White Space Technology for Wireless Broadband

SREB | Educational Technology Cooperative

Wanda Barker, Director

March 23, 2015

Poll: What level of education do you represent?

Agenda

Introductions

Overview of White Space

Current State of the Art

Current Applications

Educational Applications

Future in U.S.

Questions

SREB

Speakers

William Seiz, President, TV Band Service

Keith Bolick, Chief Engineer, TV Band Service

Peter Sun, VP of Products, 6Harmonics (white space radio manufacturer)

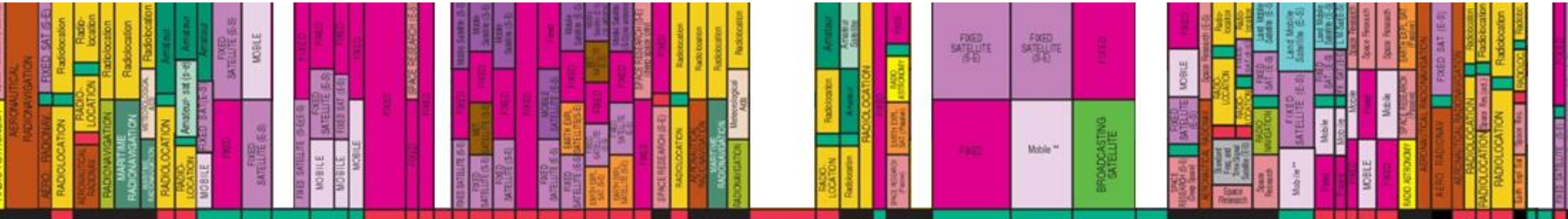**Leslie Chaney, Chief Technology Officer, New Hanover County North Carolina**

Paul Garnett, Director of Technology Policy, Microsoft

White Space Technology Overview

**William Seiz, President, TV Band Service**
Keith Bolick, Chief Engineer, TV Band Service

What are TV White Spaces?

- **TV Band Service in Wilmington, New Hanover County, NC; home of the DTV transition.**

- **Each TV broadcast channel is composed of 6 MHz of spectrum. There are currently 50 TV channels in the U.S.**

- **Each geographic market has TV channels licensed to broadcasters such as NBC, PBS, CBS, religious broadcasters, etc. In many TV markets not all 50 channels are licensed. Some of the channels are fallow or unused.**

- **TV White Spaces are unused TV channels. The FCC regulates U.S. spectrum usage and has ruled that TV White Space communications can operate on an unlicensed basis, much like today's WiFi. TV White Spaces are also called Super WiFi.**

- **Unlicensed usage means that (almost) anyone can build a wireless network without having to apply and pay for a license providing they communicate within the rules.**

US White Space Availability Heat Map: Microsoft TV White Space Database
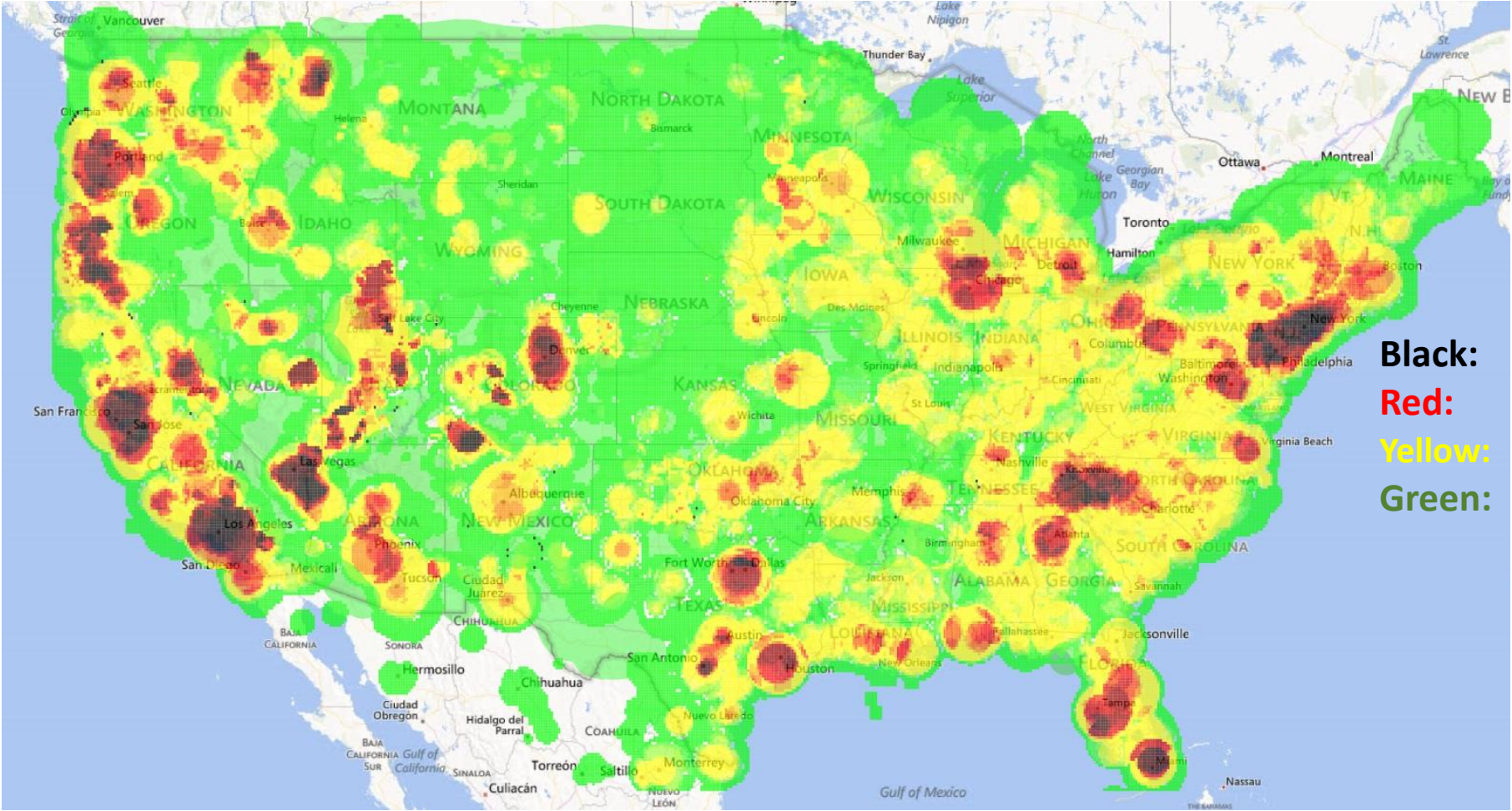
Black: Zero channels available
Red: 2 to 10 channels available
Yellow: 11 to 20 channels available
Green: 20+ channels available

TV WS Channel Availability Examples

Wilmington, NC
25

Channel Number	Frequency Range (MHz)
2	54-60
5	76-82
6	82-88
7	174-180
8	180-186
9	186-192
10	192-198
14	470-476
15	476-482
16	482-488
17	488-494
18	494-500
19	500-506
20	506-512
21	512-518
22	518-524
23	524-530
24	530-536
25	536-542
26	542-548
27	548-554
32	578-584
42	638-644
48	674-680
49	680-686

