

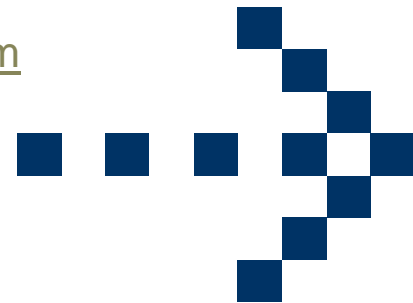
Spectrum Liberalisation

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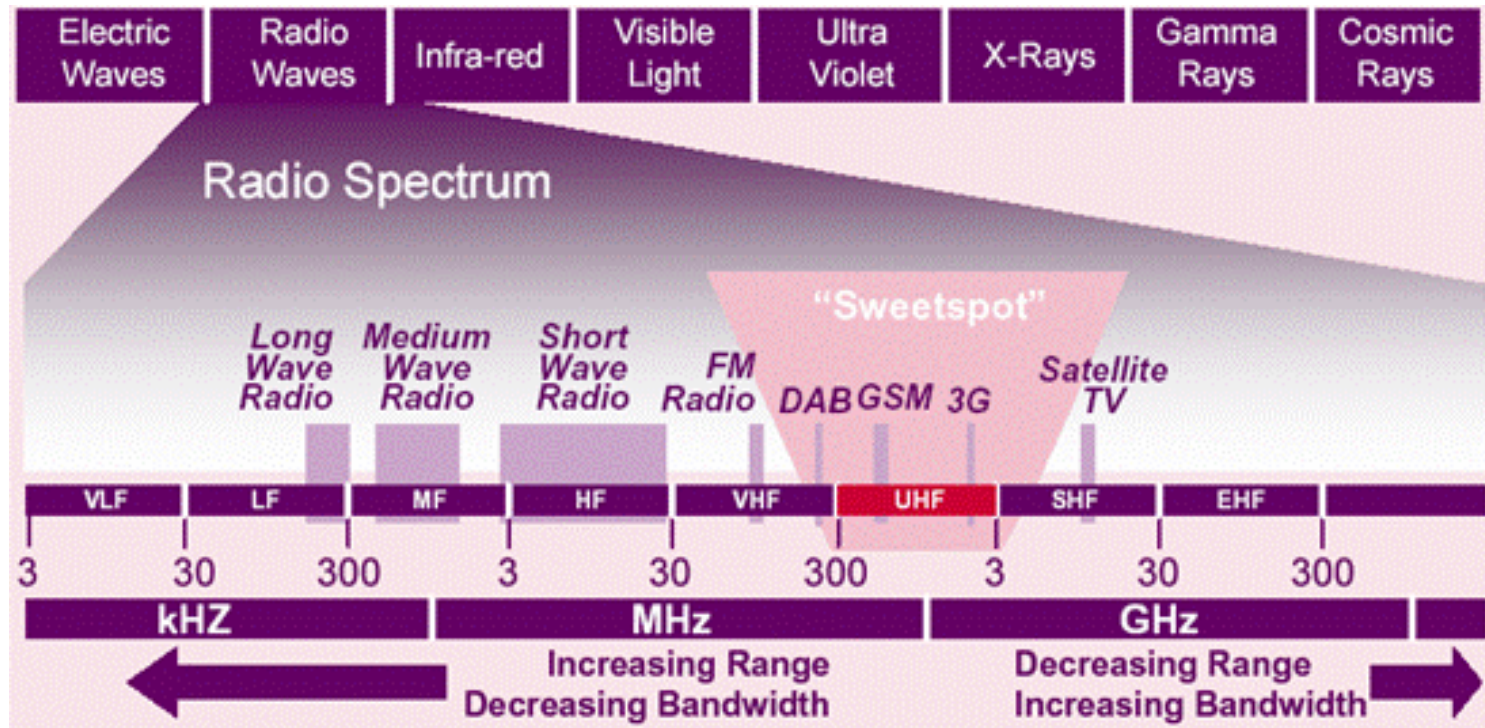
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Overview

