Journal of Computer Applications and Information Technology
Vol. 1, Issue. 1, March 2025, pp. 42~51

Wireless Technologies for Internet of Things Applications in Smart Cities

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Article Info

Article history:

Received Jan 15, 2025
Revised Feb 27, 2025
Accepted Mar 2, 2025

Keywords:

Internet of Things & applications
Intelligent community
Monitoring
Opportunistic connections

ABSTRACT

Since the term of an intelligent community was invented, IoT (Internet of Things) has been assumed as the main framework in a smart city. The spread of off-the-rack cell phones outfitted with various remote interfaces along with advanced sensors is preparing to original remote Internet of Things (IoT) situations, portrayed by multi-bounce framework fewer remote systems where gadgets conveyed by clients go about as sensors/actuators just as system hubs. Specifically, the WORK shows Real Ad-hoc Multi-bounce Peer-to peer-Wireless IoT Application (RAMP-WIA), a new arrangement that encourages the turn of events, sending, and the executives of utilizations in sparse Smart City conditions, described by clients ready to work together by permitting new features to be sent on their cell phones to distantly screen and manage fixed/cell phones. Therefore, the recent work promotes the importance of IoT technology on the technology roadmap (TRM) and RAMP-WIA of an intelligent community. These results not only explain the probability and reliability of the projected approach.

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1. INTRODUCTION

At present, it is hard to discover a consistent description of the perception of Smart City. The gadgets are regularly composed in frameworks or systems of cutting edge sensors, which catch and scatter sight and sound informational indexes, frequently of extensively huge size. Furthermore, a consistently developing choice of gadgets (cell phones, tablets, and PCs, yet also wearable gadgets, keen TVs, savvy electric machines, and any sort of device prepared for the IoT) furnished with various system interfaces (LTE/4G, WiMax, Bluetooth, WiFi, Ethernet, and so forth.) and advanced detecting capacities are entering the market, in this manner expanding much further the measure of detecting information created. For example, on the head of at any rate two cameras and a receiver, present-day cell phones include an iris scanner, a weight sensor, a unique finger impression peruser, the speed sensor, a spinner, a gauge, a nearness sensor, a guide, a pulse detector.

Specifically, Intelligent Communities overall are grasping Internet of Things (IoT) advancements to smooth out their activities and assemble the developing desires for their residents. These days, residents in the main energetic urban communities are as of now observing numerous activities intended to make urban administrations more brilliant, regardless of whether for transport, stopping, illumination, interchange, and dissipate administration, security, or law implementation. Urban administrations fueled by the Internet will surely upgrade resident personal satisfaction, yet building up this new age of administrations needs to deal with testing perspectives, for example, effective parcel dispatching in significantly powerful and potentially divided remote systems.

These applications are relied upon to execute keen data spread capacities on the head of a dispersed design of programming parts running on the head of fixed sensor frameworks, inadequate portable hubs restlessly meandering and cooperating artfully, edge gadgets situated in nearness of either crude information

sources or data buyers, and the Cloud through Internet-empowered cell phones sharing their availability to the Web.

The crude (detecting) information assortment and handling capacities actualized by Wireless IoT Applications are essentially more perplexing than those normally originate in Wireless Sensor Network (WSN) requests. Truth be told, WSNs are normally structured and sent to accomplish quite certain objectives that are very much characterized at administration execution time and are along these lines probably not going to be misused for various objectives, either simultaneously or in various timespans. Hence, hubs of WSNs are normally designed in a particular manner, with constrained necessities to definitely adjust their conduct (regardless of whether configurability and upgradeability of programming segments might be considered as an or more). Rather The use of radio-frequency IoT in sparse intelligent cities has a significantly assorted, active, and broadly useful nature; they ordinarily execute a wide range of however simultaneous information assortment, what's more, preparing undertakings, and give a lot of administrations that may completely alter within their lifespan.

