QoE Aware routing Protocol for Wireless Multimedia Sensor Network

Submitted By

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QoE Aware routing Protocol for Wireless Multimedia Sensor Network

Major Project

Submitted in fulfillment of the requirements

for the degree of

Master of Technology in Computer Science and Engineering (Networking Technologies)

Submitted By

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Guided By

Prof. Malaram Kumhar

DEPARTMENT OF INFORMATION TECHNOLOGY

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Certificate

This is to certify that the major project entitled **"QoE Aware routing Protocol for Wireless Multimedia Sensor Network"** submitted by **Harsh Bhatt (16MCEN02)**, towards the partial fulfillment of the requirements for the award of degree of Master of Technology in Computer Science and Engineering (Netwoking Technologies) 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, 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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Statement of Originality

I, **Harsh Bhatt**, **16MCEN02**, give undertaking that the Major Project entitled "**QoE Aware 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 (Networking Technologies)** of Institute of Technology, Nirma University, Ahmedabad, contains no material that has been awarded for any degree or diploma in any university or school in any territory to the best of my knowledge. It is the original work carried out by me and I give assurance that no attempt of plagiarism has been made.It contains no material that is previously published or written, except where reference 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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Endorsed by

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Abstract

Quality of Experience (QoE) identifies with how clients see the quality of an application. These days, a current pattern has risen in the Wireless Multimedia Sensor Networks (WMSNs) field. This pattern comprises of guaranteeing the best Quality of Experience (QoE) while exchanging the multimedia content, and keeping a worthy Quality of Administration (QoS) concerning the scalar information transmission. Wireless Multimedia Sensor Networks (WMSNs) guarantee a wide extent of developing potential applications in both non military personnel furthermore, military regions, which require visual and sound data to upgrade the level of gathered data. The transmission of multimedia content requires a negligible video quality level from the clients viewpoint. In Video-on-request to hold the current clients furthermore, draw in new clients, specialist co-ops endeavor to fulfill the clients desires and give an attractive review experience. To catch such a subjective measure, either by subjective tests or by means of target devices, is a workmanship all alone. Given the significance of estimating clients fulfillment to specialist organizations, look into on QoE took battle in later a long time. we display a review of different methods for estimating QoE, in this manner generally concentrating on uninhibitedly accessible instruments and systems.

Abbreviations

WSN	Wireless Sensor Network **GPSR**
MEVI	Multi-hop hierarchical routing protocol.
LEACH	Low Energy Adaptive Clustering Hierarchy.
SPEED	The Stateless Protocol for real-time communication.
CPLD	Complex Programmable Rationale Device.

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Chapter 1

Introduction

1.1 WMSN

A Wireless sensor network arrange (WSN) a remote framework involving spatially scattered self-decision devices using sensors to screen physical or common conditions. A WSN system merges an entryway that gives remote system back to the wired world and circled center points.

The incorporation of low-control remote systems administration advances with reasonable equipment, for example, CMOS cameras (integral metal oxide semiconductor) and amplifiers is currently empowering the advancement of conveyed arranged frameworks that we allude to as remote interactive media sensor systems (WMSNs), that is,networks of remote, interconnected savvy gadgets that empower recovering video and sound streams, still pictures, and scalar sensor information. [2]

Figure 1 presents a reference design for WMSNs, where three sensor systems with various qualities, perhaps conveyed in various field areas. The cloud in first par t demonstrates a solitary level system of alike video sensors. A subset of the conveyed sensors have higher preparing capacities, and are subsequently alluded to as preparing centers. The union of the preparing center points constitutes a dispersed preparing engineering. The mixed media content assembled is transferred to a remote entryway using a multi hop way. The door is interconnected to a capacity center point, that is accountable for putting away media content locally for consequent recovery. Obviously, more unpredictable structures for conveyed capacity can be actualized at the point when permitted by the earth and the application needs, which may bring about vitality reserve funds since by putting

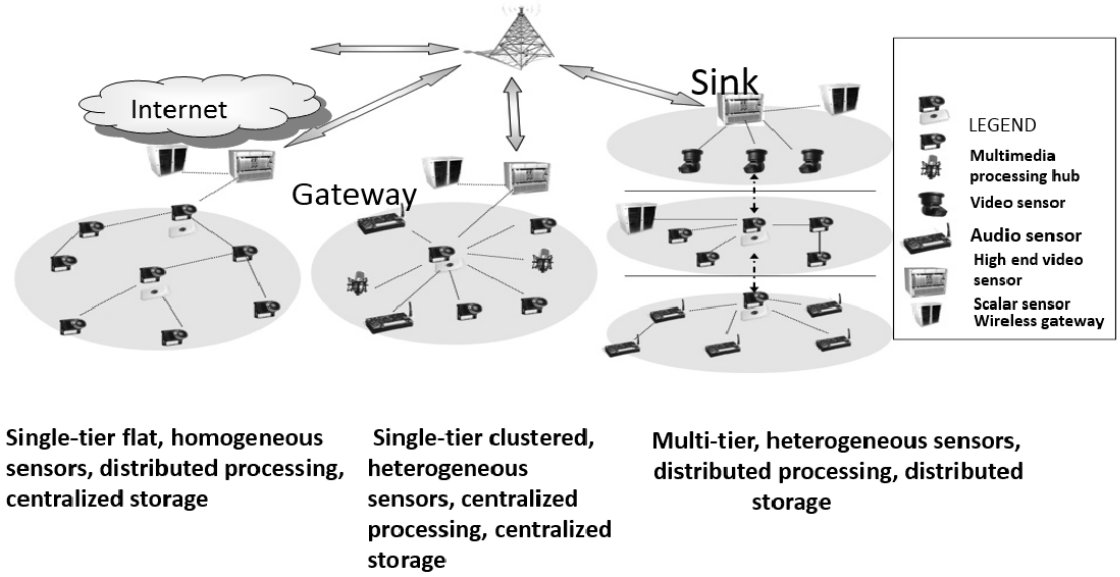


Figure 1.1: WMSN Architecture [1]

away it locally, the sight and sound content does not should be remotely transferred to remote areas. The remote passage is too associated with a focal sink, which actualizes the programming front-end for organize questioning and entrusting. The second cloud speaks to a solitary layered grouped design of heterogeneous sensors (just a single group is delineated). Video, sound, and scalar sensors hand-off information to a focal clusterhead, which is additionally accountable for performing concentrated sight and sound handling on the information (preparing center point). The clusterhead transfers the accumulated substance to the remote passage and to the capacity center. The last cloud on the privilege speaks to a multi-layered system, with heterogeneous sensors. Every level is in control of a subset of the functionalities. Asset compelled, low-control scalar sensors are in control of performing more straightforward assignments, for example, distinguishing scalar physical estimations, while asset rich, high-control gadgets are in charge of more unpredictable assignments. Information handling and capacity can be performed in an appropriated mold at each unique level. [1]

1.2 WMSN Applications

- Tracking

  Object tracking is one of the most prominent applications of wireless sensor net-

works. As an example, a large quantity of sensor nodes could be deployed over a battlefield to detect enemy intrusion instead of using landmines. Thus it can save lives of civilians to be lost because of landmines. And lot more examples can be discussed regarding this application.

- Home Automation

  Home automation is another large application area for wireless sensor networks. The uses in the industrial applications field described above also apply to home implmentations. Centralized control of home appliances has already been implemented by using wired solutions or other wireless technology solutions. Their replacement by a wireless sensor network provides a development and maintenance cost reduction, system flexibility, and stretch ability. WSN also provides total, and secure control of the home devices.[3]

- Multimedia Surveillance Sensor Networks

  Reconnaissance sensor systems will be utilized to upgrade and supplement existing observation frameworks to forestall wrongdoing and fear monger assaults. Interactive media content, for example, video streams and still pictures, and PC vision methods, can be utilized to find missing people, distinguish hoodlums or fear mongers, or induce and record other conceivably applicable exercises (thefts, car accidents, traffic violations).

- Environmental monitoring

  Varieties of video sensors as of now are utilized by oceanographers to decide the advancement of sandbars utilizing picture preparing techniques.Video and imaging sensors additionally are utilized to screen the basic strength of extensions or other common structures.

- Advanced Health Care Delivery

  Telemedicine sensor systems can be coordinated with third and fourth era (3G/4G) cell systems to give universal medicinal services administrations. Patients will convey medicinal sensors to screen parameters, for example, body temperature, circulatory strain, beat oximetry, ECG, and breathing movement. Remote medicinal focuses will screen the state of their patients to deduce crisis circumstances.

- Traffic Avoidance, Enforcement and Control Systems

  It will be conceivable to screen auto movement in huge urban communities or on parkways and send administrations that offer activity steering counsel to evade clog or on the other hand distinguish infringement. Likewise, smartparking counsel frameworks in view of WMSNs will recognize accessible parking spots and give drivers with computerized stopping exhortation.

