Routing Protocol For Wireless Multimedia Sensor Network

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Routing Protocol For Wireless Multimedia Sensor Network

Major Project

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Certificate

This is to certify that the Major Project Report entitled “”**Routing Protocol For Wireless Multimedia Sensor Network”** submitted by **Ankit Kothari (Roll No: 12MICT09)**, towards the partial fulfillment of the requirements for the degree of Master of Technology in Computer Science and Engineering, Network Technology of Nirma University, Ahmedabad is the record of work carried out by him under my supervision and guidance. In my opinion, the submitted work has reached a level required for being accepted for examination. The results embodied in this major project part-I, to the best of my knowledge, haven't been submitted to any other university or institution for award of any degree or diploma.

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I, **Ankit Kothari**, Roll. No. **12MICT09**, give undertaking that the Major Project entitled "**Routing Protocol For Wireless Multimedia Sensor Network**" submitted by me, towards the partial fulfillment of the requirements for the degree of Master of Technology in **Computer Science & Engineering, Network Technology** of Nirma University, Ahmedabad, is the original work carried out by me and I give assurance that no attempt of plagiarism has been made. I understand that in the event of any similarity found subsequently with any published work or any dissertation work elsewhere; it will result in severe disciplinary action.

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Abstract

Wireless Multimedia sensor network(WMSN) is a network of interconnected devices by which we get multimedia content such as video streams, audio, still images data from the surrounding. Rreliability, QoS, and high bandwidth demands are some additional challenges of WMSN as compare to wireless sensor Network. For achieving real- time requirements for multimedia delivery of data, new protocol need to be made which guarantee limited reaction time(End-to-End delay) as well as strive to minimize energy consumption in data processing and communication. The QoS requirements in WMSN are very not the same as traditional networks. In this report various QoS issues and functionality of all layers in WMSN are discussed. And it also explains the routing algorithms which support QoS required for the WMSN and comparison between them is done considering different parameters.

The wireless sensor networks applications are supposed to solve the conflict of energy efficient communication and should achieve the desired qos like communication delay. To compaensate this challenge we are proposing a new protocol PASPEED that is capable of achieving application specific delays at low energy cost and that can dynamically adapt routing decisions. The proposed protocol is characterized as stateless localized having minimum overhead. It forward the packet by choosing the most energy efficient choice from the neighborhood table according to the required speed maintaining the delivery speed also.

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Chapter 1

Introduction

Wireless Multimedia Sensor Networks (WMSNs) is a wirelessly interconnected devices for network. Over this network this devices can retrieve multimedia contents like audio, image, videos and data from the surrounding.

This wireless network consist of sensing nodes which are operated on small batteries. This sensor node is used for monitoring and sensing and data transmission towards the base station. For example the videos sensor will be active by the data sensors to provide videos, it can independently operate to sense or transmit videos of the surrounding.

We will be considering mechanism to encode the video sensors and transmits of videos from sensors to base station which is called sink. The major factors will be the low powered and computational capabilities of the sensors in this scenario. The transport of the realtime videos requires the large data video traffic that require to meet the periodic payout deadline of video data frame and the lossy hop between the base stations and a sensor nodes.[2]

1.1 Applications

1. **Multimedia surveillance sensor networks:** WMSN will consist of interconnected small video sensors cameras which are powered by batteries, all of them are linked with low powered wireless transceivers that is competent of processing, receiving,sending data. We can use Video and audio sensor to enhance surveillance Application against crime or terrorist attacks.[1][2]

2. **Storage of potentially relevant activities:** Multimedia sensor can be recorded

activities like thefts, traffic violations videos and images.[2][1]

3. **Traffic avoidance, enforcement and control systems:** In urban areas multimedia sensors can be utilize to determine congestion of traffic, thus traffic can be avoided. They can be used in smart parking advice which can help drivers with automated parking systems.[1][2]

4. **Advanced health care delivery:** The combine form of Telemedicine sensor networks can integrate with 3G network to provide health care service. Patient can monitor parameters like temperature of body, pressure of blood , ECG, breathing activity, pulse oximetry. Remote medical centers provide advanced remote monitoring of their patients by video data and audio data sensors, location data sensors.[1][2]

5. **Automated assistance for the elderly and family monitors:** Multi-media network can use to monitor and study the elderly people behavior to identify illnesses causes . This network can provide remote assistance between elderly people and their relatives.

6. **Environmental monitoring :** For research and development purpose, videos and images taken in time-critical fashion help them to determine the drastic changes in environment. For example, oceanographers use arrays of video sensors to determine the origin of sandbars by image processing technique

7. **Human locator services :** Videos and image, a with advanced Digital signal processing technique, can use to find criminals and to locate a missing person.

8. **Industrial process control :** Factors like imaging, temperature, or pressure used for control critical-time industrial process. It is the applications of vision techniques of computer to manufacturing and industry [1][2]

1.2 Factor influencing for design of network of multimedia sensors

1. **Application-specific QoS requirements.**Different application envisaged on Wireless multimedia networks are different requirements. In spite of delivery modes data

typically in sensor network, snapshot and streaming multi-media contents are also included in multimedia data. Multimedia data of snapshot type contains event triggered observations obtain in a less periods of time. Streaming multi-media contents are generated large periods of time, require sustained information of delivery.

2. **Large bandwidth demand.** Multi-media data mainly including video stream data requires transmission bandwidth in order of higher magnitude than the bandwidth supported by current sensors. Therefore, transmission techniques with low-power consumption or high data rate require to be leveraged.

3. **Multimedia source coding techniques.** For a wireless multi-hops environment, uncompressed raw video streams require excessive bandwidth.Example, Around 21 Kbyte is required for a monochrome frame in the NTSC-based Quarter Common Intermediate Format (QCIF, 176 x 144), and a video stream needs over 5 Mbit/s at 30 frames per second (fps), Hence, efficient processing technique for lossy compression are required for multimedia network that used lower bandwidth.

4. **Multimedia innetwork processing.**Various multimedia innetwork processing algorithms are used in Wireless multimedia sensor network on the data extracted from the surrounding. To increase the scalability of system, the transmission data is need to be reduced of redundant data by combining data/information from multiple views with multiple resolutions on several media .

5. **Power consumption.** It is the main issue in WMSNs. As a matter of fact, multimedia application produces huge amount of data which will need to extensive processing and high transmission rate. So sensor devices are highly battery constrained.

6. **Flexible architecture to support heterogeneous applications.** It supports various independent and heterogeneous applications with factor dependent requirements. Hence it is important to develop hierarchical, flexible architecture that accommodate all the requirements needed for these applications.

7. **Integration with Internet (IP) architecture.**The importance of sensor networks is to provide services for querying and retrieving information from network

at any time and anywhere. For the same, future WMSNs need to be integrated with the IP architecture to make it globally accessible.

8. **Integration with other wireless technologies.** By interconnecting local "islands" of sensors through wireless technologies large-scale sensor networks may be created. This should be done without sacrificing the efficiency of any individual technology.[1][2]

1.3 Reference architecture

In the Fig.1.1,we have introduced a reference architecture[1] for WMSNs,describing 3 sensor networks which has different characteristics, that are possibly deployed in not same physical locations.

