

**TRUST AND SECURITY OF HYPERSONIC SYSTEMS AND BIDIRECTIONAL
CHARGING NETWORKS**

HOW SOCIETY INFLUENCES GOVERNMENT WEAPONS PROJECTS

A Thesis Prospectus
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By
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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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The rise of interconnected devices, called the Internet of Things (IoT), has led to an equal growth in a systems' security issues such as privacy, authentication, and secure storage of data (Conti et al., 2018). As IoT continues to expand in the future, everyday items could become key components of a personal security breach, leading to stolen identities, credit cards, and passwords.

This prospectus outlines both a technical project and tightly coupled STS project. The technical topic consists of three parts: an analysis on the deployment of hypersonic glide bodies, a risk assessment of the research and development of bidirectional charging systems, and an overall evaluation of IoT devices in logistical systems. Both the hypersonic glide body and bidirectional charging network research will have a focus on the security of the systems and will outline the largest threats to each, allowing the research group to draw conclusions to the current state of security in IoT devices for the third part of the technical project. The STS topic is tightly coupled with the analysis of hypersonic glide bodies and discusses how the United States government weapons program interacts with different aspects of American society. Actor Network Theory (ANT) is used to discuss the current system and a new system is proposed to give citizens more influence on the future development of weapons. All of the research outlined is being worked on simultaneously and will be completed by the end of the school year.

For all three technical projects, the research group will consist of five undergraduate Systems Engineers: myself, Beatrice Li, Chris Vanye, Mai Luu, and Rahman Adekunle. Graduate Research Assistants Negin Moghadasi and Kelsey Hollenback will provide help along with Professors James H. Lambert of the University of Virginia and Zachary Collier of Radford University.

HYPERSONIC SYSTEMS, VEHICLE CHARGERS, AND TRUST IN LOGISTIC DEVICES

DEPLOYMENT LIFE OF HYPERSONIC GLIDE BODIES

Systems Planning and Analysis Inc. (SPA) is a defense contracting company that provides acquisition support for the interested parties of the Department of Defense with respect to the Department of Defense's Conventional Prompt Global Strike (CPGS) program. The purpose of the CPGS program is to "bolster U.S. efforts to deter and defeat adversaries by allowing the United States to attack high-value targets or 'fleeting targets' at the start of or during a conflict" (Woolf, 2020, p.1). The urgency and support for the program has increased as the United States is left further behind in the research and development of the technologies compared to other countries including China and Russia (Woolf, 2020). The lack of hypersonic capabilities places the United States in a position of disadvantage, which could dictate the nature of future international relations. In recent years, the efforts of the program have shifted to hypersonic technologies, the ability to fly at speeds that are at least five times the speed of sound – defined as Mach 5 (Gordon, 2018, p.141). Hypersonic technologies, or weapons in this case, can be divided into two categories; hypersonic glide vehicles and hypersonic cruise missiles. The interest of SPA's acquisition support lies within hypersonic glide vehicles, also known as Hypersonic Glide Bodies (HGB), which are launched to the appropriate altitude with a rocket before gliding to the designated target (Sayler, 2020). Though the term "glide" suggests it to be uncontrollable, it actually refers to the absence of a rocket motor on hypersonic glide bodies and they can maneuver in flight but that is not without its challenges. When working with such a complex system, there are a vast number of scenarios and challenges that have yet to be addressed but crucial to the deployment of the technology. The capstone team will analyze

literature that pertains not only to the subject of hypersonic technology but also to the challenges related to the system and produce a scenario analysis of potential conditions that can affect the success of the system, which is the deployment of the hypersonic glide bodies. The team has already started looking into how specific budget and timeline scenarios will affect the HGB life cycle (Hamilton et al., 2013, p.302).

With the focus on the deployment of a fully functioning hypersonic glide body, the performance of the HGB is evaluated through a variety of metrics describing it from the moment of deployment to moment of impact. With the scenario analysis approach, success criteria are not the only aspect to be considered but also initiatives, and emergent conditions as well as their respective relationship with each other. As this project is partially sponsored by SPA, the team will provide the scenario analysis to guide SPA in understanding which scenarios to focus on and plan for in the deployment of the hypersonic glide bodies.

