



# Wikipedia for SmallSats: The SSRI Knowledge Base

CubeSat Developers Workshop  
April 27-29, 2021

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Sedar Technologies<sup>1</sup>, NASA ARC<sup>2</sup>, NASA GSFC<sup>3</sup>, Cal Poly San Luis Obispo<sup>4</sup>,  
The Aerospace Corporation<sup>5</sup>, Cornell University<sup>6</sup>

The screenshot displays the SSRI Knowledge Base interface. At the top, it says "SSRI KNOWLEDGE BASE RESOURCES FOR SMALLSAT SUCCESS" with "Explore" and "About" links and a search bar. Below this, a descriptive paragraph states: "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." The search results section shows "radiation" entered in the search bar. Below the search bar, there are filters for "Article", "Book", "Software Tool", "White Paper", "Standard", and "Website". The main content area shows a breadcrumb "MCF > Conceptual Design >" followed by the title "Mission Architecture Design". Under "Scope and Description", it explains that this topic covers the conceptual design of all high-level elements of a smallsat mission, including payload, spacecraft bus, launch system, orbit, ground system, and mission operations. It notes that the trade space for satellite mission architecture is large and that smallsats can take advantage of innovative technologies. A "Best Practices and Lessons Learned" section follows, with a bullet point stating: "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)

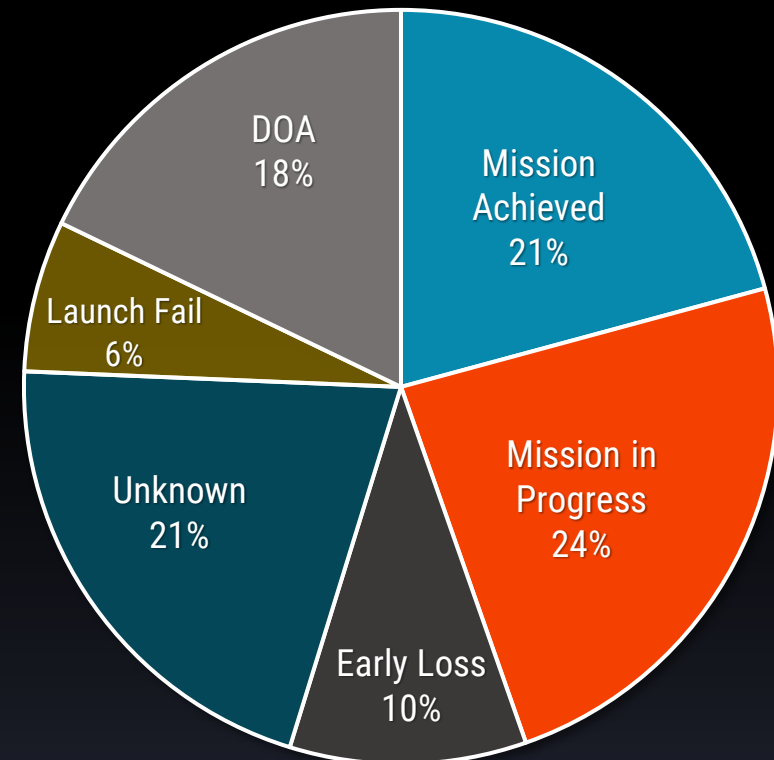


# The Problems

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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

20030225002

RL-TR-92-197  
Final Technical Report  
July 1992

AD-A256 996



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RELIABILITY ASSESSMENT OF  
CRITICAL ELECTRONIC  
COMPONENTS

IIT Research Institute  
William K. Denson

DTIC  
ELECTE  
OCT 15 1992

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED.

