



Intelligent Vehicular Communication System based on Fuzzy-Named Data Network

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ABSTRACT: The promise of brilliant number of visitors method, early on care indications regarding vehicles which could cut down path accidental injuries, enrich path issues advisement, along with availability of far better in-transit talk, inter-vehicle communication, along with road-vehicle communication are among the property involving Vehicular ad-hoc network (VANET). Yet, the latest network's troubles usually are resting inside the convenience of material along with particulars course morality, regular talk in the inclusion involving genuinely mobile nodes, along with private concerns. This specific newspaper learned the latest network's characteristics, design and style, program, talk activities, health concerns, along with acknowledgement involving present-day improvement avenue on the technology [2][3].

INDEX TERMS: VANETs, NDN, V-NDN, Routing & Its Protocols, Fuzzy Logic, PIT, TTL.

I INTRODUCTION

Vehicular communication systems can certainly be proficient at trying to keep from the loss and in addition site traffic congestions as compared to whenever almost every automotive makes an attempt to unravel these kind of issues individually. Typically, motor techniques will likely be believed to feature two types of nodes: Autos and in addition Curbside stations. They are both committed dedicated short-range communications (DSRC) devices. Your own group really should support just about every personal data electronic mails and in addition general public electronic mails on the other hand even bigger objective is supplied so that you can general public communications. Generator electronic mails are often manufactured as a part of intelligent transportation systems (ITS). ITS attempts to achieve protected routines and in addition productiveness by means of wise cars that combines talking amongst mobile phone and glued nodes. Subsequently ITS enormously banks on made and in addition cell phone connection [1].

A. VANETs

Vehicle Ad-Hoc Network is actually a distinct means of mobile ad-hoc networks (MANETs) this is a motor vehicle for you to vehicle along with motor vehicle curbside wi-fi conversing network. VANET can be a whole new prevalent the following contains Wi-Fi, Mobile and various other cell interconnection protocols. The main demand for VANET can be it must be capable of converse in every single location whatever website traffic densities along with motor vehicle locations. Vehicular marketing and sales communications appear in fluctuating location along with work with village along with straight areas. Regarding the number of nodes adding to all through these sites with full of liberty, conundrums maintain happen subject to feasibility from the navigation protocols. Examines connected with standard a navigation methods related to MANETs established that its effectiveness can be horrible with VANETs. Brightness by way of basic methods with VANETs scenarios can be training course instability. For that reason, a number of offers will likely be dropped plus the business enterprise charge on account of training course steps as well as incapacity announcements boosts appreciably, getting with regards to surprisingly

low transport percentages along with transmitting delays. This paper stresses ones multi-agent system process of do away with challenges raised recently along with supercharge Car or truck ad-hoc multi-level a navigation links.

VANETs let motor vehicles to prevent issues; frequently if you take more or less any desired motion as well as by simply informing the trucker i.e. while any kind of collision come about inside a highway as well as highway, security messages must be disseminated to see all the other vehicles. To accomplish communicating and dissemination expertise, VANETs will not depend on set structure as well as entry point. The actual architecture of VANET is manufactured out of about three groups: vehicle so that you can vehicle advertising hoc sites vehicle so that you can structure and a mix of both architecture. The principle uses of VANET present comfort and safety pertaining to guests supporting owners while travelling by simply planning on detrimental management of Targeted traffic flows, blind bridging and wreck avoidance, helped them to talk along with other vehicles along with online hosts consequently the particular traveling might obtain songs, deliver messages, watch on the net movies and might conversation on the net etc. Throughout VANETs, the navigation administration program demands multi-level operations syndication simply because pretty much every node in addition offers up your router. It's planning to consume addition cooperation concerning nodes to transmit information. It should continue to perform commonly in the event there's inability in excess of only one nodes, it must be clever to find the most beneficial routes and respond rapidly so that you can gatherings that will come about exactly like transforming communicating situations etc. Also, due to consistent action of cellular nodes, the particular topology of vehicular ad-hoc sites is by and large dynamic. Also, reduced storage, transforming situations, swift alter in topology, consistent disconnection and information add to the danger pertaining to the navigation protocols made for ad-hoc sites unsuitable pertaining to this kind of really dynamic networks. Correctly it is crucial to cultivate brand-new the navigation diet pertaining to vehicular ad-hoc sites specific around the typical the navigation protocols. Multi-agent systems evaluate the different parts of cooperation, independence, syndication and intelligence. They might be especially useful with dispersed and dynamic environments [1], [4].

