

ICTP, ICT and IoT

Marco Zennaro, PhD
Telecommunication/ICT4D Lab
The Abdus Salam International Centre
for Theoretical Physics

What is the ICTP

The Abdus Salam International Centre for Theoretical Physics was founded in 1964, by the late Nobel Laureate Abdus Salam

ICTP is administered by UNESCO and the International Atomic Energy Agency (IAEA)

The Centre is located in Trieste, Italy



What is the ICTP

ICTP is an institution that is run by scientists for scientists to support the best science possible, with special attention to the needs of scientists from Developing Countries

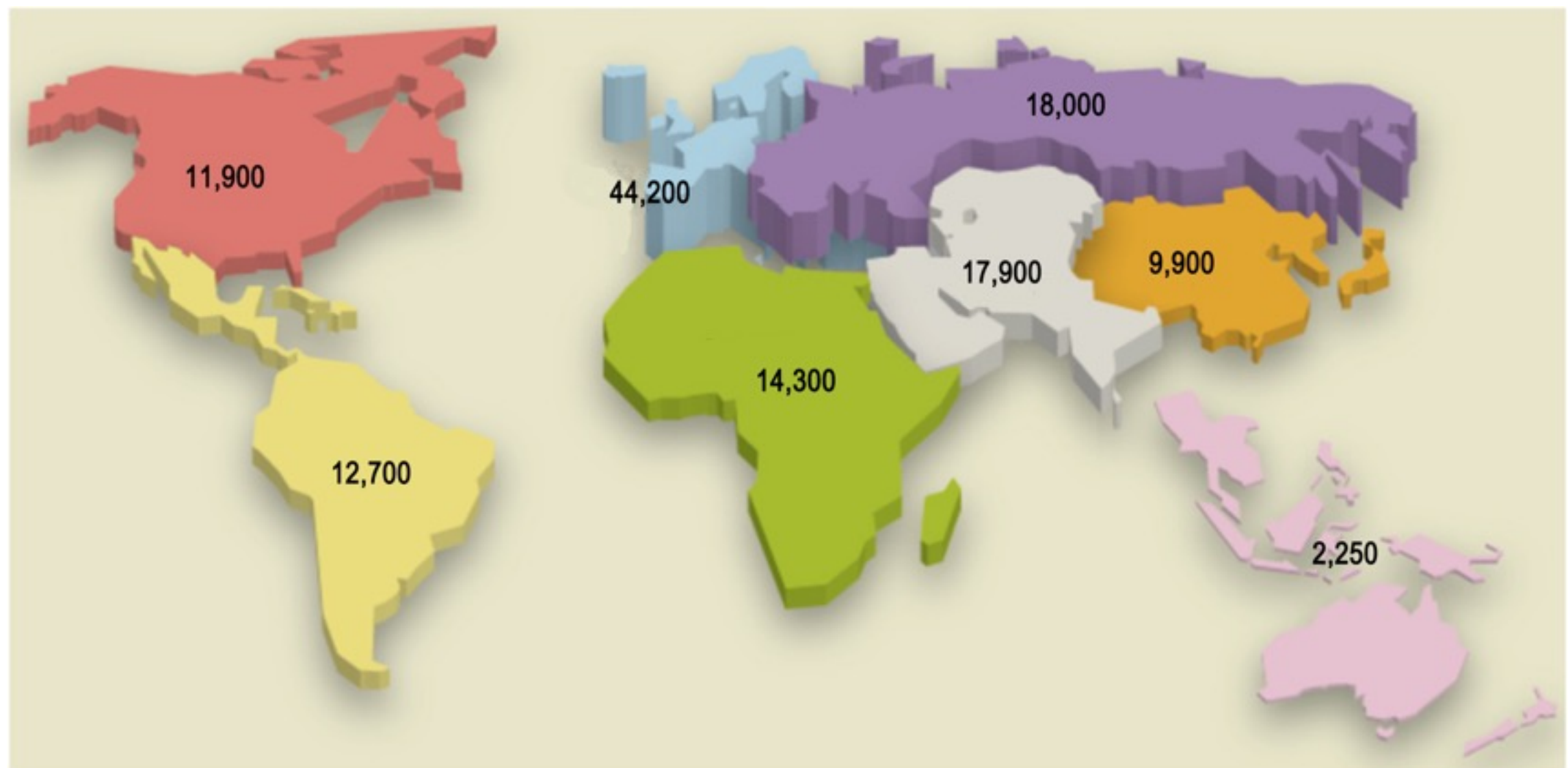
"Scientific thought is the common heritage of mankind"

Abdus Salam



Visiting scientists

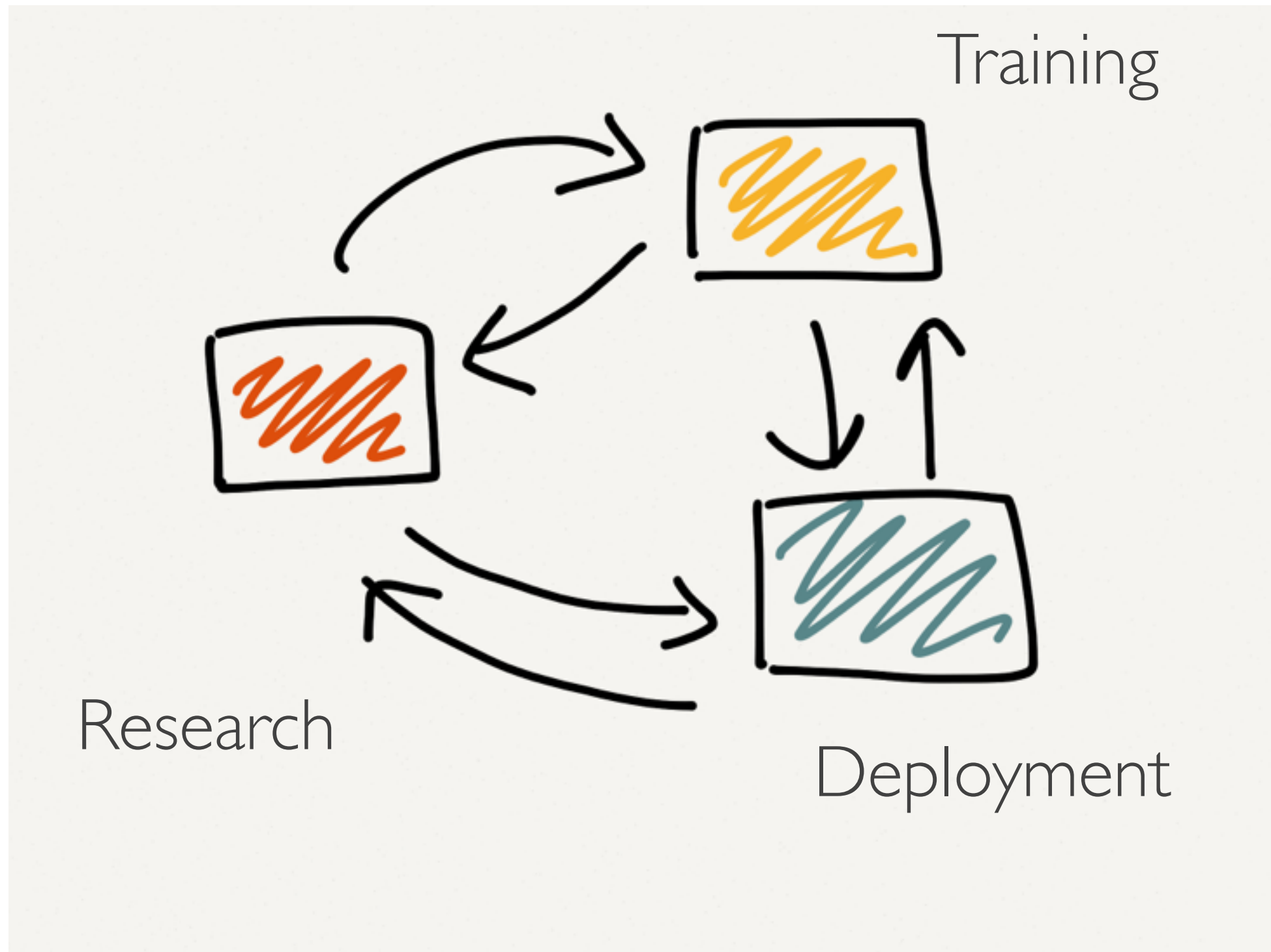
More than 120'000 visits from 188 countries, 20% of visitors are women



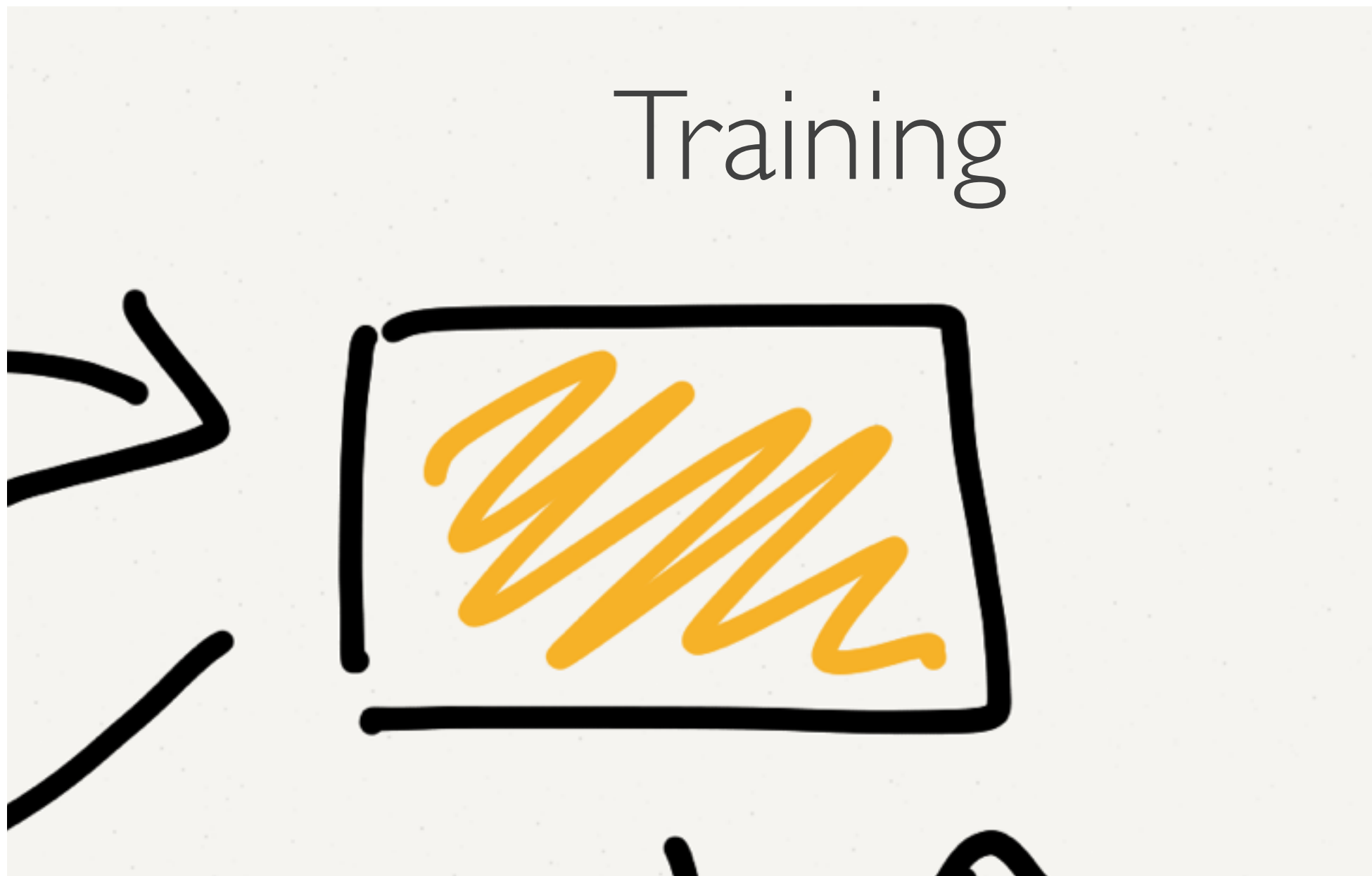
MARCONI



T/ICT4D model



T/ICT4D model



1995 vs 2010

Wireless LAN



400\$
3 Mbps



77\$
150Mbps

Activities in Trieste



Activities in Trieste



Activity in Senegal



Activity in Micronesia



[WNDW.net](http://www.wndw.net)

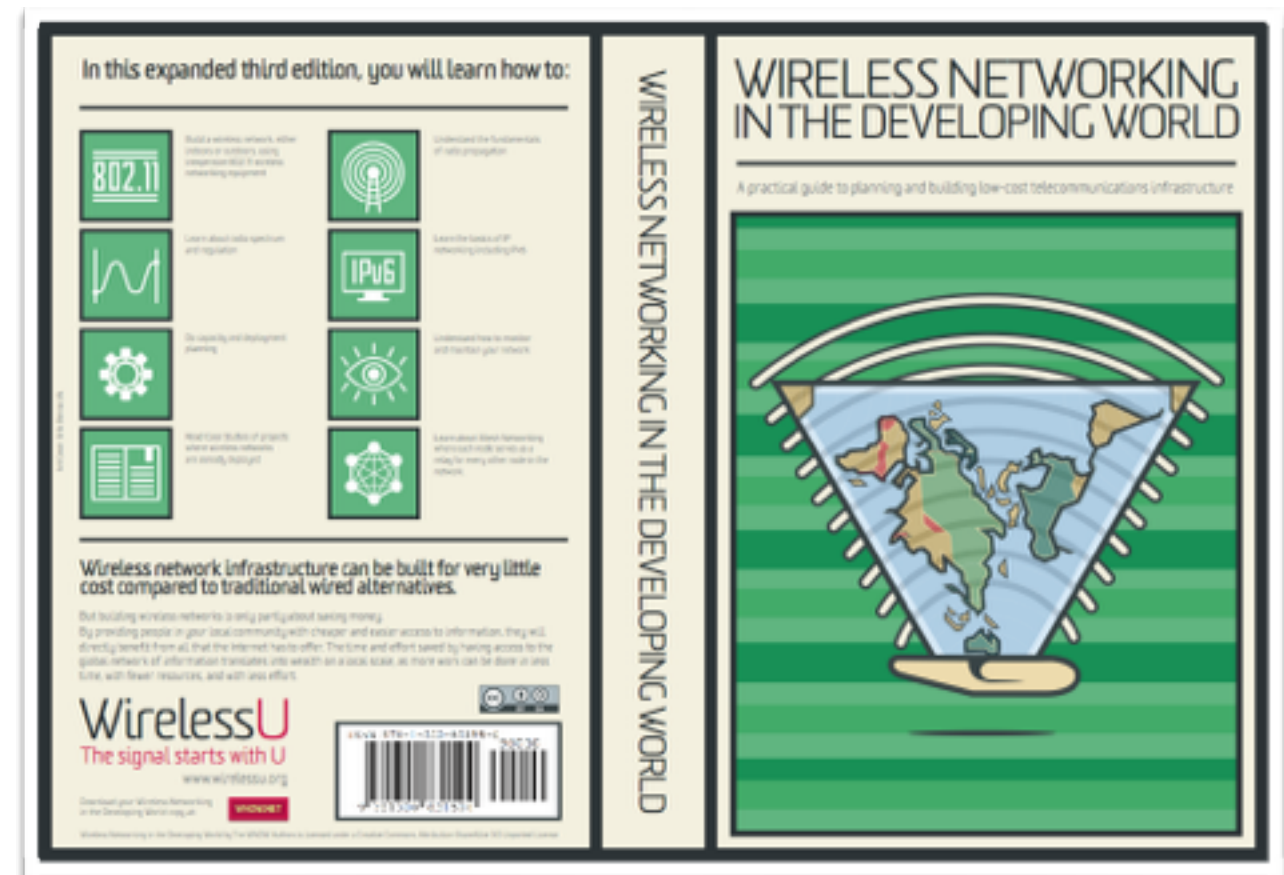
A free book on “Wireless Networking in the Developing World”

Written by wireless geeks in less than 3 months

More than **3M** downloads!

