Developments in Satellite Navigation and Wireless Spectrum

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CAASD MITRE

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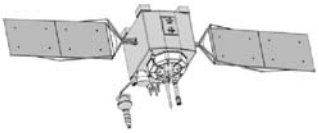
GPS Modernization

- **Block IIR-M**
  - **8 total vehicles, built by Lockheed-Martin**
  - **Launched 2005 - 2009**
  - **Adds new civil (L2C) and military (M-code) signals**
- **Block IIF**
  - **12 total vehicles, built by Boeing**
  - **Adds new civil L5 signal at 1176.45 MHz**
  - **1st launch -- 27 May 2010**
- **Block IIIA**
  - **First launch ~2014**
  - **Adds new civil L1C signal**

Block IIR-M Satellite
Source: Lockheed-Martin.



Block IIF Satellite
Source: The Boeing Company.

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GLObal'naya NAvigatsionnaya Sputnikovaya Sistema (GLONASS)

- **Russian satellite navigation system**
  - **First launch in 1982**
- **Nominal 24-satellite constellation**
  - **19,100 km altitude, 3 planes**
  - **Fully populated in 1995…**
  - **…but then deteriorated to as low as 7**
  - **Now being replenished – 21 operational**
- **1st modernized GLONASS-K satellite anticipated to be launched later in 2010**
  - **Will introduce 1st CDMA signal for GLONASS at ~1202 MHz**
  - **Later additional L1/L2 CDMA signals may be added**

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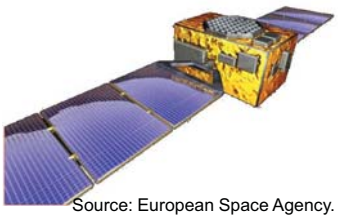
GALILEO

- European satellite navigation system
  - Jointly financed by European Commission (EC) and European Space Agency (ESA)
  - Program gained significant boost in March 2002 with release of ~$1.1B euro
- 27+ satellite constellation
  - 3-planes
  - 56 deg inclination
  - ~23,200 km altitude



Source: European Space Agency.

- Two test satellite launched in 2005, 2008
- 4 in-orbit validation (IOV) satellites anticipated to be launched ~ 2011

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COMPASS

- Chinese satellite navigation system
- Final constellation planned to include:
  - 27 satellites in medium Earth orbit (MEO)
    - 55 degree inclination, ~21,500 km altitude
  - 5 satellites in geostationary orbit (GEO)

Source: China Academy of Launch Vehicle Technology.

- Launches:
  - Three experimental GEOs: 2000 (2), 2003 (Beidou-1)
  - First MEO: April 2007
  - Second-generation GEOs – April 2009, Jan 2010, June 2010

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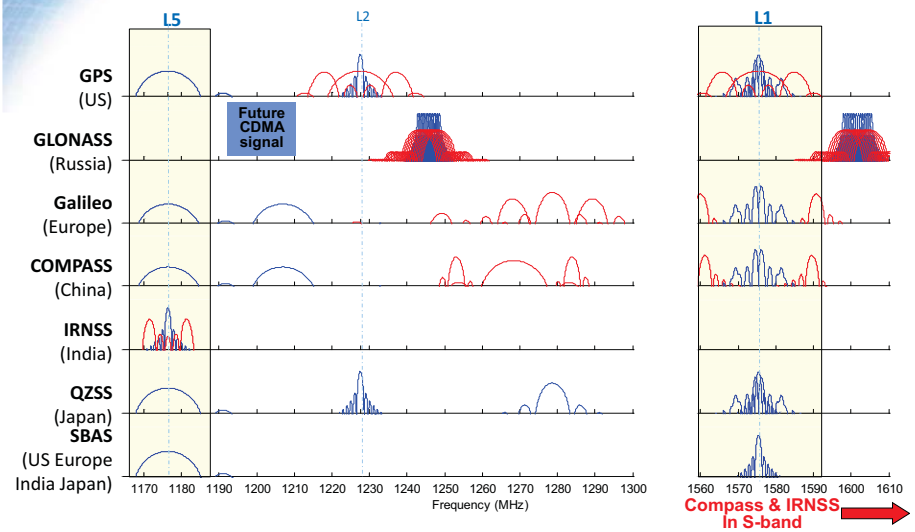
Satellite Navigation Signal Plans



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3G/4G – "A Looming Spectrum Crisis"

The New York Times

"Customers Angered as iPhones Overload AT&T" – 9/2/09

CBS NEWS

"FCC Chairman Warns Of 'Looming Spectrum Crisis'" – 10/7/09

iPhone 3G (July '08 -)
Source: Apple.

CNN

"Sprint unveils its first 4G phone" – 3/24/10
"Apple has sold more than 2 million iPads" – 6/7/10

FCC Chair Genachowski at CTIA 2009
Source: CTIA.

Defense Business Board

"While the Business Board does not generally advocate use of extreme language or use of words like "crisis" – the Task Group agreed that they see an *impending crisis based on current trends* …" – January 2010

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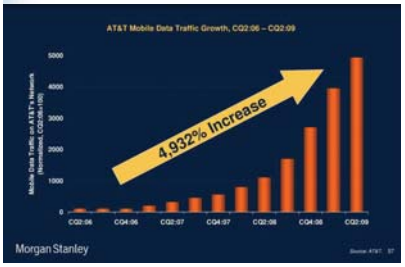
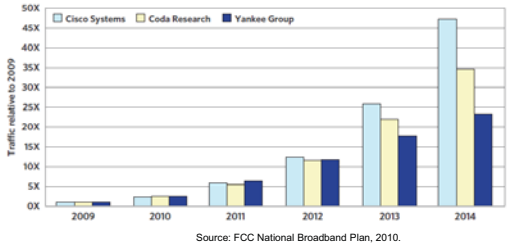
U.S. Mobile Data Traffic Growth



AT&T thru 2009



Source: FCC National Broadband Plan, 2010.

Projected Growth for All Carriers Relative to 2009

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Congressional Activities

- **February 2009 – Congress directed the FCC to develop a *National Broadband Plan***
  - **Published in March 2010**
  - **Includes recommendations on making more spectrum available for wireless broadband services**
- **March/July 2009 – Radio Spectrum Inventory Act legislation introduced in Senate/House**
  - **Mandates that FCC/NTIA create and update biennially, an inventory of government and non-government spectrum use**
  - **Purpose: "significant step in making available more spectrum for commercial and wireless services", R. Boucher (D-Va)**
  - **House version passed April 10, 2010**
  - **Senate version blocked by Sen. Tom Coburn (R-Ok)**

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National Broadband Plan Recommendations on Spectrum

- Ensure greater transparency concerning spectrum allocation and utilization
- Expand incentives and mechanisms to reallocate or repurpose spectrum
- Make more spectrum available for broadband within the next 10 years
  - 500 MHz within 10 years
  - 300 MHz (between 225 MHz – 3.7 GHz) within 5 yrs
    - 20 MHz - 2.3 GHz WCS band
    - 10 MHz - Upper 700 MHz D Block
    - 60 MHz - Advanced Wireless Services (AWS) auctions
    - 90 MHz – MSS terrestrial component deployment
    - 120 MHz – reallocate from broadcast television

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Summary

- Satellite navigation system capabilities are expanding greatly both domestically and abroad
  - Many new signals with advanced features for more robust tracking in challenged environments
  - Many more satellites providing better positioning geometry
- Mobile wireless services anticipated to utilize many additional bands over next decade
  - FCC/Congressional activities anticipated to lead to 100's of additional MHz of spectrum
- Together, these developments will offer many new possibilities for future wireless RF localization

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