Prometheus Course Management System

Product and Technical Information White Paper

(Version 1.0.1, May 25, 2001)

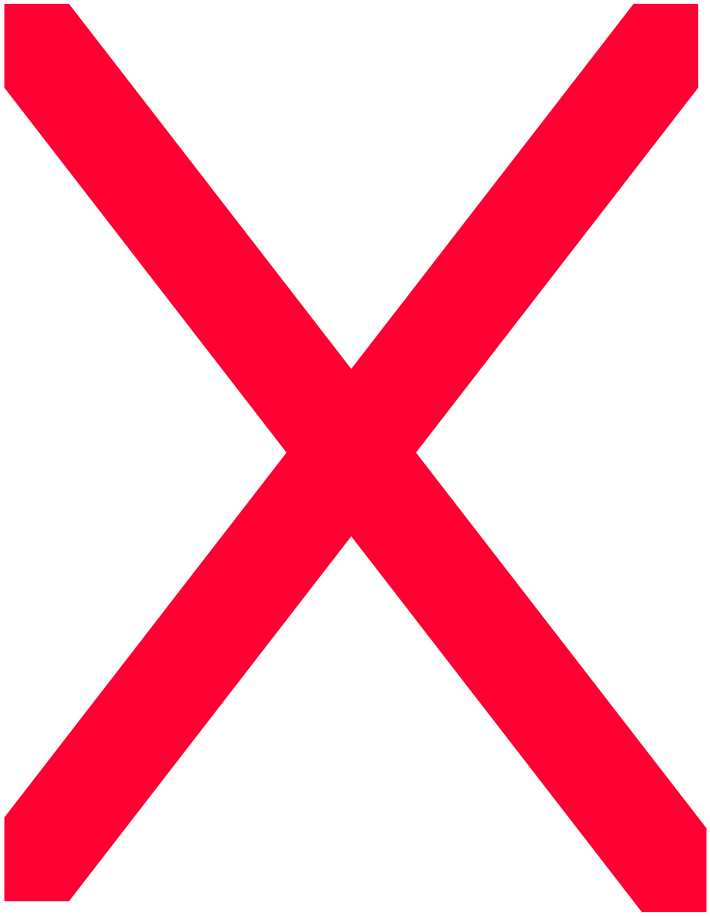

Table of Contents

1. Introduction to Prometheus

Prometheus is a scalable enterprise software solution for higher education institutions looking for learning management system software that provides a flexible and interactive environment for online courses. Prometheus was designed to be easy for any faculty member to use without extensive training. Its simple web-form format is easy enough for non-technical users to embrace; yet Prometheus is flexible enough to include the advanced features that the most technically adept users demand. This ease of use, without extensive training and support, is illustrated by the unprecedented rapid adoption of Prometheus by university faculty and students. At The George Washington University during the 2000 spring semester, more than 600 faculty actively used Prometheus. Of those faculty members, only 15 percent have received formal training on Prometheus.

1.1. Prometheus History

Prometheus is a product of The George Washington University, located in Washington, D.C. In 1997, a team at GWU began to develop their own online learning software in response to the faculty need for course-specific web sites, and the university need for a campus-wide, scalable solution for a course management system. Course management products on the market were not easy to use, flexible, or as scalable as faculty and students at a major university needed. As a result, the team created Prometheus, enterprise-level learning management system software. Prometheus is scalable, based on a ColdFusion application layer, and is licensed with open-source code – spurring online education development nationwide.

Prometheus was developed over an 18-month period, with another 18 months in intensive testing through alpha and beta stages at GWU and later at Vanderbilt University. During this time Prometheus was rapidly adopted by faculty at both campuses because of its ease of use and its ability to help faculty manage course content. At GWU over 80% of the student body uses Prometheus in over 1,500 courses. In March 2000, GWU began licensing Prometheus to partner institutions and has since been licensed to over 35 universities.

1.2. Who's Using Prometheus?

Our partners range from an impressive list of top-tier universities to mid-level state institutions and private colleges:

Columbia Business School
The Wharton School
The George Washington University
University of Texas at Austin College of Engineering
University of Michigan College of Engineering
University of Wisconsin-Milwaukee Dot.edu
The University of Wisconsin Learning Innovations
London Business School
Darden Graduate School of Business at the University of Virginia
Washington University in St. Louis
Washington University – Olin School of Business
University of Toronto School of Continuing Studies
Indiana Institute of Technology
Southern Arkansas University
New York University
NYUonline
Rochester Institute of Technology
Robert Morris College
Vanderbilt University
University of Texas at Houston Health Science Center
New York University School of Continuing and Professional Studies

Teachers College at Columbia University
The Berkman Center for Internet & Society at Harvard Law School
University of West Florida
United States Open University
University of Wisconsin - Stevens Point
New School Online University
K2Share
Nazarene Bible College
Middlebury College
Valparaiso University
Eduprise, Inc.
Santa Clara University
California State University Monterey Bay
Embanet Corporation
Saint Mary's College of California
University of Baltimore
Soka University of America
Fathom
Cerebellum
Siena College
SAMW, Inc.
Boston University
Norwich College
California Virtual Campus

2. The Prometheus Learning Management System

2.1. Course Management System Functionality

2.1.1. The Creation of a Course: Developing Course Content

Course content in Prometheus is organized around a syllabus model. Prometheus uses a self-guiding, question and answer workflow format for content creation. The guides within Prometheus are merely suggestions of what content can go into the field; the instructor can use the fields or disregard them. Any disregarded fields will not be visible to the students in the syllabus function.

The content creation model found in the syllabus section is consistent throughout Prometheus. Once an instructor reaches a comfort level where they can create content within the syllabus section on their own, they will be able to create content in any section. In the Prometheus model, the instructor titles the content, enters new or imports existing content, and/or uploads files (text, media, audio, .ppt and others) and then associates notes with the content file.

