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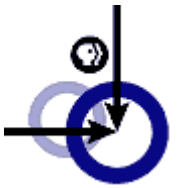


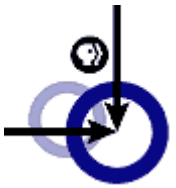
Compressed Video Data Manipulation

Jerry Berger
AgileVision

Terry Smith
Sarnoff Corporation

AgileVision

Outline



- Why work in the compressed domain?
- Challenges and past attempts
- New technology enablers
- Compressed domain splicing
- Logo insertion
- Rate control
- Applications
  - DTV MPEG master control
  - NTSC or DTV central casting

Evolution of Television

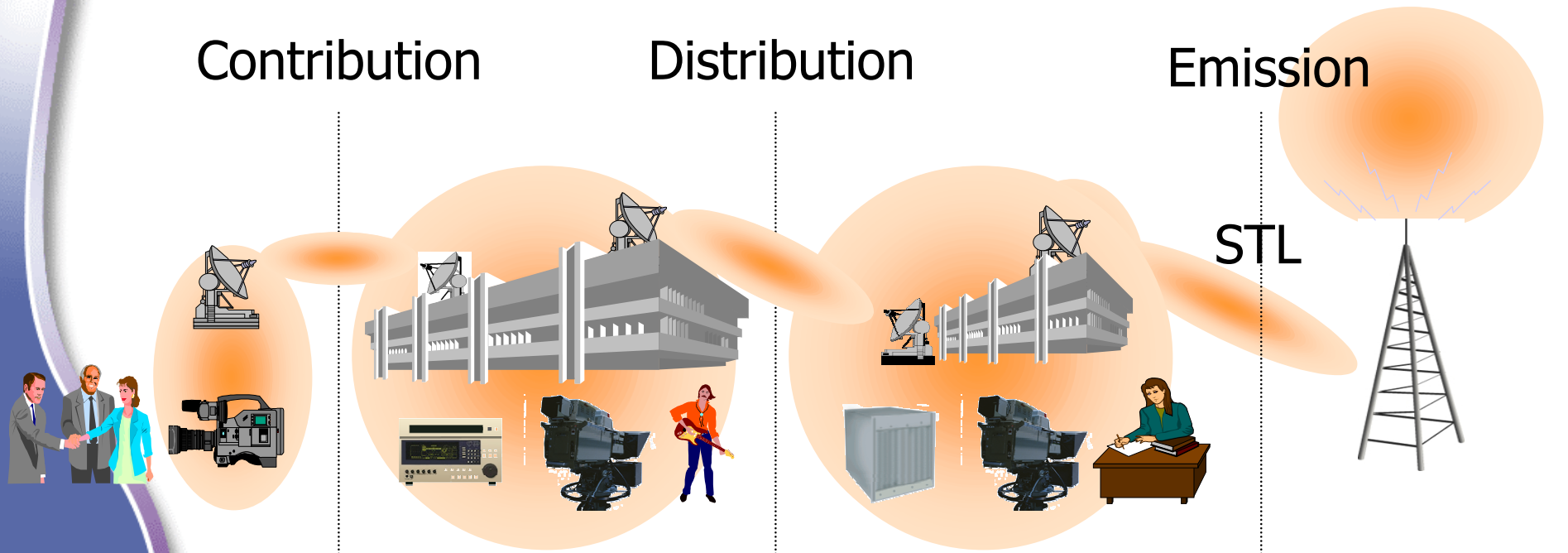
- **Analog NTSC**
  - Single format
  - Single program
  - Television only

- **DTV**
  - Multiple formats
  - Multiple programs
  - DTV + data and enhanced services
  - Distribution of compressed content

- **Discrete architecture**
  - Dedicated hardware components

- **Multi-function**
  - Scalable software systems

Production Flow



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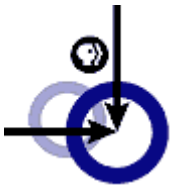
Why Work in the Compressed Domain?



- Quality
  - Original network quality delivered to home
- Cost savings
  - Transponder bandwidth
  - Reduced archive storage
- Simplify DTV transition
  - Greater choices available
  - Pass-thru with value added features
  - Scalable, upgradable system

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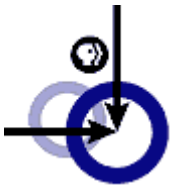

Challenges & Past Attempts

- Large collaborative research efforts independently targeted compressed domain processing for DTV
  - NIST HD broadcast technology ATP
  - Atlantic program
- MPEG and SMPTE sought approaches to provide station functionality at transport level
  - Splice point insertion and packet countdown
  - SMPTE 312

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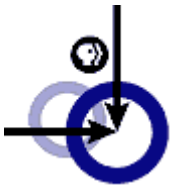
SMPTE 312



- Required pre-conditioning of compressed streams
  - *Identify valid splice points, set flag in transport packet*
  - *Insure that video buffer was well behaved at splice point*
- Because of buffer constraints and overhead, splice points were to be sparsely spaced
- Video buffer constraints could impact MPEG rate control and exhibit "pulsing" in video

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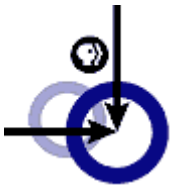
Technical Challenges



- Precision of splice point
- Latency response to splice command
- Ability to monitor at splice point
- Lack of local branding (logo insertion)
- Buffer management must be robust to avoid non-compliant streams and picture freezes

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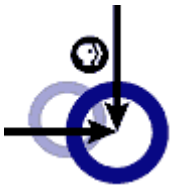
New Enabling Technology Trends



- New software-based products
  - *Larger level of software integration*
- Powerful general-purpose processors
  - *Ride Moore's law*
- Lower $/Gb of storage
- Better compression efficiencies
- Compressed stream manipulation

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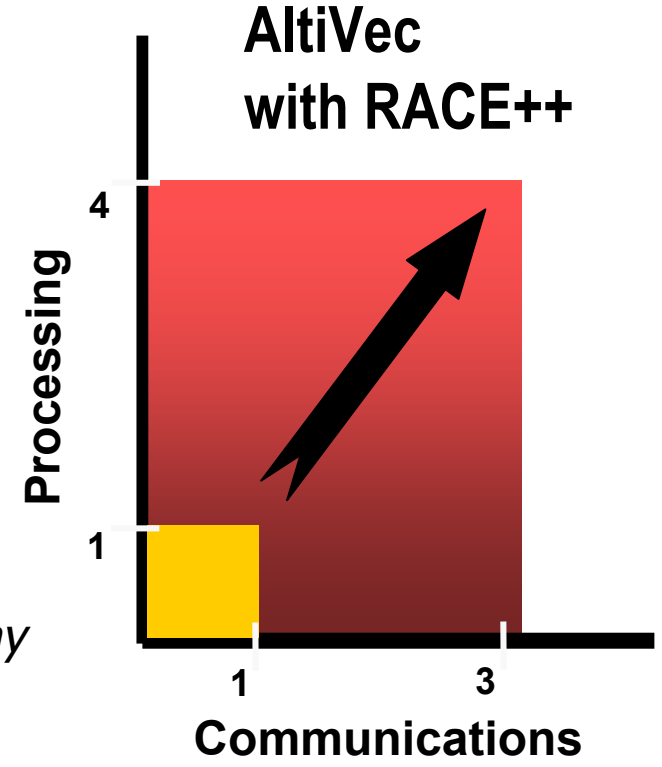
New Technology and Its Implications

- ***AltiVec™ technology***
  - *Motorola's parallel vector addition to the PowerPC processor*
  - *Performance boost: 4x on floating-point to 16x on pixels*
- ***RACE++™ switched interconnect***
  - *Follow-on to ANSI-standard RACEway*
  - *Performance boost: over 3x faster*



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AGV-1000

Hardware Overview

- Super computer with parallel processing
- Distributed memory architecture
- Scalable – Up to 28 Altivec™ PowerPC™ G4 Processors
- Up to 90 GFLOPS (90 Billion) calculations per second
- 16 PCI slots
- 12 SCSI Hot Swappable HDDs
- DVB ASI or SMPTE 310 Inputs/Outputs

