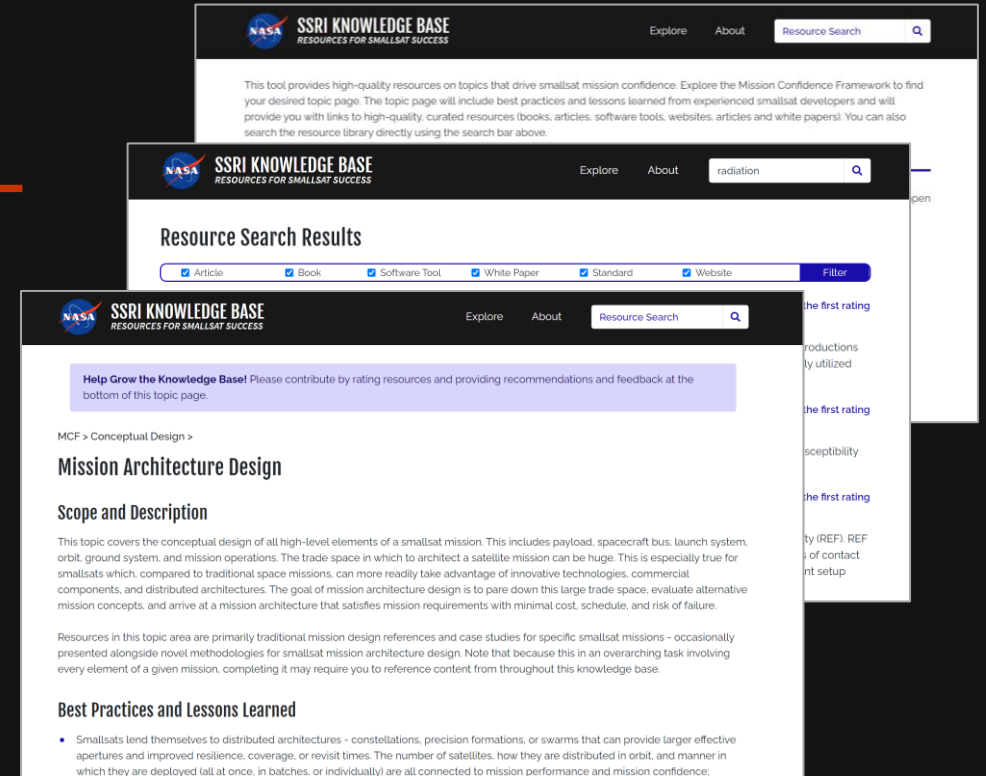


# Wikipedia for SmallSats: The SSRI Knowledge Base

NASA S3VI Community of Practice Webinar Series  
March 17, 2021

Robbie Robertson  
CEO and Co-founder  
Sedarro Technologies



The image shows a stack of three overlapping screenshots of the NASA SSRI Knowledge Base website. The top screenshot shows the homepage with a search bar and navigation links. The middle screenshot shows search results for 'radiation' with filters for Article, Book, Software Tool, White Paper, Standard, and Website. The bottom screenshot shows a detailed page for 'Mission Architecture Design' under the 'Conceptual Design' category. This page includes a 'Scope and Description' section, a 'Best Practices and Lessons Learned' section with a bullet point about distributed architectures, and a call to action to 'Help Grow the Knowledge Base!' by rating resources.

**SSRI KNOWLEDGE BASE**  
RESOURCES FOR SMALLSAT SUCCESS

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.

**SSRI KNOWLEDGE BASE**  
RESOURCES FOR SMALLSAT SUCCESS

Explore About radiation

**Resource Search Results**

Article Book Software Tool White Paper Standard Website Filter

**SSRI KNOWLEDGE BASE**  
RESOURCES FOR SMALLSAT SUCCESS

Explore About Resource Search

**Help Grow the Knowledge Base!** Please contribute by rating resources and providing recommendations and feedback at the bottom of this topic page.

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 is 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

- 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.

# Small Satellite Reliability Initiative (SSRI)



# Small Spacecraft Systems Virtual Institute (S3VI)



# Small Satellite Reliability Initiative

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*“The SSRI seeks to share resources, best practices, and lessons-learned that improve mission confidence for small satellites while, to the extent practical, considering the constraints and maintaining the efficiencies associated with these missions.”*

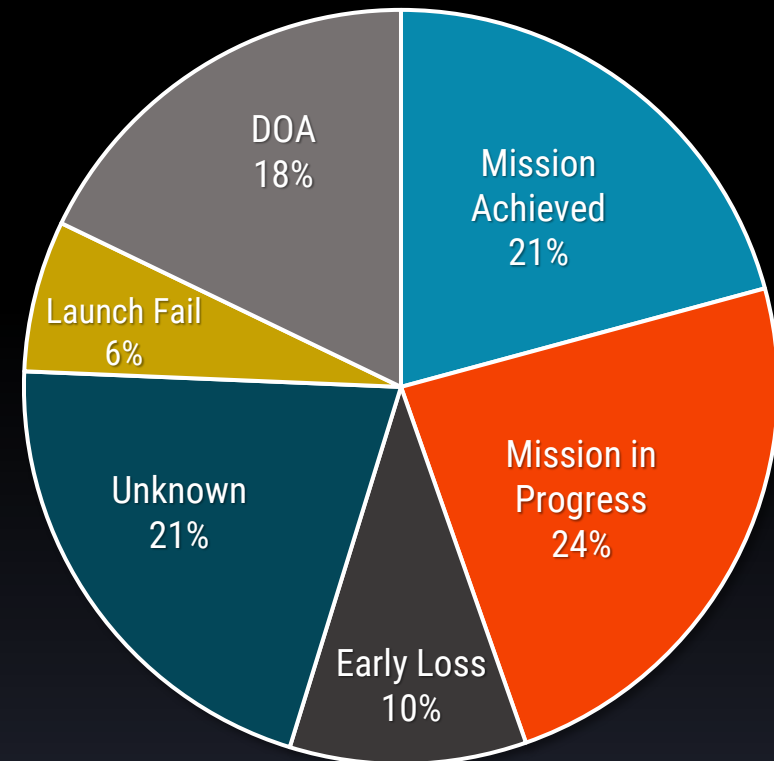
- Public-private collaboration kicked-off in 2017
- Monthly virtual tag-ups and annual technical interchange meetings
- Interested in joining the SSRI?
  - Help shape the state-of-the art and improve small satellite reliability
  - Email [robbie.robertson@sedarotech.com](mailto:robbie.robertson@sedarotech.com)

