INTEROPERABILITY BY THE EXAMPLE: THE LOXBOX

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Abstract:

When a car driver comes to a service station, he knows what he wants, how to proceed and how to pay. He is confident that the service will be delivered safely and properly, without having to worry if its vehicle is suitable for the particular station. It looks simple, and it really is from the user's point of view. But on closer inspection, the services provided are numerous and complex: several fuel choices, hundreds of different compatible vehicles, many ways to consume, to pay, additional services...and if the local station tank is empty, the customer could be informed that there is another gas station 50km away, maybe on the other side of the border, operated by another company, which will provide him with an equivalent service. We can affirm that gas stations are interoperable.

Spaceports are not. For instance, why isn't it possible to deliver liquid oxygen (LOX) for several different launchers, in many locations, with the same means and procedures, in a sustainable manner?

The goal of this project is to develop the LoxBox (liquid oxygen box) aiming at managing liquid oxygen services to mini- and micro-launchers, as easily as if it were to fill up a car and in a sustainable manner. The related services include: pressure management, tanks filling, flushing, shilling, topping, safety draining, emergency management, etc. There are no operators, the launch vehicle drives the operations and calls the Loxbox functional services while the safety is completely handled by the ground means.

To achieve interoperability, the following approach is warranted. It is necessary to develop the services with several user-cases and issues in mind such as: who pays, who acts, who is responsible of what, what do they pay for, what is the usage domain, what is the expected quality of service and what are the external rules (i.e., applicable legislations). Then, it is necessary to model the services and address the issues of what is seen by the user and what is the user experience. It is noticeable that the user in development is not the user in operation. Therefore, it is necessary to develop multiple models: physical model, logical model, transactional model. They are validated with the customer at every step of development. Services take place through interfaces that are technically specified. Once this level is reached, it is possible to speak of "standards". But the services are not yet completely described: to considered them as interoperable, they must comply with design properties such as: adaptability, modularity, configurability, mobility, being modellable, testable, scalable, and most of all users-friendly.

Once completely described, the services may be deployed into solutions. In view of the above, the way of developing services with the "interoperability mantra" in mind is fundamentally different of the way space infrastructures and launch ground means are currently developed: there are no silos between technical domains such as mechanics, fluids, control command, data management, reliability, sustainability etc. The services are developed at once, and the final user see it as a "black box" and most of all does not have to understand precisely what lays inside.

We have developed the Loxbox in an incremental way: defining the service, developing a digital twin hosting the models, delivering a virtual then real commissioning. We will qualify next year the Loxbox services in front of multiple New Space users.