Grand Alliance System Flexibility

...and What it Means to Broadcasters

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Outline

- **Grand Alliance HDTV system flexibility**

- **What it Means to Broadcasters**
  (Some concepts for flexible use)

- **Conclusions**

Introduction

- **Powerful flexibility has been designed into the Grand Alliance HDTV system**

- **This flexibility can be taken advantage of immediately at the introduction of HDTV to provide multiple program services**

- **Other business opportunities for data delivery will likely develop over time**

- **Since the performance of compression encoders will continue to improve over time, there will be increased opportunities for flexibility in the future**
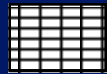
HDTV System Layers

Picture Layer

1920 x 1080
1280 x 720
60,30, 24 Hz

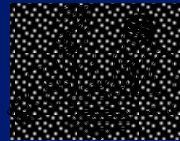**Multiple Picture Formats and Frame Rates**

Video Compression Layer

Data Headers   **Motion Vectors**   **Chroma and Luma DCT Coefficients**

Variable Length Codes

MPEG-2 compression syntax

Transport Layer

Packet Headers   **Flexible delivery of data**

Video packet   **Audio packet**   **Video packet**   **Aux data**

MPEG-2 packets

Transmission Layer

6 MHz

8-VSB

Basic Principles

1. **Packetization allows the channel capacity given to different services to be allocated (fixed or dynamic)**

2. **Picture format and frame rate impact the bit rate (preference will depend on the type of program)**

3. **Compression is scene-dependent (some pictures require fewer bits to encode than others)**
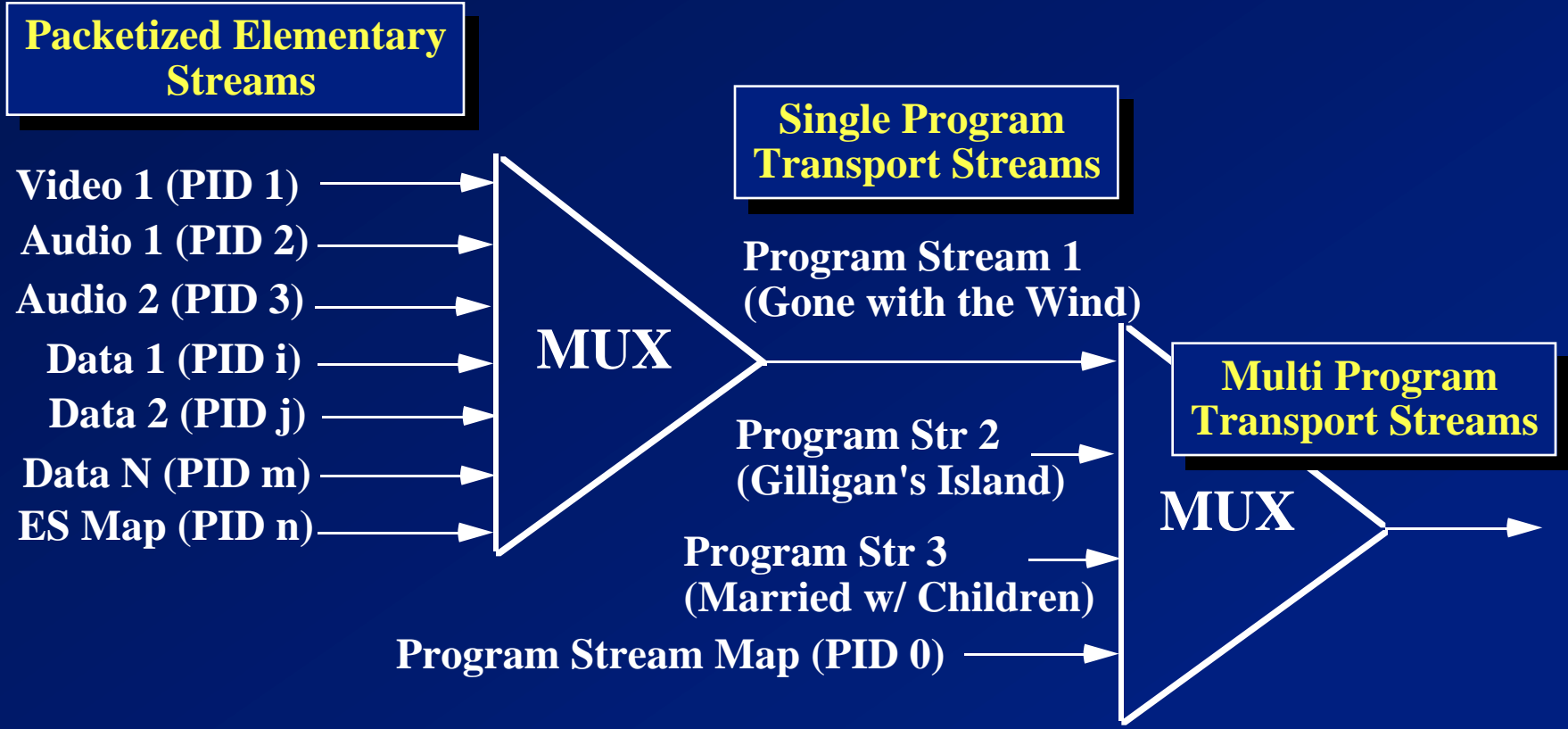
Transport Packet Stream

..many services can be dynamically multiplexed and delivered to the viewer...

