BROADBAND WIRELESS FOR DISASTER OPERATIONS : RESILIENT NETWORKS AND RECONFIGURABLE INFORMATION SYSTEMS FOR RAPIDLY DEPLOYABLE DISASTER RESPONSE

Final Report J2 Project

Prepared for: The Asia Pacific Telecommunity

Prepared by: Nathaniel Libatique, Gregory Tangonan, Hideki Yamamoto and Cesar Pineda.

Project Leader: Usec. Louie Casambre (ICT Office - DOST, Philippines)

May 28, 2014 (with minor updates on 25th of September, 2014)

Cover Photo: Panelists and attendees representing the PWD sector in CTC-219, ECCE Dept. Ateneo de Manila Univ., with the conference live streamed from the *Asia Pacific Meeting on Disability-inclusive Disaster Risk Reduction: Changing Mindsets Through Knowledge, 22-23 April 2014, Sendai, Japan.*

EXECUTIVE SUMMARY

Objective

We envisage the design of a BBW (broadband wireless) network that is very resilient and rapidly deployable for quick end to end information flow from affected areas right up to the war room. *The system has to be able to carry effective broadband content, to prepare communities, especially persons with disabilities (PWDs), during the critical pre-disaster planning and preparation periods and for effective response immediately upon the onset of disasters and over the long term recovery effort*. There is a critical need for systems designs that offer broadband access solutions to disaster risk management, assessment, rescue, medical treatment, survivor support system, resource allocation and long term recovery.

Accomplishments

During the J2 Phase of this project, we have

- shown initial test deployments and designs for rich information systems based on ITU standards for IPTV testbed deployments of Oki Electronics IPTV platform and area One Seg HDTV system at Ateneo de Manila University
- demonstrated conceptual designs for web based interactive disaster channels configurable for pre disaster preparation and recovery (iptv.ateneo.edu content in ASTI-DOST streaming servers)
- designed and demonstrated near-cloud architectures for the low bandwidth off grid-or-low-power environments that characterise at risk pre-disaster post-disaster recovery scenarios
- demonstrated the use of broadband wireless systems based on IP standards and new white space tv frequencies ideal for rapid deployment in immediate post disaster rescue and long term recovery scenarios

Partners

The success of this project is critically dependent on the cooperation of many partners from industry, academe and government, from both Japan and the Philippines:

1. Keio University, Japan
2. Oki Electronics, Japan
3. Mitsubishi Electric, Japan
4. ICT Office, Dept. of Science and Technology-DOST, Philippines
5. PLDT - Philippine Long Distance Telephone Company, Philippines
6. AIC - Ateneo Innovation Center and ECCE Department, Ateneo de Manila University, Philippines
7. ASTI - Advanced Science and Technology Institute, DOST, Philippines
8. Vastnet Inc., Philippines
9. Ionics Inc., Philippines
10. Other partners that were gained over the course of the project include:
    - Daisy Consortium; ATDO - Assistive Technology Development Office, Japan
    - NCDA - National Council for Disability Affairs; NLP - National Library of the Philippines
    - RBI - Resources for the Blind; Physicians for Peace, Philippines

MEETINGS & CASE STUDY VISITS

Kick-Off Meeting

The kick off meeting was led by the Project Lead Usec. Louie Casambre and was held at the Information and Communications Technology - ICT Office, National Computer Center (NCC) C.P Garcia Avenue, Quezon City, on 5 July 2013.

Attendees included representatives from ICT Office - DOST, Oki Electronics, NTT, Oki Electronic Industry, ASTI - DOST, COMSTE - Congressional Committee on Science and Technology, Vastnet Inc., Ionics, Inc. and the Ateneo Innovation Center - Ateneo de Manila University. The project goal and schedule were also discussed and approved during this meeting.

Japan Case Study

A case study visit was held 12 – 14 November 2013 in Japan. Table 1 shows the participants of this case study and Table 2 shows the venues they visited. The discussion in the each venue was informative and highly relevant for this project. During the case study visit, several proposals and decisions were reached, including the request for an area one segment HDTV system test deployment in the Philippines.

TABLE 1. Japan Case Study Participants

No.	Name	Title / Organization
1	Prof. Gregory Ligot Tangonan	Executive Director, Commission on Science Technology and Engineering of the Philippine Congress
		Director, Innovation Center, Department of Electronics, Computer and Communication Engineering, Ateneo de Manila University
2	Engr. Cesar Pineda	Associate Lecturer, Research Faculty, Innovation Center, Department of Electronics, Computer and Communication Engineering, Ateneo de Manila University
3	Alvin M. De Garcia	Science Research Specialist, ASTI - DOST
4	Gladys S. De Ocampo	Engineer, ICT Office - DOST
Japanese Member		
5	Dr. Hideki Yamamoto	Oki Electric Industry
6	Seiji Kozaki	Mitsubishi Electric
7	Takahiko Ebisu	Oki Consulting Solutions
Others (not project member)		

No.	Name	Title / Organization
8	Masatoshi Mano	TTC
9	Katsura Shioi	NTT Advanced Technologies
10	Maki Sugiura	NTT Advanced Technologies

TABLE 2. Case Study Venues.

