SSRI KNOWLEDGE BASE

RESOURCES FOR SMALLSAT SUCCESS

Small Satellite Reliability Initiative (SSRI) Knowledge Base Tool: Use Case Review and Future Functionality and Content Directio

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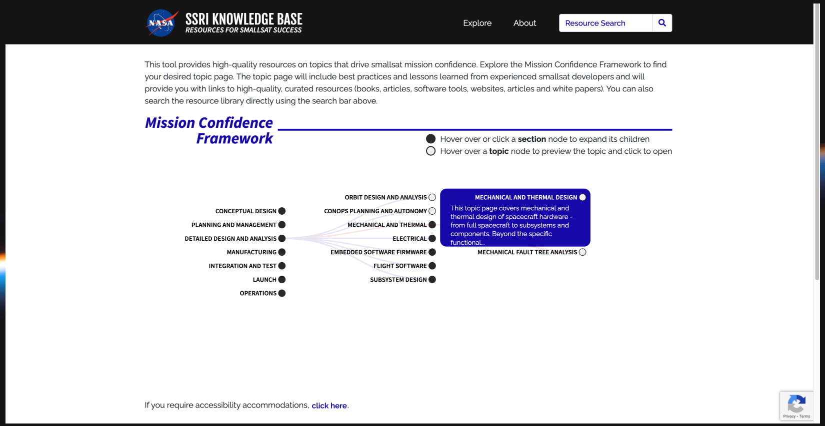
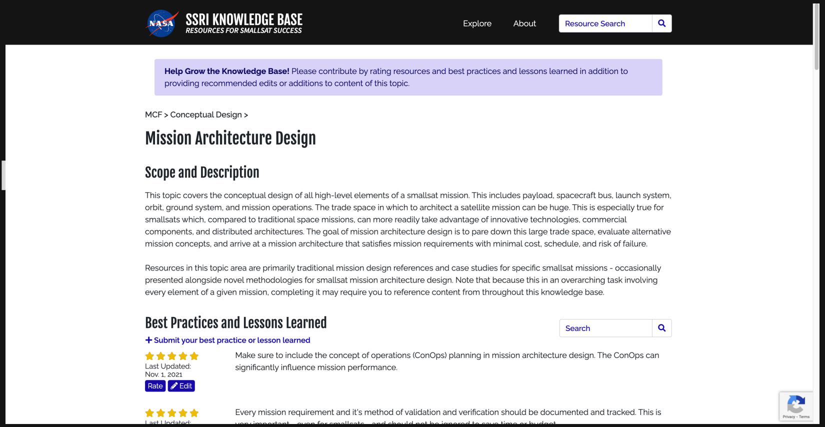
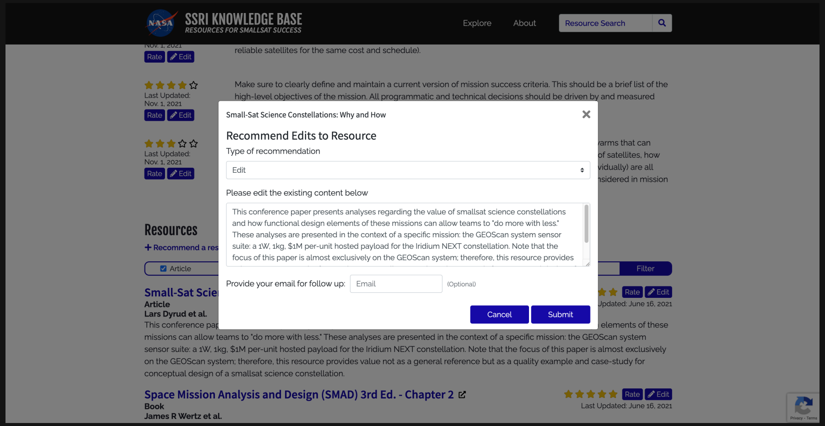
36th Annual Small Satellite Conference
Logan, Utah, USA







Intro to the SSRI Knowledge Base

Overview

- NASA website located at **https://s3vi.ndc.nasa.gov/ssri-kb**
- Resources, lessons learned, and best practices for SmallSat developers
- Publicly available tool for the entire community
- Comprehensive and searchable