- Storage of Potentially Relevant Activities

  - Thefts, car accidents, traffic violations
  - Make video/audio streams or reports available for future query

Chapter 2

Literature Survey

Wireless Multimedia Sensor Networks:A Survey by Ian F. Akyildiz, Tommaso Melodia Kaushik R. Chowduryportrays the WMSN as a developing zone of enthusiasm for late circumstances. It likewise examines the best in class and the real research challenges in structures, calculations, and conventions for sight and sound transmission in WMSN. It additionally talks about the current arrangements at the physical, interface, system, transport, and application layers of the correspondence convention stack.[2]

A survey on wireless multimedia sensor networks by Ian F. Akyildiz, Tommaso Melodia Kaushik R. Chowdury states the accessibility of CMOS camera and receiver gadgets for WMSN has had an effect on the advancement of WMSN. In this paper different reference models for WNSM are examined with it's focal points and downsides. Open research issues and existing courses of action at the application, transport, system, interface, and physical layers of the correspondence convention stack are talked about nearby possible cross-layer helpful energies and upgrades.[4]

QoE-aware Multiple Path Video Transmission for Wireless Multimedia Sensor Networks by Denis Rosario, Rodrigo Costa, Aldri Santos3, Torsten Braun, Eduardo Cerqueirasays that WMSN ensure a wide degree of creating potential applications in both normal resident and military zones,

which require visual and sound information to redesign the level of gathered data.The joins for WMSN are temperamental and does not give legitimate QoE to the client.In request to accomplish negligible video quality the directing convention utilized should end-to-end interface for higher parcel conveyance ratio.This paper proposes video-mindful numerous way progressive directing convention for productive mixed media transmission

over WMSN, called video-mindful MMtransmission.[5]

Routing in wireless multimedia sensor networks: A survey and challenges ahead by Hang Shen, Guangwei Bai discusses the steering and it's related issues in WMSN.To give different levels of QoE/QoS we require an effective directing convention which is hard to accomplish because of constrained system assets and dynamic system changes and complex sight and sound operations.The paper likewise talks about the difficulties and outline necessity for directing in WMSN.It additionally examines open issues in WMSN steering in different applications.[6]

Evaluation of Video Quality in Wireless Multimedia Sensor Networks by Mustafa Shakir, Obaid Ur Rehman, Zeeshan Abbas, Abdullah Masood, Wajeeha Shahid describes the simulator OMnet++.OMNet++ can reenact conditions having interactive media transmissions with attributes of video quality control and assessment must be figured based on Quality of Experience (QoE), which depends on client's discernment to keep up the video quality.The situations are first tried on radio parameters in OMNet++ for enhancement.In this paper different condition are setup utilizing OMNET++ and the execution is assessed on the QoE measurements; i.e. Pinnacle Signal-to-Noise proportion (PSNR) and Mean Opinion Score (MoS), which rely upon client's recognition to keep up the video quality.[7]

Evaluation of LEACH QoS Subject to Multimedia Traffic Types by Abedelhalim HNINI, Ahmed MOHCIN, Abdellah EZZA TI, Abdelmajid HAJAMI,In this paper show a plan to assess QoS of LEACH convention and transmit an interactive media activity of sensor systems and the examination between the mixed media movement and the ordinary activity in LEACH convention.[8]

A Link Quality and Geographical-aware Routing Protocol for Video Transmission in Mobile IoT by Denis Rosario, Zhongliang Zhao, Eduardo Cerqueira,Torsten Braun, Aldri Santos.LinGO, a convention to empower video spread with QoE bolster in versatile interactive media IoT applications. Language focuses on the conveyance of video with QoE confirmation to help remote sensor-based mixed media systems to bolster keen urban communities/IoT stages. Dialect empowers the finding of dependable courses for transmitting media content with a base video quality from a client's viewpoint. The convention embraces a DFD-based approach, and considers different measurements, for example, connect quality, advance, and remaining energy.Simulation comes about fea-

tured the advantages of LinGO by estimating SSIM, VQM, and MOS measurements.[9]

A Realistic Multipath Routing for Ad Hoc Networks by I. Bennisy, H. Fouchaly, K. Piamratz, O. Zytoune In this Multihop various leveled steering convention for Efficient VIdeo correspondence (MEVI),which sends continuous recordings for a happened occasion. MEVI joins a sharp plan to make bunches, and to give a cross-layer answer for select courses in light of system conditions. NS2 simulater is utilized for explore the carier sense go impact on the interactive media transmission.And likewise have QoE percived by the clients.[10]

GPSR: Greedy Perimeter Stateless Routing for Wireless Networks by Brad Karp, H. T. Kung ,In this GPSR settles on covetous sending choices utilizing just data about a switch's prompt neighbors in the organize topology. At the point when a bundle achieves a district where raveno us sending is unthinkable, the calculation recuperates by steering around the edge of the region.And GPSR reliably conveys upwards of information bundles contrast with DSR.[11]

Chapter 3

Technical Specifications of Video Sensor

3.1 Cyclops

Cyclops is intended to work with Mica2 bit, a WSN orchestrate from Crossbow improvement . The photo is a CIF (352*288) confirmation camera. The MCU is a 8-bit processor, which is in charge of controlling Cyclops, conversing with Mica2 and performing picture acknowledgment. In spite of restricted measure of inside MCU memory, there is an outside SRAM (64 KB) and what's increasingly an outer Streak (512 MB). Picture get is performed by the CPLD (Complex Programmable Method of thinking Device).

3.2 MeshEye

MeshEye, which is a particular board completely encouraged vision sensor orchestrate delineated with two low-confirmation pictures and one high-determination camera. The primary processor of MeshEye has 64 KB SRAM and 256 KB FLASH memory. For picture buffering and constrain there is a MMC/SD FLASH memory card of 256 MB measure. The remote correspondence module is a CC2420 radio. [12]

3.3 Panoptes

The Panoptes organize is at first made on an Applied Data Bitsy board, which utilizes a processor with 64 MB of on-board memory. A camcorder is utilized for obtainment with

resolutions going from VGA (640*480) to cut down resolutions (160*120). The correspondence module is an off-the rack IEEE 802.11 card. The structure is later moved to the Crossbow Stargate organize .Panoptes use USB 1.0 as the fundamental I/O interconnect with a most outrageous of 12 Mbps add up to exchange speed on account of the route that at the period of execution low-controlled embedded devices don't reinforce higher exchange speed (455 Mbps) USB 2.0.

3.4 Meerkats

The Meerkats testbed includes Meerkats focus brings up out as standard VSN focuses and a helpful PC going about as an information sink. Meerkats focus focuses are based over a Crossbow Stargate compose , which fuses a CPU working at 400 MHz with 32 MB FLASH memory and 64 MB RAM on the basic board. The camera can get VGA (640*480) quality picture plots.

3.5 FireFly Mosaic

FireFly Mosaic stage is made by arranging FireFly WSN sort out with a dream stack up including CMUcam3 inserted vision processor (there is also an extra load up for PC interface). The vision board contains a CMOS camera chip, an edge bolster, and a MCU. The imager is equipped for supporting 50 fps in CIF confirmation. The edge bolster is an Averlogic AL440b FIFO chip. Preparing of pictures is performed by a 32-bit LPC2106 ARM7TDMI running at 60 MHz with 64 KB on-chip RAM and 128 KB on-chip FLASH memory. The FireFly WSN focus focuses are furnished with a CC2420 radio and an ATMEL Atmega1281 8-bit processor.

3.6 MicrelEye

The processor is an ATMEL FPSLIC SoC, which combines an AT40K MCU, a Field Programmable Gate Array (FPGA) with 40 K passages, and 36 KB of presented SRAM (16 KB can be utilized for information and 20 KB is held for program storing up). The outside memory for outline accumulating is a 1 MB SRAM. Remote cutoff points of the

inside point are given by the trade off of LMX9820A Bluetooth handset, which merges a radio, a baseband controller, and a memory square.

3.7 XYZ-ALOHA

XYZ focus focuses utilize a processor that highlights an ARM7TDMI 32-bit microcontroller. The processor has 32 KB of inner RAM and 256 KB of FLASH. There is an extra 2 MB outside RAM open on the inside point. The radio handset of the stage is a CC2420 radio. Three special stages are based over XYZ sensor center points with

- ALOHA picture sensor
- OV 7649 camera module from OmniVision
- programming picture emulator

The first of these stages is named XYZ-ALOHA. OV7649 camera module can get pictures at VGA (640*480) and QVGA (320*240) resolutions.

3.8 CITRIC

Tmote Sky is outfitted with a 16-bit MCU (10 KB RAM moreover, 48 KB FLASH), an IEEE 802.15.4-solid radio, and 1 MB outside FLASH memory. Imaging stage combines a 1.3 megapixel CMOS imager, a rehash adaptable PDA class CPU, 16 MB FLASH, and 64 MB RAM. The imager outfits pictures with SXGA affirmation and can be reduced to 40*30 confirmation. The processor has 256 KB inside SRAM. [13]

3.9 Vision Mote

Vision Mote has 128 MB Streak and 64 MB SDRAM memory. An unspecified CMOS camera is used for visual data acquirement.

