WhiteSpace Enabled Rural Broadband to Cognitive M2M

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- I would like to thank various members from the WhiteSpace Alliance and the IEEE 802 community for providing inputs to this presentation.

Time is Ripe to Turn Digital Divide into Digital Opportunity

Time is ripe to turn Digital Divide into Digital Opportunity

UN Secretary General Kofi Annan addressing the 6th session of the UN ICT Task Force in New York, March 25, 2004.

- The UN ICT Task Force was created by United Nations Secretary-General Kofi Annan in November 2001, acting upon a request by the United Nations Economic and Social Council (ECOSOC) dated July 11, 2000, with an initial term of mandate of three years (until the end of 2004).

- In November 2002 Kofi Annan issued a Challenge to Silicon Valley to create suitable systems at prices low enough to permit deployment everywhere, whether through international aid programs, NGOs, charities, or microcredit support.
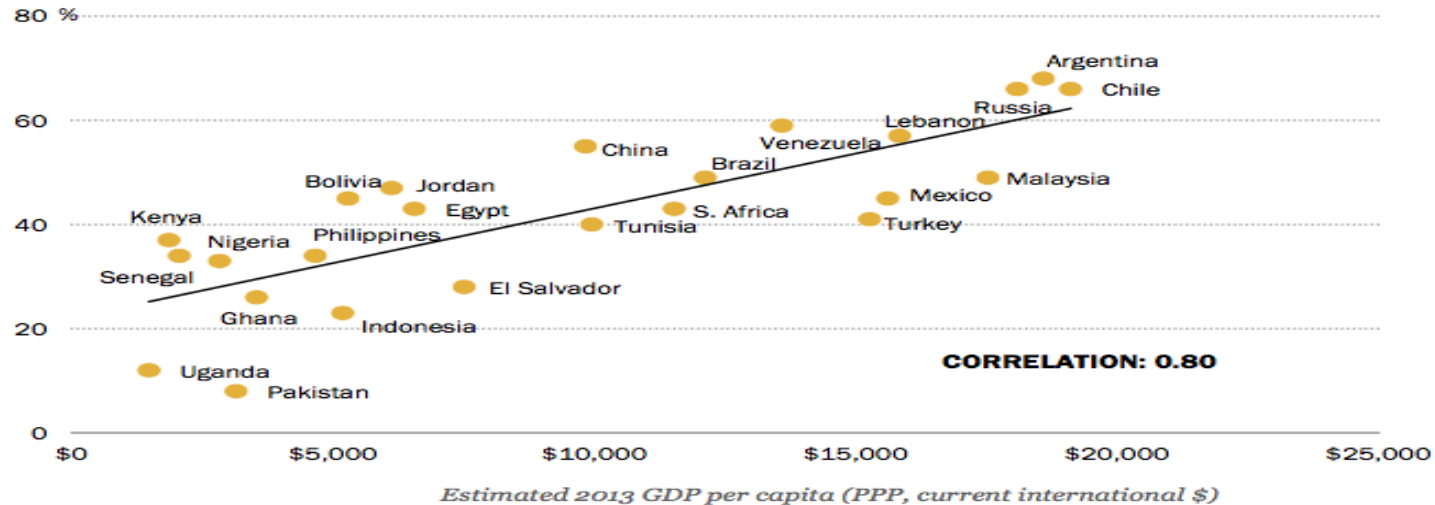
UN Information and Communications Technologies Task Force: Link

Cannot Bridge the Digital Divide without Cost-effective Broadband Internet Connectivity

Internet Use Linked to National Income

% who use the internet*

Feb 13 2014 Time Magazine issue

CORRELATION: 0.80

Estimated 2013 GDP per capita (PPP, current international $)

*Based on total sample.

Source: Spring 2013 Global Attitudes survey. Q66. Data for GDP per capita (PPP) from IMF World Economic Outlook, October 2013.

PEW RESEARCH CENTER

- Higher Per Capita Income is Correlated with Greater Internet Proliferation.

- Another survey shows that access to internet increases the per capita household income per year by $2.1K in developed countries (4 Mbps) and $800 in developing countries (0.5 Mbps)

- This also points to the fact that **Price Points for Broadband Internet Access in Developing Countries are as low as $15/ month / household**

Worldwide Opportunity – 4.3 Billion Customers

- Two out of Three people in the world have No Internet Access (4.3 Billion people) (Source: Internet World Stats)

- 49.5% of the 7 Billion people in the world (~3.5 Billion) live in rural areas.

