The New Space Exploration Policy

Learning from the Past
& Implementing the Future

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President Bush's Challenge is Brand-New

- Unlike *Apollo*: we have been told to plan for the <u>sustained</u> exploration of space

- Unlike *Apollo, Skylab, Shuttle* and *ISS*:
  - Far better space-related technologies
  - Modern analytical tools never before available
  - Trained work force actively engaged in space

- Unlike *Apollo*:
  - Constrained by budget realities
  - NASA cannot go it alone -- need DoD, international and commercial participation

Overview

- Implementation of new space exploration vision must be reliable, safe and economical
  - An integrated plan extending 30 to 40 years into the future
  - Decisions made now can have major impacts on future approaches
- We can look back at “lessons learned” in past programs to guide us in how to implement

Lessons Learned: Heavy Lift

- Work in space is hard, risky, time consuming and expensive and should be avoided.

- A comparison:
  - *ISS*: 7 astronauts, over 900,000 lbm assembled mass
    - Full assembly requires 45+ STS flights, 160 EVAs totaling 1960 man hours, 8+ years until fully functional
  - *Skylab*: 3 astronauts, 170,000 lbm (1/6 the mass)
    - No Assembly required - One *Saturn V* launch

- Difference? Heavy Lift! Today's launch infrastructure not positioned to support future space exploration requirements

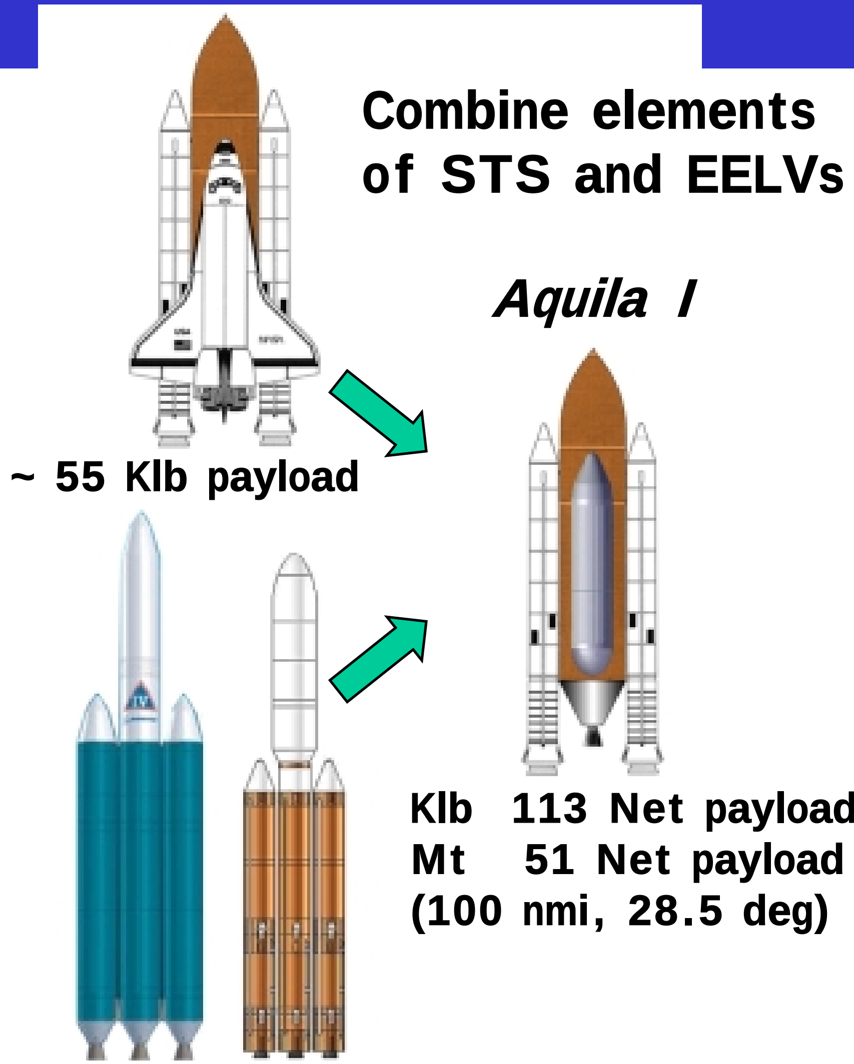
Lessons Learned: Heavy Lift cont.

- Heavy lift reduces costs, risks and time for large space missions
- Reduced number of delivery flights
- Greatly reduced EVA's required
- Acceleration of schedule - Time is money!
- *EELV*'s are not sufficient; Heavy Lift (multiples of *EELV* payload capacity) is needed.

