Spectrum Regulation for the 21st Century:

Arab States Workshop

Roberto Ercole, GSMA

GSMA Capacity Building Seminar

Amman, 2 February 2016

Capacity Building

GSMA Capacity Building Programme

Advanced Spectrum Management

Introductory taster course

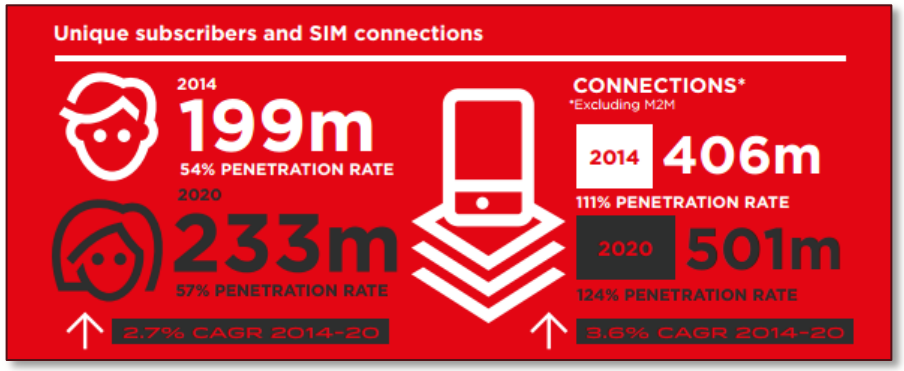
Roberto Ercole, Senior Director of Spectrum Regulation, GSMA

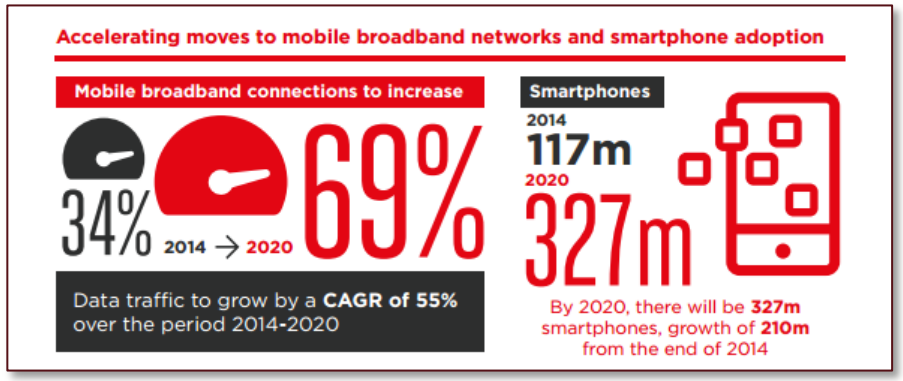
2nd February 2016

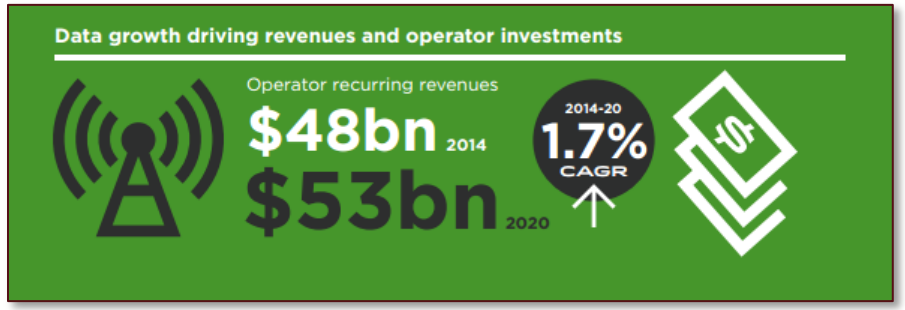
Course objectives

- Understand how radio spectrum is used for wireless telecoms
- Be aware of the trends in mobile-sector growth and data demand
- Understand the core concepts in spectrum use and management
- Learn how mobile technology has evolved and changed
- Understand the core issues for spectrum managers — efficiency competition, band characteristics and interference
- The importance of international harmonisation and the ITU/WRC process
- Understand regulatory best practice and how the issues are changing

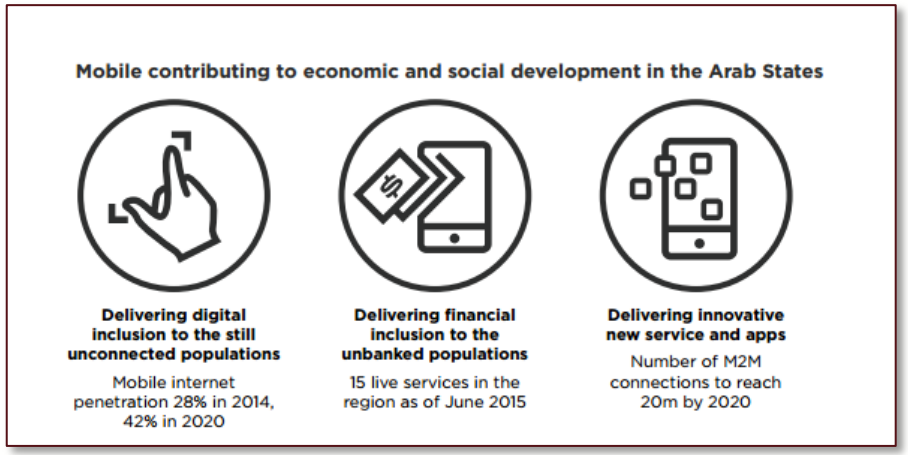
Mobile economy — Arab States

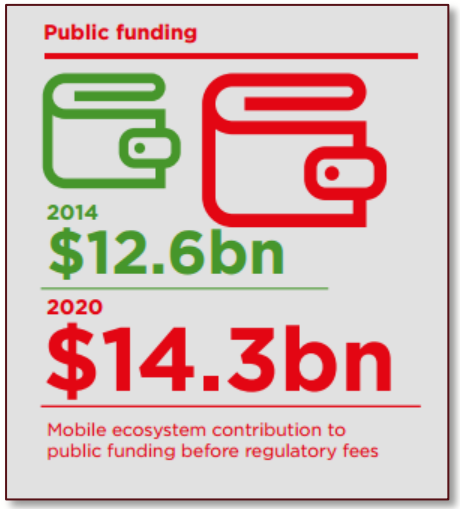




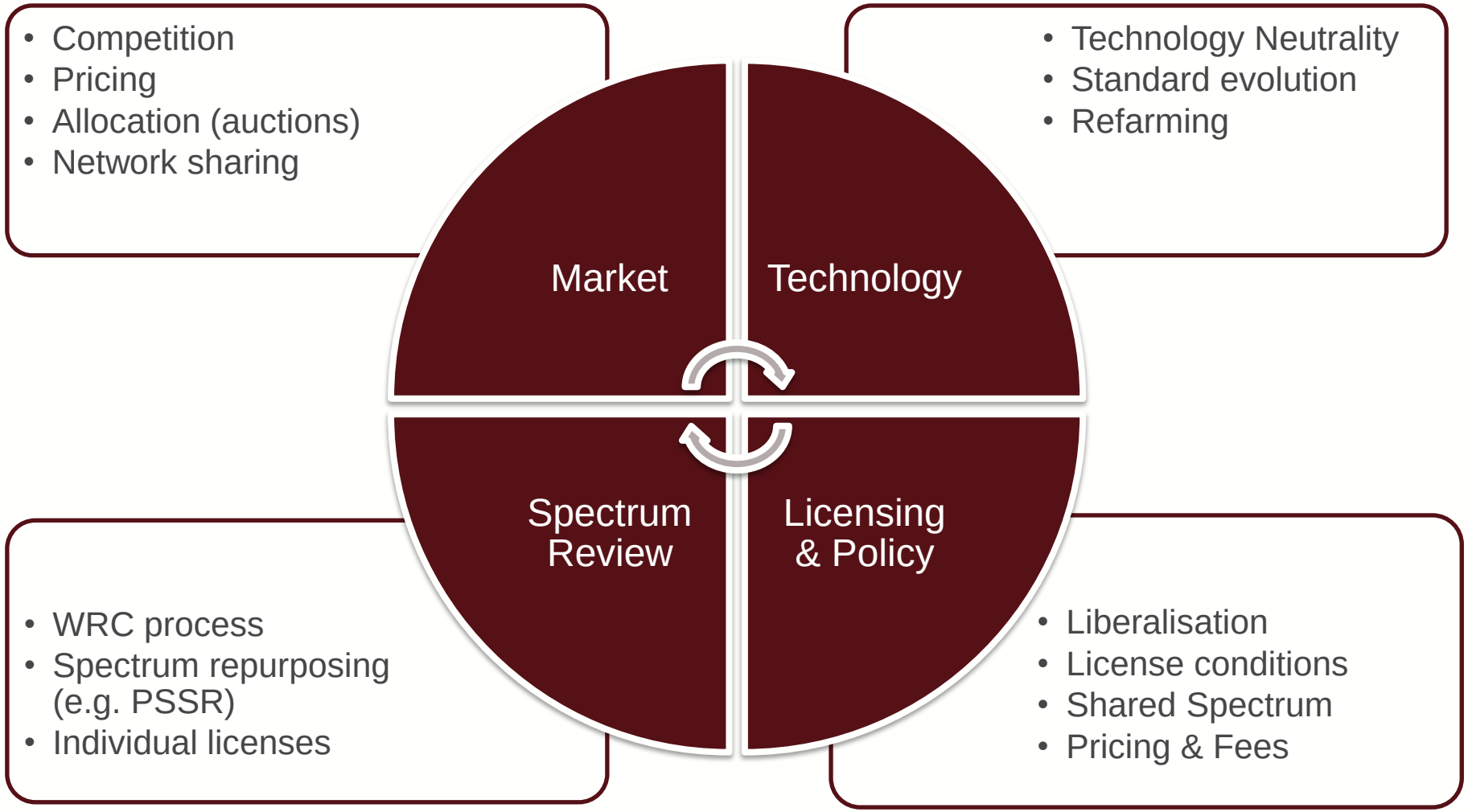


Mobile economy — Arab States





Optimising spectrum use – A complex task!

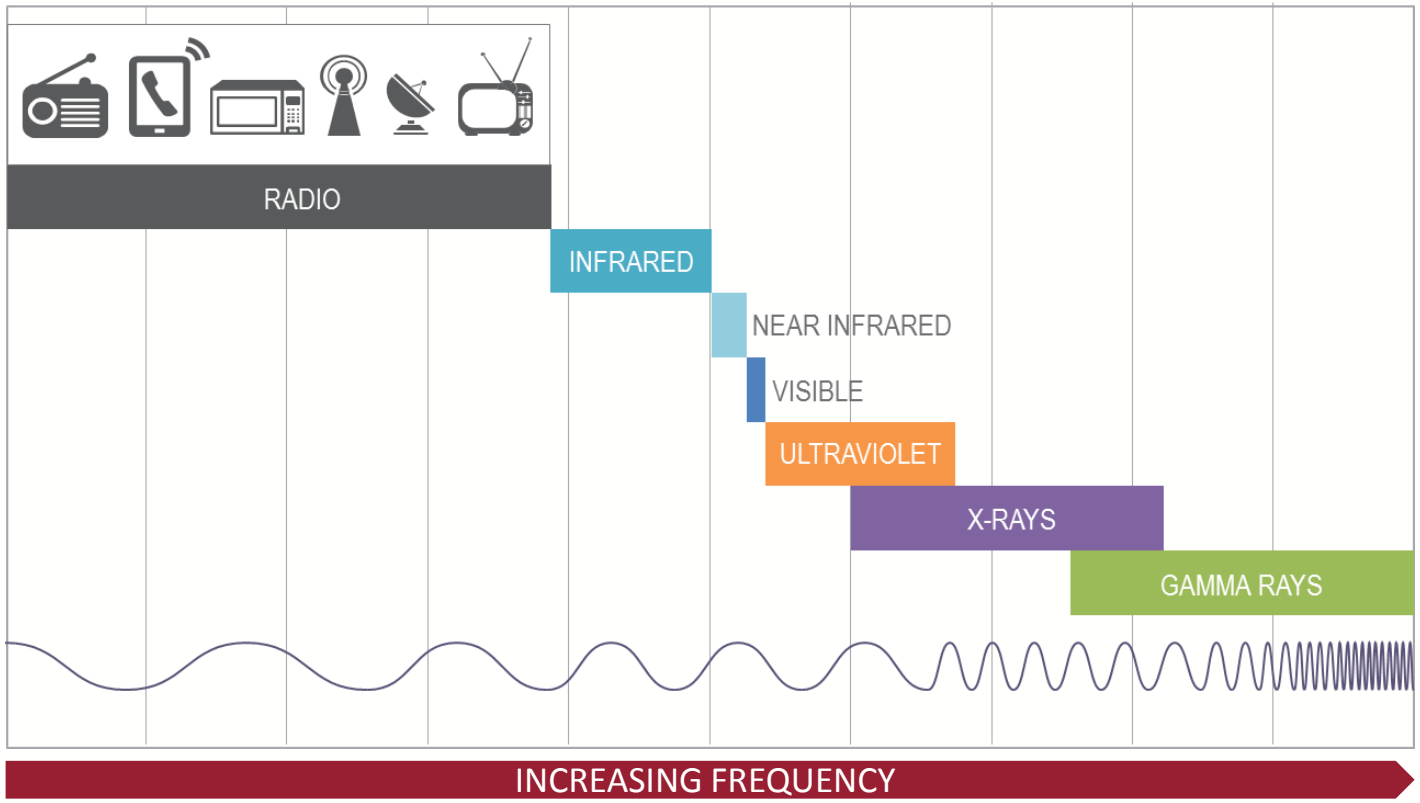


Overview of Radio Spectrum

What is spectrum?

