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Syed Hassan Ahmed, Shalli Rani

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A Hybrid Approach,Smart Street Use Case and Future Aspects for Internet of Things in Smart Cities

Syed Hassan Ahmed[1], Shalli Rani[2,*]
[1]School of Computer & Engineering, Kyungpook National University, Daegu, Republic of Korea.
[2] Department of Computer Science, S.S.D. Women's Institute of Technology, Bathinda (Punjab), India.
Emails: [1]s.h.ahmed@ieee.org, [2]shalli@ssdwit.org

***Abstract*—Internet of Things (IoT) has led to the development of smart projects by connecting heterogeneous devices and has accelerated the global growth by providing digital services to the users. The Smart City Project is very complex concept and has many hurdles in its way and many of the hurdles (Digitization services) can easily be solved by IoT. Urban IoT, is designed to support the future vision of smart cities which supported the new hybrid technologies and provide the value added services to the citizens. In this Urban IoT framework the first layer is Data Layer. In Data layer, sensor platform uses the optimized AODV-SPEED protocol (Hybrid Approach), proposed in this paper. Hybrid approach has shown improvement over delay, energy, miss ratio of the packet transmission and packet delivery rate over traditional SPEED protocol which is suitable for IoT applications. This article also identifies the framework, challenges and trends of Smart city IoT and use case for the smart street highlights the importance of proposed structure. Furthermore, Smart City projects are discussed to recognize the importance of IoT in smart cities and its future.**

***Index Terms*—Framework of Internet of Things; Smart City; Virtual World; Smart Objects; Hybrid Approach; AoDV-SPEED**

I. Introduction

The internet of things (IoT) is the network of connected physical devices, objects and sensors to offer many services to the people. These objects are connected through information and communication building blocks. Today IoT has become the most discussed part of every business due to its benefits and this term was first used in 1998 [1]. It is expected that around 3/4th people will live in smart cities and smart surroundings till 2050 [2] and IoT can play a great role in the implementation of the smart city concept. For welfare of people in terms of economics, social and environment, smart city can provide a good platform. Wireless sensor network is the sensing part of IoT which can be combined with urban infrastructure by forming the special skin cover for IoT building blocks. IoT has boosted the development of many applications which makes the use of large amounts of data generated by heterogeneous devices to provide emerging services to the people, various private and public organizations. The applications include the areas of smart home, smart environment, smart energy management and smart grids, smart agriculture and smart traffic management, etc. Heterogeneity of the devices has acknowledged the potential solutions for all application conditions alarming challenges. These challenges lead to the propagation of various and sometimes unsuited proposals for the practical implementation of IoT. IoT intends to make the internet more submerged and persistent. With the interaction of heterogeneous devices like surveillance cameras, actuators, transport vehicles, domestic devices etc., the IoT will promote the various applications. From these applications the smart city concept is the most interesting idea. Smart City uses the concept of information and communication technologies (ICT) to make the city services more responsive, aware and efficient. To increase the effectiveness of city administration, it is important to understand the need of urbanization. Today only a few organizations have live monitoring of the urban processes. The scheme trail behind is a collection, filtering, analyzing and offline processing of data with action, and these processes are repeated again for the whole system. Collection of data is very costly and is very hard to repeat it. Increased demand over municipalities to integrate smart techniques for collection and action over real time data has lead to the use of IoT which is platform independent and can help in the management of real time data. With advancements in computations and sensing methods, data can be extracted and evaluated for the useful decision making. This will aid people in decision making policies and in turn conversion of conventional cities to smart cities. There is not yet widely accepted and recognized definition of Smart City but the objective is to make best use of public resources to increase the quality of services (QoS) for the public and to cut the cost for government organizations. This aim can be fulfilled by smart urban IoT due its simple, unique and cheap access to public services in excess and to provide the transparency to the public. It may transport many advantages, in the traditional public services like waste management, monitoring of buildings, transportation, lightning, parking, etc. It will enhance the participation of people in public administration and they will be more aware about the status of the city. It is the great hope of the smart city life, but existing services and applications required to be optimized. Researchers are proposing different types of architectures to achieve the dream of smart city and one of them is cognitive framework [3]. This framework plans to hide the heterogeneity of things, to ensure resilience, to assess proximity and to use the cognitive technologies.

*Corresponding author, shalli@ssdwit.org.

Wireless sensor network is the baseline of IoT. However, it is constrained by many parameters and largest constraint among them is energy. For the real time applications of Smart City, it is mandatory to conserve energy. We have made efforts to design a methodology to conserve energy for Smart City applications.

A. *Motivation behind the use of IoT for Smart Cities*

In todays world, cities face a number of challenges like financial growth, social security, jobs control and creation, environmental monitoring etc. [4]. For these challenges internet has become the crucial part of future planning. Due to the benefits of IoT and challenges faced by cities, Digital Urbanism is quickly gaining attraction and interest of architects, transportation organizations and public services. IoT is the basic architecture to implement the smart urban projects and it is flexible enough to accommodate the dynamic requirements of the people. Leading technology, software defined network (SDN) and network function virtualization (NFV) can accelerate the optimization of IoT architectures, consequently authors recommend the IoT architecture for smart city projects based on both terms. Encouraged by benefits via coupling of SDN and NFV, we propose an intelligent software simulated IoT (ISS-IoT). Exploiting the benefits of software modules and intelligent communication, it decouples the software techniques (virtualization) from hardware devices. ISS-IoT, expands the ISS approach from sensor network platforms to smart applications by enabling intelligent communication for transmission, processing and pronouncement of data. Fig.1, depicts the usage of the proposed architecture, consisted of cloud servers, control gateways, processing, transmitting and retrieving units with smart city interaction through virtualization. On the uppermost layer, several smart city applications are installed and each application requirement is different and customized. Use of application program interfaces (APIs) [5] can simplify the servicing of applications and use of same physical architecture can trim down the overall cost (implementation, maintenance, operation and processing cost). The intelligent communication (cognitive) will provide the optimal solution to the end user and will reduce the end to end delay. Control gateways authorize the clients to make it secure. These features make ISS-IoT potential architecture and novel vision to serve the various applications requirements and consequently facilitate smart city sensing.

Contributions of the proposed work is outlined as below:

1) A software architecture is proposed for Smart City.
2) Optimized SPEED protocol performs on the sensor layer of the architecture for required quality of service metrics of Internet of Things.SPEED is a real instance QoS routing protocol which is responsible for transmitting a data packet to the destination within a certain time interval, if the packet cannot be reached within that time slot, the packet is dropped back decreasing the performance of this protocol. Node failure or congestion leads to, large amounts of dropping of the data packets, which may lead to devastating consequences. Therefore it cannot be used for Smart City applications and optimization is mandatory, proposed here.
3) Various challenges of Smart City and Solutions are elaborated.
4) Smart Street use case is discussed with the flow chart to present the importance of proposed architecture. Thereafter, work on the popular Smart City projects is discussed to highlight the future scope.

