Model of an E-Learning Solution Architecture for the Enterprise

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**Introduction**

**The Emergence of E-Learning**

At the end of the 20th century, the first wave of Internet applications forever transformed the way the world conducts business. E-commerce revolutionized the way companies sold their products and services and the way they managed their supply chains. Customer support via the Internet changed the way businesses addressed customer needs and concerns, and web-based, employee self-services empowered workers to access and seek information once limited to a select few. For the early adopters, these applications garnered huge productivity gains and cost savings, while increasing customer satisfaction, accelerating time to market, and providing competitive agility.

Many businesses today are thus implementing e-business models, hoping to replicate these business benefits to maintain their competitiveness. As companies rethink almost every aspect of the way their employees work, e-learning holds the potential of becoming the most widely used application in the enterprise. In this era of rapid change, employees around the world are expected to regularly assimilate vast amounts of new product, market, and competitive information to compete effectively. Traditional instructor-led training cannot scale to meet these new learning challenges. E-learning, defined as Internet-enabled or Internet-enhanced learning, provides the tools to help companies tackle these learning challenges and make continual, lifelong learning a reality.

**The Evolving Vision of E-Learning**

E-learning is evolving quickly. In its earliest stages, thousands of static pages of content were posted on the web. It then became a quick and easy way to deliver instructions or learning modules to many people around the clock. The vision for e-learning going forward builds on this concept by continually imparting new bits of knowledge to thousands of people globally, in a variety of media, from many different subject matter experts. Employees will be able to choose when, where, how, and how much they are ready to undertake in three- to five-minute learning increments as part of their work day.

Searching for these nuggets of knowledge will be easy, because each nugget will be a self-contained, tagged object. These learning objects will be targeted to learners when they need them and only to those who need them. Practice exercises after each one will reinforce the learning. Completing these short learning sessions will become as natural as checking e-mail from work, home, or on the road. Combining a number of these knowledge increments will result in a 30-minute learning module. Pre-assessments will identify the gap between what learners already know and what they need to know to effectively do their jobs. Post-assessments will confirm if they retained the knowledge.

Along individualized learning roadmaps, employees and their managers will be able to track learning progress based upon business objectives. Learners and providers alike will be held accountable for their
E-learning as defined by Cisco is not simply “e-training.” It is not just about placing classes online to address training issues. E-learning encompasses training, education, information, communication, knowledge management and performance management. It addresses business issues such as reducing costs, providing greater access to information and accountability for learning, and increasing employee competence and competitive agility. E-learning is a critical element of any enterprise workforce optimization initiative.

Key E-Learning Stakeholders and Business Drivers

The key e-learning stakeholders can be divided into two broad categories—the consumers of e-learning and the providers of e-learning.

1. The consumers of e-learning are:
   - **Learners** seeking knowledge, whether they are internal employees of the corporation or customers, channel partners, and supply chain vendors external to the enterprise
   - **Managers** responsible for guiding the learning and development of individuals and/or organizations
2. The providers of e-learning are:

- **Content providers**—instructors, subject matter experts (SMEs), and instructional designers—who perform a needs analysis to determine the learning objectives required to make a targeted audience competent in performing a task. This group also includes curriculum developers, who look at job roles and tasks, and then specifically define the competencies (skills, behaviors, and knowledge) required to do them.

- **Administrators** responsible for managing catalog items, schedules, resources (classrooms, instructors, equipment), lab time, and pricing. They may also identify generic curricula for an organization.

**The Key Business Drivers**

Before beginning to build an architecture, it is important to understand the business needs that can be addressed with an e-learning solution: **cost, access, modularity, timeliness, relevance, and accountability**. These very same business issues and opportunities have driven and will continue to shape the Cisco E-Learning Solution Architecture. It’s also worthy to acknowledge that the various stakeholders view the key business drivers from very different perspectives. While e-learning offers many new opportunities for learners and their managers, it is up to the e-learning providers and administrators to tackle some of the challenges associated with this new vehicle to make e-learning a viable solution within their companies.

