Random Reporting User's Guide Revision

Presented by

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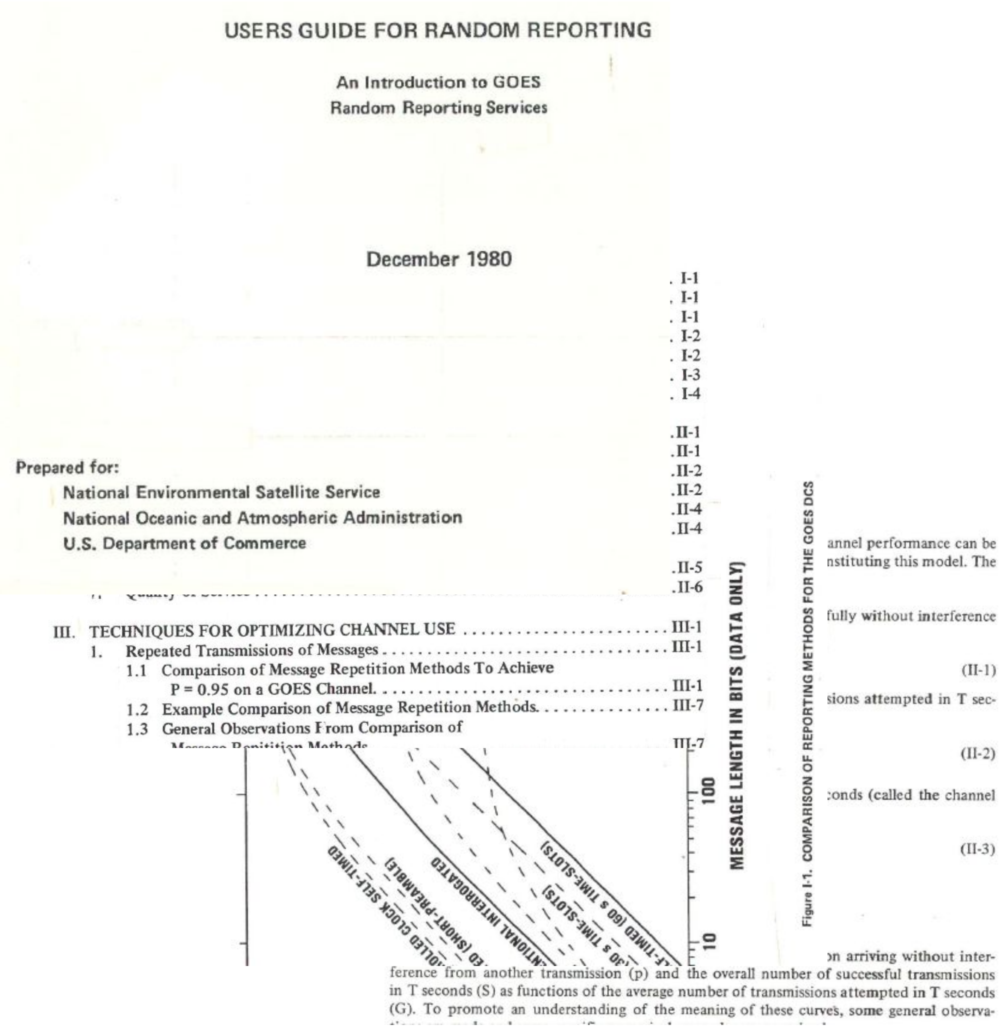
April 2021

Original Users Guide

- Original Random Reporting “User’s Guide” published in 1980; Currently a non-searchable PDF document.
- NOAA wanted to look at random reporting performance and refresh the users guide.
- The tasks in this effort included:
  - Review of the original user guide and current Certification Standards requirements (CS2).
  - Analysis of the current performance of the random reporting channels.
  - Survey of users and vendors to understand how random reporting is done now and what operational variations were being used.
  - Propose document revisions and user recommendations for the update.
  - Implement the approved changes in a revised document.
- Current Status:
  - First draft of revised users guide is complete.
  - NOAA has performed an initial review, and made some suggested changes.
  - NOAA soliciting feedback from this presentation before Microcom updates draft.
  - Once second draft is complete, NOAA will release to STIWG for comments.

