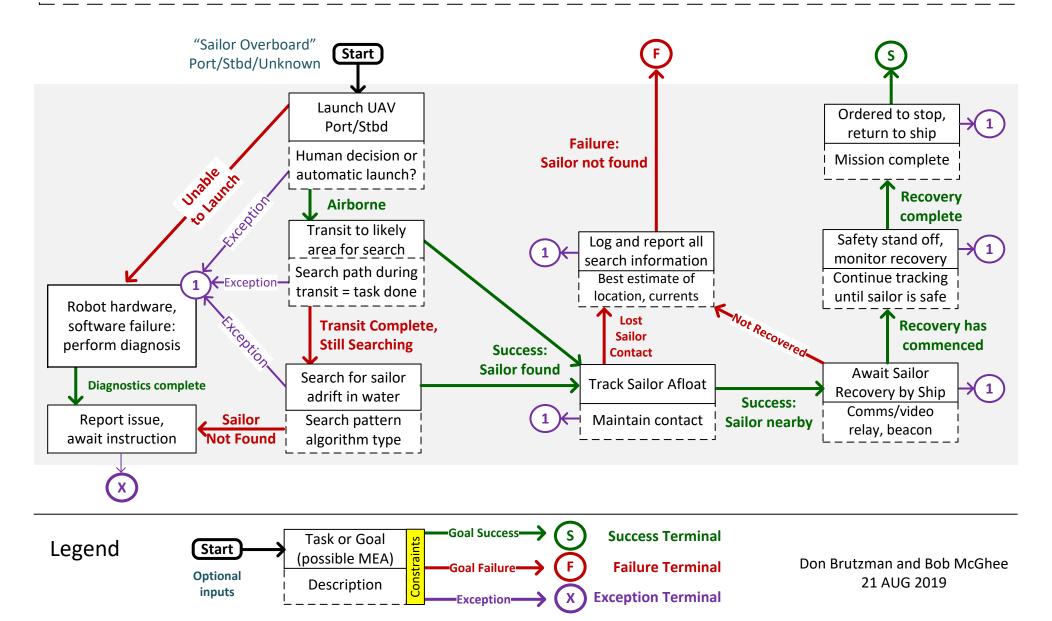
# **Ethical Control Mission Diagrams**

https://gitlab.nps.edu/Savage/EthicalControl/tree/master/missions/diagrams

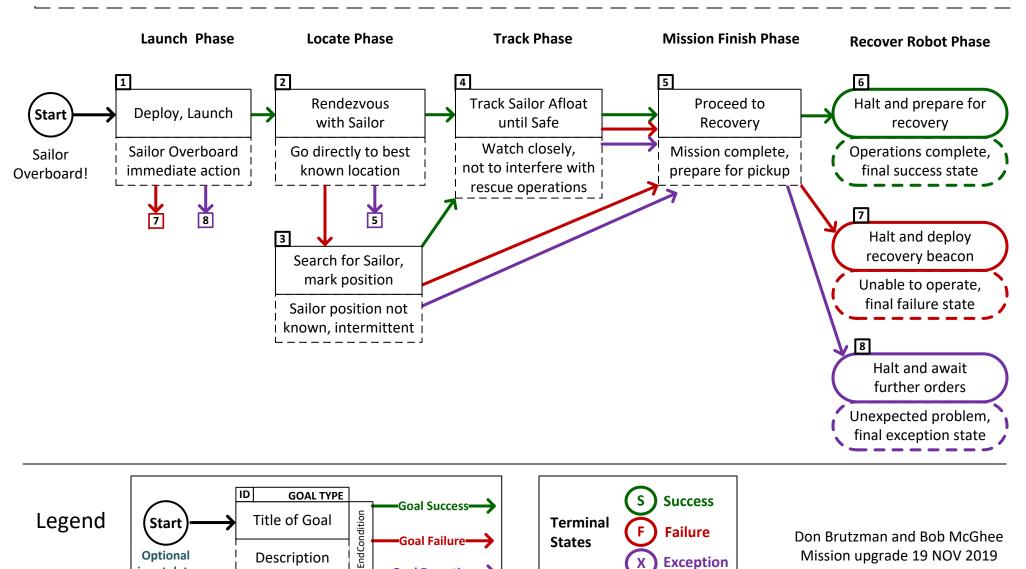
#### Find Sailor Overboard – Mission Execution Automaton (MEA)

Single unmanned air vehicle actions to complement humans performing "SAILOR OVERBOARD" operations using **shipboard emergency procedures**. Multiple UAVs can be employed in parallel, each following these mission orders.



