# DADDS/DAMS-NT
# Message Statistics

Presented by

**Microcom Design, Inc.**

May 2011


# DADDS Message Data Tab


Home | Channel Stats | Process Stats | Message Data | Platforms | Channels | Radios | Groups

Current View: All Msg Data Load Select a view to see related results. add/edit filters • clear filters • save current filter • delete current view • CSV export • PDF export

| Address | Channel | Baud | Signal | Phase Noise | Msg Quality | Freq. Dev. | ARM | Carrier Time | End Time | Msg Time | Data Length | Data |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D10B8746 | 178 | 300 | 46.6 | 1.9 | 100 | 55.1 | G | 11/89 17:35:51.531 | 11/89 17:35:57.249 | 5.718 | 185 | BST@Bn@MX@NR@Bn@MU@ ... |
| AAA2D3FE | 30 | 300 | 39.9 | 3.0 | 99 | 14.5 | G | 11/89 17:35:50.398 | 11/89 17:35:57.227 | 6.829 | 227 | +2011.,+089.0,+12 ... |
| 336BD34A | 150 | 300 | 39.6 | 3.0 | 99.4 | -10 | G | 11/89 17:35:54.294 | 11/89 17:35:57.157 | 2.863 | 78 | "P94498801Ag[~V@@^0U ... |
| 43493148 | 20 | 100 | 43.5 | 2.2 | 100 | -363 | G | 11/89 17:35:34.332 | 11/89 17:35:57.154 | 22.822 | 266 | :HG 33 #60 6.185 6. ... |
| DDF1F7DA | 102 | 300 | 38.7 | 3.2 | 99 | -0.5 | G | 11/89 17:35:52.284 | 11/89 17:35:57.043 | 4.759 | 149 | bB1E@A\|@BP@Gc@A\|@BP@ ... |
| DDBC1492 | 155 | 300 | 42.6 | 2.5 | 99.9 | 28.9 | G | 11/89 17:35:51.488 | 11/89 17:35:56.593 | 5.105 | 162 | HG 10.07 10.06 10 ... |
| HG 10.07 10.06 10.06 10.07 10.07 10.06 10.07 10.07 10.07 10.07 10.07 10.07 PC 79.00 79.00 79.00 79.00 79.00 79.00 79.00 79.00 79.00 79.00 79.00 VB 13.5 | | | | | | | | | | | | |
| 3B04414A | 152 | 300 | 45.9 | 1.9 | 100 | -0.8 | G | 11/89 17:35:52.289 | 11/89 17:35:56.402 | 4.113 | 125 | bB1M@Ox@Oc@OG@OE@X\@ ... |
| 17886512 | 105 | 300 | 38.2 | 3.8 | 97.4 | -5.3 | G | 11/89 17:35:53.516 | 11/89 17:35:55.963 | 2.447 | 62 | 4.91 4.92 4. ... |
| DD3CF0D8 | 83 | 300 | 43.9 | 2.2 | 100 | -16.6 | G | 11/89 17:35:53.510 | 11/89 17:35:55.823 | 2.313 | 58 | "BCT@EY@EU@ER@EO@EM@ ... |
| DD15C2F0 | 109 | 300 | 47 | 2.1 | 100 | 17.1 | G | 11/89 17:35:52.484 | 11/89 17:35:55.569 | 3.085 | 86 | TW 6.29 6.08 5 ... |
| 4560C3B2 | 137 | 300 | 45.1 | 2.2 | 100 | -0.4 | G | 11/89 17:35:50.295 | 11/89 17:35:55.491 | 5.196 | 166 | ":HG2 3 #15 1.005 1. ... |
| DE0200A2 | 202 | 300 | 44.6 | 2.1 | 100 | 17.4 | G | 11/89 17:35:54.146 | 11/89 17:35:55.388 | 1.242 | 17 | `B1E@Hv@Hv@Hv@HvH |
| 17EC81E8 | 153 | 300 | 44.3 | 2.1 | 100 | -8.8 | G | 11/89 17:35:50.524 | 11/89 17:35:55.176 | 4.652 | 146 | 03/30 12:00 19.48 ... |
| 17DF6364 | 157 | 300 | 41.6 | 2.6 | 100 | 11.2 | G | 11/89 17:35:53.486 | 11/89 17:35:54.891 | 1.405 | 23 | BCT@C~@DF@DL@DN@DQ@ ... |
| 32743016 | 46 | 100 | 47.5 | 1.7 | 100 | -33.5 | G | 11/89 17:35:46.609 | 11/89 17:35:54.710 | 8.101 | 82 | 21.47 006 164 0 ... |

Change page: 1 2 3 4 5 6 7 8 9 10 ... Change page: 1 Go Page size: 15 Change Displaying page 1 of 1212149, items 1 to 15 of 18182227.

# Message Stats – Who, What, Where & Why

- **Why Are They Important**
  - Message Data versus Message Quality
  - Proactive Monitoring versus Reactive Troubleshooting
- **Where Do They Come From**
  - NOAA/NESDIS
  - Via the DADDS Website
  - Beginning with the DAMS-NT System
- **What Are They**
  - Time, Frequency, Amplitude, Phase
  - What do they mean?
  - What do they tell us?
- **Who Needs to Know About Them and Can Access Them**
  - DCS Users, Managers, etc.
  - Field Techs, Service Depot Techs, etc.

# Message Statistics
# Why Are They Important?

# Message Data versus Message Quality

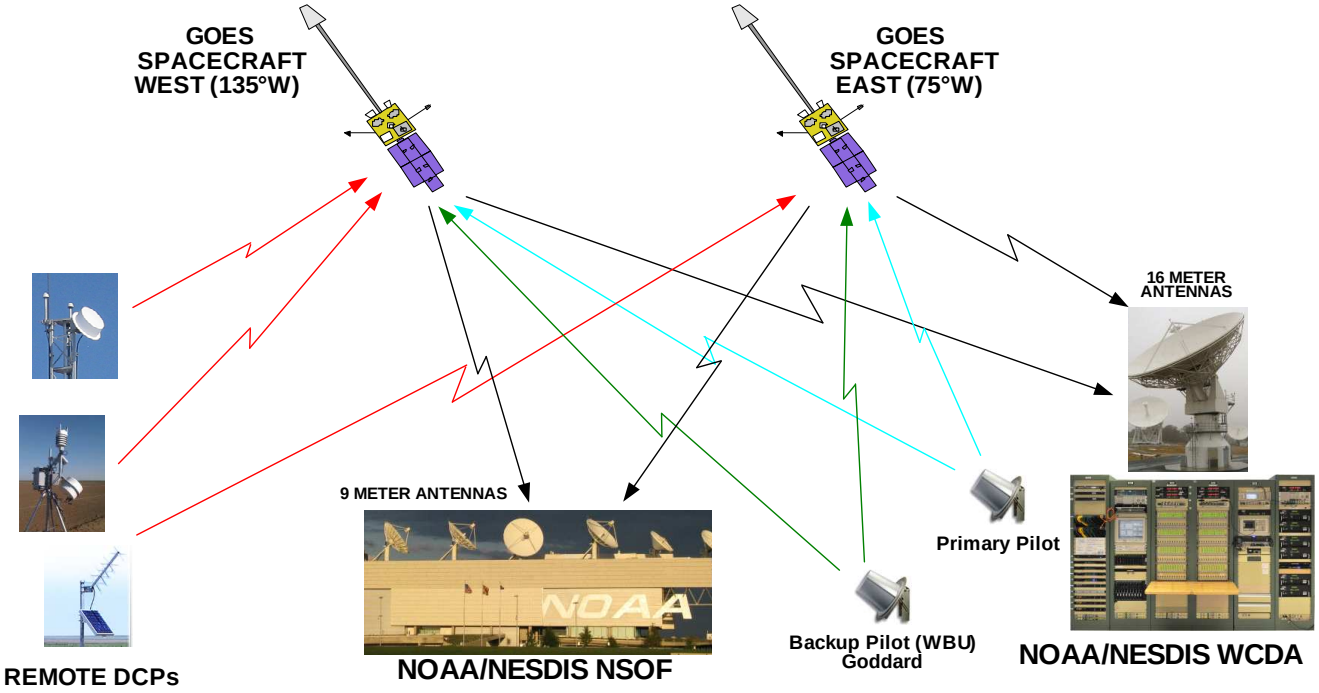
- **Isn't getting the Message Data is what is most important?**
  - **Certainly!**
  - **The environmental data being collected is often critical and in some cases life-saving (e.g. flood, tsunami, etc.).**
- **However, these Data Collection Platforms (DCPs) are satellite based because …**
  - **The are in remote locations.**
  - **Often difficult to get to (some require a helicopter trip).**
  - **Have no other communication option.**
- **For reliable message data reception it is important to know the quality of the "received" message.**

# Proactive versus Reactive

- **Users should proactively monitor message quality.**
  - **Failure to do so could result in loss of data when it is needed it most.**
  - **Data lost from a garbled or missed message typically cannot be recovered in real time.**
- **Reactive troubleshooting is possible on a garbled message.**
  - **Message statistics are available and can usually explain why message was received with errors.**
- **A "missed" message is not received at all.**
  - **No Data $\Rightarrow$ No site troubleshooting information is received, e.g. battery voltage or transmitter power readings.**
  - **No Message Quality or Statistics are available.**
  - **Cannot troubleshoot a missed message.**
- **Proactive Monitoring of the Message Statistics is key to ensuring reliable message reception.**

