CANADIAN SUPERCOMPUTER THREAT ASSESSMENT AND POTENTIAL RESPONSES

Date: December 5, 2018

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KEY EVENTS

Four key events are addressed in this briefing note. Key event one is the announcement in April and May of 2017 with the launch of two supercomputers in Canada (Graham at University of Waterloo; Cedar at Simon Fraser University) and a third one (Niagara at The University of Toronto) using Compute Canada's Resources Allocation (Compute Canada, 2018a). Key event two is the announcement that Huawei Canada is building Graham's operating system (Feldman, 2017). Key event three entails CSIS being warned by the US Senators (Rep. Sen Marco Rubio and Dem. Sen Mark Warner) about the possibility of China and Russia spying on Canada. Key event four, the United States has reportedly banned sales of Huawei products on US military bases (Bronskill, 2018; Collins, 2018).

This briefing note is particularly relevant as Compute Canada is now preparing for 2019 resource allocation; there may be a raised/elevated security risk of economic espionage, intellectual property theft, and abusing education access privileges which needs to be considered (SFU Innovates Staff, 2018).

NATURE OF DISCUSSION

This briefing note will explore the potential risk of foreign nationals accessing Canadian innovation and research linked to healthcare data, artificial intelligence, and data modeling. In particular, focusing on supercomputing systems known as *Cedar and Graham*. This briefing note will use a kill chain model to demonstrate a prior case example of how Ruopeng Liu allegedly stole data about the manufacturing of metamaterials from Dr. David Smith's Duke University lab (McFadden et al, 2018), which specializes in research regarding "invisibility cloaking technology." That technology may have then been used by Liu to create a start-up company called Kuang Chi Science in Shenzhen China

that is now worth approximately six billion and linked to Chinese military product development using similar low radar visibility metamaterials (McFadden et al, 2018).

A similar attack will be exemplified in which *vector* can be used in Canada to target Canadian supercomputing projects and associated research hosted on the supercomputer network.

This briefing note will also introduce open-source articles and commentary in which the need for a cybersecurity assessment to be conducted with specific focus on how supercomputing contracts currently at Compute Canada and CFI innovation are funded. These contracts include contributions by Lenovo and Huawei, which arguably may lead to potential security risks.

Indications of the potential security risks that may be poised by Lenovo and Huawei are noted in the following examples: Lenovo was ordered to pay a fine of $7.3m for allegedly installing adware in 750,000 laptops (Waqas, 2018), the installation of microchips on Elemental computers (developed in China by Supermicro) deployed inside the U.S. Department of Defence data centres (Robertson & Riley, 2018), and China's government ability to directly influence Chinese company operations (U.S. House of Representatives, 2012).

This briefing note will then address the possible connection between Huawei and supercomputing risks in Canada. Lastly, an outline will be provided of a potential attack that may involve compromising an individual with access to any of the computers connected to the Arbutus network. By spoofing the credentials of one of these targets, attackers may gain access to the computers computational power. This access may be gained through users who are active teaching faculty and may become a target of opportunity for a potential attacker.

BACKGROUND

Two potential attack vectors against supercomputing are possible: the human vector, and the technological vector. The human vector is potentially a foreign national student, and the technological vector is a spoofing attack.

Human Vector: A potential attack under the kill-chain model could be demonstrated as follows. A university student conducts reconnaissance (by potentially becoming a trusted member of a research project thus gaining access to the computer network) and gathering information on potential targets and

technical specifications (server details, operating systems used, vulnerability to malware, etc.). Once having gathered the data, the student would then gain access to the network through the use of legitimate credentials for the purpose of stealing data, which is also known as weaponization of access privilege. Once system access has been obtained, the student would then steal the research data set. The data is then moved to a foreign nation, which is then potentially converted into military products for a foreign government.

Technological Vector: "A spoofing attack is when a malicious party impersonates another device or user on a network in order to launch attacks against network hosts, steal data, spread malware, or bypass access controls" (DuPaul, n.d.). A spoofing attack to compromise Cedar and Graham could be feasible if potential attackers are able to identify researchers with access to that network. In 2018, a list containing more than 400 names associated with research projects that utilized Cedar and Graham computing resources was made available online (Compute Canada, 2018b). This list could potentially provide a number of targets for identity theft and spoofing, which are then converted into login credentials via keylogging software or other backdoor access.

