POSITION BASED ROUTING USING INTERNET CONTACT TO VANET THROUGH SATELLITE RECEIVE-ONLY TERMINAL

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Abstract

The most challenging barrier to expanding connectivity of Internet to vehicle ad hoc networks is the necessity for vast proper infrastructure of roadside network. This need is problematic to meet, specifically in the early stages of vehicle network building & in zones with limited infrastructure of roadside. As a result, that solutions rely exclusively on roadside structure are unworkable. Other remedies, like cell phone networks / symmetrical communications via satellite, are also too expensive or do not deliver adequate connectivity, putting the change to a robust VANET difficulty in the later stages. We provide one method that supplements obtainable ones while avoiding the need for completely networked roadside infrastructure. To provide widespread Internet access, the approach employs satellite receive-only endpoints and a small number of (widely dispersed) wayside devices. The solution is affordable, gradual, and practical. We show numerous design possibilities that can be employed depending on the environment.

Keywords:

VANET, Routing, Internet, Satellite, Terminal, Connectivity

1. INTRODUCTION

Communication, particularly internet connectivity, is a basic component of the most productive workplaces. We spend a significant amount of time in vehicles traveling from one location to additional and this time be able to utilize additional effective if we have access to the internet. A considerable deal of research has gone into introducing the internet to automobiles [11].

To that purpose, four ways have been taken. a) internet via roadside structure only, b) internet via roadside structure with Vehicle-to-Vehicle (V2V) connection, c) internet via cellular network, and d) internet via satellite. However, all three approaches face considerable problems.

Because the normal peripheral range of an RSU is 250 meters, it's necessary to install an RSU every 400-500 meters to enable connectivity via roadside infrastructure. Furthermore, all of these RSUs should be linked with the internet. Furthermore, the connection, installation, maintenance & upkeep of these RSUs will be highly costly, and the needed connectivity possibly not attainable, particularly throughout the early VANET days implementation and along roads or in rural areas. With the development of 3G/4G technologies, internet access via cellular networks now affords speeds of data suitable to internet; nevertheless, these skills are not inaccessible all over the cellular service part and numerous customers continue to receive lesser rate of data [1].

One of the concerns in cellular network design (to save infrastructural costs) is to use bigger cell sizes where the number of users is little, which is particularly relevant beside roads and in urban areas. However, the quantity of coverage in vehicular networks is projected to expand, needing an expansion of cellular networks. Aside from these problems, when a motor vehicle overtakes a global border, the service operators' and carriers' frequencies regularly change, raising the price and complexity of user equipment [15].

Having access to the internet through symmetric satellite necessitates the installation of a satellite transceiver in cars, which raises the cost of user equipment [2]. Losses in satellite channels are significant; these losses generate errors in transmission and necessitate error correcting techniques. The losses could be caused by the atmosphere or by shadowing. The link margin normally compensates for air losses; However, shadow loss makes communication impossible. Damage of shadows are even more severe in metropolitan settings, which are densely packed with structures and other man-made items. As a result, satellite internet connectivity is not a cost-effective alternative for urban regions.

In this study, we present an approach that supplement current systems and enables access to the internet in the preliminary disposition stage of networks vehicle, as well as in zones with extremely low roadside connection (like beside roads and in remote regions). The approach includes satellite receive-only terminals and a minimal number of (distributed) RSUs. It be able to keep protocol of transmission control (TCP) links open even when the uplink is unavailable on behalf of extended periods of time. We provide a selection of choices by different levels of fault-supervision ability and recommend their use depending on the circumstances.

Once more RSUs are added, the solution's presentation will improve by creating better use of RSUs and reducing inter-RSU distance, allowing for an easy transition to a completely functional VANET [12]. Similarly, it will facilitate the transition between places with varied VANET exposure. The explanation is affordable, gradual, and practical. Much research has been conducted to address internet connection problems (particularly TCP presentation) via postponement tolerant networks/satellite networks. To minimize repetitions, we are not going to concentrate on minor level particulars of which internet practice to use in this paper; somewhat, we will figure out the wanted properties of the practice and any existing established protocol (or mixtures of these) can be used for this [4].

