Spectrum Management fundamentals, policy and regulatory aspects for different services

Scope of presentation

- Purpose of SM
- Spectrum as a resource
- The objectives of national SM
- Changing context
- Impact on different services

A historic quote...

"Wireless communication is plagued by a shortage of space for new services. As new regions of the radio spectrum have been opened to practical operation, commerce and industry have found more than enough uses to crowd them."

Report by the US Joint Technical Advisory Committee , **1952**

Purpose of SM

- Spectrum has to be managed to ensure its *rational, equitable, efficient and economical* use by all radiocommunication services and users, taking into account that:
  - Interference is caused between radiocommunications systems unless sufficient isolation from each other is provided: in Frequency, Distance or Time domains
  - Radio spectrum is a finite resource in terms of instant capacity, although it is inexhaustible when used over time
  - New and new applications mean ever growing demand for new spectrum access opportunities. For physical/technical reasons, some parts of the spectrum have greater demand, e.g. VHF/UHF bands due to better propagation conditions
  - There is a need to ensure equitable distribution of spectrum – between operators within a country and between countries
  - There is a need to ensure spectrum use is well coordinated between various users within the same and neighboring countries

Spectrum as national resource

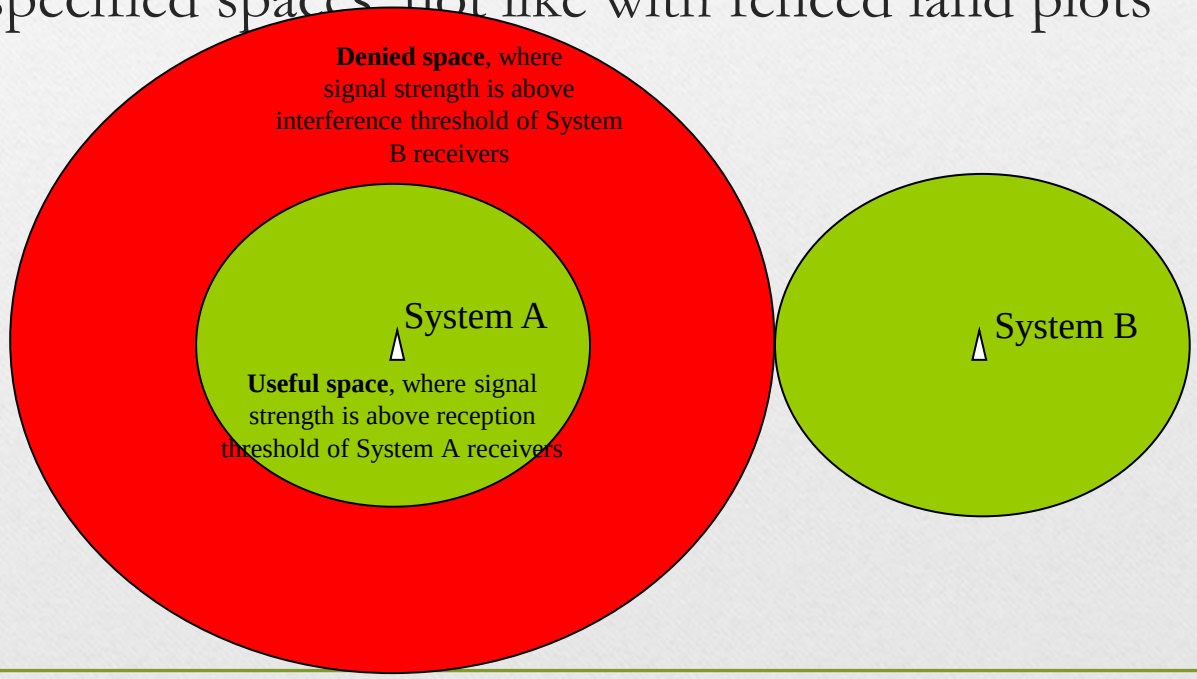
	Spectrum	Land	Oil	Water
Is the resource varied?	YES	YES	Not very	Not very
Is it scarce?	YES	YES	YES	YES
Can it be made more productive?	YES	YES	YES	NO
Is it renewable?	YES	Partially	NO	YES
Can it be stored for later use?	NO	NO	YES	YES
Can it be exported?	NO	NO	YES	YES

