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Analysis On The Role Of Infrastructure And Protocols In Enhancing Intelligent Transport System

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Abstract – Communication Dissemination Has Been Very Important Among The Service Provider And Requester In The Network Of Intelligent Vehicles. Resources Like Network Data, Interaction Between The Real Time Data And Sharing Of Data Has Been Challenging In A Constrained Network. To Address The Issue Of Communication Based On The Location Service For The User Several Protocol Has Been Developed. Secondly, Traffic Congestion Is The Major Problem When It Comes To The Emergency Cases Like Accidents Or Any Other Problem With The Vehicle Over The Highway Roads. Safety Of The Users Is Also A Prominent Factor. Considering All These Factors, Based On The Safety Protocols Has Been Recommended Avoiding The Chain Accident Occurrences. Authentication Has Also Been A Major Concern Before The Communication Even Happens Between The Client And Server. The Data Sharing Between The Client And Server Requires A Cryptographic Strategy Where The Generation Of Key Happens For The Secure Communication. Many A Protocols Have Been Designed To Achieve This Strategy As Well. Before Analyzing All These, Role Of Infrastructure Is Very Necessary To Understand On How The Vehicles Process Information Within The Smart Surrounding. Here, Priory We Brief On The Working Of Infrastructure Of The Intelligent Transport System To Get The Basic Overview. Research Of The Various Protocols Has Been Made In The Literature Survey From The View Of The Location Recommendation Service, Safety Ensure And Authentication Mechanism. Out Of The Analyzed Research, We Bring Out The Best Methods And Strategy For Adopting The Certain Protocols.

Index Terms: - Location Service, Safety Efficiency, Authentication, Internet Of Vehicles, ITS.

1. INTRODUCTION

1. Components Of Its

The ITS Infrastructure Components Can Be Partitioned Into Four Different Categories: Field, Centre, Vehicle And Telecommunications.

- Field Devices Incorporate Roadway Devices, Which Includes:
- Sensors And Cameras In Traffic
- Real Time Parking Occupancy Detectors In Parking Management Systems

- Radio-Frequency Identification (RFID) For Automated Toll Collection System Which Includes Receivers In Roadway Payment System
- Surveillance Cameras And Intrusion Detectors In Security Monitoring Devices
- Traffic Lights And Signal Controllers
- Centre Infrastructure, Such As:
- Synchronizing Real Time Roadway Operation Functions In A Traffic Management Centre – For Example, Rerouting Of Traffic And Incident Management
- Vehicle Infrastructures, Comprises Of:
- Acknowledging To A Critical Traffic Happening By Emergency Vehicles
- Buses , Mini-Buses, Coaches, Trams – For Example, Supporting Real-Time Scheduling And Travel Information By The Vehicle Location Systems
- Vehicles Deployed In A Work Zone For Maintenance And Construction
- To Determine Traffic Characteristics, Vehicle Fleets And Taxis Used As Probe Vehicles
- Telecommunications Infrastructure, Which Can Be:
- Fibre Optic Cable Network In The Category Of Wired
- Cellular Or Wimax Technology , In The Category Of Wireless

The Fig.1 Shows The Connection Between Field, Centre And Vehicle Infrastructure. Through Wireless Or Wired Technology, Centers May Transmit With Each Other And With Field Devices. Vehicles Communicate With Field Devices And Centers Through Wireless Infrastructure.