2. PROBLEMS IDENTIFIED

If utility of an RSU will express as the length of time it positively interacts by an individual car, the added advantage of RSUs is substantially greater in downtown areas than in countryside or along roads. This is because of their supplementary traffic features, including the reality that median limit speeds are considerably lower in towns and cities than in countryside or on roads, and the ratio of shift to pause in urban areas is more eliminated towards stop (because of to numerous junctions, breaks, as well as road messages) than in countryside regions or along highways.

This implies that the connection established by a specified number of RSUs is significantly greater in municipal regions than in countryside or along highways. As a result, to get the similar level of connection for a specific car, we will have required far more RSUs in countryside than in municipal areas. Furthermore, installing and maintaining RSUs in cities is far less expensive than in urban locations. Furthermore, because urban regions already have widespread internet connectivity, connecting RSUs to the internet is simple. It stands to reason those systems entirely dependent on RSUs are impractical in countryside (or along highways).

A variety of digital video broadcasting (DVB) values describe communicating data facilities such as access of internet through public switched telephone network, satellite, wireless, and so on [5]. Because broadcasting and communication channels are sent by satellite, user equipment is expensive and mismatched with VANET principles [13]. As per ETSI (2002), the two channels are delivered over wireless VHF/UHF groups, comparable to VANET. DVB principles too allow for the merging of several DVB communicating systems [3]. Satellite as a transmission channel combined with dial-up as an interaction channel has been utilized successfully for quite some time to give internet to home users, particularly in remote locations. Our method employs satellite for broadcast/downlink and terrestrial wireless (as outlined by VANET principles) for communication/reappearance.

The internet, as well as other potential VANET applications, display asymmetric traffic, with downlink traffic being numerous orders of magnitude greater than uplink traffic [14]. This disparity is anticipated to grow over time as more content becomes multimedia in nature. To take benefit of this asymmetry, we deploy asymmetrical satellite communication. in rural areas to provide connectivity the use of satellite also appears to make sense, as there will be fewer observation and hence fewer mistakes in urban zones. The communication is accomplished through the infrastructure of roadside, using vehicle-to-infrastructure (V2I) communications or communication between vehicles (V2V) communication when combined by V2I communication. Standard asymmetric satellite solutions, however, are unfeasible because to the restricted RSUs number. The intermittent accessibility of grounded interaction/return pathways, with potentially extended interruption periods, is a challenge with VANET, especially in the preliminary periods disposition of VANET.

3. ASSOCIATED WORK

Several studies, Drive-thru internet including, FleetNet and others, heavily rely on roadside architecture and communication between vehicles for offering internet connectivity to automobiles. The accessibility of widespread roadside substructure and/or a significant number of intelligent vehicles is a basic prerequisite for these solutions. Both norms are unrealistic in the time of preliminary deployment stage; continuing usage of V2V interaction raises other safety concerns, including confidentiality, rejection of service, and so on. Present WiFi networks-based solutions suffer related challenges [1].

Numerous studies have used cellular networks in VANET. These are primarily used as a backbone, replacing wayside infrastructure. Although ubiquitous, cellular networks provide lesser data speeds than Wi-Fi (roadside infrastructure). Although 3G/4G skills have enabled rate of data near to broadband, these skills are not universally presented during cellular exposure areas, leaving numerous users reliant on other diverse skills. Furthermore, data of cellular package subscriptions are costly; an unrestricted plan with a monthly data cap of 5 GB costs almost $700. All major cellular network carriers now provide and promote data access via hotspots. This also point out the beneficial ratio of Wi-Fi vs 3G-4G. Mobile networks have also a number of drawbacks, such as high building and upkeep costs, licensing conflicts among service suppliers, increased rates of roaming, massive and changeable delay, central swapping management, scaling of problems, and infrequent blackouts [16]. Using satellite channels for internet service to both fixed and mobile consumers has been a fascinating research topic. Most of this research focuses on modifications to internet procedures that operate over asymmetric / symmetric satellite channels using static nodes. Symmetric satellite communication, which is more expensive, does not take benefit of the unequal structure of internet traffic. Furthermore, in this study, we have to deal with asymmetric communications via satellite where every node are mobile nodes.

