Binary Message Protocol and Latitude/Longitude/Tx ID DCS Enhancements

Presented by

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Binary Protocol – A Brief History

- ASCII and Pseudo-Binary (a subset of ASCII characters) have been the standard for 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 (aka 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.
  - Implementing a Binary Protocol would open up new possibilities for data compression and reliability.
  - Several approaches to come up with a Binary Protocol have been previously attempted, but the last major discussion occurred in 2012.
- In November 2021, NOAA decided it was time to move forward with Binary and authorized Microcom to review prior recommendations, propose a preliminary standard, and develop a prototype implementation.

DCS CS1 ASCII Character Set

HEX / HEX	0x	1x	2x	3x	4x	5x	6x	7x	8x	9x	Ax	Bx	Cx	Dx	Ex	Fx
X0	NUL	DLE	SP	0	@	P	`	p	Ç	É	á	░	└	╨	α	≡
x1	SOH	DC1	!	1	A	Q	a	q	ü	æ	í	▒	┴	╤	ß	±
x2	STX	DC2	"	2	B	R	b	r	é	Æ	ó	▓	┬	╥	Γ	≥
x3	ETX	DC3	#	3	C	S	c	s	â	ô	ú	│	├	╙	π	≤
x4	EOT	DC4	$	4	D	T	d	t	ä	ö	ñ	┤	─	╘	Σ	⌠
x5	ENQ	NAK	%	5	E	U	e	u	à	ò	Ñ	╡	┼	╒	σ	⌡
x6	ACK	SYN	&	6	F	V	f	v	å	û	ª	╢	╞	╓	µ	÷
x7	BEL	ETB	'	7	G	W	g	w	ç	ù	º	╖	╟	╫	τ	≈
x8	BS	CAN	(	8	H	X	h	x	ê	ÿ	¿	╕	╚	╪	Φ	°
x9	HT	EM	)	9	I	Y	i	y	ë	Ö	⌐	╣	╔	┘	Θ	∙
xA	LF	SUB	*	:	J	Z	j	z	è	Ü	¬	║	╩	┌	Ω	·
xB	VT	ESC	+	;	K	[	k	{	ï	¢	½	╗	╦	█	δ	√
xC	FF	FS	,	<	L	\	l	|	î	£	¼	╝	╠	▄	∞	^{n}
xD	CR	GS	-	=	M	]	m	}	ì	¥	¡	╜	═	▌	φ	^{2}
xE	SO	RS	.	>	N	^	n	~	Ä	₧	«	╛	╬	▐	ε	■
xF	SI	US	/	?	O	_	o	DEL	Å	ƒ	»	┐	╧	▀	∩	

DCS CS2 ASCII Character Set

HEX \ HEX	0x	1x	2x	3x	4x	5x	6x	7x	8x	9x	Ax	Bx	Cx	Dx	Ex	Fx
X0	NUL	DLE	SP	0	@	P	`	p	Ç	É	á	░	└	╨	α	≡
x1	SOH	DC1	!	1	A	Q	a	q	ü	æ	í	▒	┴	╤	ß	±
x2	STX	DC2	"	2	B	R	b	r	é	Æ	ó	▓	┬	╥	Γ	≥
x3	ETX	DC3	#	3	C	S	c	s	â	ô	ú	│	├	╙	π	≤
x4	EOT	DC4	$	4	D	T	d	t	ä	ö	ñ	┤	─	╘	Σ	⌠
x5	ENQ	NAK	%	5	E	U	e	u	à	ò	Ñ	╡	┼	╒	σ	⌡
x6	ACK	SYN	&	6	F	V	f	v	å	û	ª	╢	╞	╓	µ	÷
x7	BEL	ETB	'	7	G	W	g	w	ç	ù	º	╖	╟	╫	τ	≈
x8	BS	CAN	(	8	H	X	h	x	ê	ÿ	¿	╕	╚	╪	Φ	°
x9	HT	EM	)	9	I	Y	i	y	ë	Ö	⌐	╣	╔	┘	Θ	∙
xA	LF	SUB	*	:	J	Z	j	z	è	Ü	¬	║	╩	┌	Ω	·
xB	VT	ESC	+	;	K	[	k	{	ï	¢	½	╗	╦	█	δ	√
xC	FF	FS	,	<	L	\	l	|	î	£	¼	╝	╠	▄	∞	^{n}
xD	CR	GS	-	=	M	]	m	}	ì	¥	¡	╜	═	▌	φ	^{2}
xE	SO	RS	.	>	N	^	n	~	Ä	Pts	«	╛	╬	▐	ε	■
xF	SI	US	/	?	O	_	o	DEL	Å	ƒ	»	┐	╧	▀	∩	

