# Changes & Challenges

Ofcom

Changes & Challenges

# Agenda – Day 2

| | |
|---|---|
| 09:30 – 10:00 | Full Duplex radios: From impossibility to practice |
| 10:00 – 11:00 | Coverage and capacity – The mobile data challenge |
| 11:00 – 11:15 | Coffee break & technical demonstrations |
| 11:15 – 12:30 | The future of content delivery |
| 12:30 – 13:30 | Networking lunch and technical demonstrations |
| 13:30 – 14:00 | Keynote: World Radio Conference 2015 |
| 14:00 – 15:15 | Internet of Things |
| 15:15 – 15:30 | Coffee break and technical demonstrations |
| 15:30 – 16:45 | Public sector spectrum release |
| 16:45 – 17:00 | Conclusion and close |

Ofcom

The Institution of Engineering and Technology

Essential Engineering Intelligence

Ofcom

# FUTURE TECHNOLOGIES & SPECTRUM

The Institute of Engineering and Technology together with Ofcom will hold a one day event, early in 2015 to explore with technologists, spectrum users and researchers, the implications of future technologies, including 5G, for spectrum management.

**EVENT DATE TBC EARLY 2015**

~~16-12-14~~

**The event will be by invitation only - you can register your interest by sending your details to the event mailbox - spectrum.event@ofcom.org.uk**

# FULL DUPLEX RADIOS FROM IMPOSSIBILITY TO PRACTICE

Joel Brand, Vice President, Product Management

Changes & Challenges


Full-Duplex Revolution

# Kumu Networks

*Challenging the basic assumptions of wireless networking*

## Invented In-Band Full Duplex Radios

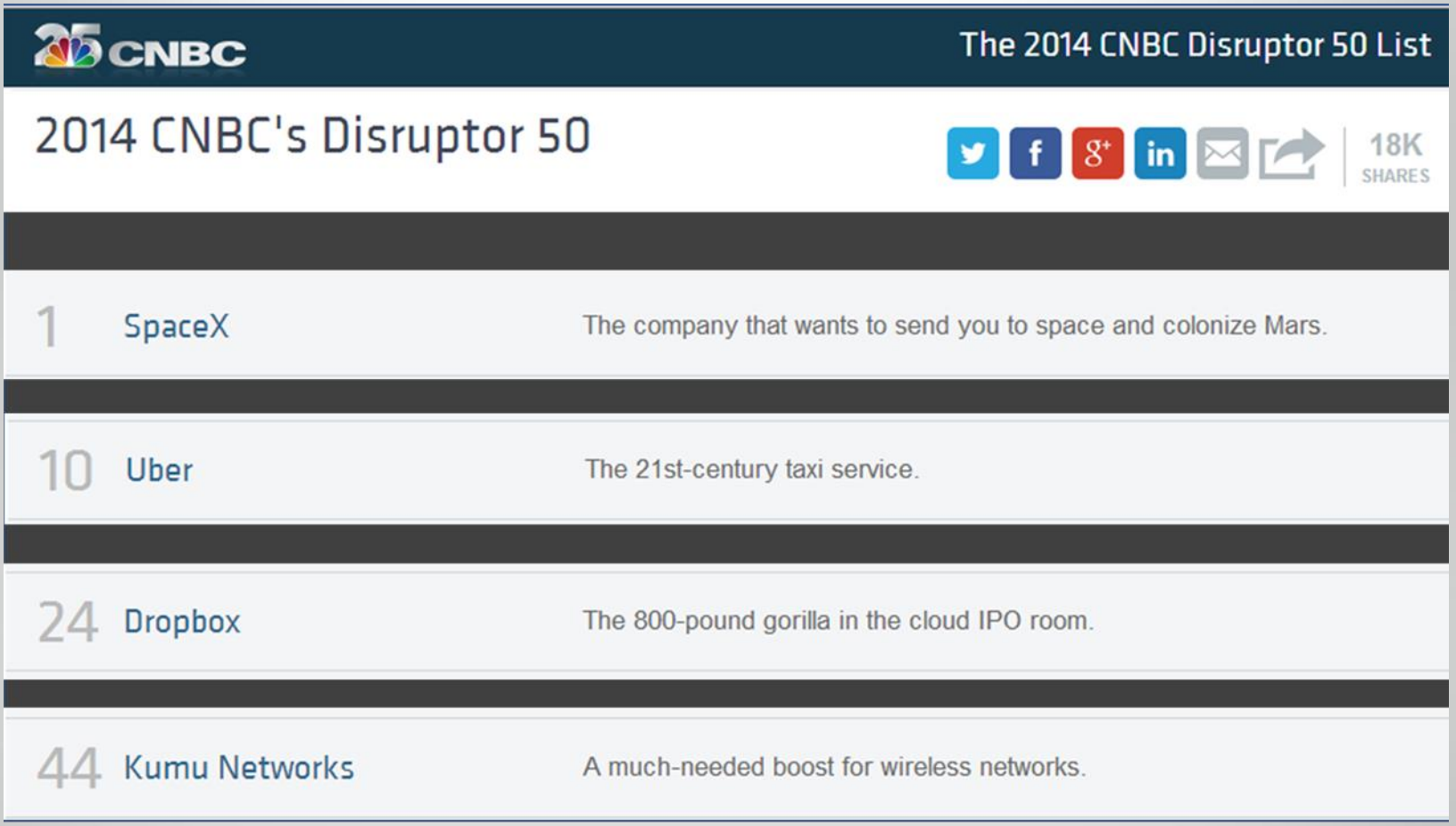
- Full Duplex Breaks a Fundamental Assumption in Wireless
- Best Paper & Demo Awards at SIGCOMM 2012 and MOBICOM 2010
- Rich Patent Portfolio
- Candidate for Next Generation Wireless Standards

## Executive Team and Investors

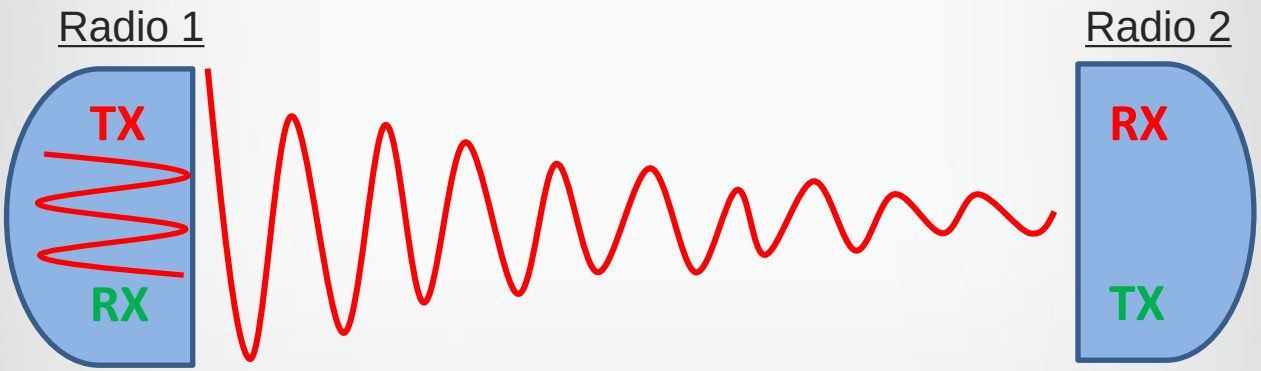
- Two Stanford EE & CS faculty and four Stanford EE PhDs
- Augmented with industry veterans
- Top-tier investors:

NEA khosla ventures THIRD POINT

# Disruption is in the air

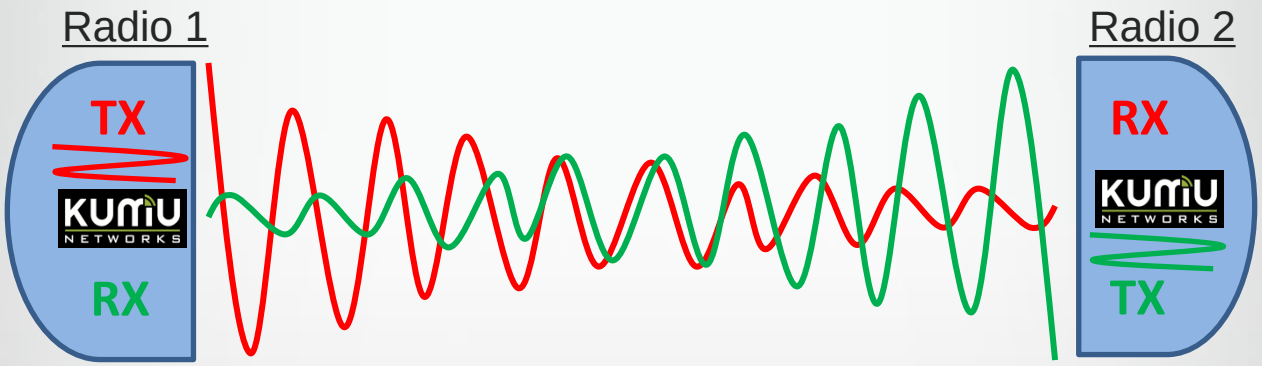


# Radios today cannot transmit and receive at the same time on the same channel




Self-Interference is billions of times stronger than the received signal

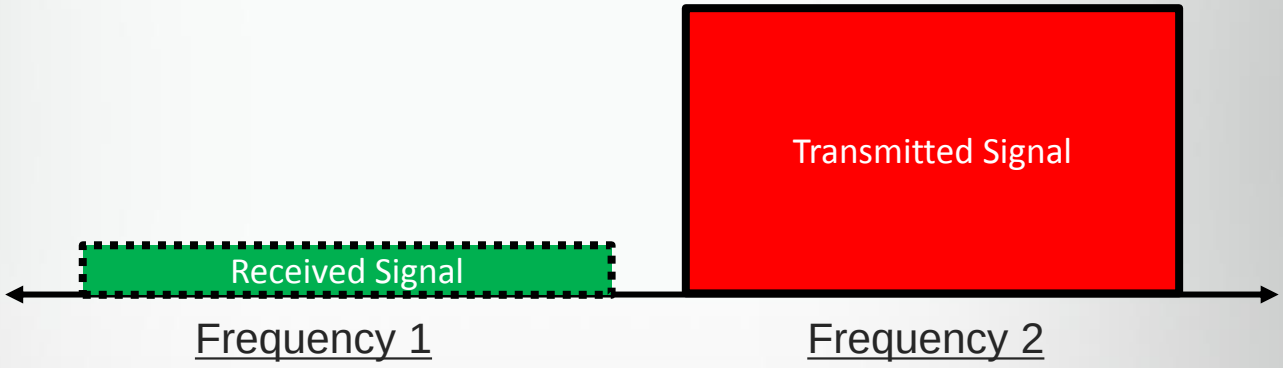
# Kumu Radios can transmit and receive on the same channel!



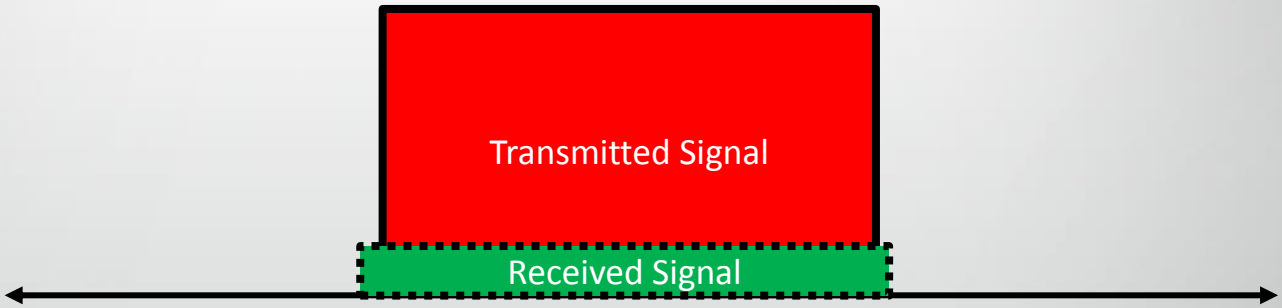

Kumu has developed a patented self-interference cancellation technology which isolates the receiver from the transmitter

# Self-Interference Cancellation enables full-duplex, doubles spectral efficiency

***FDD requires paired frequencies***



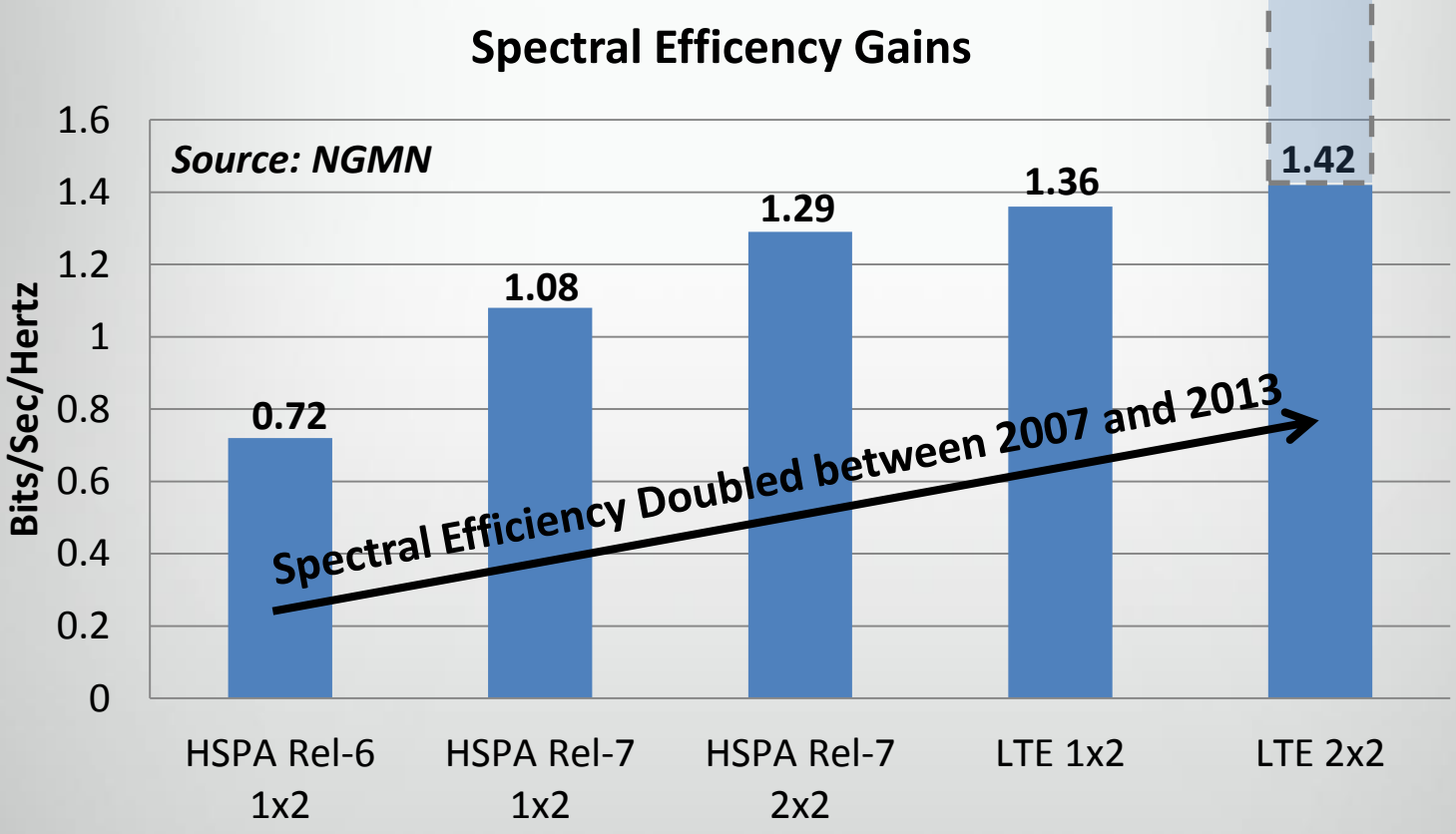

***Full-duplex uses single frequency for same performance***

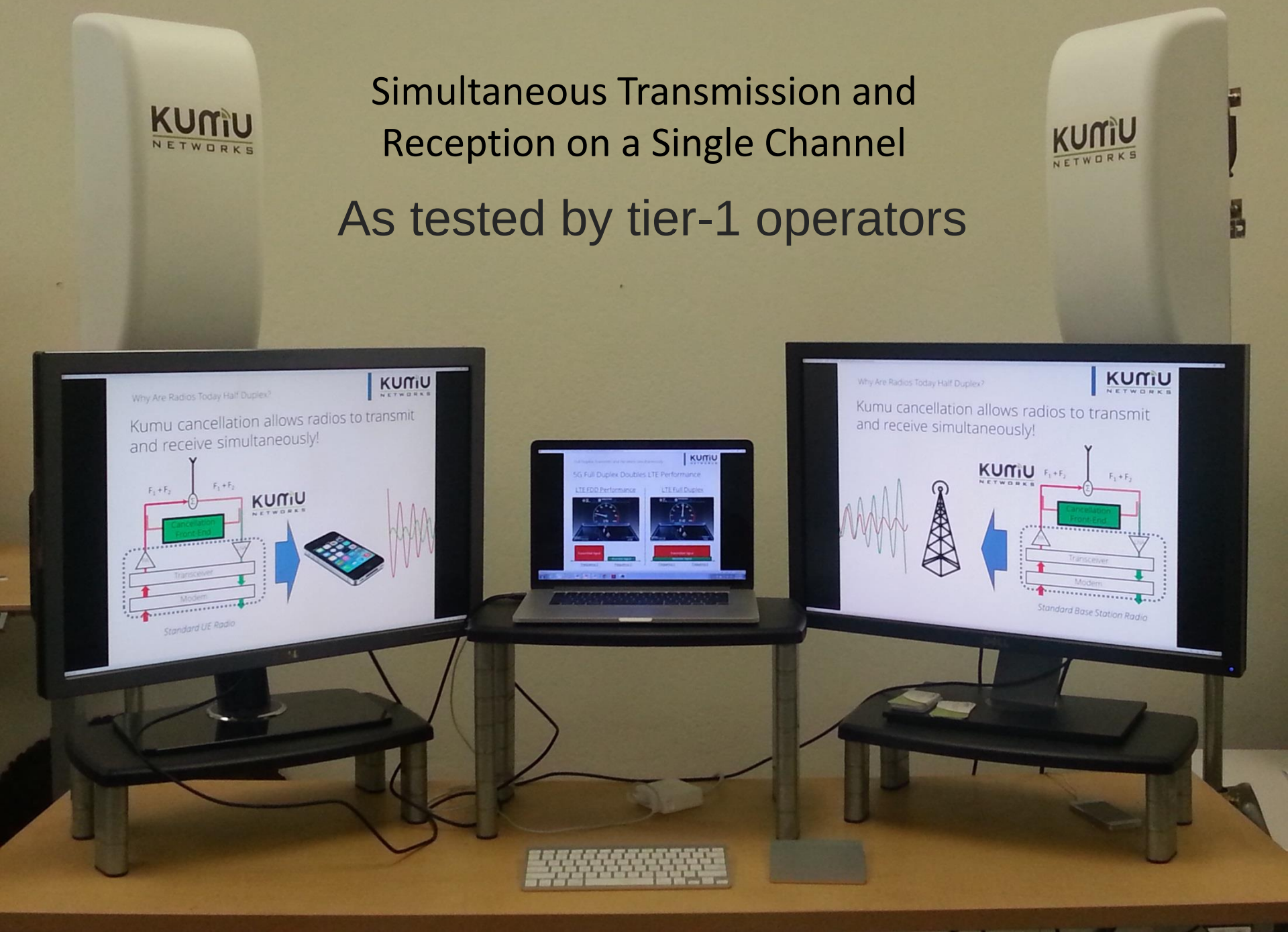


KUMU NETWORKS

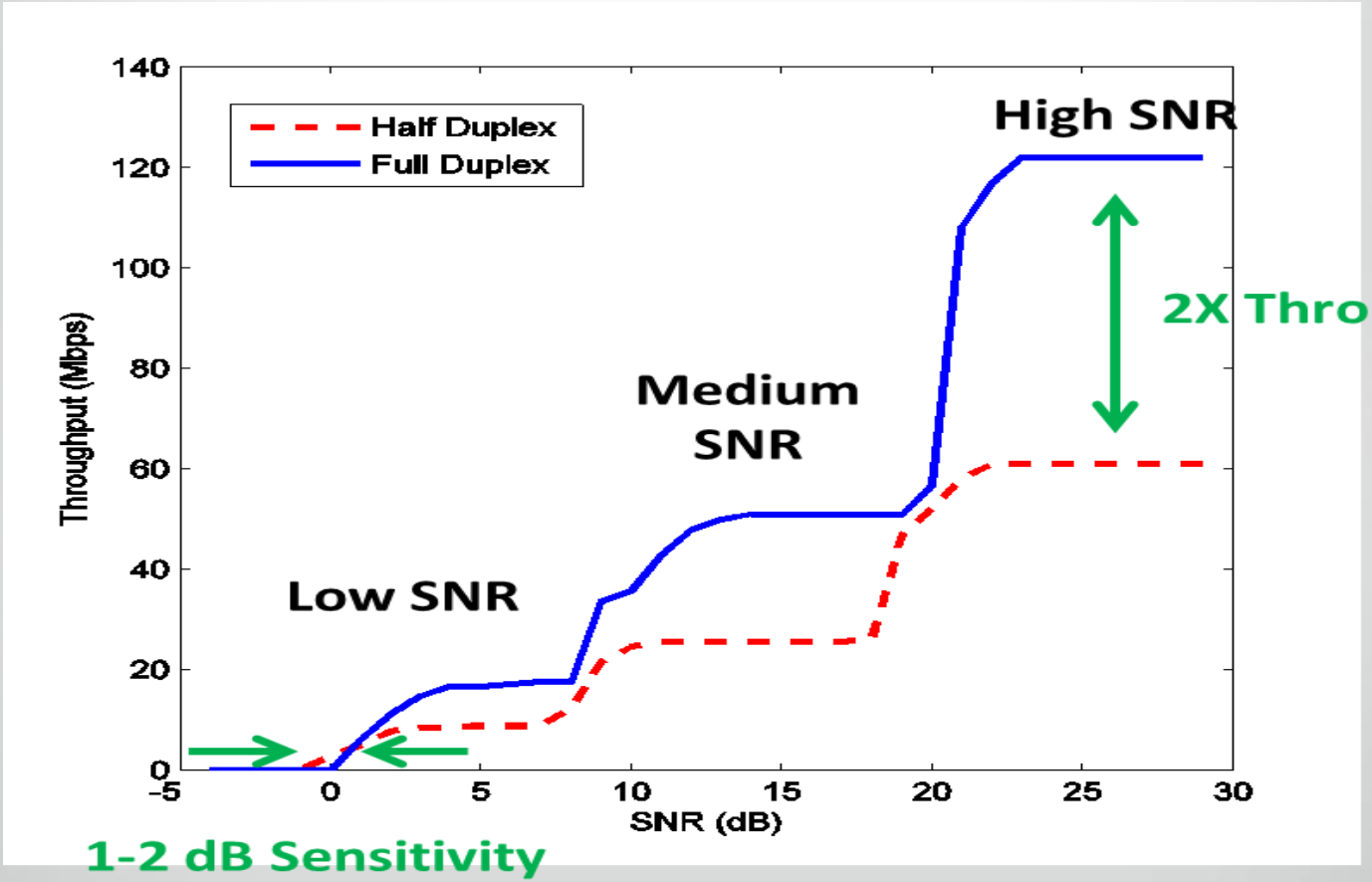
# Full Duplex Boosts Spectral Efficiency

***in face of slowing gains due to coding technology limits***

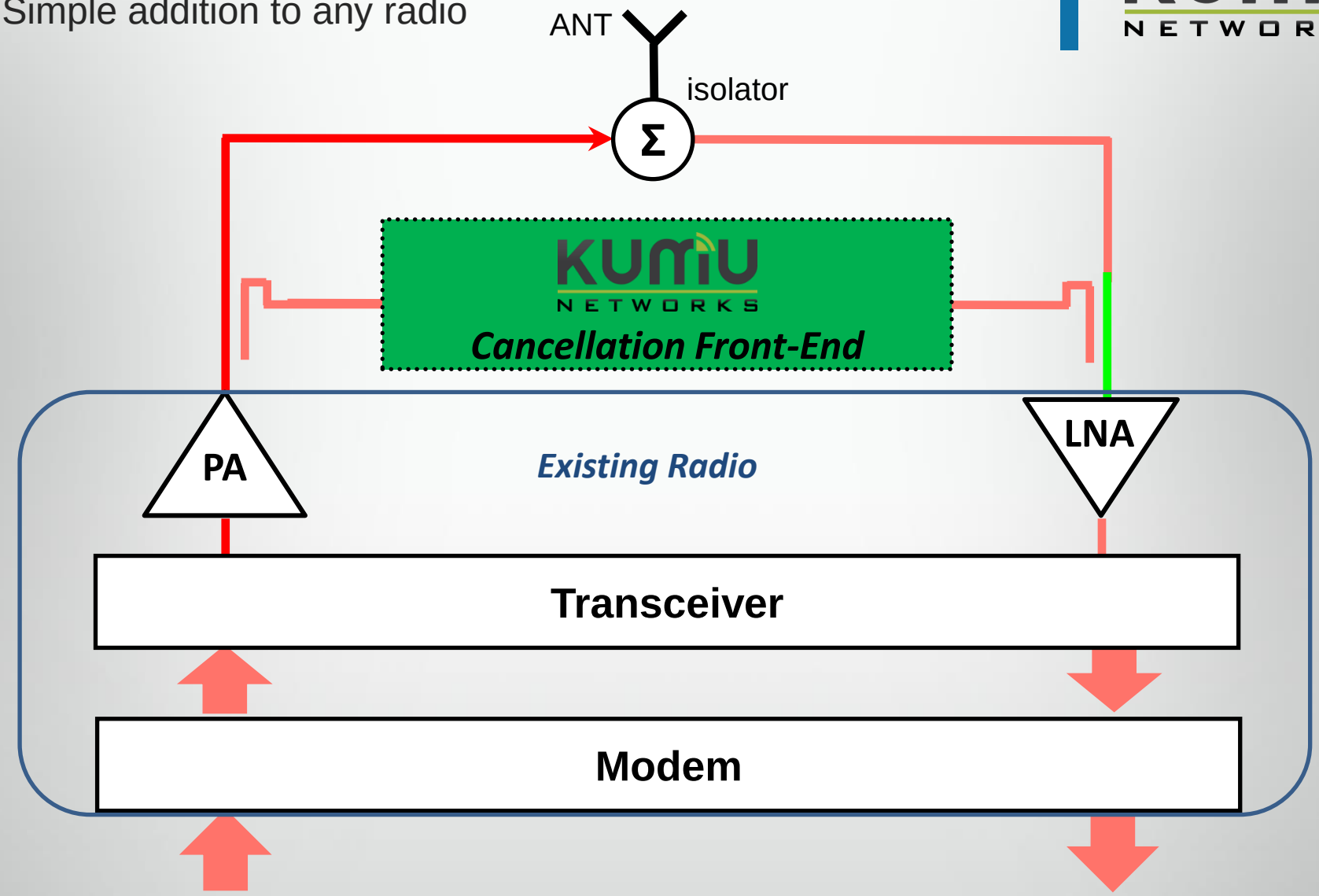


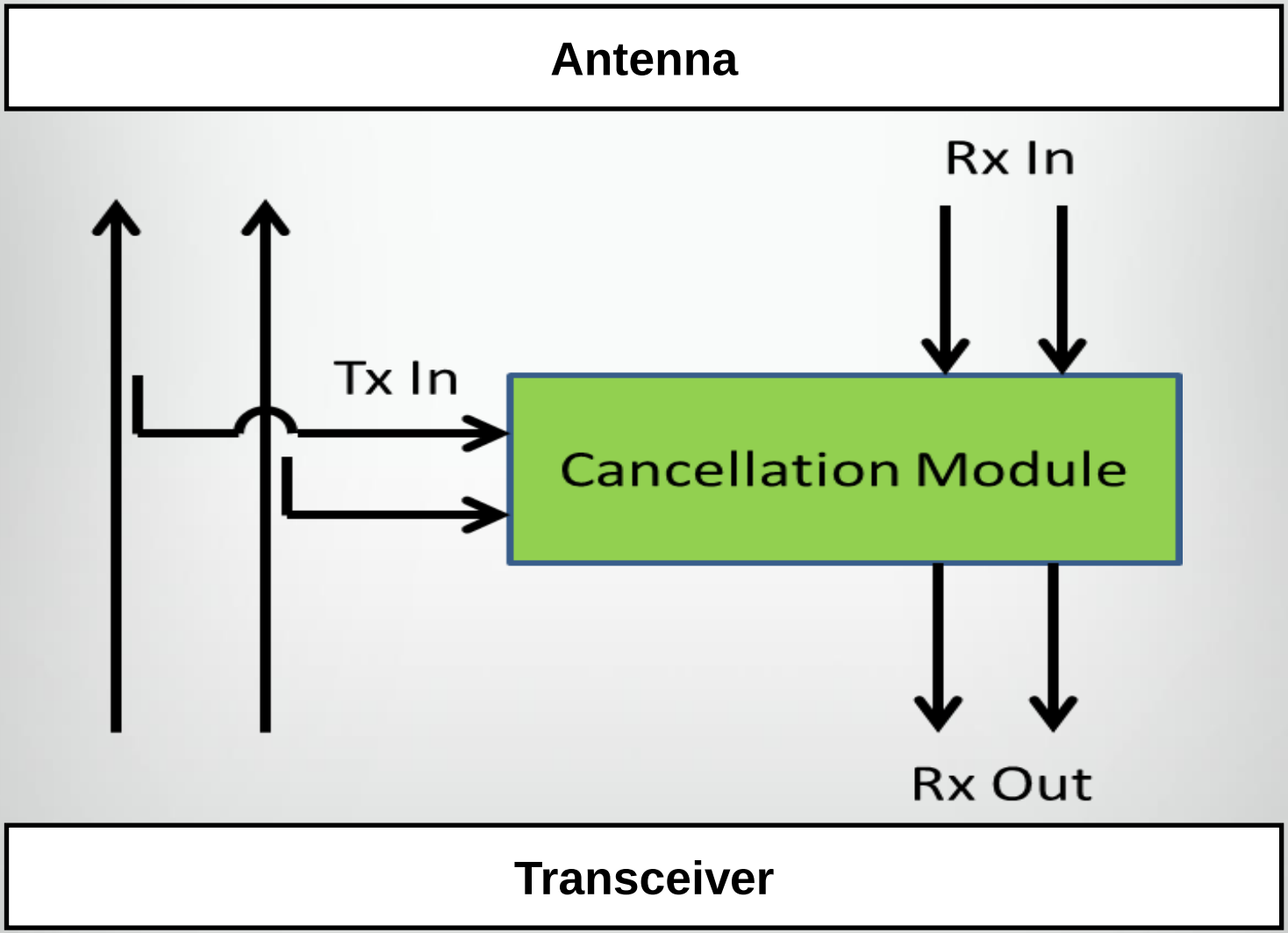

KUMU NETWORKS
Simultaneous Transmission and Reception on a Single Channel
As tested by tier-1 operators
Why Are Radios Today Half Duplex?
Kumu cancellation allows radios to transmit and receive simultaneously!
Cancellation Front-End
Transceiver
Modem
Standard UE Radio
5G Full Duplex Doubles LTE Performance
LTE FDD Performance
LTE Full Duplex
Why Are Radios Today Half Duplex?
Kumu cancellation allows radios to transmit and receive simultaneously!
Cancellation Front-End
Transceiver
Modem
Standard Base Station Radio