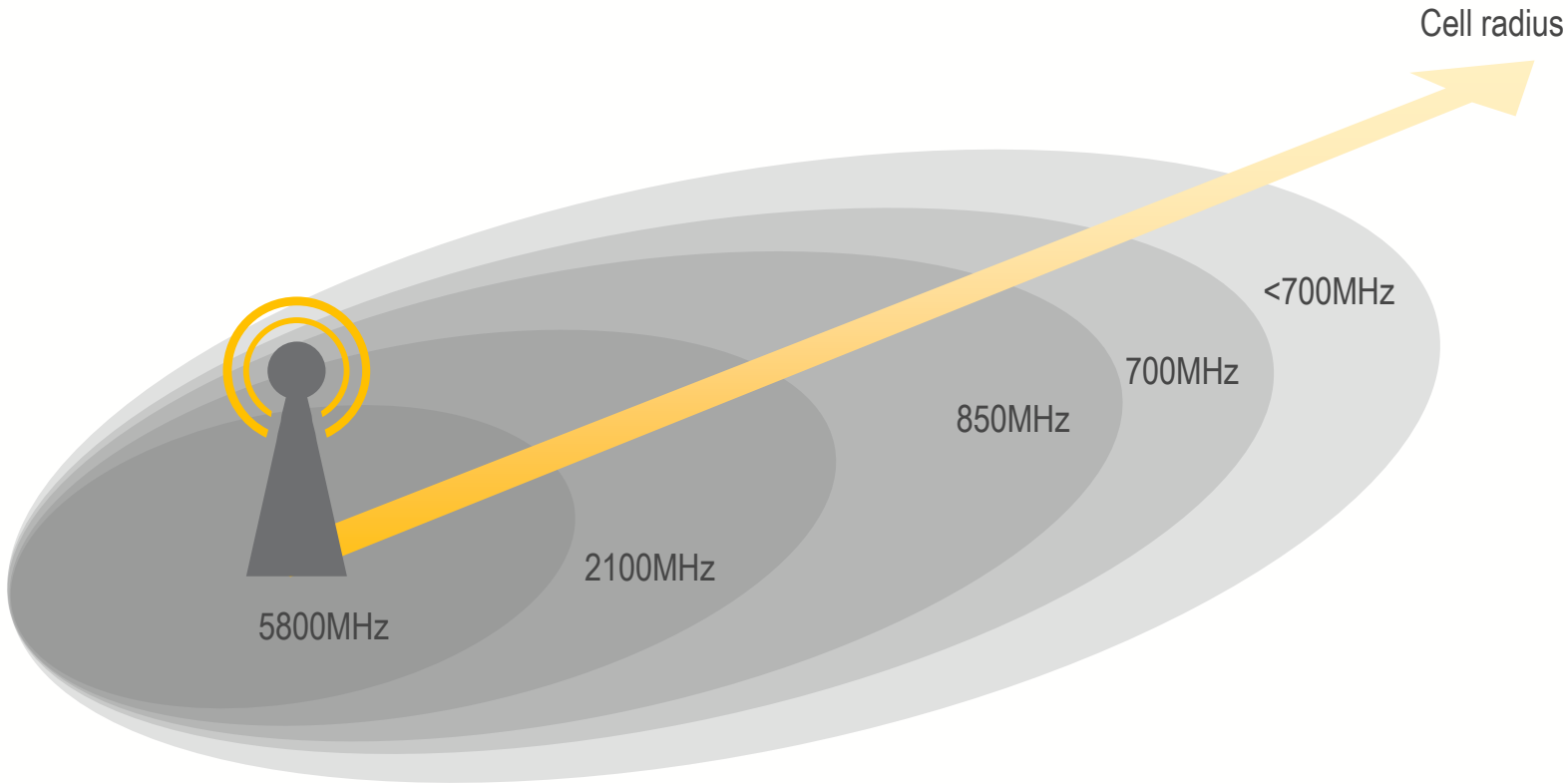
Different users of spectrum

What is spectrum?



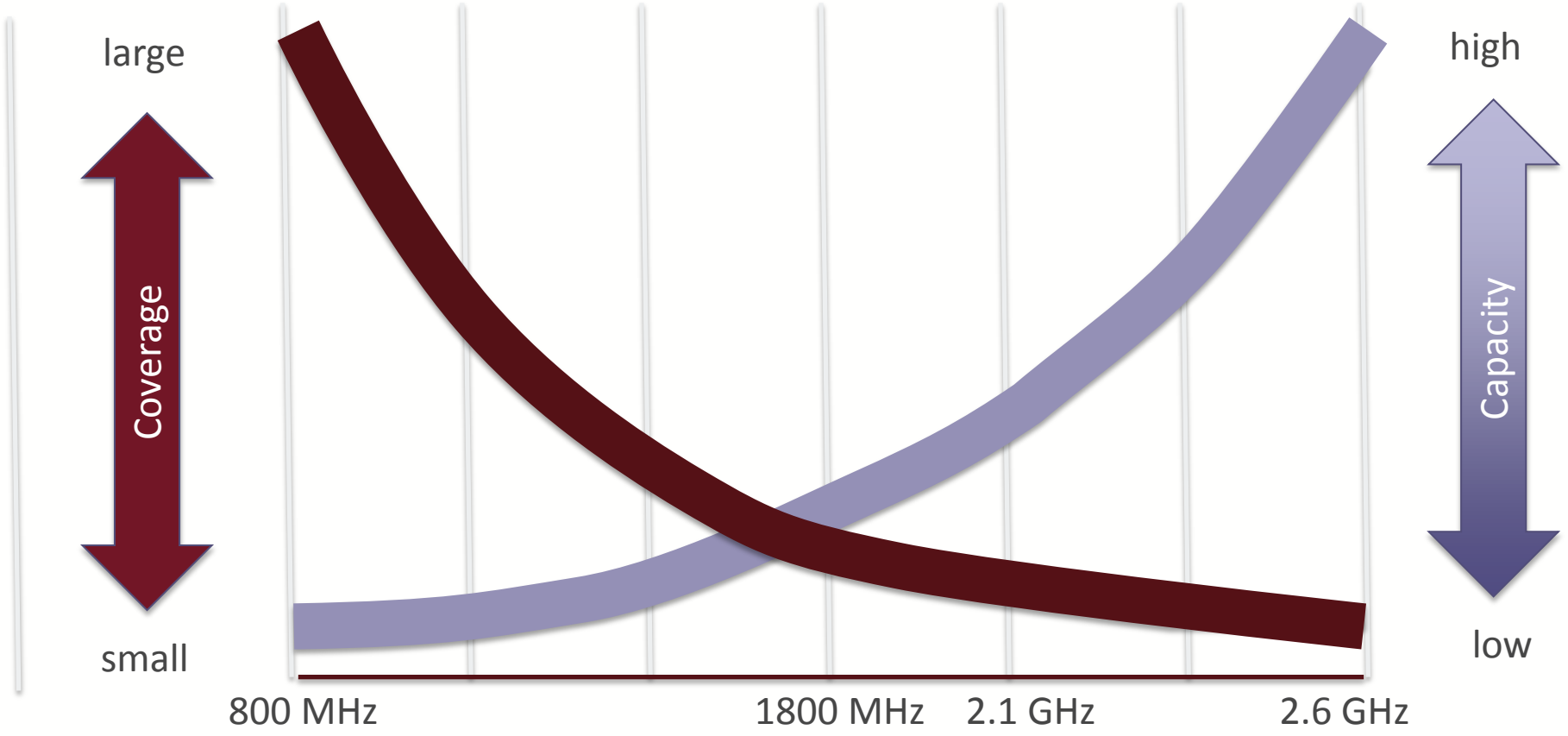
The radio broadcast that wakes you up every morning is delivered by radio spectrum, an important natural resource needed for all wireless applications. Radio spectrum is always around us in the form of invisible waves.

Effect of frequency range



In general, a network that uses higher-frequency spectrum requires more base stations to cover the same area as a network using lower frequencies.

Capacity and coverage



Types of spectrum users

Mobile: Cellular, PMR, Wi-Fi

Fixed: Point-to-point or point-to-multipoint

Maritime: Shipping, coast stations and radar

Aeronautical: Aircraft and airports

Broadcasting: Radio, television and satellite

Satellite: Government, commercial, fixed, mobile

Space services: Control of spacecraft

Space exploration: Radio telescopes

Industrial, scientific and medical: Heaters, ovens, scanners, wireless LAN

Spectrum Management Basics

Mobile networks

Duplex techniques

Evolution of mobile technology

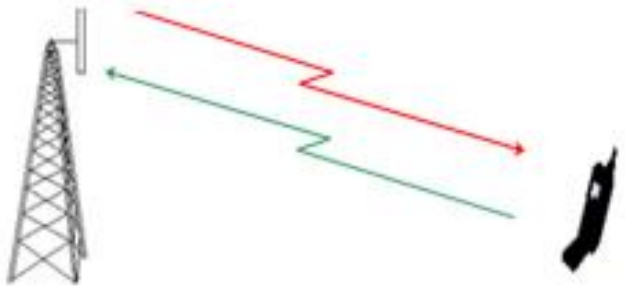
Radio transmission

Radio station (one-way radio)

Radio stations broadcast their content over specific frequencies — one to many

Mobile network base station

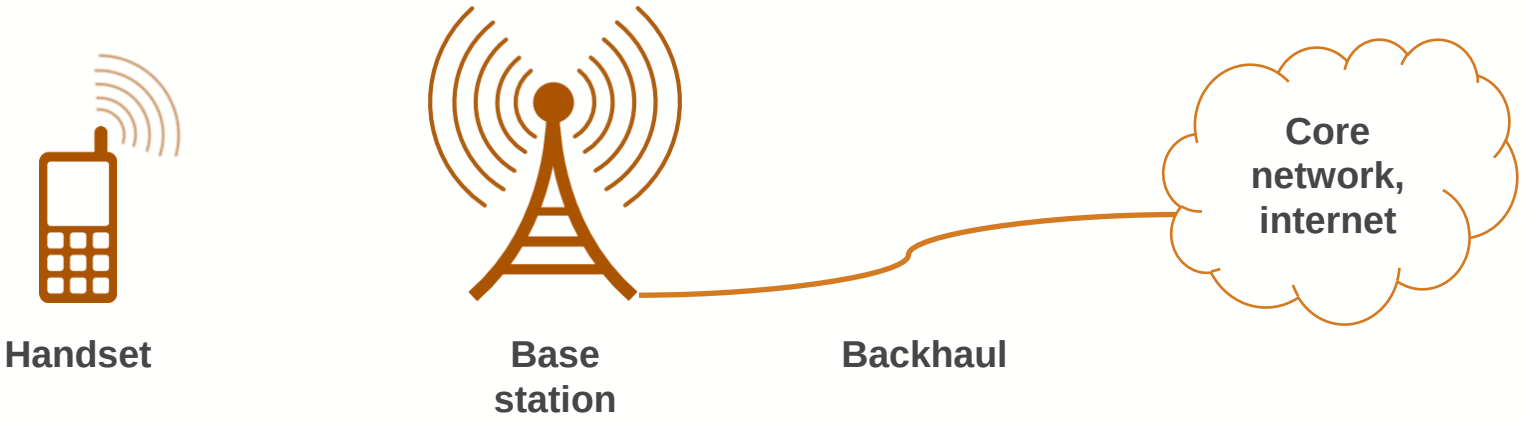
Base stations are designed to provide coverage to a wide area (also called cells) or to increase capacity in a heavily congested area.



Two-way radio

When you talk into a mobile phone, it converts your voice into data and then transmits it via radio to a nearby base station. The base station then sends your call through the network until it reaches the person you are calling. To receive a call, the nearest base station sends out radio waves that are detected by a receiver in your mobile phone, where the signal is changed back to sound.

Mobile network structure



Handsets communicate with base stations using specified radio frequencies.

Base stations provide the wireless connections to handsets.

Backhaul connects base stations to the core network, using fixed connection or wireless microwave links.