No.	Schedule	Site Visited	Location	Theme
1	12 Nov 2013 12:00 to 14:00	The University of Electro-Electrocommunications	Chofu, Tokyo	Area one seg research project
2	12 Nov 2013 16:00 to 18:00	NTT PLALA Inc.	Koto, Tokyo	IPTV Commercial Service in Japan
3	13 Nov 2013 10:00 to 12:00	Mitsubishi Electric	Kamakura, Kanagawa Pref.	IPTV and Digital Signage Research and Development
4	13 Nov 2013 13:00 to 14:30	Mitsubishi Electric	Kamakura, Kanagawa Pref.	Project Meeting
5	14 Nov 2013 10:00 to 12:00	Oki Electric Industry	Meguro, Tokyo	4K IPTV, Digital Signage, 920M Zigbee, etc.

During the 13 Nov Project Meeting (see Table 2 Item 4), system architectures and experimental system layouts were discussed and deliberated. Figure 1 below shows a future system architecture for a possible Phase II implementation, highlighting the different components of an information network suitable for disaster risk reduction and management.

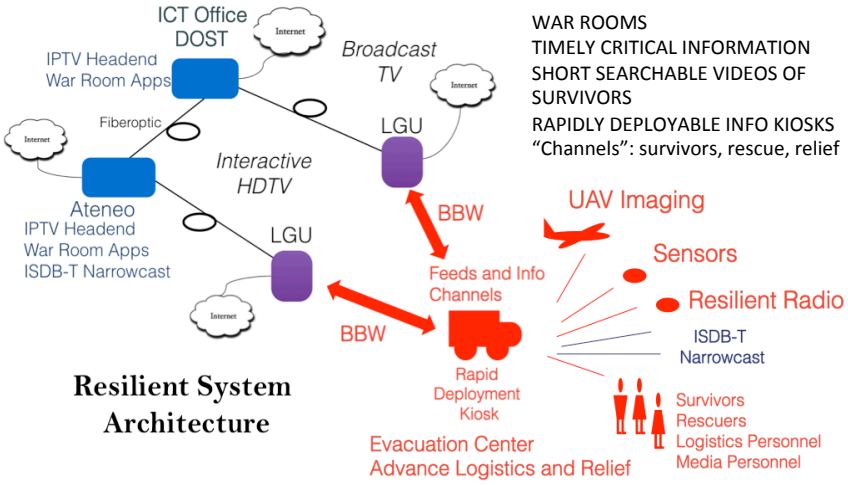

Figure 1. Future wireless system for pre-disaster preparation and post disaster rescue and recovery.

Figure 2 below details the sub-systems necessary for an end-to-end information delivery system that incorporates in a hybrid manner many key wireless and broadband technology components that can prove critical for our application: one set communications, IPTV standards based content delivery, wifi and other wireless (such as tv white space), as well as headend technologies that include realtime encoding, web streaming, rapidly deployable mobile media servers and transcoders.

