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Digital TV: opportunities and connectivity alternatives - Cognitive Radio

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November 8, 2016

Introduction:

The Cuban DTV deployment Program is about to start ATV blackout stage. Plenty of radio channels will be released. In parallel, data connectivity demand increases while the “last mile” access is the main bottleneck to provide affordable connectivity to the whole Cuban society. Fiber-Optic Technologies involves huge civil infrastructure CAPEX and return term makes its widespread deployment unreliable. In such circumstances, IEEE 802.22 cognitive radio technologies arises as a unique opportunity to provide really the whole Cuban society with home connectivity and Internet access on affordable base and in necessary shortest term. It's also a profitable and flexible business for operators.

While DTV deployment program is on-going ...

Next/current challenge:

Data connectivity avidity and demand increases.

Main Difficulty:

The “last mile” (home, SOHO) access.

Expression:

Not enough and non affordable connectivity.

First-sight solution:

Fiber-Optic Technologies.

Fiber-Optic ... GREAT!



Sounds good! Let's do it ...

Fiber-Optic deployment ...

2016



Fiber-Optic deployment ...

2017



Fiber-Optic deployment ...

2018



Fiber-Optic deployment ...

2019



Fiber-Optic deployment ...

2020



Fiber-Optic deployment ...

2021



Fiber-Optic deployment ...

2022



Fiber-Optic deployment ...

2023



Fiber-Optic deployment ...

2024



Fiber-Optic deployment ...

2025



Fiber-Optic deployment ...



Let's "go back" to the present day ...

2016



While DTV deployment program is on-going ...

Next/current challenge:

Data connectivity avidity and demand increases.

Main Difficulty:

The “last mile” (home, SOHO) access.

Expression:

Not enough and non affordable connectivity.

~~First sight~~ **Solution:for Long/Middle term:**

Fiber-Optic Technologies.

Is there any Short term alternative?

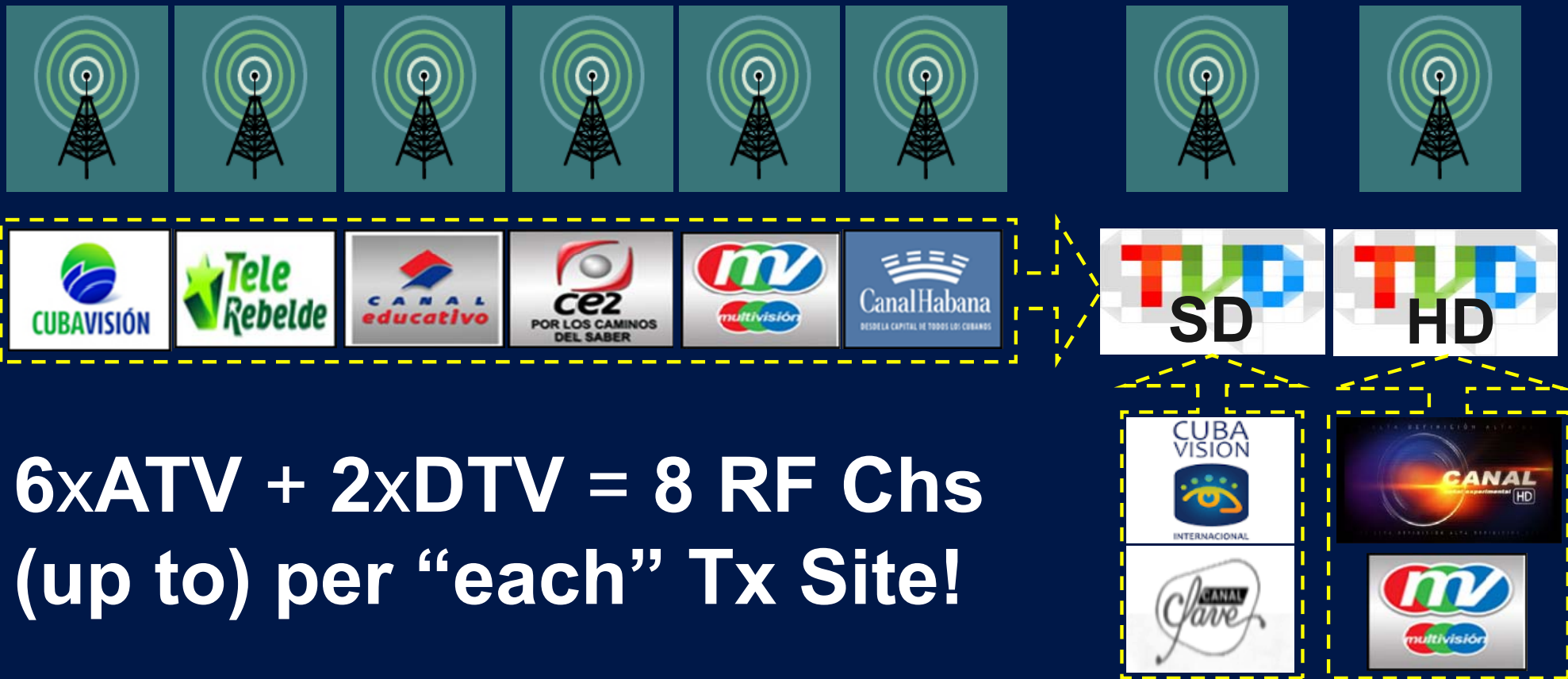
Let's think innovative ways !!!

