UAT-WP-2-15
20 February 2001

RTCA Special Committee 186, Working Group 5

UAT MOPS

Meeting #2

FIS-B Uplink
The General Purpose of the UAT Link

(Presented by Jeff Giovino and Chris Moody)

SUMMARY

The General Purpose UAT Uplink

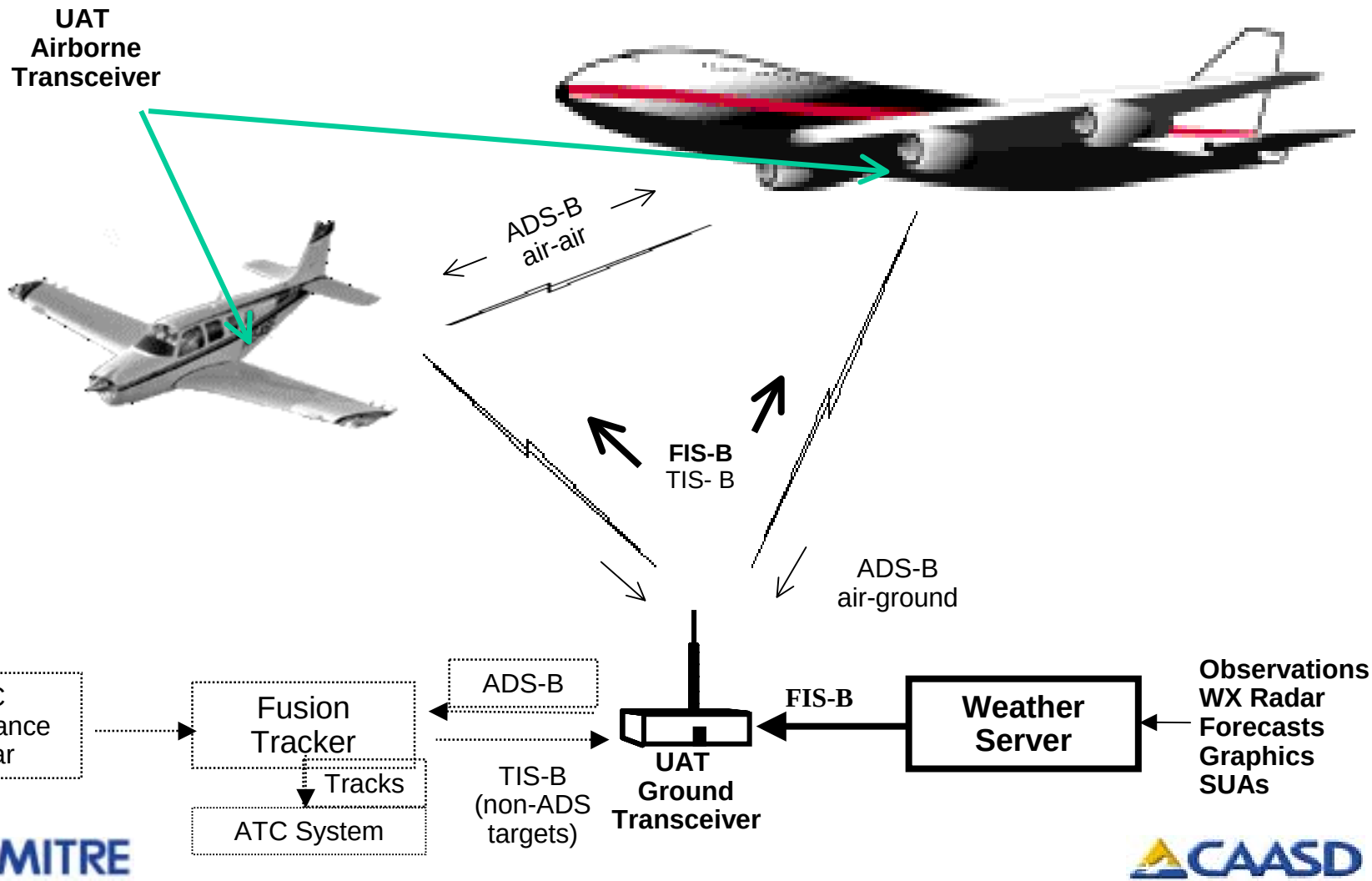
Jeff Giovino and Chris Moody

February 2001

Overview

- UAT Background
  - Applications and connectivity
  - Uplink message formats
  - Utilization of uplink
- RTCA SC 195 FIS-B MASPS
  - The “APDU”
  - Use of HDLC
- Capstone implementation
- Recommended MOPS scope in defining format of uplink payload

