15. Architecture Advantages

The Exploration Systems Architecture Study (ESAS) team examined a wide variety of architecture element configurations, functionality, subsystems, technologies, and implementation approaches. Alternatives were systematically and objectively evaluated against a set of Figures of Merit (FOMs). The results of these many trade studies are summarized in each major section of this report and in the recommendations in Section 13, Summary of Recommendations.

Although many of the key features of the architecture are similar to systems and approaches used in the Apollo Program, the selected ESAS architecture offers a number of advantages over that of Apollo, including:

- Double the number of crew to the lunar surface;
- Four times the number of lunar surface crew-hours for sortie missions;
- A Crew Module (CM) with three times the volume of the Apollo Command Module;
- Global lunar surface access with anytime return to the Earth;
- Enabling a permanent human presence at a lunar outpost;
- Demonstrating systems and technologies for human Mars missions;
- Making use of in-situ lunar resources; and
- Providing significantly higher human safety and mission reliability.

In addition to these advantages over the Apollo architecture, the ESAS-selected architecture offers a number of other advantages and features, including:

- The Shuttle-derived launch options were found to be more affordable, safe, and reliable than Evolved Expendable Launch Vehicle (EELV) options;
- The Shuttle-derived approach provides a relatively smooth transition of existing facilities and workforce to ensure lower schedule, cost, and programmatic risks;
- Minimizing the number of launches through development of a heavy-lift Cargo Launch Vehicle (CaLV) improves mission reliability and safety and provides a launcher for future human Mars missions;
- Use of a Reusable Solid Rocket Booster (RSRB-) based Crew Launch Vehicle (CLV) with a top-mounted Crew Exploration Vehicle (CEV) and Launch Abort System (LAS) provides an order-of-magnitude improvement in ascent crew safety over the Space Shuttle;
- Use of an Apollo-style blunt-body capsule was found to be the safest, most affordable, and fastest approach to CEV development;
- Use of the same modular CEV CM and Service Module (SM) for multiple mission applications improves affordability;
- Selection of a land-landing, reusable CEV improves affordability;
- Use of pressure-fed Liquid Oxygen (LOX)/methane propulsion on the CEV SM and Lunar Surface Access Module (LSAM) ascent stage enables In-Situ Resource Utilization (ISRU) for lunar and Mars applications and improves the safety of the LSAM; and
- Selection of the “1.5-launch” Earth Orbit Rendezvous–Lunar Orbit Rendezvous (EOR–LOR) lunar mission mode offers the safest and most affordable option for returning humans to the Moon.