

A COMPREHENSIVE QUANTITATIVE ECONOMIC ASSESSMENT OF GPS

Establishing Scope, Duration, Expectations and Deliverables

National Space-Based Positioning, Navigation and Timing

Advisory Board Meeting

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Outline

- Study Parameters
- Approach
- Conclusions and Next Steps
- Appendix A: Work Plan
- Appendix B: Sources and Methods

STUDY PARAMETERS

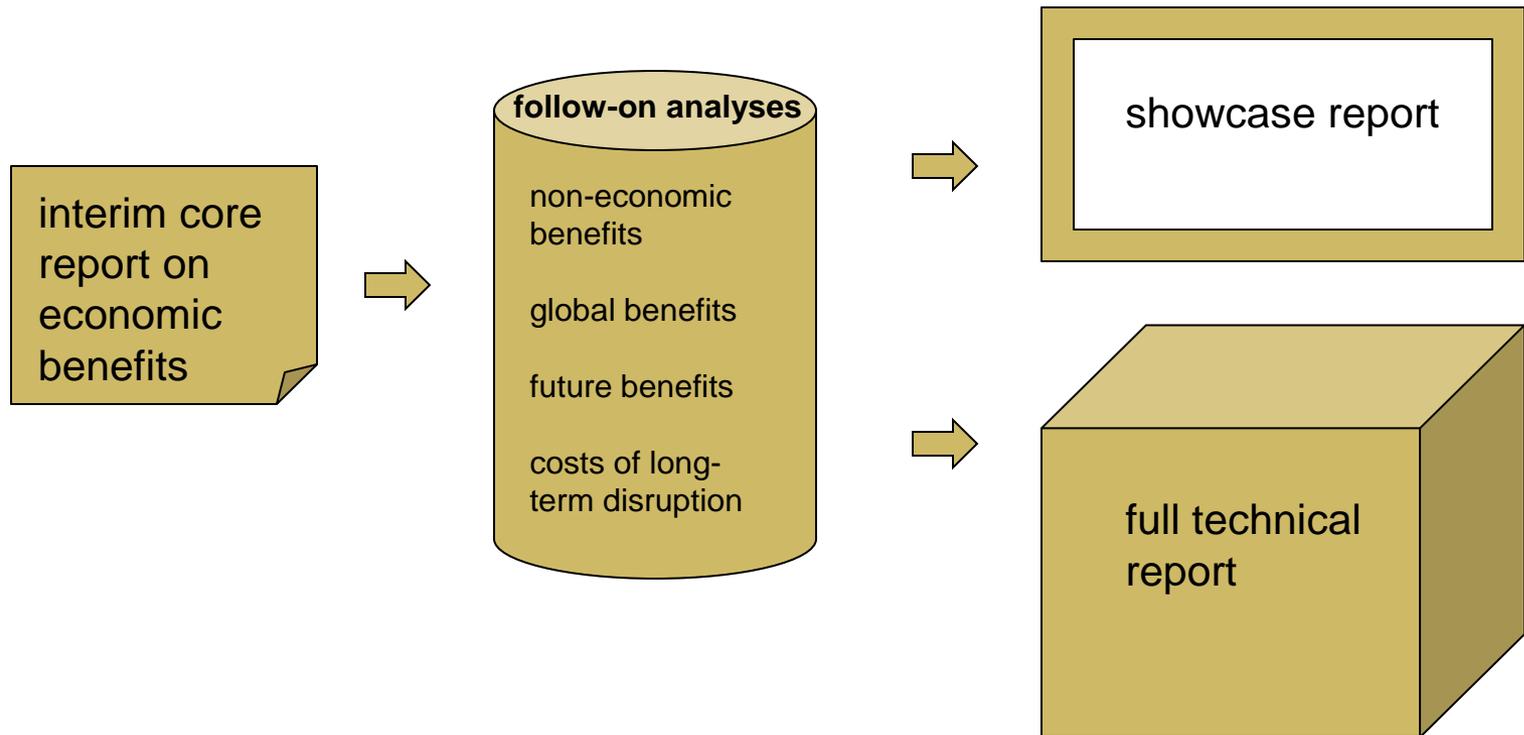
EXCOM Action Item

DOC to lead interagency team in consultation with the National Space-Based PNT Advisory Board to develop a way forward for an updated, authoritative GPS economic benefit assessment.