UAT Applications and Connectivity

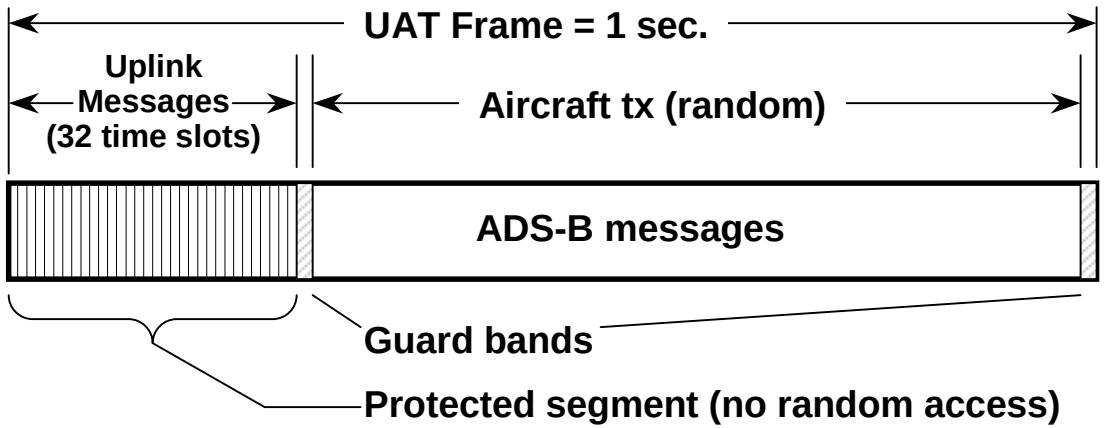


MITRE

CAASD

UAT Media Access Plan

- **UAT is a hybrid media access system based on a 1 second frame:**
  - **Short bursts**
    - ADS-B transmissions made on pseudorandom basis in last 80% of frame
    - TIS-B uplink transmissions made at any predefined MSOs
  - **Long Bursts**
    - General purpose uplink transmissions made in one of 32 time slots defined in first 20% of frame.
    - These are separate and protected from aircraft ADS-B transmissions



MITRE

CAASD

UAT Uplink Message Forms

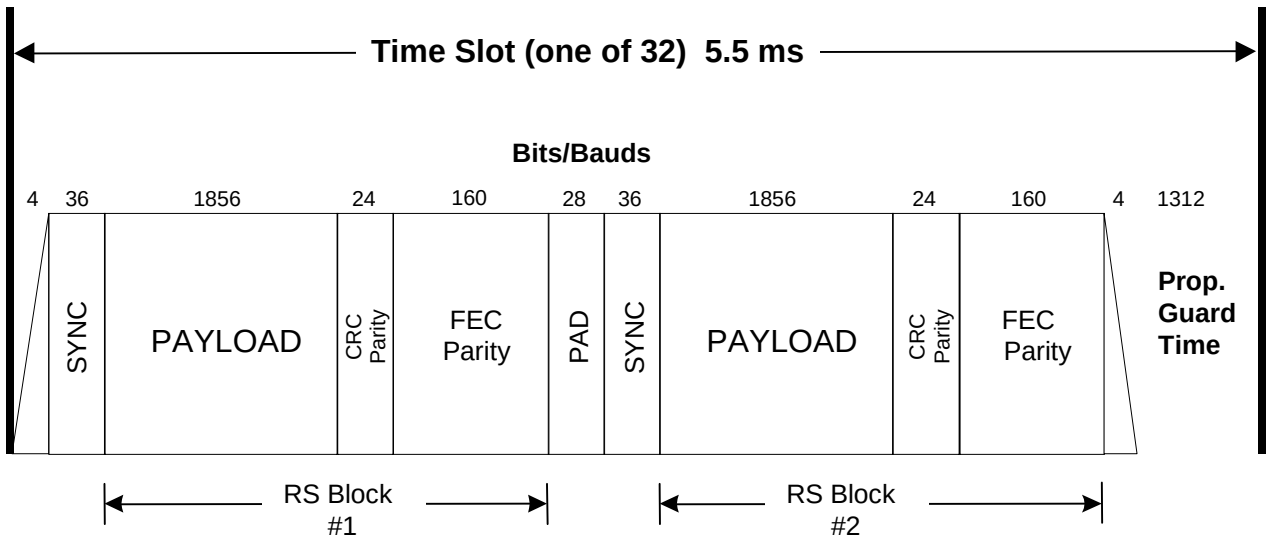
- **General Purpose**
  - **UAT uses a general purpose uplink message format that conveys a UAT specific header and up to 455 bytes of application data per transmission**
  - **Primary use of this uplink payload is for FIS-B information**
- **Special case**
  - **TIS-B information is a special case of uplink information because it uses the ADS-B message format**
  - **Uplink TIS-B transmissions may or may not occur in the protected segment of the frame**
- ***This presentation focuses on the general purpose uplink format***