## Sailor Overboard, 8 Phases – Mission Execution Automaton (MEA)

Single unmanned air/surface vehicle actions to complement human response when performing "SAILOR OVERBOARD" operations, carried out in concert with shipboard emergency procedures. Multiple UAVs/USVs can be employed in parallel with ships/aircraft, each following mission orders.



States

-Goal Failure-

Goal Exception

Optional

input data

Description

**Failure** 

**Exception** 

Don Brutzman and Bob McGhee

Mission upgrade 19 NOV 2019



Life-saving force: locate, track, communicate, beacon

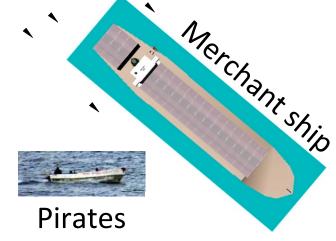
Life boat

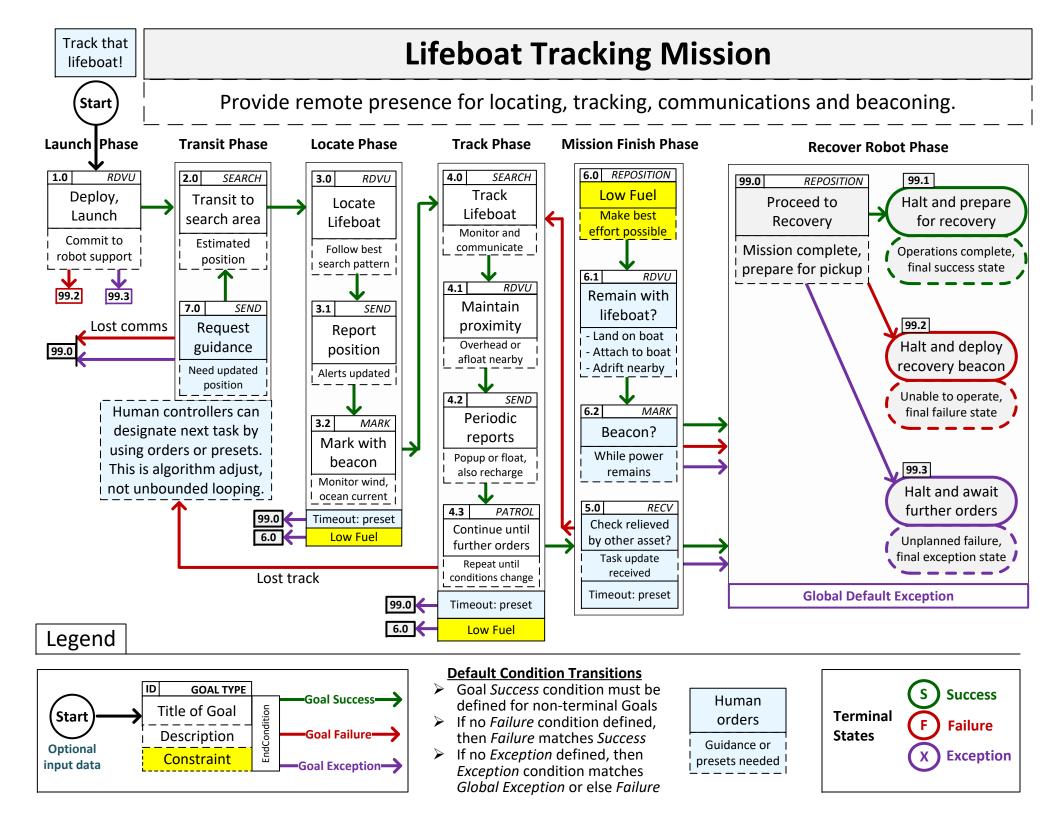
Response dilemma for U.S. Navy ship

Ethical control of unmanned systems is required for both lethal and lifesaving force if remote robots communicate intermittently, operating across lengthy time and distance.

