The Rural Broadband Opportunity: Close the digital divide with a new network foundation

Cisco Knowledge Network

October 6, 2020
Speakers

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Agenda

1. Powering an inclusive future for rural broadband
2. Broadband funding programs
3. Cisco Converged SDN Transport architecture for rural broadband
4. Cisco Rural Broadband Innovation Center
Powering an Inclusive Future with Broadband Infrastructure

Broadband is essential for accessing education, maintaining a livelihood, receiving hard-to-reach healthcare, and more.

The COVID-19 pandemic has demonstrated that internet connectivity is more critical to the success of our society than ever before.

As more things get connected and more services move online, the digital divide is growing.

- 5.3B Internet users
- 3.6 connected devices per capita
- 110 Mbps avg global broadband speeds
  (Cisco Annual Internet Report 2023 projections)

60% traffic increase at Internet Exchange Peering Points (IXPs) reported Dec 2019 – Mar 2020 (OECD)

Bringing the Internet to those who are offline would lift another 500 million people globally out of poverty (PricewaterhouseCoopers)
A Problem of Supply and Demand in Rural America

- 60 million Americans, or 19.3% of the total population, live in rural areas. (U.S. Census Bureau)
- As of 2019, over 20 million Americans—predominantly those living in rural areas—lacked access to high speed broadband service. (U.S. Federal Communications Commission)

Rural Americans have consistently lower levels of broadband adoption

% of U.S. adults who say they have ...

Note: Respondents who did not give an answer are not shown. Source: Survey conducted Jan. 8-Feb. 7, 2019. Trend data from other Pew Research Center surveys.
$37B in U.S. Rural Broadband Funding Programs over the next 10 years

2016 Alternative Connect America Cost Model (A-CAM)
  - $4.5B over 10 years: https://www.usac.org/high-cost/funds/acam/

2018 Connect America Fund Phase II (CAF II)
  - $1.98B over 10 years: https://www.fcc.gov/auction/903

2018 US Dept of Agriculture “Re-Connect” Program
  - $744M in grants and loans for 2020: https://www.usda.gov/reconnect

2019 Rural Digital Opportunity Fund (RDOF)
  - $20.4B over 10 Years (2 phases): https://www.fcc.gov/rural-digital-opportunity-fund

2019 Secure & Trusted Communications Networks Act
  - $1B over 10 years: President Trump signed the Act on 3/12/2020

2020 5G Fund for Rural America
  - $9B over 10 years:
Rural Broadband Opportunity

- **Bridge the Digital Divide**: Expand broadband access. Power an inclusive future.
- **Government Funding**: Economic feasibility. $37B+ over 10 years.
- **Innovation**: Modernize your network. New services monetization.
TruVista Expands Rural Broadband to Unserved Communities

• Cost-effectively expanding fiber network with USDA funding to reach 1700+ additional subscribers/homes
• Increasing network capacity to deliver improvements in broadband speeds and latency
• Upgrading network while maintaining operational efficiency and reliability
• Driving additional ARPU with Clean Pipes offering using Umbrella Easy Protect
Polling Question 1

• What types of funding programs have you previously applied for or participated?
  A. Federal funding grant
  B. FCC auction
  C. Other state/local government funding
  D. Open capital markets (debt/equity)
  E. Never
Broadband Funding Programs

Michael Paddock
CEO
The Grants Office
$20.4 Billion in rural broadband funding and other broadband grant opportunities
FCC Broadband Programs (Reverse Auctions)

Rural Digital Opportunity Fund (RDOF)
- $20.4 Billion total
- Phase I will distribute $16 billion
- Two (actually three)-phase process:
  - Short Form Applications were due in June
  - Bidding Begins: October 29, 2020
  - Long Form required for auction winners
- Voice AND Broadband
  [https://www.fcc.gov/auction/904](https://www.fcc.gov/auction/904)

5G Fund for Rural America
- $9 Billion in multiple phases (Phase 1 >$8 Billion)
- Final rulemaking and bid timing TBD
## RDOF Phase I - Timing