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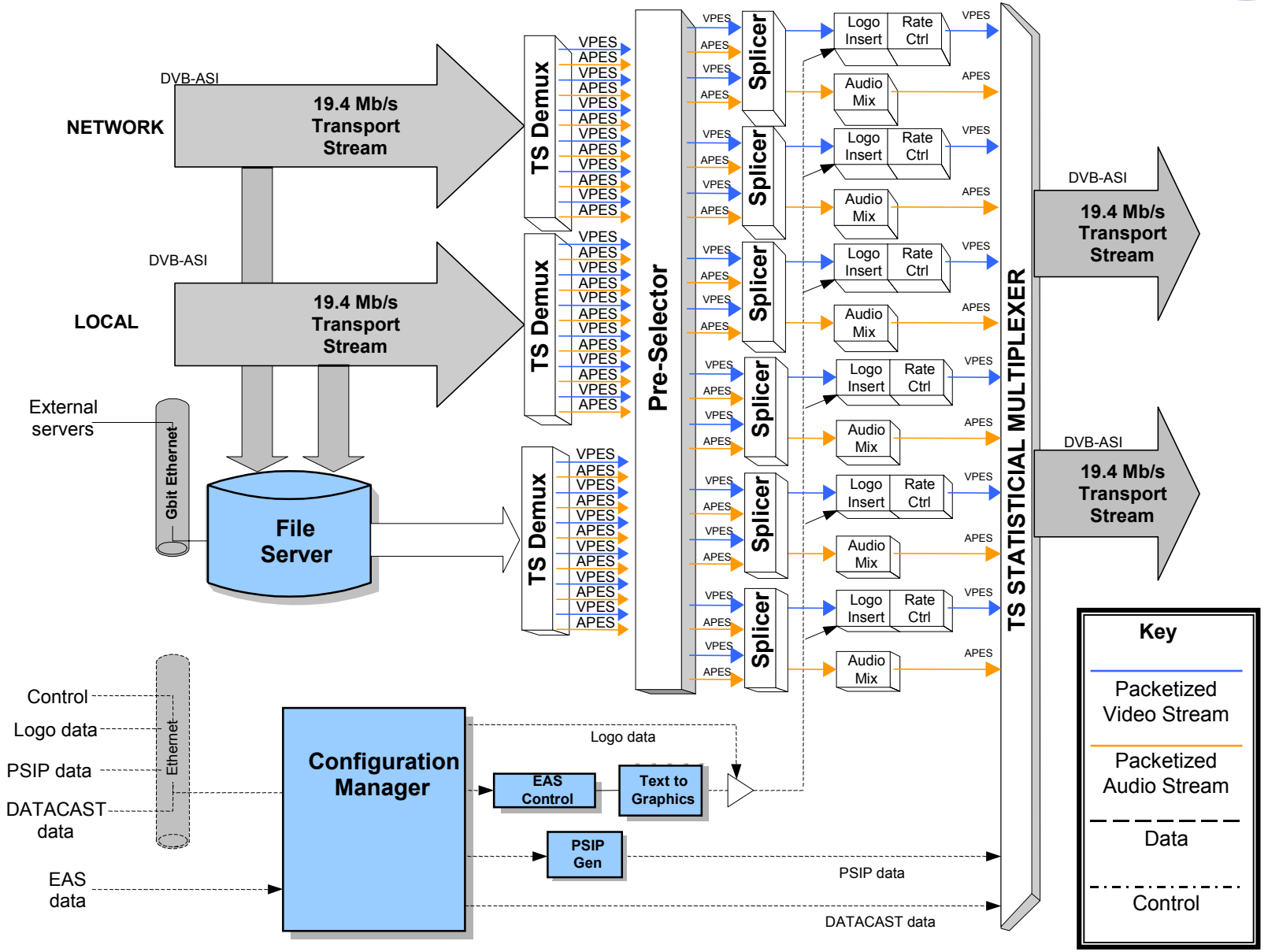
AGV-1000



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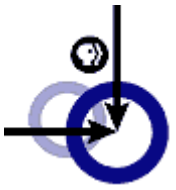
Configuration Manager



- Defines the product's feature set
  - Creates all components and data pipes
  - Maps components to processor
- Single interface to external control automation
  - Commands passed to individual components
  - Status messages returned

Control Automation Protocols

- New paradigm for control automation
  - Multiple functions in single platform
- AgileVision components mimic existing industry standard protocols
  - Louth VDCP for file server
  - Standard switcher for splicing
  - Character generator for logo insert

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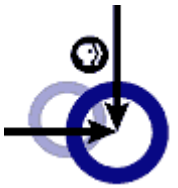
Compressed Domain Splicing



- Ability to switch to or insert program elements is a core station requirement
- To assure visually seamless operation, splicing must maintain compliance
  - MPEG Syntax
  - VBV Buffer Models

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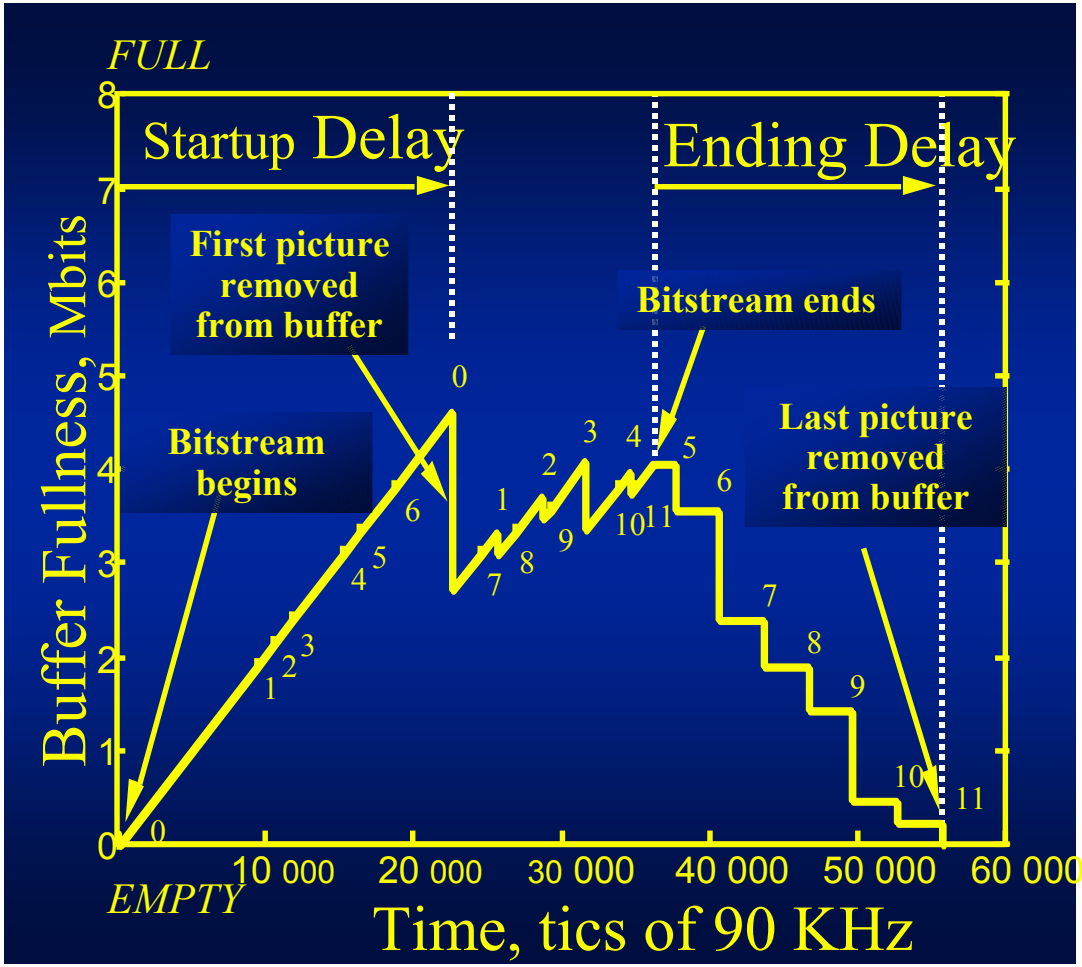
VBV Fullness Graph

- Fullness depends on input and output processes
- Output: instantaneous picture chunks every frame
- Input: continuous, or continuous until full, at a bitrate



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Correct Startup Delay Is Crucial!