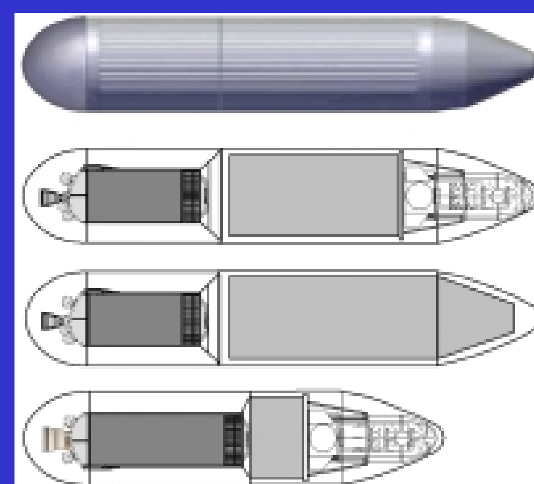
Heavy Lift Decisions

- In retrospect, retiring *Saturn V* may have been unwise
- We now face a similar decision
- Do we retire the entire *STS* system or just the *Orbiter*?
  - Combination of *STS* and *EELV* elements can provide heavy-lift capabilities that can grow and evolve as the space exploration program progresses - reduces need for costly on-orbit assembly
  - We call it ***Aquila (Eagle)***

Aquila Heavy Lift



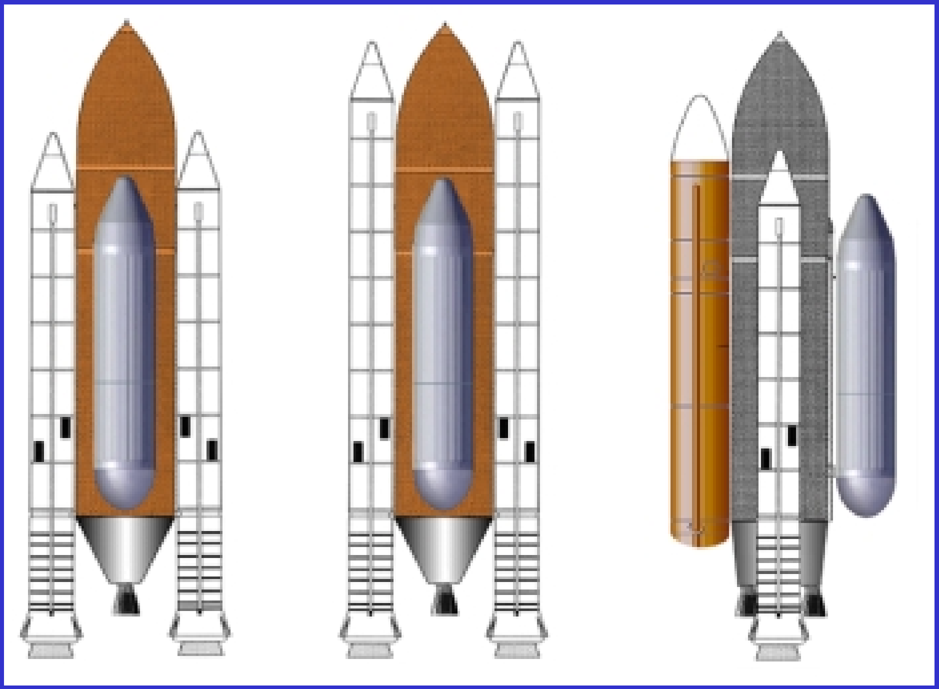
- Builds on present *STS*
- Multi-use Pod uses existing components
- Three *EELV RS-68* engines mounted beneath the *ET*
- Minimizes ground infrastructure modifications.
- Ready for flight by 2009



Aquila Heavy Lift Options

Payload to 100 nmi, 28.5 deg includes payload structures & *Atlas V Centaur* upper stage

Aquila Reference 3 RS-68 @ 67%	5-segment *RSRM* 3 RS-68 @ 67%	*Delta IV* drop tank 3 RS-68 @100%