# The Problems

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- Too many small satellite missions fail
- No quality, public forum for knowledge sharing

CubeSat Mission Status  
2000-2020



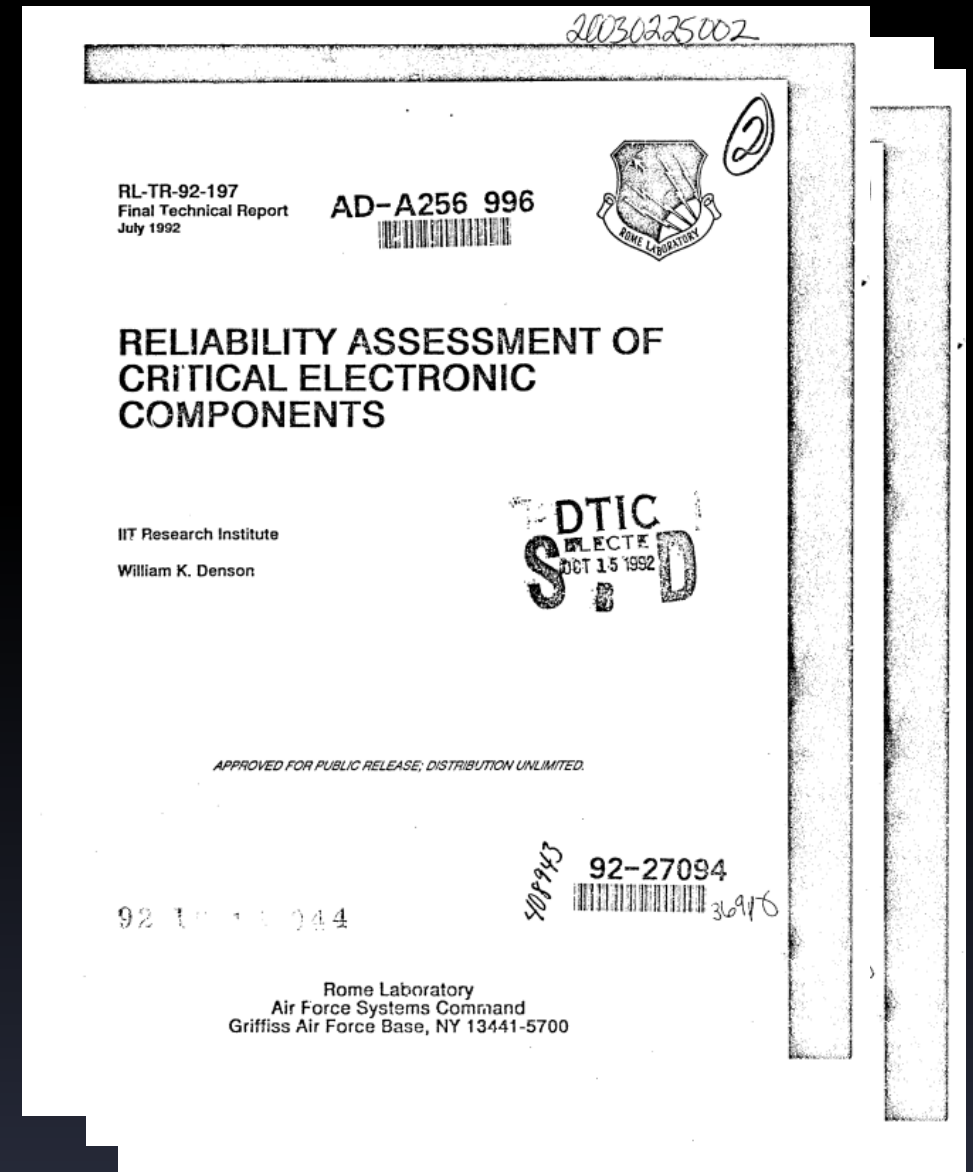
Data from M. Swartwout

<https://sites.google.com/a/slu.edu/swartwout/home/cubesat-database>

# The Problems

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- Too many small satellite missions fail
- No quality, public forum for knowledge sharing
- Slow and expensive methods of communicating best practices
- Constant change and innovation to keep up with



