

An Implementation of Chapter 7 Packet Telemetry System

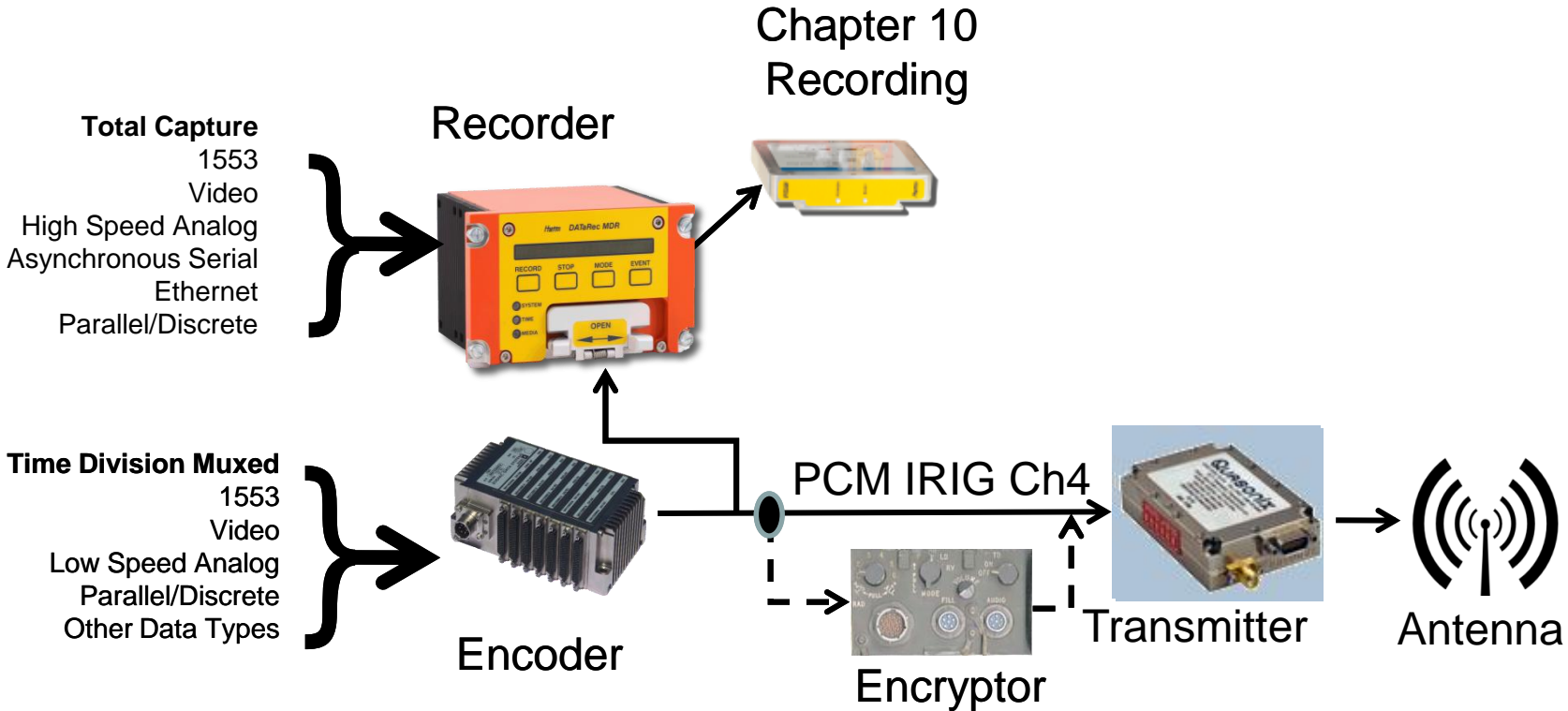
19th Test Instrumentation Workshop: *Tools, Training and Intellectual Capital* Workshop ITEA

Johnny Pappas

Chief Technical Officer and Executive VP

Zodiac Data Systems

Typical Airborne System Architecture



How do you want to send your Telemetry Data ?