Baltimore, MD
2

Channel Number	Frequency Range (MHz)
2	54-60
22	518-524

Dallas, TX
3

Channel Number	Frequency Range (MHz)
11	198-204
12	204-210
13	210-216

Chipley, FL
24

Channel Number	Frequency Range (MHz)
2	54-60
5	76-82
6	82-88
11	198-204
14	470-476
15	476-482
16	482-488
25	536-542
26	542-548
27	548-554
28	554-560
29	560-566
30	566-572
31	572-578
32	578-584
34	590-596
40	626-632
41	632-638
42	638-644
43	644-650
44	650-656
45	656-662
46	662-668
47	668-674

www.showmywhitespace.com

TV White Spaces
unlicensed frequencies

Existing unlicensed frequencies

5 & 2.4Ghz — **WiFi, BlueTooth**

900Mhz — **Various uses**

UHF TV Channels 14-51

Channels 52-69 Auction 73

VHF TV Channels 2-13

TV broadcast channels now available for unlicensed use
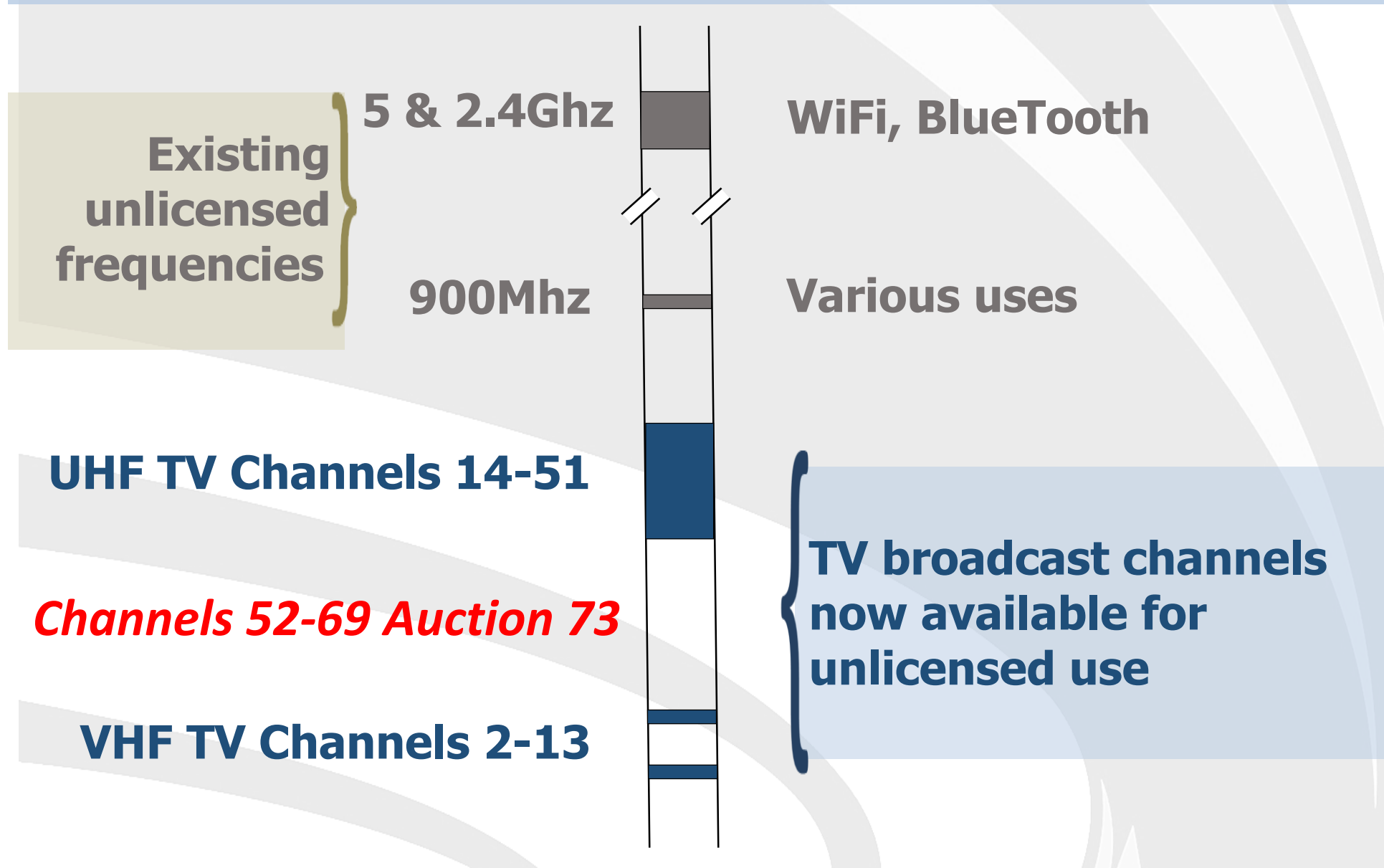
White Spaces transmissions travel farther: SUPER Wi-Fi

THROUGHPUT (MBPS)

400

300 — WLAN-5

200

100 — WLAN- 2.4

TVWS - FIXED

EXTENDS TO 10 KMS

TVWS

0

10   250   500   750   1000   1250   1500   1750
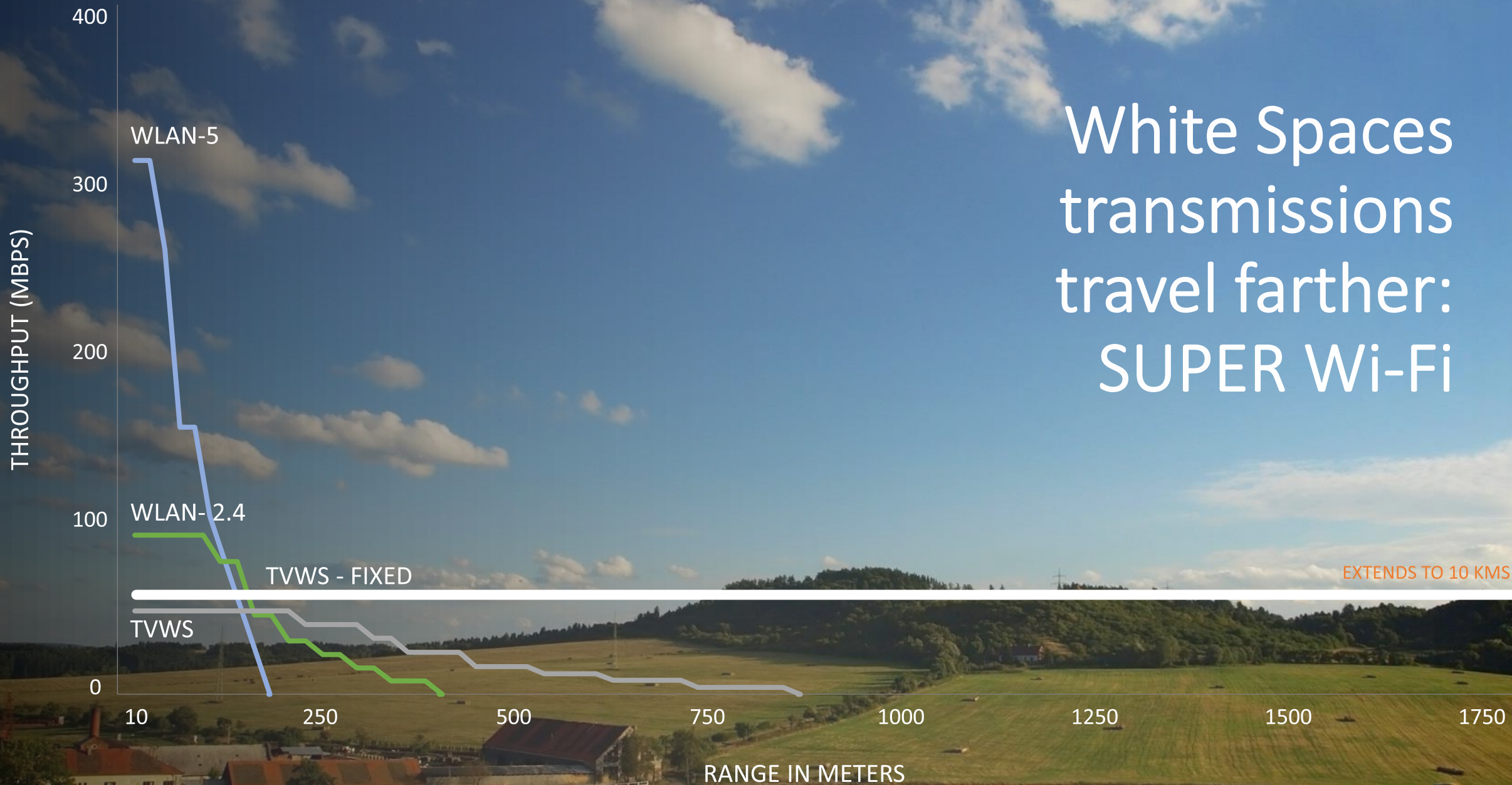
RANGE IN METERS

