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September 25, 2019

VIA ECFS

Marlene H. Dortch
Secretary
Federal Communications Commission
445 12th Street, SW
Washington, DC 20554

**Re: *Ex Parte* Presentation of ACA Connects—America's Communications Association;
Expanding Flexible Use of the 3.7 to 4.2 GHz Band, GN Docket No. 18-122**

Dear Ms. Dortch:

On September 23, 2019, Ross Lieberman of ACA Connects – America's Communications Association ("ACA Connects"); Pantelis Michalopoulos and Georgios Leris of Steptoe & Johnson LLP; Nikos Andrikogiannopoulos of Cartesian, Inc.; and the undersigned (collectively, "ACA Connects Representatives") met, in separate meetings, with Will Adams, Legal Advisor to Commissioner Brendan Carr; Bill Davenport, Chief of Staff to Commissioner Geoffrey Starks; and the representatives of the International Bureau ("IB"), Office of Economics and Analytics ("OEA"), Office of Engineering and Technology ("OET") and Wireless Telecommunications Bureau ("WTB") copied below. On September 24, 2019, ACA Connects Representatives met with Umair Javed, Legal Advisor, Wireless and International, to Commissioner Jessica Rosenworcel.¹

In each meeting, ACA Connects Representatives presented and discussed the enclosed supplement to the 5G Plus Plan.² The supplement provides further details on how to design and implement a fiber network for delivery of multichannel video that matches or exceeds the reliability, capacity and quality provided today via the C-band. To ensure that the network meets the requirements of video programmers, the supplement proposes the allocation of an additional \$0.9 billion for programmers' transition costs. The supplement also clarifies and enhances other

¹ Mr. Andrikogiannopoulos and Mr. Leris did not participate in the meeting with Mr. Javed.

² See Letter From Pantelis Michalopoulos to Marlene H. Dortch, Secretary, FCC, GN Docket No. 18-122 (filed July 9, 2019); Letter From Ross Lieberman, ACA Connects; Elizabeth Andrion, Charter Communications, Inc.; and Alexi Maltas, Competitive Carriers Association to Marlene H. Dortch, Secretary, FCC, GN Docket No. 18-122 (filed July 2, 2019).

aspects of the 5G Plus Plan, including safeguards for incumbent C-band users, protections for the U.S. taxpayer, and an important role for the transition administrator in ensuring a timely transition.

During the meetings, ACA Connects Representatives also underscored the immense benefits of the 5G Plus Plan and its advantages over alternative approaches. The 5G Plus Plan would clear 370 megahertz of C-band spectrum for 5G at a rapid pace, future-proof the distribution of multichannel video, finance fiber buildout in rural communities, usher in a better and cheaper video distribution medium than the C-band, and protect incumbents, all while bringing in billions of dollars for the U.S. Treasury. No other plan on record comes close to matching these benefits.

This letter is being filed electronically pursuant to Section 1.1206 of the Commission's rules. Please address to the undersigned any questions regarding this filing.

Sincerely,



Brian Hurley

Enclosure

cc: Will Adams, Office of Commissioner Carr
Bill Davenport, Office of Commissioner Starks
Julius Knapp, OET
Giulia McHenry, OEA
Donald Stockdale, WTB*
Tom Sullivan, IB
Jonathan Campbell, OEA
Pat DeGraba, OEA
Anna Gentry, WTB
Matthew Pearl, WTB*
Paul Powell, WTB*
Brian Wondrack, WTB

Umair Javed, Office of Commissioner Rosenworcel

**indicates participation by telephone*

5G Plus Plan Supplement

September 23, 2019

Prepared for:



AMERICA'S
COMMUNICATIONS
ASSOCIATION

#ACAConnects



5G Plus Plan Supplement Overview

ACA Connects has supplemented the 5G Plus Plan to provide more details about the fiber network that will be used by the MVPD industry, the transition to this network, and other changes to protect the public interest



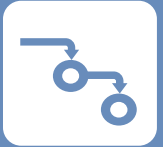
Fiber Network Improvements

Amendments ensure fiber network will match or exceed the reliability, capability and quality of C-band distribution



More Funding for Programmers' Reimbursements

Amendments add \$0.8B to cover programmers' capital expenditures and 5-year operating expenses



Better Taxpayer Protections

Amendments ensure U.S. Treasury receives at least a minimum return on auction proceeds, and satellite industry receives no more than a maximum amount in incentive payments



Measures to Safeguard C-band Users

Amendments ensure satellite industry supports C-band customers during and after transition

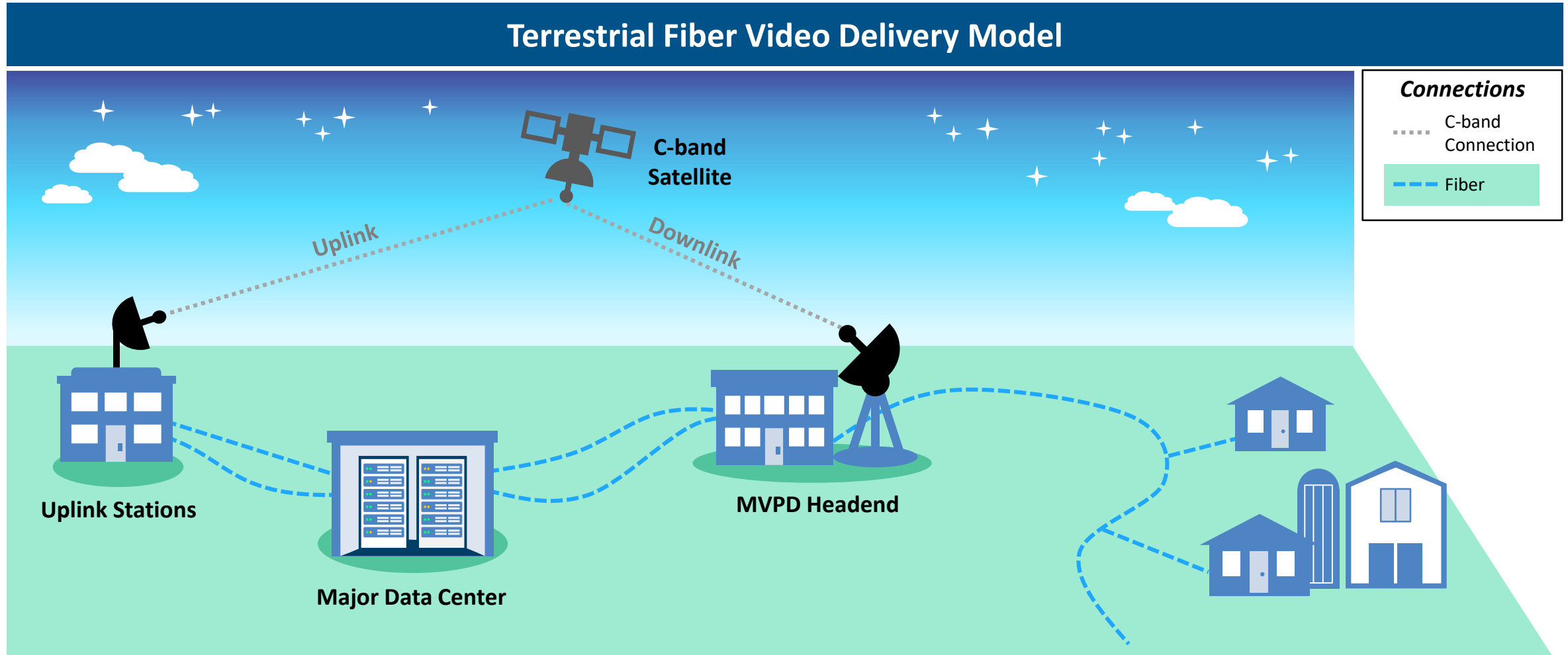


Other Supplements

Amendments clarify management role of transition facilitator and transition clearing timeline

5G Plus Plan Delivery Model

The 5G Plus Plan proposed to clear at least 370 MHz of C-band spectrum in a timely manner by transitioning the delivery of MVPD programming from the C-band to a fiber network



Amendment Process

ACA Connects has spent several weeks discussing details of the plan with various parties, such as major programmers, who will be affected or play a part in the proposed transition



Over 20 hours in separate meetings with over 10 programming companies of different sizes



Two webinars with Q&A sessions, attended by dozens of programmers



Meetings with multiple national fiber service providers














Meetings with content aggregators



Feedback: We heard concerns and incorporated feedback from all parties to provide assurances of reliability, capability, quality and cost for the transition to a fiber network.






Amendments to Original 5G Plus Plan

Programmer Network	 Managed Video Transport Services	Four nationwide fiber infrastructure providers will deploy a video transport network across 42 data centers to programmer specifications
	 Programmer Autonomy/Optionality	Programmers will receive funds to make key decisions regarding network architecture – contract services to vendors of choice
	 Fiber Reliability & Capacity	Refinements including route diversity (200 ft minimum separation distance), and upgraded backbone capacity (100G)
	 Managed Video Transport Network	Traffic rides over network deployed solely for the purpose of video transport
	 Necessary Contractual Changes	MVPDs will agree to programming contract changes necessary for the transition to a fiber network, while leaving other provisions unchanged
	 Backup/Disaster Recovery Sites	Increase in the number of uplink sites to reflect the number of programmers' existing backup/disaster recovery sites
	 Security & Network Operations Staff	Security system supporting end-to-end encoding and responsible for 24/7 operations of the new private network
Other	 Taxpayer Protections	U.S. Treasury receives minimum return on auction proceeds, and satellite industry does not obtain windfall
	 C-band User Protections	Satellite industry to receive incentive payments over seven-year period to ensure C-band users receive good service during and after transition
	 Transition Facilitator	Responsibilities of the transition facilitator better defined
	 Timeline Clarification	Market clearing timelines start from date transition facilitator receives reimbursement funds from winning bidders – planning can begin immediately

Programmer Reimbursement
Changes increased reimbursable funds to programmers to approximately **\$1B**

Benefits of a Comprehensive Transition to Fiber Video Transport

Fiber-based video transport offers a future-proof, superior delivery mechanism at a lower steady-state cost

Fiber-based Video Transport Provides More for Less		
1	 Operational Cost Reduction	<ul style="list-style-type: none">Fiber-based video distribution steady-state costs are significantly lower than satellite video distribution costs, even under the use of new compression standards (HEVC)
2	 Improved Customer Experience	<ul style="list-style-type: none">Fiber video distribution allows for improved bandwidth, better quality of service (QoS) and lower latencyImproves customer experience and can support rapid growth in use cases with higher video resolution and bandwidth (e.g., Ultra-HD, Virtual Reality, etc.)
3	 More Network Capacity	<ul style="list-style-type: none">Fiber has practically unlimited bandwidth (e.g., about 100 wavelengths x 100Gbps can be transmitted over 1 fiber pair) compared to the finite bandwidth of C-bandCurrent & near-future needs satisfied; no need for a forced migration to next generation compression standard
4	 No Interference	<ul style="list-style-type: none">Fiber transmission offers an isolated glass medium with no external interferencesC-band is a shared wireless transmission medium and signal transmission is susceptible to both in-band and out-of-band interference, including from 5G
5	 Increased Regulatory Certainty	<ul style="list-style-type: none">The 5G Plus Plan provides a comprehensive transition that eliminates the uncertainty of future spectrum repurposing associated with plans that keep video programming on the C-band