- Backhaul and Middle mile constitutes 50% of the cost for rural broadband deployment scenarios

- It is expensive to lay fiber / cable in rural and remote areas with low population density. Wireless is the most economically viable solution

- Urban areas also need increasing cost-effective alternate access solutions for internet connectivity (e. g. off-loading cellular traffic, smart grid solutions etc.)

THIS IS A DIGITAL OPPORTUNITY FOR THE MILLENIALS – COST-EFFECTIVE BROADBAND SERVICES, PRODUCTS AND SOLUTIONS

Digital Divide - Focus on Cost-effective Middle Mile Solutions

- There is a urgent need for cost-effective backhaul and middle mile solutions for broadband access in both developed and developing countries. This especially true in rural areas.

- If we solve the Cost-effective Middle Mile Problem, then Rural Broadband will be solved

- VHF/ UHF spectrum offers ten times the coverage of the traditional Wi-Fi™ spectrum with the same transmit power. **Increasing power to at least 4 Watts is necessary.**

4 Watts
Omni

10 – 30 km

5.8 GHz

2.4 GHz

900 MHz
VHF / UHF and
TV Whitespaces
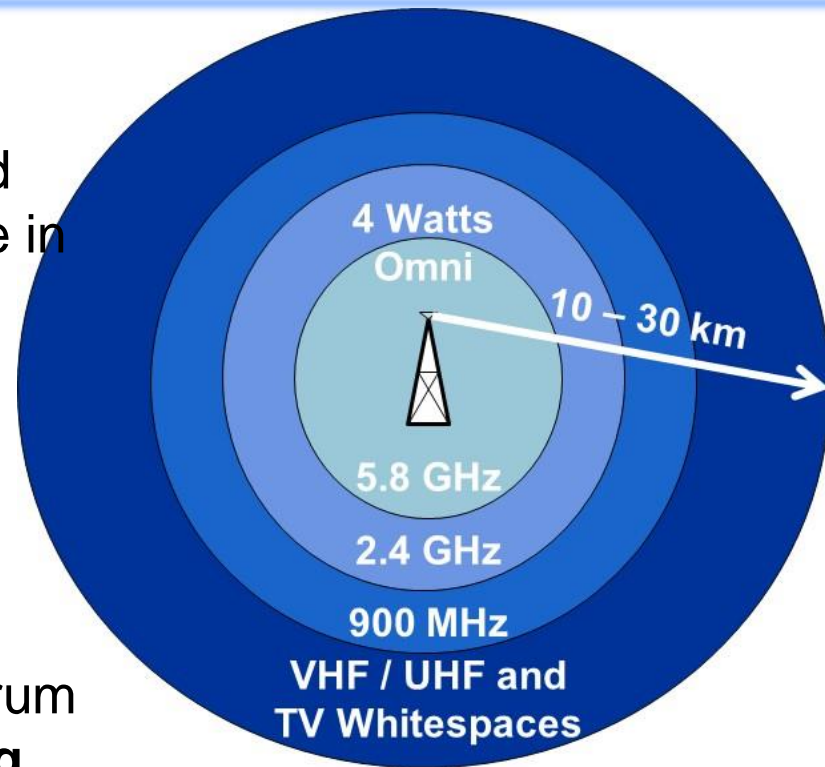
Larger coverage of VHF/ UHF spectrum means more customers covered in sparsely populated rural areas. Combine this with License-Exempt (Wi-Fi like) or Lightly Licensed use of Devices Reduces the Barrier to Entry and Allows Cost-Effective Broadband Deployments

