



Spectrum issues and challenges

The major challenges and issues confronting
telecoms companies and regulators

Graham Friend & Stefan Zehle

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Contact



Stefan Zehle, MBA
CEO, Coleago Consulting Ltd

Tel: +44 7974 356 258
stefan.zehle@coleago.com



Graham Friend, MA, M.Phil. (Cantab), ACA
Managing Director, Coleago
Consulting Ltd

Tel: +41 79 855 1354
graham.friend@coleago.com



Scott McKenzie, BE, MBA
Director, Coleago Consulting Ltd

Tel: +44 7825 294 576
scott.mckenzie@coleago.com

Further information: www.coleago.com

Contents

- 1 Spectrum issues and challenges
- 2 Spectrum valuation
- 3 Auction and bid strategy
- 4 Coleago's spectrum services
- 5 Introducing Coleago Consulting

Spectrum issues and challenges

A collection of papers on the key themes related to spectrum and spectrum valuation

1

Spectrum issues are moving centre stage

Events require operators to make complex decisions which require expertise to ensure that shareholder value is not destroyed

Spectrum is moving centre stage

Spectrum was always a key resource for mobile operators and a factor that explained differences in coverage, notably the ownership of lower band spectrum. Spectrum is now moving centre stage again driven by a number of factors:

- **New Mobile Spectrum:** Spectrum is being freed for mobile services, notably in 2.5 / 2.6 GHz and the digital dividend spectrum in 700 / 800 MHz.
- **Mobile Broadband:** The development in technology notably HSPA and LTE enabled the development of a mobile broadband market which drives spectrum needs.
- **Refarming:** In most countries GSM licences were not technology neutral, i.e. the licence only allowed operators run GSM. GSM is now nearing the end of its life cycle. HSPA and LTE are being introduced in former GSM bands.
- **Licence Expiry:** In many countries the 900 and 1800 MHz GSM licences are near to expiry and some 2.1 GHz licence are only 4 years away from expiry.
- **Complex Spectrum Auctions:** The primary manner of allocating spectrum are no longer beauty contests but auctions. Some of these are highly complex auctions, including combinatorial auctions.

Developing a spectrum strategy is not the only challenge

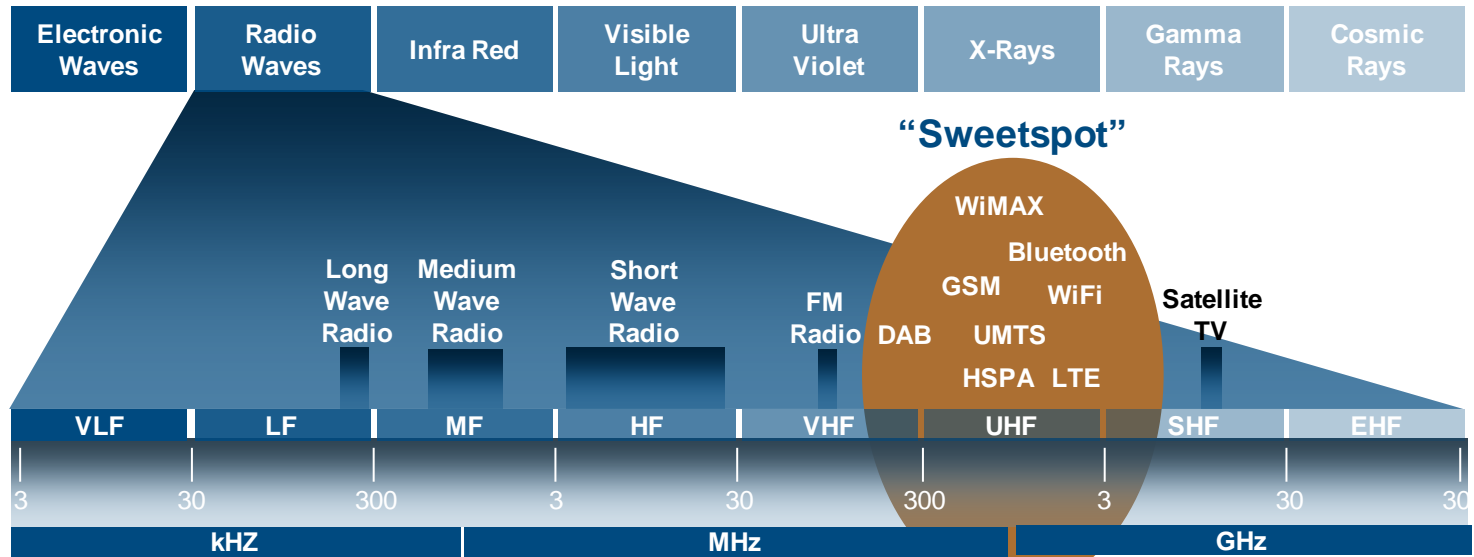
The spectrum related evolution is challenging its own right, but other factors contribute to the complexity of the business decisions with regards to the acquisition, renewal and redeployment of spectrum:

- **Mature Markets:** Many mobile markets are no longer experiencing revenue growth as mobile broadband revenues simply offset declining voice revenues.
- **Large Investment Decisions:** The acquisition of new spectrum and subsequent technology deployment results in significant capex. Corporate governance demands high standards of due diligence with regard to investment appraisal of this magnitude.
- **Demand Uncertainty:** There is uncertainty with regards to iPhone like device penetration, dongle penetration, traffic volumes per user, and real throughputs.
- **Technology Uncertainty:** The evolution of the technology ecosystem, e.g. the number of bands and technologies that will be incorporated in devices, software defined radio, and other technology factors is uncertain.
- **Operational Complexity:** The multiplication of bands and technologies within these bands, as well as rolling off GSM results in operational challenges.
- **Traffic Offload:** The degree to which traffic offload is possible via WiFi or femto cells may mitigate mobile network demand.



Prime spectrum real estate is being made available and existing licences are expiring

The next few years will witness an unprecedented release and re-allocation of key spectrum frequencies and the expiry of existing licence terms.



Many spectrum licences are now reaching the end of their term and operators have negotiate renewal. The issue is often linked to re-farming and the redistribution of lower band spectrum., e.g. 900MHz GSM spectrum.

The frequencies in the range 700MHz to 2.6GHz provide the optimal combination of propagation or coverage (the lower the frequency the better the coverage) and the ability to carry information or traffic (the higher the frequency the greater the data carrying capacity)

Additional spectrum is required to support the exponential growth in mobile data

Following many false dawns, the drivers required to deliver the long awaited inflection point in mobile data growth have finally coalesced

Data speeds capable of delivering a good user experience

Data optimised and desirable devices for consumer and business applications

Flat fees; pricing consistent with the application

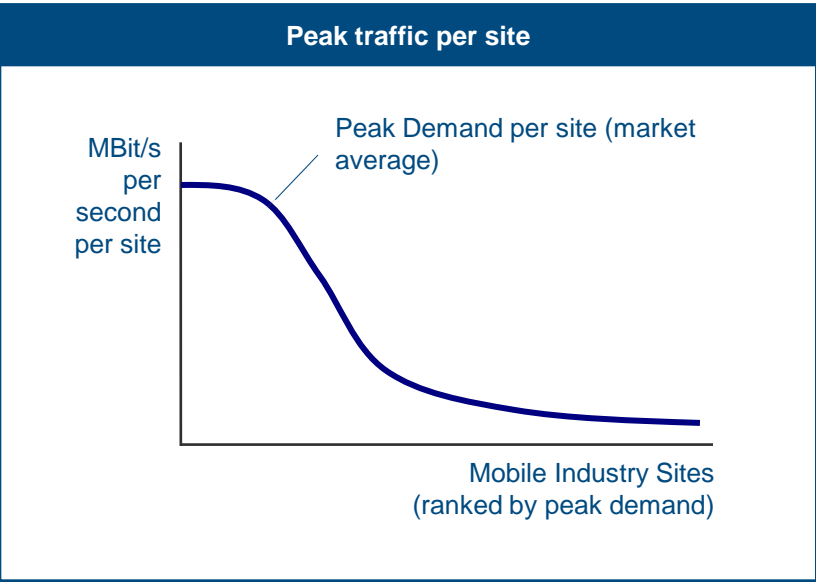
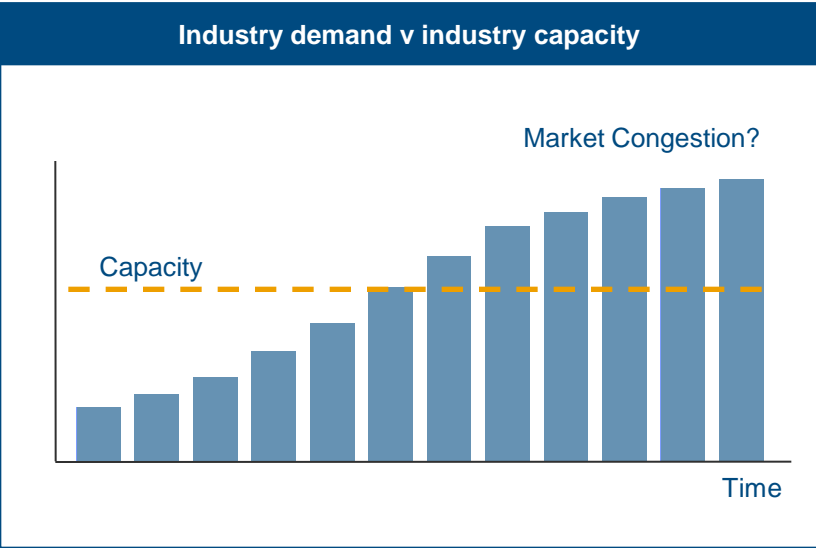
Compelling applications and content

A Step Change in Mobile Broadband Data traffic but revenues have de-coupled from traffic growth

Falling Returns in the Mobile Industry

Exponential data growth could lead to congestion and capacity constraints

Confronted with capacity constraints market share may increasingly be driven by share of capacity and the share of spectrum assets will determine the share of industry capacity



Share of capacity drives market share in a constrained world

In the short time since mobile broadband has gained momentum in Europe we have seen continuous growth in the amount of data provided with a monthly mobile broadband contract. Whilst pricing has moved to a flat fee basis the small print always reveals a “fair usage policy” which provides the effective size of the data bundle. As data demand continues to grow the size of that data bundle will increase and one dimension to the competition between operators will be the size of data bundles. In the long run, the operator with the greatest capacity on their network will ultimately prevail in the market. Congestion and the quality of the mobile broadband service will also be a competitive dimension. If capacity is constrained then congestion leads to degradation in the quality of the customer experience. If other networks are less congested, a net flow of customers may be expected towards the latter, until a new equilibrium is reached. Accordingly, in a congested market, there is likely to be a relationship between market shares of traffic and shares of capacity.

However since congestion is likely to affect only a proportion of sites, the distribution of peak site traffic across the network needs to be considered. As mass market mobile broadband remains a relatively new phenomenon there is uncertainty over the distribution of data traffic compared to voice and also the timing of the busy hour which is critical for network dimensioning.

Combined data and voice accounts

While relative capacity levels in relation to mobile broadband data may determine market share the resulting incremental revenues may arise from new customers data and voice revenues if there are linked voice and data accounts. The value of winning incremental customers because of data is not restricted simply to the value of their data traffic.

New spectrum awards offer the prospect of new market entry

The award of new spectrum may introduce new players to the market as we have seen in the Netherlands

Increased competition is a possibility

National regulatory authorities are concerned with levels of competition to ensure that customers benefit in terms of quality and range of services and price. The release of additional spectrum is often used as a vehicle for introducing additional competition.