MITRE

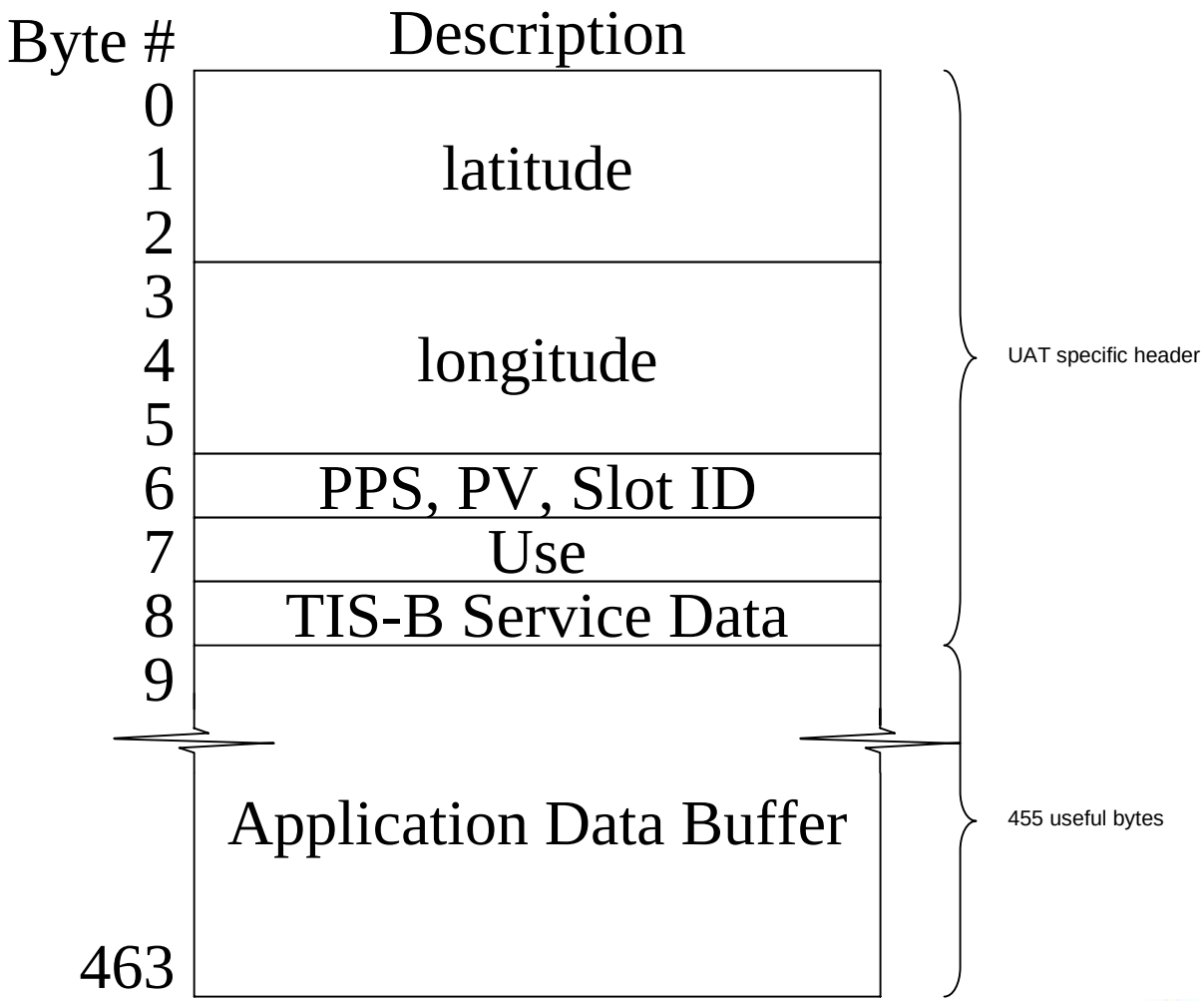
CAASD

UAT General Purpose Uplink Message

- **The general purpose uplink consists of two consecutive Reed Solomon FEC blocks**
- **Each R/S block is decoded independently; however, from application perspective both blocks are treated as a single combined payload (all or nothing)**
  - **464 byte payload:** *(2 x 1856) / 8*



UAT General Purpose Uplink Payload



UAT Utilization of Uplink Messages

- **Time division of multiple overlapping sites**
  - **Designed for prop. delay of more than 200 nmi**
  - **250 nmi product coverage range**
  - **Multiple timeslots assigned per site**
- **Reasonable fixed sized unsegmented payload**
  - **Simplifies time division technique**
  - **Minimize header over head**
  - **Minimize wasted BW due to message fragmentation**