# Our Approach

---

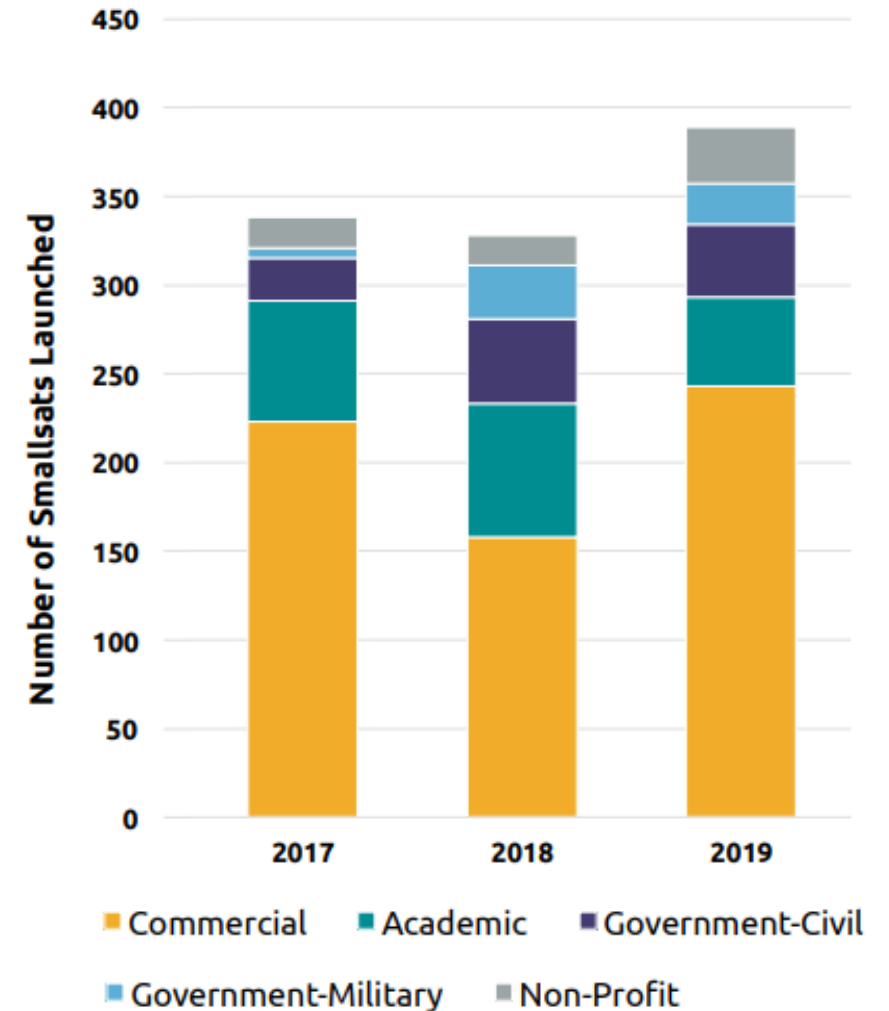
- Web-based tool
- Avoid prescriptive solutions



# Our Approach

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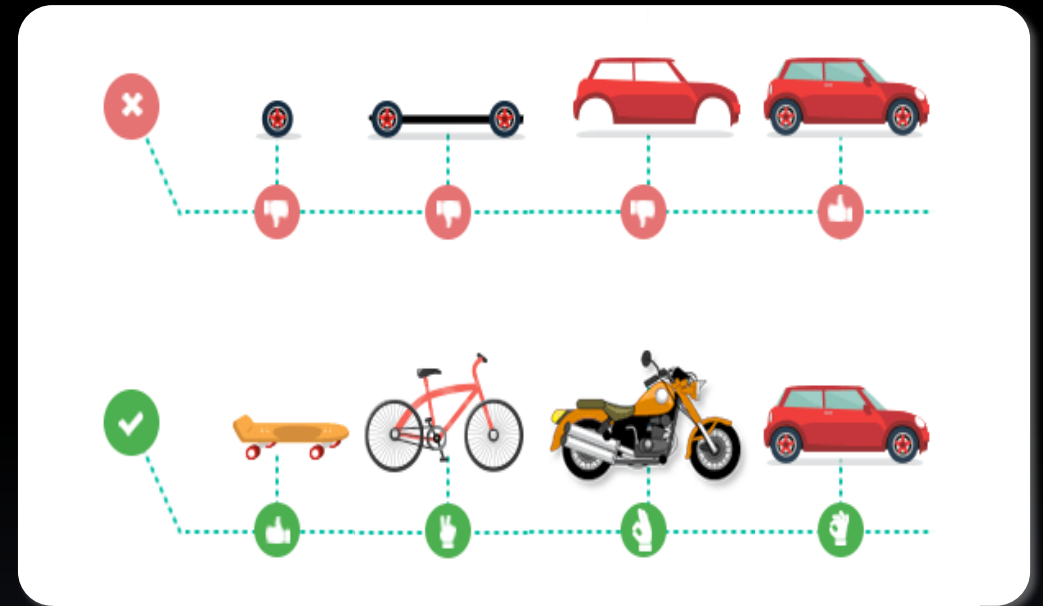
- Web-based tool
- Avoid prescriptive solutions
- Target a wide audience



# Our Approach

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- Web-based tool
- Avoid prescriptive solutions
- Target a wide audience
- Fast, lean development



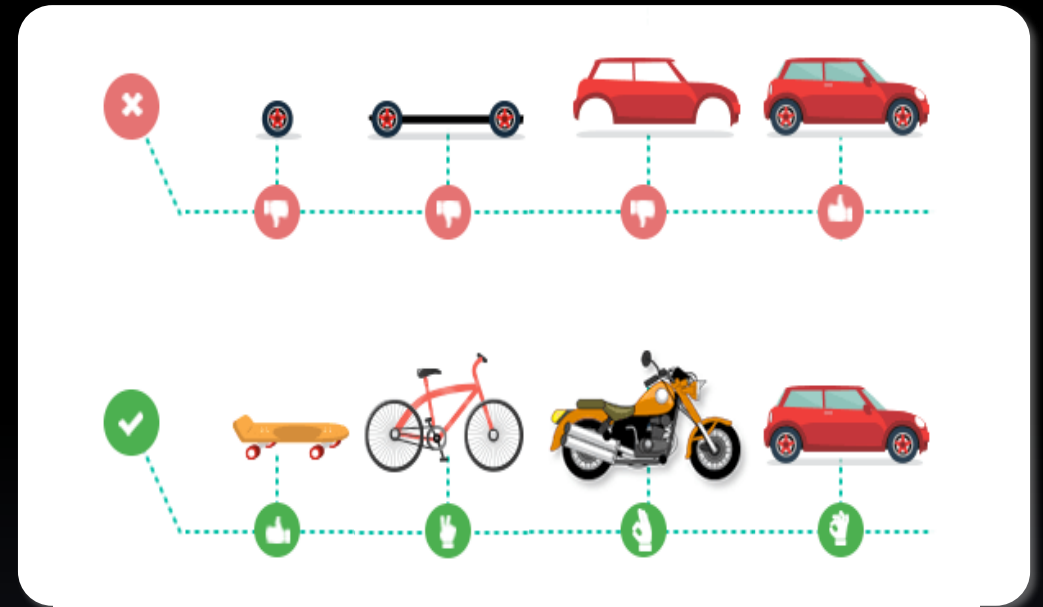
<https://guide.quickscrum.com/minimum-viable-product/>