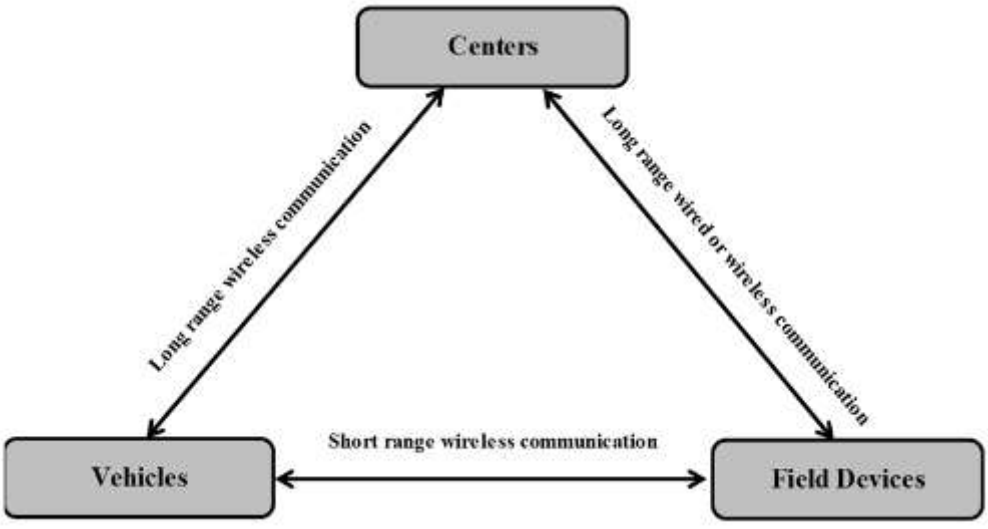


Fig. 1. Communication Between The Components

2. Working Of Its

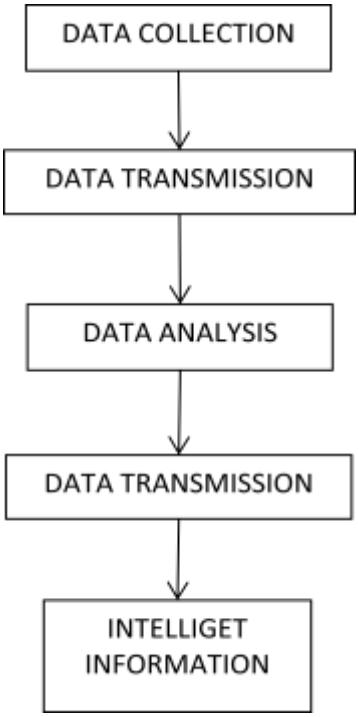


Fig. 2. Workflow Of ITS

Hardware: GPS, Cameras, Sensors
Data: Surveillance, Traffic Count, Location Speed And Time, Delays, Vehicle Weight Etc

Rapid Real-Time Data Transit Between The Road And Traffic Management Center

Adaptive Logical Analysis, Data Cleaning, Data Synthesis, Error Rectification,

Rapid Real-Time Data Transit Between The Traveler And Traffic Management Center

Electronic Devices Like Internet, SMS, Automated Cell, Variable Message Signs, Highway Advisory Radio, Delivers Real-Time Information Like Change In Route, Diversions, Delay, Accidents On Roads, Work Zone Conditions ,Travel Time, Travel Speed, Etc

2.1 Data Collection

Accurate Data Collection With Real-Time Observation Lead To Strategic Planning. So The Hardware Devices That Form The Foundation Of ITS Tasks Collect The Data Here. These Devices Are Sensors, GPS Based Automatic Vehicle Locators, Camera, Automatic Vehicle Identifiers; Etc. The Hardware Mainly Tracks And Preserves The Data Like Vehicle Weight, Speed And Time, Surveillance Location, Delays, Traffic Count, Etc. The Servers Probably Situated At Data Collection Centre Stores Enormous Amounts Of Data For Additional Research Are Connected To These Hardware Devices.

2.2 Data Transmission

Real-Time Data And Rapid Conveying Is The Key To Expertise In The Implementation Of ITS. These Feature's Of ITS Does The Work Of Carrying The Gathered Data From The Field To Traffic Management Center And Reverting The Processed Information From Traffic Management Center To Travelers. Internet, SMS Or Onboard Units Of Vehicle Remains As The Medium For Traffic-Related Announcements In Turn Communicated To The Travelers. Other Means Of Communications Are Continuous Air Interface Long And Medium Range Using Infra-Red Links And Cellular Connectivity And Dedicated Short-Range Communications.

2.3 Data Analysis

The Data Will Be Further Processed Which Undergoes Various Steps That Are Received And Collected At TMC. These Steps Include Adaptive Logical Analysis, Data Synthesis, Error Rectification, And Data Cleaning. Specialized Software Identifies The Inconsistencies In Data And Fixed. Lately, The Data Is Further Modified And Grouped For Analysis. To Predict Traffic Scenes Which Are To Be Made Available To Deliver Apt Information To Users, These Collective Data Is Analyzed Further.

2.4 Traveler Information

Travel Advisory Systems (TAS) Keeps Informed To The Users Who Are Traveling About The Movement Updates. The System Delivers Real-Time Information Like Change In Route, Diversions, Delay, Accidents On Roads, Work Zone Conditions ,Travel Time, Travel Speed, Etc. Electronic Devices Like Internet, SMS, Automated Cell, Variable Message Signs, And Highway Advisory Radio Delivers This Information.

3. Literature Survey

In [1], CAV's (Connected Autonomous Vehicle) Is Designed With The Combination Of WI-FI Networks Fused With GNSS To Improvise The Location Precision And Accuracy. To Enable Pervasive Location Services For CAV's As They Travel Through Different Places, Hybrid Vehicular Localization Systems Have Been Proposed. In [2], For Iov (Internet Of Vehicle) A Proprietary Protocol Stack And Communication Architecture Is Designed To Address The Issues Like Data Collection From The Network, Interaction Between Real Time Data And Sharing Data. Also To Eradicate The Flaws Of The Above Mentioned Issues, An Recommendation Based Method For The Trustworthy Services To Find The Location For The Iov Makes The Inter Communication With The Service Providers And Service Requesters Through The Network. In [3], To Enhance The Safety Of Drivers And Create A Comfortable Driving Environment, VANET(Vehicular Adhoc Network) Introduces A Variety Of Application. Routing Is The Base Operation In VANET That Allows A Vehicle To Attain Its Destination From The Source. This Becomes A Challenging Task Due To Topological Change And High Speed Movement Of Vehicles Involved. To Resolve This, PGRP(Predictive Geographic Routing Protocol) Is Implemented Improving The Connectivity. [4] Topological Deviations In The Vehicular Adhoc Network Is Common When Finding The Linked Route To Reach The Destination With Minimum Delay. SPEA(Strength Pareto Evolutionary Algorithm) Is Adopted By The Multimetric Protocol To Optimize The Metrics Involved. Using This, Algorithm Optimal Path Can Be Found To The Destination Where The Delivery Of Data Is Efficient. Authors Of [5], Has Made A Protocol Analysis And Enhancement Considering Road Side Unit(RSU). This Provides A Intersection