When a decoder begins, the buffer is empty.

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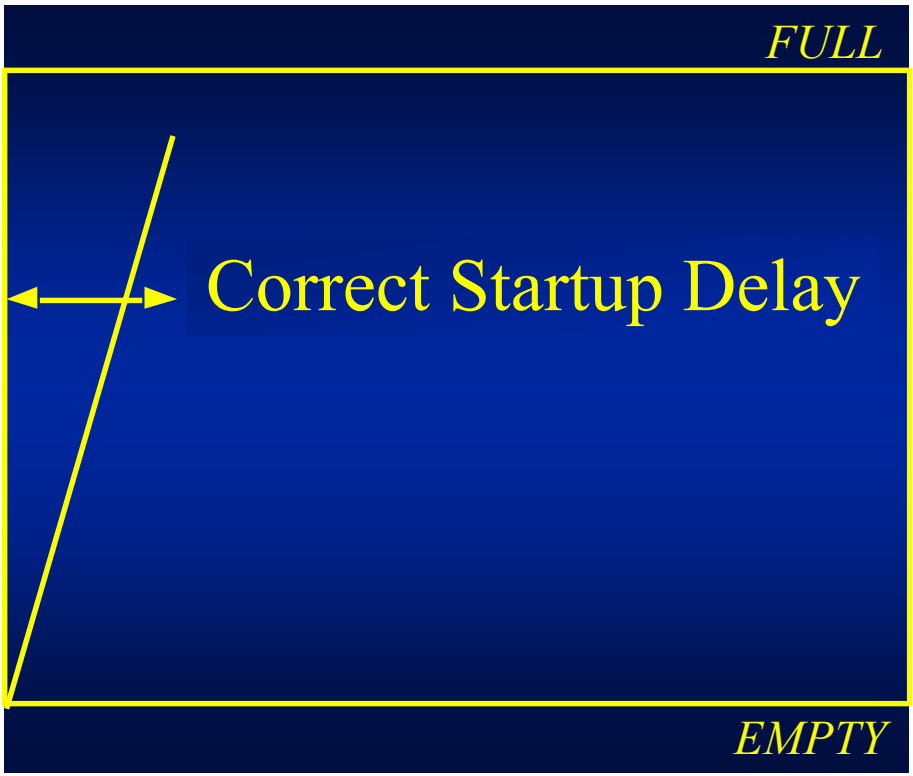
Correct Startup Delay Is Crucial!

The buffer fills without decoding for a time specified in the stream.



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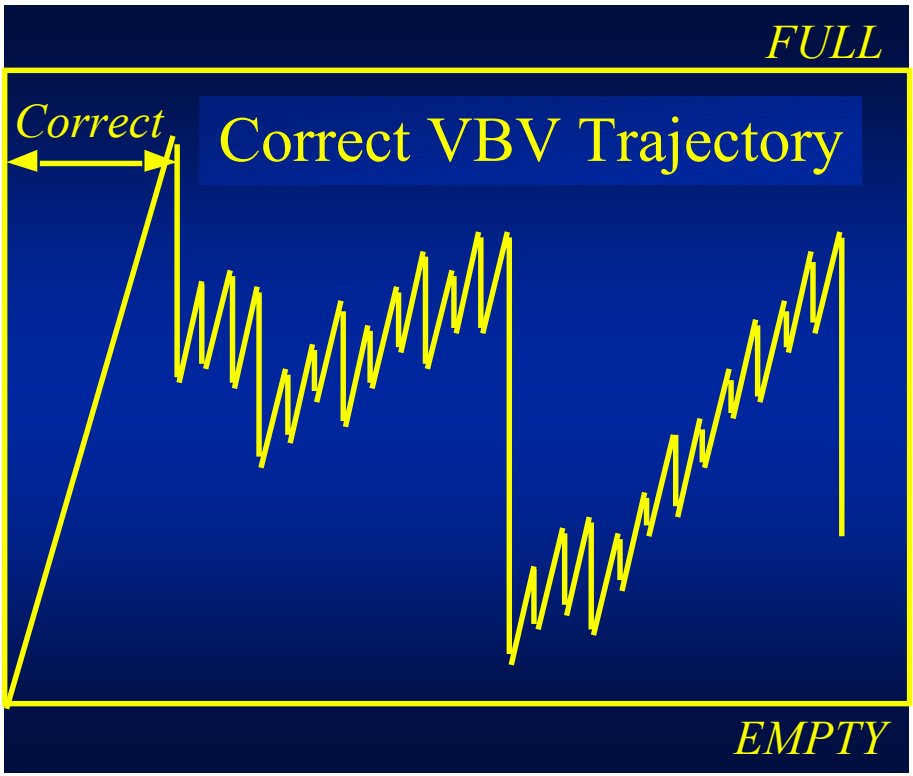
Correct Startup Delay Is Crucial!

The startup delay sets the correct initial buffer "bias" or "offset". Correct buffer bias is critical to avoid underflow and overflow!



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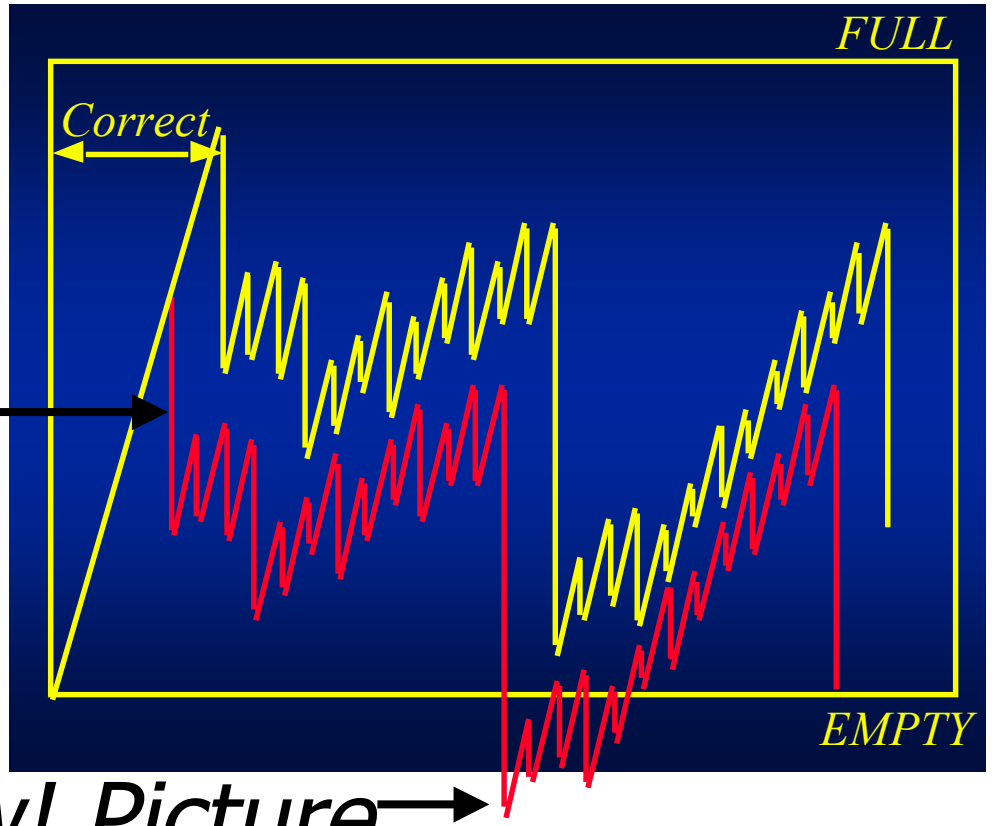
Correct Startup Delay Is Crucial!

