

The Phoenix Project

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Uses of Outer Space

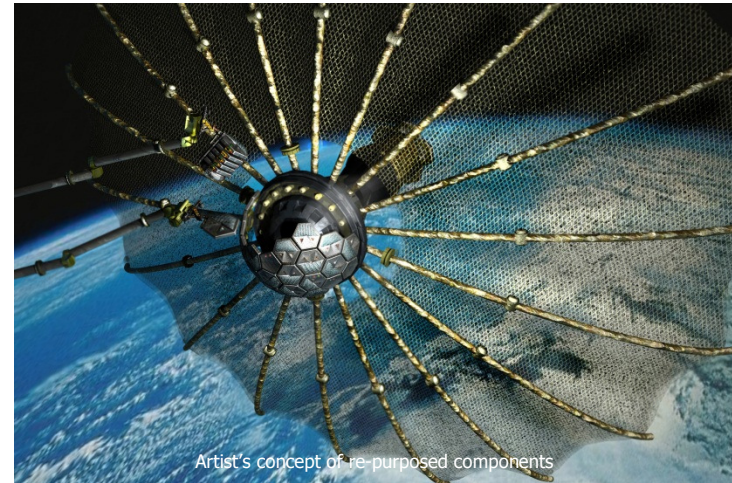
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The Phoenix project vision