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Rome Laboratory  
Air Force Systems Command  
Griffiss Air Force Base, NY 13441-5700

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# Our Approach

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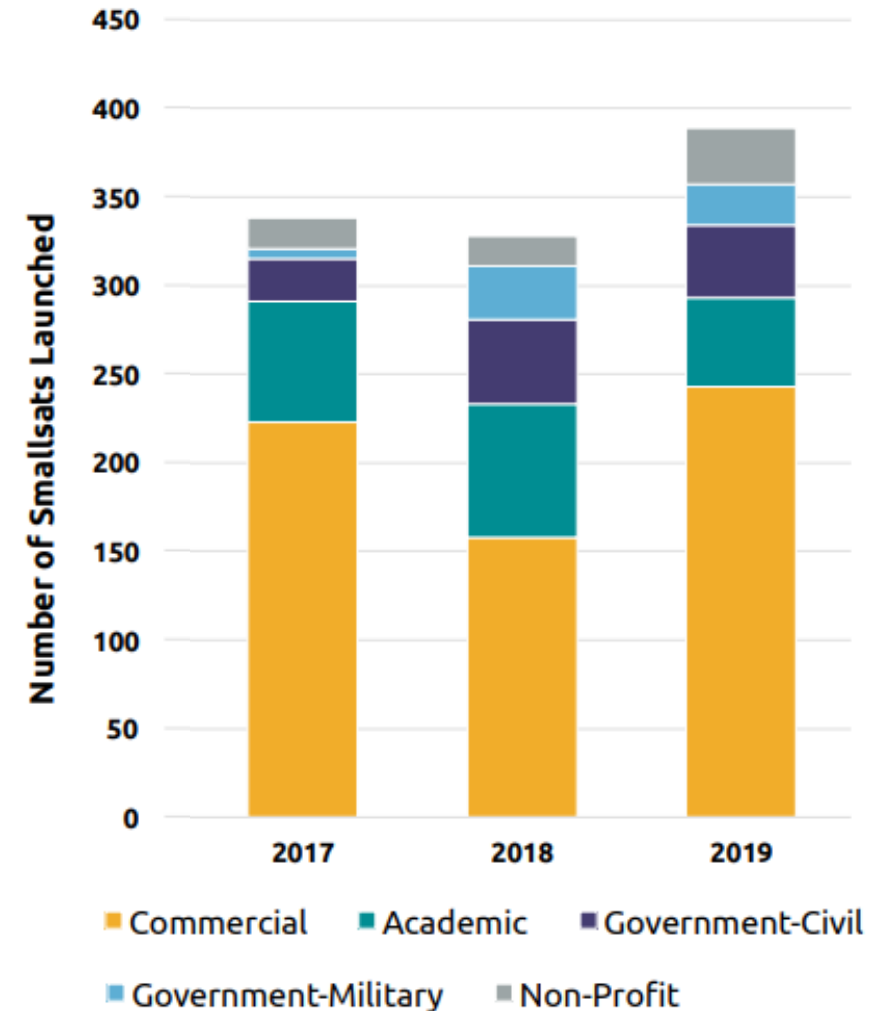
- Web-based tool
- Avoid prescriptive solutions



# Our Approach

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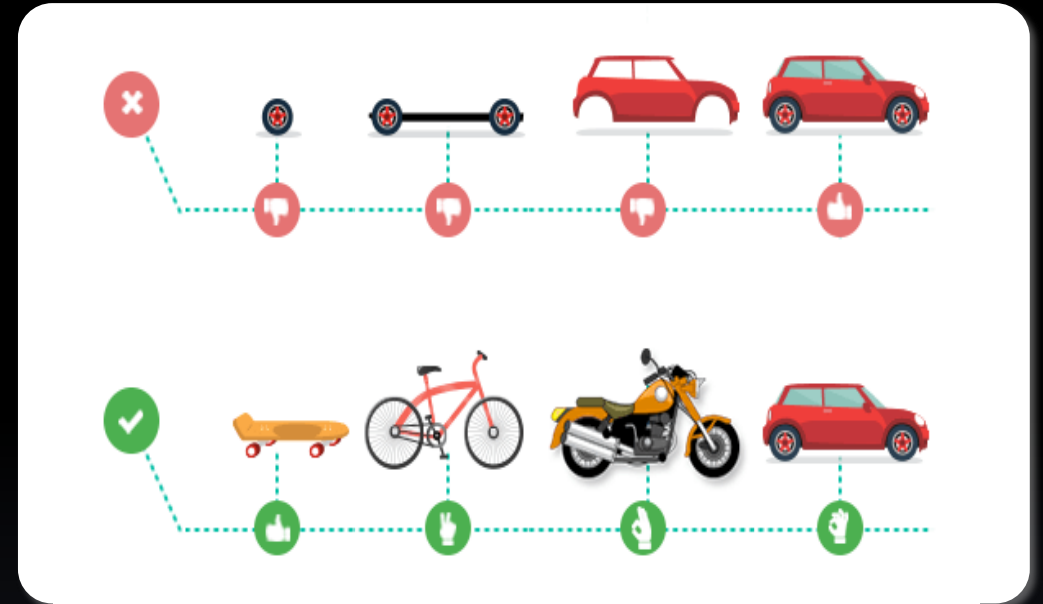
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- Avoid prescriptive solutions
- Target a wide audience