- ⌘ Radio spectrum
- ⌘ Three models of access
- ⌘ Spectrum liberalisation
- ⌘ Auctions
- ⌘ Spectrum Trading
- ⌘ Incentive based spectrum prices
- ⌘ Summary

Radio spectrum



- ☐☐☐ Spectrum is accessible to all
 - ☐☐ Most valuable spectrum lies in the so-called sweet spot UHF band

Spectrum: an analogy with the oceans



- ❑ To avoid problems of interference and/or economic inefficiency, oceans are managed
- ❑ In some cases licences and prices are used

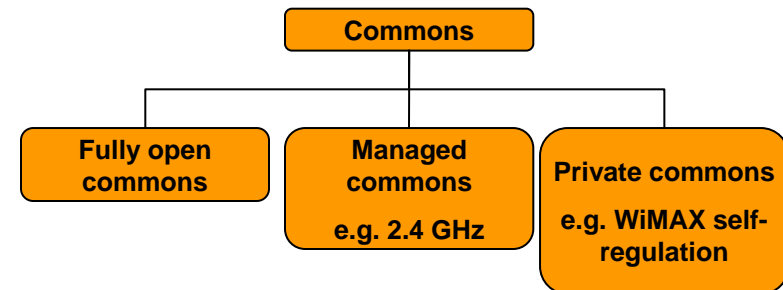
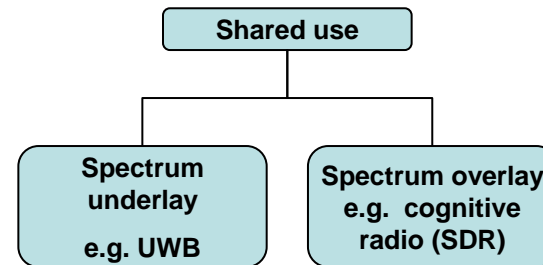
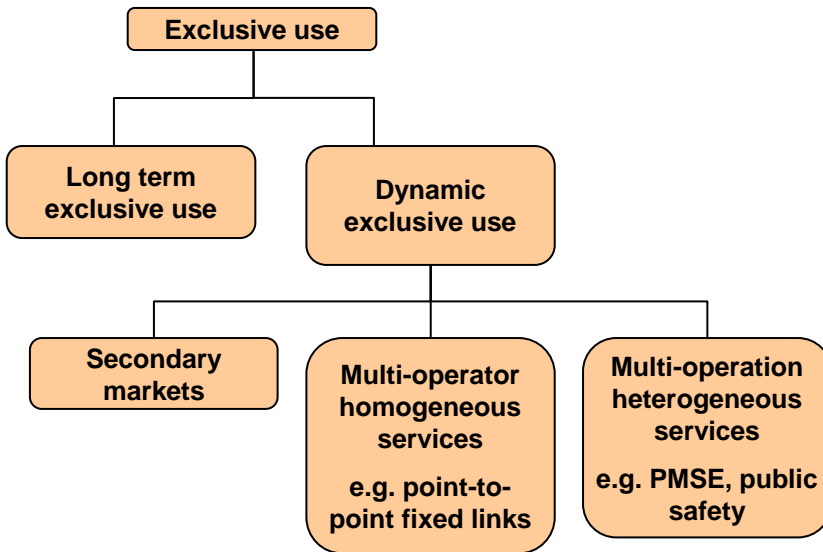
- ❑ The ocean is a common access resource
- ❑ Ocean value varies:
 - ❑ Marine fishing valuable in parts, less attractive in other parts
 - ❑ Leisure users have different values (surfers, swimmers, cruise boat users, etc.)
 - ❑ Commercial shipping fleets have values dependent on time
- ❑ Competing users

7-dimensional spectrum space (at receiver)