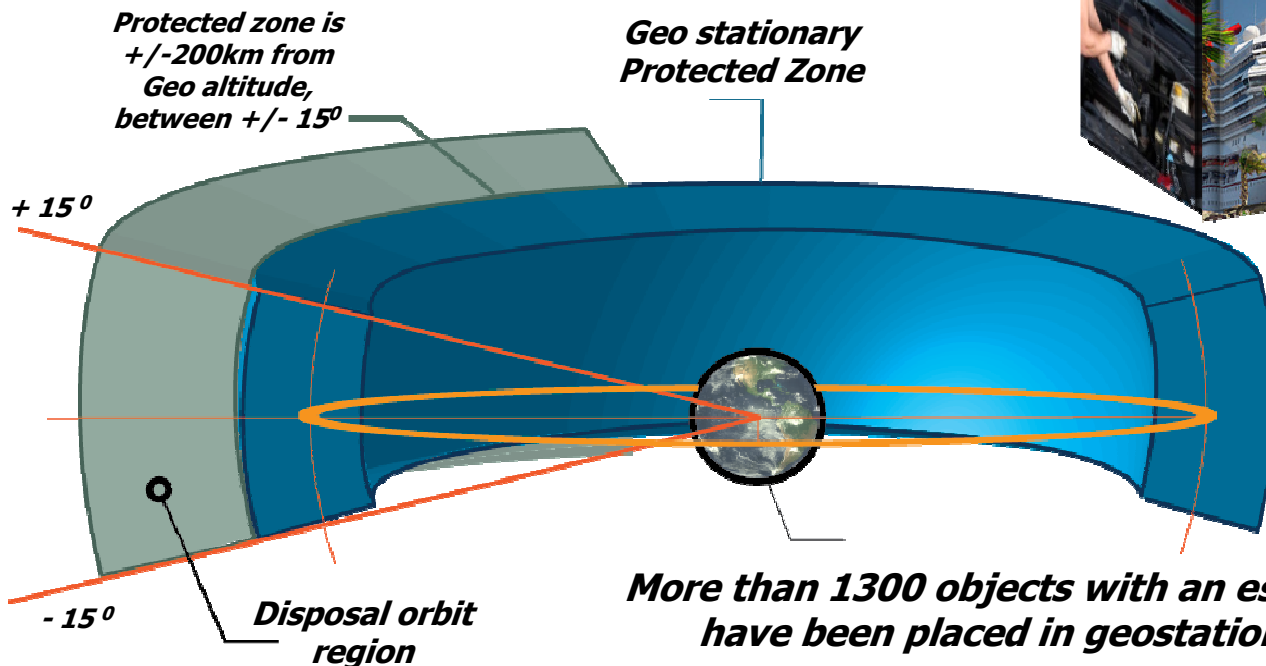
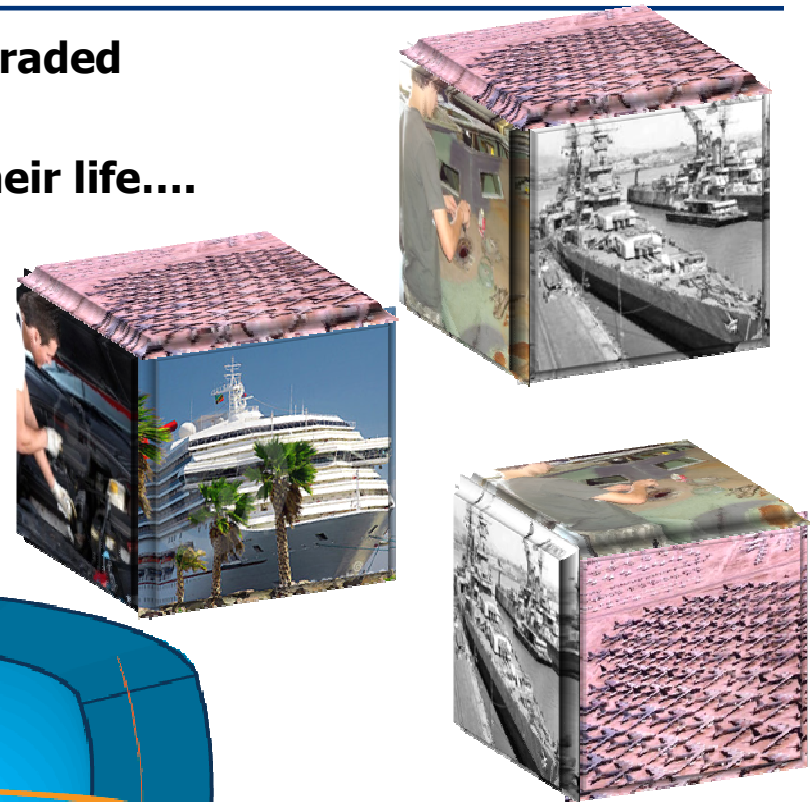
- Change how satellites are built, shifting to **on-orbit assembly**.
- Create ability to upgrade satellites faster to **accommodate new electronics/technologies**.
- Increase effective US Government Return on Investment by **re-using highest value components** on orbit in cooperation with retired satellite owners.
- Allow non-traditional space suppliers and players to enter space market using high volume, low-cost manufacturing through dispensed **commercial hosted payload delivery**.
- **Encourage a national and international responsible ecosystem for spacecraft servicing.**





The precept of return on value through simple re-use is employed everywhere on earth, but not in space...

- **Aircraft (e.g., U.S. Air Force C-130's) are upgraded multiple times over their life...**
- **Ships are re-furbished multiple times over their life....**
- **Ground vehicles are re-furbished multiple times over their life....**



More than 1300 objects with an estimated value over \$300 billion have been placed in geostationary orbit since the 1960s...

Is it possible to “re-use” satellites?



One example of re-purposeable components that could provide benefit are "apertures"...

