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

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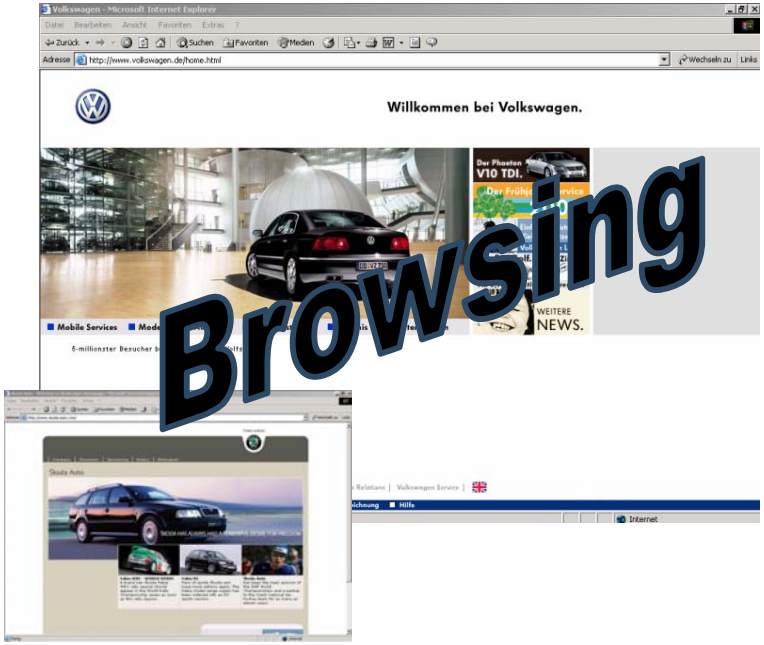
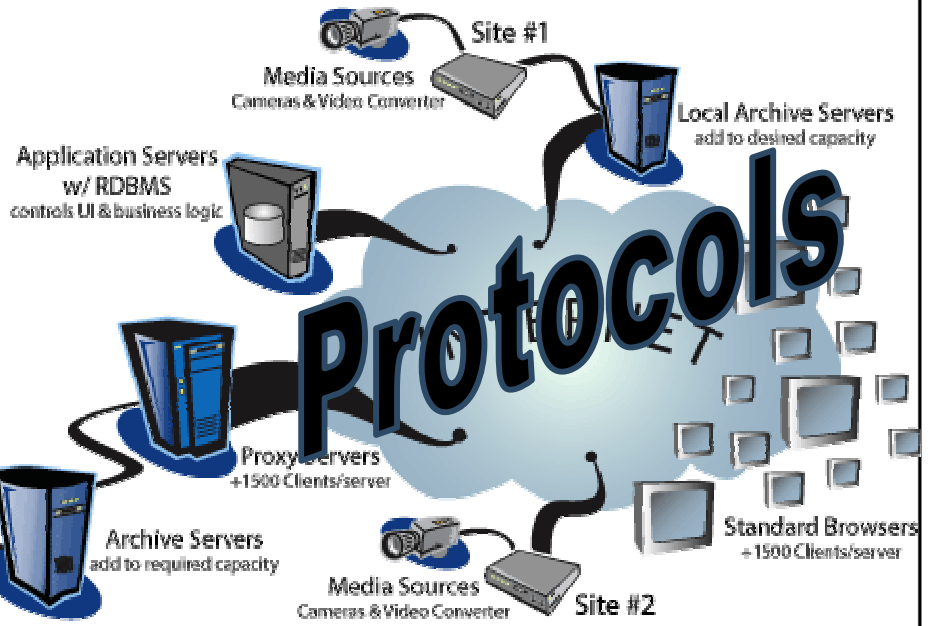
- World Wide Web
  - URI schemes, HTTP methods, media types
- Linux
  - kernel modules
- Apache httpd
  - feature modules, modular process models, I/O filters
- Mozilla Firefox
  - extensions, themes, XUL, CSS
- Eclipse
  - an architecture of plug-ins

World Wide Web Perspectives

Day





Web Protocol Extensibility

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Uniform Resource Identifiers