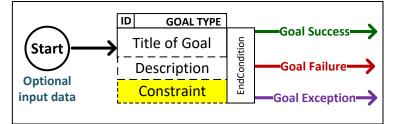


Respond to one or both scenarios with USV/UAV assets to establish on-scene visibility and presence





Defend the **Pirates Seizing Merchant Mission: Approach Phases** Merchant! Overtake pirate small-boat gang attempting to capture threatened merchant ship 10 Start Launch Phase **Transit Phase Locate Phase Track Phase Mission Finish Phase** 11.0 RDVU SEARCH 12.0 14.0 SEARCH 22.0 REPOSITION 13.0 RDVU Deploy, Track Transit to Low Fuel Locate Launch Merchant hostile area Make best Fleeing or Merchant Monitor and Commit to effort possible **Estimated** stationary communicate robot support Follow moving position ship and boats 14.1 RDVU 22.1 RDVU 99.3 Maintain Remain with 21.0 XMIT 13.1 SEND proximity merchant? Lost comms Request Report Beyond range - Land on boat guidance Loop of small arms position i - Attach to boat Need updated l - Adrift nearby Alerts updated 14.2 SEND position Periodic Human controllers can Includes all 22.2 MARK reports 13.2 MARK designate next task by vessels, focus on Beacon? Situation reports, Mark with merchant ship using orders or presets. 99.0 changing status While power This is algorithm restart, beacon remains not unbounded looping. Monitor wind, 14.3 PATROL ocean current Continue until 14.9 RECV Loop Timeout: preset further orders Check posture Escalate 22.0 Low Fuel Repeat until changed? conditions change Task update Lost track: Loop received 99.0 99.0 Timeout: preset Timeout: preset 22.0 Low Fuel Legend



#### **Default Condition Transitions**

- Goal Success condition must be defined for non-terminal Goals
- If no Failure condition defined. then Failure matches Success
- If no Exception defined, then Exception condition matches Global Exception or else Failure