In the rest of the paper, we present the recent applications with troubles and drifts. There after-wards, proposed architecture has been outlined with open problems and solutions. A use case of Smart Street has been given to validate the use of ISS-IoT architecture in a Smart City project. Future projects on smart city are also discussed and elaborated in last section.

II. Dilemma and Drifts for Smart Cities

Fig.2, demonstrates the familiar applications (Pollution, Traffic, Temperature and Industrial Process Control sensing/monitoring). Different types of sensor nodes (SNs) are required for all these applications and can be handled by different expert nodes (EN) [7-10]. The sensed data is collected and stored by the expert nodes and transmitted to the gateways for further action. Expert nodes take decisions on the basis of intelligence computation of data. Normally, SN transmits data to the gateway via wireless sensor network (WSN) which is further transmitted to the servers. All the data is filtered, processed and compressed at the gateway only [11]. Moreover authors have proposed the ideas for the smart home and people centric interaction in smart cities [12-13].Refined data is processed at the server. To reduce the volume of data at the gateway, a customized approach is used to validate the traditional working of WSN [14]. Researchers need to develop the customized platform, according to the requirements of the applications. Software modules can play a great role in implementing virtual functions for each specific service (SDN and NFV) and will be useful in customization in less cost and need of new firmware for each application, can be lessened by the use of software modules. Many projects have already been working to convert the internet of people to the internet of things like EBBITS, CONVERGENCE, CASAGRAS, OneFit etc. and their objective is to convert each device into web service to provide all the features of internet at low cost by using ontology. Still, some requirements like where to store, how to secure and reduce end to end delay, etc. pose other challenges in front of IoT. Proposed Architecture (ISS-IoT) and novel optimization scheme in this article, for WSN-IoT to gather and transmit the Smart city data efficiently, kept in view these challenges.

A. *Dilemma*

From ongoing projects, it is clear that cities are in the development stage and require digitization. To handle the problems of states, government has introduced Smart City Challenge to optimize the traditional architectures. The application oriented architecture discussed above has many challenges to face.

1) Economics: According to the reports (High Power Expert Committee), smart city projects are costly and for more than a million people in each smart city, the investment is very high. To compensate this cost a bond

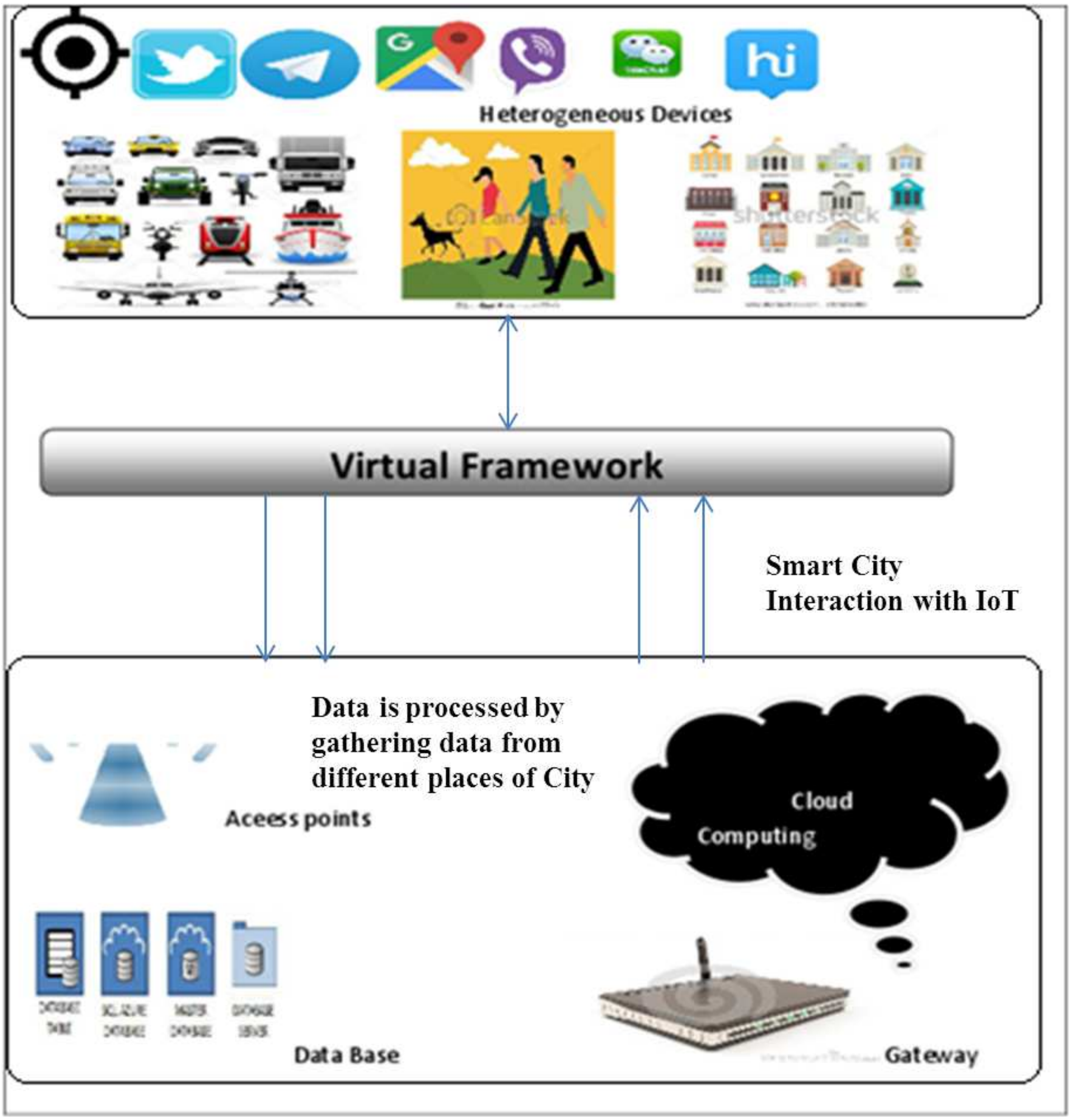

Fig. 1: Interaction of Heterogeneous Devices in ISS-IoT

between the private and public organizations is required. To develop different platforms for different applications incurred huge amount. Many Urban Local Bodies (ULBs) are not financially strong and cost recovery will be difficult even in installments and it can lead to great financial loss. The common platform (Sensor network) can be proved as an optimal solution and can be shared among different applications to reduce this cost.

2) Communication Paradigm: Communication of the elements and objects should be continuous, random or incremental is a major concern of IoT infrastructure. The design of communication can be hierarchical or single hop. The connectivity of the network may be continuous or for the time being, depends upon the applications. Hierarchical structure with scalability approach and software modules to decide the data should be transmitted continuous, random or incremental can be a resolution of this confront.

3) Sustainable Network: Communication network should be sustainable as IoT brings together the physical objects located at huge distances. Compatibility of the heterogeneous devices is also an issue. By using a platform independent communication, expert system and control gateway with a new addressing scheme based on network data naming (NDN) can be constructive.