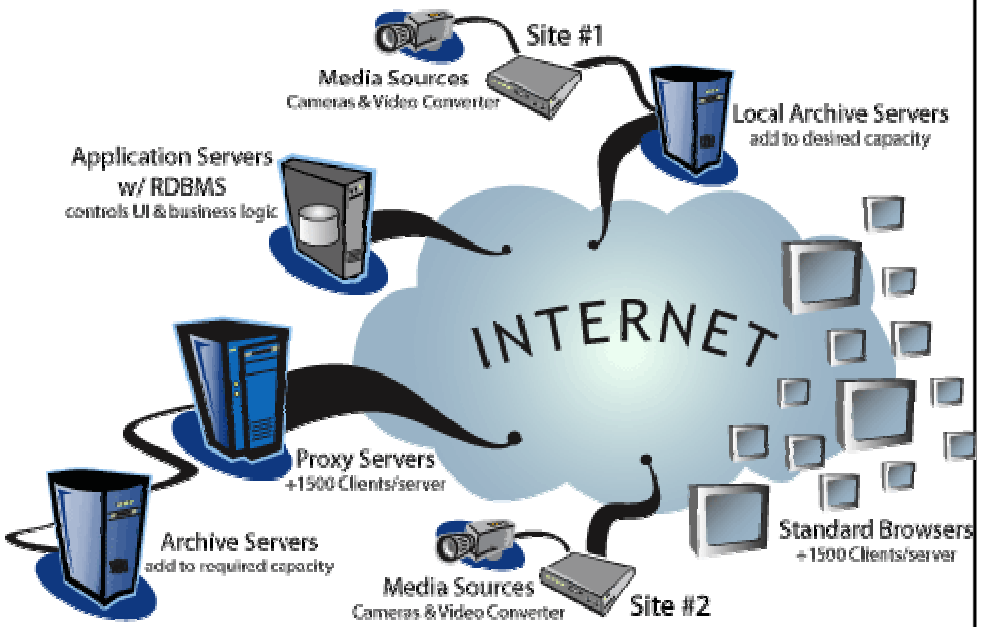
- schemes
- hierarchical delegation

HTTP

- versions
- methods
- header fields

Media types

- HTML
- XML



Linux Kernel Modules

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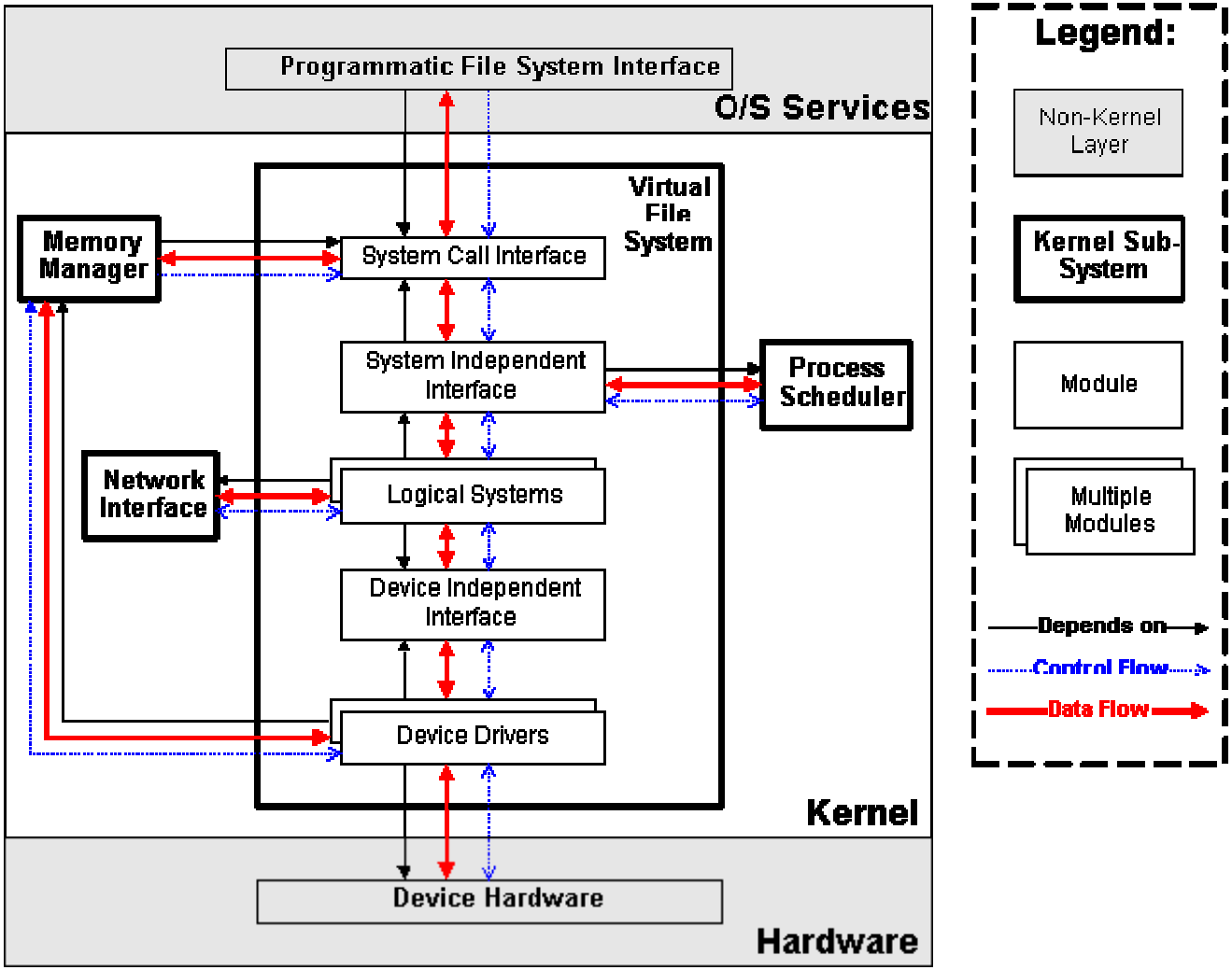
Modules

- 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

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- 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

