



# Switched Digital Video (SDV)

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August 2010

# What is Switched Digital Video (SDV)?

*aka – Switched Digital Broadcast (SDB)*

Replacement methodology for current linear “Broadcast” whereby only “Broadcast” programming that is being watched is transmitted on the HFC network.



# Why deploy Switched Digital Video (SDV)?

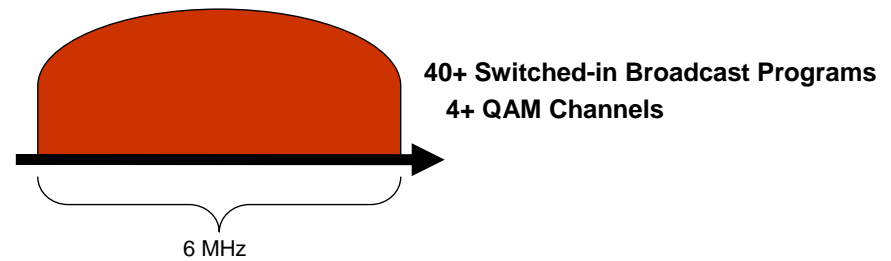
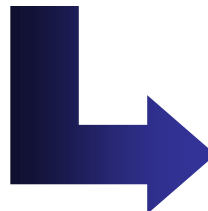
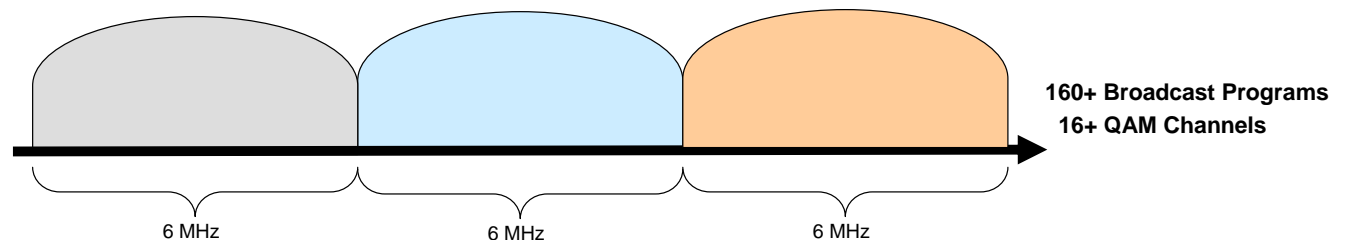
## FACT:

*In a Broadcast architecture, only ~ 20% of the Broadcast channels are being viewed within a serving group at any instant*

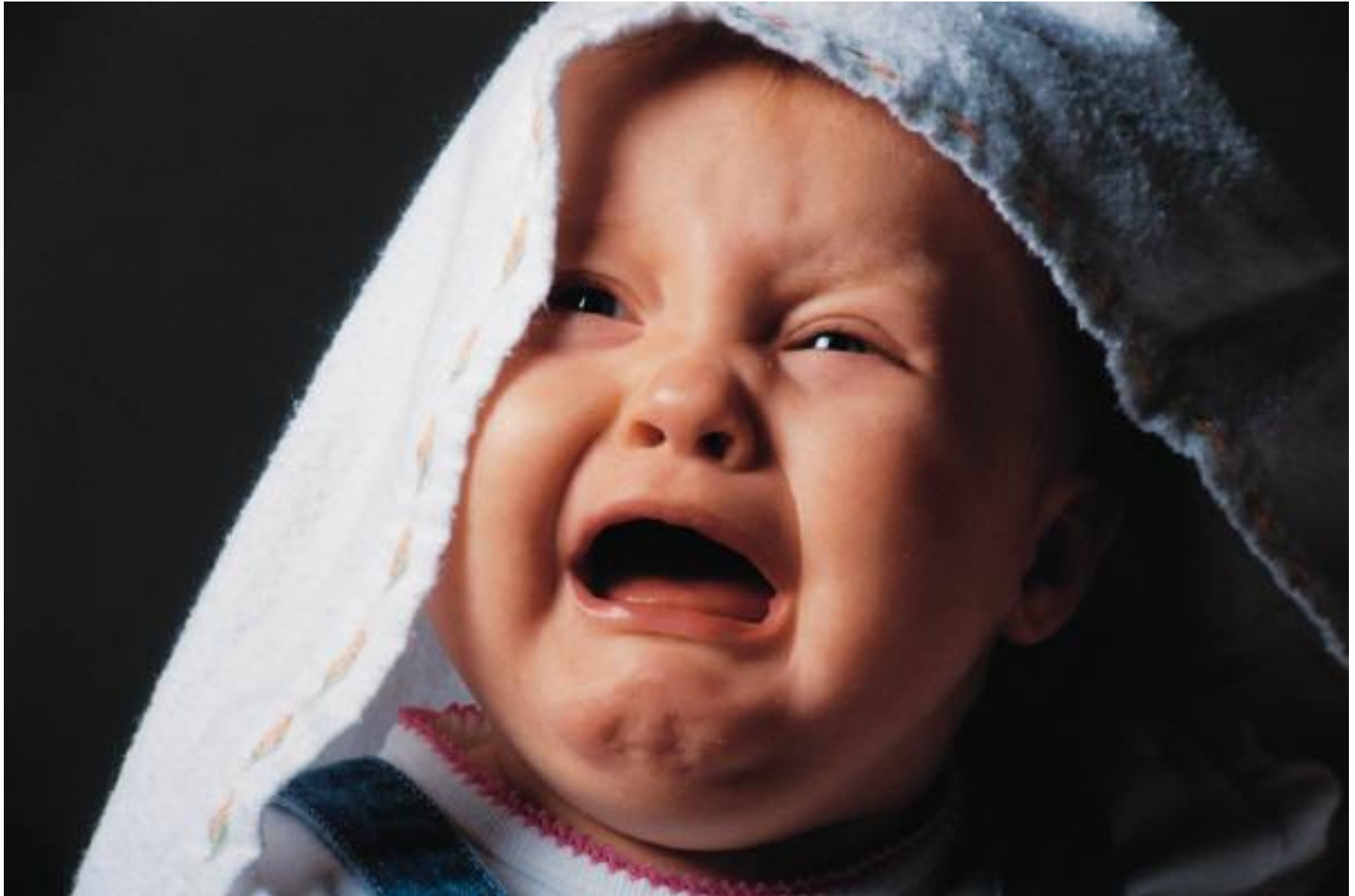


## ISSUE:

*A significant portion of a 160+ program lineup goes unwatched, and therefore wastes **Bandwidth!***



**I need more reasons WHY!!!!**



# Why do Switched Digital Video (SDV)?

## **ISSUE:**

*In a Broadcast architecture, the operator has no real way to gather empirical viewing habits of its customers.*



## **FACT:**

*All STBs must report real-time, program usage therefore provider can understand viewing habits to offer better targeted services.*



- More Revenue
- More Satisfied and Sticky Customers
- Superior Services to Competitors
- Competitive answer to Telco/Satellite providers
- More tiers of programming and More channels
- First migration to everything on demand (EOD)

# More reasons Why!!!!

Since many customers are watching the same programs, statistical efficiencies result from offering a virtual channel map having more programs than the physical bandwidth is capable of (over-subscription).

Switched Video is transparent to the consumer.

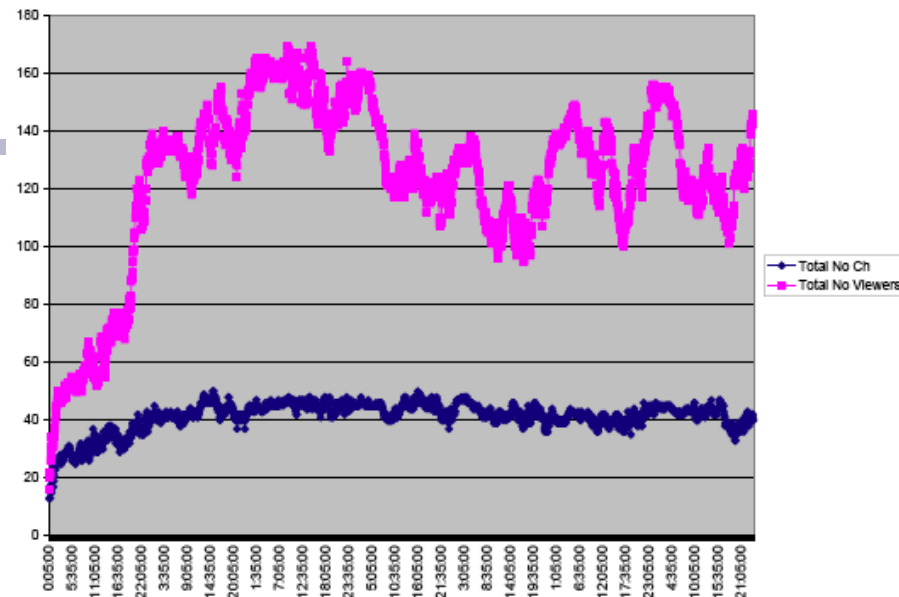
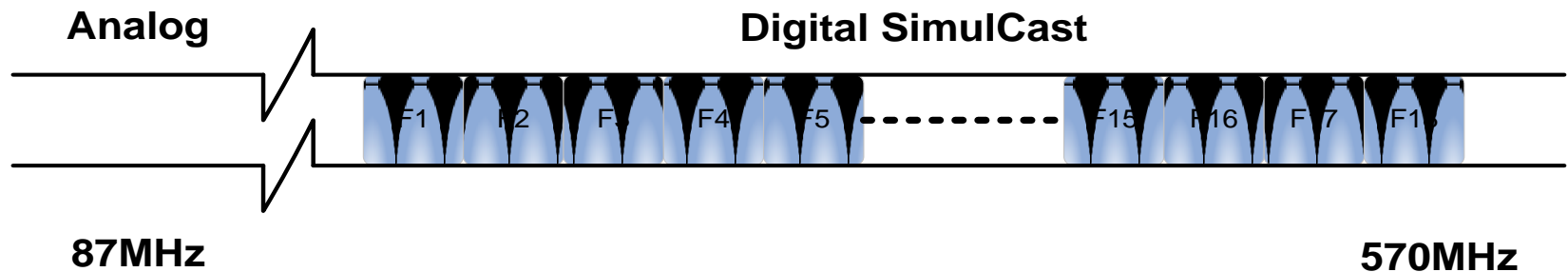


Figure 2 – Trial A, Subscribers and Watched Programs, All 4 Nodes, 7/9/04-7/15/04

- Allows bandwidth usage to be scaled as a function of viewer-ship rather than as a function of TV programs offered
- Extends life of existing network capacities by making more efficient use of currently available bandwidth
- Enables Opportunity to increase niche programming
- Historical tracking of viewership
- Enables optimization of performance, programming and line-ups
- Viewer demographics info enables node-level directed advertising

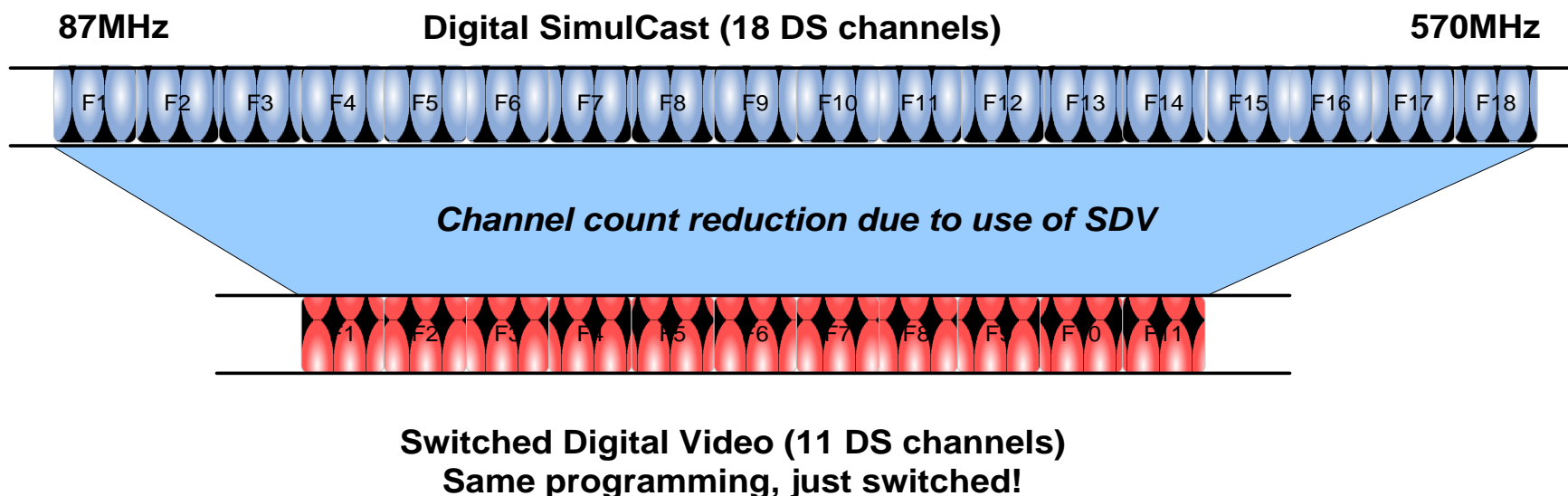
# Broadcast Video Limitations

- All content stacked on transport
- All TV programs available to digital TV subscriber at all times
- Requires a high bandwidth network that translates to lots of downstream frequencies
- Requirement for HD content increase overall bandwidth needs



# Switched Digital Video

- Requires network control protocols such as CCP, MCP, SSP-SIS
- Video trans-coding and clamping controls stream accounting
- Efficient IP multicast switching through network
- Switched offers optional program capacity over-subscribing
  - ~2:1 (safe)
  - >3:1 (aggressive).



