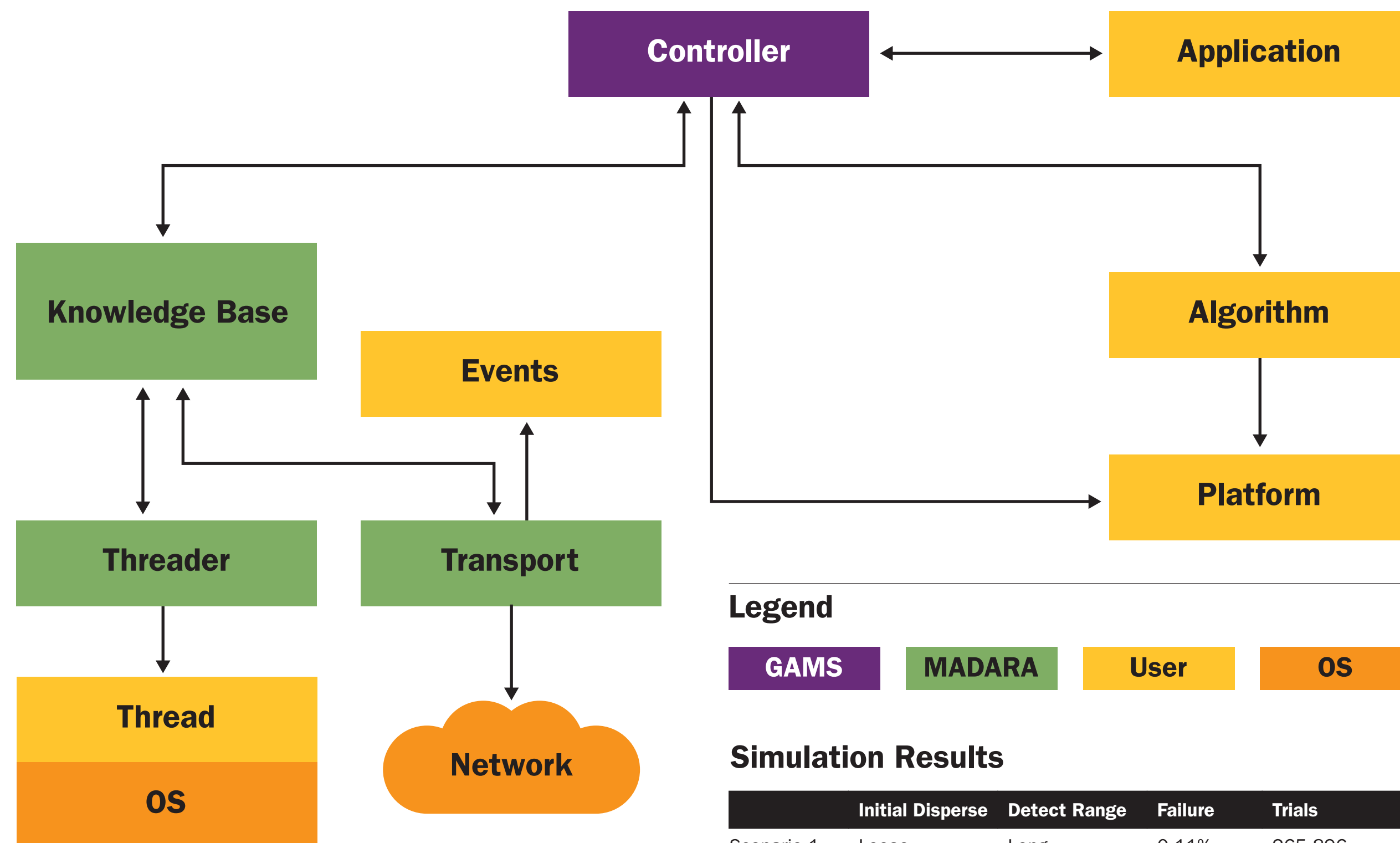
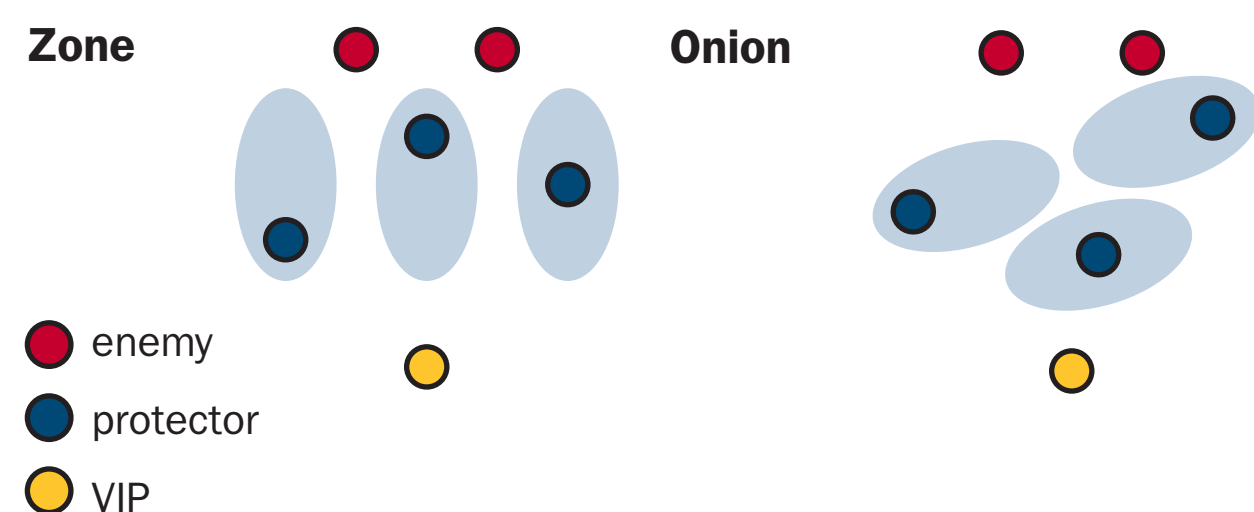