If Startup is too short, the buffer may underflow later, causing the decoder to freeze and wait for more data.

Startup Delay too short



Underflow! Picture Freezes

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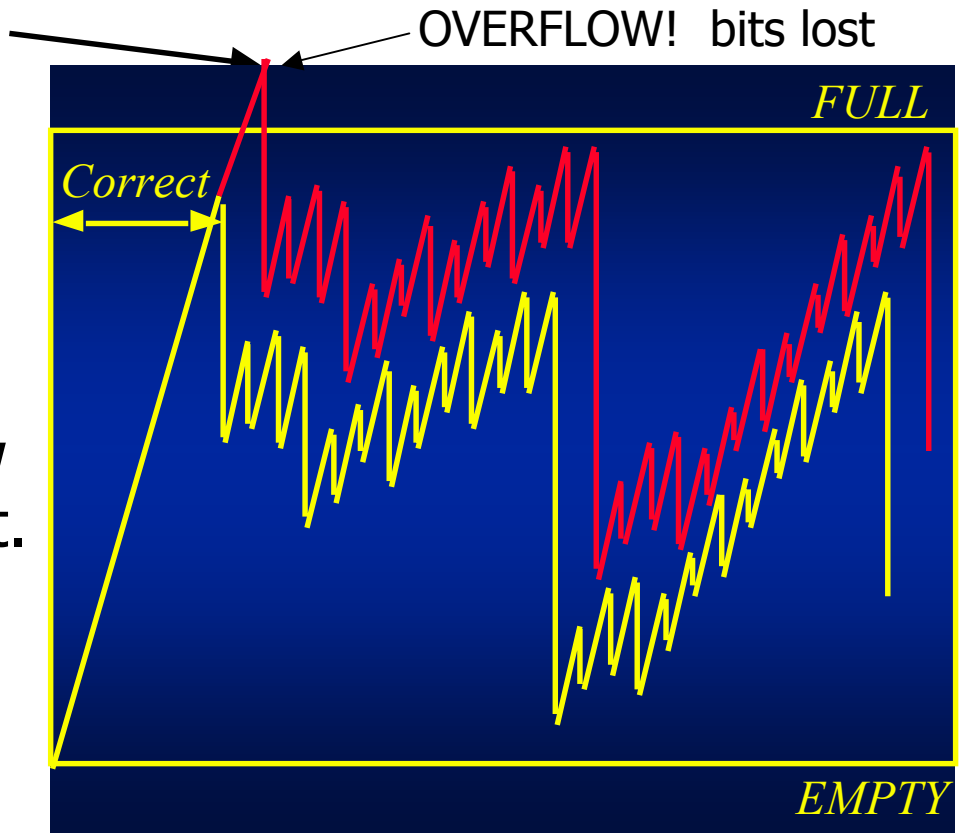
Correct Startup Delay Is Crucial!

Startup Delay too long

If the startup delay is too long, the buffer may overflow and data will be lost. This is *much worse* than buffer underflow.



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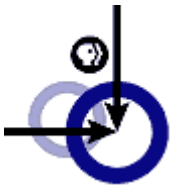
Video Splicing



- Compressed domain splicing with no degradation to picture quality
- Input streams are buffered and continuously evaluated for splice opportunities
  - SMPTE 312 splice points can be used - but not required
  - Splice out prior to any anchor (I or P) frame
  - Splice in on I frame
- Video streams constantly monitored to insure VBV buffer compliance

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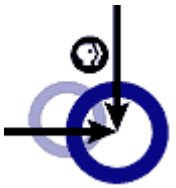
Audio Splicing



- Like video, audio splicer operates on frame boundaries
- Video splicer acts as master in responding to splice commands - audio slaved to video
- Splice command and synchronization information are passed to splice audio and other associated services
- PTS/DTS are restamped to preserve video/audio time relationship

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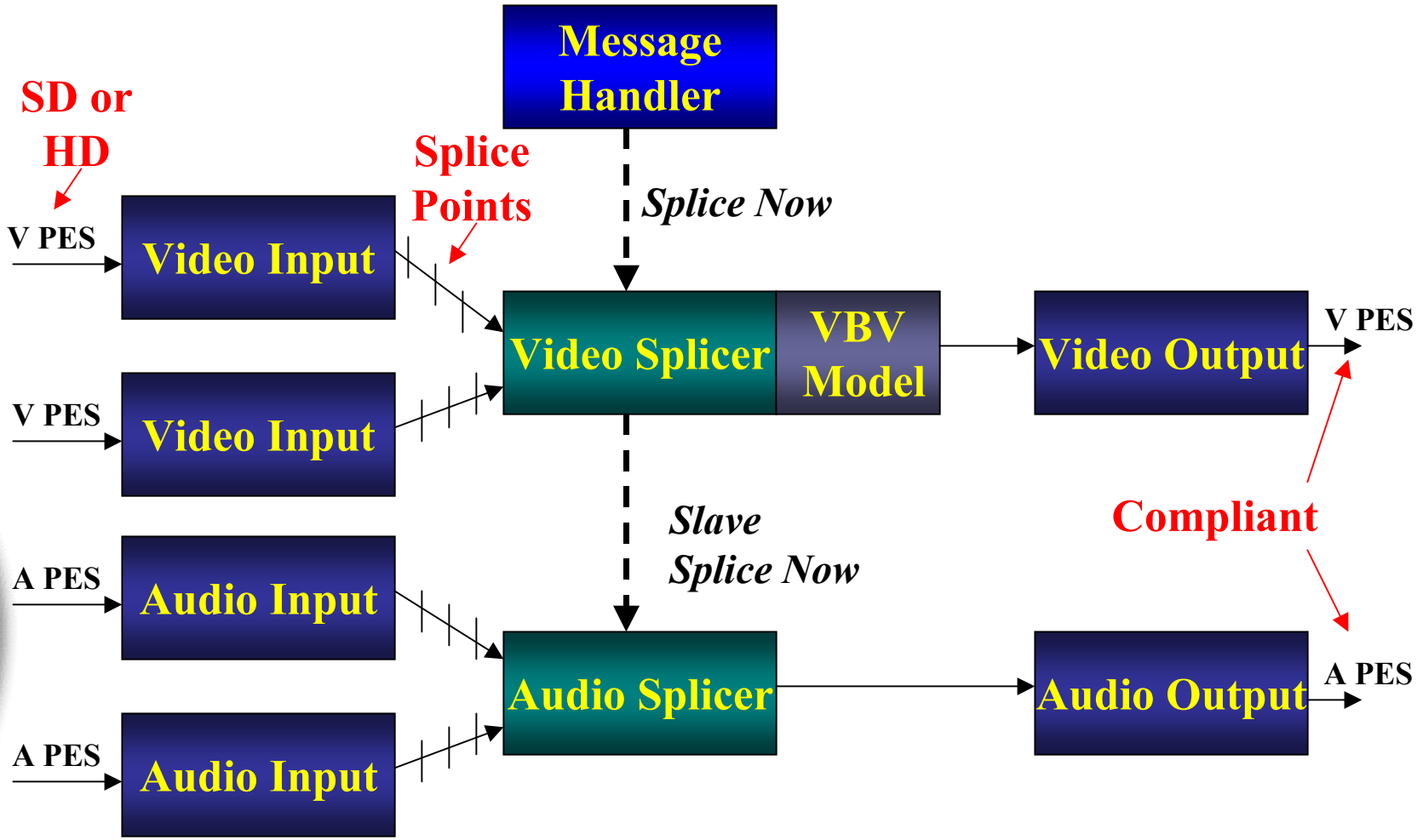
Seamless Splicing Architecture