4) Information and Communication Technology (ICT): ICT has affected the development of applications and has introduced many concepts viz. Cloud computing, data mining, new architectures and services for various applications of IoT. But which technology and standard should be used for which application is still a question mark. IETF and IEEE societies are already working on this issue. A novel communication protocol with unified modeling, which could be incorporated into any

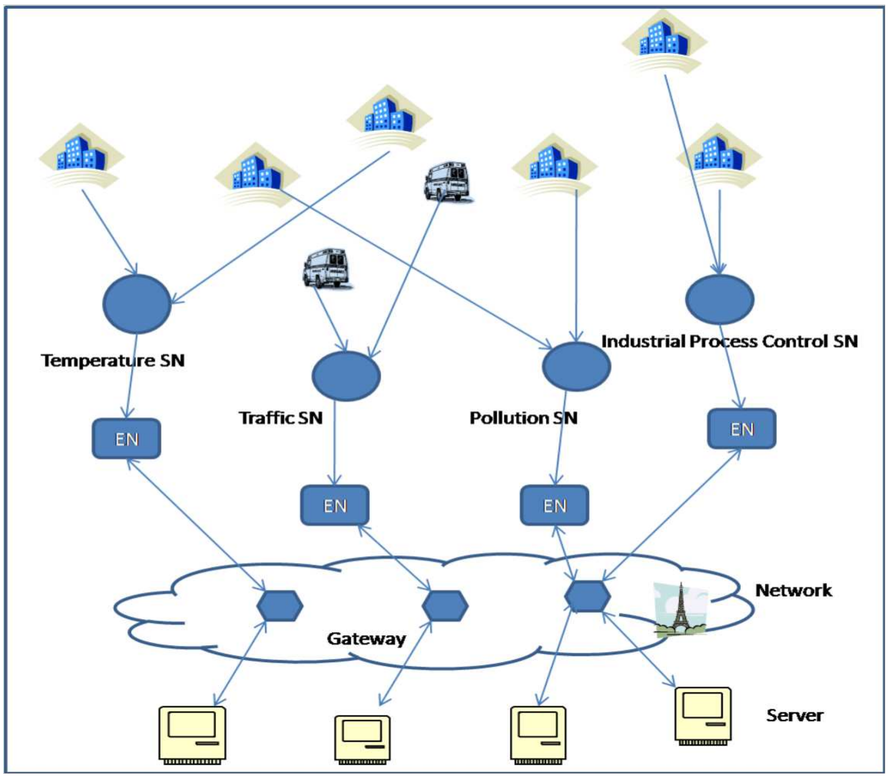

Fig. 2: Smart City Applications Interaction with Expert Nodes and Gateways

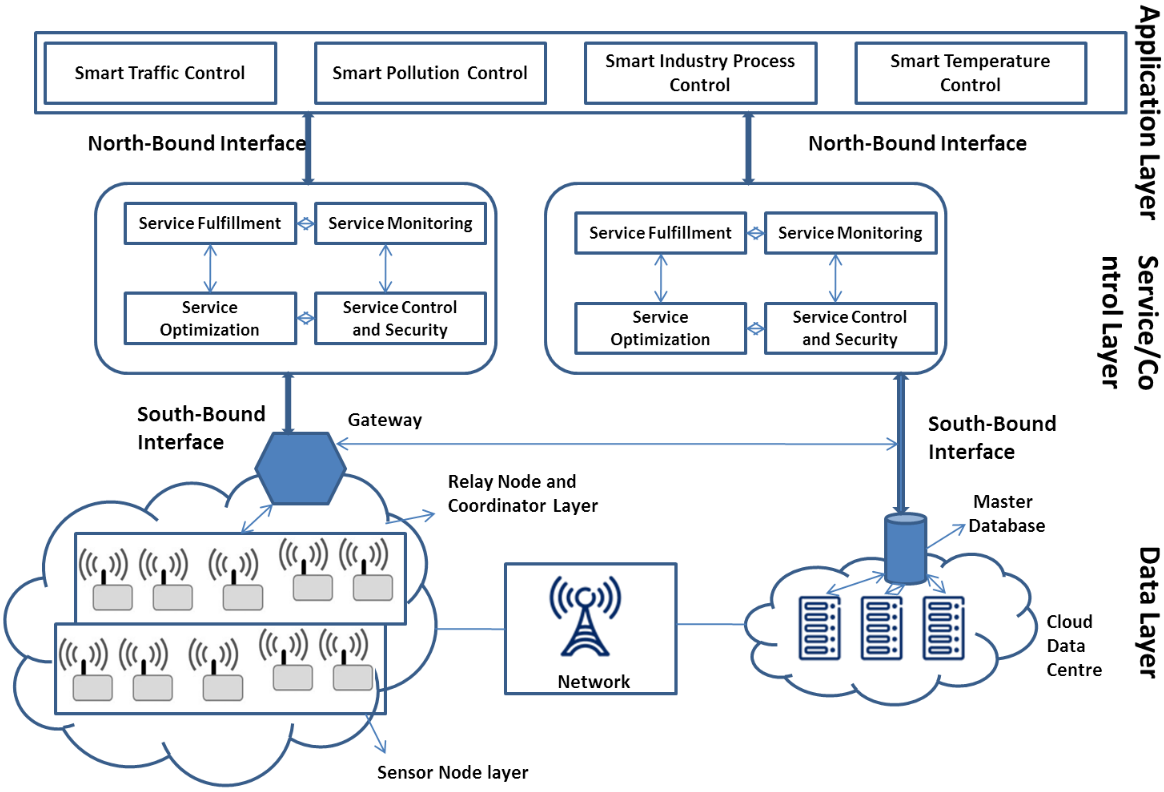

Fig. 3: Software Architecture for ISS-IoT

standard, will be suitable.

5) Extensive time of development: For application specific architectures and platform, new requirements required to be accommodated each time. Tremendous amount of time shall be required for all the modules of each application and which will also add-on the extra cost. Cities have many diverse applications and it is not feasible to provide extra time and cost to each application under the umbrella of IoT. A common platform will be the optimal and valid answer to the key issue discussed here.

Smart City projects need to handle all the above mentioned problems. We have outlined only few and main challenges. Most of the challenges can be overcome by using IoT [7].

B. *Drifts*

Smart city projects will have more users and applications. Hence, new architectures and platforms are in progress to confront the challenges of IoT. There are popular drifts or trends which can be considered for infrastructure of IoT.

