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POTENTIAL USE OF NAME DATA NETWORKING IN VEHICLE-TO-VEHICLE COMMUNICATION

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ABSTRACT

Researchers have proposed several content dissemination techniques for addressing the massive growth in content exchange. Named Data Networking (NDN) is one of the novel ideas in which networks use named data for content dissemination instead of host identities. In NDN, the content itself is presented in the network layer based on user interests. The use of NDN in Vehicle-to-Vehicle (V2V) communication has numerous potential due to the advantages of named based data retrieval against host based data searching. This paper presents an in-depth review of the potential uses of NDN in V2V environment with special emphasis on their advantages and disadvantages. The paper also provides future research direction that could be undertaken on the subject.

Keywords: named data networking, vehicular ad hoc networks, vehicle-to-vehicle, naming.

INTRODUCTION

Named Data Networking (NDN) (Jacobson, 2009) is a new Internet architecture which focuses mainly on name-centric networking, in lieu of the traditional host-centric approach. Recently, numerous Vehicle-to-Vehicle (V2V) applications based on NDN have been proposed (Baid, 2013) (Grassi, 2013). Intuitively, the multi-source nature and in-network caching features of NDN are supportive of the information dissemination in widely covered regions and intermittent contact challenges which are difficult with traditional IP-based networks. For instance, a data retrieval failure due to intermittent contact will be able to recover more quickly via the advantages of distributed caches.

Vehicular Networking (VN) is one of the most important technologies in the widespread network, also as of now; technologies are prepared for implementation and distribution. The use of vehicle sensors for environmental monitoring, space, logistics industry, and so many other applications is therefore an advantage. The most prone question that researchers have in their minds is, what is the connection between vehicle platform and information dissemination?

This paper focuses on improving the timing and promptness of information delivery among vehicles, to bring Intelligent Transportation System (ITS) based on the concept of NDN to the vehicular network. ITS combine the advances of information system, sensors, communication, and algorithms to improve the outstanding performance of transportation. A new research area in wireless telecommunication has opined of ITS application by creating communication between vehicles such as V2V, which support data collection and exchange of data information.

The paper is further organized as follows: V2V communication requirements and some functionality are covered in the next section. Further details on V2V motivation and challenges are discussed. NDN architectures, Layered protocol model, and research challenges are also presented in the paper. Features and advantages of NDN for V2V were exposed in the remaining parts of the paper. Conceptual design of Named Data Vehicular Networking (NDVN) as contribution and other recommendations concludes the paper.

V2V communication requirements

In vehicular network, due to the restrictions on the available spectrum and wireless networks, the requirements aimed at better usability of bandwidth, low latency. These will enhance stability of the network (Puvvala, 2012). Since the entire network poses unpredictability of the vehicles on the network, hazards, dangers and safety information need adequate delivery in time. The system needs almost a perfect deployment in the environment so as to function as a V2V to actualize message delivery as when needed (Bhuvaneshwari, 2013). In V2V, due to its flexible structure through topology, messages and information are predestined from a vehicle to another. Once a vehicle has information, it forwards the information to a nearby vehicle with the hope of concurrently re-forwarding until it gets to the final destination. For the purpose of the mentioned communication fashion in V2V, all vehicles need to have the V2V enabled accessories to engage in the practice.

The underlining technology behind V2V communication is Dedicated Short Range Communications (DSRC). Devices installed on vehicles allow high speed communication between vehicles and infrastructures make up the DSRC. In order to have an operating communication in V2V, one needs spectrum, an attribute enables people to develop application with low latency. The primary goal of choosing this application can provide the prioritization of information such as safety applications.

V2V communications mainly are performed with the Wireless Access Vehicle Environment (WAVE) technologies. WAVE technology is incorporated with system architecture, different interfaces, and services it provides such as the wild card Basic Service Set (BSS).

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WAVE allows the transmission and reception of data frames with the wildcard BSS. This feature enables communication-group setup without much of the overhead needed in nomadic IEEE 802.11a/g. According to Puvvala in (Puvvala, 2012), WAVE standard to an acceptable score transmit on 5.9 GHz band with the transmission range of about 100-500 meters on frequency. The global standard in US/Europe that uses this mechanism is presented as a summary on Figure-1.

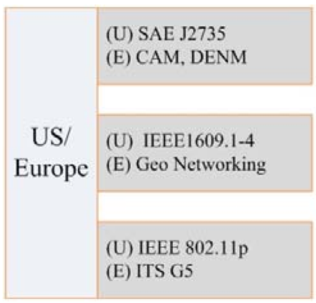

Figure-1. US/Europe standard for short range communication (Puvvala, 2012).

