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NII Shonan Meeting Report

No. 2014-8

Water Disaster Management and Big Data

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July 7–10, 2014

National Institute of Informatics
2-1-2 Hitotsubashi, Chiyoda-Ku, Tokyo, Japan

Water Disaster Management and Big Data

Organizers:
Fang-Pang Lin (NCHC,NARL, Taiwan)
Satoshi Sekiguchi(AIST, Japan)
Philip Papadopoulos (UCSD, USA)

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Water disasters include flooding from typhoon, seasonal storms and other natural or man-made causes, usually coupling with land, mud-slides and often occur without warning. Water disaster management is a challenge that faces many parts of the world. Big data emerges as a new opportunity for prediction and decision support. Using water disaster management as a specific disaster management application, the goal of this meeting is to bring together an interdisciplinary community of researchers, practitioners, and developers to explore current and future challenges identified by planners and responders that require research, development or deployment of big data and cyberinfrastructure solutions. This Shonan meeting makes use of the unique opportunity to bridge various areas and to establish sustainable research collaboration between various communities. The seminar comprises both representative background presentations to set the context for discussions, working sessions to develop joint research agendas, and sessions that focus on joint problem-solving of a target issue selected during the meeting. The seminar report includes the framework of the discussions that leads to new ideas and summaries of presentations following the breakout sessions.

Background

Over the 12 years of PRAGMA (2002 2014, member institutions had experienced several types of disasters: typhoon damages (annually in Taiwan in particular Nock-ten October 2004, Morakot August 2009), flooding (Thailand 2011, Australia), earthquake/tsunami (March 11, 2011 tsunami that affected Japan), and fires (October 2003 and 2007 affecting San Diego). At the PRAGMA 21 Workshop, sponsored by GEO Grid supported by MEXT Japan, organized by AIST, co-organized by Osaka U, Titech, and U Tsukuba, with many other sponsors(see http://pragma21.pragma-grid.net/dct/page/1) there was a special session on GEO Grid and a focus on this in the PRAGMA 21 Workshop. In discussions, the keynote speaker Kenzo Hiroki (ICHARM) was asked the question

- If you could have (or improve) one technology in handling a disaster, what would that be?

- His response was: Have a technology where he could have all of the (distributed) people responding to focus, simultaneously, on the same piece of information (e.g., video or data feed).
- His presentation and the ensuing discussion stayed with the participants for many years.

Given the nature of PRAGMA, to delve more deeply into how to address this concern (and other concerns around disaster management), we knew we needed to have an extended, dedicated time for discussions between disaster management and IT experts. The Shonan venue gave us that opportunity. A proposal to Shonan was first discussed at Supercomputing November 2012 (Salt Lake City). It was decided then to focus on water disaster management, both to allow us to make progress, but also to reflect the issues that motivated the organizers. A proposal was finally submitted in 2013, and accepted in December 2013.

In parallel to PRAGMA's journey to this meeting, the larger community, within countries and internationally, saw needs to address issues around the entire disaster management cycle. One most relevant to this workshop is National Research Council. Improving Disaster Management: The Role of IT in Mitigation, Preparedness, Response, and Recovery. Washington, DC: The National Academies Press, 2007.

Topic of Interests

Water disasters include flooding from typhoon, seasonal storms and other natural or man-made causes, usually coupling with land, mud-slides and often occur without warning. Water disaster management is a challenge that faces many parts of the world. Big data emerges as a new opportunity for prediction and decision support. Using water disaster management as a specific disaster management application, the goal of this meeting is to bring together an interdisciplinary community of researchers, practitioners, and developers to explore current and future challenges identified by planners and responders that require research, development or deployment of big data and cyberinfrastructure solutions.

The topics will include:

- Water disaster events and mitigation practices
- High frequency sensor networks and fast response.
- Remote sensing and aerial imaging
- Flood and land sliding modeling
- Crowd sourcing and data mining for water disaster management.
- Tera- and Peta- scale data infrastructure
- Configurable and high availability networking

