Demographic Sensitive Inter-Vertical Technologies Association For Smart City Planning And Management: Optimistic Integrated-SCPM Proposal For Muscat

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Abstract: The decision making process of smart city planning is challenging task. In this paper we explore that task with IOT as well as Big data. Multilayer optimization model is proposed that intends to augment both IoT data gathering as well as Big data processing. the novel smart city concept while taking into consideration of all factors such as such as demographic factors, people perception, people-choice, adaptability, marketability, technology as well as its optimistic success perception, is of paramount significance. It is compared with classical approach to reduce the computation cost, time and service quality. The proposal has employed both primary data based case study to access people (from Muscat) perception and their preference towards smart city.

1. BACKGROUND

The exponential rise of urbanization and population up surge in urban areas have demanded administration agencies as well as private players to exploit advanced Information and Communication Technologies (ICTs) to augment living standard and enable more productive life cycle. Smart city the term doesn't mean enabling certain specific technology both technologies as well as human resources. Smart City concept has gained world-wide momentum and appreciation. For instance, unlike classical approaches Smart City can help Muscat to avoid traffic congestion and identifying the best route for conveyance. It can help Muscat city residents to manage their resources in effective manner, to live a more productive life with better decision making. They are two dominant technologies; Internet of Things (IoTs) and Big Datas playing decisive role towards augmenting process and practices across urban society, serving major applications including healthcare, surveillance, business intelligence, resource management and many more. However, in this overall process timely and reliable data gathering through the Big Data analytics has always been a challenging task. To achieve it augmenting both IoT data gathering and Big Data analytic technology can be vital.

In this research proposal a multilayer optimization model is proposed. both IoT data gathering as well as Big Data processing in this research proposal, the emphasis is made on enabling (time, energy, resource) efficient, reliable and cost-effective IoT system development. smart city planning to support certain specific task such as Water-management, traffic surveillance and management, waste management, hospital management, single card ticketing or transaction system for multiple purposes (i.e., bus/train ticketing, payment at the different locations such as movie ticketing, etc), pollution monitoring and control etc; however most of the classical approaches have either exploiting technology single task or multiple tasks that eventually results into increased computational cost, time and service quality degradation. Developing a novel Smart City concept while taking into consideration of all factors such as demographic factors, people perception, people-choice, adaptability, marketability, technology as well as its optimistic success perception, is of paramount significanceOn the other hand, numerous case study has been performed for the already existing smart city concepts across the world (USA (North America—Philadelphia and Seattle), Quebec City (Canada), Mexico City (Mexico), Hong Kong, Beijing, India (Raipur), London, Tokyo, Amsterdam, etc.). This proposal has employed both primary data based case study to assess people (from Muscat) perception. . The detailed discussion for the proposed SCPM model is given in the subsequent sections.

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2. SMART CITY (BIG DATA + IOT ARENA): THE CATALYTIC NEED FOR NEXT GEN COMMUNITY

The rise in urban population and resulting density has alarmed for more efficient and sufficient infrastructures as well as allied services to meet the demands of city inhabitants. especially embedded technologies, including sensors, relays, smart-phones, M2M communication infrastructures, etc. These all demands have given rise to a new arena having huge business potential being served through a novel technology named the Internet of Things (IoT). IoT has emerged as a novel substantial new generation paradigm or technologies for next generation. It performing communication and data exchange over the Internet to serve certain defined task or assignment. IoT continues to extend the current Internet by providing connectivity and interaction between the physical and cyber worlds. 16 billion connected devices that will get IoT technology-enabled by 2021. Huge amount of heterogeneous data retrieved through a large number of sensors distributed across the network region to perform certain task. Gathered data is nothing else but the term called "Big data". However, under such gigantic heterogeneous (massive) data presence it becomes highly intricate to perform data analysis and targeted decision process. In addition to increased volume, the IoT generates Big Data characterized by velocity in terms of time and

location dependency, with a variety of multiple modalities and varying data quality. In practical applications, swift and intelligent data processing and assessment are of utmost significance. Augmenting Big Data systems is also must to ensure optimal decision process and services to the different stakeholders (i.e., business houses, administration, government agencies, public for personal uses, strategists, manufacturers etc). Smart Cities are using big data and IoT for the exchange of digitized information and communication in order to improvise the city services with respect to performance, quality, and well-being of citizens. Considering technology, both Big Data and IoT have been emerged as a highly advanced technology to play predominant role in forming a robust infrastructure to serve demands of smart city. The amalgamation of IoT and Big Data in optimal manner could alleviate major management challenges across the city and could provide automated resource management and decision support (to all allied stakeholders including public, business houses and government). There are a number of applications scenarios such as fire sensors, critical waste management sensor, water, and air quality control sensor, traffic surveillance systems etc. In this research proposal, enhanced routing models for IoT ecosystems have been proposed while ensuring reliable and QoS centric communication, even under mobile IoT ecosystems. Furthermore, a multi-layered architecture based Big Data framework is developed to ensure reliable and time efficient smart city functions.