There are also numerous studies dealing with mobile nodes, however most of these focus on internet protocol performance/enhancements. Furthermore, these consider symmetric satellite channels, in which together uplink and downlink message takes conducted through satellite. Symmetric message requires the use of costly transceivers at nodes of mobile and does not receipt use of the asymmetrical character of internet connection. In this study, we exclusively use a communication of satellite downlink. The paper is [27] points out to certain challenges that may be faced by VANETs like GPS signal may be not possible to be communicated in case when vehicles wre travelling through underground structures like tunnels. This paper also suggested a few methods that have been proposed to overcome this problem, one of the is Internet of Vehicles or IoV. In order to improve upon the quality of service the authors in [28] have presented the concept of VDTN or Vehicular Delay Tolerant Network which they propose will be placed at the roadside to coordinate the communications between the Satellite and the Ground Base station. In [29], the authors presented a method of implementing a VANET without requiring the implementation of a fully networked road network infrastructure by using a satellite backed-up communication infrastructure. In [30] the authors have proposed a methodology of estimating distances between the vehicles by the analysing of the strength of the signals that have been received. This analytical information was to be transmitted to the units of wireless communications lying by the sides of the street. In [32] the authors have presented a prototype of a VANET communication system terminal that can communicate with GNSS using RF frequencies. In [31] the authors have presented tha GAACO techniques which enables the communication between different vehicles in different levels of traffic densities and this proposed framework was tested in practice by the authors in Dehradun city of India. According to the authors this protocol may be used for inter-satellite communications also. In [33] the authors have presented the role that Satellite communications will play in the evolving og VANET to Internet of Vehicles concept. They have also discussed the roles that other wireless communications technologies like WIMAX will play in this transformation. In [34]-[36] a group of works have been presented which gives a great vision into the development of VANET with satellite communications over the years. The research work in [37] have presented a comprehensive review on the different challenges that is faced while connecting road based VANET with satellite transmitters and receivers. In this work Satellite-Air-Ground integration process to achieve VANET-satellite connections with satellite terminals have been described in details. In [38]-[41] the works presented methodologies to improve the connections of earth based VANET networks with the satellite terminal connections using RIS technologies. In the works from [42]-[45] the aspect of secure communications between deployed VANETs and the attached satellite communications in presented. The main focus of these works is discussions on encrypting the data from transfer from one vehicle to another vehicle in real-time. Necessitates of system design that the node of mobile has both satellite and cellular boundaries. The architecture undergoes from the problems of employing a cellular network (as previously explained). Furthermore, the design excludes any roadside infrastructure, which, when accessible, might deliver significantly higher data speeds at reduced prices. Furthermore, because satellite connection is not highly trustworthy in metropolitan settings, this means that the layout will not be very effective [17].

Our method of design differs from the studies provided above in several respects. We exclusively use satellite connection for downlink, lowering user terminal complexity and running costs. For uplink connectivity, we employ highway infrastructure and do not require any mobile transmitters or nodes of satellite transmitters. This makes it easier to integrate with various systems of network vehicle. The design operates by a modest number of RSUs is best matched for early phase arrangement. We offer many choices with variation capability for error-handling degrees and recommend their applicability for certain contexts [6].

3.1 CHANNEL ON SATELLITE CHARACTERISTICS

Satellite channel is distinguished by long postponements, significant signal disappearing, huge bandwidth, and packet delivery in order. The signal undergoes a multitude of degradations or losses as it travels from satellites to earth location (or, in this instance, from satellite to mobile node). Some of these costs are permanent, whereas others can be predicted using data from statistics, and yet some are impacted by weather. The structure of a satellite system accommodates for any possible weather losses by including enough buffers for these losses. All of these losses can be fairly considered to be covered by the current satellite connection; the only expenses that must be handled are impressive reduction and mobile channel charges [19].