Developers

- You! (crowdsourced input)
- Collaboratively developed and maintained by the SSRI Working Group
- Funded by NASA's Small Spacecraft Systems Virtual Institute (S3VI)
- S3VI is jointly sponsored by NASA's Space Technology Mission Directorate and Science Mission Directorate

Motivation

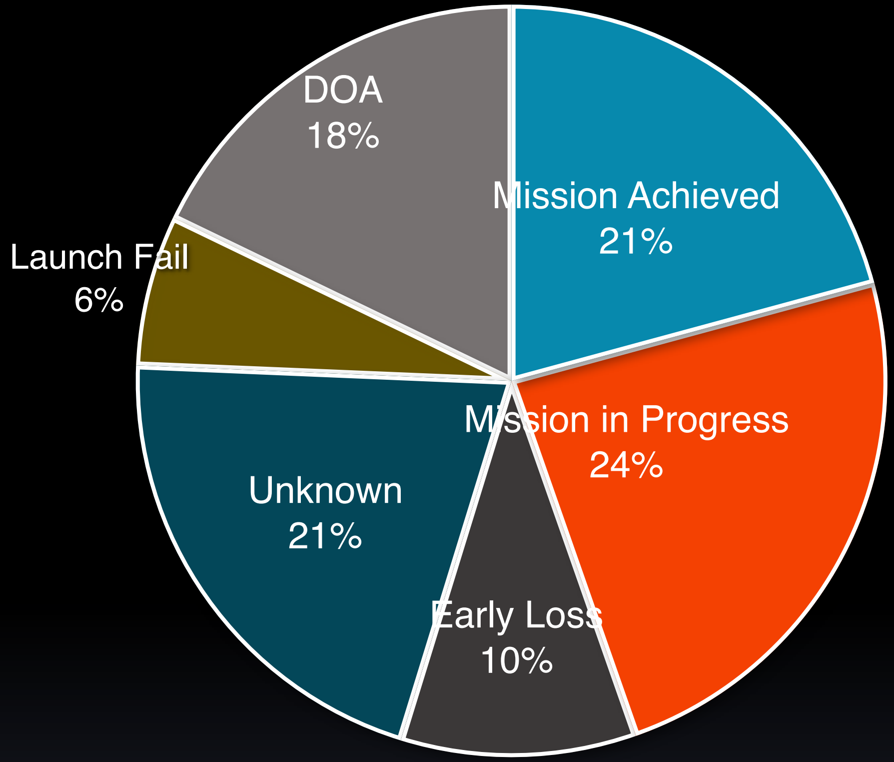
Too many small satellite missions fail.

High failure rates are significantly driven by:

1) Lack of standard processes and institutional knowledge

2) No quality, public forum to inform the development and evolution of processes and institutional knowledge

CubeSat Mission Status 2000-2020



Data from M. Swartwout https://sites.google.com/a/slu.edu/swartwout/home/cubesat-database

Approach

Legacy Approach (Documents)

- Standards and other docs **are slow and expensive** to prepare, maintain, and update.
- **Constant change** in small spacecraft tech presents additional challenges

SSRI Knowledge Base Approach

- Embrace digital transformation by creating a **web-based tool**
- Efficient knowledge sharing and a solution that can **keep up with constant change**
- **Completely public** to engage the entire community and enable cross-pollination
- Leverage an **open, collaborative** approach to content generation

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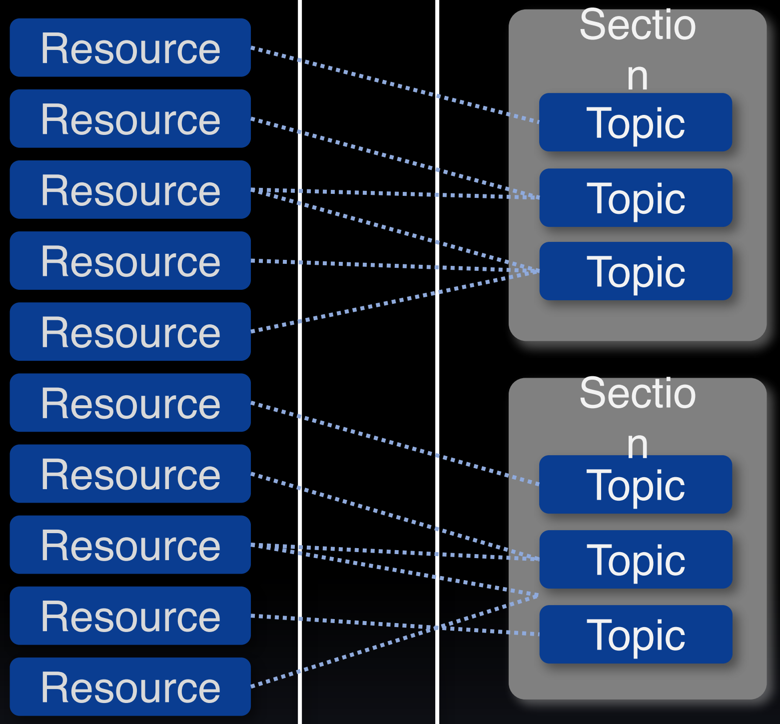
Structure

