GNSS Applications Workshop: Seminar on GNSS Spectrum Protection and Interference Detection and Mitigation

Course Introduction

20-21 March 2018
Satellite Navigation in the 1950s

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
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<tbody>
<tr>
<td>1950</td>
<td>4 Oct 1957 Sputnik I Launched</td>
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<tr>
<td>1951</td>
<td>Dec 1958 The U.S. Navy Navigation Satellite System (Transit) Approved and Funded</td>
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<td>1952</td>
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Satellite Navigation in the 1960s

13 April 1960
First Successful
Transit
Experimental
Satellite (1B)

5 Dec 1963
First
Operational
Satellite

Jan 1964
Transit
Become
Operational

Other Successful
Experimental
Satellites:
2A, 22 Jun 1960
3B, 21 Feb 1961
4A, 29 Jun 1961
4B, 15 Nov 1961

July 1967
Transit
Released
for
Commercial
Use
- - - -
Establishing
U.S. Dual
Use SatNav
Policy

Operational
Transit
Satellite

Satellite Navigation in the 1970s

1971
First Timation Receiver for the Naval Research Lab (NRL)

1975
First Concept Validation GPS Navigator, the GPS X-Set

April 1973
Formation of the GPS Joint Program Office (JPO)

1978 GPS Launches
22 Feb, 13 May, 7 Oct, 11 Dec
## Satellite Navigation in the 1980s

<table>
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<th>Year</th>
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<td>1980</td>
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<td>1981</td>
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<td>1983</td>
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<tr>
<td>1984</td>
<td>Commercial 5 Channel GPS Navigator</td>
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<td>1985</td>
<td>GPS + Transit + Omega</td>
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<tr>
<td>1986</td>
<td>6 Channel GPS Navigator</td>
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<td>1987</td>
<td></td>
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<td>1988</td>
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<td>1989</td>
<td>14 Feb ‘89 Launches Resume</td>
</tr>
</tbody>
</table>

- **9 Oct ‘85**: Last Block I Launch
- **28 Jan ‘86**: Challenger Disaster

**Key Events:**
- **28 Jan ‘86**: Challenger Disaster
- **9 Oct ‘85**: Last Block I Launch
- **14 Feb ‘89**: Launches Resume

**Equipment Images:**
- WM101 GPS Satellite Surveying Set
- GPS Navigator
- Commercial 5 Channel GPS Navigator

**Additional Information:**
- 1984
- 1985
- 1986
Satellite Navigation in the 1990s

- 1990 GPS/GLONASS Navigator
- 4 Apr ‘91 S/A Turned On
- 1991 6 Channel GPS Engine
- 1991 Compact GPS Surveyor
- 26 Dec ‘91 Dissolution of the Soviet Union Enacted
- 8 Dec ‘93 GPS IOC
- 27 Apr ‘95 GPS FOC
- 1996 Professional Marine DGPS Navigator
- 1997 Machine Control, 10 Hz, 30 ms, 1 cm
November 2004, Qualcomm announced successful tests of assisted GPS for mobile phones.

1-2 Dec ‘05 ICG-1 Vienna
Satellite Navigation in the 2010s

- Approaching a new GNSS Golden Era
  - Many more satellites (GPS, Galileo, BeiDou, QZSS) with L1 and L5 interoperable signals
  - Much better availability, accuracy, integrity, e.g., enabling ARAIM
- Anticipating CDMA signals from GLONASS
- What does the future hold?
GNSS: A Global Navigation Satellite System of Systems

- **Global Constellations**
  - GPS (24+3)
  - GLONASS (24+)
  - GALILEO (24+3)
  - BDS/BEIDOU (27+3 IGSO + 5 GEO)

- **Regional Constellations**
  - QZSS (4+3)
  - IRNSS/NAVIC (7)

- **Satellite-Based Augmentations**
  - WAAS (3)
  - MSAS (2)
  - EGNOS (3)
  - GAGAN (3)
  - SDCM (3)
  - BDSBAS (3)
  - KASS (2)
Who Anticipated GPS in Cell Phones?

- Sparked by the E911 requirement
- Use of Location Based Services (LBS) is exploding
- Improved by Assisted GPS (A-GPS)
  - Better accuracy
  - Location in seconds
  - Turn-by-turn navigation

More than a Billion Cell Phone GPS Users
Who Anticipated Precision Agriculture?

- One to 10 cm accuracy
- Far better productivity, efficiency, and protection of the environment
- Enabled, e.g., by MSS signals for the John Deere StarFire Service and several others
Seminar History

• Pre-ICG Action Team on GNSS (1999-2005)
  – Regional Meetings 2000-2003
  – Fall 2004: 1st effort to develop Workplan for ICG
    • Spectrum protection and Interference detection and mitigation (IDM) drafted into ICG Workplan from the beginning

• Proposal by U.S. for Educational Seminar on Spectrum Protection and IDM at Final Pre-ICG Experts Meeting in 2005
  – Never took place… until 2015!
Purpose of this Workshop

Describe the importance of GNSS spectrum protection at the National level, and what you can do to reap the benefits of GNSS
Session Agenda: Day 1

Tuesday, 20 March 2018

09:00 – 10:30  Session – Seminar on GNSS Spectrum Protection and Interference Detection and Mitigation

I. Overview

09:00  Course Introduction, Jeffrey AUERBACH, United States of America

09:20  Participant Introductions: Country, Meeting Participants, GNSS Use Within Country, Robyn ANDERSON, United States of America, Dominic HAYES, European Commission, Takahiro MITOME, Japan

II. Introduction to GNSS

09:55  How GNSS Works and Applications, Dominic HAYES, European Commission

10:15  Spectrum protection of global navigation satellite systems (GNSS) from unwanted emissions caused by International Mobile Telecommunications (IMT) systems in the frequency range below 3 GHz, Dimitry ARONOV, Russian Federation

10:30 – 10:45  Coffee Break
Session Agenda: Day 1

Tuesday, 20 March 2018

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
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<tbody>
<tr>
<td>13:00 – 15:05</td>
<td>Session – Seminar on GNSS Spectrum Protection and Interference Detection and Mitigation (continues)</td>
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<tr>
<td>13:00</td>
<td>GNSS Receiver Fundamentals, Takahiro MITOME, Japan</td>
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<tr>
<td>13:20</td>
<td>Introduction to Interference, Robyn ANDERSON, United States of America</td>
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<td>13:40</td>
<td>What is Spectrum Management, Dominic HAYES, European Commission</td>
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<td>13:55</td>
<td>The ITU and Spectrum Management, Dominic HAYES, Takahiro MITOME, Japan</td>
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<td>14:10</td>
<td>Introduction to National Spectrum Agencies and National Applications, Dominic HAYES, European Commission, Takahiro MITOME, Japan</td>
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<td>14:30</td>
<td>Q&amp;A Session, All Workshop Participants</td>
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<td>14:50</td>
<td>Conclusion: Summary and Homework Assignment, Robyn ANDERSON, United States of America</td>
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<tr>
<td>15:05</td>
<td>Adjourn</td>
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</table>
Contributors

- Jeffery AUERBACH
- Robyn ANDERSON
- Rick HAMILTON
- Dominic HAYES
- Takahiro MITOME
- Tom STANSELL
- David CHOI
Participant Introductions