Original Users Guide

- Published in December of 1980; Currently a non-searchable PDF document.
- Not really a users guide, but more of a brief on how to best implement random reporting.
- Presented methods for implementing random reporting in DCS.
- Includes predicted performance data from both analysis and simulation.
- Includes recommendations for managers on how to assign channel resources for platforms performing random transmissions.
- Recommends resending messages a limited number of times to achieve satisfactory probability of success without channel overload.

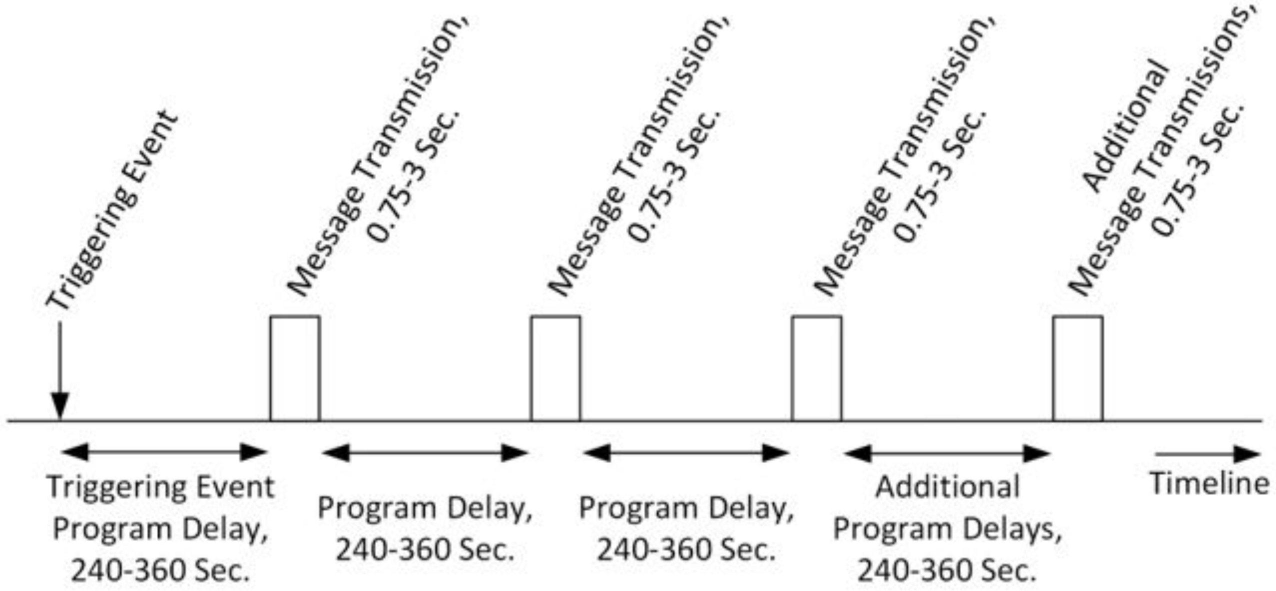


Original Users Guide

- Since 1980, random reporting has become a common tool for DCP data retrieval at near real-time.
  - The current methods used for random reporting are based on the original users guide.
  - Some alternative methods presented in the original users guide were not implemented.
- Analyzed several different message lengths (transmission times) for analyzing how many DCPs can be assigned to a channel.
- Made recommendations based on the statistical assumption of independent transmissions, among users, and also from an individual user.
- Current CS2 specification limits random reporting transmission times to 3 seconds at 300 bps and 1.5 seconds for 1200 bps.
  - The only CS2 specification that addresses random channel operation.
  - Currently vendors and users are permitted to implement random reporting with any number of repeated messages, at any rate, with any fixed or random intervals in between them.
  - No random channels are currently assigned for 1200 bps operation.