5G Plus Plan's Approach

Programmers' concerns, interests, and desires dictated our plan's approach

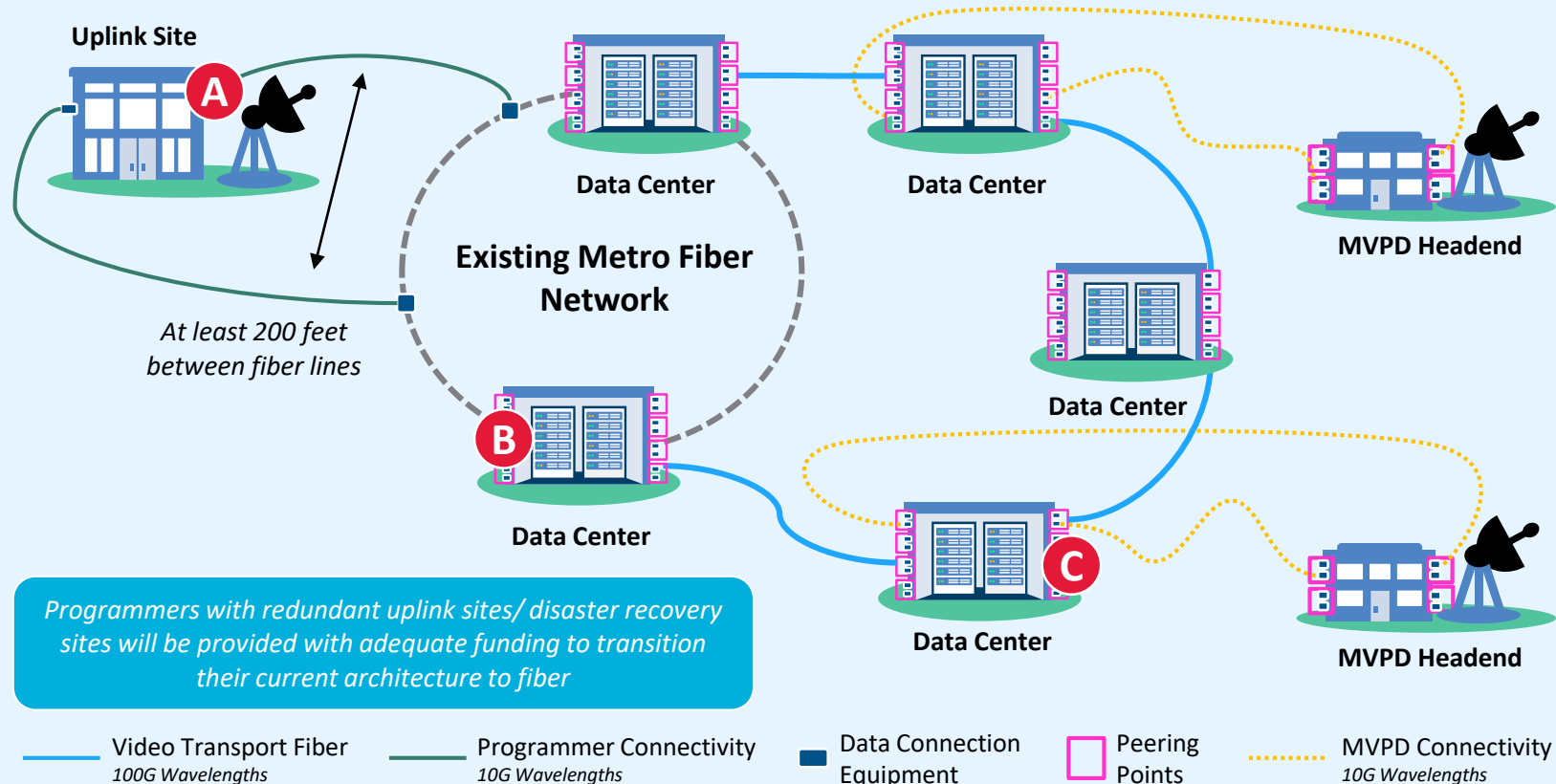
- ▶ **Programmers' Content must be Transported Over Private Video Transport Network Dedicated Solely For This Purpose**
- ▶ **Reliability, Capability, and Quality of Fiber Network must Match or Exceed C-band Delivery**
- ▶ **Programmers must have Autonomy/Optionality to Choose Vendors, Equipment, and Software for the Fiber Networks of their Choice**
- ▶ **Programmers must have Competitive Options for Managed Video Transport Services & Fiber Connectivity**
- ▶ **Fiber Connectivity must be Provided to all Locations Receiving MVPD Programming via C-band, Including any Non-MVPD locations**
- ▶ **Cable Operators must be willing to Update Certain Terms in their Programming Contracts to be Consistent with the use of the Fiber Network**
- ▶ **MVPDs should not be Forced to Forgo Use of C-band Earth Stations in a Market Until All MVPDs in that Market Are Connected to Fiber**
- ▶ **Programmers should not be Left Paying for Fiber Delivery for Some MVPDs and Satellite Delivery for Other MVPDs**
- ▶ **All Cost Related to Fiber Delivery Must Be Reimbursed – 5G Auction Winners Must Provide 130% of Estimated Cost to Account for Overruns**

We have executed on each of these matters while designing the 5G Plus Plan

Video Transport Network – Architecture

The 5G Plus Plan reimburses programmers for the use of a video transport network

5G Plus Plan Terrestrial Video Delivery Network Architecture



A Programmer Connectivity

Programmers will transport their content from their uplink site(s) to two nearby handoff points

B Managed Video Transport Service

Programmers will be given funds to pay MVTPs for a managed network solution to transport content from each programmer's two handoff points to the 42 data centers

C MVPD Handoff

MVPDs will be responsible for obtaining connectivity to a data center, where they will cross-connect with the programmers' MVTPs

Video Transport Network – Five 9s of Reliability

The video transport network's architecture is designed to provide at least 99.999% reliability

5G Plus Plan Terrestrial Video Delivery Architecture

Programmer Reimbursement Covers:



Redundant Fiber

The fiber network has been designed to provide redundant and geographically diverse fiber routes of at least 200 feet as they travel from all existing uplink sites to two different handoff points, and to enter and exit each facility from opposite sides



Redundant Equipment

The fiber network has been designed to include redundant equipment, to ensure full redundancy end-to-end



Network Operations Center

The fiber network will have a network operations center that is equipped with traffic monitoring software and a team of 340 engineers, client support, and technicians available for immediate issue resolution

SEE SLIDE 19

Based on its own reports, the satellite industry only provides between three and four '9s' of reliability

SEE SLIDE 20

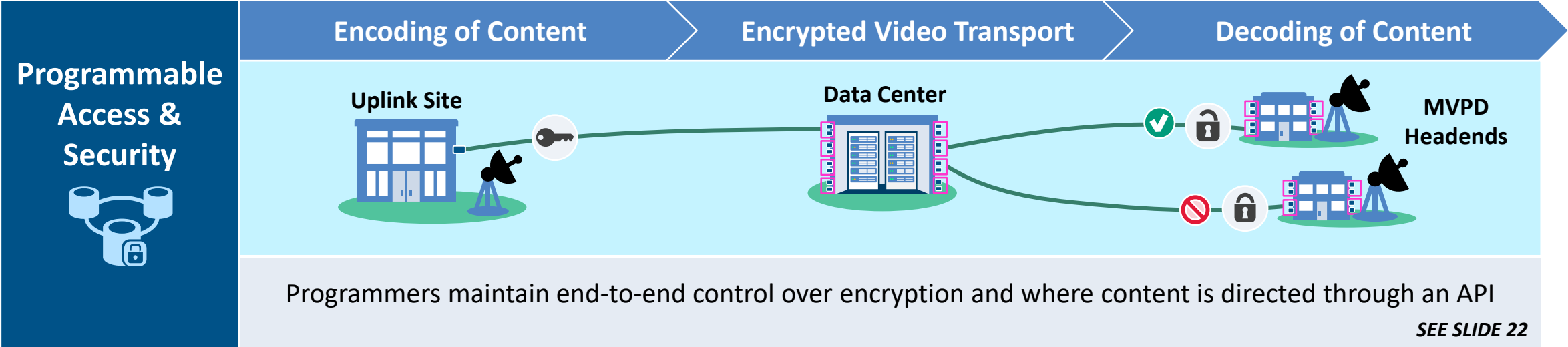
5G Plus Plan Video Transport Solution





The proposed fiber network contains all components required for reliable, secure video transport and handoff via fiber

A Uplink Site to MVTP	B Managed Video Transport Provider	C MVPD Hand-off
<div></div> Uplink Site Connectivity <ul style="list-style-type: none">• Redundant 10G wavelengths• Two geographically diverse routes, at least 200 feet apart, to two hand-off points <div></div> Uplink Site Equipment & Software <ul style="list-style-type: none">• New Enterprise Customer Premises Equipment (CPE) to enable fiber connectivity• If upgrades for IP transport are required:<ul style="list-style-type: none">– Encryption– Encoding• Installation, testing and turn-up of new equipment and software <div>SEE SLIDES 21-22</div>	<div></div> Data Center Connectivity <ul style="list-style-type: none">• 100G backbone connectivity among the 42 data centers• Dual geographically diverse circuits; entering data center from different directions (east/west); at least 200 feet apart• Redundant optical transmission, routing and aggregation switching equipment• Cross-connects for programmers to the video transport network in data centers• New User Interface for programmable access <div></div> Dedicated Network Operations Center <ul style="list-style-type: none">• 24/7 dedicated NOC teams for end-to-end network monitoring <div></div> Other Software & Security <ul style="list-style-type: none">• Any necessary development of a third-party security solution <div>SEE SLIDES 23-24, 35</div>	<div></div> Data Center Hand-off <ul style="list-style-type: none">• Cross-connects enable MVPDs to access all programmer content <div></div> MVPD Headend <ul style="list-style-type: none">• New IP integrated receivers/decoders (IRDs)<ul style="list-style-type: none">– Maintained flexibility for different levels of channel density per IRD• If necessary, the MVPD is reimbursed to obtain MPEG-2 transcoders/analog conversion equipment at its headend <div><i>MVPDs will be reimbursed separately for establishing (either through IRU or build) fiber connectivity to their nearest data center(s)</i></div> <div>SEE SLIDE 24</div>

Security & Network Operations

Programmers will maintain controlled access through the endpoints while a dedicated NOC team by the managed video transport providers will guarantee 24/7 operational excellence