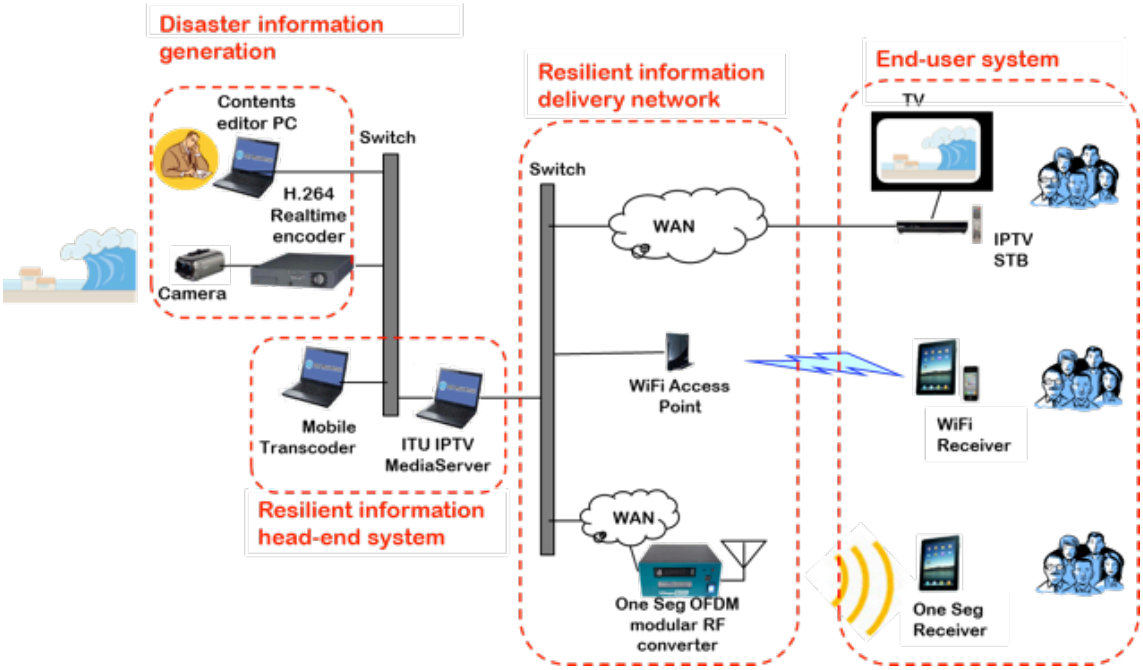

***Fig. 2**. Proposed experimental system for test deployment at the Ateneo de Manila University testbed site. Rapidly deployable components such as laptop based media servers (instead of rack mounted technologies), mobile transcoders and one segment receivers.*

Meeting with Ateneo de Manila University President

In May 8, 2014, the Philippine Project Team held a Technical Briefing on our J2 Project for University President Jose T. Villarin, S.J. in the President's Board Room. In attendance were Prof. Fabian Dayrit, Executive Director of Ateneo Innovation Center, Benjz Gerard Sevilla and Dr. Nathaniel Libatique. The implications of the capability in the context of the University's Mission and Vision were much appreciated by the President, who expressed his full support for the project.

Meeting with Village Island

Fig. 3. *Village Island with Ateneo Team discuss architectures for HD broadcast as well as rich tagged information streams.*

In May 26, 2014, Ateneo de Manila hosted a visit by Village Island (Fig 3 below), a key component vendor for the current IPTV Testbed at CTC (Convergent Technologies Center) 208. In attendance were Michael Van Dorpe, Village Island co-founder, Engr. James Rodney Santiago, Country Representative as well as Project Team Members Prof. Gregory Tangonan, Dr. Nathaniel Libatique, Engr. Cesar Pineda and Benjz Gerard Sevilla. In the meeting, we discussed Village Island's capabilities for video stream quality testing at the headend as well as advanced techniques for content distribution and identification. We also discussed possible architectures for a ISDB-T multichannel demonstration for the Phase 2 J3 Project. The Philippine Project Team discussed our near cloud approach and our interest in interactive content generation, with a focus on disaster preparedness as well as standards development using TV White Space frequencies for post-disaster and recovery applications.

Project Meeting in Tokyo

A penultimate project meeting was held in Tokyo from 27-29 May 2014. Representing the Philippine Team, Prof. Gregory Tangonan met with Dr. Yamamoto of Oki Electric, and Prof. Kawamori of Keio University to discus recent developments and also to explore future Intelligent Transport projects for white space post disaster systems and PWD tracking using new standards for vehicle to vehicle systems.

University of Malaysia

A team from University of Malaysia led by Drs. Fitri Mohamad and Gary Loh Chee Wai visited our facility to gain ideas for solutions to their problems deploying wireless broadband communication systems in Indonesia and Malaysia.

They presented to us some of their ongoing deployments and the Philippine Team shared with them our Near Cloud Architecture to address their needs: high bandwidth delivery of rich multimedia content to local users in a bandwidth constrained environment.

Clearly, the facility and work on network designs that this APT J2 Project started is already paying dividends in providing a reference design for problems being encountered by Asia Pacific Telecommunity member states!

SYSTEM DESIGN, TECHNICAL DEMONSTRATIONS & CONSULTATIONS

Key Design Goals

For our system architecture we have identified the following key components:

1. End to end standards based system software and hardware
2. Rapidly deployable and transportable components
3. Low power content appliances at the deployment site
4. Ability to provide necessary content even in low bandwidth environments
5. Inclusive content design and delivery, PWDs are a critical part of the community addressed

Accomplishments

To meet these design goals, we have put together a series of proof of concept sub-systems that have the necessary capabilities and concluded the project with the following accomplishments:

1. **Standards based (ITU) IPTV platform head-end architecture**

2. **Near-cloud edge architecture**

3. **TV White space non-commercial-frequency wireless platforms**

4. **A hybrid approach** that marries current technologies and standards based approaches in a **mission critical capable content streaming platform: iptv.ateneo.edu**.

