

International Committee on  
Global Navigation Satellite Systems

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

## **Course Introduction**

**20-21 March 2018**

# Satellite Navigation in the 1950s

1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
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4 Oct 1957  
Sputnik I  
Launched

Dec 1958  
The U.S.  
Navy  
Navigation  
Satellite  
System  
(Transit)  
Approved  
and  
Funded

# Satellite Navigation in the 1960s

1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
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13 April 1960  
First Successful  
Transit  
Experimental  
Satellite (1B)

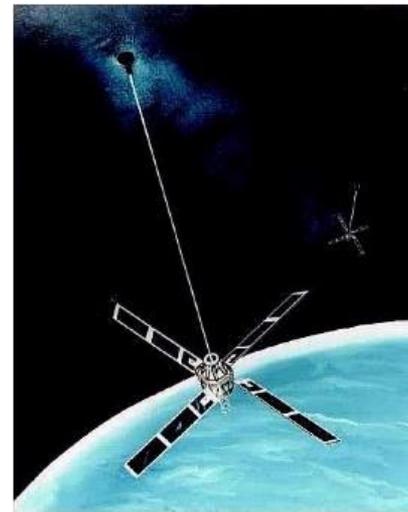
5 Dec 1963  
First  
Operational  
Satellite

Jan 1964  
Transit  
Became  
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

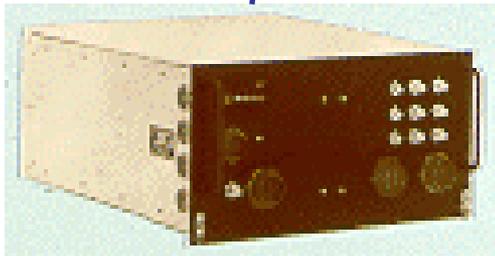


# Satellite Navigation in the 1970s

1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
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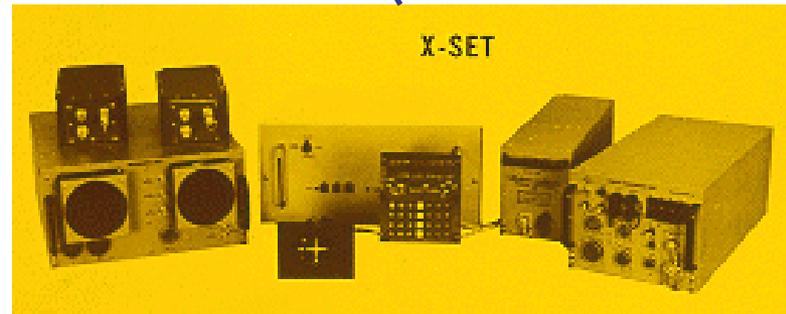
April 1973  
Formation of the GPS  
Joint Program Office  
(JPO)

1978 GPS Launches  
22 Feb, 13 May,  
7 Oct, 11 Dec



1971

First Timation Receiver  
for the Naval Research  
Lab (NRL)



1975

First Concept Validation GPS  
Navigator, the GPS X-Set

# Satellite Navigation in the 1980s

1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
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1984  
Commercial 5  
Channel GPS  
Navigator

9 Oct '85  
Last Block I  
Launch

28 Jan '86  
Challenger  
Disaster

14 Feb '89  
Launches  
Resume



1985  
GPS + Transit + Omega



1986  
6 Channel GPS  
Navigator



1986  
WM101 GPS Satellite  
Surveying Set

# Satellite Navigation in the 1990s

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
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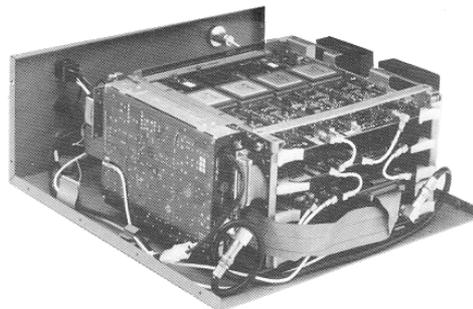
4 Apr '91  
S/A Turned  
On