<table>
<thead>
<tr>
<th>Auction Element</th>
<th>Date Due</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short Form Window Opens</td>
<td>July 1, 2020</td>
</tr>
<tr>
<td>Short Form Window Closes</td>
<td>July 15, 2020</td>
</tr>
<tr>
<td>Auction Bidding Begins</td>
<td>October 29, 2020</td>
</tr>
<tr>
<td>Auction Bidding Ends</td>
<td>November 26, 2020*</td>
</tr>
<tr>
<td>Form 683 Long Form Window Opens</td>
<td>January 6, 2021*</td>
</tr>
<tr>
<td>Form 683 Long Form Window Closes</td>
<td>January 21, 2021*</td>
</tr>
<tr>
<td>Letter of Credit Commitments, Detailed Technology and System Designs Due</td>
<td>February 10, 2020*</td>
</tr>
<tr>
<td>ETC Designations, Certification Letters, and Audited Financial Statements Due</td>
<td>March 21, 2020*</td>
</tr>
</tbody>
</table>

*Forecasted based on CAF II Timelines. Because the scope of the RDOF Phase 1 auction is more than 10 times larger than CAF II, these timelines may differ from the above.
## RDOF Phase I – Performance Tiers

<table>
<thead>
<tr>
<th>Performance Tier/Latency</th>
<th>Speed</th>
<th>Monthly Usage Allowance</th>
<th>Latency</th>
<th>Weight (Bid Penalty)</th>
<th>% of CAFII Winners*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum/Low</td>
<td>≥ 25/3 Mbps</td>
<td>≥ 250 GB or the US average, whichever is greater</td>
<td>≤ 100 ms</td>
<td>50</td>
<td>&gt;1%</td>
</tr>
<tr>
<td>Minimum/High</td>
<td>≥ 25/3 Mbps</td>
<td>≥ 250 GB or the US average, whichever is greater</td>
<td>≤ 750 ms &amp; MOS of ≥4</td>
<td>90</td>
<td>0</td>
</tr>
<tr>
<td>Baseline/Low</td>
<td>≥ 50/5 Mbps</td>
<td>≥ 250 GB or the US average, whichever is greater</td>
<td>≤ 100 ms</td>
<td>35</td>
<td>13%</td>
</tr>
<tr>
<td>Baseline/High</td>
<td>≥ 50/5 Mbps</td>
<td>≥ 250 GB or the US average, whichever is greater</td>
<td>≤ 750 ms &amp; MOS of ≥4</td>
<td>75</td>
<td>48%</td>
</tr>
<tr>
<td>Above Baseline/Low</td>
<td>≥ 100/20Mbps</td>
<td>≥ 2 TB</td>
<td>≤ 100 ms</td>
<td>20</td>
<td>27%</td>
</tr>
<tr>
<td>Above Baseline/High</td>
<td>≥ 100/20Mbps</td>
<td>≥ 2 TB</td>
<td>≤ 750 ms &amp; MOS of ≥4</td>
<td>60</td>
<td>0</td>
</tr>
<tr>
<td>Gigabit/Low</td>
<td>≥ 1 Gbps/500 Mbps</td>
<td>≥ 2 TB</td>
<td>≤ 100 ms</td>
<td>0</td>
<td>12%</td>
</tr>
<tr>
<td>Gigabit/High</td>
<td>≥ 1 Gbps/500 Mbps</td>
<td>≥ 2 TB</td>
<td>≤ 750 ms &amp; MOS of ≥4</td>
<td>40</td>
<td>0</td>
</tr>
</tbody>
</table>

*CAF II had slightly different speeds and latency numbers than RDOF in some Tiers*
1. Review all available FCC guidance
2. Target your bidding to the areas you know
3. Don’t bid on tiers you haven’t already deployed elsewhere
4. Consider collaborating
5. Be mindful of prohibited communications
6. Thoroughly research the requirements for your target bidding areas

7. Model auction procedures for each census block track you plan to bid on

8. Get more financing commitments than you think you’ll actually need if you win

9. Stay engaged throughout the auction
10. Try not to get too emotionally committed to any one bid or territory.

There are plenty of other opportunities out there!
Digital Divide Grant Programs

Federal Broadband Expansion Programs
• USDA ReConnect ($660 million)
• USDA Community Connect

