ESA & GJU Workshop – IfEN Receiver

- SW receiver, FPGA receiver, ASIC chips-sets
- IfEN covers all types of frequencies – L1 & L1/E5 & L1/E5ab/E6/L2

**NAVPort**
GPS/GALILEO L1 Wideband SW Rx

**GATE Monitor Rx**
GPS/Galileo 3-frequency Monitor Rx

**ARTUS**
GPS/Galileo 4-frequency Professional Rx

**INTrack**
GPS/Galileo L1/E5a ASIC Chip-set

Presented by Dr. Jon Winkel,
Head of Receiver Technology Department at IfEN
IfEN GmbH

- **General**
  - **IfEN GmbH** – Gesellschaft für Satelliten Navigation mbH.
  - Small & Medium-Sized Enterprise (SME).
  - Founded **1998**.

- **Address**
  - Alte Gruber Strasse 6
  - 85586 Poing / Germany

- **Further Details**
  - Internet: [www.ifen.com](http://www.ifen.com)
  - Tel.: +49-(0)8121-2238-10
  - Fax: +49-(0)8121-2238-11
IfEN GmbH – Business Activities

- Integrity Systems
- Navigation Applications
- Mobile Solutions
- Receiver Technology

IfEN GmbH – Business Activities
NAVPort

- USB Galileo/GPS L1 Front-End
- Bandwidth: 10 MHz
- Bit resolution: 1.5 bits
- Data Rate: 6MByte/s
- Prototyping finished
- Commercially Available Q2-Q3 2006
NAVPort RF-Front & SW Receiver-2

- Real-time S/W Receiver
- Windows XP
- High-Precision
  - High-Bandwidth
  - Configurable Correlation Technique (e.g. Double-Delta)
  - Carrier Phase and RINEX
- Advanced Multicorrelator techniques
  - Standard Correlator (ACF)
  - $\delta$-Correlator (similar to VisionTM Correlator)
  - 2-Dimensional Correlator (code-phase plus Doppler)
- Target markets:
  - Research and Development
  - Reference Receivers
  - Signal Quality Monitoring
  - High Precision Applications
- Availability:
  - GPS C/A code: Q4 2006
  - Galileo/GSTB L1 OS: Depending on ICD Availability
GATE Monitor Receiver

- Galileo/GPS L1, E6 and E5 (AltBOC)
- Bandwidths
  - L1: 41 MHz
  - E6: 41 MHz
  - E5: 72 MHz
- 60 Generic Channels, 20 Channels per Band
- AltBOC Requires two Channels Slaved Together
- End Prototyping: May 2006
- First Units Available for GATE: Q2/Q3 2006
- First Commercial Units: Q3 2006
- GATE is a German National Project funded by DLR

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<th>Sub-Carrier</th>
<th>Galileo Services</th>
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<td>OS Data</td>
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<td>BOC(1,1)</td>
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<tr>
<td>L1C</td>
<td>OS/CS/SoL Pilot</td>
<td>BOC(1,1)</td>
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Artus – Professional Receiver

System Architecture

- Main-board Daughter-board Concept
- One RF-PCB with RF-splitter and 4 RF-ASICs
- Planar Spiral Wide-band Antenna
- Frequency Bands (Galileo/GPS):
  - L1: 41 MHz
  - L2: 41 MHz
  - E6: 41 MHz
  - E5: 72 MHz
- 90 Generic Channels, freely allocable
- AltBOC Requires two Channels
- Project Mile-Stones:
  - PDR Mar. 2006
  - CDR Sept. 2006
  - QR Jun. 2007
- First Commercial Units: Q3 2007
- Call 2414, Area 1B: User Segment, Technological Development
INTrack Galileo/GPS Chip Set

- Frequency Bands (Galileo/GPS):
  - L1 GPS C/A, Galileo BOC(1,1): 6 MHz [TBC]
  - E5a/L5 GPS and Galileo BPSK(10): < 20 MHz [TBC]

- High Sensitivity Capability
  - Supports Real-time Coherent/Non-coherent Integration

- Kick-off: 02/2006
- 1. ASIC Q3/Q4 2007
- 2. ASIC Q1/Q2 2008

- Targeted Markets/Applications
  - Automotive/Mass market
  - Public Services (Police/Fire fighters…)

INTrack L1/E5a High-Sensitivity ASIC - 1
Development, Validation and Testing - 1

Basic Test Set-ups:

- Setup 1: Digital base-band Signals from General Purpose SG
- Setup 2: RF-Signals from General Purpose SG into Front-end board
- Setup 3: SIS, Merlin, GATE RF-Front-End Board
Test Levels:

Test Setup 1/2 (Coherent and Non-coherent Mono-channel Data-less Setups):
- Test Correlators, Code and Carrier NCOs
- Bit-sync/Frame Synchronization
- Functional Acquisition and Performance
- Functional Tracking (DLL/FLL/PLL)
- Coherence between Code and Carrier
- Code and Carrier phase jitter as a function of C/No

Test Setup 3: SIS, Merlin/GATE (Multi-channel/Multi Frequency)
- Data demodulation
- FEC and de-interleaving
- Data Decoding
- Positioning
- High-level Receiver Management (Channel Mngt., Intelligent use of non-volatile data for start-up, Commanding)
Critical Testing and Verification Issues

- Inter-Frequency Bias (Merlin)
  - Coherence between Code($f_a$)/Code($f_b$)
  - Coherence between Carrier($f_a$)/Carrier($f_b$)
  - Coherence between Code($f_a$)/Carrier($f_b$)

- RTK Processing
  - Generate a Base-line Scenario, i.e. Input Signal for two Receivers Performing Differential GNSS
The indoor Scenario

- Very Complicated Channel
- High-Sensitivity Performance Figure of Merit: Received Power-Level, e.g. -159dBm… What about the Noise-floor? C/No is the Relevant Parameter
- Multipath, Coherence time, Difference in received power-levels (cross-correlation peaks)

This is Indoor…

...and so is this…

...and this.