TakNet: A Community White Space Network

ADISORN LERTSINSRUBTAVEE intERLab, Asian Institute of Technology (AIT)

























Our Technologies





TPlink MR3040

- Coverage: 50-60 m
- WiFi 2.4 GHz
- Usage: Portable, Apply to emergency situation



1] Kanchanasut, K., Tunpan, A., Awal M.A., Das, D.K., Wongsaardsakul, T. and Tsuchimoto, Y., "DUMBONET: A Multimedia Communication System for Collaborative Emergency Response Operation in Disaster-affected Areas, International Journal of Emergency Management, Inderscience, Vol. 4, No. 4, pp. 670 – 681, 2007.



TPlink AC1750

- Coverage: 100 m
- WiFi 2.4/5 GHz
- Usage: Static and Indoor



Unifi Outdoor AP

- Coverage: upto 200 m
- WiFi 2.4/5 GHz
- Usage: Outdoor, Link to GW

Raspberry Pi

- Micro Server
- Running local services (e.g., chat, VoD)



Wok Extend the connectivity

- DIY p2p antenna



Extending the network coverage?



Imagery/Date: 1/9/2014 Lat 16.794152º Jon 98.5991

Some houses were abandon

- WiFi signal (Mesh) is not sufficient
- Too much multi hop (3 hops max) NLOS





Utilising the excellence radio characteristics of TV spectrum to provide digital broadband communication



- Support NLOS with better throughput and low latency
- Long distance propagation (10 20 km)
- **Point to Multipoint communication (Up to 12 client** nodes¹)



TVWS (TV White Spaces) solution



- The part of spectrum that is unused by the primary (licensed users) at specific location and time
- **Plenty of spectrum allocated to TV broadcasting is** currently idle, specially in rural areas of developing countries.







ส่านักงานคณะกรรมการกิจการกระจายเสียง กิจการโทรทัศน์ และกิจการโทรคมนาคมแท่งษาติ

TVWS Trial

- **Duration: 2017 2019**
- A grant from the National Broadcasting and Telecommunication Commission (NBTC) office
- License: 470 790 MHz
- First TVWS trail in Thailand
- Carry out TVWS spectrum measurements to explore the white space spectrums





How much White Spaces ?

EQUIPMENTS



Spectrum Analyser: RFExploer (Low cost and portable) Measurement tools: A laptop/RPI with RFestatic (ICTP) to record the spectrum measurement



MEASUREMENT SETUP





Frequency range	510 - 790 MHz (THA - UHF TV channels)
Signal bw	8 MHz (ETSI)
Resolution bw	500 kHz
Location	Outdoor vs Indoor
Antenna hight	1m (ground level) vs 15 m (Roof









TVWS Trial@TakNet





TVWS base station@ Public School

TVWS Client (CPE)@

Village M1 Village M9 Village M10





eNodeB (LTE small cell)@ Village M1











White Spaces @TakNet



MOBILE SPECTRUM MEASUREMENT

RFExplorer and Android Phone + RFtrack^[1]





[1] http://wireless.ictp.it/tvws/rftrack/

Spectrum Measurement around Thai Samakkhi village (TakNet1)

More than 80% of sample received signal has power less than -100 dBm (standard threshold for white spaces)









White Spaces@TakNet

SETUP STATIC MEASUREMENT@THREE LOCATIONS



RFExplorer and Laptop/RPI + RFtrack^[1]



Agilent 15:07:41 11, 22, 2018 13:584.1 MHz 550 9 MH-16:587.4 MHz -74.85 dB 5 channels are used ETrg Center:650.000000 MHz Span:300.000000 NHz BW:1.000000 MHz VBW:1.000000 MHz Sweep:105.60 ms Screen Capturing.....

