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"Store carry and forward" routing in DMANET using publish subscribe

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ABSTRACT: Nodes in Due to the intrinsic dynamics of MANET network, lack of connectivity between the nodes of this network can be exacerbated what makes it a factor leading to the partitioning of the islets network.
The network can then be modeled a disconnected graph consisting of a set of related sub-graphs in which nodes can communicate through conventional and approved routing techniques.
Opportunistic solution based on the principle "Store, Carry and Forward" designed in this work is to bypass this network fragmentation problem and ensure a result-based content the communication between any information publishers with receptors involved in their information.
VANET as an application of Disconnected MANET communications is susceptible to numerous and frequent loss of connectivity. To solve this problem, we had to implement a cache manager that which is an important module in the proposed solution.

INDEX TERMS: DMANET, publish-subscribe, VANET, opportunistic, routing, cache.

KEYWORDS: MANET; publish-subscribe; cache; VANET; opportunistic; routing.

I. INTRODUCTION

Mobile Ad Hoc asynchronous communication modes using the publish-subscribe paradigm now experiencing a resurgence of interest in the context of distributed applications, unlike other types such as client / server model.
They are better suited to manage interactions between loosely coupled systems. This characteristic of weak coupling between the connecting elements in the publish-subscribe model is the result of a spatial nature factor through the remoteness and temporal nature through the high frequency of disconnections link, hence its usefulness and its derived importance for mobile users.
These users typically form a self-organizing wireless network having no overall view of the system. Moreover, this network is fully meshed and device can send a message only to nodes present in its radio transmission range and type of information according to their perspective needs. Thus sending is usually done according to the publish-subscribe model in this kind of network.
Since the connectivity of the network is not constantly ensured, the network can be temporarily partitioned into isolated sets of nodes. Indeed in MANETs deployed in real conditions, mobile terminals may be insulated with frequent changes of topologies.
In this case, the network is in the form of a fragmented group of islets due to the high mobility of the environment.
In the majority of these mobile networks where intermittent connections are common, mobile nodes can then be used to route messages to single nodes.
In this type of networks, traditional approaches routing and communication to maintain routing paths through the network would be insufficient.
So the utility to use an enhanced routing approach and adapt it to DMANET using publish subscribe model.

II. CONTENT BASED COMMUNICATION IN VANET

2.1. Disconnected network with high mobility:

VANET uses cars as mobile nodes in a MANET to create a mobile network. A VANET turns every participating car into a wireless router or node, allowing cars to connect and, in turn, create an extended mobile network. As cars fall out of the signal range and drop out of the network, other cars can join in, connect vehicles to others so that a mobile network will be created.

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The nodes of these kinds of mobile networks are usually dynamic and autonomous. This dynamicity usually causes loss of connectivity on a frequent basis. The mobile ad hoc network appears in most of the time as a non-connected graph with a set of islets of connectivity. The fragmentation of the mobile network increases with the dynamicity and the high mobility of its nodes.

This type of network is the application context of our work. Indeed, its importance comes from the nature of most mobile networks. Indeed, in real conditions its mobile nodes can be isolated every time especially when it is extensive and with high mobility

The characteristics of this network require more advanced communication techniques that comply with these properties. These techniques must firstly meet the operational needs of the deployed network applications. On the other hand, they must provide constantly a path between the producer of information and its consumers. These paths can become unusable due to the high mobility of nodes.

2.2. DMANET:

Thus, as we understood from the previous paragraph, our work will be projected to a disconnected network with high mobility. So the issue is how we can ensure a route in all the time between the producer and the consumer of the information in a communication inter-vehicules.

So for each time t, the network formed by moving vehicles will be simulated in a disconnect network formed by a set of islets of connectivity.

So we took DMANET as a general model to apply the communication in VANET in a context of high mobility.

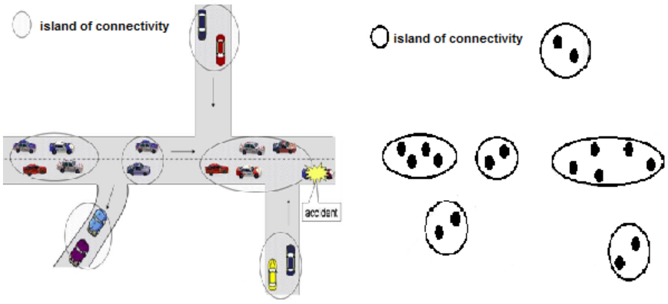

Figure 1: Simulate VANET as DMANET.

