# OLSR for InternetCar System

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## Abstract

*In Japan, the informatization of automobiles is promoted by InternetCAR project. In the automobile environment, utilizing OLSR for vehicle-vehicle communication method realize the effective multihop wireless communications. In this paper we clear out the problems of existing InternetCAR system architecture and propose the system adapt OLSR to InternetCAR for the useful automobile environment.*

## 1. Introduction

InternetCAR project [1] and IITS(Internet Intelligent Transport System)[2] are the projects which develops and deploy the system to provide the internet connectivity to automobiles. The projects treat automobiles as mobile networks consists of sensors and computers for passengers. NEMO(Network Mobility)[3] is the network mobility support technology to provide the network transparent mobility and the systems for the automobiles characteristic service on the automobile mobility system are developed.

The system developed by InternetCar project does not support the wireless multihop communication environment such as the vehicle-vehicle communication. The vehicle-vehicle communications makes it possible to distribute the traffic jam information and the accident information to other vehicles expeditiously with the wireless multihop communication. In addition, it is useful to utilize the wireless LAN communication for the mass data transmission such as video conferences that passengers in separate vehicles talk to each other.

The vehicle-vehicle communications using OLSR enhance the variety and the reliability of the internet connectivity on automobiles. The availment of multiple communication media properly realize the traffic distribution and the continuous connectivity on automobiles. Short range medias such as wireless interfaces are useful in the situation vehicles are in tunnels lose its connectivity for the internet. This paper shows the problem statements in the adaptation of OLSR to the vehicles communication method and propose the model to manage multiple link connectivity on the vehicles properly.

## 2. Automobile Networks

In this section, we make clear the vehicle environment. Automobiles as mobile objects is free from battery outage because of high-capacity battery equipment, thus free from the overhead concerned with power-save signal communications. Moreover, vehicles have efficient room for plural larger transmission equipment.

### 2.1. Supposed Environment

Automobiles as mobile objects have to be treated as mobile networks. There are nodes inside the vehicles such as lots of sensors or computers for passengers. Mobile routers which provide the internet connectivity for the nodes inside automobiles are indispensable. NEMO is the technology which realize such mobile networks. NEMO is one of the MIPv6 extensions achieve the transparent mobility by binding for network prefixes and provides wide-range communications for automobiles.

We propose to utilize OLSR to realize vehicle-vehicle communications. It is possible to fulfill users' various requirements by constructing the vehicle-vehicle connectivity with TCP/IP network stack. Services which have the tight requirement such as the auto automobile driving is out of scope. The short-range wireless multihop communication

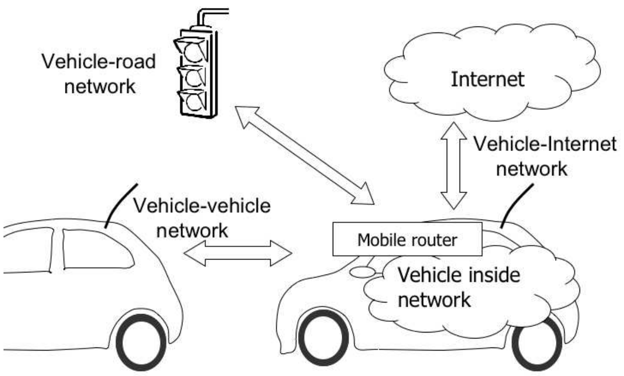


**Figure 1. Vehicle environment**

utilizing OLSR realize the construction of vehicle-vehicle networks and vehicle-road networks.

The system proposed in this paper achieve the cooperation of the wide-range communication by NEMO and the short-range communication by OLSR. The policy based routing is necessary to fulfill the requirements from each various services. Additionally, to enhance the stability of the communication, it is required to monitor the link status of each link for the selection of the active link. This feature helps to continue the internet connectivity through the access point on the road side or the cellphone connectivity on other automobiles via the short-range link.

The vehicle network environment is shown in figure1. We describe the details of networks surrounding automobiles below.

