

# Satellite Servicing

## Policy, Economics, Law

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# Outline of Topics

1. U.S. Policy
2. Economics
3. Law

# U.S. Policy and History

- No policy on servicing satellites
- No coordinated R&D programs
- Demonstrations by the Government over the past 28 years
  - Manned flights (Shuttle & ISS)
  - Robotic missions
  - Fascinating technology but expensive

# Related Policy: Space Sustainability

- 2010 and 2011 formal commitments
- International—UNCOPOUS
- 2 Separate Issues
  1. Dealing with existing debris in space
  2. Minimizing new debris
- Servicing could address some debris issues

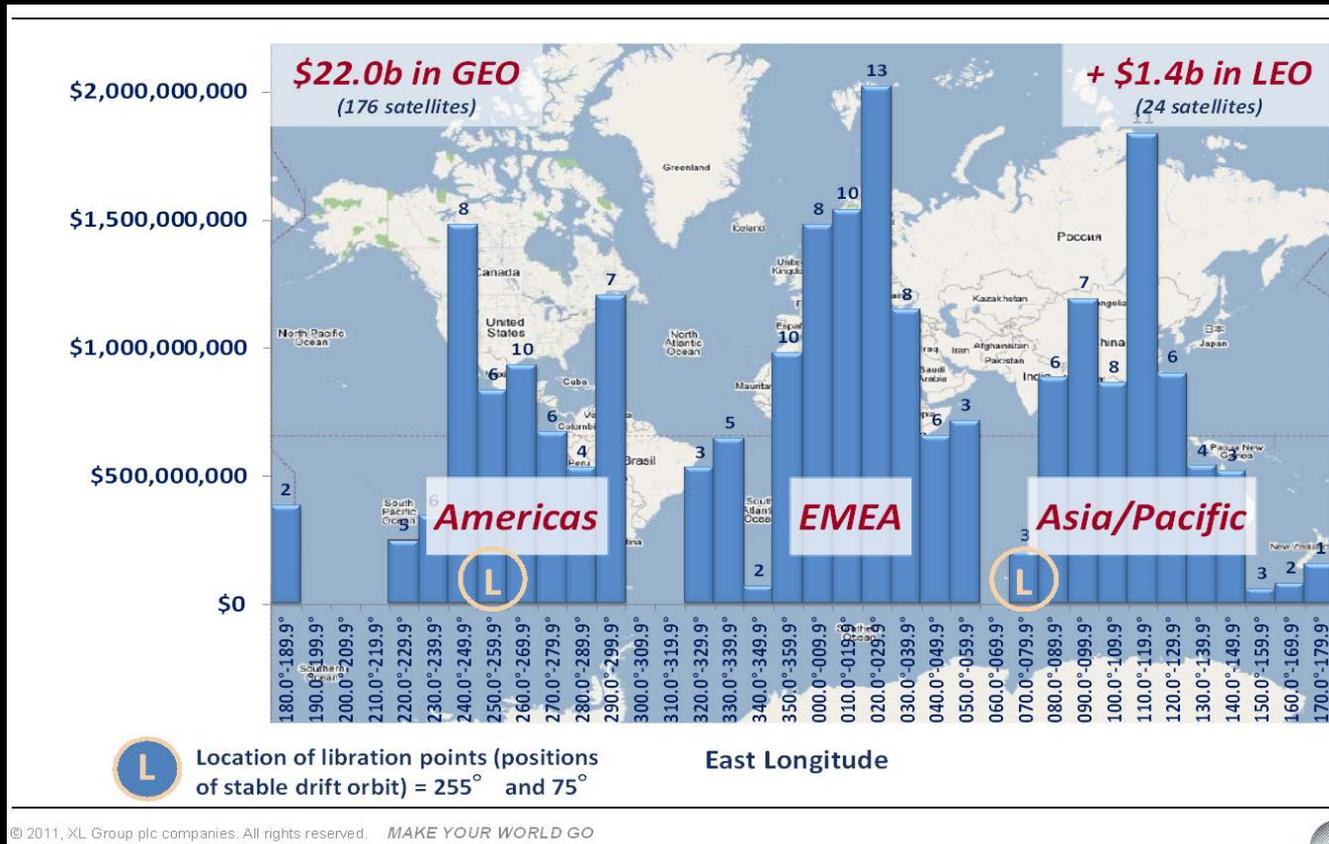
# Economics

- Basic Economic Questions
  - Market Demand
  - Supply: costs and availability
  - Benefit/Cost of servicing (Gov't. satellites)
  - Is there a business case; a profitable ROI?
  - Opportunity costs; alternate approaches

# Servicing in GEO

- Current projects are mainly for re-fueling
  - Market for re-fueling: older satellites
  - Most profitable market: newer satellites that have the greatest value