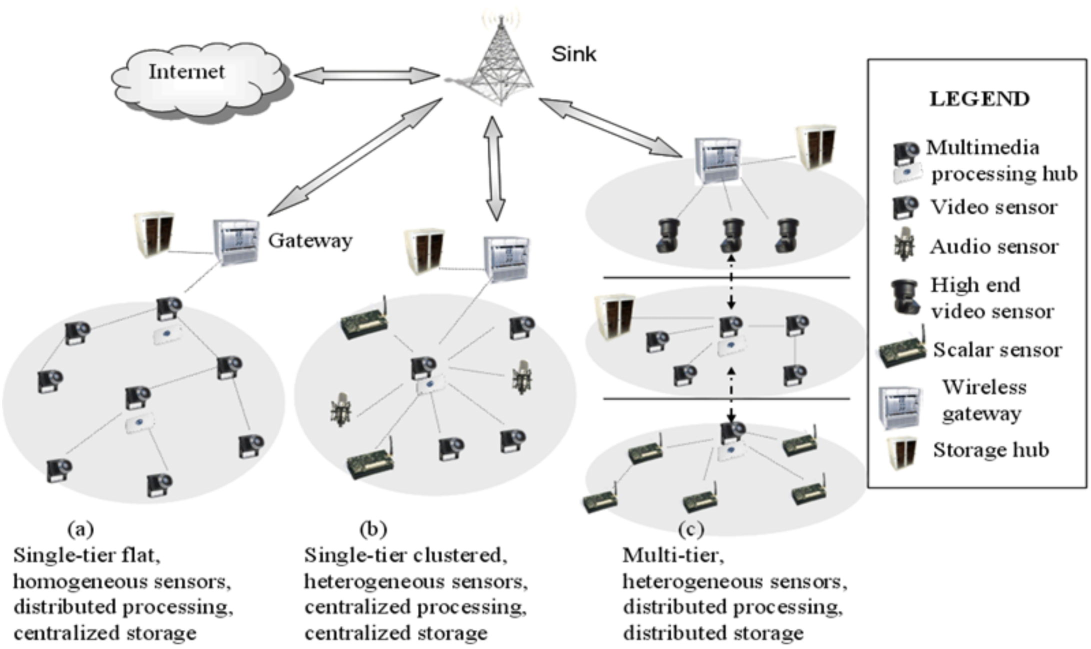

Figure 1.1: Reference Architecture for WMSNs

Fig.(a) describes a Single tier flat network consisting of homogeneous video sensor with high distributed processing and centralized storage refereing as processing hubs. Fig.(b) describes the Single tier clustered network consisting of heterogeneous video sensors with high centralized processing and centralized storage refereing as processing hubs. Fig.(c) describes the Multi tier network consisting of heterogeneous video sensor with high distributed processing and distributed storage refereing as processing hubs. The multimedia data is relayed to a gateway which is interconnected with storage hub through a multi-hop path which stores multimedia data locally for periodic reception. For more complicated architecture distributed storage is used saves energy by reducing the number of subsequent retrieval by storing the information locally preventing it to relayed on wireless networks.

1.4 Multimedia sensor hardware

In this topic, I classified and explained some already existing multimedia, processing wireless devices and imaging which can be used for upcoming wireless multimedia sensor networks.

Cyclops As MICA2 or MICAz, Cyclops are electronic interfaces in between a wireless mote such and a CMOS camera module, having memory and programmable logic needed for super-fast communication. Cyclops have ADCM-1700 CIF camera, an external SRAM and an external Flashis a programmable logic device (CPLD) , an 8-bit ATMEL ATmega128L micro controller (MCU). The MCU has control over the imager, its parameters, and also exhibits local processing to produce an inference.

Stargate board It is a processing platform of veryl high-performance for applications like signal processing(SP) sensor, control and sensor networks. It is made by Intel and produced by Crossbow. Stargates have 64 Mbyte of SDRAM, 32 Mbyte of Flash memory, and it has an on-board connector for MICAz or MICA2mote .

Imote and Imote2.

Integrated wireless controller is used in the design of the Imote which consists of Bluetooth radio, having configurations of 8-bit and 12 MHz ARM7 processor,32 Kbyte FLASH memory and 64 Kbyte.

The 2nd generation of Intel mote have common cores of next Stargate(2) platform, that enables performing Digital Signal Processing operation for compression or storage, and radio ChipCon CC2420

Table 1.1: Multimedia Sensor

sensor	cyclops	Cmucam3	Cmucam4	imot2
Proce-ssor	ATMEL Atmega 128	NXP LPC3166	parallax p8*324	XA271 XScale
camera	CMOS	OV6620 and OV7630 Cmos Cam	oblivision 9665 Cmos Cam	OV7670 image Cmos cam
color depth	8bpp	8bpp	8bpp	8bpp
servo frequency		50 Hz	50 Hz	
resolution	352*280(CIF)	352*280(CIF)	VGA (320*240)	640x480 pixels
image buffer		FIFO	FIFO	
compression	JPEG	JPEG	JPEG	JPEG
network inter-face	802.15.4	802.15.4	802.15.4	802.15.4 compli-ant radio.
field of view	52 deg			90 deg
maximum serial rate		115,200 bpp	2,50,000 bpp	2,50,000 bpp
full resolution image load		26 FPS	30 FPS	30 fps max

1.5 Multimedia Coding Fundamentals

The multimedia coding algorithms are known as CODECs (enCOder/DECoder). Their main objective is to reduce the transmission bandwidth of digital multimedia content and to allow recovery of lost information. The received multimedia content will have the maximum quality when the content transmitted is accomplished with the lossless data compression techniques and have proper mechanisms to compensate packet loss. However, for this high transmission bandwidth is required, which may be prohibited for other networks. In compliance to lower transmission data rates, codec is used to reduce size of the original data using some compression techniques, including some processing resources and computational time, but efficient compression usually results in some loss. In WMSNs applications the codec techniques combine high compression efficiency, error resilience and low complexity by saving energy in the whole path from source node to the sink.

Table 1.2: Comparison table of Operating system

OS	Tinyos	SOS	Contiki	liteOs	MANTIS
Programming paradigm	event based	event based	event based,	Thread based	automatic preemptive
Building Block	componts interface	module and message	service interface stats	application independent	user level threads,
Scheduling	FIFO	FIFO	Priority based	Priority based	Priority/ round-rondin
memory allocation	statics	dynamic	dynamic	dynamic	statics
System control	not	not	run time libraries	memory cells	remote call
minimum system overhead	3.32 byte	ca.1163 Byte	ca.810 byte	not available	not available
separation of concern	no clean distribution	replaceable modules	produce a reprogramming	sperate entities.	at compilation time
Dynamic Programming	external software s	supported	supported	supported	supported
Potability	high	medium to low	medium	low	medium
sensor mote	BSN,CITNodea and Dot and Micaz	micaz,TELOS and Tmote sky	scatter web/ESD	micaz & Iris	micaz,TELOS and Nymph
microcontroller	ATMEL ATMega 128	Atmega 1281(8 bit)	ATM ARM,Lpc2103	Atmega 1281(8 bit)	Atmega 1281
Radio	cc2500,cc2420	IEEE802.15.4/ ,cc2420	cc2420/zigbee	cc2420	cc2420/zigbee
remaks	no kernel process	dynamic reconfigurability	30 kb of ram c language	c++compiler threads	energy efficent scheduler,

1.6 MPEG Compression

The I frames (intra-coded frames) can be reconstructed independently without any need of the reference to other frames. From the last I-frame or P-frame, the P-frames are predicted, which simply means it is almost not possible to generate the P frame without using I or P frames The B-frames are predicted by the last or next I-frame or P-frame. Inter coded frames are P-frames and B-frames.

1.6.1 The discrete cosine transform(DCT)

$F(u,v) = C_u/2C_v/2\sum_{y=0}^{7}\sum_{x=0}^{7} f(x,y)cos[(2x+1)u\pi/16]cos[(2y+1)v\pi/16]$ with: $C_u = \begin{Bmatrix} 1/\sqrt{2} & if u = 0 \\ 1 & u > 0 \end{Bmatrix}; C_v = \begin{Bmatrix} 1/\sqrt{2} & if v = 0 \\ 1 & v > 0 \end{Bmatrix}$ Where f(x,y) is a function of the brightness of the pixels at position [x,y].

1.6.2 The inverse discrete cosine transform(IDCT)

$F(u,v) = \sum_{y=0}^{7}\sum_{x=0}^{7} f(x,y)C_u/2C_v/2cos[(2x+1)u\pi/16]cos[(2y+1)v\pi/16]$ Where F(u,v) is function of the transform matrix values at position [u,v].

The quantized value is obtained by using above transform function. It is divided by a value which is equal or greater to 8, as the DCT supports value till 2047. The decoder gives same value by multiply.

1.7 Multimedia Characteristics And Evaluation

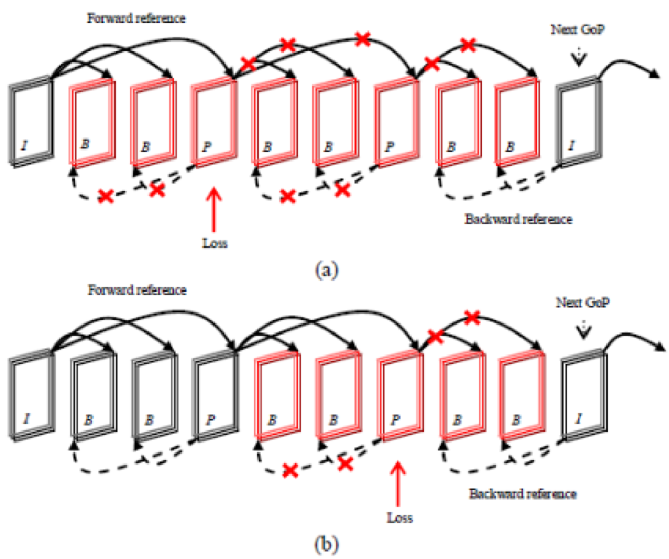

Figure 1.2: Cases of P-frame loss: (a) first P-frame and (b) second P-frame.