3. DECODING MUSCAT'S (PEOPLE) PERCEPTION: EMPIRICAL RESEARCH BACKED SCOPE IDENTIFICATION

People living in Muscat city (functional in different verticals such as business community, serving employees, hospitals, government employees etc) have been interviewed for their personal perception towards Smart City in Muscat city. To perform people expectations for the different verticals such as Smart concept in governance, healthcare, economy, business, smart living, lifestyle (smart people), education etc.

Table 1 *Muscat's (people) choices for Smart City planning and management*

Smart City Verticals	Smart City Concept Applications
Smart governance	Enabling supply and demand side policy.
	Transparency and open data
	ICT and e-Government
	Smart Public wallet to make identification document free and use-when-needed concept
	Single Card based identification, payment system for ticketing purposes.
	Smart vehicular (traffic) monitoring or surveillance and control
Smart living	Smart Surveillance based Public safety
	Smart Health provision
	Smart Grid (for industry as well)
Smart mobility	Inter-vehicular communication system (for ambulance as well as critical functional systems)
	Integrated ICT
	Reliable communication system across city (across different stakeholders)
Smart Economy	Industries 4.0 assisted Smart Manufacturing and supply chain management for better productivity and less resource dependencies on classical resources (skilled/unskilled labors)
	Local and global interconnectedness (connectivity across the business community to enable better business decision, promotion as well as sales increase)
	Entrepreneurship and innovation (Idea exchange and cooperative support to enable more constructive business decision)
	Green buildings

Smart environments	Green urban planning

4. OBJECTIVES

The overall objective of this proposal can be categorized into two broad types; general objectives and specific objectives,

GENERAL OBJECTIVES - overall goal of the work

• To develop a robust and efficient Smart City Planning and Management (SCPM) model for Muscat to serve multiple socio-economic centric purposes.

• To develop a centralized or integrated SCPM (I-SCPM) model by exploiting different technologies (BigData, Internet of Things (IoT), Machine to Machine (M2M) communication etc).

SPECIFIC OBJECTIVES - methodological paradigm to be applied to achieve the overall objective

• To develop highly robust Real-Time Data (RTD) and Non-Real-Time (NRT) data transmission system for event-driven mission critical communication over mobile-communication technology (IoT communication system under lossy conditions).

• To develop a novel Smart Governance protocol to serve Single Card based identification, payment system for ticketing, ICT and e-Governmance provision, transparent inter-node (user) communication and data storage, quality of service assessment and quality valuation across the city for services being provided, Smart Public wallet to make identification document free and use-when-needed concept, and Smart vehicular (traffic) monitoring or surveillance and control

• To develop a novel smart living concept to enable public security and safety measures, smart grid provision for uninterrupted and reliable quality electricity provision, and healthcare support when-and-where needed.

• To develop a robust routing protocol assisted inter-machine or component communication system (i.e., M2M communication) system for Inter-vehicular communication system (for ambulance, fire-extinguisher trucks etc) to enable timely decision and safety measure.

• To develop a novel BigData and IoT assisted Smart concept to support Industrie 4.0 assisted Smart Manufacturing and supply chain management for better productivity and less resource dependencies on classical resources and Entrepreneurship and innovation (Idea exchange and cooperative support to enable more constructive business decision).

• To develop a novel Smart technology assisted smart environment mechanism to assist or promote Green buildings, green urban planning, etc.