Resource Library

- Third-party content
  - Articles, books, software tools, white papers, standards, and websites
- Access to resource
- SmallSat context
- Ratings



Mission Confidence Framework

- Order, structure, context
- Best practices & lessons learned
- Crowdsourcing interfaces

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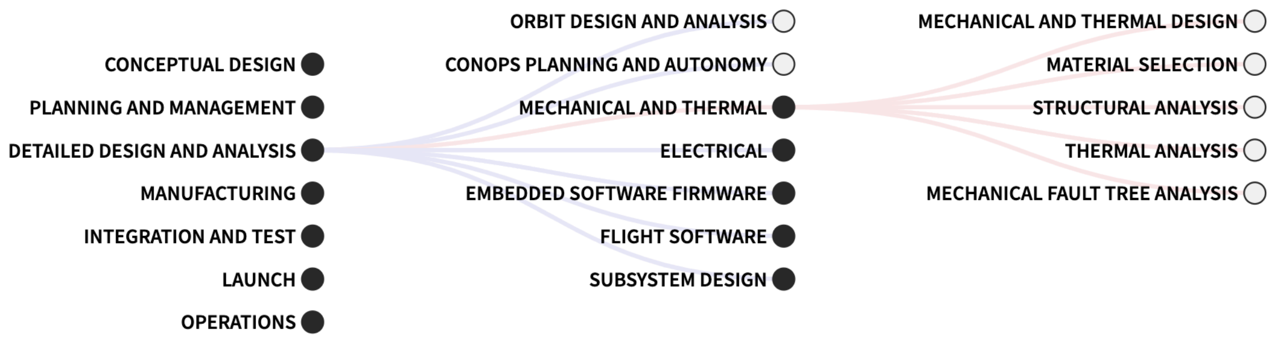
Explore About Resource Search

This tool provides high-quality resources on topics that drive smallsat mission confidence. Explore the Mission Confidence Framework to find your desired topic page. The topic page will include best practices and lessons learned from experienced smallsat developers and will provide you with links to high-quality, curated resources (books, articles, software tools, websites, articles and white papers). You can also search the resource library directly using the search bar above.

Mission Confidence Framework

- ● Hover over or click a **section** node to expand its children
- ○ Hover over a **topic** node to preview the topic and click to open



https://s3vi.ndc.nasa.gov/ssri-kb/

If you require accessibility accommodations, click here.

Home Page > MCF

Topic Page > Scope and Description

Help Grow the Knowledge Base! Please contribute by rating resources and best practices and lessons learned in addition to providing recommended edits or additions to content of this topic.

MCF > Conceptual Design >

Mission Architecture Design

Scope and Description

This topic covers the conceptual design of all high-level elements of a smallsat mission. This includes payload, spacecraft bus, launch system, orbit, ground system, and mission operations. The trade space in which to architect a satellite mission can be huge. This is especially true for smallsats which, compared to traditional space missions, can more readily take advantage of innovative technologies, commercial components, and distributed architectures. The goal of mission architecture design is to pare down this large trade space, evaluate alternative mission concepts, and arrive at a mission architecture that satisfies mission requirements with minimal cost, schedule, and risk of failure.

Resources in this topic area are primarily traditional mission design references and case studies for specific smallsat missions - occasionally presented alongside novel methodologies for smallsat mission architecture design. Note that because this in an overarching task involving every element of a given mission, completing it may require you to reference content from throughout this knowledge base.

