RWA Webinar: Leveraging CBRS services for additional revenues

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CBRS three-tier shared spectrum

- **Federal and other incumbents**
  - Full interference protection
  - Protected from other PAL/GAA users
  - Must avoid interference to incumbents

- **Priority access licenses**
  - No interference protection
  - Must accept interference from other users

- **General authorized access**

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### Band 48 - CBRS

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>3550-3600</td>
<td>Military radar</td>
</tr>
<tr>
<td>3600-3650</td>
<td>Fixed satellite service - FSS</td>
</tr>
<tr>
<td>3650-3700</td>
<td>Priority access license (PAL)</td>
</tr>
<tr>
<td>3700</td>
<td>WISPs</td>
</tr>
</tbody>
</table>

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**Notes:**
- ESC: Electronic Spectrum Coordinator
- SAS: Spectrum Access System
- FCC: Federal Communications Commission
- Global band 42: paging/short bursts
- Global band 43: shared spectrum
- CBRS: Citizens Band Radio Service
- NTIA: National Telecommunications and Information Administration
- C-Band: 3.7-4.2 GHz
- FSS: Fixed Satellite Service
- WISPs: Wireless Internet Service Providers
- GAA: General Authorized Access
CBRS current status

- Full commercial deployment [27 January 2020]
- Total ~ 30 thousand CBSDs [SAS admins]
- Generally good experience
- All parts of ecosystem in place

5 SAS vendors  180+ FCC certified devices
Increasing numbers of smartphones, IoT devices, routers, CPE, and other devices are being FCC certified under Part 96.
### Ericsson products and needs

- **Outdoor micro radio**
  - Low power strand version for cable

- **Outdoor massive MIMO radio**
  - Ongoing features for RC customers and cable

- **Indoor Radio Dot**
  - NR version in 2021
  - Multi-operator, neutral host with OAM
  - IoT features

- **Domain coordinator software**
  - Cloud architecture, decoupled from ENM, for scale, reliability
  - Ongoing WiNnF / CBRS-A roadmap
CBRS PAL auction

Spectrum for auction
70 MHz PAL licenses

Gross proceeds
$4.5 Bn
$0.217 / MHz-Pop

Qualified bidders 271
Winning bidders 228
Total licenses won 20,625

Verizon with the highest spend of $1.8 Bn ~ 41% of total
Dish won the highest number of licenses, 5,492 – $0.91 Bn

Cable companies Comcast, Cox and Charter combined spend ~ $1.1 Bn

Top 10 contributed to 91% of total spend
PAL enablement timeline

Today

T1: 12/21
PAL Channel Assignment Procedure document sent to licensees

FCC issues PN existing PAL licenses acceptable for filing (11/30)

T2: 12/26 to 12/28
Username/password to PAL Channel Assignment Portal sent

T3: 12/28 to 2/26
Licensees input PAL channel preferences to Portal

T4: 1/29 to 2/16
Processing of Portal inputs

T5: 2/27
Initial results determined

T6: 2/18 to 3/10
Final channel assignments published

Channel swapping opportunity

T7: 2/24 to 3/19
Testing and preparation

T8: 3/11
PAL Commercial enablement

T9: 4/15
Commercial enablement
GAA and PAL behavior summary

• PAL
  • 7 x 10 MHz licenses auctioned per area
  • Each entity can buy up to 4 x 10 MHz licenses

• GAA
  • Can use up to full 150 MHz if no PAL or incumbents deployed in given location
  • Objective is SAS to allocate spectrum evenly between operators

• PAL owner can also get their fair share of GAA spectrum
  • For example, a PAL holder could potentially use 60-80 MHz combined between GAA and PAL
CBRS use cases

- Massive MIMO
- Outdoor
  - Cat B base station
- Dedicated networks
- Indoor small cell

- Fixed wireless access
- Outdoor mobility
- Private LTE
  - In-building
    - Multi-operator neutral host
Opportunity drivers

- Underserved communities
- Work at home
- Government incentives (CAFII, RDOF)
- New cost-effective spectrum
- WISPs must transition from Part 90
- New revenue stream
- Lower cost of entry compared to wireline
- Leverage mobile network
- MSOs expand BB service beyond cable footprint

North America market outlook

- Ericsson market outlook 2Q2 - FWA
- 3X 5yr Subscriber growth

FWA deployment model

- Managed device (CPE)
- Special fixed-inspired price plan
- Subscription tied to known location