Human orders Guidance or presets needed Use of Lethal Force

Phase Names Terminal States

Ρ Phase ID

30

Warn

Proceed to

Warning Phase

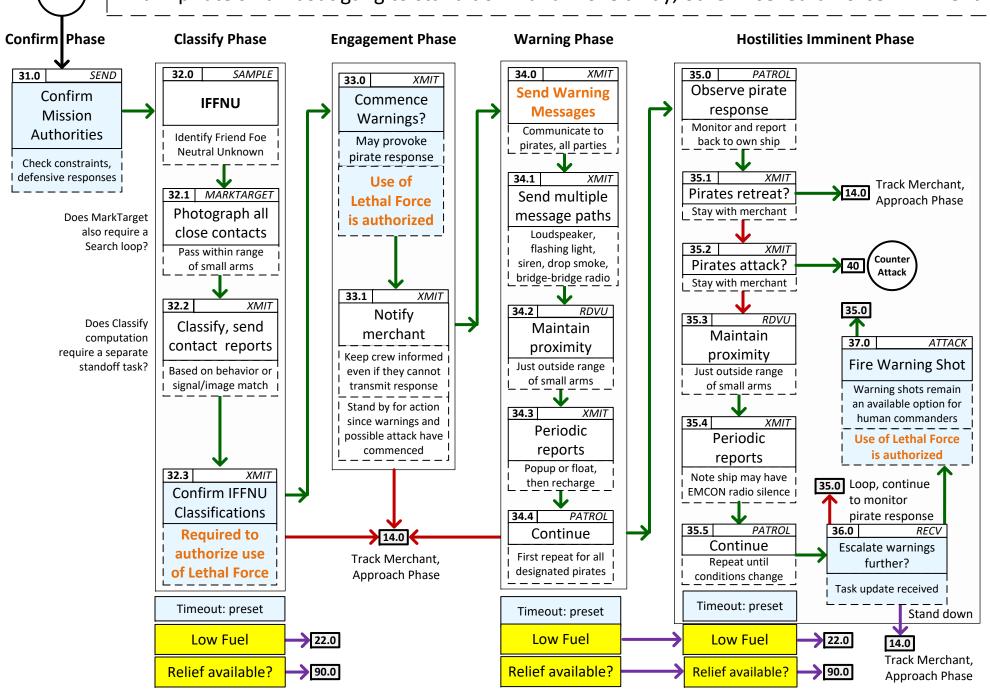
Success

**Failure** Exception Warn Pirates!

#### **Pirates Seizing Merchant Mission: Escalation Phases**

30 Warn

Warn pirate small-boat gang to stand down and move away, otherwise lethal force imminent



#### Attack Pirates Seizing Merchant Mission: CounterAttack Phase Pirates! Counter CounterAttack to force pirate small-boat gang withdrawal from threatened merchant ship 40 Attack Mission Finish Phase CounterAttack Phase **Recover Robot Phase** 99.1 ATTACK REPOSITION **Attack Pirate Boats Use of Lethal Force** Halt and prepare Proceed to in priority order is still authorized for recovery Recovery Rapidly engage, shoot Operations complete, to disable or kill Mission complete, final success state prepare for pickup 41.1 XMIT Pirates retreat? Track 14 Merchant Stay with merchant 99.2 Halt and deploy XMIT recovery beacon Pirates attacking? 42.0 XMIT Stay with merchant Low or no Unable to operate, ammunition: **Low Ammo** final failure state need to disengage? 41.3 RDVU Track Merchant, Hold ammo in reserve, 14 Maintain proximity, Approach Phase or else fight to the finish 99.3 continue attack Halt and await Engage highest, closest further orders threats to merchant ship Unplanned failure, Loop, continue 41.0 final exception state 41.4 XMIT to attack pirates Periodic reports **Global Default Exception** XMIT 43.0 Note ship may have Track Merchant, Check for guidance: **EMCON** radio silence Approach Phase resume tracking or continue attacking? 41.5 PATROL 90.0 XMIT Continue Relief by **Humans** monitoring Track Merchant. Repeat until attack may decide to other asset Approach Phase conditions change interrupt or override

Task update

received

Relief available?

