# Data Sharing in Satellite Systems: Review of the Past and Opportunities in the age of large LEO constellations

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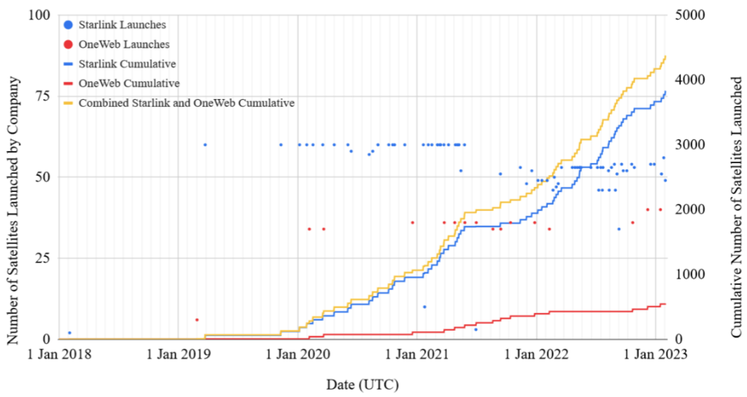
**ABSTRACT:** This paper provides a review of data collection and sharing practices across three types of satellite systems: university smallsat missions, federal government missions, and private sector/commercial missions. In this review and synthesis, the utility of those datasets is identified along with challenges associated with moving towards standard structures and stakeholder sharing practices.

## INTRODUCTION

The **number of satellites launched** per year in the last decade has **increased more than a factor of ten, with 2022 making a record year with 2,163 satellites launched [1].** Technological developments in satellite communications in combination with the increased number of satellites has caused the **quantity of data collected from satellites to increase more than fifteen times over the past decade [2].** These large datasets available to operators can be utilized both to ensure the coexistence of satellites in orbit. These datasets can help engineers and scientists better understand the impacts of space weather on satellites by **characterizing anomalies and improving the overall system reliability**. For such applications to be possible, telemetry data needs to be shared amongst operators and maintained in a format that can be accessed by researchers, engineers and satellite operators.




## REVIEW OF DATA SHARING PRACTICES

Sharing of satellite data presents confidentiality challenges due to the proprietary nature of the commercial companies and federal organizations. The level of confidentiality can be broken down to **four categories based on the operator: Universities/research laboratories, civilian government agencies, commercial companies and defense agencies.** The first three categories will be presented in the following table.

| Data category | How they share |
|---|---|
| University Satellites | Mission webpage with different data product levels |
| Federal Agencies | Accessed through the National Oceanic and Atmospheric Administration (NOAA) website or via request |
| Commercial databases | Behind paywalls with discounted pricing for academic institutions |
| Real-time data sharing | Via sensors on device |

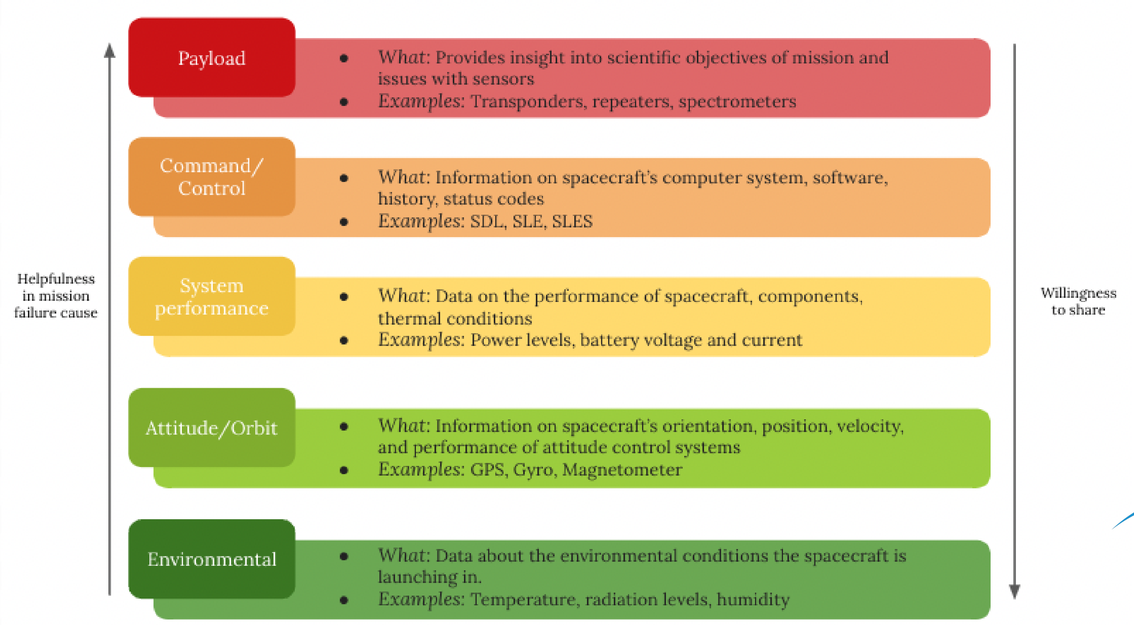
## UTILITY OF DATA SHARING PRACTICES

The analysis of satellite data in real time or post-mission has led to a better understanding of satellites and the space environment. The deployment of large satellite networks has created potential new data sources and their geographically diverse distribution makes them ideal for localizing phenomena such as atmosphespheric drag and micrometeoroid showers. These new data sources can also help minimize the challenges that arise from the coexistence of all these satellites in orbit. The vast amount of new data cannot be utilized though without a proper data sharing system.

| Category | Problems that exist |
|---|---|
| **Space Environments and Effects Detection** | *Problems that exist:* There is a lack of a robust data sharing system in place for collection and storage of data from different operators. |
| **Reliability of satellites** | *Problems that exist:* Most publicly available datasets have limited information and the majority of failures are attributed to unknown factors. |
| **Coexistence of satellites** | *Problems that exist:* The collision avoidance system in place as of May 2023 is primarily passive with radar and optical sensors of the 18th Space Control Squadron actively tracking more than 47,000 man-made objects and alerting satellite operators of potential close encounters with space debris or active satellites [48]. It is estimated that only approximately 3-4% of these alerts require operators to move their satellites to avoid collisions creating a need for developing better techniques to monitor and estimate collision risk [47]. |
| **Confidentiality in data sharing** | *Problems that exist:* Data points from the satellite payload, sensor outputs and system performance are the most critical in identifying failures and sensing the space environment, however, they are also the measurements operators are least willing to share. |

## CONCLUSION

For the vast amounts of data collected to be accessible, a data sharing and storage framework needs to be developed to ensure the usability of data. The figure below presents different categories of data and ranks them based on their helpfulness for reliability purposes (upwards) and their willingness to share such data (downwards)

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