- **Cost.** For learners and their managers, travel expenses associated with attending a week-long course represent a huge cost for a company, not to mention the opportunity costs of being away from the office or away from customers. By moving at least a portion of this learning online, the potential cost savings can be significant, especially for a large enterprise. Administrators of an e-learning solution must consider the most cost-effective ways to manage and integrate e-learning with the rest of the enterprise’s applications. To reduce the cost of producing new e-learning modules, providers must be held accountable for reusing and repurposing as much existing content as possible, rather than continually recreating it.

- **Access/Scalability.** Instructor-led training (ILT) poses timing, geographical, and availability constraints that restrict access to learning. E-learning scales to make valuable knowledge available to hundreds or thousands of learners simultaneously and at their convenience. E-learning also enables a company to better leverage global resources, utilizing subject matter experts around the world. To meet the needs of a global, diverse audience, e-learning providers must offer multiple presentations of the same learning object based on a learner’s profiling information. For example, a provider wouldn’t attempt to stream TV-quality video to a learner in Asia using a 14.4 Kbps modem.
• **Modularity.** E-learning objects created in three-to-five minute increments can be reused in multiple training modules. This level of modularity also becomes an essential element in providing a highly personalized experience based on pre-assessments or other selection criteria.

• **Timeliness.** Timeliness and pervasiveness of training in an era of rapid change and growth is an ongoing challenge today. ILT content creation is often the bottleneck for delivering learning, because it may take six to twelve months to create a full weeklong course. Once the ILT is completed, it may not be offered for many weeks, may only be offered in a few locations, and/or it may fill up quickly given the space constraints. E-learning can be as simple as providing a video or audio-on-demand for anyone who immediately needs to know something to improve job performance.

• **Relevance.** It’s difficult to make all aspects of an ILT course relevant for all learners, since every learner enters a class with a different baseline of knowledge. E-learning addresses this issue in two ways: by letting learners select only the information they need and by providing a prescribed learning target for the individuals or groups. Online pre-assessments will indicate the learning opportunity most relevant to each learner.

• **Accountability.** Aside from certification programs, it has been difficult to hold learners accountable for what they’ve learned, hold managers accountable for the development of their teams, or hold instructional designers and instructors accountable for the effectiveness of their offerings. E-learning tracks learner progress with practice exercises and post-assessments online. Online feedback buttons allow learners to provide specific feedback on each small increment of learning, rather than limiting the feedback to a brief evaluation at the end of a 40-hour training. The number of times an object is accessed provides an indicator of its value to the learner and a good measure of its effectiveness. With e-learning, managers can create individualized roadmaps of learning to ensure that their employees master the skills that they need. Content providers can be held accountable for reusing and repurposing content based on the cost of their creations.

**Design Principles and Implementation Guidelines**

With a clear picture of the business drivers fueling an e-learning initiative, it is appropriate to consider some implementation guidelines that can be used by those preparing to build an e-learning solution architecture. Cisco recommends an enterprise-wide e-learning architecture that is open, scalable, and global, with plug-and-play capabilities.
Open Architecture
With the goal of creating a plug-and-play e-learning applications environment that supports interoperability among different vendor solutions, the framework of the architecture must be an open, standards-based model. A proprietary situation can be limiting. Be sure to choose the vendors and solutions that are aligned with the emerging standards for interoperability as defined by organizations such as AICC (The Aviation Industry CBT [Computer-Based Training] Committee), IMS (IMS Global Learning Consortium), SCORM (Sharable Course Object Reference Model), and IEEE (Institute of Electrical and Electronics Engineers).

Scalable
No matter how small an e-learning solution architecture may begin, it must be scalable. E-learning will probably become one of the most widely used applications in the enterprise, accessed by every employee. As the enterprise builds more and more objects, bear in mind that the object repository will grow quickly, and the systems and applications required to manage it will need to scale as well. A scalable architecture delivers appropriate performance as broadly as possible, while providing the flexibility to increase the level of sophistication of the overall learning solution as it matures.