Timeout: preset

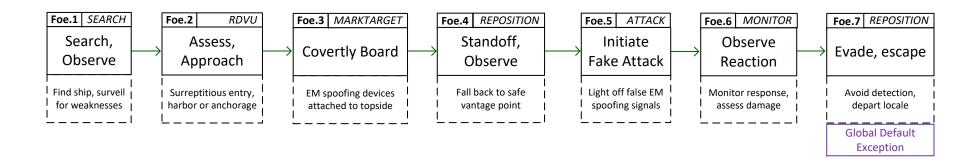
Low Fuel

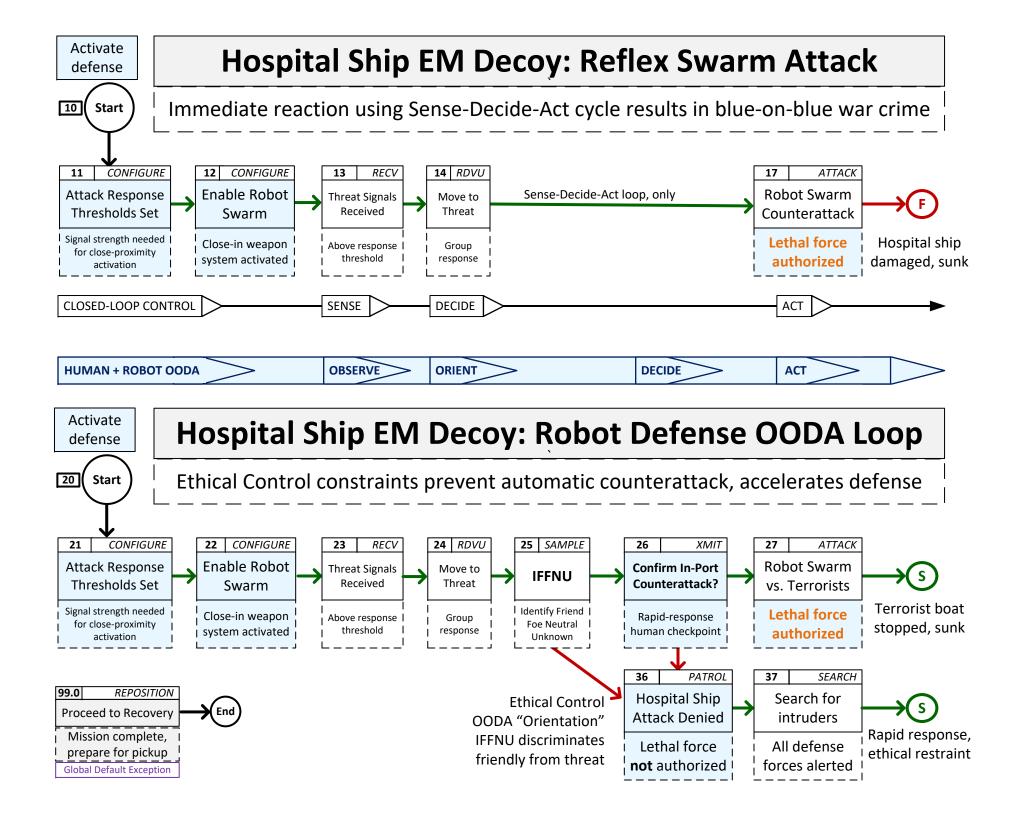
22.0

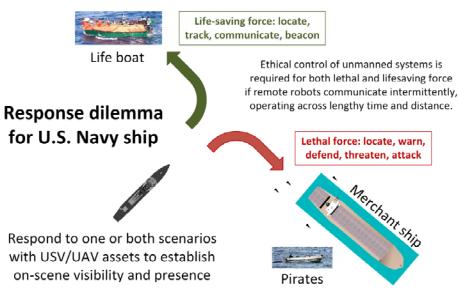
99.0

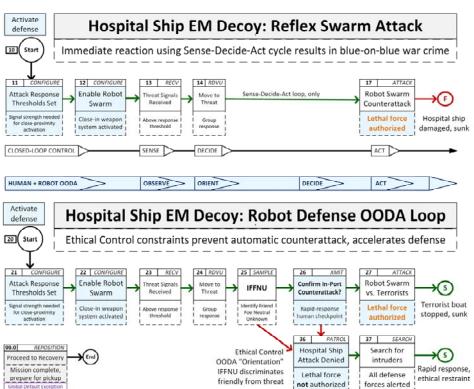
## **Hospital Ship EM Decoy: Opponent Actions**

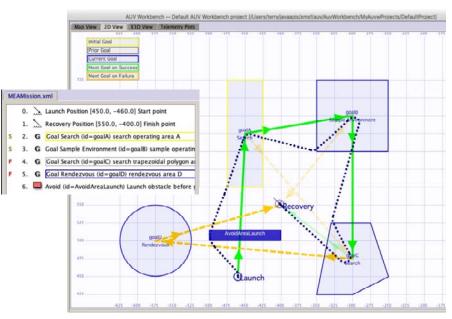
Plant "false flag" electromagnetic (EM) decoy devices to provoke blue-on-blue robot swarm attack. Although this mission is likely to be manned by human opponents, AVCL representations still work.











#### Mission Execution Ontology (MEO) evolving

