

Spectrum market or spectrum commons?

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Note: These are preliminary notes, intended only for distribution among the participants. Beware of misprints!

Background

- How the RF spectrum resources are used and managed, has profound impact on the society, its prosperity, education, culture, and security.
- Radio and satellite industries have become multi-billion-dollar businesses, being at the same time subject of national and international regulations and agreements.

Background

- Current management, regulations and treaties consider the radio frequency spectrum and satellite orbits as common heritage shared by the whole of humanity
- That approach was created when the radio and space activities were the governments' monopoly

Changing environment

- The influence of private entities is growing and the role of governments is changing.
- There is growing congestion of the radio spectrum and orbital positions
- There are opinions that the present regulatory system needs to be reviewed/changed.

2 views on spectrum

- “Economists”
- “Engineers”
 - » [Raja & Bar]

“Economists”

- Define property-rights
- Market mechanism to replace the present allocation, use, and management (spectrum to be traded, aggregated, divided, used, etc.)
- The “WTO spirit”

“Engineers”

- Eliminate all barriers to innovation
- No property-rights, Keep the spectrum resources as “Commons”
- Seek new technical solutions to make it working
- The Internet or “open source” spirit

Interference

High predictability Low severity	High predictability High severity
Low predictability Low severity	Low predictability High severity

History

1822: Concept of spectrum (Fourier)

1873: Concept of radio waves (Maxwell)

- Abstract concept of no practical value

History

- 1888: First experiments with radio waves (Hertz)
- 1895: First experiments with wireless communications (Marconi, Popov)
- A physical object expected to have some value for military & maritime applications

History

1901: First transatlantic wireless transmission

- Spectrum is a natural resource open to all like air, from which everybody can profit freely
- Its use requires coordination (interconnection problems) - it is shared

1906: First Radiotelegraph Conference in Berlin (27 States)

History

1910: First aviation radio

First world war: technological progress

1921: First broadcasting networks

- Private business involved
- Power race, radio interference, chaos

1925: “...no more spectrum available” declares a US Secretary of Commerce

- Spectrum is a scarce resource

History

1927: Creation of International Radio Consultative Committee (CCIR) to study questions related to radio communications.

- Membership open to non-governmental entities,
- Concept of Radio Services
- Spectrum allocated to separate services
- First International Frequency Allocation Table covering 10 kHz - 60 MHz

History

1932: Integration of Radio, Telegraph & Telephone regulatory activities in the framework of the International Telecommunication Union (ITU)

- Spectrum congestion/ scarcity
- Must be regulated by an intergovernmental telecommunication organization

History

1934: The Federal Communications Commission (FCC) created in the USA

- Charged with regulating internal and international communications by radio, television, wire, satellite and cable.
- An independent government agency, directly responsible to Congress.
- Directed by 5 Commissioners appointed by the President and confirmed by the Senate for 5-year terms.
- The President designates one of the Commissioners to serve as Chairperson.
- Only three Commissioners may be members of the same political party.
- None of them can have a financial interest in any Commission-related business.

History

1939: First commercial TV

2nd world-war: technological process

1947: Creation of International
Frequency Registration Board (IFRB) and
International Frequency List

- Spectrum use is to be registered and controlled internationally

History

1949: The ITU became the United Nations' specialized agency for telecommunications

- Spectrum is a “common heritage of mankind”

1957: First artificial Earth satellite

1963: First World Space Radiocommunication Conference

- The geostationary satellite orbit included into spectrum concept as a common heritage of all people

History

1989: First trade-able rights in radio frequencies in New Zealand

- Privatization: Spectrum becomes a sellable commodity
- Spectrum market

1993: FCC for the first time treated spectrum as a private good and auctioned it [Raja]

Licensing

- The use is controlled via licensing
- QoS guaranteed implicitly via interference control
- Interference is controlled via technical rules, standards, protocols, restrictions, and clear legal responsibility

Licensing

- Spectrum allocation to specific users/ uses as defined by governments and intergovernmental treaties
- Government-defined rules specify license eligibility and restrictions
- Licensing specifies who, when, where and how can use the spectrum/ orbit

Licensing

- Those without license not satisfied
- Question raised:
 - Distortion of economic system; Inadequate consideration of economic factors
 - Rigidity, reallocation and transferring impossible
 - Some portions of spectrum unused, used sporadically, or reserved for future use
 - When the licensee does not transmit, his spectrum is not used but is still denied for others

Licensing

- Apparent congestion
- Scarcity?
- Demand exceeds supply, no place for new applications
- Difficult, expensive, and time-consuming management & monitoring
- Expensive license fees