What economics would tell us

- Because frequencies differ in what they can do, there is an optimisation problem of matching them to particular uses - *compare with city planning*
- Spectrum can be in short supply in areas of high demand – the need for rationing its use and giving priority to more important applications
- Shortage of spectrum in particular bands can be addressed by moving to less favored frequencies or making more efficient use of spectrum (sharing, compression, MIMO) - *compare to bringing less fertile land into cultivation or applying fertilizer (extra costs) to make existing areas more productive*
- Because spectrum is fully renewable and cannot be stored, there is no reason to hoard it for later use, as a country might save oil reserves for use or sale later
- Spectrum demand is localised, it can only be used to provide services in a given territory. However, it can be traded, in the sense that property rights can be assigned to it – *compare to land trading*
- But...

But, differently from the land

- The spectrum use is hardly possible to contain within specified spaces, not like with fenced land plots



Contribution of spectrum to GDP

- By different estimates spectrum-based economic activities constitute up to several per cents of GDP

Service application	Equipment	Services	Total
Fixed links	0.01	0.01	0.02
Maritime[a]	0.01	0.02	0.03
Broadcast	0.09	0.19	0.28
Mobile	0.21	0.56	0.77
PMR[b]	0.03	0.03	0.06
Defense	0.00[c]	0.04	0.04
Total	0.39	0.81	1.20

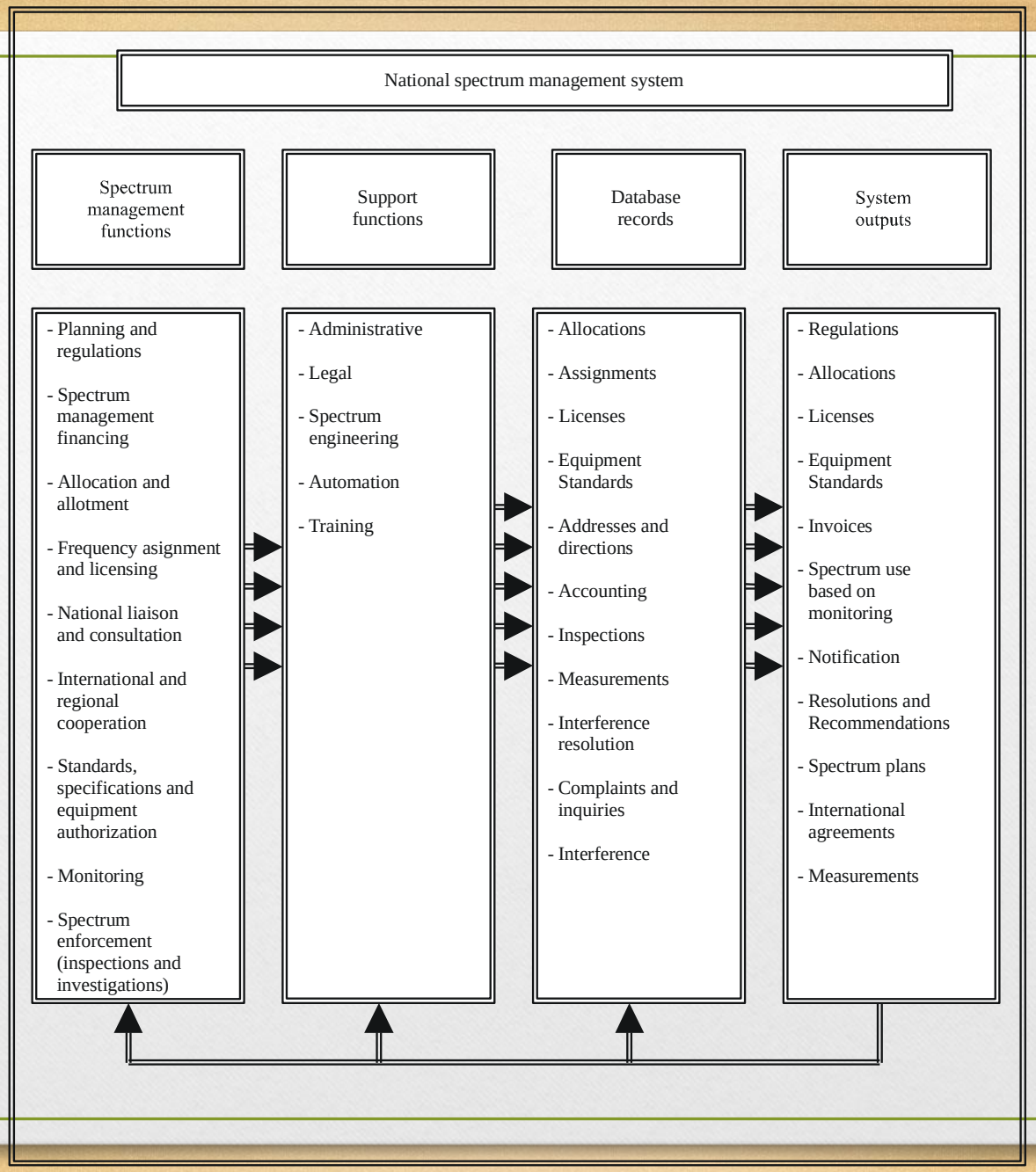
Source: DTA (2000).