DCS Pseudo-Binary Character Set

<table>
<tr><th>HEX \ HEX</th><th>0x</th><th>1x</th><th>2x</th><th>3x</th><th>4x</th><th>5x</th><th>6x</th><th>7x</th><th>8x</th><th>9x</th><th>Ax</th><th>Bx</th><th>Cx</th><th>Dx</th><th>Ex</th><th>Fx</th></tr>
<tr><td>X0</td><td>NUL</td><td>DLE</td><td>SP</td><td>0</td><td>@</td><td>P</td><td>`</td><td>p</td><td>Ç</td><td>É</td><td>á</td><td>░</td><td>└</td><td>╨</td><td>α</td><td>≡</td></tr>
<tr><td>x1</td><td>SOH</td><td>DC1</td><td>!</td><td>1</td><td>A</td><td>Q</td><td>a</td><td>q</td><td>ü</td><td>æ</td><td>í</td><td>▒</td><td>┴</td><td>╤</td><td>ß</td><td>±</td></tr>
<tr><td>x2</td><td>STX</td><td>DC2</td><td>"</td><td>2</td><td>B</td><td>R</td><td>b</td><td>r</td><td>é</td><td>Æ</td><td>ó</td><td>▓</td><td>┬</td><td>╥</td><td>Γ</td><td>≥</td></tr>
<tr><td>x3</td><td>ETX</td><td>DC3</td><td>#</td><td>3</td><td>C</td><td>S</td><td>c</td><td>s</td><td>â</td><td>ô</td><td>ú</td><td>│</td><td>├</td><td>╙</td><td>π</td><td>≤</td></tr>
<tr><td>x4</td><td>EOT</td><td>DC4</td><td>$</td><td>4</td><td>D</td><td>T</td><td>d</td><td>t</td><td>ä</td><td>ö</td><td>ñ</td><td>┤</td><td>─</td><td>╘</td><td>Σ</td><td>⌠</td></tr>
<tr><td>x5</td><td>ENQ</td><td>NAK</td><td>%</td><td>5</td><td>E</td><td>U</td><td>e</td><td>u</td><td>à</td><td>ò</td><td>Ñ</td><td>╡</td><td>┼</td><td>╒</td><td>σ</td><td>⌡</td></tr>
<tr><td>x6</td><td>ACK</td><td>SYN</td><td>&</td><td>6</td><td>F</td><td>V</td><td>f</td><td>v</td><td>å</td><td>û</td><td>ª</td><td>╢</td><td>╞</td><td>╓</td><td>µ</td><td>÷</td></tr>
<tr><td>x7</td><td>BEL</td><td>ETB</td><td>'</td><td>7</td><td>G</td><td>W</td><td>g</td><td>w</td><td>ç</td><td>ù</td><td>º</td><td>╖</td><td>╟</td><td>╫</td><td>τ</td><td>≈</td></tr>
<tr><td>x8</td><td>BS</td><td>CAN</td><td>(</td><td>8</td><td>H</td><td>X</td><td>h</td><td>x</td><td>ê</td><td>ÿ</td><td>¿</td><td>╕</td><td>╚</td><td>╪</td><td>Φ</td><td>°</td></tr>
<tr><td>x9</td><td>HT</td><td>EM</td><td>)</td><td>9</td><td>I</td><td>Y</td><td>i</td><td>y</td><td>ë</td><td>Ö</td><td>⌐</td><td>╣</td><td>╔</td><td>┘</td><td>Θ</td><td>∙</td></tr>
<tr><td>xA</td><td>LF</td><td>SUB</td><td>*</td><td>:</td><td>J</td><td>Z</td><td>j</td><td>z</td><td>è</td><td>Ü</td><td>¬</td><td>║</td><td>╩</td><td>┌</td><td>Ω</td><td>·</td></tr>
<tr><td>xB</td><td>VT</td><td>ESC</td><td>+</td><td>;</td><td>K</td><td>[</td><td>k</td><td>{</td><td>ï</td><td>¢</td><td>½</td><td>╗</td><td>╦</td><td>█</td><td>δ</td><td>√</td></tr>
<tr><td>xC</td><td>FF</td><td>FS</td><td>,</td><td><</td><td>L</td><td>\</td><td>l</td><td>|</td><td>î</td><td>£</td><td>¼</td><td>╝</td><td>╠</td><td>▄</td><td>∞</td><td>ⁿ</td></tr>
<tr><td>xD</td><td>CR</td><td>GS</td><td>-</td><td>=</td><td>M</td><td>]</td><td>m</td><td>}</td><td>ì</td><td>¥</td><td>¡</td><td>╜</td><td>═</td><td>▌</td><td>φ</td><td>²</td></tr>
<tr><td>xE</td><td>SO</td><td>RS</td><td>.</td><td>></td><td>N</td><td>^</td><td>n</td><td>~</td><td>Ä</td><td>₧</td><td>«</td><td>╛</td><td>╬</td><td>▐</td><td>ε</td><td>■</td></tr>
<tr><td>xF</td><td>SI</td><td>US</td><td>/</td><td>?</td><td>O</td><td>_</td><td>o</td><td>DEL</td><td>Å</td><td>ƒ</td><td>»</td><td>┐</td><td>╧</td><td>▀</td><td>∩</td><td></td></tr>
</table>

