NERA Economic Consulting

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World's first economic consultancy, providing advice for over 50 years

- NERA's expertise spans multiple industries and practice areas (auctions, competition, securities, regulation, transfer pricing etc..)
- Member of the Oliver Wyman Group, a subsidiary of Marsh & McLennan Companies

Our spectrum and auctions team:

- Implements major auctions for regulators and advises bidders on strategy
- Has experts in London, New York and Tokyo who have collectively worked on over 50 auctions
- Offers exceptional experience with all auction formats, and has developed and refined a suite of software tools for running, simulating and analysing auctions
- Is widely recognised for its work on spectrum allocation and pricing, through publications and presentations at industry conferences

Richard Marsden

Managing Director

Advisor to MNOs or governments in over 50 spectrum awards since 1999

Author of multiple reports on best practice in spectrum auctions, allocation and pricing

Recent project work at NERA:

- Design and implementation of 4G auctions in Belgium, Mexico, Singapore and Saudi Arabia
- Bid strategy advice to mobile operators in more than 20 countries, including 4G auctions in Australia, Canada, Germany, Italy, Spain, Switzerland, UK and USA
- Provision of simulation software for the US Incentive Auction to broadcasters who in aggregate accounted for 15% of nationwide revenues (US$1.5bn)
- Support for consultation work and legal actions relating to the pricing, valuation and management of radio spectrum

Recent publications:

- Reports on best practice in spectrum pricing for GSMA
- Book chapters and articles on bid strategy in combinatorial clock auctions and on auctions for shared spectrum

This slide taken from Mozambique presentation – GSMA to replace as appropriate

Spectrum allocation – a vision for the future

13 November, 2017

Nairobi, Kenya

Best practice in allocating spectrum

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Best practice in spectrum allocation primarily concerns four issues:

#1

Timely availability of spectrum

- Follow international band plans
- Release usable spectrum in anticipation of need
- Provide a roadmap for future spectrum availability

#2

Efficient assignment across operators

- Use market mechanisms whenever there is competition for spectrum
- Adopt appropriate rules to preserve competition
- Allow secondary trading with technology & service neutrality

#3

Reasonable prices

- Set reserve prices below a conservative estimate of true market value
- Treat annual fees as an integral part of the reserve price
- Avoid fees that deter rollout of network infrastructure & use of spectrum

#4

Investment-friendly terms & conditions

- Establish well defined property rights that allow for trading and change of use
- Grant longer licence durations (ideally 20 years +)
- Avoid onerous rollout, coverage or service quality obligations

Mobile trends driving spectrum use

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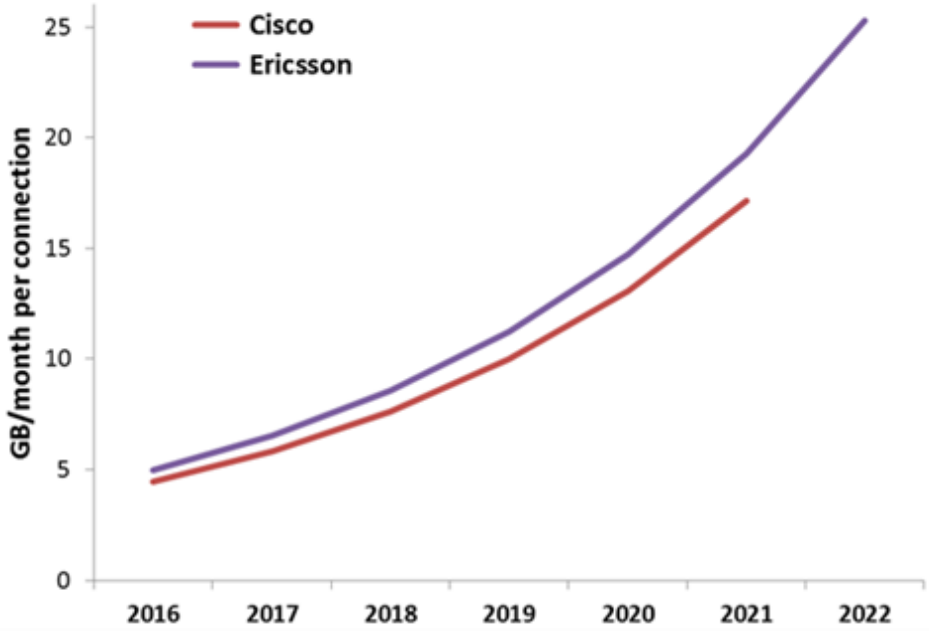
What is happening in Europe and North America:

1. Exponential growth in demand for data
   - 4G is a huge success story
   - Rapidly increasing use of video over mobile networks
   - Internet of Things
2. New mobile technologies
   - Transition from 4G to 5G
   - New network technologies: small cells, MIMO, beamforming etc..
3. Limited scope for operators to raise revenues
   - Saturated markets (>100% penetration)
   - Limits on willingness to spend on communication services

Projected mobile data usage in North America



Source: Ericsson Mobility Report, June 2017 & Cisco VNI Mobile Forecast Highlights 2016-2021

- **The time lag between what is happening in the most developed mobile markets and emerging markets, such as Kenya, is becoming ever smaller**

#1 Timely availability of spectrum

Implications for spectrum allocation

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1. Much more bandwidth needed
   - Cost of spectrum per MHz will have to fall or expansion unaffordable
2. Greater focus on capacity rather than coverage spectrum
   - Some degree of convergence in value of spectrum across bands
3. Preference for contiguous spectrum for next generation of technology
   - May require defragmentation and refarming of existing bands
4. Increasing interest in higher frequencies
   - May require trading, sharing and change of use

#1 Timely availability of spectrum

Spectrum bands for mobile

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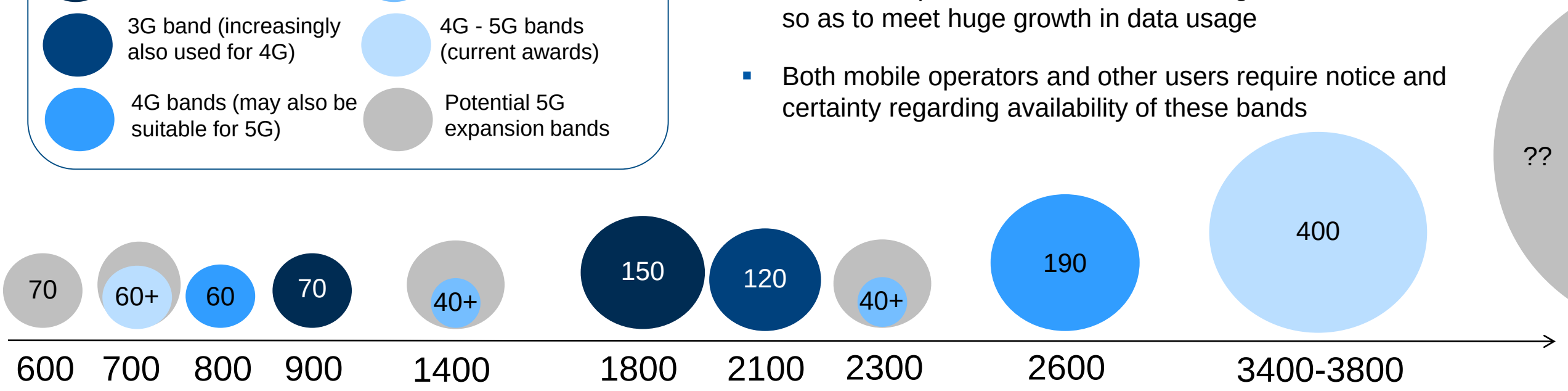
Legend for Europe / Africa plan

- 2G bands (now widely used for 3G + 4G)
- 3G band (increasingly also used for 4G)
- 4G bands (may also be suitable for 5G)
- 4G expansion bands (current awards)
- 4G - 5G bands (current awards)
- Potential 5G expansion bands

- Europe currently in process of increasing spectrum availability for mobile from about 670 MHz to over 1,100 MHz
- Additional spectrum will follow, including bands above 20 GHz, so as to meet huge growth in data usage
- Both mobile operators and other users require notice and certainty regarding availability of these bands



- **Key to success: Developing and regularly updating a ROADMAP for future spectrum release, including regimes for spectrum sharing, trading or clearance of incumbent uses as appropriate**

#2 Efficient assignment across operators

Why licence spectrum?