RESEARCH AND DEVELOPMENT OF BIDIRECTIONAL CHARGING NETWORKS

Fermata is the national leader in proven Vehicle to Building (V2B) and Vehicle to Grid (V2G) systems. As electric vehicles become more popular, there is a growing need for forward thinking about how the power grid will handle the increased stress of not only powering all the buildings and infrastructures in an area but also the need for electricity in new electric vehicles. More specifically, the project's main goals are to find potential risks to the research and development of a bidirectional charger network and to assess the resilience of a power grid that supports electric vehicle charging. Bidirectional charging allows electric vehicle owners to get paid to give power back to the grid during times of grid stress. As seen in Figure 1 on the next page, this means that electric vehicle (EV) owners can use their cars as extra power banks for the grid while they are not in use and can substantially help out the grid (Almutairi et al., 2018).

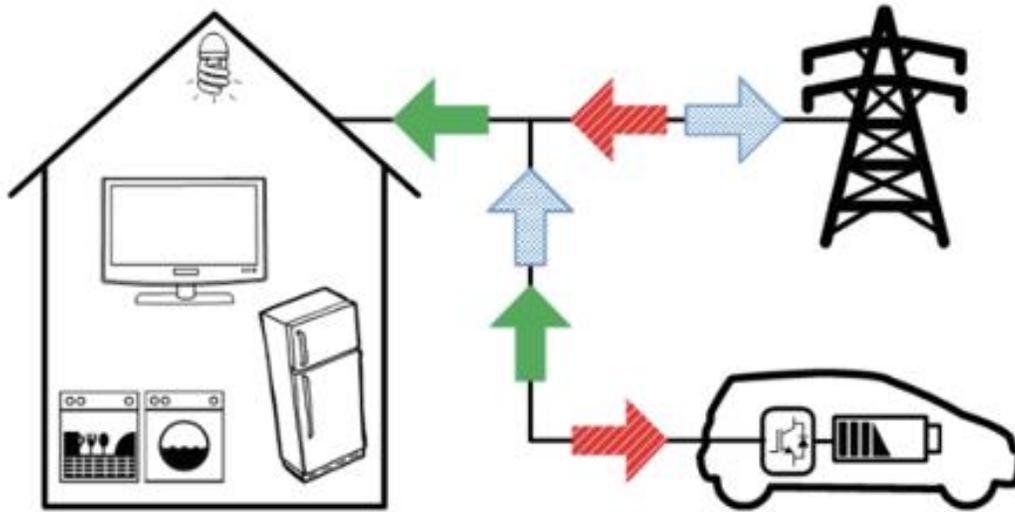


Figure 1: Bidirectional Charger Connectivity. This figure shows a concept of a vehicle’s ability to both pull and push electricity to the grid. (Pinto, 2013).

The approach to this project will be a combination of established resources and publications combined with new ideas from the research group. The existing literature will act as a guide for understanding previous work in the topic area along with giving the group previous indicators of good and bad performance from an electrical system, like charging capacity and hours of maximum usage. Data like surveys, fault trees, and initiative charts will be essential in giving the group a good idea in where the direction of electric vehicle charging is going (Andrews et al., 2020, p.12). A spreadsheet outlining the success criteria for the system, along with initiatives and potential emergent conditions will be produced for Fermata to better understand potential risky situations that the company might run into while developing a bidirectional charger.

SECURITY AND TRUST IN LOGISTIC SYSTEMS

The Commonwealth Center for Advanced Logistic Systems (CCALS) is an applied research center that brings universities and companies together to preform analysis on rapidly growing technologies in the IoT sphere. The objective of this part of the technical project is to

produce a compiled analysis of the hypersonic glide body and bidirectional charging results in terms of connectivity and hardware security risks. The technical group will present our findings in a slide show presentation to CCALS and draw conclusions from the two previously mentioned projects to determine the current state of security in connected devices, along with giving observations on where the future of security and trust in IoT devices will lead logistic systems.