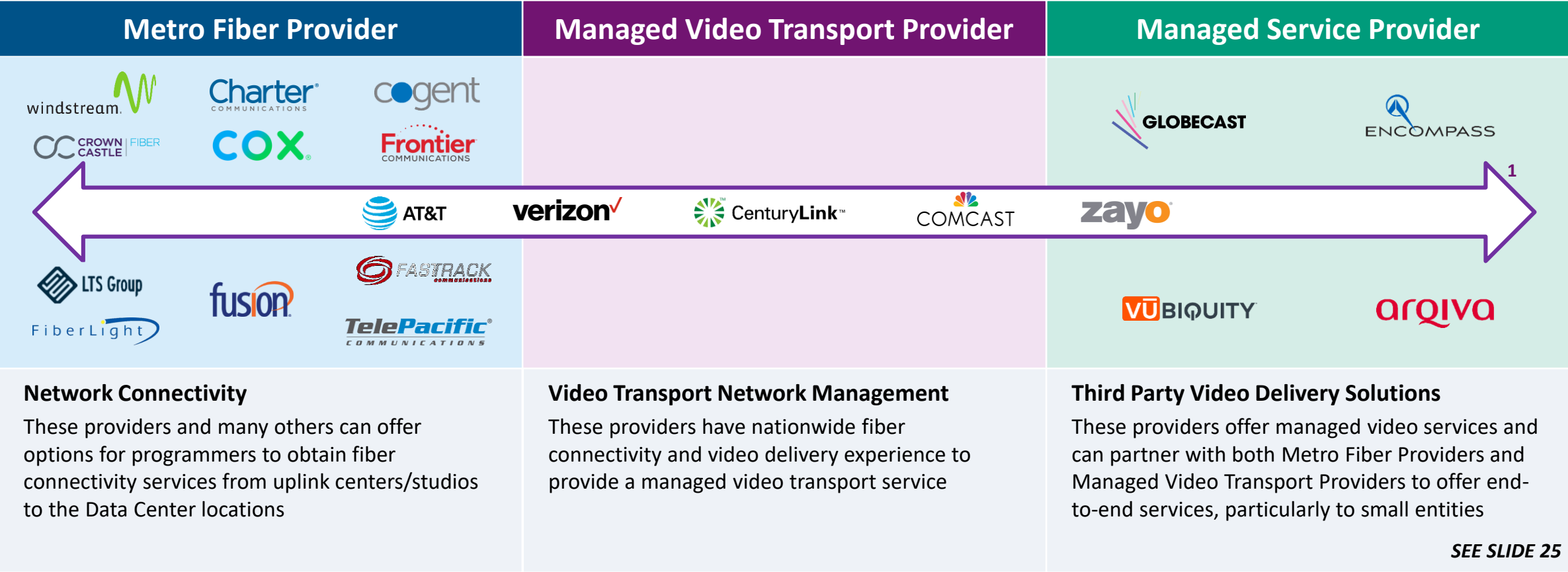


Network Operations 	 Network Operation Center Team	A team of engineers, client support and data techs at each data center resolve issues as they arise
	 Network Management System	Network probes automatically monitor traffic at data centers and MVPDs
	 Network Probe Monitoring Process	NOC team technicians resolve the issue and report to client

SEE SLIDE 23

Service Provider Options

Programmers can choose among an existing ecosystem of fiber-based video solution providers

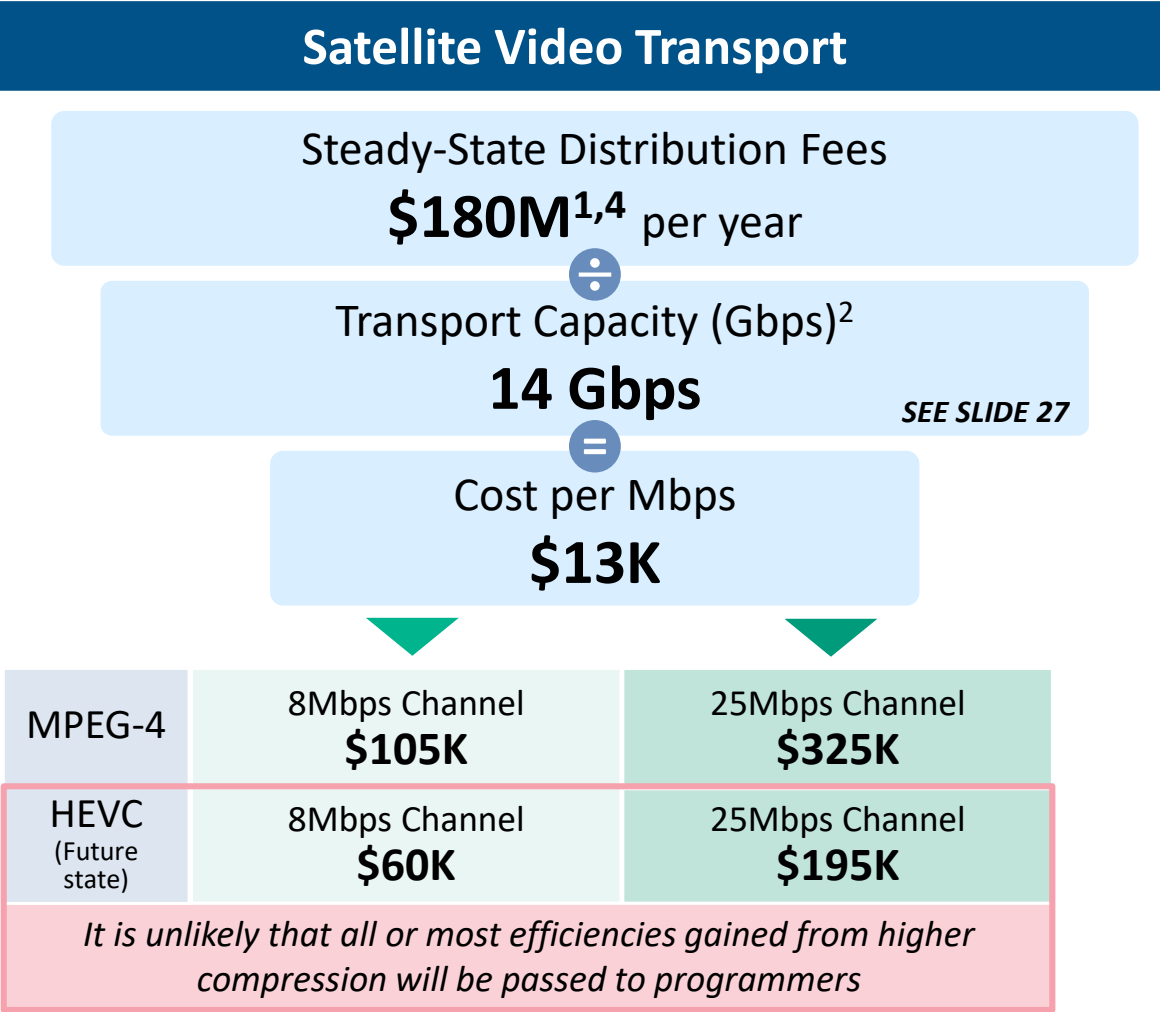
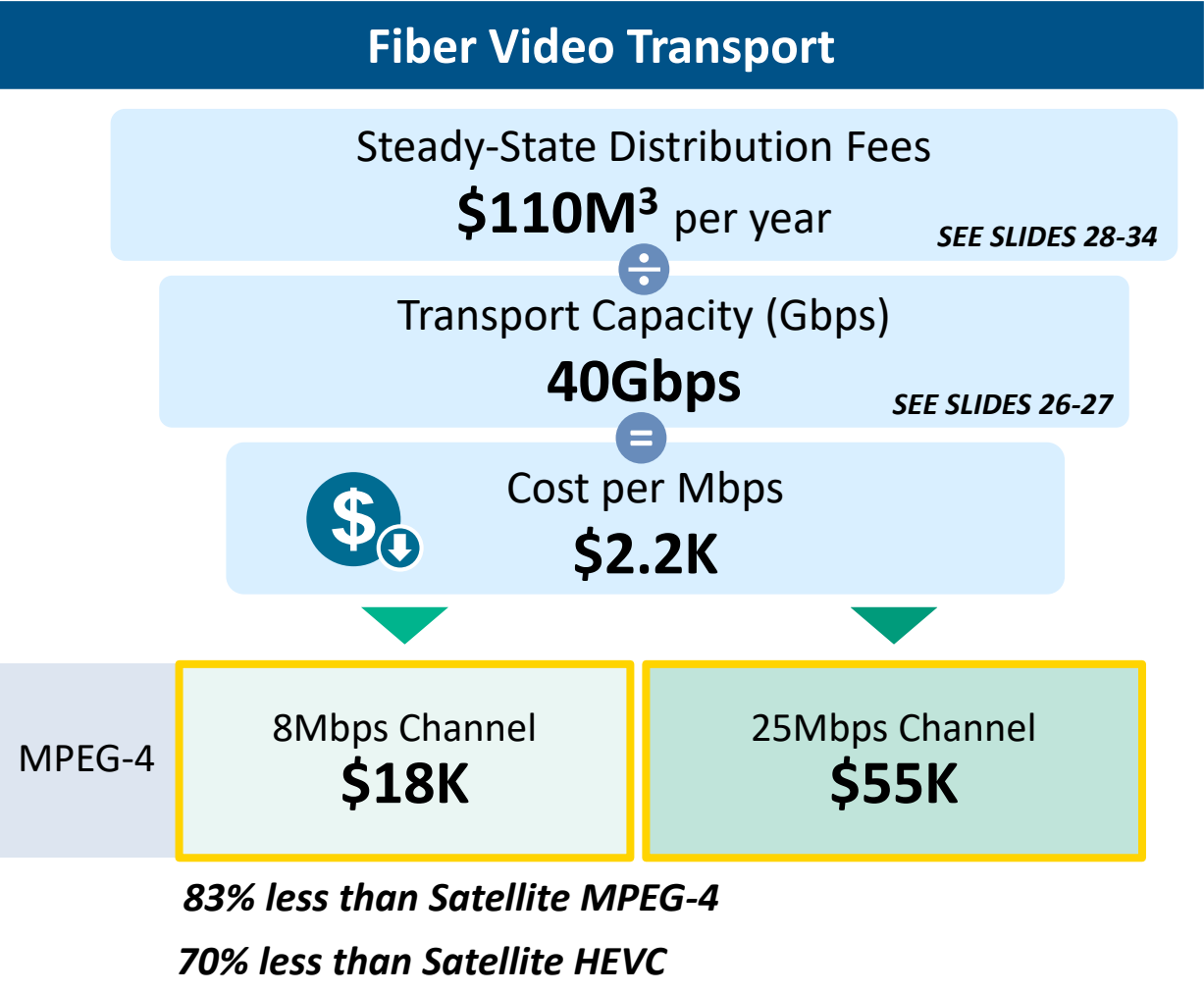


Programmers will be reimbursed for capital and 5-year operating expenses to pay these providers

1. These managed video transport providers could provide programmers with both metro fiber connectivity and a managed video transport service, offering an end-to-end solution
Note: Inclusive but not an exhaustive list of companies
Note: Use of logos does not imply support of the 5G Plus Plan
Sources: Cartesian, Communication Provider websites
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Future State Comparison: Fiber vs. Satellite Cost per Channel

Fiber delivery per channel is estimated at **70% to 83%** less than satellite delivery cost, at its steady state