... unoccupied TV channels ..., ... premium wireless broadband ... that has the ability to transmit over greater distances with increased coverage, significantly lower power consumption and **reduced network and end-user costs.**



<http://whitespaces.microsoftspectrum.com/#>

Cuba's Current TV Broadcasting, Analog and Digital:



Havana's TV Tx Sites locations and used Channels

Ubicación centros transmisores de televisión LA HABANA

Cantidad de transmisores: 31

1 Centro Transmisor TELEVILLA

CUBAVISIÓN 5
TELEREBELDE 2
C. EDUCATIVO 4
C. EDUCATIVO (2) 15
CANAL HABANA 40
MULTIVISIÓN 21
TDT 38
TDT HD 36

2 Centro Transmisor Lawton

CANAL HABANA 62
MULTIVISIÓN 56
TDT 31

3 Centro Transmisor Guanabo

CUBAVISIÓN 58
TELEREBELDE 52
C. EDUCATIVO 49
C. EDUCATIVO (2) 68
CANAL HABANA 29
MULTIVISIÓN 17
TDT 23

4 Centro Transmisor San Pedro

MULTIVISIÓN 60
CANAL HABANA 65
TDT 51

5 Centro Transmisor Habana Libre

CUBAVISIÓN 8
TELEREBELDE 10
C. EDUCATIVO 12
C. EDUCATIVO (2) 44
MULTIVISIÓN 33
TDT(E) 48
TDT HD 50
TDT(HIBRIDO) 12

6 Centro Transmisor Plaza Revolución

CANAL HABANA / MULTIVISIÓN 27



● Centros Principales
● Centros Secundarios
— TDT Transmisor Dg del Terreno

Havana's TV Tx Sites & used Channels detailed

Prg Chs / Tx Site	Cuba Visión	Tele Rebelde	Educa-tivo	Educa-tivo 2	Multi-visión	Canal Habana	Digital Ch (SD)	Digital Ch (SD)	Digital Ch (HD)
Televilla	6	2	4	15	21	40	38	—	36
Habana Libre	8	10	12	44	33	—	48	12	50
Plaza de la Rev.	—	—	—	—	27	27	—	—	—
Lawton	—	—	—	—	56	62	31	—	—
San Pedro	—	—	—	—	60	55	51	—	—
Guanabo	58	52	49	68	17	29	23	—	—

Current Havana's TV Tx Sites & used Chs summary

Frequency Bands	Channels Numbers	Total Channels	Channels In Use	Unused Channels
VHF I	2 to 6	5	3	2
VHF III	7 to 13	7	3	4
UHF up to Ch 51	14 to 51	38	16	22
Total	—	50	—	28

White Space

White Space... **what is it?**

... refers to portions of licensed radio spectrum that licensees do not use all of the time or in all geographical locations. Several regulators around the world are moving towards allowing unlicensed access to these frequencies, subject to the proviso that licensed transmissions are not adversely affected. By allowing access to these White Space frequencies, more effective and efficient use of the radio spectrum is envisaged.

