Funding the Technologies to Bridge the Digital Divide

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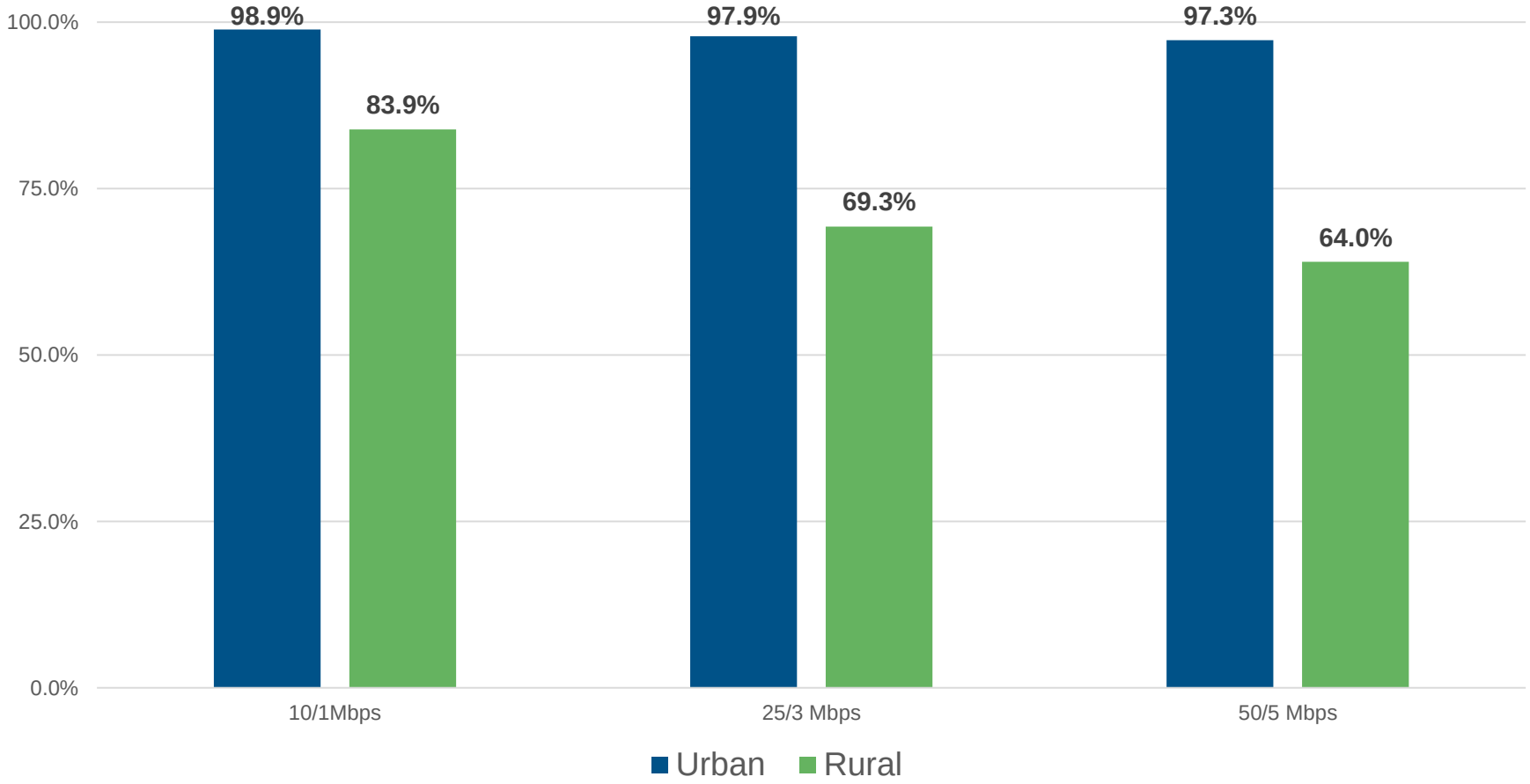
Urban Vs. Rural Broadband Access*