As a result, it clearly poses the particular requirements in every aspect of the system. DSRC and WAVE are the major requirements needed to vend into V2V communication. A unified V2V framework operates on some important requirements, namely Naming, Scalability, Mobility, Storage and Cache, Traffic characteristics, Security and Privacy which are outlined as follows.

Naming

Naming sees as an open research gap of challenges in issues such as flat, hierarchical and distributed forms in designing NDN-based V2V application. The first action to realize in a unified V2V communication framework is the ability to assign unique names within the scope of each vehicle. Data information exchange generated by vehicles or a group of vehicles, needs proper naming approach in design to enable traffic message sharing when needed (Wang & Wakikawa, 2010). Firstly, names must be unique as an application-centric, so as to provide the principle of application and services. Secondly, the names must be carefully designed to meet safety ways to secure based on application requirements. Naming in NDN is chosen as at-types and hierarchies; however, Distributed-Hash Tables (DHT) are also used in some architectures of NDN e.g. Seen in (Grassi, 2013), (Jacobson, 2009).

Scalability

A major challenge in V2V is posed by the enormous growth of vehicular advancements in future when a large number of vehicles are equipped with sensors as regards to scalability and growth of the network. The challenge posed is how can this technology gives successful communication that shows great promise for a large-scalable deployment of V2V cooperative safety systems (Puvvala, 2012) and (White, 2009). An integrated V2V communication concept needs to name every item, such as data and devices, etc. Moreover the system must be able to insert, update, and introduces a name with low latency so as to aid the efficiency of the V2V communication. With the aforementioned challenges, NDN-V2V seems to be the suitable paradigm to handle large vehicular communication against highly scaled network on the road due to its advantages of name-centric nature.

Mobility

For V2V communication, mobility is managed via road discovery, recovery, and maintenance. Efficient mobility in the V2V framework consists of topology control, location, and handoff. Commitment to support mobility is to be able to deliver V2V information, data exchange based on an application acceptable delay constraint on all of the above three cases (topology control, location and hand-off). The fixed assets into dynamic V2V environment seek to improve speed and ability to make decisions by users effectively. In addition to unifying the network architecture, protocol stacks and service, Application Programming Interface (API) that migrates smoothly from fully connected to weakly connected ad hoc network environments must be associated with vehicular systems (Baid A., 2013). Putting into consideration that vehicles move in-and-out of the network almost exponentially.

Storage and cache

Storage and caching both play an important role in V2V communication (Wang, 2007). Based on the content caching requirements (Xu, 2010), information can be disbursed at will or at service licensed points resulting in not requiring sending frequent content request to the originator (publisher). Instead, the content will be served by the cache based stations. The operation of caching takes the forms of in-path or off-path design. Without an adequate caching, V2V would not be possible as every car (node), requires cache and send information and data on request or operation.

Traffic Characteristics

V2V communication traffic can generally be classified into two types, local and wide areas traffic. Local area traffic is between neighboring vehicles; For instance, cars can work together to detect potential hazards on the highway; more so, sensors are used to detect and mitigate collision rates as a preventive device. Sensors in cars on the same road may act as a team to determine how to adjust the hitting level on the road (Wang & Wakikawa, 2010). For the purpose of traffic control, data aggregation and filtering, cover real time constraints, and require data service for discovery and association. This makes it necessary for the V2V framework to support wide area communications. For instance, consumers can locate a real-time traffic and road usage information, after that a car may choose which way (path) to take. Wide area communications, therefore, need efficient data and service detection form with extremely high resolution services to curtail the menace of traffic on the road.

Security

The V2V communication system is prone to huge data generation which is subject to privacy and security guidelines lapses. The lack of a centralized control structure in a dynamic network and weak wireless communication would be a key factor to increase the number of possible security breaches and intruder threats in V2V communication (Zhu1, 2013). Therefore, there is a strong need to use good and appropriate security measures to safeguard the information transmitted.

Privacy

Privacy, as it relates to the V2V, can be defined as the acceptance and un-acceptance of the rights of using information about a person, vehicles and other related information by another party. It also defines the forms of information acquiring about a person and a vehicle (Puvvala, 2012). Therefore, the NDN-V2V concept can be used to curtail and prevent publishes of controlled information.