1. Estimated by assuming a 25% decline in revenue due to removal of 25% of SD feeds over the next 5 years
2. Estimated assuming 25% of MVPD programming transponders use DVB-S Parameters (40MB cap) and 75% use DVB-S2 Parameters (80MB cap)
3. Data Center Costs, Equipment Maintenance, Wavelength Leases, Network Operations Team
4. Transponder Licenses, Equipment Maintenance, Transmission Fees, Personnel
Source: Cartesian, ACA Connects, [Intelsat](#)
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Protecting U.S. Taxpayers

There should be a minimum guarantee payment to the U.S. Treasury from the proceeds of the 5G auction, as well as a ceiling preventing a windfall to incumbents



- 1 Floor (\$x billion) for payments to U.S. Treasury**
- 2 Ceiling (\$y billion) on incentive payments to incumbents**
- 3 Auction fails if proceeds are not enough to cover Treasury minimum, 130% of estimated costs to MVPDs, programmers and satellite industry, and reserve amount for incumbents**

Clearing Timeline: Summary

Industry stakeholders are able to begin planning and executing service contracts in the period between an FCC decision and the completion of an auction (at least 1 year)

Spectrum Clearing Phase	ACA 5G Plus Clearing Timeline					
	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Planning/Negotiation Period Programmers, MVPDs, service providers negotiate contracts while the auction structure is set up						
Some Urban Markets For some urban markets, it can take just 18 months						
Majority of Remaining Markets For the majority of the urban and suburban markets, needed fiber builds can take up to 3 years						
Remaining Markets For hard-to-build markets, it can take up to 5 years						
						SEE SLIDE 36, 38

Year 0 Activities:



Planning & Contracts

- MVTPs establish network connectivity
- Programmers and MVPDs work with fiber providers to renew and establish contracts to connect to data centers

SEE SLIDE 37

Transition Facilitator Responsibilities

In the past, the Commission has designated an entity to serve as a Transition Facilitator overseeing the clearing of spectrum and reimbursement process

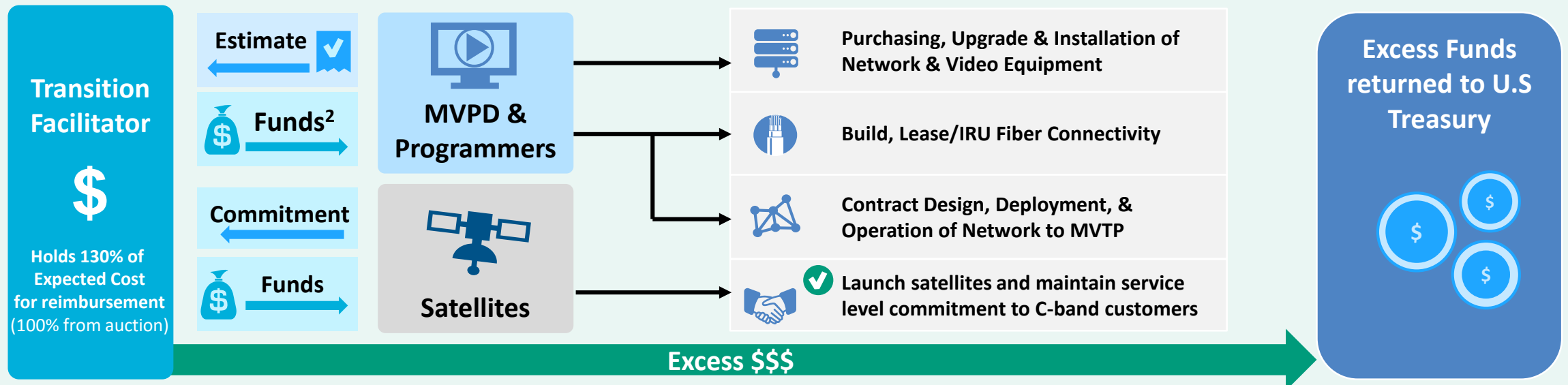
Primary Roles

- Collect and Disburse Reimbursement and Incentive Funds
- Provide Approval for 5G Use of C-band in Individual Markets
- Provide Assistance to Stakeholders During Transition Process
- Monitor whether the Satellite Industry Meets its Commitments to Serve C-band Users During and After transition

Responsibilities left to Parties

- Select own vendors, equipment, and software, as needed
- Take steps to transition within timeframe

Reimbursement Model for MVPD Stakeholders and Satellite Industry¹



1. Not depicted is role of transition facilitator to also reimburse other parties

2. Funds to be administered to MVPDs and Programmers once estimates are delivered to transition facilitator; estimates to be trued up later date

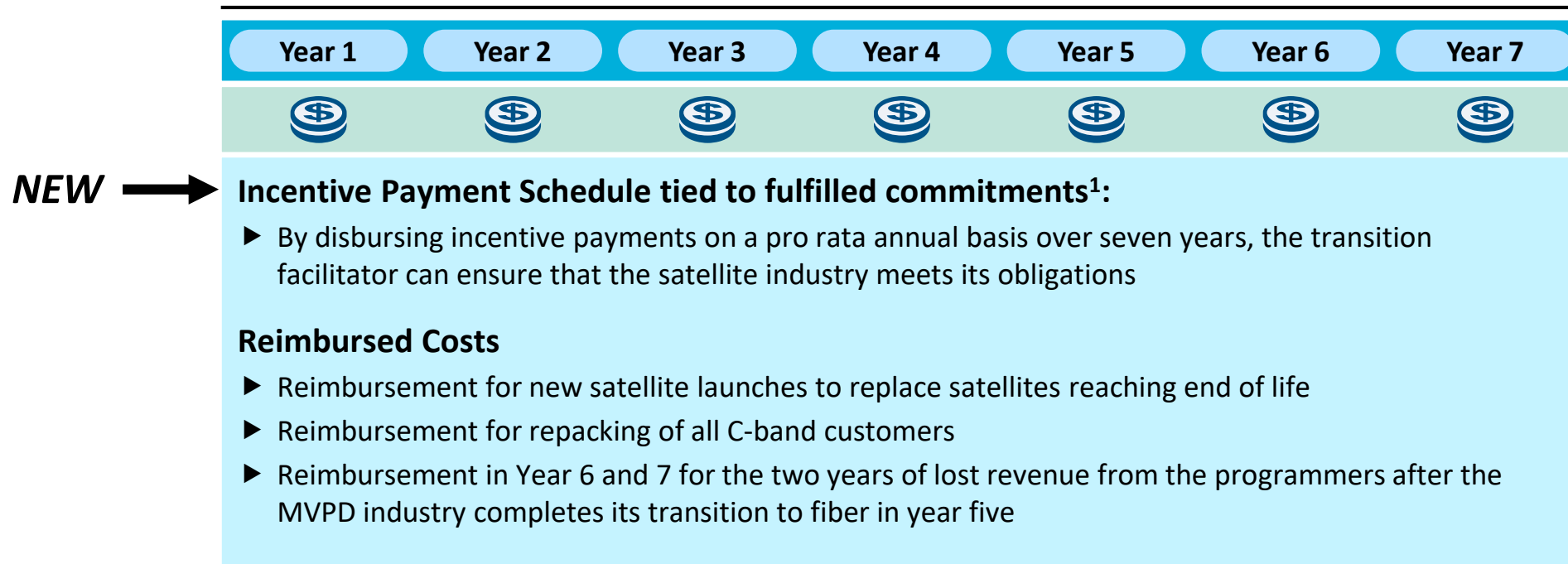
Source: Cartesian, ACA Connects, FCC Docket 18-122

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Measures to Safeguard C-band Users

The satellite industry will receive both incentive payments and cost reimbursements. To guarantee that satellite operators continue providing superior service to C-band users during and after the transition, incentive payments will be made on a pro rata annual basis over seven years

Satellite Industry – Incentives & Reimbursements



1. ACA Connects C-band Spectrum Clearing Plan, July 8th 2019, slide 13:
"Continue serving non-MVPD earth station operators over the remaining spectrum without price increases for extended period of time"

Appendix

Video Transport Network – Reliability

Based on probability theory, 99.999% or greater reliability can be achieved by 2 independent fiber links; geographic fiber link diversity does satisfy the independency requirement

 >= Targeted 5 nines reliability

	Annual Cuts on Each Fiber Link	Uptime Reliability	
		Single-Path Architecture	Dual-Path Architecture
Mean Time to Repair (“MTTR”) 4 hours	1 (Rural)	3 nines 99.95%	6 nines 99.9999%
	3 (Urban)	2 nines 99.86%	5 nines 99.9998%
MTTR 8 hours	1 (Rural)	3 nines 99.91%	6 nines 99.9999% ¹
	3 (Urban)	2 nines 99.73%	5 nines 99.9993%

Calculation Assumptions





- Cuts per year on each fiber link varied between 1 and 3
 - 3 fiber outages per year per 1,000 miles in rural areas and 13 in urban areas**, based on FCC reported historical average requirements ¹
 - Between any 2 data centers of the 42 proposed the **maximum distance is about 390 miles** (between Flextentia in Salt Lake City and Billings – Central in Montana) and **average distance is about 190 miles**
- The MTTR varies between 4 and 8 hours, the typical SLA for a fiber cut
- Redundant fiber paths are **fully geographically diverse** and not affected by the same fault

Calculation Formula

- Annual Urban Cuts on Each Link = $\frac{13}{1000} \times 190 \text{ (max. 390)} = 2.47 \text{ (max. 5.07)}$
- Annual Rural Cuts on Each Link = $\frac{3}{1000} \times 190 \text{ (max. 390)} = 0.57 \text{ (max. 1.17)}$
- Percentage Downtime = $\frac{\text{Cuts per year} \times \text{MTTR}}{100}$
- Percentage Uptime Single Path = $1 - \% \text{ Downtime}$
- Percentage Uptime Dual Path = $1 - (\% \text{ Downtime})^2$

C-band Reliability

Based on self reported information, the satellite industry is currently providing between three and four '9s' of reliability

Typical Transponder or Network Fleet Availability	 INTELSAT	99.997% ¹	<h3>Examples of C-band Satellite Issues</h3> <p>Satellites are at risk from technical issues, the following examples resulted in adverse effects to C-band service over the past 8 years:</p> <ul style="list-style-type: none">• SES AMC-9 experienced an undetermined anomaly on 6/17/17, resulting in full retirement⁵ and 1-day service downtime⁶• SES NSS-806 suffered a power anomaly in 2017, resulting in 14 out of 34 C-band transponders being permanently turned off ⁵• Telesat Anik F2 suffered an anomaly on 2/10/16, resulting in 1 day blackout ⁷ along with another on 6/10/11 ⁸• Intelsat 33e experienced thruster malfunction in 9/1/16, resulting in a 3-month delay in reaching orbit ¹• Intelsat 19 damaged its south solar array during launch on 6/1/12, resulting in reduced operational capacity ¹• Intelsat 28 experienced an anomaly in deploying its west antenna in 4/1/11, resulting in full C-band failure ¹
	 SES [▲]	99.999% ²	
Typical Service Availability	Industry Benchmark	99.97% ⁴	
	 INTELSAT <i>Quoted C-band service availability per year based on Link Analysis</i>	99.96% ³	
	 SES [▲] <i>Based on Integrated GEO-MEO O3b service targeted at Enterprises</i>	99.991% ⁴	
<h3>Signal Jamming Risk</h3> <p>“The threat of satellite signal jamming has increased dramatically... Rogue actors can easily determine with precision which frequencies to jam or monitor in an effort to disrupt active satellite control.” - <i>Eutelsat 2019</i> ⁹</p>			