# What Alternatives are there?

- Go “ALL Digital” (\$\$\$\$ in STB)
- Reallocate Analog to HD (60% of spectrum is analog)
- Spectral Extensions up to 1GHz
- Advanced Codecs (MPEG4)
- More Statistical Multiplexing / Rate shaping
- Go “All On-Demand”

Going SDV does not mean you have  
to stop doing any of these



# On-Demand vs. Switched Video

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## On-Demand

- Each subscriber views a unique session
- Each session has a definite endpoint
- Programs are cached and unicast from the server to a single QAM output port.

## Switched Video

- Sessions may simultaneously be viewed by multiple subscribers
- Session endpoint is variable
- Program streams are real-time MPEG broadcasts and may be multicast to multiple QAM output ports.

# How did we get here (SDV)?

- **Market Trials – 2006 (e.g. Time Warner and Cox)**
  - **Mass Deployment – 2007-2008 in North America (Proprietary)**
  - **Mass Deployment – 2009-present in North America (GQI and NGOD standard methods)**
  - **ROW Mass Deployment TBD**
- 
- A cartoon character with large eyes and a small body is standing on a reflective surface, holding a glowing blue orb. The character's reflection is visible on the surface below. The background is a dark teal color with scattered white and blue stars, suggesting a night sky or a digital space.

# What are some of the SDV requirements?

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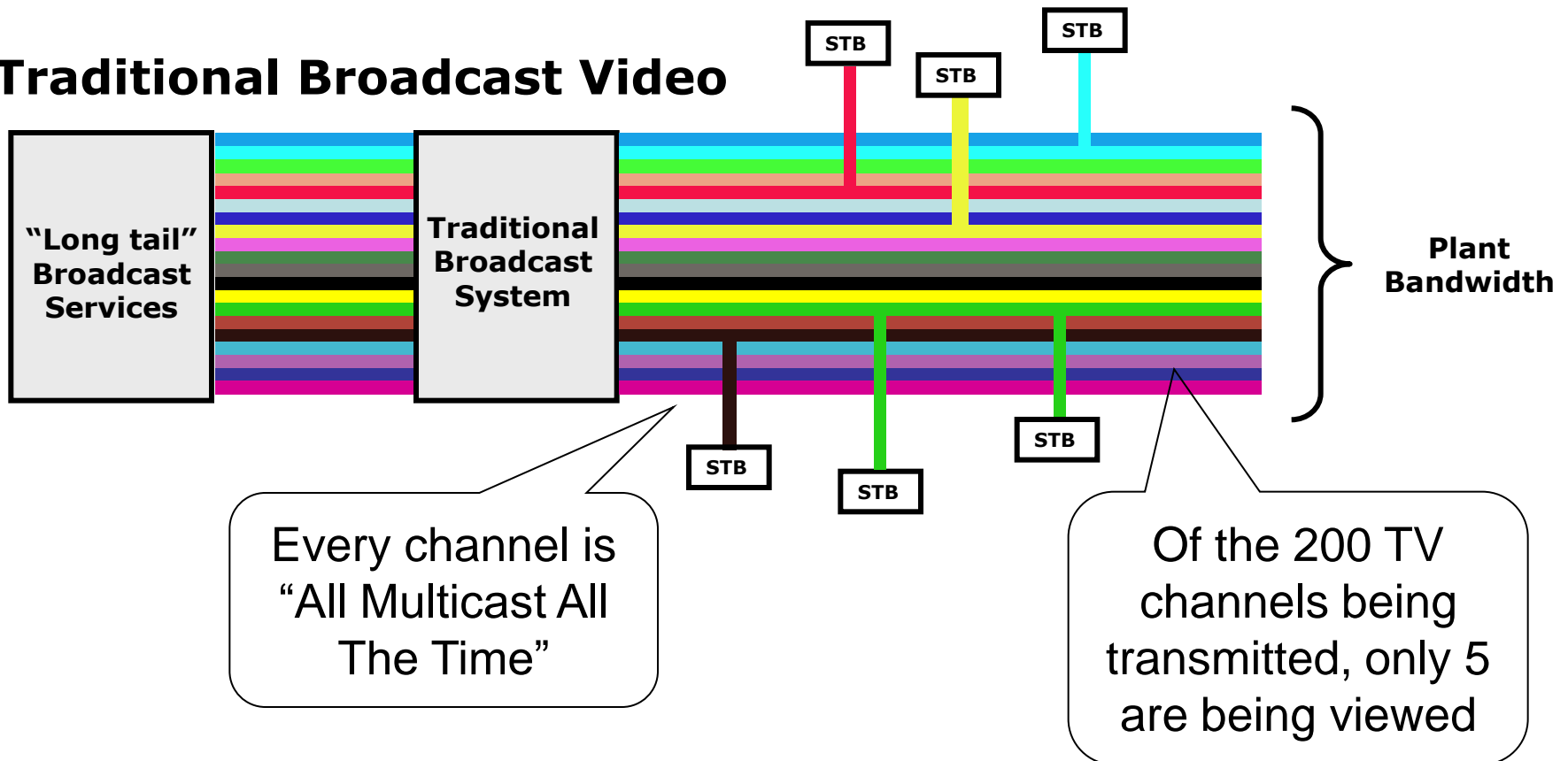
- Content delivered only when requested (e.g. Switched In)
- Content not delivered when unwatched (e.g. Switched Out)
- Requires network control mechanism (e.g. Venerable TCP/UDP/IP)
- Requires Resource Management System (e.g. “Traffic Cop”)
- Must be fast (sub-second program transitions)
- All STBs must be willing and able participants
- Must be supportable on legacy STBs



# Traditional Broadcast System

QAM Digital channels used to deliver 100-200 TV Programs.

