Binary Message Protocol and Proof of Concept Prototype Update

Presented by Microcom Design, Inc.

May 2022





Binary Protocol – A Brief History



- ASCII and Pseudo-Binary (a subset of ASCII characters) have been the bread and butter of DCS messages for decades.
 - Use of ASCII characters and prohibition of certain non-printable ASCII codes dates back to the teletype days, and was a requirement of the NWS.
- Binary is referenced in both the original and second generation High Data Rate Certification Standards (CS1 & CS2), but was never fully defined.
 - CS1 included the statement ... "precise format and error checking for HDR binary transmissions is TBD".
 - CS2 noted that a Binary Protocol Specification would to be "*published separately*" and would then be appended the to standard.
- While several approaches to come up with a Binary Protocol were attempted even before CS2 was released, the last major discussion on this topic occurred at the May 2012 TWG in Boise, Idaho.
 - Sutron (now Ott), Signal Engineering, and Microcom all submitted recommendations in 2005.
 - EDDN's Binary Transmission Project (BTP) in the 2009-2010 timeframe.



Binary Protocol – Moving Forward



- While the last serious discussion on a Binary Protocol Specification was in 2012, it continued to be a somewhat regular, albeit informal, discussion topic.
 - As part of its sustainment contract, Microcom annually prepared a system analysis document that includes recommendations for work assignment projects.
 - The Binary Protocol has always been a low priority task on the recommendation list with a caveat, that if Binary is ever going to happen, NOAA must take the lead.
- In September 2021, Microcom once again prepared a system analysis document and again included Binary Protocol on the list.
- This time however, NOAA decided it was time to move forward and in November 2021 approved a work assignment that directed Microcom to ...
 - Perform a "fresh" review and analysis of the previous recommendations with a focus on Pros and Cons of some of the specific suggestions.
 - Develop a proof-of-concept demonstration of the Binary protocol suggested in an attempt to revitalize the topic and gauge user interest in a Binary Protocol.



Binary Protocol – The Fresh Look



- > Dr. Brian Kopp and Matt Taylor performed the *fresh look*:
 - Both have extensive expertise in RF communications and data processing.
 - They are intimately familiar with the DCS from a manufacturer's and a user's perspective, but neither were familiar with the prior work on a Binary Protocol.
- ➢ To aid Dr. Kopp and Matt Taylor in their review and analysis, Microcom and NOAA held a TIM to get NOAA's input on setting priorities for potential advantages of using binary.
 - NOAA/NESDIS' mission with regard to the DCS is to provide users with a reliable satellite telemetry capability to gather the *user's* environmental data so NOAA's top priority was to offer the user's the option to use binary with as few restrictions as possible.
 - The Binary Protocol should be like the existing ASCII and Pseudo-Binary specifications with just enough specified to allow the data to be collected, and should not be overly concerned with any specific advantage (e.g. efficiency, reliability, compatibility, etc.), but instead should allow user's flexibility in the data portion of the message.
- Kopp's and Taylor's initial recommendations were presented at the December virtual STIWG and the final recommendations were presented to NOAA in early January 2022.



Binary Protocol – Key Recommendations

- Message Length
 - Use message length in place of EOT.
 - Need 14-bit message length field.
 - BCH protect message length and original Flag byte.
- ➤ CRC-16
 - Append 16-bit CRC to data field to replace Odd Parity bits in each byte as was used in the Pseudo-Binary and ASCII formats.
 - Use the code polynomial $0xd175 = x^{16} + x^{15} + x^{13} + x^9 + x^7 + x^6 + x^5 + x^3 + x + 1$
- Reduced Flush
 - Originally Microcom believed it was possible to eliminate the flush entirely due to the fact that the message length is known.
 - However, implementation and testing showed that a 16-bit flush is needed.
 - Current HDR specification requires 32 bits of flush.