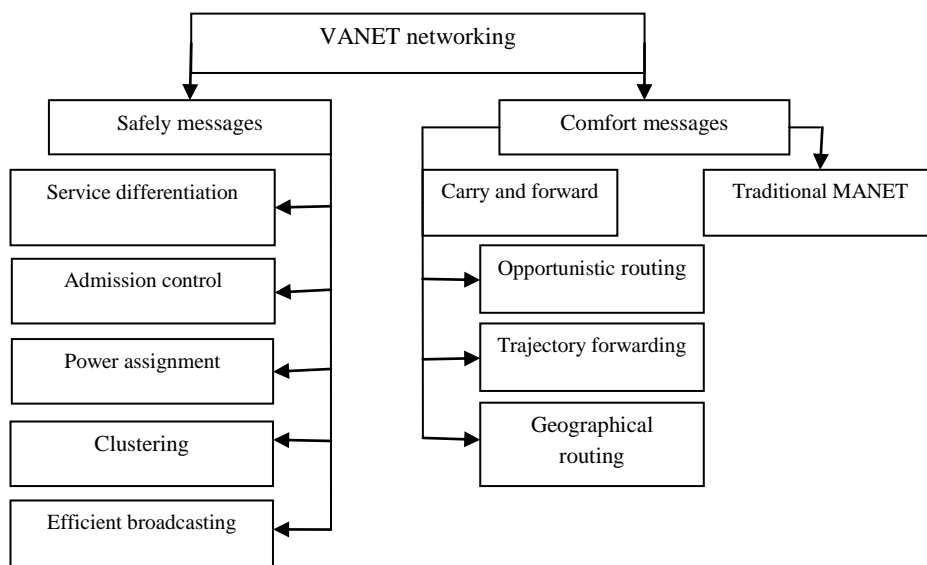


Figure 1: Networking challenges in VANETs

VANET networking has two types of messages: Safely and Comfort

- Securely Software: Vehicle-to-vehicle safety transmission sometimes features crash see, street obstruction see, flexible traveling a car or truck, intersection crash see, together with In transform assistance. Using this distinct class raise the protection affecting individuals through interchanging safety suitable details caused by IVC. The details are the two demonstrated towards the trucker along with used to stimulate a superb actuator affecting an interested safety system. Case in point apps are generally: pressing see technique, lane-changing asst, intersection handle, focused visitors sign/signal ticket see, together with road-condition warning. Applying fashion normally want lead vehicle-to-vehicle transmission caused by rigorous think twice requirements. Although substantially efforts is required right until finally these kind of apps get truth, submission associated with numerous marketing communications is a vital challenge. On this record many of us concentrate on internet 2.0 issues which should become remedied pertaining to revenue message interchanging concerning motors or maybe trucks together with VANETs.
- Comfort and ease Software: This particular program elevates traveler coziness in addition to precise guests overall performance in addition to optimizes the actual tactic to any destination. Scenarios for this class usually are: precise guests details approach, temp details, program station together with coffee shop website and price details, in addition to online communication.

B. V-NDN

Vehicular network possesses not just one however a pair of standard attributes: advert hoc, intermittent on the net connection and also dark beer actually consuming data. In a very V-NDN group of friends, a motor vehicle can participate in any of the some capabilities: details client, details machine, forwarder, whether it is installed with the idea to amenities and also other motor vehicles, and also “details mule”, whether or not it carries details about great distance considering the zero on the net connection that you can any personal else. As opposed to different styles of cellular phones, motors or maybe trucks haven't any nervous about storage systems power and also electricity supply. NDN is usually a wonderful enabler that you can vehicle network by remedy for issues within TCP/IP diet pack; in spite of these lots of improvements towards baseline NDN businesses are important for ones VANET environment. At first, simply because most promotion and purchasers emails happen by means of mobile phone programs, people today must take into account whole benefits through mobile phone more than mid-air nature. In its place regarding merely tallying to be able to details having complementary data within PIT, a motor vehicle may choose to storage cache most received details regardless of whether it has an complementary PIT access and also whether or not it will take information pertaining to itself. Given that a motor vehicle can have greater details storage systems when compared to mobiles, of which opportunistic caching process could be advantageous within facilitating instantaneous details dissemination within really solid environments. 2nd, Files cardboard boxes could be needed by going for walks cars and trucks perhaps whether they have also been zero group of friends connectivity. Files may well shift outside the producer's identify both by requires or maybe as well by car movements. In case your car does respond into a Awareness having Files, ones act in response may well provided by using mobile phone more than mid-air route that you can nearby cars and trucks plus develop into cached by a lot of the receivers. When these cars and trucks actually maneuver, people functionality details high heel mules hauling the pad that you can more expansive area. Obtaining large number of high heel mules develops details scattering sections and also increases rendezvous power including people today buying particular piece of online details and also high heel mules hauling a duplicate linked to it. And lastly, ones persona linked to on the net connection including relocating motors or maybe trucks helps produce it problematical, in any other case absolutely infeasible, to be able to mosey a fresh direction-finding diet to generate and also keep up with the FIB. Consequently V-NDN ought to mature other sorts of technique to tutorial Awareness lot of money sending.[3]

