# Cooperative and Coordinated Guidance For Adversarial Engagements

Julia Kolaszynska, Supervised by Jason Ralph, Vassil Alexandrov
EPSRC Centre for Doctoral Training in Distributed Algorithms, University of Liverpool, Liverpool, UK

## Background & Aims

In the modern day warfare the attacks can happen suddenly and with multiple threats attacking at the same time. The speed and number of attackers creates a congested aerial environment that can cause a human operator to make sub-optimal decision cause life threatening situations. That calls for automation of the process. TEWA is a complex, multistep process that is responsible for threat recognition, **Threat Evaluation and Weapon Assignment**. TEWA is a Decision Support System (DSS) its main role is to perform high speed and accurate calculations about the danger that an incoming threat poses.

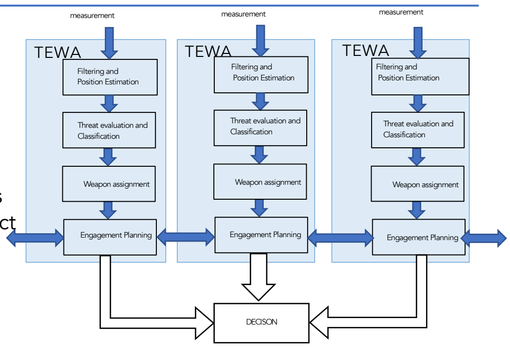
**Cooperative TEWA** relies on communications **during** engagements to achieve an optimal decisions and outcome in a fast pace aerial scenarios

**Coordinated TEWA** shares the information collected between the systems to use it to calculate the course of action **before** engaging.[1]

**Threat Evaluation** algorithm uses estimations and other data like speed, heat signature and Doppler Effect to identify if the object poses a threat and what type of object it is. That data is used in **Weapon Assignment** to choose a correct strategy to deal with the incoming threat.

**Engagement planning** modules use all the above information and calculation to schedule the responses and exchange the data between other systems to achieve an optimal response.

**AIMS:** To Develop a Coordinated and Coordinated TEWA DSS that is robust, reliable and can deal with an overwhelming number of threats.




Flow Chart of a TEWA process

## Ongoing work

Current work focuses on implementing a weapon assignment system. Using inputs of predicted impact point, threat type and weapons available TEWA function calculates the output of assignment weapon- target.

One the assignment is established the Predicted Interception Point is Calculated (PIP) and the defending weapon is being released.

On going work also focuses on developing a scenario with an overwhelming number of missiles. In this experiment the coordinated and cooperative response is being compared. Success rate and reaction time for the same scenario are the main metrics deciding which solution is optimal.

## Preliminary Results

Results show the capability of the Particle Filter to accurately estimate position of 100 ballistic threats incoming simultaneously.

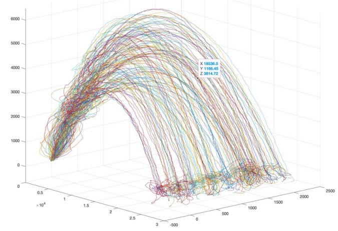


Fig 1. 100 ballistic trajectories estimated by Particle Filter

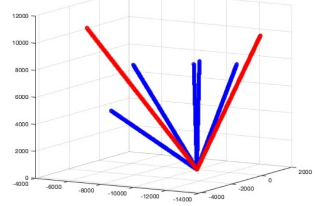


Fig 2. PIP and Weapon Assignment M1 missile being blue and M2 red.

PIP and Weapon assignment results show the ability to simultaneously deal with multiple threats

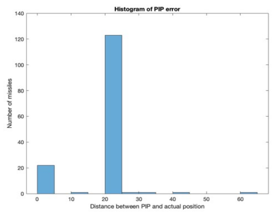



Fig 3.Interception of threats – 148 out of 150 threats were intercepted

## Future Work

- **Weapon - Weapon Systems assignment**: implementation of one on many algorithm.
- **Weapon - Threat assignment**: implementation of a stable marriage algorithm for many-on-many scenario.
- **Coordination and cooperation of TEWA**: distributing. the communications between TEWA algorithms to achieve an implementation of a cooperative system.
- **Network of TEWAS** : creating a network of TEWA algorithms that assign a task to the most cable defender

## Conclusion

This project focused on implementing a robust and accurate TEWA DSS for multi target multi defender and multi asset scenarios. Using various techniques, algorithms and High Performance Computing.

## References

[1] Z. Jiang and Z. Rui, "Obstacle avoidance for multi-missile network via," Journal of Aeronautics, vol. 29, no. 2, pp. 441-447, 2016.
[2] S. Gomez-Gonzalez, S. Prokudin, B. Scholkopf and J. Peters, "Real Time Trajectory Prediction Using Deep Conditional Generative Models," IEEE Robotics and Automation Letters, vol. 5, no. 2, 2020.

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