Property-rights

- Spectrum is treated as private property.
- The owner has exclusive and transferable rights to use, aggregate, divide, buy, sell, etc.
- Responsibility for interference
- Maximize the owner's profit

Spectrum commons

- Unlicensed users share frequencies
- No rights to protection from interference,
- Rules imposed and etiquette expectations to eliminate interference
- Maximize the access to spectrum resources

Unlicensed spectrum

- No licenses are granted
- Any device is allowed to transmit
- Interference controlled via imposed rules, standards, restrictions, , etiquette, and built-in protocols
- No legal responsibility for interference

Unlicensed spectrum

- Simplification for new users
- Simplified management
- Forces spectrum sharing
- Potential for greater efficiency
- Limited (presently) interference control
- QoS not guaranteed
- Spectrum that is freely available may be used for applications of negligible value

Spectrum auctions

- [Peha] Auctions may be used for revenue generation for government. However, maximizing revenues is not always in the national interest.
- Auction participants are trying to maximize their profits rather than serve the public good.
- It is hoped that in a free market these two goals will roughly coincide, but sometimes they completely diverge.
 - One example is if firms can bid on a license that would give the winner a monopoly. This license to overcharge consumers will therefore bring in more money in the auction, but is certainly not in the public interest.

Spectrum auctions

- Government influence auction revenues by controlling when spectrum is released and how much.
- Creating artificial scarcity, i.e., not releasing much spectrum at once may maximize long-term revenues .
- Releasing too much spectrum too quickly may maximize short-term revenues.

Spectrum auctions

- European auctions for UMTS licenses gave some US \$100 billion in recent years
- Increased prices of telecom services
- Contributed to bankruptcy of many telecom companies and to general crisis
- Most of that money was not used for further telecommunication development but for other purposes

Innovation- Commons regime

- Open network
- Device market
- Anybody can innovate
 - Example: development of internet, ISM-WLL, amateur radio
- Support innovation and the rapid expansion of new networks and services

Innovation - Property rights regime

- Closed network
- Infrastructure market
- Owners of the spectrum property would not accept innovation unless it fits their revenue models and capacity to own it

Welfare - Commons regime

- No mechanism to limit spectrum congestion
- Lack of incentives for efficient use of spectrum
- Devices optimized for cost rather than conserving spectrum

Welfare - Property-rights regime

- Built-in mechanism to limit spectrum congestion
 - Spectrum market regulates demand and supply by rising the price
- Spectrum is used by those who value it most (wealth criterion)

Possible future

- Eventually, technology may remove the need for some functions now included in spectrum management.
- Future radio systems will be able to automatically coordinate among themselves the best use of spectrum resources.

Future spectrum engineering

- Software-defined radio
 - Senses the radio environment
 - Selects appropriate frequency, time, direction, protocol, etc.
 - Negotiates access conditions with other users
 - Arranges for transmission
- Applicable in unlicensed “commons” regime and in “property-right” regime

Future – property rights

- The equipment explores the environment
- Identifies the local spectrum users (systems, protocols, possibilities, etc.)
- Communicates with them to request the right to transmit
- Negotiate conditions/ price for each transmission
- Starts and completes the processes of authentication, transmission, transferring payment, and monitoring actual usage to make sure that all transmissions are paid for

Alternative solution

- Another method of providing access is for a device manufacturer to pay for every new device created and sold
 - For example, for every device operating at a given frequency that Nokia sells in Canada, it would pay a fee to the holder of the Canadian license at that frequency.

Future - Commons

- The same operations as previously
- The price is replaced by prioritization rules
 - The rules are commonly agreed
 - They are embedded in the software or hardware
- Example
 - An emergency phone network shares spectrum resources and has the highest priority. When operating, it has the exclusive access to spectrum automatically. When it does not operate, the resource is open for use by others.
 - Teledesic

When?

- Self-adaptive software-defined radio systems are now finding various cost-effective applications.
- However, in view of enormous investments in the “old” equipment, the “new” systems will not be popular soon.

Concluding remarks

- New policy concepts are appearing
 - *Flexible use doctrine*
 - *Spectrum market*
 - *Unlicensed spectrum access*
- None of the available publications on these concepts addresses adequately the doctrines prevailing until now:
 - *Common heritage doctrine,*
 - *Common benefit doctrine,*
 - *Special needs of developing countries doctrine*

Discussion

- Re-evaluation of concepts, policies, and practices governing the uses made of the radio waves and satellites is taking place.
- All intellectuals, engineers, economists, business executives, scientists, lawyers, and politicians should be involved in that discussion.

Discussion

- As long as the spectrum/orbit is considered a common heritage of the humanity, everybody has the right to express his/her ideas publicly.
- Those who understand its role and problems should use that opportunity.

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