- ⌘ Frequency (1)
- ⌘ Time (2)
- ⌘ Spatial location (latitude (3), longitude (4), altitude (5))
- ⌘ Angle of arrival (azimuth (6), elevation angle (7))
- ⌘ Technology is evolving to enable more signals to share the same spectrum space
- ⌘ Smart antennas can narrowly focus beams
- ⌘ Modern frequency filters can resolve much smaller variations in frequency
- ⌘ Advanced signal processing (e.g. code spreading, digital filters)

Three models of access to radio spectrum

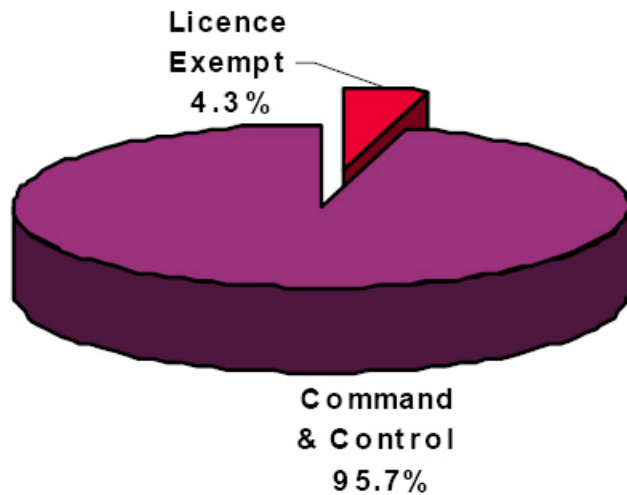
Trend is towards accommodating shared use and some commons



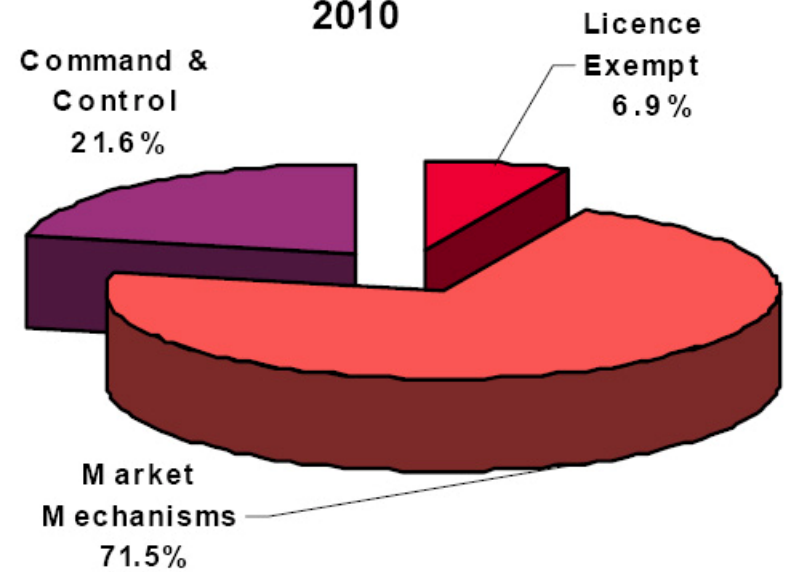
The exclusive use model is the predominant form of access today

Case example: Ofcom's 2004 vision

2000



2010



How Ofcom is achieving its vision

- ❑❑❑ November 2004: By allowing market forces to prevail wherever possible principally through:
 - ❑❑❑ Trading
 - ❑❑❑ Liberalisation
 - ❑❑❑ (SFR)
- ❑❑❑ January 2007: A more dynamic and market-oriented approach through inter-related projects of spectrum pricing, spectrum trading and liberalisation
 - ❑❑❑ (Modifications to Spectrum pricing consultation document)

Spectrum liberalisation

- ▣▣▣ Assignments via auctions
- ▣▣▣ Spectrum trading
- ▣▣▣ Liberalisation in use
- ▣▣▣ Unlicensed spectrum bands increased
- ▣▣▣ Underlays
- ▣▣▣ Overlays
- ▣▣▣ Transition through administered incentive prices

Spectrum auctions

- Many spectrum auctions have been held since 1989, with over \$200bn raised in revenue
- Most significant auctions have involved spectrum for mobile telecommunications
- Amount of spectrum allocated for mobile applications is relatively low
- Some authorities pioneering innovations auction formats (e.g. Ofcom and combinatorial clock auctions)

Spectrum trading

- ❑ Models include out right transfers through to concurrent use
- ❑ Transparency of market seems important
- ❑ Applied in only a few countries: Australia, Guatemala, Netherlands, New Zealand, UK, US (leasing)
- ❑ Trade is relatively thin – why?