Very few late entrants in the mature voice and SMS markets have been successful in establishing critical mass and creating value for their investors. However, these new entrants have destroyed considerable value for other players in the market. Whilst it is unlikely that the voice and SMS markets will attract new entry, the growing mobile data market and the trend towards convergence may encourage some players to bid for spectrum.

The introduction of new competition can have a very significant impact on the valuations of incumbents. Existing operators are therefore prepared to pay significant premiums for spectrum to prevent new entrants from acquiring it and entering the market. This premium is nearly always the most significant element of spectrum value. However, many regulatory bodies are setting maximum spectrum caps to prevent blocking and this will reduce the value of the spectrum considerably.

If new entry is inevitable then it will not have an impact on spectrum valuations but it will have an impact on the market and existing players. Operators should already be thinking about how they will contend with new market entry.

Weakening existing competitors

Although spectrum caps may make it difficult to block new market entry the ability to secure the maximum amount of available spectrum may imply less spectrum is available for other existing players. Reducing the ability of others to compete through reduced capacity could confer competitive advantage and create a source of value from the spectrum.

900MHz and 1800MHz spectrum re-farming

Re-farmed 900MHz spectrum will allow operators to extend mobile broadband coverage but valuing re-farmed spectrum is challenging

Re-farming of 900MHz spectrum will help enable the extension of mobile broadband coverage in rural areas

Spectrum re-farming provides operators with the opportunity to deploy new technologies such as UMTS and HSPA, and in the longer term LTE, in the 850 / 900MHz frequency band. This lower frequency range offers attractive propagation characteristics and therefore lowers the cost of providing coverage as fewer sites are required. The lower cost of providing coverage will enable operators to extend mobile broadband services outside of urban areas where coverage may currently be limited due to the use of spectrum in the 2100MHz spectrum range. With government pressure for universal access to broadband re-farming is a key issue for governments and regulators. UMTS900 networks have already been successfully deployed in Europe (e.g. DNA in Finland), Asia (e.g. AIS in Thailand) and in South America (e.g. Digitel in Venezuela).

Regulators are using re-farming as an opportunity to update outdated licence conditions and to raise revenues

Spectrum re-farming is not without its challenges for both operators and regulators. Coleago recently advised a regulatory authority on potential licence conditions for re-farmed spectrum. Many regulators are taking the expiration of existing 2G licences as an opportunity to update licence terms to reflect the recent changes in the mobile industry. Coleago has conducted an extensive survey of licence conditions introduced by the countries that have completed the re-farming process as well as all the current consultations. Licence issues being considered include:

- spectrum trading;
- net neutrality;
- quality of service; and
- technology and service neutrality.

In addition to updating licence conditions some regulators may also see spectrum re-farming as an opportunity to raise additional revenues to help reduce large government budget deficits.

Spectrum re-farming cannot be considered in isolation

Spectrum re-farming cannot be examined in isolation but must be considered in light of anticipated future spectrum releases such as the Digital Dividend in the lower frequency bands and 2.5GHz and 2.6GHz spectrum in the higher frequency range. These future awards of spectrum complicate the process of spectrum strategy formulation and valuation as these alternative frequency bands can be considered as imperfect substitutes for the re-farmed spectrum. The substitutional nature of some spectrum bands therefore requires a holistic approach to re-farmed 900 and 1800MHz spectrum strategy and valuation.

The approach of regulators differs

A number of regulators such as those in Germany, Switzerland and Spain have recognised the importance of this holistic approach and have determined to complete the re-farming and award of additional spectrum in a single auction. Whilst this is optimal from an economic efficiency perspective it does create challenges for valuation and auction bid strategy.

Where re-farming and new spectrum awards take place sequentially operators face far greater challenges. These challenges arise as there are uncertainties over the timing of the release of additional future spectrum and when valuing spectrum today operators need to consider what they might have to pay for spectrum alternatives in future auctions. As a result on valuation and auction strategy based on possible substitution faces much higher levels of risk.

Challenges in valuation

The process of re-farmed spectrum valuation is complicated by the fact that there are very few relevant benchmarks from re-farmed spectrum auctions. A bottom-up approach is essential for understanding the value of re-farmed spectrum.

Trends in spectrum licence conditions for re-farmed spectrum

Recent licence awards and consultations on spectrum re-farming demonstrate much greater flexibility over services and technology

Licence term

Licence terms have ranged from 8 to 20 years (although in the UK a licence term to perpetuity has been granted). Most recent licence awards have been based on 15 year terms.

Technology neutrality

There is a trend towards awarding spectrum on a technology neutral basis.

Service neutrality

There is a trend towards service neutrality.

National roaming

Relatively few operators have licence conditions relating to national roaming. Of those that do some mandate it and some prohibit it.

Coverage requirements

The trend is mainly away from coverage requirements but the approach depends largely on the circumstances.

Performance bonds

The use of performance bonds has never been widely adopted. Ireland and Hong Kong are the only two examples of countries that use performance bonds that Coleago has identified.

Homogeneous licence conditions

The desire for homogenous licence conditions remains constant across Europe.

MVNO conditions

Few if any licences contain any specific conditions relating to MVNOs.

Licence expiry may be better managed through a negotiated settlement

Operators who face licence expiry are usually better off with a negotiated settlement rather than a re-auction. This also appears to be the approach preferred by most regulators.

Licence Renewal and Refarming: Developing the right arguments

Operators faced with the expiry in their licence and refarming usually go through a negotiation process. It is rare for regulators re-auction spectrum. Therefore the development of suitable arguments for low spectrum licence renewal fees is the most important aspect.

Based on our experience, Coleago will develop a coherent set of arguments for an appropriate form of renewal and technology neutrality at the lowest possible cost.

Administered Incentive Pricing (AIP)

Most regulators are obliged to agree a methodology for renewal that extract a return for society and ensures that economic benefit is generated. Recognising that a simple re-auction may not be appropriate, many regulators have opted for negotiated renewal prices using different forms of AIP such as benchmarking, Optimum Deprival Value (ODV) or Best Alternative Use (BAU).

Optimum Deprival Value (ODV)

Deprival value is a cost-based valuation approach that answers the question “what is the least cost system or bundle of assets needed to provide customers with the existing level and quality of services, should a certain existing asset be removed?”

This approach can be applied to valuing spectrum rights by addressing the following: “If an operator was deprived of incremental spectrum rights, what incremental costs would be incurred to replicate the existing level and quantity of services using the remaining spectrum rights?” These costs are “avoided” by owning the incremental spectrum rights and so, in this context, represent the value of those rights. That is, the rights holder should be prepared to pay up to the value of the incremental costs to avoid being deprived of its spectrum rights, so long as the incremental costs are less than the present value of the free cash flows generated from the spectrum services.

Typically ODV is based on a calculation of the deprival value of an “average” operator. As a consequence, the value per MHz (applied to all operators) should lie between the highest and lowest private values of all the individual operators. ODV therefore stimulates efficient use of the resource by incentivising spectrum hoarders to release it or put it to more productive use.

ODV (also known as the ‘Smith-NERA’ or ‘least cost alternative’ method) is the basis of the UK’s Administered Incentive Pricing (AIP).

Best Alternative Use (BAU)

In contrast to ODV, BAU considers the value placed on an additional amount of spectrum by alternative user(s). This could, in theory, include:

- An alternative technological use
- A new mobile entrant
- Competitors

ODV vs. BAU

ODV represents an upper bound on what spectrum holders will be willing to pay. ODV has the potential to encourage reallocation to most efficient mobile operator, but conservative (lower) valuations should be set, given the risk of substantial negative consequences if ODV is overestimated.

The highest of these BAU values determines the corresponding fee. The calculation of the BAU requires modelling of the revenues and costs of alternate uses.

Coleago’s experience in ODV and BAU modelling and argumentation can produce substantially lower renewal fees

Coleago can help you to produce the most favourable (low) spectrum valuations based on ODV and BAU and, depending on the situation present well reasoned arguments for the suitability of the preferred methodology.

2.6GHz spectrum

The value of 2.6GHz spectrum is currently being priced at relatively low levels in auctions

Coverage versus capacity is a key trade-off when developing spectrum strategy and valuing spectrum

2.6GHz spectrum presents operators with some interesting challenges from both a spectrum strategy and spectrum valuation perspective. The frequency range, sometimes referred to as 2.5GHz spectrum or 2.6GHz spectrum, has poor propagation characteristics compared to spectrum in the sub 1GHz range such as 900MHz spectrum and the Digital Dividend. As a result it is not suited to extending mobile broadband coverage and is usually regarded as being suitable for increasing capacity, especially in urban areas.

TDD versus FDD

Developing spectrum strategy is further complicated by the fact that the band is typically split into blocks of paired and unpaired spectrum, which are particularly suitable for UMTS/LTE and mobile WiMAX technologies respectively. Operators therefore have to also grapple with the choice of technology. In Europe, as the recent Dutch auction revealed there may be a preference for FDD spectrum but in emerging markets a better business case can be made for TDD spectrum.

Wide blocks of spectrum offer better spectral efficiency

Determining the best approach to the band should also consider the fact that there is typically a large amount of spectrum being made available. Some technologies such as LTE provide better performance when they can be deployed in wide contiguous spectrum blocks and so spectrum strategy must also address the optimal block size.

2010 should see a number of spectrum awards

Relatively few countries in Europe outside of Scandinavia and the Netherlands have so far successfully completed their allocation of this spectrum. We have seen awards in Hong Kong and also Norway, Denmark and Sweden as well as the Netherlands. A number of auctions can be expected to take place in 2010 and in the coming years.

The spectrum may have to be acquired now but may not be required for a number of years

Part of the problem for operators in developing their spectrum strategy and spectrum valuation and therefore regulators is that despite rapid growth in mobile data traffic the operators do not yet require the additional capacity that this spectrum offers. Not surprisingly in the current climate they are reluctant to participate in an auction and to commit cash for spectrum that they will not require for a number of years and where there is uncertainty over future demand the availability and performance of technology. As a result many operators have sought to use the courts to slow down or derail the process.

Spectrum valuation is challenging

Despite all the challenges and complications for regulators and operators alike the process of awarding 2.6GHz spectrum continues in a number of countries. Operators must grapple with a wide range of issues and a holistic approach to 2.6GHz spectrum strategy and valuation is essential. The valuation has largely been focused on estimating the capital expenditure avoided as a result of being able to provide additional capacity through additional spectrum rather than having to increase the density of the network. Indeed, in some dense urban cities networks are now approaching the limit of network densification and additional spectrum and or new technologies may be the only route for alleviating network capacity constraints.

Prices paid are so far relatively low

The prices paid so far for 2.6GHz spectrum have ranged from \$0.33 MHz / Pop in Hong Kong to \$0.002 MHz / Pop in the Netherlands. In the German auction the sub 1GHz spectrum is likely to command a very significant premium over the 2.6GHz spectrum.

The Digital Dividend

The Digital Dividend is a critical spectrum block and uncertainty over the timing of its release will create significant challenges for operators

Digital Dividend spectrum is highly prized

Within Europe and elsewhere the process of switching over from analogue television to digital is making available a significant amount of additional spectrum. This spectrum is often referred to as the 'digital dividend'. The spectrum is of particular interest to mobile operators as the low frequency range in which it resides, 700MHz spectrum and 800MHz spectrum, makes it particularly attractive due to the superior propagation characteristics of lower frequencies which allows operators to provide low cost coverage compared to higher frequency bands.

