

Ofcom Spectrum Advisory
Board
Annual Report 2005 - 2006

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Section 1

Message from David Currie

When we chose to establish OSAB, almost two years ago, we did so in the hope that OSAB would provide an important mechanism of delivering external advice from some of the best-qualified and experienced individuals in disciplines connected with radio spectrum. Over this time our hopes have been more than fulfilled.

During this last year, the Ofcom Board strengthened its engagement with OSAB by meeting twice with members of OSAB, a practice we propose to continue. Each meeting has been extremely stimulating, providing insight and alternative views which the Board has valued very highly. The outcomes from these meetings have led to a new emphasis in a number of policy areas.

We have seen the benefits of OSAB in many ways, from the detailed input they have provided to on-going projects at their bimonthly meetings, through their contribution to other Ofcom activities such as the Annual Technology R&D Symposium, to their injection of radical new ideas as to how spectrum might be managed and assigned.

This Annual Report provides a concise summary of some of the major topics that they have covered during the year. It makes fascinating reading and is a testament to the breadth and complexity of the topics they have turned their minds towards.

We continue to believe in the importance of external input and are looking forward to OSAB challenging and stimulating us over the coming year.

Section 2

Foreword by Chairman

This report summarises the activity of the Ofcom Spectrum Advisory Board (OSAB) in the second year since it was established. When I look back at OSAB's programme of work in the last twelve months and the advice that OSAB has offered to Ofcom, I am struck by three things in particular.

First, the diverse nature of OSAB's workload. The topics which OSAB has considered have ranged from the challenges likely to be encountered by Ofcom in the implementation of its spectrum trading and liberalisation proposals; through the part that spectrum might play in addressing the issue of the 'digital divide'; to the role of Ofcom in promoting innovation in the spectrum-dependent industries.

Second, OSAB's strongly optimistic stance toward our wireless future. OSAB has suggested to Ofcom that there may be a greater latent demand for spectrum than is readily apparent. Some of that demand may be realised in the relatively short term with innovative initiatives to increase the liquidity of the market for spectrum. Yet unlocking the rest of the demand will depend also on longer-range technological innovation. It may be that that Ofcom can stimulate such 'ahead of the regulatory headlights' innovation by sending encouraging signals in the short term about how it intends to regulate the eventual usage of novel technologies.

Third, the high quality of the dialogue between Ofcom and OSAB. It is evident from Ofcom's responsiveness to OSAB that it weighs OSAB's advice carefully. The energy with which OSAB continues to pursue its remit owes much to the value which Ofcom places on its work.

OSAB is embarking on its third year with its customary enthusiasm, and I am confident that, in due course, we will be able to report on another productive year. In the meantime, the members of OSAB hope that you will enjoy reading about our work in 2005-06.

Sir David Brown

Chairman, Ofcom Spectrum Advisory Board

Section 3

Introduction

Background

- 3.1 The Ofcom Spectrum Advisory Board (OSAB) was established on 19 May 2004 to provide independent advice to Ofcom on strategic spectrum management issues. OSAB provides Ofcom with:
- A rapid way to test new ideas across a wide range of experts.
 - A means of identifying issues that are beyond Ofcom's regulatory "headlights".
 - A demonstration of Ofcom's commitment to consult industry in an open and collaborative manner.
 - A mechanism to help reach an agreed industry view of difficult and contentious issues through the hosting of open fora.
- 3.2 This document reports on its second year.

Membership

- 3.3 The membership of OSAB continued broadly unchanged during its second year under the chairmanship Sir David Brown (Chairman of Motorola Ltd), with the exception of Mike Hibberd who resigned. OSAB and Ofcom recorded their thanks to Mike for the valuable contribution he had made during his time on OSAB. The members of OSAB were appointed in 2004 for a three year term. OSAB and Ofcom plan to address the issue of possible changes in membership as this term approaches its end during the coming year.
- 3.4 Details of OSAB membership are at [Annex 2](#).