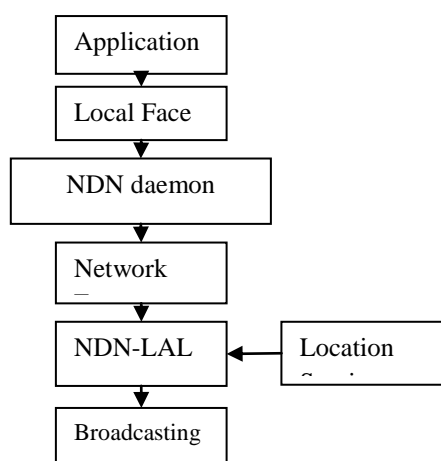


Figure 2: V-NDN

- **NDN Daemon:** Delivers main NDN features simply by retaining one of the keys information properties regarding CS, PIT along with FIB, along with taking care of label prefix complimenting along with bundle forwarding decisions. In the event the node is equipped with several multilevel connections, the actual inclusion uses a straightforward strategy regarding forwarding every Attention to any or all a connections that you can get right at that moment, therefore, the FIB is not utilized in Attention forwarding around this time. The search for forwarding approach pattern to get VANET is part of our future work. As a final point, a CS caches many Facts packages overheard around the wireless channel.
- **NDN Local Faces:** These are interfaces between the applications and the NDN daemon. They support application registration, Interest request, and content delivery.
- **NDN Network Faces:** These facial looks give the adapting to it functions joined with the unique know-how utilized within the communication. Most people use IEEE 802.11 inside advertisement hoc mode for V2V, and still provide the particular user interface using the Web link Adaptation Level that helps Wi-Fi broadcast. Most people use several wireless engineering to get V2I which includes Wi-Max, 3G, plus Wi-Fi mesh networks. For 3G online connectivity, the particular NDN Network Encounter provides important adapting to it to get IP tunneling regarding the mobile and many NDN node within the central network.

- **Link Adaptation Layer (LAL):** LAL is conceptually layer made to efficiently leverage the specific layer mechanisms. The actual LAL posts all packages seeing that L2 sent out, employing a organic 802.11 structure to handle NDN packages directly. Even so, sent out assistance within Wi-Fi is practically nonexistent, making numerous projects for being surrogated by simply LAL.
- **Location Service:** Provides opposite geo-coding features, along with high-level operates about distance along with likely, towards LAL, which utilizes these phones geographically opportunity your communication. Moreover, a number of programs may choose to encode area details with information companies whenever this content problems a tiny location, for instance website traffic or maybe vehicle data. The venue may after that be employed to guide Curiosity forwarding. Help successful along with sturdy transmissions, which experts claim enables opportunistic sending along with caching, we all launched a straightforward number of things to deliver Wi-Fi transmitted support with VANET communications.

C. ROUTING

Direction-finding around VANET one of many difficulties around layout and elegance about engine ad-hoc multi-level might be maximizing just about any enthusiastic your routing course of action to help you disseminates the principle points based on within node (vehicle) for you to another. Direction-finding around VANET requires a new procedure for the conventional MANET your routing due to highly enthusiastic and in addition in the past transforming topologies inside the former. Handover involving communities involving before conceived about MANET environment tend to be scanned in relation to VANET. A debate actually is always given that the best way to cut down be reluctant about moving past the principle points based on within node for you to another. Whipping most of these challenges around MANET communities, will help put into practice real-time apps about VANET environment? More significance an example is reducing regulate overheads need to be looked into carefully. Sustaining just about any tally in the enthusiastic attributes about VANET, the exact your routing course of action could withstand the exact quick and in addition enthusiastic features about engine multi-level topology [8]. Potentially the exact roughest job around VANET your routing might be purchasing and also the ideal routes about communication around desired environments. Almost all the routing communities around VANET might be very carefully became a member of when using topology utilized inside the multi-level architectural mastery combined with the effectiveness can vary whenever there can be result-oriented multi-level topology your routing around VANET might be move into try main courses which includes given that:

- **Ad-hoc or Topology Driven Routing:** Altogether, VANETs tend to be infrastructure-less communities and lots of the navigation practices made pertaining to previous ad-hoc network as an example MANET based upon unique network topologies may apply to VANETs having a number of modifications. Topology operated practices tend to be sub-classified in a few groups as an example aggressive, reactive and hybrid.

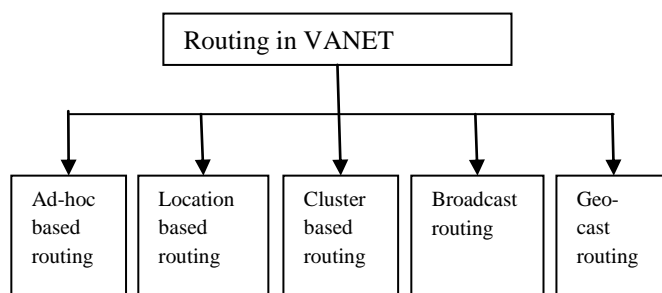


Figure 3: Routing

- **Location Based Routing:** Another list of practices that contain indicated attention one of the analysts tend to be Position or perhaps Place Structured Redirecting protocols. With made regarding practices facts concerning geographic spot regarding cars is definitely stripped away from unique methods including maps, Global Ranking Process (GPRS) and also history regarding website traffic styles to help you disseminate this information. A lot of studies including and possess shown a wide assessment regarding common topology based practices including AODV and DSR along having Place Structured formula and results possess indicated far better and superior performance when compared to the working with bare topological approach.
- **Cluster Based Routing:** In an attempt to lessen the network website traffic and the navigation overheads throughout VANET, any the navigation paradigm namely Bunch Structured Redirecting (CBR) is definitely launched in. The best notion guiding CBR is definitely to develop a network structures based upon compact teams of cars known as clusters. In a bunch, one of several cars plays this factor in the cluster-head since proven in. How big this bunch is dependent to the thought of this the navigation formula which might be in accordance with the various cars within a bunch or geographic situation together with the vehicles. Bunch Structured Redirecting The manner regarding CBR aren't going

to be an amateur for you to ad-hoc networks. You can get scientific studies throughout literature to determine this performance regarding CBR throughout MANETs in which network the weather is rigid. These kind of the navigation practices provide first setting up any procedure or perhaps standard protocol for you to make the bunch selection, and then looking at hunting the suitable channels pertaining to communication. Because of scalability problem, this bunch configuration solutions MANET tend to be circuitously added to VANET. [2]

- **Broadcast Routing:** Transmit Redirecting had been among the many regular the navigation different types of solutions VANET. Largely transmitted tactic must be used when the information is definitely has to be shipped for the traveler pickup truck which can be at night range. Packages tend to be transmitted working with inundating techniques. This specific ensures distribution regarding true details, nonetheless makes use of substantial means regarding bandwidth. While briefed formerly, such type of technique is used throughout a lot of well-established the navigation practices; specially hobby is definitely regarding obtaining regarding substitute for this destination. BROADCAST and also the Nth-Powered P-persistent Transmit standard protocol (NPPB) tend to be such common practices intended with your transmissions concept.
- **Geo-cast routing:** Geo-cast the navigation will be the category regarding the navigation that deals with distribution regarding true details throughout certain region of relevance. Considering early on induction regarding VANET, many solutions regarding Geo-cast the navigation have been presented. Many VANET applications demand situation primarily based variable launching e.g. examining dangerous website traffic details for you to cars nearing throughout the same direction. The important thing notion guiding this Geo-cast the navigation is normally for you to restrict looking all over pertaining to future hop using a certain Zone regarding Significance (ZOR). Envision possibly employing a procedure whereby in case your automobile gets throughout a mishap, it is going to quickly report this automobile accident to your nearing cars inside of that zone.

