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November 19, 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 November 15, Ross Lieberman of ACA Connects—America's Communications Association ("ACA Connects"); Ken Johnson and Jarrod Head of Sparklight; Mike Ott of MCTV; John Joslin of DAWNCo; Nick Jessee, Christopher Fergus and Vincent Merta of Cartesian, outside consultants to ACA Connects; Pantelis Michalopoulos and Georgios Leris of Steptoe & Johnson, outside counsel to ACA Connects; and the undersigned met with the Commission staff listed below from the Wireless Telecommunications Bureau, Office of Engineering and Technology, and Office of Economics and Analytics to discuss the above-captioned proceeding.

During the meeting, participants discussed Attachment A to this letter, a slide presentation that details the glaring deficiencies of the C-Band Alliance's ("CBA's") recently disclosed plan to use video signal compression and other techniques to cram existing C-Band users into a mere 200 MHz portion of the band. As the presentation explains, CBA's latest proposal would leave multichannel video programming distributors ("MVPDs"), especially in rural America, with a C-Band that fails to meet their current and future needs. Furthermore, CBA contemplates a massively complex transition that could not be accomplished within the timeframe or budget that CBA projects. The Commission must therefore reject CBA's proposed transition plan.

The representatives of Sparklight and MCTV, both of which are ACA Connects member companies and MVPD earth station operators in the C-Band, discussed in the detail the adverse impact CBA's proposed transition would have on their business. They explained that CBA's plan would require them to complete a grueling series of tasks, many of which must occur sequentially, and each of which comes with considerable risk of delay. They shared their

judgment that CBA's projected three-year timeline to complete the transition is unrealistic, and that five years is more likely. Additionally, they observed that, at the end of the transition, they would be left with a C-Band that is less reliable, less capable, more prone to interference, and unable to meet future demand for higher-resolution video offerings. They also discussed the substantial costs of completing the transition, which greatly exceed CBA's estimates. In particular, they estimated that the cost to upgrade MVPD earth stations along the lines CBA proposes would be approximately $1.5 million per earth station, resulting in a total cost of more than $3 billion for this aspect of the transition alone.[1]

Mr. Joslin of DAWNco shared his perspective as a provider of C-Band earth station equipment and services. He explained that the 4000-4200 MHz bandpass filters that will be required to implement CBA's latest plan have not been developed or tested, and there is no certainty that these filters will be able to meet the same performance specifications as those of CBA's now-obsolete 3900-4200 MHz filter prototype. Moreover, he stated that distributing programming using higher modulation would require cable operators to replace many of their 3.7-meter satellite dishes with larger ones, and these dishes are yet to be manufactured. He also noted that CBA's proposed multistage transition plan will be cumbersome to implement for the owners of the more than 16,000 C-Band earth stations in operation today, and that CBA's proposed 3-year timeline is unrealistic. He said a less centralized transition in which C-band earth station owners had more flexibility to choose their own equipment and installers would result in a smoother and more efficient process. As part of his presentation, Mr. Joslin distributed to meeting attendees a DAWNCo sales brochure that depicts a variety of C-Band equipment his company offers, attached hereto as Attachment B.

To conclude the meeting, ACA Connects representatives urged the Commission to ensure that, as part of any plan to repurpose a significant amount of C-Band spectrum for 5G use, MVPD earth station operators are given the flexibility – and the funds – to elect fiber-based video solutions that best meet their needs. As explained ACA Connects' prior filing,[2] there are several potential fiber-based video delivery solutions for those MVPDs, including solutions that permit video programmers to maintain use of the C-Band to deliver video. Moreover, the costs for an MVPD to employ such solutions would be comparable to those of the substantial equipment upgrades, labor costs, and other transition activities required under the CBA plan, but the benefits could potentially be much greater.

ACA Connects urges the Commission to seek comment on a transition plan that enables MVPDs to elect fiber-based video solutions that meet their needs. Finally, any transition plan

[1] The upper bound of CBA's cost estimate for the entire transition, including substantial non-MVPD-related costs, is $3.5 billion. *See* Letter From Bill Tolpegin, CBA, to Marlene H. Dortch, Secretary, FCC, GN Docket No. 18-122 at 1 (filed Oct. 28, 2019). ACA Connects posits that $6 billion is more realistic. *See* Letter From Ross Lieberman, ACA Connects, to Marlene H. Dortch, Secretary, FCC, GN Docket No. 18-122 at Attach. p. 7 (filed Nov. 15, 2019) ("ACA Connects Nov. 15 Letter")

[2] *See* ACA Connects Nov. 15 Letter at Attach. p. 9.

the Commission ultimately adopts for MVPDs must put in place a neutral administrator – rather than CBA – to oversee the transition.

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

Sincerely,

Brian Hurley

Cc: Julius Knapp, Office of Engineering and Technology ("OET")
Donald Stockdale, Wireless Telecommunications Bureau ("WTB")
Ken Baker, WTB
Jonathan Campbell, WTB*
Anna Gentry, WTB*
Kevin Graf, OET*
Michael Ha, OET
Paul Lafontaine, Office of Economics and Analytics ("OEA")
Matthew Pearl, WTB*
Paul Powell, WTB*
Becky Schwartz, WTB*
Brian Wondrack, WTB*

**indicates attendance by telephone*

Attachment A

5G Plus Plan: The Case for Fiber-Based Video Distribution

A Focused Risk Analysis of CBA's New Transition Plan

November 15th, 2019

Prepared for: ACA AMERICA'S COMMUNICATIONS ASSOCIATION #ACAConnects

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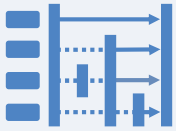
Optimizing C-Band Spectrum Clearing

The 5G Plus Plan remains the best option for clearing the most C-Band spectrum while simultaneously bridging the digital divide with rural communities through fiber buildouts

The CBA's latest proposal[1] leaves MVPDs with C-Band services that are *less reliable*, *less affordable*, *more prone to interference* and *unable to meet future demand*

This is an unacceptable outcome for consumers, particularly those in rural America



The CBA vastly underestimates the cost, complexity, timing, and overall burden of its proposed transition

Latest CBA proposal will cost at least $6 billion and take more than three years

The 5G Plus Plan provides flexibility and modularity – video programmers could remain on the C-Band, while MVPDs employ fiber-based solutions including:

- *Connecting to an existing terrestrial-based video transport provider*
- *Interconnecting headend clusters to super headends*

Costs are comparable to other solutions and well worth the substantial benefits

1. The CBA's alternative plan repacks all existing users into 200 MHz with no fiber alternative

Source: Cartesian, ACA Connects

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The CBA Proposal Will Harm the TV Industry and Its 80M+ Customers

The latest CBA proposal – once again light on details – is a step in the wrong direction and does not provide cable operators, and particularly their rural customers, with a future-proof solution

What Can Cable Operators and Their Customers Expect?

1	**Reduced Access to New and Higher-Resolution TV Services**	Cramming content into a smaller section of spectrum prevents programmers from offering new and higher-bandwidth TV services, such as ultra high-definition (UHD) content
2	**Reduced Reliability of C-Band Transport**	Reliability decreases with limited availability of back-up transponders, to the detriment of end-user customers
3	**Higher Operational Costs**	Reducing C-Band capacity would subject programmers to de facto monopoly pricing on remaining spectrum, which ultimately could be passed on to MVPDs and potentially consumers
4	**Intolerable Risks of Signal Interference**	Relying on new and untested filters to block out 5G signals would introduce risks of interference that threaten video quality
5	**Disproportionate Harms to Rural MVPDs**	Rural MVPDs that lack fiber alternatives will suffer most from the end-state of the CBA transition, placing them at a competitive disadvantage against larger MVPDs with fiber alternatives

Source: Cartesian, ACA Connects

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The New CBA Proposal Is "All Pain, No Gain" for MVPDs

Breezy CBA filings obscure the burdensome and costly nature of their proposal, particularly for small and rural cable operators, and suggest operators will not be reimbursed for significant costs

What Would the Transition Mean?

