Technical Advisory Council
Federal Communications Commission
Summary of Meeting
December 6th, 2017

The Technical Advisory Council (TAC) for the FCC was convened for its twenty-fifth meeting at 10:00 A.M. on December 6th, 2017 in the Commission Meeting Room at the FCC headquarters building in Washington, DC. A full video transcript of the meeting is available at the FCC website at http://www.fcc.gov/encyclopedia/technology-advisory-council together with a copy of all materials presented at this meeting. In addition, materials presented at this meeting are included in electronic form in an Appendix to this document.

In accordance with Public Law 92-463, the entire meeting was open to the public.

Council present:

Shahid Ahmed, SME	Steve Lanning, Viasat, Inc
John Barnhill, Genband	Gregory Lapin, Independent Consultant
Mark Bayliss, Visual Link Internet, Lc	Kevin Leddy, Charter Communications
Nomi Bergman, Advance Newhouse Communications	Brian Markwalter, Consumer Technology Association
John Chapin, Roberson & Associates Consulting	Tom McGarry, Neustar
Lynn Claudy, National Association of Broadcasters	Milo Medin, Google, Inc
Marty Cooper, Dyna LLC	Lynn Merrill , Monte R. Lee & Company
Brian Daly, AT&T	Jack Nasielski, Qualcomm, Inc.
Pierre De Vries, Silicon Flatirons Center for Law, Technology, and Entrepreneurship University of Colorado at Boulder	Chuck Powers, Motorola
Adam Drobot, OpenTechWorks	Mark Richer, Advanced Television Systems Committeee, Inc.
Jeff Foerster, Intel Corporation	Dennis Roberson, Illinois Institute of Technology
Lisa Guess, Juniper Networks	Jesse Russell, incNetworks
Russ Gyurek, Cisco Systems	Marvin Sirbu, Carnegie Mellon University
Dale Hatfield, Silicon Flatirons Center for Law, Technology, and Entrepreneurship University of Colorado at Boulder	Kevin Sparks, Nokia (Remote)
Stephen Hayes, Ericsson North America	David Tennenhouse, VMWare
Mark Hess, Comcast Corporation	David Young, Verizon

FCC staff attending in addition to Walter Johnston and Julius Knapp included:

Eric Burger, FCC	Rashmi Doshi (Remote)
Martin Doczkat, FCC	Ajit Pai, FCC
Rangam Subramanian, NTIA	

Meeting Overview

Dennis Roberson, TAC Chairman, began the meeting by calling for attendance. He then introduced the Chairman of the FCC, Ajit Pai. Chairman Pai began the meeting by noting the representatives of the TAC spanned the technology industry. He thanked them for their past recommendations which have influenced and directed the actions of the FCC and indicated was looking forward to the readout of the recommendations for the current year's work program. In addition, he noted that he would be working with Dennis Roberson and FCC staff on the TAC work program for next year. He thanked Dennis Roberson for serving as the current year's chairman and thanked the FCC staff that have supported the TAC.

Chairman Pai also noted the recent passing of Vanu Bose adding that he and Dennis Roberson had signed a TAC affirmation of Vanu's many contributions to the industry and humanitarian efforts. He also noted that this was fitting as Vanu had recently given what may have been his last technical presentation direct to the TAC a few weeks before his untimely death. Dennis then presented the signed affirmation for a vote by attending members who passed it unanimously. Following, Dave Tennenhouse, who had been Vanu's thesis advisor at MIT, gave a short overview of Vanu's life.

The formal meeting began with the Broadband Deployment Technology Challenges work group presenting their work. An important part of this effort was to identify areas where investment could become stranded due to a lack of a technology evolution path. They identified a number of tradeoffs involving areas such as cost and scalability that factor into the overall capabilities of specific technologies. Next the work group focused on reducing unnecessary regulation gave its report having identified a number of areas where industry participants believed streamlining of regulations was possible. They also noted that their outreach to industry stakeholders produced a different and in some contexts richer set of suggestions than the FCC's own biannual review of obsolete regulations. The Mobile Device Theft prevention group presented its recommendation for further improvements in this area, noting the difficulties it is still having getting baseline tracking data on the rate of theft. Finally the satellite group gave its assessment on issues deriving from the increased scaling of the satellite industry, offering suggestions on using risk based assessment for managing interference.

Two white papers were presented for voting by the TAC. One describing implications of next generation broadcasting and the second on an NGSO risk assessment framework. Both were passed unanimously without comment. The meeting was adjourned at 3:50 pm with a small celebration in honor of Vanu Bose.

A copy of all presentations made at the TAC meeting is attached herein.

Walter Johnston, Chief EMCD-OET
FCC

FCC
Technological Advisory Council
December 6th, 2017

Technological Advisory Council Agenda

- Introduction - (Dennis Roberson)
- Chairman's Remarks
- Broadband Deployment Technical Challenges
- Recommendations for Removing Obsolete or Unnecessary Technical Rules
- Lunch
- Mobile Device Theft Prevention (MDTP) Work Group
- Implications of Next Generation TV Broadcasting Technology
- Satellite Communications Plan

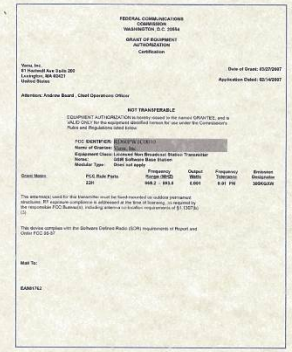
FCC TAC
Life Acknowledgement

The Federal Communications Commission's Technological Advisory Council
Hereby Acknowledges the Technical and Humanitarian Contributions of

Vanu Bose, Ph.D.

Which have included:

- ***The First Software Defined Radio Certified for Use by the FCC***
- ***Extending the Benefits of Broadband Technology to Underserved Areas***
- ***Guidance to the Technological Advisory Council***
- ***Emergency Restoration Efforts for the Commonwealth of Puerto Rico***



FEDERAL COMMUNICATIONS COMMISSION
WASHINGTON, D.C. 20554

GRANT OF EQUIPMENT AUTHORIZATION
Certification

Vanu, Inc.
81 Hartwell Ave Suite 200
Lexington, MA 02421
United States

Date of Grant: 05/07/2007
Application Dated: 05/14/2007

Attention: Andrew Beard , Chief Operations Officer

NOT TRANSFERABLE

EQUIPMENT AUTHORIZATION is hereby issued to the named GRANTEE, and is VALID ONLY for the equipment identified hereon for use under the Commission's Rules and Regulations listed below.

FCC IDENTIFICATION: [redacted]
Grantee Code: [redacted]
Equipment Class: Licensed Non-Broadcast Station Transmitter
Name: 3GM Software Base Station
Modular Type: Direct not apply

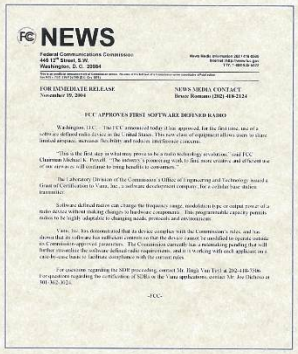
Grant Notes	FCC Rule Parts	Frequency Range (MHz)	Output Watts	Frequency Tolerance	Emission Designator
	22H	869.2 - 894.8	0.001	0.01 PM	3M0G7W

This equipment used for this transmitter must be fixed-mounted on outdoor permanent structures. RF exposure compliance is addressed at the time of licensing, as required by the responsible FCC Bureau(s), including antenna co-location requirements of § 1.1307(b)(3).

This device complies with the Software Defined Radio (SDR) requirements of Report and Order FCC 06-97.

Mail To:

EA001762



FCC NEWS

Federal Communications Commission
445 12th Street, S.W.
Washington, D. C. 20554

News Media Information 202 418-0500
Internet: http://www.fcc.gov
TTY: 888-835-5322

This is an unofficial announcement of Commission action. Release of the full text of Commission decisions is contingent upon release of the text. FCC 04-270 (WT Docket No. 04-)

FOR IMMEDIATE RELEASE
November 19, 2004

NEWS MEDIA CONTACT:
Bruce Romano (202) 418-2124

FCC APPROVES FIRST SOFTWARE DEFINED RADIO

Washington, D.C. – The FCC announced today it has approved, for the first time, use of a software defined radio device in the United States. This new class of equipment allows users to share limited airspace, increase flexibility and reduce interference concerns.

"This is the first step in voluntary press to be a radio technology revolution," said FCC Chairman Michael K. Powell. "The industry is pioneering work to flow more creative and efficient use of our airwaves – will continue to bring benefits to consumers."

The Laboratory Division of the Commission's Office of Engineering and Technology issued a Grant of Certification to Vanu, Inc., a software development company, for a cellular base station transmitter.

Software defined radios can change the frequency range, modulation type or output power of a radio device without making changes to hardware components. This programmable capacity permits radios to be nightly adaptable to changing needs, protocols and environments.

Vanu, Inc. has demonstrated that its device complies with the Commission's rules, and has demonstrated its software has sufficient controls so that the device cannot be modified to operate outside its Commission-approved parameters. The Commission currently has a rulemaking pending that will further streamline the software defined radio requirements, and is working with each applicant on a case-by-case basis to facilitate compliance with the current rules.

For questions regarding the SDR proceeding, contact Mr. Hugh Van Tuyl at 202-418-7506. For questions regarding the certification of SDRs in the Vanu application, contact Mr. Joe Dichoso at 301-362-3124.

-FCC-

Approved this Wednesday, December 6th, 2017 by Attending Members

Ajit Pai, Chairman
Federal Communications Commission

Dennis Roberson, Chair
Technological Advisory Council

Report on the contributions of

Vanu Bose

FCC Technical Advisory Council

December 6, 2017

COPY

FEDERAL COMMUNICATIONS COMMISSION
WASHINGTON, D.C. 20554

COPY

GRANT OF EQUIPMENT AUTHORIZATION
Certification

Vanu, Inc.
81 Hartwell Ave Suite 200
Lexington, MA 02421
United States

Date of Grant: 03/27/2007

Application Dated: 02/14/2007

Attention: Andrew Beard , Chief Operations Officer

NOT TRANSFERABLE

EQUIPMENT AUTHORIZATION is hereby issued to the named GRANTEE, and is VALID ONLY for the equipment identified hereon for use under the Commission's Rules and Regulations listed below.

FCC IDENTIFIER: RD60PW1C0010
Name of Grantee: Vanu, Inc.
Equipment Class: Licensed Non-Broadcast Station Transmitter
Notes: GSM Software Base Station
Modular Type: Does not apply

Grant Notes	FCC Rule Parts	Frequency Range (MHZ)	Output Watts	Frequency Tolerance	Emission Designator
	22H	869.2 - 893.8	0.001	0.01 PM	300KGXW

The antenna(s) used for this transmitter must be fixed-mounted on outdoor permanent structures. RF exposure compliance is addressed at the time of licensing, as required by the responsible FCC Bureau(s), including antenna co-location requirements of §1.1307(b)(3).

This device complies with the Software Defined Radio (SDR) requirements of Report and Order FCC 05-57.

Mail To:

EA981762

FEDERAL COMMUNICATIONS COMMISSION
FCC
USA

FEDERAL COMMUNICATIONS COMMISSION
FCC
USA

CUBIC
VANU

FEDERAL COMMUNICATIONS COMMISSION
FCC
USA

Watch webcast.mit.edu/memorial to learn more about Van
© Chris Wall

2018 Meeting Dates (Proposed)

2017	2018
NA	March 7th
June 8th	June 12th
Sept 19th	Sept 20th
Dec 6th	Dec 5th

Potential New 2018 Work Areas

- IOT
  - What are the categories of services/applications for IOT, what network requirements will this imply, what steps networks should take to safeguard against threats posed by IOT.
- 5G Challenges
  - Focus on integration with various market sectors/industrial requirements
  - V/V V/I capabilities
  - Network mitigation of botnet/IOT created threats
- Status of Advanced Sharing Strategies
  - TV White Spaces
  - 3.5 GHz
  - Other bands for sharing
  - SAS platform strategies
  - Sharing issues with federal partners
  - Market mechanisms for sharing
  - ETSI/LSA
- Noise Limitation Strategy: analysis of sector issues, status and remediation strategies
  - Expand TAC membership to include other stakeholders such as NEMA
  - Compliance
- Communication/Spectrum Strategies for Drones
- Directed Satellite Communication and bandwidth sharing strategies
- Impact of New Antenna technologies : handsets, RANs, radars; impact on standards, regulations, testing, safety
- Suggestions/Comments due 2nd week of January

Broadband Deployment Technology Challenges Working Group

WG Chairs: Nomi Bergman and Adam Drobot
FCC Liaison: James Miller and Walter Johnston

SWG Chairs: Marvin Sirbu and Kevin Sparks – Technology Roadmap
SWG Chair: Lynn Merrill – Universal Access

6-December 2017 Washington, DC

Working Group Members

- WG Chairs: Nomi Bergman, Advance Newhouse
  Adam Drobot, OpenTechWorks
- SWG Chairs: Lynn Merrill, NTCA
  Marvin Sirbu, CMU and Kevin Sparks, Nokia
- FCC Liaison: James Miller and Walter Johnston
- Members:

Shahid Ahmed - SME
John Barnhill - Genband
Mark Bayliss - Visuallink
Nomi Bergman – Advance Newhouse
KC Claffy - CAIDA UCSD
Brian Daly - AT&T
Adam Drobot - OpenTechWorks
Russ Gyurek - Cisco
Dick Green - Liberty Global
Dale N. Hatfield - Silicon Flatirons

Working Group Members Cont'd

Mark Hess - Comcast
Jason Livingood - Comcast
Tom McGarry - Neustar
Milo Medin - Google
Lynn Merrill - NTCA
Jack Nasielski – Qualcomm
Chuck Powers - Motorola Solutions
Dennis Roberson – IIT
Mark Richer - ATSC
Marvin Sirbu – CMU (SGE)
Rob Alderfer - CableLabs
Henning Schulzrinne – Columbia U.
Paul Steinberg - Motorola Solutions

Michael Tseytlin - Facebook
David Young – Verizon
Kevin Leddy – Charter
Stagg Newman – Land of Sky (SME)
Michael Bugenhagen – CenturyLink
Mariah Shuman – OneWeb
Christine Hsu - OneWeb

Paul D'Ari - FCC
Walter Johnston - FCC
Padma Krishnaswamy - FCC
James Miller - FCC
Zach Ross - FCC

BDTC Working Group Charter for 2017

Broadband Deployment Technological Challenges: This group would bring together technical experts from a broad cross section of the communications industry – including among others: wireline, mobile, cable, satellite, and broadcast, – to study and provide information on available technologies, their limitations, and any technical rules or policies that impede broadband deployment. This group's work may also provide a ready resource for technical support for the FCC's Broadband Deployment Advisory Committee (BDAC).

Broadband Deployment Technological Challenges SWGs

- **Broadband Technology Roadmap** to guide future investments
  - Marvin Sirbu and Kevin Sparks Chairs
- **Universal Access** dealing with coverage in rural, sparsely populated, and underserved areas
  - Lynn Merrill Chair
- **Critical Policies and Regulations** to encourage Broadband Deployment - All

Agenda

- List of presentations to Broadband Technology Challenges WG
- Overall Observations
  - Broadband for underserved and sparsely populated areas
  - Advances in technology
  - Impact of business models
  - Policy and regulations to speed broadband adoption
- Broadband Technology Roadmap – Marvin Sirbu and Kevin Sparks
  - Overview
  - Recommendations
- Universal access in rural areas – Lynn Merrill
  - Overview
  - Recommendations
- Summary

SME Presentations and Discussions

Date 2017	Speakers	Topic	Affiliation
May 26th	Stagg Newman	Discussion of Current Broadband Issues a Local Perspective from North Carolina	Land of Sky
June 2nd	Blair Levin	Lessons learned from the Broadband Plan and Broadband Futures	SME
July 28th	Jonathan Chambers Randy Klindt	A Regional Business Model, Low Cost Deployment, and Partnering	OzarksGo ConexOn
August 4th	Robert Whitman Claudio Mazzali	Cost Model for Rural Fiber Deployment and Future Fiber Technology	Corning
August 10th	Rob Alderfer	Planning, cost, and construction for build-out to rural areas	CableLabs
August 11th	John Chapman	Infinite DOCSIS	Cisco
August 18th	Kevin Larson Joe Buttweiler	Partnership in providing broadband services	Consolidated Telephone Co.

SME Presentations and Discussions

Date 2017	Speakers	Topic	Affiliation
August 25th	Jeff Bratcher	Goals, technology capacity, wireless build-out strategies and networks use for Public Safety and commercial Broad Band uses	FirstNet
August 31st	Rob Rainhart Rob Miller	Satellite infrastructure used to determine RF interference for rural areas	Hawkeye 360
September 6th	David Reed	Wireless for rural areas	University of Colorado
September 8th	Ron Reuss	Line powering capabilities for HFC use for small cell environments	CableLabs
September 8th	David Mason	Historical Perspective on rural build-out	Keene Valley
September 13th	Joseph Tiernan Dave Charbonneau	Massachusetts Broadband Initiative	DTC MBI
September 22nd	Christopher Mitchell Elliot Noss	Community fiber projects	Community BB Initiative Network and TUCOWS
September 27th	Mariah Shuman Christine Hsu	Global Internet Access (Joint session with the Satellite WG)	OneWeb

SME Presentations and Discussions

Date 2017	Speakers	Topic	Affiliation
September 29 th	Chad Duval	Universal Service Fund Changes by the FCC and how it impacts Broad Band in Rural Areas	Moss Adams
October 13th	Ken Kuchno	Department of Agriculture's Loan and Grant programs for Broad Band Service	RUS Dept. of Agriculture
October 20th	Vanu Bose	Rural Broadband and Emergency Cellular Service for the Caribbean	
October 27th	Daniel Turner	Fiber and placement technologies within roadways	TRAXyL
November 3rd	Ryan Korte	CDN's NFV and Cloud Edge for rural markets	Level 3
November 3rd	Henning Schultzrhine	The economics of networks: The challenge of rural netrification. (Circulated presentation)	Columbia University
November 17th	Danny Huffman	FTTH computer designs and improved efficiency in design and proposed reduction in construction cost of facilities	ONUG

Observations: Broadband for Rural and Underserved Areas

Overcoming the Widening Gap in Broadband Performance and Cost

- Broadband performance, capabilities, and services will continue to advance in and around population centers at a significant pace.
  - More and more services that will be deemed essential will rely on broadband, accompanying infrastructure, and specific capabilities such as wireless mobility.
- For rural and other underserved areas solving the problem of broadband deployment is an imperative for:
  - The opportunity to participate in the US economy on an equitable basis
  - Rural communities to be seen as desirable places to live
  - Citizen engagement and employment
  - Critical services such as: law-enforcement, education, and healthcare
- In changing attitudes broadband is increasing seen as an investment and a must for rural communities not to fall behind the rest of the nation

Population Covered	Notional Cost Factor
00% – 90%	1X-2X
90% - 99%	2X-20X
99% - 100%	20X – 200X

- **To achieve sustainable universal broadband the economics are daunting – and deserve a fundamental rethinking! Across Technologies, Local Conditions, and Business Models.**

Observations: Advances in Technology

Virtuous Cycle for Urban American but No Silver Bullets for Rural America

- The “Technologies” for delivery of Broadband solutions continue to evolve rapidly fed by large profitable markets that in turn generate the investments to drive future advancements
  - The likely average improvement in performance is a factor of 2 every 18-36 months
  - Broadband is no longer a stand alone and goods, services, and processes increasingly rely on infrastructure and capabilities traditionally not within the FCC’s jurisdiction. It is not simply connectivity but also CDNs, caching, cloud and edge computing and storage!
  - In addressing rural Broadband no one “Technology” can address the wide range of requirements posed by differences in geography, population patterns, and local needs.
- Some of the major opportunities in Technologies for Rural and sparsely populated areas include:
  - Deep penetration of core and middle mile feeder fiber capacity
  - The use of wireless solutions for last 0.1-1.0 miles access and mobility
  - NGSO (LEO, MEO, and HEO) and GEO Satellite that can compete for general services by investing in capacity, but also uniquely address the most sparse and hardest to service areas (such as Alaska, the Mountain West, etc.)
  - Improvements in civil engineering design and craft work
  - Use of automation and autonomy in Broadband plant operations
- The cost/revenue structure for Broadband can be impacted by “Technologies” that contribute to:
  - Investments in “innovation” capacity
  - Planning and Design
  - Build-out and Deployment
  - Operation and Maintenance
  - Upgrade of Services and Capabilities to follow Technology evolution

Observations: Impact of Business Models

Solving the Economics of Broadband for Rural Areas

- The basic problem of providing universal broadband access is economic and consequently business models and incentives play a considerable role in outcomes. Key issues include:
  - Investments for capitalization of service build out and/or service creation
  - Sustainability of operating costs as balanced by support levels and income
  - Management capacity and capabilities for competitive deployment and operation
  - Aggregation and bundling of profitable service offerings and applications to offset costs with support income and adequate revenue
  - Readiness for adoption and high level of penetration
- Some of the approaches that appear important
  - Partnering to spread capital costs among multiple infrastructures
  - Partnering for efficient operations
  - Joint Local/Regional planning to create deployments of critical scale
  - Sharing of practices and knowledge nationally
- In high cost scenarios/situations relying on pure market forces may fail and community based approaches to satisfy local needs may be necessary
  - Indirect investments that stimulate innovation in technologies for rural areas
  - Sharing of knowledge and resources across jurisdictions
  - Partnering with non-traditional businesses and operations that have their own needs for Broadband capabilities reinforced by incentives for participation

Observations: Broadband Policy and Regulations

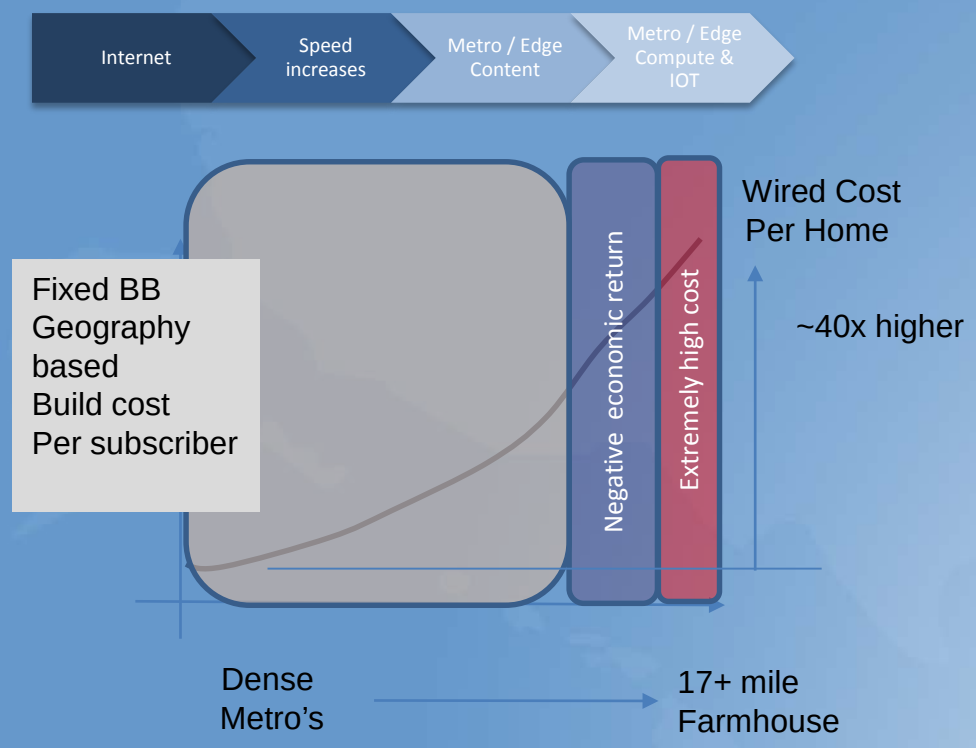
New Policy Needed to Prevent the Widening of the Digital Divide

- While the focus of the WG was on “Technology” many of the issues raised from presentations and from the WG discussion dealt with issues of Policy and Regulations for deployment
  - To eliminate dis-incentives
  - To encourage promising approaches
  - To enable both fixed and *mobile* broadband for all Americans

- Recurring themes regarding the FCC’s role in encouraging and providing for Broadband service to underserved, rural, and low density areas include:
  - A re-examination of eligibility for support in determining who is and who is not an operator
  - A long term view of Broadband to encourage investment in solutions that are capable of evolving at the rapid pace of Technology change and growing expectations for Services that depend on Broadband for delivery (not simply connectivity). Limit support to solutions that can evolve!
  - Balanced investments in the life cycle aspects of Broadband deployment and adoption – from core to edge and from concept to in service operation and sustainment
  - A technology neutral approach – other than for a limited number of corner cases – the last fractions of a %. The technology must support evolvable access to >> 100 Mpbs, gigabits per second middle mille and backbones,
  - Considerations which would require Service Providers to transparently provide their policies and programs surrounding Line Extensions and Construction Charges.
  - Moving the leadership and onus to Community led efforts with local, regional, and state based support to supplement Federal inputs.