# Potential Demand: Lots of Insured Satellites in GEO

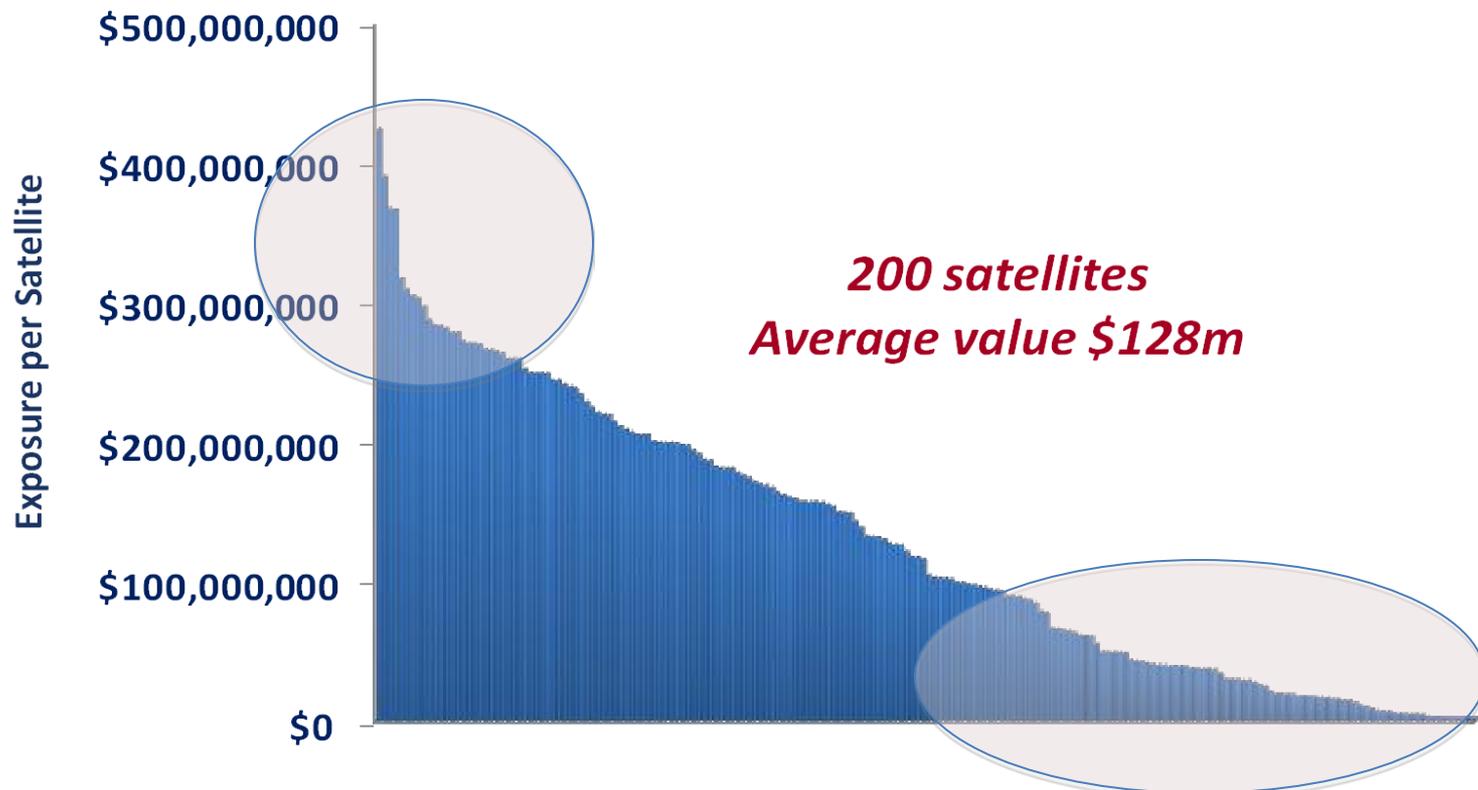


Average Value of Insured GEO Satellite: \$128 million

# But, How Many Have High Value?

## Market Exposure Profile

*All insured satellites in orbit, as of January 2012*



# Space is a Risky Business

- Launch risk
- In-orbit failure risks
- Accident/debris risks
- Important Issue: Who Bears the Risk?

# Space Debris and Risk

- 2004 study: risk of GEO collision 1 in 135 years
- LEO is far more vulnerable
- 2010 study: to maintain a new constellation of satellites in LEO at 850 km; costs increases will range from 5% to 26%
  - Depends on size and number of satellites in constellation, design of solar panels, and when the constellation was first operational
- Costs (and risks) can be reduced today

# Space Law

- International Treaties
  - A “Big Sky” when treaties were ratified
  - Liability burden rests with nations, not companies
  - Liability Convention requires proof of fault for a recovery from an in-orbit incident
- We’ve been lucky—accidents have not generated major economic damage...yet...

# Servicing and International Law

- Untested and unresolved issues:
  - Servicing another nation's satellite without consent could be considered willful action
  - Even with consent, ultimate legal responsibility does not transfer
  - Servicing one's own national satellites involves legal risks

# Domestic Legal Issues

- No agency regulates commercial in-orbit activities
- No policies prohibit indemnification for ultra-hazardous activities in space
- Technology will drive some new laws and/or regulatory modifications
  - Responsibility to maneuver to avoid an accident
  - Removal if failure to operate in-orbit
  - Definition of end-of-life for satellites