### 2.2. Vehicle inside network

The vehicle inside network consists of three different types of networks. The first one is the multimedia network, the network composed by the car navigation systems or car audios. The second type is the body network consists of head lights, windshield wipers and so on. The third type is the control network which manage the automobiles control devices such as engines or breaks.

### 2.3. Vehicle-vehicle network

The vehicle-vehicle network realizes the multihop data transmission by forwarding the data between each automobiles on short range communication media such as IEEE 802.11b or DSRC. The vehicle-vehicle communication makes it possible to distribute urgent information such as traffic jam information or accident information from the point the event occurred.

### 2.4. Vehicle-road network

The vehicle-road network is for the communication between automobiles and the nodes on road-side, the nodes on signals or electric poles, and connect the vehicle-vehicle networks to the internet with large-bandwidth links. It is not efficient to use cellphones when people on an automobile browse video streamings. The vehicle-road network is also useful in the situation automobiles distribution is rarefact and the construction of the vehicle-vehicle communication is difficult. In those situation the data from a automobile may be forwarded by the data transmission between each access point set along the road.

### 2.5. Vehicle-Internet network

The vehicle-Internet network is the network directly connected to internet using wide-range communication media such as cellphones. This network is more stable and reliable than other networks of automobiles, Therefore it is useful for the health management data transmission which requires high reliability.

Vehicle-vehicle networks and vehicle-road networks use the short range multihop communication. There are three situations using the short range communication as the data transmission method. The first one is to transfer large volumes of data such as the multimedia data transmission, the second one to realize the low delay data transfer such as the accident detection service, and the last one to compensate for the lack of the connectivity when vehicles are in the tunnels or vehicles are outside of the cellphone service area.

## 3. Problem Statement

Vehicle-vehicle communications and vehicle-road communications make possible the construction of the low latency and high bandwidth network. To adapt OLSR as the vehicle-vehicle communication and vehicle-road communication method, the current InternetCAR architecture lacks the system that retains the routing information consistency. The system is not able to select the best path for the destination with the mismatch of the routing information and, thus, is not able to provide the stable connectivity for the node inside the vehicles.

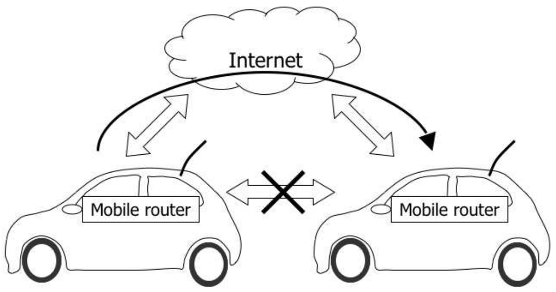


**Figure 2. Problem Statement**

NEMO is intended for the communication to the nodes on the Internet, however the communication through the Internet includes the overhead if the nodes inside a vehicle try to communicate with the nodes inside another vehicle nearby. The requirements from applications are various, and which communication method, NEMO or MANET, to utilize depends on such requirements from the applications. For that reason, the policy management system to choose the desirable communication method and the policy routing system to realize the traffic policy are required.

## 4. OLSR enhancement

This chapter shows the improvement of OLSR to adapt it to InternetCAR architecture.

### 4.1. Route re-distribution

The route management has to be done with the route abstraction system to avoid the conflict of the routes obtained via the both of the short-range media by OLSR and the wide-range media by NEMO. To abstract plural routes for same destination, the application layer routing table should manage the routing information from each routing daemon, and update the kernel routing table. Additiionally policy routing module in the kernel and the application layer policy management module are required, because the data transmission with NEMO is stable, but it is inefficient to utilize NEMO link as the vehicle-vehicle communication path. It is possible to maximize each link's feature unilizing the traffic policy preset by users.

### 4.2. Location based data dissemination

It is desirable that mobile routers in MANET select the best path for the destination using GPS information equipped in the automobiles. It is possible that mobile routers without geographical information selects inadequate intermediate mobile routers that are located at the edge of the wireless coverage and, thus, have bad link qualities. Mobile routers can decide the appropriate intermediate nodes by compare their own wireless coverage to the distance for the candidate routers.

