

Just-In-Time Training of Deployed Skilled Support Personnel via Cell Phone Multimedia

Cesar Bandera
BanDeMar Networks, LLC
Newark, NJ
cesar@bandemar.com

Mitchel Rosen, Barry Schlegel
Univ. of Med. & Dentistry of NJ, School of Public Health
New Brunswick, NJ
mrosen@umdnj.edu, schlegba@umdnj.edu

ABSTRACT

Skilled Support Personnel (SSP) are non-first responder specialists dispatched to serve in emergency incidents, and include laborers, operating engineers, carpenters, ironworkers, sanitation workers and utility workers. SSP called to an emergency incident rarely have detailed and recent training on the chemical, biological, radiological, nuclear and/or explosives (CBRNE) agents or the personal protection equipment (PPE) relevant to the incident. This increases personal risk to the SSP and mission risk at the incident site.

We present the configuration and field tests of an SSP training system deployed at the Atlantic OSHA Training Center that augments conventional classroom instruction with just-in-time context-aware training via the cell phones of dispatched SSP. Specifically, dispatched SSP enrolled in the Just-In-Time Training for Emergency Incidents System (JITTEIS) receive brief training multimedia modules on their cell phones derived from the Occupational Safety and Health Administration (OSHA) Disaster Site Worker Course. The modules describe the CBRNE threats and safety protocols (including PPE) identified by the Safety Officer (SO) at the incident site. The SO is also permitted to upload new content for immediate broadcast, such as video clips of newly discovered hazards.

We discuss various challenges including (1) interoperability among diverse mobile devices, wireless service providers, calling plans, and incident management systems, (2) training adaptation to rapidly changing threats, (3) user modeling and system ergonomics, (4) pushed versus pulled content delivery, and (5) tailoring audio, video, and graphics to the capabilities of the individual mobile device.

ABOUT THE AUTHORS

Cesar Bandera is founder of BanDeMar Networks and Principle Investigator for the just-in-time training program under the National Institute for Environmental Health Sciences which received the 2007 New Jersey Entrepreneurial Award. He has been researching and advancing internationally ratified multimedia standards for wireless and object-based content, first as Senior Systems Engineer at AT&T Labs, and then as BanDeMar Networks' Chief Technology Officer. His background is in video processing for autonomous systems. Dr. Bandera received his Masters in Computer Engineering and Ph.D. in Signal Processing at the University of Buffalo.

Mitchel Rosen is the Director of the Office of Public Health Practice at the UMDNJ-School of Public Health. Since 1992 he has been the Center Manager of the NIEHS sponsored New Jersey/New York Hazardous Materials Worker Training Center, overseeing a training program that has provided hazardous materials training to over 350,000 workers. Mr. Rosen has a MS in Public Health from the University of Massachusetts, Amherst and is a PhD candidate at the Rutgers University Bloustein School of Planning and Public Policy.

Barry Schlegel is the instructional designer for the just-in-time training program. He is an Assistant Professor at the University of Medicine and Dentistry of New Jersey (UMDNJ)-School of Public Health, Department of Health Education and Behavioral Science. He has Doctorate in Education from Rutgers University, a Master of Arts in Teaching degree from Fairleigh Dickinson University, and a Master of Science degree in industrial hygiene from the University of Pittsburgh. He has been at UMDNJ for 17 years working on educational and research projects involving instructional design, curriculum development, and evaluation.

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JUST-IN-TIME TRAINING REQUIREMENTS

Skilled Support Personnel (SSP) are non-first responder specialists dispatched to emergency incidents and include laborers, operating engineers, carpenters, ironworkers, sanitation workers and utility workers. Although SSP are often exposed to the same hazards as first responders, they lack instruction in hazard assessment and the use of personal protective equipment (PPE) because their primary employment reinforces skill development, budget constraints of the private sector preclude advanced preparedness for disaster sites, and the range of potential disasters and protocols is too broad. These factors increase personal risk to the SSP and mission risk at the incident site.

The need to provide occupational safety and health training to SSP is well recognized (Lippy, 2002; National Clearinghouse, 2002). In the analysis of the 9/11 World Trade Center disaster response, training for SSP was identified as a critical need by two reports issued by the National Institute for Environmental Health Sciences (NIEHS) Worker Education and Training Program (WETP). SSP with general training (i.e., outside the context of any specific incident), such as Occupational Safety and Health Administration (OSHA) Disaster Site Worker Course #7600, would benefit from last-minute training on the PPE and chemical, biological, radiological, nuclear and/or explosives (CBRNE) agent(s) specific to the incident to which they have been dispatched.

Just-in-time training (JITT) is a distance learning paradigm for time-critical scenarios of known context. Conceptually, JITT for SSP is brief incident-specific training delivered to their mobile devices (m-learning) while they are on route to the incident site or awaiting orders in the staging area or command post. The most ubiquitous mobile device among SSP is the cell phone, but JITT must meet the following requirements to avoid being a distraction in an already stressful setting: (1) courses should be audiovisual, maximizing imagery, animation, video and audio, while minimizing

text, (2) the system should not require the learner to change any settings on his/her cell phone, install any new software, or change cell phone, wireless service provider, or service plan, (3) enrollment, authentication, course selection, and viewing should minimize key strokes, the memorization of passwords, or the maintenance of phone number lists, (4) the rendering of multimedia must be tolerant of temporary wireless bandwidth decreases and signal interruptions, and (5) user operations should conform to standard phone graphical user interfaces (Kangas and Kinnunen, 2005).