Participants

Title	First Name	Last Name	Affiliation
Dr.	Fang-Pang	Lin	NCHC, NARL (TW)
Prof.	Phil	Papadopoulos	UCSD, San Diego (US)
Dr.	Satoshi	Sekiguchi	AIST (JP)
Dr.	Junichi	Aoki	Hitachi, Ltd. (JP)
Prof.	Lan-Kun	Chung	GIS Research Center, Feng Chia University (TW)
Prof.	Shinji	Shimojo	Osaka University (JP)
Prof.	Susumu	Date	Osaka University (JP)
Dr.	Peter	Arzberger	NSF (US)
Prof.	Jose	Fortes	University of Florida (US)
Dr.	Whey-Fone	Tsai	NCHC, NARL (TW)
Dr.	Prapaporn	Rattanatamrong	Thammasat University (TH)
Dr.	Sirod	Sirisup	NECTEC (TH)
Mr.	Bo	Chen	NSPO, NARL (TW)
Dr.	Kyoungsook	Kim	AIST (JP)
Prof.	Yoshiyuki	Kido	Osaka University (JP)
Dr.	Jason	Haga	AIST (JP)
Dr.	Hiroaki	Yamanaka	NICT (JP)
Mr.	Chen-Yu	Hao	GIS Research Center, Feng Chia University (TW)
Prof.	Wanida	Putthividhya	Thammasat University (TH)
Dr.	Yasuhiro	Murayama	NICT / ICSU-World Data System (JP)

Program

Structure of the Workshop:

We anticipate a series of presentations, increasingly technical, to provide examples of the needs of individuals and groups responsible for anticipating, planning for, and responding to natural disasters caused by water. We plan to have individuals from several countries present scenarios where there are technical challenges. We anticipate that there will be a dialog between individuals and groups planning or responding to aspects of disasters and individuals who can understand and ask questions to clarify technical aspects of the challenges. Out of that discussion we hope to classify challenges as long term (research: there are basic questions for which there are no existing solutions), medium term (development: most of the technologies are developed but need to be integrated or tested or modified) and short term (deployment: (affordable) solutions exist).

Goals of Workshop:

The workshop will produce a report for the community. We plan to achieve the following goals in water disaster management and big data:

1. generate possible research opportunities for funding agencies (such as JSPS or NSF);
2. create some personnel connections between participants;
3. develop funding proposals to further ideas from the workshop; and
4. in the PRAGMA Context establish a working group or new expedition to prototype solutions, in collaboration with groups with the needs.

Day 1: Scenarios andfs Problems in Water Disaster Management

7,July,2014	Activity	Chair
9:00-9:10	Introduction of the Meeting: Morale & Objectives	Satoshi Sekiguchi, Peter Arzberger, Phil Papadopoulos, Shinji Shimojo, Fang-Pang Lin
9:10-9:30	Whoś who	Fang-Pang Lin
9:30-10:30	Water Disaster Management Practices & experiences Sharing (I)	Whey-Fone Tsai
10:30-10:50	Coffee break	
10:50-12:00	Water Disaster Management Practices & experiences Sharing (II)	Bo Chen
12:00-13:00	Lunch	
13:00-14:30	Scenarios Build Up & Problems Identification	Peter Arzberger, Phil Papadopoulos
14:30-14:50	Coffee break	
14:50-17:00	Break-up Discussions in Identification of Key Issues (3 working groups and working on a framework with quick and slow onset disaster types and operations on monitoring/predicting, communicating and responding, as the starting point)	Kyoungsook Kim, Jason Haga, Prapaporn Rattanatamrong

Day 2: Identify Key Topics

8,July,2014	Activity	Chair
9:00-9:10	Wrap-up Report from Day 1	Fang-Pang Lin
9:10-10:30	Big Data: Challenge and Opportunities Break-up Discussions in Identification of Key Issues and Opportunities	Shinji Shimojo, Yasuhiro Murayama
10:30-10:50	Coffee break	
10:50-12:00	Presentation on Identified key Topics from Each Working Group	Lan-Kun Chung
12:00-13:00	Lunch	
13:00-14:30	Searching for Solutions: Sharing of Experiences & Technology from Participants (I)	Wanida Putthividhya
14:30-14:50	Coffee break	
14:50-17:00	Searching for Solutions: Sharing of Experiences & Technology from Participants (II)	Jose Forte, Fang-Pang Lin

Day 3: Technologies and Solutions

9,July,2014	Activity	Chair
9:00-9:10	Wrap-up Report from Day 2	Fang-Pang Lin
9:10-10:30	Breakup Discussions in Technology and Solutions (I)	Fang-Pang Lin
10:30-10:50	Coffee break	
10:50-12:00	Breakup Discussions in Technology and Solutions (II)	Lan-Kun Chung, Susumu Date, Sirod Sirisup, Janyu How
12:00-13:00	Lunch	
13:00-17:00	Excursion in Shonan Area	

