

Expertise in spectrum issues

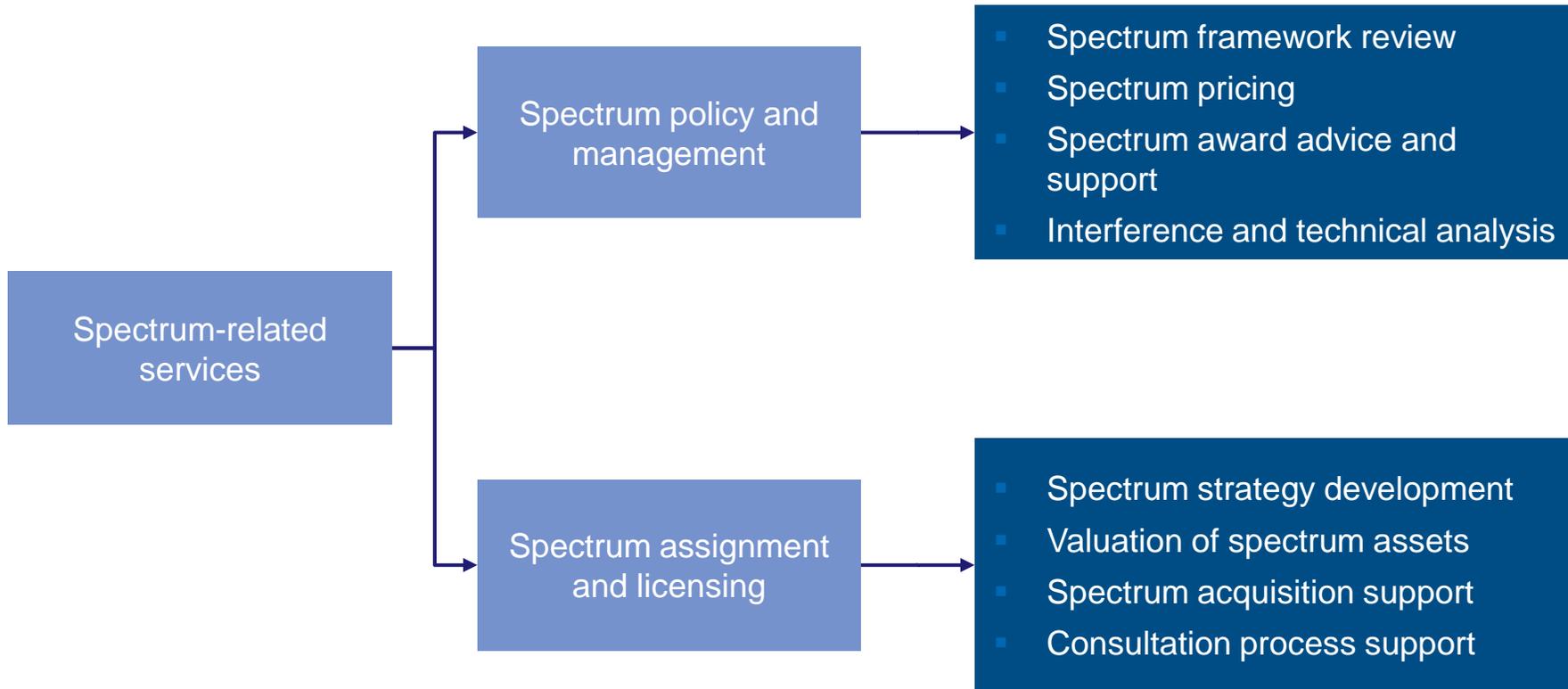
Contents

Our spectrum services

Our experience

Industry commentary

We offer support on spectrum management, assignment and licensing issues to regulators and spectrum users



We offer a range of spectrum management services to regulators and government bodies dealing with spectrum regulation

Spectrum framework review

- Spectrum management strategies, including:
 - spectrum trading and liberalisation
 - spectrum awards
 - re-distribution of spectrum
- Strategy implementation, development of processes and roadmaps
- Estimate of spectrum requirements

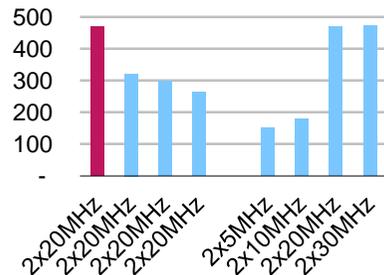
Example output: award roadmap



Spectrum award advice and support

- Development of award policies
- Assessment of economic benefit generated by candidate uses
- Design of auction and licence conditions, including:
 - number of licences
 - spectrum packaging
 - licence obligations
 - reserve price
- Marketing of licences

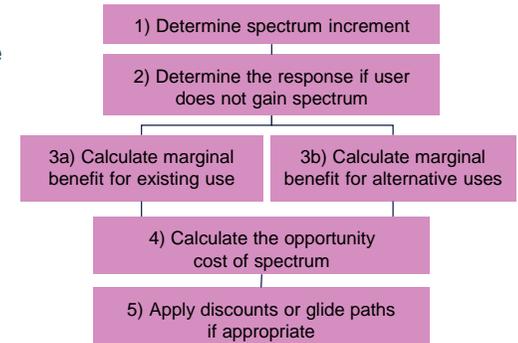
Example output: value of different amounts of new spectrum under different market assumptions



Spectrum pricing

- Development of frameworks for spectrum pricing
- Identification of appropriate bands for Administrative Incentive Pricing (AIP)
- Calculation of the opportunity cost of spectrum bands
- Implementation of AIP:
 - e.g. setting glide paths

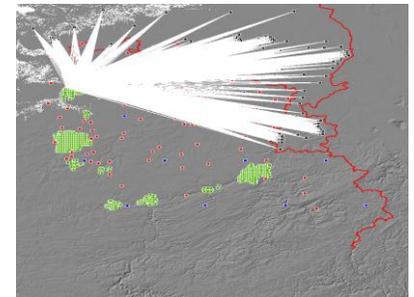
Example output: approach



Interference and technical analysis

- RF link budget analysis
- Radio coverage prediction
- Interference modelling:
 - including deterministic and Monte-Carlo modelling
- Assessment of measures to mitigate interference issues
- Cross-border co-ordination (e.g. ITU-R GE-06)

Example output: Base station to base station interference

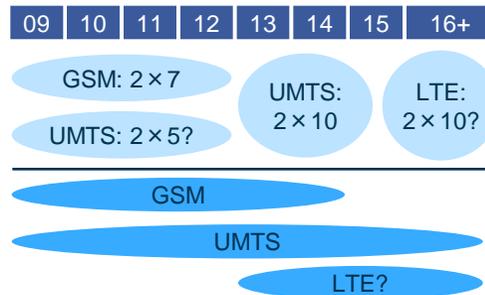


We help spectrum users to understand their spectrum needs and then acquire that spectrum

Spectrum strategy development

- Assessment of spectrum requirements
- Review of regulatory landscape
- Assessment of competitor requirements
- Assessment of wireless technologies
- Development of strategy for spectrum acquisition

