

Integrating GPS and Loran-C

Basic principles and first testing results

TeleConsult Austria

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International Loran Association, 30th Annual Convention and Technical Symposium

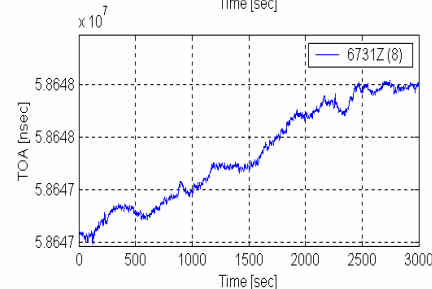
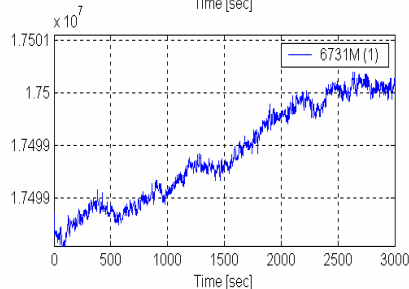
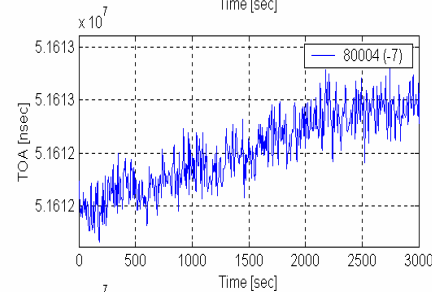
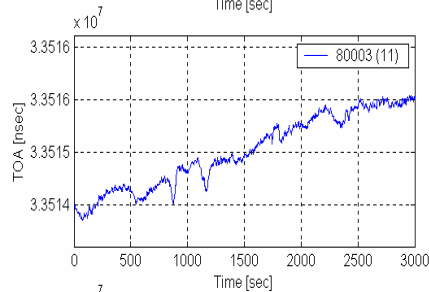
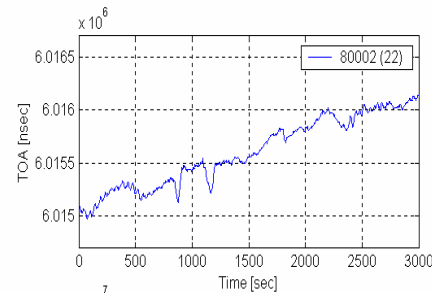
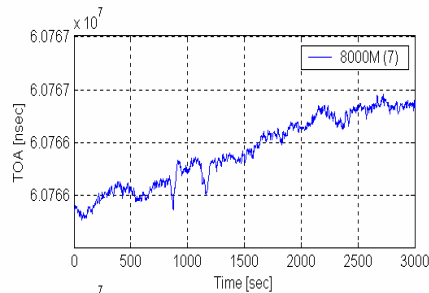
Saint Germain-en-Laye, October 9th, 2001

- Introduction
- Fundamentals
 - GNSS
 - Loran-C
- Integration of GNSS and Loran-C
- Characteristics of TOAs
- Combined GPS/Loran-C position solutions
- Conclusions

- GNSS
 - High absolute accuracy
 - 3D positioning
 - Needs line-of-sight to satellites
 - Integrity problems
- Loran-C
 - Low absolute accuracy
 - High repeatability
 - No line-of-sight to transmitters required
 - High availability and integrity

- Pre-computed position fixes vs. raw data
 - TDs vs. TOAs
 - Error sources:
 - ASF
 - Receiver clock error
 - Transmitter clock error
 - Synchronization error between chains
- Conclusions: Integration on raw data basis by use of TOAs!

Characteristics of TOAs (1)

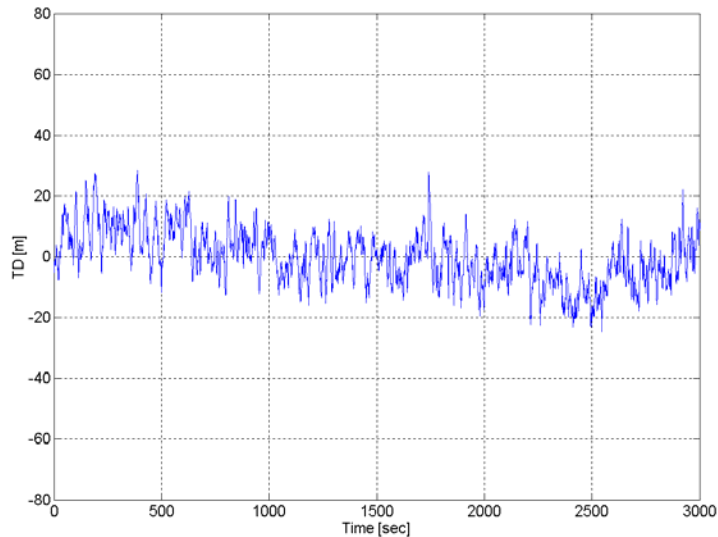


- SNR as weighting factor
- Unique trend (receiver clock)
- Magnitude of TOA variability differs