1 A Grueling Series of Time-Consuming Tasks

The transition will be complicated by many moving parts across the entire video distribution industry, with many considerable risks of delay at each stage

2 Significant Out-of-Pocket Expenses

The CBA grossly underestimates transition costs, particularly for MVPDs, suggesting these users must divert their own funds from other broadband investments to pay for the transition

3 Investment in Assets with Limited Utility

The transition would waste billions of dollars on a diminished C-Band, rather than investing in assets, like fiber, that can offer high quality video delivery and improve broadband services

4 The Death of Smaller, Rural Cable Systems

MVPDs distribute video over a variety of architectures, or with third parties' assistance – the complexity and unclear financial support will likely push smaller MVPDs out of the industry

Source: Cartesian, ACA Connects

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A Gruelling Series of Time-Consuming Tasks

The CBA proposal requires a complex transition, with considerable risks of delay – particularly for small MVPDs – due to many moving parts across the video distribution value chain

MVPD Headend Transition

Each MVPD must complete

1. Renegotiate Satellite Contracts
2. Identify Equipment Requirements
3. Manufacture of New Equipment

Install: Satellites & Filters

4. Repack and Dual Illuminate
5. Install and Test Equipment
6. Retire Equipment

Replace: Satellites & Filters

All Earth Station Transitions

Phase 1: Filters and Antenna Repoint

- Antennas will need repointing and filters will need to be installed to accommodate the initial repack of 120MHz within 18 months
- While installing new filters, unanticipated outdated antennas will be identified and need replacement

Phase 2: Filters and Antenna Repoint

- Repointing antennas and 4000-4200Mhz filters will need to be installed *on all antennas* to prevent interference and maintain acceptable quality for proper functioning of new satellite receivers
- While installing/replacing new filters, unanticipated outdated antennas will be identified and need replacement

50+ Programmers
2,000+ MVPD Earth Stations

100,000 Filters Installed
35,000 Satellite Dishes Impacted
16,000 Earth Station Locations

Considerable Risks of Delay Exist at Each Stage – a 3-Year Transition is Not Feasible

Source: Cartesian, ACA Connects

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Transitioning to Higher Compression Will Cost At Least $3 Billion

Accounting for equipment upgrades, labor, and operational costs, the CBA-proposed transition is expensive and comes with no commitment from the CBA to fully reimburse the costs

Requirement	Description	Expenditure	
		Equipment	Labor
Headend Equipment	• **To receive more highly compressed content, MVPDs must replace nearly all IRDs** › IRDs that can also transcode will be needed as many MVPD headends do not have the space to accommodate separate transcoders	**$2.0B**	**$80M**
IRD Licensing	• **In addition to headend equipment, transcoding licenses will need to be covered** › Headends will be charged licensing fees for each IRD that's upgraded	**$660M**	N/A
Testing Equipment	• **Testing equipment required to ensure signal quality** › With the introduction of new compression and modulation schemes within a short window, MVPDs will need testing equipment to ensure signal quality	**$90M**	N/A
Earth Station Upgrades[1]	• **The use of new satellite orbital slots and higher modulation schemes will require MVPD earth stations to install new and/or larger antennas** › Process requires third party installation and can take 2-3 months each	**$25M**	**$140M**
Power Increases	• **Maintain dual feeds throughout CBA Commitments** › Electrical costs will need to be incurred for three years of cooling, dual IRDs, and any transcoders	**$145M**	N/A
Total Reimbursable Cost to MVPDs Alone		**$2.9B**	**$200M**
		TOTAL: $3.1B	

Source: Cartesian, ACA Connects

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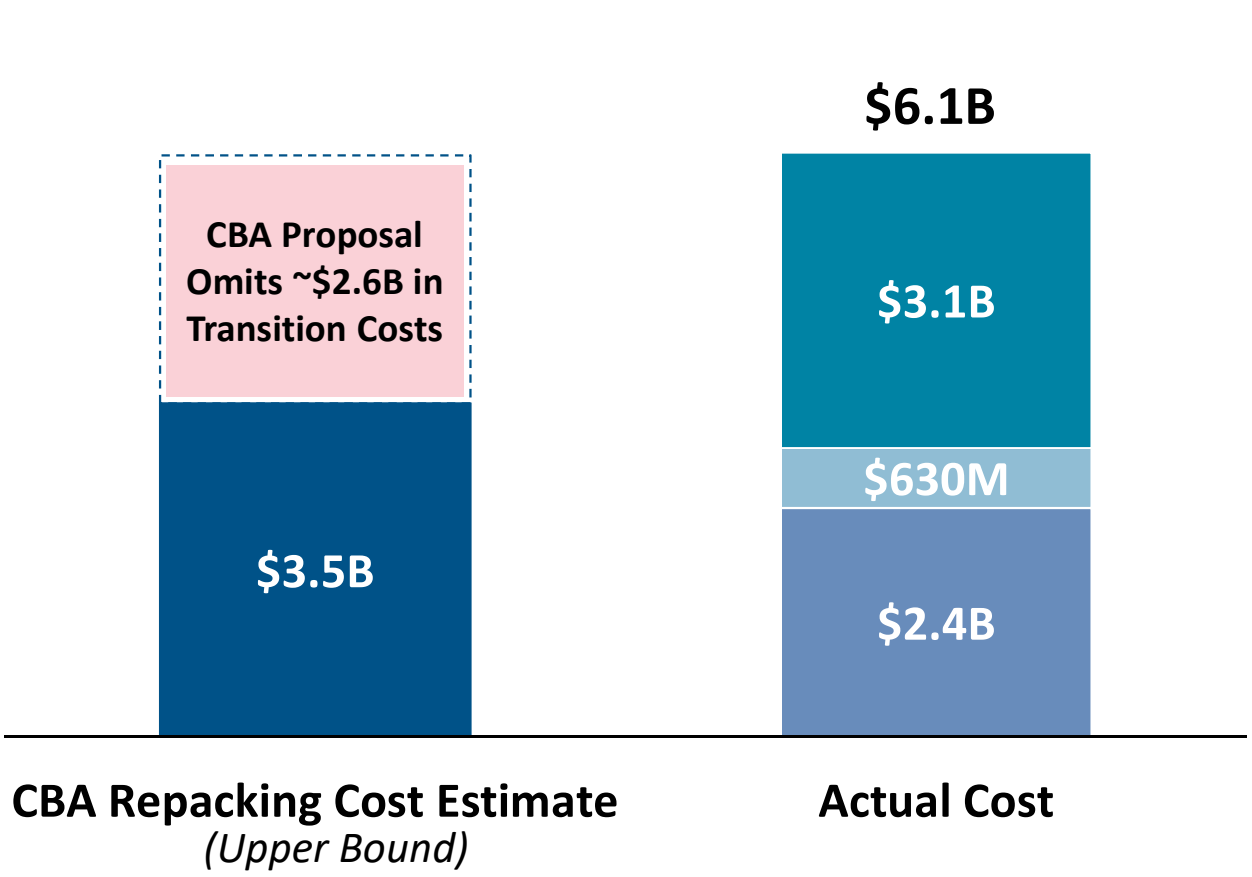
The CBA Proposal Underestimates Transition Costs

The CBA's stated costs of $2.5 to $3.5 billion to clear 300 MHz is a wildly insufficient estimate, suggesting the CBA either lacks sufficient understanding of the transition's complexity for MVPDs, or expects MVPDs to incur significant out-of-pocket expenses



MVPD Headend Upgrades

Headend Upgrades: Primarily IRDs and transcoding equipment – the CBA appears to have not included these costs

Transcoding Licenses: Cost to transcode HEVC feeds to MPEG2/MPEG4

Power & Cooling: Additional power consumption during dual illumination

Industry Satellite Antenna Upgrades: Filter installation and replacement antennas (24,000 Non-MVPD Earth Stations)

Satellite Launches: Launching 8 satellites already accounts for 70% of the CBA budget

CBA's inability to accurately scope the cost and timing of their proposed transition raises serious doubts about their ability to oversee and execute the transition

Source: Cartesian, ACA Connects

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The Better Course – Give MVPDs a Fiber Option

Without a unified approach to clear C-band spectrum for 5G use prior to an FCC Order, MVPDs should have the right to choose a technology-based transition that best meets their future needs

"No subset of stakeholders—whether earth station operators, terrestrial facilities owners, or satellite service providers—should force technology choices upon the entire ecosystem."