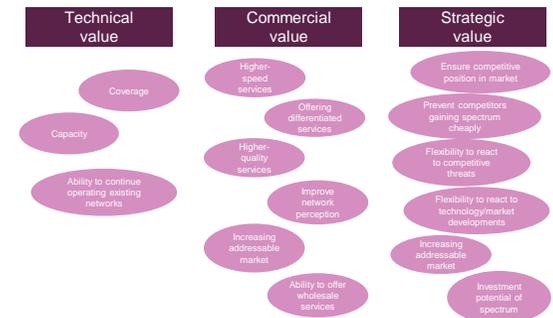
Example output: spectrum demand



Valuation of spectrum assets

- Bidder valuation modelling: *Example: sources of spectrum value*

- relative value of different bands
- value for different amount of spectrum
- how value varies between lots

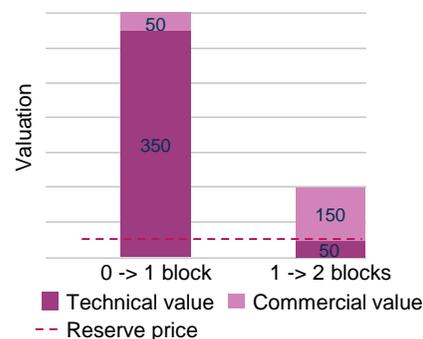


- Valuation of competing bidders' valuations
- Global benchmarking of spectrum auction prices

Spectrum acquisition support

- Business case development
- Project management of licence applications
- Drafting and delivery of application documents
- Assessment of licence conditions and regulatory environment
- Design and running of mock auctions

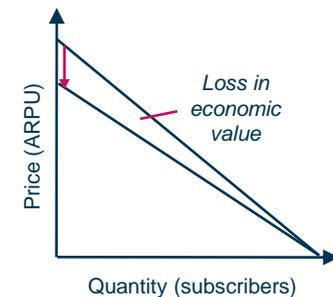
Example: spectrum valuation



Consultation process support

- Review of regulatory consultation documents and auction rules
- Assessment of optimal response strategies
- Development of economic arguments to support consultation responses
- Drafting and editing of consultation responses

Example: economic analysis



The most significant allocation processes at present fall into three areas of the radio spectrum



Re-allocation of UHF spectrum

- UHF spectrum currently used for analogue TV is potentially valuable for a wide range of uses
- Digital switchover frees up significant capacity, called the 'digital dividend'
- There are two alternative band plans: 700MHz (698–806MHz) and 800MHz (790–862MHz)
- Regulators need to decide:
 - the balance of spectrum required between broadcasting and mobile
 - how to award the 700/800MHz band

2G spectrum re-farming

- Historically, the 900MHz and 1800MHz bands have been reserved for 2G services
- There is a market need to migrate legacy 2G services to HSPA/LTE:
 - 900MHz – to offer mobile broadband in rural areas
 - 1800MHz – to provide capacity for high-speed mobile broadband
- Regulators need to decide:
 - how to liberalise existing licences
 - how to award/reallocate 2G spectrum upon licence expiry

Award of the 2.6GHz band

- The 2.6GHz band was identified as IMT expansion spectrum by the ITU at WRC-2000
- The harmonized band plan for mobile broadband use of the 2.6GHz band has 2 × 70MHz of paired spectrum plus a 50MHz unpaired centre block
- This band plan has been adopted by many regulators:
 - e.g. Sweden, Germany, Denmark, Austria
- However, other regulators may choose different band plans:
 - some countries have MMDS or other existing services to protect

Different countries are following different approaches to allocating new mobile spectrum in particular, as demonstrated in Europe

Germany and Switzerland using a 'big bang' approach	The UK will auction 800MHz and 2.6GHz spectrum	France and Belgium first introduced a new entrant
<ul style="list-style-type: none"> ▪ BNetzA awarded 360MHz of spectrum in four bands in Germany: <ul style="list-style-type: none"> – 800MHz – 1.8GHz – 2GHz – 2.6GHz ▪ All licences were aligned (valid until December 2025) ▪ Spectrum below 1GHz: <ul style="list-style-type: none"> – was capped at 2 × 20MHz per operator, taking into account previous 900MHz allocations – has rural coverage obligations for the 800MHz band ▪ Spectrum above 1GHz was not capped and had less stringent coverage obligations ▪ The Swiss government will auction all available mobile frequencies via a single award (800, 900, 1800, 2100, 2600MHz) 	<ul style="list-style-type: none"> ▪ The UK will allow existing 2G licence holders to retain existing 900MHz and 1800MHz spectrum and use for 3G/4G ▪ There are also plans to extend the 2.1GHz licences indefinitely ▪ The UK plans to auction new 800MHz and 2.6GHz licences via a single award: <ul style="list-style-type: none"> – 2 × 30MHz of 800MHz and 2 × 70MHz of 2.6GHz paired spectrum, along with 50MHz of 2.6GHz unpaired ▪ Spectrum floors and spectrum caps are proposed: <ul style="list-style-type: none"> – minimum spectrum portfolios for four national competitors – safeguard cap on total sub-1GHz spectrum, and on overall holdings 	<ul style="list-style-type: none"> ▪ A fourth 3G licence was awarded in Belgium to use 2 × 15MHz of 2.1GHz spectrum, with an option to take up reserved 900MHz and 1800MHz spectrum in future ▪ Available 2.1GHz spectrum was split into three lots of 2 × 5MHz in France ▪ One block was reserved for a new entrant and was won by Free, which was also granted additional spectrum in the 900MHz band <ul style="list-style-type: none"> – the remaining 2 × 10MHz was then auctioned, and SFR and Orange were each awarded 2 × 5MHz ▪ Following the new entrant award, the French government has published proposals for award of 2.6GHz and 800MHz spectrum, with the intention to assign spectrum in the 2011–2012 financial year

Contents

Our spectrum services

Our experience

Industry commentary

Our recent track record spans the range of key issues at the top of operators' and regulators' agendas

Category	Examples of recent projects
Digital Dividend	<ul style="list-style-type: none"> Studies for the regulators and governments in Singapore, the UK, France and the Netherlands on alternative uses of the Digital Dividend Preparation of lobbying positions and arguments for Malaysian mobile operator on allocation of Digital Dividend spectrum for mobile broadband Study for the European Commission to assess options for European co-ordination of approaches to the Digital Dividend
GSM re-farming	<ul style="list-style-type: none"> Support for a Malaysian mobile operator on responding to consultation on spectrum re-farming and assignment of 2.6GHz spectrum Support for a Western European operator with valuation of 900MHz spectrum and response to a government consultation on re-farming Study for the UK regulator (Ofcom) and two other Western European regulators to assess options for liberalising 900MHz and 1800MHz bands Assistance to a private equity client in establishing the value of 900MHz spectrum for a European mobile operator
Spectrum acquisition	<ul style="list-style-type: none"> Support for a Thai mobile operator on lobbying key issues on 3G licensing and in preparing the prequalification submission for participating in the auction
Spectrum trading	<ul style="list-style-type: none"> A study on the implementation of spectrum trading in an Asian country Study on the issues associated with the introduction of a secondary market in spectrum across Europe for the European Commission Valuation of 800MHz spectrum holdings in the USA (for the seller) and 3.5GHz spectrum in the UK (for a potential buyer)
Spectrum pricing	<ul style="list-style-type: none"> Study for Ofcom on the opportunity cost and recommended administered incentive pricing (AIP) levels for PMSE Study for Ofcom on the opportunity costs for business radio spectrum in VHF Band I
Future spectrum demand	<ul style="list-style-type: none"> A study for Singapore regulator on key mobile industry trends, including an assessment of future spectrum demand Forecast demand for mobile spectrum on behalf of a major cellular industry organisation Assessment of future spectrum demand below 15GHz on behalf of the UK government
Digital switchover	<ul style="list-style-type: none"> Analogue to digital television switchover strategy advice for a regulator in the Middle East
New technology economic assessments	<ul style="list-style-type: none"> Economic cost/benefit analysis of potential introduction of UWB technologies for Ofcom Study for major cellular industry organisation on demand and future prospects for LTE