# Message Statistics
# Where Do The Come From?

# GOES DCS Overview

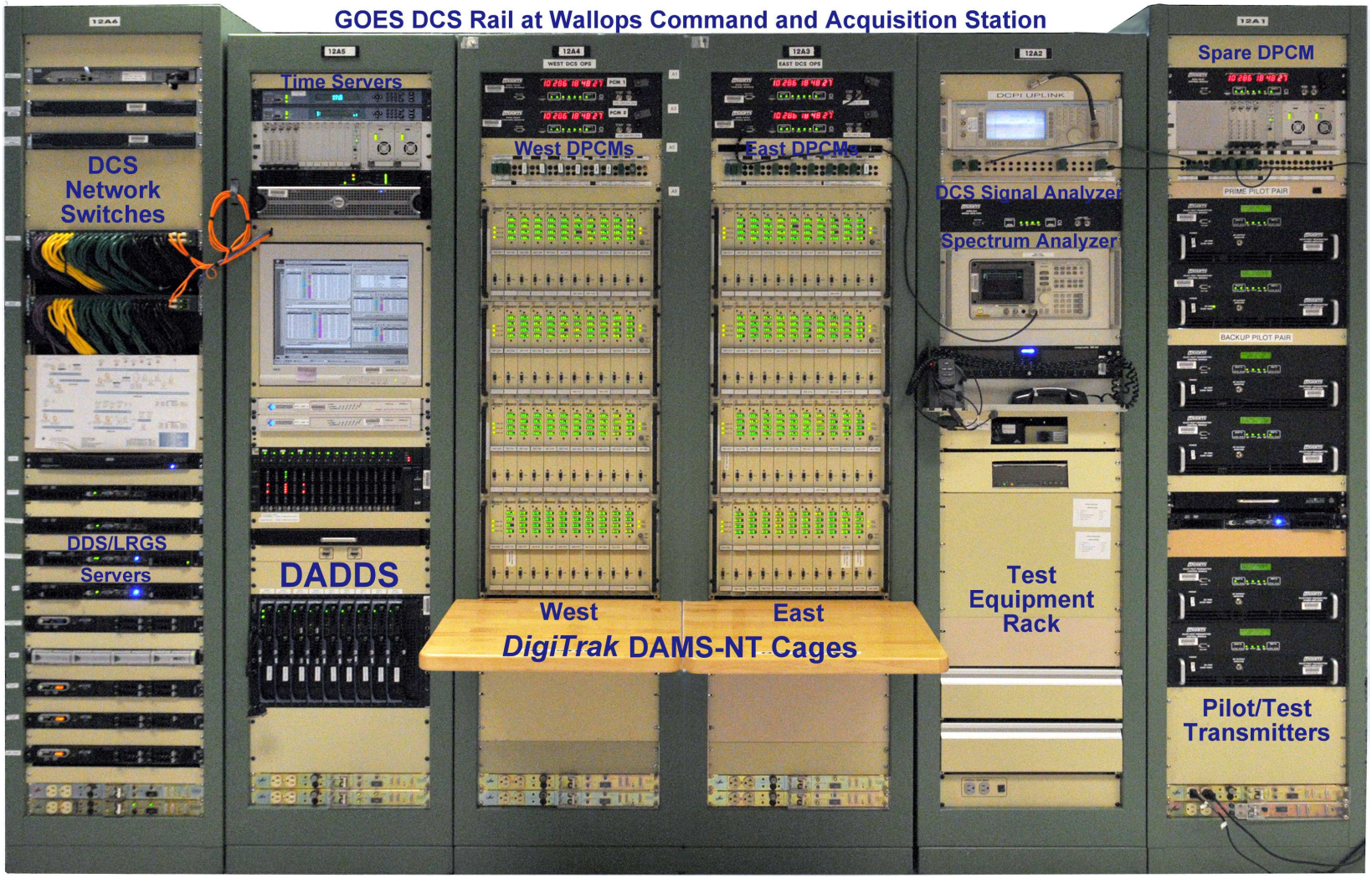



- Geostationary Satellites: GOES East @ 75°W and GOE S West @ 135°W
- WCDA – Primary Receive Site NSOF – Alternate Receive Site
- DCPs Uplink in UHF Band (~402 MHz) & DCS Downlink in L Band (~1694 MHz)
- Primary Pilot: Uplink = 401.850 MHz Downlink = 1694.450 MHz
- Backup Pilot: Uplink = 401.700 MHz Downlink = 1694.300 MHz

# GOES DCS – A Shared Resource

- FDMA: Frequency Division Multiple Access
  - Each DCP is assigned a specific number channel.
  - Channel are shared by multiple DCPs and/or Users.
- TDMA: Time Division Multiple Access
  - On a given channel, each DCP is assigned a specific time window.
  - Time windows are typically 5-15 seconds.
- Power Sharing
  - All active DCP signals are received at the satellite, translated in frequency, and retransmitted as a composite signal to the Direct Readout Ground Stations (DRGS).
  - The composite signal's downlink power is held constant, i.e. each active DCP shares a portion of the total power.
- GOES DCS Pilots
  - Provide an Amplitude and Frequency reference for all DCPs.
  - Critical to system operation. No Pilot $\Rightarrow$ No DCS.
  - Pilots have special frequency (channel) and share downlink power.

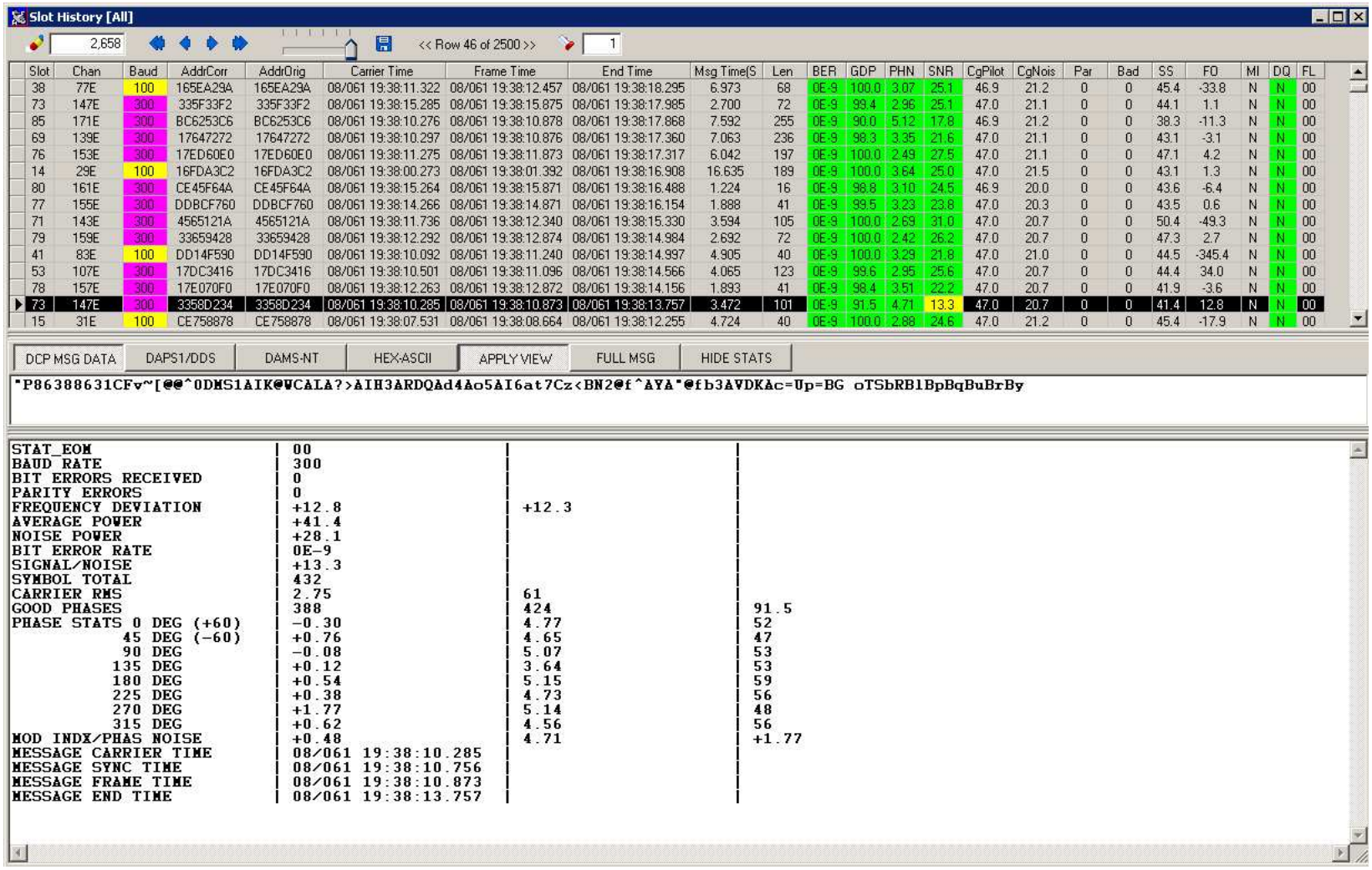
# GOES DCS Rail at WCDA



# DAMS-NT System – *DigiTrak* Demodulator

- Every GOES DCS Message is received by a DAMS-NT *DigiTrak* DSP based demodulator at WDCA and NSOF (and the USGS EDDN at EROS).
- As messages are received, the message data and message statistics are collected in real-time by the DAMS-NT Server application