1) SDN and NFV: Software defined network and network function virtualization can work individually, but together they are looked as most favorable elucidation for present scenarios (e.g. Dell and Intel architectures for IoT). The logical structure is decoupled from the physical structure by its use and it is realized in evolving proposals [15-16]. To enhance the flexibility of the complex architecture of IoT, insight of SDN-NFV can be borrowed.
2) Control Gateways: On the edge layer of IoT, Control gateways are proposed to provide the secure and authenticated communication [16]. Security is the key issue for all the people as data will be stored in the cloud. Gateways can offer the software modules for validation of clients and data for secure communication.
3) Physical Infrastructure Sharing: With the increase of developers and users, sharing of physical infrastructure is common practice in cloud computing. Rather than using a new physical structure, the applications are deployed in a cloud computing environment and it saves a lot of time and money. This practice is realized in new applications of smart cities.
4) Application program Interface Dominance: APIs can handle the complexities of heterogeneity of objects and can provide the simplification of service offered by architecture of IoT.
   These drifts pave a way to novel architecture where cognitive and secure communication will offer a new direction to IoT.

III. Related Work for Proposed Hybrid Approach

Tian Hea et al. [17] has presented a real-time statement protocol for sensor networks, called SPEED. The protocols provide three types of real-time communication services, namely, real-time unicast, real-time area-multicast and real-time area-any cast. Simulation experiments and a real execution on Berkeley motes are provide to validate the claims. Patrick Jailletet al. [18] has described by, optimization problems on networks with deadlines imposed at a subset of nodes, and with uncertain arc move times. The objective is to find optimal routing policies such that arrival times at nodes respect deadlines probable. Georges R et al. [19] has introduced the compact genetic algorithm which represents the population as a probability distribution over the set of solutions and is operationally equivalent to the order-one behavior of the simple GA with identical intersect. M. Younis et al. [20] has presented a novel approach for energy-aware and context-aware routing of sensor data. The approach calls for network clustering and assigns a less-energy-constrained gateway node that acts as a centralized network manager. X. Huang, Y. Fang et al. [21] has utilized the multiple paths between the sources and sink pairs for QoS establishment. Dissimilar to E2E QoS schemes, soft-QoS charted into links on a route is delivered based on local link state information. By the estimation and approximation of path quality, traditional NP-complete QoS problem can be transformed to a modest problem. Saini, A., and Kumar, H. [22] have discussed on the various issues created in AODV routing process because of the cooperative Black Hole Attack. Although AODV protocol performs well with mobile nodes it incurs high overhead with an increase in network size. Khin, E. E., and Phyu, T. [23] has analyzed the effect of black hole outbreak on Ad-hoc On-Demand Distance Vector (AODV) protocol. The simulation is carried on NS-2 and the simulation results are analyzed on various network performance metrics such as packet delivery ratio, normalized routing overhead and average end-to-end delay. Kumar Arora, S., et al. [24] implemented on AODV protocol which reduce the performance parameters of network by manipulating the packet sequence number encompassed in some packets header. S. Rani et. al. [25] proposed the cooperative routing for the energy efficient communication. The planned Strategy of Intrusion Detection System (IDS) is also implemented to enhance the network performance. Simulation consequences using Network Simulator 2(NS2) illustrates that, in a extraordinary mobility environment, malicious node could be detected and the packet delivery ratio has been improved. The The SPEED [17] protocol delivers four application-level application program interface calls:

1) AreaMulticastSend (position, radius, and packet): This support pinpoints some sort of destination node place by simply its center situation and radius.
2) AreaAnyCastSend (position, radius, and packet): This support communicates some sort of duplicate from the packet in order to one or more node in the chosen place using a speed above a threshold value.
3) UnicastSend (Global ID, packet): On this support the particular node recognized by simply Global ID will probably get the packet using a speed above a clear desired value.
4) SpeedReceive (): This primitive allows nodes to simply accept packets geared to these. Any WSN developer who considers each of these layout issues checks previously mentioned segment features to enhance several nonlinear goal functions and layout criteria [22].

Within the application layer, the traffic load is usually

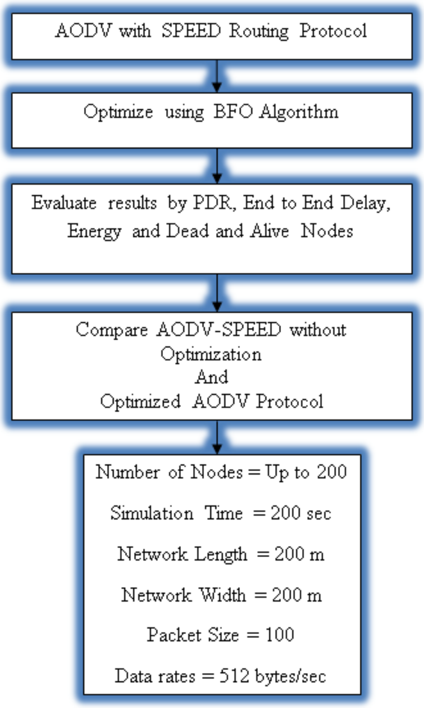

Fig. 4: Simulation Model of Optimized SPEED

squeezed to scale back the data size; various other algorithms such as in-network data processing, are actually produced to scale back energy consumption when compared to sending each of the raw data towards end node. The routing layer as well as MAC layer is usually optimized by simply choosing appropriate protocols to gain productivity. Node optimization can be achieved by simply strengthening battery utilization and implementing power-aware equipment layout. Three different types of optimizations are labeled, because optimizations of the communication layers, the actual node and cross-layer can enhance the network performance.

IV. Simulation Model of Proposed Approach for Smart City Applications

Above mentioned simulation model (Fig. 4) is followed to optimize the SPEED protocol. Node deployment is done in 200 * 200 space. The network for the deployment of the nodes in WSN is configured first and shows the effect of failure node on the performance of the network in terms of end to end delay, PDR, Dead and Alive Nodes and in terms of Energy. In addition a novel algorithm for optimization of SPEED protocol using Bacterial Foraging Optimization (BFO) is adopted to increase the lifespan of the network and then compare it with SPEED-AODV without optimization. The focus, however, has been given to the routing protocols which might differ depending on the application and network architecture. In this article, we have proposed the state-of-the-art routing technique using SPEED protocol that has the delivery of speed at the sensor network by considering the traffic at network layer as well as at MAC layer in which the packets are being sent for regulating. The mobility behavior of nodes in the proposed work is modeled by the random way point model through which random locations to which a node move are generated, and the associated speed and pause time are specified to control the packet data rate at which the network topology is changed. The Optimized-SPEED Routing protocol incorporates path accumulation during the route discovery process in SPEED Protocol to attain extra routing information. It is evident from the results that Optimized SPEED protocol improves the performance of SPEED Routing Protocol under conditions of high load and moderate to high mobility. BFO is an optimization technique to choose an alternative path in WSNs. This technique is used for the problems like control of optimization, quantization of image, detection of images etc. This controlling of system of bacteria that shows the process of foraging is being divided into further parts like Chemotaxis, Swarming, Reproduction, dispersal and elimination.