The next few slides provide case studies for some of our recent projects in key spectrum issues

Digital dividend

Client	Year	Summary
European Commission	2009	A high-profile study to investigate the benefits of European digital dividend co-ordination
ARCEP (French regulator)	2008	Economic analysis of different allocations of digital dividend spectrum in France
E-Plus	2010	Valuation support for E-Plus ahead of the 'big bang' auction in Germany
Asian Pacific regulator	2010	Study on allocation of digital dividend spectrum

- ← Case study 1
- ← Case study 2
- ← Case study 3
- ← Case study 4

2.6GHz awards

Client	Year	Summary
KPN	2008–10	Supported KPN to value 2.6GHz spectrum in the Netherlands, prepare for the auction (auction strategy, auction procedures) and then bid in the auction itself
Asian mobile operator	2009	Advised a company wishing to bid in the 2.3/2.6GHz auction in Hong Kong on valuation and bid strategy
NITA	2009/10	Supported the Danish regulator to design the award process for auction of the 2.6GHz band

- ← Case study 5
- ← Case study 6
- ← Case study 7

2G re-farming

Client	Year	Summary
European mobile operator	2009	Development of scenarios for future use of 900MHz frequencies to assist the operator in responding to the regulator's consultation proposals
South East Asian mobile operator	2010	Support on responding to a regulatory consultation on spectrum re-farming

- ← Case study 8
- ← Case study 9

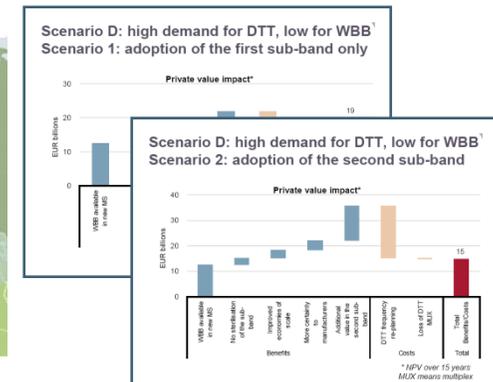
Case study 1: A study for the European Commission on a coordinated approach to the digital dividend

The problem

- EU Member States were planning or in the process of switching over from analogue TV signals to digital, freeing up a significant amount of spectrum (primarily in the UHF band), the so-called 'digital dividend'. This was a unique opportunity to realise economic/social benefits across Europe, due to:
 - the superior propagation characteristics of the UHF band and the amount of spectrum that is potentially available
 - the wide range of potential uses of the spectrum (SD/HD DTT, cellular/wireless broadband, broadcast mobile-TV networks, low-power uses)
 - the potential role this spectrum could play in creating economic growth and new employment opportunities across Europe
- However, there is a risk that the actions of individual Member States could have a negative effect on the interests of others, although there could be an overall gain in welfare if there was co-ordinated action at EU level over future use of the digital dividend
- The European Commission appointed Analysys Mason, together with consortium partners DotEcon and Hogan & Hartson, to ascertain what action needed to be undertaken at EU level to ensure that the benefits of the digital dividend are maximised

The solution

- This project involved:
 - conducting an inventory of the situation in each Member State regarding the digital dividend
 - carrying out analysis to understand the demand for the spectrum as well as the social and economic value of potential users
 - reviewing technical issues, such as technology trends, interference issues
 - developing a range of scenarios for a co-ordinated EU approach, and a cost/benefit analysis of each approach
- A significant input was consultation with stakeholders: the study involved various consultation events



The result

- The output of the study included a final recommendation for a co-ordinated approach along with a proposed roadmap for implementation. This informed the [EC's public consultation](#) on digital dividend, as well as the EC 800MHz Decision

Case study 2: For ARCEP, economic analysis of different allocations of digital dividend spectrum in France

The problem

- ARCEP required an in-depth legal and economic analysis of the digital dividend spectrum and its value, to inform policy-making in France
- Analysys Mason and Hogan & Hartson assisted ARCEP in:
 - defining precisely the digital dividend in the context of French law, and drawing on experience in other markets
 - providing an economic valuation of the digital dividend according to its use: should it only be allocated to media services or should it be shared between electronic communications and media services?

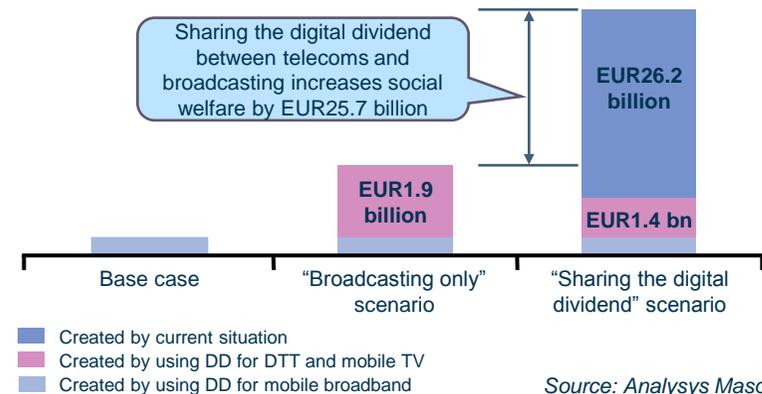
The solution

- The study qualified and quantified the key alternative uses of the digital dividend frequencies:
 - focusing in particular on fixed and mobile broadcasting, and broadband wireless communications
- We developed realistic scenarios based on interviews with key stakeholders in France, as well as on economic and technical modelling:
 - we conducted economic valuation at the micro- and macro-economic levels
- Our economic analysis was complemented by Hogan & Hartson's legal analysis of the situation in France, and by an international benchmark to analyse use of the digital dividend in major OECD countries that had already taken a position on this subject

The result

- Our analysis provided crucial information to ARCEP and policy-makers in France in reaching a decision on the digital dividend. Indeed, the Parliament Commission advising the Prime Minister on digital dividend has used and quoted our report extensively:
 - the decision needs to be made quickly, as any delay will significantly affect the benefits to the economy and society
- The conclusions that we reached facilitated robust and rapid decision-making:
 - there is enough room to share the released spectrum between telecoms and broadcasting services
 - sharing the spectrum in such a way would be highly beneficial to the French economy, potentially increasing GDP by EUR25 billion