TV Band WhiteSpaces: How it Will Enable Rural Broadband

Number of Channels Available
- 0 - 11
- 12 - 23
- 24 - 32
- 33 - 39
- 40 - 47
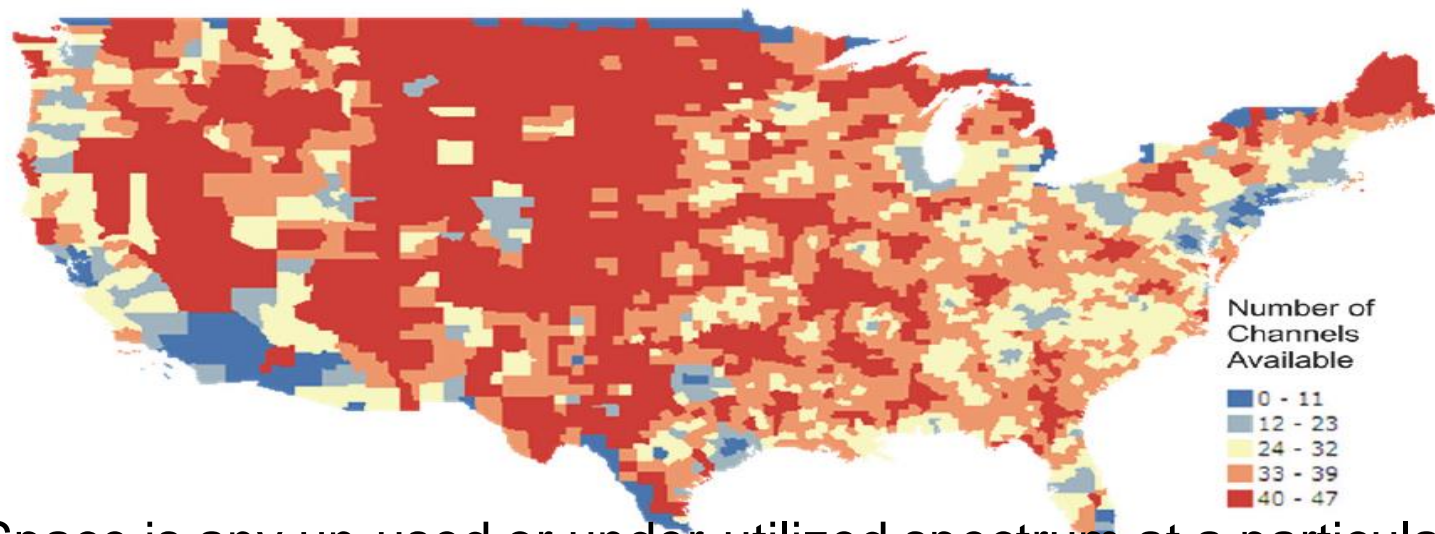
- WhiteSpace is any un-used or under-utilized spectrum at a particular location that can be accessed on an opportunistic basis

- VHF / UHF bands traditionally reserved to broadcasters have highly favorable propagation characteristics. Penetrating through foliage and structures, they reach far and wide