V. Overview of ISS-IOT Framework for Smart Cities and Simulation Results of Proposed Approach

IoT requires a general framework which could suit each and every application with slight modification or with new layers. It integrates layers of sensors to sense, collect and transmit the data from the environment. Interaction of sensors with devices requires some explicit integration. Novel network is deployed around the applications of smart cities. As each application necessitate different networks, so different domains cannot be optimized in terms of security, reliability, availability and cost. The main challenge is to add new devices into the framework with low cost, less disruption and less energy depletion to the existing infrastructure. The architecture proposed for smart

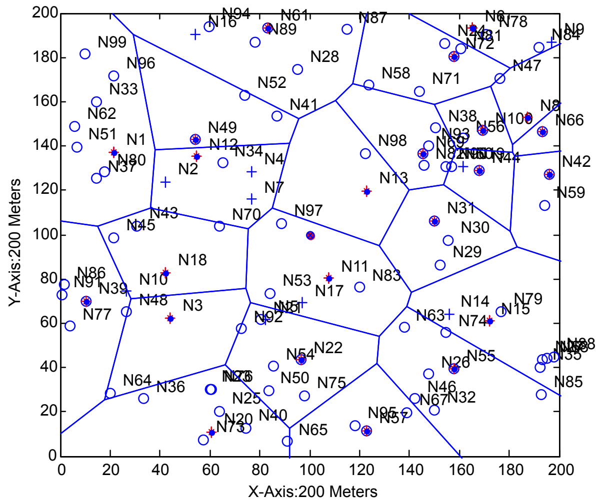

Fig. 5: Network Simulation

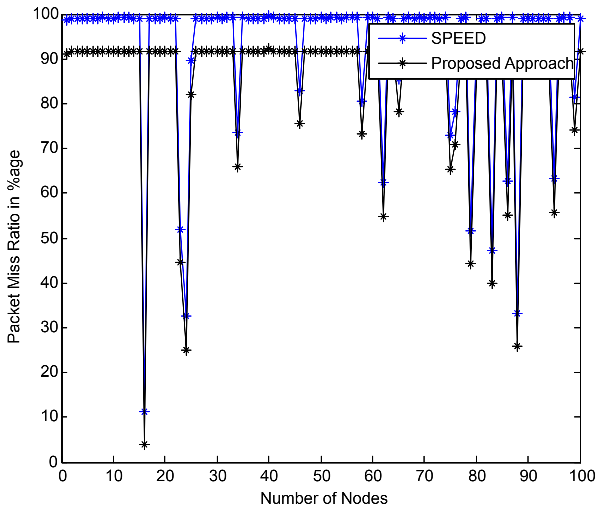

Fig. 6: Comparison of Packet Miss Raito in 100 Rounds

city consisted of three layers, as shown in Fig. 3. Results obtained from the simulations carried out in MATLAB are shown from Fig.5 to Fig. 8.

In the Fig. 5 a network simulation is shown after data transmission for 100 rounds. When a source node transmits the data packet to the destination, some packets are dropped and this is known as the miss ratio of the data transmission which is shown in Fig. 6. Delay is not tolerable in the real time applications of the Smart City and hybrid approach has shown the improvement in this feature (shown in Fig. 7).

Packets are composed of 4000 bits. Proposed approach, has shown that the speed of the data transmission is also improved and can be noticed from Fig. 8.

The main objective of the proposed methodology is to conserve the energy, which is the main constraint of WSN and proposed method is advantageous for the Smart City applications as even after 100 rounds of data transmission, a lot of energy of the nodes is conserved for other rounds. Remaining energy of all the nodes in novel approach is higher than the SPEED protocol and can be noticed in Fig. 9. This

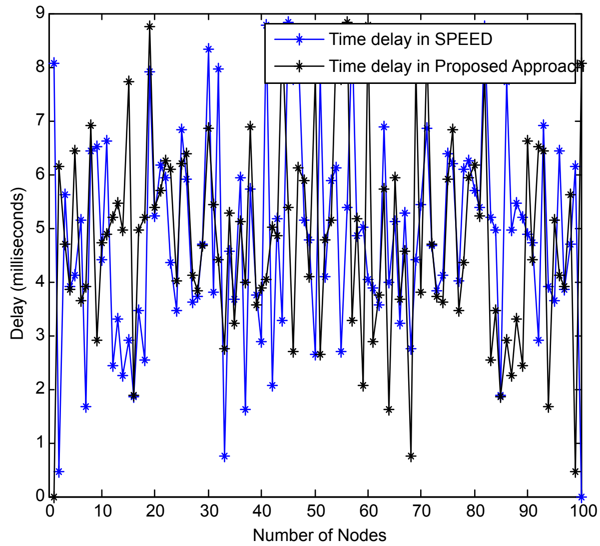

Fig. 7: Delay in Data Transmission

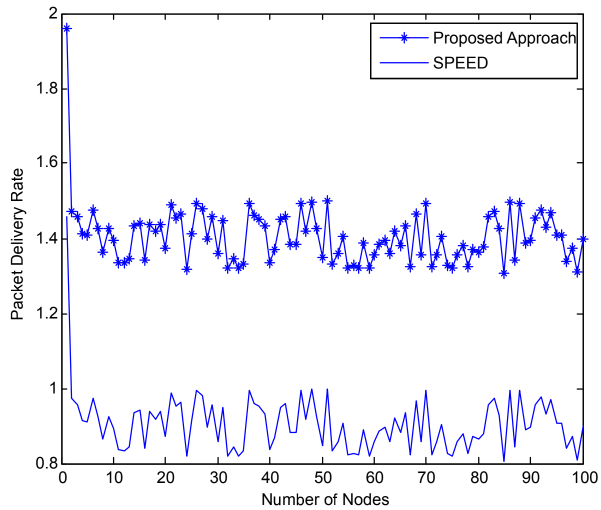

Fig. 8: Packet Delivery Rate(4000 bit length of packet)

methodology will be used in the base layer of IoT that is sensing layer of Smart City applications. In the subsequent section, a framework for Smart City is explained with its various layers where sensor platform will be consisted of the proposed methodology.

A. Data Layer

This layer is comprised of sensor platform, network and cloud server. In sensor platform, we propose the communication with the help of relay nodes and cluster coordinators as proposed in [23]. It is to tackle the issues of energy efficiency and scalability. The layered sensor platform is proposed for the efficient communication of sensor nodes. Gateways at the edge of sensor platform will provide the security of the platform. Edge computing with secure communication, will enhance the quality of service metrics for network. Cloud servers will be used to store and compute the data in a cognitive way. They will enable the developers to deploy the applications, without

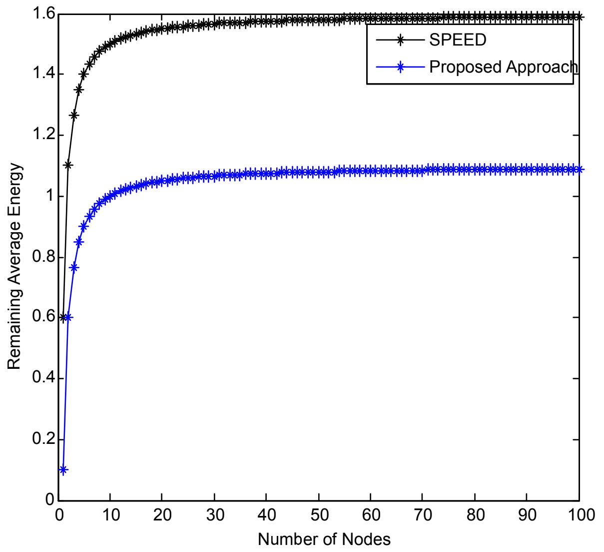

Fig. 9: Average Energy Consumption in 100 Rounds

the need of new devices for data processing and storage. Data transmission, gathering and dissemination are facilitated by this layer. It is done via secure mode (by checking the data at the gateway for validation and by protecting from hackers by implementing encryption techniques); intelligent decisions as to whom the data should be sent (artificial intelligence) and in compact form (to determine the clients and extract the exact data as queried); and exploiting the advantages (to eliminate the requirement of new devices for new applications) of cloud server. All these services are provided by the standardized southbound interface.

