RECOGNIZING GPS CONTRIBUTIONS

IRV LEVESON

LEVESON CONSULTING

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Outline

- Benefit Measurement
- Spectrum Policy and Analysis
- Needs for Assessing and Communicating Benefits

BENEFIT MEASUREMENT

Objectives of Benefit Studies

- To inform policy-making by:
  - Enhancing understanding of applications, constituents, markets, returns on investment, and costs for effective planning and resource allocation
  - Providing a baseline for determining the gain or loss of benefits from alternative developments or courses of action
  - Advancing recognition of the contributions of the program

Uses include:

- Support for program planning and budgeting
- Assessing the impact of long term signal interference
- Support for architecture assessment

Measuring Benefits

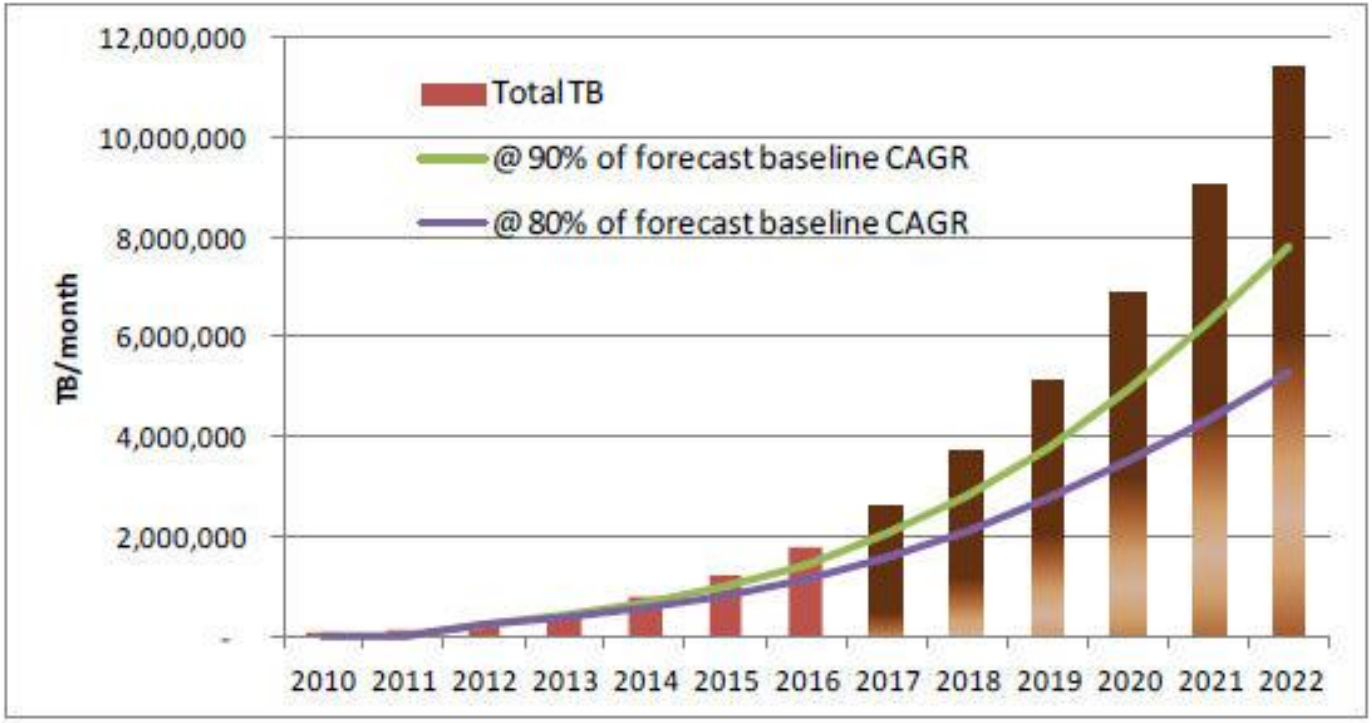
- Focus on productivity gains and cost savings in sectors where GPS is used
- Benefits should include:
  - Induced benefits from influences on productivity, cost, innovation, and output in the rest of the economy
  - Consumer and producer surplus – value above market price
  - Societal benefits such as those to life, health, safety, security, and the environment

Loss of Benefits if No GPS

- **Long run benefits** are measured as the loss of benefits **if GPS never existed**
  - Without GPS there would be greater use of alternative technologies and services so there would not be a full loss of benefits
- Loss from **temporary denial of benefits** is useful in examining security and risk issues, including temporary interference and interruptions of service
  - Impacts may be large for a short period because there isn't time to adjust production methods or services
- **Continuing sources of interference**, even if intermittent, can have major effects

SPECTRUM POLICY AND ANALYSIS

Forecast U.S Mobile Data Demand



Notes: Forecasted total demand growth assumes Voice TB remain flat at 2011 levels. Cisco (2012a) figures for Data TB used for 2010-2016. These Data TB figures are extrapolated forward for 2017-2022 assuming that Cisco's forecasted demand growth rate for 2015-16 decays by 4 percentage points per year over the 2017-2022 period.