5. **A successfully concluded consultation and needs analysis process culminating in an international conference**

The IPTV platform was architected to function either as a head end or as a rapidly deployable node, utilising 1SDB-T standard and portable components. At the edge of the deployment, small form factor low power (<10 Watt) near cloud capable network appliances with full-up computer capabilities deliver and gather information at full bandwidth while updating metadata via the narrowband pipes often available in remote rural areas or in post disaster recovery sites. With the lead of the ICT Office of DOST, a test deployment using TV White Space frequencies, a developing standard, was implemented in post earthquake areas in Bohol Island. While all this design and development work was ongoing, we configured a publicly accessible streaming capability via the iptv.ateneo.edu site to test new content and engage the DRRM community. In parallel we started a

consultation process with multiple stakeholders, such as post disaster camp managers and the PWD community, which culminated in a UN ESCAP Sendai International Conference which was participated in by the PWD Community with remote online participation in panel discussions by the Manila Group, convened by this APT Project Team.

1. Standards Based (ITU) IPTV Platform Head End Architecture

The head end technologies in this platform are mainly based on mobile and transportable components: laptops vs. rack mounted servers, PC architecture based transcoders and transmitters vs. custom hardware, HDTV rich content standards (single segment) vs. legacy wireless technologies.

From specifications and criteria communicated by Prof. Tangonan and Engr. Pineda during the and arising from the November 2013 case study visits in Japan, including the need for local ISDB-T targeted broadcasts, live transcoding and portability of components for rapid deployability, the Japan Team led by Dr. Yamamoto and Dr. Masahito Kawamori came up with an integrated IPTV system that can function as a standards compliant system for the needs of this J2 Project. A figure of the envisioned experimental testbed was shown in Fig. 2 above and repeated in this page (Figure 4 to the left) for convenience. Based on this design, a platform was put together with the required capabilities and successfully demonstrated last March 2014 (see Fig. 5 below).

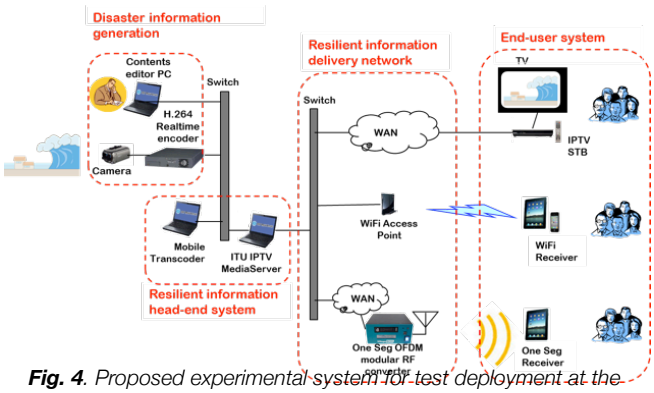

***Fig. 4**. Proposed experimental system for test deployment at the Ateneo de Manila University testbed site. Rapidly deployable components such as laptop based media servers (instead of rack mounted technologies), mobile transcoders and one segment receivers.*

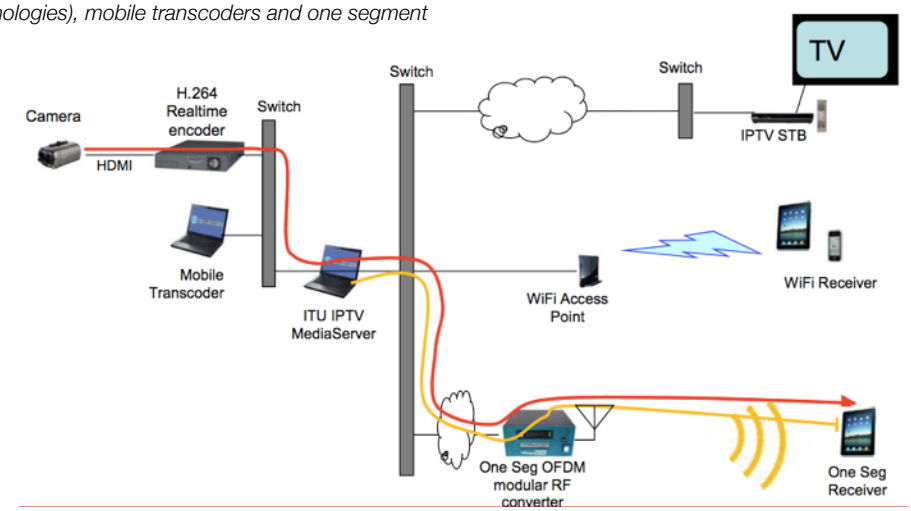

***Fig. 5**. System streaming test for March 2014 testbed deployment. Successful streaming of content over single segment channels to tablets and handsets. The content were sourced from a realtime encoded feed from an HD camera, or PC content.*

The testbed installation and demonstration was led by Dr. Yamamoto, integration and testing of the experimental testbed with the existing IPTV platform at the Ateneo de Manila Univ. campus. Prior to integration with the legacy platform, three tests were conducted using an HD Camera as video source to configure and check out the functioning of the three subsystems - the set top box, wifi receivers and the one seg channel.