2.1.2. Module organization

Our new module organization could have important applications for sharing content, especially for seminar-style courses. Prometheus gives instructors the ability to create learning objects outside the context of a course, group them into "Content Modules", then insert and rearrange them within courses. Modules can contain content that can be directly entered into a course including outline items, assignments, tests, projects, lectures, files, and discussion topics. Other course management systems have focused on the development and distribution of entire course “cartridges” (Prometheus will have that ability with its June, 2001 release). Prometheus recognized the need for a more granular form of content as expressed by faculty, instructional designers, and distance learning directors.

Modules make content independent of any particular course, allowing its reuse in multiple courses. Changes made to the module replicate across courses, enabling centralized content management.

Within a course, the instructor changes the session(s) with which the module is associated using a simple drag-and-drop interface.

2.1.3. Outstanding or Unique Features

Equation Editor. A mathematical equation editor using an intuitive interface is integrated into Prometheus. Once an equation is created, it is converted into an image and embedded into the web page. When accessing the equation editor, the user will be presented with a library of user-defined equations; each user will have a library of their own equations.

eReserves Library Feature. Prometheus has an Electronic Reserve system that interfaces directly with the library. This system allows faculty to request a reserve from the library online and have the reserve placed back into the course as a course reading. The reserve system allows librarians complete control of the reserves placed into a course so all files associated with a course can be removed and destroyed to comply with fair use rules and regulations.

Foreign Language Support. Born of a co-development project with Middlebury College Center for Educational Technology, all text entry areas of Prometheus accept international characters and symbols. Prometheus now supports Western European, Traditional Chinese, Simplified Chinese, and Japanese characters as well as Unicode and Cyrillic fonts.
HTML Editor. Prometheus users can reap the benefits of HTML without needing to know the code. The integrated HTML editor makes it easy to create rich, web-based content. Information is simply entered directly into Prometheus' What-You-See-Is-What-You-Get (WYSIWYG) editor, which automatically translates it to HTML. The editor can be turned off for those who know HTML.
Palm PDA Integration. Class information and assignments can be downloaded directly to any PDA running the Palm OS.

2.1.4. Quizzing, Testing, and Grade Book

Quizzing and Testing. The Prometheus quizzing and testing feature accepts Multiple-Choice, True/False, Short Answer, and Long Answer questions. Prometheus gives the instructor the choice of manually grading a test or to auto-grade tests consisting of only multiple choice and true/false questions. Auto-Graded test scores can be edited as well. When you go into the test, you are able to change the value of the points awarded for the answers.

The instructor can review grades by student. Prometheus will list the students who have taken the test. The questions and the student's answers will appear with the correct answers in red. Prometheus will have graded the multiple-choice and true/false questions already according the point values assigned by the instructor upon creation of the test. The awarded points will appear in the text fields to the left of each question. The instructor can change this point value after the test if desired. There are text fields below each question/answer for the instructor to comment on the student's answer. The test may be re-graded or reset for the student to take it again. The instructor can also view the test graded by question.

Grade Book. The grade book lists all students registered for a course. The instructor can set the grade book so online tests and any corresponding grades will automatically be posted to the grade book. Test scores cannot be changed from the grade book; however, if scores are edited in the testing section, the grade book will automatically be updated.

The instructor can grant students permission to see only their own grades or the grades for their entire course (grades only, no names), or the instructor can close the grade book to student view completely.

The instructor can post the grades for all items, either by student or by item. The instructor can also email a student from the grade book page by clicking on his or her name. The instructor has the control to add, reset or delete their entire grade book, or just specific items inside the grade book. They can also download their grade book to Microsoft Excel.

2.1.5. Communication Tools

Email Messages. There are several ways to get messages to the students in a course. The messages section of the course allows all members of the course to send an individual email message to any person or work group in the course, to send a broadcast email to everyone signed up for the course, or a group email to selected course members.

Threaded Discussion and Bulletin Board. The discussions section allows the members of the course to conduct an asynchronous threaded discussion by posting comments to a discussion board under a particular topic. Faculty can categorize the discussions in the discussion area, delete topics, and administer the threaded discussion. Each workgroup or team can have their own section of the discussion board, accessible only to those course members in that group.

Announcements. The instructor can post an announcement to all of the students in the course, as well as send individual, broadcast (all students in the course), or group emails. The announcements are viewable at the top of the course listings page, which is the first page the student sees when logging in.

Calendar. The calendar feature of Prometheus appears at the portal level of the product. The calendar function within the portal allows users to come to a single place that will display all of their events relating to their courses, affinity groups, as well as personal events.

Calendar features include:
- user defined events [add/remove]
- multi-day events [add/remove]
- timed events [add/remove]
- views by the day/week/month/year [specify]
- printable views [print]
- go to date [select]

The calendar integrates with:
- session dates (from all courses enrolled) [receive]
- affinity groups (events) [receive]
- institutional events [receive]
- Palm Pilot synchronization (summer 2001 release of Prometheus)

Chat. The text chat allows course members to communicate in real-time. These chats can be logged and the transcripts can be viewed at a later time. Students and groups in the course can also create their own chat rooms and make them private by password protecting them. The text chat allows anyone in the course to communicate in real-time with anyone else in the course. Along with the text chats, Prometheus supports voice chat in the chat rooms. Prometheus currently supports one-way voice chat; however, two-way voice chat is planned for the upcoming release. For the chat room, the latest version of Macromedia's free Shockwave plug-in must be downloaded.

Whiteboard. The synchronous whiteboard feature allows users to create diagrams and illustrations using the mouse. The color and diameter of the drawing tool can be changed. Users also have the ability to use a text tool on the whiteboard. Slide shows can be created and pushed through the whiteboard, thus one still has all writing/drawing abilities of the whiteboard on top of slides. Both students and faculty have whiteboard capabilities.