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Seamless Splicing

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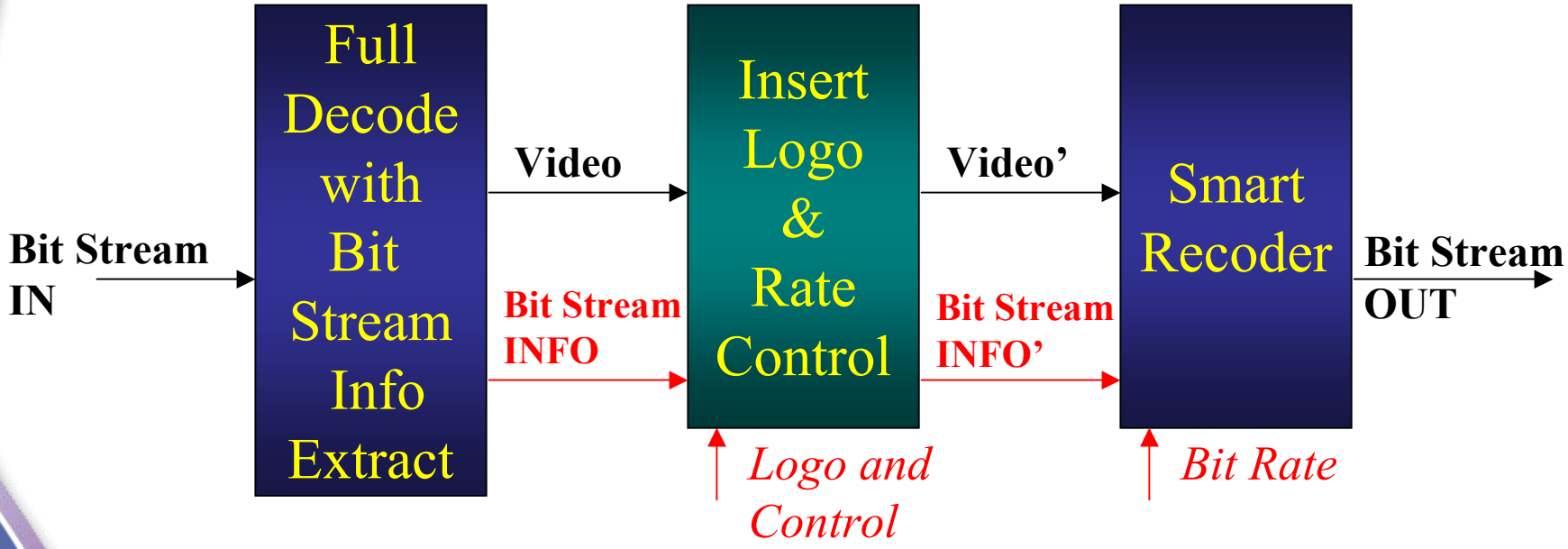
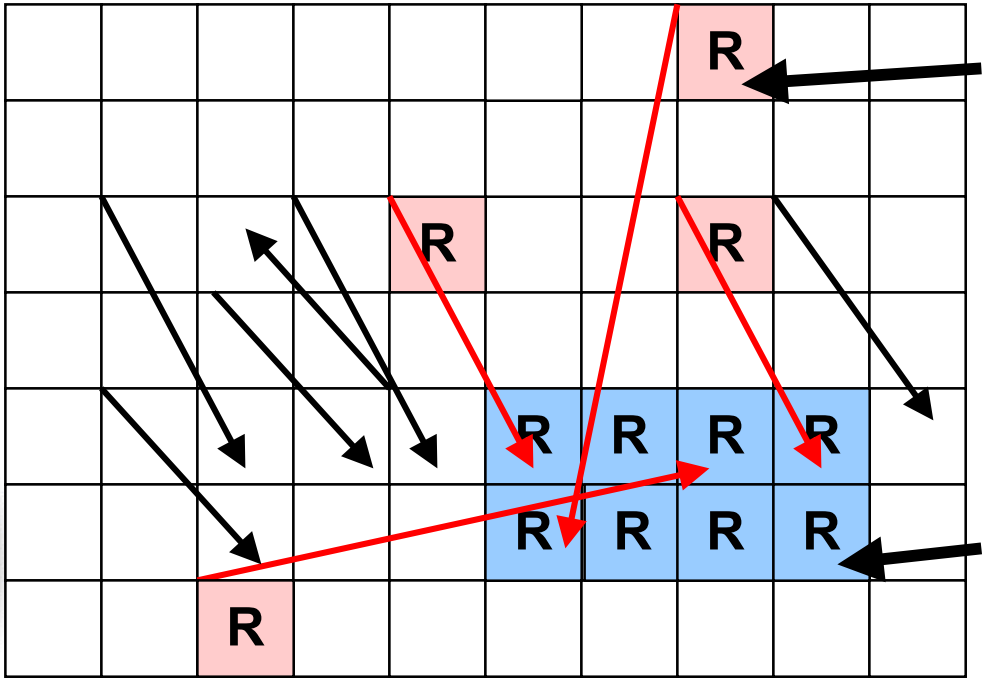
Logo Insertion Architecture



- Retains Original Bitstream Info to Preserve Picture Quality
- Like "Mole", but keeps all coding parameters inside one box
- Provides "Bug" Insertion and Text Message Crawl
- Allows High-Quality Bit Rate Reduction for "Grooming"

Logo Insertion and Rate Control

Decoder Delivers Pixel and MPEG Coding Info to Logo Insertion Component



Macroblocks that Reference the Logo/EMS Region are also Tagged for Recoding

Macroblocks in the Logo/EMS Region are Tagged for Recoding

Rate Control may also Modify MPEG Coding Info Prior to Smart Recoding Component

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Logo Insertion

Broadcast Product Roadmap

AGV-1000 – Encoding, Insertion & Branding

- Input Encoding
- Multi-Program Splicing
- Data Services
- Logo Insertion
- On Board Storage
- PSIP
- Multiple Interfaces

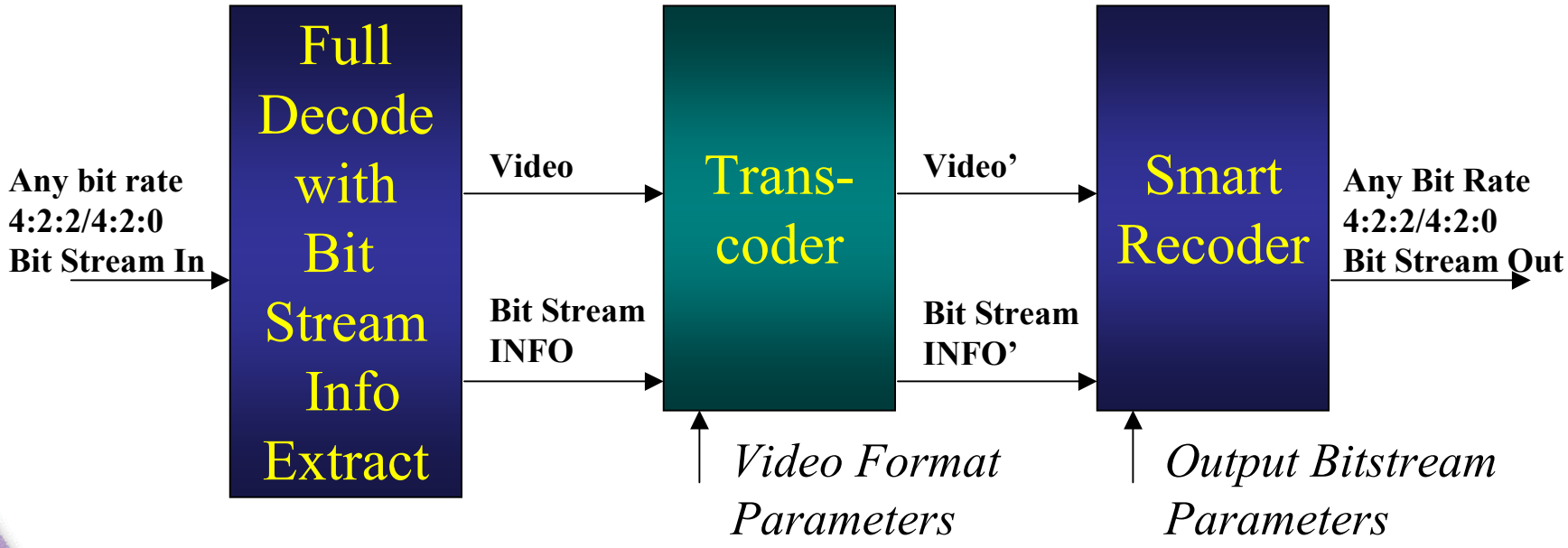
AGV-3000 - ->

- Advanced PSIP
- Error Monitoring
- Multi Transport Streams
- Transcoding
- Format Conversion

