ITU Seminar
"Economic aspects of national radio frequency spectrum management"
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Spectrum market or spectrum commons?

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Note: These are my personal views.

Outline

1. What is the RF spectrum?
2. ITU approach
3. Views on spectrum reform
4. Private or open spectrum?

What is the RF spectrum?

- Abstract concept of no practical value
  - 1822: Mathematical concept of spectrum (Fourier)
- Physical object of no practical value
  - 1888: First experiments (Hertz)
- Communication medium with no business value
  - 1895: military maritime applications only (Marconi, Popov)

- Business
  - 1901: First transatlantic radio transmission (Marconi).
  - A natural resource, open to all like air, everybody can profit -- Private business develops.
  - Interconnection (fees) and mutual interference problems require international coordination.
  - 1906: First Radiotelegraph Conference in Berlin (27 States)

– 1910: First aviation radio. First world war technological progress.
– 1921:First broadcasting networks → politics involved directly. Private radio business boom. Power race → radio interference → chaos.
– 1925: "***...no more RF spectrum available...***" declares a US Secretary of Commerce

– 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
  - Now BR & BDT Study Groups

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.

- 1932: Radio, Telegraph & Telephone regulatory activities integrated into a common framework of the International Telecommunication Union (ITU)
- 1947: International Frequency Registration Board (IFRB) and International Frequency List created
    - Spectrum use is to be registered and controlled internationally if is to enjoy recognition
    - Now Radiocommunication Bureau

- 1949: The ITU became the United Nations' specialized agency for telecommunications
- 1957: First artificial Earth satellite
- 1963: First World Space Radio. Conference
    - The geostationary satellite orbit included into spectrum concept as a common heritage of all people
- Spectrum & Geostationary Satellite Orbit = = a "Common Heritage of Mankind"
  – All treaties concerning the FR use & management, consider the RF spectrum and satellite orbits as common heritage shared by the whole of humanity.

- Radio and satellite industries
  - A cost-effective means to assure social („Information Society”) and economic („Global Market”) development of nations
  - A multi-billion-dollar business
- How the RF spectrum resources are used has profound impact on the society, its prosperity (business, jobs), quality of life (education, culture), and security
- Governments are under pressure from business and from civil society activitsts

- 1989: Liberalization wave started
  - First trade-able rights in radio frequencies (New Zealand)
  - Privatization: Spectrum becomes a sellable commodity
- There are opinions that the present regulatory system needs to be fundamentally changed

Internationalization

- Coordination
  - ITU
  - WTO (Trade)
  - ICAO (Aviation)
  - IMO (Maritime)
  - CEPT
  - EU
  - IEC (Electricity)
  - ISO, ETSI (Standards)
  - CISPR (Interference)
  - Industrial Forums