4 Byte Packet Header

188 Byte Packet

184 Byte Payload (incl. optional Adaptation Header)

| video | TEXT | video | audio 1 | video | video | audio 2 | video | video | PGM GD | video |

- **All packet types carry one type of data, identified by a PID**

- **Various data types are multiplexed into the packet stream**

- **PID eliminates backward compatibility problems - receivers ignore packet types that they cannot process**

System Level Multiplex

Packetized Elementary Streams

Video 1 (PID 1)

Audio 1 (PID 2)

Audio 2 (PID 3)

Data 1 (PID i)

Data 2 (PID j)

Data N (PID m)

ES Map (PID n)

MUX

Single Program Transport Streams

Program Stream 1
(Gone with the Wind)

Program Str 2
(Gilligan's Island)

Program Str 3
(Married w/ Children)

Program Stream Map (PID 0)

Multi Program Transport Streams

MUX

PID0 (program_association_table) =>
PID (program_map_table) =>
PIDs of elementary bitstreams

Channel Capacity Allocation

- **Fixed Bit Rates for each service**

- **Opportunistic Data - send non-time-critical aux data as a variable video bit rate with a target "quality level" allows**

- **Pre-Packaged Mix - a carefully produced mix of video, audio and aux data constructed to deliver a certain amount of aux data within a certain amount of time (e.g., commercials)**

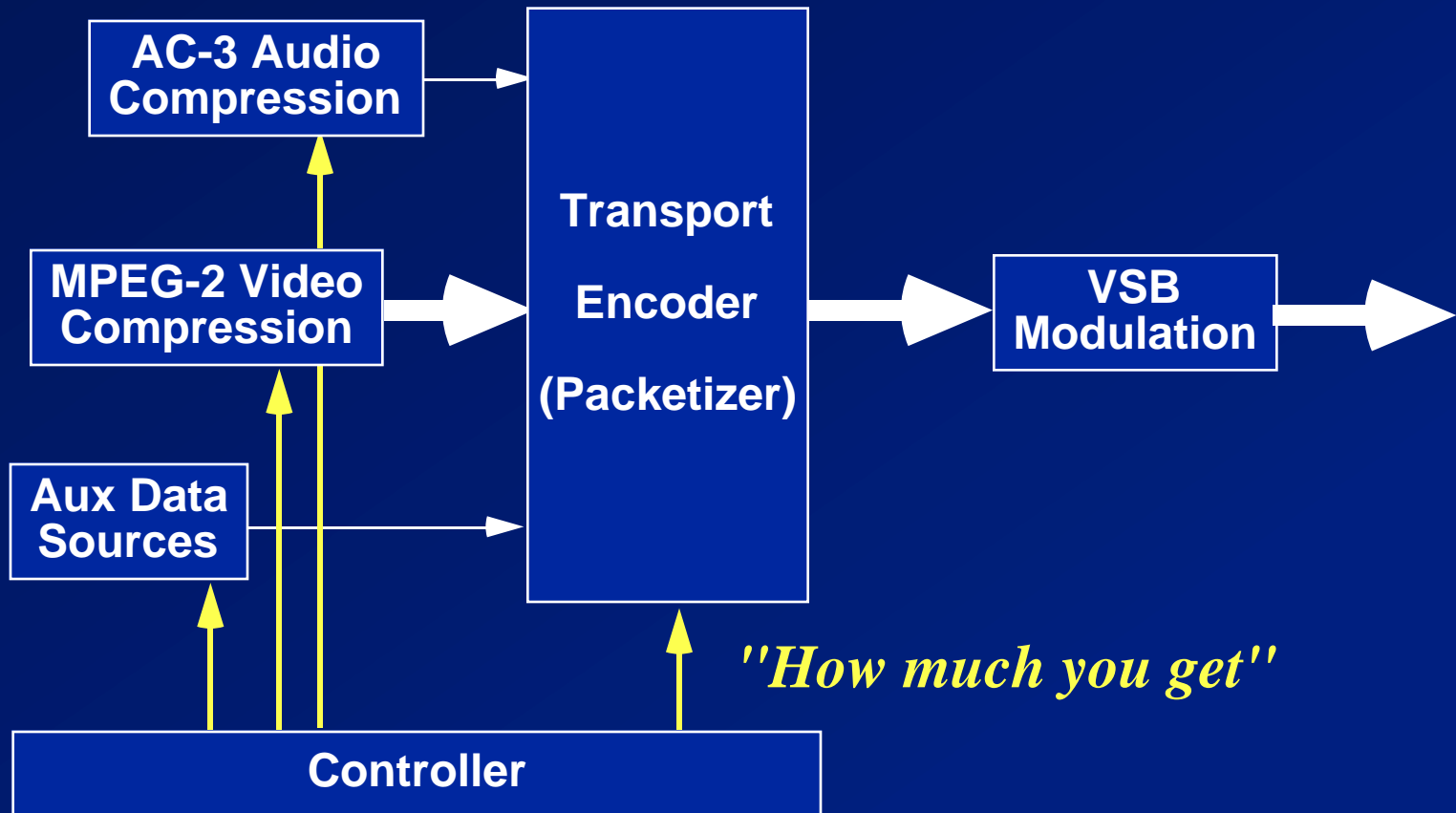# GA Hardware Control

HDTV Picture Formats

Spatial	Temporal	
1920 x 1080 (square pixels)	**59.94 / 60** **29.97 / 30** **23.97 / 24**	**interlaced** **progressive** **progressive**
1280 x 720 (square pixels)	**59.94 / 60** **29.97 / 30** **23.97 / 24**	**progressive** **progressive** **progressive**

- **Every HDTV receiver will decode and display a picture for *all* of these transmitted formats**

