Australian Government
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SMARTSAT Cooperative Research Centre

University of South Australia

An Automated Method of Detecting, Characterising, and Responding to Radiation Events in Space

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Introduction

Electronics onboard spacecraft are susceptible to instantaneous and cumulative damage caused by energetic charged particles. Anomaly detection systems play an important role in ensuring the reliability, availability, and integrity of spacecraft, as radiation damage frequently results in disruption of operations or mission failure. With recent developments in detector technology, there is opportunity to increase the use of onboard monitoring, and to implement automated mitigation strategies. Defence, Science and Technology Group (Australian Department of Defence), the University of South Australia, and SmartSat CRC are currently developing a modular system capable of autonomously detecting, characterising, and responding to instantaneous radiation events in real-time.

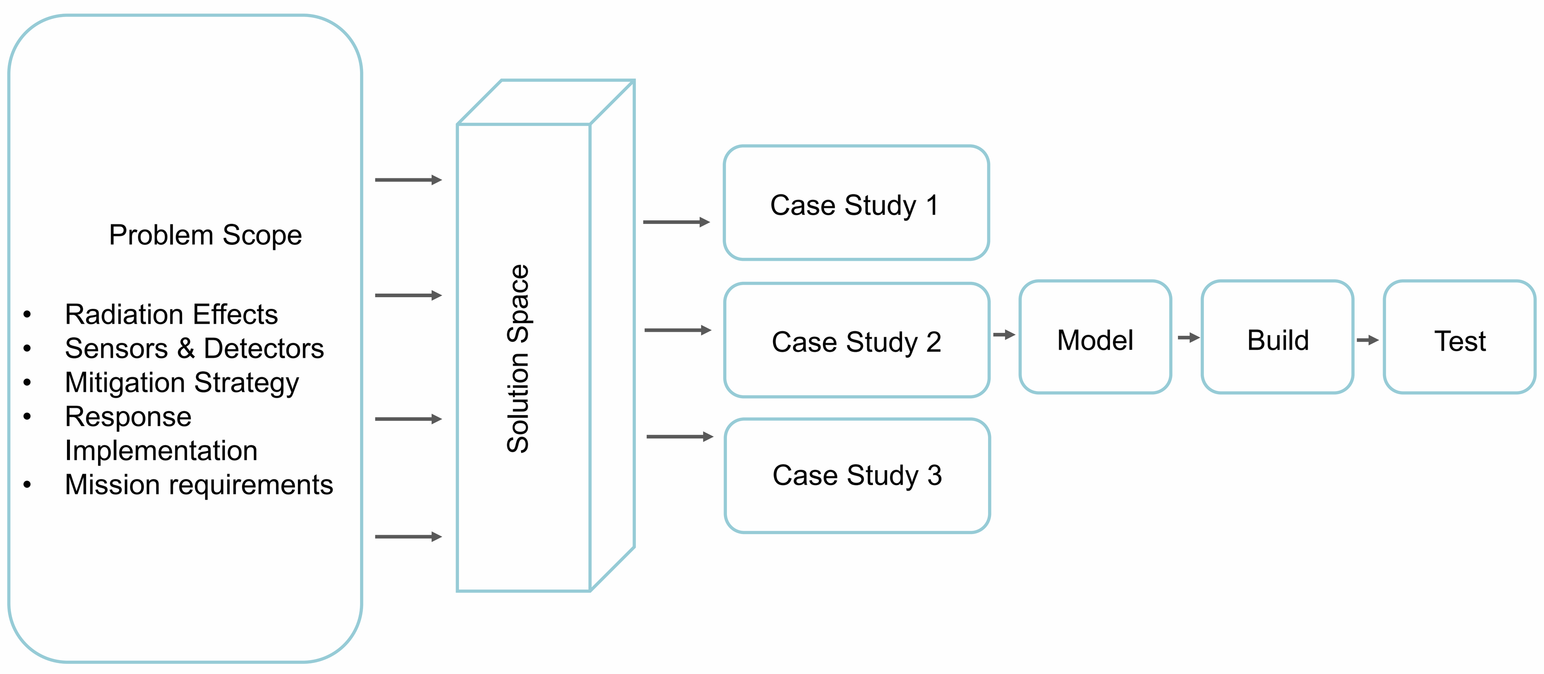
Aims

This research will result in the design and build of a radiation detection and real-time response instrument, capable of pre-emptively avoiding radiation damage to system electronics, resulting in reduced mission failures. Existing datasets will be used in amalgamation with real-time sensor data to respond to incoming radiation events autonomously, with response dependent on the capability of the host spacecraft.