Work Programme

- 3.5 OSAB is responsible for agreeing its own work programme. During its second year, key topics for OSAB were:
- The role of Ofcom in promoting innovation, particularly in the wireless sector.
 - The content and direction of Ofcom's Research and Development work.
 - Digital divide issues and the role that spectrum might play in addressing them.
 - A detailed and wide-ranging assessment of Ofcom's trading and liberalisation proposals and the difficulties and improvements that might be made in implementing them.
 - The type of metrics that might be useful in measuring the impact of Ofcom's spectrum initiatives.
- 3.6 In addition, OSAB provided substantial input and advice into the Cave Audit of Government spectrum holdings which was completed during the year.

- 3.7 OSAB meets 5-6 times a year and holds an annual brainstorming where a whole day is devoted to a particular issue.

The Year Ahead

- 3.8 OSAB sets its agenda from meeting to meeting depending on progress made in particular areas, time available and topics arising. It deliberately does not plan a year ahead to allow for flexibility and responsiveness. Topics areas that are likely to be addressed in the coming year are:

- Future architectures for wireless communications networks.
- Metrics for measuring spectrum efficiency.
- The role of the UK in a European and wider international context.
- The use of spectrum managers or intermediaries to facilitate trading and liberalisation.
- Views on the prioritisation of Ofcom's spectrum initiatives.

Further Information

- 3.9 For further information on the work of the Ofcom Spectrum Advisory Board, please contact the OSAB Secretary:

Mrs Glenis Rylance
Ofcom
Riverside House
2a Southwark Bridge Road
London SE1 9HA

Tel: 020 7981 3037

E-mail: glenis.rylance@ofcom.org.uk

- 3.10 Or visit the OSAB website at www.osab.org.uk/ .

Section 4

Topics considered during the year

The role of Ofcom in promoting innovation

- 4.1 OSAB has long seen one of its key roles as stimulating innovation through encouraging bold and far-sighted regulation. During the year, Ofcom developed its thinking on its own role in stimulating innovation and discussed this on a number of occasions with OSAB, gaining valuable advice throughout. Some of the key points made by OSAB were:
- Promotion of innovation was less about R&D and more about providing a climate to encourage people to “do different things and to do things differently”.
 - Innovation was not just about exploitation of ideas but promotion of processes, eg the task of bridging the Digital Divide would be facilitated by encouraging use of a wide variety of processes such as ethnographics and scenario planning.
 - Innovation should not be confined by regulation. For example, the legal requirement to provide equal access to services for the blind, hard of hearing etc might prevent the deployment of some innovative web services which could not readily be made available to this community. Clearly a balanced approach is needed.
 - A key way for Government to encourage innovation was by being an early adopter of new technologies. While the DTI promoted the need for Government to be an intelligent consumer, in practice Government tended towards adopting low risk procurement strategies.
 - There is a need for specific intervention where the market fails to provide, eg provision of clean audio television and radio for the hard of hearing.
- 4.2 These points were welcomed by Ofcom and have been taken on board in its future policy development.

The content and direction of Ofcom’s Research and Development work

- 4.3 Throughout its existence, OSAB has retained a key interest in the R&D work sponsored by Ofcom. OSAB has provided a mix of high level advice and detailed steering on particular pieces of research.
- 4.4 OSAB also played a key role in Ofcom’s first annual R&D Symposium, providing many of the panel members, a substantial amount of comment and discussion from the floor and guidance as to how the event could be improved in subsequent years.
- 4.5 Some of the key points made by OSAB during the year included:
- i) The R&D budget was relatively low (£5 million) so Ofcom would need to work closely with other bodies to make best use of this resource. It would be useful to work with the Engineering and Physical Science Research Council (EPSRC) so that data from Ofcom studies could be utilised further, thereby maximising the original investment.

- ii) There was a need to ensure that Ofcom kept abreast of developments both in the UK and internationally. It was noted that there was little R&D work carried out by other regulators but a watching brief needed to be kept on international developments through attendance at conferences, literature searches, etc.
- iii) OSAB remained concerned that there was no formal process for identifying emerging issues and in consequence, there was a risk that Ofcom would be caught out by unforeseen developments.

4.6 Ofcom recognised all these points, and in response to the concern over the limited ability of Ofcom to keep abreast of developments Ofcom decided to place a contract with QinetiQ to keep a watching brief on relevant developments in universities.

