

Software Architecture in an Open Source World



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Disclaimers



- There is no single “Open Source” model
 - Projects range in scope from the miniscule
 - thousands of code dumps on SourceForge
 - student projects and system dissertations
 - failed commercial ventures
 - to the truly international
 - hundreds of developers
 - collaborating, directly or indirectly
 - on a common platform

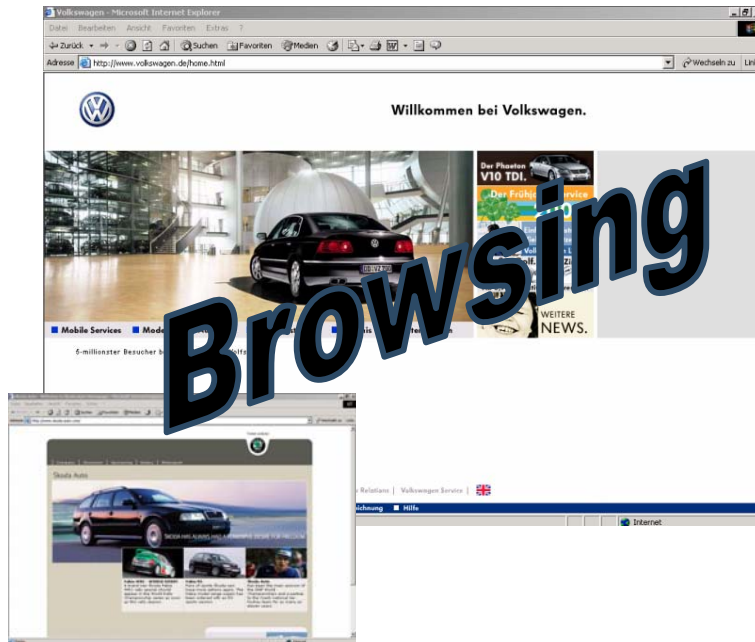
- I’ll focus on a subset of “Software Architecture”
 - Run-time architecture, not software structure
 - Realized architecture, not architectural descriptions
 - Principled design for desired properties

Example open source projects



- World Wide Web
 - URI schemes, HTTP methods, media types
- Linux
 - kernel modules
- Apache httpd
 - feature modules, modular process models, I/O filters
- Mozilla Firefox
 - extensions, themes, XUL, CSS
- Eclipse
 - an architecture of plug-ins

