A High Throughput Offering Iot System For Agriculture Applications

B. Balaji Bhanu, Mohammed Ali Husain, Mahmood Ali Mirza

Abstract: In this paper, we have proposed a high throughput offering IoT system for agriculture applications. The proposed system performance is analyzed using network simulator tool by different network protocols and proposed an best performance offering IoT topology. Finally the best performance offering topology is physically realized using controllers, sensors and actuators. We have extended our analysis theoretically, simulation wise and finally practical realization. Overall the proposed topology is offering high throughput. The IoT system is capable to collect six physical parameters like humidity, temperature, solar radiation, wind direction, wind speed, and pressure. Finally an application is designed to display the physical parameters.

Keywords: IoT, wireless sensor networks, agriculture, sensors.

NOMENCLATURE

AIoT- Agriculture Internet of Things
SBC-Single Board Computer
WSN- Wireless Sensor Network
RF- Radio Frequency

1 INTRODUCTION

As Internet of Things (IoT)applications are emerging, in the next decade the world economy is greatly influenced by these advanced applications. Prior to the IoT technology, wireless data collection is done using RF ID, WSN, smart objects. From the last decade IoT technology showing a great potential in the area of physical data collection and monitor with high security. With its flexibility and sturdy nature IoT technology is recommended by researchers in health, manufacturing, security, agriculture applications. In the area of Crops and production internet of things is termed as agriculture internet of things (AIoT). In IoT system design communication technology plays an important role. The communication technology may be wired or wireless, the wired communication technologies like RS485,HART, ProfiBus are generally used in IoT for transducer interface. The wireless communication technologies like Wi-Fi, Zigbee, 6LoWPAN are used in IoT for data uploading into the cloud (bigdata). From any communication technology the novel and sturdy IoT system design expecting high transmission rate, high coverage, low latency, large number of connections, high reliability, high security. Markov discrete time M/M/1 queuing modeling is preferable modeling the parameter like energy consumption, delay, throughput, path loss, wireless link channel, non-isotropic transmission.

- *B. Balaji Bhanu, Mohammed Ali Husain, Mahmood Ali Mirza*
- *1Research Scholar, Department of Computer Science and Engineering, SCSVMV University, Kanchipuram, Tamilnadu, India.*
- *2Professor, Department of ECM, KL to be University, Vaddeswaram, Guntur Dist., AP, India.*
- *3Department of Computer Science Krishna University, Machilipatnam, AP, India.*
- *balajibattu@gmail.com, dralihussain@kluniversity.in, alimirza.md@gmail.com*

The paper is organized as follows: in section II, we investigate the modeling of IoT systems in terms of power consumption, delay, throughput, path loss. Section III analysis of different AIoT topologies for high throughput. Section IV describes the design methodology of high secure industrial IoT system with novel and sturdy nature. Design and analytical work is presented and discussed in section V and followed by conclusions in section VI.

2 PERFORMANCE INDICES

The major performance indices of IoT system are power consumption, delay, throughput, path loss.

A. Power consumption:

The total power consumption of any IoT system depends on transducers, controllers, and communication modules. The length of the packet also plays a major role in the overall power consumption. In any communication amplifiers are important for efficiency; these are the major power consumption modules.

$$P_{total}(n) = \frac{PACKET_{len}}{R}((n-1)P_{RX} + nP_{TX} + P_{idle} + 2P_{cir} + P_{amp} + P_{sleep}) + 2P_{startup} \quad (1)$$

Where P_{RX} is the receiver power, P_{TX} is the transmitter power, P_{cir}, P_{idle} is the idle power, $P_{startup}$ is the power for the startup RF, P_{amp} amplifier power in communication module.

$$Energy_{e2e} = \frac{1}{P_{st}}\left[\sum_{t=1}^{n} E(\pi_m(\tau))\right] \quad (2)$$

B. Delay:

The efficiency of any IoT system is decided with the delay performance indices.

$$D_t = D_{cont} + D_{Prc} + D_{swit} + D_{prop} + D_{trans} + D_{queue} + D_{rec} \quad (3)$$

Where, contention, propagation, switching, processing, transmission, queuing delays. Software defined networks are preferable in IoT to minimize access delay.

C. Throughput:

Throughput is nothing but, the amount of data passing through a system or process. The Throughput can be expressed as,

$$T_{MHC} = N(1-\pi_m(\tau))\, p_s \frac{S}{T} \quad (4)$$

Where, N is the number of nodes in the network, S is the packet size, T is the length of the cycle, P_s is the window size, $\pi_m(\tau)$ is the probability of successful DATA packet transmission.