# Full Duplex improves throughput compared to Half Duplex at all SNRs and Modulations

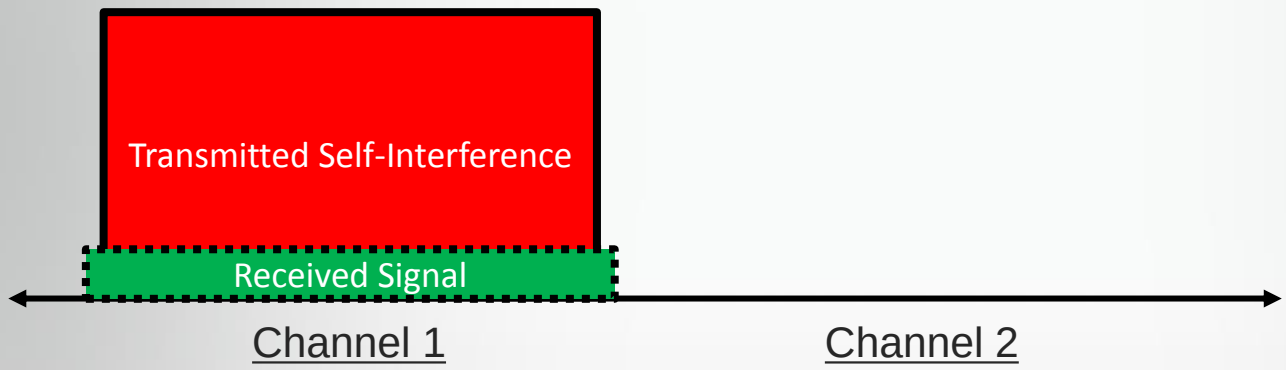


Simple addition to any radio



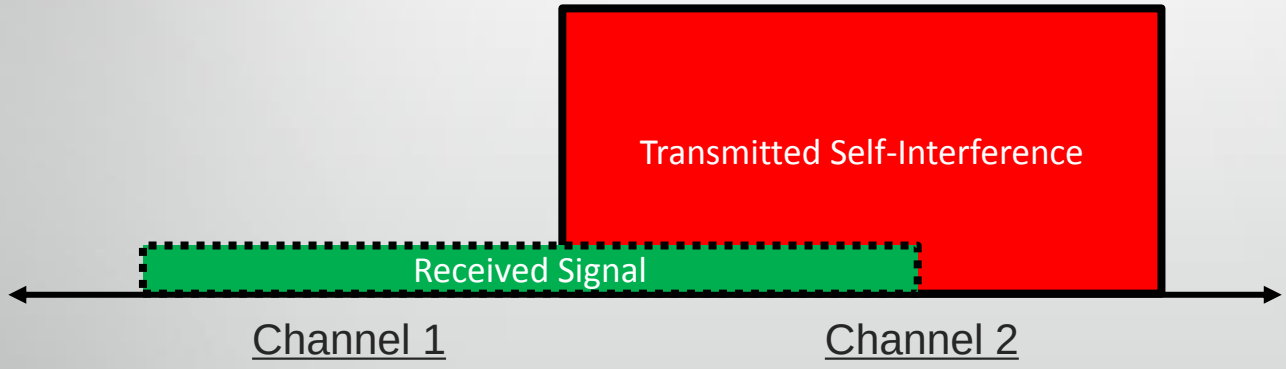

Antenna
Rx In
Tx In
Cancellation Module
Rx Out
Transceiver

# Kumu's Self Interference Cancellation is fundamental, applies broadly beyond full duplex




**In-Band Full Duplex**

Double capacity




**Adaptive Frequency Division Full Duplex (FDD)**

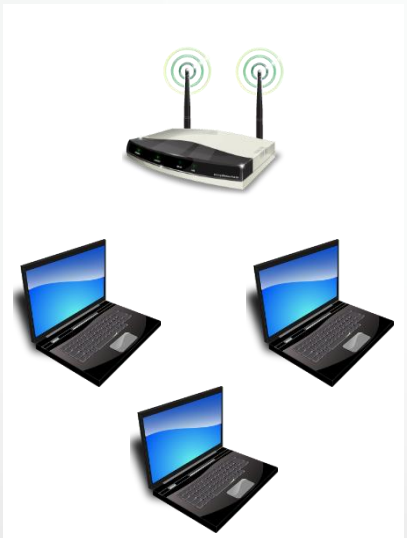
Flexibly decide which channels to transmit & receive on

KUMU NETWORKS

# Applicable To a Host of Horizontal Markets

**Microwave Backhaul**

Doubles spectral efficiency, and mitigate interference in unlicensed bands



**WiFi Access**

Dense coverage by avoiding interference between adjacent bands

**Mobile Devices**

World phones supporting any FDD channel pairs with adaptive duplexers

**LTE Access**

High performance Relay Node. Doubles spectral efficiency for TD-LTE.


Full-Duplex Revolution

# COVERAGE AND CAPACITY

The mobile data challenge

Mark Caines, Director of Spectrum Policy, Ofcom

Changes & Challenges

# Panel

**Jonas Wessel, Head of Spectrum Department**
Swedish Post and Telecom Authority (PTS)

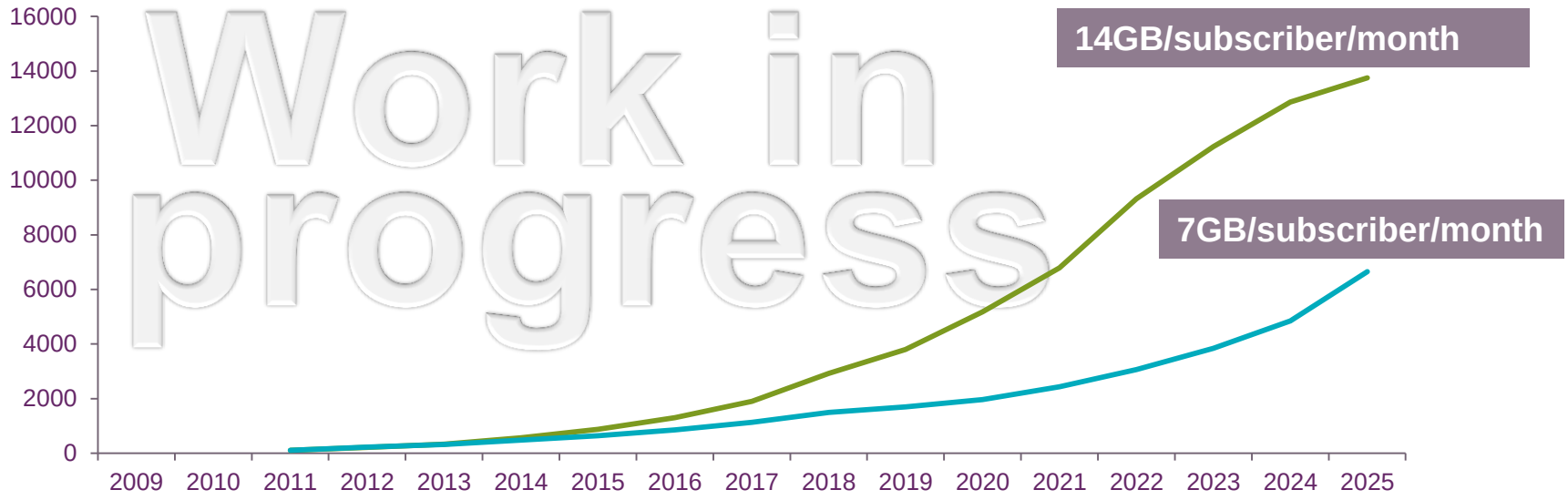
**Alexander Kühn, Chairman, WRC-15 Conference Preparatory Group**
CEPT

**Kenan Masic, Senior Telecommunication Consultant**
P3 Communications

**Mansoor Hanif, Director of RAN Development & Programmes**
EE

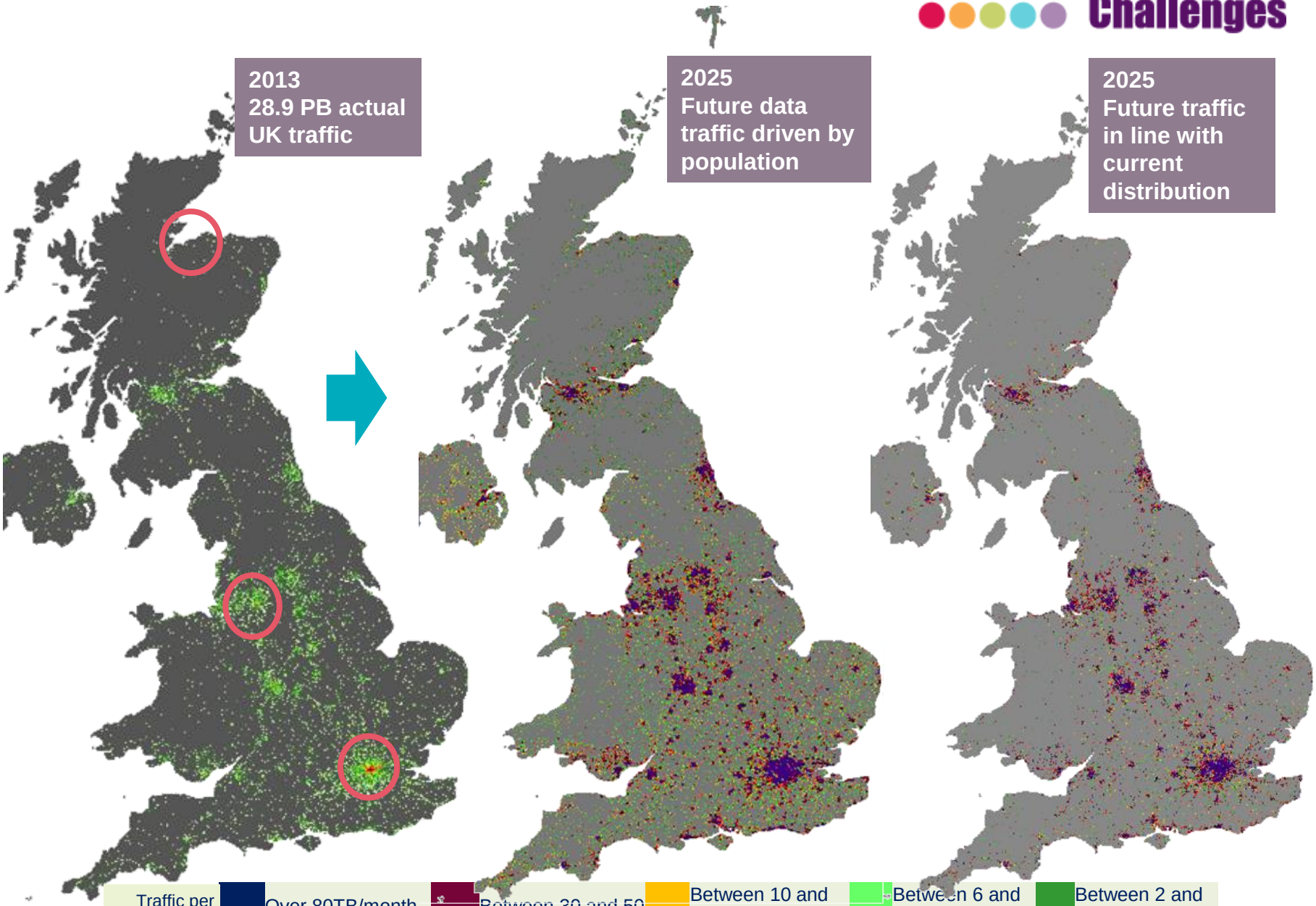
**Andrew Conway, Head of Mobile Access**
Telefonica UK

# There is considerable uncertainty about the level of future mobile data demand…



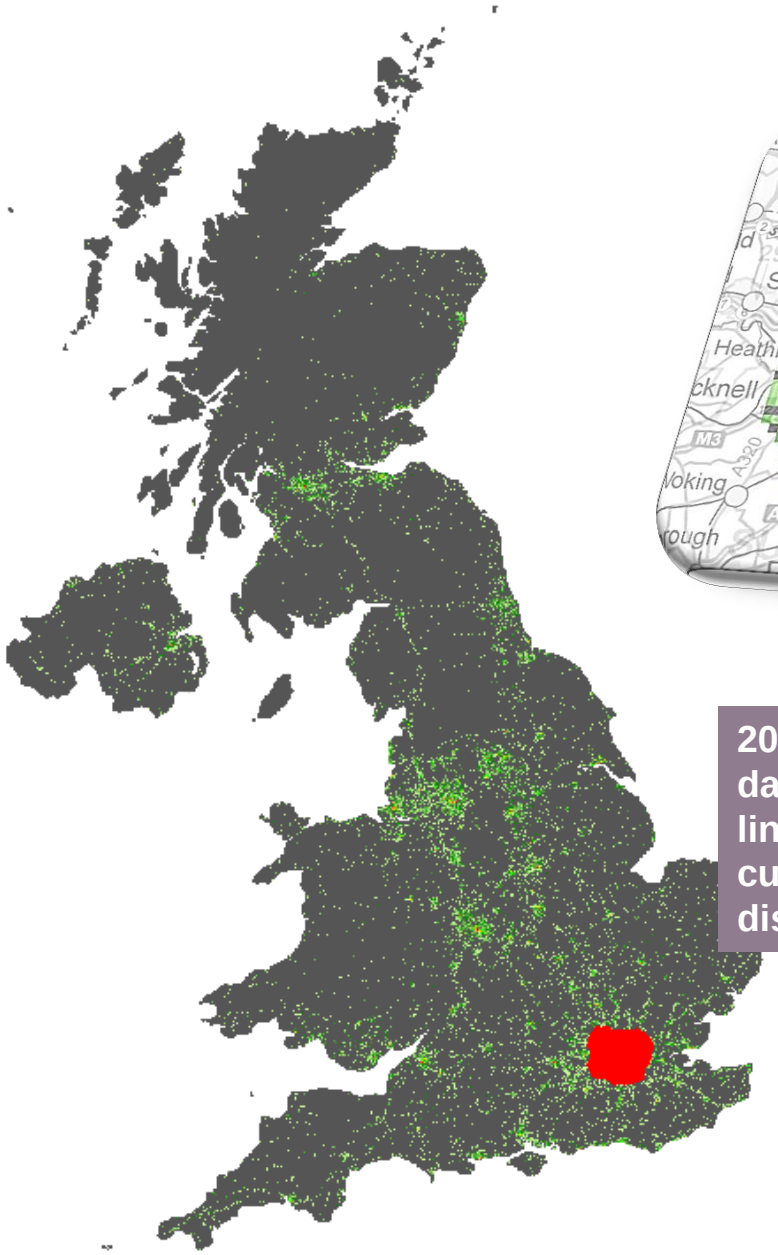
# … and about its distribution

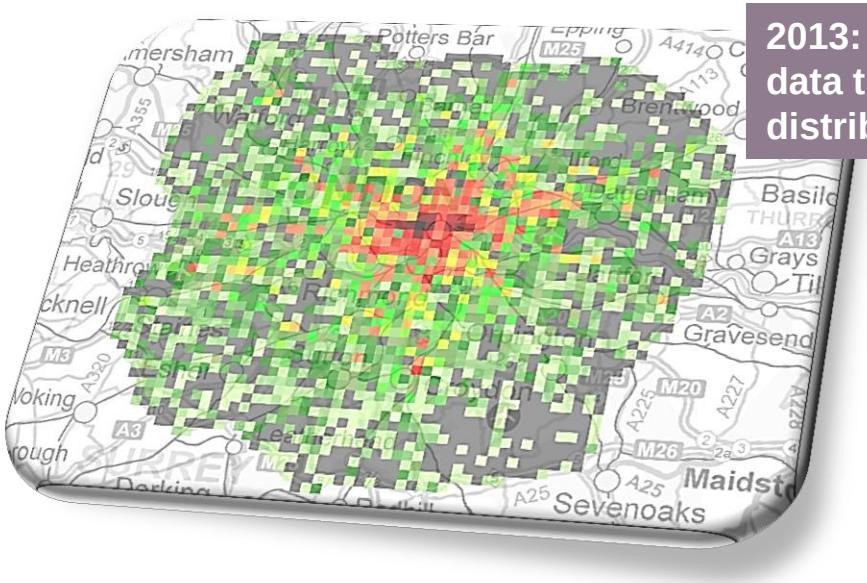
Changes & Challenges



# Future mobile data demand: London

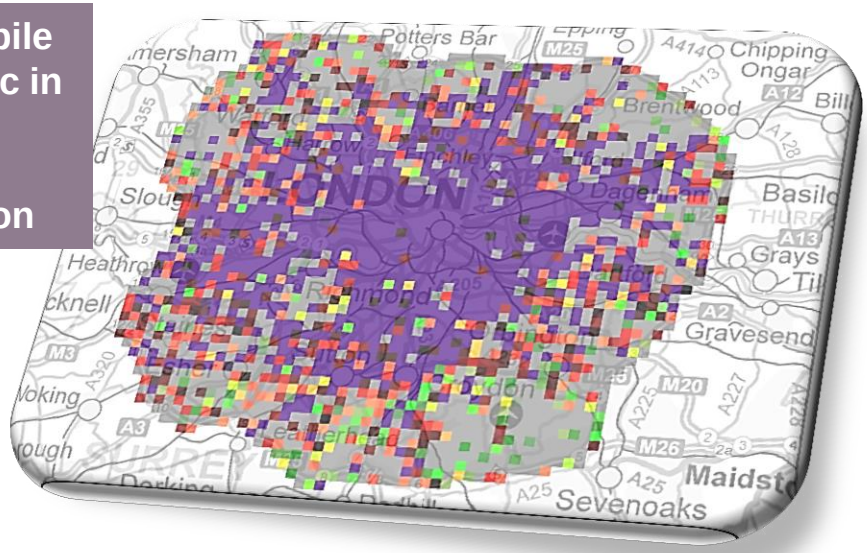
Changes & Challenges





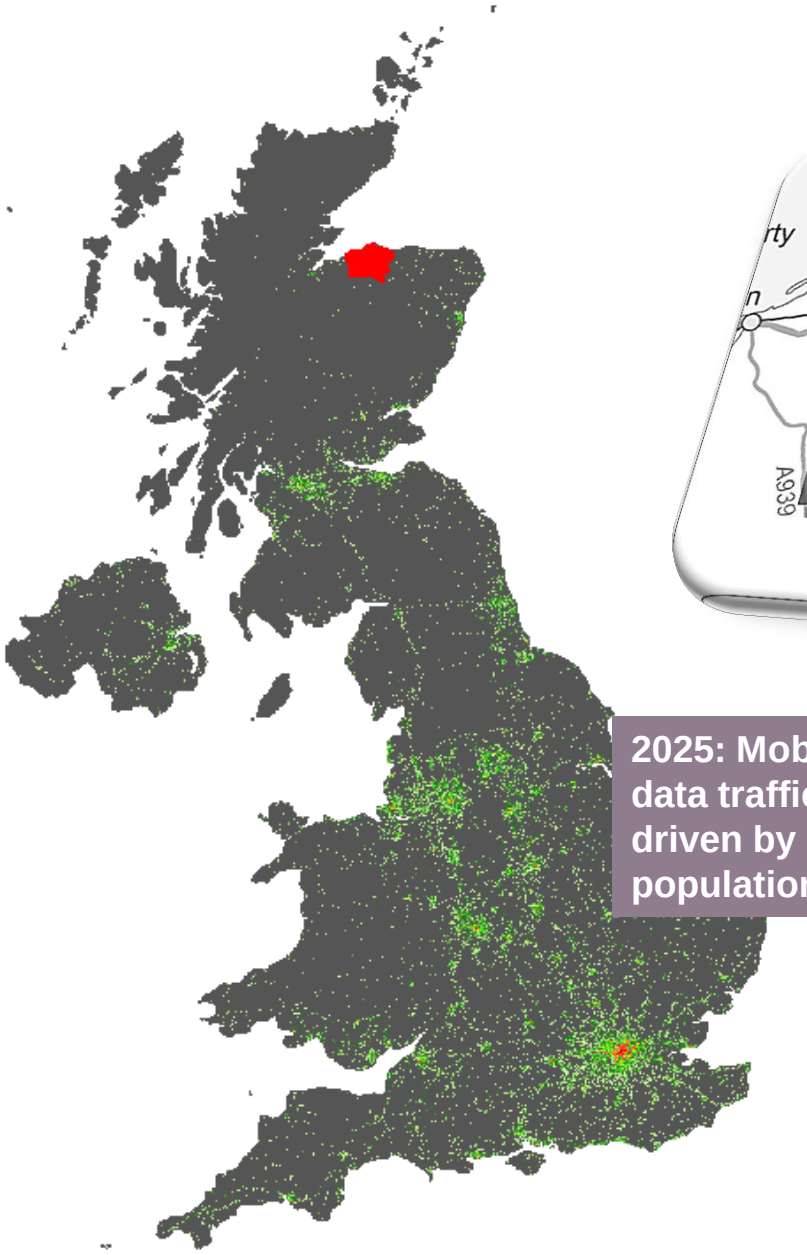

2013: Mobile data traffic distribution

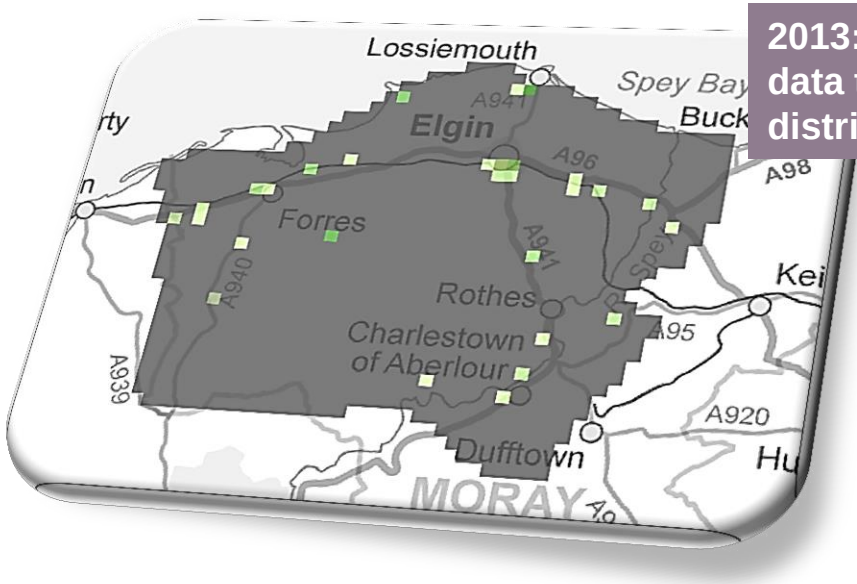
2025: Mobile data traffic in line with current distribution



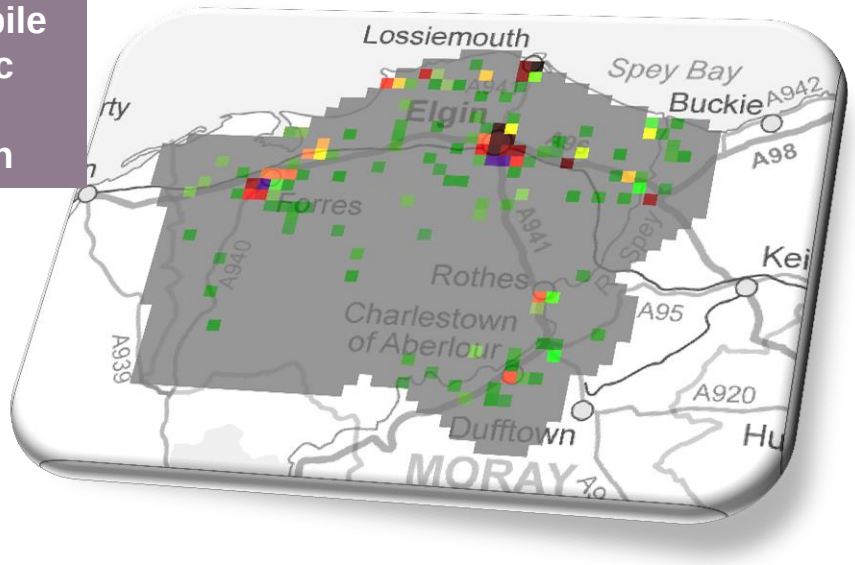
# Future mobile data demand: Elgin

Changes & Challenges



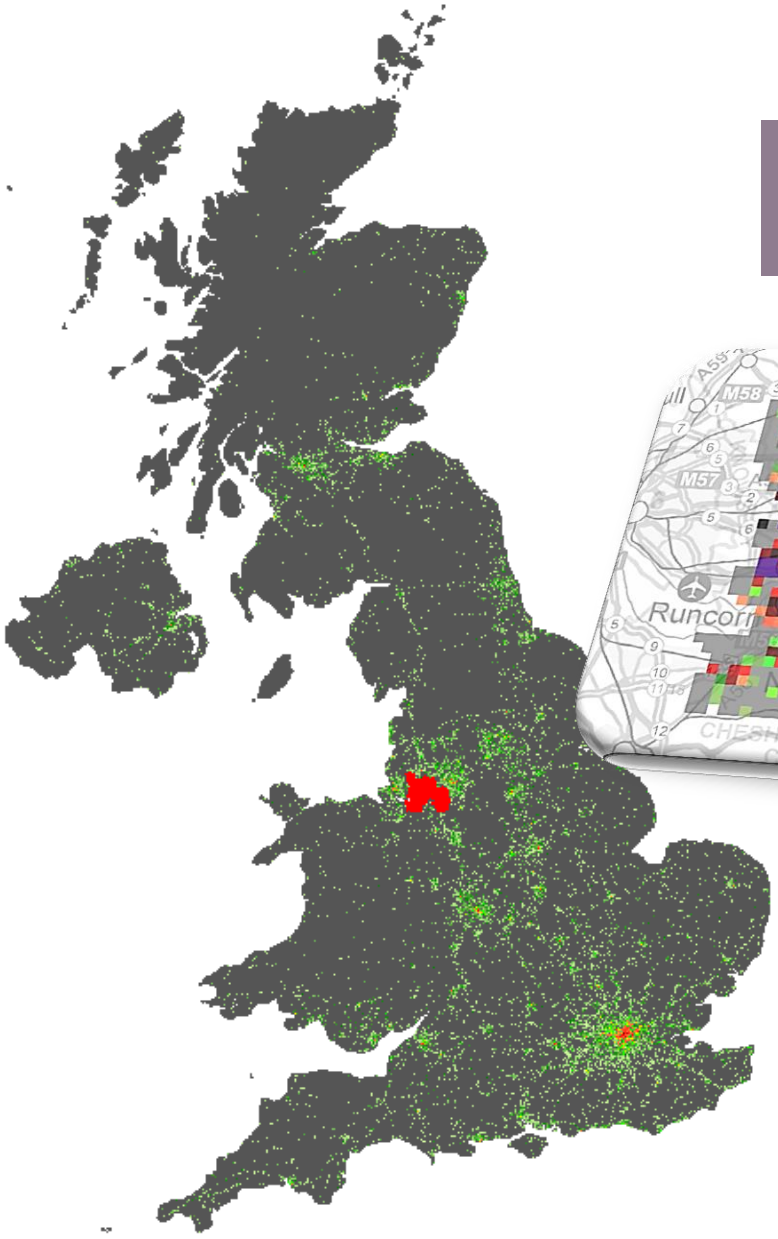


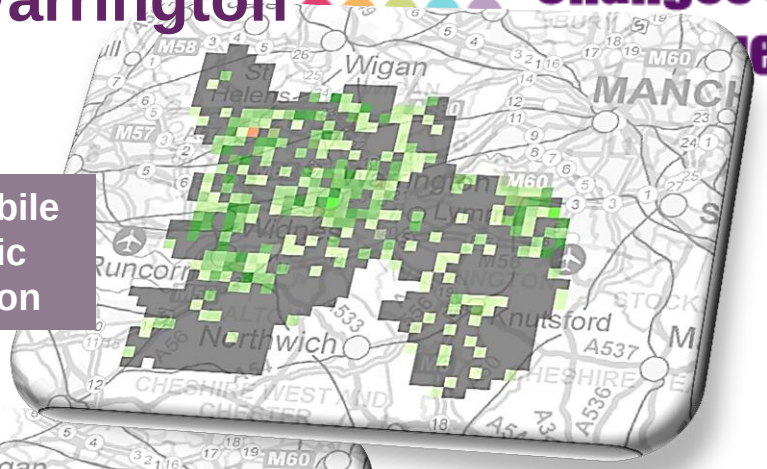

2013: Mobile data traffic distribution




2025: Mobile data traffic driven by population

# Future mobile data demand: Warrington






2013: Mobile data traffic distribution


2025: Mobile data traffic driven by population


2025: Mobile data traffic current distribution

# Summary of future challenges

| | |
|---|---|
| **UK demand against other countries?** | • What is the nature of future consumer demand? |
| **Role of industry?** | • What can industry do to meet demand for capacity and coverage? What are the obstacles? |
| **Spectrum quantity and mix?** | • How important is additional spectrum and what mix of frequencies will be most desirable? |
| **Sharing?** | • What is the role of geographically shared spectrum compared to nationally available spectrum? |
| **5G?** | • What implications will 5G have? |
| **The role of the regulator?** | • What regulatory steps can we take to improve coverage, capacity (and hence speeds) for consumers? |

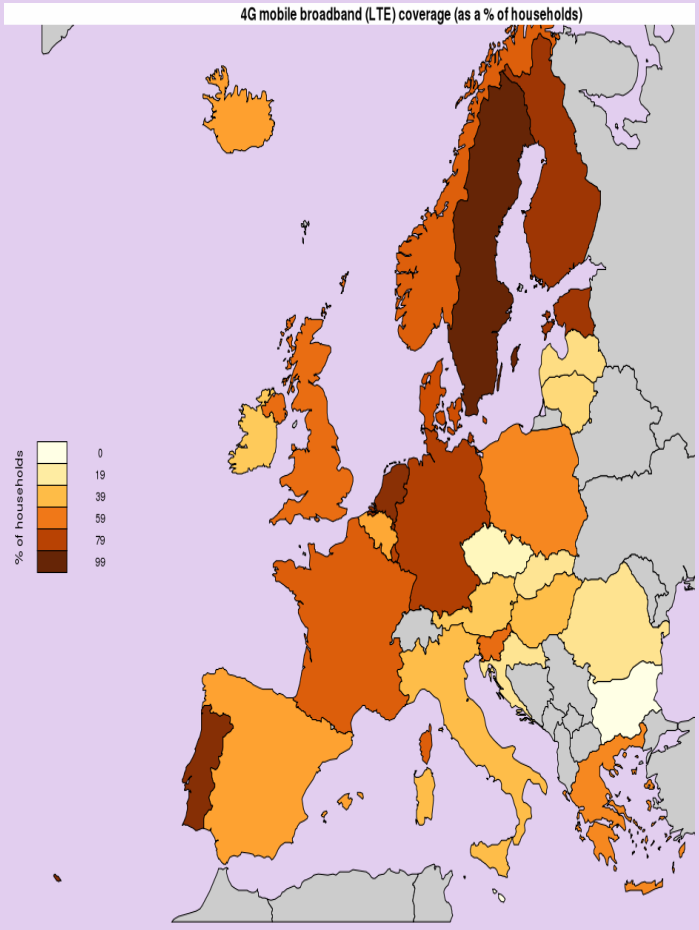
**Jonas Wessel**
**Head of Spectrum Department**
**Swedish Post and Telecom Authority (PTS)**