Cell phones, in our opinion, will play a crucial role in enabling wireless Internet of Things programs since they will be entrepreneurially received to progressively expand and improve Intelligent Society situations, by sending information just as by carrying on as IoT gadgets this is able to monitor and manage the general condition. Specifically, by exploiting their inescapable accessibility and expanded programming/equipment capacities, cell phones will turn into a coordinated piece of Smart communities are going to work together to help multi-jump network, by powerfully and straightforwardly interrelating each other (I) to make single-bounce joins in a shared manner and (ii) to cooperatively dispatch parcels by going about as middle person hubs among senders and collectors (notwithstanding abusing the "more conventional" yet inconsistent accessibility of foundation availability, e.g., in light of IEEE 802.11 Access Points).

2. RELATED WORK

Shrewd urban situations various uses for IoT are gotten a significant consideration by way of logical writing as of late. Just to give some outstanding models, consider that Smart Cities can give another age of the continuous and time-basic, area, social-, and setting mindful administrations to their computerized residents, for example, for crisis and human services [4], observation [5], amusement, and social great [6,7]. Ongoing exploration action has been centered around a wide range of IoT-related subjects, for example, occasion gauging [8], WSN directing conventions [9], multi- sensor data combination [10], plan of action and benefit amplification [11], ontologies [12], administration models [13], nature of practice [14].

Data-Centric Networking (ICN) is an additional hopeful exploration field introducing answers for help application correspondence in remote and heterogeneous systems administration situations, additionally permitting simpler sending and the board insufficient intelligent cities for radio Internet of Things (IoT) uses. Amadeo et al., for instance, presented CHANET, an ICN engineering for IEEE 802.12 MANETs [24].

For CHANET to identify the material, naming is essential, and it utilizes communication for the transmission of both intrigue bundles and information. Other intriguing methods actualized in CHANET to expand adequacy in the remote condition are the catching of close by hubs' transmissions and the neighborhood dynamic procedures concerning parcel sending. Mendes [25] portrayed pioneering, content-driven engineering that exploits the expanding number of inescapable frameworks accessible to share material currently. The information and context-oriented networking (ICON) system that is being developed incorporates techniques in the study areas of information-driven systems administration and deft systems administration. Al-Turjman [29] introduced and thought about a few strategies for the IoT worldview, contrasting corresponding to vitality utilization, cost, and deferral.

In the stage of coordination, Wireless IoT Applications can profit by the executive's choices dependent on powerfully accumulated setting data. For example, Pilloni et al. [31] proposed an according to the approach planned for expanding the lifetime of gatherings of hubs, to satisfy QoI prerequisites. For this reason, hubs organize one each other using an agreement approach explicitly thinking about the lifetime of hubs, stockpiling limit, processor capacities, and accessible data transfer capacity to enhance the portion of errands. Cao et al. [32] all the more explicitly introduced cutting edge writing proposing coordination arrangements in the business area. Specifically, it presents a few works targeting accomplishing agreement among a few specialists in disseminated situations. Caraguay et al. [33] recommended an answer to get better arrange the executives additionally considering novel systems administration ideal models, for example, SDN and NFV. Specifically, the proposed SELFNET arrangement permits to handily inquiry huge measure of observed information, assembled from heterogeneous sources. Also, data gave by SELFENT could be linked to provide improved data and enhance the system's Quality of Service (QoS) by properly coordinating and authorizing legitimate activities.

3. WIRELESS IOT APPLICATIONS

We have recognized three essential highlights that ought to be bolstered to cultivate the advancement of Applications for cellular IoT in sparse clever cities: one-bounce availability the executives to make simpler the dynamic making of gadget to-gadget associations, sharp multi- jump bundle the board to appropriately dispatch parcels at multi-jump separation likewise in the event of briefly divided remote systems, and use coordinating tools to promote the distribution and organization of mobile Internet of Things programs.