DCS Binary Character Set

HEX / HEX	0x	1x	2x	3x	4x	5x	6x	7x	8x	9x	Ax	Bx	Cx	Dx	Ex	Fx
X0	NUL	DLE	SP	0	@	P	`	p	Ç	É	á	░	└	╨	α	≡
x1	SOH	DC1	!	1	A	Q	a	q	ü	æ	í	▒	┴	╤	ß	±
x2	STX	DC2	"	2	B	R	b	r	é	Æ	ó	▓	┬	╥	Γ	≥
x3	ETX	DC3	#	3	C	S	c	s	â	ô	ú	│	├	╙	π	≤
x4	EOT	DC4	$	4	D	T	d	t	ä	ö	ñ	┤	─	╘	Σ	⌠
x5	ENQ	NAK	%	5	E	U	e	u	à	ò	Ñ	╡	┼	╒	σ	⌡
x6	ACK	SYN	&	6	F	V	f	v	å	û	ª	╢	╞	╓	µ	÷
x7	BEL	ETB	'	7	G	W	g	w	ç	ù	º	╖	╟	╫	τ	≈
x8	BS	CAN	(	8	H	X	h	x	ê	ÿ	¿	╕	╚	╪	Φ	°
x9	HT	EM	)	9	I	Y	i	y	ë	Ö	⌐	╣	╔	┘	Θ	∙
xA	LF	SUB	*	:	J	Z	j	z	è	Ü	¬	║	╩	┌	Ω	·
xB	VT	ESC	+	;	K	[	k	{	ï	¢	½	╗	╦	█	δ	√
xC	FF	FS	,	<	L	\	l	|	î	£	¼	╝	╠	▄	∞	^{n}
xD	CR	GS	-	=	M	]	m	}	ì	¥	¡	╜	═	▌	φ	^{2}
xE	SO	RS	.	>	N	^	n	~	Ä	₧	«	╛	╬	▐	ε	■
xF	SI	US	/	?	O	_	o	DEL	Å	ƒ	»	┐	╧	▀	∩	

Binary Format – Recommended Goals and NOAA's Priority

- Prior recommendations focused on four potential advantages:
  - Efficiency: same information to be transmitted in less bytes; shorter messages.
  - Reliability: error detection and/or correction schemes could be added
  - Compatibility: compaction of ASCII/PB data at the transmitter and expansion at the demodulator to allow existing DCP configurations and decoding schemes to be utilized.
  - Commonality: require a common message structure or data format, which would make it easier to implement decoding software.
- However none of these completely aligned with NOAA's top priority which is to offer the User's the *option to use binary with as few restrictions as possible*.
  - 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.
  - NOAA/NESDIS does not own or use the data so they should not specify the *data* format.
  - Instead, the Binary Protocol Format should be much like the existing ASCII and Pseudo-Binary specifications with just enough specified to allow the data to be reliably collected.

Binary Protocol – Key Features

- Message Length
  - Use message length in place of EOT.
  - 14-bit message length field handles maximum message length of 16,000 bytes.
  - BCH protected 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 = $x^{16} + x^{15} + x^{13} + x^{9} + x^{7} + x^{6} + x^{5} + x^{3} + x + 1$
  - Applied every 4,000 bytes
- Reduced Flush
  - Current HDR specification requires 32 bits of flush.
  - Using Message Length in place of EOT allows reducing flush to 16 bits.

