Early survey report on ICT disaster recovery activities in the Great East Japan Earthquake

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SUMMARY

The Great East Japan Earthquake made a hard impact to ICT facilities. In the present age, ICT environments are absolutely essential for handling communications. Even in the disaster area, there are huge amount of information to be handled. Therefore, suspension of TCP service due to this disaster is critical issue to help the victims. On March 25, 2011, we founded "Pdrnet project: Post Disaster Recovery Internet Project" to carry out integrated ICT environment in the disaster areas to eliminate this issue. We provided ICT environment to 54 sites and evaluated disaster recovery technologies on the actual disaster area. Moreover, the trend of the application usage in the shelters was clarified from the traffic analysis.

1. INTRODUCTION

The 2011 off the Pacific coast of Tohoku Earthquake, also known as the Great East Japan Earthquake made a hard impact to infrastructure. Especially in the Sanriku coast area, tsunami made critical damage to infrastructure. From NTT press release [NTT East CORPORATION, 2011], over 6500km cable such as Optical fiber cable and metal cable was carried away by tsunami and 385 telecom facilities were not in service. Also, most ICT services such as Internet connection service, IT service, and etc., were suspended.

In the present age, ICT environments are absolutely essential for handling communications. Even in the disaster area, there are huge amount of information to be handled. For example; in the shelters, operation staffs are reporting situation reports such as the evacuated people list, hygienic status, medical records, sanitary conditions and etc. to survive in the initial stage of this disaster. In this disaster, Tsunami left great destruction for ICT environment to coastal areas (Figure 1). So, suspended ICT services were resumed within 2-3 weeks in the inland area but the services are not resumed completely in the tsunami affected area as of the end of July. This difference of restoring status of ICT service is widening the information gap between restored and restoring sites. And also the gap produces differences of support to victims. Therefore, restoring of ICT environment is very important to help victims and to narrow the gap.

Figure 1 Minamisanriku Town on March 12.

2. AIMS OF THIS PROJECT

"Pdrnet project: Post Disaster Recovery Internet Project" by WIDE Project, Cisco Systems, IPSTAR, SKY Perfect JSAT, Fusioncom, Intel, Keio University, National Astronomical Observatory of Japan and others, was founded on March 15, 2011 [PDRNET PROJECT, 2011]. The aim of this project is to carry out integrated ICT environment in the disaster areas to eliminate information gap. Another aim of this project evaluates the effective technologies for disaster recovery on the actual disaster area. This

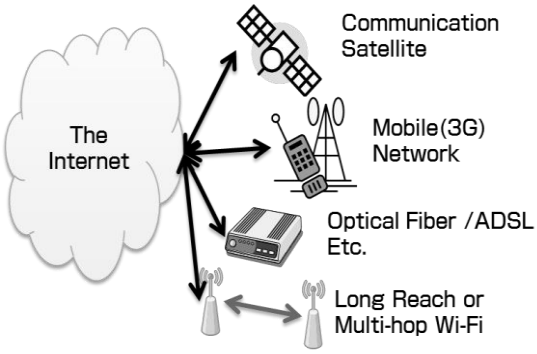

Figure 2 Internet access type

Figure 3 Cisco 1941 and Cisco Aironet

project provides temporary ICT environment composed of satellite access, 3rd generation mobile telecommunication network (hereafter called "3G network"), a fiber optic broadband service, long reach and multi-hop Wi-Fi, LAN, Wi-Fi access, PC and printer to shelter, hospital, local government office and etc.

The last aim is improving ICT literacy in the disaster area and technology transfer to local volunteer or evacuee for sustainable operation.

3. SUPPORTING PROCEDURE

In this section, we describe procedure of our support activities from opening to closing.