World Wide Web Perspectives



Browsing



Web Protocol Extensibility



Uniform Resource Identifiers

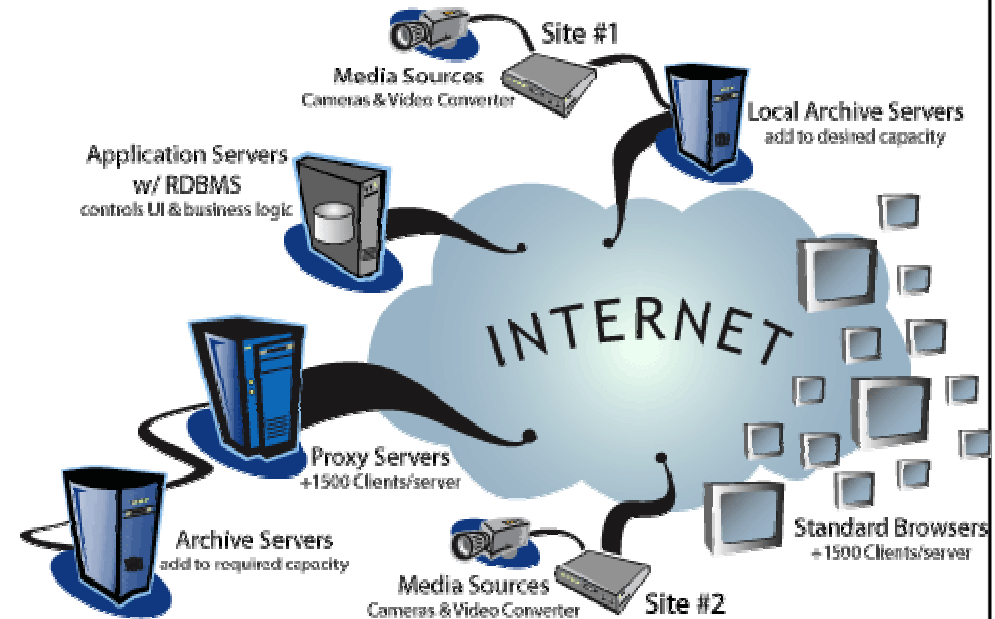
- schemes
- hierarchical delegation

HTTP

- versions
- methods
- header fields

Media types

- HTML
- XML



Linux Kernel Modules

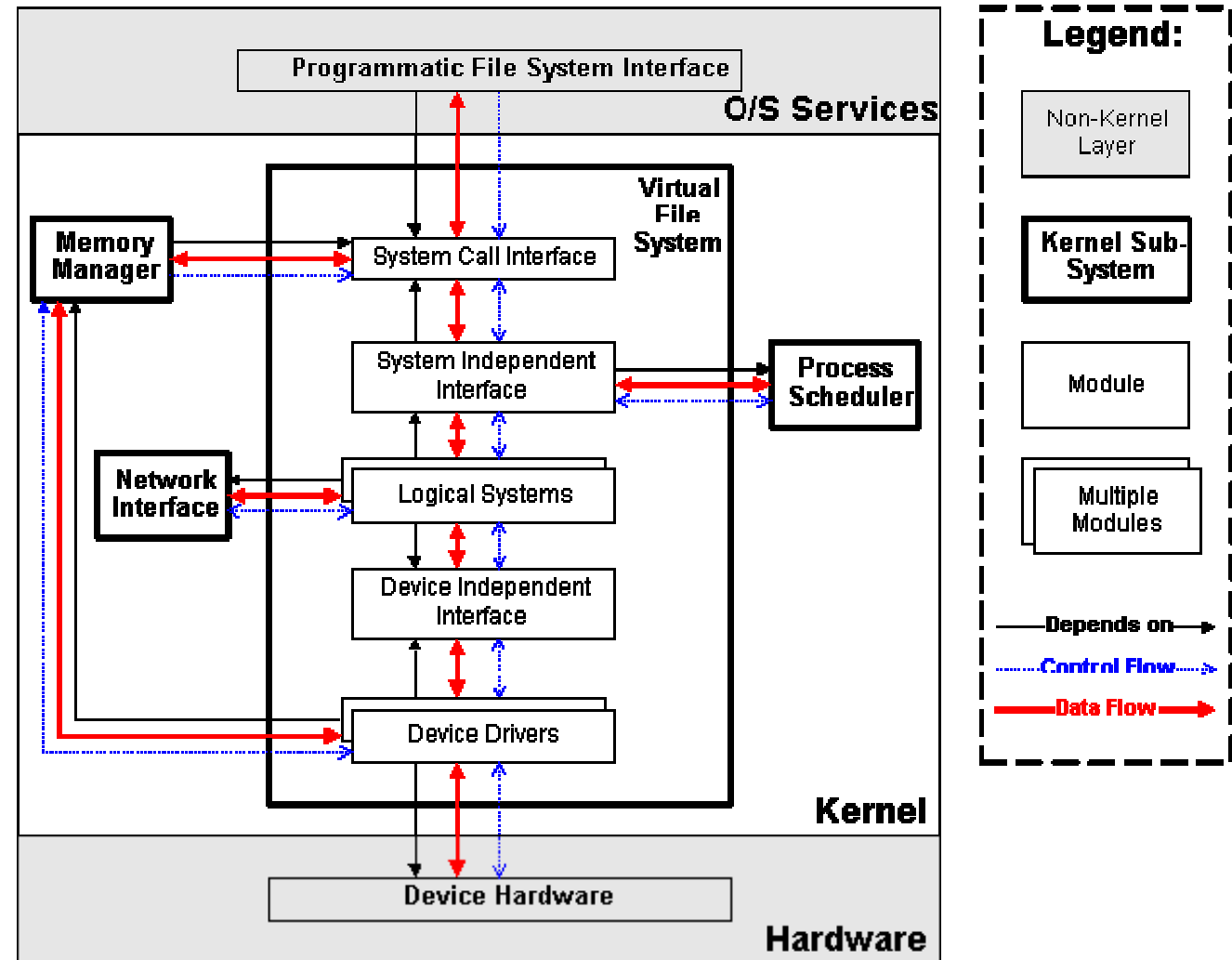


Modules

- simplify core
- enable independent development
- promote experiments

Project improves

- reduced friction
- anarchic growth
- more features
- less communication



[diagram from Ivan T. Bowman, 1998]

Apache httpd



- Started with NCSA httpd 1.3
 - Simple, easy to compile on many legacy platforms
 - Limited extensibility via CGI
- Improved security, features, and performance
 - Virtual hosts
 - Pre-forking (adaptive hunt-group) model
- 0.8: re-architected for extensibility (Shambhala)
 - Modular API for features (hook and ladder design)
 - Pools for memory allocation (robustness)
- 2.0: architecture enhanced for more extensibility
 - Modular Process Model (pre-fork, multithreaded, win32, ...)
 - I/O filters and protocol modules