# Our Approach

---

- Web-based tool
- Avoid prescriptive solutions
- Target a wide audience
- Fast, lean development
- Adaptable, extendable



<https://guide.quickscrum.com/minimum-viable-product/>

# The Solution: Wikipedia for SmallSats

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## Strengths of Wikipedia



- Free, publicly available tool
- Go-to starting place for information on a broad range of topics
- Open, collaborative development (crowdsourcing) for continuous growth and improvement

# The Solution: Wikipedia for SmallSats

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## Strengths of Wikipedia



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- Go-to starting place for information on a broad range of topics
- Open, collaborative development (crowdsourcing) for continuous growth and improvement

## How is the SSRI Knowledge Base Different?

- Primarily providing users with existing, third-party content
- Final moderation by the SSRI, not the user community

# Structure

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## Resource Library

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

Resource

Resource

Resource

Resource

Resource

Resource

Resource

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Resource

# Structure

---

## Resource Library

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Resource

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Resource

## Mission Confidence Framework

Section

Topic

Topic

Topic

Section

Topic

Topic

Topic

- **Order, structure, context**
- **Best practices & lessons learned**
- **User interfaces for submitting feedback and recommendations**

# Structure

---

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Resource  
Resource  
Resource  
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Resource  
Resource

## Mission Confidence Framework

- Order, structure, context
- Best practices & lessons learned
- User interfaces for submitting feedback and recommendations

Section

Topic

Topic

Topic

Section

Topic

Topic

Topic

# SmallSat Community Survey

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- Online survey to inform design of the Knowledge Base
- Emailed to hundreds of SmallSat team members and stakeholders
- Diverse group of 66 respondents

## SSRI Knowledge Base Survey

The Small Satellite Reliability Initiative (SSRI) is an activity with broad participation from civil, DoD, and commercial space systems providers and stakeholders. The SSRI seeks to share resources, best practices, and lessons-learned that improve mission confidence for small satellites while, to the extent practical, considering the constraints and maintaining the efficiencies associated with these missions. To this end, the SSRI is developing a comprehensive online knowledge base to provide organized, vetted, and high-quality information to SmallSat teams and stakeholders. More information about the Initiative and archive of past Technical Interchange Meetings (TIMs) can be found here:

<https://www.nasa.gov/smallsat-institute/reliability-initiative>

We would appreciate your input to help inform the development of the SSRI Knowledge Base website.

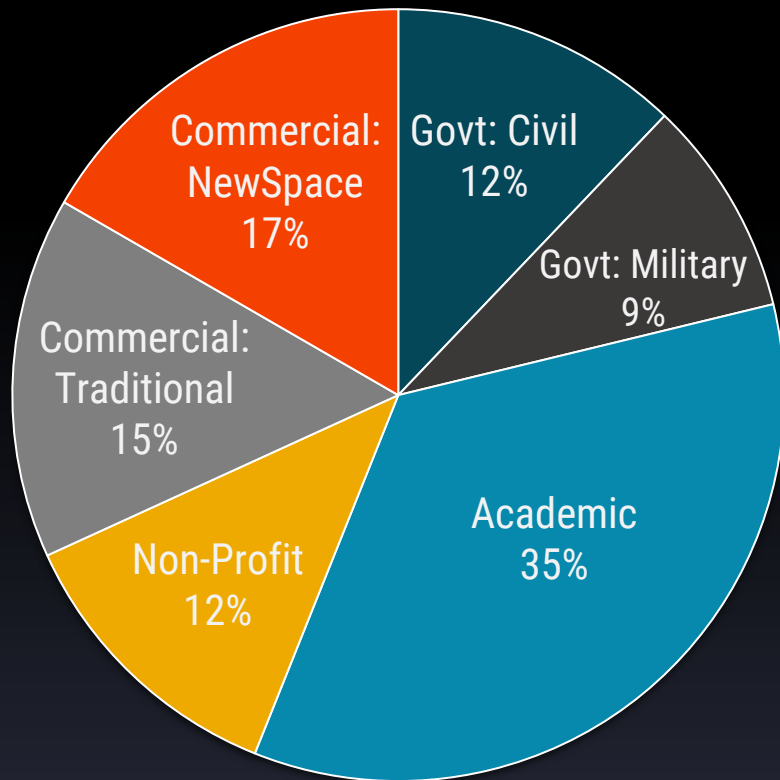
OK

0 of 10 answered

# SmallSat Community Survey

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## Respondent Demographics



## Outcomes

- “Mission Phase and Task” structure for the MCF
- Resource search and rating features
- User input interface on each topic page instead of centralized forum
- Content recommendations



# Visual Design

## Simple and Utilitarian

- Minimal distraction and clutter
- Allow for quick and efficient development
- Easy to update, grow, and evolve
- Efficient with users' time and energy

The screenshot shows the NASA SSRI Knowledge Base interface. At the top, there is a navigation bar with the NASA logo, the text "SSRI KNOWLEDGE BASE RESOURCES FOR SMALLSAT SUCCESS", and links for "Explore" and "About". A search bar labeled "Resource Search" with a magnifying glass icon is also present. Below the navigation bar, a paragraph explains the tool's purpose: "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

The framework is displayed as a tree structure with nodes. The left column contains section nodes, all of which are filled circles (●). The right column contains topic nodes, all of which are empty circles (○). The "CIRCUIT ANALYSIS" node is highlighted with a blue background and a white text box that reads: "This topic covers the analysis of the electrical circuits implemented in space electronics. These analysis are used to verify that circuit designs can..."