D. NDN ROUTING

To use this Attention along with Information bundle forwarding features, every NDN modem preserves three info components, plus a forwarding scheme:

- Pending Interest Table (PIT): stores all the Likes and dislikes that your modem offers submitted yet not gratify yet. Each one PIT admittance information your data label moved while in the Web, together with it's inward bound along with extroverted interface.
- Forwarding Information Base (FIB): a the navigation desk which in turn roadmaps label elements to be able to interfaces. Your FIB is brimming by way of name-prefix dependent the navigation process, along with can offer a number of production connects for every prefix.
- Content Store (CS): a brief storage cache associated with Information packages this modem offers received. For the reason that a great NDN Information bundle can be special separate from the place the idea emanates from or maybe the place it truly is submitted, it might be cached in order to reach foreseeable future Interests. Substitute approach is typically very least recently used, although the replacement unit technique depends upon this modem and can differ.
- Sending Strategy component: a number of procedures along with guidelines about forwarding packets. Please note that this Sending Strategy should decline a great Attention in a few instances, e.g., when all of upstream back links will be congested or Interest rates are suspected to be able to participate a DoS attack. For each Attention, this Sending Strategy retrieves this longest-prefix harmonized admittance from the FIB, along with chooses to view the next hopeto be able to frontward this Interest.

II FUZZY LOGIC

Fuzzy logic can be viewed as being a generalization of an reasoning program that features the course of the reasoning systems having truth-values while in the interval (0, 1). "In a very greater feeling, Fuzzy logic can be considered a system involving methods, key points, and methods for dealing with processes involving thinking which have been approximate rather than exact." Klir, St. Clair, and Yuan (1997). Fuzzy logic is actually useful in representing individual know-how inside a particular area involving program and in thinking to be able know-how to create practical inferences and also actions. Throughout unclear reasoning, the feeling base is represented by way of if-then rules involving unclear descriptors De Silva (1995). One particular unclear rule can be „in case final results is actually slowly as well as the aim for is way, then slightly increase the power“, which will offers the unclear descriptors slowly, far and moderate. Your unclear descriptor may very well be represented by a member performance, the industry performance that gives a membership quality among 0 and 1 for every single possible benefit in the unclear descriptor the item represents. A standard Fuzzy control comprises of four segments: this rule platform, this inference engine, this fuzzification, as well as the defuzzification.

There are some examples of Fuzzy Logic:

This Japan were being the first ones to employ fluffy logic to get functional applications. The initial significant application seemed to be for the high-speed educate around Sendai, wherein fluffy logic can help the economy, ease, and accuracy with the ride. Them is included in reputation regarding written signs around Panasonic pants pocket; journey support to get helicopters; preventing regarding train methods so as to strengthen traveling ease, accuracy regarding stopping, and electricity economy; enhanced energy intake to get auto smart phones; single-button handle to get cleanup products, programmed engine handle to

get cleaning appliances using reputation regarding work surface condition and a higher level soiling; and idea methods to get very early reputation regarding earthquakes throughout the Institute regarding Seismology Bureau regarding Metrology, Japan.

III REQUIREMENTS OF VEHICULAR COMMUNICATION WITH APPLICATION SCENARIOS

The actual absolute goal regarding inter-vehicular communicating method is to supply protection in addition to site visitor’s info to its guests, yet due to ability to move of an individual in addition to wide utilization of web, now the thing is to supply commercial in addition to infotainment info to its people in addition to passengers.

- Flexible site visitors lights.
- Automated site visitors intersection control.
- Ambulances, flames trucks, in addition to law enforcement motors hotel
- Promoting, Travel-related info
- Course in addition to direction optimization
- Changing velocity limits.
- Car parking a vehicle
- Policing in addition to enforcement
- Isle holding assist
- Route warning reputation
- Posted speed limit forewarning
- Restricted articles
- Pull-over requires
- Toll acquiring
- Car parking repayments
- Mapping
- Car or truck providers
- Location-based company

IV PROPOSED ARCHITECTURE

In this paper, the proposed algorithm will likely be implementing by employing Mat lab. The mathematical toolbox and data analysis toolbox is accustomed to implement the proposed algorithm [6][7].