Apache httpd: modules

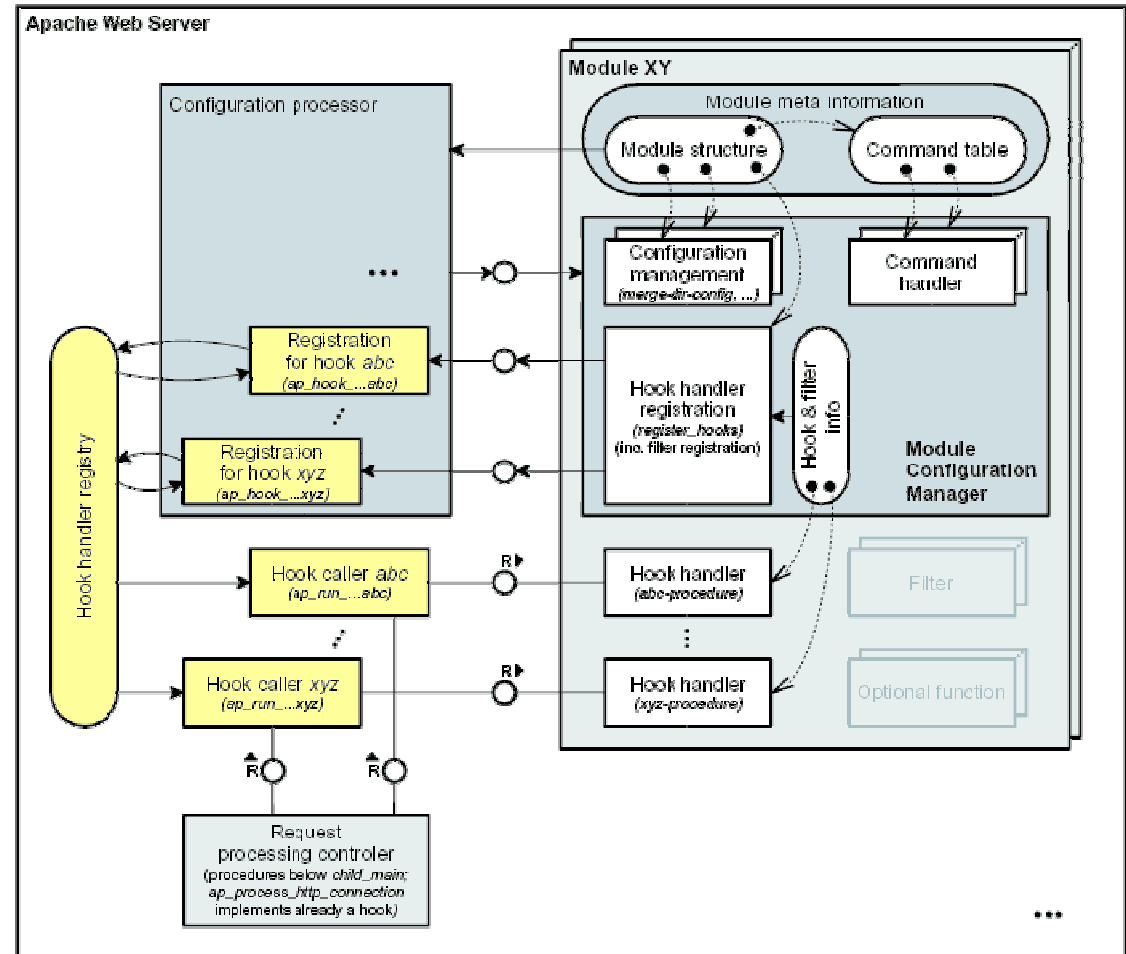


Modules

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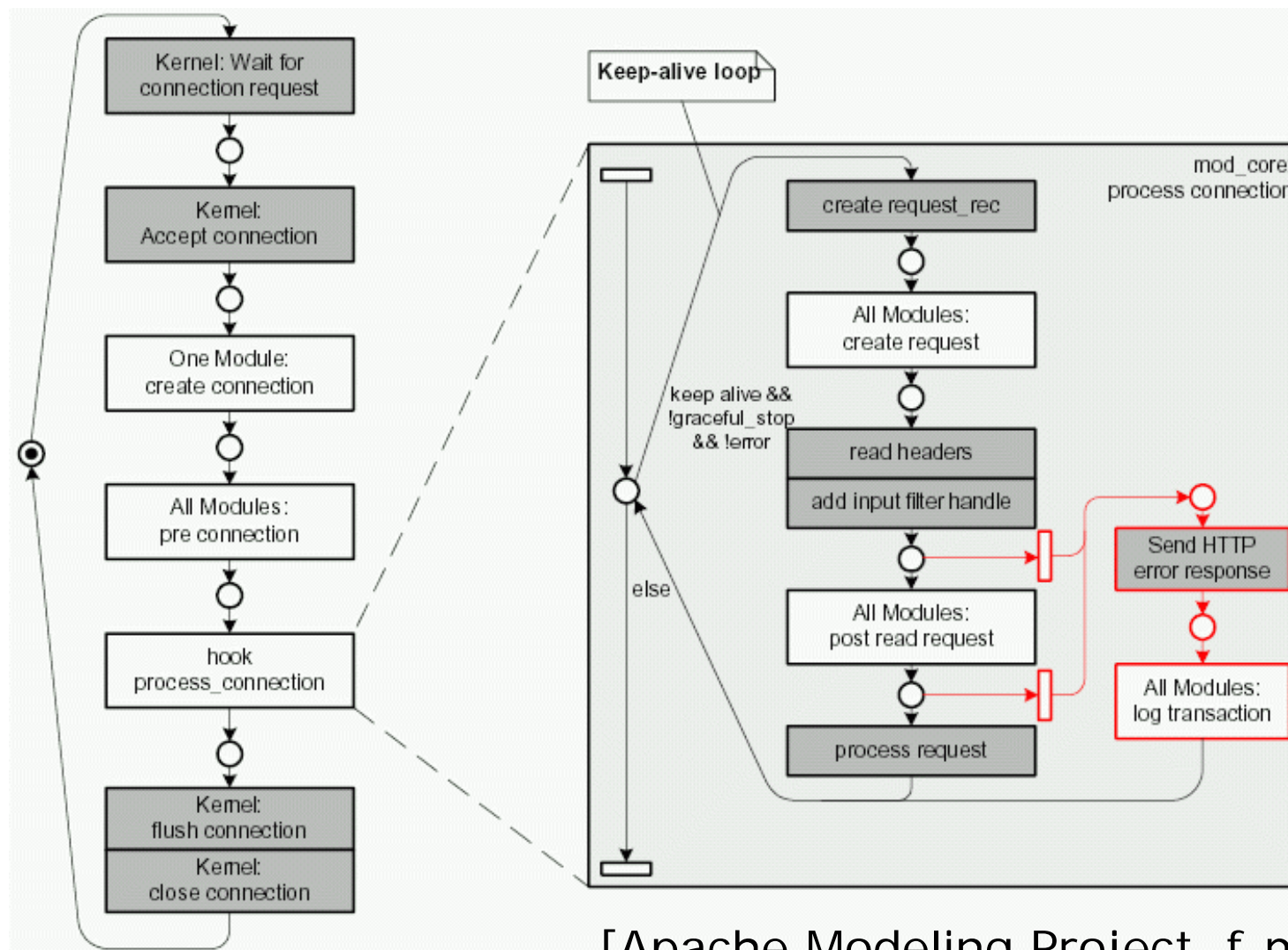
- reduced friction
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Agent/Storage definition is generated by processing the C-MACROs
`AP_DECLARE_HOOK`, `APR_IMPLEMENT_HOOK_{VOID|RUN_FIRST|RUN_ALL}`, `APR_HOOK_STRUCT` & `APR_HOOK_LINK`