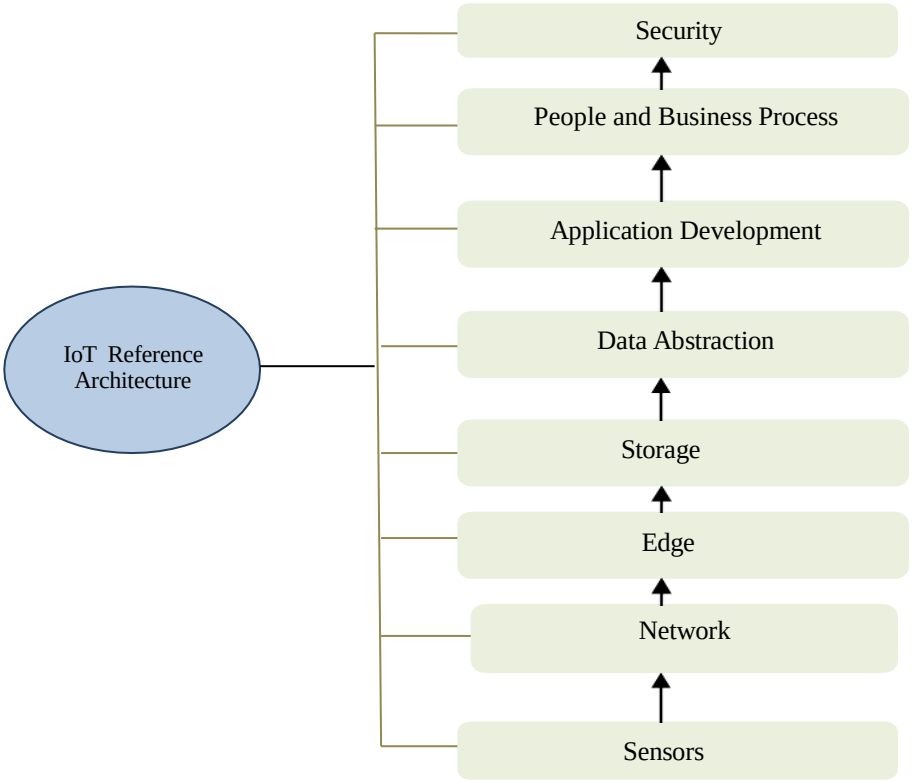

Figure 1. Reference Architecture of IoT

Beginning from the base layer of the projected orientation design, the primary goal the creation and operation of IP networks with the aid of the Single-Hop Connections Network dependent on remote conventions broadly accessible on off-the-rack portable hubs. Specifically, the layer ought to give the capacity of:

- Manually designing the IP network. For this situation, designers can enhance systems to accomplish explicit objectives dependent on the full information on nature, that is, hub area and developments. In any case, since hubs may have capricious development designs, it might be unfeasible (or exceptionally complex with significant expenses as far as data scattering and concentrated control) to physically arrange every single system connection of hubs;
- Handling Intellectual Property availability in a self-sufficient way. The stratum ought to have the option to alter organize setups to exploit conceivably accessible hubs in a similar area, both getting to and giving availability in a distributed manner. As such, it is conceivable to accomplish a serious extent of dynamicity while concealing any connection availability unpredictability. The objective of the Multi-bounce Communication Layered Protocol is to facilitate parcel delivery between hubs using numerous single-jump joins gave by the layer underneath. To this reason, we recognize two essential highlights this layer should bolster:
- It ought to productively oversee arrange disappointments and parceling that must be considered as an incessant occasion in the unsatisfactory technology-driven scenarios. Because of this, we have effectively increased the functionality of our RAMP software by designing and implementing the RAMP Advantageous Networks (RON) part, straightforwardly backing the effective administration of bundles in the event of the goal hub is incidentally inaccessible. If there should be an occurrence of bundle dispatching disappointment, RON endures parcels and afterward consequently retries to transmit them to the goal in the event of connection availability changes (in any event, copying bundles to amplify bundle

conveyance probabilities), that is, since a hub moved to start with one area then onto the next giving permission to novel IP subnets has adjusted the setup of a system boundary.