- **Continuous or Periodic Data-**

- PCM Time Division Multiplexing is optimal

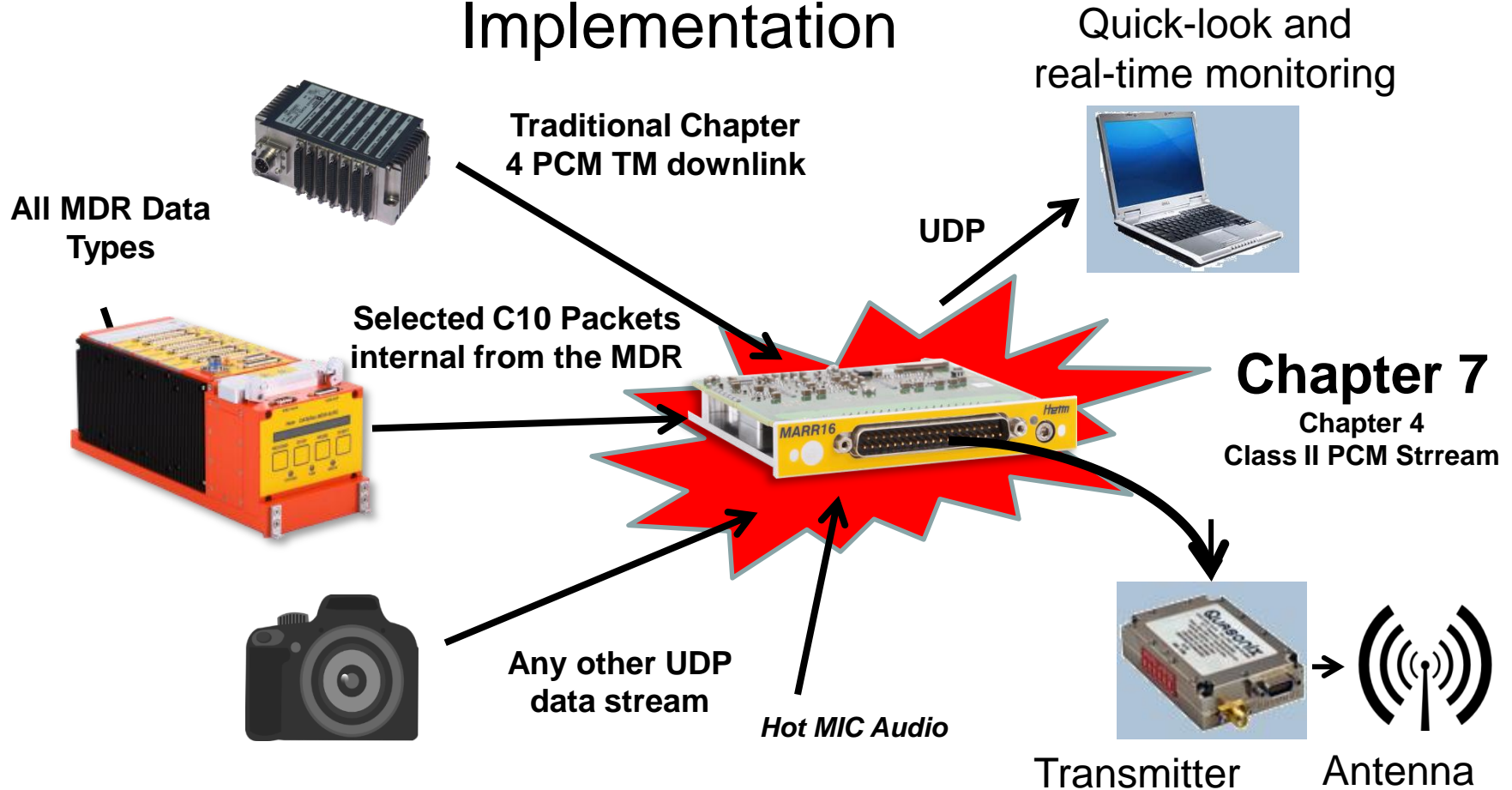
- **Asynchronous Data-**

- Asynchronous Packet transmission is optimal

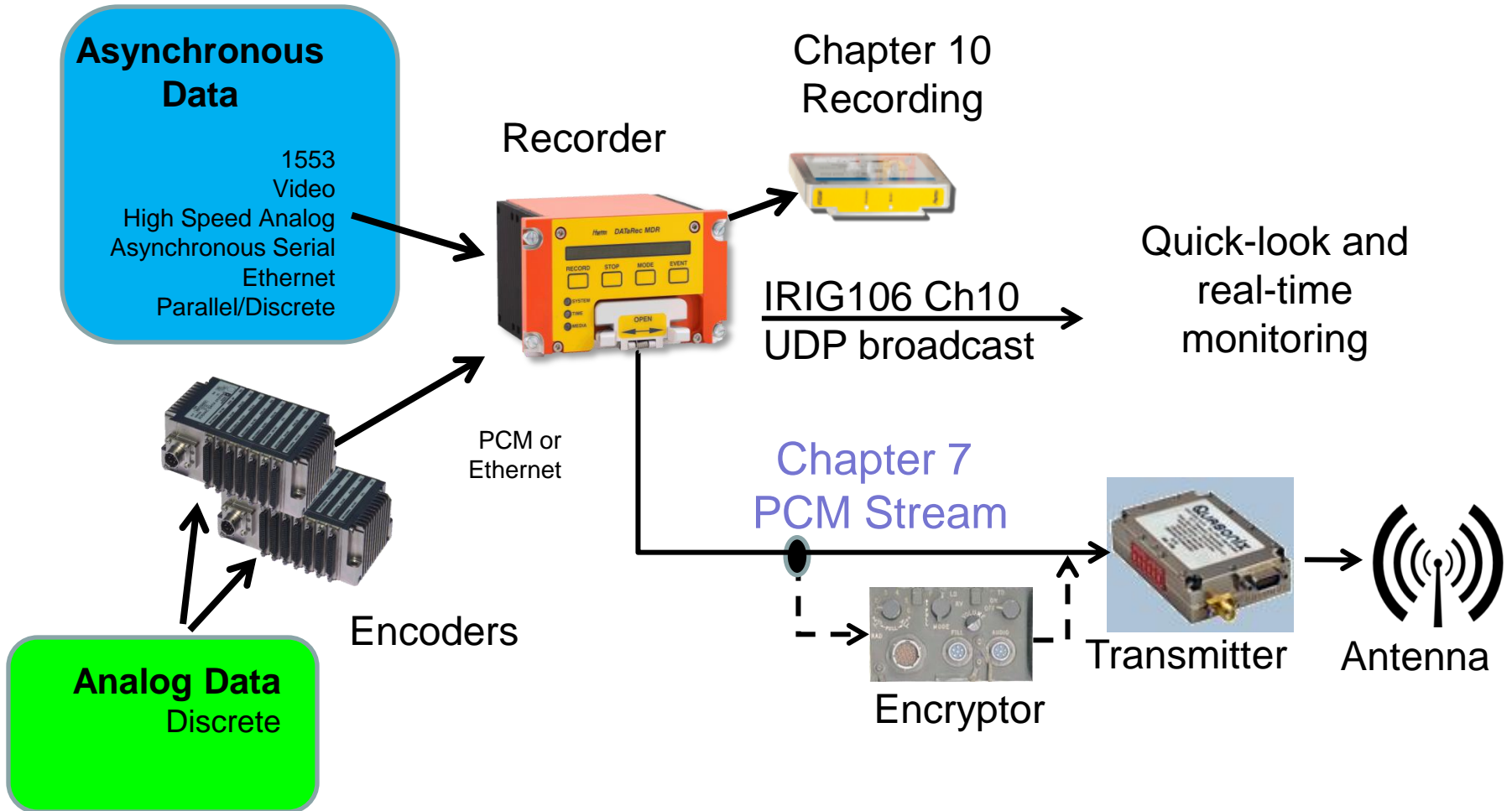
Due to major increase in high speed Asynchronous Busses on test platforms and reduced PCM Telemetry Bandwidth. This is an extremely important aspect to consider.