Day 4: Summary

10,July,2014	Activity	Chair
9:00-10:30	Overview and Guidelines	Peter Arzberger
9:10-10:30	Report from Technology & Solutions Working Groups	Fang-Pang Lin
10:30-10:50	Coffee break	
10:50-12:00	Future Development & Action Items	Fang-Pang Lin
12:00-13:00	Lunch	

Key Observations

Key observations from the meeting (some of these were stated at the meeting, others are based on reflection of meeting discussions)

- Disasters are not confined to national boundaries. Learning how to effectively manage them is an opportunity to share effective practices and approaches in an international setting
- Disaster management (including all four phases see below) is an extremely complex operation, requiring collaborations among many expertise and ultimately among many agencies.
- Ability to access and process data, often real time, is critical to improve managing disasters.
- There are major opportunities for and need of information technology most phases of disaster management. While the NRC report cited above covers many of these challenges, technology has continued to evolve. One technology that offers opportunities and challenges is social media. The opportunity is the ability to connect with people and expand the sensing and real time data into managing disasters (both data in and data out). On the other hand, there is a great deal to learn about validating such information and how all participants should understand these data.
  - A statement from one of the references indicated that in none disaster scenarios, much effort is put into ensuring technologies and

approaches are efficient; however in the cases of disasters we need solutions that are scalable and resilient

  - Currently, most academic resource providers do not think/test about backing up services (like they have learned to back up data)

- There are key assumptions that underpin many scenarios: namely that there is communications and power.
- In thinking about responding to disasters, one needs to define success. This could be saving lives or saving some particular lives, protecting property,
- While we did not dwell on this, there are potentially disruptive technologies / disruption deployments in the future
  - Ubiquitous communications
  - UAVs for data gathering, available for rapid deployment
  - Tiling tablets for shared visualization

Phases in Disaster Management From Earthzine

`(http://www.earthzine.org/disaster-management-theme/).`

Vanneuville et all, posted March 21, 2011

`(http://www.earthzine.org/author/Vanneuville/)`

in Is Flood Risk Management Identical to Flood Disaster Management?

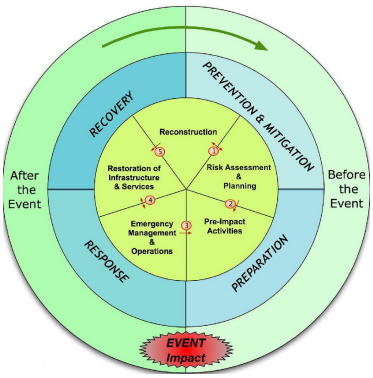

Figure 1: Phases in disaster management according to Vanneuville et al.

Summary of Discussions

The Scenarios: The group focused early in the meeting on three motivating type of disasters:

- Flooding: This can result from typhoons as well as ongoing and frequent monsoons. The image many participants had was the flooding in Thailand in 2011.
- Tsunami: The image participants had was of the devastating Tsunami that struck Japan in March 2011. In addition there was a severe Tsunami that hit Aceh Indonesia in 2004.
- Typhoon: These affect the region, from the Philippines (most recently November 2013 with Typhoon Haiyan) to Typhoon Morakot (August 2009;

  `http://en.wikipedia.org/wiki/Typhoon_Morakot.`

) that created conditions that created a mudslide that buried a village), to others that affect Japan, Korea and China.

There are commonalities among the scenarios

- Need to integrate data from various sources
- Promise and challenges in social media, in getting information to and from population, and being able to have a measure of validity about data from others
- Predictions of impact of disaster are required for allocation of resources for response and recovery. Often this will require models of the natural disaster (e.g., trajectories of typhoon, predictions of rainfall).

In addition, there are differences, chief is the time scale in responding to a disaster, with the shortest possibly being tsunami, to the longest being floods. However, many factors are still difficult to predict, e.g. exact amount and location of rainfall.

