Community-based Cloud for Emergency Management

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Outline

1. Introduction and motivation
2. The framework
3. Conclusions
2011: A year of natural disasters, 2012 ??
Motivation

Disaster Management may involve:

• Various organizations and people
• Massive amounts of information
  • E.g., Construction, medical facilities, transportation, food, housing shelters, rescue resources and personnel

Classical disaster management:

• Top-down approach
• Failed to address local needs
• Ignored the potential of indigenous resources and capacities

Opportunities:

• Web 2.0, pervasive computing
• Disaster management can involve general public
“The public is a resource not a liability.”

--Craig Fugate (Administrator of the Federal Emergency Management Agency (FEMA))
We propose: A community-based disaster management approach

- The complement to the prevailing emergency management framework
- Corrected the defects of the top-down approach
- Proactive disaster management signifying the role of general public and local communities
- Utilize local knowledge and means of communication and organization.
- Increase the scope of disaster management
- Sustainable disaster reduction
- Real-time situational awareness
What is it?

- A cloud computing platform to address the community's information, coordination and collaboration needs.
- A Web based portal with browser as the UI.
- Support access through multiple channels including low-end wireless devices.
- Enable collaboration between civil society, government, private sector, volunteers and the victims themselves.
Classical Cloud computing model

The cloud infrastructure is owned by an organization selling cloud services to the general public or to a large industry group.
Problems of using classical cloud

- Moving legacy data to a central data center is expensive.
- Emergency related data changes fast -- data updating and synchronizing is difficult to achieve.
- Moving data to third-party may cause security issues.
- Data center vulnerable to disaster.
  - E.g., the FEMA’s loss of access in May 2010.
A community-based Cloud

- A paradigm for Cloud Computing in the community without (or with little) dependence on Cloud vendors
  - Resource pooling
  - Economic scalability
  - Individual autonomy: nodes act in their own self interest
  - Openness: nodes may join or leave easily
  - Graceful failure
  - Security and privacy
Outline

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System architecture

Information Repository

Hospital
Community Data Sources

University
Utility

Virtual Community Database

Social Media

twitter
facebook
YouTube
LinkedIn

Social Media Database/Stream

Social Networking

Information Query
Communication/Collaboration tools
Authentication/Authorization

SMS Gateway
Web Service

Intermittent connection

GSM

(low-end) cell phone

smart phone/PDA

desktop

Internet
Information repository

“The world looks at a disaster, often willing to help, but needing an accurate picture. … Humanity’s effectiveness will be much increased if relevant data streams are made available.”

http://www.w3.org/wiki/DisasterManagement
2.1 Construction of virtual community database
What is it?

- P2P overlay networks
  - Every peer can be both a server and a client
  - Peers join and leave at will
- Data integration systems
- Federated databases (scale, ad-hoc nature)

**Goal:** To enable users to share data across local or wide area networks in an ad-hoc, highly dynamic distributed architecture.
Characteristics of disaster information

- Rapid changeability
- Large-amount
- Domain-heterogeneity
- Data format heterogeneity
  - A spectrum of possibilities:
    - Relational tables
    - XML
    - RDF
Ontology and semantic web technologies can be used to **identify and associate semantically corresponding concepts** in the disaster-related information, so that the heterogeneous data can be integrated and ingested.

We generalize and define disaster management ontology mostly from the **existing** ontologies.
Phased Framework Model

Recovery
- Strategic Planning
- Returned & Resettled Evacuees
- Task Reviews
- Demobilise
- Long Term Planning

Response
- Coordinators
- Victims
- Evacuees
- Response Teams
- Damage Assessment
- Deployments
- Resource Needs
- Situational Awareness

Preparedness
- Suppliers
- Responders
- Volunteers
- Evacuate
- Pre Position Resources
- Equipment Registry
- Warnings

Mitigation
- Decision Making
- Strategic Planning
- Trainers
- Scope of Actions
- Needs Planning
- Information Updates
- Education
- Organisations
- People
- Activities
- Resources
- Information
## Existing disaster-related ontologies