Social welfare created over 2012–2024



Case study 3: Spectrum strategy and valuation advice for E-plus in preparing for the German ‘big bang’ auction

The problem

- German regulator BNetzA designed a “big bang” auction, to award a total of about 360MHz in four bands – 800MHz, 1800MHz, 2.1GHz and 2.6GHz
- E-Plus was looking to complement its existing spectrum holdings in the 900MHz, 1800MHz and 2.1GHz range
- A key challenge for E-Plus was that the largest operators in the market (T-Mobile and Vodafone) were granted generous spectrum caps. This meant that competition for spectrum in the 800MHz band would be strong. Therefore E-Plus needed to clearly understand the incremental value of 800MHz spectrum over higher frequencies, and at what price differential it should opt for higher frequencies rather than 800MHz spectrum

The solution

- We assisted E-Plus in its spectrum valuation:
 - we reviewed its valuation approach and model
 - we developed a competitor analysis based on the existing valuation model
- We assisted E-Plus in the final stages of its auction preparation:
 - we provided inputs to internal presentations and management meetings
 - we had regular on-site meetings with auction team members to assist the decision-making process
 - we were also available for ad-hoc advice on all matters concerning E-Plus’s approach to the auction

Valuation of different lots in a specific band by competitors



The result

- In the final stages of its preparation for this complex auction process, E-Plus benefited from our previous auction expertise. We were able to validate E-Plus’s approach to valuing different spectrum lots and also provided input on key decisions concerning E-Plus’ auction strategy
- Ultimately, E-Plus won 2 × 30MHz of paired spectrum (about 20% of the total paired spectrum provided) but only paid EUR284 million. This represented just 6% of the total auction fees and was over EUR1 billion less than the amount paid by either of E-Plus’s competitors
- Although E-Plus did not gain access to any spectrum in the 800MHz range, it now holds 2 × 20MHz of contiguous spectrum in the 1800MHz and 2.1GHz bands, enabling it to offer the highest-speed mobile data services in these frequency ranges

Case study 4: Recommendations to an Asian–Pacific regulator on the allocation of digital dividend spectrum

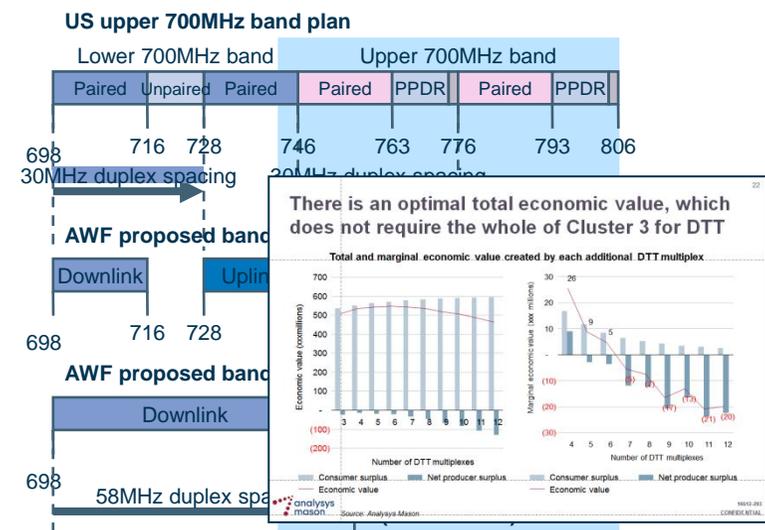
The problem

- The regulator of a small developed Asian country required a detailed socio-economic impact analysis of different allocation scenario of its digital dividend, which will be available from 2015
- Analysys Mason drew on its expertise to conduct in-depth research into the range of uses for the digital dividend that our client may consider, and recommended allocation principles under a range of scenarios, guiding the client in its subsequent policy decisions

The solution

- The study qualified and quantified the key alternative uses of the digital dividend frequencies:
 - focusing in particular on broadcasting and wireless broadband services for both commercial and public safety uses
- We developed scenarios based on demand and supply constraints, for which we conducted detailed economic and technical modelling:
 - we took explicit account of international coordination drivers and constraints in the country: alignment with the wider Asia-Pacific region, yet is constraints by its immediate neighbours
 - we conducted economic valuation of the spectrum, both from the perspective of the regulator and of potential users
 - we issued a comprehensive set of recommendations on the management of the band, which our client will use as an input into its decision-making process
- As part of the study, we also conducted detailed research into the evolution of technology and regulatory frameworks for the use of ‘white spaces’ and their applicability to the country

Proposed band plans for the 700MHz band



The result

- Our analysis identified a range of options for spectrum allocation, and their contingency to international development
- In particular, we identified one particularly beneficial outcome for all stakeholders in the country; our client subsequently retained Analysys Mason to support its efforts in bringing about the conditions necessary to the possible realisation of this outcome, and these efforts are still ongoing

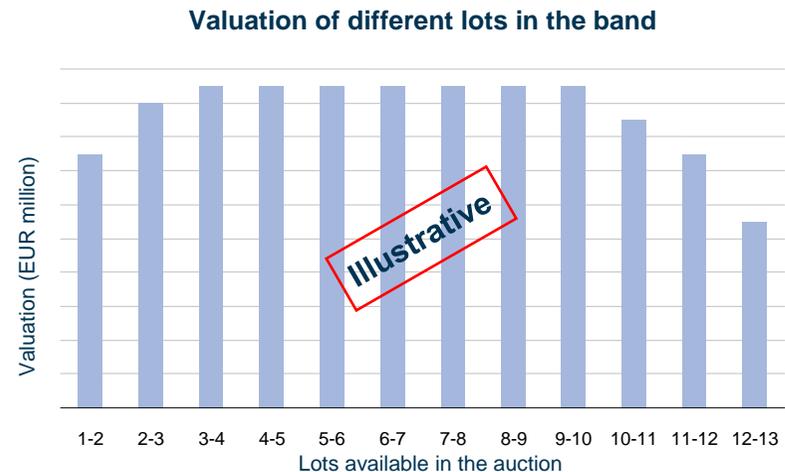
Case study 5: Support for KPN in the 2.6GHz auction in the Netherlands

The problem

- KPN wished to acquire spectrum in the Dutch 2.6GHz auction held in April 2010. The objective was to gain sufficient spectrum to support its future deployment of mobile broadband services
- The auction design chosen by the regulator was a complex two-stage process: a multi-round clock auction to determine how many lots each bidder won, followed by a single-round sealed bid to determine which exact frequencies would be awarded to each bidder
- The auction was further complicated by unusual spectrum caps that limited KPN to $2 \times 10\text{MHz}$ and ensured there would be at least two new entrants

The solution

- We supported KPN throughout its preparations for the auction:
 - we reviewed KPN's valuation approach and model
 - we calculated the differences in valuation between the different spectrum lots available (see chart to the right)
 - we valued the spectrum from the perspective of a WiMAX operator
 - we provided inputs for its response to the regulator's consultation
 - we developed an optimal auction bidding strategy for KPN
 - we developed auction processes and governance structure
- We also provided on-site support to KPN during the auction itself:
 - as the auction developed we provided ad-hoc auction bidding strategy and valuation advice