Collision Risk Warning Using Intersection Assistance Systems(IAS) With The Help Of Adaptive Beaconing Protocols. Improving The Performance Of Beaconing Protocol For Ensuring Safety RSU Based IAS Is The Main Theme.
In The Paper [6], Authors Have Investigated The Possible Emergency Cases Happening In The Highway Roads And Consequences Of The Surrounding Vehicles As The Effects Of These Cases. A Recommendation Protocol Is Implemented That Provides The Right Response To Each Vehicle In The Locality Where The Emergency Case Is Detected. As An Advantage, Vehicles Safety Condition Has Increased And Vehicles That Are Likely To Get Involved In Accidents Has Decreased. In [7], The Authors Focused On The Vehicle Safety With The Guide Of Periodic Safety Dissemination Protocol, By Designing An Effective And Accurate Pre-Crash System To Avoid Vehicular Crashing In Both Front And Back. Vehicle's Information Is Collected To Predict The Crash Based On The Safe Avoidance Time Between Two Vehicles. Authors Of [8] Surveyed The Prediction Based Protocols For Vanets, To Predict The Vehicles Future Movements That Resolve Several Issues Of Intelligent Transportation System. This Factor Paves Way For Enhancing The Vehicles Robustness And Reliability In Vanets. In This Paper [9], Conventional Traffic Lights Are Replaced By Intelligent Crossroads. These Provide The Space Efficient Traffic Protocol Which Handles Overlength Vehicles Especially Which Needs Relaxing Space Requirement On The Road Intersection. In This Way The Throughput Of The Vehicle Is Increased While Handling The Intersections Of The Road. In This Paper [10], The Experience Of Routing Is Improved With The Help Of An Unmanned Aerial Vehicle (UAV), With Its Capability Of Three-Dimensional Movements. This Helps In Increasing The Better Connectivity, Line Of Sight Probability, And Efficient Store-Carry-Forward Mechanism.

Position Based Routing[11] Considers City Environment Along With The Routing Scheme For Connectivity. In Order To Select The Path By Utilizing The Road Junction A Fog-Oriented VANET Architecture Supports PBR. Moreover This Architecture Supports The Metrics Like Transmission Time, Communication Cost, End To End Delivery And Packet Delivery Ratio. It Reduces The Time To Carry Forward The Information Even In The Absence Of Guarding Nodes. This Paper [12] Considers The Bi-Directional Highway Environment For Vigorous Dispel Of Warning Messages. DABFS Determines Movement Of The Node's Using Hamming Distance, Forwarding The Warning Messages Through Neighbor Node And Best Route Discovery. Besides The Distance Parameter, Directions And Relative Positions Of Nodes Are Taken Into Account. Emphasizing On The Security [13] Has Been A Major Concern In The Fog-Based VANET Through Mutual Authentication By Generating A Session Key For Communication Privacy. Authentication Mechanism For Wireless Medical Sensor Networks (Wmsns) For Achieving The Local Password Change Has Been Attained Using Three Factor Authentication Protocol, While Comparing The Relevant Security Protocols. This Handles The Biometric Information Utilizing Fuzzy Schemes. Considering Cyclist As One Of The Vulnerable Road User, Distant Detection Of Bicycle Using V2V Communication Upto 1 Km [14] Is Ensured In Non-Signalized. A Light Weight Mutual Authentication Protocol [15] Has Been Designed To Establish A Secret Key Between The Node And The Server For Secure Communication[16]. To Protect The ITS, Multi-Model Implicit Authentication Protocol Uses The Feature Of Vehicle Owner's Behavior[17][18]. This Does Not Reveal The Sensitive Information Of The Vehicle Owner To The Authentication Server While Only Delivering The Cipher Text Size Of The Feature Vector.

2. METHODS AND MATERIALS

Based On Location Service

Internet Of Vehicles Needs A Well Designed Inter Communication Architecture And Design Protocol Stack In Order To Get The Appropriate Network Data And Real Time Data Interaction. Proposing The Location-Based Services Recommendation Based On The Location Of Users Are Time-Varying And Challenging As Well. Taking The Practical Scenario, Most Of The User Follows Regular Routines During Business Hours And This Pave Way For A Common Geographical Area. With This Characteristic It Is Possible To Achieve The Recommendation System Where The User's Mobility Is Common To A Certain Extent.