## Traditional Broadcast Video

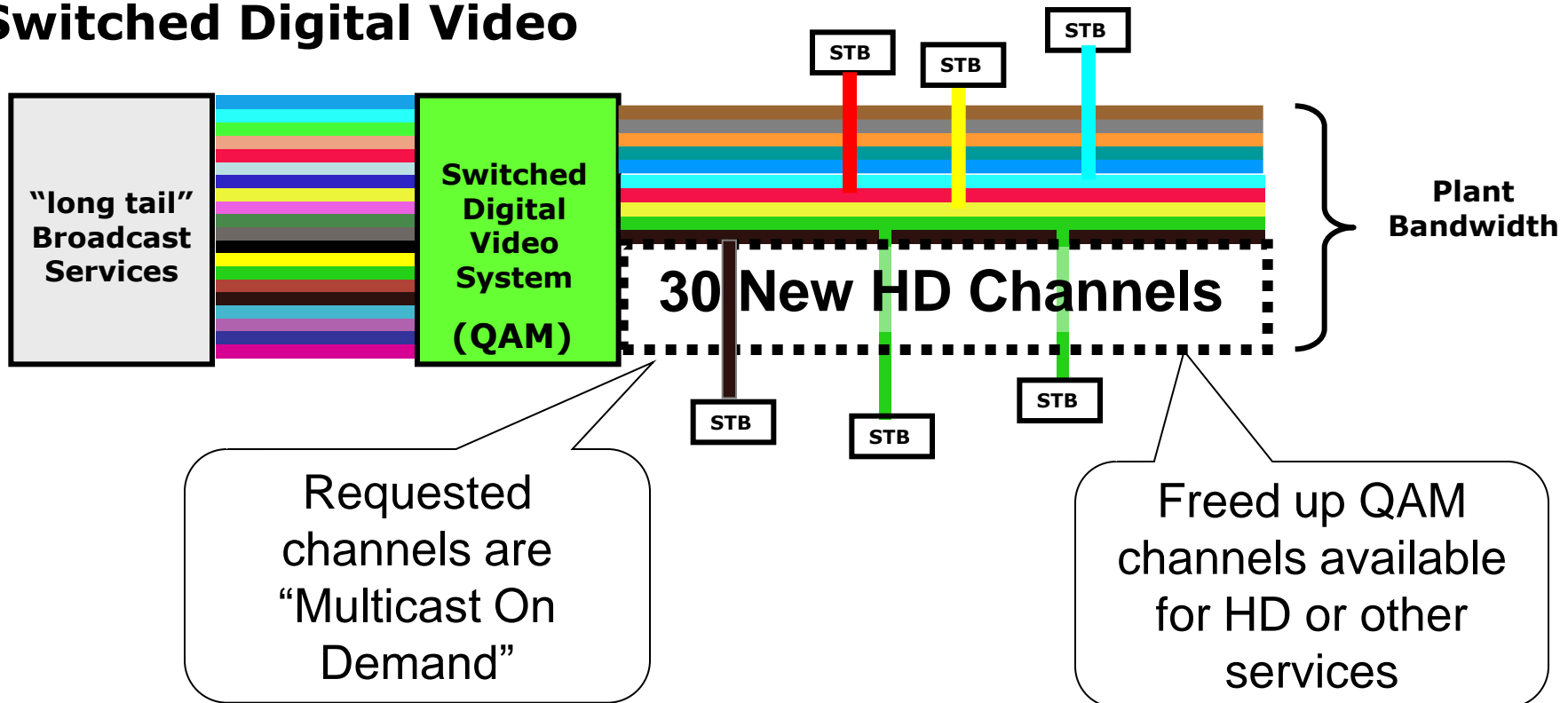


# Switched Digital Video System

**SDV: 10 QAM channels used to deliver “watched” Programs**

**SAVING: 10 QAM channels freed up for “other” services**

## Switched Digital Video



# FAQ on Switched Digital Video

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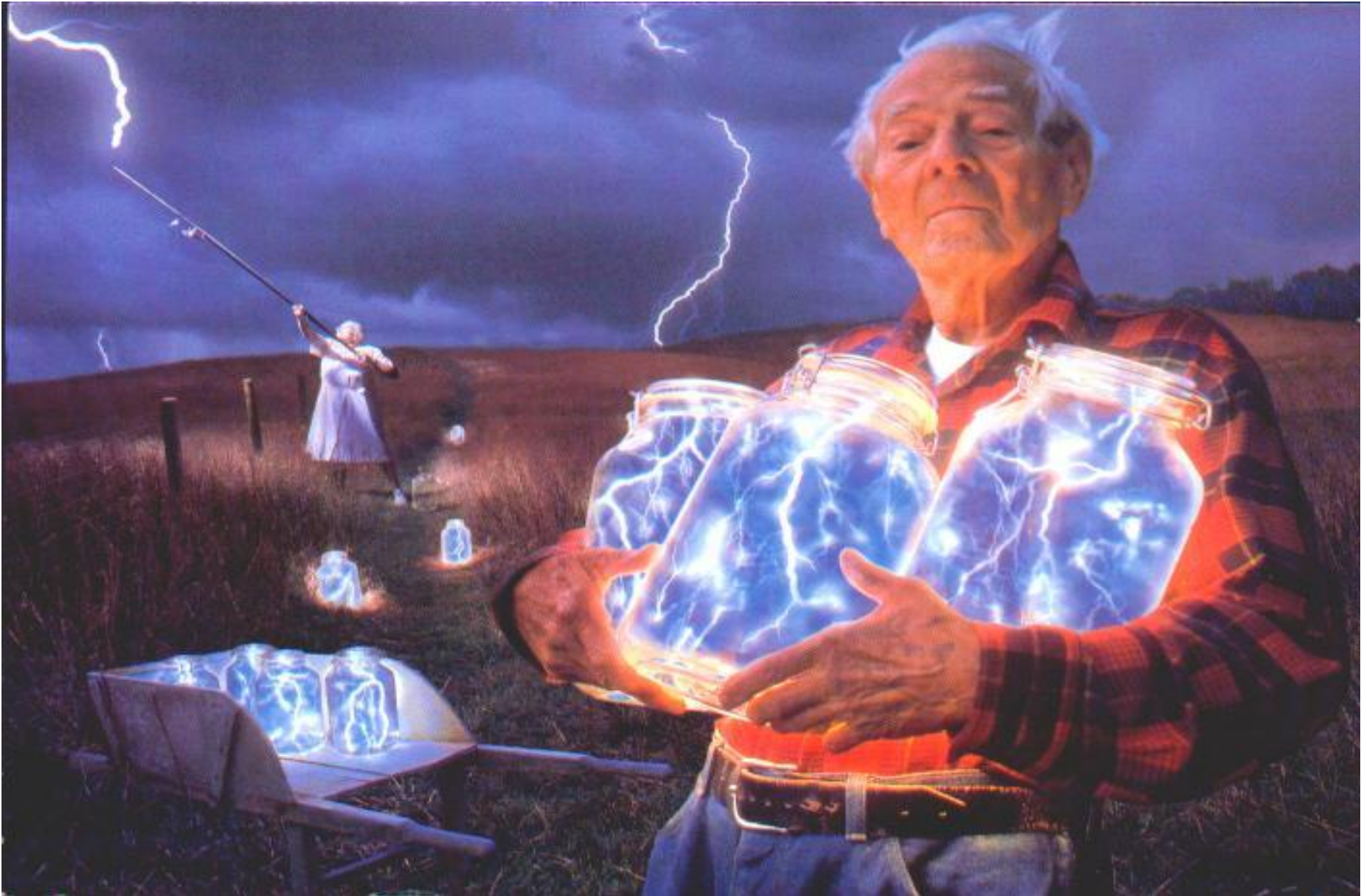
- What are the ideal programs to switch?
- How many QAMs per service group will I need?
- How many tuners per service group should I have?
- How much bandwidth can I save?
- How many programs do I need to switch in order to free up X amount of bandwidth?
- What are the risk of blocking traffic?
- HOW MUCH DOES IT COST?

***Answer..... It really depends on***

# What are your Bandwidth Needs or Objectives?

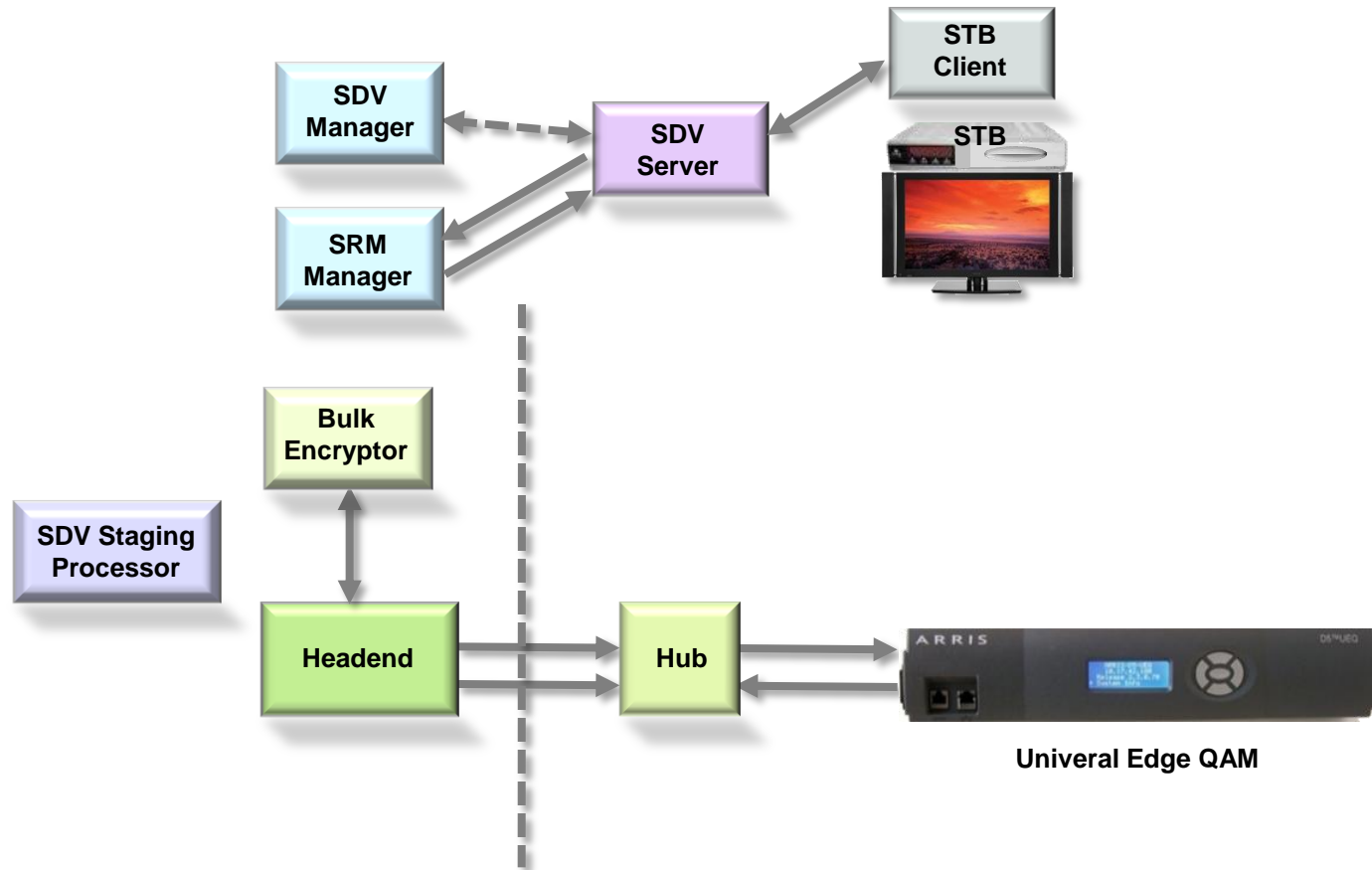
- Determine short term and long term BW saving objectives.
- Free up a minimum amount of spectrum for:
  - Launching Simulcast or VOD
  - Adding more HD or SD content
  - Adding more VOD capacity for time shifting or Network PVR
  - Targeted Advertising
- Why does this matter?
  - Network design and QAM counts will vary based on program utilization, capacity requirements and timing of those needs.
  - Large swings in QAM investment dollars based on those needs.
  - However, SDV still provides ideal pay-as-you-grow scaling.