File Sharing. Faculty and students can add individual and shared files to the course curriculum, documents, Power Point presentations, etc. Each individual has a personal files area where they can upload files that no other user has access to, although the file can be shared if desired. Through the use of our collaborative files boards, users can share annotations with others in the course. In addition to the shared files boards, each user has a notepad where they can jot down notes as they progress through the course and only that individual will have access to these personal notes. The notepad

feature enables students to take notes without leaving the courseware as well as search through all of their notes using the main search function.

2.1.6. Multimedia Features

Multimedia Files. There is a special feature for MPEG video, which allows instructors to keyword tag videos. Students can then access the video and use the faculty-defined keywords to jump through the video. Faculty can upload and insert a Flash or QuickTime movie in multiple areas within Prometheus: including the Outline, Files, Projects, Lectures, Files Collection and Discussions sections of Prometheus. Since multiple files are usually involved, java applets can be embedded into the web content feature inside the Files Collection feature of Prometheus. Please note that anything placed in the Files Collection can be placed throughout Prometheus.

Streaming Video. Prometheus supports streaming RealAudio and RealVideo (.rm) files. The Real Server is included in the implementation of Prometheus, thus end users will only need the free RealPlayer to view the files. There is also a feature for users to place MPEG video into a course and for instructors to keyword tag the video. Users will need the Windows Media Player to view these files.

CD-ROM Compatibility. Content can be distributed via CD-ROM via links in a Prometheus course. If it is necessary to distribute high bandwidth content and network speed is an issue for students connecting at slower speeds, content can be pulled off a CD-ROM on a local drive through the Prometheus framework.

2.2. Administrative Tools

Distributed administration allows the root administrator to provide groups within the University the ability to have administrative access to only the courses, faculty and students associated with the administrative group. The sub-administrators can communicate with their users, manage accounts and have a backdoor into all courses associated with the sub-administrative group.

2.2.1. Access Control and Authentication

Prometheus users can be authenticated through several mechanisms. Most often, login and password information is stored within the Prometheus database itself. We also support “plugging in” to various other authentication systems, from LDAP to NT domain security. Depending on the type of authentication method chosen, users with administrative access within Prometheus can change passwords for users in groups they are authorized to administrator. Prometheus can also be set to allow users to arrange for their passwords to be “reset” and sent to them via e-mail. Each campus can determine the administrative latitude they want users (faculty) to have.

There are several different roles for Prometheus users that are stored in the database:

Course Level
- Faculty level – full editing rights of all content and users in the course.
- Teaching Assistant Level (also team-teaching)– editing rights only as defined by user with faculty level access.
- Student Level – ability to access and manipulate course data, post files, use communication tools.
- Shadow Level – an “invisible” user that has read access only to a course; only faculty member knows of presence in a course.

System Wide
- Admin Level – One or more users can be assigned to have access to all of Prometheus as the root administrator. This user would be responsible for any administrative requirements --including having access to ALL user accounts; ability to post announcement to ALL users; access to ALL

course content. System administrators and/or Prometheus administrators retain this level of control.

- Group Admin Level – A group-level administrator has limited access to users, courses, and communication to only information identified within their group. This user has the ability to "skin" the user interface for all users associated with their group.
- Faculty level – faculty-level users must be created by an administrator – if not imported through some other form of data feed. Faculty members have the ability to create and administer anything within the course framework. They also have the ability to change a user's level of access WITHIN a course.
- Student level – full access to course content – after "joining" a course either by way of entering a course ID and course password or pulled from a data feed.

On every page within Prometheus, a user's permission levels are determined and the user's login is verified to make sure that it is valid. This prevents users from bypassing Prometheus security by, for example, linking directly to a particular page.

2.2.2. Tracking and Reporting

Tracking Within a Course. Tracking within a course enables the user (with faculty access) to follow a variety of usage statistics for that particular course. The user(s) view statistics in three different tracks – General Course Usage, By Object, or By Student. General Course Usage displays the number of users that have logged in within previous hour, day, week, and the total number of hits. Using the By Object feature tracks statistics in the specific sections of a course - Syllabus, Outline, Testing, Projects, Lectures, Files, Messages and Discussions. The By Student tracking gives a detailed description of actions of each student while logged into Prometheus.

Tracking Within Prometheus. This section allows you to view a variety of statistics about the entire instance of Prometheus. Information available includes usage, types of browsers and operating systems used, different services on the system and errors encountered on specific pages. There are graphic charts available for some types of information. The charts track the number of daily hits, average logins, and faculty and student accounts over time. This feature in Prometheus can be altered to track any of the data fields that each campus deems as critical for monitoring.

2.3. The Prometheus Portal

The Prometheus Portal is designed to facilitate a community atmosphere online allowing users to interact with course-related materials. Here they can create affinity groups to interact with each other, pull in information from an organization's existing information systems and pull in feeds from content providers. There are multiple ways for information to be placed into the portal. System administrators can place global information into the portal for all users or groups of users to use. The administrator can add the XML standard Rich Site Summary (RSS) feeds into the portal, affinity group administrators can add content into the portal for their users, and content from courses can be pulled into the portal as well. As with Prometheus, the portal is licensed as an open-source code application providing system administrators with the flexibility to go into the code and further customize it to best meet their organization's needs.

2.3.1. General Features

Calendar. The calendar function within the portal allows users to come to a single place that will display all of their events relating to their courses and affinity groups, as well as personal events.

My Courses. This section shows a list of all courses that a student is currently enrolled in. The courses are displayed as links. Both the course number and name are shown in the display. Students can click on the link to take them directly to each course. The user also has the option to display icons that designate if any changes have been made to a course. If clicked these icons will take the student directly to the page within the course that contains those changes.