Addressing Scenarios: Different Approaches, Different User Needs

Figure 2 (using iMindMap software to visualize information) resulted from the first breakout group session that used the three scenarios, but looked at different approaches:

- Monitoring
- Predicting
- Operations/Infrastructure

In each of these scenarios there were user perspectives. But even here there were different type of users

- Response Managers (needing to decide where to allocation resources)
- First responders
- Data contributors (acting as sensors for disaster response systems)

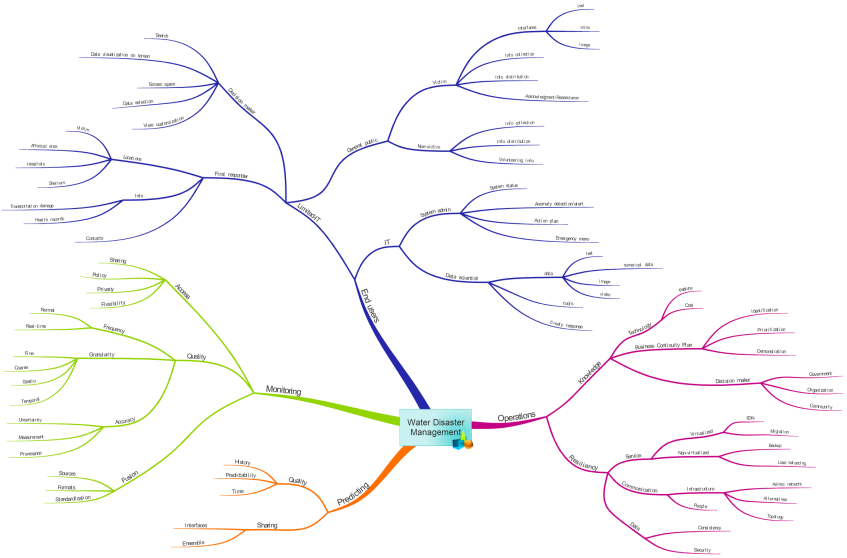

Figure 2: The mind map from the breakout session of the day one.

- Victims (how to get help)

This is not an exhaustive list. In some cases, there were very specific suggestions for testing pieces of approaches to determine how difficult it would be to implement some of the technologies. In particular see diagram for testing the migration of a data center.

One common theme among the approaches is data: Generating, accessing, using, and communicating.

Specific Scenarios: What If
To try to be more concrete about what would we focus on as subsets, after the meeting concluded, we formed three breakout groups to identify a specific scenarios problem, what if we could have or know something, and what technology might we want to use. The three scenarios are:

- Typhoon Attack: Rainfall
  - We would like better prediction of rainfall, both amounts and locations. This would allow us to better predict location of flooding, debris flow, and chances of mudslides
  - Monitoring Technology that we would use:
    - Remote sensors (Radar, UAV)
    - In-Situ (Ground based) increased coverage cameras, sensors
    - Uncontrolled sources (social media, mobile sensors)
  - Infrastructure (same order as monitor) we would want to have
    - Remote sensors: international connections networks (politics)
    - In-situ: redundancy Network, optimization, placement
    - Intelligence systems/filtering, virtualization solutions

  - Prediction Models (this was not discussed explicitly) but one would need both better (pre-calculated) models of where there are mudslide hazards, and better run-off models.

- Typhoon Attack: Communicating
  - When typhoon is coming, authority want to know the location and information of people who still struggle in the mountain area, or during disaster, the location of isolated peple
  - Assumption: Power and communication still partially work
  - Solution: Infrastructure: SDN, community network
  - Prediction: potential dangerous areas (landslide, debris flow)
  - Monitoring: not finish yet

- Flooding
  - Flooding slowly approaches to capital city
    - Where to divert water, to airport or city?
    - What information is required for decision makers
  - What if we can have
    - Virtual environment for decision making
    - Map interface sharable among decision makers
  - Where is hospital, airport, and power plant
    - Superimpose (overlap) 4D Geo, time-referenced data
    - Decision maker must want to know the situation over time
  - Technology
    - Tile display wall, tiled tablet

Concrete Steps: What happens after meeting?

- There are several ways for the community to continue to develop these ideas and to try out some of the ideas. Two particular venues are
  - PRAGMA Workshops, with the next two planned for
    - 2014 October 15 17, Bloomington Indiana USA
    - 2015 April 8 10, Nara, Japan
  - Southeast Asia Institute program (SEAIP),
    - 2014 December 1-5, City TBD, Taiwan

- Specific Activities to be tried
  - Migrate a Data center, using specific remote sensing data (phased array radar)
  - Build collaborations between Taiwan and Japan for sharing phased array radar data (that can give more information about amount and location of rainfall during a typhoon)
  - Other

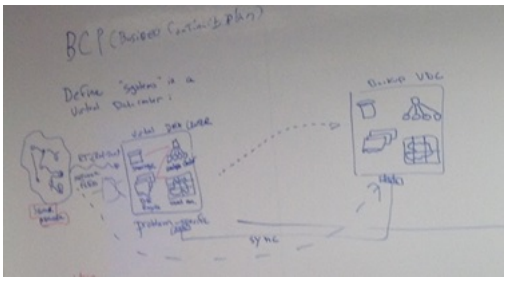

Figure 3: Migration of data center during water disasters.