MPEG principles are inter-frame coding. MPEG has three type frames :- intra-coded i.e I frame, inter-coded i.e. P frame and bi-directional coded i.e B frame. I frame has more portion of information of image and it has the low compression ratio. It decodes itself, in accordance to the previous I or P frame,I-frame is inter coded. compression ratio of the I frame is more than P frames and B frames.

To calculate the quality of the images and videos on the sender side and receiver side, Peak Signal To Noise Ratio(PSNR) is calculated. The result of the PSNR is between 30-50 dB, for video compression.

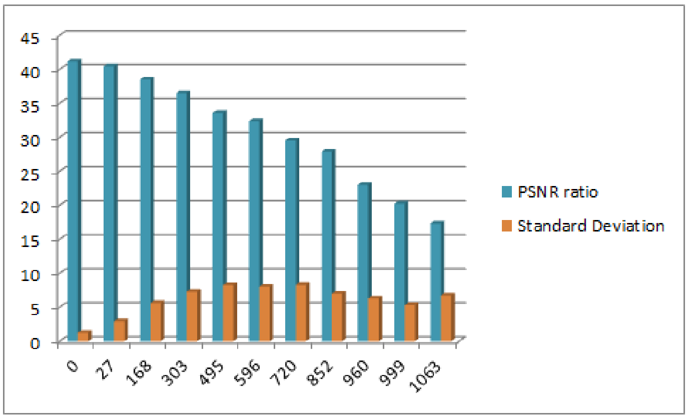

Figure 1.3: effect on psnr and standard deviation by losing Total frame

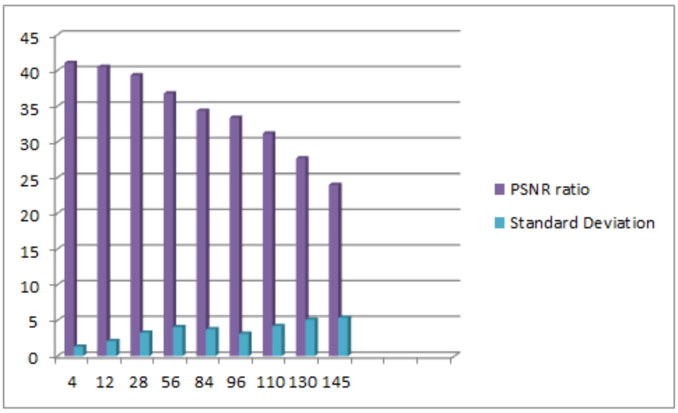

Figure 1.4: effect on psnr and standard deviation by loosing I frame.

Chapter 2

QoS Requirements for WMSNs

Mobile Ad-Hoc networks and traditional wired internet infrastructures are different from Wireless sensor networks which generates unique issue and challenge for supporting in Quality of service in wireless multi-media sensor networks. Approach for QoS depends upon application, it is not same for all. The points given below are some of the major challenges/issues that make quality of video in sensor networks different from traditional wired network are:

- **Severe Resource Constrained:**For efficient utilization of resources each node is provided with low memory, low processing capability, limited battery power and limited transmission energy.[4][11][5]

- **Data- Centric:**: In sensor networks a huge amount of data is exchanged which leads to redundancy , As we know redundancy increases reliability but lot of energy is wasted. To save energy Data fusion and aggregation techniques can be applied, but this will again increases delay and reduces throughput. So the QoS design gets affected.[4][11]

- **Node Mobility:**QoS provisioning becomes complex as network nodes and sink nodes changes their position frequently.[4][11]

- **Heterogeneous Traffic:** A sensor network can be designed to monitor change in temperature, pressure and humidity of some location leading to different set of QoS units defined for each, simultaneously. So it this can collect different type of data and therefore provisioning QoS becomes difficult in heterogeneous traffic.[4][11]

- **Packet Criticality:**Critical or high priority packets are given preference over low priority packets in real time and priority of a packet is determined by the contents of the packet. So QoS system must have some provision to differentiate between high and low priority packets and critical or high priority packets should not be avoided.[4][11]

- **Scalability:**Wireless sensor network have thousands of nodes but QoS system performance should not be affected if number of nodes gets increases or decreases.[4][11]

In the following section, we will see WSNs QoS requirement for OSI 7-layers and give definition of QoS requirement.

2.1 Application Layer

In application layer QoS requirement are defined by a user. Here are the QoS requirement for WSN application System Lifetime : The time from system deployment to the time when it can not fulfil user requirements Response Time: the time taken between the fire of a query and getting its result detection probability, data reliability,Data novelty and data resolutions are the other requirements.[1][2]

The services by application layer includes :

- Providing admission control functionalities and traffic management, that means preventing applications from establishment of data network flows when resources of network required are not available.

- Performing source coding on data packet according to the applications and hardware constraint, by using encoding technique of advanced multimedia .

- Providing simple, efficient and flexible system software like middleware or operating system which helps in exporting services for higher layer application to make upon.

2.1.1 challenges

- **Traffic classes-** Admission control should base on Quality of service needs of the applications. It is expected that WMSNetworks should provide support and differentiate service for many different classes of application. WMSNs will need to provide differentiated service between real time and delay tolerant applications. Moreover, applications like multimedia streaming needs continuous stream of multimedia for a prolonged period of time and some other application may required event triggered observation obtained in a short time period like snapshot multimedia content.

- **Multimedia encoding techniques** Some such kind of algorithm should be used which can minimize power of processing and information about data to be transmitted and allowed reliable transmission over channels(lossy) using error-resilient coding .

- **High compression efficiency-** Uncompressed data requires high data rates, huge bandwidth and consumes lot of energy. It is necessary to archive such kind of data to limit bandwidth and consumption of energy.

- **Low complexity.**

  sensor devices are embedded with multimedia encoders. Therefore they have to be less complex to low power and reduce cost and form factors to increase the lifetime of sensor nodes.

2.2 Transport Layer

This are the Quality of service requirement for transport layer Latency and cost,reliability and Bandwidth, for convenience, from sensors point-of-view, unique packet is those packets whose data is not correlated to already received data. All QoS needs within the transport layer uses collective concept, i. e. Only unique packets are counted as received by the destination. The transport layer is important because of providing end to end reliability and congestion control mechanism.

[1][2]

2.2.1 multimedia transport requirements

- **Effects of congestion.**: If we compare WMSNs and traditional network, the congestion may be even more in WMSNs. Due to retransmission and collision, energy loss may result in network partition. Therefore congestion control algorithm must be designed to provide immediate response and avoid oscillations of data rate along affected path.

- **Packet re-ordering due to multi-path.**: There may be several path between source-sink pair, and order of packet delivery depends upon the path chosen. In real time video and audio streaming, the information which is of no use becomes redundant, which introduce as challenge for transport layer to reorder the packets.

2.2.2 Important characteristics of TCP incompatible protocols in context of WMSNs.

- **Reliability-** When differentially coded packets of image or video is sent, there should be guarantee of arrival of the packets with the ROI field or I-frame. If prior recorded video is sent to the sink, then transport protocol should guarantee that each of I-frame will reach the sink and all the I-frame could be separated. For faster transmission in case of packet loss Multi-segment Transport(RMST) or the Pump Slowly fetch quickly(PSFQ) protocols can be used as they buffer packets at intermediate nodes.

- **Congestion control-** The high rate of multimedia packets into the network makes the most of use of available resources quickly. The transmission rates for sensor may be about 40 kbit/s, inactive data rates of a constant bit rate may be 64 Kbit/s. Video traffic may be of 500 Kbit/s, so congestion control should be there.

- **Use of multi-path-**This are the two reasons we suggest for using multipath in WMSNs networks : A huge burst of data(I-frame) which can divide into small units, thus not overwhelming the limited sized buffers at the in middle sensor nodes. There might be channels which do not allow large data rate during the entire time of the event, so if multiple flows will be used, effective data rate for each path will get reduced.

2.3 Network layer

The QoS n Network Layer depends on whether the stream carries time dependent data like configuration of initial parameters, high bandwidth audio/video data, time critical, low rate data like presence/absence of sensors phenomenon etc..[1][2]

2.3.1 Network layer Functionalities

- **Addressing and localization-**: In case of large WMSNs like IrisNet,it is needed to monitor individual node via internet. The global addressing is done by the IPv6 protocol in which din sensor ID with its MAC address to form IPv6 address. Address field size of generates extra overhead in each data sensor packets. Localization techniques differ substantially for sensor networks and traditional network.
- **Routing-**Routing : Nodes of sensor send collected data to the sink where Useful information extracted from that.

2.4 MAC Layer

This are the QoS requirement for MAC layer:

- Communication Range : Maximum one-hop data transmission distance.
- Transmission Reliability : Percentage of transmitted frames successfully.
- Throughput : Maximum number of data transmitted to receiver successfully by MAC Layer per unit time.
- Energy Efficiency : It calculate the amount of consumed energy by transmit one frame successfully Within one loop

.

