



# Massachusetts Institute of Technology: Transforming the Campus Experience with the MIT Mobile Web

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**E D U C A U S E**

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Massachusetts Institute  
of Technology:  
Transforming the Campus  
Experience with the  
MIT Mobile Web



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The mission of the EDUCAUSE Center for Applied Research is to foster better decision making by conducting and disseminating research and analysis about the role and implications of information technology in higher education. ECAR will systematically address many of the challenges brought more sharply into focus by information technologies.

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## Preface

The EDUCAUSE Center for Applied Research (ECAR) produces research to promote effective decisions regarding the selection, development, deployment, management, socialization, and use of information technologies in higher education. ECAR research includes

- ◆ research bulletins—short summary analyses of key information technology (IT) issues;
- ◆ research studies—in-depth applied research on complex and consequential technologies and practices;
- ◆ case studies—institution-specific reports designed to exemplify important themes, trends, and experiences in the management of IT investments and activities;
- ◆ roadmaps—designed to help senior executives quickly grasp the core of important technology issues; and
- ◆ key findings—brief high-level summaries on the scope of an ECAR research study.

As part of its 2009 research agenda, ECAR recently published a study, *Spreading the Word: Messaging and Communications in Higher Education*,<sup>1</sup> written by Mark C. Sheehan with Judith A. Pirani. The study examined current practices and future directions related to EDUCAUSE members' use of e-mail, telephony, mobile communications, and crisis communications.

## Literature Review

The literature review helped identify and clarify issues, suggested hypotheses for testing, and provided supportive secondary evidence. Besides examining articles and studies from journalistic, academic, and IT practitioner sources, we consulted with practicing CIOs experienced in IT governance to develop study objectives and survey questions.

## Online Survey

We designed and administered a web-based survey that was distributed to institutional representatives (mostly senior IT leaders) at 1,694 EDUCAUSE member institutions in July 2008. We received 351 responses (a 20.7% response rate).

## Interviews

We conducted follow-up telephone interviews with 37 senior IT leaders from a mix of institutions to gain deeper insights into findings from the quantitative analysis and to capture additional ideas and viewpoints.

## Case Study

ECAR researchers conducted this in-depth case study to complement the core study. We assume readers of this case study will also read the primary study, which provides a general context for the individual case study

findings. We undertook this case study of the Massachusetts Institute of Technology to learn about the development of its suite of web-enabled mobile services, called the MIT Mobile Web. ECAR owes a debt of gratitude for their time and insights to Justin Anderson, Macintosh Developer; Richard D. Berlin III, Director of Campus Dining; Craig A. Counterman, Architect, Content and Collaboration Services; Wilson D'Souza, Director, Infrastructure Software Development & Architecture; Michael D. Dutton, Usability Consultant; Jerry Grochow, VP for Information Services & Technology (IS&T); Eric Kim, User-Interface Design Consultant; Brian Patt, Principal, MangoText; Michael S. Sherman, Manager of Applications Services, Department of Facilities; Taeminn Song, Project Director, Office of the Vice President of IS&T; Matthew Sullivan, Mobile Device Consultant; Ann Wright Wilson, Marketing Specialist, Campus Dining; and Andrew Yu, Mobile Platform Manager and Architect.

## Introduction

For today's students, a mobile communication device is an ordinary, essential object, much like their wallets and house keys. Students' mobile device ownership is pervasive, but how they use them is not always well understood. Text messaging is commonly considered to be a popular mobile device application; *The ECAR Study of Undergraduate Students and Technology, 2008* reported that three-fourths of the student respondents use text messaging.<sup>2</sup> But the study also suggested another mobile evolution is under way, as students switch from simple cell phones to mobile devices with web-access capability. In 2007, 15.9% of the survey respondents owned a mobile device with web-access capability; the 2008 data showed respondent ownership rising to 66.1%, with another 5.3% planning to own one within the next 12 months. More students are using mobile devices for information retrieval as well as for communications.

The same research study also reported that 30.8% of respondents access the Internet from a cell phone or PDA, with 17.5% doing so weekly.<sup>3</sup>

As students become accustomed to incorporating their mobile devices' informational capabilities into their daily routines, their expectation and need to access institutional services with those devices will rise accordingly. If they can access JetBlue flight information on their mobile devices, why not the local campus shuttle schedule? If they can check what movie is playing at the nearby cineplex, why can't they learn about tonight's concert on the quad?

Whether because of a lack of resources, more pressing priorities, or a perceived lack of demand, our current study, *Spreading the Word: Messaging and Communications in Higher Education*, suggests that many higher education institutions have not responded to this mobile evolution. The survey data show that 50.6% had adapted no preexisting services for delivery to handheld devices, and 59.2% had developed no new web-based services for delivery to handheld devices.<sup>4</sup> Yet the need for mobile services exists and will continue to grow. As Matthew Sullivan, mobile device consultant at MIT, declared, "Today's students grew up with cell phones and mobile communications. Today's freshmen take it for granted that institutions would offer mobile services. It would be a disservice not to develop them."

In response to this trend, MIT's Information Services & Technology (IS&T) organization designated the development of mobile services as a strategic priority. "Ultimately IT's goal is to aid education and research," stated Jerry Grochow, vice president for IS&T. "Mobile services can enhance work productivity, social productivity, and, to a certain extent, educational productivity. IT's support of that kind of innovation advances our area's mission by helping people to work more effectively." In response, IS&T launched a suite of

seven web-enabled mobile services called the MIT Mobile Web in June 2008. Services range from course updates to emergency notification to shuttle schedules (see <http://m.mit.edu> or <http://mobi.mit.edu/about/>).