V2V Communication architecture

The current available system architecture of V2V communication is in Vehicular Ad-hoc Networks. Vehicular Ad-hoc Networks (VANETs) used alongside Road Side Units (RSU) are yielding positive research results by making communication feasible through their closed interaction. Vehicle sensors exploit the short range wireless communication to transform collected data to the remote control center. V2V communication is thus considered to handle the technology which allows the vehicles on a network to talk/communicate with each others as a public network.

V2V communications, analyze the usability of different wireless technologies, and the ability to transfer information between vehicles in order to maintain constant communication. Movement is an important task that ensures the success of vehicular communication technology in V2V. Some of the solutions proposed for wired and wireless V2V cut across the idea of using a proxy server as a gateway between the two domains. All the aforementioned techniques can extend this model to vehicular technology to work as a vehicle to other vehicles on the same road, primarily for direct connection, and then allow indirect relations through several vehicle nodes. However, the focus of this paper is to adapt the existing structured of V2V architecture features of the vehicular environment to better the performance using the NDN concept. There are three parts of applications research area in connecting vehicles as shown on Figure-2.

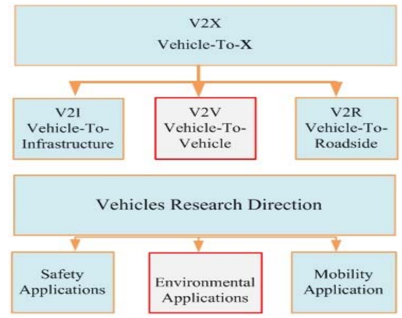

Figure-2. A research direction of vehicles communication.

Recent and modern developments in appliances, compact in cars such as cars equipped with sensing and the rapid integration of new wireless technologies has made communications with stations easier. Thus allowing the introduction of several vehicular applications and services based on VANET context to efficiently cooperate between terminals and fixed infrastructures available en-route. V2V communications are new generation of driver assistance and environment monitoring technology. The advantages of VANETs aims to improve environmental monitoring activities, traffic efficiency, minimize road accidents and enable new applications. Information technology networks in V2V communication technologies include fixed networks and wireless networks. With the architecture of VANETs, can further be termed based on following three concepts: cellular/WLAN, ad hoc and hybrid. These categories allow vehicles to be in contact with V2V communication or fixed infrastructure (Wang, 2007). Figure-3 shows the general architecture for vehicular networks in V2V communication.

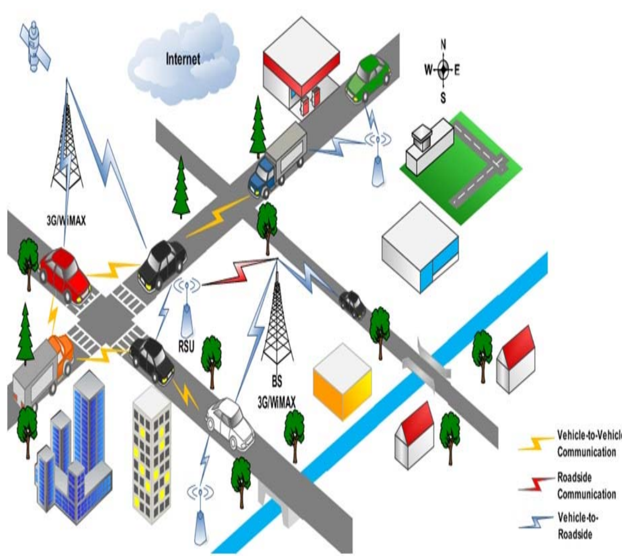

Figure-3. V2V communication architecture.

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V2V Motivation and challenges

To exploit the potential use of NDN in V2V, an efficient road network is extremely important to support reliable transport service and make vehicular ad hoc networks (VANETs) applicable for many applications. The recent trend, however, is to evolve towards a globally V2V framework, in which vehicle and objects connect to the Internet, available for interactions among themselves.

During the past decade, many standalone V2V communication systems have been developed in different domains (Xu, 2010), (Hassan & Habbal, 2013). The recent trend, however, is to evolve towards a global V2V framework, in which vehicle and objects connected to the Internet will be available for interactions among themselves. V2V supports a variety of vehicle en-route applications. A major requirement to efficiently transmit information is radio resource management strategies. This includes bandwidth, Quality of Service (QoS) control, packet loss reduction, packet scheduling, interference control, capacity enhancement, and Call Admission Control (CAC) (Kumar, 2012). To accomplish different uses of applications in a V2V communication environment, sophisticated configurations are needed for efficient V2V communication.