<table>
<thead>
<tr>
<th>EOi</th>
<th>E</th>
<th>GEM</th>
<th>UEOii</th>
<th>EMiii</th>
<th>Fiv</th>
<th>LODEv</th>
<th>SEMvi</th>
<th>GER</th>
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<td>3 classes 17 properties</td>
<td>27 classes 6 perspectives</td>
<td>3 classes 1 function</td>
<td>5 classes 6 functions 13 relations</td>
<td>5 classes 20 properties</td>
<td>DUL classes 6 DnS patterns 1 other class</td>
<td>1 class 6 properties</td>
<td>4 core classes 1 other class 5 types 3 property constrains</td>
<td>5 Categories of relations</td>
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<td>Music; linking data</td>
<td>multimedia</td>
<td>geospatial</td>
<td>AI</td>
<td>Cultural process and narrative stories.</td>
<td>Emergency response; KM</td>
<td>Historical &amp; news</td>
<td>Domain independent</td>
<td>Emergence/crisis</td>
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</tbody>
</table>
Ontology definition

- For most crisis/disaster/emergency information, they have their domain categories/hierarchies/ontologies.
- We want to reuse them, and provide freedom of meaning choices to users.
- We try to provide Disaster-Related Concept to associated disaster information and relate to other useful resources according to users’ applications.
Ontology-based integration: mappings

Mappings semantically link data at the sources with the ontology.

LAV: the source database is modeled as a set of views over the Global ontology.
Query general architecture

- Based on Distributed Hash Tables (DHT) to get many good networking properties
- A query processor is built on top

Note: the data is stored separately from the query engine, not a standard DB practice!
Research problems

- Query rewriting
- Distributed indexing
- Distributed query evaluation
- Optimization
2.2 Construction of virtual social media database
The role of social media in disaster response
## Technology Applications

<table>
<thead>
<tr>
<th>Social Network Research Categories</th>
<th>Fund Raise</th>
<th>Call for Help</th>
<th>Access to Resources</th>
<th>Basic Comms / Connections</th>
<th>Assess / Report</th>
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</thead>
<tbody>
<tr>
<td><strong>Tech Tools</strong></td>
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<td>Mobile, Text, Smartphones</td>
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<td>Website Development / Blogs</td>
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<td>Video Sharing (YouTube, Vimeo)</td>
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<td>Skype</td>
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Crisis Management PR, Social Media PR Tips, 2010,
Information from “close” circle is more important

- Information from friends, family and neighbors are particularly important for the public to fulfill information seeking requirements, and to make decisions, because this kind of information provides local context, rapid updates as well as safety & welfare checking of close relationships.
Research problems

- Visualization of the information
  - Sorting
  - Categorization
  - Crowd-mapping
  - ...

- Filtering
  - Noise, rumors...
3. Social Network-based user interface
Advantage of SNS-based system

- SNSs create inter-organizational networking
  - facilitating the flow of information across organizational boundaries in emergencies
  - increases interaction among organizations

- SNSs allow the community/group as a whole to engage in overall higher levels of risk-taking and solve collective action problems more easily.

- SNSs facilitate the rapid dissemination of information and improve access to resources among network members.
Apps/tools needed

- **Common SN applications**
  - E.g., status updates, walls, wikis, blogs, etc

- **Collaboration & communication tools**
  - E.g., authenticated discussion board, document sharing (include group editing, group calendar, instant messaging, web conferencing, etc)

- **Other management tools** (e.g., functions in SAHANA)
  - Missing Person Registry
  - Organization Registry
  - Request Management System
  - Camp Registry
  - Volunteer Management
  - Inventory Management
  - ...
Ongoing work: a prototype system

A social information system for the Red River crest
Outline

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- Conclusions
Conclusion

- Proposed a community-based cloud computing platform

Goals:

- Maximally utilize all of the available information and human power from within and outside of a community
- Rapid scaling when needed
- Significant flexibility and high cost reduction

- Lots of open research problems...