Current Implementation

- Currently, random reporting is permitted on 21 channels, each operating at 300 bps.
- Random reporting messages at 300 bps require an overhead of 0.833 seconds.
  - With a maximum transmission time of 3 seconds this leaves 2.167 seconds for random reporting message data, which equates to a maximum of 81 bytes.
- Most users implement self-timed messaging as their primary mode of communications and use random reporting as a secondary mode.
- One of the most common random reporting configurations has this general timeline profile:



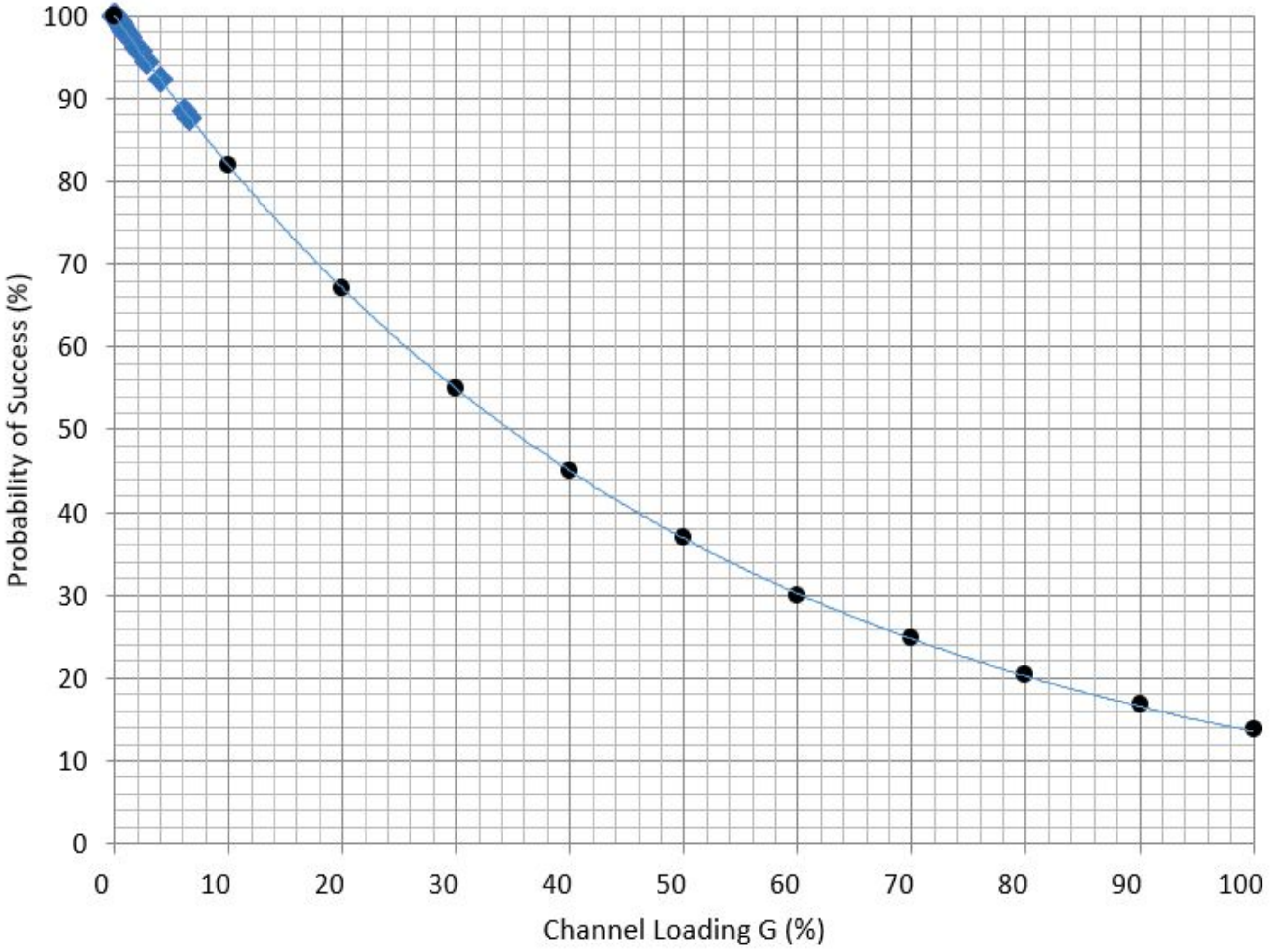
Current Performance

- The 21 channels used for random reporting have mostly secondary random reporting assignments as seen in the table to the right.
- Two parameters used for performance analysis are **probability of success** and **throughput**.
- The **probability of success** describes the likelihood of delivering a random reporting message, where failure usually occurs because of collisions with a simultaneous message from another DCP.
- The **throughput** describes what percentage of the capacity of the channel was successfully used to deliver initial messages.
- Both parameters are measured against the **channel loading** which includes all initial messages and subsequent messages, whether they get delivered, or not.