Licensed spectrum

Spectrum is a scarce resource with varying uses and demands

1. Ensure vital services can reliably access spectrum and innovate
2. Minimise interference and enable harmonisation
3. Meet policy objectives and encourage investment in vital services

Unlicensed spectrum

Unlicensed spectrum is a complement not a substitute for licensed spectrum

- Mobile networks rely heavily on WiFi offload to manage traffic
- WiFi networks cannot offer the mobility, reach or reliability of cellular networks

Common spectrum assignment objectives

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Primary objectives

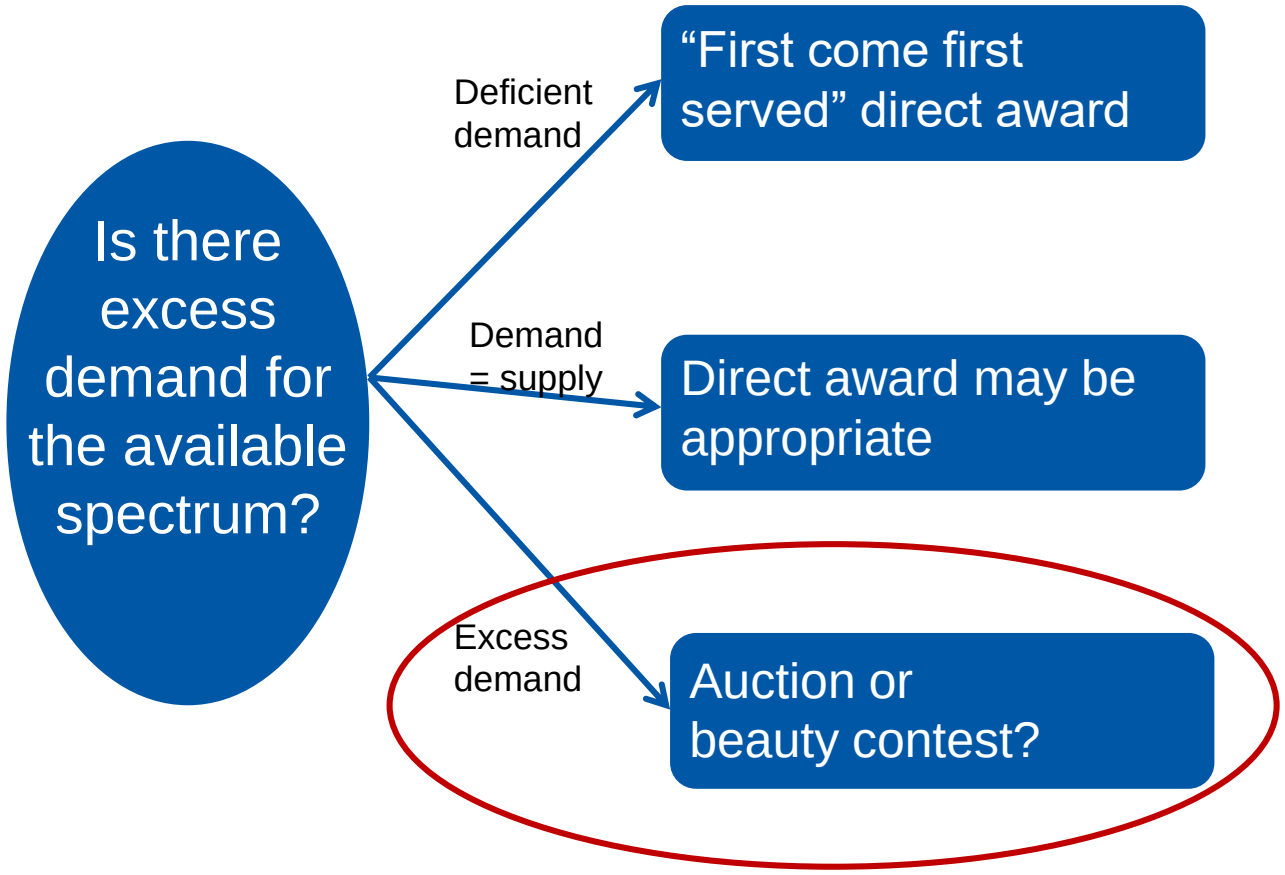
- Promoting the efficient use of spectrum
- Supporting mobile service competition