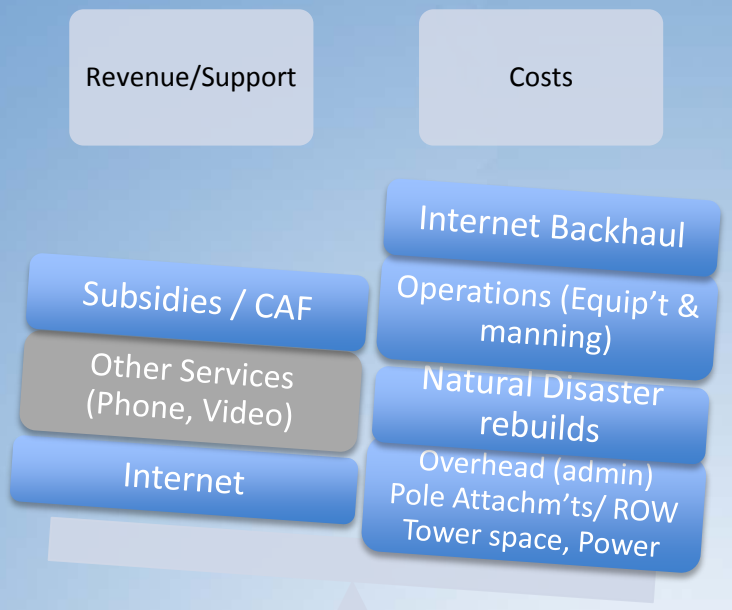
Broadband Technology Roadmap SWG
Marvin Sirbu and Kevin Sparks

Urban Internet
service evolutions
Generally missing from rural



Those building Rural are essentially betting they can improve the revenue / lower the cost after any subsidies run out.

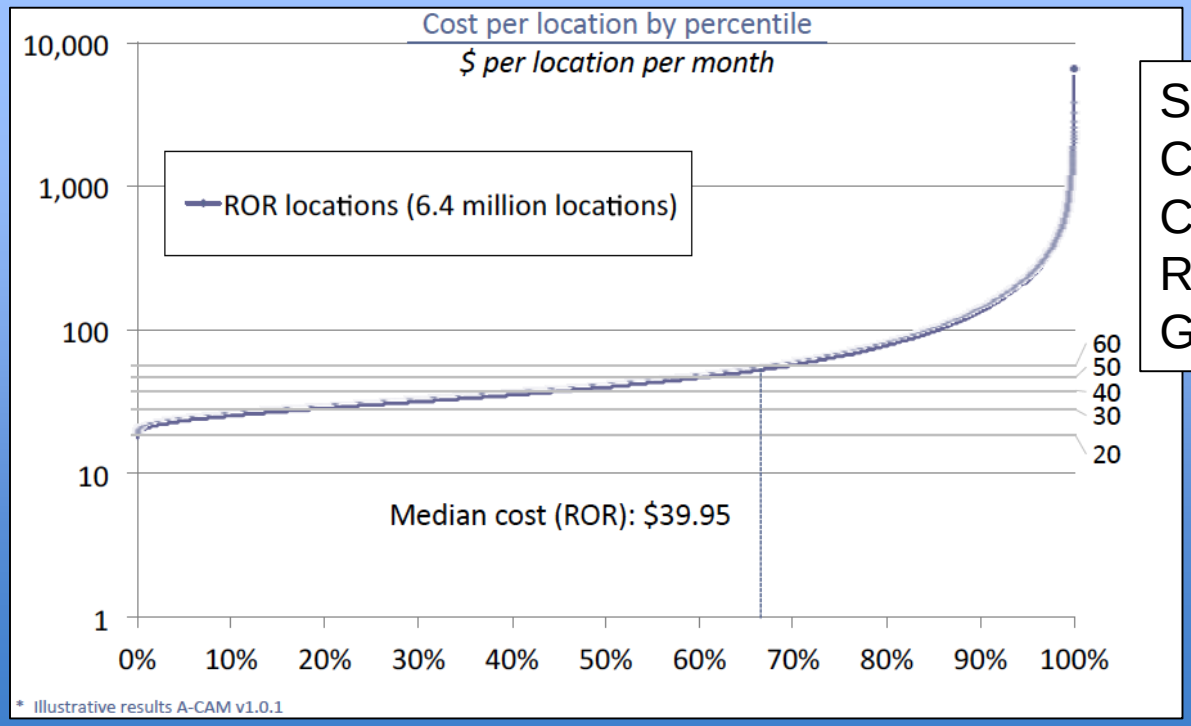
The underlying problem is that Internet services
In very rural areas are not economical due to the higher
Cost and vs. revenues (negative payback)



Viable ways to address this issues:

a) Improve the revenue opportunities
b) Lower the cost of building & Operating
c) And or Subsidize

Costs Increase 10X – 40X for Last Few Percent of Households



Source: Alternative Connect America Cost Model (ACAM) for ROR Carriers Assuming GPON FTTH

Source: https://transition.fcc.gov/wcb/ACAM040115.pdf

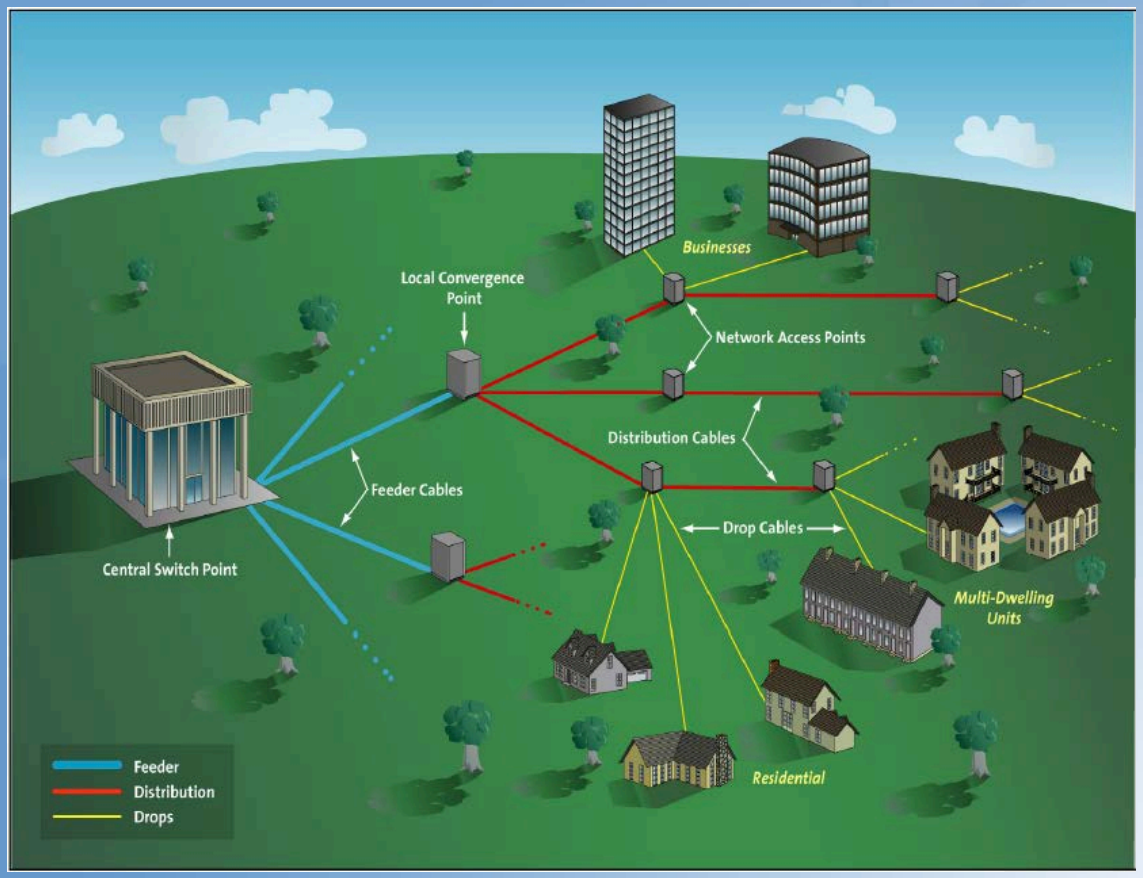
Broadband Technologies

- Fixed
- Terrestrial Wireless
- Satellite

Fixed Broadband Architecture

- Feeder Cables
  - Carries traffic serving multiple endpoints form an “office” to a neighborhood
    (local convergence point, LCP, or serving area interface, SAI)
- Distribution Cables
  - Carry traffic for one or more households from LCP to the curb (network access point)
- Drop Cables (above ground) or service wire (underground)
  - Carry traffic from curb to dwelling unit
- Depending upon the architecture
  - Cables may be fiber or coax
  - Local convergence point and/or network access point could host a patch panel, an optical splitter, an Ethernet switch, or a fiber/coax interface.
- **As bitrates increase, fiber must be pushed further into neighborhoods**

Elements of Fixed Broadband Architecture



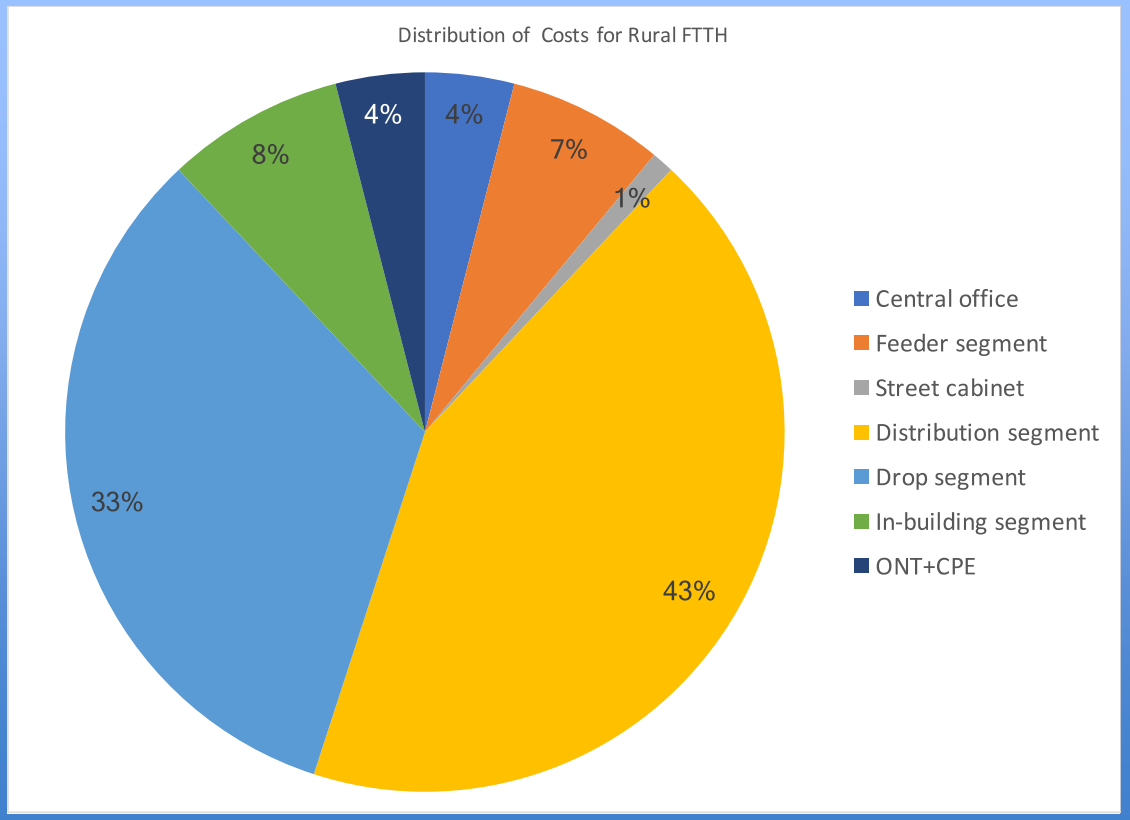
To Make Rural Access Affordable Must Reduce Capital and Opex Costs

Total cost of ownership	Capital Deployment Cost* (Cost of capital / Payback years)	Total Make Ready (Easement - Poles - and Facilities)	Cost of service Delivery	$\int$	Yearly Operational Expense to maintain & Repair plant	Unusual Natural disaster & Damage Repairs
	Plant = 20+ year depreciation Nodes = 10 or less depreciation	• Middle Mile/ Internet backhaul • Power • Attachments • Customer Churn • Op's activity • Cable locates • Trucks & Op's • Drop repairs	• Customer Aq. • Truck roll & turn Up • End equipment • Test equipment • Testing systems • ….. • Drop & Demark Cost (Depending on Deployment Type)		• Middle Mile/ Internet backhaul • Power • Pole Attachments/ easements • Customer Churn & Service Delivery • Cable locates • Trucks & Op's • Drop repairs	• Storm damage • Man made facility damage • Construction changes
	First Year Build Costs				Yearly Costs	

Fiber

- High capital expense to deploy
- Excellent expandability
- Capital cost: two components: fixed and variable
  - Fiber to the curb
  - Drop and ONT
- Costs dominated by construction labor
  - 50-75%

Capital Cost Distribution for Rural FTTH (1000-3000 Households, density 23 Households/Km²)



50% of cost is construction of outside plant to the curb

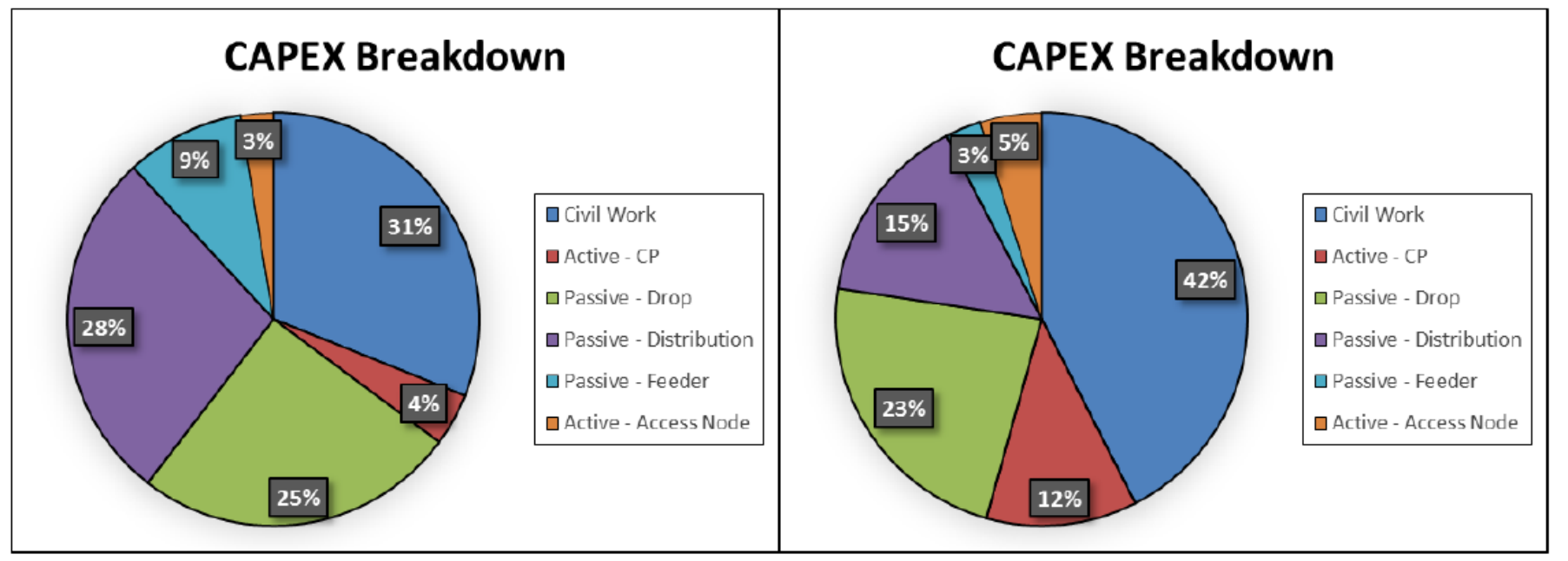
33% of cost is drop to the house

Both of these are dominated by labor costs

Source: https://doi.org/10.1016/j.telpol.2016.04.002

Cost Breakdown Varies with Take Rate

Urban Example



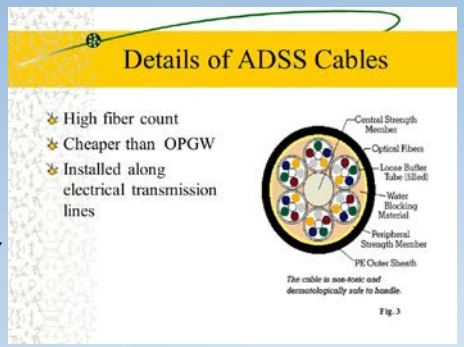
Low Take Rate

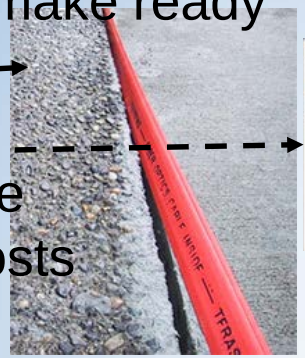
High Take Rate

Source: FTTH Council Europe

Technology Trends Reducing FTTH Costs

- To lower costs ➔ lower construction
- Engineering and planning as a service
  - New computer-based network planning tools
- Construction costs
  - Aerial
    - Lower pole make ready costs
    - Fiber in the electrical space to reduce make ready
  - Underground
    - Microtrenching
    - Traxyl: glueing fiber to the road surface
- Smaller, more flexible cables reduces labor costs
- Pre-cut and pre-connectorized fiber for drops





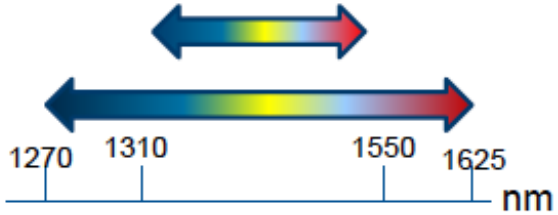
Focus of Innovation for Broadband Access is on solutions to enable cost efficient deployment of Fiber

Connection resilience

Bend-resistant fiber

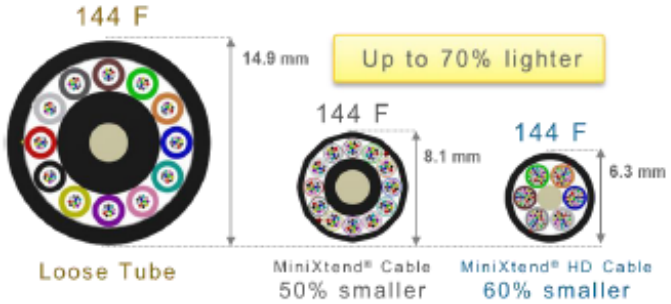
Corning® SMF-28® Ultra Fiber

Transmission agility



Broad spectrum fiber

Network congestion



Installation speed

Cables with Binderless FastAccess® Technology

Pre-connectorized cables

Fast-splice ribbon cables

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Fiber

- Operations Cost
  - Cheaper to maintain with passive plant
    - Less power/power conditioning cost
      - Consumer supplies CPE power
  - Operations as a service
  - Edge caching and caching as a service to reduce middle mile costs

- **Despite technology trends, fixed network costs remain high**

Fixed Wireless

- Various forms
  - Point-2-Point antennas
    - High spectrum reuse
  - Shared base-station antenna
    - Spectrum reuse through beam steering
  - Licensed vs unlicensed spectrum, e.g.
    - Cellular
    - TV white spaces
  - Wireless vs. Fiber backhaul

The Wireless Cost/Capacity Challenge

- Spectrum resource/user increases with distance from basestation
- Basestation capacity is divided among users
  - Minimize basestations to minimize costs
- As take rate and bitrate per user increase, fewer users can be served by same capacity base station
- Mitigate by
  - ➔Increase basestation capacity
    - Spectrum reuse through many beams
    - More bits/Hz –advanced modulation schemes
    - Fiber backhaul
  - ➔Investment in additional basestations and their backhaul

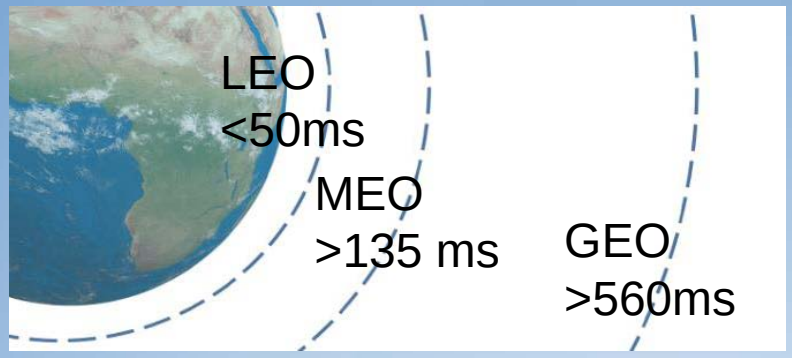
Terrestrial Wireless Technology Trends

- Beamforming antennas (Massive MIMO)
  - Higher SNR
    - ➔Greater reach
    - ➔Less spectrum for a given bitrate
  - Allows up to 10x the throughput at a single tower*
    - ➔Fewer towers needed to provide rural capacity
  - Greater throughput per tower requires greater backhaul
    - Fiber vs wireless
- Subscriber antennas to improve SNR

* *Sprint, Ericsson tout field tests for 2.5 GHz Massive MIMO*

Broadband Access via Satellite

- Rapid improvement in satellite and launch technology
  - GEO
    - Higher capacity GEO satellites (>1 Tbps/Sat)
    - > 100 Mbps/user peak bit rate
    - > 560 ms latency (irrelevant for non-realtime uses)
    - GEO satellites can be parked over the U.S.
  - NGSO (LEO, MEO and HEO)
    - Large (> 1000) constellations of satellites provide low (<50 ms) latency and > 50 Mbps bit rate to the user,
    - But, only a fraction cover the U.S. at any one time
- Because the cost of delivering Satellite Services are the same everywhere, they are attractive for the most remote households
- Current capacity may limit Satellites to a portion of the un-served households but at the same time uniquely cover the most costly scenarios. Future and ongoing investments by multiple operators could meet demand:
  - Capacity limits may be increased by more satellites in orbit or improvements in communications technologies
  - Such capacity expansion has long lead times



LEO has lower latency than GEO

GEO Satellite Capacity

Capacity/satellite	1000	Gbps	
Share of system capacity over US	1000	Gbps	
	Min	**Max**	
User streaming demand at peak	2	4	Mbps
Percent HH active during Peak Hr	25%	50%	
Streaming users who could be served	250,000	500,000	HH
Max serviceable HH/satellite	1,000,000	2,000,000	HH

- The above calculation is for a single GSO system – the actual capacity is represented by services from multiple operators with assets positioned over the US.
- It is possible to park more satellites over the U.S. in GEO orbit to increase the overall capacity to meet demand
- Latency > 560ms RTT

Illustrative LEO Capacity Analysis

Number of satellites	1000		
Beams/satellite	16		
Downlink capacity per satellite	7.5	Gbps	
System capacity	7,500	Gbps	
Surface area of the earth	196.9	million sq miles	
Surface area of the US	3.797	million sq miles	
US as % of earth's surface	1.93%		
Multiplier for adjacent regions	2		
System capacity available to US	289.26	Gbps	
	Min	**Max**	
User streaming demand at peak	2	4	Mbps
Percent HH active during Peak Hr	25%	50%	
Streaming users who could be served	72,315	144,629	HH
Max serviceable HH	144,629	578,517	HH

- Latency < 50ms RTT
- There are over a dozen (12) NGSO (LEO, MEO, and HEO) applications pending before the FCC. Four (4) NGSO applications for Fixed Satellite Service have been granted.