Available also in Spanish, French, Arabic, Portuguese, Indonesian

<http://www.wndw.net>



الشبكات اللاسلكية في الدول النامية

الإصدار الثاني

دليل عملي لتخطيط وبناء بنى الاتصالات التحتية
منخفضة التكاليف

الشبكات اللاسلكية في الدول النامية

يمكن بناء الشبكات اللاسلكية بتكاليف منخفضة جداً مقارنة بالبدائل السلكية التقليدية، لكن فوائد الشبكات اللاسلكية لا تقتصر على توفير المادي. سيعود تمكين أفراد المجتمع المحلي من الحصول على المعلومات بأساليب أرخص وأسرع بمنافع لا حصر لها. سيتم ترجم الوفرة الهائلة في الوقت والجهد نتيجة الإتصال بشبكة الإنترنت العالمية إلى ازدهار ورفاء على المستوى المحلي وذلك لإمكانية إنجاز المزيد من العمل في زمن أقل وبموارد أبسط.

ستتعلم في هذا الإصدار الموسع:

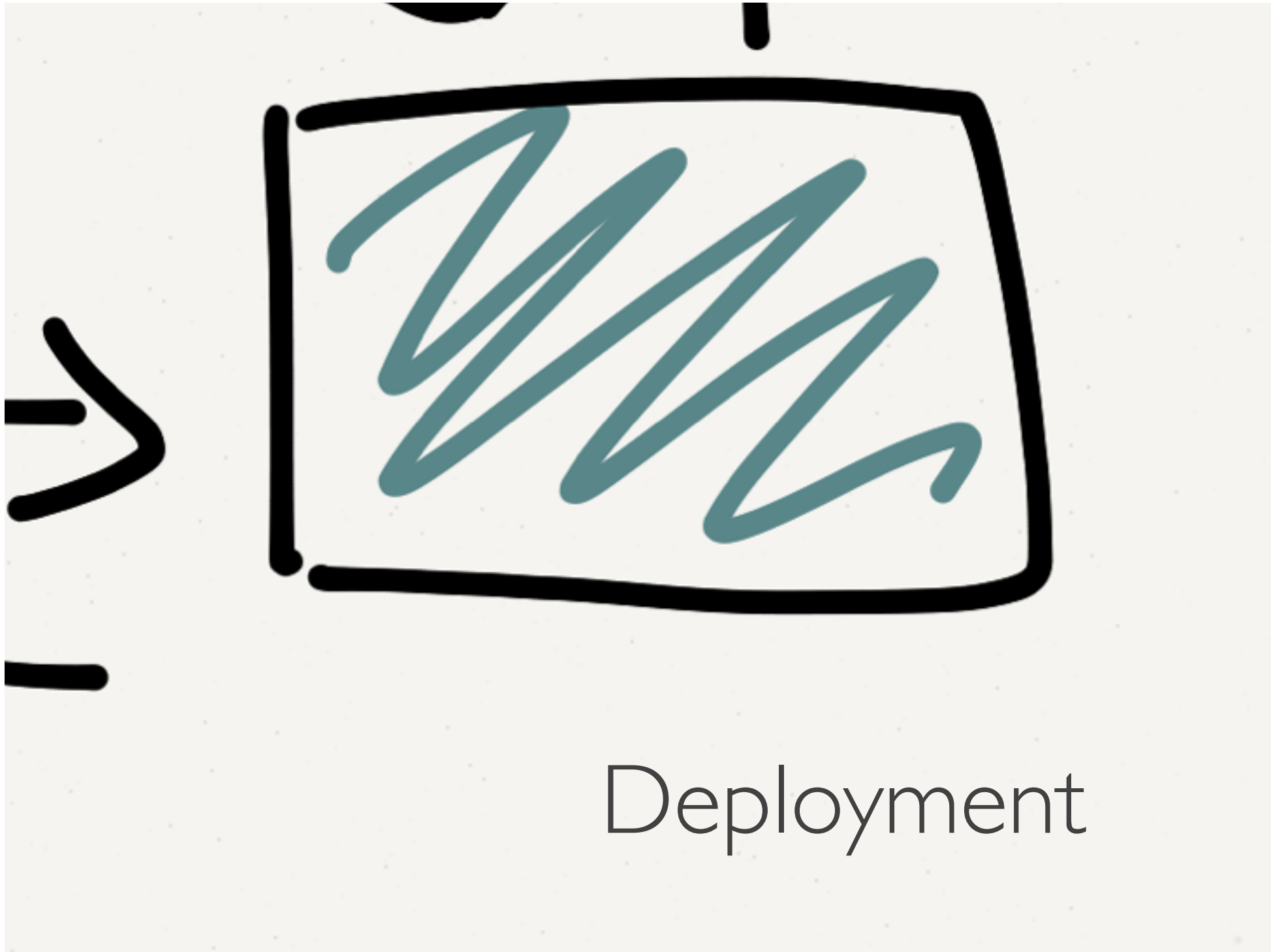
- بناء شبكة لاسلكية بعيدة المدى بواسطة التجهيزات منخفضة التكلفة والمتوافقة مع معايير 802.11
- تشارك وصلة الإنترنت بين مواقع عدة
- تحديد الجدوى الاقتصادية لمشروع الشبكة اللاسلكية
- استيعاب مبادئ إنتشار الإشارة اللاسلكية بما فيها تأثيرات البيئة وخطوط الإرسال وخصائص الهوائيات
- تصميم وبناء نظام للطاقة الشمسية لتغذية مشاريع الاتصالات في المناطق النائية
- تطبيق جميع الخطوات الضرورية لبناء شبكة لاسلكية مجتمعية بعيدة المدى بما فيها دراسة الجدوى وتخطيط الشبكة واختيار التجهيزات والتركيب والمراقبة والصيانة الدورية

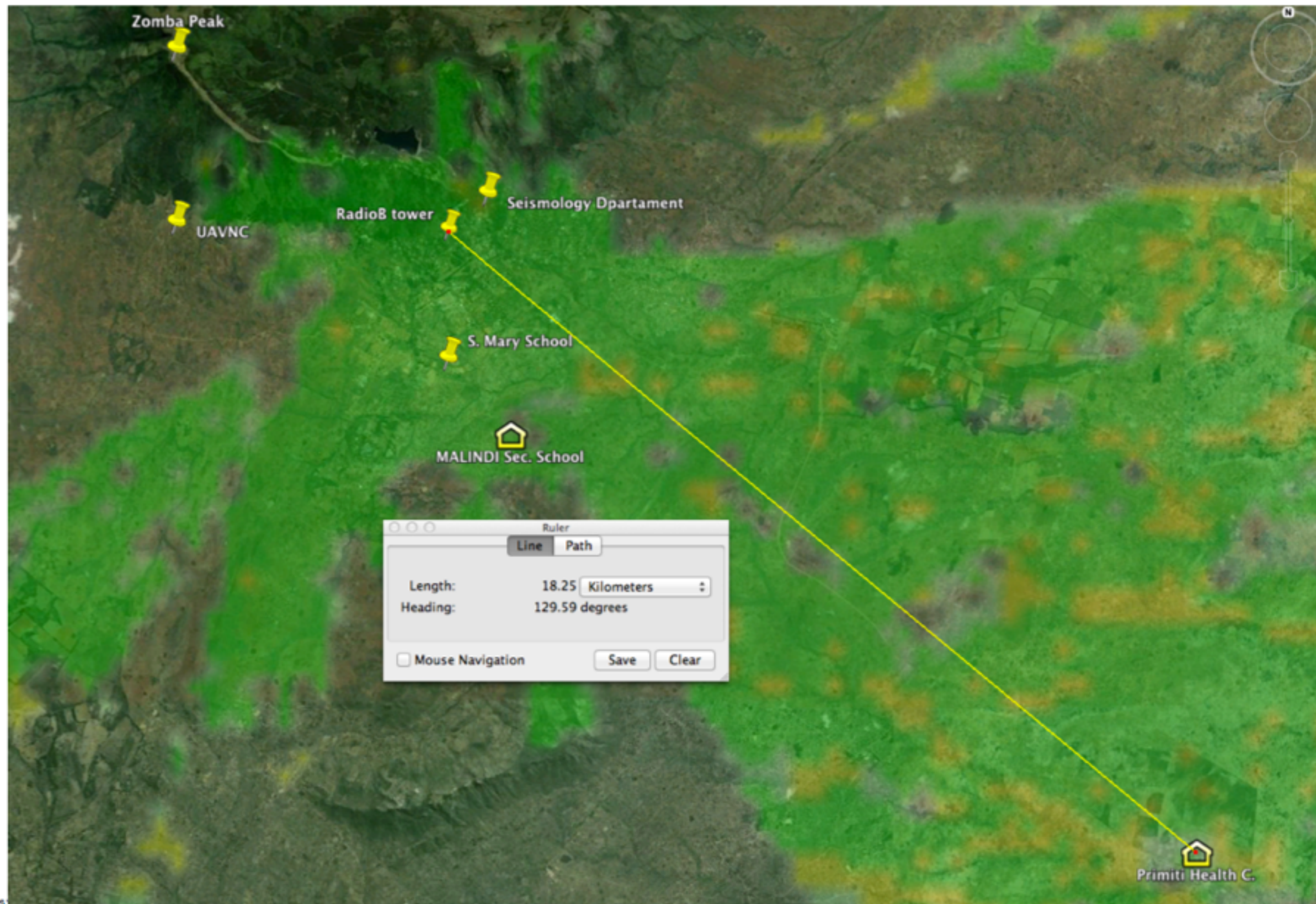
أكثر من 500000 نسخة حتى الآن
أكثر من 5 لغات
مجاناً على wndw.net

الإصدار الثاني



T/ICT4D model





Deployment



FM tower













Activities in Malawi



SEISMICITY OF SUB-SAHARAN AFRICA

[1971 - 1996]



Council for Geoscience



Private
South Africa

Scale 1:100,000,000

Copyright

Provisional Map

Legend

Earthquake

Intensity

Scale

1:100,000,000

Copyright

Provisional Map

10

Senegal











T/ICT4D model

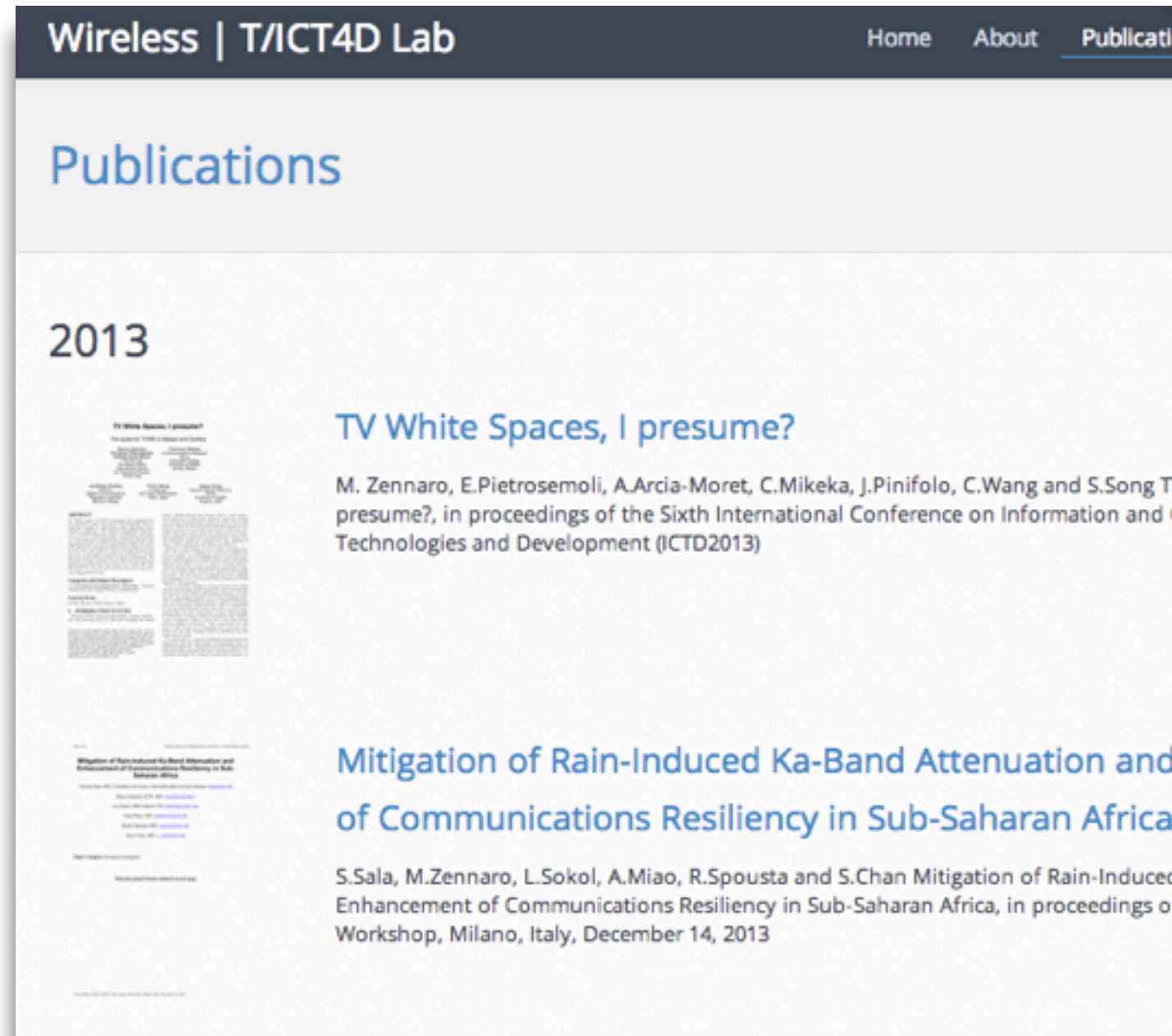


State of the Art and 100% Collaborative

Two new topics: TV White Spaces and Internet of Things

In last 3 years we published +20 papers with African co-authors (South Africa, Uganda, Tanzania, Malawi, Kenya, Zimbabwe, Nigeria, etc)