Programming interface at the The Multi-bounce Communication Layered Model can help adjust hub behavior to provide a reasonable trade-off between asset sharing to help parcel the board and asset safeguarding to stay away from an excess of overhead (extra subtleties on our usage in Section 5).

At last, the Coordinating Cellular IoT Software Layer provides devices to enhance detector and processor hub development. For instance, this level enables the simple sending of orders and hides the complex structure of hub coordination. Refreshed programming parts (extra bits of knowledge in Sections 6 and 7 individually) among sensors and organizers identified with a similar Wireless IoT Application. Simultaneously, it bolsters the tuning of the parcel the board to accomplish an appropriate tradeoff among bundle conveyance probabilities and the cost of the bundle the executives. For example, when communicating something specific, sensor hubs can indicate appropriate expiry esteem after which messages ought to be disposed of regardless of whether not yet accurately conveyed to the goal by the Multi-jump Networks Layered Level. Through an engineering perspective, it misuses natives gave by the layer beneath to help the posting of data with start to finish permeability by receiving four distinctive semantics:

Coordinated, to deliver packages from an originator to a specified recipient, for instance, to transmit an archive using a document distributing request;

1) Anyone-to-any, which delivers bundles through an originator to a single hub of numerous recipients; for example, in a dense intelligent city scenario, it can deliver discovered information to one of the accessible sinks;

2) One-to-many, to send bundles from a sender to each hub of a lot of recipients, for instance, to make an impression on a gathering of a visit application;

3) One-to-all, to send a bundle to each hub of the system, for instance, an alarm message if there should be an occurrence of fire peril.

The IoT Connection of Links Element

In order to develop and communicate cellular IoT apps that are suitable for the state of an inadequate smart city, it is necessary to logically and comprehensively believe in more than simply the flexibility of hubs conveyed by clients, yet also the genuine accessibility of remote interfaces in off-the-rack gadgets. From one perspective, in Smart Cities described by inadequate hubs working together with each other to help Wireless IoT Applications, the dynamicity of the system relies upon the portability of clients; by affecting from an area to a different they get to various IP subnets, expanding the likelihood of scattering parcels towards their goals. Nonetheless, if clients (and in this manner their cell phones) don't move for a generally significant time-frame period, bundle scattering is unimaginable, since cell phones continue misusing similar IP subnets.

Then again, to give an answer that can be practically received, prerequisites and limitations originating from certifiable situations must be taken into appropriate thought. Specifically, since hubs making the overlay organize are chiefly founded on off-the-rack gadgets, for example, cell phones and workstations, gadget to- gadget correspondence can be founded on either IEEE 802.11 or Bluetooth, the main remote medium-run conventions that are at present generally accessible. A principal outcome of embracing IEEE 802.11 and Bluetooth is that every gadget can regularly perform one-jump associations; IEEE 802.11s cross-sections and Bluetooth scatter nets are not effectively accessible on off-the- rack gadgets. At the end of the day, genuine situations don't permit run of the mill WSN arrangements where parcels stream from hub to hub misusing a solitary remote interface in a multi- bounce style as is conceivable by utilizing innovation, for example, ZigBee. Indeed, IP subnets gave by cell phones conveying in a gadget to-gadget style may speak to numerous availability islands of a statically divided system. Indeed, even the appropriation of a multi-jump overlay layer dependent on deft systems administration might be insufficient to effectively convey parcels, since the constrained dynamicity of systems can forestall to spread parcels towards their goal.

