The Carmel Group’s

The State of Broadband Wireless Access/ Fixed Wireless, 2017

By Jimmy Schaeffler Chairman & CSO

TELRAD MIAMI
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The Carmel Group

A Hodge-Podge of Recent Highlighted Companies and Studies/Topics

- BWA Industry Overview
- Telecom/Media Mergers
- Networks’ Valuations
- Set-top Boxes
- Distance Learning
- Digital Signage
- Digital Video Recorders
- Piracy
- Retransmission Consent
- Content Providers
- Intra-Industry Competition
- Distribution Systems
- Next Gen TV/ATSC 3.0
WHY ARE YOU HERE TODAY?
What’s Changing In BWA, And Why A Service Provider Should Care?
7 KEY ITEMS:

1) DATA & TRENDS
2) CORE ISSUES
3) IMPLICATIONS
4) STAKEHOLDERS
5) ALLIANCES
6) OPPORTUNITIES
7) POVs
7 KEY BWA METRICS:

1) REVENUE
2) SUBSCRIBER GROWTH
3) ARPU
4) SUBSCRIBER ACQUISITION COSTS
5) CHURN
6) INFRASTRUCTURE COST/SUB
7) TRENDS & OPPORTUNITIES
FACTOID, SET # 1:

- MORE THAN 2K BWA PROVIDERS
- AVG. BWA SIZE: 1,200 SUBSCRIBERS
- AT 200K, LARGEST BWA OP IS RISE BROADBAND
- GLOBALLY, MANY LARGER BWAs EXIST
FIGURE 2: Typical BWA Network Architecture

BWA “SWEET SPOT” 100 - 1,500 Locations per Square Mile

< 100, tough economics, >1500 and competition eats into margins

Source: The Carmel Group

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FACTOID, SET # 2:

• 39% OF RURAL AMERICA, REPRESENTING 23 Mil. PEOPLE, DOES NOT HAVE ACCESS TO THE FCC BROADBAND STANDARD OF 25 Mbps DOWN/3 Mbps UP
OPERATOR SURVEY:

KEY DATA
## FIGURE 7: Spectrum Bands Most Commonly Used by the BWA Industry

<table>
<thead>
<tr>
<th>FREQUENCY</th>
<th>500-700 MHz</th>
<th>902-928 MHz</th>
<th>2.4 GHz</th>
<th>2.5 GHz</th>
<th>3.55 – 3.7 GHz</th>
<th>5.15- 5.85 GHz</th>
<th>5 GHz Wi-Fi Band 33</th>
<th>LMDS, TN</th>
<th>Millimeter Wave</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMMON NAME</td>
<td>White Space</td>
<td>ISM</td>
<td>ISM/Wi-Fi</td>
<td>EBS/BRS, LTE Band 41</td>
<td>CBRS, LTE Band 42, 43 &amp; 48</td>
<td>U-NII</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LICENSE</td>
<td>ASA*</td>
<td>EXEMPT</td>
<td>EXEMPT</td>
<td>LICENSED</td>
<td>ASA, PAL or GAA</td>
<td>EXEMPT</td>
<td>LICENSED</td>
<td>VARIOUS</td>
<td></td>
</tr>
<tr>
<td>INTERFERENCE RISK</td>
<td>Medium</td>
<td>High</td>
<td>High</td>
<td>Low</td>
<td>Low, Medium</td>
<td>High</td>
<td>Low</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>BAND SIZE</td>
<td>Varies by Location</td>
<td>26 MHz</td>
<td>83.5 MHz</td>
<td>194 MHz</td>
<td>150 MHz</td>
<td>580 MHz</td>
<td>1.2 GHz</td>
<td>6.2 GHz</td>
<td></td>
</tr>
<tr>
<td>NLOS ABILITY</td>
<td>Excellent</td>
<td>Excellent</td>
<td>Fair</td>
<td>Good</td>
<td>Fair</td>
<td>Poor</td>
<td>Poor</td>
<td>Poor</td>
<td></td>
</tr>
<tr>
<td>PRIMARY TECHNOLOGY</td>
<td>802.11af “Super Wi-Fi”</td>
<td>Proprietary</td>
<td>Wi-Fi TDD</td>
<td>LTE</td>
<td>Proprietary, WiMax and LTE</td>
<td>Wi-Fi, LTE-U</td>
<td>5G</td>
<td>5G</td>
<td></td>
</tr>
</tbody>
</table>

*Authorized Shared Access
Source: The Carmel Group
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FIGURE 13: What is your company's average monthly churn (or turnover) rate for the past year (take your average number of disconnected subscribers in a given month and divide that by your subscriber base at the beginning of month)?

- 30% 0-0.05%
- 10% 0.51-0.1%
- 10% 0.11-0.5%
- 17% 0.51-1%
- 10% 1.1-1.5%
- 8% 1.51-2.0%
- 6% 2.01-5%
- 9% Don't Know

Source: The Carmel Group
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Figure 10: What was your actual or best estimate of the annual residential subscriber growth percentage rate for your company during the past year?