Sub 1GHz spectrum supports government policies of providing near universal access to broadband services

Government policy in Europe and around the world is increasingly focusing on the importance of developing the digital elements of the economy. Many governments have identified the need to provide near universal access to broadband as a pre-requisite for future economic prosperity. As the economics of extending coverage through expanding mobile networks is more attractive than building additional fixed infrastructure governments see a key role for mobile networks in achieving their public policy objectives (see for example the UK's Digital Britain Final Report.) As a result governments are anxious to release the spectrum as early as possible to accelerate the development of the economic benefits.

As with all spectrum a holistic approach is essential

In developing their spectrum strategy operators cannot ignore the potential of the Digital Dividend when they contemplate their strategies in relation to re-farming of 900MHz spectrum in particular as well as other spectrum releases such as 2.6GHz spectrum.

The award of Digital Dividend spectrum presents one of the greatest spectrum uncertainties in many central and eastern European markets

Spectrum in the 900MHz range is the current bedrock on which many of the first mobile networks are founded (later operators tended to be awarded spectrum in the 1800MHz range) and the loss of this spectrum would impose very significant costs on operators. It is not surprising therefore that many operators are arguing that the process of re-farming cannot proceed until there is clarity over the release of Digital Dividend as the two may be regarded as (imperfect) substitutes.

Over time as uncertainty over the availability of technology and devices in the Digital Dividend range diminishes and the time at which it is available for commercial deployment becomes closer the 900MHz and Digital Dividend spectrum will become closer substitutes for each other. It is certainly the case that valuing spectrum today is extremely challenging when considerable uncertainty remains over the Digital Dividend.

Limited spectrum and congestion will require mitigating strategies to handle traffic

Commercial strategies for managing demand include pricing, cap enforcement, segment focus and traffic management

Commercial Strategies			
	Operator	Strategy	Comments
Pricing	StarHub (Singapore) DNA, Elisa (Finland) Telia (Sweden)	Charge a premium for higher data speeds	There are potential a number of alternative pricing strategies e.g., Busy Hour pricing
Enforcement of caps	3 UK	High out of bundle charges with caps being enforced	In Europe all operators have "caps" on usage levels, although many are not enforcing them due to billing limitations
Segment focus	O2 UK	Focus on complimentary customers rather than substitutional by offering bundled fixed and mobile broadband	
Traffic management	Elisa (Finland)	Prohibit P2P traffic	Difficult in a "net neutrality" environment

Network sharing may be an imperative for success*

Operators can achieve significant savings in cost and achieve faster coverage roll-out through sharing of network assets.

In mature markets with limited or no revenue growth, cash flow can only be increased through cost reduction. Hence, the recent surge in sharing infrastructure.

The trend towards network sharing

In the early days of mobile, operators built entirely separate networks. Since then there has been a gradual evolution from this approach, starting with site sharing (often mandated by the regulator), and now going as far as merging networks i.e. sharing the radio access network (RAN).

Infrastructure and network sharing deals have been agreed between major operators in Europe, North America and Asia and elsewhere showing compelling opex and future capex savings. Industry players and regulators appear to agree that at this stage of the mobile industry life cycle, it does not make sense to build entirely separate networks.

Models of network sharing

There are five main models of network sharing:

- site sharing and / or tower sharing is the most common form of network sharing;
- full RAN sharing, including backhaul transmission is more complex and hence rarer;
- backbone (core) transmission sharing;
- core network sharing, which is quite rare;
- national roaming, which does not involve asset transfer.

Each sharing model has its own strategic and economic drivers, technical requirements and regulatory considerations. An operator specific assessment must be made to evaluate network sharing potential and attractiveness considering:

- the overall strategy as well as the value and competitive position of the current and planned network;
- the availability of suitable partners and partnership models based on existing assets and competitive positions;
- market structure and forecast usage patterns; and
- regulatory imperatives and constraints.

The benefits

The greatest benefit of network sharing are substantial reductions in cash expenses:

- Roll-out capex can be reduced, thus yielding immediate cash flow benefits; and
- lower network opex can be achieved, providing a long term saving and hence higher EBITDA margins.

Network sharing can speed up coverage roll-out, notably for mobile broadband services, using higher frequency bands.

- National roaming provides an attractive option for new market entrants and operators who do not have lower band spectrum. In some markets regulators have mandated national roaming to aid new entrants.
- Shared networks also mean shared investment risk particularly in the case of mobile broadband.

In markets where coverage obligations are a feature of licencing, network sharing can be an attractive alternative to fulfill such coverage obligation. Collaboration between MNOs makes it more commercially feasible to cover regions with low population density.

* Extracted from the Coleago paper "Network Sharing" November 2009 which is available in full on request

Improving capacity with network offload via Wi-Fi

With the growing demand for mobile broadband, vendors and operators alike are looking a technologies and strategies to offload traffic from the cellular network yet still ensure subscribers maintain an excellent data experience.

With this in mind, numerous handsets now support Wi-Fi enabling data to be offloaded onto the Internet at the customer site rather the backhauling it through the operator's RAN and Core Network.

Femtocells

Relatively few operators have launched commercial femtocell propositions and many launches have been very low key such as the case of Vodafone. The table below identifies the operators who have commercially launched a femtocell proposition.

Many other operators are trialling femtocells (T-mobile recently announced a trial) and further commercial launches can be expected in 2010.

There are a number of issues and challenges with the femtocell business case but we anticipate that this will be a topic which will continue to receive considerable attention in 2010.

Advantages

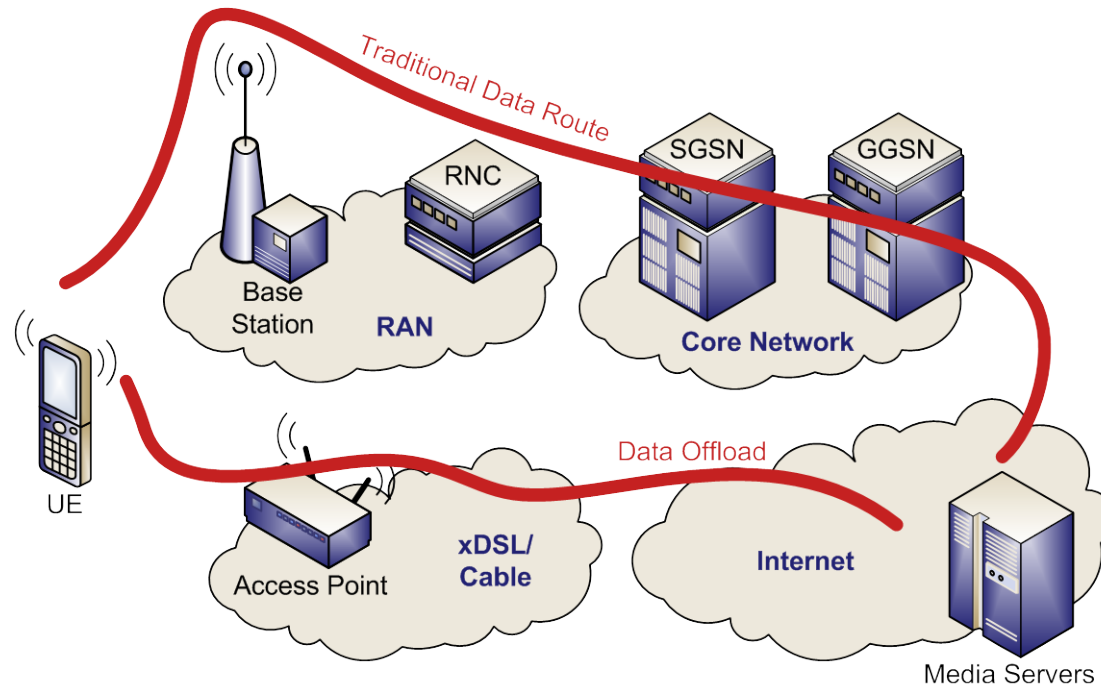
- RAN & core network capacity saved
- High Availability of Wi-Fi Technology
- Home / coffee shop utilisation model

Disadvantages

- Difficult to bill
- Requires mature broadband network
- No mobility (unless UMA is adopted)

Implementations

- UK, USA, Germany, Switzerland and elsewhere



Improving capacity with network offload via femtocells

The jury appears to be still out on Femto Cells at the present time as operators are still running trials to establish the impact this technology will have on their network coverage and data capacity.

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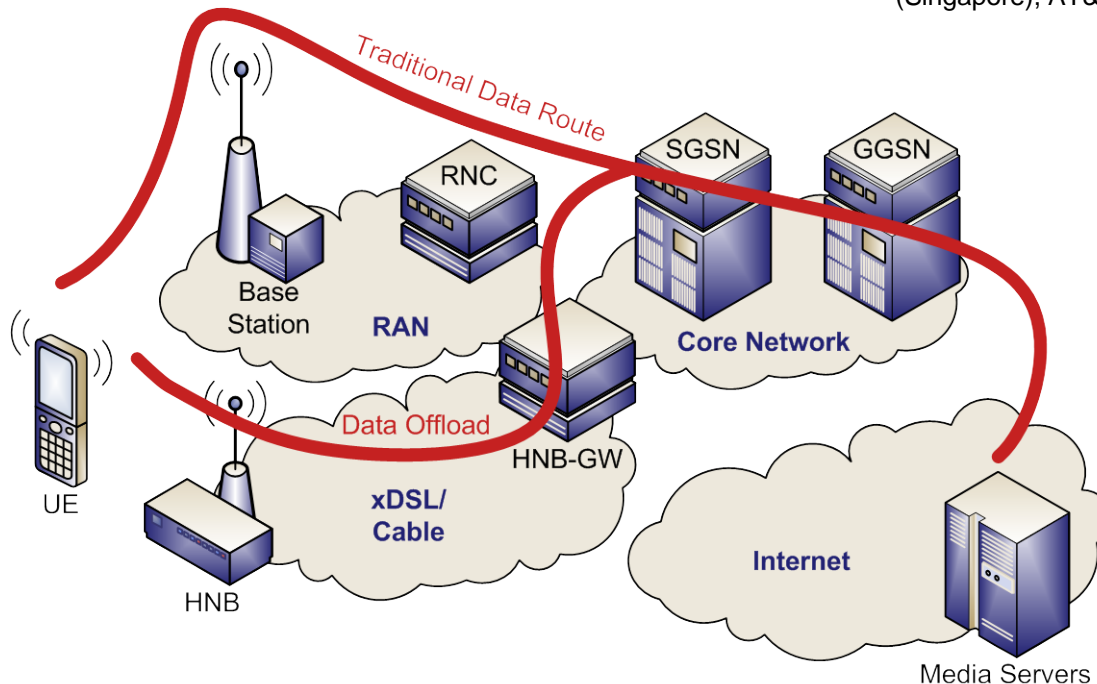
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- Difficult to bill
- Requires mature broadband network
- No mobility (unless UMA is adopted)

Implementations

- Vodafone (UK), SFR (France), Softbank (Japan), StarHub (Singapore), AT&T (USA)



Coleago's services in relation to spectrum auctions, licence renewal and refarming

Coleago's spectrum related services are structured into four blocks, supporting you when facing licence renewal, refarming or a spectrum auction.

What is the issue at hand?

Coleago worked with operators who faced different issues, namely spectrum auctions, licence renewal, and refarming. In some cases these three issues are addressed by the regulator as part of a single process. In each case spectrum strategy and valuations are likely to be key components in successfully addressing the issue at hand.

