GNSS applications in Flight Test Instrumentation Systems

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eurocopter
an EADS Company

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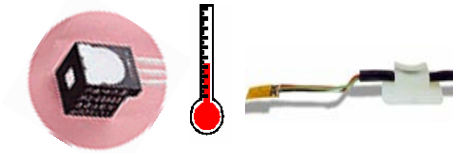
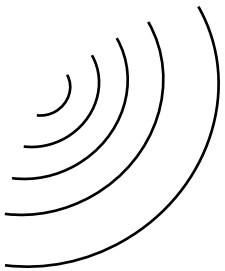
Flight Test and FT Instrumentation

Analogue parameters
Bus data
Video & Hot Mike





Onboard test data
and crash recording

Real-time visualisation in
FT Ground Station

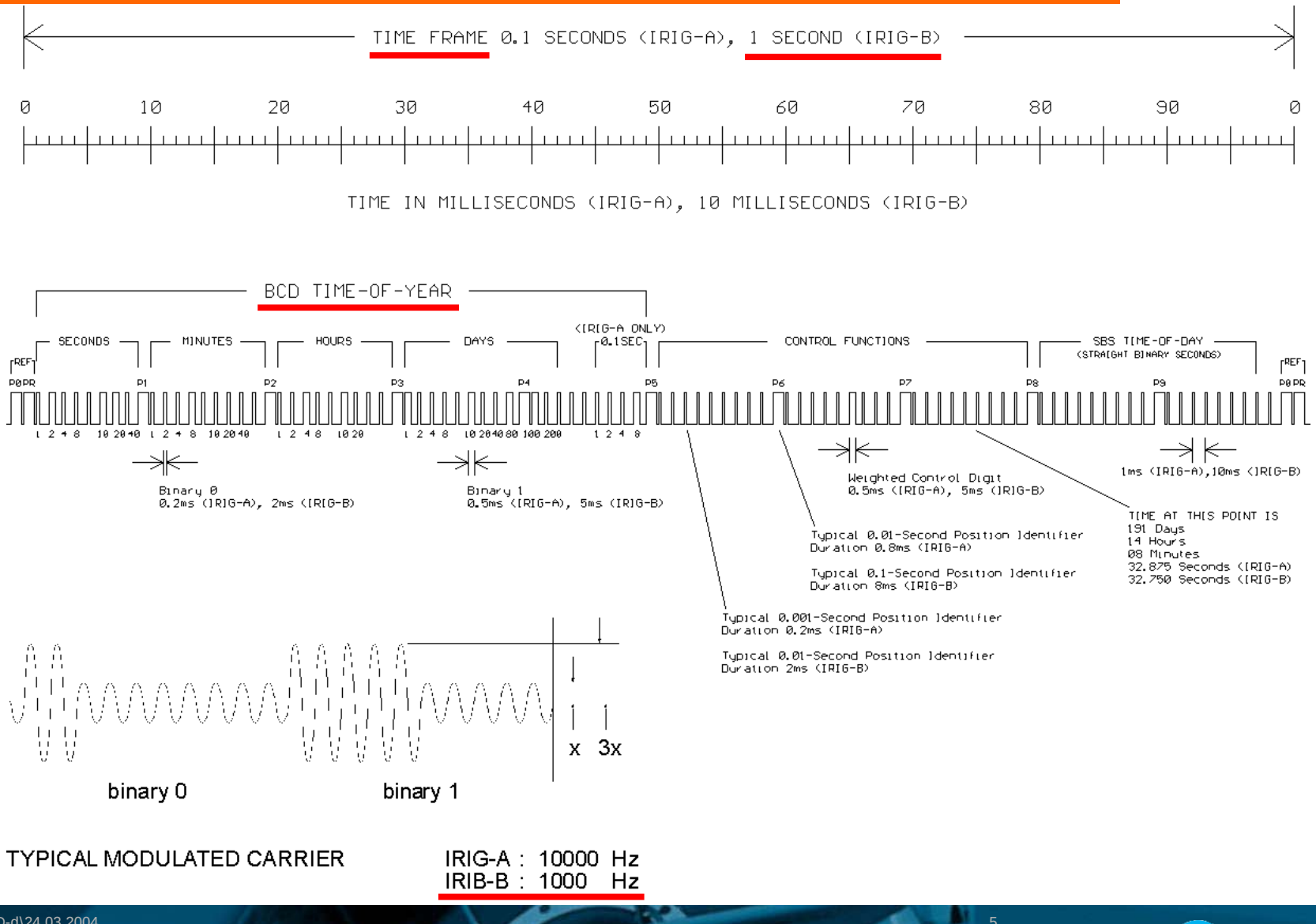
Need for time – IRIG

- Data **correlation between sources** and sub-systems
- Eurofighter Mach 2 ~ **700 meters per second**
  Data busses with clock period up to 50 ns

- Accuracy requirement for bus message time stamping: < 1 µs (100 ns)

- US Range Commanders Council (RCC) Inter Range Instrumentation Group
- Worldwide (IRIG) standards for flight test ranges to enable test data exchange between ranges and laboratories: data acquisition, recording, telemetry
- **Serial time code format** for time synchronisation of hardware, independent of manufacturer
- IRIG formats: A, B, D, E, G, H