5. SCPM Implementation Plan and Allied Technology Demands

Taking into consideration of the people (Muscat's) preferences and interest, we have identified certain technologies that in conjunction with an optimal implementation strategy could meet major expectations. A snippet of the proposed methodology against each demands or needs is given as follows:

Table 2 *Muscat's (people) choices for Smart City planning and management*

Smart City Verticals	Smart City Concept Applications	Implementation Technology
Smart governance	Enabling supply and demand side policy.	BigData, Cloud Computing, Enhanced Data Mining, web-mining technologies, Top-N recommendation (BigData analytics)
	Transparency and open data	BigData and IoT communication system
	ICT and e-Government	BigData, Cloud computing, IoT communication.
	Smart Public wallet to make identification document free and use-when-needed concept	BigData, Robust data security systems, cloud computing technology.
	Single Card based identification, payment system for ticketing purposes.	Advanced security system, multi-factor authentication system, inter-banking transaction, or unified point transaction, single attribute based multiple-platform (say, multipurpose) registration and activity scheduling.
	Public safety	IoT, BigData and cloud computing assisted this system transforms data stream sources into an emergency system. Here data flowing through emergency calls and text messages for improving the situational awareness and safety applications

	Smart vehicular (traffic) monitoring or surveillance and control	M2M communication assisted inter-vehicular communication. GPS system and local wireless network assisted communication paradigm to enable RTD and NRT communication. Advance tracking and control system. Anti-Tracking or anti-spying model to support personalized safety solution.
Smart living	Smart Surveillance based Public safety	High data rate and reliable wireless sensor network to enable live surveillance, tracking and offline tracing for certain events to avoid any crime or loss.
	Smart Health provision	IoT/M2M/BigData assisted hospital management, Diagnosis details or logging process for better healthcare support, Uni-health card or Identify based diagnosis information exchange to support swift and reliable healthcare facility or diagnosis. IoT/BigData/GPS controlled ambulance (internal conditional support (time-sensitive automated diagnosis support)) monitoring and control (including navigation).
	Smart Grid (for industry as well)	IoT/BigData/GPS system supposed grid design, monitoring and control to preserve energy exhaustion, reliable transmission. It improves safety, efficiency, reliability
Smart Water	It is an advanced system that senses the water usage. It can be used for asset management and water conservation. Various systems includefull-color LCD touch screen and solar-powered wireless tank sensor.	Sensor technology, wireless communication system, BigData, cloud computing, and IoT.
Smart mobility	Inter-vehicular communication system (for ambulance as well as critical functional systems)	IoT/BigData/GPS controlled Vehicle to Vehicle (V2V) communication system for both RTD as well as NRT communication. It can help in enabling real-time communication, coordination, and information exchange thus helping the mass to make effective process/event-decision.
	Reliable communication system across city (across different stakeholders)	BigData/Iot assisted secure data communication, multi-level abstracting for data exchange, communication acknowledgement and update mechanism (e-relationship management across

		stakeholders).
Smart Economy	Industries 4.0 assisted Smart Manufacturing and supply chain management for better productivity and less resource dependencies on classical resources (skilled/unskilled labors)	Industries 4.0 standard/BigData/Cloud computing/Machine learning/secure multiparty communication/Secure multiparty computation/Privacy preserved communication/Advance interrupt controlled actuation system for wastage control/ BigData/IoT/Cloud computing based supply chain management.
	Local and global interconnectedness (connectivity across the business community to enable better business decision, promotion as well as sales increase)	BigData/IoT/Cloud computing technologies based connectivity to enable people provide their offers, purchase intentions, inventory etc.
	Entrepreneurship and innovation (Idea exchange and cooperative support to enable more constructive business decision)	E-platform based model to provide common platform for entrepreneurial opportunity, information exchange etc. It can help entrepreneurs to get solutions easily while providing fair opportunity to all. It can also help people reach or penetrate to a far market place.
Smart environment	Green buildings	GPS/Sensor technologies/BigData/Machine learning concept for eco-friendly construction decision and allied management. It can enable easy data collection from sensors, connected equipment, and existing enterprise systems.
	Green urban planning	GPS/Sensor technologies/BigData/Machine learning concept for spatial planning and development to achieve long run goals.
Smart Agriculture	Obtain information of trunk diameter of plants, forecast weather, moisture level of soil, forecast weather, microclimate condition	IoT/BigData/Satellite technologies/Machine learning based weather forecast/market bulletin etc.
Smart Metering	Used for electricity energy consumption prediction	Wireless sensor technologies, BigData, Cloud computing.
Smart Transportation	In Smart city domain, number of vehicles travels towards the road networks. There can be huge number of taxi rides per year. This leads to the problems of high economic rate and congestion (traffic). Here reduce the number of taxi on particular road link, sharing the message to the citizens could reduce the congestion and result in high economic savings.	BigData/GPS/IoT

Smart Energy	Smart Energy saving in local and central governments	BigData/GPS/IoT, Wireless Sensor communication, Cloud computing and analytics technologies.