Digging into better subtleties, LCC depends on three- layered sub-segments:

- The Configuration Part or Component, Runtime component, and Transparency Component

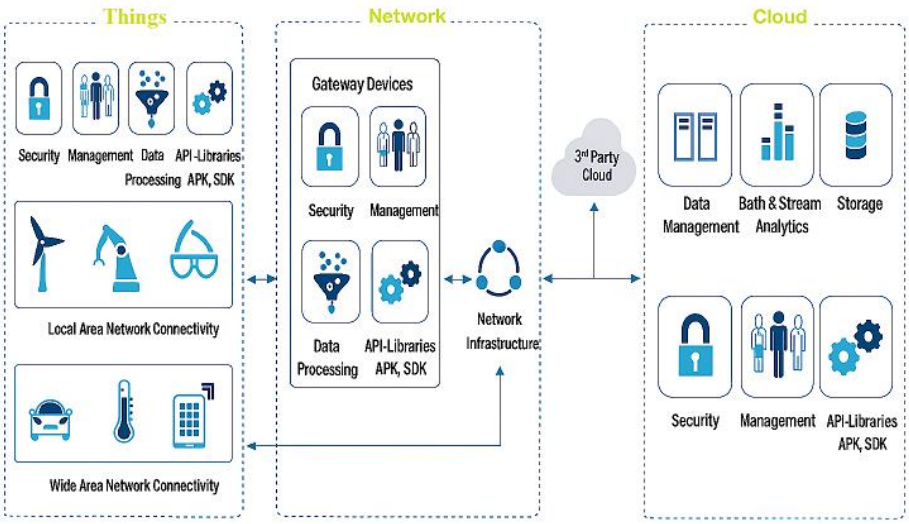

Figure 2. IoT Connectivity Technologies

4. DYNAMIC PROCESSING UPDATE

New administrations gave to (and perhaps at the same time by) residents will need the active arrangement Featuring new uses for radio IoT, by spreading new programming segments or redesigning as of now sent ones to exploit and coordinate with extra equipment frameworks. This perception directs for an answer to improving the inadequate Smart City situation by permitting the dynamic dissemination, arrangement, design, abuse, and redesign of code communicating with sensors and handling accumulated information on hubs making the system itself. To this reason, we recognize three essential arrangements:

1. Dynamic code circulation. The conduct indicating how hubs ought to cooperate with sensors and procedure accomplished information is disseminated to hubs as pre-arranged/content records. As such, the measure of code dispersed through RAMP parcels is limited, in this manner permitting to expand the proficiency of conduct change systems. Be that as it may, for this situation the RAMP middleware is responsible for overseeing equally the dispersion and the implementation of the system;
2. The selection of the entrenched and kept up open- source Kura undertaking can recover the dependability of the arrangement while limiting the necessary upkeep exertion. Truth be told, Kura is a Java-based Open Services Gateway activity (OSGi) empowered structure previously sustaining, between the entire obtainable highlights, to handily oversee programming segments from distant areas;
3. To additionally bolster the energetic arrangement and redesigning of hubs, it is likewise conceivable to abuse Docker to disseminate among hubs code, yet also the product condition the code must run in. Truth be told, Docker permits to install in a solitary compartment all the product bundles it is requisite to convey, subsequently incredibly rearranging the arrangement (and overhaul) of new programming in heterogeneous gadgets.

Given these contemplations, we have settled on an answer dependent on powerful code dispersion, since it gives bigger materialness (it very well may be effectively embraced on whatever hub that utilizes the Java-based the RAMP software) while ensuring limited latency (just the code that is executing the fresh conduct must be moved). We are going to conduct more thorough research on the viability of choosing Container in sparsely populated intelligent cities. Situations, in the long run abusing RAMP to dispatch compartments while conveying them just on reasonable gadgets, for example, Raspberry Pis. The three arrangements above there altogether various granularity stages; besides, they show away from andcons as far as normalization, all-inclusive statement of arrangement, effectiveness, and appropriateness. As a matter of first importance, Kura and Docker speak to open-source arrangements picking up energy in the logical and modern network, as of now being worked on and with persistent enhancements and overhauls. As far as the consensus of the arrangement, Docker is the most ideal decision, since it very well may be received on the head of most spread working frameworks, running from Windows to numerous kinds of Linux. What's more, it can contain any kind of programming condition, in this way permitting one to disseminate and send (nearly) any arrangement. Be that as it may, Docker holders are as a rule of generally enormous size (likely more noteworthy than 100 MB) and in this manner don't fit severe effectiveness necessities as far as systems administration traffic of scanty Smart City situations, whose hubs are eager to work together yet couldn't be accessible for dispatching gigantic measure of information. Also, Docker can't be effortlessly sent on off-the-