3.2 STRUCTURE OF CHANNEL

In the satellite communication effects of on the internet, namely TCP. Several models of satellite channel were used for that. For this, a satellite channel model was assumed/used. The most fundamental of these considers that the satellite channel is error-free while the remainder revisions the delay effects of bandwidth, and asymmetry. A mode extension, l would be to presume constant error bit rates and examine the implications for procedures. Other model is depending on an extra noise of white Gaussian satellite channel. All of these models assume that the recipient remains constant, but because our node is mobile, the channel behaviour will shift over time. A 2 state Markov channel model which is based on chain, can be simulated using an electrical two-state Gilbert-Elliott model is the utmost often required in land mobile satellite channel (LMSC) model. In this study, a 2-state channel model is going to be used [20].

It has two states: ON/OFF. After putting on current satellite message channel coding, connection is error free in ON (1) state; the state mostly covers the region of line sight. Communication faults exceed the present channel correction capability in the OFF (0) state, making reliable communication impossible; the state mostly includes non-line of deep-fade zones / sight (NLOS)/shadowed. This model's transition probability is affected by the surroundings (mean length of OFF/ON state), the speed of the car, and communication (bit) rate. Because the model removes short duration fading events, transitions between states can be considered to occur at cell limits, wherein a cubicle equates to a section of data.

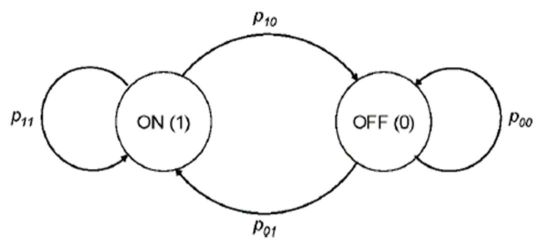

Fig.1. LMLC structure (2 state OFF/ON)

The transition possibility from x to 'y' is signified by p_{xy}, and the one-step state change matrix is specified by Eq.(1). Represent π_x like steady state chance to state x; Eq.(2) gives the 2 steady state possibilities.

$$P = \begin{bmatrix} p_{00} & p_{01} \\ p_{10} & p_{11} \end{bmatrix} \quad (1)$$

$$\pi_1 = \frac{p_{01}}{p_{01} + p_{10}};\ \pi_0 = \frac{p_{10}}{p_{01} + p_{10}} \quad (2)$$

For a fixed rate of transmission node speed in a certain environment, define D_x means the average sojourn period of state x, and the two probability of transitions are assumed by Eq.(3). Define $p_x(>n)$ like the chance that a denoted x continues extended than n time units; Eq.(4) gives $p_x(>n)$ for two states. The average time in every scenario is primarily determined by the surroundings through which the node/vehicle moves.

$$p_{10} = \frac{1}{D_1}; p_{01} = \frac{1}{D_0} \quad (3)$$

$$p_0(>n) = p_{00}^n; p_1(>n) = p_{11}^n \quad (4)$$

also

$$p_{00} = 1 - p_{01}; p_{11} = 1 - p_{10} \quad (6)$$

The average time spent in each state primarily relies on the specific environment in which the vehicle or node is operating. The Table.1 provides insight into different environments, their respective average vehicle speeds, and the average durations of both bad and good states within these environments.