The result

- Throughout the auction KPN benefited from our experience of 2.6GHz auctions, meaning that it was constantly well informed and prepared. For example, at one stage we were able to calculate the minimum amount that KPN needed to bid in order to guarantee winning the lots it required
- Ultimately, KPN won $2 \times 10\text{MHz}$ (the maximum amount it could win) in its preferred location within the band (away from the edges of the band) for less than EUR1 million. This was an excellent result for KPN, as it was orders of magnitude below prices paid in other European 2.6GHz auctions, and KPN can deploy its network free from interference issues at the edges of the band

Case study 6: Advice to an operator bidding in Hong Kong's 2.3/2.6GHz auction

The problem

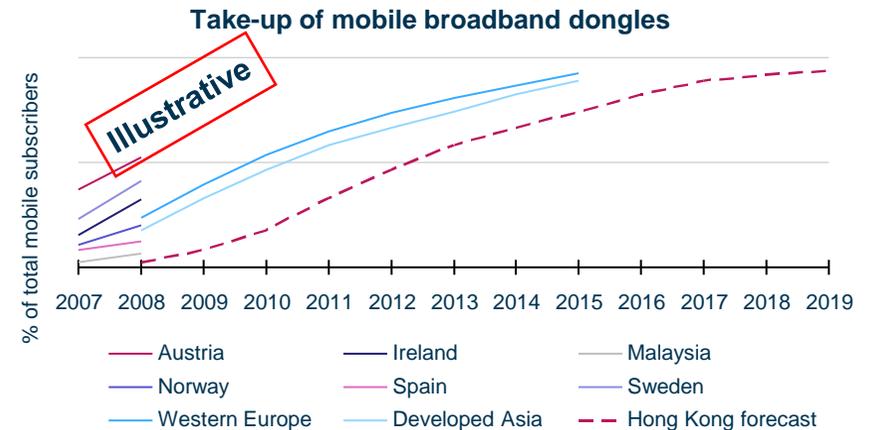
- Our client wished to bid for one of three blocks of paired 2.6GHz spectrum auctioned in Hong Kong in January 2009, so that it could offer LTE mobile services in the future
- Unlike previous spectrum awards in Hong Kong, the auction was expected to be highly competitive. Our client therefore wanted to know what value other approved bidders were likely to place on the paired spectrum, and how to bid effectively in the auction design specified by the regulator (a simultaneous multi-round clock auction with an optional final round of sealed bids)

The solution

- We built a discounted cashflow model for each of the other approved bidders to estimate the value of a block of paired spectrum to them, taking account of their relative market positioning, market share and estimated cost structure. Since 2.6GHz spectrum is expected to be used for advanced data services, our understanding of the evolution in demand for broadband 'dongles' and smartphones was a key input
- We also undertook international benchmarking of the prices paid in other 2.6GHz and LTE / 3.5GHz auctions
- Based on these two workstreams we estimated the closing prices for the auction
- Our partners, Empiris LLC, provided detailed advice on bidding tactics and ran a number of internal mock auctions so that the client could see how different approaches would play out in practice. Empiris continued to provide advice throughout the actual auction

The result

- Our work enabled the client's bid team to secure prior approval from the company board to bid up to a realistic sum of money and gave it confidence in its bidding strategy
- The client ultimately won a block of paired spectrum at a price that was similar to the closing price estimated by Analysys Mason



Case study 7: Advice to the Danish regulator on the award of the 2.6GHz band

The problem

- NITA wished to auction the 2.6GHz band (and 2010–2025MHz) with the objective of maximising the economic and social benefits to Denmark
- Key aspects to be considered included: the likely level of demand for the spectrum, how it should be packaged, constraints on use of the spectrum due to international harmonisation/restrictions, what the licence conditions should be, and what auction format would produce an efficient outcome
- In conjunction with our partner DotEcon, Analysys Mason managed the auction process for NITA, from design of the licences and auction format through to the execution of the auction

The solution

- During the project the Analysys Mason/DotEcon team:
 - assessed likely market demand for the spectrum, including:
 - identifying candidate uses and technologies
 - identifying technical constraints in use of the spectrum
 - identifying potential bidders
 - assessing the business cases for potential bidders
 - determined the licence terms, including packing of the licences, coverage obligations, duration and payment terms
 - marketed the licences in order to ensure interest
 - designed the auction model
 - drafted the Information Memorandum and consultation documents
 - executed the auction using an electronic auction tool

Result of the Danish 2.6GHz auction

Bidder	Paired spectrum	Unpaired spectrum	Price (DKK million)	Price (EUR million)
TDC	2 × 20MHz		333.3	44.8
Hi3G	2 × 10MHz	25MHz	7.1	1.0
Telia	2 × 20MHz	10MHz	336.3	45.2
Telenor	2 × 20MHz	10MHz	333.3	44.8
Total			1010	136

The result

- Our work produced a cutting-edge auction design that addressed NITA's objective of maximising economic and social benefit
- Industry stakeholders were consulted at numerous points during the process and their feedback was incorporated into the auction design, thus producing an auction design that was widely accepted
- The auction proved to be a competitive auction and produced what is widely viewed as an efficient outcome

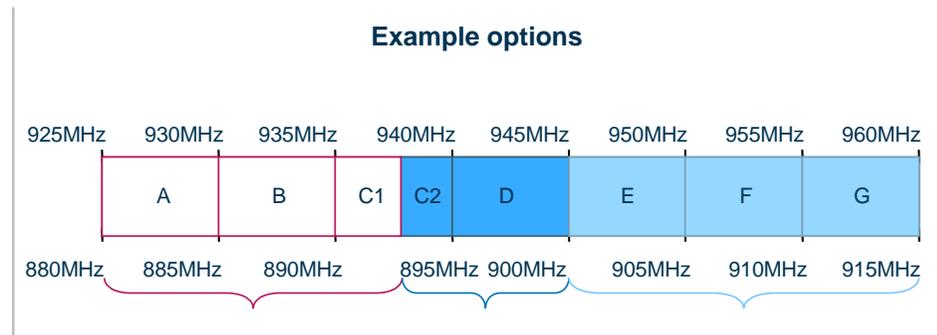
Case study 8: Scenarios for future use of 900MHz frequencies in a Western European country

The problem

- Following publication of national regulatory proposals for liberalising 900MHz and 1800MHz frequencies, which set out alternative options for re-awarding part of the GSM 900 band, we were asked to advise an incumbent 900MHz operator on the impact of each option on its future business plans
- We were commissioned to assess the alternative options being proposed by the regulator, to assist the operator in responding to the regulator's consultation proposals

The solution

- We assessed the two main options being proposed by the regulator and developed scenarios which the operator might face under each option, to compare their advantages and disadvantages
- We then assessed the financial implications of each option for the operator, and considered what strategies other operators might adopt in response to each option
- Our overall assessment was presented in a workshop to the operator, and we prepared a final report that took account of discussions with the operator at the workshop



The result

- Our client benefited from a clear examination of the national regulator's consultation proposals, possible outcomes, and the impact on future capital and operational expenditure

Case study 9: Support to a mobile operator in a major South-East Asian country on spectrum re-farming