OBSTACLES TO UBIQUITOUS M-LEARNING

At first glance, it would appear that the pervasiveness of cell phones with multimedia functionality, such as cameras or web browsers, would facilitate the deployment of JITT. However, for the foreseeable future, the mobile marketplace will continue to witness variability in the multimedia capabilities of mobile devices and in standards compliance by device manufacturers and service providers. Interoperability between service providers is further hampered by their "walled garden" approach to media services and subscriber retention (Wu, 2007). The challenge facing the delivery of cross-provider and cross-device mobile media is thus identifying which of the many media formats and delivery protocols are in fact supported by each user. Interoperability barriers to multimedia services stem from both technology and business plans:

1. International multimedia message protocols were initially defined only for the Global System for Mobile Communications (GSM) wireless standard prevalent in Europe and used by some US carriers, the largest of which are Cingular/ATT and T-Mobile. However, some of these protocols such as Wireless Application Protocol (WAP) Push cannot be implemented in the Code Division Multiple Access (CDMA) wireless standard used in the US by Verizon and Sprint (Norwood, 2006).

2. Some middleware, such as Qualcomm's Binary Runtime Environment for Wireless (Brew) used by CDMA carriers, prevents users of non-smart phones from installing 3rd party applications. Subscribers can only install software purchased from that carrier.
3. User Agent Profiles (UAProfs), on-line descriptions of hardware and software of individual cell phones (e.g., screen size, codecs), are intended to support the automated tailoring of media to the capabilities of the recipient's device (i.e., content adaptation), but are incorrect or missing for over 20% of devices, primarily CDMA (OMA, 2006; Butler, 2002).
4. HTTP Get headers of microbrowsers in Microsoft Windows-based devices usually include only the non-descript */* in their ACCEPT tag and do not specify any user agent profile at all.
5. Content adaptation and local number portability resolution can delay a picture message from one wireless carrier to another by over eight hours.

JITTEIS ARCHITECTURE AND PROTOCOL

A JITT system for SSP called the Just-In-Time Training for Emergency Incidents System (JITTEIS, Figure 1) has been undergoing trials since February 2007, primarily at the Atlantic OSHA Training Center, and at the 2007 NIEHS WETP National Trainers Exchange conference. Learning modules (derived in this trial from the OSHA Disaster Site Worker Course #7600) are stored in a learning content management system (LCMS) that also maintains an account of each incident with the caller IDs of enrolled users.

The Incident Commander (IC) or Safety Officer (SO) creates a new incident account in JITTEIS via the web (Figure 2a) or by sending an e-mail or text message to the LCMS, to which JITTEIS responds with a unique incident ID number. From this time forward, the IC/SO can recommend courses for the incident, update course recommendations (e.g., if a new threat is found), and broadcast messages (including multimedia messages with photos and videos) to the SSP.

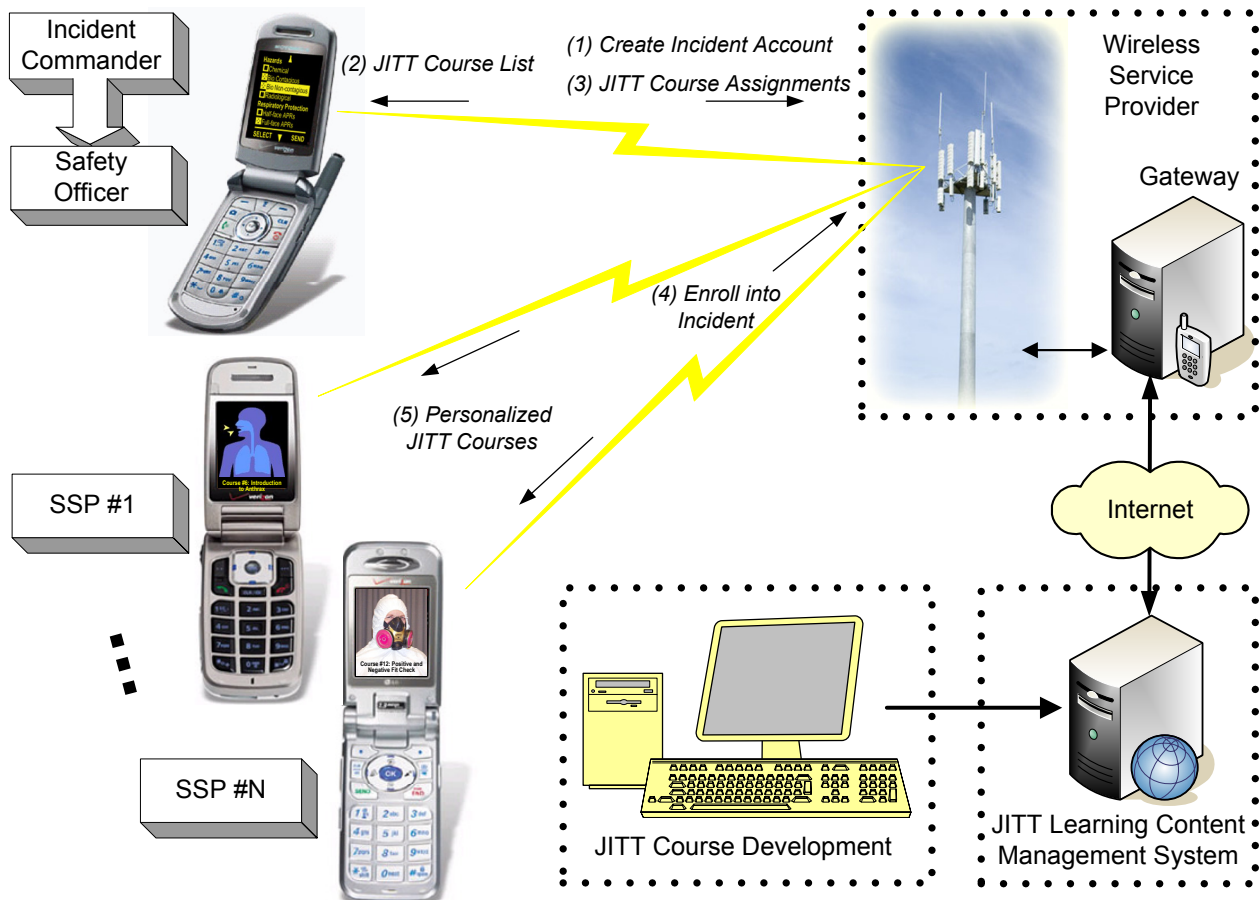


Figure 1. Architecture of the Just-In-Time Training for Emergency Incidents System.



