# ARCS
AUTONOMY RESEARCH CENTER FOR STEAHM

**Trustable Autonomy**

# The Proteus Programming Language



```
event Next_SIG();
actor NestedStates{
    statemachine{
        initial State_Initial;
        state State_S{
            initial State_s1;
            state State_s1{
                initial State_s11;
                state State_s11{
                    on Next_SIG{}{
                        go State_s12{}
                    }
                }
                state State_s12{
                    on Next_SIG{}{
                        go State_s11{}
```

## Synopsis

- Hierarchical State Machines (HSMs) are used for the simulation of software models to be implemented, such as flight software and control systems

- In space applications, software correctness is top priority

- Existing languages developed have significant issues with one or more or usability, performance, and safety, making them problematic for HSM development

- Proteus allows for the definition of large systems composed of multiple asynchronously-communicating HSMs

## Research Objective

- Model-Based Programming (MBP) Domain-Specific Languages (DSLs) allow systems engineers to model and simultaneously implement system behavior

- MBP DSLs also allow engineers to specify behavior and arbitrary constraints specific to the machine

- Design in a way that is usable and approachable for JPL software engineers

- HSM modeling and tracing are built into the language for ease of development

- Goal: make a reliable language with built-in HSM support that fits seamlessly into JPL's existing development toolchains

## Research Approach

- Designed to look and feel similar to C/C++

- HSM support built directly into the language

- Permits complex HSM design

## Research Results and Products

- Demonstrated reliable HSM support

- Multiple HSMs able to communicate with each other

- Visible state execution trace

- Eliminated issues with machine dependency

## Commercialization and/or Societal Impact Opportunities

- **Applications:** Embedded Programming

- **Key Values:** Safe, fast, reliable, fault-tolerant

- **Potential Customers:** Aerospace agencies, consumer electronics, medical device development

## Team Names & Collaborators

**ARCS Students:**
Morgan Barrett, Ahmed Bahyal, Deekshith Myakala, Isaiah Martinez, Nicholas Rodriguez Weda, Computer Science

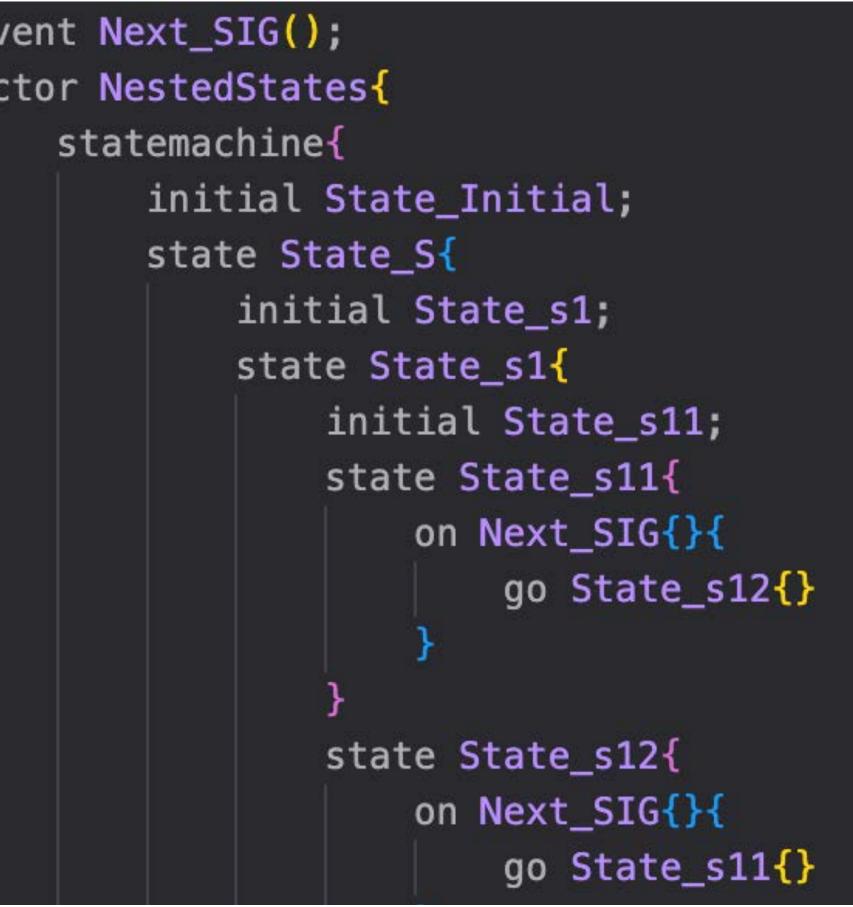**NASA/JPL Collaborators:**
Dr. Michel Ingham and Dr. Klaus Havelund

**CSUN Advisor:**
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### Citations

B. McClelland et al., "Towards a Systems Programming Language Designed for Hierarchical State Machines," 2021 IEEE 8th International Conference on Space Mission Challenges for Information Technology (SMC-IT), Pasadena, CA, USA, 2021, pp. 23-30, doi: 10.1109/SMC-IT51442.2021.00010.

Havelund, K., Joshi, R. (2017). Modeling and Monitoring of Hierarchical State Machines in Scala. In: Romanovsky, A., Troubitsyna, E. (eds) Software Engineering for Resilient Systems. SERENE 2017. Lecture Notes in Computer Science, vol 10479. Springer, Cham. https://doi.org/10.1007/978-3-319-65948-0_2

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