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Design and Implementation of Wireless AMI Network for Smart Grid using OPNET Riverbed

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Abstract

The Smart grid is a vital part of the electric power system that is employed for the facility of knowledge technology to showing intelligence carry energy to the consumers by usingthe two-way communication. The smart grid, there are a unit variety of workable meters that area unit interconnected for the data flows in two- way manner. The smart Grid has the most goals for the active the participants of punters for the advance excellence and responsibility for energy consumption to lose energy feeding and assume cumulative responsibility as communication between energy meters and clients. Basically, The AMI (Advance Meter Infrastructure) is a network infrastructure with various kind of smart meters connected in distributed system. This AMI desires with without wired communication technology for relay data from the server as center to the smart meters. Here, OPNET (Optimized Network Engineering Tool) modeler is a simulation tools which is used for examination of the communication networks. Herewith in this paper, there are various kind of simulation network as copies of variousdesignedof SMsystem or networks are created with various network constraints used and they are connected with the different communication network as wireless and wired network for the find out the data are transported to the sever with traditional knowledge of data transmission and attempt to novelty out the perceive of DDoS attack to the AMI network and it has been distribute the approval to the adjacentperiod of the AMI network where seepage weird tasks handled by supply companies. The result of this paper is proposal for long lasting smart meter AMI network creator thus on avoid unpleasant encounters part by a number of the deliverycompanies.

Keyword: *DDoS Attack, Smart Grid, Advance Meter Infrastructure, OPNET Riverbed Simulation*

I.Introduction

The main power system, in which it distributes the one-way power or electricity distribution to the consumers fromthe utility center or central power plants, which areincompetent, untrustworthy, and obsolete.This kind of traditional system or legacy system is not basically accomplished of answering to the cumulative or increasing request ordemand for energy in the near future nor to satisfy the requests of today's modern life. Herewiththe smart grid system is the next-generation energy or power system which is offers or delivers power or electricity between service providers and customers or users and an advancedelectric system network that are depends using on two-way digital communications between service providers and costumers or users in an automaticmethod to progress the competence, consistency, finances, and sustainability of the production and

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distribution of electricity. It also controls intelligent appliances at consumers' home or building to save energy, reduce cost and increase reliability, efficiency reliability analysis, failure protection, and security and privacy protection services and transparency.A successful smart grid infrastructure requires integration of cyber system with the physical power system. The smart meters are devices as a digital meter which is delivers the latest features of remotely reading or collecting the samrt meter data or information. It is also sending, receiving and performing control command as remotely connect and disconnect. Herewith others smart meters are creating or formed a network of smart meters is called the Smart Metering Networks (SMNs). This kind of network is also known as Advance Meter Infrastructure and this is the portion of the Smart Grid. The SG is the responsible for managing and delivering SM data such as request data from SM, billing data, command data, and also Demand and Response data. Here, all these kinds of data or information will be sent to the servers or utility centre providers workplace as well as consumers or customers for examination and billing procedures. Advanced Metering Infrastructure (AMI) is well-thought-out to be the heart of Smart Grid. AMI has been the emphasis in recent times for vendors and utilities. [1,2,3,4]
Section II discussion about DDoS attack. Section III is the proposed model, IV is Overview of Smart Meter Network Using OPNET Riverbed Modeler simulation tool. Section V discussion about research works and result. Section VIshows the simulation results and analysis. Finally, section VIIrepresentsthe conclusion.

II.Impression of DDoSAttack

Ping Yiet al [4]present an attack called asDDoS attack, in which results in denial of service in AMI network. In this attack, the attacker first selects one or more normal nodes as victim node. Then the attacker sends out data packets, which contain specific attack information to these victim nodes. When the victim nodes receive these attack packets, they generate a high volume of route packets. There is limited communication bandwidth in mesh network and route packets are top priority in all packets. Excess route packets will exhaustlimited communication bandwidth and result in network congest. As a result, DDoS attack causes a denial of service attack in AMI network.Here, the diagram is shows for the DDoS attack in Advance Meter Infrastructure as shown in figure 1.

