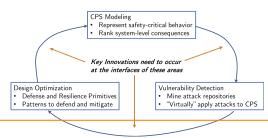# 1 Motivation and Objectives

- CPS are increasingly everywhere

- many CPS are safety-critical, and a fault can literally kill people

- cyber threats and vulnerabilities are increasingly everywhere

- **key assertion** traditional defense techniques are not only insufficient, they are at least in some cases unnecessary. This assertion is also true for the different paradigm of what we will call "cyber resilience" techniques; i.e. it is unclear whether they are necessary or sufficient

- therefore, we propose to understand the theory and science behind whether, when, and where different CPS security/resilience techniques are (in)effective and/or (un)necessary

Consider the example in Figure 2, where

Our focus is not on improving defenses against cyber attack, or even improving detection and adaptation techniques in the face of a cyber attack. Rather, our efforts aim to

Our approach is to develop models that can...

Figure 1: not sure what to put here.

bold statement about the current state of cyber and safety-critical CPS

2 Background and Related Approaches

A bit about traditional defense and its limitations, some of our work (and others') on resilience, etc

CPS Modeling
- Represent safety-critical behavior
- Rank system-level consequences

Key Innovations need to occur at the interfaces of these areas

Design Optimization
- Defense and Resilience Primitives
- Patterns to defend and mitigate

Vulnerability Detection
- Mine attack repositories
- "Virtually" apply attacks to CPS

catchy example with associated figure

3 Research Goals and Approaches

We propose to focus on three research thrusts that aim to

3.1 Thrust 1: ...

Goals and Challenges:

Approaches and Preliminary Work:

Future Work: If successful, this project will extend our preliminary work by

Figure 2: Overview this is just notional, needs a good figure

understand the trade-offs and optimize decision-making about when, where, and how to apply design patterns...

3.2 Thrust 2: ...

Goals and Challenges:

Approaches and Preliminary Work:

Future Work:

1, 2, and 3...

by "future work" I mean the work we'll do if this is funded

Figure 4: Timeline of proposedwork, including technical development, evaluation ,and broader impact

3.3 Thrust 3: ...

Goals and Challenges:

Approaches and Preliminary Work:

Future Work:

4 Integration and Validation Plan

This multidisciplinary research requires expertise in a number of areas, a tight collaboration among its team members, and a close integration of all phases of the research. The primary expertise needed includes The team consists of experts in all of the areas and the rough team breakdown is shown in Figure 3. The PIs are all members of the Link Lab, whose mission is to enhance excellence of CPS research at the University of Virginia. They and all of their students will be sitting together on a daily basis in a 17,000 square foot collaborative lab. They will formally meet as a group once per week but subgroup meetings and impromptu meetings will take place on a daily basis.

controls, decision-making, modeling...

While significant research progress will occur in each subproject, we emphasize a rigorous plan for integration throughout the project. This includes a periodic interactive activity called the

Figure 3: Proposed experimental testbed will consist of one ground and two aerial vehicles.

something related to exercising our theory on a testbed, which we will describe below. Nicola, do you have boilerplate on the stuff in your lab?

Timeline and milestones:

5 Broader Impact, Education Plan, and Outreach Activites

Dissemination: The proposed research will enhance the ...

Integration into curriculum: The proposed research will be integrated into coursework

Undergraduate research:

K-12 outreach:

Contributions to diversity:

6 Relevant Prior Research Funded by NSF

Cody Fleming is Co-PI on NSF grant... . **Peter Beling** is ... . **Nicola Bezzo** ...