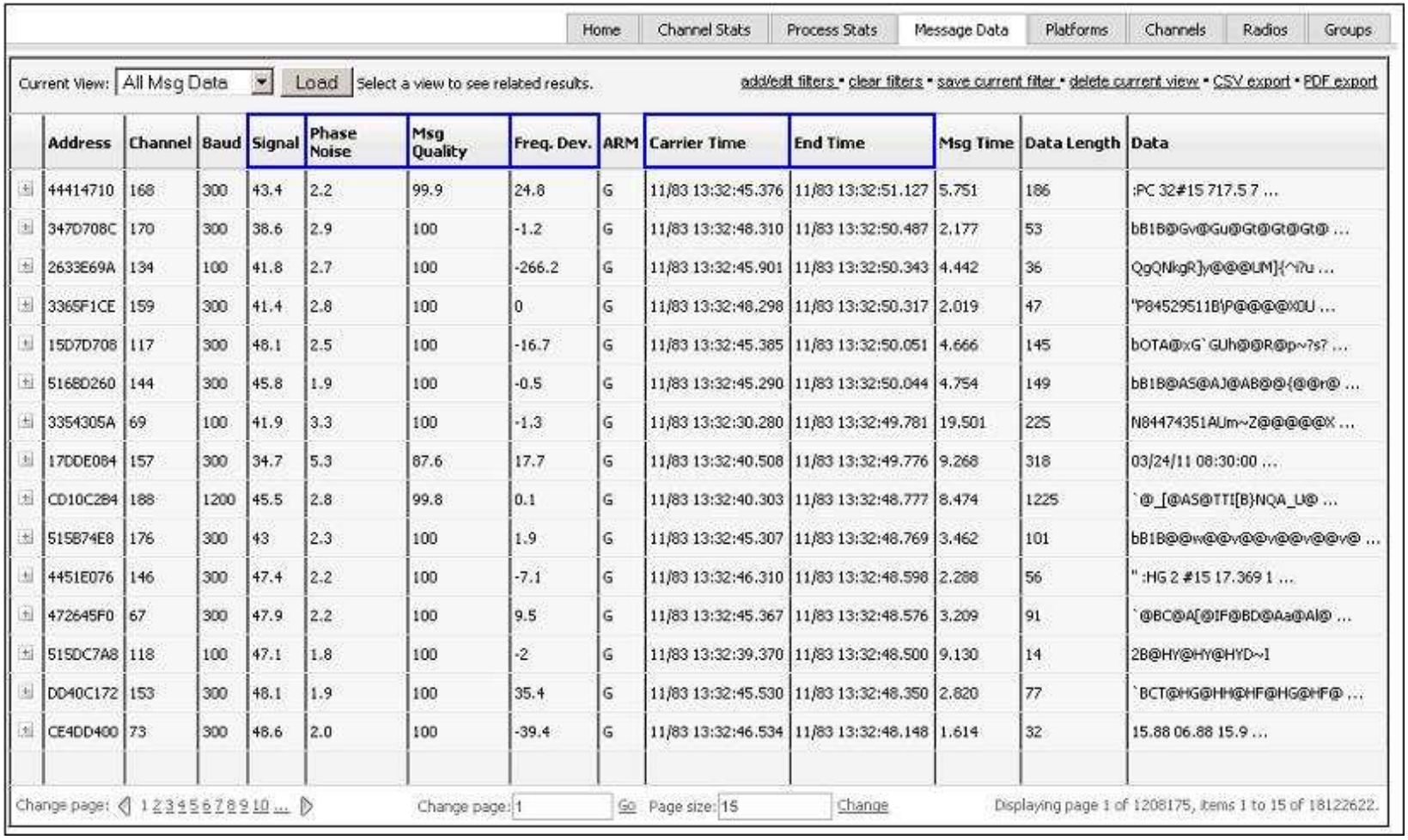
# DAMS-NT *DigiTrak* Message Statistics




| Slot | Chan | Baud | AddrCorr | AddrOrig | Carrier Time | Frame Time | End Time | Msg Time(S | Len | BER | GDP | PHN | SNR | CgPilot | CgNois | Par | Bad | SS | FO | MI | DQ | FL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 38 | 77E | 100 | 165EA29A | 165EA29A | 08/061 19:38:11.322 | 08/061 19:38:12.457 | 08/061 19:38:18.295 | 6.973 | 68 | 0E-9 | 100.0 | 3.07 | 25.1 | 46.9 | 21.2 | 0 | 0 | 45.4 | -33.8 | N | N | 00 |
| 73 | 147E | 300 | 335F33F2 | 335F33F2 | 08/061 19:38:15.285 | 08/061 19:38:15.875 | 08/061 19:38:17.985 | 2.700 | 72 | 0E-9 | 99.4 | 2.96 | 25.1 | 47.0 | 21.1 | 0 | 0 | 44.1 | 1.1 | N | N | 00 |
| 85 | 171E | 300 | BC6253C6 | BC6253C6 | 08/061 19:38:10.276 | 08/061 19:38:10.878 | 08/061 19:38:17.868 | 7.592 | 255 | 0E-9 | 90.0 | 5.12 | 17.8 | 46.9 | 21.2 | 0 | 0 | 38.3 | -11.3 | N | N | 00 |
| 69 | 139E | 300 | 17647272 | 17647272 | 08/061 19:38:10.297 | 08/061 19:38:10.876 | 08/061 19:38:17.360 | 7.063 | 236 | 0E-9 | 98.3 | 3.35 | 21.6 | 47.0 | 21.1 | 0 | 0 | 43.1 | -3.1 | N | N | 00 |
| 76 | 153E | 300 | 17ED60E0 | 17ED60E0 | 08/061 19:38:11.275 | 08/061 19:38:11.873 | 08/061 19:38:17.317 | 6.042 | 197 | 0E-9 | 100.0 | 2.49 | 27.5 | 47.0 | 21.1 | 0 | 0 | 47.1 | 4.2 | N | N | 00 |
| 14 | 29E | 100 | 16FDA3C2 | 16FDA3C2 | 08/061 19:38:00.273 | 08/061 19:38:01.392 | 08/061 19:38:16.908 | 16.635 | 189 | 0E-9 | 100.0 | 3.64 | 25.0 | 47.0 | 21.5 | 0 | 0 | 43.1 | 1.3 | N | N | 00 |
| 80 | 161E | 300 | CE45F64A | CE45F64A | 08/061 19:38:15.264 | 08/061 19:38:15.871 | 08/061 19:38:16.488 | 1.224 | 16 | 0E-9 | 98.8 | 3.10 | 24.5 | 46.9 | 20.0 | 0 | 0 | 43.6 | -6.4 | N | N | 00 |
| 77 | 155E | 300 | DDBCF760 | DDBCF760 | 08/061 19:38:14.266 | 08/061 19:38:14.871 | 08/061 19:38:16.154 | 1.888 | 41 | 0E-9 | 99.5 | 3.23 | 23.8 | 47.0 | 20.3 | 0 | 0 | 43.5 | 0.6 | N | N | 00 |
| 71 | 143E | 300 | 4565121A | 4565121A | 08/061 19:38:11.736 | 08/061 19:38:12.340 | 08/061 19:38:15.330 | 3.594 | 105 | 0E-9 | 100.0 | 2.69 | 31.0 | 47.0 | 20.7 | 0 | 0 | 50.4 | -49.3 | N | N | 00 |
| 79 | 159E | 300 | 33659428 | 33659428 | 08/061 19:38:12.292 | 08/061 19:38:12.874 | 08/061 19:38:14.984 | 2.692 | 72 | 0E-9 | 100.0 | 2.42 | 26.2 | 47.0 | 20.7 | 0 | 0 | 47.3 | 2.7 | N | N | 00 |
| 41 | 83E | 100 | DD14F590 | DD14F590 | 08/061 19:38:10.092 | 08/061 19:38:11.240 | 08/061 19:38:14.997 | 4.905 | 40 | 0E-9 | 100.0 | 3.29 | 21.8 | 47.0 | 21.0 | 0 | 0 | 44.5 | -345.4 | N | N | 00 |
| 53 | 107E | 300 | 17DC3416 | 17DC3416 | 08/061 19:38:10.501 | 08/061 19:38:11.096 | 08/061 19:38:14.566 | 4.065 | 123 | 0E-9 | 99.6 | 2.95 | 25.6 | 47.0 | 20.7 | 0 | 0 | 44.4 | 34.0 | N | N | 00 |
| 78 | 157E | 300 | 17E070F0 | 17E070F0 | 08/061 19:38:12.263 | 08/061 19:38:12.872 | 08/061 19:38:14.156 | 1.893 | 41 | 0E-9 | 98.4 | 3.51 | 22.2 | 47.0 | 20.7 | 0 | 0 | 41.9 | -3.6 | N | N | 00 |
| 73 | 147E | 300 | 3358D234 | 3358D234 | 08/061 19:38:10.285 | 08/061 19:38:10.873 | 08/061 19:38:13.757 | 3.472 | 101 | 0E-9 | 91.5 | 4.71 | 13.3 | 47.0 | 20.7 | 0 | 0 | 41.4 | 12.8 | N | N | 00 |
| 15 | 31E | 100 | CE758878 | CE758878 | 08/061 19:38:07.531 | 08/061 19:38:08.664 | 08/061 19:38:12.255 | 4.724 | 40 | 0E-9 | 100.0 | 2.88 | 24.6 | 47.0 | 21.2 | 0 | 0 | 45.4 | -17.9 | N | N | 00 |