Global
Ideally, enterprises with a global employee base should localize the content and the user experience of its e-learning applications. If a subject matter expert wants to do a search in Chinese, for example, the metadata should account for that. This is a challenge, however, because most new e-learning solution vendors base their business models on initially addressing a U.S.-based audience, with ultimate plans to fine-tune global capabilities. Applications development providers today are creating technologies and standards that will not only translate content, but will translate the applications themselves.

Integrated
The goal of seamless integration extends beyond the individual components that comprise an e-learning architecture. An e-learning architecture must integrate with all backend application systems — including human resources, finance, performance management, knowledge management, entitlements, and security — as well as the overall network infrastructure.

Flexible
E-learning has fueled the need for new types of applications. New, better, best-of-breed products will continue to emerge. A plug-and-play architecture needs to be adaptable to changing business requirements and processes, emerging technologies, and new vendor solutions.
**Rapid and Timely**

Set a goal of delivering incremental value rapidly, with an eye for continuing to add levels of sophistication over time. Given the critical issues that e-learning initiatives are attempting to address, companies do not have the luxury of 18-month implementation schedules. It is important to be able to implement new solutions without major architectural changes. The potential cost savings are significant, so enterprises will want to be able to reap business benefits quickly.

Since the e-learning concepts in practice today are so new, one can assume that the business model will continue to change as it matures. This is an appropriate place to take some risk, with rational experimentation. Remember, e-learning could be the most widely used enterprise application, so factor a significant level of complexity and mission criticality into the systems planning effort.

As noted earlier, this paper’s focus is large enterprise deployment, but many of these concepts could also apply to a small- or medium-sized business. Now that some strategic implementation issues have been covered, it is time to drill down to enabling technologies upon which the e-learning application blueprint is based.

**Cisco’s E-Learning Solution Architecture**

The following enterprise model is based on the Cisco E-Learning Solution Architecture. This model provides a glimpse of an e-learning solution architecture that is in various stages of implementation. The full architecture includes three layers: the top access layer, the middle application blueprint, and the underlying network infrastructure layer. The primary focus of this section is on the application blueprint.
The Access Layer

The top access layer serves multiple audiences, including all Cisco employees, the sales organization, customers, and external partners. Each of these audiences may have their own access schemes or portal designs tuned to their own needs, such as consolidated content sources based on common interests. Everyone enters the e-learning solution from this access layer.

The Underlying Network Infrastructure

With access to all of Cisco’s leading-edge equipment and technologies, the e-learning solution architecture relies heavily on a robust network infrastructure to deploy many of the services that are based on the applications layer of the blueprint. The architecture is built upon a Cisco Intelligent Network, which ensures availability, scalability, and performance, as well as the ability to simultaneously deliver data, voice and video. It also manages security, quality of service and content distribution.

The Application Blueprint

This application blueprint is divided into four functional areas—Business Operations Services, Content Management Services, Delivery Management Services, and Learning Management Services—to break down the processes of conception, development, delivery, and management into appropriate areas of responsibility and promote cross-functional integration. This model is similar to those used for previous enterprise-wide application implementations at Cisco. The plug-and-play, modular approach provides the flexibility to enable best-of-breed functionality in each of these areas as the e-learning vision evolves.

Business Operations Services (BOS)

The tools and applications within Business Operations Services support all Cisco training organizations. The architecture enables various training groups to continue managing with the tools and applications currently in use, while providing services that consolidate requirements shared by all organizations. In this functional area, Cisco identifies business initiatives of the organization, performs needs analysis relative to skills development, develops competency models by job family, establishes necessary curricula to meet business goals, and prioritizes and initiates learning initiatives. This is also the area where generic applications services needed in all other areas have been consolidated. Many of these applications have cross-functional dependencies on other enterprise level projects.