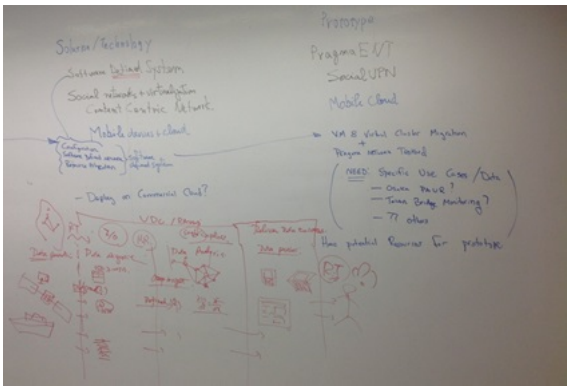

Figure 4: Migration of data center during water disasters with a big data framework, plotted in red.

Meeting Structure and Participant Composition

There were 22 attendees of the meeting. The meeting schedule and structure allowed for a great deal interaction. Notable about the interactions:

- The small number of participants allowed for people to know everyone at the meeting. It was helpful that nearly half of the participants are regularly engaged in PRAGMA, and many others were known to at least one of the PRAGMA members.
- There were different expertise present on the technology side, and a few people who had closer experience with disaster management.
- Two entire walls of white boards allowed for much real-time sharing of ideas about specific topics and sketching out ideas
- Breakout sessions (two sessions, different groups and topics) allowed for smaller groups to meet
- Critically, many junior members were asked to chair the breakout sessions, giving them an opportunity to shape discussions.

Comment for future meetings:

- We need to do more to attract women participants. At this meeting only three participants of the 22 where women.
- Also, we need to plan to have more people who have been directly involved with disaster management at a meeting.

References

[1] National Research Council. Improving Disaster Management: The Role of IT in Mitigation, Preparedness, Response, and Recovery. Washington, DC: The National Academies Press, 2007.

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Appendices

Comments during the presentations are shared through Google Docs as seen in the appendices below. All meeting documents presented or developed at the meeting are shared through shared google drive for all participants.

Online discussions on Google Document:

SHONAN MEETING

Shonan Meeting (51): Water Disaster Management and Big Data

Scratch Note for ideas:
Format [your name]: your ideas

Satoshi(S): FYI. ALOS-2 capture any area everyday with its emergency mode, while 14days in nominal mode. Satoshi(S): More to know about FORMOSAT-5. Sattelite Constellation is useful. Key issues: Networking groundstations, Standardize command to control these sattelites.

`http://www.nspo.org.tw/2008e/projects/project5/intro.htm`

Shinji: Networking groundstations are very interesting. But Can It be temporal or sustainable? How much bandwidth we need ?

Satoshi(S): AFAIK unfortunately, it requires temporal but peaky bandwidth.

FP: HPWREN provides sustainable service to observatory transmitting images between groundstations. Good for last mile that requires heavy loading of moving data. We need something like Bandwidth-on-Demand.

FP: Public involvement now plays a crucial role in Taiwan. The problem is the data quality when you hand some responsibility to the public.

Jason Haga: Is it possible to use NPOs for some of the crowd-sourced data? They could have trained volunteers and it might help increase the veracity of data. But the coverage may not be ideal.

FP: The purpose of involving public is not only for the coverage issues, in which sensor network always has limitation, but also for avoiding direct impact to the people from disasters. People tend to respond themselves using their own way, since most methods government introduced are not working properly.

Jason Haga: One comment about Slayers Geothings. He deployed a mobile app to be used by NPOs for reporting. The mobile app became more and more simple with each new version, eventually ending up with a single button to push.

How: its interesting that utilized app to report flood level, for avoiding typo

error, maybe we can use automated image recognition tech to determine the value from colum images.