Zodiac Data System

Chapter 7 Hardware Implementation



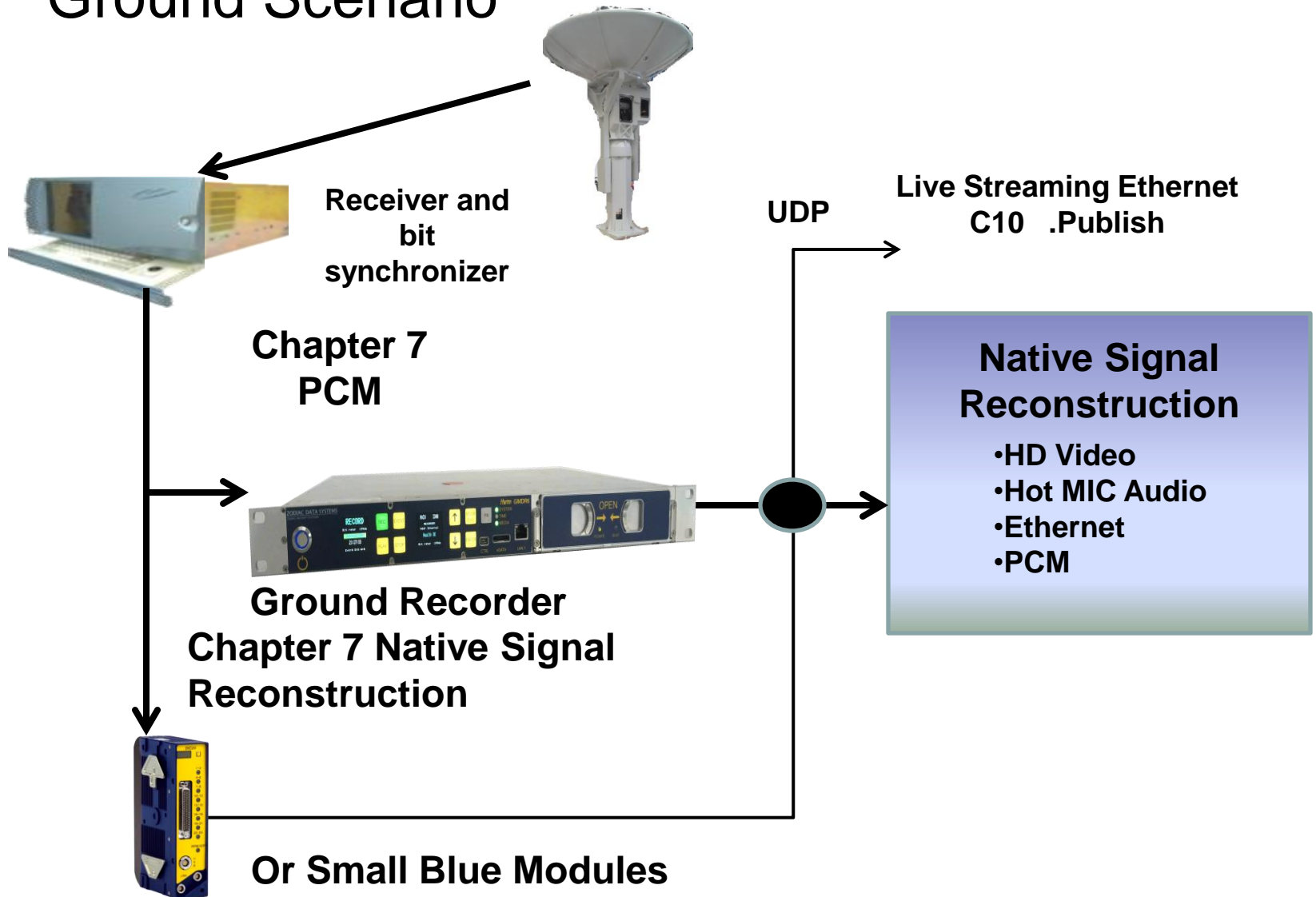
Typical Chapter 7 Downlink Airborne Scenario



