Software Receiver Development and Applications

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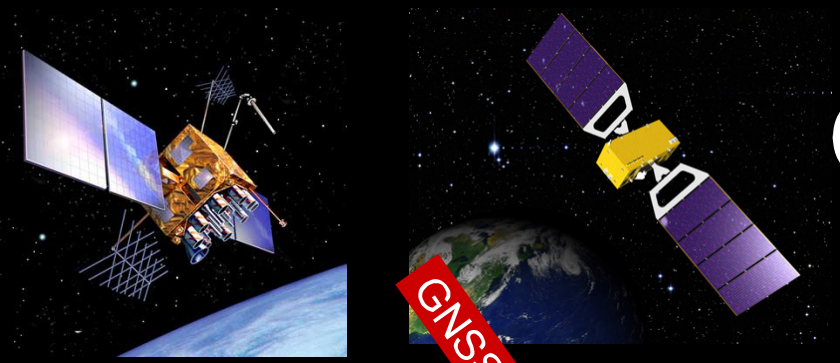
Nottingham Scientific Limited (NSL)

Our Business



GNSS services

1 System Performance

2 Signal/Service quality

System Integrator/ Service Provider

services

payment

Customer

3 User equipment

4 Back-office processes

NSL

“Socially, economically and security” critical..

Advisory

Pay-as-you-drive

Safety

Security

Justice

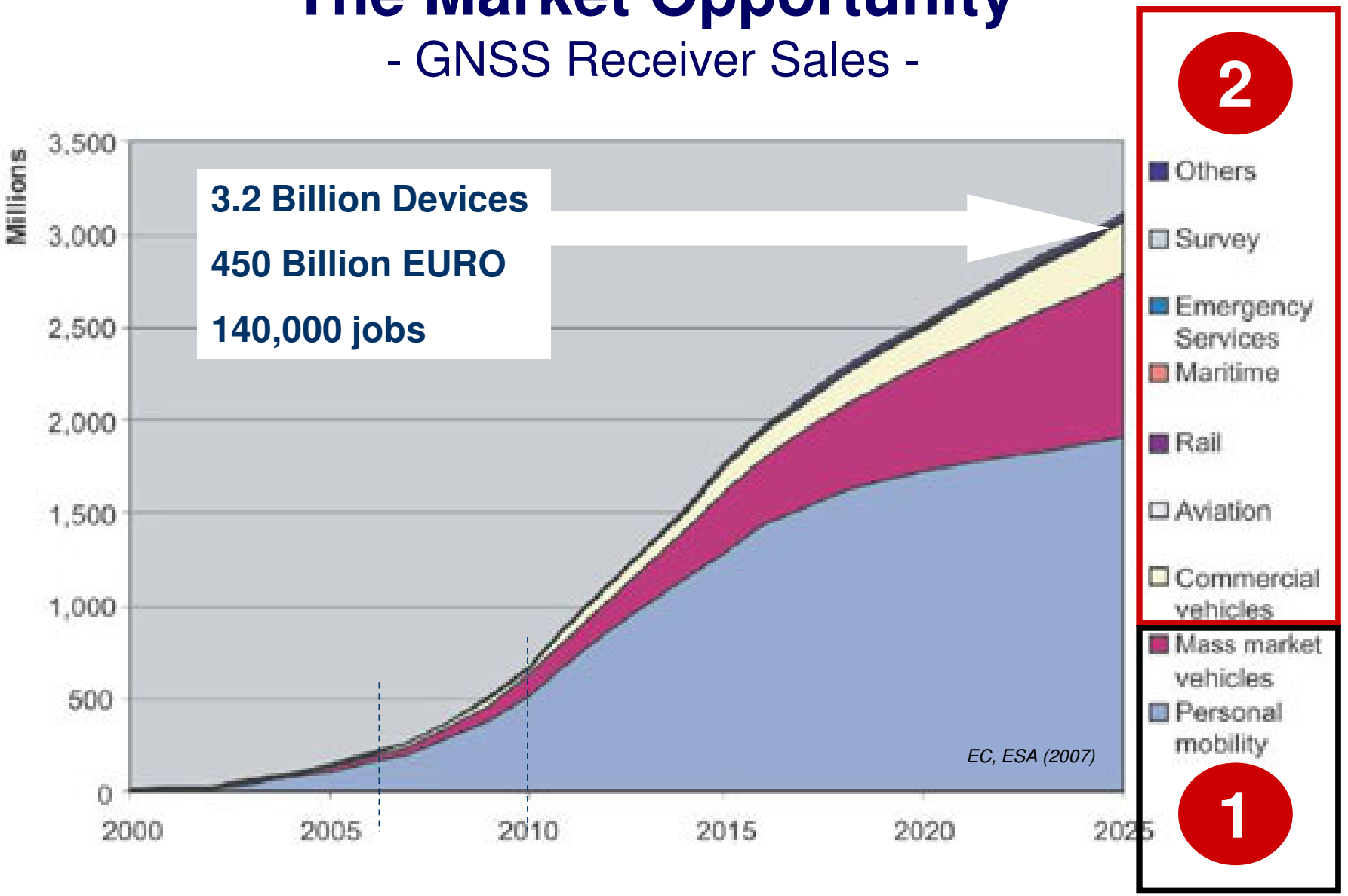
Policy Enforcement

Assisted Living

Congestion

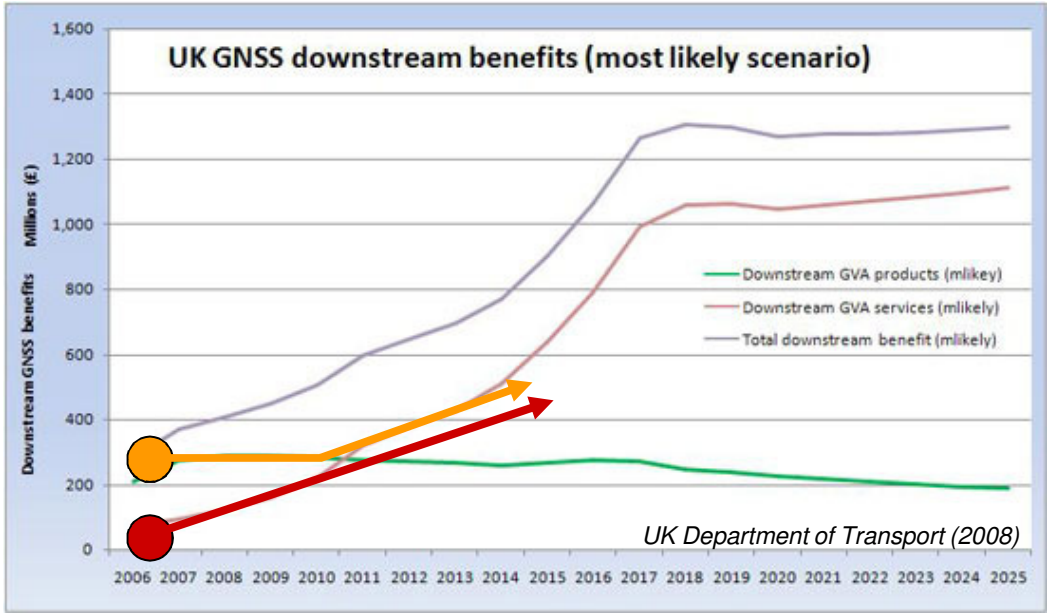
The Market Opportunity

- GNSS Receiver Sales -

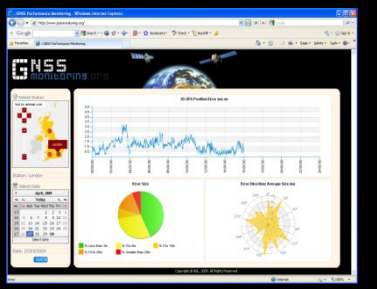


Our Motivation

- NSL enhance 3rd party hardware through software
- NSL detected a change in suppliers' business models