Business Operations Services include the systems, tools and applications used to support the following services:
User/Learner Experience
BOS defines requirements for the user experience and oversees the effectiveness of e-learning solutions. The goal is to align both Cisco’s internal and external web sites by maintaining standards and leveraging existing tools and services to enhance the experience.

E-Learning Support
When fully implemented, the E-learning Support Service will encompass all levels of support, including, but not limited to, learner support in the form of e-mail, an 800 call number, and online answers to frequently asked questions. This service will also provide support for all tools in the other administration and management areas. It will also align with Cisco’s current support model (e.g. internal and external technical support).

Online Help/Learning
The Online Help Service offers assistance for all e-learning tools and services. It provides users and learners access to solutions for solving their own problems. It was developed using the methodologies for building all of Cisco’s e-learning solutions.

Security
The Security Service will help to manage access to applications and content based on the roles of users and learners. This will align with Cisco’s current security standards.

Reporting
The future Reporting Service will be used to manage the data that rolls up into Cisco’s Corporate Data Warehouse (CDW). This will allow the cross-functional reporting tool the ability to provide reports on progress, usage, reusability of content, and overall business results for e-learning.

Requirements Repository
The Requirements Repository provides the central collection and storage location for the learning product business requirements shared among the training organizations. A Cost Model Analysis function enables Sales and Marketing to model scenarios that help determine the optimal packaging of education product offerings, based on parameters such as operating costs, resource usage, and geographic economic fluctuations. A Gap Analysis function determines the difference between what learners need and want, as determined by surveys and evaluations, and their current knowledge based on assessment results. Data from the Cost Model Analysis function influences how the package is built and the Gap Analysis function helps determine what kind of content is created in the next functional area—Content Management Services.
**Content Management Services (CMS)**

Once all of the e-learning business decisions have been made in Business Operations Services, the Content Management Services enable content providers to register (check-in content and categorize that content through the use of metadata), assemble, manage and publish learning content for delivery. CMS provides access to all the internally built systems, authoring tools and applications listed below, as well as the third-party authoring tools supported by IT, such as DreamWeaver, Microsoft Word, OutStart, gForce, or PowerPoint. It enables e-learning providers to register entire learning applications as binary large objects (BLOBs) or to register structured objects.

As more learning organizations write their offerings in objects or three- to five-minute learning increments, it will be important for content authors to be able to locate existing content authored elsewhere to reuse or repurpose it rather than completely recreate it. This will require instructional designers, content providers or course developers to register and maintain a complete, accurate and up-to-date description of their program in the CMS repository. Structured learning authoring tools enable the author to assemble learning objects, including text, graphics, assessment items, executable files, videos, etc., into a lesson template. Effective delivery of a dynamic, prescriptive learning experience to the learner requires consistent descriptive and structural metadata for all content.

**Workflow Application**

The future Workflow application will not only offer a default learning content development workflow, but the flexibility for each workgroup to create their own flow. The workflow will require only mandatory step: to register content and baseline metadata into the repository before publishing the content.

**Authoring Tool Integration**

The Authoring Tool Integration Service enables content creators to write learning objects such as text, graphics, and assessment questions that can be linked to any level of the learning hierarchy. The Authoring API enables users to import questions authored in another tool to the Content Storage System.

**Registry Services**

The Registry stores the location, the descriptive metadata, and the structural metadata associated with a particular content object. The object may be physically stored in the Content Storage System or in another secure location. Registering objects promotes widespread reuse, repurposing, or modeling of content. Registration can be done using the standard CMS interface, the Workflow application, or an API to directly enter the required information into the Registry Repository.
Object Mining Service

The Object Mining Service uses the metadata repository and the content itself to locate learning objects that meet an author’s search criteria. The author then previews the objects to determine applicability for reuse. Search and edit functionality enables repurposing of the content. The search functionality of the Object Mining Service is also available through an API.

Assembler

Working in tandem with the Object Mining Tool, the Assembler enables the author to drag and drop the desired learning objects from the object mining result set into an authoring template. These templates are authored, registered and stored in the e-learning content repository and provide the basis for packaging content in the Assembler.