# Mobile broadband coverage and capacity in Sweden - current and future issues

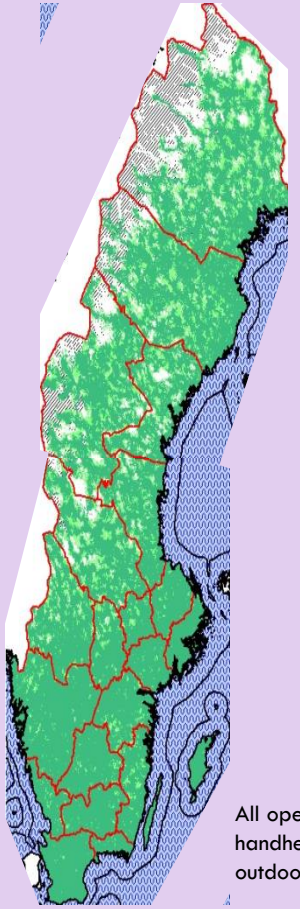
Jonas Wessel, Head of Spectrum Department

Swedish Post and Telecom Authority (PTS)

# Mobile coverage - population and area



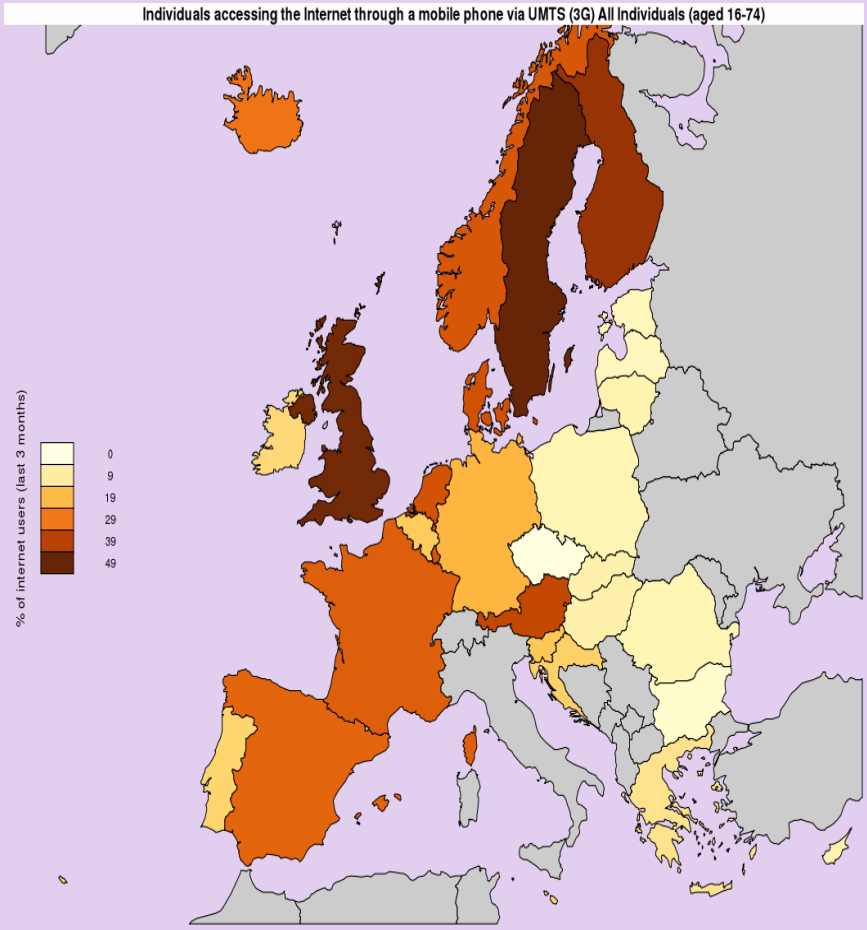

| Handheld outdoor | Pop | Area |
|---|---|---|
| Voice | >99,9% | 84% |
| 1 MBps | 99% | 39% |
| 10 MBps | 98% | 42% |
| 30 MBps | 61% | 2% |

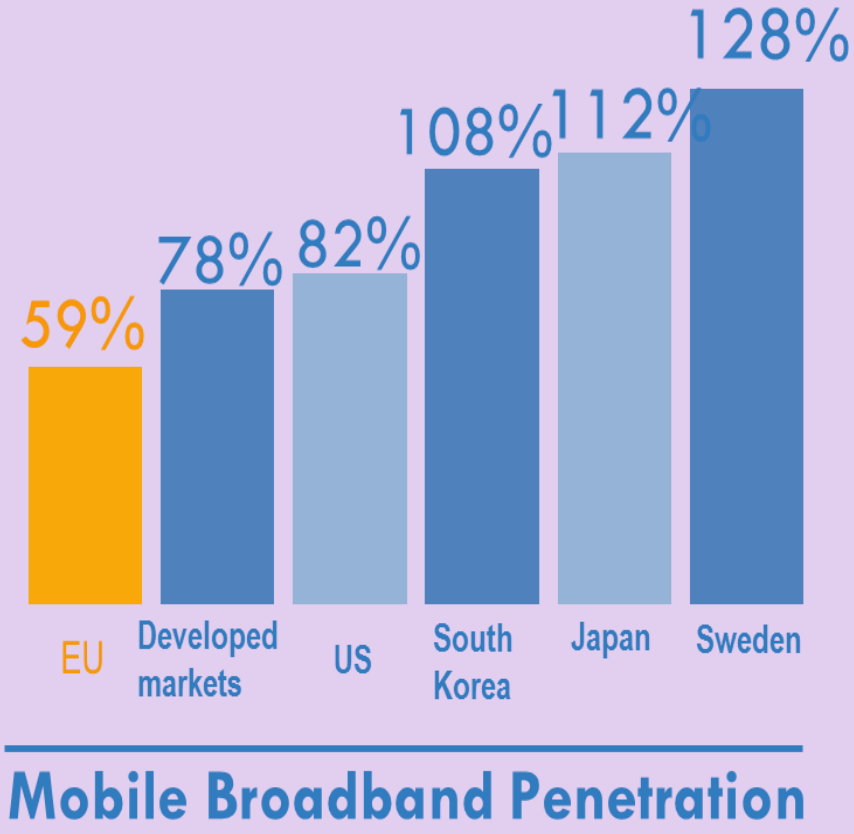


All operators handheld outdoor

Source: PTS, Operator coverage maps,
European Commission, Digital Agenda Scoreboard 2014

# Mobile internet access and mobile broadband penetration

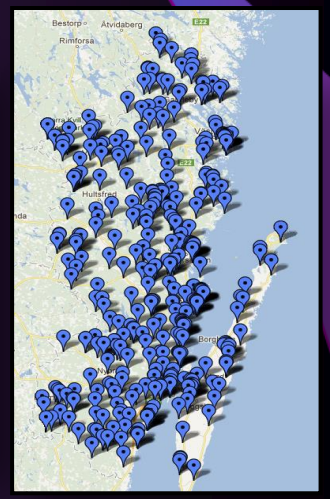


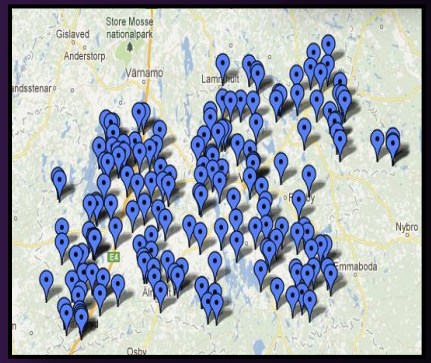




Source: GSMA Intelligence 2013, European Commission, Digital Agenda Scoreboard 2014

# Coverage and capacity
## - a hot topic in Sweden over the last two years

- We have gone from being a “country in the lead” to a “country with a problem”
- “Shame-maps” in abundance
- Rapidly changing consumer behaviour
  - Mobile internet access increasing dramatically
  - Fixed telephony declining (66% of outgoing traffic is mobile)
  - Societal dependency on electronic communication and services increasing



# What has happened lately?

- A general focus shift from ”network coverage” to ”consumer coverage”
- Coverage is not about dBµV/m outdoors - it is based on the consumer experience
  - if it’s not working – it’s bad coverage
- Four government assignments related to coverage
- Decision on 700 MHz February 27, 2014
  - Band empty by April 1st, 2017
  - Award anticipated before April 1st, 2017

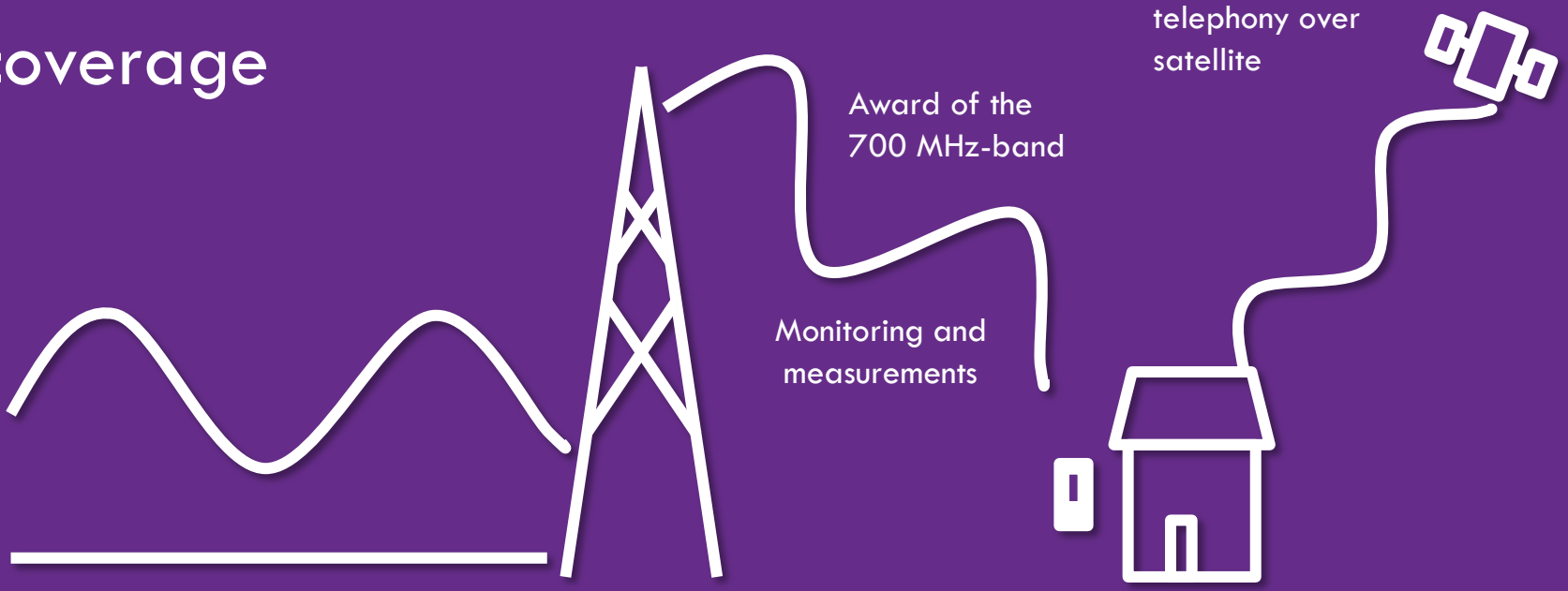
# PTS actions for increased mobile coverage

Use of spectrum to meet demand for wireless services

Evaluation of broadband and IP-telephony over satellite

Award of the 700 MHz-band

Monitoring and measurements



Industry agreement on minimal conditions for fibre networks

”Societal masts” for mobile coverage

Increased indoor coverage incl. wifi

Consumer information on mobile and broadband services

Support to regional work on mobile and broadband issues

Actions for robustness and handling of electricity incidents

Decrease problems with mobile card terminals

Changes & Challenges

**Alexander Kühn**
**Chairman, WRC-15 Conference Preparatory Group**
**CEPT**

Ofcom

**Kenan Masic**
**Senior Telecommunication Consultant**
**P3 Communications**

# Market Trends for Coverage and Capacity

P3 communications GmbH

London, 02.10.2014

# Agenda

1 **Introduction**

2 **Coverage**

3 **Capacity**

# Introduction - P3 Experience

## P3 provides leading-edge network testing and optimisation to tier-1 operator groups on a worldwide scale

### Some References

Public Benchmarking - „connect“

- Public Benchmark in Germany, Austria and Switzerland together with popular „connect“ Magazine - P3 methodology recognised as industry standard for E2E performance test

Certification Projects

- 10 European national operators certified by P3 in 2011-2013

International Tier-1 Operator Group Benchmarks

- Operator Group 1: 20 countries on 3 continents
- Operator Group 2: 9 countries on 2 continents
- Operator Group 3: 12 countries in Europe

Statistics 2013:

- > 1Million Drive Test kilometres worldwide
- 147 projects in 42 countries

### Hot Optimisation Topics

**E2E Service Performance Testing and Optimisation**

- LTE CSFB
- VoLTE/SRVCC
- 3G Multi-RAB
- HD Voice (AMR-WB)
- Detailed Expert Failure Analysis
- LTE FDD/TDD
- LTE Cat 4 Data
- HD YouTube
- Live Web Pages
- On-Device Smartphone testing

**Measurement Scenarios**

- Drive
- Hotspot
- Indoor Walk
- Public Transport
- Railway
- Stationary long-term

**Competitor Intelligence**

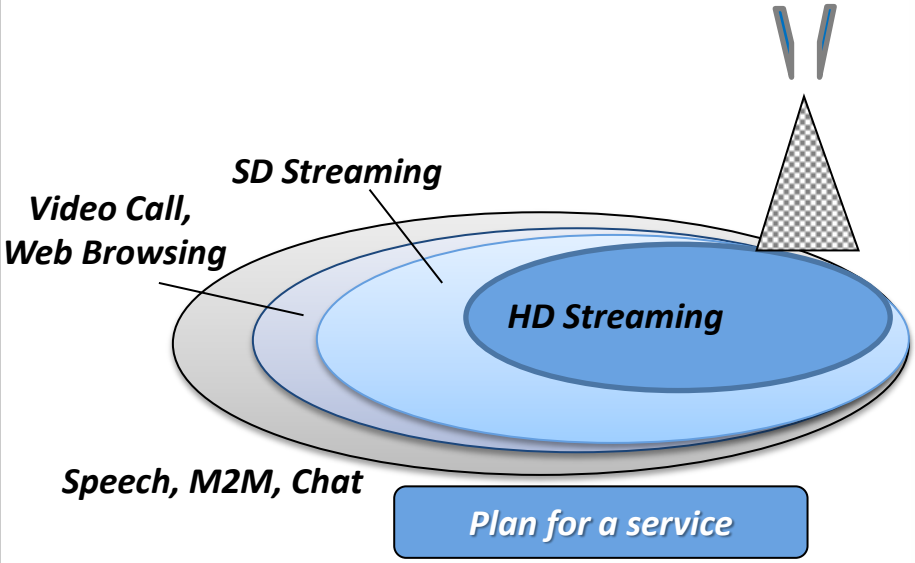
- Performance
- Rollout status
- Radio capabilities
- Parameter Sets
- Layering Strategies
- Frequency Usage
- Feature Usage
- Voice Codec Usage

# Coverage & Customer Demands

**Each service has its own coverage and interference requirements. Good coverage does not necessarily mean good throughput performance in interference limiting systems**

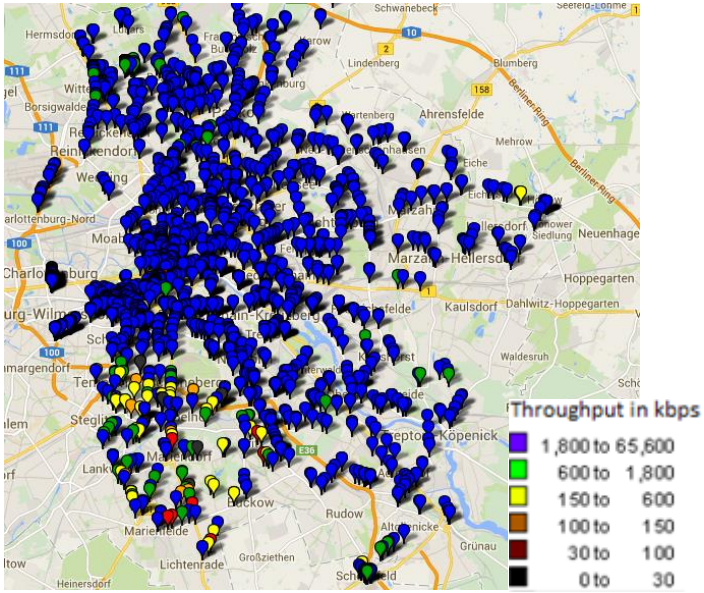
## Does RF Signal Do Enough for "Coverage"?

- Each customer has different demands
- Each service has different coverage requirements
- Video services becomes more popular
- Voice - Browsing - Download - Upload - SD/HD Video




## Network Dimensioning

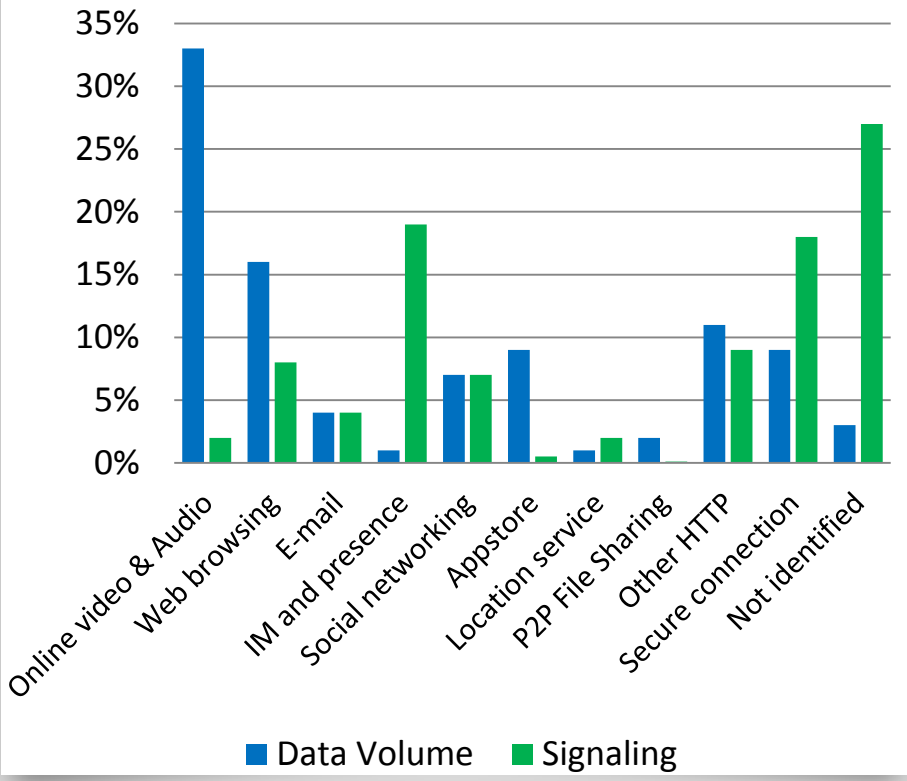
- Ensure that indoor locations have at least 600 kbps data rate in busy hours to cover video streaming services
- Throughput distribution (Berlin)
  - Whole city: Voice coverage
  - Blue areas: Coverage for all services
  - Non-blue areas: Problem for some services



# Capacity & Signalling Challenges

**Capacity demands change everyday with new services and changed customer behaviour. Continuous network dimensioning and optimisation is critical for customer satisfaction**

## CAPACITY AND SIGNALLING EVERYWHERE




- Non-user generated apps drive signalling
- Online media & web drive data volume

| Application | Signalling Messages |
|---|---|
| Hotmail MSN | 280 |
| Downloading Large Files ( 5 Mb) | 200 |
| Sending and Receiving Email | 110 |
| Web Browsing | 90 |
| Skype Video Call | 60 |
| Watching a YouTube Video | 50 |
| Fring (keep alive messages) | 20 |
| Receiving an Incoming Phone Call | 20 |

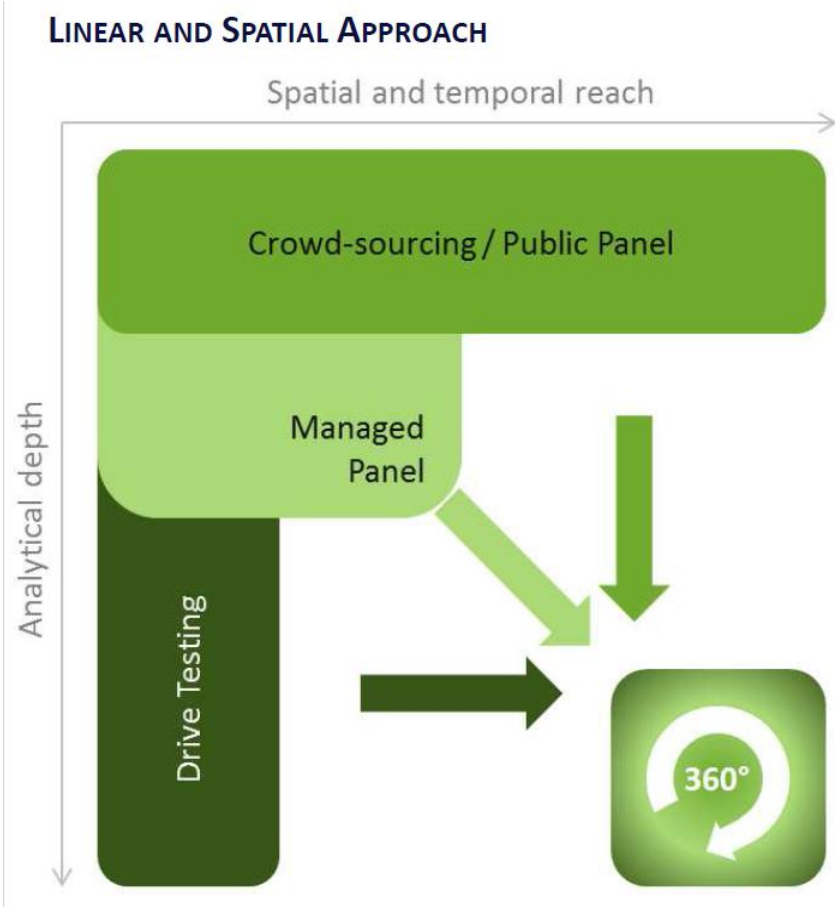
- Operators should consider devises as additional source of creating capacity bottlenecks

# E2E User Impact on Capacity

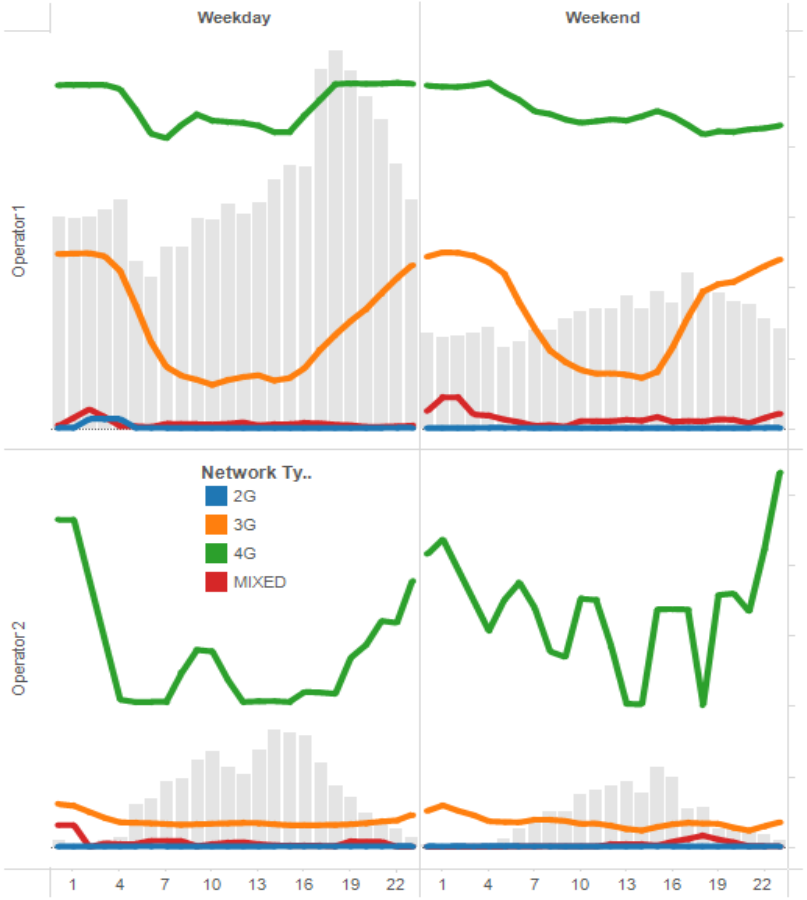
**Lack of capacity results in poor end user experience as well as revenue loss for operators. Optimisation is also a key point besides capacity extensions**

## Combined View

### Linear and Spatial Approach




## Throughput Change During Day Time



# Future of Technologies

**Many features and techniques are available esp. in LTE to improve the capacity. In parallel operators must invest in 3G since most customers will be served during next 5 years**

### 2G Highlights

- ~180 users per cell (HR voice)
- Low OPEX for voice service
- Necessary for legacy terminals and M2M
- Not satisfying for most data users

### 3G Highlights

- ~96 users per cell (50 optimum)
- High OPEX
- Challenging for optimisation

### 4G Highlights

- ~90 users per cell
- Highest ROI due to lower CAPEX/OPEX
- Minimal cell overlap is critical
- Varying bandwidth
- Convergence with existing networks

### 2G Market Trends

- Spectrum refarming towards 3G/4G
- Future‘s world has less and less 2G
- Voice services for high capacity network (stadium, concerts etc.)

### 3G Market Trends

- 3G will be dominant technology for next 5 years
- UMTS 900
- SON in 3G
- HetNet & small cells
- New features more capacity

### 4G Market Trends

- VoLTE/SRVCC
- HetNet & small cells
- SON (Rel8 ANR, Rel9 & Rel10)
- LTE-A trialled in Germany
- Intelligent antenna systems
- CoMP - 3GPP Rel-10
- Advanced MIMO Transmission

# Your Contact

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## Disclaimer

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## Director of RAN Development & Programmes
## EE

# MOBILE DATA CHALLENGES

## OFCOM SPECTRUM EVENT

1ST OCTOBER 2014

MANSOOR HANIF
Director of RAN & Programmes

# Our thoughts on Spectrum

Q. How important is additional spectrum to meet mobile demand?

A. Very! But not as important as high-quality, high bandwidth, cost-effective transmission

Q. When is new spectrum likely to be needed?

A. 2020-2025 depending on individual network strategy. But let's first focus on making the best use of existing spectrum to serve our customers : no hoarding!

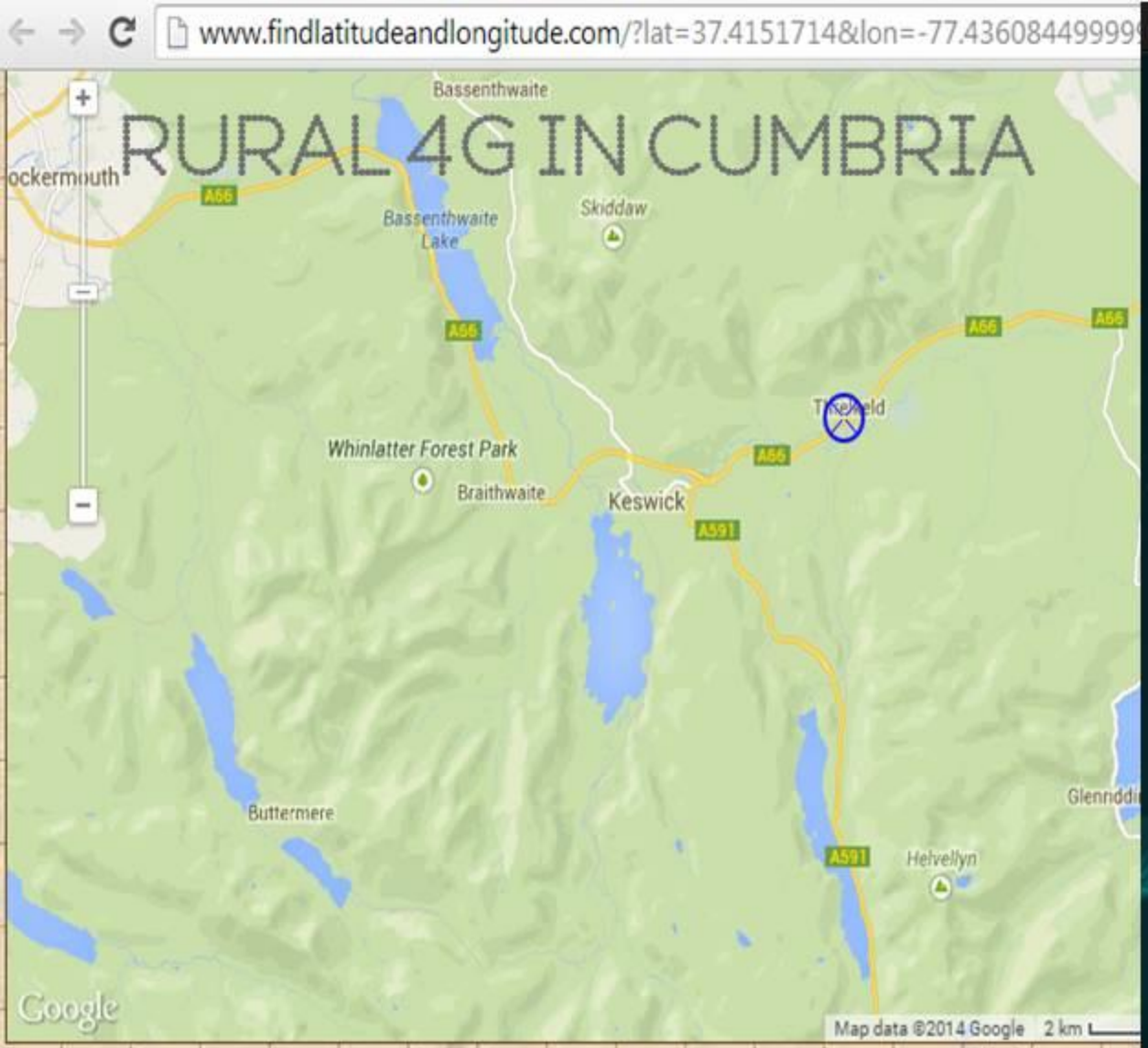
Q. What frequencies are most desirable and in what mix?