Binary Protocol – Comparison to ASCII/Pseudo-Binary



			Cu	rrent 300 a	& 1200 bps ASCII and Pseudo-Binary DCPRS Message Format		
Carrier 0.5s/ 0.25s	Clock States 3 '0-1'	FSS 15 bits	GOES ID 32 bits	Flag Word 8 bits	DCP DATA Max: 32,000 bits @ 300 bps 128,000 bits @ 1200 bps	EOT 8 bits	Encoder Flush 32 bits

	-				Proposed 300 bps	s Binary DCPRS	Message Format		
Carrier 0.5s	Clock States 3 '0-1'	FSS 15 bits	GOES ID 32 bits	Flag Word 8 bits	Msg Length 14 bits	BCH 10 bits	DCP DATA Max: 32,000 bits	CRC 16 Bits	Encoder Flush 16 bits



Binary Protocol – BCH Protected Length



- ➢ BCH Details:
 - DCP address currently utilizes Bose-Chaudhuri-Hocquenghem (31,21) encoding scheme.
 - This error correction/detection code can correct all 2-bit errors and detect most 3-bit errors.
 - Since the length is only 14-bits, the Flag Word and Message Length are combined to produce the 21-bit information portion, which is then used to generate the 10-bit check field.
 - The normal Odd Parity of the Flag Word is still included in the overall 32-bit (4-byte) field bit as the most significant bit (MSB).
- ➢ Flag Word:
 - The 7 information bits in the Flag Word will not be changed.
 - Two of the bits (FW6 & FW5) identify the message as ASCII, Pseudo-Binary, or Binary.
 - One of the reserved bit (FW2) was utilized in the prototype demo to identify Compact PB.



Binary Protocol – Proof-of-Concept Demo



- Once NOAA accepted the Binary Protocol recommendations, Microcom began implementing the protocol in the DCS Pilot/Test Transmitter (P/T Tx) and the DAMS-NT Demodulator and Receiver systems.
 - Prototype work was completed in January and early February 2022; virtual demonstration was provided to NOAA in late February.
 - Microcom commanded the P/T Tx at its office in Hunt Valley and received the test messages on the Sustainment DAMS-NT/DADDS rail also at Microcom's facility in Hunt Valley.
 - Binary messages were also detected by the NOAA sites, but were not properly received since the operational DAMS-NT/DADDS systems had not been updated.
- In addition to sending some test legacy ASCII/Pseudo-Binary messages, the Demo consisted of two main binary examples:
 - A binary fill message that consisted of all 256 8-bit binary values to demonstrate that the implementation would not be confused by key values (e.g. the ASCII EOT character – 0x04).
 - A Compacted Pseudo-Binary example using a typical Florida Department of Transportation message to demonstrate how Compact PB can reduce the message size by ~25% while still conveying the same amount of environmental and system information.