2.3. Vehicular applications:

The car represents one of the most things in our live which resists in a world that is becoming increasingly computerized. In fact, since more than a century cars remain a conservative field based on an inter-car usually visual and executed by the driver (lights, horn,)

In the last years, the communication between vehicles and the road infrastructure is advanced especially with the need for content-based communication.

It is estimated that the first systems that will integrate this technology are police and fire vehicles to communicate with each other for safety purposes.

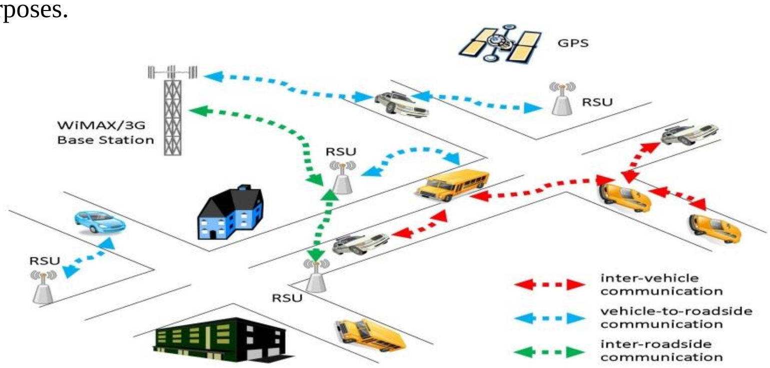

Figure 2: V2V and V2I communication.

The main Vehicular safety applications include emergency, collision, car accident, and other safety warnings. For high performance, highly robust, scalable, robust, fault tolerant, and secure vehicular networking, several extraordinary challenges are remained as follows:

- Safety and commercial applications
- Mobility and traffic models
- Security and privacy
- Cooperative aspects of vehicular communication
- Vehicle-to-Vehicle
- Vehicle-to-Roadside
- Scalability and Availability issues in Vehicular networks.

III. THE PROPOSED APPROACH

In the DMANET network, the proposed approach must permit to palliate the absence of peer to peer connectivity, it subsists difficulties bound to the address of the information. To solve this problem, the proposed approach rests on a model of communication publish-subscribe according to DDS.

In this model, every injected information in the network is supposed to reach the set of the interested elements, rather than the recipients specifically designated by the emitter.

Thus, the flow of information is interest-driven rather than destination-driven

This style of communication, intrinsically many-to-many, permits a clear decoupling between producers and consumers of information

The underlying communication system is responsible for delivering each message to elements that are interested in this kind of message.

Therefore, we concentrate on the problem of supporting content-based communication in a disconnected mobile ad hoc network (MANET): The VANET (Vehicular Ad-Hoc Network) is taken as an example.

So, on the one hand we must ensure routing between vehicles that form a network with a high volatility and secondly we must ensure the exchange of data based on the publish-subscribe model.

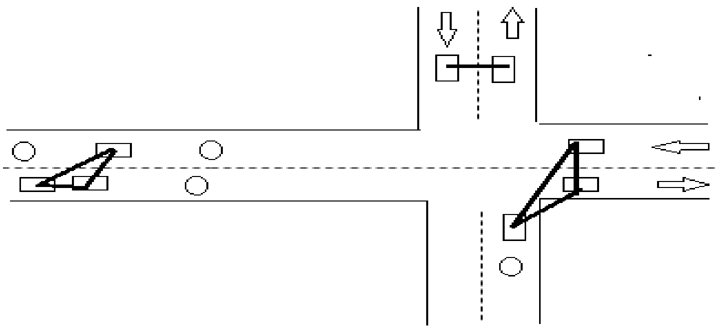

Figure 3: Example of a disconnected VANET.

IV. ARCHITECTURE OF THE SOLUTION

Because of the fragmentation of the DMANET network into islets of connectivity, it will be impossible to achieve a routing events and messages between elements belonging to different islets using classic techniques of routing destination-based which are dedicated to the classic MANETs.

This is why routing in DMANET's must rely on routing protocols that are dedicated for this kind of networks according to the concept store, carry and forward.

This concept allows an event to be transported by a mobile terminal of a block of nodes to another, and later be relayed to other terminals concerned to the information.

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The difference between this routing technique adopted by DMANETs classic and one that should be adopted by DMANET's-content-based is that in the first type, the target is a destination well known and in the second type the target is a set of subscribers to the information.
Thus, we must mix the routing technique in DMANETs with the content-based communication based on publish-subscribe paradigm according to DDS – Data Disctribution Service.