Multi-Agent Decentralized Planning for Adversarial Robotic Teams

For the past four years, the SSD CPS-ULS group has been working on technologies to enable one human operator to control and interact with a team of autonomous, unmanned systems. In FY16 MADPARTS, we focused on defensive algorithms that protect a human operator or an important asset from a mobile adversary. We demonstrated our line-of-sight prevention algorithms in simulated quadcopters and in real-world demonstrations with unmanned surface vehicles in lakes near Pittsburgh. The algorithms resulted in line-of-sight prevention at over 99% success rates in simulations against mobile adversaries

Defensive Schemes

- We took some inspiration from American football and robot soccer
- Zone defense: Protector agents move to assigned zones between a vip and the enemy
 - Useful for holonomic robots like quadcopters
- Onion defense: Protector agents layer a defense between vip and enemy
 - Useful for non-holonomic robots like fixed-wing planes and boats that drift



The result is rapid prototyping and verifiability of distributed autonomy in robotics (FY16 DART, SMC for Swarms)

Our Autonomy Process

- Users write an application in C++ or Java
 - Developers read and write to knowledge handled by the underlying middleware
 - Platforms have standardized interfaces that algorithms interact with
 - No interaction with message queues (handled under the hood)
- Users only have to focus on their algorithm or platform
- Built-in translations between simulation and real-world
 - Pose system (Cartesian to GPS and vice-versa)
- High consistency, predictability and QoS
 - Important for verification

Legend



Simulation Results

	Initial Disperse	Detect Range	Failure	Trials
Scenario 1	Loose	Long	0.11%	265,896
Scenario 2	Loose	Short	0.35%	114,912
Scenario 3	Tight	Short	0.28%	114,504
Scenario 4	Tight	Long	0.00	400,000+

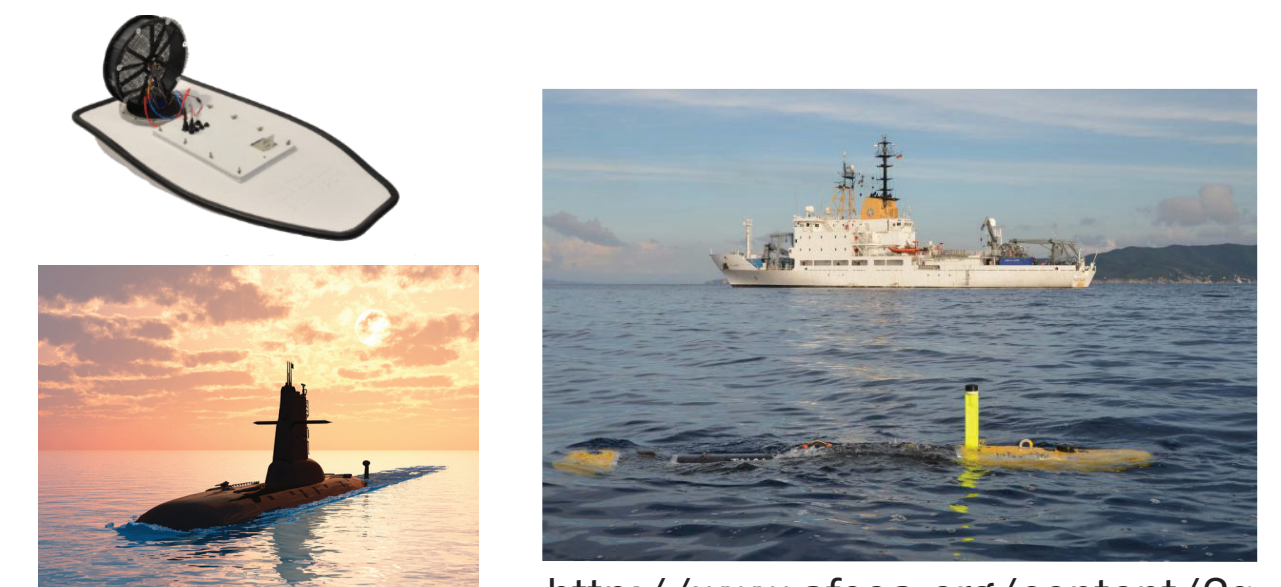
Transition (ALW)

- PWP in place for AFRL Autonomy of the Loyal Wingman FY17-FY18
- Core software candidate for autonomous F-16 wingmen for a human pilot
- Algorithm creation for target defense and prosecution



Transition (NATO)

- Invitation to participate in NATO CMRE REP17-Atlantic exercise
- REP17 is a joint exercise between Portuguese Navy, NATO CMRE, and the University of Porto
- Current plan is for our autonomous boats to participate in the joint exercises



<http://www.afcea.org/content/?q=Article-cyber-earns-its-sea-legs>

Transition (Multi-Planetary Smart Tile)

- GAMS and MADARA are core software architecture for the Keck Institute for Space Studies' Phase 1 Multi-Planetary Smart Tile
- Hardware prototyped by GE GRC and Biovericom
- Separate offers to launch into LEO by United Launch Alliance and NASA
- Phase 1 is expected to perform simple autonomy experiments in low-earth orbit for up to 1 year
- Goal of project is to create a distributed, renewable power infrastructure for solar system that scales to tens of thousands of interacting robotic systems