Random Channel Number	Number of DCPs Assigned P = Primary Assignment S = Secondary Assignment
104	15P + 25S = 40
114	0P + 159S = 159
115	0P + 1338S = 1338
118	0P + 1429S = 1429
119	0P + 1565S = 1565
120	0P + 202S = 202
1211	0P + 1207S = 1207
123	0P + 585S = 585
124	0P + 1086S = 1086
125	0P + 2681S = 2681
126	20P + 1402S = 1422
127	0P + 1628S = 1628
128	0P + 1159S = 1159
129	0P + 1428S = 1428
130	0P + 2899S = 2899
131	1P + 2121S = 2122
132	2P + 1380S = 1382
133	0P + 1162S = 1162
134	50P + 6S = 56
135	0P + 1131S = 1131
136	1P + 507S = 508

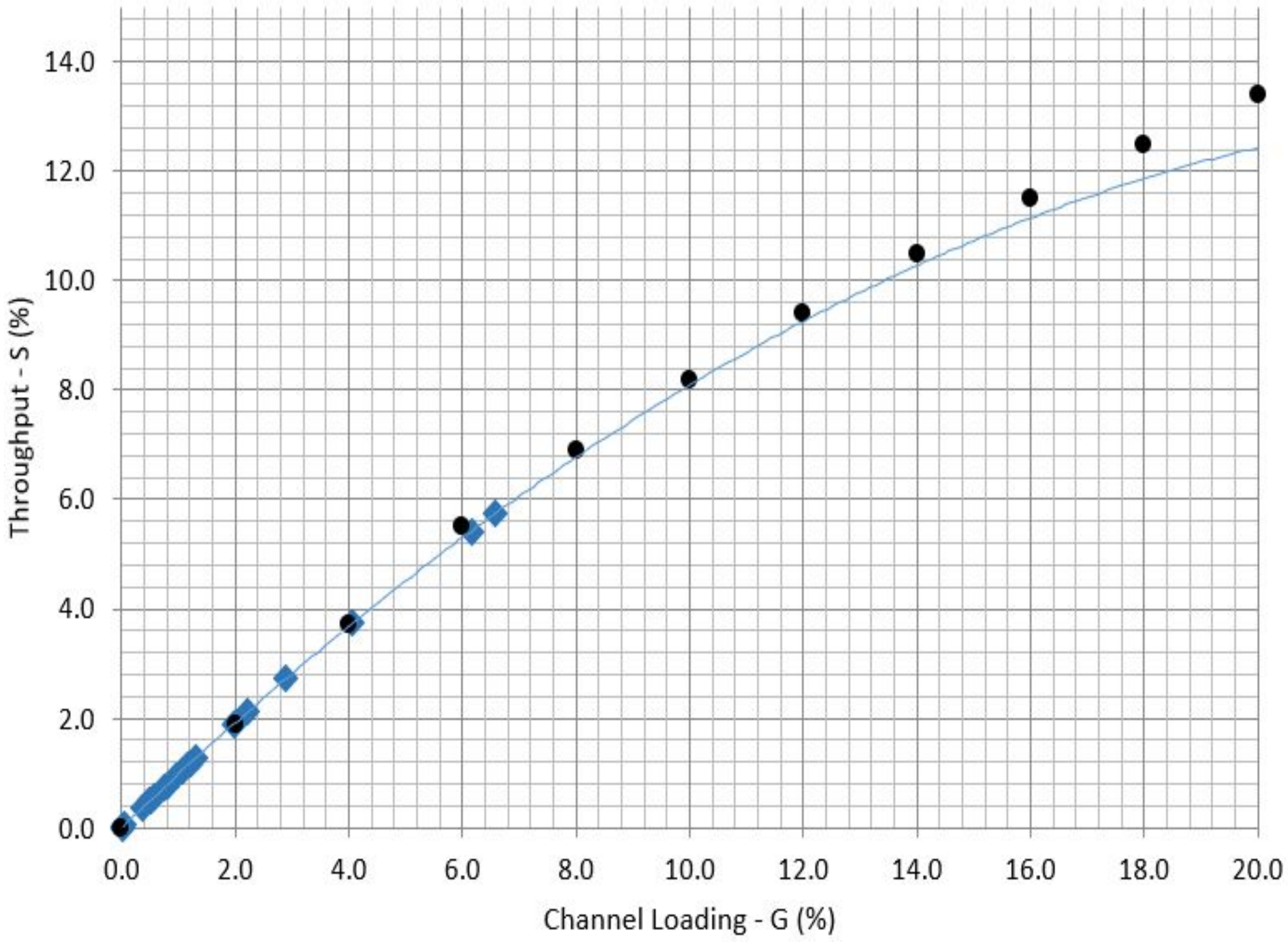
Current Performance – Probability of Success