Publish-Subscribe with DDS
Opportunistic routing (content-based)
intra-islet routing

Figure 4: Layers of the communication model.

V. APPLICATION LAYER SOLUTION

5.1. Publish subscribe communication with DDS:

The OMG Data-Distribution Service for Real-Time Systems (DDS) is the first open international middleware standard directly addressing publish-subscribe communications for real-time and embedded systems.
DDS introduces a virtual Global Data Space where applications can share information by simply reading and writing data-objects addressed by means of an application-defined name (Topic) and a key. DDS features fine and extensive control of QoS parameters, including reliability, bandwidth, delivery deadlines, and resource limits. DDS also supports the construction of local object models on top of the Global Data Space.

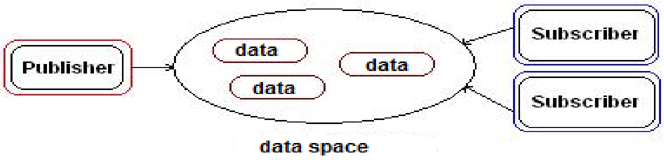

Figure 5: Communication model in the application layer.

5.2. Using DDS in DMANET:

The flexibility and configurability of DDS makes it a better solution for applications in such DMANET network.
The architecture of a conventional system based on DDS is a set of nodes connected via a transport protocol in real time. In each node are embedded real-time operating systems, middleware and Publish/Subscribe interface based on the DDS specification.
The middleware will keep track of data-objects that are considered rows in a table. Each data-object is identified by the combination of a topic and a key. This is depicted by the figure below.

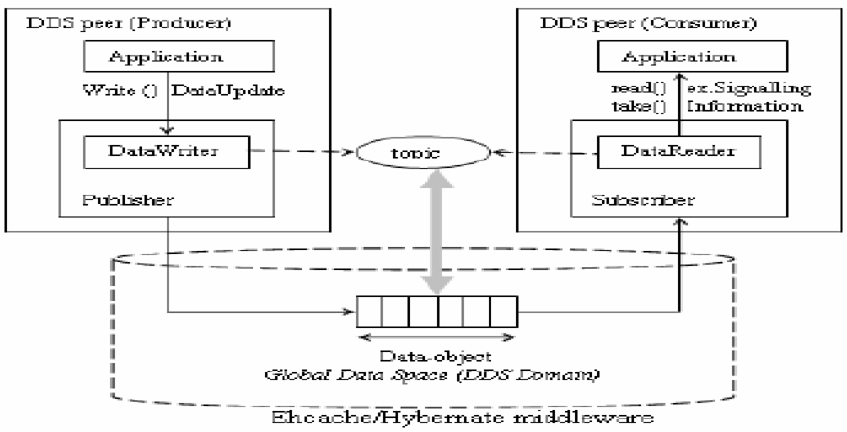

Figure 6: The topic and the data-object in the middleware

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5.3. Application layer architecture:

Application Services	
Administration	publish-subscribe
List of interest	Cache

Figure 7: Application layer architecture.

a) Applications services: The designed platform offers a set of application services such as subscription or publication of information relating to traffic (eg notifications slowdowns, notifications on the presence of work zones, the presence of plugs, etc ...). These services take advantage of the communication model content based through a dedicated publish-subscribe interface.
b) Administration: This module focuses to administer and manage the various application services. Thus, thanks to this module, the terminal owner may also adjust its interest in each service configured. This management module may even be able to influence the behavior of the local terminal by switching to a pro-active altruistic behavior.
c) The Cache: is used as storage space for each message that has just been published. It is useful for the terminal that holds the message to can spread it to another at each new encounter occasionally. This cache is also used to resume sending in case of loss of connectivity due to the frequent mobility of terminals.
d) List of interests: Each application service must subscribe to a topic by specifying the information that interests them. This forms the interest profile of the terminal and will be useful on the one hand to receive further information regarding this profile and secondly it will serve to reduce the exchange between terminals since the terminal will have an idea about the interests of each one. Thus the choice of the carrier of the message will be change according to the needs of them application services.