- Comparison Table

Platform	**Processor**	**Memory**	**Radio**	**Resolution**
Cyclops	ATmega(8-bit)	64kb SRAM	CC1000	352*288
MeshEye	ARM7TDMI(32-bit)	64kb SRAM	CC2420	640*480
Panoptes	StrongARM(32-bit)	64mb	IEEE802.11	320*240
Meerkats	XScale PSA(32-bit)	32mb	IEEE802.11	640*480
Xyz-Aloha	ARM7TDMI(32-bit)	32kb RAM	CC2420	320*240
Citric	PXA270(32-bit)	64mb	CC2420	640*480

Chapter 4

Parameters

Quality of Experience (QoE) alludes to the general worthiness of an application or administration, as saw subjectively by the end-client. QoE there by incorporates the total end-to-end framework (customer, terminal, organize, administrations foundation, and so forth.)

- Human subjectivity associated with quality and how happy is a user with respect to the service he gets.
- Parameters that affect QoE are: The nature of the video/sound substance at the source, Quality of Service (QoS), which alludes to the conveyance of content over the system and Human recognition, which incorporates desires, atmosphere, and so forth.

4.0.1 QoE Metrices

- Mean opinion Score

  The minimum threshold for acceptable quality is application dependent.

  The client QoE is regularly communicated on a Mean Opinion Score (MOS) scale.

  The MOS is expressed on a five point scale, where

  5 = excellent

  4 = good

  3 = fair

  2 = poor

  1 = bad

- Peak Signal to Nois Ratio(PSNR)

  PSNR is mostly used to measure the quality of reconstructions during compressions.[7] On the off chance that information flag is the first video and the mistakes are presented by the pressure through codecs. PSNR is the human discernment estimate about the reproduced video.

  Higher PSNR means the quality of reconstruction is high and vice versa PSNR = 10 log10 MAX2/MSE

  MSE = Mean Squred Error,MAX=Maximum Input power

  The Mean Square Error (MSE) and the Peak Signal to Noise Ratio (PSNR) are the two error metrics used to compare image compression quality.

- Structural Similarity (SSIM)

  SSIM is utilized for estimating the similitude between two pictures. The SSIM file is a full reference metric; as it were, the estimation or forecast of picture quality depends on an introductory uncompressed or contortion free picture as reference.[14] SSIM is intended to enhance customary strategies, for example, PSNR,MSE, which have turned out to be conflicting with human visual perception.

  The SSIM is an estimation of the auxiliary mutilation of the video, which endeavoring to acquire a superior relationship with the clients subjective impression, where the qualities differ in the vicinity of 0 and 1. The nearer the metric gets to 1, the better the video quality.

- Video Quality Metric (VQM)

  VQM is a product device created by the Institute for Media transmission Science (ITS) to impartially gauge seen video quality.

  It quantifies the perceptual impacts of video weaknesses counting obscuring, jerky/unnatural movement, worldwide clamor, piece mutilation, and shading twisting, and joins them into a single metric, by utilizing a direct mix of these parameters.

  Nature of video is examined utilizing the quantity of bundles sent to that of number of parcels got.

Chapter 5

Routing Protocols

5.1 LEACH

Low Energy Adaptive Clustering Hierarchy

The main aim of hierarchical routing protocol is to maintain energy consumption of nodes of the sensor network.

However LEACH is only used for Cluster Head selection and for the Data aggregation.

It is also used for data fusion for reduce the number of messages forwarded to the destination. [15]

5.2 SPEED

The Stateless Protocol for real-time communication

The main aim of SPEED is to maintain end to end delay to the distance between the source and destination.

SPEED uses back pressure and re-routing technique with the use of back pressure beacon it reduce the congestion.

SPEED uses Stateless Non deterministic Geographic Forwarding (SNGF), which provides soft, real-time, end-to-end delivery.SNGF does load balancing over wide area, which helps to reduce congestion. The only drawback is no priority is considered for packets and packet's speed can not be increased. [16]

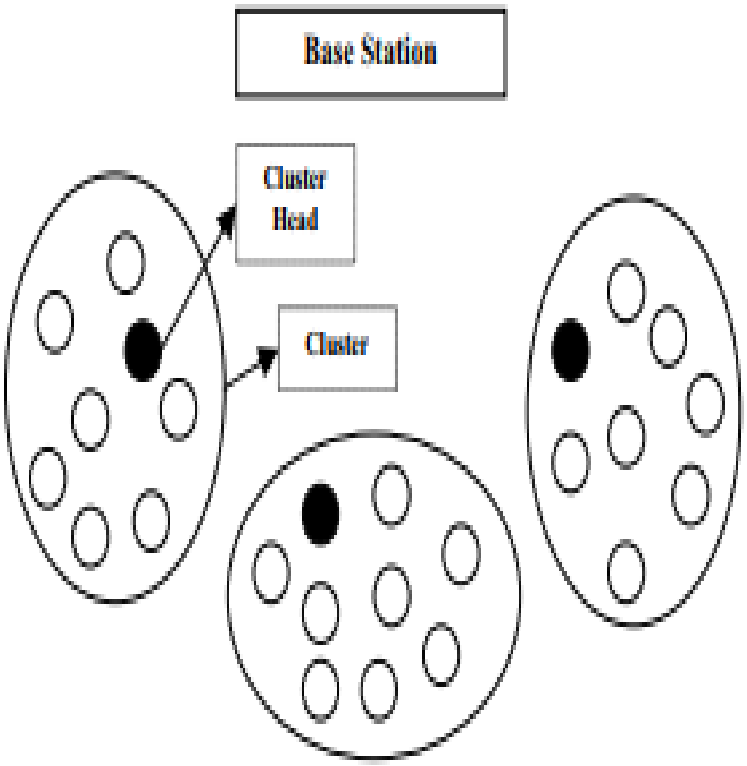


Figure 5.1: Leach

5.3 MEVI

Multi-hop hierarchical routing protocol

The main aim of MEVI is to send the real time video transmission. It creates cluster and support cross layer design.

The routes selection is based on network's condition. Link quality indicator is used to define the condition.

Path selection is depend upon remaining energy(RE) and hope count(HC) and LQI. It transmit the packets to the path which have a highest path conditions.

However considering the LQI in the CH decision and in the way development requires intermittent updates, since the connections state change after some time, which produces higher overhead. [17]

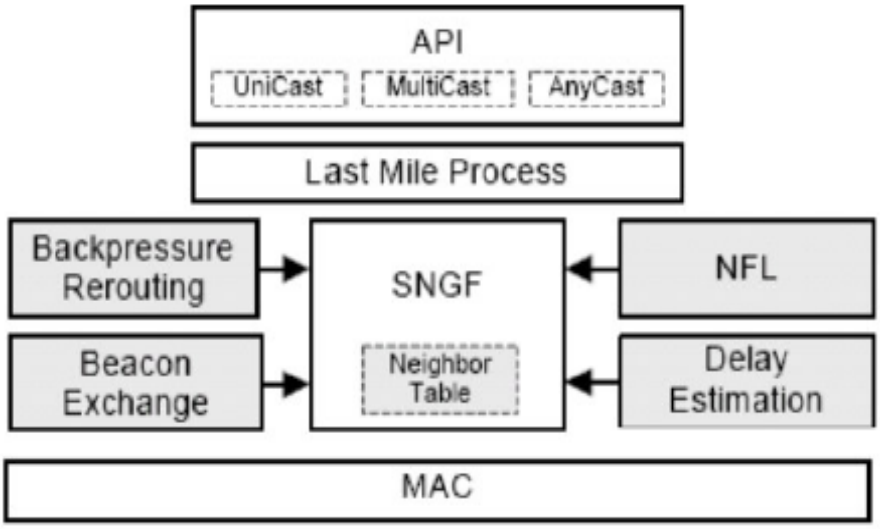


Figure 5.2: SPEED

5.4 GPSR

Greedy Perimeter Stateless Routing The main aim of GPSR is to uses the location and information as well as link quality to measure the path. It has two methods for forwarding the packets. First is greedy forwarding and second is peremeter forwarding which is only used when greedy forwarding is failed. However packet breakdown during the transmission beacause the destination node is moving its information in the packet header of intermediate node is never updated.In this GPSR settles on covetous sending choices utilizing just data about a switch's prompt neighbors in the organize topology. At the point when a bundle achieves a district where ravenous sending is unthinkable, the calculation recuperates by steering around the edge of the region.And GPSR reliably conveys upwards of information bundles contrast with DSR. [11]