Binary Protocol – Comparison to ASCII/Pseudo-Binary

Current 300 & 1200 bps ASCII and Pseudo-Binary DCPRS Message Format

Carrier	Clock States	FSS	GOES ID	Flag Word	DCP DATA	EOT	Encoder Flush
0.5s/ 0.25s	3 '0-1'	15 bits	32 bits	8 bits	Max: 32,000 bits @ 300 bps 128,000 bits @ 1200 bps	8 bits	32 bits

Proposed 300 bps Binary DCPRS Message Format

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

Proposed 1200 bps Binary DCPRS Message Format

Carrier	Clock States	FSS	GOES ID	Flag Word	Msg Length	BCH	DCP DATA	CRC	…	DCP DATA	CRC	Encoder Flush
0.25s	3 '0-1'	15 bits	32 bits	8 bits	14 bits	10 bits	32,000 bits	16 Bits	…	Max: 32,000 bits	16 Bits	16 bits

BCH Encoded 31 bits

Maximum of 128,000 bits which will be split into four sections of 32,000 bits each with a 16 bit CRC

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.
  - 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.
  - Odd Parity bit of the Flag Word is still included in the overall 32-bit (4-byte).
  - Parity/check bits provide a high reliability of correct reception of this critical info.
- 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.
  - Other unused bits may be utilized to identify special Binary formats; Compact PB and ASCII.

Flag Word								Message Length														Parity									
7	6	5	4	3	2	1	0	13	12	11	10	9	8	7	6	5	4	3	2	1	0	9	8	7	6	5	4	3	2	1	0

Odd Parity Bit

21 Bit BCH Encoded Block

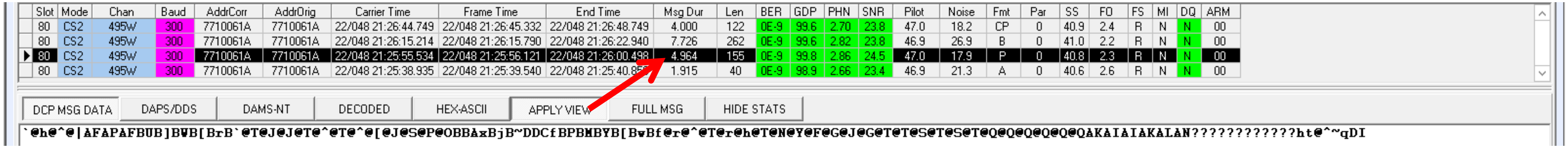
10 Bit BCH Parity

Binary Protocol – Proof-of-Concept Demo

- Once NOAA accepted the preliminary Binary Protocol recommendations, Microcom developed a proof-of-concept demonstration using the NOAA's Pilot/Test Transmitter.
  - Virtual demonstration was provided to NOAA in late February 2022.
  - Primary goal was achieved by confirming the binary messages can be implemented in addition to the existing ASCII and Pseudo-Binary formats.
- 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 (PB) example using a typical PB message to demonstrate how Compact PB can reduce message size while still conveying the same information.
  - Both examples demonstrated use of new BCH protected Flag/Length and CRC fields.
- PB Compaction is a simple technique of discarding the 2 formatting bits in each Pseudo-Binary byte, retaining the 6 information and compacting the information bits across multiple PB bytes to formulate a Binary message.

Binary Protocol – Compact PB Example

- Example message consisted of a 5-second message of 155 Pseudo-Binary characters.