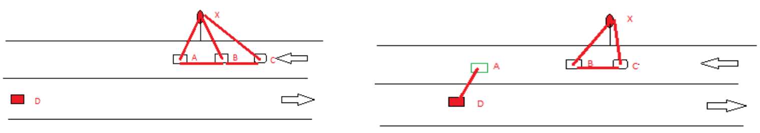
VI. ROUTING LAYER SOLUTION

6.1. Routing layer architecture:

Opportunistic routing (content-based)
DDS API
intra-islet routing (OLSR)

Figure 8: Routing layer architecture.

a) Opportunistic Content based Dissemination - DOC: This layer ensures opportunistic routing discontinuity network by bypassing the high mobility and especially the sudden loss of connectivity. This technique uses a content-based and epidemic approach by using "Store Carry and Forward" algorithm.
Thus according to the communication principle of this mode, it can store the message locally, transport and forward it and subsequently disseminate it to new neighbors.
b) Communication Intra-islet-CII: This module provides communication between terminals within the same islet that its topology is already temporary because of their high mobility.
It allows the terminal to communicate with not only neighbors but also to communicate with other devices on the same islet. It uses routing protocols approved, including OLSR, to ensure this multi-hop communication.
6.2. Store, carry and forward:



At t=t1 At t=t2>t1

Figure 9: Propagation of information from one islet to another.

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The X terminal wants to send at time t1 a message to the terminal D. At this point, D is out of range of X, so there is no route end-to-end to D can be identified.
X uses the opportunity offered by A to carry physically the message to the destination D.
From time t1, A stores and transports the message, and then contributes to the routing through the network.
A meeting, at time t2, the terminal D. D gives the message that was given by X.
Finally, the terminal D receives the message sent by X though no route end-to-end existed between sender and recipient.
We can see that the opportunistic communication can involve high latency because the speed of movement of the terminals and the frequency of their contacts are not controllable properties.

6.3. Behavior of the carrier:
According to the principle of opportunistic routing based on the technical "Store, Carry and Forward", the message carrier enjoys casual encounters caused by fragmentation and network mobility. The carrier may have several behaviors depending on the configuration of system administrators. This will influence the way of managing the cache.
a) Selfish behavior: the terminal hosts in its cache only the information that he is interested in it
b) Altruistic behavior reactive: in this case, the terminal can host in its cache information that does not interested in directly. When it receives information from its neighbors in the same islet, it saves it in its cache even if they do not interest but in fact are requested by other devices.
c) Altruistic behavior proactive: it is an extension of the Altruistic behavior reactive but in this case the owner of the message who decides the intervention of the terminal to play the role of the carrier even if he is not interested to the information.

6.4. Description of the model:
a) Structure of the message
The message exchange between publishers, carriers and subscribers can be represented by a structure that consists of these fields:
Code: It can be an integer value, it is unique and it will appoint a well-defined type of information. This is especially useful when storing the message in the cache .Indeed it prevents terminal to get multiple copies of the same message.
Service: it refers to how the service belongs to the current topic.
Info: information about the current message (eg . the number of the vehicle, the identifier of the publisher or the identifier of the road side unit).
Expiration date: that is the duration of the importance of the information exchanged. This date is set by the application service side of the editor.
Content: represents the actual information corresponding to the code mentioned in the first field.
Example:
The structure of a message m1:
Code: 10
Service: info.road
Info: producer : 156TUNIS456
expiration_date: 2012-06-07/10:12:24
content: 1km:TUNIS-BEJA

10: the value of the code that represents a specific information.
b) The principle of the algorithm:
Process : opp-pub-sub()
{ i : number of the node
inti : interest of i
ci : description of the cache of i
Thread_Reception() ;
// thread blocked waiting for a message of discover from other terminals
Thread_Emission() ; // thread to broadcast a message of Neighbor Discovery
}
Thread_Emission(i)

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```
{while (1)
{wait(Δt) //Δt : the period of time between two broadcasts
discover_diff(annonce(ref, inti, ci))
}}
```

// ref: denotes the reference of the ad

Thread_Reception(i) //i is the identifier of the current node