- CONCEPTUAL DESIGN ●
- PLANNING AND MANAGEMENT ●
- DETAILED DESIGN AND ANALYSIS ●
- MANUFACTURING ●
- INTEGRATION AND TEST ●
- LAUNCH ●
- OPERATIONS ●

- ORBIT DESIGN AND ANALYSIS ○
- CONOPS PLANNING AND AUTONOMY ○
- MECHANICAL AND THERMAL ●
- ELECTRICAL ●
- EMBEDDED SOFTWARE FIRMWARE ●
- FLIGHT SOFTWARE ●
- SUBSYSTEM DESIGN ●

- CIRCUIT DESIGN ○
- BOARD LAYOUT ○
- PART SELECTION ○
- CIRCUIT ANALYSIS ●

# Visual Design

## Simple and Utilitarian

- Minimal distraction and clutter
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## Clean, Informal Aesthetic

- Avoid harshly technical, aggressive, tactical
- Use familiar interfaces and structures

## Fonts

NASA SCIENCE

Overview

SHARE THE SCIENCE

Science Topics News

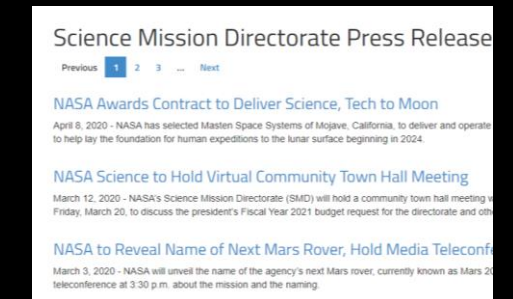
NASA leads the nation on a great

*Fjalla One*

*Metropolis/  
Source Sans Pro*

*Raleway*

## Search Results



Science Mission Directorate Press Release

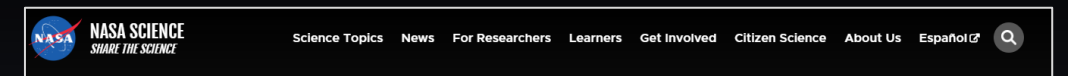
Previous 1 2 3 ... Next

[NASA Awards Contract to Deliver Science, Tech to Moon](#)  
April 8, 2020 - NASA has selected Masten Space Systems of Mojave, California, to deliver and operate to help lay the foundation for human expeditions to the lunar surface beginning in 2024.

[NASA Science to Hold Virtual Community Town Hall Meeting](#)  
March 12, 2020 - NASA's Science Mission Directorate (SMD) will hold a community town hall meeting on Friday, March 20, to discuss the president's Fiscal Year 2021 budget request for the directorate and other topics.

[NASA to Reveal Name of Next Mars Rover, Hold Media Teleconference](#)  
March 3, 2020 - NASA will unveil the name of the agency's next Mars rover, currently known as Mars 2020, during a teleconference at 3:30 p.m. about the mission and the naming.

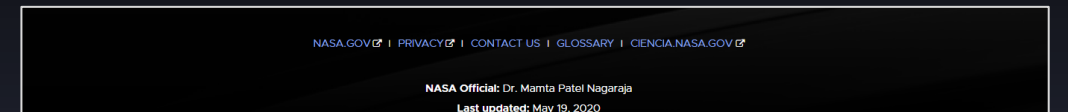
## Header



NASA SCIENCE  
SHARE THE SCIENCE

Science Topics News For Researchers Learners Get Involved Citizen Science About Us Español