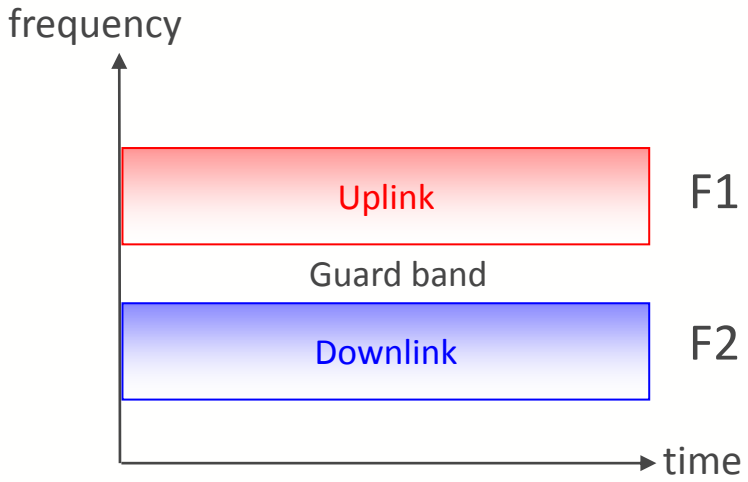
The core network connects the mobile network to other operators for phone calls and the wider internet for data.

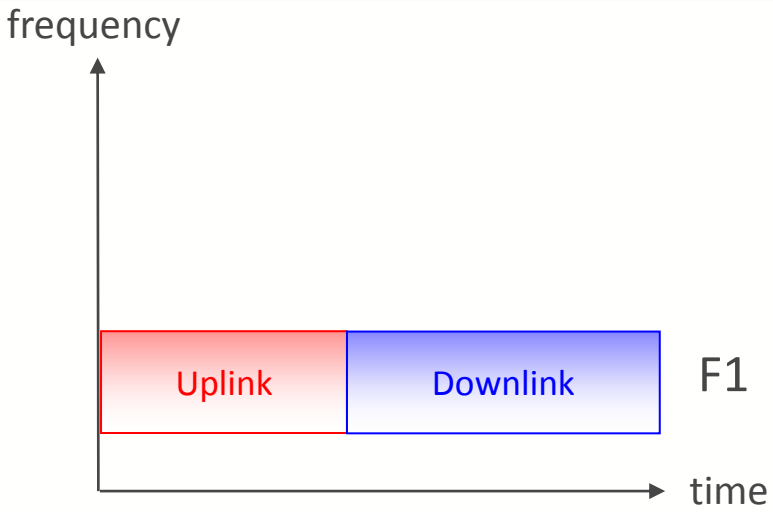
Duplexing modes: FDD and TDD

Frequency division duplexing (FDD)

FDD requires two separate communications channels.

A sufficient gap, or guard band, separates the uplink and downlink bands. Good filtering of duplexers and possibly shielding are a must.

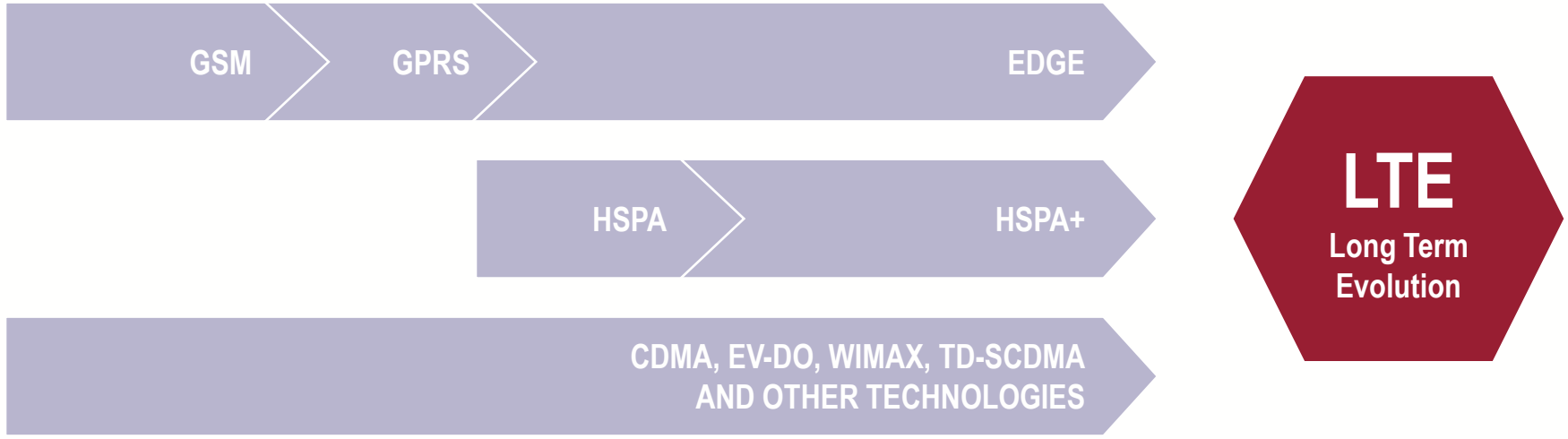


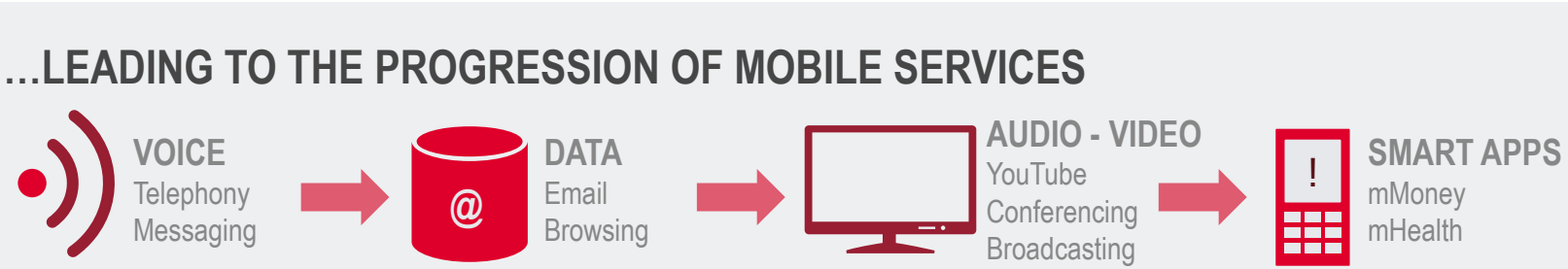


Time division duplexing (TDD)

TDD uses a single frequency band both to transmit and receive. It shares that band by assigning alternating time slots to transmit and receive.

Evolution of mobile technology





The Rise of Mobile Data

Data demand and market trends

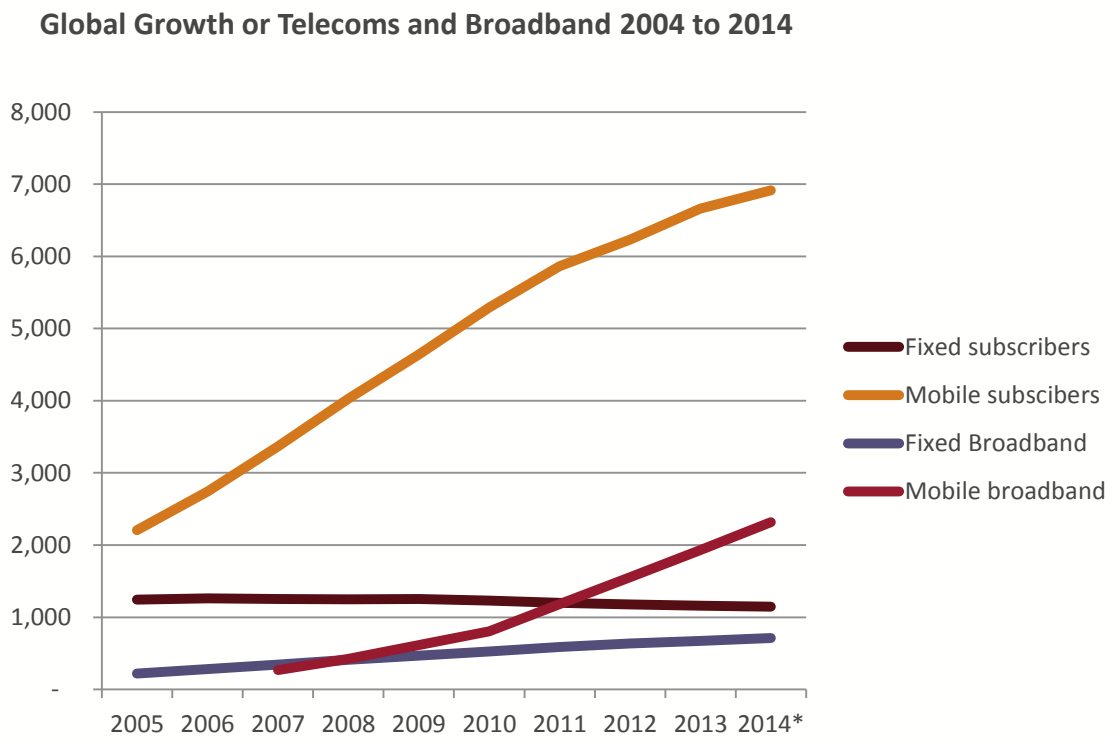
Estimating and forecasting mobile traffic

The growth of telecommunications

The telecommunication industry has grown sharply in recent decades. The main contributor to this growth is wireless mobile communications.

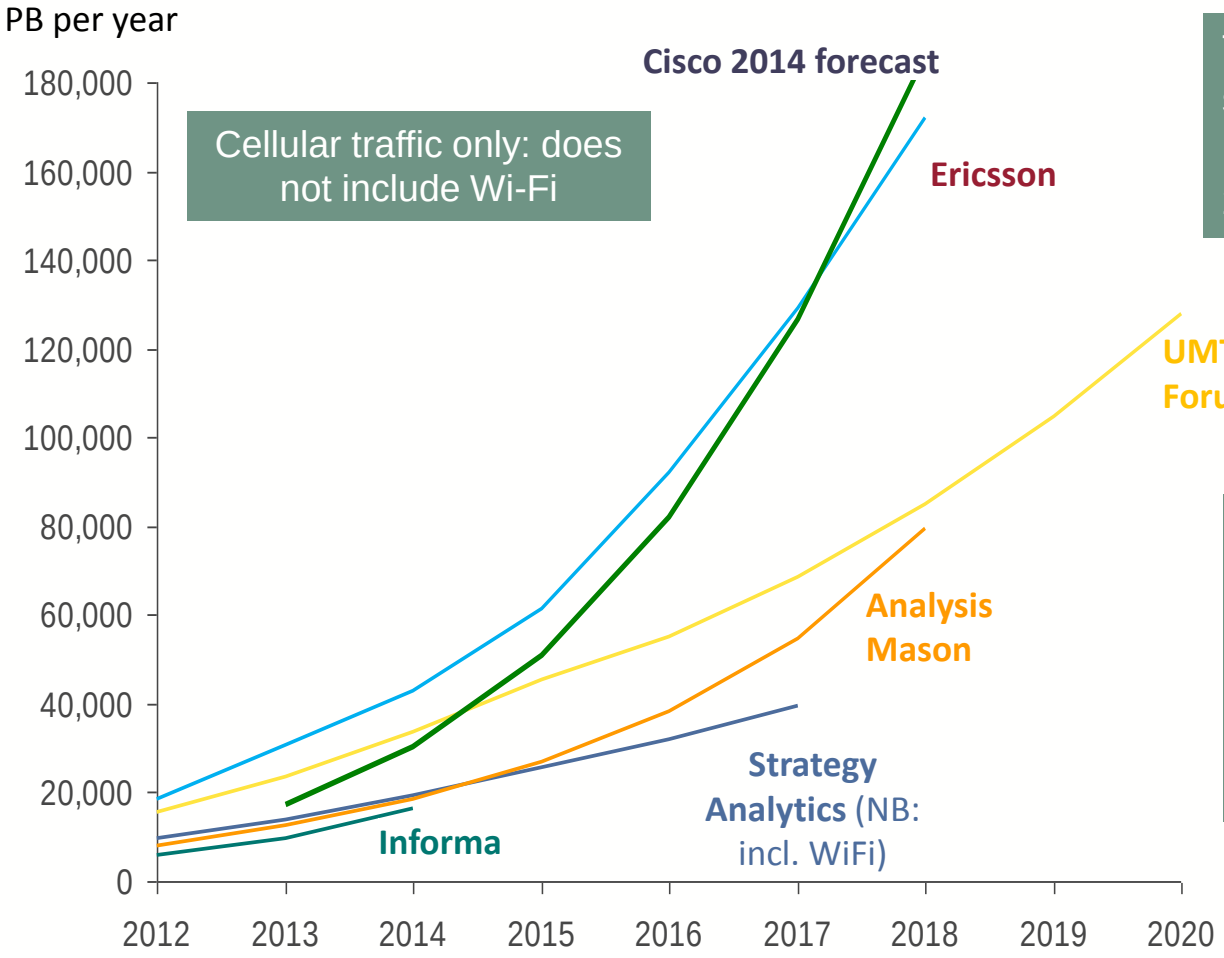
A radical change of vision has recently appeared for wireless mobile communications. Until the end of the 1990s, voice calls were the main wireless application.

In the new millennium, data-oriented mobile wireless applications have become more and more popular.