Day

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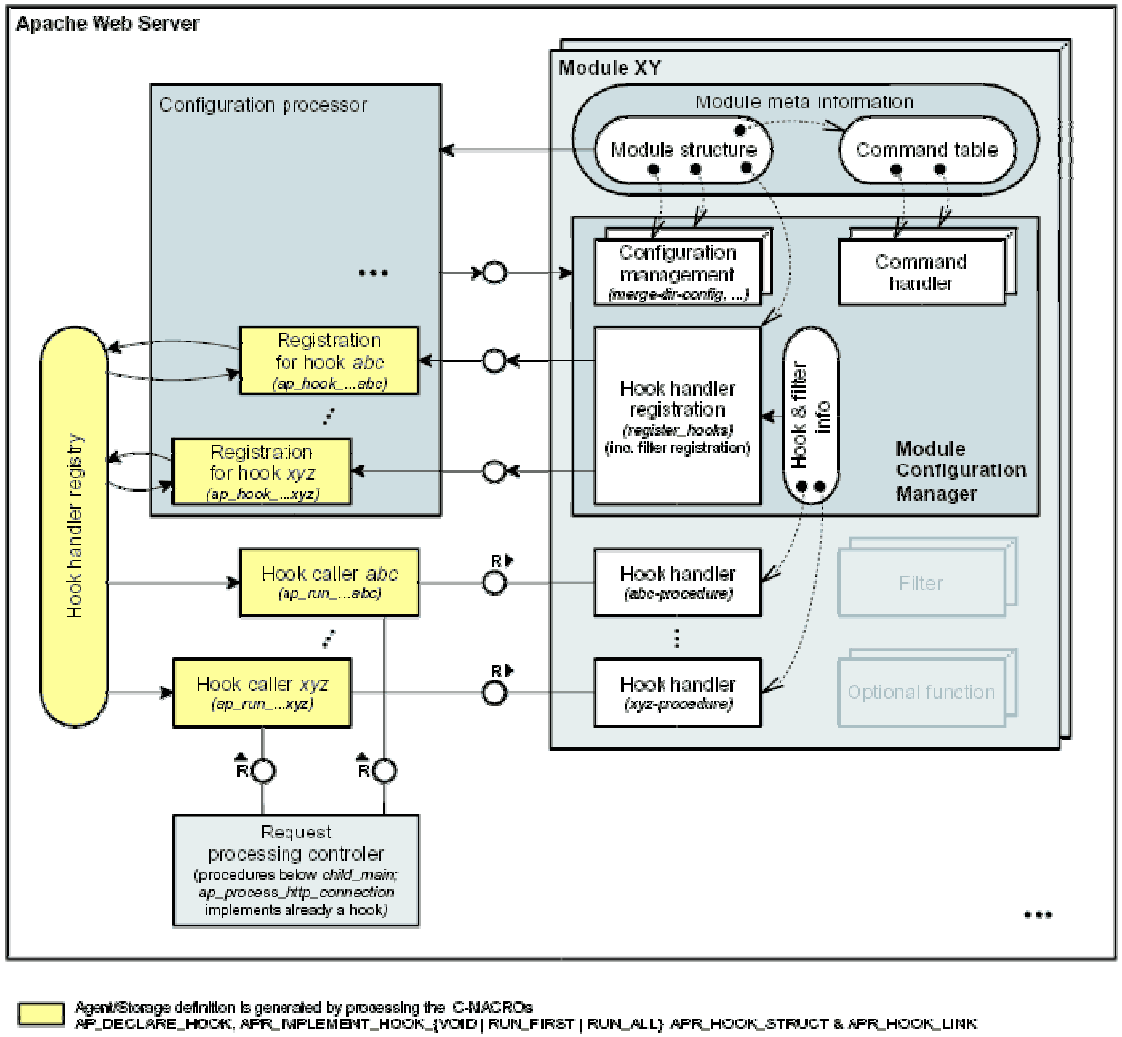
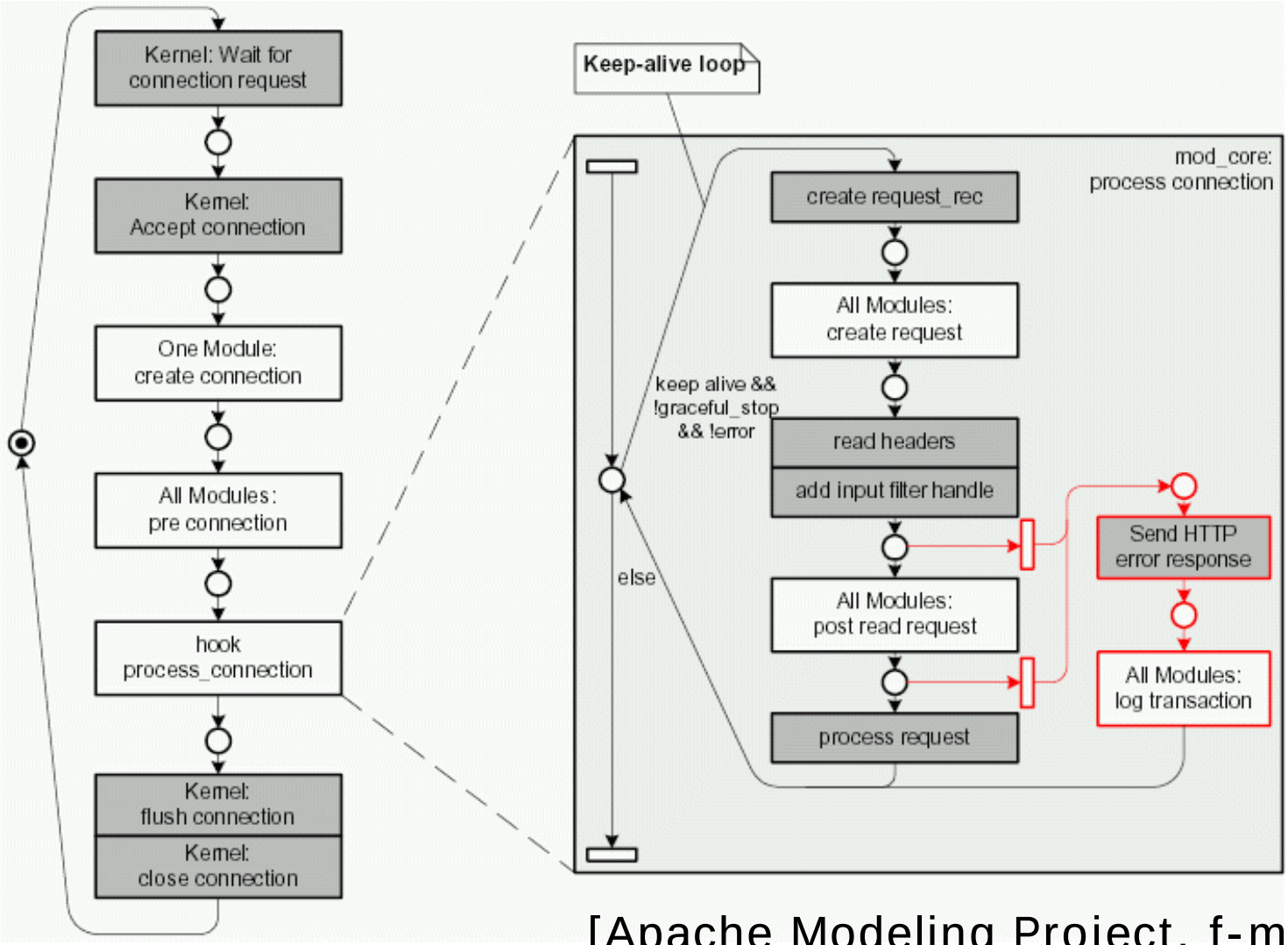