Figure 2. JITTEIS Screen Samples: IC/SO Course Selection (left) and SSP Learning Module (right).

SSP enroll in an incident by sending a text message to JITTEIS with the incident ID. JITTEIS records the caller ID and the multimedia capabilities of the device, and responds with the recommended courses (Figure 2b) and all broadcast messages associated with that incident. All enrolled SSP receive broadcast messages and newly recommended courses in real-time.

Most current multimedia-enabled mobile devices are supported by four different file formats and four different delivery mechanisms (Table 1). In other words, there are 16 different ways to convey a multimedia experience to a mobile JITTEIS user, but only a few of these will be supported by the user's device, carrier, and service plan. Prior to enrolling in an incident, each JITTEIS user registers his/her device so that JITTEIS can determine which of these 16 ways will work reliably.

Table 1. Content and Delivery Options for JITT Learners

Client Device		Multimedia Content Type (Multimedia Envelope)	Delivery Mechanism			
Mobile	PC		MMS via MM1	E-mail Attachment	URL via SMS ³	WAP Push ³
Video phones	QuickTime	Video (3GP)	☞	1	☞	2
MS Smartphones	Media Player	Video (WMV)	☞	1	☞	2
Camera phones	Real Player	Slideshow w. audio (SMIL)	☞	1	☞	2
Blackberry	Web Browser	Slideshow w/o audio (HTML)	☞	☞	☞	☞

☞ Supported content/delivery mechanism combination
 ☞ Unsupported content/delivery mechanism combination

1 Requires carrier domain; received as MMS via MM1
 2 GSM carriers only
 3 Directs microbrowser to content

MOBILE MEDIA FORMATS

The four mobile multimedia formats differ in user experience, compression (hence download time), and mobile device hardware requirements. Each format is in fact collection of files (e.g., audio, animation, text) with a "wrapper" that describes how the files assemble into the multimedia show. Good multimedia authoring practices can maximize both the user's audiovisual experience and the consistency of a course rendered in the different formats. Figure 3 illustrates frames from three courses used in the JITTEIS field trials.

HTML

A text file written in the HyperText Markup Language (HTML) specifies the spatial layout of a web page and the location of the page's image files. Microbrowsers in mobile devices recognize only basic HTML, and rarely any proprietary extensions such as Internet

Explorer's background sound or auto-scrolling. Any mobile device can receive the Uniform Resource Locator (world wide web address, or URL) of an HTML file via text messaging (Short Message Service, SMS), and some devices will retrieve the HTML file with a simple click on the URL, instead of retyping the URL in the microbrowser. However, many wireless service providers charge extra for Web browsing. Some devices can also receive an HTML file and its referenced assets as an e-mail attachment, and then render the web page on the device's microbrowser.

SMIL

A text file written in the Synchronized Multimedia Integration Language (SMIL) specifies the spatial and temporal layout of a multimedia message, including audio, picture and video messages. A multimedia message player can render background audio concurrently with imagery, which is an important

instructional design advantage over a microbrowser which rarely supports audio. Microbrowsers do not understand SMIL, but are able to recognize a link in a web page to a SMIL file and some microbrowsers can relay it to the device's multimedia message player.

Video

Web pages and multimedia messages are collections of media files referenced by a text file written in HTML or SMIL, respectively, whereas video is a single binary

file. Nevertheless, video file extensions such as .AVI refer to the binary language of a wrapper that specifies the assets found in the same file, such as audio, video, caption, and hyperlinks. At a minimum, the wrapper component of a video file specifies the codec used to compress the audio and video components of the file. The MPEG-4 video codec and 3GPP envelope were designed specifically for mobile devices - Apple and Real were leading contributors to these ratified standards - and Microsoft advocates its proprietary Windows Media Video format.

