Public Response to Mobile Alerts: A Technology Perspective

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Center for Emergency Response Technologies

- **CERT Mission**
  - ***lead research, technology development & coordination of projects on role of IT to improving emergency response.***
  - ***provide a forum for collaboration between academia, industry, and government agencies.***
- **20+ associated faculty, 40+ students, staff, programmers, researchers**
  - **Computer Science, Social Science, Engineering**
- **Close partnerships with local & state agencies, industry.**
  - **Cities of LA/SD/Ontario/Rancho, OCFA, LA County Fire…**
- **Responsphere – A campus-wide testbed for technology testing**

Industrial Partners

5G Wireless	5G Wireless	AMD	AMD
Apani	Apani Networks	Asvaco	ASVACO
Boeing	Boeing	Canon	Canon
Convera	Convera	Cox Communications	COX
D-Link	D-Link	Ethos	ETHOS
IBM	IBM	ImageCat, Inc.	ImageCat, Inc.
Microsoft	Microsoft	Printronix	PRINTRONIX
	The School Broadcasting Company	Vital Data Technology	
Walker Wireless	Walker Wireless		

Government Partners

California Governor's Office of Emergency Services	California Governor's Office of Homeland Security	
City of Champaign	City of Dana Point	
City of Irvine	City of Los Angeles	
City of Ontario Fire Department	City of San Diego	
Department of Health and Human Services – Centers for Disease Control	Lawrence Livermore National Laboratory	
Los Angeles County	National Science Foundation	
Orange County	Orange County Fire Authority	
U.S. Department of Homeland Security		

SocioTechnical Alerting Systems@CERT

Grand Challenge

Next generation warning systems that customize risk/crisis communications based on various factors resulting in appropriate level of response (not under or over response)

- ***Variability in warning times, geography, characteristics of recipient populations, diversity of delivery mechanisms (social and technological), size of impacted population***

Challenges

- ***Delivery Level***
  - ***Goal: Resilient infrastructures for message generation, targeting***
  - ***Failures, surge demands, scalable infrastructure***
- ***Content Level***
  - ***Goal: Customize risk communications to generate appropriate level of response***
  - ***Diversity of information sources, multiple modalities, and needs, uncertainty in data, challenge of scale, human-as-a-sensor***
- ***Deployment and Societal Issues***
  - ***Goal: Enable technology solutions to work in societal scale deployments***
  - ***Privacy, Novel IT practices, Cost/Culture, Reliability, Digital Divide***

Spectrum of End-User Systems

- ***Short Notice Warning Systems***
  - ***Real-time seismic alerts and warnings***
  - ***Meta-alert systems for organizational dissemination***
- ***Longer term risk communications systems*** **for informing public through all phases of response**
  - ***Portal Based Solutions – City of Ontario Disaster Portal***
  - ***Peer Oriented Communication Systems - Traffic Alerts***

Mobile Alerting Technologies

Instant Dissemination in Connected Networks

Delayed Dissemination in Disconnected Networks

Hybrid Networks for Reachability and Scalability

Cell Broadcast – A Low Hanging Fruit

- Leveraging wide deployment of cellphones
- Leveraging the broadcast nature of single-hop wireless communication
  - Low latency, sender is recipient agnostic
- Leveraging existing service provider capabilities
- End-user deployment probably straightforward
  - No complex device capabilities, typically no complex software
  - No complex software to install, manage, maintain and update (maybe!!)
- However – challenges arise in realizing effective, scalable alerting to the public-at-large
  - MBMS (Multimedia Broadcast and Multicast Services)
    - Feature in 3G spec (bandwidth concerns hamper implementation)
  - Cell Paging
    - Small size control messages
- Part of an *integrated alert and warning system* that works during all phases of crisis communications (pre, trans, post disaster)

Challenge 1: Under-reach vs. Over-reach

- **Determining which cells to reach – accuracy of targeting**
  - Cell size can vary significantly
    - Geography covered may be small (highrises)
    - Or large (e.g. Camp Pendleton)
  - Will we miss those who are actually impacted?
  - Will we reach those who are not impacted (shadow evacuation)?