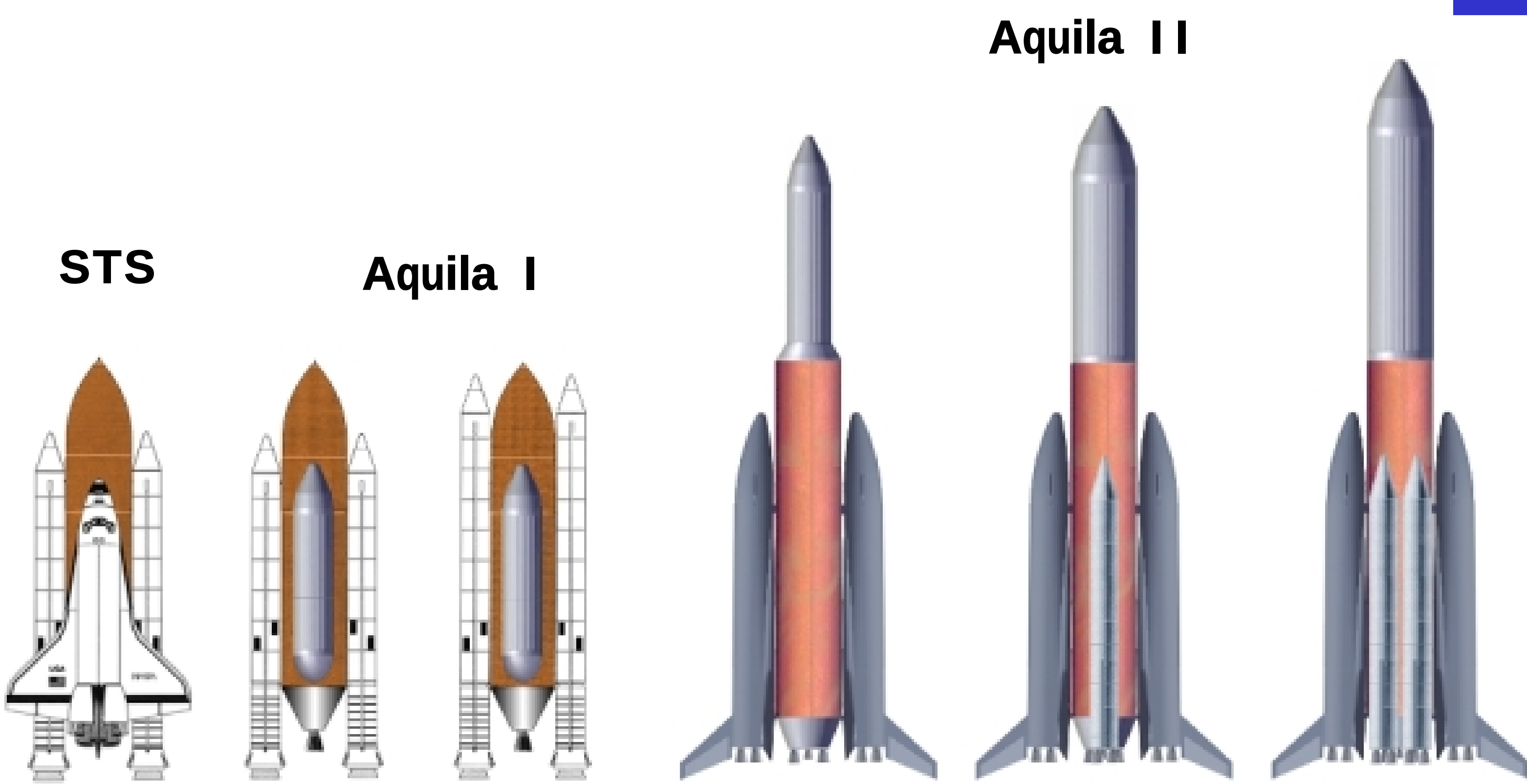


Aquila II In-Line Options

- External tank modifications
  - 3 RS-68 engines at 100% on base
  - Lengthened ET tanks
  - Strengthened tank structures
- Match payload fairings to payload
- Combination of kerosene rocket engine, flyback boosters and expendable propulsion modules

Aquila II In-Line Options

Payload to 100 nmi, 28.5 deg reference orbit

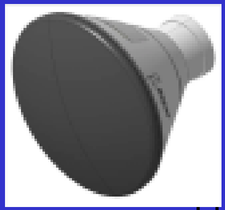


Klb	55	128	150	137	253	387
Mt	25	58	68	62	115	176

5 seg RSRM   Combinations of expendable & reusable boosters

Lessons Learned: *Crew Exploration Vehicle (CEV)*

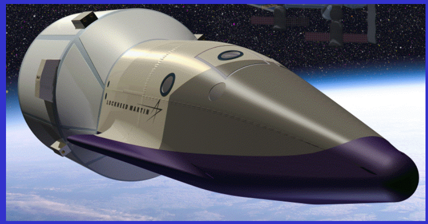
- We must consider the long term and not take expedient, near-term design solutions
- *CEV* will evolve
- Capsule used for *Apollo* was most expedient
  - Characteristics of winged & lifting bodies were not well known
- Capsule has disadvantages
  - High G re-entry
  - Little cross range or maneuverability
  - Water landing required