Binary Protocol – Binary Fill Example – Demod Comparison

DAMS-NT Server r1-53 [DAMS-NT Test] [A SERVER: PRIME] [8 Server: Fault] File Setup Operations Jerminal View Window Help	- 0 ×
Slot History (Slot80, Chan 495]	
Messages Summay	
Stat Mode Dhan Baud AddCorr AddCorr Carrier Time Finance Ent Mag Dux Len BER GOP Finance Finance	F0 FS MI DQ ARM A
80 CS2 495W 300 7710051A 2710051A 22/048 21:26:15:790 22/048 21:26:22:940 7.726 262 0E-9 986 2.82 2.83 46.9 26.9 8 0 41.0 80 CS2 455W 300 7710051A 27/048 21:25:55:34 22/048 21:26:50:412 22/048 21:26:00:498 4.964 155 0E-9 98.0 2.85 24.5 47.0 17.9 P 0 40.8	22 R N N 00
80 CS2 439W 1300 7710061A 7710061A 22/048 21:25:38:935 22/048 21:25:39:540 22/048 21:25:40:850 1.915 40 126.4 383 2.66 23.4 46.9 21.3 A 0 40.6	
DCP MSG DATA DAPS/DDS DAMS-NT DECODED HEX.ASCII APPLY VIEW FULL MSG HIDE STATS	
0176: AC AD AE AF B0 B1 B2 B3 B4 B5 B6 B7 B8 B9 BA BB ,/0123465789;; 0192: BC BD BE BF C0 C1 C2 C3 C4 C5 C6 C7 C8 C9 CA CB 0123465789;;</td <td><u>^</u></td>	<u>^</u>
0208: CC CD CE CF D0 D1 D2 D3 D4 D5 D6 D7 D8 D9 DA DB IMNOPQRSTUTWIYZ[0224: DC DD DE DF E0 E1 E2 E3 E4 E5 E6 E7 E8 E9 EA EB \]bcdeddybijk 0240: EC ED EE EF F0 F1 F2 F3 F4 F5 F6 F7 F8 F9 FA FB lanopqrstuwwyz{	
0256: EC ED EE FF OF 15 F5	=
	v
STAT_EOM 00 BAUD_RATE_ 300	<u>^</u>
FRAME CBAR R FREQUENCY DEVIATION +2.2 AVERAGE POWER +41.0	±
NOISE POWER 417.2 BIT ERROR RATE 0E-9	
SIGNAL/NOISE +23.8	
PHASE STATS 0 DEG (+60) +1.19 3.14 45 DEG (-60) +0.64 2.87 90 DEG -0.63 2.82	
30 DEG -0,83 2,82	× ×
Stot History (Slot81, Chan 495) Messages Summay	_ 0 ×
2 4 ★ ★ ★ ★	
Skt Mode Chan Baud AddCor AddOre Carlier Time Frame Time End Time Mig Dur Len BER GDP PHN SNR Pilot Note Fint Par SS	
81 CS2 495W 300 7710061A 7710061A 22/048 21:26:15:213 22/048 21:26:15:790 22/048 21:26:23:114 7:901 1 06:8 100.0 1.96 23.8 46.9 26.9 B 13 40.8	25 R N N 01
81 CS2 495W 300 7710061A 2710061A 22/048 21:2555.533 22/048 21:25:06.121 22/048 21:25:00.458 4.965 155 0E-9 988 2.87 24.6 47.0 17.9 P 0 40.6 81 CS2 495W 300 7710061A 27/048 21:25:33:540 22/048 21:25:40:850 1.915 40 0E-9 989 2.87 23.5 46.9 21.3 A 0 40.4	25 R N N 00 27 R N N 00
DCP MSG DATA DAPS/DDS DAMS-NT DECODED HEX.ASCII APPLY VIEW FULL MSG HIDE STATS	
STAT_EON 00	<u></u>
FRAME CHAR R FREQUENCY DEVIATION +2.4 +2.6	=
AVERAGE POVER +40.8 NOISE POVER +17.0	
BIT ERFOR RATE 0E-9 SIGNAL/NOISE +23.8	
PHASES STATS 0 DEG (+60) +1.25 3.80	
90 DEG +0.22 1.47	v
	>
DAMS-NT Text [CPU Usage: 0%] MEMORY [Total: 3,332 KB] [Allocated: 1,783 KB] [Overhead: 2,148 KB] ALLOCATIONS [Total: 19,488] [Allocat/Sec: 371] WINDOWS [CPU Usage: 2%] MEMORY [Commit Size: 12,529 KB] [Working Set: 25,923 KB] UP TIME	E: 00:10:38 UP SINCE: 22/048 21:20:58 CAGE UTC: 22/048 21:31:36

- Received properly by top demod (Slot 80), which was updated to support new binary protocol.
- Not received by bottom demod (Slot 81) that had not been updated.
 - Summary grid shows legacy demod identified message as binary ('B').

• Albeit with parity errors.

40.8 2.4 R H

 Even though message lasted nearly 8 seconds, only 1 data byte was reported.

DCP MSG DATA	DAPS/DDS
0000: 40	

Microcom Design, Inc.

Binary Protocol – Binary Fill Example – Updated Demod



- Updated demod reported 262 bytes received: The 256 binary values (00-FF), the 4-byte Flag & Length field (40 04 01 E7), and the 2-byte CRC (4B 55).
- Note that the second data byte being 0x04 (ASCII EOT) is why the legacy demod truncated the message data to single byte as was shown in the previous slide.