Improving end-to-end satellite C-band service availability is expensive and requires the use of back-up satellites and/or reserved transponder on capacity on existing satellites

¹ Intelsat Annual Report 2018. ² SES Annual Report 2008. ³ Intelsat website: Link Analysis. ⁴ SES Annual Report 2016. ⁵ SES Annual Report 2017. ⁶ SES 6/27/2017 Press Release. ⁷ Telesat 10/3/16 Press Release. ⁸ Telesat 10/6/11 Press Release. ⁹ Eutelsat Mitigation of Orbital Debris comments to the FCC. Source: Eutelsat, Intelsat, SES, Telesat
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Programmer Connectivity

Programmers can select their preferred metro fiber services provider to connect their origination/uplink sites to nearby data centers and handoff their content to a managed video transport provider (MVTP)

Programmer Uplink Site to Data Center Connectivity

Uplink Site



Example Uplink Site Equipment/Software



User Interface for Programmable Access



Encoding

Enterprise CPE

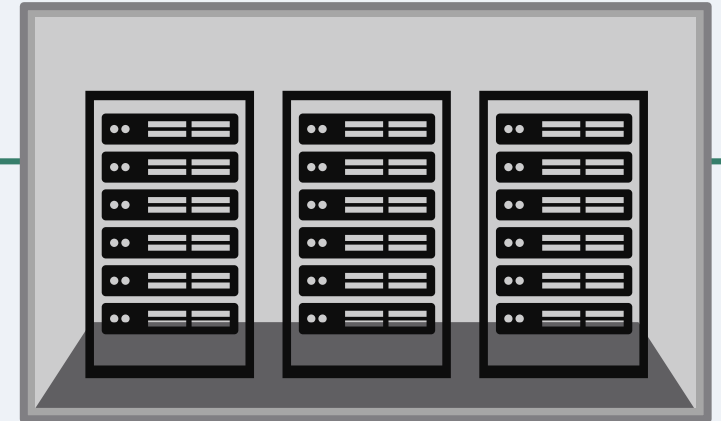


Encryption

Uplink Site to Data Center Connectivity:

- Redundant 10G wavelengths
- Diverse routes; at least 200 feet, entering data center from east & west
- Multiple provider options

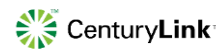
Data Centers



Programmer Determines How to Obtain Connectivity:

- Programmers will be reimbursed to obtain connectivity from their uplink sites to handoff points
- Programmers will have funds to choose connectivity vendor, level of redundancy, and data center endpoints
- Labor costs for equipment installation and testing included

Example Fiber Connectivity Providers:



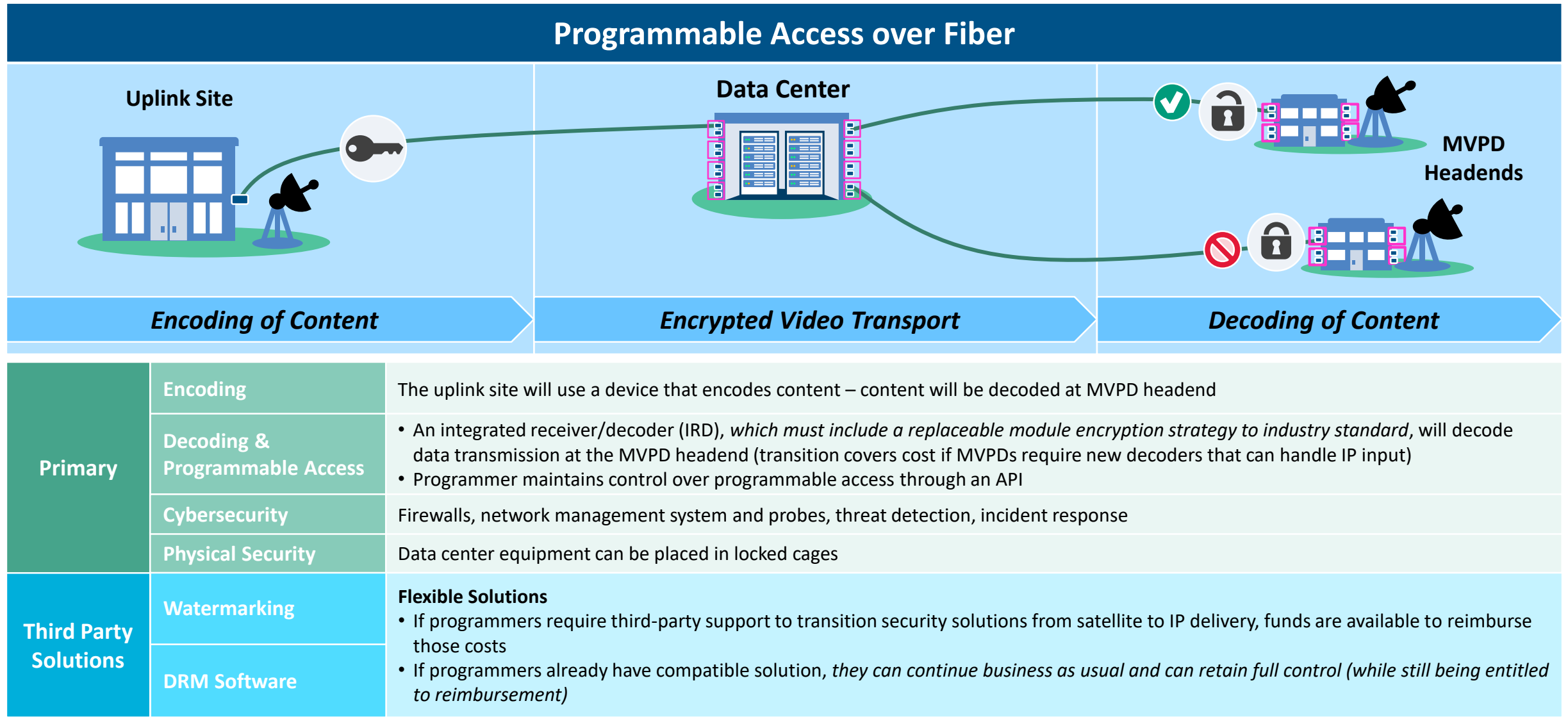
Managed Video Transport Provider Responsibility:

- The provider will have an incentive to establish a presence in 42 data centers across the country to which programming will be distributed

See Next Slide for Data Center Details

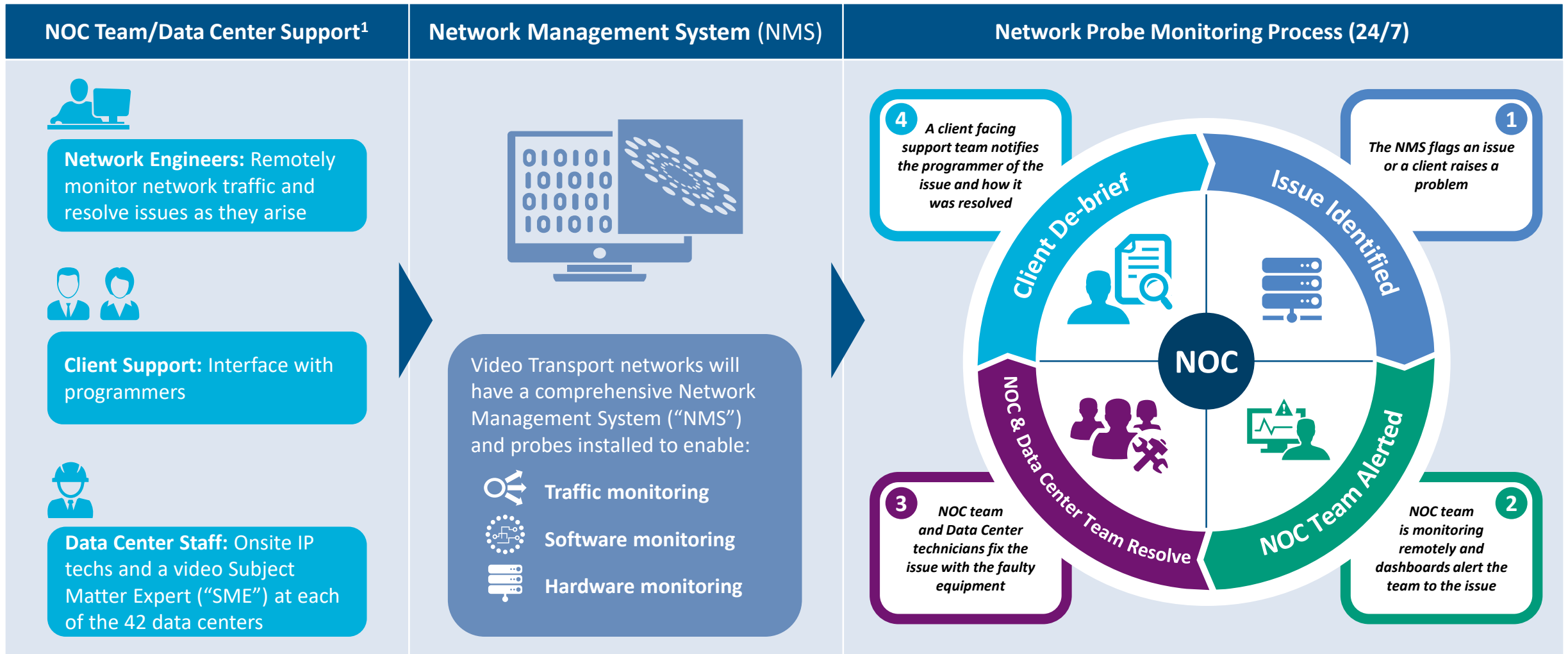
Video Delivery System – Security & Programmable Access

Programmers can be medium-agnostic and use the same encoding over fiber as they use today over satellite



Video Transport Network – Network Monitoring & Operations Center

A Network Operations Center within each managed video transport provider will be responsible for 24/7 operations of this new private network