In addition, IS&T released a beta version of an interactive SMS text messaging service in March 2009 (<http://mobi.mit.edu/about/sms.html>).

This case study focuses primarily on the MIT Mobile Web. Its purpose is to recognize the service's operational status, to highlight IS&T's notable development path that enables all MIT community mobile device users to access the Mobile Web, and to assist other institutions with their own mobile service development. This case study offers readers the MIT Mobile Web model for consideration, detailing the drivers, the platform, the mobile service development process, and IS&T's future plans in mobile services.

## Background

Jerry Grochow leads MIT's IT organization, which consists of the following functional areas:

- ◆ Client Support Services provides user support in the forms of departmental technical support, help services, training, communication, and consultative assistance.
- ◆ Infrastructure, Software Development, and Architecture maintains MIT's infrastructure and software architecture.
- ◆ Operations and Infrastructure Services provides fundamental IT services such as network and network-based applications, service operations, and data aggregation and administration.
- ◆ Student and Administrative Services manages MIT's financial, student, and human resources enterprise systems.
- ◆ Telephony Services as well as IS&T Human Resources and Administrative Services comprise two areas. The former provides telephone services to

the MIT community; the latter provides financial, site, and human resources services to the IS&T staff.

Along with regular operations, the VP of IS&T funds an annual "Big Initiative" program to promote the development of "new experimental or prototyping initiatives that would be highly visible or have a significant impact on the community and that are likely to result in some ongoing service or benefit for the Institute."<sup>5</sup> IS&T funds these projects separately and draws personnel from across the IS&T organization. The MIT Mobile Web is the product of a FY2008 Big Initiative project targeted at the development of mobile web services at MIT.

## Mobile Service Drivers: Keeping Ahead of the Technology Curve

Like most higher education institutions, MIT has supported the increasing technological mobility of its students, faculty, and staff over the years. For example, as the MIT community embraced wireless networking, IS&T responded accordingly by blanketing the campus with approximately 3,000 access points in 2005.

Consequently, more people carried their laptops, but many students found them too heavy and cumbersome to tote around MIT's geographically dispersed campus. IS&T staff members noticed more students gravitating toward mobile devices instead for information access. "When a 6-ounce device contains your music, telephone, and web access, there is no excuse not to carry it around full time," stated Grochow.

This trend accelerated when smartphones (cell phones with e-mail, web access, and/or PC-like functionality) entered the market in recent years and—still more recently—when mobile services carriers began to slash monthly service fees for unlimited web access. The introduction of the Apple iPhone in June 2007, with its touchscreen,

enhanced web browser, and other functionality, spurred mobile web access on the MIT campus, especially among students. For many users, the mobile device was no longer just a telephone; rather, it was quickly evolving into a handheld information retrieval device. Throughout this period, too, IS&T noticed the growing popularity of text messaging among MIT community members.

IS&T realized in 2007 that its IT service structure was not keeping up with the MIT community's evolving mobile information needs. "It was still a painful process for users to access information on the MIT.edu website via their mobile device," said Andrew Yu, mobile platform manager and architect. "We realized IS&T needed to embrace mobile communications because it is a fact of life that 98% of MIT students have access to a cell phone, with the main driver being information access on the go." And given the varying capabilities of mobile devices, IS&T realized that information access could mean text messaging as well as web access.

Thus, mobile services became an IS&T priority. "Since students are more likely to have their smartphones out than their laptops, I wanted to get in front of this technical adoption curve," stated Grochow. "Our goal is to eventually provide all the information that you want to access via a mobile device in one form or another."

At MIT, this view led to the designation of mobile service development as a Big Initiative project during FY2008 to create platforms for both the Mobile Web and interactive SMS services. After approximately 10 Big Initiative submissions were considered that year, mobile services was one of the three proposals chosen as best representing the Big Initiative program ideals.

The Big Initiative designation enabled IS&T "to put a very strong, dedicated, focused effort around a mobile platform and services," according to Wilson D'Souza, director, infrastructure software development

& architecture. "We could rationalize where to deliver top-quality applications using our current service portfolio and where it would be easier for others [i.e., MIT areas] to develop their own services." Today's MIT Mobile Web and SMS Service are outcomes of the IS&T Big Initiative project. IS&T developed the Mobile Web service in under a year, from an October 2007 kickoff to a June 2008 release; the SMS Service is currently in beta release. The following section details the Mobile Web service; the "Future Steps" section updates the SMS Service's progress.

## MIT Mobile Web

The MIT Mobile Web is designed to offer "on the fly" information to MIT community members and visitors through a suite of web-enabled services adapted for mobile devices. The services revolve around the MIT experience so that people can access needed information while completing their daily MIT-related activities. "The student's everyday routine involves the mobile device—going to class, going to lunch, going home," stated Ann Wright Wilson, marketing specialist, campus dining. "MIT Mobile Web brings all parts of their day onto the mobile device. For example, a student on the first day of fall semester classes can access the following via the MIT Mobile Web: her course information, classroom location, any course-related updates, faculty contact information, and the next shuttle's arrival time to transport her to class."

Current MIT Mobile Web services include

- ◆ 3DOWN: Status updates about MIT's essential technical services, including phone, e-mail, web, and network services.
- ◆ Campus Map: An interactive, searchable campus map to find buildings, parking, and landmarks. Searchable by building number, name, or keyword.
- ◆ Emergency Notification: Information about campus emergencies with one-

click access to campus police, medical services, and other emergency phone numbers.