Simplified Example of Packets in Chapter 7 PCM Stream

	Word 1	Word 2	Word 3	Word 4	Word 5	Word 6	Word 7	Word 8	Word 9	Word 10	Word 11	Word 12	Word 13	Word 14	Word 15		
Sync Word	Fill Word	Fill Word	VIDIN Chan1	VIDIN Chan1	VIDIN Chan1	VIDIN Chan1	VIDIN Chan1	VIDIN Chan1	VIDIN Chan1	VIDIN Chan1	Fill Word	Fill Word	1553IN Chan1	1553IN Chan1	1553IN Chan1	Sync Word	
Sync Word	1553IN Chan1	1553IN Chan1	1553IN Chan1	Fill Word	VIDIN Chan2	VIDIN Chan2	VIDIN Chan2	VIDIN Chan2	VIDIN Chan2	VIDIN Chan2	VIDIN Chan2	VIDIN Chan2	VIDIN Chan2	Fill Word	PCMIN Chan1	PCMIN Chan1	Sync Word
Sync Word	PCMIN Chan1	PCMIN Chan1	PCMIN Chan1	Fill Word	VIDIN Chan1	VIDIN Chan1	VIDIN Chan1	VIDIN Chan1	VIDIN Chan1	VIDIN Chan1	VIDIN Chan1	VIDIN Chan1	VIDIN Chan1	Fill Word	VIDIN Chan2	VIDIN Chan2	Sync Word
Sync Word	VIDIN Chan2	VIDIN Chan2	VIDIN Chan2	VIDIN Chan2	VIDIN Chan2	VIDIN Chan2	VIDIN Chan2	Fill Word	PCMIN Chan1	PCMIN Chan1	PCMIN Chan1	PCMIN Chan1	PCMIN Chan1	Fill Word	Fill Word	Fill Word	Sync Word
Sync Word	Fill Word	Fill Word	Fill Word	Fill Word	Fill Word	1553IN Chan1	1553IN Chan1	1553IN Chan1	1553IN Chan1	1553IN Chan1	1553IN Chan1	Fill Word	Fill Word	Fill Word	Fill Word	Sync Word	
Sync Word	PCMIN Chan1	PCMIN Chan1	PCMIN Chan1	PCMIN Chan1	PCMIN Chan1	Fill Word	VIDIN Chan1	VIDIN Chan1	VIDIN Chan1	VIDIN Chan1	VIDIN Chan1	VIDIN Chan1	VIDIN Chan1	VIDIN Chan1	VIDIN Chan1	Fill Word	Sync Word
Sync Word	VIDIN Chan2	VIDIN Chan2	VIDIN Chan2	VIDIN Chan2	VIDIN Chan2	VIDIN Chan2	VIDIN Chan2	VIDIN Chan2	VIDIN Chan2	Fill Word	PCMIN Chan1	PCMIN Chan1	PCMIN Chan1	PCMIN Chan1	PCMIN Chan1	Fill Word	Sync Word
Sync Word	VIDIN Chan1	VIDIN Chan1	VIDIN Chan1	VIDIN Chan1	VIDIN Chan1	VIDIN Chan1	VIDIN Chan1	VIDIN Chan1	VIDIN Chan1	Fill Word	VIDIN Chan2	VIDIN Chan2	VIDIN Chan2	VIDIN Chan2	VIDIN Chan2	VIDIN Chan2	Sync Word

Ground Scenario



Simplified End to End System

Chapter 7
Encoder and
C10 Recorder



Encoder
PCM
inserted



Ch4 PCM and Ch10 UDP
merged together

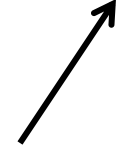


Antenna



Encoder PCM
output

IRIG106 Ch10
UDP
broadcast



**Reproduce
Native Signals**

- Video
- PCM
- Enet

Decom



What is the Future Objective for Chapter 7 PCM- Objective

- All of the DECOM Front Ends to handle Chapter 7 exactly like any other Chapter 4 Class I or II PCM Stream



- Telemetry and Ground Operations exactly identical for Chapter 4 and Chapter 7 Telemetry

How Does C7 TM Work

- Determine Maximum bandwidth available for telemetry downlink
- Determine the channels you want to downlink
- Determine if you want to transmit all data for that channel or transmit data at a lower rate (I.E Filtering)
- For lower rate packet downlink, determine the lower rate amount of data to be down linked

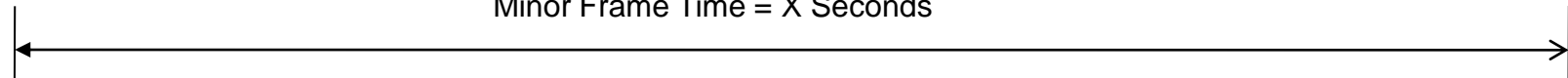
NOTE: PACKET DOWNLINK DOES NOT REQUIRE ANY PROGRAMMING ASSIGNMENT OF DATA IN THE PCM STREAM TYPICALLY REQUIRED FOR ENCODERS. THE PACKET PLACEMENT IN THE PCM STREAM FLOATS IN THE STREAM. PACKETS ARE STUFFED FIFO INTO THE PCM STREAM.