3.1. Gathering information

The 1st step of the procedure is we find out a site where ICT support is requested such as shelter, schoolhouse, local government facility, hospital, volunteer center and etc. We gathered local information from local government, volunteer group and evacuee. The location and the person in charge and the situation of each shelter are included in the information. Then, we called each shelter based on the information to inquire the necessity of ICT support. Some local government specified the shelter and local government facilities that had to be supported to us. However, we should investigate demands by us in many cases. This step was spent a great deal of time working in finding.

Site	Location
2 Sites Akamae Elementary School	Miyako City
18 Sites Yamada City office B&G sea center Osawa Elementary School	Yamada City
Otuchi High School	Otuchi Town
Kuribayashi Elementary School	Kamaishi City
SaveTakata	Sumida Town
4 Sites Ofunato City Office Ofunato Sanriku branch Office	Ofunato City
5 Sites Takata-Dai1 Junior High school Takata Hospital	Rikuzentakata City
6 Sites K-wave Kawakura branch City Office	Kesennuma City
4 Sites Sizugawa HighSchool	Minamisanriku Town
Wakuya Kensyukan	Wakuya Town
10 Sites Oginohama Junior High school Oginohama Elementary School Minato Elementary School Ishinomaki Royal Hospital	Ishinomachi City
Kaisenkaku Inn	Onagawa Town

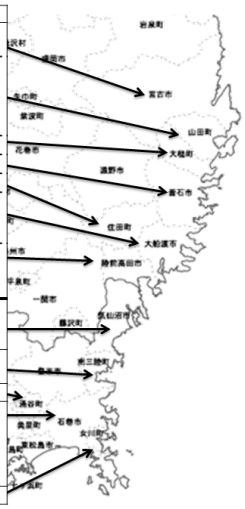

Figure 3 the site list and location

3.2. Network Design

According to a formal support request from the site, we design a temporary ICT environment based on the demand from the site. A design of ICT environment is composed of the Internet access service type, design of wired LAN and Wi-Fi access area in the facility, and the number of personal computers and printers. We choose the most effective Internet access service from satellite, 3G network, multi-hop and long reach Wi-Fi, and a fiber optic broadband service based on the number of users and the usage plan reported from the person in charge on the site (Figure 2).

Some of government and school buildings have been ICT facilities but the Internet connection was lost due to this disaster. So we supported the Internet connection on the site and in some case we also setup a patch connection to headquarter with IPsec VPN.

3.3. Installation, operation, and closing

After the design work finished, we installed our temporally ICT environment to the site. The installation team consisting of 3-4 engineers constructed the environment within 3-4 hours per site.

To reduce the cost of maintenance and the installation, we use a common hardware configuration is shown in Figure 3. We selected Cisco 1941 for a routing service and Cisco Aironet 12xx access point for Wi-Fi service and Cisco 2960 for wired LAN service. And also, Cisco 1941 is installed 3G network access module.

For maintenance work and traffic monitoring, all gateway routers in the supporting sites were connected to the monitoring center in Tokyo. The monitoring center is recoding traffic usage, activity check of equipment in the all sites and is enable to remote login.

When the environment has failed, our engineer or

Figure 5 ICT environments in Kesennuma City

local volunteer in the site will be supported. When the site was closed, we removed all of equipment and restored the site before installation.

4. RESULTS

We describe the results of out activates.

4.1. Usage and Operation

We are provided our support to 54 sites as the end of July. The site location is shown in Figure 4. People in Figure 5 are viewing "Tsunami" video on our providing ICT environment. 28 sites of all are connected via satellite and 21 sites are connected via 3G network (Table 1).

In March, we helped mainly for governments and medical care. They used E-mail and WEB to exchange information necessary to support the victim, for example, evacuation list, request for help, medical condition report, announcements, etc. The target user and the usage were rich in variety one month after this disaster. For example, the environment is used as an information gathering, education and an amusement by the victim, and used as a business use in the school and the government.