The problem

- The national regulator issued a consultation to the industry on a proposed big auction of spectrum, including 850/900MHz bands as well as 1800MHz and 2.6GHz
- We were appointed by an existing 850/900MHz licence holder wishing to determine its overall spectrum strategy
- The operator was seeking external advice in relation to preserving its current assignments as well as to identify future spectrum needs, to assist in responding to the regulator’s proposals

The solution

- We assessed the three main areas of change being proposed by the regulator and developed key issues for each from the operator’s perspective to respond to the regulator’s consultation
- We then assessed the key questions that the operator should raise with the regulator, including clarification on proposed spectrum caps, position on secondary market trading, coverage obligations, and plans for release of other mobile bands (e.g. 700MHz)
- Our overall assessment was presented in a report to the operator, including elements of response from the operator to the regulator

Example analysis

Area of change	Proposed changes	Impact
1 Coverage obligations	2.6 GHz obligations should reflect the limitations of the spectrum as well as its availability	In most geographic areas, the cell radius of a 2.6GHz site will not exceed 750m to 1km, affecting population coverage relative to other bands
2 Band planning	Compatibility with international standards should be ensured	Achieving a band plan compatible with international standards is critical to ensuring network equipment and end-user devices are available quickly and cheaply
3 Auction design	The auction must be designed to ensure bidders can have access to large contiguous blocks of spectrum	LTE is the most likely technology to be deployed in the 2.6 GHz band, and this requires 20MHz carriers to deliver maximum performance

The result

- Our work gave the operator a thorough understanding of issues relating to re-farming of 850/900MHz and 1800MHz spectrum, currently used for 2G services, as well as the assignment of new spectrum in the 2.6GHz band
- We proposed a holistic approach to overall spectrum strategy for the operator, considering the broader implications of availability of all sub-1GHz mobile bands in the market as well as capacity requirements in bands above 1GHz

We have advised regulators throughout the world on a wide range of other spectrum issues

Category	Recent relevant experience	Our achievements
Spectrum framework review	<ul style="list-style-type: none"> BIPT spectrum strategy review (2009) EC spectrum trading study (2004) Ofcom mobile spectrum liberalisation (2005) 	<ul style="list-style-type: none"> Assisted the Belgian regulator to review spectrum policies for frequencies between 790MHz and 3400MHz Detailed set of recommendations and action plan for the Commission to take forward; raised awareness of spectrum trading and liberalisation issues across the European Union Assessment of the impact of allowing spectrum not currently used for mobile services to be used for mobile services, and the impact and options for liberalising existing 2G spectrum
Spectrum award advice and support	<ul style="list-style-type: none"> Ofcom Band III/L-Band award options (2005) Ofcom award options for selected bands (2005) Asian 3G assignment options (2003) Second GSM licence in the Middle East (2003) 	<ul style="list-style-type: none"> Developed recommendations on allocation of spectrum to T-DAB, PMR and other uses, based on an assessment of economic benefits and other constraints Study on the allocation options for the bands 410–415/420–425MHz, 872–876/917–921MHz, 2010–2025MHz and 2290–2302MHz Quantitative economic assessment of approaches to awarding 3G licences Recommendations on the number of licences, valuation and supporting regulatory policies
Spectrum pricing	<ul style="list-style-type: none"> AIP for PMSE spectrum for Ofcom (2009) Opportunity cost for Band I for Ofcom (2009) 	<ul style="list-style-type: none"> Study to calculate the opportunity cost and recommend administered incentive pricing (AIP) levels for PMSE spectrum A study to determine the opportunity costs for business radio spectrum in VHF Band I
Interference analysis	<ul style="list-style-type: none"> Ofcom 2.6GHz interference analysis (2006) Ofcom assessment of interference in L-Band (2005) WiMAX/HSPA cross border coordination (2008) 	<ul style="list-style-type: none"> Impact on mobile network deployment in the 2.6GHz band of radio astronomy usage in adjacent spectrum Assessment of the international interference restrictions on future users of the L-Band, as well as identifying mitigating measures Assessment of field strength threshold values for regulatory coordination of WiMAX and LTE systems in the 2.6GHz band in Europe
Other spectrum issues	<ul style="list-style-type: none"> Review of UWB for Ofcom (2004) Digital switchover strategy (2010) 	<ul style="list-style-type: none"> Economic cost/benefit analysis of potential introduction of UWB Development of a strategy in relation to switchover from analogue to digital terrestrial broadcasting for a Middle Eastern regulator

In addition, we regularly advise users of radio spectrum on a wide range of issues

Category	Recent relevant experience	Our achievements
Spectrum acquisition support	<ul style="list-style-type: none"> Combined auction of 800MHz and 2.6GHz spectrum in Poland (2010) Hong Kong 2.6GHz auction support (2009) North African GSM licence application (2009) Canadian AWS auction support (2008) Middle East mobile licence applications (2007–2008) Egyptian mobile licence application (2006) European UMTS beauty contest support (2005) Asian 3G business plans (2000–2002) European 3G licence auction support (2010) 	<ul style="list-style-type: none"> Support for a Polish mobile operator to prepare for a combined auction of 800MHz and 2.6GHz spectrum Support for a bidder in the 2.3/2.6GHz auction in Hong Kong on valuation and bidding strategy For a fixed and 3G mobile operator in North Africa, assistance in producing a 2G GSM licence application Support to a global telecoms operator with valuation of spectrum and strategy in Canadian AWS auction Support to operators with applications for new mobile licences in Kuwait and Qatar Support to Middle Eastern operator with acquisition of third mobile licence in Egypt including preparation of technical application and business plan Support to a fixed operator managing a beauty contest application for a UMTS mobile licence in a Western European country Developed detailed 3G business plans for operators in Malaysia, Taiwan, Singapore and Hong Kong, and (where relevant) provided auction support, leading to licence acquisition Valuation work and auction process analysis for a mobile operator ahead of a 2.1GHz spectrum auction in a major Western European country
Valuation of spectrum assets	<ul style="list-style-type: none"> Spectrum price benchmarking (2008) US 220MHz valuation (2008) WiMAX spectrum valuation (2007) US 220MHz valuation (2006) WiMAX spectrum valuation (2005) US 800MHz valuation (2003) 	<ul style="list-style-type: none"> Review of spectrum auction prices across the world for a major global mobile operator Valuation of 220MHz spectrum for US railroad companies looking to make a purchase Spectrum valuation for a East European WiMAX operator looking to raise finance Valuation of 220MHz spectrum in the USA on behalf of a financial organisation Valuation of WiMAX spectrum on behalf of a major UK telecoms operator 800MHz spectrum valuation in the USA for a major global organisation
Other spectrum issues	<ul style="list-style-type: none"> Global spectrum forecast (2006) Review of spectrum trading implications (2005) Band management options (2010) 	<ul style="list-style-type: none"> Forecast cellular spectrum demand for 2010–2020 for the UMTS Forum Identified opportunities and threats for a major mobile operator arising from the potential introduction of spectrum trading in a Western European market Identified options for a Western European regulator for spectrum band management

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The digital dividend in Europe: Urgent action is needed by each Member State

In every country in Europe, the switch-over from analogue to digital television will free up UHF spectrum, at frequencies below 1GHz. Consequently this spectrum, which has become known as the 'digital dividend', will be reallocated.