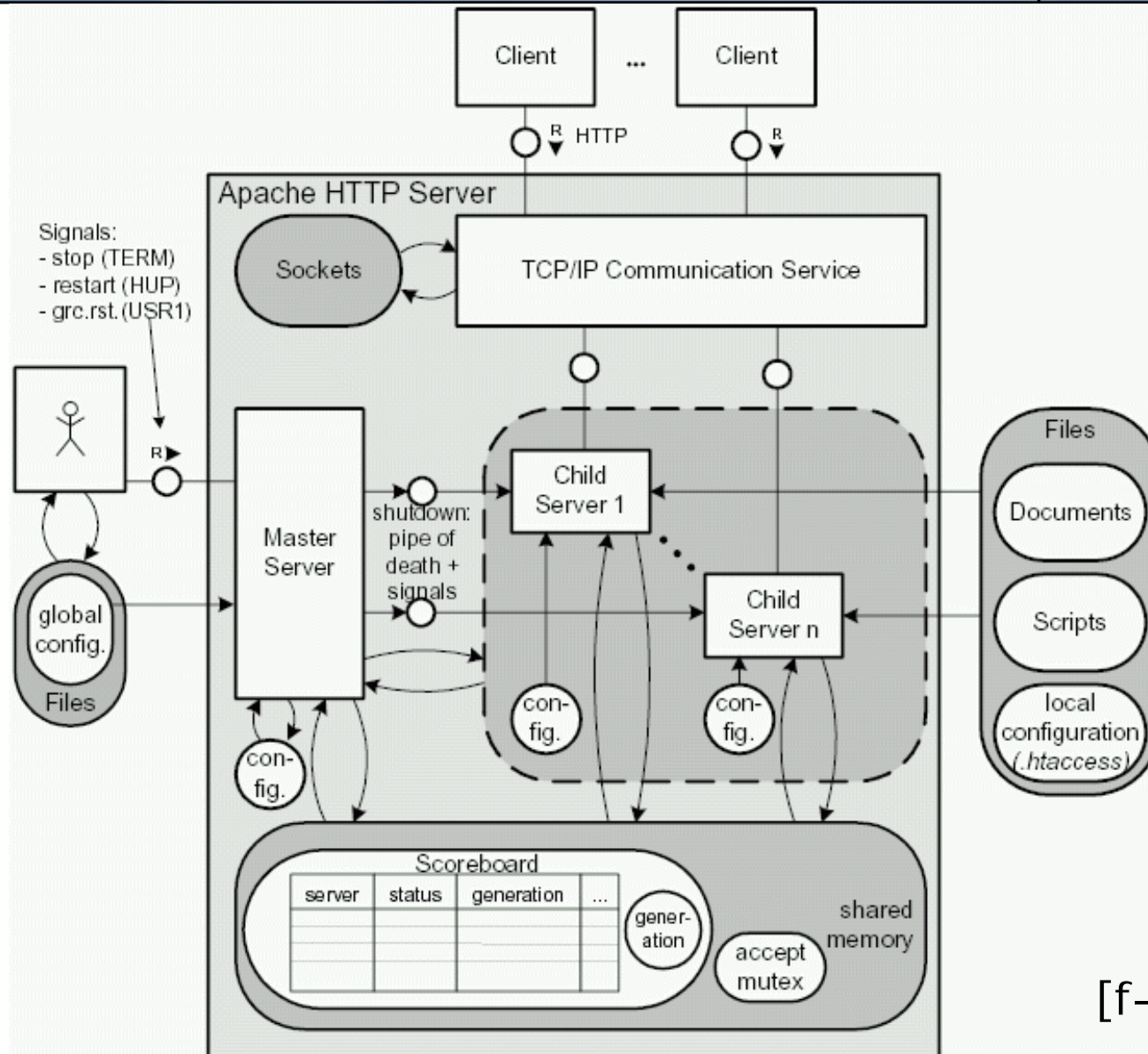
[Apache Modeling Project, f-m-c.org]