😹 DAMS-NT Server	r r1-53 [DAMS-I	NT Test] [/	A SERVER: PRIM	ME] [B Serve	r: Fault]	- [Slot Histor	y [Slot80	, Chan 495]]														-	-	1	x
Setup O	_	minal <u>V</u> i	ew <u>W</u> indow	<u>H</u> elp																				_ 8	×
Messages Summary																									_
- 4				-	< Row 2	of 4 >>																			
Slot Mode Cha		AddrCorr	AddrOrig	Carrier		Frame T		End T		Msg Dur	Len	BER		PHN S		Pilot	Noise	Fmt	Par	SS	FO	FS M	_	ARM	^
80 CS2 495		7710061A 7710061A	7710061A 7710061A			22/048 21:2				4.000	122 262	OE-9		2.70	_	47.0 46.9	18.2 26.9	CP	0	40.9	2.4	R N		00	≡
80 CS2 495		7710061A	7710061A			22/048 21:2				7.726 4.964	155	0E-9	99.8			46.9	26.9	P	0	40.8	2.3	R N	A N		
80 CS2 495		7710061A	7710061A			22/048 21:2				1.915	40			2.66		46.9	21.3	A	0	40.6	2.6	B N			\mathbf{v}
DCP MSG DATA	DAPS/DDS	DA	MS-NT	DECODED		HEX-ASCII	AF	PLYVIEW	FULI	MSG	HIDE S	STATS													
0016: 0C 0D 0032: 1C 1D 0048: 2C 2D 0064: 3C 3D 0080: 4C 4D 0096: 5C 5D 0112: 6C 6D 0128: 7C 7D 0144: 8C 8D 0160: 9C 9D	1E 1F 20 2E 2F 30 3E 3F 40 4E 4F 50 5E 5F 60 6E 6F 70 7E 7F 80 9E 9F A0 AE AF B0 BE BF C0 CE CF D0 DE DF E0 EE EF F0	11 12 21 22 31 32 41 42 51 52 61 62 71 72 81 82 91 92 A1 A2 B1 B2 C1 C2 D1 D2 E1 E2 F1 F2	03 04 05 13 14 15 23 24 25 33 34 35 43 44 45 53 54 55 63 64 65 73 74 75 83 84 85 93 94 95 A3 A4 A5 B3 B4 B5 C3 C4 C5 D3 D4 D5 E3 E4 E5 F3 F4 F5	16 17 26 27 36 37 56 57 66 67 76 77 86 87 86 87 86 87 C6 C7 D6 D7 E6 E7	18 19 28 29 38 39 48 49 58 59 68 69 78 79 58 89 98 89 98 89 98 89 98 89 98 89 98 89 98 89 98 89 98 80 98 80 99 80 80 80 80 80 80 80 80 80 80 80 80 80 8	2A 2B 3A 3B 4A 4B 5A 5B 6A 6B 7A 7B 8A 8B 9A 9B AA AB BA BB CA CB DA DB EA EB	 1m 1m 	./01234 >?@ABCD NOPQRST ^_`abcd nopqrst	%&'()= 56789: EFGHIJ UVWXYZ efghij uVWXYZ %&'()= 56789: 56789: EFGHIJ UVWXYZ efghij	·+;K[k{ · ·+;K[k															



Binary Protocol – Binary Fill Example – Error Detection STAT EON 00 BAUD RATE 300 FRAME CHAR R FREQUENCY DEVIATION +2.2 +2.5AVERAGE POWER +41.0NOISE POWER +17.2BIT ERROR RATE 0E-9 SIGNAL/NOISE +23.8GOOD PHASES 99.6 1060 1064 PHASE STATS 0 DEG (+60) +1.193.14 45 DEG (-60) +0.642.87 90 DEG 2.82 -0.63135 DEG -0.412.80 180 DEG +0.582.81 225 DEG +0.762.52 270 DEG -1.422.77 315 DEG 2.91 -0.59MOD INDX/PHAS NOISE +1.42+0.022.82 MESSAGE CARRIER TIME 22/048 21:26:15.214 MESSAGE SYNC TIME 22/048 21:26:15.674 NESSAGE FRAME TIME 22/048 21:26:15.790 MESSAGE END TIME 22/048 21:26:22.940 BINARY BCH (R|C|L) 400401E7 256 400401E7 BINARY CRC (RIC) 4B55 4B55 -> DAMS-NT Test [CPU Usage: 0%] MEMORY [Total: 3,932 KB] [Allocated: 1,783 KB] [Overhead: 2,148 KB] ALLOCATIONS [Total: 19,427] [Allocs/Sec: 371] WINDOWS [CPU Usage: 1%] MEMORY [Commit Size: 12,439 KB] [Working Set: 25,956 KB] UP SINCE: 22/048 21:20:58 UP TIME: 00:17:11 CAGE UTC: 22/048 21:38:09

- > Check of BCH and CRC fields is shown in DAMS-NT Stats section (highlighted lines).
 - For both fields, the received value (R) matches the checked (C) value (i.e. no errors).
- The decoded BCH field shows a data length (L) of 256 bytes, which is the actual message data length and does not include the BCH and CRC overhead bytes.