Recognized as members of the ICT4D academic community



Spectrum allocation

UNITED STATES FREQUENCY ALLOCATIONS THE RADIO SPECTRUM

RADIO SERVICES COLOR LEGEND

AERONAUTICAL MOBILE	INTELSAT	MOBILE
AERONAUTICAL MOBILE SATELLITE	LAND MOBILE	MOBILE SATELLITE
AERONAUTICAL RADIO NAVIGATION	LAND MOBILE SATELLITE	MOBILE SATELLITE
NAVY	NAVY MOBILE	NAVY MOBILE SATELLITE
NAVY SATELLITE	NAVY MOBILE SATELLITE	NAVY MOBILE SATELLITE
BROADCASTING	NAVY RADIO NAVIGATION	NAVY RADIO NAVIGATION SATELLITE
BROADCASTING SATELLITE	NAVY RADIO NAVIGATION SATELLITE	NAVY RADIO NAVIGATION SATELLITE
EARTH ORBITATION SATELLITE	NAVY RADIO NAVIGATION SATELLITE	NAVY RADIO NAVIGATION SATELLITE
FIXED	NAVY RADIO NAVIGATION SATELLITE	NAVY RADIO NAVIGATION SATELLITE
FIXED SATELLITE	NAVY RADIO NAVIGATION SATELLITE	NAVY RADIO NAVIGATION SATELLITE
GOVERNMENT EXCLUSIVE	NAVY RADIO NAVIGATION SATELLITE	NAVY RADIO NAVIGATION SATELLITE
GOVERNMENT/GOVERNMENT SHARED	NAVY RADIO NAVIGATION SATELLITE	NAVY RADIO NAVIGATION SATELLITE
NON-GOVERNMENT EXCLUSIVE	NAVY RADIO NAVIGATION SATELLITE	NAVY RADIO NAVIGATION SATELLITE

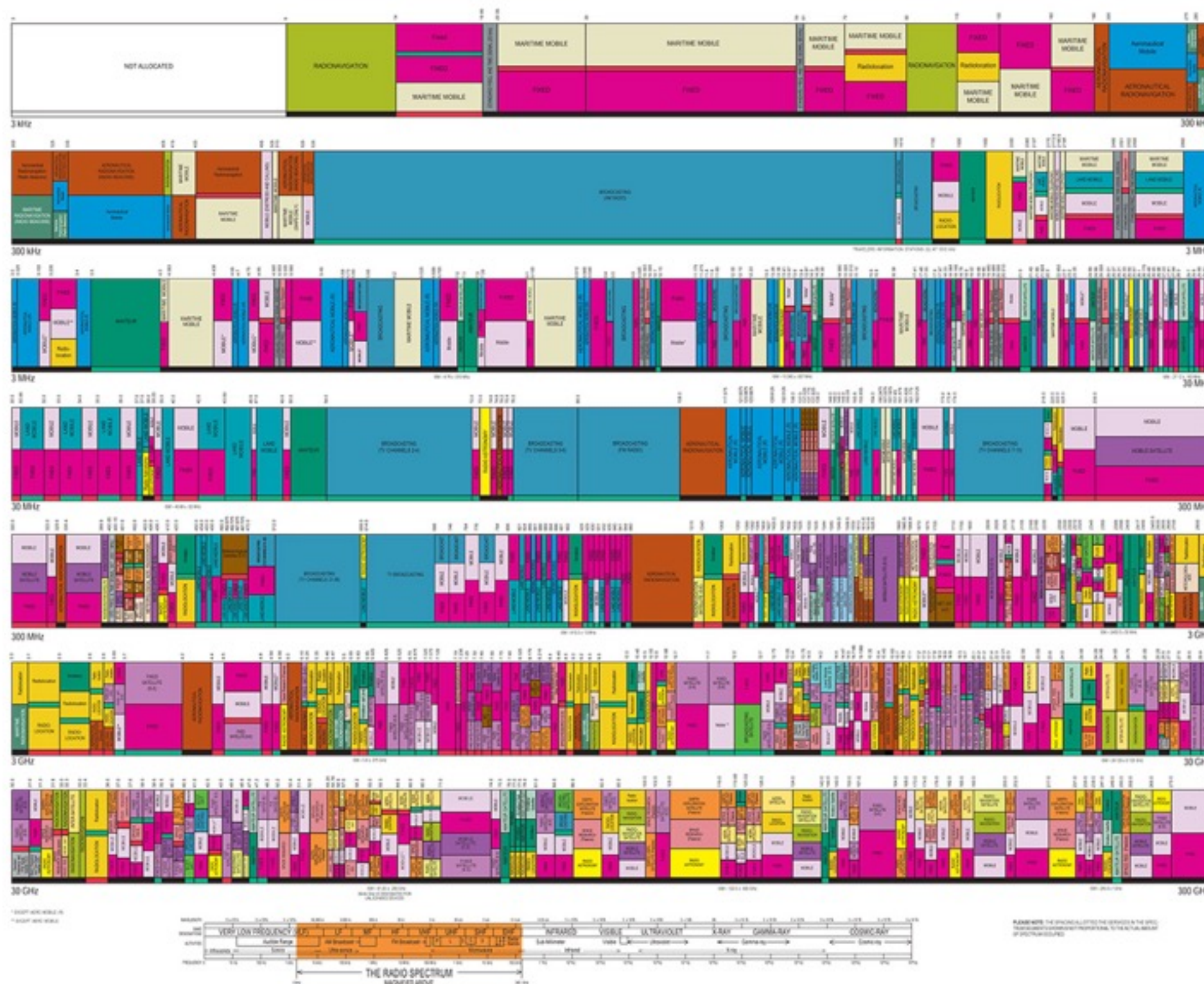
ACTIVITY CODE

GOVERNMENT EXCLUSIVE	GOVERNMENT/GOVERNMENT SHARED
NON-GOVERNMENT EXCLUSIVE	

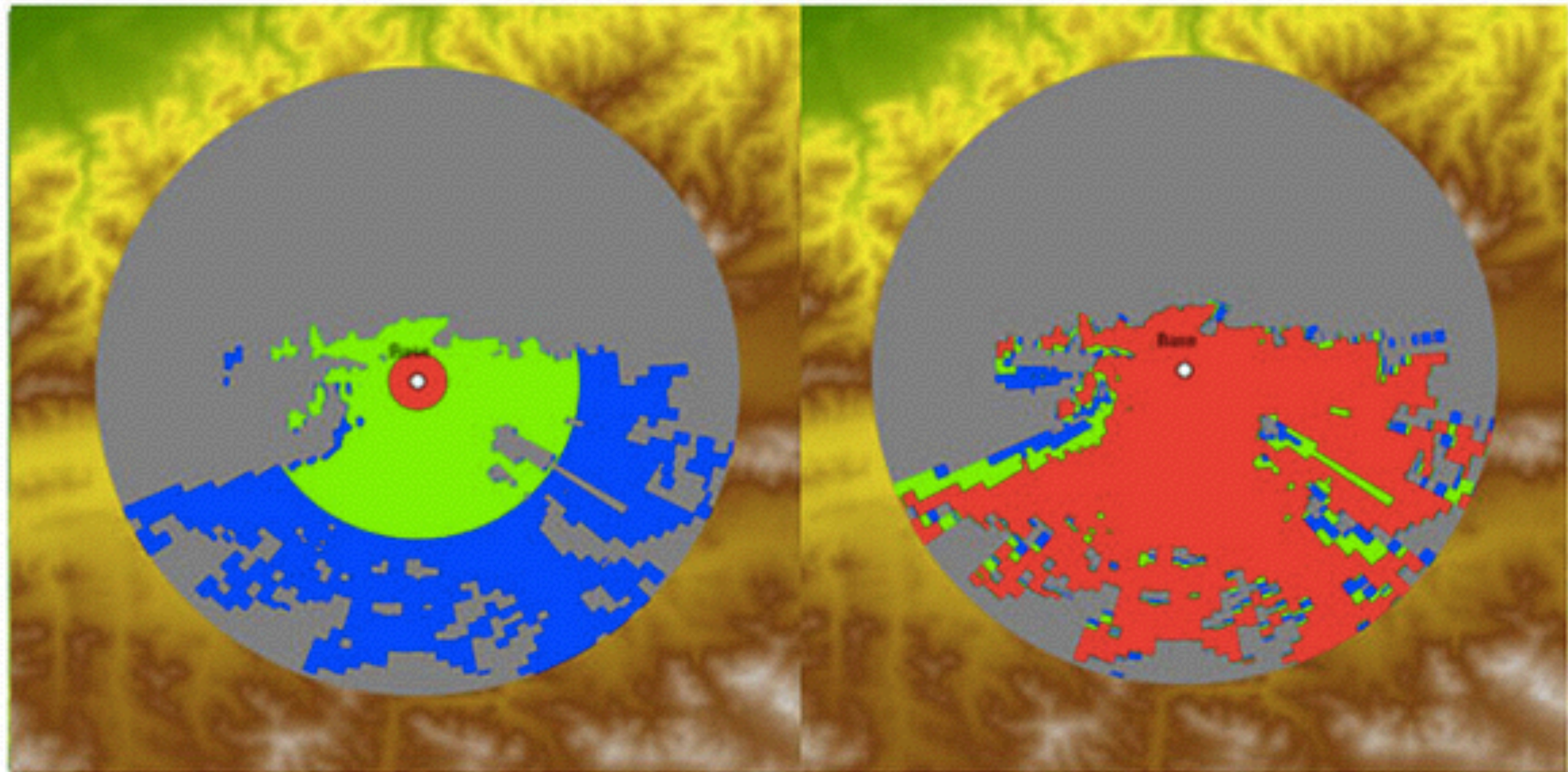
ALLOCATION USAGE DESIGNATION

SERVICE	EXAMPLE	DESCRIPTION
Primary	FIXED	Capital letters
Secondary	Mobile	For Capital with lower case letters

This chart is a graphic representation of the Table of Frequency Allocations and is for informational purposes only. It does not constitute a legal document. For complete information, users should consult the Table of Frequency Allocations. Therefore, for complete information, users should consult the Table of Frequency Allocations.



