

Space For New Ideas... ...New Ideas For Space

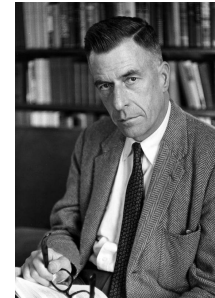
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(+1) 212-915-6387
chris.kunstadter@xlgroup.com

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A thought for today...



“The only function of ... forecasting is to make astrology look respectable.”

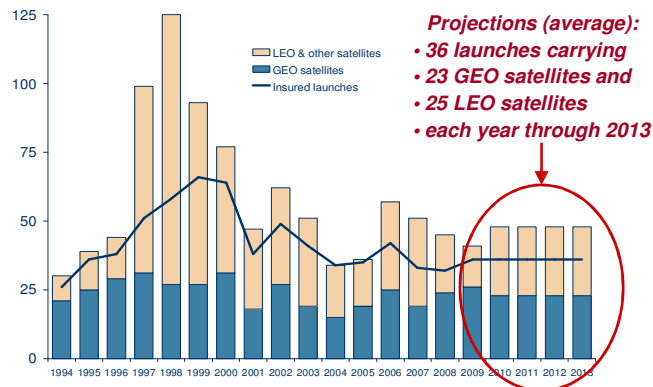
-- John Kenneth Galbraith

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How Many Launches Are Insured?