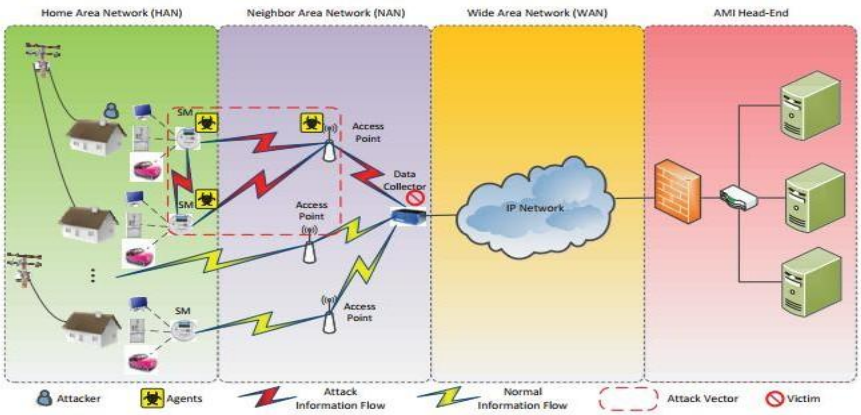

Figure 1: Conceptual DDoS attack in Advance Meter Infrastructure network[10]

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The attack as DDoS attack isessentiallyproceeding by an attackaffectionatefilling to accomplishmentsystemliabilities that will trace the suitability of systemfacilityandpolicies. The mountingtrustworthinessfor the SM Infrastructure which is based on Internet communication has to amended to the faintness of the SM network to the Internet-based various attacks as DDoS, replay, overhearing, false data injection, repudiation and node compromised.These kinds of attacks are very dangerous to the SG network or system which can be origin the difficulties such as power instability and huge economic losses.In this model, the main objective of the attackers is sewer the bandwidth and the processing power of the unprotected victims' nodes as SM which are connected to the AMI. In this AMI network, the feeble node or devices which is detection in the very first stage in commencement of DDoS attack. There are three types of attack have been possible in to the AMI network as attack on network bandwidth, attack on targeting network protocols, attack on network infrastructure.[4,5]

III.Proposedsystem for AMI in Smart Grid with attack

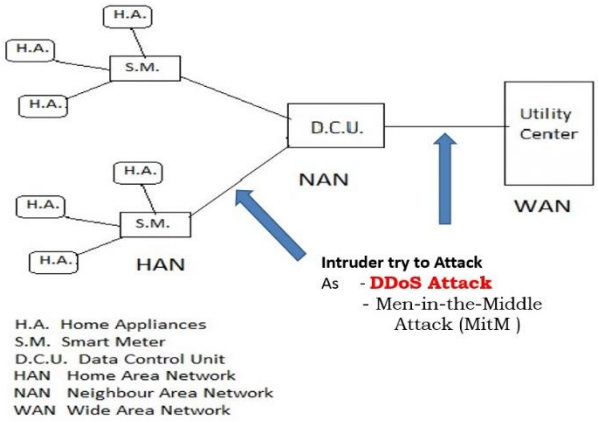

Figure 2: Propose Model in AMI network with attack

Here with, the proposed system for AMI network in which the SM are the important elements or devices for the customers and these devices is used for and responsible for the recording of power consumptions which user used by the Home appliances and also responsible or used for the monitoring for the same. The Home Area Network is offered the communication or connection between the different home appliances or devices or others Integrated devices or systems such as smart thermostat, plug-in electric vehicles, in-home display, rooftop photovoltaic system and smart meter also. For which these devices or system, communication elements are PLCs, and wireless communications such as Zigbee, Z-wave and others can be used. The Neighborhood Area Network, which is provides the communication or connections between the various separately or individual smart meters and concentrator or data collector Unit with use of WiMAX or cellular system or technologies. The various data collector unit are connected or communication to the central system as server or Utility center through the WAN. The WAN is basically interconnected with two or more networks are the core network and backhaul network. Here, the core networks are basically provided thatthe communication between the utility center orcontrol center as server or utility center and is used with cellular network or fiber optics cable with high data rates and low latency. While the backhaul, networks are

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basically used and handle for the broadband connections to Neighborhood Area Network and also it is use for monitoring to all the elements.