Source: Clarke (2013), Exhibit 4

Spectrum Policy

- The FCC National Broadband Plan recommended that the Commission make available 500 MHz of new spectrum for wireless broadband, including 300 MHz for mobile flexible use, within five years
- The President directed, in a June 28, 2010 Executive Order "Unleashing the Wireless and Broadband Revolution," that 500 MHZ of new spectrum be made available for mobile and fixed broadband use over the next ten years

The Executive Order cited the following benefits:

- "Expanded wireless broadband access will trigger the creation of innovative new businesses, provide cost-effective connections in rural areas, increase productivity, improve public safety, and allow for the development of mobile telemedicine, telework, distance learning, and other new applications that will transform Americans' lives."
- "Spectrum and the new technologies it enables also are essential to the Federal Government, which relies on spectrum for important activities, such as emergency communications, national security, law enforcement, aviation, maritime, space communications, and numerous other Federal functions. Spectrum is also critical for many State, local, and tribal government functions."

These are applications for which GPS positioning, navigation and timing provides major benefits.

FCC Evaluations

- Focus on:
  - Numbers of subscribers that can benefit from a technology or service
  - Level of service/performance they would get with each technology
  - Cost of relying on alternative technologies
  - Extent of competition with alternative configurations of technologies and providers
- Industry projections of overall demand
- Uses in some key applications
  - **No measurement of the economic and societal benefits of the services provided by use of the technologies beyond telecom cost savings**
- Industry plans and effects of policies are examined
  - **No estimation of the effects of price increases in moderating increases in spectrum demand**

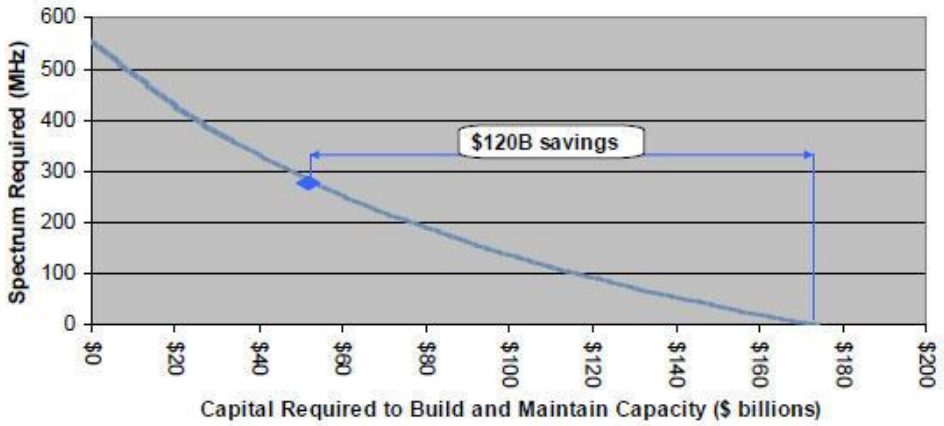
The Big Unanswered Question

How do the incremental benefits of using spectrum that interferes with GPS compare with the benefits of GPS that would be lost due to interference?

FCC Studies 1

Mobile Broadband: The Benefits of Additional Spectrum

- Projects gap in spectrum of 275 MHz in 2013 from surplus of 377 MHz in 2009, assuming no new spectrum
- Estimates saving in cost of capital required to generate additional capacity of $120 billion if additional spectrum is unavailable
  - Includes net present value of operating costs discounted at 10%
  - Includes extensive sensitivity analysis to alternative assumptions