The one of the functions of MAC layer are providing error control and arbitration of channel and schemes for recovery . When a devices receives data, transmission is disrupted from all other devices in a device's range

Chapter 3

QOS based and Location Aware Routing Protocols

3.1 SAR Protocol

SAR protocol [3] is first routing protocols proposed which Provides QoS. The SAR algorithm is designed to make the network energyefficient and fault tolerant. SAR maintains routing tables to record information about its neighbors and use multihop routing. Multiple trees are constructed, rooted from one hop sink's neighbor, for creation more then one paths from every node to the sink. For path selection process, we take into account the priority and the energy resource of a packet. SAR calculates the QoS weighted metric, which is the product of the weight coefficient and additive QoS metric that is associated with the priority level of that packet, For each packet in a network, The lower that the average weighted Quality of service metric is, the higher the QoS level will be. A handshaking process is used to handle failures within the network,which enforces routing table consistency between the downstream and upstream neighbors on each path so that any failure automatically triggers a recomputation local procedure.By simulation results we can say that SAR gave better performance than the minimum metric algorithm. The main pros of this protocol is the overhead that is involved in maintaining the states and tables at each node.

3.2 SPEED Protocol

The aim of SPEED [6] is to support soft realtime communication services by maintaining desired speed(delivery) across the network so that endtoend delay is minimized. Each node keeps information only about its immediate neighbors and utilizes location information to make decisions of localized routing and hence the protocol is called stateless, as it does not use routing tables resulting in minimal memory usage.

3.2.1 Modules:

- **Stateless Nondeterministic Geographic Forwarding (SNGF)** This routing module is responsible for selecting the next neighbor hop and at the network layer, it works with four more modules to achieve desired speed(delivery) across network.

- **Neighbor beacon exchange module** gives geographical location of the neighbors node.

- **Delay estimation module** It calculates delay at each node, which helps SNGF to select the node meeting speed requirements and also helps to determine the occurrence of congestion. If a node meeting desired speed requirement couldn't be found, this module check relay ratio

- The relay ratio is provided by Neighborhood **Feedback Loop (NFL) module**e. Relay Ratio determines whether the packet is to be dropped or relayed. It is calculated by miss ratios of the neighbors of the node (the nodes which could not give the preferred speed) and is feed into the SNGF module, where a drop or relay action is taken.Packet is dropped when value of relay ratio is in between 0 to 1.

- **Backpressure rerouting module** It use to avoid voids i.e., when a node not discover the next node hop or if congestion is occurred, this module sends message back to source node so that it can take new routes.

3.2.2 Limitation:

The major limitations of SPEED protocol are that it does not employ any packet differentiation mechanism. It gives same preference to both real time and nonreal time packets.

It is not scalable as it maintains a desired speed for each packet and if the parameter is changed than protocol performance degrades.

3.3 Energyaware QoS routing protocol:

This protocol[7]is used to find leastcost, transmission energy, delayconstrained path for real-time data based on error rate, energy reserve of node and other communication parameters. Moreover,throughput of non realtime traffic is maximized. This protocol helps in ensuring guaranteed bandwidth through the connection duration while providing the use of path which is most energy efficient.

The protocol has two steps.

- The first step consists of calculating candidate paths in ascending order of least costs using Dijkstra's algorithm(extended version) without considering endtoend delay.
- In second step, it is checked which path fulfills the endtoend QoS constraints and the one that gives maximum throughput is selected.

3.4 MMSPEED:

Multipath and Multispeed Routing Protocol[8] This protocol is an extension of SPEED protocol,is designed to provide Qos with respect to timeliness domain and reliability domain. For Scheduled delivery of packets, MMSPEED provides multiple speed(delivery) options for each incoming packets. Each incoming packet according to its speed class is placed into proper queues. On the basic of packet speed queue are served in FCFS basis. The priotrization of packet is done with the MAC layer support. Service differentiation in reliability domain is achieved by calculating the reaching probability of each packet and then forwarding the packets through multiple paths whose progress speed is higher than the threshold speed. These decisions are made locally at every node without store global network state information and endtoend path setup.

3.4.1 Limition

MMSPEED protocol is scalable and adaptable to large networks. Only limitation of the protocol is that the energy metri is not taken into consideration.

3.5 Realtime PowerAware Routing (RPAR) protocol

Realtime PowerAware Routing (RPAR)[10] protocol pioneers the approach of incorporating energy efficiency in realtime communication. This protocol(RPAR) achieves application end-toend delay guarantee at lower power level by dynamic adjustment of power of transmission and routing decision based on the packet deadlines and workload. It handles dynamic and realistic properties of WMSNetworks such as limited memory, lossy links and bandwidth. RPAR is scalable as it uses the localized information. In addition to all these features its novel neighborhood management mechanism and forwarding policy introduces significant power reduction resulting in longer lifetime of network with realtime guarantee. The cons of this protocol is that in handling large hole and congestion occurs suddenly it shows degraded performance.

3.6 Realtime and Energy Aware Routing (REAR)Protocol

REAR protocol[9] is an event-driven protocol which makes use of meta data for establishing multipath routing to reduce the consumption of energy . Cost function is constructed and QoS routing is chosen for evaluating the transmission bandwidth consumption which trades off the relationship of delay and energy. The end-toend delay of multi-hop routing depends on both transmission distance and queuing delay and processing of relay nodes. A queue model is created at every node which deals with non-real time and real-time data because of the high bandwidth real time multimedia data requirement When streaming applications comes into picture, the metadata is not used because for streaming data metadata can be very large and it will consume high energy and bandwidth.

3.7 MCMP Protocol

According to QoS requirements like reliability and delay, a Multi Constrained QoS Multi Path routing protocol (MCMP) [11] uses best routes to send packets or data to sink node. The problem of end-toend delay is referred as an problem of optimization, and the imposed solution is based on linear integer programming. The aim of this protocol is to optimize the use of the multiple paths to enhance performance of network with restrained energy cost. Nevertheless, the protocol transfers the information through path including the minimum number of satisfying hops as per QoS, which results to large consumption of energy.

Table 3.1: Multimedia Sensor

Routing protocol	SAR	SPEED	EAQos	RPAR	MMSPEED	REAR	MREEP	ECMP	MCMP	QAMPAR
Architecture	Flat	Flat	Hierarchical	Flat	Flat	Flat	Hierarchical	Flat	Flat	Flat
Qos Parameter	end-to-end delay	End-toEnd Delay	End-toEnd Delay & energy matrix	End-toEnd Delay	Delay & Reliability	End-toEnd Delay & energy matrix	end-to end delay, reliability, energy consumption, lifetime and fairness	reliability, delay and geo-spatial energy consumption	energy consumption, reliability, average delay	end to end delay parameter and consumption of energy
Location Aware	yes	yes	no	yes	yes	no	no	no	n0	no
multipath capability	yes	yes			yes	yes		yes	yes	yes
Energy efficiency	yes	no	yes	yes	no	yes	yes	yes	yes	yes
Reliable delivery		no	no	no	yes	no	yes	no	yes	no
Data delivery model	Query driven	Query driven	Query driven	Query driven	Query driven	Event driven	Query driven	Event driven	Query driven	
scalability	no	no	Limited	yes	yes	limited	limited	yes	no	no
Node Mobility	no	no	no		yes	no	no	no	no	no
Data aggregation	no	no	no	no	no	no	no	no	no	n0
Service Differentiation	no	no	no		yes	no	no	no	no	no
Cross layer Design	no	no	no		MAC layer support	no	no	no	no	no
link reliability	no	no	N/A		high	no	no	yes	no	yes

Chapter 4

Problem identification and proposed routing Protocol

In battle field Surveillance application,we require energy efficient routing protocol by which we can increase the lifetime of the network. Becouse we known all sensors node are operated on battery and we can't change their battery frequently.

The routing protocol SPEED and MMSPEED, none of them consider any energy parameter for the sending the packets to the neighbor node. So the network lifetime is decreased. For improving the lifetime of network so that our battlefield surveillance application can increase.

4.1 PASPEED Protocol

PASPEED protocol maintains a desired speed(delivery) across the network and send packets to forward node which consume less energy. It consists of the following components:

- Dynamic Speed assignment
- Estimate energy cost
- Forward policy
- Delay estimator
- Frame type differentiate

- Neighborhood manager
- Backpressure Rerouting

Forward policy is responsible for deciding the next forward hop candidate which can support the desired speed(delivery) that consume less energy. Dynamic Speed assignment is responsible for calculate speed of all forward node. Estimate Energy cost module calculates estimate cost when we progress towards the destination.