A. All Spectrum is good! Blocks of minimum 20MHz most practical

Q. What about Sharing?

A. Share deeply! (but passively). Spectrum sharing is implicit in unlicensed spectrum aggregation

# WHAT IS EE DOING ABOUT IT?







**Load Location**

| | |
|---|---|
| Latitude: | 54.617 |
| Longitude: | -3.056 |
| Location: | |
| Post Code: | |

Latitude and longitude loaded.

**Map Coordinates**

Latitude: N 54°
Longitude: W 3°
Latitude: N 54°
Longitude: W 3°
Latitude: 54.61
Longitude: -3.05

# Rural strategy

**The backbone of EE's rural strategy is to improve macro voice and coverage. Current plan delivers**

- **All 18,500 macro sites refreshed with 1800MHz LTE**
- **Targeted LTE 800MHz on existing sites to increase coverage**
- **Investment in higher capacity backhaul in rural areas**

**Remote coverage ( last 3%) requires low cost or innovative solutions:**

- **The government funded MIP programme will provide additional macro sites**
- **Discussing passive sharing of macro sites to extend coverage**
- **Investigating more innovative solutions...**

# Rural sites are challenging to build and run!

# FURTHER NETWORK INNOVATIONS

Bringing the best mobile technology to the UK as soon as possible...

VoLte™


LONDON FASTEST CITY IN THE WORLD

# THANK YOU

Disclaimer text if required.
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# Andrew Conway

Head of Mobile Access

Telefónica UK

# Panel

**Jonas Wessel, Head of Spectrum Department**
Swedish Post and Telecom Authority (PTS)

**Alexander Kühn, Chairman, WRC-15 Conference Preparatory Group**
CEPT

**Kenan Masic, Senior Telecommunication Consultant**
P3 Communications

**Mansoor Hanif, Director of RAN Development & Programmes**
EE

**Andrew Conway, Head of Mobile Access**
Telefonica UK

# COFFEE BREAK AND TECHNICAL DEMONSTRATIONS

11:00 – 11:15

Changes & Challenges

# FUTURE OF CONTENT DELIVERY

Richard Wronka, Principal, Ofcom Policy Development

Changes & Challenges

# Panel

**Nigel Walley, Managing Director**
Decipher

**Simon Pilsbury, Head of TV Regulation**
Talk Talk

**Claire Enders**
Enders Analysis

**Jonathan Thompson, Chief Executive Officer**
Digital UK

# Broadcast TV's importance is well-established

- **Equilibrium amongst free and pay TV, and distribution technologies**
  - Free to view TV services remain popular across **all** sections of society
- **Audience behaviour relatively stable**
  - Some groups embracing new technologies, but traditional TV remarkably resilient
- **Free to view TV has supported important policy outcomes**:
  - Reach and impact of Public Service Broadcasting
  - Platform choice and range and the overall level of competition in TV markets
  - Mitigating the potential risk of powerful gatekeepers

# But mobile data growth is providing challenges

- **Mobile data traffic increasing rapidly**
  - Driven by smartphone and tablets usage, and demand for video streams
- **Causing increased competing demands for key spectrum bands**
  - Alongside complementary solutions to meet any mobile data crunch
- **and ensuing debate at home and abroad**
  - UK proposals for making the 700MHz band available for mobile
  - Debate around the future of the 470-694 MHz band at WRC 2015
  - Lamy proposals**:** “2020/2025/2030” model

# What are the key market developments?

**1. Greater levels of connectivity**

Driving new functionality:

- catch-up and on demand
- more personalised services

**2. A drive for improved picture quality**

Advances in transmission and compression enabling greater picture clarity

**3. New services and pricing structures**

Pay TV suppliers seeking opportunities to grow

New entrants introducing low-cost, low-commitment subscription options

**The challenge:** free to view platforms will **need to evolve** in line with wider market developments if they are to continue to meet the needs of audiences

# Are there alternatives to DTT in the long-term?

| A move to IPTV: great potential, but… | Satellite? Freesat is a success, but… |
|---|---|
| **Availability and take-up of SFBB**<br>Plans for 95% availability by 2017. But encouraging take-up is more challenging? | **Coverage**<br>- Line of sight issues<br>- Planning restrictions, landlord consent etc. |
| **Take-up of IP capable consumer kit:**<br>Falling prices will encourage take-up, but not all viewers will adopt naturally. | **The "block-of-flats" challenge**<br>Where no internal satellite distribution system and where individual dishes are not possible. |
| **Quality of experience:**<br>More work needed to ensure sufficient resilience. | **A complementary technology?**<br>Potential option for those who don't have access to broadband. |
| **Early interest around converged mobile-broadcast networks, but…** | |
| Commercial and technical viability unproven<br>Likely to require less spectrum for DTT to enable meaningful benefits for mobile | |
| **Conclusion** | |
| **Base case: DTT will continue to be important for the next 10 years and we do not expect a full switch off before 2030, absent significant policy intervention.** | |

# Two main routes for broadcasters to develop DTT

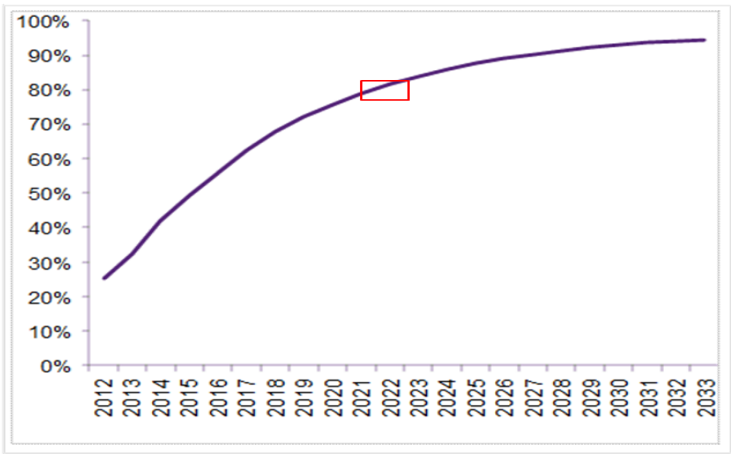
**Transition to more efficient broadcast standards to deliver more services and/or HD**

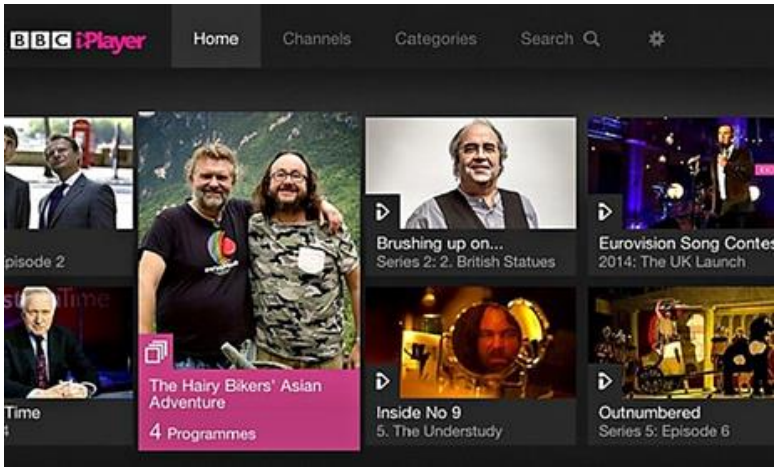
**Challenges around encouraging consumers to upgrade TV sets / set-top boxes.**

**Additional services delivered through a DTT-IPTV "hybrid" model**

**Challenges around consumers without access to broadband, and quality of experience.**

**Forecast take-up of MPEG4/DVB-T2 technology, % of DTT primary sets** *Source: 3 Reasons, November 2013*



# Questions for discussion…….

1) What will viewers want in the future and how does this vary between free and pay platforms?

2) What can broadcasters do to evolve free TV platforms?

3) Can we envisage a world where DTT is no longer the most effective way of delivering free to view TV? What could broadcasters, telcos and policy makers be doing now to prepare for such a future?

Changes & Challenges

## Nigel Walley
## Managing Director
## Decipher

Ofcom

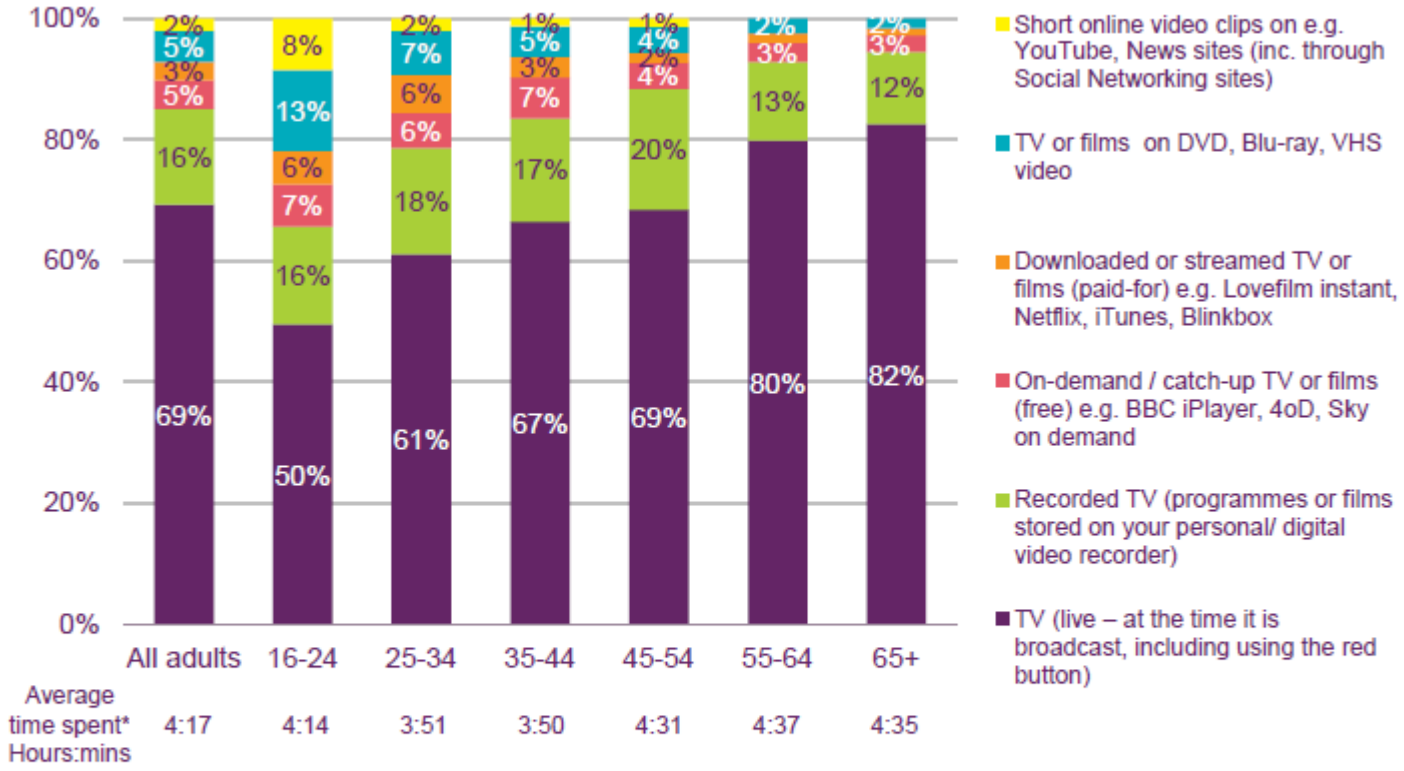
Changes & Challenges

## Simon Pilsbury
## Head of TV Regulation
## Talk Talk

Ofcom

# Age profile of AV content use

**Figure 1.90 Total time spent watching audiovisual content, by age group**




*Source: Digital Day 7-day diary*
*Base: All watching activity records for adults 16+ (25272), 16-24 (1583), 25-34 (3390), 35-44 (5362), 45-54 (6012), 55-64 (4905), 65+ (4020)*
**Average time spent is the total average daily time spent watching media, including simultaneous activity*

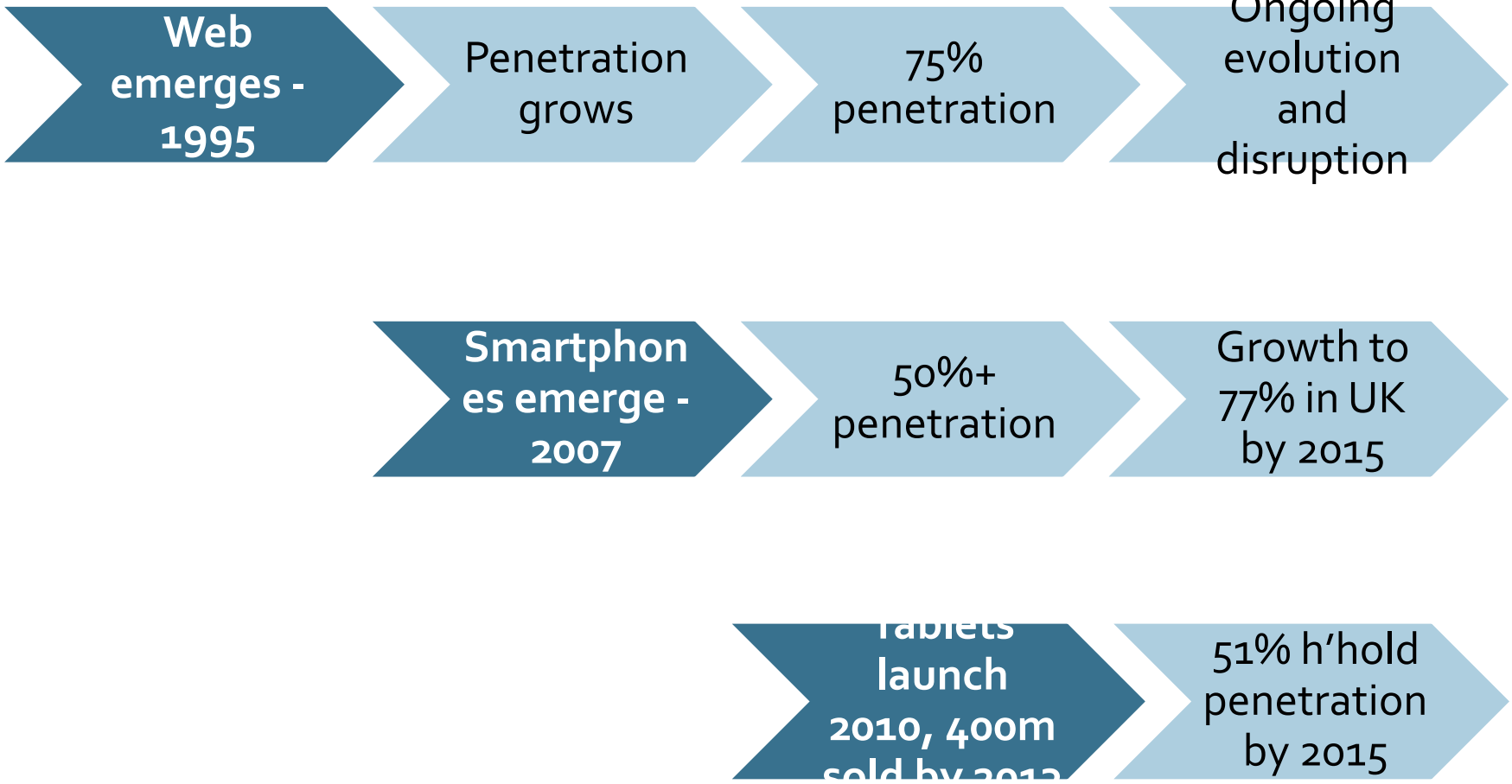
# Claire Enders
## Enders Analysis

# Ofcom Spectrum Event 2014

## The Future of Content Delivery

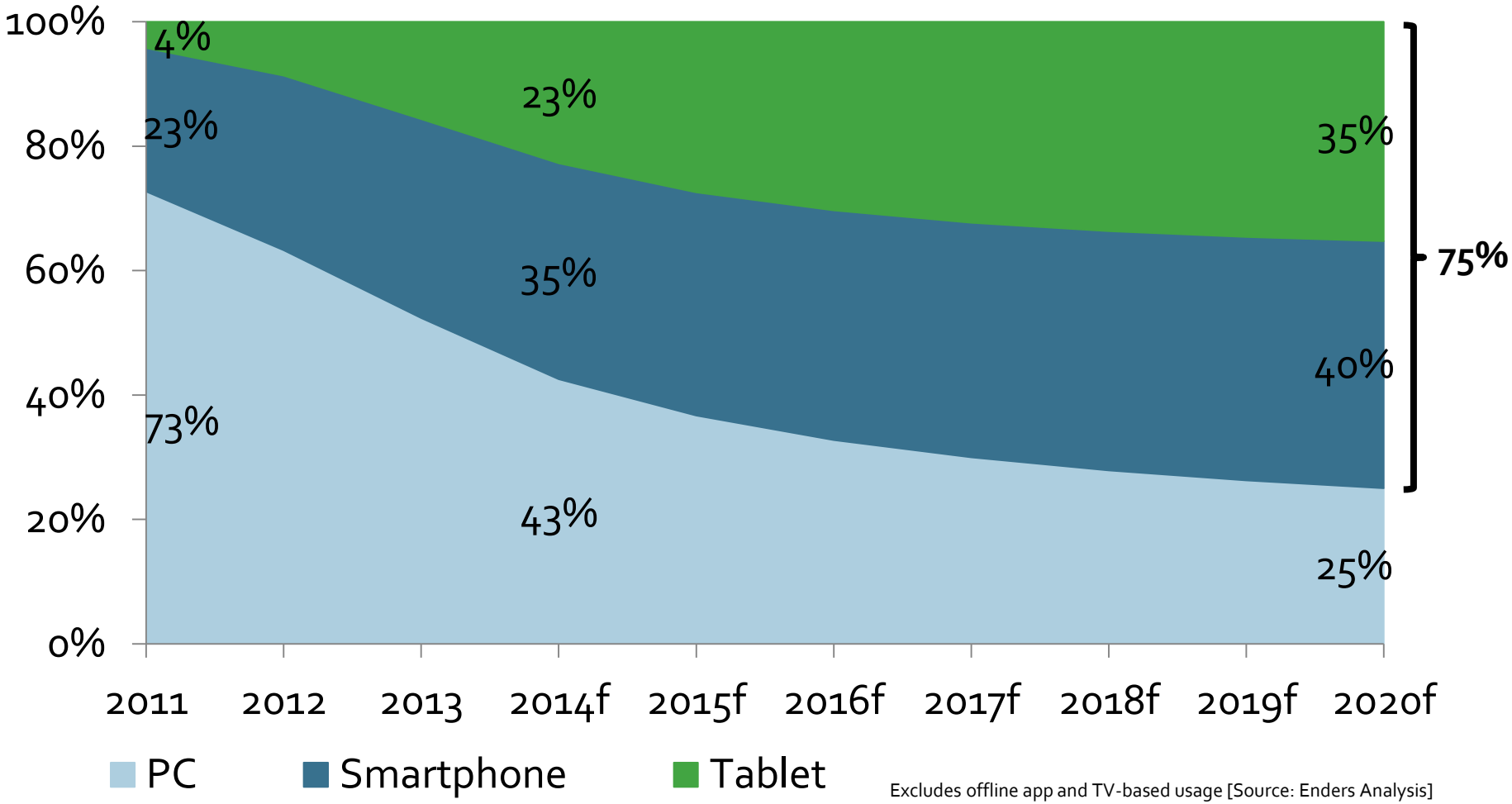
Claire Enders claire.enders@endersanalysis.com

# Three waves of tech disruption



# Mobile will soon be 75% of time online

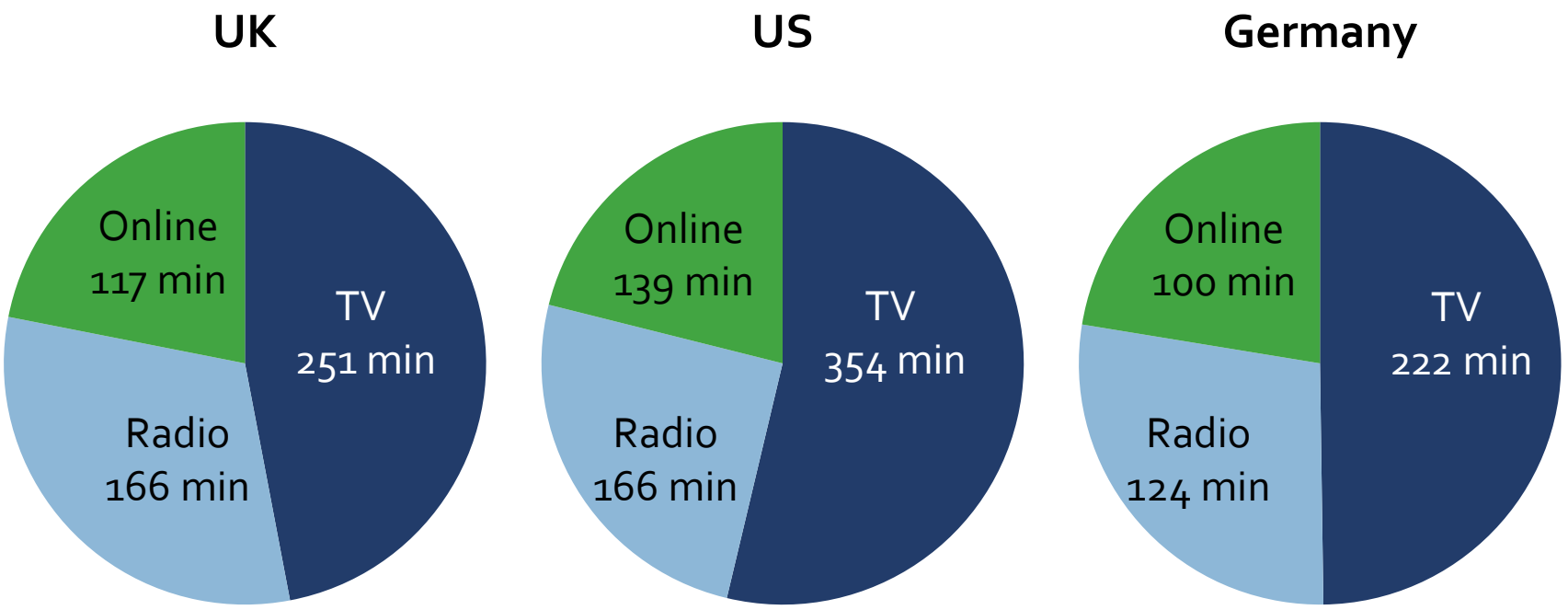
## Share of internet consumption (% of total)




Excludes offline app and TV-based usage [Source: Enders Analysis]

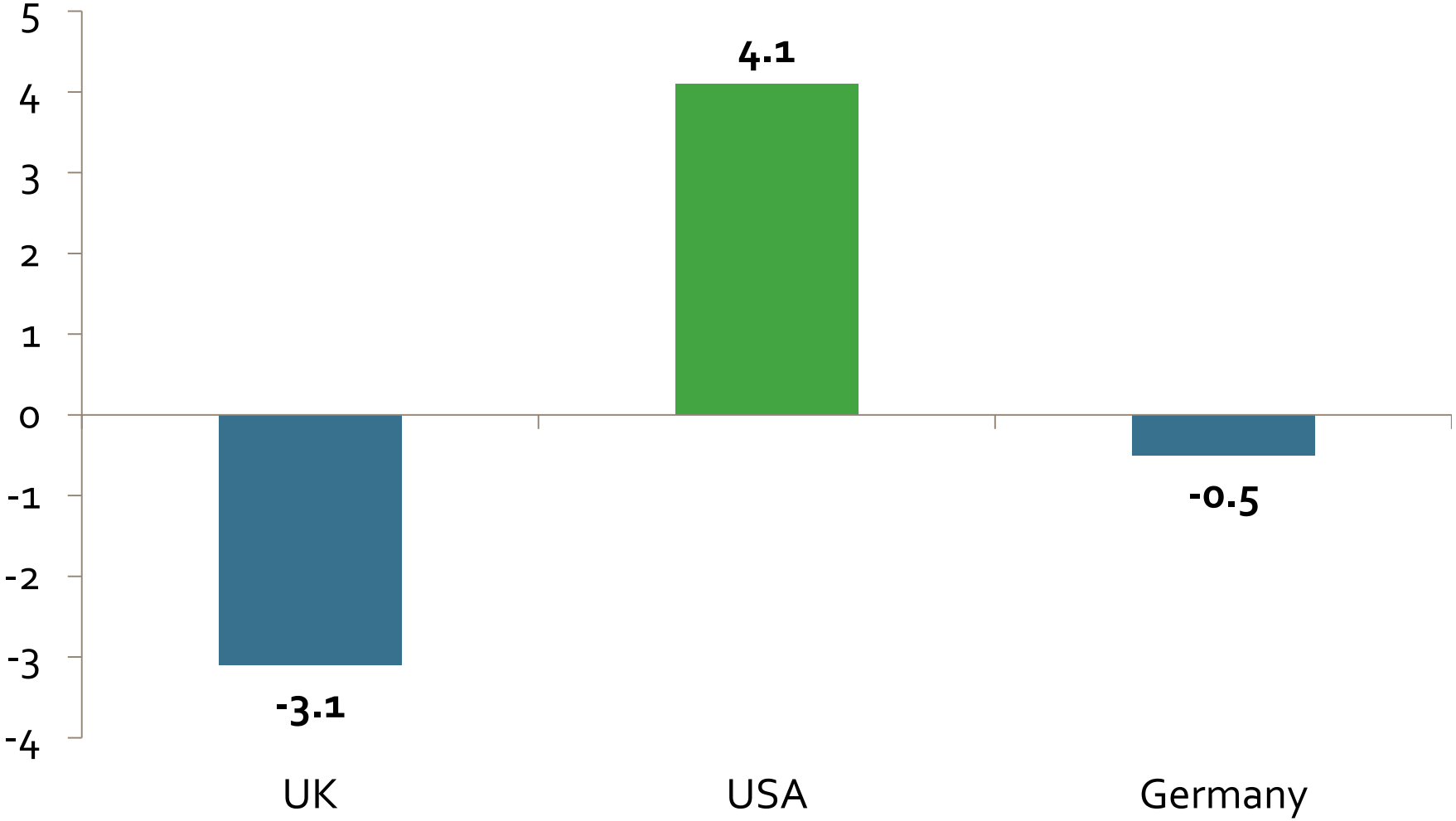
# Traditional media consumption remains strong

## The digital media day by device (mins/day)



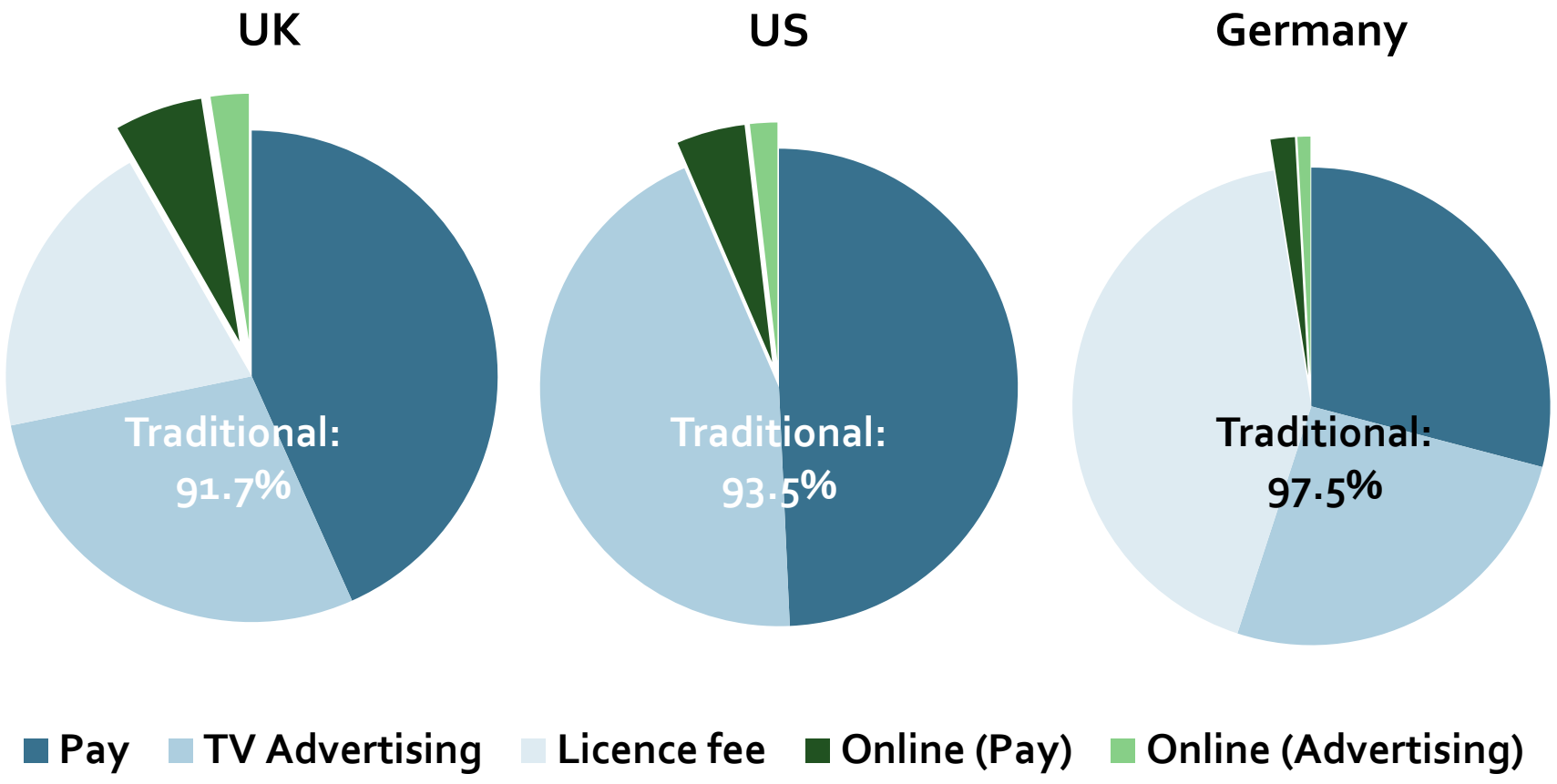

[Source: Enders Analysis based on BARB/InfoSys+, RAJAR, Ofcom, comScore, Nielsen, statista, TNS]

## 2010 – 2013 change in total TV set viewing (%)




[Source: Enders Analysis, BARB/InfoSys+, Nielsen, eurodataTV, die medienanstalten, statista, Ofcom]