PIT: Some sort of Pending Interest Table (PIT) is actually a center aspect within Named Data Network. Scalable PIT style is definitely complicated for the reason that it takes per-packet improvements plus what they're named located in the PIT tend to be prolonged, requiring far more memory. During this, many of us propose to her some sort of work of fiction pending interest table style in which assures package transport having a strong plus close safe-keeping representation. This reminiscence condition plus multi-level site visitors over head tend to be assessed, as well as performance involving a software implementation in the proposed style is definitely measured. With these pub maps x-axis exhibits awaiting interest a serious amounts of y-axis exhibits emulator time. This awaiting interest time period among aggregators on upper and lower degree in the case of established plus proposed tactics If your cooking timer value is definitely too small, the actual PIT declare around the hub may very well be taken out before the data will come, plus in such a case, the actual upper level aggregator will not have all the data. Compared, how big PIT around the upper level aggregator will likely be increased for the reason that several data would possibly not are available inducing the upper level aggregator to wait patiently unnecessarily[5][9].

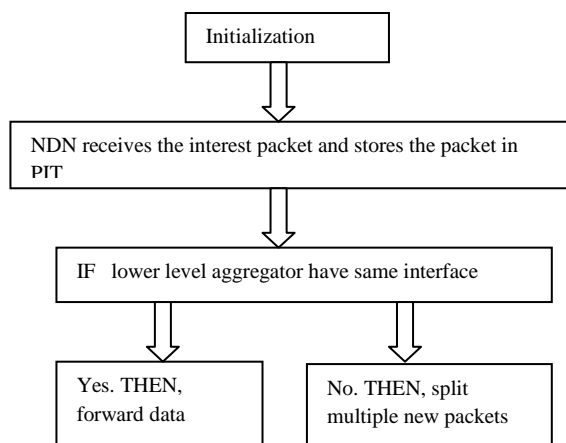


Figure 4: Fuzzy NDN architecture of PIT

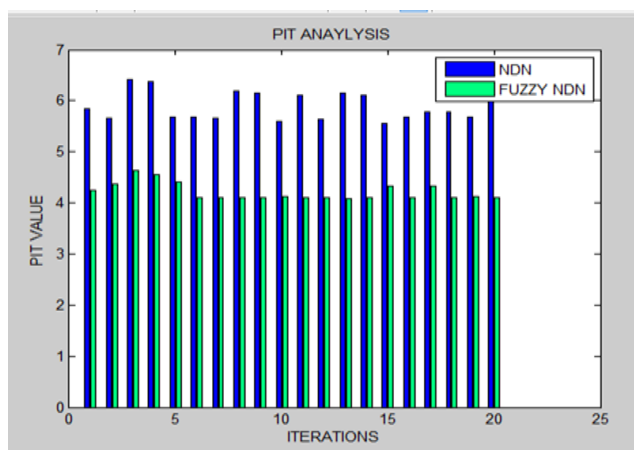


Figure 5: PIT analysis comparison of NDN and FUZZY-NDN

Calculation term: $T_{exp} = T_{rr}(n-1)$ where time in milli seconds

Memory size: $(F1 + (PIT - F1)/2) * (T_{rr} + T_{exp}) / T_{rr} * M / \text{load}$

Where: T_{exp} -expired time, T_{rr} -re-request time, n - Number of aggregators, I -Number of interest packets

M -Current memory size, Load - (interest packets/data packets)

5.2 TTL: It presents a simple approach to custom modeling rendering a reach costs associated with caches that make use of a time-to-live (TTL)-based consistency policy. TTL-based consistency, seeing that exemplified by DNS and also Internet caches, could be coverage surely exactly where a good data object, as soon as retrieved, stays correct for just a period of time termed as “time-to-live. Storage cache programs working with massive TTL periods usually are well-known to own substantial reach costs and also scale perfectly, having said that a results of working with reduced TTL periods normally will not be perfectly understood. Many of us product reach pace being a goal of obtain birth instances and choosing TTL, making it possible for us all to higher have an understanding of cache actions pertaining to reduced TTL periods. The actual time-to-live (TTL) price will be the round-trip time between aggregators with the next door neighbor levels.