D. Path loss:

In wireless sensor networks the topology performance mainly depends on path loss, the path loss can be expressed as,

$$PL_l = PL(d_0) + 20\xi \log_{10}(d_l) \quad for \quad d_l < 8meter, \quad l = 1,2,....., n. \quad (5)$$

$$PL_l = PL(d_0) + 33\xi \log_{10}(\frac{d_l}{8}) \quad for \quad d_l > 8meter, \quad l = 1,2,....., n. \quad (6)$$

Where, $PL(d_0)$ is the path loss at a distance of d_0, ξ is the path exponent, d_l is the distance of the length l.

3 NETWORK TOPOLOGY ANALYSIS

Before physical realization of the proposed IoT system the performance of the system is analyzed using network simulator (ns3). We have analyzed the performance by different IoT topologies. The performance of the system is analyzed in terms of power consumption, throughput, delay, packet loss and the lifetime. This analysis will helps the IoT system designer for better practical system design. The basic IoT topology consist a sensor node (Wi-Fi station), internet provider (Wi-Fi access point) and Internet enable server (sink). Here, the IoT system is for agriculture applications overall six sensors(humidity, temperature, solar radiation, wind direction, wind speed, and pressure) are connected to Wi-Fi enable sensor node.

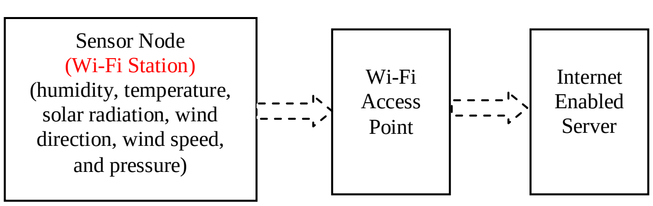


***Figure 1**. Basic model of IoT topology.*

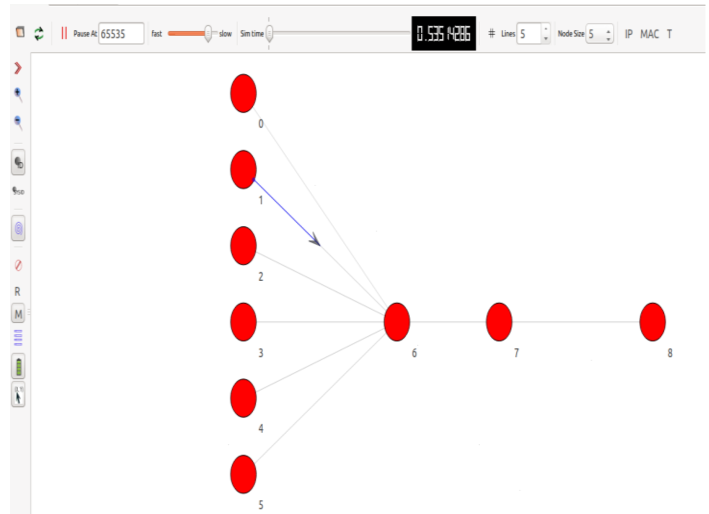


***Figure 2**: Design of IoT topology in network simulator.*

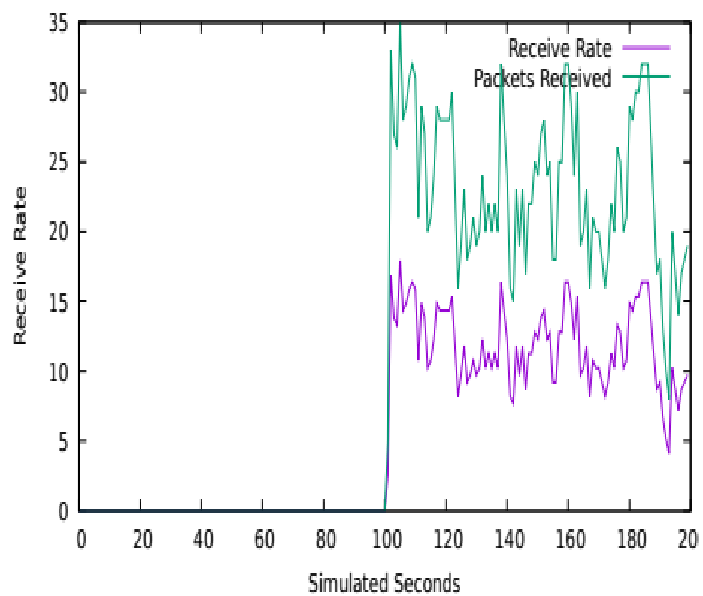


***Figure 3**: Packets received and receive rate.*

***Table 1**: Topology network simulation results.*

Parameter	*Value*
Average Throughput	*950 kbps*
Delay	*20 ms*
Energy Consumption	*46%*
Path Loss	*96%*

4 Design and Analysis

The design of real agriculture internet of things (AIoT) system is done in three layers i.e., initially in the perception layer the sensor nodes are designed and the sensors are interfaced with single board computer i.e., raspberry pi-3 with built-in Wi-Fi module. The programming is done using python language. In the network layer the sensor nodes are connected to the access point and internet gateway is provided. In the application layer the database is designed using MySQL and the application is designed using HTML/PHP.