There are many challenges facing the V2V communications. Some of the most important ones as presented in (Puvvala, 2012) are discussed below with the addition of Number of Messages, Heterogeneous and Hop Distribution.

Radio

Radio is one of the most popular issues based on the spectrum and congestion (Puvvala, 2012); this is due to the nature of the radio access network throughout the trip because of its heterogeneous nature. Thus a seamless connection for ubiquitous communication is a major challenge.

Positioning

Positioning is often determined using differential Global Positioning System (GPS). It is difficult to know the exact positions of moving vehicles which may create uncertainties in the messages received as well as transmitted (Kumar, 2012).

Hop distribution

In reality, vehicles are not uniformly distributed in a certain area (Zhu1, 2013); a large population prone area usually faces more hop distribution against a less populated one. The population may be as a result of trading, offices, schools, recreational centers and bars etc.

Number of messages

A key evaluation metric is the total number of messages sent. Distribution is usually calculated between nodes and the total number of hops the messages across during message distribution.

Heterogeneous distributions

The heterogeneous distributions of vehicles increases the challenges for designing new applications, Intercontact time and arrival time (Zhu1, 2013), distribution interval, then becomes distinctive in communication between vehicles, the network connection is extremely better if the time between the contacts is less. The duration of a contact decides the total data that can be transferred within a contact and finally the security with certificates challenge.

The paper aims to improve the communication for better environmental and highly mobility structured net- work between vehicles. Today's cars use TCP/IP communications with the current back-end server. Figure-4 shows the scientific, technical challenges based on V2V communication.

The limitation of existing system nowadays, most of the vehicles are equipped with a variety of wireless communication interfaces such as 3G/LTE, WiFi, WiMAX, IEEE 802.11p (DSRC/WAVE), and Power Line Communication. A car should be able to take advantage of any and each of these interfaces to communicate with other vehicles as long as it is needed by other applications such as basic safety message (BSM). A study conducted by Wang & Wakikawa, (2010), used a context-aware V2V application as an example to display messages from one vehicle to another traveling at an estimated speed of 60 miles per hour (mph). However, the study concluded that the ability to exchange at least 10 messages per second with 3Kbits in each message was achieved.

Additionally, vending into Name Data Vehicular Networking (NDVN) could curtail and mitigate the existing challenge of message linear sending by adopting a broadcasting scheme. The broadcast is done using N-array structure where a source (Publisher) sends out the information using a broadcast. Once the message is broadcasted, the neighboring vehicle pulls the information which is then cached for subsequent forwarding.

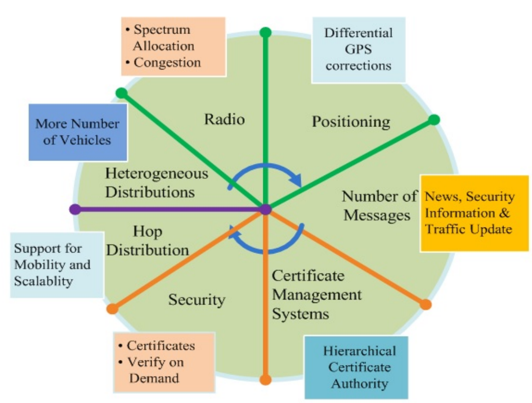

Figure-4. Technical challenges.

Unfortunately the traditional mechanism type and the fundamental networking do not efficiently support the core functions that the budding applications demand

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such as wide area coverage. However, installing access points in every 500m will be too costly in practice. This scenario therefore introduces recent research efforts that address the issues under NDN technology.

NDN architecture

At NDN, users and applications have a lesser concern about where the address information is located. Rather, NDN has more emphasis on the data. This makes it a unique paradigm of content-centric as against the IP addressing paradigm. NDN architecture is built upon neighbor node communication of information sharing. In NDN communication, packets are known as interests which are requested by a subscriber (consumer) and the data packets which are in-turn created by the publisher (producer) ends of the consumer.