Table.1. Mean time in OFF and ON conditions for various situations

	City	Out-of-town	Country side	Main road
Speed of Vehicle	< 50.1 km/hr	< 50.1 km/hr	60.1 to 70.1 km/hr	< 120.1 km/hr
ON state (1) Period: D1	22.01 s	8.01 s	16.1 s	18.1 s
OFF state (0) Period: D0	15.01s	2.1 s	4.1 s	2.1s

3.3 COMMUNICATION OF SATELLITE

The satellite downlink communication applies well-known error-correcting techniques on each sent segment. Despite severe fading and shadowing, it is expected that current correction of error techniques is adequate for flawless communication [18]. Time variation is employed to lessen the effects of segment losses because of extensive fading and shadowing. It can be succeeded through either inter-user or section of intra-user inclosing, or together. This aids in distributing the fault across multiple sessions or users and utilizing error correction. Because interleaving eliminates the impact of sequential losses, we are able to presume that successive segments of data user are self-governing of one another. This supposition facilitates our subsequent examination of segment rates under various topologies. The parts considered/shown adjacent to each other in the rest of the paper are successive parts of a session and are not always sent repeatedly unless described otherwise. On techniques at a higher layer (described below) improves the odds of recovery [7].

3.4 ANALYSIS OF INDEPENDENCE

After adopting the segment interleaving method, we can present an equation that demonstrates the degree of interdependence between dual successive sections of single transmission session. The method of enclosing goal is to scatter a subdivisions session so that a single satellite fault does not result in successive losses for one session at a time. The amount of Markov describes changes that occur amongst the broadcasts of two successive session of a segments. $P(d)$ is the d-step transition state matrix of the Markov model [20].

$$P^{(d)} = P^{d} = \begin{bmatrix} p_{00}^{d} & p_{01}^{d} \\ p_{10}^{d} & p_{11}^{d} \end{bmatrix} \quad (7)$$

where d_{ij}^{p} is the probability of a d-step alteration from i to j. According to the fixed state evaluation, as the worth of d rises, p_{00}^{d} and p_{10}^{d} will progressively converge to π_0, whereas p_{01}^{d} and p_{11}^{d} will eventually come together to π_1. As a result, we may describe the level of dependency following a d-step state transition as follows:

$$P_{dependent} = \left(\frac{p_{00}^{d} - p_{10}^{d}}{\pi_0}\right) + \left(\frac{p_{01}^{d} - p_{11}^{d}}{\pi_1}\right) \quad (8)$$

The interleaving approach demands that the degree of dependence between two consecutive sessions be less than a pre-set parameter, i.e., $P_{dependent} < \delta$. We can satisfy this need by adjusting the interleaving parameter, d. As the d-step probability of transitions in Eq.(8) lack closed form solutions, we might attempt $d = 1$, $d = 2$,... to calculate the appropriate values of $P_{dependent}$, till the criterion $P_{dependent} < \delta$ is fulfilled.

4. CONCEPT OF ARCHITECTURE

There are no high-shadow losses in the environment. We examine the preliminary deployment phase of VANET, somewhere the thickness of vehicles will be one vehicle per km; also, the network will be quite sparse in a highway setting. When compared to traffic congestion circumstances (45 vehicles/km), a small network with very little vehicle density will not have significant impacts [8]-[9].

4.1 EXPECTATIONS

Our scheme is built around a few fundamental expectations. 1st, vehicles are fitted with GPS, which allows them to record their exact location and give travel direction data to the RSU. 2nd, automobiles can receive satellite broadcasts. Third, RSUs have access to a computerized region map and have knowledge of the precise places of neighbouring RSUs. It is important to note that GPS satellite response often experiences fewer damages than communications via satellite transmission. Every RSU will be linked to a proxy site so that it may receive map bring up-to-date from the intermediary server. The RSUs have permanent installations, and it is believed that they will not be installed on a regular basis. Because of the modest number of RSUs and the extended gap among changes in their state there will be extended gaps between map updates, which will not be too noticeable [24].

4.2 SIMPLE KNOWLEDGE

In the context of Vehicle-to-Roadside Unit (RSU) connectivity, when a vehicle joins to a close RSU, it initiates a request for internet data. This request includes the vehicle's site, speed, and travel direction. The RSU utilizes this information to estimate the potential time for connection and identify the probable next RSU, specially throughout the primary disposition of the Vehicular Ad-Hoc Network (VANET), where vehicle density is relatively low (≤1 vehicle/km), ensuring manageable load for RSUs.