Delay estimation is the mechanism by which we can calculate delay. And neighborhood module maintain the neighbor information like co-ordinates, reaming energy, delay etc. Backpressure rerouting module is use to avoid presence of void.

4.1.1 Dynamic Speed assignment

Before explaining Dynamic speed assignment, we introduce some definitions: A set of forward nodes:we take those node in set of forward node whose difference between Distance from destination and distance of source to destination is greater than 0,

Dynamic speed assignment : we can calculate speed by below formula.

$$speed_A^N = \frac{AD-ND}{HopDelay_A^N}$$

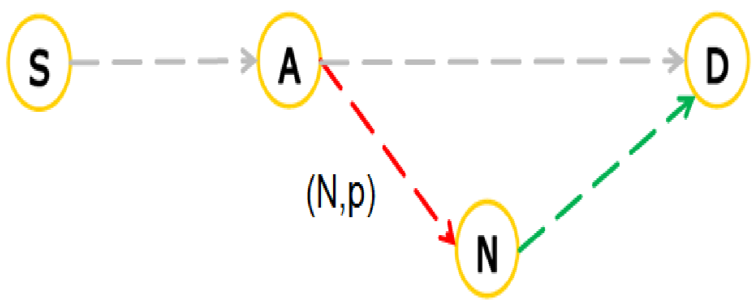

Figure 4.1: Estimate Energy Cost

4.1.2 Estimate energy cost

In Proposed Routing protocol consider two QoS parameter energy consumption, end-to end delay, by this equation we can calculate estimate energy cost of each neighbor node when we progress towards the destination.

$$E(A, D(N, Pwr)) = E(Pwr).Re(A(N, Pwr))\frac{AD}{AN-ND}$$

E(pwr) is the transmission energy at power level pwr.// Re(A(N,pwr)) - no. of re-transmission packets.

4.1.3 Delay estimator

Delay is calculated at the sender side, for calculation of delay we consider packet queue time and round trip time, for this we use timestamp. We observe that the delay by unicast packet and broadcast packet are different due to different MAC layer handling mechanism and that unicast packets delay are best for making routing decisions.

4.1.4 Frame type differentiator

As we know in MPEG format video, there are three type of frames- I, P, B frames. This module tells that which type of frame does our packet contained. Or simply we can say that this module helps in finding out frame our packet has.According to that information we can decide the packet we can drop. But to remember, we can't drop the packets Containing I and P frames as they are not tolerated however B can be dropped.

4.1.5 Forward policy

Forward policy module is responsible for selection of next forward node. Flowchat of module as below:

When packet enter into network layer first it calculate setSpeed using-AD/Packet Deadline.setSpeed is minimum speed required of a packet to reach at destination. Then, We find the forward set containing a node which satisfy (AD-ND>0)condition.

For all nodes in fs, we calculate the speed (AD-ND/Delay). And for each node whose speed is greater than setSpeed store in speedOption. For this array, we will select the next node, if the speedOption is empty, it will return -1 means condition of void presence.

If speedOption has only one element then nextHop is that node only. For more than one node, we will calculate estimate energy cost using the formula which is given in the energy module. And nextHop is determined, which node has less energy consumption. We have assumed that all nodes have same power and packets sent have same transmission power.

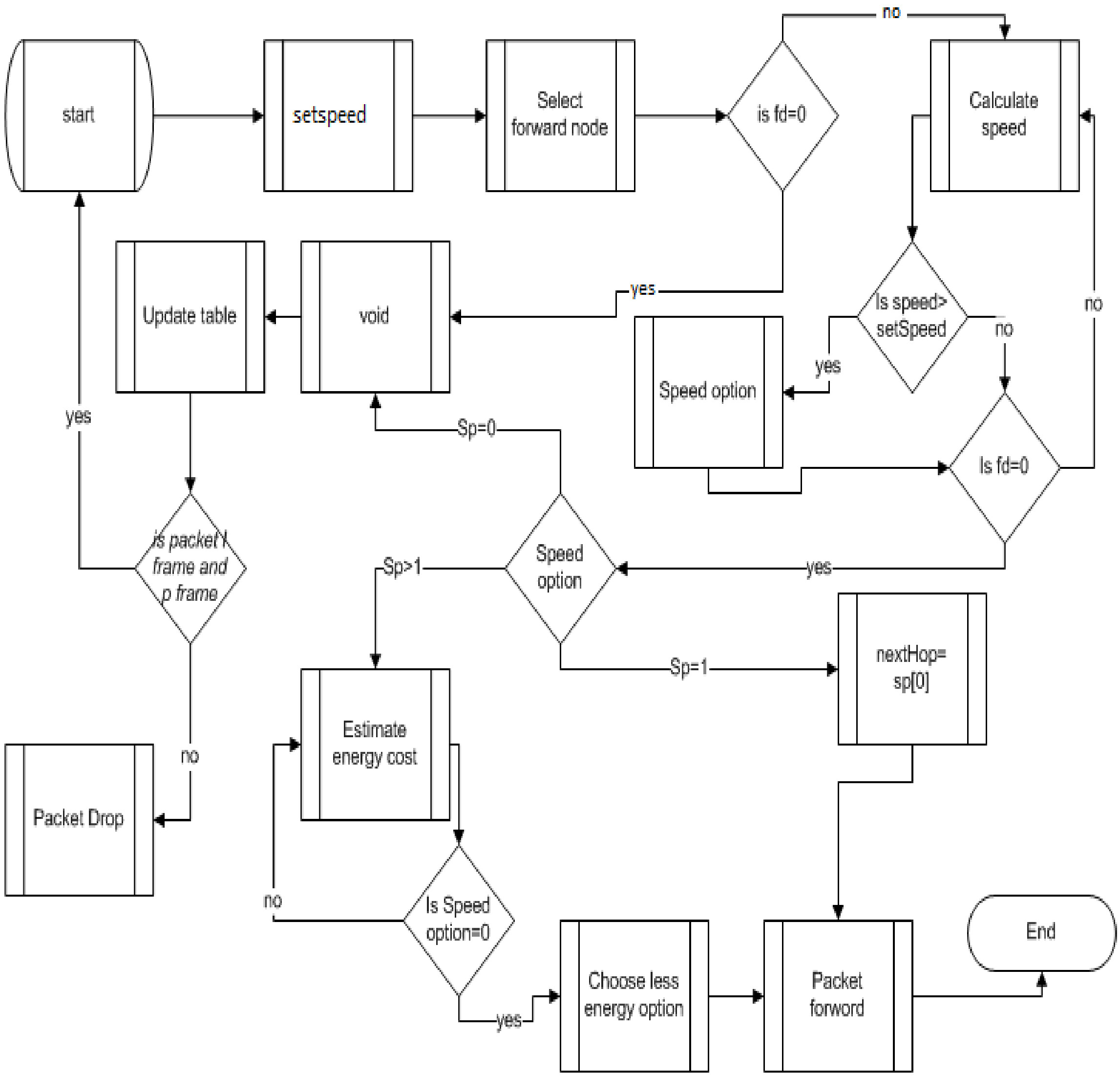

Figure 4.2: flow chart for packet forwarding schema

According to distance, we have applied dynamic power adjustment. Suppose we have 3 node at 3m, 4m, 5m of distance respectively and use transmission power p for all node till 5m. Suppose the selected node is at distance 4m. Then instead of using same power, we adjust the power it needs to transmit to 4m. This is the dynamic power adjustment applied in the proposed work.

4.1.6 Neighborhood manager

Neighborhood manager module maintains the information about the neighbor node including node co-ordinate, residual energy, consumed energy for send one packet, delay etc.This information is needed in measuring the route from the source node to destination

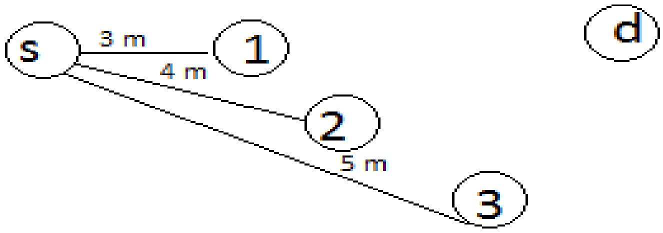

Figure 4.3: Dynamic power adjustment

node.