Federal Broadband R&D Programs (NSF)
• Platforms for Advanced Wireless Research
• Office of Advanced Cyberinfrastructure
• Computer and Information Science and Engineering
• Computer and Network Systems
• Computing and Communication Foundations

State Broadband Expansion Programs
(including municipal service providers)

<table>
<thead>
<tr>
<th>Alabama</th>
<th>Maine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arizona</td>
<td>Massachusetts</td>
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<td>Arkansas</td>
<td>Michigan</td>
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<td>California</td>
<td>Minnesota</td>
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<td>Colorado</td>
<td>Missouri</td>
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<td>Iowa</td>
<td>Nebraska</td>
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<td>Kansas</td>
<td>Nevada</td>
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<td>South Dakota</td>
<td>Tennessee</td>
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<tr>
<td>Virginia</td>
<td>Washington</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>Wyoming</td>
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</tbody>
</table>
Polling Question 2

- Where are you prioritizing your rural access network investments?
  A. Extending fiber to the node/home
  B. Fixed wireless last mile
  C. Licensed mobile spectrum (4G/5G)
Converged SDN Transport Architecture for Rural Broadband

Marty Fierbaugh
Solutions Architect
Cisco Americas SP
Today’s Agenda

- Access Network Evolution
- Subscriber Management
- Converged SDN Transport
- Automation
- Summary
Strategy to Modernize Rural Network Architectures

**Open Access**
Vertically Integrated, Disaggregated, Any type

- Mobile Providers
  - Licensed spectrum

- Fixed Wireless Last Mile
  - Licensed, unlicensed, shared

- Residential Broadband
  - FTTH, FTTN, xDSL, Cable

**Converged SDN Transport**
Reduce cost and complexity
Enhance customer experiences

**Subscriber Management**
Complete and validated stack
to accelerate deployment

- 60% improved capital efficiency
- 66% better OPEX utilization
- 78% faster time-to-service
Access Network Evolution Trends

Virtualization: Virtualize subscriber management gateways

Network Convergence: Converge wireless, wireline, cable, and business traffic

Decomposition: Separate Control Plane from User Plane and User Plane distribution

Disaggregation: Hardware and software separation (i.e., Whitebox)

Subscriber Management Unification: Common subscriber management independent of access type

Common across all access network architectures
Access Evolution – Mobile
vRAN/CRAN, vPC, CUPS, NFVi

Virtualization
• Every MNO is either planning or already deploying vPC

Decomposition CUPS
• 5G driving CUPS with UPF distribution: most of 5G trials include CUPS; cloud strategy first step is vPC on the distributed DC

Decomposition CRAN
• Most EMEAR SPs starting with DRAN, although majority is testing CRAN and studying business cases
• US and Asia more aggressive with CRAN deployments:
Access Evolution – Cable
vCMTS, R-PHY/DAA

Virtualization
• Cable SPs interested in vCMTS evolution
• vCMTS location can be centralized

Decomposition R-PHY
• Major cable operators have completed network upgrade to CCAP and DOCSIS3.1
• Cable investments moving to R-PHY/Distributed Access Architecture (+ fiber-deep)
• High interest from cable operators on exploring RPHY CIN and DOCSIS3.1 networks for 4G/5G
• Similar approach to CUPS currently under debate in the industry – Flexible MAC
Access Evolution – Wireline
vOLT, vBNG, cnBNG

Virtualization
- Deploy geographically distributed mini data centers at the network edge for broadband Internet and VPN access (vOLT, vBNG, vSwitches)

Decomposition - cnBNG
- Userplane (UP) highly bandwidth intensive & current dataplane scale of a virtual component not scaling to support required economies = UP needed in HW ASIC
- Cloud BNG with HW and/or SW dataplane options
Evolution and future of wired/wireless technologies

By 2023, 27.4% of WLAN Endpoints will be equipped with 802.11ax (Wi-Fi 6)
By 2023, 66.8% of WLAN Endpoints will be equipped with 802.11ac
Future Wi-Fi Enables Virtualization, IoT, Speech Processing, Security, Data Analytics