Filtering- PCM

- Filtering based on Minor Frame Words
- Minor Frame Rate is unchanged
- Example of approximate 25% reduction in Bit rate

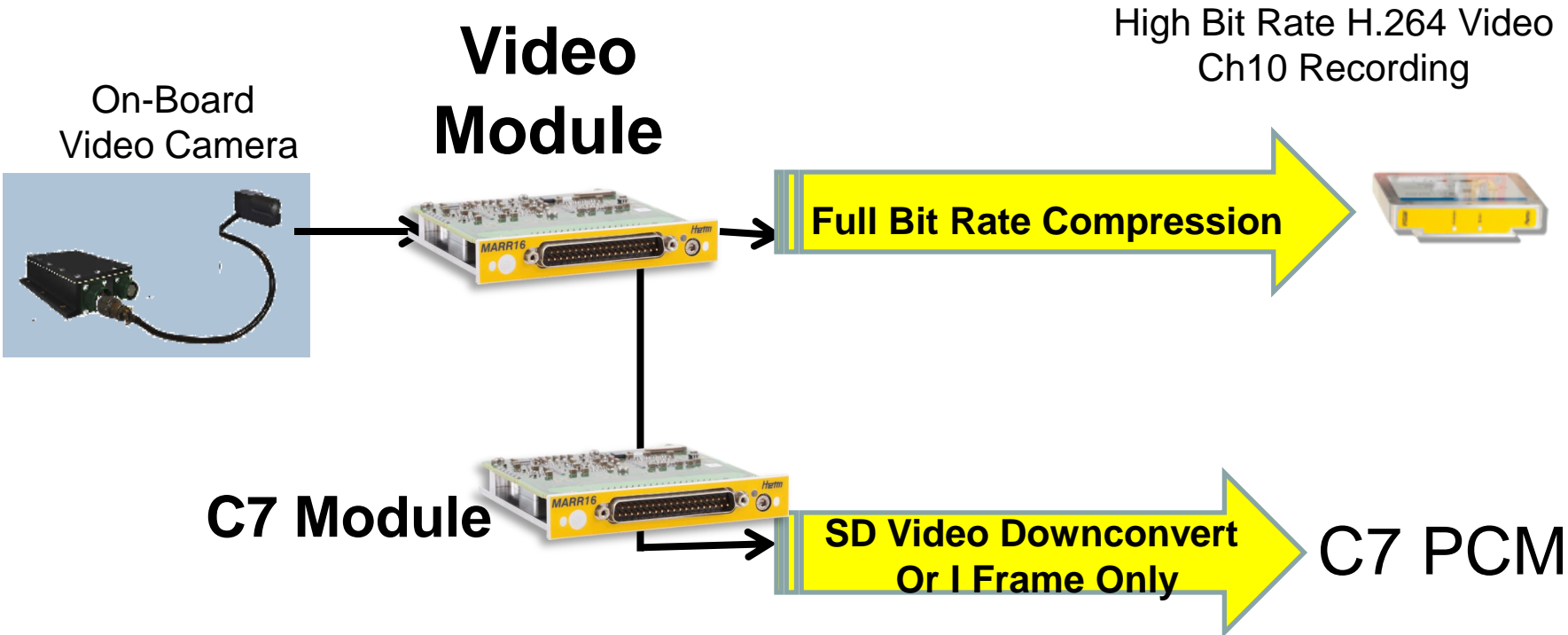
Word 1	Word 2	Word 3	Word 4	Word 5	Word 6	Word 7	Word 8	Word 9	Word 10	Word 11	Word 12	Word 13	Word 14	Word 15	Sync Word
Word 1	Word 2	Word 3	Word 4	Word 5	Word 6	Word 7	Word 8	Word 9	Word 10	Word 11	Word 12	Word 13	Word 14	Word 15	Sync Word
Word 1	Word 2	Word 3	Word 4	Word 5	Word 6	Word 7	Word 8	Word 9	Word 10	Word 11	Word 12	Word 13	Word 14	Word 15	Sync Word
Word 1	Word 2	Word 3	Word 4	Word 5	Word 6	Word 7	Word 8	Word 9	Word 10	Word 11	Word 12	Word 13	Word 14	Word 15	Sync Word
Word 1	Word 2	Word 3	Word 4	Word 5	Word 6	Word 7	Word 8	Word 9	Word 10	Word 11	Word 12	Word 13	Word 14	Word 15	Sync Word
Word 1	Word 2	Word 3	Word 4	Word 5	Word 6	Word 7	Word 8	Word 9	Word 10	Word 11	Word 12	Word 13	Word 14	Word 15	Sync Word