6. PROPOSED IMPLEMENTATION PARADIGM (TECHNICAL PROPOSAL)

Observing above identified SCPM artefact or constructs it can be visualized that the majority of the systems demand reliable communication paradigm that in conjunction with a highly robust BigData platform and allied cloud computing technologies can enable optimal performance to meet the demands. With this motive in this proposal the focus is made on identifying the best conceptual paradigm to enable time-efficient reliable and secure M2M communication system and BigData analytics. Here, it is hypothesized that the efficiency of any smart city concept can be successful only when the allied communication paradigm and multi-vertical technologies (Hardware as well as software components) functions well.

6.1 Proposed Model Communication System Enhancement

- Developing a robust and novel IoT based data gathering system and more efficient BigData analytics could be of paramount significance for SCPM purposes as indicated in above table (Table 2).
- the development of time efficient and robust data gathering protocol, especially exploiting IoT technology can be of utmost significance as it could enable collecting large scale data within a defined time period .
- majority of the applications are in mobile stage which require a robust routing approach to communicate and deliver real time data (RTD), also called event data to the BigData repositories to make optimal decision.
- Enabling this capability can help smart city paradigm to collect reliable data from different operating sensors to make better decisions.
- These data could be from the vehicles, city management vehicles, hospital (management) data, etc.
- However developing a routing protocol under mobile topology and with low cost solution (i.e., Wireless Sensor Networks under LLN conditions)
- On the other hand, IoT must be capable of interfacing billions or trillions of heterogeneous communication equipments or devices through the internet.
- These factors motivate researcher to develop a low cost and reliable data gathering protocol for mobile-WSN to serve deadline sensitive data gathering at the BigData infrastructure.

Considering these all major motivating factors a few key research questionnaires can be derived which could be considered as the key motivating constructs for the presented research. These are given as follows:

- How can an IoT data gathering protocol be developed to collect event data (say, mission critical RTD data) without violating deadline time to serve sensitive smart city applications?
- How can low cost and efficient mobile-WSN/Low Power Lossy Network (LLN) assisted routing approach could be developed to meet low cost solution for data gathering over IoT-BigDataecosystem for SCPM?
- To cope up with the mobile LLN conditions or WSN networks for smart city, how a network (parameters) sensitive routing model be developed to ensure reliable and QoS centric data gathering at the Big Data infrastructure or repositories?
- How an efficient (time as well as process) Big Data analytics model be developed to ensure optimal data processing and delivery to the associated users or (smart city) stakeholders.

Developing a more robust fault-resilient (due to induced mobile or varying topology) and IoT network parameter sensitive routing approaches, say forwarding IoT path selection can ensure optimal performance for delay- sensitive communication over IoT ecosystem. To achieve it the optimization in standard of native IEEE 802.15.4 protocol stack can be vital, which can be greatly supported by cross-layer architecture. Though, cross-layer architecture can enable sensing different network parameters and exploiting them for reliable IoT forwarding path, Cross Layer Concept (CLC) Based QoS-Centric Data is used.

Gathering in Mobile-IoT Ecosystem for SCPM

In this research phase a highly robust Cross Layer Concept (CLC) Based QoS-Centric Data Gathering in Mobile-IoT EcoSystem for SCPM has been proposed. The proposed routing model applies different layers of the IEEE 802.15.4 protocol stacks, Application layer, Network Layer, MAC layer, PHY layer etc so as to enable fault-resilient and optimal best forwards IoT node selection for data transmission. The proposed model applies proactive IoT-node table management, data sensitive traffic classification, advanced service differentiation and data prioritization, service differentiation and fair resource scheduling, and congestion detection at the network layer, adaptive link quality measurement and packet velocity estiamtion at MAC layer, and energy and QoS centric dynamic power management and switching at the PHY layer. Though, in mobile-IoT ecosystem ensuring reliable data transmission is must and therefore in this research proposal three key parameters; dynamic link quality, pakcet velcity, congestion probability (or buffer availability) are applied to perform best forwarding path selection. The parameters could be applied cumulativelly to derive a node rank matrix that can be used to signify suitability of a node to become IoT forwarding node. This as a result could avoid any link-

outage probability and data drop probability that eventually enables QoS centric and reliable data transmission over mobile-IoT ecosystem. It can be effective for mission critical communication over smart city architecture to make timely decision. A snippet of the proposed cross-layer architecture based mobile-IoT protocol is given in Figure 1.