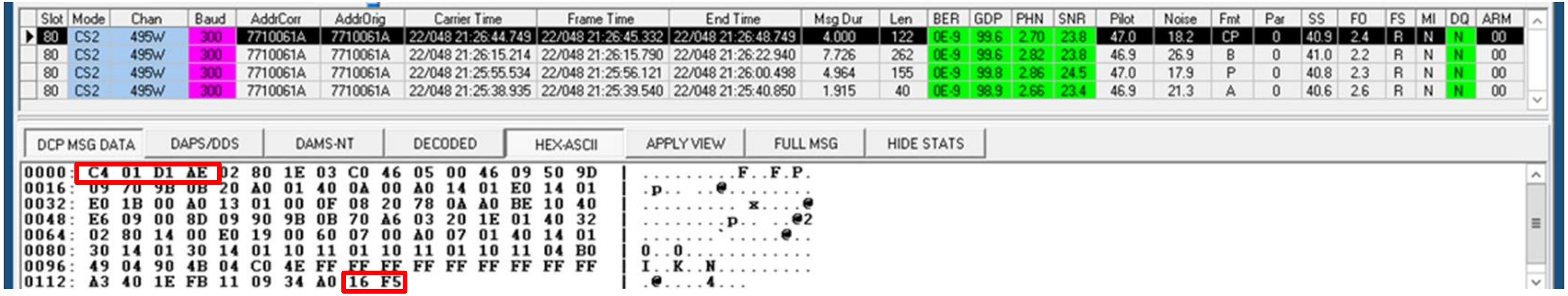


Slot	Mode	Chan	Baud	AddrCorr	AddrOrig	Carrier Time	Frame Time	End Time	Msg Dur	Len	BER	GDP	PHN	SNR	Pilot	Noise	Fmt	Par	SS	FO	FS	MI	DQ	ARM
80	CS2	495W	300	7710061A	7710061A	22/048 21:26:44.749	22/048 21:26:45.332	22/048 21:26:48.749	4.000	122	0E-9	99.6	2.70	23.8	47.0	18.2	CP	0	40.9	2.4	R	N	N	00
80	CS2	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	0	41.0	2.2	R	N	N	00
80	CS2	495W	300	7710061A	7710061A	22/048 21:25:55.534	22/048 21:25:56.121	22/048 21:26:00.498	4.964	155	0E-9	99.8	2.86	24.5	47.0	17.9	P	0	40.8	2.3	R	N	N	00
80	CS2	495W	300	7710061A	7710061A	22/048 21:25:38.935	22/048 21:25:39.540	22/048 21:25:40.85	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@^@|AFAPAFBUB]BVB[BrB`@T@J@J@T@^@T@^@[@J@S@P@OBBAxBjB~DDCfBPBMBYB[BvBf@r@^@T@r@h@T@N@Y@F@G@J@G@T@T@S@T@S@T@Q@Q@Q@Q@Q@QAKAIAIAKALAN????????????ht@^~qDI

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



Slot	Mode	Chan	Baud	AddrCorr	AddrOrig	Carrier Time	Frame Time	End Time	Msg Dur	Len	BER	GDP	PHN	SNR	Pilot	Noise	Fmt	Par	SS	FO	FS	MI	DQ	ARM
80	CS2	495W	300	7710061A	7710061A	22/048 21:26:44.749	22/048 21:26:45.332	22/048 21:26:48.749	4.000	122	0E-9	99.6	2.70	23.8	47.0	18.2	CP	0	40.9	2.4	R	N	N	00
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	0	41.0	2.2	R	N	N	00
80	CS2	495W	300	7710061A	7710061A	22/048 21:25:55.534	22/048 21:25:56.121	22/048 21:26:00.498	4.964	155	0E-9	99.8	2.86	24.5	47.0	17.9	P	0	40.8	2.3	R	N	N	00
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

```
0000: C4 01 D1 AE 02 80 1E 03 C0 46 05 00 46 09 50 9D | ..........F..F.P.
0016: 09 70 9B 0B 20 A0 01 40 0A 00 A0 14 01 E0 14 01 | .p.. ..@.........
0032: E0 1B 00 A0 13 01 00 0F 08 20 78 0A A0 BE 10 40 | ........... x....@
0048: E6 09 00 8D 09 90 9B 0B 70 A6 03 20 1E 01 40 32 | .........p.. ..@2
0064: 02 80 14 00 E0 19 00 60 07 00 A0 07 01 40 14 01 | ..........`.....@..
0080: 30 14 01 30 14 01 10 11 01 10 11 01 10 11 04 B0 | 0..0..............
0096: 49 04 90 4B 04 C0 4E FF FF FF FF FF FF FF FF FF | I..K..N..........
0112: A3 40 1E FB 11 09 34 A0 16 F5                   | .@....4...
```

Binary Protocol – Compact PB Example – De-Compacted

- De-Compacted message restored Pseudo-Binary characters and Flag byte.

Slot	Mode	Chan	Baud	AddrCorr	AddrOrig	Carrier Time	Frame Time	End Time	Msg Dur	Len	BER	GDP	PHN	SNR	Pilot	Noise	Fmt	Par	SS	FO	FS	MI	DQ	ARM
80	CS2	495W	300	7710061A	7710061A	22/048 21:26:44.749	22/048 21:26:45.332	22/048 21:26:48.749	4.000	122	0E-9	99.6	2.70	23.8	47.0	18.2	CP	0	40.9	2.4	R	N	N	00
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	0	41.0	2.2	R	N	N	00
80	CS2	495W	300	7710061A	7710061A	22/048 21:25:55.534	22/048 21:25:56.121	22/048 21:26:00.498	4.964	155	0E-9	99.8	2.86	24.5	47.0	17.9	P	0	40.8	2.3	R	N	N	00
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

```
d@h@^@|AFAPAFBUB]BWB[BrB`@T@J@J@T@^@T@^@[@J@S@P@OBBAxBjB~DDCfBPBMBYB
[BwBf@r@^@T@r@h@T@N@Y@F@G@J@G@T@T@S@T@S@T@Q@Q@Q@Q@Q@QAKAIAIAKALAN????????????ht@^~qDI
```