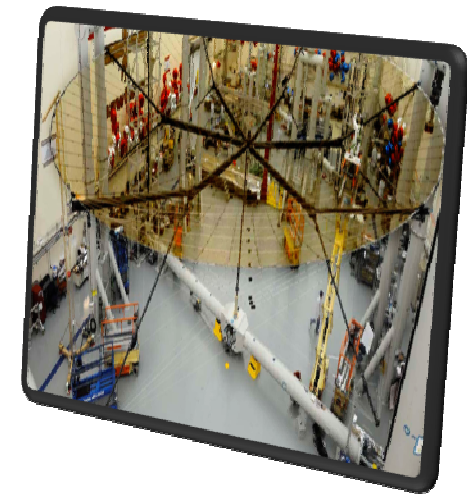
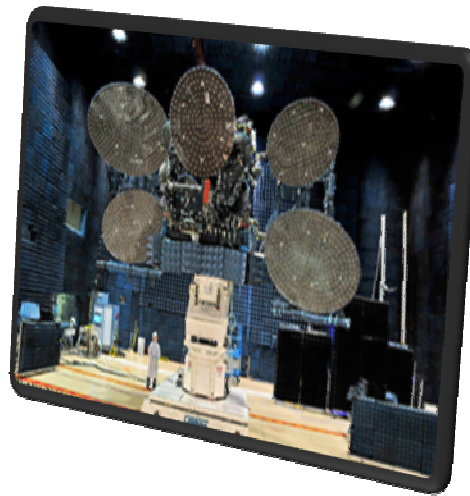
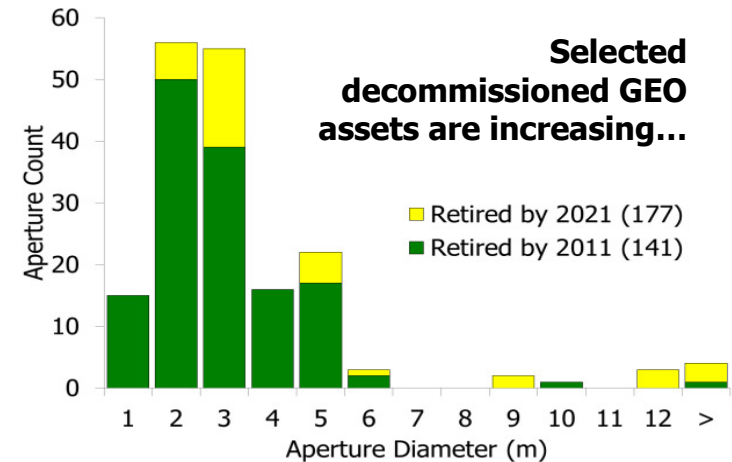
Satellite Component Life estimates

- Batteries ~10-18 yrs
- Solar Arrays ~15 yrs
- Electronics ~10-18 yrs
- Fuel ~10-15 yrs

100+ years?

Apertures in GEO have:

- No electronics or moving parts
- Stationary persistence
- Long operational lifetime
- Fabrication, deployment, and launch costs already realized



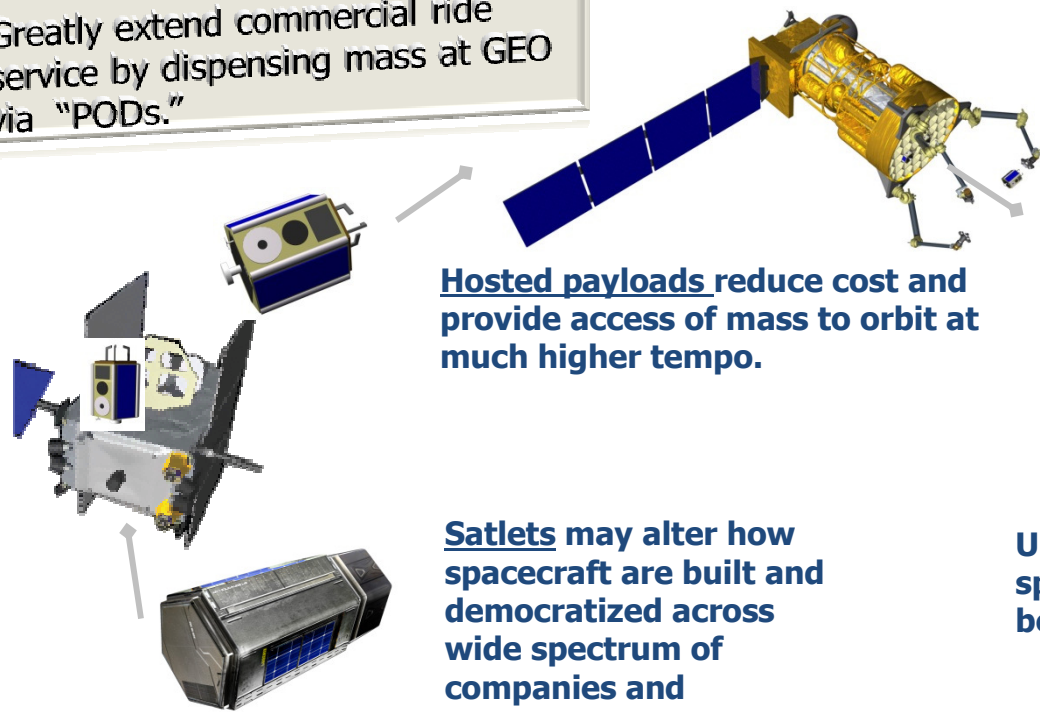
Larger apertures provide flexibility in throughput (i.e., bps), # of users, or lower power to close a given frequency.
 ~ 20,000 kg of apertures currently in GEO