Minor Frame Time = X Seconds

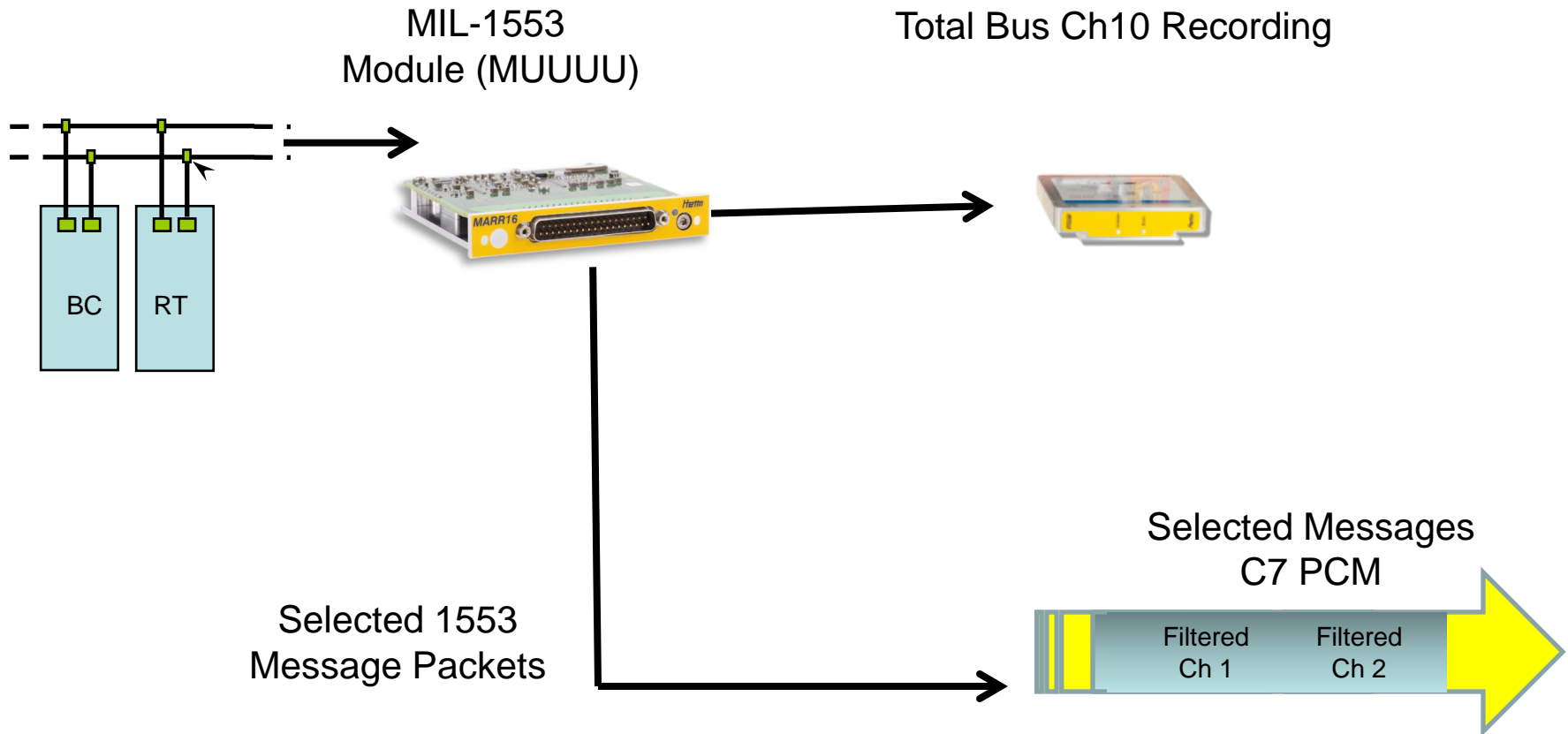


Word 1	Word 3	Word 5	Word 6	Sync Word
Word 1	Word 3	Word 5	Word 6	Sync Word
Word 1	Word 3	Word 5	Word 6	Sync Word
Word 1	Word 3	Word 5	Word 6	Sync Word
Word 1	Word 3	Word 5	Word 6	Sync Word
Word 1	Word 3	Word 5	Word 6	Sync Word

