

# Tools for Assured Autonomy

Praful Sigdel

Principal Investigator: Dr. Gabor Karsai

Mentors: Dr. Yogesh Barve and Charles Hartsell



# Cyber Physical Systems and ALC Toolchain

→ Assurance-based Learning-enabled Cyber-Physical Systems(ALC) toolchain<sup>1</sup>: An integrated set of tools corresponding to model-based development of CPS utilizing learning-enable components (LECs).



The New York Times

## *2 Killed in Driverless Tesla Car Crash, Officials Say*

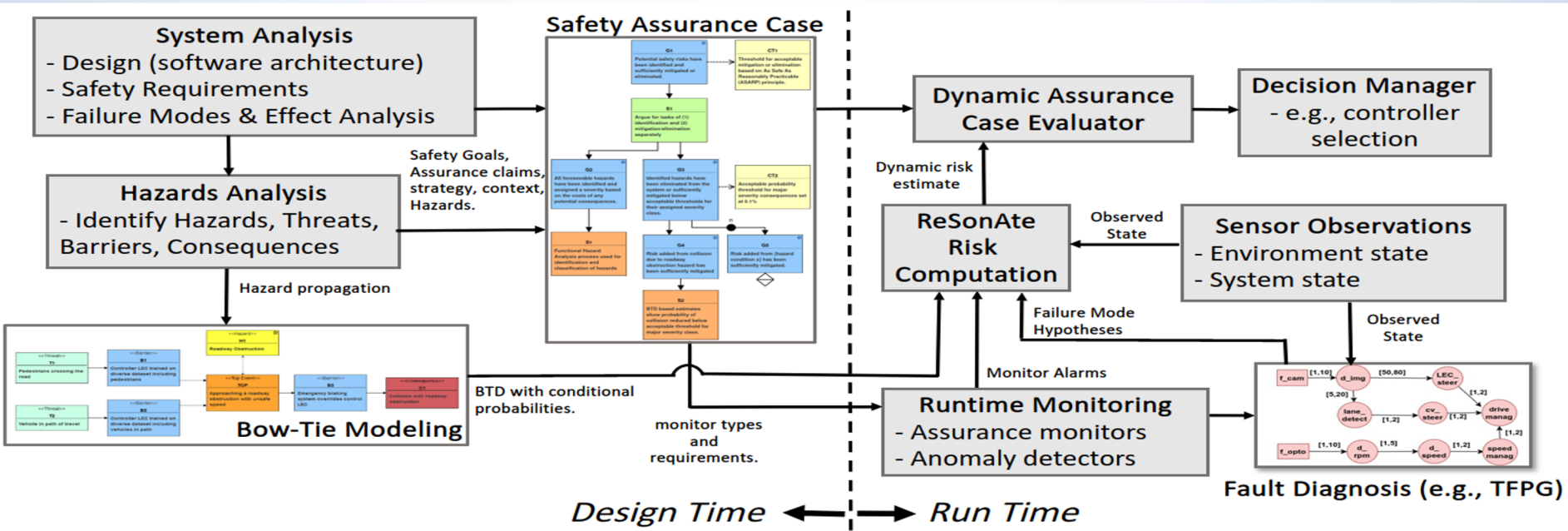
“No one was driving the vehicle” when the car crashed and burst into flames, killing two men, a constable said.

## **Indian Air Force drone crashes in field in Punjab; probe initiated, says report**

1. <https://editor-alc.isis.vanderbilt.edu/doc/tutorial/Overview.html>

# ReSonAte: A Runtime Risk Assessment Framework For Autonomous Systems

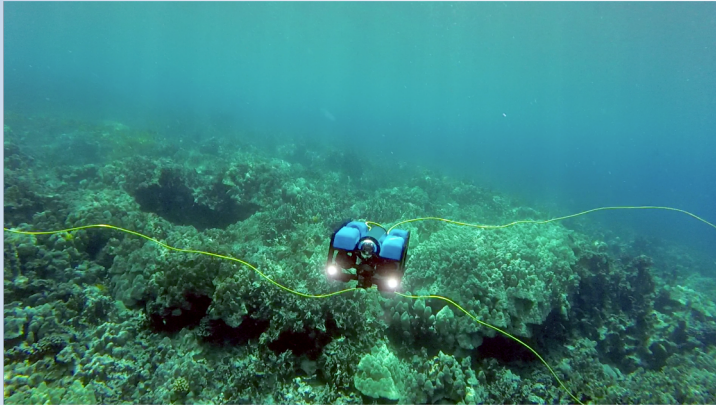
- An engineering framework that calculates probability of consequences dynamically using BowTie Diagrams.
- Probabilities change based on the state of the system and environment.