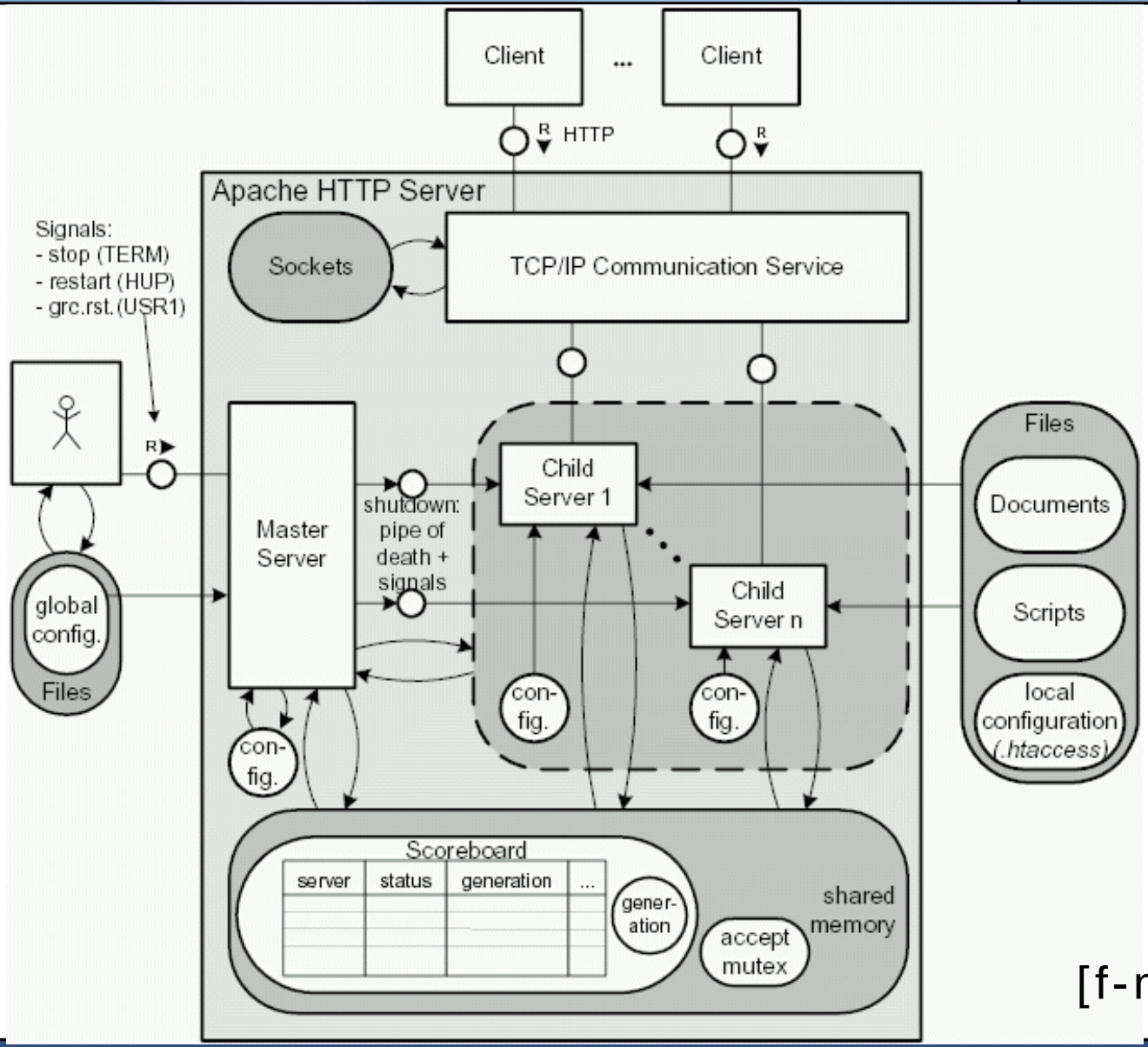
[Apache Modeling Project, f-m-c.org]

Apache httpd: kernel



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

Apache httpd: preforking MPM



[f-m-c.org]

Apache httpd: worker MPM

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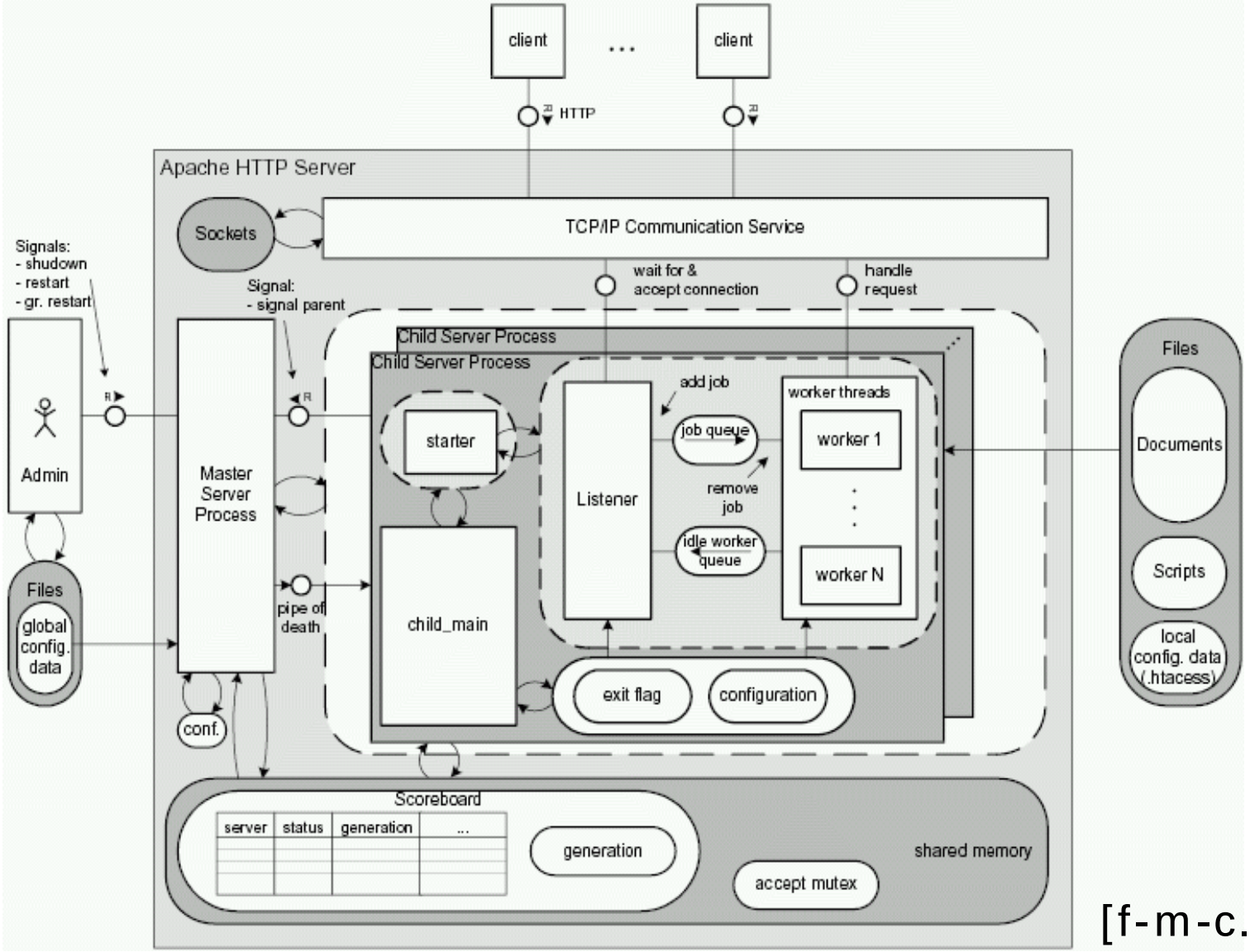

[f-m-c.org]