Spectrum Auctions

For operators facing a spectrum auction, Coleago offers a well defined service set at the different stages in the run up to the spectrum auction as set out in the table on the right.

Licence Renewal

Coleago can help you to negotiate with the regulator to retain spectrum without going to auction, e.g. by arguing the case for an Administered Incentive Pricing (AIP) process looking at the Optimum Deprival Value (ODV) and Best Alternative Use (BAU) based renewal fees. Good regulatory advocacy can save millions of dollars in auction spend.

Refarming

Coleago can help to argue your case with regards to refarming. Often this is associated with renewal or redistribution of lower band spectrum. Coleago AIP pricing methodologies and spectrum auction valuation techniques are an important part of this service.

Coleago's Spectrum Auction Related Services

Spectrum Strategy & Consultation

The objective is to influence the process of allocating spectrum in a favourable manner consistent with your spectrum needs. Questions that need to be answered include:

- What spectrum blocks do we need in which bands?
- What auction format should be argued for?
- Should there be restrictions, e.g. caps?
- In the case of renewal, can an auction be avoided?
- In the case of Administered Incentive Pricing, what should the spectrum renewal fee be; should we argue for ODV, BAU or benchmarking?
- What arguments can be presented consistent with regulatory policy objectives, economic rationale and international best practice?

Spectrum Valuation

The objective of any investment decision is to increase or at least maintain shareholder value. Prior to bidding in an auction you need to answer the question how much is each block or combinations of blocks worth to us? This allows you set bid limits. Coleago's structured spectrum valuation process would give your board confidence in making the investment decision associated with acquiring the spectrum and subsequent technology roll-out.

Auction Strategy

Depending on the auction format there may be dominant bid strategies or ways to avoid negative outcomes in cases where there is aggregation risk. This can be explored at theoretical level, through simulations and mock auctions.

Auction Support

In theory a bidder enters the auction well prepared and the auction itself is a mechanical exercise. However, as the auction unfolds there will invariably be some learning which needs to be processed at the end of each day in order to be prepared for the next day's bidding.

Coleago's recent spectrum related credentials

Coleago brings extensive experience in valuing spectrum in a mobile broadband world. Sample recent projects include:

Valuation for Renewal of 900 MHz Spectrum

In January 2010 Coleago concluded a project in respect of the expiry and re-auction of 900 MHz spectrum in Ireland for Telefonica O2. This is the first time re-auctioning of 900 MHz spectrum is taking place in Europe and the valuation took account of a complex schedule of different expiry dates, refarming and future spectrum auctions for 2.6GHz and 800MHz. Coleago examined and reported on:

- Minimum prices, reserve prices and spectrum usage fees.
- The proposed auction format and bidding strategy.
- Spectrum packages, strategies and valuation requirements.
- The value of different spectrum blocks to Telefonica O2.
- The value of different spectrum blocks to competitors.

Coleago's work also included advice on policy issues, i.e. what steps might be undertaken to change the process in a manner that would provide a more favourable outcome to Telefonica O2.

Valuation of 2.6 GHz Spectrum in the UK

Coleago carried out strategy, market forecasting, technology assessment modelling and valuation of 2.6 GHz spectrum in the UK across a broad range of scenarios. The project took account of refarming and reassignment of 900/1800 MHz and the new digital dividend 800MHz spectrum. We also provided bid strategy advice, workshops and simulations for the auction. This project for Orange concluded in 2009, but the auction has not yet been held.

Valuation of 3G and BWA Spectrum in India

On behalf of Telenor, Coleago carried out the valuation for the 3G and BWA spectrum in 22 circles. The valuation was complex due to the interdependencies between the value of spectrum blocks, i.e. the value of a block in a circle would change depending on the spectrum won in another circle. In the event Telenor decided not to bid (2009).

2.1 GHz Spectrum Auction in Thailand

Coleago provided a complete strategy, market forecasting, technology assessment modelling and valuation of 3G spectrum with several scenarios and assumptions as well as strategic advice on future concession structures for dtac (2009).

Bid Strategy and Auction Support in India

Coleago provided bid strategy and auction support for Tata Communications during the BWA auction, including daily reviews of the auction progress. One Coleago consultant was on site and others connected via video link (2010).

2.1 GHz Spectrum Auction in the Ukraine

On behalf of Kyivstar, Coleago carried out the valuation of 3G spectrum for the client and competitors, including an affordability study of mobile broadband. Different blocks were not available at the same time. Hence the valuation differed by the timing of their availability, thus further complicating the valuation (2009).

Valuation for AWS Spectrum Auction in Canada

Coleago valued different spectrum blocks and combinations thereof on a regional basis for Rogers, the main incumbents and new entrants. Rogers ended up paying \$ 2 bn for 20 MHz nation-wide, outbidding Bell who obtained 10 MHz. Coleago had assessed the maximum value of 20 MHz to Bell at close to \$ 2bn. We also participated in the mock auctions.

Other Spectrum Valuations and Licence Bids

Coleago and its consultants have worked on numerous spectrum valuations as well as mobile and broadband wireless licence bid projects. A list is provided in the appendix to this proposal.

Proprietary Modelling Tools

Coleago has developed modelling tools that allow us to value spectrum under a multitude of market, technology and spectrum option scenarios. Using pre-build models means time can be spent on analysing the results and thinking through the implications

Spectrum strategy and valuation

Formulating a spectrum strategy and spectrum valuation is becoming increasingly challenging

2

How to approach a spectrum auction

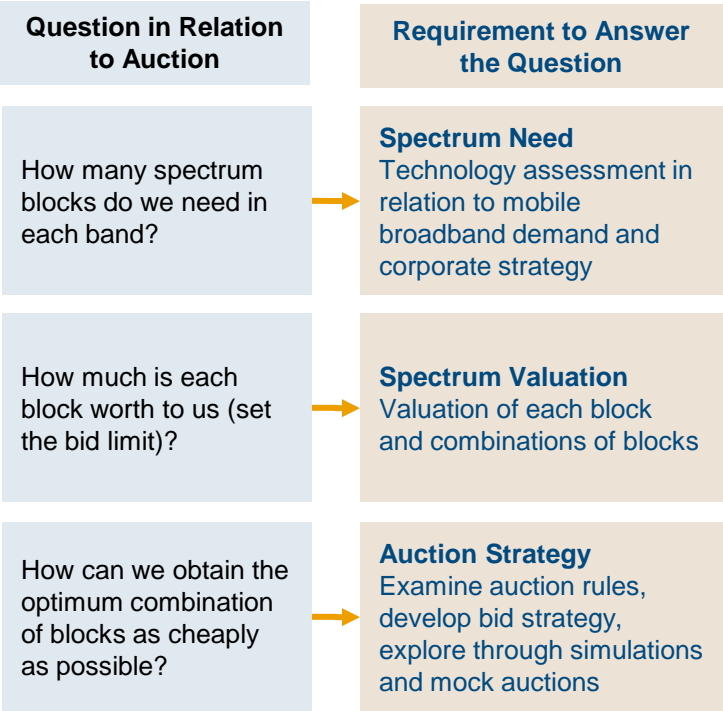
Valuing the spectrum is the most critical and time consuming task in a spectrum auction process.

Spectrum valuation is quite different from bid strategy.

Three Key Questions in relation to a Spectrum Auction

In respect of a spectrum auction an operator has to find an answer to three fundamental questions:

- **How much spectrum do we need in different bands?** The question relates to an assessment of **spectrum need** in the context of the growth in demand, notably mobile broadband. This needs to take account of the overall strategy, for example traffic offload through WiFi or Femto cells.
- **How much is each block worth, i.e. what is the most we should bid for it?** This relates to **valuing each spectrum block** in order to set the bid limit for the auction. This is quite separate from auction strategy. Clearly, if there is no bid limit, the auction will be simple because a bidder would simply pay whatever it takes to win the spectrum. However, such an approach may not result in the creation of shareholder value and may draw criticism from shareholders and the financial press and capital markets.
- **How do we obtain the spectrum as cheaply as possible?** This relates to **auction strategy**. In any auction, the bid limits should be set before the start of auction. The role of bid strategy is to ensure the spectrum is obtained for less than the bid limit and at the lowest possible price. Depending on the auction format there may be an opportunity to influence the outcome and avoid negative effects such as aggregation risk (e.g. be stranded with unwanted blocks). This is addressed by examining the auction rules and developing a bid strategy which will be tested through simulations and mock auctions.



Developing spectrum strategy and spectrum valuations

A great many factors must be considered when developing a spectrum strategy and valuing spectrum

The challenges of developing a spectrum strategy and valuing mobile spectrum

Understanding the value of spectrum to a business is essential for developing a spectrum strategy and participating in a spectrum auction. Valuing spectrum is conceptually straightforward. The value of spectrum is usually estimated by comparing the value of the business with the spectrum with the value of the business without the spectrum. The actual practical process however is becoming increasingly complex as it is no longer simple to define what the business might look like “with” and “without” the spectrum due to a range of factors considered below:

- Licences for existing holdings of 900MHz and 1800MHz are approaching their expiry dates and so operators have to consider whether they will be able to retain their existing spectrum and at what cost and under what licence conditions and whether re-farming will enable them to deploy alternative technologies in these bands.
- A range of new spectrum bands are becoming available which include spectrum below 1GHz such as the “Digital Dividend” in the 700MHz or 800MHz bands as well as spectrum above 1GHz such as in the 2.5GHz / 2.6GHz frequency range.
- Valuing spectrum also requires the identification of the optimal technology strategy and evolution path and this task is complicated by uncertainties over which technologies will dominate and when and in which bands will they become commercially available. The valuation of spectrum is also complicated by uncertainty over the actual rates of throughput that the technologies can deliver in a live network environment in different spectrum bands.
- New spectrum may be made available at a nationwide or regional level or both and in individual blocks which could be amalgamated into a single larger block affording increases in spectral efficiency. As a result the valuation process must consider stand-alone regional and / or block valuations and also packages of regions and / or blocks. When considering packages over stand-alone valuations the impact of scale must be included. The use of regional and multiple block awards and the resulting potential number of combinations can result in potentially many thousands of spectrum valuation points that may need to be estimated.
- New spectrum awards may allow new players to enter the market and the value of spectrum to existing players will depend on how the competitive landscape changes as a result of new market entry. The ability to block new entrants may also enhance the value of the spectrum to incumbents and the value of blocking depends on the damage that a new entrant might inflict and the damage may vary depending on who enters which cannot be known prior to the start of the auction.
- Operators also have to consider mitigating strategies for the “no spectrum case” but also if they face network congestion and so a range of mitigating strategies such as traffic shaping and fixed line off-load must also be examined and incorporated into the valuation process. Operators must also consider how regulation on net neutrality might impact their ability to shape traffic profiles and whether there are any long run cost implications of offloading to other players fixed networks.
- Spectrum re-farming and the award of all new spectrum may take place simultaneously (such as in Germany) which does provide operators with certainty over the price to be paid for spectrum but makes developing a value maximising bidding strategy very complex. Alternatively re-farming and the awards of spectrum may take place over a period of time which complicates spectrum valuation considerably due to the uncertainties over the timing of future spectrum releases and the prices that will be paid in future auctions.

Understanding your competitor valuations may be as important as your own valuation

In some auction designs it is the value your competitors place on the spectrum that will determine how much you will have to pay as a business

- Future industry consolidation and network sharing deals should also be considered.
- There are also all the usual uncertainties regarding inflation, exchange rates, economic growth, interest rates, etc but the other major uncertainty that remains is customer demand. There is no certainty as to what levels customer usage will rise to, what data speeds they will demand, whether and where network congestion might occur and finally how much customers are prepared to pay for their traffic.