There Arises Four State Of Consideration To Define The Location Based Service Preference Similarity Assuming:

1. For A User At Different Location
2. For A User In Different Time Periods
3. For Two Users At Different Location
4. For Two Users In Different Time Periods

All The Mentioned Assumptions Are Multidimensional Eigen Vectors, Where After Normalization Process These Vectors Have The Same Length. Finally These Preferences Are Recommended Using Euclidean Distance.

Based On Authentication

Through The Architectural Model Communication Between The Vehicle And The Vehicle Server Which Consist Of Four Attributes Namely Vehicle, Registration Authority(RA), Trusted Authority(TA) And Vehicle Server(VS).The Vehicle, First Needs To Register Its Identity With Trusted Authority, Thereafter Any Data From The Vehicle Server Can Be Fetched Easily. This Process Allows The Authenticity Of The Vehicles In Future And Also It Adds A Cover Of Security To The Overall Process. TA, Which Stores Vehicle Related Data And Controls The Traffic Request Between The Vehicle And The Vehicle Server.

The Security Protocol Is Enabled In Such A Way That Will Enable The Host To Get Authenticated As Well As Establish Secret Key Between The Vehicle And VS. To Reduce The Overhead Of RA And Not Involving It Every Time During The Authentication Process, After Registration RA Forwards Some Parameters To TA. These Are Used For Authentication During The Time Of Communication. Similarly Few These Parameters Are Made To Inbuilt In OBU Inside The Vehicle. The Values Are Taken From This, During The Authentication Check.

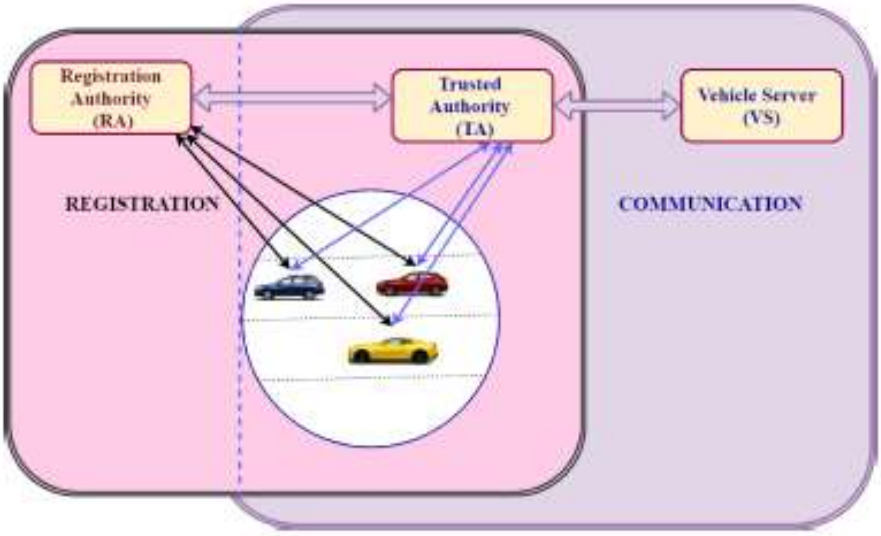


Fig. 3. System Model

From The Fig 1 It Is Clear That, The Registration Requires Only RA To Be Involved And Later RA Forwards Values To TA. Moreover, In The Phase Of Communication TA Acts As An Intermediate To Fetch The Data From The Vehicle Server To Prove Its Authenticity. Also, From The Fig 1 All The Communications Are Bi-Directional And Shown With The Help Of Double Arrow Link. The Network Model Is Based On Few Assumptions:

1. Iov Communication Scenarios Can Take Place Only If The Vehicles Are Registered.
2. VS,RA And TA Are Trusted Entities And Cannot Be Compromised.
3. The Registered User Does Not Share His/Her Credentials With The Third Party.

4.3 Based On Safety Control

This Protocol Is Designed In A Way That There Are Sequential Steps Are Configured To Detect The Emergency Cases, Determining The Best Response For Each Vehicle And Instructing Drivers To Follow The Best Response Given For High Way Road Scenario.

A. *Detecting Emergency Cases*

Vehicles Broadcasts An Advertisement Adv Message With The Help Of Some Of The Parameters Such As Vehicle Number, Current Position, Direction, Speed, Destination And Type. The Type Parameter Helps In Detecting The Emergency Cases Of The Vehicle On The Highway Scenario. For Example, The Type Is Turned As “Broken” In Case The Vehicle Is Met With Any Accident. Also If It Is A Regular Vehicle Its Type Is Set To “Vehicle”, Heavy Vehicle As “Lorry” Or If It Is An Emergency Vehicle “Emergency”. Sending The Adv Message Is Based On The Stretch Of The Highway And The Streak(Km/Hr) On That Particular Road. Vehicles That Are Within The Surrounding Range, Receives Adv Message That Conveys The Emergency Cases And Finds The Blocked Roads.