If there is ample connection time remaining, the RSU might service the request directly. When the vehicle moves out of the current RSU's coverage, subsequent responses are redirected to the next RSU in the vehicle's path [22]. If the distance between consecutive RSUs is reasonable, typical in metropolitan areas, the succeeding RSU will remain content delivery once the vehicle enters its coverage area. However, in cases where the distance between RSUs is significant, especially in countryside areas where RSUs are widely spaced, content delivery will be facilitated through a satellite downlink channel. The focus of the paper primarily addresses the satellite downlink option.

During the vehicle's transit among dual RSUs within the satellite downlink-only area, it cannot transmit acknowledgments. To maintain TCP (Transmission Control Protocol) connections and prevent unnecessary retransmissions, adaptive TCP timeouts and delayed TCP timeouts will be forecasted based on the location of the next RSU and utilized accordingly [26]. Given the substantial delays in the downlink, selective acknowledgments will be employed to circumvent unnecessary retransmissions.

4.3 CHOICES

For data transmission from satellites to vehicles, four different techniques are described: forward error correction (FEC), baseline, repeated transmission, and fault position prediction and avoidance. Every alternative has a different capacity to handle errors and comes with a different amount of overhead and delays.

4.3.1 V2V Connection Enhancements:

Communication via V2V can be employed in an array of ways to improve the effectiveness of the previously stated procedures.

4.3.2 Recovery Of Local Error:

If several vehicles in a region use a single satellite channel on a time-sharing basis, vehicles may store data intended for other vehicles. The quantity of data stored and the length of time it is cached are determined by the amount of space for storage obtainable. A recurring buffer can be used for this, and when it is full, the eldest data gets rewritten. Hash tables can be used to perform fast indexing. When a motor vehicle leaves an error region, it can conduct NAK to the following motor vehicle, which may be capable to send the desired package via its cache [25].

4.3.3 ACK / NAK Relay

Another possibility is to use cars traveling in opposite directions to communicate NAK to the preceding RSU. The deleted package can then be re-transmitted by satellite, and the car is not required to wait until it gets to the next RSU to report it [10]. This strategy might be extended further by using V2V communication as a reversing channel for sending all of the selective ACKs and NAKs.

4.3.4 Re-Transmission Relay

Missed packages may similarly be retransmitted by the following RSU by vehicles traveling in the other way. The safety of tricked salutations must be assured in this circumstance.

4.3.5 Options Comparison

The choices provided in the preceding sections provide varying degrees of tolerance for errors at the expense of costs for overhead and delays. When choosing a solution, one must weigh efficiency (error intolerance) vs. cost (overheads and delays); also, some alternatives may be better suited to one setting than others. For movement control and error improvement, the baseline design employs straightforward ACK/NAK. This technique has no overhead; however communication completion may be overdue until the car meets the afterward RSU. This structural design is appropriate where RSUs are not extensively scattered. Proactive retransmission of suspected lost segments is used for error site prediction and prevention. This system offers minimal overhead and latency. The FEC-based architecture features reduced latency at the expense of intermediate expenses [21]. It is appropriate when faults are spread arbitrarily, and poor state periods are inside the FEC limits. Continuous broadcast is a particularly vigorous method; it is particularly effective when experiencing extended periods of evil state, but at the charge of significant above and moderate latency. It equates the success rates of various structural design. It is worth noting that error position forecasting (p_d = 0.9) performs nearly as well as repetitive broadcasting (n = 2).

5. EVALUATION

Simulations were run within the framework of our investigation to verify our conclusions and assess how different architectural solutions performed. The scenario presumed that the node or vehicle had previously requested a file or content via a Roadside Unit (RSU) and was presently travelling through an area that was only served by satellite downlink transmission. The focus of our study predominantly revolved around this 'satellite downlink-only region', narrowing the simulations to this specific area [23]. There was an irregular distribution of a single RSU every 20 kilometres in the roadway environment under investigation because RSUs were positioned at significant intervals and there were no intermediate RSUs. The satellite downlink operating model was based on the LMSC model discussed in Section 3. In Table.2 we have presented a table that will give the set of simulation parameters which may be considered when building a simulation model for Satellite operated VANET.