Part 1 Objectives

- Describe the major uses of GPS and its position in the value chain
- Provide updated, more complete and methodologically sound estimates of economic scope and benefits of GPS to the U.S.
 - In support of follow-on analysis of additional benefits and assessment of costs of loss of GPS
- Provide an Interim Report that can serve as a core for development of follow-on analysis and final reports on GPS benefits in Part 2
 - The Part 2 analysis will include non-economic benefits, international benefits, future benefits and selective estimation of economic costs of long-term denial of GPS
- Results of the combined analyses will be presented in:
 - A “showcase report” designed for a broad audience, with examples and stories
 - A full analytic report documenting sources and methods

Interim Report Flows Into Next Stage and Final Reports



Arrangements

- The study is being conducted under the auspices of the PNT Coordination Office
- The PNT Coordination Office will regularly convene an inter-agency working group of economists to consult on methodology and information sources
 - A preliminary meeting of DOC members was held on Dec. 9, 2014
- The contractor will confer with and brief the National Space-Based Positioning, Navigation and Timing Advisory Board

Tasks for Part 1

- Describe numerous applications of GPS, their role in the value chain of economic activity, and their benefits to users and others
- Extensively review U.S. and international studies of economic benefits of GPS and other GNSSs and document the evidence
- Explain concepts, types and reliability of data, and estimation methods for economic benefits
- Estimate current U.S. market sizes and market penetration for key applications
- Estimate the value of current economic benefits of GPS to the U.S. and major using sectors and discuss less tangible values of GPS to the U.S. and other nations
- Define approach and tasks for the Part 2

APPROACH

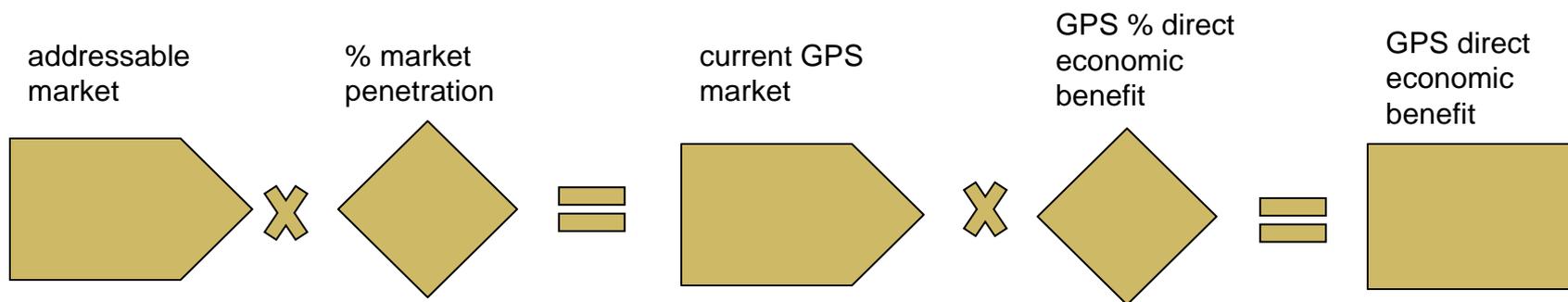
Definition of Benefits

- Benefits are measured relative to what would have been expected if there were no GPS
- Economic benefits are measured primarily by productivity improvements, cost savings and cost avoidance
- Expenditures on GPS/GNSS user equipment and applications are costs to the user, not benefits

Some Types of Benefits

- Increased productivity and cost savings
- Saving time
- Innovation and development of new products and markets
- Improved management of business and personal activities
- Facilitating commerce
- Increased choice and opportunities
- Reduced stress and anxiety (e.g. over wrong directions, lateness, lack of communication)
- Increased safety and health and improved warnings and handling of emergencies
 - Reduced loss of life, injury and disability, medical costs, damage and loss of income
- Scientific research, exploration, legal, financial and educational aspects
- Improved environment and environmental management
- National leadership and prestige

Relationship of Addressable Markets to Benefits



Methods

- Since benefits are measured relative to what would have been expected if there were no GPS, consideration is given to:
 - The availability of alternative technologies
 - Ways markets could have evolved without GPS
- Allowance is made for:
 - Roles of GPS as part of application systems
 - Roles of other GNSS systems in producing measured benefits
- Allowance is made for deficiencies in benefit information
 - **Balancing between presenting better data and covering important sectors which are less well measured is necessitated by limitations on data on market size, benefit data availability, quality of data and whether methods are documented or source materials available**
- Indirect and induced benefits are calculated based on multiplier analyses
- Less tangible values of GPS to the U.S. and other nations are discussed