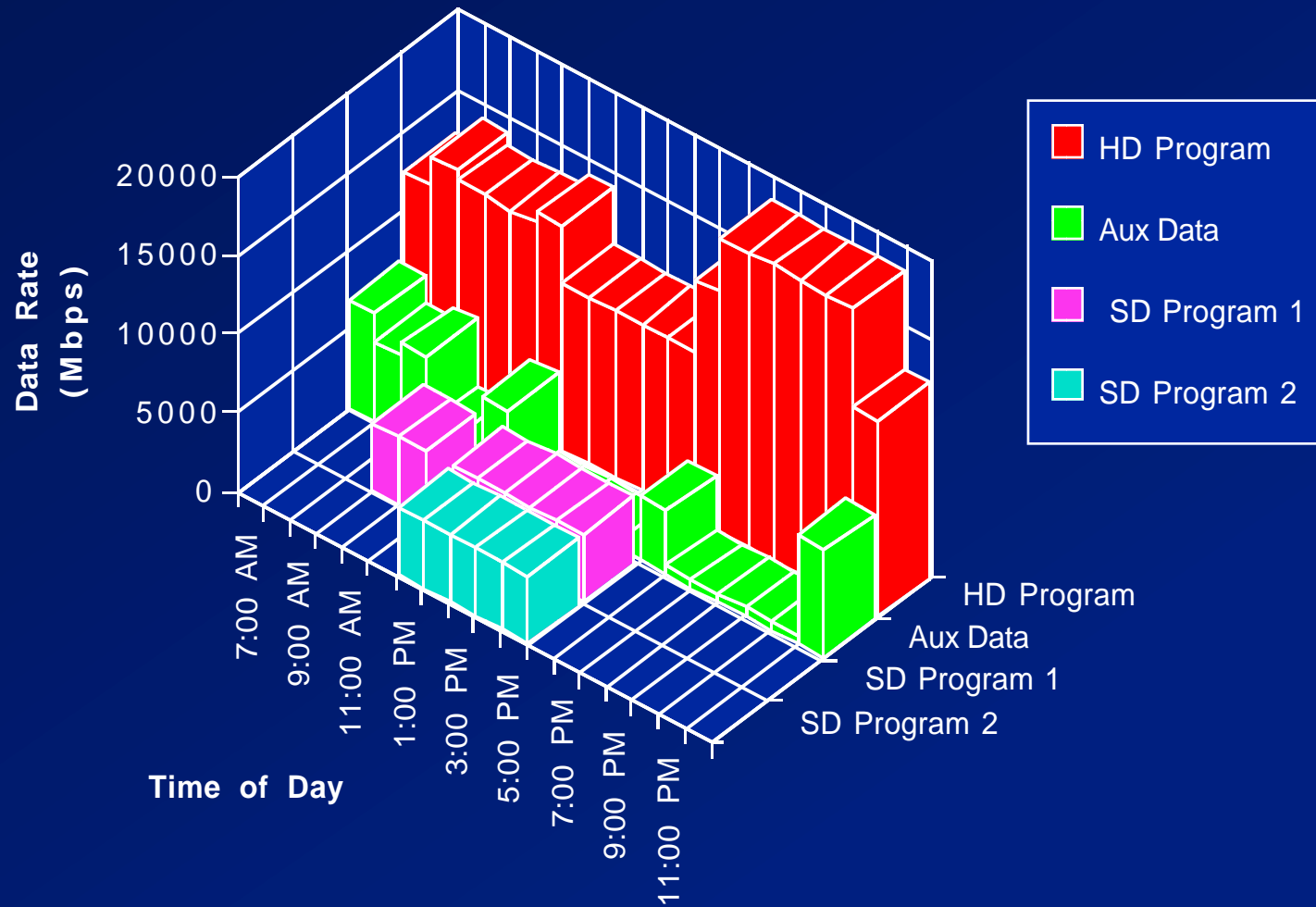- **The display itself is a receiver implementation option**

Format - Potential Impact on Data Rate

Material	Format	FrameRate	Data Rate
Sports	1920 x 1080	60 i	18.3
	1280 x 720	60 p	18.3
Drama/Sitcom	1920 x 1080	30 p	≈17
	1280 x 720	30 p	≈16
Movies	1920 x 1080	24 p	≈15
	1280 x 720	24 p	≈14
Newsroom	1920 x 1080	30 p	≈14
	1280 x 720	30 p	≈13
Still picture	1920 x 1080	30 p	≈6
	1280 x 720	30 p	≈5