Table 1 Internet access type

Internet access Type	Number of sites
Satellite by IPSTAR	10
Satellite by SKY Perfect JSAT	18
3G Network	21
Long Reach Wi-Fi	2
a fiber optic	3

4.2. Evaluate technology

We evaluated technologies were used for temporally ICT environment based on results of our operation.

4.2.1. Satellite access

Satellite access is Internet access provided through satellites. Satellite access can provide Internet access anywhere in satellite coverage area without access to terrestrial infrastructure. A satellite access also has a high latency connection is due to the signal having to travel to an altitude of 35,786 km above sea level out into space to a satellite in geostationary orbit and back to Earth again.

On this project, we are using two difference satellite based Internet service, IPSTAR serviced by THAICOM and EXBird serviced by Sky Perfect JSAT (Figure 6).

One advantage IPSTAR use has good cost-effectiveness. With a maximum of 45 Gbps bandwidth capacity, IPSTAR drastically increases bandwidth efficiency at significantly lower cost of service [THAICOM Public Company Ltd., 2011]. IPSTAR are providing Internet connection service to 14 countries in Asia Pacific. The IPSTAR service area in Japan is nationwide expecting Okinawa and Ogasawara islands. The IPSTAR gateway station is connecting between Internet and the IPSTAR satellite backbone is operated in Saitama. IPSTAR uses the earth station with satellite dish 84cm or 1.2m for two-way satellite communications service. The total initial changes including an earth station setup

Figure 6 Earth station

EXBird (Left) IPStar (Right)

change and contract charge are only from three hundred thousand yen. A downstream connection from Internet is up to 4Mbps and an upstream connection is up to 2Mbps are available to individual customers. Monthly charges are available from 3500 yen. The fixed IPv4 address allocation plan and the bandwidth grantee plan are also available. The largest disadvantage of the IPSTAR service is IPSTAR has a strict FAP, fair access policy. The IPSTAR FAP usually apply a bandwidth cap is a limit placed on the size and speed of data transfers when customer's daily consumption is probably measured in megabyte of data exceed invisible limitation. We received several complaints about slow down network speed from users in the site connected via IPSTAR.

On the other hand, the advantage EXBird use are EXBird provides TCP acceleration service and has no FAP. TCP acceleration feature can improve poor performance to shorten the latency per packet by splitting the feedback loop between the sender and the receiver. Users will never feel poor performance

with this function. In fact, we have almost never complaint about network performance. JCSAT2A satellite is servicing EXBird covers nationwide including Okinawa and Ogasawara islands with a high EIRP. Therefore the satellite dish size is 74cm which is smaller than the IPSTAR's. A downstream connection is up to 4Mbps and an upstream connection is up to 800Kbps are available to individual customers. The gateway station of EXBird is located in Yokohama. Some disadvantages in the EXBird service are only private IPv4 address assignment, slower upstream bandwidth and communication among earth stations administratively prohibited by technical restrictions.
When a disaster occurs in Tokyo metropolitan area, the both the satellite services will be suspend because each gateway station of IPStar and EXBird is located in Tokyo metropolitan area and there are no backup station.

4.2.2. 3G network

We selected the FOMA data communications service of NTT DoCoMo. This service provides an Internet connection in an area where FOMA 3G network can connect. FOMA service has resumed in over 90% of FOMA service area as March 28 and in almost same area before this disaster at the end of April [NTT DoCoMo CORPORATION, 2011]. Therefore, we could use 3G network for connectivity to the Internet in the disaster area. Disadvantage 3G network use is unstable network performance problems due to the physical characteristics of radio signal and the network congestion. During restoration work by mobile carriers in the disaster area, radio coverage of a base station and band are updated with considerable frequency. From the results of monitoring the RSSI in Band VI (W-CDMA 800MHz) and Band I (W-CDMA 2100MHz) in Kesennuma area at the end of March, both of RSSI and service Band are unstable. There is much demand for 3G network because most of Internet access service based on fixed line such as phone, ADSL, a fiber optic and ISDN are suspended in the disaster area. From the result of bandwidth benchmark around in the disaster area, the actual bandwidth is different from 128Kbps to 2Mbps according to the monitoring area. Therefore we only adopted 3G network as Internet access on the small-scale sites.