![Bar chart showing percent responding for different growth rate categories.]

Source: The Carmel Group
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FIGURE 4: U.S. BWA Customer Growth

Users double every five years.

Source: The Carmel Group
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FIGURE 3: U.S. BWA Industry Revenue Review and Forecast

More revenue means more staying power.

DOLLAR AMOUNTS IN BILLIONS

$0.0  $1.0  $2.0  $3.0  $4.0  $5.0  $6.0


$1.3  $1.5  $1.8  $2.0  $2.3  $2.7  $3.1  $3.7  $4.4  $5.2

Source: The Carmel Group

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FIGURE 11: What is your company’s average Subscriber Acquisition Cost (SAC) for a new residential customer?

Source: The Carmel Group
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69.4% are at $41 or above....
FIGURE 5: U.S. BWA Average Monthly Billing Review and Forecast

Consumer savings from unbundling more than offset small price increases.

Average Monthly Service Fee:
- 2012: $52
- 2013: $51
- 2014: $51
- 2015: $50
- 2016: $51
- 2017 E: $52
- 2018 E: $53
- 2019 E: $55
- 2020 E: $56
- 2021 E: $58

Source: The Carmel Group
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7 KEY BWA DRIVERS:

1) INCREASED CONSUMER BROADBAND/VIDEO DEMAND
2) NEW URBAN + INDUSTRIAL MARKETS
3) TECHNOLOGY DEVELOPMENTS, e.g., LTE
4) FAVORABLE ECONOMICS, ROI OF DEPLOYMENT
5) FAVORABLE SPECTRUM DEVELOPMENTS
6) IMPROVED FINANCING AND CONSOLIDATION
7) NEW ENTRANTS + HYBRIDS
7 KEY BWA BTWs:

1) MORE BWA BIZ THAN RURAL RESIDENTIAL

2) BELEAGURED COMPETITORS (Esp. Pay TV)

3) IMPROVING INTERNATIONAL DATA POINTS

4) MORE DEVICES DISPLAY MORE VIDEO

5) OPPORTUNITIES FOR DISRUPTION

6) MORE EFFECTIVE LOBBYING

7) BROADBAND = NECESSITY!!!
1 KEY TAKEAWAY:

BWA IS LOWER COST/SUB THAN...

• DBS/SATELLITE
• CABLE
• MOBILE/CELLULAR
• FIBER
### Figure 6: Residential Consumer Broadband Comparative Economics

<table>
<thead>
<tr>
<th></th>
<th>Fiber</th>
<th>Cable</th>
<th>Satellite</th>
<th>Mobile</th>
<th>BWA</th>
</tr>
</thead>
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<tr>
<td>CAPEX/SUB RELATIVE TO BWA (1)</td>
<td>70</td>
<td>45</td>
<td>10.5 (2)</td>
<td>21</td>
<td>10</td>
</tr>
<tr>
<td>SPEED (3)</td>
<td>1 Gbps</td>
<td>150 Mbps</td>
<td>12-35 Mbps (4)</td>
<td>10-12 Mbps</td>
<td>100 Mbps</td>
</tr>
<tr>
<td>UPGRADE COSTS</td>
<td>MODEST Only the fiber remains the same</td>
<td>HIGH Complete CPE &amp; network change</td>
<td>LOW/HIGH Incremental upgrades until the satellite fails</td>
<td>HIGH Complete device &amp; network change</td>
<td>MODEST Incremental upgrades in CPE and network</td>
</tr>
<tr>
<td>BROADBAND ARPU</td>
<td>$69</td>
<td>$42</td>
<td>$61</td>
<td>$59</td>
<td>$51</td>
</tr>
<tr>
<td>PAYBACK PERIOD</td>
<td>60 months</td>
<td>38 months</td>
<td>12 months</td>
<td>21 months</td>
<td>11.5 months</td>
</tr>
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Sources: Wisper ISP, National Rural Telecommunications Cooperative, and The Carmel Group.
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(1) This is a relative presentation comparing all of the technologies to BWA, which is set to an index value of 10. See above for explanation.
(2) Does not include the cost of satellites.
(3) Max speeds; most service providers are not yet offering max speed. For cable, the DOCSIS 3.0 standard is capable of 1 Gbps. For BWA, point-to-point links and millimeter-wave, point-to-multipoint connections can provide more than 1 Gbps to end users.
(4) Anticipated typical speed.

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- Fixed wireless costs less  
- Spectrum trends favor fixed wireless  
- Video is fueling overall growth in demand for broadband  
- Standards-based technologies give providers more choices  
- Capital availability and government support are growing  
- New entrants are validating the business model  
- New markets and service categories = more opportunities

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2) 20/44 VENDOR SURVEYS
3) 30 TWO-HOUR INTERVIEWS
4) COMPANY DATA
5) MEDIA/ENTERTAINMENT/TELECOM INDUSTRY MEDIA
6) 45 YEARS INDUSTRY EXPERIENCE
7) STRONG BACK-UP TEAM
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