Listed names included researchers from across Canada in a variety of fields and topic interests, some of whom are active teaching faculty at their respective institutions. Attackers may pose as students, in order to send infected files possibly disguised as assignment submissions or other seemingly legitimate documents containing keyloggers or spyware. In this way, the user can be compromised, and attackers can have access to the system. Once Cedar and Graham is compromised, it could then be vulnerable to a malware upload, potentially resulting in disruptions to the system or a potential backdoor access to the system being implemented.

Implications of These Attacks

Analysis of the Compute Canada (2018b) project data requests reveals research allocation projects which included artificial intelligence and big data analytics. These projects may be relevant to Canadian Armed Forces and Canadian police services who are currently using or exploring the role of AI and big data modeling to combat dark web activities. Furthermore, such research frameworks are also being pursued at various Canadian universities. This target rich environment is similar to the security risk at Duke University, which was previously noted in the nature of discussion.

Previous Supercomputer Hacks

Similar supercomputer hacks have occurred that demonstrate there are vulnerabilities which can be exploited.

In 1999, a fifteen-years old boy known as C0mrade caused a 21-day shutdown after hacking NASA computers and invading Pentagon systems. In June 1999, he accessed 13 computers at the Marshall Flight Space Centre and downloaded $1.7 million worth of NASA proprietary software that supports the space station's environment. Between August and October 1999, he entered the computer network ran by the Defence Threat Reduction Agency (DTRA) through a router in Dulles, VA. and intercepted DTRA emails which included 19 usernames and passwords of employees, ten of which were on military computers (Wilson, 2000).

In 2013, Andrew James Miller was able to gain access to the supercomputers used at the National Energy Research Scientific Computing Center in the Lawrence Berkeley National Lab California. He was arrested by the FBI when he attempted to sell root access to the supercomputers to an undercover FBI agent via an online chat platform. Selling unauthorized access to a government supercomputer would have enabled the purchaser to easily compromise information resources for the US Department of Energy (Goodin, 2013).

In 2014, a New Zealand based weather supercomputer named Fitzroy was hacked from an IP that was reportedly traced back to China. Paul Buchanan, a former policy analyst for the US Secretary of Defense, noted that the attack followed similar Chinese patterns and may have been searching for back doors to other government computers including computers with access to Five Eyes network. Fitzroy's operators were confident that the hackers did not get beyond the supercomputer (Richmond, 2014).

Based on current case studies, the impact of these hacks is summarized as threats against intellectual property, compromised infrastructure security, and a loss of confidence in academic institutions' ability to adequately protect national security based research.

While searching for historical cases of supercomputers being hacked, there is evidence that supercomputers may also provide a solution. In 2018, a potential countermeasure against hacking powered by current or future supercomputers was announced. A team from Monash University is claiming to have "devised

the world's leading post-quantum secure privacy preserving algorithm—so powerful it can thwart attacks from supercomputers of the future" (Monash University, Faculty of Information Technology, 2018). This algorithm allows for the secure transfer of data, as well as the preservation of user privacy. Furthermore, it was noted that even taking into consideration the future existence of a more powerful quantum computer, which allegedly would be able to easily break the current security algorisms in use, the Monash University developed algorithm "HCash" will remain secure and continue to protect user privacy. (Monash University, Faculty of Information Technology, 2018).

Huawei

In the past, some Chinese companies have reportedly been connected to incidents involving compromised computer security. In particular, the microchip found in Supermicro was connected to supercomputing mother boards (Robertson & Riley, 2018). Currently, there are security concerns about Huawei as a cybersecurity threat that have been expressed by US and the Five Eyes intelligence community.

As reported in the Globe and Mail (2018), Canada, "does not allow Huawei to bid on federal government contracts." The contracts for Graham and Cedar supercomputers are funded by the Canadian Innovation Fund, which is a federally funded agency to implement and manage research, which benefits Canadians. This funding is linked to Computing Canada, Cedar and Graham supercomputing, and Huawei Canada. Given that Canada does not allow this bidding, there are still concerns that "the Shenzhen-based firm (Huawei Canada) has established relationships with leading research universities in Canada to create a steady pipeline of intellectual property to underpin its market position in 5G technology" (Fife & Chase, 2018, para. 15).