Binary Protocol – Compacted Pseudo-Binary Example



- Microcom's Compacted Pseudo-Binary recommendation was a subset of its overall Binary Protocol recommendation, and was offered as a way to allow users to quickly transition to Binary.
 - It is based on the fact that there are only 6-bits of information in each Pseudo-Binary byte.
 - The other two are the odd parity bit and a forced bit to make the byte a printable character.

$\mathsf{P}_{\mathsf{O}} \; \mathsf{F} \; \mathsf{B}_{\mathsf{5}} \; \mathsf{B}_{\mathsf{4}} \; \mathsf{B}_{\mathsf{3}} \; \mathsf{B}_{\mathsf{2}} \; \mathsf{B}_{\mathsf{1}} \; \mathsf{B}_{\mathsf{0}}$

- The Forced is typically a 1, but can be a 0 if all the information bits are 1 allowing the question mark character (? = 0x3F) to be sent instead of the ASCII DEL code (0x7F).
- Discarding the 2 non-informational bits and then concatenating the six information bits from four bytes results in a total of 24-bits that can then chopped up into three bytes.
 - This will yield an immediate 25% reduction in raw data size.
 - The compaction is done at the transmitter and the de-compaction occurs at the receiver.
 - Transmitters and data loggers can continue to use the same configuration setups and processing software can use existing decoding scripts – dubbed "IT Transparent".



Binary Protocol – Compact PB Example – Legacy PB Message



- > Example messaged consisted of 155 Pseudo-Binary characters.
- \succ Total message duration ~5 seconds.

😹 DAMS-NT Server r1-53 [DAMS-NT Test] [A SERVER: PRIME] [B Server: Fault]	
<u>F</u> ile <u>S</u> etup <u>O</u> perations <u>I</u> erminal <u>V</u> iew <u>W</u> indow <u>H</u> elp	
Slot History [Slot80, Chan 495] Messages Summary	- - X
Slot Mode Chan Baud AddrCorr AddrOrig Carrier Time Frame Time End Time Msg Dur Len BER GDP PHI Noise Fmt Par SS FD FS MI DQ ARM 80 CS2 495W 300 7710061A 22/048 21:26:45.332 22/048 21:26:45.749 4.000 122 0E-9 93.6 2.70 23.8 47.0 18.2 CP 0 40.9 2.4 R N N 00 80 CS2 495W 300 7710061A 22/048 21:26:15.790 22/048 21:26:22:400 7.72 262 0E-9 93.6 2.08 46.9 2.9 N N 00 80 CS2 495W 300 7710061A 22/048 21:26:515.790 22/048 21:26:22:240 7.726 262 0E-9 93.6 2.45 4.0 2.9 B 0 41.0 2.2 R N N 00 80 CS2 495W 300 7710061A 27/048 21:26:515:12 22/048 21:26:22:249 7.726	^
80 CS2 495W 300 7710061A 7710061A 22/048 21:25:38.935 22/048 21:25:39.540 22/048 21:25:40.850 1.915 40 0E-9 98.9 2.66 23.4 46.9 21.3 A 0 40.6 2.6 R N N 00	~
DCP MSG DATA DAPS/DDS DAMS-NT DECODED HEX-ASCII APPLY VIEW FULL MSG HIDE STATS	
`@h@^@ &F&P&FBUB]BWB[BrB`@T@J@J@T@^@T@^@[@J@S@P@OBB&xBjB~DDCfBPBMBYB[BwBf@r@^@T@r@h@T@N@Y@F@G@J@G@T@T@S@T@S@T@Q@Q@Q@Q@Q@Q@Q@Q&&&I&I&I&K&L&N???????ht@^~qDI	
STAT_EOM 00 BAUD RATE 300 FRAME CHAR R FREQUENCY DEVIATION +2.3 AVERAGE POWER +40.8 NOISE POWER +16.3 BIT ERROR RATE 0E-9 SIGNAL/NOISE +24.5	
GOOD PHASES 639 640 99.8 PHASE STATS 0 DEG (+60) +1.32 2.38 99.8 45 DEG (-60) +0.97 3.04 90 DEG 90 DEG -0.94 3.02 99.8	>