Secondary objectives

- Ensuring service continuity for end-users
- Adopting a well run, timely and legally robust process
- Other policy goals such as wide coverage
- In some cases, generating revenue for government

#2 Efficient assignment across operators

Auctions or administrative assignment?



Why regulators and operators typically prefer auctions	
Allocative efficiency	Transparency of outcomes
Consistency of rules	Robustness to legal challenge

With 3+ operators, awards of mobile spectrum should typically have excess demand if spectrum is priced and packaged appropriately

Auctions will only deliver if the licences are attractive and rules are well designed

#2 Efficient assignment across operators

The global spread of spectrum auctions

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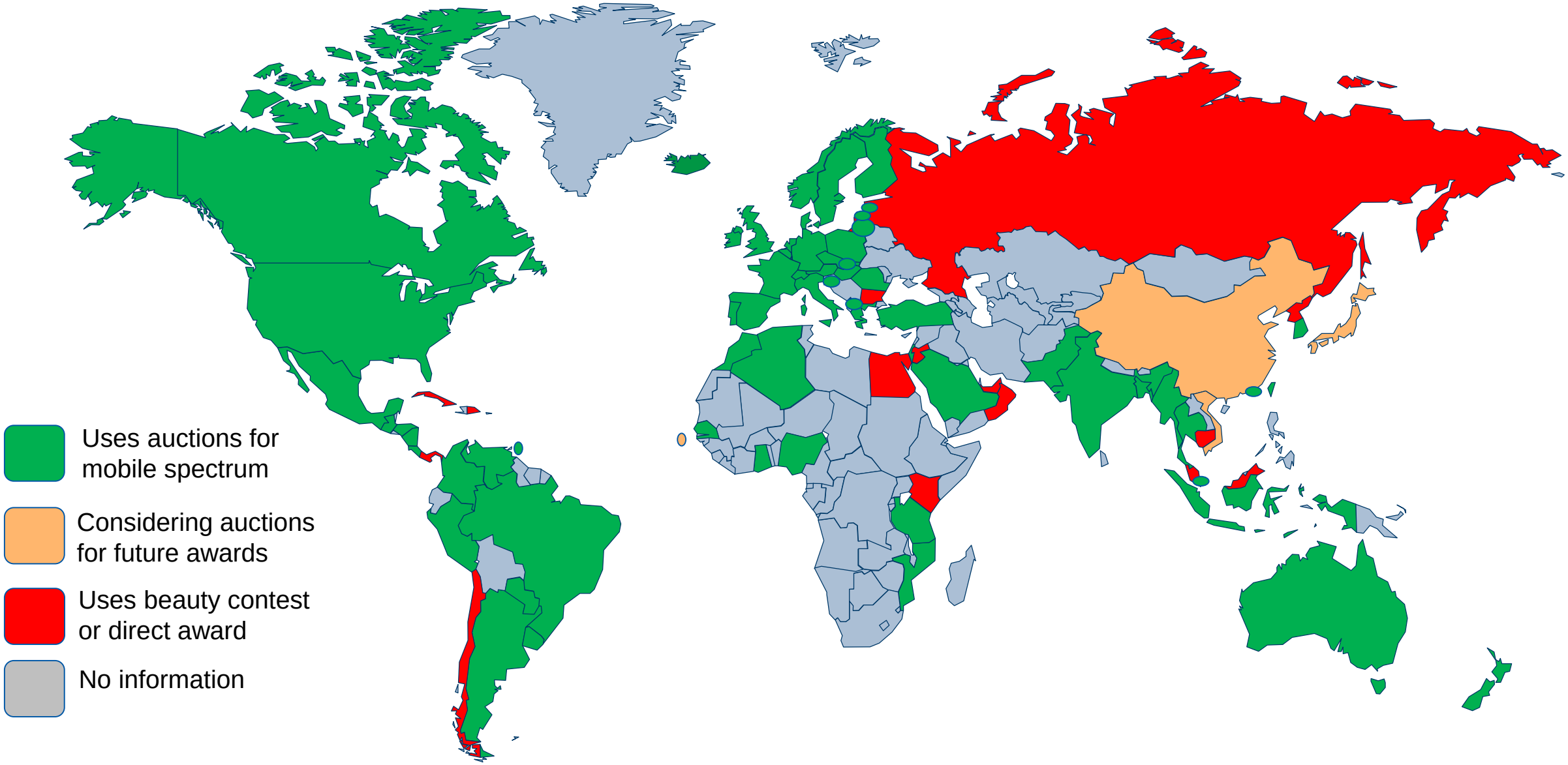