4.1.7 Backpressure Rerouting

It is a mechanism to find the possible route when a void node us encountered. A void node is that node which has no possible eligible forward node. in fig. node 1 is source,

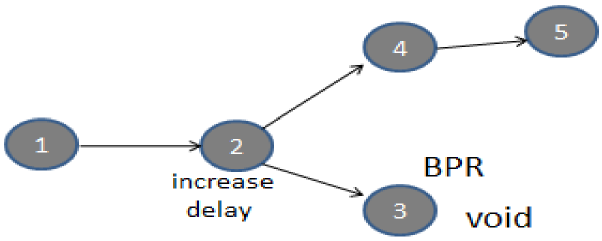

Figure 4.4: example for Backpressure Rerouting

and 5 is destination node. Node 2 want to send packet to destination. Node 2 has two neighbor node 3 and 4, and node 3, 4 both fulfill the speed requirement, but node 3 consume less energy so next node of 2 is 3,Node 3 has no other forward node, means node 3 is void node. In such condition we use back pressure re routing ,the node 3 will send the backpressure packet to it pervious node.Thus pervious node update the routing table and increase delay for node 3 showing it is void node and node will forward packet to node 4 through which it reaches the destination i.e node 5

Chapter 5

Simulation and Results

For simulation, Castalia simulator M3WSN framework is used to configure the simulation parameters. M3WSN framework enables us to deliver the video content over the sensor networks and it also generates the data type file both on the transmitter side and receiver side. Evaluate tool is used to calculate the PSNR ratio and MOS matrix by which the video quality is measured. We have considered following three routing protocols as GPSR, SPEED and PASPEED.

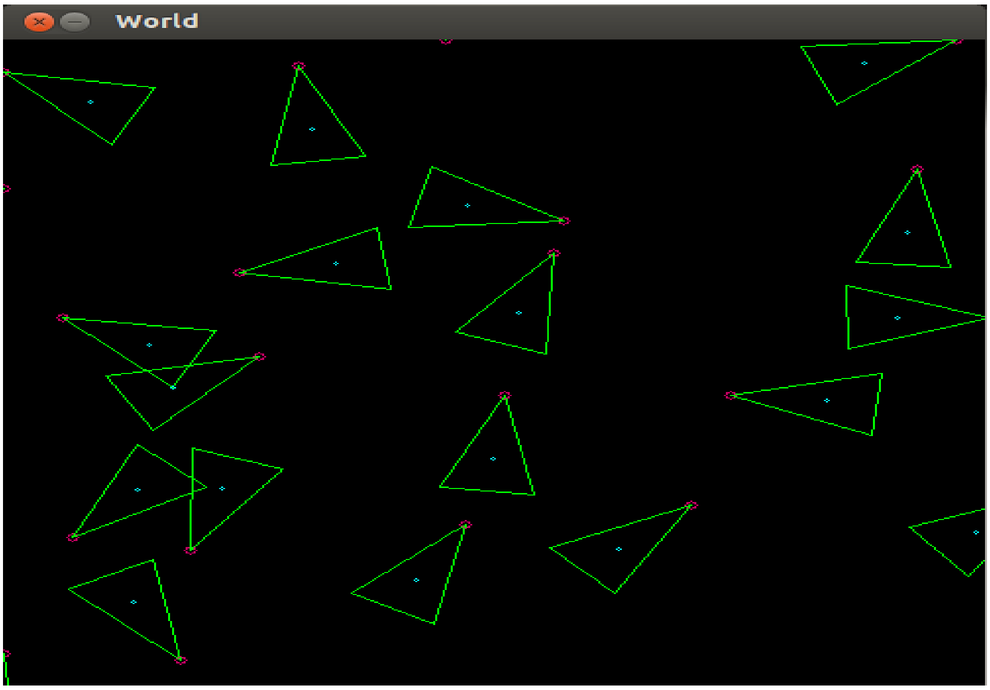

Figure 5.1: Deployment of the nodes in M3WSN

For Fig. 5.2, 5.3 and 5.4, simulation time is 500seconds, Fig 5.2 represents the no. of packet deliver in the above mentioned protocols. For every protocol the field size taken for uniform random deployment of video sensor network is 100 x 100m.

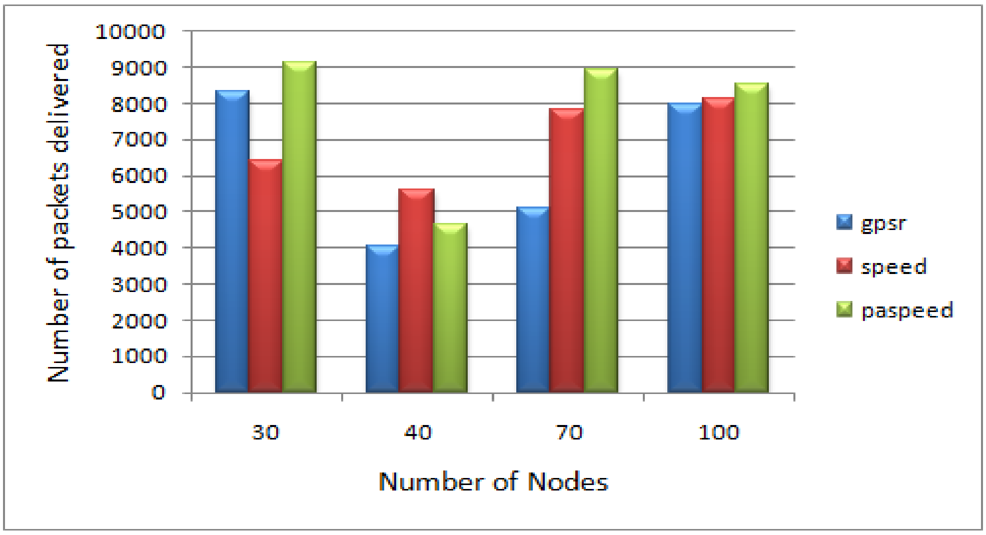

Figure 5.2: Number of Packet Delivered Vs number of node

As shown in fig., PASPEED's packet delivery ratio is better in comparison to other. The results are not uniform because every protocol selects different types of forward nodes.

Fig.5.3 shows packet overhead of the above protocols for same field size i.e of 100x 100m. For packet overhead we considered hello packet for discovering the information about neighbor nodes and delay packet messages. PASPEED protocol uses less no. of hello and delay packets as compared to GPSR and SPEED protocols which in turn results in less packet overhead.

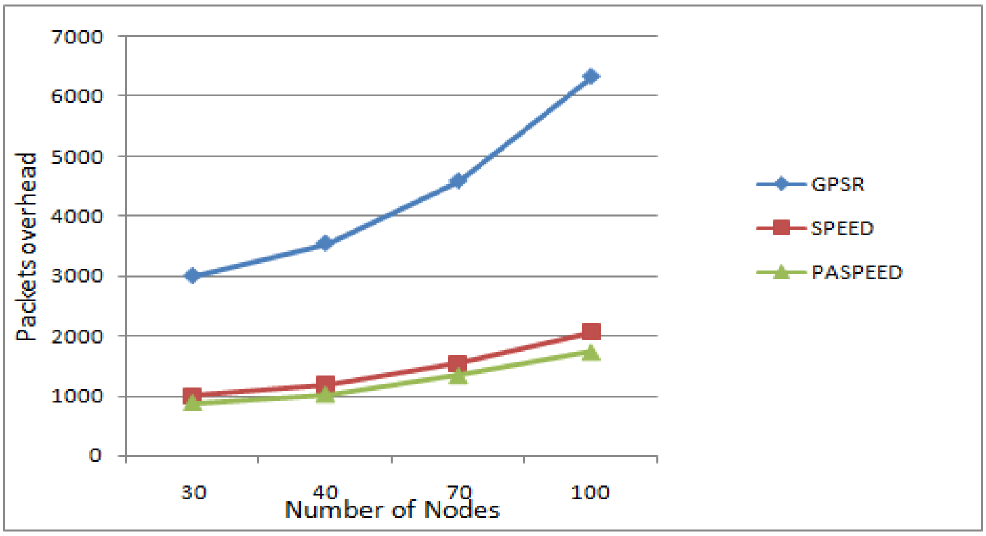

Figure 5.3: Packet overhead and number of node

Fig.5.4 shows Average end-to-end delay for all the packets for similar field size of 100x100m. PASPEED is designed to provide less delay or lesser average end- to-end delay.

