Last-mile Analogies for a Lunar Communications Network

There is an opportunity for actors interested in entering the lunar communications space to learn from the best practices of network infrastructure providers (ISPs/IXPs), as well as the open source community.

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Sustainable human presence on the Moon necessitates the need for a lunar communications infrastructure. Multiple private and government missions are focusing on various communication elements to support future lunar orbiters a landers. A key component enabling these plans will be the communication links between the Earth and the Moon, established through data relay satellites, as well as the corresponding ground infrastructure required to disseminate data t end-users. In this piece, our focus will be on the “last-mile” of a lunar communications network i.e. the components required to deliver data to end-users in cislunar space. To conceptualize business and operating models for thi future infrastructure, we will draw on learnings from Earth-based communicatio analogies.

Status Quo for Space Communication Business Models

communications is rooted in traditional models to finance satellite telecommunications infrastructure. One approach is where a public agency purchases services from a commercial provider under a space agency or government solicitation leading to a Public Private Partnership (PPP). In this scenario, the commercial entity may continue to own and operate its communication relay orbiters. In the case of NASA, these solicitations are typica open to all types of organizations including industry, universities, not-for-profits, the U.S. government and international organizations. The converse is where the satellite infrastructure is government-funded and government-operated such as the RADARSAT Constellation Mission (RCM).

Another model is where the satellite infrastructure is privately-funded and privately-owned. Here, the private company chooses to bear the cost of a space communications infrastructure backbone between the Earth and the Moon. In this scenario, companies have the ability to fund their own R&D and bear the ris for new missions. Companies may decide to pursue this path through debt financing and other traditional financing mechanisms. If a company decides to privately finance such an endeavor, vertical integration of key infrastructure components may be required to keep down costs from additional sub-contracts

Many early stage startups also have aspirations to develop satellite constellatio to enable future Earth-Moon communications. VC-funding is typically sought to realize financing for such capital-intensive initiatives in the private sector. We als see current models encompassing communication-as-a-service with infrastructure like satellites and ground stations being rented out for customer usage. In the future, Earth-Moon communication capabilities could be sold und similar service contracts to public and private stakeholders who require use of c satellite relay and its associated communications network.

The rise of the internet led to the formation of distinct roles in network architecture, like Internet Service Providers (ISPs) and Internet Exchange Points (IXPs) to provide services and infrastructure around this data and information exchange capability. An ISP is an organization that provides a means for accessing, using and participating in the internet. ISPs provide wired/wireless access by building and operating the physical equipment that carries data from one place to another. ISPs may be not-for-profit, commercial, privately-owned, even community-run. Internet Exchange Points (IXPs) also emerged to allow participating ISPs to exchange data with their respective networks. IXPs are generally located at data centers, operating physical infrastructure such as switches to connect their participants.

When we think about the current lunar communications landscape, the lack of actors and traffic suggests that a closer analogy might be to a “last-mile” ISP rather than a major IXP or a traditional telecommunications business model. Important findings from research into not-for-profit ISP governance models include voting rights and governance by the organization’s members which not only helps to determine the price of the service, but also helps regulate market pricing. Such “cooperative” ISPs often budget core capital costs (for equipment etc.) from donations rather than relying on external government funding. There an emphasis on community-first service and practices, creating training opportunities for the membership and advocacy around fair and accessible internet services.

Another pertinent analogy is the open source business model which has seen widespread adoption. Large open source projects are also commonly manage by not-for-profit foundations. OpenStack is one example of an open source platform that uses pooled virtual resources to build and manage both private and public clouds. One of the core strengths of OpenStack and many open source offerings has been their interoperability, which not only allows seamless

different networks and vendors. Given that future conceptual models for lunar communications infrastructure envision several stakeholders, service providers and networks, interoperability will be a key feature required to enable an accessible lunar communications network.

Considerations for Lunar Communications

Clearly, there is an opportunity for actors interested in entering the lunar communications space to learn from the best practices of network infrastructur providers (ISPs/IXPs), as well as the open source community. For the Open Lunar Foundation, these analogies are particularly relevant because of our interest in an open and collaborative infrastructure for lunar exploration more broadly, which also encompasses future lunar communications.

One step towards addressing this will be establishing the operating structure of lunar communications node. Takeaways from the open source community shov that designing a foundation and membership structure around timescales of multiple decades with long-term monetary commitments is important when thinking about longevity in operations. Given that satellite communications infrastructure operates on similar timescales, this will also be an important consideration for lunar communications nodes.

While momentary support is essential to the initial lunar communications node's deployment, it is equally important to think about how this infrastructure supports long-term revenue for participating members. The open source community for example, addresses this through various avenues including sellir support arrangements around the software itself, or operating, or charging for services around, the code base. Any kind of cooperative lunar relay will also hav

founding members, and users.

Additionally, an open and collaborative lunar communications node will have t be centered around the importance of the broader membership that comprises its user base. Users have an important role to play, especially voting members that help set the framework for governance and other strategic initiatives. It will be important to incentivize participation by understanding the motivations of members wishing to participate in disseminating the last-mile of lunar communications data. Are their interests inherently technical? Do they wish to provide utility to the community? Is it altruistic community service? A hobby activity resulting in a sense of personal accomplishment? Answers to these questions will also help tailor the framework and criteria by which participation solicited and acknowledged in the community.

Once the drivers that bring together diverse communities to volunteer their time and effort to technical projects is clearly discerned, this can be leveraged to incentivize contributions and organize tasks in a future lunar communications node. For example, a hobby-based community in the current communications space which also provides utility is the amateur radio community, where individuals use their low-rate communications capabilities and assigned frequencies to support activities in times of need. This community has even gon a step further, successfully organizing projects to launch their own amateur rad satellites. Ultimately, the design of any future lunar node will have to be cogniza of the voices and values of the user base that is handling and generating servic around its data.

As future stakeholders in the lunar communications infrastructure, community networks must self-organize to establish reflexive strategies to help influence technological and legal developments in this new sphere. We believe that learnings from network infrastructure and the open source community, coupled with strategies for open and collaborative community involvement, will help pa

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