ANALYSIS OF DYNAMIC CAPABILITIES IN THE CITIZENS BROADBAND RADIO SERVICE

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Outline

Introduction
Research objectives
Citizens Broadband Radio Service (CBRS) framework
Theory of dynamic capabilities
CBRS from the dynamic capabilities perspective
Conclusions

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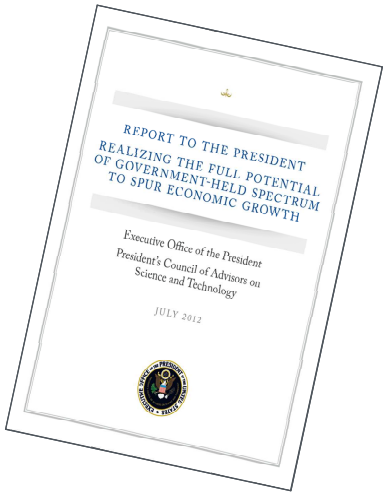
WRC 2015 afterlife

New era in spectrum regulation and standardization

US President's Council of Advisors on Science and Technology Report Proposed Major Changes to Spectrum Policy, Using Federal Spectrum

1. *Define a spectrum license to be a right not to be interfered with, but with no right to exclude -- all spectrum therefore usable by somebody*
2. *Provide a band where all types of users have the same capability, but still allow for purchasing protection (3 tiers)*
3. *Allow for spatial and temporal sharing of a band among a wide class of users (initially, federal radars and civil broadband)*
4. *Automate de-confliction through micro transactions based on interference criteria*
5. *Shorter term licenses to enable successor uses to enter the band naturally*



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+ Sharing economy

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Research questions

1) What are Dynamic Capabilities required for the processes of spectrum sharing using CBRS?

2) Could this be of help to key stakeholders and regulators for implementing CRRS and SAS?

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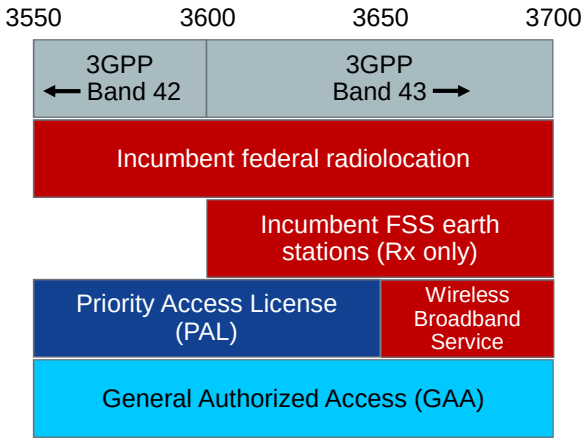
US 3-tiered spectrum access model and band plan

FCC's spectrum access models for 3550-3650MHz and 3650-3700MHz spectrum segments



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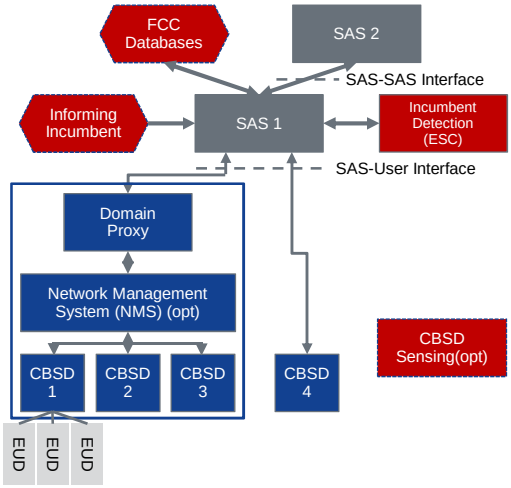
CBRS Functional Architecture

The WINNF Spectrum Sharing Committee, "SAS Functional Architecture,"



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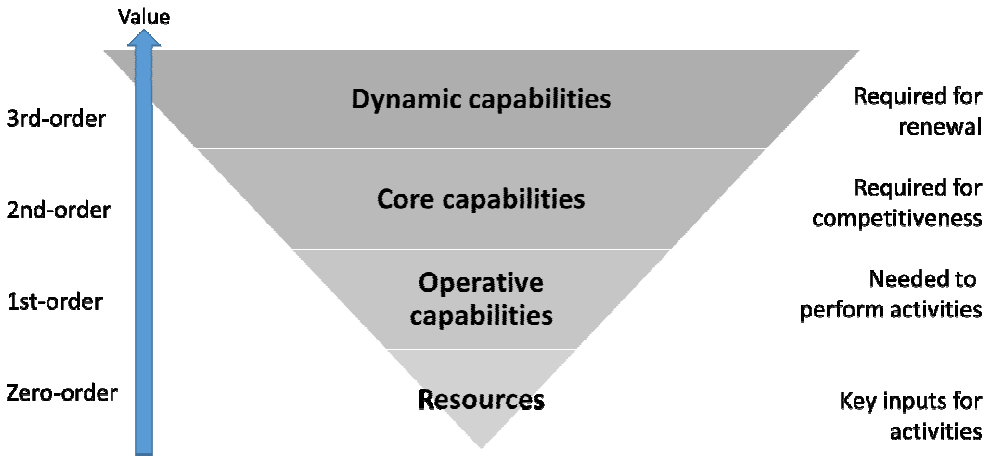
The dynamic capabilities framework



