Panel: Sharing Radar Bands with Commercial Systems

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CSMAC Spectrum Sharing Working Group Questions

- How do we setup sharing arrangements, when the primary service may continue or has the right to continue to evolve?

- What kinds of sharing are workable for the industry in the long term?

Spectrum Sharing Issues

- Cost to implement spectrum sharing
- Certainty of spectrum access – Minimize risk

Need to know the spectrum sharing requirements to determine costs and risks

Requirements of Entrant

• Do No Harm to entrant
- •Concerns that incumbent will have unreasonable interference criteria. Concerns that the incumbent system receiver and other equipment characteristics are different than originally planned for.
•Safeguards/security
- •Protect against unauthorized and accidental use, avoid hackers
•Support current architecture (i.e. frequency duplex)
•Minimal changes to standards
- •Want to purchase standardized, non-proprietary equipment from multiple vendors
•Low prime power
•Minimal software integration costs
•Capacity
- •Minimal capacity lost with 'Do No Harm' or with fair use rules
•High reliability and assured access
•Reduce operator workload
•Trust
- • Need assurance that agreement points will not change
•Fair use policy

Requirements of Incumbent

- Do No Harm to incumbent
- Accommodate Changes in Incumbent Use
  - Waveform types, occupancy, locations, etc
- Backup Band for entrant
  - Able reclaim the spectrum
- Enforcement
  - Track down interference events economically and quickly
- Safeguards/security
  - Protect against unauthorized and accidental use, avoid hackers
- DSA system diversity causing complexity
  - Many DSA types and entrants is too hard to manage
- Trust
  - Need assurance that agreement points will not change
- Security
  - Don't want to reveal classified information

Spectrum Sharing Costs

Requirement	Approach Description	Cost		
		Incumbent	Entrant	Incumbent or Entrant
Do No Harm	Certain frequencies at certain locations/times are unavailable for entrant use.	None	Implement dynamic network management	None
Do No Harm	Implement sensing-based sharing approach	Provide waveform information and equipment description.	Modify equipment to implement sensing.	None
Do No Harm	Implement geographic-based sharing approach	Provide and update location information and equipment description.	Modify equipment to implement position location and connection to database.	Build and operate database system.
Do No Harm	Implement physical layer-based sharing approach	None	Reduced link distance performance.	None
Do No Harm	Implement cooperative time sharing-based sharing approach	Provide and update location and schedule information and equipment description.	Modification to equipment to implement position location and connection to database.	Build and operate database system.
Do No Harm	Implement opportunistic time sharing-based sharing approach	None	Modification to equipment to allow rapid sensing and response to avoid interference	None
Accommodate Changes in Incumbent Use	Entrant equipment connected to a database.	Provide information on usage (locations, waveform types, etc).	All equipment must be periodically connected to a database.	Build and operate database system.
Accommodate Changes in Incumbent Use	Sensing-based approaches must have a programmable detector/classifier	Reduced flexibility in waveform design and must provide sensitive waveform information	Implement flexible, re-programmable detector/classifier.	None
Enforcement	Implement mechanism to detect and mitigate interference cause.	Provide information on interference event (locations, waveform types, etc).	Centralized method to locate and control equipment.	Operate interference management service.
Backup Band	Entrant hardware must cover multiple spectrum bands.	None	Additional hardware cost to cover additional spectrum bands.	None
Backup Band	Extra entrant spectrum must be provided by incumbent or entrant	Potentially need to provide additional spectrum to entrant.	Potentially need to acquire additional spectrum.	None
Safeguards / Security	Implement secure method to manage entrant spectrum.	None	Minimal cost, COTS solutions.	None

Impact to Accommodate Changes in Incumbent Use
(1=easy, 3=hard)

Incumbent Change in Use	Impact to Geolocation-Based Entrant Only	Impact to Sensing-Based Entrant Only	Impact to Both Entrant Types	Method to Provide Certainty to Entrant
Waveform Type - modulation type, signal bandwidth or MAC	None	Must have enough waveform information to design classifier(3)	None	To enable sensing approach classifier design relative to entrant waveform, incumbent provides waveform information to limit waveform parameters.
Mix Waveform Types Within a Band(	Adjust exclusion zone(1)	Implement multi-detector/classifier system(2)	None	Incumbent provides waveform types in the band
Withhold Transceiver Location Information	Approach not feasible(3)	None	None	Incumbent agrees to not change Transceiver Location Information policy
Provide Entrant Advanced Warning of Transceiver Operation	Assume 100% duty cycle and reduces amount of available of spectrum, (2)	None	None	Incumbent agrees to not change advanced warning plan.
Mobility - Fixed to mobile to airborne transmitters	Obtain real-time transceiver location information, use large exclusion zones, or approach not feasible(3)	None	None	Incumbent agrees to not change mobility, or to provide transceivers info in real-time to enable geolocation approach.
Link Type – Duplex vs telemetry vs f1/f2)	Adjust exclusion zone size(1)	Telemetry links require lower detection thresholds. f1/f2 requires frequency plan information.(3)	None	Incumbent agrees to provide link type information.
Transmit Power Level	None	Change detection thresholds(1)	Decreases amount of available spectrum if sharing based on interference to entrant.	Incumbent agrees to limiting min and max transmit power level.
Transmit Mask Shape	Adjust exclusion zone if based on entrant interference(1)	Change detection thresholds(1)	Decreases amount of available spectrum if sharing based on interference to entrant.	Incumbent agrees to limiting min and max transmit mask.
Desired Interference To Noise Level	Adjust exclusion zone size(1)	Change detection thresholds (1)	Decreases amount of available spectrum.	Incumbent agrees to limiting interference level.
Number of transceivers or TX duty cycle	Provide waveform information and equipment description.(1)	None	Decreases amount of available spectrum	Incumbent agrees to limiting number of TX duty cycle within each operating area.
Receiver Selectivity	Adjust exclusion zone size(1)	Change detection thresholds(1)	Decreases amount of available spectrum	Incumbent agrees to limiting adjacent channel rejection level.
Antenna heights or antenna gain values	Adjust exclusion zone size(1)	None	Decreases amount of available spectrum	Incumbent agrees to limiting antenna height.

Summary

- Spectrum sharing requirements and costs are being discovered and documented
    - Significant process in obtaining requirements in the last few years
    - Sources: 5 GHz sharing, conversations with stakeholders
- Complicated problem, but solutions exist
- Cost and uncertainty are the drivers
- Example requirement
    - 'Accommodate Changes in Incumbent Use'
- Next step: Document and quantify requirements