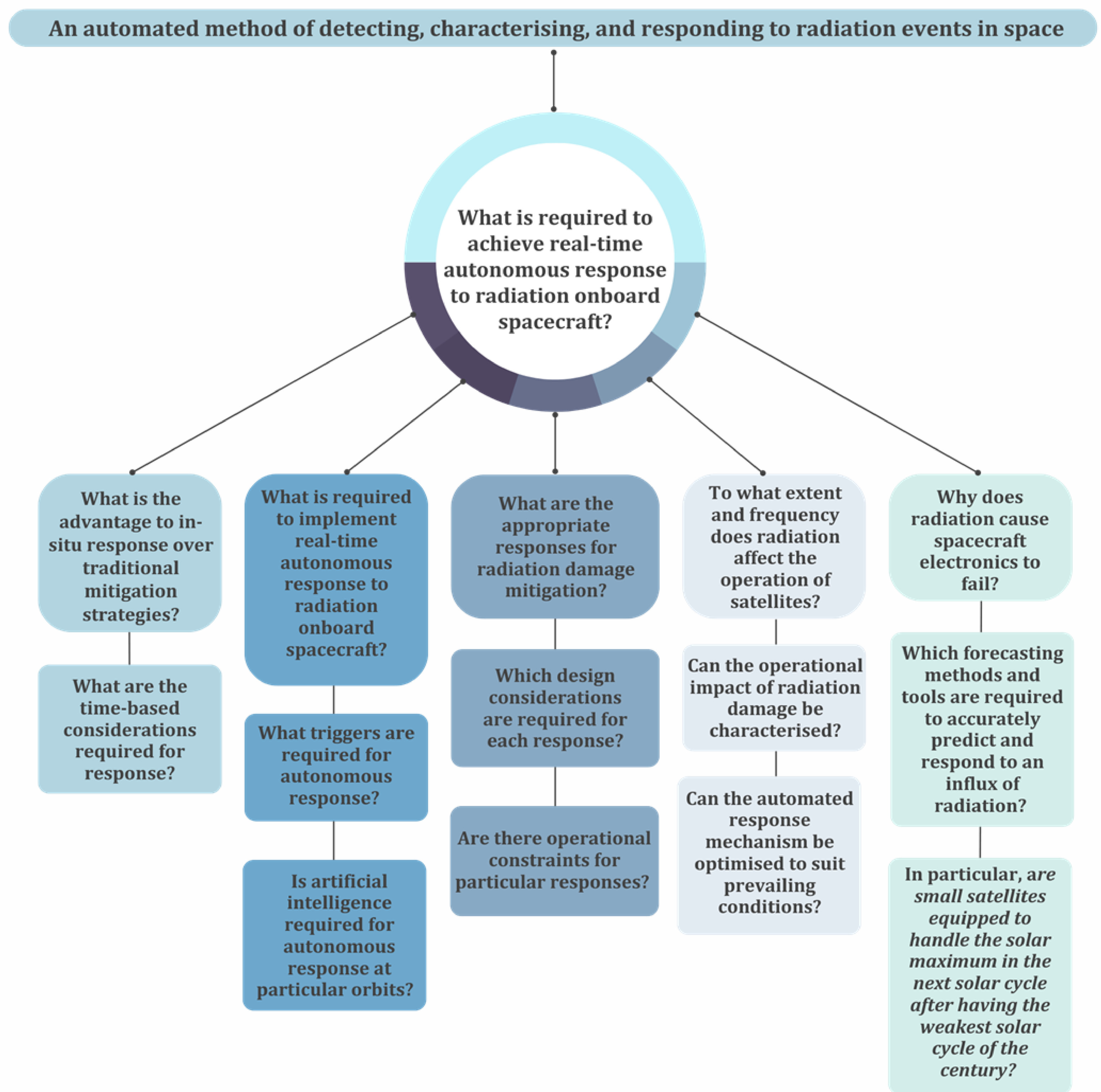
Methods

Traditional radiation mitigation strategies are preventative in nature, implemented prior to the launch of spacecraft. These avoidance, prevention, and protection measures include shielding, redundancy, and hardened/tolerant by design components. Whilst these strategies all present valuable strengths, they all have various shortcomings. Spacecraft autonomy has been recognised as a key enabler of next-generation space systems. Spacecraft autonomy encompasses onboard autonomous decision-making capabilities that enable the space segment to continue mission operations and to survive critical situations without relying on ground segment intervention.