# This is great but how does it work?

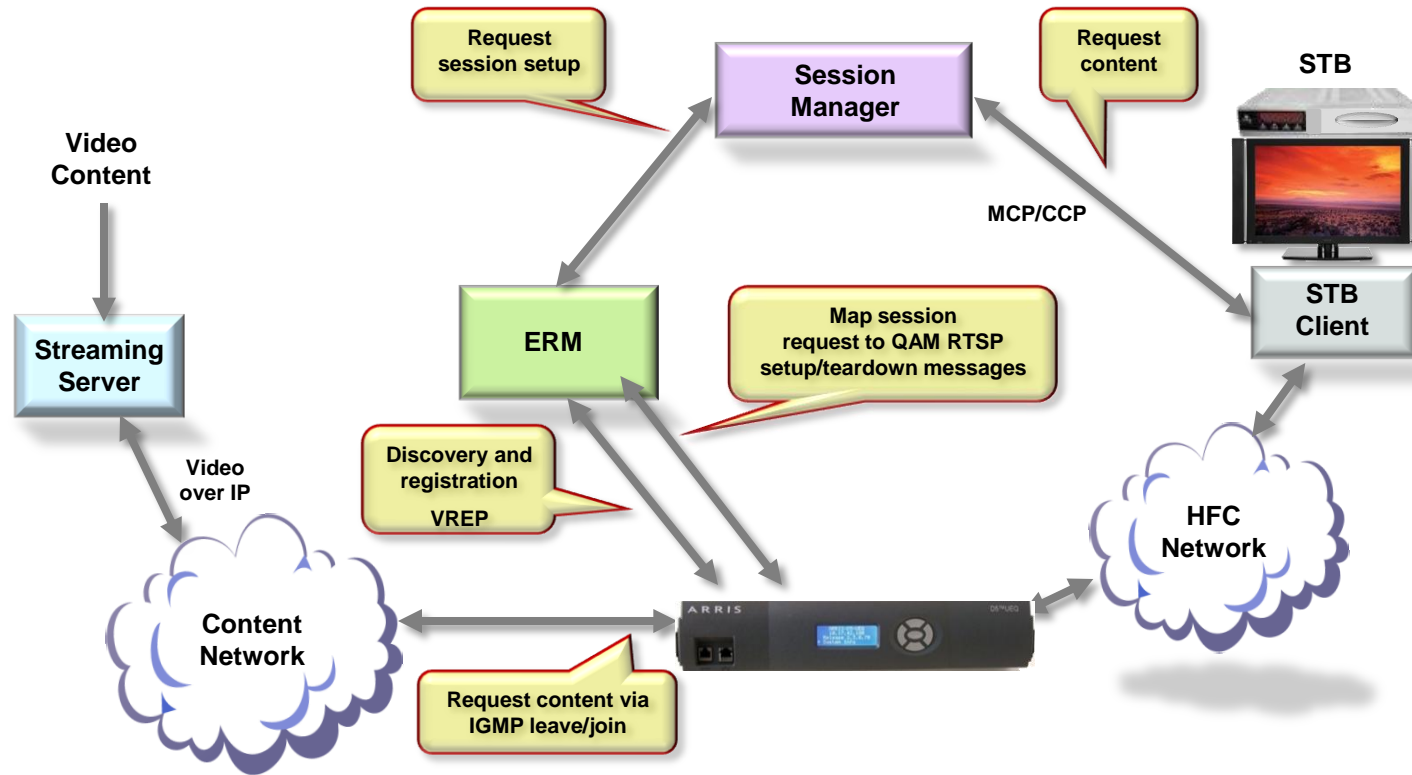


# SDV Architecture

## Elements in the SDV Architecture

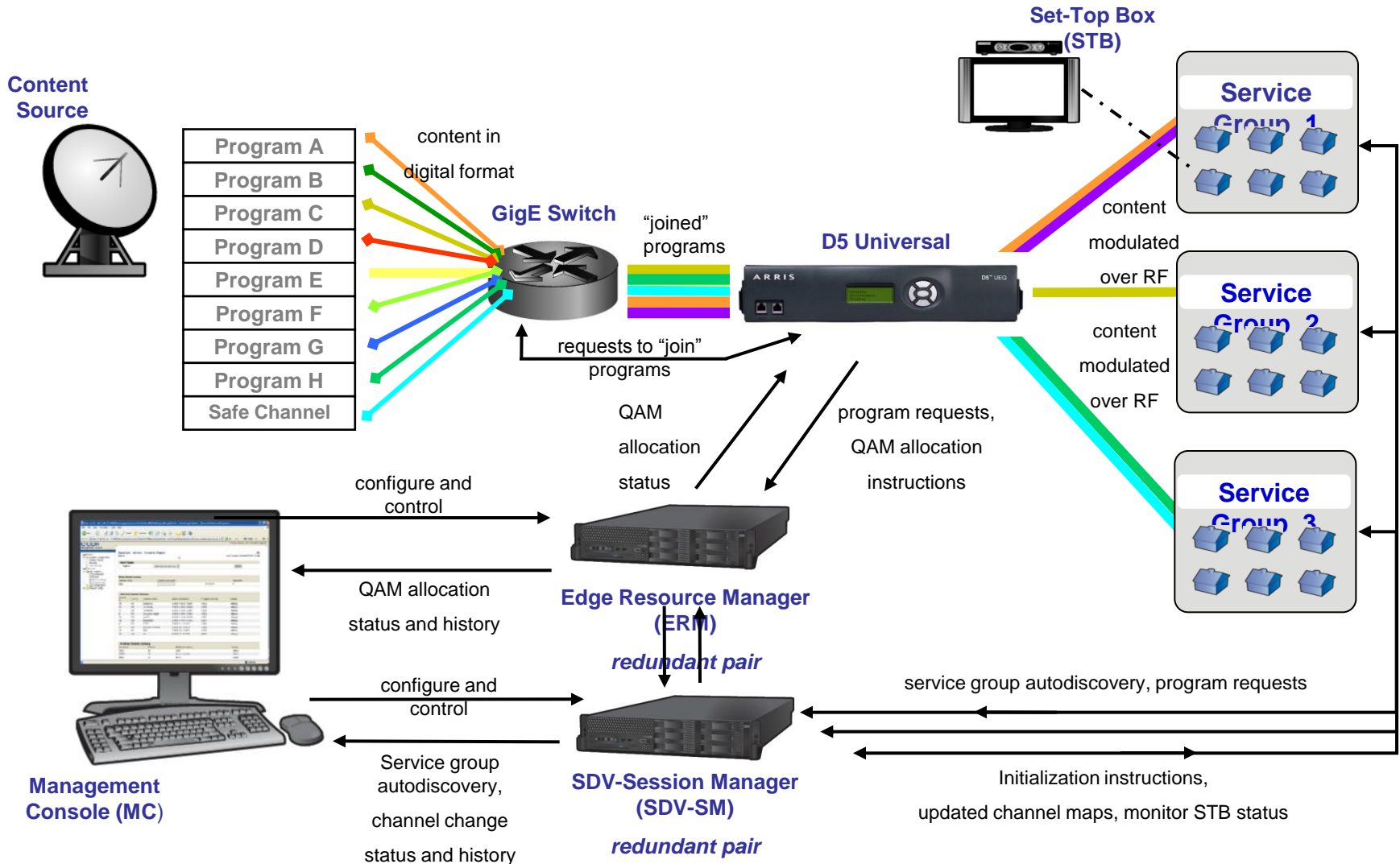


# SDV ERM Application

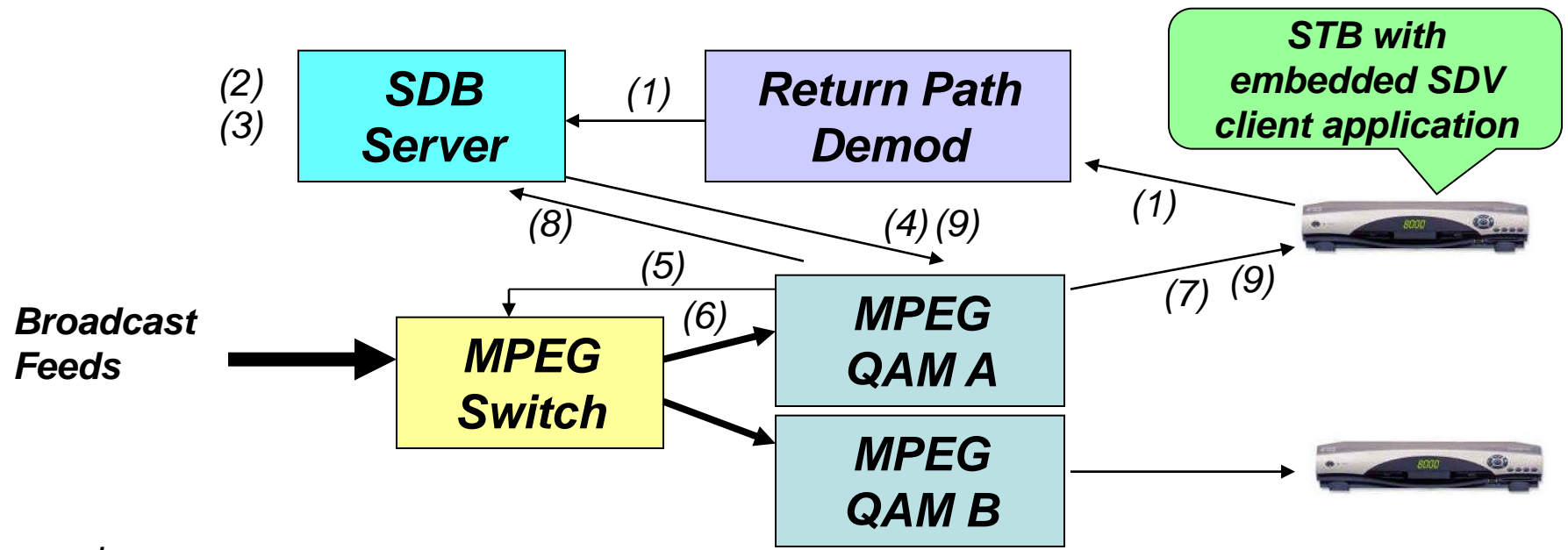


MCP – Mini Carousel Protocol  
 CCP – Channel Change Protocol

# How does Switched Digital Video (SDV) work?



# How does Switched Digital Video (SDV) work?



**Legend:**

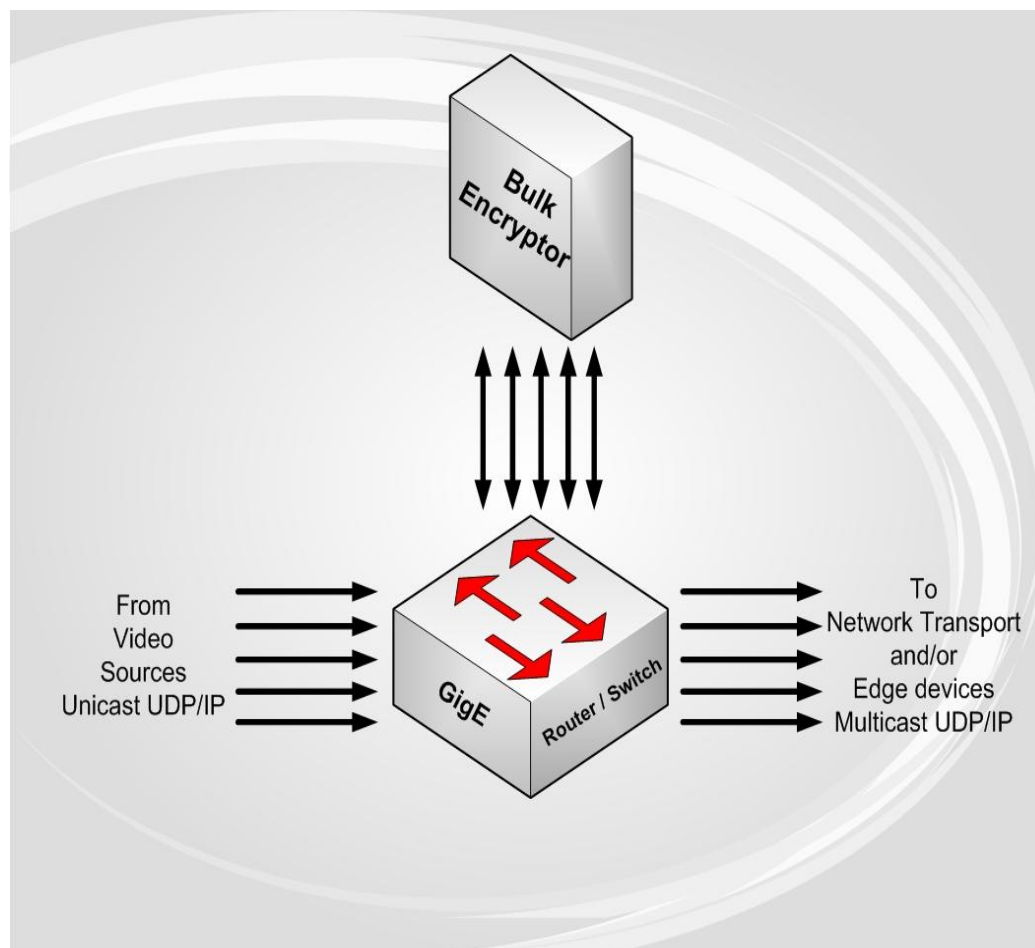
1. Session setup request from STB for Channel X in Service Group A
2. The SDB Server determines if Channel X is already in channel map for A – Yes, go to (9)
3. Session Resource manager in Server selects proper QAM for MPEG muxing change
4. Multicast “Join” command to selected QAM for channel X to join Service Group A
5. Multicast “Join” command to MPEG Switch – add Channel X to lineup
6. Channel X now included in MPEG mux to QAM A
7. Channel X now included in RF output from QAM A
8. QAM A confirms Multicast “Join” to Server
9. New channel map loaded into MPEG tables for STB – STB receives new map and tunes to X

# Staging Processor

- Is a grooming and video transrating device, which takes in and aggregates the content from multiple sources, converts the variable bit rate (VBR) video streams to constant bit rate (CBR) streams, de-multiplexes the multi-program transport streams (MPTS) and delivers the streams as CBR, single program transport streams (SPTS) over UDP/IP
- Can insert local digital advertisements into the converted content
- Can multicast or unicast the SPTS streams as required
- Sends the SPTS video streams out to a Gigabit Ethernet switch. The streams that need to be encrypted are sent out unicast to a bulk encryptor. The streams that do not need to be encrypted are sent out multicast

# Bulk Encryptor

- Accepts the video streams in the clear, over UDP/IP as unicast streams, and sends them out as encrypted UDP/IP multicast streams over GigE interfaces
- May also be used to generate multicasts for unencrypted streams to simplify network management