Current Applications

**Leslie Chaney, New Hanover County
Chief Technology Officer**

Putting White Spaces to Work

New Hanover County Applications

Leslie Chaney

Director, NHC Information Technology

- Population over 200,000
- 198.93 square miles
- 4 municipalities
  - Wilmington
  - Wrightsville Beach
  - Carolina Beach
  - Kure Beach
- First community in the nation to transition from analog to digital TV

Current Deployments

1. Parks – Video surveillance, public access wireless

2. Detention Facility – Perimeter monitoring

3. Urban areas – Public access wireless

Airlie Gardens
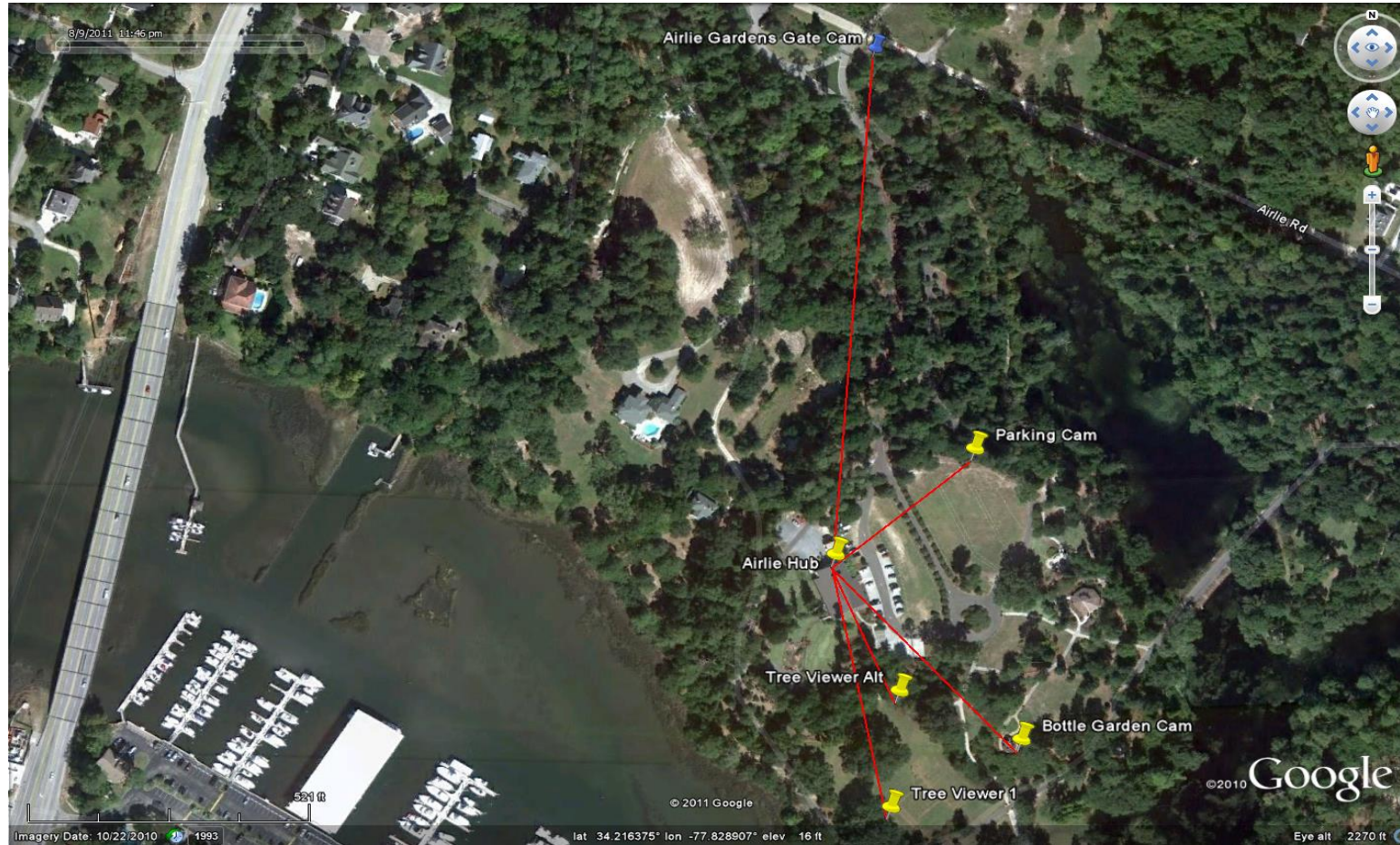
Hugh MacRae Park
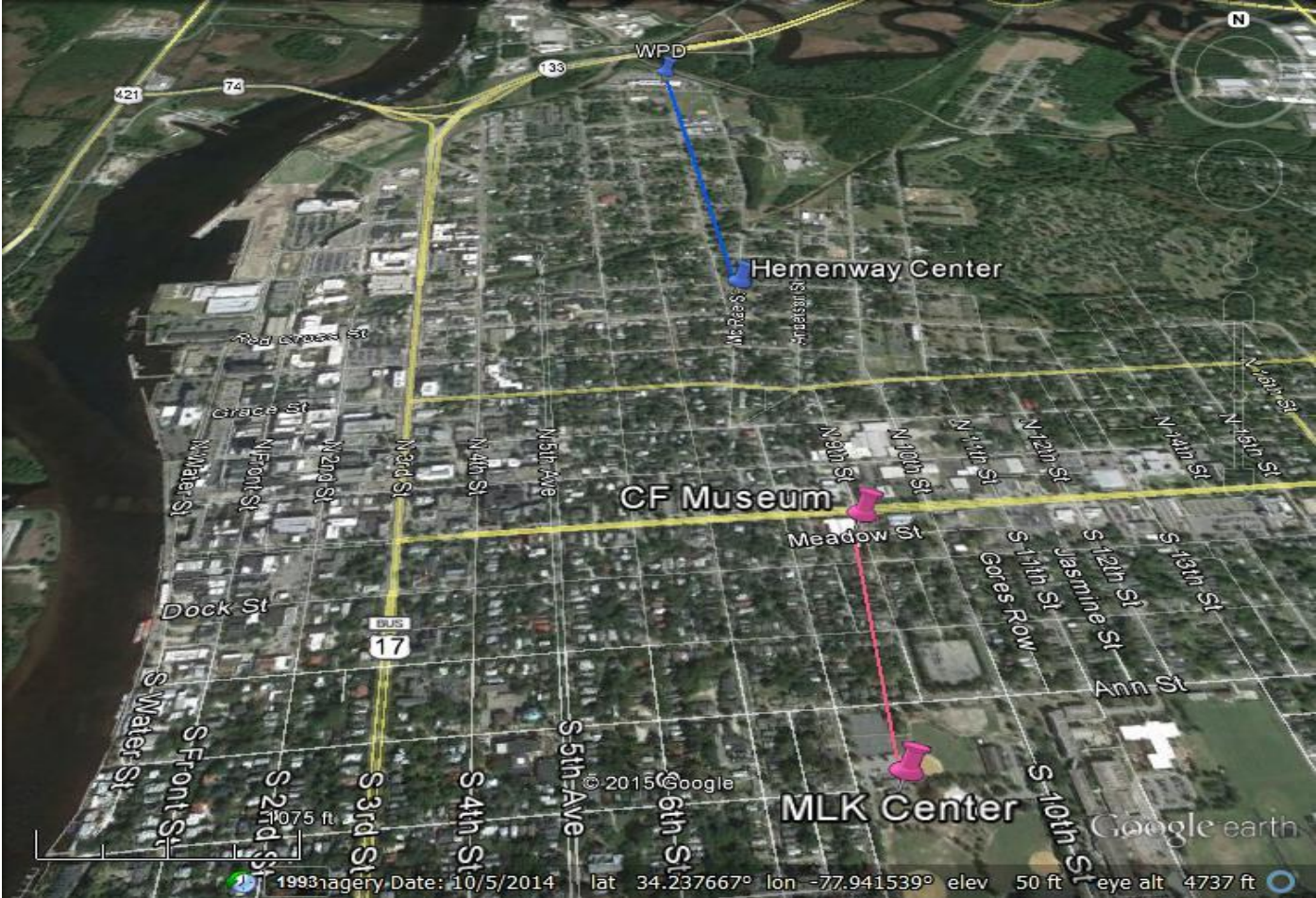
Hugh McRae Park - Video