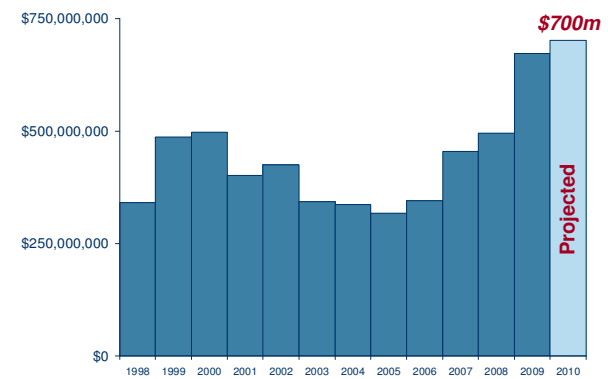


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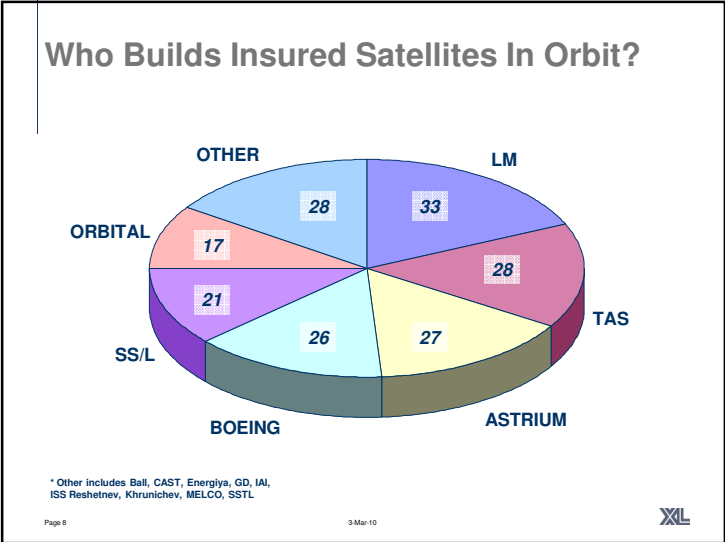
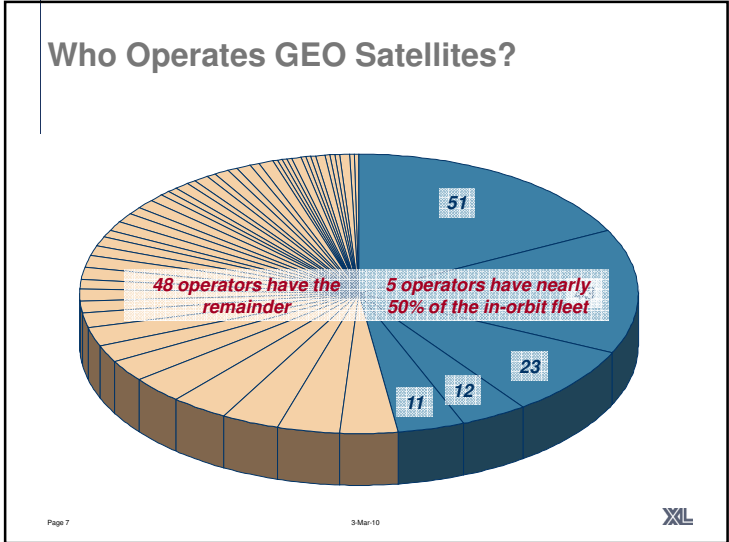
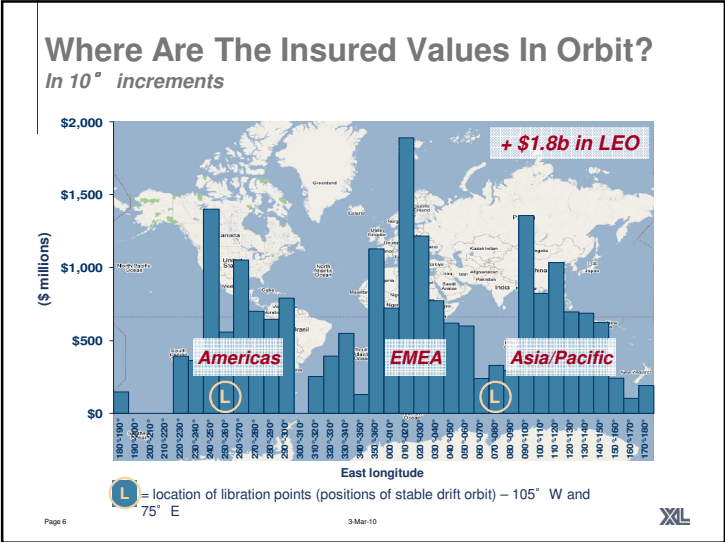
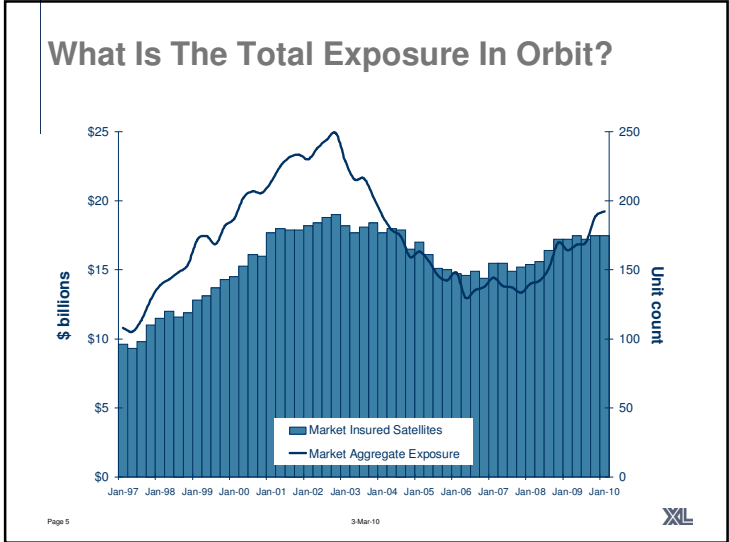
What Are The Peak Insured Values?



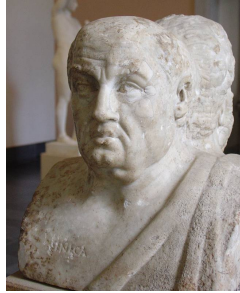
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A thought for today...