IV.Development of Smart Meter Network Using Riverbed OPNET Modeler

The OPNET Riverbed N/W simulator isthe simulation the comportment and the recital of somewhat kind of network. It is different from the other network simulator as it is lies on power and versatility. The IT guru, which is offers the in-built different models of protocols and elements. It also consents for the create or develop and simulation of various kind of network topologies. Here, in OPNET simulator, there are fixed of different kind of protocols and elements or devices so, there is not possible to create a new protocol or cannot change or edit the performance or behavior the performance of the already avail in it.[2,7,8]

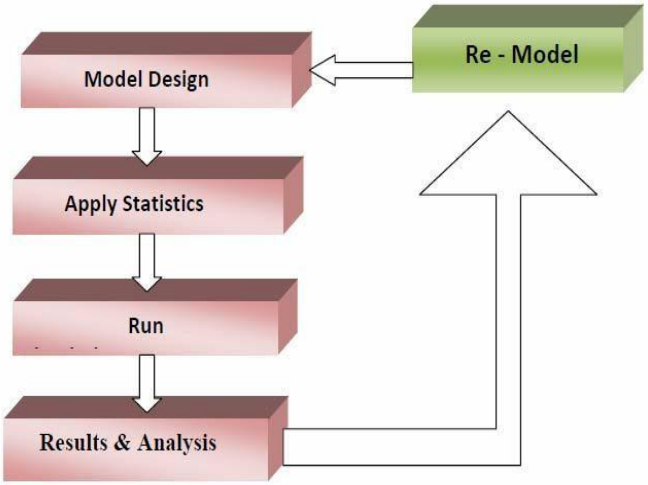

Figure 3.OPNET with workflow[7]

V.SimulationSetupusingwith OPNET

Herewith, there are various test cases with various scenarios are considered and examination of wireless smart meter connection through cloud environment with various networks devices as Switches, Routers, Nodes, Servers.

In this AMI network, there are number of AMI environment having wireless connection system with various scenarios.

Scenario-1shows here as simple Advance Meter Infrastructure environment with use of numbers of smart meter devices which are connected with network devices as wireless connections and among them network elements are connected as wired with servers with 100BaseT connection through cloud environment. In this AMI environment, smart devices are connected as wireless communication with network elements as switch and these AMI environments are connected with network devices as router and it is connected directly to the servers through the cloud environment.

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Scenario-2, in this scenario, thee different AMI environment are communicated to the servers as utility servers through network connecting device as router through the cloud environment and herewith, a malicious node is tried to attack on server as utility center and cloud environment. In which, this is the DDoS attack who congestion the whole AMI network with the send lots of request to the server as utility center show from figure 4.

Scenario-3, in this scenario, from the congestion of network means Attack as DDoS on to the AMI network we have to use the firewall for defending the AMI network, shows infigure-5.

