Spectrum Auction Best Practice

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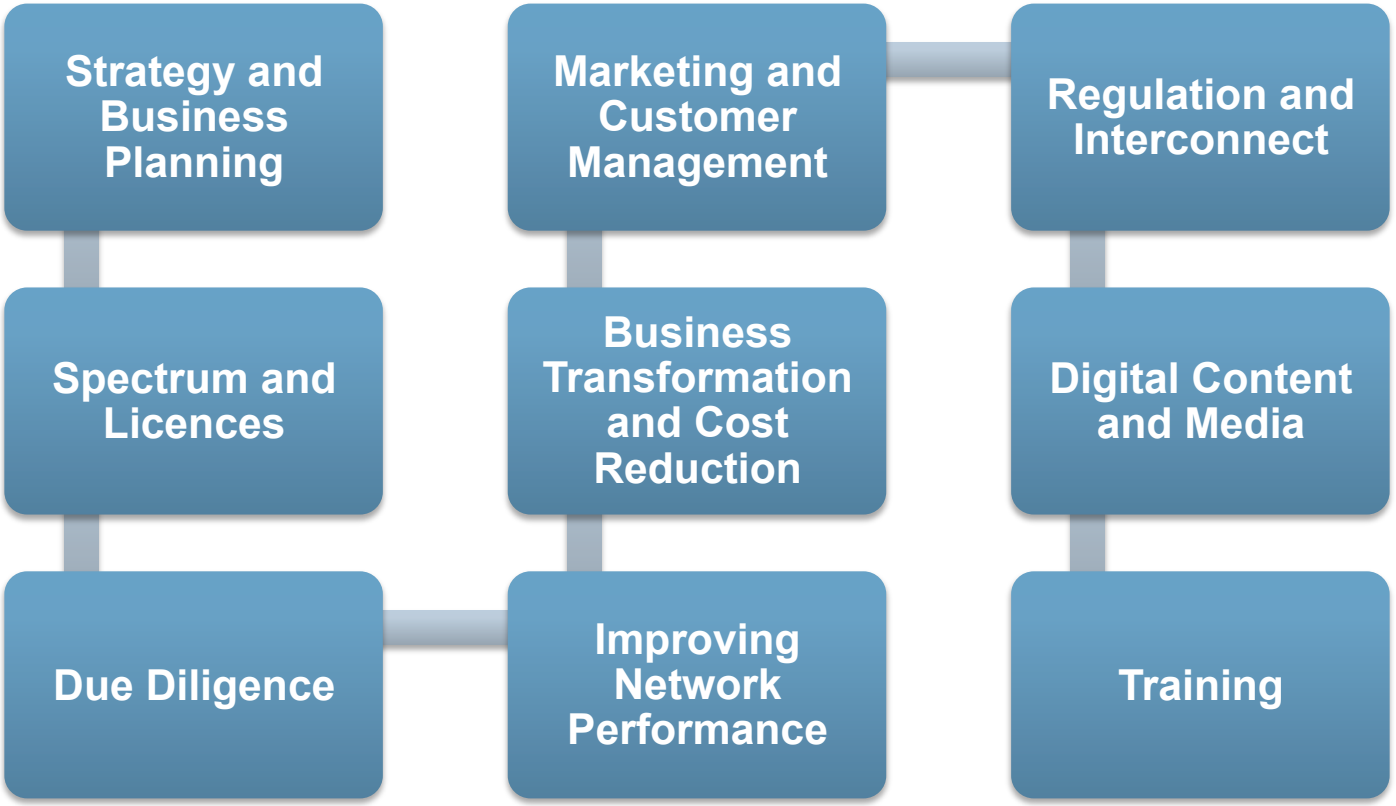
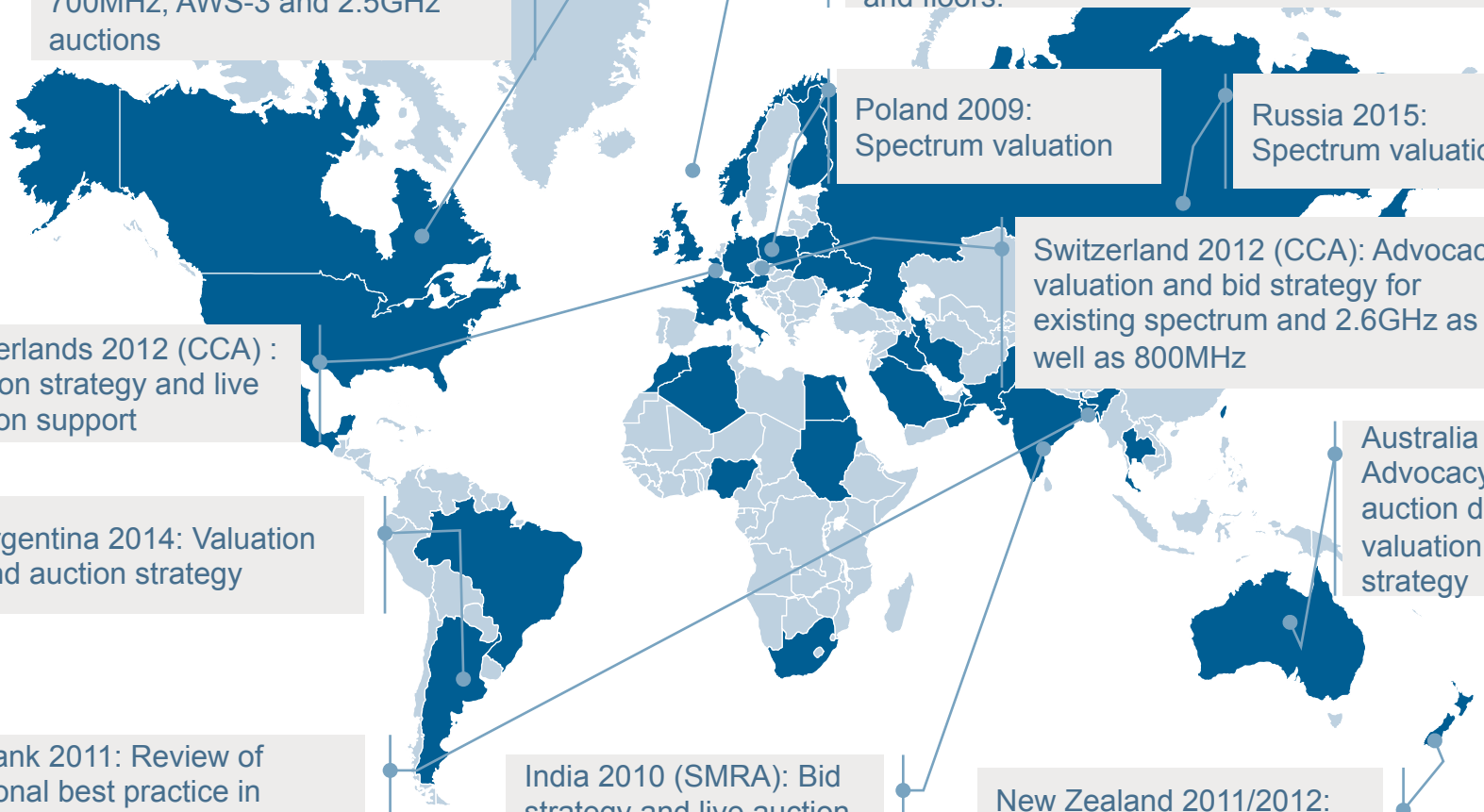
coleagoconsulting

Since 2001, Coleago has offered a wide range of advisory services to the telecom industry



We are experts in spectrum issues having advised in over 70 awards globally



Canada 2012-2015 (CCA): Valuation and bid strategy for 700MHz, AWS-3 and 2.5GHz auctions

UK 2008-2013 (CCA): Valuation and bid strategy support for 2.6GHz and 800MHz auction. Advocacy support on spectrum caps and floors.

Poland 2009: Spectrum valuation

Russia 2015: Spectrum valuation

Switzerland 2012 (CCA): Advocacy, valuation and bid strategy for existing spectrum and 2.6GHz as well as 800MHz

Netherlands 2012 (CCA) : Auction strategy and live auction support

Australia 2010-2013: Advocacy, AIP, auction design, valuation and bid strategy

Argentina 2014: Valuation and auction strategy

World Bank 2011: Review of international best practice in spectrum allocation

India 2010 (SMRA): Bid strategy and live auction support for regional BWA

New Zealand 2011/2012: Lobbying auction design and LTE Strategy

Agenda

1. Mobile industry evolution
2. Policy objectives, efficiency and uncertainty
3. Competition, licence conditions and pricing
4. Best practice in spectrum management
5. Auction design issues

Mobile industry evolution

New technology enables operators to offer faster services and pass more traffic through a given amount of spectrum

3G HSPA

GSM

- Not well suited for modern data needs
- Download speed of up to 384 kbps with EDGE technology

3G HSPA

- Spectral efficiency: 0.7 bits / Hz / cell
- Download speed of 42Mbps

LTE and LTE Advanced

- Spectral efficiency: 1.4 bits / Hz / cell (possibly twice that for LTE-A)
- Download speed of 150Mbps (300 for LTE advanced)

How many Gbytes per month per user should operators plan for?

- How about 1 Gbyte per user per day?
- What if TV Anywhere Apps really take hold?