Flexible Use: Time of Day Variability

Legend:
- HD Program
- Aux Data
- SD Program 1
- SD Program 2

Vertical axis: **Data Rate (Mbps)** — 0, 5000, 10000, 15000, 20000

Horizontal axis: **Time of Day** — 7:00 AM, 9:00 AM, 11:00 AM, 1:00 PM, 3:00 PM, 5:00 PM, 7:00 PM, 9:00 PM, 11:00 PM
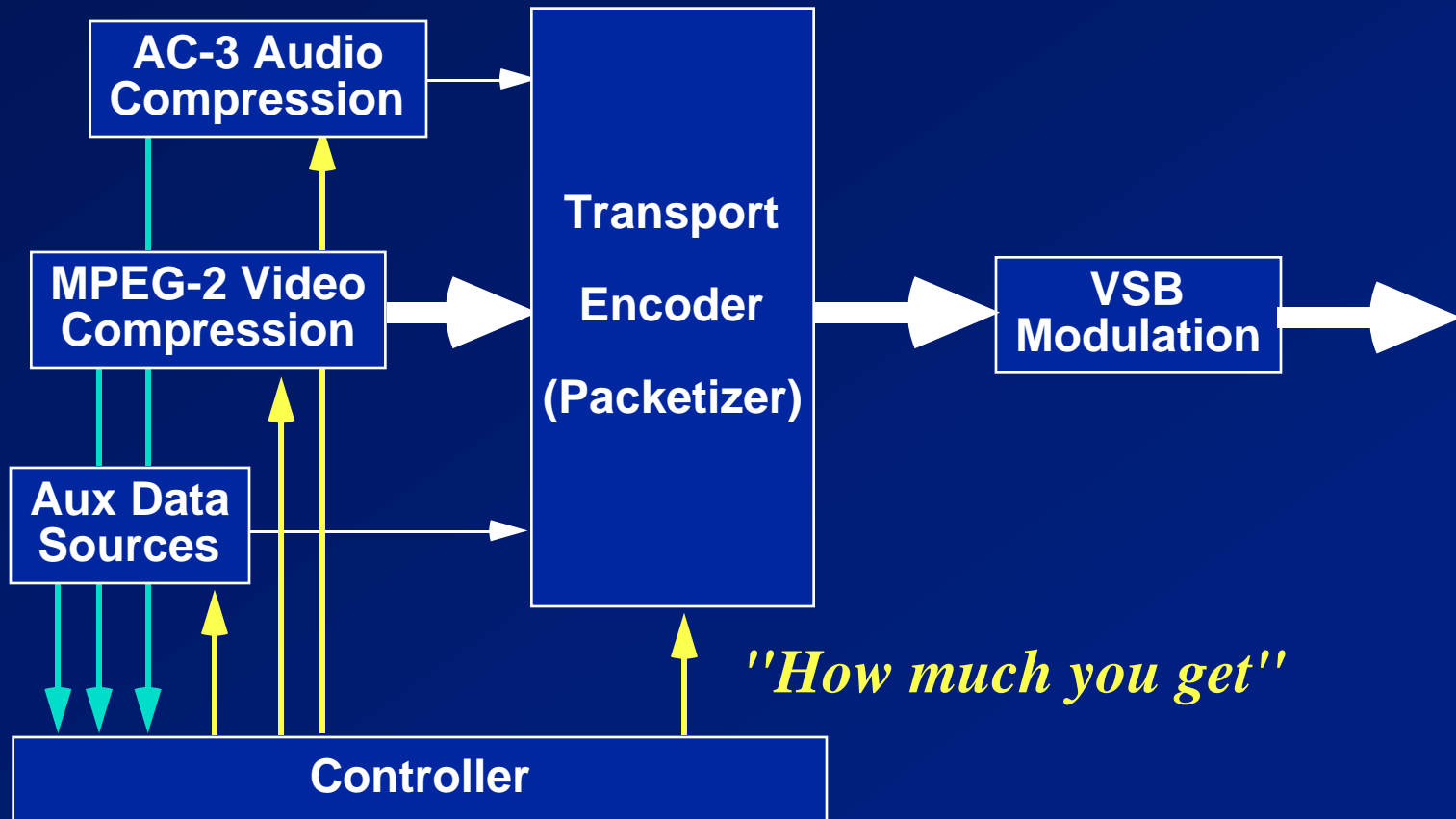
Depth axis: HD Program, Aux Data, SD Program 1, SD Program 2

Different Scenes - Impact on Data Rate

...a look at diversity within the 1920 x 1080 / 60 / 2:1 format...

- **Sports (18.3 Mbps)**

- **Interview (14 Mbps)**

- **Runners (11 Mbps)**

- **GA logo (6 Mbps)**

These are preliminary, highly subjective results

Opportunistic Data Capacity: Varying Maximum Video Rate

% Channel

Mbps

14 Mbps

17 Mbps

18 Mbps

Time (seconds)

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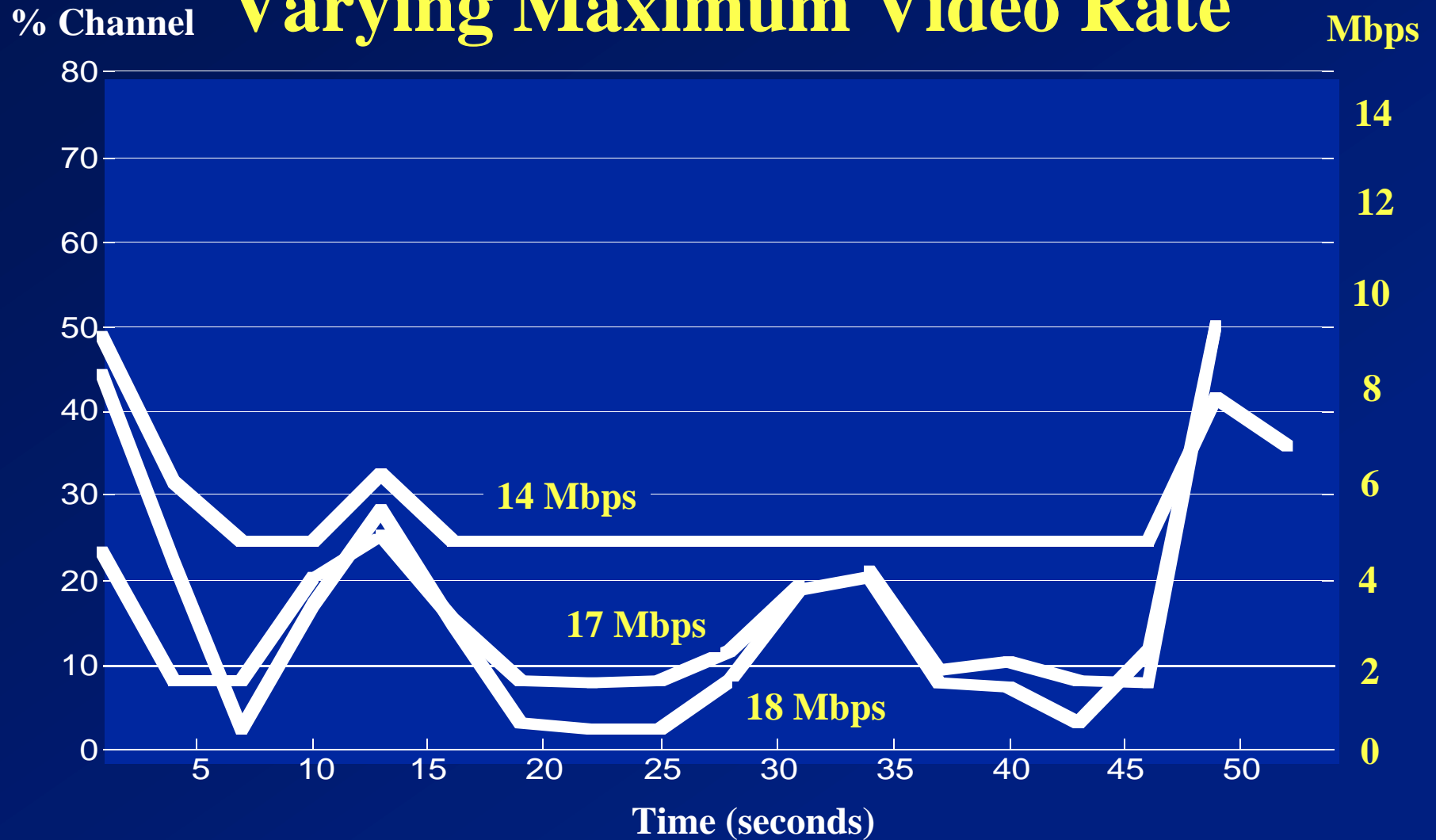
Grand Alliance