UAT Utilization of Uplink Messages *(continued)*

- **Precipitation**
  - **Generated every 5 minutes**
  - **Derived from one mosaic of NEXRAD data**
  - **~15-25 bytes per block**
  - **Rebroadcast every 2 minutes**
  - **Can utilize up to 90 general uplink transmissions per image**
  - **~60 % of BW using 1 uplink time slot**

UAT Utilization of Uplink Messages *(concluded)*

- **METAR/TAF (surface observations/forecasts)**
  - **Generated hourly and 4 times a day respectively**
  - **Derived from hundreds of reporting stations per ground station coverage area**
  - **~ 40 bytes long per report (w/o remarks)**
  - **Rebroadcast every 5 minutes**
  - **Can utilize up to 20 general uplink transmissions per period**
  - **~10 % of BW using 1 uplink time slot**

MITRE

CAASD

RTCA Special Committee 195

MIMIMUM AVIATION SYSTEM PERFORMANCE STANDARDS (MASPS) for FLIGHT INFORMATION SERVICES-BROADCAST (FIS-B) DATA LINK

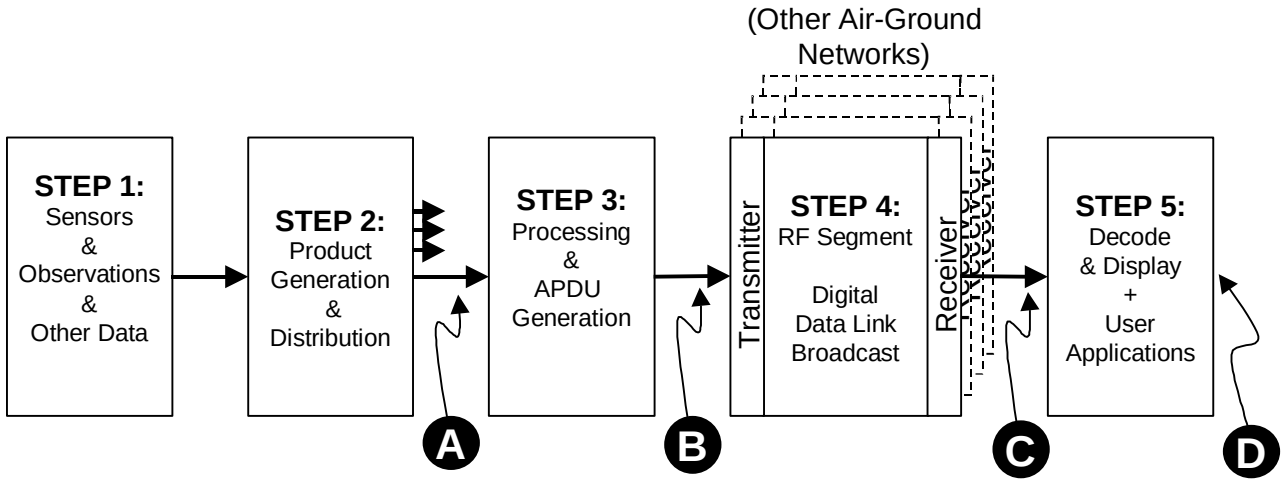
RTCA SC 195 protocol stack

- **Application data**
- **Application Service Element (ASE)**
- **Application Protocol Data Unit (APDU)**
- **Data Link Service (DLS)**
  - ***assumes variable transmission duration ****
  - uses HDLC
    - *artifact of VDL-2 implementation*
    - *AVLC Aviation VHF Link Control*
  - assume 1 APDU per UI-frame
- **communications media (VDL-2)**