My Links. My links is a set of user-definable links that a student can create. These can include campus links or links to their favorite web sites. There is no limit to the number of links that a student can create. Each link also has a place for a description of that link.

My Groups. The portal is designed to create a community around the individual courses. To help foster the sense of community, we have created a place where people can come together to interact. The portal allows instructors and students (if permitted by the administrator) to create affinity groups. Each group has its own private area in which to have discussions, chats, exchange files, schedule events, and post announcements to group members. Each group can be public, private, or hidden. Public groups can set default membership for all students, all faculty/staff, or all users. Private groups require a password to gain access. Hidden groups control membership through the group owners. All group events are integrated into the user's calendar and all discussions are also reflected in the user's discussion area.

Affinity Group features summary:

- Affinity groups [create/add/remove]
- Share discussions, chats, files
- Group announcements
- Group events integrated with calendar function
- Private, public and hidden groups
- Multiple owners

Announcements. The portal is designed to facilitate communication across the system. The portal administrator can issue campus wide announcements visible to faculty, students or both. All announcements – whether institutional, course, or group - are visible in the announcements window. Users can keep or delete individual announcements.

External Content Feeds. The system is designed to receive feeds from a variety of sources that users can select. These feeds provide information to the user so that they can customize their portal page to fit their needs. From Art and Culture to CNN news, users can get the information they want on their portal home page. Users also have the flexibility to determine where on the page they want each feed displayed.

2.3.2. Administrative Features

Portal administrators have complete control over all portal settings. Multiple administrators can control the system. Here is a list of some general administrative features:

- Portal wide announcements (students, faculty, both)
- Announcements saved
- Ability to add new RSS feeds
- Ability to add new cities to the weather module
- Ability to define the default settings for new user accounts
- Ability to reset all users' preferences
- Affinity group creation, edit, delete
- Affinity group membership control

- Default settings and system defaults
- Module creation
- Administrative override of user settings

Extensibility. The portal will be able to take feeds from student registration systems or other HR systems for direct integration. It is also possible to integrate with other course management systems so that all courses are listed in the student's "My Courses" section.

3. Prometheus Specifications, Implementation and Support

3.1. Overview

The purpose of this section is to provide technical specifications of the community source code courseware application Prometheus.

The Prometheus learning management system provides instructors and content creators with the tools needed to place course content online. The application uses a self-guiding, question and answer driven content creation model where the content creator uses web-based forms to create the course materials. Prometheus allows for syllabus and course outline creation; assessments and grade book functionality; communications tools, both synchronous and asynchronous; file sharing, course management tools for creating, copying, deleting and archiving courses; an electronic library reserve feature for placing reserve materials into a course and administrative tools.

The administrative tool allows the Prometheus root administrator to create sub-administrative groups within a single instance. The sub-administrators have administrative access over all courses, faculty and students in their group. The administrators also have the ability to customize or skin the interface for their administrative group. The root administrator can also create the libraries participating in the ereserves feature, view statistics on usage, manage all user accounts, and access any course in Prometheus with faculty level access.

One of the advantages of using Prometheus is that it is completely database driven. When content is entered into the web forms, it is stored in a highly structured database. The database provides Prometheus users with the flexibility to present data over multiple mediums and even in completely redesigned interfaces. This is possible because content objects are pulled from the database to populate the interface.

3.1.1. Technical Specifications

Prometheus was designed for portability over multiple operating systems and database platforms. Its three-tier architecture can operate on a single physical server or be distributed among multiple servers. It is a flexible database driven web application running on industry standard operating systems and databases. Prometheus takes advantage of modern web technologies and uses Macromedia's ColdFusion as its application layer. Prometheus is designed modularly, making it relatively easy to extend or replace its current feature set.

Prometheus can run in a windows environment, a Unix based environment, or a mixture of windows and Unix. The operating systems currently supported are Sun's Solaris, Microsoft's Windows NT 4.0 and Windows 2000. Prometheus runs on the industry-proven SQL Server and Oracle 8i databases. A "mixed" system can also be supported; your ColdFusion server can reside on a Sun and your database on Windows system, or vice versa.

Recommended Hardware Requirements for a Single-Server Configuration:
This recommendation is for running approximately 250 courses and about 4,000 user accounts. Your usage may vary based on course and account demands, which may be less than this specification and reduce your system requirements.

Windows Implementation:
- Windows 2000 (Windows NT 4.0 will also function)
- SQL Server 2000 or Oracle 8.1.6+ database (SQL Server 7 will also function)
- Dual Pentium II 733-Megahertz Processors
- 1 GB RAM
- 30 Gigabytes disk space, mainly for user file storage

Unix Implementation:
- Solaris 7, 8 (2.6 will also function)
- Oracle 8.1.6 or higher database
- Dual 300Mhz+ UltraSPARC II Processor
- 1 GB RAM
- 30 Gigabytes disk space, mainly for user file storage

Ideally, the database files should be on a mirrored volume, and the user file storage area should be on RAID-5.

We also strongly recommend a development implementation of Prometheus so systems administrators and developers have a place to work with the open source code while not affecting the production server. Once the development code has been tested, it can be ported over to the production server. The development server can be a less powerful server given the fact that a limited number of users will have access to this server. Maintaining a development server application of Prometheus for code modifications and course development is included in the Prometheus license.

OS Platforms:
- Window NT 4.0
- Windows 2000
- Sun Solaris version 2.6, 7, 8

Web Servers:
- IIS version 4.0 or higher
- Apache version 1.3.12 or higher

Database:
- Oracle 8iR2
- SQL Server 7.0 and 2000

Note: The Prometheus license does not include the license of the database platform you choose to run.

Software. Each licensing institution will need Macromedia's ColdFusion Server 4.5.1 Professional Edition with service pack 2, or the Enterprise Edition of ColdFusion Server 4.5.1. The Enterprise Edition includes clustering software for running multiple ColdFusion servers together. For a single server, the Professional Edition is recommended.