Wanida(Tik): There is a project in Thailand (NECTEC) utilizing social network to report traffic condition. Good points are lots of data from all the places. Down side is that they need to clean up and pre-process the data into the format that can be used

Satoshi(S): My 2yens comment on Peters talk. It would be useful if the scale sing with poles has an ID Q-code (or similar) to

Phil: Can we simulate an outage of a data center that holds satellite data and reroute/reaccess via PRAGMA Experimental Network Testbed (ENT)? Is there old satellite data we share among PRAGMA (and others!, but not the world) for testing?

Whey-Fone: It is possible to test the case of satellite rapid image processing for emergency reponse to disaster event occurred in Japan and Taiwan, as presented by NSPO Bo Chen, via Japan-Taiwan APAN network or Japan-US-Taiwan network.

Peter A: At some point we may want to look at several reports, to see what they have said. one report is Improving Disaster management, the role of IT in Mitigration, Preparedness, Response and Recovery

`http://www.nap.edu/download.php?record_id=11824`

FP: A reference that I used for this meeting: A UNEP Report: Early Warning Systems: A State of Art Analysis and Future Directions (2012):

`http://na.unep.net/siouxfalls/publications/`
`early_warning.pdf.`

Whey-Fone: Stallite radar image data is very useful for disaster scenario analysis; while ground radar observing spatial vapor data is critical for forecast of typhoon induced and storm rainfall, and hence, contributes to the disaster response.

Satoshi(S): Will Formosat-5 have SAR system ?

How: in some cases, typhoon causes flood.

Satoshi(S): Cause - Earthquake, Heavy rain, Typhoon -¿ Resulting- Flood, Debris flow, Tsunami

FP: Complexity in the causes.

Jason Haga: Common problem areas I see, but please add or correct if wrong
1) Data/information collection and dissemination (crowd/sensors)
2) Data filtering/fusion (operations on variety of data types)
3) Short vs. long term responses (either case must be fast) [clarification - short/long are relative, minutes may be short, hours may be long, or perhaps days are long; also, we discussed this both in terms of warnings about upcoming event, and getting word back to community (PeterA)]
4) Cultural background and education (by shinji)
5) Infrastructure to support real-time information

Peter A: Some initial comments from discussions: - Need to define success and/or KPIs. - Think about getting information in as well as informing individuals (getting information out)

Peter A: General comments about three scenarios - Integation of data from various sources, some of the data real-time
- Getting information to community
- There is a promise and challgenges (trustworthiness)
of social media, both getting data into a control center, and getting it out (since social media can a be an all-to-all network) - Prediction is required before distribution of resources
- Modeling is required for prediction
- There are assumptions that communication / electricity persist

FP: Big Data presented here by Murayama-san means getting data in finer resolutions in both temporal and spatial scales. The mash-up google map with both rainfalls observation and traffic and its implication for possible analysis/prediction on human behavior is interesting, which is something beyond the traditional efforts focusing merely on resolutions.

PMP: Radar data is very interesting. Is there a way we could replicate some of this data to PRAGMA sites? Is the data format open so that others could work with it? It seems that processing this data at other sites could make a use case for disaster preparedness – in other words if processing pipeline is replicated elsewhere, then in the event of local issues (power, for example, it might still be possible to process the incoming data stream elsewhere)

Here is the image Fang-Pang Showed:

`http://www.earthzine.org/wp-content/uploads/2011/03/Figure-2cropped.jpg`

Satoshi (S): Phils idea - Ad hoc Tiled Display (?) bring your own tablet to configure a large display connected. easy to attach and detach automatically reconfigurable.

Jason Haga: See these papers for ad-hoc mobile display

`http://juliaschwarz.net/research/phone_pixel.pdf`

http://www.graphics.rwth-aachen.de/media/papers/schmitz_2010_egarea_031.pdf

content...
iMindMap - interesting application for displaying hierarchy/relationships between concepts.

Verification of prediction models: which model can we choose in case of emergency?

Jason Haga:
BCP = Business Continuity Plan
ICP = Information Continuity Plan (suggests data-centric plan? just a thought)
Possible outline of report (mostly assembling work we have done) [Do we want to discuss this?] Here is a draft - probably too much for a report.

o Introduction
o Three scenarios: Typhoon, Flood, Tsunami
o User-based approach: with the iMindMap
o Three areas of technologies: Monitor, Simulation, Infrastructure
o Scenarios from breakout groups (include the slides of short-term goals)
o Actions: Short term and long term
o Participants (from material provided to Karen)