** As of 2016 (latest year available)*

Source: Federal Communications Commission

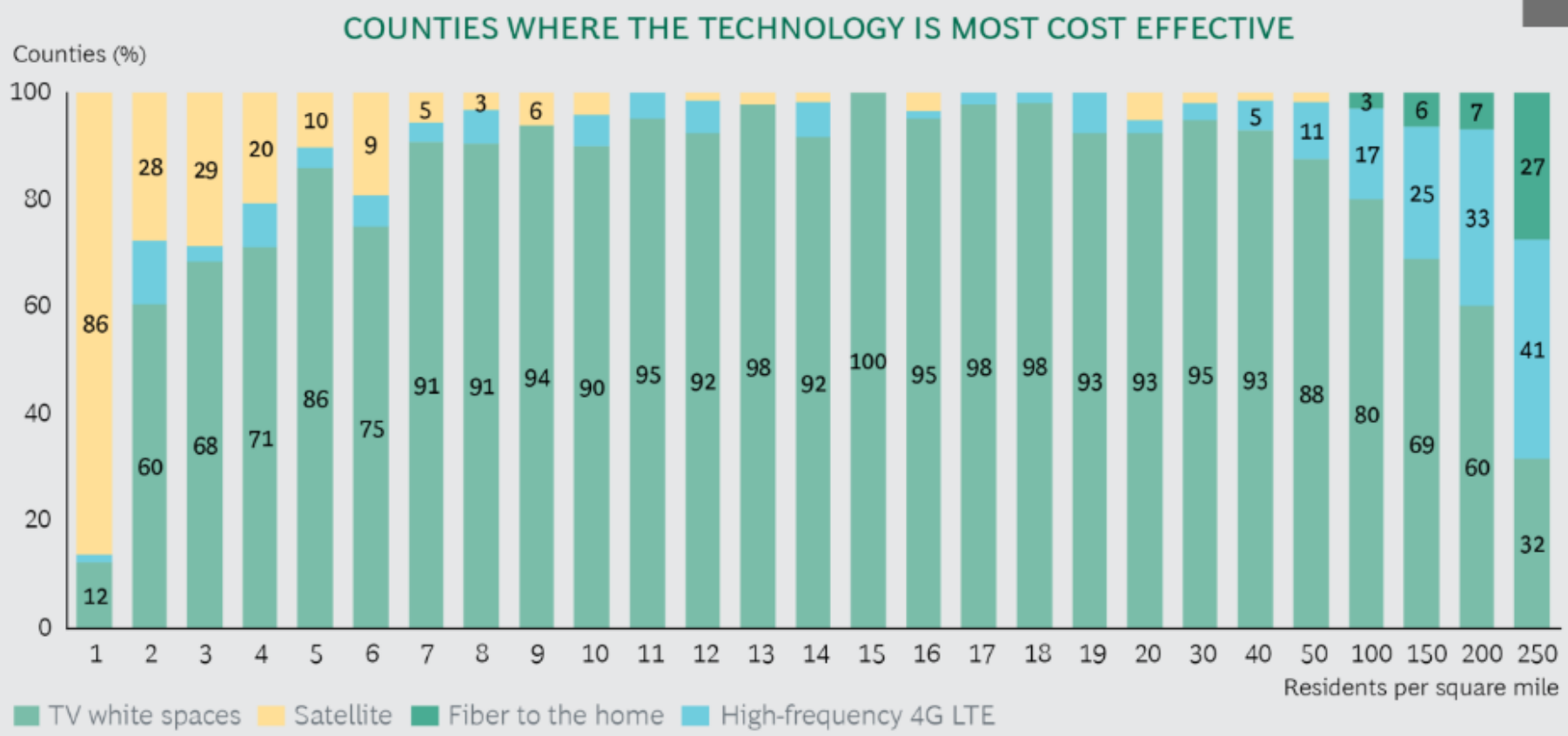
CAF II designed to bridge the digital divide

Connect America Fund II (CAF)

- $2 billion in funding to be distributed over a 10-year period
- FCC selected geographic regions across the country that were determined to be “high-cost, but not extremely high-cost” for subsidized broadband and voice development
- Reverse auction process based on proposals from service providers for plant buildouts that meet the established standards
- Initial awards were announced in August; 8 of the top 10 winners plan to use a combination of fiber to the home and fixed wireless or standalone fixed wireless networks
- The top 10 winners were awarded 73% of the total CAF 2 proceeds.
- 73% of the top 10 winners proceeds have been earmarked for some kind of a fixed wireless investment.