Primary objectives of national SM

- To avoid interference between radio systems
- To meet international obligations (ITU RR)
- To satisfy the demand for access to the radio spectrum by all kinds of users
- To ensure rational distribution of spectrum to support safety, social, economic, security and defence requirements, according to national policies
- To protect existing services, while enabling the introduction of new services and technologies

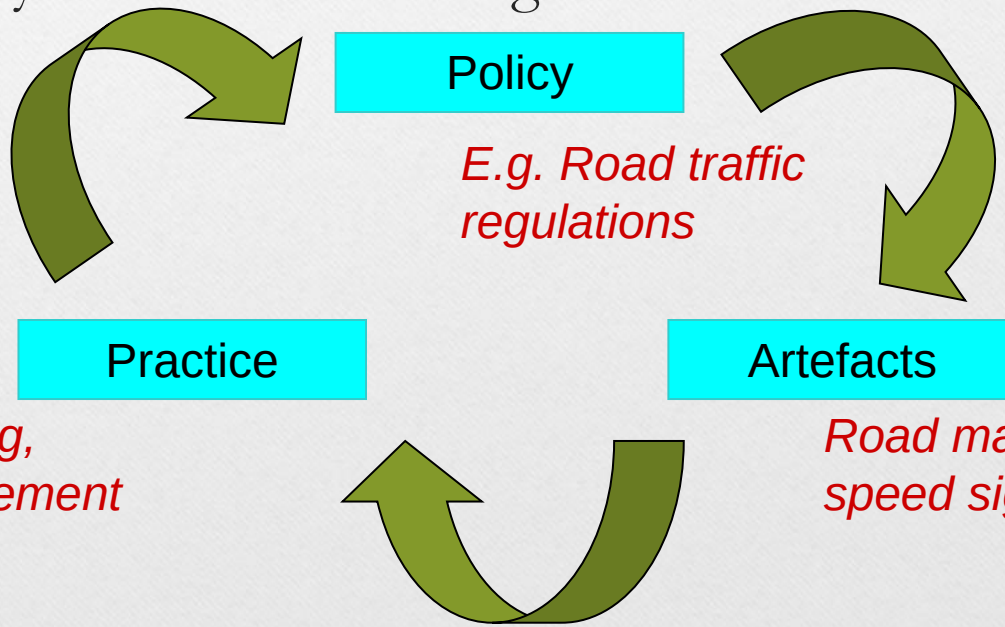
Main SM functions of NRA

- developing spectrum management policy and planning/allocation of spectrum
- frequency assignment and licensing
- standardisation and type approval of equipment
- spectrum control (enforcement and monitoring)
- international cooperation
- liaison and consultation with stakeholders
- administrative and legal support