Digital divide issues and the role that spectrum might play in addressing them

4.7 OSAB has given attention to a number of aspects of the Digital Divide and especially to considering ways in which decisions and policies regarding the allocation and utilisation of spectrum could serve to reduce the divide and, instead, promote digital opportunities for all. Some of the key points made by OSAB include:

- There are important linkages to make regarding (i) measurement of impact in relation to quality of use (ii) access to services required by disadvantaged groups in society and (iii) innovation.
- With respect to innovation, digital technologies offer unprecedented opportunity for enhancing the quality of life and life chances for all. There is vast scope for development of innovative products and services to bridge the digital divide, in meeting for example, the needs of older citizens in ageing societies worldwide. Here there is very substantial competitive advantage to be gained by developing and delivering successful services in areas such as telemedicine or remote access to rehabilitation/post-operative care to diverse groups in the community.
- Encouraging such innovation requires affordable access to spectrum. In the implementation of spectrum trading where market forces will be the major determinant of pricing, it will therefore be critical to ensure that such access is safeguarded for use in socially beneficial applications.

4.8 Regarding the wider role of Ofcom, OSAB noted that there is a very considerable and constantly growing body of knowledge about the Digital Divide. Prolific activity worldwide and in the UK has the objective of promoting social inclusion. This is evidenced by the considerable investment by several UK government departments in a variety of aspects of social inclusion. However it appears to OSAB that there is no clear 'owner' of this set of issues and no shared problem statement regarding social inclusion and the digital divide. What are particularly conspicuous by their absence are any evaluation criteria for assessing return on investment in social inclusion or on the success of all the activity in progress. OSAB has sought to make a contribution in a number of ways:

- Asking key strategic questions eg who is accountable for progress towards greater inclusion; what is the ROI in social inclusion activities.
- Indicating where there might be implications for spectrum usage and related costs (eg implementation of virtual reality rehabilitation regimes in citizens' homes).

- Identifying some specific actions such as the need for a 'problem statement' that is shared by all the government departments concerned with tackling the digital divide and social inclusion; and the proposal for a scoping study or mapping exercise to determine who is doing what, how much is being spent what are the problems and what are the relevant groups at risk of exclusion.

4.9 Ofcom has welcomed OSAB's input in this important area and in some cases as a result has considered digital divide issues in policy areas where it might not have done so otherwise. It welcomes OSAB's initiative to work across Government departments.

The type of metrics that might be useful in measuring the impact of Ofcom's spectrum initiatives

4.10 Ofcom was considering whether there might be a set of metrics that could be used to understand how successful its spectrum management policies have been. Such metrics might enable errors in spectrum management to be corrected, align all spectrum management policies to a common goal, provide additional information to stakeholders as to the intended outcome of actions, and assist in the setting of relevant budgets such as for research & development.

4.11 Ofcom consulted OSAB on a range of questions including:

- Whether Ofcom should adopt a set of metrics.
- Whether metrics might have too long a time lag or otherwise be misleading.
- What set of metrics should be used and how should they be collected.
- What weight or value Ofcom should give them.

4.12 OSAB concluded that two quite different sets of metrics were required, one for economic value and one for quality of utilisation. Quality of use was important not only in economic terms such as shareholder value, but also in citizen/social terms for the benefit of society.

4.13 OSAB noted that such measurements were important in relation to public accountability, however, the measurements should be reliable enough not to outweigh the costs of doing the work. Consideration could also be given to benchmarking the measurements against any measures taken within the EU, and considering also whether there was a strong case for an EU Project.

4.14 It was noted that not all spectrum is of the same worth or technical value and could be classified into different categories. These might be termed "platinum" (most valuable), "gold", "silver", etc. Ofcom could then track the amount of spectrum in each class and show how its strategies were improving overall spectrum quality.

4.15 Ofcom is now further developing its thoughts in these areas and will return to OSAB in the coming months for further guidance.

Novel architectures – the "IP radio"

4.16 During 2004, OSAB had raised the question as to whether it was possible to design a radio system that worked in a decentralised manner, in a way analogous to the Internet (hence the term "IP radio"). A brainstorming session with a subgroup had

given this idea some initial definition. During 2005, OSAB members working in conjunction with the Cambridge-MIT Research Network, organised a conference at which this, and similar ideas, were discussed.

- 4.17 As a result of the OSAB initiative, Ofcom commenced a research programme in 2005 to further investigate "IP radio". This is due to conclude in summer 2006 when the results will be published and further discussed at OSAB.