— AT&T[1]

"Video distributors should continue to have flexibility to determine the technologies that best meet their needs going forward – whether continued use of C-band or fiber or something else."

— Verizon[2]

"Market participants should retain the autonomy to determine what makes them "whole" rather than having the FCC dictate the new market structure."

— AT&T[1]

The Commission can provide fiber-based solutions for MVPDs *without* obligating programmers to migrate to fiber

1. AT&T Ex-Parte August 7, 2019 AT&T
2. Verizon Ex-Parte October 9, 2019 Verizon

Source: Cartesian, ACA Connects

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5G Plus Plan Can Modularity for MVPD Earth Station Users

Rather than force upgrades of all earth station/headends as proposed under the CBA plan, the 5G Plus Plan can give video distributors flexibility to choose technologies that best meet future needs

Alternative[1]	Description	Benefits	Avg. Cost per Headend[3,4]
Collapse Headends into Super-headends	• Upgrade two headends per regional cluster into super-headends that can get programming in higher compression via C-band • Collapse remaining headends and interconnect them to the super-headends by getting redundant 10G fiber • Obtain equipment needed at collapsed headends to receive content from super-headends via fiber	• Fiber Connectivity **(50K New Route Miles of Fiber)** • Lower Risk Transition • Lower Operational Costs • Programmers utilize C-Band	**$1.4M**
Collapse Headends with Managed Video Service Provider[2]	• Connect one headend per regional cluster to a managed video service provider by getting redundant 10G fiber • Enter 10-year agreement with the managed video service provider to receive programming terrestrially • Collapse remaining headends and interconnect them to the one connected headend by getting redundant 10G fiber	• Fiber Connectivity **(80K New Route Miles of Fiber)** • Lower Risk Transition • Improved Video Product • Programmers utilize C-Band	**$1.7M**
Migrate All Headends to Higher Compression	• Upgrade all headends to get programming in higher compression via C-band • Painful transition to reach a lesser end-state • No improvement in broadband connectivity		**$1.4M**

Interconnecting remote headends is less complex, and a more efficient use of MVPD time and labor, than migrating all headends to a higher compression standard

1. Neither fiber-based modules require programmers to migrate to fiber – it's expected they continue to offer services using higher compression and modulation, consistent with CBA plan
2. Third parties such as Vubiquity or MobiTV already distribute content to MVPDs via terrestrial fiber – they would only need to expand networks to accommodate a larger customer base
3. Estimated based on 2,200 MVPD headends
4. Estimated costs are averages and ***do not*** indicate actual payouts for cable operators based on selected options – actual payouts to be determined based on review of MVPD network architecture and needs

Source: Cartesian, ACA Connects

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BOSTON

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Renegotiate Satellite Contracts

While the CBA has used language suggesting some upgrades are optional (e.g., coding standards), some changes will certainly need to be mandatory to free up promised spectrum

CBA Requirements	Competing Customer Interests
Migration to Higher Compression	**Minimal Compression:** Some customers may hesitate to remove MPEG-2 feeds because some MVPDs will struggle to install and upgrade required equipment
Removal of SD Feeds	**Retain SD Feeds:** Some programmers may want to avoid imposing the installation of down convert equipment at MVPD headends
Reduction in Backup Capacity	**Ensure Redundancy:** Some programmers may balk at having to give up reserved capacity in the event of satellite failure
Limit Bitrate/Modulation Scheme	**Maintain Quality:** Some programmers may refuse to lower bitrates or use standard modulation schemes to sacrifice quality for efficiency

The CBA may invoke force majeure to trigger contract renegotiations to accommodate spectrum reclamation

1. CBA Ex Parte filed October 28, 2019 – language suggests changes are optional, but for successful transition some of these changes will need to be mandated

Source: Cartesian, ACA Connects

Identify Equipment Requirements

Before procuring new equipment, programmers must conduct an extensive evaluation to understand the hardware implementation requirements for existing headends

Identify All Existing Headends

- Collect information (e.g., addresses, number of services, current technology)
- Determine current equipment configuration
- Understand current network architecture

Engineer Solution for Affiliates

- Determine optimal equipment upgrades for affiliates (e.g., off-the-shelf, custom, or combination)
- Depending on the use case, engineers may need to decide if custom equipment is required or if off-the-shelf equipment is sufficient
- Likely 150K – 250K new pieces of hardware will be required

Risks

- **Quantity of Headends:** Some programmers will need to collect information from over 2,000 headends
- **Unique Headend Infrastructures:** Some headends may have unique infrastructures because some IRDs are purchased by MVPDs, raising concerns about compatibility with new equipment
- **Legacy Equipment:** Some small headends with legacy equipment (e.g., analog) may require a dispatch to evaluate equipment to ensure compatibility with expected upgrades

Risks

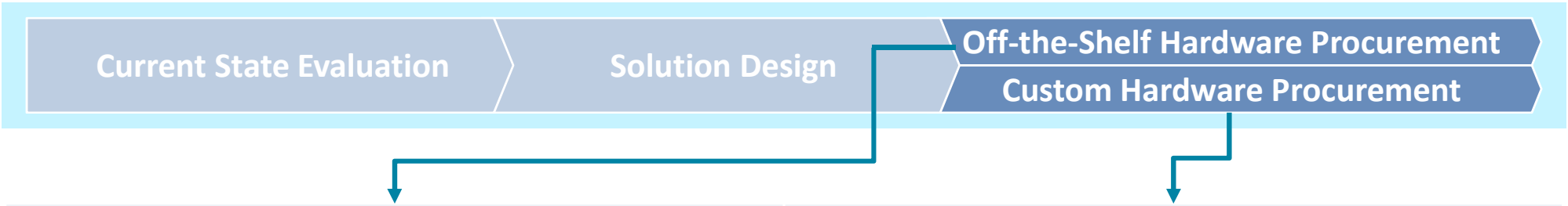
- **MVPD Procurement:** MVPDs often have to buy and manage the hardware on their own – *"The CBA reserves the right to refuse any request it deems out of scope"*[1], which could be problematic for small MVPDs with unique, legacy hardware
- **Headend Space:** There may not be space for new equipment at headends to support additional equipment during the dual illumination period

1. CBA Updated Transition Implementation Process

Source: Cartesian, ACA Connects

Mass Production of New Equipment

Manufacturing new compression hardware could strain supply capacity of a niche market



Order Off-the-Shelf Hardware

- Submit order for off-the-shelf equipment
- Vendor submits RFP to hardware manufacturer
- Manufacturer fulfills order and ships hardware

Develop Custom Hardware

- Submit RFP for custom hardware to vendors
- Vendor prototypes and test custom hardware
- Vendor submits RFP to hardware manufacturers
- Manufacturer fulfills order and ships hardware
- Vendor validates operational readiness of customer hardware

Risks

- **Niche Market:** The CBA proposal requires a massive increase in manufacturing an immature HEVC market likely can't handle
- **Bugs/Issues:** The strain on production could manifest itself in faulty or low quality production
- **Compatibility Issues:** Off-the-Shelf hardware may not meet compatibility requirements of legacy systems, forcing the development of custom hardware