Opportunistic Data Capacity: Varying Minimum mQuant

% Channel

Mbps

10

8

1

Time (seconds)

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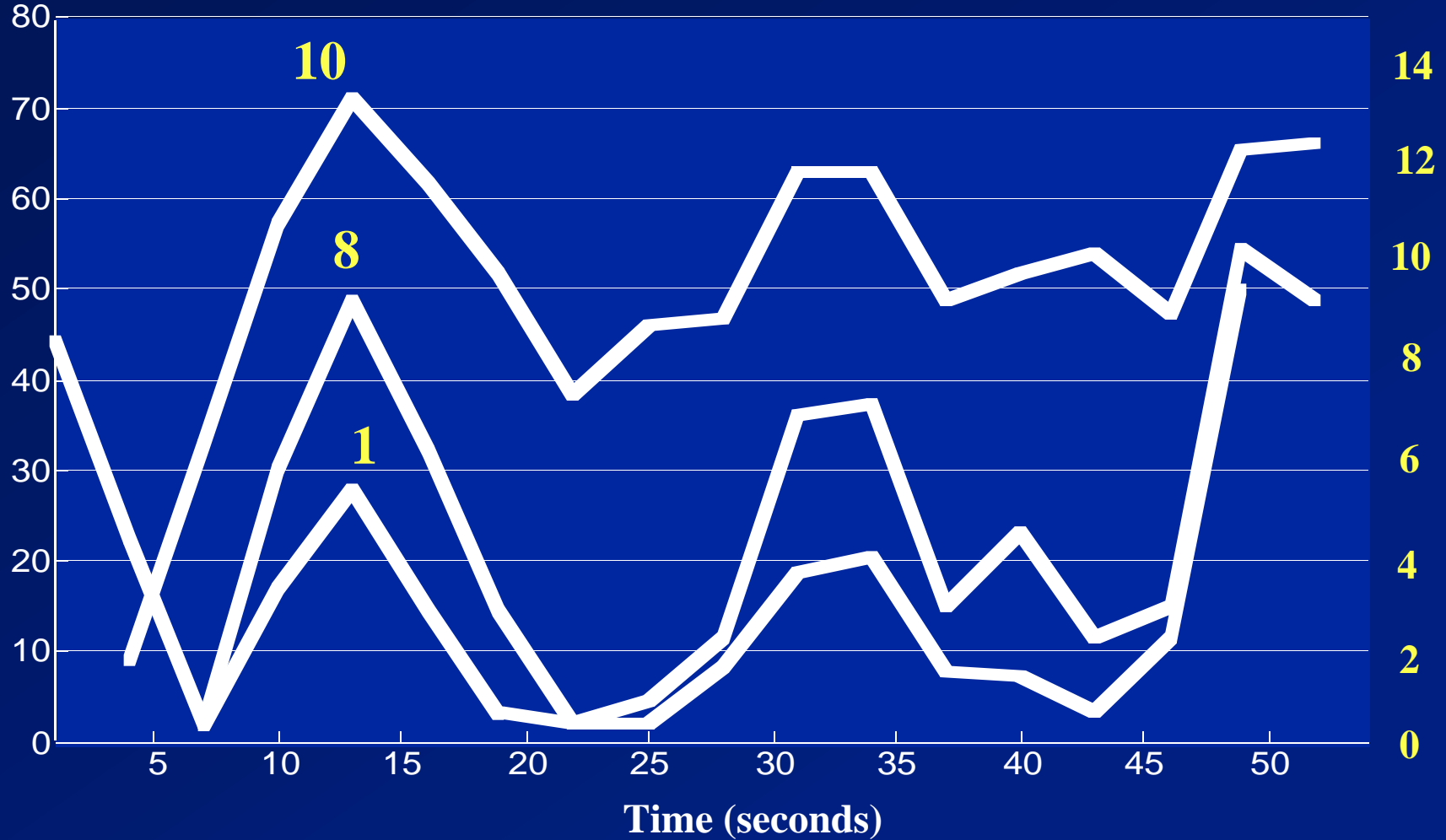
Opportunistic Data Conclusion