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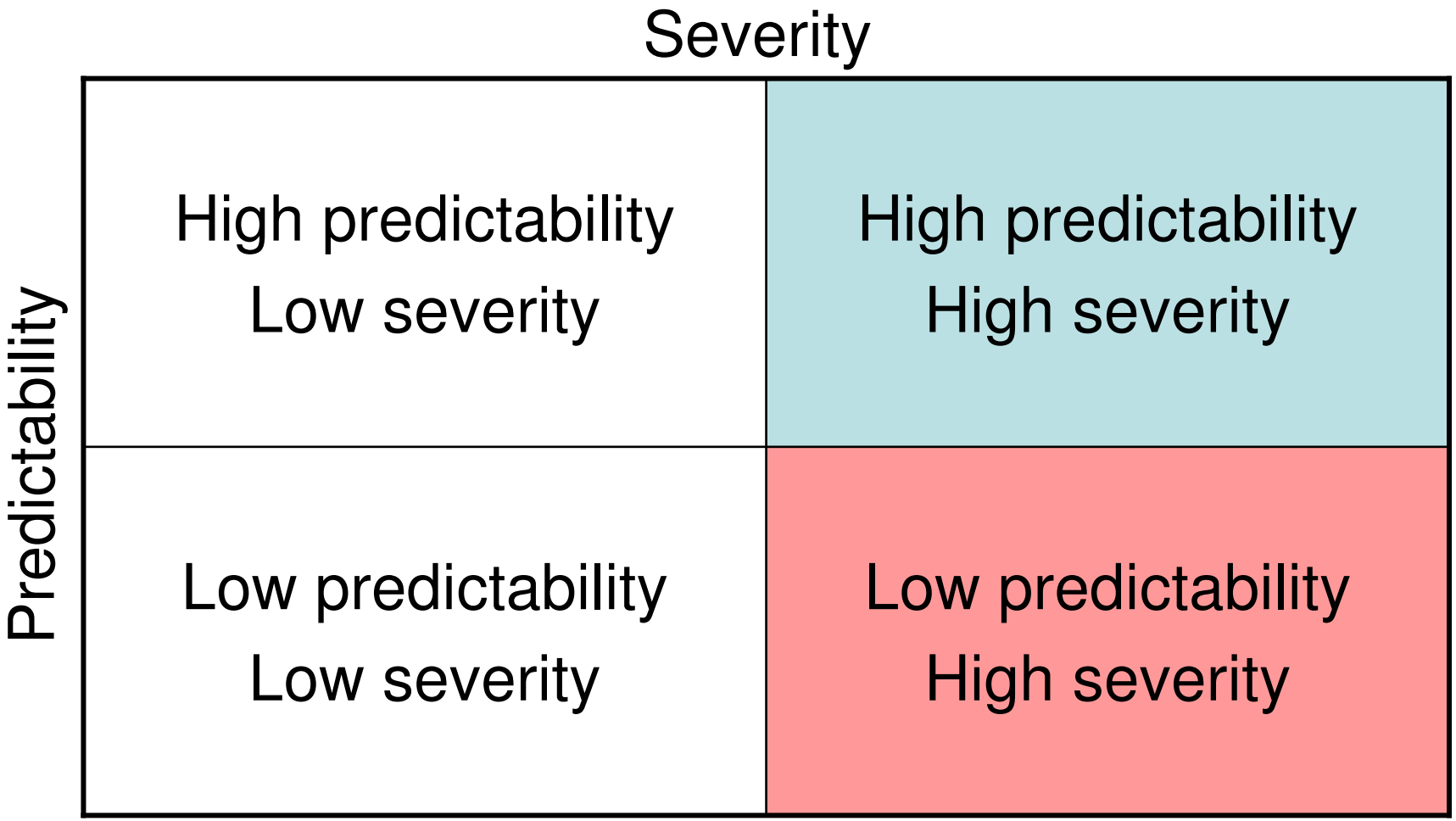
ITU approach

- Since 1906 Conference, ITU is the central place for negotiations, coordination, and collaborative long term planning
  - Governments & private sector
- Needs & proposals of member countries are regularly reviewed and updated at ITU radio conferences, but to satisfy all members, it is a long process
- Avoiding interference - a major topic