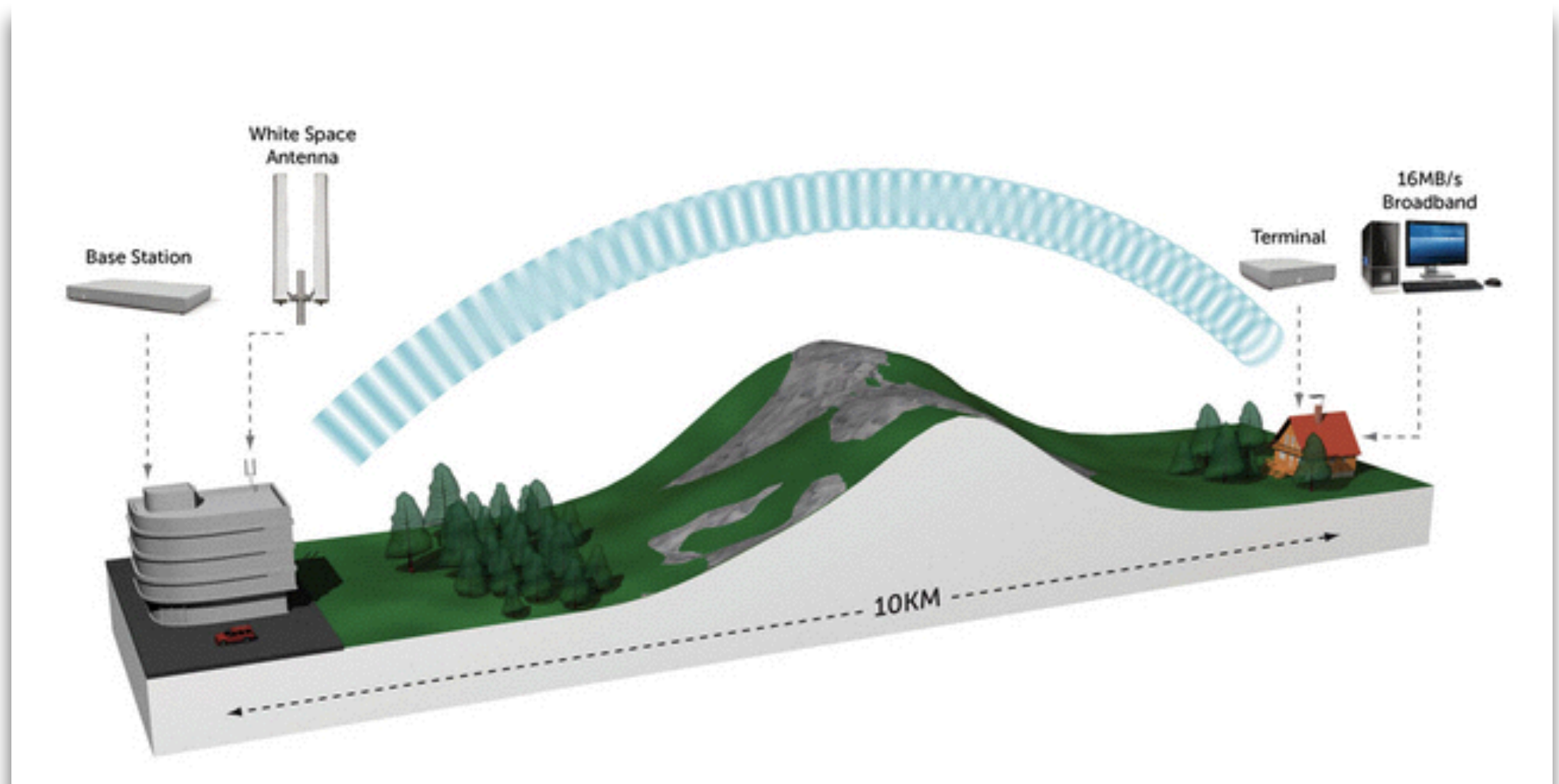
Propagation advantage



Coverage with 5 GHz

Coverage with 470 MHz

TVWS propagation



Lower free space loss
Better diffraction efficiency
Lower building attenuation

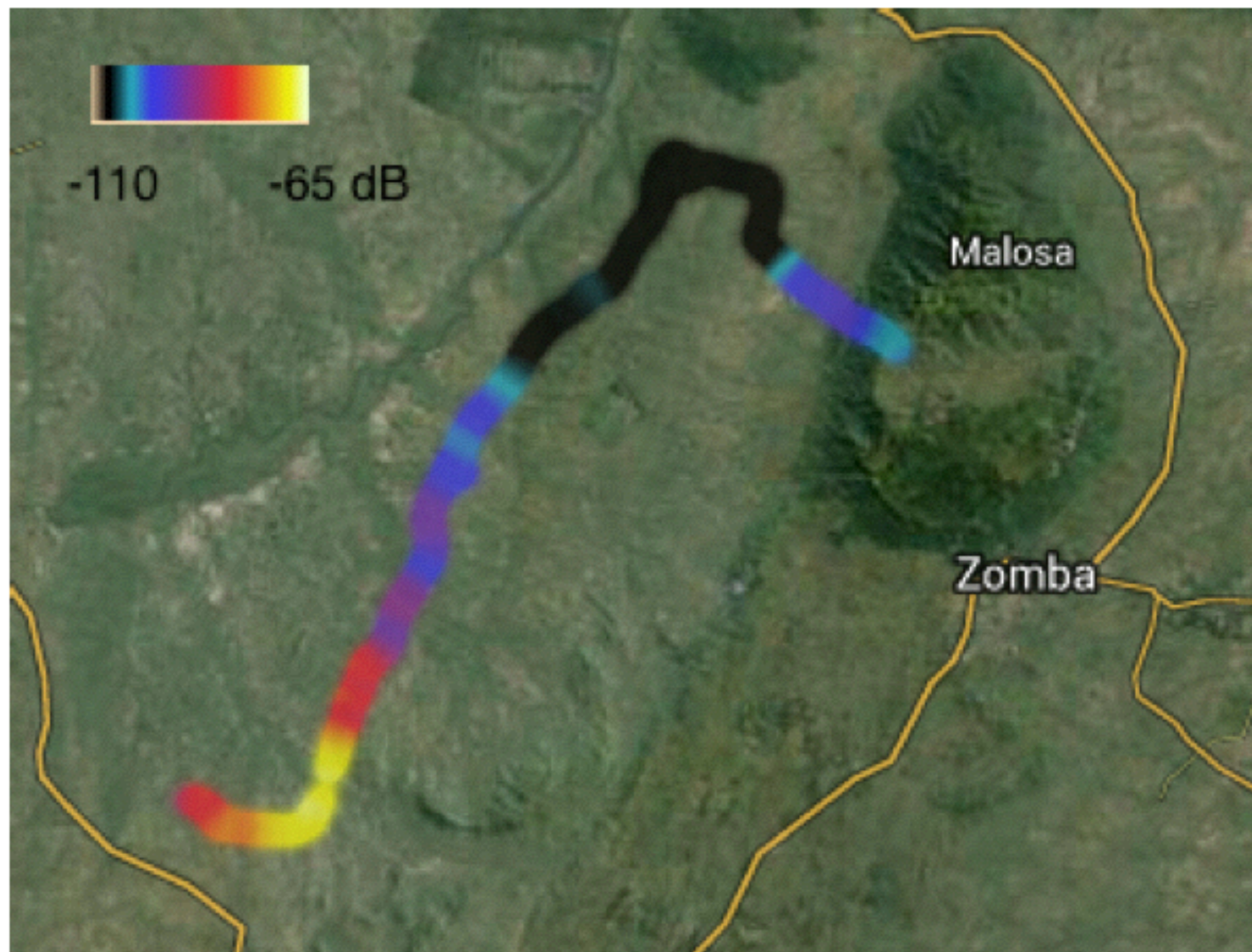
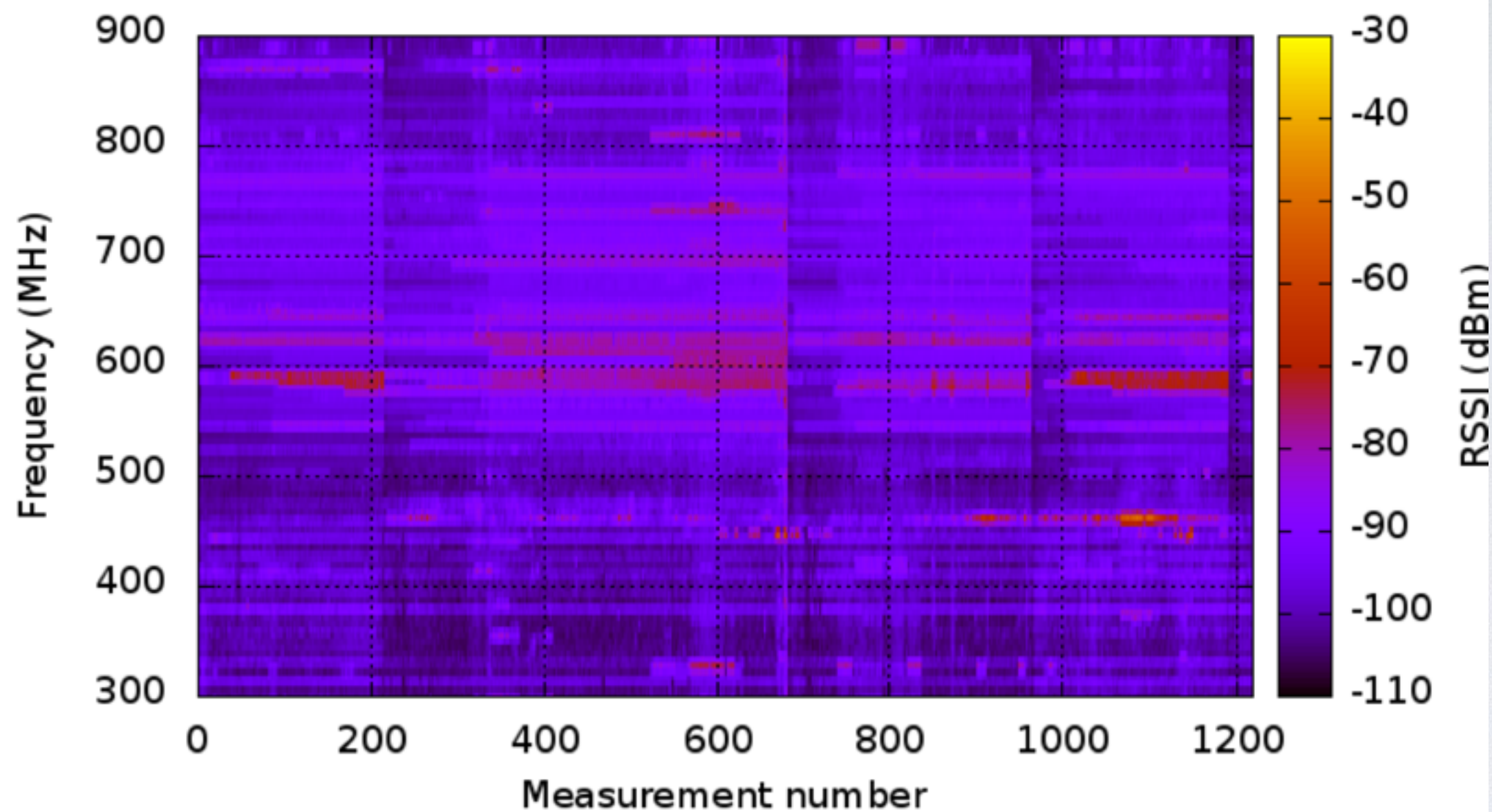


Figure 3: Heatmap for 546 MHz in Malawi.