Source: ITU World Telecommunication/ICT Indicators database

Global data traffic forecasts



The growing adoption of data services has become the major source of traffic since 2010.

According to Analysys Mason forecasts, mobile traffic is expected to grow at a compound annual growth rate of 42% to reach 28,000 PB per year in 2015.

Factors that affect traffic forecasting

Device Type	2014	2019
Nonsmartphone	22 MB/month	105 MB/month
M2M Module	70 MB/month	366 MB/month
Wearable Device	141 MB/month	479 MB/month
Smartphone	819 MB/month	3,981 MB/month
4G Smartphone	2,000 MB/month	5,458 MB/month
Tablet	2,076 MB/month	10,767 MB/month
4G Tablet	2,913 MB/month	12,314 MB/month
Laptop	2,641 MB/month	5,589 MB/month

* Monthly basic mobile phone data traffic. Source: Cisco VNI Mobile, 2015

- Tablets generate 119 times as much data traffic as a basic mobile phone.
- Smartphones generate, on average, around 37 times more data per month than a basic phone.
- Laptops operating over mobile broadband networks generate about 119 times as basic mobile phone

➔ Mobile data usage is heavily device-dependent

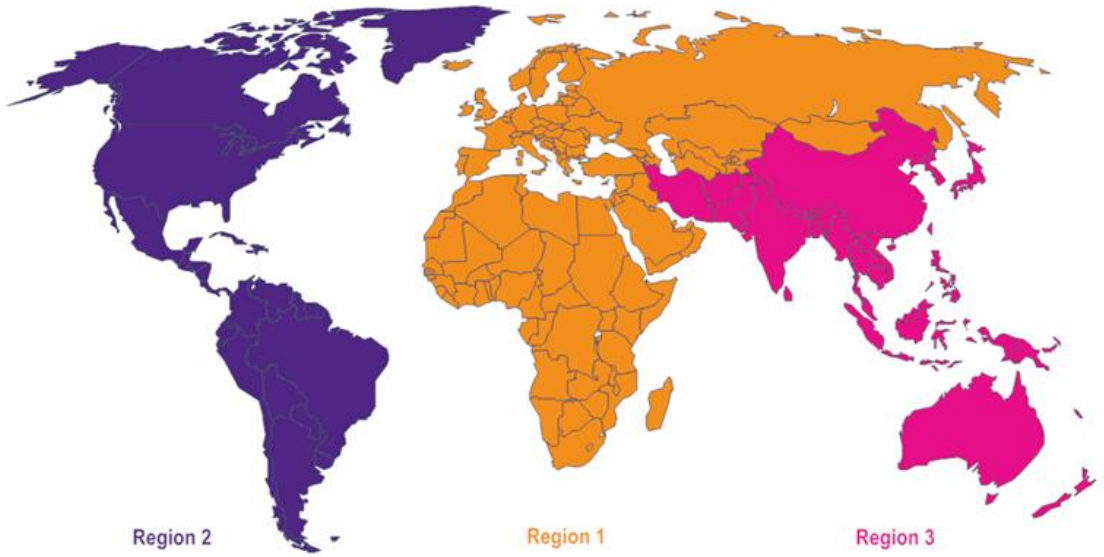
Spectrum Planning

International harmonisation

Spectrum management — international, regional and national

Radio spectrum bands identified for mobile

International harmonisation



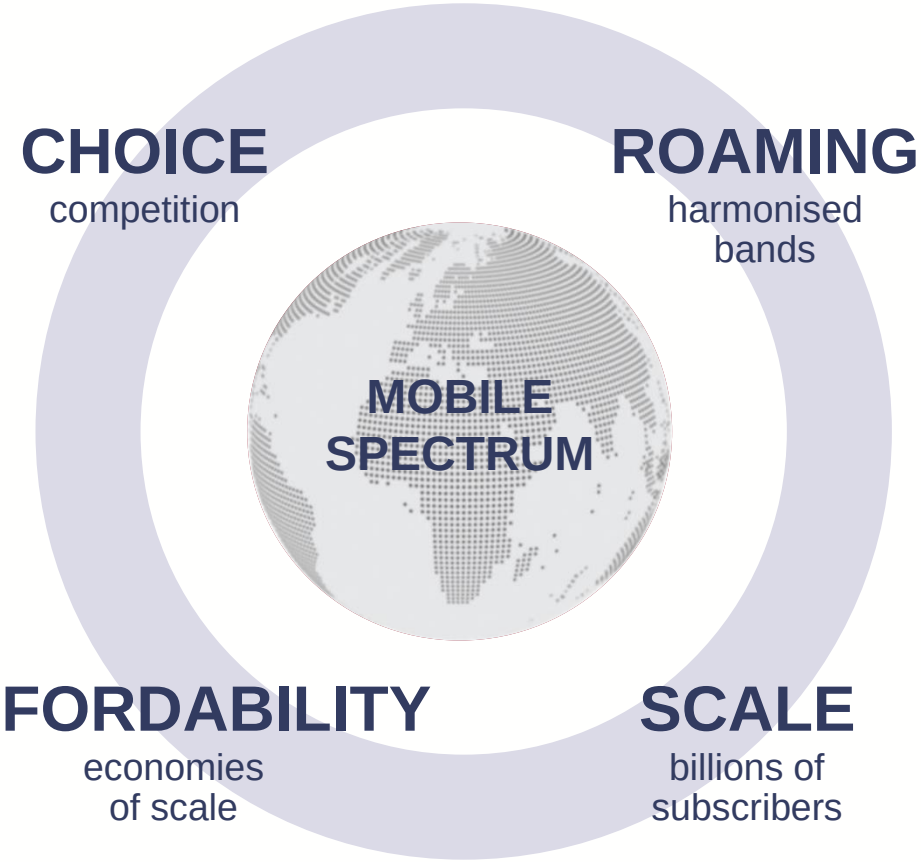
The regulator needs to coordinate with other countries at three levels:

- Neighbouring countries
- Countries that are part of regional agreements
- Worldwide (ITU) regulations

The ITU arranges the harmonisation of frequency bands by three world regions.

Spectrum harmonisation

- Brings down the cost of mobile devices
- Enables people to roam
- Reduces interference issues across borders



Layers of spectrum management

International level

Allocation (of a frequency band): Entry in the Table of Frequency Allocations of a given frequency band for the purpose of its use by one or more terrestrial or space radiocommunication services or the radio astronomy service under specified conditions

Regional level

Allotment (of a radio frequency or radio frequency channel): Entry of a designated frequency channel in an agreed plan, adopted by a competent conference, for use by one or more administrations for a terrestrial or space radiocommunication service in one or more identified countries or geographical areas and under specified conditions

National level

Assignment (of a radio frequency or radio frequency channel): Authorization given by an administration for a radio station to use a radio frequency or radio frequency channel under specified conditions

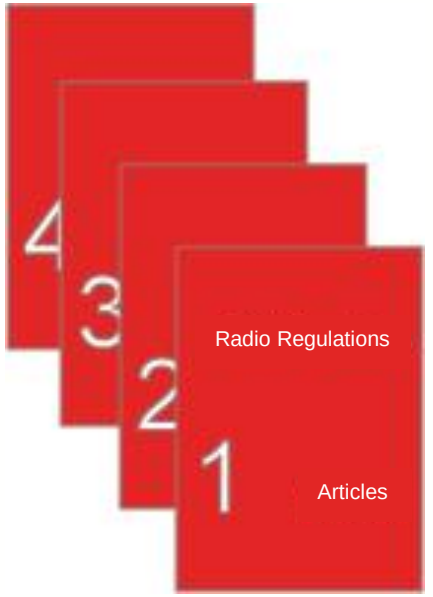
Contents of the radio regulations

International spectrum management rules and regulations

Definitions for services

1.16 allocation (of a frequency band): Entry in the Table of Frequency Allocations of a given frequency band for the purpose of its use by one or more terrestrial or space radiocommunication services or the radio astronomy service under specified conditions. This term shall also be applied to the frequency band concerned

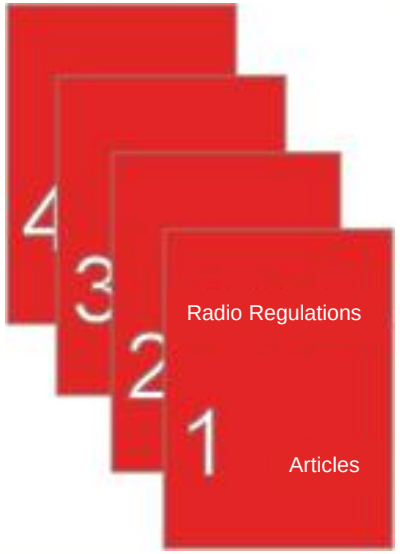
1.24 mobile service: A radiocommunication service between mobile and land stations, or between mobile stations



Contents of the radio regulations

Frequency allocations

Allocation to services		
Region 1	Region 2	Region 3
2010-2025 FIXED MOBILE 5.388A 5.388B	2010-2 025 FIXED MOBILE MOBILE-SATELLITE (Earth-to-space)	2 010-2025 FIXED MOBILE 5.388A 5.388B
5.388	5.388 5.389C 5.389E	5.388



Technical constraints

5.388A In Regions 1 and 3, the bands 1 885-1 980 MHz, 2 010-2 025 MHz and 2 110-2 170 MHz and, in Region 2, the bands 1 885-1 980 MHz and 2 110-2 160 MHz may be used by high altitude platform stations as base stations to provide International Mobile Telecommunications-2000 (IMT-2000), in accordance with Resolution **221 (Rev.WRC-03)***. Their use by IMT-2000 applications using high altitude platform stations as base stations does not preclude the use of these bands by any station in the services to which they are allocated and does not establish priority in the Radio Regulations. (WRC-03)

WRC-15 (Geneva — November 2015)

- World Radiocommunication Conference 15 was run over four weeks in Geneva
- Nearly 4,000 attended (3,300 admins and 500 observers)
- Looked at over 40 topics including:
  - Spectrum for mobile broadband (IMT)
  - Global flight tracking for civil aviation
  - Universal time (Leap second)
- The decisions reached at WRCs have a long term impact on investment in the ICT industry, and hence also affect consumers and citizens
- http://www.itu.int/en/ITU-R/conferences/wrc/2015/Pages/default.aspx

The GSMA's view on the outcome

- "The GSMA applauds the strong support from governments in all regions for the global harmonisation of 200MHz of the C-band (3.4-3.6GHz) to meet capacity requirements in urban areas. We are also pleased by the decision to globally harmonise the L-band (1427-1518MHz), a mid-frequency band that provides an ideal blend of coverage and capacity capabilities."

- "The sub-700MHz band is now available for mobile in markets covering more than half the population of the Americas and, in addition, several major markets within the Indian subcontinent announced their intention to use part of this band for mobile broadband. This WRC-15 decision represents a significant milestone in building momentum towards global harmonisation."

Arab/European situation from WRC-15

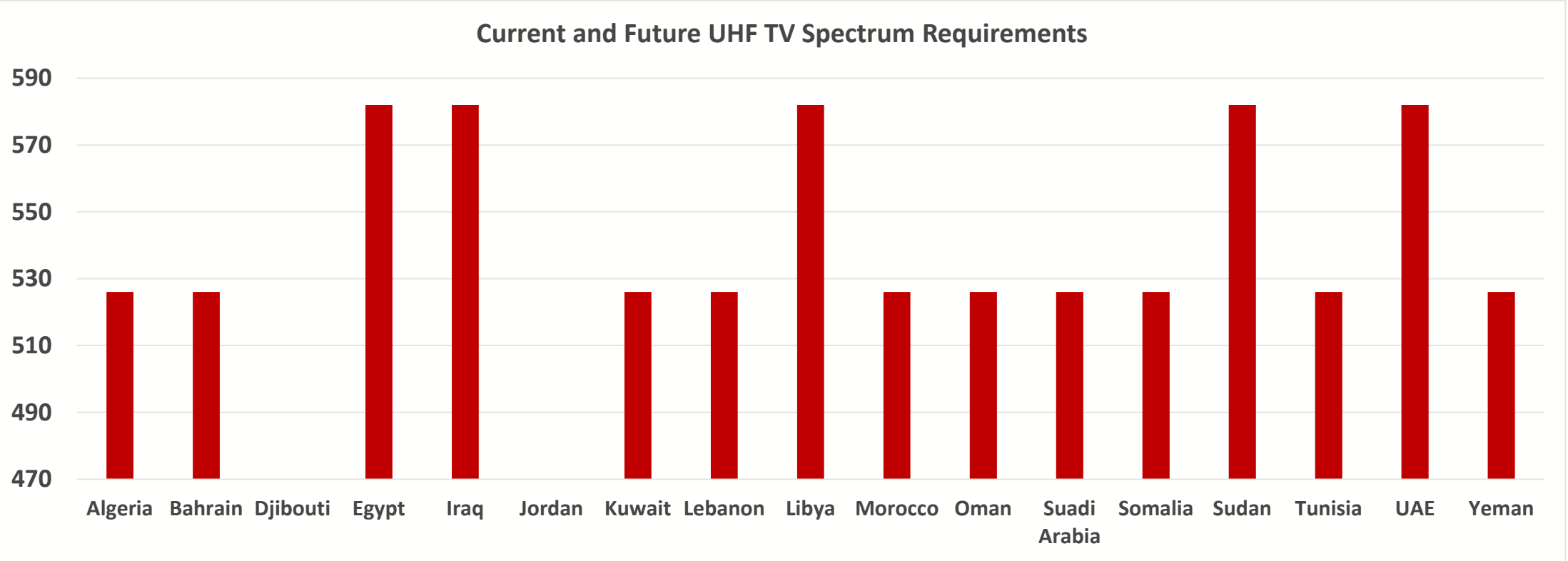
- **700 MHz band: now harmonised across Arab States, Europe, and Africa**
- **L-band (1427-1518 MHz): now harmonised for mobile/IMT use across Europe and globally**
  - 1427-1452 MHz & 1492-1518 MHz identified for IMT – mobile allocation already exists for 1452-1492 MHz,
  - European decision has been made to license the full band for mobile broadband (licensing has begun)
- **C-band (3.4-3.6 GHz): is now harmonised / identified for IMT internationally**
  - Global harmonisation will help the equipment market which has held back use in Europe so far
- **3.6-3.8 GHz was not agreed, but this is unlikely to stop European rollouts**
  - European Commission has already agreed to harmonise the band for mobile so deployments can begin
  - 3.6-3.7 GHz agreed in North America which will provide economies of scale that Europe can benefit from
- **WRC-23 Agenda Item to review the UHF band including sub-700 MHz for IMT in Europe**
  - Likely to speed up developments for sub-700 MHz in Europe