- Particular broadcast deployment scenarios as well as the worldwide move from analog to digital TV frees up spectrum creating what is called TV Band WhiteSpaces (TVWS) which may be opportunistically accessed to provide broadband internet. This is also called Spectrum Sharing.

TV Band Protected Transmitters Mapped to Create a Database for Protection Zones
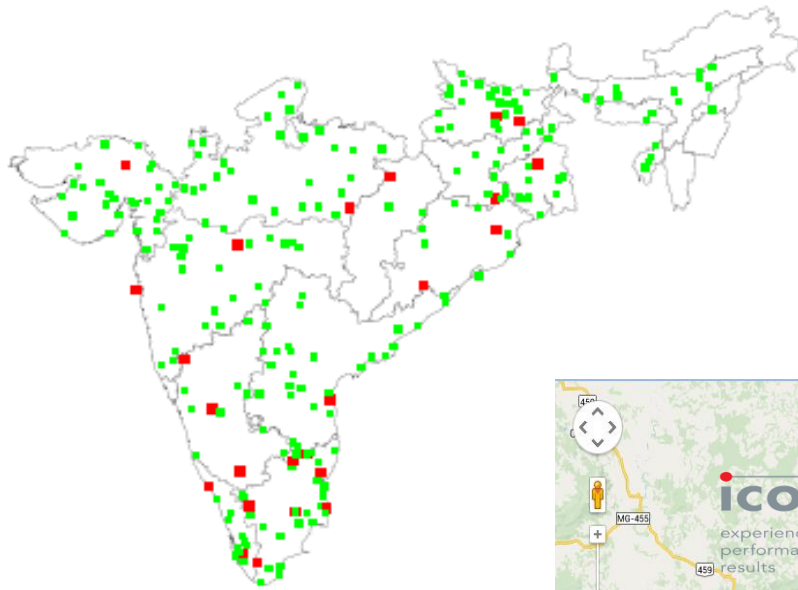
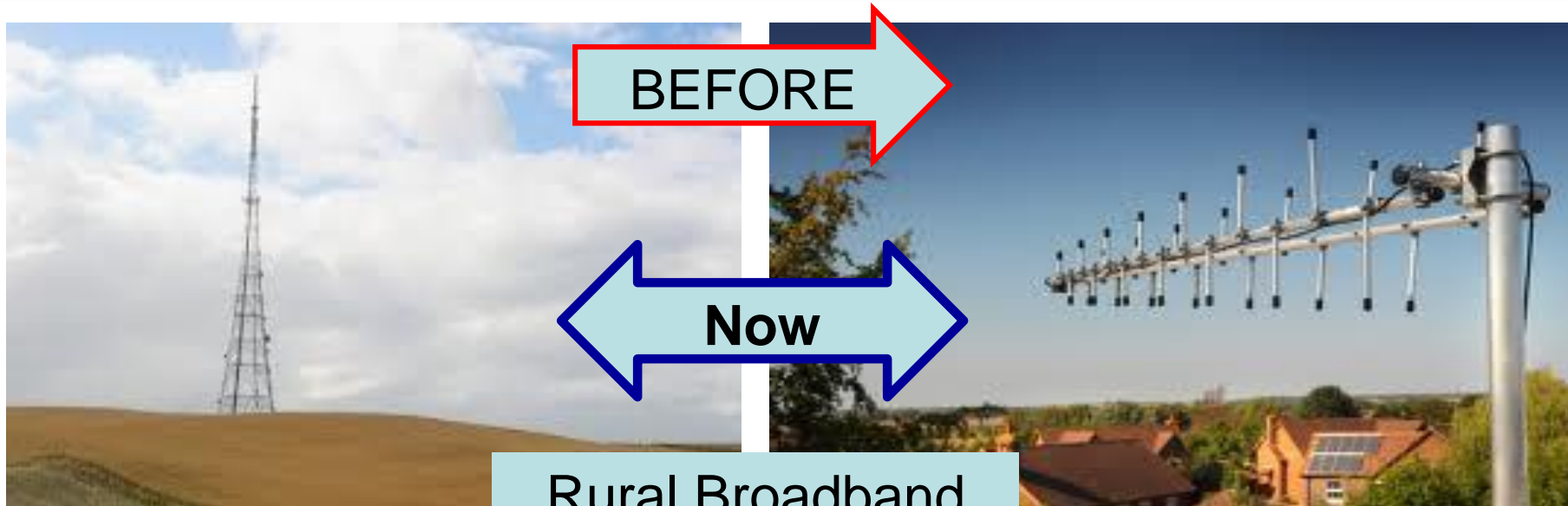WSA/ IIT Bombay Research to Map the 1415 TV Transmitters in India