Universal Access SWG
Lynn Merrill

Universal Access SWG

- **Statement of the problem:**
  - There is no single link as to why broadband is less prevalent in the rural and sparsely populated area versus suburban/urban counter parts. The common thread breaks with density**,** though other factors such as technology, SPs' goals, community involvement, funding opportunities /available support, i.e.. play equally important roles.
  - Universal Access SWG in conjunction with serving as a technical resource to the BDAC**,** will examine how technology, processes, implementation and applications affect BB deployments in rural and sparsely populated areas

SWG Universal Access Objectives

- Determine the different roles played between technology, business models and policy in establishing BB in the rural areas
- Identify the difference type of BB providers and how they approach the buildout of the rural areas
- Determine ways to extend fiber deeper into the network
- Define buildout and types of use cases for the rural area
- Detail items for the BDAC
- Actionable Recommendations to the FCC

Common Threads of Business Development

- Determine areas needing service
- Organization Structure
- Rural Buildout
- Partnerships
- Funding/Capital
- Business Disruption
  - Revenue Uncertainty
  - Risk Assessment

Determine Areas Where Service is Needed

- Munis
  - Crowd or Community Sourcing/speed testing
  - Map out existing utilities using GIS or LiDAR to assist in BB and other future facility designs
  - Survey
- Existing Provider extending service
  - Neighborhood Coordination Sign Ups for Service
- New Rural Provider
  - Survey residents and business
  - Provide early bird sign ups for service

Organization Structure

- Cooperative (Local Electric or Communication)
  - Owned by its members already has relationship
  - Takes greater risks to provide service to members
  - Know community or customer it servers
- Locally Providers (Smaller locally owned Business)
  - Lives and works within the community
  - Knows the customers
  - Takes risk to meet their needs
- Munis
  - There to serve community – BB provides opportunity for growth
  - Moderate Risks but may offset cost with community growth or tax
- Regional Provider (Nationwide or regional for CATV, Mobile or Voice)
  - Has a scale of network and may have staff within the community
- National Provider (Satellite)
  - Larger scale and resources to construct and operate no staff onsite

Buildout of Rural Areas

- Towns Below FCC BB Speeds
- No BB at Edge of Town
- Rural Area Below FCC BB Speeds
- No BB in Rural Areas

Rural Buildout: Case Study of Electric Cooperative

- 850 Coops Serve 42 m Electric customers
- Average user 5 to 10 meters per mile
  - Feasible as low as 8 BB customers served per mile
  - Places Fiber in power space eliminates make ready costs; NESC separation with same owner has much smaller distance requirements than Communication Companies
  - Estimated incremental aerial fiber construction costs for last mile $18k per mile
  - Electric Coop builds Fiber and lease all fiber (non smart Grid) to Subsidiary to use for BB
  - Fiber lease and pole rental rolled into one agreement
  - Loan on project useful life (18 to 22 years)
  - Video through NCTC
  - 100 Mbps at $49.95 or 1 Gbps at $79.95 - Average revenue w/triple play $120 to $130/Mo
  - Requires support (USF, Grant or other) below 5 customers per mile
- Recommendation or take-aways
  - Receives large benefit from being in power space reducing or eliminating Make Ready Costs other providers are required to work around
  - Has a relationship with customer for electric service transfers over to BB service

Partnerships

- ILEC Partnering with Electric
  - Provides scale adding 4000 Electric BB customers to network – GPON 70% aerial includes summer with no video
  - Both companies are Cooperatives with same purpose
  - Partnering saves on Gateway costs, Justifies CDN, saves on Operations cost for back office and support staff, etc.
- Take away
  - Elements for Developing a Successful Partnership
    - Similar Mission statement
    - Champions on both sides of the table
    - Time to build trust
  - Build on successful partnership allows for the building of others
  - Requires either a 70% grant or 30% USF operations costs to create a stable entity for rural BB operations

Partnerships cont.

- Massachusetts Broadband Initiative – NTIA Grant
- State set aside $50 M to build last mile to 24,000 HH
  - 53 Communities must provide (2/3) of Funds and cover 93% of HHs
- Developed Playbook for towns to obtain HED grants
  - Broadband 101 - Cost estimates, bonding methodology
  - Technology Neutral but required sustainable operations
- Limited Cellular Service – Working with FirstNet – AT&T build 10 sites
- Issues for Communities
  - Meeting build expectations - Using a third party to manage projects, design FTTH, coordinate make ready
  - Time for Make Ready – Used part to help Power Company Resources
- Take Away
  - Opportunity for communities in other states to learn about buildout of networks using MBI's playbook if made available
  - Grants or support is required to build and operated in rural towns

Partnerships cont. - Munis

- Assist with upgrade of existing provider and/or attract new provider
  - Community help with development of grants
  - Community provide tax incentives to obtain improved plant
  - Partner with provider to construct new facilities – Place conduit with city fac.
  - Assist with backhaul construction to improve services
  - Solicit BB providers within region to extend network to un(der) served areas
  - Provide incentive or grants to HSI provider
  - Develop a long term make ready plan for road crossing, bridges and conduit

- Lower cost for broadband operators
  - One-stop easy shopping for permits
  - GIS data (by street of existing infrastructure, by address of service offered…)
  - Build conduit and/or fiber and lease for BB providers to place fiber for service
  - Community as anchor tenant for BB provider
  - Facilitate partnerships with educational and other government entities
  - Lower build costs through “dig once”, coordination w infrastructure upgrades (electric, sewer, water, etc. in new neighborhoods)

Partnerships cont. - Keene Valley Project

- 1,000 HH and Business located in NY Adirondack region
- High Peaks Education Foundation worked with Local CATV Company forming a public-private partnership
- Raised $100 K from state for schools. Raised $300 K by finding captains for each street to obtain service signups and collect donations for construction
- Built FTTH for $12 K per mile using local resources purchasing through NCTC. Used buying co-ops for materials, labor, content and more.
- Backhaul was an issue with just 2 T'1s then added fiber to next town. Last was able to get connected to fiber built through town with stimulus.
- Look to serve HH's outside of town but determined too expensive
- Fiber is built and operational, and the project is now run by Keene Valley Video & Internet. Selling 30mbps x 3mbps for $90/mo
- Take Away
  - Needs a strong supporter with BB knowledge to start a project
  - Need towns, schools and individuals on streets to promote/market the system
  - Required grants to get started with schools and complete backhaul

Funding / Capital

- Cooperatives (Local Electric or Communication)
  - Long-term funding useful life + 3 year through RUS or other rural banks (extends ROI for rural areas)
- Local Providers (Smaller locally owned)
  - Long-term loan useful life through RUS or other rural banks (extends ROI for rural areas)
- Munis
  - Bonding shorter than RUS or tax on other services
- Regional Providers (Nationwide or regional for CATV, Mobile or Voice)
  - Shorter term loan 6 years (shortens ROI)
- Nationwide Provider (Satellite)
  - Wall Street funding Short term (shorter ROI)

Business Disruptions

- Revenue Uncertainty
  - Disruption of revenue streams places hardships on providers Disruptions include:
    - Replacement of the portions of the triple play (Video and Voice)
    - OTT Services offered by others
    - Loss of Support
    - Unable to offer newest services or highly watch content

Business Disruptions cont.

- Risk Assessment
  - Long term revenues streams are needed to support rural builds
  - Longer payout creates higher risk of unrealized revenues
  - Single revenue sources create high risk should entity be saddled with lose of revenue stream
  - Using Power Space reduces options for sale separate from Elect
  - Inexperienced operator can make error early that can be fatal
  - Low throughput technologies may fall short of long-term data requirements reducing revenues
  - Smaller organization have less scale in back room costs

Corporate Structure of Broadband Service Providers

Type of Structure	Provider's Core Business/Technology	Funding Sources	Length of Loan	Local Presence	Advantage	Disadvantage	Partnering	Area Served	ROI	Revenue Risk
Cooperative Owned	Electric/FTTH ILEC/FTTH or VDSL	RUS	Life of Plant + 3	High	Owns Pole Line - Owned by those they serve	Little experience in BB services	Candidate for partnering	Must build all area it serves rural included	High risk long payout	High risk if BB is only revenue and #'s not met
		Rural Lender	Less than RUS							
Small Locally Owned Provider	ILEC/FTTH or VDSL CATV/HFC or FTTH WISP/Fix Wireless	RUS	Life of Plant + 3	High	Part of Community	Higher Cost due to Scale	Can Serve as Partner	Must build out Exchange rural included	High risk long payout	Slightly Diverse lower risk
		Rural Lender	Less than RUS							
Community Owned	City Services/FTTH	RUS	Life of Plant + 3	High	May Receives added benefits - taxes, growth in community helping ROI	Little BB experience Lack of experience can be a killer to long-term sustainability	Candidate for partnering	Community only rural areas are limited	Does not have to be positive Receives other benefits	Hight risk if BB is only revenue and #'s not met
		Bonds	Shorter than RUS		Receives added tax benefit with community growth from BB	May increase tax based if system can't make ROI	Option to Build Duct or fiber and lease to other providers		Requires shorter time for payout	Tax Payers can bail out if insolvent
		Grants with matching funds				Higher Cost due to Scale				
Regional Owned Provider	RLEC/FTTH or VDSL	Wall Street and other Large Lending	Much shorter than RUS	Moderate	Scale of Network and Operations	Less Local involvement	Can serve as partner hard to manage in Corporate Structure	Larger communities Less rural area outside of town	Lower Risk	Low Risk Can spread Risk to othe areas or products
	CATV/HFC or FTTH	Wall Street and other Large Lending	Much shorter than RUS	Moderate to High	Scale of Network and Operations	HFC may require conversion to FTTH	Looks for marketing partner for build out of unserver areas	Larger communities Less rural area outside of town	Lower Risk	Low Risk Can spread Risk to othe areas or products
National Provider	Satellite	RUS or Self Funded	Determined by Cash Needs	Installers and Sales Agents	Nationwide with no added capital	Longer Planning Cycles to Increase Capacity	Looks for Local Marketing Partners	Best for Rural Areas with no BB Service	Cost per Unit same	Lower Risk with Nationwide footprint

Candidates to Provide Service in Rural Areas

Expansion of Service into Rural Area	Rural Power FTTH	Rural Telco FTTH or VDSL	Regional Telco FTTH or VDSL	CATV HFC or FTTH	Munis Technology Netural	Fix Wireless 3.65 GHz or Unlicensed White Spaces	Cellular 4G or 5G LTE	Emerging Service Provider Satellite
Towns Below FCC BB Speeds	Within Service Territory	Size and Location to Existing operation dependent	Depends on Size of Community	Yes requires upgrade to existing plant	Yes	Yes	Difficult to handle capacity with 4G technology and limited spectrum	Can tolerate lower take rates
No BB at Edge of Town	if provider in Area	Near existing service area or facilities	If provider in town	Will build within ROI requriement	Limited to community	Yes	yes if offering fix BB Packages	Can tolerate lower take rates
Rural Area Below FCC BB Speeds	Within Service Territory	Near existing facilities with lower ROI	With High ROI	With High ROI	No	Pockets	Within current coverage	Yes
No BB in Rural Areas	Within Service Territory with low ROI	Within Service Territory with USF	Provide service with USF if ROI is not too Low	Not without existing infrastructure	No	Pockets Fill in with MFII	Within current coverage	Yes

Can Occur if Accepted	Can Occur with Difficulty Higher Risk	Technical Difficulty	Short Usful Life	Should not Occur without Revenue Suppement	Should not occur will not meet long term objectivies

Technologies and Service Areas Overlap

Use Cases by Candidates to Provide Service in Distinct Areas

Use Case Issues by Area	Rural Power FTTH	Rural Telco FTTH or VDSL	Regional Telco FTTH or VDSL	CATV, HFC or FTTH	Munis FTTH	Fix Wireless 3.65 GHz or Unlicensed or White Spaces	Cellular 4G or 5G LTE	Emerging Service Provider Satellite
Towns Below FCC BB Speeds	Build if part of Power service territory	Can partner with Power or Muni	Low ROI Hard to Serve	Can Upgrade existing plant to provide higher speeds	Look for Provider to Service Town	Build but limited on BB speeds with dense pop	Difficult to handle capacity with 4G technology and limited spectrum	Can tolerate low local take rates
	Build cost are lower due to placement of facilities in the power space	Aerial Cost are high in cases were Make Ready is required	1/2 build cost is Pole Attachment and delays in Permitting	Build Towns that can support ROI	Develop Model to Construct Fiber for Lease by Others	Build at low cost	comments on 5G usage in the system	Cost spread across entire subscriber base
		Can build if close to existing facilities	Look for Munis to provide easy access to R/W		Look for Partner Operate Network if Built by Muni	Trade off between capacity and speed	Limited throughput on service plans	
					Build and Operate Independently			
					Determine Grants or other funding sources			
					Use Crowd Sourcing to determine need for service			

Use Cases by Candidates to Provide Service in Distinct Areas (cont.)

Use Case Issues by Area	Rural Power FTTH	Rural Telco FTTH or VDSL	Regional Telco FTTH or VDSL	CATV, HFC or FTTH	Munis FTTH	Fix Wireless 3.65 GHz or Unlicensed or White Spaces	Cellular 4G or 5G LTE	Emerging Service Provider Satellite
No BB at Edge of Town	Build if part of Power service territory	Aerial Cost are high in cases where Make Ready is required	1/2 build cost is Pole Attachment and delays in Permitting	Build out to ROI	Usually stops service at town boundary	Easier to provide capacity to potential customers	Service easy to expand to include	Can tolerate low local take rates
	Build cost are lower due to placement of facilities in the power space	Can build if close to existing facilities	Looks to Route Crowd Sourcing To Obtain High Penetration Rates	Solicit potential customer to help increase proposed take rate		Build at low cost	Limited throughput on service plans	Can be a primary provider
	Already has Power Customer Base	If in existing area may receive support to construct	Asks for Aid for Construction			Trade off between capacity and speed		
	Partner with BB Providers is surrounding areas for Experience							
Rural Area Below FCC BB Speeds	Build cost are lower due to placement of facilities in the power space	Can build if close to existing facilities	Requires both USF CAF II and reasonable ROI	Build out to ROI	Usually stops service at town boundary	Build in areas with higher density	Build out depends on ROI	Can support high take rate
	Already has Power Customer Base	If in existing area may receive support to construct		Solicit potential customer to help increase proposed take rate		Trade off between capacity and speed	Limited throughput on service plans	Can be a primary provider
	Partner with BB Providers is surrounding areas for Experience							

Use Cases by Candidates to Provide Service in Distinct Areas (cont.)

Use Case Issues by Area	Rural Power FTTH	Rural Telco FTTH or VDSL	Regional Telco FTTH or VDSL	CATV, HFC or FTTH	Munis FTTH	Fix Wireless 3.65 GHz or Unlicensed or White Spaces	Cellular 4G or 5G LTE	Emerging Service Provider Satellite
No BB in Rural Areas	Build cost are lower due to placement of facilities in the power space	Can build if close to existing facilities	Requires both USF CAF II and reasonable ROI	Build out to ROI	Usually stops service at town boundary	Build in areas with higher density	Build out depends on ROI	Can Support high take rate
	Already has Power Customer Base	If in existing area may receive support to construct		Solicit potential customer to help increase proposed take rate		Trade off between capacity and speed	Limited throughput on service plans	Can be a primary provider
	Partner with BB Providers is surrounding areas for Experience	May use wireless technology for farthest areas if in existing exchange						

Broadband Service Provider Sustainability and Risks

Long-term Sustainability	Rural Power FTTH	Rural Telco FTTH or VDSL	Regional Telco FTTH or VDSL	CATV, HFC or FTTH	Munis Technology Netrual	Fix Wireless 3.65 GHz, Unlicensed or White Spaces	Cellular (Mobility) 4G or 5G LTE	Emerging Service Provider Satellite
Revenue Streams At Risk								
Voice	Offer as a bundle	Decreases Each Year	Decreases Each Year	Part of Bundle	Offer as a Bundle	May Provide	Not as Risk	Offer as an Add on Service
Broadband								
Video	Available long term only through Fiber connections	Available long term only through Fiber connections	Available long term only through Fiber connections	Meets Long term requirements	Available long term only through Fiber connections	N/A Due to Increased Capacity requirement	Requires added Spectrum and 5G to meet long-term requirements	Can Meet Long term requirements
Mobile	Only through Partnership	Limited Area Only through Partnership	Only through Partnership	Only through Partnership	Only through Partnership	Only through Partnership	Provides as a Service	Only through Partnership
USF Support								
ACAM	N/A	10 years Speed Varies	N/A	N/A	N/A	N/A	N/A	N/A
BLS	N/A	10 years Speed Varies	N/A	N/A	N/A	N/A	N/A	N/A
CAF Phase I	N/A	N/A	6 years Speed 4/1	N/A	N/A	N/A	N/A	N/A
CAF Phase II	10 year Speeds 25/3, 10/1, 4/1	10 year Speeds 25/3, 10/1, 4/1	10 year Speeds 25/3, 10/1, 4/1	10 year Speeds 25/3, 10/1, 4/1	10 year Speeds 25/3, 10/1, 4/1	10 year Speeds 25/3, 10/1, 4/1	10 years Speed 25/3, 10/1, 4/1	10 year Speeds 25/3, 10/1, 4/1
Mobility Fund II	N/A	N/A	N/A	N/A	N/A	May Apply	May Apply	May Apply
FCC Experiment	10 yr Speed 100/25, 25/5, 10/1	10 yr Speed 100/25, 25/5, 10/1	Did not apply	Did not apply	Did not apply	Did not apply	Did not apply	N/A

Broadband Service Provider Sustainability and Risks (cont.)

Long-term Sustainability	Rural Power FTTH	Rural Telco FTTH or VDSL	Regional Telco FTTH or VDSL	CATV, HFC or FTTH	Munis Technology Netrual	Fix Wireless 3.65 GHz, Unlicensed or White Spaces	Cellular (Mobility) 4G or 5G LTE	Emerging Service Provider Satellite
Operational Expenses Risk								
Video Content	Escalation of Costs	Escalation of Costs	Escalation of Costs	Escalation of Costs	Escalation of Costs	N/A Due to Capacity	Escalation of Costs	Escalation of Costs
Maintenance	Low Cost for FTTH	Low Cost for FTTH Highest Cost VDSL	Low Cost for FTTH Highest cost VDSL	Low Cost for FTTH High cost for HFC	Highest Cost Wireless Low Cost FTTH	Increases with each added Subscriber not scalable	Higher Cost in Rural Areas	Marginally Higher Cost in Rural Areas
Long Term Operation Risk	High	Moderate	Low	Moderate	Very High	Very High	Low	Low
OpEx Substainability Risk	High	Moderate	Low	Moderate	High	High	Moderate	Very Low
Dependence on Vendors	High	Moderate	Low	Low	Very High	Very High	Moderate	Low to Moderate
Substinability Risk	Very High	High	Moderate	Moderate	High	Very High	Moderate	Moderate
Capital Cost Versus Risks	Rural Power	Rural Telco	Regional Telco	CATV	Munis	Fix Wireless	Cellular	Emerging Service Provider
Towns below FCC BB Speeds	Moderate Risk	Low Risk	Very Low Risk	Low Risk	High Risk	Moderate Risk	Very Low Risk	Very Low Risk
No BB at Edge of Town	Moderate Risk	Low Risk	Low Risk	Low Risk	High Risk	Moderate Risk	Very Low Risk	Very Low Risk
Rural Area Below FCC BB Speeds	High Risk	Moderate Risk	Low Risk	N/A	N/A	High Risk	Low Risk	Very Low Risk
No BB in Rural Areas	Very High Risk	High Risk	Moderate Risk	N/A	N/A	High Risk	Moderate Risk	Very Low Risk

SWG Universal Access Recommendations to FCC

- FCC to continue to encourage BB providers to use long term technologies. Short term technologies may exhaust USF Support over long-term.
- FCC to develop an Economic Advisory Council to assist the Chief Economist in understanding the micro economic operation and capital costs, and risk for Broadband facilities in Rural Areas.
- FCC to coordinate government entities to develop a standardized GIS model and accessible data base for:
  - Distribution pole line and pole loading calculation for use in BB design
  - Land use
  - Surface geological land soil surveys
  - Availability by Address: GIS address for a location FTTH design
  - Make Government LiDAR HWY survey data available for us in BB design

SWG Universal Access Recommendations to BDAC

- BDAC to develop a planning guide for future BB Providers to use to assist in developing best methods to obtain service in communities and rural areas with no BB service or BB speeds below FCC recommendation

- FCC and BDAC to assist industry in the development of a partnering guide used by:
  - PWR, Munis or other future providers contemplating providing BB service in unserved or underserved areas
  - Provide to Munis playbook for
    - Attracting BB service providers to communities or rural areas
    - Developing a long-term plan to place conduit in community to assist with future BB construction

SWG Universal Access Recommendations to BDAC cont.

- FCC and BDAC to coordinate with entities in better identifying where BB exists today and how to track BB deployment
  - Real-estate industry to assist in process on nationwide basis
  - National Agricultural Associations
- BDAC to collect and publish BB success stories for all industry types
- FCC and BDAC work to coordinate with MBI to develop a playbook to distribute to States and rural areas groups looking to enhance BB services

Summary

- The “Broadband Gap” between rural and underserved areas and urban centers in American is widening rapidly. Costs to close the much larger gap have increased dramatically in the last decade.
- Broadband for the vast majority of Americans is on a virtuous cycle with performance doubling every 18 to 36 months continuing to exacerbate the divide.
- There is a rich set of technology options that can contribute to solutions but the heart of the problem is overcoming the cost of construction and operations.
- New business models and new polices must enable diverse local/regional solutions – because Broadband is increasingly seen as a means for economic well being and as an investment in making rural areas desirable places to thrive.

Thank you!