Apache httpd: winnt MPM

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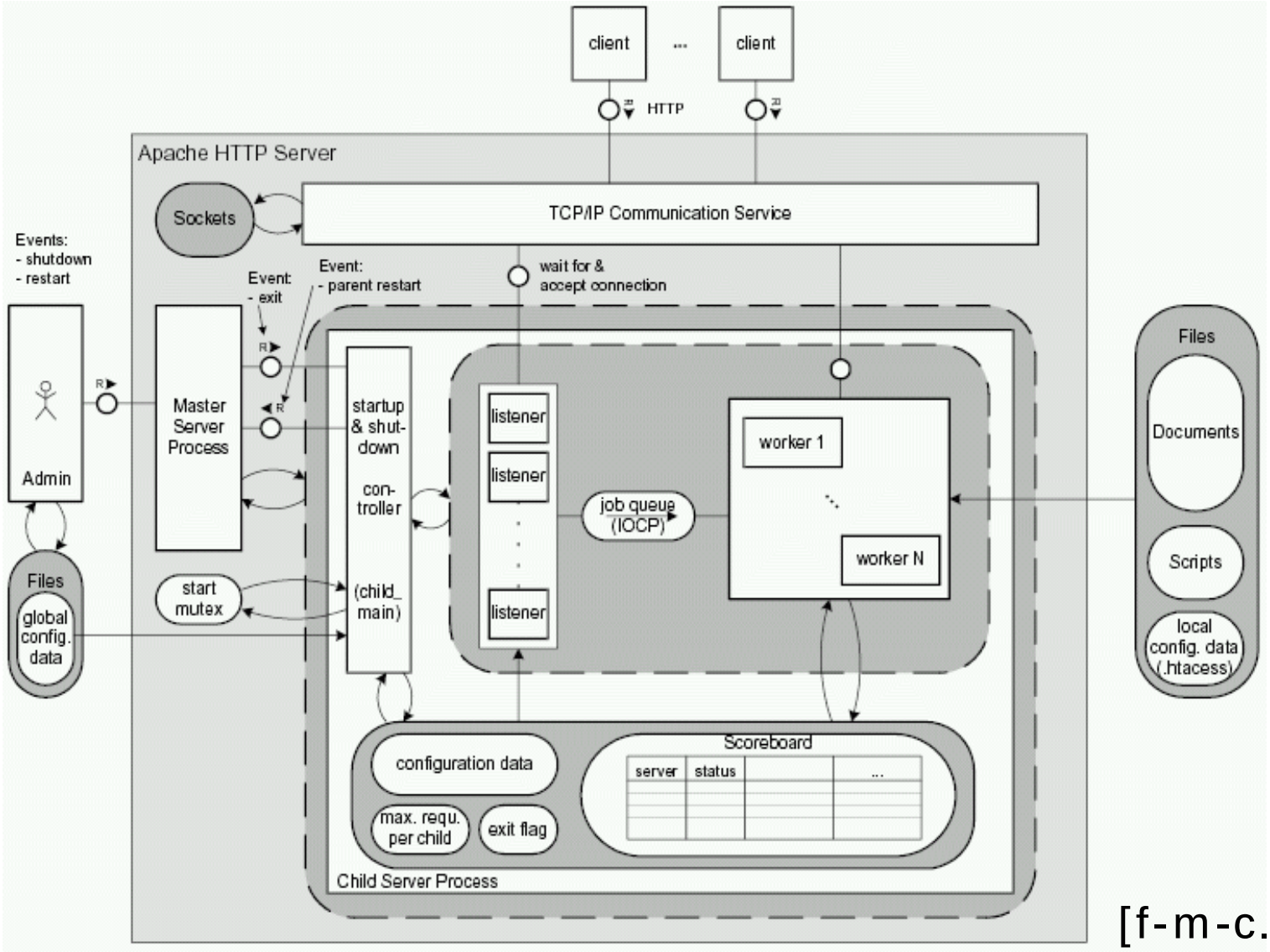
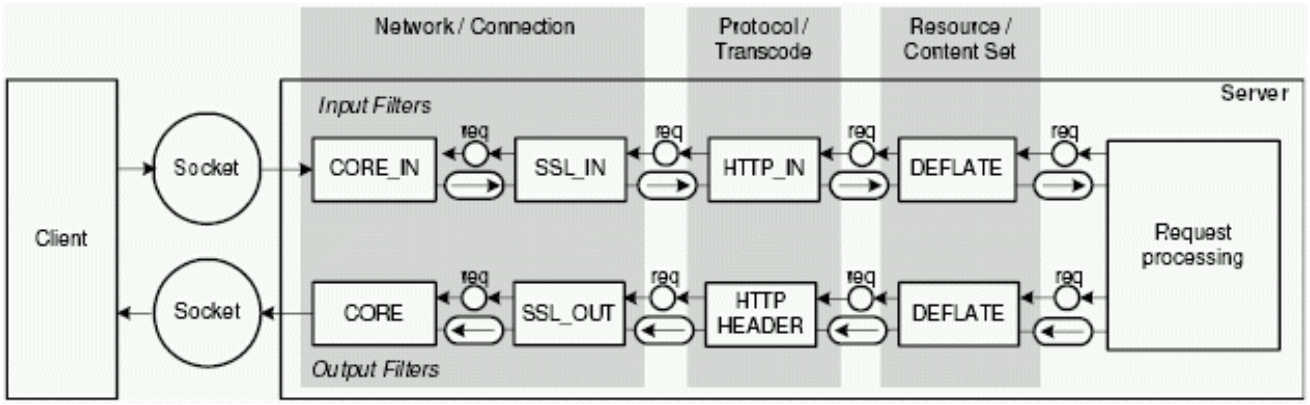


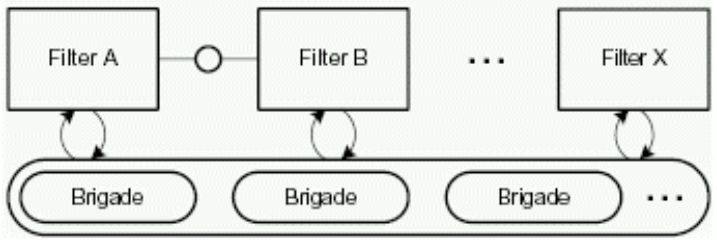
[f-m-c.org]

