Spectrum Use and Coordination

ITS 214

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Spectrum is Limited

- In one place, you can use a given range of frequencies only once
- Every channel must be efficient
- Every channel must operate with acceptable (low) incidents of bit errors
- If you have 1 MHz of spectrum, what bit rate can you get
  - It depends...

Meet Mr. Shannon

- Information Theorist
- Remind you of Nyquist?
- Maximum bit rate on a channel decreases with the noise level
- There is a formula - it computes the theoretical best case
  - The 1 MHz Channel
    - 10-50 Mbps or more on a very strong channel (WLAN)
    - a few Mbps for small battery-powered devices (Cell Phones)
    - a few hundred kbps in bad conditions (military communications)

Only one station at a time!

- Spectrum use must be coordinated
- Internationally
  - Long range transmissions can interfere with each other
    - Radio and Television
    - Military and Public Safety Systems
    - Satellite Systems
  - Manufacturers prefer coordination
    - Less variation in equipment
    - Lower prices
The ITU
- International Telecommunications Union
- Agency of the UN
- ITU-T sets telecommunication standards and coordinates international telephone numbers
- ITU-R coordinates satellite placement and makes recommendations for spectrum use
- The ITU does not own black helicopters (as far as I know...)

ITU Recommendations

In the US

US Spectrum Regulation
- FCC is the US representative to the ITU
- Regulates all spectrum use except for federal users
- Issues licenses for spectrum use
- NTIA issues Authorizations for spectrum use by
  - DOD (Military)
  - CIA, Homeland Security, etc.
- NTIA/FCC hold monthly coordination meetings
Licensing Methods

• Primary/Commercial License
  • Comparative Bidding
  • Lottery
  • Auctions
  • Blanket Licenses (aka Free-For-All, aka Unlicensed)
• Experimental/Secondary Licenses
  • May be asked to “cease and desist” (aka quit doing what you are doing)

Comparative Bidding

• The original option
  • License applications are evaluated based on technical merit
    • Often there is only one application; FCC just wants to make sure the service works
    • If there is more than one application, pick the technically better one
    • Hard to implement for large numbers of applications for the same spectrum

Lottery (really...)

• Variation on Comparative Bidding
  • Select all applications that are “technically sound”
  • Conduct a random drawing among the technically equivalent applications to pick a winner
• In practice
  • Applications are filed by speculators who hire engineering firms
  • Licenses, once obtained are traded (in some cases many times before anyone actually uses the license)

Auctions

• What happened in the Lottery?
  • The winner creates a market (sometimes using an auction) to get the best price for the license they just won
  • Why not start with an auction?
  • Economists like markets and auctions because companies are likely to pay what they think a license of worth to them -- the winner should be the one who will create the most value
  • This fails sometimes, several European 3G license auction winners went bankrupt before deploying services


Unlicensed

- Licenses are used to make sure there is only one user

- What if the technology or the users can coordinate among themselves?
  - Wireless LAN protocols
  - Walkie-Talkies and CB Radios

- FCC can issue technical rules, and we can use any device that adheres to the rules.