# Message Statistics
# What Are They?

# DADDS/DAMS-NT Message Statistics



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add/edit filters • clear filters • save current filter • delete current view • CSV export • PDF export

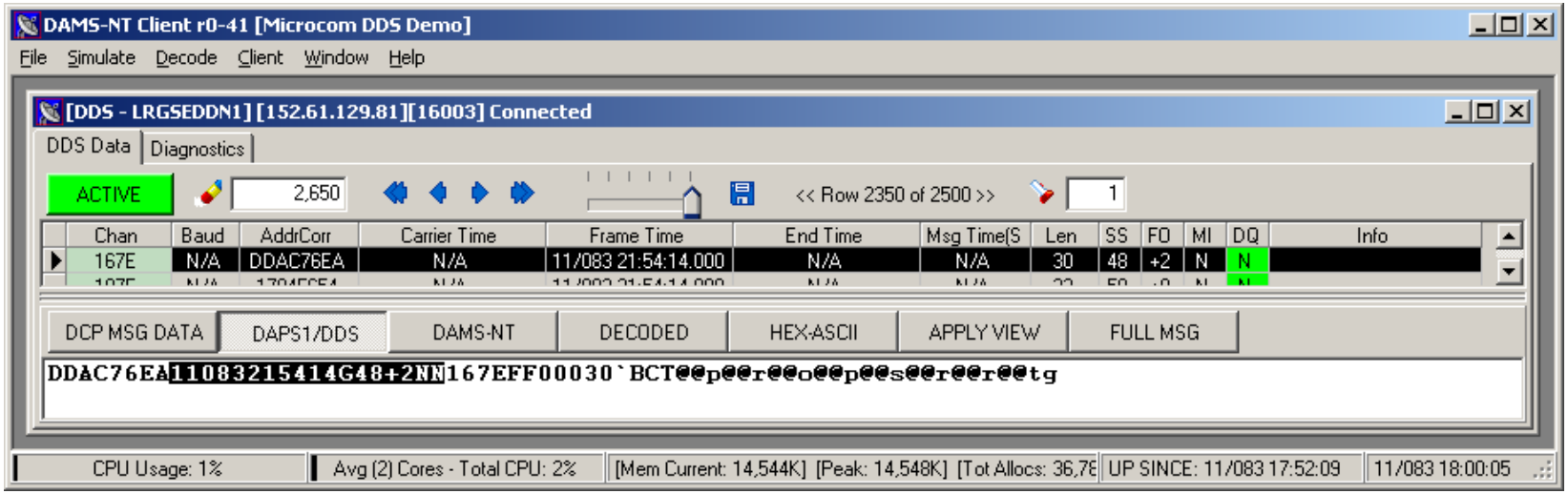
| | Address | Channel | Baud | Signal | Phase Noise | Msg Quality | Freq. Dev. | ARM | Carrier Time | End Time | Msg Time | Data Length | Data |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| + | 44414710 | 168 | 300 | 43.4 | 2.2 | 99.9 | 24.8 | G | 11/83 13:32:45.376 | 11/83 13:32:51.127 | 5.751 | 186 | :PC 32#15 717.5 7 ... |
| + | 347D708C | 170 | 300 | 38.6 | 2.9 | 100 | -1.2 | G | 11/83 13:32:48.310 | 11/83 13:32:50.487 | 2.177 | 53 | bB1B@Gv@Gu@Gt@Gt@Gt@ ... |
| + | 2633E69A | 134 | 100 | 41.8 | 2.7 | 100 | -266.2 | G | 11/83 13:32:45.901 | 11/83 13:32:50.343 | 4.442 | 36 | QgQNkgR}y@@@LM]{^\?u ... |
| + | 3365F1CE | 159 | 300 | 41.4 | 2.8 | 100 | 0 | G | 11/83 13:32:48.298 | 11/83 13:32:50.317 | 2.019 | 47 | 'P84529511B\P@@@@X0U ... |
| + | 15D7D708 | 117 | 300 | 46.1 | 2.5 | 100 | -16.7 | G | 11/83 13:32:45.385 | 11/83 13:32:50.051 | 4.666 | 145 | bOTA@xG`GUh@@R@p~?s? ... |
| + | 516BD260 | 144 | 300 | 45.8 | 1.9 | 100 | -0.5 | G | 11/83 13:32:45.290 | 11/83 13:32:50.044 | 4.754 | 149 | bB1B@AS@AJ@AB@@{@@r@ ... |
| + | 3354305A | 69 | 100 | 41.9 | 3.3 | 100 | -1.3 | G | 11/83 13:32:30.280 | 11/83 13:32:49.781 | 19.501 | 225 | N84474351AUm~Z@@@@@X ... |
| + | 17DDE084 | 157 | 300 | 34.7 | 5.3 | 87.6 | 17.7 | G | 11/83 13:32:40.508 | 11/83 13:32:49.776 | 9.268 | 318 | 03/24/11 08:30:00 ... |
| + | CD10C2B4 | 188 | 1200 | 45.5 | 2.8 | 99.8 | 0.1 | G | 11/83 13:32:40.303 | 11/83 13:32:48.777 | 8.474 | 1225 | `@_[@AS@TTI[B}NQA_U@ ... |
| + | 515B74E8 | 176 | 300 | 43 | 2.3 | 100 | 1.9 | G | 11/83 13:32:45.307 | 11/83 13:32:48.769 | 3.462 | 101 | bB1B@@w@@v@@v@@v@@v@ ... |
| + | 4451E076 | 146 | 300 | 47.4 | 2.2 | 100 | -7.1 | G | 11/83 13:32:46.310 | 11/83 13:32:48.598 | 2.288 | 56 | " :HG 2 #15 17.369 1 ... |
| + | 472645F0 | 67 | 300 | 47.9 | 2.2 | 100 | 9.5 | G | 11/83 13:32:45.367 | 11/83 13:32:48.576 | 3.209 | 91 | `@BC@A[@IF@BD@Aa@Al@ ... |
| + | 515DC7A8 | 118 | 100 | 47.1 | 1.8 | 100 | -2 | G | 11/83 13:32:39.370 | 11/83 13:32:48.500 | 9.130 | 14 | 2B@HY@HY@HYD~1 |
| + | DD40C172 | 153 | 300 | 46.1 | 1.9 | 100 | 35.4 | G | 11/83 13:32:45.530 | 11/83 13:32:48.350 | 2.820 | 77 | `BCT@HG@HH@HF@HG@HF@ ... |
| + | CE4DD400 | 73 | 300 | 46.6 | 2.0 | 100 | -39.4 | G | 11/83 13:32:46.534 | 11/83 13:32:48.148 | 1.614 | 32 | 15.88 06.88 15.9 ... |

Change page: 1 2 3 4 5 6 7 8 9 10 ... | Change page: 1 Go | Page size: 15 Change | Displaying page 1 of 1208175, items 1 to 15 of 18122622.

# Message Statistics – The Final Four

- **Four Most Critical/Useful Message Statistics:**
  - **Time**
    - DCP transmissions must stay with NESDIS window or time slot.
    - Straying outside the window can cause interference with another DCP/User.
    - Transmission start and end times should be monitored.
  - **Frequency**
    - Transmissions must be within ±500 Hz of center of 1500 Hz channel.
    - Future changes will tighten up frequency requirements.
    - Straying outside of channel can affect other transmissions.
  - **Signal Strength**
    - Ensures that the message can be received in a noisy radio environment.
    - Upper and lower limits must be observed.
  - **Phase Measurements**
    - DCP Transmitters use Phase Modulation (PM) to convey information.
    - Phase statistics can single handedly identify the reliability of signal reception and message data processing.
- **Maintaining these four in acceptable ranges will virtually guarantee valid message data reception.**

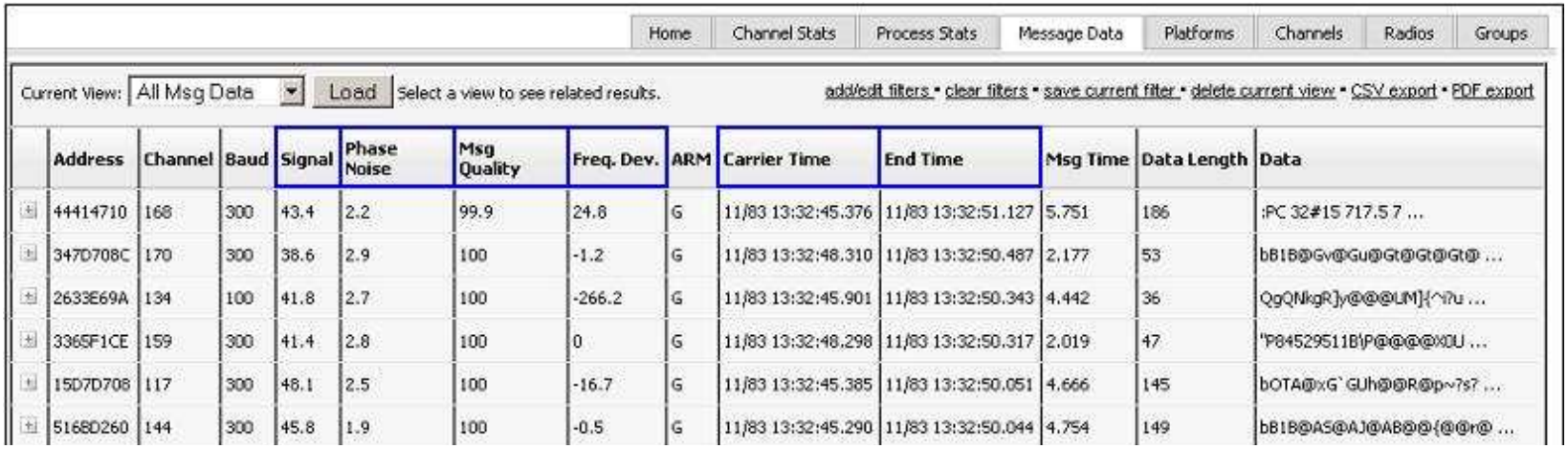
# Message Statistics – DADDS versus DAPS




