Two-Way Update

Presented by
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General Two-Way History

- Long been a desire of the DCS community to have a communication link to the remote DCPs.
  - The addition of Two Way communications would considerably enhance the value of the entire DCS system.
  - Also known as DCPI (interrogate) and DCPC (command).
- Original 1965 design was based on Interrogate Operation
  - DCPI was never widely utilized due to limited capability and cost of receivers.
  - DCPI link terminated around 2005 since it did not meet NTIA Power Spectral Density (PSD) requirements.
- Work by NOS/Sutron (circa 2007-2009) proved feasibility of a spread spectrum approach to meet PSD.
  - DCPC utilized Direct Sequence Spread Spectrum (DSSS).
  - Never fully implemented by NOAA.
- Transponders have always been available.
  - GOES-R series satellites include DCP I/C transponder, but may be removed from future satellites if not utilized.
In 2015, NOAA tasked Microcom with performing comprehensive study on resurrecting the Two-Way

**Two-Way Link Concerns:**
- DCS is an NTIA Secondary Licensee on non-Interference basis with FCC Primary Licensees
- Primary Licensee is Land Mobile Radio (LMR).

Study results presented at April TWG and formal report submitted to NOAA In July.

**2015 Study Key Recommendations:**
- Frequency Hopping Spread Spectrum (FHSS) instead of DSSS.
  - FHSS will perform better in busy LMR environment.
- NOAA to fund and provide reference receiver design.
- Utilize DADDS to provide secure User interface for sending commands, confirming receipt, and delivering response.
- Synchronize hop pattern, packet structure and error correction (Reed-Solomon) to UTC.
  - Quicker acquisition when time known, allows time sync when not.
2016 Two-Way Study

- In 2016 NOAA authorized Microcom to perform a follow-on study to further confirm the FHSS recommendation.

- 2016 Study Goals
  - Extend simulation models to better confirm FHSS performance in presence of LMR interference.
  - Evaluate impact on Bit Error Rate (BER) with truncated RS (250,218).

- Study results presentation at May TWG.

- 2016 Study Key Results
  - Simulations confirmed only minor BER degradation in the presence of two simulated, 20 dB stronger LMR signals.
  - Negligible performance difference for shortened RS (250,218) versus (255,233); shortened code showed slight improvement.

- Following 2016 TWG, NOAA requested proposal to build prototype modulator and demodulator for bench test.

- Bench prototype work began in the fall of 2016.
First step in bench prototype project was to develop a test set up to confirm synthesizers can maintain phase coherence on hops.

Test setup consisted of two LMX2485E Synthesizer Evaluation boards connected to Microchip Micro Controllers interfaced to a Laptop.

Synthesizers were stepped in synchronisms utilizing GPS, and phase coherence from hop-to-hop was confirmed.
Modulator completed in fall; custom design based on DCS Pilot/Test Transmitter previously designed for NOAA.

Can produce a variety of test signals to support the demodulator development; including desired FHSS BPSK signal at 200 bps with pseudo-random data.
Bench Prototype Update - Demodulator

- Demodulator to be built off several evaluation boards; including ARM Cortex 4 development board shown to right (TI TM4C123).
- Once signal was digitally sampled, remaining signal processing handled in code.
- Demodulator Functions Realized:
  - ADC Sampling of a 455 kHz carrier with …
  - Direct digital down conversion to 25 kHz.
  - Digital generation of a 25 kHz LO.
  - Initial development of carrier phase lock.
- Task put on hold before demodulator could be completed.
Two-Way Project Status

- Two-Way bench prototype put on hold due to budget and priority concerns.
- Unexpected DCS Management change and focus on GOES-16 has delayed resuming project.
- NOAA has requested and recently been provided proposal to complete task for consideration.
- If authorized in the near future, goals will be …
  - To complete demodulator by end of 2017.
  - To begin end-to-end bench testing in early 2018.
  - To provide BER results with channel noise (AWGN) and simulated LMR interference by March 2018.