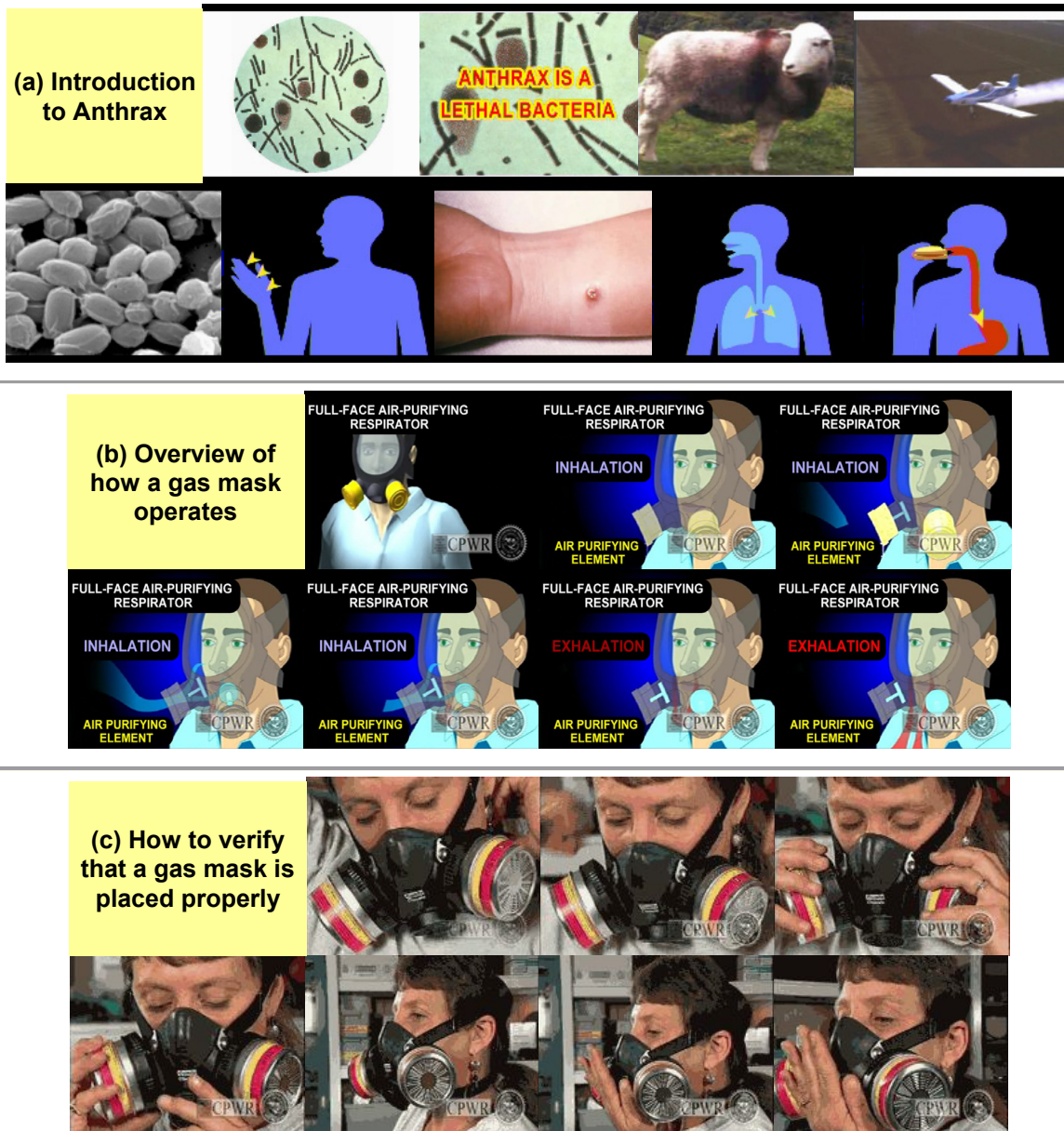


Figure 3. Frames from JITTEIS field test courses.

Most video-enabled mobile devices will not render video in their microbrowser or multimedia message player; instead, any video file referenced in an HTML or SMIL wrapper is relayed to the device's video player and rendered outside the HTML or SMIL spatiotemporal context. A video player will have convenient controls for pause, play, forward, reverse, volume, zoom, and landscape or portrait viewing.

MOBILE MEDIA DELIVERY MECHANISMS

The four prevalent media delivery mechanisms among mobile devices (Table 1) are somewhat independent of content type but are ergonomically very different. All four can alert the user when new content is available. Furthermore, MM1 can *push* the courses themselves onto the mobile device without user intervention; from the user's perspective, new content notification and delivery are simultaneous. SMS and WAP Push require the user to *pull* a course onto the device; from the user's perspective, new course notification and course retrieval are separate procedures. Push-based delivery mechanisms are more convenient in that they do not require any user attention to complete; a cell phone simply "beeps" to notify the user that a multimedia course awaits in the messaging in-box.

Strictly speaking, e-mail is a pull-based protocol; however, Post Office Protocol (POP3) e-mail clients periodically check for new messages and automatically download them, effectively providing the user a (non-instantaneous) push-based experience.

MM1 and Content Adaptation

MM1 is a ratified data transfer protocol standard for picture messaging between a mobile device and the carrier's gateway over GSM (LeBodic, 2005). MM1 is simple in that it deposits the content directly in the message in-box of the mobile device; however, some devices limit content to 300KB per message.

Before the carrier's gateway delivers a multimedia message via MM1 to a mobile device, the gateway applies content adaptation to the message content. Content adaptation compares the media types supported by a client with those in the message, and reformats any unsupported media objects into supported formats. For example, content adaptation considers the size of an image referenced by an HTML file, the codec of an audio file referenced by a SMIL file, or the codec of a video file, and in principle change changes the asset's resolution and bit-rate if necessary.

In practice, content adaptation is not refined, and assets in client-unsupported formats are typically deleted instead of converted by the gateways of both CDMA and GSM carriers. In one test, a video file was not delivered because the provider's gateway re-encoded it into a less-advanced format that require less processing at the mobile device to render, but in doing so raised the file size beyond the MM1 limit. Service provider gateways apply content adaptation to both incoming and outgoing MM1 messages. For example, provider gateways often delete the SMIL file of an MM1 message sent from a subscriber to an e-mail address, but leave the accompanying media assets intact.

POP3 and Web Based E-Mail

Phones with PDA operating systems ("smart phones") often have POP3 e-mail which is not subjected to MM1 content adaptation and size constraints. If the e-mail service is web-based, the e-mail server will not deliver any attachment whose type is not listed in the microbrowser's HTTP ACCEPT tag and the user will instead see an "HTTP 406" error message. Moreover, web-based e-mail does not automatically download new messages or attachments.

SMS and WAP Push

SMS and WAP Push are not multimedia delivery mechanisms; SMS only conveys a character string and WAP Push only conveys a URL. We nevertheless consider them because they are push-based mechanisms that can direct a web browser to multimedia content. A mobile device can receive the URL for web-hosted content via a simple SMS, but this may requires the user to copy/paste or retype the URL in the microbrowser. Alternately, a GSM-connected mobile device can receive a WAP Push message, which is a binary encoded SMS that the mobile device automatically recognizes as a URL to downloadable content; a simple click on the WAP Push message invokes the device's microbrowser to that address.

JITTEIS-Carrier Communications

The four delivery mechanisms in Table 1 serve the communication between the user's mobile device and the wireless service provider's gateway. The JITTEIS LCMS itself has two options with which it can communicate with users' service providers: messaging over an MM1 channel, and e-mail over the Internet.

