

Optimizing the Placement of Chemical and Biological Agent Sensors

Daniel L. Schafer

January 10, 2006

Thomas Jefferson High School for Science and Technology
Defense Threat Reduction Agency TDOA OR
Mentor: George D. Gumm, PhD

Purpose of the Experiment

Although tools exist to simulate biological and chemical attacks, the detailed approach taken by these programs made optimization runs on such tools take unfeasibly large amounts of time. The development of a new tool that can both quickly simulate such attacks and optimize the placement of sensors to detect those attacks was needed for practical sensor optimization purposes.

Procedures Used

An existing C++ program, which would run a Monte Carlo simulation of a biological attack on a base, was modified and converted to Java. Additional evaluation functions were programmed, to allow varying sensor grid comparisons. Two optimization algorithms were added to the program, one which would find the best distribution of a limited number of sensors, and the other which could determine the fewest number of sensors needed to meet a specified performance threshold. Mathematical models were also created to perform numerical analysis on the effectiveness of different sensor grids.

Observation/Data/Results

The results found not only verified the mathematical models created, but also were in agreement with previous analysis. Additionally, the program is quite fast, as it takes between 1 and 5 minutes to complete an entire optimization run.

Conclusions

The final version of the program both can quickly and easily determine how best to distribute a limited amount of sensors, or decide how many sensors need to be allocated to other bases to ensure a certain level of protection. The functionality offered by this tool should ensure that military and civilian facilities can be better protected from any potential biological or chemical threat.