Sub-700 outside R1 (TV spectrum)

- **Sub-700 MHz (614-698 MHz): Harmonised across North America**
  - Identified for IMT in Bahamas, Barbados, Belize, Canada, Colombia, United States and Mexico
- **Sub-700 MHz (470/614-698 MHz) was identified for IMT in several markets**
  - 470-698 MHz: Micronesia, the Solomon Islands, Tuvalu and Vanuatu
  - 610-698 MHz: Bangladesh, Maldives and New Zealand
  - India and Pakistan did not sign up but have publically agreed to consider mobile in parts of the band
  - Whole region has a mobile allocation, which could facilitate deployment before Europe.
- A number of Arab countries at WRC-15 were in favour of IMT below 700 (including Jordan, Egypt, Morocco, Lebanon, Qatar, UAE, Kuwait and Palestine)
- No Sub-Saharan African countries were in favour of IMT/MOBILE.

Sub-700MHz (470-694/8 MHz)

Not a choice between the two: Mobile and broadcast can share UHF



Partitioning the band at 600MHz would allow 50 TV channels and additional spectrum for mobile

Source: Plum Consulting

Spectrum Licensing for Mobile

Spectrum assignment methods

Licence renewal

Spectrum auctions

Technology neutrality

Summary of the licensing regime

Individual authorisation (Individual rights of use)		**General authorisation** (No individual rights of use)	
Individual licence	**Light licensing**		**Licence-exempt**
Individual frequency planning / coordination Traditional procedure for issuing licences	Individual frequency planning / coordination Simplified procedure compared to individual licensing With limitations in the number of users	No individual frequency planning / coordination Registration and/or notification No limitations in the number of users nor need for coordination	No individual frequency planning / coordination No registration nor notification (some countries require notification for recording purposes)

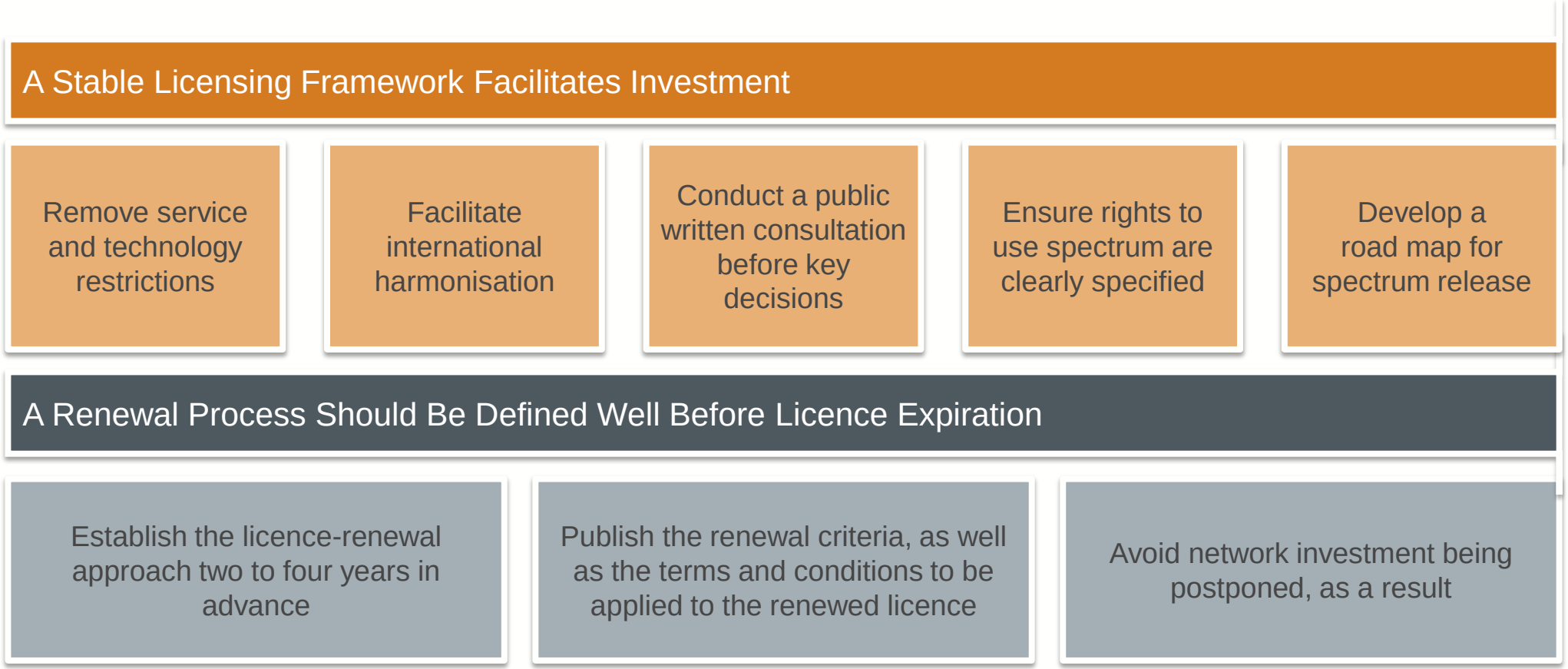
Source: CEPT ECC Report 132

Spectrum regulations – License types

Spectrum / Service	Summary description
Aeronautical	Licensing managed by the Civil Aviation Authority on behalf of Ofcom
Amateur Radio	Private radio licenses
Business Radio	Two-Way PMR Radio Licenses
Earth Stations, Satellites and Science	FSS and BSS licenses as well as Meteorological, Radio Navigation, Time Signals
Fixed Terrestrial links	Point to point links between 450MHz an 86GHz
Fixed Wireless Access	Point to multipoint licenses for WISP and BB access in 5.8 GHz
License Exempt SRD	Short range device including UWB, CB, Cordless phones, Vehicle radar
Maritime Radio	Ship to shore communications
Mobile and Wireless Broadband	Cellular and BB access networks
Programme Making & Special Events	Spectrum shared with TV Broadcast spectrum
Radio licenses	Commercial radio broadcasting
Ship Radio	Ship to ship communications
TV White Spaces	Authorisation for use of TV-WSD in the broadcasting spectrum
TV Broadcast	TV Broadcasting licenses for UK commercial broadcasts

Spectrum licensing

Choosing the appropriate spectrum policy licensing framework to facilitate the large investments required in rolling out networks and introducing updated technologies and new services



Licence renewal

- There needs to be a clear, timely and transparent process for the renewal of licences.
- The approach for licence renewal should be agreed at least 3 to 4 years prior to licence expiry to ensure investment in networks and services for consumers is maintained.
- There should be a presumption of licence renewal to the existing licence holder. The exception to this only applies where there has been a serious breach of licence conditions, evident in advance of renewal.
- If governments choose to reappraise market structure at the time of renewal, it is important to ensure this is done in such a way as to maintain services for consumers and avoiding stranded investments.
- New licences should be, at a minimum granted for 15–20 years to give investors time to gain a reasonable return on their investment.
- Renewal of mobile licenses should be on a technology- and service-neutral basis.

Spectrum auctions

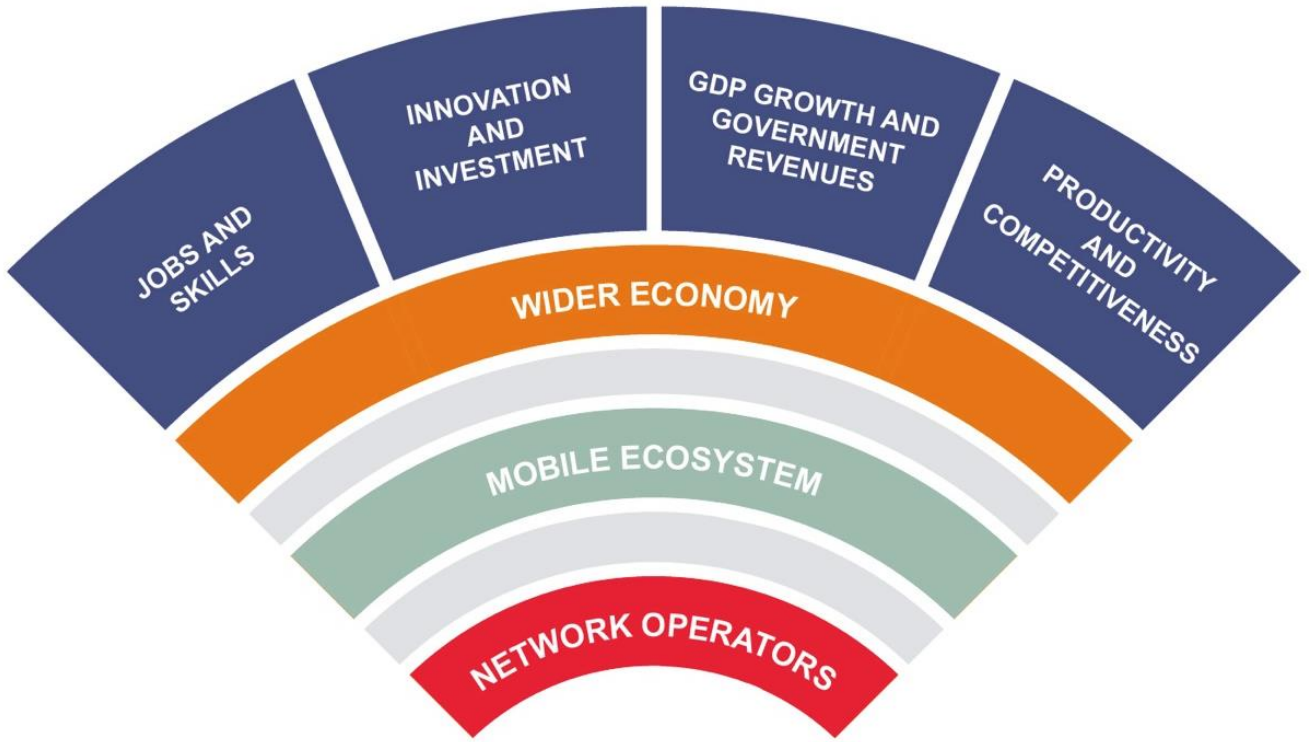
Prior to the late 1990s, most countries assigned spectrum through beauty contests or direct award. Auctions have since supplanted beauty contests as the dominant assignment mechanism for various reasons, including expected outcome efficiency and relative robustness to legal challenge.