Binary Protocol – Compact PB Example – Raw Binary



- Compact PB message is 122 bytes: 116 bytes of compacted data; 4 Flag & Length bytes (C4 01 D1 AE) and 2 CRC bytes (16 F5).
 - 25% raw data reduction (116/154); 21% total byte count reduction (122/155).
- ➤ Total message duration ~4 seconds (20% overall reduction).

🔀 DAMS-NT Server r1-53 [DAMS-NT	Test] [A SERVER: PRIME]	[B Server: Fault] - [Slot Hi	listory [Slot80, C	Chan 495]]									-	-	•)	×
Eile Setup Operations Termin Messages Summary	nal <u>V</u> iew <u>W</u> indow <u>H</u>	lelp													- 8	×
4 4 4 4	Image:	<< Row 1 of 4 >>														
	ldrCorr AddrOrig		ame Time	End Time	Msg Dur		ER GDP	PHN SNF	Noise	Fmt I	Par S	S FO	FS	MI DQ		^
80 CS2 495W 300 771 80 CS2 495W 300 771 80 CS2 495W 300 771	10061A 7710061A 22 10061A 7710061A 22	/048 21:26:15.214 22/048 /048 21:25:55.534 22/048	21:26:15.790 2 21:25:56.121 2	22/048 21:26:48:749 22/048 21:26:22.940 22/048 21:26:00.498 22/048 21:25:40.850	4.000 7.726 4.964 1.915			2.70 233 2.82 233 2.86 24. 2.66 23	18.2 26.9 17.9 21.3	B P A	0 4	0.9 2.4 1.0 2.2 0.8 2.3 0.6 2.6	R R R	N N N N N N	00 00 00 00 00	
DCP MSG DATA DAPS/DDS	DAMS-NT D	ECODED HEX-ASI		YVIEW FULL		HIDE ST.										
0000: C4 01 D1 AE 02 80 0016: 09 70 9B 0B 20 A0 0032: E0 1B 00 A0 13 03 0048: E6 09 00 8D 09 90 0064: 02 80 14 00 E0 19 0080: 30 14 01 30 14 03		0 14 01 E0 14 0	01 .p. 10 32 01	F.F.P 	è											^ =
0096: 49 04 90 4B 04 CO 0112: A3 40 1E FB 11 0			F I	K N												~