```
{ while (1)
{listen()
if (arrivage(annonce(ref, intk,ck)))
compare (ck,inti,M) //with M is the set of messages of ck witch correspond to inti. It is the intersection between ck and inti.
MAJ(table_proximity) //update the table of proximity
demand(M)
}}
MAJ(annonce, table_proximity)
{
 if (annonce.sender belongs to {table_proximity[i][identity]}) // the current node receives an announcement from the same transmitter
        {if(annonce.ref != table_proximity[i][annonce.sender][ref])
        modify_entry(table_proximity[i][annonce.sender])} //modify the table row neighborhood witch the identity of the neighbor is the issuer of the announcement; to update the value of the last announcement received.
else
        insert_entry(table_proximity[i][annonce.sender])}
// This instruction allows to insert a new line by filling its various fields from the content of the announcement received (identity of the sender, the reference of the announcement and the set of requests is empty).
}
```

c) The technique of caching:

Our model of communication requires that a terminal is capable of hosting messages in transit in a persistent storage space and limited in where transported messages will be stored.

The action of message storage in the cache always depends on the type of node behavior that keeps. Indeed, if this is selfish behavior, a copy of the message will be put in the cache if it matches the profile of current interest.

If it is an altruistic behavior, a copy of the message will still store at each passage.

To manage this limited space, a cache manager maintains a policy of management to free up space when necessary.

To facilitate cache management (add, search, sort ...), it must be organized in two parts.

The first part is reserved for control information (code, service, info, date expiration). The second part is reserved for data.

This will, on one hand, reduce processing messages stored, and secondly, minimize the cost in terms of resource use.

Indeed, when you restart a terminal, the cache manager does recharge memory control information that is very inferior in size to that of the data.

The payload of a message is loaded into memory only when the message must be delivered to a local service or needs to be broadcast on the radio medium.

The Persistent of the cache must be ensured to avoid frequent losses of connections which result primarily from excessive volatility of nodes due to the nature of network application.

VII. DESCRIPTION OF THE PROTOCOL

AODV This protocol allows the routing of the message between mobile islets in a context of content-based communication according to DDS specification. It combines the Mode "Store, Carry and Forward" of the opportunistic approach with the publish-subscribe model. The opportunistic protocol active the exchange just only during a meeting with another terminal occasionally. That is why we are primarily interested in the communication between neighbors. therefore the protocol must be able to detect the neighborhood by periodically sending an announcement.

Example:
We assume, we have 2 nodes belonging to two islets distant.
At time t; V2 is assumed moves approaching V1
List of interests of V1= I1=E1
E1 = (service = «info.route») or (info.editeur= «156TUNIS456»)
Cache(V1) = void
V2 received the message m1 described above. It is stored already in its cache (V2 may be the initiator of the message or a simple interested or a carrier)
List of interests of V2 =E2
W assume for example that E2 = (service = «info.route») and (code=20)
Cache of V2=m1
Periodically, V1 broadcasts the following vector: (E1, void)
Periodically, V2 broadcasts the vector: (E2, m1)
At the time of an occasional meeting:
• V1 receives the announcement of V2: since the profile of interest of V1 = E1: it is suitable with the message m1 announced by V2. V1 send a request to V2 by requesting the message m1.
V2 reply to V1 by sending the message m1.
The cache of V1 will be filled by m1.
• V2 receives the announcement of V1: V1 doesn't have any thing to send and the profile of V2 doesn't correspond to the cache of V1, so nothing happens.
• After that, V1 and V2 will have the message m1 in their caches and the periodic broadcast of the announcement continues but in this case V1 send (E1, m1).

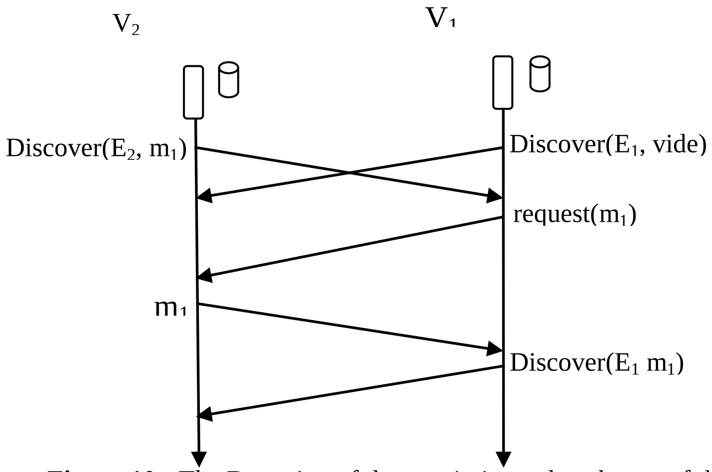

Figure 10: The Detecting of the proximity and exchange of the message.

After that V2 becomes a consumer and a transporter of the message m1 received from V1.