Best Practices and Lessons Learned

Search

+ Submit your best practice or lesson learned

★★★★★
Last Updated:
Nov. 1, 2021
Rate Edit

Make sure to include the concept of operations (ConOps) planning in mission architecture design. The ConOps can significantly influence mission performance.

★★★★★

Every mission requirement and it's method of validation and verification should be documented and tracked. This is

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s3vi.ndc.nasa.gov/ssri-kb/topics/1/

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Explore About Resource Search

Best Practices and Lessons Learned

Search

+ Submit your best practice or lesson learned

★★★★★
Last Updated: Nov. 1, 2021
Rate | Edit

Make sure to include the concept of operations (ConOps) planning in mission architecture design. The ConOps can significantly influence mission performance.

★★★★★
Last Updated: Nov. 1, 2021
Rate | Edit

Every mission requirement and it's method of validation and verification should be documented and tracked. This is very important - even for smallsats - and should not be ignored to save time or budget.

★★★★★
Last Updated: Nov. 1, 2021
Rate | Edit

The lack of process requirements typically flowed to smallsat missions means that the reliability level of each mission element should enter the mission architecture trade space (e.g. do we deploy one very reliable satellite or four less reliable satellites for the same cost and schedule).

★★★★☆
Last Updated: Nov. 1, 2021
Rate | Edit

Make sure to clearly define and maintain a current version of mission success criteria. This should be a brief list of the high-level objectives of the mission. All programmatic and technical decisions should be driven by and measured against these mission success criteria.

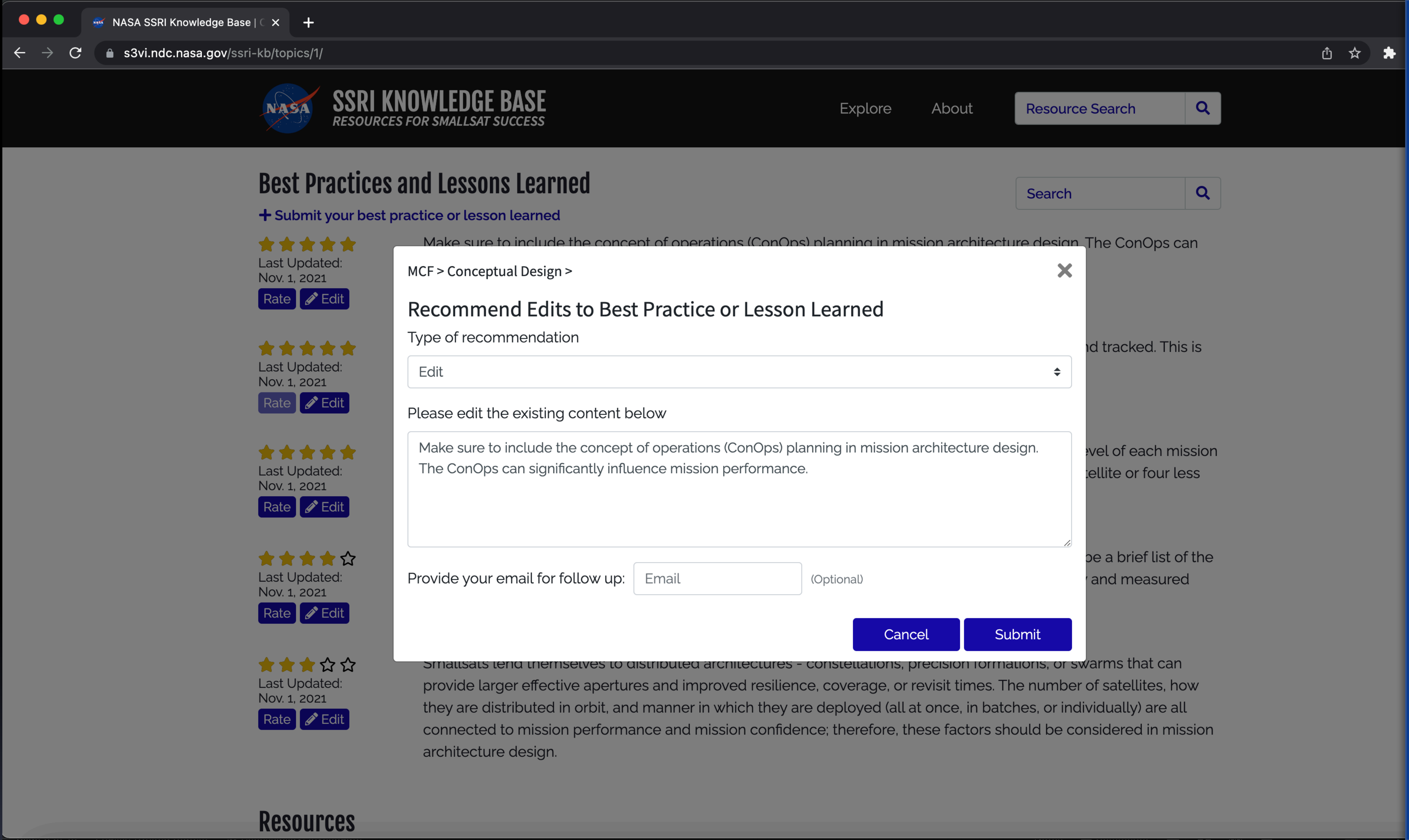
★★★☆☆
Last Updated: Nov. 1, 2021
Rate | Edit