TVWS Database in Brazil

Brazil Pilots TVWS Database
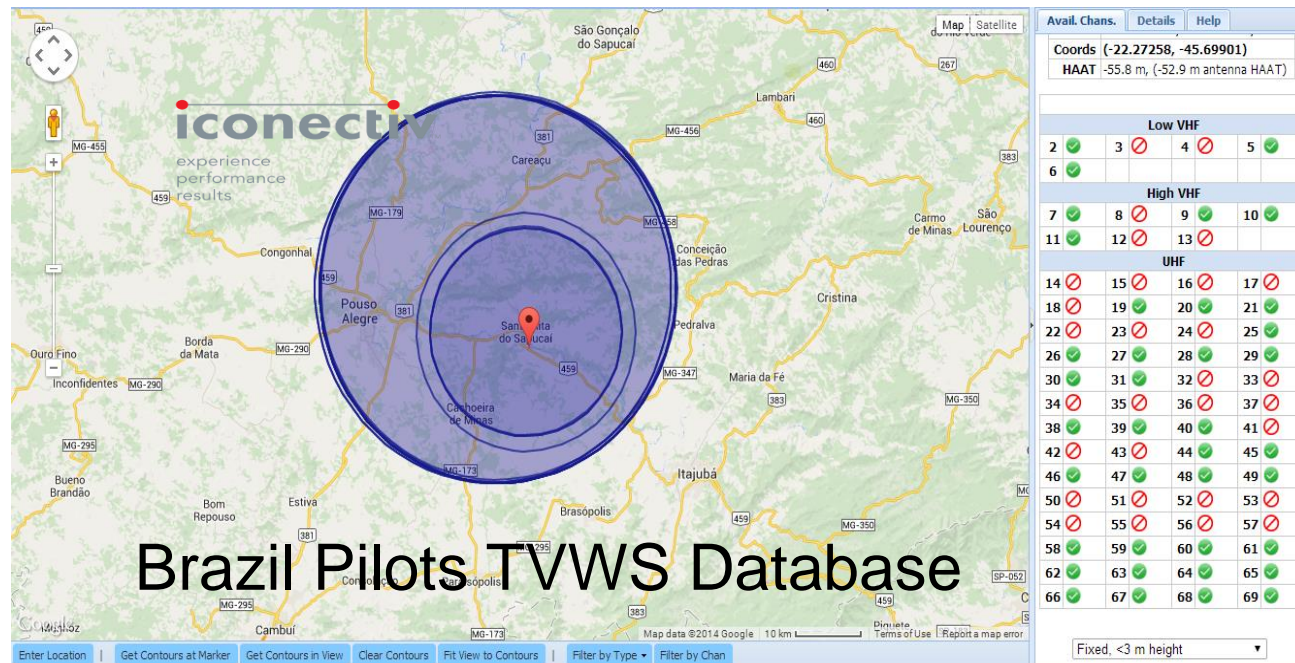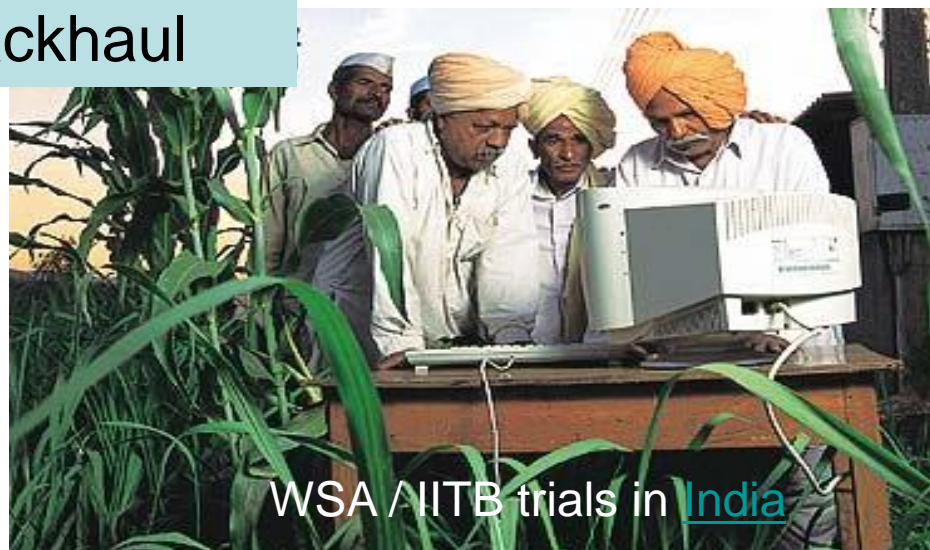
WhiteSpace Alliance Pilots: Link

WhiteSpace Applications

BEFORE

Now

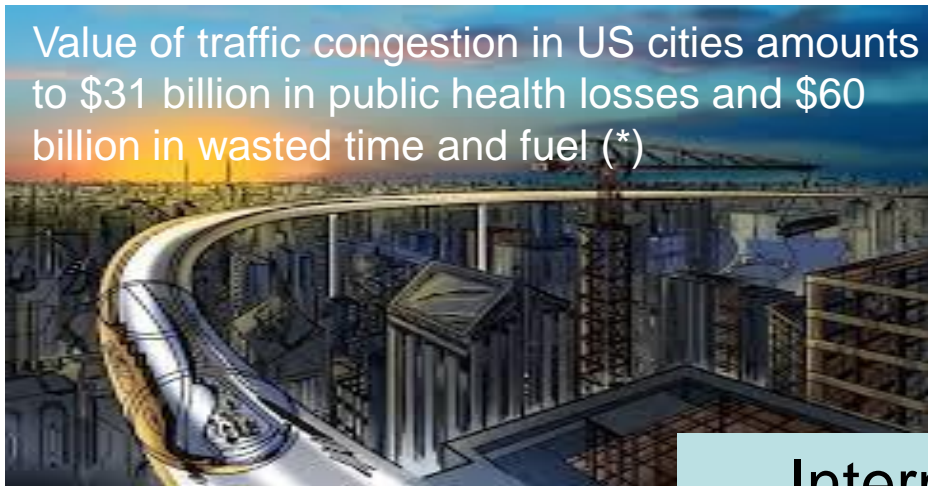Rural Broadband and Backhaul

Microsoft TVWS trials in Kenya

WSA / IITB trials in India

WhiteSpace Applications

Intelligent Transportation System

Value of traffic congestion in US cities amounts to $31 billion in public health losses and $60 billion in wasted time and fuel (*)