rack cell phones, presently requiring established Android gadgets and custom pieces. Kura is as of now misused on numerous gadgets and its highlights are appropriate on gadgets with constrained equipment assets. Be that as it may, similar to Docker, Kura is likewise not accessible yet for versatile conditions, for example, Android, along these lines constraining its relevance. Likewise, Kura uses situations where hubs are on the Internet -empowered, and in this manner, it isn't reasonable for sensor hubs reachable through multi-bounce ways.

5. EVALUATION OF RESULTS

1. Assessment regarding the RON part while sending bundles in an isolated intelligent town situation abusing our LCC and RAMP-WIA. For this situation, the fundamental reason for existing is to quantitatively show that the projected arrangement adequately transmit parcels at multi-bounce separation likewise in a scanty remote system created by off-the-rack gadgets;Evaluation of the majority based circulated incitation and versatility strategy arrangement. For this situation, the objective is to analyze the viability among the suggested arrangement by demonstrating way the detector hubs powerfully find/ connect to the gaming device hubs and embrace the flexibility strategy on the off chance that a controller hub isn't accessible any longer.

2. The objective of this area is to check and evaluate the viability of the planned access by concentrating on a couple of key parts of the actualized RAMP-WIA middleware. Specifically, execution outcomes detailed beneath depending on experimentation over genuine and off-the-rack gadgets, with the principle motivation behind testing the specialized sufficiency and handy achievability of the correspondence and organization components utilized in RAMP-WIA. Increasingly broad and thorough execution results, given a Large-scale metropolitan testbeds are outside the purview of this paper and are among the most pertinent areas for our upcoming research.As a matter of first importance, we have attempted the two-bounce condition shown in Figure 5, which is framed by an IEEE 802.12 hop between L1 and a Raspberry and a wireless leap between a smartphone running Android (A1) and a PC (L1). Pi 3 (RPi), playing out the accompanying advances:

- t0: A1 sends a bundle to RPi yet the Bluetooth isn't accessible and the parcel is continued by RON;
- t1: A1 (manual design) makes a Bluetooth connect with L1;
- t2: sooner or later RON on A1 recovers the persevered parcel and searches for the goal hub RPi;
- t3: RON on A1 doesn't locate any accessible way towards RPi since the IEEE 802.11 connection isn't accessible. Thusly, it sends the parcel to the neighbor hub L1;
- t4: L1 gets the bundle and attempts to dispatch it to RPi. Be that as it may, since there is no way right now accessible, RON on L1 endures the bundle;
- t5: L1 makes an IEEE 802.11 connection with RPi (manual setup);
- t6: inevitably RON on L1 recovers the endured bundle and searches for the goal hub RPi;
- t7: RON on L1 finds a way towards RPi using the IEEE 802.11 connection and in this manner, it sends the bundle to RPi.

In this paper, we tried the arrangement over multiple times, accomplishing a normal start to finish parcel transmitting time of 115.8 s with a normal divergence of 4.8, exhibiting that the projected arrangement can transmit bundles towards the goal in conditions described by visit organize segments, by completely misusing any availability chance. Note that the past qualities likewise incorporate the amount of time needed to physically arrange the system, which involves the time somewhere in the range of t0 and t1 and the moment somewhere in the range of t4 and t5 evaluated in 55 s for every bounce. As such, estimated values incorporate, from one perspective, an opportunity to sit tight for manual system setup and, then again, the time needed for RON to intermittently revise bundle broadcasts (time of 10 s). In any case, Package delivery takes only 5.6 seconds (115.6seconds × 55 seconds) assuming the time required to physically system reconfiguration. Specifically, when a hub enacts another connection with another RAMP hub, it takes about 2.9 s to advance parcels because of RAMP neighbor disclosure and RON techniques (containing occasional holding up time, bundle reestablishing, and parcel sending to new neighbors).