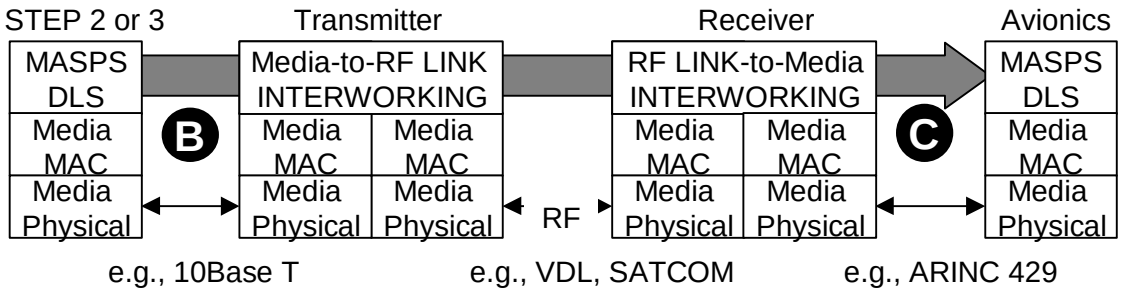
MITRE

CAASD

RTCA SC 195 protocol stack *(concluded)*



(a) Notional Hardware/Processing View of FIS-B Architecture



(b) Notional Protocol Stack View of FIS-B Architecture

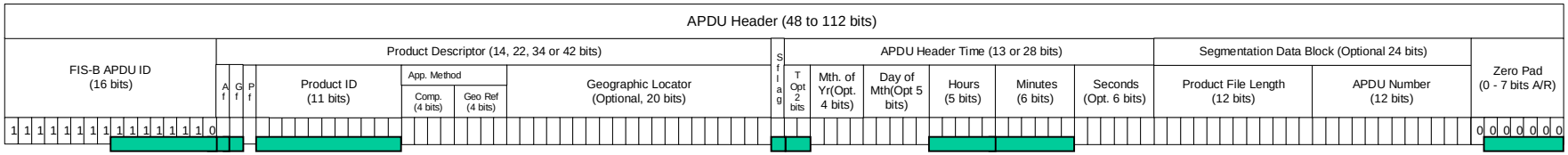
RTCA SC195 APDU

- RTCA SC195 defines the Application Protocol Data Unit (APDU) as the smallest incremental units of data conveyed to the airborne FIS application
- Philosophy of APDU
  - Choose APDU lengths to maximize tx success rate
  - One APDU is self contained; if “peer” APDUs are lost data is still useful
  - For bursting technology choose APDU length one order less than message size
    - Allows for efficient packaging of uplink burst
    - Minimizes unused bytes in each burst
    - Minimizes “starving” of other applications

RTCA SC195 APDU *(continued)*

- APDU header specifies:
  - product type
  - product time of applicability
  - APDU segmentation/sequence info (if applicable)
  - compression method
  - georeference framework

RTCA SC195 APDU *(concluded)*



Product ID

Bit ID 11	10	9	8	7	6	5	4	3	2	1	Prod ID	Product Descriptio	Type
0	0	0	0	0	0	0	0	0	0	0	0	METAR and	Text
0	0	0	0	0	0	0	0	0	0	1	1	TAF and Amended	Text
0	0	0	0	0	0	0	0	0	1	0	2	SIGMET	Text
0	0	0	0	0	0	0	0	0	1	1	3	Convective	Text
0	0	0	0	0	0	0	0	1	0	0	4	AIRMET	Text
0	0	0	0	0	0	0	0	1	0	1	5	PIREP	Text
0	0	0	0	0	0	0	0	1	1	0	6	AWW	Text
0	0	0	0	0	0	0	0	1	1	1	7	Winds and Temp	Text
8-50													
0	0	0	0	0	0	1	1	0	0	1	51	National NEXRAD,	Graphic
0	0	0	0	0	0	1	1	0	1	0	52	National NEXRAD,	Graphic
0	0	0	0	0	0	1	1	0	1	0	53	National NEXRAD,	Graphic
0	0	0	0	0	0	1	1	0	1	1	54	National NEXRAD,	Graphic
0	0	0	0	0	0	1	1	0	1	1	55	Regional NEXRAD,	Graphic
0	0	0	0	0	0	1	1	1	0	0	56	Regional NEXRAD,	Graphic
0	0	0	0	0	0	1	1	1	0	1	57	Regional NEXRAD,	Graphic
0	0	0	0	0	0	1	1	1	1	0	58	Regional NEXRAD,	Graphic
0	0	0	0	0	0	1	1	1	1	1	59	Individual NEXRAD,	Graphic
0	0	0	0	0	1	1	1	1	0	0	60	Individual NEXRAD,	Graphic
0	0	0	0	0	1	1	1	1	0	1	61	Individual NEXRAD,	Graphic
0	0	0	0	0	1	1	1	1	1	0	62	Individual NEXRAD,	Graphic
63-80													
0	0	0	0	1	0	1	0	0	0	1	81	Radar echo tops, scheme	Graphic
0	0	0	0	1	0	1	0	0	1	0	82	Radar echo tops, scheme	Graphic
0	0	0	0	1	0	1	0	0	1	1	83	Storm tops and	Graphic
84-100													
0	0	0	0	1	1	0	0	1	0	1	101	Lightning Strike type	Graphic
0	0	0	0	1	1	0	0	1	1	0	102	Lightning Strike type	Graphic
103-150													
0	0	0	1	1	0	0	1	0	1	1	151	Point phenomena, vector	Graphic
152-200													
0	0	0	1	1	1	0	0	1	0	0	201	Surface conditions/winter	Graphic
0	0	0	1	1	1	0	0	1	0	1	202	Surface weather	Graphic
203-253													
0	0	0	1	1	1	1	1	1	1	0	254	AIRMET, SIGMET Bitmap	Graphic
255-350													
0	0	1	0	1	0	1	1	1	1	1	351	System	Text/bin
352-400													
0	0	1	1	0	0	1	0	0	0	1	401	Generic Raster Scan,	Graphic
0	0	1	1	0	0	1	0	0	1	0	402	Generic Vector, Type	Graphic
0	0	1	1	0	0	1	0	0	1	1	403	Generic Symbolic,	Graphic
0	0	1	1	0	0	1	0	1	0	0	404	Generic Text, Type	Text
405-2047													