The decisions relating to this reallocation process are to be taken by each Member State, taking into account national circumstances as well as international context – in particular the identification by the 2007 World Radiocommunication Conference (WRC-07) of a sub-band between 790MHz and 862MHz for electronic communication services. Additionally, the European Commission has expressed in several reports its wish to see a homogeneous approach by Member States to the reallocation of the digital dividend; definitive guidelines are expected by the end of 2008.

It is widely recognised that the digital dividend is a complex and important issue that will have significant impact on the industry over a long period of time (probably 15–20 years). For instance, Eric Besson (Secretary of State in France, in charge of development of the digital economy) recently stated in front of the European Parliament that: "if Europe manages to co-ordinate properly with regard to the digital dividend, as it did for GSM, it will be in front of an historical opportunity ...".

The sooner decisions are taken by a Member State to reallocate spectrum and definitive plans are created for effective implementation, the more beneficial the impact on that country.

Clear decisions and plans will also provide visibility to industry players such as broadcasters, telecoms operators and network equipment or terminal manufacturers. Decisions made in particular countries may also contribute to achieving a critical mass of users in Europe for specific services in specific frequency bands. This would create economies of scale which could, in particular, speed up the availability of network equipment, devices and handsets, increase the diversity of such products, and reduce prices.

In this context, fully harmonised decisions across Europe are desirable. However, in practice it appears that each country is unique in a number of ways, including geography, expected benefits to society, culture, legal compliance, current access to TV programmes (through DTT/cable/satellite/IPTV) and associated service take-up, current allocation of spectrum, interference issues with neighbouring countries and the status of the analogue switch-off and digital switch-over process. As a result, a focused debate is needed in each country, with a co-ordinated approach at the European level, leading to appropriate decisions that will maximise benefits and value creation throughout Europe.

Progress being made in Europe should be analysed in relation to what is happening in the USA. There, discussion of re-use of the UHF band began in 1997, it was adopted as law in 2001, and spectrum was awarded progressively until early in 2008. As a result, the USA currently provides better visibility to the industry than does Europe, which may have an impact on business development priorities for international players. Hence, if not adopted in Europe, a planned and unified approach could, to some extent, be seen as the USA's comeback to Europe's success with GSM.

900MHz re-farming: the effects of delay

The GSM directive currently stipulates that 900MHz frequencies must be reserved for GSM networks in Europe. It is expected that this legislation will be lifted, which will enable these valuable frequencies to be re-farmed for emerging UMTS 900MHz deployments.

The anticipated benefits of using 900MHz for UMTS deployments include lowering the cost of deploying UMTS and mobile broadband services in less populated, rural areas, and improving in-building signals. These benefits could be realised by incumbents, new operators or recent entrants across Europe.

However, there are two aspects of market evolution that will determine the benefits generated from early re-farming: whether 3G voice and mobile broadband becomes a nationwide proposition, and whether there is a rapid migration of subscribers, handsets and voice traffic to UMTS networks (and subsequent rationalisation of the old GSM networks).

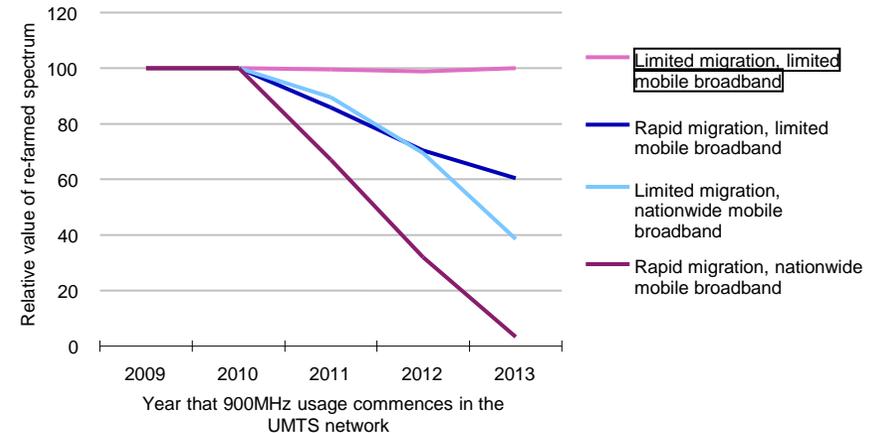
If re-farming is delayed, any gains would be significantly diminished. For mobile operators, this could impact in three ways.

They would be required to make extra investments to deploy their networks at 2100MHz, without being able to rely on long-term access to the more cost-effective, re-farmed 900MHz spectrum.

They would have to limit the extent of mobile broadband deployment, focusing on cities and dense suburban areas and neglecting areas of lower population density. Mobile operators would also have to delay their migration to 3G and operate overlapping GSM and UMTS networks in parallel for longer.

The figure opposite shows the relative values of re-farmed spectrum, estimated using a generic cost model of a mobile operator.

In the situation of rapid migration to 3G combined with the early roll-out of nationwide mobile broadband, delays to 900MHz re-farming will be costly. The value of having unrestricted access to this spectrum reduces rapidly by 97% for delays during the three years in which rapid network evolution occurs



If the evolution of the mobile network is slower – with either limited migration or limited mobile broadband service availability – early re-farming would still be important, but delays would result in a smaller reduction in spectrum value, around 40%–60% over three years.

If migration to 3G is slow and mobile broadband services are limited to urban areas, delays in re-farming the 900MHz spectrum will not be significant. However, in this situation, the overall development of the mobile market could be significantly impeded.

In order to create the maximum benefit for mobile operators, and to generate the greatest value, GSM restrictions on 900MHz frequencies should be lifted as soon as practical, ready for spectrum re-farming from 2009 or 2010.

Consequently, the directors of spectrum policy in regulators and mobile operators should explore the opportunities for early 900MHz re-farming within their jurisdiction and consider their options in the context of expected mobile market evolution. As experienced advisors to regulators, policy makers and operators, Analysys Mason is ideally placed to support organisations engaged in the debate on spectrum re-farming.

Dutch 2.6GHz auction raises just EUR2.6 million

The 2.6GHz auction in the Netherlands in April 2010 had some noteworthy results: the unpaired spectrum was left unsold, and the revenue raised (EUR2.6 million, or EUR0.0012 per MHz per pop. for the paired spectrum) was much lower than previous 2.6GHz auctions in Scandinavia and Hong Kong. This raises a number of questions:

- Why was the revenue raised for the FDD spectrum so low?
- Why was the TDD spectrum left unsold?
- What implications does this have for future 2.6GHz spectrum auctions?

Revenues were low because there was limited demand due to the spectrum caps applied during the auction. The Dutch Parliament insisted that the auction limited the amount of spectrum that the three existing mobile operators could win, in order to ensure that new entrants could participate in the auction. As a result, KPN, Vodafone and T-Mobile were limited to winning 2 × 25MHz of paired spectrum in total. This left 2 × 40MHz of paired spectrum plus 60MHz of unpaired spectrum – sufficient for at least three new entrants. In the end, only two new entrants (Ziggo/UPC and Tele2) participated in the auction, each demanding 2 × 20MHz of paired spectrum. The result was twofold: no interest in the unpaired spectrum, and demand equalling supply for the paired spectrum, meaning that it was sold just above the reserve price.