- ◆ Events Calendar: Campus event calendar searchable by keyword and time period, or browsable by category with one-click access to the campus map to find the event's location.
- ◆ People Directory: Searchable directory of students, faculty, and staff at MIT by part or all of their name, e-mail address, or phone number with one-click calling or e-mail access, or office location (where available).
- ◆ Shuttle Schedule: Schedules and route maps for each of the MIT daytime and nighttime shuttles.
- ◆ Stellar (MIT course management system): News and announcements for any class with a Stellar site, as well as faculty and staff contact information.

Figure 1 is a representation of the Mobile Web interface.

## Project Fundamentals

The Mobile Web development team drew IS&T staff members from Client

Support Services and Infrastructure Software Development & Architecture areas, as well as external consultants from local firms like MangoText. Yu was appointed project manager. Taemin Song, project director, office of the vice president of IS&T, serves as the project's advisor, helping the group to keep the project's business implications in mind and to ensure that the platform and services are scalable and sustainable. IS&T allocated \$250,000 to the project.

For the Mobile Web, IS&T observed two fundamental principles when creating its mobile services: create a device-independent, standards-based platform; and piggyback on currently available web content. These principles ensure that the Mobile Web precludes no mobile user from access to its services, and they create a replicable service development framework to efficiently build web-enabled mobile services. To facilitate the development of web-enabled mobile services at other institutions, MIT plans to release MIT Mobile Web's code as an open-source resource for general use. The following sections discuss how MIT approached each principle in practice.



Figure 1. MIT Mobile Web Interface

## Neutral Platform Provides Flexibility

The MIT Mobile Web development team initially had to address the fundamental question of device support. With so many different mobile device makes and models in use, MIT could not create specially formatted content for each one. MIT might have developed content for a small number of selected devices, but instead they decided to create a device-independent platform for several reasons.

The first reason is market dynamics. In the turbulent mobile communications industry, vendors can rise and fall—and then rise again—in the marketplace. A classic example is Palm, Inc., which after its initial success with its Pilot and Treo lines experienced financial difficulties. Given these circumstances, it might not have seemed feasible for a mobile web service platform to support the Palm operating system in the long term. However, in January 2009, Palm announced its latest model, the Pre, which garnered rave product reviews, complicating the issue of whether to support Palm or not. “The market is all over the place and changing so rapidly that if you pin down a strategy to a particular mobile platform, and something happens, the entire landscape changes, sometimes in six to nine months,” stated Yu. A device-neutral platform

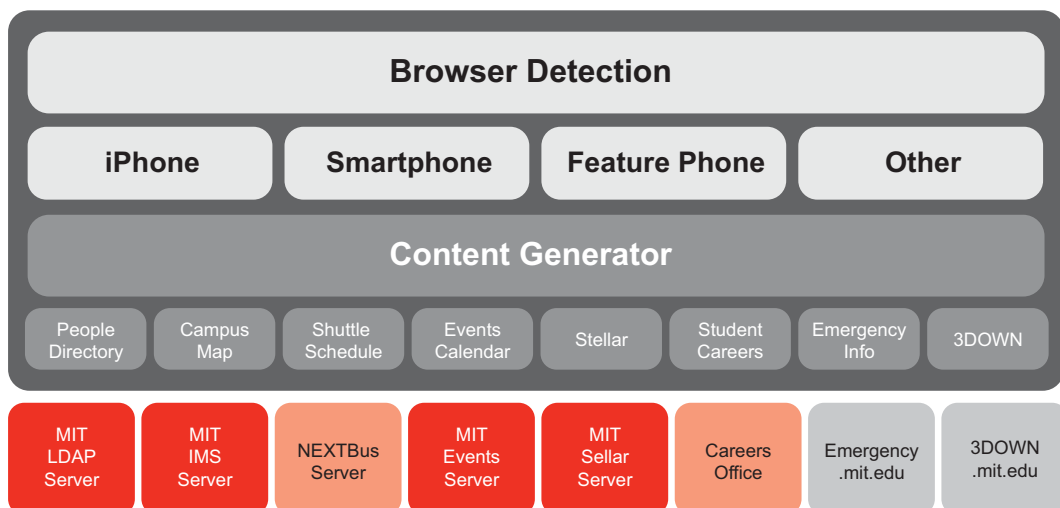
resolves this question by maintaining a neutral stance, and as a result MIT Mobile Web can be updated relatively easily to support newer operating systems like the Apple iPhone and Google Android as they emerge.

A second reason is the marketing relationships within the U.S. mobile communications industry. If MIT’s mobile platform were to support a particular device, it would automatically marry the service to a specific carrier or carriers. A prime example is the exclusive relationship between Apple and AT&T for the highly popular iPhone.

This leads to the third reason—the lack of standardization among U.S. mobile service carriers. Whereas AT&T and T-Mobile support the Global System for Mobile Communication (GSM) network, Verizon embraces the code division multiple access (CDMA) network.

“In the mobile world, there are so many different permutations,” continued Yu. “This lays out the fundamental challenge with the mobile applications—making them work on multiple standards. We saw the Mobile Web as an opportunity to build a cross-carrier and cross-platform solution.” So rather than customizing web services for the tens of thousands of cell phone user streams, the development team designed the neutral mobile service platform, whose components appear in Figure 2.

Figure 2. MIT Mobile Web Service Platform



## The Wonders of WURFL

WURFL is an open-source XML configuration file that lists approximately 100 capabilities and features for over 400 mobile phone models around the globe, providing a centralized resource for mobile application and service development. It is maintained primarily by Luca Passani, though contributors around the world submit relevant product information. Located on the SourceForge.net open-source software website, the project notes that its creators' ambition is "to model the properties of common wireless devices around the planet and provide a simple API to programmatically query the capability database."<sup>1</sup>

WURFL is based upon the premise of commonality among browsers and devices. For example, different browsers contain many common features and are adopted by numerous mobile device manufacturers; newly introduced mobile devices frequently incorporate evolutionary versions of the preexisting hardware and software. WURFL utilizes this commonality to build a compressed matrix of browser features based upon the concept of families of devices. This matrix is smaller and easier to update than a normal data file. For more information, see <http://wurfl.sourceforge.net/index.php>.