Apache httpd: kernel



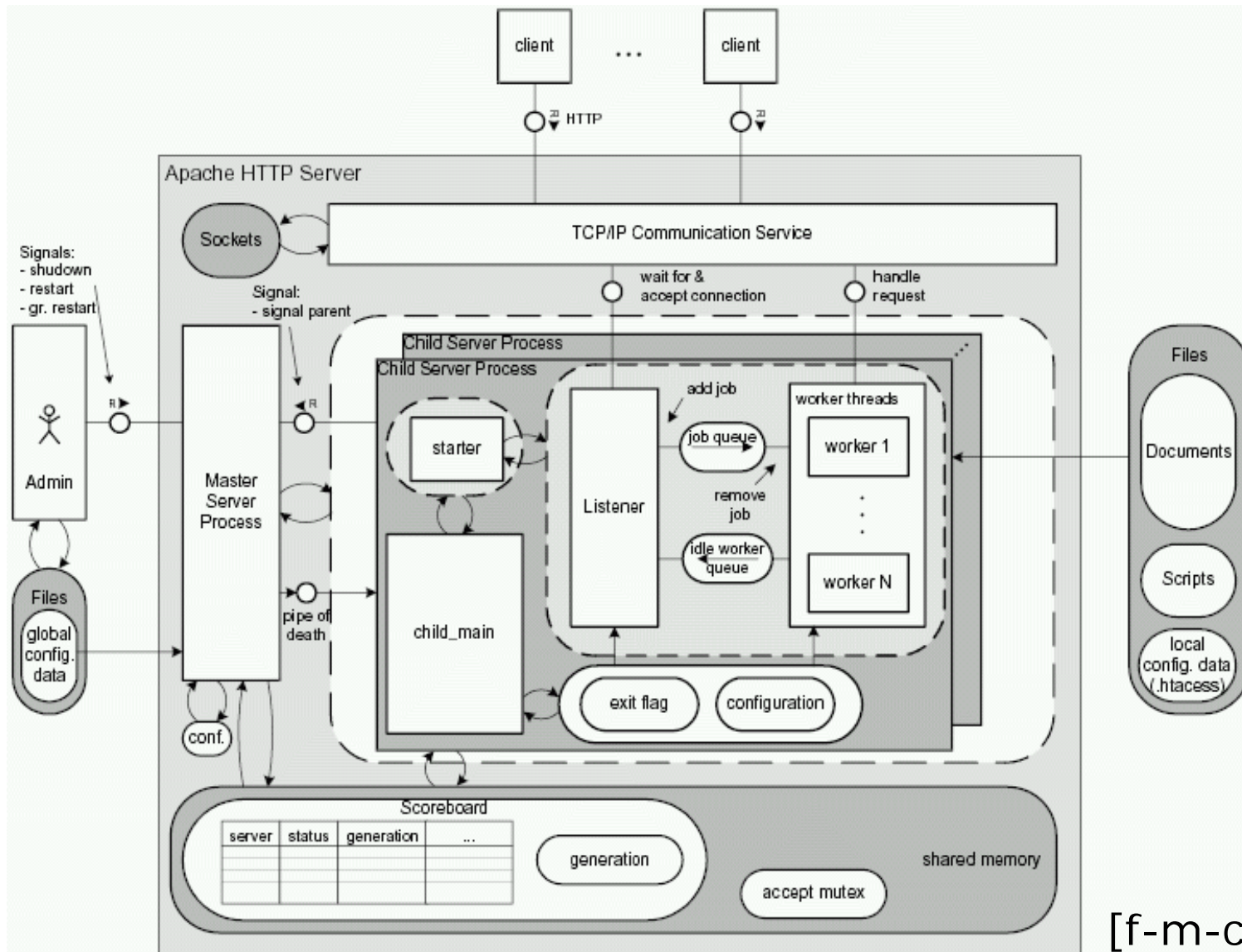
[Apache Modeling Project, f-m-c.org]

Apache httpd: preforking MPM



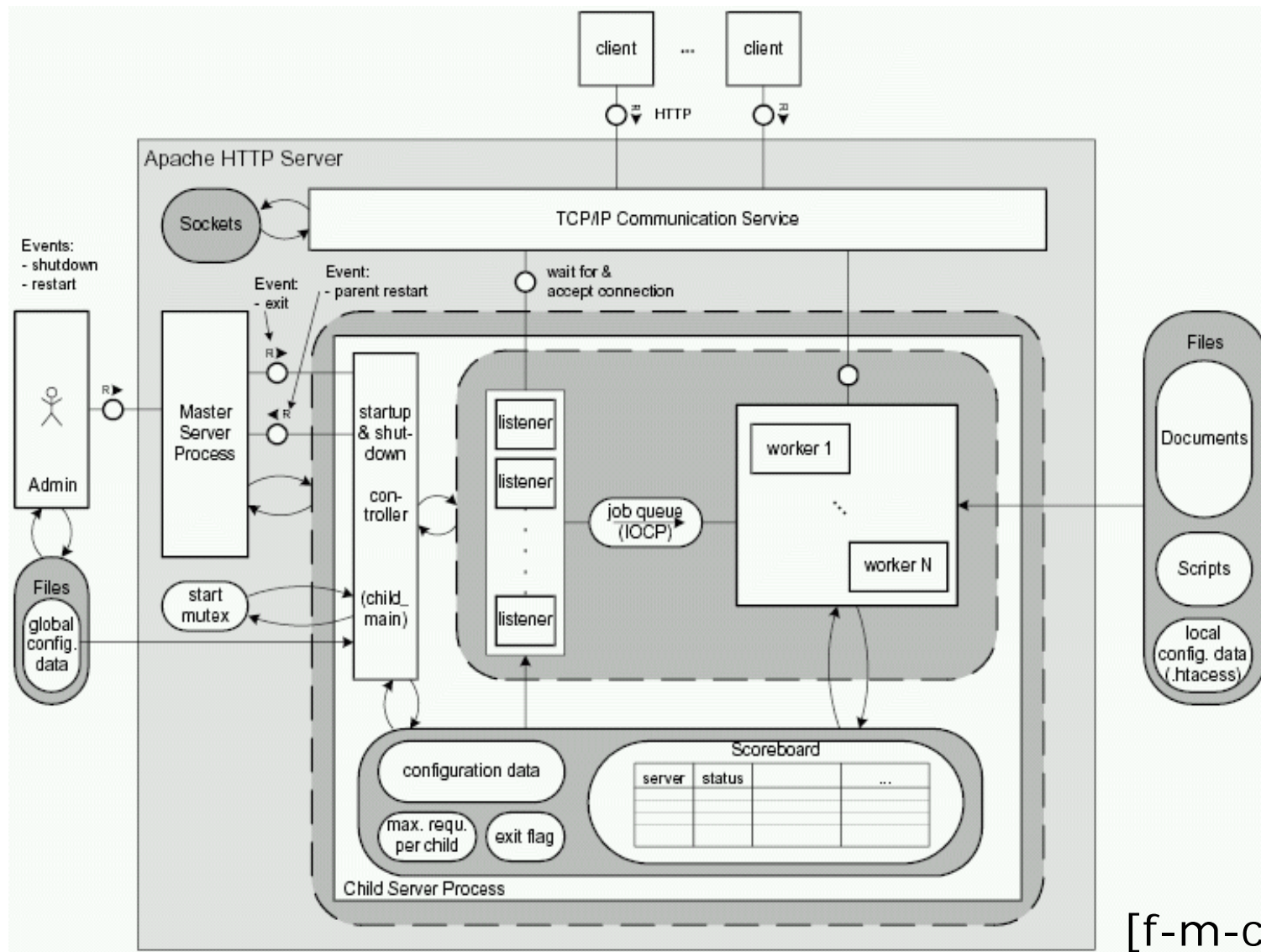
[f-m-c.org]