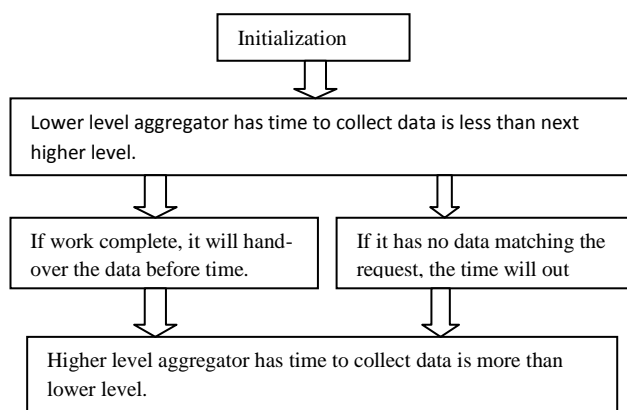


Figure 6: Fuzzy NDN architecture of TTL

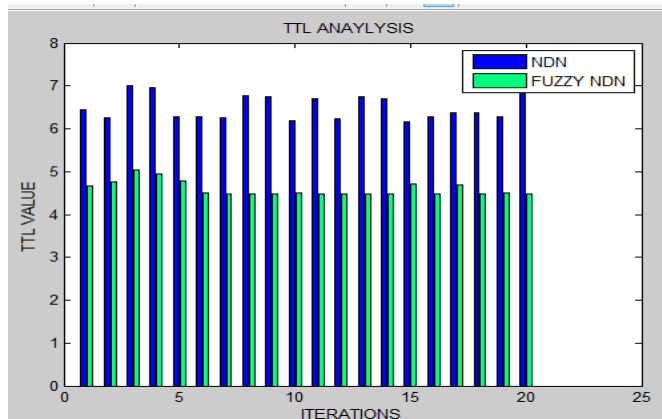


Figure 7: TTL analysis comparison of NDN and FUZZY NDN

In previous researches, plenty of time to reside in is usually rounded journey time between all of amounts of aggregators is usually equal. However in Fuzzy NDN, each one stage a the best possible egg timer price perhaps there is like reduce stage aggregator offers a lesser amount of price and also grows up to advanced level gradually. Although if the egg timer price is usually too small, a PIT talk about on a the router can be wiped prior to the results occurs, and also in cases like this, a 2nd floor aggregator will never acquire all the required data. On the flip side, how big is PIT around the 2nd floor aggregator will probably be enhanced since a few data may well not can be found causing the 2nd floor aggregator to await unnecessarily. The time to reside in between aggregators on next door neighbor ranges in case there is pre-existing and also planned procedures seeing that revealed throughout figure.

The following figures shows the comparison of NDN and FUZZY NDN techniques:

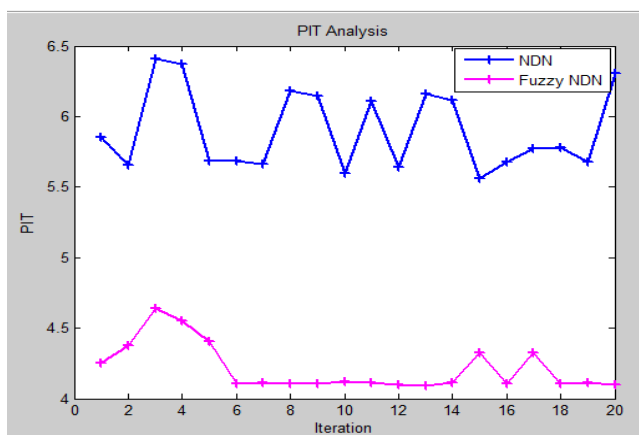


Figure 8: optimum value of PIT timer

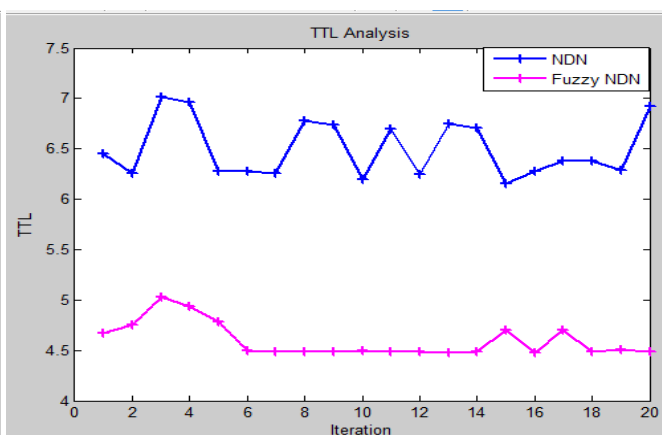


Figure 9: optimum value of TTL timer

V APPLICATIONS

Software based on intelligent vehicular communication consist of very simple swap of car condition details to be able to extremely elaborate large-scale obstruction management including infrastructure integration. Being a commence to investigating uses, this section allows a summary of request areas with regard to vehicle networks. Curve quickness alert, reduced fill alert, alert concerning dishonored targeted traffic signals or cease indicators, Sightless place alert, side of the road modify alert, intersection wreck alert, send wreck alert, urgent situation electronic digital brake pedal signals, railroad wreck alert, alert concerning people spanning, getting close urgent situation automobile alert, urgent situation automobile signal preemption, urgent situation automobile with landscape alert, Alert with lock up or street area situations to your targeted traffic business heart, brilliant targeted traffic circulation manage, boosted direction guidance, vehicle place locator service[10].