SOCIETY AND GOVERNMENT WEAPONS PROGRAMS

Since the technology boom of the 1990s, the general population has not stopped to think about the countless hours that go into planning a launch of a new technology. Whether it was the iPhone's data security software or the safety mechanisms in the new F-22 Raptor fighter jet, society often takes the product for granted without thinking about the potential risks that come with using it. The back end of these technological systems has dozens of prioritized mechanisms that take into account things like what data should be private, how often the performance dips below the standard, and how resilient the system is to a malfunction (Hassler et al., 2020). For example, the risks of designing and developing a product include company strategy, competitiveness compared to similar products, and the social impacts of releasing the product (Tulenheimo, 2015, p.475), something that a lot of consumers fail to think about when making a purchase. These notions can be carried into the government side of American society too. Just like publicly owned companies, the American government produces technological products that have complex logistical processes and risks that come with use.

The thesis paper will aim to describe how the United States government weapons programs currently influence society, along with proposing an alternative way to set up the network so that American citizens influence the weapons programs. For the future, hopefully citizens can start to understand the risks that are taken to deploy a weapons program, along with

the security protocols that are inside the system (Awerbuch, 2000, p.1025-1027).

ACTOR NETWORK THEORY AND GOVERNMENT WEAPONS PROGRAMS

The current system can be seen through the lens of Actor Network Theory (ANT), a social theory that “makes use of some of the simplest properties of nets and then adds to it an actor that does some work” (Latour, 1996, p. 371). By grouping people with similar traits and calling them actors, these groups can exert their influence on a network. Figure 2 shows four actors in a government weapons network. Since each actor only influences one other actor sequentially, it can be shown as a linear network.

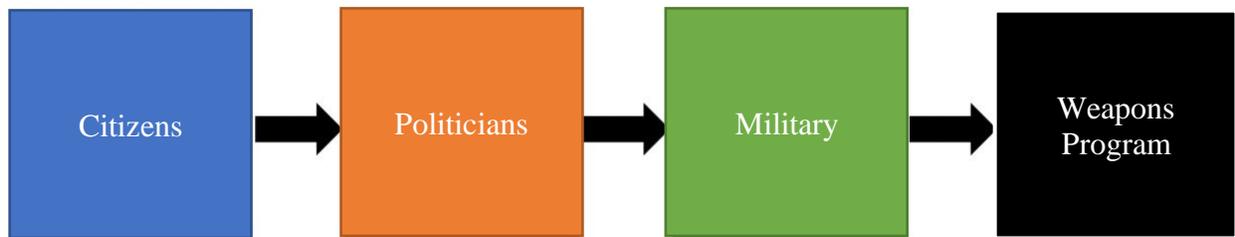


Figure 2: ANT Applied to Government Weapons Programs. A depiction of the four actors, citizens, politicians, military, and weapons program, who influence the final product. (Koch, 2020).

In this figure, the American citizens delegate decision making to politicians by electing them. Once in office, politicians delegate the military to make weapons and defense decisions through a multitude of ways and can limit the military by cutting their budget. Once the military has their funding, they delegate the production of weapons systems to government contractors by applying goals and limitations. While this might appear to be a good system, Miller, a University of Virginia scholar who studied technological innovation in cars, brings up the point that “a worthwhile goal should be to output a device that is sufficiently superior to the pre-existing condition” (2020, p.7). Currently, the United States military is only making incremental upgrades to their weapons arsenal, costing America billions of dollars. As of September 2019,

the United States spends more on its military than the next ten countries combined, indicating an overcommitment to defense resources without any plan of a budget cut (“U.S. Defense”, 2020). For example, the United States government spent almost 600 billion dollars on the military compared to only 70 billion on education, a space where a 10 percent increase in spending could lead to about 8 percent higher wages per person (Jaeger, 2016). If there was any way for citizens to better influence how government money is spent, society could see an increase in quality of life in different sectors outside of the military.

REVISED ACTOR NETWORK THEORY

While Asaro (2019), an artificial intelligence and robotics professor at The New School, refutes ANT and Social Construction of Technology (SCOT) by believing that autonomous weapons will influence society no matter what they decide, a change to the current view of the network can potentially be important in giving society a chance to reject autonomous innovation. Figure 3 on page 8 shows a revised network in which the American citizens elect a committee to influence the production of military weapons. While the need for secrecy in the development of these weapons is understood, there has to be a way for the American people to better sway decisions on the massive, continual production of aircraft, ships, and ballistic missiles by the military.