Understanding the value of the spectrum to your competitors is sometimes more important

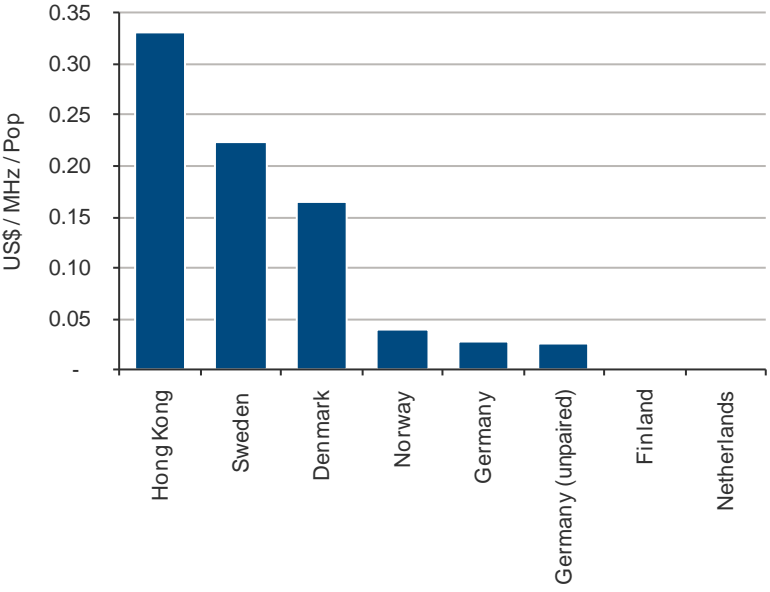
Spectrum is often awarded through an auction process and recent auction designs favour a second price rule which means that bidders cannot influence the price they pay for the spectrum only the price that others pay. At the margin what this implies is that the price an operator will have to pay for a spectrum block will be determined by the price the next highest bidder is or was willing to pay. In order to determine how much your business might have to pay for the spectrum you need to value the spectrum to your competitors.

Valuing the spectrum to your competitors essentially means confronting all the same valuation challenges but from your competitors' perspectives.

Limited benchmarks are available for 2.6GHz and 700MHz spectrum

In the absence of meaningful benchmarks a bottom-up approach is inevitable for valuing 2.6GHz and 700MHz spectrum

2.6GHz FDD spectrum auction benchmarks



2.6GHz Spectrum Benchmarks

Auctions in Sweden and Norway took place in November 2007 and May 2008 respectively and prior to the onset of the current economic crisis. The auction in Hong Kong took place in January 2009 when the economic downturn was well under way and Finland later 2009.

In Sweden the auction was competitive with 4 incumbents and 2x70 MHz of FDD available. The Hong Kong auction was highly competitive with 5 incumbents competing in the 2.6GHz auction and 2 players bid jointly. Only 2x45MHz of spectrum was available split into 3 licences. The auction in Norway was uncompetitive with only 2 incumbent players. The lack of competition reduces the insight that can be gained from this auction. An auction for 2.6 GHz spectrum in Finland in November 2009 was also un-competitive, not attracting new entrants. Prices paid were close to the reserve price, amounting to a mere 0.0047 US\$ / MHz / pop.

The Dutch auction in 2010 saw spectrum caps for the incumbents and two new entrants and very low prices. The unpaired spectrum did not attract any bids.

Digital Dividend Benchmarks

The US provides a number of reference points for spectrum in the lower frequency bands. The national average was 0.53 US\$/MHz/Pop but the top 20 cities were considerably more valuable matching the high prices paid in the UK and Germany for 3G spectrum of approximately 4 US\$/MHz/Pop. The German auction saw an average price of 0.9 US\$/MHz/Pop.

Bottom-up and Top-Down Approaches

Even when good benchmarks are available most operators prefer to combine a bottom-up valuation approach with a top-down benchmark based review. Benchmarking is usually considered too blunt a forecasting tool for spectrum valuations when significant valuations are being considered. However, they provide an essential “sense check.”

To value spectrum it is important to understand how spectrum will generate value

Our bottom-up methodology captures all the sources of potential value

Blocking value

- If a new entrant can be blocked from entering the market by acquiring spectrum, this will give value to the spectrum, regardless of any 3G demand or technology issues. One of the issues is that all incumbents benefit if one of the incumbents buys additional spectrum to block a new entrant, i.e. the “free riding” problem. However, spectrum caps may prevent the possibility of blocking.

Capacity

- Depending on the view of the future demand for data it may not be possible to serve this demand economically with existing spectrum, thus putting a block on the ability to compete. Success may be determined by the share of industry capacity which is linked to relative spectrum holdings.

Avoiding additional site build

- Additional spectrum may allow an operator to install additional carriers on existing sites, but without it new sites would have to be built. Additional spectrum could reduce site build capex.

Voice and packet data traffic

- It is a common misconception to view 3G only as a technology for new data services. Depending on existing 2G spectrum holdings, 3G spectrum may be the most economic way to cater for projected increases in voice traffic in urban areas.

Access speed claim

- While many applications work well with EDGE, the headline speed claim of HSPA and LTE may confer a commercial advantage. This may determine the value of 10 MHz vs. 20 MHz blocks, because deployment of LTE in 20 MHz gives higher maximum access speeds. The validity of the commercial and technical arguments supporting this source of value can be easily challenged!

Technology migration

- The re-farming of upper and lower band 2G spectrum to WCDMA has started and is unavoidable in the longer term. Introducing new technology within an existing spectrum allocation can be very costly. Additional spectrum would reduce the migration cost.

Tax shield

- The amortisation or writing down allowances of licence fees for spectrum provide a shield against future tax and therefore increase free cash flow and shareholder value. Any methodology must account for this tax shield.

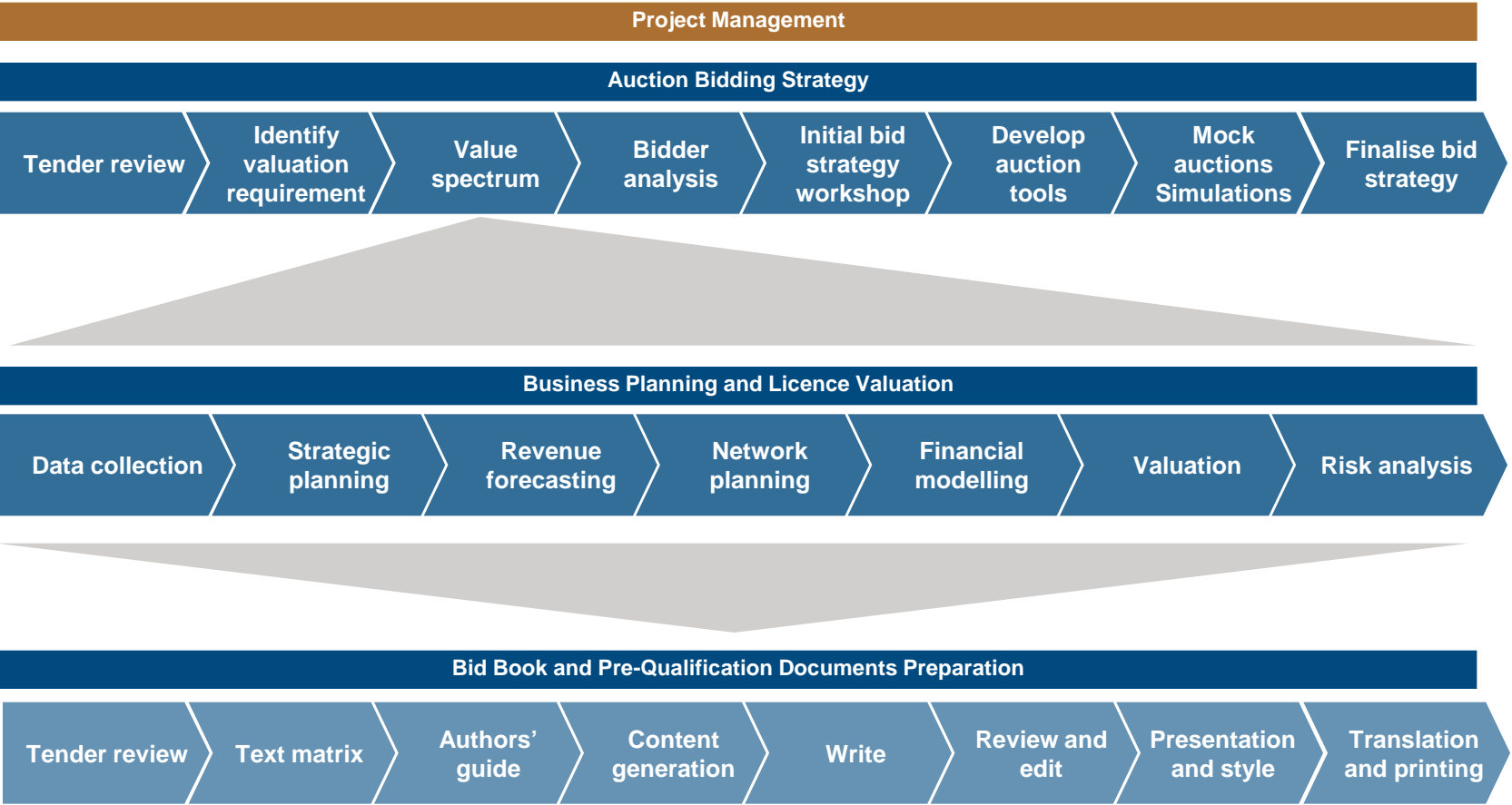
Critical questions for developing spectrum strategy and valuations

The valuation of spectrum will raise many questions for MNOs and here we provide some of the key questions

Market landscape	<ul style="list-style-type: none"> • Will the mobile broadband landscape be more substitutional / complementary to fixed networks? • Will business or consumer drive MBB penetration? • What will be MBB penetration in 20 years time?
Data usage	<ul style="list-style-type: none"> • How much will customers use in future? • What services are driving forecast growth? • What is likely usage by device type?
Technical	<ul style="list-style-type: none"> • What are likely uplifts from LTE / MiMO? • Spectrum efficiency factors? In-building coverage? Device penetration? • What are the incremental costs of 2.6GHz?
Spectrum	<ul style="list-style-type: none"> • What is likely to happen with re-distribution of 900/1800 MHz? • How much spectrum is needed? • How does Interference impact on specific blocks and how does it effect valuation?
Data traffic profile	<ul style="list-style-type: none"> • Will the data traffic profile continue to follow voice profile e.g. top X% sites carrying Y% of Busy Hour Traffic? • Will profile change over time? • Will this depend on mix of complementary versus substitutional traffic?
Impact of network congestion	<ul style="list-style-type: none"> • Will network congestion lead to higher retail prices and/or lower SACs? • What implications does possible network congestion have on MNO's DVNO/MVNO strategies?
Relationship with fixed broadband	<ul style="list-style-type: none"> • Will they complement or compete? • How much traffic can be offloaded?
Mitigating strategies	<ul style="list-style-type: none"> • Infrastructure share, fixed network offload • Manage demand – QoS pricing, enforce caps, service restrictions • Acquire spectrum at a later date

Coleago has developed an integrated approach to spectrum strategy and valuation

Our approach integrates developing auction bidding strategy with spectrum strategy and valuation and the preparation of any pre-qualification documents or bid books



Auction and bid strategy development

Developments in spectrum auction design

3

Background on spectrum auctions

The design of auctions has improved over the years and many regulators opt for a simultaneous multi-round auction (SMRA).