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

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Multiplatform

Standards Compliant

Lightweight

Community Supported

Firefox: User-friendly

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Tabbed Browsing

Integrated Search

Live Bookmarks

RSS / XML Feeds

UI Themes

Firefox: Developer-friendly

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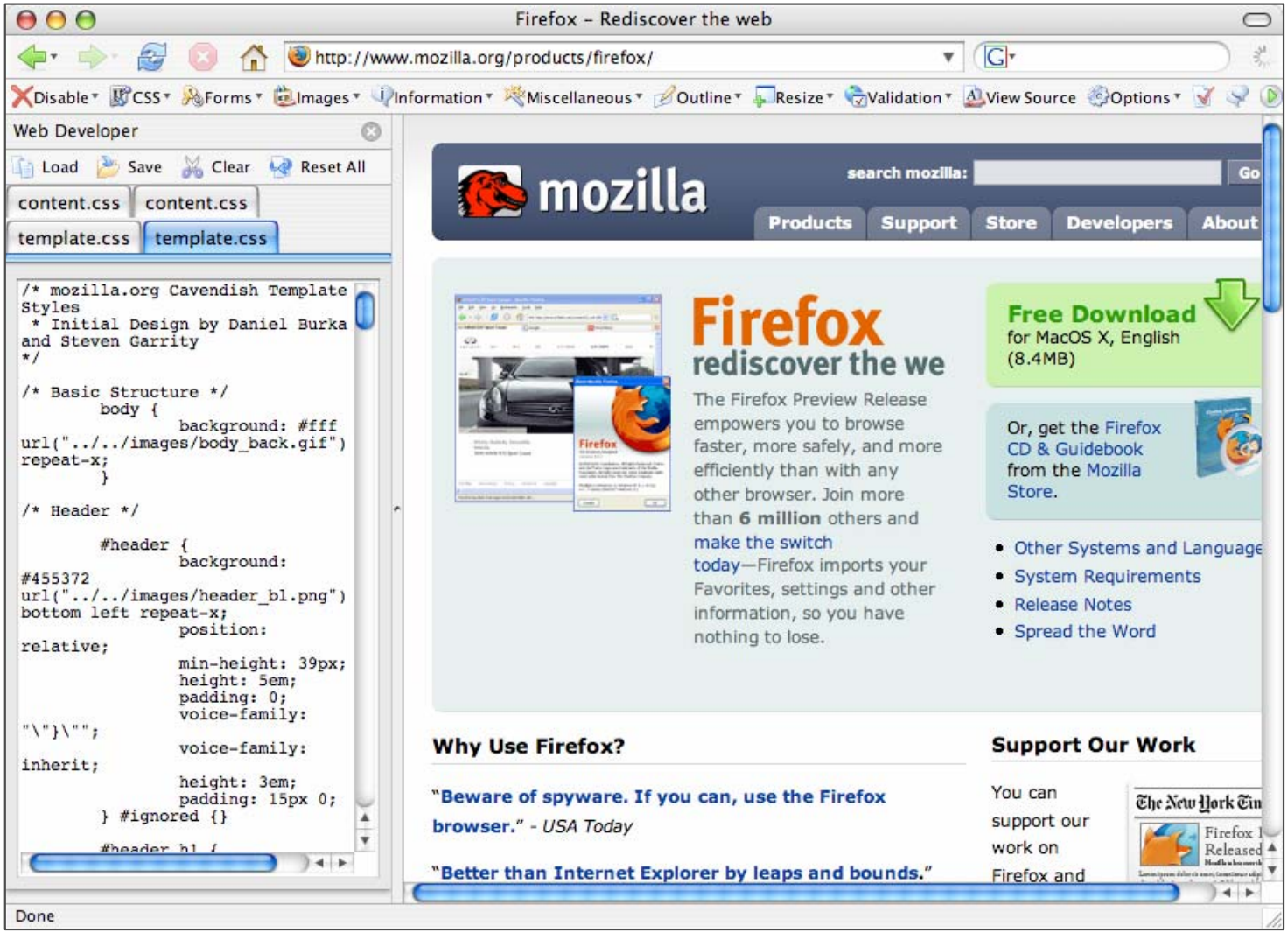
Open Source

Extensible Architecture

Plug-in Tools

Layered CSS

Editor Platform



Eclipse Platform

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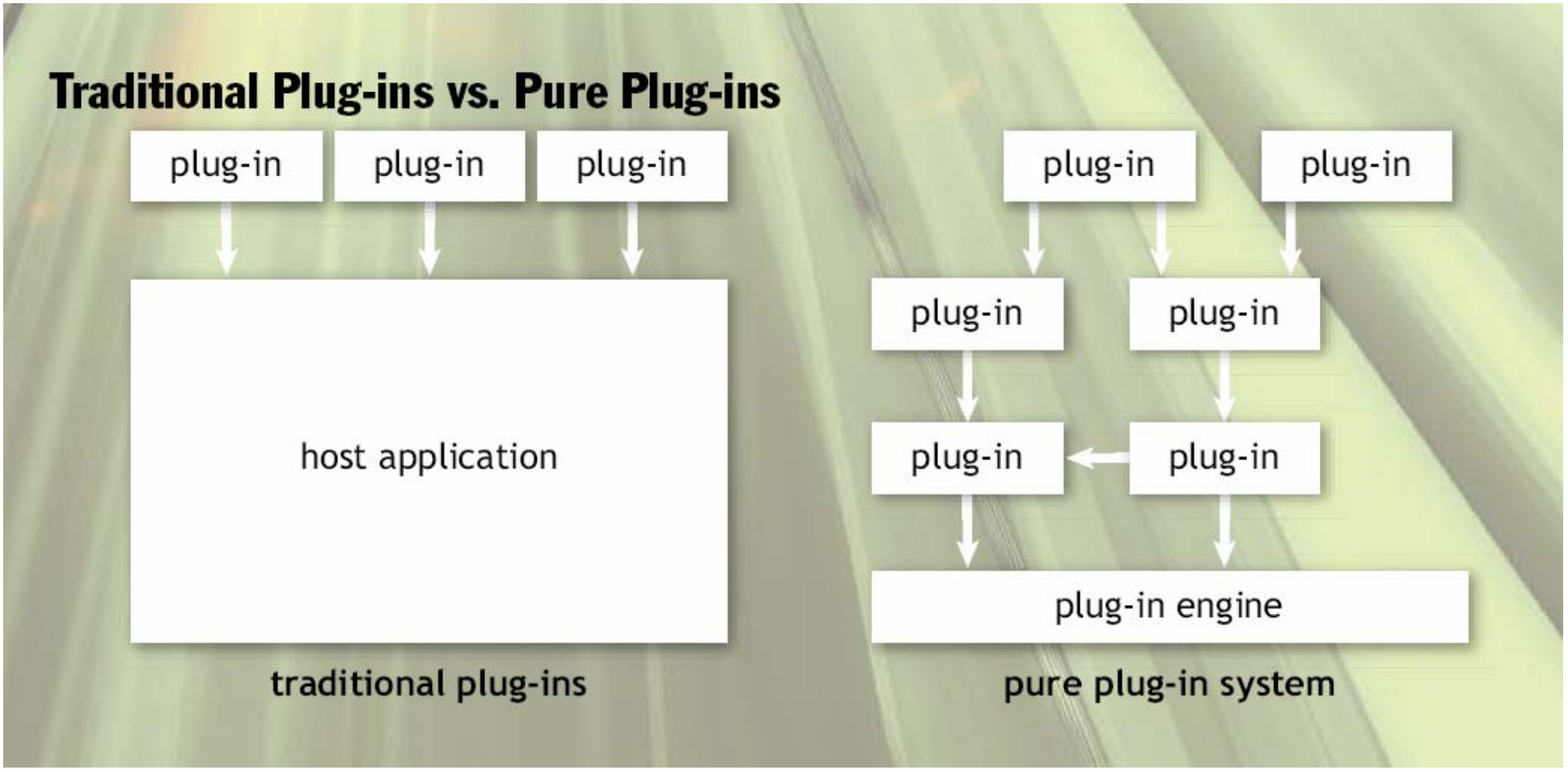
Taking modular extensibility to the next level



