Federal Communications Commission

Stanford Institute for Economic Policy Research (SIEPR)

Incentive Auction Design Conference

Forward Auction Band Plan

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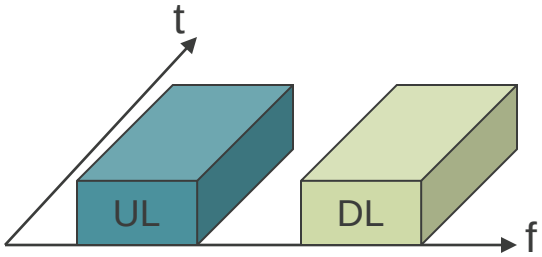
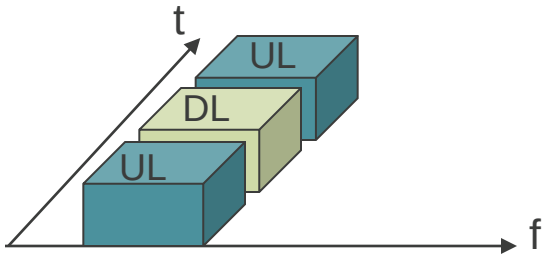
Introduction

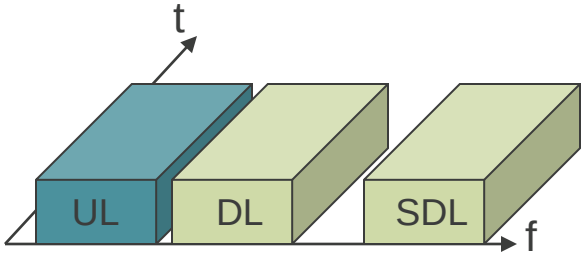
- The forward auction band plan defines the “lots” that will be auctioned, which are blocks of spectrum
- Three areas of discussion today
  - Technical characteristics of spectrum blocks
    - FDD (frequency division duplex)
    - Supplemental downlink
    - TDD (time division duplex)
  - Size of spectrum blocks
    - Reverse auction creates supply of 6 MHz blocks
    - Propose 5 MHz blocks for forward auction
  - Geographic area of spectrum blocks
    - The shape of the blocks
    - Propose Economic Areas (EAs), 172 areas in the US

Cellular Uses of Spectrum

- FDD – Frequency Division Duplex
  - Pairs of frequencies are used for the two directions of communication
  - Downlink – from network to user device
  - Uplink – from user device to network
- TDD – Time Division Duplex
  - Uplink and downlink are on the same frequency, transmitted at different times
- Supplemental Downlink
  - Downlink only frequencies used to supplement an FDD pair, increasing network to device capacity
- Broadband data networks carry far more downlink than uplink, while voice services are symmetric



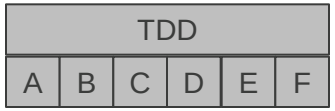




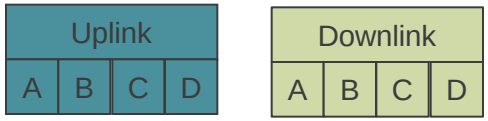
Organization of Blocks

- Uplink-downlink adjacencies cause more interference scenarios
- Separate uplink and downlink:
  - Separation of uplink from downlink blocks in FDD, called a “duplex gap”
  - TDD is both uplink and downlink, so no adjacent unsynchronized TDD blocks without guard bands
  - No TDD to FDD boundaries (frequency adjacencies) without guard bands
- Therefore, need to place blocks in separate frequency regions:
  - Uplink blocks together
  - Downlink blocks together
  - TDD blocks together
- Auctioning unspecified blocks would lead to uncertainty about block-to-block interference