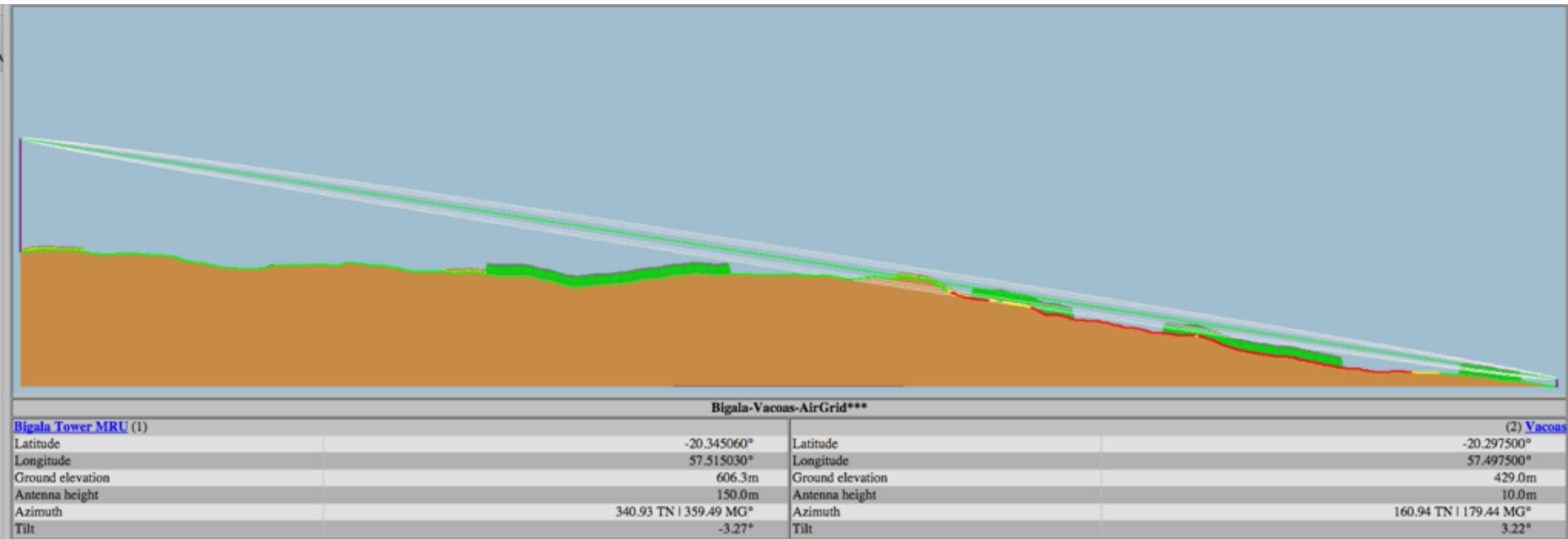
ICTP-UNECA



From 2015-10-23 14:11:09 to 2015-10-23 15:57:04

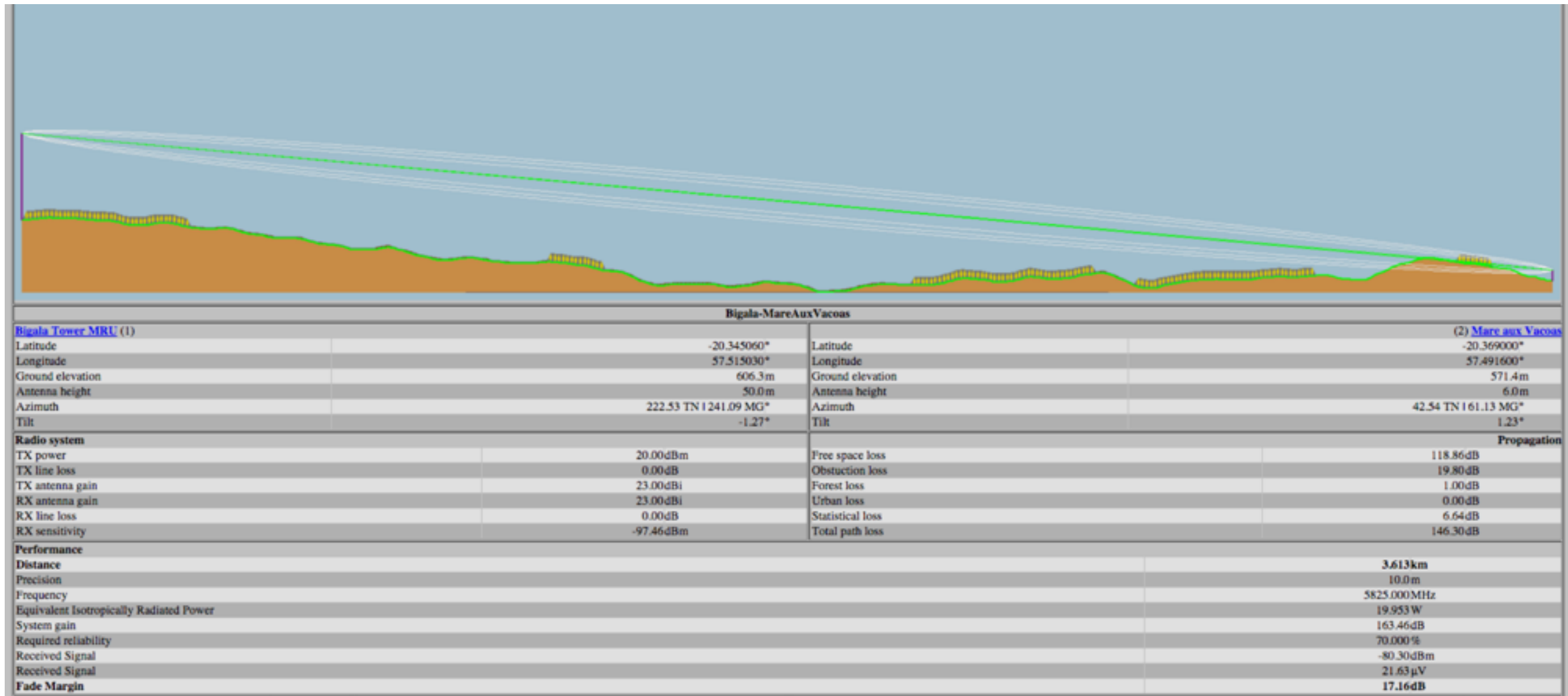


Mauritius Wireless



Simulation of the link between Bigara tower and
MMS at Vacoas

Mauritius Wireless



Simulation of the link between Bigara and Mare Aux Vacoas

Take aways

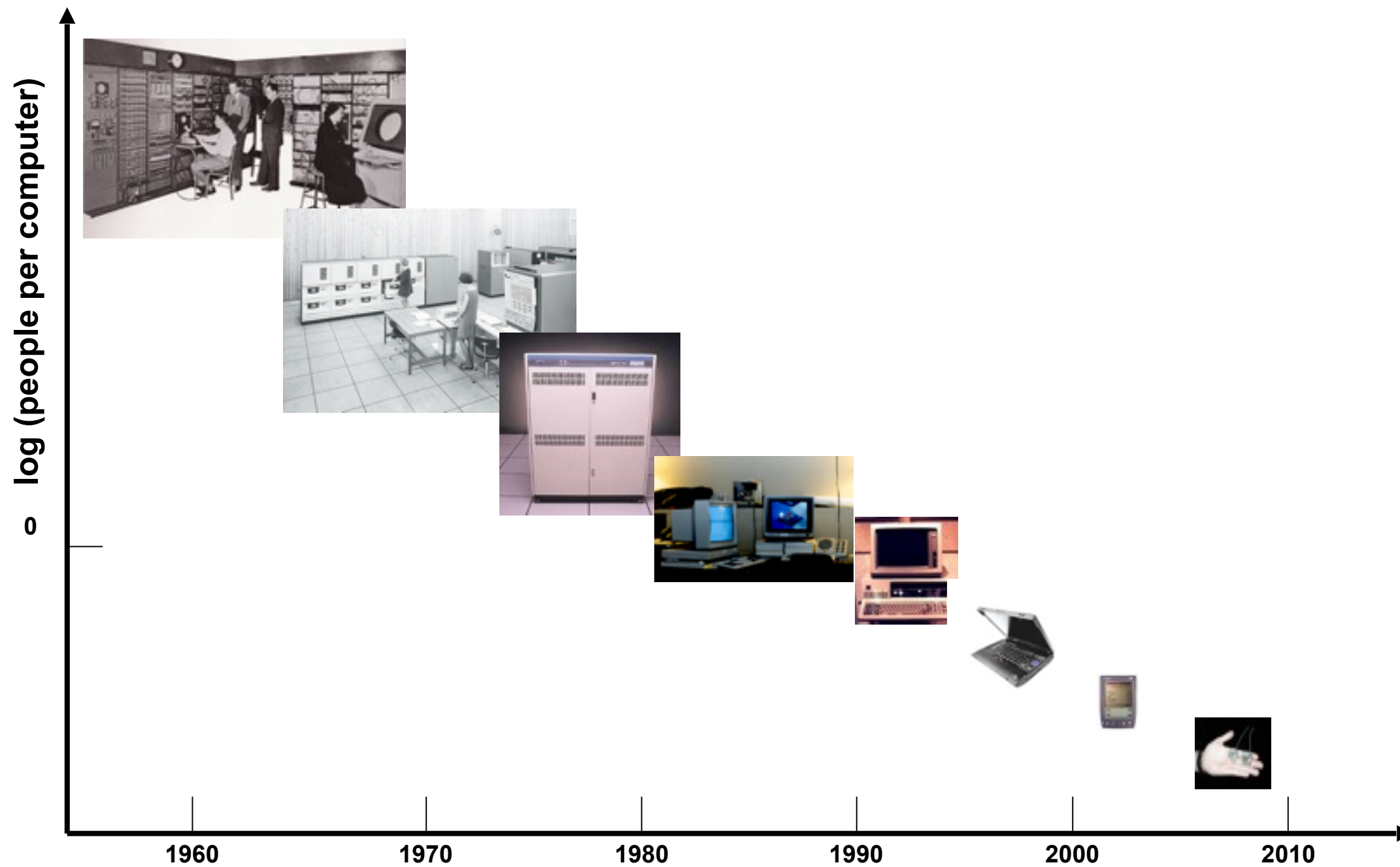
The Marconi Lab of ICTP can help you solve connectivity problems, using low-cost equipment

We carry out collaborative research

Capacity building is **very** important

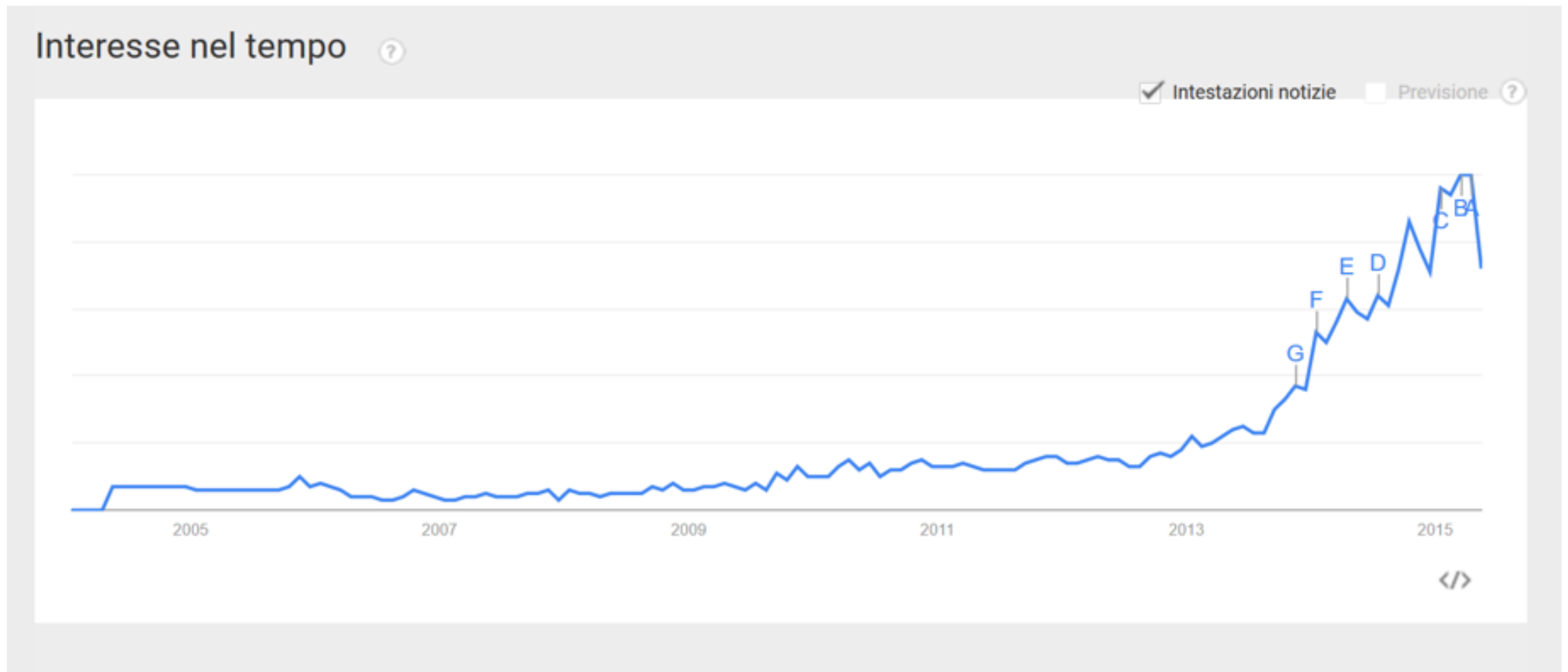
TVWS can be used in some cases

Vision for IoT



[Culler:2004]

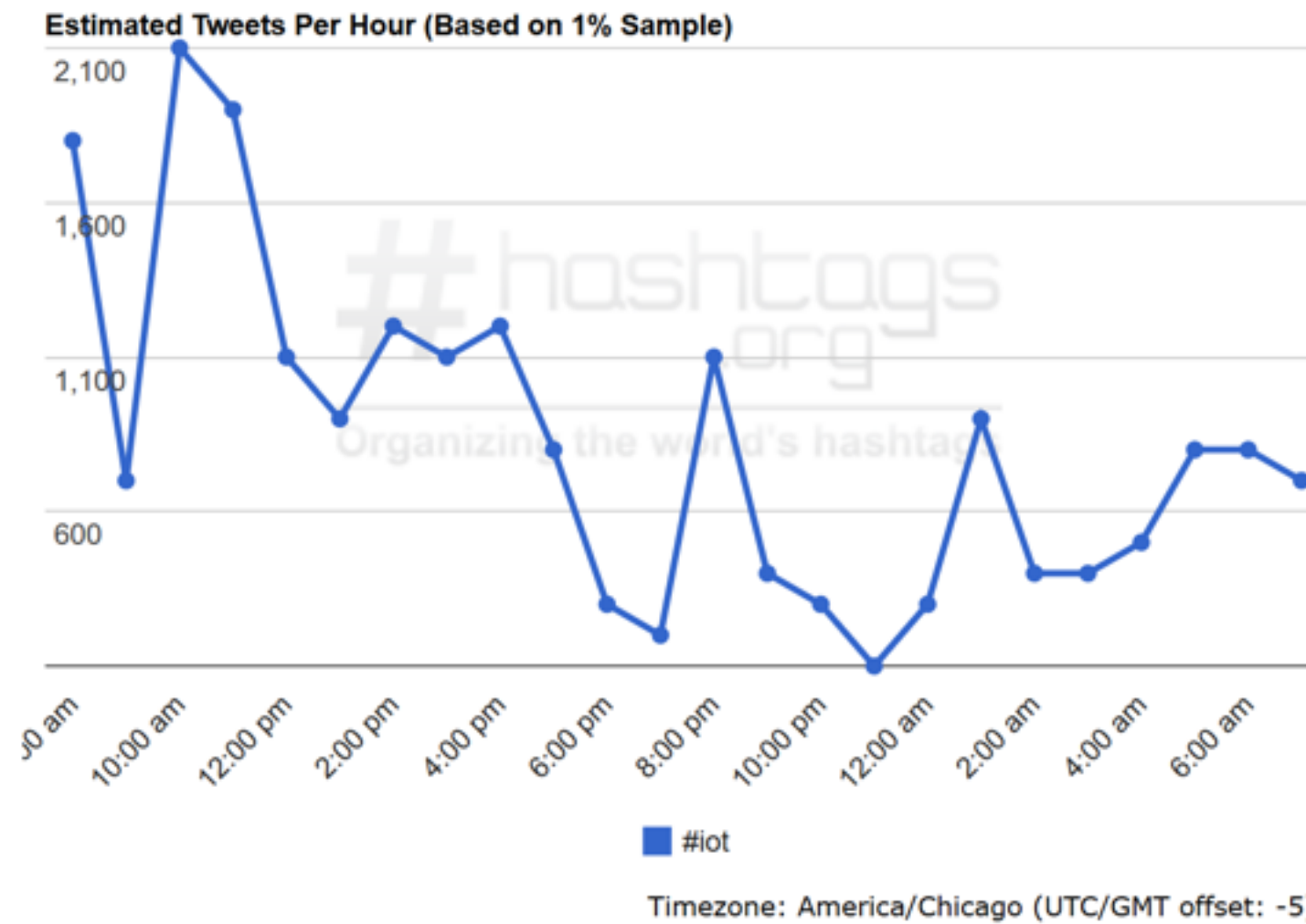
Google Trends for IoT





Twitter #IoT

#iot 24-Hour Trend Graph

[Upgrade Analytics](#)



Connected Devices



In 2014 nearly **2 billion** connected devices will be shipped

This number will grow to nearly **8 billion** devices for the year 2020

**Not including mobile phones*

Home (Consumer)

3,745.71 (Devices millions)

Transport (Mobility)

392.72 (Devices millions)

Body (Health)

360.03 (Devices millions)

Buildings (Infrastructure)

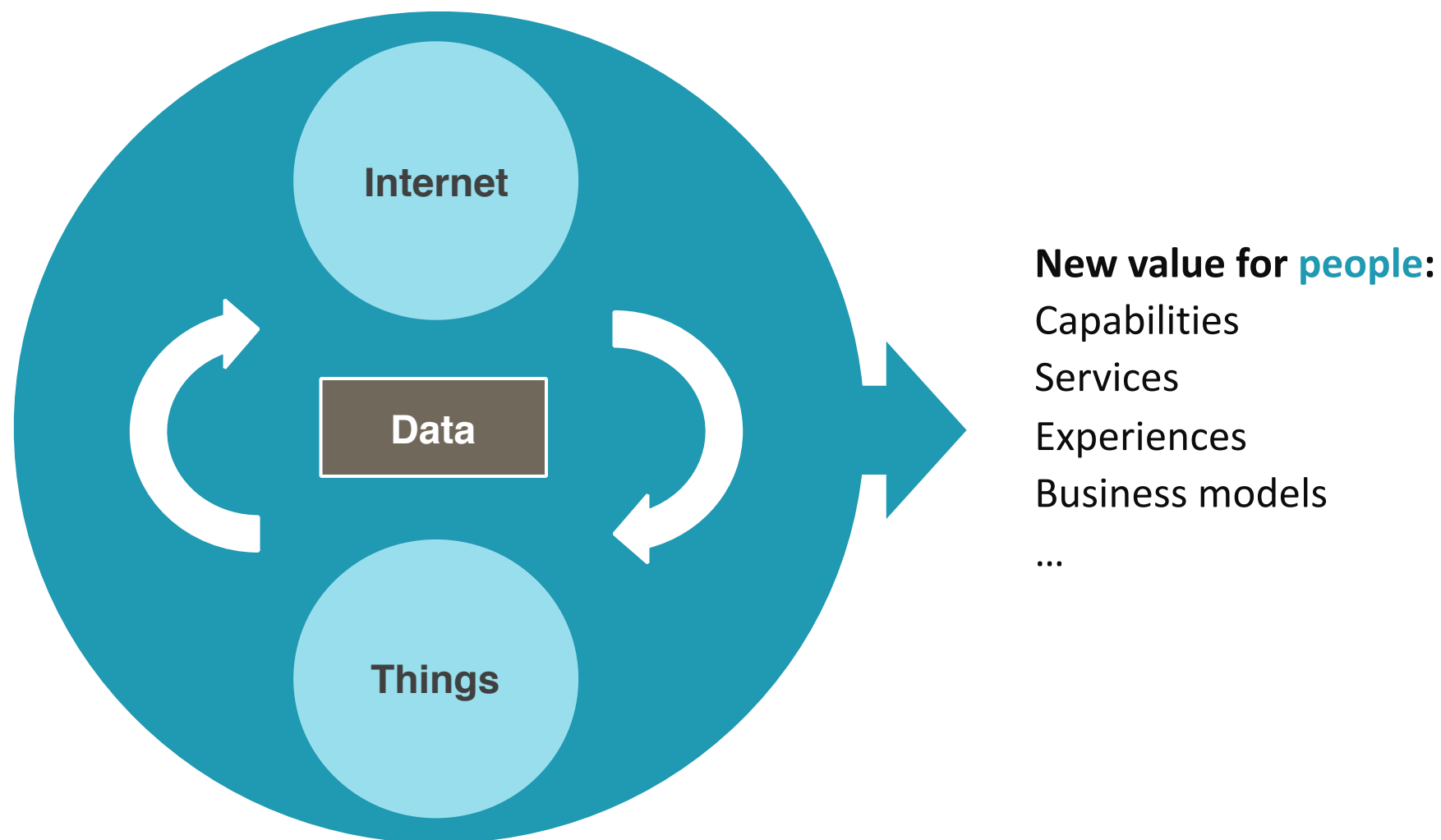
1,726.59 (Devices millions)

Cities (Industry)

1,524.70 (Devices millions)

What is IoT

- The IoT is more than connecting things to the internet, it's about bridging the physical and digital worlds **to create value for people**



What is IoT ?