Compression Method (Opt.)

Bit ID 4	3	2	1	Field Value	Descriptio
0	0	0	0	0	None
0	0	0	1	1	Run Length Encoding
0	0	1	0	2	Run Length Encoding
0	0	1	1	3	Deflate
0	1	0	0	4	Weather Huffman
0	1	0	1	5	PNG
0	1	1	0	6	MNG
7-15					Reserved

Geo. Reference Method (Opt.)

Bit ID 4	3	2	1	Field Value	Descriptio
0	0	0	0	0	Discrete
0	0	0	1	1	Cylindrical
0	0	1	0	2	Lambertia
0	0	1	1	3	Polar
0	1	0	0	4	GeoTIFF File
0	1	0	1	5	Single Text
0	1	1	0	6	Multiple Text Products
0	1	1	1	7	Global Block
8-15					Reserved

Option Flags

Flag	Bit Value	Descriptio
Application	0	Method Fields
	1	Method Fields
Geographic	0	Geo Loc Field
	1	Geo Loc Field
Provider-Specific Flag	0	Provider
	1	Provider
Segmentatio	0	Seg Fields
	1	Seg Field
Time Flag	0	Day of Month and Month Year
	1	Day of Month and Month Year
Time Flag	0	Seconds
	1	Seconds

Month of Year (Opt.)

Bit ID 4	3	2	1	Field Value	Month
0	0	0	0	0	Unused
0	0	0	1	1	1
0	0	1	0	2	2
0	0	1	1	3	3
0	1	0	0	4	4
0	1	0	1	5	5
0	1	1	0	6	6
0	1	1	1	7	7
1	0	0	0	8	8
1	0	0	1	9	9
1	0	1	0	10	10
1	0	1	1	11	11
1	1	0	0	12	12
1	1	0	1	13	Unused
1	1	1	0	14	Unused
1	1	1	1	15	Unused

Day of Month (Opt.)

Bit ID 5	4	3	2	1	Field Value	Day
0	0	0	0	0	0	Unused
0	0	0	0	1	1	1
0	0	0	1	0	2	2
0	0	0	1	1	3	3
0	0	1	0	0	4	4
0	0	1	0	1	5	5
0	0	1	1	0	6	6
0	0	1	1	1	7	7
0	1	0	0	0	8	8
0	1	0	0	1	9	9
0	1	0	1	0	10	10
0	1	0	1	1	11	11
0	1	1	0	0	12	12
0	1	1	0	1	13	13
0	1	1	1	0	14	14
0	1	1	1	1	15	15
1	0	0	0	0	16	16
1	0	0	0	1	17	17
1	0	0	1	0	18	18
1	0	0	1	1	19	19
1	0	1	0	0	20	20
1	0	1	0	1	21	21
1	0	1	1	0	22	22
1	0	1	1	1	23	23
1	1	0	0	0	24	24
1	1	0	0	1	25	25
1	1	0	1	0	26	26
1	1	0	1	1	27	27
1	1	1	0	0	28	28
1	1	1	0	1	29	29
1	1	1	1	0	30	30
1	1	1	1	1	31	31

Hours

Bit ID 5	4	3	2	1	Field Value	Time
0	0	0	0	0	0	12 AM
0	0	0	0	1	1	1 AM
0	0	0	1	0	2	2 AM
0	0	0	1	1	3	3 AM
0	0	1	0	0	4	4 AM
0	0	1	0	1	5	5 AM
0	0	1	1	0	6	6 AM
0	0	1	1	1	7	7 AM
0	1	0	0	0	8	8 AM
0	1	0	0	1	9	9 AM
0	1	0	1	0	10	10 AM
0	1	0	1	1	11	11 AM
0	1	1	0	0	12	12 PM
0	1	1	0	1	13	1 PM
0	1	1	1	0	14	2 PM
0	1	1	1	1	15	3 PM
1	0	0	0	0	16	4 PM
1	0	0	0	1	17	5 PM
1	0	0	1	0	18	6 PM
1	0	0	1	1	19	7 PM
1	0	1	0	0	20	8 PM
1	0	1	0	1	21	9 PM
1	0	1	1	0	22	10 PM
1	0	1	1	1	23	11 PM
24 - 31						

Minutes / Seconds (Opt.)