# Our Approach

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

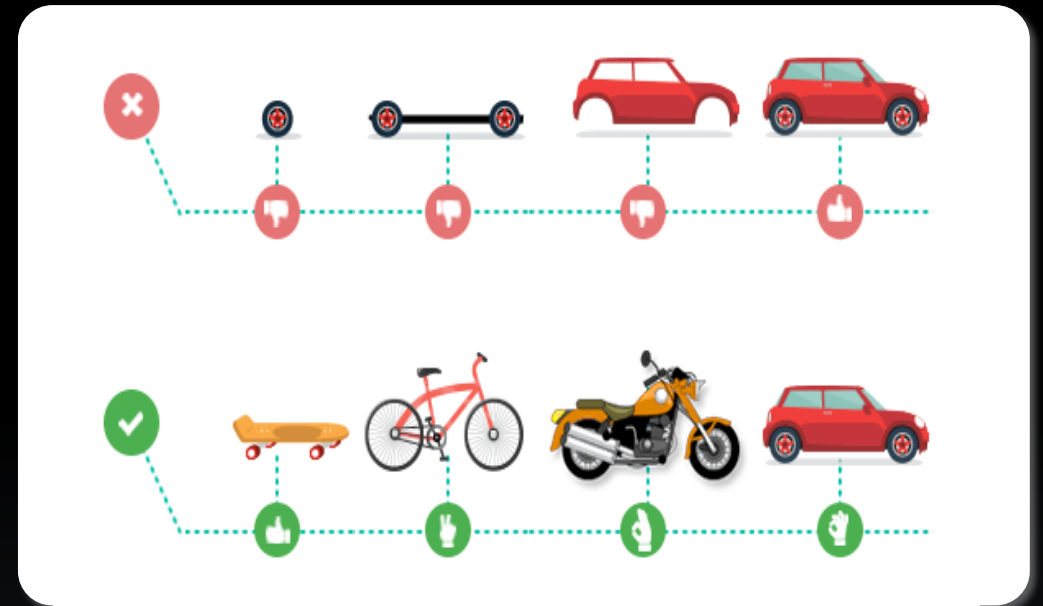


<https://guide.quickscrum.com/minimum-viable-product/>

# Our Approach

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- 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

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## 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

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## Mission Confidence Framework