To communicate via MM1, JITTEIS subscribes to a wireless service provider, and appears to that provider

simply as a cell phone sending and receiving messages to/from other cell phones. When messaging a mobile device over the Internet, JITTEIS e-mails the device's e-mail address $N@domain$, where N is the device's ten digit phone number and $domain$ is a carrier specific domain. Because carriers route SMS and MMS messages differently, they often assign SMS and MMS different domains. For example, the e-mail address of a Verizon Wireless phone is $N@vtext.com$ for SMS and $N@vzwpx.com$ for MMS.

The Internet has much higher bandwidth than the MM1 channel, and can send more courses to more users per unit time. E-mails also have fast and equal access to all service providers, whereas messages sent over an MM1 channel to subscribers of different providers must traverse two sets of gateways (that of the JITTEIS carrier and that of the recipient) and endure the content adaptation and latency of both. Cross-carrier delivery of multimedia messages is still an immature service that can vary from minutes to hours (Figure 4).

A drawback of e-mailing a mobile device is that it requires the device's domain(s), whereas messages over MM1 are simply sent to N . The only sure method of knowing the domain(s) of a device is for the user to

send JITTEIS an SMS and an MMS. Moreover, some legacy cell phones can only send an SMS or an MMS to a phone number and not to an e-mail address.

MOBILE DEVICE PROFILING

Since not all device hardware manufacturers, device software developers, and wireless service providers reliably maintain standards for device profiling (e.g., UAProf, HTTP GET headers), user involvement is required to verify the functionality any content type-delivery type combination at the user's mobile device. Ongoing field trials are alpha-testing three approaches: smart echo, caller-ID initiated (CIDI) profiling, and SMS initiated (SMSI) profiling. Smart echo profiling requires the user to send JITTEIS a multimedia sample from the mobile device; JITTEIS then delivers courses in the same format. Caller ID initiated (CIDI) profiling only requires the phone number of the mobile device; CIDI profiling then sends to that number brief test messages in different formats, and the user need only reply to the message with the best audiovisual experience. SMSI is similar to CIDI, except the user sends an SMS instead of making a voice call.

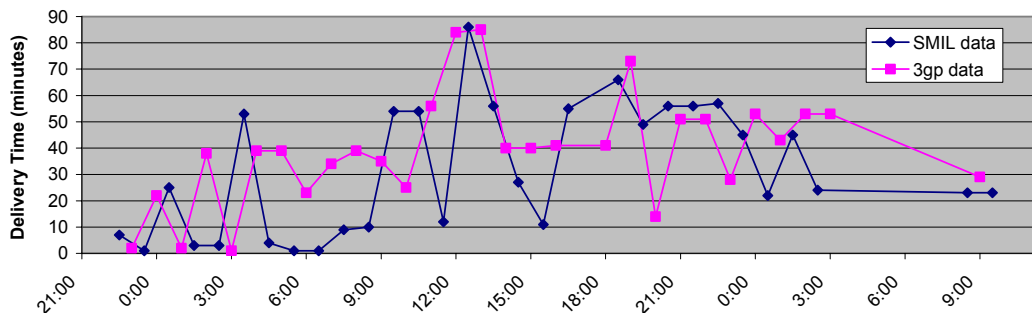


Figure 4. Fluctuations in the delivery time of trans-carrier multimedia messages over MM1 (3/13/2007).

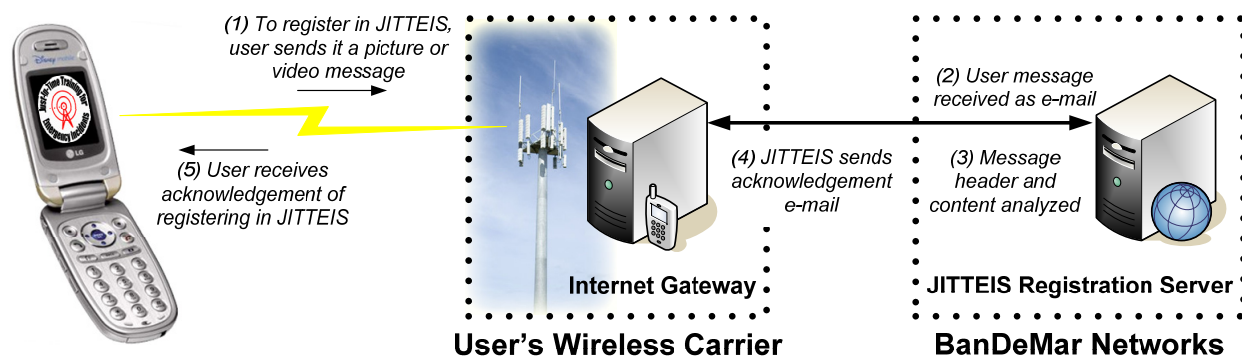


Figure 5. Registering a cell phone in JITTEIS using smart echo profiling.

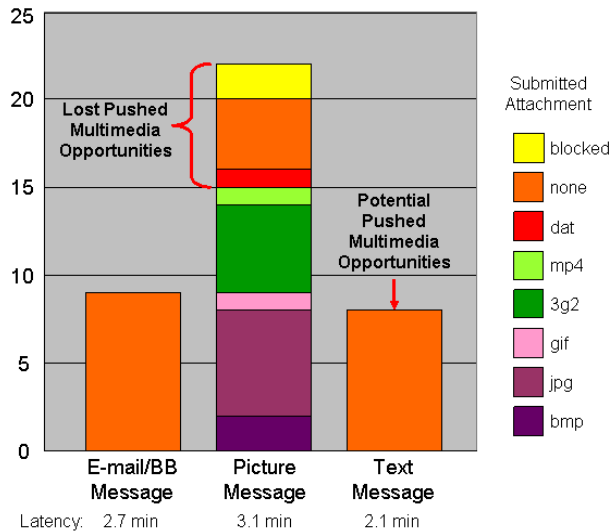


Figure 6. Registration messages received by JITTEIS during one smart echo field trial.

