**SE3250 Project 3 (Winter AY2012)**

**General setting:** Consider the following scenario. A force of 4 expeditionary warships protected by 2 cruisers and 3 destroyers is attacked by a near-simultaneous launch of surface skimming anti-ship cruise missiles. What is the distribution of possible outcomes? What factors are most important for improving the survivability of the force?

**Background information and assumptions:**

*Note: the numbers in this example are (hopefully) of the right order of magnitude. They are not exactly correct to avoid accidental compromise of classified material, among other reasons. For consistency, even if you know the correct number, use the ones given here.*

The incoming missiles (“Intracets”) can be detected at a maximum range of 24,000 yards. The time to detect and classify a target for the expected sea state is lognormally distributed with a mean of 5 seconds and a standard deviation of 2 seconds. The two cruisers and three destroyers share a common battle management system, and can simultaneously track and classify up to 200 incoming missiles.

The cruisers are armed with 60 Standard-2 missiles each. They can be fired sequentially, at an interval of 3 seconds per missile. The standard missiles fly at a speed of 44K yards per minute. Each standard missile has a 0.7 probability of kill against an “Intracet” missile. The standard missile has a max range of 80,000 yards and a minimum range of 4,000 yards (engagement inside 4,000 yards is not possible).

The destroyers are armed with 30 Standard-2 missiles, with the same properties.

The Intracet missile flies at a speed of Mach 0.93, or 20.2K yards/min. It has a probability of hitting one of the ships of the force of 0.8, and a probability of killing a ship of 0.4 for the destroyers, 0.25 for the cruisers, and 0.125 for the larger ExWar ships. The Intracet seeks targets, and is more likely to hit the ship with a larger radar cross section (RCS) in proportion to the size of the RCS. The ExWar ship is considered to have 10 times the radar cross section of the cruiser, and 15 times the radar cross section of the destroyer.

If an Intracet closes within 2000 yards, it can also be engaged by a CIWS system. The CIWS system has a 0.3 probability of killing the Intracet. There are two CIWS per ship in the force. The average time for a CW engagement is 4 seconds.

You can choose your priority of fire scheme. Clearly explain it.**Requirements:**

**1.** Determine what metrics are appropriate for this situation. Use them for all subsequent requirements.

**2.** Without considering sequencing or ranges, do a “back-of-the-envelope” simulation using Excel to model the number of hits per ExWar ship based on a salvo of 150 Intracets, and whether or not the ExWar ships are sunk. This should be similar to the example worked in class. Make 500 runs and report statistics on as many of your metrics as possible. Support your back of the envelope calculation with a simple range-target graph. **(Big Hint**: there is an Excel demo, which we will discuss in class in detail, in the course materials folder for module 7 that steps you through this.)

**3.** Model the defense of the 4 ExWar ship force against the incoming swarm of missiles, including sequencing and ranges. Describe how you will (or will not) account for the geometry and dispersion of your ship formation.

**4.** Implement your model in Extend. Organize, label, and document your file.

**5.** Based on 500 runs of your Extend model, estimate the average, best, and worst outcomes of your metrics resulting from a salvo of 150 Intracets fired to have simultaneous arrival in the vicinity of the ships.

**6.** For the given force package, determine a cost-effective set of improvements to either the sensors, standard missile, EW countermeasures, or the CIWS that results in 90% confidence of a less than a 1% chance of losing an ExWar ship from a salvo of 150 Intracets fired to have simultaneous arrival in the vicinity of the ships. Make plausible assumptions about what your changes will cost. Use a designed experiment or optimization search to explore your trade space, and document why you chose that particular approach and its particulars.

**7.** Without changing the combat systems from the initial configuration, determine the number of cruisers or destroyers necessary to result in a less than 1% chance of losing an ExWar ship from a salvo of 150 Intracets fired to have simultaneous arrival in the vicinity of the ships. Again, assume no changes to the original capabilities. Make an assumption about what your changes will cost.

**8.** Construct a cost –effectiveness curve for your answers to (6) and (7).

**9.** If you wanted to examine the scenario space (i.e. the spanning set of stressing scenarios), how do you think the results of your analysis would change for a) 50 incoming missiles, or b) 200 incoming missiles? You do not need to redo the analysis in detail, but support your assertion with at least a trial run or BOE analysis.

**10.** What is the effect if the Intracets are not fired to impact simultaneously, but instead have a common expected arrival time with a standard deviation of 30 seconds? What is the effect if the first 25% of the missiles are targeted against the cruisers and destroyers, not governed by RCS?

**11.**

**a)** Summarize your results in a concise, well-written, and well-illustrated report. Document your Extend model. Use spreadsheets or an Extend database for your input and output. Your well-written, well-illustrated report is due **at the eleventh, and last, class meeting.**

**b)** Include a summary brief as an appendix (no more than 12 slides). During our last class meeting, each team will be asked to discuss their results using their summary brief. Ensure that your team members’ names are included in all file names. Recall that you must use new partners for this project.

Note: If you get stuck, solve a simpler problem, and clearly state your simplifying assumption (or call me!).