- How many hours does the average American watch TV per day?
  - Answer: 2.8 hours
- How much data volume does this represent per month, assuming HDTV?
  - Answer: 0.7 Terabyte (700 Gigabytes)
- **If just 4-5% of viewing is via LTE, that's 1 Gbyte per user per day**

How many Gbytes per month per user should operators plan for?

Samsung Galaxy S6

- Quad HD screen, i.e. 4 x normal HD or 2K
- 4K will be next

YouTube

YouTube

- 4K (Ultra HD) video content is available now

The battle between operators will be over the user experience in urban environments with high traffic volumes per square kilometre

- The high spending customers will migrate to the operator which is the least congested and offers the best user experience
- Spectrum is a key ingredient in delivering the LTE capacity required to keep data traffic moving in a high traffic density environment
- This is one of the factors explaining the high price paid in the US AWS-3 auction in February 2015 of 2.71 $/MHz/pop

Mobile broadband is a key ingredient for the development of the digital economy …

- An increase of 10% in mobile adoption boosts GDP growth by 0.8% (World Bank, 2009)
- For a given level of total mobile penetration, a 10% substitution from 2G to 3G increases GDP per capita growth by 0.15 % points (Deloitte, 2012)
- Doubling broadband speeds for an economy can add 0.3% to GDP growth (Arthur D. Little, 2011)

There are tangible benefits to society which illustrate the impact of mobile data

- A significant increase in financial inclusion in countries such as Kenya
- Healthcare: up to 70% improved compliance for TB
- 10-15% increase in farmer income
- mEducation solutions can significantly improve the affordability of education by up to 65%

Existing and new spectrum is required for mobile broadband services

700 MHz	**New spectrum for LTE, in some markets previously used for TV, referred to as "digital dividend" band**
800/900 MHz	**Originally only used for GSM and CDMA, progressive redeployment to 3G HSPA and recently to LTE**
1800 MHz	**Originally only used for GSM, progressive redeployment to LTE**
2100 MHz	**Currently used for 3G, upgrading to dual carrier HSPA+ and LTE**
2300 MHz	**Originally used for WiMax, now a standardised LTE band for capacity**
2600 MHz	**New capacity band for LTE**

Implications for spectrum management and auctions

Supply of new spectrum

- Focus on making a maximum of spectrum available for mobile broadband as fast as possible

Assign new spectrum

- Assign new spectrum to mobile operators to facilitate and encourage rapid deployment of LTE

New technology in existing spectrum

- Ensure that LTE can be deployed in existing bands

Policy Objectives, efficiency and uncertainty

What is your policy objective?

700MHz auction in Chile in 2014

The 700MHz spectrum award process focused on connectivity and competition policy objectives …

- cover 1,281 rural towns and 500 schools
- obligation to build fibre
- mandated MVNO access and roaming

… rather than extracting money from the mobile industry.

- Auction proceeds amounted to a relatively small 0.017 $/MHz/pop

Regulator policy objectives should determine allocation process, auction design and licence conditions

Policy objectives differ between countries

- Maximise immediate revenue generation from a spectrum auction
- Make spectrum available to mobile operators as cheaply as possible
- Increase mobile broadband access in rural and remote areas
- Increase competition
- Introduce new, faster speed services
- Ensure development of a connected society to deliver long-term economic benefits by making best use of spectrum
- Promote economic efficiency i.e. create economic value to society

Spectrum is a highly valuable, natural resource

A valuable national resource

- The benefits of increased mobile broadband are well documented
- Africa can expect a tsunami of mobile data growth
- New technology creates greater capacity from existing spectrum
- Technology alone will not be sufficient to meet demand
- New spectrum will be required
- A key role for regulators is ensuring the efficient use of spectrum

Spectrum has no intrinsic value, investment is required to build networks that extract producer and consumer value from spectrum

- Spectrum has no intrinsic value. Value is only created through the use of spectrum.
- Spectrum that lies fallow has no value.
- If operators invest and build networks which are used, consumer value is created.
- However, the investment only takes place if producer value is created, i.e. there has to be a return on investment.
- The return on investment needs to be at least as high as that in an alternative investment of similar risk.

Mobile operators seek to maximise value creation for their shareholders

Create shareholder value…

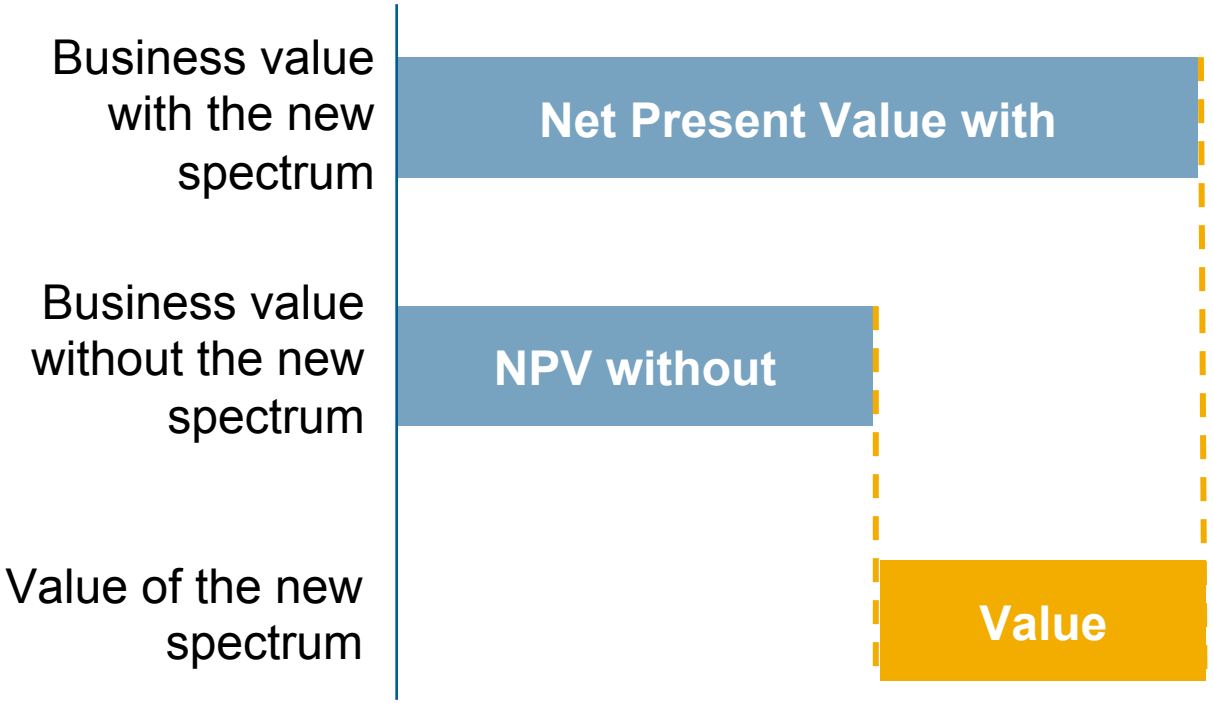
…by earning a return above the cost of capital

A trivial example

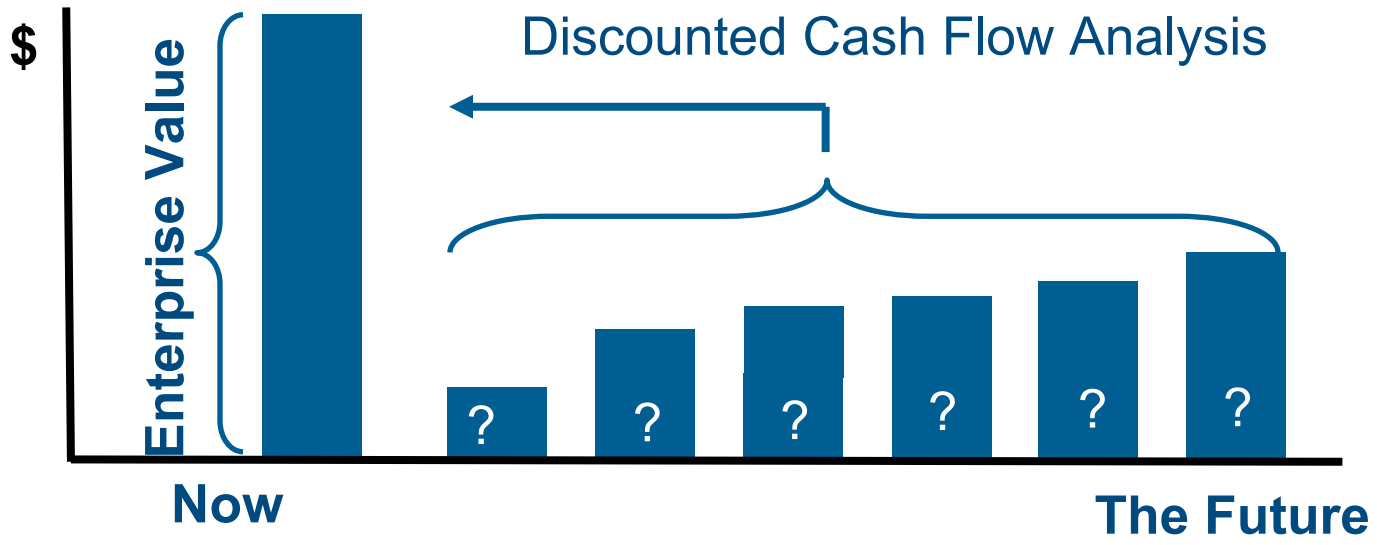
- The pharmaceutical industry delivers a return of 10%
- The mobile industry delivers a return of 5%
- Both industries are equally risky
- What would you do with your cash?