Binary Protocol – Compact PB Example – De-Compacted

🔀 DAMS-NT Server r1-53 [DAMS-NT Test] [A SERVER: PRIME] [B Server: Fault] - [Sic	ot History [Slot80, Chan 495]]				_ = ×
Eile Setup Operations Terminal View Window Help					_ 8 >
Messages Summary					
4					
Slot Mode Chan Baud AddrCorr AddrOrig Carrier Time ▶ 80 CS2 495W 300 7710061A 7710061A 22/048 21:26:44.749 22/	Frame Time End Time /048 21:26:45.332 22/048 21:26:48.749		PHN SNR Pilot		SS FO FS MI DQ ARM A
80 CS2 495W 300 7710061A 7710061A 22/048 21:26:15.214 22/	/048 21:26:15.790 22/048 21:26:22.940	7.726 262 0E-9 99.6	2.82 23.8 46.9	26.9 B O	41.0 2.2 R N N 00
	/048 21:25:56.121 22/048 21:26:00.498 /048 21:25:39.540 22/048 21:25:40.850	4.964 155 0E-9 99.8 1.915 40 0E-9 98.9	2.86 24.5 47.0 3 2.66 23.4 46.9		40.8 2.3 R N N 00 40.6 2.6 R N N 00
00 C32 435W 300 7710001A 7710001A 227040 21.23.36.333 227	040 21.20.00.040 227040 21.20.40.000	1.313 40 00-3 30.3	2.00 23.4 40.3	21.3 A 0	40.0 2.0 H N N 00
DCP MSG DATA DAPS/DDS DAMS-NT DECODED HEX	ASCII APPLY VIEW FUL	L MSG HIDE STATS			
dehe^e AFAPAFBUB]BVB[BrB`eTeJeJeTe^eTe^e[eJeSePeof	BAxBiB~DDCfBPBMBYB		De-Com	pacted me	ssage restores P
[ByBfere^etereheteneÿefecejeceteteseteseteQeQeQeQe		??????ht@^~qDIMJ	characte	rs and Flac	n hvto
			Characte		J Dyte.
STAT_EOM 00 BAUD_RATE 300					^
FRAME CHAR R					
FREQUENCY DEVIATION +2.4 AVERAGE POWER +40.9	+3.1				
NOISE POWER +17.1					
BIT ERROR RATE 0E-9 SIGNAL/NOISE +23.8					
GOOD PHASES 502	504	99.6			
PHASE STATS 0 DEG (+60) +0.79	2.38				
45 DEG (-60) -0.12 90 DEG -0.79	2.72 3.27				
135 DEG -0.76	2.90				
180 DEG +1.65 225 DEG -0.04	2.63 2.45				
270 DEG -1.20	2.46				
315 DEG −0.01 MOD INDX/PHAS NOISE −0.06	2.82 2.70	+1.65			
MESSAGE CARRIER TIME 22/048 21:26:44.749	2.70	+1.03			
MESSAGE SYNC TIME 22/048 21:26:45.216 MESSAGE FRAME TIME 22/048 21:26:45.332		Binany	fields still	roported	n State
MESSAGE END TIME 22/048 21:26:48.749			neius sun	reported i	II Stats
BINARY BCH (R C L) C401D1AE BINARY CRC (R C) 16F5	C401D1AE 16F5		in BCH is	Compacte	ed byte count.
	101.5	Lengu		compact	
<					>
DAMS-NT Test [CPU Usage: 0%] MEMORY [Total: 3,932 KB] [Allocate	ed: 1,783 KB] [Overhead: 2,148 KB]	ALLOCATIONS [Total: 19	9,328] [Allocs/Sec: 374]]	
WINDOWS [CPU Usage: 3%] MEMORY [Commit Size: 12,304 K	(B] [Working Set: 25,755 KB]	UP TIME: 00):34:04 UP	SINCE: 22/048 21:20:58	CAGE UTC: 22/048 21:55:03 .;



Binary Protocol – Key Decisions



- > Move forward with Binary Protocol as recommended?
 - Pro: Will allow users to begin to use Binary DCS messages, and provide system flexibility and security going forward
 - Con: Requires updates to Certification Specification, DCS transmitters, and DCS receive systems (initial implementation already done).
- > Include Compacted Pseudo-Binary?
 - Pro: Will allow users to transition to binary quickly using existing message coding schemes and decoding scripts (IT Transparent).
 - Con: Requires additional work updating Certification Specification, DCS transmitters, and DCS receive systems (initial implementation already done).



Binary Protocol – ASCII Compaction



- Microcom's original Binary Protocol proposal also included a similar suggestion for compacted ASCII.
 - Subset of all ASCII characters would be encoded in 4 or 5 bits and compacted.
 - If the DCS community is going to make updates, now would be the time to include this approach if it desirable to the DCS community.

> Include Compacted ASCII?

- Pros: Will allow ASCII message users to transition to binary quickly using existing message coding and decoding schemes (IT Transparent).
 Will allow human readable data on DADDS Field Test even when using binary messages.
- Con: Requires additional work updating Certification Specification, DCS transmitters, and DCS receive systems (was not prototyped).



Binary Protocol – Summary and Next Steps



> Summary

- The idea of binary message data has been around for quite some time.
- It's use has been held back since a complete Binary Protocol specification has never been fully defined and adopted by the DCS community.
- NOAA funded a new study and proof-of-concept prototype to push forward on a proposed Binary Protocol.
 - Preliminary recommendation has been made, but needs to be accepted and ratified.
 - Successful Proof-of-Concept has been developed, demonstrated and reported on herein.

Next Steps

- Decision to move forward.
- User and manufacturer feedback on protocol recommendations and key decisions.
- NOAA to fund initial Certification Specification updates that will then be shared with DCS community for questions and comments (may be tied in with Lat/Long Tx ID).