All three tests were successfully concluded. To illustrate one of the three tests, we show the ISDB-T test over a local network in Fig. 5 above. Two content streams are delivered, one via the HD camera and another via content stored in hard disk. In either case, one seg converter takes as input an RTP (real time protocol) stream from the ITU IPTV Media Server to a one seg profile and successfully broadcast this over the air at 200 kbps (SD resolution) to the one seg receivers - a tablet or handset.

After the successful tests, the new system was integrated into the legacy system in a two-phase process. First the existing equipment was integrated into the new APT J2 system (Fig. 6 below) over a local area network only. After this was done, the connections were made for an open - IP addressable over the public internet - system (Fig. 7 below). A modified version of this architecture was subsequently demonstrated with end to end connectivity during the April 2014 Sendai meeting.

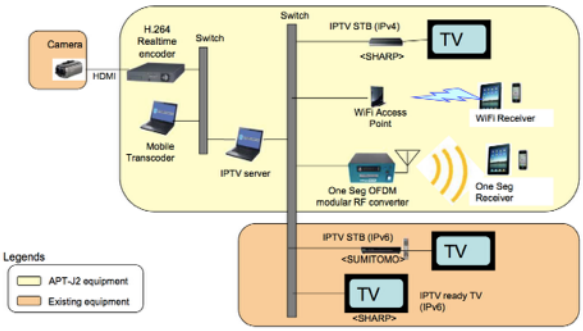

***Fig. 6**. The new APT J2 equipment is integrated to the legacy IPTV equipment over a local area network.*

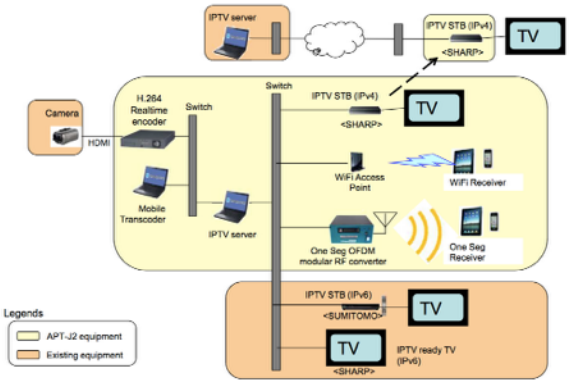

***Fig. 7**. In a second step the integrated system is made available to the open internet via a global IP connection provisioned by PLDT.*

2. Near Cloud Edge Architecture

We have recently designed an architecture centred on network appliances running open software technologies and are low power (< 10 Watts), off grid-capable, and are operable in low to medium bandwidth environments due to automated pre-caching of targeted content. This caching is transparent to the user and is content specific (such as weekly or monthly updates to a K-12 curriculum, or metadata updates to a high resolution map) with the bulk of the content already pre-deployed at the local site using TB-class drives connected to the network appliances, which are essentially small form factor computers.

The near cloud approach (see Fig. 8) is critical to the deployment of rich content in rural and remote areas that have no high bandwidth internet services or in post disaster communities where power and internet is slowly being phased in over the long recovery phase. Arguably it is in these areas that the need is greatest and where the urgency of surmounting the digital divide is most critically required. Libraries or select classrooms or teach training sites seeking to set up quickly after a disaster have an opportunity to migrate without resistance to facilities that are all-digital, with the advantage of buildings that are not as demanding in floor loading requirements as a room filled with stacks of books. The content is readily upgradable during off hours where long download times over the narrowband internet connection is not much of an issue. During the day, the content can be streamed live at high local bandwidths, transparently to the user. Local file and content uploads are made quickly to the near cloud, with the remote cloud servers synchronised at night.

Fig. 8. *Near cloud architecture, with small form factor network appliance (blue inset) providing broadband streaming, storage and caching of targeted content in the local "near cloud". This near cloud node is lconnected through a bandwidth constrained pipe to the internet.*

Our Near Cloud system design have technical features that, once implemented in a single integrated system, will combine several approaches: (a) conventional web caching configuration files for targeted content sites (such as a Dept. of Education Grade 11 math module), (b) Dropbox-like 'near cloud' folders, (c) and possibly a peer to peer distribution mechanism akin to Torrent.

In one temporary deployment, we put together a demonstration classroom for the Department of Education, with industrial partner Ionics Inc. and the ICT Office, showing automated testing and evaluation capabilities, as well as streaming, over the local network, cached multimedia video and content from simulated disaster risk