Note: The licensing of the ColdFusion server software is not included in the Prometheus license. ColdFusion must be purchased separately with your *significant* educational discount.

Chat Server. Prometheus offers its partners the ability to host the chat server from its hosting facility. This reduces the time system administrators will spend with Prometheus and it makes it easier for managing upgrades to the chat server. If the partner university chooses to host the chat server locally, it will need a system with at least a gigabyte of memory to run Hearme's PopX server. The PopX license is included in your institutional license of Prometheus.

Supported Browsers. Prometheus supports the following Web Browsers across all platforms including PC, Mac, Unix and Linux.
- Internet Explorer version 4.0 and higher.
- Netscape version 3.0 up to 4.7.

- AOL version 4.0 and higher.

3.1.2. Partner Support

At Prometheus, you will have an account manager and a technical support contact assigned specifically to your account. Your account manager will schedule installations and training as well as be your contact for functionality and administrative questions. Your technical support contact will be available for installations, upgrades, website bugs and database problems.

Technical Support. The Prometheus license includes two days of on-site installation by one of our technical support engineers. This is the first step in establishing an on-going relationship with your technical support contact. After the installation, your contact will be available to help you with upgrades, website bugs, database problems, etc.

We ask that you designate 2 people at your institution that will have contact with our technical support team. These people will then support their own helpdesk at the institution to answer student and faculty questions about Prometheus.

You will have access to our technical support team 24 hours a day, 7 days a week via our toll-free number. This line of support is for technical emergencies. Many questions can be addressed by email and that communication path is always open between our partners and your technical support engineer.

Note: For tech support, the toll free number is an answering service that will ask the customer a series of questions about their emergency. Then, a member of our tech support staff will be paged with the message 24x7.

Customer Support. Your Prometheus account manager will schedule your installation, schedule your on-site training, answer functionality and administrative questions, address your concerns, and gather suggestions and feedback from you. Your account manager typically works with the system administrators, the faculty development coordinator, the instructional designers/trainers, etc. Your account manager is available during business hours.

Training Support. Once your installation is complete, the final step toward a successful implementation of Prometheus is training on the best ways to use this learning management system. Two days of on-site training by our Learning Manager are provided with the Prometheus contract.

Because the needs of every Prometheus client are different, training is always customized. Concurrent with installation, a training needs analysis is conducted to be certain that all training needs will be met. Based on this analysis, our Learning Manager designs whatever tools are required to assure your use of Prometheus is as effective and efficient as possible.

Analysis takes into account such diverse issues as functions used, learning and teaching styles, instructional strategies and institutional requirements, user abilities, learner and instructor support needs, and instructional delivery methods. Training sessions can be developed for any level or role, from student to technical administrator and everyone in between. Supporting texts specific to your needs can also be included in the training event.

On-site training can include, but is not limited to:

- Overview of all functions and uses
- ‘Train-the-Trainer’ workshops
- One-on-one faculty training
- Course developer and faculty training
- Lab-based sessions
- Large-scale presentations
- Pedagogical development planning assistance

- Consultation for further documentation development

A ‘typical’ two-day training period is divided into separate 3-hour workshops, which are each customized to the level and usage of participants. Because of the flexibility of these sessions, individuals can choose to attend one or several of the sessions.

3.1.3. Integration with Student Information Systems

Prometheus integrates the learning management system with your campus student information system (SIS) as part of the original software license. This automated process will populate the Prometheus database with all users, both faculty and students, from your SIS and tie the users into the courses with which they are associated. This relieves administrators, faculty or students from manually having to add student accounts to courses.

Once setup, students can log into Prometheus with the username and password they use to access other campus applications. Upon logging in, all of the courses that they are registered for will appear in their account and they can access the course by clicking on the course number. Every night faculty will have an updated class roster as your university’s SIS will produce nightly batches files. The Prometheus Team has written scripts to parse through the data in these batch files and populate users into courses they are registered for. These scripts can be adjusted to meet a university’s desired integration goals within reason.

Our technicians will need a pipe delimited flat file produced on a nightly basis, which feeds directly into Prometheus. When Prometheus receives this file, scripts are run to parse through the flat file and populate the appropriate fields in the database's tables with the data provided from the SIS.

The following user information is needed from the SIS:
First and Last Name,
Email address,
Username,
Password.

The following course information is needed from the SIS:
Course number,
Department id,
Section number,
Course title,
The starting and ending dates for the course and the days of the week the course meets,
Identify which users are enrolled in the course.

There is a level of flexibility in how this integration will work. The system can be left with the flexibility to add users or courses, which did not come from the SIS data feeds. Or it can be setup so users cannot change any of their personal information in the system, so all changes made to personal information are completed within a centralized university application. If desired, additional information can be fed into Prometheus such as the instructor's office location, phone number or other data residing in your systems. Pulling this sort of data from your information systems will reduce the amount of time your instructors spend creating their course content.

3.1.4. The Prometheus Hosting Model

Prometheus was designed to provide your institution with an enterprise-wide learning management system installed and implemented on your campus servers, but Prometheus also provides hosted applications of the software. Prometheus has hosting facilities located at AboveNet Communications, a wholly owned subsidiary of Metromedia Fiber Network. AboveNet is an Internet Exchange Service (ISX) bringing together ISPs and Content Providers in a centralized facility where they can enjoy the privileges of one-hop access to the backbone. Measured against simple co-location services, the ISX

has no rivals. Co-located clients benefit from direct-route backbone connectivity, access to AboveNet's huge bandwidth and co-located clients, optimal routing programs, unbreachable security, unsurpassed facilities, and support.

AboveNet clients include: America Online, WebMD, Ebay, MSN – Hotmail, and other nationally recognizable companies that rely on uninterrupted Internet service.