Information in NDN are lodged in a special store known as the Content Store (CS); which store all contents and respond to the interest packet when requests (interests) are sent by subscribers. Pending Interest Table (PIT) is a special forwarding table in NDN that saves interests on its feature when message interests are not met. PIT immediately forwards the interests from the CS when subscribers request. In case where interest packets are not saved previously in the CS, or unsatisfied requests, the PIT stores that interest. PIT has the functionality of decision making on whether to store the interest or to forward to the Forwarding Information Base (FIB) for forwarding operation. The FIB can as well be related to the IP forwarding operation with a distinction of using names against the IP addressing in the traditional Internet. IP sometimes produce redundant links during packet forwarding while in NDN operates more using loops to reduce redundancy links.

NDN architecture will function better when most nodes (routers) are cached-enabled. The negativity and lack of cache-enabled routers will cause packets drops and loss. From Figure 5 below, when an interest is sent out by a consumer, on Host A, the interest is placed in the PIT. The cache-enabled router (Router X) is the first to be served with the requested interest. CS from Router X is the first name resolution site. In the event that the object is not found, the interest is placed in PIT and FIB then forwards interest in the network.

Moreover, after the interest is matched from the producer, the data object is forwarded back via the route as depicted in Figure-5. Data A was cached by Router X for subsequent feeding of interest from other nodes.

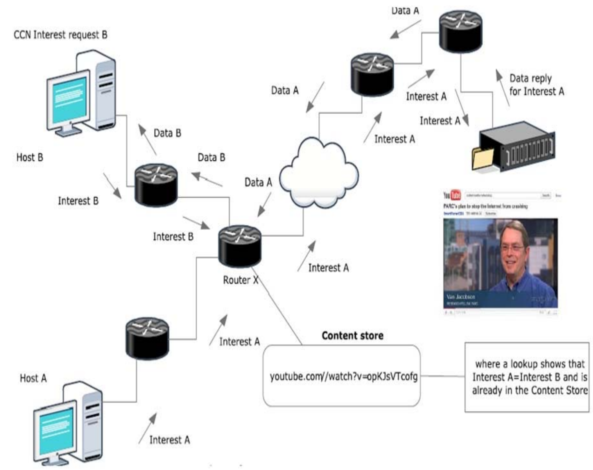

Figure-5. Sample NDN architecture (Jacobson, 2009).

The main concern of the network revealed, is to find and provide the information that cannot be accessed using some parameters and the content of their conversation. Information of influence, and retrieval of information, which can be divided into two functional areas as low level with respect to NDN, and network, which is a collection of related pieces of information, also known as the objects name content/information. Data for direction and control applications of services at a higher level and intermediate are serviced by the functional areas.

In NDN, information is produced by publishers and consumed by subscribers, while none of them has any knowledge of the each other's existence. The data sent through the network, passes from a number of other elements that determine the correct path they should follow. NDN uses dynamic content caching content distribution which is fast, reliable and scalable with a maximum capacity to avoid congestion.

Router (placed along the way from the sender to the receiver), for example, saves the contents of the cache for objects that intersect so that they can guarantee subsequent requests for the same objects quickly with a router. Thus, this avoids much load across the original publisher. This means that the introduction of the NDN is a search and display of copies of data objects according to the effective receiver in the network. With NDN cache also, content has the ability to translate the movement of traffic within the operator's network, provided that there is an incentive to publish Application Layer Traffic Optimization (ALTO).

Mobile NDN can be defined as an NDN that supports elements in the network path, consumer and/or provider mobility. Consumer mobility is more frequent in mobile NDN, when requests are not fully granted due to consumer mobility; it can re-issue any packets sent by interests that are not satisfied yet. This can happen without notice because there is no need to make any new registration, etc. With these advantages, CCNx can handle up to 97 percent of the queries in the high mobility (Wang & Wakikawa, 2010).

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Layer protocol model

The work in this paper turns its attention to the current new and enhanced protocol for V2V that hopes to replace presentation, session and transport layers of the legacy OSI framework to provide the functionality in a more efficient way. The IP (Network Layer) will be replaced by the NDN Platform i.e. NDN architecture would stand in for more efficient and robust routing see Figure-6. Routing is maintained using the unique names of contents instead of IP addresses as shown in the figure below, but the mechanism to choose the best route with the longest prefix match will remain the same as in traditional Internet in particular, with reference to the model of TCP/IP communications architecture during different methods.