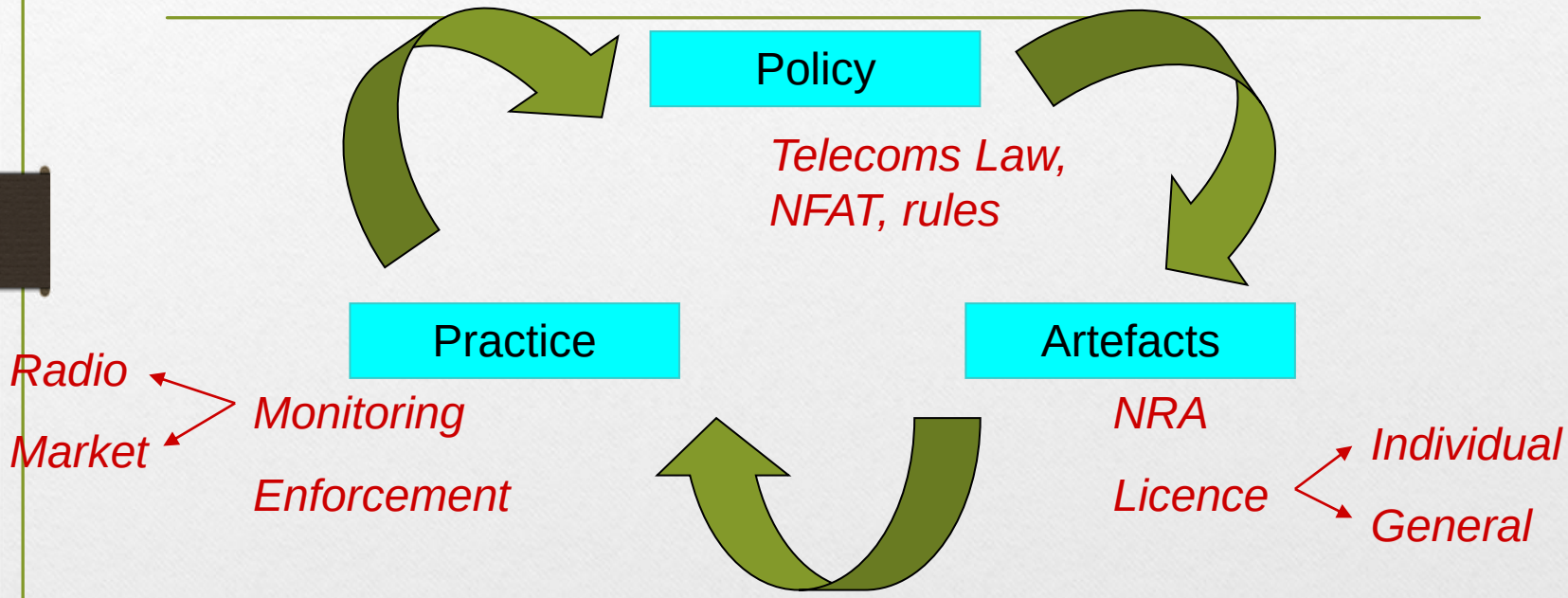

National spectrum management system
Spectrum management functions
Support functions
Database records
System outputs
- Planning and regulations
- Spectrum management financing
- Allocation and allotment
- Frequency asignment and licensing
- National liaison and consultation
- International and regional cooperation
- Standards, specifications and equipment authorization
- Monitoring
- Spectrum enforcement (inspections and investigations)
- Administrative
- Legal
- Spectrum engineering
- Automation
- Training
- Allocations
- Assignments
- Licenses
- Equipment Standards
- Addresses and directions
- Accounting
- Inspections
- Measurements
- Interference resolution
- Complaints and inquiries
- Interference
- Regulations
- Allocations
- Licenses
- Equipment Standards
- Invoices
- Spectrum use based on monitoring
- Notification
- Resolutions and Recommendations
- Spectrum plans
- International agreements
- Measurements