Create Opportunistic Data capacity by:
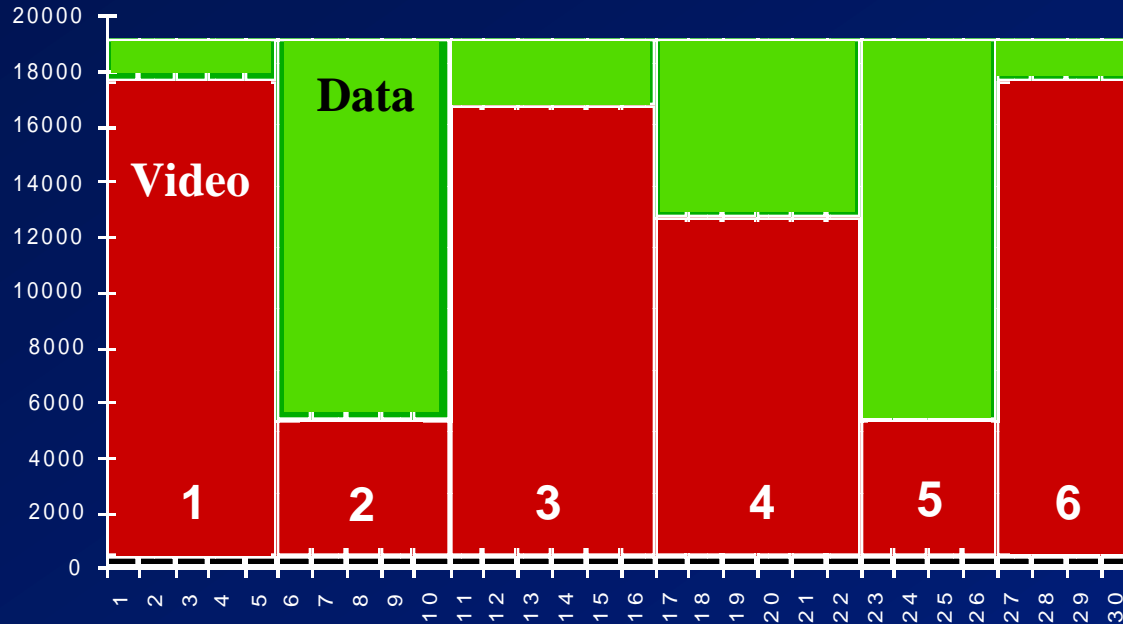
Making the easy scenes less good

NOT BY

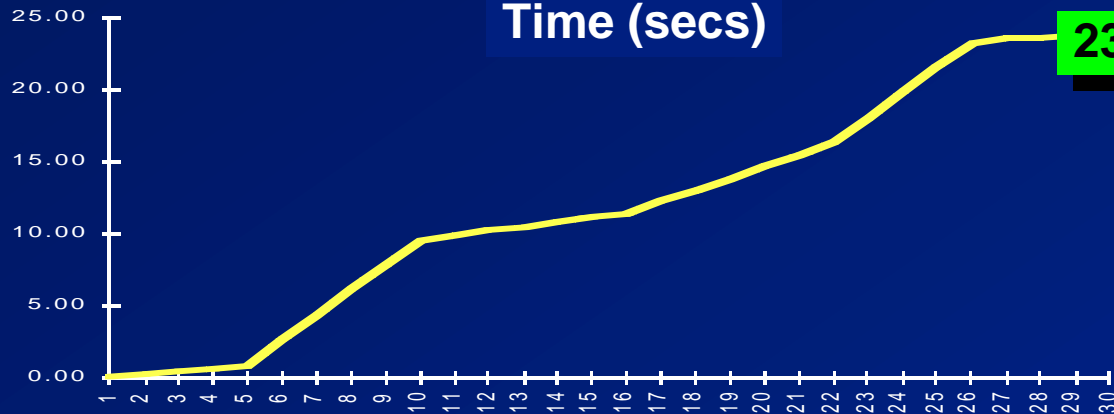Making the hard scenes any worse

Pre-Packaged Mix:
Delivering Supplemental Data

- **The amount of data required to encode any particular scene to a given level of quality can vary, but it does not have to be left to chance**

- **The picture quality vs. data capacity tradeoff can be managed on a scene-by-scene basis as part of the production process**