Smallsats lend themselves to distributed architectures - constellations, precision formations, or swarms that can provide larger effective apertures and improved resilience, coverage, or revisit times. The number of satellites, how they are distributed in orbit, and manner in which they are deployed (all at once, in batches, or individually) are all connected to mission performance and mission confidence; therefore, these factors should be considered in mission architecture design.

Resources

Topic Page > BPLL

Topic Page > BPLL Crowdsourcing



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Explore About Resource Search

Resources

+ Recommend a resource

Article Book Software Tool White Paper Standard Website Filter

Small-Sat Science Constellations: Why and How

Rate Edit

Article

Last Updated: June 16, 2021

Lars Dyrud et al.

This conference paper presents analyses regarding the value of smallsat science constellations and how functional design elements of these missions can allow teams to "do more with less." These analyses are presented in the context of a specific mission: the GEOScan system sensor suite: a 1W, 1kg, $1M per-unit hosted payload for the Iridium NEXT constellation. Note that the focus of this paper is almost exclusively on the GEOScan system; therefore, this resource provides value not as a general reference but as a quality example and case-study for conceptual design of a smallsat science constellation.

Space Mission Analysis and Design (SMAD) 3rd Ed. - Chapter 2

Rate Edit

Book

Last Updated: June 16, 2021

James R Wertz et al.

This chapter covers "the initial process of selecting and defining a space mission." The process is presented in detail and includes flow diagrams, tables, definitions of key terms, and an instructive example. Note that this resource is not smallsat-specific and should be considered along with other smallsat-specific resources to develop an approach that is appropriate for the cost and schedule constraints of your mission.

Methods for Achieving Dramatic Reductions in Space Mission Cost

Rate Edit

Article

Last Updated: June 16, 2021

James R Wertz et al.

This conference paper presents what the authors describe as the "most useful of roughly 100 methods, processes, technologies, and programs for achieving dramatic reductions in space mission cost." This guidance is broken down into nine categories: Attitude, Personnel, Programmatic, Government/Customer, Systems Engineering, Mission, Launch, Spacecraft Technology, and Operations. The tables presented throughout this article allow for quick access to the key takeaways from each section.

Systems Engineering Body of Knowledge

Rate Edit

Website

Last Updated: June 16, 2021

Topic Page > Resources

Topic Page > Resources Crowdsourcing

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Explore About Resource Search

Resources

+ Recommend a resource

Article Filter

Small-Sat Scie
Article
Lars Dyrud et al.
This conference pap... elements of these missions can allow t... Scan system sensor suite: a 1W, 1... almost exclusively on the GEOScan sys... ase-study for conceptual design c...

Rate Edit
Updated: June 16, 2021

Space Mission
Book
James R Wertz et al
This chapter covers ... cludes flow diagrams, tables, de... hould be considered along wi... ule constraints of your mission.

Rate Edit
Updated: June 16, 2021

Space Mission Analysis and Design (SMAD) 3rd Ed. - Chapter 2

Recommend Edits to Resource

Type of recommendation

Edit

Please edit the existing content below

This chapter covers "the initial process of selecting and defining a space mission." The process is presented in detail and includes flow diagrams, tables, definitions of key terms, and an instructive example. Note that this resource is not smallsat-specific and should be considered along with other smallsat-specific resources to develop an approach that is appropriate for the cost and schedule constraints of your mission.