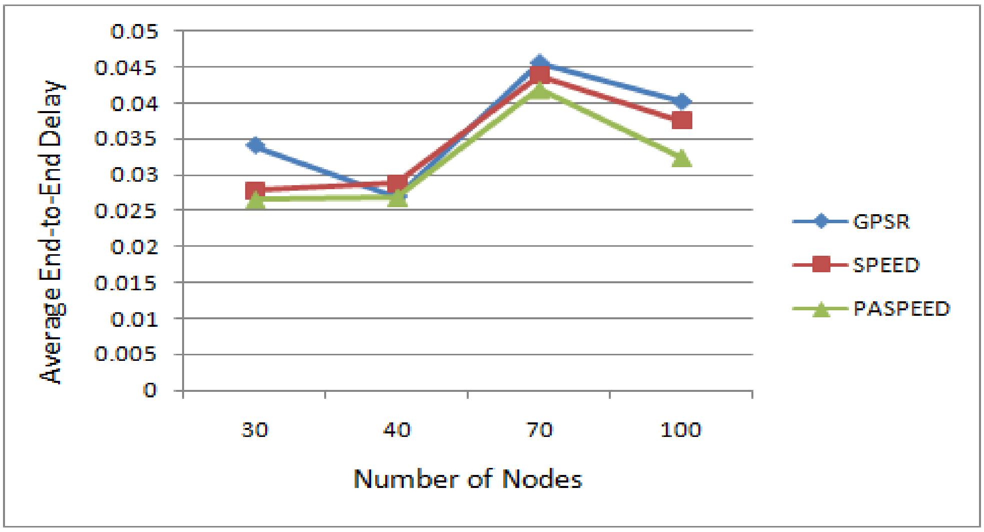

Figure 5.4: Average End to END delay and number of node

Fig.5.5 shows received packets missed deadline for similar field size of 100x100m. PASPEED is designed to improve missed packet deadline.

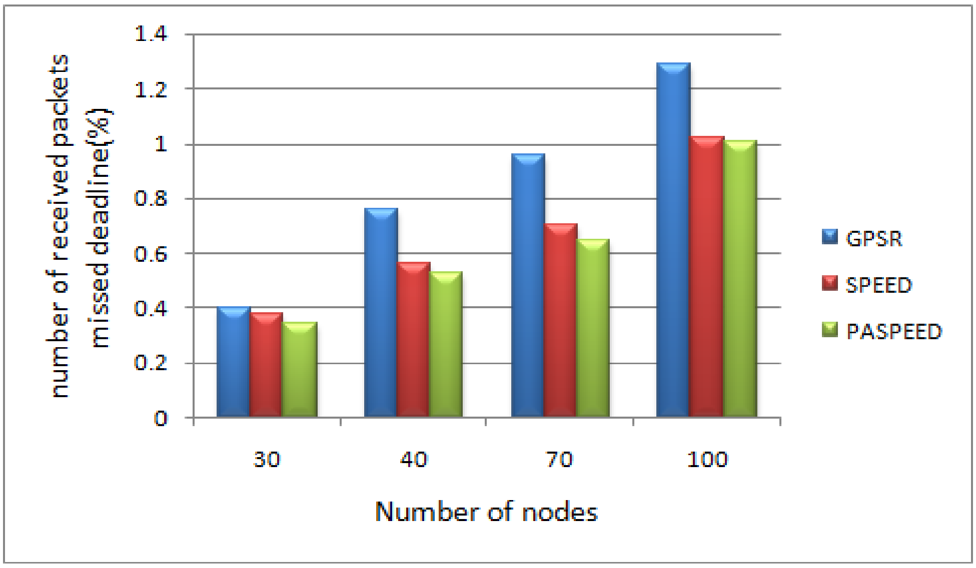

Figure 5.5: number of received packets missed deadline(%) Vs number of node

For Fig. 5.6, 5.7 and 5.8, simulation time is 1000seconds and explains throughput, packet overhead and average end-to-end delay for the same protocols.

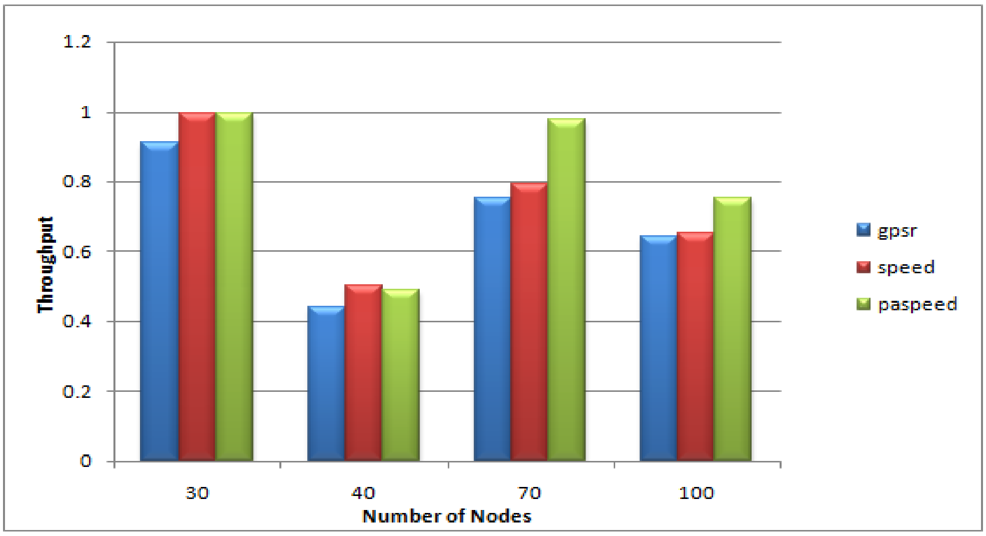

Figure 5.6: Packet Delivered Vs number of node

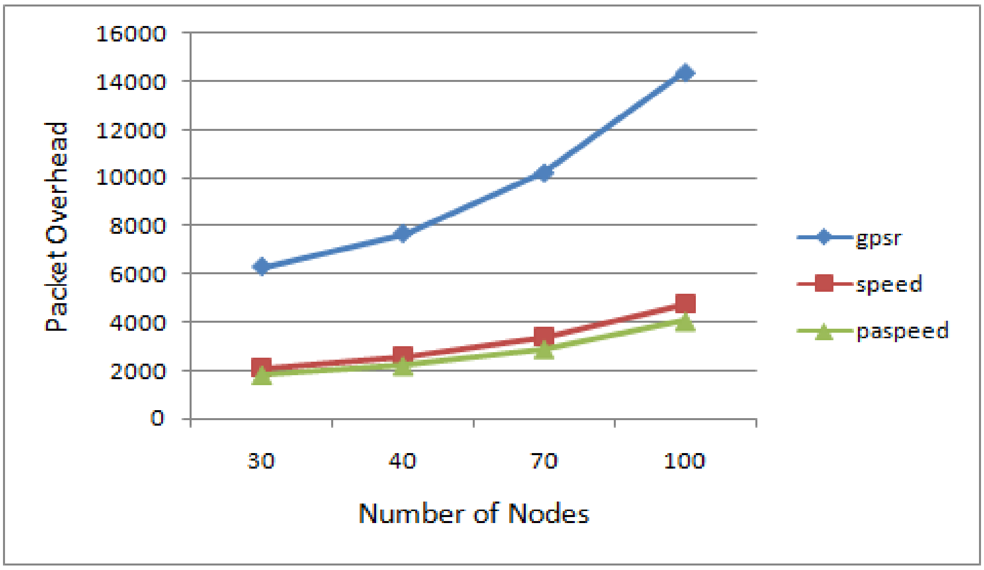

Figure 5.7: Packet overhead and number of node

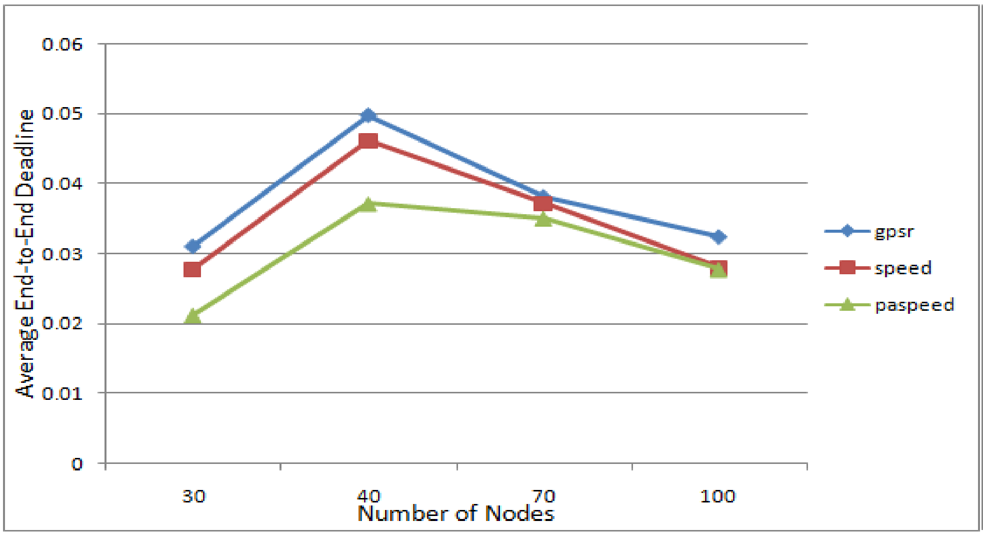

Figure 5.8: Average End to END delay Vs number of node

In Fig. 5.9,5.10, the field size is 150x150m random deployment, the packet overhead is shown. PASPEED is performing efficiently in this topology in contrast to GPSR, SPEED and PASPEED.