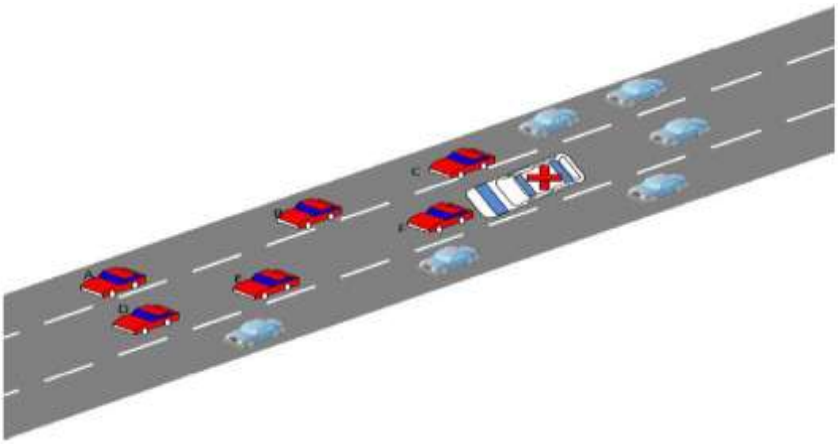


Fig. 4. Emergency Vehicle On The Highway.

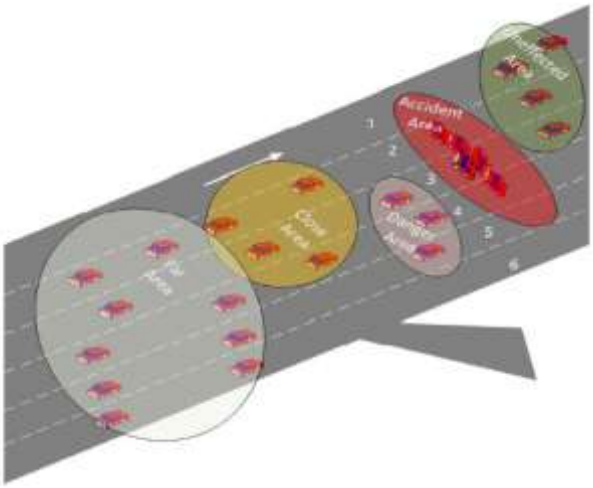


Fig. 5. Accident Detection On The Highway.

A. Determining The Best Response For Each Vehicle

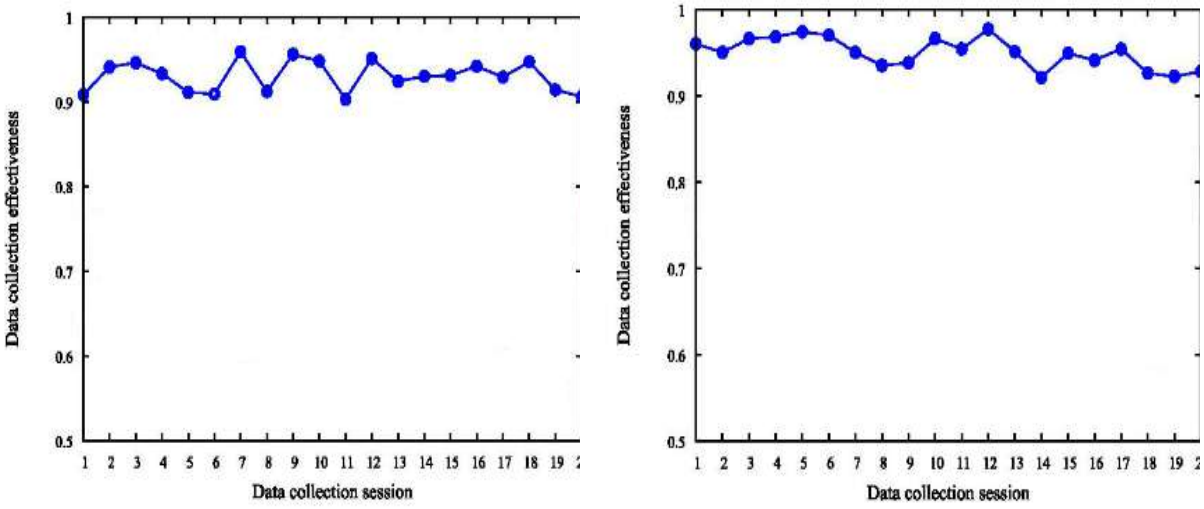
The Protocol Aims To Collect The Accurate Data About The Emergency Cases Detected Which In Turn Helps The Drivers To Get The Best Response In That Particular Area. Information Regarding Emergency Cases Like The Position Of The Emergency Vehicle, Vehicle Behavior In The Surrounding And The Clumsy Traffic In The Area. The Main Behavior Of The Drivers Lies In Changing The Directions, Reducing Speed Or Even Stopping The Vehicle In Severe Scenarios. These Are Some Of The Best Ways To Respond To The Scenario Happened.