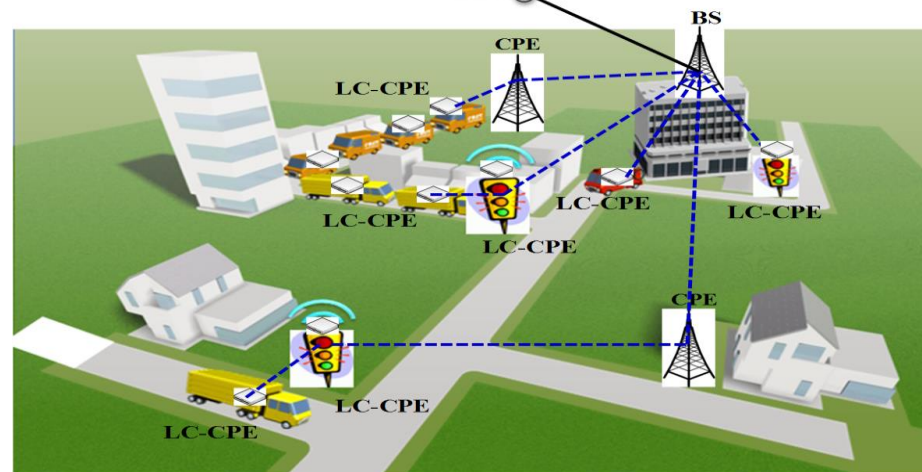## Spectrum Characterization and Occupancy Sensing (SCOS) - IoT
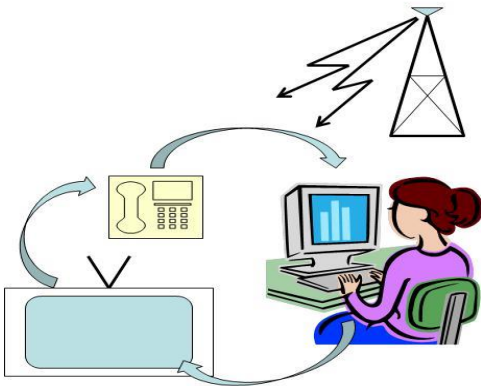
Internet of Things (IoT)

Smart Home

40% of employment growth in US metropolitan cities is due to improvement in quality of life (**)

Smart cities

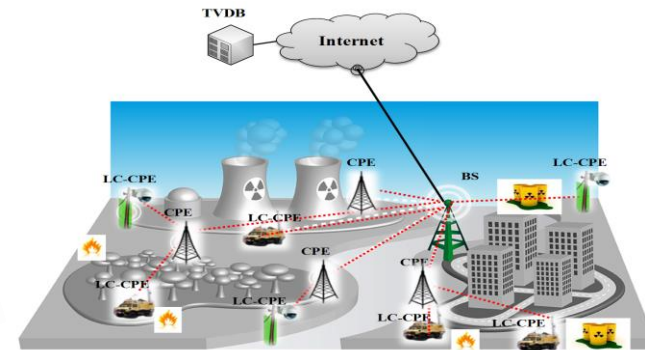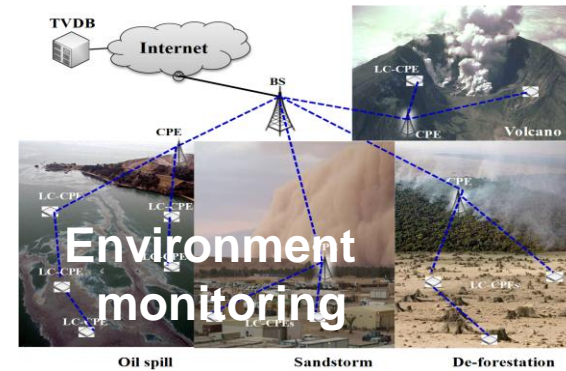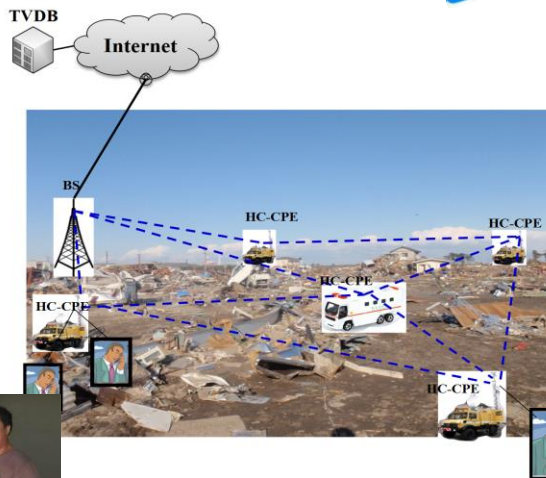# WhiteSpace Applications