The development team chose WURFL because the members felt WURFL offered the most comprehensive set of data at the time for mobile browser identification, and it is an open-source resource. Andrew Yu, mobile platform manager and architect, noted that other commercial alternatives are now available.

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1. "What Is the WURFL?" WURFL, <http://wurfl.sourceforge.net/faq1.php>.

### **Layer One: Browser Detection**

To display its web content optimally, the MIT Mobile Web service first determines the accessing mobile device's browser capabilities. To do this, the MIT Mobile Web server reads the device's browser user agent string, which contains information about the name and version of the device's web browser and operating system. Then it references a configuration file that lists mobile devices and their capabilities. The Mobile Web relies upon an open-source configuration file called Wireless Universal Resource File (WURFL). (See "The Wonders of WURFL" sidebar.) "Unlike a normal website, where you have to worry about just a few major browsers—as for example Microsoft Internet Explorer or Mozilla Firefox—the mobile web space consists of tens of thousands of different user agent strings because of the many mobile web browsers and mobile devices in use, especially if you include the older cell phones," Yu said.

"WURFL enables the Mobile Web to quickly identify the type of device that the user is calling from."

### **Layer Two: Device Categorization**

When developing the Mobile Web platform, the development team was determined to offer an optimal user experience, regardless of mobile device. "We want to open up the Mobile Web to all members of the MIT community—even visitors," stated Yu. "But if we used the lowest common denominator of every mobile device, the user experience would be pretty poor. But customizing the Mobile Web for every mobile phone device is technically challenging, bogging down the development effort."

So the development team designed a solution that matches a version of the Mobile Web to the accessing mobile device on the basis of the device's assignment into one of four categories, or as the team calls them,

“buckets.” Once the Mobile Web recognizes the mobile device, the service assigns it to one of the buckets, offering a user experience that optimizes the device’s preexisting capabilities. For example, when Mobile Web detects a browser with JavaScript, it can then generate a view that takes advantage of that technology.

The following paragraphs describe the four buckets.

*Feature phones or regular cell phones.* According to Yu, this group comprises “the great majority of all the cell phones sold in this country in 2007 and 2008.” Feature phones possess very small and limited browsers, and almost none of them utilize JavaScript, so the Mobile Web’s user experience must necessarily be simple and straightforward. The development team also determined from their industry research that few feature phone users subscribe to a mobile service data plan. So while the development team believe feature phone users will constitute a very small percentage of Mobile Web users, they created a feature phone bucket because the installed base is so large. Consequently, the development team designed a user experience that would be “very light on anything but text,” stated Justin Anderson, Macintosh developer.

*Smartphone devices (e.g., Palm Treo, BlackBerry Pearl).* This category comprises all smartphones with the exception of the iPhone. Through their research, the development team determined that smartphone users are more likely to surf the web because they typically subscribe to a mobile service data plan. The devices themselves utilize a better browser that incorporates limited JavaScript. Smartphone users can surf the web via a scroll ball or touchscreen instead of arrowing, so they can review long web pages. The development team incorporated these capabilities to design a more robust user interface and experience for devices that fall into this bucket.

*iPhone/iPod touch.* During the Mobile Web’s initial development phase in 2008, the Apple iPhone and its sister product, the iPod touch, offered a unique user experience owing to their more graphical interface, enhanced browser and PC-like capabilities, and touch-screen. Consequently, the development team created a separate bucket for these devices to showcase the Mobile Web’s full potential (and to address the diversity of the MIT user market). Though the content displayed on an iPhone/iPod touch mirrors that of the smartphone devices, the user interface is more robust.

*Other devices.* This bucket contains any remaining devices, most notably desktop or laptop PCs, and provides a user interface accordingly.

The development team concedes that the bucket definitions are far from absolute. “We constantly evaluate new mobile devices and their industry market share and the shifting product segmentation,” stated Eric Kim, user-interface design consultant. The development team’s consensus is that feature phones’ usefulness has peaked because of their technical limitations; the development team may eventually merge the smartphone and feature phone segments. At the same time, the iPhone/iPod touch bucket could be expanded to incorporate new devices, such as the BlackBerry Storm and the Google Android–supported T-Mobile G1 that mirror the iPhone/iPod touch user experience.

### **Layer Three: Content Generation**

The next step was to display the Mobile Web service’s content. The development team chose not to create new content for the Mobile Web. “We piggybacked off current MIT services,” explained Brian Patt, principal, MangoText. “We coded the back end to communicate via standard interfaces with preexisting databases and services, and then generate our specially designed Mobile

Web content pages. For example, for the Mobile Web's People Directory, the development team created a solution that accessed the information directly from the MIT People Directory's LDAP server instead of building an entirely discrete directory. The Event Calendar accesses information from the MIT Event Calendar via a SOAP application programming interface. Other Mobile Web services may use XML or RSS feeds."

Not only did this decision accelerate the initial development process, but it also made the Mobile Web services smaller and faster to load, a real advantage on the slower mobile networks these devices use, and on the slower processors embedded in the current crop of mobile devices. The one challenge with using preexisting content is the rendering of page displays, because sometimes the content that the Mobile Web draws on is not designed for mobile applications, subsequently requiring the development team to redesign the content format.