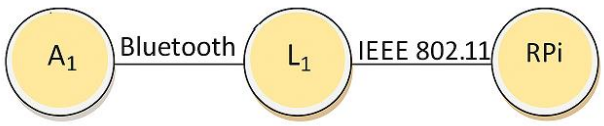

Figure 3. Two-hop deployment scenario

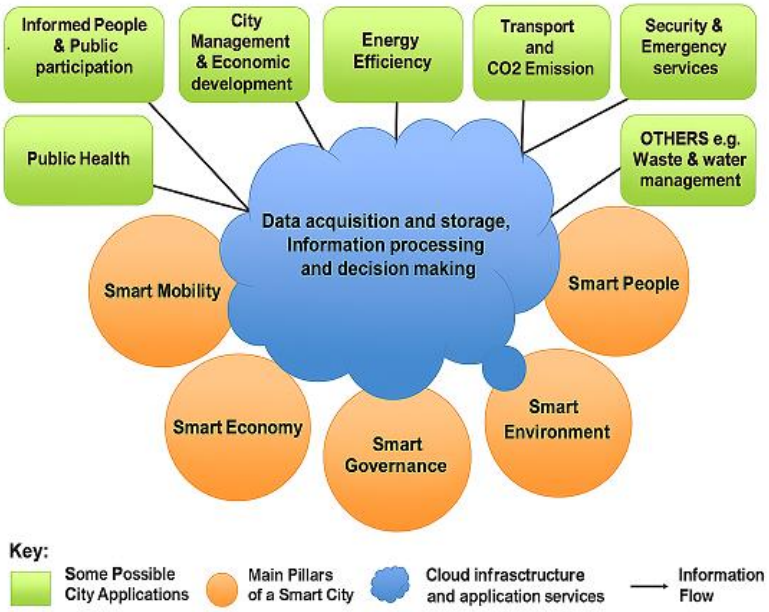

Figure 4. Smart City application in cloud in cloud computing scenario

After that, the previous circumstance is developed with a supplementary strategy separating A1 (the transmitter) and RPi (the authority), and by using motorization to force LCC to operate with slow and disordered courses of action (see Figure 5). This circumstance in like manner consolidates a reliably on an Internet connection, whereas Wireless and IEEE 802.12 joins are every so often sanctioned and deactivated by LCC. Also, LCC on center point A2 is in user simply work, trading between the two frameworks against L2 and RPi.

While embracing languid and frenzied strategies, the start to finish bundle dispatching takes by and large 365.4s and 158.9s individually. Hence, it is conceivable to see that the feverish arrangement appropriately brings down the necessary time on account of decreased HC, RS, and RW values. Be that as it may, the necessary time is still.

For the most part high as a result of two major issues. In particular, when the Bluetooth interface someplace in the scope of A1 and L2 is used, LCC needs around 93s to truly authorize IP accessibility while RON takes around 10s to form careful which it's impossible towards RPi (7.5 s to retry on different occasions to propel the package towards the as of late known way and 2.5s to vainly look for an elective way). Likewise, when center point A2 gets the package from L2, it has as of late traded framework and a short time later it needs to keep it together for the going with hotspot change period. It is noteworthy that at whatever point LCC alters orchestrate plans it establishes a connection with the close by RON, thusly impelling the last when additional system openings rise and improving the adequacy of pack transport. Thinking about just RON targets and package transfer, the deferral of the underlying three jumps is approximately 2.6s per skip, out of which 2.4s are spent searching for RPi (ineffectively in each case because there isn't a multi-hop route to RPi) and the remaining time is spent informing the group to the newly exposed one-bob neighbor (because RPi isn't available). Or perhaps on the final hop, A2 successfully looks for RPi, the package's final goal, and sends the group in 0.2 seconds.