Smart Echo Profiling

In March 2007, we conducted JITTEIS focus groups and field trials at the Atlantic OSHA Training Center in the University of Medicine and Dentistry of New Jersey's School of Public Health, and at the NIEHS WETP conference in Las Vegas. Participants (mostly skilled support personnel and trainers) registered with JITTEIS by sending a message containing a sample of their preferred multimedia format from their cell phone to a JITTEIS gateway address `test1@jitteis.com` (Figure 5). There were no conditions placed on cell phone model, carrier, and service plan.

JITTEIS was programmed to analyze the attachments of each message received at that gateway address and respond (or "echo") with the three courses illustrated in Figure 3. If the message from the user contained a file with a WMV extension, JITTEIS replied with courses in that format. Otherwise, if the message contained a 3GP or MP4 file, JITTEIS replied with courses in 3GP format. Otherwise, if the message contained an image file (.JPG, .GIF, .BMP), JITTEIS replied with courses in SMIL format. If none of the above conditions were detected, JITTEIS replied with a text message containing the URL of the courses in HTTP format.

Ideally, users of picture phones or videophones would send a multimedia message with either a picture or video, respectively, although a videophone can also display SMIL content. Blackberry devices cannot render video or SMIL content, but have microbrowsers; ideally their users would send a simple text message.

The JITTEIS system performed perfectly for those participants that were able to send the registration message from their mobile device. The total round-trip wait time experienced by participants between sending their registration message to JITTEIS and receiving these courses in their mobile device was approximately six minutes: five due to message cueing at the carrier's MMI/Internet gateway, and one due to message cueing at the JITTEIS server. All participants were able to view the courses JITTEIS pushed onto their phones without any problems, even if they had no prior experience with multimedia phone messages.

Some participants did not know how to send a picture message or video message from their phone, even when it had the capability. In one trial with 39 participants, eight sent a text message instead of a picture or video message ("potential pushed multimedia opportunities" in Figure 6) and seven sent a picture or video message incorrectly ("lost pushed multimedia opportunities"). All participants received an acknowledgement SMS from JITTEIS, but $8+7=15$ participants (38%) did not receive courses in the richest format supported by their phone. General feedback from the field trials was that the system would be an asset to emergency incidents, but registration could be easier so as to not require the use of "advanced" features of a phone.

Caller ID Initiated Profiling

Caller ID initiated profiling only requires the user to place a voice call from his/her cell phone to an automated attendant (Figure 7), as opposed to transmitting a multimedia message. The automated attendant records the user's phone number via caller ID and e-mails it to the JITTEIS server. The automated attendant also records any dual-tone multi-frequency (DTMF) key strokes by the user and includes it in the e-mail to JITTEIS as an audio file attachment.

When JITTEIS receives an e-mail from the automated attendant, it identifies the user's carrier by performing a reverse number database look-up using the caller ID's most significant seven digits (North American Number Plan NPA-NXX-X). A much smaller database look-up returns the SMS and MMS domains used by that carrier, from which JITTEIS forms the SMS and MMS e-mail addresses of the caller's mobile device. All the SQL database lookups are near instantaneous. It should be noted that approximately 6.1% of NPA-NXX-X regions with SMS service do not support MMS, most notably those of 2-way paging services (Figure 8). Also, reverse number databases do not reflect local number portability for up to several weeks.

With this estimate of the mobile device's SMS and MMS e-mail address, JITTIES sends four test e-mails each from a unique alias: (1) an SMS with a registration acknowledgement and test URL from $N\text{-SMS}@jitties.com$ where N is the user's ten digit phone number, (2) an MMS with a short 3GP clip from $N\text{-3GP}@jitties.com$, (3) an MMS with a short SMIL slideshow with audio from $N\text{-SMIL}@jitties.com$, and (4) an MMS with HTML, imagery, and no audio from $N\text{-HTML}@jitties.com$.

Upon receiving these test messages, the user need only reply to the message that provided the best multimedia experience. All four test messages should be received, although content adaptation by the user's wireless service provider strips off attachments in unsupported format. The reply can be with any SMS, MMS, or e-mail; JITTIES is able to track the original user address because the JITTIES alias uniquely identifies it and the preferred multimedia format.