Societal aspects of regulation

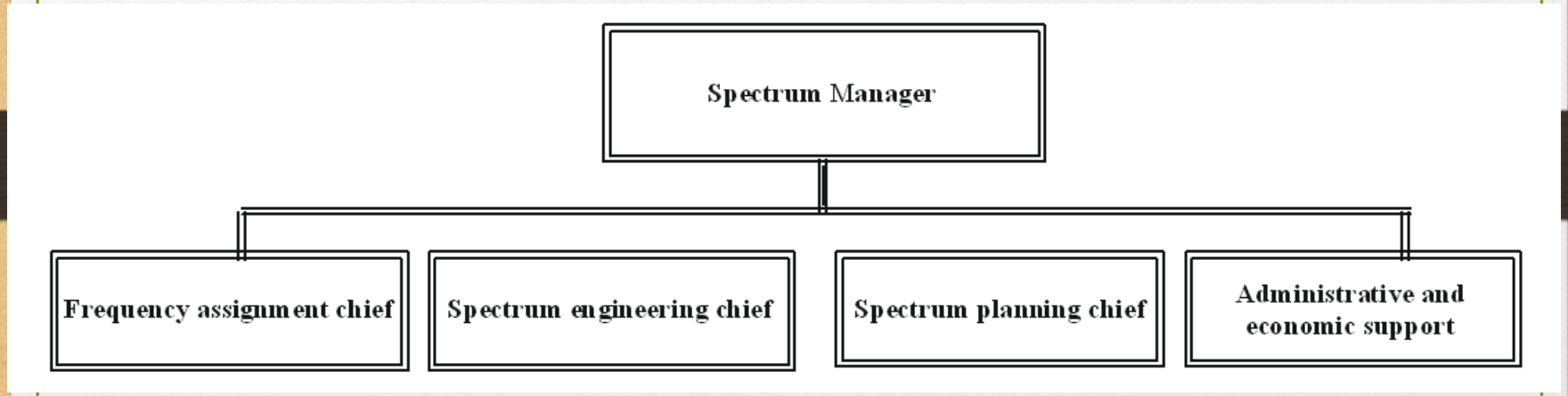
- There a need of holistic view on relations between society and artefacts of regulation