Expertise of Others Could Be Useful In Assessing

- Market size and market penetration
- Availability of benefit information
- Possible evolution of technologies and markets in the absence of GPS
- GPS contribution vs. other technologies and systems
- GPS contribution vs. other GNSSs

CONCLUSIONS AND NEXT STEPS

Advantages of the Present Analysis

- More current information on the present role and economic benefits of GPS to the U.S.
- More complete and detailed coverage of sectors and applications
- Methodological improvements
- Communication and documentation

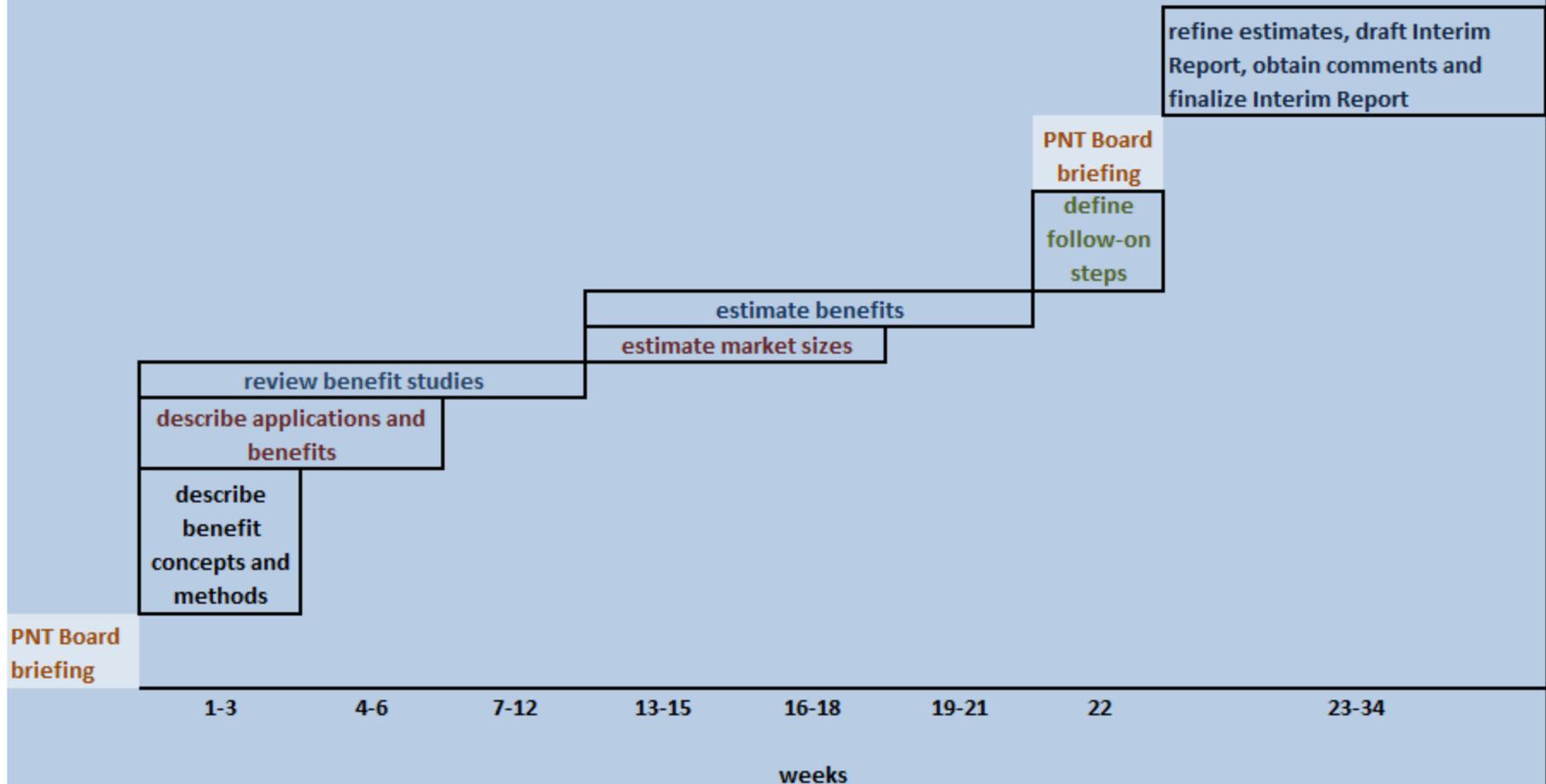
Conclusions

- Benefit estimates are “ball park,” no matter how sophisticated the methodology because of limits to the availability of information
- Nevertheless, it is possible to demonstrate orders of magnitude in many specific applications as well as in total, along with the widespread nature of the benefits and beneficiaries, and to effectively communicate that information
 - The information can be used to improve understanding of the importance of GPS if it is presented in interesting and understandable ways, repeated often, and used in specific as well as broad situations
 - It can be an important component in analyses of long-term signal degradation or loss and can be useful in planning