B. Recommendation Of Best Response For Each Vehicle

It Is Evident That There Is No Need For External Unit For Recommending The Best Response For Each Vehicle. It Wholly Relies On The Co-Operative Communication Among The Vehicles Over The Highway Road Scenes. Delivering The Details Of The Vehicles Such As Traffic Distribution, Location Of The Emergency Vehicle And Other Details Enables The Best Response For Each Vehicle.

Analysis

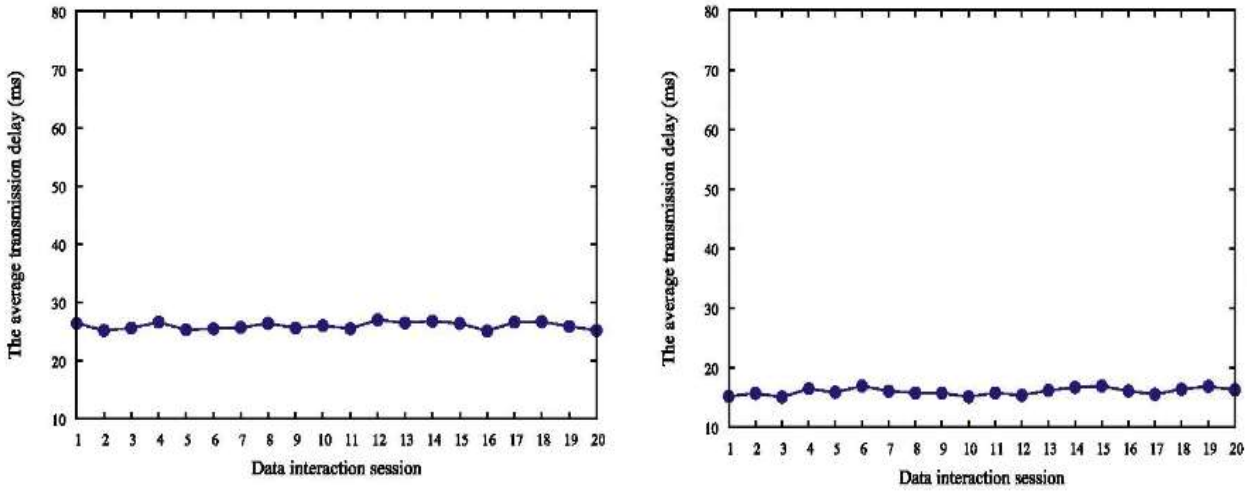
To Evaluate The Performance On The Location Service Recommendation, On The Whole Network's Data Collection, Interaction Of The Real Time Data And Data Sharing, A Prototype Has Been Deployed To Implement Co-Operative Communication Architecture And Protocol Stack. Through High Speed Transmission, This System Can Achieve Efficient Data Interaction Among The User Based On The Real Time Data Collections.



During Rush Hour *During Non-Rush Hour*

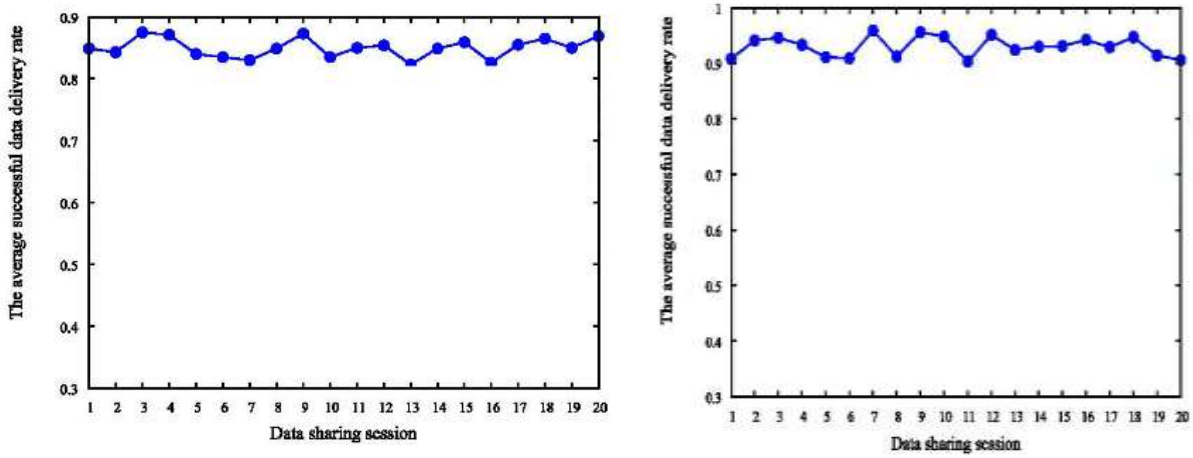
Fig 6. Comparing Data Collection

To Comment On The Effectiveness Of The Data Collection, Due To The Unsecured Variance Of The Data Interface, The Data Collected During The Rush Fewer Hours With Medium Traffic Condition Seemed To Be Better Than The Same Action During Rush Hours. During The Interaction Of Real Time Data, Average Transmission Delay Is Taken To Evaluate. In Each Data Sharing Session, The Average Data Delivery Success Depends On The Ratio Between The Data Reception Among The Entire User And The Amount Of Data Collected In The Session Of Data Collection. This Is Made To Evaluate The Performance Of Data Sharing.