### **From Big Initiative to Rollout: Mobile Web Service Development Cycle**

In October 2007, Yu assembled a small project team: mobile device programmers and web application developers to develop the initial set of Mobile Web services and user interfaces. Because of time and resource constraints, IS&T fielded a development team that included both MIT staff members and external consultants. Development proceeded through four phases: service selection, feature development, user testing, and rollout.

#### **Phase One: Service Selection**

With the team in place, the service selection phase commenced. To identify an initial suite of Mobile Web services, the development team had to comb through the hundreds of existing services in the MIT web space. Members relied on a number of resources, including earlier research that

Yu had conducted with the Sloan School of Management during the spring 2007 semester. Yu served as the IS&T sponsor for a project-oriented course entitled "Practical Information Technology Management." Three students worked with Yu, surveying MIT undergraduate students to gauge general interest in web-enabled mobile institutional services and to identify potential services to develop. The team concluded there was indeed interest in such services, and, on the basis of their analysis of the screen size of devices, the way they are used, and expectations for interactivity, they developed a list of potential services, including a People Directory and a Shuttle Schedule.<sup>6</sup>

Augmenting the Sloan School research was the development team's own inventory of current web services offered by all university units, to identify which content the Mobile Web could access with minimal or no modifications. For example, the development team determined that a mobile People Directory service could be designed very easily by accessing information in the MIT People Directory's LDAP server.

Sometimes slight modifications were accommodated during mobile service development. For example, the Emergency Management Office agreed to make emergency information accessible to the Mobile Web by setting up an RSS feed. Another example involves MIT's Stellar Learning Management System. In 2006, when that system was brought online, application architect Craig A. Counterman included in it course catalog features based on a lightweight XML architecture. "We thought this information could be used in portal or other web pages," Counterman said. "The data was available when the Mobile Web project came along. We discussed potential use cases, and with a few XML file enhancements and data clarifications, the Mobile Web team could access the data and reformat it for the Mobile Web's Stellar service."

To meet their Mobile Web's launch deadline, the development team had to rule out other services. For example, time constraints forced them to scrap an MIT News Service in the Mobile Web's initial version because the development team determined they could not reconfigure the existing campus news feed for the Mobile Web within the project's time frame.

A final criterion was that the service content had to be publicly available to avoid the complexities of user authentication during the Mobile Web's initial rollout.

Eventually the development team elected to reconfigure seven currently available web services, listed above, into the Mobile Web's initial offerings, released in June 2008.

### ***Phase Two: Feature Development***

With the broad web services selected, the second phase was to design "the subsets of functionality that we wanted to syndicate, federate, and represent in a way that was appropriate in the mobile context," stated Kim. This required the development team to think about the broad web services in a more focused way. "I had to think about technical and physical confines of the mobile device in the context of potential usage situations," continued Kim. For example, a user who accesses shuttle information while waiting at a bus stop has a different information need than one surfing the web in the library. "Mobile is a whole different concept from the Internet," explained Taeminn Song. "You need to access information quickly and concisely on a mobile device; you don't search the web for hours. Consequently, you need to be more proactive when designing mobile services, anticipating how users will use them. The applications must look pretty and be simple to use, but very functional, too." Richard D. Berlin III, director of campus dining, elaborated: "You are parsing out the relevant pieces of your website for mobile applications, and there are information,

functions, and features that are unique to mobile only. How these meet together is important."

This phase was very difficult and time-consuming because of the very richness of the MIT website and the demands of the mobile screens. "The MIT website has a lot of depth and breadth," stated Michael S. Sherman, manager of applications services, department of facilities, and a Mobile Web user. "Extracting salient services to a limited screen space and then narrowing it to a very small, relevant feature set is very difficult to get exactly right." As the team worked through this process, they created user experience diagrams and flowcharts that depicted the screen flow for each mobile service feature on each of the four device buckets defined earlier. The screens were then HTML-prototyped for usability testing on representative devices.

### ***Phase Three: User Testing***

Next, the development team tested the usability and popularity of those Mobile Web service feature prototypes with MIT students, faculty, and/or staff. From this, "We learned how people expected the services to behave versus the way we actually designed them," stated Michael D. Dutton, usability consultant.

The development team felt usability testing was especially important with mobile services because "you are dealing with the limited real estate on a mobile device's screen," explained Sullivan. "By observing where people naturally gravitate first on the user interface, we were able to rearrange the user interfaces accordingly." Another goal was to incorporate users' expected terminology into the service design—something of particular importance because of the MIT community's extensive use of acronyms and jargon.

The development team commissioned two usability studies. First, the team conducted real-life scenario testing of Mobile Web service features in a usability laboratory during April

2008. A more informal session followed in May 2008 wherein randomly selected people walking by the MIT student center tested Mobile Web features.

The formal usability sessions examined the services' content terminology, information structure, and navigation, as well as whether they matched users' preconceived assumptions. A general invitation to participate was issued via public venues and the IS&T listserv. About a dozen people participated in two one-hour testing sessions. Each group consisted of users whose mobile devices corresponded to one of the feature phone, smartphone, and iPhone device buckets described earlier. Smartphone and iPhone users constituted the majority of testers. The development team observed the testing from an observation room.

Testers completed 5 to 10 commonly used tasks related to three prototype services: Campus Map, People Directory, and Shuttle Schedule. For example, they located a specific building on the Campus Map or searched for a hard-to-find name on the People Directory. Tasks were presented to the testers in descending order of the developers' priority. A camera faced down over the tester's device so that the development team could observe how the user interacted with the device and the application.