Lockheed & Boeing CEV Capsules

Crew Exploration Vehicle

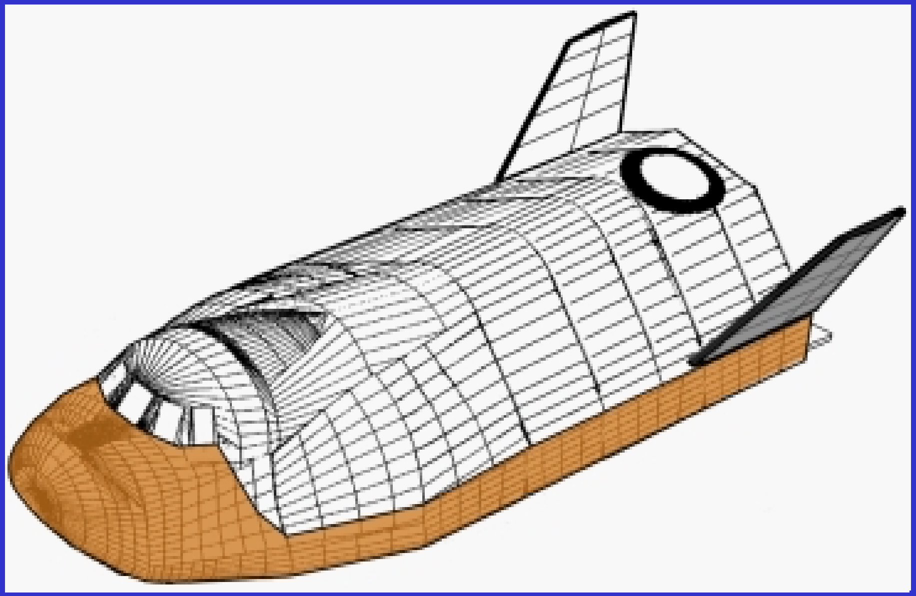
- Future *CEV* shape tied to requirements
- A shape such as the lifting body (as studied in *HL-10, HL-20, X-24A, M2-F2, X-38, Bor-4* programs) may be best compromise



Lockheed CEV Wing-Body

  - Low g's (< 2)
  - Moderate cross range
  - Adaptable to runway landings eventually
  - Expandable to multipurpose missions beyond low-Earth orbit with add-on modules
  - Provides the environment for commercial applications

4 to 8-Person Crew Module

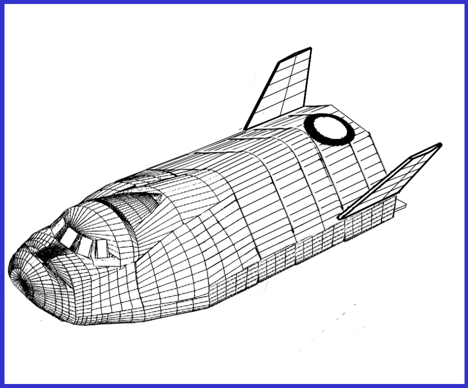


Proposed CEV - Designed for use on multiple launch vehicles including EELV

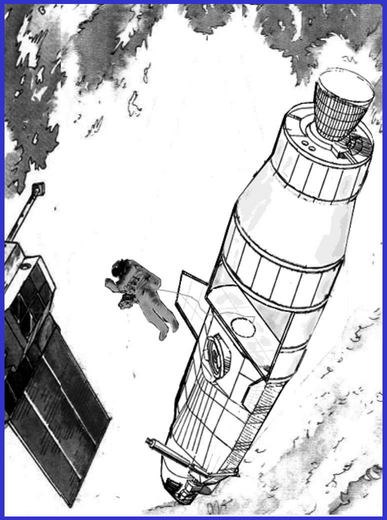
Crew Module Evolution

CM is basic building element a family of *CEVs*
Using building block & module approach

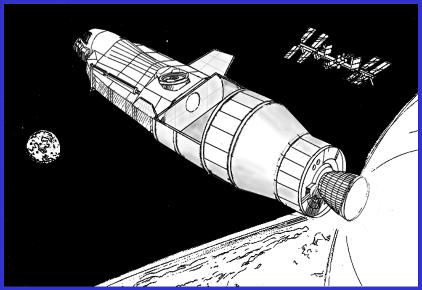
LEO Transfer



ISS On-Orbit Servicer



***Cislunar* Transfer**



Starcraft Boosters, Inc.

- A Texas-based Corporation established in 1996
- 8 seasoned NASA & Air Force veterans
- Contracts
  - NASA Space Transportation Architecture Study
  - LaunchTransportation Plan for Mars Cycling Concepts (includes heavy-lift)
  - United Space Alliance (USA) - 2002: Multi-purpose Crew Module System Study
  - Air Force Research Lab Reusable Booster
  - Technology for Small Launch Vehicles - Development, build and test

Summary

- Learn from the lessons of the past
- Real tangible accomplishments by mid-2008 are necessary to build momentum.
- Decisions must be based on building capability for the long run.
- Many other lessons learned

My group and I stand ready to share our decades of experience