Risks

- **Prototyping:** The process of designing, prototyping, and lab testing custom hardware will delay the manufacturing phase of hardware procurement, undoubtedly increasing the CBA timeline
- **Manufacturing:** Ensuring thousands of pieces of custom hardware are manufactured could be a lengthier process than off-the-shelf hardware and tax manufacturer resources

Source: Cartesian, ACA Connects

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MVPD Transition Process

Dual illumination would have to continue until the last MVPD repoints and installs new antennas, and completes integration and testing of equipment compatible with new compression formats

Component		Timeline Risk Associated
	Dual Illumination	**No MVPD Left Behind:** Likely delayed as it must be continued until all receiving MVPDs have transitioned their satellites and IRDs to prevent service disruption
	Upgrading Antennas and Antenna Components	**Antenna Installation:** MVPDs have to either install new antennas on premise or repoint antennas *before* other hardware upgrades and filter installation, requiring detailed planning (which has yet to occur)
	Integrating New Feeds	**Wholesale Equipment Swap Out:** After antennas are installed, new feeds require all headend technical equipment to be replaced, which will pose significant challenges to MVPDs, particularly small, rural operators
	Phased Equipment Installations	**MVPD Headend Constraints:** Equipment must be swapped out in phases to accommodate size, power and resource constraints within MVPD headends, creating a myriad of delay inducing dependencies
	Testing & Troubleshooting	**Testing and Retiring IRDs:** MVPDs need testing equipment to evaluate stream quality, otherwise customers will identify issues, leading to service disruption and a lengthy troubleshooting process

Replacing video processing equipment is a phased process and will need to be repeated many times at each headend, creating significant opportunities for delay

Source: Cartesian, ACA Connects

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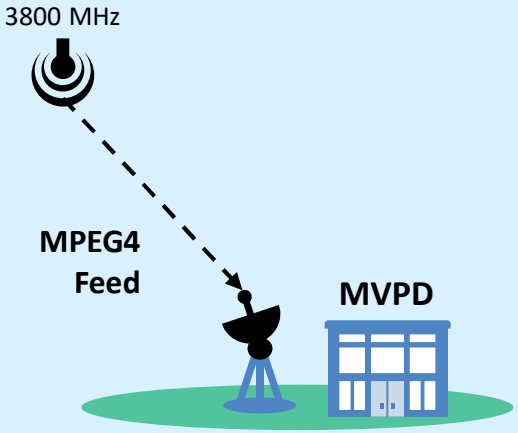
MVPD Reception of New Feeds

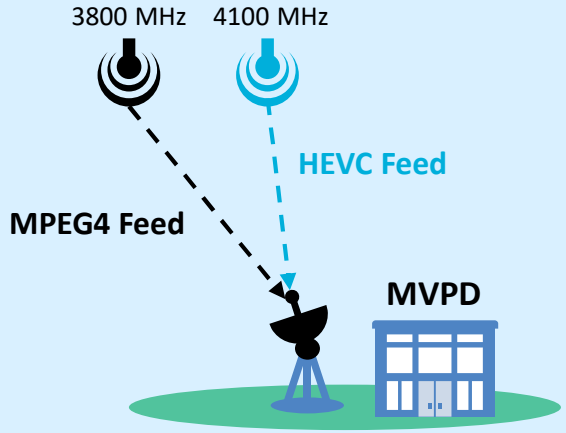
MVPDs need to install equipment to integrate new feeds (e.g., HEVC) into their networks while simultaneously delivering services from existing feeds (e.g., MPEG4)

ILLUSTRATIVE

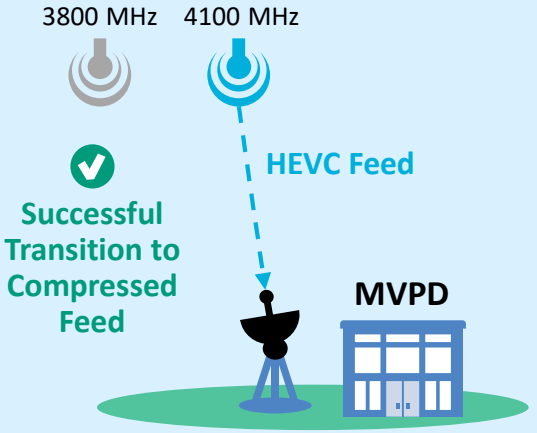
MVPDs Receive Feed in One Compression Format



MVPDs Receive & Integrate HEVC Feed



Successful Decommission of Legacy Feed



MVPDs receive feeds from programmers in a format compatible with existing receive equipment

MVPDs receive multiple feeds while upgrading receiving equipment and integrating stream into network

After successful implementation, MVPDs receive compressed feed via upgraded equipment

Source: Cartesian, ACA Connects

Obstacles to Installing New Satellite Antennas

Some MVPDs will need to install new, larger satellite antennas if 1) feeds are moved to different satellites or 2) modulation modes are changed – this process takes several months to complete

Challenges Receiving New Feeds

If feeds are repacked onto the same satellite:

- Increases in phase-shift-keying (PSK) may be difficult to receive with old, small, antennas
- There is an increased need for amplification which creates interference risk, diminishing signal quality

If feeds are repacked onto a new satellite:

- Antenna look angles may fall below the horizon especially for MVPDs located in the Northeast and Northwest
- Physical obstacles can obstruct line-of-sight – if they aren't on MVPD property then removing obstacles may be impossible

4.2 meter dishes are the smallest size that ensure reception of higher compression feeds:

- Many MVPDs satellites do not have these satellites installed currently and will need to upgrade

Difficulty Installing New Satellite Dishes

Installing and operationalizing dishes of this size require specialists and takes months

MVPD must hire specialists to install new antennas:

- If space is available, large antennas will need concrete foundations to be laid
- Additional conduit and electrical wiring will need to be fed into each headend

Require cranes to install antennas:

- Additional equipment is required if antennas are to be placed on top of buildings

Space limitation for new dishes:

- MVPD roofs and property may not have space for new dishes
- City permitting may not allow new antenna installation

These challenges are so significant that some MVPDs will need to build new headends

Source: Cartesian, ACA Connects

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Challenges to Updating Satellite Antenna Components

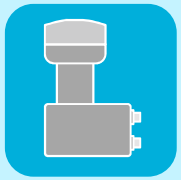
Installing filters and upgrading satellite dishes to facilitate spectrum repacking is prone to mission creep, due to the many moving parts and components of earth station antennas

Earth Station Antenna Components

One or all of the below components requires equipment upgrades and labor to receive new RF feeds

Bandpass Filters

- A bandpass filter prevents interference from 5G services by filtering for a specified frequency range (e.g., 4000-4200 MHz)
- The CBA estimates *100K filters* need to be installed across *35K antennas*



Low Noise Block Downconverters (LNB)

- RF signals are more sensitive to noise/interference when 5G services are on neighboring frequencies with a small guard band
- LNB amplifiers need to be replaced to mitigate additional noise sensitivity from services on nearby frequencies

Antenna Age & Size

- Many dishes are too old or small to pick up a signal in a crowded environment
- Many small MVPDs have old or small antennas
- These satellite dishes will need to be replaced

MVPD Earth Station Upgrade Challenges

- **Hard-to-Reach Areas:** Many satellite antennas are in hard to reach areas (e.g., top of buildings) or rural areas
- **Diversion of Staff/Resources:** Many earth station owners insist on conducting upgrades with existing staff rather than outsourcing to a third party (e.g., roaming crew)
  - This diverts resources from other business opportunities
- **Technical Installation:** Installation of filters requires a specific skillset and familiarity with antenna components
  - Climb up Antenna
  - Remove LNB
  - Bolt on Filter
  - Reinstall LNB

Mission Creep Timeline Delays

Although the above steps could be executed simply an earth station owner could discover signal quality is weak, causing:

- Troubleshooting/Identifying additional equipment or labor requirements
- Waiting for new equipment delivery
- Repeating installation steps above with new LNBs or even new antennas

Source: Cartesian, ACA Connects

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Risks of Installing New Filters

There are significant risks associated with filter installation and satellite dish upgrades that will inevitably delay timelines

Risk	Description
Complications from Migration to Higher Compressions	• **Signal Quality:** Installing filters on old/marginal satellite antennas will degrade video quality • **Unknown Extent of Problem:** This problem may not be identified until filters or receivers are installed at earth stations • **Additional/High-Quality Equipment:** New LNBs, filters, and satellite antennas will need to be installed causing delays from late orders
Multiple Clearings	• **Initial 100 MHz Clearing:** To clear 100 MHz in 18 months, some urban earth station owners will have to support repacking to an intermediate transponder before the final destination • **Multiple Installations:** An initial round of filter installations, antenna repointing, and dish upgrades in the first 18 months is required to clear 100 MHz before a second round of filter installs, repoints and upgrades to clear the remaining 200 MHz
Inadequate Filters	• **Guard Band:** A 20 MHz guard band may not be adequate for 5G interference protection without high quality filters • **Untested Production:** Without extensive testing, 4000 – 4200 MHz filters may not have sufficient sharpness, insertion loss, or attenuation to filter nearby 5G services
New Filter Development & Production	• **No Filters Yet:** There are no 4000 MHz – 4200 MHz bandpass filters on the market currently • **Designing Filters:** It would likely take 2 months to design the required filters • **Niche Market:** The market for bandpass filters is currently supported by few factories, requiring an increase in production to meet 3-year timeline

Source: Cartesian, ACA Connects

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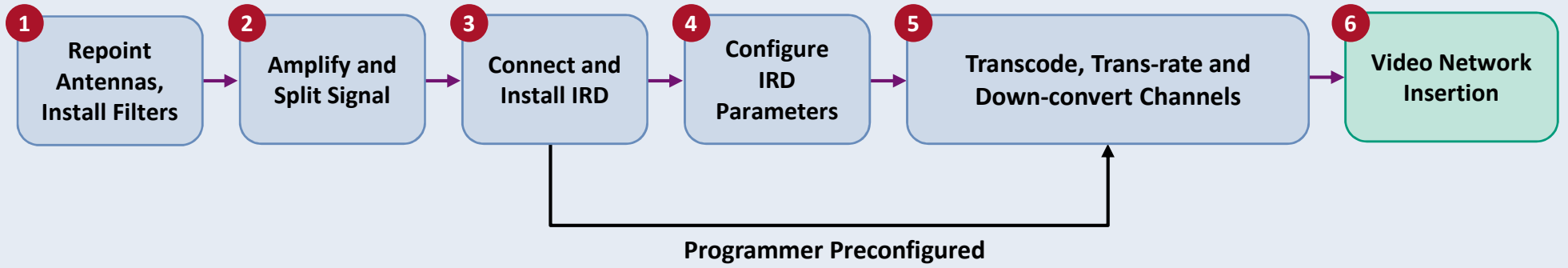
Time Consuming Process to Integrate New Video Streams

The process to replace a single IRD is extensive and could take a significant amount of time – up to days for some MVPDs that will need to swap out dozens of IRDs



Many MVPDs don't have test equipment to validate each step and may not be able to identify errors until the end of this process

Risk by Step in Replacing IRDs:

1 Old Antennas
- The process of replacing filters uncovers damaged antenna equipment

2 Increasing Interference
- Multi-routed signals degrade strength & quality
- Installing amplifiers increases interference "noise"

3 Straining MVPD Resources
- Limited resource constraints include:
  - Rack space
  - Power Supply
  - Cooling capacity
- Lengthy programmer authorization period

4 Troubleshooting Risk
- More sophisticated receivers require backend database and technical configuration
- MVPD Staff have limited resources to help troubleshoot

5 Increasing Resource Strain
- Implement additional lower channel density equipment that requires more space to install
- Permanent resource strain on MVPD businesses

6 Loss of Quality
- Field set-top boxes vary in age and video profile configuration
- Down-converted feeds may not display properly for a small segment of end users

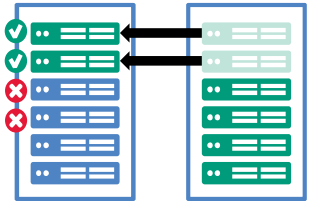
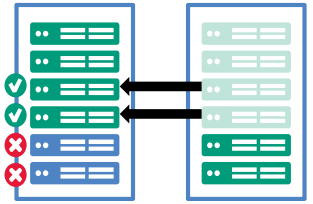
Identifying the root cause of errors at any step in this process is challenging, particularly for MVPDs that may not have staff or resources with relevant training or experience

Source: Cartesian, ACA Connects

Cartesian®

Dependent Phased Equipment Installations

Meeting dual illumination timeline targets is entirely dependent on the coordination, execution and lack of physical (e.g. space, power) constraints across all MVPD headends

Current	Phase 1	Phase 2	Phase N ILLUSTRATIVE
Low Rack Space 	In Use IRDs / New IRDs to Install 	In Use IRDs / New IRDs to Install 	 **Process repeats until all old equipment is retired** *(hundreds of IRDs)*
Potential Delay at Phase 1:	 **Poor Stream Quality**	 **Phase 2 delayed by Phase 1**	

Dependencies

- **Phase 1:** IRD swap out begins during dual illumination period
  - If errors are encountered in the field, Phase 1 dual illumination extends to allow MVPD to troubleshoot issue
- **Phase 2:** Can't begin its IRD swap out/dual illumination until the last MVPD in Phase 1 finishes troubleshooting issues, and frees up space in the headend to begin Phase 2, causing timeline delays

Resource Diversion

- The transition is a full-time job – massive diversion of time for small staff
- Many headend engineers are already working overtime and will be further strained by the burden imposed by the CBA
- Other staff have little experience upgrading new equipment and could struggle to troubleshoot unexpected issues

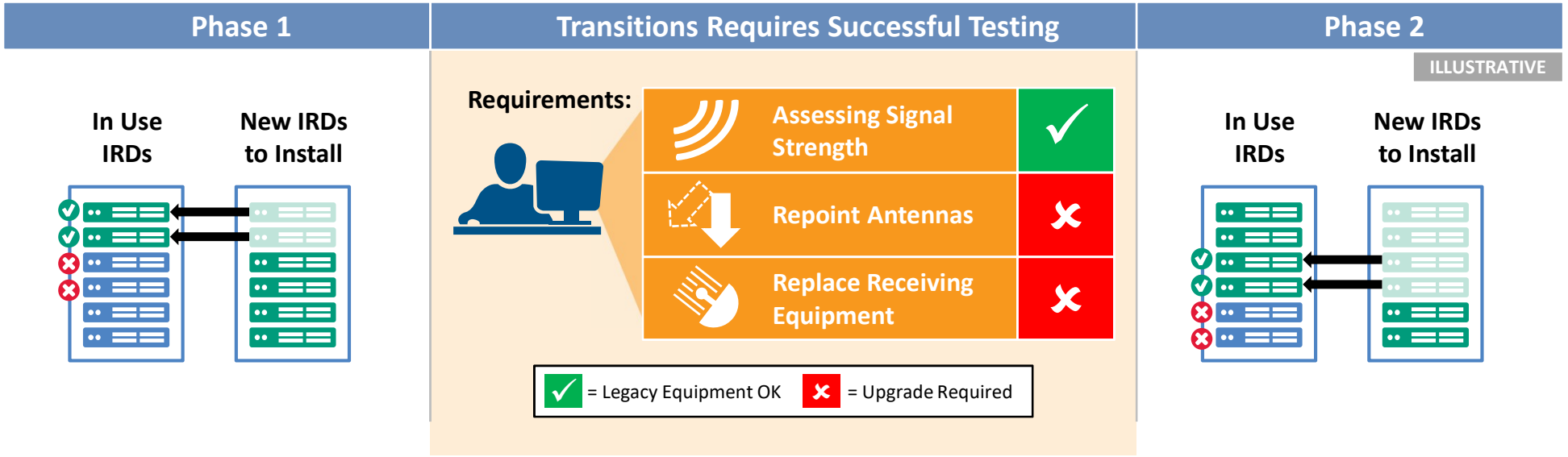
Each instance of troubleshooting in the field compounds and delays the entire industry migration