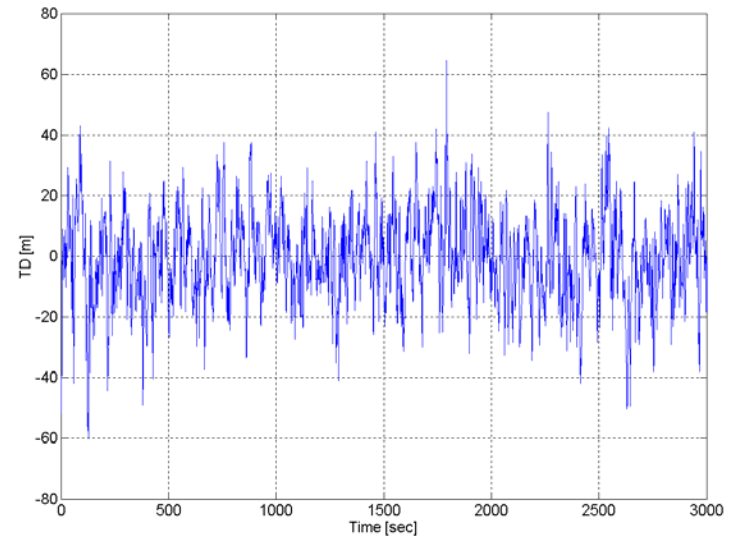
!! Measurements on the outer limit of the nominal coverage !!

Characteristics of TOAs (2)

Time series of time differences (TDs)

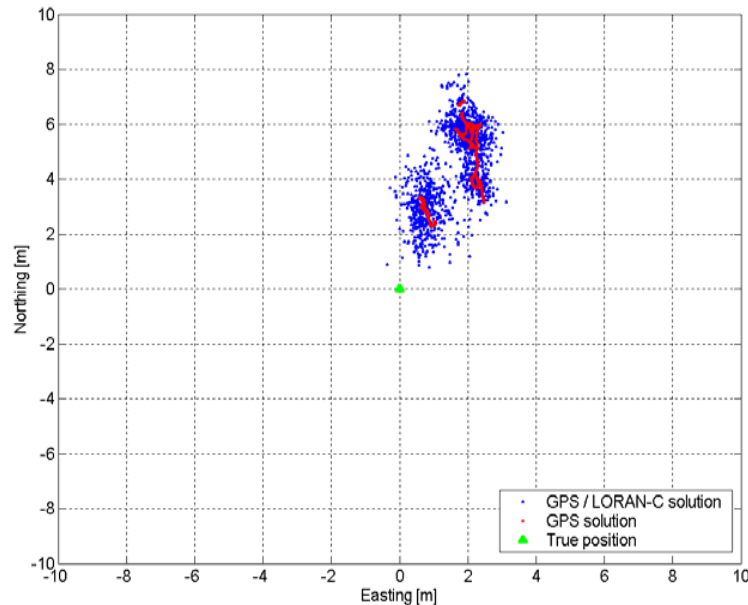


TD1: 8000M (7) – 80002 (22)



TD2: 6731M (1) – 6731Z (8)

