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.