Source: Cartesian, ACA Connects

Cartesian®

MVPD Considerations – Testing & Troubleshooting

Testing new equipment could reveal issues that delay the process of operationalizing new IRDs

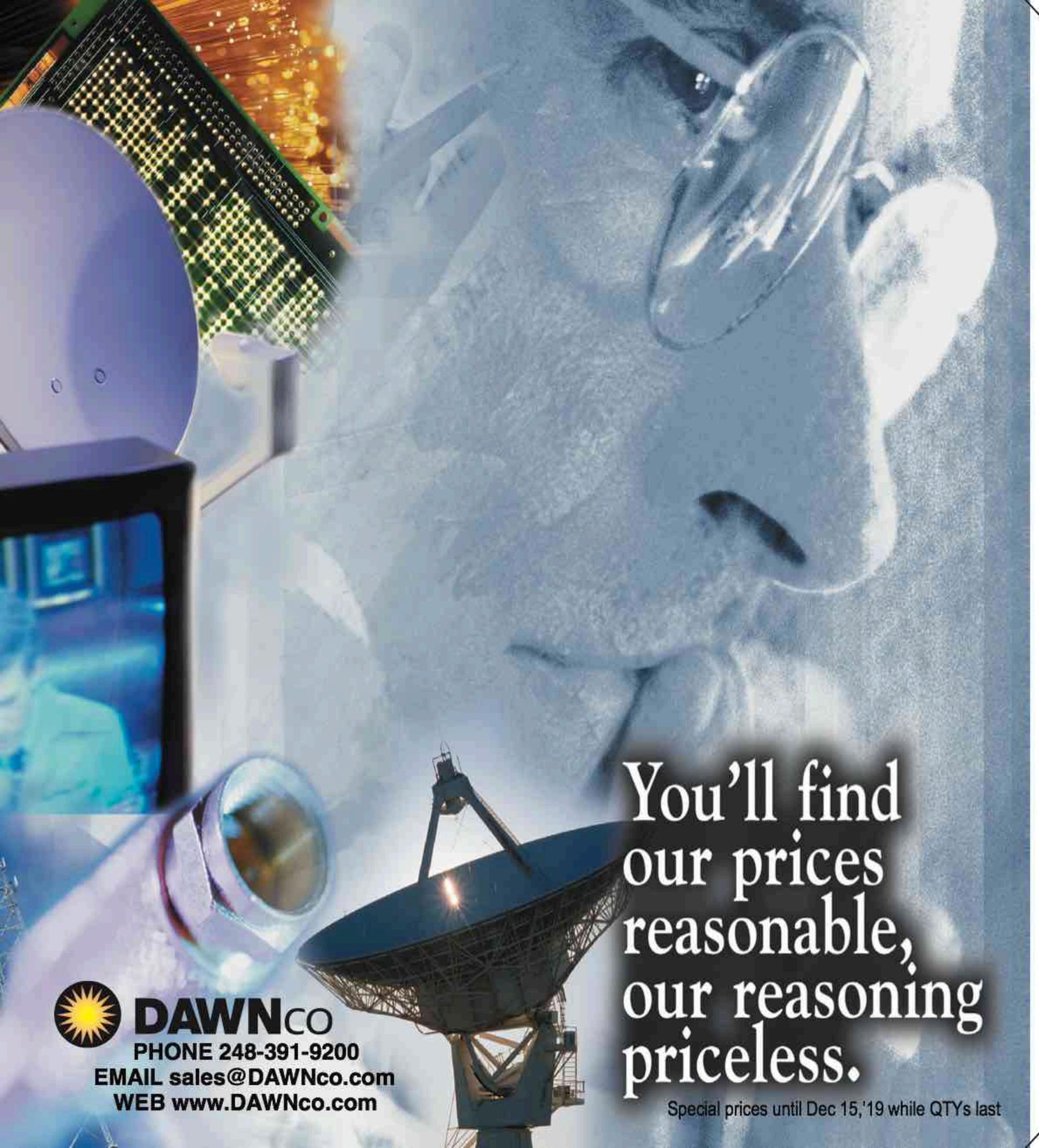


Delays from Transitioning in IRDs:

- **Poor Stream Quality:** Upgrading compression requires replacement of unknown network components
- **Antenna Repointing and Replacement:** Headend antennas need to be repointed if signals moves to a different satellite or if signal quality is found to be weak during testing
- **Troubleshooting Time:** Identifying and replacing faulty equipment adds time to the industry wide upgrade

Source: Cartesian, ACA Connects

Attachment B



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BLOCK interference and BOOST sat signals

Coming soon to a dish near you: Tapered C band with 5G interference

Count on DAWNco for the newest FILTER designs and best LNBs. Email DAWNco or visit us on Facebook for more info.

New TI FILTER 5G blocking
Get the first 5G blocking tapered C band TI Filters (expected fall 2019)

Best C-Band BANDPASS FILTERS

Terrestrial Interference (TI) blocking

Block airport & marine radar and Wimax signals before they enter your LNB. Stop drop-outs and degraded sat reception. Pass desired sat channels

C-BANDPASS-WIMAX4
$369

DAWNco
C BAND
Shield
5G

High Performance C BAND LNBs

Get improved signal quality readings on digital sat receivers. Best gain compression, phase noise, stability. Prevent signal outages when outdoor temps change.

best C band LNB
±2 Khz stability
CLNB20-PL02L
$329

HIGH GAIN DISH

Big dish boosts signal quality on desired channels to fight interference

NARROW BEAM Focus on 1 satellite with max-rejection of adiacent sats

HIGH GAIN Very precise aiming, perfect-align 8-petal stationary 4.2m dish for best-in-class C band gain of 43.5 dB. Feed, LNB sold sep.

Ask us about other sizes 1.5m to 5.0m in motorized or fixed configurations

4.2 meter STATIONARY
#D42F48-8PC-6.6 $5777

SATfiber LINK Place your dish a long distance away, and convert your LNB signals to light using our fiber transmitter and receiver units. Perfect signal quality, lightning protection, dish placement flexibility. Option: ethernet monitoring of RF & optical power

SATfiber 1LNB-on-1fiber TX+RX set $1699

SATfiber 6LNB-on-1fiber TX+RX set $7700

CALL for system design help

SATELLITE RECEIVER-DECODER Tuner and decoder for satellite L band input. Decoder for IP input. MPEG2 & H.264 with 4:2:0 profile, DVBS or DVB-S2, and QPSK or 8PSK. Output baseband A/V & ASI, plus SDI & HD-SDI. Cross convert using a built-in format converter. Embed 8 ch audio & Dolby AC3. Call for INFO

MPEG2/4 Sat Receiver, #D5500-IRD $1688

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1-DISH RECEIVES 3-SATS Retrofit for 3 adjacent satellite reception. Kit with new struts and 3 dual pole C feeds inside tray. Specify dish make & size. **3-Beam RETROFIT Kit starting at $1K** Call for INFO

ADD NEW FEED TO OLD DISH Specify dish make & size. **CALL FOR PRICE**

FEEDHORNS

Stationary 4-port C/Ku band, **FEED-4CK-ECON CALL**

Motorized 2-port C/Ku band, **FEED-2CK-MOT CALL**

Motorized 4-port C/Ku band, **FEED-4CK-MOTHQ CALL**

BEST FEEDHORN for C band DISH Stationary 2-port C band feedhorn **FEED-2CD $129**

CATVfiber LINK pass Cable TV channels over long distances using fiber. Feed Cable TV channels to one or many viewing locations without using noisy RF amps. Perfect way to send TV channels within building or campus environment.