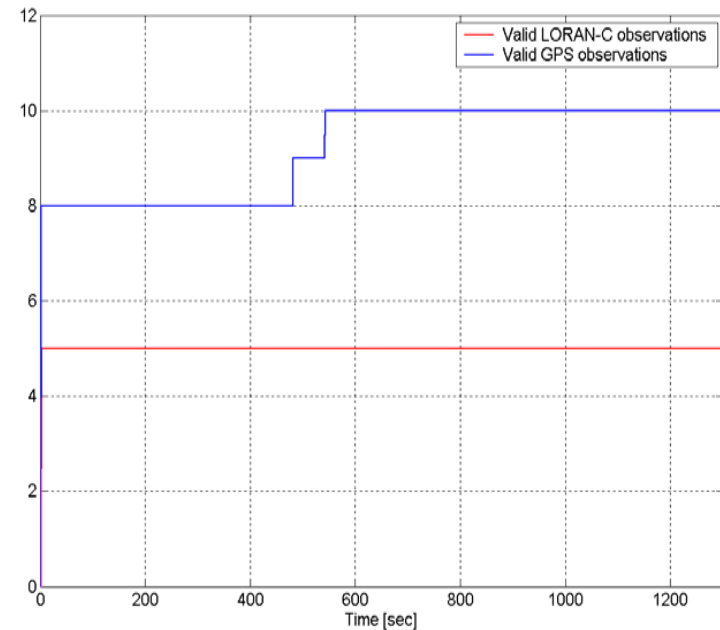
Combined GPS/Loran-C position solution (1)



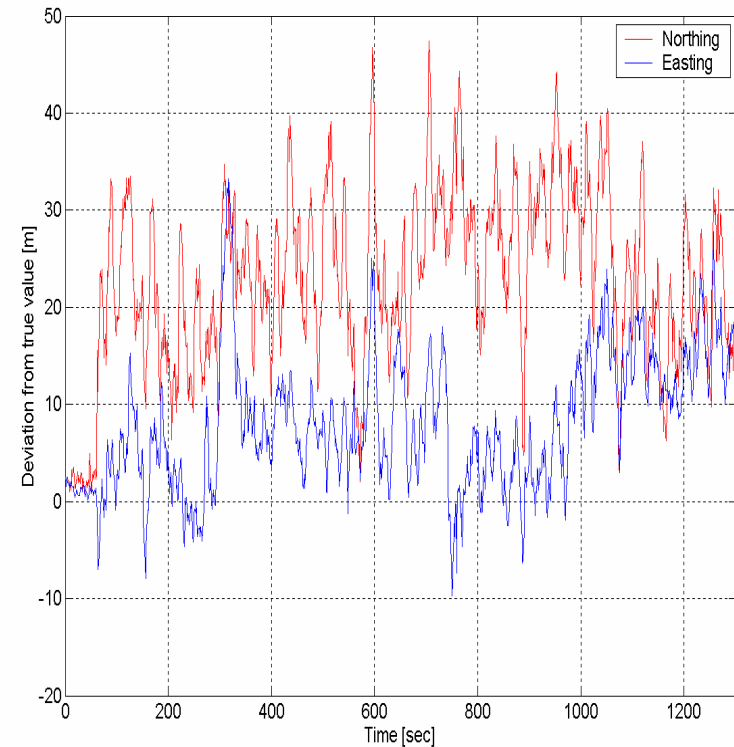
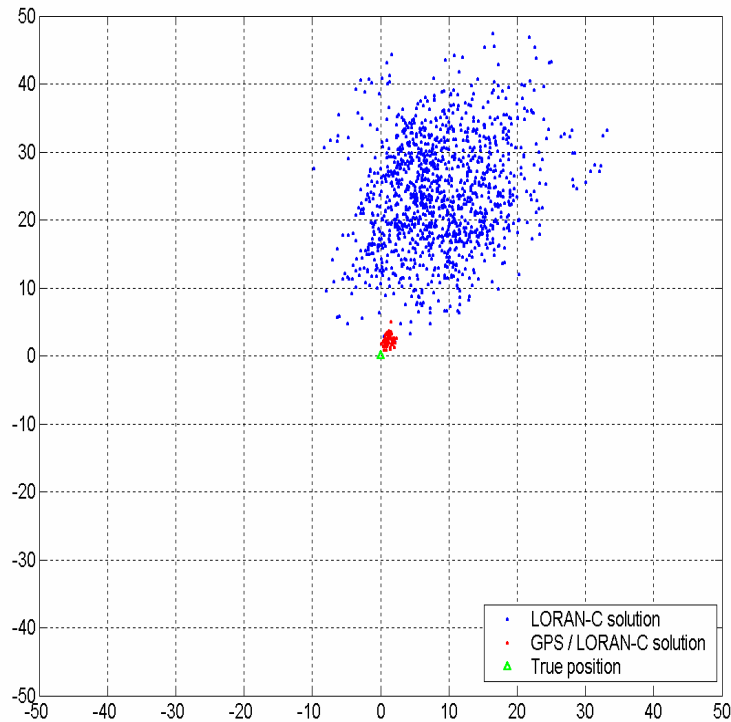
Scatter plot of position fixes