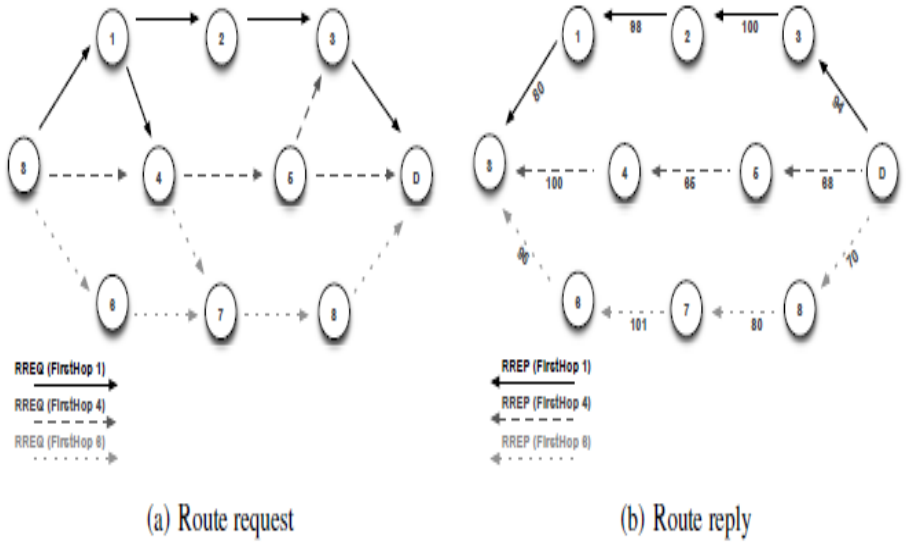


Figure 5.3: MEVI

- Comparison Table

Routing Protocol	Approch Used	Reliablity	Location Awareness
LEACH	CH Head selection and data aggrigation	Yes	No
SPEED	End to End Delay	No	Yes
MEVI	CH creates and LQI	Yes	No
GPSR	Greedy forwarding	Yes	Yes

5.5 Different aspect of Multipath

- Performances

  Exhibitions cover diverse perspectives. One of those is the information rate. Part the message and utilizing distinctive ways in the meantime to send diverse bundles can build the information rate: it is like interface source and goal more than once. To accomplish this, a connection disjoint topology ought to be utilized.

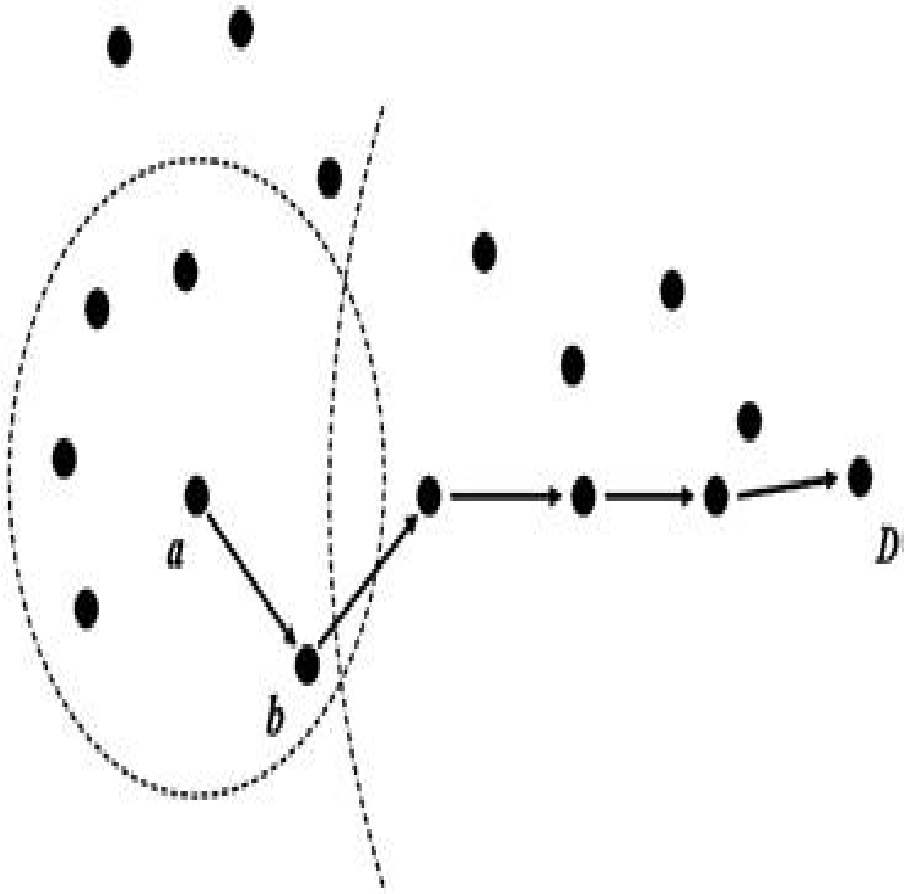


Figure 5.4: Greedy forwarding

5.6 Path Discovery

- As we realize that information transmission in remote sensor systems are done in different jumps so picking the middle of the road hubs for making various ways from source to the goal is a standout amongst the most imperative assignment. Among the previously mentionedparameters path disjointedness is the main criterion which is utilized by all the existing protocols. The path disjointedness is categorized as node disjoint, link disjoint and partially disjoint. Node disjoint means there will be no common nodes in the discovered paths. Link disjoint paths may have several nodes in common, while there will be no shared link between the paths. Partially Disjoint paths include paths which share several links or nodes between paths.

5.7 Path Selection and Traffic Distribution

- Choose a way from various ways to transmit information from source to goal. Some directing calculations utilize the best way to transmit information and keep the

others for reinforcement, some may utilize the ways simultaneously to exchange the information through various ways for unwavering quality or even movement dispersion. The essential criteria considered for finding an arrangement of ways is the way disconnection yet because of time fluctuating properties of radio correspondence and asset impediment, thinking about just this factor can prompt development of some low quality ways. To conquer this issue notwithstanding the measure of way incoherence different steering calculations utilize different steering expenses to settle on the best directing choice. Way length, parcel misfortune rate, delay, lingering battery level are a portion of the fundamental parts of steering cost work. Once the arrangement of ways is chosen the steering convention ought to decide instructions to circulate the system with the goal that the asset usage is expanded, progress execution requests, for example, throughput, information conveyance proportion, delay, life time and so on.

5.8 Path Maintenance

- Because of the asset limitations of the sensor hubs and high flow of low-control joins ways are exceptionally mistake inclined. Thusly there ought to be component for way remaking to decrease execution debasement. The way revelation can begin in three distinct circumstances,

  1. At the point when a dynamic way has fizzled
  2. At the point when every single dynamic way have fizzled
  3. At the point when certain number of ways have fizzled

5.9 Energy consumption

- Two approaches to restrict vitality utilization:

  (Flooding)First of all, the way revelation demand can be restricted: a hub keeps in its memory all the conceivable ways (even with basic connections), and when a connection is broken, this hub picks another way from its memory and deletes the old one. (Sending)The general execution can be enhanced by picking the most cost productive way, with various criteria (control utilization, separate between the hubs, number of blunders, and so on.). It is additionally conceivable to share the

heap between the hubs by picking interchange ways, i.e. utilizing the full limit of the system. At the point when a connection is exceptionally utilized, it reduces blockage by utilizing less utilized connections. Subsequently, the topology would be hub disjoint.

5.10 Fault-tolerance

- Multipath can give course flexibility, and along these lines the system can recoup rapidly from any change.

5.11 Quality of Service (QoS)

- This is additionally a result of a higher total transfer speed and end to end postpone as the information could be conveyed in a settled delay.QoS as far as system throughput, end to end inactivity, and information conveyance proportion are essential goals in outlining multi-way directing conventions for various systems. For example the found way can be used to disseminate the system movement in view of the QoS requests of the particular application. As the basic information can be sent through higher limit with least deferral and others can be sent through non ideal ways.

5.12 Reliability

- To guarantee the transmission of a parcel from a source to a goal, multipath can give diverse ways. Two of them are flooding and blunder amendment. Flooding a parcel to each way known to achieve a goal is an approach to realize greater unwavering quality a transmission. Sending distinctive parcel by various ways, it is conceivable to utilize a code mistake redress to enable the goal to modify a missing bundle. This would build the likelihood of an effective transmission.

5.13 Security/Privacy

- Multipath can be utilized to give a smidgen of security. In fact, part a message and spreading the parcels utilizing diverse ways for each other, no transitional hub would have the capacity to revamp the message. Surely, no hub would get the whole message, with the exception of the goal.