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

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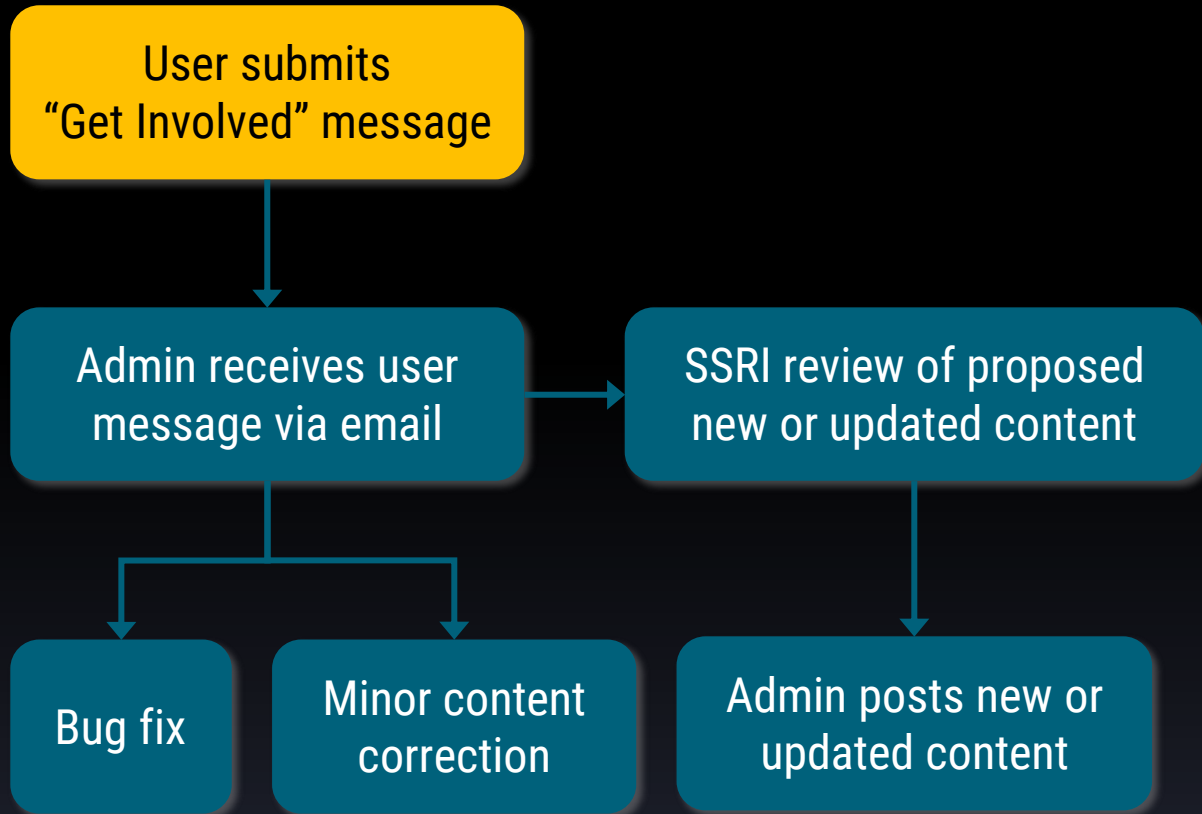
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# Administration