During Rush Hour *During Non- Rush Hour*

Fig 7. Comparing Performance Of Data Collection



During Rush Hour *During Non-Rush Hour*

Fig 8. Comparing Performance Of Data Sharing

In The Authentication Protocol Design, Resistance Towards Various Attacks Has Been Made. The Implementation Was Made Using Two Models: 1. Using One Desktop Device: In This Entire Authentication Policy Was Based On The Client – Server System And Involved SHA-3 Module For The Secure Cryptographic Hash Function. The Second Model Was Using Raspberry Pi: A Desktop Unit Acted As A Trusted Authority And Raspberry Pi To Drive The IOT Devices. Here The Communication Model Had 2 Raspberry Pi'S Connected To The VS (Acted As Cloud Server) And One More Is Connected To The Trusted Authority. The Computation Cost Was Compared Between Two Models And Tabulated.

Phase	Simulation On Desktop Device	Simulation On Raspberry Pi
Registration Phase	0.0014s	0.0106s
Authentication Phase	0.0039s	0.0161s

Table 1. Comparing Registration And Authentication Phase With 2 Models

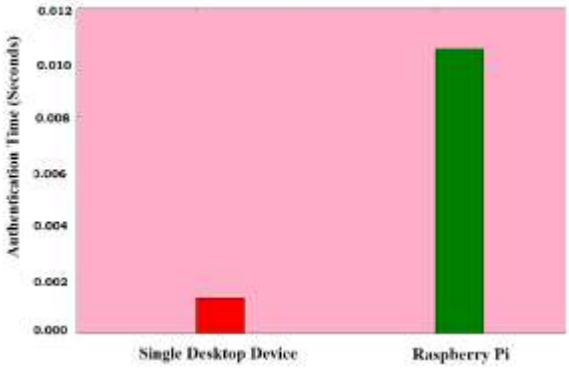


Fig.9.Comparison For Authentication Time Based On H/W Implementation

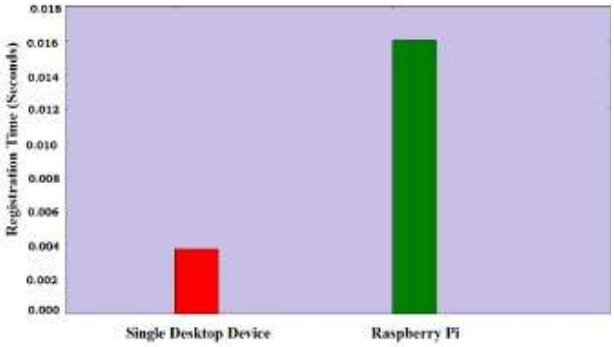
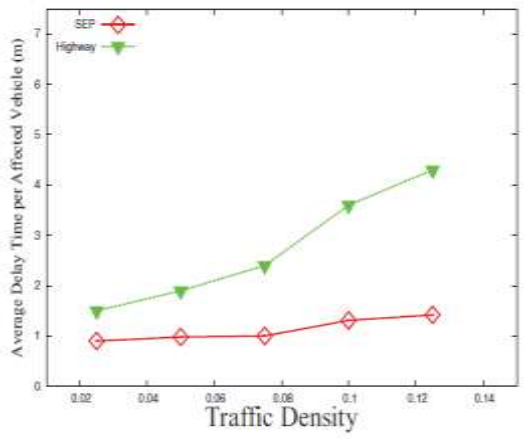
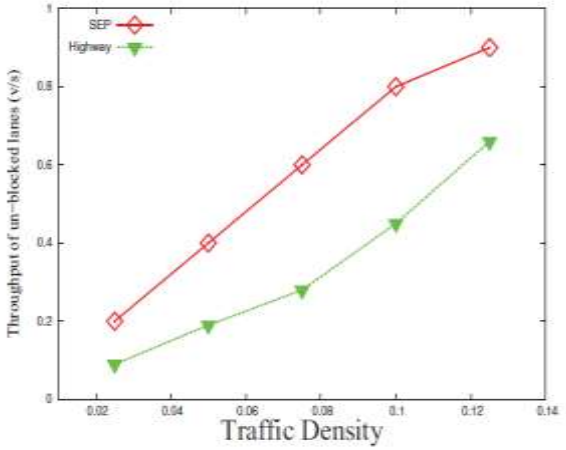


