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Exploring 6LoWPAN Based Intelligent Transport System for Surveillance

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***Abstract*—This time of internet of things (IOT) and ubiquitouscomputing technology demands that their future be dominance in all areas of human life. Towards this effort this paper proposes a novel architecture for intelligent transport system (ITS) for surveillance based on 6LoWPAN technology which also combines ubiquitous computing technology. The creativity of the proposed architecture lies in integrating maximum aspects of ITS surveillance into a single architecture. Also the combination of IOT and ubiquitous computing comes as an added advantage to existing ITS.**

***Keywords*— 6LoWPAN, CoAP, QOS, IEEE 802.15.4, IPV6/IPV4.**

I. INTRODUCTION

The existing ITS for surveillance do not make use of ubiquitous computing concepts and also do not include all the aspects of ITS surveillance in a single architecture. Hence we intend to design Intelligent Transport System (ITS) for surveillance to sense, store and transmit real time data about vehicles, traffic, road situations and all the issues pertaining to transport system. The users or clients have to register themselves with central station to get updates.

To this end the ITS for surveillance performs the following functions.

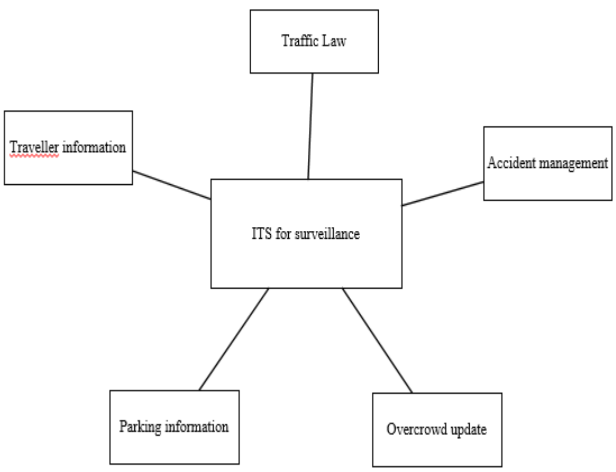

Figure 1: ITS for surveillance

Traffic law implementation

Sensor nodes which include camera sensors, speed sensors, gas sensors place in the appropriate places detect the cases of over speeding, wearing of seat belt, harmful emissions and this sensed data is processed at the central station and sent to the traffic police database for further action.

Parking information

Camera sensors placed in the main parking places give information about free slots in parking area which in turn can be shared with the registered clients through central station.

Overcrowding update

Camera sensors placed in overcrowding subject areas give information about the amount of traffic overcrowding and this is shared with the registered user's PDA through a central station or the questions from the clients about the overcrowding in a particular area can be answered with the help of sensor data which is stored in the central unit.

Accident management

Camera sensors and audio sensors are deployed in accident prone regions such as highways where seeking immediate help may not be possible. These sensors will alert the nearest hospital through a central station when unusual scene or a decibel level is detected. [1]

Traveler information

The user PDAs (clients) can be registered with the network and get information about the places of interest such as restaurants, hotels, parks etc. which will be useful for new people coming to that particular city or a place. Based on the location of the client, information about the nearest restaurant or a hotel can be provided and food could also be ordered even before he/she reaches the restaurant, provided the client provides his/her choice while registering to the network.

II. 6LOWPAN FOR SURVEILLANCE

The sensor nodes used in the proposed ITS for surveillance are considered to have an IPV6 address and they are low power devices which are connected to other IPV6 nodes.

Hence this network of low power IPV6 nodes comes under Low Power wireless sensor networks which is an IEEE 802.15.4 standard. The two most popular technologies of low power WSN are Zigbee/802.15.4 and 6LoWPAN. The reason why 6LoWPAN is chosen over Zigbee for ITS surveillance system is because 6Low PAN has significant advantages over ZigBee to suit the ITS surveillance system.
Firstly the 6LoWPAN has an adaptation layer in addition to the same physical layer and MAC layer of IEEE 802.15.4 standard. This adaptation layer guarantees interoperability with IP networks, performs header compression and address mapping between IPV6 and 802.15.4.networks. Hence when Zigbee devices can communicate with each other only if the new upper layer protocols are common in both devices, the 6LoWPAN devices support interoperability with IEEE 802.15.4 physical links as well as other IP devices.

Secondly bridging between a ZigBee and non-ZigBee devices requires a complex gateway whereas 6LoWPAN devices can communicate with the server on the internet without the need for additional translation mechanisms.

Thirdly 6LoWPAN nodes work in non-beacon enabled mode and their duty cycles depend on amount of traffic, but the delay introduced due to low power traffic is almost constant as opposed to ZigBee in which nodes experience relatively larger delays.

Lastly as compared to ZigBee, 6LoWPAN carries more payload as it reduces overhead related to security aspects.