<= De-Compacted message.

```
STAT EOM                    | 00                  |            |
BAUD RATE                   | 300                 |            |
FRAME CHAR                  | R                   |            |
FREQUENCY DEVIATION         | +2.4                | +3.1       |
AVERAGE POWER               | +40.9               |            |
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               | 2.72       |
           90 DEG           | -0.79               | 3.27       |
          135 DEG           | -0.76               | 2.90       |
          180 DEG           | +1.65               | 2.63       |
          225 DEG           | -0.04               | 2.45       |
          270 DEG           | -1.20               | 2.46       |
          315 DEG           | -0.01               | 2.82       |
MOD INDX/PHAS NOISE         | -0.06               | 2.70       | +1.65
MESSAGE CARRIER TIME        | 22/048 21:26:44.749 |            |
MESSAGE SYNC TIME           | 22/048 21:26:45.216 |            |
MESSAGE FRAME TIME          | 22/048 21:26:45.332 |            |
MESSAGE END TIME            | 22/048 21:26:48.749 |            |
BINARY BCH (R|C|L)          | C401D1AE            | C401D1AE   | 116
BINARY CRC (R|C)            | 16F5                | 16F5       |
```

Binary fields reported in Stats section; Length in BCH row is PB Compacted byte count.

Binary Protocol – Advantages to DCS Community and NOAA

- *Basic Binary Protocol*
  - *Will allow users to develop new message formats that can convey more information in their existing time slots.*
  - *More efficient use of fixed time/frequency resources.*
  - *ASCII -> PB (~50% reduction) -> Binary (~20% vs. PB - ~70% vs. ASCII)*
- *Compacted Pseudo-Binary*
  - *Will allow quicker transition to binary using existing message coding schemes and decoding scripts (IT Transparent).*
- *Compacted ASCII – An additional possibility*
  - *Will also facilitate quicker transition to binary (also IT Transparent).*
  - *Will provide human readable data w/o decoding script when using binary messages.*
  - *45-50% compaction numeric only – 30-35% compaction alphanumeric (reduced character set).*

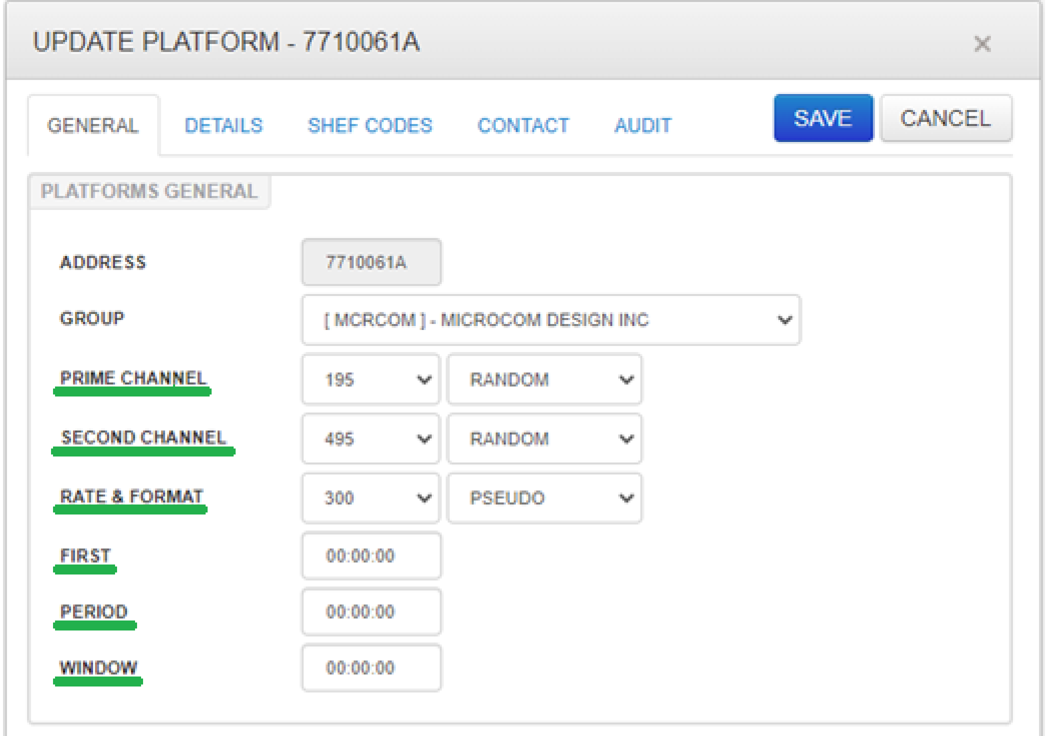
Questions Regarding the Binary Message Protocol?