## Footer



NASA.GOV | PRIVACY | CONTACT US | GLOSSARY | CIENCIA.NASA.GOV

NASA Official: Dr. Mamta Patel Nagaraja  
Last updated: May 19, 2020

# Visual Design

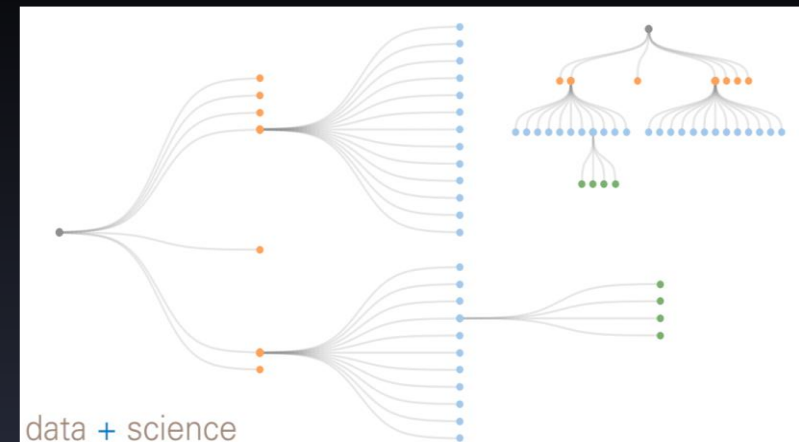
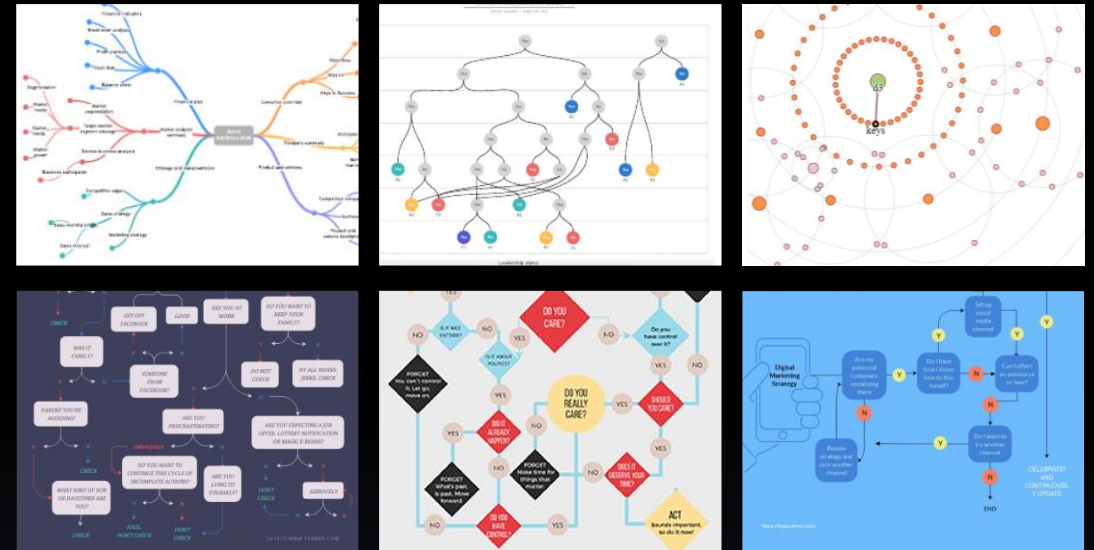
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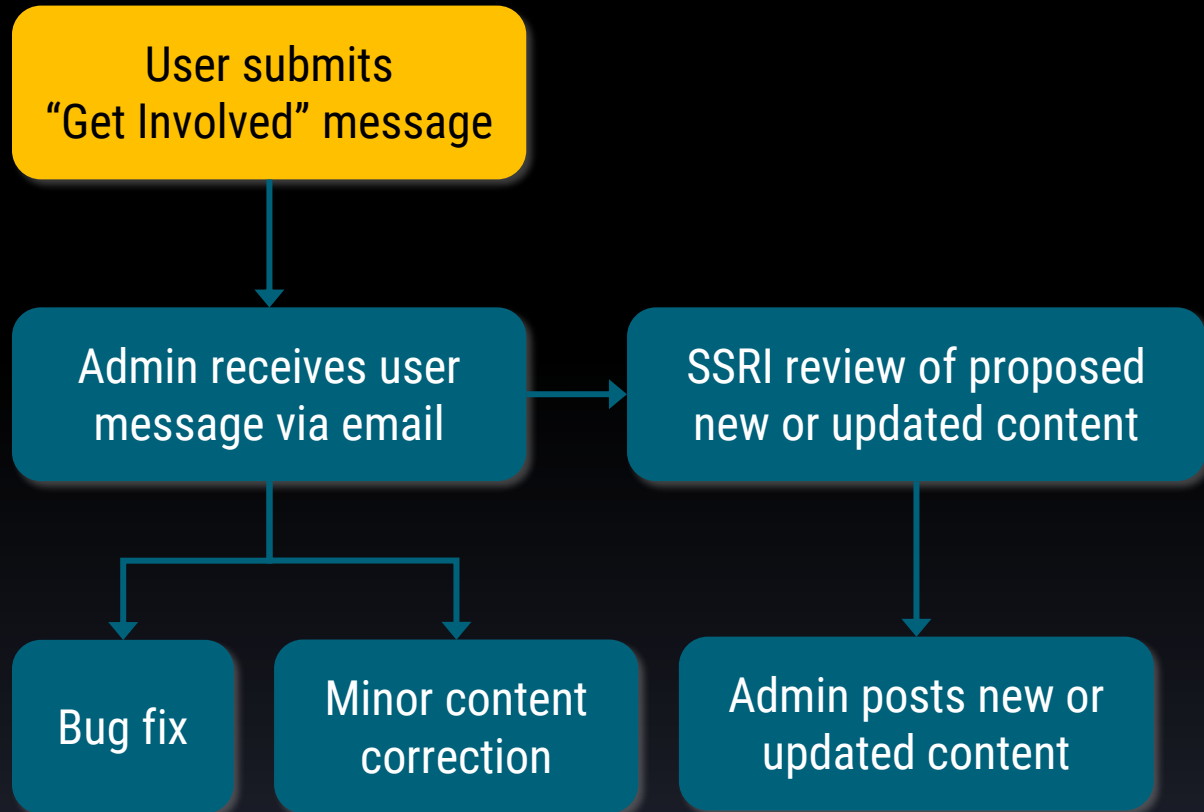
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- Use familiar interfaces and structures