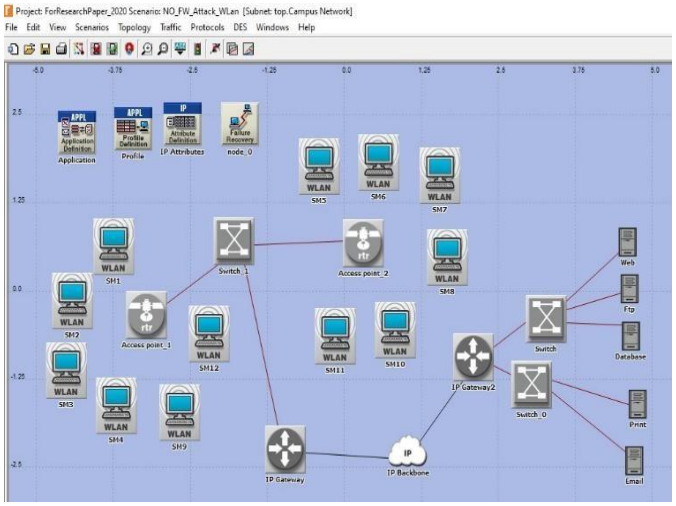

Figure 4. Wireless Advance Meter Infrastructure Network

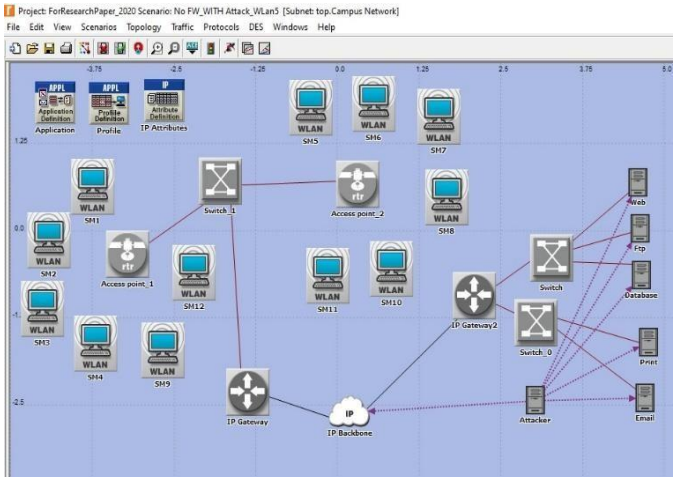

Figure5.DDoSAttack on Advance MeterInfrastructure network

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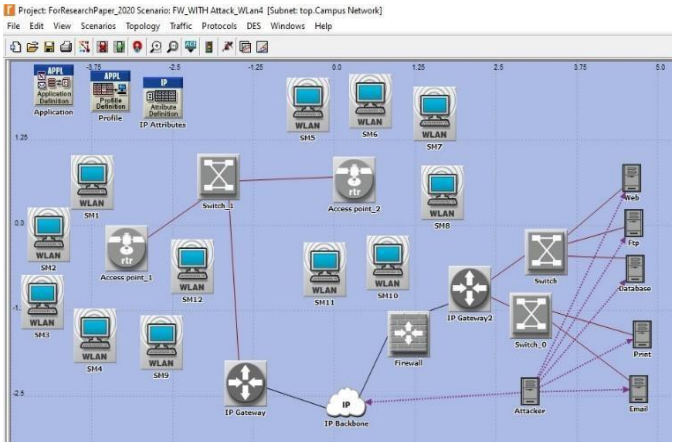

Figure6. Firewall on Advance Meter Infrastructure Network

VI.AMINetworkResultsusing withOPNET simulator

From the simulation of the AMI environment on to the Opnet Riverbed Simulation as HTTP, Database, and FTP request to the server as utility center from any smart meter.Here with, find the results of the requests to servers with normal and attack as DDoS attack. Below figures show as how much requesting are transmitted to the utility center with time duration within 5 minutes in DDoS attack AMI network and 5hrs for keep firewall in AMI network.