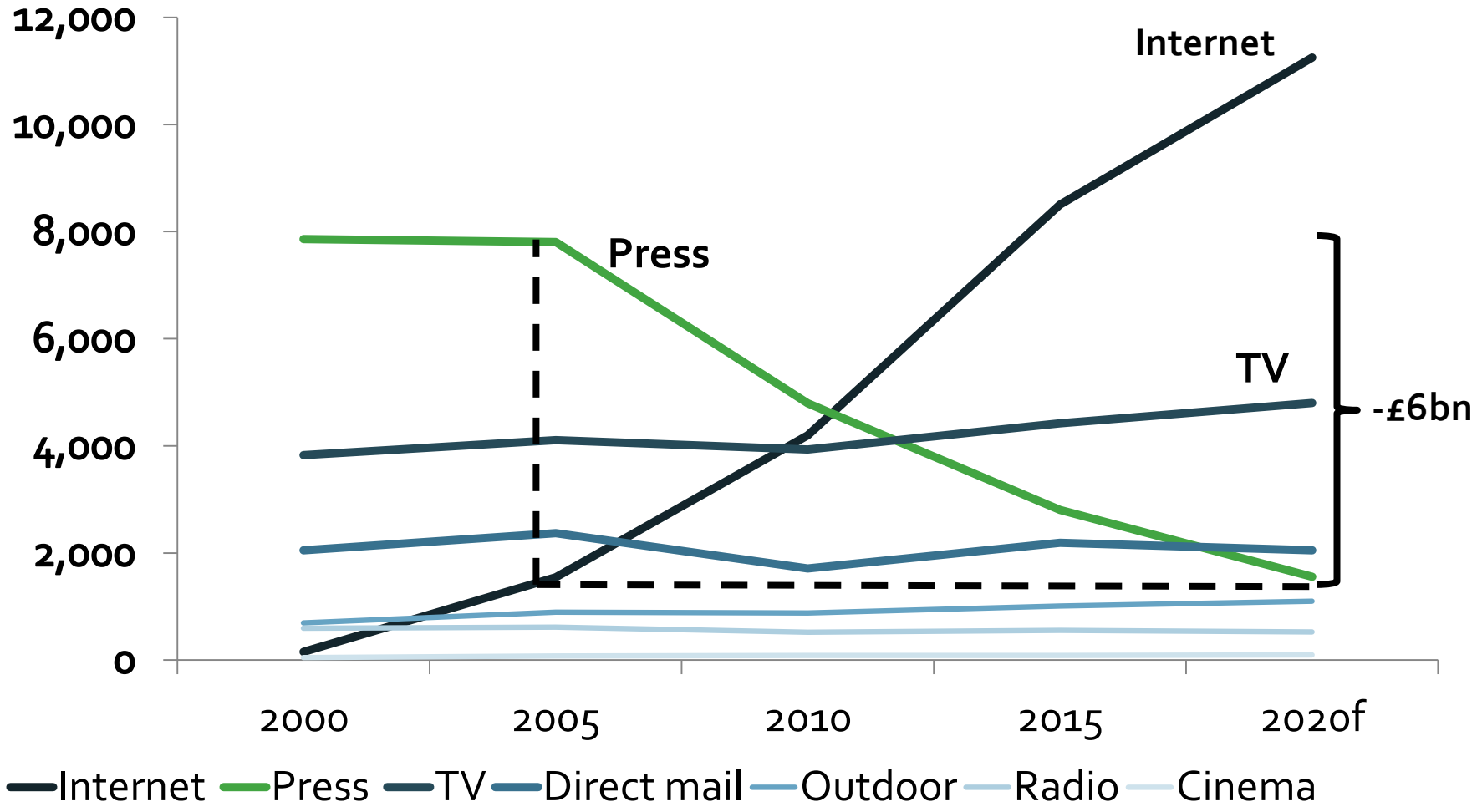
# TV industry revenues 2013




[Source: Enders Analysis based on Ofcom, GroupM, PwC, IAB, IHS, EAO]

# The marketing landscape

## Ad revenue by media (£m)




[Source: Enders Analysis forecasts based on AA/WARC and other industry data]

# Thank You

## Jonathan Thompson
## Chief Executive Officer
## Digital UK

# Panel

**Nigel Walley, Managing Director**
Decipher

**Simon Pilsbury, Head of TV Regulation**
Talk Talk

**Claire Enders**
Enders Analysis

**Jonathan Thompson, Chief Executive Officer**
Digital UK

# NETWORKING LUNCH AND TECHNICAL DEMONSTRATIONS

12:30 – 13:30

Changes & Challenges

# WORLD RADIO CONFERENCE 2015

Alexander Kuhn, Chairman
WRC-15 Conference Preparatory Group, CEPT

Changes & Challenges

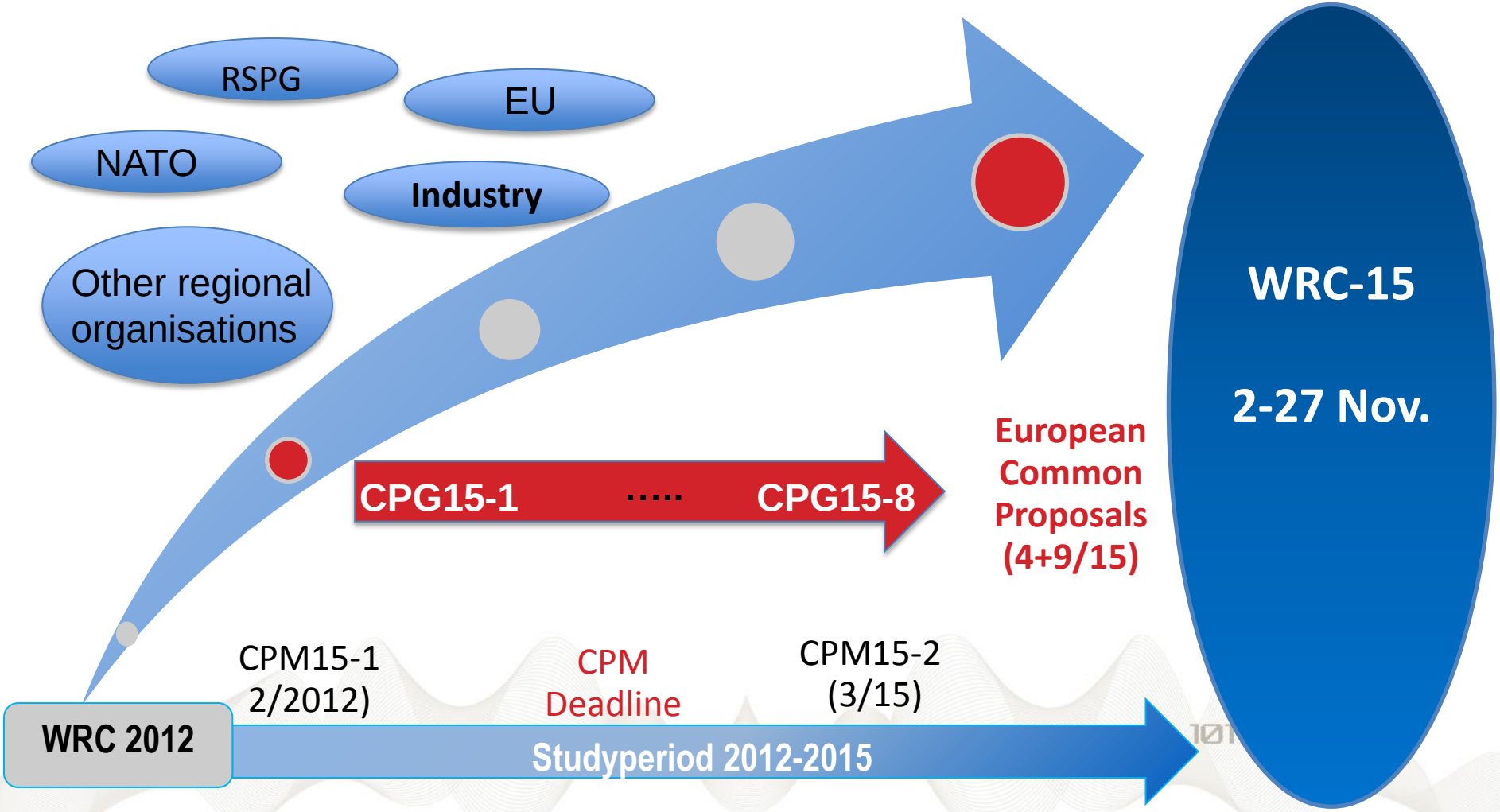
CEPT ECC
Electronic Communications Committee

# World Radiocommuncation Conference 2015

Alexander Kühn
Chairman CPG15

alexander.kuehn@bnetza.de

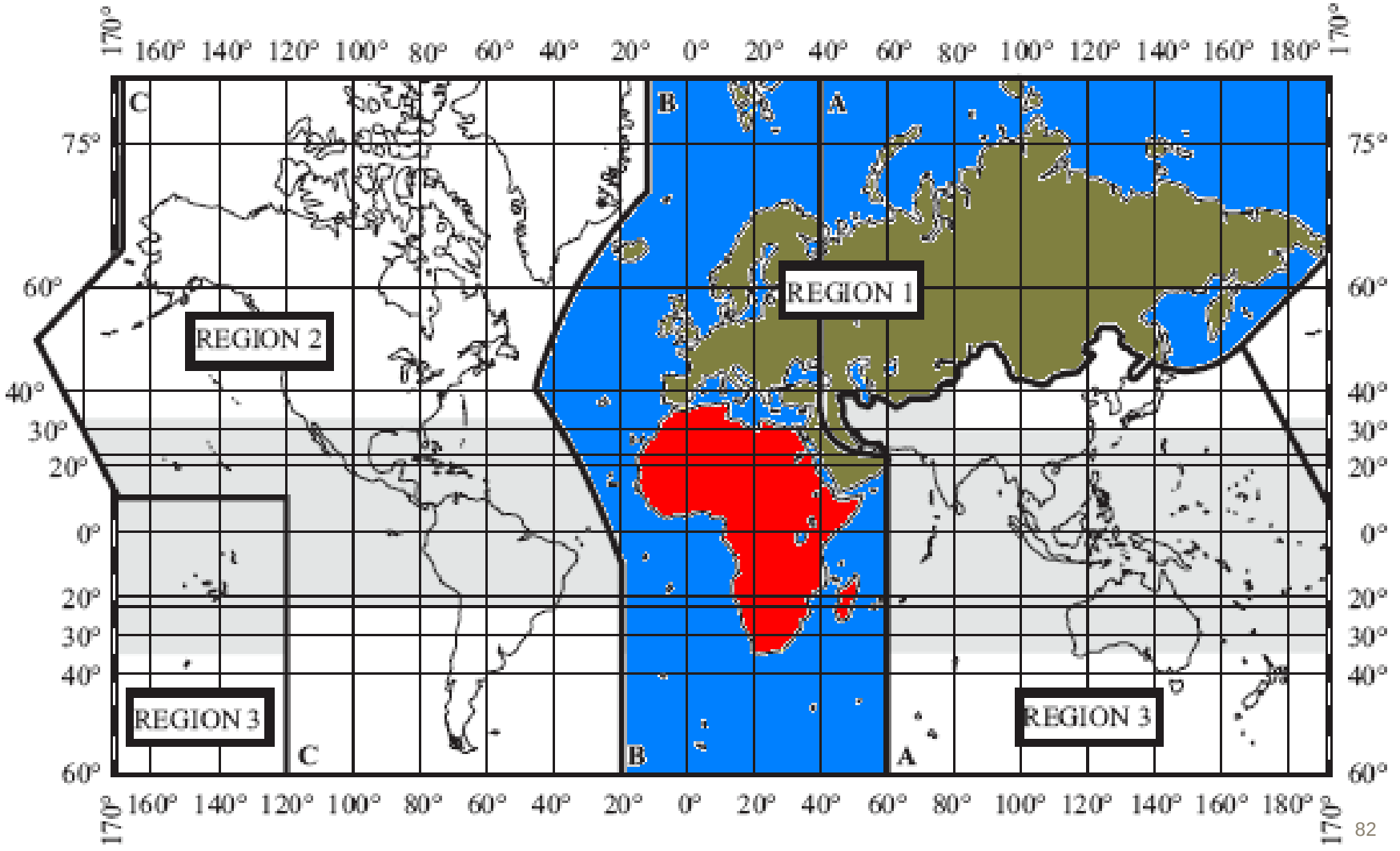
# Timeline


RSPG
EU
NATO
Industry
Other regional organisations
CPG15-1 ..... CPG15-8
European Common Proposals (4+9/15)
WRC-15
2-27 Nov.
CPM15-1 2/2012)
CPM Deadline
CPM15-2 (3/15)
WRC 2012
Studyperiod 2012-2015

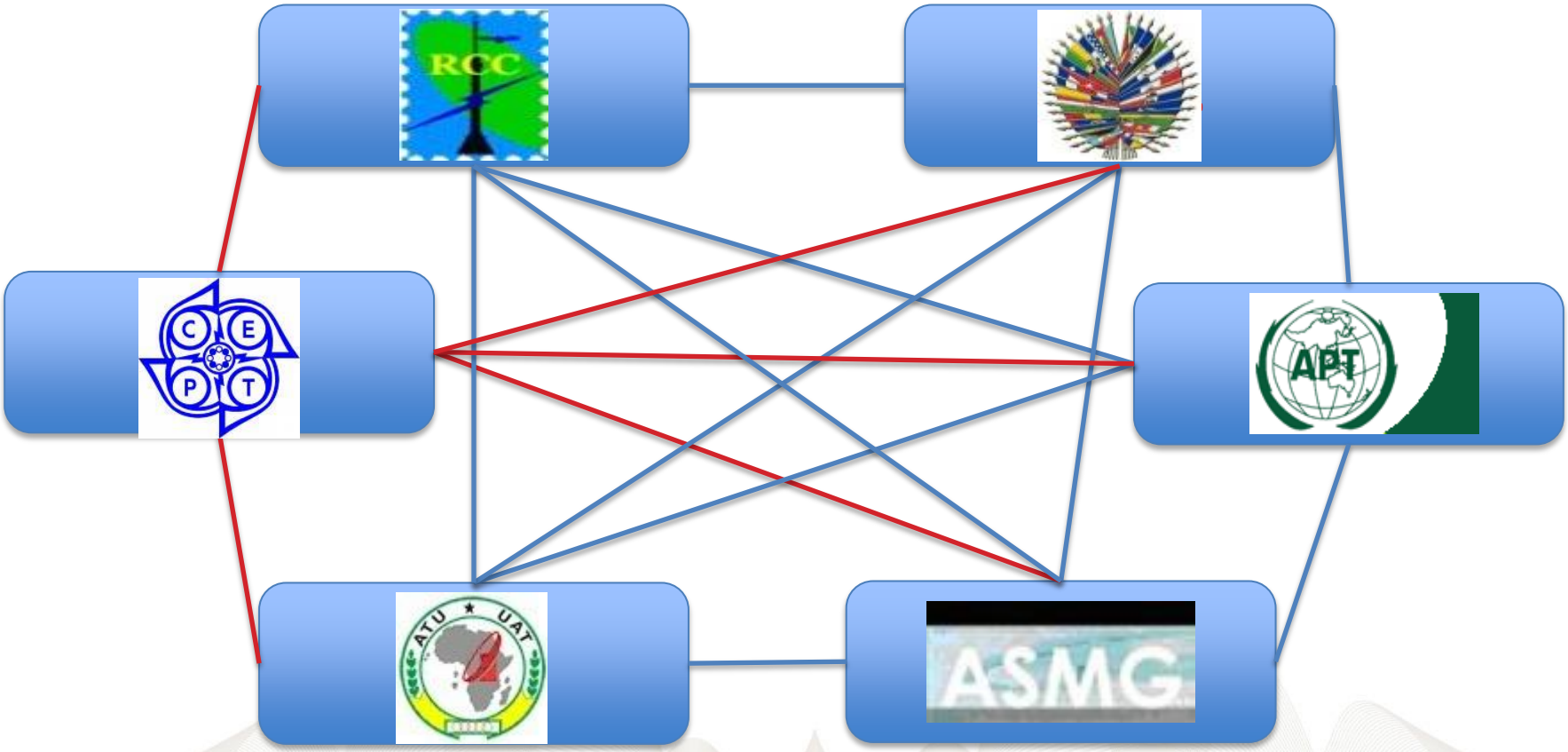
# In general

- WRC decisons are designated to create new opportunities for spectrum usage by innovative applications.
  - ↳ That does not imply any guarantee for efficient spectrum usage or market success.
- An international allocation does not preclude other usages, but may facilitate the need for national / regional considerations on the spectrum use in a specific band.
- Lessons learned:
  - Spectrum scarcity is constant and inevitable, but seems to promote dynamic innovation.
  - International preparation with other Regions and regional Organisations is getting more important.

# International perspective



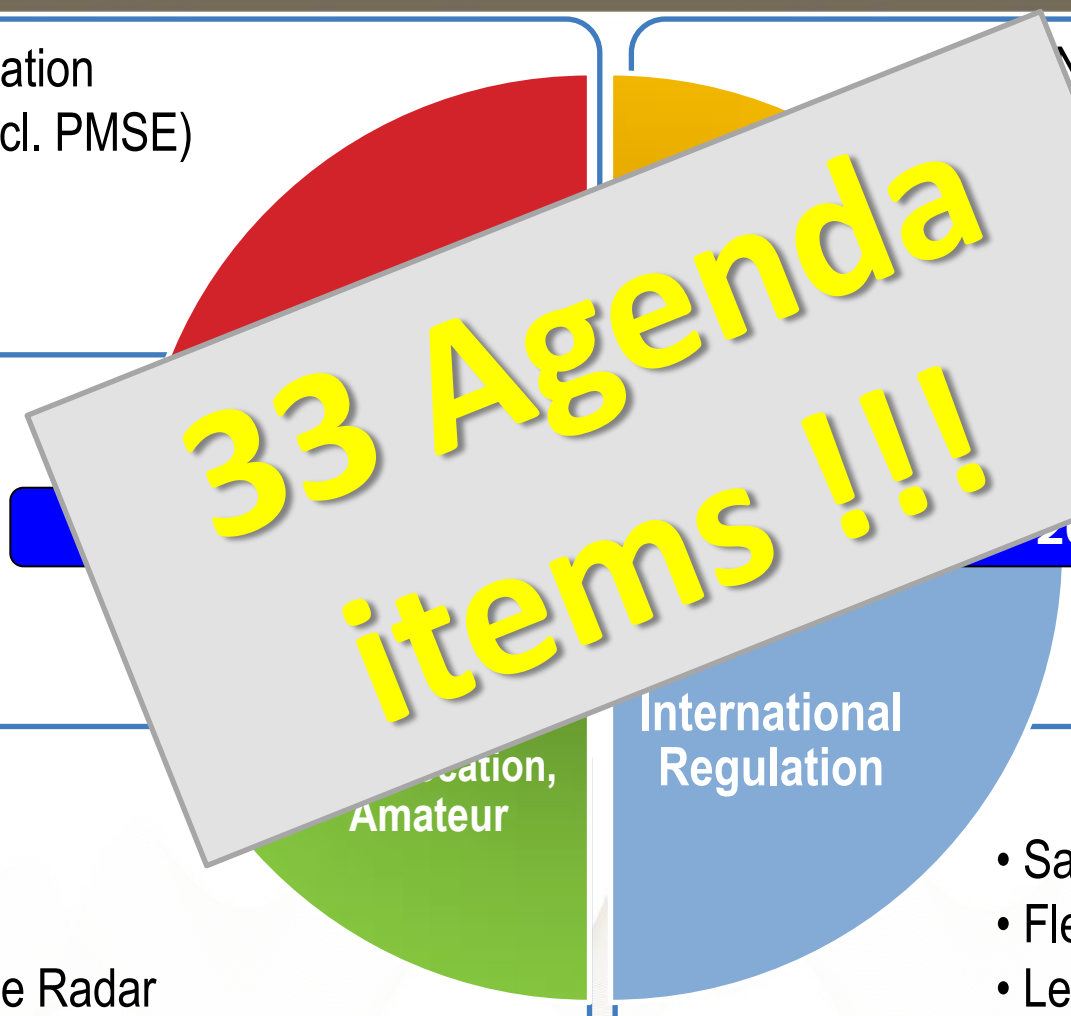
# The knot of international coordination…



# WRC-15

- IMT Identification
- 700 MHz (incl. PMSE)
- PPDR

- New FSS spectrum
- ESS (UL and DL)
- SS




33 Agenda items !!!

- UAS / FSS
- WAIC
- Short Range Radar

- Satelliteregulation
- Flexibility / Definitions
- Leap Second

# CEPT is currently aiming at…MOBILE BROADBAND

New spectrum (1.1)

- All Bands between 400 MHz and 6 GHz are under consideration.
- Harmonised bands (1427-1518 MHz and 3400-3800 MHz)
- Corresponding international regulatory provisions, which allow an economic use of the band 1427-1518 MHz

700 MHz (1.2)

- Coordination with other services
  - by application of existing agreements – Broadcasting or
  - under a common framework – Radionavigation
- Technical criteria to protect digital Television below 694 MHz

# CEPT is challenged with…

„Leap second“ (1.14)

- Objective to achieve a continuous time scale
- Highly sensitive issue

Satellite Procedures (7, 9.1, 9.2, 9.3)

- Nano-Pico satellites with high commercial potential
- Growing number of issues on satellite regulation – also on very short notice

Global flight tracking (NEW)

- Issue discussed at highest level
- Short timeframe to conduct necessary technical work.

# Outlook

- Collecting proposals for new agenda items
  - IMT above 6 GHz (Spectrum for 5G)
  - Nano- Picosatellite Regulation
  - ....
- Constant study period: Next WRC envisaged in 2019!
- Challenges:
  - How to address urgent issues?
  - Strengthening international harmonisation
  - Involvement of the European Commission (?)
  - ...

Alexander Kühn

Chairman CPG-15

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Nyropsgade 37, 4th floor

DK-1602 Copenhagen

Tel: +45 33 89 63 00

# THE INTERNET OF THINGS

David Harrison, Technology Strategy Director, Ofcom

Changes & Challenges

# Panel

**Wendy McMillan, Managing Director Smart Metering & M2M**
Arqiva

**Dominique Guinard, Co-founder and Chief Technology Officer**
EVRYTHNG

**Stan Boland, Chief Executive Officer**
Neul

**David Lister, Research Manager**
Vodafone Group R&D

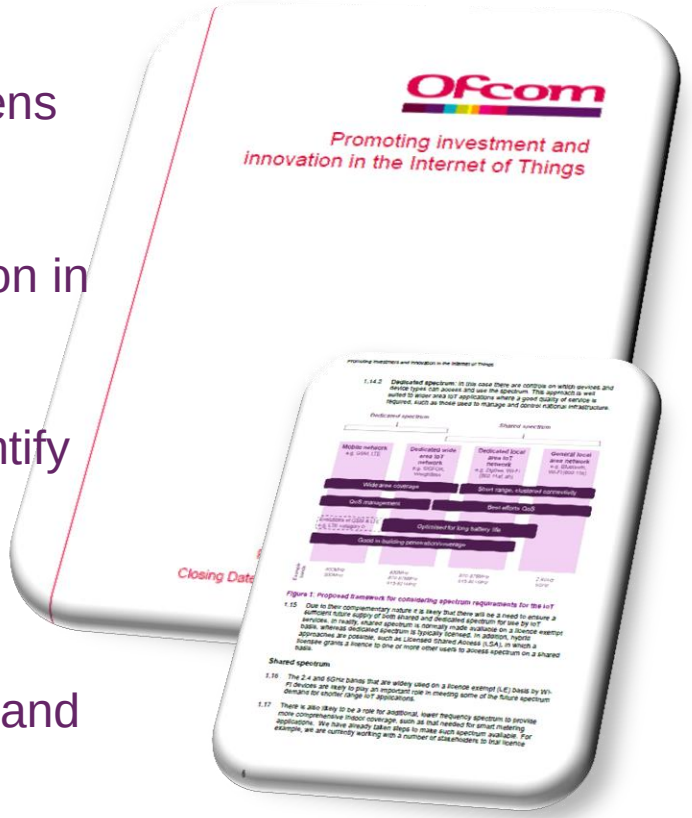
# Ofcom interest in the Internet of things ….

Potential to deliver significant benefits for citizens and consumers

Opportunity for significant growth and innovation in the UK

The aim of our recent Call for Input was to identify potential barriers to its future development and where we might be able to help:

1. Spectrum
2. Numbers and addresses for identifying and authenticating devices
3. Network resilience and reliability
4. Access to big data and consumer privacy …



Changes & Challenges

## Wendy McMillan
## Managing Director Smart Metering & M2M
## Arqiva

Ofcom


# Arqiva and the Internet of Things

Wendy McMillan

Managing Director – Smart Metering and M2M

# Arqiva's Business

## TV and Radio

"**Market leader** in terrestrial TV and radio broadcast infrastructure"

## Satellite

"Nearly **50% market share** of UK channels uplinked"

## Telecoms and WiFi

"Own **largest independent** portfolio of WiFi/wireless sites"


## Smart Metering and M2M

"Building a smart network for **10m homes** and a **national IoT network**"

BBC
















# Arqiva's role in the Internet of Things

- Invest in infrastructure
- Focus on using the best technology to meet each customer's specific needs
- Connectivity is core to our proposition

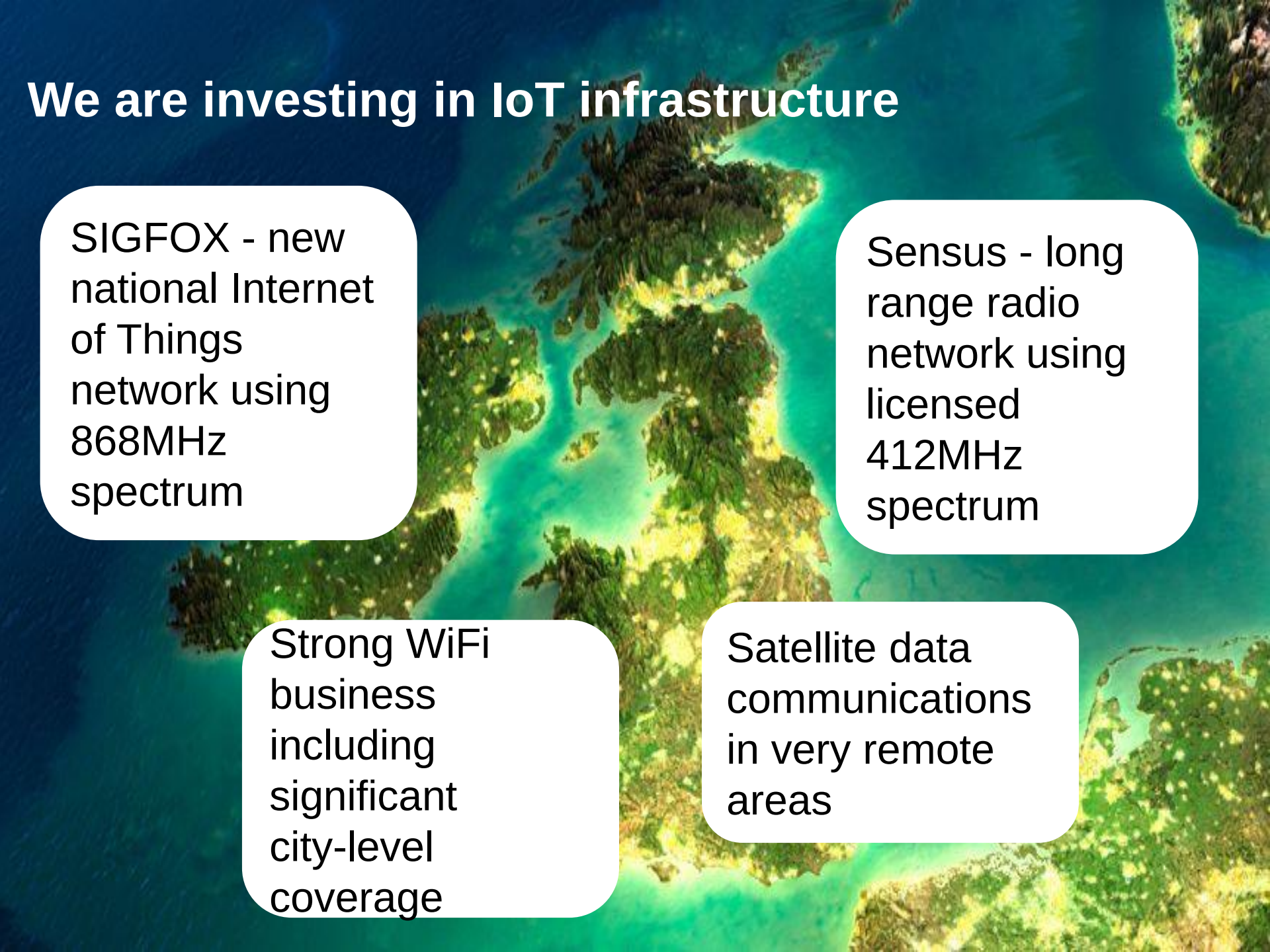
arqiva

# Customer needs are diverse

- Network coverage
- Managed vs. unmanaged LAN
- Display/keyboard requirements
- Length of battery life
- Security requirements
- Cost of modules
- Physical size of device

arqiva

# We are investing in IoT infrastructure



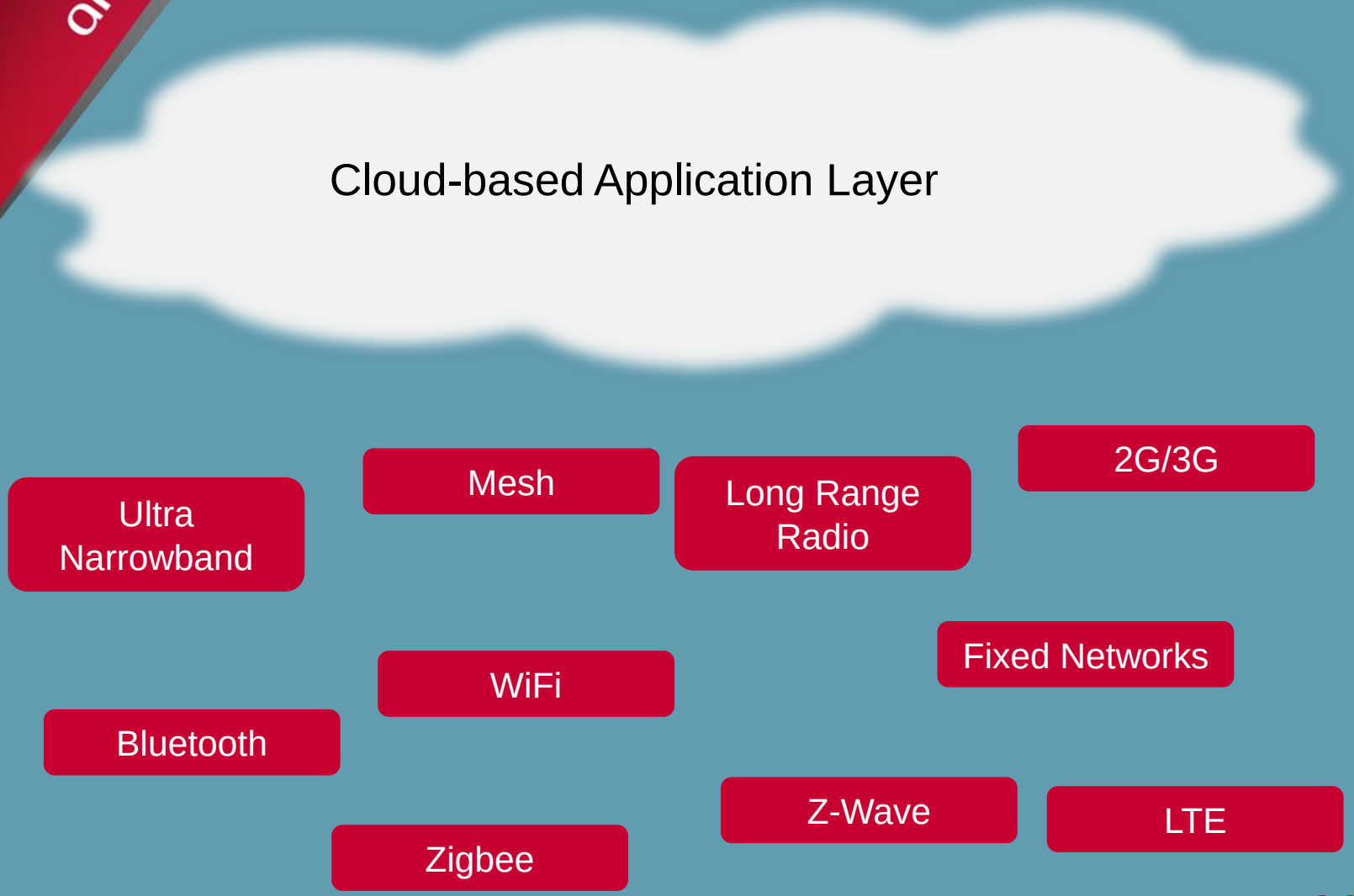
SIGFOX - new national Internet of Things network using 868MHz spectrum