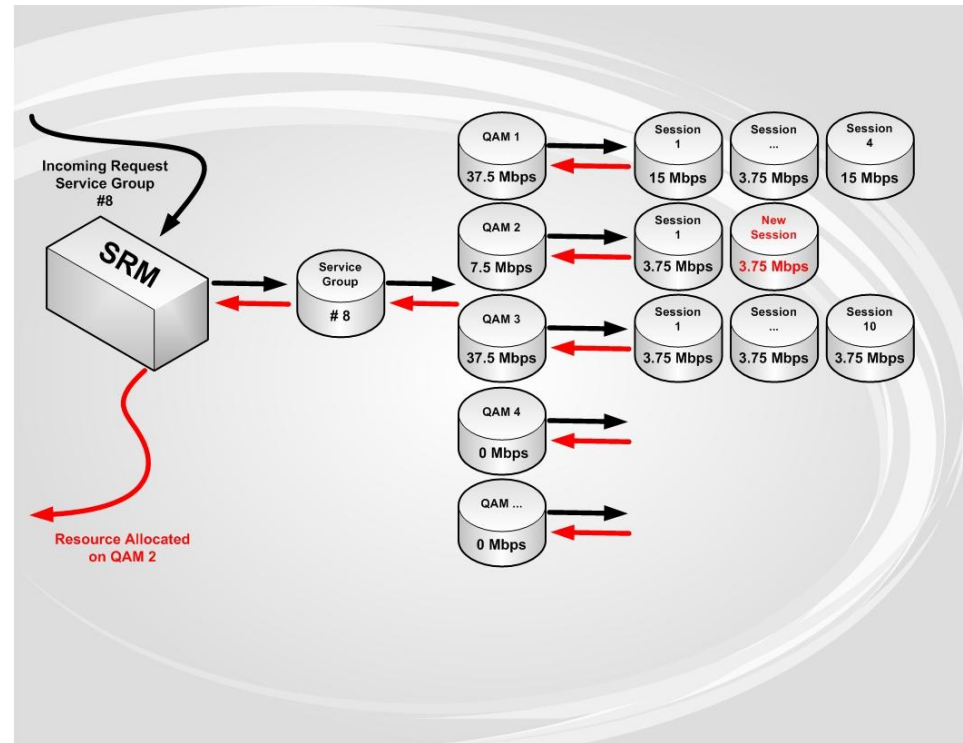
# Content Routing Network

- The actual switching in the SDV switched multicast system occurs in a standards-based layer 3 routed network
- Multimedia streams output by the staging processor are input to the routed network as SPTS IP multicasts or SPTS unicasts if bound for a bulk encryptor
- The content routing network may also carry IP multicast streams containing "mini-carousel" data, including server addresses and tuning information, which are generated by the SDV server
- The network, or at least the edge switch-router, must support version 3 of the Internet Group Management Protocol (IGMPv3)



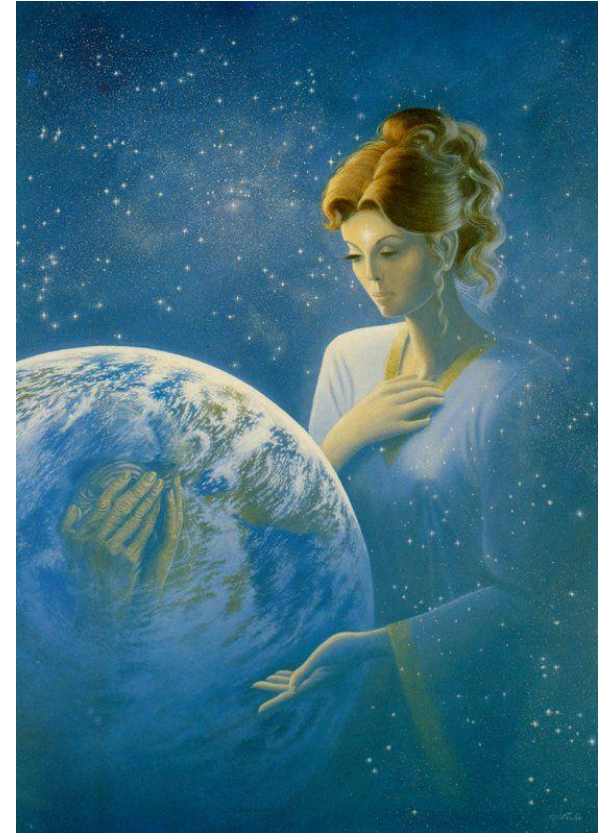
# Session Resource Manager (SRM)

- Allocates the QAM resources used for the SDV environment
- Usually resides in the head-end and is in constant communication with the SDV application server
- Can be shared by other applications as VOD, SDV or network PVR (nPVR)
- Can be configured to reclaim bandwidth that is not in use by any applications
- Can generate specific network usage reports and historical statistics, which help improve the network architecture and aid in SDV troubleshooting



# SDV Server

- Receives channel change requests for switched content from a set-top.
- Generates a repeating (carousel) file containing a list of services currently streaming
- Requires a connection to both the control network, for communication with other network elements including the clients, and also to the content routing network in order to make the mini-carousel IP multicast available to the SDV client via the content-carrying QAM modulators
- To prevent set-tops from accessing incorrect content due to outdated information



# SDV Set-top Client

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- The SDV client is a software component that should be fully integrated in the resident application of an SDV-enabled set-top box in order to make the SDV service transparent to the user
- The set-top box uses the QPSK or DOCSIS return channel network to send signals to the SDV servers, which contain information on channel change requests
- The SDV client enables the set-top to communicate to the SDV server using the SDV Channel Change Message Interface Specification (CCM)

# Universal Edge QAM Device

It is a device that allows MSOs a future direction for cost-competitive, all-digital migration and creates a common converged platform for an assortment of new services mostly based on video, data and voice.



# Common Qualities of a Universal Edge QAM Device

<b>Legacy</b>	<b>Universal</b>
<b>Low Density Edge QAM</b> - 8,16 QAM channels	<b>High Density Edge QAM</b> - 48, 72, 144, 192 and more QAM Channels
<b>DHEI, ASI, Single GbE input</b>	<b>Multiple GbE inputs</b>
<b>Proprietary or no Encryption/Scrambling support</b>	<b>Open Standards Compliance (NGOD, GQI, ITU, DVB, Cablelabs)</b>
<b>Only VOD, Standard Def, CBR support</b>	<b>QAM Sharing for HD/SD/CBR/VBR</b>
<b>Primitive Layer 3 TCP/UDP/IP support</b>	<b>Powerful Layer 2/3 TCP/UDP/IP support (IGMP, Snooping, MAC switching)</b>
<b>Limited to / No Redundancy features</b>	<b>Modular / Hot-Swappable / Redundant</b>
<b>Limited management features</b>	<b>Remote Ops via GUI / Telnet / SNMP / Radius /TACACS+ / Demod RF reports</b>
<b>No DOCSIS Support</b>	<b>M-CMTS DOCSIS 3.0 Downstream</b>
<b>High cost per QAM channel</b>	<b>Lots of QAMs, Small RU, Low Power Use</b>

# Next Generation Edge QAM must:

- **High density, multi-service Edge QAM**

- Increased # of QAM channels
- Decreased Rack space
- Low Power Use

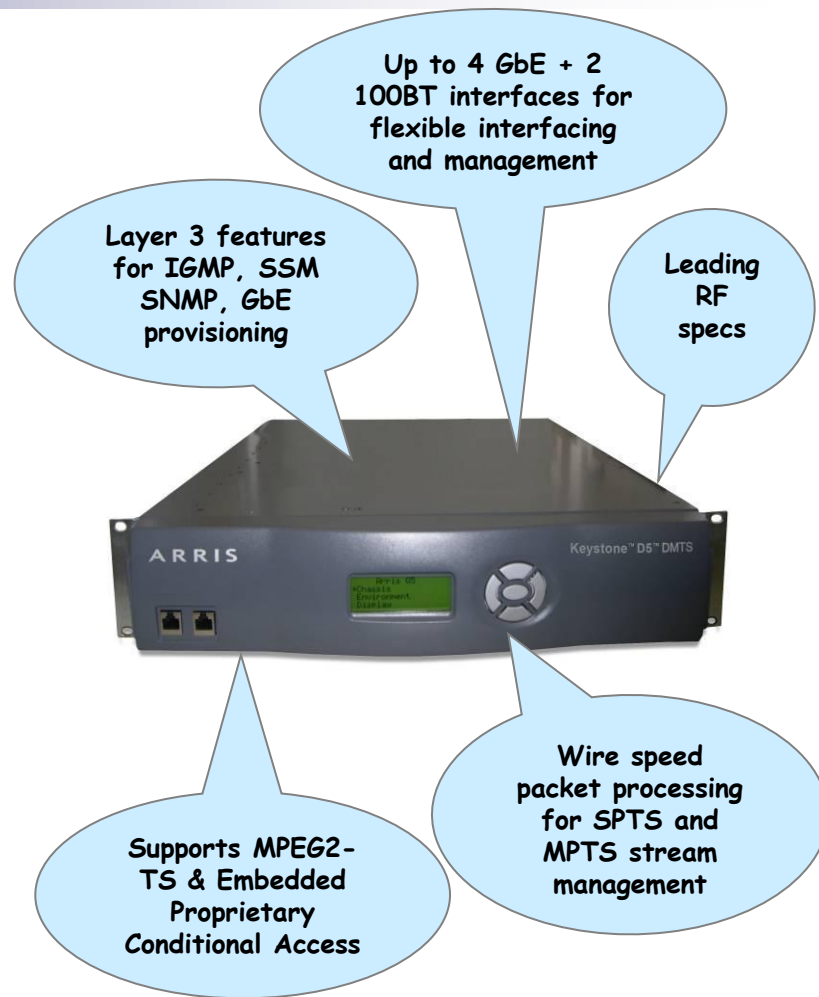
- **Modular architecture allows flexible configurations**

- Cost effective for a variety of applications
- Software only field upgrades for future IP multimedia processing requirements
  - VOD, SDV, Broadcast, DOCSIS, etc

- **Redundancy features for all single points of failure modes**

- **Extensible for M-CMTS Compliance & QAM sharing**

- **Advanced GUI Tools**

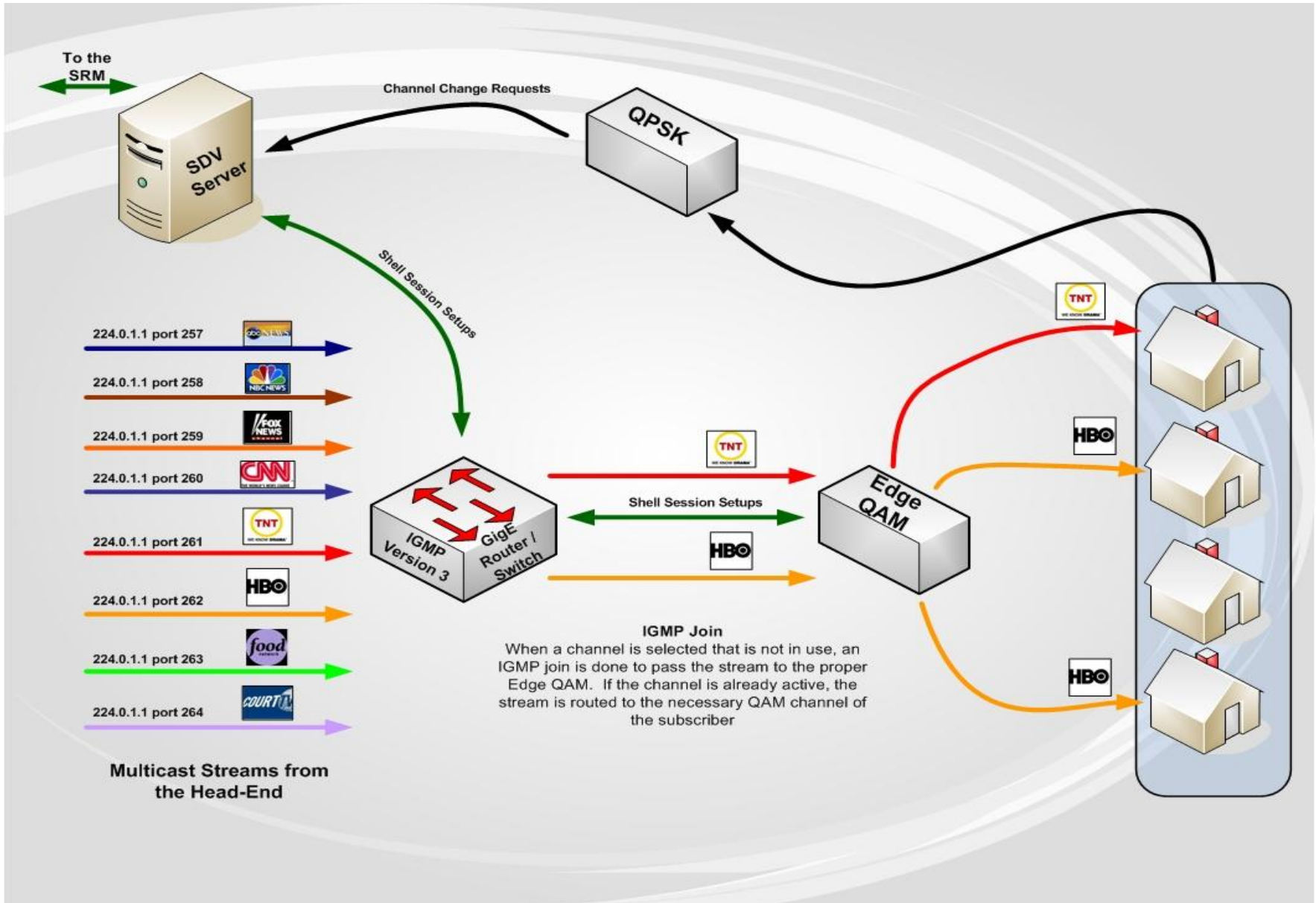


# Other Possible Universal Edge QAM Features



- Superior Jitter Tolerance
- Multiple, flexible modes of UDP port mapping for VOD and SDV support (static and dynamic mapping)
- Multiple RF configurations per unit (QAM card level)
- Channel muting (e.g. 1, 2, 4 active channels per bond)
- Superior RF specifications (e.g. M-CMTS/DOCSIS 3.0 specs DRFI compliance)
- Stream Replication (e.g. directed or all channels)
- Full Spectral Range Support
- Simultaneous Multi-feature support (e.g. VOD, SDV, passthru, M-CMTS data)