- Receiver-based communication model: Receivers pull information by sending an Interest message. At most one data message is delivered in response to an interest. Communication is initialized by publishing interest on the network by the subscriber which in-turn is handled at the receiver based nodes. The applications on the receiver side have to re-express interest for content if previous interests have timed out due to non delivery.
- Hierarchical content naming scheme: NDN does not address hosts, but location independent content objects. Content is given arbitrary, user-defined names organized in a hierarchy similar to URLs. Interests are matched with content or with routes to, content, by doing longest-prefix matching. Because of these properties, receivers can express interest in names that do not yet exist. These Interests will be routed to a content source capable of generating the corresponding content.
- Cache-based architecture: Every participant in the system, such as end nodes and routers, may cache content objects and use them to serve future requests. However, the caching is done according to the forms and algorithms to avoid collision of information and reduce redundancy of information.
- Content Security: Every content message exchanged in NDN is digitally signed. In this way, the content publisher certifies the binding between the content and its name to ensure integrity and authenticity. Encryption can be used if confidentiality is required.
- Stateful, more powerful routers: Content routers in NDN need to keep per-interest state to avoid routing loops, and to send back data responses on the same path that the corresponding Interests took. Routers can verify the content objects signatures to avoid content spoofing attacks. NDN also supports a limited query language for Interests that routers must implement.

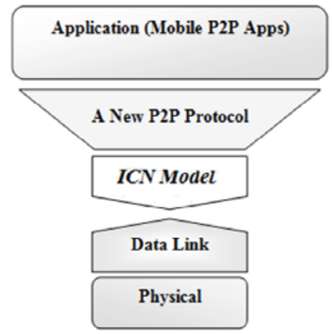

Figure-6. NDN model (Jacobson, 2009).

Research challenges

In this section, research challenges for various network layer protocols are discussed, which has the unique characteristic of V2V communication that raises a number of design challenges. These characteristics generate a good opportunity to solve ITS problems from a different point of view.

Application layer

In the application layer, the main challenge lies in the effective expression, discovering, storage, and updating all the information over the network. This technology is facing the main challenge which includes naming and addressing, and the most recent applications are incapable of utilizing Geo-location. If any vehicle wants to encode multidimensional information in the form of names as an example of Information Traffic data, name must carry location and time of information. Addressing is considered as a problem which needs to be solved as regards to V2V communication network (Xu, 2010). Addressing faces the challenges of how to index the information from the physical world for efficient storage of information dissemination.

Transport layer

In the transport layer, the functions such as error detection, congestion, flow control, lost data retransmission, and bandwidth management are implemented at the end host as an end-to-end communication process. This is harmonious with the NDN paradigm which is the role of end hosts making it extremely different as compared to the traditional IP networks. This is because the communication sessions are only information-centric. Moreover, transport layer should completely remove the dependence on endpoints. For more clarity, senders and receivers are decoupled in NDN, and due to caching advantage, a consumer can receive queried interest (data) from multiple different sources in an unexpected way (Arianfar, 2010). In this case, the challenges are how to carry out transport control per data source under uncertainty since the communication does not make sources of data or information known in advance. Furthermore the challenge of providing consumers' details with authenticated data without exposing the producer identities becomes vital.

Network layer

Information dissemination in V2V has also a number of challenges in the network layer. Literature study in the last decade has proposed and proven many protocols in ad hoc networks, such as Mobility-Centric Data Dissemination algorithm for Vehicular Networks (MDDV) (Wu, 2004) and Vehicle Assisted Data Delivery (VADD), which considerably improve the packet delivery in V2V mobility with the aid of Global Positioning System (GPS) positioning and road layout (Zhu1, 2013). Even though in the context of NDN, the source and destination for certain applications are not known for routing the packet. Another open issue is, information may be combined when traversing through different vehicle destined without the prior knowledge of the vehicle's position.

Link layer

Link Layer is responsible for functionalities such as receptiveness, reliability and scalability to adopt changes in V2V mobility (Xu, 2010). The interrelated concept of reliability and scalability become vital in safety, security and immediate data transmission while looking into the parameter access point selection. Address Resolution Protocol (ARP), MAC management issues with respect to timeout are all challenges in NDN; because of all these issues, increase start-up delays and underutilization of bandwidth leads to inefficiency in a mobile environment. Hence, they are open ended issues for researchers.

Features and advantages

NDN has features categorized in three as mentioned in the previous section. The features are CS, PIT and FIB; however, similar to the Domain Name Server (DNS) that generates the IP addresses and the forwarding information, FIB provides the routing information using the names as what is seen in a host-centric network paradigm. Additionally, FIB performs functions almost similar to the routing operations on IP Internet. Security features such as the Secure Sockets Layer (SSL) are represented in the FIB using different encryption and hash functions; therefore no routing loops occur in communication. Inclusion of special feature for self-identifying mechanism in NDN enables NDN in removing the need of spanning-tree. This results in better optimized and enhanced routing functionality. Part of the advantages in NDN is the use of simultaneous messaging in different scenarios of routing interests in case of different changing condition.