The Cave Audit of Government holdings of spectrum

- 4.18 In late 2004, Professor Martin Cave, an OSAB member, was asked by the Chancellor to conduct an audit into Government holdings of radio spectrum, with a view to assessing whether they could be more efficiently used. The Audit work took place during most of 2005, and OSAB was consulted on a number of occasions throughout the process.

- 4.19 Early in the process, the Cave Audit team asked OSAB a number of questions:

- *Question 1: Is safe band sharing in military and aeronautical spectrum technically feasible?* OSAB felt that safe sharing was feasible. They noted that this might be protocol rather than frequency based. However, they also cautioned that sharing of commercial spectrum might be needed in some cases, such as the 7 July bombings. OSAB noted that the vast majority of the publicly held spectrum between 1 and 10 GHz was reserved for radar use. To date it had always been seen as too difficult to band share here, given safety of life issues. An alternative approach suggested by OSAB was the idea of overlaying services. As commercial communications technology developed and radar technology became more sophisticated there might be a technical solution to the safety requirements.
- *Question 2: What are the relative roles of AIP, public sector trading and specific intervention?* OSAB suggested that defining the rights that public sector users have was very important, not just for trading by public sector users but for trading and particularly liberalisation. If a commercial user decided on a change of use, and if that would potentially cause interference, that might lead to a situation of negotiation with another user to buy off their rights. If the rights of public users were not defined it would not be possible to know if a proposed use was interfering with those rights.
- *Question 3: Does secondary sharing present a genuine market opportunity?* OSAB suggested that the terms and conditions of secondary sharing would need to be spelt out. There had been some very good examples of secondary use but there was a need to understand the categorisations of secondary use and the geographic extent of proposals. For example, there was high demand for spectrum in London and so the value would also be very high, but the same was not true in, say, the Yorkshire Dales. It was suggested that whilst it would be important to "think big", it would also be important to think small in terms of local opportunities for smaller enterprises, particularly outside the urban areas.

- 4.20 In commenting on the Audit's final report OSAB noted that a large number of variables affected any possible demand outcome, demonstrating the difficulty in predicting one specific outcome with any certainty. This suggested that any approach involving second guessing future demand was likely to fail – and hence taking steps to mandate the clearance of such spectrum was also likely to fail. Equally taking steps to mandate the clearance of such spectrum was likely to lead to an ineffective allocation of resources.

- 4.21 A more flexible and responsive approach to spectrum management is likely to be more appropriate, enabling needs to be met through allowing market forces to signal the demand for public sector spectrum, this would address needs as they arise in the medium to long term.
- 4.22 OSAB also cautioned on the need for a rigorous change management programme to be implemented in the affected Government organisations.
- 4.23 In summary, OSAB welcomed the report and its comprehensive set of recommendations.

Section 5

Brainstorming

Theme and External Inputs

- 5.1 Each year OSAB sets aside a day for detailed consideration of a topic of its choosing. In 2005, OSAB decided to conduct a detailed and wide-ranging assessment of Ofcom's trading and liberalisation proposals and the difficulties and improvements that might be made in implementing them.
- 5.2 In order to stimulate discussion and understand whether there were lessons to be learnt from other industries OSAB first had a talk from Professor George Yarrow on the energy marketplace and the lessons to be learnt from implementing market mechanisms there.
- 5.3 OSAB was also joined by Björn Thegeby from the European Commission so as to better debate international issues.
- 5.4 OSAB structured its discussion around:
- The potential distortionary effects of trading.
 - International issues.
 - Achieving sufficient liquidity in spectrum markets.
 - The implementation of technology neutral rights.
- 5.5 Each of these areas is discussed briefly below.

Distortion Effects (caused by partial application of spectrum liberalisation and trading)

- 5.6 OSAB noted that distortions may arise as entities find themselves competing with spectrum obtained under different regimes. This can be a function of:
- Legacy issues.
 - Licence exempt versus licensed spectrum.
 - Different services being treated in different ways – eg satellites versus terrestrial.
 - Services being treated in different ways in other countries.
- 5.7 OSAB recommended that risks of distortion should not deter Ofcom from pressing ahead. But some account of distortion effects needs to be taken. Otherwise the end position might be a “re-arrangement of the deckchairs” with no net overall gain. OSAB noted:
- There are risks in Ofcom taking a partial view:
 - Ofcom needs to be pragmatic not doctrinaire.