# IGMP v.3 Diagram



# IGMPv3 Switching

**Session Resource Manager dynamically maintains**

**Dual Content Sources  
192.168.17.100 and 101**

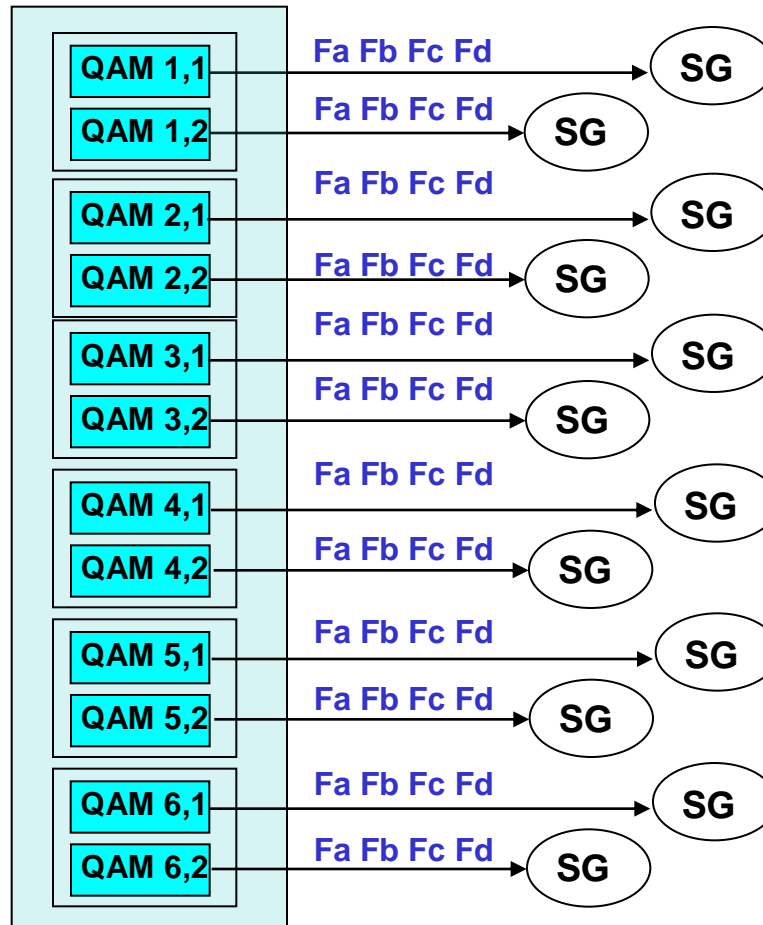
Program	IP Multicast Address	Source Address	Always On
Ch1	225.0.1.1 port 20001	192.168.17.100	Yes
Ch1	225.0.1.2 port 20002	192.168.17.101	Yes
Ch2	225.0.1.3 port 20003	192.168.17.100	Yes
Ch2	225.0.1.4 port 20004	192.168.17.101	Yes
	""	192.168.17.10x	No
	""	192.168.17.10x+1	No
Ch70	225.0.1.71 port 20071	192.168.17.100	No
Ch70	225.0.1.72 port 20072	192.168.17.101	No
	"" ""	192.168.17.100	No
	"" ""	192.168.17.101	No
Ch149	225.0.1.140 port 20140	192.168.17.100	No
Ch149	225.0.1.141 port 20141	192.168.17.101	No
Lc2	225.0.2.2 port 20002	192.168.17.100	No
Lc2	225.0.2.3 port 20003	192.168.17.101	No
Lc3	225.0.2.130 port 20003	192.168.17.100	No
Lc3	225.0.2.130 port 20004	192.168.17.101	No
"	"	"	"

**D5 processes joins very fast for no noticeable difference from linear Broadcast !**

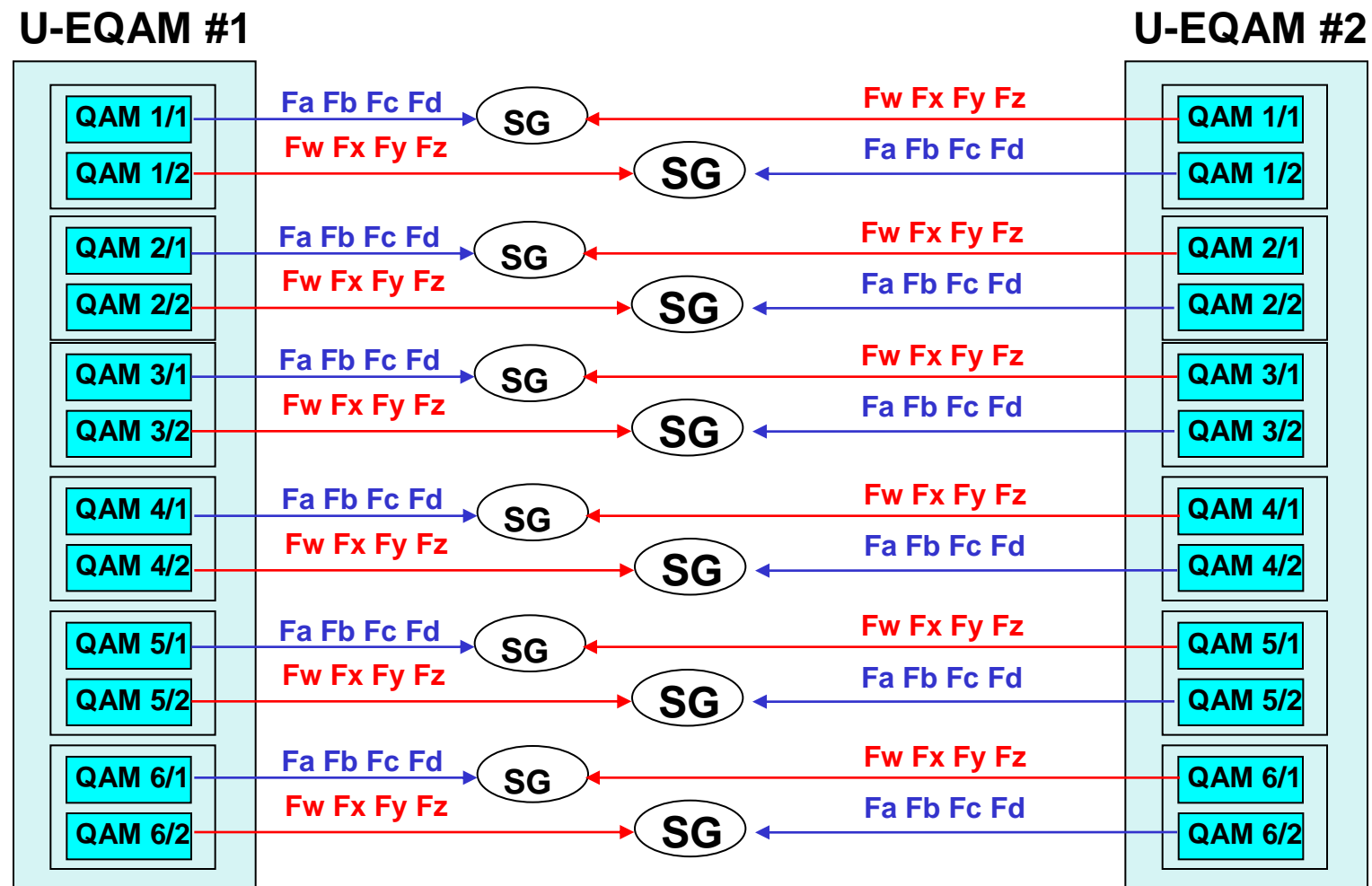


# Tell Me about QAM Striping

# No Striping - Chassis Deployment

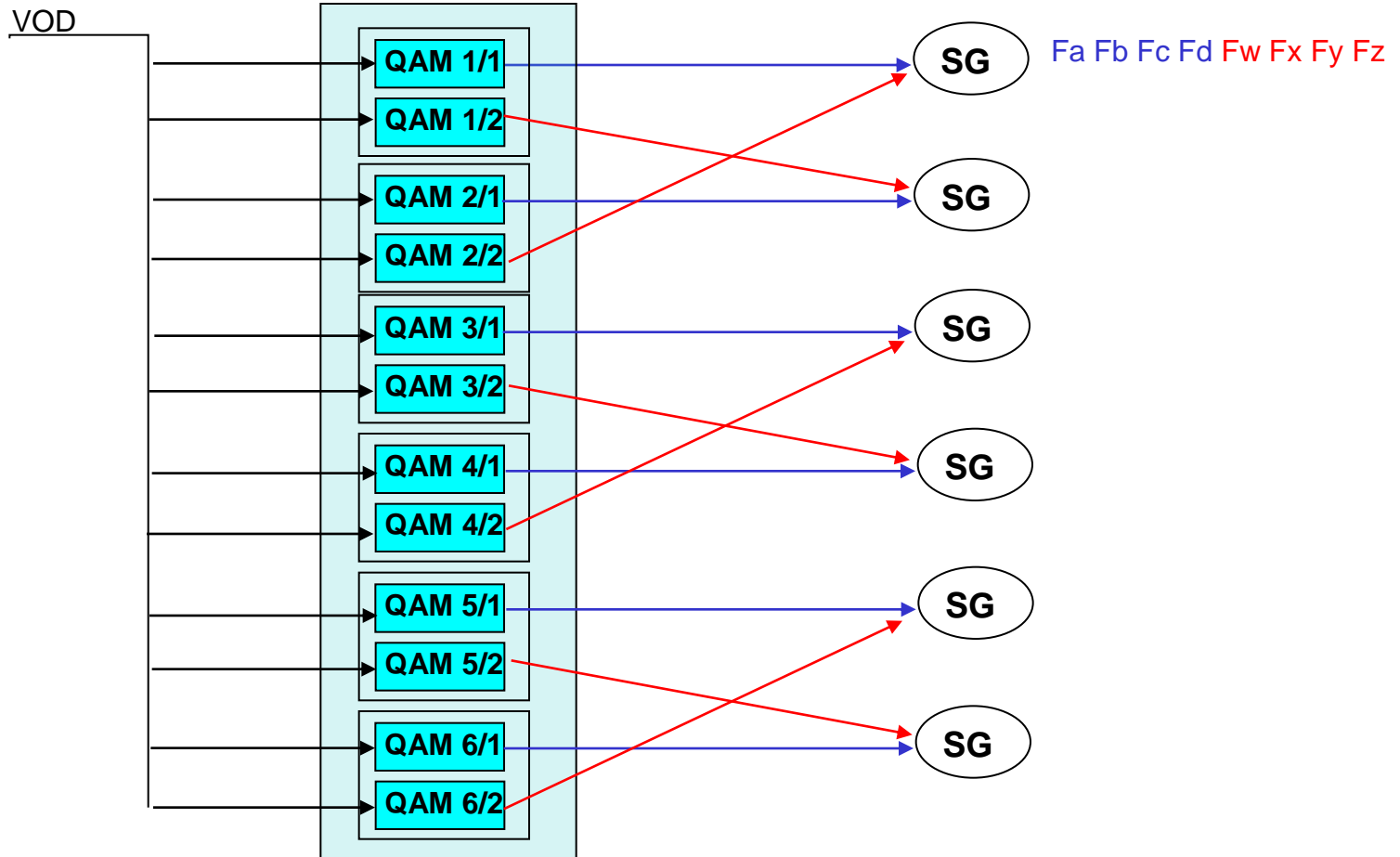


# Inter-Chassis QAM Striping



*Based on a model of 4 QAMs available per F-connector*

# Intra-Chassis QAM Stripping





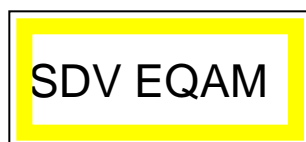
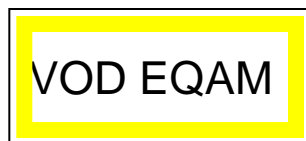
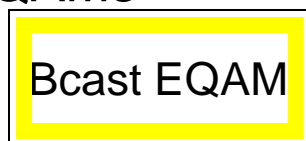
# Tell Me about QAM Sharing