"North Carolina Now" Feature Story at
http://video.unctv.org/video/2364992308/

Veterans' Park

Youth Enrichment Zone

Youth Enrichment Zone – Base Radios
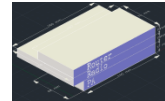
Future Deployments

- Water quality monitoring – intercostal waterway and tidal creeks

- Back haul for network extension – replacing high cost connections in remote areas

- Public wireless in open spaces in the County including parks

- More video surveillance

Current State of the Art

Peter Sun, 6Harmonics

End to end ARN (Adaptive Radio Network) portfolio

Item	GWS3000x	CPE	High power module	CPE module	900/2.4/5.8G product
Tx power	17/20 or 27/33dBm	17dBm	17/20/27/33dBm	17dBm	26dBm
Spectrum	470 ~ 770MHz	470 ~ 770MHz	470 ~ 770MHz	470 ~ 770MHz	ISM900/2.4/5.8G
Channel BW	1MHz ~ 24MHz	1MHz ~ 24MHz	1MHz ~ 24MHz	1MHz ~ 24MHz	1MHz ~ 40MHz
Rx sensitivity	-99dBm	-98dBm	-99dBm	-98dBm	-99dBm
Modulation	BPSK,QPSK, 16QAM, 64QAM	BPSK,QPSK, 16QAM, 64QAM	BPSK,QPSK, 16QAM, 64QAM	BPSK,QPSK, 16QAM, 64QAM	CCK, BPSK,QPSK, 16QAM, 64QAM
MIMO	SISO/MIMO	SISO	SISO/MIMO	SISO/MIMO	SISO/MIMO
Power consumption	25W/40W	2~8W	25W/40W	2~8W	3W

Antenna
~1dBi omni
1dBi omni vehicle
3dBi omni portable
6dBi sector
7dBi sector
8dBi Yagi
11dBi sector

All hardware share the same OS

ARN solution uniqueness

ARN solution character:

- **UL OFDM with high throughput (26Mbps UDP) – good fit for UL video**

- **Single button triggered explicit frequency scan**

- **802.11e QoS**

- Automatic power control

- Cell selection/reselection

- Configurable channel bandwidth (2MHz ~ 24MHz)

- Configurable frequency hopping (programmable hopping scheme)

- Configurable topology (AP/STA or mesh)

- Ethernet switch/router as the core

- Quick setup

Typical Round trip delay < 3ms, ideal solution for video monitoring

Mature ARN solution - ready for mass deployment

ARN* passed FCC certification in March 2014

Wilmington deployment won USA innovation award
https://www.natoa.org/2013/09/2014-community-broadband-recipients.html

Commercial deployment/trial
   Wilmington, North Carolina, USA - partner with New Hanover County gov't
   Maniwaki, Quebec, Canada - partner with SADC, CNRC and Picanoc
   Singapore, Philippine and Bhutan - partner with Microsoft
   China emergency communication
   South Africa/Kenya/Tanzania/Ghana - partner with Microsoft
   Uruguay, partner with Microsoft

   Glasgow, UK, partner with Microsoft and University of Strathclyde
   London Zoo, UK, partner with Google

Exclusive partner of MTK on 802.11af reference design (Front End Module and system software)

South Africa field deployment case – bandwidth distribution
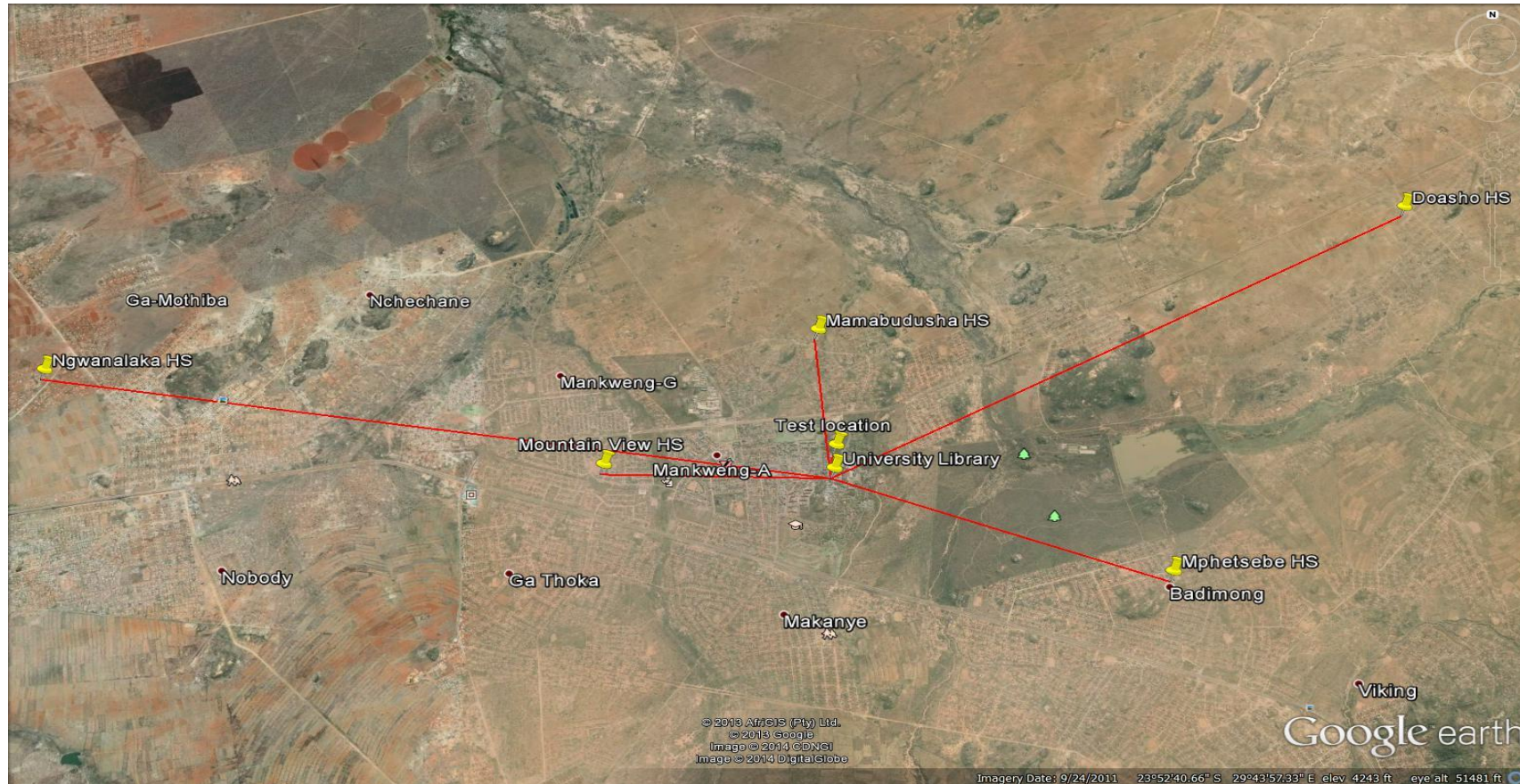
> Core radios on roof of university library
> 6 Core radios with 4 antennas
> C1, C2 share one antenna via duplexer
> D1, D2 share one antenna via duplexer