Through the continuous exchange of the announcements to neighbors, terminals can build a vision about the current block.
Indeed, every standby or stopping of the vehicle as an example, its neighbors must be notified in order to update their tables of neighbors.

VIII. CONTEXT OF SIMULATION

Route discovery to demonstrate the feasibility of developing and using the communication model proposed above and its adaptation to network vehicles, we have developed a prototype simulation is inspired by the structure layer.
This prototype simulation is mainly based on the publish-subscribe context and the frequent loss of links. Opportunistic routing model will be useful when it comes to communication between distant blocks of vehicles characterized by high mobility. This will help ensure the communication between terminals regardless of their affiliations to different blocks.

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In order to evaluate the utility of storage capacity in this type of application, we will look at a network of mobile vehicles which generally takes the form connected but it is characterized by the absence of connection between its elements frequently because of their mobility.
This loss of connectivity, usually caused by the remoteness of the vehicles from time to time, is simulated by the failure or disconnection of a link. The combination of the new vehicle is simulated by the recovery of the link.

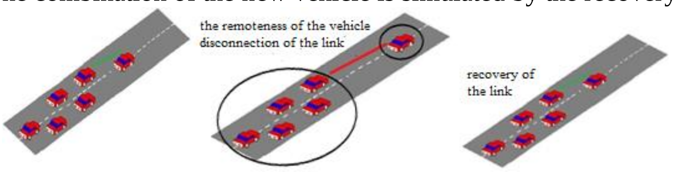

Figure 11: Simulation of loss and recovery of the link.

The figure above shows the context of the simulation of the proposed model.
The first case of the figure shows the initial state of a connected network of vehicles. The second case shows remoteness of a vehicle from the network. This can create a link disconnection and the fragmentation of the network to two blocks. The third case shows the recovery of the disconnected link due to the approchement of the vehicle which will reform the original connected network.
In the context of simulation, we discuss firstly the case of highly mobile MANETs is the general context of our work. On the other hand, we introduce the usefulness of the cache space in each publish-subscribe communication. This argues the choice of our general model of communication according to structuring layer described above.

IX. PLATFORM OF SIMULATION

Our solution is based on the "caching" distributed through mobile nodes DDS. The "caching" will be useful to keep recent events in a given period in order to withstand frequent disconnections links following the high mobility of nodes.
These nodes are then simulated by communicating entities through a connected network that is transformed from time to time in a fragmented network after each disconnection. Each one contains essentially the DDS API.
This API is superposed on the top of a layer which maintains the current network structure. This structure is updated in reality thanks to opportunistic routing process. It actually represents multichip communication that supports relay immediate messages in the k-hop neighbourhood of a terminal. The evaluation process is then interested in evaluating the proposed system in the case of frequent disconnections because of the high mobility of communicating nodes. The cache space is among the solutions proposed to overcome this problem.
Indeed the problem of high mobility is solved in part by the epidemic routing using the routing technique "store, carry and forward" and secondly by using the technique of "caching" allow save the messages exchanged and transport them.
Since it is quite difficult to organize and carry out experiments campaigns involving tens or hundreds of vehicles, we designed a simulation application that is based on what is described above essentially keeping frequent disconnections characterizing the network.
Our simulation application has been implemented in Java; it simulates the mobile network and the structural change with each new connection loss.
We conducted a number of simulations in order to observe the performance of our model under different conditions.

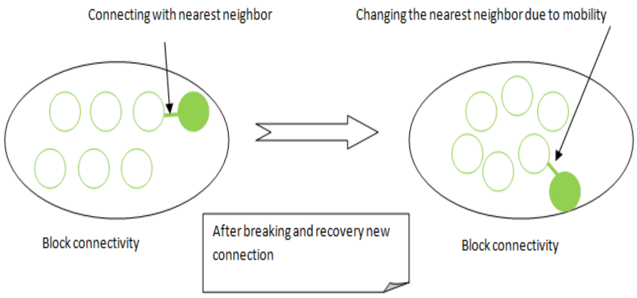

Figure 12: modelling the general simulation environment.

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We notice in the above figure a special case of MANET fragmented where initially, nodes form a connected network. Following their mobility, we obtain two separate islets.