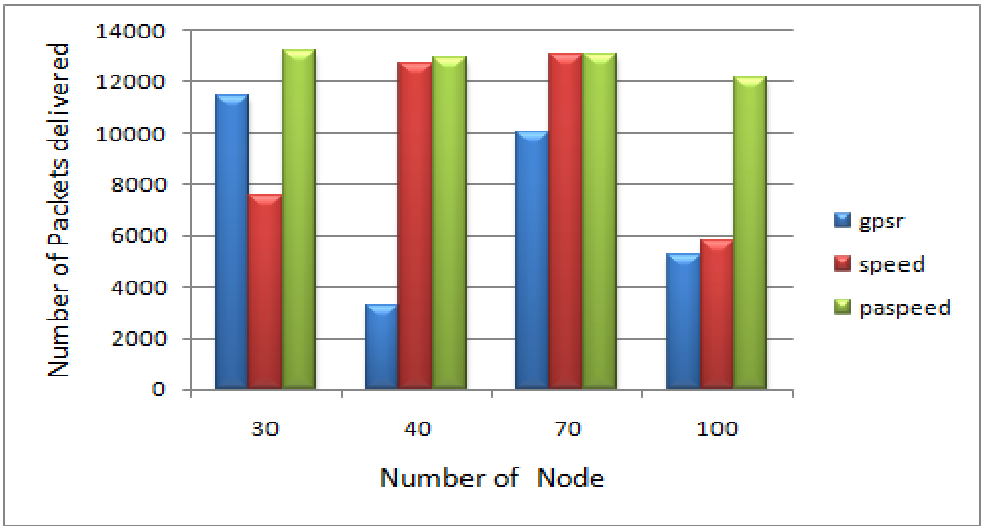

Figure 5.9: Packet Delivered Vs number of node

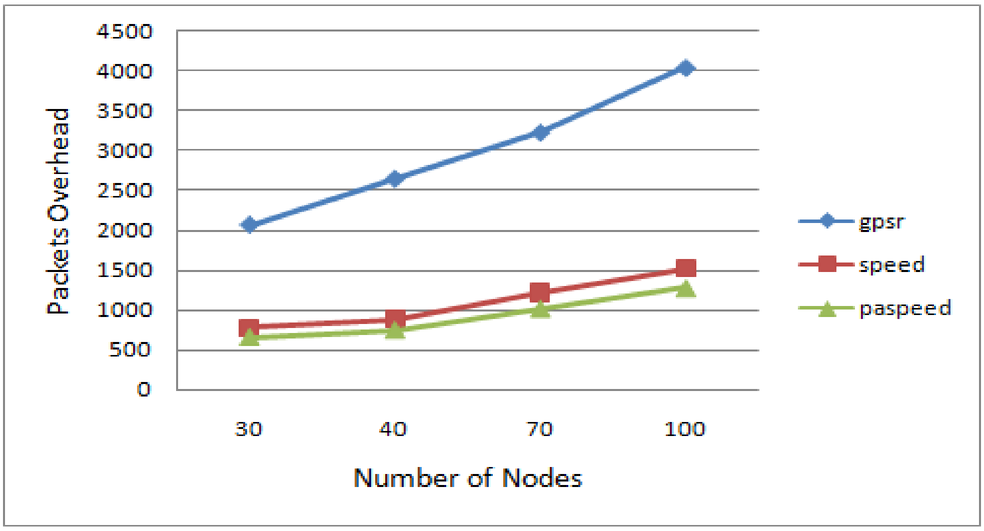

Figure 5.10: Packet Overhead Vs number of node

Fig.5.11 shows PSNR for all the packets for similar field size of 150x150m. PASPEED is designed to improve the Quality of video.

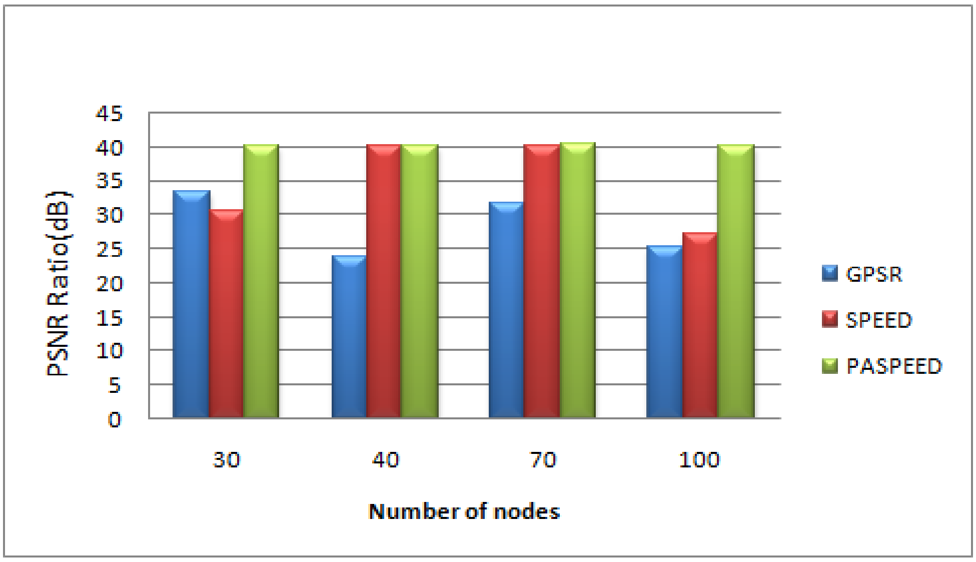

Figure 5.11: PSNR Ratio Vs number of node

As we can see the graph, amount of energy consumed by PASPEEED protocol is always less then the existing routing protocol for varying number of nodes

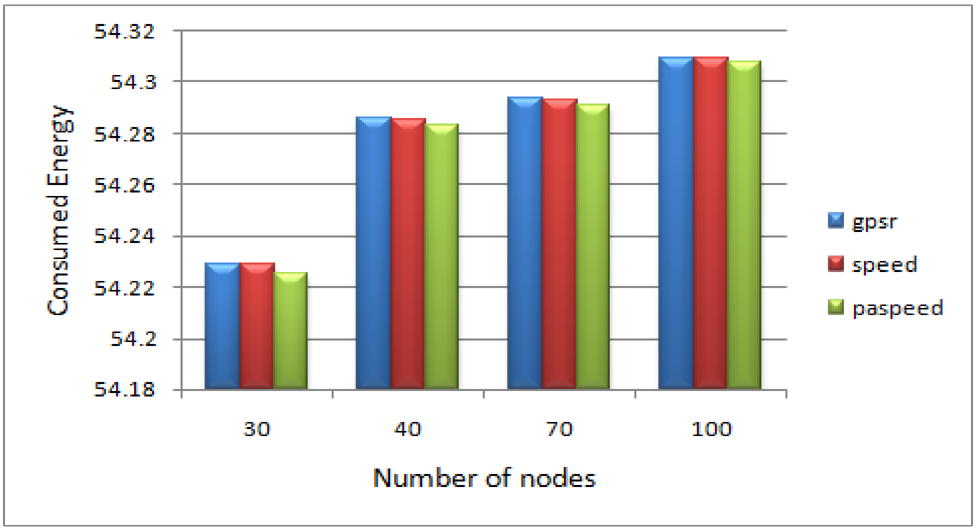

Figure 5.12: Average Energy Consumed Vs number of node

Chapter 6

Conclusion

In this thesis report the functionality of the layers in sensor network is explained and different QoS metrics and challenges involved in implementing QoS in routing protocols are listed out. Also we have presented a brief overview of some recently designed QoS based routing protocols. Table summarizes the various QoS based routing protocols considering different parameters or characteristics. QoS routing protocols developed to minimizing end-to end delay only. The parameters such as jitter, throughput etc. is not being considered. The report tries to cover most of the routing protocols available for WMSNs and proposed and implemented a new real-time power-aware SPEED routing protocol which provide end-to-end delay with energy consumption. PASPEED protocol packets find new neighbor according to their energy consumption as well as reach sink before its deadline. It handles WSNs properties such as limited memory, lossy links, and bandwidth. Proposed protocol also includes frame type differentiate and according to type of frame we decide their priority and and reliability probability.Thus, it is analysis from the simulation result that our proposed approached is better in end-to-tnd delay,energy consumption, deadline miss ratio.

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