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INVESTMENT DECISION MODEL FOR A COMMERCIALLY OWNED AND OPERATED SPACE STATION IN LOW EARTH ORBIT

Abstract

NASA and private companies are actively exploring a privately owned successor to the International Space Station (ISS) upon its retirement. However, cost remains a stumbling block, and state of the art costing methods are still tuned primarily for contractors and government agencies. For private investors interested in space tourism, there is a need for new modeling techniques which integrate demand modeling with new cost models to support investment decision making. This is especially critical because important model inputs, such as projections of future launch costs, impact both the demand and supply sides of a commercial space opportunity.

We built such an integrated model and applied it to our NASA/NIA-sponsored study for a private space station: the MAnaged, Reconfigurable, In-space Nodal Assembly (MARINA). MARINA's main activity is space tourism via its anchor tenant, a luxury Earth-facing space hotel. Secondary activities are the rental of serviced berths for customer-owned modules as well as the rental of interior rack space to smaller companies wishing to trade with other MARINA tenants. The starting point was to select appropriate anchors and uncertainty ranges for model parameters. These drive the ensemble of interlinked models, including models of demand for space tourism and berth / rack leases, construction costs, operating costs and launch costs. We simulate exogenous and endogenous events, including agent decisions and interactions among model components. The models drive a 20-year cash flow forecast, condensed to a Net Present Value (NPV) using a conservative 20% discount rate. A Monte Carlo of the NPV's samples uncertain variables, simulates agent actions and yields a statistical distribution of Expected NPV (ENPV). A genetic algorithm repeats the Monte Carlo analysis for alternative decisions, automating the search for best strategies.

Our control case estimated the ENPV range to between -\$2.2 billion to +\$3.2 billion, with probability 80%. The real options built into the model were varied to seek improved strategies. The best result was an improved ENPV range from +\$0.2 billion to +\$3.9 billion with probability 80%, demonstrating commercial viability.

The key contribution to the field is the methodology to simultaneously model demand and lifecycle costs for complex space systems while retaining the realism of uncertain input variables and flexible, path-

dependent strategies by rational agents. Our approach facilitates the computationally expensive Monte Carlo simulation of many decision alternatives and the discovery of strategies that improve the ENPV distributions sufficiently to support a “GO” investment decision by a private investor.