Filtering Video



Lower Rate 1553 Channel TM Downlink



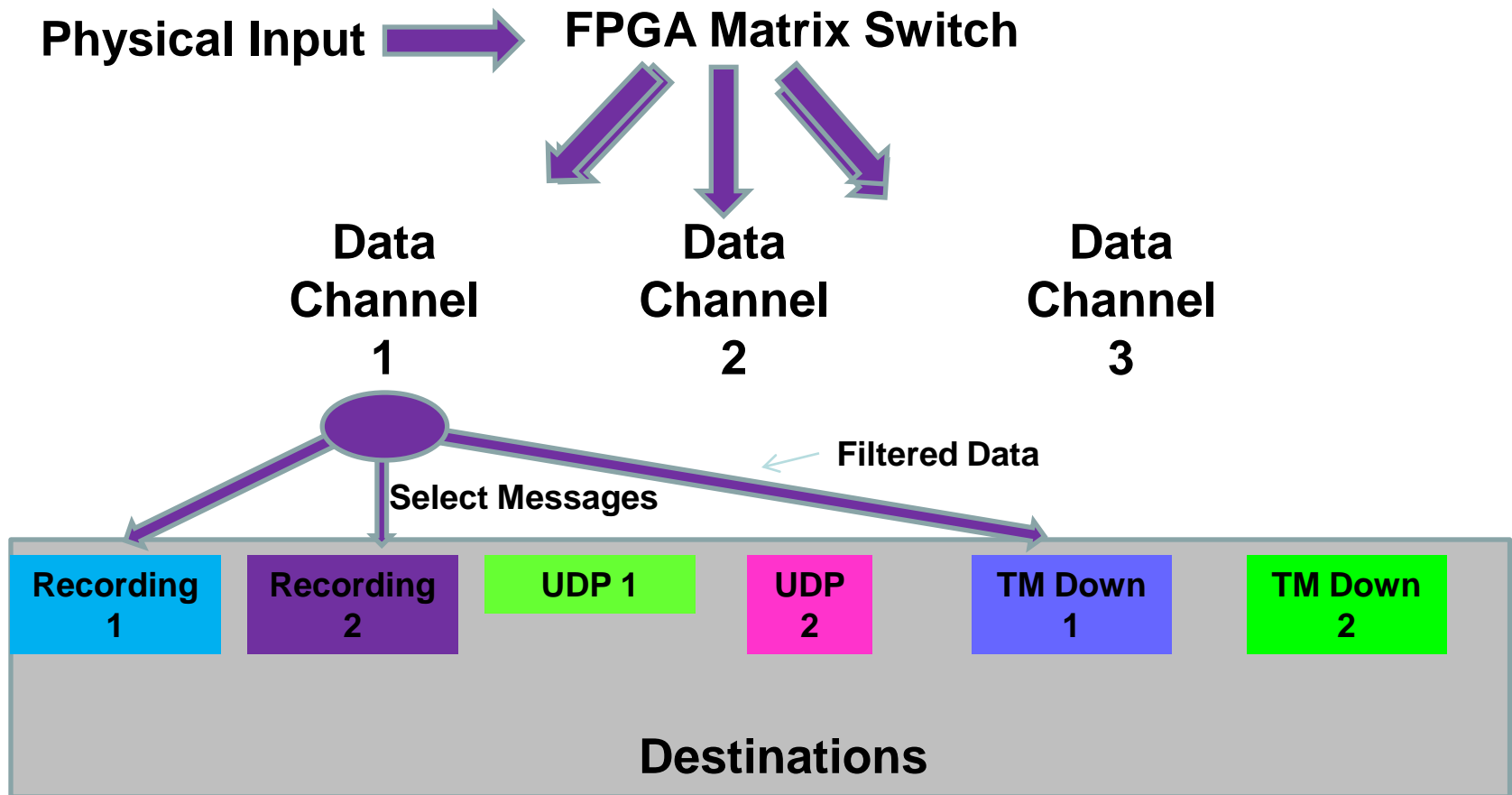
Summary- Filtering

Data Type	Description of Filtering/Sub Sampling
Video (MVCR1, MVCR3 and MVCR5)	The video channel is sent to two independent encoders. One is operating at a high rate for the on board recording. The other encoder is compressing the data at the desired data rate suitable for the TM downlink. HD to SD downscaling is available in some resolutions.
MIL-STD 1553 (hybrid modules)	All or filtered messages are recorded on board. For TM Down-Link Messages from specific busses are selected, based on RT, SA, WC, Transmit or Receive.
Analog, Discrete	No filter available yet.
Asynchronous Serial	Full traffic is recorded. User definable filter algorithms for TM downlink could be implemented in the future.
Ethernet (METH2A and hybrid modules)	Full traffic is recorded. User definable filter algorithms for TM downlink available based on source or destination IP addresses – or on IENA key.
PCM (hybrid modules)	Full rate recording. User definable filter algorithms for TM downlink available based on selected words from the Minor Frame Words.
ARINC 429	Full message recording. Label filtering for TM downlink could be implemented in the future.

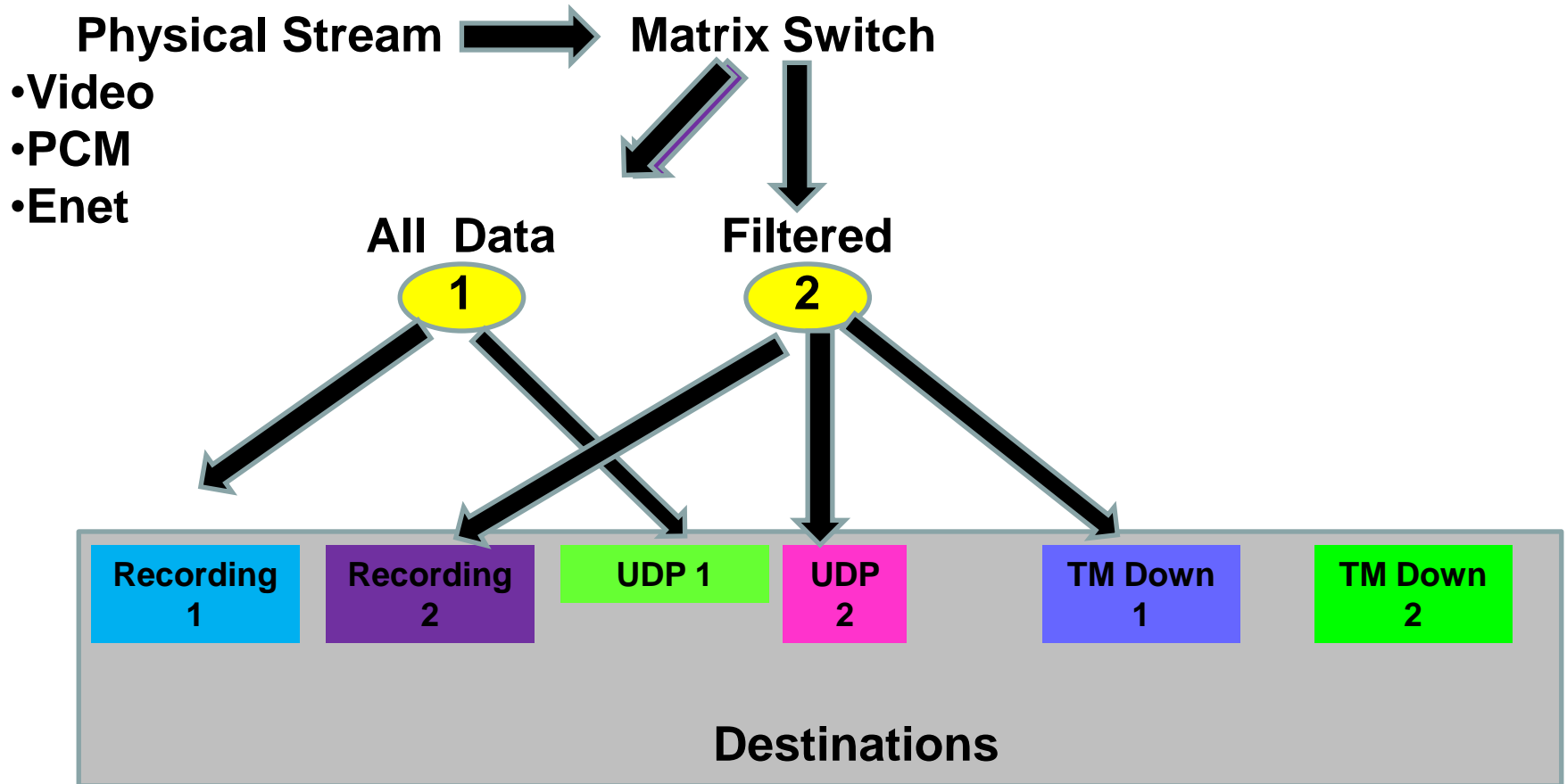
Implementation of Data Management System