The Evolution of Spectrum Awards

Spectrum was originally allocated in the US by a random ballot but when a group of dentists won a key spectrum block in the US (which they then sold to an operator for a fortune) a new approach was required. During the 80s & 90s beauty contests were used to award spectrum to the operators who submitted the best business plans.

However, governments realised they could generate significant revenue if they sold spectrum in competitive auctions. These auctions were initially simple sealed bid auctions. Auction structures then evolved into Simultaneous Multi-Round Auctions and from there onto Combinatorial Clock Auctions which may also include a sealed-bid element.

A common goal in auction design is efficiency. An efficient auction is one where the spectrum is awarded to the bidder who places the greatest value on the spectrum. Auctions may be designed however to maximise revenue generation and such auctions may be inefficient.

First Price Sealed Bid Auctions

The challenge with first price, sealed bid auctions (the highest bidder wins and they pay the amount they bid) is that there is no “dominant strategy” or a unique number to bid. It becomes rational for an operator to “shade” an amount off the true value they place on the spectrum - the issue is how much to shade their bid. As there is no clear strategy on how much to shade, the auction can be inefficient as the bidder with the highest value for the spectrum may not secure it. There is also no opportunity to learn about the value of the asset from the bids of others and so there is a risk of a “winners curse,” bidding significantly more than you need or, more strictly, bidding more than the true value of the spectrum.

Second Price Auctions

In second price auctions (the highest bidder wins but they pay the amount of the second highest bidder) a dominant strategy exists and that is to bid your value. You maximise the chance of winning and are guaranteed to create value if you win. The amount you pay however is determined by the other bidders. By introducing a multi-round element the ability to learn about the true value.

Standard SMRA

The standard Simple Multi-Round Auction sees bidders bid for specific spectrum blocks. This format was first used by the US and has subsequently been adopted by many other regulators including Hong Kong for its 2.6GHz auction. Bidders submit multiple bids in each round. A standing high bidder is declared for each lot at the end of each round. Prices of lots that receive new bids are increased in the next round. Bidders can shift their demand between lots over successive rounds, subject to certain activity rules. The auction continues until there is a round in which there are no new bids for any available blocks of spectrum. Each block is then awarded to the bidder that had the highest bid on that block (the standing high bidder) at the end of the auction and they pay the amount they bid. In such an auction there is no second price rule.

Combinatorial Clock Auction

This is the auction design that was used in the Indian auction and prior to this in Denmark and the Netherlands. In each round of a CCA, bidders state their demand in terms of a number of blocks at a specified price. The price increases over successive rounds until demand falls to the same as (or lower than) the supply of blocks. A follow-up procedure allows bidders to place further bids for packages that they did not get an opportunity to bid for during the clock stage. Winning bids are then calculated from the set of bids placed in the clock rounds and the follow-up round. Once the winners are identified, a final round is required to allocate specific frequencies amongst the winning bidders.

In the case of the Indian auction bidders could only express demand for 1 generic block in a particular circle. The price increases over successive rounds until demand falls to match the supply of blocks and there is no more bidding activity in any circle. A set of eligibility rules ensure that bidders must continue to bid or drop out. A follow-up procedure then randomly allocates specific blocks to the winners from the clock phase. The price actually paid by the winning bidders is determined by the lowest winning bid and so the clock auction incorporates a second price rule.

Auction Strategy, some considerations for auction strategy

The value attributed to a spectrum block depends also on what other block are won in the same band and in other bands. This increases complexity.

Auction Strategy, some basic considerations

A bidder's valuation for a spectrum block or a package of spectrum is the price at which he walks away from a take-it-or-leave offer.

- Where aggregation risk is present valuations should be defined over packages, not just individual blocks.
- A valuation is conditional on information known at the time.
- We can distinguish between "private" and "common" values where the latter implies that the bidder will "learn" about the "true" market value of the spectrum from the bidding of other bidders.
- A valuation includes everything relevant to the spectrum block or package.
- A valuation should include any possibility of spectrum resale.

With multi-unit auctions, i.e. several blocks auctioned simultaneously, packaging becomes important. An individual block's valuation is its marginal valuation in the context of other blocks also captured as part of the package. This means that individual blocks can be either complements or substitutes:

- A package of substitutes is worth less than the sum of its parts.
- A package of complements is worth more than its components.

Combinatorial auctions take care of packaging. With substitute blocks, a simultaneous auction design is fine. With complements, there can be significant aggregation risk.

Key issues for auction strategy formulation

Formulating valuations correctly is the primary issue. Once this is done, then:

- Think carefully: are there complementarities?
- With complementarities, think about aggregation risk.
- Without complementarities, think about shading and gaming.
- With no interdependence, think about proportional returns.
- With interdependence, think about marginal block valuations.

Even if the auction is not designed as a combinatorial auction, a general solution would be bidding for packages rather than blocks:

- Formulate all relevant block packages of relevance and interest.
- At each stage, use a bidding tool to narrow the feasible set.
- Think about the aggregation risk if there are complements.

The objective of auction strategy is to create value

The objective spectrum strategy is to ensure that value is created from the auction by acquiring spectrum for less than you value it.

Creating Value in a Spectrum Auction

In the context of a spectrum auction and auction strategy, there are two objectives:

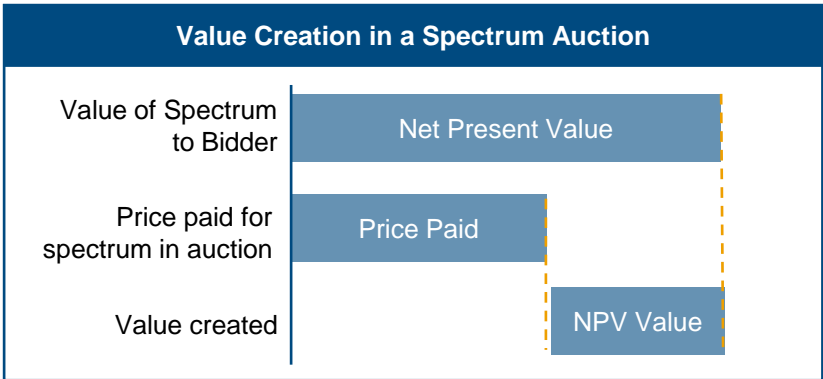
- The objective of a spectrum auction is to obtain the desired amount of spectrum, but not at any price.
- The objective of spectrum strategy is to obtain the spectrum for less than your valuation.

The value created is the difference between the value assigned to the spectrum and the price paid for it at auction. If the price paid is the same as the valuation, the bidder would simply earn its normal WACC, but not create any additional value.

To illustrate this point consider the following scenario towards the end of an auction. You have two options to end an auction:

- Option A, you could obtain 20 MHz
 - You value 20 MHz at €500 million and you can obtain it for €480 million. You would create €20 million value.
- Option B, you could obtain 10 MHz
 - You value 10 MHz at €300 million and you can obtain it for €240 million. You would create €60 million value

Option B creates more value and should be the one chosen.



Value Creation in Denmark's 2.6 GHz Auction

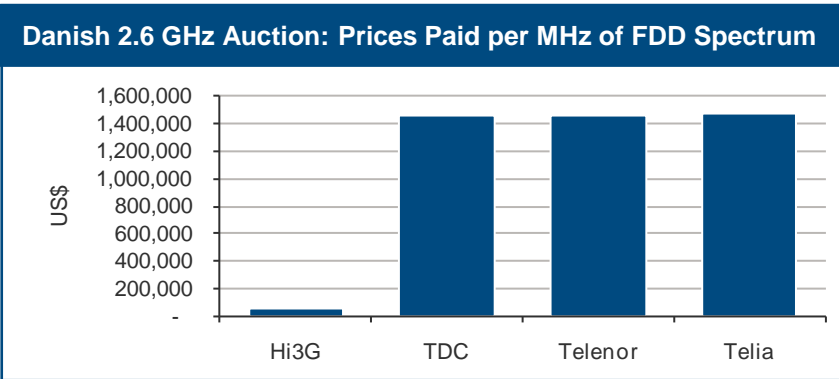
The 2.6 GHz auction in Denmark which concluded on the 11th of May 2010 was a combinatorial auction, i.e. bidders had to bid for combinations of blocks rather than individual blocks. 2x70 MHz of FDD (paired) spectrum was on offer as well as 50 MHz of TDD (unpaired) spectrum. During the auction the four winning bidders favoured combinations with 2x20 MHz of FDD spectrum. However, with four bidders and 2x70 MHz on offer, one operator would only be able to obtain 2x10 MHz of FDD.

As prices rose, Hutchison (Hi3G) changed to a different combination, which included only 2x10 MHz of FDD spectrum. At this point the auction stopped, because demand for FDD blocks matched supply.

The result of the auction was as follows:

- Hutchison paid US\$ 1,237,00 for 2x10 MHz of FDD and 25 MHz of TDD. If we assign no value to the TDD spectrum the price paid for the FDD spectrum amounts to US\$ 61,849 per MHz
- If we assign no value to the TDD spectrum, the other bidders who acquired 2x20 MHz of FDD paid US\$ 1.4 million per MHz.

This is an interesting example how a strategy of demand reduction at the right point in an auction can create considerably shareholder value.



Auction Strategy

A simultaneous multi round auction (SMRA) is complex, particularly if there are significant interdependencies between blocks.

Objectives

- Understanding what blocks and combination of blocks the Client should bid for and at what thresholds bidding should switch between blocks.
- Obtain the preferred combination of blocks at the lowest possible price.
- Avoid being stranded with unwanted blocks.
- Be prepared to participate effectively in the actual auction process, i.e. to place bids on a daily basis for different combinations of blocks..

Main Activities

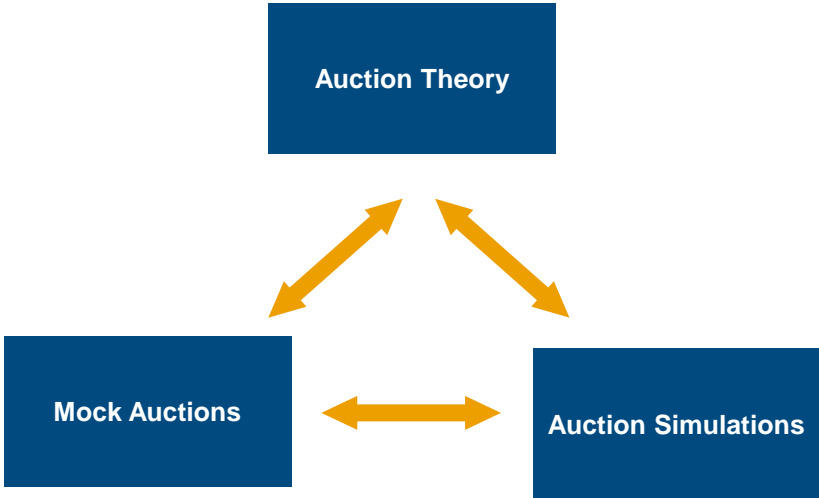
Auction Theory: We apply the principles of economic game theory analysis to attempt to identify a dominant bidding strategy. We test the hypothesised dominant strategy in both practical mock auctions and through a range of simulations. The process is highly iterative, workshop and facilitation based and ensures a robust strategy and a well prepared and trained bid team capable of executing the strategy effectively. These workshops create auction awareness among your management.