Table.2. Simulation parameters used for Building the Simulation Model for the VANETs being tested.

Simulation Platform	NS-2
Coding Language used	TCL, OTCL and C++
R_{Time}	50 seconds
Search Time	Begin from: 0 sec End at: 2.4 sec
# of nodes	50 to 400
Interface Priority Que	Drop Tail
Antenna Use	Patch Antenna
Range of Data transmission	100 metres
Mean Size of message generated	256 KiloBytes
Memory Buffer/node	75 packets

These parameters are used when building the Satellite – VANET communication model for evaluation of different algorithms designed for the Satellite-VANET framework.

The file size is segmented, ranging from ten to fifty segments. Each segment corresponds to a single Markov state lasting 1 millisecond. During a good state, the transmission of a segment occurs error-free, whereas during a bad state, the segment is lost. The intervals between consecutive segment transmissions by a node or vehicle adhere to a Poisson distribution with parameter λ. For each file, 1 lakhs simulation run were executed. Every thousand simulation runs employed a single produced satellite channel Markov chain model.

The performance evaluation is similar to repetitive transmission but with significantly lower overhead, primarily with regard to Error Position Estimation and Avoiding at an expected rate of detection (Pd) = 0.9. Table 3 shows segment loss probabilities and transmission times for various topologies.

- "a" represents the chance that the lost sections are fewer than or equal to a specified cost.
- "b" denotes the likelihood that the transfer of files time will be less than or equal to a given value (normalised using the baseline architecture's mean transfer time).

Table.3. Transmission time

Vehicle Transmission Time	BL	Repeated	P_d	FEC
0.00	0.15	0.45	0.45	0.7
0.05	0.4	0.55	0.7	0.9
0.10	0.55	0.65	0.84	0.9
0.20	0.65	0.74	0.88	0.92
0.25	0.75	0.84	0.90	0.95
0.30	0.8	0.88	0.92	0.97

Table.4. Transmission section loss prospects

Transmission Time (t)	BL	Repeated	P_d	FEC
0.60	0.15	0.17	0.18	0.18
0.90	0.2	0.55	0.7	0.9
1.15	0.5	0.65	0.8	0.9
1.40	0.7	0.74	0.9	0.9
1.65	0.9	1.0	1.0	1.0
1.90	1.0	1.0	1.0	1.0
2.15	1.0	1.0	1.0	1.0
2.40	1.0	1.0	1.0	1.0

The Table 4 presents transmission section loss prospects across different transmission times (t) for various methods, including BL, Repeated, Pd, and FEC. The data clearly illustrates the effectiveness of the error position estimation approach compared to repetitive transmission techniques. Moreover, these findings provide empirical support for the distinctive features of different architectural options, thereby validating their efficacy in practical scenarios. The outcomes distinctly demonstrate the advantage of the error position estimation approach over repetitive transmission. Additionally, these results validate the characteristic images of various architectural options.

6. CONCLUSION

We have given an approach for providing access of internet to automotive systems, particularly throughout the initial installation phase and in places by extremely little roadside connectivity. The approach is useful and cost-effective as it only employs satellite receive-only stations and a small number of (widely dispersed) RSUs. We also discussed an error-handling method number of that can be used depending on the running environment. We analysed these choices using mathematical investigation and simulation; together assessments agreed. The solution's efficiency can be increased further by utilizing communicating via V2V in an assortment of ways.

The method is appropriate for request-response uses in which a minor wish is trailed by a large amount of return data. Active or continually demanding applications such as IP telephony are not enabled because the approach does not provide continuous connectivity. Furthermore, the technology is not meant to serve time-critical security applications that require enormous data flows from autos.; however, non-time vital or displayed safety applications, like the weather, transmission of certificate withdrawal lists, danger circumstances, local news or additional safety alerts using satellites, are supported.

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