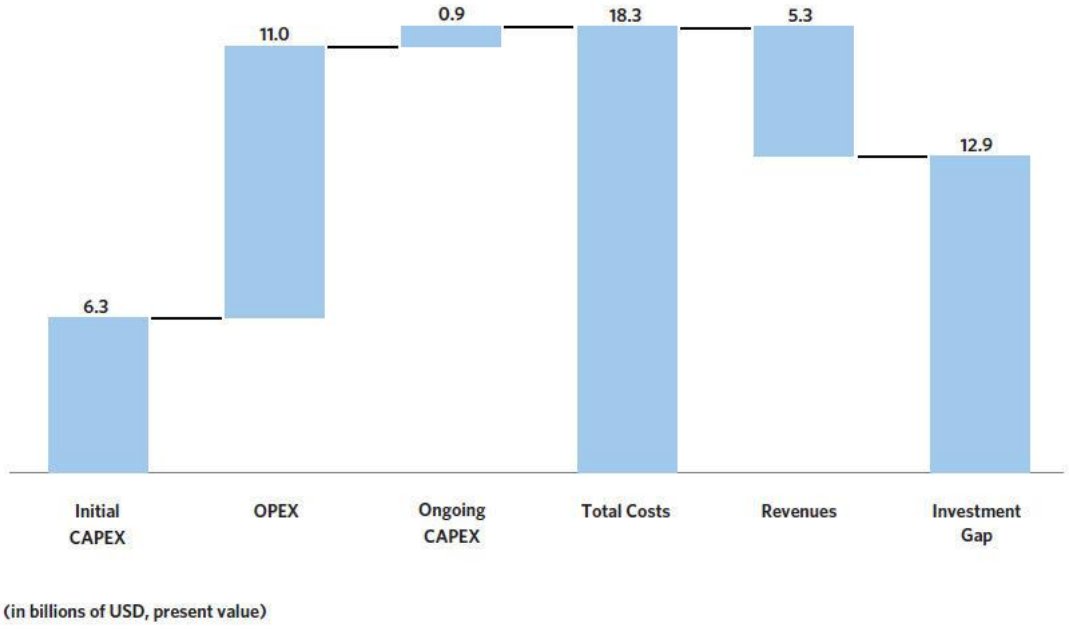


FCC Studies 2

"Network Economics," Chapter 4, *The Broadband Availability Gap*

- Models technologies to compare costs of delivering the last mile to underserved areas with different requirements
  - Provides extensive information on wireless technology configurations

Investment Gap for Wireless Networks



Council of Economic Advisors

The February 2012 CEA report: *The Economic Benefits of New Spectrum for Wireless Broadband:*

- Put the logic of the *National Broadband Plan* in easier to understand terms
- Reviewed evidence on the strong impact of broadband on economic growth in the U.S. and other countries
- Reviewed the evidence on projected benefits of *wireless* in the U.S., noting: **"…it is too soon for the empirical data to yield reliable estimates of the economic impact of wireless broadband."**

Studies cited by CEA

- A 2008 study by Roger Entner of Ovum for CTIA that estimated "…the productivity gains from wireless broadband adoption resulted in $33 billion in annual cost savings in 2005, with that figure projected to grow to $127 billion [per year] by 2016."
- A 2011study by D. Sosa and M. Van Audenrode of Analysis Group for Mobile Future that estimated reassigning 300 MHz of spectrum to mobile broadband "will lead to 300,000 new jobs, and $230 billion in additional GDP, within five years." [five year total]
- Other studies estimate the impact of investment on GDP and jobs from industry investment using the RIMS II input-output model

Available Studies are Inconsistent

- FCC studies measure benefits by the capital spending that is made unnecessary by freeing up spectrum
- Sosa and Van Audenrode treat additional capital spending that is *made possible* by the release of spectrum as a benefit that is multiplied to produce even greater increases in GDP
- No measure is available of the net effect of spectrum reallocation on telecom capital spending after allowing for capital spending that would no longer take place and new capital spending, including changes that would take place in the intensity of geographic reuse and/or increases in throughput capacity per MHz

NEEDS FOR ASSESSING AND COMMUNICATING BENEFITS

What's Needed for a More Complete Picture of GPS Benefits and Consequences of Their Loss?

- More economic benefits to more sectors
  - Especially **timing** and **aviation**
  - Precision, scientific, and government, intelligent transportation systems, power generation and transmission, financial, homeland security and emergency services, etc.
  - Households
  - Facilitated economic effects such as growth of new products and industries and increased growth
- **Societal benefits** – life, health, safety, security, environment, etc.
- Implications for jobs and incomes
- **Future benefits** and costs for alternative system, technology and market developments
- System investments and user costs
- Value net of benefits of other constellations
- **Stories** that illustrate present and future uses and benefits
- **Impacts of disruption**: loss of benefits of affected commercial, government and household applications and costs of mitigation
  - Costs and loss of benefits from imposition of receiver standards and other methods of mitigation, including effects on productivity and innovation

Assessing Future Benefits

- Estimating U.S. benefits under alternative future **scenarios**:
  - Illustrates the magnitude of benefits over an extended period of time
  - Provides a framework for examining implications of potential future developments and policies
    - Reflecting changing technologies, GNSS evolution, growth of market potential, market penetration, creation of new applications and markets, costs, threats, and societal aspects