Interference



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Source: ITU News 1/90

ITU RR

International
Telecommunication Union
Place des Nations,
CH-1211 Geneva 20

http://www.itu.int

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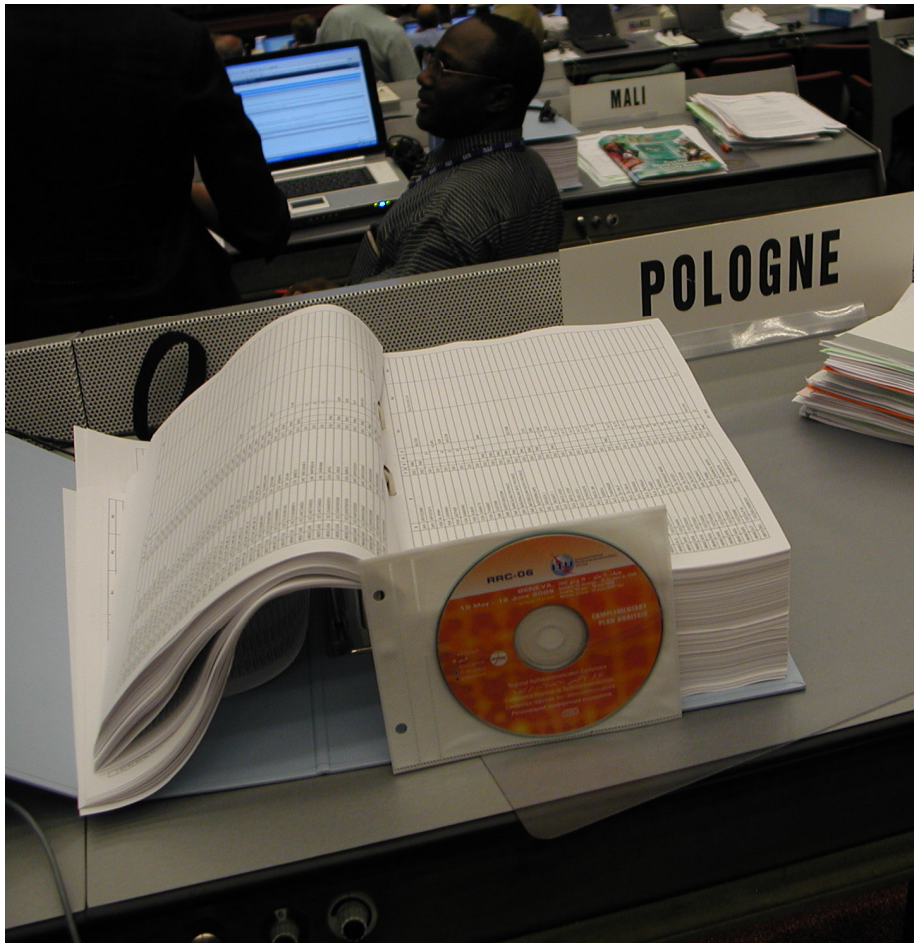
Example: GE-06



6-year pre-conference preparations

Work in Geneva

- 34 days
- 22 plenary sessions
- 48 committee sessions

Participation

- 972 delegates
- 38 observers
- 104 countries

Calculations

- CERN Super-computer & Grid Network

Results

- Accepted Plan for DTV
- 2094 pages A4

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Regulatory doctrine

- To protect the existing users & investments made
- To assure order & predictability
- To solve (avoid) interference problems
- To assure inexpensive radio services→ mass market across the Globe (e.g.. GSM) via standardization of equipment and transmission methods

- To protect society from abuse of market power, to achieve social objectives (e.g. universal services) , [Haucap and Marcus]
- To facilitate central management of shared resources
    - Analogy to management of telephone numbers and/or internet domain-names; (Haucap and Marcus)
- To guarantee QoS via interference control, technical rules, standards, protocols, restrictions, and clear legal responsibility

Criticizm of current practices

- Those without licenses not satisfied
- Question raised:
  - Too slow
  - Too expensive
  - Too many organizations
  - Too many coordinations
  - Too much bureaucracy
  - Difficulties for newcomers

- Excessive control
- Rigidity: blocking unused frequency bands
- Delaying innovation
- 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

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Views on spectrum reform

- "WTO spirit"
  - Replace the present negotiation/ collaboration ITU system and regulatory mechanism by market mechanism
- „Internet spirit"
  - Eliminate barriers to innovation
  - Seek technical solutions to make it working
  - Keep the frequencies as "Commons"

“WTO spirit”

- Spectrum and positions on the Geotationary Satellite Orbit treated as private property.
- The owner has exclusive and transferable rights to use, aggregate, divide, buy, sell, etc.
- Regulations replaced by market mechanism (= the owner’s profit maximization)
- Responsibility for interference
- The present ITU negotiation system (consesnus) system replaced by WTO negotiations