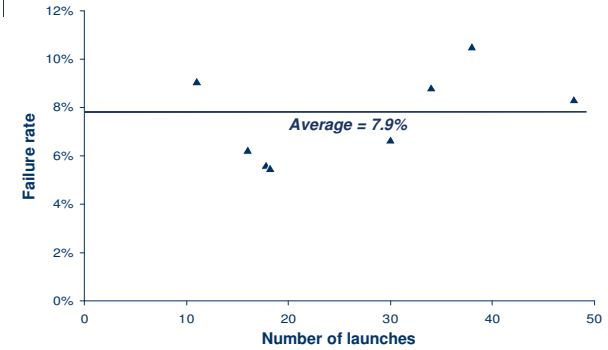


**“Non est ad astra
mollis e terris via”**

*(There is no easy way from
the earth to the stars)*

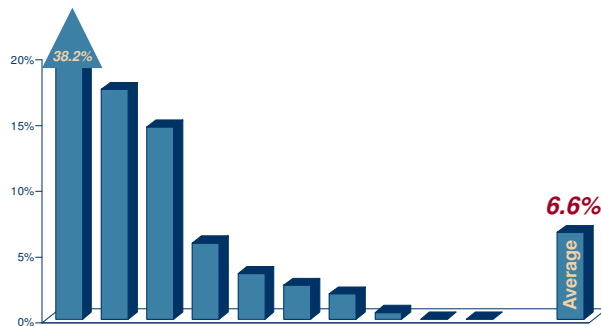
-- Seneca the Younger

What Are Launch Vehicle Failure Rates? Current GEO Launch Vehicles



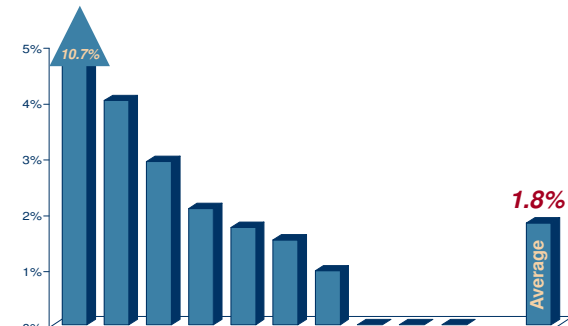
* Major GEO launch vehicles included in this survey are Ariane 5, Atlas 5, Delta 4, H2-A/B, LM-3A/B/C, Proton M/Breeze M, Soyuz, Fregat2, Zenit 3 SL/SLB (not shown in that order)

What Are Satellite Failure Rates? First year in orbit GEO comm. satellites, by manufacturer, launched since 2000*



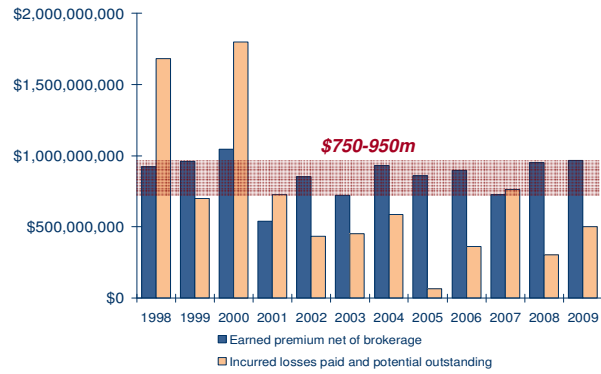
* Major manufacturers of commercial communications satellites included in this survey are Antrix, Astrium, Boeing, CAST, LM, Loral, MELCO, Orbital, Reshetnev, TAS (not shown in that order)

What Are Satellite Failure Rates? 2nd and subsequent years in orbit (annualized) GEO comm. satellites, by manufacturer, launched since 2000*



* Major manufacturers of commercial communications satellites included in this survey are Antrix, Astrium, Boeing, CAST, LM, Loral, MELCO, Orbital, Reshetnev, TAS (not shown in that order)

What Are The Total Premium and Claims?