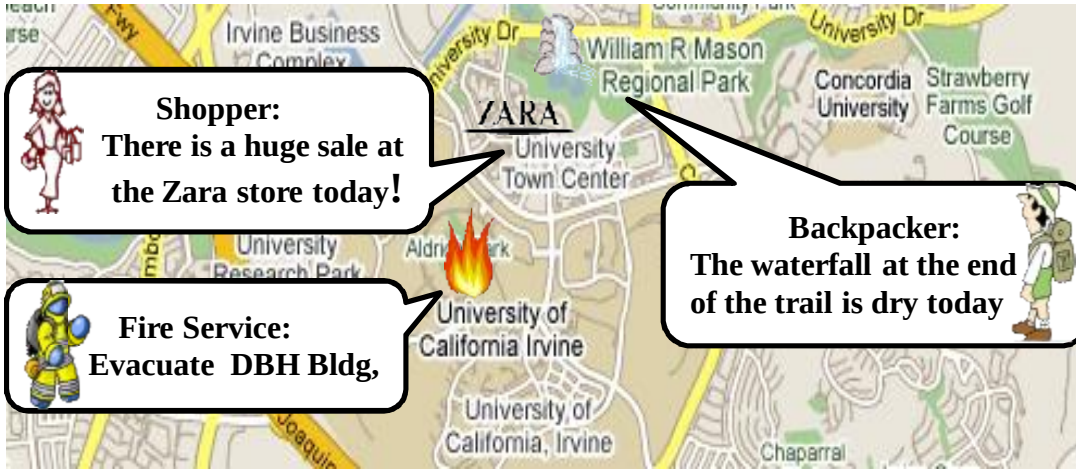
- **Reliability of reaching users must be understood**
  - Cell crossing boundaries
  - Weak signal, signal not available
  - Intermittently available signals results in misconception
  - Device may be off or running low on battery
  - How many broadcasts to issue to ensure that the message is received?
  - Infrastructure Failures!!
- **Dealing with high mobility**
  - Users in vehicles may receive multiple conflicting broadcasts as they travel through different cells

Challenge 2: Warning Specificity

- **Telling users specifically what-to-do**
  - This may vary based on physical geography and situation specifics
  - Disaster geography may not correlate with geography of cell deployment
- **Ability to customize messages has benefits**
  - Customize to populations (overcome device, language, ability barriers)
  - Provide more relevant information and richer content (maps, weblinks)
  - Challenges: Bandwidth, Privacy
- **Technologies in use**
  - SMS-based alerting – gateway issues (delays/cutoffs)
  - Subscription based softwares exist for specific alerts (e.g. ShakeCast)
- **One-size-fits-all nature of broadcast may not suit all scenarios**
  - Utility of small message size ; combine with on-board software for visual alerts??

Challenge 3: Getting the attention/Having the impact

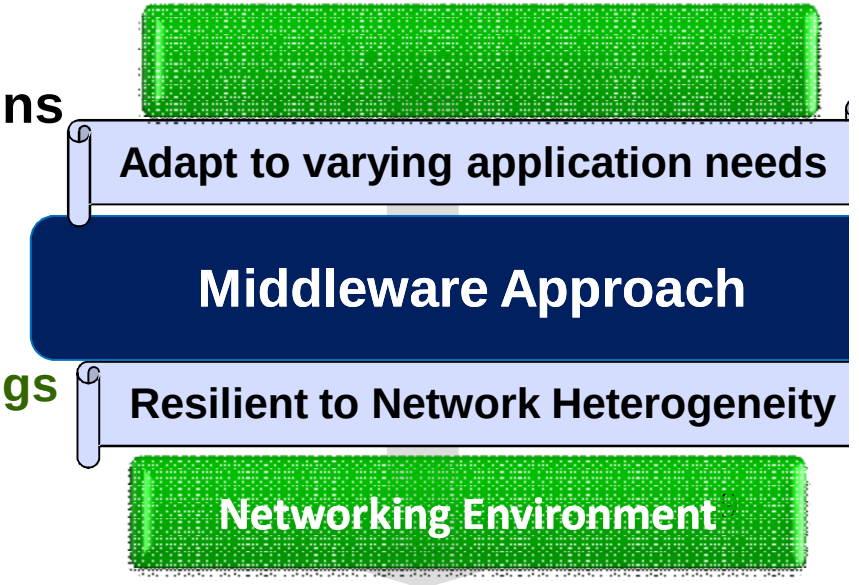
- **Missed alerts**
  - Maybe user related
    - User ignores alert (spam!)
    - Noisy environment
    - Not on person
    - Device off, Battery low
  - or infrastructure related
    - No communication
    - Supporting Seeking Behavior: Call drops; noisy network