Bit ID 6	5	4	3	2	1	Field Value	Min. / Sec.
0	0	0	0	0	0	0	0
0	0	0	0	0	1	1	1
0	0	0	0	1	0	2	2
0	0	0	0	1	1	3	3
0	0	0	1	0	0	4	4
0	0	0	1	0	1	5	5
0	0	0	1	1	0	6	6
0	0	0	1	1	1	7	7
0	0	1	0	0	0	8	8
0	0	1	0	0	1	9	9
0	0	1	0	1	0	10	10
0	0	1	0	1	1	11	11
0	0	1	1	0	0	12	12
0	0	1	1	0	1	13	13
0	0	1	1	1	0	14	14
0	0	1	1	1	1	15	15
0	1	0	0	0	0	16	16
0	1	0	0	0	1	17	17
0	1	0	0	1	0	18	18
0	1	0	0	1	1	19	19
0	1	0	1	0	0	20	20
0	1	0	1	0	1	21	21
0	1	0	1	1	0	22	22
0	1	0	1	1	1	23	23
0	1	1	0	0	0	24	24
0	1	1	0	0	1	25	25
0	1	1	0	1	0	26	26
0	1	1	0	1	1	27	27
0	1	1	1	0	0	28	28
0	1	1	1	0	1	29	29
0	1	1	1	1	0	30	30
0	1	1	1	1	1	31	31
Continued							

Minutes / Seconds cont. (Opt.)

Bit ID 6	5	4	3	2	1	Field Value	Min. / Sec.
1	0	0	0	0	0	32	32
1	0	0	0	0	1	33	33
1	0	0	0	1	0	34	34
1	0	0	0	1	1	35	35
1	0	0	1	0	0	36	36
1	0	0	1	0	1	37	37
1	0	0	1	1	0	38	38
1	0	0	1	1	1	39	39
1	0	1	0	0	0	40	40
1	0	1	0	0	1	41	41
1	0	1	0	1	0	42	42
1	0	1	0	1	1	43	43
1	0	1	1	0	0	44	44
1	0	1	1	0	1	45	45
1	0	1	1	1	0	46	46
1	0	1	1	1	1	47	47
1	1	0	0	0	0	48	48
1	1	0	0	0	1	49	49
1	1	0	0	1	0	50	50
1	1	0	0	1	1	51	51
1	1	0	1	0	0	52	52
1	1	0	1	0	1	53	53
1	1	0	1	1	0	54	54
1	1	0	1	1	1	55	55
1	1	1	0	0	0	56	56
1	1	1	0	0	1	57	57
1	1	1	0	1	0	58	58
1	1	1	0	1	1	59	59
60 - 63							

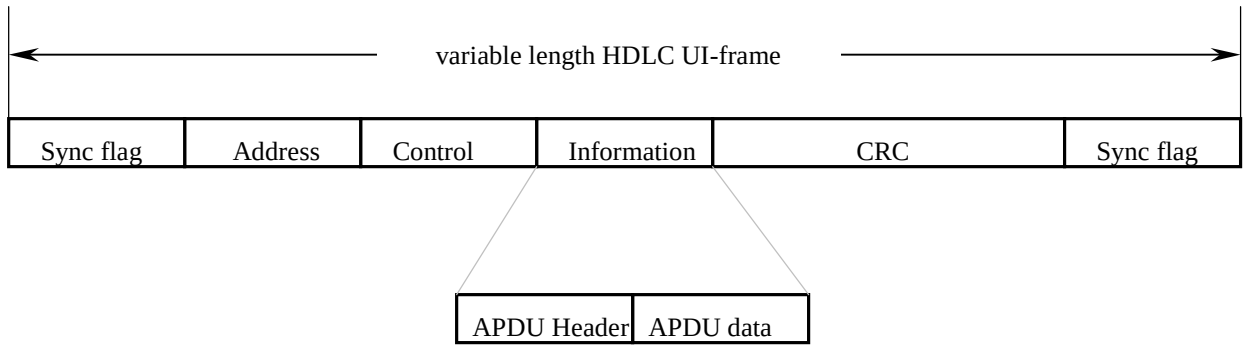
Geographic Locator (Optional)

Lat 7	6	5	4	3	2	1	Long 8	7	6	5	4	3	2	1	Extent 5	4	3	2	1
0-180, N-S, 2 res							0-360, W-E, 2 deg								S and E, 2 deg. res				