Table 2: *List of physical parametric sensing devices (sensors)*

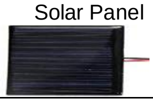
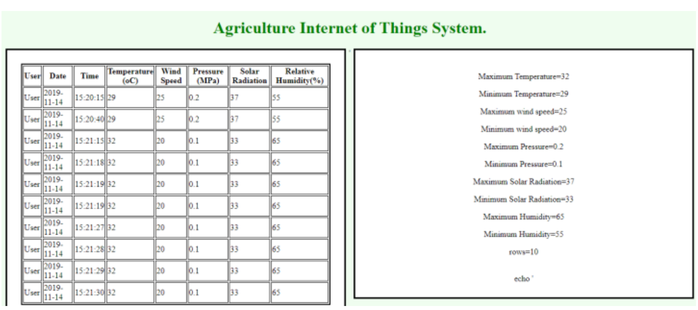
Physical parameter (Units)	Sensor (analog/digital)	Analog/Digital, (working principle)	Parametric range
Wind speed (Anemometer)	A3144 	Analog (Hall Effect Sensor)	0 to 100 m/s (0 to 224 mph)
Temperature	LM 35 	Analog (IC Based)	-10 to 80 ^{o}C
Wind direction	Potentiometer (Continuous)	Analog (Resistive)	1.8 m/s (4 mph) with 5° displacement
Relative Humidity	DHT-11 	Digital (Capacitive)	20-90% RH
Solar Radiation	Robu 6V 80mA Mini Solar Panel 	Analog	--
Pressure (Barometer)	BMP 180 	Digital (piezo resistive)	300 to 1100 hPa

Figure 4*: User login page in IoT application.*



Agriculture Internet of Things System.

User	Date	Time	Temperature (oC)	Wind Speed	Pressure (MPa)	Solar Radiation	Relative Humidity(%)
User	2019-11-14	15:20:15	29	25	0.2	37	55
User	2019-11-14	15:20:40	29	25	0.2	37	55
User	2019-11-14	15:21:15	32	20	0.1	33	65
User	2019-11-14	15:21:18	32	20	0.1	33	65
User	2019-11-14	15:21:19	32	20	0.1	33	65
User	2019-11-14	15:21:19	32	20	0.1	33	65
User	2019-11-14	15:21:27	32	20	0.1	33	65
User	2019-11-14	15:21:28	32	20	0.1	33	65
User	2019-11-14	15:21:29	32	20	0.1	33	65
User	2019-11-14	15:21:30	32	20	0.1	33	65

Maximum Temperature=32
Minimum Temperature=29
Maximum wind speed=25
Minimum wind speed=20
Maximum Pressure=0.2
Minimum Pressure=0.1
Maximum Solar Radiation=37
Minimum Solar Radiation=33
Maximum Humidity=65
Minimum Humidity=55
rows=10
echo '

Figure 4*: Sensor data page in IoT application.*

Table 3*: Competition of present IoT system with literature*

Parameter	*Ref. [3]*	*Ref. [4]*	*Ref. [13]*	*Present System*
Domain	*Water Quality Monitoring System*	*Air Quality monitoring System*	*Three Wireless Sensor For Environment Monitoring*	*Agriculture*
Transducers	*PH, Water level , temperature, Carbon dioxide, Turbidity.*	*PMS5005, Temperature, Humidity*	*BLE Sensors*	*humidity, temperature, solar radiation, wind direction, wind speed, and pressure*
Controller /Processors	*FPGA*	*ARM*	*PSoC3*	*Raspberry Pi (AVR)*
Communication Module	*Zigbee*	*LPWA Transmitter Module*	*Local area unit (LAN) [RN131C/G]*	*Wi-Fi*
Internet Protocol	---	*TCP/IP Protocol*	*UDP,HTTP*	*TCP, HTTP Protocol*
Cloud Computing	---	---	---	*IaaS*
Cloud Security	---	---	---	*User credential*

5 CONCLUSION

This study focuses on design of a high level of quality of service and performance offering agriculture internet of system (AIoT). The communication system performance depends on the parameters like power consumption, path loss, delay throughput. The proposed AIoT topology is offering a throughput of 950kbps, delay of 20ms, energy consumption of 46% and path loss of 96%. After topology analysis in network simulator the IoT system is physically realized in Infrastructure as a service level. The system has its own dedicated server and applications are designed.