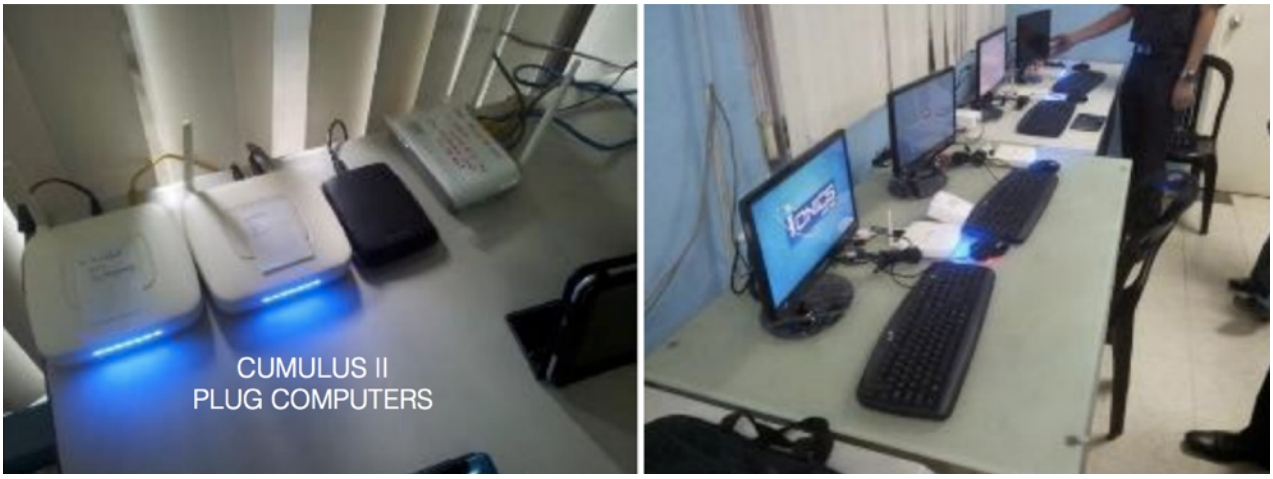

Fig. 9. *Near cloud architecture demonstration using small form factor computers from industry partner Ionics Inc.*

reduction and management channels. The content is deliverable over low cost terminals or onto portable android or IOS tablets using ssh clients on the portable devices.

3. TV White Space Non-Commercial-Frequency Wireless Platform

A test deployment in post-Bohol Earthquake sites was accomplished during the Project Performance Period. New resilient communication systems should be capable of rapid deployment, wide coverage and customisation for DRRM (disaster risk reduction and management), at the same time conformable to international standards. With the adoption of the Philippines of the Japanese HDTV standard over the European standard, there is a possibility of re-allocating the frequencies opened up for new applications.

In anticipation of this event, the Philippine ICT Office of the Dept. of Science and Technology (ICT Office - DOST) is spearheading, in partnership with LGUs in Bohol, a TV White Space trial. The TV white space frequencies, which is comprised of unallocated and unused bands around analog TV channels and guard bands, are being pilot tested for disaster applications (post disaster and recovery) in Bohol Island, which was the site of a recent disastrous earthquake in 2013 last year. Fig. 10 below shows a community centre in the town of Tubigon, Bohol, that was setup using this communications approach. Also in Bohol, in cooperation with the Dept. of Education, an initial demonstration (Fig. 11) was made of the near cloud architecture, with a small form factor, low power, high storage internet appliance delivering high bandwidth to a classroom equipped with low cost tablets.

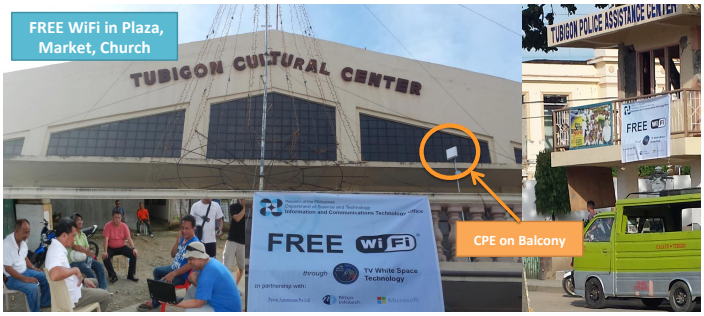

***Fig. 10**. Wifi internet access offered via TV White space core connection in Tubigon town in Bohol.*

***Fig. 11**. An initial demonstration is done in Bohol of the near cloud capability.*

If provided an opportunity, the Philippine Team will deploy, in a J3 APT program, a hybrid capability of this resilient information architecture, using dynamic allocation of unused TV white space channels to provide a narrow bandwidth internet pipe, with intelligent caching of critical content using our near cloud architecture that stores and updates content appropriate to the application (e.g. health center, K-12 curriculum, local library archives, etc).

4. Mission-Ready Hybrid Content Streaming Platform

As part of the Project Performance Period, the Philippine Team configured and soft launched, in partnership with ASTI-DOST (Advanced Science and Technology Institute), a live streaming server with client based software in the Ateneo Campus, that is capable of live streaming content to and from the Ateneo site using a special leased line from PLDT, allocated specifically for this and other research purposes.

The site is use-ready for testing new concepts for disaster and war room channels, for test deployments of the near cloud architecture as well as remote conferencing and online consultations with experts and critical sectors such as the PWD community. If J3 support is allocated, the pilot deployment will depend on this platform for content delivery and updating.