Spectrum-market doctrine

- Economists: the spectrum is a profitable resource and should be treated in the same way as all other resources, i.e. via market
- Benefits
  - 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)
  - Flexibility, “natural selection” of the “best” uses & users (as they seek maximum profit)
  - Automatic „management” through market forces

- Drawbacks
  - Lack of incentives for efficient use of spectrum: Devices optimized for cost rather than conserving spectrum
  - Closed network: Infrastructure market
  - Owners of the spectrum property would not accept innovation unless it fits their revenue models and capacity to own it
  - Auction participants are trying to maximize their profits rather than serve the public good.
  - Social aspects ignored (E.g. Universal Access, Not-for-profit uses)
  - [Peha] Auctions may be used to revenue generation for government. However, maximizing revenues is not always in the national interest.
    - Monopoly threat: 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.
    - Some people hoped that in a free market these two goals will roughly coincide, but sometimes they completely diverge.

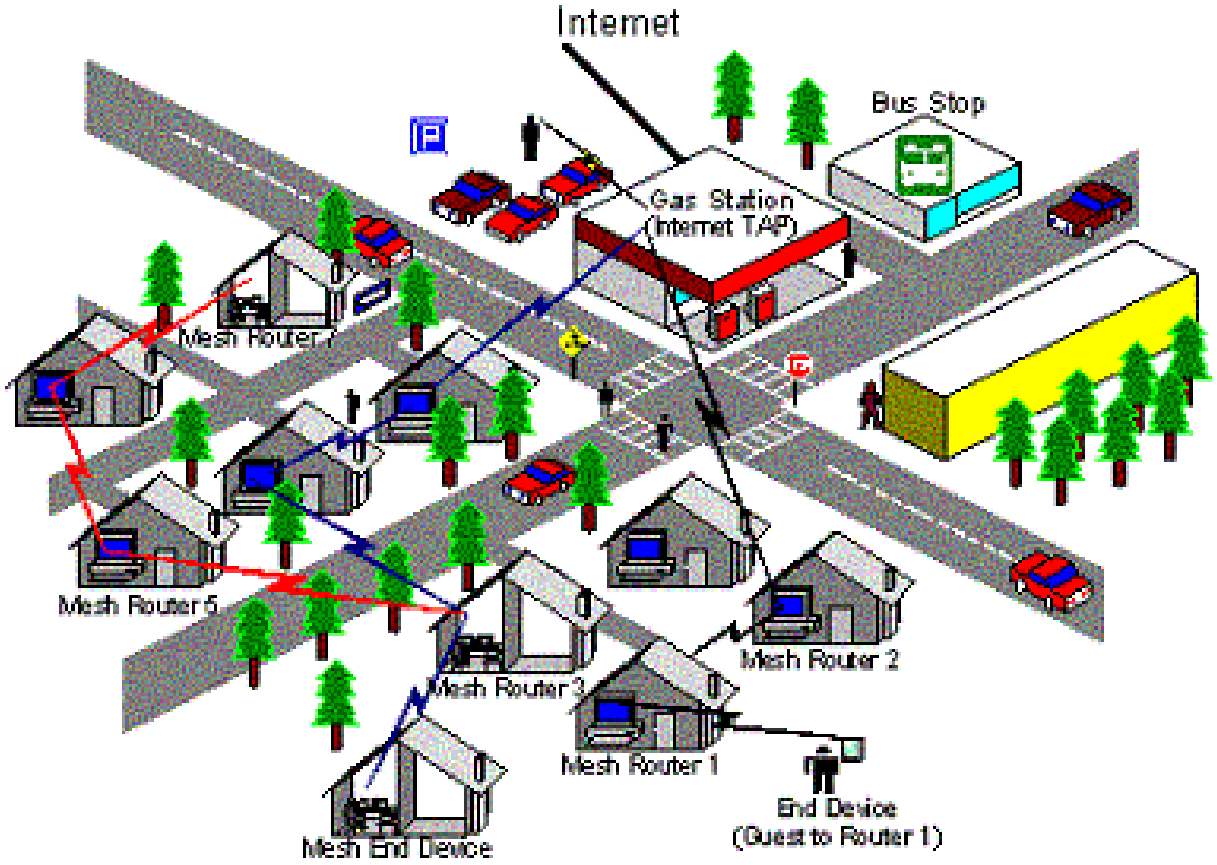
„Internet spirit”