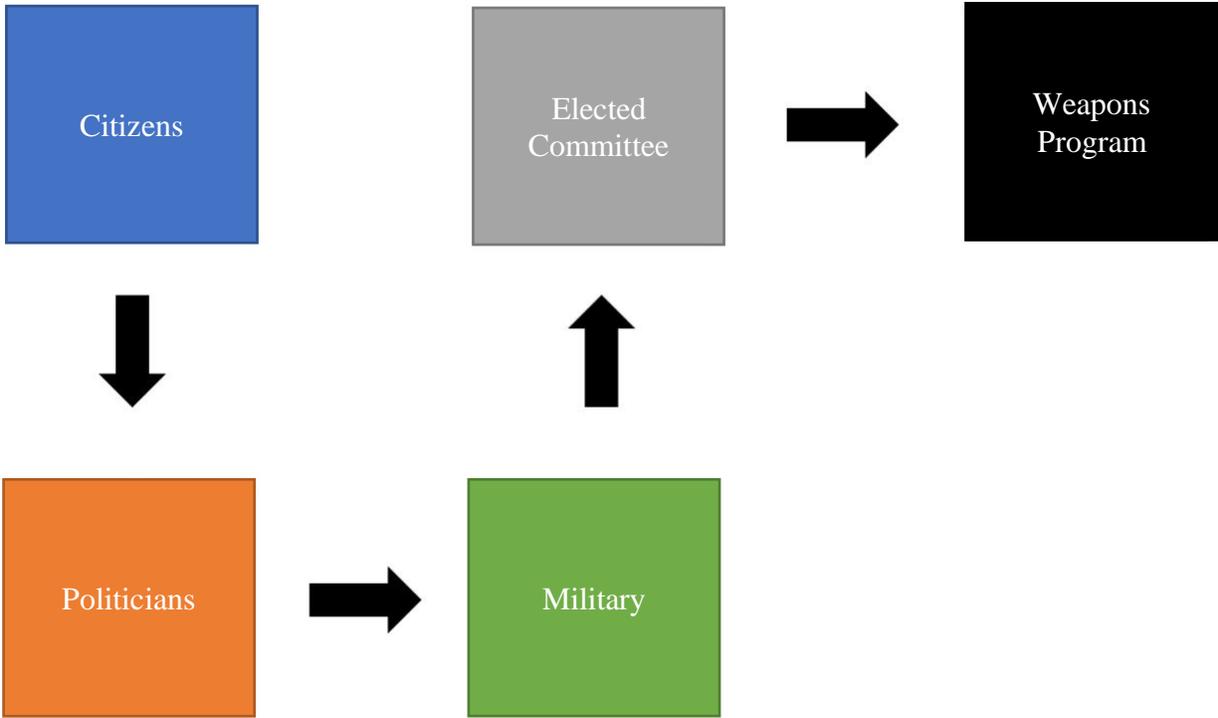


Figure 3: Revised ANT Model of Government Weapons Programs. A modified network where a committee elected by the citizens make final decisions on whether or not specific weapons programs should be funded. (Koch, 2020).

While moving the American citizen actor in between the military and weapons programs was considered, it is still important for the population to elect politicians. Therefore, a new citizen-elected group is added as a buffer between the military and weapons programs to ensure the general population still has influence on the development of future weapons. The goal of this change is to better involve citizens in the overall process of the military and to get them to better understand what the military spends their money on, much like how elections allow the regular person to read about and decide on what they think is best for their country by voting.

Through changing the current way this network operates, the American citizens will greatly benefit in the long term. If the citizens decide the military is spending too much on weapons, they will now have the chance to stop a specific project or contract by electing the correct people to the committee. Through this, government funding to non-military operations

could increase, meaning benefits to other operations like education could be worked out by politicians. On the other hand, if America finds itself in a tense situation with another country, the population could vote on committee members to allow more weapons to be created and prepare for the worst. While it is imperative that the general population would need to be thoroughly informed before making decisions regarding the military, social media and traditional media sources could make vital information easily accessible, much like what they are doing right now before an election.

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