Apache httpd: worker MPM



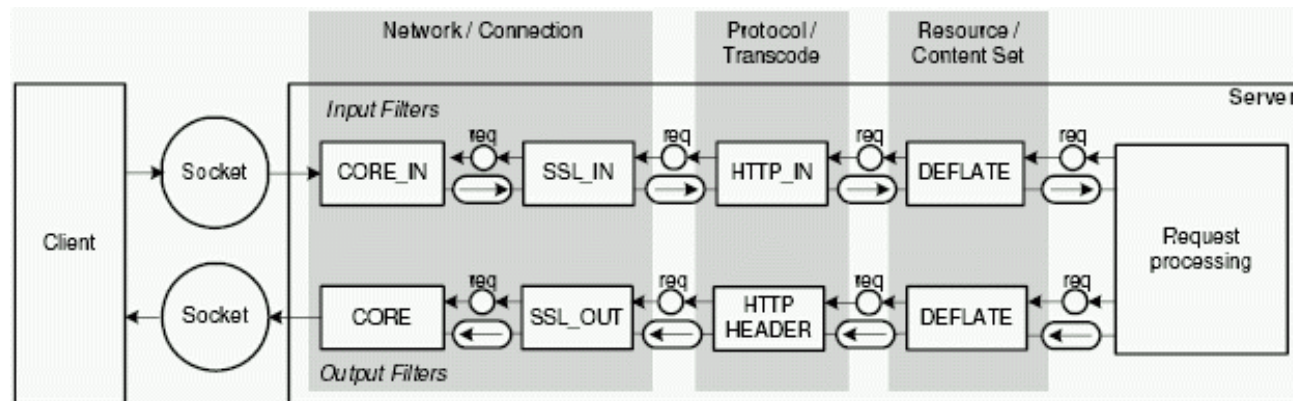
[f-m-c.org]

Apache httpd: winnt MPM



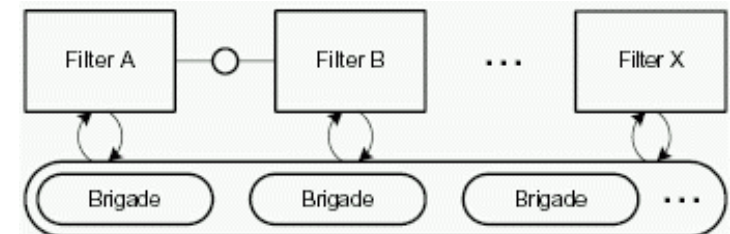
[f-m-c.org]

Apache httpd: I/O filters



Filters provide more extensibility

- protocol replacement
 - httpd, ftpd, nntpd, ...
- stackable content manipulation
 - extensions that can extend other extensions



[Apache Modeling Project, f-m-c.org]

Mozilla Firefox



Multiplatform

Standards
Compliant

Lightweight

Community
Supported

Firefox - Rediscover the web

http://www.mozilla.org/products/firefox/

search mozilla: Go

Products Support Store Developers About

Firefox
rediscover the web

The Firefox Preview Release empowers you to browse faster, more safely, and more efficiently than with any other browser. Join more than **6 million** others and [make the switch today](#)—Firefox imports your Favorites, settings and other information, so you have nothing to lose.

Free Download
for MacOS X, English (8.4MB)

Or, get the **Firefox CD & Guidebook** from the Mozilla Store.

- Other Systems and Languages
- System Requirements
- Release Notes
- Spread the Word

Why Use Firefox?

"**Beware of spyware. If you can, use the Firefox browser.**" - USA Today

"**Better than Internet Explorer by leaps and bounds.**" - FORBES

Popup Blocking
Stop annoying popup ads in their tracks with Firefox's built in popup blocker.

Tabbed Browsing

Support Our Work

You can support our work on Firefox and other projects and get some sweet stuff in return. [Make a donation](#) or [buy a Firefox shirt](#) at the Mozilla Store. Or [donate to the Firefox Outreach program](#)

The New York Times
Firefox 1.0 Released!