Spectrum valuation involves comparing an operator's Enterprise Value with and without the spectrum

Approach to Valuing Mobile Spectrum



Estimating the Enterprise Value, involves forecasting uncertain cash flows for 15 to 20 years and discounting them back using the cost of capital



The Weighted Average Cost of Capital or WACC reduces the value of future cash flows to take account of the uncertainty

Inject cash as shareholder funds in return for an equity stake or share of the ownership of the business

Borrow from the bank or issue corporate debt

Capital Employed

Equity

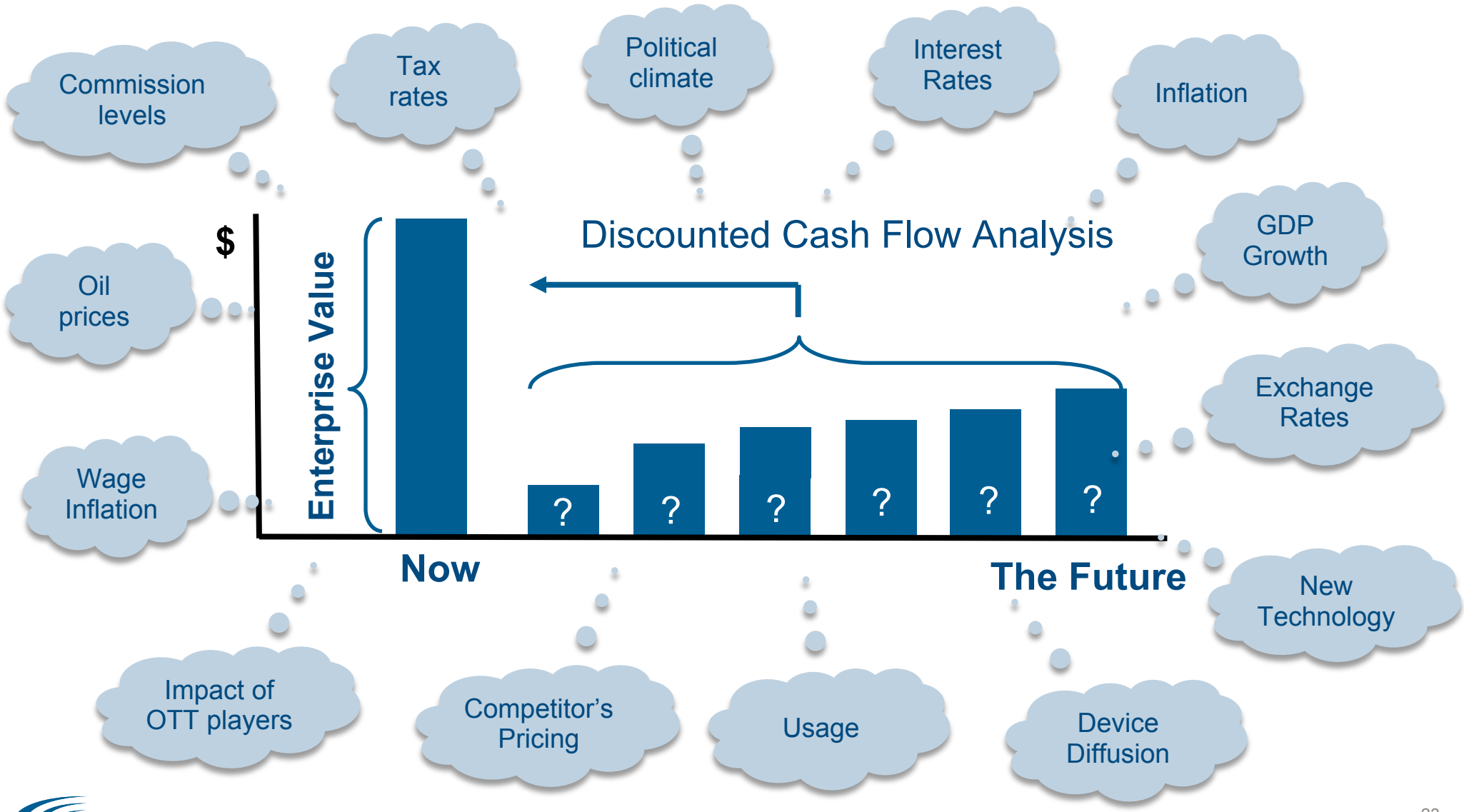
40% and 13% Return

Debt

60% and 8% Return

Example: WACC = 60% x 8% + 40% x 13% = 10%

And there is a very high degree of uncertainty associated with valuing spectrum… and these are the "usual" uncertainties

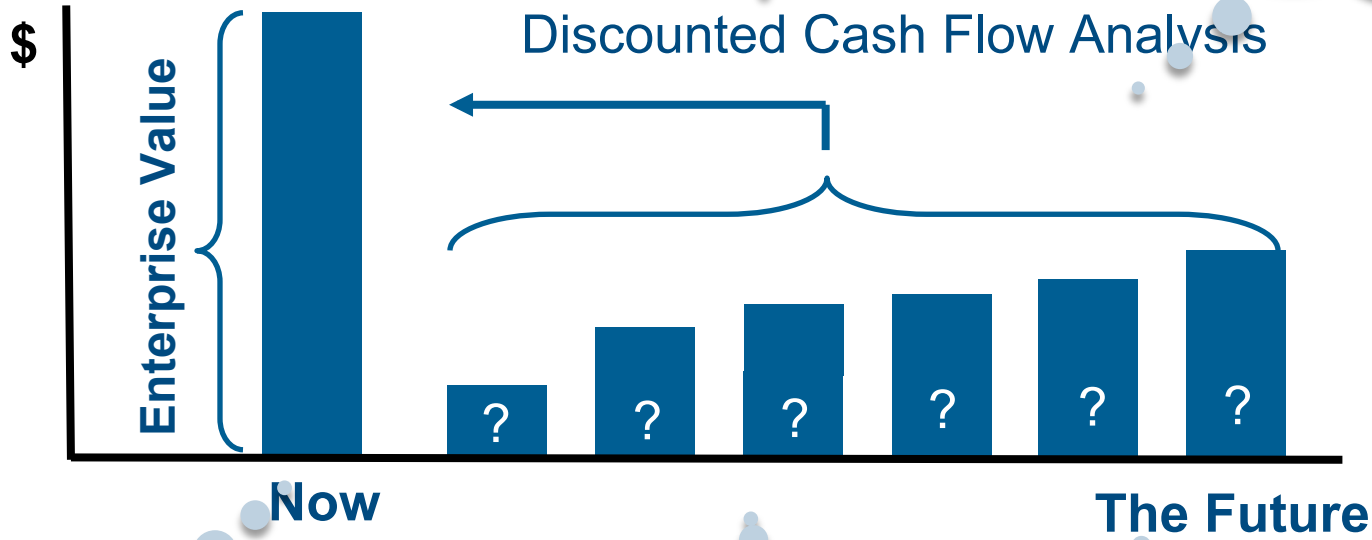


Some of the greatest uncertainties that impact spectrum values are often generated by the regulators themselves

Uncertainty over on-going annual spectrum fees

Outcomes from M&A decisions

Uncertainty over the prospect of new market entry



Uncertainty over future spectrum rights and licence conditions

Uncertainty over existing and new spectrum renewal

Uncertainty over when the Digital Dividend will be available

Regulators have an incentive to reduce uncertainty and this is a key element of best practice

Reducing uncertainty means

- Mobile operators will have greater certainty over the value of spectrum
- Mobile operators will place a higher value on spectrum
- Mobile operators will not delay or reject investment decisions
- Greater certainty encourages participation in the assignment process