6 REFERENCES

[1] Cristiano André da Costaa, Cristian F. Pasluostab, Björn Eskofierb, Denise Bandeira da Silvaa,Rodrigo da Rosa Righia," Internet of Health Things: Toward intelligent vital signs monitoring inhospital wards", Artificial Intelligence In Medicine, https://doi.org/10.1016/j. artmed. 2018.05.005, 2018.

[2] Olakunle Elijah, Tharek Abdul Rahman, Igbafe Orikumhi, Chee Yen Leow Member, MHD Nour Hindia, " An Overview of Internet of Things (IoT) and Data Analytics in Agriculture: Benefits and

Challenges", IEEE Internet Of Things Journal, DOI 10.1109/JIOT.2018.2844296, 2018.

[3] Hugh Boyes, Bil Hallaq, Joe Cunningham, Tim Watson," The industrial internet of things (IIoT): An analysis framework", Computers in Industry, https://doi.org/10.1016/j.compind. 2018.04.015, 101, Page No.:1–12, 2018.

[4] Huan Wang, Zhanfang Chen, Jianping Zhao, Xiaoqiang Di1, and Dan Liu," A Vulnerability Assessment Method in Industrial Internet of Things Based on Attack Graph and Maximum Flow", DOI 1

[5] 0.1109/ACCESS.2018.2805690, IEEE Access, 2018.

[6] Qiao Yan, Wenyao Huang, Xupeng Luo, Qingxiang Gong, and F. Richard Yu," A Multi-Level DDoS Mitigation Framework for the Industrial Internet of Things", Advanced Industrial Wireless Sensor Networks And Intelligent Iot, Digital Object Identifier: 10.1109/MCOM .2018. 1700621,2018.

[7] Long Zhao And Xiangjun Dong," An Industrial Internet of Things Feature Selection Method Based on Potential Entropy Evaluation Criteria", IEEE Access, Digital Object Identifier 10.1109/ ACCESS .2018.2800287, 2018.

[8] Chunsheng Zhu, Joel J. P. C. Rodrigues, Victor C. M. Leung, Lei Shu, and Laurence T. Yang," Trust-Based Communication for the Industrial Internet of Things", Advanced Industrial Wireless Sensor Networks And Intelligent Iot, Digital Object Identifier: 10.1109/ MCOM .2018 .1700592,2018.

[9] Arbia Riahi Sfar, Enrico Natalizio, Yacine Challal, Zied Chtourou," A Roadmap for Security Challenges in Internet of Things", Digital Communications and Networks, http://dx.doi.org/10.1016 /j.dcan. 2017.04.003, 2017.

[10] Maxim Chernyshev, Sherali Zeadally, Zubair Baig, Andrew Woodward, "Internet of Things Forensics", IEEE Computer Society, May/June 2018.

[11] Richard Cartwright," An Internet of Things Architecture for Cloud-Fit Professional Media Workflow", SMPTE Motion Imaging Journal, Digital Object Identifier 10.5594/JMI. 2018.2816879, June 2018.

[12] Basim Hafidh, Hussein Al Osman, Juan Arteaga-Falconi, Haiwei Dong, and Abdulmotaleb EL Saddik, " SITE: The Simple Internet of Things Enabler For Smart Homes", IEEE Access, 10.1109/ACCESS.2017. 2653079, January 2017 .

[13] Fadi Al-Turjman, and Sinem Alturjman," Context-sensitive Access in Industrial Internet of Things (IIoT) Healthcare Applications", IEEE Transactions on Industrial Informatics, DOI 10.1109/TII.2018.2808190, 2018. Mahmoud Ammar, Giovanni Russello, Bruno Crispo," Internet of Things: A survey on the security of IoT frameworks", Journal of Information Security and Applications 38, 8–27, 2018.

[14] Tanvi Banerjee and Amit Sheth, " IoT Quality Control for Data and Application Needs", IEEE Intelligent Systems, 10.1109/MIS.2017.35, 2017.

[15] Mandrita Banerjee, Junghee Lee, Kim-Kwang Raymond Choo," A blockchain future to Internet of Things security: A position paper", Digital Communications and Networks, 10.1016/ j.dcan.2017.10.006, October 2017.

[16] Guneet Bedi, Ganesh Kumar Venayagamoorthy, Rajendra Singh, Fellow, Richard Brooks, and Kuang-Ching Wang, " Review of Internet of Things (IoT) in Electric Power and Energy Systems", IEEE internet of things journal, DOI:10.1109/JIOT.2018. 2802704,2018.