MPEG-2 Bitstream Manipulation

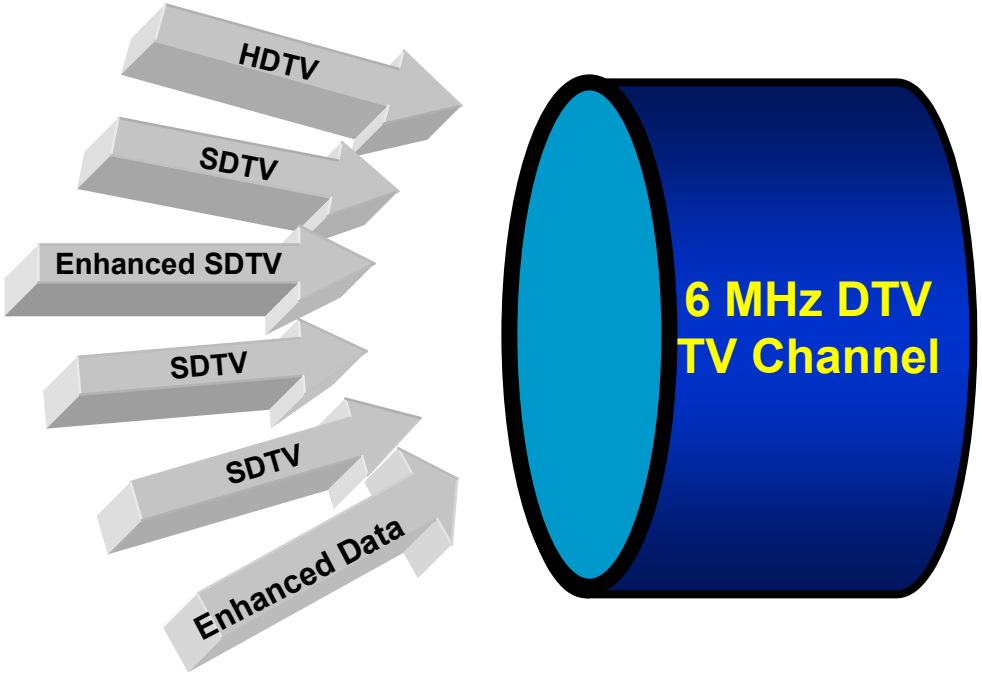
- GOP, bit rate, VBR/CBR, chroma format conversion
- Splices, wipes and dissolves
- Image size and frame rate conversion
- Logo and Message/Alert Insertion

Transcoding Architecture



- Architecture allows modifications to
  - Video format
  - Chroma format (4:2:2 to 4:2:0)
  - GOP structure
  - Bit rate with high-quality rate control

Capitalize on DTV's Opportunities



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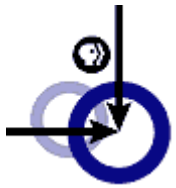

Applications
DTV MPEG Master Control

- Achieve highest image quality
- Enhance your programming
- Reduce costs
- Multi-functional, scalable, *software* systems provides flexibility for CHANGE

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Software Overview

- ✓ ATSC compressed DTV Transport Stream Processing
- ✓ Seamless Splicing in the Compressed Domain
- ✓ High-quality logo insertion
- ✓ HD/SD Source Content
- ✓ Datacast Services
- ✓ PSIP Insertion
- ✓ Application Control Software
- ✓ 3rd party Automation/Server Interface

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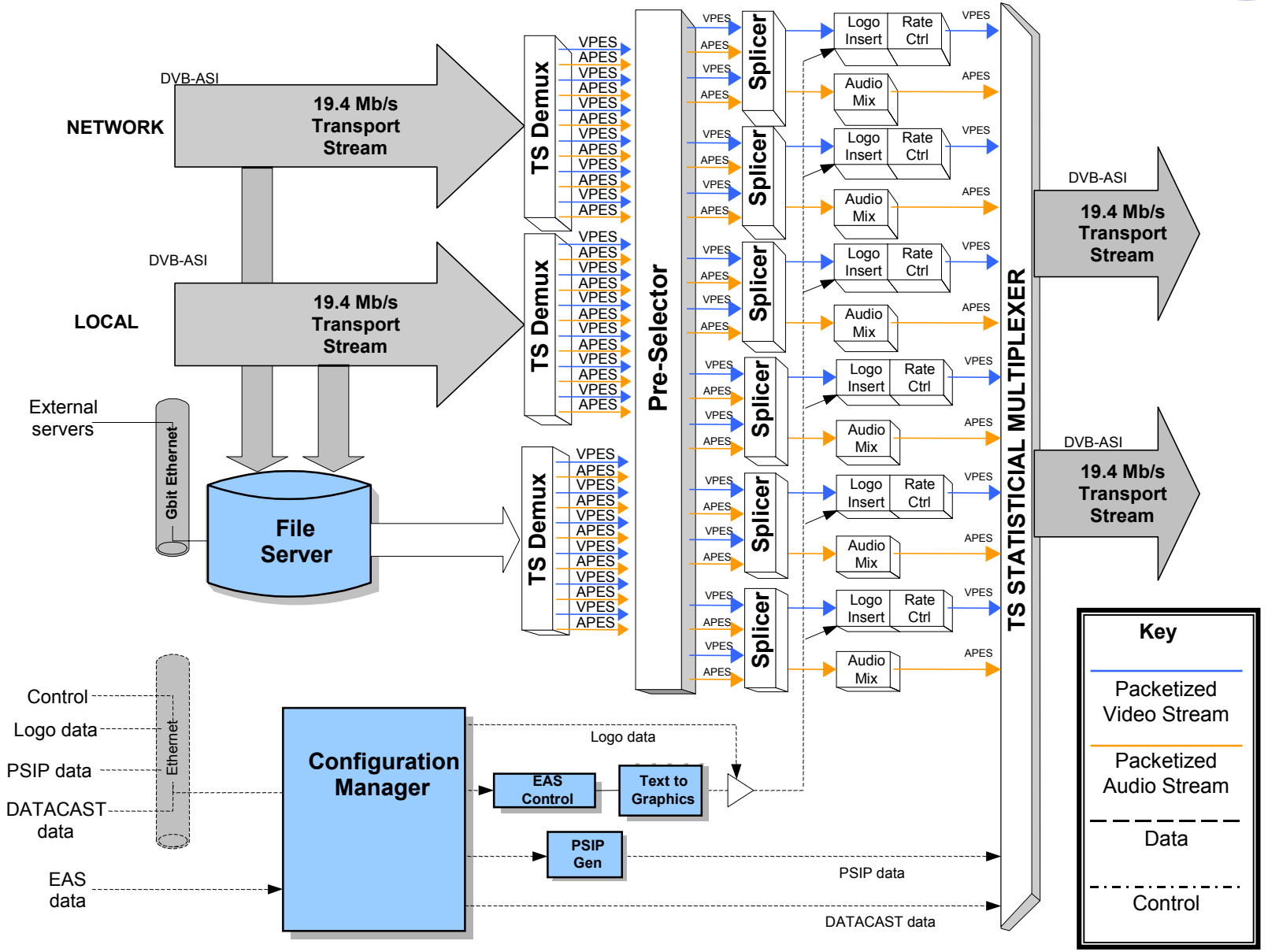