Source: Cisco Annual Internet Report, 2018–2023
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Common Architecture
Converging Access Network and Subscriber Management

Access
Preaggregation
Aggregation
Core

Fiber
(v)OLT
(v)CMTS
CRAN

Edge DC
Regional DC
Centralized DC

Copper
DSLAM

CM
CMV
ONU

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BNG Architecture Evolution
Subscriber Termination Evolution

**Physical BNG**
- Native IPoE/ PPPoE termination with multi-service capability
- Stateful redundancy
- Streaming telemetry
- Throughput & power optimized
- Limited control plane scalability

**Virtual BNG**
- Elastic scaling based on requirement
- Low & controlled failure domains
- Native automation integration
- Service chain traffic and network functions
- Limited dataplane scalability

**Cloud Native BNG CP**
- Infinite control plane scale/performance for higher flexibility
- Choose data plane based on service capabilities
- Easier integration of CP to OSS/BSS, faster customization with lower vendor code dependency
- Network-level resource optimization
- Higher network/subscriber visibility
- Smaller protocol stack
- Lighter/none AAA/PCRF layer
Accelerate Service Creation with Cisco Telco Cloud

Scale flexibility from cloud
- Cloud-native, dynamic microservices

High-performance 4G/5G subscriber services
- Forwarding: +50% faster
- Services Proxy: +20% faster during congestion and +40% cell site capacity
- Traffic Optimization: reduces congestion 30% to save RAN expansion

Turnkey for easy deployment
- Cisco CX Services – Right Sized

Market Proven Cloud RAN
- Rakuten cloud RAN deployment
- Over 1.3B mobile connections across Cisco 5G packet core networks

<table>
<thead>
<tr>
<th>Subscriber Services</th>
<th>Service Edge</th>
<th>3rd Party</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobility, Cable, Residential</td>
<td>Business Services</td>
<td>Applications and Services</td>
</tr>
<tr>
<td>Tooling</td>
<td>Cisco Customer Experience</td>
<td></td>
</tr>
<tr>
<td>NFVO</td>
<td>Cisco Network Services Orchestrator (NSO)</td>
<td></td>
</tr>
<tr>
<td>qVNFM</td>
<td>Cisco Elastic Services Controller (ESC)</td>
<td></td>
</tr>
<tr>
<td>NFVI</td>
<td>Cisco Virtualized Infrastructure Manager (CVIM)</td>
<td></td>
</tr>
<tr>
<td>Hardware</td>
<td>Cisco Unified Computing System (UCS)</td>
<td></td>
</tr>
</tbody>
</table>

Cisco Cloud Services Stack

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## Cisco SP Design Principles

<table>
<thead>
<tr>
<th>Category</th>
<th>Principles</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Best of Breed</strong></td>
<td>• Scalable fabric designs to accommodate elastic network service expansion</td>
</tr>
<tr>
<td></td>
<td>• Granular building blocks using high-density and efficient Cisco routers</td>
</tr>
<tr>
<td><strong>Simplify the Network</strong></td>
<td>• Separate network function into building blocks with simplified feature sets</td>
</tr>
<tr>
<td></td>
<td>• Increased resiliency without additional complexity using Segment Routing</td>
</tr>
<tr>
<td></td>
<td>• Reduction in control-plane protocols</td>
</tr>
<tr>
<td><strong>Open Automation</strong></td>
<td>• Streaming telemetry available for all protocols using standards-based YANG models</td>
</tr>
<tr>
<td></td>
<td>• Common automatable tasks prescribed</td>
</tr>
<tr>
<td></td>
<td>• Standards-based YANG models used for configuration and state</td>
</tr>
<tr>
<td><strong>Secured</strong></td>
<td>• Device level security</td>
</tr>
<tr>
<td></td>
<td>• Infrastructure security and monitoring</td>
</tr>
<tr>
<td></td>
<td>• Best practices</td>
</tr>
<tr>
<td><strong>Validated Design</strong></td>
<td>• Network design and its component features tested individually and as a system</td>
</tr>
<tr>
<td></td>
<td>• Design is continually evaluated as a component of end to end network</td>
</tr>
</tbody>
</table>
Converged SDN Transport for Rural Broadband