1) When sender would like to send information in order to spot destination then it broadcasts RREQ message in addition to posts a replicate in order to IDS (Intrusion Detection System).
2) RREQ are going to be made up of the whole variety of packets sender would like to submit among the network.
3) Thereafter on RREQ, destinations will response RREP message in addition to advanced beginner route are going to be embedded within it.
4) While Sender gets the RREP through vacation spot, sender will mail information with the advanced beginner node in the event zero maliciously marked nodes can be found within it.
5) Immediately after getting packets through sender vacation spot, vacation spot will mail variety of packets acquired in order to IDS node.
6) IDS node will find Nd/Ns (packet shipping and delivery ratio); wherever Nd is variety of packets acquired in addition to Ns is the quantity of packet sent.
7) After that IDS node will mark node seeing the delay node in order to other nodes inside the network.
8) Then it will evaluate parameters.

B. *Service/Control Layer*

This layer implements NFV functions and optimize the services for the clients. Request for the data and controlling of the requests are entertained by this layer. It acts as the middleware and hides the complexities of the data layer from the application layer. The most important aspect of this layer is to provide the common platform for all the applications and independent of the different operating systems. Any application with any operating system can communicate with this layer. Decisions to control the requests of the valid clients (security monitoring to check with the gateway), to optimize the service (to provide the result within time and to find out the nearest architectural element to retrieve data) and to get back to the accurate application with the results are performed by this layer. It manages all these services with the help of northbound interfaces.

C. *Application Layer*

All the applications of smart city (pollution monitoring, traffic control, smart lightening system, smart grid, smart industry, etc.) are developed by using the standardized interfaces (northbound services). Applications can be customized without modification in physical configurations. For example, data can be deployed and processed on the cloud servers without knowledge about the infrastructure of the cloud. Mapping from one layer to another layer is handled by the software modules designed specifically for IoT. Physical and conceptual data abstraction handle all the complexities (helps in cost reduction and simplifies the process). Sysmex Corporation has used Thingworx platform for the development of IoT applications. Platform of Thingworx (M2M communication) can be further improved by the proposed architecture due to cognitive communication and sensor platform based on cooperative communication (Relay Nodes and Cluster Coordinators).

We have demonstrated the use of proposed software simulated, IoT architecture by taking the use case of intelligent decision making for smart streets.

VI. USE CASE: SMART STREET

Many pilot programs are developed to implement the smart projects. Various municipalities are working with these projects. But there are many products that are not reachable to market because of security and privacy issues. But these issues can be overcome by the integration of smart technologies on the platform of ISS-IoT. We have considered one scenario to show the use of the proposed scheme for smart streets and its use-case flow can be observed from the Fig. 10.

A. *Case*

We have discussed in the previous section that the framework proposed (ThingWorx) for IoT applications can be modified by inclusion of intelligent decision making for better services. A use case of intelligent communication for street safety has been considered here (Based on ISS-IoT). Consider a scenario in which lights are off in the streets. Streets and homes are connected by sensors and data from homes is sent to streets main center, which is transmitted to the police station on any suspicious activity (unauthorized person trying to get

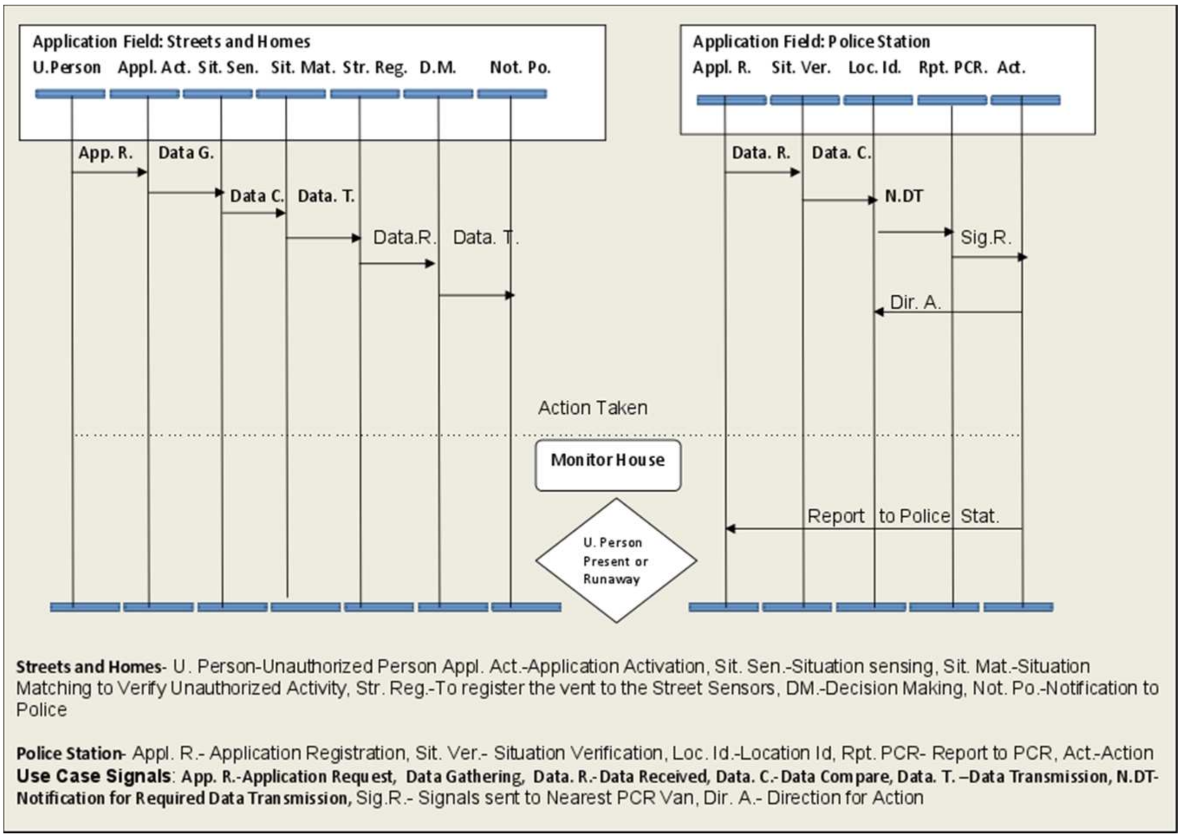

Fig. 10: Use Case Data Flow in Smart Streets

into someones home by unethical means) and police van is reached to the location of the incident within no delay (By using a smart app to find the exact location of the unauthorized person and activity).