> Edge radios on pole point to core radios
> Longest School link = 8.94 km
> Shortest School link = 1.91 km
> University Test link = 310 meters

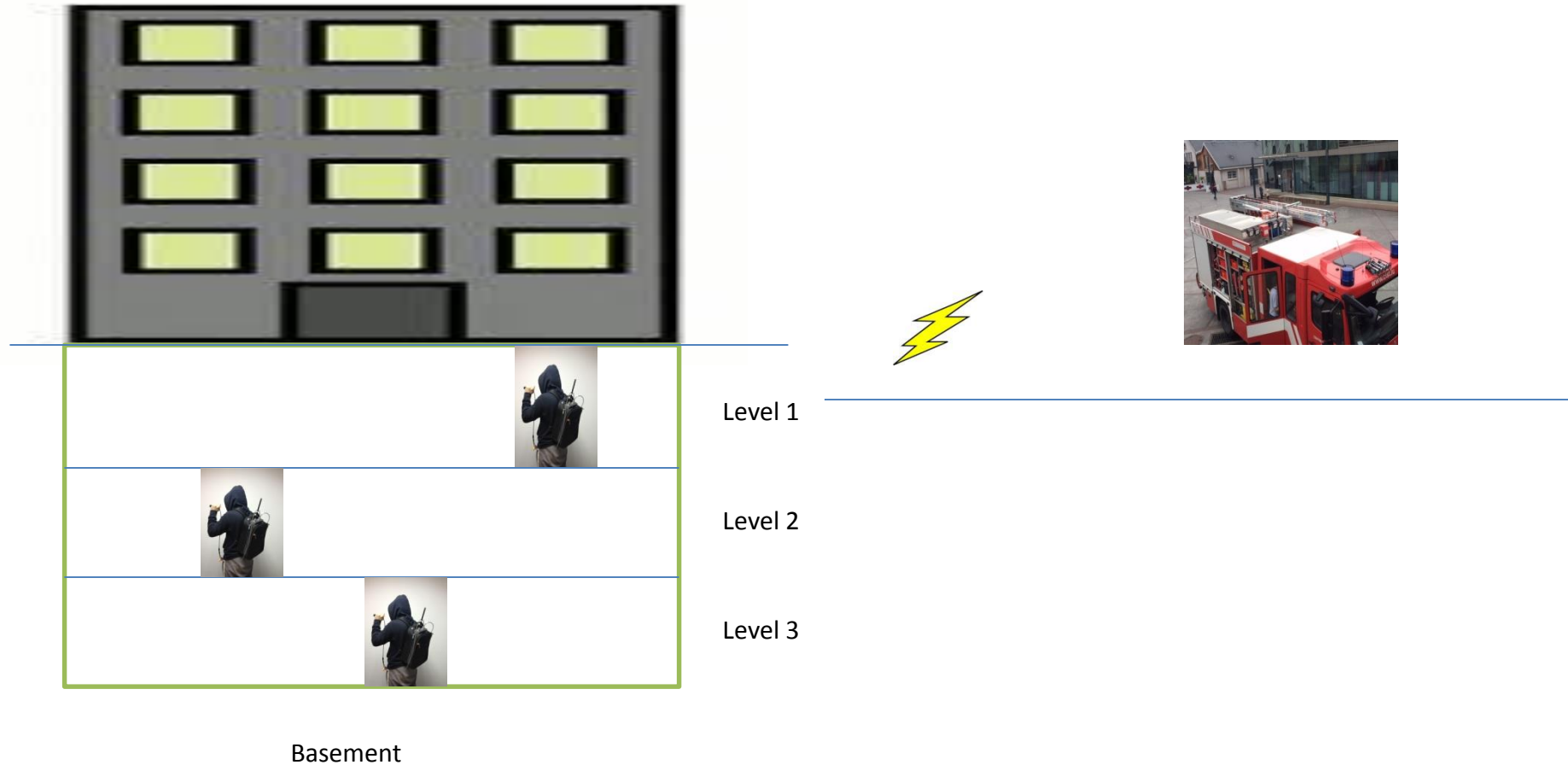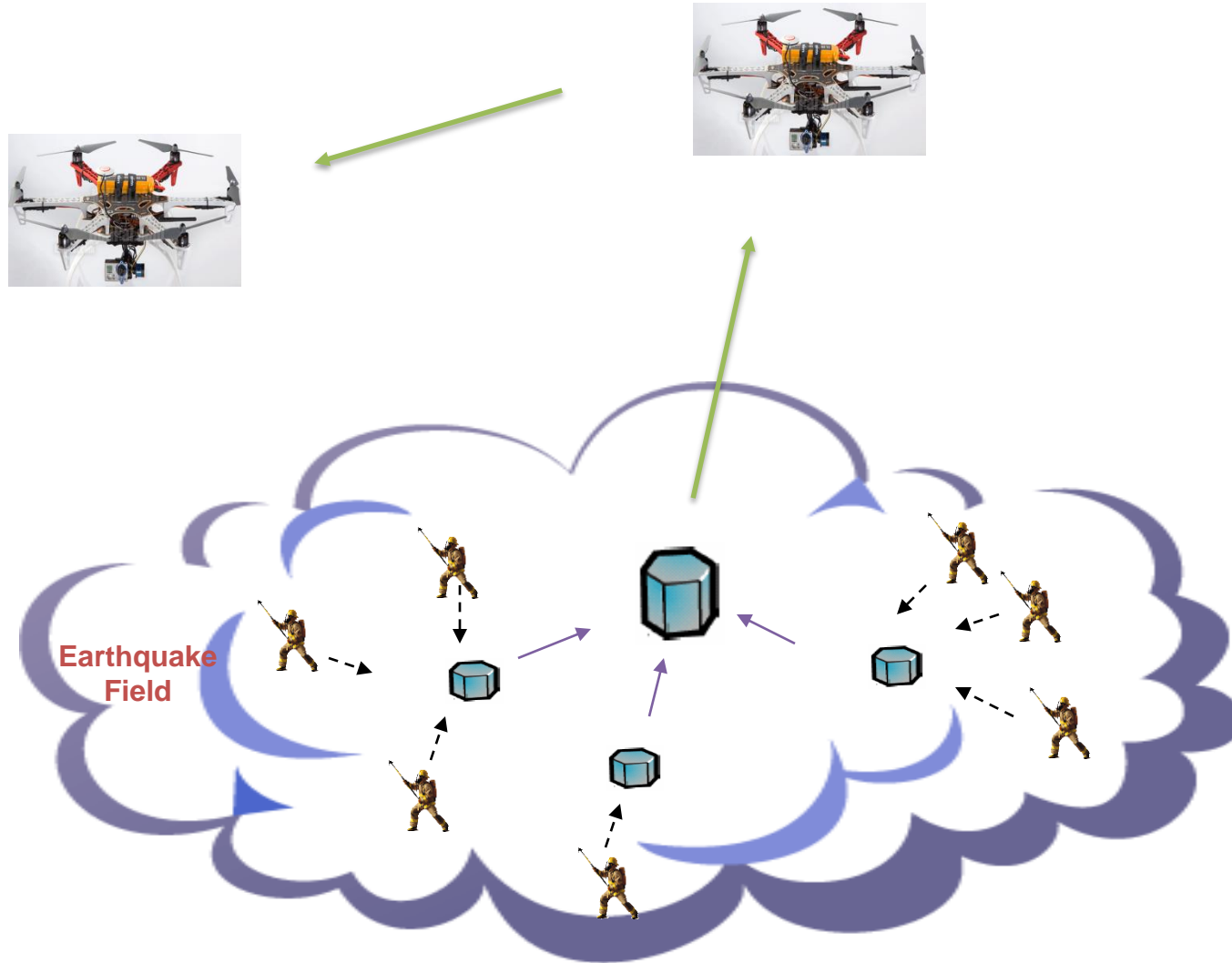# UK field deployment case – video monitoring