Spectrum measurement from commercial spectrum analyser (Keysight-Agilent N9340B Spectrum Analysers)







Our White Spaces;)





ANNEL NUMBERS	TOTAL TVWS
 30, 31, 33, 34, 35, 39, 41, 42, 43, 45, 48, 49, 50, 51, 53, 56, 57, 58, 59, 60 	28
28, 29, 30, 32 33, 37, 38, 40, 41, 42, 45, 46, 48, 49, 50, 54, 55, 56, 57, 58, 59, 60	30



TVWS Backhaul - Last Mile Access

CH27: 522 MHz





TVWS BACKHAUL LINKS IEEE 802.11AF (SUPER WI-FI)

CH44: 658 MHz

TVWS base station@public School

NTERNET



TAKNET CWMN

3 USE CASES

- CPE-M9: second gateway of TakNet community.
- CPE-M10: public WiFi at the assembly point in the village.
- CPE-M1: connects to an eNodeB. 10 MiFi were distributed for

accessing the network









Installation



Base station @ Public School



CPE-M10 & eNodeB



CPE-M9





Performance Evaluation: TVWS Link BW





Configuration

Setup an iPerf Server@ Base Station and 3 Client at three CPEs

Maximum achieved BW

12Mbps (over TVWS) and 15 Mbps (over cable)

Distance sensitivity (over TVWS)

- 0.5 km :12 Mbps (Base M1)
- 1km: 10Mbps (Base M9)
- 2km: 3.5 Mbps (Base M10)







Performance Evaluation: RTT vs Packet Loss



Sending ping to Base station while increasing payload size (32, 512, 1500 Bytes)

Distance doesn't have much impact on RTT and Packet Loss

Packet loss is high when payload is large, RTT is quite acceptable (15ms for 1500 Bytes)















Key Takeaways: Potential of TVWS

- TVWS is under-utilised

 - Rural: Less number of TV broadcasting stations
- Other successful use cases



ICASA makes headway with TV white space regulations







White Space Tech Brings 30Mbps Wireless Broadband to Loch Striven

Monday, March 18th, 2019 (1:47 pm) - Score 1,362 Email | Link News



The TVWS technology works by harnessing the gaps that exist between radio spectrum in the Digital Terrestrial TV bands (these operate between about 470MHz to 694MHz) which makes them good for delivering wide coverage (up to around 10km). Such signals can even travel through permanent obstacles, such as buildings and traves, as well as around terrain, although finding enough frequency to deliver good speeds is challenging.

Homes around part of Loch Striven (Argyll and Bute) in Western Scotland will soon be able to access "superfast broadband" speeds of up to 30Mbps, which comes after Sheffield-based ISP Whitespace Technology announced they would be deploying a new TV White Space (TVWS) using wireless network in the area.

• Urban: Less number of real TV users due to emerging of alternative online content platforms e.g., Netflix, Amazon, Google

0 Comments







Public WiFi and VDO surveillance @ Gardens by the bay





Wireless Backhaul **@ Sentosa**









Key Takeaways: Technological Barriers





- Bandwidth is limited
 - Maximum Link BW is limited to 12 Mbps -> not sufficient to support for current Internet usage
- Point to multipoint is supported by nature
 - The BW is shared (CPE@M1 and M9 got only 6Mbps).
- Lacking of incentive for product vendors
 - Not much variety of products
 - The existing products in the market is not yet stable (in our case, CPE was down when many users try to connect)
 - Many companies cannot be sustain due to lacking of demand of using this technology









Key Takeaways: Policy Restrictions

Many Possibilities

In the beginner's mind there are...





All Things Open TV White Spaces Spectrum Net Neutrality

• Several TVWS trials have been carried out worldwide by governments and the business sector.

• TVWS can only be legally launched in a few countries (e.g., US, UK, Singapore and South Africa).







Our Team



Kanchana













Preechai

Atthaphongse Nunthaphat Apinun

Internet Education and Research Laborator

Adisorn

Nisarat

Thank you Q&A



มูลนิธิศูนย์สารสนเทศเครือข่ายไทย THAI NETWORK INFORMATION CENTER FOUNDATION





The Abdus Salam International Centre for Theoretical Physics



Microsoft[®] Research



Thanks to APNIC Fellowship Program



FELLOWSHIP

Overview

The programme is designed to provide funding assistance to selected applicants to attend APRICOT 2020.

Starting from APRICOT 2000, APRICOT has been providing financial support to selected individuals from the Asia Pacific region to attend APRICOT.

ABOUT