B. Concept Description

In the scenario given above, a suspicious activity is sensed by the sensors (Layer 1, Fig. 3)) in a particular home. An unauthorized person is trying to get into someones home in unethical ways. Data is gathered at the Base Station of the Street (Sensor Platform) and data is checked to verify the malicious activity (via gateway). Data is transmitted to the appropriate control centre (Layer 2, Fig. 3) and here malicious activity data are sent to the Police station. Data at the Police station is verified and checked to ensure the activity is malicious and appropriate signals (Based upon the location of the Home) are sent automatically to the PCR (Police Control Room) van (Layer 3, Fig. 3) located near to the street (Intelligent decision making) and action is reported to the Police station. Security surveillance system is needed in the entire city to ensure the safety of the citizens.

C. Case Study: Smart Street

Street safety of smart city is the most important application and drawing the attention of IoT developers. This is why the SMART STREET project is developing the urbane solutions and software services in this field to provide the quality of smart life for future urban environments. In this perspective, we have proposed in Fig. 4 a reference use-case envisioned by the SMART STREET project and we have revised it in the context of information centric network (ICN). In this example, street device communicates with sensors (Smart guards) deployed in the street to gather the information of houses about various parameters (unauthenticated entry, stealing of vehicles, uncommon activities, etc.) and transmits them to the smart street hub and which is accessible to the police station in real time for appropriate action. The information between street device and sensors is exchanged through IoT technology. Reporting of the nearest PCR van is done by cognitive communication. Recognition of the activity is performed by the service/control layer and validity of the information is checked at the gateway of sensor platform. Communication with remote hub, i.e. police station is done by SDN-NFV infrastructure. The street device occasionally transmits the queries to sensors to gather the data by transmitting the interest packet with the content name as:

/domain/StreetSafety/ResidentAssistance/Query
/StreetMonitoring/CategoryOfData

By gathering the information from all the data packets, identification of anomalies can be recognized and can be sent immediately to the nearest police station and nearest PCR vans can be informed of the action (urgent action will be triggered). The interest packet on the name of the cause will be issued by SDN-NFV as:

TABLE I: Smart City Projects Based on IOT

Smart City	project Challenge	Solution	Implementation
Structural health	To find the Cracks in the Buildings before Danger	To opt IoT framework for timely delivery of data.	Libelium uses the Crack Sensors to monitor Structural health
Smart Parking	To get the information of free and busy parking slot beforehand	Applications at the user end designed to collect the real time data	SENSIT by Moscow
Noise Urban Maps	Control the Noise Pollution	By using greenhouse Implementation	FP7 Marie Curie ITN project TANGO
Smart Lightning	Eco-friendly and Energy Conservation	Control of lightning	Intelligent Lighting System by LED Renting in Spain
Waste Management	To use the innovative technology to find out the filling of the tanks	By using Intelligent Sensors 4.0	MOBAs Smart Waste Management System by Barcelona
Smart Roads	To guide the citizens about the milestones and traffic patterns.	By using the applications like Heijmans Solar Noise Barriers and BikeScout.	Joint Project by Virginia Department of Transportation (VDOT) and managed by Virginia Techs Transportation Institute (VTTI)

/domain/StreetSafety/ResidentAssistance/Query
/StreetCheck /ResidenceDetails/Data

This request be entertained and confirmed by the remote PCR van and will reach the street to provide support. Another application in SMART STREET is the finding out the correct residence in proper locality. It is comprised by a remote user who wants to search residence in a remote city of other town/city. LTE technology can be helpful as we assume that the internet is accessible to the person on a cell phone. The discovery phase helps the user in finding out the information from the streets table and transmits the interest packet with content as shown below:

/domain/StreetSearch/ResidenceAssistance/Query
/StreetAddress/Discover/Residence

Several NDN sensor nodes can respond to the query. The validity of his query will be checked at gateway (Security to both resident and User) and after validation the user can receive multiple data packets; and user can figure out the address by matching the data of packets. The negotiated session (User and the Street Cloud) will encrypt additional info fields of queried packets and the content of data packets. User at this stage will be using the service of the optimized service layer. To optimize the response to the query for better and speedy results during discovery phase, category-of-query and additional-var fields are updated. ProviderPublicKeyMD5 and ResponseOriginType fields of the queried packet are set strictly to ensure the true data. In response to both the use cases (Malicious activity and Residence inquiry), control room will transmit the encrypted data. Any caching of the data without users permission will be prohibited (Security algorithm implemented on the edge of the cloud and at the gateway of the sensor platform). Furthermore, the above discussed use case gets the advantage of cognitive communication which facilitate the intelligent decision making for the assistance of the user and PCR.

VII. FUTURE AND VISION OF SMART CITY

Several NDN sensor nodes can respond to the query. The validity of his query will be checked at the gateway (Security to both resident and User) and after validation the user can receive multiple data packets; and the user can figure out the address by matching the data of packets. The negotiated session (User and the Street Cloud) will encrypt additional info fields of queried packets and the content of data packets. User at this stage will be using the service of the optimized service layer. To optimize the response to the query for better and speedy results during the discovery phase, category-of-query and additional-variable fields are updated. ProviderPublicKeyMD5 and ResponseOriginType fields of the queried packet are set strictly to ensure the true data. In response to both the use cases (Malicious activity and Residence inquiry), the control room will transmit the encrypted data. Any caching of the data without users permission will be prohibited (Security algorithm implemented at the edge of the cloud and at the gateway of the sensor platform). Furthermore, the above discussed use case gets the advantage of cognitive communication which facilitate the intelligent decision making for the assistance of the user and PCR. Smart cities are the creation of new technologies of information technology [10-11] and analytical databases which is based on the wireless network, internet, telecommunication network and its heart lies in IoT. IoT includes RFID, GPS, IR, etc. and connect all the devices with the help of protocols. Half of the population in major countries will be under the stress of water scarcity. 89% of the population is using some form of refined water. It is expected that there will be a rise in usage of energy globally by 56%. U.S.A. is the second major consumer of energy. If energy efficient IoT is used in the U.S. then it could save 1.2 trillion energy sources. Farming can be improved with the help of food management IoT applications. DUBUQUE, implemented smart water project in 2010 and on average it saved 7% of water usage. Santander, Spain has installed 12500, IEEE GPRS and RFID sensors around the city for the project of smart energy and conserved waste management cost by 20% and energy cost by 25%. San Franciscos I-80, smart corridor project uses 133 tech signs to gather information about traffic patterns. Seattle started the use of smart building project with its launch in 2013 and its main aim is to save energy. Some of smart city projects based on IoT can be analyzed in table

1. With the help of IoT, traditional city is converted into interconnected, intelligent and instrumented city. The future aim of smart city is to provide the maximum benefits to citizens directly by cutting down the role of middleman. There is no clear indication of which projects will lead towards success. So, smart city projects are being termed as puzzles without the knowledge of their real picture. It is not easy to implement these projects as there are many hurdles. As the scale of the problem is large, so does the size of the solution. The architecture proposed in this article can be beneficial in many applications of smart cities and it proposes the optimization of already developed architectures of IoT (Thingsworx).