Later, we return to an initial state of a single islet. Thus, a node may change its neighbour. This mobile network, including networks of vehicles, is the main purpose of our simulation work.
Indeed, this case is similar to the situation Handoff protocol where a node loses connectivity to a broker and gets the network connection again from another.
The theoretical evaluation will be useful in order to evaluate the utility of the cache for bypassing the loss of connectivity.
The fundamentals modules that have to be evaluated in each node are: the publish-subscribe module, the manager of the neighbours table Based on the routing techniques which have been described previously, the cache manager
Above this layer structure, the exchange of messages takes place content-based according to DDS.

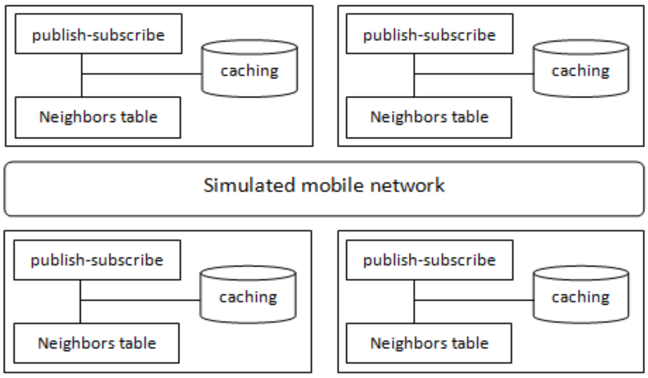

Figure 13: The network of DDS nodes to be evaluated.

These evaluation requirements, which have been described, specify the parameters that characterize the environment in which mobile devices evolve, the mobility pattern followed by the terminals in this environment, and the communication scenario specifying the conditions of publication of the messages.

X. PERFORMANCE ANALYSIS OF THE CACHE MANAGER

In the performance analyses section we are fixed the following assumptions:

- When the link is lost during the publish/subscribe process, the data transfer is delayed until the link is reconnected, Thus publishers and subscribers wait until the handoff process is completed.
- When a subscriber fails, the lost events will be preserved in persistent logs managed by the Data Base Management System – DBMS. The subscriber can access events occurred during failure using theses persistent logs.
- When a publisher fails, another will replace it and the exchange of data won't be interrupted.
- In order to measure the influence of errors to the clustered DDS architecture, we fixed the following metrics:

λ_{pub} : The publication rate,

λ_{sub} : The subscriber's access rate of published events.

λ_{fail}^{L} : The failure rate of the communication link

t_p and t_s : time delay for subscribe and publish. (t = tp+ts)

$\lambda_{\mathrm{Re\,cov}}^{sub}$ and $\lambda_{\mathrm{Re\,cov}}^{L}$: The recovery rate of the subscriber and the link

In the subscriber side, we suppose that i events are occurred during failure. When a DDS subscriber recovers from a failure it obtains its data from the DBMS which conserves persistent data. The probability that i events occurred between failure and recovery is:

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$$p = \left(\frac{\lambda_{pub}}{\lambda_{pub} + \lambda^{sub}_{recov}} \right)^{i} \frac{\lambda^{sub}_{recov}}{\lambda_{pub} + \lambda^{sub}_{recov}} \qquad (1)$$

We note NL the maximum number of events that DBMS can store. If i> NL the events are lost. Thus, the average number of lost events by subscriber is:

$$E(N) = \sum_{i=N_L+1}^{\infty} \left(\frac{\lambda_{pub}}{\lambda_{pub} + \lambda^{sub}_{recov}} \right)^{i} \frac{\lambda^{sub}_{recov}}{\lambda_{pub} + \lambda^{sub}_{recov}} (i - N_L)$$
$$\Rightarrow E(N) = \left(\frac{\lambda^{sub}_{recov}}{\lambda_{pub} + \lambda^{sub}_{recov}} \right)^{N_L} \frac{\lambda_{pub}}{\lambda^{sub}_{recov}} \qquad (2)$$

In case of subscriber failure, the system will be in an unknown state. Thus, on behalf of the subscriber, the loss of pursuit of the system's evolution is occurred during the following average time:

$$T = t_S \, E(N) = t_S \left(\frac{\lambda^{sub}_{recov}}{\lambda_{pub} + \lambda^{sub}_{recov}} \right)^{N_L} \frac{\lambda_{pub}}{\lambda^{sub}_{recov}} \qquad (3)$$

Likewise, in case of the failure link we could measure the cost of the model in a pulish/subscribe process on behalf of the subscriber. It is calculated by the addition of the publish subscribe delay (tp+ts) with the lost average delay which is multiplied by the probability to have a disconnection and the probability that a subscriber reaches events.

$$T = t + \left\{ \frac{\lambda^{L}_{Fail}}{\lambda^{sub}_{recov} + \lambda^{L}_{Fail}} \left(1 - \varepsilon^{-t \lambda^{L}_{Fail}} \right) + \frac{\lambda^{L}_{Fail}}{\lambda^{sub}_{recov} + \lambda^{L}_{Fail}} \right\} \left\{ \frac{\lambda_{sub}}{\lambda^{sub}_{recov} + \lambda_{sub}} \right\} \left(\frac{1}{\lambda^{sub}_{recov}} \right) \qquad (4)$$