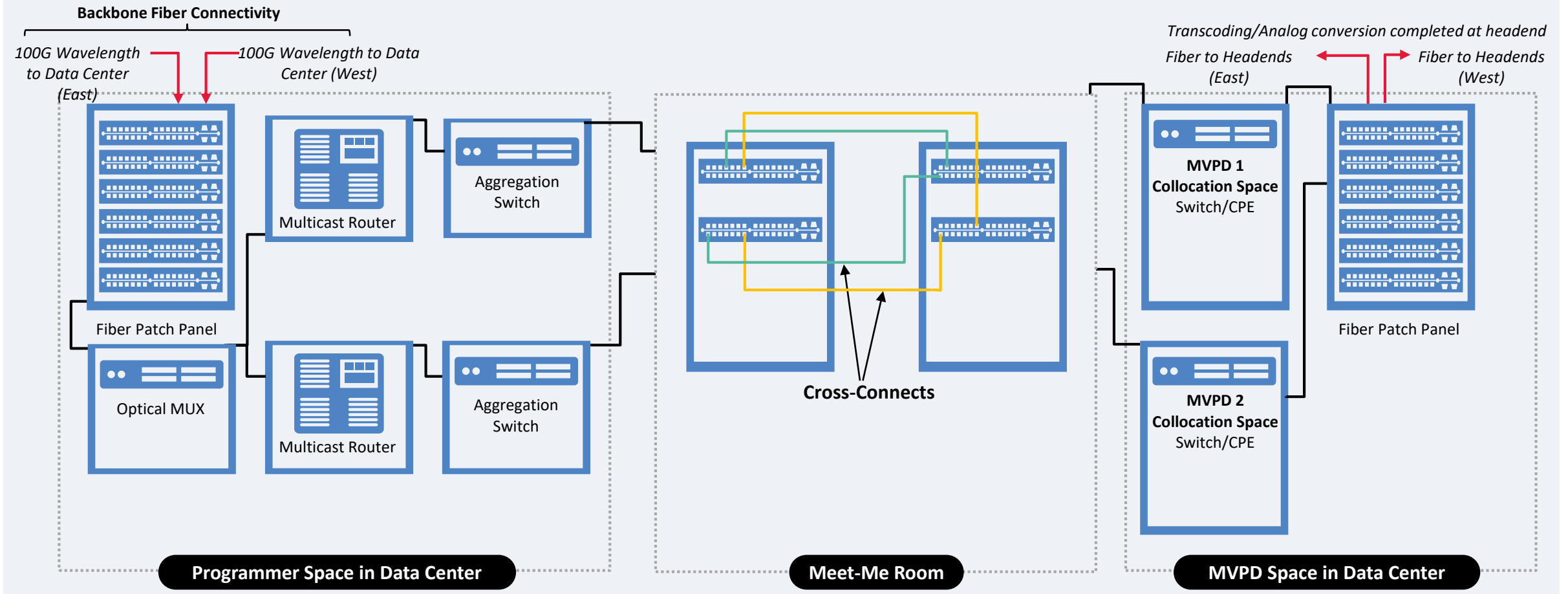


1. Team size determined by revenue for each MVTP and scaled to ensure average revenue per employee is in line with enterprise business units of fiber connectivity and managed service providers
Source: Cartesian, ACA Connects
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Video Transport Network – Managed Video Transport Service & MVPD Handoff

MVTPs will deploy redundant optical and routing/switching equipment across the 42 data centers and cross-connect with MVPDs to deliver the programming content

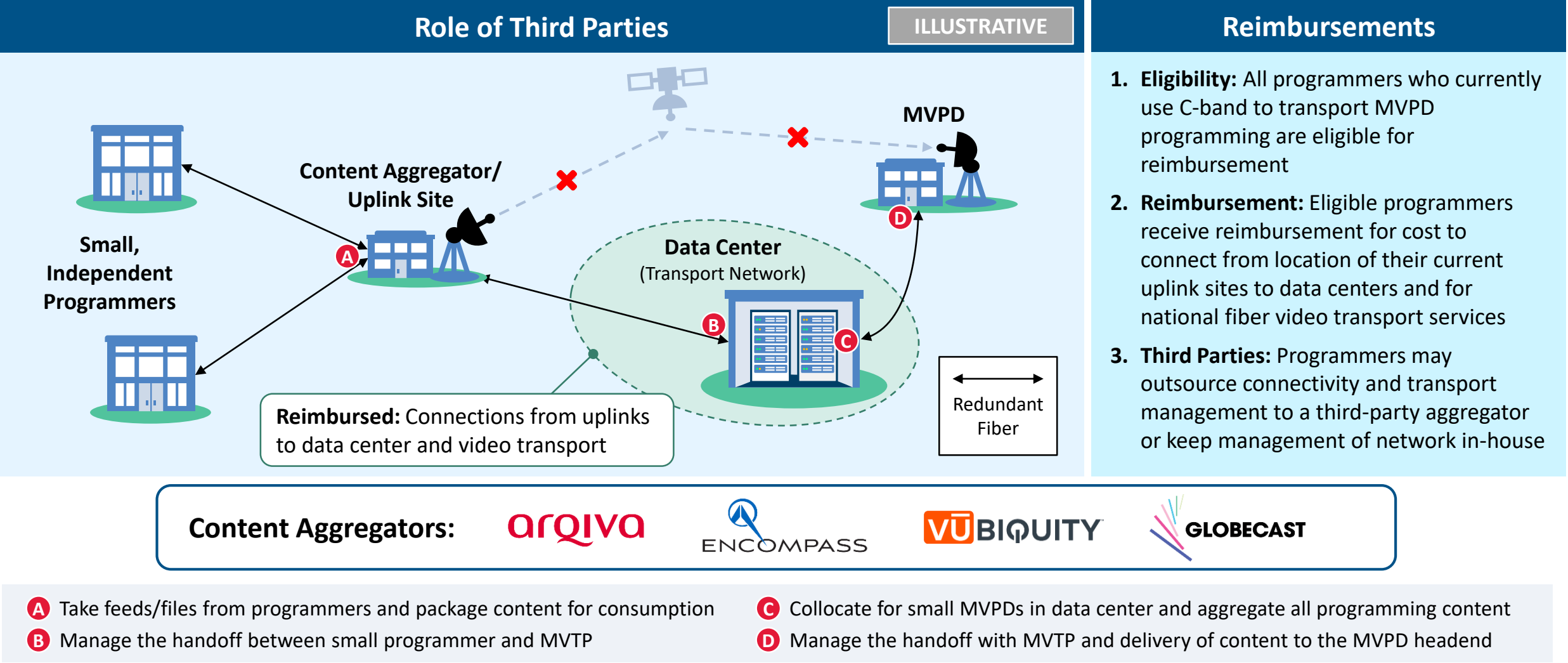
Illustrative Managed Video Transport Service & MVPD Hand-off Scenario



NOTE: Programmers and MVPDs may be located in different Data centers

Independent Programmers

Small, independent programmers using the C-band for MVPD programming who do not own their own uplink sites may use their reimbursement to obtain connectivity from a content aggregator offering a turn-key solution



Updated Bandwidth Assumptions

A 40G fiber core is sufficient for all current & near-future needs

Bandwidth Estimates				
Future State	UHD Channels	X	Bandwidth/Channel	=
	200		35 Mbps	
				=
	Bandwidth			
Future State	HD Channels	X	Bandwidth/Channel	=
	500		25 Mbps	
				=
	Bandwidth			
Future State	SD Channels	X	Bandwidth/Channel	=
	1,200		10 Mbps	
				=
	Bandwidth			
Future State	Blackout Channels	X	Bandwidth/Channel	=
	100		25 Mbps	
				=
	Bandwidth			
Future State	VOD Channels	X	Bandwidth/Channel	=
	100		25 Mbps	
				=
	Bandwidth			
Current State	UHD Channels	X	Bandwidth/Channel	=
	0		35 Mbps	
				=
	Bandwidth			
Current State	HD Channels	X	Bandwidth/Channel	=
	500		25 Mbps	
				=
	Bandwidth			
Current State	SD Channels	X	Bandwidth/Channel	=
	1,200		10 Mbps	
				=
	Bandwidth			
Current State	Blackout Channels	X	Bandwidth/Channel	=
	100		25 Mbps	
				=
	Bandwidth			
Current State	VOD Channels	X	Bandwidth/Channel	=
	100		25 Mbps	
				=
	Bandwidth			

Total
Bandwidth

36.5 Gbps

Total
Bandwidth

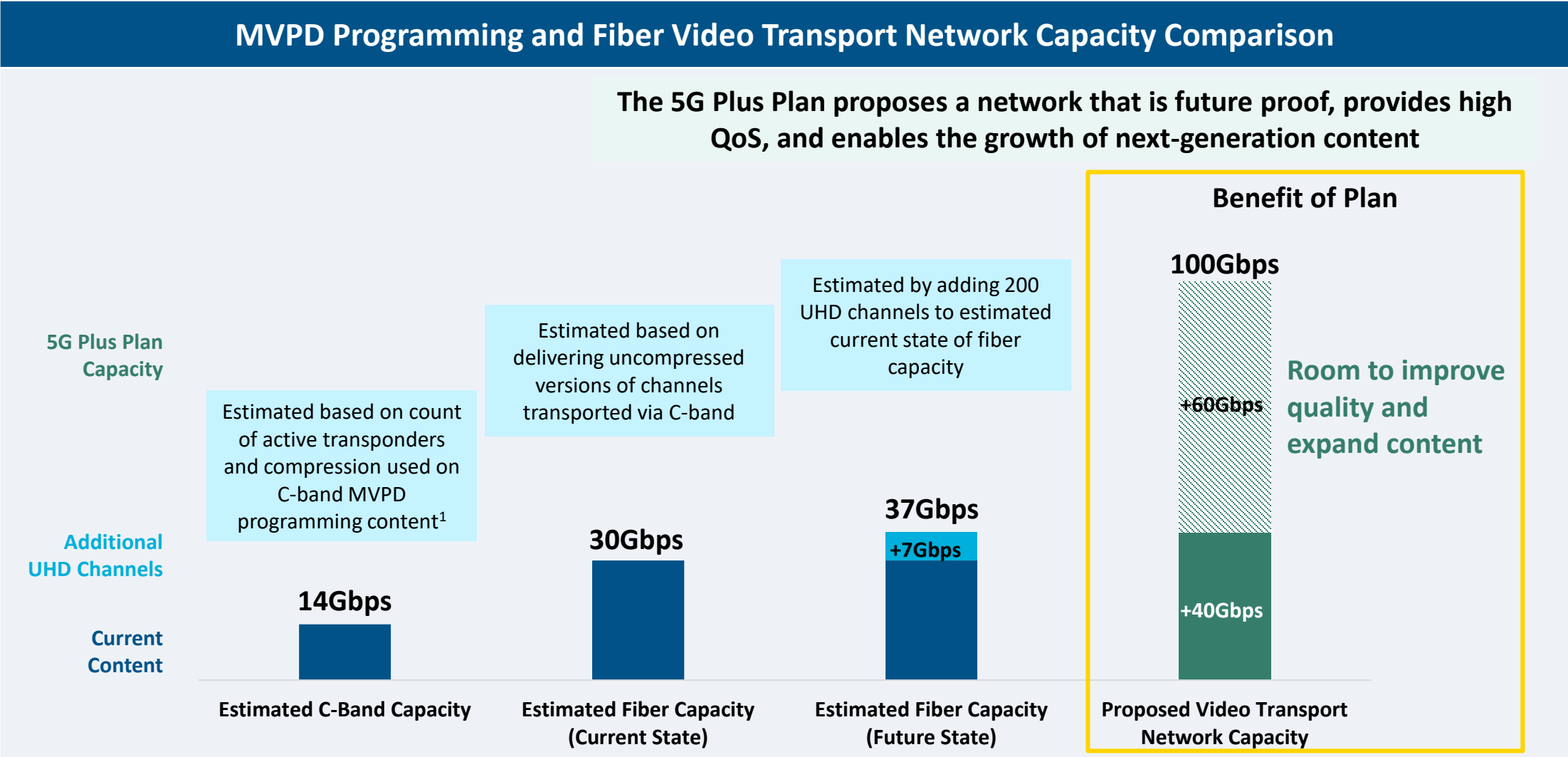
29.5
Gbps

Comments and Implications

- › **100G Backbone Link:** Reimbursable cost accounts for each MVTP to provide redundant 100G links to ensure the network:
 1. Has capacity to transport future high-quality content (i.e., 200 UHD Channels)
 2. Can accommodate bandwidth of numerous blackout channels
 3. Can transport the highest-quality, uncompressed streams provided by programmers
- › **MVPD Handoff:** Not all MVPDs will offer the entirety of available content and are expected to:
 1. Compression content to reduce bandwidth
 2. Buildout or IRU fiber to connect to data center endpoints
- › **Blackout Channels:** Estimate includes only local blackout channels to account for reusable bandwidth between markets