Current Stage Next Steps

1. Confer with the inter-agency working group
2. Confer with the PNT Advisory Board
3. Review literature and assess reliability
4. Develop estimates of market size and penetration
5. Estimate present benefits to the U.S.
6. Brief the PNT Advisory Board and government agencies
7. Prepare the Interim Report

Timetable for GPS Economic Value to the U.S., Interim Analysis



The final timetable is 30 weeks

Deliverables

- A preliminary current U.S. economic value analysis briefed to the PNT Advisory Board and appropriate government agencies
- An Interim Report that can form the core of a summary “showcase report” and a full technical report of the follow-on analysis

Components of Part 2

1. Estimate selected values of current benefits in public safety and reduced loss of life in critical applications
2. Estimate orders of magnitude of economic benefits of GPS to other regions and the world
3. Assess potential future applications and markets and make projections of future market penetration and values of benefits of GPS to the U.S. under alternative scenarios.
4. **Estimate orders of magnitude of economic costs of partial and complete long-term loss of GPS availability** in selected applications under alternative scenarios, drawing on the sector estimates of benefits, and including rough estimates of economy-wide impacts
5. Integrate analysis and findings of both phases in 1) a “showcase report” designed to appeal to a general audience, and 2) a full technical report and briefings covering all stages of the analysis

THANK YOU

APPENDIX A: WORK PLAN

Work Plan (1 of 3)

1. Discuss the context, tasking, objectives and work plan with DOC, DOT, the PNT Advisory Board and others
2. Describe benefit concepts and methods
 - Explain benefit concepts, types and reliability of data, and estimation methods for economic benefits
 - Indicate methods available for measuring international economic benefits, benefits to public safety and reduced loss of life, assessing future benefits and evaluating costs of long-term loss of GPS
3. Describe applications of GPS and their benefits to users and others, roles of GPS in the economic value chain, and less tangible values of GPS to the U.S. and other nations
4. Review U.S. and international studies of economic benefits of GPS and other GNSSs
 - Studies of overall benefits
 - Studies of applications and sectors

Work Plan (2 of 3)

5. Estimate current U.S. market sizes for key applications
 - Review estimates of market size for GPS/GNSS user equipment
 - Review sizes of sectors affected by GPS
 - Review evidence and calculate U.S. addressable market sizes for GPS/GNSS applications and industries
 - Assess market penetration and estimate current market sizes for applications
6. Estimate values of current economic benefits of GPS to the U.S. and major using sectors
 - Make initial estimates of direct benefits that would exist in the absence of GPS
 - Allow for contributions of other technologies and systems, other GNSSs and biases in data
 - Estimate multiplier effects and calculate total economic benefits
 - Assess uncertainty in the benefit estimates
7. Enumerate steps for a follow-on analysis to address U.S. non-economic benefits of GPS, global economic benefits, future U.S. benefits, and analysis of effects of potential long-term disruption of GPS on selected sectors and the economy

Work Plan (3 of 3)

- Present findings to DOC and other agencies and the PNT Advisory Boards
- Prepare the Interim Report, obtain comments and finalize the Interim Report

APPENDIX B: SOURCES AND METHODS

Broad Quantitative Studies of GPS/GNSS Benefits

- GSA (2013)
- Oxera – GEO services (2013)
- NDP (2011 and 2013)
- Leveson (2010)
- ACIL-Taman – spatial info in Australia (2008)

Benefit Information Can Come From

- Government, industry, trade and academic studies and materials
- Discussions with government and industry experts
- Parallels with analogous applications and circumstances

Types of Information On Productivity and Cost Savings Can Differ Greatly In Reliability

1. Provider claims
2. User claims and testimonials
3. *Judgments of experts*
4. Before and after studies of technology or program introductions
5. Comparative studies of introducing or using different technologies or systems

There may be a greater tendency to report successes in any of these sources. Allowance needs to be made for possible biases.