Chapter 6

Multipath Routing

6.1 GPSR Routing protocol

Greedy Forwarding

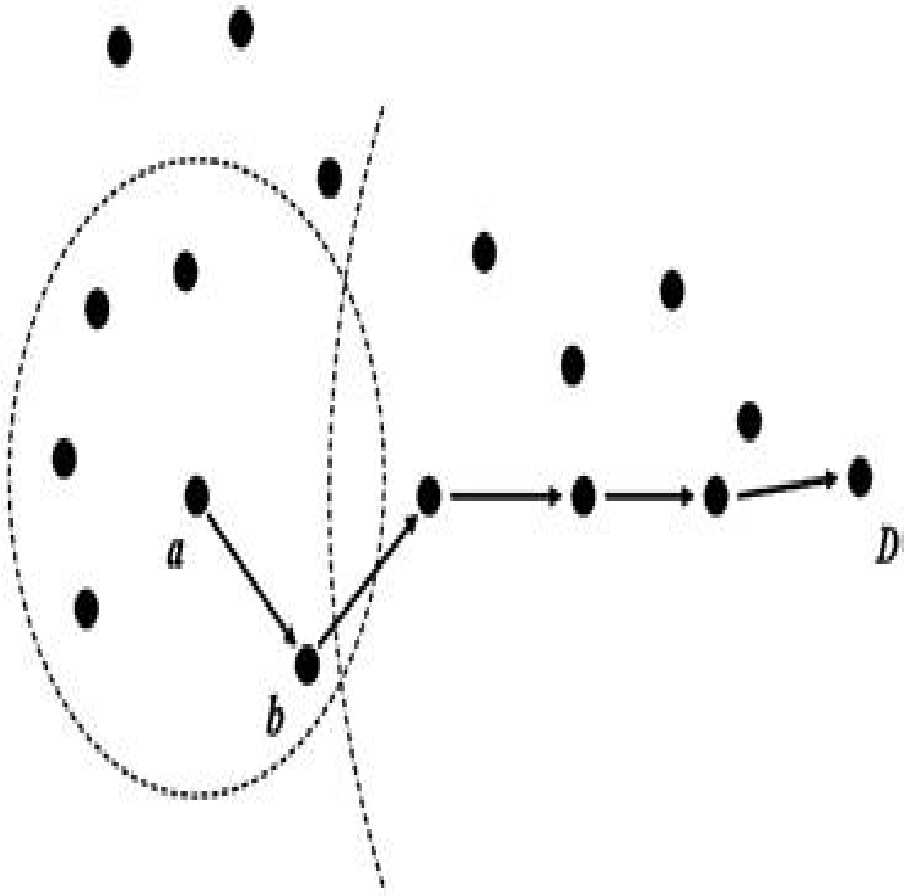


Figure 6.1: Greedy Forwarding

- Find neighbours who are closer to the destination

- Forward packet to the neighbour closest to the destination
- A node only needs to remember the location information of one-hop neighbour

Greedy forwarding fails

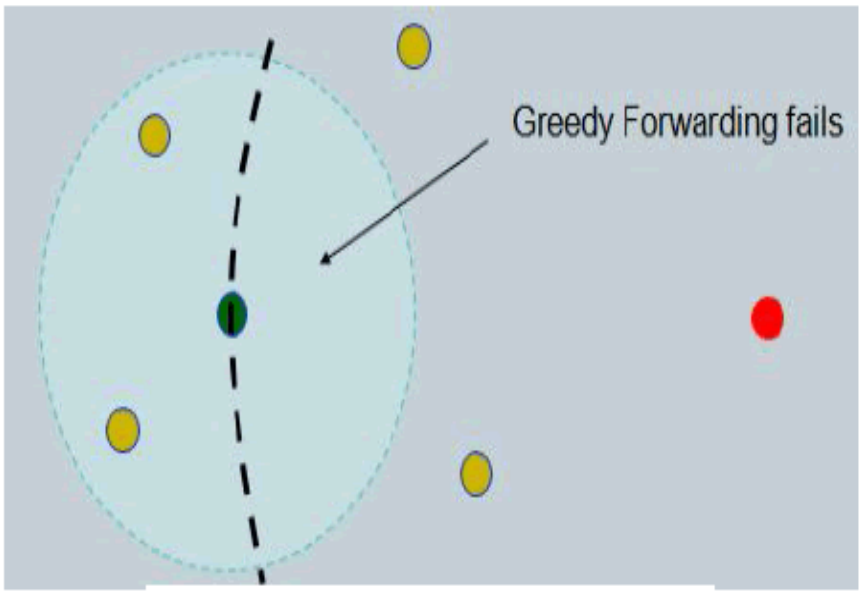


Figure 6.2: A situation where Greedy Forwarding Fails

Right Hand rule

- When the Greedy Forwarding algorithm fails, the Perimeter Forwarding algorithm will be used
- Apply the right-hand rule to traverse the edges of the void and find a path using the topologys perimeter
- Right hand rule does not work with the cross edges

6.2 Multipath Construction

- The network is static. The application is sink based,all packets have the same destination. It uses disjoint multipath geographical routing.

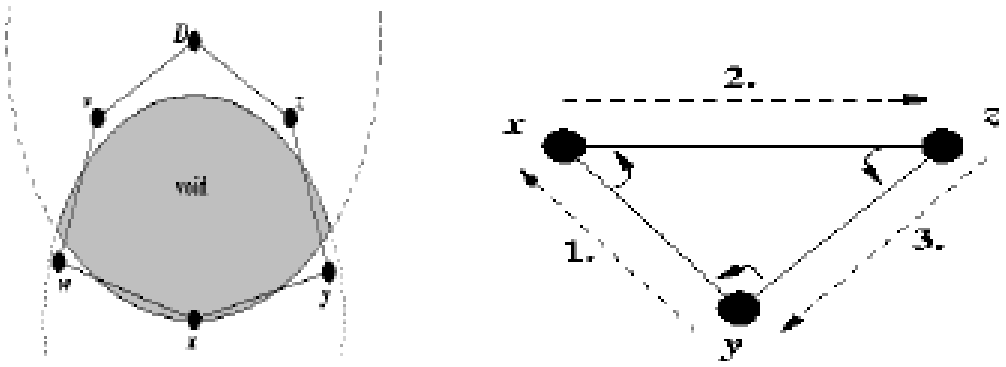


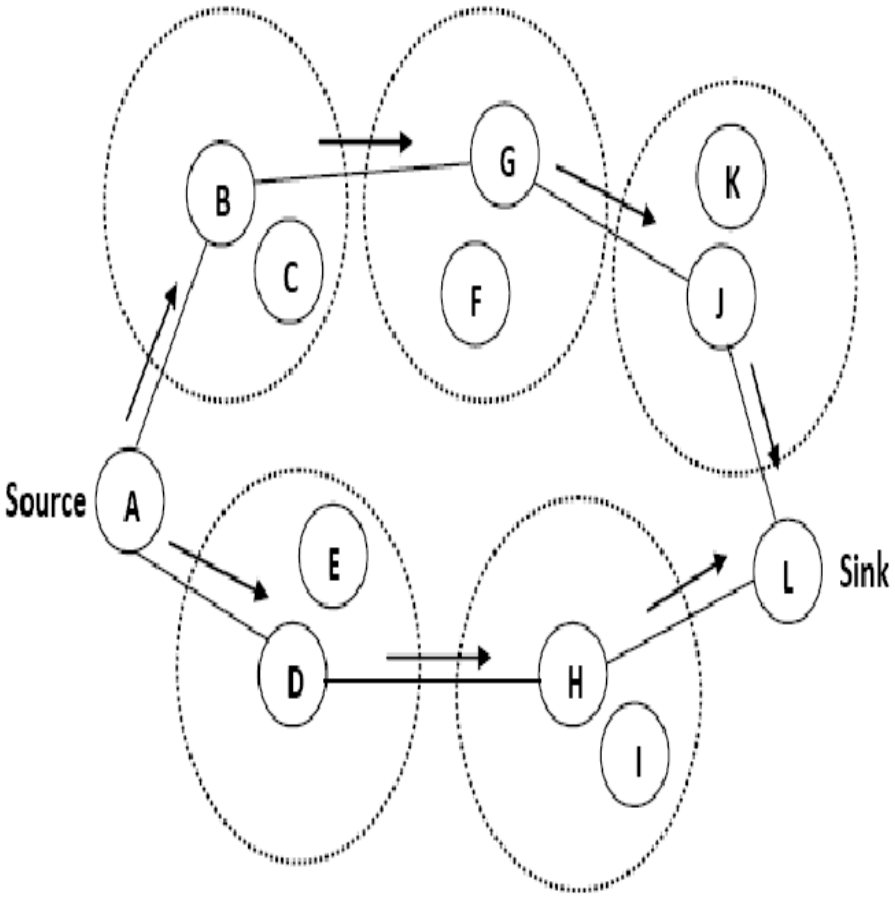
Figure 6.3: Right Hand Rule for Greedy Forwarding

- After the Neighbor Discovery phase, each node possesses their neighbor information and then the Multipath Construction phase starts. We assume that the source node location is known to the sink and based on the location of the source the sink starts the route request process.

- In the Neighbor table formation, each node knows its neighbors and maintains a neighbor table. To do broadcast the Hello packet to the all node, that hears the broadcast message and updates the node value in its Neighbour table. Table contains the below formation.

Node-ID	**X-coordinate**	**Y-coordinate**	**PQ**

where $PQ = \frac{Energy}{Distance}$



- In this the main concept is that, there are two type of nodes primary and alternate. A node is a primary node if it is in the primary path from source to sink else if it is the part of any alternate path then it is the alternate node.

- As described in the Algorithm, the primary nodes find two paths to the source, the primary path and the alternate path.

- The primary path is built with the best possible neighbor (having the best(PQ)) and the alternate path is constructed with the next best neighbor (having the next best(PQ) after the primary path node).

- The alternate nodes find one single path towards the source node and searches its neighbor table for the node with best (PQ) and will prefer a primary node if possible, this is done to converge the path else it goes to the perimeter mode.