Benefits for the regulator

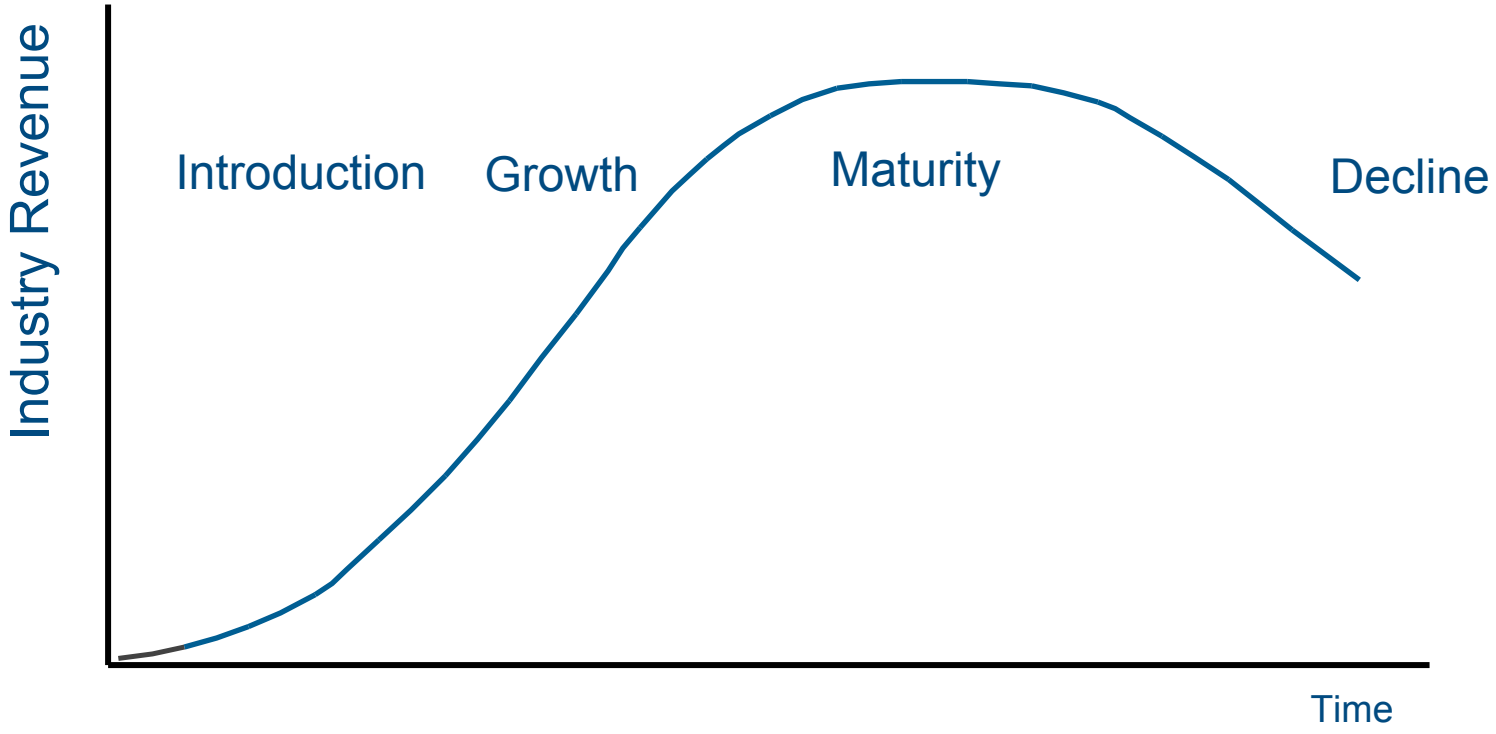
- Spectrum is more likely to be assigned to those that value it most highly
- Revenues generated from the assignment process may be higher
- Investment and innovation will be increased

Competition, licence conditions, and pricing

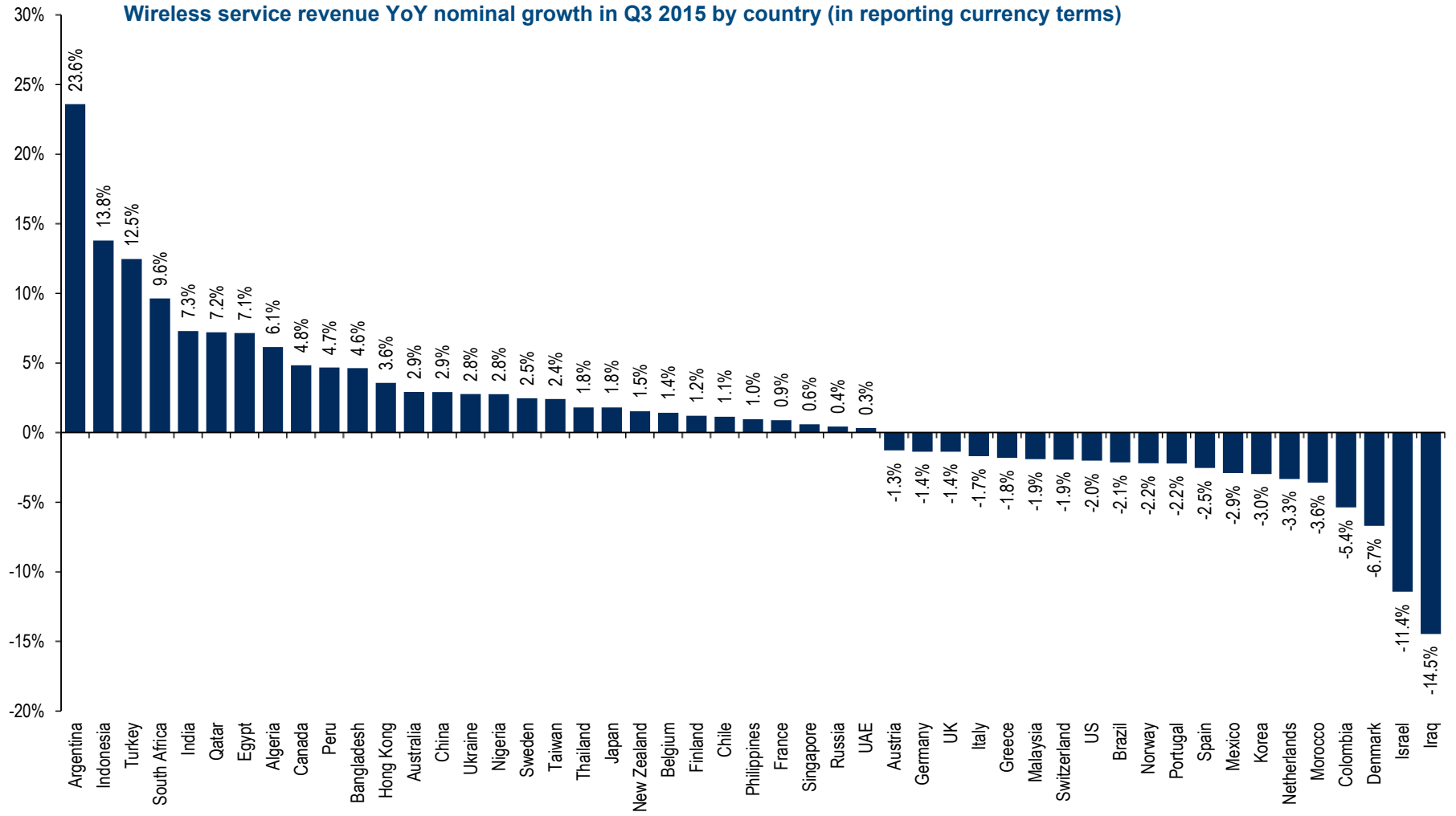
Like all industries the mobile sector is passing through the different stages of the industry life cycle

The Industry Life Cycle Curve

How would you classify your market?



Today almost all mobile markets are maturing or in decline

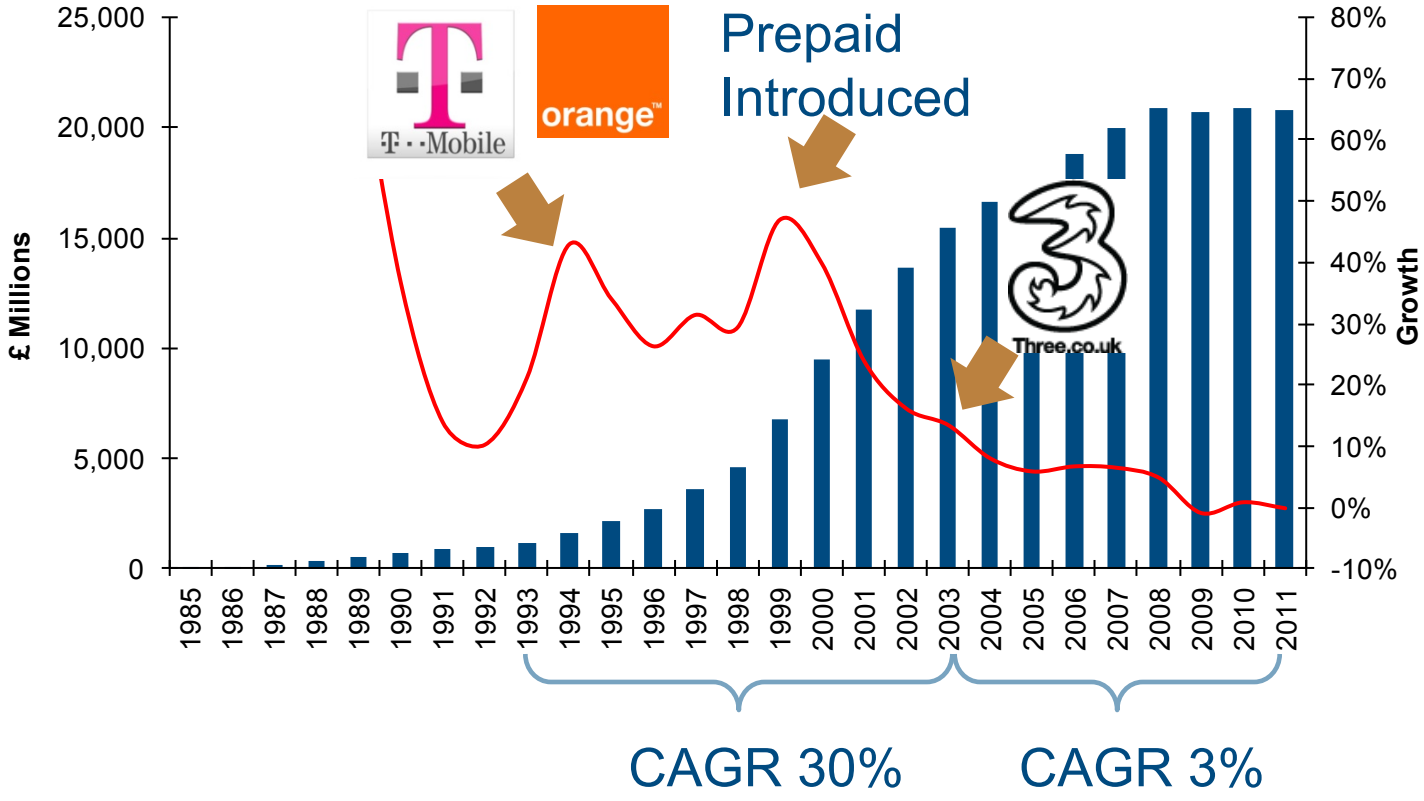


Note that real growth rates will be lower

Source: Merrill Lynch Global Wireless Matrix Q1 2016

Success as a new entrant depends entirely on how mature the market is when you enter it