Sources of Information on GPS Revenue and Shipments

- Revenue and shipments from ABI with updates for 2010 are available in NDP slides
 - It may be possible to update some of this information based on other sources
- Scattered information is publicly available from diverse market research studies and industry sources
 - For example, recent reports from the Consumer Electronics Association and Frost & Sullivan
 - These often provide data for specific sectors

Market Size Information Is Now Available from Census and Other Sources for 2012

- The 2012 Economic Census is a 5-year update of data on “value of sales, shipments, receipts, revenue or business done” and employment for 3-digit private industries according to the 2012 North American Industrial Classification System (NAICS)
 - The Advance Report of the Core Business Statistics Series at the 3-digit NAICS level has been released
 - Industry reports for the Industry Series providing data at the 4 and 5-digit NAICS level are being released through February 2015
- The Census Bureau also has published annual surveys of services, trade and other industries and the Census of Governments with data for 2012.
- Extensive scattered information is available from trade and industry sources, including special studies and company reports
 - Market research reports typically have data for 2012 at this time. It is necessary to rely on summary releases of proprietary reports

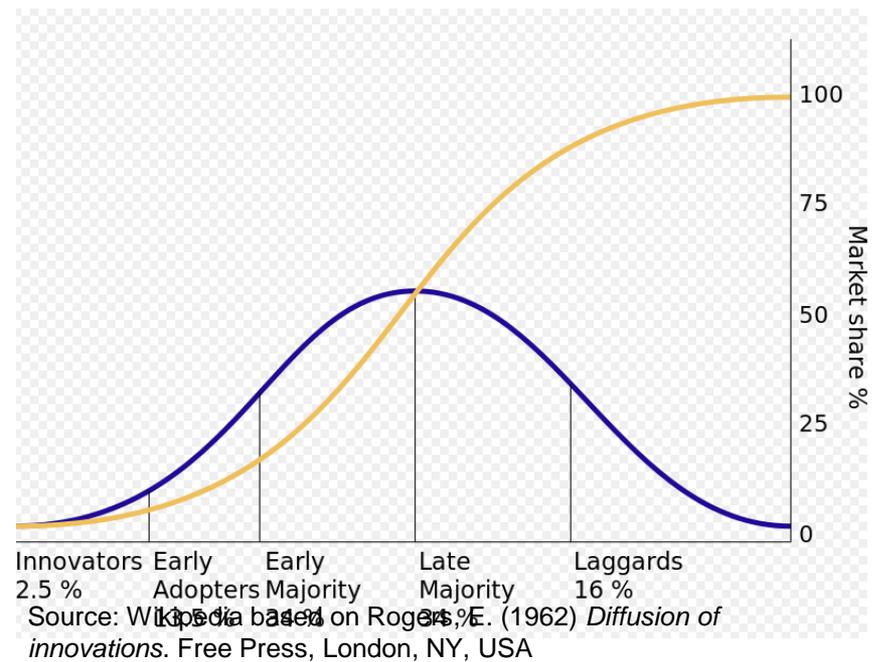
A Classification Previously Proposed by Brad Parkinson

Application Areas and Applications					
General GPS Applications		Hi-Precision Applications		Military Applications	
•Emergency Services	Ambulance	•Aviation	Area Navigation	•Military	Precision Weapon Delivery
	Building Fire		Approach		Launch Guidance
	Police		Landing up to Cat III		Military Rescue
	Rescue Helicopters		NextGen		Unit and Individual Location
	Wildfire	•Scientific	International Time Standard		RPV Guidance
	National Disasters		Earth Crustal Movement		
E-911	Atmospheric, Ionospheric				
•Tracking	Fleets		Earth's Shape		
	Animals		Environmental Research		
	Alzheimer Victims	•Robotics/Machine Control	Construction Vehicle Guidance	This partial list of applications, illustrates the need to define sectors by function to the extent possible	
	Cargo	• Commercial Timing	Mining Vehicle Guidance		
	Criminals, Suspects, Parolees		Cell Phone Towers		
	Railroads		Power Grid		
• Marine	Fishing Limits and Border Enforcement	•Agriculture	Banking		
	Harbor and Harbor Approach		Auto Farming		
	General Navigation		Crop Spraying		
• Weather	Forecasting		Precision Cultivating		Yield Assessment
	Weather Balloon Tracking	• Survey and Mapping	Geodetic and Cadastral		
•Rescue	Emergency Beacons		Roads and Bridges		
	Airplane and Ship Locaters		Site Layout and Survey		
	OnStar				
•Recreational /Automotive	GeoCaching				
	Turn by Turn Guidance				
•Convenience	Cell phones				