Universal Access SWG

Back Up Slides for BDAC

Universal Access SWG
Back Up Slides for BDAC

- Additional Case Studies Information Used in Review
  - CATV Build Out Considerations
  - Fix Wireless and Mobile
  - FirstNet Update on BB service
  - Update on Satellite Usage for Improving Terrestrial Wireless Service through Interference Mitigation
  - NTCA Broadband Survey
  - Summary Of Findings
- Reference for Resource Information

Cable Network Build Considerations

- Rob Alderfer and Ron Reuss, CableLabs
- Construction cost and other items derived from short survey of CATV Companies
  - Aerial Construction cost from 30K to 65K per mile
  - Pole Attachments and Make Ready biggest expense up to 50 percent
  - Buried Construction costs from 50K to 100K+ for underground
  - Actual costs and revenues vary across US
- Requires at least 20 HH past per mile to be economical (assuming aerial plant, low costs & utility fees, and normal service revenue and economic considerations)
  - Higher pole attachment / make-ready / franchise fees or other local requirements will push minimum required density much higher
  - States / localities / customers can assist with costs for organically uneconomical areas
  - Reflects today's technologies and market conditions; some business lines may grow (e.g., IoT) and others may shrink (e.g., video and voice) – these factors not reflected in current economics

Continued Cable Network Build Considerations

- ‘Core’ construction costs are largely fixed (e.g., design, build) as a function of local circumstances, but local utility and regulatory considerations can add significant inorganic cost volatility that affect area builds
  - Pole attachment, Make Ready
  - Delays placed on aerial construction may make underground the only option
  - Localities pressing for underground reduces areas that can be economically reached
  - Permitting and other related requirements for Fed/State or Local increase cost and delay project implementation
- DOCSIS provides a migration path for higher speed without having to convert to complete FTTH network
  - Step upgrades as needed, significantly extends coax network’s life allowing customer’s growth in speed, throughput and reduced latency
  - Video channels can be reduced by changing compression schemes to gain BB capacity
  - Drive fiber deeper into the network and reduce the nodes to zero
- HFC has capacity and the power pass through allowing for future powering of 5G (CableLabs to validate)
- http://www.cablelabs.com/cable-broadband-technology-gigabit-evolution/

Continued Cable Network Build Considerations

- Cable Network Take Away
  - Cost for aerial construction are relative equal to Power FTTH removing the cost for Make Ready
  - Cable like other BB providers look to expand where profitable. BB service outside town along rural routes may require customer assistance in reaching sign up goals
  - Larger providers relying on Wall Street Capital have a loan or payout of 6 years

Overlap/Augment Services
Wireless Case Study

- Fix Wireless
  - Difficulty to meet video and future data throughput requirements
  - Hard to scale operations
  - 4G Wireless Overlap of Areas for BB
    - Fiber pushed to towers allows fiber companies to extend services deeper into the rural areas
- 5G Wireless Overlap in Communities
  - Larger Communities only
  - Development of fiber in town for 5G and assist in the buildout of FTTH throughout town

Overlap/Augment Services Wireless Case Study Cont.

- BB enhancements in areas due to outside industry allow for the piggyback of BB service or initial launch of BB service.
  - Schools (local and Colleges)
  - Industry
  - Community
- Fiber being pushed into rural areas based on needs address both providers requirements and develops opportunity for:
  - Connection of schools
  - Other industry
  - Communities develop plans to enhance and offer BB service
  - Provide FTTH along routes of fiber
  - Upgrade copper facilities to provide higher speed BB
- Satellite can be the primary provider. Some cases users may have data caps.

FirstNet

- Jeff Bratcher CTO FirstNet
- AT&T obtained the contract and will use FirstNet's 20 MHz in conjunction with existing frequency bands
- AT&T will prioritize FirstNet Users within opt in states with priority status on all AT&T networks
- FirstNet has rural buildout requirements - any buildouts made by AT&T will add BB coverage to rural areas

- Take Away
  - SWG looking to receive feedback from FirstNet on rural square miles that AT&T will add to its existing network which will enhance rural BB service

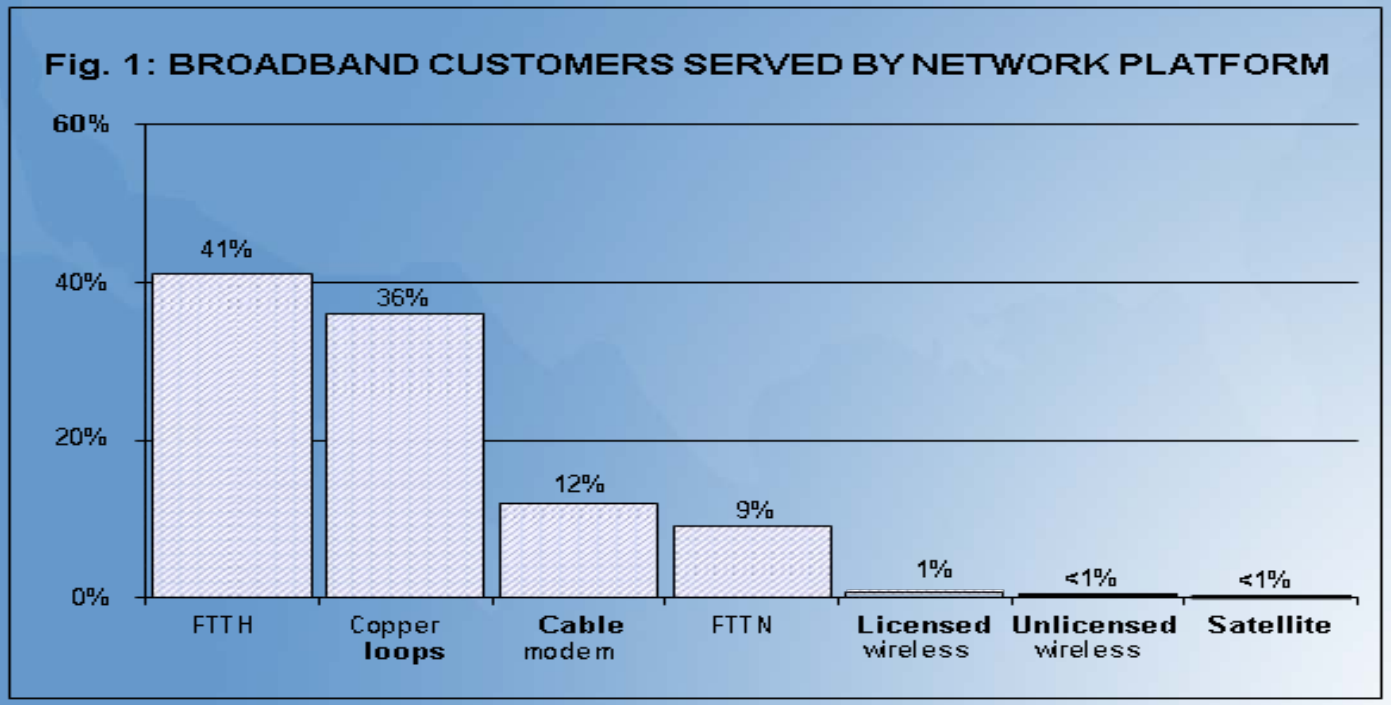
Hawkeye 360

- Rob Miller and Rob Rainhart
- New Satellites to perform RF Detection
- Launch after first of year proof of concept by aircraft
- Creates a heat map of certain RF frequencies
  - Rural areas greatest benefactor
  - Assists with interference or rogue transmitters
  - Determine where frequencies are not being used
- Take Away
  - Works in rural areas only
  - Interest to FCC Enforcement Bureau (locate unauthorized users)
  - Interest to FCC in determining if spectrum is being used or warehoused
  - Wireless providers can use to help eliminate self interference
  - Measure noise floor of RF levels over a period of time

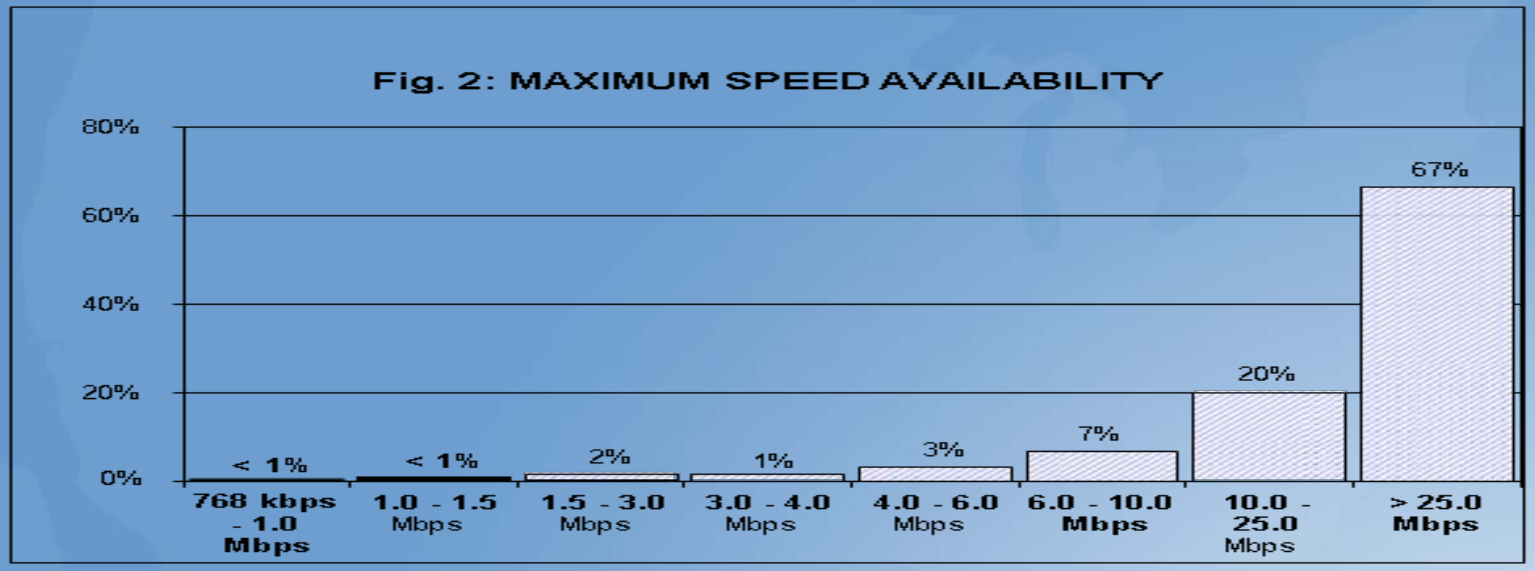
NTCA Broadband Survey 2016

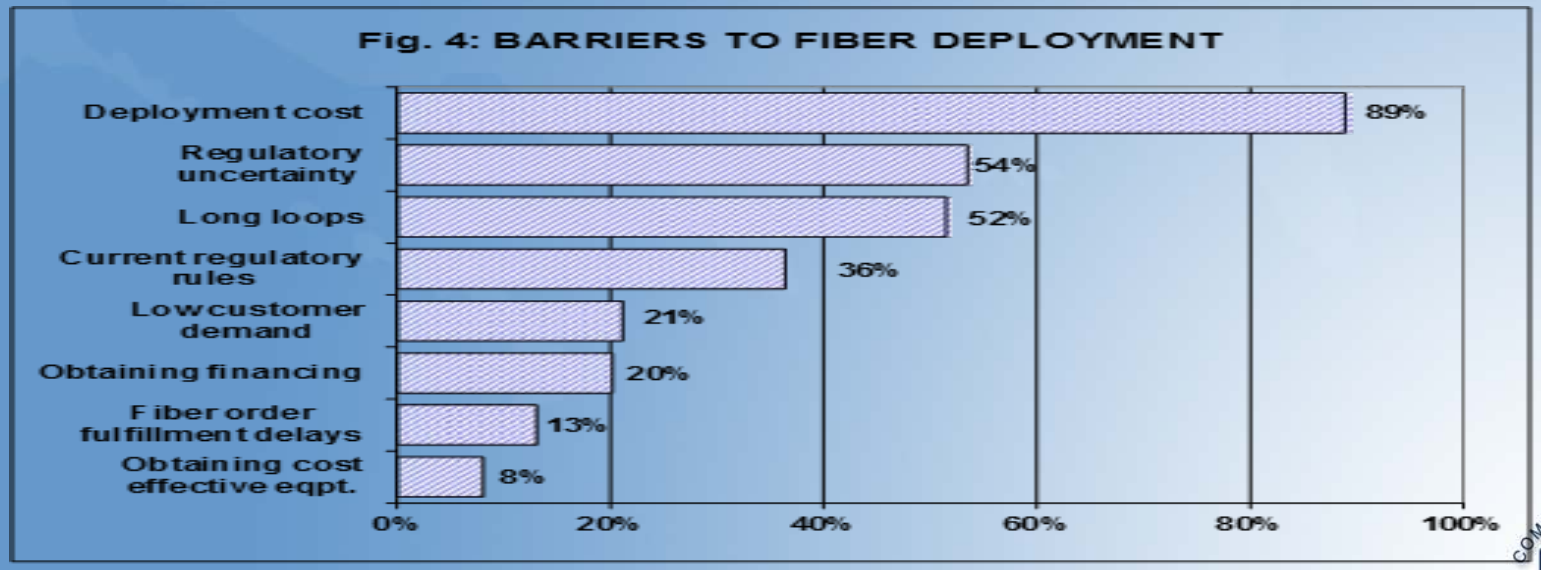
- 172 members responded (29% total membership)
- 31 % surveyed has FTTH to all customers
- All surveyed offer BB service to a portion of its customer base
- 68 miles average distance to Internet Connection Point

https://www.ntca.org/images/stories/Documents/Advocacy/SurveyReports/2016ntcabroadbandsurveyreport.pdf



Continued NTCA BB Survey **2016**





Summary of Findings
BB Service Provider's Structure

- Cooperatives (Local Electric or Communication)
  - Have a vested interest to serve those customers which are owners
  - Takes on higher economic risk with longer payback terms
- Local Providers (Smaller locally owned business)
  - Vested interest to serve the communities where they live and associate
  - Takes on higher economic risks with longer payback terms
- Community Owned Networks
  - Looks to fill the gap left by non-performing BB providers
  - Vested interest; grow community, attract business and expand tax base
  - Can take on risk weighted against gains from growth in other areas
- Regional Providers (Nationwide or regional for CATV, Mobile or Voice)
  - Interested in serving customers as deep as possible and be economical
  - Long-term risk for extensions more difficult with shorter term funding

Summary of Findings
BB Service Provider's Structure Cost cont.

- Corporate Structure makes difference in buildout of rural areas
  - Larger companies use capital first for higher density areas. Smaller companies use capital in same manner but start with lower density rural areas
  - Companies with RUS loans have longer payout periods (18 years or longer), companies without government assistance loans use 6 years for payout
  - Create avenues for rural providers to receive long-term funding specific areas
- Rural Partnerships
  - Assist in the development of partnership workshops for power, municipalities or other new infrastructure providers to gain advantage as startup by partnering with non competitive service providers
- Understand MBI model and consider for duplication in other areas

Summary of Findings cont.
Existing Operators Service Below FCC BB Speeds

- How to determine poor service areas
  - Speed test
  - Crowd sourcing of data
  - Mapping
- How to solve issue
  - Assist with upgrade
    - Community help with development of grants
    - Community provide assistance in tax incentives to obtain improved plant
    - Partner with existing provider to construct new facilities
    - Assist with backhaul construction to improve services
    - Community can serve as anchor tenant
  - Assist with overbuild of existing plant
    - Solicit BB providers within region to overbuild existing network
  - Community to construct own facility
    - Construct, own and operate BB facility to serve community
    - Partner with regional provider to use city facilities to build out area

Summary of Findings
Extension of Existing BB Plant in Unserved Areas

- Construction Costs
  - Incremental costs: Last Mile, drop and CPE
  - Electrical holds cost advantage for use of power space not afforded to others due to NESC rules; however, hold a Higher Risk to Lender
  - May be able to obtain aid to construction for individual long drops
  - Work with other infrastructure projects during construction
- Ongoing Costs
  - Few incentives given
  - Fix costs spread across additional users
- Partnering: Not applicable
- Revenues
  - Incremental revenues supports construction
  - Pre-sign up techniques create up front service demand
- Financing
  - State, CAF Support, grants, etc

Summary of Findings cont.
Ext. of Existing BB Plant in Unserved Areas

- Understand and use micro buildout models for adjacent areas to existing plant
  - Calculations based on consumer take rates, ease of construct, permitting and other associated cost (poles attachments)
  - Use of crowd sourcing to obtain sufficient public interest to obtain economic take rates
  - Determine amount of grant or support needed to serve areas

Summary of Findings
BB Buildout of New Areas

- Construction Costs
  - Incremental decrease: Largest impact is from expedited permitting
  - Electrical holds cost advantage for use of power space not afforded to others due to NESC rules; however, hold a Higher Risk to Lender
  - Required investment in middle mile for last mile construction
  - Leverage joint construction with Highway and other infrastructure projects
- Ongoing Costs
  - Tax incentives
  - Pole Attachment Fees
  - Billing, customer support, maintenance with shared by communities
    - Larger scale economies occur with back office cost
- Partnering: operators realize scale economies in const., opex and market
- Revenue
  - Provision of Video: NCTC is key to minimize content licensing
  - Develop pre-commitments and long term contracts
  - Anchor tenants and backhaul of wireless
- Financing
  - Payback Period is key also Municipal bonding offer lower interest rates
  - State, CAF support, grants, etc

Summary of Findings
Revenues: Disruption of Services

- Long term revenue streams are needed to support builds in rural areas
- Disruption of revenue streams places hardships on providers
- Disruption includes
  - Replacement of the portions of the triple play (Video and Voice)
  - OTT Services offered by others
  - Loss of Support
  - Unable to offer newest services or highly watch content
- Look for new revenue sources
  - Applications within community
  - Metering
  - Public Safety

Summary of Findings
Additional BDAC Work

- Understand support funding and its impact to rural construction of BB infrastructure and on-going operation
  - Universal Service Funding under ACAM and BLS
  - USDA RUS loan and grant programs
  - FCC experimental BB grant program
  - CAF Phases I and II
- Better identifying where BB exists today and how to track
  - Real-estate industry to assist in process on nationwide basis
  - National Agricultural Associations
  - National Mapping Resources Collectors
- Examine alt. business models (munies involvement)
- Use cases and success stories
- Build simplified matrix to use as playbook to begin process to analyze development of BB service in rural area

Additional Resource Information

- NTCA 2016 BB Survey
  https://www.ntca.org/images/stories/Documents/Advocacy/SurveyReports/2016ntcabroadbandsurveyreport.pdf

- Keene Valley Project Report
  http://www.kvvi.net/TWBBP_%20Final_Report_%201-7.pdf

- Rural Utility Service Loan and Grant Programs
  https://www.rd.usda.gov/programs-services/all-programs/telecom-programs

- NTCA Partnering Program
  www.PartnersInBroadband.com

Recommendations for Removing Obsolete or Unnecessary Technical Rules

Chairs: Russ Gyurek, Cisco
John Barnhill, Ribbon Communications

FCC Liaisons: Walter Johnston, Matthew Pearl, Jeffrey Neumann, Zachary Ross, John Kiefer, Rashmi Doshi

Date: December 6, 2017

2017 Working Group Team Members

- Mark Bayliss, Visualink
- Nomi Bergman, Advance
- Marty Cooper, Array Comm
- Brian Daly, AT&T
- John Dobbins, Windstream
- Jeffrey Foerster, Intel
- Dick Green, Liberty Global
- Lisa Guess, Juniper
- Dale Hatfield, Silicon Flatirons
- Stephen Hayes, Ericsson
- Tim Kagele, Comcast
- Greg Lapin, ARRL
- Brian Markwalter, CTA
- Tom McGarry, Neustar
- Lynn Merrill, NTCA
- Jack Nasielski, Qualcomm
- Mike Nawrocki, ATIS
- Kevin Sparks, Nokia
- David Tennenhouse, VMware
- David Young, Verizon

Additional Contributing SMEs

- David Case, Cisco
- Al Morton, AT&T
- Dheena Moongilan, Nokia
- Robert Paxman, Intel
- John Roman, Intel

Simplified Working Group Mission

- Goal: Reduce the “friction” of working with the FCC
  - Reduce the regulatory burden and identify defects in current processes
  - Seek recommendations from multi-stakeholder groups
  - Seek FCC staff input on areas to improve process and leverage industry input
  - Identify list of relevant standards bodies and multi-stakeholder groups
  - Balance industry impacts from new or changed rule implementations
  - Develop realistic timelines that recognize impacts and costs to small, medium, and large industry segments as new rules or rules changes are adopted

“Enduring Values” of FCC Technical Transitions

Technology Transitions, GN Docket No. 13-5

- **Public safety**
  - Public safety communications must be available no matter the technology
- **Universal access**
  - All Americans must have access to affordable communications services
- **Competition**
  - Competition in the marketplace provides choice for consumers and businesses
- **Consumer protection**

\+ **Protecting the commons (shared resources)**

- spectrum usage, utilization, sharing

How do we achieve these principles while promoting innovation and growth?

Work Group Activities Through 4Q 2017

- Reviewed current FCC actions seeking to reduce and simplify
  - Issued inquiry (ET Docket 17-215) on reforming Technical Regulation
- Continued stakeholder engagements
  - Industry Associations, Standards Bodies, Equipment Manufacturers
- Next Generation Policy development
  - Examined ways for industry standards organizations and the commission to more closely work towards consensus driven standards
- Reviewed Commission actions on simplification and removal of obsolete regulations
  - *FCC Biennial Review – November 2016 comments and contributors*

Industry Engagements: Stakeholder Organizations

WISPA® Wireless Internet Service Providers Association

TIA

Consumer Technology Association™ CES®

ITU ITU-T

intel

atis

IEEE

Advocates for Rural Broadband

SMALL COMPANY COALITION SCC WE BUILT IT. WE MAINTAIN IT. WE VALUE IT!

NTCA THE RURAL BROADBAND ASSOCIATION

ctia Everything™ Wireless

FCC

INCOMPAS

FEDERAL COMMUNICATIONS COMMISSION FCC USA

Key Themes From Industry Presentations

- Reporting Requirements For Small Companies
  - NTCA, SCC both emphasized the need for Commission to carefully consider the administrative impact when releasing regulations. Particularly asked for stronger priority on the Regulatory Flexibility Act.
- Certification requirements for devices
  - Sub-work group examined certification and testing requirements with examples and proposed improvements.
- FCC Technology Initiatives with Standards and 3rd party groups
  - Market experiencing huge transformation in standards
  - Open Source, First to Market solutions driving timing
  - Multiple silos are converging
  - Commission engagement with SDO/ Associations mission critical
  - International Harmonization

PUBLIC NOTICE

http://transition.fcc.gov/Daily_Releases/Daily_Business/2017/db0901/DA-17-800A1.pdf

PUBLIC NOTICE

Federal Communications Commission
445 12th St., S.W.
Washington, D.C. 20554

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Internet: https://www.fcc.gov
TTY: 1-888-835-5322

Posted August 30, 2017

DA 17-800
Released August 30, 2017

OFFICE OF ENGINEERING AND TECHNOLOGY ANNOUNCES TECHNOLOGICAL ADVISORY COUNCIL (TAC) TECHNICAL INQUIRY INTO REFORMING TECHNICAL REGULATIONS

ET Docket No. 17-215

Comment Deadline: October 30, 2017

To more effectively ensure that its rules keep pace with the rapidly changing technology in communications, the FCC has asked its Technological Advisory Council to help identify FCC technical rules that are obsolete or may be ripe for change in light of current communications technologies.