UK Mobile Market Revenues and Growth

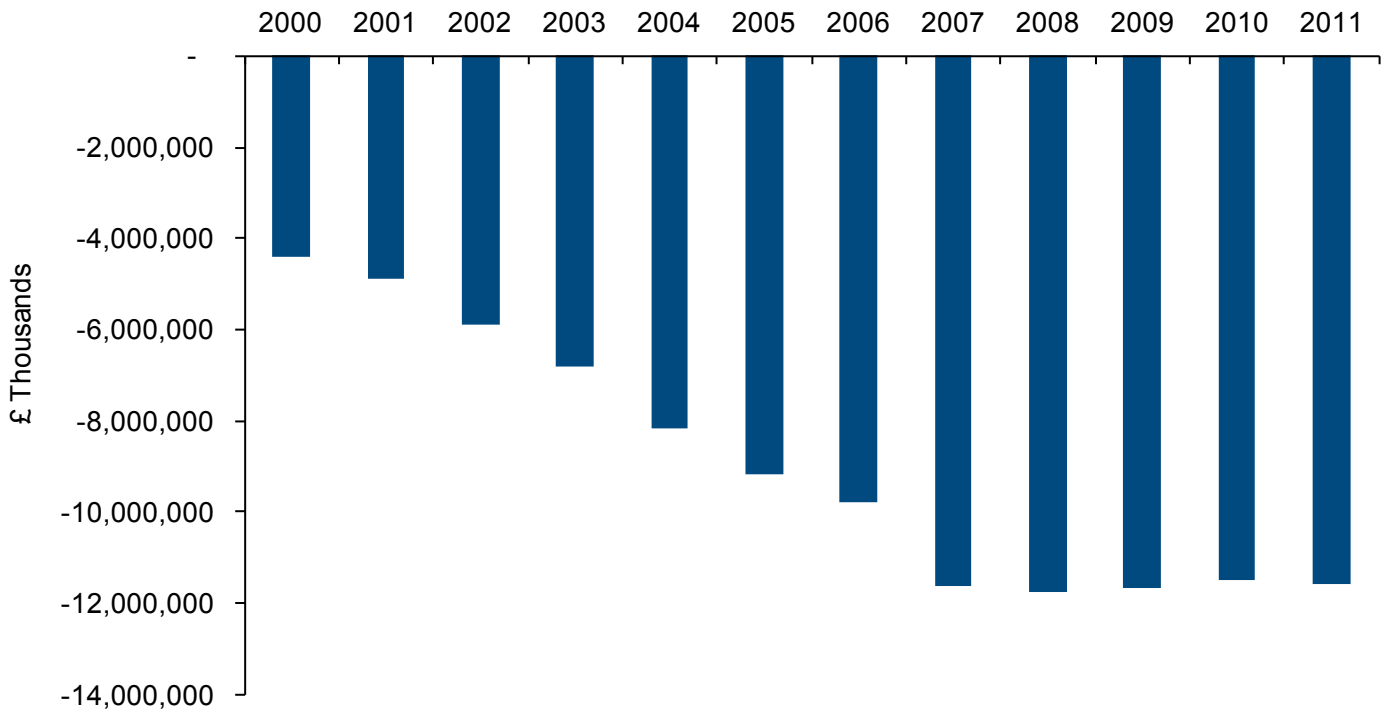


Source: Operator accounts, Coleago Analysis

3 in the UK had to “buy” share which is expensive and today has only achieved circa 12% market share after 14 years

Source: Operator accounts, Coleago Analysis

3 UK Cumulative Operating Free Cash Flow



Our experience of supporting operators is that new entrant business cases are not viable and very few investors would accept the losses of 3

Spectrum set-asides and spectrum caps can lead to inefficient outcomes if not designed with great care

Spectrum set-asides and caps are typically designed to prevent excessive spectrum concentration

Potential impact of auction design	Examples
Spectrum is acquired by inefficient users who deploy little and fail to gain market share	Chile AWS auction (2009) Canada AWS (2008)
Spectrum remains unsold and hence the economic value is not extracted	Netherlands 2.6GHz (2010) Belgium 2.6GHz (2011)
Spectrum is not deployed and held for resale at a profit for private investors	Canada AWS (2008)
Increased spectrum costs for incumbents damage the operator	Netherlands 800MHz (2012)

Best practice should promote competition between incumbents and not discriminate in favour of new entrants

Technical considerations for the efficient use of spectrum

Spectrum packaging is a critical aspects of spectrum awards

Factors to be considered are:

- organisation of the lots
- size of each lot
- use of generic or specific lots
- contiguity of lots
- geographical reach of lots
  - regional or national

There may be a trade-off between technical efficiency and competition

When spectrum is released, the entire band should be made available at once to provide the widest channels

Auctioning small amounts of spectrum is inefficient

- LTE and LTE Advanced require an assignment of at least 2x10MHz or 2x20MHz of spectrum per operator to maximise spectral efficiency

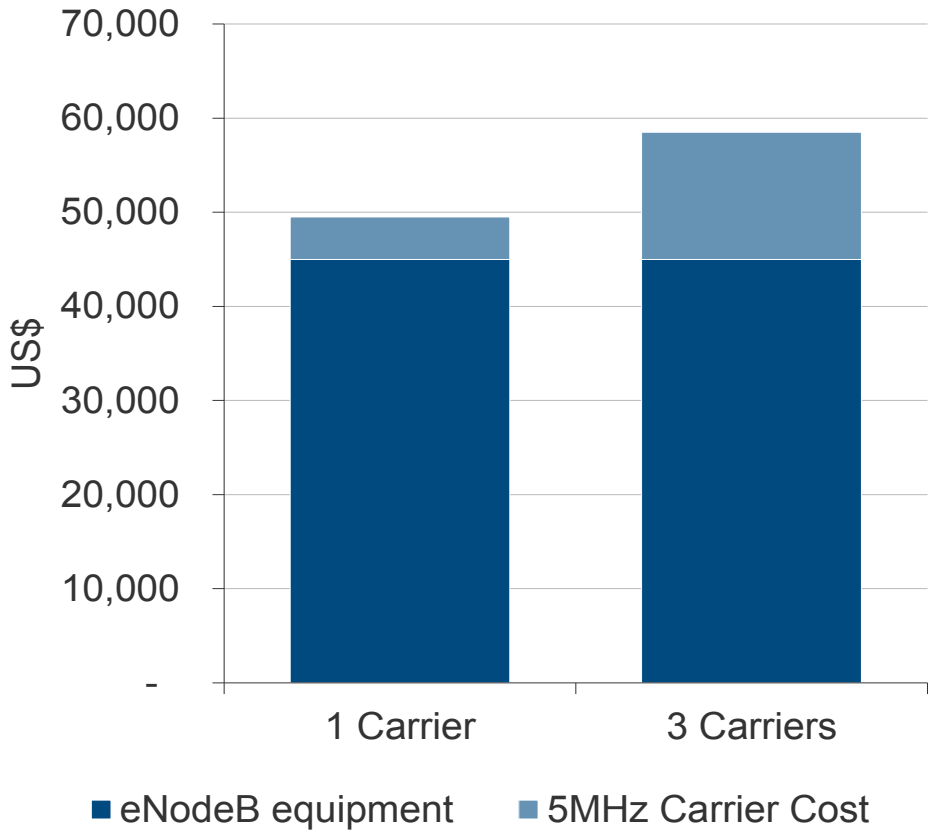
New spectrum for LTE: More and wider is better

Band	MHz
7 (2.6 GHz)	2x70MHz + 40MHz TDD
28 (APT 700)	2x45MHz

Ensuring a minimum block size of 2x10MHz is key for the efficient LTE deployment

- Deploying LTE in 2x15MHz costs around $3,900 per MHz; deploying in only 2x5MHz costs $9,900 per MHz
- The maximum downlink speed in 15MHz is 112 Mbps compared to only 35 Mbps in 5MHz
- Potential solutions:
  - assign wide enough bands to individual operators
  - Allow spectrum sharing
  - Allow spectrum trading

Capex per LTE e-NodeB



Technical efficiency also requires that spectrum is contiguous

Potential non-contiguous assignments are a key drawback of some auction designs

- Not technically efficient
- Vulnerable to anti-competitive bidding (e.g. attempt to isolate individual blocks)