Foresee* Havana's TV Tx Sites & used Chs summary



$2(1) \times \text{DTV}_{\text{VHF}} + 1(2) \times \text{DTV}_{\text{UHF}} = 3 \text{ Ch}$
(up to) per “each” Tx Site!

* Foresee taking into account the Analog Blackout



Foresee* Havana's TV Tx Sites & used Chs summary

Frequency Bands	Channels Numbers	Total Channels	Channels In Use	Unused Channels
VHF I	2 to 6	5	0	5
VHF III	7 to 13	7	4	3
UHF up to Ch 51	14 to 51	38	11	27
Total	—	50	—	35

* Foresee taking into account the Analog Blackout

White Space

Potential* Havana's TV Tx Sites & used Chs summary



$3 \times \text{DTV}_{\text{VHF}}$ or $3 \times \text{DTV}_{\text{UHF}} = 3 \text{ Ch}$

* Potential after the Analog Blackout,
with the SFN technology introduction.



Potential* Havana's TV Tx Sites & used Chs summary

Frequency Bands	Channels Numbers	Total Channels	Channels In Use	Unused Channels
VHF I	2 to 6	5	0	5
VHF III	7 to 13	7	3	4
UHF up to Ch 51	14 to 51	38	3	35
Total	—	50	—	44

* Potential after the Analog Blackout,
with the SFN technology introduction.

White Space

Two main IEEE standards have been developed to provide wireless connectivity on **TVWS**:

- ✓ **IEEE 802.22** (updated version: **IEEE 802.22b**)
- ✓ **IEEE 802.11af**

IEEE 802.22 (updated version: IEEE 802.22b)

IEEE Standard for Information Technology-Telecommunication and information exchange between systems – Wireless Regional Area Networks (**WRAN**).

This standard founds the specifications for **cognitive WRAN** medium access control and physical layer, policies and procedures for operation of wireless telecommunication (point-to-multipoint) devices on TV Bands. A previous version of this standard was **released on 2011 (IEEE 802.22-2011)**.

IEEE 802.11af

IEEE Standard for Information technology - telecommunications and information exchange between systems Local and Metropolitan area networks (**LAN, MAN**).

This standard founds the specifications for LAN and MAN medium access control and physical layer. It is basically an amendment to define enhancements to the **IEEE 802.11 (WiFi standard)** physical layers (PHYs) and medium access control (MAC) sublayer to support operation in the **TVWS**.

