Course 521:

New Developments in Ambiguity Resolution for GNSS Precise Positioning

Marriott Mission Valley
San Diego, California
May 5-6, 2005

	Thursday	Friday
	Dr. Kees de Jong, *Fugro*	Dr. de Jong
8:30	**Ambiguity Resolution: The Problem** GNSS processing scenarios High precision applications	**Overview and Comparison of Approaches to Ambiguity Resolution** Rounding and integer bootstrapping Integer least squares Laning and other ambiguity combinations Partial ambiguity resolution
9:45	**Introduction to Least Squares Estimation and Quality Control** Principle of least squares Measurement and stochastic model Batch estimation Recursive estimation Linearization Hypothesis testing Internal and external reliability	**The Fixed Baseline and Its Quality** Distribution of the fixed ambiguities and resulting baseline Validation of estimated ambiguities
11:00	**GNSS Observables** Code and carrier observations Error sources: troposphere, ionosphere, orbits, multipath Baseline models: geometry-free and geometry-based (stationary and roving) Ionosphere fixed, weighted and float solutions	**Ambiguity Success Rates** Success rate as a design parameter Current GPS, modernized GPS and Galileo Multi-carrier ambiguity resolution (MCAR)
12:00	*Lunch is on your own*	
1:30	**The LAMBDA Method for Ambiguity Resolution** Integer least squares and ambiguity decorrelation	**Biases and Ambiguity Resolution** Influence of biases due to ionosphere and multipath on ambiguity resolution and the ambiguity success rate
2:45	**The LAMBDA Method for Ambiguity Resolution (cont'd)** Analysis of various baseline scenarios on ambiguity resolution performance	**Implementation Aspects** Single-epoch ambiguity estimation Accumulation of normal equations Integration of LAMBDA functions in GPS processing software
4:00	**Software Demonstration I** Matlab 2D Visualization® of integer mapping regions for different scenarios (depending on influence of ionosphere) for the geometry-free baseline model using one pair of satellites	**Software Demonstration II** Ambiguity success rates for GPS, Galileo and integrated GPS/Galileo for different (ionosphere fixed, weighted and float) baseline models as a function of stochastic model Number of frequencies and number of epochs
5:00		

This class was held for the first time in 2003 and was presented to a highly motivated group of about 16 people. Their response was most enthusiastic and the overall ratings were excellent.

"Participants should be aware of the high level of GPS processing knowledge required."
Sunil Bisnath

"All questions were answered with patience."
Name withheld

"Kees did a great job."
Steve Hilla

"Excellent teacher who demonstrated a lot of experience."
Name withheld

Fee: $1195
1.2 CEUs

About This Course

Resolution of the carrier cycle ambiguities to their correct integer values is a prerequisite for precise positioning using Global Navigation Satellite Systems (GNSS's) such as GPS and the future European Galileo system. Since the integer ambiguities are estimated from stochastic observations, the ambiguities are stochastic as well and may contain integer errors. Validation of the estimated integer ambiguities is therefore of utmost importance. This course addresses the fundamental concepts and new developments in integer ambiguity estimation, including multi-frequency techniques, as well as validation methods assuring high confidence levels for the results. Also, a wide variety of implementation aspects and practical considerations are discussed and evaluated relating to integer ambiguity resolution applications.

Objectives

- To provide an understanding of the concept of integer ambiguity estimation and present an overview of ambiguity resolution methods.
- To discuss the concept of the ambiguity success rate as a design tool for the reliability of integer ambiguity.
- To introduce concepts for the validation of the estimated integer ambiguities.
- To make participants aware of the influence of biases (as multipath, ionosphere) on the estimation of the integer ambiguities.
- To discuss implementation aspects and other practical aspects of integer ambiguity resolution.

Instructors:

Dr. Kees de Jong

Who Should Attend

- Engineers and technical professionals seeking conceptual explanations, trade-offs among various methods and a presentation of recent developments in the concepts of precise GNSS positioning employing ambiguity estimation techniques.
- System specialists, system engineers, software analysts and developers concerned with the implementation of ambiguity estimation procedures in GNSS processing software.
- Academics interested in obtaining or maintaining a high level of expertise and updating their knowledge base with new developments in this rapidly changing and analytically challenging area.

Prerequisites

- Familiarity with the basic concepts of GNSS positioning, linear algebra, statistics, and least squares estimation.
- An understanding of GPS operational principles; *Course 111, Course 122, Course 356,* or equivalent experience is recommended.

Materials You Will Keep

- A notebook including all materials presented during the course.
- PDF files of selected papers and slides. Source code of LAMBDA functions (Matlab®, C), in combination with the material on Navtech's CD-ROM of references.
- Selected papers on ambiguity estimation by the staff of the Department of Mathematical Geodesy and Positioning of Delft University of Technology and selected other papers.