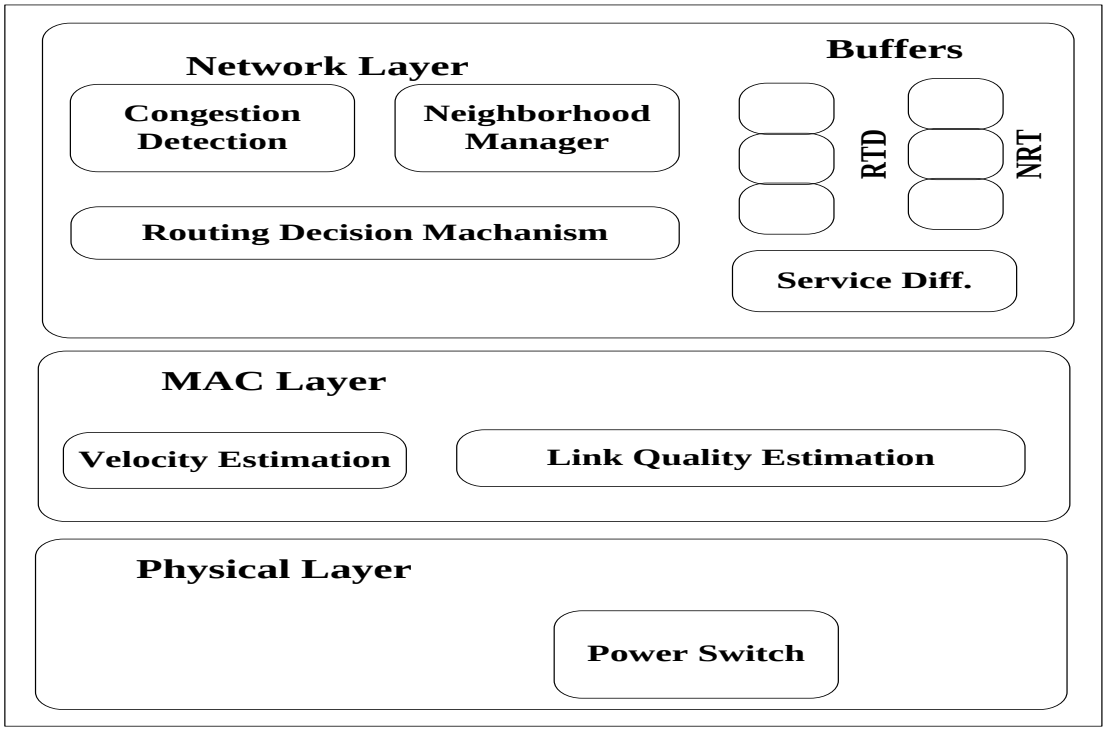

Figure 1 *CLCbased QoS-Centric Data Gathering in Mobile-IoT EcoSystem for SCPM*

BIG DATA COMPUTATION FOR SCPM

Now, once the data has been collected from the different sensor nodes, it is stored on cloud infrastructure or BigData warehouse where the data is processed to meet the user demands who make query for certain information. Or the processed data is shared amongst the allied stakeholders to meet their respective demands. Considering major classical BigData centers that use classical Hadoop based platform often undergoes huge computational time and complexity (due to native Map Reduce computation). Therefore, to avoid this problem we propose a robust Apache-Spark based cloud system or BigData infrastructure that could enable time efficient and reliable computation to meet user demands.

Considering the fact that from BigData warehouse where the sensory data or allied data are stored in certain format, when user makes query to retrieve information the classical approaches use normal search-term matching based results, which can be further augmented by means of ontological or Semantic technologies. With this motivation, in this research we propose to use latent semantic analysis (LSA) technology to exploit data stored and provide most suitable and reliable data as query-result to the users. It can make overall service support more reliable and QoS oriented. In addition, there can be gigantically huge data sets on the cloud server and therefore it is proposed to use certain robust and more efficient machine learning methods to yield accurate and time efficient data processing. Furthermore, this approach can help identifying best suitable audience for certain information and hence can push the information to the target audience efficiently. It can enhance overall performance of the system. Thus, the overall technology being proposed to accomplish targeted IoT-Big Data infrastructure for SCPM implementation in Muscat is given as follows:

Table 3 *Proposed SCPM module and allied Technology*

Targeted SCPM Vertical
• Smart Governance • Smart Health • Smart Traffic Surveillance • Smart Weather • Smart Energy • Smart Mobility • Smart Grid • Smart Economy • Smart Environment • Smart Metering • More (Those all SCPM concept employing Sensor technologies and BigData analytics)

Technology	Proposed Mechanism
IoT/M2M/Sensory Communication	The proposed CLC based QoS-Centric Data Gathering in Mobile-IoT Eco-system for SCPM (Figure 1).
BigData computation	1. Apache-Spark based computation 2. Resource Distribution Framework (RDF) based data storage (an ontology concept) 3. Semantic (Latent Semantic Analysis) data analysis based (in addition to the classical frequent search) query-data provision or data recommendation to the users. 4. Machine Learning based data classification to meet precise data delivery to the users. 5. Advanced analytics
Note: During implementation the better technologies would be explored (as per industry standards and availability) to ensure optimal performance.	