## MCF Interface Design



# Administration



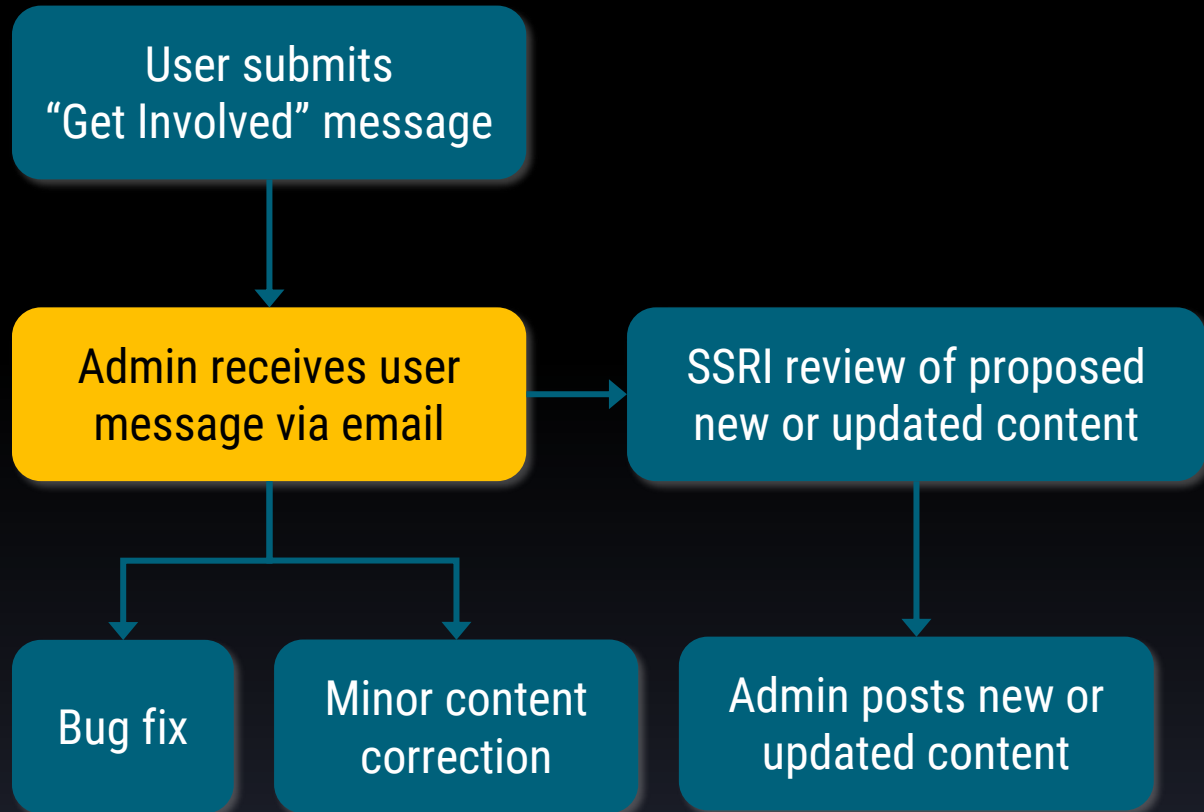
The screenshot displays the SSRI Knowledge Base website interface. The header includes the NASA logo, the title "SSRI KNOWLEDGE BASE RESOURCES FOR SMALLSAT SUCCESS", and navigation links for "Explore" and "About". A search bar is located in the top right corner.

The main content area lists several articles, each with a title, type, author, and a link to "Add the first rating":

- The Role of Small Satellites in NASA and NOAA Earth Observation Programs - Section 6** (Article, National Research Council 2000)
- Space System Architecture Lecture 1: Space Systems and Definitions Framing Document** (White Paper, Annalisa Weigel)
- Systems Engineering Body of Knowledge** (Website, INCOSE Et al.)
- CubeSat 101: Basic Concepts and Processes for First-Time CubeSat Developers - Chapter 2** (Website, NASA)

At the bottom of the page, there is a "Get Involved" section with a text area for submitting feedback and a "Submit" button. Below the text area, there is a field for providing an email address for follow-up, labeled "Email" and "(Optional)".

# Administration

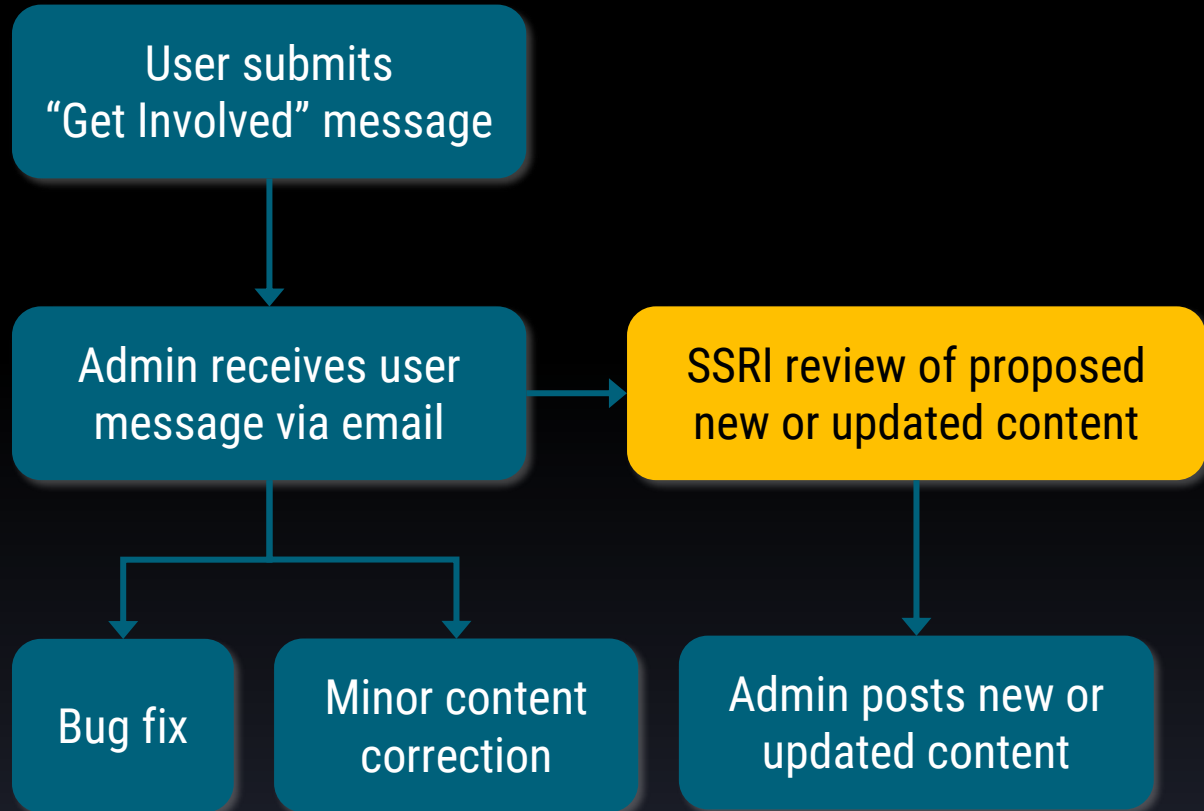


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# Administration



Django administration

Home > Topics > Topics > 1.0 Conceptual Design > Mission Architecture Design

Change topic

Order:

Heading:

SubHeading:

Title:

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.