VIII. Conclusion

This article gives a look into the role and need of IoT in development of smart city. In this paper, a novel approach has also been proposed for sensor platform of the data layer of ISS-IoT. In this approach AODV with SPEED shows the value of remaining energy from .8 to 1.1 (joules) while AODV with hybrid approach shows the remaining energy, from .6 to 1.6 (joules). In packet delivery rate, the proposed methodology shows the values from 1.4 to 1.5, while the value in SPEED ranges from 0.9 to 01. Delay in proposed method ranges from 2 to 10 milliseconds which is again optimized over the SPEED, which shows delay from 2 to 11 milliseconds. Packet miss ratio of hybrid approach is 0 to 95 which is again better than SPEED which is 5 to 100. These results prove that proposed method is more suitable for the sensor platform in ISS-IoT. The framework (ISS-IoT) is also proposed for the smart street, that can also be used for other application services . To provide the sustainable growth of digital services and dynamic realization of new updates of cities, IoT plays a major role. Many projects are already in development and it is expected that in 2020, there will be a rise of 9.7 billion in connecting services. A new architecture with cognitive communication and security paradigm has been proposed to optimize the existing infrastructures. A case study on a smart street justify the validation of the new prototype.

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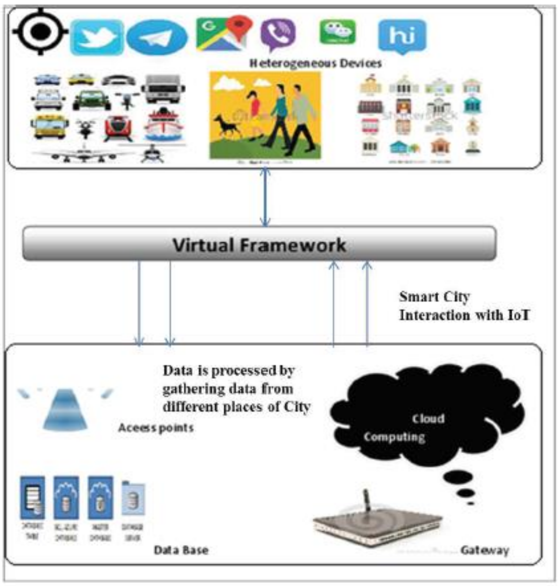
Syed Hassan Ahmed (S'13, M'17) received his B.S in Computer Science from Kohat University of Science and Technology, Pakistan. Later, he completed his Masters combined Ph.D. in Computer Engineering from School of Computer Science and Engineering (SCSE), Kyungpook National University (KNU), Korea. In 2015, he was a visiting researcher at the Georgia Institute of Technology, Atlanta, USA. Dr. Hassan published over 80 International Journal and Conference articles in addition to two Springer brief books. From the year 2014 to 2016, he consequently won the Research Contribution awards by SCSE at KNU, Korea. In 2016, he also won the Qualcomm Innovation Award at KNU. He is also an active IEEE and ACM member while serving several reputed conferences and journals as a TPC and Reviewer respectively. His research interests include Sensor and Ad hoc Networks, Cyber-Physical Systems, Vehicular Communications, and Future Internet.

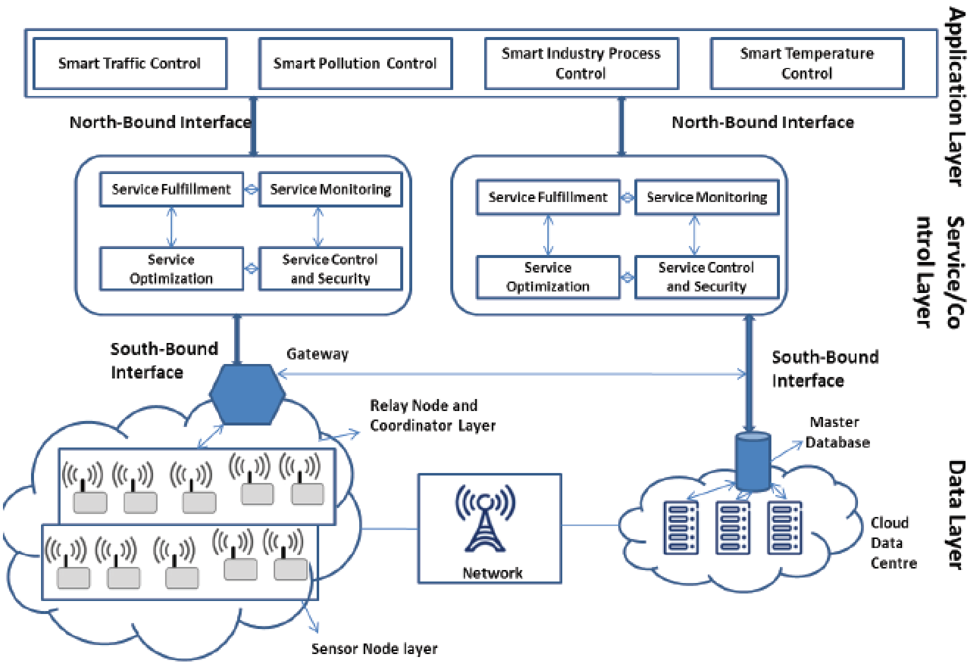
Ms. Shalli Rani is an Assistant Professor with the S.S.D Women's Institute of Technology, Bathinda (Punjab), India. She received an MCA degree from the Maharishi Diamond University, Rohtak in 2004 and the M. Tech. Degree in Computer Science from Janardan Rai Nagar Vidyapeeth University, Udaipur in 2007 and is currently pursuing the Ph.D. degree in Computer Applications from Punjab Technical University, Jalandhar. Her main area of interest and research is wireless sensor networks, Underwater Sensor networks and Internet of Things. She has published/accepted/presented more than 10 papers in international journals /conferences. She received a young scientist award in Feb. 2014 from Punjab Science Congress, in the same field.

A Hybrid Approach for Internet of Things in Smart Cities: Smart Street Use Case and Future Aspects

Highlights



Interaction of Heterogeneous Devices in ISS-IoT



We proposed our own novel framework for IoT enabled applications for Smart Cities.

For performance evaluations, we used AODV and WSN as a use case and verified our framework by showing graphical results.