Stories: In Boston, GPS Was There

- In the rescue
  - Ground and air transport and communications
- In the search
  - Photo location and time stamping
  - Cell phone and other communications timing
  - Mapping
  - Tracking vehicles
  - Helicopter navigation
  - ATM timing and location
  - Investigation of people and objects of interest

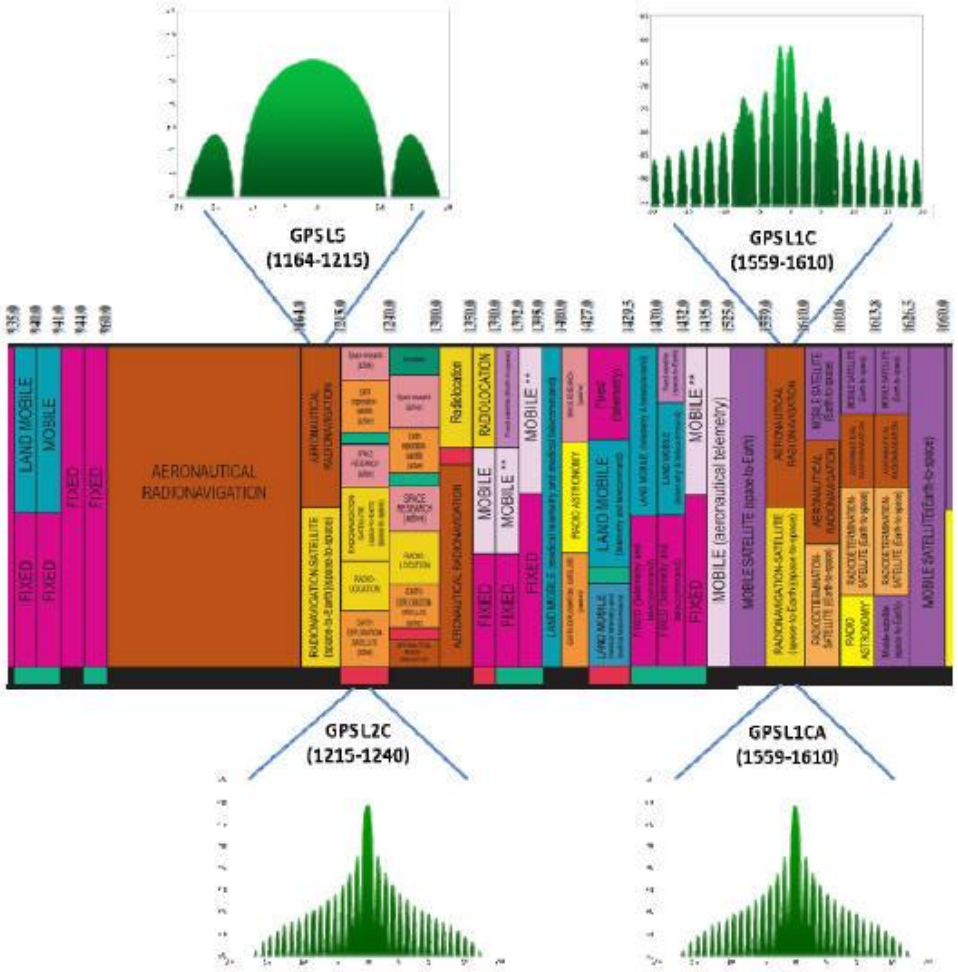
Conclusion

- A lot of information exists on benefits and utilization of GPS but it is incomplete, widely scattered, of uneven quality, and often not up to date
- A measure of overall benefits is helpful in policy discussions. It should include:
  - All major economic sectors
  - Indirect and induced economic effects
  - Broader societal benefits
- Detailed information for key sectors is needed for understanding uses and benefits
- Demonstrating value is more compelling when it includes consideration of future as well as present benefits
- Communication of benefits can be enhanced by inclusion of stories
- Estimates of loss of GPS benefits from interference are needed
- Benefits and costs of mitigation alternatives need to be quantified
- Comparative benefits of alternative spectrum use is needed to assess the value of preventing interference

THANK YOU

SUPPLEMENTARY SLIDES

Civil GPS Signals and the Spectrum Environment



Source: *2012 Federal Radionavigation Plan*

Information Required for Estimation of Direct Benefits

- Market size of applications
- Total productivity impact of introducing GPS in application
  - Above what would occur in the absence of GPS
  - Excluding the share of benefits attributable to any other productivity enhancing changes in methods of production or use of resources that accompany introduction of GPS in the application
- Percentage of productivity impact lost, net of mitigation, if there is particular type of sustained or ongoing intermittent disruption
- Need for more complete and current information on the above
- Future values for the above