Time to market

FWA advantages

Financial attractiveness

Sustainability
Advanced antenna technology
Massive MIMO - beamforming

- Traditional cell sites project radio waves in a fixed predefined pattern – similar to a flood light
- Massive MIMO cell sites project radio in narrow beams directed to the users – similar to a spotlight
- Multiple beams can be created which will dynamically adjust to user locations and usage
- The result is an increase in signal and a reduction in interference from other users in the sector – improved throughput to each user in the sector
Advanced antenna technology
Multi-user MIMO

• Sector capacity in a traditional cell site is shared amongst all the users of the cell site

• With multi-user MIMO, sector capacity resources can be reused across multiple users in the same sector

• The result is an increase in sector capacity due to the re-use of resources across multiple users – creating virtual sectors within a single sector
Peak sector throughput, average sector throughput and busy hour throughput

- **Peak throughput**
  - CPE is in great SINR conditions. CPE gets all available LTE resources.

- **Average throughput**
  - CPEs are distributed throughout the cell under various RF conditions. LTE resources are shared amongst all CPEs
  - Used to dimension the network for capacity planning

- **Busy hour throughput**
  - Average measured backhaul throughput divided by number of homes connected. Based on industry trends and wireline industry input, it is currently 2–3 Mbps per home

<table>
<thead>
<tr>
<th>Assumptions</th>
<th>Peak TDD LTE DL throughput</th>
<th>Peak TDD LTE DL throughput 256 QAM</th>
<th>Peak TDD LTE DL throughput 256 QAM</th>
<th>Average TDD LTE DL sector throughput baseline + fixed + LTE evolution gains</th>
<th>Average TDD LTE DL sector throughput baseline + fixed + LTE evolution gains</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 MHz cell carrier capacity</td>
<td>111 Mbps</td>
<td>147 Mbps</td>
<td>960 Mbps</td>
<td>50 Mbps</td>
<td>200 Mbps</td>
</tr>
<tr>
<td>3 x 20 MHz cell carrier capacity</td>
<td>333 Mbps</td>
<td>440 Mbps</td>
<td>2880 Mbps</td>
<td>150 Mbps</td>
<td>600 Mbps</td>
</tr>
</tbody>
</table>

20 MHz cell carrier capacity

20 MHz cell carrier capacity
CBRS cell coverage – rural

4T4R

64T64

Coverage shown with 3.5Ghz, 3x20 MHz, LoS TDD Frame config 2. Actual results vary based on clutter, terrain and other conditions.

Network throughput = Cell density x Available spectrum x Spectral efficiency

Multiplying rate services supported on the same cell site
Outdoor mobility - capacity and offload

**Problem statement**
- Operators must grow spectrum portfolio to keep up with demand
- CBRS supplements MNO spectrum
- Primary spectrum for MSO

**Opportunity drivers**
- Significant mid-band spectrum
- Spectrum unencumbered and centrally managed
- Unlicensed access available now with GAA, licensed with PAL
- Supplement licensed band capacity in high traffic areas
- MSOs reduce reliance on MVNO
- LTE today, NR path
- Device ecosystem in place
- Better coverage characteristics than LAA

**MANA mobile data traffic**

- Ericsson 20Q2 market outlook
  - ~4X 5yr traffic growth

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**Base Station**

**Supplement spectrum holdings with CBRS**

**Supplemental band (3.5GHz)**

**Anchor band (850, AWS, PCS)**

CBRS
- 10 - 150MHz

Comm. Bands
- 20MHz
CBRS private network use cases

- Utilities
- Mining
- Oil and gas
- Smart cities
- Manufacturing
- Public venues
- Campus networks
- Warehousing
Path to 5G...

• 5G has been defined for CBRS (specifications largely complete)

• Infrastructure and devices introduced over next 2 years

• Stand-alone expected to be deployed architecture for 5G CBRS
RINA Overview

* Founded by Strata and South Central in 2006
* 4 Class A owners and 5 Class B Owners
* Full range hosting services for rural wireless operators, including CBRS
* Carriers helping Carriers

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Customer Device/Router

Google SAS

SAS

RINA ENM

RINA HSS

RINA MME

RINA PCRF

SGW

PGW/NAT

PGW/NAT

VPN

S1U

S1U

eNode B

RINA Network

RINA Wireless

RINA ENM

RINA HSS

RINA MME

RINA PCRF

eNode B
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<th>CBRS</th>
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<td>5G NSA</td>
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<tr>
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<td>3GPP</td>
<td>Landline Soft Switch</td>
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