Testers also talked about how to tackle a specific task and discussed whether the Mobile Web matched their thought processes. Dutton explained, "For example, when I observed that a tester was unhappy about a feature, I asked them to elaborate further. Their unhappiness told us that the users' mental schematic—the way they saw it—was different from the way the application worked. Talking with them helped us understand in what ways it was different. Perhaps we would see from the conversation that we could fix the problem by placing the button to access a specific shuttle bus schedule in a different screen position or by reducing the number of steps required to access the information."

After each task, the testers completed a five-question survey about the ease of completion, efficiency, and intuitiveness of the task, and whether they would complete this task daily on the Mobile Web. Dutton and his team compiled users' remarks and looked for trends—e.g., five people approached the task in a given manner, but one completed it another way. "Little things give us a lot of data that enable us to build affinity diagrams to synthesize the relationships between the testers' expectations, experiences, and the actual service design," explained Dutton.

The development team then reconciled the differences between the original design and the new ideas gained in testing. The informal session in May 2008 tested their redesign efforts. They set up a tent in front of the MIT student union, inviting students to complete a task on the Mobile Web service. Then participants filled out a survey to evaluate the service and to describe their mobile device usage. Three dozen students participated, mainly iPhone and BlackBerry users. The redesigns were well received, but the development team further refined the Mobile Web on the basis of the students' feedback, in preparation for the Mobile Web rollout.

#### **Phase Four: Mobile Web Rollout**

IS&T released the MIT Mobile Web in June 2008. Marketing efforts were relatively low key. The development team printed and displayed some posters, and MIT highlighted the Mobile Web on its institutional website. IS&T gave presentations during the 2008 fall semester student orientation. Since the service's release, word of mouth has spread awareness of the Mobile Web around campus.

As awareness grew, so did traffic. Yu reported that Mobile Web traffic had increased significantly, from 6,000 page views per month in June 2008 to a monthly rate of 80,000 page views nine months later, though traffic varies depending upon the time of year.

Average traffic composition by mobile device category is iPhone 55%, smartphones 17%, feature phones 11%, and other 17%. IS&T reported that iPhone traffic rose significantly when the students returned for the 2008 fall semester. The most frequently accessed services are the Shuttle Schedule and the Campus Map.

Overall, IS&T views the Mobile Web as a success for several reasons. “The traffic continues to rise, which gives us a reasonable idea that the service is being used,” stated Yu. “We have received considerable feedback from the MIT community, which is overwhelmingly positive because users feel the Mobile Web adds value to the MIT experience. The Mobile Web has caught the attention of a growing number of MIT areas that want to add mobile content, to the point of straining our development resources. From a technical perspective, the post-release accommodation of Google Android–supported mobile devices proves the Mobile Web is easily scaled to new platforms.”

## Future Steps

With the MIT Mobile Web launched, IS&T has identified several future mobile-related activities.

## Version 2.0: More Services and User Authentication

With the launch, Mobile Web left the Big Initiative incubator and is now an operational IT service. IS&T has funded the development of a Version 2.0 of the Mobile Web, with plans to introduce a broader array of services for a proposed release in summer 2009. With the interest generated by Version 1.0, IS&T found it has many choices when selecting the next round of services to develop. “Now that we have established our presence and demonstrated the increased traffic, we have so many campus entities approaching us, it was time for us to prioritize the new wave of service development,”

said Yu. The heightened interest highlighted the issue of fiscal resources, as IS&T funding levels are inadequate to develop modules for all the MIT areas that wish to provide Mobile Web content; therefore, units that provide content may have to contribute to the development costs.

Proposed modules for Version 2.0 include MIT news, MIT museums, Athletics, Campus Dining, and the Libraries. These areas require some data preparation to ensure the development team receives a clean feed in order to propagate the content back to the Mobile Web user. For example, the MIT News Office will strip down its news feed, eliminating high-resolution photographs in order to fit on a mobile device. The office is even modifying its workflow process to identify a single, lower-resolution photo to highlight in the mobile version of each article. Yu admitted that convincing areas to modify their data “was not a hard sell, because mobile technology is one of the hottest topics on campus today.”

Some potential content providers for the Mobile Web 2.0 areas begin without a workable content presence on the web, but they are likely to benefit from the development process created during the Mobile Web’s initial rollout. One example is the MIT Campus Dining unit. MIT does not offer traditional meal plans; meals are paid for through two debit card systems—Dining Dollars or TechCASH—at 20 campus locations, two off-campus restaurants, and a pizza delivery business. MIT Campus Dining launched a website in 2002 with dynamic menu information that was updated weekly, but that unit is now updating its website to offer more enhanced capabilities and to provide more nutritional information for students. As director Berlin and marketing specialist Wilson observed more mobile device usage, they felt it was an opportunity to revamp Campus Dining’s web presence accordingly. “As we got into our website redesign, we decided that we needed to make our menu accessible on the fly,” Berlin

said. “So if you are walking around campus, you are hungry, and you want to know what a certain café is serving for lunch, you can pull the menu up on your mobile device.”

Berlin and Wilson involved Yu at the beginning of Campus Dining’s website redesign, discussing mobile service capabilities. They identified three features that involve information from the most highly trafficked sections of the current website:

- ◆ dynamic menu searching,
- ◆ notification of dining-hour changes due to an emergency, and
- ◆ a dynamic map locator for dining options.

The team decided to use RSS feeds to create a Campus Dining service on the Mobile Web. To create the dynamic menus, Campus Dining will utilize templates already developed for other Mobile Web services, thereby enabling each food service provider and contractor to enter its menu selections to be displayed in optimal format for mobile access.