The overall proposed SCPM paradigm can be presented as follows:

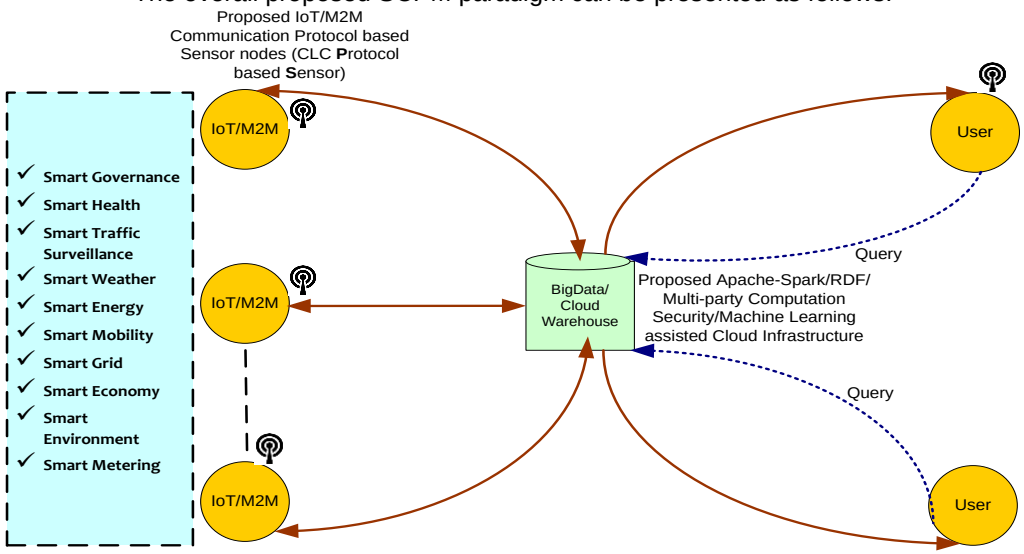

Figure 2 *Proposed IoT-BigData Infrastructures for Integrated SCPM (I-SCPM) in Muscat.*

I. Significance

Some of the key novelties and robustness of the proposed SCPM model are given as follows:

- Unlike classical sensor data gathering protocols (which are defined due to statistical nature of sensor deployment), in this proposed model at fist it is intended to augment data transmission routing protocol with the cross layer concept that exploits different layers of the IEEE protocol stack to ensure reliable data transmission.
- Since the proposed IOT/M2M communication paradigm ensures multiple parameter based routing decision it can assure reliable data gathering over IoT/M2M ecosystem for SCPM.
- The proposed routing model can be applied for any sensory network (or Smart City concept operating on the basis of sensor collected data).
- The proposed model applies highly robust computational paradigm such as Machine learning, semantic data nature, RDF data management, Spark platform that all can ensure higher performance than the classical Hadoop based approach.
- The proposed system can be applied for Hybrid network as well that makes it more suitable for real-time communication over SCPM.
- Since, the proposed system intends to apply privacy preserved SMC computation platform (secure multiparty computation), it can achieve optimal security across the network to serve seamless communication and data access for Smart City planning and management for Muscat.
- In addition, the proposed I-SCPM model can have numerous advantages as being single platform (cloud) based integrated solution it can be cost effective as well.

CONCLUSION

In this paper, we proposed an IoT-based system in order to achieve smart city concept. In this work we explored Muscat's (people) choices for Smart City planning and management. It performing real-time decisions based on current city scenarios. To process a huge amount of data, coming with very high speed, we use Multilayer optimization model. On the other hand, numerous case study has been performed for the already existing smart city concepts

across the world (USA (North America—Philadelphia and Seattle), Quebec City (Canada), Mexico City (Mexico), Hong Kong, Beijing, India (Raipur), London, Tokyo, Amsterdam, etc). In future, we are planning to deploy the system using practical smart systems to test the real world implementation and feasibility of the system.

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