- **Plethora of alerts on mobile devices**
  - Traffic, social networks, emergencies
  - Location-based alerts – shopping coupons
- **Ubiquity of cellular devices**
  - Consequences of alerts to Children, seniors
- **Needs *significant testing* for usability in large societal-scale deployments**
- **Needs *significant training* with end-user to have impact**

- **A variety of I-phone , J2ME, Android apps will be developed**
  - **Device and process automation (utilities, alarm systems, blue light phones, vehicular networks)**
  - **Automatic messaging in social networks (information diffusion)**

- **Use this to enhance the basic CMAS alert**
- **False warnings can trigger a series of actions**
  - **Consequent liability issues**
  - **Log track messages sent to device**
  - **Leverage experience**
    - **Trinet study on earthquake early warnings**
    - **Who is interested (e.g. K-12 schools)?**

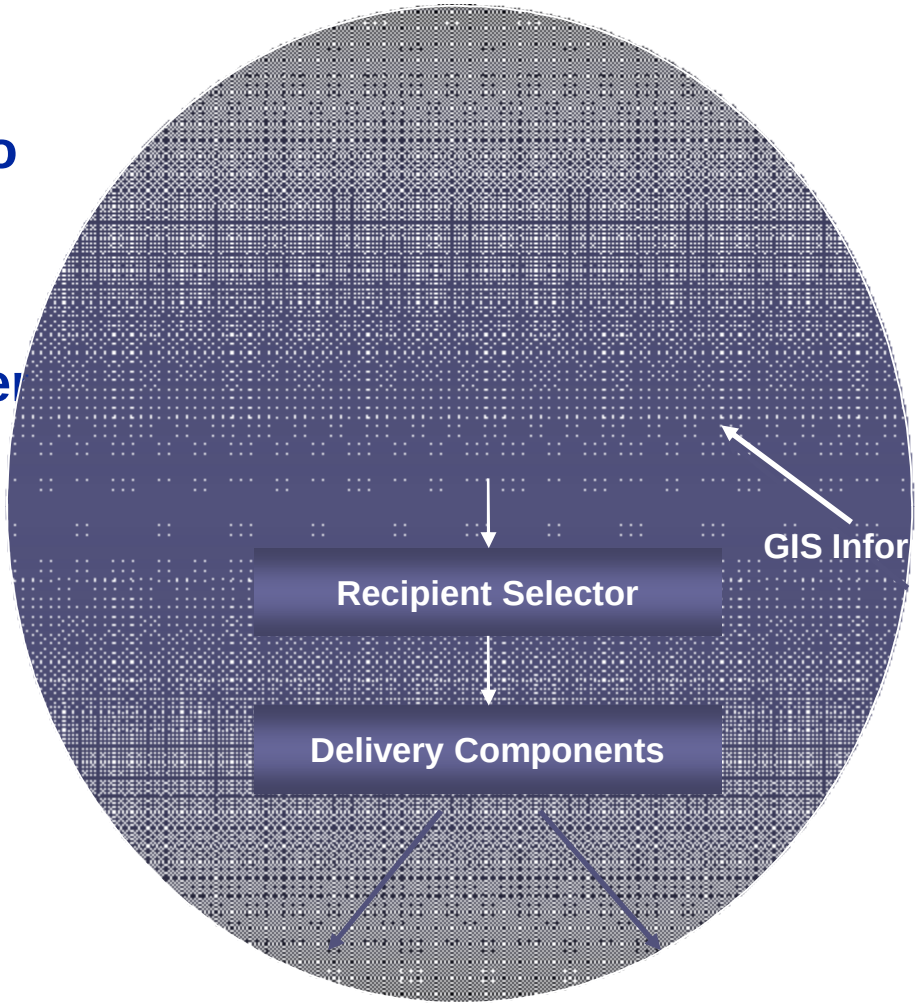


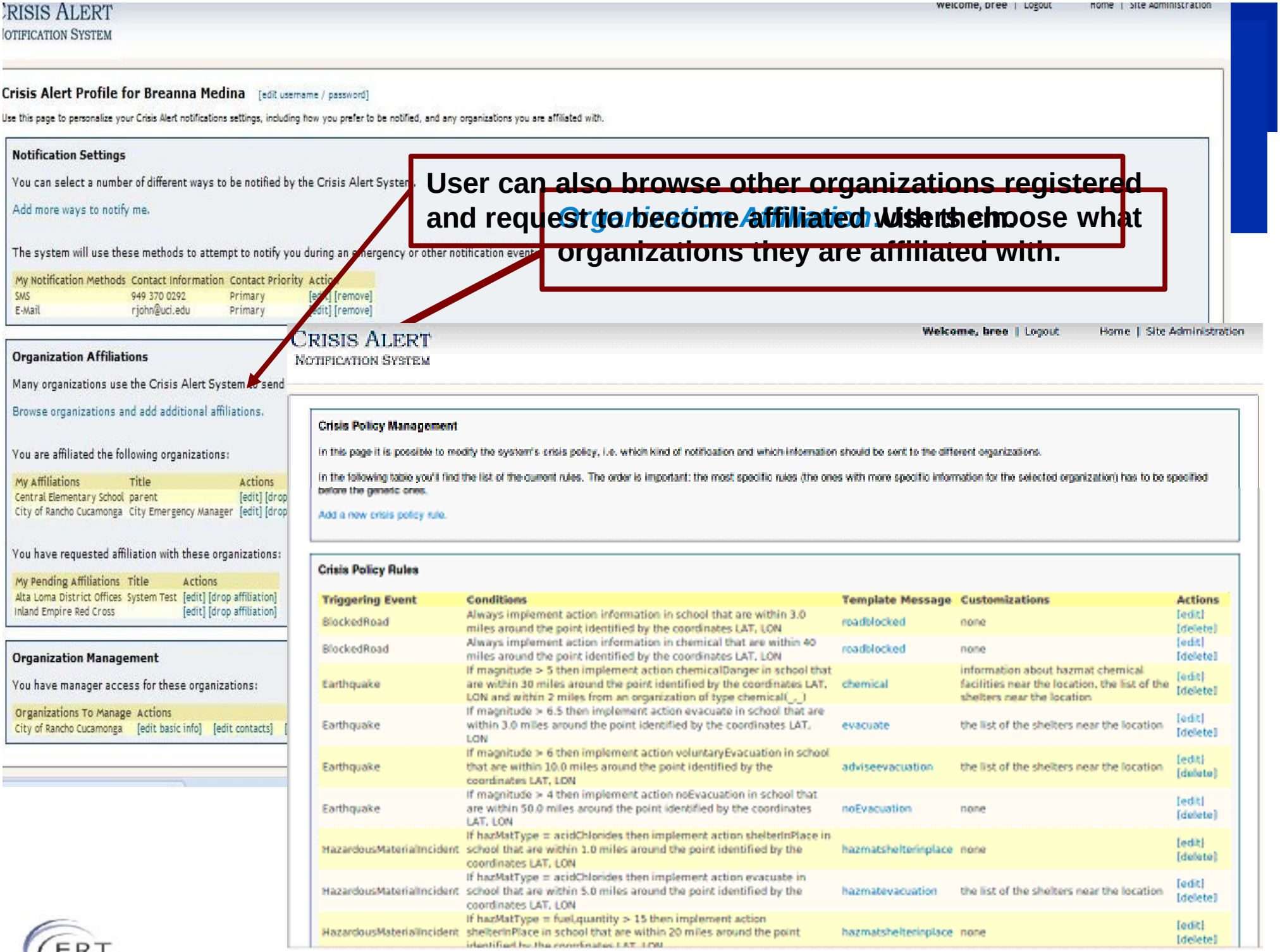
- **Security concerns**
  - **Malicious intruders may spoof alert**

Challenge 5: Beating the Disaster

- **Disaster events may cause infrastructure failure**
  - **Earthquakes, tornadoes, hurricanes may destroy the alerting infrastructure**
- **Can it be quickly detected and redeployed?**
  - **Mobile cell towers brought in**
- **Exploit geographically correlated nature of failures**
  - **Especially true for moving disasters – tornadoes, plume propogation etc.**
  - **Predict potential path of disaster and pre-issue alert via cell broadcasts along these paths**

- **Policy-Based Alerting**
  - Pre-create messages and automate message creation to the extent possible
- **Exploit Multiple Networks**
  - For repeat messages, for richer content, robust alerting
- **Customize content to the extent possible**
  - Exploit publish/subscribe technologies
- **Exploit prediction to target potential recipients**
- **Test broadly**
- **Train frequently**