Internet + **Things** + Data

Things

These **nodes** are highly constrained in terms of

Physical size

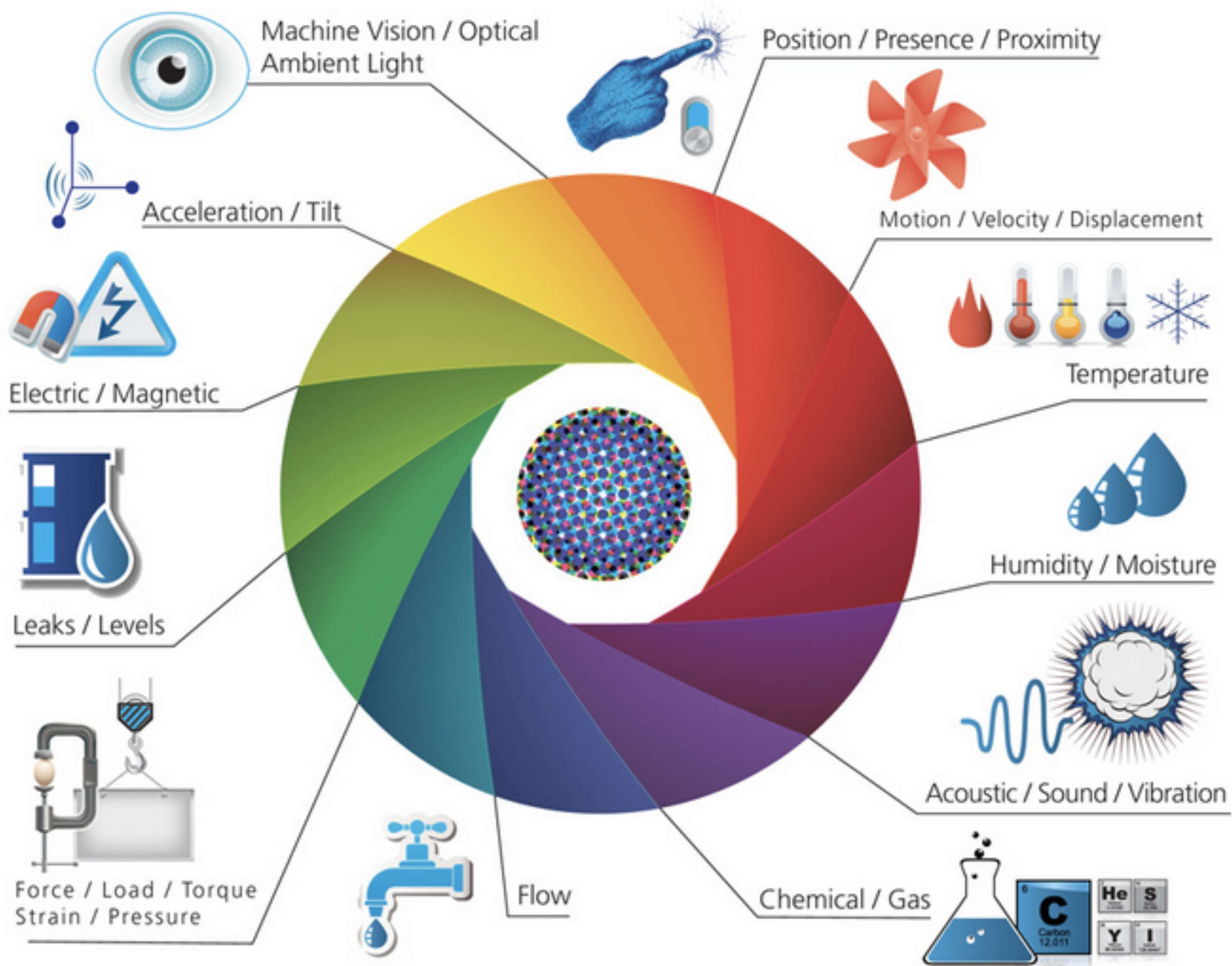
CPU power

Memory (few tens of kilobytes)

Bandwidth (Maximum of 250 KB/s, lower rates the norm)

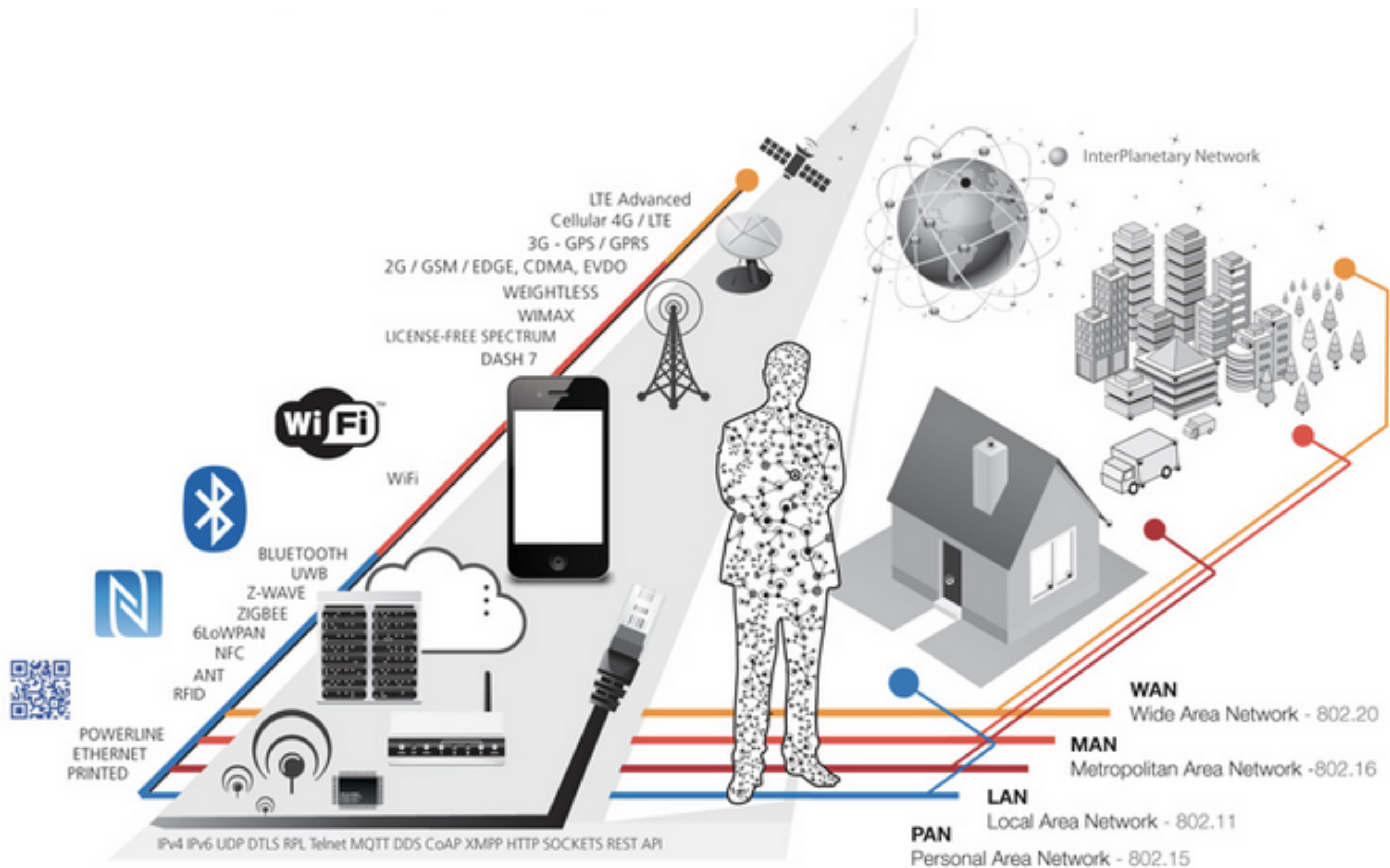
Power consumption is critical, if battery powered then energy efficiency is paramount





What is IoT ?

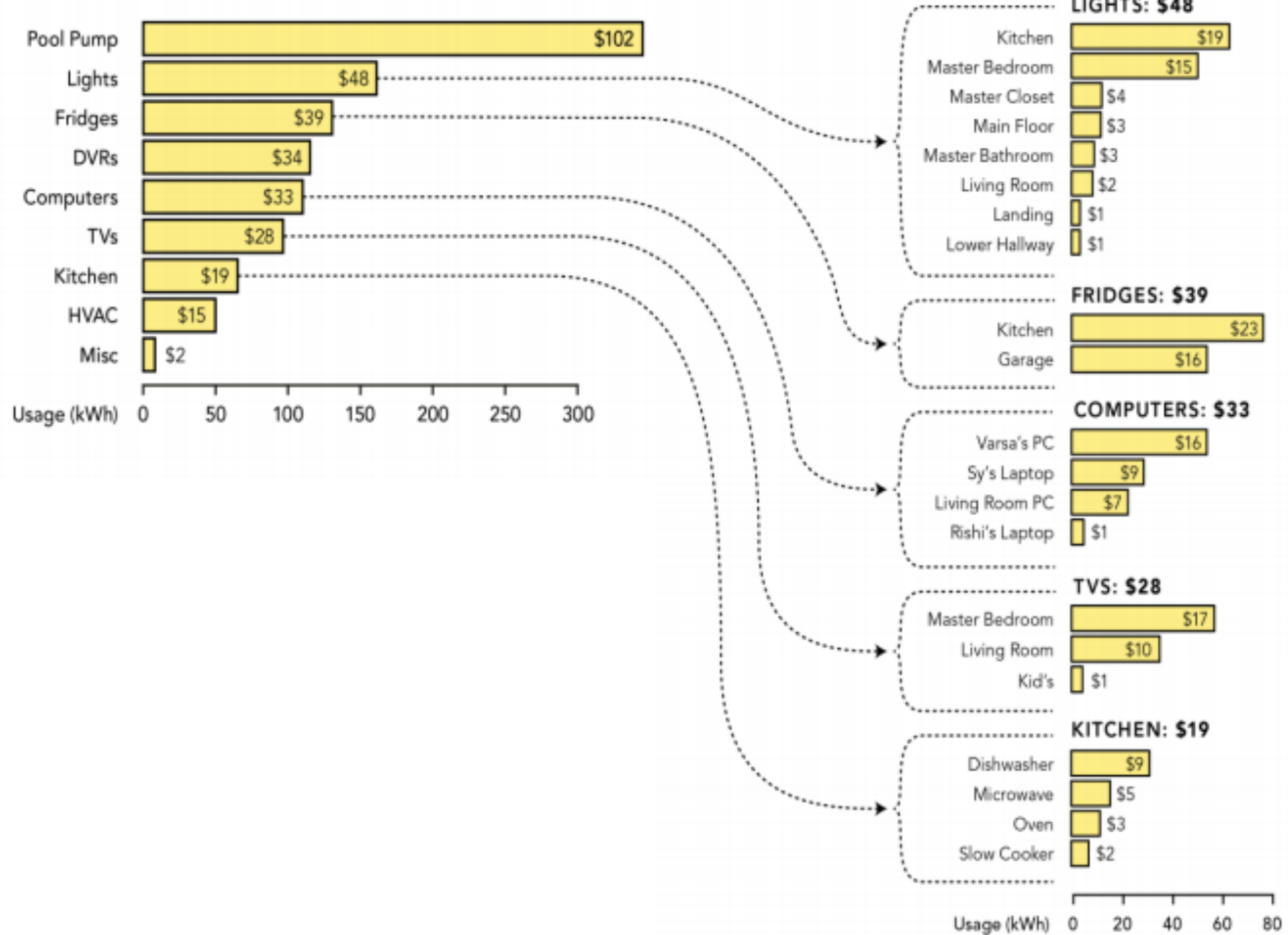
Internet + Things + Data



What is IoT ?

Internet + Things + **Data**

ELECTRICITY: \$319



These **things** are starting to talk to each other and develop their own intelligence. Imagine a scenario where.....

This is communicated to your **alarm clock**, which allows you 5 extra minutes of sleep.



...your **meeting** was pushed back 45 minutes.



...your **car** knows it will need gas to make it to the train station. Fill-ups usually take 5 minutes.



...there was an accident on your **driving route** causing a 15 minute detour.



...your **train** is running 20 minutes behind schedule.



And signals your **car** to start in 5 minutes to melt the ice accumulated in overnight snow storms.



And signals your **coffee maker** to turn on 5 minutes late as well.

What does that mean in size?

