Eurofix Implementation in Saudi Arabia





Eurofix System Overview





Why Eurofix ?

- Cost-effective and very reliable means to broadcast data
- Integrity messages and differential corrections available in regions where other augmentation signals might not be (urban environment, mountainous areas, forests and polar regions)
- No new infrastructure required
- Large coverage area (1,000 km)
- Calibrated Loran-C when GNSS fails (urban and mountainous environment)
- Increased availability and continuity of navigation system



Integration strategy

- Use DGPS while available
 - Use Eurofix correction and integrity data
- Use accurate DGPS position to calibrate Loran-C ranges (ASF)

In case GPS (partly) fails

 Continue navigation using Loran-C and if possible available GPS measurements



Eurofix Datalink summary

- Additional Data channel by 3-level 1 μs pulse position modulation
 (1 μs advance, prompt or 1 μs delay)
- 6 pulses modulated, balanced per GRI results in 7bit symbols
- Forward Error correction: Reed-Solomon (Same as in Compact Disc)
- Effective data rate ± 35 bits per second



History of Eurofix installations

- 1997 February:
 - DGPS Reference Station in Sylt (Germany)
- 1998 March:
 - DGPS Reference Station & Datalink Monitor Wildwood (USA)
- 1999 April:
 - DGPS and DGIonass Reference Station Chayka transmitter Bryansk
- 2000 July:
 - DGPS Reference Station 4 NELS transmitters, Lessay, Sylt, Bø & Værlandet
- 2001 January:
 - DGPS Integrity Monitor & Datalink Integrity Monitor 4 NELS transmitters, Lessay, Sylt, Bø & Værlandet
- 2001 September:
 - DGPS Receiver & modified Reference Station Korean Pohang

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Eurofix Installation





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- Reference station
 - Industrial PC
 - Novatel GPS Rx
 - Connection to Loran Timer
 - Modem for remote monitoring/maintenance
- Integrity Monitor
 - Industrial PC
 - Novatel GPS Rx
 - Eurofix datalink monitor RX
 - Integrity feedback to Reference Station





DGPS correction and integrity service on Saudi Positioning Service

- Contract to Megapulse (USA) and Reelektronika (NL)
- Local Area Differential corrections for GPS
- On-site Integrity monitoring on 3 levels:
 - GPS pseudorange correction level
 - DGPS positioning level
 - Loran message transmission level
- Installation and signal broadcast by the end of 2004



Predicted coverage area of DGPS service at three Saudi-Arabian Loran-C stations





Eurofix DGPS performance

(Measured in Delft with corrections from Sylt @ 400 km)



Accuracies better than 2.5 meter expected throughout the coverage area

Description 33rd Annual Convention and Technical Symposium

Eurofix Site Equipment



RS/IM Functional Block Diagram



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Eurofix Local System Controller



Association

Eurofix Local System Controller







Loran Timer Modification Kit





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Saudi Timer Modifications





International



- Timer modification kit designed to be field installed.
- Six (6) spare Saudi timers sent to Megapulse to mitigate risk
 - Significant additional repair required
 - Power supplies
 - Trigger Format Board
 - LPA Board



Eurofix Reference Station



Eurofix Reference Station (cont'd)





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Eurofix Reference Station (cont'd)



Novatel GPS Receiver, OEM4-G2-3151R

- 12 channel, single frequency
- provides raw data output
 - Compatible with existing implementation
 - Minimized porting/development effort



Eurofix Digital Signal Processor, 32-10959-101

- Custom manufactured by Megapulse
- TI TMS320C6713DGP, 225 MHz, floating point DSP
- 2/4/8 Meg Flash (Boot/Program) with paging
- 8/16 Meg SDRAM
- SC28L198 8-channel UART
 - Housekeeping performed internally
 - Minimizes processor overhead
- MAX3160 Multi-protocol Transceivers
 Configurable for RS232 or RS422 operation



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Eurofix Integrity Monitor



Eurofix Integrity Monitor (cont'd)





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Eurofix Integrity Monitor (cont'd)

Eurofix Datalink Receiver, reelektronika



Eurofix Digital Signal Processor, 32-10959-101

> Novatel GPS Receiver, OEM4-G2-3151R





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Eurofix Integrity Monitor (cont'd)



- Integrity Monitor uses Integrated eLoran/GPS receiver
 - Developed by Reelektronika
 - Motherboard / A/D board
 - DSP daughter board

Size:

11 x 8.5 x 3 cm

Original Eurofix ERX104-D1 Datalink Receiver used at Sylt





Antennas



Eurofix Monitor Loop Antenna

- Custom Megapulse design
- Passive architecture
- In use at Sylt

Novatel GPS-701 Antenna

- GPS L1 (1575.42 Mhz) only
- Pinwheel aperature coupled slot array technology
- Reduced errors from electromagnetic interference and multipath
- Performance similar to a "choke ring" antenna



User Interface



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User Interface (cont'd)

Operational

- Main Screen
- Send RSIM
- Position Error
- Satellite Residuals
- Datalink Status
- DGPS Corrections
- Send SMS
- Raw RSIM

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- both RS and IM

Configuration

- Control Station Config
 - (Comm Port, Log Closeout interval, etc)
- Configure Station
 - (Actual RS or IM parameters)
- Startup RSIM for RS and IM
- Log Displays for RS, IM, and CS.
- Log Setup for RS and IM
 (RSIM #1 requests)
- Version Display.



Manual RSIM Generation

🛃 Send RSIM				
RSIM #1 RSIM #3 RSIM	#6 RSIM8	RSIM #11	RSIM #16	RSIM #32
	Threshold	Observatio	n Interval	
Number of Satellites	토 클	p	÷	
HDOP		ρ	÷	
Horizontal Position		0	÷	
PR Residual	1	30	-	
RR Residual	0.05	30	-	
Low UDRE		p	÷	
Correction Age		þ	÷	
Load Curr	ent Cle	ar S	Send	
				Close

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Configuration Screen Example

Configure Station	
Reference Station Id Set	Set Health 1 🗧 🔽 Set
Reference Station Position	Reset Health
Height Set	Max PRC 10485.76 Set
Integrity Monitor Position Latitude Longitude Height Set	Max RRC 4.096 Set
	Min SNR 35.0 Set
Loran ID A B Set	Min Number of 5 📻 Set
Load Curre	nt Load Default Close



Log Display

<pre>/\Program Files\Eurofix\Control Station\CS Log\CS20041020-3.log</pre>	
<pre>0-0ct-2004 16:18:24 IN: \$PRCH,32,10,4567X,1,2.5,10,5678Y,1,2.5*2C 0-0ct-2004 16:18:24 local: Watchdog timer failed to initialize 0-0ct-2004 16:58:50 local: Version -1.0 of ControlStation 0-0ct-2004 16:59:50 local: RS Connection, COM1, open succeeded 0-0ct-2004 16:59:51 local: IH Connection, COM2, open succeeded 0-0ct-2004 16:59:51 local: Opening RS Startup RSIM c:\Program Files\Eurofix\Control Station\RSStartRSIM.txt 0-0ct-2004 16:59:51 RS: \$PRCH,1,5,1,1,,*0B 0-0ct-2004 16:59:51 RS: \$PRCH,1,5,2,1,,*0B 0-0ct-2004 16:59:51 RS: \$PRCH,1,5,2,1,,*0B 0-0ct-2004 16:59:51 RS: \$PRCH,1,5,2,1,,*0B 0-0ct-2004 16:59:51 RS: \$PRCH,1,5,2,1,,*0B 0-0ct-2004 16:59:51 RS: \$PRCH,1,7,2,1,,*09 0-0ct-2004 16:59:51 RS: \$PRCH,1,1,2,2,1,,*09 0-0ct-2004 16:59:51 RS: \$PRCH,1,1,2,2,1,,*0B 0-0ct-2004 16:59:51 RS: \$PRCH,1,1,2,2,1,,*0B 0-0ct-2004 16:59:51 RS: \$PRCH,1,1,2,1,0,0,5,*16 0-0ct-2004 16:59:51 RS: \$PRCH,1,1,2,1,1,,*3D 0-0ct-2004 16:59:51 IM: \$PRCH,1,2,1,1,,*08 0-0ct-2004 16:59:51 IM: \$PRCH,1,2,1,1,,*08 0-0ct-2004 16:59:51 IM: \$PRCH,1,2,1,1,,*08 0-0ct-2004 16:59:51 IM: \$PRCH,1,2,1,1,,*08 0-0ct-2004 16:59:51 IM: \$PRCH,1,2,1,1,,*05 0-0ct-2004 16:59:51 IM: \$PRCH,1,2,1,0,4567X,1,2,5,10,56787,1,2,5*2C 0-0ct-2004 16:59:51 local: Watchdog timer failed to initialize</pre>	



Site Surveys



Afif

Ashayk

Humayd



- Site Surveys conducted September, 2004 to determine:
 - Equipment and antenna placement
 - GPS Survey
 - Loop Antenna Measurements
 - Equipment readiness
 - Material
 - requirements

Riyadh Control Center









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Thanks



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