Sensus - long range radio network using licensed 412MHz spectrum

Strong WiFi business including significant city-level coverage

Satellite data communications in very remote areas

# Complementary technologies



# Spectrum Requirements

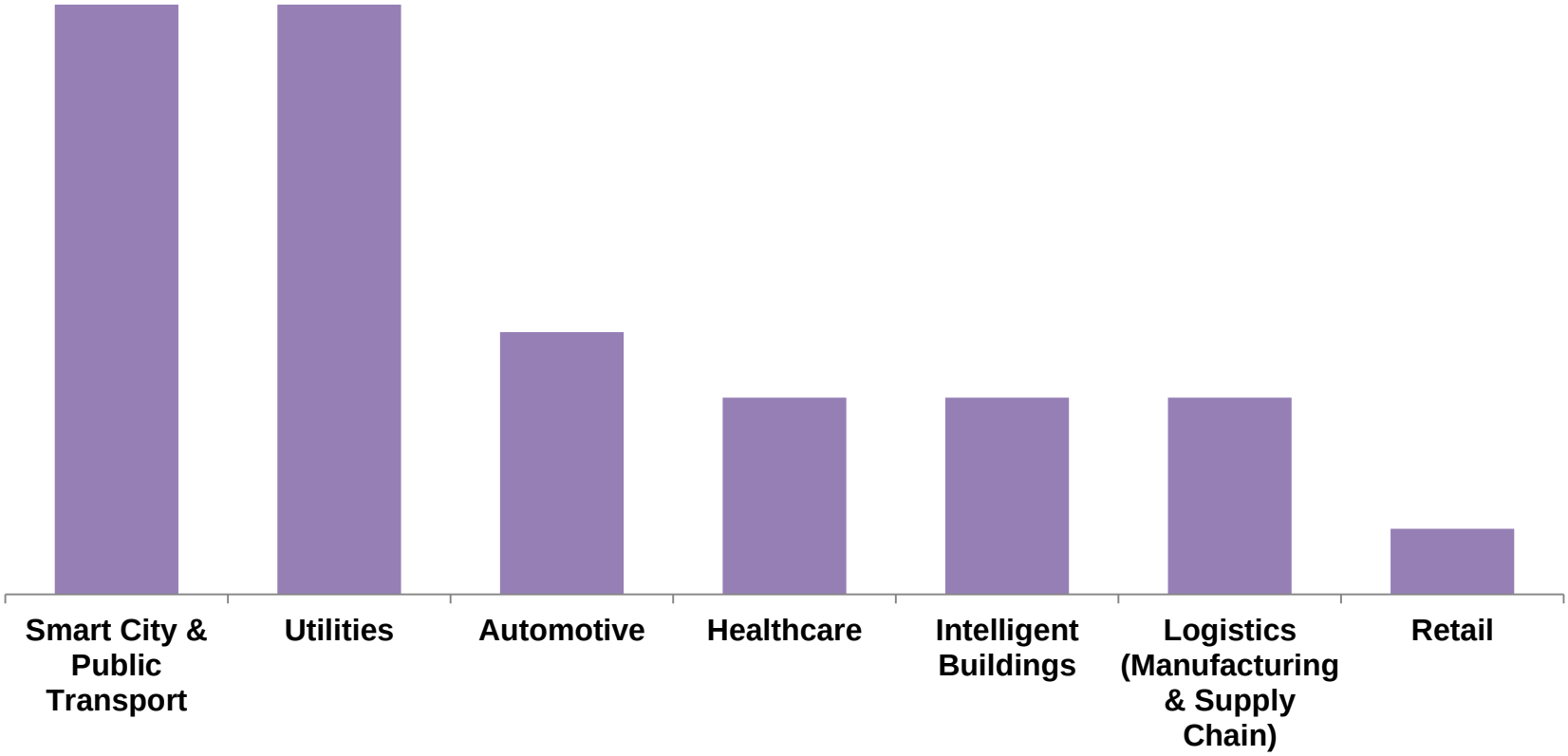
- **IoT applications often characterised by**:
  - Relatively low data throughput
  - Need for good coverage, including building penetration
  - Low energy consumption for long battery life
  - Low total cost of ownership
  - ‘Out of box’ simple deployment
- **Ideally suited to frequencies below 1GHz**
  - Unlicensed, such as ISM bands
  - Licensed and Harmonised
  - Licensed
- **Need to optimise end-to-end performance and reliability of networks**

# Perspective on IoT spectrum

- **Unlicensed spectrum** (e.g. 868Mhz ISM band) widely adopted for IoT ‘data harvesting’ networks with interoperability across EU
- Welcome **harmonisation** of 870-876MHz spectrum
- **Licensed spectrum (e.g 412MHz used for smart metering)** valuable for high availability, 2-way critical services, where QoS must be guaranteed
- Ensure regulation supports **market choice and opportunity for competition** between new market entrants and established cellular networks

# Relative scale of opportunities in our pipeline

**We are being approached about IoT opportunities using our technologies by companies across a wide range of sectors**



# Arqiva and the Internet of Things

Wendy McMillan

Managing Director – Smart Metering and M2M

Changes & Challenges

## Dominique Guinard
## Co-founder and Chief Technology Officer
## EVRYTHNG

Ofcom

Dominique Guinard
twitter: @domguinard
CTO & Co-founder @ EVRYTHNG


# Fostering the Internet and the Web of Things

## Definitions and Challenges

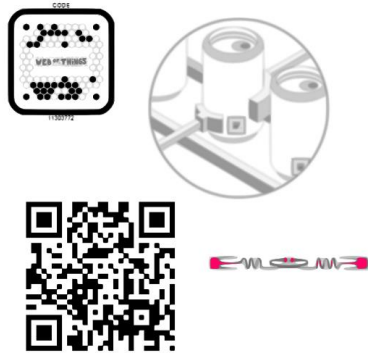
EVRYTHNG makes products smart, interactive and trackable by connecting them to the Web.

# IOT AT LARGE

# All things considered!

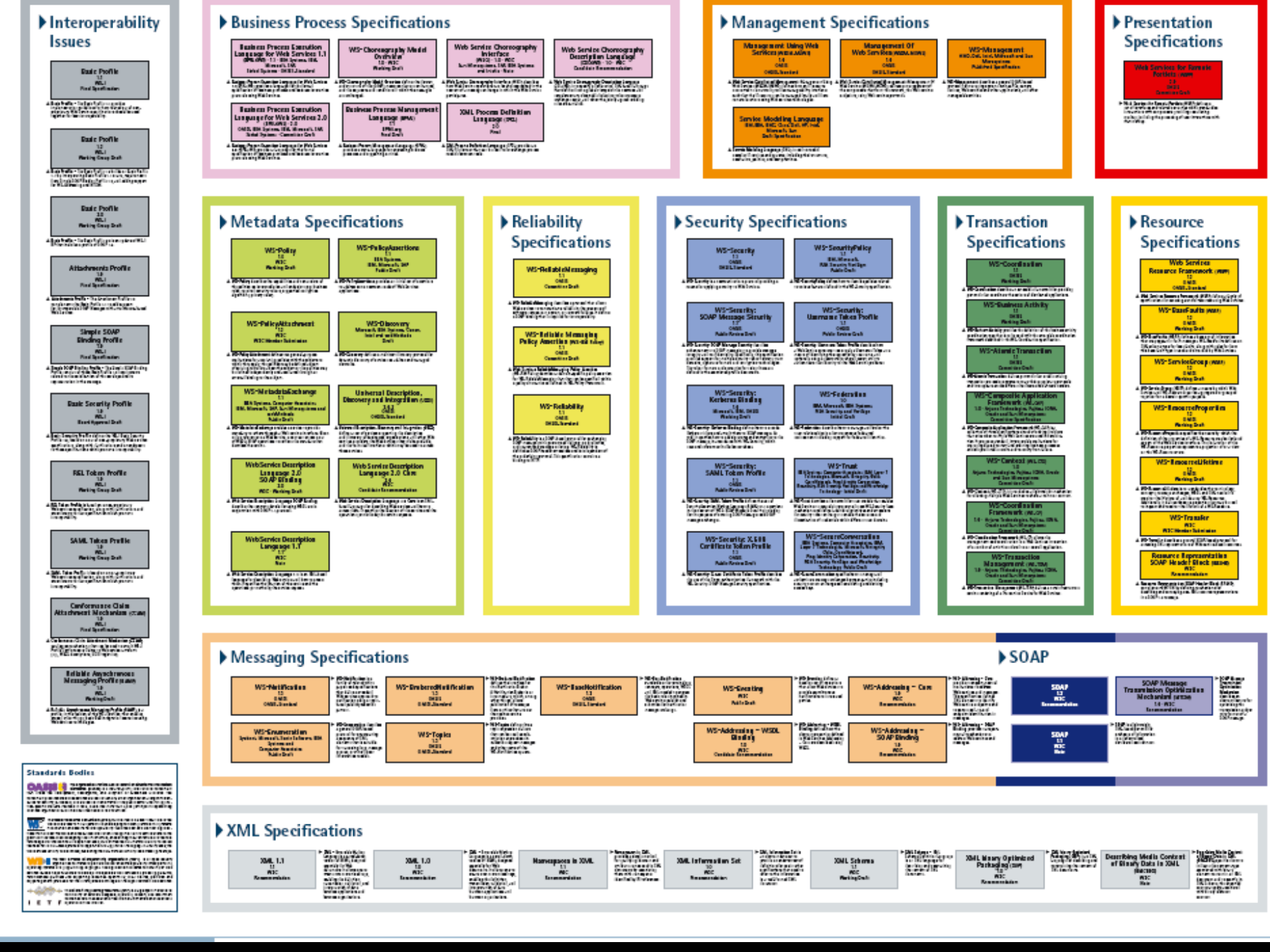
From machines & home appliances...

to sensor networks...



and tagged objects.

# IOT VS WOT


Interoperability Issues
Basic Profile
Basic Profile
Basic Profile
Attachments Profile
Simple SOAP Binding Profile
Basic Security Profile
REL Token Profile
SAML Token Profile
Conformance Claim Attachment Mechanism
Reliable Asynchronous Messaging Profile
Standards Bodies
OASIS
W3C
WS-I
IETF
Business Process Specifications
Business Process Execution Language for Web Services 1.1
WS-Choreography Model Overview
Web Service Choreography Interface
Web Service Choreography Description Language
Business Process Execution Language for Web Services 2.0
Business Process Management Language
XML Process Definition Language
Management Specifications
Management Using Web Services
Management Of Web Services
WS-Management
Service Modeling Language
Presentation Specifications
Web Services for Remote Portlets
Metadata Specifications
WS-Policy
WS-PolicyAssertions
WS-PolicyAttachment
WS-Discovery
WS-MetadataExchange
Universal Description, Discovery and Integration
WebService Description Language 2.0 SOAP Binding
Web Service Description Language 2.0 Core
WebService Description Language 1.1
Reliability Specifications
WS-ReliableMessaging
WS-Reliable Messaging Policy Assertion
WS-Reliability
Security Specifications
WS-Security
WS-SecurityPolicy
WS-Security: SOAP Message Security
WS-Security: Username Token Profile
WS-Security: Kerberos Binding
WS-Federation
WS-Security: SAML Token Profile
WS-Trust
WS-Security: X.509 Certificate Token Profile
WS-SecureConversation
Transaction Specifications
WS-Coordination
WS-Business Activity
WS-Atomic Transaction
WS-Composite Application Framework
WS-Context
WS-Coordination Framework
WS-Transaction Management
Resource Specifications
Web Services Resource Framework
WS-BaseFaults
WS-ServiceGroup
WS-ResourceProperties
WS-ResourceLifetime
WS-Transfer
Resource Representation SOAP Header Block
Messaging Specifications
WS-Notification
WS-BrokeredNotification
WS-BaseNotification
WS-Eventing
WS-Addressing – Core
WS-Enumeration
WS-Topics
WS-Addressing – WSDL Binding
WS-Addressing – SOAP Binding
SOAP
SOAP 1.2
SOAP Message Transmission Optimization Mechanism
SOAP 1.1
XML Specifications
XML 1.1
XML 1.0
Namespaces in XML
XML Information Set
XML Schema
XML Binary Optimized Packaging
Describing Media Content of Binary Data in XML

# Web of Things vs. Internet of Things

**"Application architecture for physical objects"**
- **D. Guinard, V. Trifa, E. Wilde, D. Raggett ~ 2007**

How do we connect applications & things?

***Applications?***
- **OSI Layer 7 + : -)**
- **HTTP, REST, JSON, Pub/sub**
- **Social nets, semantics**
- **Mashups**

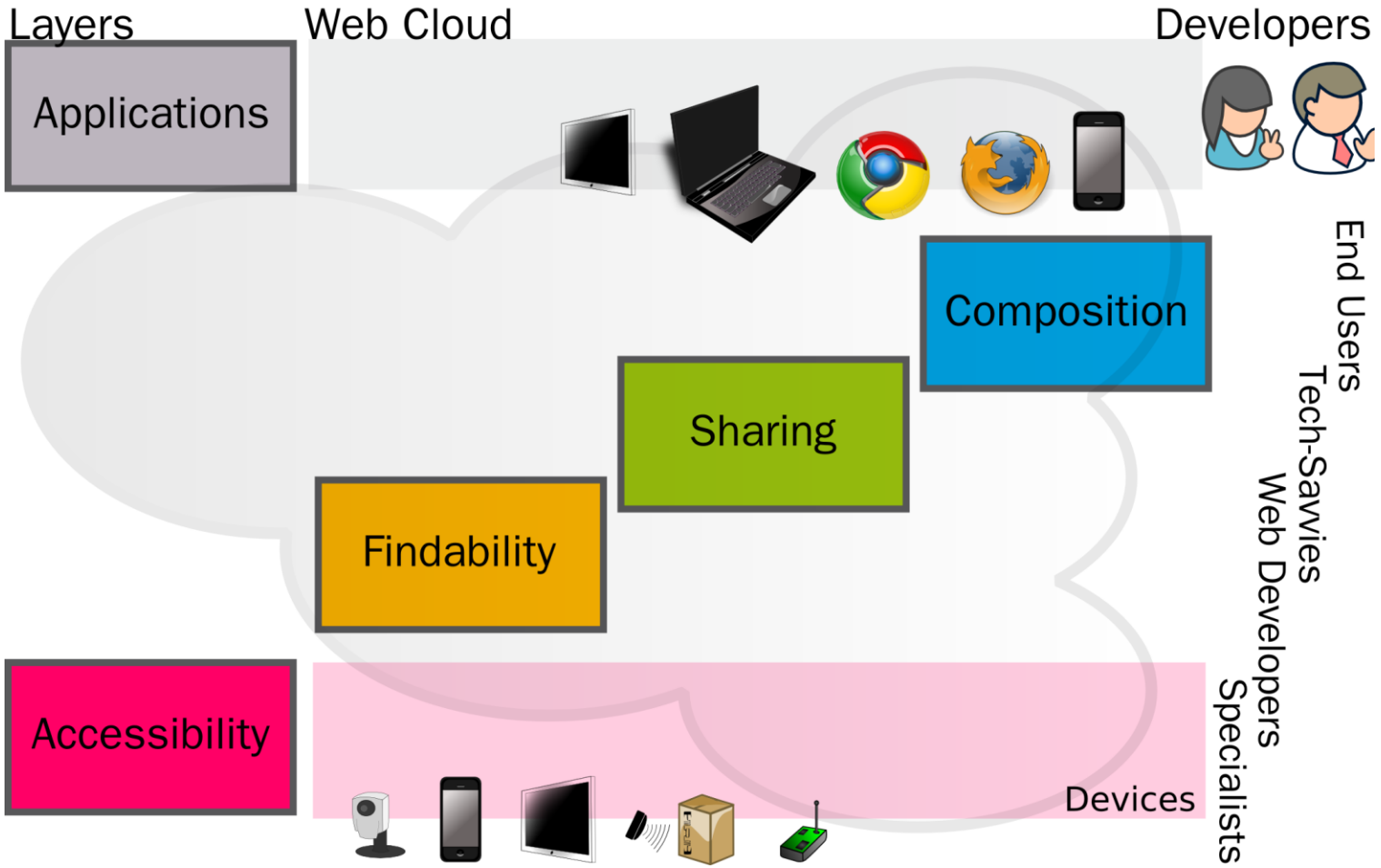
How do we connect things to the Internet?

**"Uniquely identifiable objects and their virtual representations in an Internet-like structure"**
- **Auto-ID Labs (K. Ashton, S. Sarma, F. Mattern) ~ 1999**

***Networking?***
- **OSI Layer 4 –**
- **IPv6lowpan, EPC, WiFi, BLE Zigbee / 800.15.04**

# Web of Things Application Architecture


http://www.webofthings.org/publications



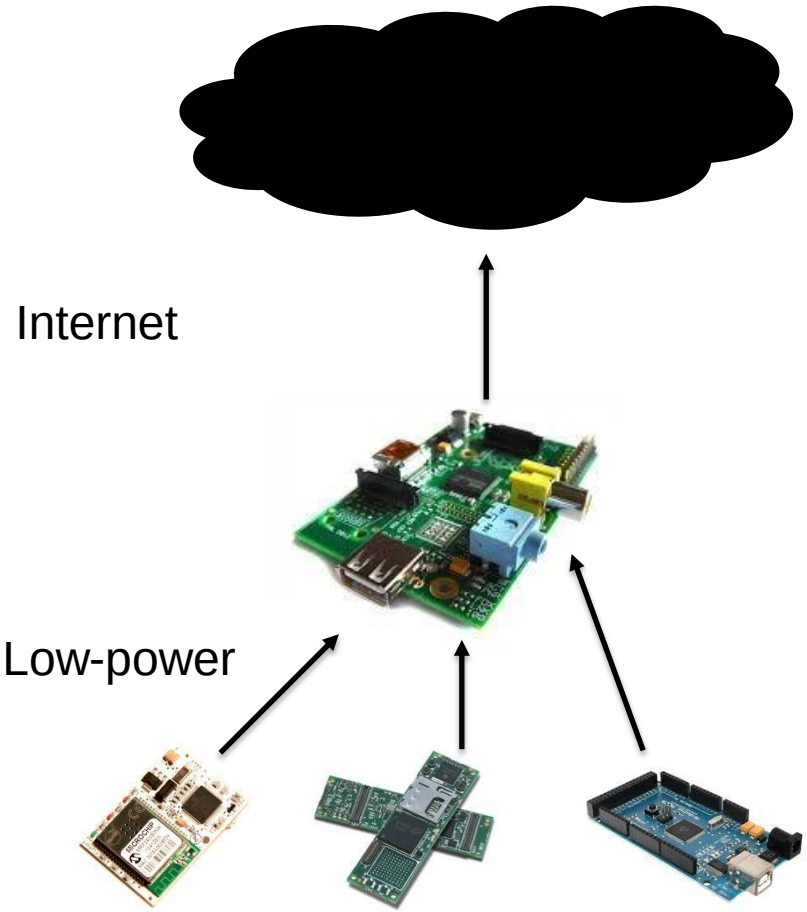
# A FEW CHALLENGES

# Low-power connectivity

- Power consumption
  - IoT's #1 problem
- (Too) many options:

WiFi, Weightless, ZigBee, CoAP & 6LoWPAN, NFC, Blue- Tooth & BLE, ANT, Infrared, USB, IEEE 1394, DASH7, KNX, EnOcean, GPRS/3G/4G, WiMAX, etc.

- Smart Gateways
  - OpenHab
  - Cisco IoX
  - Intel Moon Island



# Things' Semantics

- Semantic layer to help
  - Finding things
  - Semi-automate services
  - M2M communication
- Don't reinvent the wheel
  - Semantic Web
    - JSON-LD, RDFa, Microdata

Sharing

# End-to-end security

- Many many breaches to date…
- Web best practices
  - (SSL) TLS
  - End-to-end

SECURITY ■ Home Automation

Webportale oder zumindest indirekt über Server der Hersteller gesteuert. Und die können dabei sehr viele Daten über die Benutzer und ihr Verhalten sammeln. Dafür dürften sich sicher viele interessieren, allen voran natürlich die Marketingabteilungen. Google zum Beispiel ist bestimmt nicht aus Langeweile ins Geschäft mit der Heimautomation eingestiegen. George Orwell hat nur einen Big Brother beschrieben. Was der Autor wohl zur gerade entstehenden Welt mit mehreren Big Brothers sagen würde?

**Dipl.-Inform. Carsten Eilers** ist freier Berater und Coach für IT-Sicherheit und technischen Datenschutz und Autor einer Vielzahl von Artikeln für verschiedene Magazine und Onlinemedien.
www.ceilers-it.de, www.ceilers-news.de

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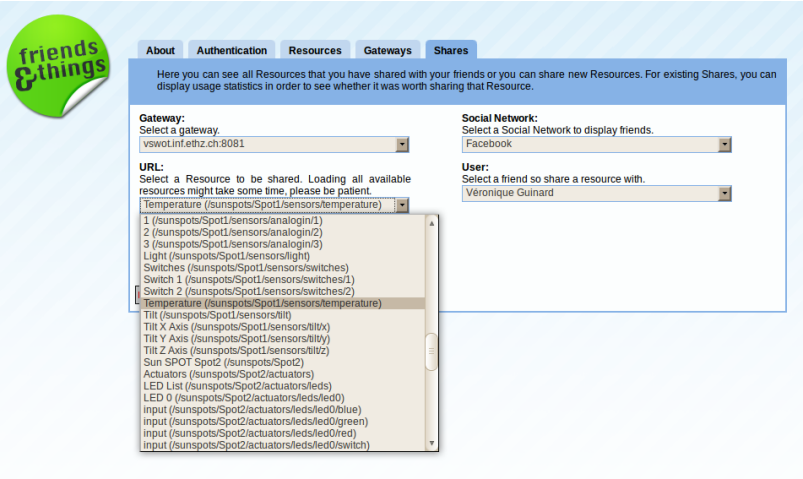
# Privacy & Sharing

- Privacy, data ownership, right to archive, etc.
- Models that foster data transport and access sharing
  - Unleash the IoT power

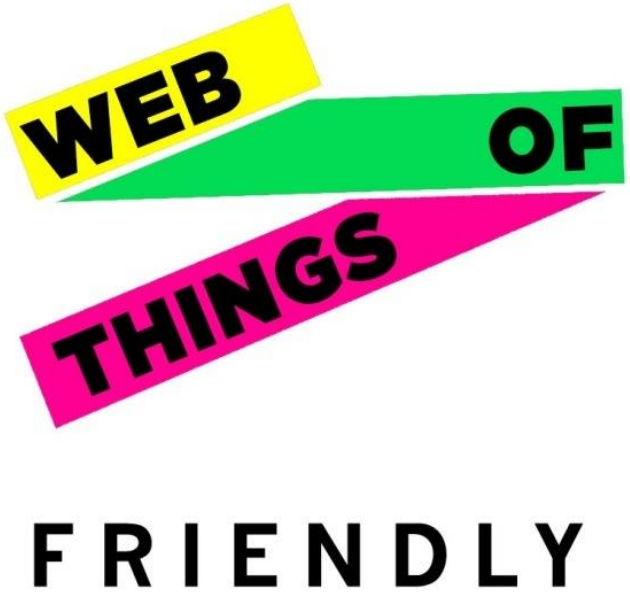


# Thanks for you attention!

**Dr. Dominique Guinard**

dom.guinard.org

**@domguinard**




http://www.webofthings.org/publications

Changes & Challenges

## Stan Boland
## Chief Executive Officer
## Neul

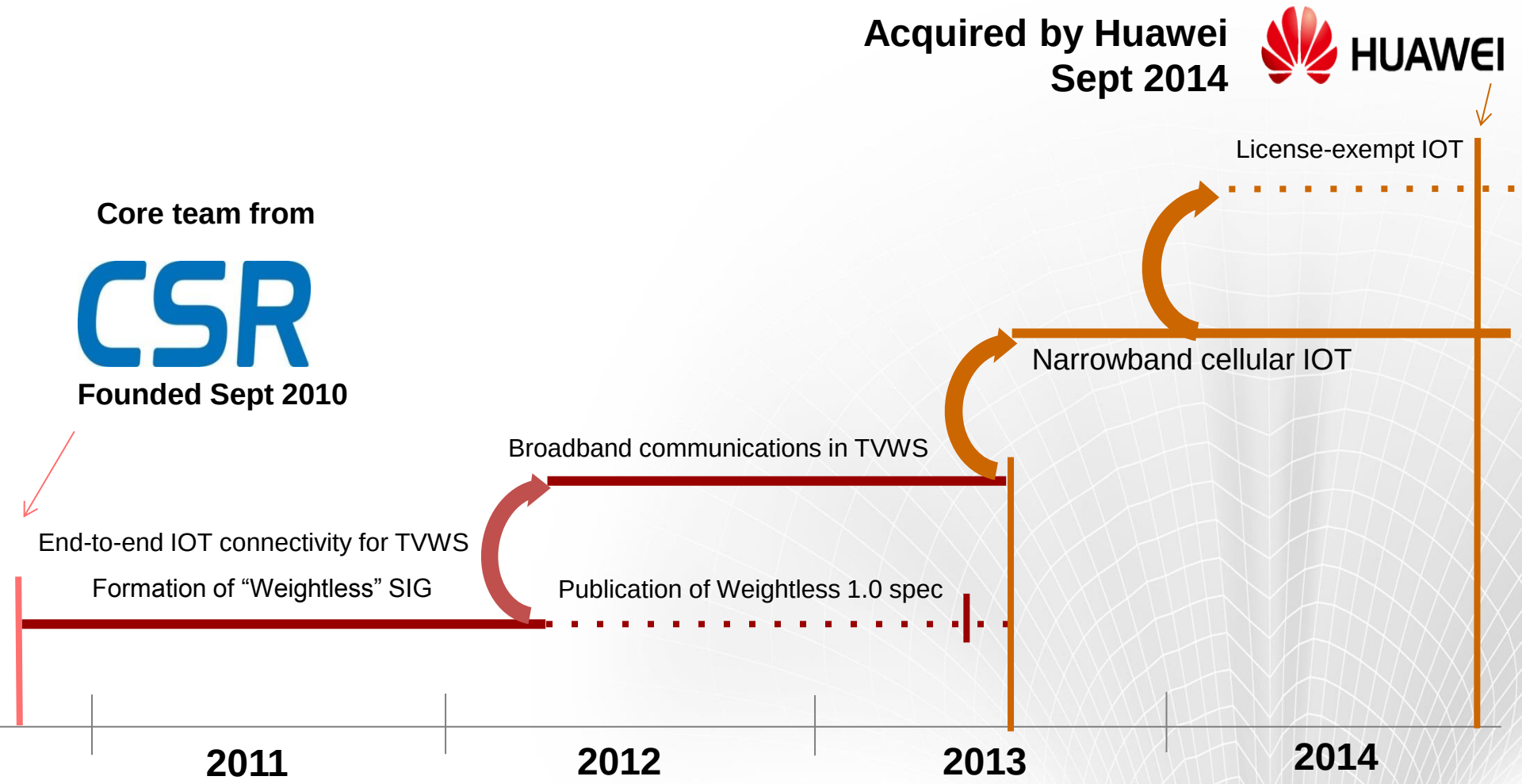
Ofcom

# OfCom Spectrum Event
# Neul Perspective
# October 2, 2014

www.huawei.com

neul HUAWEI

# Neul: Introduction and Timeline



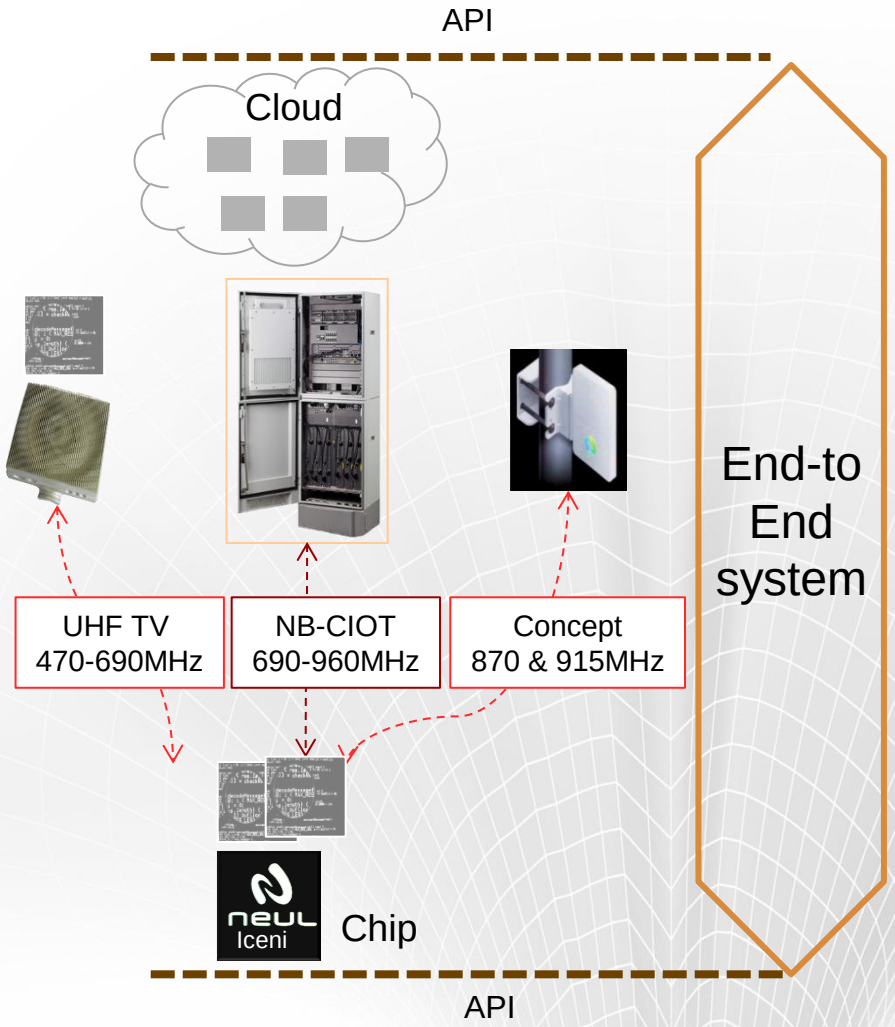
# Neul's Progress So Far

New, open-source, cloud-based core network & OSS for IoT

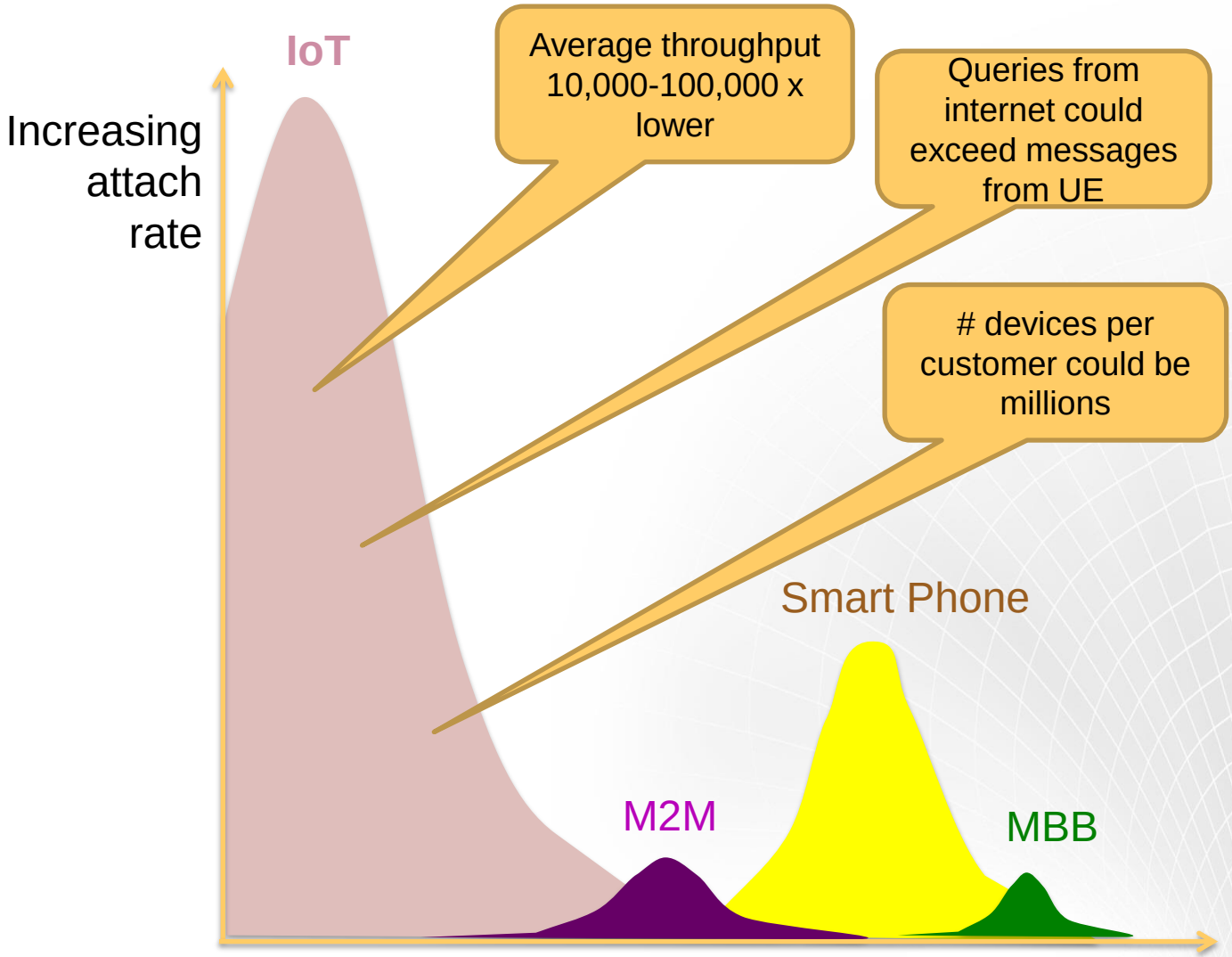
Joint leadership in defining NB Cellular IoT air interface specification and first trials