GPS Market Penetration

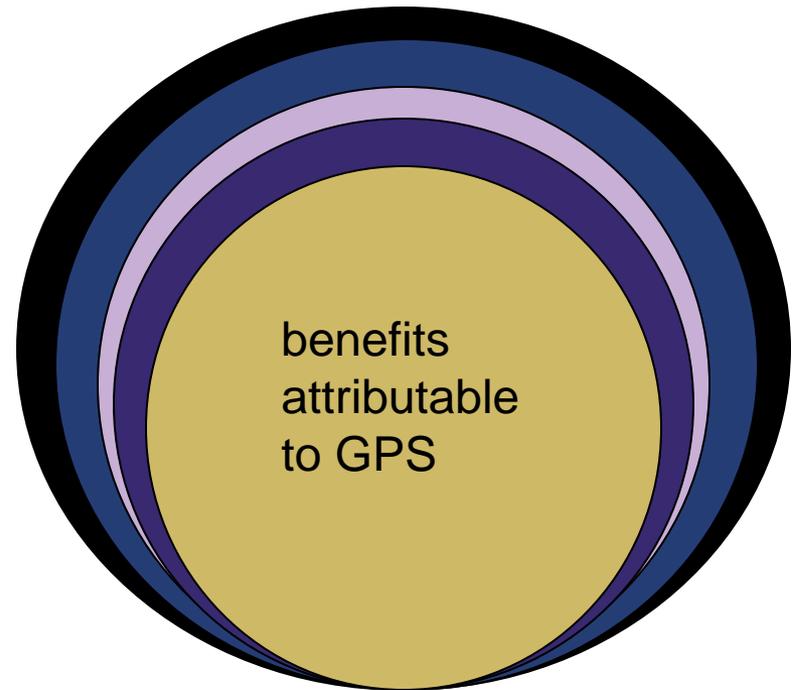
- Direct data is available on the extent of current use of GPS for some applications
- Expert opinion can be help fill in gaps
- Where necessary, estimates can be made based on earlier data along with previous growth projections or growth in other situations
- GNSS market penetration in other countries and other GNSS applications, and historical patterns in non-GNSS applications also may be applied

Example of market penetration derived from a distribution of preferences



Allocations May Be Needed for:

- Reporting bias
- Use attributable to other technologies and systems
- Use along with other GNSSs
- Benefits in the absence of GPS
 - Allowing for long run adjustment of technologies and business models



Economic Multiplier

- Benefits to the economy can be direct, indirect and induced
 - Indirect effects are impacts on demand for goods and services of supporting industries
 - Induced effects include resulting product and process innovation and expansion in the economy
- Multipliers have been estimated from input/output models and econometric models of the economy to determine indirect and induced economic effects
- As a substitute for new formal modeling, multipliers from existing studies that use both of these methods may be adapted to allow for different characteristics of the applications and study methods

Analysis of Uncertainty in the Benefit Estimates

- Ranges will be used to reflect uncertainty in some components of the estimates
 - Typical ranges will be applied to totals
- A convenient method of expressing uncertainty which has often been used in project management and business decision-making is to assume a triangular distribution of values around the mean
 - In a triangular distribution the point estimate is the mode and the lower and upper bounds are a given percentage from the mode (10% has been used by some analysts)

Leveson Biography

- Dr. Leveson has strong analytical skills in economics, business and public policy and extensive experience analyzing programs, markets and technologies. His background includes strategic and economic consulting and research in private industry, non-partisan think tanks, and government. Dr. Leveson has done extensive work on GNSS markets and issues for over 10 years. He has been an independent consultant since 1990. He has served as a consultant to the Aerospace Corporation and is an Adjunct Fellow at the Hudson Institute.
- Dr. Leveson holds a Ph.D. in economics from Columbia University. Prior to establishing Leveson Consulting he served as Senior Vice President and Director of Research of Hudson Strategy Group, Director of Economic Studies of the Hudson Institute, Assistant Administrator for Health Systems Planning for the New York City Health Services Administration and as a research director for the New York City Planning Commission. He also was an economist for the RAND Corporation and an analyst with the National Bureau of Economic Research. Dr. Leveson is a member of the Institute of Navigation, the American Economic Association and the National Association for Business Economics.
- 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.).

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