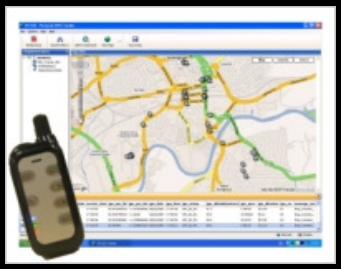


- NSL responded by developing their own receiver
  - EMDA Grant for R&D – software (2006)
  - EMDA Knowledge Transfer Partnership – hardware (2008)



Services

Onboard Systems



Applications

Software Receiver Development

- **Aim**: To develop a novel GNSS receiver capable of acquiring and processing ALL signals (any system, any service, any frequency)

- **Idea**: Using an innovative and disruptive approach (via software)
  - Create new Market Proposition (product differentiator)
  - Generate new Business Model (upgrade via software)
  - Maximise our chances of success (consumer & professional)

- Identified "Knowledge Transfer Partnership" as a good vehicle
  - Signal Processing **Software** → **Company**
  - Signal Acquisition **Hardware** → **University + Company**

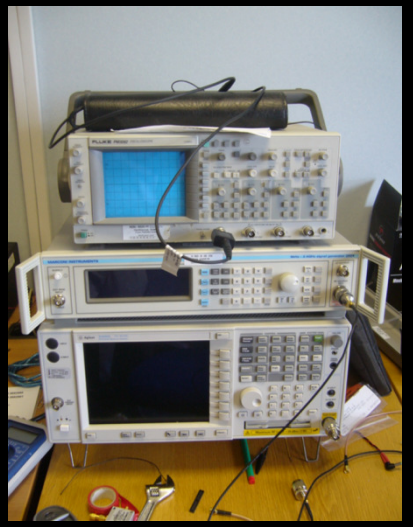
The University

- Not the obvious academic partner in GNSS!
- Experienced in delivering KTP projects with SMEs

- Understood that “project requirements change”
  - Offered a flexible, commercial approach
  - Dedicated commercial team
- Understood that industry’s “priorities will change”