Headend to 1 or more viewing locations

TX+RX set $2K

CALL for system design help

DIGITAL VIDEO VIA FIBER Pass digital video, including embedded audio. Distances up to 20 Km via fiber. Pass 3G for 1080p, ASI, SDI, & HDSDI. With RS485 control.

FDS1-D1TJ (TX+RX set) $990

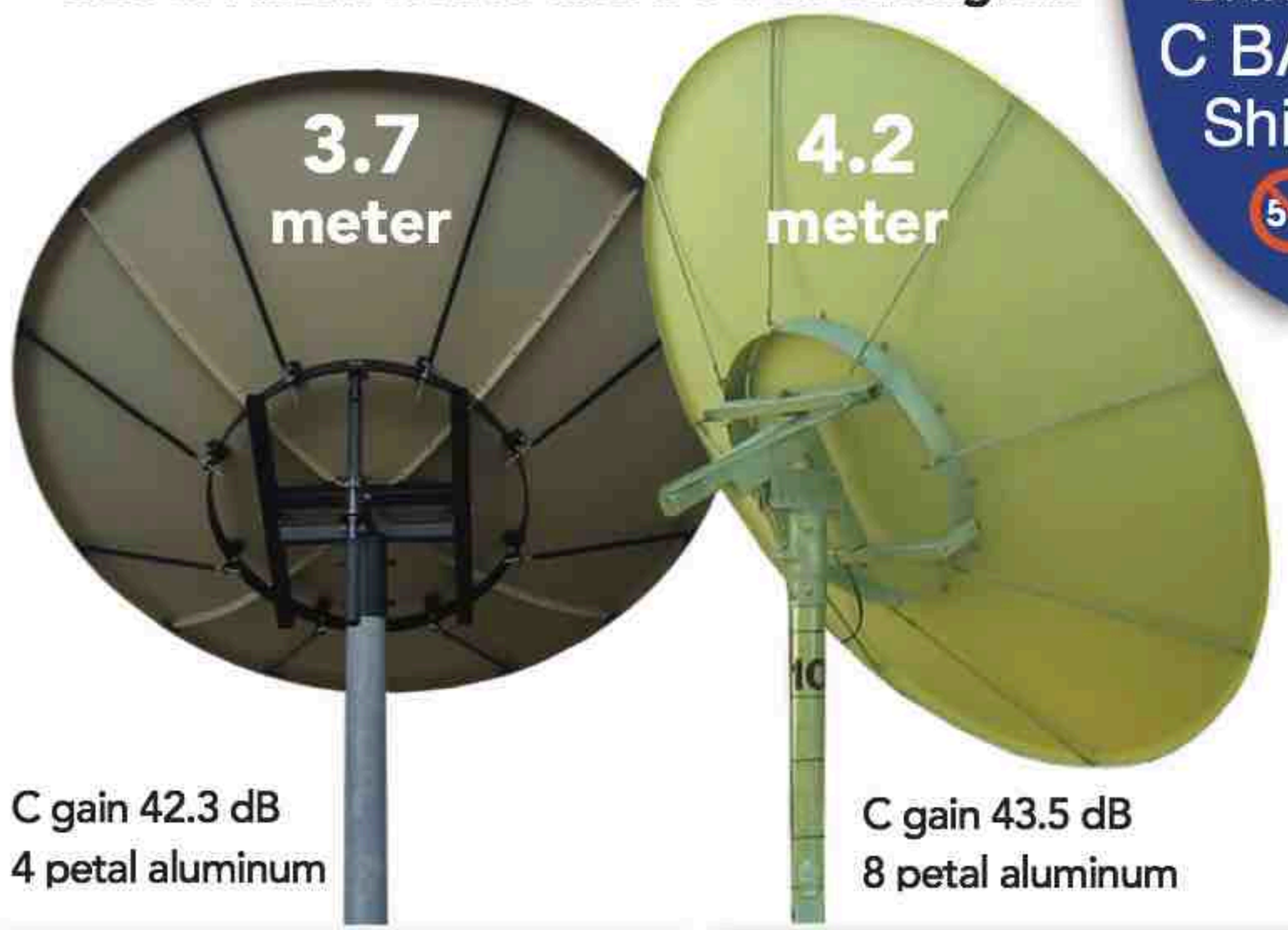
great for remote camera

FIBER OPTIC CABLE Factory connectorized, pull-it-yourself reel, waterproof protective pulling eye for easy pull. Say No of fibers & length

CALL FOR BEST PRICE

BLOCK interference and BOOST sat signals

DAWNco C BAND Shield 5G



C gain 42.3 dB
4 petal aluminum

C gain 43.5 dB
8 petal aluminum

C gain 44.3 dB
FLA hurricane rated
194 mph survival
8 petal aluminum

5m dish Pictured with optional Galv & backside electric heater & black insulative back cover.

C gain 47.9 dB
20 petal alum

3.7 METER STATIONARY
#D37F48-4PC-5.5 $2399
Most popular size and model. Simple 4 petal design. Reliable C band reception, for an economical price. Mount onto in-ground 5.5" OD pipe. Feed, LNB, wire sold sep.

4.2 METER STATIONARY
#D42F48-8PC-6.6 $5777
Lowest-cost high-gain stationary dish. For finicky programs that need high-gain & high-rejection of adjacent satellite interference. Feed, LNB, wire sold sep.

5.0 METER STATIONARY
#D50FAE-GIB-8PC
$9333 Option: 4.5 meter
Strong dish to receive important programs from one satellite. Max-gain & max-rejection of adjacent-sat interference. Feed, LNB, wire sold sep.

Big 6.3 or 7.5m FIXED or MOTORIZED, #CH63 or #CH75 CALL for Price
This big strong dish will give you the best gain, for great satellite reception no matter what your location.

3.7 METER MOTORIZED
#D37PMD60-4PC-5.5 $3999
Standard-gain motorized dish for a good price. Dual axis 2-motor mount for perfect aiming to any C or Ku satellite. Feed, LNB, wire, actuator #2 and controller sold sep.

4.2 METER MOTORIZED
#D42PMD60-8PC-6.6 $7099
Lowest-cost high-gain motorized dish. Dual axis 2-motor mount for perfect aiming toward any C or Ku satellite. Feed, LNB, wire, actuator #2 and controller sold sep.

5.0 METER MOTORIZED includes controller
#D50MAE-GIB-8PC
$16,699 Option: 4.5 meter
Highest gain sat antenna with 50 position controller, moves to any C or Ku sat. Strong motorized AZ/EL mount for hi-wind usage. Feed, LNB, wire sold sep.

D18F-1PC-NPRM
$944 SMALL DISH
Stationary prime focus 1.8 meter satellite antenna and built-in non-penetrating roof mount tray for quick installation using cement blocks. Ku band gain is 45.6 dB.