RISIS ALERT
OTIFICATION SYSTEM
Welcome, bree | Logout
Home | Site Administration
Crisis Alert Profile for Breanna Medina [edit username / password]
Use this page to personalize your Crisis Alert notifications settings, including how you prefer to be notified, and any organizations you are affiliated with.
Notification Settings
You can select a number of different ways to be notified by the Crisis Alert Syste
Add more ways to notify me.
The system will use these methods to attempt to notify you during an emergency or other notification event
My Notification Methods Contact Information Contact Priority Acti
SMS 949 370 0292 Primary [edit] [remove]
E-Mail rjohn@uci.edu Primary [edit] [remove]
User can also browse other organizations registered and request to become affiliated with them
Organization Affiliations
Many organizations use the Crisis Alert System to send
Browse organizations and add additional affiliations.
You are affiliated the following organizations:
My Affiliations Title Actions
Central Elementary School parent [edit] [drop
City of Rancho Cucamonga City Emergency Manager [edit] [drop
You have requested affiliation with these organizations:
My Pending Affiliations Title Actions
Alta Loma District Offices System Test [edit] [drop affiliation]
Inland Empire Red Cross [edit] [drop affiliation]
Organization Management
You have manager access for these organizations:
Organizations To Manage Actions
City of Rancho Cucamonga [edit basic info] [edit contacts]
Organization Affiliations
Users choose what organizations they are affiliated with.
CRISIS ALERT
NOTIFICATION SYSTEM
Welcome, bree | Logout
Home | Site Administration
Crisis Policy Management
In this page it is possible to modify the system's crisis policy, i.e. which kind of notification and which information should be sent to the different organizations.
In the following table you'll find the list of the current rules. The order is important: the most specific rules (the ones with more specific information for the selected organization) has to be specified before the generic ones.
Add a new crisis policy rule.
Crisis Policy Rules
Triggering Event Conditions Template Message Customizations Actions
BlockedRoad Always implement action information in school that are within 3.0 miles around the point identified by the coordinates LAT, LON roadblocked none [edit] [delete]
BlockedRoad Always implement action information in chemical that are within 40 miles around the point identified by the coordinates LAT, LON roadblocked none [edit] [delete]
Earthquake If magnitude > 5 then implement action chemicalDanger in school that are within 30 miles around the point identified by the coordinates LAT, LON and within 2 miles from an organization of type chemical(_,_) chemical information about hazmat chemical facilities near the location, the list of the shelters near the location [edit] [delete]
Earthquake If magnitude > 6.5 then implement action evacuate in school that are within 3.0 miles around the point identified by the coordinates LAT, LON evacuate the list of the shelters near the location [edit] [delete]
Earthquake If magnitude > 6 then implement action voluntaryEvacuation in school that are within 10.0 miles around the point identified by the coordinates LAT, LON adviseevacuation the list of the shelters near the location [edit] [delete]
Earthquake If magnitude > 4 then implement action noEvacuation in school that are within 50.0 miles around the point identified by the coordinates LAT, LON noEvacuation none [edit] [delete]
HazardousMaterialIncident If hazMatType = acidChlorides then implement action shelterInPlace in school that are within 1.0 miles around the point identified by the coordinates LAT, LON hazmatshelterinplace none [edit] [delete]
HazardousMaterialIncident If hazMatType = acidChlorides then implement action evacuate in school that are within 5.0 miles around the point identified by the coordinates LAT, LON hazmatevacuation the list of the shelters near the location [edit] [delete]
HazardousMaterialIncident If hazMatType = fuelLquantity > 15 then implement action shelterInPlace in school that are within 20 miles around the point identified by the coordinates LAT, LON hazmatshelterinplace none [edit] [delete]
ERT
Center for Emergency Response Technologies
University of California - Irvine
UCIRVINE

Questions??

IT Infrastructure Research @ CERT

- **Reliable Networking at the Crisis Site**
  - Cognitive MANETS that self-adapt at all levels of protocol stack to adjust to load and add robustness (Jafarkhani/Yousefi'zadeh)
  - Disruption tolerant hybrid Instant Networks that combine "store-n-forward" with ABC networks to support quality guarantees (Venkat)
- **Reliable Mobile computing platforms**
  - Power aware cross-layer architectures for mobile applications (Dutt/Venkat)
- **Scalable Information Dissemination**
  - Internet-scale rapid dissemination using P2P infrastructure (Mehrotra/Venkat)

