

## Final Project Report (Executive Summary) Form

**I. Title of Proposed Project:** TV White Space (TVWS) Experimental for Application in Remote Area

**II. Project Leader:**

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**III. Project Members:**

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**IV. Total Amount (US\$):** USD 29,900

**V. Duration (6-36 Months):** 21 months (Jul 2016 – Mar 2018)

## **VI. Executive Summary**

TV white space (TVWS) is a portion of the spectrum in ultra-high frequency (UHF) and very-high frequency bands, which is not utilised by primary users in specific time and location. The regulators in the USA and in the UK have given approval for companies to operate new communication systems with the capability of utilising TVWS spectrum. This project focuses on experimental test bed for TVWS implementation for applications in rural areas.

The main achievements for this project for in 2016 are as follow; we have conducted radio propagation study at Chini (Malaysia) and Bogu (the Philippines), as well as completed comprehensive spectrum measurement at Chini Lake. In 2017, this project has achieved major accomplishment by conducting the following experiments successfully; Surigao, Philippines Experiment for Emergency Communications using TV White Space (IEEE 802.11af) as well as WiSUN and LoRa (sub-GHz) Experiment at Chini Lake for Hydrological Monitoring Application. This project has utilized TVWS transceiver equipment as well as WiSUN node and gateway which were design and build by NICT Japan. The devices were deployed in the Philippines and Malaysia.

In the Philippines, the TV white space technology (IEEE 802.11af) has so far been tested successfully in providing internet connectivity through multihopping (1) in a hilly terrain covering a distance of about 600 meters obtaining a maximum throughput of 4.81 Mbps and 4.93 Mbps for uplink and downlink, respectively; and (2) in a relatively flat terrain that further extends distance coverage to a total of about 1200 meters with a maximum downlink throughput of 3.25 Mbps and 3.16 Mbps for uplink. The success has so far encouraged further deployment and testing of the prototypes to applications in vehicle-to-vehicle communications, besides emergency applications for disaster communications. The results of the study have so far been disseminated in a form or oral presentations both in and outside the Philippines.

Based on our experience in this project in Malaysia, we found that the main challenges are to address the thick foliage and various terrain profile that obstruct the propagation of the EM waves in the remote jungle area. These challenges limit the penetration and coverage to reach the water sampling stations that scattered across the lake area. In other words, higher elevation is the key to solve variable terrains & tall trees in rural wireless communications. The next plan is to increase the tower height or be innovative such as to experiment the use of the unmanned aerial vehicle (UAV), or drones.