Disaster Management Communication Networks: Challenges and Architecture

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Outline of Presentation

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• Motivation
• Major Disaster
• Related Research Work
• Challenges/ Concerns Observed in designing disaster management
• Proposed Architecture
• Conclusion
• Questions
Introduction

• In the past decades, serious natural disasters such as earthquakes, tsunamis, floods and storms have occurred frequently worldwide with catastrophic consequences.

• Communication resources are often entirely or partially damaged by disasters. The demand for information and communication technology (ICT) services explosively increases just after the events.

• The article presentation proposes a network architecture design by integrating the existing network infrastructure with the reinforcement of layers based techniques and cloud processing concepts.
Why Technology?

• The development of technologies and the changing demands make the professionals high alert in managing the technology especially when life-threatening situation involved.
Introduction Conti....
International Telecommunications Union (ITU-T)

“When disaster strikes, telecommunications save lives”

Information and Communication Technology (ICT) has been recognized as a powerful tool for national economic, social and culture development to raise productivity and improve the quality of life.
Motivation

• Proliferating Wireless access technology
• Co-existence of various radio technologies over a region is more a reality
  • WLAN, LTE, WiMAX, GPRS, WCDMA etc..
• The first 24 to 72 hours of disaster tend to be very hectic as well as critical period for immediate rescue and lifesaving activities.
People recognised the importance of ICT network that needs to be resilient and affordable.

Disaster Situations
- Earthquakes
- Floods
- Rains
- Storms

Sharing of Information
- Victims
- First Aid
- Fire Fighters
- Emergency Services (such as Medical, Food, Security)

Network
- Available
- Reliable
- Repairable, Recoverable

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Motivation Cont. . .

- Disaster may attack us at any time at any scale without premonition. The only way of knowing the scales of disaster comes from the past history concerning the disaster.
Related Research Work

- Significant message learned from previous major disasters,
  - Tokachi-Oki earthquake in 1968
  - Los Angeles earthquake of 1971
  - Nagasaki heavy rains in 1982
  - Tsunami in Japan 2011
  - Quetta-Pak earthquake in 1935
Related Research Work Conti…

• Nippon Telegraph and Telephone Corporation (NTT) Network Innovation Laboratories, “Movable & Deployable Resource Units (MDRU)”

• Keigo, “IEEE 802.22-based WRAN system for disaster-resistant network systems” (Presented at Humanitarian Technology, 2013)

• Yoshitaka, ”Analysis of and proposal for Disaster Information Network form Experience of the Great Japan Earthquake” (Communications Magazine, IEEE, March 2014)

• NHK Broadcasting Culture Research Institute, ”How Broadcasters Used the Internet” IEEE communications Magazine, March 2014)
Challenges in Designing A Communication Network For Disaster Management

• The development of technologies and the changing demands make the professionals high alert in managing the technology especially for developing countries at the time and aftermaths of any disasters.

But...

• People recognized the importance of ICT network that need to be resilient and affordable.

Compared with traditional disaster communication infrastructure we learned
Challenges in Designing

Major Problem “Traffic Congestion”

- High Cost
- Loss of Energy
- Limited Resources
- Limited Services
- Low Reliability & Availability

Operating Cost

Human Resources

Number of Sites

Maintaining Cost
Proposed Architecture

- Pre Disaster Activities
- Disaster Events
- Post Disaster Activities
Block Diagram for Pre Disaster

1. Microwave Link
2. Sensors detects disaster & generates alarm

Pre-Disaster Activities

System response
Normal activity

PTCL Internet Bandwidth

Base Station
Remote Base Station Van (RBSV)
Disaster Area

Remote Station Building

Sensors at Building, Towers or Poles

Emergency Service Providers
Pre-Disaster Activities

• Remote station building
• Sensors are mounted on building
• Efficient wireless resource
Post-disaster activities

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Service Layer
- Flexibility
- Availability

Cloud Layer

Connectivity Layer
- Resilient
- Fast
- Extendable

Real-Time Communication
I am alive/Friend Finder

Data Communication
Text/Image/Message

Network Cloud

MANET

Base Station

Laptop

RBSV
Case study (Pakistan)

• The vision of the twenty-first century is accessing Internet services from lightweight portable devices, instead of accessing them from a traditional desktop PC.

• Our proposed communication architecture would be suitable in many parts of Pakistan as Internet is used in various ways for many activities and the rise of mobile phone technology is also one example, how people in one part of the country took advantage of emerging technology to leapfrog their lack of facilities at the time.
# Major Disaster Summary (Pakistan)

<table>
<thead>
<tr>
<th>Disasters</th>
<th>Locations</th>
<th>Deaths</th>
<th>Affected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earthquake 2005</td>
<td>Muzaffarabad</td>
<td>1,00000</td>
<td>2,500,000</td>
</tr>
<tr>
<td>Flood -2005</td>
<td>Punjab/Baluchistan/Sindh</td>
<td>520</td>
<td>7,000,450</td>
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<tr>
<td>Storm-2007</td>
<td>Baluchistan/Sindh</td>
<td>732</td>
<td>1,650,000</td>
</tr>
<tr>
<td>Earthquake 2008</td>
<td>Quetta</td>
<td>267</td>
<td>13000</td>
</tr>
<tr>
<td>Flood-2010</td>
<td>Punjab/Baluchistan</td>
<td>1,985</td>
<td>20,000000</td>
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<tr>
<td>Earthquake 2012</td>
<td>Baluchistan</td>
<td>34</td>
<td>15,000</td>
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<tr>
<td>Earthquake 2013</td>
<td>Baluchistan</td>
<td>558</td>
<td>3,000000</td>
</tr>
</tbody>
</table>

Percentage of reported people killed by disaster

- Earthquake 85.3
- Ext. Temp 1.4
- Flood 10.4
- Storm 1.7

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Effects on Quetta

• Quetta is the provincial capital and largest city of Baluchistan province of Pakistan.

• Considering the above analysis, we propose resilient disaster network for Baluchistan (Quetta)

• The resilient network architecture allows the ICT services to be launched within a reasonable short period of time.

• Implementation of three-tier layers network architecture would also minimize the physical & logical redundancy for resilient and flexible ICT resources.
Conclusion

• The developing countries were especially considered where indispensably communication system needs to stay alive in situation people are fully on the edge of life and death.

• Our proposed architecture has given a new hope for the developing countries to consider cloud computing services because of cost effectiveness, unlimited resources with limited expenses and give better dependability on the architecture to save ICT and humanitarian network at the time of disaster.
Thanks
Questions

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