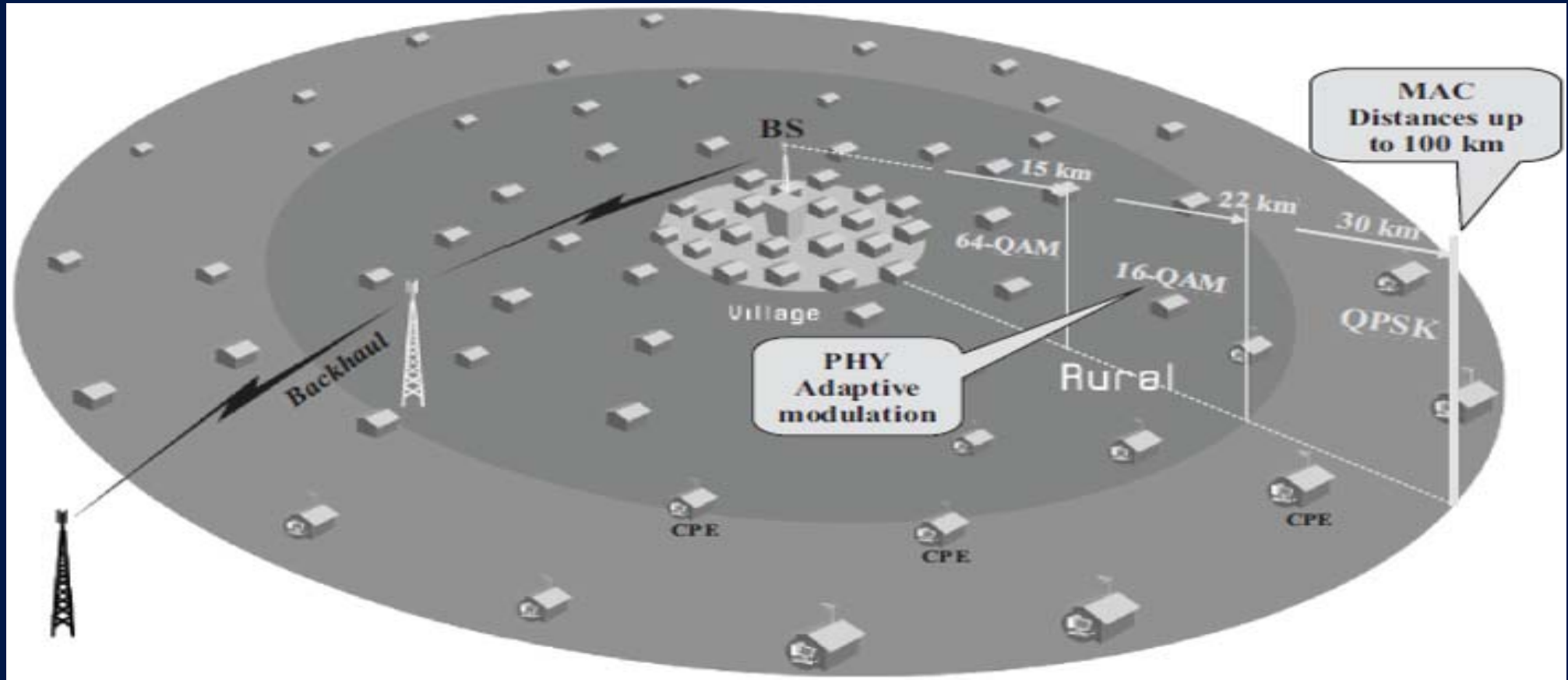
Larger coverage areas can be achieved, in comparison with current mature mobile standard technologies operating at higher frequencies.

Why not 3G (HSPA), 4G (LTE), ...?

