Spectrum Use and Coordination

ITS 214
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 1MHz 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

ITU

National Agency

Regional Group

National Agency

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In the US

ITU

NTIA

FCC

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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.