#2 Efficient assignment across operators

Secondary trading & liberalisation

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General principle: Whenever possible, let the market decide how spectrum is used and who uses it

Trading

- Tradable property rights, with only limited regulatory oversight
- Safeguards to protect competition, national security etc..

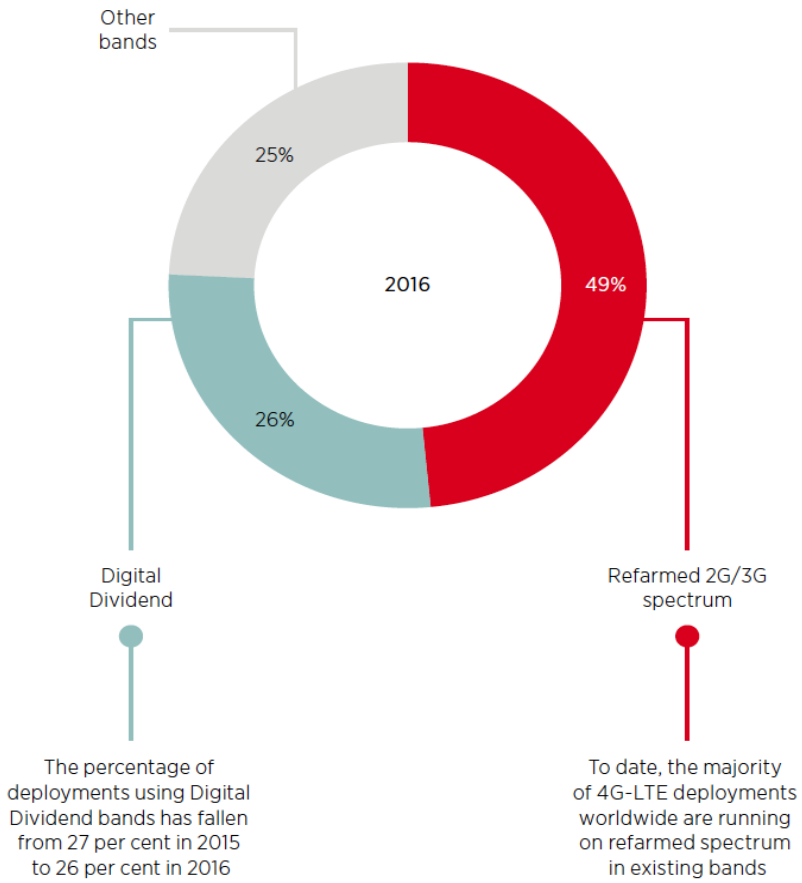
Liberalisation

- Technology & service neutrality
- Usage rights that support commercial management of interference