An important feature in Version 2.0 is user authentication, which enables the Mobile Web to offer new services or features containing secured information. For example, MIT policy prohibits the display of actual room locations in buildings shown on the MIT Campus Map unless the person is an MIT user. Authentication will enable the development team to add this greater detail to the Mobile Web service. Another benefit is the ability to apply context and personalization to content, further enriching services—for example, more location-based services as well as mobile payments via the MIT TechCASH debit card. The current strategy is for users to install personal certificates on their mobile devices instead of relying upon user IDs and passwords. Not only does the former provide greater security, but also a user wishing to access the Mobile Web does not have to repeatedly key in personal information—a tedious task at best on many mobile devices.

IS&T also plans to remain attuned to the changing mobile communications landscape. “There is no question that devices other than a standard laptop are on that exponential part of the growth curve,” stated Grochow. “We are not sure what the next set of devices is going to be, but we need to ensure that we can deliver services in different sized screens and formats, on a variety of different devices at a reasonable cost so we can satisfy the MIT community’s mobile needs.”

## Structured Development Process

The service development process is maturing to enhance its efficiency. This is especially important as more MIT areas desire to create mobile services. As a first step, the development team has issued guidelines to assist areas with proper data preparation. “This will make it easier for the content providers, as they are responsible for providing their data in a good format to us,” stated Patt. “We documented our project experience as to how to display and format, and what to display or not. We can work with areas directly to develop any complex applications.”

## Open Source

Not only does IS&T want to structure its internal development process, but another goal is to facilitate the development of mobile web services at other colleges and universities by releasing the MIT Mobile Web as an open-source resource. “The idea is for an institution to take our source code and implement its own version of the Mobile Web with a customized interface,” stated Yu. “So instead of investing a hundred hours to create the browser detection system, the data templates, and user interfaces, they can cut their development time by modifying the MIT Mobile Web code.”

As noted earlier, the development team purposely built the Mobile Web modules to use standardized interfaces. Now any insti-

tution can use these standard interfaces to build its own modules accordingly. “From our perspective, the data and format are unique to MIT, but the rest is not,” stated D’Souza. “It is like building a highway. We are instructing how to get on the highway, where are the ramps, and what are the rules for driving on the highway. For example, another institution may use our People Directory module, but pointing it to their own LDAP directory. For the Stellar module, we structured the templates, and it is a web server that pulls in the data from the core LMS. If an institution is using Blackboard or anything else, they can do the same.”

MIT’s goal is to enable institutions to focus more on creating the content for their mobile services, less so on the actual mobile service platform or on specific segments of the mobile web space, whether it is specific device-level operating systems—like the iPhone, Android, or Symbian—or specific applications in libraries, student services, or athletics. As with other open-source initiatives, users would share their enhancements or their new work with the community. “We are looking for the open collaboration that will help the outside as well as MIT users,” D’Souza said. “The goal is to enable the rest of community to innovate with us.”

The MIT Technology Licensing Office approved IS&T’s plan to open development of the MIT Mobile Web platform in March 2009. Now the Mobile Web team is developing descriptions of the resultant organization and management of its planned open-source community. “We are open to whatever is going to work best in the community and MIT,” stated Grochow. Yu described one scenario of initially publishing the code via SourceForge.net, the open-source software development website, and then potentially moving toward a more formal management structure.

But some things are clearer. “We envision an open community that is not purely academic, with a managerial structure not

tied to specific development cycles of new releases,” explained D’Souza. “Each community member will focus their development energies to address their individual priorities. Transparency is important to reduce overlap and duplication.” D’Souza compared the envisioned Mobile Web community to the Apache Software Foundation, “where there will be many contributors, but no licensing and no legal agreements with every contributor.”

## Student Involvement

Another way to develop Mobile Web services is to work with the primary users themselves—the students. This has become an important part of IS&T’s development strategy. In the spring and fall 2008 semesters, after Google announced the Android platform, Hal Abelson, electrical engineering and computer science professor, and Yu taught a course, Building Mobile Applications, to teach students how to build prototype mobile services on open-source mobile platforms. The students were divided into project teams and presented their prototypes at the final class. IS&T can work with the students upon the course’s completion to prepare any feasible prototypes for eventual deployment to the community. One team from the spring 2008 course won a \$275,000 competition from Google for its application called Locale, whereby a mobile device’s settings change automatically depending upon the device’s location—for example, silencing a mobile device’s ringer when in a classroom.

D’Souza envisions taking student outreach a step further by creating an entity to work directly with any students—MIT or otherwise—helping with front-end guidance on service or feature development, or helping to advance the Mobile Web open platform.

## SMS

As noted earlier, the IS&T Big Initiative specified the development of an interactive SMS Service as well as web-based mobile

services. iPhones and smartphones are well suited for the MIT Mobile Web, but the same is not true for feature phones, which currently make up the vast majority of mobile devices in use. Though the Mobile Web offers a version for feature phones, the limited capabilities of those devices make web access an often unwieldy proposition. As Yu discussed earlier, feature phone users are less likely to subscribe to a mobile data access plan, too. So an interactive SMS service provides another means for feature phone users to access information on the fly.

MIT's SMS Service will provide the same information as the Mobile Web, minus things like the campus map that cannot be put into a text messaging format or other content that is hard to format in an ASCII/text manner. So when a user text messages "648338" (MITEDU on a feature phone's regular numeric keypad) and submits a question in query format, as for example DIR and the name of a person, the system sends back a text message containing the answer to the question—in this case, the person's phone number and e-mail address. Thus, a feature phone user can participate at a basic level in the Mobile Web. IS&T released a beta version of the SMS Service in March 2009, featuring text messaging versions of the three most popular Mobile Web services: People Directory, Shuttle Schedule, and Stellar. (See <http://mobi.mit.edu/about/sms.html>.)