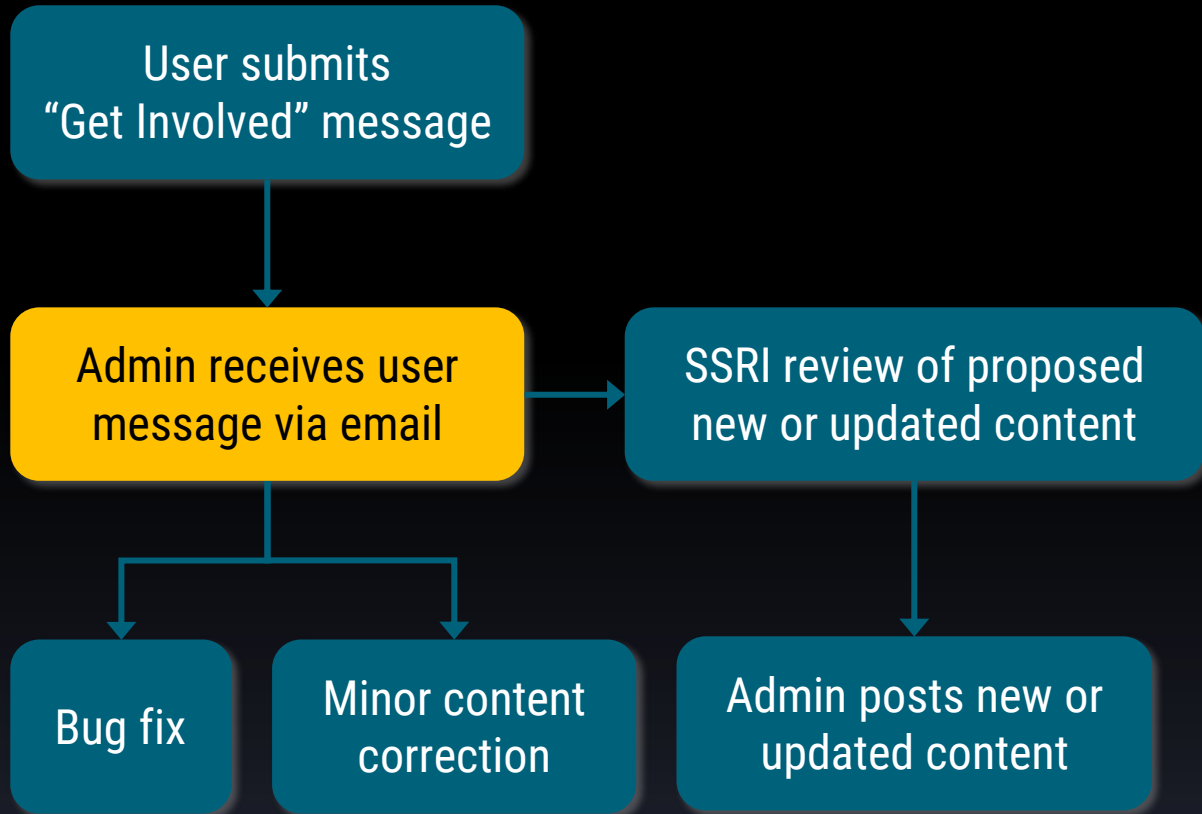


The screenshot shows the SSRI Knowledge Base website. The header includes the NASA logo, the text "SSRI KNOWLEDGE BASE RESOURCES FOR SMALLSAT SUCCESS", and navigation links for "Explore", "About", and a "Resource Search" box. The main content area lists several articles, each with a title, type, author, 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, a yellow-bordered box titled "Get Involved" contains a text area for feedback, an email input field (optional), and a "Submit" button.