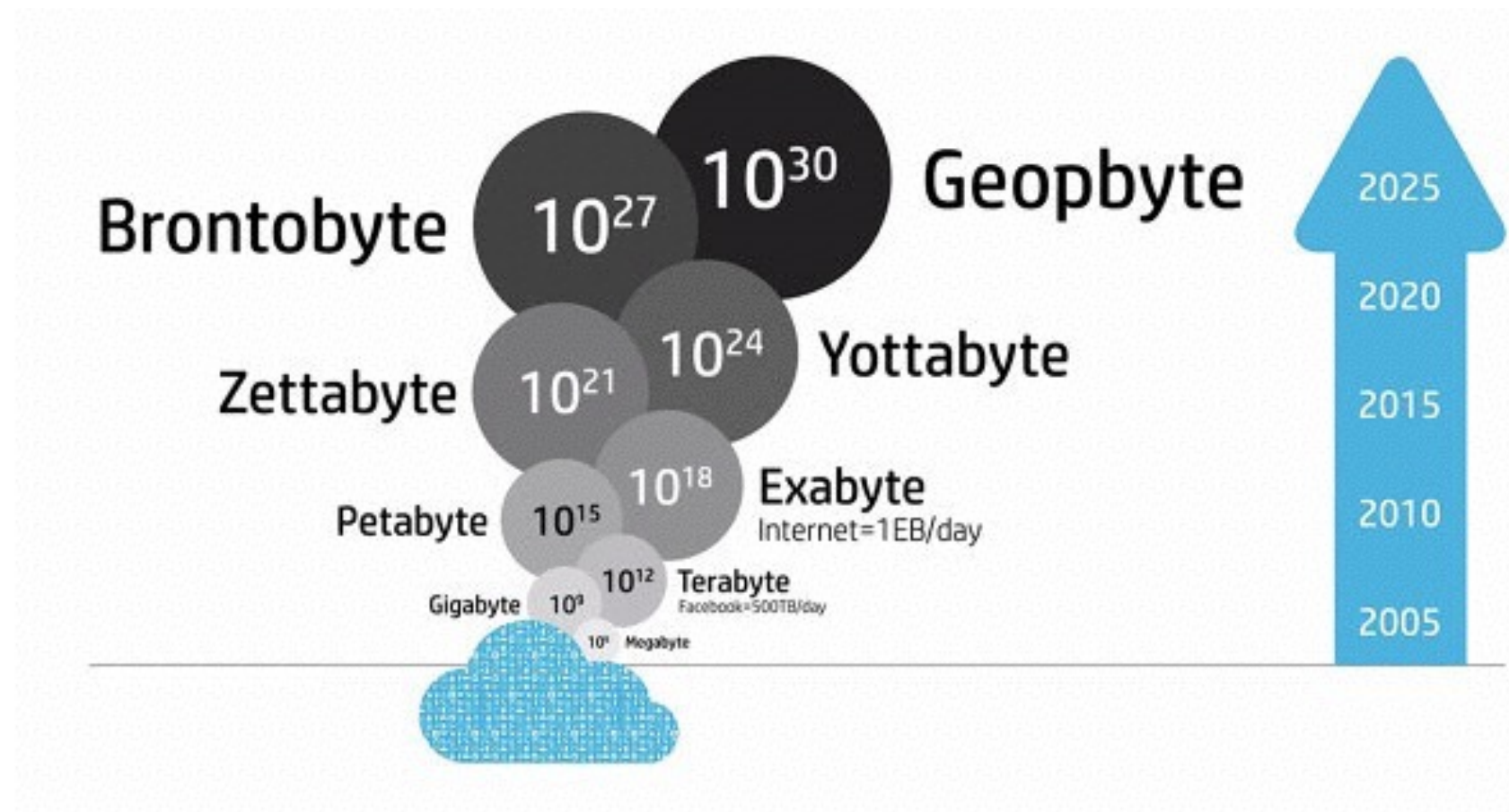
Not gigabytes

Most likely not a few terabytes

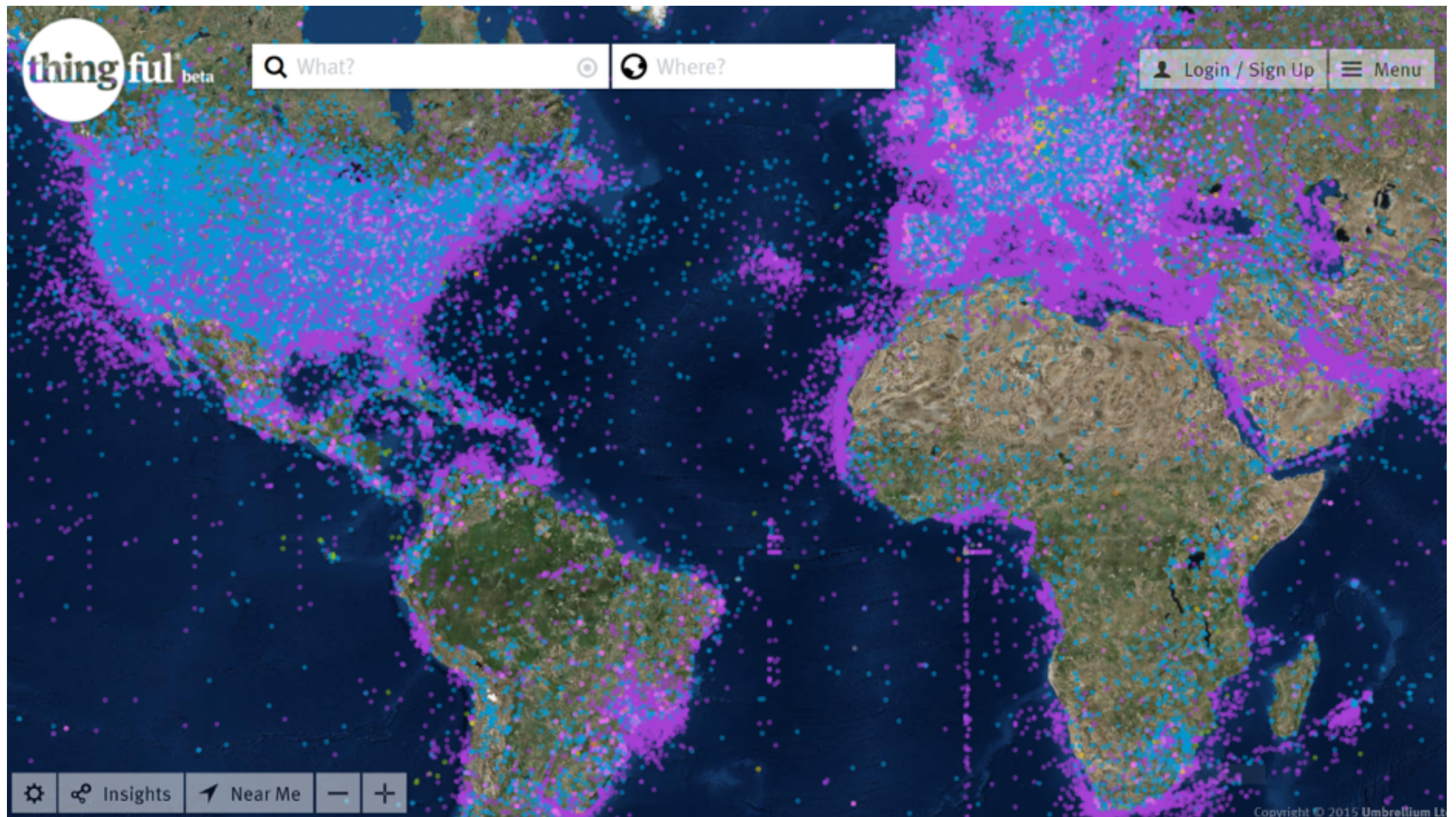
Possibly not 10's of terabytes

Probably 100's of terabytes

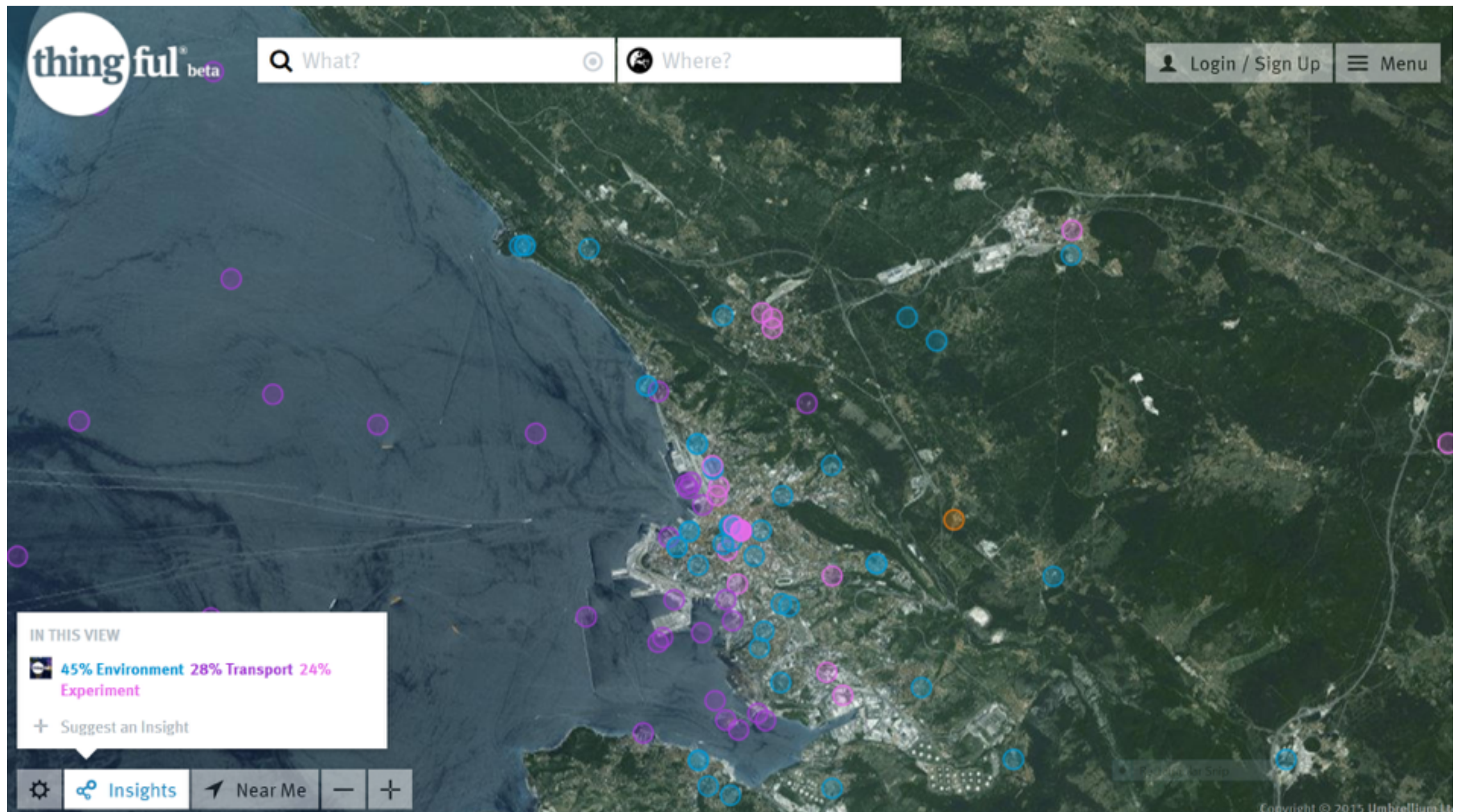
Definitely petabytes



IoT4D



IoT - Trieste



IoT4D - weather

In **Africa**, one WMO weather station covers an area of 27,347 km².

Altogether, there are **1,108 WMO weather stations** on the continent.

In **Germany**, the covered area per WMO weather station is 1,244 km².

There are **287 WMO weather stations** operated in Germany.

IoT4D

Local conditions drive IoT4D applications:

- Unreliable power supply → low power systems
- Slow internet connectivity → local storage
- Illiterate final users → voice, fm solutions
- No Internet connection → gsm-based IoT

Training in IoT

Workshops in Africa: South Africa, Kenya, Ghana, Benin, Rwanda

Workshop in Trieste

Workshops in Latin America: Panama, Nicaragua, Costa Rica

Workshops in Asia: Thailand, India, Japan, Indonesia



IoT4D – Weather stations in Kenya



IoT4D – Radiation sensors in Indonesia



IoT4D – Air quality sensors in Benin



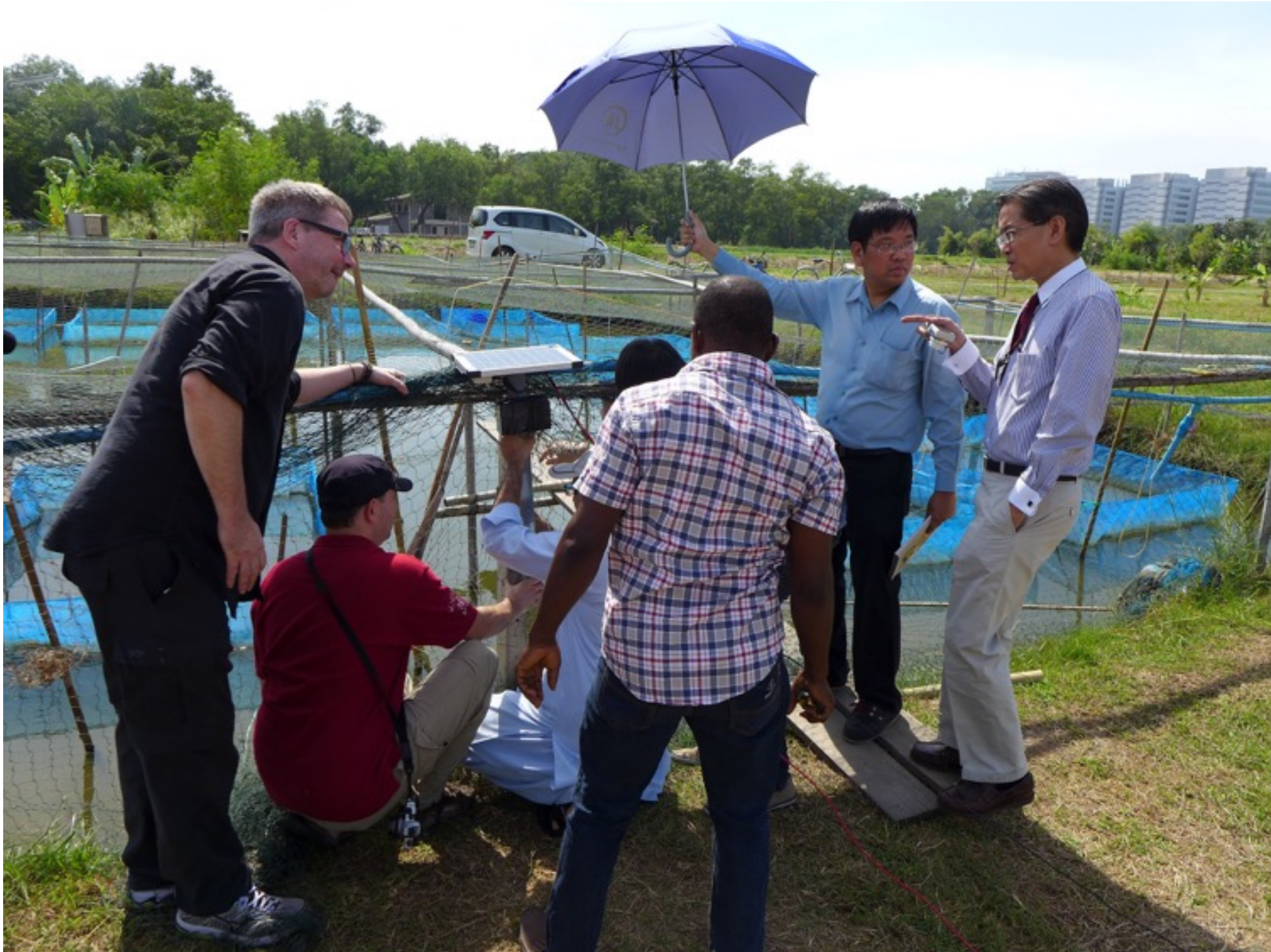
IoT4D– Air quality sensors in Benin



IoT4D – IoT Living Lab in Thailand



IoT4D – IoT Living Lab in Thailand



Economic impact

BIG DATA

IBM Scores Weather Data Deal and Starts Internet of Things Unit

By STEVE LOHR MARCH 31, 2015 12:01 AM 10 Comments

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Share

Tweet

Save

More



Analyzing weather data and energy consumption can **keep the lights on.** Energy and utility companies say weather causes

70% of power outages.*

*Source: Climate Central, April 10 2014, data from 2003-2012



ibm.com/ibmandweather



IBM announced a partnership with the Weather Company, whose data powers weather apps for Apple, Google, Microsoft and others.