  - In LEO, responsible rules for operations of micro, nano, and cubesats

# More Unanswered Legal Issues

- Enforcing the international treaty regime
- Will servicing satellites be considered weapons by some nations?
  - If so, need for proper protocols, warnings, public advanced notice of operations, etc.
- The relationship between governments and commercial entities in space.

# Future Legal Options

- International Codes of Conduct and TCBMs
  - May be effective if translated into national regulations
- Changes to Treaty Regime or new treaties
  - Unlikely in near future
- International Private Solutions
  - Cooperative organizations like the Satellite Data Association
  - Reduction of legal uncertainties through bi- or multi-national agreements and treaties
  - Insurance
  - Government partnerships and cooperation

# Will We Resolve the Problems?

- Economics

- Benefits and costs of servicing need to be assessed
- Need to target most valuable markets
- Clear need for partnerships among companies and government

- Law

- Unlikely to be major changes in near term
- In-orbit regulations for other activities will be necessary
- If servicing technology advances, a regulatory regime will develop to permit and encourage in-orbit servicing

# Adding it Up

- Government programs
  - R&D demonstrations will continue
  - Servicing may only make economic sense for a few satellites relative to the number of satellites in orbit
  - Budgets and costs will delay programs
- Private potential
  - Again, only a few satellites may be good business candidates
  - Cost considerations
  - Companies and investors are generally risk adverse
  - Legal relationship between manufacturers, operators and governments needs to be clarified
  - International legal uncertainties