Novel and valuable IPR in future license-exempt systems

Working, flexible prototyping IC for developing & trialing IoT



# Vast Numbers of Connections Expected



# What type of Things will be connected?

## Anything with current going through it







## And a lot of things that don't, today





**Literally, almost anything and anyone!**



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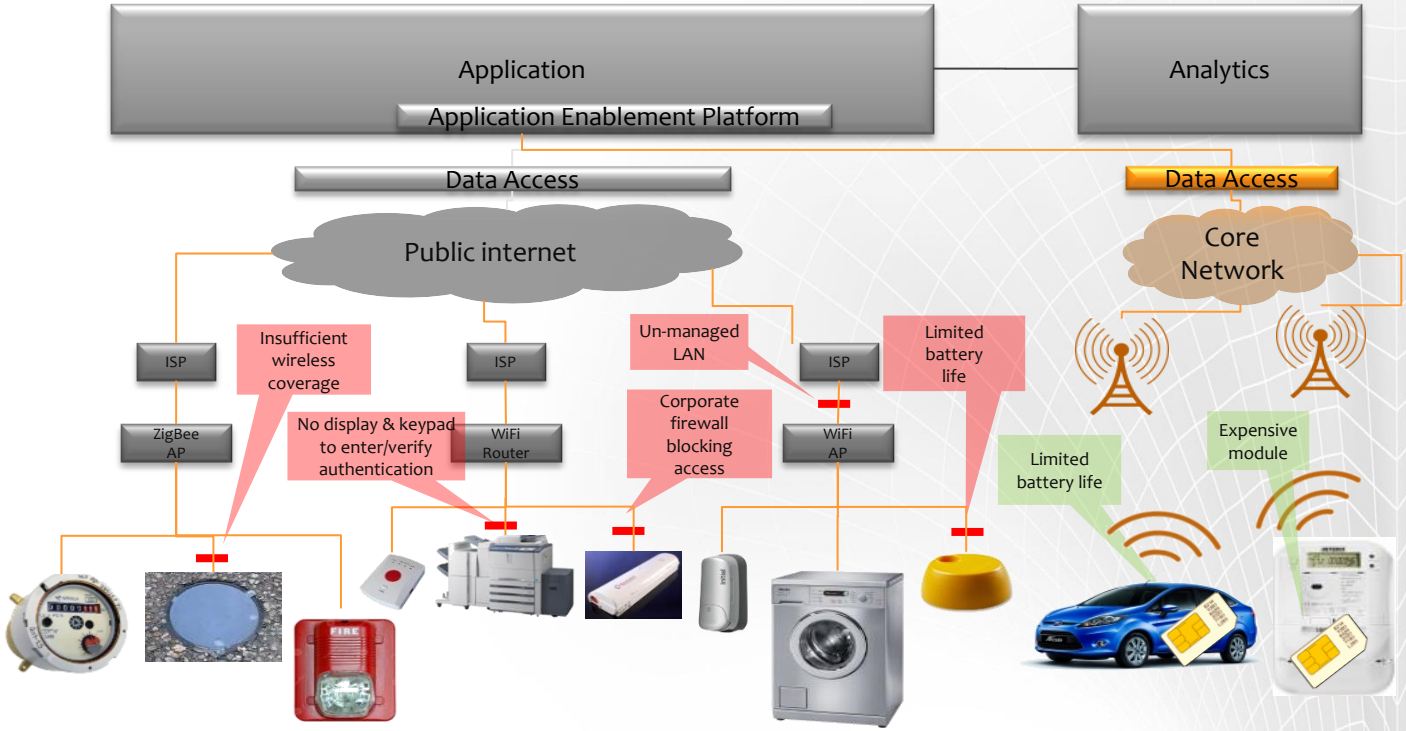
# ‘Internet of Things’ air interface

**Conventional view: we’ll connect Things using existing technology**

- LAN/PAN (WiFi, Bluetooth, ZigBee, RFID) 85%
- Cellular (GPRS, cdma, 3G, LTE-MTC) 15%



# New WAN ‘Internet of Things’ air interface

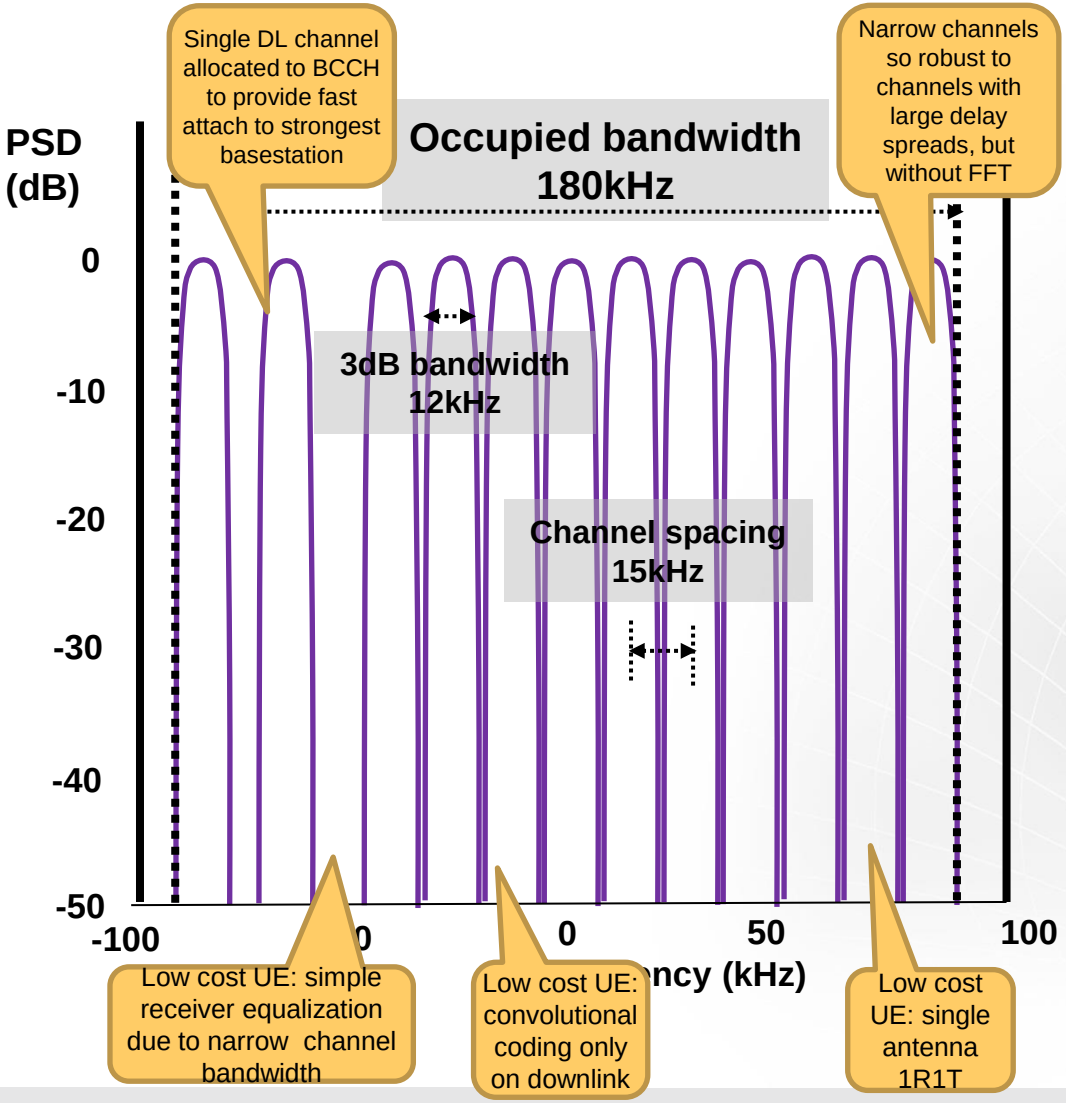
## What’s needed

- System scaleable to billions of devices
- Very long battery lives: cost of truck rolls >> modules
- Ultra-cheap user equipment (UE)
- Strong and uniform security
- Works globally in harmonized spectrum using existing infrastructure and co-existing with cellular

## Conventional cellular technologies don’t get us there

- Coverage must quickly become near-universal
  - Maximum coupling loss (link budget) 100x better (20dB) than GPRS
- IoT data payloads way below LTE-MTC
  - Scaleability and battery requirements means we need simplified protocols and low control traffic
- System can’t afford a separate SIM card
  - Yet we need uniform, reliable and persistent mutual authentication and cryptographic key exchange
- UEs cannot carry overhead or SEP % royalties of 3G or LTE
  - Must be FRAND-Z or ultra-low royalties and ~$3 modules

# Narrowband Cellular IoT Downlink PHY




**Wide range of deployment options**

**Each 200 kHz block is split into:**

- 12 x 15 kHz downlink channels
- 2 x 10 kHz guard bands

**Each is single carrier modulated**

- BPSK/QPSK/16-QAM
- RRC filtered with 3 dB bandwidth of 12 kHz

**Convolutional coding FEC (1/2 & ¾)**

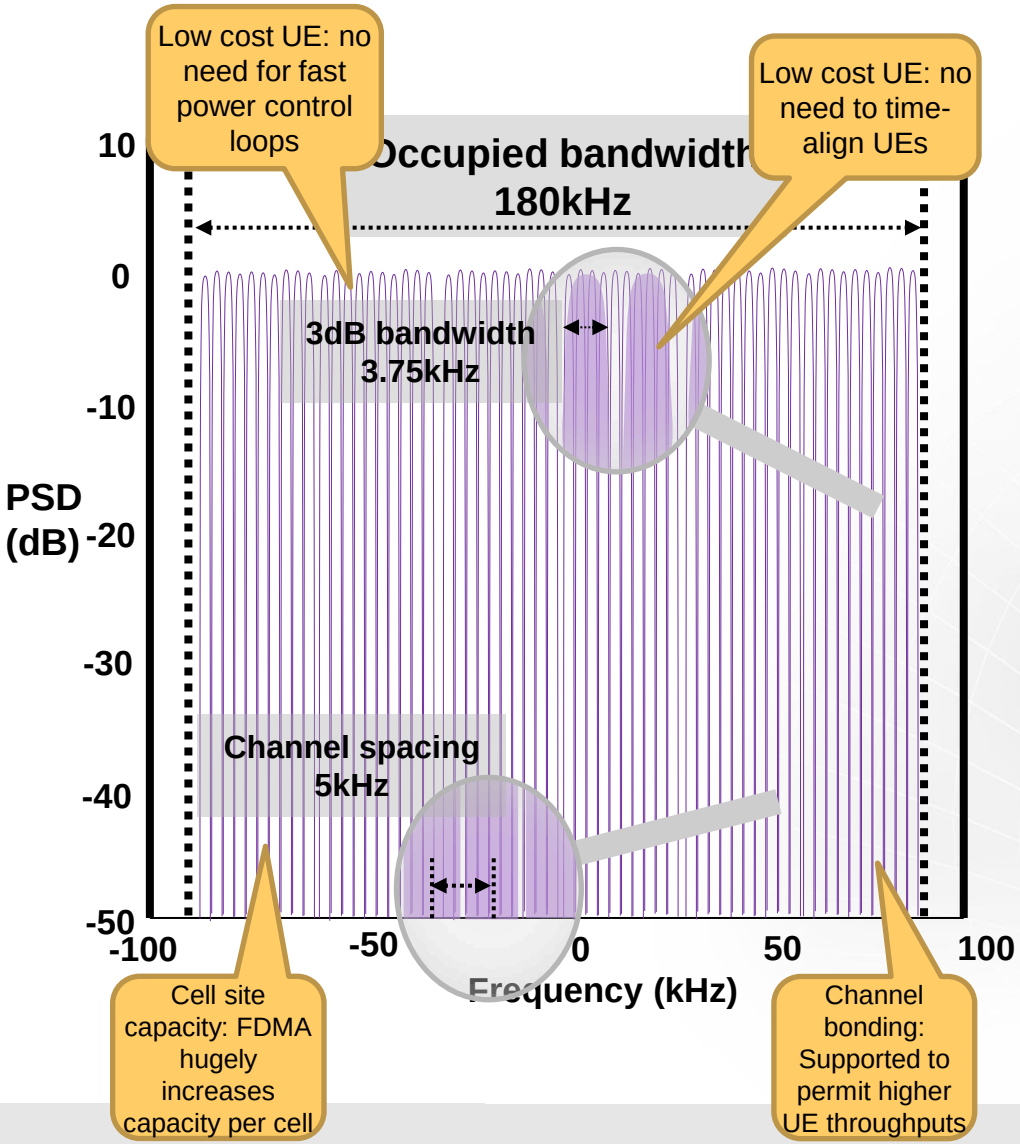
**Tx diversity at basestation**

- Alamouti space-time block coding

**Processing gain through spreading (1, 2, 4) and repetition (1, 2, 4, 8)**

**Channel tracking through insertion of pilot symbols**

# Narrowband Cellular IoT Uplink PHY




**200 kHz block is split into:**

- 36 x 5 kHz uplink channels
- 2 x 10 kHz guard bands

**Each is single carrier modulated**

- GMSK, BPSK, QPSK
- RRC filtered with 3 dB bandwidth of 3.75 kHz

**Turbo coding FEC (1/3 or 2/3)**

**Capacity delivered through FDMA**

**Processing gain through burst rate repetition (1, 2, 4, 8)**

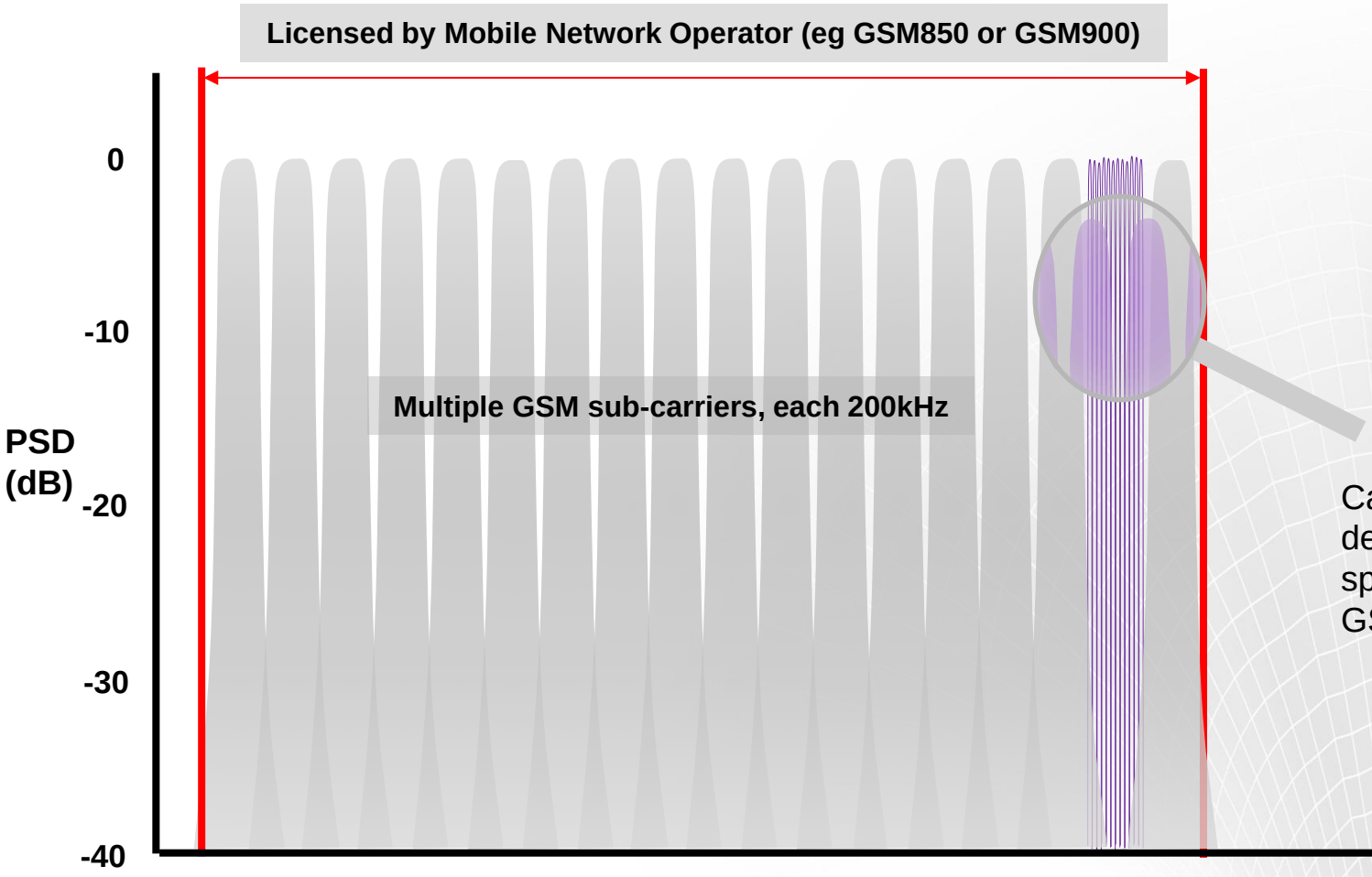
**Offers 20dB better uplink link budget than GPRS**

# >20dB Improved Link Budget

| | GPRS | | Cellular IoT | | |
|---|---|---|---|---|---|
| | Downlink | Uplink | Downlink | Uplink +23 dBm | Uplink +29 dBm |
| **Transmitter** | | | | | |
| (0) Total Tx power (dBm) | 43 | 29 | 43 | 23 | 29 |
| (1) Tx power per channel (dBm) | 43 | 29 | 32.2 | 23 | 29 |
| **Receiver** | | | | | |
| (2) Thermal noise density (dBm/Hz) | -174 | -174 | -174 | -174 | -174 |
| (3) Receiver noise figure (dB) | 9 | 5 | 9 | 5 | 5 |
| (4) Interference margin (dB) | 0 | 0 | 0 | 0 | 0 |
| (5) Occupied channel bandwidth (kHz) | 180 | 180 | 12 | 3.75 | 3.75 |
| (6) Effective noise power = (2) + (3) + (4) + 10 log((5)) (dBm) | -112.4 | -116.4 | -124.2 | -133.3 | -133.3 |
| (7) Required SINR (dB) | 7 | 11 | -7.5 | -5.0 | -5.0 |
| (8) Receiver sensitivity = (6) + (7) (dBm) | -105.4 | -105.4 | -116.7 | -138.3 | -138.3 |
| (9) Receiver processing gain (dB) | 0 | 5 | 0 | 0 | 0 |
| **Maximum coupling loss (MCL) = (1) – (8) + (9) (dB)** | **148.4** | **139.4** | **163.9** | **161.3** | **167.3** |

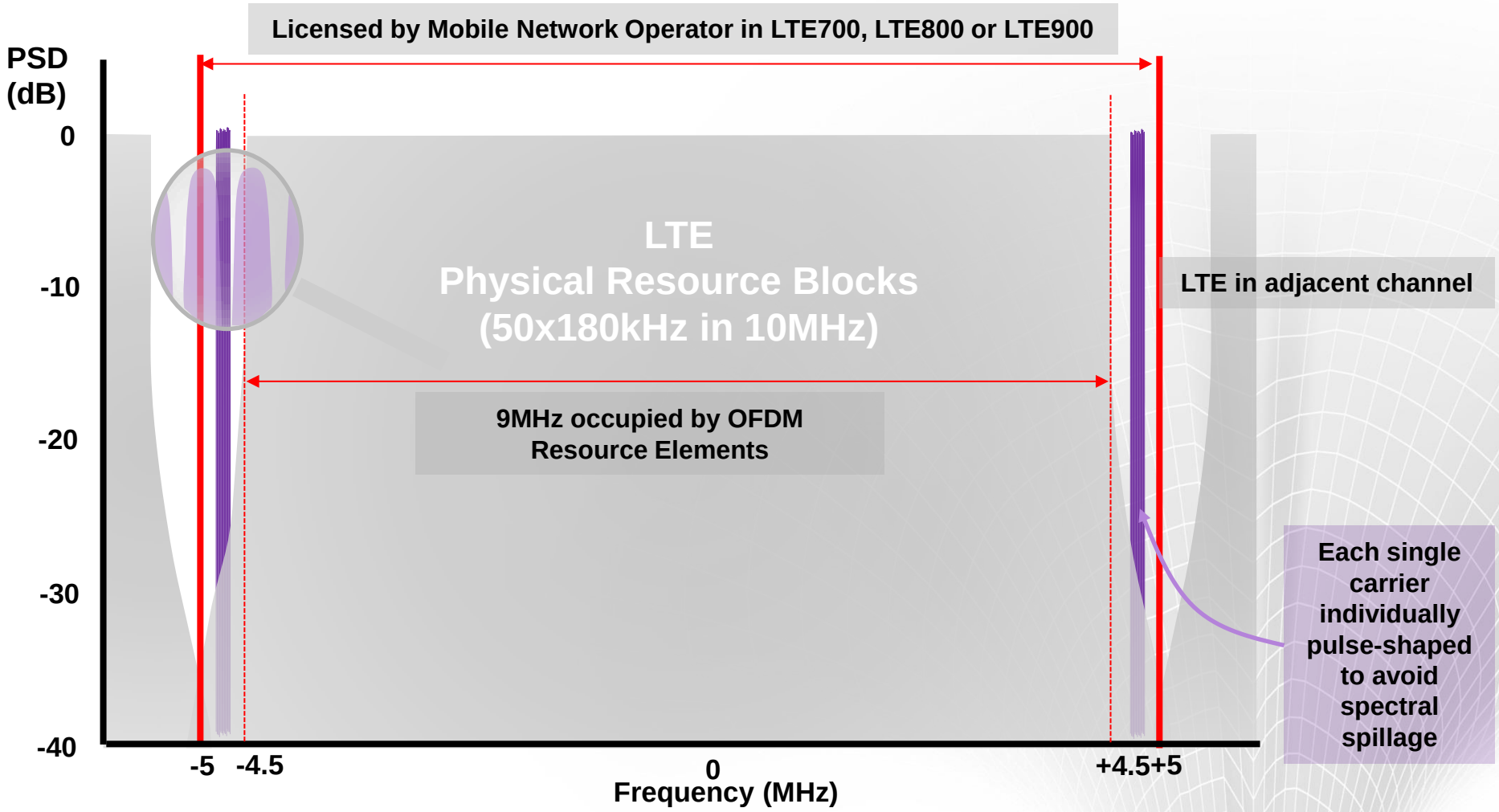
+22dB higher link budget at only 23dBm

# Attractive Strategy:
# Cellular IoT Insertion in GSM Sub-Carrier




Can also be deployed in left-over spectrum following GSM re-farming

# Possible Future Strategy: Cellular IoT Insertion in LTE Guard Bands



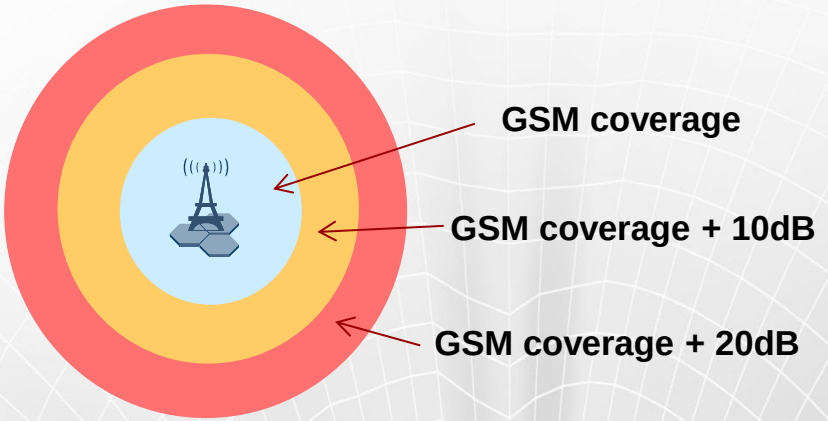
# These systems achieve long service lives on 50¢ batteries

| | Battery life for 2500 mAH x 3.7V capacity<br>Report = 100 bytes uplink, 20 bytes downlink | | |
|---|---|---|---|
| Coverage enhancement vs. GSM | 6 reports/hour | 1 report/hour | 1 report/day |
| 0 dB | 6.7 years | > 20 years | > 20 years |
| 0 – 10 dB | 3.0 years | 14.7 years | > 20 years |
| 10 – 20 dB | 0.4 years | 2.3 years | > 20 years |

**eg** parking sensor

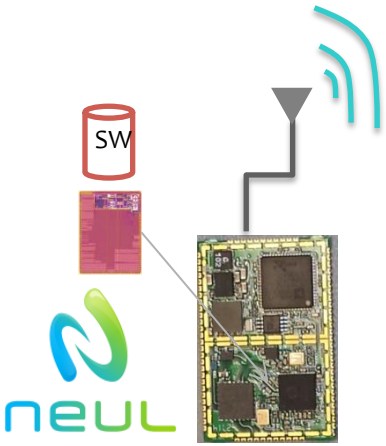
**eg** gas or electric meter

**eg** fire alarm or water meter



# Multi-party NB Cellular IoT Cooperation in Licensed Spectrum

1. Convergence on NB Cellular-IoT PHY & MAC






2. Trial in GSM900
   *Implemented in 200kHz sub-carrier*

3. Work now a study item in 3GPP GERAN



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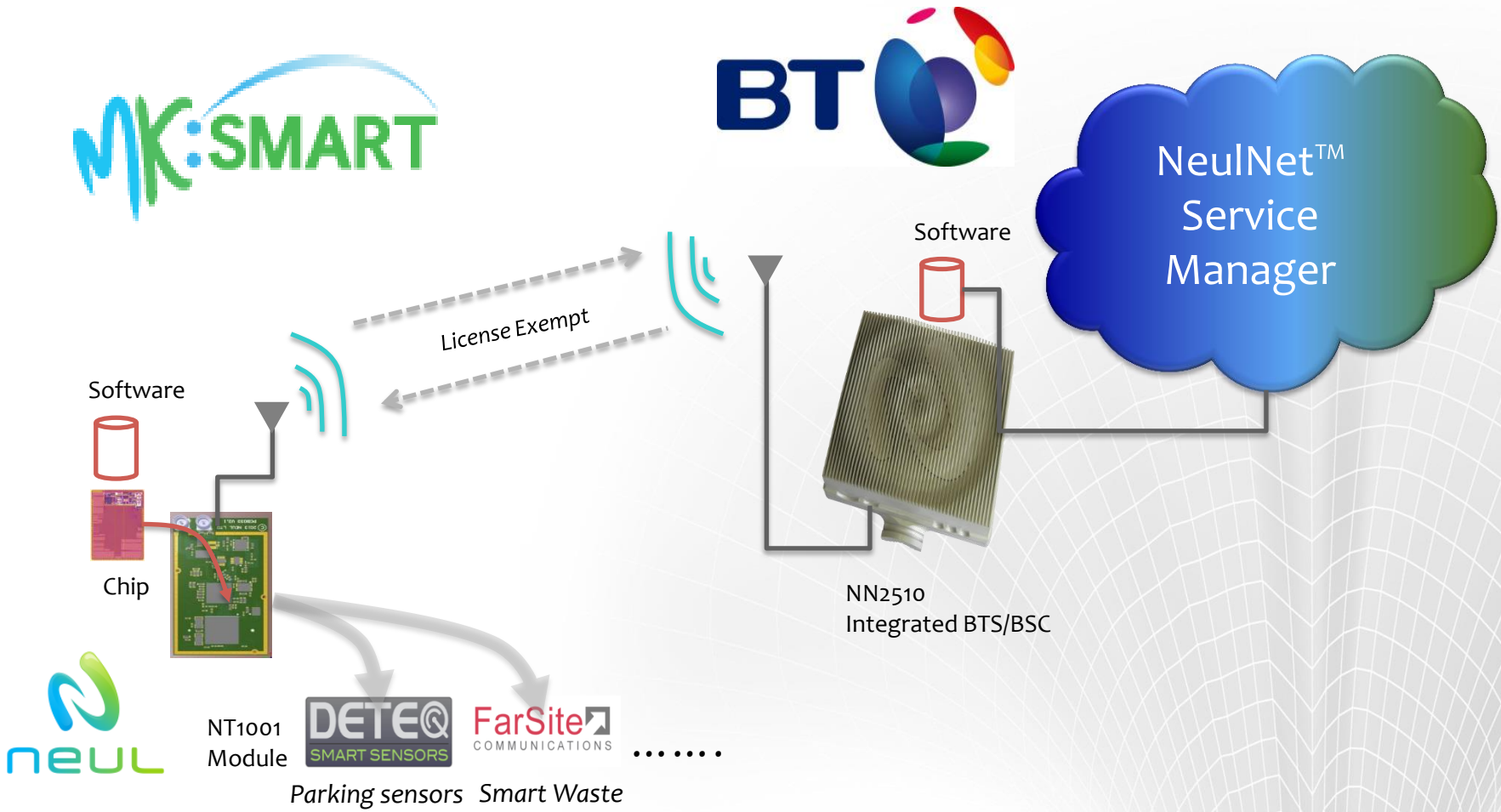
# License-exempt Low Power WAN trial 2014