NOI Summary: 28 Total Replies from 27 Contributors

- 11 Radio Amateurs and 1 academic
- Consumer Technology Association
- Tech Alliances
  - GPS Innovation Alliance
  - Wi-Fi Alliance
- Technology Companies
  - Boeing
  - Decawave
  - IBM
- Public Safety
  - Kingfisher Company
  - National Public Safety Telecommunications Council
- Satellites
  - Commercial Smallsat Spectrum Management Association
  - EchoStar/ Hughes Network Systems
  - Space Exploration Technologies Corp
- Telecom
  - ATIS
  - CTIA
  - TIA
- Association of Federal Communications Consulting Engineers (AFCCE)
- Information Technology Industry Council (ITI)

Biennial Review Respondents

- Industry Associations
  - American Cable Association
  - Competitive Carriers Association
  - CTIA
  - INCOMPAS
  - NCTA - Internet & Television Assoc.
  - United States Telecom Association
  - WISPA
- Public Interest
  - Common Cause
  - New America's Open Tech. Institute
  - Next Century Cities
  - Public Knowledge
  - Schools Health & Libraries BB Coalition
- Service Providers
  - BT Americas, Inc.
  - CenturyLink
  - Cincinnati Bell
  - Frontier Communications
  - Granite Telecommunications
  - Hughes Network Systems, LLC
  - Sprint
  - T-Mobile USA, Inc.
  - TelePacific
  - United Utilities, Inc.
  - Verizon
  - Windstream
- Think Tank
  - The Free State Foundation

NOI Response Summary

Comment on Rulemaking Processes

- Paperwork reduction
  - Data reporting, Emergency procedures
- Certification rules/test changes
- Process streamlining e.g. Licensing
- Leveraging of standards
- Technical Specifications
- Open participation
- Frequency Allocations
- International harmonization (SDO)
- Policy symmetry - Alignment of rules
- Interagency coordination
- Enforcement

Comments on Specific Rules

- 1.1310
- 2.105
- 2.1206
- 2.803
- 2.805
- 15.103
- 15.109
- 15.25
- 15.517
- 15.519
- 25.142
- 25.146
- 25.202
- 25.217
- 73.168
- 73.3452(a)(vi)
- 90.241(a)
- 97.1
- 97.25
- 97.305
- 97.307
- 97.309
- 97.313
- 97.317

Technical Inquiry – Radio Amateur Takeaways

- Radio Amateur rule changes
  - Replace modulation specifications in the rules with bandwidth limits, similar to rules in many other countries, to permit experimentation with new modulation types
  - Permit the amateur radio community to agree on band plans rather than codifying them in the rules
  - Change maximum power limits to be more equitable across different modulation types
  - Remove regulations that are obsolete

Recommendation: Multi-stakeholder Process

The TAC underscores the value of multi-stakeholder groups to improve processes and leverage industry input.

- *Groups should have clearly defined expectations and goals, and allow new entrants and technology developers to meaningfully participate*
- *Rules that incorporate industry standards by reference are subject to long rulemaking timelines and Administrative Procedure Act-related reqs.*
- *Giving consideration to the work of multi-stakeholder groups and industry standards when making policy, even if actual standards are not codified, can improve the FCC's technical rules and help the Commission keep up with technological developments.*
- *Example: Work reforming low-power device certification rules could function in a multi-stakeholder group charged with developing a detailed proposal on how to update the current process.*

FCC TAC

RECOMMENDATIONS

Recommendation 1

The FCC should begin to use consensus-based standards as an alternative or an augmentation to traditional regulation

Recommendation 1 (Details): Technical Industry Engagement

Transition from Regulation to Consensus-based Standards

- To better collaborate on industry evolution and velocity, the Commission should engage with SDO's & Industry Associations
  - Creates strong real-world connections and context to technology evolution
  - FCC better able to keep pace with industry, including open source
  - Industry better able to make business vs technical trade off decisions
- SDO's include 3GPP, IETF, IEEE, ATIS, TIA, CTA
  - Leverage standards liaisons for key technical focus on current matters
  - FCC participation in relevant SDO's when technical direction impacts policy
- Industry Associations including TIA, INCOMPAS, NTCA, NCTA, CTIA, SCC, CTA and many more
  - Develop strong liaisons to leverage industry expertise and experience

Recommendation 1 (Details): Rules of Engagement

- Clearly defined expectations and goals
  - Often constrained by legislation, but should be as collaborative as possible
- Process must be open
  - Must allow fair industry representation - seek and engage relevant participants and organizations
  - Work activity results need to be available to all known and future parties
- Requires a Commitment from FCC for staff support
  - Effectively use Commission to drive towards consensus
  - Must include adequate budget in order to meaningfully participate

Recommendation (Details): Keys to Success

- FCC should make public their key technology areas of focus:
  - 5-10 year plan
  - Flexibility needs to be built into the plan
- Focus areas should guide the selection of stakeholders
  - Provide direction for what standards, consortia to engage
  - External parties can prioritize their involvement with the FCC
- FCC staffing and engagement should support these priorities

Recommendation 2

The FCC should change some of the certification process and industry engagement models: streamlining, harmonization and create a self-certification / trusted vendor program

Issues of concern from Industry view that impact product certification and sales

- **Supply chain** – are constantly evolving, need to make sure rules do not impact these changes while protecting spectrum
- **IoT**- These products will increase exponentially , need to make sure certification program can handle projected workload.
- Products **time to market** (TTM) is critical for products with short term shelf life
- Assumption on "**module-based**", manufacturer dependent, not modular approval coverage- individual certifications (increased integration)
- Increased **device complexity**
- **Global marketplace**- need for international harmonization of Requirements and standard test methods when possible.

Summary of Recommendations for Removing Certification Barriers

- Establish Manufacturers DoC for specific very low power wireless devices
- Establish a TCB Fast Certification Process for Radio Devices
- Review Sections 2.803 (Marketing) and 2.805 (Operation) of RF Devices Prior to Equipment Authorization
- Adopt / Harmonize to Internationally Developed Standards for RFE
- Review additional recommendations from Public Notice
  - Work to complete open issues in NPRM 15-170 including Permissive Changes, Module Approval, family approvals and other open issues
  - Review the current Pre Authorization Guidance KDB
  - Discuss with NTIA issues involving DFS and possibly streamlining process
  - Address open NPRM's in regards to product certification processes
  - Consider adoption of internationally developed standards where appropriate
- TAC to continue to work off-line with FCC on improving process

Establish Manufacturers DoC for specific very low power wireless devices (Public Notice Support: TIA, CTA)

- MDoC for low power wireless devices (LPWD) will reduce regulatory burden and speed time to market for new LPWD. (*Longer term, fold the MDoC into the SDoC process)*
- Could initially include low power Bluetooth, & many low power IOT radio technologies.
- Sample criteria includes:
  - Devices not on the FCC Pre-Approval Guidance (PAG) list
  - Limited to devices tested under FCC Part 15 Subpart C 15.245, 15.247, 15.249 as well as Part 15 Subpart E Client only without radar detection
  - Devices must be tested in an Accredited Test lab recognized by FCC
  - Maximum of 30mW EIRP or 18mW ERP for single or multiple transmitters
  - If portable the SAR value is less than 0.8W/Kg or meets SAR test exclusion
  - Labeling per DoC scheme (FCC logo).
- Industry impact:
  - Example: Cost $1k to 2k per approval or updated approval (adds up over time)
  - Adopting MDoC would greatly shorten time to market for new IoT technologies, decrease product costs, and overall costs to consumers.

TCB Fast Certification Process for Radio Devices

- TCB should be authorized to certify any low power (<36 dBm EIRP) devices based on submittal of simple manufacturer's Declaration to TCB. Applicable to Class II and III changes
- Program restricted to trusted manufacturers / labs with proven compliance record in regards to specific technology (802.11, BT, RFID or Mobile service client devices). TCB would make decision in terms of "trusted manufacturer"
- Submittal package to be same as for current certification except no formal TCB review
- TCB may audit the test data within 30 days of post certification date
- Product label to be provided to TCB

Public Notice Support: WiFi Alliance, CTA

TCB Fast Certification Process for Radio Devices - Continued

- Sample Manufacturer's Declaration information on document to include:
  1. Manufacturers name
  2. FCC Identification
  3. Applicable FCC sections for Device Operation
  4. Emissions Designation
  5. Frequency Range of Device Operation
  6. Maximum power levels based on test results
  7. Test Report number
  8. RF Exposure information (MPE distance or SAR numbers)
  9. Name of test Lab with Accreditations
  10. US Contact for the Device

Fast TCB Approval process for Radio Devices: Examples for Improving Process

- This process will reduce TCB process time for certification submittals from “trusted manufacturers” (reference CBP’s “trusted trader” as model)
- Confined to products where the manufacturer has demonstrated competency in testing
- FCC registered labs and ISO 17025 accredited labs only allowed to perform testing
- TCB council and Accredited labs will formulate a mutually agreed test data filing process
  - Filing will include all required FCC test data as specified in the Part 2 rules and supporting KDB’s
- TCB grant issued upon completion of uploading all required documents
- Grant will signify if done via Fast Review
  - Subject to 30 day FCC or TCB review
- Industry impact: improving process for manufacturers for TTM

Review Sections 2.803 (Marketing) and 2.805 (Operation) of RF Devices Prior to Equipment Authorization (pg. 1)

- Section 2.803 includes broad prohibitions against marketing devices ("includes sale or lease, or offering for sale or lease, including advertising for sale or lease") prior to equipment authorization, which impedes reputable companies, who know and follow FCC rules, from assessing consumer demand and developing global product launches
  - The regulations take interference protection into the marketing and design cycle phase even before a product is launched. Devices not in consumers' hands cannot cause interference or RF-related harm.
- Industry Impact
  - Section 2.803 regulation of marketing devices prior to authorization create challenges with how respected brands assess demand and allocate global products at launch.
- The Commission should modify the rules to clearly permit the advertising, promotion, and pre-ordering of devices prior to authorization while continuing to allow sale and delivery under current exceptions.

Review Sections 2.803 (Marketing) and 2.805 (Operation) of RF Devices Prior to Equipment Authorization (pg. 2)

- Section 2.805 sets conditions for operating devices prior to equipment authorization.
  - The current requirements for labeling as reflected in the KDB's for labeling and e Labeling need to be addressed in this rule part.
  - The Commission should make clear that e-labeling and small device labeling rules apply to devices awaiting authorization under Sections 2.803 and 2.805.
  - The Commission should streamline labelling rules under Sections 2.803 and 2.805 to reduce the variety and length of disclosures companies must affix to pre-authorization devices.
  - Open a discussion with industry regarding guidance around pre-authorization devices at trade shows and in field trials.

Public Notice Support: CTA, ITI

Adopt/ Harmonize to Internationally Developed Standards for RFE

- Recommendations:
  1. Form FCC, FDA, and industry working group to harmonize US to ICNIRP.
  2. In the interim FCC establish KDB procedures for spatial and time averaging, and for duty cycle control for RFE compliance, for example leveraging methods in ICNIRP HF Guidelines, and IEC EN 62311. Note: Mathematical calculation of RFE should continue to be allowed for FCC compliance.
- Industry Impact:
  - Current regulatory differences impede 5G development and deployment, increase development and test lab time, cost of the network, and to consumers. Harmonization would benefit consumers by providing uniformity in manuals.
  - Current FCC limits are based on outdated IEEE-C95.1 1992, updated in 2005, but not adopted by FCC; ICNIRP was established in 1998, is being updated in 2018
  - These differences add extra testing, product variants, and cost to consumers.
- Furthermore, SAR to power density introduces discontinuity (Colombi et al) and further disadvantages US 5G systems (~10 dB difference).
  https://www.ericsson.com/assets/local/news/2015/11/implications-of-emf-exposure-limits.pdf

Public Notice Support: TIA, IBM, ITI

Recommendation From Public Notice Related to 15-170

- PN: *Equipment Authorizations should cover a family of products. FCC should approve a family of products that share fundamental characteristics but are no electrically identical. This was considered in Docket No. 15-170 proceedings, but was not addressed in the First R&O. Industry Canada has already provided guidance for family approvals and the FCC could take the same approach. This could be accomplished by issuing an additional R&O in the 15-170 proceedings, or the OET can clarify the new rules through its KDB process.*
- FCC should consider criteria in line with Canada regulations updated with comments filed in NPRM 15-170 in regards to family approvals.
- Recommendation: FCC complete this action, appears to have already been addressed but not done

Public Notice Support: WiFi Alliance

From Public Notice- Additional Recommendations

- Review the current Pre Authorization Guidance KDB to determine what can be removed from this process to speed product review time up.
- Discuss with NTIA, issues involving DFS and possibly streamlining process by moving pre grant audit to post grant as needed.
- Address open NPRM's in regards to product certification processes and consider adopting by reference test standards discussed in these open proceedings.
- Adopt/Harmonize on international standards where appropriate

THANK YOU!

Technical Inquiry – August 30 2017, Reponses Due October 30
The TAC is looking for responses related to:

1. Regulations that should be removed because they have become outdated, inhibit innovation or would be better handled by the involved parties.
   - What would replace such regulations if they are removed?
2. Regulations that should be retained because they promote competition, protect incumbents from interference, regulate unlicensed frequencies, are necessary to comply with international agreements, or support the purpose of the FCC.
3. Regulations that should be modified because technical reporting requirements are too burdensome, data contained in the reports are no longer used, or existing regulation does not fully apply to new technology.
   - If the technical requirements are too burdensome, should the FCC automate existing reporting or leverage other data or reporting from third parties or organizations?

Technical Inquiry – August 30 2017, Reponses Due October 30
The TAC is looking for responses related to:

4. Processes to resolve competing interests:
   - Is there a better way to mediate conflicts between different parties, perhaps that is quicker and does not require as many resources from interested parties?
   - Is there potential for a 'body' other than the FCC to host this role and what are the legal impediments, if any, to delegating certain conflict mediations to other parties?
   - How would a new process work?
5. Regulations that can be combined:
   - What general principles that apply to all forms of a type of communication?

Technical Inquiry – August 30 2017, Reponses Due October 30

6. How should the FCC approach coordination between regulations and standards bodies or industry consortia?
   - Should regulations be written by leveraging industry standards?
   - How should the regulatory process (which must be available to all parts of our society) be tied to the standards update process?
   - How would the requirement for public availability of documents related to federal rules be met when referenced standards are copyrighted?
   - How can regular changes to standards upon which regulations are based be propagated to the rule making processes that are required when regulations are changed?

Technical Inquiry – August 30 2017, Reponses Due October 30

7. How can FCC work processes best be improved?
   - Increasing use is made of external multi-stakeholder groups to develop complex technical requirements, systems, and procedures necessary to implement Commission service rules.
   - How can the Commission leverage these efforts to accelerate the introduction of new technologies and services?

Standards Development Marketplace

ARIB	ARIB	Association of Radio Industries and Businesses	Japan
atis	ATIS	Alliance for Telecommunications Industry Solutions	USA
ANSI	ANSI	American National Standards Institute	USA
CCSA	CCSA	China Communications Standards Association	China
ETSI	ETSI	European Telecommunications Standards Institute	Europe
IEC	IEC	International Electrotechnical Commission	International
IEEE	IEEE	Institute of Electrical and Electronics Engineers	International
ISO	ISO	International Organization for Standardization	International
ITU	ITU-R / ITU-T	International Telecommunication Union	International
TIA	TIA	Telecommunications Industry Association	USA
tsdsi	TSDSI	Telecommunications Standards Development Society of India	India
TTA	TTA	Telecommunications Technology Association	Korea
TTC	TTC	Telecommunication Technology Committee	Japan

Mobile Device Theft Prevention WG
Report to the FCC TAC

December 6, 2017

2017 MDTP WG

- The MDTP Work Group has focused on analyzing the theft of mobile devices in the United States; working with industry and law enforcement to increase the security of mobile devices, facilitate coordination of theft related data between industry, law enforcement and the consumer, and track trends in the theft of mobile devices.
- Prior work has led to alignment of theft prevention features among smartphone manufacturers and initial development of an industry information portal to coordinate theft data among stakeholders.
- The work group is tasked in 2017 to build on this early work. It will focus on:
  - Working with law enforcement in assessing the benefits of the information portal to relevant stakeholders
  - Make recommendations for the continuing involvement of law enforcement in industry theft prevention efforts, and analyzing the ongoing effectiveness of past efforts in combatting device theft.
- Study future mobile device threats in an evolving ecosystem and make further recommendations on actions to combat theft.
- Develop baseline statistics on device theft based on data from directed consumer surveys and law enforcement data to help track long term progress and identify theft scenarios.

WG Participants

- Co-Chairs:
  - Brian Daly, AT&T
  - Rob Kubik, Samsung
- FCC Liaisons:
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  - Charles Mathias
  - Elizabeth Mumaw
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- David Dillard, Recipero
- Mark Harman, Recipero
- Maxwell Szabo, City and County of San Francisco
- Gary Jones, T-Mobile
- Samir Vaidya, Verizon Wireless
- Samuel Messinger, U.S. Secret Service

Thank You!

Focus Areas for 2017

- Investigate possible methods to obtain regular data updates:
  - Law enforcement statistics refresh
    - Select sample list of cities to refresh stolen phone statistics obtained in 2014 to see trends post implementation of on-device mobile theft solutions
    - Develop procedure to obtain regular updates of the data
  - Getting more operators engaged both domestically and internationally
  - Analysis of 5G and what 5G may offer in terms of additional solutions
  - Enhancements to the Stolen Phone Checker
- IMEI Security
  - Reliability and issues of compromising the IMEI
  - Where is the industry on this?
- Where are stolen devices ending up?

Smartphone theft statistics

- As reported in September …
  - Smartphone robberies (taking smartphones by force, threat of force or by putting the victim in fear) from one major U.S. city:
    - 2013 – 2,368
    - 2014 – 1,728
    - 2015 – 1,528
    - 2016 – 1,191
- That's a promising 50% decline….
  - There are many efforts underway, outreach, word of mouth, lists, etc. that may be contributing to this decline
  - We do not know which program(s) are working/not working towards this decline
- However, results and trends cannot be extrapolated from a single data source
  - **Statistics from additional locations are needed before any type of statistical analysis can be performed and before any conclusions can be drawn**

Refresh of Mobile Device Theft Statistics

Proving difficult to obtain

- Mobile device theft data may be grouped into other crime statistics

Proxy approach

- Identify benchmark cities which can provide data on mobile device theft trends
  - Those that break out and specifically track mobile device theft

Outreach to International Association of Chiefs of Police (IACP) and potentially others to help get this refresh of data

Could more unified reporting of Mobile Device Theft Statistics assist in the MDTP initiatives analysis/tracking/etc.?

MDTP is a crime issue and cannot be left to industry alone to resolve

Where are stolen devices ending up?

- Provision of statistics about the trafficking of stolen devices to overseas markets
- No visibility of what devices connect to individual mobile networks so cannot provide any insights into the migration of devices, stolen or otherwise, from one network to another
- Multiple options with varying levels of support, participation and value.
- OEMs / OS vendors – greatest visibility of device location
  - Solution may lies with the device manufacturers and OS vendors and not at all with the network operators
  - OEMs/OS vendors have full visibility of where their devices connect from and they have the capability to much more easily provide the data sought if reporting metrics are defined
- Network Operator specific studies
  - One option is to ask network operators that are connected to the IMEI Database to report on instances where they notice connection attempts by device IMEIs that are downloaded from the database
    - This is a capability that is beyond most operators with no incentive for them
  - Second option is to extract data from GSMA's Device Check service which could indicate instances where an IMEI blacklisted in one jurisdiction is queried in another, suggesting the device has moved
    - However, Device Check is not sufficiently ubiquitous in countries to which stolen devices are likely to be trafficked to provide any meaningful data

How do we connect more operators?

Connecting more network operators in other countries to the IMEI Database

- Getting operators connected to the IMEI Database is a very difficult undertaking
- Additional GSMA resources are being allocated, together with existing regional teams, to create awareness and promote participation. There is very much a domino affect when one Operator in one country begins participating, leads to additional Operators and then neighboring countries.
- GSMA has decided to focus on, and prioritize, the countries in which regulatory attention to be particularly high at present
  - Efforts are best focused in Africa in the near future as many regulators there are interested in taking action and we have real prospects of being successful
- Regulator to Regulator interaction may be beneficial
  - List of countries where there is a favorable relationship
  - Possibly identify if local law enforcement relationships may help
  - Relationship between FCC and other regulators may be used to set proof point that database is effective

Connecting more operators in the U.S.

- Still much work to be done in the US where there are just five operators out of approximately 50 GSMA member networks connected
- ~ 98% of all connections in the U.S. are provided by Operators that participate in IMEI Blacklisting
- Knowledge/awareness, understanding benefits to participate
- Commitment to blocking lost/stolen devices
  - Identify how small operators can participate without an EIR - Multiple options exist

GSMA International Engagement

- GSMA's international engagement to date has highlighted an area in which the FCC may be able to help
- Relates to a tendency in some regions for local regulators to develop their own local systems to share stolen device data and to ignore the global solutions that have been developed and available to address the same need
- The failure to align solutions with those already in place globally results in undesirable fragmentation and unnecessary duplication of effort and costs for all stakeholders
  - Ultimately we see these systems end-up connecting to the GSMA Black List but delayed after trying to "do too much"
  - The FCC could also help by more closely observing and shaping the work ongoing within the ITU on device theft Recommendations and the potential they have to cause even more fragmentation
- Further work is needed to identify how the FCC can help and what options and avenues are available to complement GSMA's lobbying efforts so that we can better understand how we may be able to work together to help other nation states

IMEI Hardening

- GSMA has not received a single report of a compromised IMEI implementation from the US - how much of an issue this really is in the US?
- Last year GSMA reviewed and updated the IMEI security technical design principles and the IMEI security weakness reporting and correction process.
  - First activity is to review and increase device and chipset manufacturer participation in the IMEI security initiatives to reflect the current device market
  - Second activity is to restore an outsourced service to monitor and report device models that have had their IMEI implementations compromised
- RFP process that underway to restore a GSMA funded IMEI security weakness monitoring and reporting service to ensure IMEI security issues are proactively tracked and addressed in the absence of reports and intelligence from carriers, law enforcement, the FCC or other stakeholders.
- Education opportunity – FCC become more knowledgeable on industry-driven security issues, including IMEI hardening
  - ATIS, GSMA, CTIA opportunity
  - Examples, GSMA initiatives: a) digitally signed IMEI, b) eSIM / remote SIM provisioning enhancements, all incorporated into the current GSMA Black List ecosystem.

Future Technological Advances

- GSMA is looking to future technological advances to combat device theft
- Support for digitally signed device identifiers which has the potential to solve a lot of problems and particularly IMEI security and reprogramming issues
- Potential for the GSMA defined remote provisioning architecture to make a real difference and prevent the reuse of stolen devices in a way that EIR and IMEI Database blocking and data sharing never could
  - eSIM security enhancements through the remote SIM provisioning architecture, integrated into the GSMA Black List database
- Future opportunity for FCC/MDTP to identify impact of these technological advances

CTIA Harris Poll Survey 2017

Education and Awareness is most significant take-away

- Half of Smartphone Users Have Remote Lock/Locate
  - Over 1/3 of owners did not know if they have this feature; 14% had the feature but didn't enable it

Biggest roadblocks continue to be not knowing about the feature and/or not knowing how to use or enable it

Two respondents voice concerns that data could be accidentally wiped once enabled

How to make consumers aware of remote features:

- Include it in the setup wizard / make it part of initial device setup
- Salespeople / store techs should inform customers at time of purchase of these features while performing the initial setup

Recommendation

- The FCC TAC Mobile Device Theft Prevention Working Group recommends the FCC define a national objective for mobile device theft prevention including:
  - Establishing a partnering relationship with industry to become more knowledgeable on security issues in general (with support of ATIS, CTIA and GSMA); and
  - Establishing international outreach to increase global participation in mobile device theft prevention initiatives, leveraging favorable relationships between the FCC and regulators in other countries
    - Identify if/what law enforcement relationships may assist in establishing international outreach
    - Relationships between FCC and regulators in Latin America and the Caribbean may be used to set proof point that mobile device theft prevention initiatives, including the global IMEI database, are effective

Summary of FCC Asks/Challenges

- Define a national objective for mobile device theft prevention
- Outreach to International Association of Chiefs of Police (IACP) and potentially others in law enforcement to help get a refresh of data
  - Identify benchmark cities which can provide data on mobile device theft trends
- Regulator to Regulator interaction may help connecting more network operators in other countries to the IMEI Database
- FCC more closely observing and shaping the work ongoing within the ITU on device theft recommendations and the potential they have to cause even more fragmentation
- Further work is needed to identify how the FCC can help and what options and avenues are available to complement GSMA's lobbying efforts so that we can better understand how we may be able to work together to help other nation states
- FCC become more knowledgeable on industry-driven security issues, including IMEI hardening
- Opportunity for FCC/MDTP to identify impact of future technological advances (GSMA, 3GPP, etc.)

