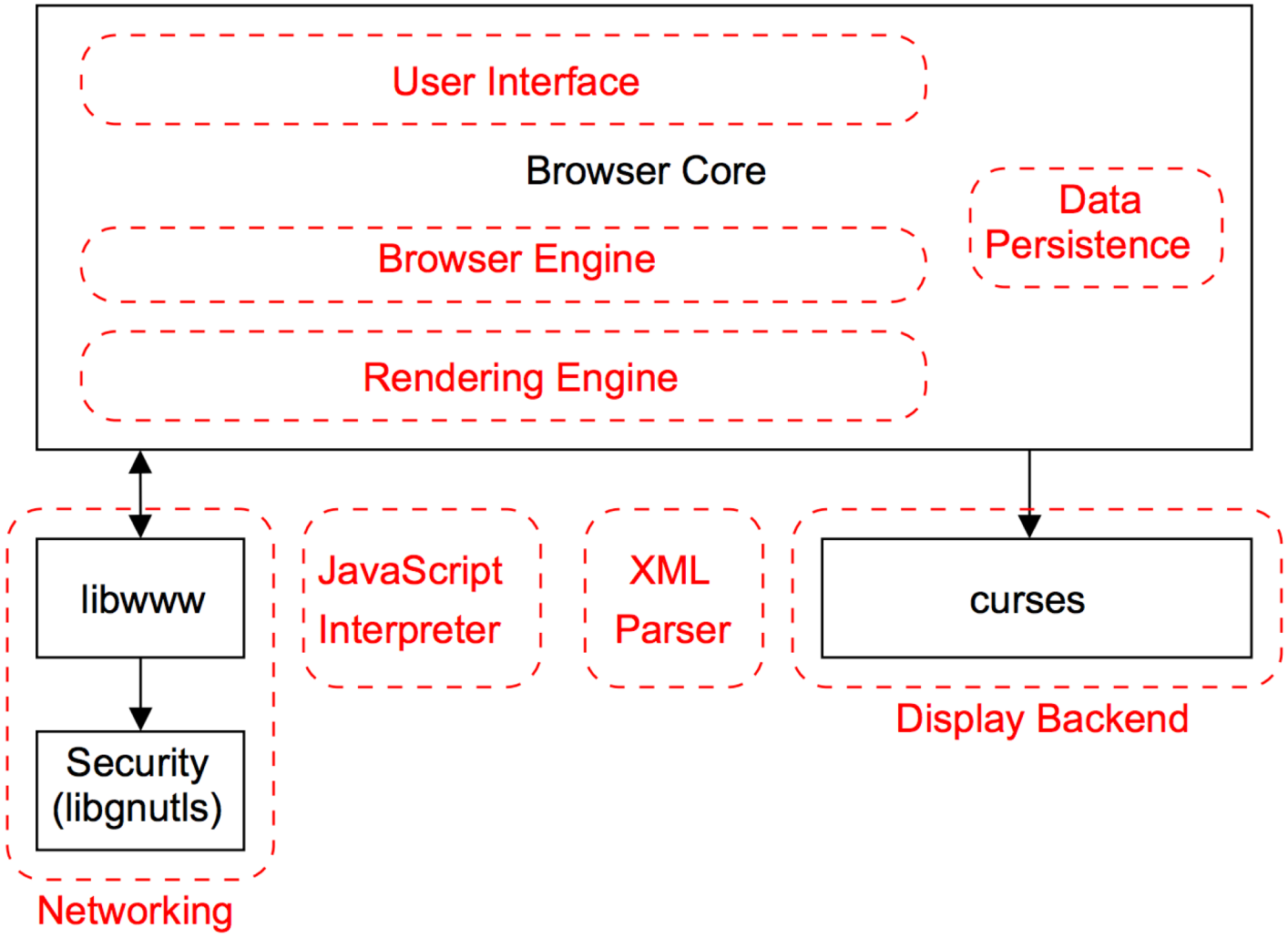
Epiphany


User Interface
User Interface
User Pref. Persistence (GConf)
User Data Persistence (libxml2)
Engine Persistence (Mozilla)
Data Persistence
Browser Engine
Gecko
Rendering Engine
Necko
Security (NSS/PSM)
Networking
Spider–Monkey
JavaScript Interpreter
Expat
XML Parser
GTK+ Adapter
GTK+ / X11 Libraries
Display Backend