The hosting environment established at AboveNet is a fully fault tolerant environment with redundancy built in at every level from the network layer, to the application layer and to the database layer. Traffic coming into Prometheus via AboveNet's network will go through a firewall, with a backup firewall available if a failure occurs, which is then passed off to a switch with a back available. There are both primary and secondary DNS servers available. We have two databases, one is the primary database and the other database is a mirror of the primary, both have RAID storage devices containing the data. The ColdFusion application servers are cluster, using Macromedia's ClusterCats to provide both load balancing and fault tolerance if one of the 5 ColdFusion servers crashes. The file server also utilizes RAID storage device capable of storing over 125 GBs of data.

3.2. Overview of our multiple configurations

Prometheus Three-Tier Architecture:
The three layers that make up the Prometheus architecture are the end user/client layer, the application layer and database layer.

When a user makes a request for Prometheus content, the request is sent along the network to the web server. The web server in turn passes on the user's request to the ColdFusion application server to be processed. Any information that ColdFusion needs to answer the user's request can be fetched from the database, incorporated into standard HTML and presented back to the user via the web server.

This three-tiered architecture allows Prometheus to reside on different physical servers, and even be split up in different operating systems. It is also possible to cluster the ColdFusion Application servers both for redundancy and increased capacity.

3.2.1. Why Use ColdFusion?

ColdFusion is a complete Web application server for developing and delivering scalable e-business applications. Prometheus has chosen ColdFusion as primary software language tool to develop our core product because ColdFusion uses a tag-based, server scripting language that is ideal for programming Web applications. Processed entirely on the server, the ColdFusion Markup Language (CFML) cleanly integrates with HTML for user interface and XML for data exchange. Both open and extendible, CFML supports more than 70 server-side tags, 200 functions, and 800 third-party components making it the most productive language available for creating advanced Web applications. In addition, ColdFusion supports both Java and C++, and can fully integrate with object transaction middleware through COM, CORBA, or EJB.

ColdFusion is designed to handle key elements that are necessary in a Web environment such as Prometheus.

- Rapid Development - Intuitive visual tools and an innovative tag-based programming environment make ColdFusion a highly productive platform for delivering applications.

- Scalable Deployment - A high performance, multithreaded architecture and advanced features such as just-in-time compiling, load balancing, and fail over ensure that applications will scale to handle the most demanding sites.

- Open Integration - Open integration with databases, email, directories, Java, XML, and enterprise systems that allow you to develop complex Web applications quickly and easily.

The following link contains case studies of companies and educational institutions that are using ColdFusion as the foundation of their web tools: http://allaire.com/casestudies/index.cfm

3.2.2. Environments Supported By Prometheus

The Prometheus application is fully functional on both Windows and Solaris platforms. Prometheus currently runs on Windows NT 4.0 and 2000 operating systems, as well as Solaris 2.6, 7 and 8. The databases supported are Oracle 8iR2 (8.1.6) and 8iR3 (8.1.7), and SQL Server 7 and 2000. A "mixed" system is supported; the ColdFusion server can reside on a Sun and the database on Windows system, or vice versa.

3.2.3. Future Operating System and Database Environments

At present, Prometheus only certifies Oracle on Solaris and Windows platforms. This is due primarily to a lack of demand. We believe that it would function properly on Linux, OS/390, OpenVMS, etc.

It is possible for the database side of the Prometheus application to be ported to databases other than Oracle and SQL Server. Prometheus requires support for foreign keys, transactions, triggers, and stored procedures, as well as ODBC drivers for ColdFusion. In theory, it could be ported to any relational database with this level of functionality. For example, Sybase, Ingres, and the free database PostgreSQL. However, Prometheus could not be ported to MySQL due to that database does not support stored procedures.

OS Support. The ColdFusion application server end of Prometheus currently only functions on Windows and Solaris. Because ColdFusion also runs on HP-UX and Linux, it is possible that Prometheus may also be ported to these environments.

Migration. It is very easy for a university to change its "front end" Prometheus servers running ColdFusion from one operating to another. For example, a college could move its Prometheus server from a Windows NT system to one based on Solaris with relative ease. Changing database platforms from SQL Server to Oracle (or vice-versa) is possible, but may require significantly more work to accomplish.

3.3. Maximum number of users

There is no definite limit on the number of users that can be hosted on Prometheus because of the inherent scalability of the databases and the ease in which ColdFusion servers can be clustered and added to the front-end. At our largest installation, The George Washington University, Prometheus runs comfortably on a pair of dual-processor Dell 2450 systems, with Oracle occupying roughly one processor on a Sun Enterprise 450 system. An additional 2450 that serves as user file storage. This serves about 31,000 user accounts. On average, 9,000 of these users will sign in at least once on any given week. The PopX chat server software can support more than 20,000 simultaneous users.

3.3.1. ClusterCats Information

Clustering enables multiple ColdFusion servers to be joined together to increase the capacity and availability of the site. ClusterCats is bundled with the Enterprise license for ColdFusion.

As in a standard cluster, there are two failure conditions to be concerned with: physical server failure and ColdFusion service failure. The Web servers are clustered together, so in the event that one fails, another healthy Web server in the cluster will assume the IP address of the failed server. This is a standard clustering feature. To protect against a ColdFusion application server failure, the administrator needs to configure a ColdFusion URL probe for each of the Web servers by using ColdFusion's

ClusterCats Explorer, the administrative interface to ClusterCats, Macromedia's clustering solution. Once the probe is running, it will detect the failure of the ColdFusion server for any reason and will restrict the server, preventing additional requests from starting on the Web server and associated ColdFusion server. New requests will be redirected to another clustered Web server connected to a healthy ColdFusion server until the failed ColdFusion can once again be probed successfully.