- Blue squares represent the measured probability of success of random channels.
- Black dots represent what theory predicts for channel loading values.
- Regression curve derived from measured performance (blue squares) follows what theory predicts (black dots).
- Notes:
  - Highest channel loading is about 6% (a good thing).
  - Probability of success of measured data is high (also a good thing).



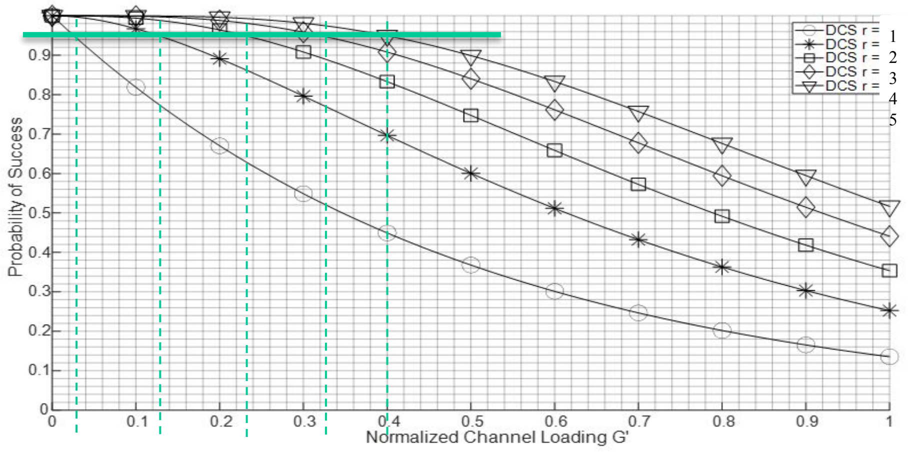
Current Performance – Measured Throughput

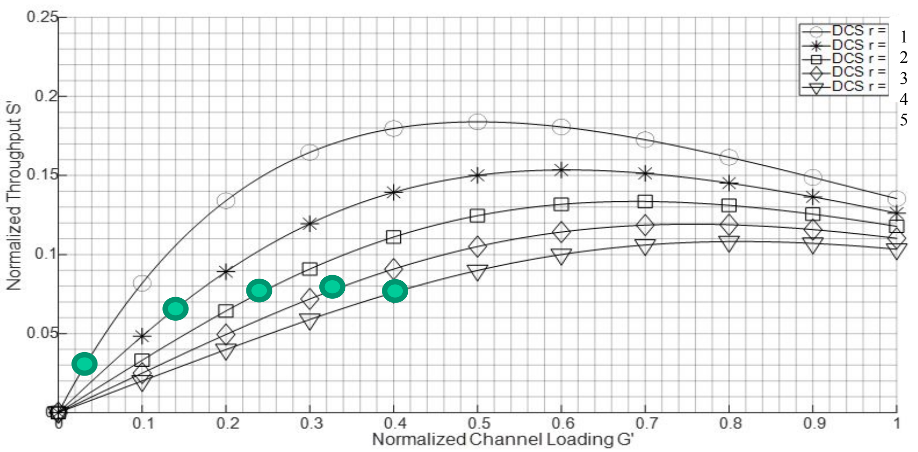
- Blue squares represent the measured throughput of random channels.
- Black dots represent what theory predicts for channel loading values.
- Regression curve derived from measured throughput (blue squares) follows what theory predicts (black dots).
- Notes:
  - Throughput is low because channel loading is low.
  - Represents the percentage of channel capacity being utilized.
  - Regression only a good fit initially due to limited data points.