- There is a need to recognise the hierarchy of political pressures on the scale of global versus European versus Member State level.
- Ofcom's strategy should be divided between early wins, reserving powers for EU compromises, and "taking the necessary time" to deal with serious potential distortions such as getting satellite spectrum into a trading environment.

Trading in an international context

5.8 OSAB has continued to stress the importance of acting at an international level and the critical need for equipment economies of scale. OSAB therefore felt that Ofcom should take careful account of international issues in developing its strategy. It recommended Ofcom should:

- Gather evidence of starting points, both within the EU and globally, so that we can baseline where we are today.
- Understand the different drivers of change in different models/countries eg US "land of the free" versus the EU "Lisbon agenda" versus Korea "industrial policy planning to drive GDP".
- Map the progression from multiple starting points through a refining process to the ultimate end policy positions.
- Develop and publish a UK band by band analysis of:
 - Options (including standards/scale).
 - Occupancy.
 - Opportunities.
- Reduce uncertainty by going through the analysis, taking a smooth long-term view and publishing a set of likely scenarios.

Achieving market liquidity in spectrum trading

5.9 OSAB has long noted that spectrum trading would not succeed without sufficient market liquidity. It concluded that there is scarcity in specific spectrum segments, but current market inflexibilities may be stifling wider demand.

5.10 OSAB suggested that market inflexibilities are driven by regulation, legacy fragmentation, lack of visibility and openness, and a lack of intermediaries to broker value creating solutions. It noted that most spectrum is seriously underutilised in most frequencies/places.

5.11 OSAB recommended that Ofcom:

- Aggressively implement the spectrum awards programme to release as much spectrum to the market as rapidly as possible.
- Make frequency allocation database available to trusted brokers.
- Sell overlay management rights to intermediaries in certain bands such as business radio, fixed links, and interleaved broadcast bands.

- 5.12 A particular recommendation was the development of “Intermediaries”. OSAB felt that the “management rights” to certain bands such as PBR, might be sold to bodies that could maximise the value extracted from these bands. Incumbent users would be granted certain degrees of protection. The intermediaries might then negotiate refarming with incumbents to provide equivalent/better services, whilst creating value for new entrants. This opens the potential for technological innovation measures, eg dynamic frequency assignment or differentiated quality of service options.

Spectrum Usage Rights (SURs)

- 5.13 OSAB recognised SURs as a complicated problem where Ofcom is making steady progress. However, a OSAB expressed a number of concerns:
- Size matters (spectrum/geographical area) and the UK is too small. Satellites are a symptom of this problem.
 - Ofcom should consider defining rights at a European or Global level.
 - Rights will need to be carefully defined to prevent abuses such as anti-competitive behaviour, but it is likely these issues have been covered in other areas such as Corporate Governance and Law.
 - Continual technological and service changes could make any previous rights formation outdated. Hence, Ofcom will need to monitor new developments to understand their impact on rights and should define rights in a way that allows them to subsequently be changed if needed.

Conclusion

- 5.14 OSAB pulled together all the various threads of its discussion to conclude that when Ofcom is plotting the route from A (the current situation) to B (a world where spectrum trading is implemented), it needs to recognise that there is a C and a D, and so on, and to plan for further changes and enhancements.
- 5.15 OSAB noted that for UK market to operate well, clarity and confidence are required. Some issues cannot be solved now, and some current solutions will need to be revisited in the future. So Ofcom should consider a three-phase strategy:
- Now – full-blooded initiatives to secure early wins.
 - Later – reserve powers to negotiate EU compromises.
 - In due course – resolve potentially serious distortions.
- 5.16 Ofcom should proceed optimistically – there may be a greater latent demand for spectrum than we realise. Increasing liquidity (eg with intermediaries) may have an immediate effect on innovation in spectrum-dependent industries.
- 5.17 The results of the OSAB brainstorming were presented to the Ofcom Board in February 2006.

