Wireless Communications: The Future

Professor William Webb
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To Katherine and Hannah, who will be choosing their own future over the next 20 years.
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Preface

My previous book forecasting the future, The Future of Wireless Communications, was published in 2001, but mostly written during 2000. This was the time just before the ‘dot.com bubble’ burst. At that point Internet and wireless companies were flying high, and to predict anything other than a bright future would have seemed highly pessimistic. Of course, that all changed during the latter part of 2000 and 2001 as is well known, and explored later. Now, predicting a bright future for wireless communications is more likely to be seen as unduly optimistic. As will be explored throughout this book, these changes in the market have broadly not changed the technological roadmap that we predicted earlier, but they have had an impact on the timing of the critical investment. Overall the events have been so tumultuous for the industry that another version of the book, some six years after the first edition, seems appropriate.

Along with the wireless communications environment, my role has also changed somewhat. In September of 2001, a few months after the publication of The Future of Wireless Communications, I left Motorola and returned to the UK and to the consultancy environment. After a spell with PA Consulting Group, the UK’s sixth largest consulting company, I moved to Ofcom, the UK regulator of all things to do with communications, as the Head of Research and Development. This has given me the ability to commission research across a wide range of communications technologies and to be involved in developing policies, such as the UK’s ‘Spectrum Framework Review’ that will shape the industry and the future in their own right.

Other appointments have helped me in this respect. I play a range of roles within the Institute of Engineering and Technology (IET) where I am a member of the Board of Trustees and chair of the Communications Engineer Magazine Advisory Panel. My appointment as a Fellow of the Royal Academy of Engineering provides me with access to most of the key engineers in the UK and my role as a Visiting Professor at Surrey University gives me access to world-class research. Finally, my appointment to a number of judging panels such as the Wall Street Journal’s Annual Innovations Awards has provided me with valuable information and contacts in understanding strategic changes in the industry.

In the preface of the earlier book, I noted that there seemed to be nobody producing a coherent and well thought-out vision as to how the whole world of wireless communications would develop, and perhaps converge, over the coming years; and that further, nobody
seemed to be prepared to try to predict 20 years out. This still appears to be broadly the
case – there have been a few books published with individual essays on the future but no
coherent and complete text. Hence, I believe it is worthwhile to publish a new version of this
book, to continue to provide some sort of a framework on which future strategic decisions
can be made.

Those readers who recall the earlier version will remember that around half of the book
comprised contributions from a range of eminent industry experts. I have used the same
format in this edition, but have elected to ask a different set of experts for their views. I
have made this decision in order to provide increased diversity of views and not because of
any implied criticism of the previous experts – indeed, as will be demonstrated throughout
this book they did an outstanding job in predicting the future.

Perhaps it is worth explaining why I am qualified to undertake such a task. I am an
engineer, qualified to PhD level, but also with business qualifications. I have spent much of
my career as a consultant, working across a wide range of different problems and issues with
clients including regulators, governments, user groups, operators, manufacturers and SMEs.
I have also spent time working for Motorola and for the UK regulator, Ofcom. Projects have
varied from building hardware demonstrators of novel technologies through to developing
business cases for operators planning national roll-outs. I have lived in the UK and the
USA and worked for clients around the world including diverse environments such as South
Africa, Bolivia, Denmark and Ireland. And above all else, I have previously made a range
of predictions, almost all of which have proven to be accurate.

As always, it is important to remember that ‘forecasting is very difficult, especially when
it concerns the future’. The forecast presented in this book is highly unlikely to be correct in
every respect. Regardless of this, the information presented here and the thought processes
followed will be of value in helping others to build their own view of the future and to
modify that view as circumstances change.
Acknowledgements

Firstly, I am deeply indebted to those experts in the field of wireless communications who gave up their time to contribute substantial chapters and shorter pieces to this book. I would also like to express my thanks to the earlier contributors who made the previous version such a great book.

In writing this book I have drawn upon all my experience gained over my years in the industry. I have learnt something from almost everyone I have come into contact with and would thank all of those with whom I have had discussions. Special thanks are due to a number of key individuals. During my time at Multiple Access Communications, Professor Ray Steele, Professor Lajos Hanzo, Dr Ian Wassell and Dr John Williams amongst others have taught me much about the workings of mobile radio systems. At Smith System Engineering (now Detica), Richard Shenton, Dr Glyn Carter and Mike Shannon have provided valuable knowledge as have contacts with a number of others in the industry including Michel Mouly, Mike Watkins, Jim Norton and Phillipa Marks (Indepen). At Motorola I had tremendous guidance from a range of individuals including Sandra Cook, Raghu Rau, John Thode and the immense privilege of discussions with Bob Galvin, ex CEO. At PA Consulting, Dr Phil White, Dr John Buckley, Dr Mark Paxman and many others have contributed to my understanding of the cellular industry. In my work with Institutions I have been privileged to work with John Forrest CBE, Sir David Brown, Walter Tuttlebee, Peter Grant and many more. At Ofcom, Peter Ingram, Mike Goddard, those in my R&D team and others have provided invaluable guidance. Many presentations and papers from those involved in the mobile radio industry have contributed to my understanding.

Finally, as always, thanks to Alison, my wife, who supports all my endeavours to write books with good humour and understanding.

Disclaimer
Note that the views and opinions presented in this book are those of the authors and not necessarily of the organisations that employ them. These views should in no way be assumed to imply any particular strategic direction or product development within the organisations thus represented.
About the Author

William has worked in the wireless communications industry since his graduation in 1989. He initially joined Multiple Access Communications, a consultancy based in Southampton, UK, in 1989, becoming a director in 1992. There he worked on many research and development projects including detailed research into QAM for mobile radio – the subject of his PhD thesis – directing multiple propagation measurements, designing and writing a microcell propagation tool and producing hardware demonstrators for early DECT and QAM systems.

He moved to Smith System Engineering (now Detica), based in Guildford, in 1993. There he undertook a wide range of projects including taking the lead technology role on the ‘Smith/NERA’ studies into the economic value of spectrum and spectrum pricing. He played a key part in the standardisation of the European Railway’s GSM technology, authoring many of the changes to the standard within ETSI and working across industry to build support for the proposals. He also worked on PMR systems, providing strategic and technical advice to major users such as police and fire services. While at Smith he completed his MBA, continued to publish widely and became well known as a speaker and chairman on the conference circuit.

In an effort to widen his understanding of the cellular industry, William then moved to Motorola. He spent a year in the UK working in the European infrastructure division, then he moved to Chicago in the United States where he was a Director of Corporate Strategy. He also worked closely with Motorola Labs on research directions. This exposure to strategic and technological issues enabled him to produce Motorola’s medium- to long-term strategic plan. At this point he was elected a Fellow of the Institution of Engineering and Technology (IET; formerly the IEE) and had his biography included in Who’s Who in America.
William then returned to consulting, moving to PA Consulting Group in Cambridge as a Managing Consulting in 2001. At PA he consulted widely across the wireless industry on a range of strategic, technical and regulatory issues. He was asked to become a judge for the Wall Street Journal’s Annual Innovation Award and has been invited to sit on this judging panel annually since. Also in 2003 he was invited to become a Visiting Professor at the Centre for Communications Systems Research at Surrey University. In 2004 he was elected as a Vice President of the IET where he sits on the Board of Trustees, directing the IET’s strategy during a time of significant change and merger activity.

William joined Ofcom as Head of Research and Development just prior to it officially becoming the national telecoms regulator. Key outputs from the team include the Annual Technology Review and a range of research reports. William also leads across a wide range of spectrum strategy. He wrote the Spectrum Framework Review – Ofcom’s long-term framework for radio spectrum management – and led on Ultra Wideband strategy and property rights for spectrum (‘spectrum usage rights’). He is a member of Ofcom’s Senior Management Group.

In 2005, at the age of 38, William was invited to become a Fellow of the Royal Academy of Engineering. This highly prestigious body comprises the top 1300 engineers in the UK. Admittance is by invitation only and limited to 50 engineers, across all disciplines, annually. Only a handful of individuals have ever been elected below the age of 40.

Predicting the Future is a Necessary Part of Business

Almost all activities in the world of wireless communications require a forward-looking assessment. Operators who are deciding whether to buy spectrum at auction need to assess the likely services and revenue they can expect over the lifetime of their licence – often 20 years or more. Manufacturers need to decide which areas to focus their research activities on and which technologies and devices to develop into products. Academics and other researchers need to understand which areas will require the greatest advances and hence be most amenable to research. With the development of standards taking 5–10 years from inception to commercial product, those developing the standards need to predict what types of product will be needed and technologies available during the lifetime of their standard. There are many examples of poor forecasting – for example Iridium over-forecast the number of users who would be prepared to pay for an international satellite phone; and some examples of excellent forecasting, such as Vodafone’s decision to enter the mobile communications marketplace when it was in its infancy. Getting these forecasts right is one of the most critical factors in building a successful business.

All of these players – manufacturers, operators, researchers, investors, regulators and more – make their own predictions of the future in developing their business plans or other business activities. In doing so, they sometimes draw upon available industry information such as analyst and consultant reports which forecast the uptake for specific technologies or services. But these often take a very narrow view of a particular segment or technology. As a result, they can forecast that a particular technology will be successful when compared to its direct competitors, but may not notice the advent of a disruptive technology which will change the entire competitive playing field. The track record of such forecasts, particularly over timescales of three years or more, is generally poor.
It is the role of this book to provide a broad and long-term forecast, looking across all the different elements of wireless communications and into related areas such as wired communications where appropriate. This forecast can then become an overall roadmap under which those involved in wireless can build their more specific forecasts.

I prepared such a forecast in 2000: *The Future of Wireless Communications* (Artech House, 2001). Despite the tumultuous time that many communications companies have experienced between 2000 and 2005, the predictions have proved surprising accurate, as discussed in more detail in Chapter 2. Equally, much has changed since then. New technologies or standards such as WiMax and IEEE 802.22 are being developed. New approaches to using radio spectrum such as ultra-wideband and cognitive radio have been proposed. Services predicted in the previous edition, such as combined home and cellular systems, have actually started to be deployed.

The approach adopted in this book is very similar to the successful approach I adopted in 2000. The book starts with a careful analysis of the current situation, looking at underlying technological drivers, user demands, existing and emerging standards and technologies, and business drivers among the key players. It then turns to gaining views from a range of eminent experts in the field, ranging across different types of stakeholder and from different parts of the world. This range of views, coupled with the earlier analysis of constraints and drivers, is then brought together into a single vision of the world of wireless communications in 2011, 2016, 2021 and 2026. Such a single vision is much more valuable than a wide range of different scenarios which readers need to interpret and come to their own conclusion as to which, if any, they consider likely.

So, in summary, five years after my previous book, it is an appropriate time to have another look at the current environment, gather some fresh opinions and make another prediction 20 years into the future. This book provides a credible, broad prediction of the future which will aid all those involved in wireless communications in their most important task – making the right decisions themselves as to their best investments of time and effort.
Previous Predictions have been Accurate

2.1 Introduction

The previous book made concrete forecasts for 2005, a period five years into the future from the time of writing. Just over five years later, it is possible to review how well we did and understand what this means for future predictions.

It is worth remembering that the period 2000–2005 has not been a happy one for many companies involved in wireless communications. Most major manufacturers and operators have seen their value decline considerably over this period and between them they have contributed to some of the largest write-offs in history. These corporate difficulties were not generally foreseen in 2000. The impact that they would have on wireless development might be expected to be profound.

2.2 There have been Huge Changes in the Telecoms Climate

*There was a huge erosion of revenue, jobs and confidence between 2000 and 2003*

Most readers will be only too well aware of the scale of the changes that took place in the telecoms industry between 2000 and 2003. Some will have been unfortunate enough to lose their jobs as a result, others to lose money on investments they have made. Those still employed became used to falling sales and budgets, to economy grade travel and to daily doses of bad news from the media. Take, for example, Lucent – one of the leaders in the telecoms industry in 2000 with over 100,000 employees and a share price hovering around $100. By mid 2003 it had fallen to 35,000 employees with further job cuts forecast and a share price of around $1.50. Just considering the major manufacturers and operators, it is clear that over 500,000 jobs were lost in the telecoms industry between 2000 and 2003.
Of course, the pain was not restricted to the cellular industry. Across almost all sectors share prices fell by up to 50%. But technology-related companies were particularly badly hit, with the NASDAQ in 2003 standing at around 25% of its highs of 2000. Worst hit of all were the so-called dot.com start-up companies pioneering new ways of business over the Internet. By 2003, few of the many thousands of start-ups existed.

In the cellular industry there was a clear turning point in fortunes around the time of the 3G auctions in the UK and Germany. Between then and 2003, share prices of the major players – operators and manufacturers – fell steadily to around 25% of their peak values in 2000. Matters became sufficiently bad that the Financial Times, in April 2002, speculated that perhaps the cellular operators no longer had growth prospects and should be treated instead as a typical utility company, albeit one that was highly indebted.

The causes of the malaise in the cellular industry are generally well known. Operators could no longer rely on subscriber growth as penetration levels reached saturation in most developed countries. Add to this a slight decline in average revenues per user (ARPU, normally measured on a monthly or annual basis) as tariffs fell and some operators were reaching a point where they were experiencing a slight decline in revenue. This situation, although undesirable, would not have been too bad if it were not for the general level of indebtedness of the operators at the time, resulting from a spate of acquisitions and the license fees paid for the 3G licenses – in particular in the UK and Germany.

The fees paid for the 3G licenses were predicted on significant growth in ARPU as consumers increasingly used services such as web-browsing, video telephony, location-based services and a host of other offerings for which the operators predicated they would be prepared to pay much more than their current monthly bill. However, in 2003 indications were not promising. The first mobile data service – WAP – as has been widely discussed, was mostly unsuccessful, with many concluding that it was just too awkward and too expensive to browse the Internet on a mobile phone. The advent of a packet data service – GPRS – was predicted to improve data usage as it provided ‘always-on’ connectivity at higher speed and lower cost; but even though GPRS networks were available since 2001, in 2003 less than 1.5% of cellular phone users had a GPRS subscription. Worse, uptake of GPRS services was widely believed to be a strong indicator of the eventual demand for services on 3G. Elsewhere in Europe, operators that had launched offerings such as location-based services were reporting disappointing results.

Only in Japan had there been growth in ARPU, initially through DoCoMo’s i-mode service and then through J-Phone’s service that enabled photos to be sent as part of a text message. Whether this could be replicated elsewhere was unclear. On the one hand there is much about Japan’s culture that is different, including long commute times where mobile data applications can relieve boredom, and a low penetration of ‘conventional’ fixed Internet making the mobile device the main browsing tool for many. On the other hand, applications such as sending pictures would appear to have interest regardless of culture.

The one clearly successful service in Europe was the use of short message service (SMS) where revenues by 2003 were in the region of 10–15% of voice revenues. SMS had proved profitable to operators not least because its data requirements were so low that it produced

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1 Broadly, this is mobile access to the Internet, however to sites where content has been carefully tailored for delivery to mobile devices.
There have been huge changes in the telecoms climate. In 2003, many were pinning their hopes of a growth in ARPs, particularly in the short term, on an enhancement to SMS known as the multi-media messaging service (MMS) which enabled attachments to be added to text messages. These might be pictures, ringtones or short music clips.

By 2003, the evidence suggested that adding new services to existing and enhanced cellular networks would not have the desired effects on ARPs. This left the industry in crisis, with operators unwilling to invest because they were unsure that they would get any return on this investment, and preferring to repay debts instead. This lack of spending was devastating the supply chain – manufacturers, suppliers, consultants, etc. – which in turn tended to reduce the flow of innovative technologies and applications just at the time they were most needed. All told, in 2003, the future for the wireless industry was not looking bright.

These problems were caused by overly optimistic growth in the late 1990s. Much has been written about what caused these enormous changes in the telecommunications industry. It is worth spending some time looking at them because understanding the root causes makes it easier to predict the likelihood of future repetitions.

First, it is worth understanding where the problems lie. If we look specifically at the cellular industry, the overall revenue flowing into the industry, in the form of payments from cellular subscribers, had not fallen. Indeed, for most operators it continued to grow throughout the period 2000–03, albeit at a lower rate of growth than in the heady 1990s. Such a slowdown was not unexpected as it was obvious that penetration levels would eventually reach saturation. The problems appeared to reside on the supply side. Orders for equipment fell hugely compared to the late 1990s. So although the revenue entering the cellular industry had increased, it had not flowed out into the supply chain in the same manner as during the period prior to 2000. Instead, in many cases it was used for debt repayment. For example, in late 2002, France Telecom – owners of Orange – cancelled many capital projects to focus on debt repayment.

In tracing the cause of the debt, many point their fingers directly at the 3G auctions that took place around the world, but particularly in Europe, during 2000 and 2001. Certainly these contributed to the operators’ debts – by some $100bn. However, they are far from the whole story – the debt of France Telecom alone stood at nearly $70bn in 2002. In practice, much of the debt actually arose from the takeovers which raged across the industry between 1998 and 2001 as the larger operators tried to establish a global presence. Others ran up debts as they invested heavily in operators with a minority share of the market in an often unsuccessful effort to increase their share.

But none of these are really the cause of the debts, they just explain where the money went. More important are the reasons why operators decided to spend the money in this fashion. These vary from operator to operator but include:

- a desire by some operators to gain a global presence under the belief that only the global players would survive
- optimism over the future of mobile data, leading operators to predict increasing ARPs which then made the business cases for investment look attractive

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2 Indeed, on the basis of cost per bit, SMS is very attractive to the operators, being charged at around £1,000 per Mbyte!
• rapid growth in their share prices persuading them that they could increase debt without impacting debt to equity ratios.

The simplistic summary is that the industry, and in particular the operators, got too optimistic. Years of buoyant growth, high stock prices and the Internet bubble persuaded them to behave as if this growth would continue indefinitely. It is now clear that the growth slowed, rapidly exposing positions that were untenable in this kind of market.

Confidence slowly returned to the industry between 2003 and 2005

Slowly, from around 2003, things improved. The levels of debt for the major operators declined substantially as operators repaid large amounts, or used other financial instruments to restructure and dilute the debt. No major operators collapsed, or even appeared to be in serious trouble, and the manufacturers started to return to profitability, albeit on a much reduced order base. Around 2003, 3G started to come of age, with major roll-outs from new entrants, such as 3 in the UK and Italy, and early deployments from existing 2G operators. This increased the overall spending in the industry, helping to restore confidence.

Operators accepted that ARPUs and subscriber levels were relatively static, hence overall revenue was static, and reorganised themselves accordingly, outsourcing, downsizing and generally optimising their internal structures for this new, more static role. There were some bright spots. For the new 3G operators, ARPUs appeared substantially higher than the industry average, raising hopes that the new data services offered by 3G would, after all, encourage users to spend more. Others were more cautious, noting that the offers put together by these operators were most attractive to the high ARPU spenders, so it was possible that migration of high ARPU users had occurred rather than users increasing spending levels.

New technologies started to become mentioned by 2005. For 3G, HSDPA was seen to be the next major advance. Outside of 3G, WiMax was widely expected to bring attractive new services to end users. Mobile TV also was trialled as a potential new service.

None of this changed the total revenue entering the industry which remained broadly static from 2000 to 2005. But the change in confidence lifted share prices of both operators and manufacturers and made all more inclined to innovate and try new ideas.

2.3 What we Predicted for the Period 2000–2005

In our previous book we predicted that during the period 2000 to 2005:

• Office buildings would increasingly have W-LANs composed of technology based on either BlueTooth, cellular pico-nodes or W-LAN standards.
• W-LAN coverage would start to appear in airports and some other public hotspots.
• Early versions of intelligent call filtering systems would be deployed in some networks but these would typically be restricted to devices operating on one network and would not be able to work across multiple networks.
• Early third-generation cellular networks would start to roll out.
• Cells and networks would become self-planning and optimising, reducing the management burden on the operator but increasing the software complexity delivered by the manufacturer.