This selecting The proposed approach permit to palliate the absence of peer to peer connectivity. In this model, every injected information in the network is supposed to reach the set of the interested elements. Thus, the flow of information is interest-driven rather than destination-driven

This style of communication, intrinsically many-to-many, permits a clear decoupling between producers and consumers of information.

The underlying communication system is responsible for delivering each message to elements that are interested in this kind of message.

Therefore, we concentrated on the problem of supporting content-based communication in DMANET: The VANET was taken as an example.

So, we ensured routing between vehicles that form a network with a high volatility and the exchange of data based on the publish-subscribe model.

REFERENCES

1. R Baldoni, R Beraldi, et al. Structureless content-based routing in mobile ad hoc networks. In Proceedings of the International Conference on Pervasive Services, 2005; 37- 46.
2. R Baldoni, R Beraldi, et al. Contentbased routing in highly dynamic mobile ad hoc networks. International Journal of Pervasive Computing and Communications, 2005; 1:277.
3. B Chiara, M Conti, et al. HiBOp : a History Based Routing Protocol for Opportunistic Networks. In Marco Conti, éditeur : IEEE International Symposium on a World of Wireless, Mobile and Multimedia Networks WoWMoM 2007; 1- 12.
4. A Chaintreau, P Hui, et al. Impact of human mobility on opportunistic forwarding algorithms. IEEE Transactions on Mobile Computing, 2007; 6: 606 – 620.
5. P Costa, C Mascolo, et al. Socially-aware routing for publish-subscribe in delay-tolerant mobile ad hoc networks. IEEE Journal on Selected Areas in Communications, 2008; 26: 748 - 760.
6. P Costa et G Picco, Semi-Probabilistic Content-Based Publish-Subscribe. In 25th International Conference on Distributed

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Computing Systems (ICDCS 2005), Columbus, Ohio, USA, juin 2005. IEEE Computer Society. 2005; 575 – 585.
7. I Chakeres, C Perkins, Dynamic MANET On-demand (DYMO) Routing.draft-ietf-manet-dymo-19 (work in progress), 2010.
8. A Eriksen, E Olsen, et al. Cooperative Vehicle-Infrastructure Systems, D.CVIS.3.1 Reference Architecture, December 2006, http://www.cvisproject.org/ [visited, August 2, 2010].
9. Technology Watch report on CALM: "Continuous Air-interface, Long and Medium Range (CALM)," http://www.itu.int/ITUT/spd/docs/002-tw-CALM.pdf [visited, August 2, 2010].
10. B Williams, The CALM Handbook v1.2, September 2004.
11. A Schalk , W Rom, CALM Standards: Advanced ITS Communication, ITS Seminar on The Vision of ISO-CALM, Bangkok 29 May 2007. http://wiki.nectec.or.th/its/Forum/ISOCALM- Seminar [visited, August 2, 2010].
12. K Evensen, Is there an issue between the CALM and Car2Car approaches?, The Fully Networked Car Workshop, March 2007. http://www.itu.int [visited, August 2, 2010].
13. O Kristiansen, CVIS: Cooperation Vehicle Infrastructure Systems, October 2009. http://nvtf.org/ [visited, August 2, 2010].
14. J Moring, Presentation of the 1609 and 802.11 (TGp), ITS Communications (M5) Workshop, September 2008.
15. H Fischer, IEEE P1609, 802.11p and ISO CALM," ISO TC204 WG16 Workshop on M5, September 2008.
16. G Castellote, OMG Data-Distribution Service: Architectural Overview," Real-Time Innovations Inc. (RTI). IEEE 23rd International Conference on Distributed Computing Systems, pp. 200- 206, May 2003.
17. G Castellote, "Introduction to DDS," OMG Real-Time Workshop, Washington DC, July 2008.
18. C Riquier, N Ricard, et al. DES (Data Exchange System), a publish/subscribe architecture for robotics, First National Workshop on Control Architectures of Robots, Montpellier, April 2006.
19. S Oh, S Pallickara, et al. Publish/Subscribe Systems on Node and Link Error Prone Mobile Environments, in 5th International Conference Computational Science ICCS 2005; 576-584.
20. S Schneider, The Data-Centric Future," White Paper, Real-Time Innovations, Inc. http://www.rti.com [visited, August 2, 2010.
21. J Kaiser, M Mock, Implementing the Real-Time Publish/Sub scriber Model on the Controller Area Network (CAN), Proc. IEEE International Symposium on Object-Oriented Real-Time Distributed Computing, May 1999; 172-181.
22. T Guesmi, et al. Design and Performance of DDS-based Middleware for Real-Time Control Systems," International journal of computer science and network security, Vol7, December 2007; 188-200.