Mock Auctions: This is the training ground for the staff executing the auction and are required to test systems. In Coleago’s experience the participation in mock auctions is also an “eye opener” for senior management, notably helping them to understand the risk associated with an auction of either overpaying or not obtaining the desired combination of spectrum blocks.

Auction Simulations: While a mock auction gives some strategic insight, running hundreds or even thousands of computer simulations produces a much better understanding of possible outcomes and thus gives better insight into the outcomes of different bid strategies.

Key Deliverables

- Coleago will conduct auction awareness seminars and familiarise your business with auction process.
- Coleago will develop an auction strategy in the context of the valuation, i.e. what combination of blocks should you bid for, taking account of complementarity and substitutability.
- We will review the bid strategy with your senior management.
- Coleago will set up an auction room and run mock auctions in order to test potential bidding scenarios and bid strategy.



Coleago's spectrum services

Coleago can support operators with a range of spectrum related services

4

Coleago Consulting can provide a broad range of support

Clients can benefit from our experience in major spectrum valuation and auction projects

Coleago's Services for Operators in relation to Spectrum Valuation, Auctions and Licence Renewals

Spectrum Valuation	Bid Strategy
Regulatory strategy, position papers and lobbying strategy	Project management
End-to-end turnkey solution	Development of bid strategy
Project management	Bid strategy workshop facilitation
Methodology and approach	Mock auctions
Pre-built spectrum valuation tools and bespoke modelling	Auction simulations
Technical analysis and assumptions	Auction support and analysis tools
Market analysis and assumptions	Bid team members
Financial analysis and assumptions	Development of argumentation with regulator
Alternative valuation methods for renewal, e.g. deprivation value, alternative use	

Coleago's Services for Regulators

Analysis of the industry and spectrum valuations for setting reserve prices
Licence conditions for new licence awards and re-farming of existing spectrum
Setting licence fees
Market research and industry analysis
Interconnect modelling, accounting separation and price controls

Introducing Coleago Consulting

A brief introduction to our expertise, services and experience in spectrum valuations and auctions

5

A leading boutique telecoms consulting and training firm

Based in the UK Coleago provides consulting and training services to global and regional telecoms, media and technology players

Operators and regulators

Telecoms operators around the world trust Coleago to provide insight and advice on key strategic and commercial issues through our broad range of consulting and training services.

Experience based consulting approach

We do not use inexperienced associates or analysts – all our consultants have a minimum of 10 years experience and most have over 15 years, often at board level in operational businesses. Our insight and advice is therefore based on practical experience and proven processes and methodologies developed over many years. Clients can be confident that their project will be delivered by Partner and Senior Manager level consultants from start to finish and our solutions and recommendations will be credible, relevant, realistic and practical.

Developed and developing market experience

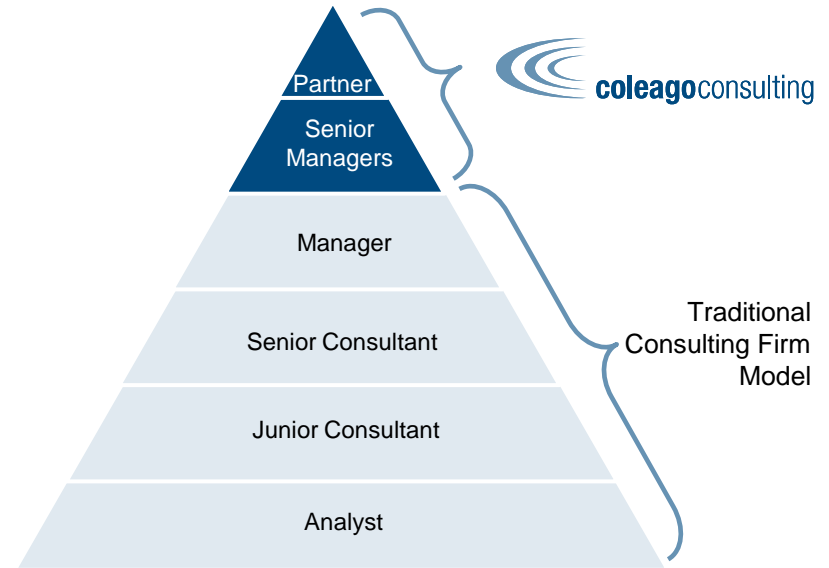
Coleago has worked with clients in developed markets and also in some of the most challenging emerging markets including the Yemen and the Sudan and we have launched and operated GSM businesses in countries such as Algeria.

Small, effective teams

Our consultants are highly experienced, multi-skilled and have extensive project management experience. This allows Coleago to deploy smaller teams as we do not require the hierarchy of traditional consultancies to manage large teams of juniors. Clients find our small teams easier to work with and integrate into their own project teams.

Exceptional value

By eliminating many of the overheads of traditional firms we are able to offer end-to-end partner level consulting at fee rates that provide exceptional value.



Advice covering a broad range of technologies

We have advised clients on wireless, fixed, cable, satellite and fibre based technologies. We have specialist expertise in spectrum valuations and spectrum auctions have participated in more than 50 awards since 1994.

Media and technology experience

We have developed strategies and business plans for media companies, TV channels and web based businesses as well as technology companies.

Innovative training services

Coleago has developed a range of training and management development programmes, including a War Game (business simulation)

We provide a broad range of consulting services

We specialise in telecoms business analysis, planning and modelling to ensure that our advice and recommendations deliver increased shareholder value

Strategy & Business Planning	Strategy Development, Marketing Strategy	War Gaming	Business Planning	Business Modelling
Spectrum and Licences	Spectrum Strategy	Spectrum Valuation for Auctions	Spectrum Auction Bid Strategy	Licence Applications
Marketing & Customer Management	Market Forecasting & Market Planning	Market Segmentation & Customer Insight	Customer Life Time Management	Improving Customer Care
Due Diligence	Commercial Due Diligence	Technical Due Diligence		
Business Transformation & Cost Reduction	Cost Reduction	Restructuring	Turnaround	
Improving Network Performance	Network Audit	Network Sharing	Outsourcing	
Regulation & Interconnect	Interconnect Cost Modelling	Interconnect Agreements and RIO	Regulatory Strategy	Accounting Separation
Digital Content & Media	TV Business Planning	Digital Media Strategy	Digital Content Monetisation	
Fund Raising	Information Memorandum	Equity Fund Raising	Debt Fund Raising	

We offer an innovative suite of training, development and coaching services

Our telecoms War Game is a unique and exceptional management development platform and our Dragons' Apprentice offers a new approach to team building

Specialist Telecoms Trainers

Our trainers are first and foremost telecoms industry experts who are able to gain the respect of programme participants. They are also outstanding trainers with a passion for their subjects.

Telecoms Focus

Our programmes are developed exclusively for the telecoms sector and use real life telecoms case studies, examples and benchmarks throughout.

Bespoke Solutions

We develop bespoke solutions for clients often utilising information about their specific markets to illustrate key points.

Tailored Deliver

We provide pre-course questionnaires and hold telephone interviews with every participant to ensure that each and every delivery contains the right content delivered at the appropriate level.

Innovative Programmes

We use simulation tools, role plays and challenging case studies to provide an entertaining and rewarding learning experience.

War Gaming

Our War Game process is the most realistic simulation of a telecoms market currently being offered and is the closest thing to running a telecoms business after actually running a telecoms business!

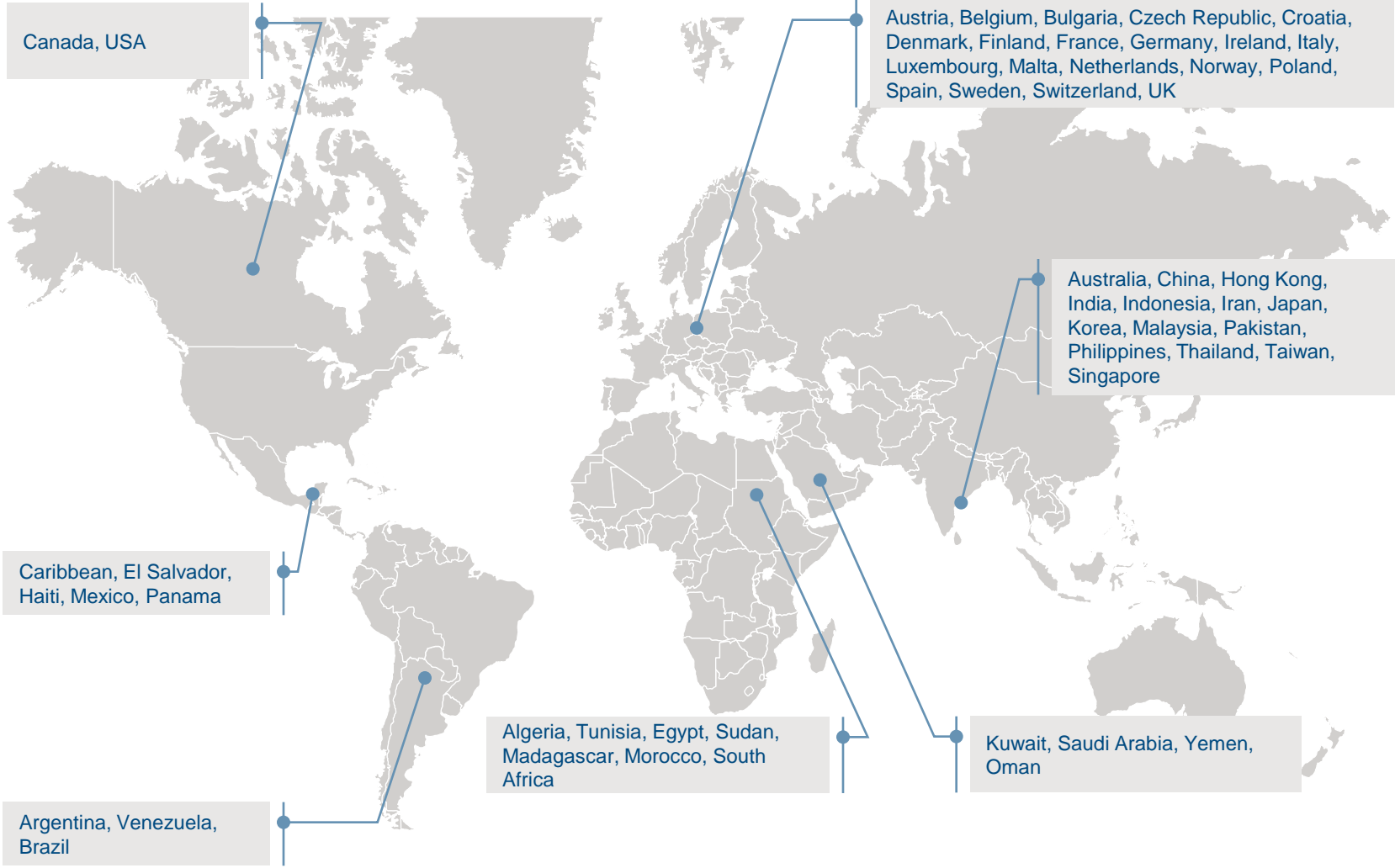


Coleago has delivered assignments for global operators and smaller players

Our clients include fixed and mobile operators, MVNOs, equipment vendors, regulators and content providers



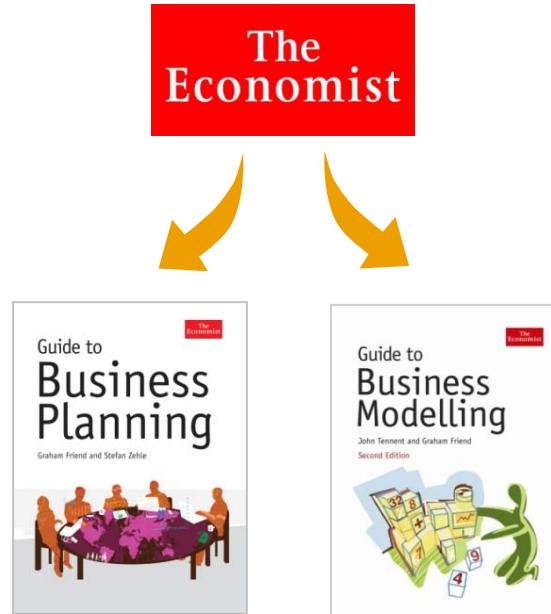
We have delivered projects on every continent of the globe



Coleago's consultants lead and shape the industry

Coleago is regularly asked to speak at key telecoms conferences around the world as well as sitting on governmental working groups and industry bodies that shape the future of the industry

Business texts written by the founders of Coleago



Guide to Business Planning named Outstanding Academic Title 2009

The Guide to Business Planning, a book authored by Graham Friend and Stefan Zehle the Directors of Coleago, which recently appeared in its 2nd edition was named as one of the "Outstanding Academic Titles, 2009 (Business and Economics)" by Choice, the US academic review journal.