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CBRS in the dynamic capability view
Incumbent access

	Antecedents	Processes	Outcomes
Incumbent Access	• underutilized spectrum assets • governmental pressure on defense expenditure • mandatory to continue critical operations • compatibility with military spectrum management objectives and procedures • long product life-cycles and high relocation costs	• identifying and offering desirable spectrum assets for sharing • military system capability model • iteratively phased predictable approach to novel spectrum management concepts • administrative processes in procurement and operations domains	• retain rights to the spectrum (no re-allocation) with interference protection • save on spectrum fees / create revenues • real option to use civil spectrum • demonstrate ability and willingness to contribute • relocation and research fund for technology renewal

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CBRS in the dynamic capability view
National Regulatory Authority

	Antecedents	Processes	Outcomes
National Regulatory Authority	• increasing demand for mobile services and capacity • supporting legislation, regulation and political willingness • government direct budgetary requirements and incentives for entrepreneurs and economic growth • facilitates inter-domain interference studies i.e. exclusion zone analysis for initial service	• identifying specific bands for sharing through long term planning • improving federal spectrum management and utilization • incentive process utilizing e.g. incentive auctions, administrative pricing or spectrum currency • sharing arrangement and framework rules and conditions with incentives for both PAL and GAA users	• further efficiency with GAA • promote competition with lower entry barrier to access spectrum • empowers entrepreneurs in verticals • incentives for local operators • stable framework to secure investments • better valuation of shared spectrum • shorter transition times • revenue from annual payments

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CBRS in the dynamic capability view
Spectrum Access System

	Antecedents	Processes	Outcomes
Spectrum Access System	• standardized functional architecture, interfaces, data models and protocols • operational and communication security • inter-operability and verification • controlled degree of dynamics and complexity • deep near real time insight into CBRS networks • scalable big data and analytics capabilities • experience of radio propagation modeling	• employing NRA rules in coordination with other SASs • coordination with incumbent operations • incumbent sensing (could be independent sensor network) • predict and manage interference • opportunity detection and dynamic frequency assignment (interference, co-existence) • CBSD authorization and usage monitoring • user data and context monetization	• incumbents protection • Quality of service certainty and guaranteed spectrum for PAL users • optimize spectrum availability for GAA users • monitor and trace the use of spectrum, possible harmful interference, and other phenomena • possibility to use data for license fees and value added services • real option to move towards spectrum aggregator/ broker role

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CBRS in the dynamic capability view
CBSD access network

	Antecedents	Processes	Outcomes
CBSD access networks	• service provider market position • harmonization of technology e.g. power and OOBE limits • utilization of existing tech. assets • certainty and QoS of the shared spectrum asset • near real time network element management system for managed CBSD • network virtualization • managed network interference resolution capabilities • new cheap BS and /AP products	• spectrum opportunity detection, valuation and decision making • network planning based on CBRS spectrum availability and existing network assets • CBSD – SAS protocol work flows • automated network configuration and optimization according band availability and demand (CEM, SON) • assist SAS with sensing capability • SAS assist / domain proxy in co-existence management • business strategy and modeling across domains and verticals	• unbundles investment in spectrum, network infrastructure and services flexibility in local spectrum use • faster access to flexible lower cost extra capacity in hot spots • optimized use of MNO's spectrum • legal certainty only for PAL • opportunity to access spectrum for cable operators, local small cell networks, MVNOs, WISPs… • new access channel for Internet players • concerns over complexity (new elements) and transaction costs

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CBRS in the dynamic capability view

End user devices

	Antecedents	Processes	Outcomes
End User Device	• scale of technology • device ecosystem • harmonization of spectrum • full CBRS spectrum coverage	• standardization of possible new requirements and bands	• timely availability of terminals and potential impact on cost and complexity • LTE ecosystem scale up • GAA devices create co-existence interference concerns

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Conclusions

Analysis of Dynamic Capabilities in the Citizens Broadband Radio Service

- Realizing and fine-tuning incumbent spectrum users' incentives is essential, e.g., by avoiding re-allocations, by providing additional revenues, or by lowering spectrum fees.
- Incentives triggered by the CBRS may contribute to transitioning from administrative to market-based spectrum management.
- Complement and improve current mobile broadband services, enable new services, and introduce new roles in local area and across verticals.
- Increased system dynamics in spectrum sharing introduced needs for big data analytics and near real time network management capabilities.
- Technology harmonization in spectrum and radios with dominant ecosystems, 3GPP (and IEEE), will be essential to ensure economies of scale and fast time to market.
- CBRS framework will significantly improve the efficiency of the spectrum use, influence the management approach of other spectrum bands and create new business opportunities.

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Thank you
Questions/discussion?

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