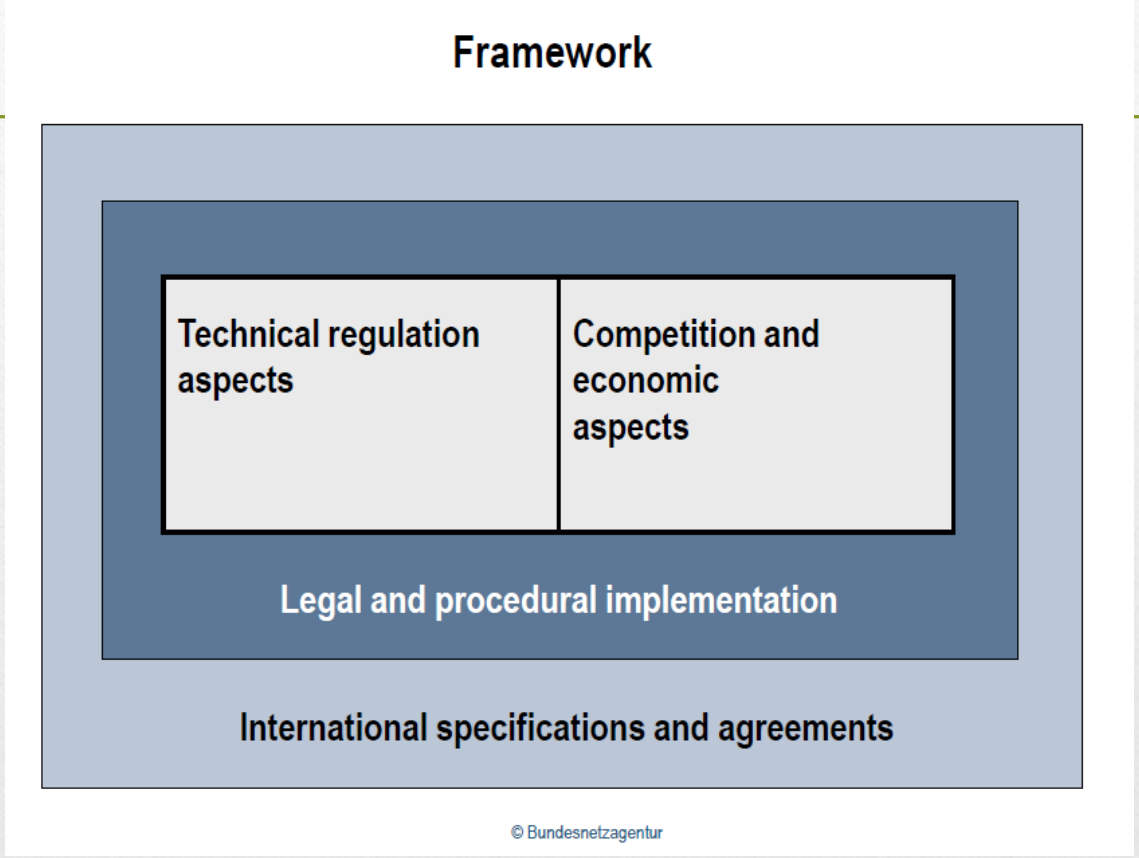
Societal aspects of national SM



Traditional national SM structure



Modern view on SM framework



Impact on different services

Spectrum partitioning

- Different services had been historically allocated

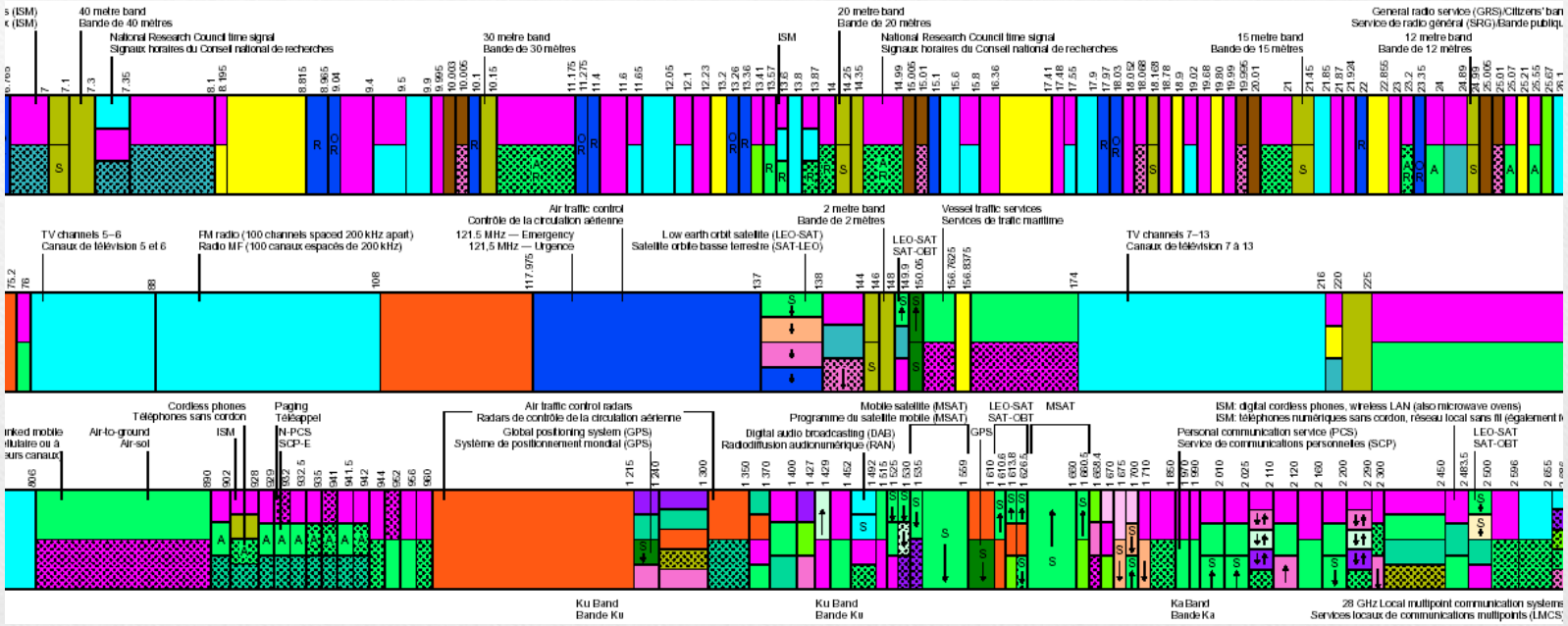
Frequency resources allocated for each application by frequency band (in %)