NDN is envisioned as a future Internet for addressing some inefficient use cases of operation in the Internet such as content retrieval, mobility, Internet of Things (IoT) etc. The features of NDN make it easy to understand in internetwork functions in cloud computing, multicasting information, mobility and scalability support etc. Part of NDN operations are that in a network, objects/interest are identified by their names not by IP addresses as practice in the traditional Internet. Additionally, objects like mobile devices, services and contents are seen as a node of publishers and subscribers. Secondly, routing uses a hybrid name or addresses from the FIB. Routing could be reactive or proactive depending on the interests and the best routes to deliver the requests. Third, delay tolerant transport is seen as a feature in NDN with the advantage of the nearest node providing the information.

Technological shifts through innovation have envisioned the wide sharing and usage of information among V2V. In the NDN architecture in V2V, Road Side Units (RSUs) provide the intermediary service of the communicator in the middle and a server-like station. This aids in acquiring information from moving and stationed vehicles in the V2V environment. Authors in (Baid, 2013) (Bhuvaneshwari, 2013), (Wang & Wakikawa, 2010) at this point, consider the preliminary investigation of the NDN model in vehicular environments as beneficial. The use of V2V communication for traffic information sharing and other data outstands NDN for Interest with data broadcasting. NDN has therefore been proposed and evaluated for its efficiency and better coverage. The output of the researchers in different studies shows that situated timers to coordinate transmissions and minimize packet collisions on the shared wireless medium has been addressed. The dissemination of safety information on vehicles is applied in NDN framework and equipped with several radio interfaces (Arnould, 2011). A prototype for vehicular communication has been designed and developed so that consumers consume all available communication technologies to search and route named data (Grassi, 2013).

Conceptual named data vehicular networking (NDVN)

V2V and VANETs follows the same principle and apply these principles to the highly dynamic environment of surface transportation (Wang & Wakikawa, 2010). Data sharing in V2V environment has become large to handle thereby increasing the need for better computing service to handle the data object. V2V with the adoption of the NDN is thus seen as solution direction of the aforementioned data size issue for handling large-scale data sharing, object content distribution, and application-level multicast application etc. Figure-8 shows an example of VANETs and V2V communication.

The paper presents the concept of V2V communication; the concept will be referred to as Name Data Vehicular Networking (NDVN) formal communication action. The work contends that NDVN is very important. This is because focusing on content sharing between vehicles is an aspect of NDN that has not yet been fully analyzed and understood. The concept of NDN based V2V is becoming more and more significant in day-to-day activities due to the increasing number of interaction and communication on the road. This proposal is based on the NDVN framework which present three important roles played via vehicles and RSUs. The work

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describes the following: data publisher, data mule and data consumer with layer protocol model as seen in Figure-7.

NDVN scenario

NDVN environment defines the combination of ICN-able vehicle scenario. Information sharing use name for referral in lieu of the IP addresses in host-centric network. From the Figure-7 below, vehicles are enabled with sophisticated cache node abilities that make it possible for Vehicle 1 to share information with Vehicle 2. This is possible in the scenario with the functionalities of the Content Store (CS), Forwarding Information Base (FIB) and Pending Interest Table (PIT) for storage, route forwarding and interest checking for presentation respectively. NDVN operation as depicted starts its initiation from the Publisher which is usually a vehicle as a source. The information is then pushed into the network through the neighbors which are cache-enabled. In the Road Side Unit (RSU), information is fetched by the vehicles in the network.

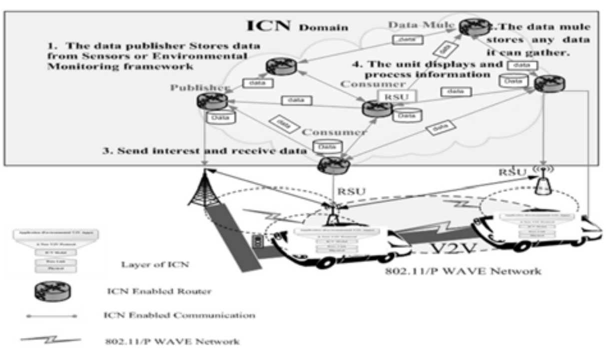

Figure-7. NDVN framework.

