

JRAPS For Mission Planning

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1. Abstract

The Joint Routing and Analysis Planning System (JRAPS) is a prototype ArcGIS-based application developed to support combat mission planning. The tool analyzes the most critical factors in strike mission planning—the threats and the geospatial factors. JRAPS has two primary functions: auto-routing and jammer planning and modeling. The auto-routing function uses a 3D air maneuver network created using "costs" associated with threats taken from the ETIRMS database. The jammer planning function shows which threats can potentially see an aircraft at any point along a flight path, and gives crucial information about that threat including which jamming type could keep sensors from seeing that aircraft.

2. Introduction

2.1 Statement of the Problem

Today's mission planner lacks the capability to perform comprehensive threat analysis within a geospatial context. Current applications allow the user to digitize and display flight paths, to select aviation threats within that area of interest from available databases, to generate visibility plots for those threats, and to generate Air Tasking Orders (ATOs). However there is no current capability to:

- Fully quantify and analyze the threat along the given flight path
- Display visibility threat domes in three dimensions
- Graphically depict the expected radar jamming effectiveness to reduce risks
- Automatically determine "best routes" based on geospatial analysis and the current Jamming Game Plan (JGP).

The Joint Routing and Analysis Planning System (JRAPS) was developed to provide these capabilities.

2.2 Background

The specific objective of JRAPS was to quickly integrate commercial technologies in mission planning systems for the display and analysis of threat data, and geospatial information, to determine the "best" route for a defined mission. To meet this objective, customized extensions were developed for ESRI's ArcGIS application suite that could be executed directly from the ArcMap interface. JRAPS provided the capabilities of legacy mission planning tools to query existing threat databases to provide analysis and identification of the threats that satisfy the specific parameters of Electronic Attack (EA). The application provided enhanced capabilities to narrow threat selection to those threats that impact a specific mission profile. The result was a set of data selection filters based on proximity to flight path and terrain masking. The resulting filtered threat data was coupled with other geospatial data and used to derive cost-analysis, radar jamming planning and effectiveness, and "best route" determination.

3. Air Maneuver Network (AMN)

3.1 What Is The AMN?

The AMN is a 3D network developed from cost factors derived from a variety of sources. These cost factors are analyzed and combined into a series of cost surfaces at several user-defined altitudes. These cost surfaces are then used to create the geometric networks at each altitude. Connector lines are then added between each of these geometric networks in order to allow for movement of aircraft between altitudes. The result is a fully solvable 3D Air Maneuver Network that is weighted based on the cost factors calculated into the cost surfaces.

3.2 Cost Surface

The Cost Surface is the key to the AMN. This cost surface will dictate how aircraft will move through the airspace in the area of interest. The costs in the cost surface can be derived using many different strategies. Our focus for the purposes of this application was to use a worst-case visibility surface. This approach will find inherent weaknesses in the existing radar coverage of an area. Striker aircraft can then be routed through these areas of weak coverage. The base for the cost surface is a set of radar terrain masks (visibility viewsheds) of existing weapon and radar systems. Terrain masked viewsheds are created for each sensor and weapon system at each configured altitude. These viewsheds serve as the base for the cost surfaces. Several factors can then be applied to the base costs to refine the cost surface.

3.2.1 Air Corridors

Defined Air Corridors will reduce the cost associated with that region of the airspace. These areas will have the costs reduced to 0.

3.2.2 Restricted Areas - High Cost Penalties

Restricted areas will take into account those areas that have been deemed unsecured (thus a large cost penalty will be applied in those areas).

3.2.3 Warning Areas - Variable Cost Penalties

Warning areas will be segmented into 3 categories (Low, Medium and High). Costs in those areas will take a 2x, 3x, or 4x impact to the defined volume.

3.2.4 Radar Cross Section

Cost factors are reduced/increased per emitter type due to the Radar Cross Section of a particular Air Frame. Factors in the capability of the emitter/technology/age to the cost surface generation process.

3.3 Automated Route Generation

Once the cost surface has been generated and the Air Maneuver Net built, the next logical step is the calculation of an optimal route that meets mission requirements and minimizes cost. The automated route generator will be capable of generating an optimal route given points of ingress, target location and egress or by modifying an existing route plan. It should be noted that the route selected is optimal relative to the network generated. This network is an approximation of the current airspace, which is based on a snapshot from the threat database.

4. Jamming Game Plan (JGP)

The JGP tool was developed to aid a mission planner in indicating what type(s) of radar jamming is required for a specific mission and when it is required. The goal of the JGP is to provide the jamming mission planner with a complete jamming effectiveness tool. This tool allows the planner to visualize how radar jamming reduces cost along a given flight path and to conduct “what if” scenarios to select the most effective JGP. Similar to the AMN, the JGP starts with radar terrain masks for each emitter and weapon system at each configured altitude. From this base, several overlays are created in order to aid in jammer planning.

4.1 Threat Density Overlay Threat density overlay is a simple overlay that displays the density of threats within the area of interest. This threat density shows the number of threats that can see any given point within the area of interest.

4.2 Jamming Game Plan Overlay

The Jamming Game Plan Overlay is used by the jamming mission planner to develop a JGP for a specific mission (flight path). The flight path is intersected with this overlay in order to determine which threats can see a given flight path at any given point. It can also tell the mission planner which jamming types to apply to specific emitters to prevent those emitters from seeing the flight path at a given point. In order to facilitate this level of analysis, the radar terrain masks for each of the emitters at each altitude are broken down into individual jamming effectiveness range rings. The assumption here is that a specific jamming type applied to an emitter will reduce the range of that emitter by a certain percentage. This jamming effectiveness is calculated for each emitter and stored in a configuration table in the geodatabase.

4.3 Jamming Modeler

The Jamming Modeler allows the user to apply jamming to the radar systems along the mission flight path (s). This tool allows the user to interactively view the affects of each jamming type on the individual radar systems. The user will have the ability to store the inputs to the modeler for other applications such as animating the threat ring adjustments.

4.4 Jamming Game Plan Report

Along with the ability to visualize threats, the JGP includes the ability to print out a report of the complete mission Jamming Game Plan. This report will contain pertinent information for the JGP including aircraft information, threat information and jamming needs (including the time-relative to the mission timeline-each jamming type is needed). This report will be a carry-away representation of the Jamming Game Plan created with the above tools.

5. C/JMTK Compatible

The Commercial Joint Mapping Toolkit (C/JMTK) provides a common set of GIS tools and Component Object Model (COM) objects that can be customized to meet specific user requirements. C/JMTK will be Defense Information Infrastructure Common Operating Environment (DII COE), Command, Control, Communications, Computers,

Intelligence, Surveillance, Reconnaissance (C4ISR), and Joint Technical Architecture (JTA) compliant, and will provide commercial products to underlie the foundation of Joint architectures within the DOD Community. The results will be greater functionality, reliability, support, and interoperability using these tools. C/JMTK will provide the technology to implement the next generation of Joint architectures for C4ISR and, through better horizontal integration and interoperability, paves the way to a shorter kill chain.

JRAPS was developed using C/JMTK objects and delivered as extensions to the ArcGIS product suite. Because C/JMTK is the DoD standard, JRAPS is compatible across the services as a common geospatial threat analysis tool.

6. Contac Information

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