3.3.2. How Clustering Works

Macromedia Clustering is built upon a localized monitoring-centric model. The theory behind this model is that by locally monitoring the right information about the health of the total solution, a cluster is equipped to ensure that requests always get processed on an optimal server. There are two primary services that make up this solution: monitoring and the redirector. Both run locally on every Web server that participates in a cluster. And both play a key role in delivering optimal application availability and scalability.

The monitor tracks critical information that determines a local server's "state." The local redirector then uses the server state to determine when requests should be processed locally or should be redirected to another server in the cluster best suited to serve the request.

Macromedia's clustering technology operates in a peer-to-peer operations model, which means there is no "master" server that distributes to backend servers in the cluster. Each server is responsible for monitoring itself and for communicating load and server state to all other servers in the cluster. This peer-to-peer model ensures that there is no single point of failure in the cluster.

To handle hardware failures, this clustering technology uses an IP-Keep-Alive strategy, sharing heartbeats between servers and reassigning Web site IP addresses to alternative servers as required.

Finally, Macromedia’s clustering also runs in conjunction with selected hardware load balancers (e.g. Cisco’s Local Director) to achieve better load distribution and to scale to ultra-high volumes.

3.3.3. Clustering Advantages

Macromedia clustering optimizes ColdFusion application performance and availability. No other technology in the marketplace focuses specifically on ColdFusion. Designed as a server-side software solution, Macromedia clustering manages application load and availability, and recovers from Web server and application server software problems. Additionally, significant site management and maintenance capabilities are included with clustering, such as the ability to easily pull a server out of the cluster to perform routine server maintenance. In the event of an application or server failure, alerts are automatically distributed.

3.3.4. Scalability Comparison - Windows vs. Solaris

Solaris tends to be more scalable than Windows systems. Fujitsu sells up to 128 processor systems running a single instance of Solaris. Specifically with respect to the Prometheus application, the current version of ColdFusion seems to scale optimally to around four processors. At this point, it is often better to buy another ColdFusion server and cluster instead of adding processors. As a rule of thumb, a Sun system will perform at least as well as a Windows server with about one and a half the processor speed.

More detailed benchmarks are being developed. Watch this space for more information.

3.4. Hardware/Software Configurations

This section of the white paper discusses the hardware and software configurations that are specific to the Prometheus application. Both the Windows and UNIX configurations for Prometheus setup are similar.

3.4.1. Windows Hardware

The following table contains the hardware recommendations for a single-server installation of Prometheus, based on an average of 5,000 Prometheus users.

Operating System: Windows 2000 (Windows NT 4.0 will also function) Database: SQL Server 2000 or Oracle 8.1.6+ (SQL Server 7 will also function) Processors: At least dual 800Mhz RAM: At least one gigabyte, preferably two Disk Space: At least 35 GB, mainly for user file storage.

Note: While the "user file storage" can reside comfortably on a RAID-5 volume, it is *strongly* recommended that the database files live on mirrored or striped and mirrored drives (RAID 1 or RAID 0+1).

3.4.2. Unix Hardware

Hardware equipment recommendations for a single-server installation with 5,000 users on Solaris are provided below.

Processors: At least dual 400Mhz+ UltraSPARC Operating system: Solaris 7, 8 (2.6 will also function) Database: Oracle 8.1.6 or higher Memory: At least 1.5 GB, preferably 2 GB Disk Space: 35 GB, mainly for user file storage

Note: While the "user file storage" can reside comfortably on a RAID-5 volume, it is *strongly* recommended that the database files live on mirrored or striped and mirrored drives (RAID 1 or RAID 0+1).

3.4.3. A Note on the Chat Server

Most clients choose to use the chat server provided by Prometheus itself. This is a free service included with the software license. However, if you have a particularly "chatty" bunch of users or are concerned with possible network latency, then you can run a chat server locally.

Because the POPX software is Java-based, we find it runs better on Solaris. However, it does function on Windows NT.

Sun Hardware Recommendations:

Processor: One 300Mhz + UltraSPARC Memory: One gigabyte Operating system: Solaris 2.6 or later Disk Space: Two gigabytes, including the operating system

NT Hardware Recommendations: Processor: Dual 600Mhz + or one gigahertz + Memory: One gigabyte Operating System: Windows NT 4 SP 6a Disk Space: Two gigabytes, including the operating system.

3.4.4. Software for Windows & UNIX

The following table contains the software specification for both the Windows and UNIX version based Prometheus.

3.4.5. Windows/UNIX Software Table

Operating System: Solaris or Windows NT4/Windows 2000 Web servers: IIS (Windows only) or Apache 1.3.12+ (Windows and Solaris) Database: SQL Server 7 or 2000 or Oracle 8.1.6+ Java: JRE 1.2.2 or 1.3 Real Server Basic: 7 or 8 (free 25 concurrent stream) ColdFusion: 4.5.1SP2 Professional. If clustering is needed, use Enterprise version. Solaris users must use Enterprise. We also recommend

ColdFusion Studio if you are interested in modifying the Prometheus application or doing additional programming in ColdFusion. Chat server: Only needed if run locally, requires Java 1.2.2 SDK

Note: The Prometheus license does not include the license of the database platform you choose to run.

Note: The Enterprise Edition of ColdFusion Server 4.5.1 includes clustering software for running multiple ColdFusion servers together. For a single server, the Professional Edition is recommended.

Note: The licensing of the ColdFusion server software is not included in the Prometheus license. ColdFusion must be purchased separately with a significant educational discount.

Note: It may be necessary to run both Apache (to serve a handful of ColdFusion pages) and IIS on a Windows NT 4.0 server due to a bug introduced in service pack 6a. Both SP5 and Windows 2000 do not have this bug.

3.4.6. Network Issues

The Prometheus server is a fairly lightweight application, and does not require large amounts of network bandwidth. From the end users perspective, Prometheus provides a text-based interface that makes the software useable by clients coming in with extremely slow modem connections, down to 9600 baud. Users with faster connections may prefer the more graphically rich environment, which performs adequately for a user with a 28.8 modem connection.