So, the Dutch politicians gained their wish: two new operators are able to enter the mobile market. However, this clearly compromised the revenues generated by the auction. Moreover, it remains to be seen if the two new entrants will be viable. The vast majority of European markets have four or fewer mobile operators. The UK market, which is more than four times larger than the Dutch market, has just consolidated from five operators to four. Moreover, the new entrants, Ziggo/UPC and Tele2, will (for now) only have high-frequency 2.6GHz spectrum, in principle requiring the deployment of many base stations for nationwide roll-out. So, the success of these operators is not certain by any means, and they may therefore be tempted to sell off the spectrum – or even their entire business – at a later stage, when the incumbents' caps expire.

What does this mean for future 2.6GHz spectrum auctions?

Well, firstly, interest in WiMAX (which uses unpaired spectrum) did not emerge. This is reinforced by the observation that in Germany only the four existing mobile operators (and no WiMAX operators) qualified for the ongoing auction. However, in terms of spectrum valuation, the very low revenues generated for the paired spectrum in the Netherlands provide little indication of future prices in other countries. The spectrum caps masked the underlying level of demand for 2.6GHz spectrum from the existing three mobile operators. Perhaps more interesting is the wide range of prices paid by the five spectrum winners (shown below). KPN paid more than four times as much as Vodafone for two blocks, at first sight suggesting that either Vodafone got a good deal or KPN overpaid. However, KPN seems to have paid to avoid interference issues that can occur at the bottom (lot 1) and particularly at the top of the band (lot 13). If the Dutch results are compared to the equivalent Swedish auction results from 2008, it suggests the extra EUR709 000 that KPN spent to avoid that edge of the band may be money well spent: in Sweden H3G paid EUR0.013 per MHz per population more than Tele2 to be in the middle rather than the bottom of the band (equating to EUR4.3 million for two blocks in the Netherlands). In conclusion, the Dutch auction raised an unexpectedly low level of revenue. To some extent, the mobile operators will be pleased, but it is likely that they would have wanted the opportunity to win more spectrum. Meanwhile, operators in other markets should not read too much into the Dutch results, as they are likely to have to pay more for their spectrum.

Licensee	Frequencies acquired	Amount paid (EUR)	EUR/MHz/ pop.
Vodafone	2×10MHz (lots 1–2)	200 000	0.0006
Ziggo/UPC	2×20MHz (lots 3–6)	1 009 000	0.0015
T-Mobile	2×5MHz (lot 7)	109 000	0.0007
KPN	2×10MHz (lots 8–9)	909 000	0.0027
Tele2	2×20MHz (lots 10–13)	400 000	0.0006

The German and Indian spectrum auctions: Did operators get value for money?

Two of the biggest auctions in the last decade finished within a day of each other.

On 19 May, the Indian 3G auction concluded, raising EUR11.7 billion (USD14.6 billion). This was the second-highest revenue-generating spectrum auction for almost a decade, behind the US 700MHz auction in 2008.

The Indian auction was quickly followed by the German auction, raising EUR4.4 billion (USD5.5 billion). Did these massive auctions result in value for money for operators? Spectrum prices have significantly fallen since the 3G auctions in 2000–01. Although the EUR3.4 billion (USD4.2 billion) that Vodafone (the only operator to participate in both the German and Indian auctions) spent last week may sound like a lot, it is dwarfed by the EUR18.3 billion it spent in the UK and German auctions in 2001.

The spectrum sold in the Indian 3G auction is widely viewed to have been expensive. The Indian Department of Telecoms auctioned either three or four 2×5 MHz lots in the 2.1GHz band in each of the 22 telecoms “circles” across India. The auction generated nearly double the revenue predicted before the auction, and at approximately EUR0.34 (USD0.42), per MHz, per population, it generated nearly 40% more revenue per MHz per population than the equivalent band in the German auction (the 2.1GHz band). This was despite India having a GDP per capita 40 times less than that of Germany.

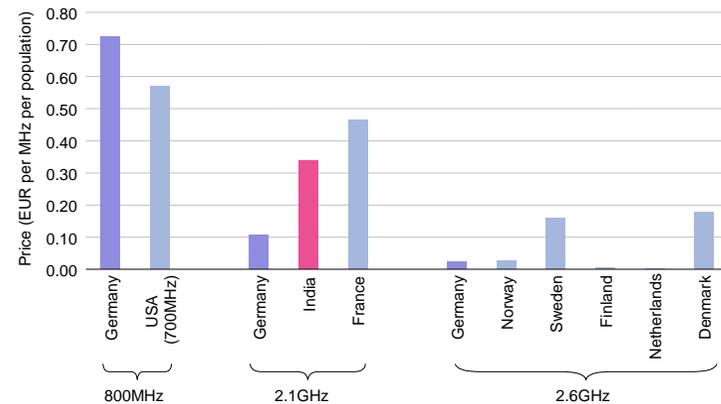
The German auction, on the other hand, raised less revenue than expected. Ahead of the auction, Barclays Capital forecast that it would raise EUR5.8 billion, and KPMG forecast that it could raise up to EUR8 billion. Ultimately, it only raised EUR4.4 billion (USD5.5 billion). BNetzA auctioned a total of 360MHz (of which 2×145 MHz was FDD spectrum) ranging across the 800MHz, 1800MHz, 2.1GHz and 2.6GHz bands. T-Mobile, Vodafone and O2 each spent between EUR1.3 billion and EUR1.4 billion, for which they gained between 95MHz and 100MHz of spectrum. Critically, each of these operators won 2×10 MHz of 800MHz spectrum, which is viewed as the most valuable on offer, due to its favourable propagation characteristics enabling cheaper roll-out of mobile broadband to rural areas. In contrast, E-Plus spent just EUR284 million for 70MHz of spectrum, but it failed to gain any 800MHz spectrum.

In order to assess how much value for money each operator received, it is necessary to look at the prices achieved on a band-by-band basis.

The 800MHz band actually raised more revenue than forecast. Meanwhile, the 1800MHz, 2.1GHz and 2.6GHz band all raised less than anticipated. If the German results are compared with other recent auction results, as shown below, again the 800MHz band looks relatively expensive, given that it fetched a higher price than the US 700MHz auction, and the 2.1GHz and 2.6GHz band looks cheap when compared to similar recent auctions. Effectively, with just 2×30 MHz available at auction, the 800MHz spectrum band was scarce; while with 2×115 MHz of high-frequency, paired spectrum available (1800MHz, 2.1GHz and 2.6GHz), there was more than enough to go around.

Therefore, on reflection, E-Plus’s decision not to purchase 800MHz spectrum and instead focus on the more economical, higher-frequency bands may have been a good one. Further, having more than EUR1 billion extra in the bank is never a bad thing.

In conclusion, the Indian auction looks expensive, especially given its level of economic development. However, it should be noted that a scarcity of mobile spectrum (regardless of whether it is 2G or 3G) is likely to have pushed up the prices. By comparison, the German auction looks like it was value for money, especially in the high-frequency bands.



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