JMA Wireless Internship Experience

(Technical Paper)

Virtualization: What it is and How it Helps

(STS Paper)

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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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Introduction

JMA Wireless is a telecommunication company that engages with every aspect of the cellular network industry. While they started just by creating cables and connectors, JMA has expanded to incorporate the development of 5G networks into their repertoire (Alleven, 2018). Now the company has products ranging from physical equipment such as cables and radios to software for 4G and 5G networks. Headquartered in Syracuse, New York, JMA has good relationships with Syracuse University and has recently had the Syracuse football stadium named after them, The JMA Wireless Dome. This is because due to JMA's radio and 5G technology, the dome has antennas all over the stadium (as well as beginning to implement them around campus). Furthermore, they support the wireless communication between coaches and quarterbacks as well as coaches and the top box.

The primary software side of the company is focused on developing and implementing an XRAN Architecture as a replacement for the baseband unit with antennas. The appeal of XRAN is that it is 100% software and does not rely on the physical machine(s) it runs on. This virtualization leads to several benefits one may ordinarily overlook. First, the virtualizing of the baseband unit allows for a 90% reduction of physical space. Because the software can run on such a small server, there is no need for large server rooms to run a network. Second, in conjunction with a reduced number of servers, virtualization allows for an 80% reduction in energy consumption. Lastly, software can be updated remotely and can be constantly changed and improved. This allows for constant improvement in the network as well as allows for an evolution of the network system. An ordinary baseband unit may not be compatible with the new 5G network on the rise, whereas a virtualized XRAN architecture would and can update to be compatible. (*XRAN® - JMA Wireless*)

Technical Discussion

This internship with JMA Wireless, which occurred during the summer of 2022, was in the Richmond, Virginia office with other computer scientists. While the original plan was for the other intern and me to create a simulation for phones connecting and disconnecting from cell towers for other software testing purposes, this did not happen. Instead, a systems architect from Chicago came and taught us a testing automation software that we would then use for the remainder of the summer. This software was called Salt.

Salt is a configuration management system used for automation (Contributor, 2018). Consisting of master and minion servers, Salt can run tests that are stored on the master server on the minion servers and report which minions have incorrect states, settings, or configurations. It can then run remediations where the master will send commands to the minions which they will then run, thus fixing the incorrect states. Sometimes the commands sent will need sensitive configuration data that only the master server is allowed to know. If it were not stored in the pillars, other minions would be able to access it and it would cause a security issue. Salt also has access to a database through what is called a runner. This runner is part of the master server and can access and read from the database or other external APIs as well as using queries connected to minions. (*Saltstack - Architecture*) While Salt has more complex features than this, these are all that were used during the summer.

As a phone connects to a cell tower, it effectively becomes a 4G or 5G node depending on its connection. These nodes are one example of a minion as it connects to the XRAN architecture that JMA develops (*XRAN® - JMA Wireless*). This master XRAN controls all the settings needed for the nodes to run correctly, some of which are stored in pillars. These nodes are managed by another one of JMA's products called XOAS or "XRAN Operations Application

Server". This system allows for operator visibility into thousands of nodes and servers as a crucial point for fault management, configuration, accounting, performance, and security. Much of the software development that occurs at the Richmond office is focused on improving XOAS in one way or another, whether it be managing a database, improving the user interface, working on the dashboard that provides statistics about nodes, or working on Salt.

The first month of the summer primarily focused on teaching the other intern, Jordan, and me about all the environments and softwares that we would be using throughout the summer. The primary ones were Git, Linux, XRAN and XOAS, and Salt. While both Git and Linux are systems that are used in some software development classes at UVA, neither of them is explicitly taught. Therefore, I had a lot of learning to do over the course of the summer, but I was reasonably familiar with them by the end. XRAN, XOAS, and Salt took many more whiteboard sessions to learn about and how to use but are much easier to understand through pictures and diagrams.

As the main part of my project, I was tasked with developing tests and remediations according to the Center for Internet Security Linux 8 Benchmark so that the XRAN nodes managed by XOAS would be secure against cyber-attacks (*CIS Benchmarks™*). This package that Jordan and I would develop would be stored in the master server and would be able to be remotely run on each node. These tests and remediations would check to verify that the 4G and 5G nodes both have the security needed as well as the capabilities to perform as specified. The CIS Benchmark has some tests as Automated, as opposed to Manual, and these are the ones that were translated into Salt using the templating language Jinja and the markup language YAML.