**Advantages**

- Simplifies operations and reduces network complexities
- Increases space, power and operational savings
- Reduces time-to-market for services
- Improves scalability while maintaining a consistent, superior customer experience

Converge access services, simplifying management
Converge IP and optical, increasing share in high-value segment
Innovation across silicon, optics, software, and systems
Simplify Your Transport with Segment Routing

Create New Revenue Streams
- Differentiate Services with SR Policies
- Statelessly Chain Value-Add Services (no added protocols)

Monitor Health
- Data Path Validation Including ECMP
- Real Time Per-Link Performance Monitoring with Telemetry

Deploy with Ease
- Seamless Brownfield Integration
- Single Control for Inter Domain Implementations

Increase Availability
- Automated 50ms Protection
- Assured Loopfree Convergence upon Recovery
Business Agility for the Next Decade of Performance
Pay as you grow with Flexible Consumption Model
Today’s Agenda

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## Automating the Network Operations Lifecycle with Cisco Crosswork Automation

### Day 0

- **Prepare | Plan | Integrate | Design**

  - **WAN Automation Engine**
    - Planning and predictive modelling to analyze potential scenarios
  - **Qualification Environment**
    - Rapid qualification and integration to support new feature and software delivery into production

### Day 1

- **Implement**

  - **Network Insights**
    - Provides routing data analytics to significantly reduce mean time to repair
  - **Trust Insights**
    - "Always on monitoring" to determine the integrity of infrastructure
  - **Network Service Orchestrator**
    - Mass scale intent-based configuration across multi-vendor
  - **Network Controller**
    - Turnkey solution for end-to-end provisioning and management of intent-based networks
  - **Data Gateway**
    - Large scale distributed data collection

### Day 2/N

- **Operate | Optimize**

  - **Situation Manager**
    - Connect events across multi domains and provide root cause analysis.
  - **Health Insights**
    - Learn and measure the health of network elements.
  - **Change Automation**
    - Safely execute operational tasks with structured workflows.
  - **Optimization Engine**
    - Optimize network paths to improve utilization & efficiency (SR-PCE)
  - **Evolved Programmable Net Manager**
    - Element and network management
Today’s Agenda

- Access Network Evolution
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Summary of Cisco’s Rural Broadband Architecture

Reference Architecture
Validated and tested architecture designed for large/medium/small networks

SDN Transport / Segment Routing
Network simplification, slicing, service chaining, policy, 50ms protection

Infrastructure Security
Hardening of network functions, trustworthy infrastructure

Multiple Access Technologies
Cable, fixed wireless (licensed and unlicensed), PON, and DSL

Converged Subscriber Management
vBNG, cnBNG, Cloud-native 5G Packet Core, vCCAP/R-PHY

Programmable
Automation through open and standard APIs, Cisco Crosswork

Open / Standards Based
No vendor lock-in

Distributed Access Architecture
Regional/Edge datacenter for hosting distributed user-plane and disaggregated access functions
Polling Question 3

• How far have you progressed in evolving your access network?
  A. Exploring network access function virtualization and/or network function distribution to the network edge.
  B. Begun virtualizing functions in the packet core, cable access, or wireline access networks.
  C. Begun distributing access network functions to the network edge.
  D. Fully virtualized access networks
  E. Not yet started to explore options
Cisco Rural Broadband Innovation Center

Robin Olds
Business Development
Cisco Americas SP

Accelerate device programmability and automation with infrastructure as code

NFV Infrastructure to accelerate new service roll-out with Telco Cloud services

Optimize network transport and operations with Segment Routing

Network modernization with TDM transport over IP

Change the economics of networking with Cisco Silicon One and Cisco 8000
Introducing the Rural Broadband Innovation Center
Next Steps

1. Explore solutions: [Cisco.com/go/ruralbroadband](https://Cisco.com/go/ruralbroadband)
2. Learn how to prepare for RDOF success: [read whitepaper](#)
3. **Discover** Cisco Capital options to bridge the funding gap
4. **Register** to experience the broadband innovation center