# Benefits – QAM Infrastructure Sharing

■ Past  Present  Future 

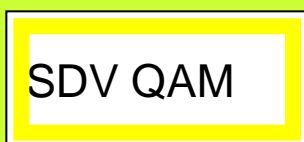
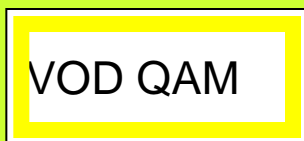
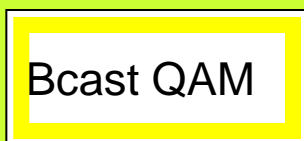
Separate

EQAMs



- No QAM sharing
- Each service uses different EQAM

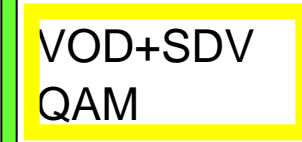
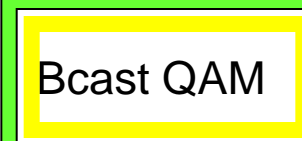
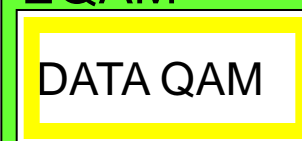
Shared EQAM



- Inter QAM sharing
- Single EQAM supports Broadcast, VOD and SDV services
- SRM and ERM coordinate separate VOD/SDV sessions on separate QAM channels

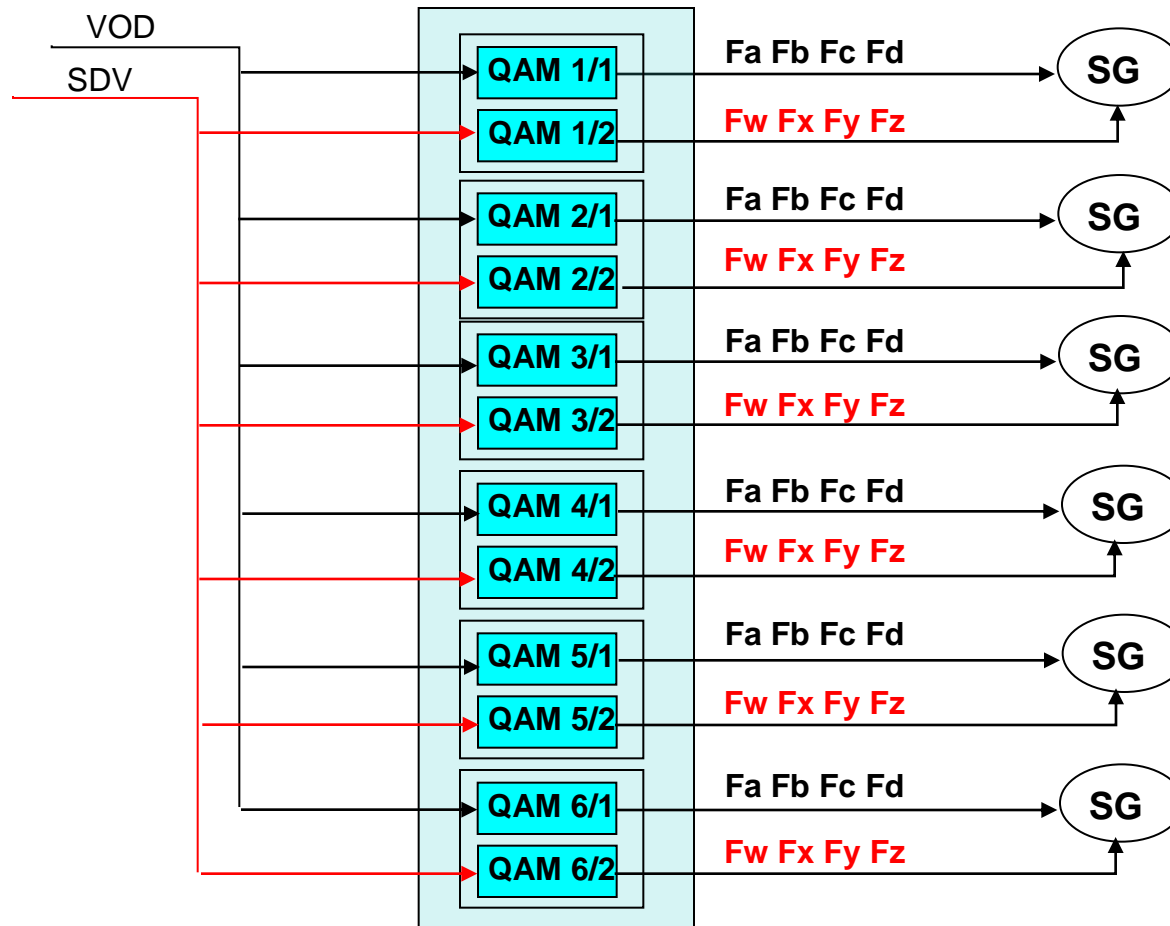
Universal

EQAM

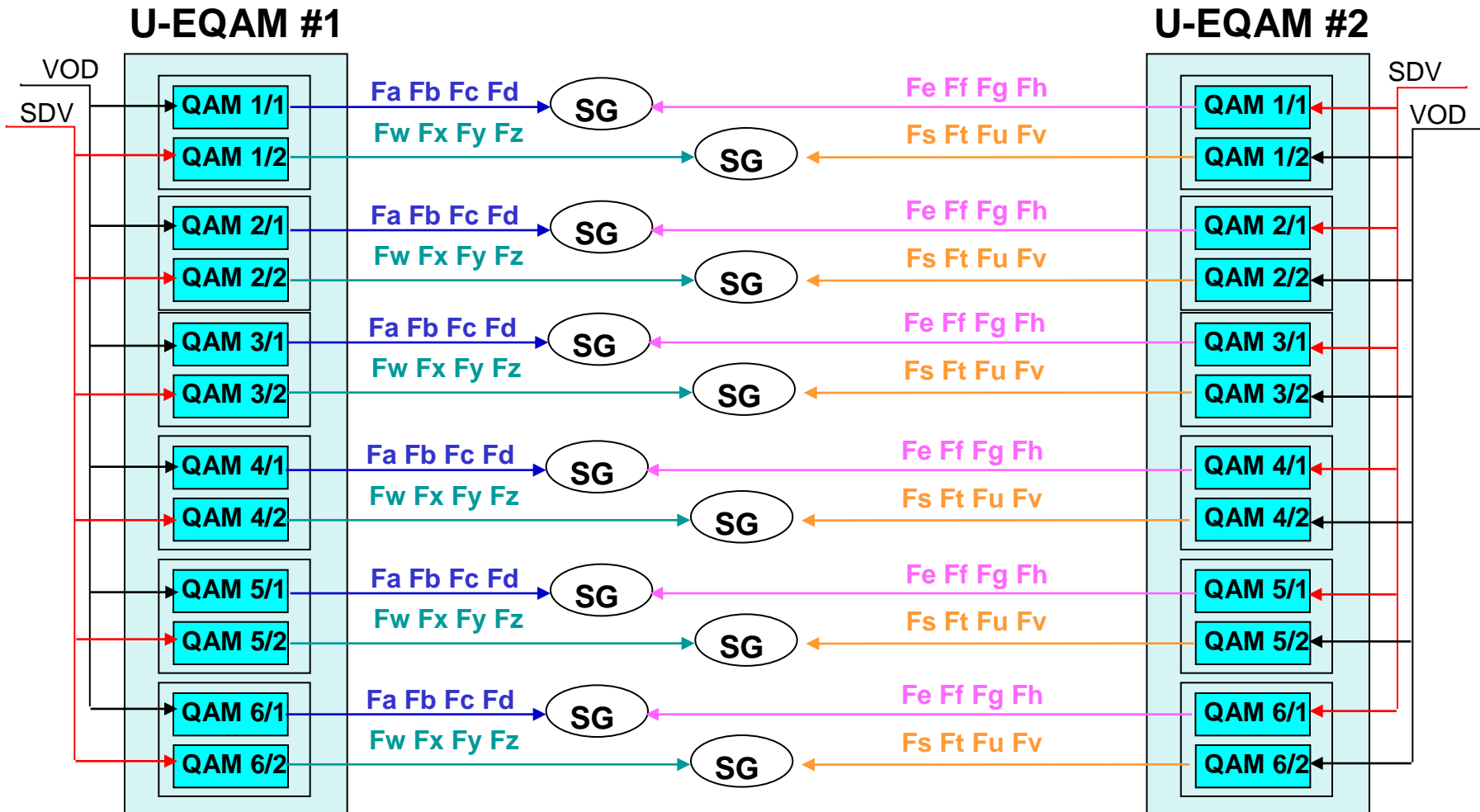


- Intra QAM sharing
- SRM/ERM coordinates VOD and SDV on same QAM channel
- DATA on separate QAM channels

