PETERSON INTEGRATED GEOPOSITIONING

Loran Data Channel

Progress to Date and Future Plans

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Effort Supported by FAA Loran Evaluation Program
Mitch Narins, Program Manager

March 2004 LORIPP Report Conclusions

- "*The evaluation shows that the modernized Loran system can satisfy the current NPA, HEA, and timing/frequency requirements in the conterminous United States and could be used to mitigate the operational effects of a disruption in GPS services, thereby allowing the users to retain the benefits they derive from their use of GPS.*"

Loran Data Channel (LDC) Transmits Information to enhance the LORAN Signal

- Absolute time & Station Identification
- Differential Loran
- Almanacs
- Early skywave warning
- Others (TBD, for example: geo-encryption, encrypted government use only)

Current Loran Data Channel Information

- NAVCEN posts current status on their web site (www.navcen.uscg.gov).
- "Loran Data Channel Communications using 9th Pulse Modulation" contains the signal specifications.
- An Almanac document will contain the information that is broadcasted.
- Daily transmitted data files will be available from LSU:
  - See Kevin Shmihluk for details.

Example Almanac Document

Last Revised: 20 Oct 06

Subtype (0-LORSTA 1-REFSAT): 0
LORSTA ID Seneca(GRI,Sta): 8970, X
RefSta ID1 (FAA Tech Center): 8
RefSta ID2 (CGA): 5
Status(0-off,1-legacy,2-LDCtest,3-LDC): 2
Control(0-SAM,1-TOT): 1

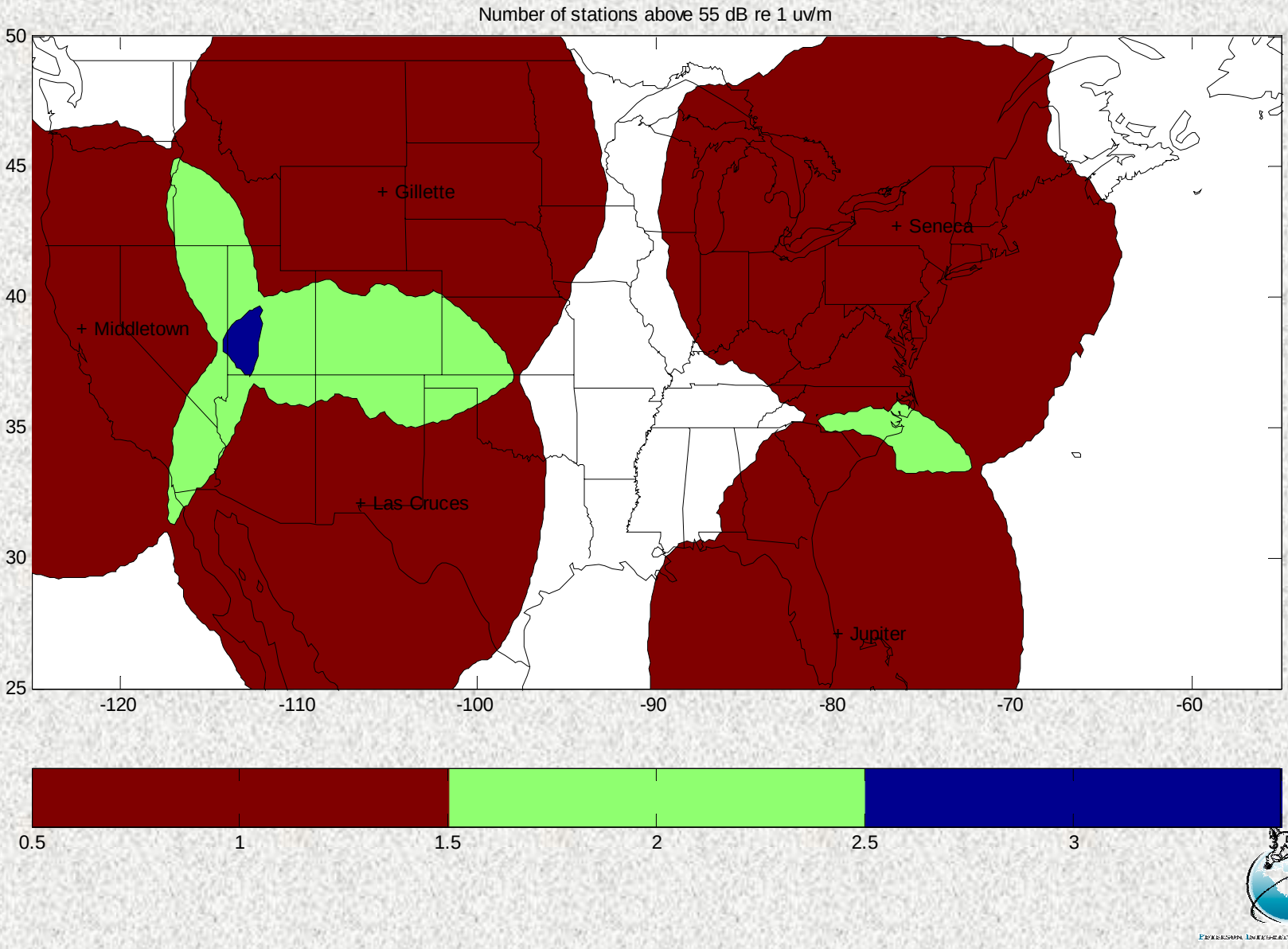
Subtype (0-LORSTA 1-REFSAT): 0
LORSTA ID Seneca(GRI,Sta): 8970, X
RefSta ID1 (Volpe): 1
RefSta ID2 (URI): 6
Status(0-off,1-legacy,2-LDCtest,3-LDC): 2
Control(0-SAM,1-TOT): 1