### 4.3. Global connectivity

It is required to assign global routable addresses on the short-range media network interfaces of each automobiles for the Internet connectivity for automobiles inside MANET[4]. Then automobiles get the internet gateway's address by the advertisement from the internet gateways. If there are multiple internet gateways each mobile router gets the load or the preference with the internet gateways, and select most desirable one autonomously.

## 5. System Overview

This chapter show the system overview of the proposed internet car system.

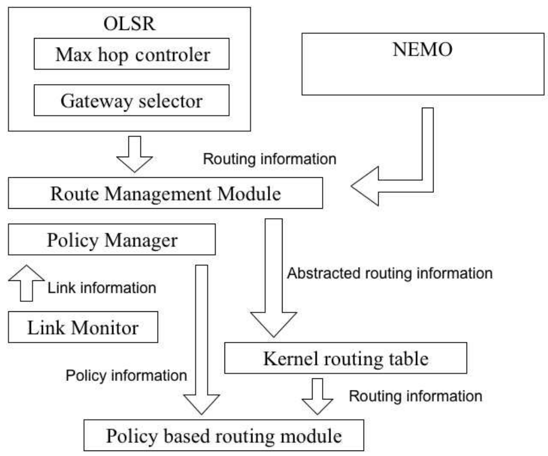


**Figure 3. System Architecture**

Figure3 shows the module relations.

### 5.1. OLSR

OLSR module has the hop-limit control module to determine the border of MANET and the module to negotiate with the internet gateways to select the best internet gateway, this module have the function to obtain the global routable address from the internet gateway. The OLSR module create the application layer routing table utilizing the geographical information.

### 5.2. Route re-distribution

The route management module create the appropriate routing table with the information from OLSR and NEMO. This module have the application layer routing table and update the kernel routing table.

### 5.3. Policy routing

Users install the routing policy via the policy management module. The policy management module gets the link status information from the link monitor module to select the active link to use. The policy on the mobile router changes dynamically dependent on the link status of users' configuration update, and the policy management module update the policy rule set in the policy routing module in the kernel, and the policy routing module forward the traffic with the policy rule set. The traffic that does not match the policy rule set is forwarded according to the routing table.

### 5.4. System operation

At the system start-up, the mobile router establishes the wide-rage connectivity with NEMO. Then the mobile router join the MANET utilizing OLSR when the link monitor detect the link up of the wireless LAN interface set in the adhoc mode. OLSR module search the internet gateways on the MANET and negotiate the global routable address on the wireless LAN interface with the selected internet gateway. The policy management module put the preset policy to the policy routing module.

The mobile router monitor the link status of each network interface utilizing link monitor module. When the link monitor module detect the link-down information, the mobile router wait the timeout and set the default route to the router on the active link if the link does not recover. If the all network interfaces are active, the traffic is forwarded according to the routing policy.

## 6. Conclusion

In this paper we proposed the system to utilize multiple routing architecture on the automobiles. There are two communication environment on the automobiles, the Internet communication and the ad-hoc communication, and the existing systems utilize former one only. Utilizing the Internet communication method only causes the high delay and narrow band communication environment, MANET communication area fulfill the outage of the Internet Connectivity. Moreover to deal with users' various requirement such as multimedia data transfer, The short-range communication is useful to deliver the mass data transmission with low delay.

We pointed out the problems with the adaptation of OLSR to the existing automobiles environment and proposed the system architecture to solve them. Our system consists of the effective route management module to manage the routes from multiple routing daemons and the policy routing architecture to provide the data transmission meets the users' requirement. The system proposed in this paper realize the efficient automobiles communication environment.

## References


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[4] R. Wakikasa, J. Malinen, C. Perkins, A. Nilsson and A Tuominen "Global connectivity for IPv6 Mobile Ad Hoc Networks" Internet-Draft Oct 2003