Done

Firefox: User-friendly



Tabbed Browsing



Integrated Search

Live Bookmarks

RSS/XML Feeds

UI Themes

Firefox: Developer-friendly



Open Source

Extensible
Architecture

Plug-in Tools

Layered CSS

Editor Platform

The screenshot shows the Firefox browser window displaying the Mozilla website. The address bar shows the URL `http://www.mozilla.org/products/firefox/`. The browser interface includes a search bar, navigation buttons (Products, Support, Store, Developers, About), and a main content area with a "Free Download" button for Firefox on MacOS X. A sidebar on the left shows a CSS editor with the following code:

```

/* mozilla.org Cavendish Template
Styles
* Initial Design by Daniel Burka
and Steven Garrity
*/

/* Basic Structure */
body {
    background: #fff
url("../images/body_back.gif")
repeat-x;
}

/* Header */
#header {
    background:
#455372
url("../images/header_b1.png")
bottom left repeat-x;
position:
relative;
min-height: 39px;
height: 5em;
padding: 0;
voice-family:
"\}\}\\"";
voice-family:
inherit;
height: 3em;
padding: 15px 0;
} #ignored {}

#header_b1 /

```

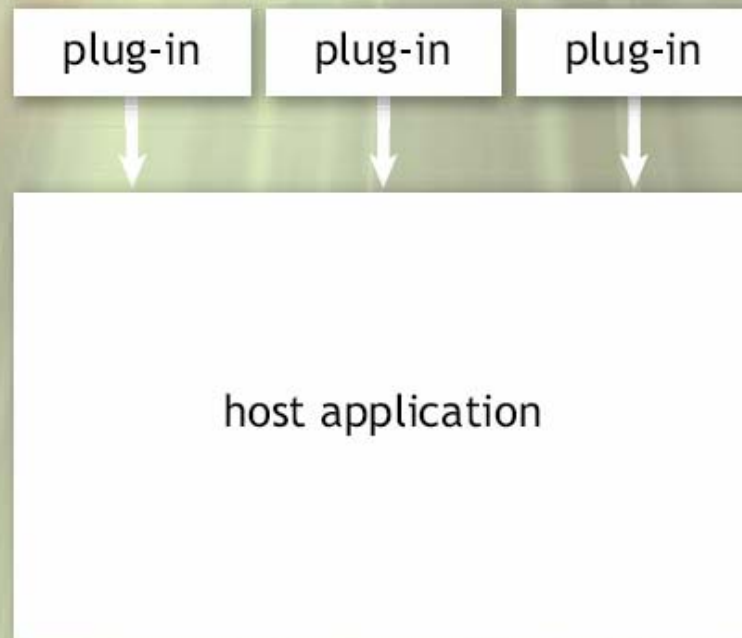
The main content area of the website features the Mozilla logo, a search bar, and a "Free Download" button for Firefox on MacOS X (8.4MB). Below this, there is a section titled "Why Use Firefox?" with a quote: "Beware of spyware. If you can, use the Firefox browser." - USA Today. Another quote reads: "Better than Internet Explorer by leaps and bounds." The "Support Our Work" section includes a link to "The New York Times" article about Firefox 1.0.

Eclipse Platform

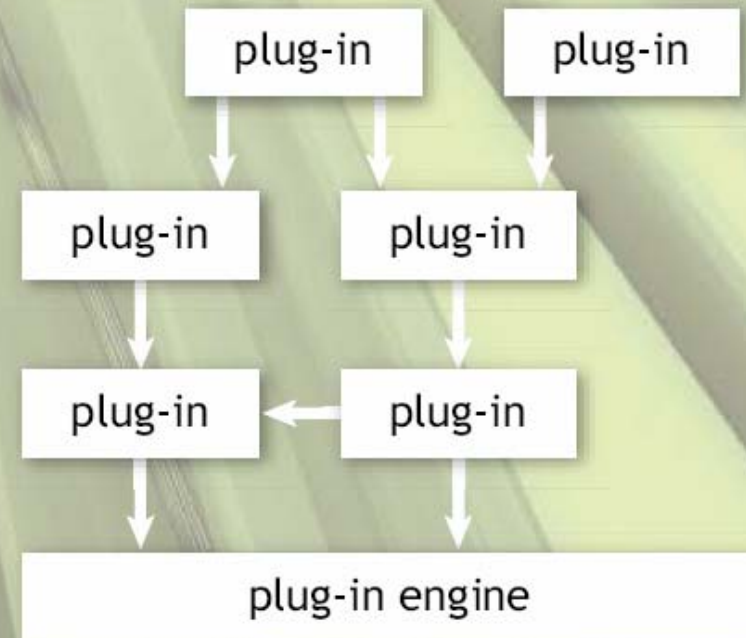


Taking modular extensibility to the next level

Traditional Plug-ins vs. Pure Plug-ins



traditional plug-ins



pure plug-in system

[Birsan, *ACM Queue*, Mar 2005]

Eclipse Platform



Unit Tester - Eclipse Platform

File Edit Navigate Search Project Run AppPerfect Window Help

Unit Tester

Summary

Code Coverage

Source Files

- net.percederberg.mi
- net.percederberg.mi
- net.percederberg.mi
- net.percederberg.mi
- net.percederberg.mi
- net.percederberg.mi

Developers

- No Author
- Per Cederberg, <per
- Watsh Rajneesh

Exceptions

- java.io.FileNotFoundException
- java.lang.IllegalArgu
- java.lang.NullPointer

Assertion Failures

Execution Summary

Summary of	Successful	Failed	Executed	Total
Packages	17% (1)	83% (5)	100% (6)	6
Source Classes	62% (42)	38% (26)	100% (68)	68
Test Classes	62% (42)	38% (26)	100% (68)	68
Test Cases	55% (370)	45% (303)	100% (673)	673
Lines covered			51% (3546)	6934

