



## ON ORBIT SERVICING PERSPECTIVES OCT 1, 2004

Vancouver, Canada

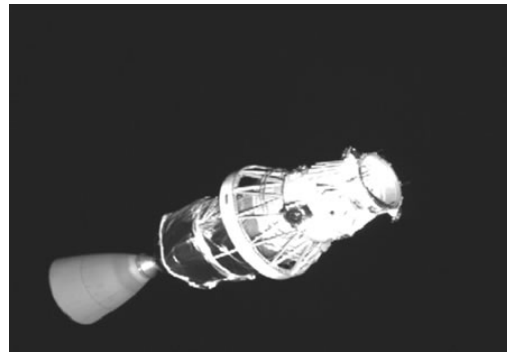
ON ORBIT SERVICING WORKSHOP

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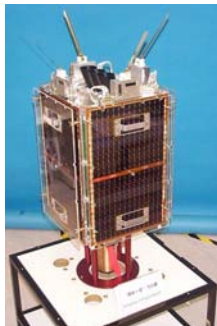
### On-Orbit Servicing Perspectives (US)

- CURRENT STATUS
  - SPACE RENDEVOUS
  - DARPA ORBITAL EXPRESS PROGRAM
  - HUBBLE SERVICING
- COMMENTARY
  - EXPENSIVE – COST EFFECTIVE?
  - RISKY
- FUTURE
  - PRIVATE SECTOR
  - SPACE ACCESS
  - ROLE IN SPACE EXPLORATION

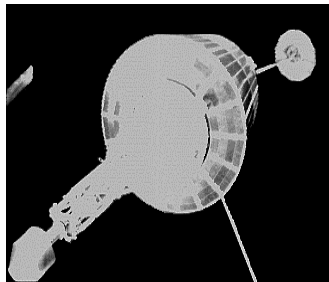
## U.S. AFRL XSS-10 MICROSAT PROGRAM, FEB 2003



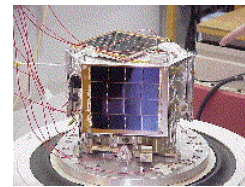
## OTHER EFFORTS: JUNE 2000



**Figure 7**  
**Tsinghua-1**  
**Microsatellite**

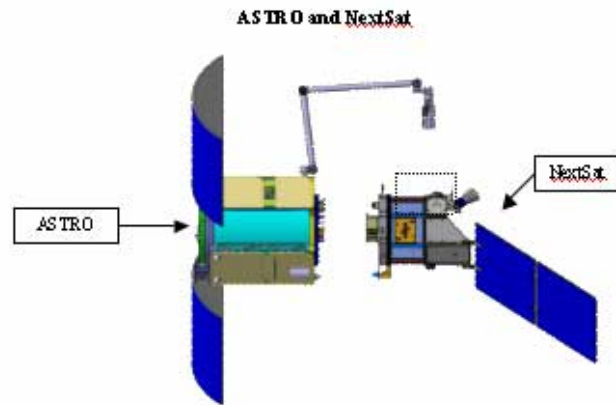


**Figure 8 Russian**  
**COSPAS-SARSAT**  
**Satellite Image Taken**  
**by SNAP-1**



**Figure 6**  
**SNAP-1**  
**Nanosatellite**

## DARPA – ORBITAL EXPRESS



## NASA PROGRAMS-HUBBLE



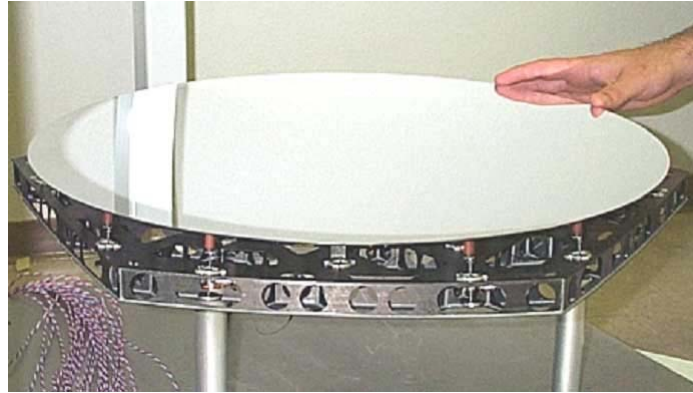
## OOS COMMENTARY

- 2003 – U.S. Air Force and NRO concluded few rationale for OOS – primary use might be re-fueling
- Major programs have not (and probably will not) seriously consider OOS – “Chicken or Egg” problem
- Cost of Orbital Express large and growing

## Hubble Servicing

- Estimated cost is \$1.8B – real cost is more like \$2.5B – unproven technology “a real brown trouser job”
- Shuttle servicing is probably \$1-2B
- “Hubble Light” concepts have not been considered but they are likely much cheaper (\$500M - \$1B)
- New low-cost, microsatellite, “responsive” space a major competitor – disposable diapers are cheaper and less trouble than the old fashioned serviceable kind

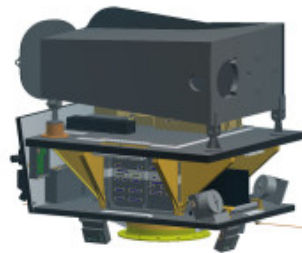
## LOW-COST TELESCOPES



Ultralightweight 50-cm mirror made as a demonstration for NRO. This mirror achieved an areal density of 5 kg/m<sup>2</sup>, including its glass, support structure, actuators, cabling, and mounting hardware.

## LOW-COST MISSIONS

- **UK Mission for High Resolution Imaging**
- SSTL is developing the TopSat enhanced microsatellite bus as a subcontractor to QinetiQ, for the UK Government. TopSat is jointly funded by the British National Space Centre (BNSC) Microsatellite Applications in Collaboration (MOSAIC) programme and the Ministry of Defence. TopSat's primary mission is to demonstrate that a microsatellite can provide responsive high-resolution imaging, with 2.5 metre-resolution images delivered directly from the satellite to ground terminals within the same footprint.



## The Future

- Low-cost, private access to space promises to revolutionize space operations
- Does On-orbit servicing have a role
- Space Exploration is probably the biggest challenge and opportunity

## PRIVATE SECTOR SPACE



## Falcon Summary (SpaceX)

- Payload capability: Approx 1100 lbs to LEO (28.5 deg)
- Launch from both Eastern and Western Ranges
- Multiple manifest, secondary, and piggyback capabilities
- Benign payload environment
- \$6M per vehicle through 2004
- First launch possible by 2004



- Diameter 5.5' tapering to 5'
- Length 68'
- 1<sup>st</sup> Stage Parachute/Water Recovery
- 1<sup>st</sup> Stage Lox/RP1
- 2<sup>nd</sup> Stage Lox/RP1
- Next step FALCON V then "BFR"

## Human and Robotic Space Exploration

- In USA human space exploration initiative has generated limited enthusiasm – barely getting started
- Only real programs are China's and India's – a new "space race" – mostly robotic
- A new paradigm? – aim at robots to build robots (an astronaut's idea!)
- Use the moon to do things too dangerous to do elsewhere – robotic construction and servicing critical