REPAIR PARTS-CONTROLLER-MOTOR
Position controller with 50 positions, for fast movement to desired satellite. Motors & linear actuator arms for all dish makes.
24 inch actuator/motor, ACT2400 CALL
36 inch actuator/motor, ACT3600 CALL
1-axis controller, CONTROL-1500A CALL
2-axis controller, CONTROL-2000A CALL

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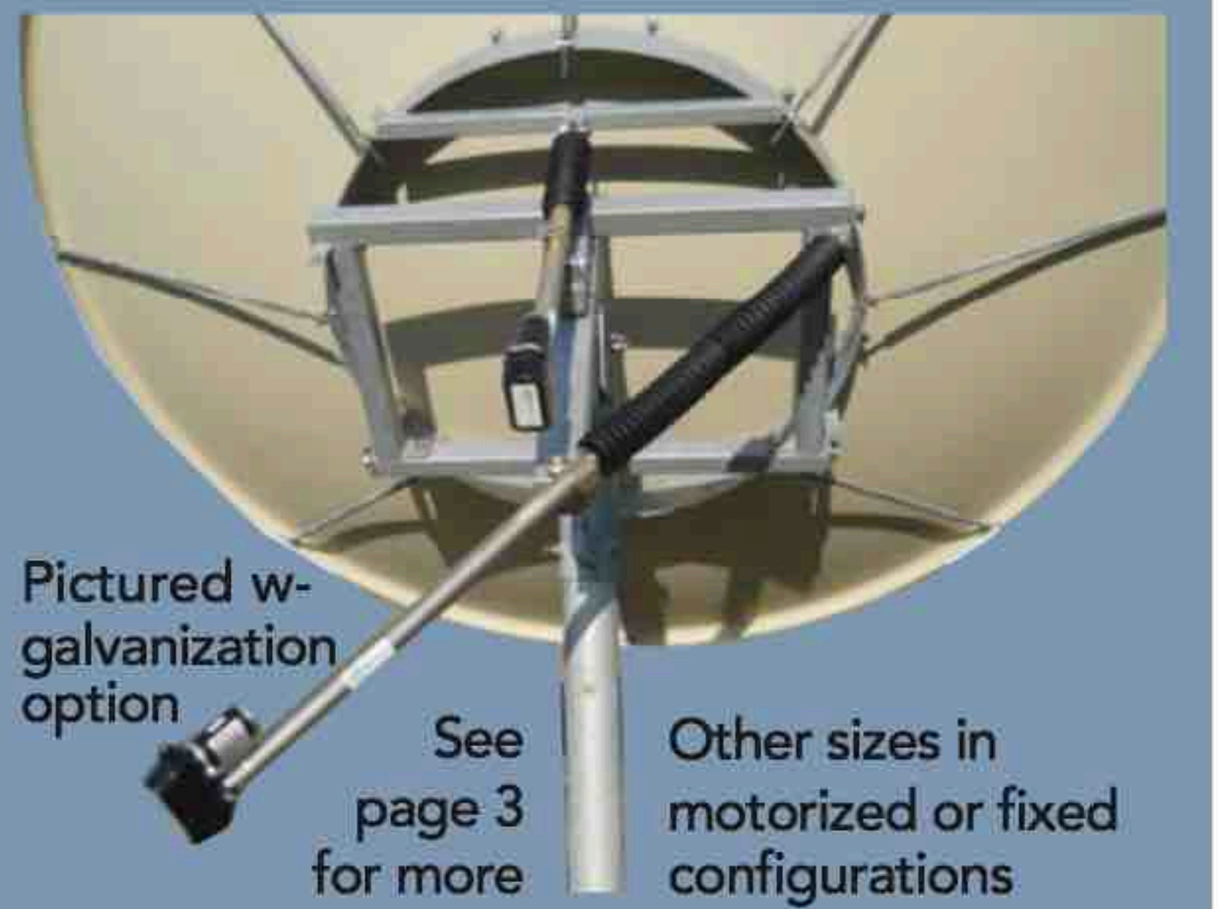
AMEX MasterCard VISA

MOUNT TO HOLD DISH Choose the basestand to bolt antenna to a steel or cement surface. Non-penetrating mount to roof mount an antenna, using weight of cement blocks to hold dish in place.
Basestand with 5.5" OD pipe CALL
Basestand with 6.6" OD pipe CALL
NonPen roof mount for 2.4m dish $750
NonPen roof mount for 3.7m dish $2K
NonPen mount for 5.0m dish CALL

Big Dishes solve ALL sat reception problems!

Economical MOTORIZED dish
Receive any C or Ku satellite
3.7 meter, 50 preset positions



Pictured w- galvanization option

See page 3 for more

Other sizes in motorized or fixed configurations

3.7m 4-petal dish, controller, sensors and 2 actuator arms w- motors

#D37PMD60-4PC
3.7m MOTORIZED package $6777

Most popular 3.7m sized dish, 42.3 dB C band gain, 2-motor drive for perfect peaking on any sat, with 50 position controller, moves to any C or Ku sat. Base pipe, feed, LNB, wire sold separately.

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BLOCK interference and BOOST sat signals

Our top LNBs provide improved signal quality on digital satellite receivers. Best gain compression, phase noise, stability. Prevent signal-drops when outdoor temps change.

High Performance LNBs

Best C Band LNB ±2 Khz, CLNB20-PL02L $329

Best Ku LNB ±5 Khz, KLNB.7-PL05 $329

3.7 meter STATIONARY #D37F48-4PC-5.5 $2399

Most popular 3.7m dish for C band gain of 42.3 dB. 4-petal aluminum. Feed, LNB sold separately.

Ask us about other sizes from 1.5 to 5.0 meter in motorized or fixed configurations. See page 3 for more.

Best C-Band BANDPASS FILTERS

Terrestrial (TI) Interference blocking

Block airport & marine radar and Wimax signals before they enter your LNB. Stop drop-outs and degraded sat reception. Pass desired satellite channels

C-BANDPASS-WIMAX4 $369

TI Filter 5G Blocking
Get first 5G blocking tapered C band TI Filters (new unit expected fall 2019)

LIGHTNING SURGE SUPPRESSOR

$194 LNB-Zap-Stop

Stop lightning surge on signal cable from damaging equipment. Can take multiple hits, with no need for reseting

SUPER-LOW-LOSS SIGNAL CABLE Choose the best signal cable based on distance to dish.

DAWNflex 300ft to 500ft

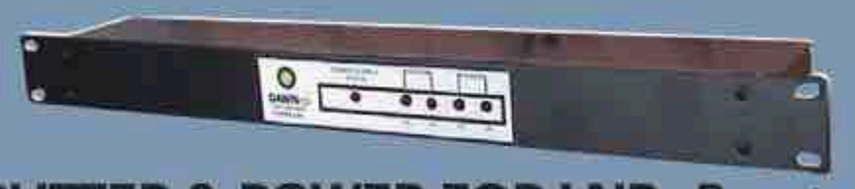
SATfiber link from 500ft to 50 miles

DAWNflex cable $1.39 per ft
SATfiber link shown on page 2

SAT-METER TO AIM DISH & TROUBLE-SHOOT Boost signal quality several dB using meter to peak dishes. See satellite names, plus precise C/N & signal level feedback for every adjustment. Powers LNB.

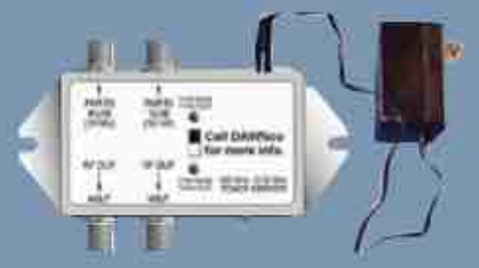
FLEXtest + VSAT module $758
Option: Add cable TV/OffAir module & case

DIVINSUP $259



SIGNAL SPLITTER & POWER FOR LNBs Boost signal levels. All signal wires go into this amplified splitter. 1 LNB can feed signals to 9 receivers, or 2 LNBs each feed 5 receivers. 18 vdc power to LNBs.

LNB POWER SUPPLY insert 18v dc power via coax cable for 1 or 2 LNBs **DCP7A $99**



HEATsat stops snow outages using sensors for precipitation and temp, to turn on heat elements bonded to dish backside. Tell us dish size/make.

HEATsat-half for 3.0m $2400 • Other sizes: CALL

COVERsat will block snow pile-ups and keep your signals strong. Uses gravity and a steep surface for simple cost-effective protection. Tell us your dish size & make.

3.7m COVERsat $555
4.5m COVERsat CALL