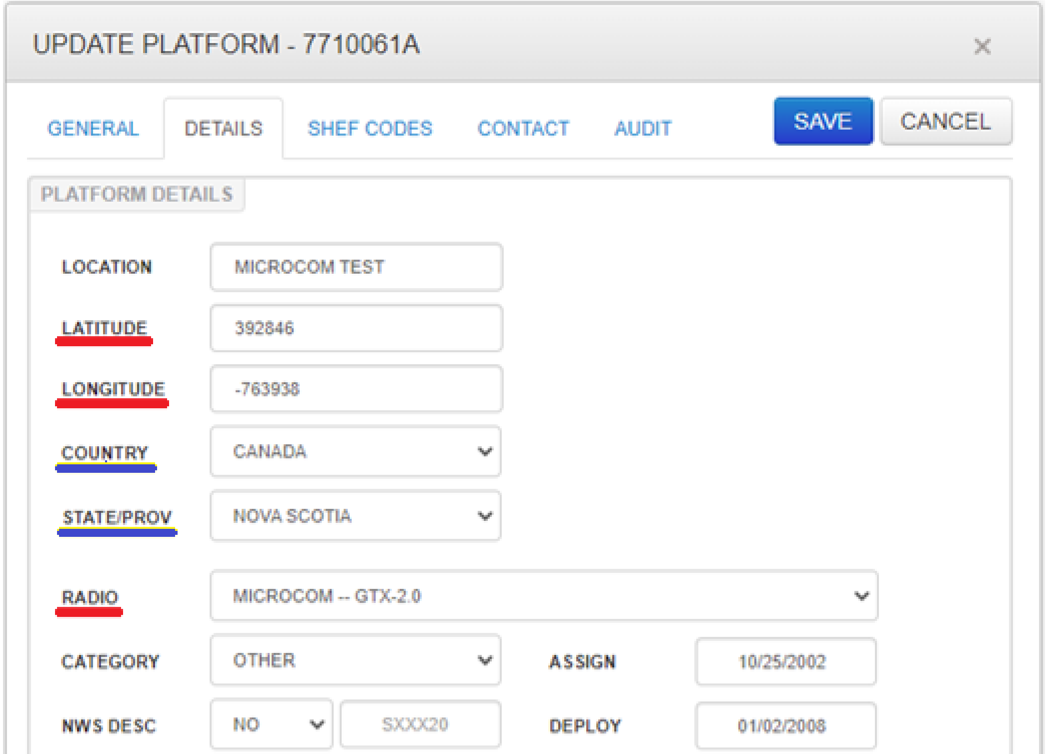
Latitude/Longitude/Tx ID DCS Enhancement

Lat/Long Tx ID – Goal and Functional Concept

- All DCS Users are required to update critical fields for their DCPs in the DADDS Platform Definition Table (PDT).
  - Keeping this data up to date is critical to properly managing the DCS.
  - However, often PDT information is incomplete, inaccurate, or not up to date.
- Since much of the PDT information has to be entered into or is otherwise known to a DCP, it has been suggested the platforms could send a special "Identification Message" upon deployment that would be automatically processed by DADDS and utilized to …
  - Populate or update key fields in the DADDS PDT.
    - Fields such as latitude, longitude, and transmitter type are primary goal.
    - Lat/Long could then be used to set/update the Country and State/Province fields.
  - Compare key configuration parameters to NOAA assigned values, and generate notifications to users and NOAA managers of a misconfigured platform.

Lat/Long Tx ID – Fields to Validate, Update, or Calculate





- GREEN: Fields that are known to a platform that could be checked in the database
- RED: Fields that are known by a platform that can be updated.
- BLUE: Fields that could be calculated from the Lat/Long fields by DADDS (not by DCP).

Lat/Long Tx ID – Initial Suggested Message Fields

- Initial look suggested 11 fields that should definitely be included, and 5 possible additional fields.
  - Additional fields in YELLOW are not currently in DADDS, but should be added or would be useful.
- ASCII messaging requires 69 bytes (77 if separators are used); PB could reduce to 37 bytes.

