PETERSON INTEGRATED GEOPOSITIONING

Multiplexing GPS & eLoran on single RF cable for retrofit installations

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17 October 2007
Effort Supported by FAA Loran Evaluation Program
Mitch Narins, Program Manager

Background

- Ongoing Minimum Operational Performance Specifications (MOPS) effort since 2006 (Kevin Bridges, Tom Gunther, Sherman Lo, Tommie Lee (formerly BAH) & I)
- Intended eventually to support all modes but used aviation as model

Recommending Separate MOPS for Antennas
(at least for avionics)

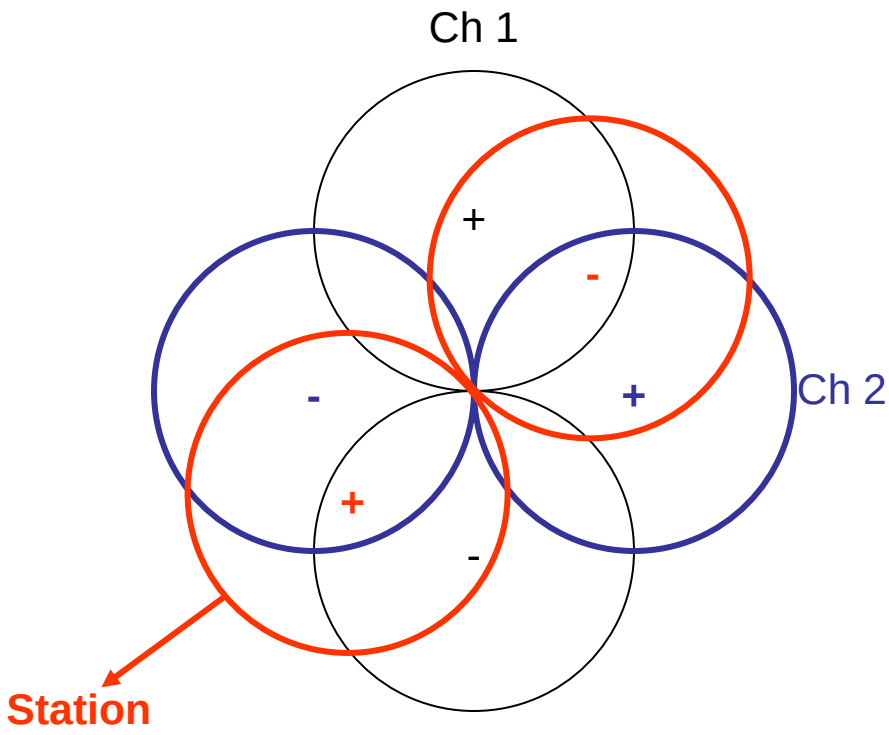
- Avionics Engineering Center @ Ohio U. (Dave Diggle & Chris Bartone) leading effort
- Engage smaller companies w/expertise in antennas or DSP but not both
- Allows “standard” antenna compatible with any receiver
- Receiver manufacturers don’t have to re-certify equipment if they change antennas
- Similar structure to WAAS MOPS
- Simplifies requirements and testing
- Enables same sensor for both new and retrofit installations
- Does not preclude company making sensor/antenna system that only works as complete unit
- Current assumption is that antenna will provide two analog signals to receiver

Multiplexing GPS and H Field Loran on Single RF Cable

- Single coax between antenna and sensor
  - The goal is to put GPS and two channel eLoran H-field signals (or data) on a single cable (significant retro-fit cost savings)
  - Is the performance degradation due to combining H-field signals in quadrature (3dB) too large to overcome?
  - Is there some innovative method? (modulation/demodulation)
  - Not intended to support use of legacy E field receivers with H field antennas, (why would we do this?)
- This presentation intended to
  - Stimulate thinking, not to present a solution
  - Discourage some possible approaches

E field vs H field antennas

- For aviation, H field antennas much more immune to precipitation static
- We realize 3 dB of processing gain by using linear combination of the two loops



