SPACEDEV ILO PHASE SIX EXECUTIVE SUMMARY: "ILO PRELIMINARY PAYLOAD DEFINITION" (2008)

Objective

The ILO Founders Meeting statement included a set of six goals to be pursued by ILOA immediately, one of which dictated "Establishing the ILO science and communications requirements and instrumentation." This task is critical in defining the essence of the ILO mission, laying the foundation for detailed design and fabrication of the payload, which comprises the astrophysical and observational instruments as well as the communication systems. The payload is the heart of the mission, and its definition will drive the design of many other aspects of ILO. Furthermore, it is expected that increased clarity of the mission's specific functionality will be beneficial in terms of generating interest and support for ILO. Thus, the preliminary payload definition was deemed the highest priority engineering need, and was designated as SpaceDev's next project for ILO.

Method

The Preliminary Payload Definition Study plan included the following steps:

- A. Identify Observation Goals: The ILO is envisioned to have two broad categories of functionality: 1) observation; and 2) communication. Generally, the variability in potential observation instruments is of a higher degree than that of potential communications systems. Also, it is much more likely that particular choices of observation instruments will drive the specification of the communications equipment than vice versa. Therefore, the observation instruments were addressed first, beginning with identification and prioritization of the observation goals. The identification of observation goals included both a literature survey and a survey of the science community.
- B. Select Science Instruments: After identifying and prioritizing the observation goals, the study focused on analyzing options for observation instruments that could be constructed from Commercial Off-The-Shelf (COTS) components, and that would most efficiently meet as many of the high priority goals as possible considering the mission constraints.
- C. Identify Communications Goals: The communications systems should support maintenance of spacecraft health, operation of observation instruments, delivery to ground systems of observation data, and commercial communication activities.
- D. Select Communications Systems: Potential communications systems were analyzed, again aiming for low-cost COTS-based solutions.
- E. Select Conceptual Payload Physical Configuration: The physical packaging of the hardware that makes up the ILO payload is an important consideration. The instruments and antennas have important requirements for range of motion and pointing precision, and also must not physically interfere with each other. Meanwhile, the design must strive for low mass and compact packaging, while exhibiting high reliability and tolerance to stresses such as launch and landing loads.
- F. Develop Requirements: Ultimately, the ILO mission needs a requirements database to guide and justify choices in the design and manufacture of the various hardware and software systems. These requirements will evolve through an iterative process throughout the mission development, but it is helpful to begin laying them out early, so that the various systems are

designed and built in a coherent manner. The study delivered the first iteration of the requirements database for the ILO payload.

Results

The survey of the scientific community revealed clear interest across the full spectra of investigation categories and observed wavelengths. There is a particular enthusiasm for sky surveys, motivated by the profound and unexpected discoveries that inevitably emerge from such efforts. In terms of wavelengths, the preference is somewhat concentrated in the mid-regions from sub-millimeter (sub-mm) through Ultra-violet (UV).

The literature survey uncovered many novel proposals for Moon-based astronomy, but most require very large, complex missions beyond the planned scope of the ILO, in terms of both cost and development time. However, again, it is clear that while there are some skeptics, there are many proponents of Moon-based astronomy, and there are a number of distinct advantages of the Moon over Earth and even space (e.g. Earth orbit), as a location from which to make astrophysical observations.

After substantial research and trade studies, SpaceDev presented ILOA with a variety of options regarding the architecture of the ILO payload. The final recommendation was that the primary instrument be a 14-inch aperture telescope to observe UV, Visible and Infra-red (IR), with full high precision pointing and tracking capability. Promising secondary instruments were identified as: UV / Visible spectrograph; X-Ray imager; Very Low Frequency (VLF) tri-pole sensor. Recommended communications equipment included: a two-way local S-band system (for rovers, Moon-orbiting spacecraft, etc.) with a fixed omni-directional antenna; a dedicated two-way Earth comm Ku-band system with a 0.8 meter dish having sufficient pointing capability to track Earth, and achieving a downlink data rate of 1 Mbps in the baseline scenario.

Conclusion

The recommended design would take good advantage of SpaceDev's general philosophy, leveraging COTS components to achieve high-value performance at a modest cost. The logical next step in the ILO payload development process would be a detailed system design to the Preliminary Design Review (PDR) level.

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