Field	Num or Alpha	Min	Max	Res	ASCII Format	ASCII Chars	ASCII Sep	PB Chars	Notes
ID Format Type	N	1	9	1	n	1	N	1	To Allow for New Messages Formats
Latitude	N	-90	+90	0.00001	sll.ddddd	9	N	5	Approximate distance accuracy is 4 feet
Longitude	N	-180	+180	0.00001	slll.ddddd	10	Y	5	Approximate distance accuracy is 4 feet (at equator)
Transmitter ID	N	1	99	1	tt	2	Y	2	NOAA to assign Tx ID Numbers to CS2 platforms
Serial Number	N/A					6	Y	3	Not in DADDS; would need input from manufacturers
Firmware Version(s)	N/A					8	Y	4	Not in DADDS; would need input from manufacturers
Prime Channel	N	0	566	1	ccc	3	N	2	
Prime Rate	A					1	N	1	H=1200,L=300
Prime Format	A					1	N	0	A,P,B (Combined with Rate in Pseudo-Binary)
First	N	00:00:00	23:59:59	00:00:01	hh:mm:ss	8	Y	3	
Period	N	00:00:00	12:00:00	00:00:15	hh:mm:ss	8	Y	3	
Window	N	1	120	1	www	3	Y	2	Seconds
Second Channel	N	0	566	1	ccc	3	N	2	
Second Rate	A					1	N	1	H=1200,L=300 - Not in DADDS, needs to be added.
Second Format	A					1	Y	0	A,P,B - Not in DADDS, needs to be added.
CRC Check	A					4		3	Reported as Hexadecimal in ASCII
					Totals:	69	8	37	

Lat/Long Tx ID – Proof-of-Concept Demo

- NOAA authorized a proof-of-concept demonstration, but work was put on hold due to other priorities; work is expected to resume in near future.
- ASCII message will be implemented in prototype for simplicity.
  - Proposed message structure is small enough to fit in existing 300 bps random length.
  - ASCII would make reports human readable and therefore easy to check in the field.
  - Switching to Pseudo-Binary (or even Binary) would not be too difficult at receive end if future decision dictates new format.
  - If a switch is made to PB or Binary in the future, DADDS could show decoded message on website in place of or in addition to the raw message.
- Will use Decimal Degrees to five decimal places for Latitude and Longitude.
  - Not current format for DADDS, but can be readily converted.
  - A future DADDS enhancement could make use of higher precision.
- Will include 5 additional fields in demonstration message, but these fields will not need to be processed in DADDS as part of proof-of-concept.

Lat/Long Tx ID – Message Constraints and Decisions

- Cannot use a self-timed approach, must be random messages.
- Current Random Message Limitations …
  - 300 bps: 3 second max message, which equates to just under 80 bytes.
  - 1200 bps: 1.5 second max message, which equates to 175 bytes.
  - Presently there are no 1200 bps random channels.
  - Could allow longer duration for random ID Messages since they won't be sent often.
- Dedicated or normal Random Channel for Tx ID? *(Still TBD)*
  - Dedicated channel would simplify ID Message determination.
  - Use of DCP's assigned Random channel will require another mechanism to distinguish ID message from normal random message with user's environmental data.
  - Utilization will depend on typical number of platforms getting deployed per day and whether or not it is decided to repeat ID Messages periodically (e.g. weekly or monthly).
- Other Useful Data?
  - Platform Altitude (typically available along with Latitude and Longitude from GPS receiver).
  - Manufacturer Specific data – could be appended after CRC so it would not processed by DADDS.

Lat/Long Tx ID – Advantages to DCS Community and NOAA

- *Will help ensure PDT records are entered and kept up-to-date.*
- *Would eliminate need for users to enter this PDT information.*
- *Could help identify DCP-to-DCP interference.*
  - *Miss entered channel and/or time slot info in DCP will most likely cause one DCP to interfere with another.*
  - *Interference can be between users or within a single user's network of DCPs.*
- *Enhancing DADDS and ID Message to include transmitter Serial Number and Firmware Version will facilitate necessary future updates (e.g. GPS WNRO).*
- *Allowing Manufacture Specific data could be highly useful to manufacturers.*

Binary Protocol & Lat/Long Tx ID – Common Themes

- Both enhancements provide numerous advantages to DCS Community at large.
- Both enhancements will require an update be made to the current Certification Standard (CS2).
- Both enhancements are expected to only require firmware updates to certified DCPs.
  - No hardware changes will be required to implement.
  - Will not require a complete re-certification of previously approve transmitters.
  - Will allow field updates to deployed systems.

Summary and Next Steps

- Summary
  - Initial binary message protocol has been defined and demonstrated.
  - Initial ID Message with Lat/Long Tx ID and other info has been defined, but still needs to be and demonstrated.
  - The Binary Protocol and Lat/Long Tx ID enhancements to the DCS are readily achievable and offer significant advantages to the community and NOAA.
  - The Binary Protocol and Lat/Long Tx ID will both require amendments to CS2.
- Next Steps
  - Resume work on Lat/Long Tx ID.
  - NOAA to begin and oversee task of Certification Specification updates that will then be shared with DCS community for questions and comments.
  - NOAA will begin adding a Manufacture Day to future TWG meetings to specifically discuss these two enhancements and focus on reviewing proposed changes to certification specification.

Thank you for your attention!

Questions?

Presented by

Microcom Design, Inc.

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