- Keep the RF spectrum resources as “Commons”:
  - Unlicensed users share frequencies
  - No individual licenses are granted
- Seek technical solutions to make it working
  - Interference controlled via built-in rules, protocols, standards, restrictions, etiquette (hardware /software)

- Benefits
  - Open network: Device market
  - Simplification for new users & management
  - Any device is allowed to transmit
  - Potential for greater efficiency:
    - Forces spectrum sharing (efficiency)
  - Maximize the access to spectrum resources
  - Eliminate barriers to innovation
    - Anybody can innovate: Support innovation and the rapid expansion of new networks and services

- Drawbacks
  - No mechanism to limit spectrum congestion
  - Limited interference control (presently)
  - QoS not guaranteed (presently)
  - Only „intelligent” systems able to work
  - No legal responsibility for interference
    - No rights to protection from interference
  - Spectrum that is freely available may be used for applications of negligible value

Mesh networks



[Microsoft]

- Multiple-service signals hop from one device to another until the destination is reached
- Similar to the wired Internet with dynamic routing

Source: http://research.microsoft.com/mesh/

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Private or open spectrum?

- We are unable to predict what will happen, but we know current trends will continue
- Technology will not solve the problem: Technology is ideology- and politically-neutral
    - The SDR, quantum electronics, nanotechnology, etc. will work as well with the spectrum-market, as under the open-spectrum doctrine

- The society is composed of various groups
  - Each with its individual interests, goals and world-views
- Those, whose needs have been satisfied, are against any change
  - Any modification would threaten their acquired benefits
- Newcomers, with no access to the spectrum resources press for changes.

- What is the best for one group is not necessarily good for another
- Spectrum management reflects:
  - The status of science and technology
  - The relative balance of powers of the competing interest groups
  - The „inertia” → earlier investment in infrastructure & devices
  - The prevailing „ideology”

- One day, self-organizing cooperative radio networks will make most of the current spectrum management practices obsolete
- Access to RF spectrum will be free – companies will pay for using it!
- When will it happen? Not sooner than
  - New technologies are inexpensive
  - The investments already made in radio pay off
  - Interests of the present spectrum users are duly accounted for
  - There is a political will

Thank you

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Formerly, Prof. Struzak was employed as Acting Assistant Director & Head of Technical Department, CCIR-ITU; Visiting Professor, Institut National Polytechnique de Toulouse (F); Full Professor, University of Information Technology and Management, Rzeszow (PL); Professor, Wroclaw University of Technology (PL); Research Professor & Head of NIT's Wroclaw Branch (PL); Editor-in-Chief, Global Communications, (UK), as well as Consultant to ITU, OCHA, WB, IUCAF, PWC, and other entities. He co-founded and chaired International Wroclaw Symposium on EMC. He published some two hundred publications in radio science and engineering.

Prof. Struzak was active in international organizations: ITU-RRB; ITU-CCIR; URSI; IEC-CISPR, where he was elected to leading positions. Among others, he was elected (and then re-elected) a Member and then the Vice-Chair of the ITU Radio Regulations Board. He is a recipient of the ITU Silver Medal and two International Awards (Int'l Symposiums on EMC in Montreux and in Rotterdam), an IEEE EMCS "Acknowledgment of Gratitude" and numerous national awards and decorations. International Biographical Centre listed him among the "Leading Scientists of the World".

Prof. Struzak has been elected to the grade of a Fellow and then a Life Fellow of IEEE, a Member of the New York Academy of Science and an Academician of the International Telecommunication Academy.

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- ***Important notes***.
  Beware of misprints!!! These materials are preliminary notes for my lectures and may contain misprints. If you notice some, or if you have comments, please notify the author.