Apart from these advantages there are certain issues to be considered when integrating 6LoWPANs with other IP networks though. [2] [3]

III. PROPOSED DESIGN

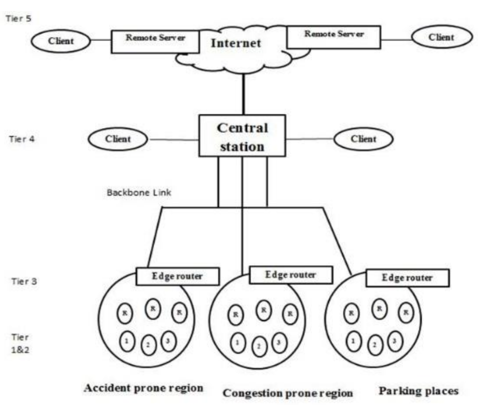

Figure 2: Proposed design

The proposed design for ITS surveillance consists of dividing the area under surveillance into three main regions which are accident prone region, traffic congestion prone region, parking places. These regions could be more than one in a particular city where ITS surveillance system is implemented. The topology used is considered to be star and has a 5 tier hierarchy. Each region will consist of IPV6 sensor nodes (indicated as 1,2,3 in figure2) which sense the data, local routers which do the local data aggregation and edge orborder router which typically connects the 6LoWPAN network to internet through a backbone link. Before the data from the sensors reach the internet, there is a central station (proxy) which performs the HTTP- 6LoWPAN integration. This server also collects the data from all the regions and performs the function of segregating the data based on the regions, process the data and send it to appropriate clients over the internet. For this the central station (proxy) must also have the database of the clients.

The first tier of the architecture consists of low power wireless sensor nodes indicated as 1,2,3 in figure2 with IPV6 address. These nodes are considered to be reduced function devices (RFD) as they only sense the data and forward it to the edge routers with minimum or no processing. Each LoWPAN node reaches the edge router through multihop connection by a forwarding mechanism and configures its link-local address by obtaining a prefix from its edge router. Hence both the LoWPAN nodes and edge routers share a same IPV6 prefix. A particular 6LoWPAN node may be a part of two regions and hence help in fault tolerance as well.

The second tier of the architecture consists of local routers which are also logical functional entities that perform the special role of coordinating and controlling its child nodes for local data aggregation, status management of 6LoWPAN nodes, etc.

The third tier consists of edge routers which are responsible authority for IPv6 Prefix propagation for the LoWPAN it serves. They are full function devices capable of routing traffic in and out of the LoWPAN, while handling 6LoWPAN compression and Neighbour Discovery for the LoWPAN. If the LoWPAN is to be connected to an IPv4 network, the edge router will also handle IPv4 interconnectivity. Edge routers typically have management features tied into overall IT management solutions. Multiple edge routers can be supported in the same LoWPAN if they share a common backbone link.

The fourth tier consists of a central station where processing of the data from each region is performed and the processed information is forwarded to appropriate clients directly (alarm to hospitals during an accident) or can be forwarded to internet remote servers to be sent to clients over internet (congestion updates, traveller information). This station also implements Constrained Application (CoAP) proxy/gateway which takes the responsibility of connecting the internet/IP/web to 6LoWPAN. As the IPV6 links and 6LoWPAN links do not share same application protocols, (IPV6 uses HTTP while 6LoWPAN uses COAP) a mapping between them is provided by the COAP proxy/gateway. [5]

The fifth tier consists of the Internet server to which the clients are connected and are served through the central station.

IV. Issues And Possible Solutions In Implementing The Architecture

The prominent issues in implementing this architecture as follows:

A. Integrating 6LoWPAN with traditional internet (IPV4, IPV6):

As most of the sensors nodes used in the proposed architecture are embedded with cameras and hence the sensed data is large. The maximum Transfer Unit (MTU) of IPV6 is 1280 bytes. Hence to accommodate the data from the sensors, 6LoWPAN has to perform fragmentation and reassembly. This results in degradation of performance. Hence there is a need to find ways to avoid fragmentation and reassembly and hence better performance. As this architecture consists of constrained nodes and constrained networks in terms of energy, usual http application protocols do not hold good. Hence a new protocol called CoAP which is designed for 6LoWPAN networks has to be used. Hence there is a need to integrate this protocol with the traditional internet application protocols. [5]

B. Providing QOS:

As the proposed architecture is supposed to cover wide varieties of services starting from traffic law enforcement (noncritical) to accident management (critical), there is a need for modelling the QOS according to the data delivery model. The following table shows the classification of services based on data delivery model and their level of QOS requirement.

Data delivery Model	Service	QOS level
Event driven	Accident management, service under traffic law enforcement such as over speeding etc.	High
Query driven	Traveller information, parking information, queries from the users.	Medium
Continuous real time	Accident management	Highest
Continuous non-real time	Services under traffic law Enforcement,overcrowd update	Low

There is a need for a scheduling algorithm to allocate the resources according to the levels of QOS required. [6] [9]

C. Providing Security

As the proposed architecture consists of 6LoWPAN nodes which are limited in resources mainly energy, it would not be feasible to use Ipsec suite or complex firewalls on each node for security purposes. Although link-layer security inside a 6LoWPAN (employing the 128-bit AES encryption in IEEE 802.15.4) provides some protection, communication beyond 6LoWPAN routers is still vulnerable. This increases the need for end-to-end security at the application layer. [2]

D. Deployment and safeguarding the sensor nodes

As there are huge number of sensor nodes to be deployed in the proposed architecture and which are of various types and require deployment in variety of places, some to be deployedin contact with the ground (gas sensors) and some on the roadside (camera sensors) and most of the sensors have cameras embedded within them, there is a need to safeguard these sensor nodes from climatic changes, human and animal/bird interferences. Hence care should be taken while choosing the places of deployment of these sensor nodes.

CONCLUSION

Although the proposed architecture covers most of the aspects of intelligent transport system, there may still be few more aspects such as vehicle collision avoidance, car navigation and traffic signal control systems. These aspects may be considered to further integrate into the proposed architecture. Also here all the nodes are considered to be stationary. By integrating mobile nodes in the form of on board units on vehicles, the efficiency of the intelligent transport system can be further enhanced.

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