Nuclear Power Plant WAN Design

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1 Introduction

There is a theory which states that if ever anyone discovers exactly what the Universe is for and why it is here, it will instantly disappear and be replaced by something even more bizarre and inexplicable. There is another theory which states that this has already happened.

2 Networking between DAE and other Nuclear Power Plants

2.1 Requirement

The nuclear power plants across India and Department of Atomic Energy offices should be able to get access to specific sections of the power plant and data communication should happen in reliable and secure manner.

2.2 SD-WAN

Software defined Wide Area Networking is a method of management and operation of a WAN by decoupling the networking hardware from its control mechanism. This protocol is being chosen mainly because most of the data that needs to be communicated with DAE will be confidential and security is a critical consideration. The disadvantage of this architecture is that due to a lot of rules that needs to be verified for communication, the data transfer will be slower when compared to other WAN technologies. This will not be an issue with respect to our requirement as most of the data that needs to be shared with other DAE and Nuclear power plants is not immediate in nature. Please note that, immediate in this case is few micro seconds. The WAN will not be too slow (few to several minutes) as that will turn out to be a liability in case of emergencies. For example, lately Kudamkulam was infected with a malware and such information needs to be informed to DAE and other power plants. In this case, several minutes delay is not preferred. But SD-WAN at the most only causes a few milliseconds of delay which can be afforded.

2.2.1 Architecture

SD-WAN consists of several programmable switches and controllers connected to it. Controller dictates the packet forwarding rule and switches forward the packet according to that rule. In our SD-WAN, we have programmable switches:

- At the edge of network gateway acting as a firewall

- At edge of each department VLAN for individually being able to forward packets to DAE and nuclear power plants

- At the server that collects live data from the sensors protected by another firewall

All controllers and fibre optic switches are connected using fibre optic cables. All the above shown switches are programmable switches connected to some
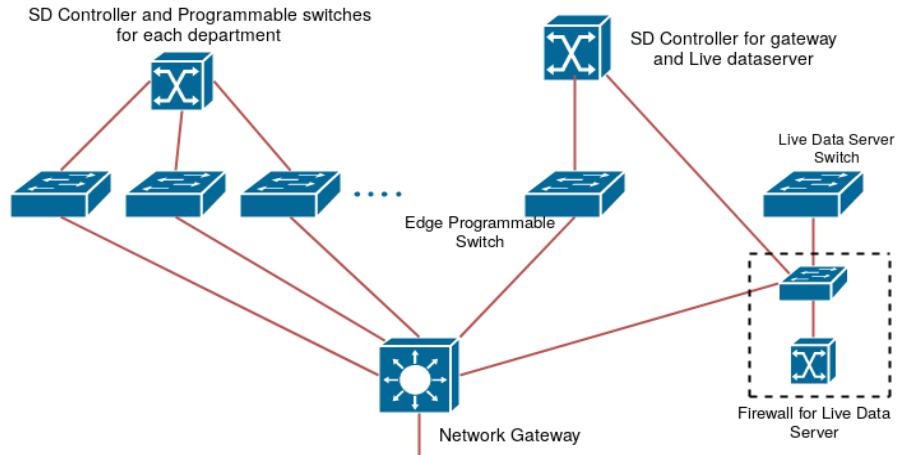
SD controller. The SD controller is where rules are configured and the switches do the forwarding. There is no requirement for another firewall in the network gateway as the SD WAN devices itself can be configured in such a manner that it does everything a firewall does. There is a separate firewall installed for live data as the number of rules will be very large and might overload the common controller. All rules related to live data filtering to send to DAE office can happen in this firewall.
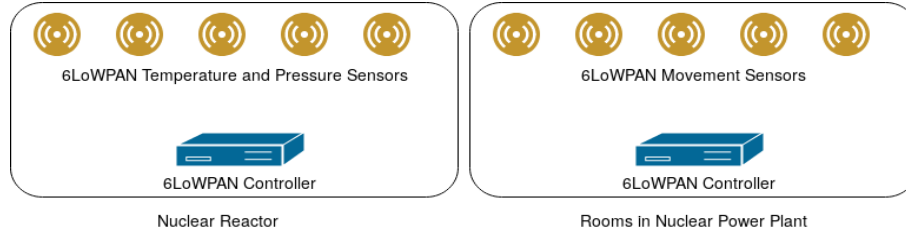
2.2.2 Protocol and Device Specifications

The rules for all SDN devices are configured using **Cisco Open SDN Controller**. **Terneray Content Addressable Memory (TCAM)** tables are used to route packet sequences. If flows arrive at a switch, a flow table lookup is performed. Depending on the flow table implementation this is done in a software flow table. In the case when no matching flow is found, a request to the controller for further instructions is sent. This is done using **Hybrid-mode**

which is a combination of two modes: Reactive and Proactive mode. In reactive mode the controller acts after these requests and creates and installs a rule in the flow table for the corresponding packet if necessary. In proactive mode the controller populates flow table entries for all possible traffic matches possible for this switch in advance. Hybrid mode, follows the flexibility of a reactive mode for a set of traffic and the low-latency forwarding (proactive mode) for the rest of the traffic. **Cisco's vEdge** routers can be used as switches for SD-WAN. Lanner Incorporated's **Hybrid TCA 5000** is another option for this.

3   Wireless Personal Area Network for live data

It is important to get live updates from inside the nuclear reactor for safety and monitoring and also to control the working of the reactor. Temperature sensors and pressure sensors are used to get live reading of temperature inside the reactor. Movement sensors can also be used to check movement inside the room to control its electricity supply. Since these sensors and its corresponding controllers need to be working all the time, it is important that they have to be power-saving. For this reason, we propose 6LoWPAN devices for IoT.

3.1   Protocol and Device Specifications

For the Wireless personal area networks we propose **6LoWPAN** technology. 6LoWPAN stands for IPv6 over Low Powered Wireless Personal Area Networks. 6LoWPAN is a networking technology or adaptation layer that allows IPv6 packets to be carried efficiently within small link layer frames, such as those defined by IEEE 802.15.4. 6LoWPAN is an open standard defined in RFC 6282 by the Internet Engineering Task Force (IETF), the standards body that defines many of the open standards used on the Internet such as UDP, TCP and HTTP to name a few. A powerful feature of 6LoWPAN is that while originally conceived to support IEEE 802.15.4 low-power wireless networks in the 2.4-GHz band, it is now being adapted and used over a variety of other networking media. **Texas Instruments** make 6LoWPAN temperature sensors, pressure sensors and movement sensors. Its **CC2538 Powerful Wireless Microcontroller** or **TIDA-01547** 6LoWPAN controller can be used for data collection and forwarding to specific systems.

4   Connecting International Bodies

There is a need for Prime Minister of India (through the Nuclear Power Plant) to make secure international connections to bodies like United Nations and POTUS (President of United States). This may be for various reasons primary of which includes sending data regarding how the nuclear fuel is being used. This is done usually because United Nations want to keep a check of whether nuclear fuel is being used to make illegal weapons. The data should be therefore confidential and data transfer should be highly reliable. Since regular WAN protocols like MPLS, SD-WAN and VSAT only connect within specific geographic location (usually a country), we need to do something else to establish this kind of connection. There are many service providers such as Verizon that provides secure and reliable data transfers internationally. Using this we can establish a secure connection between PMO and United Nations or Nuclear Power Plants and United nations.

5   Conclusion

"I always thought something was fundamentally wrong with the universe" [**?**]

References