Fig. 12. *Various applications were tested and demonstrated on the mission-ready* ***iptv.ateneo.edu*** *site, such as interactive twitter updates from remote narrow bandwidth sites, to channels configured for disaster readiness, online education to remote sites as well as targeted local content delivery.*

Fig. 12 on the left shows a collage of test content and demonstrations mounted on this system, from Disaster Channel layouts, to interactive low bandwidth twitter updates from disaster sites as well as directives from war room centers. Special educational channels and online courses are also easily enabled, and targeted advertisements and local LGU content can also be delivered. Twitter or social network -like interactivity makes for a richer engagement and can lead to better decision support mechanisms.

The server is easily configured for offline or realtime content delivery, and is presently reachable via the domain iptv.ateneo.edu.

Since the capability is currently configured for mission critical events, we use a variety of platforms (ITU IPTV, ustream, flash servers), both commercial and ITU-standard to deliver the content and to perform multiple engagements in behalf of the team. One such recently concluded event was the ESCAP Sendai event discussed in the next page.

5. Successfully Concluded Consultation and Needs Analysis Process

In this process, we have endeavoured to consult with experts and practitioners in the disaster readiness and recovery sector, camp managers, the PWD sector, and post disaster victims, both from government, civil society and research institutions. This process also includes the case study visit in Japan, where the team learned from existing use cases from Project Partners and from leading edge technologies still under development, as well as the July 2013 APT Meeting in SMX Mall of Asia, Manila. From all these we drew some lessons on the requirements necessary for a communications infrastructure that is inclusive in design and more importantly, in content and delivery.

This process culminated in the involvement of our group, as Lead Convenor for the Manila Group, in the ESCAP "Asia-Pacific Meeting on Disability-inclusive Disaster Risk Reduction: Changing Mindsets through Knowledge" last 22-23 April 2014 held in Sendai Japan (and live streamed to Urakawa, Japan and ADMU, Quezon City, Philippines). This conference was sponsored by UN ESCAP, Rehabilitiation International and the Nippon Foundation. The Manila group of Panelists included the National Library of the Philippines, National Council for Disability Affairs, ICT Office, Resources for the Blind, Physicians for Peace, Department of Education, Dept. of Social Welfare and Development among many others. The group actively engaged the Sendai and Urakawa attendees via realtime panel presentations and open ended discussions, highlighting the critical role that can be played by resilient and reconfigurable rich content platforms, both in post disaster and 'peacetime' pre-disaster risk reduction activities. A schematic of the network configuration for the ESCAP Sendai conference is shown in Fig. 13 to the left. The conference attendees came up with a common statement on the need for inclusive planning and recovery efforts, taking account not only the vulnerability of the PWD community, but also their resilience and capability for active participation and contributions. This statement is included as part of the appendices in this Final Report and forms part of the library of documents that should guide any study or system architecture that hold DRRM as a key objective.

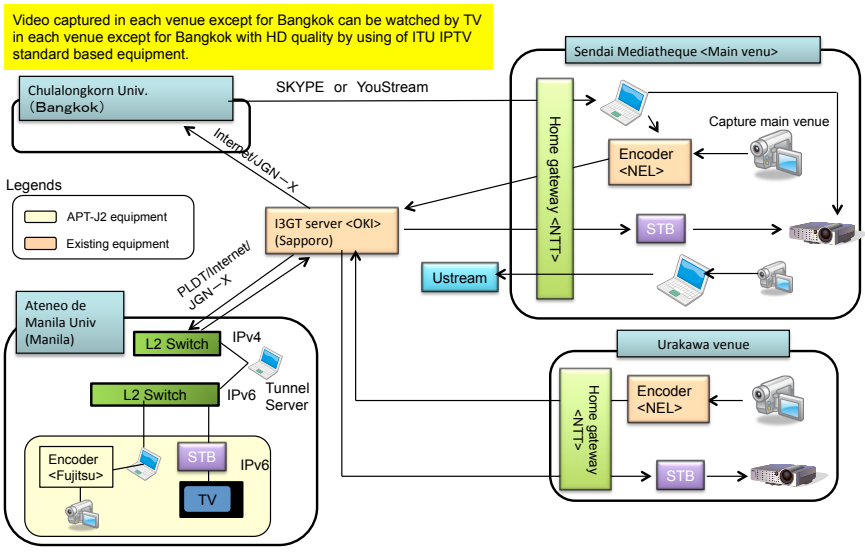

Fig. 13. *Network configuration for the live streamed ESCAP Sendai 2014 conference on Inclusive Disaster Risk Reduction and Management. The Manila Group was composed of experts and PWDs from civil society, government and academe and engaged attendees from Sendai and Urukawa Japan via presentations, talks, chatroom and content livestreaming.*

FORMAL HANDOVER AND PARTNERSHIP LAUNCH

The APT J2 Project testbed was handed over last July 22, 2014 in formal ceremonies at the Convergent Technologies Center at the Ateneo de Manila University, with dignitaries and attendees from the ICT Office of the Department of Science and Technology, Senior Executives from SMART Telecommunications and PLDT, high level administrators from the Loyola Schools and the local press.