This paper shows V2V message/data communication between vehicles that in close proximity or in large distances away to demonstrate how V2V can be potentially used. The scenario will be based on mobility of content in V2V communication to serve the future drivers warning with potential crash avoidance, traffic information as safety application and efficiency or with any other potential message in commercial applications and entertainment support such as content sharing of V2V communications.

NDVN Fundamentals and System Operations

In this part, the paper provides a scenario of the operation of NDVN in order to clarify the thought of sharing information of content such as message/data communication. The basis of NDVN framework which classify the system into three different roles as shown in Figure-8, where data consumer, data publisher, and data mule are in communication.

The system operations are as follows, a vehicle as a publisher produces a data (message) and stores it in its cache by Content Store (CS), which makes it available, actives and offered for distribution. The interest reaches the first vehicle. This is then looked up if similar or the same interests are requested by other vehicles. In this particular case, the message will be sent at the same time by using an N-array of solution of sending messages on Multicast application. A vehicle might send a message to N number of vehicles which are nearer to it or far by some distance.

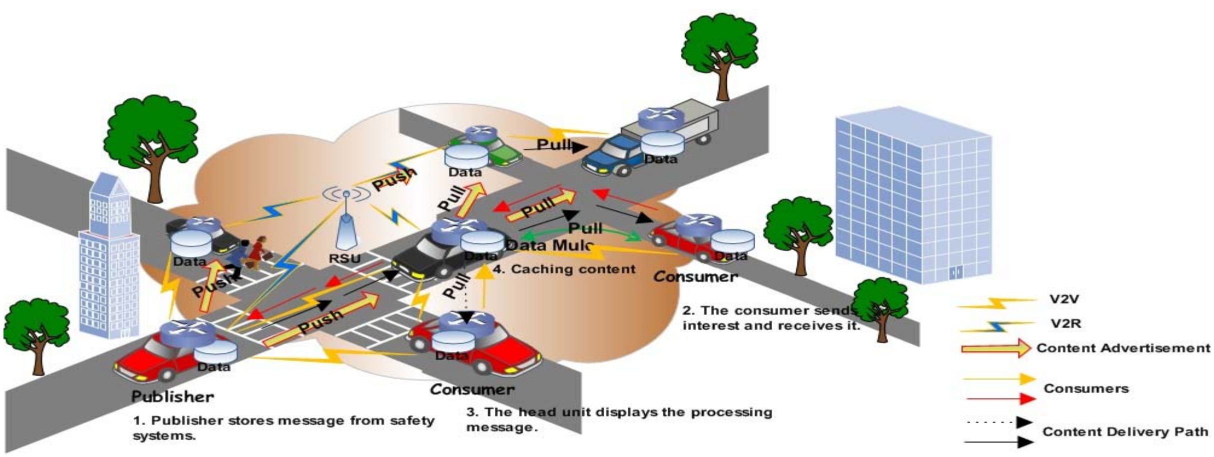

Figure 8: NDVN framework architecture.

Second a data mule is a vehicle that collects information from another vehicle in addition to its own data. Messages can be transferred away from the producer's location, whether by interest or through vehicle movements, which in turn can carry the content to wider areas, content can be carried by the vehicles while they do not have a network connection.

Finally, a data consumer sends Interest (message) to retrieve data information from publishers and data mule. Practically, in NDN model content has a unique name.

Furthermore, data consumers can be fully served their requested data name in the Interest (message).

CONCLUSIONS

This paper discussed about the potentials of using NDN for V2V in a wider perspective, a first step for identification of information communication based on NDVN which is used for remote V2V communication. Numerous challenges of V2V and NDVN combinations were discussed, which are open to be addressed by the research community in different applications and scenarios.

The contribution of the paper can be categorized into the following. Namely: reviewing emerging V2V applications with the existing of V2V networking, studied the existing challenges of network models in V2V communication and the introduction of the conceptual design of a proposed NDVN framework which was missing in (Wang et al, 2012). The paper concludes by exposing the possibility of increasing the total number of messages sent using the N-array, and also the use of multicast against the common practice of the linear messaging. N-array therefore, enhances more messages sent per unit time. Its usage improves the overall enhancement in message delivery at a better time as compared to the linear messaging in ordinary V2V. The paper also exposed a concept of broadcasting on route as all vehicles are equipped with the cache-enable routers for subsequent dissemination of information. This will reduce the total communication by lowering the load at the publisher end.

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