APT Band Plan assigned in 2 x 5 MHz blocks

703 MHz & 758 MHz

748 MHz & 803 MHz

Example: Bidders B2 and B3 have contiguous assignments, while B1's assignment is fragmented, thus increasing deployment costs and reducing efficiency

Coverage requirements can have a very significant impact on the value of spectrum

Coverage requirements should be clearly stated

- Operators provide coverage which is commercially viable
- If coverage requirements exceed commercially viable levels then the value of the spectrum will fall
  - resulting in lower revenues from spectrum assignment
- Efficiency is high when population densities are high and so geographic coverage requirements will result in less intense use of spectrum

The cost of spectrum – definition of terms

Spectrum Access Fee

The cost of gaining initial access to the spectrum

- Typically a one-off, upfront fee but increasingly staggered
- Determined through the award process
- The majority of the cost of spectrum access

Under best practice these should be determined by some form of market mechanism i.e. auction

Spectrum Usage Fee

The costs of ongoing spectrum usage

- Typically an annual charge to ensure ongoing efficiency
- Should be known in advance of an award
- The higher the usage charge the lower the spectrum access fee

Under best practice these should be low and related to administrative costs only

Access fees capture the opportunity cost of spectrum for society and so any usage fees should only cover admin costs

A Spectrum Usage Fee per MHz of spectrum:

- ✓ Encourages operators to make as much use of spectrum as possible, i.e. encourages investment
- ✓ Is easily calculated and transparent
- ✓ Should only cover the cost of spectrum management

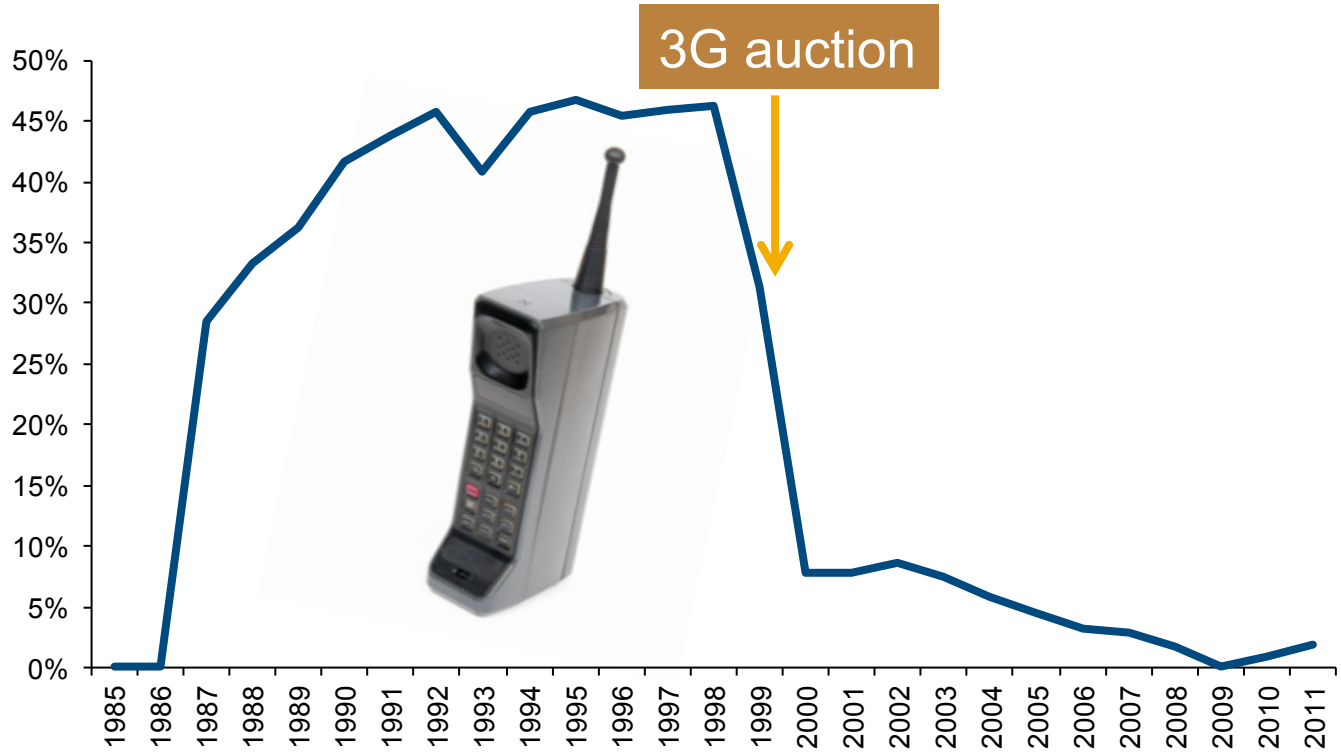
A Spectrum Usage Fee based on revenue:

- ✘ Penalises operators who make efficient use of spectrum
- ✘ Discourages investment in the network
- ✘ Reduces the socio-economic value of spectrum

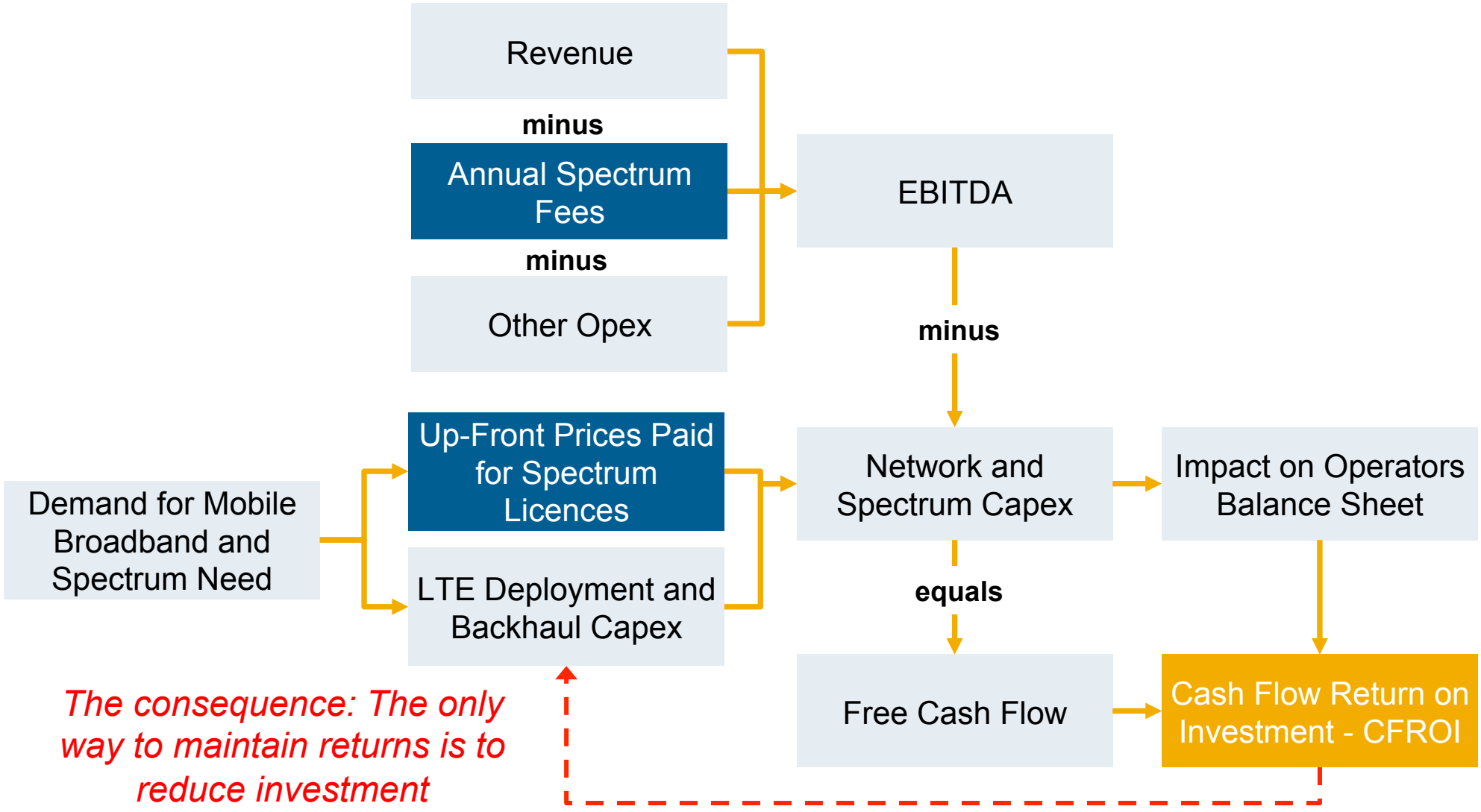
High spectrum costs and new market entry reduced returns below the cost of capital resulting in the withdrawal of capital