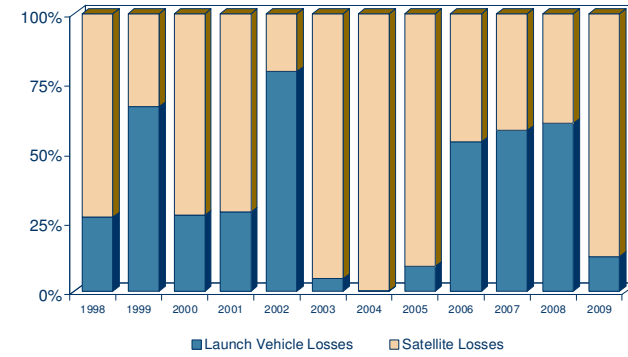


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What Causes Insured Losses?



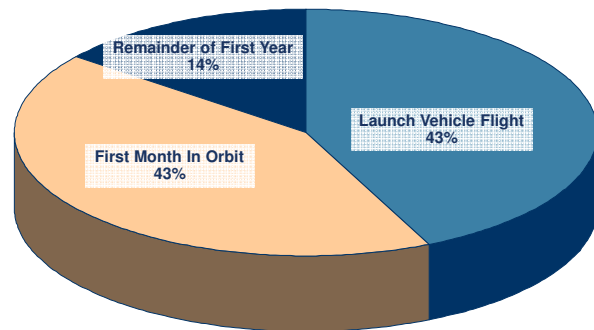
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When Do Losses Occur?

*By phase of mission
Launch plus first year in orbit, since 2000*

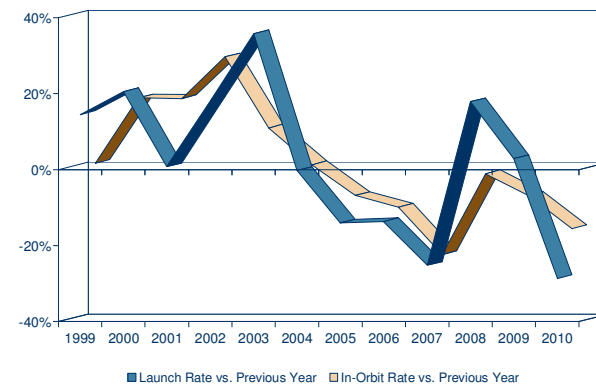


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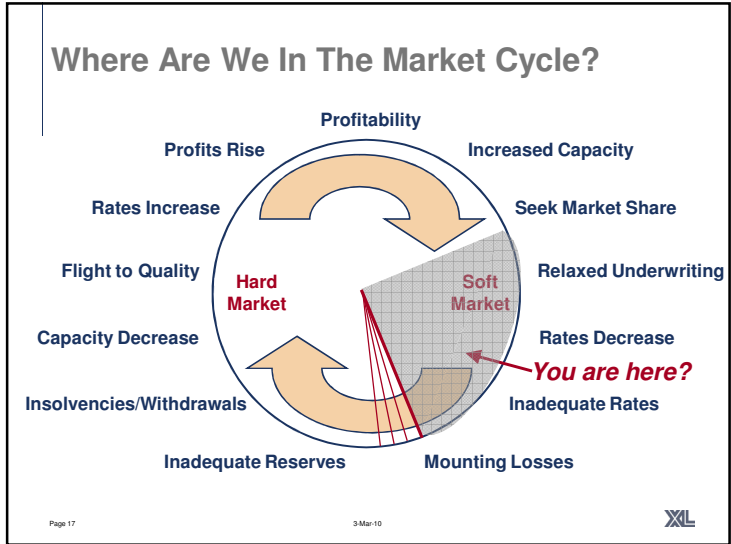
How Have Rates Changed With Experience?