Result: Algorithm

Sender Broadcast Hello Message ;

Calculate PQ based on energy value of node and distance of that node to the destination;

Start Greedy Forwarding ;

Set Source Node;

while *Destination Node Reached* **do**

    Forward the Hello Packet to next hop neighbour;

end

if *Destination Node Reached* **then**

    Message Forwarded through greedy Forwarding;

else

    Go to Perimeter Mode;

    First send the I-frame which has highest PQ;

    Second send the P-frame which has highest PQ;

    Third send the B-frame which has highest PQ;

end

Algorithm 1: Proposed Algorithm

Chapter 7

Simulations and Results

7.1 Castalia

Castalia is a test system for Wireless Sensor Networks (WSN), Body Area Networks (BAN) and for the most part systems of low-control implanted gadgets. It depends on the OMNeT++ stage and can be utilized by scientists and designers who need to test their conveyed calculations or potentially conventions in reasonable remote channel and radio models, with a practical hub conduct particularly identifying with access of the radio. Castalia can likewise be utilized to assess diverse stage attributes for particular applications, since it is profoundly parametric, and can recreate an extensive variety of stages. The primary highlights of Castalia are:

- Advanced channel demonstrate in light of experimentally estimated information
- Model characterizes a guide of way misfortune, not just associations between hubs
- Fully underpins versatility of the hubs
- Fully underpins versatility of the hubs
- Interference is taken care of as got flag quality, not as discrete element
- Advanced radio model in view of genuine radios for low-control correspondence
- Probability of gathering in view of SINR, bundle measure, tweak compose. PSK FSK bolstered, custom adjustment permitted by characterizing SNR-BER bend
- Multiple TX control levels with singular hub varieties permitted

- States with various power utilization and defers exchanging between them
- Realistic displaying of RSSI and bearer detecting
- Extended detecting displaying arrangements
- Highly adaptable physical process display
- Sensing gadget commotion, inclination, and power utilization
- Node clock float
- MAC and directing conventions accessible
- Designed for adjustment and extension

Concerning the last shot, Castalia was composed ideal from the earliest starting point with the goal that the clients can without much of a stretch actualize/import their calculations and conventions into Castalia while making utilization of the highlights the test system is giving. Legitimate modularization and a configurable, mechanized form system help towards this end. The measured quality, dependability, and speed of Castalia is mostly empowered by OMNeT++, an incredible system to manufacture occasion driven test systems [OMNeT++ link].

What Castalia isn't: Castalia isn't sensor-stage particular. Castalia is intended to give a non specific dependable and reasonable system for the primary request approval of a calculation before moving to usage on a particular sensor stage. Castalia isn't valuable in the event that one might want to test code ordered for a particular sensor hub stage. For such use there are different test systems/emulators accessible (e.g., Avrora).

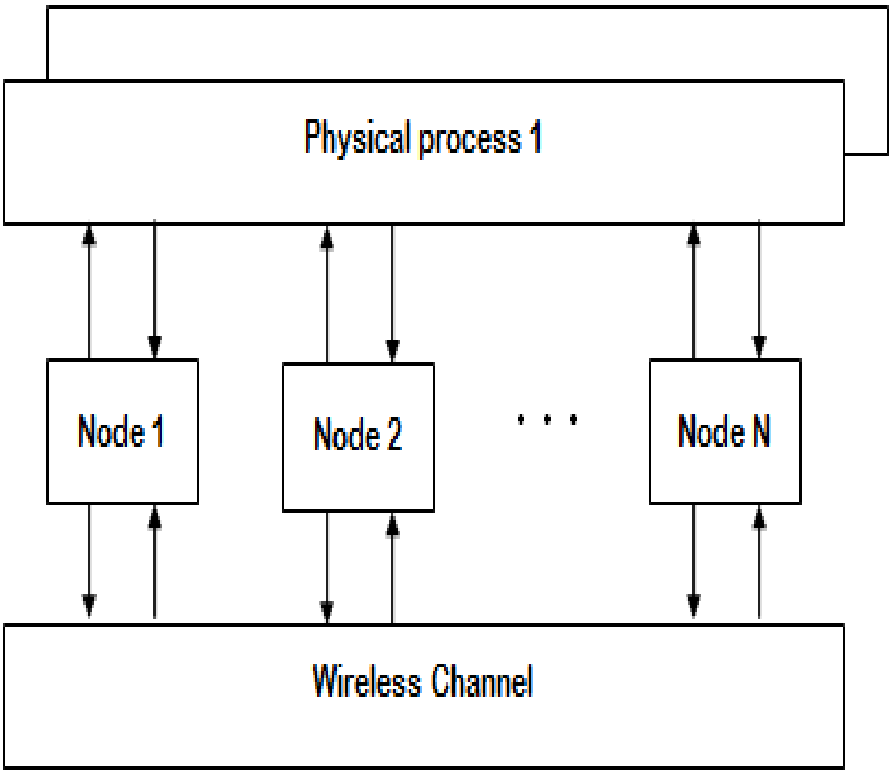


Figure 7.1: Castalia Architecture

7.2 Simulation

GPSR a stateless routing protocol was simulated in the Castalia .The simulation consists of two modes of GPSR protocol:

- Greedy Forwarding
- Perimeter Forwarding

The results of the above simulations are represented as screen-shots in the following order:

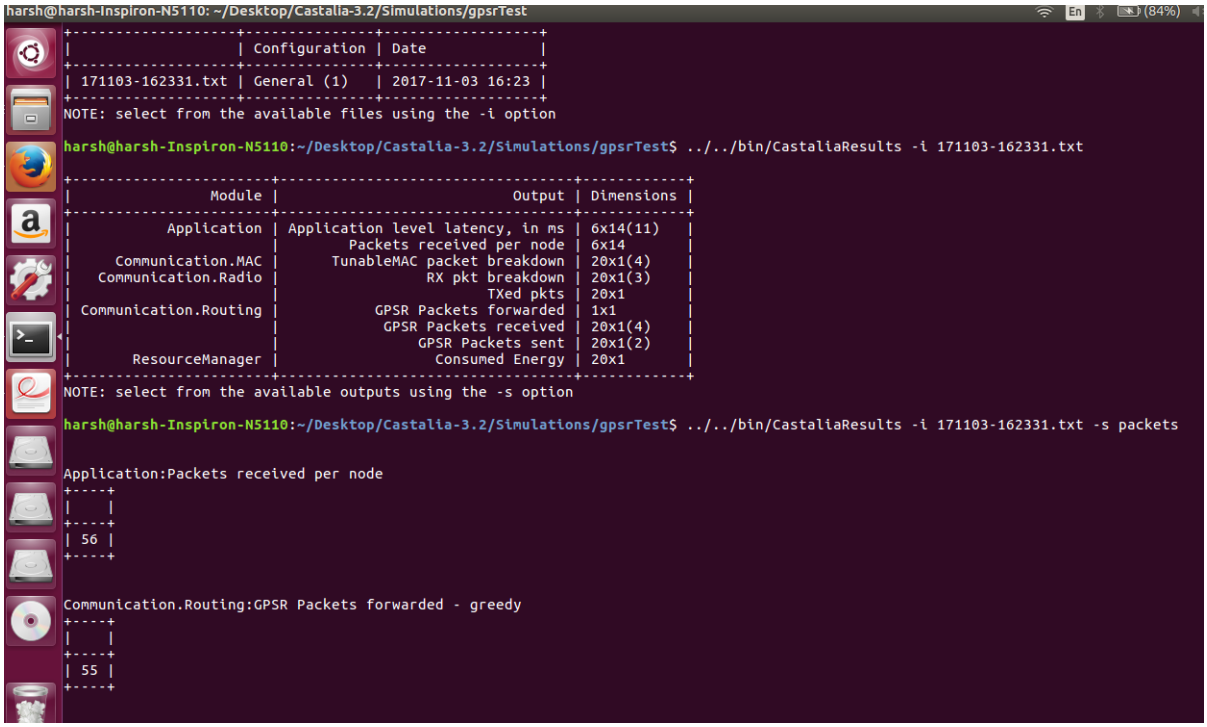


Figure 7.2: Simulation-1

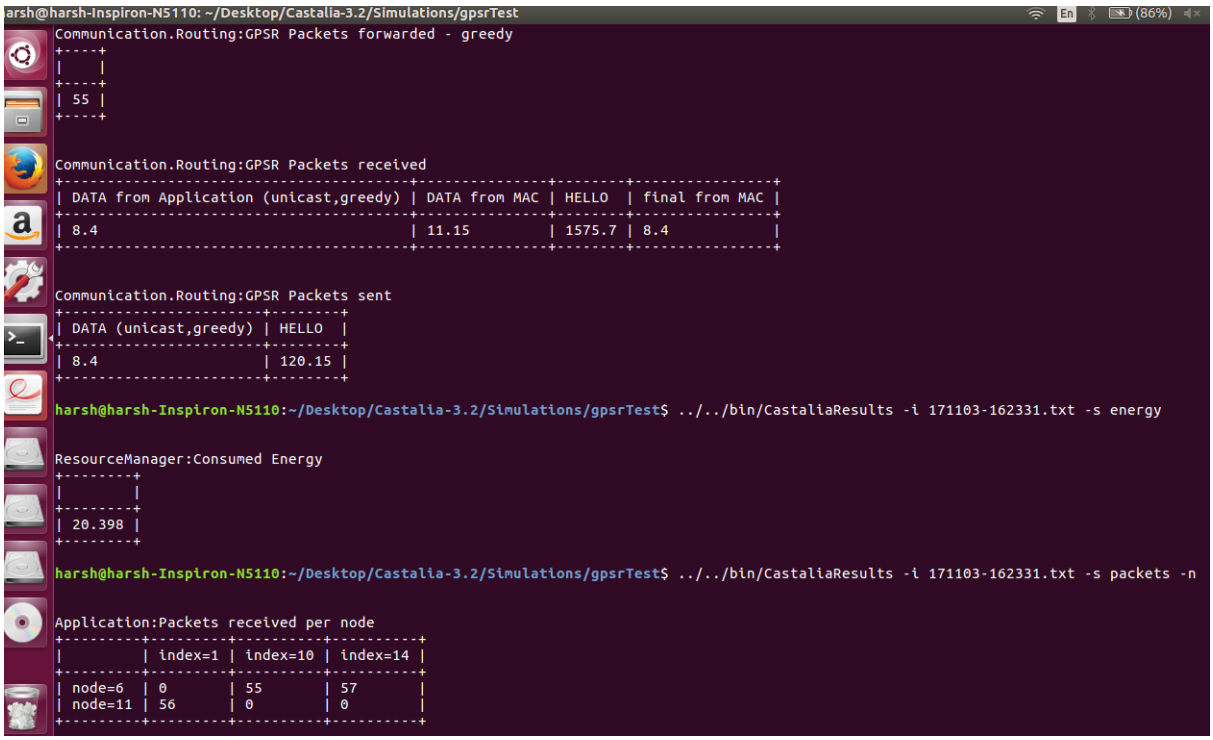


Figure 7.3: Simulation-2

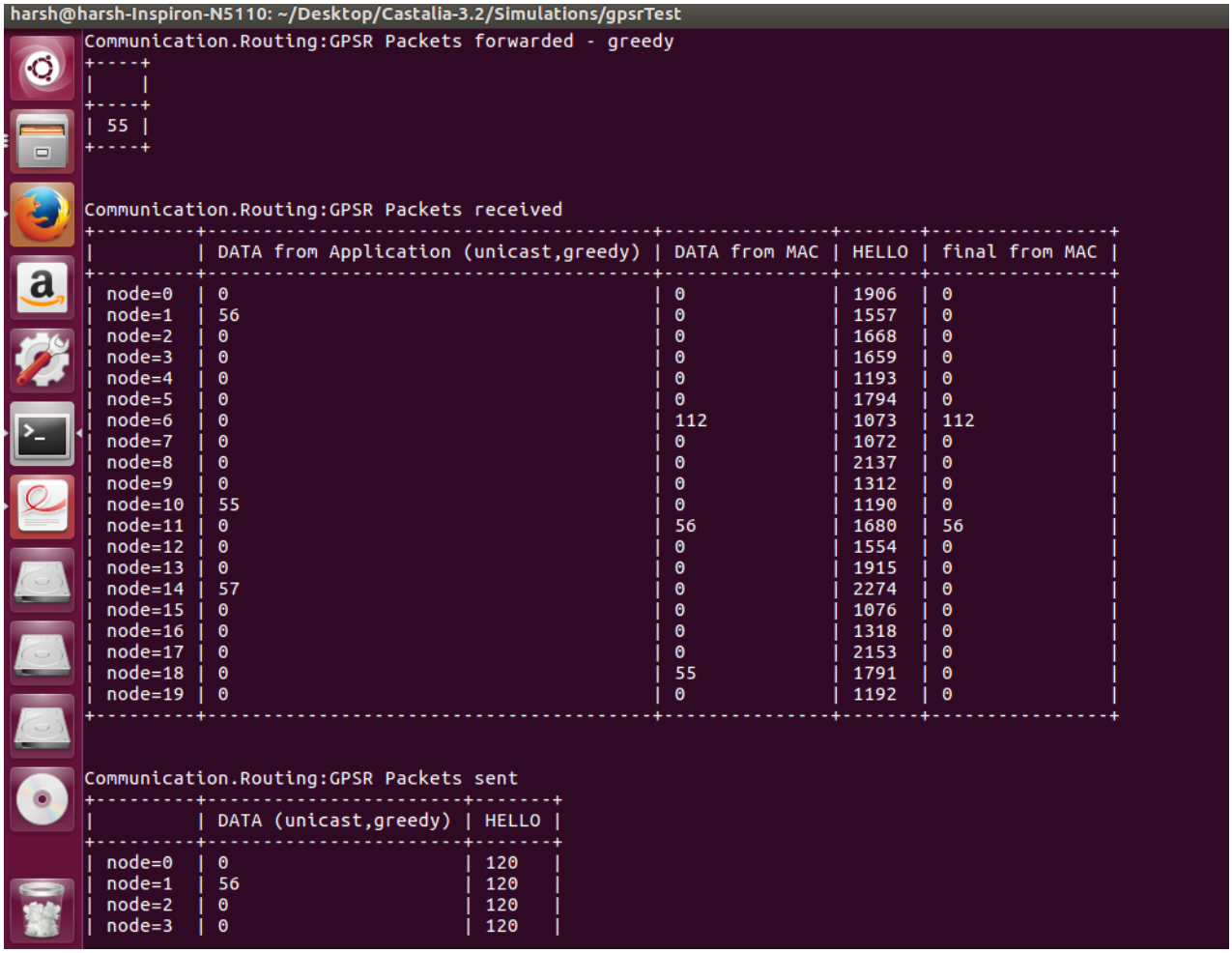


Figure 7.4: Simulation-3

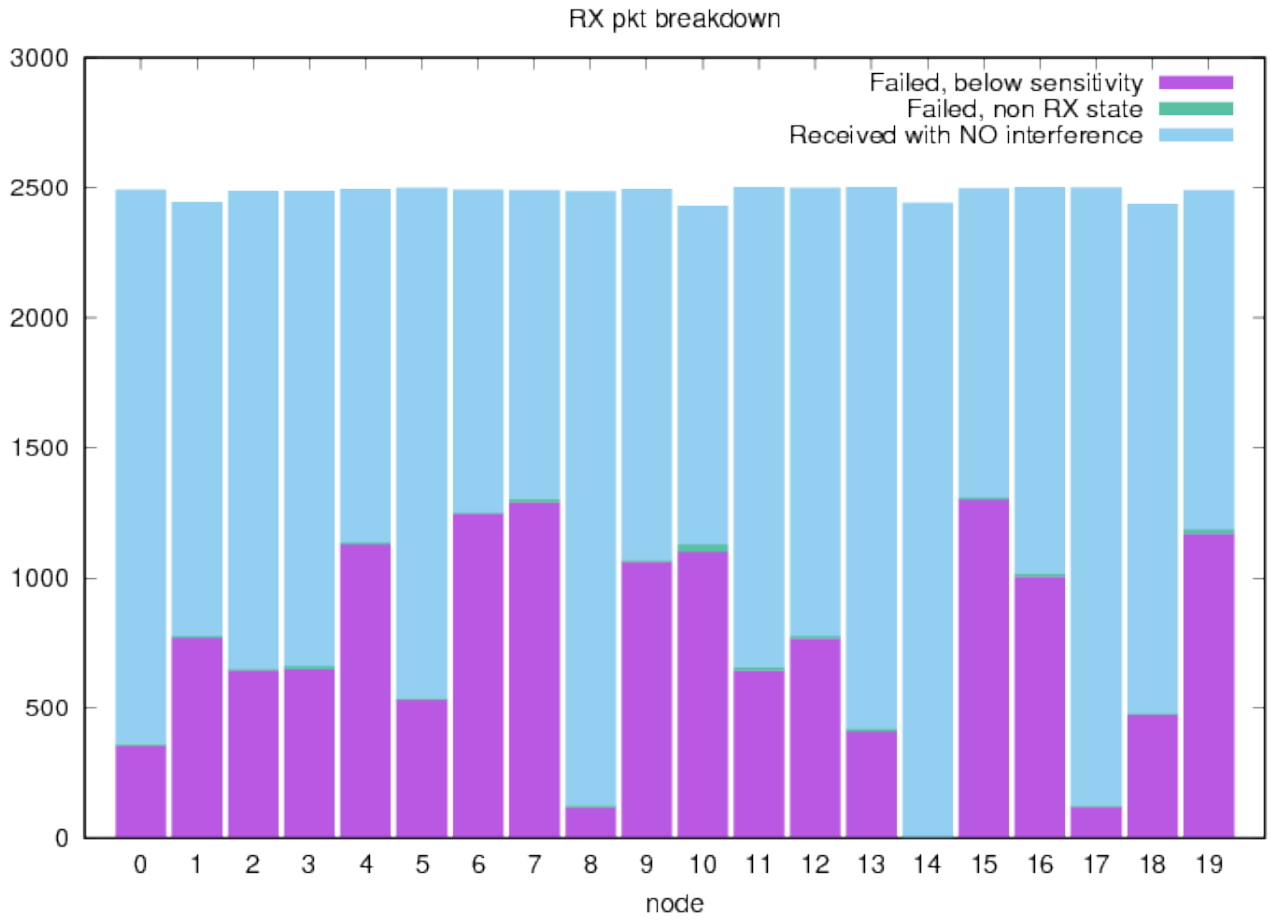


Figure 7.5: Greedy Forwarding Simulation Result

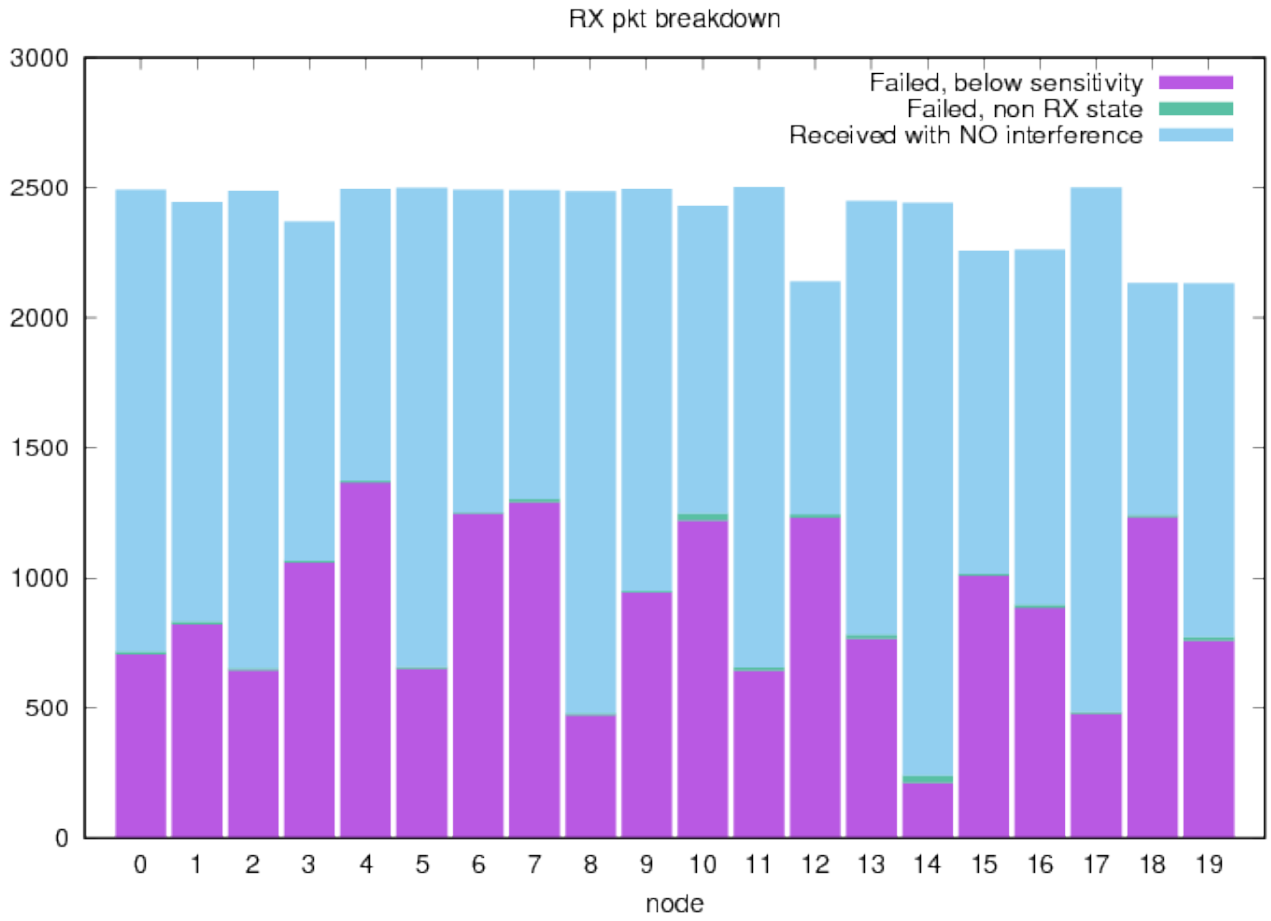


Figure 7.6: Perimeter Forwarding Simulation Result

Chapter 8

Conclusion and Future Work

We can conclude that Quality of Experience(QoE) in the protocols used for transmission for Wireless Multimedia Sensor Networks is important and it can be done by including a multipath forwarding as mentioned in proposed algorithm which can be implemented using the Castalia Simulator using OMNet++.GPSR protocol and it's two foremding odwas have been implemented and results are presented in the report.

8.1 Future Work

- The routing protocol can be customized as per application requirement
- The Video transmission can be done through M3WSN tool

Bibliography

[1] I. F. Akyildiz, T. Melodia, and K. R. Chowdhury, "Wireless multimedia sensor networks: Applications and testbeds," *Proceedings of the IEEE*, vol. 96, no. 10, pp. 1588–1605, 2008.

[2] I. F. Akyildiz, T. Melodia, and K. R. Chowdhury, "A survey on wireless multimedia sensor networks," *Computer networks*, vol. 51, no. 4, pp. 921–960, 2007.

[3] A. Sharif, V. Potdar, and E. Chang, "Wireless multimedia sensor network technology: A survey," in *Industrial informatics, 2009. INDIN 2009. 7th IEEE international conference on*, pp. 606–613, IEEE, 2009.

[4] I. F. Akyildiz, T. Melodia, and K. R. Chowdury, "Wireless multimedia sensor networks: A survey," *IEEE Wireless Communications*, vol. 14, no. 6, 2007.

[5] Z. Zhao, T. Braun, D. do Rosario, E. Cerqueira, R. Immich, and M. Curado, "Qoe-aware fec mechanism for intrusion detection in multi-tier wireless multimedia sensor networks," in *Wireless and Mobile Computing, Networking and Communications (WiMob), 2012 IEEE 8th International Conference on*, pp. 689–696, IEEE, 2012.

[6] H. Shen and G. Bai, "Routing in wireless multimedia sensor networks: A survey and challenges ahead," *Journal of Network and Computer Applications*, vol. 71, pp. 30–49, 2016.