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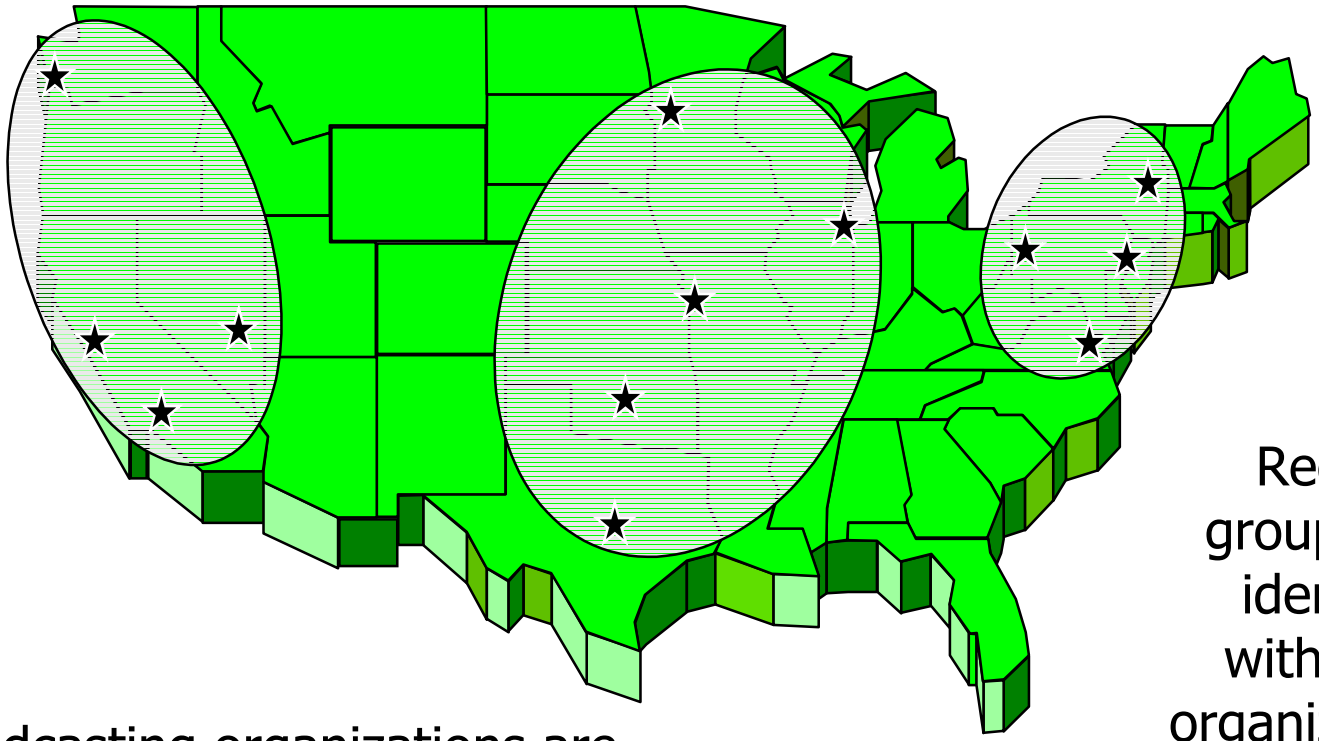
Central Casting Application



Broadcasting organizations are building larger groups of stations scattered across the country

Regional groups are identified within the organization for the Central Casting plan

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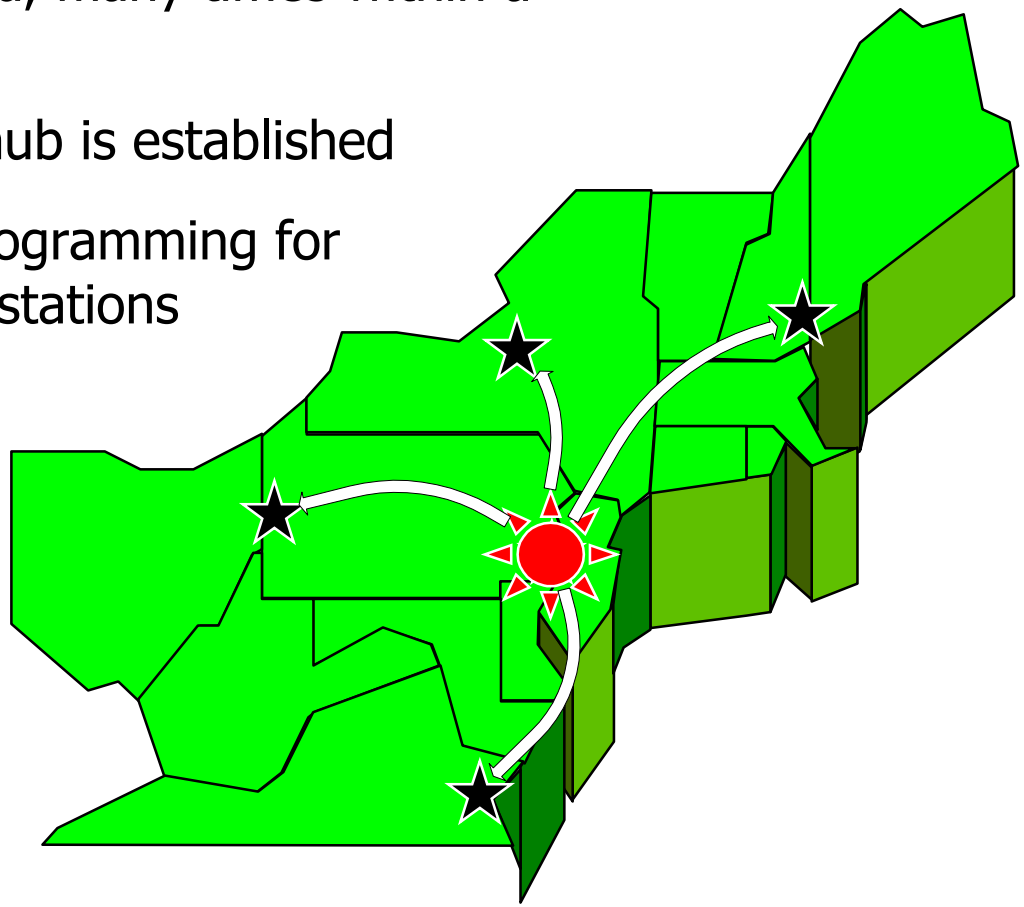
Central Casting Application

Groups are established, many times within a geographical region

Within each group a hub is established

The hub originates programming for itself and it's satellite stations



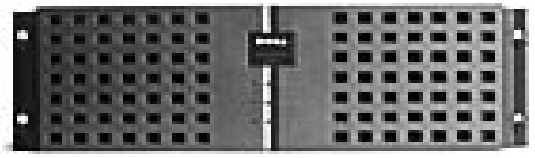
Established Technology Repackaged for New Application

- Splicer
- File Server

CentralCaster

AGV-1000

- Splicer
- Logo Inserter
- Rate Control



CentralCaster
Satellite

"CentralCaster" System

CentralCaster

Leased Lines

Local Studio

TV station #1 In City "A"

TV station #2 In City "B"

TV station #3 In City "C"

TV station #4 In City "D"

TV station #5 In City "E"

TV station #6 In City "F"