- **DAPS Legacy Stats Still Used by DDS**

```
1108321541 4G48+2NN
YYDDDHHMMSS          Time:  YYDDDHHMMSS (Frame Sync)
           T         Type:  G = Good   ? = Parity Errors (ARM)
            SS       Signal Strength:  dBm EIRP
              ±X     Frequency: Sign & Digit (±F times 50 Hz)
                M    Modulation Index (Phase):  Normal, High, Low
                 D   Data Quality (Phase):  Normal, Fair, Poor
```

# Message Statistics – DADDS versus DAPS



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| 44414710 | 168 | 300 | 43.4 | 2.2 | 99.9 | 24.8 | G | 11/83 13:32:45.376 | 11/83 13:32:51.127 | 5.751 | 186 | :PC 32#15 717.5 7 ... |
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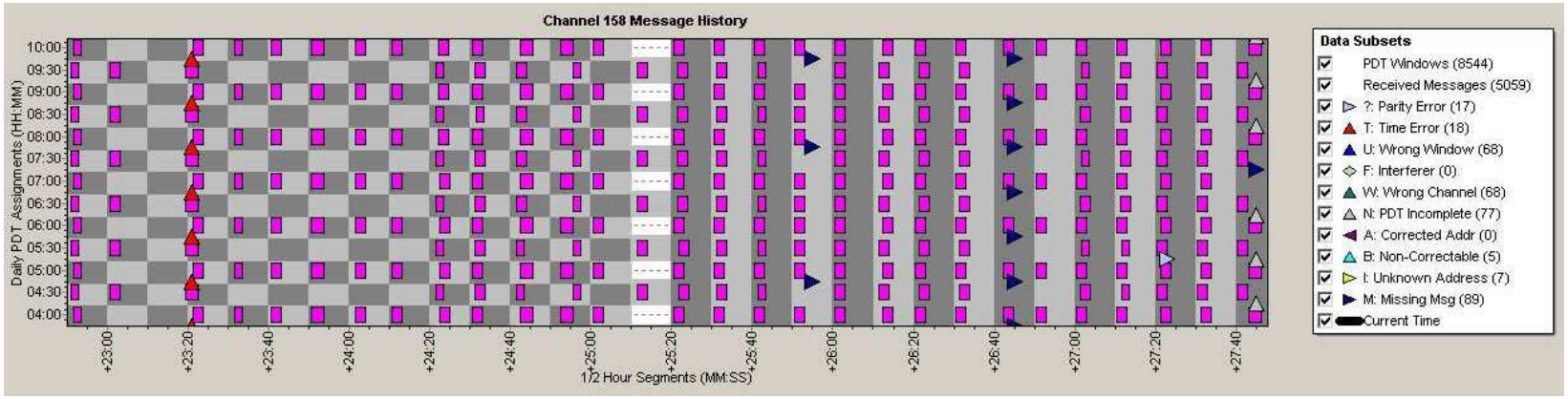
| 3365F1CE | 159 | 300 | 41.4 | 2.8 | 100 | 0 | G | 11/83 13:32:48.298 | 11/83 13:32:50.317 | 2.019 | 47 | 'P84529511B\P@@@@X0U ... |
| 15D7D708 | 117 | 300 | 46.1 | 2.5 | 100 | -16.7 | G | 11/83 13:32:45.385 | 11/83 13:32:50.051 | 4.666 | 145 | bOTA@xG`GUh@@R@p~?s? ... |
| 5168D260 | 144 | 300 | 45.8 | 1.9 | 100 | -0.5 | G | 11/83 13:32:45.290 | 11/83 13:32:50.044 | 4.754 | 149 | bB1B@AS@AJ@AB@@{@@r@ ... |

- **Time:** “Carrier Time” (Start) & “End Time” to 0.001 seconds
  “Msg Time” in seconds to 0.001 seconds
- **Frequency:** “Freq. Dev” from channel center to 0.1 Hz
- **Strength:** “Signal” dBm EIRP to 0.1 dB
- **Phase:** “Phase Noise” in degrees RMS to 0.1°
  “Msg Quality” in percent to 0.1% (aka “Batting Average”)
- **Type:** “ARM” is same as in DAPS legacy stats

# Message Stats – Time – Relative or Absolute?

- Absolute
  - Each DCP has a defined Time Window.
  - Time windows and time stamps are in UTC (Universal Time Coordinated), which is same as GMT (Greenwich Mean Time).
  - Time stamps down to the millisecond.
- Relative
  - ~0.24 second travel time (72,000 km / 300,000 km per sec)
  - How close are we to our neighbor?
  - Message length versus window size.



# Message Stats – Time – Keeping Synced

- Monitor for Time Syncs in Data Stream
  - Flag Byte or Character is a required part of certification.
  - All GOES transmitters must send this byte after GOES ID and before user's data.
  - Identifies:
    - Message format - ASCII or Pseudo-Binary (Binary in future)
    - Whether or not there has been a GPS time sync since the last transmission.
- Deciphering the Flag Byte/Character:
  - ASCII Message:
    - No Time Sync: Space (0x20)
    - GPS Time Sync: " Double Quote (0x22)
  - Pseudo-Binary:
    - No Time Sync: ` Tic Mark (0x60)
    - GPS Time Sync: b (0x62)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 17DDE084 | 157 | 300 | 34.7 | 5.3 | 87.6 | 17.7 | G | 11/83 13:32:40.508 | 11/83 13:32:49.776 | 9.268 | 318 | 03/24/11 08:30:00 ... |
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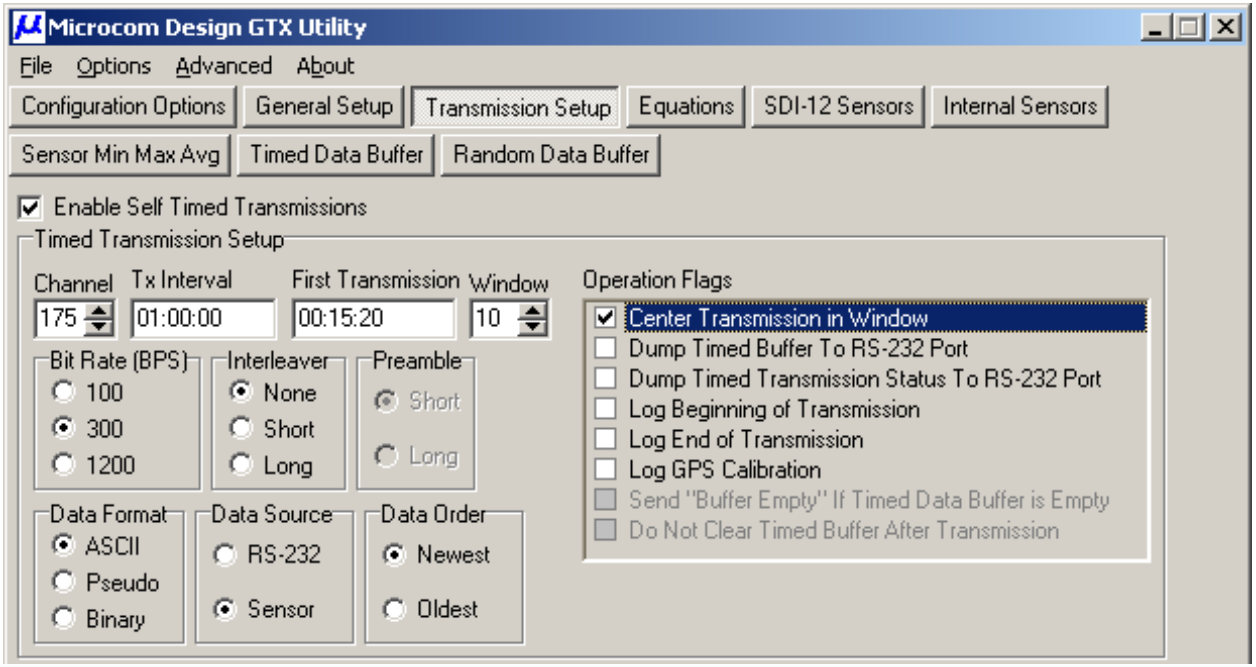
| 472645F0 | 67 | 300 | 47.9 | 2.2 | 100 | 9.5 | G | 11/83 13:32:45.367 | 11/83 13:32:48.576 | 3.209 | 91 | `@BC@A[@!F@BD@Aa@Al@ ... |

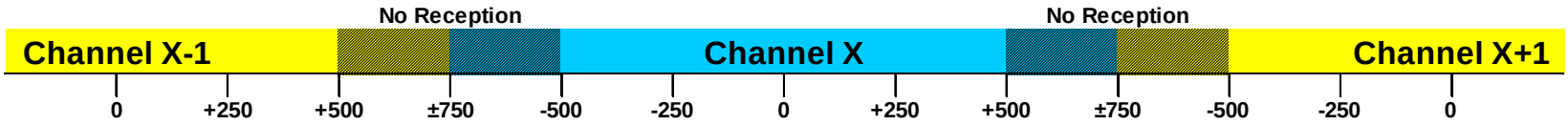
# Message Stats – Time – Making Sure

- "To Center or Not to Center"
  - Until DADDS, message centering was not advisable due to latency in DAPS time stamping.
  - Centering ensures maximum time guard bands at start and end of transmission



# Message Stats – Frequency – Where Are You?

- *DigiTrak* DSP Demods currently allow ±500 Hz error from channel center.
  - 300 BPS Channel is 1500 Hz.
  - 1200 BPS Channel is 3000 Hz.
- Outside this designed limit, messages will not be received.
- Most transmitters today have little trouble meeting this limit.
  - Loss of data due to frequency is usually the result of a faulty transmitter.
- Good idea to monitor “Freq. Dev.” for excessive deviation from channel center.