To assess the majority depend on disseminated activation & versatility strategy arrangement we have built up a Presence Sensor Java application (in light of the Sensor segment) operating on two webcam-empowered Raspberry Pis and a PC (hubs RPix, RPiy, and L2, Figure 5) intermittently securing pictures webcam and sending ready messages just if the past and current pictures contrast more than an edge. What's more, a Presence Controller application (in light of the Controller segment) runs on a PC (hub L1, Figure 4). Digging into better subtleties:

- Presence Controller on hub L1 recorded within it as a director hub offering the "nearness" application;
- Presence Sensors on hubs RPix and RPiy seek out a supervisor hub providing the "nearness" application, and afterward go along with it;
- Presence Sensors on hubs RPix, RPiy, and L2 intermittently get images and communicate ready data at whatever point pictures contrast over 40% (default esteem);

- Presence Controller on hub L1 intermittently sends pre-order data's to sensor hubs in the "nearness" gathering; Sooner or later, the Presence Controller sends an order to the sensory hubs of the "nearness" gathering using what comes next qualities:
- Sensing hub rate: 100 percent, meaning that only when each sensing hub is reachable is order data provided;
- Current picture contrast esteem: 20%, that is, ready data are transmitted if pictures vary over 20%;
- Resilience picture contrast esteem: half, that is, if there should be an occurrence of controller inaccessibility, ready messages are sent at whatever point pictures vary over half.

To this reason, the Presence Controller on hub L1 misuses the operator will notify the detector of the "pre-order" hubs:

- If each sensor hub answers with a "here-I-am message" (default hold up a break of 3 s), hub L1 sends the order. At the point when sensor hubs get the order, Sensor parts misuse the enlisted audience to advance the order to Presence Sensor cases;
- If not, controller hub L1 doesn't send the order, since the sensor hub rate necessity isn't satisfied.

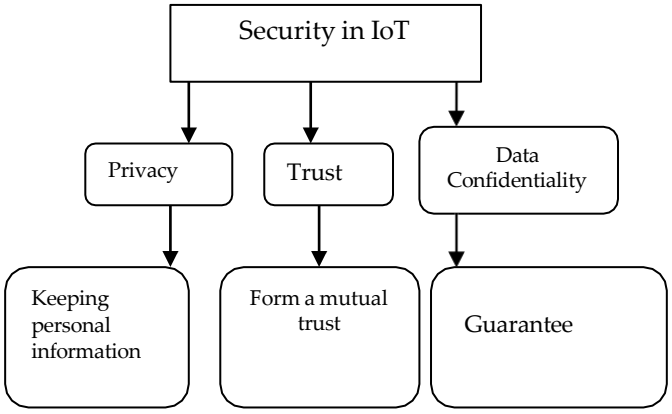

Figure 5. IoT security aspects

At that point, the system's controller hub L1 has been removed. Five seconds later, sensor components on sensor hubs detect the absence of a microcontroller. Hub anything else (since they don't get intermittent pre-order messages) and start a disclosure methodology to search for another one (since the three hubs are not Internet-empowered, they don't begin the pioneer political race calculation). Following 20 seconds (adjustable limit), the sensing segments realize that the system is without a controller and misuse audience-based engineering to relay data to the Attendance Detector. Cases an "initiate strength strategy" occasion.

6. CONCLUSIONS

This new work provides a course of action sustaining the new growth and dynamic association of usages in system less far off conditions, expressly considering insufficient Smart City circumstances where mobile phones passed on by customers cooperate to help the distant watching as well as management of sensing centers. Specifically, the advanced RAMP-MIA interface system grants dynamical arrangement of adaptable centers, not precisely at the correspondence level, through the creation of fresh single-bob links and crafty package discharge at the multiple -bounce detachment, yet furthermore at the purpose level, by accepting programming sections on convenient centers to be sent and refreshed on-the-fly. Lastly, we plan to operate more broad and more start to finish execution assessments reliant on a veritable global laboratory using the scale predictable for the concentrated on sagacious town. Implementation conditions, In other words, having countless off-the-rack procedure.

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