H field antenna pattern

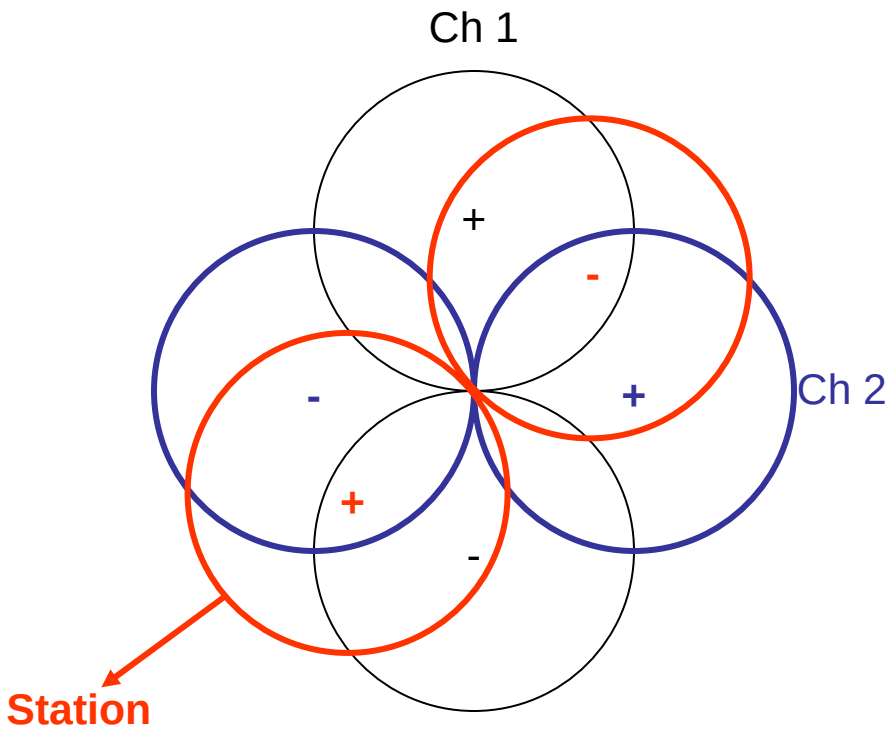
Add loops in quadrature?

(shift one channel 90 deg)

- Omni-directional magnitude response
- Lose 3dB of processing gain
  - same comments as with 10th pulse apply, we can say performance is degraded but not whether it is unacceptable
- Loran envelope stays at same point in time
- Shift in zero crossing is the angle of arrival of the signal relative to the (x 10 usec/2π)
- Shift in ECD is equal and opposite to shift in phase
- To process signals we need heading reference input
  - 1 degree heading reference error does result in 10 usec/360 = 28 ns TOA & ECD error but these are common and only affect cycle integrity & not position
- Can we simply connect such a signal to a legacy E field receiver?
  - Yes, if we modify receiver software to account for TOA and ECD shifts noted above (but why, cost of mod & recertification for minimal capability)

Beam steering via analog switching at the antenna

- **Requires**
  - **Heading reference**
  - **Timing signals from receiver back to antenna**
- **Successfully done by Megapulse in support of the DARPA Urban canyon effort in 1994**
  - **Switches were tri-state (+1, -1, 0) resulting in steering pattern in increments of 45 degrees**
  - **Timing signal was GRI strobe, nominal TD's for NYC were hard coded**
- **Limited mainly to single chain receiver**
  - **Multi-chain operation via time multiplexing chains for would be complicated & result in considerable loss in processing gain**
- **Might work with legacy receiver**
  - **Would likely require significant mods & recertification**



H field antenna pattern

Analog Modulation/Demodulation

- Preserves advantages of 2 analog RF channels
- Potential for interference with other systems
- Maintaining sufficient dynamic range??

Digital Data on top of GPS RF

- Violates intent to provide 2 analog channels & implies antenna/receiver produced by same company & will only function as complete system
- Outputs of A/D converters
  - High data rate implies more potential for interference
- Co-locate Loran sensor with antenna
  - Lower data rate

Conclusions

- Not recommended (at least by me)
  - Use of legacy E field receivers,
  - Adding loops in quadrature
  - Analog switching
- Important and interesting problem looking for some good ideas

Acknowledgements/Contact Info/Disclaimer

Supported by Federal Aviation Administration (Mitch Narins)

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-Note-

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