# QAM Sharing - 4 QAM SDV & 4 QAM VOD



# SDV/VOD QAM Sharing & Chassis Striping



*Based on a model of 4 QAMs available per F-connector*

# SDV needs to have Redundancy!!!!

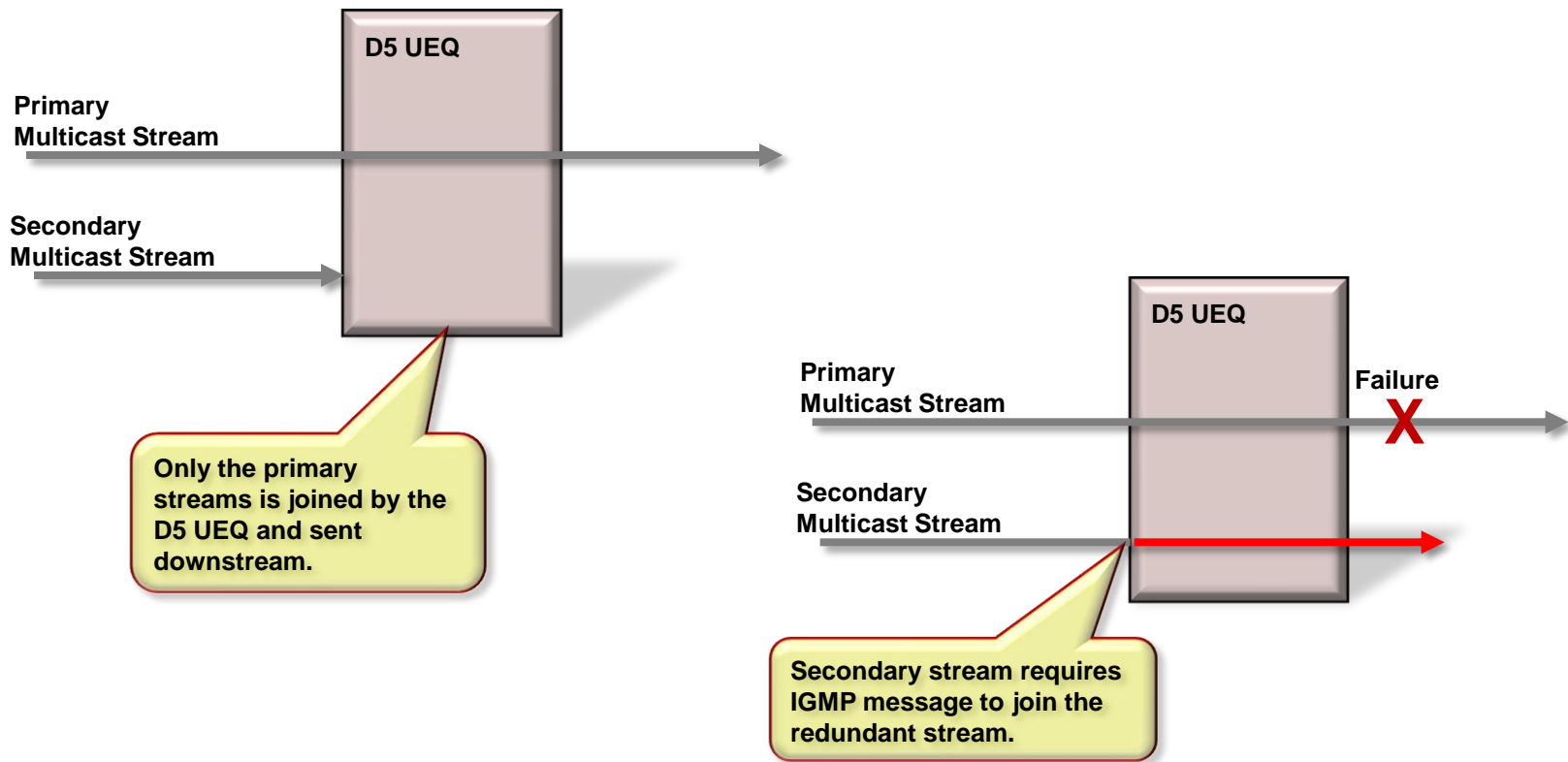


# Redundant Multicast Streams

- **D5 UEQ has the ability to identify a dropped multicast stream and attempt to join a secondary multicast stream with the same content**
- **Two methods available:**
  - **Hot/Warm – joins only one multicast stream at a time.**
    - **Less bandwidth intensive but takes longer to recover to a redundant stream**
  - **Hot/Hot – joins multiple multicast streams of the same content.**
    - **Requires more bandwidth (2 to 3 times more) but recovery time has no impact on the customer**

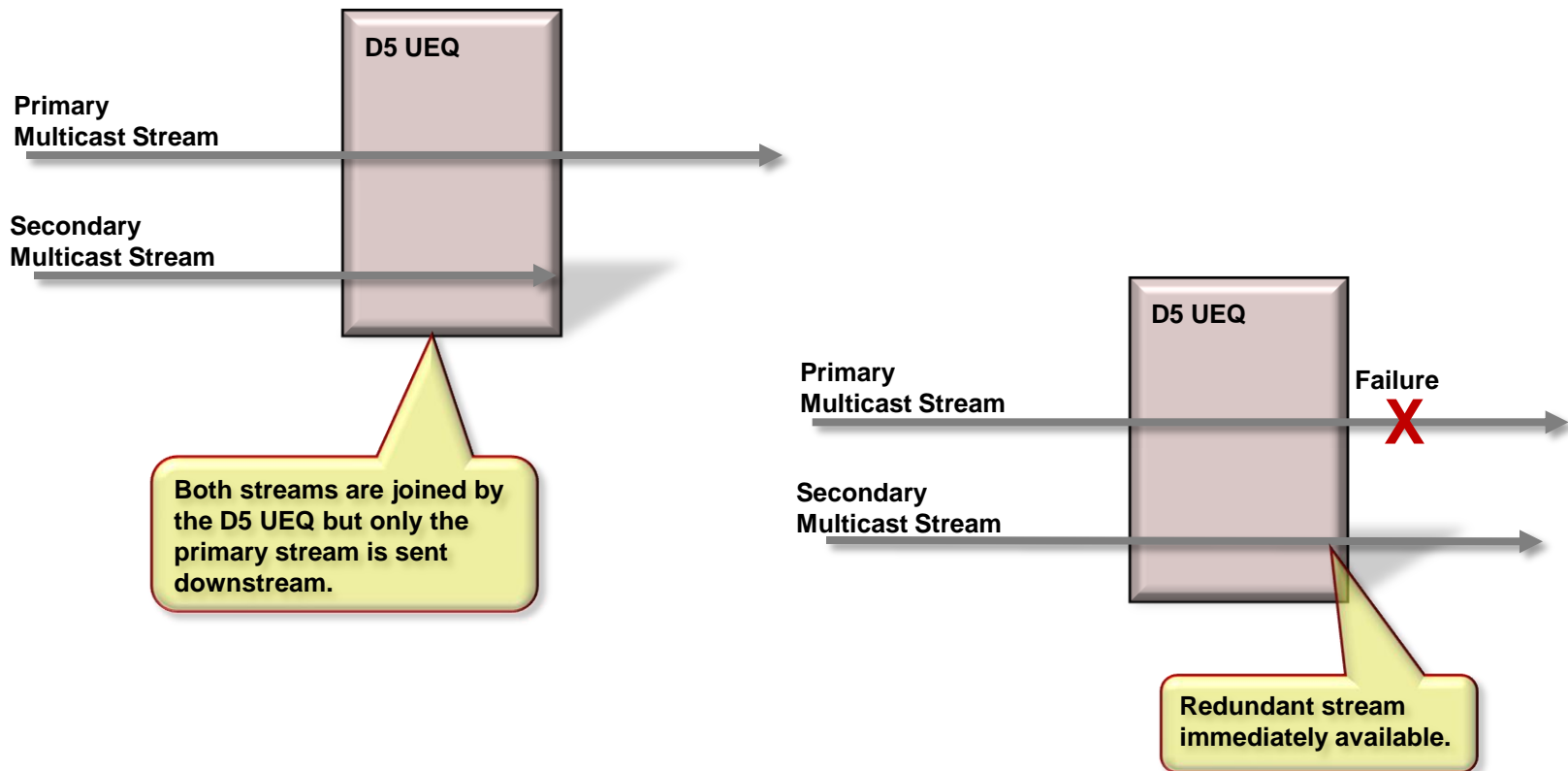
# Hot/Warm

- Hot/Warm – joins only one multicast stream at a time.



# Hot/Hot

- Hot/Hot – joins multiple multicast streams of the same content.



**SDV could be complicated.**

**Where are my  
Operational  
Tools?**



IMAGEBANK  
IMAGEBANK

# Operational GUI Tools

- From Configure → Operations → Global Video Management, configure redundant multicast streams.

Logon: **Video Manager**

Monitor Configure SDV CAS Device Info Access Management Startup Configuration Help

**Global Video Management** Refresh Apply Changes

*Video (PSI) Transmission Interval*

PAT:  milliseconds

PMT:  milliseconds

CAT:  milliseconds

NIT:  milliseconds

SDT:  milliseconds

*Video (PSI) Auto Generation*

PAT:  ▼

PMT:  ▼

CAT:  ▼

NIT:  ▼

SDT:  ▼

*Video Network Attributes*

Network ID:

Network Name:

Original Network ID:

NIT Packet ID:

*MPEG Manager Video Attributes*

Maximum Programs/Stream:	<input type="text" value="63"/>	Jitter Depth (milliseconds):	<input type="text" value="500"/>
Stream Timeout Interval (seconds):	<input type="text" value="10"/>	Bandwidth Over Subscription Margin (Kbps):	<input type="text" value="0"/>
Disallow Reserved DVB PIDs in ES:	<input type="text" value="Enabled"/> ▼	Bandwidth Over Subscription Recovery:	<input type="text" value="Disabled"/> ▼
Automatic Cycling of PID Values on the RF:	<input type="text" value="Disabled"/> ▼	Filter CA Descriptors:	<input type="text" value="Disabled"/> ▼
Default UDP Port to QAM Mapping Scheme:	<input type="text" value="UDP"/> ▼	PCR Drift Correction:	<input type="text" value="Disabled"/> ▼
QAM Pass Through Mode:	<input type="text" value="Disabled"/> ▼	<b>Global Redundancy Mode:</b>	<input type="text" value="Hot/Hot"/> ▼
Fast PSI Updates at Expense of Repetition Interval:	<input type="text" value="Disabled"/> ▼	<b>SETUP Transport Selection:</b>	<input type="text" value="Wait-for-Primary"/> ▼

# Operational GUI Tools

- Example: Configure the RPC interface.

Switched Digital Video RPC Configuration Refresh Apply Changes

SDV Configuration		
SDV RPC Interface Enabled:	<input checked="" type="checkbox"/>	Line Protocol is down
Master SRM IP Address:	<input type="text" value="10.17.50.155"/>	TCP <input type="button" value="v"/>
Save SDV client response connections indefinitely. This avoids Port Mapper negotiation and maintains open TCP connectivity for RPC responses:	<input checked="" type="checkbox"/>	
Default RPC Timeout:	<input checked="" type="checkbox"/>	Default Value = 25000 ms
RPC Timeout Period(0-65535):	<input type="text" value="25000"/>	Milliseconds
QAM Model:	<input type="button" value="2x4-QAM v"/>	
	Requests Received:	0
	Responses Sent:	0
	Errors:	0
	SDV Errors:	0
	SDV Successes:	0

# Operational GUI Tools

- Example: Configure the serving group allocations on a QAM channel.

Monitor Configure SDV CAS Device Info Access Management Startup Configuration Help

**Transport Stream ID & Serving Group Allocation** Refresh Apply Changes

*NOTE: Duplicate TSIDs should be used with some caution because the use of such is not fully compatible with conditional-access encryption, channel-container replication, or PSIG. Where a TSID is ambiguous generally the DS matches the TSID to the lowest numeric QAM channel e.g. QAM 3/2.2 rather than QAM 3/2.3*

Allow duplicate TSIDs   Change TSIDs

QAM 1							
Port 1				Port 2			
.1	.2	.3	.4	.1	.2	.3	.4
1	2	3	4	5	6	7	8

QAM 2							
Port 1				Port 2			
.1	.2	.3	.4	.1	.2	.3	.4
9	10	11	12	20201	20202	20203	20204

QAM 3							
Port 1				Port 2			
.1	.2	.3	.4	.1	.2	.3	.4
17	18	30103	30104	30201	30202	30203	30204

QAM 4 is not present/configured

QAM 5 is not present/configured

QAM 6							
Port 1				Port 2			
.1	.2	.3	.4	.1	.2	.3	.4
60101	60102	60103	60104	60201	60202	60203	60204

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# Operational GUI Tools

- Set up IGMP version 3 on the desired GigE.

Steps	Notes
1. From the Configure → Multicast drop-down menus, launch the <b>Multicast Configuration</b> screen.	
2. Check the <b>Enable IGMP</b> box on the desired <b>GigE</b> interface.	

- Example: Configure a GigE for a multicast group.

Multicast Configuration Refresh Apply Changes

#	Interface	IGMP Enable	Version	Number Groups	Robustness	Max Query Response Time (1/10 sec)	Query Interval (1/10 sec)	Check IP Router Alerts	IGMP Querier Status	Routers Present
1	GbE1	<input checked="" type="checkbox"/>	Version 3	2	2	100	125	<input type="checkbox"/>	10.17.42.254 uptime: 4h51m - timer expires: 3m19s	
2	GbE2	<input type="checkbox"/>	Version 3	0	2	100	125	<input type="checkbox"/>	Not present	---
3	GbE3	<input type="checkbox"/>	Version 3	0	2	100	125	<input type="checkbox"/>	Not present	---
4	GbE4	<input type="checkbox"/>	Version 3	0	2	100	125	<input type="checkbox"/>	Not present	---

Configure Static Multicast Group

Interface:  Group Address:



Thank You!