RTCA SC 195 use of HDLC

- HDLC ISO/IEC specifications 3309 and 4335
- Flag sequence and bit stuffing
  - synchronization
  - message delimiting
  - message length derived using flags
- FCS/CRC for integrity
- “Best effort” vs. Asynchronous Balanced Mode (ABM)
  - “Best Effort” or Datagram service = broadcast
  - Un-numbered information frames *(UI-frames)*
    - *flag, address, control, information, FCS, flag (6 bytes)*
- *Already implemented in UAT uplink message*

RTCA SC 195 HDLC format



ALASKAN REGION

MITRE

CAASD

Capstone Protocol Stack

- **Application data**
- **Application Service Element (ASE)**
- **Application Protocol Data Unit (APDU)**
- **Data Link Service (DLS)**
  - ***Fixed transmission duration ****
  - Capstone Frame
    - Determines APDU length
  - General purpose uplink payload
  - General Purpose uplink timeslot
    - Assures integrity with FEC/CRC
    - Synchronization
- **UAT**

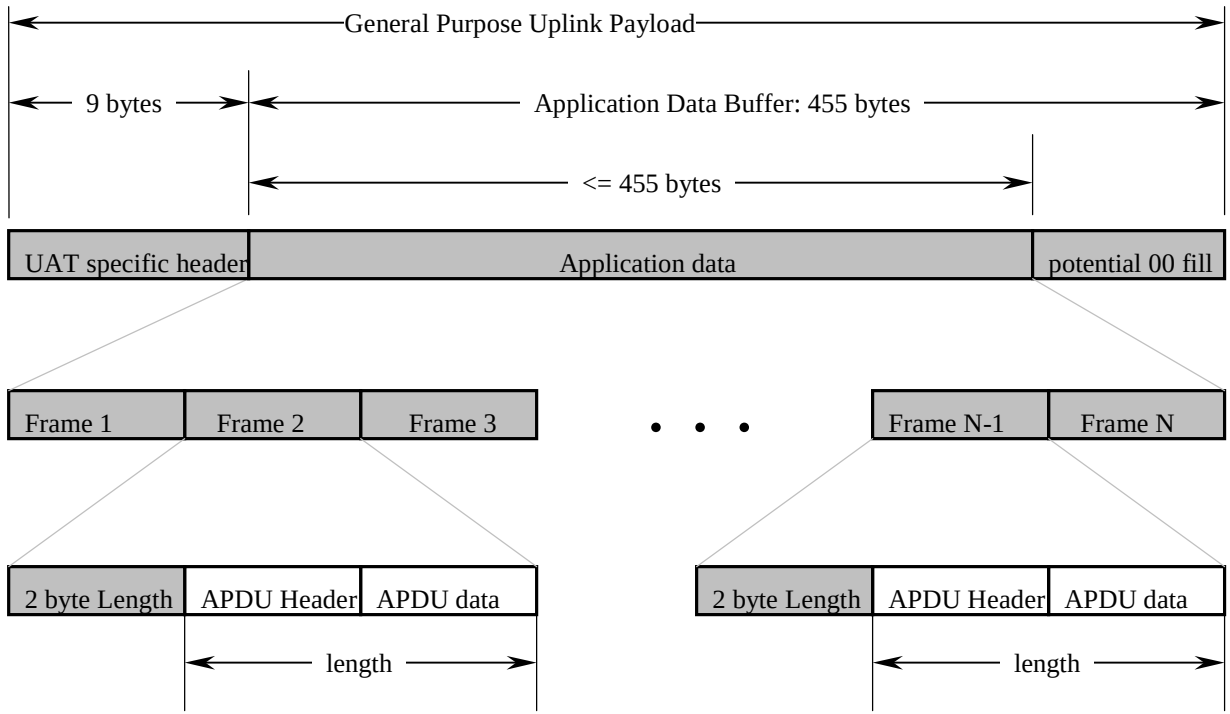
MITRE

CAASD

Capstone: How APDU's are packed into the general purpose uplink payload

- Multiple frames are concatenated to fill the UAT uplink payload efficiently
- Currently a 2 byte frame length followed by the data is used
- One APDU per frame
- APDU length is determined by frame length

Capstone Protocol Stack *(concluded)*



Shaded boxes represent proposed scope of MOPS

Recommended MOPS Scope in Defining Format of General Uplink Payload

- **Define format of general uplink payload up to the Frame level only.**
- **Refer APDU definition to other application MASPS/MOPS**
- **UAT MOPS should specify support for the following only**
  - **identifying uplink transmitter location and time slots**
  - **proper delimiting of APDUs**
  - **ensuring APDU integrity**
- **TIS-B is special case uplink not covered under this recommendation**

MITRE

CAASD