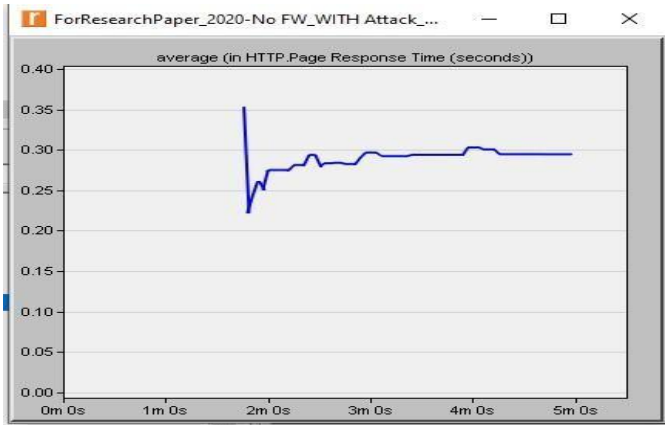

Figure7. without Firewall, FTP request to the server

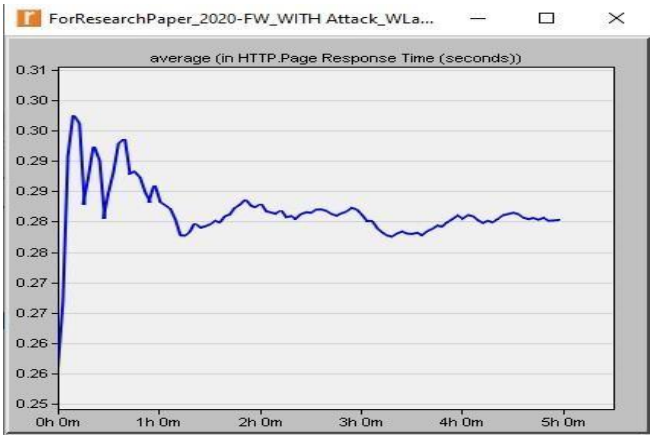

Figure8.With Firewall, FTP request to the serve

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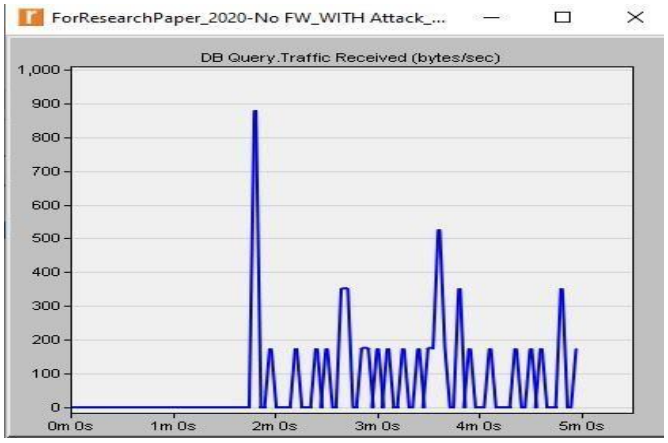