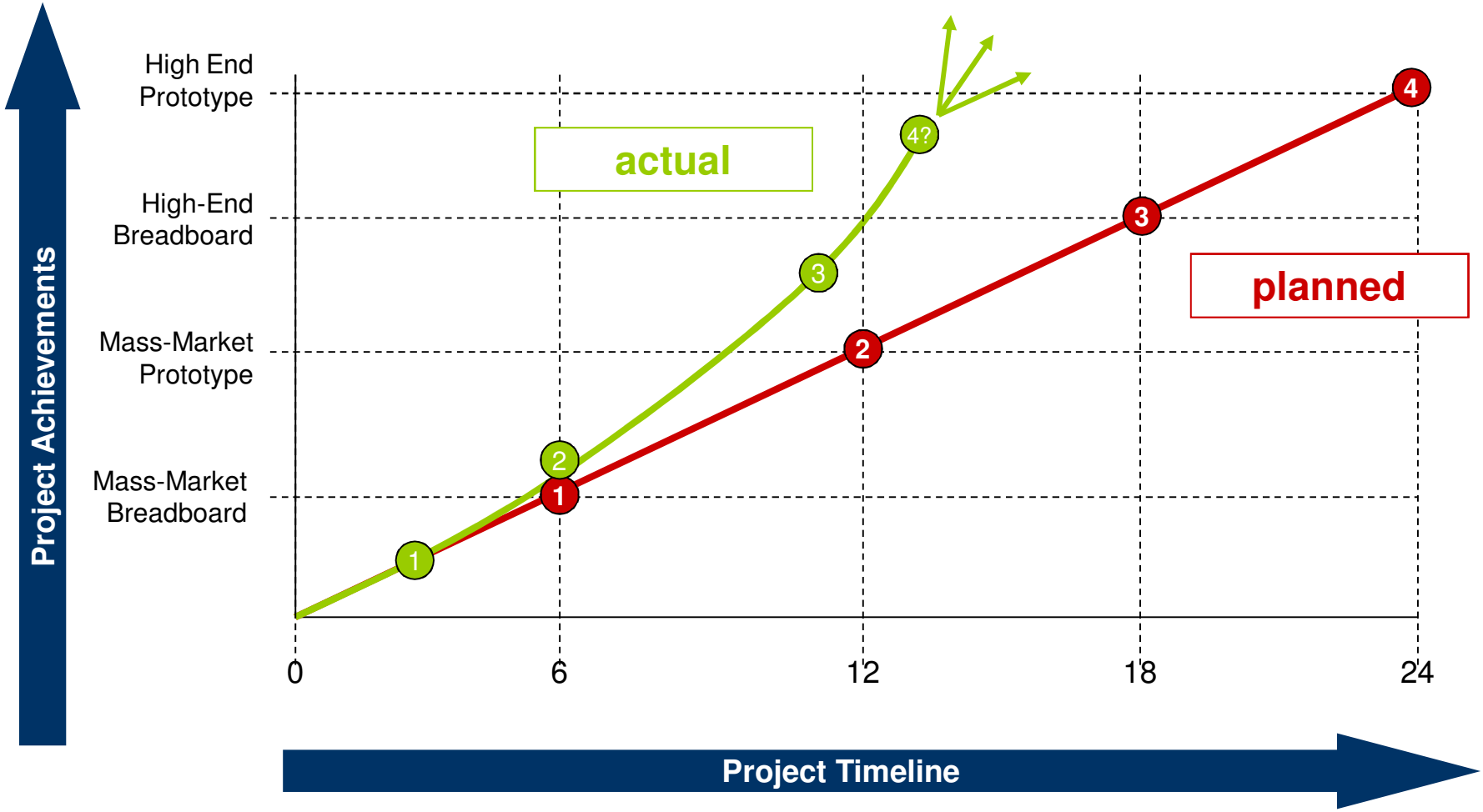
- Commercially orientated T&Cs
  - Ex-Industry personnel
- Professional attitude
  - “KTP is not a research grant!”