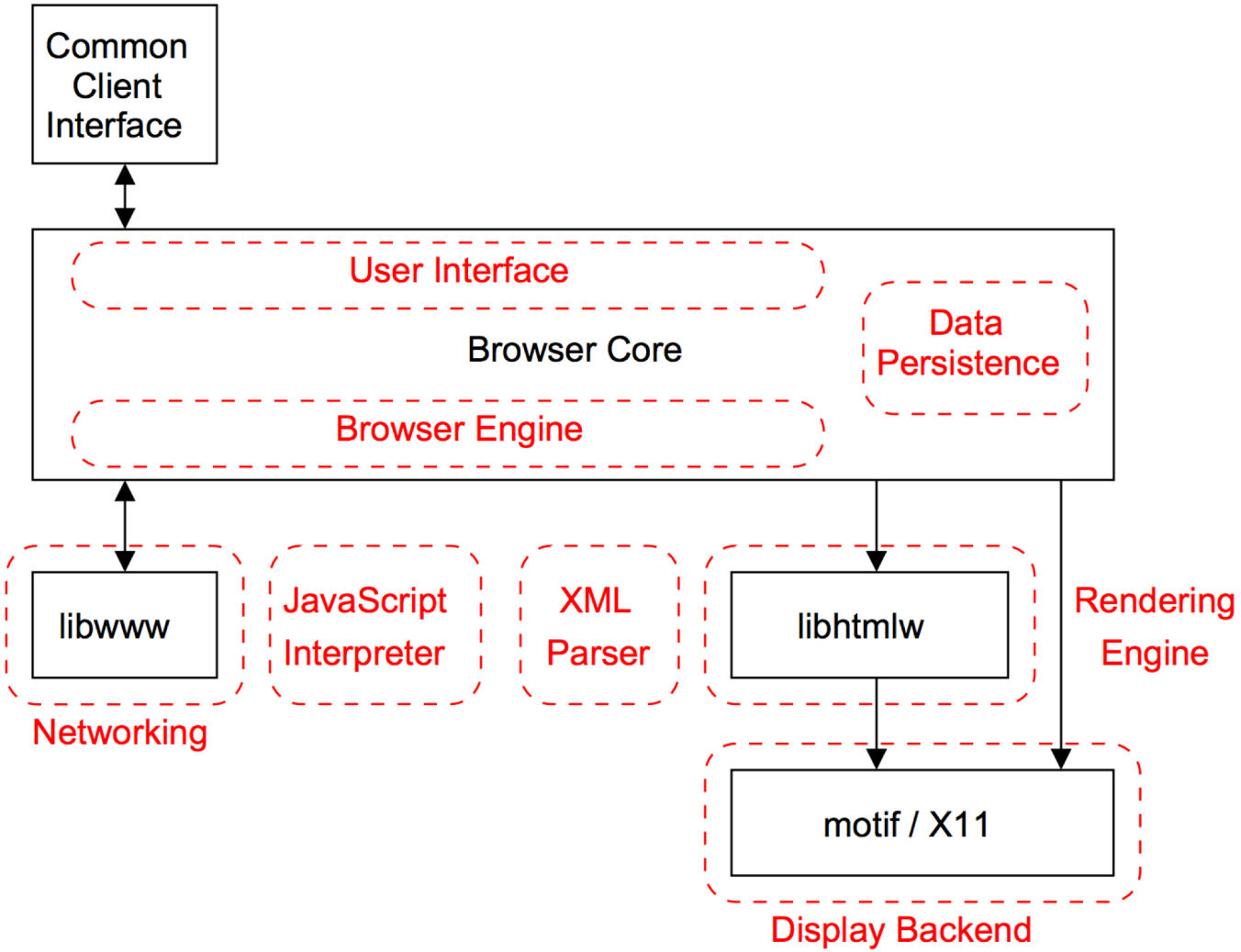
Safari


User Interface
User Persistence
User Interface
Brower Engine (WebKit)
Secure Persistence (Keychain)
Browser Engine
Adapter (KWQ)
KHTML
Engine Persistence
Rendering Engine
Data Persistence
Core Foundation
KJS
Expat
Cocoa / Carbon
Networking
PCRE
XML Parser
Display Backend
JavaScript Interpreter

Lynx


User Interface
Browser Core
Data Persistence
Browser Engine
Rendering Engine
libwww
Security (libgnutls)
Networking
JavaScript Interpreter
XML Parser
curses
Display Backend

Mosaic


Common Client Interface
User Interface
Browser Core
Data Persistence
Browser Engine
libwww
JavaScript Interpreter
XML Parser
libhtmlw
Rendering Engine
Networking
motif / X11
Display Backend