The learning objects may include text, graphics, VoD/AoD, synchronous events such as labs, assessment questions, executables, or imported courses. Authors can then preview assembled content using a delivery style sheet, which becomes the basis for learning roadmaps and catalog entries.

Content Storage Services

Content Storage Services (CSS) provide all of the traditional content management services for learning objects, including version control, notifications, history and reporting, and check-in/check-out object locking. CSS also has an import/export function to transfer objects or packages of objects to and from other content storage systems, including third-party vendor systems.

Publishing Services

When a learning offering is ready for release, it must be published to the delivery distribution environment. Publishing Services assign the offering a release version number. The metadata provides the Delivery Management Services (DMS) information about how to deploy this offering. From here, DMS delivers the offering to a learner upon request by Learning Management Services (LMS).

Delivery Management Services

Once content is authored and ready to publish, Delivery Management Services determine the best way to deliver it to users. At Cisco, some of the distribution environment is internal, and some of it is outside the firewall. This provides the flexibility to work with partners and vendors to host content outside the company. Cisco has piloted and put into production delivery technologies of virtually all media types to satisfy specific business objectives and optimize the learning experience.

Delivery Management Services include the systems, tools and applications used to support the following services:
**Content Presentation**

Content Presentation uses a learner’s profile and preferences to identify matching content. The Content Management system specifies the template for the delivery of a given lesson. DMS dynamically generates personalized content by mapping the profile and preferences of a learner to the content. This is also where the target for delivery is decided, whether it is to the web, print, or another access point with download capability.

**Distribution Management**

Business users can set up business rules to help define how to manage the distribution of content. A request broker delivers pre-packaged content and/or links directly into third-party vendor content that may not have the ability to track at any level smaller than the offering level. Proximity Management ensures that the content requested by Learning Management Services is retrieved from the storage device closest to the learner. If the content is not retrieved immediately, it may be downloaded overnight for availability the next day.

**Interaction Results Management**

The Delivery and Distribution Management System tracks a learner activity while managing delivery of the content, then reports those results back to Learning Management Services (LMS) to track the history. This tracking is only temporary, since all information pertaining to an individual is kept in the LMS. Here are some examples:

- DMS must provide bookmarking within the location of the dynamically delivered content and that of the third-party vendor, if the vendor has this capability. It must then pass the bookmark back to LMS. Bookmarks are used when LMS makes the same request the next time a learner wants access.

- The offering related to a missed assessment item will need to be tracked and passed back to the LMS to enable prescription.

- Anything that a learner wants tracked will need to be managed at the time of delivery by DMS, and the results need to be passed back to LMS.

**Learning Management Services (LMS)**

Learning Management Services provide the user experience as well as the back-end systems to manage training transactions such as registration and validation. This is where learners access their e-learning environment and where their personalized tracking occurs. LMS manages all interactions here, including navigation, selection of learning offerings, and connection to Delivery Management Services for delivery of learning offerings.
**Personalization**

The combination of a user’s system profile and personal preferences provides the basis for personalizing the user experience and creating dynamically generated, personalized development plans. Profiles contain stored information about the learner, such as job title, organization, and location. These cannot be edited by the user. Personal preferences, such as delivery mode and language, may be edited by the user.

**Search/Browse**

The Catalog is the virtual repository of all Cisco e-learning offerings, and users can Search/Browse to easily find, add, and maintain Catalog offerings. They can also use the Search/Browse feature to register and pay for specific offerings in the Catalog.

**Registration**

Registration enables learners to access Catalog offerings from any portal location, register, and enroll in the offerings. Learners can be registered automatically while navigating through a portal or they can be directed to the LMS Catalog for additional Search/Browse functionality. Registration manages access to learning offerings and learning history/plans. It also handles notifications, schedule changes, waitlisting and drop policies for learning offerings.