8 Dec '93  
GPS IOC

27 Apr '95  
GPS FOC



1996 Professional  
Marine DGPS  
Navigator



1990  
GPS/GLONASS  
Navigator



1991 6 Channel  
GPS Engine

26 Dec '91  
Dissolution of  
the Soviet  
Union Enacted

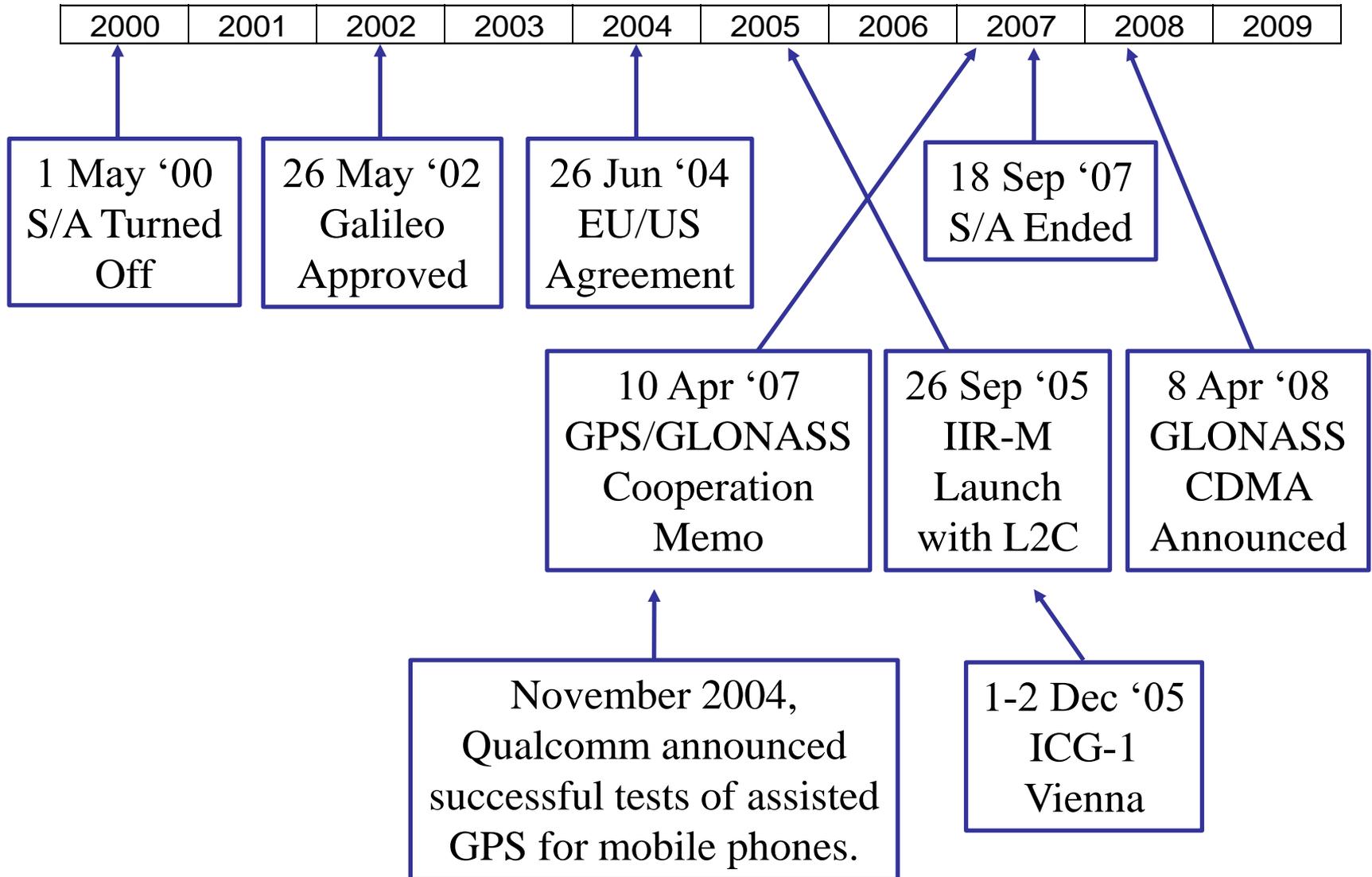


1991 Compact  
GPS Surveyor

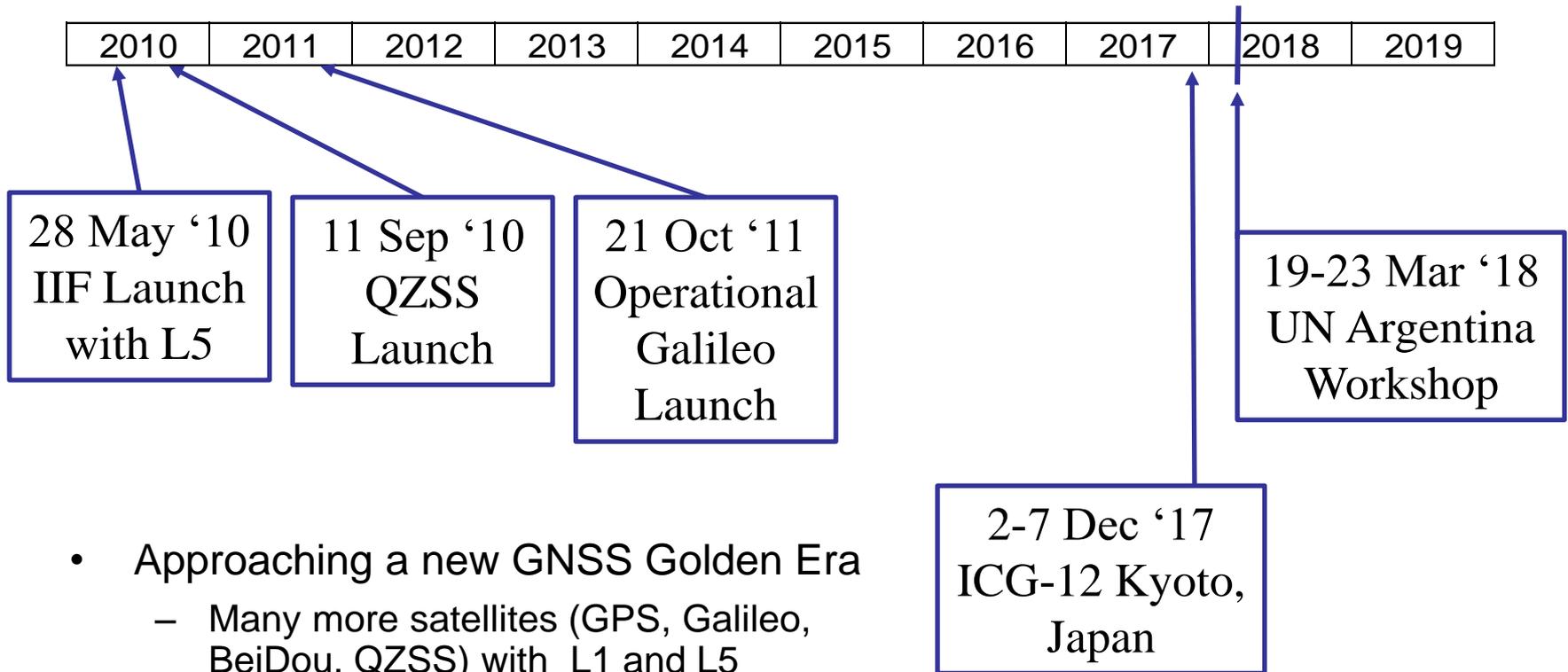


1997 Machine  
Control, 10 Hz,  
30 ms, 1 cm

# Satellite Navigation in the 2000s



# 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



Automatic Steering

Automatic Spray Control

# Seminar History

- Pre-ICG Action Team on GNSS (1999-2005)
  - Regional Meetings 2000-2003
  - Fall 2004: 1<sup>st</sup> 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**

13:00 – 15:05 **Session – Seminar on GNSS Spectrum Protection and Interference Detection and Mitigation (continues)**

## **II. Introduction to GNSS (continued)**

13:00 GNSS Receiver Fundamentals, *Takahiro MITOME, Japan*

13:20 Introduction to Interference, *Robyn ANDERSON, United States of America*

## **III. Spectrum Management**

13:40 What is Spectrum Management, *Dominic HAYES, European Commission*

13:55 The ITU and Spectrum Management, *Dominic HAYES, Takahiro MITOME, Japan*

14:10 Introduction to National Spectrum Agencies and National Applications, *Dominic HAYES, European Commission, Takahiro MITOME, Japan*

14:30 Q&A Session, *All Workshop Participants*

14:50 Conclusion: Summary and Homework Assignment, *Robyn ANDERSON, United States of America*

15:05 Adjourn



# Contributors

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





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# Participant Introductions