Provide your email for follow up: Email (Optional)

Cancel Submit

Methods for Ac
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Rate Edit
Last Updated: June 16, 2021

Systems Engineering Body of Knowledge
Website

Rate Edit
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s3vi.ndc.nasa.gov/ssri-kb/resources/?search=Thermal+Vacuum

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Explore About Thermal Vacuum

Resource Search Results

☑ Article ☐ Book ☑ Software Tool ☑ White Paper ☐ Standard ☑ Website Filter

Development of a Thermal-Vacuum Chamber for testing in Small Satellites

Rate Edit
Last Updated: June 16, 2021

Article
Roy Chisabas et al.
Thermal-vacuum testing is critical to ensuring satellite reliability and survivability. Unfortunately, many thermal-vacuum chambers are much larger than necessary for small satellites, resulting in an unnecessary cost burden for developers. This paper seeks to outline the methodology for developing thermal-vacuum chambers for testing small satellites.

Method for CubeSat Thermal-Vacuum Cycling Test Specification

Rate Edit
Last Updated: June 16, 2021

Article
Roy Chisabas et al.
Thermal-vacuum cycling tests are necessary for evaluating the survivability of a satellite in the harsh thermal environment of space. The objective of this resource is to deliver and establish a set of "comprehensive and coherent thermal-vacuum specifications." Detailed specification and process is provided throughout.

Insight Into the Value of System Level Thermal Vacuum Testing

Rate Edit
Last Updated: Aug. 5, 2020

White Paper
Aerospace Corporation
Cost and schedule pressures that becoming more often a part of smallsat development has led many developers to debate the costs and benefits of thermal vacuum testing. This resource takes a deeper dive into this question to determine just how valuable thermal vacuum testing is.

Thermal-Vacuum Versus Thermal-Atmospheric Tests of Electronic Assemblies

★★★☆☆ Rate Edit
Last Updated: June 9, 2021

White Paper
NASA
This site provides a high-level overivew, lessons learned, and recommendations related to thermal vacuum (T/V) testing. A NASA JPL study

Resource Search Results

NASA SSRI Knowledge Base | A

s3vi.ndc.nasa.gov/ssri-kb/api/#tag/Resources/operation/getResources

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Explore | About | Resource Search

Search...

- Errors
- Topics
- Resources
  - GET Retrieve Knowledge Base Resources
  - GET Retrieve specific Knowledge Base Resource by ID
- Resource Search

Documentation Powered by Redocly

Retrieve Knowledge Base Resources

GET /resources

Responses

200 SUCCESS

RESPONSE SCHEMA: application/json

Array [

id	integer <int64> The unique ID of the Resource
dateCreated	string <date-time> The date and time that the Resource was created
dateModified	string <date-time> The date and time that the Resource was last updated
rating	number <float> [0 .. 5] The rating of the Resource. Note that a rating of 0 indicates that the Resource has not yet been rated.
owner	string The owner/author/manufacturer of the Resource
title	string The title of the Resource
description	string

Response samples

200

Content type
application/json

Copy Expand all Collapse


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     "dateModified": "2019-08-24T14:15:22Z",
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   }
]
```


API Docs

Use Cases

Education

- University SmallSat courses and extra-curricular programs
- SmallSat PI's
- Professionals with traditional space background working on SmallSat projects

Integration

- Use the API to integrate with other databases and digital engineering tools
- Engineering software tools: context-driven guidance and resource links
- Federation with other best practices, lessons learned, and resource databases

Future Enhancements

- SSRI Knowledge Base can be **continuously improved and expanded**
- Enhancements to the Knowledge Base are driven by **feedback from the user community**
- Near-term priorities include improved linking to PDF documents and **interfacing with other online tools** via the new Knowledge Base API
- Continuously soliciting **feedback and recommendations** for relevant resources and capabilities from the domestic and international SmallSat communities

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Acknowledgements

- Small Satellite Reliability Initiative Working Group
- NASA’s Space Technology Mission Directorate (STMD)
- NASA’s Science Mission Directorate (SMD)