Fig.10.Comparison For Registration Time Based On H/W Implementation

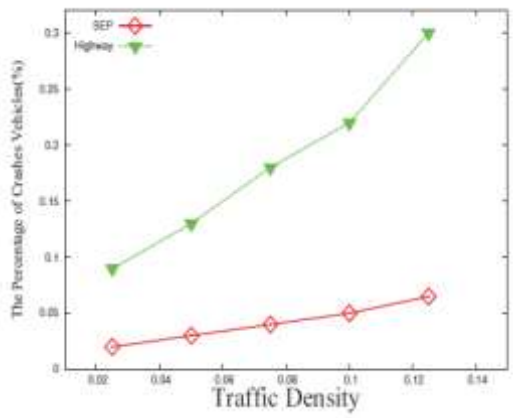
The Protocol Handling The Emergency Cases In Highway Road Scenario Are Implemented For The Sudden Happening Of Accidents Or Broken Vehicles. NS2 Is Involved In Evaluating The Performance Of The Protocol And The SUMO Has Been Made To Generate Mobility Models In The Highway Roads. The Below Graph Represents The Performance Evaluation Of The SEP (Safety And Emergency Protocol) And The Normal Driving Rules Applied In Highway Roads When Accidents Or Broken Vehicle Is Detected.



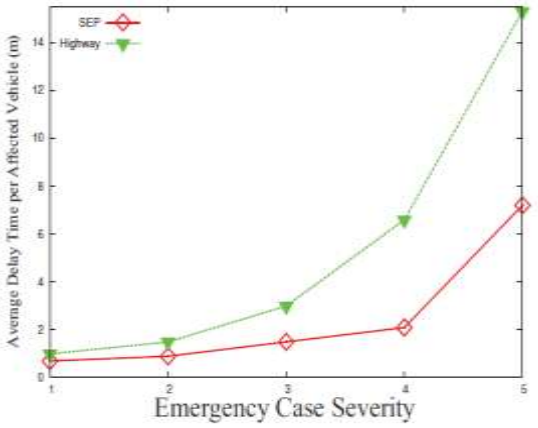
Vehicles Average Delay Time



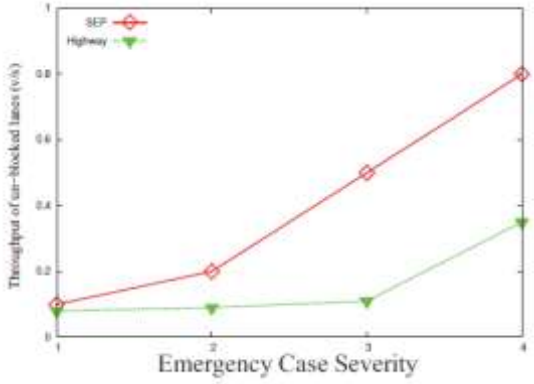
Throughput Of The Lane Unblocked



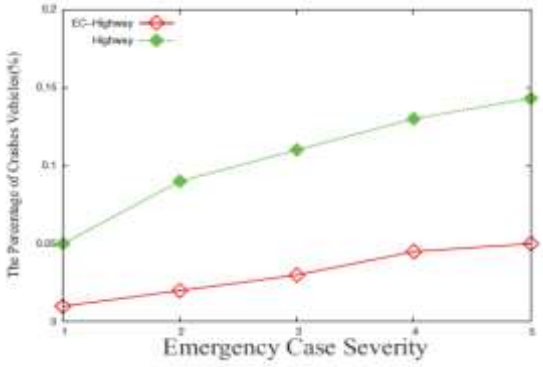
% Of Vehicle That Hits With Existing Accident



Average Delay Time Of Vehicles



Throughput Of Unblocked Lanes



% Of Vehicle That Hits With Existing Accident

Fig.11. Comparison Between Normal Traffic Rules And Safety Protocol In Highway

3. CONCLUSION

There Occurred The Distinct Flaws In The Data Collection Around The Network, Interaction Of Real Time Data And Sharing Of Data. With The Help Of The Protocol That Implemented Recommendation Service Among The Iov, Flaws Studied In The Literature Survey On Various Protocols Compared With This Have Been Drastically Reduced. The Authentication Protocol Has Been Lightweight In Terms With Lower Computation Cost And Execution Time. Authenticity Between The Vehicle And The Vehicle Server Has Been Made Possible, Thus Paving Way For Smooth Communication. The Safety Efficiency Protocol Has Been Enabled For The Emergency Vehicles To Reach The Destination Quicker. Moreover, It Helps The Vehicle Drivers In Creating Awareness About The Situation By Providing Best Recommendation Response. On The Other Side, It Also Avoids The Occurrence Of Chain Accidents. Nevertheless, Increasing The Traffic Smoothness Over Highways In Case Of Any Appearance Of Emergency Vehicle And Spot Of Broken Vehicle Has Been The Ultimate Goal Set. In The Future Work, Cyber Attacks On These Protocols Will Be Explored And The Solution For The Same Can Be Modeled Using Deep Learning Techniques.

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