Simulated Performance – Multiple Messages

- Measured data analysis treated all messages as initial traffic.
- To see the impact on probability of success and throughput when subsequent messages are sent, the theoretical performance was derived for transactions involving “r” messages.
- Note the green 95% probability of success line. The corresponding channel loading values, when plotted on the throughput curves, suggest that to maximize throughput, the optimum number of messages in a random reporting transaction should equal 3-5.





Simulated Performance – Repeat Interval

- Simulations were also conducted to analyze the interval between messages.
  - The multiple message profile common with random reporting was used.
  - Two interval profiles were used.
    - In the first profile, the intervals were all created using a 5 minute fixed interval + 1 minute random interval between all messages and between the triggering event and the first message.
    - In the second profile, the interval between the triggering event and the first message was cut in half to a 2.5 minute fixed interval + 0.5 minute random interval. The other intervals remained in the same 5 + 1 profile.
  - The results of the simulations suggest in all profiles that the use of the fixed + random interval outperforms the theoretical results which are derived using a specific probability function called a Poisson distribution.
  - It may be that shortening the delay intervals (a desired performance change) is possible, without significantly impacting the probability of success.

User & Vendor Surveys

- Random Reporting Operation Variations:
  - Four vendors responded and all four reported they implement multiple message transactions
    - Three vendors indicated the number of multiple messages is programmable.
      - The range of multiple messages is 0 to 99.
      - 3 multiple message transactions is the default for two of the three vendors.
    - The one vendor with fixed multiple-messaging transmits 1 subsequent message.
  - All four vendors reported they can support configurable intervals between messages and that they include a random time component.
  - All four vendors indicated they implement a delay between the triggering event and the first transmitted message.
- In the user survey it was reported that:
  - Users do use random reporting on many of their platforms.
  - All users expected a high probability of success: from 85-100%.
  - 70% of users said faster self-timed transmissions would eliminate the need for random reporting, and that 15 minutes was the maximum self-timed interval they could tolerate to stop using random reporting (some users wanted 5 minute self-timed intervals).

User Recommendations

- Four main recommendations:
- Recommendation 1: Comply with the CS2 requirement to keep messages shorter than 3 seconds for 300 baud transmissions.
- Recommendation 2: After a triggering event, wait a random length interval before initiating the first random message. Use a 5 + 1 (fixed + random) minute interval. A Poisson interval with a message rate > 1 per hour is also acceptable.
- Recommendation 3: Send no more than 3 copies of the initial message and separate them with the same interval used in recommendation 2.
- Recommendation 4: Use only 300 baud for random reporting. 1200 baud is permitted but less efficient from a channel utilization standpoint. While random messages sent at 1200 baud can be sent in half the time (1.5 seconds for 1200 baud) they require three times the bandwidth. As a result, it is a net loss of channel resources to use 1200 baud for random reporting.

User Recommendations

- Two potential additional recommendations to consider:
  1) The initial delay interval between the triggering event and the first transmission could be shortened.
     - Having this interval ensures that separate platforms monitoring the same event will not transmit simultaneously so it is necessary.
     - However, it is possible to cut it in half to 2 ½ minutes ± 30 seconds.
     - Question for users… Would this be of any benefit?

  3) For many users, the value of the random reporting system is tied to the interval used for self-timed messages. If we shorten the interval for self-timed messages to 15 minutes, the random reporting delay intervals should likewise be shortened, perhaps to 2-3 minutes.
     - Question for users… If self-timed message intervals drop below 15 minutes will random reporting still be required?

Next Steps

- NOAA would like to receive any feedback from Users and/or Manufacturers on the information provided here; especially the recommendations.
- Following receipt of this feedback, Microcom will consult with NOAA on any impact to User Guide.
- Microcom will then amend the first draft and provide NOAA with a second draft.
- NOAA will distribute to STIWG for final comment.
- Assuming the feedback from the STIWG is positive, NOAA will officially publish the revised Random Reporting User's Guide.