Subtype (0-LORSTA 1-REFSAT): 1
RefSta ID(USNO): 3
Lat(degrees): 38.92038
Lon(degrees): -77.06632
Sig1 ID (GRI,Sta), Offset (usec): 9960, M, 3100
Sig2 ID (GRI,Sta), Offset (usec): 9960, W, 5400
Sig3 ID (GRI,Sta), Offset (usec): 9960, X, 1500
Sig4 ID (GRI,Sta), Offset (usec): 9960, Y, 3100
Sig5 ID (GRI,Sta), Offset (usec): 9960, Z, 5300
Sig6 ID (GRI,Sta), Offset (usec): 7980, M, 5800
Sig7 ID (GRI,Sta), Offset (usec): 7980, Y, 2500
Sig8 ID (GRI,Sta), Offset (usec): 7980, Z, 2900
Sig9 ID (GRI,Sta), Offset (usec): 5930, X, 1500
Sig10 ID (GRI,Sta), Offset (usec): 8970, M, 4000
Sig11 ID (GRI,Sta), Offset (usec): 8970, W, 6400
Sig12 ID (GRI,Sta), Offset (usec): 8970, X, 3100

Status of Loran Stations Transmitting Loran Data Channel Data

- Since Oct 2005, Jupiter on air with time messages only
- Oct/Nov 2005, Las Cruces on air with time messages to support testing during JAMFEST at White Sands Missile Range, now on air permanently
- Dec 2005, Seneca on air with time messages differential corrections from monitor at USNO
  - Test of leap second transition on 1/1/2006 successful in both modulator & user receiver
  - Sept 2006 transmitted corrections from USCGA, Volpe, URI, FAA Tech Center.
- Gillette came on air with time messages on Oct 2006
- In cooperation with Stanford, Middletown came on air with time and authentication messages on Oct 2006.

Loran Data Channel Coverage as of Oct 06



LDC Modulation & Coding Scheme

- 9th pulse Pulse Position Modulation (PPM)
- 32 state PPM, 5 bits/GRI
  - 3 bits phase, 2 bits envelope & phase
- Message length is 24 GRI or max of 2.38 seconds
  - 9 words/45 bits data
  - 15 words/75 bits Reed Solomon parity
    - Corrects up to 7 word errors
- Coset Vector added before transmission
- Averages to zero in legacy receivers, CRI increases 0.5dB
- PPM vice IFM means no transmitter modifications, modulation done in software in TFE
- 9th pulse in cross rate would be blanked, other 8 will be cancelled

Symbol Delays

i = [0,7]			*i* = [8,15]			*i* = [16,23]			*i* = [24,31]	
0	0.0		**8**	50.6		**16**	101.2		**24**	151.8
1	1.2		**9**	51.8		**17**	102.6		**25**	153.2
2	2.6		**10**	53.2		**18**	103.8		**26**	154.4
3	3.8		**11**	54.4		**19**	105.0		**27**	155.6
4	5.0		**12**	55.6		**20**	106.2		**28**	156.8
5	6.2		**13**	56.8		**21**	107.6		**29**	158.2
6	7.6		**14**	58.2		**22**	108.8		**30**	159.4
7	8.8		**15**	59.4		**23**	110.0		**31**	160.6

Table 1: Symbol Delays from Zero-symbol Offset (μs)