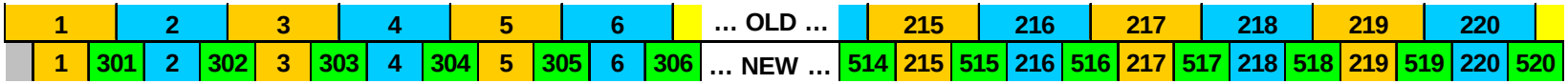


# Message Stats–Frequency–Today & Tomorrow

- Certification Standard 1 (CS1) versus Certification Standard 2 (CS2)

| | Current (CS1) | Future (CS2) |
|---|---|---|
| Channel Capacity | 220 | 440 |
| Total Frequency Bandwidth | 330 kHz | 330 kHz |
| Basic Channel Bandwidth | 1500 Hz | 750 Hz |
| 100 bps Bandwidth | 1500 Hz | N/A |
| 300 bps Bandwidth | 1500 Hz | 750 Hz |
| 1200 bps Bandwidth | 3000 Hz | 2250 Hz |
| Tx Allowed Uncertainty | ±400 Hz | ±125 Hz |
| Tx Frequency Stability | ±1 ppm | ±0.3 ppm |

- CS1 versus CS2 Channel Mapping




- Transition to CS2 will most likely require reducing demodulator acquisition range to ±150 Hz making frequency monitoring more critical in future.

# Message Stats – Signal Strength – Bad?

- Too Low
  - Missed messages - *DigiTrak* DSP Demods have programmable reception threshold of 30 dBm EIRP.
  - Poor Signal-Noise-Ratio (SNR)
    - Signal Strength relative to RF Noise.
    - Lower Signal Strength ⇒ Higher SNR ⇒ Increased Phase Noise ⇒ Worse Performance
- Too High
  - Demod overload - *DigiTrak* DSP Demods have maximum reception threshold of 56 dBm EIRP.
  - Violation of certification and use agreements.
  - Not being a good neighbor – excessive transmit powers increases noise which lowers SNR for others.
  - Unnecessary battery discharge.

# Message Stats – Signal Strength – Good?

- Measured in dBm EIRP (Equivalent Isotropic Radiated Power)
  - Three Components:
    - Transmitter Power – Usually specified in Watts
    - Antenna Gain – Specified in dB (typical 3-11 dB)
    - Cable Loss – Between Transmitter & Antenna (0.5 – 1.0 dB)
  - dBm = Decibel (logarithmic) scale relative to one milliwatt.

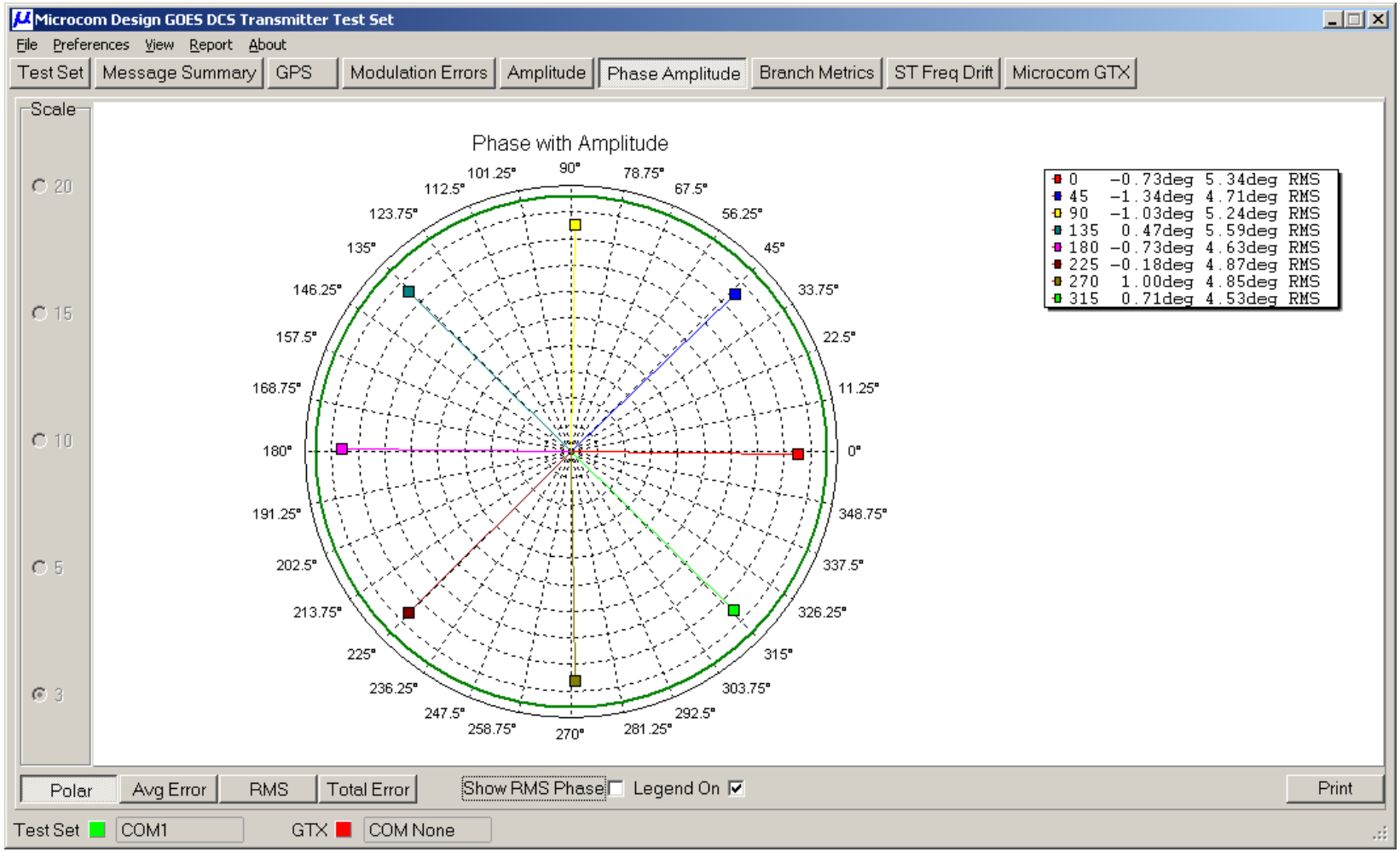
| Watts | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| dBm | 30.0 | 33.0 | 34.8 | 36.0 | 37.0 | 37.8 | 38.5 | 39.0 | 39.5 | 40.0 | 40.4 | 40.8 | 41.1 | 41.5 | 41.8 | 42.0 | 42.3 | 42.6 | 42.8 | 43.0 |

- Example: Microcom GTX (12 Watts) with Microcom UB8 (8 dB).
  - 40.8 dBm + 8 dB – 0.8 dB = 48.0 dBm EIRP
- Certification Levels:
  - CS1:
    - 300 BPS: 48 dBm EIRP
    - 1200 BPS: 51 dBm EIRP
  - CS2: GOES-13 and Higher (GOES-12)
    - 300 BPS: 39 dBm EIRP (44 dBm)
    - 1200 BPS: 45 dBm EIRP (50 dBm)
  - Reported variations of ± 3 dB are normal since Signal Strength is measured relative to GOES DCS Pilot.