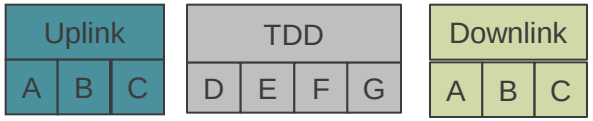
Example TDD plan



Example FDD plan



Example FDD and TDD plan

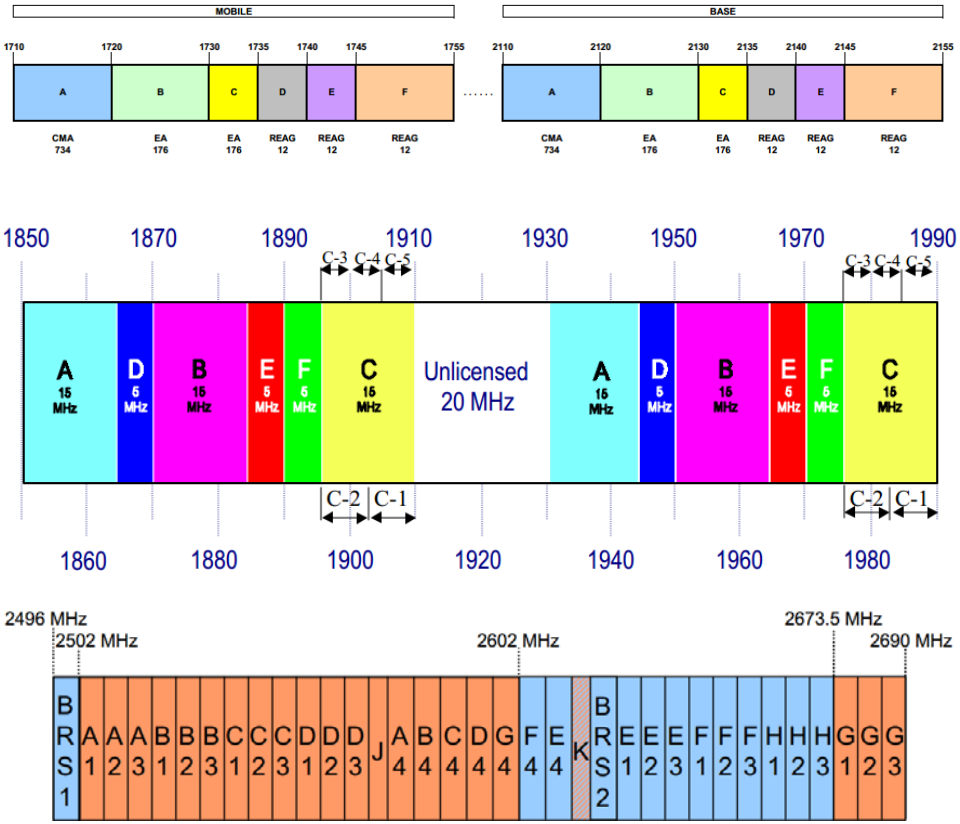


Block Size

- UMTS and HSPA (3G)
  - Operate in 5+5 MHz FDD pairs
  - Very few deployments of the 5 MHz TDD option
- WiMAX (4G)
  - 5, 10, and 20 MHz options, TDD and FDD
  - Deployments are mainly 5 and 10 MHz TDD
- LTE (4G)
  - Supported block sizes 1.4, 3, 5, 10, 15, and 20 MHz, FDD and TDD
  - 1.4 and 3 MHz less widely deployed
  - More FDD deployed than TDD
- TV and DTV
  - Currently organized in 6 MHz channels, so the reverse auction frees up multiples of 6 MHz

Traditional Band Plans

- Known spectrum block locations, bid on specific frequencies
- Blocks sizes
  - May be uniform or varied
- Geographic licensing areas
  - May be the same for all blocks or varied
- Pairing
  - Blocks may be paired or unpaired