http://consumers.ofcom.org.uk/news/london-zoo-trial/

> 3 core radios on ZSL HQ roof

> 1 edge radio in each location

> Real time video monitoring

> Live broadcast through Youtube

Level 1

Level 2

Level 3

Basement

Live audio/video from 3 level of basement – save the fire fighter

Earthquake
Field

5 ~ 8km

5 ~ 8km

London Zoo – Live

http://consumers.ofcom.org.uk/news/london-zoo-trial/
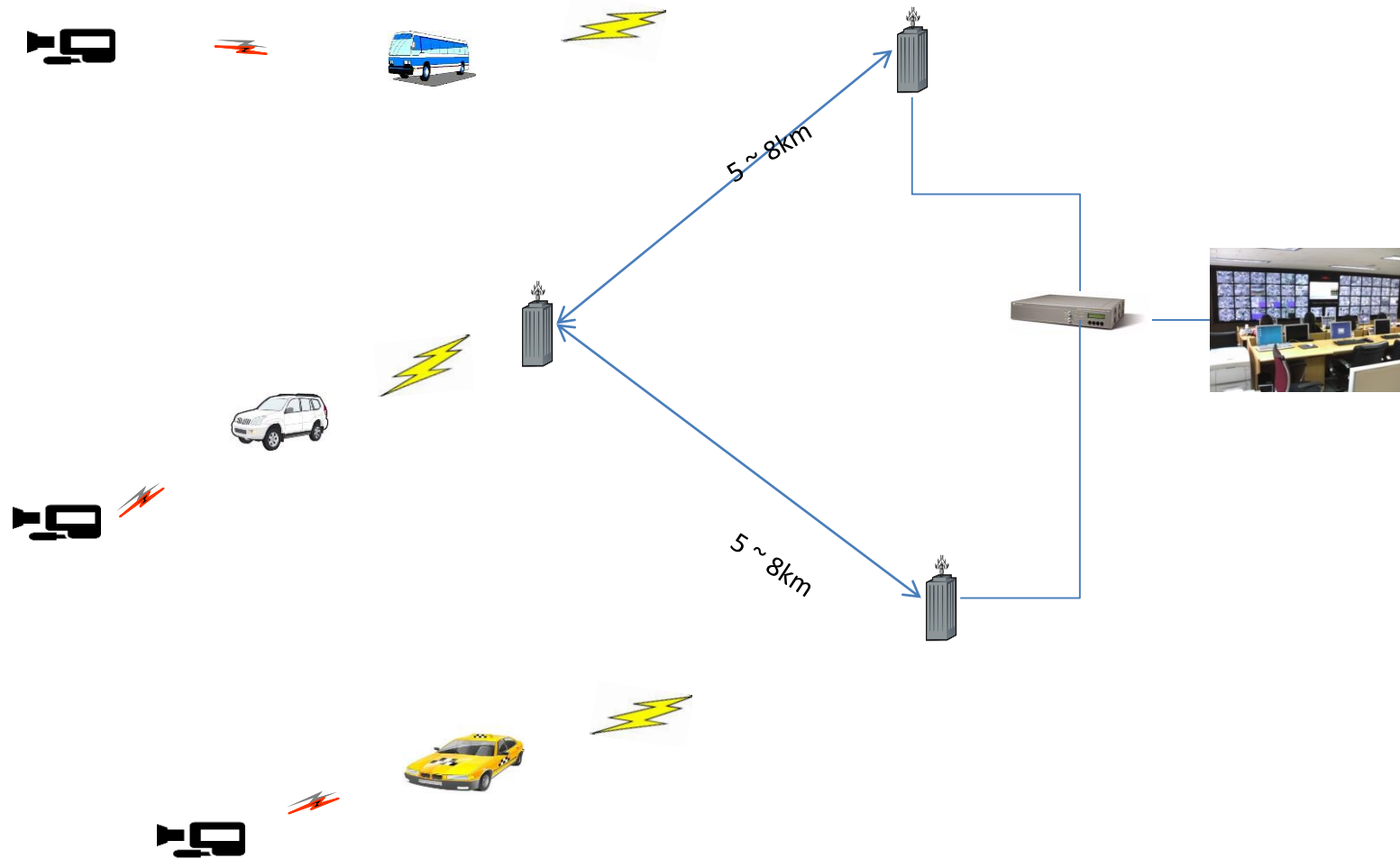
Educational Applications

Paul Garnett, Microsoft

Microsoft's Perspective on Connectivity

Microsoft

Microsoft is making big bets on cloud-first and mobile-first experiences . . .

"The cloud is how *a* device becomes *your* device. And the cloud is how your *device* becomes part of your *life*, by connecting to all the people, information and experiences that matter to you. And for us, the cloud is also how a tablet becomes a useful and powerful tool."

"Simply put, our vision is to deliver the best cloud-connected experience on every device."

-Satya Nadella, Official Microsoft Blog (March 27, 2014)

Microsoft Wants Wireless Connectivity to Be . . .

Ubiquitous	Affordable	Robust
Available Where and When Needed	Declining Pricing that Reflects Efficiency Gains	Supporting High-Capacity & Low-Latency Applications

Enabling Emerging Experiences Around Meetings, Wearables, Internet of Things, etc.

Global Trials, Pilots & Deployments

Microsoft

MSFT Supported Pilot Projects: Current Snapshot
Commercial Scale is the Next Step