[Birsan, *ACM Queue*, Mar 2005]

Eclipse Platform

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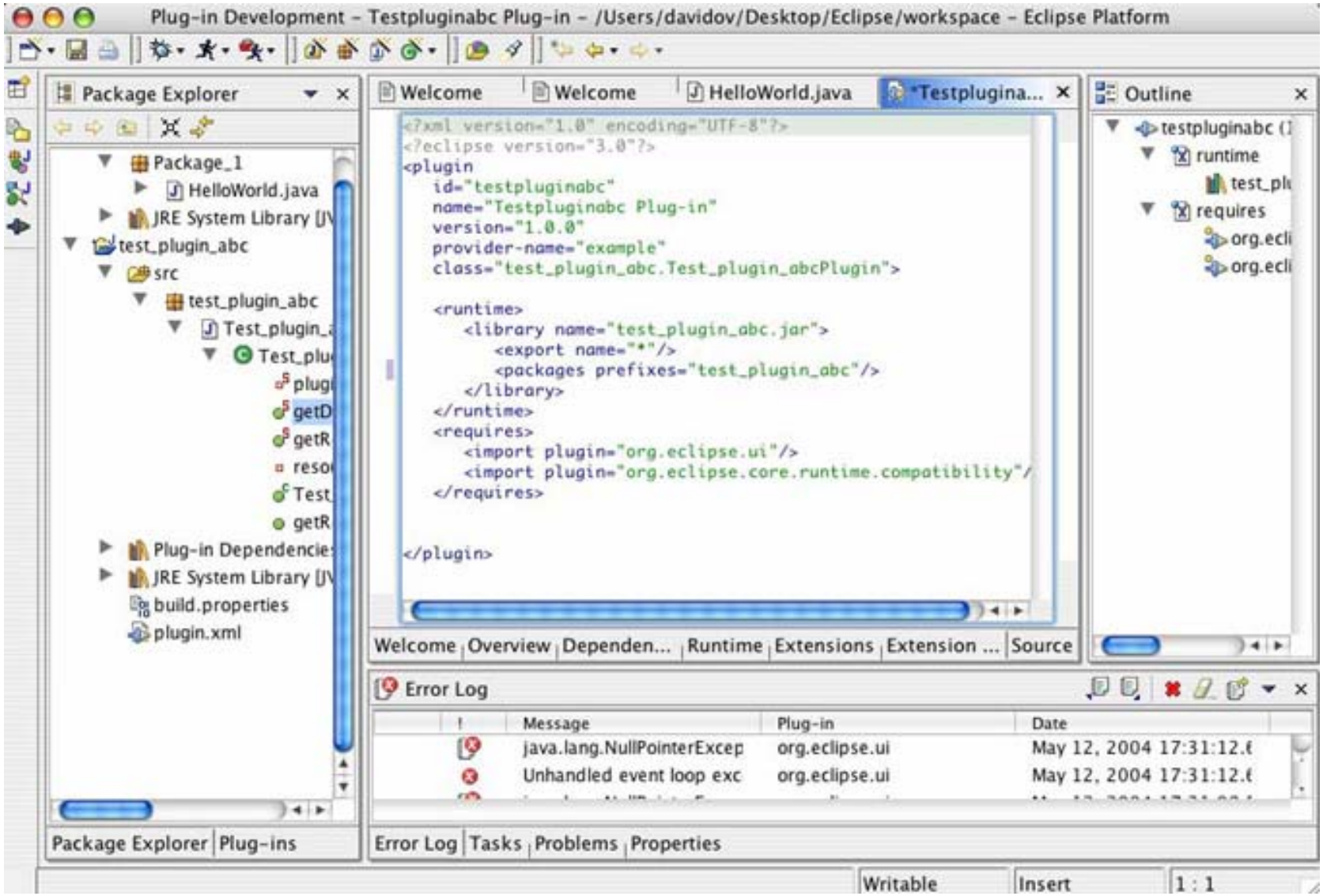