Source: Operator accounts, Coleago Analysis

Return on Capital Employed for a European Mobile Operator

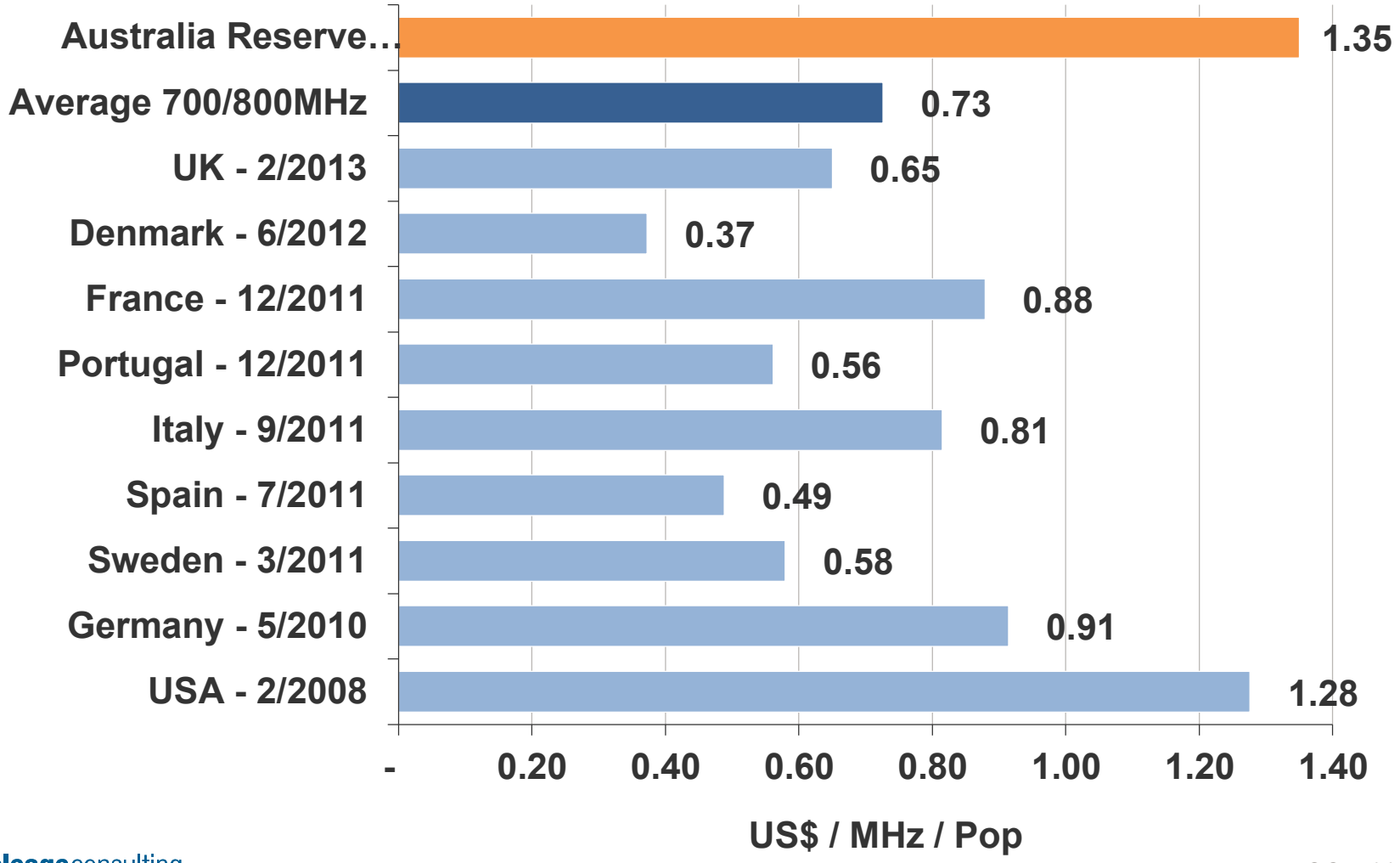


Extracting high spectrum fees from the mobile industry is not sustainable



Driven by the desire to plug a hole in the budget, Australia set extremely high reserve prices for 700MHz

700/800MHz auction prices paid vs. Australian reserve prices



The Australian APT 700MHz auction resulted in a loss to society and is an example of policy failure due to high reserve

- Potential socio-economic gain for Australia?
  - Between AU$ 7bn and AU$10bn
  - 2x15MHz of 2x45MHz unsold hence not all of the potential socio-economic gain is realised
- Is the spectrum is actually used?
  - Only Telstra obtained 2x20MHz, can deploy at lowest cost, Optus obtained only 2x10MHz
- Can operators deploy the 700MHz band as cost effectively?
  - One operator, Vodafone, did not obtain any spectrum and the leading operator Telstra increased its advantage, thus reducing competition
- Is there competition to drive down prices?

Ghana and the 2015 auction of 800MHz spectrum

Ghana 2015 800MHz auction

- 2 Lots of 2 x 10MHz of 800MHz offered via auction
- Reserve price of US67.5 million per Lot
- Existing spectrum not technology neutral

Failure to achieve policy goals

- MTN secured an LTE monopoly
- Inefficient allocation of spectrum
- Future policy challenges

Senegal spectrum auction boycott

January 2016 headline

"*Senegal's incumbent cellcos 'boycott' 4G licence tender; ARTP invites bids from new entrants*"

- Reserve price US$ 50 million
- In short, the ARTP is dismayed at what it acknowledges to be '*the collective and coordinated non-participation of the operators*'
- The ARTP intends to restart the 4G licensing process, this time opening the call for applications to new entrants…

Best practice in spectrum management

The process of awarding mobile spectrum has become more sophisticated over time

~1980's

Lottery!

- Dentists, actors, hairdressers etc. entered the lottery for US wireless licences in the early 80s
- Chuck Hagel (ex US Secretary of Defence) was one of the many who made a fortune this way
- This led to legislation in 1993 mandating the use of auctions for future FCC licenses

~1990's

Beauty contests

- Widely used outside the US for GSM licences
- Difficult to administer, bureaucratic
- Open to dispute and vulnerable to corruption

~2000's

Auctions

- Transparent process (no subjectivity)
- Policy objective: maximise economic efficiency
- Theoretically whoever values spectrum the most will produce the greatest social good

Options for spectrum renewal

Administered renewal to existing holders

Administered re-assignment (some or all) to new users

Auction rights to existing or new users

Hybrids

Options for renewal

Administered renewal to existing holders	Administered re-assignment (some or all) to new users	Auction rights to existing or new users	Hybrids

- No major imbalance in spectrum or limited impact on competition
- Spectrum deployed and intensely utilised
- Investment in new technology initiated and on-going
- Customer disruption likely

Options for renewal

Administered renewal to existing holders	Administered re-assignment (some or all) to new users	Auction rights to existing or new users	Hybrids

- Imbalance in spectrum holdings is affecting competition
- Imbalance cannot be addressed through other bands
- Spectrum not deployed or is under utilised
- Spectrum can be divided and distributed effectively
- Any customer disruption can be managed