If the database and the ColdFusion application servers are not running on the same physical machine, we recommend that they be logically "close" to one another to help minimize latency. A direct 10 Mb/s ethernet connection is more than sufficient.

3.4.7. Prometheus Provided Software (WebEQ/CFX_Zip/PopX)

Not all the software that makes up the Prometheus application needs to be purchased by clients. As part of the base license we bundle WebEQ, CFX_Zip, the 25 user version of Real's RealServer and the PopX chat server.

WebEQ, the Web Equation Editor, is Java software written by Design Science with a custom interface developed by the Prometheus development team.

CFX_Zip is a ColdFusion "custom tag" written by Ben Forta.

The PopX Shockwave Server is software licensed by Prometheus for Chat functionality. Prometheus has purchased an unlimited license (including source code) from the third party vendor, to implement chat functionality as part of the Prometheus application. Most clients will use Prometheus' PopX servers, and will not need to run the server locally.

3.4.8. User Recommendations – Browsers/Hardware/Plug-ins

End users need a computer with a browser. End users can use Windows, Macintosh, Linux or Unix machines with browsers to utilize Prometheus. Prometheus supports Netscape's Navigator 3.0 to 4.75 and Internet Explorer 4.0 or higher. The only plug-in needed to use Prometheus is Macromedia's Shockwave 8.0 to utilize the Chat feature. Depending upon the content uploaded into the course, plug-ins such as Adobe's Acrobat may be needed.

3.5. Recommended Configuration

Smaller colleges with experience in Windows may find it more effective to run Windows and SQL Server due to cost considerations. We recommend very large schools consider using Solaris with Oracle due to the inherent scalability of the platform. In the case of GW, we run our "front end"

ColdFusion environment on Windows NT, with a Solaris system running Oracle as the database backend.

3.6. Student Information System (SIS) Integration

Prometheus integrates the learning management system with your campus student information system (SIS) as part of the original software license. Prometheus allows flexibility to integrate with SIS systems such as PeopleSoft, Banner, various homegrown systems, etc.

This is an automated process that populates the Prometheus database with all users, both faculty and students, from your SIS and ties the users into the courses with which they are associated using a batch file. By automating the tie in process, this relieves administrators, faculty or students from manually having to add student accounts to courses.

However, Prometheus technicians will need a pipe delimited flat file produced on a nightly basis, which feeds directly into Prometheus based on the spec that is given below. When Prometheus receives this file, scripts are run to parse through the file and populate the database with information provided by the SIS.

The following user information is needed from the SIS:
First and Last Name,
Email address,
Username,
Password.

The following course information is needed from the SIS:
Course number,
Department id,
Section number,
Course title,
The starting and ending dates for the course and the days of the week the course meets,
Identify which users are members of the course.

The following SIS have already been integrated with Prometheus:

* SCT's Banner * Poise * Numerous proprietary systems

Note that the batch file generation is very simple; virtually any administrative system should be able to produce the required data.

3.7. Security

Prometheus' native authentication method allows the users to log in using the combination of User ID and password. The entered password is encrypted via MD5 and compared against a security table within the database. If it matches, the user is assigned a randomly generated unique User Key and Whois key.

This is done to prevent the intrusion of unauthorized users trying to gain access to Prometheus course content. Prometheus uses the Universally Unique Identifier (UUID) that is generated within ColdFusion to store session variables. Instead of passing the user id between pages, Prometheus uses the randomly generated UUID. The UUID is then matched with several other URL variables against a temporary usage table to determine the real ID of the user.

3.7.1. Implementation of SSL in Prometheus

SSL (secure sockets layer - also seen as https://) is a common technology used to secure form submissions on the web. SSL works by a server exchanging a "key" with a client before any data is transmitted including login data like usernames and passwords. The data is then encrypted before it is sent, and decrypted on the other end. A protocol analyzer viewing these encrypted packets would see what looked like garbage - jumbled data. While Prometheus is capable of running completely through secure SSL connections, be aware that it will require more hardware and network resources to encrypt and decrypt the SSL connections. It is also possible to encrypt just the login page.

3.7.2. Integration with Campus-Wide Authentication Systems

Prometheus has been successfully integrated with many other authentication systems. Integration has been done either directly (against LDAP or Active Directory) or indirectly, by using FTP or POP connections against a University's central server. Furthermore, multiple kinds of authentication can be supported simultaneously; for example, a University could verify a Prometheus login against LDAP. If the LDAP connection failed, Prometheus could revert to its "native" authentication mode. This allows the creation of guest accounts within Prometheus that would not require any kind of external privileges.

3.8. System Administration Requirements

Many users are concerned when it comes time to install any type of new application. How much time does it take to administer the system? What kind of skill set will be required to monitor and troubleshoot the application?

Since Prometheus courseware requires very little maintenance after the installation or upgrade to new version, the administrator who takes up the responsibility of the administering Prometheus is expected to spend on average about 20% of their weekly duties on monitoring the Prometheus application and troubleshooting user related errors.

Although it is not required for the administrator to be highly skilled in the operating system that the application is running or the type of database and web server it resides on, it is recommended that the administrator have sufficient knowledge about the system so that it is easier to serve the needs of the users.

3.9. Appendix A - CF Scalability

To better understand the ColdFusion's ability to scale, please refer to following link: http://www.allaire.com. This document contains detailed information on scalability and examples of the scalability testing that was performed by Macromedia.

Contact Us

Thank you for your interest in Prometheus learning management system. For more information, or to speak directly to a Prometheus Sales Manager, you can reach us at:

Toll free phone: 866-295-4107

Butch Gemin: 202-994-0585

Prometheus
The George Washington University
1922 F Street NW, Suite 301
Washington, DC 20052