The Phoenix demonstration project is intended to, with permission, repurpose non-operating cooperative functional apertures in GEO graveyard orbit.



To achieve repurposing, an integration of three specific investment regimes is being pursued.

Second:
Greatly extend commercial ride service by dispensing mass at GEO via "PODs."



Hosted payloads reduce cost and provide access of mass to orbit at much higher tempo.

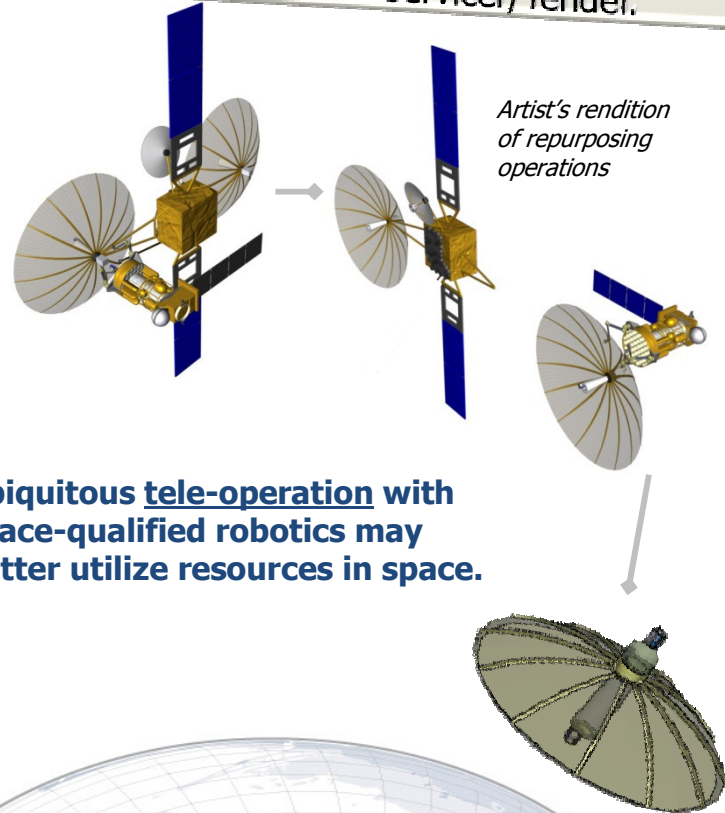
Satlets may alter how spacecraft are built and democratized across wide spectrum of companies and organizations.

Artist's rendition of satlets & PODs

First:
Change morphology of satellites via a new concept in satellite design & manufacturing with "satlets."