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# Use of spectrum should be friendly to IoT and harmonized regionally and globally

**No point in any one country trying to do its own thing since the air interface design is highly dependent on Tx power, duty cycle etc**

**No point in each country using different frequencies since that means large antennas and expensive components**

**Global CE companies will deploy in consumer products and wearables if UEs are small, cheap and there's a high probability of a network being available**

- Licensed spectrum:
  - GSM850, GSM900
  - LTE700, LTE800, LTE900
- Unlicensed spectrum:
  - EU: 868MHz, 870-876MHz
  - US: 902-928MHz
- Other bands possible

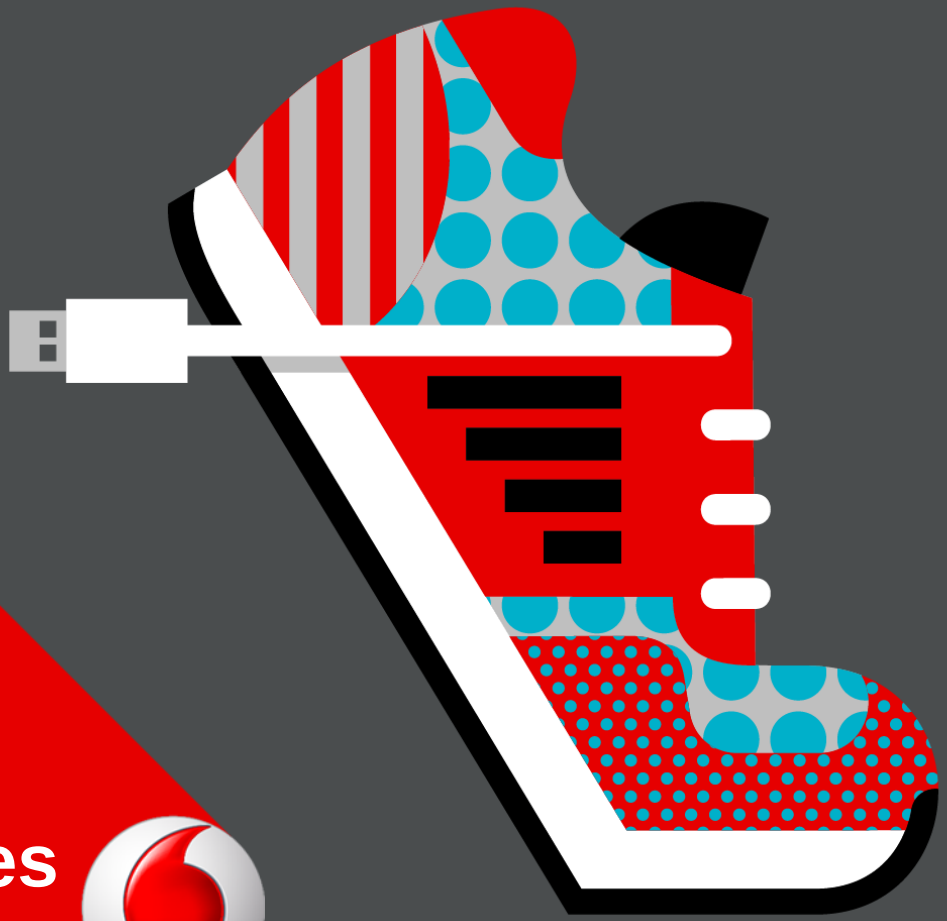
# Summary

- **We are at the dawn of a new era**
  - WAN technologies are emerging fast for IoT connectivity
  - They are needed and will open up the IoT market for us all
- **UK is at the epicenter of this**
- **Please join with us in converging the necessary standards**
- **Please help in permitting use in existing licensed spectrum and in coordinating release of spectrum for license-exempt use**

**David Lister**
**Research Manager**
**Vodafone Group R&D**

# The Internet of Things Changes and Challenges

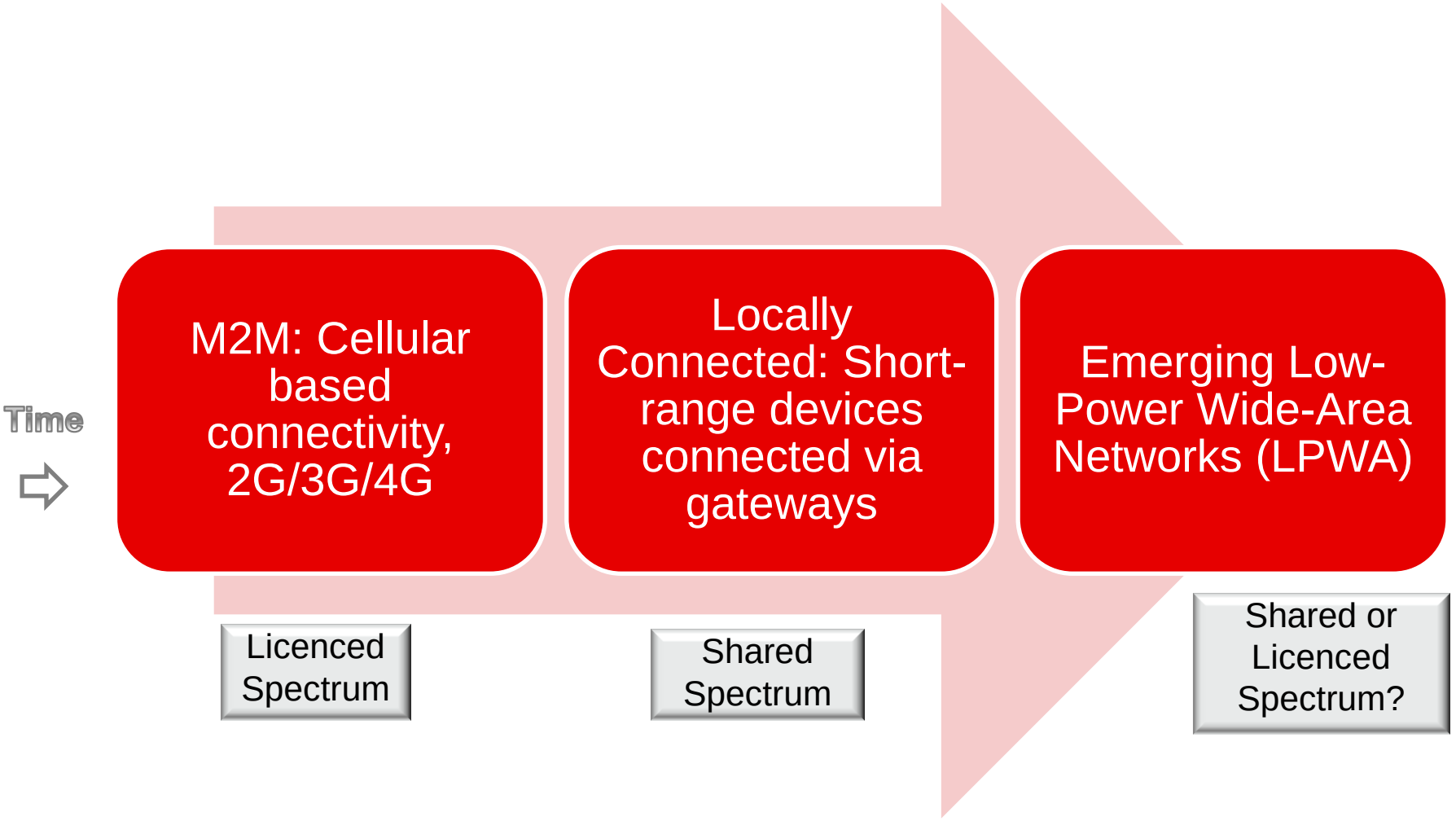
Ofcom Spectrum Event, 2nd October 2014



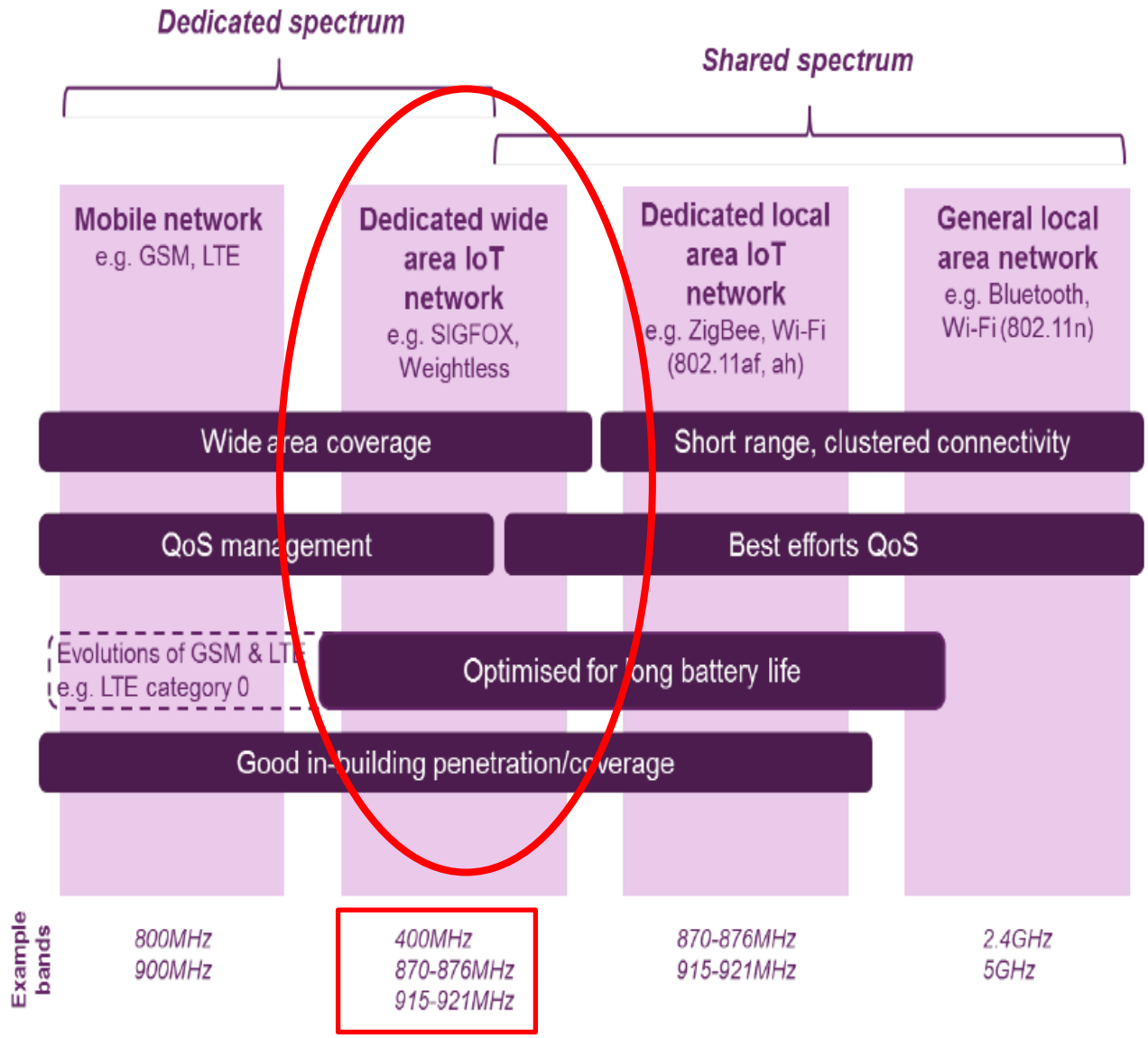
David Lister

Vodafone Group R&D

# The Changing World of M2M/IoT Connectivity



# Licence Exempt and Licenced Spectrum




Wide Area IoT Networks

1. Promoting Investment & Innovation in the Internet of Things, July 2014, *Ofcom*

# Emerging Low Power Wide Area Networks

| Characteristics | Consequences – spectrum related |
|---|---|
| Mostly event driven (uplink) but support for bi-directional communications required for message confirmation, device management, and remote provisioning | **Unconstrained duty-cycle** otherwise future systems will face congestion, applications will be limited and less secure |
| Ubiquitous Coverage | **Sub-GHz bands** to maximise geographic reach including deep-indoors and hard-to-reach rural areas;<br>Nationwide investment: require dedicated access to spectrum to enable future Quality of Service to be assured |
| Scalability | **Effective radiated power** at base station comparable to existing cellular system to support downlink capacity |
| Ultra low-cost | Adoption of **public standards** |

**Best addressed with licenced, and harmonised spectrum in sub-GHz bands**

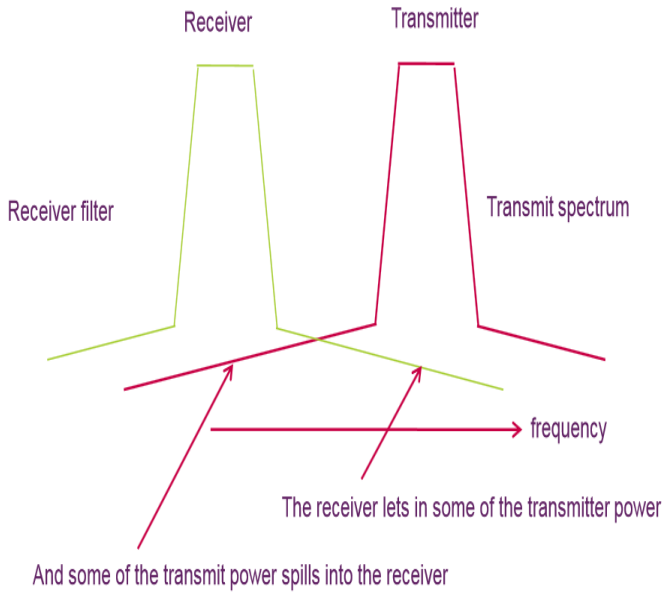
# The Changing World in Cellular Standards

| 3GPP Technical body and release | Work-Item Description | Key Technology Components | Spectrum Implications |
|---|---|---|---|
| **GERAN Rel13** | Cellular System Support for **Ultra Low Complexity and Low Throughput Internet of Things** | (1) Non-legacy based design ("clean-slate" or **Cellular_IoT**)<br><br>and/or<br><br>2) Backward compatible evolution of GSM/EDGE | Possible introduction of new/modified channel modulation<br><br>Non-legacy design would be suited to deployment in licenced harmonised band – either GSM or a future allocation at 700MHz |
| **RAN1 Rel12** | **Low cost Machine Type Communications** (MTC) UE for LTE | De-feature some aspects of LTE and reduce peak-data rate for a new category of device (**Category 0**) | None. |
| **RAN1 Rel13** | **Further LTE Physical Layer Enhancements for MTC** | De-feature further aspects of LTE including reduced UE bandwidth to 1.4MHz | None. |

# IoT: The Infrastructure of Things

- Re-use existing infrastructure
  - Reduce cost and environmental impact

- Co-existence with existing systems
  - Avoidance of TDD/FDD boundaries on co-sited systems
  - Alignment with existing licenced bands to enable re-use of radio equipment

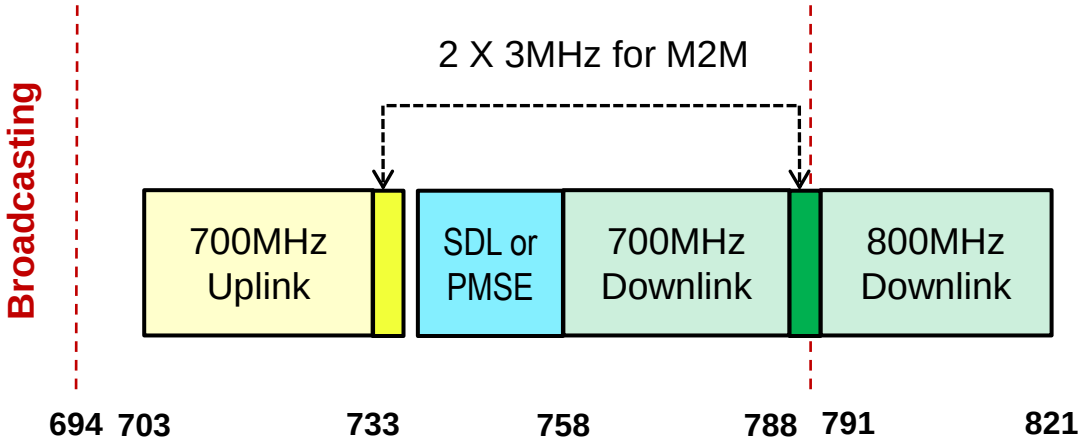



- Licenced Spectrum for the Cellular IoT
  - Globally aligned – ideally.
  - Re-purposing of GSM carriers and new allocations such as the duplex and guard band at 700MHz

# Summary

- Billions of devices will be connected by using existing cellular and short-range technologies.

- Future growth using dedicated wide area IoT networks is best served by licenced spectrum. Potential band at 700MHz has been identified.




- More attention should be given to the Infrastructure of Things than the Internet

# Panel

**Wendy McMillan, Managing Director Smart Metering & M2M**
Arqiva

**Dominique Guinard, Co-founder and Chief Technology Officer**
EVRYTHNG

**Stan Boland, Chief Executive Officer**
Neul

**David Lister, Research Manager**
Vodafone Group R&D

# OFFEE BREAK AND TECHNICAL DEMONSTRATIONS

15:15 – 15:30

Changes & Challenges

# PUBLIC SECTOR SPECTRUM RELEASE (PSSR)

Andrew Hudson, Director of Spectrum Policy, Ofcom

Changes & Challenges

# Panel

**Martin Cave**
Regulatory Economist

**Paul Norris, Executive Director**
Shareholder Executive (ShEx)

**Thomas Welter, Head of Spectrum Policy**
SFR

**Elisabeth Cassin**
VP Group Spectrum Office, Orange

# We all benefit enormously from public sector services which rely on spectrum

## Defense

## Transport

## Emergency services

## Science

# But it is not always being used as efficiently as it might

- We thought we could solve this through incentivising Departments to release or share spectrum.
- The UK also has a commitment to release or share 500MHz of Government spectrum for commercial use by 2020.

# There has been some good progress so far

Announcement

## MOD to auction off radio spectrum

Organisation: Ministry of Defence
Published: 17 December 2012
Policy: Providing versatile, agile and battle-winning armed forces and a smaller, more professiona
Ministry of Defence
Minister: Philip Dunne MP

The Ministry of Defence is planning to auction some of its radi
sale of its kind by a government department.

A Bowman radio operator (right)
(library image)

Radio spectrum refers to the radio wa
communication takes place, includin
mobile voice and data. Under plans a
auction around 200 Megahertz (MH

The announcement comes as market
mounting, fuelled by the sharp rise in
such as smartphones and tablets.

The sale will give private operators th
support the introduction of fourth

- Working towards the release of 190MHz in the 2.3 and 3.4 MHz bands:
  - Technical co-existence studies
  - Auction design consultation
- Spectrum sharing opportunities

# But there is more we need to do….

| Strategy | Future Demand | Supply | Management |
|---|---|---|---|
| • Influence international context<br>• Understand technology development<br>• Objectives and incentives | • Split by type of service, geography & time<br>• Demand for public sector spectrum<br>• Demand from commercial users | • Understand current use of public sector spectrum<br>• Release mechanisms<br>• E.g. auctions or sharing | • Operating models<br>• Transfer into sector policy / operations |

# How do we make this work in practice?

- Understand demand (for services) and supply (of public sector spectrum)
- Identify where it makes sense to group similar services (commercial and public sector)
- Ensure we create “safe havens” for government applications
  - to minimise the risk of moving again
- Ensure suitable spectrum will be available for future public sector use
  - so existing users do not need to ‘sit on’ spectrum to reserve it for possible future use

# Government has committed to release or share 500 MHz of spectrum below 5 GHz for new civil uses by 2020

**Martin Cave**
Regulatory Economist

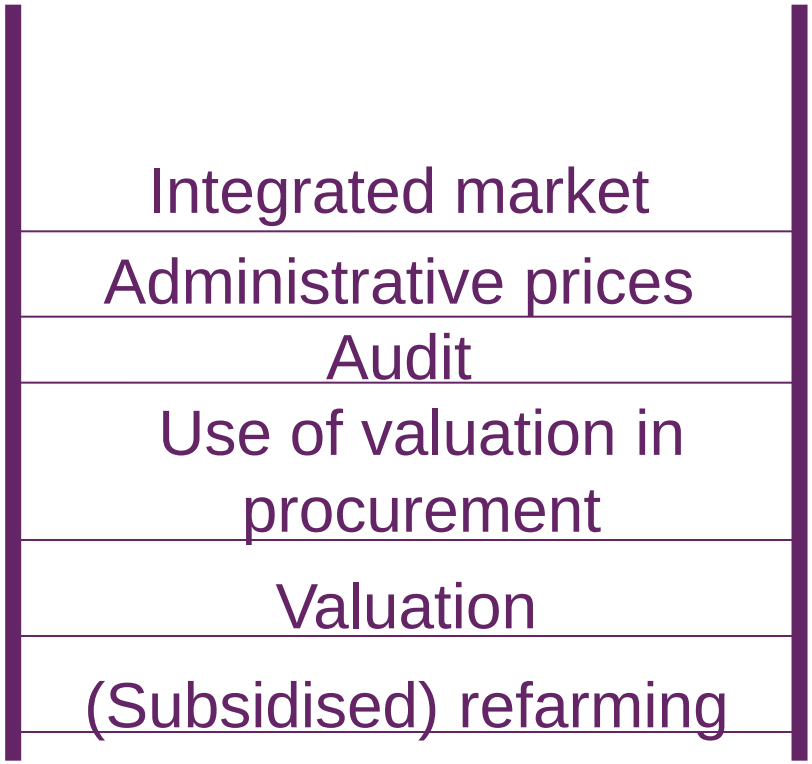
**Paul Norris, Executive Director**
Shareholder Executive (ShEx)

**Thomas Welter, Head of Spectrum Policy**
SFR

**Elisabeth Cassin**
VP Group Spectrum Office, Orange

# Martin Cave
## Regulatory Economist

# The standard public sector spectrum reform ladder



## Paul Norris
## Executive Director
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Changes & Challenges

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# DIFFERENT WAYS TO REPURPOSE OR SHARE SPECTRUM

**01.** Spectrum reallocation fund

- **Efficient coordination mechanism, but no financial incentive for the incumbent to leave.**

**02.** Incentive auctions

**Pair of auctions (forward and reverse). Part of the auction revenues are shared with the incumbent**

**03.** Licensed shared access

**Dynamic sharing method, based on individual authorizations. Third party database.**

**04.** Overlay rights

- **Almost like a nationwide mobile authorization, with some technical restrictions**

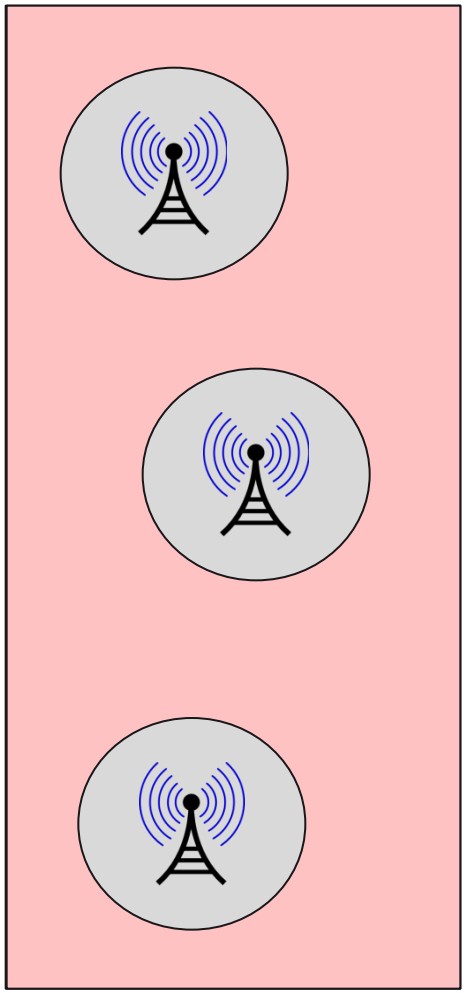
**05.** Spectrum trading and leasing

**A solution if the original authorization of the incumbent is flexible enough.**

# SPECTRUM REDEPLOYMENT FUND

- “Fonds de réaménagement du spectre” (FRS). State-managed fund to pre-finance spectrum redeployments.
- Used to repurpose spectrum bands, following a national or European decision to modify the frequency allocation tables.
- **Future (higher-value) users, *a priori* unknown, will reimburse this fund once the licenses are awarded.**
- Has been used in France to clear the 900 MHz, 1800 MHz, 2.1 GHz, 2.6 GHz, 800 MHz bands, and the analog-to-digital TV switchover.
- **Efficient coordination mechanism. It simulated a “market”.** However only real cost of moving are reimbursed. There is no financial incentive for the incumbent to move. Will this be sufficient in the future?

# “OVERLAY” RIGHTS



- New rights can be created “surrounding” the incumbent users, fully protecting the incumbent use.
- Has been used in France and the US to allocate new rights for new mobile use, with incumbent radio relay links.
- Has been proposed in the US to allocate new rights (licensed) in the TV “white spaces”, instead of cognitive radio (unlicensed).
- Let the new overlay licensees negotiate with the incumbent users.
- **Almost like a nationwide mobile authorization, with some technical restrictions.**

# EXTERNALITIES

- The fact that other operators and countries are using the same combination of spectrum and technologies has a huge value for us: **« Network effects », economies of scale,** international roaming, facilitates cross-border coordination.
- **International harmonization matters.**
- What is the best forum to achieve this international harmonization for spectrum / technologies?
- The bands which are valuable are those who find their way into attractive mass-market handsets: they generate traffic and revenues
  - Example iPhone 6 and 6plus, September 2014: **1 (2100 MHz)**, 2 (1900 PCS), **3 (1800 MHz)**, 4 (AWS), 5 (850 MHz), **7 (2600 MHz), 8 (900 MHz)**, 13 (700c MHz), 17 (700b MHz), 18 (800 Lower), 19 (800 Upper), **20 (800 DD)**, 25 (1900+), 26 (850+ MHz), **28 (700 APT)**, 29 (700de MHz), **38 (TD 2600), 39 (TD 1900), 40 (TD 2300),** 41 (TD 2500).

## Elisabeth Cassin
## VP Group Spectrum Office
## Orange

# Public Sector Spectrum Release (PSSR)

Elisabeth Cassin
Senior Vice President of Group Spectrum
Orange Group

# Orange in brief ….

- Orange has operations in nearly 33 countries across Europe and Africa
- In total it supports over 230 million customers worldwide
- In terms of spectrum in Europe, Orange operates networks that use all the ITU region 1 mobile spectrum bands (800, 900, 1800, 2100 and 2600 MHz bands)
- In the past 3 years, Orange has spent approximately €3bn in acquiring spectrum licences
- Orange main presence in the UK is through EE which represents 27.5million customers

# What do operators require to deliver an efficient customer service?

When considering operators requirements for spectrum it is helpful to summarise some of their relevant key business objectives:

**Universality**

- Provide service to customers on a national basis – services are mobile and customers expect to have the same service to the same level of quality wherever they happen to be

**Long-term investments**

- Providing network and spectrum capacity requires large upfront investments. The returns on these investments need to be predictable for the longer term

**Predictability**

- Network quality, and therefore capacity, has a significant impact on customer happiness. Network capacity can take a significant amount of time to deliver, so predictability on present network capacity and future growth is key

**Scale economies**

- Mobile business model relies on deriving economies of scale – essential to have wide-scale harmonisation of devices, network infrastructure and spectrum usage

# How does this translate to spectrum requirements

**Universality**

- National spectrum licences are a must
- Geographical or temporal capacity restrictions are operationally difficult to manage
- Lack of universality drives up costs

**Long-term investments**

- Deployment of new spectrum bands costs money – in terms of both procurement and deployment costs
- Any investment needs to be matched with a relevant revenue or cost reduction benefit

**Predictability**

- Delivery of a good customer experience on a mobile network is complex
- Operators need to adequately forecast geographic customer demand and match with a predictable long-term capacity supply in order to ensure an optimal "Just In Time" experience

**Scale economies**

- To justify the large capital investments required, operators need to maximise the use of common network and device elements to derive scale economies
- For a multi-national operator such as Orange, this requires using the same spectrum in all country operations

# So what's the impact on the requirements for release of Public Services spectrum?

- Access to licensed spectrum is optimum as it delivers all the objectives detailed
- Sharing concepts, such as LSA, are possible but subject to the following constraints:
  - Any of the geographical / temporal restrictions on the use of a spectrum band do not significantly undermine the use of the spectrum so as not to outweigh the deployment and operations costs
  - The spectrum band must be available for use in all countries that Orange operates in
  - Any sharing contract must be long-term – minimum 15years and optimally 20 years (similar to licensed spectrum)
  - Spectrum capacity is in areas where we experience high demand
  - Spectrum needs to be clean from interference
  - There is sufficient global demand for the spectrum band that it is incorporated in all devices

Release of spectrum on a mobile - only licensed basis should always be considered first

Shared spectrum is not a panacea to overcoming any mobile broadband spectrum crunch. Any significant restrictions on its long-term use would make the spectrum not viable

# Panel

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