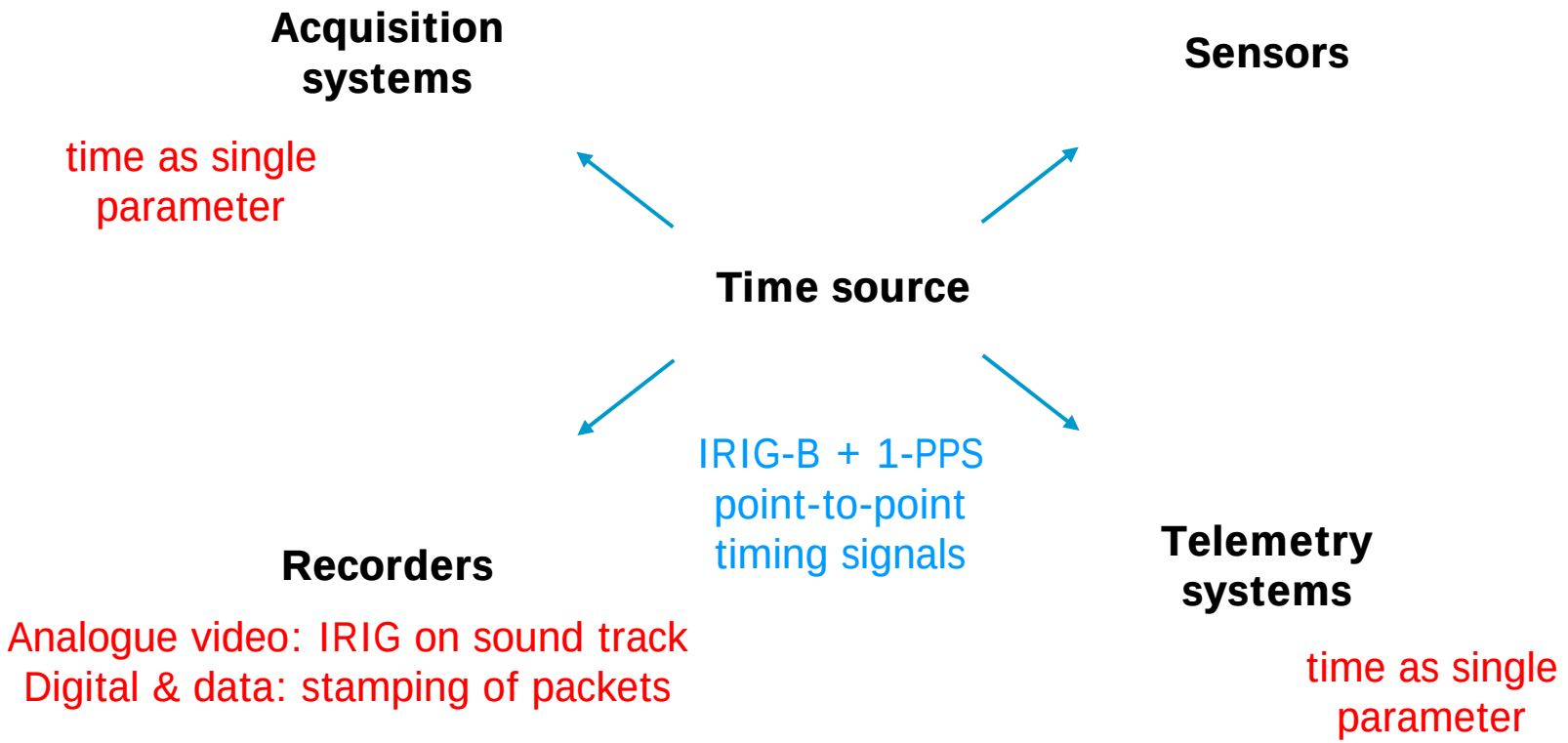
IRIG-B



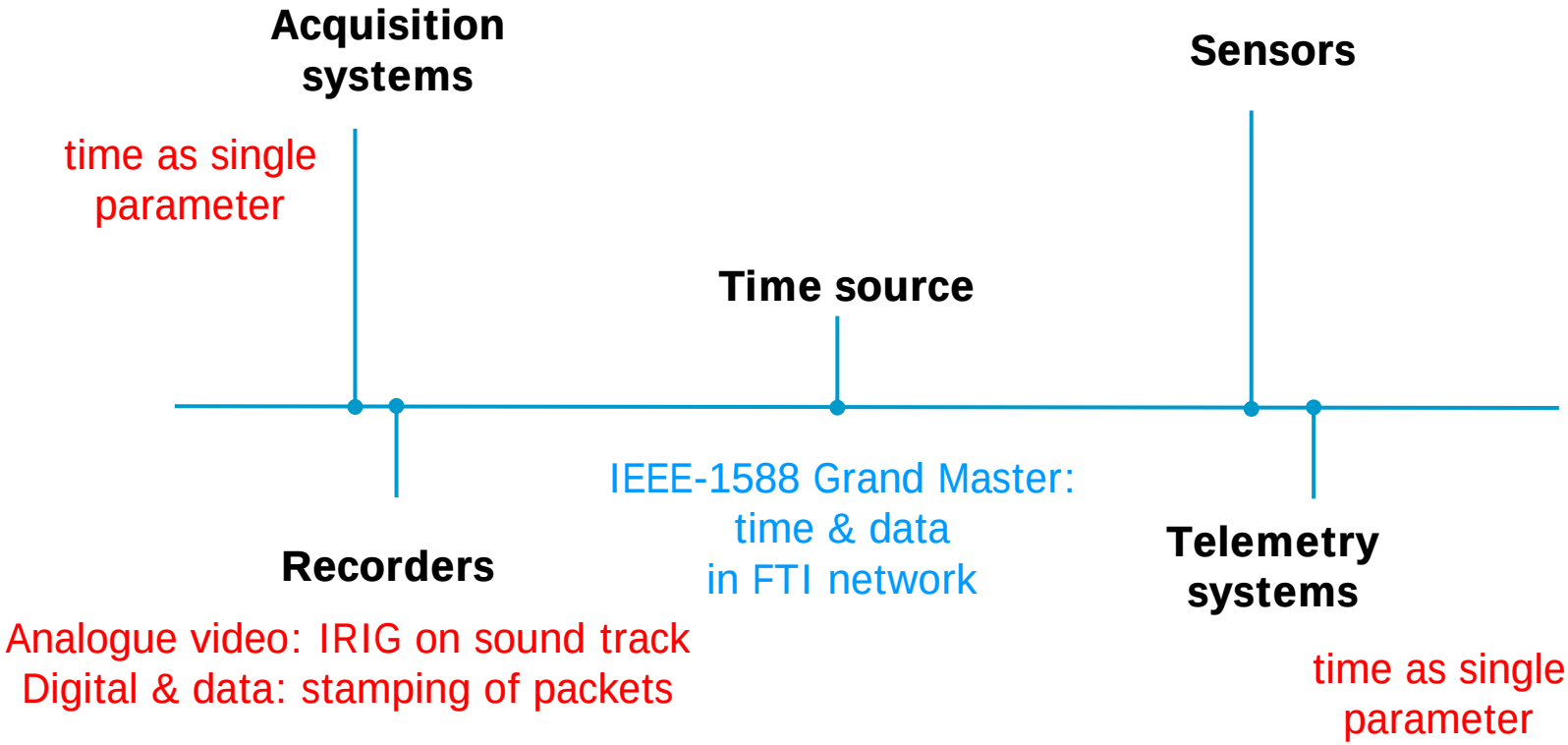
TYPICAL MODULATED CARRIER

IRIG-A : 10000 Hz
IRIB-B : 1000 Hz

Time distribution



Time distribution



Time synchronisation with GNSS receivers

Issues

- Short time to first fix vs. quality of first fix
  Jitter of 1-PPS signal up to several 100 ns

  ⇒ timing receivers usually work in position average/hold mode
  ⇒ jitter recognition necessary i.e. in recorder

- Time synchronisation vs. positioning:
  PDOP max when SVs spread over sky, i.e. 3 low over horizon, 1 in zenith
  TDOP max when SVs with high elevation

Improvement

- RAIM algorithm and overall time accuracy estimation

Future