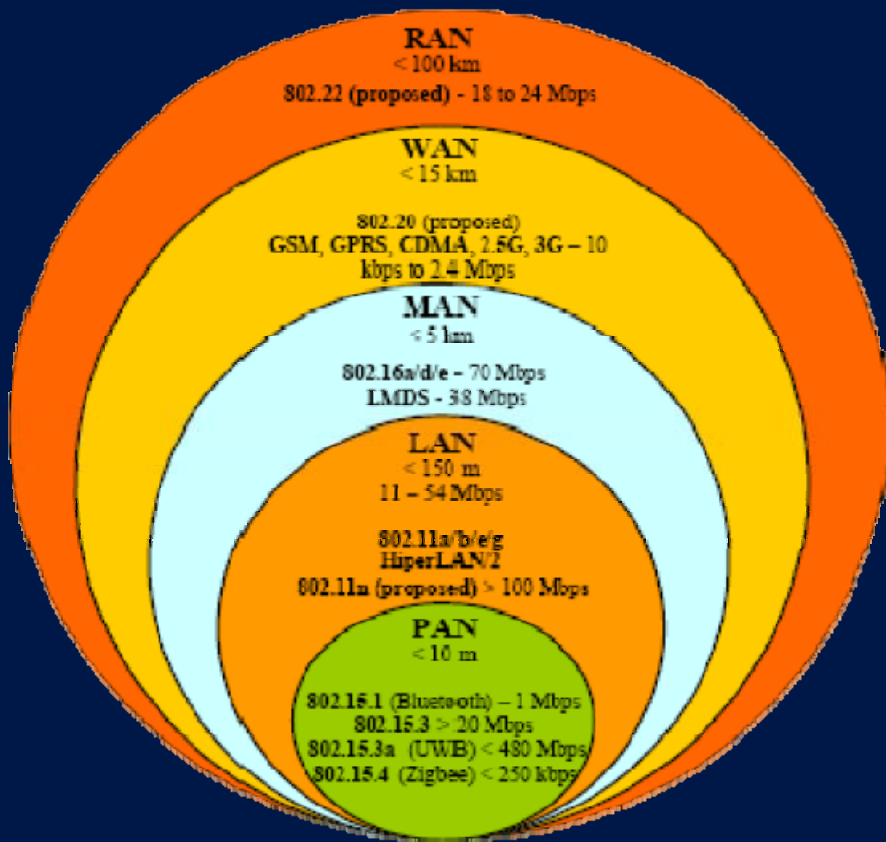
Parameter	TVWS (IEEE 802.22)	HSPA / LTE
Spectrum regulation	Unlicensed	Licensed
Spectrum Access	Dynamic	Fixed
Spectrum Cost	Free	Paid
Coverage	Larger than HSPA & LTE (low fq bands available at VHF and UHF, as low as 54MHz).	Shortest (Only available above 850MHz in most countries, and in US above 703MHz).
NLOS access (Non-Line of Sight)	Lower losses at all frequencies.	Limited access, at higher frequencies NLOS losses are higher.
CAPEX cost per subscriber/month @<400 users - 1GB month	< €1.05	€ 8.3-12 \$ 80 (Cuba currently)