- GPS only solution
- GPS/Loran-C solution

Visibility of navigation sources

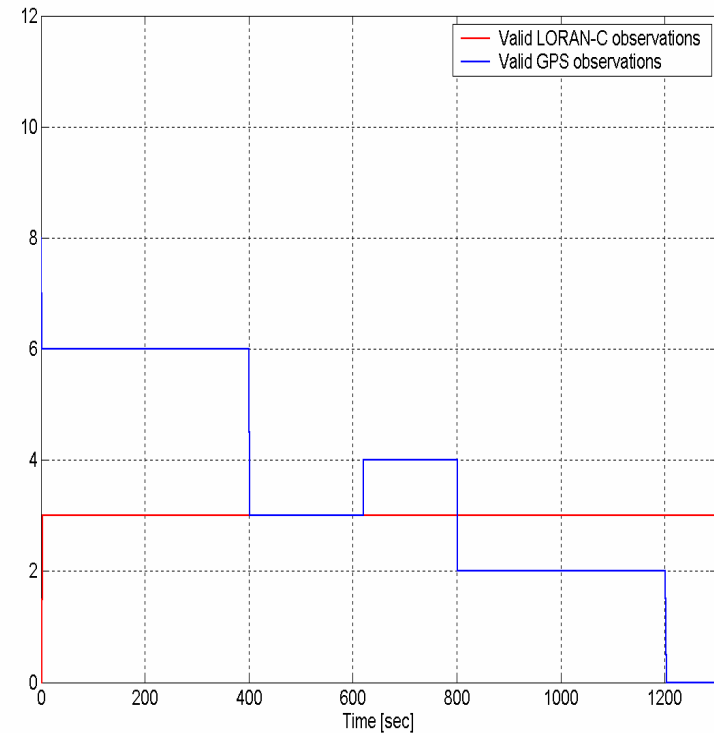
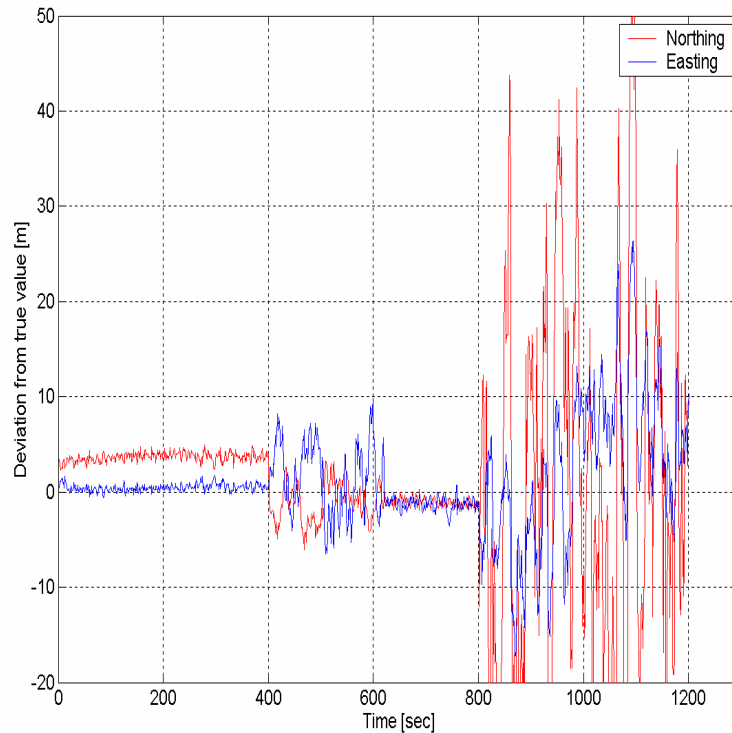


Combined GPS/Loran-C position solution (2)



Combined position solution with initial calibration

Combined GPS/Loran-C position solution (3)



Simulating a kind of „real situation“

Conclusions (1)

- Loran-C
 - Poor absolute accuracy
 - Good repeatability
 - High availability
 - High integrity
- GNSS
 - High absolute accuracy
 - Good repeatability
 - Moderate availability (depends on surroundings)
 - Moderate integrity

Conclusions (2)

- Integration of GNSS and Loran-C is promising
- Too poor coverage of Loran-C in Europe
 - Re-activation of existing transmitters
 - Installation of new transmitters
- Further development of Loran-C receivers
- Pushing of new satellite systems for political and performance reasons
- Further research on integration techniques