- **For example, each 30 sec. commercial can be produced to deliver supplemental data for later viewer interaction**
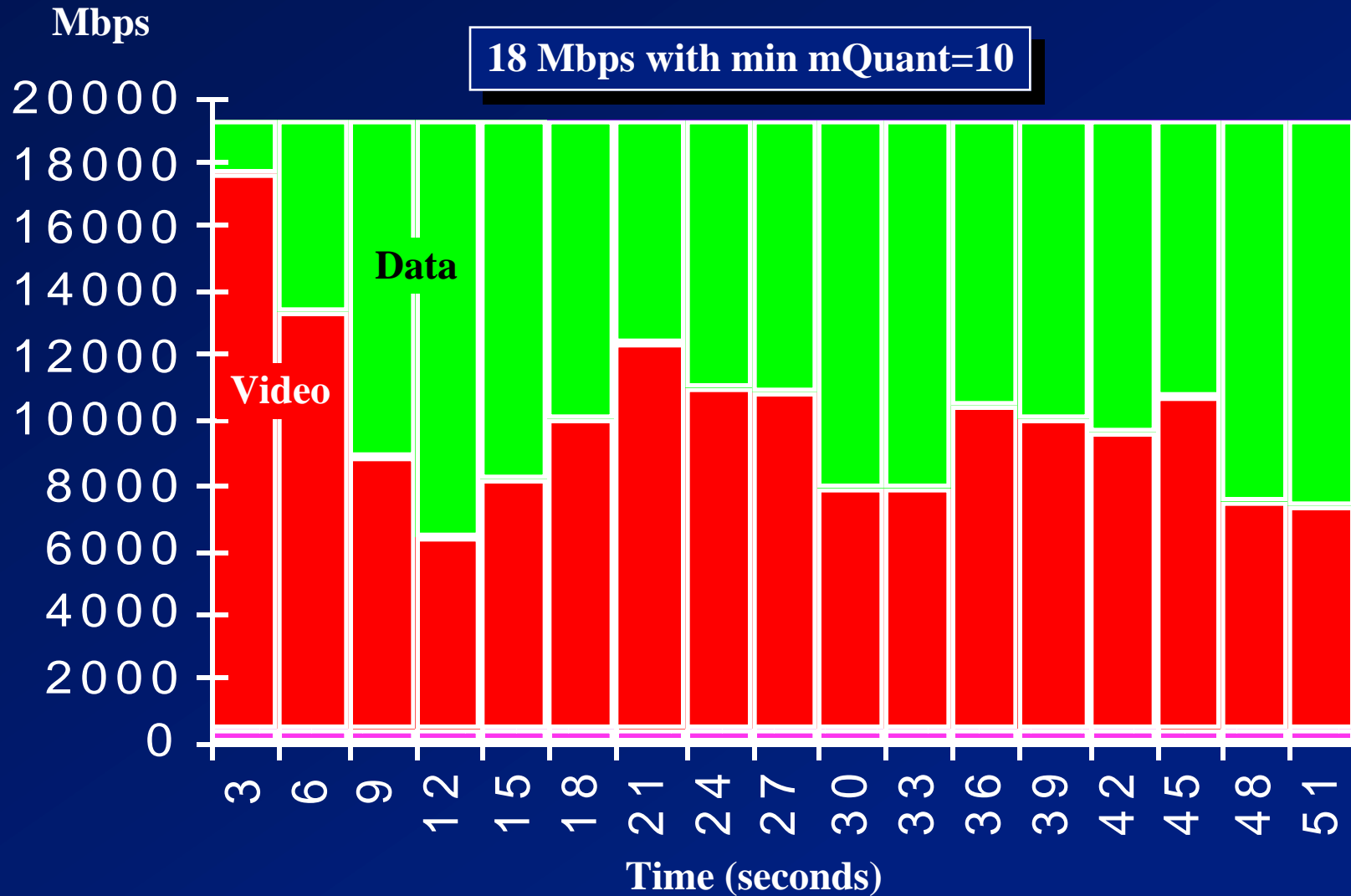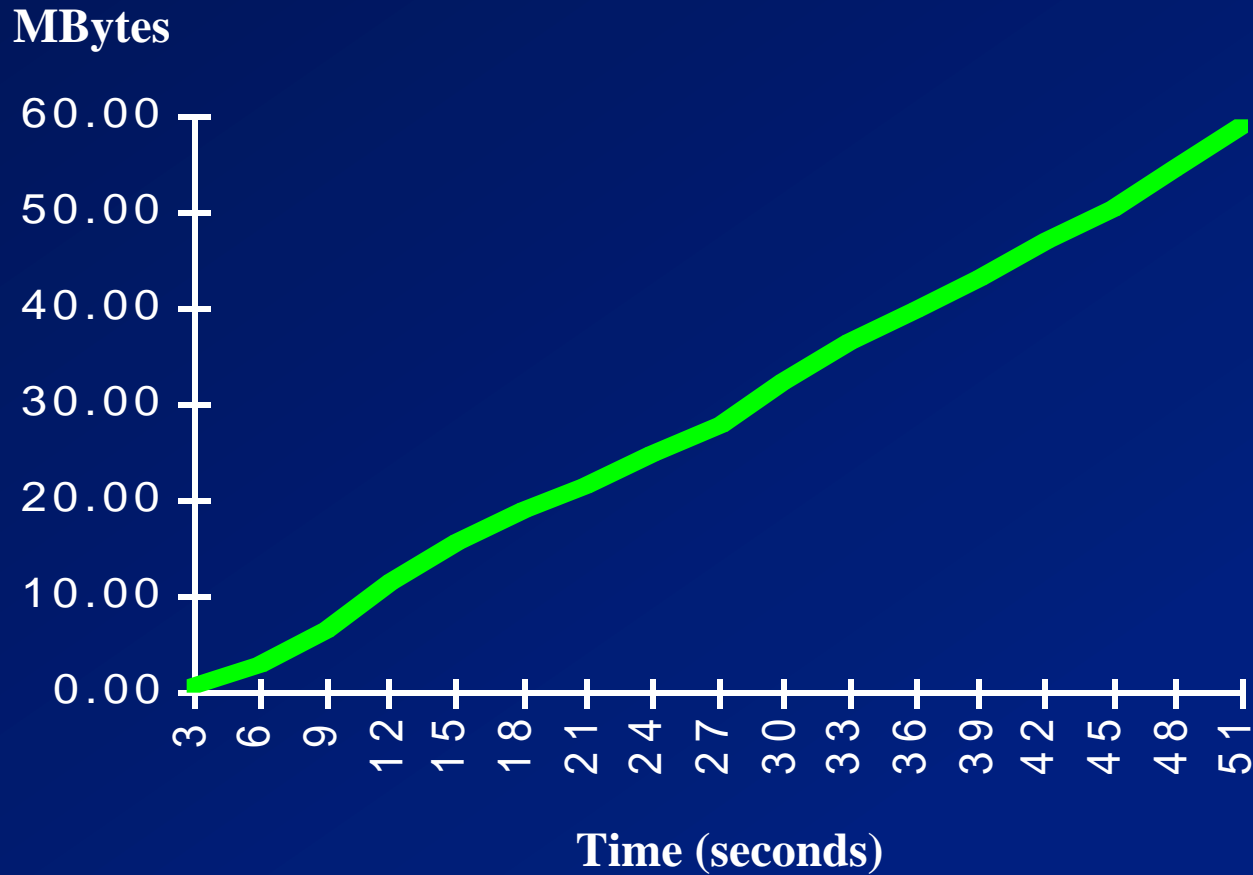
Car Commercial Demo Cumulative Data