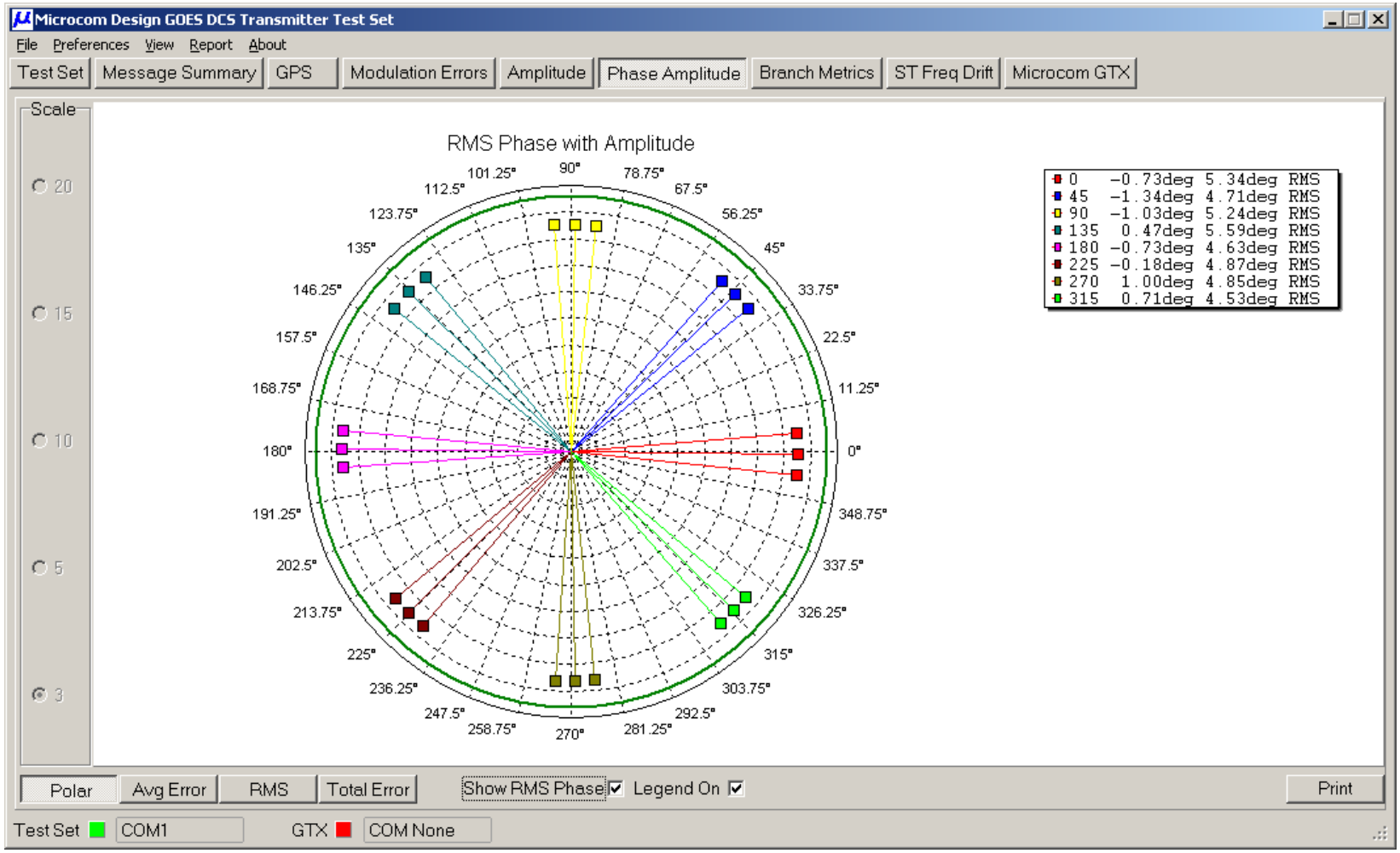
# Message Stats – Phase – The Ultimate Telltale

- What Is Phase?
  - GOES DCS Transmitters use Phase Modulation, as opposed to Amplitude Modulation (AM) or Frequency Modulation (FM).
  - Modulation ⇒ Change in a Deterministic Pattern.
  - Phase is Measure in Degrees ⇒ Think of Position Around a Circle
  - Transmitters send one of Eight Phase Symbols to convey message information (0°, 45°, 90°, 135°, 180°, 225°, 270°, 315°).
- Two Components Determine Quality of Phase Modulation
  - Absolute Phase – Average – How close is average to nominal?
  - RMS Phase Noise – Standard Deviation – How much do the phase symbols vary around the average?
- Under Normal Circumstances …
  - Average Phase is strictly a function of the transmitter.
  - Phase Noise is a function of the Signal-to-Noise Ratio (SNR).

# Message Stats – Phase – Average



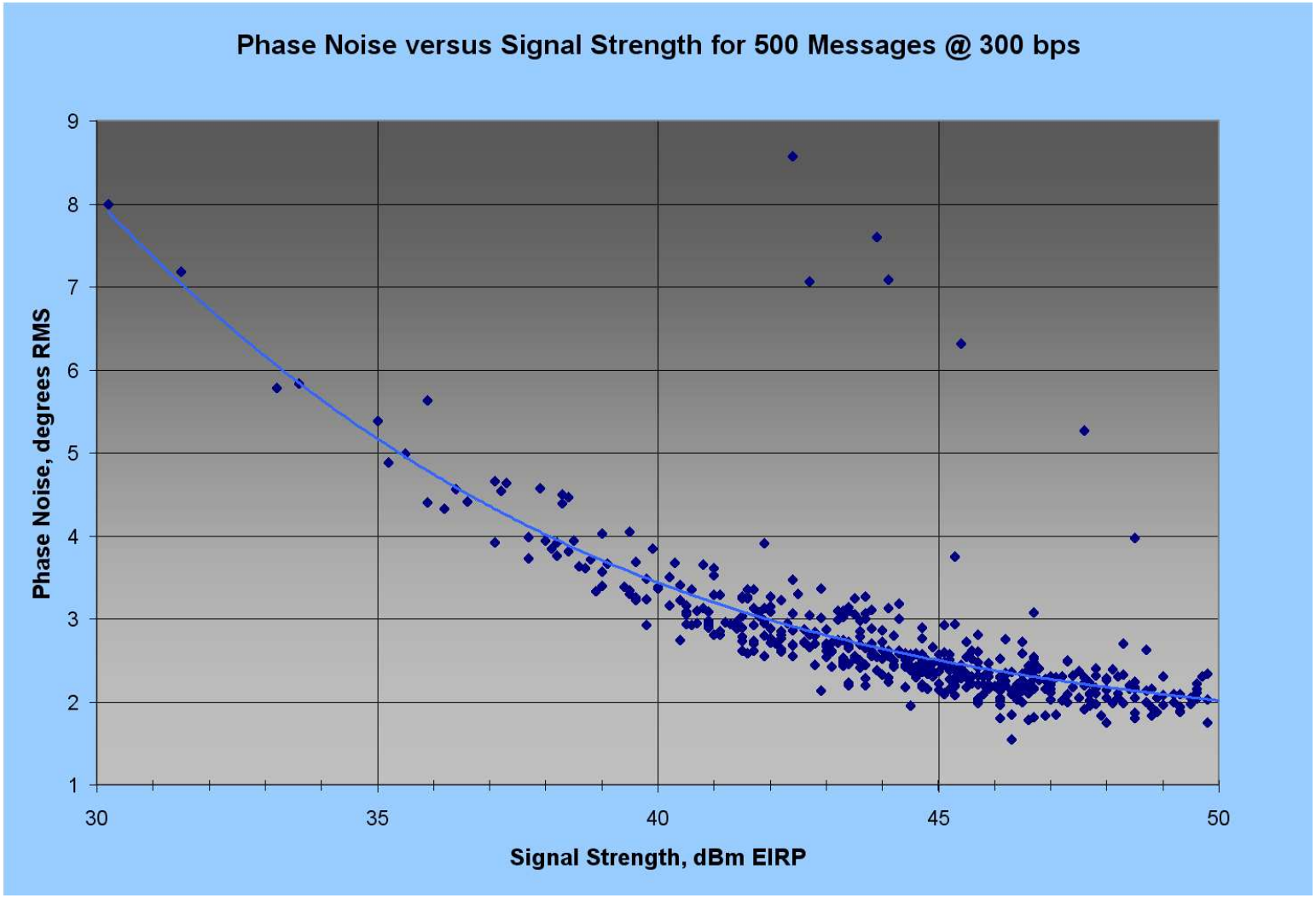
# Message Stats – Phase – Average



# Message Stats – RMS Phase Noise

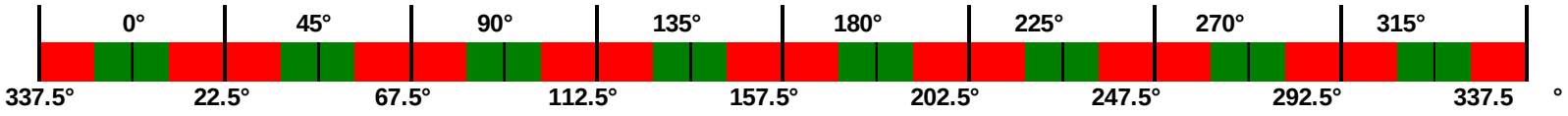
- Standard Deviation of Phase Symbols Relative to Average
  - Designated by Greek Symbol σ (sigma).
  - 68.3% of received symbols should be within ±1σ
  - 95.4% of received symbols should be within ±2σ
  - 99.7% of received symbols should be within ±3σ
- Good, Fair, and Poor …
  - 300 BPS: Good < 6.0° < Fair < 8.0° < Poor
  - 1200BPS: Good < 5.5° < Fair < 7.5° < Poor
- Lower Limit
  - Can never be less than 0
  - Typically, never less than 1.5° - 2.0°
- Upper Limit
  - Reception barely possible around 11° - 12° (short mess ages)
  - Beyond 13° highly unlikely.