Amount of trading in UK has been disappointing

	2004-05	2005-06	2006-07	2007-08 up to June 4 2007
Number of WTA Licences	54,614	54,220	54,000+	54,000+
Tradable licences	c900	c900	c900	000s
Number of completed trades	None	None	16	2

Source: TNR, Ofcom 5 June 2007

Setting spectrum fees

- ❑ The approach to setting spectrum fees in most countries is largely based on the exclusive access model
 - ❑ In some instances users share spectrum and this has been accommodated in fees
- ❑ The approach taken by most spectrum agencies is to set fees that typically recover administrative costs (the cost recovery model)
- ❑ In some cases countries collect fees in excess of administrative costs, using access to spectrum as a tax base (or as a consequence of incentive pricing, see below)

Pros and cons of cost recovery model

❑ Pros:

- ❑ Fees are usually straightforward and calculated related to quantity (bandwidth) and type of service
- ❑ Fees are low
- ❑ Satisfactory where supply exceeds demand (often the case for many high frequency services)
- ❑ Little incentive for administrator to manage costs

❑ Cons:

- ❑ Where demand exceeds available supply, opportunity cost not incorporated and this means:
 - ❑ Some users pay too little
 - ❑ Little incentive to use most efficient technologies
 - ❑ Spectrum is not directed towards the most valuable uses

Incentive based pricing of radio spectrum

- ❑ Fees for using radio spectrum should reflect economic value of radio spectrum
- ❑ What is the economic value?
 - ❑ This is the opportunity cost – the value foregone to society by permitting a piece of spectrum X be used for service Y
 - ❑ If the spectrum has no alternative use, then the incentive price should be zero as the opportunity cost is also zero
- ❑ How do we measure the value forgone?
 - ❑ This is measured by asking how much the marginal unit of spectrum would be worth in the best alternative use versus the current use
- ❑ How do we measure the best alternative use?
- ❑ The approach used is AIP – Administered Incentive Prices

AIP in practice

- ❑ AIP are based on calculating opportunity costs making use of ‘the least-cost alternative’ – emphasising the opportunity cost of assigning more/less spectrum to a use/user
- ❑ Method calculates willingness to pay for a marginal unit of spectrum
 - ❑ For example, the marginal unit of spectrum for a cellular operator may be 2 x 2.4MHz
 - ❑ The least cost-alternative for a cellular operator is the lowest cost way to meet current demand at the current quality level by adding/subtracting a marginal unit of spectrum to/from the operator’s existing spectrum holding
 - ❑ This cost provides a figure for the marginal value of spectrum to the cellular operator
- ❑ The calculated AIP is based on the ‘average’ operator
 - ❑ Some operators will be less than average and will find spectrum prices too high and either return spectrum to the regulator or improve production to lower costs

When are AIP unnecessary?

- ■ ■ Where spectrum has been assigned via auction it is not necessary to apply spectrum prices
- ■ ■ With auctions there may exist subsequent secondary trading possibilities
- ■ ■ Secondary trading may generate market prices rather than administrative prices
- ■ ■ In an ideal world, market prices would be equal to AIP

Summary

- ▣ Liberalisation of spectrum management has and is occurring in many countries
- ▣ The process towards liberalised markets necessitates a move away from command and control
- ▣ Countries that have embarked on spectrum liberalisation have not seen as much 'activity' as may have been expected
- ▣ Transition may require incentive prices – though these need to be calculated carefully

Essentials of Modern Spectrum Management

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