# Administration

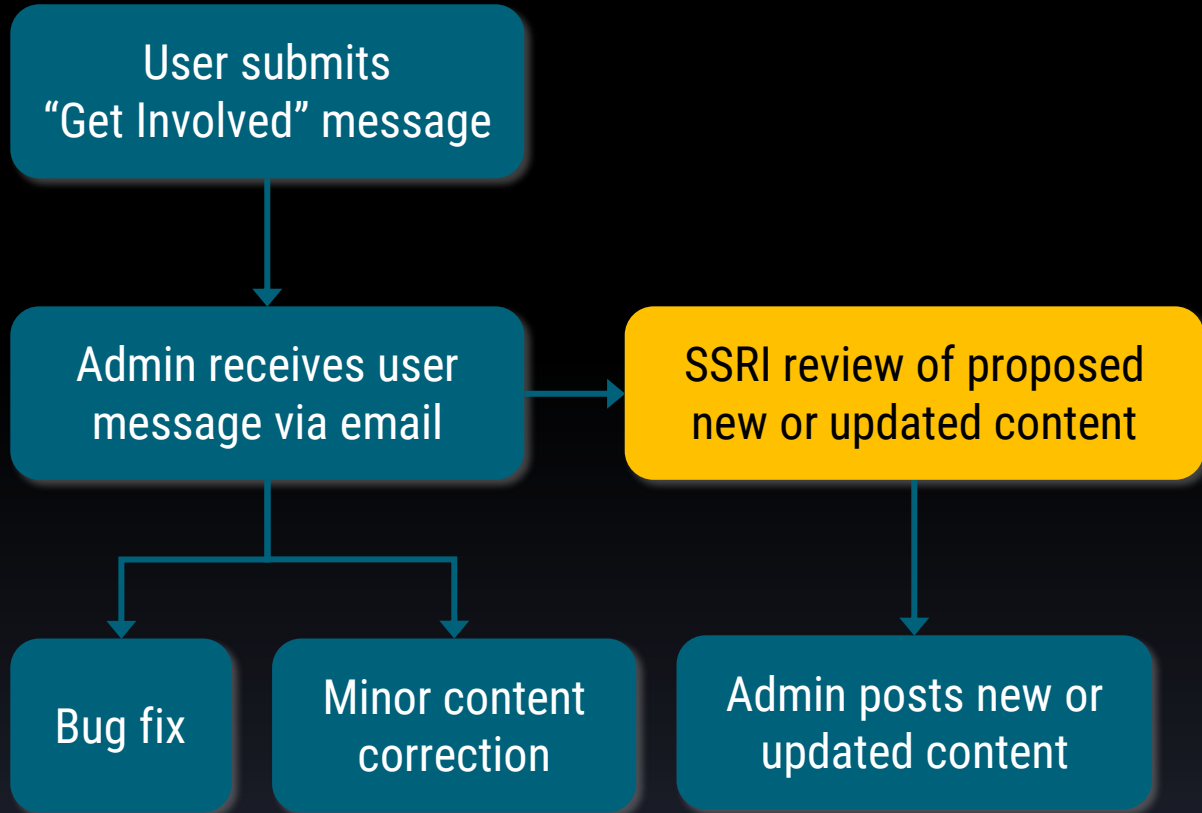


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At the bottom of the page, there is a "Get Involved" section with a text area for submitting feedback, questions, or resources, and a "Submit" button.

# 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.

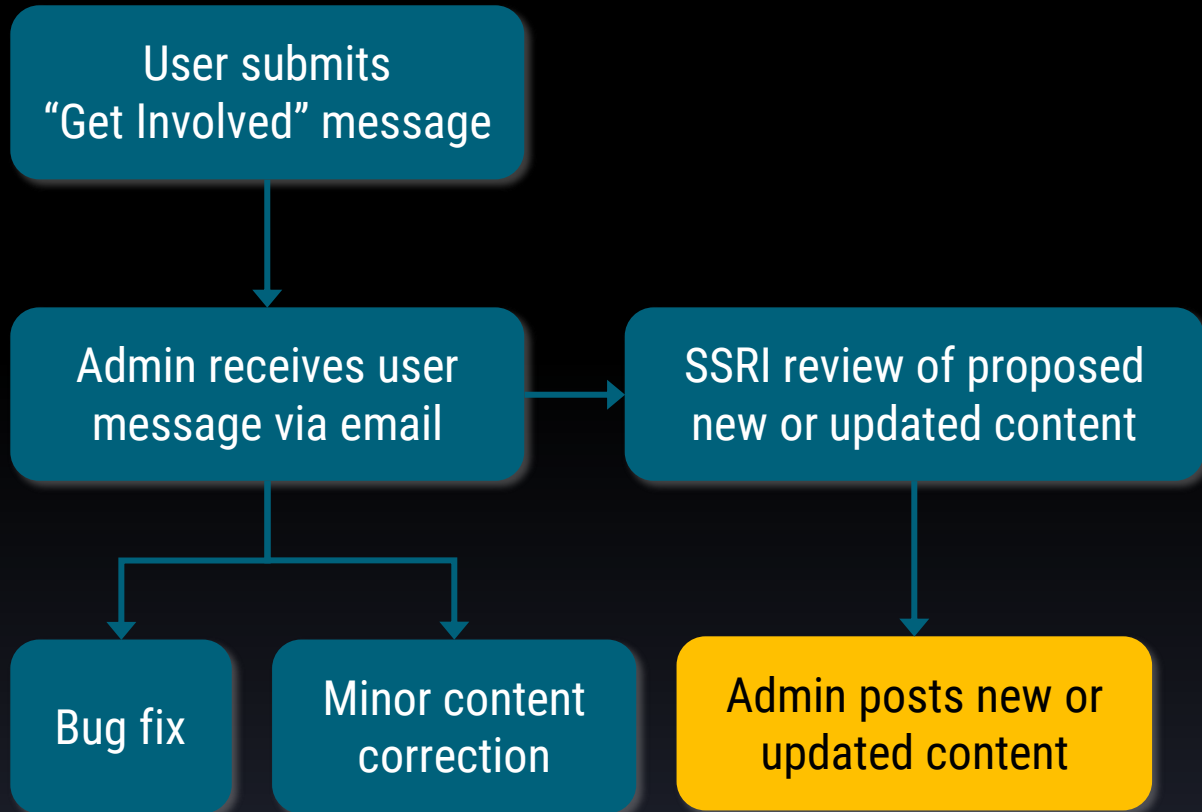
Resources in this topic area are primarily traditional mission design references and case studies for specific smallsat missions - occasionally presented alongside novel methodologies for smallsat

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



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### 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 its 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

Filter:  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

Join our virtual side-meeting!

Try out the SSRI Knowledge Base at:

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

Have questions? Want to get involved?

Robbie Robertson

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(781) 573-3276