- IEEE-1588 Grand Master in GNSS receiver to act as time source and as position sensor in FTI systems @ Eurocopter, EADS MAS, Airbus...

GPS Top Counter Device

- Data streams recorded during one test flight: from 1 Mbps up to 200 Mbps
  ⇒ 3 hour-test = 270 GB
- Efficient data analysis and archiving need event markers – “tops”
- Tops: pre-flight calibrations, test points, flight manoeuvres, post-flight calibrations
- GPS Top Counter Device

GPS Top Counter Device

- Top Counter device: Eurocopter self-made cockpit control for top definition through pilot or flight test engineer
  Push & release = 6 second-top
  Push & maintain = top as long as pushed

- Top list saved on flash card

- Time synchronisation through internal GPS receiver (Type Jupiter T30-140-xx) or free running RTC

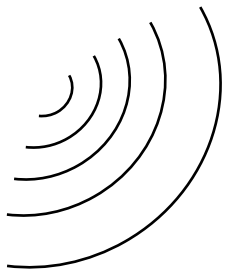
- Outputs:
  IRIG-B for FTI sub-systems
  Azimuth base – A/C for antenna tracking

Some real-time positioning applications

Positioning applications of GPS for real-time are numerous. Some examples:

- Ground Station antenna tracking during telemetry flights
- Test safety during shooting in test range or UAV flights
- Tests with multiple A/C: weapon systems or radar validation
  GPS Pod on A/C under test and on multiple targets

- Accuracy requirement: > m



Some real-time differential GPS applications

- Real-time distance between 2 A/C (validation flights for traffic collision avoidance system)