<https://arxiv.org/pdf/2102.09419.pdf>

# BlueROV2 and ROS

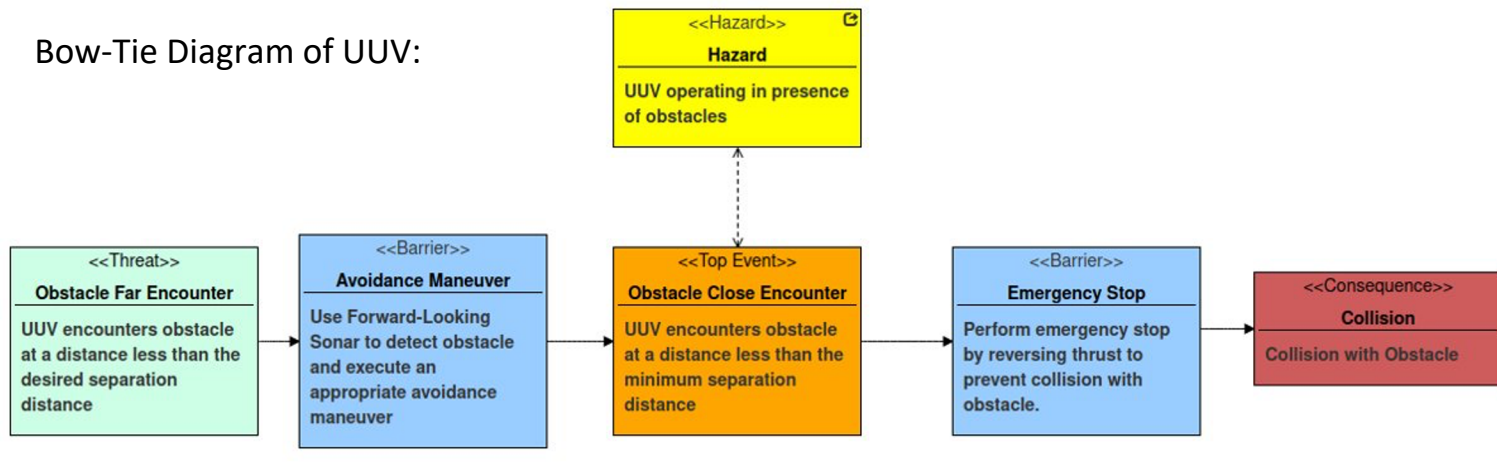
BlueROV2<sup>1</sup>



- Robot Operating System(ROS)<sup>2</sup> is a collection of framework for writing robot software.
- ROS supports Gazebo, a physics-based simulator.

- Underwater Vehicle with 6-thruster vectored configuration used for research, surveillance, and adventure.