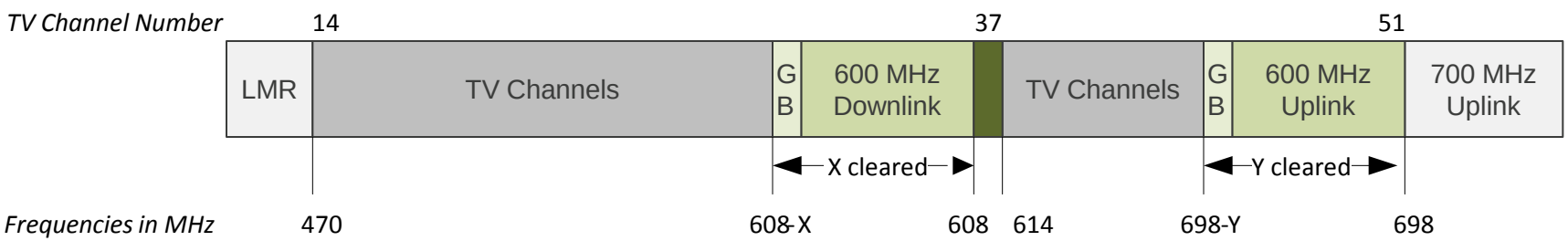


Incentive Auction NPRM

- Flexible framework rather than fixed band plan
  - Amount of spectrum not known until conclusion of auction, depends on final results of both reverse and forward auctions
- Generic blocks
  - Location not known, so must promote fungibility, including the use of guard bands
- Building blocks
  - Bidders bid on one or more building blocks
  - Mechanism to contiguously assign a winner's blocks in a license area
- Market variation
  - Allow limited variation in band plans across areas
  - May increase amount of spectrum returned by preventing border markets or other markets with poor clearing from limiting nationwide clearing

Proposed Approach

- Generic 5 MHz building blocks
- Mechanism for assigning blocks contiguously in a license area
- Focus on FDD with some supplemental downlink, no TDD
- Guard bands between wireless blocks and TV
- Use EAs (Economic Areas) for licensing
- Support market variation in spectrum clearing
  - (see subsequent slide)
- Locations
  - Uplink located at channel 51 (698 MHz) and expands downward
  - Downlink located at channel 36 (608 MHz) and expands downward
  - (Channel 37 is used for radio astronomy and wireless medical telemetry)

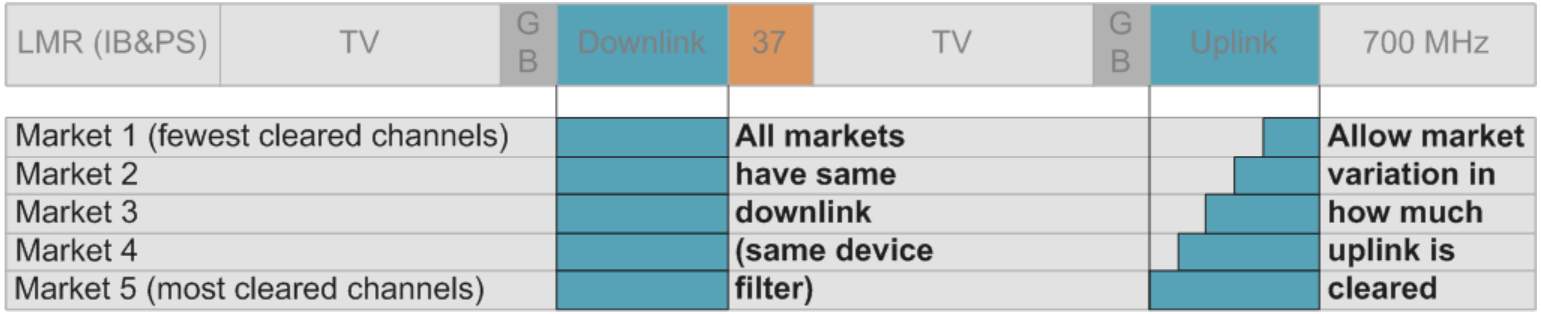


Economic Areas

EAs delineated by the Regional Economic Analysis Division
Bureau of Economic Analysis, U.S. Department of Commerce
January 1995

Proposed Geographic Variation

- Allows 2 or more total plans nationwide, with individual license areas each using one plan
- Proposes fixed amount of downlink spectrum nationwide
  - Allows for uniform receiver filters in all devices, reducing cost and promoting interoperability
  - Allows for variation in amount of uplink spectrum to accommodate different quantities of cleared spectrum in different geographic areas
- Tradeoff with asymmetry
  - Markets with less clearing have a lower uplink to downlink ratio
  - Markets with more clearing have a higher uplink to downlink ratio



Proposed Block Assignments

- Single nationwide examples:
  - 100 MHz licensed: 50 + 50 MHz, 10 paired blocks
  - 105 MHz licensed : 55 + 50 MHz, 10 paired blocks, 1 supp. DL
  - 110 MHz licensed : 55 + 55 MHz, 11 paired blocks
  - That is, paired 5+5 MHz blocks plus 0 or 1 supp. DL blocks of 5 MHz
- Market variation example
  - E.g., 120 MHz licensed nationwide except 100 MHz in border regions
  - Nationwide: 60 MHz DL, 60 MHz UL, 12 paired blocks
  - Border regions: 60 MHz DL, 40 MHz UL, 8 paired blocks, 4 supp. DL
- Mix of pairs and supplemental downlink not completely predictable
- TDD not assigned in lead proposal
- Alternately, can we use auction mechanisms to determine the optimal mix of uplink and downlink blocks?