**Learner Tracking**

Learner Tracking tracks a learner’s progress through e-learning offerings by recording the history, current status, and anticipated future progress through the offerings. Learners invoke subscription when they want to modify their own development plan, but they cannot modify system-based or manager prescriptions. Managers use manager-based prescription to modify their employees’ development plans. System-based prescription is activated when a learner does not meet a required test threshold while taking an assessment.

**E-Commerce**

When a learner chooses to purchase a Catalog offering, e-commerce provides the payment functionality. The learner accesses the e-commerce engine through an API to take advantage of multiple payment methods, centralized financial management, and multi-language and currency processes. When Registration receives notification of payment authorization, it adds the offering to the learner’s plans or marks the product for delivery.

**Assessment**

Pre- and post-assessments are integrated with offerings to complete a comprehensive curriculum that provides feedback to both learners and managers and to add value to the overall learning experience. Pre-
assessments enable learners to study only the necessary material for a task at hand, saving valuable time. Post-assessment results are also a key element for progress reporting.

Today, threshold-based prescription triggers the system to prescribe content for further study based on assessment results that fall below a targeted percentage. Moving forward, assessment items and the rules that govern their relationship to specific content and to each other will be built in Content Management. They will be moved to Delivery Management when ready for production to enable dynamic, personalized delivery and object level prescription.

**Manager’s Toolkit**
Managers can access a learning plan/history for each direct report in their reporting chain. They can approve registration and add to their employees’ future learning plans. They can also review their employees’ progress for both offerings and assessments.

Managers have essentially the same user experience as learners – except that their user experience includes tools and services available only to managers – such as manager-based prescription. Managers can prescribe offerings to register learners, adding to each learner’s current plan. Managers can also prescribe offerings to be added to a learner’s future plan. This functionality will be tightly integrated with the corporate Performance Management system.

**Survey**
Surveys enable users of the Learning Management Services functions to provide input to Business Operations Services regarding their satisfaction with the material.

**Resource Management**
Resource Management assigns classrooms and instructors for instructor-led training and virtual events, managing the schedules for equipment, facilities, and instructors.

**Program Management Recommendations**
Once an e-learning solution architecture has been implemented, these program management recommendations will help ensure long-term success for evolving e-learning solutions.

- Obtain executive management support. Without executive management’s ability to see the vision, it will be difficult driving the change management required across the enterprise and will delay reaping the benefits of e-learning.
- Focus on business issues, not training problems. Address those business issues and establish business metrics to determine that those needs are met.
• Partner early and completely with e-learning solution groups as they emerge in the enterprise. This includes active IT involvement and partnership because e-learning relies heavily on new and evolving information technologies.

• Don’t treat this as a long-term technology decision. E-learning is a young industry, so stay agile while keeping an eye on emerging standards and technologies.

• Use an experienced application development team for implementation.

• Don’t proceed without the necessary infrastructure (e.g. network, funding, resources, etc.) in place.

Summary

With the proper executive support, e-learning can provide significant strategic and competitive advantage for an enterprise. Depending on current circumstances, e-learning can also provide significant and immediate return on investment by reducing non-value-added expenditures such as travel.

The key to success in implementing any solution is to clearly capture and articulate the enterprise’s most important business drivers and then create solutions to address those requirements. This will determine the appropriate level of complexity or sophistication required for content creation and management, delivery management and overall learning management services to be provided. Once an initial framework is implemented, it will be easy to add more functionality and capabilities, provided that the e-learning solution architecture considers all possible components, as outlined throughout this document.

Keep in mind that this is still a very nascent industry, so standards and technologies will continue to emerge. Vendors will also continue to emerge or consolidate, so do not feel trapped into thinking that a strategic, long-term decision relative to technology choices must be made. Focus on providing a reasonably open application platform that considers various functional elements to allow for future flexibility and rapid enhancement.

Additional Resources

Feedback or questions about this white paper can be e-mailed to the content providers: Bill Souders, Director of IT, bsouders@cisco.com and Rick Crowley, Senior Manager, E-Learning Architecture, rcrowley@cisco.com. You could also visit the following sites:
