Essentials of Modern Spectrum Management

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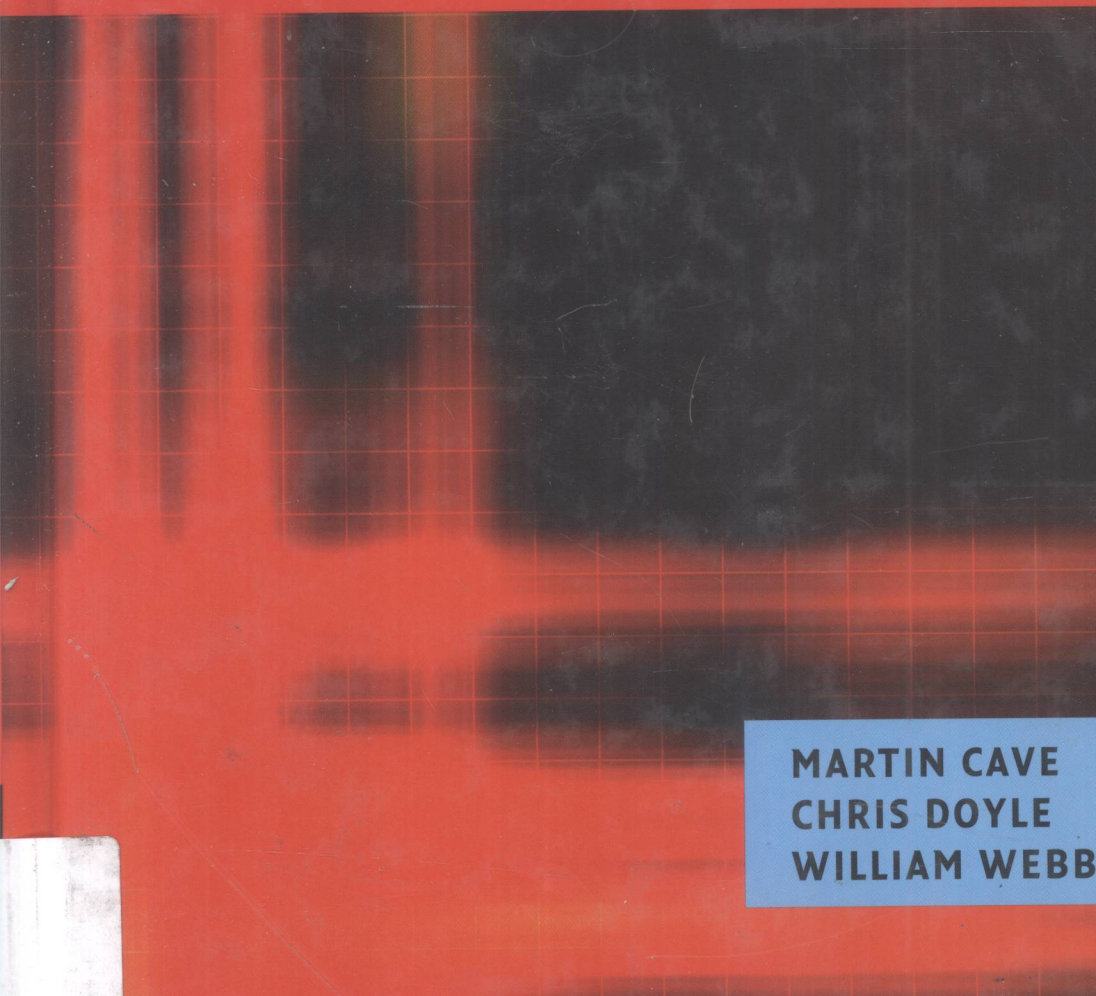

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Essentials of Modern Spectrum Management

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Essentials of Modern Spectrum Management

Are you fully up-to-speed on today's modern spectrum management tools? As regulators move away from traditional spectrum management methods, introduce spectrum trading and consider opening up more spectrum to commons, do you understand the implications of these developments for your own networks?

This is the first book to describe and evaluate modern spectrum management tools. Expert authors offer you unique insights into the technical, economic and management issues involved. Auctions, administrative pricing, trading, property rights and spectrum commons are all explained. A series of real-world case studies from around the world is used to highlight the strengths and weaknesses of the various approaches adopted by different regulators, and valuable lessons are drawn from these.

This concise and authoritative resource is a must-have for telecom regulators, network planners, designers and technical managers at mobile and fixed operators and broadcasters, and academics involved in the technology and economics of radio spectrum.

MARTIN CAVE is Professor and Director of the Centre for Management under Regulation at Warwick Business School. He is the author of the *Cave Review* commissioned by the Chancellor into spectrum management in the UK.

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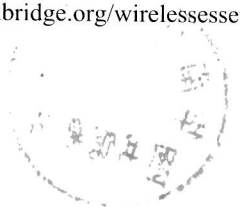

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William Webb

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Disclaimer

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

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1 Current spectrum management methods and their shortcomings

1.1 Why spectrum needs to be managed

A large and growing part of the world's output relies upon use of spectrum.[1] Frequencies are used both commercially, notably for mobile communications and broadcasting, and by public sector bodies to support national defence, aviation, the emergency services and so on. As demand grows spectrum needs to be managed to avoid the interference between different users becoming excessive. If users transmit at the same time, on the same frequency and sufficiently close to each other they will typically cause interference that might render both of their systems unusable. In some cases, "sufficiently close" might be tens or hundreds of miles apart. Even if users transmit on neighbouring frequencies, they can still interfere since with practical transmitters signals transmitted on one channel "leak" into adjacent channels, and with practical receivers signals in adjacent channels cannot be completely removed from the wanted signal. The key purpose of spectrum management is to maximise the value that society gains from the radio spectrum by allowing as many efficient users as possible while ensuring that the interference between different users remains manageable.

To fulfil this role, the spectrum manager provides each user with the right to transmit on a particular frequency over a particular area, typically in the form of a licence. Clearly, the spectrum manager must

[1] Spectrum is a term to describe a band of electro-magnetic frequencies. It is often used to refer to the radio spectrum, which extends from approximately 10 kHz to 300 GHz. This band is then subdivided with different parts being used for different applications. A licence will typically give a user the right to access or transmit on part of this spectrum, e.g. 800 MHz–820 MHz.

ensure that the licences that they distribute do not lead to excessive interference. In practice, this can be a highly challenging task.

This book is about how best the spectrum manager can accomplish this task, and in particular how the use of market mechanisms can assist them.

1.2 The current management mechanisms

Historically, the approach adopted by spectrum managers around the world to managing the radio spectrum has been highly prescriptive. Regulators often decide on both the use of a particular band and in some cases which users are allowed to transmit in the band.[2] Keeping a tight regulatory control over the use of the spectrum makes it easier for the regulator to ensure that excessive interference does not occur because the regulator is able to carefully model the interaction between neighbouring services and tailor the licence conditions appropriately. It also allows for other regulatory goals to be achieved – for example, ensuring that a service is available on a pan-European basis, or imposing coverage requirements to achieve ubiquity of services. Finally, it can result in high technical efficiency of spectrum use – that is to say in packing a large number of users into the spectrum. This is because like services in neighbouring bands tend to interfere less than unlike services and so can be allocated more closely together. If the regulator collects together like services and places them adjacent to each other it can increase the capacity of the spectrum (although maximising the capacity, or technical efficiency, is not always the same as maximising the benefits that society can gain from the spectrum, or economic efficiency, since the spectrum can be completely used but by a low value application).

As well as licensing users, the spectrum manager typically exempts other users from licensing. These exempted users are often assigned a band of spectrum sometimes known as unlicensed spectrum, or spectrum

[2] In the spectrum world, deciding the use of a band is called "allocation"; deciding which organisation can use it is called "assignment".

commons. The decision to exempt users is made on the basis that they will not interfere significantly with each other if they use the spectrum in an uncoordinated manner. In practice, this is likely only if they transmit at a relatively low power level such that the distance over which they can cause interference is small and hence the probability of there being another user within this small "coverage" area is low. Typical services that are exempt include cordless phones and wireless LANs such as WiFi. It is up to the regulator to decide which equipment to exempt, what the rules for its operation should be, how much spectrum should be set aside for its operation and where in the frequency band this should be.

The current spectrum allocation process operates at both a national and international level. International coordination is essential in some cases because the zones of possible interference extend beyond national geographical boundaries and in other cases because users are inherently international, e.g. aviation. Broadly, international bodies tend to set out high level guidance which national bodies adhere to in setting more detailed policy.

At the highest level of management sits the International Telecommunication Union (ITU), a specialised agency of the United Nations. The ITU's International Radio Regulations allocate the spectrum from 9 kHz to over 275 GHz to a range of different uses. In some cases these are quite prescriptive, e.g. "satellite". In other cases they allow substantial variation, e.g. "fixed or mobile". The Radio Regulations also set out how countries should coordinate with each other and in the case of global services, such as satellite, provides a mechanism for the assignment of rights to individual users. The ITU conducts the key parts of its business through World Radio Conferences which are typically held every three to four years. These are events attended by thousands of delegates from spectrum managers and users around the globe where potential changes to the Radio Regulations are considered. In some cases the ITU may seek international spectrum allocations for particular uses, for example in previous years it has allocated spectrum to global low Earth orbit satellite systems (of which Iridium is an example) and in its 2007 conference is intending to discuss whether there should be a global allocation for 4G cellular