Scotland

Seattle Center

Bhutan

Taiwan

India

Philippines

Ghana

Singapore

Kenya

Tanzania

Indonesia

Projects (15)
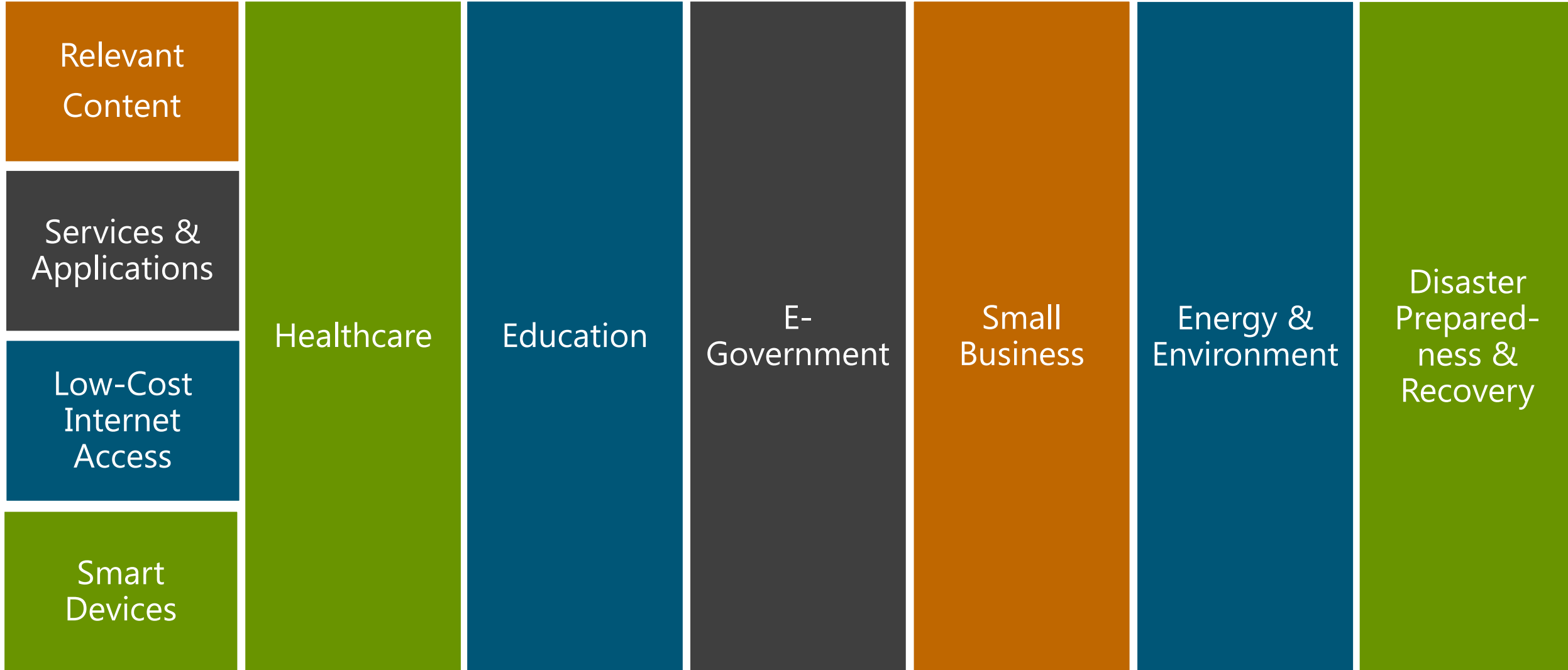
Namibia

Botswana

South Africa

Uruguay

| 67 K-12 Schools Being Connected | 36,000 K-12 Students Being Connected | 6 University Campuses Being Connected | 38,500 University Students Getting MSFT Devices & Services | 200,000+ Population Under Coverage |

Identification of Shared Goals

Relevant Content

Services & Applications

Low-Cost Internet Access

Smart Devices

Healthcare

Education

E-Government

Small Business

Energy & Environment

Disaster Prepared-ness & Recovery

Mawingu Project

Collaboration between Kenya's Ministry of Information and Communications, Microsoft, and Mawingu Networks.

Pilot delivering low-cost wireless broadband access to previously unserved locations near Nanyuki.

First deployment of solar-powered based stations together with TVWS to deliver high-speed Internet access to areas currently lacking even basic electricity. Base stations allow end-users to charge devices.

To maximize coverage and bandwidth, while keeping costs to a minimum, the Mawingu network relies on a combination of "license-exempt" wireless technologies, including Wi-Fi and TVWS.

Initial findings

Phone

80% of adults own a mobile phone – against only 13% of teens (11 – 18)

Only 14% of adults own a smartphone and only 3% of teens

Average weekly voice spend is 147 KSh ($1.80). Average data spend is 56 KSh ($0.67).

Device charging

On average each phone user charges their phone 2.15 times a week

Each user has to walk 20 minutes to reach the nearest charging place

On average 23 KSh ($0.28) is spent weekly on charging

Lighting

¼ of households don't report any spend on lighting – mainly using solar torches

The average weekly spend on lighting for the remaining households is 111 KSh ($1.38)

Internet

Only 17% of adults and 9% of teenagers use the internet.

On average users spend 63 KSh ($0.78) weekly on internet. BUT return transport to the cybercafe is 140 KSh.

The most common frustrations given with the internet are the high costs and slow speeds of access.

UNIVERSITY OF Southampton
Institute for Complex Systems Simulation

Microsoft®

Kenya Learners said they would like...

"To be an electronics engineer"

"Adding more books in school"

"Bringing more computers in school"

"Improvement of Internet connections"

"Learning the Internet"

"More teachers"

South Africa Project

Collaboration between CSIR, Multisource, Microsoft, and the University of Limpopo.

Pilot delivers broadband connectivity, Office 365, Windows tablets, and content to underserved communities in South Africa.

TVWS base stations deliver high-speed Internet access to schools in unserved townships areas near Limpopo. Base stations allow end-users to charge devices.

The focus of the pilot will be to prove that TV white spaces can be used to meet the South African government's goals of providing low-cost access for a majority of South Africans by 2020.
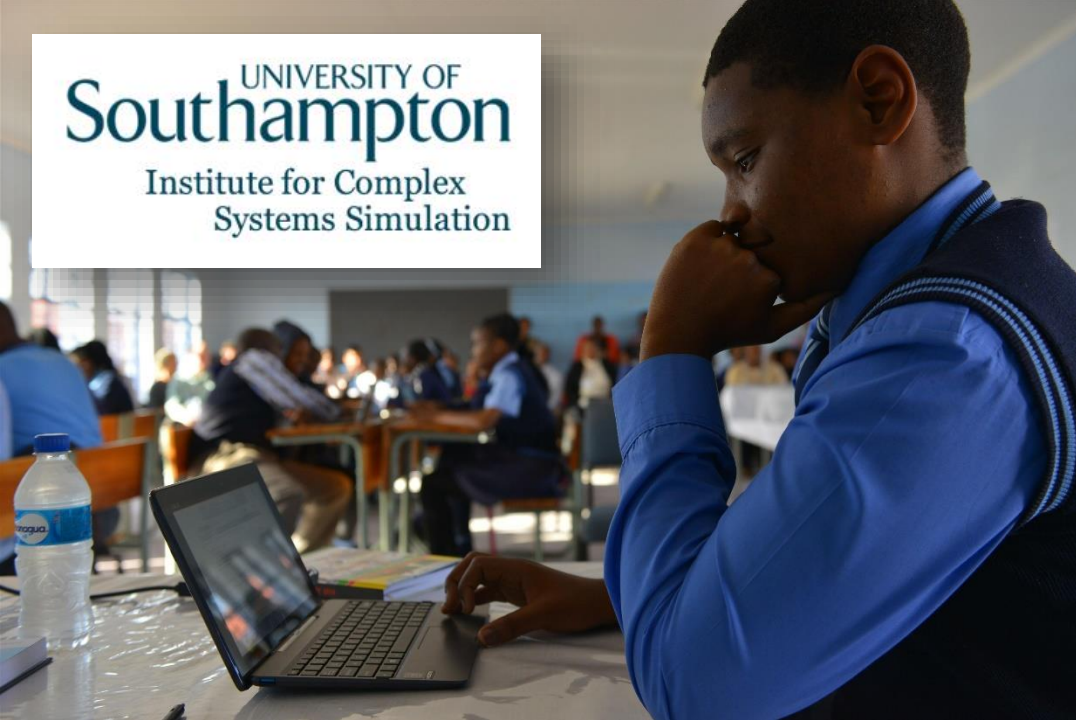
Computer & Internet usage @ Limpopo Schools *before the TVWS trial*
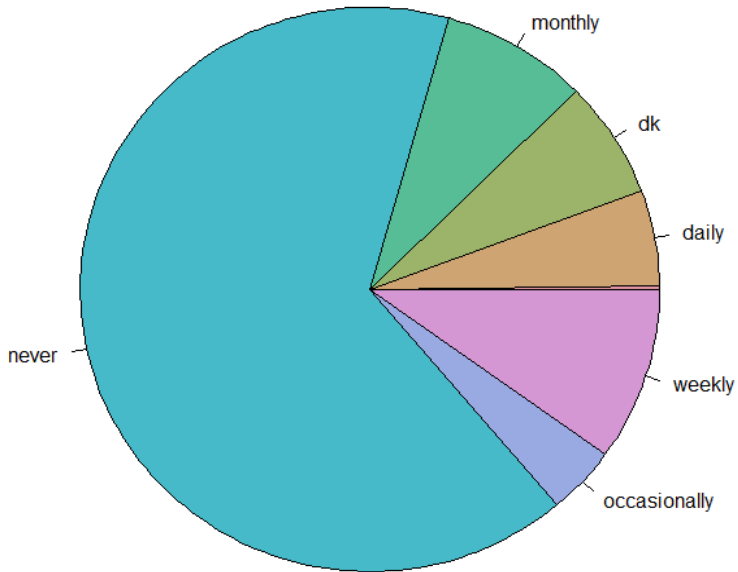
Out of 562 Limpopo learners surveyed, almost 66% said they never use a computer at school.