MBytes

60.00
50.00
40.00
30.00
20.00
10.00
0.00

3 6 9 12 15 18 21 24 27 30 33 36 39 42 45 48 51

Time (seconds)

System Control for Pre-Packaged Mix

AC-3 Audio Compression

MPEG-2 Video Compression

Aux Data Sources

Transport Encoder (Packetizer)

"Does it look OK?"

"How much you get"

Controller
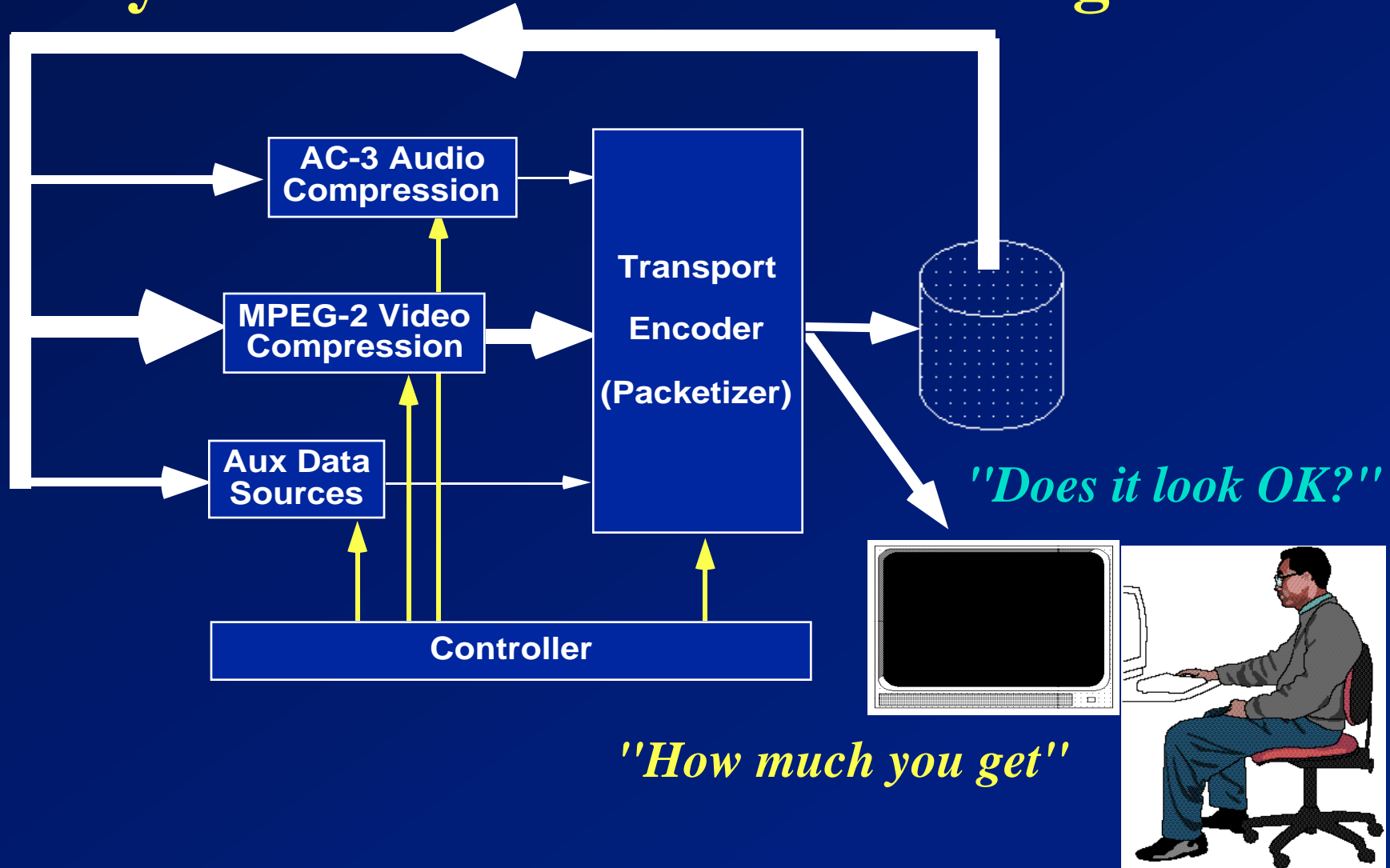
Service Flexibility

...HDTV - and a whole lot more...

- **Many kinds of TV service, varying by time of day**
  - **HDTV**
  - **HDTV + 1-2 low resolution programs**

- **New advertising approaches**
  - **interactive brochures**
  - **catalogues**

- **Data broadcasting services**
  - **news, weather, sports, traffic...**
  - **computer software, CDs...**

- **Other media delivery**
  - **many audio programs**

Conclusions

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Special Thanks

- **John Maillot (AT&T)**

- **Norm Hurst (Sarnoff)**

- **Paul Lyons (Sarnoff)**