Next Steps – Opportunities for 2018 TAC

- Continue working on establishing communication channels with Law Enforcement to obtain theft statistics & to hold additional discussions with Federal/State/Local/Tribal Law Enforcement
  - MDTP is a crime issue and cannot be left to industry alone to resolve
  - Refresh of mobile device theft statistics to confirm initiatives are having a positive effect
  - Collaboration with the Police Foundation, Solicit feedback from the Police Chiefs (IACP) on the Stolen Phone Checker
  - Request the Police Chiefs to advertise the Stolen Phone Checker with their Law Enforcement colleagues
- Education/focus on national objectives for mobile device theft prevention
  - IMEI Security – educational workshop in 1Q2018 to highlight industry efforts on securing the IMEI
  - Identification of security areas where the FCC should obtain more knowledge
  - Consumer awareness
- Determine the impact of the industry voluntary commitment for the Remote Lock/Locate capability and identify and assess the state of the market, its effectiveness, and any improvements that may be required

Next Steps – Opportunities for 2018 TAC

- Determine the impact of the Stolen Phone Checker & provide any suggested improvements which can be submitted to CTIA for consideration
  - Recommend establishing quantifiable goals for penetration of Law Enforcement by Federal, State and Local
  - Consider recommendation for Network Operator promotion of Stolen Phone Checker
- Determine the mobile device theft prevention activity effectiveness especially as related to stolen phones international destinations
- Work with GSMA NAFFSG to develop a plan to bring its best practices implementation to fruition in order for a consistency of approach and policy to device blocking and data sharing that the FCC MDTP sought, including a self-assessment for alignment
- Understand timing and impact of future technological advances

Technological Advisory Council Report

WORKING GROUP on

Implications of Next Generation TV Broadcasting Technology

Implications of Next Generation TV Broadcasting Technology Working Group

- **Co-Chairs:**
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  - Mark Hess, Comcast
- **FCC Liaisons:**
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  - Lisa Hobbs, Ericsson
  - Kevin Leddy, Charter
  - Brian Markwalter, CTA
  - Tom McGarry, Neustar
  - Maureen O'Connell, Charter
  - Mark Richer, ATSC
  - Marvin Sirbu, Special Gov't Employee
  - Charlie Zhang, Samsung

Working Group Charter

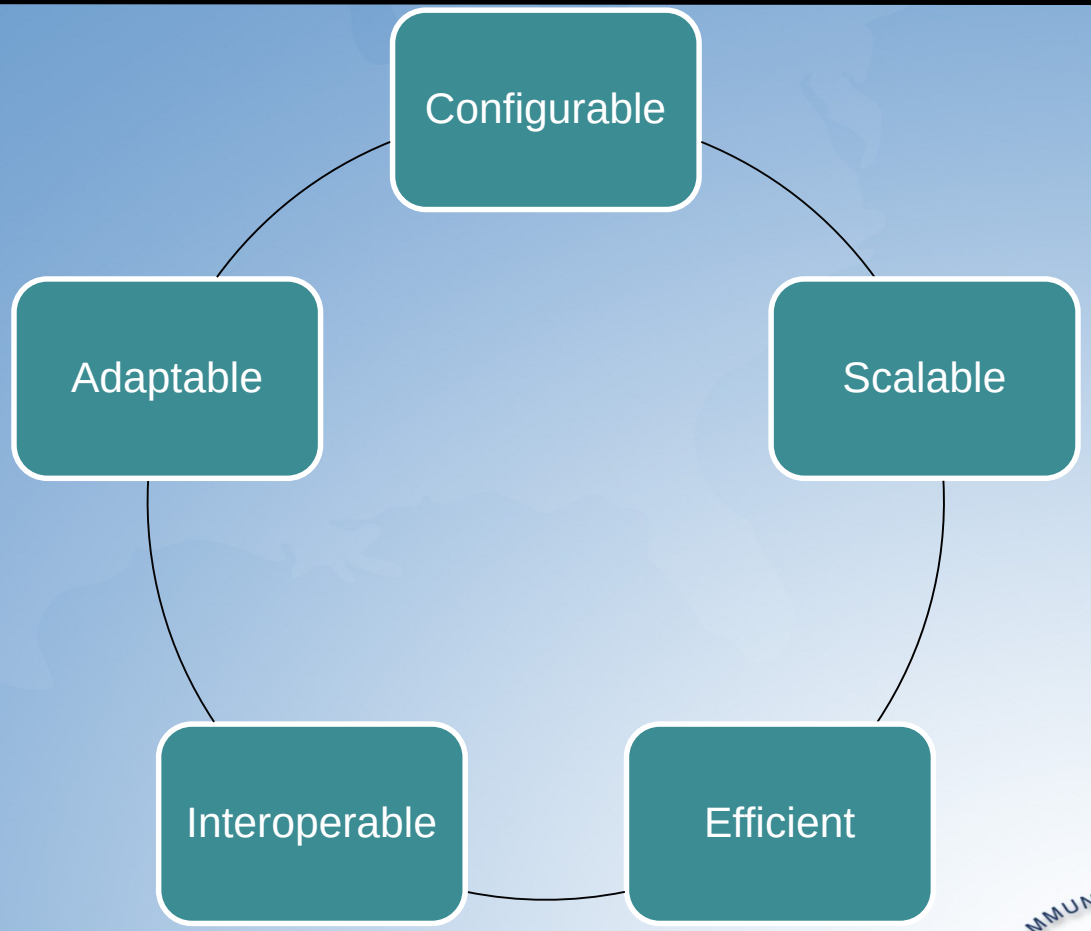
- TV broadcasting is poised to introduce its next generation standard ATSC 3.0. The new standard differs from the traditional TV broadcasting standard in several important ways. It has the capacity to carry not only what can be characterized as traditional content (in a high definition format), but also provides substantial additional capacity to offer new services. The task of the work group is to consider how the new standard might fit into the overall communications landscape of the future.
- The intention is specifically not to address the topics raised in the Commission's rulemaking to facilitate ATSC 3.0 but rather to look ahead to how implementation may impact the future of communications generally.

Presentations from Contributing Experts

- Richard Chernock, Triveni Digital (ATSC 3.0 standard)
- Glenn Reitmeier, NBC Universal (ATSC 3.0 applications)
- Mark Aitken, Sinclair Broadcasting (ATSC 3.0 applications)
- Hossam H'mimy, Ericsson, (5G wireless technology developer)
- Brian Daly, AT&T (5G wireless mobile operator)
- So Vang, NAB (ATSC 3.0 gateway devices)
- Ralph Brown, CableLabs (Wi-Fi technology)

The Basic Features of ATSC 3.0

- Next generation broadcast television
  - Significantly higher data capacity
  - Flexible spectrum use
  - Higher physical layer robustness
  - Future extensibility
  - Mobile / handheld support
  - Hybrid broadcast + broadband delivery
  - Advanced A / V compression
  - Immersive audio, UHD video
  - Interactivity and personalization
  - Potential for new business models
  - Provide a path to the future of broadcasting



Video Compression Comparison

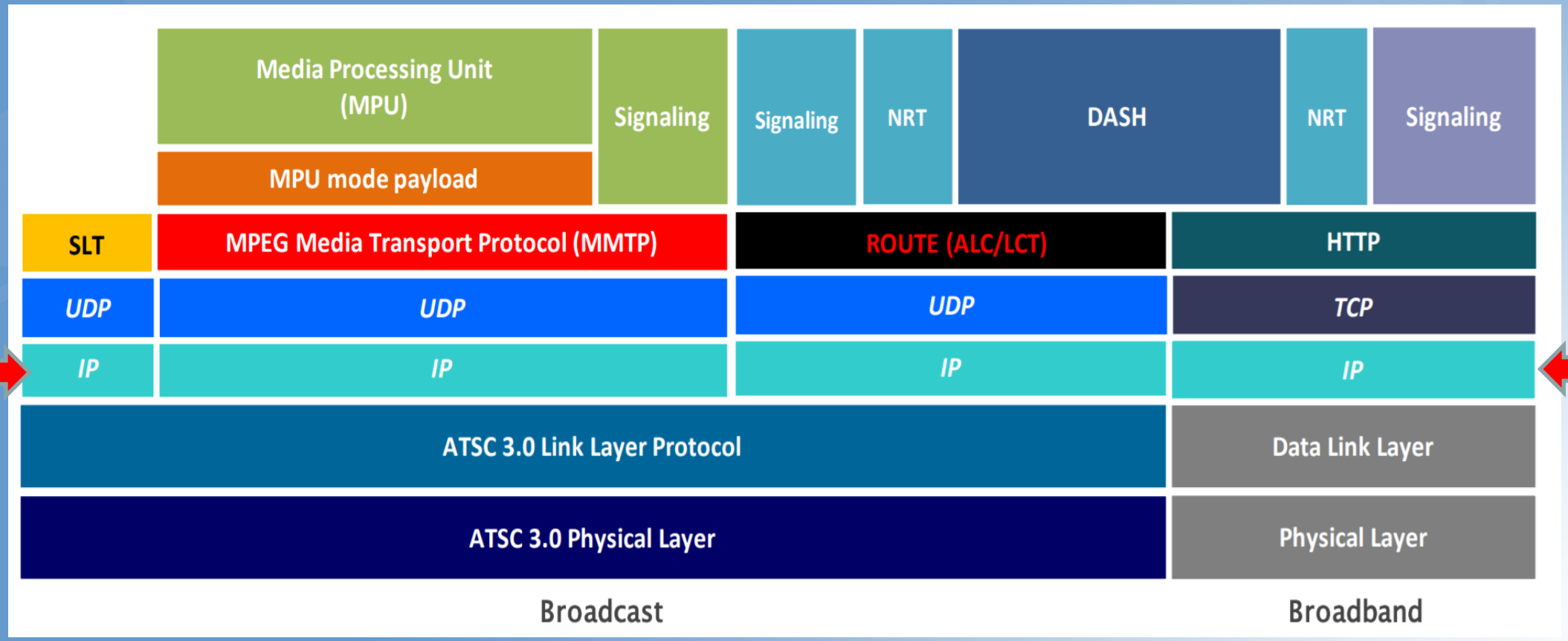
For Similar Picture Quality

Bitrate table courtesy of Matthew Goldman, Ericsson

	ATSC 1.0 (MPEG-2 Video)	**ATSC 3.0** (HEVC)
SD	3 - 5 Mbps	1 – 2.1 Mbps
HD	9 - 18 Mbps	2.5 - 4.8 Mbps
4K UHDTV (2160p60 10b)	N/A	8 – 16 Mbps* 15 – 25 Mbps**

**For nominal PQ comparisons, for mature implementations (circa 2020)*
***For higher PQ expectations of UHD vs. HD PQ typical of today*

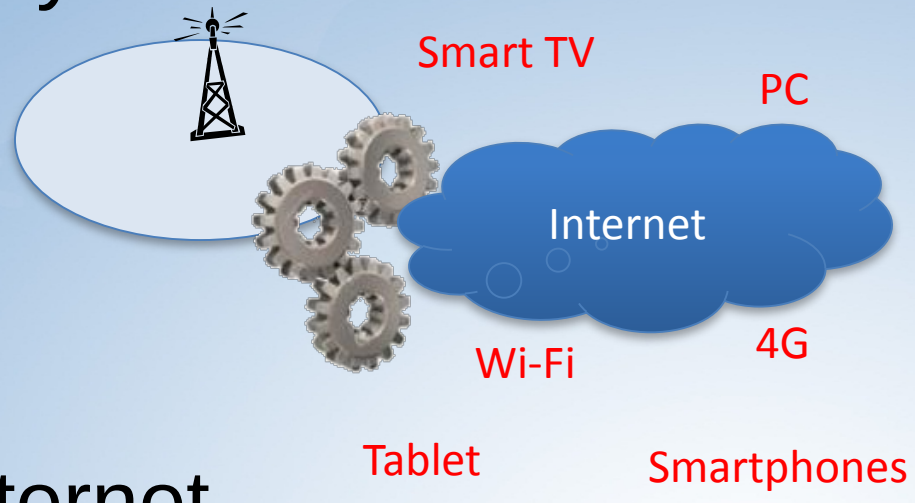
ATSC 3.0 Protocol Stack



Benefits of IP transport

- Broadcasting no longer an independent silo
- Broadcast & Broadband as peer delivery mechanisms
- Enables new types of hybrid services
- Localized Insertion
  - Ads or other content
  - Allows new revenue models for broadcasters

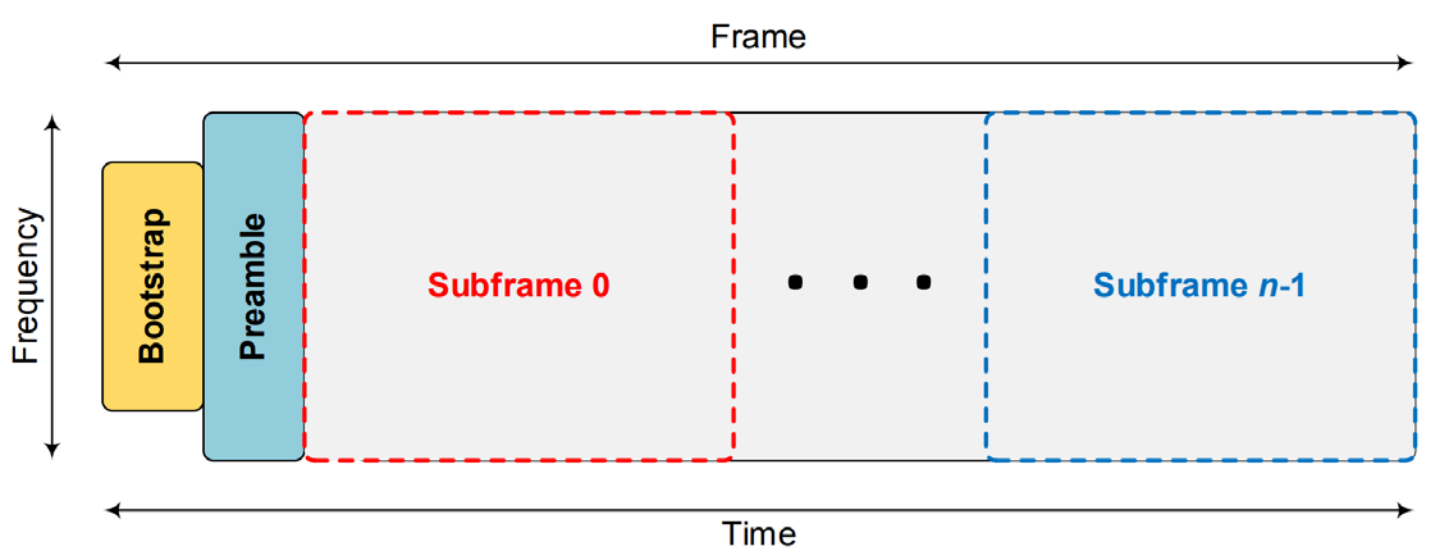
Take advantage of evolution speed of Internet



Robust Transmission-Easy Reception

ATSC 3.0 Physical Layer Bootstrap

- Highly robust synchronization
- Service discovery
- Emergency alert wake-up
- Typically used to indicate ATSC Physical Layer (A/322)
- Other waveforms may occupy a data frame for future extensibility and evolution



Robust Transmission

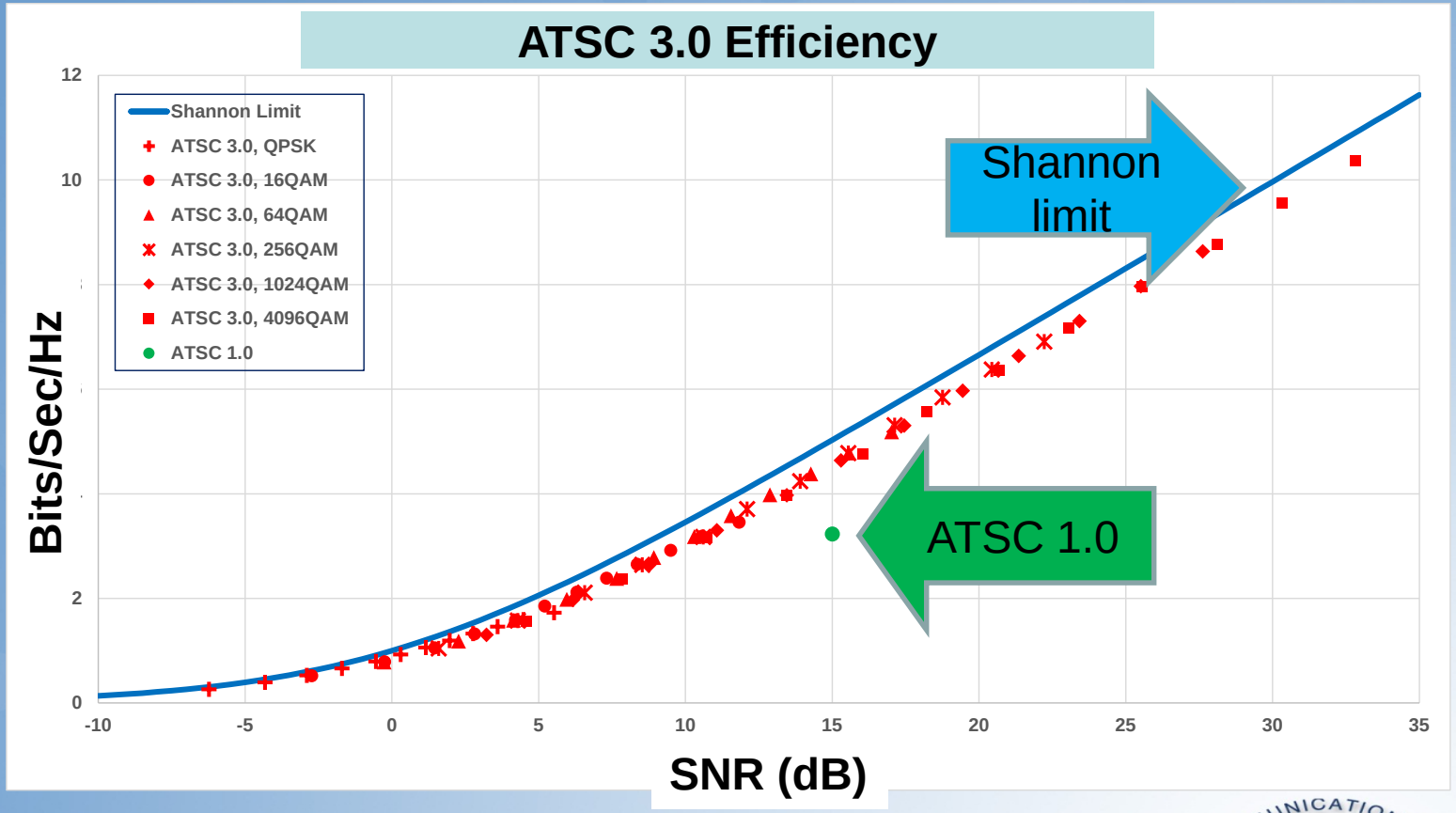
ATSC 3.0 Physical Layer

- COFDM
- Flexibility in operating points
  - Low capacity, highly robust
  - High capacity, less robust
- Efficiency (more bits/Hz)

  ATSC 1.0: 19.4 Mbps*

  ATSC 3.0: ~25 Mbps*

  *At SNR of 15 dB

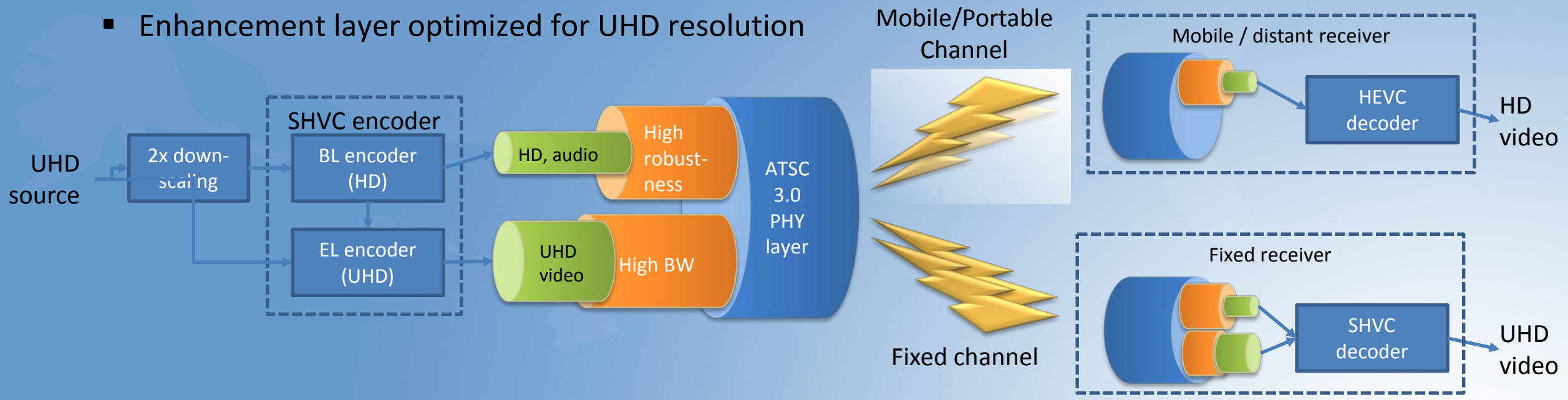


Physical Layer Pipes

- ATSC 3.0 signal can be configured with up to 4 Physical Layer Pipes (PLP) “virtual channels”
- Each has an independent ability to operate at a different data rate / CNR noise threshold

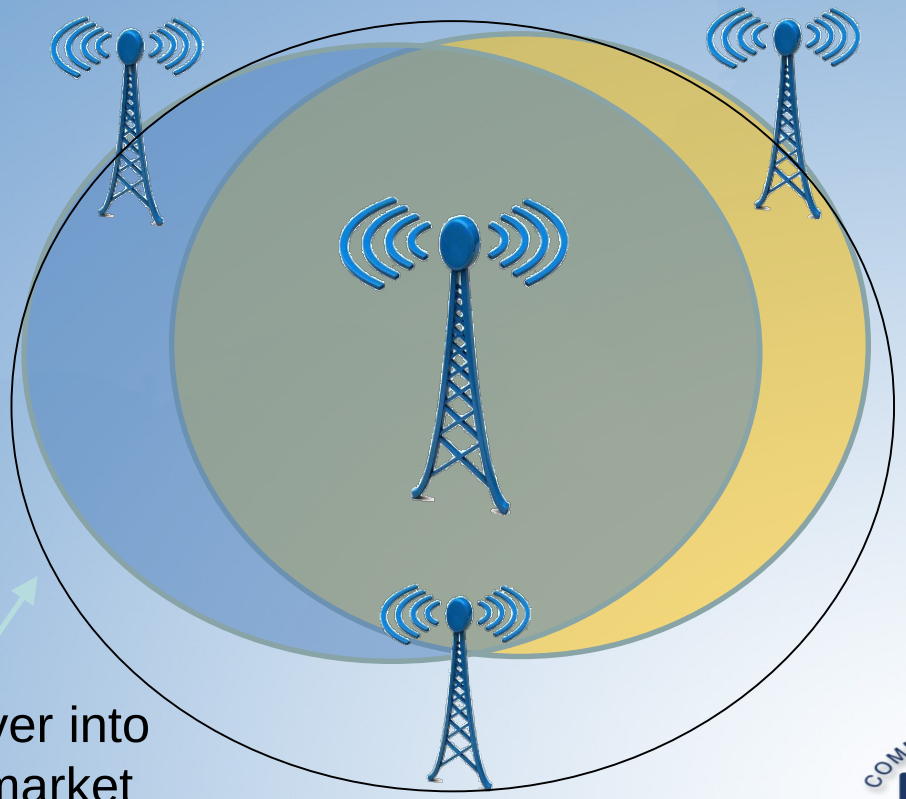
Example use of PLPs or LDM

- SHVC (Video Spatial Scalability)
  - Base layer optimized for mobile reception
  - Enhancement layer optimized for UHD resolution