To Xmtr

CentralCaster for the Hub

CentralCaster Satellite for each satellite station

CentralCaster Satellite

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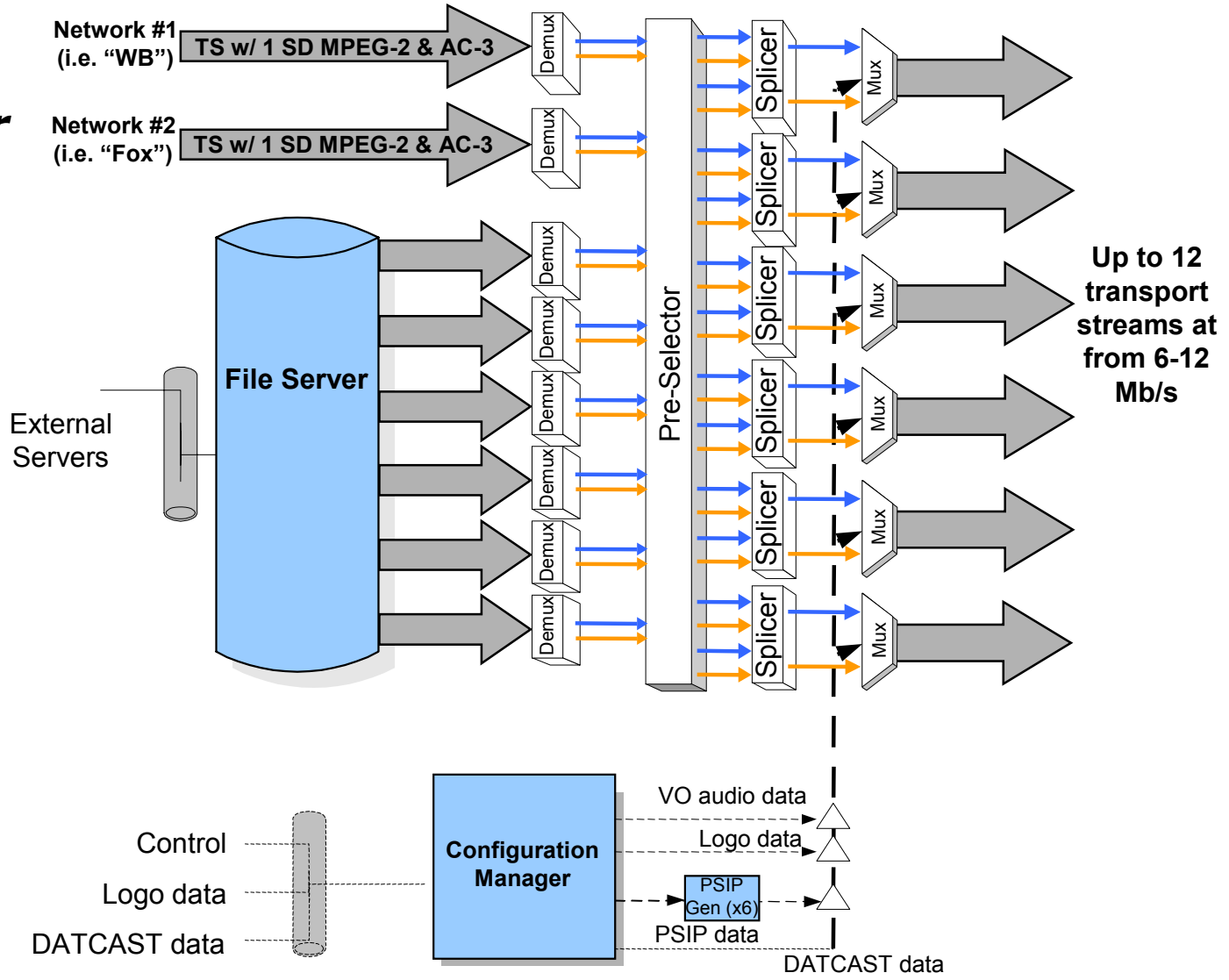
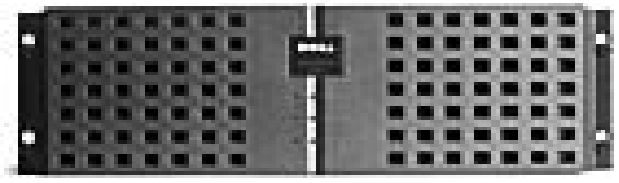
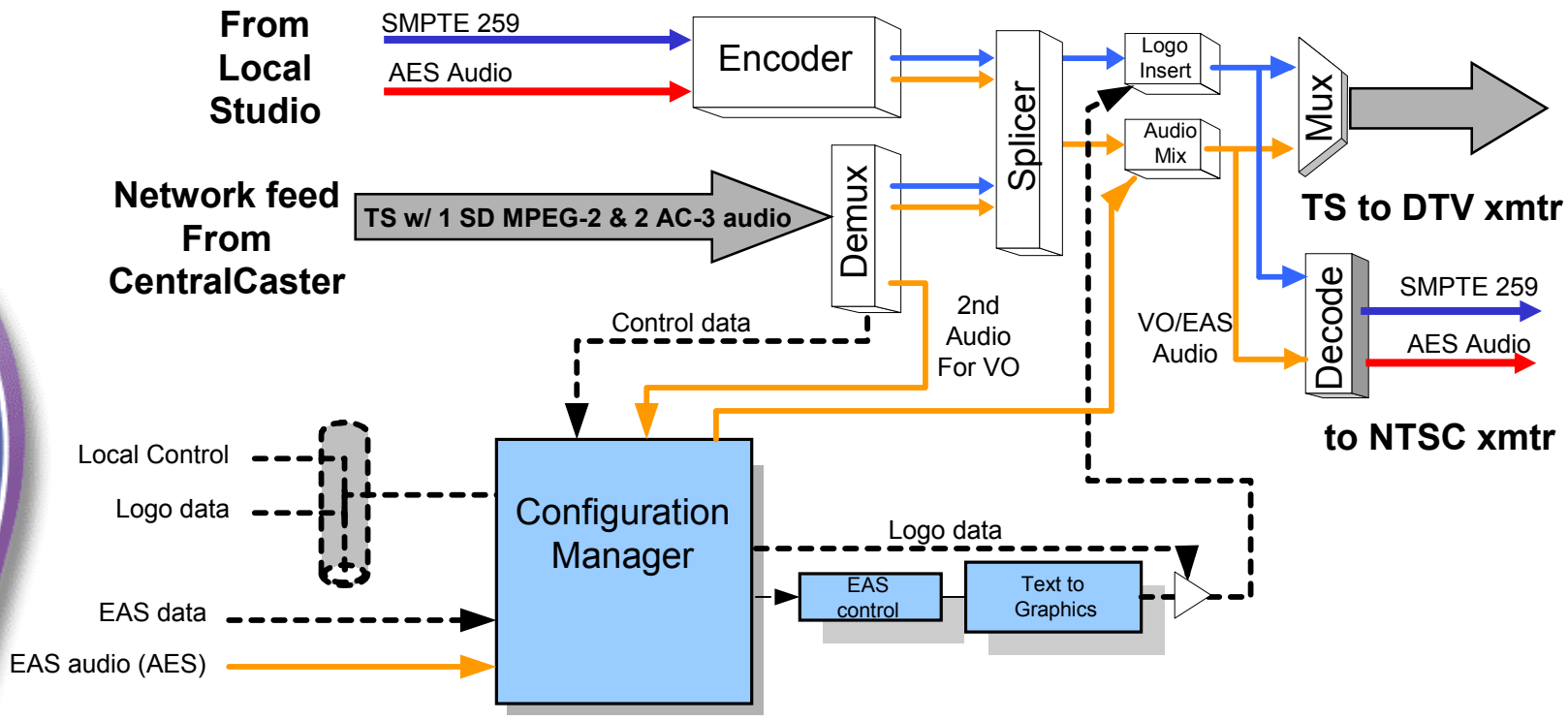
CentralCaster

CentralCaster



CentralCaster Satellite





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DTV or Central Casting

Just One Box

Booth L141

April 21, 2001 ***PBS 2001***

Total DTV

On the Air with Just ONE Box.

Find new uses for your equipment racks! With AgileVision's AGV-1000 you'll be ready to broadcast fast, with lots of rack space to spare.

The AGV-1000 is multifunction platform for the new age of television. It does station IDs and logo insertion, compressed content storage, emergency warning insertion, even seamless splicing of compressed program materials, all controlled by your automation system.

Start with the cost-effective standard package. As your DTV operation expands you can add modules for more capacity or additional functions such as local content origination. You'll still have room to hang your coat or display that prized plant.

The AGV-1000 works with existing equipment, and runs with mission-critical reliability. See it today at NAB in the LVCC North Hall, booth #L1746.

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