Neither HSPA or LTE are affordable for less than 2k subscribers per site

Medium Access Control & Physical Layer



Networks by covered area radius



RAN – Regional AN, <100Km

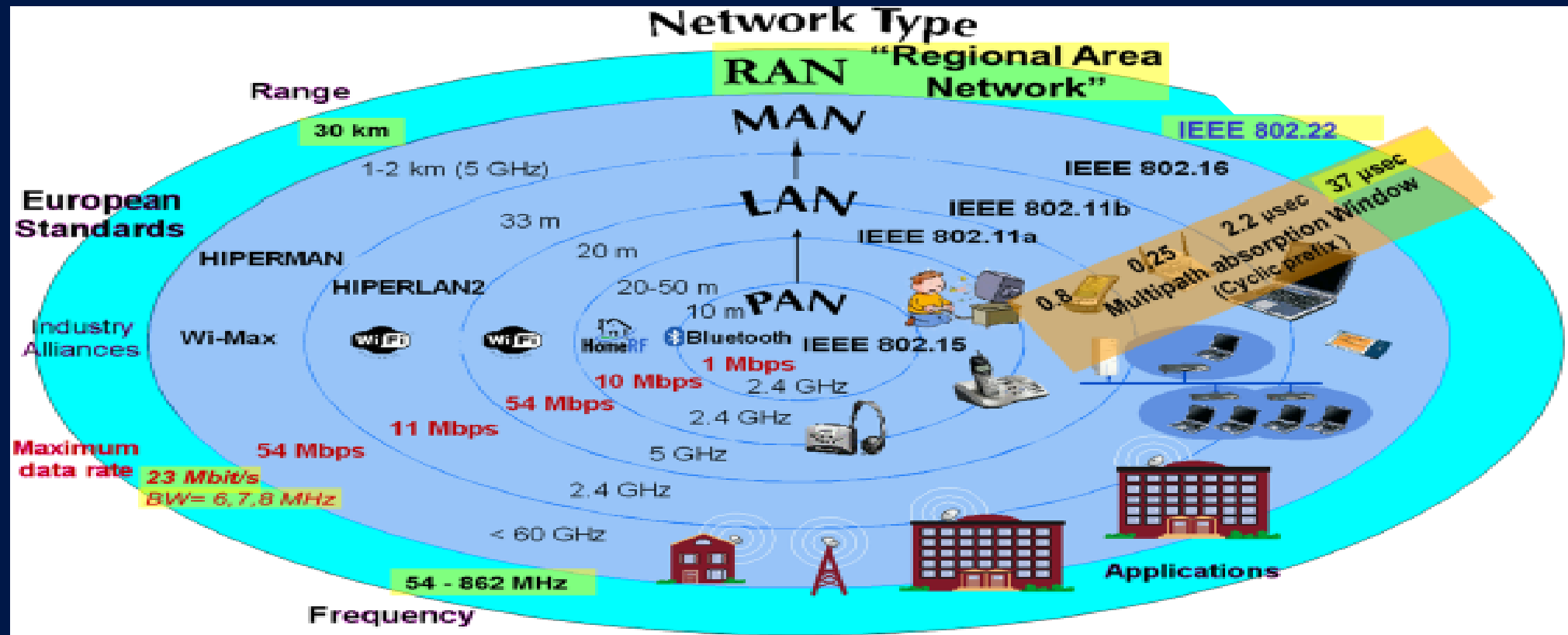
WAN – Wide AN, < 15Km

MAN – Metropolitan, < 5Km

LAN – Local AN, < 150m

PAN – Personal AN, < 10m

Wireless Networks Standard Technologies



Link budget parameters of considered technologies

Parameter	802.22	802.22b	802.11af	UMTS	HSPA	LTE	Unit
Frequency Band	54-862	54-862	54-862	900/2100	900/ 2100	700/1800/ 1900/2100/ 2300/2600	MHz
Bandwidth	6/7/8	6/7/8	6/7/8	5	5	1.4/3/5/10/15/20	MHz
Max MIMO Gain	0	4x4:4	4x4:4	0	2x2:3.5	2x2:3.5 4x4:4.0	dB
Multichannel operation	No	4	4	No	No	No	-
Max. Data Rate	22.69	31.76 508.15	26.7 426.7	2.0	14.4	100.0 326.0	Mbps
EIRP Base Station	36	36	36	41.3, 53.4, 46.9	40.6	46.9	dBm
Max. Qty. of users	512-4096	-	-	64 16 4	75	-	-
Fade Margin	10	10	10	10	10	10	dB
BS Noise Figure	4	-	-	8	9	8	dB

TVWS Pilots and Trials (concluded or ongoing):

- ✓ **United Kingdom:** supported by the local regulatory domain authority (Ofcom), including trials in Cambridge (2011); Isle of Bute (2012); Orkney Islands (2013); Glasgow, London (2014); ...
- ✓ **USA:** New Hanover County (2012); Skokie (2013); Humboldt County (2013); Delta County (2013); Washington County, Louisa County, Dover (2014); Seattle (2015); ...

TVWS Pilots and Trials (concluded or ongoing):

- ✓ **Asia-Pacific:** *Singapore* (2012); *Taiwan, Iwate, Philippines* (2013); *Buthan* (2014), ...
- ✓ **South America:** *Uruguay* (2014); *Jamaica* (2015), ...
- ✓ **Caribbean and Central America:**
Cuba, **What are we expecting for?**

Conclusions:

- ✓ The for coming Analog TV blackout is a great opportunity to reuse the released (TVWS) frequencies.
- ✓ There is a quite **mature and industry available IEEE 802.22 cognitive radio** standard ready to do so.
- ✓ It's the **fastest, cheapest and not committed alternative** to have provided really the whole Cuban society with connectivity and home Internet access.

Recommendation:

- ✓ Set up in no time a **test trial and demonstration zone** of WRAN, based in IEEE 802.22 standard implementation.
- ✓ Identify an **strategy partner** to jointly research, develop and support the operators in the implementation of optimized custom tailored solutions.
- ✓ Continue the **deep study and widely disseminate knowledge** about cognitive radio technologies, its promising and inevitable future and its large advantages for our particular case.



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