The SMS Service has taken longer to roll out partly because it requires approval from each mobile service carrier. According to Yu, carriers manage text messaging services more carefully because users are charged for incoming and outgoing messages, so they are careful about allowing organizations to send text messages. This per-message charge has impacted SMS rollout plans, too, because MIT is charged for each text message sent in response to a user information inquiry. Consequently, the SMS Service rollout will be more gradual.

## Lessons Learned

The MIT Mobile Web team learned several lessons from their project experiences.

### *Put yourself in the mobile context.*

When designing mobile services, developers have to put themselves in the mobile context. "The temptation is to take a slice of everything that's available on the general website and cram it down into a mobile web service," stated Kim. "The necessary starting point is to understand what is appropriate in a mobile context. This is a more fundamental question than the selection of modules and content." Kim described mobile context as experiential but with philosophical questions that the team must answer even before the design and technical questions.

### *Start small and build momentum.*

It may be tempting to build a plethora of mobile services to meet students' rising demands and expectations, but Song advised otherwise. "Start small with something that is really meaningful and build upon it," he suggested. "The success of the initial module can, in turn, create momentum for other applications." He cited a campus map application that could eventually integrate with a calendar service to display an event's location.

In that vein, Wilson advises institutions to create mobile services with an institutional perspective. "If you are bringing mobile services to a certain group, look for complementary groups to see if it makes sense to collaborate. The shuttle buses travel by buildings where the Dining Services has cafés. It makes sense to bring groups together and cross tab on user behavior to encourage more frequent mobile service use."

Song even suggested that the development of interinstitutional mobile services is appropriate, especially among peer institutions that share unifying characteristics, services, or activities. Obvious examples are mobile services that provide a multi-institutional campus map or event calendar.

*Start small and stay focused.*

Introducing mobile services in small, incremental releases also enables the development team to stay focused and not get overwhelmed by the project's potential magnitude. "Realize mobile web services are evolving—not static," suggested Sullivan. "This enabled us to release our first set of services on a timely basis. We knew we could introduce other services later."

*Take advantage of existing institutional resources and industry standards.*

Incorporating this strategy enabled the development team to accelerate the development process, introducing the Mobile Web several months after the project kickoff. "Instead of creating something totally new, we pooled available MIT resources and combined [them] in a nice interface," stated Sullivan. "This strategy worked well when we approached departments to use their content, because frequently it was time for that area to update its apps, too. They updated their content and then we implemented it into the Mobile Web, and both parties were happy."

*Don't forget the students.*

Though institutional administrators are the ones who design most of the actual institutional services, students are the primary mobile device users. Throughout MIT's mobile services development, IS&T and the development team worked to maintain students' relevancy and to let student input guide design. The initial survey work, the usability studies, the informal focus groups, and the application development classes all enabled students to contribute to the Mobile Web design. "Talk with the users, understand their unmet needs, find out how they work around what is missing or working incorrectly, and have them prioritize their requirements," stated Dutton. "This identifies the opportunities when starting a mobile web."

And the development team plans to keep in touch with students because in a rapidly evolving technology like mobile communications, today's hot application quickly becomes yesterday's news. "We can't be content with the results from our first round of research," Sullivan stated. "We want to see how we progressed, whether the Mobile Web is still fresh, and whether it still addresses the users' interests."

*Create one central place of ownership.*

Like an institutional website, a mobile web service is a broadly representative IT initiative, with many departments and areas across the institution participating in service development and content generation. Thus, a single entity must initiate and manage it institutionally "to ensure an integrity and commitment from everyone throughout the process on the quality and the delivery of information," stated Berlin. "If our area's mobile service distributes inaccurate or incomplete information, the users will not necessarily fault Campus Dining; the blame falls on everyone." This supervisory entity ensures the institution operates a unified mobile service, with a cohesive look and feel. With its strong, centralized IT organization, this was not an issue at MIT, but the situation may differ at a more decentralized institution.

*Good relationship management is key.*

The Mobile Web's comprehensive nature also requires a strong rapport throughout MIT and within the development team; and project manager Yu stepped up to this challenge admirably. Throughout various interviews, people commented repeatedly about his approachable demeanor, his strong engagement in the project, and his excellent communication and consensus-building skills. Within the institution, Yu was able to entice areas to contribute—and sometimes reformat—content. Different areas may have had specific opinions about how their content

was to be reformatted, but thanks to Yu's work all agreed to display it to match the Mobile Web's general look and feel.

Internally, Yu managed a development team comprising IS&T staff members and external consultants. "Andrew understands that the combination of people and the way you put together a team is a key project success factor," stated Song. During our interview sessions, all team members conveyed a sense of camaraderie and mutual respect. IS&T members were not perceived as territorial, and contractors never felt like outsiders. All noted how Yu encouraged members to discuss their differences openly to build a common solution.

## Conclusion

Web-enabled mobile services represent the next generation of information dissemination, especially among students. Sooner rather than later, every IT organization will have to address this new information need. "Typically IT asks the question: If we build it, will people use it?" stated Yu. "But for web-enabled mobile services, it is not a question of 'if,' but rather a question of 'when.' Today 90% of college students in this country have cell phones, so there are plenty of users who will use mobile services when you do build it."

MIT has a long history as an early adopter of new information technologies, and its approach to providing mobile access to web services is in this tradition. Accordingly, it

developed a robust suite of web-enabled mobile services in its Mobile Web—and it did so quickly and with an eye toward development efficiency and user inclusiveness. As other institutions contemplate their own strategies, the MIT Mobile Web offers an exemplary development model for consideration. With the release of an open-source version of the Mobile Web platform, MIT will also provide valuable material assistance to a community of like-minded institutions.

## Endnotes

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