Auctions Are An Economically Efficient Way To Allocate Spectrum	… when there is competition for limited spectrum … when demand is expected to exceed supply
Auctions Are Not The Only Option Available To Government For Spectrum Allocation	Consultation with mobile operators and other stakeholders is essential
Auctions Should Reflect The Long-Term Economic Value Of Spectrum, Not Maximise Short-Term Revenue For Governments	Auctions should be fair, transparent and designed for the specific market circumstances

Maximising the Benefits for Society

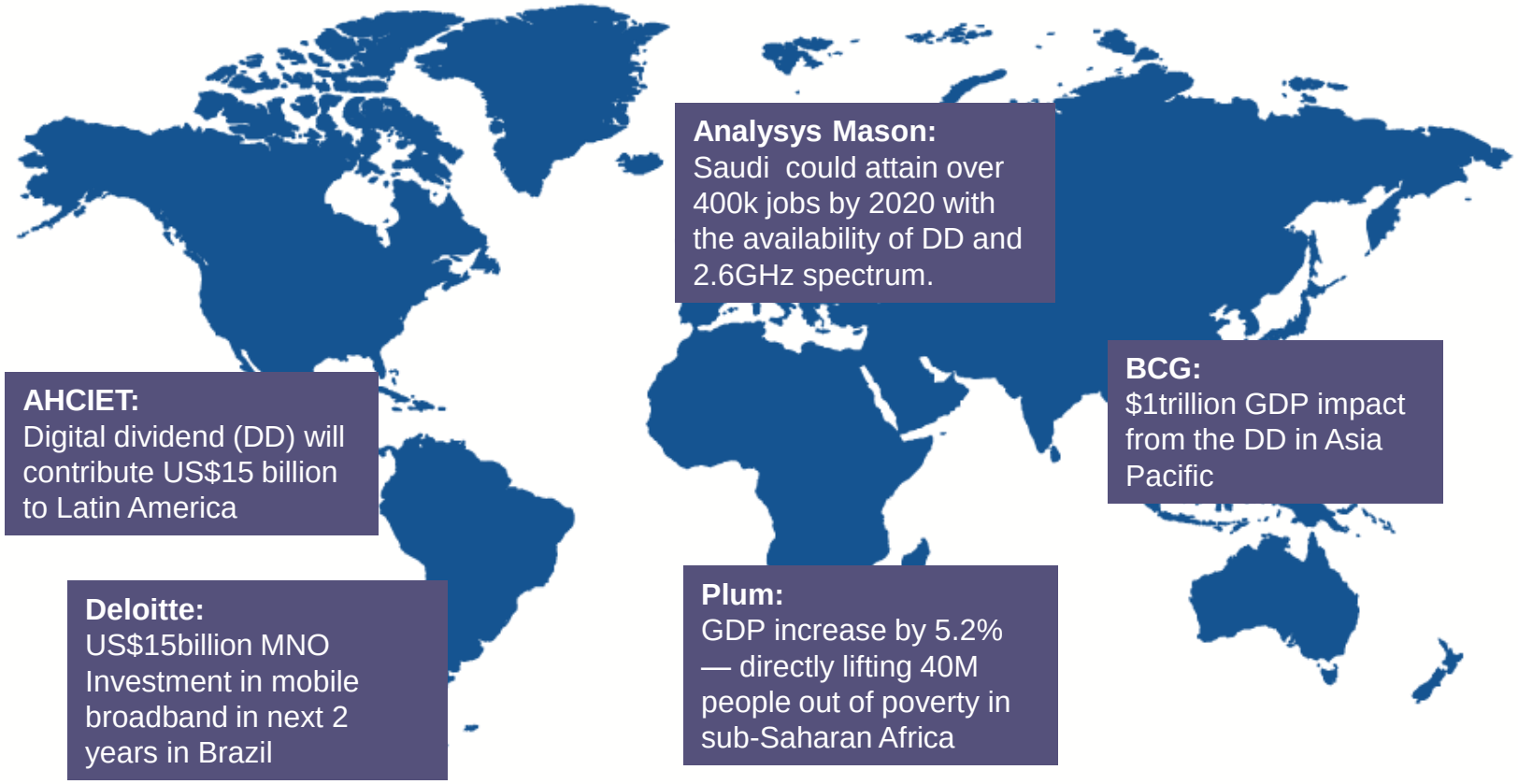
The socio-economic impact of mobile broadband

Benefit of releasing harmonised spectrum



Increased access to mobile services brings significant benefits to the population.

Socio-economic benefit



Analysys Mason:
Saudi could attain over 400k jobs by 2020 with the availability of DD and 2.6GHz spectrum.

AHCIET:
Digital dividend (DD) will contribute US$15 billion to Latin America

BCG:
$1trillion GDP impact from the DD in Asia Pacific

Deloitte:
US$15billion MNO Investment in mobile broadband in next 2 years in Brazil

Plum:
GDP increase by 5.2% — directly lifting 40M people out of poverty in sub-Saharan Africa

Significant socio-economic benefits from the release of harmonised spectrum to deliver mobile broadband (i.e., GDP and job growth)

Social impact of mobile

M-EDUCATION

Mobile technologies are especially good at increasing both the level education and achieving the goal of education for all.

Examples

- Programme in Jordan, provided in both Arabic and English, to help recent graduates with career development
- Mobile English-language programme in Tunisia with lessons covering a range of subjects including society, technology and the environment

M-HEALTH

Mobile technologies provide a significant contribution to healthcare in the region and a World Health Organisation review of m-Health programmes worldwide found that the region has a number of established programmes.

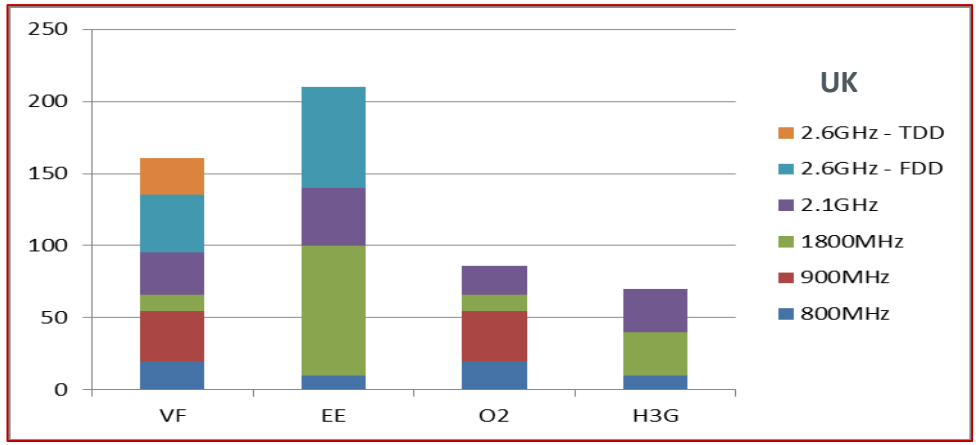
Examples

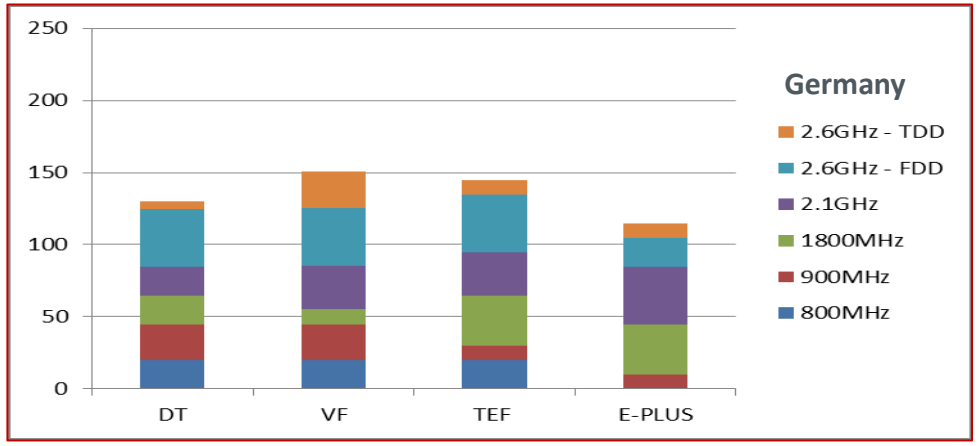
- Programme in a number of countries that promotes HIV prevention skills
- Mobile programme in Yemen that delivers medical advice via SMS