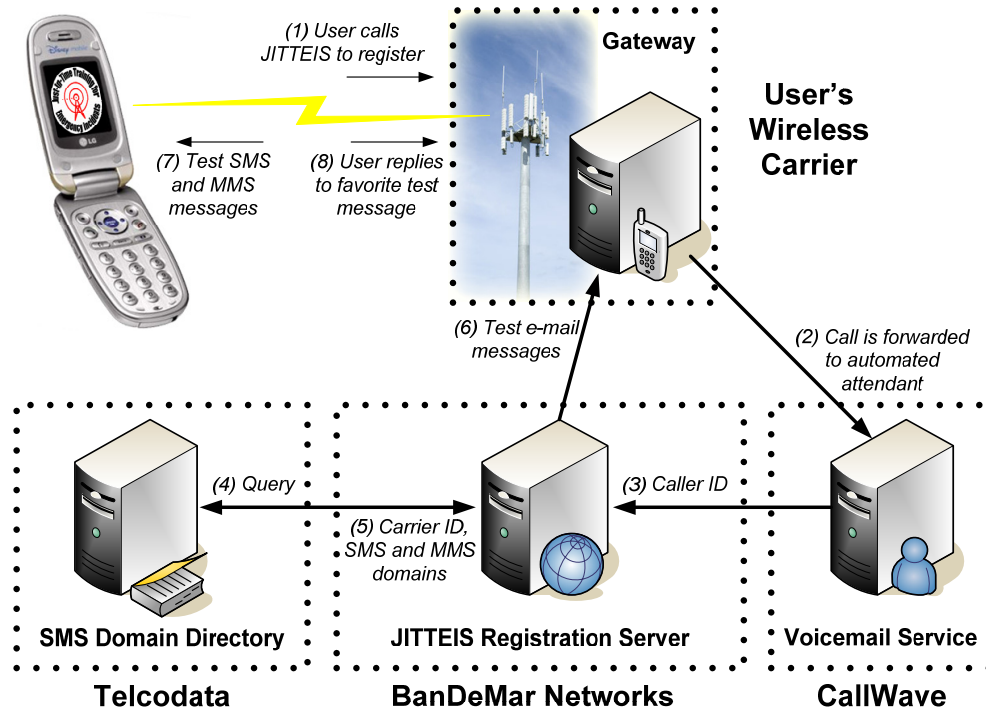


Figure 7. Registering a cell phone in JITTIES using Caller-ID initiated profiling.

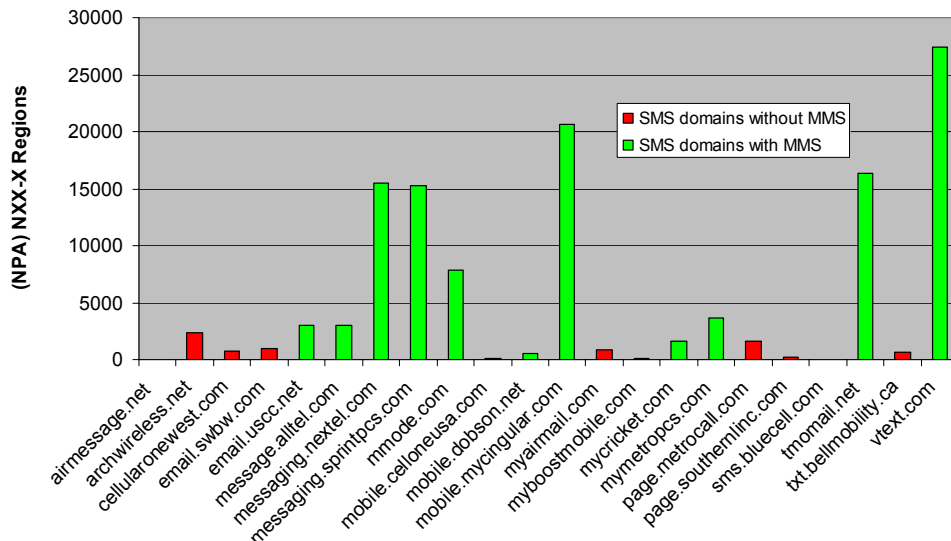


Figure 8. Reverse number lookup database statistics.

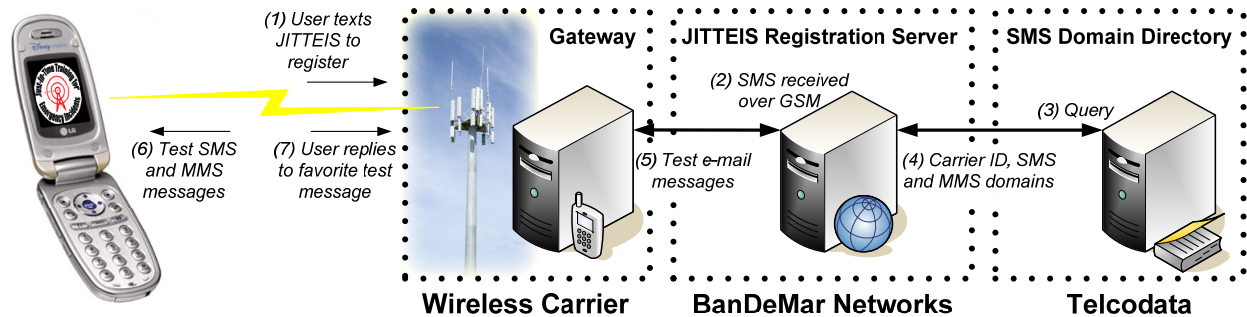


Figure 9. Registering a cell phone in JITTEIS using SMS initiated profiling.

Field trials for CIDI profiling were held on June 2007. CIDI worked well for users with multimedia enabled mobile devices, except in one case where the reverse number database lookup returned the wrong carrier for a user. This error was detected, however, because the carrier replied to the test messages as undeliverable (meaning that N was correct but domain was not).

Some users with employer-provided mobile devices under corporate plans with messaging disabled were unaware that they could not receive SMS and/or MMS messages, and the service provider neither delivered test messages from JITTEIS nor notify JITTEIS that the test messages could not be delivered. These users thus waited for messages that were never delivered.

The above two problems do not occur with smart echo profiling because the first step requires the user to send JITTEIS a message, at which time s/he confirms the messaging capability of the mobile device and JITTEIS receives the precise and current domain.

SMS Initiated Profiling

SMSI profiling requires a text message instead of a voice call, so the user verifies at the onset the device's messaging capability (Figure 9). The message is sent to the JITTEIS GSM phone number, as opposed to an e-mail address which proved to be problematic with some devices during smart echo profiling. The header of a delivered text message includes the sender's phone number, so JITTEIS has the equivalent of the user's caller-ID with which to perform a reverse phone number lookup and reply with test messages as with CIDI profiling. This also means that SMSI profiling is equally susceptible to database errors.

INCIDENT BROADCASTS AND JUST IN TIME CONTENT CREATION

On occasion, the Incident Commander or Safety Officer needs to broadcast information to the skilled support personnel. The information may be urgent, such as the evacuation of an area, procedural, such as a reminder to wear a gas mask, conveyable with simple text, or best presented in multimedia, such as a photos of a newly discovered CBRNE agent at the site and the agent-specific PPE that SSP must now wear at the site. Moreover, this information must be received not only by the SSP who were already dispatched to the incident at the time of broadcast, but also by future SSP as soon as they are dispatched to that incident.