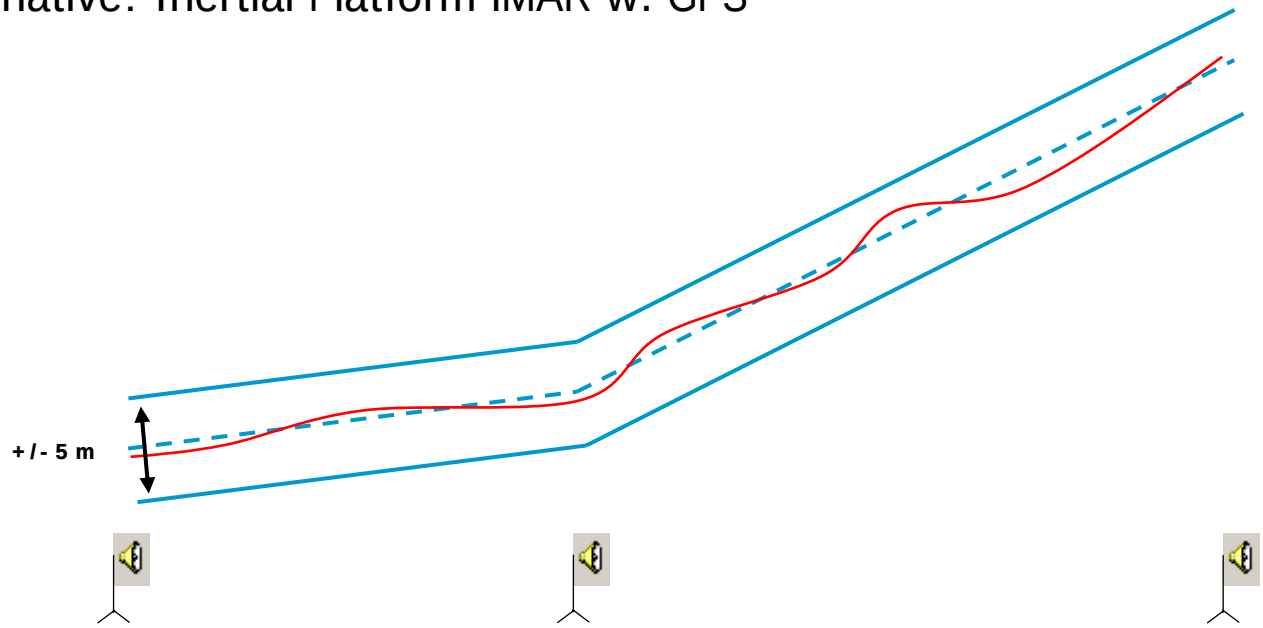
- Approach guidance over test area (noise measurements)

- Accuracy requirement: dm – m
- Future: Attitude with multiple antenna systems

Flight guidance PDA for noise measurement flights

- Noise measurement flights: manoeuvres and approaches
- PDA with flight guidance software
  GPS receiver w. EGNOS corrections
- NMEA messages GGA-RMC-GSV, rate 5 Hz

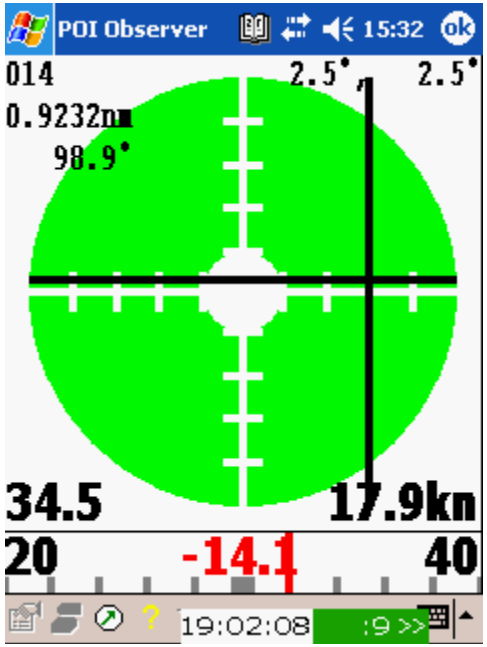
- Alternative: Inertial Platform iMAR w. GPS