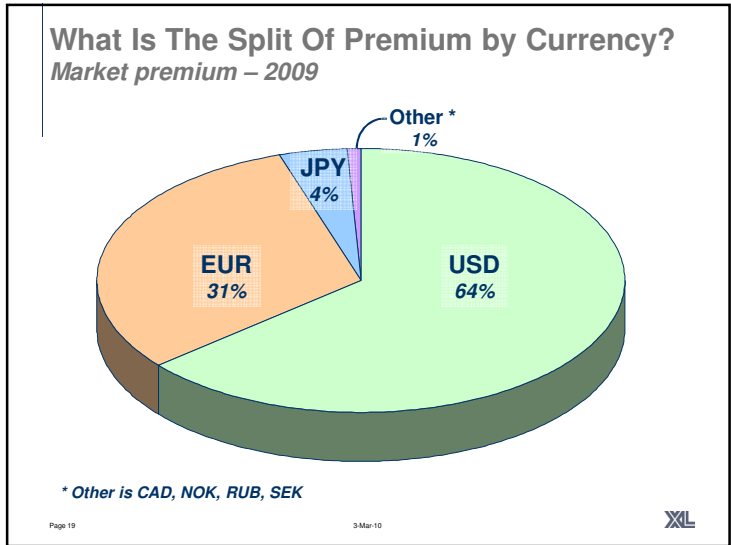
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- ### What Effect Has The Global Economic Crisis Had?
- > **Satellite operators maintain profitability**
 - > **Some effect on satellite programs**
 - > Lead time for commercial programs typically 18 to 36 months
 - > Programs for launch in next 2 years were generally begun prior to 2008 collapse of credit markets
 - > ~90 GEO communication satellites under contract
 - > **Some effect on insurance business**
 - > Fundamental insurance business largely unaffected
 - > Some increase in premium-to-surplus (*i.e.*, risk-to-capital) ratio with hardening market
 - > Investment income reduced, focus on underwriting profit
 - > **Some effect from exchange rates**
 - > In 2008, 64% of space premium was in USD, 31% in EUR
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A thought for today...

“What we anticipate seldom occurs; what we least expect generally happens.”

-- Benjamin Disraeli

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Why Is Space Debris An Issue?

- **Risk of collision**
 - With people
 - With active assets
 - Debris creation leading to “Kessler Syndrome”
- **Risk is growing**
 - “Big sky” theory doesn’t hold
 - Collision frequency will increase

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How Much Space Debris Is There?

- **15,500 tracked objects (>10 cm)**
 - 13,300 (86%) in LEO
 - 1,200 (8%) in GEO
 - 1,000 (6%) elsewhere
 - 3,000 are in a single orbit – 800±100 km x 98°
- **5,800 mT**
 - 5,600 mT (97%) is in 41% of catalog (6,000 intact objects)
 - 200 mT (3%) is in fragments (9,500 objects)
 - 300 mT (5%) is in a single LEO orbit – 900 km x 98°
 - 1,900 mT (33%) is in GEO

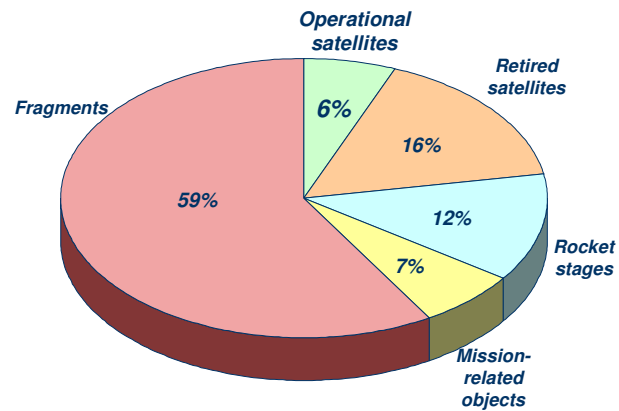
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What Are The Tracked Objects?

