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A Business Analysis of a SKYLON-based European Launch Service Operator ☆

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ABSTRACT

Between 2012 and 2014 an industrial consortium led by Reaction Engines conducted a feasibility study for the European Space Agency with the objective to explore the feasibility of SKYLON as the basis for a launcher that meets the requirements established for the Next Generation European Launcher. SKYLON is a fully reusable single stage to orbit launch system that is enabled by the unique performance characteristic of the Synergetic Air-Breathing Rocket Engine and is under active development. The purpose of the study which was called "SKYLON-based European Launch Service Operator (S-ELSO)" was to support ESA decision making on launch service strategy by exploring the potential implications of this new launch system on future European launch capability and the European industry that supports it. The study explored both a SKYLON operator (S-ELSO) and SKYLON manufacturer as separate business ventures. In keeping with previous studies, the only strategy that was found that kept the purchase price of the SKYLON low enough for a viable operator business was to follow an "airline" business model where the manufacturer sells SKYLONs to other operators in addition to S-ELSO. With the assumptions made in the study it was found that the SKYLON manufacturer with a total production run of between 30 and 100 SKYLONs could expect an Internal Rate of Return of around 10%. This was judged too low for all the funding to come from commercial funding sources, but is sufficiently high for a Public Private Partnership. The S-ELSO business model showed that the Internal Rate of Return would be high enough to consider operating without public support (i.e. commercial in operation, irrespective of any public funding of development), even when the average launch price is lowered to match the lowest currently quoted price for expendable systems.

1. Introduction

1.1. SKYLON

SKYLON (Fig. 1) is a fully reusable single stage to orbit spaceplane concept that is designed to take off from a runway reach Low Earth Orbit (LEO) with a payload of 15 tonnes at 300 km altitude. Once the mission is completed then it returns to earth for a runway landing [1]. It is under

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active development and is planned to reach operation in the early 2020s.

SKYLON is the result of 30 years of technology development and design studies. It is based on an air-breathing engine concept called SABRE, which uses a combination of a pre-cooler heat exchanger to cool incoming air and a turbo-compressor to raise the air pressure high enough to be fed as the oxidiser into a rocket engine combustion chamber to be burnt with liquid hydrogen. The air-breathing mode of the SABRE engine can be sustained to a little beyond Mach 5 and an altitude of between 26 km and 28 km, at which point the engine can switch to a staged combustion pure rocket mode using liquid oxygen as the oxidiser.

As SKYLON cannot take payloads beyond LEO it is complimented by an upper stage called the SUS (SKYLON Upper Stage). The SUS concept employs hydrogen/oxygen propellants that feed the same engine as SKYLON uses for orbital manoeuvring. It is capable of delivering a payload of 6.3 tonnes to Geostationary Transfer Orbit (GTO). It is designed to be recovered after the payload has been delivered, and is intended for 10 flights. On the tenth flight the SUS is expended increasing the payload to GTO to 8 tonnes. This approach captures the entire GTO market where around 10% of payloads are in the range 6.3–8 tonnes.

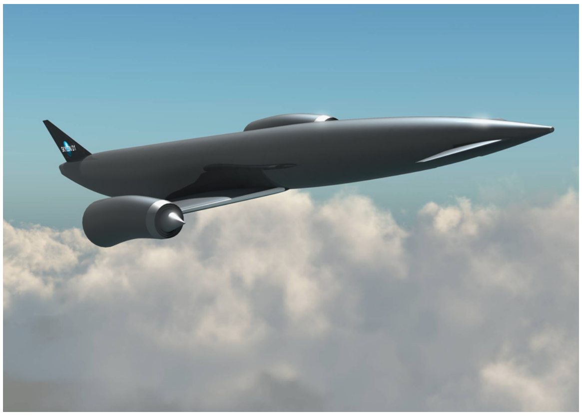

Fig. 1. The SKYLON spaceplane.

A key objective of the SKYLON project is to turn the space launch supply market into a fully commercial activity. By which is meant that ideally the price charged for the launch recovers all the costs in delivering the service including the acquisition investment. This is achieved ultimately by the vehicle's reusability, single stage aircraft-like operations and increased reliability which, combined, take the potential launch cost well below the current launch price.

The key barrier to achieving this economic sustainability is the large investment required to develop the SKYLON system. If this cost were placed on a single operator following the current business model of the launch services industry, where the manufacturer and the operator are a single business unit (Fig. 2), then the resulting upfront investment required makes the total business unviable. The history of other markets has shown this approach restricts operator competition and can lead to market failure and few markets operate this way. For example although early aviation started with this model, it is no longer used in the airline industry, and in the USA it is actually illegal under the Air Mail Act of June 12, 1934. In the civil aviation industry, manufacturers sell planes to airlines, which then compete with each other for traffic in a separate, competitive marketplace (Fig. 2).

To understand the viability of the SKYLON business case outlined in the S-ELSO study, it is important to grasp that while the vehicle operators (such as the European operator that was the focus of the study reported here) address the market for space launches, the SKYLON manufacturer (called by the study "SKYLON Holdings") will be separately addressing the market for launch vehicles by selling vehicles to organisations requiring a space access capability. This "airline" business model is shown in Fig. 2. Operators would buy SKYLONs, which provide a capability and an operational effectiveness well beyond that conceivable with any "in house" development, for an acquisition investment much lower than the development cost of all but the smallest launch system. While SKYLON Holdings spreads the high development cost among many customers giving scope for a greater return on the

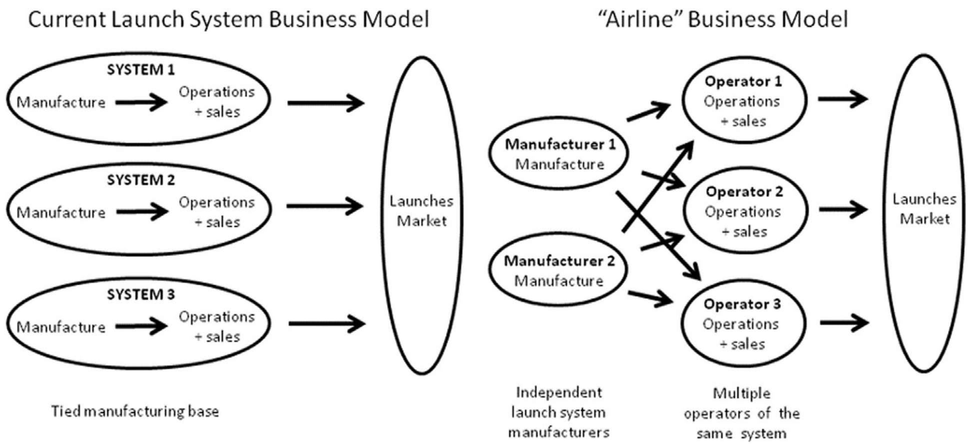

Fig. 2. Comparison of high level industrial organisational structures for launch systems.