CSE - Security Review - University Responsibilities to Address Huawei Canada Impact on Risk

The detaining and possible extradition of Ms. Wanzhou Meng (Chief Financial Officer of China's Huawei Technologies) by Canadian officials in December 2018, may raise concerns or speculations about the extent of Huawei Canada's influence on Canadian national security, in particular, 5G telecommunications design and implementation. As noted above, these concerns can be dated back to 2012 in the U.S., and 2013 in Canada with CSE providing

> Advice and guidance to mitigate supply-chain risks in telecommunications infrastructure upon which Canadians rely, including, since 2013, a program that has been in place to test and evaluate designated equipment and services considered for use on Canadian 3G and 4G/LTE networks, including Huawei. [The] testing is called the Security Review Program. Risks could affect equipment ranging from private cellular phones to large communications networks, corporations and governments (Fife & Chase, 2018, para. 5).

This kind of testing can be used to inform risk management issues and tasks which are identified as a condition of funding by the CFI funding guidelines. These guidelines can be traced back to 2013 and have evolved to address a variety of risk management issues, for example: Innovation Canada at Section 5.1.1 (p. 24) recognizes the need to ensure the institution deals with 5.1.3; special requirements for certain types of infrastructure projects; the institution should ensure that researchers follow existing guidelines and adhere to the requirements for their research facility. In signing the Institutional agreement, the institution agrees to conform to these guidelines (Canadian Foundation for Innovation, n.d.).

1. Compute Canada and the CFI Grant recognize the need for managing funding and also to ensure that Compute Canada can "review options for hosting, operating, and maintaining the infrastructure to provide the highest quality and most cost-effective total solution" (Compute Canada, 2018c). It was further noted that "Compute Canada can leverage its existing CFI-funded data centres, technical, and staffing investments to provide extremely high quality and cost-effective operations and maintenance of systems as part of the national platform, meeting a variety of uptime and security requirements" (Compute Canada, 2018c).
2. Innovation Canada provides best practices insight into a risk-based management approach to ensure the funding project is well managed. Included in that document is specific mention that some projects will require more oversight than others. This is addressed in the proposal development and internal review stages:
    a) The internal vetting process ensures that project risks that may hinder success have been identified (e.g., potential for significant delays and cost escalations or insufficient capital and operating funds) and that mitigating measures, including any oversight activities, have also been discussed (Canadian Foundation for Innovation, 2017, para. 3).

b) Innovation Canada also recognizes the need for additional oversight of large or complex projects which includes oversights such as “scope and issues” and requires those receiving funding to have clear definition of the roles and responsibilities to ensure “improved risk management during project implementation and mitigation of adverse impacts [if any]” (Canadian Foundation for Innovation, 2016 & 2017).

Based on the information found in open sources, the following points are noted.

1. The national security threat from Chinese telecommunication companies can be traced back to 2012 and 2013.
2. Canadian government agencies were actively looking at this threat.
3. Universities who are involved in supercomputing projects have risk management mandates and responsibilities.
4. There is a track record of three Chinese telecommunication companies that are currently involved in litigations which are directly related to national security concerns in Canada.

KEY POINTS OF DISCUSSION AND WEST COAST PERSPECTIVES

Increased Security Reviews and Oversights Are Necessary to Protect Canadian Researchers and Their Intellectual Property

SFU has an established history of working with federal and provincial contracts. Is there an opportunity to provide additional security? And if so, what kind of security and at what costs?

Increased Siloed Security Around Military and Public Safety Research

As noted previously, access via researcher credentials can potentially lead to a compromise of national security. The research allocation projects that share a relationship with law enforcement models may be susceptible to such a compromise. For example, SFU is conducting various research projects concerning artificial intelligence, and as mentioned above, artificial intelligence is a rich field for attack (Canadian Foundation for Innovation, 2017). In addition, with some projects potentially sharing a close relationship with the military, the risk is further increased. Projects with either a direct military relationship or potential military application may be preferentially selected as targets. Is it now

a critical requirement to have a Chief Security Officer for all supercomputing projects answering to an external governance body?

Double Edged Challenge

British Columbia has a large international student population and is actively engaged around the world on a variety of academic initiatives. While this is promoting global partnerships, it is essential to have sufficient safeguards in place to protect Canadian interests. How do we promote international cooperation while also protecting Canada's intellectual property?

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Published by the Journal of Intelligence, Conflict and Warfare and Simon Fraser University

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