The FCC favors wireless broadband

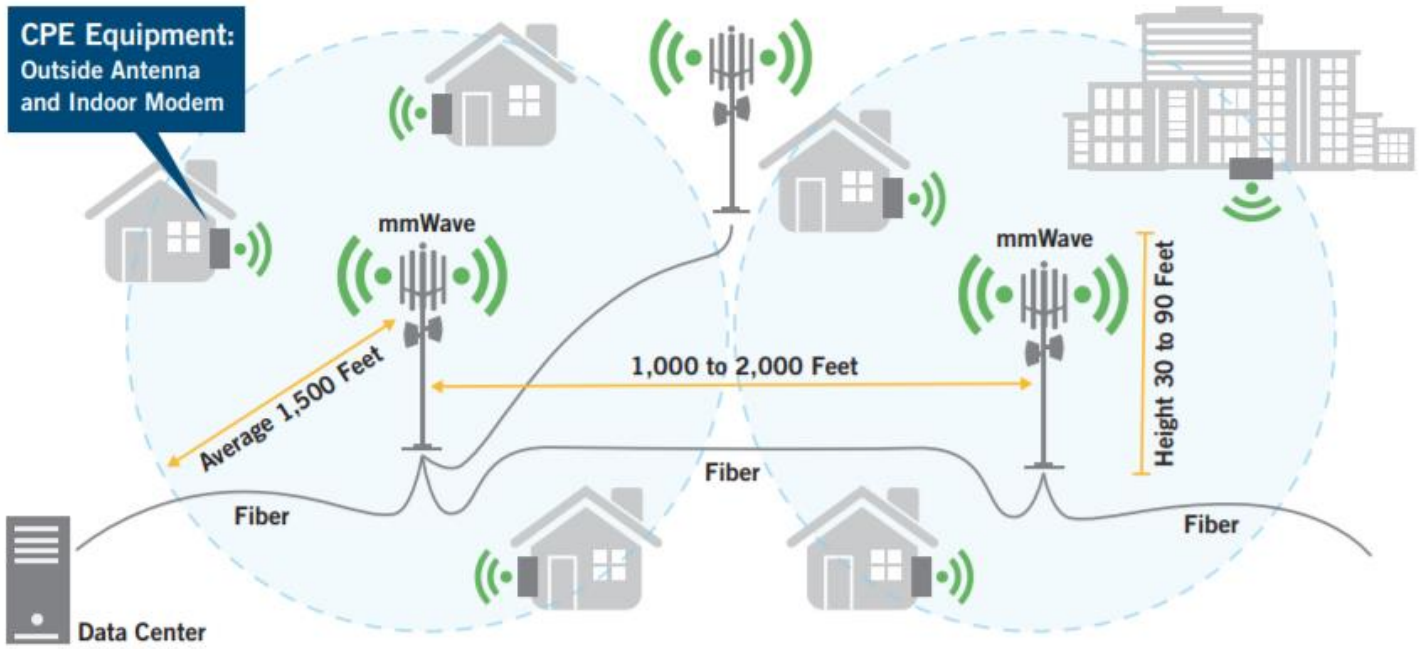
EXHIBIT 1 | The Best Solutions for Rural Counties Based on Population Density



Sources: FCC, "2016 Broadband Progress Report"; BCG analysis.
Note: 700 MHz LTE not included because it is not the most cost-effective option for residential service at any population density.

5G Fixed Wireless

As wireless technologies evolve and new spectrum bands become available, 5G fixed wireless is a solution to bring broadband services to portions of rural America.