- **Number of Output Streams and Destinations from a single signal has increased**
 - Recorded Streams
 - UDP Live Streaming (.publish)
 - Chapter 7 Filtered Streams

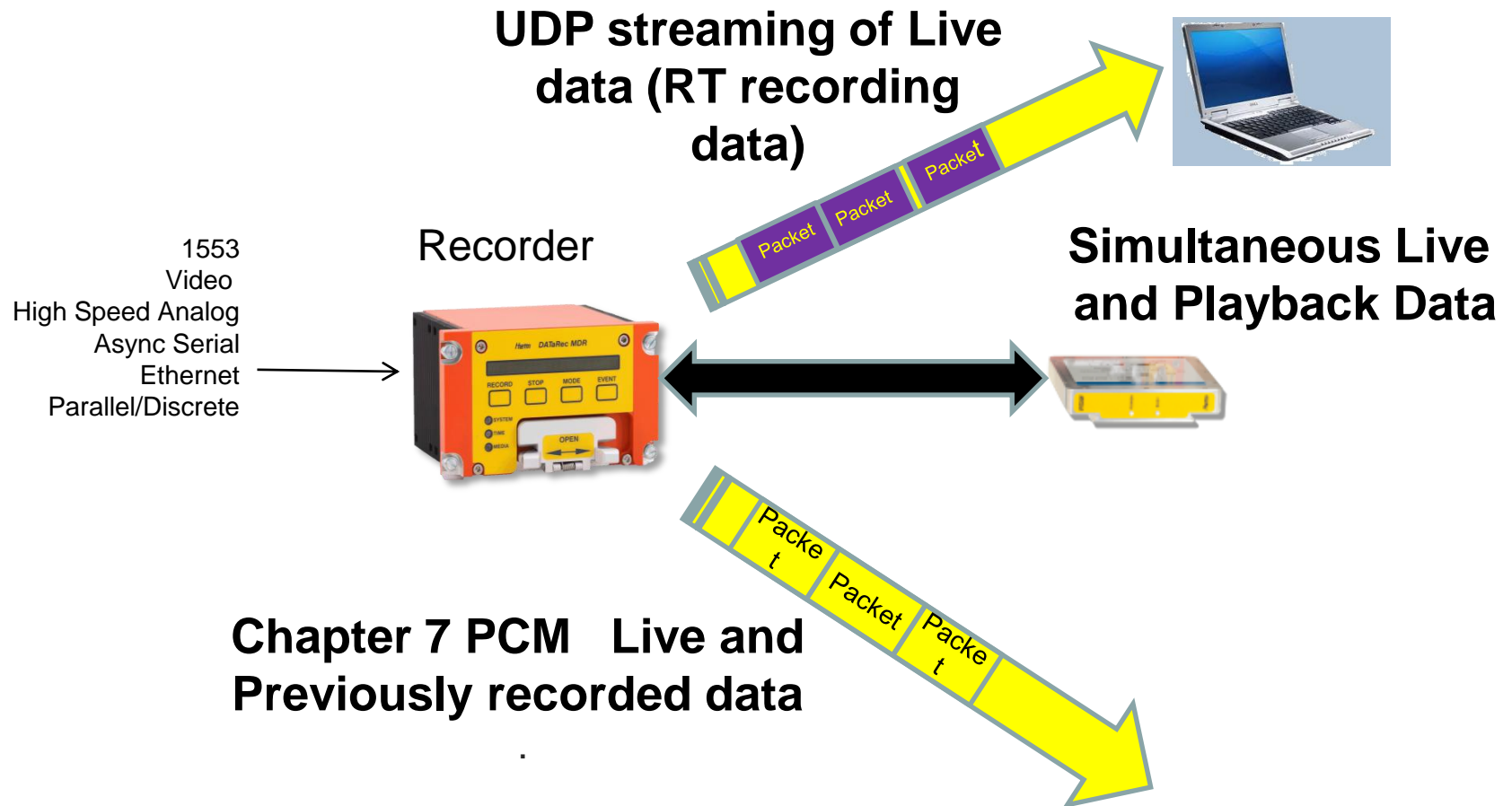
Physical Input and Data Channel Concept



Virtual Channel Example



Advanced Features- Playback Previous Recorded Data while Recording Real-Time Data

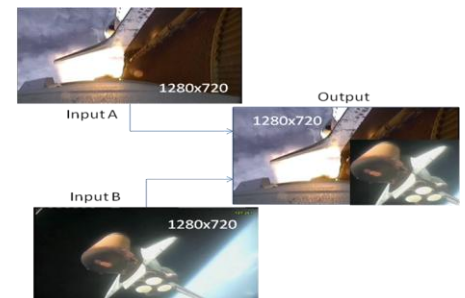


Advanced Features

- USING C10 .Dot Commands

- .Setup- (fully tested configurations)

- Switching of Sources Recorded In Real-time
 - Select Data Channels for Broadcasting (.publish)
 - Select Data Streams Sent to C7 PCM TM Link
 - Select Video Streams Downlinked



The End