[7] M. Shakir, O. U. Rehman, Z. Abbas, A. Masood, and W. Shahid, "Evaluation of video quality in wireless multimedia sensor networks," *International Journal of Electrical and Computer Engineering*, vol. 6, no. 1, p. 223, 2016.

[8] A. Hnini, A. Mohcin, A. Ezzati, and A. Hajami, "Evaluation of leach qos subject to multimedia traffic types," in *Next Generation Networks and Services (NGNS), 2012*, pp. 181–184, IEEE, 2012.

[9] D. Rosario, Z. Zhao, E. Cerqueira, T. Braun, A. Santos, and D. Rosário, "A link quality and geographical-aware routing protocol for video transmission in mobile iot,"

[10] I. Bennis, H. Fouchal, K. Piamrat, O. Zytoune, and D. Aboutajdine, "A realistic multipath routing for ad hoc networks," in *Global Communications Conference (GLOBECOM), 2015 IEEE*, pp. 1–6, IEEE, 2015.

[11] B. Karp and H.-T. Kung, "Gpsr: Greedy perimeter stateless routing for wireless networks," in *Proceedings of the 6th annual international conference on Mobile computing and networking*, pp. 243–254, ACM, 2000.

[12] R. Zilan, J. Barcelo-Ordinas, and B. Tavli, "Available mote platforms for wireless image sensors," *Lit. Surv.*, pp. 1–24, 2008.

[13] B. Tavli, K. Bicakci, R. Zilan, and J. M. Barcelo-Ordinas, "A survey of visual sensor network platforms," *Multimedia Tools and Applications*, vol. 60, no. 3, pp. 689–726, 2012.

[14] A. Sivagami and S. Malarkkan, "Assessment of qoe metrics of voice, video traffic in wireless multimedia sensor networks,"

[15] R. K. Gill, P. Chawla, and M. Sachdeva, "Study of leach routing protocol for wireless sensor networks," in *International Conference on Communication, Computing & Systems (ICCCS-2014)*, 2014.

[16] V. Ukani and D. Thacker, "Qos aware geographic routing protocol for multimedia transmission in wireless sensor network," in *Engineering (NUiCONE), 2015 5th Nirma University International Conference on*, pp. 1–6, IEEE, 2015.

[17] D. Rosário, R. Costa, A. Santos, T. Braun, and E. Cerqueira, "Qoe-aware multiple path video transmission for wireless multimedia sensor networks," *Simpósio Brasileiro de Redes de Computadores e Sistemas DistribuídosSBRC*, pp. 31–44, 2013.