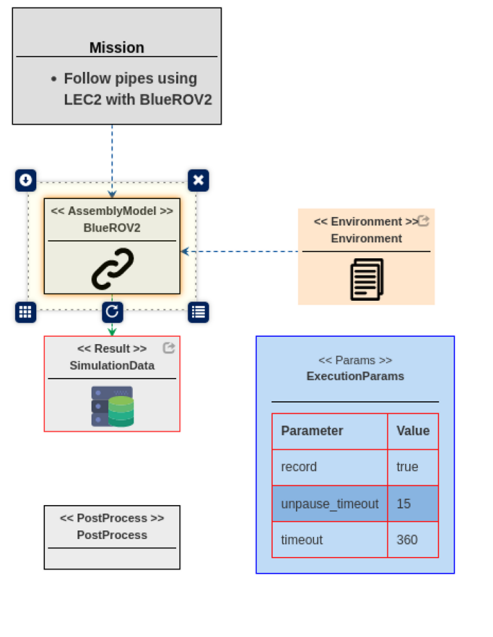
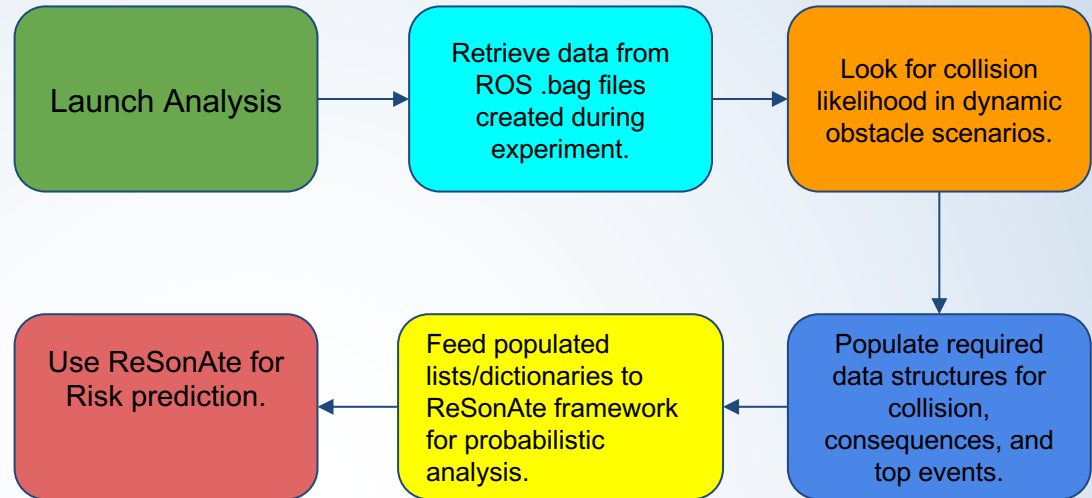
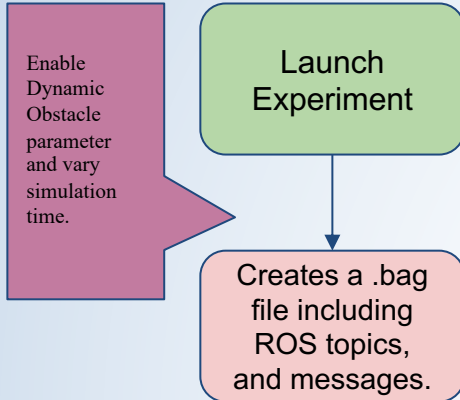
Bow-Tie Diagram of UUV:



1. <https://bluerobotics.com/store/rov/bluerov2/>
2. <http://www.robotics.stanford.edu/~ang/papers/icraoss09-ROS.pdf>

# Plugin Integration For ReSonAte With ALC Toolchain

## Workflow:



LaunchAnalysis v0.1.0

Execute on Server This plugin can not run in the browser.

Used Namespace

The namespace the plugin should run under.

Analysis Execution name

Optional name for this analysis execution

Analysis Launch Path

Location where file recorded after simulation is stored

Setup Jupyter Notebook

Setup an instance of the Jupyter Notebook for plotting data from the analysis

Recent Simulation Runner

Runs analysis on the latest ran experiment. If set to false runs analysis on all simulation data from previous experiments

