Wilman Granados
Cliff Wakeman
OA4202 Project

Global Response of U.S. Military

Back Story

The year is 2050. WWIII lasted from December 2012 to July 2040. The economic decline, worldwide conflicts stemming from religious extremism, and greed for world domination have plagued the earth for the last 10 years. Tensions between countries can no longer be restrained. Governments around the world have lost control and the remaining world powers are moving fast in order to keep the peace.

The United Nations (UN), North Atlantic Treaty Organization (NATO), European Union (EU), Arab League Union (ALU), and the African Union (AU) are the only remaining International Organizations. Currently, the UN has the most power and influence. A handful of countries, known for their world threatening actions, have isolated themselves and seek regional control with the purpose of expanding their borders. Their purpose is simple: disrupt and destroy those that will oppose them by means of violence, intimidation, and coercion. These groups sprung up shortly after the turn of the 21st century, a time of great turmoil and uncertainty. Over the last 40 years, they spread like cancer, *eating away* at civilized societies and sowing fear and chaos throughout mother earth. Sovereign nations were attacked and governments replaced. The world entered a state of pandemonium. Consequently, the UN turned to the only superpower that can help, the United States of America. In response to the call for help, the U.S. military has formed a special task force made up of two Generals who are well versed in developing war plans through never before seen tactics and strategies. Their mission is simple: develop a multifaceted interconnected worldwide network that will allow the Supreme Commander-in-Chief to make decisions on where to send US Marines. The decisions will be based on accomplishing the mission at the optimal minimum cost. Whether it's humanitarian assistance and/or armed conflicts intended to threaten world peace, the U.S. military is ready to answer the call.

The President of the U.S. has received the following intelligence report: Iran and North Korea have reached an agreement with aims to destroy the U.S. and replace the UN with an organization composed of both Iranian and North Korean leaders. Furthermore, China and North Africa have also agreed to oppose the U.S. military by negating the use of their airspace and bases. This is critical because U.S. forces will now have to launch attacks from bases farther away from the Middle East and Eastern Asia. As a consequence, the U.S. government will face exponentially higher costs for sending troops. Furthermore, attacks on bases and troop movement restrictions will cause our optimal minimum cost to increase. The mission from the UN is the following, "On order, Marine Expeditionary Units will deploy to Eastern Asia and the Middle East in order to destroy the enemy by fire and maneuver and repel the enemy's assault by fire and close combat." North Korean forces seek control of Eastern Asia and are moving into South Korea. Iranian forces seek to expand their borders and are moving westward toward U.S. interests. The coordinating instructions are as follows: send 500 Marine units to Eastern Asia and 1000 units to the Middle East. A second UN top-secret message has just reached the

office of the president and it reads, “On order, send 250 units of Marines to support the tsunami devastation along the pacific coast of Southern South America.”

Meat and Potatoes

After developing the backstory, our goal was to find the optimal minimum cost flow for our given scenario with no attacks, the optimal attack plans on our network, and lastly, find out if the U.S. military could be stopped after numerous political and resource attacks on our network. We took the world map and assigned nodes and edges. Some nodes represented real world U.S. military bases spread across the globe. These were chosen to ensure a good spread across our network. The other nodes represented world regions where U.S. military units could amass in order to meet the demand at the destination node.

Our network is comprised of 27 total nodes: 8 base nodes with some amount of supply and 19 region nodes with zero or some amount of demand. The arcs between nodes are comprised of a cost component that is a function of distance along the arc and a cost factor, an assumed lower capacity of zero, and a calculated upper capacity that is a function of distance. Cost is used as the primary measure of effectiveness for this model. The operator decision is driven by two components. The first is the desire to minimize the cost of traversing the network as supply is being directed to the demand while interdictions are being avoided. The second is the desire to minimize any unsatisfied supply and demand. This second component is needed for the problem to execute correctly, but the total cost that is used in the analysis takes out the penalized unsatisfied supply as this reserve is deemed to not be a cost to the U.S. Government.

Three types of attacks exist on this network. They are placed into two categories: node-type attacks and arc-type attacks. Alliance attacks are node-type. These involve one country in alliance with one of the aggressors. Flow into the region that includes that country is essentially cut off. These attacks are manually coded in GAMS by adding delays to all inbound arcs to a node that is attacked. Resource attacks are also node-type. These occur when a country physically attacks one of the bases, destroys all the supply, and cuts off all flow into or out of the base. These attacks are optimally determined using the GAMS dual mixed-integer program (MIP). Political attacks are arc-type. These involve one of the aggressors forming a pact with a non-ally country in the global network. One of the arcs related to that country is cut off, forcing the use of an alternate, more expensive route. These attacks are also optimally determined using the dual MIP.

Eight scenarios are analyzed with this network. Scenario 0 involves no attacks on the network. All demand is met with a total cost of $161,000,000. In scenario 1, alliance attacks are introduced. With China and Northern Africa unusable, all demand is still met with a total cost also of $161,000,000. Scenario 2 looks at modeling only resource attacks on the network. The attacks are not nested in this case. When moving from two to three attacks, there is no more remaining supply and unsatisfied demand comes into play. This results in a large jump in the operator resilience curve. In scenario 3, only political attacks are used. Once again attacks are not nested. Interestingly, the attacks are primarily located around Eastern Asia, but with five or six attacks, they swap over to the South American natural disaster effort. With any number of

political attacks, there is always some remaining supply since resources are not destroyed, just cut off from reaching the demand. Demand starts to be unsatisfied when going from four to five attacks, resulting in a large jump in the operator resilience curve. The cost to the US government skyrockets into the billions and the mission is jeopardized. Scenario 4 uses a combination of resource attacks with alliance attacks. With the addition of alliance attacks, the resource attacks are nested. Any remaining supply vanishes when going from three to four resource attacks, and unsatisfied demand appears when going from two to three resource attacks, resulting in a jump in the operator resilience curve. Scenario 5 uses a combination of political attacks with alliance attacks. Once again adding alliance attacks results in nested political attacks. A noticeable jump in the operator resilience curve occurs from four to five political attacks because of the unsatisfied demand.

In scenario 6, resource attacks and political attacks are both possible. The problem becomes three-dimensional, resulting in an operator resilience surface. The surface is non-decreasing as it moves away from the corner representing zero resource attacks and zero political attacks. It exhibits a plateau effect as it reaches eight resource attacks and eight political attacks, leveling off at $13,422,000,000. With the given problem and number of attacks the total cost can never go higher. Cutting off or destroying all supply results in an upper limit on the total cost. Scenario 7 combines all three types of attacks and is also three-dimensional. Initially, the resulting operator resilience surface has steeper edges as it moves away from the zero-zero corner caused by an early unsatisfied demand. Once again the surface plateaus as it reaches the upper limit.

Conclusion

The U.S. military response to the mission handed down from the UN was initially accomplished at a minimal cost. Unfortunately, after political and resource attacks on the network grew, U.S. troops failed to accomplish the mission. The coverall cost of not satisfying the demand rose to extraordinary amounts.

With more time…

GAMS was able to provide the minimum cost flow with no attacks, with a combination of attacks, and eventually with all attacks on the network. The information gathered from the analysis of the output provided a glimpsed of how our network can be used for real world conflicts while minimizing transportation costs. With more time, more nodes could be added to the network to represent more countries in order to realistically model the world. The costs associated with transporting units across a worldwide network include air, land, and sea movement. Our network could benefit from adding these different modes of transportation by associating MOEs to each, thus proving an even more realistic model.