Flight guidance PDA for noise measurement flights

Next waypoint:
distance
heading

Commanded bearing
and height
to next waypoint



Momentary speed

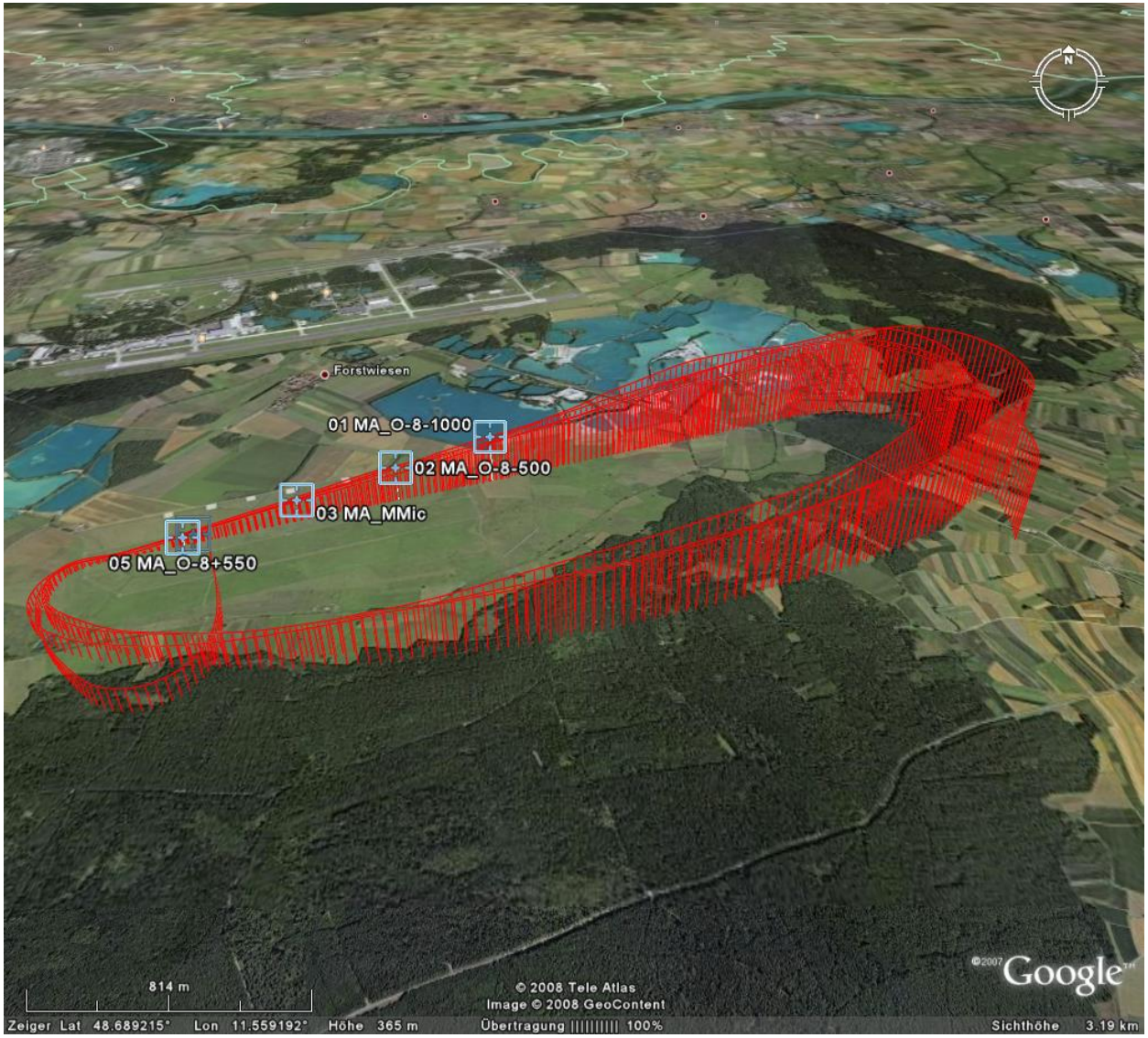
Speed next waypoint

Commanded speed
Next WP - present

Status (GPS SV, battery)

Flight guidance PDA for noise measurement flights

- Manching
  Dropping area



Post-flight differential GPS applications

- Validation of air data systems, navigation platforms
- Accuracy requirement: < dm
- Recording of rover raw data on external recorder
- Base data from own reference or virtual
- Post-processing with i.e. Waypoint GrafNav SW

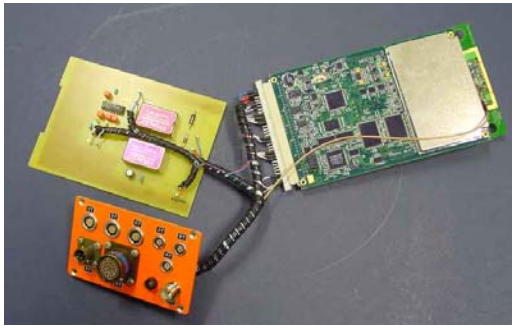
Some other receivers

Some other receivers used at EADS MAS (Manching) and/or Eurocopter Deutschland (Donauwörth)