Third:
Create low-risk robotic operations in GEO via "Servicer/Tender."



Artist's rendition of repurposing operations

Ubiquitous tele-operation with space-qualified robotics may better utilize resources in space.

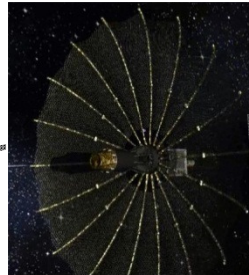




Phoenix operational goals support sustainable and repeatable low-cost repurposing logistics in disposal orbits.

Once the aperture is repurposed, the ultimate goal is to transfer the repurposed aperture to a useful position for demonstration operations.

For the demonstration, a sample POD with satlets and tools will be launched by an independent GEO communications satellite prior to or at the same time as the Phoenix vehicle.



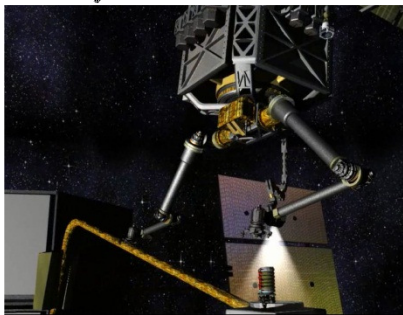
Disposal Orbit

Aperture Repurposing

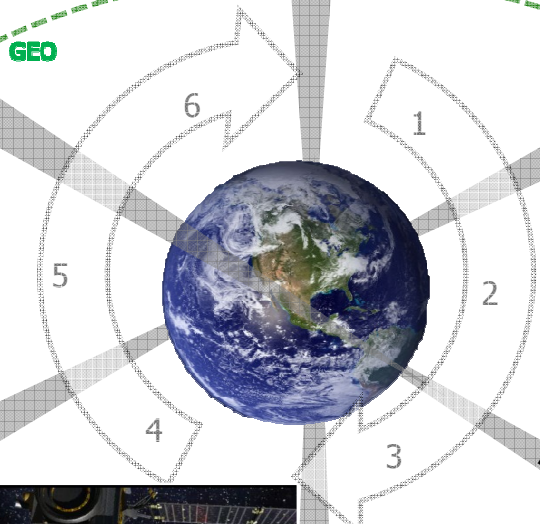
Commercial Hosted Payload Launch

Servicer/Tender Launch and Checkout

Validated operation from value added resellers (VAR) for satlets



Validate qualification of Phoenix robotics operators from internal training

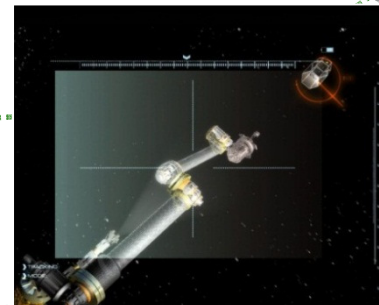
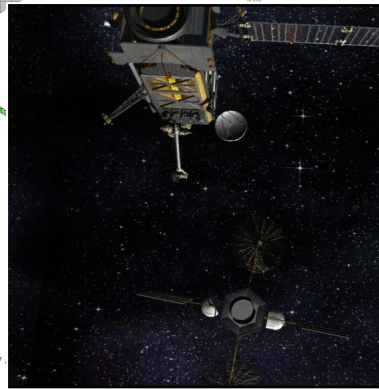


Servicer/Tender to Disposal orbit and Retired Satellite Rendezvous

PODs Release and Rendezvous and Grapple

Positive ground communication with retired GEOSat ownership chain

Positive approval between GEOSat and USG for rendezvous



Positive ground communication with GEO Host



Summary

- Initial look at selected components on retired satellites on-orbit offers near term potential for benefit by re-use.
- Economic calculus has potential to change cost/benefit equation for satellites "built" on orbit.
- Phoenix is one instantiation of a potential method to foster in-situ space hardware re-use.