Number of objects

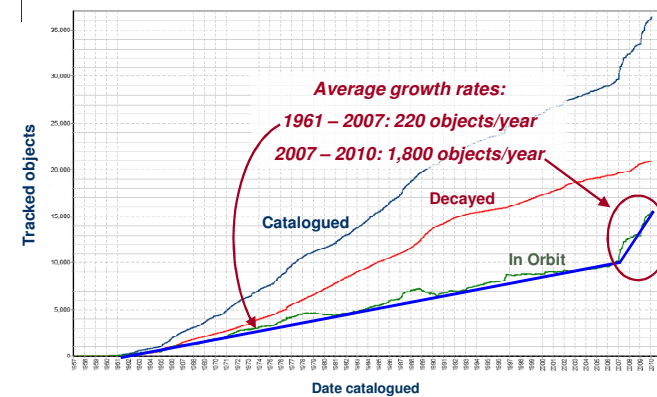


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How Fast Is The Population Growing?

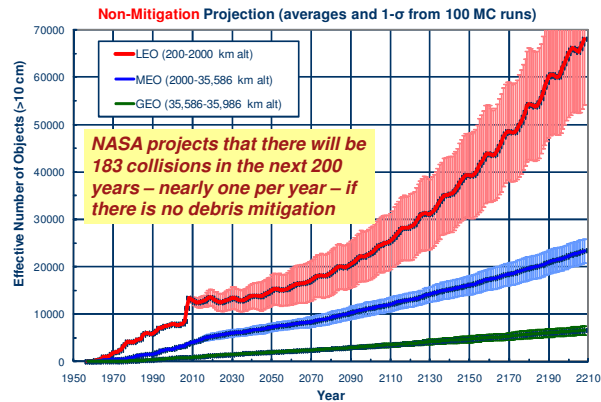


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How Fast Will It Grow In The Future?

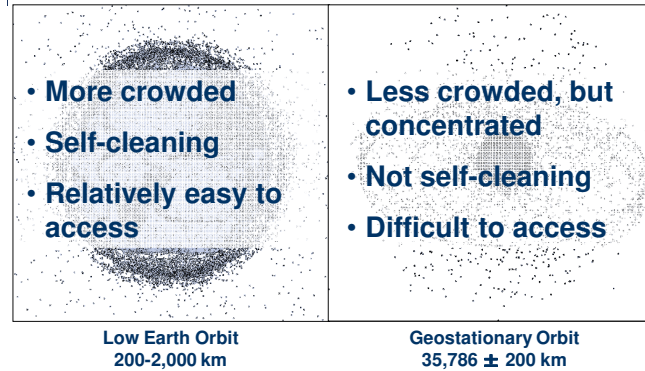


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What Are The Differences Between LEO And GEO?



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Recent Major Space Debris Events In LEO

- **FY-1C – Jan 11, 2007**
 - Chinese ASAT missile test destroyed unused Chinese weather satellite
 - Resulted in **2,680** pieces of **tracked** debris, **2,620** still in orbit
- **Briz-M – Feb 19, 2007**
 - Russian Proton launch vehicle spent upper stage exploded
 - Resulted in **85** pieces of **tracked** debris, **82** still in orbit
- **USA-193 – Feb 21, 2008**
 - US intentionally destroyed failed US government satellite
 - Resulted in **174** pieces of **tracked** debris, **0** still in orbit
- **Cosmos 2421 – Mar 14, 2008**
 - Russian satellite broke up after mission ended
 - Resulted in **509** pieces of **tracked** debris, **25** still in orbit
- **Iridium 33 / Cosmos 2251 – Feb 10, 2009**
 - Operational and non-operational satellites collided
 - Resulted in **1,660** pieces of **tracked** debris, **1,595** still in orbit

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What Are The Threats In GEO?