dmu.ac.uk
DE MONTFORT UNIVERSITY
LEICESTER



NSL

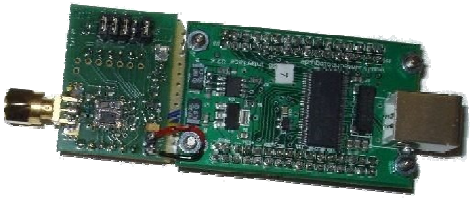
The Project Plan & Milestones



The Prototypes

Inputs

1

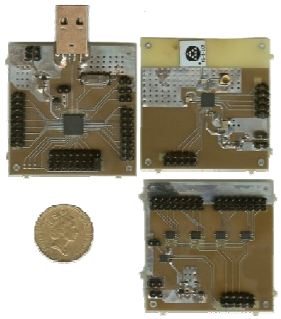


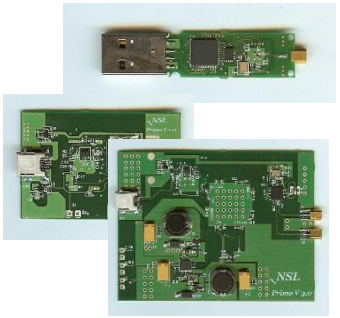
"Mass Market" PoC

2

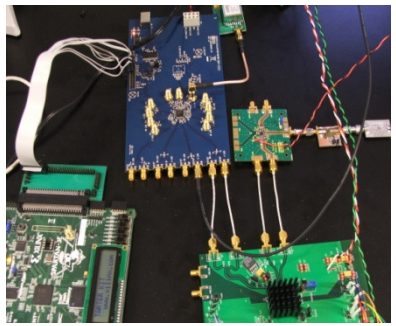
"Hi-End" PoC

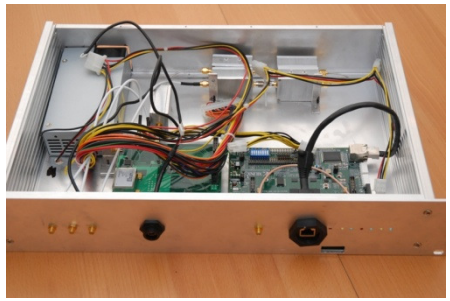
Outputs





Breadboard #1 | **Prototype #1**





Breadboard #2 | **Prototype #2**