Two properties of the JITTEIS architecture lend it to the support of the above incident broadcasts: asynchronous operation and incident-based enrollment. Specifically, JITTEIS maintains a list of all the messages associated with an incident, without making a distinction between courses or broadcasts, or between different media formats of the same course or broadcast. At any time, the IC/SO can update this list by adding or removing items without needing to be concerned about specific mobile device profiles. To add an item, the IC/SO need only send it to JITTEIS in an e-mail, SMS, or MMS referencing the incident ID; JITTEIS recognizes the sender and the incident ID, and processes the attachment automatically.

When an item is added, JITTEIS automatically sends it to all the SSP enrolled in that incident, tailored to their mobile device. Also at any time, an SSP can enroll into a JITTEIS incident account, upon which s/he receives from JITTEIS all the messages in that incident's current list, again tailored to the mobile device.

EFFECTS OF SERVICE INTERRUPTION

All delivery mechanisms employed by JITTEIS are also asynchronous, and transmitted messages move along queues until they are delivered. If a recipient is not accessible (e.g., mobile device is turned off or out of coverage) or there is a service blackout, the delivery mechanism will continuously retry until delivery is successfully completed or a time-out (usually more than three days) is reached.

The emergency response plans of wireless service providers rely on the deployment of self-powered mobile cell sites and/or “Cells on Wheels” with telescopic cell tower and a long-range directional microwave link that connects the site to an operational hub. Inventories of such resources (Figure 10) have shortened the regional recovery of complete service disruption from days to hours (Rauscher, 2001).



Figure 10. Communication-Site-On-Wheels by Integrated Tower Systems

Wireless voice call traffic congestion is a much more common (and possibly more sustained) occurrence during emergency incidents than infrastructure damage. Congestion is also encountered outside emergency incidents, for example when a cell phone receives a strong signal yet a call cannot be made.

In these scenarios, placing and/or receiving a voice call is unreliable because the cell tower cannot commit the continuous bandwidth allocation necessary for the call. Message delivery, however, remains reliable because it does not require a continuous bandwidth allocation from the cell tower. Message delivery is performed non-isochronously with residual bandwidth that fluctuates widely; the delivery of a message speeds up when bandwidth is available, and slows down or pauses otherwise, but is not dropped.

ONLINE COMMUNITIES, VIRAL CONTENT, AND DATA RIGHTS MANAGEMENT

Participants of online communities have repeatedly demonstrated a global reach and the speed with which they can spread content (text, audio, imagery, and video) within their communities, yielding new terminology such as “viral content” and “flash mob.” This kind of accelerated communications can be an asset in an emergency incident, particularly because it can include the local civilian population. To the Incident Commander, viral content delivery is both a broadcast mechanism and a data gathering tool.

Participants of online communities such as YouTube and Google Video frequently complain that they must install proprietary applications and use non-standard content formats, and that sharing is not as scalable because it is centralized and not peer-to-peer. In contrast, all of the delivery mechanisms and media formats considered for JITTEIS are such that once a user receives content, s/he can forward it directly to the mobile devices of friends and contacts, whether or not they are registered in JITTEIS and without any media conversion.

Conversely, some JITTEIS content may be privileged or not intended for viral dissemination. In this case, the Incident Commander can use data rights management (DRM) options that are built into the MM1 delivery mechanism standard. DRM controls the actions that recipients of a multimedia message can do with the content. Any or all of the following DRM controls can be set by the sender or configured in JITTEIS:

- The receiving device is not allowed to re-transmit non-text objects in the message (“forward lock”).
- A maximum number of times that the recipient can access the message.
- A start date, end date, or interval (number of days) when the user can access the message.
- The recipient can view but not print the message.

CONCLUSIONS

The first recommendation in the recent study mandated by Section 214 of the E-Government Act "Enhancing Crisis Management through Advanced Information Technology" (National Research Council, 2007) is: "Disaster management organizations should take advantage of opportunities for adoption of existing technology or adjustment of policies and procedures that would allow significant short-term enhancement of disaster management."

The study then lists "six key areas of IT-enabled capability in which shorter-term development and longer-term research offer the potential for significant benefits: more robust, interoperable, and priority-sensitive communications; better situational awareness and a common operating picture; improved decision support and resource tracking and allocation; greater organizational agility for disaster management; better engagement of the public; and enhanced infrastructure survivability and continuity of societal functions."

JITTEIS is a response to the above recommendation. Moreover, advanced cell phone functionality supports cross-cutting benefits across the six key IT-enabled capabilities. Nevertheless, the fragmented state of mobile multimedia illustrates the market's infancy. Deice manufactures and service providers are aggressively deploying multimedia to differentiate their offerings, but the resulting initial walled garden services have proven to be insufficient as evidenced by disappointing revenue from MMS plans and the filing for Chapter 11 bankruptcy protection by Amp'd Mobile, a service provider that relied heavily on multimedia services to lure younger markets.

Recent developments such as wireless 3G broadband, organic LED screens, higher resolution cameras, fold-out keyboards, stereo Bluetooth, and Adobe Flash Lite vector graphics make a cell phone more enjoyable to the user but do not contribute to interoperability.

In time, mobile multimedia services will extend beyond walled gardens, at which time their commercial value should greatly increase. Consider as a historical anecdote that SMS text messaging did not become a viable revenue source until subscribers of one carrier were able to text the subscriber of another carrier. Until then, carrier-independent m-learning will require highly adaptive techniques such as those automated in JITTEIS or implemented manually by young and early-adopter members of mobile online communities.

ACKNOWLEDGEMENTS

This work is supported by NIEHS grant 1R41ES014793-01. The authors thank The Center to Protect Workers' Rights for permission to use training content in JITTEIS field trials.

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