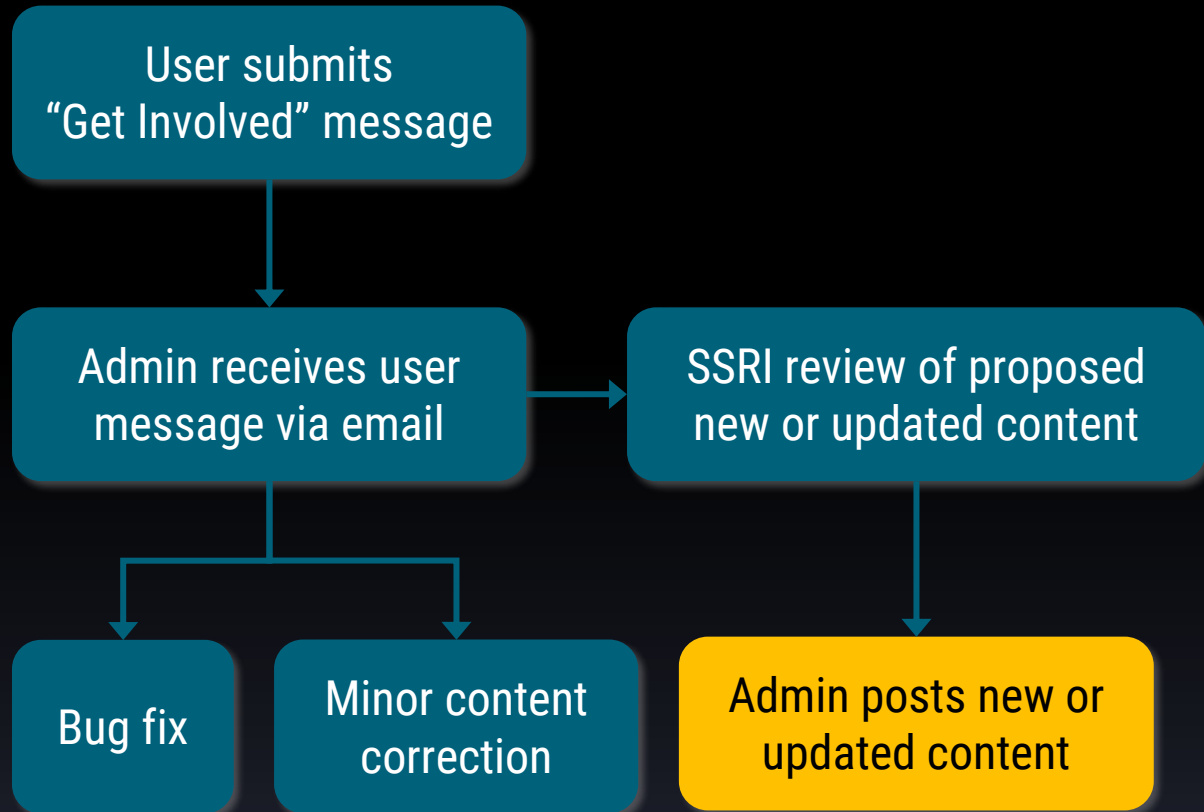
Resources in this topic area are primarily traditional mission design references and case studies for specific smallsat missions - occasionally presented alongside novel methodologies for smallsat

BestPractices: 

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.

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).

# Administration



The screenshot shows the SSRI Knowledge Base website interface. At the top, there is a NASA logo and the text "SSRI KNOWLEDGE BASE RESOURCES FOR SMALLSAT SUCCESS". Navigation links for "Explore" and "About" are present, along with a "Resource Search" box. The main content area features a section titled "Best Practices and Lessons Learned" with a list of bullet points. Below this is a "Resources" section with a filter bar and two article listings, each with a star rating.

every element of a given mission, completing it may require you to reference content from throughout this knowledge base.

### Best Practices and Lessons Learned

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

### Resources

Article  Book  Software Tool  White Paper  Standard  Website

**Mission Assurance Framework for Small Satellite Missions**   
Article  
Matthew R Capella Et al.  
This conference paper presents a method for evaluating and selecting from a set of candidate satellite constellation architectures. A reference mission is used to demonstrate each element of this method and to select from three combinations of spacecraft size and constellation size. Each candidate architecture is evaluated based on design/performance, mission assurance, and resilience.

**Application of Constraint-Based Satellite Mission Planning Model in Forest Fire Monitoring**   
Article  
Bingjun Guo Et al.  
This conference paper presents a constraint-based mission planning model for a forest fire monitoring smallsat constellation. It does not go into significant detail but does provide a concise technical description of the numerical methods and artificial intelligence concepts applied to the problem of smallsat mission architecture design. Their overall approach and methods could conceivably be applied to any mission architecture design.

# Demonstration



Use and contribute to the SSRI  
Knowledge Base at:

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

Have questions? Want to get involved?

Robbie Robertson  
[robbie.robertson@sedarotech.com](mailto:robbie.robertson@sedarotech.com)  
(781) 573-3276