Each test is written slightly differently, and some may use common Linux commands while others may not. This allowed us to sometimes use Salt modules whereas sometimes we

would have to write Bash scripts to check what needed to be checked. Using assertions, we were able to determine if the test was successfully passed and if there was a need to run the remediations to be able to fix the configuration.

Research Question and Methods

While my project this summer was focused on Salt and Linux, my supervisors offered some parting advice for me: "Look into virtualization, and Kubernetes specifically". Heeding their advice, the general topic area for my research will be on how virtualization works, the pros and cons of such technologies, and advancements in virtualization software. The deliverable will be a concentrated look into and description of virtualization and how it affects the advancement of technology we have today. Given that this is something that our society is moving towards, it is important to understand what it is, how it works, and if there are any controversies surrounding it.

STS Discussion

Simply put, virtualization is technology that allows IT services that are typically run on hardware to be run virtually in software to free up resources. The technology takes the physical resources that are available on the system that the virtual software is using and divides it up so that several applications can be running on the same machine. These machines can be computers, operating systems, servers, or networks. The virtual environments being run on the hardware are often run as a single data file that can be easily moved from one computer to another and is expected to run the same way. (*What is virtualization?*) During the rise of virtualization, hypervisors were developed to divvy up the physical resources present in a physical system. This

program runs on the hardware and creates several virtual machines (Fedoseenko, 2019). It then operates as the link between what the software needs and reallocating the physical resources to make the virtual environments run the most efficiently. (*Difference between virtualization and hypervisor*)

As is the case with most innovations, the pros are often obvious and are the reasons for innovations. Virtualization is no exception. The most notable pro that virtualizing physical systems presents is a reduction in cost. This reduction presents itself in the logic of virtualizing. First, software that once would require multiple servers or computers can now be done on just a few. This allows for a reduction in physical space needed, especially in server rooms. With less hardware, less maintenance is required. Once again, for server rooms, this can be extremely helpful if something is wrong and needs to be fixed. With less physical resources, less cooling is also needed. This reduction allows for both reduction in money and energy needed to keep large physical systems running. Overall, having fewer physical resources requires less energy, money, and space. (*XRAN® - JMA Wireless*) Furthermore, using virtualized software allows for easier scalability. As technology improves and evolves, physical hardware cannot always keep up. This requires maintenance, upgrades, and replacements. This requires a larger expenditure of money, time, and labor, but is also redundant and unnecessary. Software, on the other hand, can be remotely updated and can often use the same hardware as previous iterations. This allows for the systems to last longer as hardware does not need to be constantly updated, changed, or replaced. (*Virtualization Pros and Cons*) (*What is virtualization & what are its benefits?*)

While numerous pros are present in virtualization, nothing is ever perfect. While there is a reduction in overall financial expenditures in addition to less energy consumption and reduced maintenance, that does not include the upfront cost that may be required to switch over from

physical hardware to virtualized software. Furthermore, many businesses, particularly smaller ones, may not have the technological infrastructure to make a smooth transition. This could come from the need to hire new employees or requiring the purchase of new servers or desktops. (*Virtualization Pros and Cons*) Also, not all applications should be or have the capacity to be virtualized. Due to the sharing of physical resources, if any program is exceedingly high performance or CPU heavy, then running with reduced hardware may not be the smartest option. It is important to note that security is much less secure on virtual systems than it is on physical ones. (Crouse, 2022)

Conclusion

The opportunity to work at JMA Wireless this past summer was an experience that was both incredibly fun and very instructive. Due to it being a field that I had truly little knowledge about, that allowed for great learning and direct experience. In addition to learning about computer science topics that I may or may not use depending on what I do as a career, it also gave me valuable skills such as Git and Linux that I already use in my classes and will be very present in whatever career choice I pursue. Furthermore, virtualization was very present in the office even if I was not working on it directly. While it led to questions about its importance and how it worked, it also gave me the curiosity to learn about it more.

Word Count: 1765

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