Figure9. Without Firewall, DB request to the server

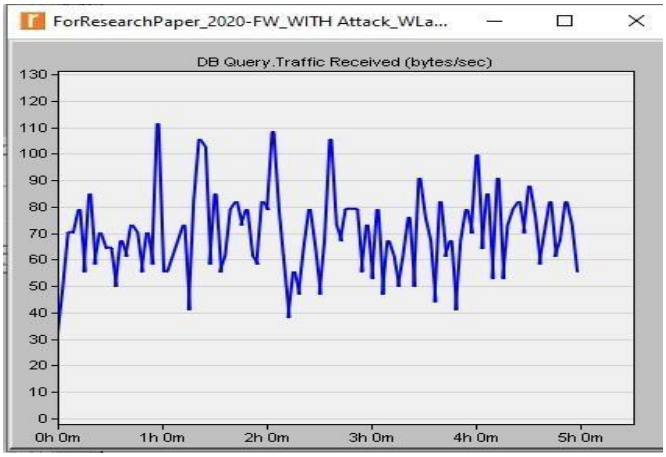

Figure10. With Firewall, DB request to the server

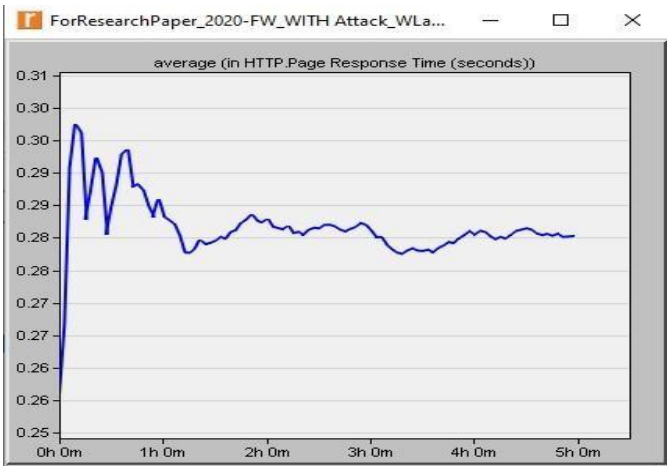

Figure11. Without Firewall, HTTP request to the server

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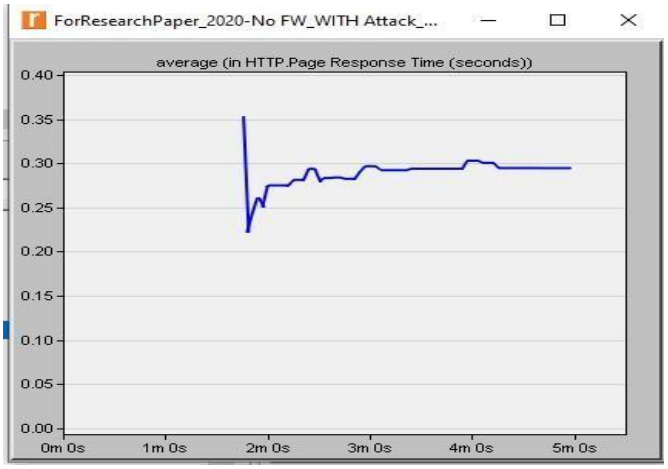

Figure12. With Firewall, HTTP request to the server

VII. ResultAnalysis

Table 1. Summary of simulation Average result with and without Firewall.

	DB query request time inserver		HTTP request received in server		FTP request response in server	
Different structured smart meter net-work	Without Firewall (bytes/ sec) in 5 minutes	With Firewall (bytes / sec)in 5hours	Without Firewall (bytes / sec) in 5 minutes	With Firewall (bytes/ sec) in 5 hours	Without Firewall (request / sec)in 5minutes	With Firewall (request / sec) in 5 hours
The SM network, ShowninFigure number as **4,5, 6**consistsofwireless Network inwhicheach networkit containsthesmartmetersandan access point,routers,a server,afirewal land a cloudserver.	66.45997	46.75761	0.3038	0.2815	2286.186	1166.223

VIII. FutureWork

From the various scenarios, here with, measured and examiningthe wireless SM with AMI N/W with the use ofdifferent routing protocol as MQTT,EIGRP, IGRP, RIP, OSPF, FTP etc. with the use of these protocols and various different network elements as access point, routers, servers over cloud environment. With the use of Opnet Riverbed simulation tool finding the different parameters results as FTP, Database, HTTP etc. requesting to the utility center as various servers from various smart meters devices.

IX.Conclusion

With use of Opnet Riverbed modeler simulator to develop a wireless smart meter network models for AMI. The OPNET simulate the various cases and figure out the recital oft h e wireless smart meter AMI network accurately. Here, test cases of AMI network with intruder try to attack on network and also test cases with Firewall and without Firewall SM infrastructure in the AMI network.From the results of the Riverbed OPNET simulations, safety is the main requirements in Advance Meter Infrastructure in Smart Grid when the vital information is transfer fromseveralSM devices to the Server as utility center as central server. Herewith, in this research paper, the test case on OPNET simulation, have develop a wireless smart meter AMI network model andan analyze for how providingsecurity.

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