Eclipse Platform

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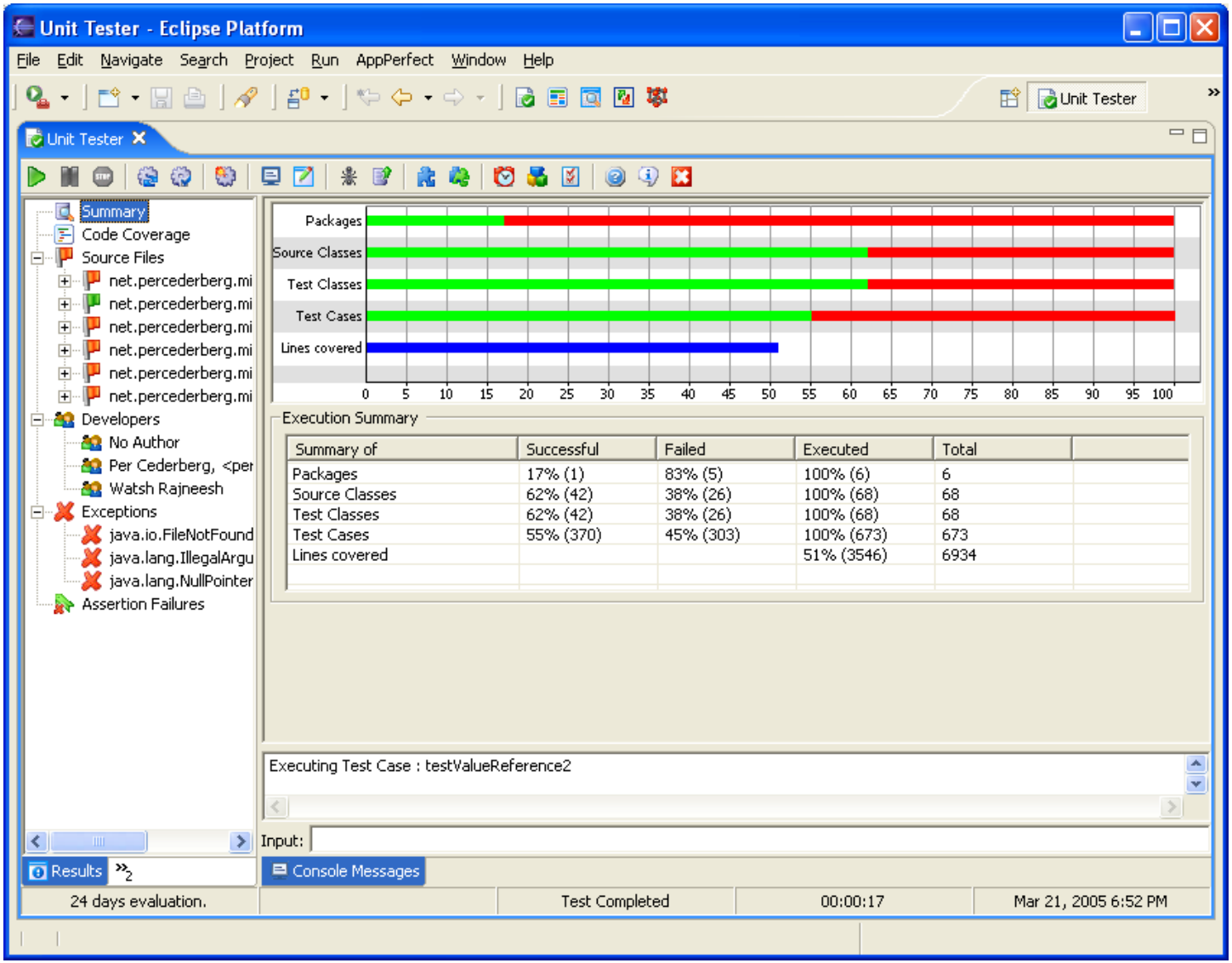

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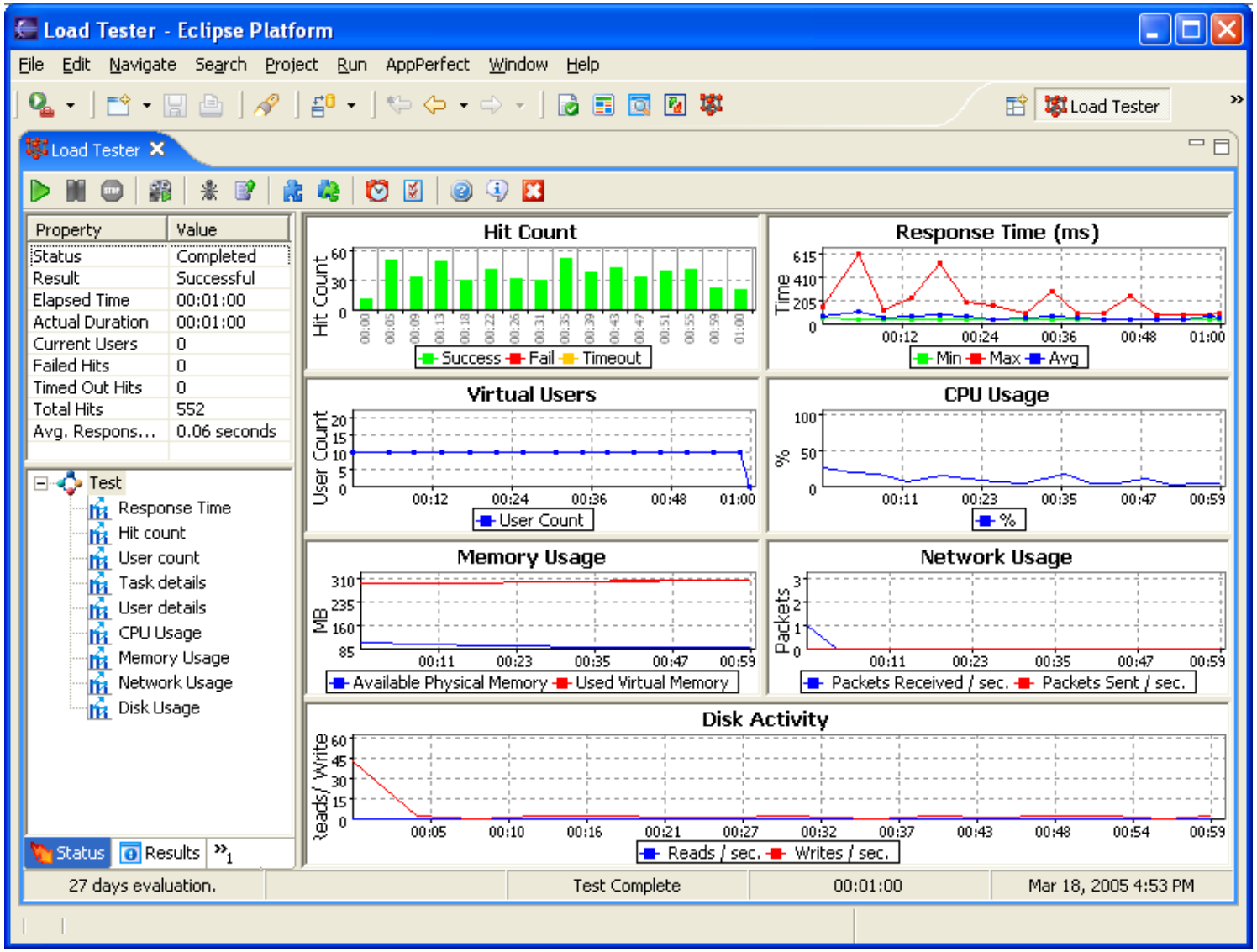

An open source world

- 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?

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- 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

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- 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)