Background

- Cospas-Sarsat (C/S) has defined operational requirements based on use of a second generation of beacons
  - Operational Requirements for Cospas-Sarsat Second Generation 406 MHz Beacons, C/S G.008
  - Second Generation Beacon Implementation Plan (BIP), C/S R.017
Operational Requirements from G.008

- Compatible with Cospas-Sarsat System
- Minimum Requirements
  - Independent location accuracy
  - First burst transmission timeliness [3] seconds
  - Increased performance in first 30 seconds
  - Cancellation function
  - Verification of Beacon Registration
- Objective Requirements
  - Better encoded location
    - 30 m, 95% of the time within 5 minutes of activation
  - Return Link Service (RLS)
  - Additional data encoded in beacon message
  - Automatic ELT activation on indication of emergency
Timeline (contained in BIP)

- According to C/S Operational Requirements, C/S G.008
  - LEOSAR SARP processing constraints limit the possible evolution of first generation beacon specifications
  - 2nd gen beacons **after** MEOSAR FOC **not required** to be LEOSAR SARP interoperable
  - 2nd gen beacons **prior** to MEOSAR FOC **required** to be LEOSAR SARP interoperable
  - MEOSAR D&E not dependent on availability of 2nd gen beacons

- BIP timeline created at C/S EWG-2 in September 2010
  - At the time, MEOSAR FOC was scheduled for January 2015.  
    (ref. C/S R.012, MEOSAR Implementation Plan, Issue 1, Rev 5, Annex I)
  - BIP timeline derived to insure 2nd generation beacons approved by first C/S Open Council after MEOSAR FOC, October 2015
  - C/S Council meeting in October 2010 moved MEOSAR FOC to 2018  
    (ref. C/S R.012, MEOSAR Implementation Plan, Issue 1, Rev 6, Annex I)
  - BIP timeline not adjusted accordingly, creating 2 year gap
U.S. and French Goals

- Improve system performance to meet or exceed C/S requirements
  - including detection probability, location accuracy and system capacity
- Modernize beacon signal for MEOSAR system
- Relax beacon requirements to reduce cost and complexity
- Collaborate with manufacturers to obtain the most competitive end product

*Fully realize ability of Cospas-Sarsat to provide the gold standard of emergency distress location*
Beacon Model: Functional

**Beacon Transmitter**
- **Data Message**
- **Add Error Correction Code (ECC)**
- **Apply CDMA Code (Spread)**
- **Modulate onto carrier frequency**

**Beacon Receiver**
- **Downconvert Digitize**
- **De-Spread**
- **Demodulate Decode DF**

**GPS Receiver**
- **Encoded Location**

**L band Nav signals (CDMA)**

406 MHz

1544.9 MHz

**Data Message**
**Add Error Correction Code (ECC)**
**Modulate onto carrier frequency**

**L band Nav signal (CDMA)**

**Message**
- **ECC**
- **Symbols**
  - 400 Hz
  - 85 KHz
Beacon Model: Physical

- GNSS Receiver
- Data Processor
- Dual DAC
- Quadrature Modulator
- Variable Attenuator
- Power Amp
- To Antenna

Connections:
- Digital Samples
- Clock
- Analog Baseband
- I
- Q
- Low Power RF
- 406.05 MHz
- TCXO
- LO
Message Format

- Simple and efficient
  - Single message structure with multiple protocols
  - Investigating use of a modified Type Approval Certification (TAC) data base to provide some required data that is currently carried in the message
  - Use of various schemes to encode some alpha-numeric data fields
  - Message length to meet requirements with some margin
  - Protected with a single BCH Forward Error Correction code to exceed Bit Error Rate requirement with minimal cost to beacon
RF Modulation

- Offset Quadrature Phase Shift Keying (OQPSK)
  - Industry standard
  - Many commercially available chip sets available
  - Relaxes requirements on amplifier
  - Increases system performance and efficiency of data transmission
Direct Sequence Spread Spectrum
Code Division Multiple Access

- Industry standard basis for major performance improvements in detection, location and capacity

- Easy to implement – code applied to digital data in software

- Relaxes beacon requirements
  - Oscillator frequency stability of 5-10 ppmillion – orders of magnitude improvement over current 1-2 ppbillion
  - All beacons transmit at same center frequency
    - never have to change oscillator
    - different codes applied in software.
Local Detection and Homing Signal

- 406 MHz signal designed for local detection and homing
  - Replace 121.5 MHz homing signal – simpler, single frequency beacon design
  - Collaborating with DF equipment manufacturers on signal design
  - Purpose built design will improve performance over current systems
  - Software configurable so beacon utilizes existing 406 MHz transmit chain
Contact Information

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