Out of the 155 Limpopo learners who said they had used a school computer, 40% said they never use the Internet at school.

Only 6% of Limpopo learners said they used a computer at school daily.

Limpopo Learners' Computer Use @ School

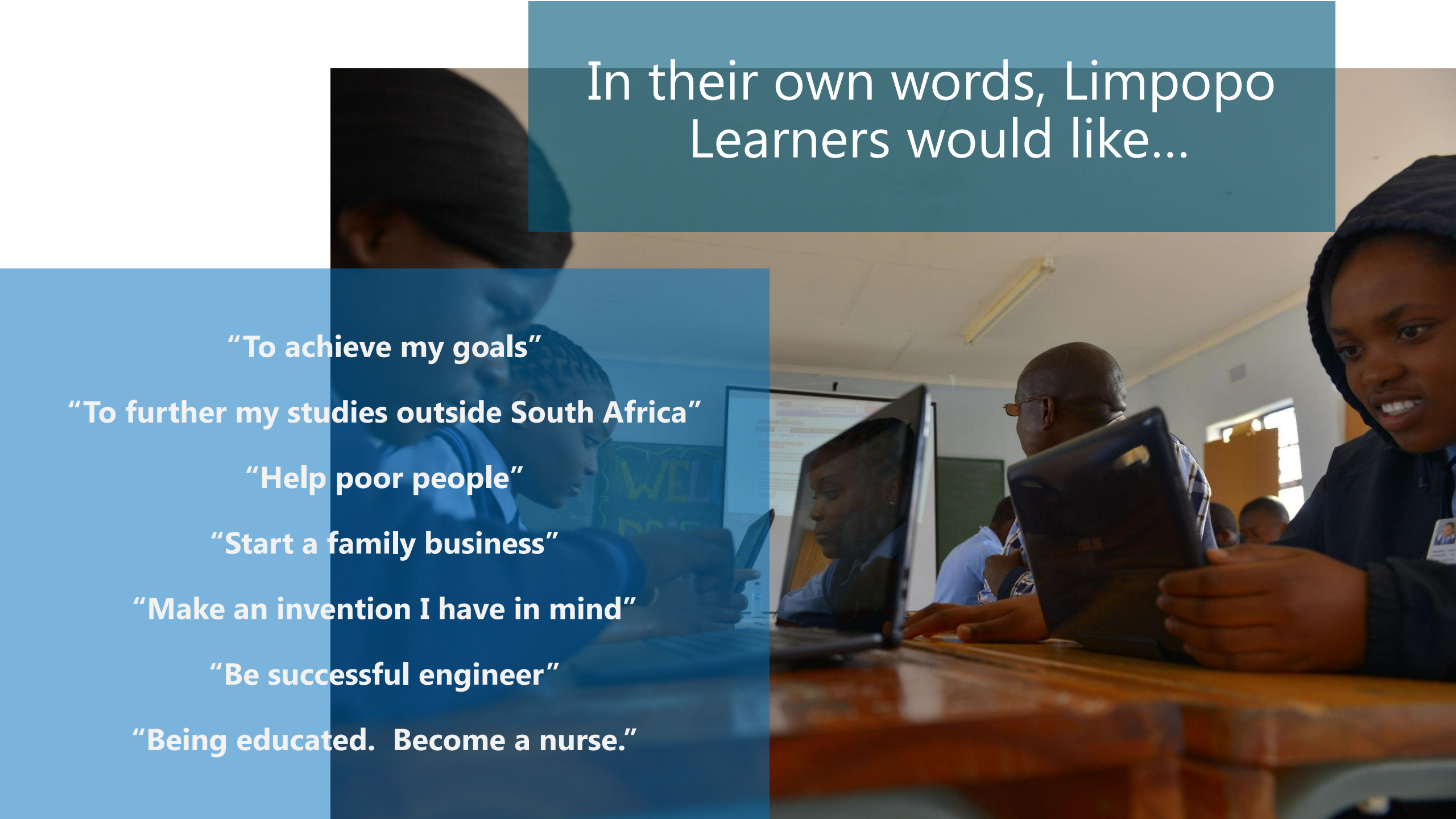| ~ 7% | don't know how frequently they use a computer at school |
~ 4%	report occasionally using a computer at school
~ 6%	use a computer at school daily
~ 10%	use a computer at school on a weekly basis
~ 8%	use a computer at school on a monthly basis
~ 66%	report <u>never</u> using a computer at school
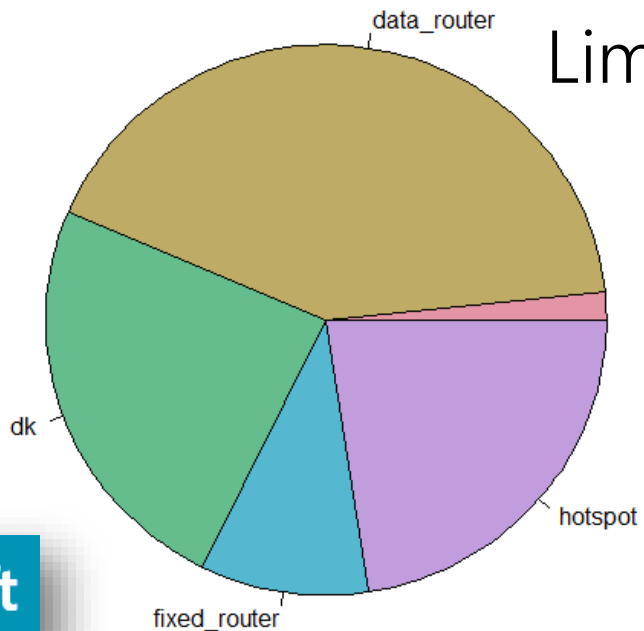
Limpopo Learners' Home Internet Connections

Almost 89% of Learners reported no home Internet connection.

Of the 62 Learners who reported having a home Internet connection,

~ 42%	use a data router at home
~ 10%	use a fixed router at home
~ 23%	use a hotspot at home
~ 24%	don't know how they connect to the Internet at home

Microsoft

In their own words, Limpopo Learners would like...

"To achieve my goals"

"To further my studies outside South Africa"

"Help poor people"

"Start a family business"

"Make an invention I have in mind"

"Be successful engineer"

"Being educated. Become a nurse."

Limpopo Educator Named Super Teacher of the Year for 2014

Simon Mosiwa Matlebjane is named Super Teacher of the Year for 2014 by the Internet Service Providers' Association (ISPA).

Educational impact

Simon Mosiwa Matlebjane, an educator at Mountainview Secondary school in Limpopo, works to reduce technophobia among educators.

He was named **Super Teacher of the Year for 2014**, because he provides his fellow educators with software training.

This technical training enabled his colleagues to use "productivity tools to mark sheets and schedules more quickly."

See: Mybroadband, ZA (September 19, 2014) *2014 ISPA SuperTeachers named*. Available online: http://mybroadband.co.za/news/quick-news/110178-2014-ispa-superteachers-named.html

Simon Mosiwa Matlebjane is a teacher at the Mountainview Secondary School in Limpopo, South Africa. Matlebjane is the head of the Maths and Technology Departments, and won the award for a implementing a project that aims to eliminate technophobia among educators.

Links to further information

More about TVWS technology

http://research.microsoft.com/en-us/projects/spectrum/default.aspx

The Dynamic Spectrum Alliance

http://www.dynamicspectrumalliance.org/

Microsoft projects

http://research.microsoft.com/en-us/projects/spectrum/pilots.aspx

White Space Future in U.S.

All Panelists

Questions?

SREB

Thank you for attending!

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