Annex 1

Ofcom Spectrum Advisory Board – Terms of Reference

1. The terms of reference for the Ofcom Spectrum Advisory Board are:
 - a. The Ofcom Spectrum Advisory Board are to provide independent, strategic advice on spectrum policy issues to Ofcom.
 - b. While the primary role of the Ofcom Spectrum Advisory Board is to look beyond Ofcom's normal planning period, there will also be a need to take a high level view of near-term issues. In particular, the Ofcom Spectrum Advisory Board are to advise on:
 - The UK Spectrum Strategy, major Ofcom allocation decisions, spectrum management, and the application of spectrum pricing/trading.
 - The spectrum policy objectives to be pursued in relevant international fora.
 - New technologies or means of managing the radio spectrum and their implications for Ofcom.
 - The high-level strategic direction for Ofcom's research programme, including key areas of market and technical research required for new spectrum allocation and analysis of gaps in industry/academia research programmes.
 - The extent to which spectrum policy objectives create a climate for innovation.
 - The need to safeguard the interests of citizen-consumers eg protection of vulnerable users, change management etc.
 - c. The Ofcom Spectrum Advisory Board will be responsible for agreeing its own work-programme. Spectrum-related topics that might be considered include:
 - Broadband Fixed Wireless Access
 - Digital TV Switchover
 - Interference Management
 - Interoperability eg wireless and wireline
 - Broadband Public Safety
 - Defence use of Spectrum
 - Short-range Radio Technologies
 - Private Mobile Radio
 - Introduction of Spectrum Trading
 - The balance between licensed and licence-exempt spectrum
 - Development of new technologies eg UWB, SDR
 - Review of spectrum efficiency
 - Trends in international relations
 - d. To avoid any conflict of interest, members of OSAB will not have access to confidential information pertaining to Ofcom decisions affecting specific

companies. This does not however preclude the discussion of potential Ofcom policies.

- e. With the support of Ofcom staff, reporting shall include an Annual Report, publication of key findings on the Ofcom website, and hosting occasional Open Fora.
 - f. Members of the Ofcom Spectrum Advisory Board should be drawn from a mix of commercial, academic and consulting backgrounds, in order to assess topics in a multidisciplinary manner, and to advise Ofcom on spectrum matters of strategic significance. Membership will include ex-officio representation by the Department of Trade and Industry who will participate fully in discussions but reserve the right to abstain from agreement on substantive matters. The Board should also consider how best to make use of global expertise, particularly from countries with innovative spectrum management policies eg through regular liaison, international representation etc. Members will not receive remuneration other than reimbursement of expenses.
2. An MoU has been established between Ofcom and the Ofcom Spectrum Advisory Board to establish their terms of reference and the basis of the Board's establishment.

Annex 2

Membership of OSAB

Sir David Brown (Chairman)

Sir David Brown joined Motorola in 1991 and has been Chairman of Motorola Limited since 1997. He is a Fellow of the Royal Academy of Engineering, a Chartered Engineer and past President of the Institution of Electrical Engineers. He is a member of the President's Committee of the Confederation of British Industry and a Past-President of the Federation of the Electronics Industry. His interests include the promotion of links between engineering and education. He has twice been an Institution of Electrical Engineers Faraday Lecturer and is a Past-President of the Association for Science Education, the professional body for Britain's science teachers. Sir David was Chairman of the University for Industry Design and Implementation Advisory Group and a member of the University for Industry Board. He was also Vice Chairman of the Board of UK Trade and Investment and a member of the Industrial Development Advisory Board. He was knighted in January 2001 for services to British Industry.

Professor Martin Cave

Professor Martin Cave is Professor and Director of the Centre for Management under Regulation at Warwick Business School, University of Warwick. He is an academic economist who led the Independent Spectrum Management Review, commissioned by the Treasury and DTI, and the Independent Audit of Major Spectrum Holdings, for the Treasury. A former member of the Spectrum Management Advisory Group, Professor Cave specialises in regulatory economics and has advised a number of regulatory bodies in the UK and Europe. He was a member of the Competition Commission from 1996 to 2002.

Dr David Cleevly

Dr David Cleevly is a leading authority on telecoms policy and the digital economy, regularly commenting on industry trends and prospects at international conferences and in the media. Founder of Analysys and previous Chairman of Analysys Limited, David has worked with numerous governments at a national and supra-national level to create policy frameworks which encourage innovation and growth. He has made a major contribution to the UK Government's proposals for a unified regulatory body in the convergent world of telecoms, IT and broadcasting (Ofcom). He was also a member of the committee responsible for the Government report [e-commerce@its.best.uk](#) and chaired the launch of the report by Tony Blair. He continues to advise the Government on policy formation for communications and media, IT and broadcasting.