Broadcasters may deploy single frequency networks to increase their signal strength within their service area

- Many broadcasters are likely to initially deploy ATSC 3.0 transmissions from a traditional single tower (high power/high tower)
- Over the long-term, the deployment of multiple transmitters in SFN's may be used to improve coverage within their service areas and add capacity by raising signal levels to improve indoor and mobile services
  - A properly designed system will not cause interference into adjacent markets

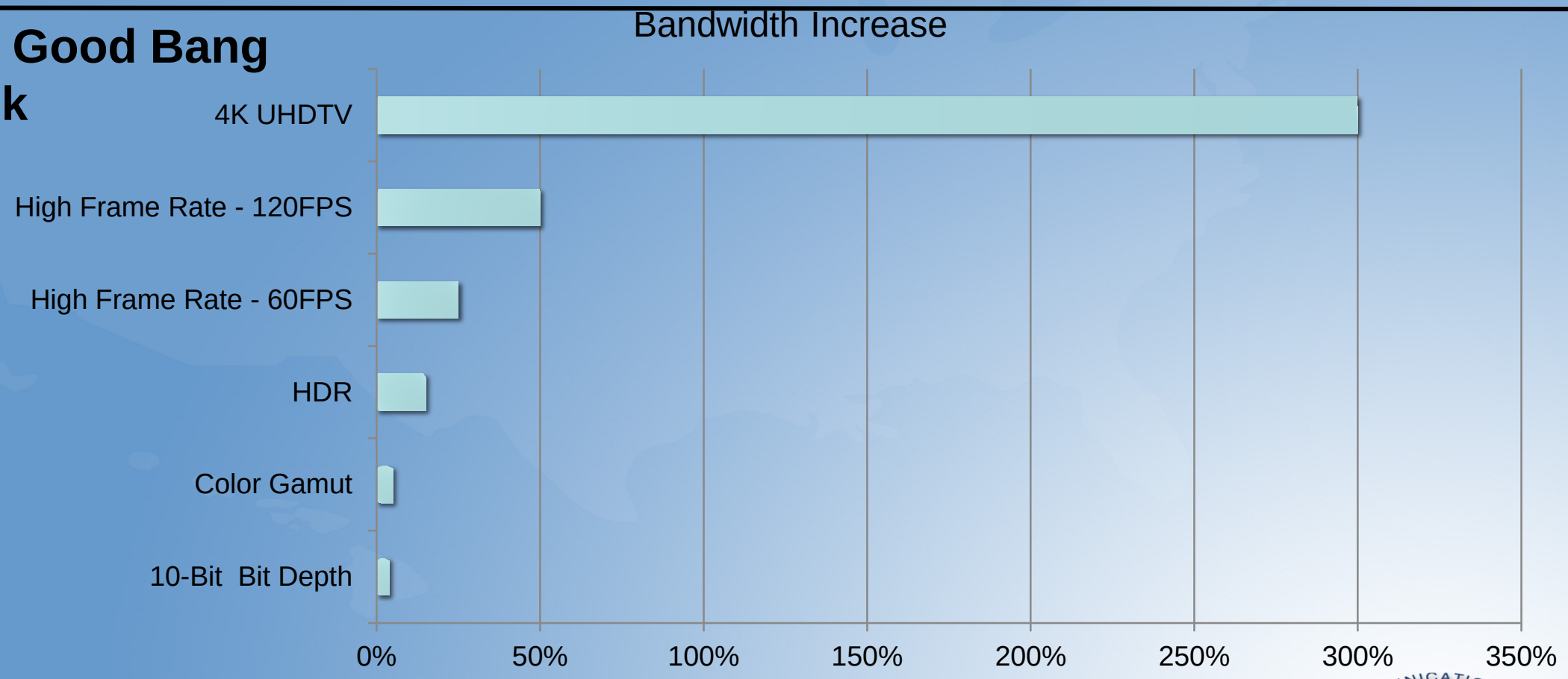


No spill-over into adjacent market

Key Video Features

- Up to 4K UHD (2160p) spatial resolutions
- High Dynamic Range (HDR)
- Wide Color Gamut (WCG)
- High Frame Rate (HFR)
- Enhanced 2K HD (1080p)
  - Add HDR and WCG to HD
- Significant efficiency improvement with HEVC video compression

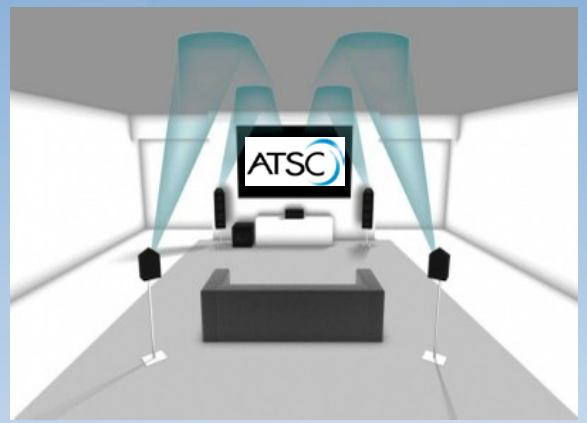
HDR/WCG: Good Bang for the Buck

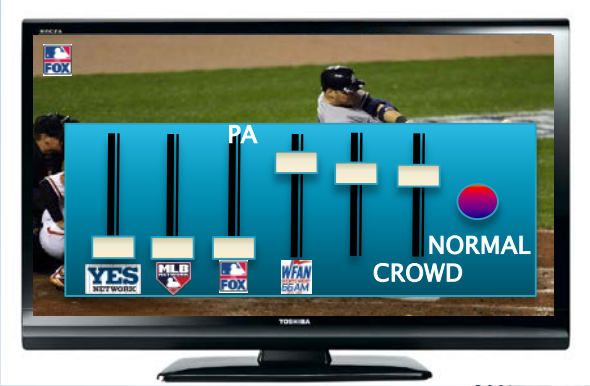


Reference bit rate is 709 color space, 1080, 30P, 8 bit. Chart courtesy of NBC/Universal and Cablelabs.

Advanced Audio

- Immersive
  - Sound with improved height and distance perspective
  - Works on different devices and speaker set-ups
- Personalization
  - Dialog Enhancement
  - Language alternatives
  - Commentary Selection





Key Accessibility Features

- Deliver **video description** audio service
  - While also sending additional alternative audio tracks
  - Alternate audio tracks can share the immersive music & effects track that the main audio listeners enjoy
  - Multiple languages are possible
- Deliver multiple **closed caption** tracks

Advanced Emergency Alerts

- Leverages the power of ATSC 3.0 to supplement existing EAS alerts
- On-screen icons/prompts/summaries
- Detailed and targeted info
- Rich media content (video, maps, etc.)
- User selection of preferences (e.g., language)
- Possibility to wake up devices for urgent alerts

Security

- Encryption system for broadcast content enables new business models:
  - Protect high value content
  - Offer Subscription or “Freemium” services
  - Offer Pay-per-View programming
- Viewer registrations for services creates a 1-to-1 relationship between broadcaster and viewer
- Transport Layer Security (TLS) for protecting broadband-delivered content
  - Standard web security technology

Next Generation Television Broadcasting Working Group Questions

- To what extent will this new service compete or integrate with services that are offered by commercial wireless services?
- To what extent might the implementation of ATSC 3.0 raise issues such as expanded deployment of distributed transmission systems that could face issues such as tower siting?
- What are the ways that ATSC 3.0 is likely to be deployed that could intersect with other communications facilities and devices such as the use of gateways that could rely on Wi-Fi to distribute multiple video signals throughout a dwelling?
- If a gateway and Wi-Fi were used, how would they interplay with wireless routers used for other services in the same dwelling?
- What other synergies or interfaces might exist between broadcast data services and commercial wireless services?

To what extent will this new service compete or integrate with services that are offered by commercial wireless providers?

- Some broadcasters may pursue a “mobile first” strategy, while others focus on a “large screen” strategy in the short-to-medium term
- Widespread ATSC 3.0 delivery to mobile devices requires incorporation of a new receiver chain, including new antenna(s), filters, amplifiers, oscillators, and demodulator/receivers.
  - The incorporation of new ATSC 3.0 receivers could result in:
    - Direct costs (i.e., higher costs for ATSC 3.0–compatible devices)
    - Indirect costs (e.g., larger devices, shorter battery life, degraded LTE/5G performance)
    - Opportunity costs (e.g., displaced functionality such as 4x4 MIMO, which could provide efficient use of spectrum, increased throughput capacity, and coverage)
- Handset manufacturers may resist incorporating the added components needed for 3.0 as they are redesigning for 5G.

To what extent might implementation of ATSC 3.0 raise issues related to tower siting?

The Working Group expects that many broadcasters will not seek to broadcast from multiple towers in the short- to medium-term—and those who do are unlikely to build new towers. Here too, however, incentives may vary from broadcaster to broadcaster.

- Many broadcasters are likely to use traditional single towers at least through the simulcast transition.
- Some may move to SFNs on a faster time frame, as part of the “mobile first” strategy.
  - This may create some challenges of signal interference within markets.
- Those broadcasters who move to SFNs more quickly are not expected to build new towers.
  - Most likely they will utilize existing towers from other wireless service operators, if available.

How might ATSC 3.0 intersect with other communications facilities?

- ATSC 3.0 is not backward-compatible with existing TV sets and receivers or MVPD infrastructure, which could create friction during the transition.
  - While there are no ATSC 3.0 tuners or converter devices currently available to consumers, the Working Group anticipates that simple converter devices may develop in the market.
    - Consumers will need more expensive full-featured devices to enjoy ATSC 3.0's new functionalities.
  - MVPD networks are engineered to receive/retransmit ATSC 1.0 signals, but not ATSC 3.0 signals.
  - Broadcasters will deploy ATSC 3.0 on different timeframes, which in turn will affect timing and nature of requests for MVPD transmission of ATSC 3.0 signal.
  - Broadcasters may downconvert ATSC 3.0 to ATSC 1.0 for fiber distribution to MVPDs.
- ATSC is developing two Recommended Practices on ATSC 3.0 redistribution over MVPDs.
  - Method for the conversion of ATSC 3.0 services into ATSC 1.0 services.
  - Delivery of ATSC 3.0 services to MVPDs for direct redistribution.
  - Publication was originally targeted for year end 2017, but now is expected in spring 2018.

How might ATSC 3.0 intersect with other communications facilities?
MVPD Technical Questions

- MVPDs face several technical challenges in transmitting ATSC 3.0 signals over their legacy networks:
  - ATSC 3.0 uses OFDM modulation; legacy cable networks rely on Quadrature Amplitude Modulation.
  - ATSC 3.0 supports HDR; legacy networks rely on standard dynamic range.
  - ATSC 3.0 requires HEVC compression; legacy networks only support MPEG-2 and -4.
  - ATSC 3.0 audio layer moves to AC-4; legacy networks rely on AC-3.
- Digital transmission, particularly for smaller operators, will remain QAM-based for the foreseeable future.
- The variability of ATSC 3.0 (picture/data) – 4K, HDR, HD, SD – presents reception and retransmission issues.
- Enhanced content standards are not yet defined and may not be uniform.
  - HDR for video.
  - Audio personalization, such as multiple languages or multiple commentators.

How might ATSC 3.0 intersect with other communications facilities?
MVPD Technical Questions

- Other enhanced features of ATSC 3.0 could present additional technical complications for MVPDs:
  - IP layer supports encryption, creating encryption/decryption issues for all 3.0 channels including the primary video stream.
  - Utilization of broadband capability and the HTML5 application layer requires return path coordination and raises questions of where applications are executed (TV or MVPD navigation device).
  - The implementation and transmission of advanced emergency alerting signals could present additional complications.

If a gateway and Wi-Fi were used, how would they interplay with wireless routers used for other services in the same dwelling?

The Working Group does not anticipate interference or service problems arising from Wi-Fi compatible ATSC 3.0 gateways.

- Manufacturers are unlikely to design ATSC 3.0 gateways to create independent Wi-Fi LANs.
- In a home that does not already have Wi-Fi, the ATSC 3.0 gateway could establish a network.
- In either scenario, the distribution of a broadcast signal is unlikely to be more problematic than other forms of video distribution that are common today.

What other synergies or interfaces might exist between broadcast data services and commercial wireless services?

- The ATSC 3.0 system supports aggregation, combination, synchronization and presentation at the receiver of content from different delivery networks (e.g., terrestrial broadcast and mobile broadband).
  - A mix of real-time and non-real-time delivery of content via broadcast and broadband paths invoked by an ATSC 3.0 service optimizes efficiency of the hybrid delivery infrastructure and can balance data bandwidth demand on each network.
- In a hybrid broadcast/broadband environment, broadband services could optimize spectrum resources by invoking the use of the broadcast channel for real-time delivery of large data sets to mass audiences.
- Commercial wireless services can provide a return path for user interactivity or independent interactive applications that may supplement ATSC 3.0 broadcast content or make broadcast content and services more flexible and useful.

Conclusions

- ATSC 3.0 is highly flexible and has the potential to offer many benefits for consumers and the broadcasting industry.
  - However, important aspects of overall system implementation remain undefined and must be agreed by industry participants.
- Different broadcasters will have different incentives to take advantage of different ATSC 3.0 features on different time horizons.
- Market dynamics will determine the technical and other issues that may arise from the intersection of ATSC 3.0 with other communications facilities.
- Many of these issues may be relatively easy to manage, but others may produce friction with distributors and consumers.

Actionable Recommendations

- **The Commission should closely monitor the rollout of ATSC 3.0 service during the transition period (and after)**
  - **Examine whether Commission action is required for issues that arise.**
    - **Any FCC actions on these issues should be reviewed periodically and revisited as the market develops.**

THANK YOU

FCC Technological Advisory Council Working Group:

Satellite Communication Plan

December 6, 2017

Satellite Communication Plan Working Group

Working Group

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- Dave Tennenhouse (Vmware)
- Dale Hatfield (CU - Boulder)
- Mark Bayliss (Visualink)
- Adam Drobot (OpenTechWorks)
- John Chapin (IEEE)

FCC Liaisons

- Matthew Pearl (FCC - Wireless)
- Robert Pavlak (FCC - OET)
- Padma Krishnaswamy (FCC)
- Jose Albuquerque (FCC - International)

Chairs

- Steve Lanning (Viasat)
- Pierre de Vries (CU - Boulder) – subgroup Chair

Satellite Communication Plan Working Group Contributors

- Mariah Shuman (OneWeb)
- Christine Hsu (OneWeb)
- Mihai Albulet (SpaceX)
- Patricia Cooper (SpaceX)
- Zachary Rosenbaum (O3b/SES)
- Joe Cramer (Boeing)
- Alex Epshteyn (Boeing)
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- Ralph Ewig (Audacy)
- Paul Konopka (Viasat, Inc.)
- Jennifer Manner (EchoStar/Hughes)
- Brennan Price (EchoStar/Hughes)
- Fernando Carrillo (EchoStar/Hughes)
- Jonathan Sheffield (Facebook)
- Giselle Creeser (Inmarsat)

Satellite Communication Plan Charter

- This work group will look at recommendations for processes and communication solutions to support both startup venture satellite operations as well as massively scaled satellite operations.
- The work group will assess the challenges faced by these new satellite ventures in the context of current and planned communication/telemetry solutions.
- The work group will focus on streamlining the regulatory process, the impact on current satellite operations from expected scaling of operations in both frequency and number, the effect of possible interference from satellites operation in MEO and LEO orbits, and proposals that would allow for higher spectral efficiency and lower costs for satellite communication needs.

Charter and Work Completed

- Work areas
  1. NGSO sub-group focused on interference risk assessment and mitigation. Output is a white paper
  2. Framing issues with satellite based on active discussion between participants in the industry

Satellite Communication Plan Working Group Work

Presentations Q2 and Q3

- Jennifer Manner and Brennan Price (EchoStar/Hughes) on evolution of GEO technology
- Professor Albin Gasiewski (University of Colorado) research perspective on Remote Sensing.
- Jennifer Manner: update on ITU
- Daryl Hunter and Fernando Carrillo Protection Criteria for FSS Interference Above 30 GHz
- Joe Fragola: expert review of how to conduct a risk assessment
- Bob Potter and David Walsh (Kratos) on RF Interference Detect, Identify, Locate, Mitigate

Done Q4

- Christine Hsu and Mariah Shuman (OneWeb)
- David Payne (Analytical Space)
- Brian Mengwasser (Aurora Insights)
- White paper review on Risk Informed Interference Assessment (done)
- White paper review on Use Cases
  - Changed to discussion on framing issues

Reframing the discussion

- Exciting time in the satellite industry due to the deployment of high-throughput geostationary orbit ("GEO") satellite systems and constellations of non-geostationary orbit ("NGSO") Fixed-Satellite Service ("FSS") satellite systems that are able to bring high-capacity, low-latency services to users globally, without regard to geography.
- These advanced capability systems are a result of:
  - The explosive demand for broadband connectivity both domestically and internationally
  - The unique capability of satellite operators to provide U.S. and global ubiquitous coverage of an increasingly larger portion of unserved and underserved households, particularly in rural areas
  - Technology innovation in spacecraft and ground systems that facilitate increasingly faster services, higher capacity, and lower latency satellite-based services
  - Mobility and Internet of Things growth as a driver for more ubiquitous coverage

Reframing the discussion - continued

- The FCC is processing additional applications for constellations of satellites that total in the thousands
  - Driven by diverse missions including high-speed broadband, earth observation, and space sensing and polar communications.
  - The largest numbers of spacecraft are in low earth orbit (“LEO”), but the number of geostationary (“GEO”) and medium earth orbit (“MEO”) satellites are also increasing.
  - GEO operators are also increasing the number of ground stations communicating with geostationary satellites, which may increase the number of potential events for interference .
  - Non-geostationary orbit (“ NGSO”) operators may also require a significant number of ground stations serving as access points .
- With this change in communications satellites, what, if anything , should the FCC do differently to mitigate the potential for harmful interference between systems ?

NGSO Risk Framework Sub-Group

Sub-group

- Mihai Albulet (SpaceX)
- Fernando Carrillo (EchoStar/Hughes)
- John Chapin (NSC)
- Pierre de Vries (U. Colorado)
- Alex Epshteyn (Boeing)
- Christine Hsu (OneWeb)
- Steve Lanning (Viasat)
- Susan Tonkin (Independent)

FCC Liaisons

- Jose Albuquerque (IB)
- Robert Pavlak (OET)

The Working Group recognizes that the issues discussed in this paper are the subject of pending adversary proceedings at the Commission, including in individual satellite license and market access applications. Many of these proceedings are the subject of pending Petitions to Deny, Opposition and separate comments currently under consideration. It is not possible to reflect all views without a complete analysis. This paper describes a method but does not offer a complete analysis or comparison to other methods. It draws no conclusions that are applicable to matters pending before the Commission.

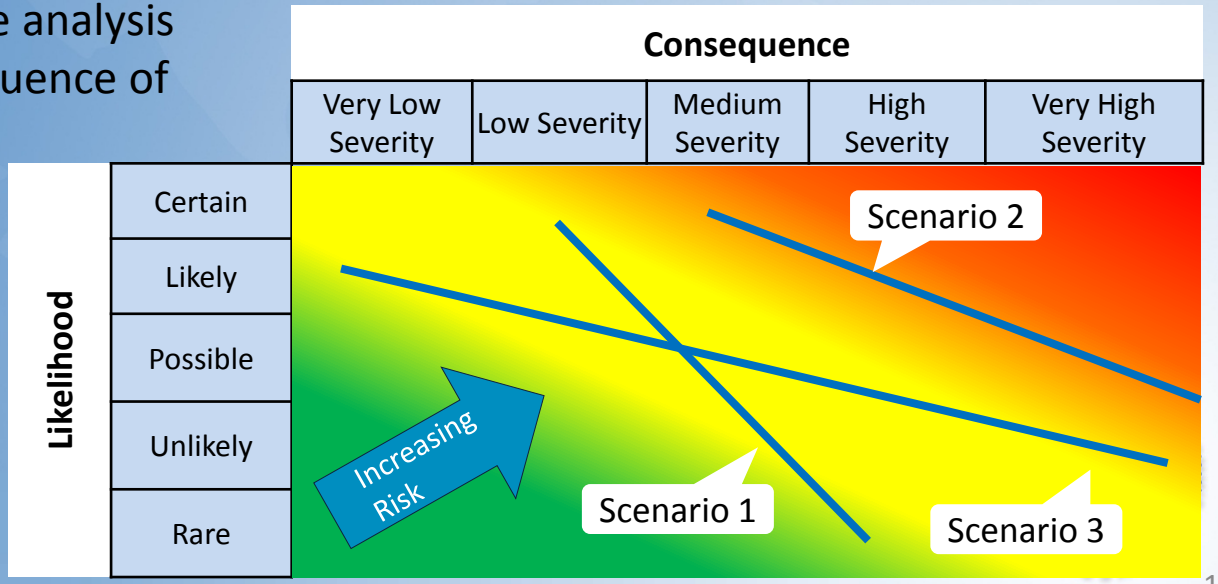
Risk assessment framework for NGSO-NGSO coexistence

- Sub-group tasked to explore whether and how framing a Risk-Informed Interference Assessment (RIIA) could assist in maximizing the value of NGSO systems
  - Explored how a risk assessment might be done
  - Did not calculate risks, or draw conclusions
- Focused on V-band
  - Space-to-Earth: 37.5–42 GHz (4.5 GHz bandwidth)
  - Earth-to-space: 47.2–50.2, 50.4–51.4 GHz (3 + 1 GHz bandwidth)
- Details in paper: “A Risk Assessment Framework for NGSO-NGSO Interference”

Risk-informed Interference Assessment (RIIA)

- Follows approach of 2015 TAC paper
- “Hazard” - potential source of harm
- “Risk” - likelihood & consequence of hazards
- “Risk-informed Interference Assessment” - quantitative analysis of the likelihood & consequence of interference hazards

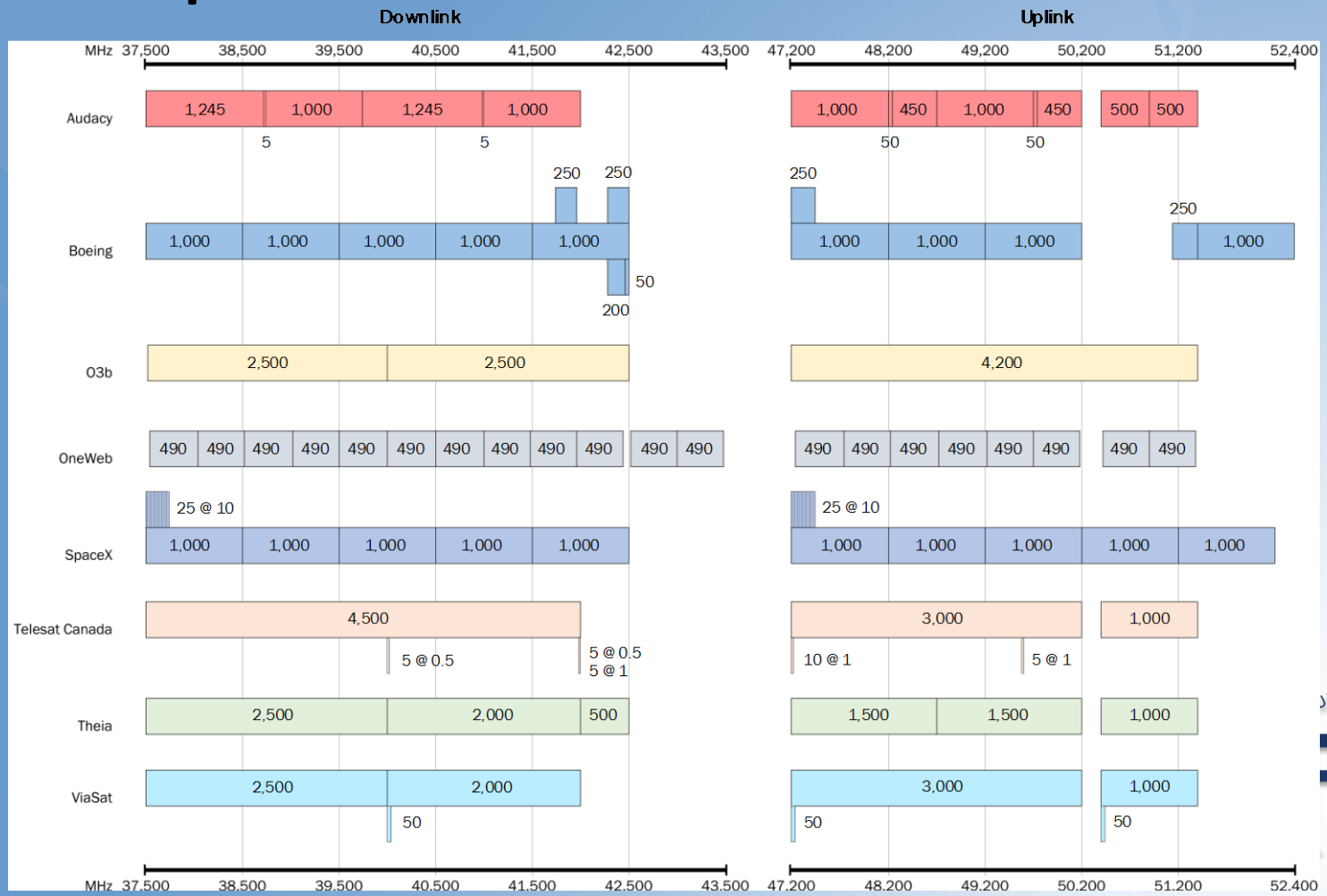
- Risk assessment elements
  1. Inventory hazards and mitigations
  2. Define consequence metric(s)
  3. Calculate likelihood-consequence values
  4. Aggregate results