# Phase Noise vs. Signal Strength



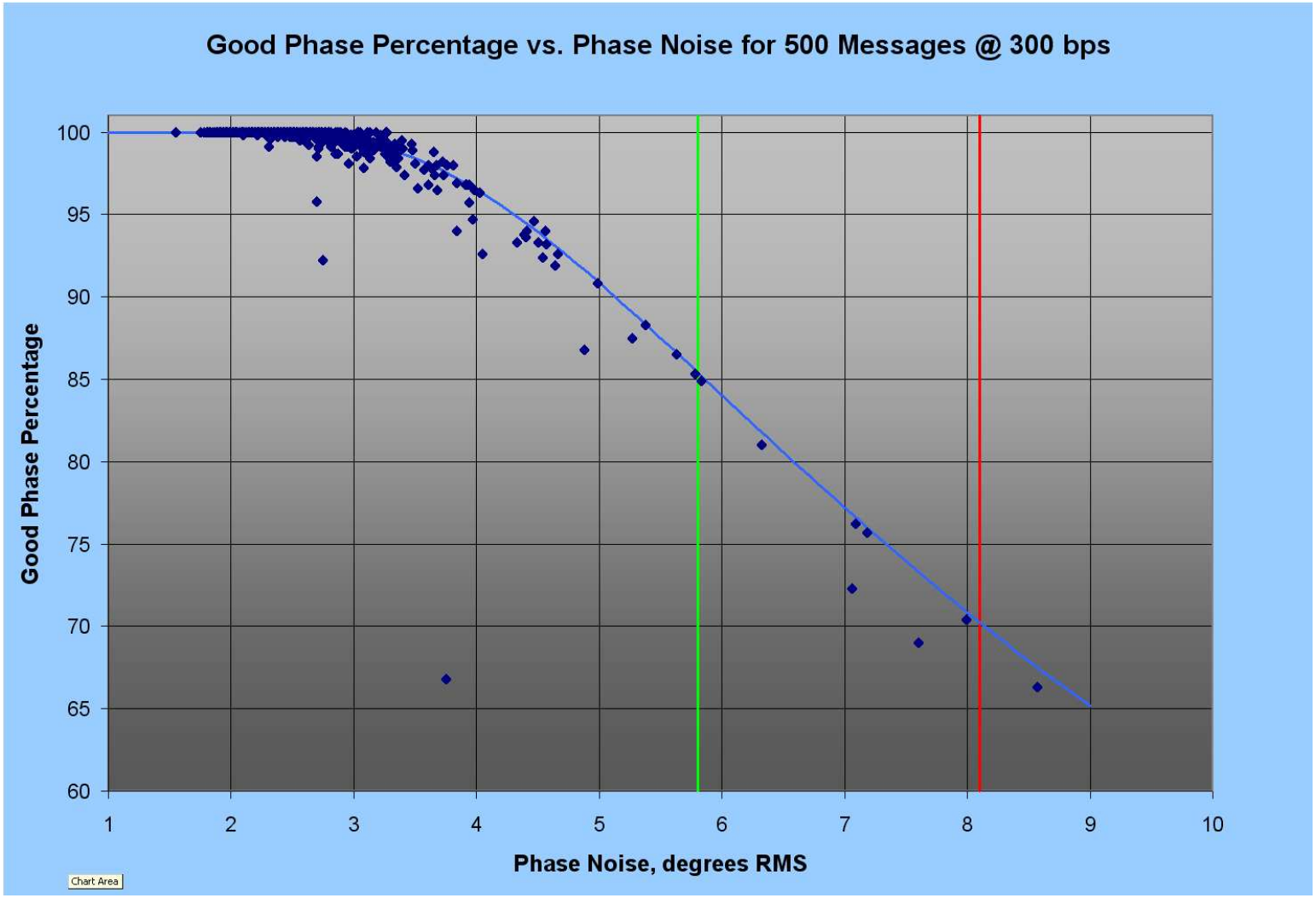
# Message Stats – Phase – Batting Average

- Also Known As – "Good Phases"
  - Percentage of "Good" phase symbols relative to total.
  - Combines phase average and standard deviation into one metric.
  - Used to determine DAPS Data Quality:
    - Good: 100%-85% Fair: 85%-70% Poor: Below 70%
- What is a "Good" Phase Symbol
  - Any symbol received within ~ ±8.4° of nominal phase (0°, 45°, etc.).

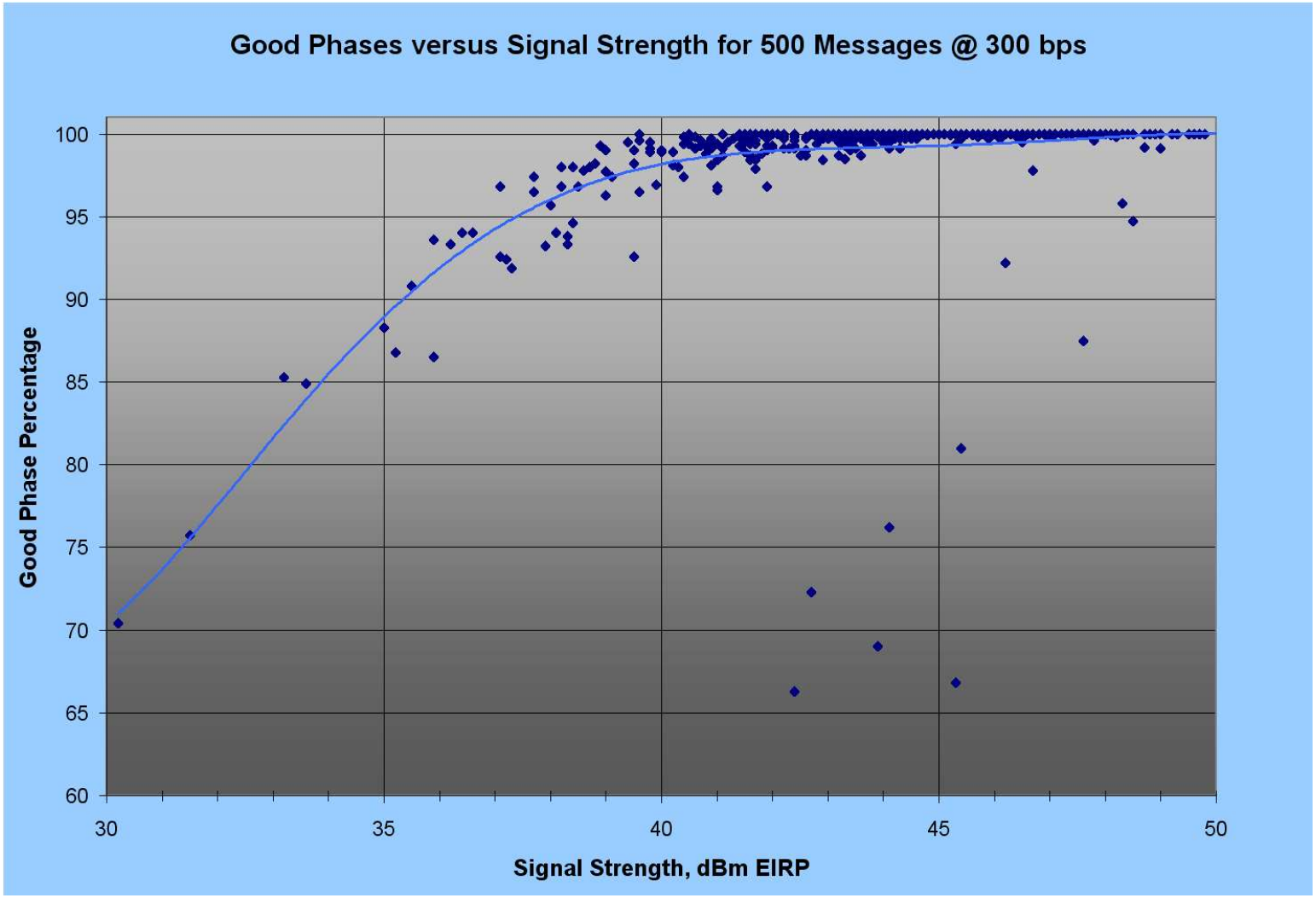



- "Good Phases" versus RMS Phase Noise with Perfect Average
  - 85% $\Rightarrow$ ~$1.44\sigma = 8.4° \Rightarrow \sigma \approx 5.8°$
  - 70% $\Rightarrow$ ~$1.04\sigma = 8.4° \Rightarrow \sigma \approx 8.1°$

# Good Phases vs. Phase Noise



# Good Phases vs. Signal Strength



# Message Stats – Signal Strength – Optimum?

- 300 bps
  - 38-42 dBmi yields consistent good phase percentage in upper 90's to 100%.
  - Optimum range is independent of CS1 or CS2.
  - Point of diminishing returns is ~42 dBmi
    - Good Phases consistently at 100%.
    - Phase Noise below 3 ° RMS.
    - Signal performance at peak ⇒ increasing signal strength provides little benefit while negatively affecting battery drain.
- 1200 bps
  - ~44 – 48 dBmi should produce equivalent results to graphs shown for 300 bps.

# Message Stats – Summary – Thumb Rules

- Time:
  - Verify Message (Start-to-End) is in Window
  - Use Window Centering if Available
  - Verify Transmitter Clock is Being Synced to GPS (UTC)
- Frequency:
  - Verify Frequency Deviation is within ±400 Hz Now
  - ±150 Hz In Future
- Signal Strength:
  - Not Too High (< 53 dBm EIRP) and Not too Low (> 33 dBm EIRP)
  - Best If Within Optimum Range
- Phase:
  - RMS Phase Noise Should Be Less Than 5.5°
  - Message Quality Should be Greater Than 85%

# END OF PRESENTATION

## "THANK YOU" FOR YOUR ATTENTION