		Land-mobile	Mobile	Science	Broad-cast	Radio links	Satellite	Aeronautic Services	Ama-teurs	Total
VLF	3–30 kHz		20.1		0.0			79.9		100
LF	30–300 kHz		8.3		44.7			47.0		100
MF	300 kHz–3 MHz		36.1		32.0			30.3	1.4	100
HF	3–30 MHz		11.8	1.5	14.7	35.6		25.3	11.0	100
VHF	30–300 MHz	13.3	49.4	2.0	21.6			12.9	0.8	100
UHF	300 MHz–3 GHz	2.3	38.2	10.4	13.7	7.5		27.3	0.7	100
SHF	3–30 GHz		11.3	13.3	2.6	27.9	27.6	16.8	0.5	100
EHF	30–300 GHz		17.5	40.3	0.8	12.3	13.9	12.8	2.4	100

Source: Calculated using data from Jensen (2002).

Example spectrum allocations

- Just a bit of VHF/UHF spectrum...



The Radio Spectrum

"…there have been four core assumptions underlying spectrum policy:

1. unregulated radio interference will lead to chaos;
2. spectrum is scarce;
3. government command and control of the scarce spectrum resource is the only way chaos can be avoided; and
4. the public interest centers on government choosing the highest and best use of the spectrum.

Todays environment has strained these assumptions to the breaking point."

- FCC Chairman, Michael Powell, 2002

Modern trends

- The changing pace of innovation (much faster product life-cycles) and disappearing demarcation between different services (convergence) requires review of spectrum partitioning principles and assignment methods

	% of spectrum allocated in UK:	
SM method	Year 2000	Year 2010
Administrative	96 %	22 %
Market	0 %	71 %
Commons	4 %	7 %

UK Ofcom

Approaching the issues

- Need to proceed steadily but cautiously
- Market-based approaches are not a universal panacea
- Different services submit differently to the various spectrum assignment mechanisms
- The following slides provide a *simplified view* to illustrate the general trends

High demand localised services

- Examples:
  - Private Mobile Radio (taxi dispatch, logistics, etc.)
  - Services Ancillary to Broadcasting (aka PMSE, such as wireless microphones, portable cameras, etc.)
  - High Density Fixed Links in mm-waves (esp. 59 GHz and above)
- Characterised by high liquidity of assignments and localised interference potential
- Well suited for market-based spectrum assignment, secondary trading, industry self-regulation, band managers

Varying demand micro-use pattern

- Examples:
  - all kinds of so called Short Range Devices, from wireless car keys to human implants
- Characterised by low interference potential on the range of few (dozens) meters, manufactured and sold by small companies
- Best served by general licensing and common bands

High demand wide-area use

- Examples:
  - Public Cellular Mobile networks
  - Broadband Wireless Access (fixed/nomadic)
  - Satellite services
- Requires very large initial capital expenditure, long term investments, broad interference potential
- Possibility of market-based spectrum assignment (auction), dangers of hoarding, administrative incentive pricing and/or central oversight (spectrum use efficiency checks), technology neutral assignment to allow service evolution over licence duration (15-20 years)

Specialised, non-public services

- Examples:
  - Defence, Public Protection Disaster Relief
  - Maritime, aeronautical, radionavigation services etc.
- Characterised by varying demand, specific requirements, non-commercial value definition
- The administrative spectrum assignment and central oversight is likely to remain the sole means for their SM
- Some measures might be considered to avoid spectrum institutionalising/hoarding, e.g. through administrative incentive pricing, or flexible spectrum access provisions, e.g. for PPDR

Conclusions

- Spectrum Management remains the crucial factor in wise and efficient utilisation of radio spectrum resource
- Modern environment poses a lot of new challenges for spectrum managers, requiring to innovate and adapt constantly
- A wise combination of administrative and market-based mechanisms is required to address differing needs of various services