Professor Leela Damodaran

Leela Damodaran is Professor of Participative Design and Change Management in the Department of Information Science at Loughborough University. She leads the Information, Technology and Society Research group at the Research School of Informatics, conducting research into the human and social aspects of informatics. Her expertise informs policy and the formulation of strategies to promote the adoption of digital technologies through participatory and inclusive design approaches in ICT development projects. Her influential report, "Analogue to Digital Switchover: Human Aspects of Adoption", proposing strategies for engaging citizens, promoting social inclusion and enhancing public access to information, has been published at www.digitaltelevision.gov.uk. Recent projects include research on the implementation of local eGovernment in the UK, evaluation of knowledge management in a

petro-chemical company and on new ways of working in the construction sector. Professor Damodaran has been a member of the Strategic Advisory Team of the EPSRC on the Infrastructure and Environment Programme and of the Spectrum Management Advisory Group. She chairs the Digital Technologies and Social Inclusion Consortium in partnership with the University of Dundee and is also Vice Chair of the British Computer Society Sociotechnical Group.

Professor Barry Evans

Professor Barry Evans was appointed to the Alex Harley Reeves Chair of Information Systems Engineering at the University of Surrey in 1983, where he leads the largest UK and European academic research group in Mobile and Satellite Telecommunications. Founder Director of the Centre for Satellite Engineering Research, he became the Director of the Centre for Communication Systems Research (CCSR) in 1996 – a post he still holds. From 1999 to 2001 he was Dean of Engineering and from 2001 to date he holds the Pro-Vice Chancellor (Research & Enterprise) role at Surrey. He has been involved in the UK Foresight programmes in Communications and ITEC, EPSRC Strategic Advisory Committees, MoD-DSAC Committees, adviser to DG of OFTEL, board member of BNSC-TNAB as well as ITU, ETSI and EU Advisory Committees. He is editor of the International Journal of Satellite Communications and has an authorship of over 500 papers in the technical literature and three books. He was elected to a Fellowship of the Royal Academy of Engineering in 1991.

Debbie Gillatt

Debbie Gillatt is currently Director, Communications Networks at the Department of Trade and Industry. Her responsibilities include the regulatory framework for telecoms; the Government's relations with Ofcom and with BT and other major fixed and mobile network companies and equipment manufacturers; information security, Internet policy and relations with the ISP industry; spectrum policy; and communications technology.

Debbie has recently returned to DTI after several years in sector regulation. She has worked extensively with business on a sectoral and regional basis, focusing at different times on trade, investment and competitiveness. She has experience of both manufacturing and service sectors, and most recently has been responsible for establishing the framework for market opening in the postal sector. Other recent work has included reviewing Government support for service sector exports and outward investment, and the 2001 Government White Paper on competitiveness.

Stephen Lowe

Stephen Lowe is a Consultant for Telewest Broadband, a leading UK cable operator. Previously, he was Director of Eurobell Holding plc. He is Chairman of the Broadband Wireless Association and a leading player in the development of broadband fixed wireless access.

Phillipa Marks

Phillipa Marks is a Director of Indepen Consulting. She specialises in the analysis of economic, public policy and regulatory issues in the media and telecommunications industries. She is an expert in the application of market mechanisms to spectrum management. She was educated in New Zealand and at Oxford University. After a period as a research officer with the New Zealand Institute of Economic Research, she moved to the UK working for the Institute of Transport Studies. She then joined the National Economic Research Associates (NERA) where she became a director, leading assignments in media,

telecommunications and utility sectors. In 2000, she was appointed by the Home Office as a member of the Gambling Review Body.