Societal Scale Deployment Research @ CERT

- **Understanding societal use of technology in disasters**
  - **Social media & its role in public awareness / crisis communication**
  - **Instant messaging as a communication modality**
- **Modeling societal information needs & characteristics during disasters**
  - **Modeling Information diffusion through social networks (Butts)**
- **Challenges in technology adoption**
  - **Cost & cultural barriers to information sharing (Sutton/Tierney)**
  - **Privacy and confidentiality in information sharing and data collection (Mehrotra/Venkat)**

RESCUE Project

Funded by NSF through its large ITR program

The mission of RESCUE is to enhance the ability of emergency response organizations to rapidly adapt and reconfigure crisis response by empowering first responders with access to accurate & actionable evolving situational awareness

1. **Extreme Networking at the Crisis Site**
2. **SAMI – Situational Awareness through Multimodal Input**
3. **Policy-Based Information Sharing Architecture**
4. **Customized Dissemination in the Large**
5. **Privacy Issues in Deployment**
6. **MetaSIM – An architecture for simulator integration**

Research Team

BYU BRIGHAM YOUNG UNIVERSITY
- Privacy
- Security
- Trust

Colorado Natural Hazards Center
- Natural Hazards Center
- Social Science

ILLINOIS
- Data Management
- Security and Trust

ImageCat, Inc.
- Disaster Analysis
- Earthquake Engineering
- GIS
- Transporation Modeling
- Urban Planning

UCIrvine University of California, Irvine
- Civil Engineering
- Data Analysis & Mining
- Data Management
- Middleware & Distributed Systems
- Privacy
- Social Science
- Transportation Science

UNIVERSITY OF MARYLAND
- Civil Engineering
- Transportation Engineering

UCSD
- Computer Vision
- Networking
- Multimodal Speech
- Wireless

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BREN:ICS INFORMATION AND COMPUTER SCIENCES UCIRVINE

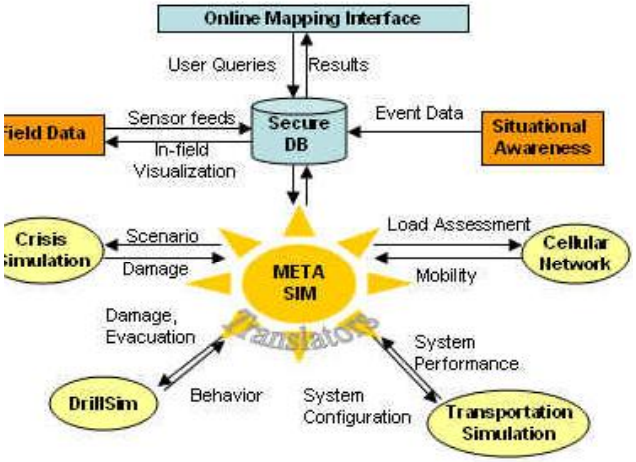
Closing Remarks

- **CERT Outcomes**
  - **Research**
    - **Robust disruption tolerant IT infrastructures**
    - **SA technologies for transformational improvements to the response process by improving decision making**
    - **Societal level technology adoption**
  - **Testbeds**
    - **Simulation and instrumented real environments for technology testing**
  - **Partnerships and collaborations**
    - **industry and government partnerships**

CERT Testbeds

MetaSim Simulator (Regional Response)

An integrated plug-and-play micro/macro simulation environment for diverse crisis response situations.
Built in hooks for technology validation



Different testbeds model information flow conditions under diverse types of crisis situations

Responsphere, UCI

Responsphere

(incident response)

A Campus-wide infrastructure to instrument, monitor, disaster drills & to validate technologies

Responsphere Enables Drills & Technology Evaluation

- **Technology Testing Exercise: 16 SEP 08**
  - **Bren Hall Evacuation w/Campus Police Department & UCI Zone Crew 3**
- **Live Burn with OCFA,LA Fire and Anaheim Fire**
  - **Testing Sensing (human bio-sensing) data collection & 2nd generation FICB**
- **SAFIRE / FICB Usability Study – 15 MAY 09**
  - **Freeze points identified as critical junction / decision points to assess SA with and without FICB**



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CERT Artifacts

- **Derivative research products of direct relevance to first responders**
  - **Mechanism to focus CERT research**
  - **Opportunity for technology transfer**
- **Some of CERT artifacts are in current deployment at partner sites**

Disaster Portal in use by City of Ontario since Sept. 2007 to improve communication of relevant situational awareness information between first responder and the public