The Innovations

- Multi-GNSS Software Receivers -

1

“Mass Market” focus

Multi-Constellation

Single Frequency

Consumer Applications, Telematics & SatNav

2

“Professional High-End” focus

Multi-Constellation

Multiple (ALL) Frequencies

Aerospace, Transport, Security Applications

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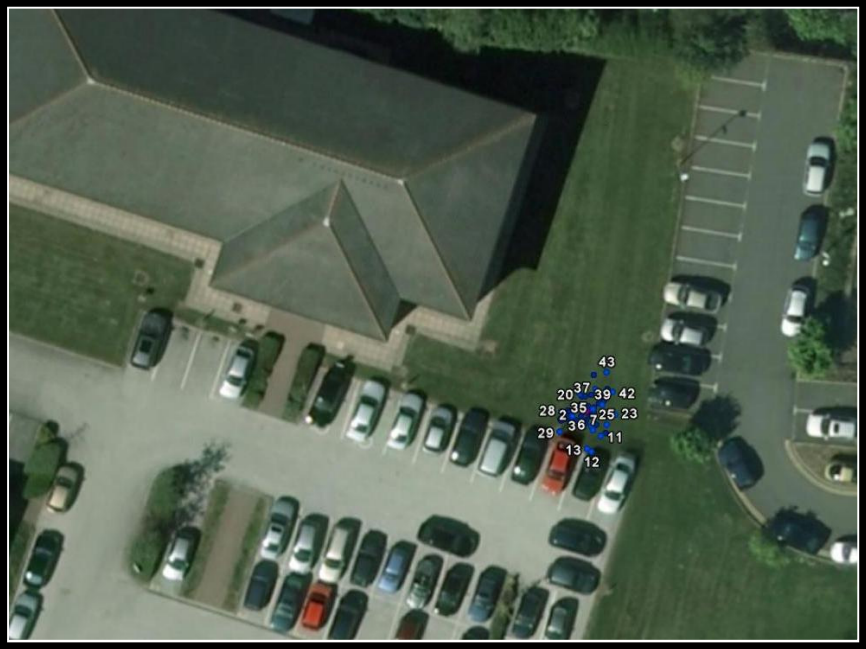
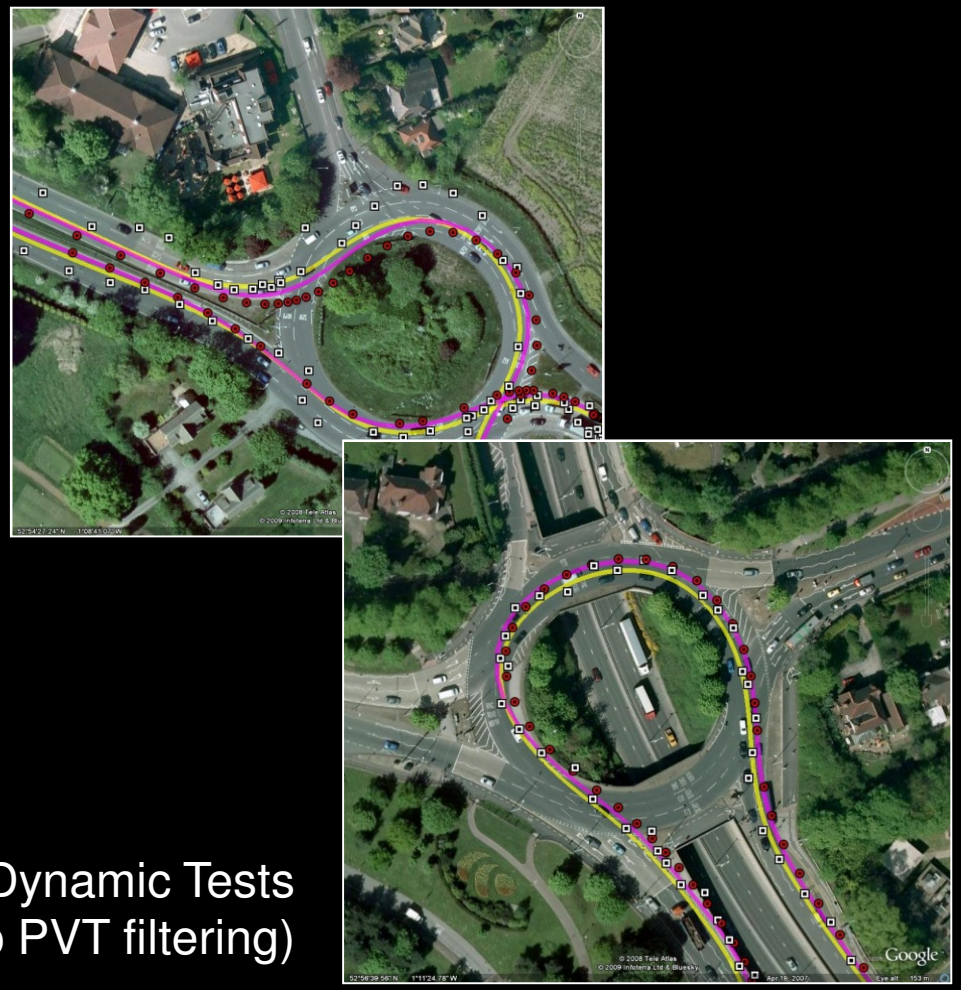
Early Indications