Executing Test Case : testValueReference2

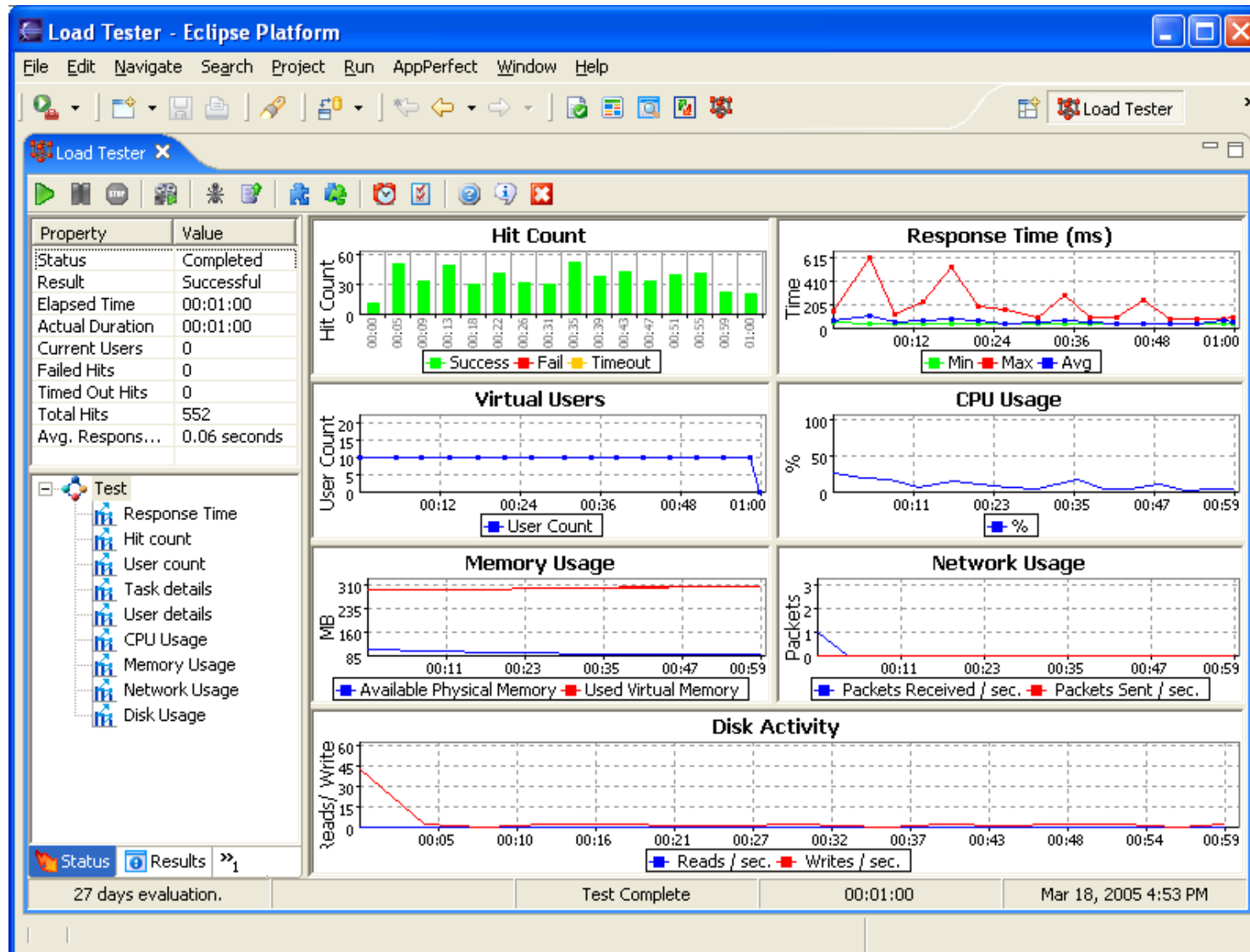
Input:

Results >>2

Console Messages

24 days evaluation. Test Completed 00:00:17 Mar 21, 2005 6:52 PM

Eclipse Platform



An open source world



- Most proprietary software projects depend on at least one open source component
 - Internet (bind, httpd, browsers)
 - XML (Xerces, Xalan, Saxon)
 - Scripting (Bash, Perl, Python, Ruby, TCL, Rhino)
 - Security (GPG, OpenSSL, MD5, SHA*)

- And those dependencies are growing
 - Apache Derby (embedded database)
 - Apache Jackrabbit (content repository API)
 - Apache Geronimo (J2EE)
 - Apache Harmony (JVM)
 - Sun OpenSolaris

Why is this important?



- Because innovation doesn't just "happen"
 - Innovation requires leadership
 - Innovation occurs in spurts
 - Innovation depends on deployment
 - Innovation is aided by extensible architectures
- Because open source is taking the lead
 - Open source encourages collaboration
 - Collaboration is simplified through extensibility
 - Extensibility allows us to stand on the shoulders of giants
- Because it makes Software Research easier!
 - Shared platforms reduce the overhead of systems work

Architecture of Participation



- What is common to the largest and most successful open source projects?
 - a software architecture
 - designed to promote anarchic collaboration
 - through extensions
 - while preserving control over the core interfaces
- Collaborative open source development
 - emphasizes community
 - takes advantage of the scalability obtainable through Internet-based virtual organizations
 - adapts to the volunteer nature of developers
- Architecture by design (not a natural byproduct)