- TrueTime 750: 6 ch., L1, 1PPS + IRIG-B

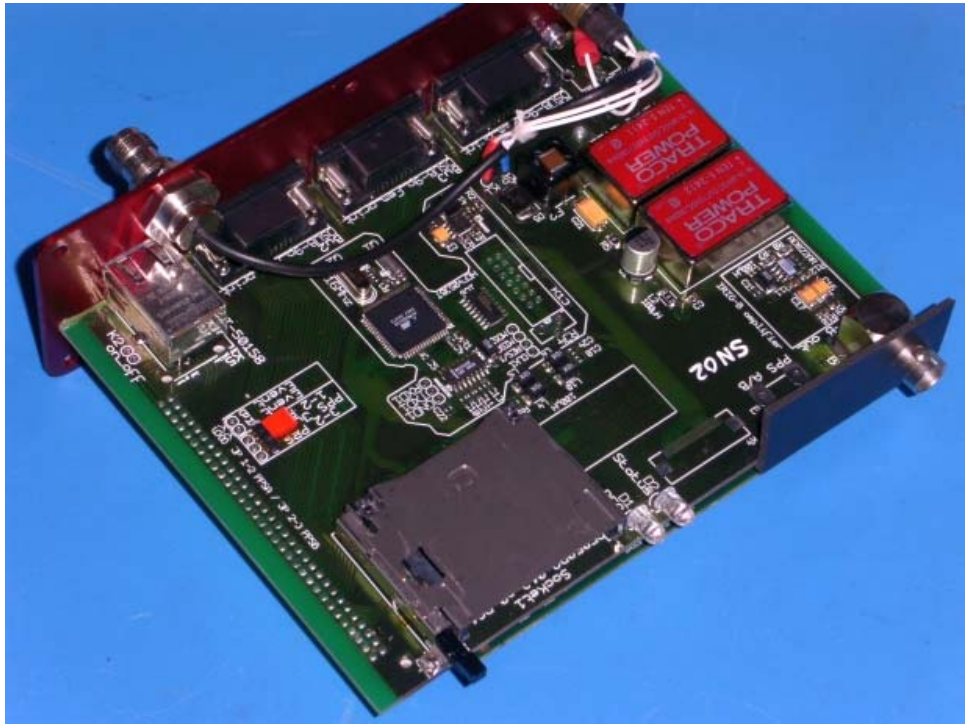
- ConWin XR5/6: 12 ch., L1, 1PPS, NMEA, Raw

- Javad Euro-GGD, GGD-112T, JNS-100GG, GeNeSiS: up to 72 ch., L1/L2 GPS/GLO, 1PPS + IRIG-B, NMEA, Raw

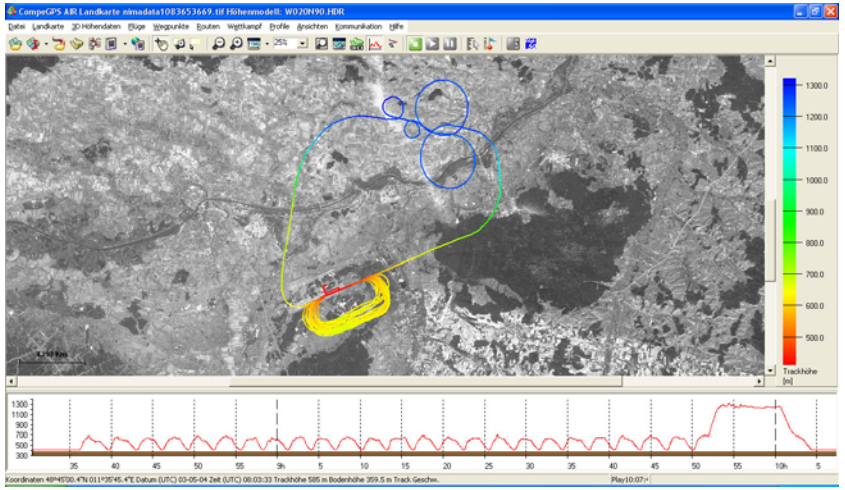


Javad GeNeSiS @ Eurocopter

- Integration of GeNeSiS OEM board in flight capable housing
- Additional CF-slot for storage of jps data on mobile medium



Some tests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Thank you!

- Thank you for your attention!
- Questions?
- Contact: Renaud Urli

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