- **1,238** known objects in GEO, and many more (~**1,000**) untracked
 - **391** are controlled satellites
 - **678** are drifting and **169** are “trapped” at libration points
 - These **847** objects remain a collision threat in GEO
- From 1998 to 2009, **186** GEO satellites were retired
 - **103** of these (**55%**) remain a collision threat in GEO
 - **48** were abandoned (“rogue” drifters), often due to anomalies
 - **55** were insufficiently re-orbited per IADC guidelines

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What Happens If There Is A Collision?

- **Determination of cause and liability are difficult**
 - Under international law, launching state has strict liability on ground
 - Launching state has liability to other objects in space if at fault
 - Determination of fault would need to show violation of standard of care and conduct
- **Applicability of insurance**
 - First party insurance may cover damage to a satellite (if in force, and subject to policy terms)
 - Third party insurance may cover loss of asset and consequential loss (if in force, and subject to policy terms)

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What Can Be Done To Mitigate Debris?

- **Current guidelines and practices**
 - Re-orbit within 25 years of end of life
 - Atmospheric re-entry
 - Storage orbit
 - Retrieval
 - Passivate
 - Eliminate stored energy in propulsion systems, batteries, etc.
- **Future active debris removal strategies**
 - Capture
 - Space tugs
 - Orbit transfer
 - Propulsion
 - Environmental forces
 - Tethers, solar sails
 - Laser

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What Are Active Debris Removal Issues?

- **Selection of objects**
 - Consensus vs aggression
- **Ownership**
 - Debris vs inactive/hibernating
 - Cooperative vs uncooperative vs non-cooperative
 - Salvage, corrective actions
- **Docking**
 - Examination
 - ITAR
- **Technical complexity, cost, timeliness**
- **Liability**
 - Debris creation
 - Re-entry

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Failed And Stranded Insured GEO Satellites *Launched since 2000*

- **Stranded in wrong orbit due to launch vehicle, and which might benefit from removal: 7** (of which three were successfully put into partial service)
- **Failed in orbit and un-maneuverable, and which might benefit from removal: 16**
- **Significant loss of propellant or power, and which might benefit from on-orbit servicing or disposal: 33**

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Who's Working On Space Debris?

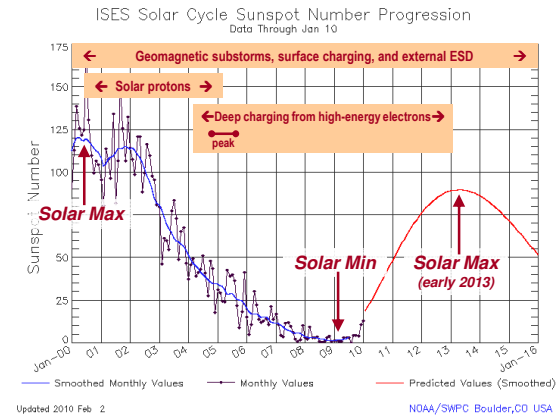
- **UN COPUOS** – treaty oversight
 - www.oosa.unvienna.org
- **IADC** – inter-governmental co-ordination
 - www.iadc-online.org
- **NASA, ESA, France, Russia, Japan** – guidelines and policy
 - www.orbitaldebris.jsc.nasa.gov, www.esa.int, ...
- **USSTRATCOM/JSPOC** – tracking and reporting
 - www.space-track.org
- **DARPA** – active debris removal concepts
 - www.darpa.mil
- **FAA COMSTAC** – effects on commercial space
 - www.faa.gov
- **Engineering companies** – tracking and analysis tools
 - www.agi.com, www.aero.org, ...
- **Satellite owners and operators** – refining operational procedures

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What's Happening On The Sun?

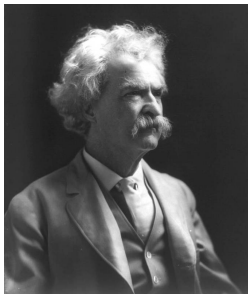


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A thought for today...



"It ain't what you don't know that gets you into trouble. It's what you know for sure that just ain't so."

-- Mark Twain

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Thank you!



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