Source: Choice, 5th of January 2010
www.lib.uwo.ca/news/business/2009/12/23/outstandingacademictitles2009businesseconomics.html

Participating in shaping the telecoms industry

- Coleago's consultants are actively involved in telecoms industry events. For example, Stefan Zehle, Coleago CEO, spoke at over 20 conferences and forums, and most recently at the GSMA Spectrum Workshop in London (June 2010).
- Coleago consultants are cited in the press world-wide including Total Telecom, Wall Street Journal, Wall Street Journal Asia, Deutsche Welle, Business & Economy India, Financial Times, New York Times, BBC News.

Coleago specialises in winning mobile licences and spectrum for clients

Coleago's consulting team have unrivalled experience in mobile business planning to support licence bids and spectrum auctions going as far back as 1994

Country	Year	Network	Client	Involvement and outcome
France	1994/5	Bouygues Telecom GSM 1800	Cable & Wireless	Carried out market research, market forecasting and modelling, positioning, services and tariffing, wrote marketing chapter of bid book. Client was awarded licence.
Hong Kong	1995	People's Phone GSM 1800	MSI	Carried out market research, market forecast modelling, pricing, positioning, services and tariffing, wrote marketing chapter of bid book. Client won licence amidst strong competition.
Singapore	1995	MobileOne GSM 1800	Cable & Wireless	Carried out market research, market forecast modelling, pricing, positioning, services and tariffing, wrote marketing chapter of bid book. Client successfully won licence.
Poland	1995	GSM 900	Telia	Market research and forecast modelling, marketing strategy, regulatory analysis, negotiations with partner. The client withdrew because the regulatory conditions posed to great a risk. The partner went ahead with another operator and subsequently encountered problems. This vindicated Telia's decision to withdraw.
Austria	1995	GSM 1800	Unisource	Market research, product & service design, coverage roll-out, tariffing. Employed or Mobile Marketing Model and wrote marketing and coverage section of bid text, assisted with presentation to regulator. After the bid had been handed in Unisource withdrew the bid due to political problems among the partners in Unisource.
Belgium	1995	GSM 900	Unisource	Market research, product & service design, coverage roll-out, tariffing. Employed or Mobile Marketing Model and wrote marketing and coverage section of bid text, assisted with presentation to regulator. After the bid had been handed in Unisource withdrew the bid due to political problems among the partners in Unisource.
Finland	1996	Telia Finland GSM 1800	Telia Sweden	Market research and market forecast modelling, development of a local mobile proposition that competes with the fixed network. Provided inputs into the bid document. Telia won the licence.

We have a proven track record in developed and developing markets

Coleago combines market research, strategic analysis and planning and business modelling to prepare high quality licence bids and pre-qualification documents which ensure success

Country	Year	Network	Client	Involvement and outcome
Denmark	1996	Telia Denmark GSM 1800	Telia Sweden	Carried out market research, market forecasting and modelling, positioning, services and tariffing, wrote marketing chapter of bid book. Client was awarded licence.
Italy	1996	GSM 1800	Unisource	Market research and market modelling, marketing strategy, pricing, coverage roll-out, wrote bid documents. Client withdrew because plan was not financially viable. The company that won the licence (Blu) ran into trouble and is now up for sale, thus vindicating the Unisource decision to withdraw.
Taiwan	1996	FareasTone GSM 900 & GSM 1800	AT&T Wireless	Market research, market forecasting, marketing planning, wrote marketing section of bid text. Used our Marketing Model. Client was awarded two licences, GSM 900 and 1800.
Brazil	1996/7	800 MHz	AT&T Wireless	Application for three regional licences. Market research, market forecasting, marketing modelling, working with banks on financing. Used our Marketing Model. In a sealed bid auction the client submitted bids, based on our models, which were lower than those of the winning applicant and therefore did not win the licences. Our advice turned out to be correct; the licence winners had to write down much of their investment because their business plans were too optimistic.
Mexico	1996/7	1900 MHz	AT&T Wireless	Application for the three best regional licences. Market research, market forecasting, marketing modelling. AT&T Wireless changed its strategy and decided not hand in the bid.
Argentina	1997	1900 MHz	AT&T Wireless	Market research, market forecasting, marketing modelling. Regulatory and market uncertainty meant that in the end AT&T did not submit a bid. The operators who won licences are now looking at significant write downs.

Coleago has developed licence winning bid books and pre-qualification documents

Coleago combines market research, strategic analysis and planning and business modelling to prepare high quality licence bids and pre-qualification documents which ensure success

Country	Year	Network	Client	Involvement and outcome
Belgium	1997	KPN GSM 1800	KPN	Market research and market forecast modelling modelling, including a complete marketing forecast. Client was awarded licence.
Kuwait	1997	GSM 1800	Telia Overseas	Carried out a detailed market analysis, employed the marketing model and produced a pre-bid document. Telia Overseas did not find the right partners and decided not to apply for a licence.
Ireland	1997	Eircell 1800	Eircell	Eircell, the incumbent 900 MHz operator, had to present a bid for additional spectrum. Carried out market research, forecasts, market modelling. Eircell won the additional spectrum.
Norway	1998	Telia Norway GSM 1800	Telia Sweden	Market research and market forecast modelling, development of a local mobile proposition that competes with the fixed network. Provided inputs into the bid document. Telia won the licence.
Czech Republic	1999	GSM	BT	Responsible for the financial forecast and business planning leading towards the valuation and contributions to the financial sections of the bid book.
Netherlands	2000	Telfort 3G	Telfort	Mobile Toolkit was used to build the business plan for the 3G auction. Business planning prior to auction and hand-on support throughout the multi-round auction process, continually adjusting the plan depending on bid amounts. Licence was won at reasonable price.
UK	2000	BT Wireless 3G	BT Wireless	Built custom marketing model. BT won licence in auction, after overpaying, by ignoring business plan.
Belgium	2000	BT Wireless 3G	BT Wireless	Using the Mobile Toolkit carried out an analysis of the business case. Developed marketing strategy and coverage roll-out plan. Specified and analysed market research. The results showed that a bid would be very risky and client decided not to hand in bid.

Increasingly we are advising on auction and bidding strategy

Spectrum is increasingly being awarded through auctions and a critical element of success is robust valuations for the client but also its competitors

Country	Year	Network	Client	Involvement and outcome
Canada	2001	Rogers Wireless 3G	KPN	Market research and market forecast modelling modelling, including a complete marketing forecast. Client was awarded licence.
Ireland	2002	O2 Ireland 3G licence	O2 Ireland	Marketing and financial planning, bid management, wrote sections of bid text, specified and managed market research. Used Coleago Mobile Toolkit. Client was awarded licence in beauty contest.
Sudan	2003	GSM 900/1800	SabaFon Sudan	Projected managed and provided consultancy support to the preparation of the complete bid book which was awarded highest ranking in the beauty contest.
Algeria	2003	GSM 900/1800	Wataniya International	Managed the bidding process. Provided consultancy support for the business planning process. Recommended the bid strategy and our recommendation resulted in the successful award of the licence.
Iran	2004	GSM 900/1800	MTN South Africa	Project managed the bid process and provided consultancy support on all aspects of business planning.
Maldives	2004	GSM 900/1800	Wataniya International	Provided the marketing section for bid book which resulted in the successful award of the licence.
Oman	2004	GSM	Celtel	Provided market forecasting and the marketing sections of the bid book and business plan.
Saudi Arabia	2004	GSM	MTN	Provided bidding strategy and advice to MTN for the 2nd GSM licence in Saudi Arabia
USA	2006	AWS spectrum auction	Cincinnati Bell	Business planning support, scenario planning and valuation for the US AWS spectrum auction.
Egypt	2006	GSM	Qtel	Provided project management, bid book and business case support and bidding tactics and strategy for the 3rd GSM licence in Egypt.

Our recent projects are at the forefront of the mobile market

Our most recent project is at the forefront of mobile technology and looks to the future of the mobile business in 20 years time

Country	Year	Network	Client	Involvement and outcome
Canada	2008	AWS spectrum auction	Rogers	Provided full strategy and business planning support, valuation analysis and bid strategy in the 2008 AWS 2100MHz spectrum auction.
India	2008	3G and WiMax	Telenor	Provide full market forecasting, market entry strategy and technology assessments in relation to the value of spectrum in India across the 22 telecoms circles.
United Kingdom	2009	2.6 GHz	Operator	Strategy, market forecasting, technology assessment modelling and valuation of 2.6GHz spectrum in the UK across a range of scenarios.; bid strategy and advice, workshops and simulations for the auction.
Poland	2009	2.6 GHz	Operator	Business planning support and business case review. Auction strategy.
Thailand	2009	2.1 GHz	DTAC	Strategy, market forecasting, technology assessment modelling and valuation of 3G spectrum with several scenarios and assumptions. Strategic advice on future concession structures.
Ukraine	2009	2.1 GHz	Kyivstar	3G spectrum valuation for client and competitor valuations; affordability study of mobile broadband. Different blocks were not available concurrently, the valuation differed by timing availability.
Ireland	2009	900MHz re-farming	O2 Ireland	Business and technology strategic review, full market, technology and financial forecasting and valuation. Advice on regulatory strategy and spectrum valuation and auction strategy
India	2010	BWA	Tata Comm.	Review valuation and auction strategy advice, on site bid support through out the auction.
Australia	2010	2.1 GHz renewal	SingTel Optus	Valuations under different scenarios to enter into negotiation with government for spectrum licence renewal.

Our recent projects dealt also with refarming and spectrum licence renewal

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Contact



Stefan Zehle, MBA
CEO, Coleago Consulting Ltd

Tel: +44 7974 356 258
stefan.zehle@coleago.com



Graham Friend, MA
Managing Director, Coleago
Consulting Ltd

Tel: +41 79 855 1354
graham.friend@coleago.com



Scott McKenzie, BE, MBA
Director, Coleago Consulting Ltd

Tel: +44 7825 294 576
scott.mckenzie@coleago.com

Further information: www.coleago.com