Case study: UK L-band (1452-92 MHz)

- L-band acquired in auction by Qualcomm in 2008
- Qualcomm's original use case did evolve
- Spectrum later identified for SDL (LTE downlink for mobile)
- Qualcomm sold spectrum to Vodafone and Three UK in 2015
- Commercial LTE services using this band expected in 2018

The success of LTE is based on a combination of refarmed spectrum and spectrum repurposed for mobile



Spectrum pricing

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- The price of spectrum consists of up to three elements:

UPFRONT RESERVE PRICE	+	COMPETITIVE PREMIUM (IN AUCTION, IF ANY)	+	ANNUAL FEES (NPV OVER LICENCE TERM)
Best practice: Usually substantive but must always be below conservative estimate of market value + take account of cost of obligations (if any)		In absence of artificial spectrum scarcity, well designed rules can allow market to determine allocations at fair prices		Should be modest and predictable, and not act as a deterrent to investment

Typical mistakes in spectrum pricing:

1. Pricing too high / ignoring costly obligations
2. Releasing too little spectrum, too late
3. Bad award rules

#4 Investment friendly terms & conditions

Licence terms and conditions

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LICENCE TERMS & CONDITIONS CAN SUPPORT NETWORK EVOLUTION & INVESTMENT

- License duration of up to 20 years
- Remove service and technology restrictions
- Use coverage obligations with caution, target them, and balance obligations with cost of license
- Avoid restrictive and onerous conditions
- Use annual fees to recoup costs – not maximise revenues

RENEWAL PROCESS SHOULD AVOID RISKING INVESTMENT & SERVICE CONTINUITY

- Establish a license-renewal process with consultation 3-4 years in advance
- A presumption of renewal (unless terms breached) supports service continuity and investment
- Renewal should be predictable and avoid introducing new terms which jeopardise return on investment

Sweden: A case study in motivating rural investment

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Early 800 MHz auction + reasonable reserve price + innovative coverage model

- Sweden auctioned 800 MHz in 2011
  - Early auction, 25 year licence duration
  - Reasonable reserve price
  - Auction revenues were healthy but not so high as to jeopardise network investment afterwards
- One licence with coverage obligation focused on precise locations of known blackspots
- Applicants for that licence were allowed to count $22m-$44m of promised network investment in the blackspots in their bid

Digital dividend + network sharing = 99.9% 4G population coverage

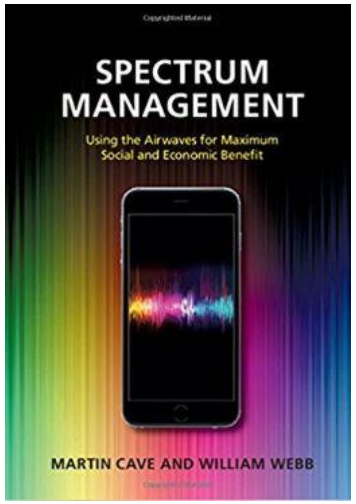
- **Question for discussion: What actions could Kenya take to encourage operators, especially smaller ones, to expand coverage in rural areas?**

Further reading

GSMA Mobile Policy Handbook & Best Practice in Spectrum Licensing

www.gsma.com/publicpolicy/handbook/download-mph
www.gsma.com/spectrum/best-practice-mobile-spectrum-licensing

An introduction to the major issues concerning mobile policy and spectrum licensing



Spectrum Management

By Cave & Webb

http://www.cambridge.org

A comprehensive guide to spectrum management from an economic and technical perspective

NERA reports for GSMA on Effective Spectrum Pricing

By Marsden, Ihle & Soria
www.gsma.com/spectrum/effective-spectrum-pricing

A guide to best practice in setting spectrum prices

Handbook of Spectrum Auction Design

Editors: Bichler & Goeree

http://www.cambridge.org

A compendium of all the best academic work on auction design for spectrum awards