Prof. Fabian Dayrit, Executive Director of the AIC, welcomed the attendees and opened the ceremony. Dr. Masahito Kawamori of NTT-Keio University and Dr. Hideki Yamamoto of Oki Electronics provided an overview of the underlying IPTV protocols and technologies that support the testbed. Dr. Nathaniel Libatique then provided an update of the contributions of the Philippine Team to the project, while Prof. Greg Tangonan proceeded to outline the vision for research and upcoming work on interactive media and networks using the testbed.

Subsequently a panel composed of the APT J2 Project Team answered questions and comments from the audience. Senior executives and school administrators as well as Philippine government representatives officially accepted the APT donation of the Convergent Platform and Network Media Testbed in a signing ceremony.

The facility was then inaugurated with a ribbon cutting activity and a live hands on technical demonstration.

FINANCES & PROJECT WRAP UP

Financial Report

Table 3 shows the interim financial report as of May 18, 2014. At the time of writing $28,534,03 had been consumed and $38,004.26 is forecast to be spent. This estimated total is within the proposed budget.

	Items	Budget	Expenditures			Balance
			Consumed	Forecast	Sub-Total	
1	Travel (Domestic & International)	US$20,420.00	US$ 4,559.77	US$ 5,377.40	US$ 9,937.17	US$ 10,482.83
2	Per Diem and Accommodations	US$13,064.00	US$ 4,135.64	US$ 2,808.00	US$ 6,943.64	US$ 6,120.36
3	Correspondence	US$ 600.00	US$ 35.10	US$ 116.99	US$ 152.08	US$ 447.92
4	Shipping Fees	US$ 1,250.00	US$ 0.00	US$ 2,303.08	US$ 2,303.08	US$ (1,053.08)
5	Equipment Purchases	US$34,900.00	US$19,704.86	US$ 26,447.40	US$46,152.26	US$(11,252.26)
6	Miscellaneous	US$ 2,000.00	US$ 98.66	US$ 951.39	US$ 1,050.05	US$ 949.95
7	Total	US$72,234.00	US$28,534.03	US$ 38,004.26	US$66,538.29	US$ 5,695.71

The *final version of the financial report have subsequently been transmitted last 2 Sep 2014* via email from our team member Mr. Takahiko Ebisu.

Schedule and Project Wrap Up

The experiments were initially delayed due to the selection and production of the wireless transmitter equipment. The wireless transmitter equipment supports the area one-seg functions, which is a critical component of the envisioned application since it enables targeted narrowcast of disaster information to the selected community and as such forms an indispensable component of disaster operations envisioned in this project. The installation of the equipment started from 17 March 2014 and concluded recently with civil works and repositioning of equipment in CTC 208. Streaming and connectivity trials are ongoing still. A late June visit is being organised to accommodate APT members wishing for a briefing on the IPTV testbed site and our near cloud demonstrators. A meeting was scheduled for end of May. In the meeting, project developments were discussed with a view to closing the project and preparing for a second phase J3 proposal. *The Partnership Kickoff and Project Handover Activity was then completed on July 22, 2014*.

ANNEX I - UPDATED MEMBER LIST

AFFILIATIONS AND PROJECT MEMBERS

ICT Office - DOST
Louis Napoleon C. Casambre, Undersecretary and Executive Director, Project Lead
Engr. Clodualdo Rodil (emeritus, now with San Miguel Corp.)
Engr. Dominador Garabiles
Engr. George Tardio
Mr. Ruben Tadina
Engr. Gladys de Ocampo

Ateneo de Manila University (ADMU)
Nathaniel Libatique, Ph.D., Associate Prof., ECCE Department and Ateneo Innovation Center - AIC
Gregory L. Tangonan, Ph.D., Exec. Director, COMSTE, Special Adviser to ADMU President, Professor - AIC
Engr. Cesar Pineda, Research Faculty, Ateneo Innovation Center - AIC
Benjz Gerard Sevilla, Research Assistant, Ateneo Innovation Center - AIC

Philippine Long Distance Telephone Company
Czar Lopez

ASTI - Advanced Science and Technology Institute, DOST
Dennis F. Villorente, Director
Alvin M. De Garcia, Science Research Specialist

Keio University
Masahito Kawamori, Ph.D.

Oki Electronic Industry
Hideki Yamamoto, Dr. of Engineering

Mitsubishi Electric
Seiji Kozaki

Oki Consulting Solutions Co. Ltd.
Takahiko Ebisu, Senior Managing Consultant