Triple play

Cellular offload

Critical infrastructure monitoring

Border protection

Environment monitoring
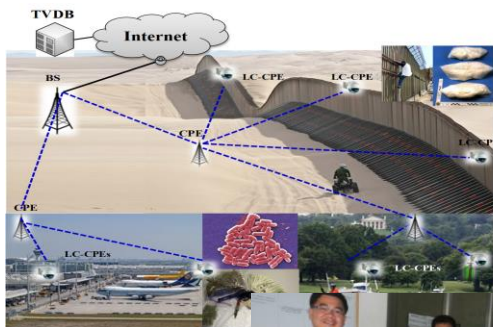
Bohol, Philippines after Hurricane Haiyan*

Emergency broadband infrastructure

Internet of Things and Cognitive Machine to Machine

20 Billion machine to machine devices will be deployed by 2020

Smart Metering @ NUS U-Town Singapore *

By 2020 Wireless Technologies are likely to contribute $4.5 Trillion to global economy through organic growth and new disruptive M2M technologies
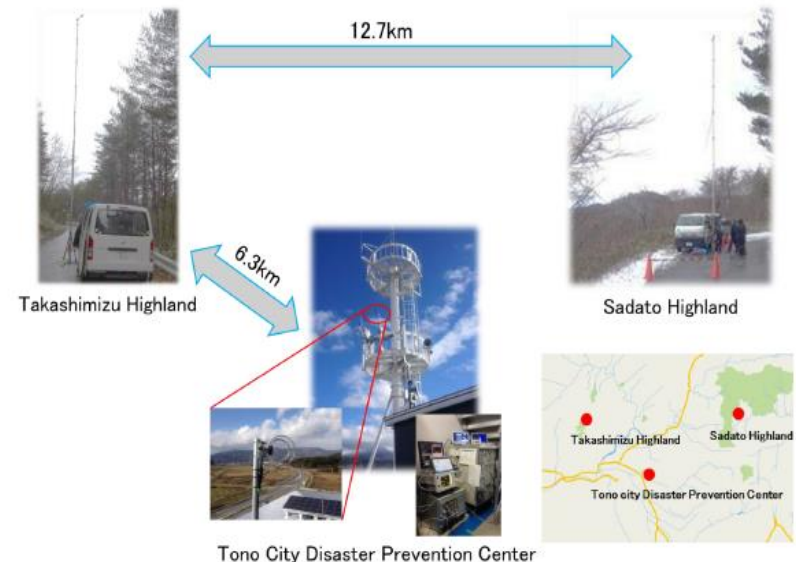
Millennial Startup Success Stories from Developing Countries

- Indian Fabless Semiconductor company
- Providing IC/Modules for building next generation 802.22 (Wi-FAR) networks
- Recognized by EE Times as one of the startups to watch in 2014

- Hitachi / NICT TVWS field experiments using IEEE 802.22 and IEEE 802.11af.
- Successful downstream and upstream data transmission at 12.7 km distance between IEEE 802.22-based base station and customer premises equipment, at a speed of 5.2 Mbps and 4.5Mbps, respectively: Link

Government Investment can Act as a Catalyst

- National Optical Fiber Network (NOFN) is a Govt of India initiative to provide broadband access to every village. $5 Billion allocated for this.

- No middle mile or last mile solutions proposed. NOFN will need to be combined with Wireless Access Solutions

- Similar catalyst proposed in Singapore and Philippines

Public Private Partnership to Reduce Digital Divide

Govt. Initiative and Vision

Suitable regulations and incentives

Viable business model

Research, development, innovations and novel applications
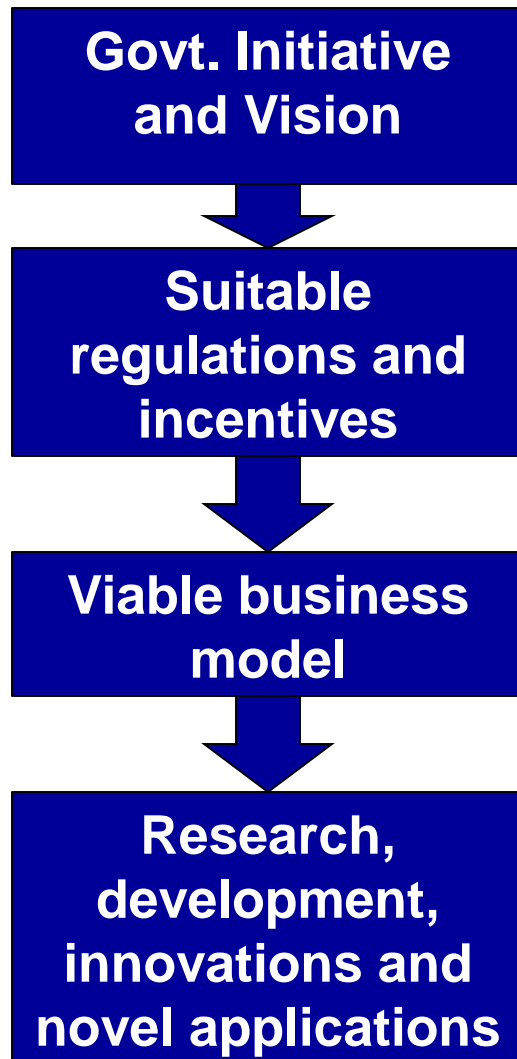
- e. g. US Third Memorandum Opinion and Order (Sept. 2012) allowing licensed-exempt operation in Television Whitespaces

