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

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

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

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

- **Poland 2009:** Spectrum valuation

- **Russia 2015:** Spectrum valuation

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

- **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

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

**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
- 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

<table>
<thead>
<tr>
<th>Frequency (MHz)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>700 MHz</td>
<td>New spectrum for LTE, in some markets previously used for TV, referred to as “digital dividend” band</td>
</tr>
<tr>
<td>800/900 MHz</td>
<td>Originally only used for GSM and CDMA, progressive redeployment to 3G HSPA and recently to LTE</td>
</tr>
<tr>
<td>1800 MHz</td>
<td>Originally only used for GSM, progressive redeployment to LTE</td>
</tr>
<tr>
<td>2100 MHz</td>
<td>Currently used for 3G, upgrading to dual carrier HSPA+ and LTE</td>
</tr>
<tr>
<td>2300 MHz</td>
<td>Originally used for WiMax, now a standardised LTE band for capacity</td>
</tr>
<tr>
<td>2600 MHz</td>
<td>New capacity band for LTE</td>
</tr>
</tbody>
</table>
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. 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**

- Business value with the new spectrum
- Business value without the new spectrum
- Value of the new spectrum

**Net Present Value with**

**NPV without**

**Value**
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.

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

Enterprise Value

Discounted Cash Flow Analysis

Now

The Future

© Copyright Coleago 2016
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

Wireless service revenue YoY nominal growth in Q3 2015 by country (in reporting currency terms)

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

- **Prepaid Introduced**
- **CAGR 30%**
- **CAGR 3%**

Source: Operator accounts, Coleago Analysis

© Copyright Coleago 2016
3 in the UK had to “buy” share which is expensive and today has only achieved circa 12% market share after 14 years.

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

Source: Operator accounts, Coleago Analysis
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**

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

**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 aspect 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**

<table>
<thead>
<tr>
<th>Band</th>
<th>MHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 (2.6 GHz)</td>
<td>2x70MHz + 40MHz TDD</td>
</tr>
<tr>
<td>28 (APT 700)</td>
<td>2x45MHz</td>
</tr>
</tbody>
</table>
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
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:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>703 MHz</td>
<td>&amp;</td>
<td>748 MHz</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&amp; 758 MHz</td>
<td>&amp;</td>
<td>803 MHz</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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.

Return on Capital Employed for a European Mobile Operator

Source: Operator accounts, Coleago Analysis

© Copyright Coleago 2016
Extracting high spectrum fees from the mobile industry is not sustainable

The consequence: The only way to maintain returns is to reduce investment
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

- Australia Reserve: 1.35
- Average 700/800MHz: 0.73
- USA - 2/2008: 1.28
- Germany - 5/2010: 0.91
- Sweden - 3/2011: 0.58
- Spain - 7/2011: 0.49
- Italy - 9/2011: 0.81
- Portugal - 12/2011: 0.56
- France - 12/2011: 0.88
- Denmark - 6/2012: 0.37
- UK - 2/2013: 0.65

© Copyright Coleago 2016
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?
- Is the spectrum actually used?
- Can operators deploy the 700MHz band as cost effectively?
- Is there competition to drive down prices?
- Between AU$ 7bn and AU$10bn
- 2x15MHz of 2x45MHz unsold hence not all of the potential socio-economic gain is realised
- Only Telstra obtained 2x20MHz, can deploy at lowest cost, Optus obtained only 2x10MHz
- One operator, Vodafone, did not obtain any spectrum and the leading operator Telstra increased its advantage, thus reducing competition
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 US$67.5 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
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

- Ireland: CCA Auction
- Portugal: Administered renewal
- Netherlands: CCA Auction
- Switzerland: CCA Auction
- France: Administered renewal and re-assignment
- Singapore: SMRA Auction
- Australia: Right of First Refusal
- New Zealand: Right of First Refusal
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

<table>
<thead>
<tr>
<th>Stage</th>
<th>Timing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spectrum Strategy Development</td>
<td></td>
</tr>
<tr>
<td>Market and Technical Assessment and Assignment Recommendations (e.g. packaging, licence conditions, reserve)</td>
<td>T – 12 Months</td>
</tr>
<tr>
<td>Detailed Auction Design and Software Development</td>
<td>T – 10 Months</td>
</tr>
<tr>
<td>Preparation of Draft Information Memorandum</td>
<td>T – 8 Months</td>
</tr>
<tr>
<td>Consultation Process</td>
<td>T – 6 Months</td>
</tr>
<tr>
<td>Information Memorandum Publication, Presentation</td>
<td>T – 4 Months</td>
</tr>
<tr>
<td>Q&amp;A Process</td>
<td>T – 3 Months</td>
</tr>
<tr>
<td>Deadline for Applications and Bidder Deposits</td>
<td>T – 15 Days</td>
</tr>
<tr>
<td>Bidder Training and Mock Auctions</td>
<td>T – 5 Days</td>
</tr>
<tr>
<td>Auction</td>
<td>T</td>
</tr>
<tr>
<td>Results, Payment Deadline and Grant of Licences</td>
<td>T + 15 Days</td>
</tr>
</tbody>
</table>
Auction design issues
All auction formats have issues

<table>
<thead>
<tr>
<th>Auction Format</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>First price single round sealed bid auction</td>
<td>No opportunity for price discovery and can lead to the winner’s curse</td>
</tr>
<tr>
<td>Second price single round sealed bid auction</td>
<td>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</td>
</tr>
<tr>
<td>Simultaneous Multi-Round Ascending (SMRA) auction</td>
<td>Simple ascending auction gives opportunity for price discovery but aggregation risk* is present as there is no package bidding</td>
</tr>
<tr>
<td>SMRA auction with augmented switching</td>
<td>More complex form of SMRA where bidders can in certain circumstances alter bids to reduce aggregation risk*</td>
</tr>
<tr>
<td>Combinatorial Clock Auction (CCA) based on second price rule</td>
<td>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.</td>
</tr>
</tbody>
</table>

* 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

<table>
<thead>
<tr>
<th>Design Principle</th>
<th>SMRA</th>
<th>CCA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supports simultaneous award of spectrum in multi-bands</td>
<td>✔✔✔</td>
<td>✔✔✔</td>
</tr>
<tr>
<td>Exposure and fragmentation risks</td>
<td>✘</td>
<td>✔✔✔</td>
</tr>
<tr>
<td>Flexibility over the use of specific or generic lots</td>
<td>✔✔</td>
<td>✔</td>
</tr>
<tr>
<td>Transparency of bidders and bids</td>
<td>✔✔✔</td>
<td>✔✔</td>
</tr>
<tr>
<td>Certainty over lots awarded</td>
<td>✔✔✔</td>
<td>✘</td>
</tr>
<tr>
<td>Certainty over prices paid</td>
<td>✔✔✔</td>
<td>✘</td>
</tr>
<tr>
<td>Avoids ‘winners curse’</td>
<td>✔</td>
<td>✔✔</td>
</tr>
<tr>
<td>Avoids adverse price asymmetries</td>
<td>✔✔✔</td>
<td>✘</td>
</tr>
<tr>
<td>Simplicity and ease of presentation and transparency of results</td>
<td>✔✔</td>
<td>✘</td>
</tr>
<tr>
<td>Promotes all spectrum being sold</td>
<td>✔✔</td>
<td>✘</td>
</tr>
</tbody>
</table>
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
Scott McKenzie
Director, Coleago Consulting Ltd
Tel: +44 7825 294 576
scott.mckenzie@coleago.com

Further information: www.coleago.com
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
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
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
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.
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
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.
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
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