Some Elements that Could Be Incorporated Into Future Scenarios

- **Impacts of L2, L5 and L1**
- Evolution of the constellation, including timing, size and capabilities
- **Evolution of other GNSSs**
- Evolution of wireless and other communications systems
- Evolution of receivers
- Evolution of technological supplements for use indoors and in obstructed areas
- Evolution of alternatives to GPS position, navigation and timing
- **NextGen evolution**
- Intelligent transportation systems evolution
- Evolution of precision applications and networks for precision uses
- Evolution of distributed devices and location-based services
- Evolution of communications, financial, power and other timing-dependent applications
- **Evolution of government applications**
- Evolution of scientific and environmental applications

Productivity Studies

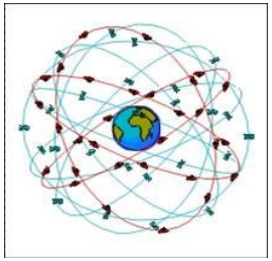
- Availability
  - Sufficient availability in agriculture, construction, mining, surveying and mapping and fleet tracking; otherwise sporadic
- How representative is available information?
  - Are productivity impacts greatest in the applications where productivity is easiest to measure?
  - Information includes actual use, controlled experiments that may not fully reflect real world conditions, best practices that differ from typical practices, case studies subject to publication bias, rough judgments and testimonials
  - How accurate is assuming that benefits in sectors that do not have information are equal to benefits in other sectors that do have information?

Use of Multipliers and Models

- Econometric models can combine application-specific productivity impacts with input-output relationships
  - Adapting multipliers from existing studies, if the studies are well done and sufficiently analogous, may be a good substitute for new formal modeling
- Computable General Equilibrium (CGE) models which more fully incorporate interactions in the economy have been used to more completely trace through the effects of changes.
  - Using available CGE models can add considerable complexity and cost to a study
  - In studies of sectors related to GPS, CGE models that have been used were designed for very different purposes, requiring alteration of the data to fit the model framework, adding a layer of error
- Even when productivity is explicitly taken into account, neither of these approaches fully captures innovation and development of new markets

Allowing for Other GNSS Systems

- In gauging benefits of GPS, benefits of other GNSS systems can be considered incremental to those of GPS since GPS would have existed without them
  - Benefits of other GNSS systems would have to be subtracted from combined benefits of multiple GNSS systems in calculating benefits of GPS



- Alternatively, benefits can be allocated among systems in proportion to their importance to each application
- Benefits of augmentations such as WAAS and EGNOS that are needed for aviation with or without GNSSs should be measured separately from benefits of GNSS systems

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Comprehensive Studies

(see August 2012 PNT Advisory Board meeting slides for details)

- GPS
  - Aerospace (Leveson) - March 2010
    Current U.S. Economic Benefits of GPS
    (Interim Report)
  - NDP (Pham) - June 2011
    The Economic benefits of Commercial GPS Use in the U.S. and the Costs of Potential Disruption
- Other
  - Australia
    - Allen Consulting Group - 2008 – high resolution positioning services
    - ACIL Tasman - 2008 – spatial information
  - Europe - various

Leveson GPS and Related Studies

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Biography

Irving Leveson is an expert in economic and strategic analysis and public policy, combining an understanding of critical issues and trends with experience dealing with practical problems. He has worked for both business and government and addressed complex social and technological, as well as economic and industry issues.

Dr. Leveson has been working on GPS customers, markets, benefits, financing and related issues since 2004.

Dr. Leveson has been providing research and consulting services through Leveson Consulting since 1990. He has served as a consultant to the Aerospace Corporation and is an Adjunct Fellow at the Hudson Institute.

From 1984 to 1990 he was Senior Vice President and Director of Research of Hudson Strategy Group, a consulting firm that was part of Marsh & McLennan. He served as Director of Economic Studies of Hudson Institute from 1977-84. He received his PhD in economics from Columbia University.

His books include *Economic Security*, *American Challenges*, *Western Economies in Transition* (co-ed.), *The Future of the Financial Services Industry* (main author), and *Analysis of Urban Health Problems* (co-ed.).

Contact:

Irving Leveson
Leveson Consulting
ileveson@optonline.net
www.levesonconsulting.com
732-833-0380
cell 609-462-3112
fax 732-833-9986
10 Inverness Lane
Jackson, NJ 08527-4047