- Comparative Performances -



Static Tests (no filtering)



Dynamic Tests
(no PVT filtering)

Introducing “PRIMO”

Hardware RF Front End

```
File  Edit  View  Terminal  Tabs  Help
          PRIMO SW RECEIVER v1.1  - NSL (c)2008 all rights reserved -

CH TYPE  PRN STAT   DOPPLER   C/NO  DS  PSEUDORANGE          PHASE    EL     AZ
 1 GPS     3 NAV   +896.9     46.2  cc   20452106.7        +25901.9  61.4  279.5
 2 GPS     6 NAV   +110.2     47.0  60   20453534.9         +4113.5  76.2  279.1
 3 GPS     7 NAV   +106.2     41.0  c6   23510166.8         +4489.1  21.8  311.6
 4 GPS    16 NAV   -2785.9    47.2  e0   21126828.0        -73267.8  56.3  174.1
 5 GPS    18 NAV   +830.4     45.2  cf   22565181.0        +23399.0  36.9  104.6
 6 GPS    19 NAV   +2207.2    40.8  d6   22818661.1        +59402.0  29.3  274.7
 7 GPS    21 NAV   -2617.5    43.8  39   21708311.2        -68213.8  47.0   65.2
 8 GPS    22 NAV   +2466.4    42.8  2c   23373299.7        +65803.3  23.3  145.3
 9 GPS    24 NAV   -4274.3    38.3  bf   25412112.3       -111817.3   5.1   50.7
10 GPS    25 NAV   -1342.2    38.5  1f   23604992.7        -33928.4  24.7  291.0
11 GPS    26 NAV   +781.5     39.9  69   24788855.6        +22063.8   4.6   34.7
12 GPS    27 NAV   +504.3     38.6  ab   24458722.4        +14488.2  17.5  321.9
13 SBAS  120 SYN   -690.6      0.0  --             -            +0.0     -     -
14 GIOVE   1 SYN   -363.9      0.0  --             -            +0.0     -     -
15 GPS    15 NAV   +1136.6    34.4  77   25566807.5        +11701.3   2.9   49.6


LON:-1.164678          LAT:+52.934376          ALT:+70.5
X:+3.851756e+06        Y:-7.830726e+04         Z:+5.066202e+06
TIME:231190.4          CB:-6.9324e+05          FO:2.3105e+05