The following diagram visually demonstrates the areas of considerations which form the problem scope for this research. The problem scope has been critically analysed to form the framework toward a solution. This solution is modular by nature, and will be demonstrated in a number of case studies. These case studies will encapsulate the details of the payload design for spacecraft of various size (weight and volume), orbital parameters, and budget.



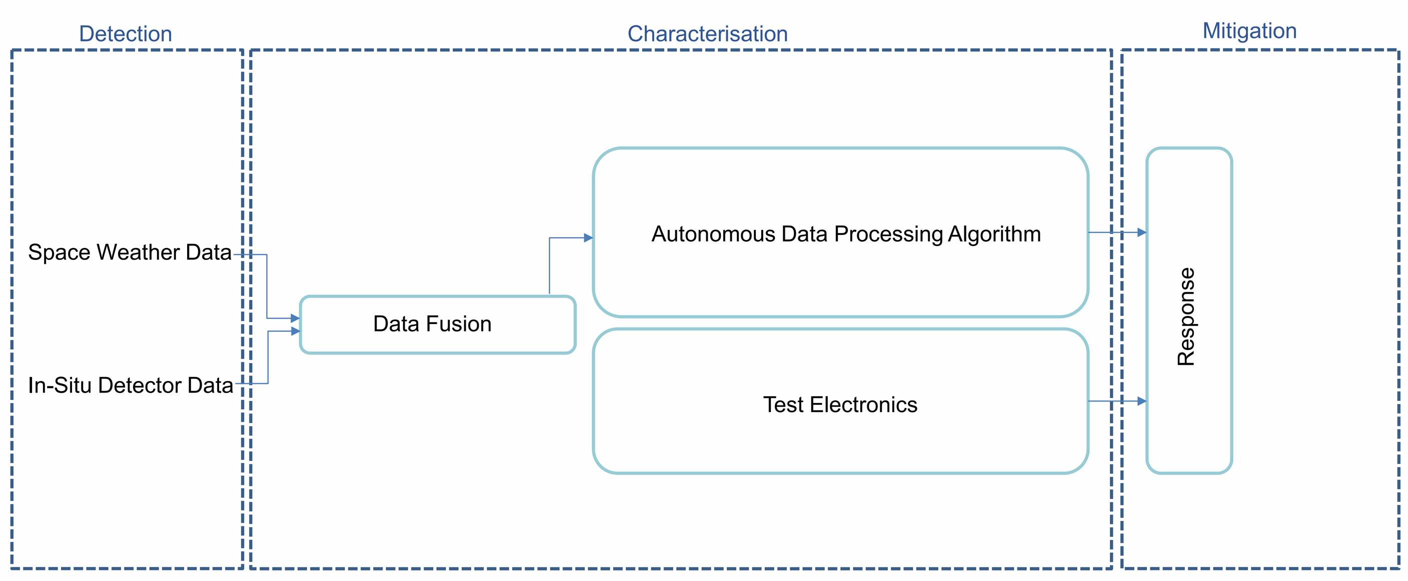
Research Gaps



Framework

Various data sets inclusive of space weather forecasting information and real-time sensor readings are being utilised to analyse the radiation environment anticipated for operation. Sensor and detector technology has been carefully investigated to determine the optimal selection for use onboard the payload. Artificial Intelligence and Machine Learning algorithms capable of processing various sets of data are being investigated to determine the optimal solution for autonomous data processing. These findings are forming the basis of design for the payload, to be followed by deep analysis of optimal real-time response mechanisms.

The proposed framework for this payload incorporates three stages of capability; 1) threat detection based on fusion of multiple data sources including in-situ radiation monitoring and space weather forecasting parameters, 2) data characterisation to determine appropriate response, and 3) mitigation dependant on event and capability of host spacecraft.



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