Source: CoBank

Fixed Wireless: Advantages and Disadvantages

Advantages

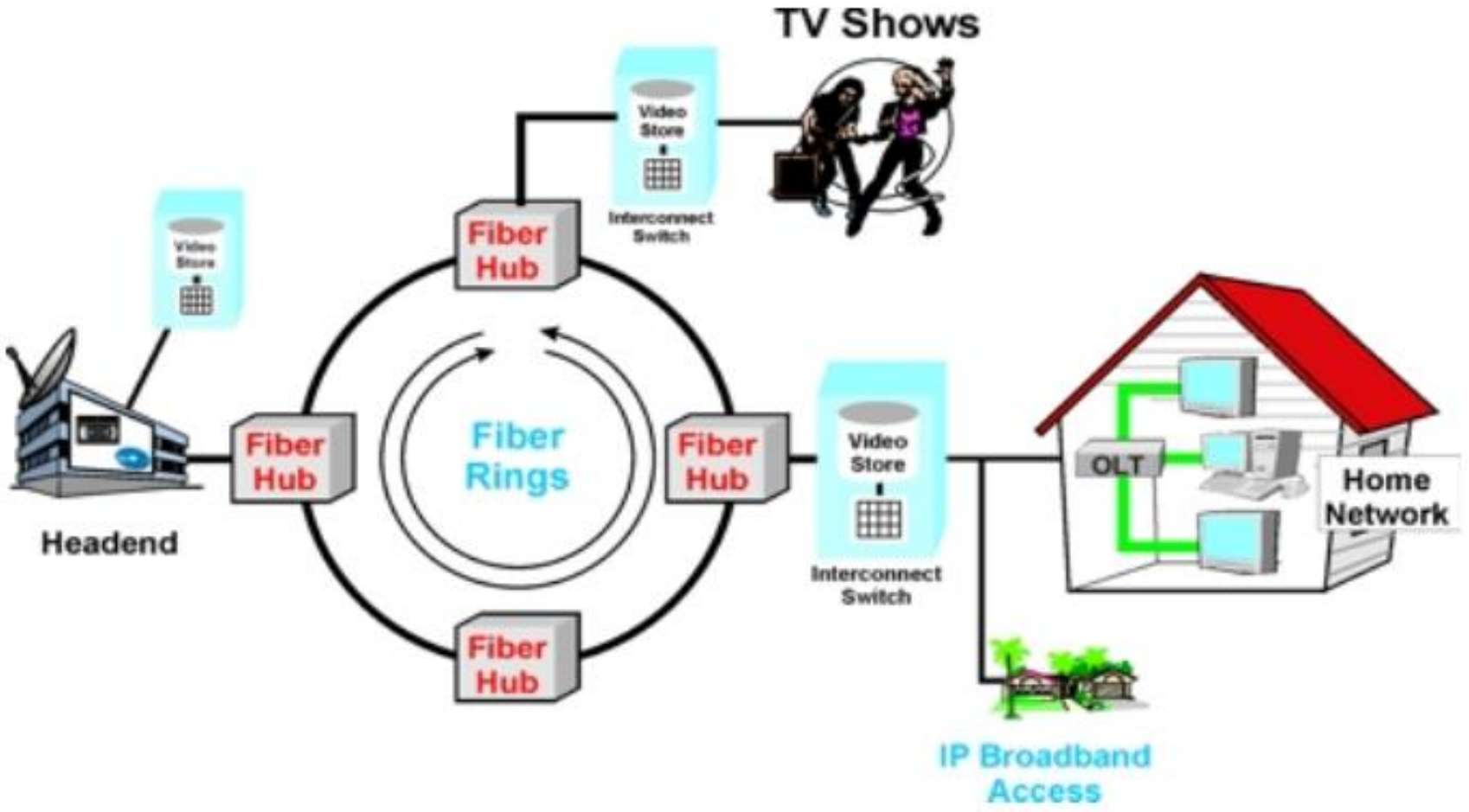
- Good for hard-to-reach areas where the terrain is not conducive to laying fiber
- Cost-effective solution for sparsely populated areas
- Faster time-to-market versus laying fiber
- 5G fixed wireless networks promise speeds north of 300Mbps
- New unlicensed spectrum bands offer greater capacity which allows operators to scale their network

Disadvantages

- Recurring operating and capital expenses can impact cash flows
- Some of the new spectrum bands do not broadcast signals very far
- New technologies require a high degree of technical expertise
- Data connection speeds have a high level of variability depending on the time of day and interference with unlicensed spectrum
- Installing the equipment at a customers home requires a truck roll and can takes several hours to complete
- Securing rights from cities and towns to erect new poles, or install equipment on existing poles is a cumbersome process

Fiber-based solutions

Fiber to the home (FTTH) or hybrid fiber-coaxial (HFC) are alternatives to fixed wireless



Source: IPTV Magazine

FTTH and HFC: Advantages and Disadvantages

Advantages

- High margin and scalable business model
- Reliable network architecture
- Ability to offer packages based on speed
- New technologies enable operators with HFC networks to squeeze more capacity and speed out of existing plant equipment
- New customer activation process (typically) does not require a truck roll

Disadvantages

- Not a cost-effective model for sparsely populated areas
- Not a good solution in mountainous or tough terrain environments
- High up-front capital investments that have a longer payback period in rural markets versus fixed wireless

Final thoughts

- There is no silver bullet solution that will close the urban-rural digital divide
- Programs such as CAF II that help address the funding shortfall are a nice start, but rural America is in need of additional subsidies/funding
- The Federal Communications Commission (FCC) estimates that it will cost $40 billion to buildout broadband to 98% of the country and $80 billion to install broadband nationwide
- The FCC needs to fix its broadband coverage maps so it can better identify where the coverage holes exist
- The FCC needs to ensure that future spectrum auction rules are designed so that rural operators are able to participate

Questions

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