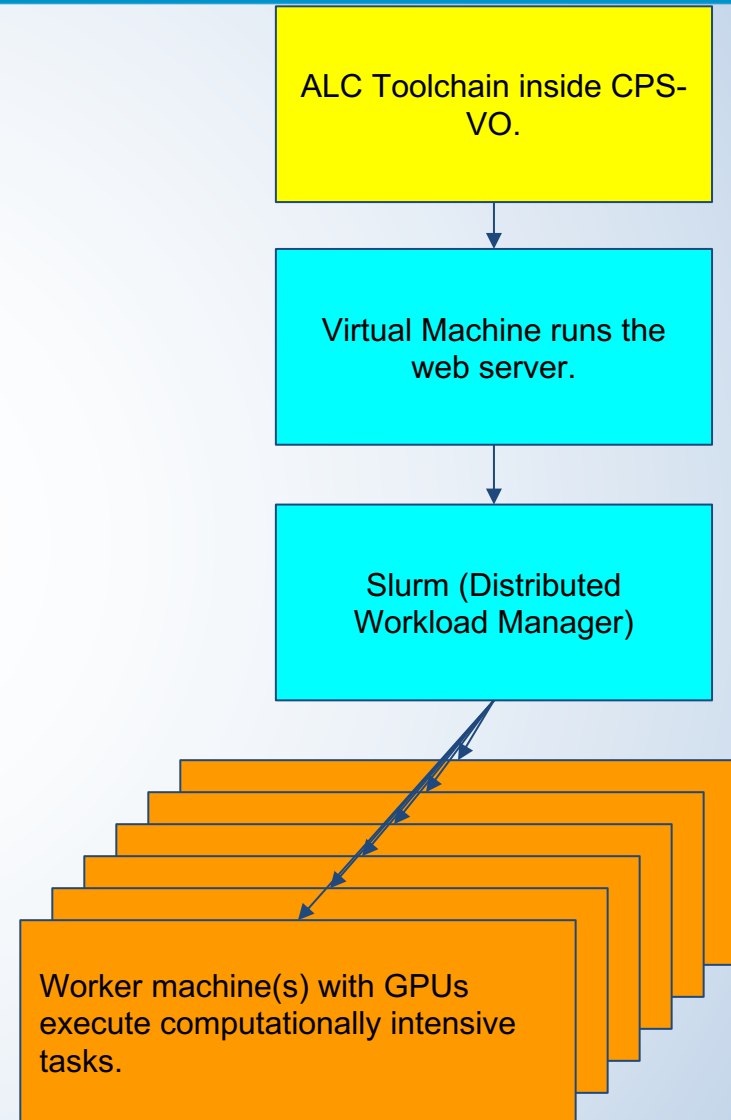
Save these settings in the current user

Run... Cancel



# CPS-VO Deployment

The screenshot shows the 'Assured Autonomy Tools Portal' website. At the top, there is a navigation bar with 'CPS-VO', 'MY GROUPS', and 'MY ACCOUNT' on the left, and 'Log out' and a search bar on the right. The main header features a satellite and a rocket against a space background, with the text 'Assured Autonomy Tools Portal'. Below the header, the page content includes a sidebar with navigation links: Home, Tools, Search Tools, Publications, Design, and Group Sims. The main area is titled 'Assured Autonomy Tools Portal' and features a 'FEATURED TOOL' section for 'CoPilot'. A description for CoPilot states: 'CoPilot is a domain-specific, embedded-stream language for generating hard real-time C code for monitors.' To the right of the featured tool is a 'TOOLS REPOSITORY' diagram, a circular chart with five segments: 'Confidence Estimation & Monitoring Tools', 'Simulation & Testing Tools', 'Integrated Toolchains', 'Assurance Arguments & Assurance Cases', and 'Formal Verification Tools'. Below the featured tool is an 'ABOUT' section with the following text: 'The goal of the Assured Autonomy program is to create technology for continual assurance of Learning-Enabled, Cyber Physical Systems (LE-CPSs). In order to ground the Assured Autonomy research objectives, the program will prioritize challenge problems in the militarily relevant autonomous vehicle space. However, it is anticipated that the tools, toolchains, and algorithms created will be relevant to other LE-CPSs. The resulting technology from the program will be in the form of a set of publicly available tools integrated into LE-CPS design toolchains that will be made widely available for use in commercial and defense sectors.'



# Conclusion

- Challenges:
  - Understanding complex design architecture of ALC Toolchain.
  - Being productive for long hours due to virtual setting.
  - Debugging Networking Issues.
- Lessons Learned
  - Familiarity with academic research experience
  - Software debugging/troubleshooting in a Linux environment
  - Time management
  - Effective communication