4.2.3. Long reach /Multi-hop Wi-Fi

Wi-Fi long reach means that each site is connected by long haul Wi-Fi connection up to 10km by Wi-Fi access point with high-gain external antenna. On the other hand, multi-hop Wi-Fi means each sites are connected via multi-hop Wi-Fi access points. Both of the technologies were useful in Hurricane Katrina disaster area.
As the results, long reach Wi-Fi connection was able to be operated only in Ofunato city office area. In desk planning, we will adapt a long reach or multi-hop Wi-Fi connection in several areas to share a bandwidth in upstream site which is connected to Internet by satellite or fixed line.
However, it was difficult to establish Wi-Fi connection between sites in the disaster area because a rugged Sanriku coast line, trees, forests, hills and buildings were blocked the passage of Wi-Fi radio signal. As a result, we couldn't find location for long reach Wi-Fi connection expecting Ofunato city office area. KAMERIA hall and the Ofunato health and welfare building were connected from the Ofunato city office via long reach Wi-Fi.

4.2.4. Fixed line

Telecommunications companies have restored damaged facilities and services following this disaster. In the end of April, NTT EAST finished repairing partially commutation facilities and resumes a fiber optic broadband service in the selected area. We were actively using this service to connect the site to Internet. It has very stable and high performance. From our benchmarking, the downstream connection is up to 40Mbps.

4.3. Traffic measurement

Top bandwidth consuming applications show in Figure 7. Top of the application, as expected, is WEB (42%) including both HTTP and HTTPS. Unexpectedly, IPsec took 28 percent of the whole amount of consumed bandwidth on all of the sites. IPsec is mainly using for IPsec tunnel for patch connection and secure communication by users. The performance issue in IPsec communication via a satellite access may be cause because TCP acceleration feature can't adapt for encapsulated traffic such as IPsec, GRE, and etc. There is no good solution to this performance issue on the network system.
The 11 percent of bandwidth is consumed by bandwidth-hungry applications such as YouTube, Skype and bit torrent. The bandwidth-hungry

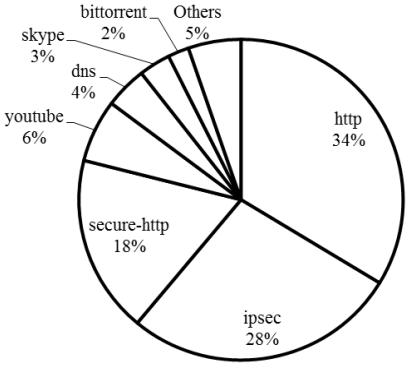

Figure 7 Application Trends

applications consuming the connection at high rates for hours were negatively affected to other application usage. On the other hand, it is difficult to apply bandwidth cap because the Internet is one of the few amusements in the shelter. It is necessary to review the bandwidth requirement in the site. Users need more downstream bandwidth from the results of inquiring survey from the users in the sites and I guess the 4Mbps downstream is minimum requirement on current Internet usages

5. FUTURE WORK

In our concern, we have many stable technology for disaster recovery before this disaster. Unfortunately disaster recovery didn't work smoothly in this disaster. The reason of issue is we don't have any scenarios for disaster recovery procedure. Fortunately we learn a lot of know-how to operate disaster recovery procedure in actual disaster field. As our future tasks, we define a useful disaster recovery scenario for the future disaster and the advance preparation of ICT environment on our society.

6. CONCLUSION

This project provided temporary ICT environment to the 54 sites. We evaluated a variety of the network technologies through operating the temporary ICT environment. Moreover, the trend of the application usage in the site was clarified from the traffic analysis. As our future tasks, we discuss a disaster recovery scenario for the future disaster and the advance preparation of ICT environment.

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