Professor Mike Short

Mike's career spans 29 years in Electronics and Telecommunications, with the last 17 years in Mobile communications. He was appointed Contracts Director of Cellnet in 1989 dealing with major infra-structure investments and UK interconnect agreements. In 1993 the focus moved to establishing Cellnet's GSM service. He was elected Chairman of the GSM Association for 1995/96 and served on their Executive Board for 3 years, was the 1st Chairman of GSM Europe in 1996 and the GSM Association Data Task Force 1999/2001. He was elected to the WAP Forum Board 2000/2 and was a founder Board Member of Open Mobile Alliance (OMA). He was also elected Chairman UK Mobile Data Association in 1998 (renewed for 2002/4). Mike has served as Vice President UK FEI 1998/2001, and led FEI (now Intellect) mobile / environmental committees. He has also been a member of Ministerial Advisory Groups on Spectrum (SMAG) and Security (Home Office TAB) since 1998, and was appointed a Visiting Professor at Surrey University in October 2003. Mike's focus today is on Third Generation cellular and steering O2's Group Research and Development in mobile.

Andrew Sleigh

Andrew Sleigh is Managing Director, Knowledge and Information Systems Division for QinetiQ. His career has included research in sensors and machine intelligence, operational analysis and strategic planning, and has undertaken a number of senior management positions. Previously, he was Managing Director, Defence Solutions for QinetiQ and prior to that he was responsible for the MoD's ICT strategy and programmes and was Co-Chair of the Cabinet Office Official Committee on Spectrum Strategy.

Professor Will Stewart

Previously the Chief Scientist at Marconi with wide interests in technologies from communications to biosensing, he was educated at Imperial College (Physics). His personal interests have been in optical fibre communications and optoelectronics. Recent interests include microstructured photonic materials (photonic crystals), optical slow-wave structures, nanomechanical systems and the application of various optical, semiconductor and acoustic technologies to medicine, particle physics and industrial processes. He is a visiting Professor at UCL and at the ORC at Southampton. He is author on some 64 conference and journal papers, including many invited papers, and on 48 patents. He is a member of the editorial advisory board for the journal 'Science', chairman of Innos, resident expert on the Foresight' EEMS' project, on the advisory board of Antenova and many other committees.

Stephen Temple CBE

Stephen Temple joined Vodafone's Corporate Strategy Group as Director of Strategic Projects in July 2003. He spent 7 years with the UK's largest Cable TV Operator NTL, for the most part, leading their technology innovation programme in the Networks Division and finished up as Managing Director of the Networks Division. Prior to that he was a senior official in the Department of Trade and Industry leading for the UK in a number of European telecommunications developments including the GSM mobile project, digital video broadcasting, collaborative R&D and telecommunications standardisation. On the latter he was Chairman of the ETSI Technical Assembly for 4 years. In an earlier part of his Civil Service career he spent 7 years in frequency spectrum management in the Ministry of Posts and Telecommunications and Home Office. He was awarded the IEEE prize for International

Communications in 1994, the GSMA chairman's award in 1996 and the CBE for services to Trade and Industry in 1996. He is a Fellow of the Institution of Electrical Engineers.

Dr Gary Tonge

Dr Gary Tonge was until the end of 2003, the Director of Technology of the Independent Television Commission, a position he had held since the ITC's beginning in 1990. During his time at the ITC, he facilitated the development both of Channel 5 and of digital terrestrial television. He is currently doing some consultancy work in the field of electronic communications technology and policy. Gary is a Fellow of the Royal Academy of Engineering, the Royal Television Society and of the Institution of Electrical Engineers.

Dr Walter Tuttlebee

As Chief Executive of the Virtual Centre of Excellence in Mobile & Personal Communications - Mobile VCE - Walter Tuttlebee heads up a unique not-for-profit company established 8 years ago by the mobile telecoms industry, academia and UK government to undertake long-term, industry-steered, collaborative research. Mobile VCE today has 20 industrial members, operators and manufacturers, including several Asian companies. Its research results 'seed & feed' its industrial members' internal R&D programmes as well as influencing WWRF, SDR Forum and IETF. Its research addresses core technology evolution to support the growth of the mobile communications industry. In the 1980s and '90s, Dr Tuttlebee led industry R&D teams in 2nd and 3rd generation mobile communications, conceiving and playing a key role in key European 3G research programmes, which contributed to the 3G standards. He is acknowledged as a pioneer of software radio in Europe and has operated in Business Development in personal communications, digital broadcasting and satcoms. He has edited five books, including "Software Defined Radio: Enabling Technology" currently being translated into Chinese. He has published widely, has several patent filings and holds BSc, PhD and MBA Degrees.