VI CONCLUSION AND FUTURE WORK

This shows intelligent vehicular communication in networking problems around vehicular ad-hoc network a ensuring technologies with regard to intelligent transportation system(ITS). Even though complaints are not really fixed, the final emotion is the fact cars could benefit from wireless marketing and sales communications in a future, doing VANETs (Vehicular Ad-Hoc Networks) any reality. Website traffic transmission command working with Fuzzy-NDN common sense with regard to PIT and TTL was developed. The fuzzy logic technique strategy mimics your command common sense associated with skilled people just like police officers linking site visitors that normally switch transmission adjustments as soon as intersections practical knowledge very high traffic lists simply by not really totally wasting time. The Unclear common sense technique helps make deciding no matter whether to lower level and higher level aggregators works together with hairy if-then guidelines centered and real-time site visitors information. Unclear common sense style was in comparison with standard set serious amounts of actuated command strategies working with a standard intersection together with differing site visitor's volume level levels. Actions associated with usefulness such as hold off, velocity, amount of time in line, and throughput-to requirement proportion ended up being examined. Unclear common sense style exhibited large enhancements in excess of standard set serious amounts of actuated command approaches for just about all measure of Effectiveness underneath high traffic volumes. General, your emulator success revealed that Fuzzy NDN technique has got the possibilities to raise expeditions in excess of pre-existing technique.

REFERENCES

- [1] Amici, Raul, Marco Bonola, Lorenzo Bracciale, Antonello Rabuffi, Pierpaolo Loreti, and Giuseppe Bianchi. "Performance assessment of an Epidemic Protocol in VANET Using Real Traces" *Procedia Computer Science* 40 (2014): 92-99.
- [2] Bali, Rasmeem S., Neeraj Kumar, and Joel JPC Rodrigues. "Clustering in vehicular ad hoc networks: taxonomy, challenges and solutions" *Vehicular communications* 1, no. 3 (2014): 134-152.
- [3] Yan, Zhiwei, Sherali Zeadally, and Young-Jin Park. "A Novel Vehicular Information Network Architecture based on Named Data Networking (NDN)", *IEEE Journal Internet of Things*, Vol11 , no. 6, pp: 525 – 532, 2014.
- [4] Bravo-Torres, Jack F., Martin Lopez-Nores, Yolanda Blanco-Fernandez, Jose J. Pazos-Arias, and Esteban F. Ordonez-Morales. "VANET Layer: A virtualization layer supporting access to web contents from within vehicular networks" *Journal of Computational Science* (2014).
- [5] Kumar, Neeraj, Naveen Chilamkurti, and Joel JPC Rodrigues. "Learning automata-based opportunistic data aggregation and forwarding scheme for alert generation in vehicular ad hoc networks." *Computer Communications* 39 (2014): 22-32.
- [6] Slavik, Michael, Imad Mahgoub, and Mohammed M. Alwakeel. "Analysis and evaluation of distance-to-mean broadcast method for VANET." *Journal of King Saud University-Computer and Information Sciences* 26, no. 1 (2014): 153-160.
- [7] Eckhoff, David, and Christoph Sommer. "Simulative performance evaluation of vehicular networks" (2015): 255-274
- [8] Bazzi, Alessandro, Barbara M. Masini, Alberto Zanella, and Gianni Pasolini. "IEEE 802.11 p for cellular off loading in vehicular sensor networks" *Computer Communications* 60 (2015): 97-108.
- [9] V.N.G.J. Soares, J.J.P.C. Rodrigues, "Vehicular delay-tolerant networks (DTNs)", *Advances in Delay-Tolerant Networks (DTNs)*, Pages 61-80, 2015 .
- [10] Silva, Fabrício A., Azzedine Boukerche, Thais RMB Silva, Linnyer B. Ruiz, and Antonio AF Loureiro. "A novel macroscopic mobility model for vehicular networks" *Computer Networks* (2015).