V-band Processing Round

Audacy	3 MEO	Space-based data relay constellation
Boeing NGSO System	1,395 to 2,956 LEO	Broadband internet and communications services
Boeing V-band Constellation	132 LEO + 15 “inclined NGSO” at ~GSO altitude	Broadband internet and communications services
O3b	24 MEO	Low-latency, high-throughput satellite connectivity
OneWeb	720 LEO + 1,280 MEO	High-throughput connectivity
SpaceX	1,600 to 4,425 LEO + 7,518 VLEO	Broadband services
Telesat Canada	72 + 45 LEO	Broadband offerings in currently unserved and underserved areas
Theia	120 LEO	Communications and remote sensing
Viasat	24 MEO	Broadband internet and communications services

V-band frequencies

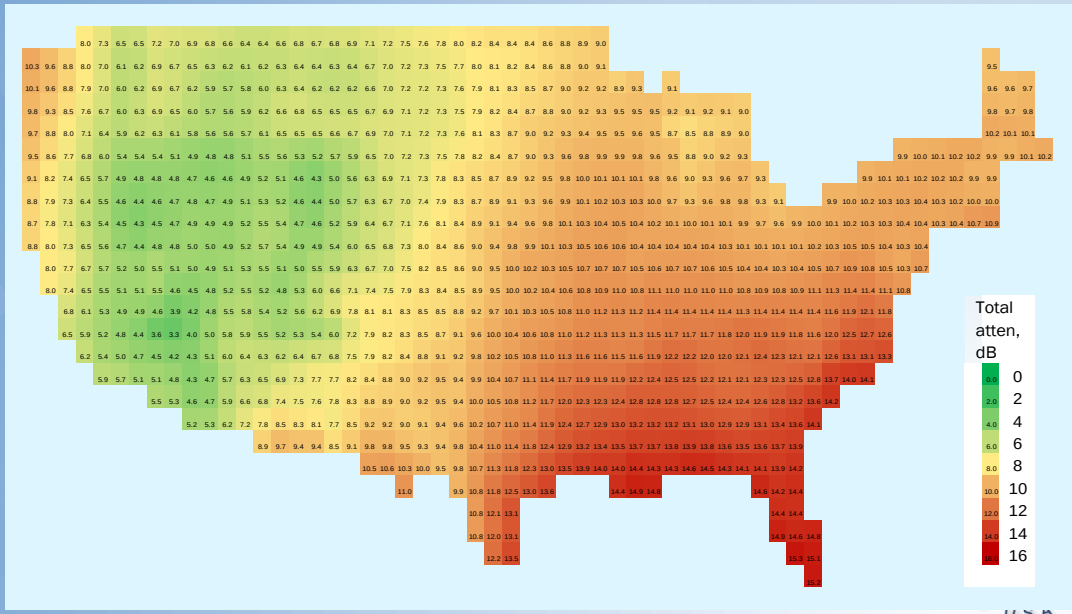


First Element: Hazards and Mitigations

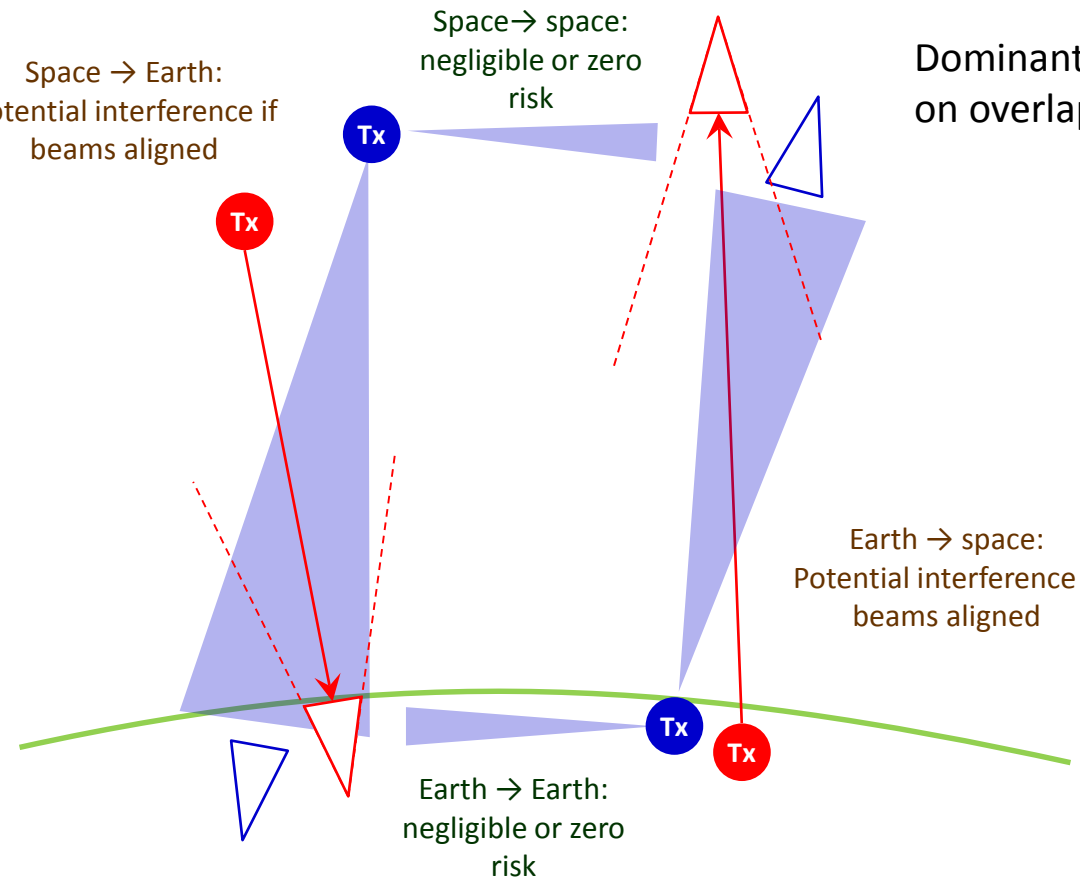
- Baseline & coexistence hazards
- Baseline: hazards that occur absent RF interference, e.g.
  - degradation of desired signal, e.g. gases, rain & cloud, beam divergence, elevation angle
  - non-interference faults and failures, e.g. misconfiguration, hardware faults

Example: Propagation losses for Earth-to-space transmission links

Total attenuation exceeded 1% of the time – due to atmospheric gases, clouds, rain, scintillation

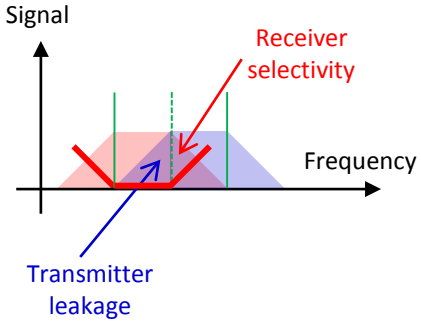


Coexistence Hazards

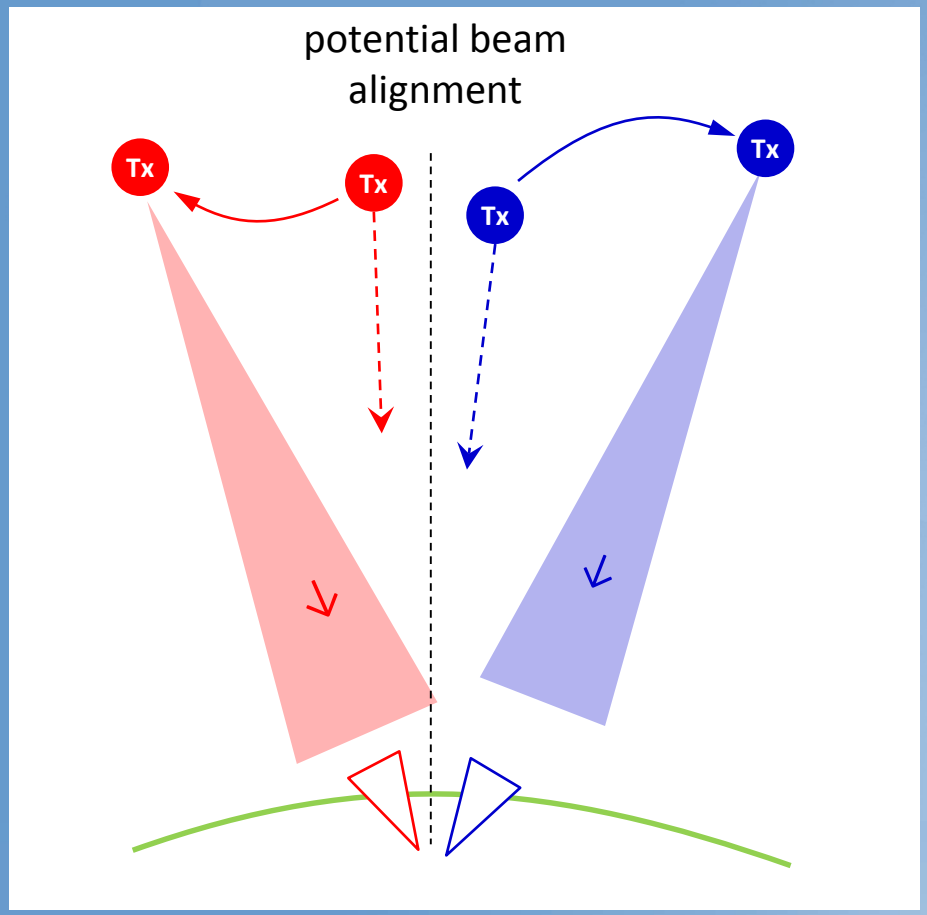


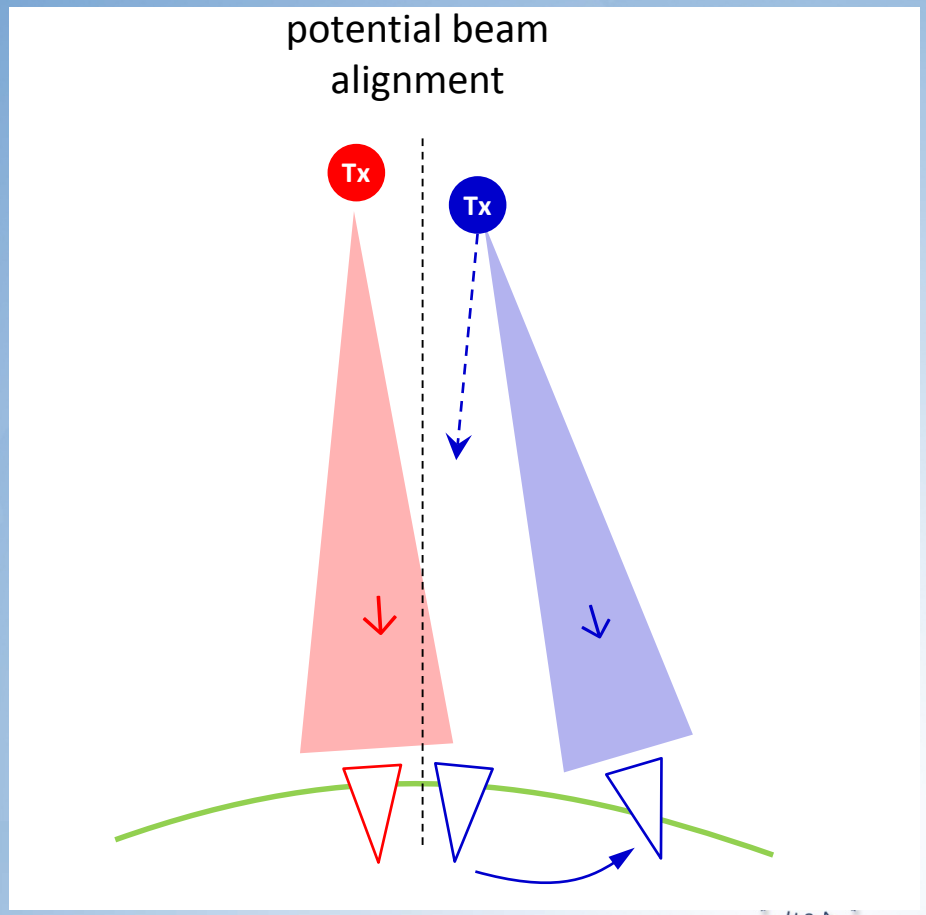
Dominant hazard is **co-channel** operation on overlapping paths

Unresolved or unsuccessful coordination and ΔT/T > 6% → band splitting, with risk of **adjacent-channel** interference



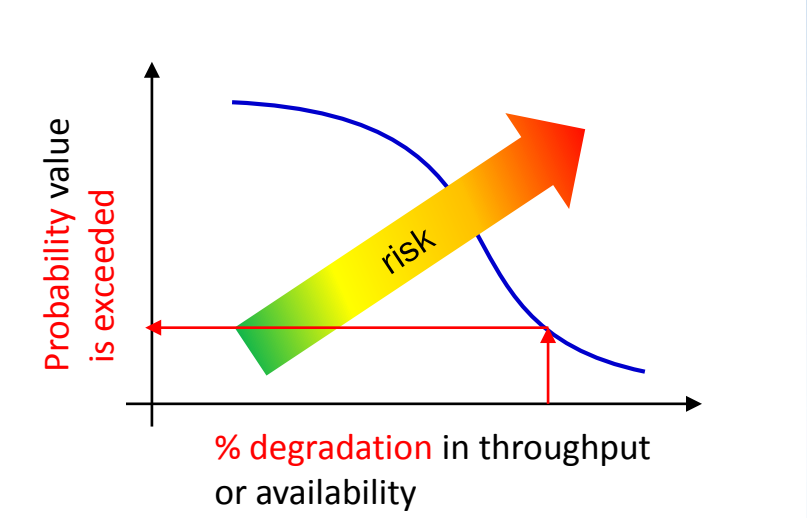
Mitigations: Satellite and geographic diversity





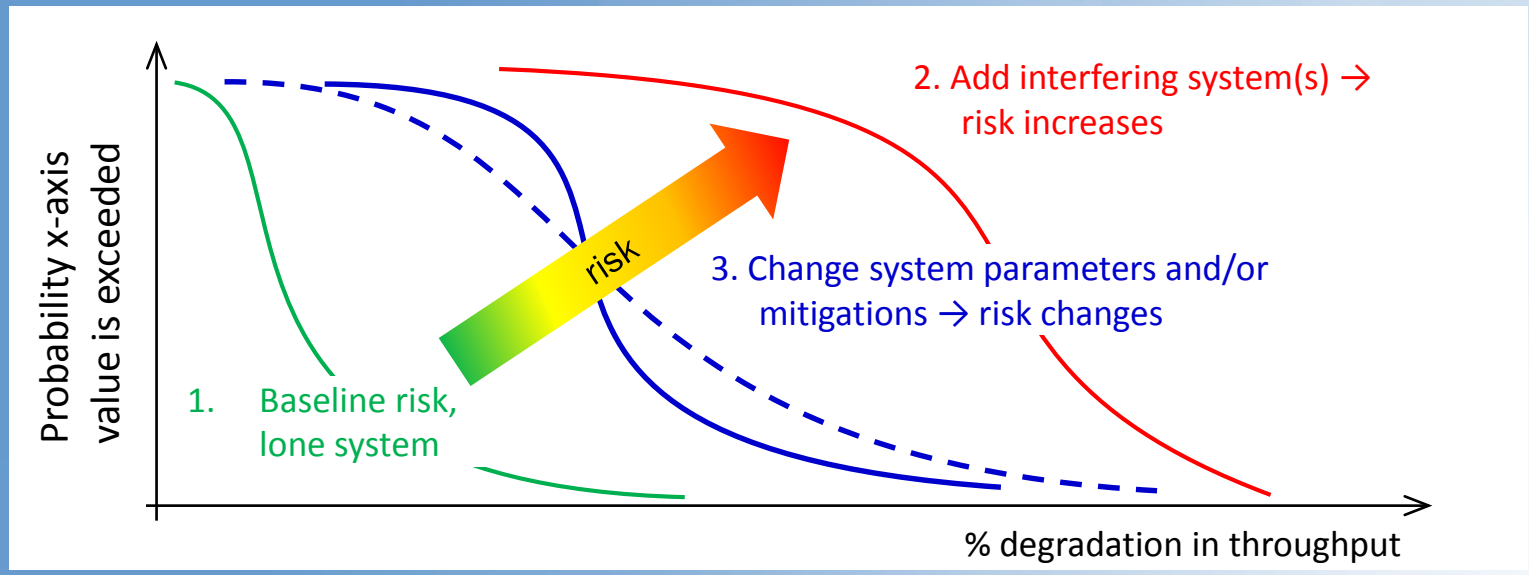
Second element: Consequence metric(s)

- A consequence metric quantifies the severity of an interference hazard
- Two possibilities considered
  - Percentage degradation in throughput from a reference value
  - Percentage reduction in availability
- Changes need to be calculated against baseline(s), for example
  - Variety of locations with different climates (rain, cloud, …)
  - Could combine into national baseline, weighted by population density
- Risk is expressed as an exceedance function (CCDF) of consequence metric



Third element: Calculate likelihood and consequence

- For example, using Monte Carlo
  - Generate many satellite/Earth station configurations, for single or ensemble locations
  - Sample attenuation (e.g. due to rain fade) from a suitable distribution
  - For each configuration, calculate link C/(I+N) → throughput
  - Plot distribution
- Adaptive coding and modulation → reduction in C/(I+N) reduces throughput



Fourth element: Aggregate results

- Compare options, e.g. relative risk of degradation under various assumptions for
  - Parameters of coexisting systems
  - Interference mitigation techniques used
- Examples of system parameters
  - channelization, antenna gain & pattern, transmit power, out-of-band emission, receiver selectivity, number of spacecraft in constellation, altitude, elevation angles while transmitting, number of ground terminals, …
- Examples of mitigation techniques
  - Band splitting, look-aside, geo diversity, align channels, adaptive links, …

Basic Principles for Assessing Compatibility of New Spectrum Allocations (TAC 2015)

1. Harmful interference is affected by the characteristics of both a transmitting service and a nearby receiving service in frequency, space or time
2. All services should plan for non-harmful interference from signals that are nearby in frequency, space or time, both now and for any changes that occur in the future
3. Even under ideal conditions, the electromagnetic environment is unpredictable. Operators should expect and plan for occasional service degradation or interruption. The Commission shall not base its rules on exceptional events
4. Receivers are responsible for mitigating interference outside their assigned channels
5. Systems are expected to use techniques at all layers of the "stack" to mitigate degradation from interference
6. Transmitters are responsible for minimizing the amount of their transmitted energy that appears outside their assigned frequencies and licensed areas
7. Services under FCC jurisdiction are expected to disclose the relevant standards, guidelines and operating characteristics of their systems to the Commission if they expect protection from harmful interference
8. The Commission may apply Interference Limits to quantify rights of protection from harmful interference
9. A quantitative analysis of interactions between services shall be required before the Commission can make decisions regarding levels of protection

Coordination based on observed degradation

The following was presented for discussion in an Appendix

- Driver: There are many unknowns in the interactions between large NGSO constellations. This could lead to significant wasted capacity if operators must prevent all potential interference.
- Possible solution
  - Operators observe rate of non-harmful degradation events
  - Operators coordinate when the rate rises to a level that a system is liable to experience harmful degradation
  - Mitigations (e.g. look-aside) are only applied for specific conditions / locations / times where degradation is observed
  - Pre-agreed mitigations can be automatically triggered, until optimal arrangement is negotiated
- Systems must be designed to support this form of sharing
  - Incorporate occasional transmission of, and ability to observe, device IDs
  - Tolerate a low rate of non-harmful degradation events

Conclusions

- RIIA may help the FCC and industry to explore questions regarding NGSO-NGSO coexistence
- RIIA could assist in identifying approximate boundaries between acceptable and unacceptable risk
- RIIA could focus attention on those interference mitigation measures that are likely to be most effective
- The FCC, industry and/or researchers could explore the use of economic and environmental analysis to complement the engineering analysis described here

Request Vote For TAC To Accept White Paper For Publication

The FCC should consider the following recommended actions

1. Taking into Account the Role of Adaptable System Architectures:
   - The FCC should adopt rules for spectrum sharing that enable the use of adaptable system architectures (e.g.,switched / shared frequency assignments), as technology evolves
   - Unfortunately, past proceedings, such as the FCC's Connect America Fund II proceeding, effectively rejected the use of such architectures to address concerns the FCC raised about latency

2. Consider using, and encouraging the use of Risk Informed Interference Analysis (among other methods) in the analysis of NGSO-NGSO coexistence

Recommended Actions: continued

3. Technology Neutrality

- The FCC should focus on technology neutral policies to ensure competition among platforms and to promote innovation of communication technologies. Accordingly, the FCC should avoid adopting performance requirements that exclude or limit the use of certain technology. Instead, the FCC should enable competition and allow the market to determine the most appropriate technology providing broadband Internet access.

Recommended Actions: continued

4. Improved Broadband Deployment Data

- The FCC should revisit how to obtain the most accurate broadband data while balancing the administrative burdens and need for confidentiality imposed on network operators and service providers.
- In its annual Section 706 NOI, the FCC should continue to seek comment on ways to improve data capture relative to actual proportions of households that actually have access to service without unduly burdening network operators and service providers.

5. Fostering innovation

- This is a topic for a future working group. We tried but did not gather sufficient input from new entrants.

Preliminary Recommendation* For Satellite WG in 2018

- Space Debris and the role of the FCC
  - Help FCC define appropriate role with respect to space debris
- Look at recommendations for processes and communication solutions to support both startup venture satellite operations as well as massively scaled satellite operations
  - Goals are
    - Improve competition
    - Reduce regulatory burdens
    - Focus on streamlining the regulatory process in particular for new entrants
    - Input from startup companies, small operators, universities, etc."
    - Might consider options like a Notice Of Inquiry
  - While many application from entrants, universities and startups include small sats, recommend exclusion from WG and focus efforts to regular rulemaking process for small sats

* Some contributors want to work on this further and update by end of Dec.

Thank You