DCPR CDMA Overlay

Application Development

April 14, 2005

DCPR Feasibility Study

- Objective is to determine the possibility of operating DCPRS in a CDMA mode
- Without degrading current TDMA / FDMA operation. (with properly operating DCPRS)
- Limit Noise Floor Rise
- Perform tests using actual signals via GOES E or W
  - HDR/CDMA Transmitters
  - CDMA 511 Spread Receiver
- Recommend follow on project

CDMA Elements 1

- Spectral coverage in this case is by direct modulation.
- Modulation is 0-180 BPSK
- Modulation rate is the spreading ratio X the data rate
- The occupied spectra must be within the DCS pass band (401.7 to 402.1)

CDMA Elements 2

- Chip rate is data rate X the spreading
  - For example 150 sps X 2047 = 307050 chips per second

- Code length is not necessarily limited to the spread ratio. Usually related by an integer.

- Occupied bandwidth will depend on the data filtering. In the example if alpha of 0.3 is used the BW is 399KHz.

CDMA Elements 3

- The spreading ratio
  - Spreads the Transmitter power on the up link
  - Spreads the narrow band "jammers" on the receive processing

- Either the spreading ratio or relevant bandwidth issues may be used to compute the Transmitter spectral spread or receive "jammer" spread.

CDMA Elements 4

- Mutual Code Channel for Asynch Operation is $(3N/(M-1))^A 1/2$

    - All Transmitters are received at equal power

    - All Transmitters are operating independently

DCPI CDMA Component

- Determine the feasibility of using CDMA

- Evaluate using link budgets, NTIA requirement, and as a secondary user subject to interference, AKA jammers.

DCPR Designed Elements

- 511 Spread CDMA receiver / Correlator

- Combined CDMA / HDR Transmitter

- Methods of analyses, tests, and integration

DCPR Tests

- Simulations (MatLab, Simulink, MathCad)

- Lab Tests with Test Gen and CDMA Transmitter

- Over air Tests at Wallops and with uCom DRGS

DCPR Analyses

Literature (IEEE, Texts, Vendors)

Extensive Link Budget measured & theoretical

Over Air Test Results

Wallops DAMS-NT Data

Comparison of theoretical and actual test results

DCPR Conclusions

- Three CDMA message noise sources

    - Thermal at 53 dBm /400 KHz equivalent

    - FT (FDMA - TDMA) transmitters at 63 dBm equivalent

    - Mutual CDMA at -20 dB from a single CDMA Transmitter

- Practical CDMA system at 44 dBm EIRP, 2047 spread, with no FT noise cancellation, 10 channels CDMA and 40 simultaneous FT operation with growth to F/T additional channels.

- With F/T Noise Cancellation system may be 38-41 dBm EIRP and 25+ channels per satellite

- FT equivalent thermal noise floor is moved above from 53 dBm to 55 , dBm. F/T Transmitter performance with EIRPs of >40 dBm are unaffected.

    Additional F/T channels would also increase the Noise Floor

DCPR Application Elements

- Practical CDMA Overlay design and implementation

- DAPS Compatible CDMA RX (2)

- Field Compatible DCPRX (30)

- Operational Management

- Draft DCPRS-CDMA Certification Standard

DCPR AP Tech Issues

- **Real Time Correlator processing**

- **Code selection and analyses**

- **Real Time Post Correlator de-spreading and tracking**

- **Real Time Message processing**
  - **Initial Synchronization**
  - **Tracking**

- **DAMS-NT / DAPS Interface**

- **F/T "Jammer" preprocessing**
  - **Hardware / Software hooks**
  - **Analytical scheme**

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CDMA DCPR Op Issues 1

- Basic System Definitions
  - Data Rate
  - Message Size

- DCPRS Objectives

- User / Site Assignments
  - Spread Code (aka CDMA Channel) -ID
  - Transmitter interval and control

CDMA OP Issues 2

- **Comparison to RR channel**
  - Does not require 3 Transmitters to assure message completion
  - Lower EIRP

- **Comparison to ST Channel**
  - Lower Date Rate
  - Lower EIRP by %
  - Currently the CDMA message would have higher bit efficiency. This may be improved.
  - Messages may be overlapped

DCPR CDMA Monitoring

- CDMA Channel Use Monitoring

- SNR monitoring of the pilot (need some back ground data)

- Message data monitoring

USER CDMA OP Issues

- **Lower System cost**
  - No need for GPS
  - Low Power, peak and average
  - Lower frequency control and phase stability specifications

- **Easier to use**
  - Fixed message formats
  - Limited operating regimens
  - Limited to short messages (<4 seconds)

- **Higher message reliability**
  - Simpler remote electronics
  - Lower Power
  - Less susceptibility to interference