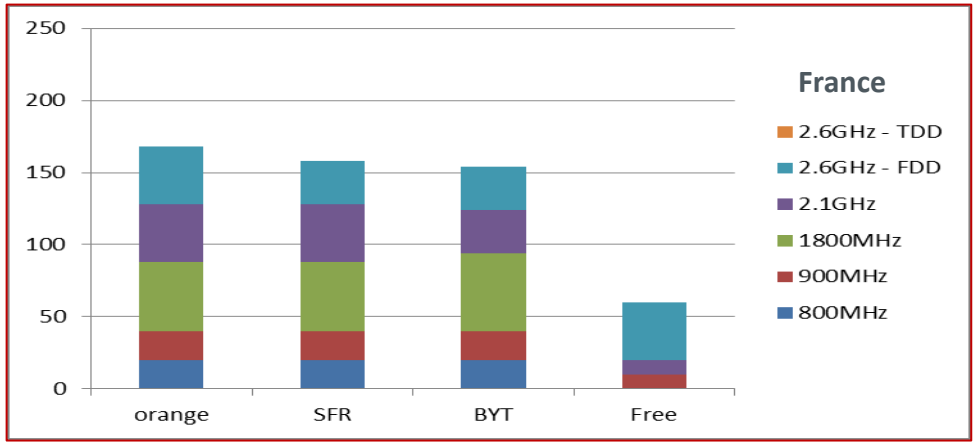
Spectrum per operator in the Region

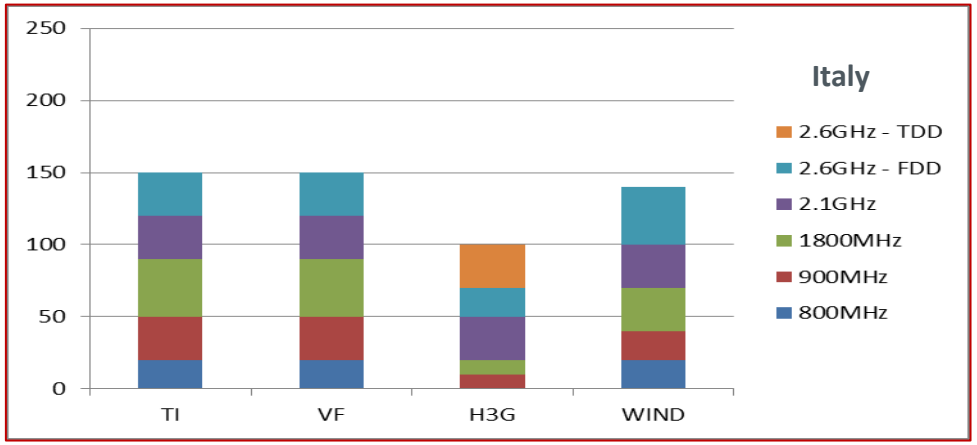
Compared to EU markets

Spectrum by operator in selected EU markets

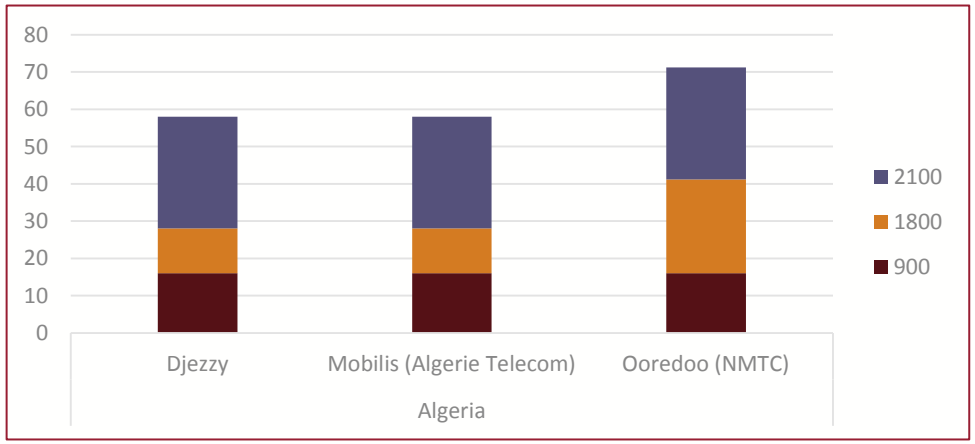


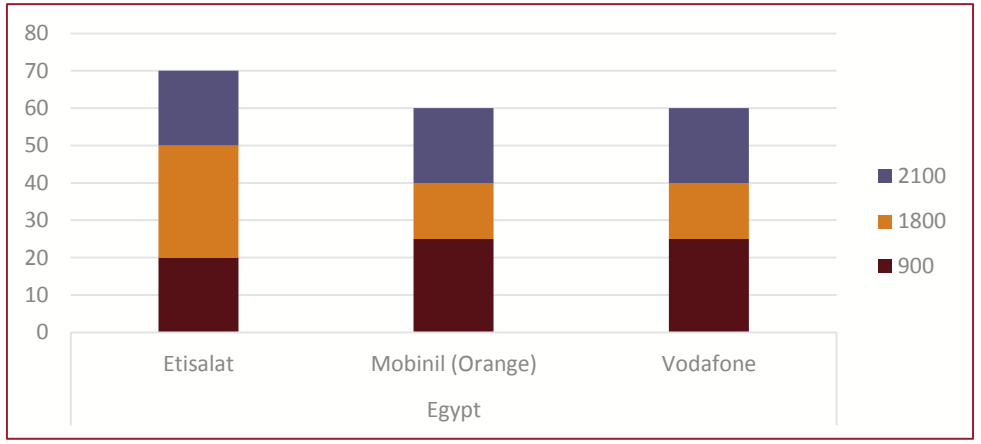


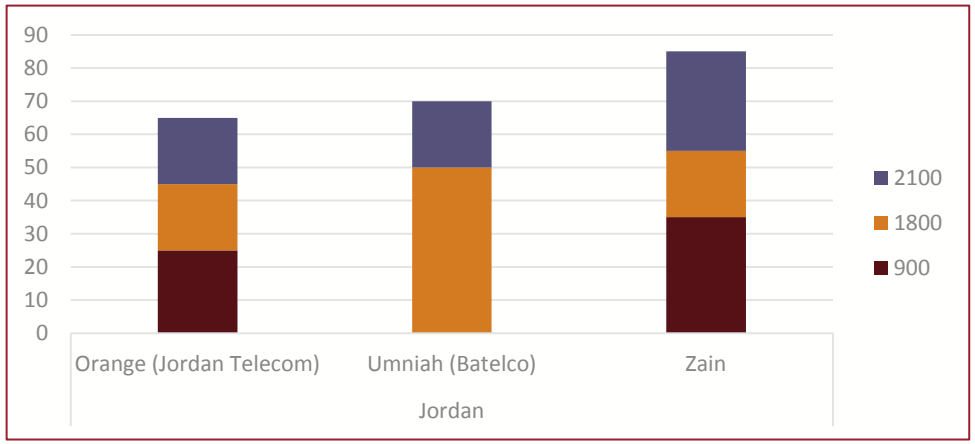


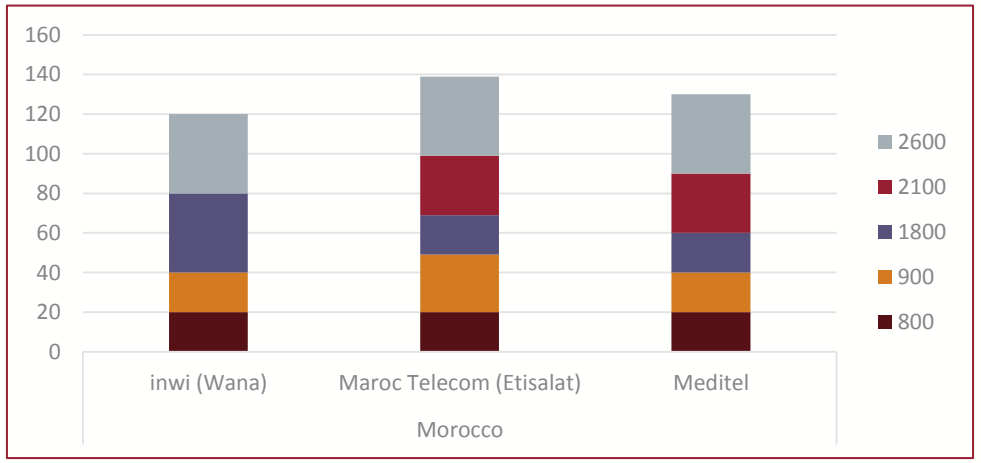


Spectrum by operator in selected MENA markets (i)



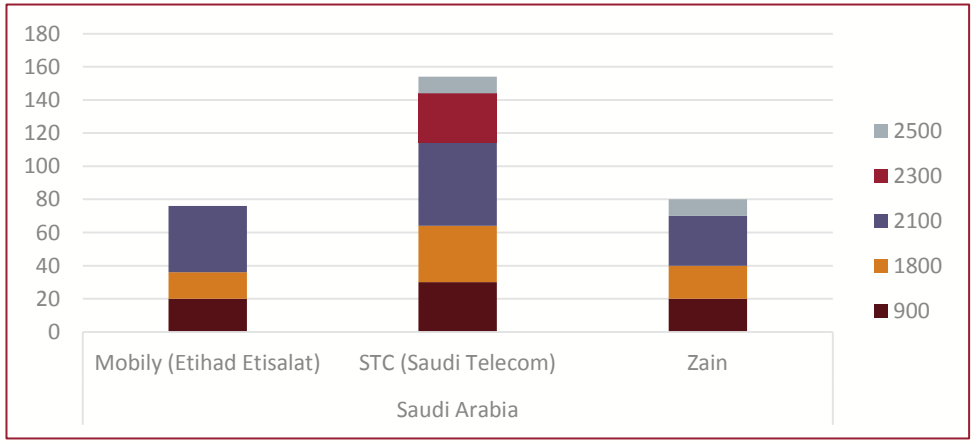


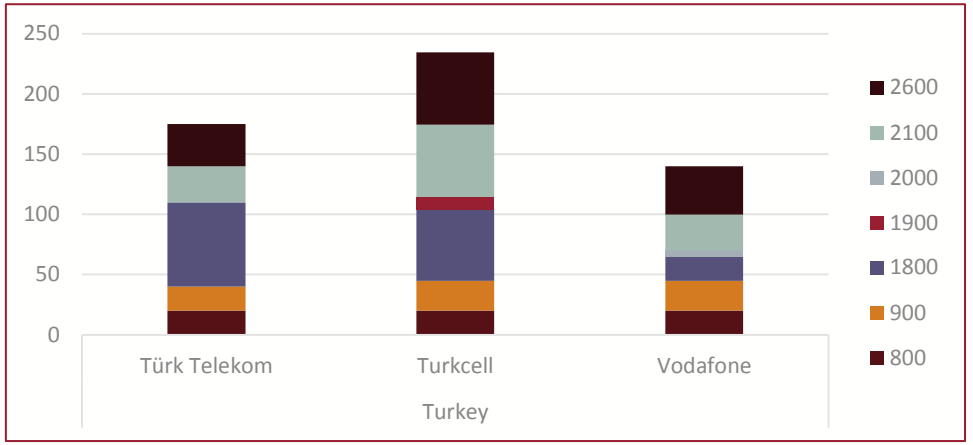


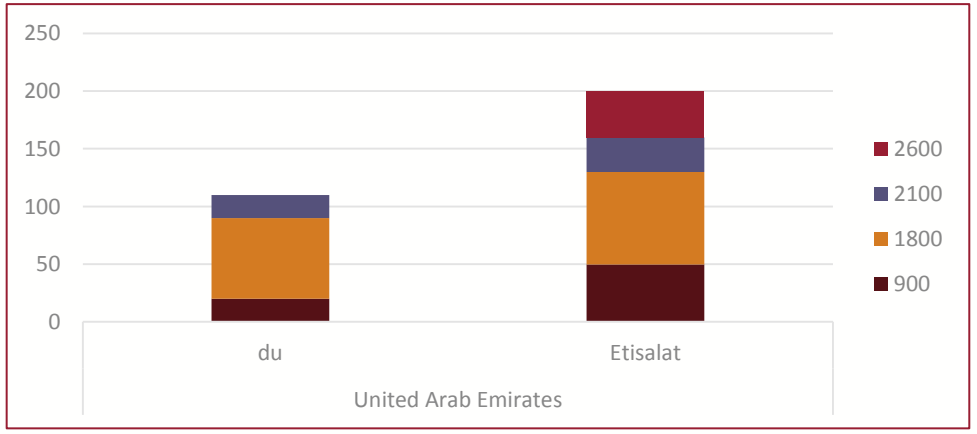


Note: All spectrum shown is for mobile. Spectrum for WiMax is not included.

Spectrum by operator in selected MENA markets (ii)







Note: All spectrum shown is for mobile. Spectrum for WiMax is not included.

Thank you

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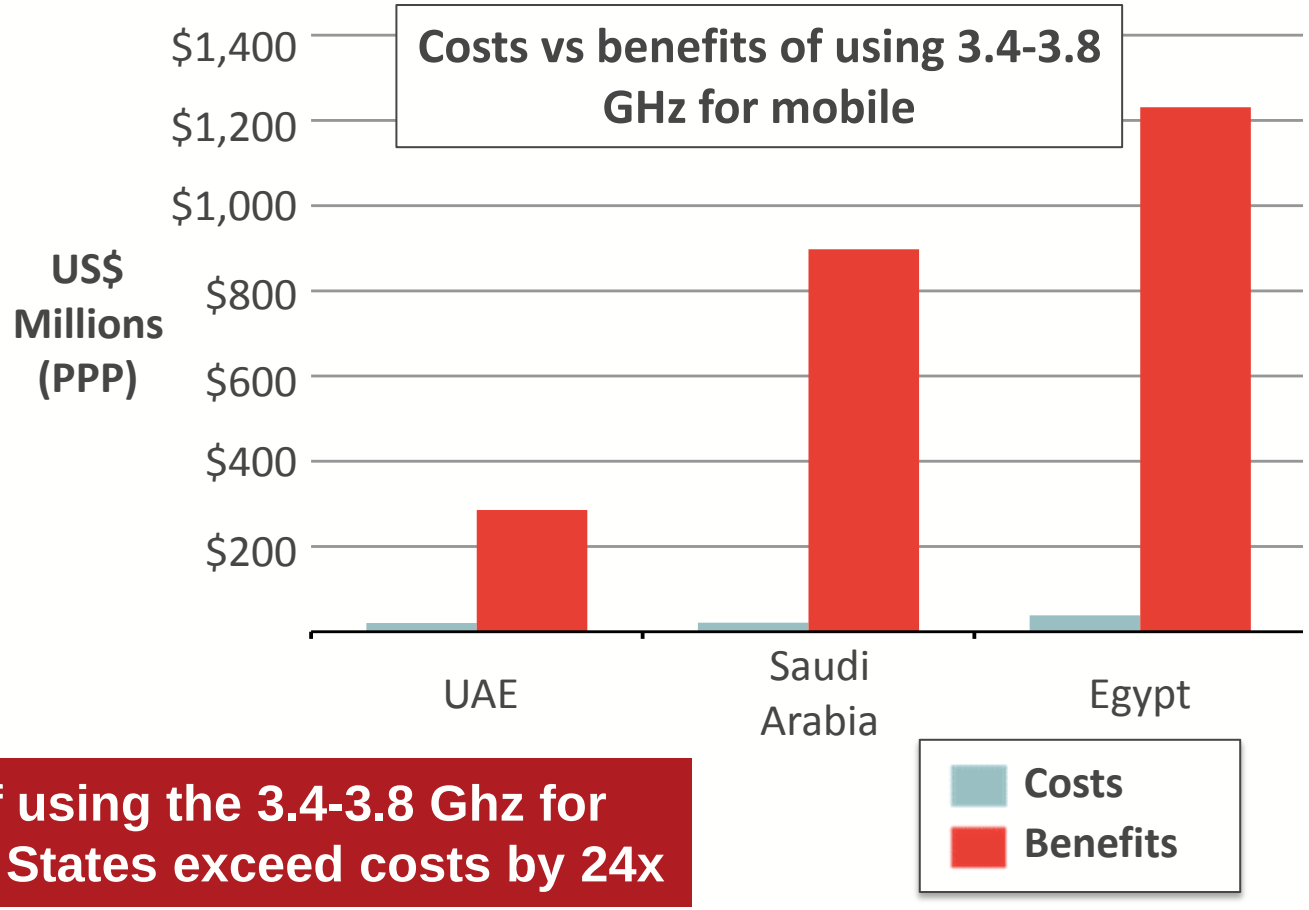
Background Information

- Supplementary Slides

C BAND (3.4-3.8 GHz): FSS and IMT can share

- C-band is shared between FSS and IMT in several countries (e.g. UK)
- Interference avoided with planning
- IMT can use part of the band in urban centres leaving FSS to use the full band in suburban/rural areas
- IMT in the C-band is increasingly possible as satellite moves to Ka/Ku
- Europe supports IMT in 3.4-3.8 GHz

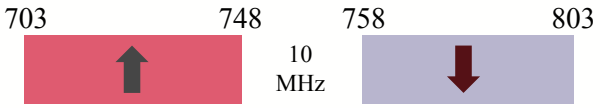


The economic benefits of using the 3.4-3.8 Ghz for mobile services in the Arab States exceed costs by 24x

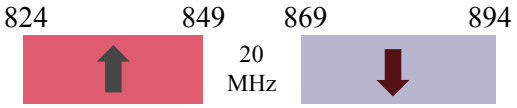
Identified spectrum bands

Asia-Pacific Region

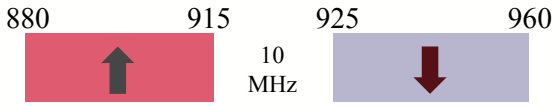
Coverage Bands (<1GHz)



The 700 MHz band: 2x45 MHz

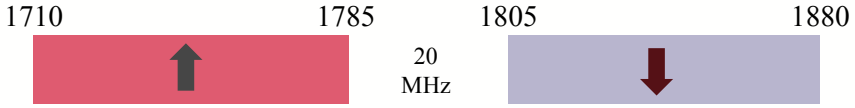


The 850 MHz band: 2x25 MHz

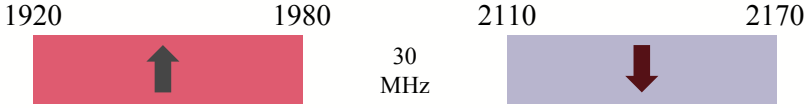


The 900 MHz band: 2x35 MHz

Capacity Bands (>1GHz)