Future-proof Capacity

A 100G fiber network core capacity makes the fiber networks entirely future-proof










1. Estimated by assuming 25% of MVPD programming transponders use DVB-S Parameters (40Mbps capacity) and 75% use DVB-S2 Parameters (80Mbps capacity)
Source: Cartesian, MVPD Operator and Programmer Interviews, Lyngsat
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Increase in Reimbursable Cost to Programming Industry

By incorporating programmers' requirements on reliability and solution feature requirements, we have refined and increased programmers' reimbursable costs to be approximately \$1B

Total 5-Year Reimbursement to Programming Industry of 5G Plus Plan (4 Service Providers)

Type	Item	Total Cost
CAPEX	 Equipment (Initial Investment & Replacement)	\$305M
	 Network Operations Center (NOC)	\$40M
OPEX	 Security and Programmable Access	\$100M
	 Hardware Maintenance	\$120M
	 Increase in Backbone Capacity	\$38M
	 Network Operations Centers Staffing	\$190M
MARGIN	 Solution Provider Margin	\$160M
Total Increase in 5-Year Reimbursement to Programming Industry		\$1B About 8% above original total estimate


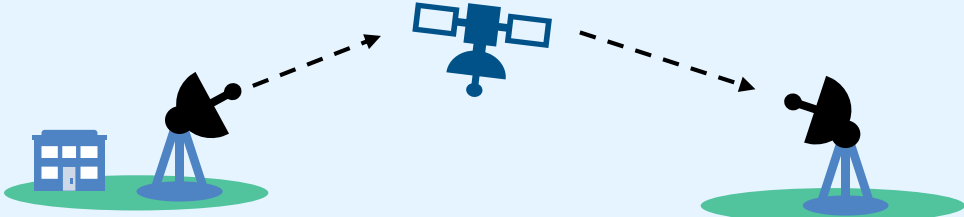
Video Transport Network – 5-Year Cost Estimate

The required amount for 4 providers to build out and operate over 5 years an end-to-end fully managed video distribution service is approximately \$1B

Requirement	Description	Expenditure	
		Capital	5 Year Opex
Hardware Costs	<ul style="list-style-type: none"> Equipment required to make 42 data centers and 80 uplink centers operational <ul style="list-style-type: none"> Full redundancy accounted for in all equipment housed at data centers and uplink stations and wavelength connections 	\$185M	N/A
IRD and Encoders	<ul style="list-style-type: none"> Paying to transition encoders at the uplink sites and IRDs at the MVPD/head-ends <ul style="list-style-type: none"> Allocating funds to replace components that aren't IP compatible 	\$100M	N/A
Maintenance Expenditure	<ul style="list-style-type: none"> Maintenance operating expenditure is estimated at 15% of capital expenditure per year <ul style="list-style-type: none"> Industry averages of 15% were used to estimate operational expenditure 	N/A	\$120M
Replacement Expenditure	<ul style="list-style-type: none"> Replacement capital expenditure was included in the 5 year reimbursement period <ul style="list-style-type: none"> Industry averages of 10% were used to estimate replacement capital expenditure 	\$20M	N/A
Wavelength Leases And Collocation	<ul style="list-style-type: none"> Geographically diverse redundant Wavelength leases connecting all data and uplink centers Collocation costs for rented space at each of the data centers 	N/A	\$110M
Security	<ul style="list-style-type: none"> Maintain an end-to-end cybersecurity solution <ul style="list-style-type: none"> Firewalls, Network Management System and probes, threat detection, incident response 	N/A	\$100M
NOC Staffing	<ul style="list-style-type: none"> NOC team <ul style="list-style-type: none"> A team of 340 engineers, technicians and client support providing back end maintenance, problem resolution and support across all four providers 	N/A	\$190M
Solution Margin	<ul style="list-style-type: none"> A managed service margin was applied to annual cost <ul style="list-style-type: none"> Industry average of 30% for managed services operating units 	\$20M	\$140M
Total Reimbursable 5-Year Cost to Programmers		\$325M	\$655M

Future State Comparison: Fiber vs. Satellite Costs; You Pay Less to Get More

In a steady state, programmers should expect savings of 40% by transitioning video delivery from satellite to fiber

Fiber Transport	Satellite Transport
	
Fiber Video Distribution Costs <ul style="list-style-type: none">• Data Center Costs• Equipment Maintenance• Wavelength Leases• Network Operations Team	Satellite Video Distribution Costs <ul style="list-style-type: none">• Transponder Licenses• Equipment Maintenance• Transmission Fees• Personnel
Annual Steady-State Video Transport Cost \$110M/Year	Annual Steady-State Video Transport Cost \$180M/Year¹

After Year 6, programmers could save about \$70M annually on video transport costs

1. Estimated by assuming a 25% decline in revenue due to removal of 25% of SD feeds over the next 5 years
Note: Steady-State Fiber Video Delivery Cost calculation is derived from years 2 – 5 excluding Capital expenditure required in year 1
Source: Cartesian, ACA Connects
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Video Transport Network – Steady State

Following year 1 capital expenditure, average operating expenditure for four video transport providers and origination connection is \$110M per year

Operational Expense	Description	Video Transport Provider	Origination Site
Uplink Station Wavelength Cost	<ul style="list-style-type: none"> • 80 Uplink Stations <ul style="list-style-type: none"> › Annual cost for 10G fully redundant wavelengths connecting 80 uplink stations 	N/A	\$10M
Data Center Wavelength Cost	<ul style="list-style-type: none"> • 42 Data Centers <ul style="list-style-type: none"> › Annual cost for 100G fully redundant wavelengths connecting 42 data centers 	\$13M	N/A
Hardware Maintenance	<ul style="list-style-type: none"> • Average annual charge for 15% of total CapEx • Average annual charge for 10% replacement CapEx Year 5 	\$30M	N/A
Collocation costs, Rackspace, Cross-connects	<ul style="list-style-type: none"> • Average rental charge per year within data centers 	\$7M	N/A
Staff	<ul style="list-style-type: none"> • Engineers (130) • Client Support (43) • Data Center Techs (168) 	\$50M	N/A
Cost	Average Annual Operating Expenditure for Programmers: \$110M		

Note: Margin for service provider is included in each line item

Source: Cartesian, ACA Connects

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Requirements – Capex for One Service Provider

The cost model includes upfront capex on equipment and hardware required to set up a video transport network for one MVTP – redundant equipment is included in the total cost incurred by MVTP

Requirement	Description	Unit Cost	Total Cost
Optical Multiplexors	▶ One multiplexor for primary and redundant links across all 42 data centers	\$200K	\$16.8M
Multicast Routers	▶ One router for primary and redundant links across all 42 data centers	\$100K	\$8.4M
Short Range SFPs	▶ Two SFPs for 1) primary and redundant links across all 42 data centers, and 2) cross-connect with 2.5K MVPD cable systems	\$4K	\$10.3M
Aggregation Switches	▶ Two 40-port aggregation Layer 2/3 switches for each primary and redundant link across all 42 data centers – assumed service providers will scale aggregation switches based on the number of clients per site	\$10K	\$672K
Network Probes	<ul style="list-style-type: none"> ▶ Full monitoring equipment at 10% of sites, sample monitoring at remainder of sites and all endpoints ▶ Cybersecurity monitoring spanning full video transport network 	\$N/A	\$8M
NOC Buildout	▶ Upfront cost of building and deploying software for a network operations team to monitor the network 24/7	\$N/A	\$2M
TOTAL ESTIMATED CAPEX FOR ONE PROVIDER			\$46M

Requirements – Capex for Equipment Managed by Programmers

The cost model includes a significant amount of upfront capex on equipment and hardware enabling programmers to update all equipment they currently manage

Requirement	Description	Unit Cost	Total Cost
Encoders	<ul style="list-style-type: none">▶ Replacement encoders for non-IP compatible encoders▶ Allocated cost for five encoders per programmer	\$10K	\$30M
Network Interface Device	<ul style="list-style-type: none">▶ Enterprise-grade CPE/Ethernet switch with SFP slots, and encryption devices for each link at 80 uplink sites	\$100K	\$16M
Integrated Received/Decoder (IRD)	<ul style="list-style-type: none">▶ Integrated Received/Decoder for each primary and redundant links – must include a replaceable module encryption strategy to industry standard	\$1K	\$80M
TOTAL ESTIMATED CAPEX FOR EQUIPMENT MANAGED BY PROGRAMMERS			\$126M

Requirements – Opex for Four Service Providers

Average steady state operating expenditure for four video transport providers is \$110M per year and excludes services not currently provided by satellite providers today

Requirement	Description	Total Cost
Uplink Station Wavelength Cost	<ul style="list-style-type: none"> ▶ 80 Uplink Stations <ul style="list-style-type: none"> › Annual cost for 10G fully redundant wavelengths connecting 80 uplink stations 	\$8M
Colocation costs, Rackspace, Cross-connects	<ul style="list-style-type: none"> ▶ Average rental charge per year within data centers 	\$7M
Hardware Maintenance	<ul style="list-style-type: none"> ▶ Operation Expenditure estimated at 15% of initial Capex Spend 	\$30M
Data Center Wavelength Cost	<ul style="list-style-type: none"> ▶ 42 Data Centers <ul style="list-style-type: none"> › Annual cost for 100G fully redundant wavelengths connecting 42 uplink stations 	\$13M
Staffing	<ul style="list-style-type: none"> ▶ 340 Staff salaries (All four) <ul style="list-style-type: none"> › Staff is comprised of engineers, client support, and data center technicians 	\$50M
AVERAGE ANNUAL OPEX FOR CORE TRANSPORT SERVICES (COMPARABLE TO SATELLITE)		\$110M
Cybersecurity	<ul style="list-style-type: none"> ▶ Enables the secure transmission of content via fiber and control over programmable access through an Application Programming Interface 	\$25M
IRD Maintenance	<ul style="list-style-type: none"> ▶ Estimated replacement and maintenance on IRD 	\$10M
AVERAGE ANNUAL OPEX FOR SERVICES NOT INCLUDED IN SATELLITE TRANSPORT COST		\$35M

Data Center Locations

To minimize the distance to all MVPD headends, the network will connect to data centers in these 42 cities.