- **Policy regulations** (license-exempt, lightly licensed, licensed), provide incentives to companies that provide rural broadband

- **Technical Regulations**
  - Ensure that the correct spectrum is allocated to deploy large Regional Area Networks (RAN) with adequate transmit power as well as Local Area Networks (LANs)

- **Low Cost** – Low cost of spectrum, low cost of equipment and Govt. incentives

How will All This Work?
Wait for Regulations or Leap Frog

- Pilots and Trials in over 30 locations world-wide have shown that Database Enabled Spectrum Sharing in TVWS works. Causes no interference to the primary users.

- Conduct Pilots for Proof of Concept if Necessary. Otherwise replicate regulations from other countries

- Fast-Track the Regulations

- Public / Govt / Private Partnership a Key - create e-Governance, e-Commerce, e-Education, e-Health, e-Inclusion programs and funding opportunities for Private Sector to be included.

Impediments and Recommendations for Moving Forward

- Large inertia from the regulators in allocating spectrum for license-exempt use
    - Although numerous studies have shown that the Economic Impact of License-exempt spectrum can be to the tune of Hundreds of Billions of $ (e. g. Prof Raul Katz Assessed the Economic Impact of Licensed-exempt Spectrum in the US alone at **$220 Billion** in 2013). This far surpasses any one time auction revenue.

- TV Broadcasters and other primary services feel that the spectrum is being taken away from them. However, this is a great opportunity for them to become internet service providers

- **Recommendation 1** – Turn Broadcasters into Partners. Allow them to Provide Internet Access using TV Band White Spaces

- **Recommendation 2** – TV Bands I through IV need to be allocated for TVWS Opportunistic Use as soon as possible

Conclusions

- Spectrum sharing can benefit *developed and developing countries*

- Spectrum sharing can create *tomorrow's spectrum super-highways*. It supports licensed, license-exempt and hierarchical access business models

- There is a *dire need to resolve cost-effective backhaul and middle mile problem*. TV Band WhiteSpaces along with the right technologies offers a way to turn digital divide into a digital opportunity.

- *Regulations* to support spectrum sharing are evolving .. *But not fast enough*

- *Products and Solutions based on Technologies and Standards* for spectrum Sharing and Database enabled Spectrum Access are emerging

- Digital Divide is also a Digital Opportunity for the Millenials to participate and create business opportunities.

References

- www.WhiteSpaceAlliance.org

- PCAST Report – Report to the President – Realizing Full Potential of the Govt. held Spectrum to Spur Economic Growth http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast_spectrum_report_final_july_20_2012.pdf

- Richard Thanki, Economic Significance of License-exempt Spectrum.

- Raul Katz, Assessment of the Economic Value of Unlicensed Spectrum

- IEEE 802.22 Working Group Website – www.ieee802.org/22

- Apurva Mody, Gerald Chouinard, "Overview of the IEEE 802.22 Standard on Wireless Regional Area Networks (WRAN) and Core Technologies" http://www.ieee802.org/22/Technology/22-10-0073-03-0000-802-22-overview-and-core-technologies.pdf

- Hitachi Kokusai NICT Field Trials of IEEE 802.22 and IEEE 802.11af technologies: Link

- United States TVWS Regulations: Link

- Singapore TVWS Regulations: Link

- *Pankaj Sharma, Institute of InfoComm Research, Singapore, TVWS Use Cases

- (*) Harvard Center for Risk Analysis (2010); Texas Transportation Institute (2007)

- (**) Shapiro (2005). *Smart Cities: Quality of Life, Productivity, and the Growth Effects of Human Capital*