Data partnerships are a key ingredient in IBM's long-term strategy, and the company is announcing a big one on Tuesday with the [Weather Company](#).

For IBM, the deal represents another close link with a leading data supplier for special access and joint development. Last fall, it forged a [similar arrangement with Twitter](#), the social network, whose tweets of 140 characters or fewer are a global wellspring of

Economic impact

**A developed Internet of Things in Kenya
will enable a 25 percent economic growth**

Written by [Odipo Riaga](#) ✓



89
SHARES



ODIPO RIAGA
6 days ago

Posted: April 30,
2015 at 8:50 pm

Social impact



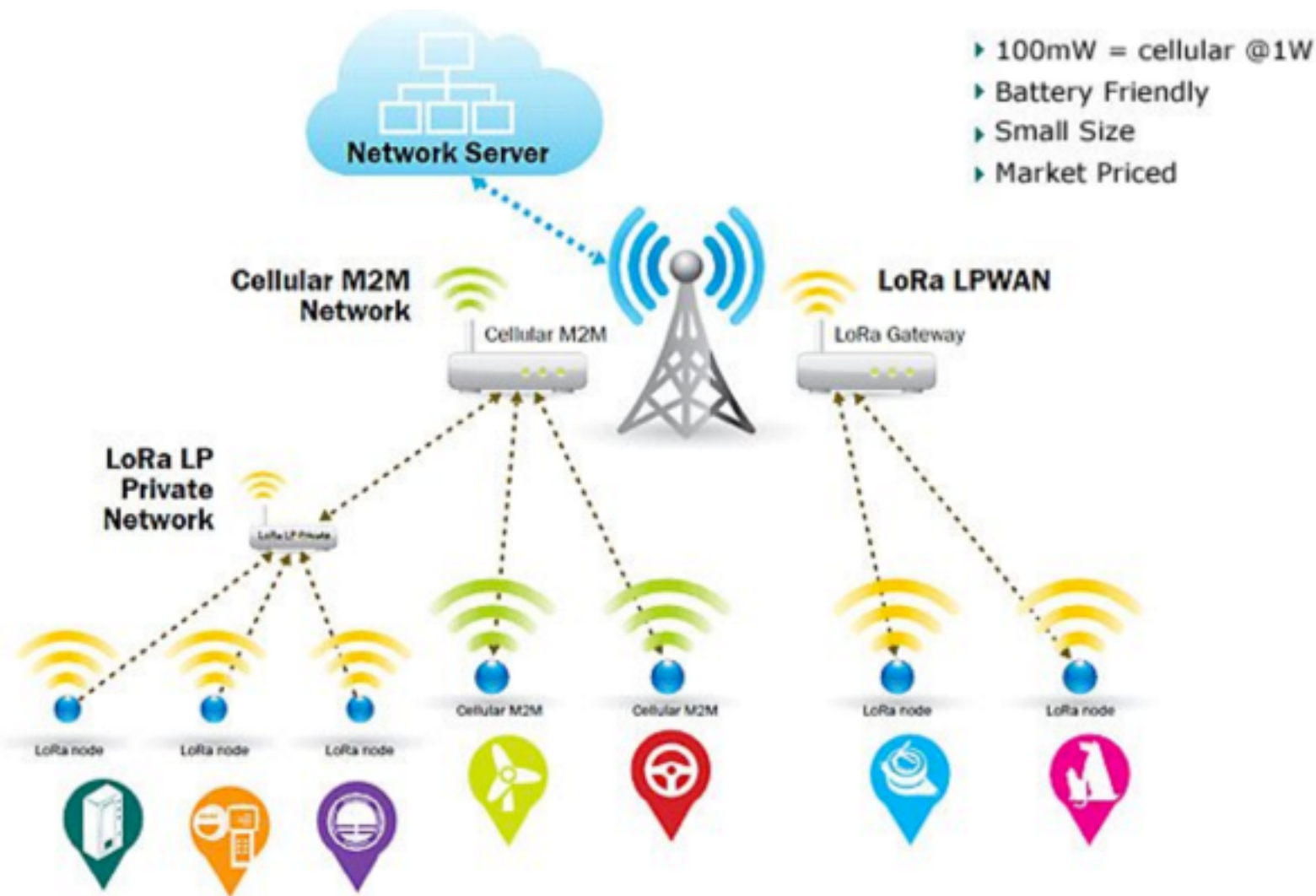
Take aways

IoT is here to stay!

The ICTP Marconi Lab has been working on IoT since 2004

We want to collaborate in IoT deployments

Weather is the most interesting application



How LoRa Works

Semtech's LoRa chips transmit in the sub-gigahertz spectrum (109MHz, 433MHz, 866MHz, 915MHz), which is an unlicensed band that has less interference than others (like the 2.4 GHz range used by Wi-Fi, Bluetooth, and other protocols). At those frequencies, signals penetrate obstacles and travel long distances while drawing relatively little power -- ideal for many IoT devices, which are often constrained by battery life.

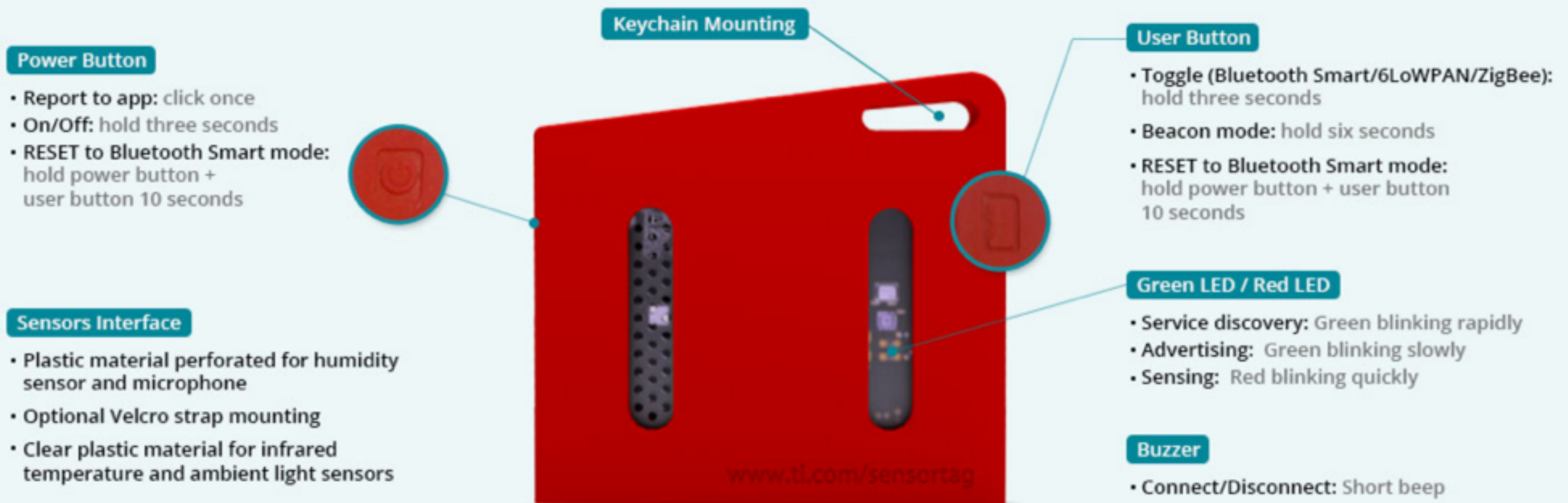
Small rain and precipitation sensor



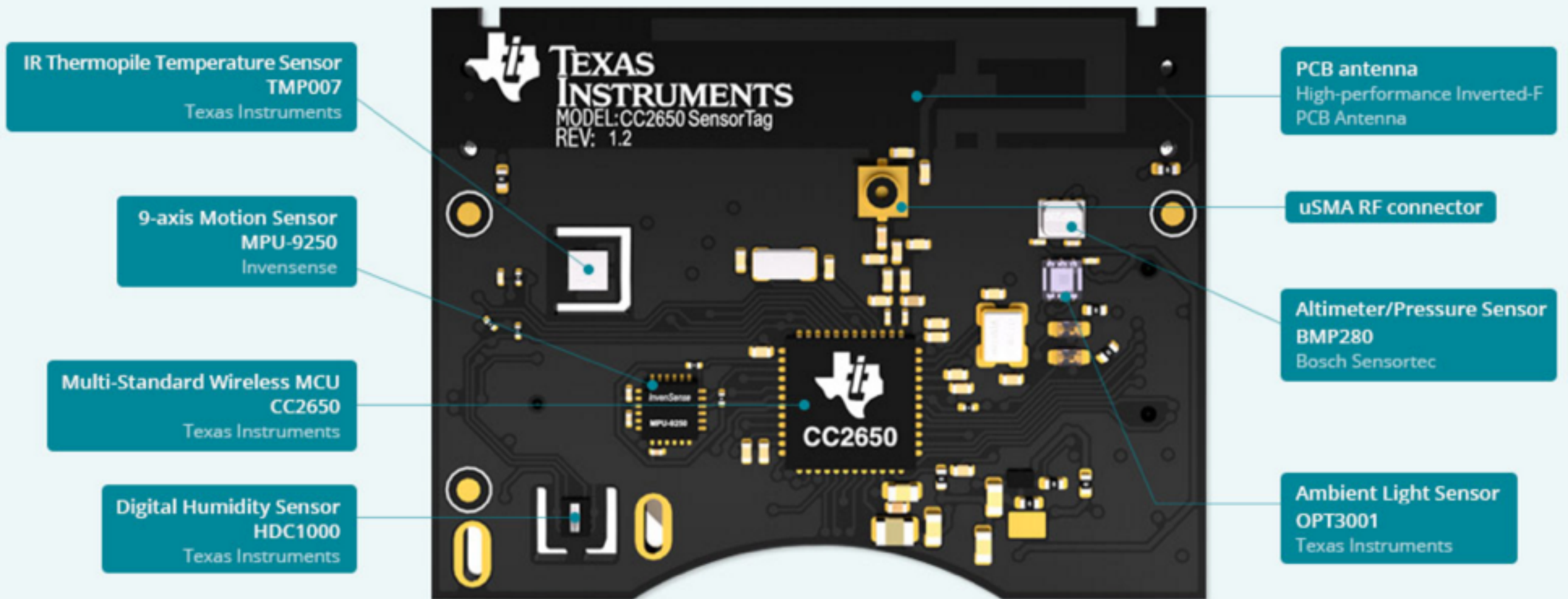
Rain-O-Matic Small rain and precipitation sensor with our patented self-emptying tipping bucket is a reliable low cost high quality rain gauge ideal for small weather stations, irrigation and consumer purposes.

For 30 years we have supplied more than 210.000 rain gauges to 41 countries on 5 continents and we deliver our products to OEM customers only and we are not competing with you for the end user. [Download datasheet here.](#)

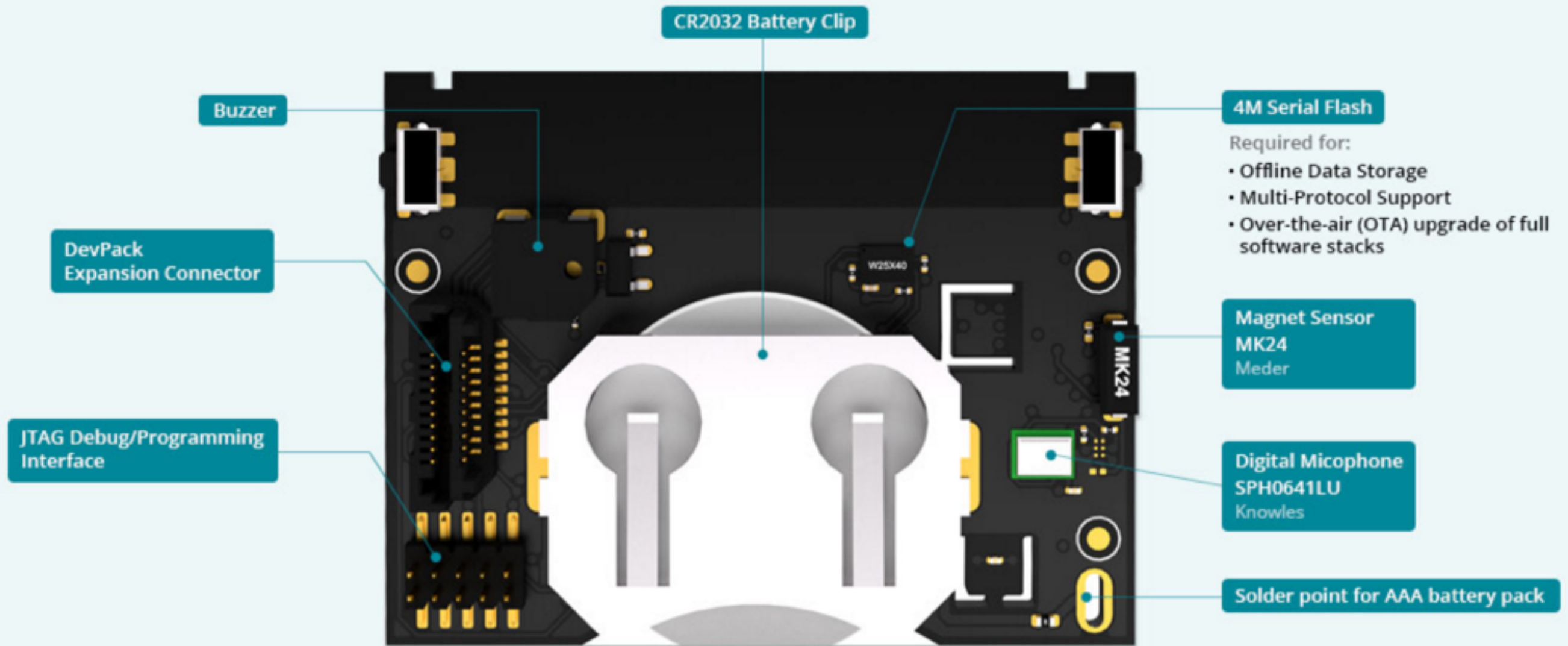
TI SensorTag



TI SensorTag



TI SensorTag



Thank you!

Marco Zennaro, PhD
Telecommunication/ICT4D Lab
The Abdus Salam International Centre
for Theoretical Physics
mzennaro@ictp.it