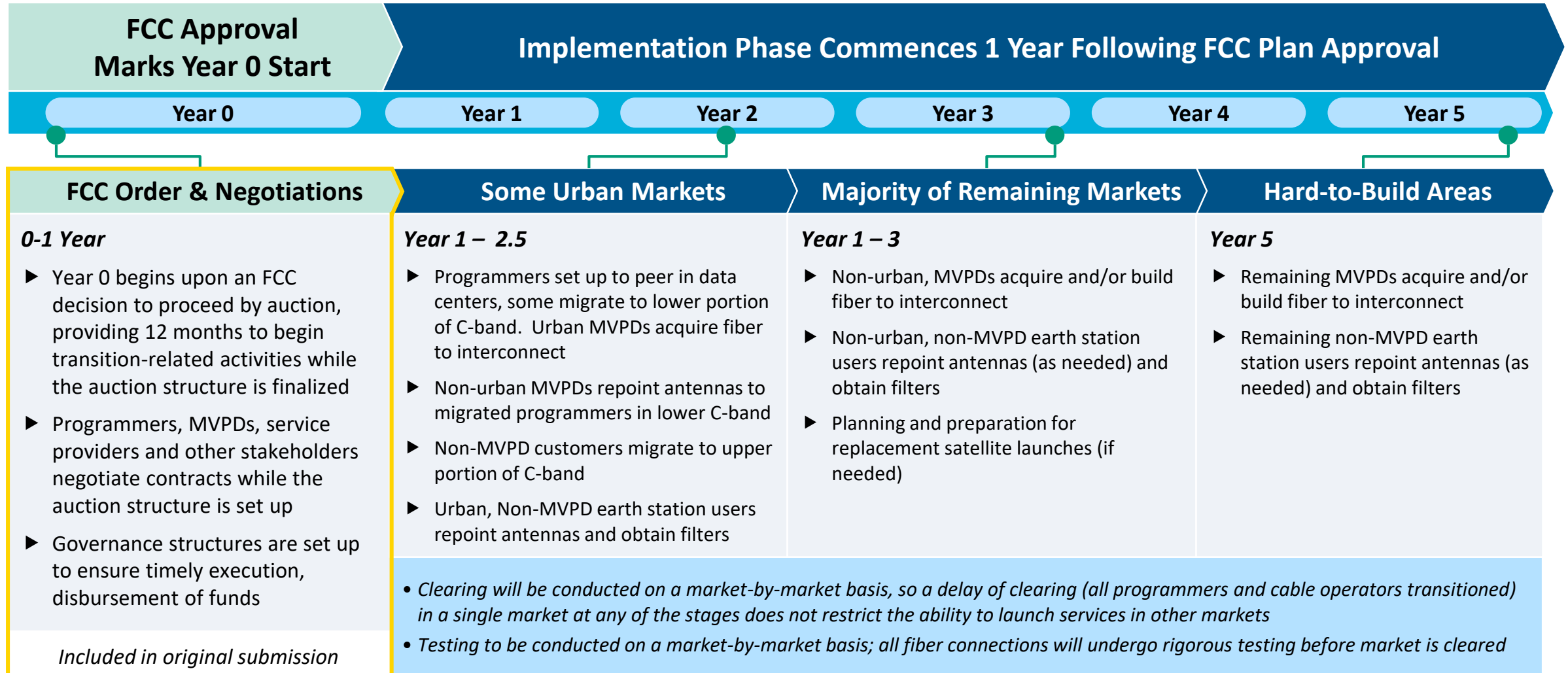
Count	City	State
1	Charlotte	NC
2	Houston	TX
3	Fairview	OR
4	Pittsburgh	PA
5	Manassas	VA
6	San Antonio	TX
7	College Park	GA
8	Cleveland	OH
9	Philadelphia	PA
10	Minnetonka	MN
11	Englewood	CO
12	Independence	MO
13	Saint Louis	MO
14	Troy	MI

Count	City	State
15	Florence	KY
16	Oak Forest	IL
17	San Francisco	CA
18	Bellevue	WA
19	Dallas	TX
20	Boston	MA
21	Orlando	FL
22	Sioux Falls	SD
23	Liberty Lake	WA
24	Albuquerque	NM
25	Oklahoma City	OK
26	Nashville	TN
27	Wilkes Barre	PA
28	Tampa	FL

Count	City	State
29	New York	NY
30	Gilbert	AZ
31	Fort Lauderdale	FL
32	Chatsworth	CA
33	Annapolis	MD
34	Boise	ID
35	New Orleans	LA
36	Memphis	TN
37	El Paso	TX
38	Salt Lake City	UT
39	Des Moines	IA
40	Las Vegas	NV
41	Billings	MT
42	Bemidji	MN

Timeline Targets

Industry stakeholders will be able to begin planning and executing service contracts in the period (at least 1 year) between an FCC decision and the completion of spectrum auctions



Year 0 Activities

Yr. 0: FCC Approval & Negotiations

Some Urban Markets

Majority of Remaining Markets

Hard-to-Build Areas

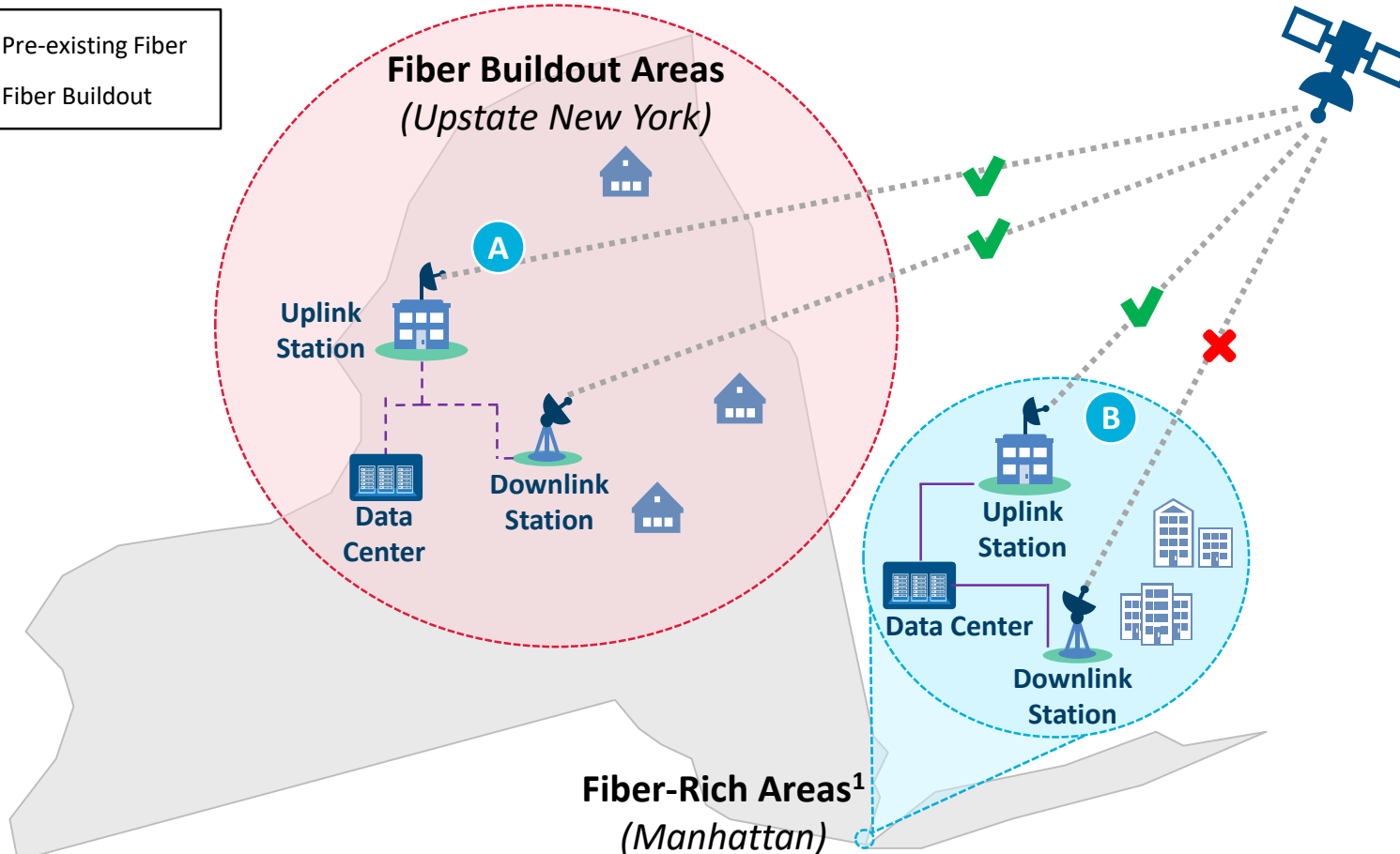
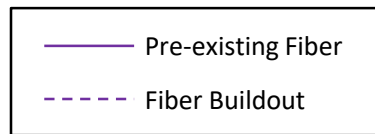
Activity	Description
Planning	<p>Uplink Site Connectivity: Programmers will work with fiber providers to increase connectivity and reliability to the video transport network</p> <p>MVPD – Data Center Connectivity: MVPDs will plan to establish fiber connectivity from MVPD headends to one of the 42 data centers that will serve as a video delivery endpoint</p> <p>Network Design: Service providers will begin designing the video transport network solution to programmer specifications (e.g., redundant, geographically diverse) and develop a workplan</p>
Contracts	<p>Technical Specifications: Programmers will work with multiple service providers to define the requirements (e.g., SLAs, content security) of the video transport network</p> <p>MVPD Contracts: Programmers will work with MVPDs to update the delivery end points as the 42 data centers on the video transport network and develop a plan to quick transition once the auction occurs</p>
Upper Band Repacking	<p>Transponder Identification: Programmers will work with satellite operators to identify the transponders that will need be repacked within the lower 370 MHz of the C-band</p> <p>Launch Preparation: Satellite operators can prepare to launch additional satellites to meet future capacity demands if necessary</p>

Market Transitioning

Satellites will remain operational for at least 5 years to ensure that service can be provided to “hard-to-reach” markets throughout the transition period

Example PEA

ILLUSTRATIVE



A Fiber Buildout Areas (e.g., Upstate NY Counties)

- Uplinks and satellites continue to transmit for 5 years
- Downlinks remain operational where the FCC finds that fiber deployment has not yet met requirements

B Fiber-Rich Counties (e.g., New York County)

- Uplinks and satellites continue to transmit for 5 years
- Downlinks decommissioned to enable refarming of spectrum for 5G services

¹. Circle is intended to represent Manhattan and has been enlarged for visual purposes
Source: Cartesian, ACA Connects, FCC Docket 18-122
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BOSTON

KANSAS CITY

LONDON

NEW YORK

PARIS