Geographic Exclusions

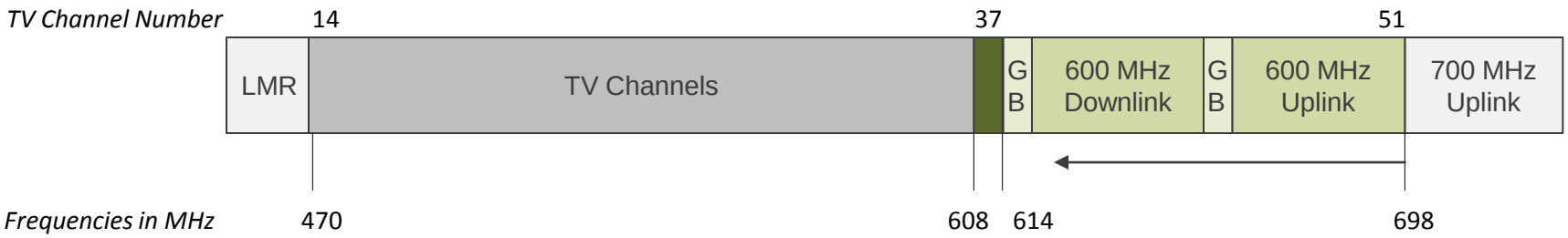
- Market variation means that some frequencies have both TV and wireless
- These services need to be geographically separated, that is, wireless can only be auctioned at a sufficient separation from TV
- The areas in which wireless can be offered based on interference calculations will not necessarily align with license areas such as EAs
- These exclusions will apply only to the blocks that are not cleared nationwide
- Interference from Canadian and Mexican TV stations may be more difficult to mitigate through repacking
- How much of a license area should be clear to be auctioned?
- Can bidders specify how exclusions impact their bid for an area?

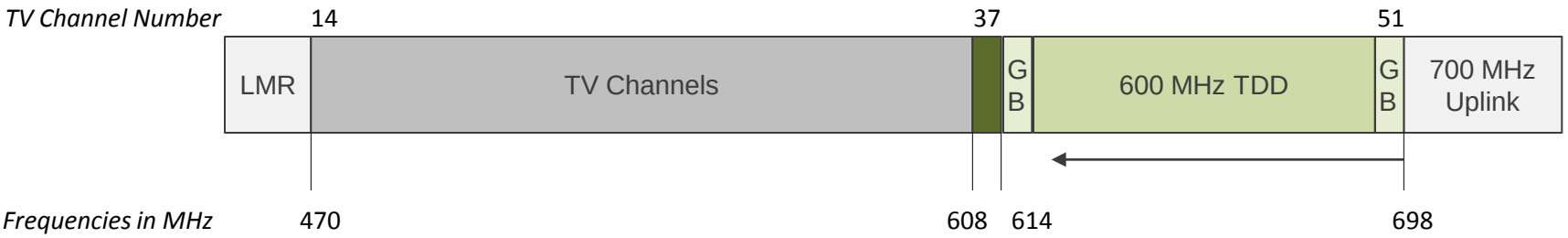
Process

- FCC is in the comment process, with initial comments received and reply comments due on March 12th
- Commenters support most band plan features:
  - Flexible band plan framework
  - Generic 5 MHz building blocks
  - Need for guard bands
  - Importance of fungibility
  - A framework that allows market variation in clearing
- Many commenters support the use of EAs as license areas, although some suggest other areas
- Many commenters support the focus on FDD blocks, although some suggest TDD or un-specified unpaired blocks
- A number of commenters are not comfortable with the proposed block locations, preferring that all blocks be located towards the top of the band

Alternatives

- Some other proposals put forward by commenters
  - Down from 51 – an alternative in the NPRM, that varies from the lead proposal primarily in the location of the blocks at the top of the band
  - Allow auction determine SDL versus FDD versus TDD for a portion of the band below channel 37
  - Allow auction winners to determine uplink or downlink use of their blocks
  - All TDD with 10 MHz unpaired blocks





Questions?