The1800 MHz band: 2x75 MHz



The 2100 MHz band: 2x60 MHz

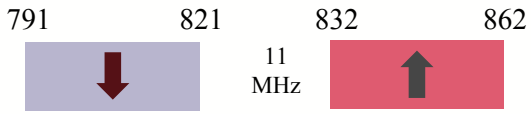
The 2300 MHz band: 100 MHz

The 2600 MHz band: 2x70 MHz with 50 MHz unpaired TDD

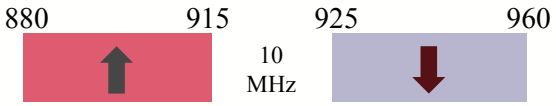
Identified spectrum bands

Europe, Middle East and Africa

Coverage Bands (<1 GHz)

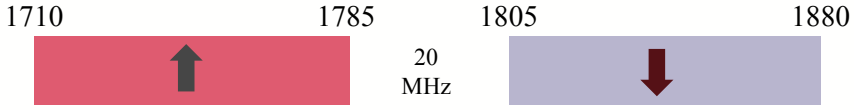


The 800 MHz band: 2x30 MHz

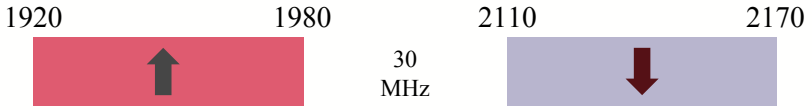


The 900 MHz band: 2x35 MHz

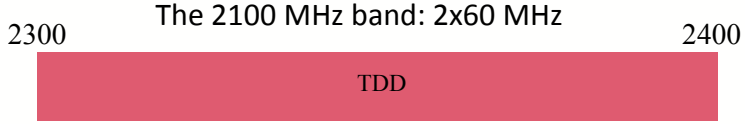
Capacity Bands (>1 GHz)



The1800 MHz band: 2x75 MHz



The 2100 MHz band: 2x60 MHz



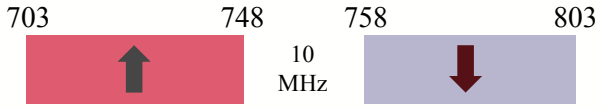
The 2300 MHz band: 100 MHz

The 2600 MHz band: 2x70 MHz with 50 MHz unpaired TDD

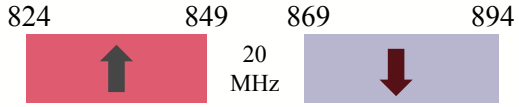
Identified spectrum bands

LatAm Region

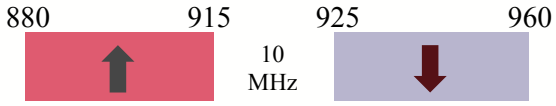
Coverage Bands (<1GHz)



The 700 MHz band: 2x45 MHz

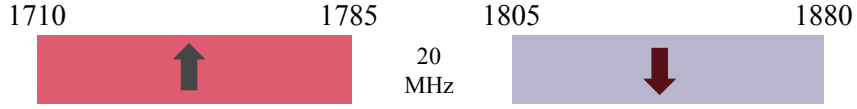


The 850 MHz band: 2x25 MHz

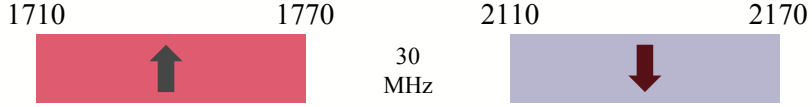


The 900 MHz band: 2x35 MHz

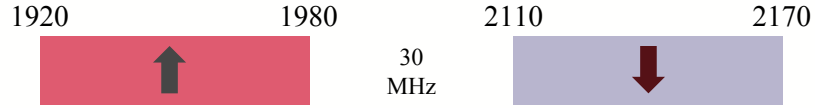
Capacity Bands (>1GHz)



The1800 MHz band: 2x75 MHz



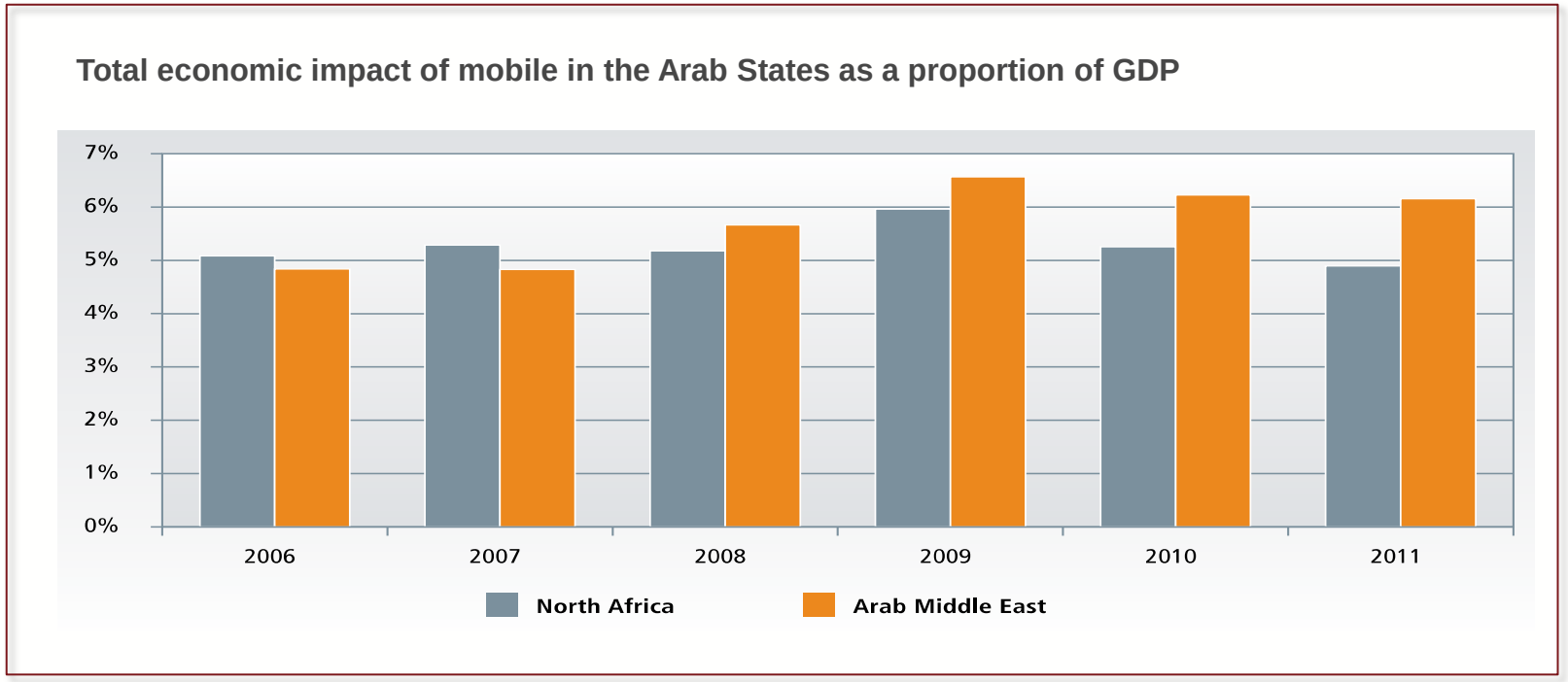
The AWS band: 2x60 MHz (including extension)



The 2100 MHz band: 2x60 MHz

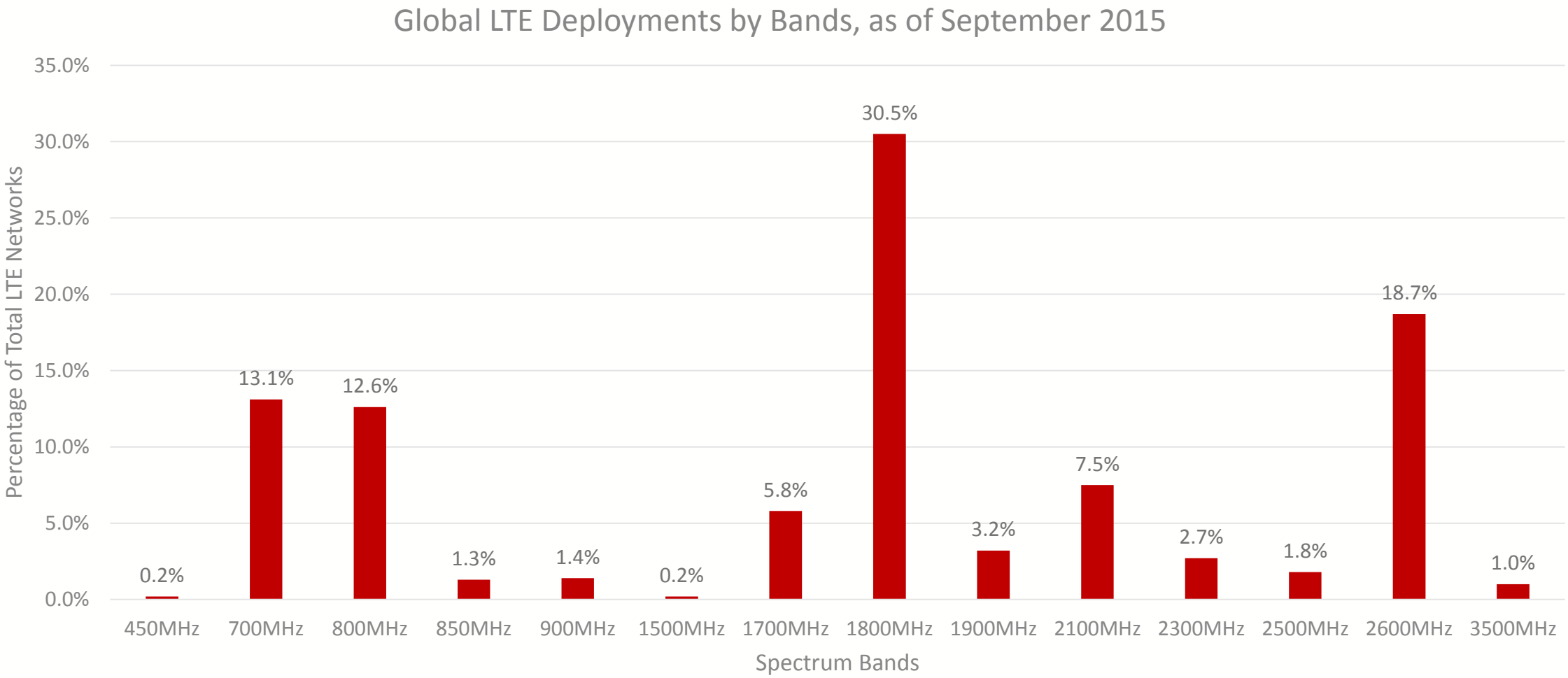
The 2600 MHz band: 2x70 MHz with 50 MHz unpaired TDD

Contribution to the national economy



- Mobile is a transformative technology that has had a significant economic and social impact across the MENA.
- The estimated economic impact of the mobile sector has stabilised around 5–6% as a percentage of GDP across MENA in the past few years, with a peak in 2009 due to lower than usual GDP growth as a result of the global financial crisis.

Global LTE network status

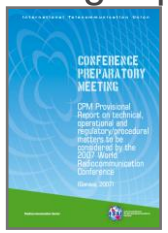


Source: GSMA Intelligence

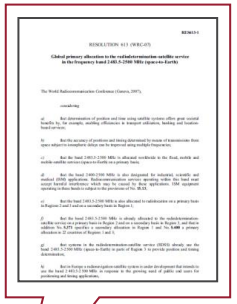
WRC process

Director's report

Conference preparatory meeting report



WRC resolutions

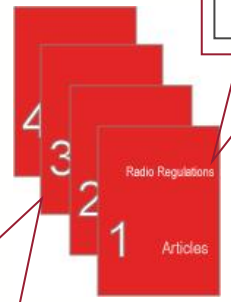


Member state proposals

WRC

Final Acts

Radio Regulations



Coordinated common proposals

Regional preparation

Frequency allocations

Allocation to services		
Region 1	Region 2	Region 3
2010-2025 FIXED MOBILE 5.388A 5.388B 5.388	2010-2025 FIXED MOBILE MOBILE-SATELLITE (Earth-to-space) 5.388 5.389C 5.389E	2010-2025 FIXED MOBILE 5.388A 5.388B 5.388

5.388A In Regions 1 and 3, the bands 1885-1980 MHz, 2010-2025 MHz and 2110-2170 MHz and, in Region 2, the bands 1885-1980 MHz and 2 110-2160 MHz may be used by high altitude platform stations as base stations to provide International Mobile Telecommunications-2000 (IMT-2000), in accordance with Resolution 221 (Rev.WRC-03)[*]. Their use by IMT-2000 applications using high altitude platform stations as base stations does not preclude the use of these bands by any station in the services to which they are allocated and does not establish priority in the Radio Regulations. (WRC-03)