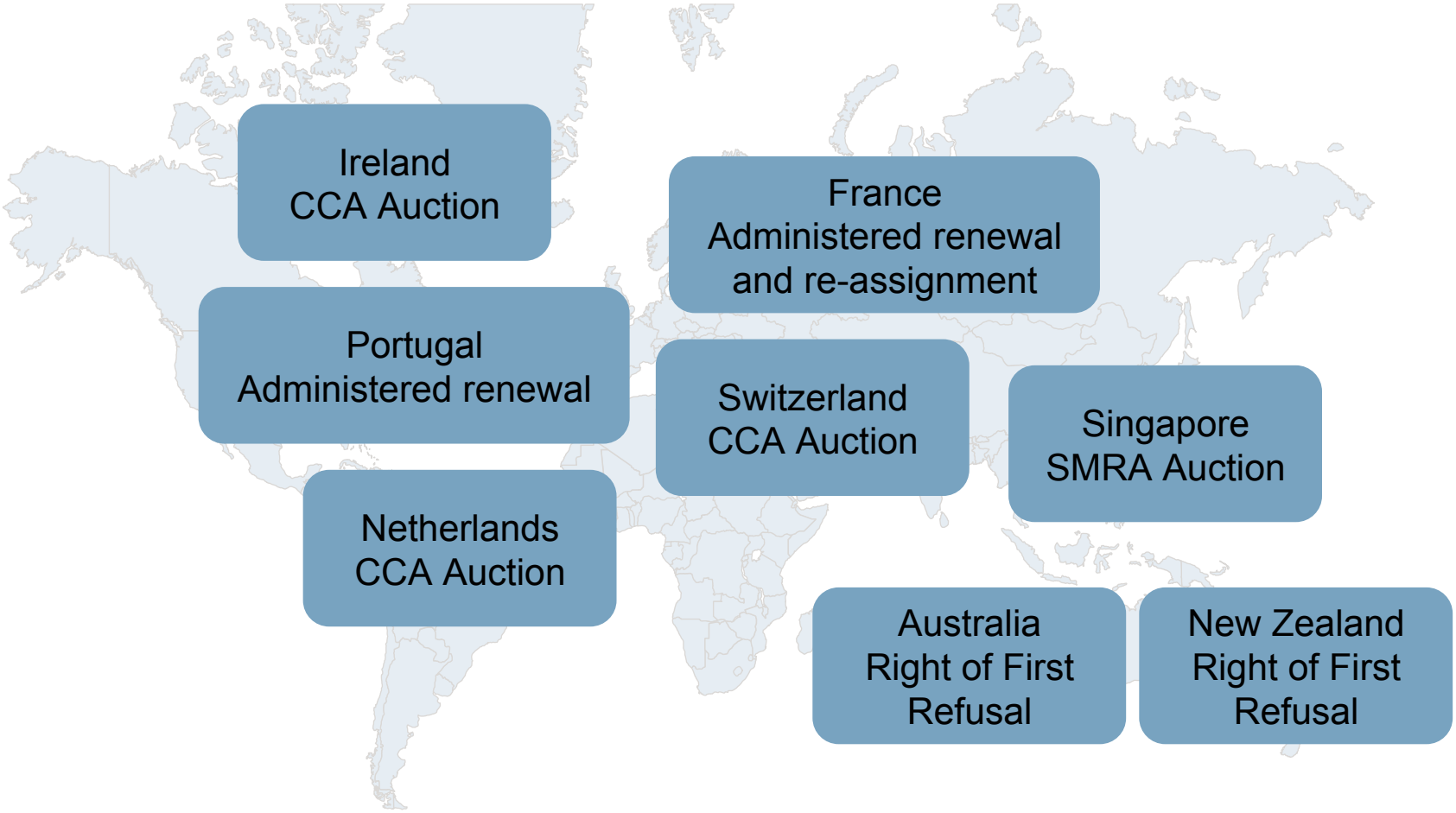
Options for renewal

Administered renewal to existing holders	Administered re-assignment (some or all) to new users	Auction rights to existing or new users	Hybrids

- Spectrum not deployed or under utilised
- Uncertainty over demand or most efficient use
- Desire to avoid making “arbitrary” judgements
- Sufficient competition expected
- Deployment of new technology not started

Examples of spectrum renewal approaches

A range of approaches have been adopted



Best practice assignment should focus on efficiency and transparency and be non-discriminatory in relation to bidders

Transparency

- Avoids suggestions of corruption
- Reduces the risk of costly and lengthy legal challenges
- Promotes participation in the process
- Increases confidence in the regulatory regime and hence encourages investment

Incorporates effective consultation with stakeholders

- Consultation covering spectrum to be assigned, draft licence conditions, process and prices
  - Typically 4 to 6 weeks
- Comprehensive and unambiguous Information Memorandum
- Adequate time for operators to complete their valuation and governance procedures
  - Typically 2 to 3 months

The implementation of a successful assignment process using a simple auction design should not be rushed

Stage	Timing
Spectrum Strategy Development	
Market and Technical Assessment and Assignment Recommendations (e.g. packaging, licence conditions, reserve)	T – 12 Months
Detailed Auction Design and Software Development	T – 10 Months
Preparation of Draft Information Memorandum	T – 8 Months
Consultation Process	T – 6 Months
Information Memorandum Publication, Presentation	T – 4 Months
Q&A Process	T – 3 Months
Deadline for Applications and Bidder Deposits	T – 15 Days
Bidder Training and Mock Auctions	T – 5 Days
Auction	T
Results, Payment Deadline and Grant of Licences	T + 15 Days

Auction design issues

All auction formats have issues

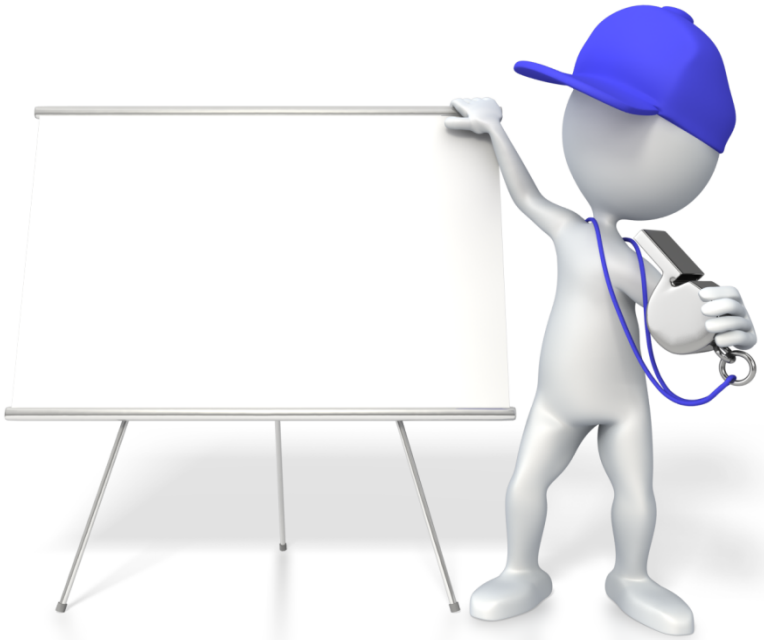
Auction Format	Comments
First price single round sealed bid auction	No opportunity for price discovery and can lead to the winner's curse
Second price single round sealed bid auction	Winner pays the price of the second highest bidder and therefore reduces risk of the winner's curse. No opportunity for price discovery which can lead to price discrepancies
Simultaneous Multi-Round Ascending (SMRA) auction	Simple ascending auction gives opportunity for price discovery but aggregation risk* is present as there is no package bidding
SMRA auction with augmented switching	More complex form of SMRA where bidders can in certain circumstances alter bids to reduce aggregation risk*
Combinatorial Clock Auction (CCA) based on second price rule	In theory, economically efficient and avoids aggregation risk* but extremely complex and not very transparent with clock and supplementary rounds. Can lead to major price discrepancies.

* Aggregation risk is the risk that a bidder might win an unprofitable subset of its desired package if there are complements between the lots

Summary – key characteristics of the two main multi-round auction formats

Design Principle	SMRA	CCA
Supports simultaneous award of spectrum in multi-bands	✔✔✔	✔✔✔
Exposure and fragmentation risks	✘	✔✔✔
Flexibility over the use of specific or generic lots	✔✔	✔
Transparency of bidders and bids	✔✔✔	✔✔
Certainty over lots awarded	✔✔✔	✘
Certainty over prices paid	✔✔✔	✘
Avoids 'winners curse'	✔	✔✔
Avoids adverse price asymmetries	✔✔✔	✘
Simplicity and ease of presentation and transparency of results	✔✔	✘
Promotes all spectrum being sold	✔✔	✘

Detailed auction rules may matter more than formats



Rules need to be set to prevent gaming while ensuring that all spectrum is sold efficiently

- Spectrum packaging
- Spectrum caps
- Spectrum set-aside
- Activity rules
- Provision of information
- Bid increments
- Spectrum trading
- Reserve prices

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Appendix

Full summary of best practice

Summary of best practice

Policy objectives

- Set appropriate policy objectives

Competition

- Promoting new entry may not be efficient

Coverage

- Coverage conditions should not be too onerous
- Coverage requirements should not be linked to specific bands
- Consider alternative mechanisms for extending coverage

Summary of best practice

Technical efficiency considerations

- Maximise the amount of available spectrum
- Allocate available spectrum together rather than artificially ration
- Ensure a minimum channel size of 10MHz for LTE
- Avoid fragmentation of spectrum
- Make spectrum technology neutral

Ensure an efficient assignment of spectrum

- Adopt proportional measure to promote downstream competition
- Allocate spectrum to those that value it most highly

Summary of best practice

Provide regulatory certainty

- Spectrum rights and obligations should be clearly defined
- Award long / indefinite licence terms with a presumption of renewal
- Ensure predictability about on-going spectrum usage charges
- Regulators actions need to be consistent and predictable
- Provide clarity about the future plans for spectrum release
  - New spectrum should all be awarded at the same time
- Let bidders know if there will be new entry before asking them to bid

Summary of best practice

Where appropriate auctions should be the preferred award mechanism

- Regulators should use market mechanisms rather than trying to pick winners when faced with an asymmetry of information
- Spectrum fees should be structured as “sunk costs” to reduce distortions on future pricing and investment decisions
- Spectrum fees should not be so high as to risk distortions
- Whenever possible auctions should be used to assign spectrum
- Auctions should be designed to be consistent with achieving policy objectives

Summary of best practice

Avoid single round and sequential auctions

- Single round auctions should be avoided in favour of multi-round formats
- Sequential auctions should be avoided to reduce Substitution and Exposure risk

Summary of best practice

Market mechanisms should be used to determine spectrum prices

- Regulators should use market mechanisms rather than trying to pick winners when faced with an asymmetry of information
- Spectrum fees should be structured as “sunk costs” to reduce distortions on future pricing and investment decisions
- Spectrum fees should not be so high as to risk distortions
- Whenever possible auctions should be used to assign spectrum

Summary of best practice

Auctions should be designed with great care

- Generic lots should be preferred if appropriate
- National licences should be preferred if appropriate
- Regulators should prefer greater transparency rather than less
- The auction design and rules should be as simple as possible
- The design should seek to minimise the scope for strategic bidding
- When placing a bid there should be a high certainty regarding the lots, price and expenditure of the bidder

Summary of best practice

Reserve prices and usage fees should be material but non-trivial

- Spectrum usage fees should be low and relate only to administrative costs of managing spectrum
- Spectrum access fees should be determined by a market mechanism
- Reserve prices should be low but non-trivial
- Options for phased payments should be provided

Summary of best practice

Spectrum Renewal

- There should be a presumption of renewal in favour of the incumbents
- An administered process will often be more appropriate
- Some form of Administered Incentive Pricing should be used to determine the cost of spectrum