                                          CPU:  9.0%        TREC:   145.4

Press 'q' to quit
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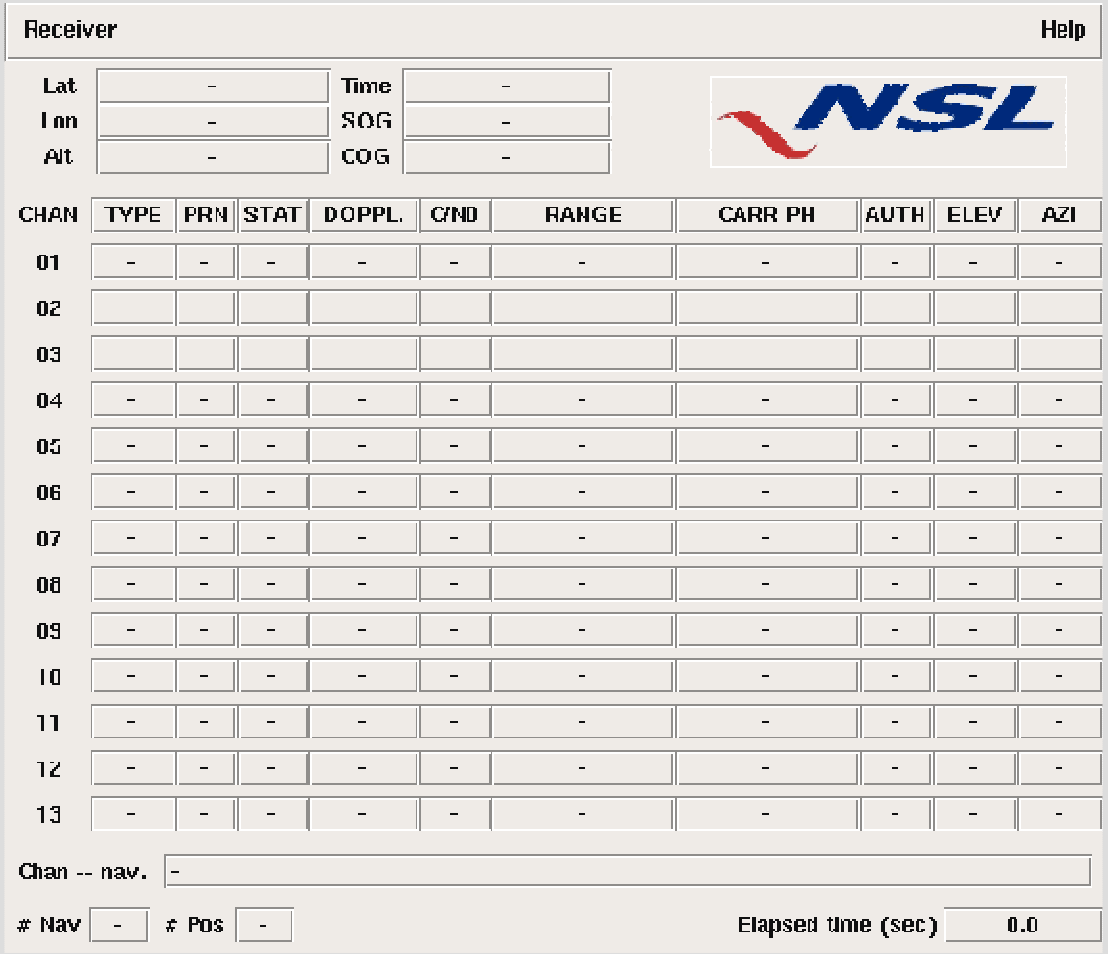
Software Processing Engine

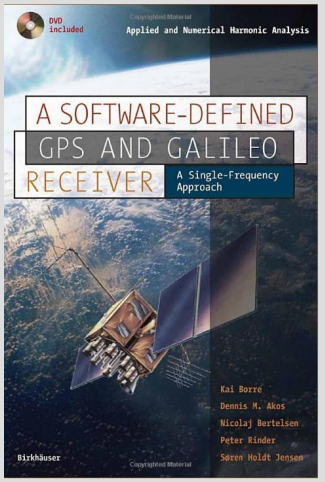
Software Engine

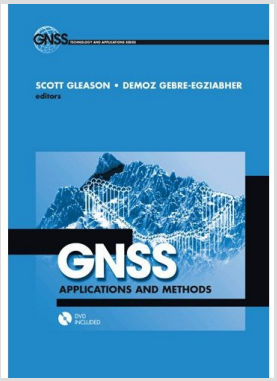
- Cold Start Acquisition and Tracking -



Software Receiver Applications

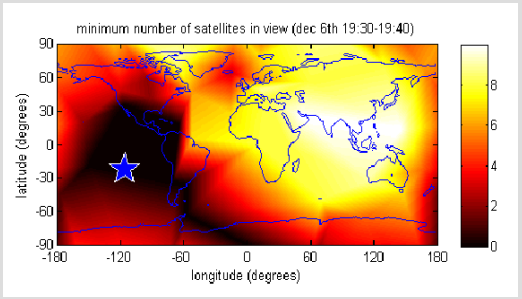
- Automotive Multi-constellation GNSS receiver
  - Requirements for future-proofing receiver functionality
- GNSS receiver testbed for multi-constellation processing algorithms
- Evaluating Galileo MBOC (versus BOC)
- Multi-constellation Software Receiver*
- Indoor positioning / E5 pseudolite receiver
- GNSS Simulator Validation Tool
- Embedded s/w receiver (OMAP platform)
- Teaching aid & Research tool
  - compatible with SDR book
  - compatible with open source s/w radio projects

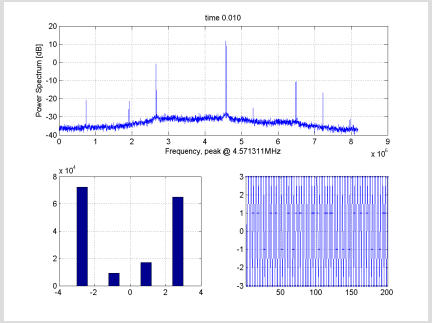


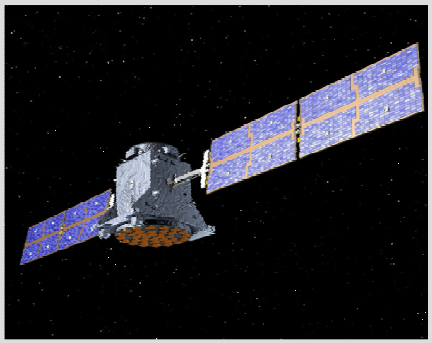


(Pending) Applications

- Direct sampling (and recording) of solar events, ionospheric scintillations (and replay)
- GNSS jammer detection and characterisation
- Bi-Static Radar applications
- “Deep-integration” with DR/inertial sensors
  - feedback loops
- GNSS Signal Anomaly diagnostics tool
- Payload verification tool?
- Prototyping Galileo Commercial services
  - High Accuracy Services
  - Authentication
- “Trusted Timing Receiver” (assurance & authentication)







thank you

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11/12 November 2009 - GRACE
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- Customisation
- Custom Builds
- Projects
- Partnerships
- IP

- Industry
- Government
- Users
- Regulators
- Standards
- Research