Cloud-based Video capture handoff in the Intelligent Transportation System

Fekri M. Abduljalil
Alandalus University for Science and Technology
Email: fmabduljalil@gmail.com

Abstract: *Handoff is the process of transferring data session from one cell to another in a cellular system or from one channel to another in the same cell. Intelligent transportation System (ITS) is the integration of information system applications and communications technologies to improve transportation safety and mobility and enhance system productivity. In this paper, cloud-based video capture handoff scheme is proposed such that vehicular cloud can be utilized to offer video capture as a service. The proposed scheme transfer a video capture session from one vehicle to another. It handles the continuity of video capture with minimum service disruption. The proposed service is implemented using OPNET.*

Keywords: *Vehicular Network, Cloud Computing, Video Capture, handoff.*

---

1. Introduction

Cloud computing is gaining more and more popularity recently based on utility and consumption of computing resources. It can be applied to the ITS applications to provide efficient real time services as well as to improve transportation safety, mobility and comfort degree for drivers. The motivation toward cloud computing in vehicular network is the communication, storage and computing resources available in the vehicular networks represented by communication, vehicles, roadside units (RSUs), and central servers. These resources can be utilized and provided to vehicles, drivers on the road, travellers, and customers on the internet. In the transportation context, the cloud computing is faced many challenges such as the production of unified architectural framework and many different services based on mobile computing [12,13,14].

Intelligent Transportation System (ITS) is the utilization of information technology to enhance the transportation system. Elements within the transportation system such as vehicles, roads, traffic lights, and message signs, become smart devices. Currently, there are many countries have Intelligent Transport Systems such as USA [1], Europe [2], Japan [3], Canada [4] and others.

Nowadays, vehicles become more and more important in our daily life and most people go to work by vehicles, so it is expected that every person will have a vehicle in near future. Since every vehicle can be equipped with a different wireless transceiver, vehicles on the road may form a wireless network named as a vehicular ad hoc network (VANET) and can be integrated with infrastructure wireless communication system such as GPRS/3G, Wi-Fi, WiMAX and LTE[5]. The VANET is a subclass of the mobile ad hoc network (MANET) that it also has no fixed topology. Vehicles may acquire information and services through the V2V (Vehicle-to-Vehicle) and I2V (Infrastructure-to-Vehicle) or R2V (Roadside-to-Vehicle) communications. The V2V communication is based on the Dedicated Short Range Communications (DSRC) technology; while the I2V communication is based on GPRS/3G, WiFi or WiMAX[6,7,8,9,10]. The emergence of new wireless systems, ITS application and services, and ITS technologies, has raised novel research questions on safety and non-safety related applications [11].

In Cellular Networks, the geographical area is split in to cells. Cells with large number of mobile users can be split into smaller cells to increase the capacity. The process of moving the mobile host from base station to another base station during connection is called handoff. As the cells get smaller, the handoff becomes much more frequent by mobile hosts. If the handoff mechanisms are not designed properly, the performance of real time and none real time internet applications will not be acceptable especially multimedia applications. As the cells get smaller, the overlap area between cells becomes very small. In case of a high-speed mobile host or cells without overlap area, the handoff process cannot be handled properly within the time.

The current research of Research and Innovative Technology Administration (RITA) [1] focuses on real-time data capture and management. Real-time data capture and management is the access to high-quality real-time multi-modal transportation data that is captured from connected vehicles and infrastructure. Such a service promises a wide range of applications in surveillance, traffic monitoring, roads monitoring, and forensics investigation. Because of the huge potential in applications, video capture is considered in our research work.

Video capture service is to provide real time video for any location in the transportation system roads based on the vehicles availability.

Due to the mobility nature of mobile vehicles, the performance of video capture will depend on the handoff mechanism. The handoff scheme should be proposed to minimize the service disruption during video capture handoff.

In this paper, a novel cloud-based video capture handoff scheme is proposed. We presented a new concept of handoff which it is different than the handoff discussed in cellular systems. The proposed concept is the handoff of the service from vehicle to another vehicle in the intelligent transportation system. This scheme enables the video capture continuity to customer. It decreases the disruption time when handing service from vehicle to another or from cloud to another cloud.

The remainder of the paper is organized as follows. Section 2 presents related works. Section 3 illustrates the proposed cloud-based video capture handoff. Section 4 presents the simulation model and simulation results The conclusion is presented in Section 5.

2. Related Works

In [15] a handoff-as-a-service architecture for optimal handoff strategies in vehicular networks is proposed. It uses a database, to computes optimal handoff decisions based on network properties for both moving vehicles and RSUs in heterogeneous networks. The handoff decisions are based on three metric classes of availability, performance, and pricing. The server pushes the handoff decisions to desired vehicles, and the on-board device eventually invokes the handoff based on the decision received. In this paper, cloud computing concept is used to offer handoff services. Our research in this paper is concerned on new concept of handoff.

In [16], a seamless service handoff based on Delaunay triangulation for Mobile Cloud Computing is proposed. It splits the network into Triangle topology by Delaunay triangulation, and accurately obtains MTs target access point. It can in advance authenticate and cache the MT needed data packet, the Mobile Terminal can obtains lower service delay when do handoff.

In [17], Cloud voice service for seamless roaming in heterogeneous networks is proposed. It presents a Virtual Room based Vertical Handoff cloud solution that only applies latest existing wireless access technologies (UMTS, LTE, WiFi) for connectivity purposes.

In [18], a cloud based network selection scheme for vehicular networks is presented. In this scheme, vehicles can have wider scope network information for decision making through a compute cloud's abundant computing and data storage resources.

In [14], a comprehensive survey on vehicular cloud computing is presented that explore different area such as vehicular cloud architecture, application scenarios, security and privacy issues, key management strategies. The research paper gives a comprehensive taxonomy of vehicular networking and vehicular cloud computing. The services proposed for vehicular cloud computing are Network as a service (NaaS), Storage as a service (STaaS), Cooperation as a service (CaaS) , Computing as a service, Pictures on a wheel as a service, Information as a service (INaaS) and entertainment as a service (ENaaS). In our research paper, a new service is proposed called video capture as a service.

An efficient digital video recording scheme for smart vehicle is proposed in [19]. The proposed scheme supports real-time video and data capture of vehicles in the intelligent transportation system. Our research work is an enhancement to [20] that utilized the cloud computing for vehicular networks.

Different from the aforementioned works, our research works present a new cloud based video capture handoff in the intelligent transportation system. To the best of our knowledge, this is a new concept of video capture handoff from one vehicle to another with minimum service disruption time in the vehicular networks.

3. The Proposed Cloud based Video Capture Handoff

This section firstly introduces the overview of the proposed cloud system, and secondly explains the video capture handoff based on the proposed system.

3.1 System Overview

The proposed system is shown in Figure 1. The overall system consists of a server, workstation, multiple local RSUs, and active vehicles in the coverage. The moving vehicle is connected to the server in the internet through access networks represented by Roadside unite or cellular base stations.

It is assumed that every vehicle has digital camera attached to the front of the vehicle. The vehicle moves on a road either in one direction, two way direction or cross circle. Any vehicle wants to provide video capture service should first register itself to server and then periodically announce its GPS location to the server. It is assumed that customer can request the service from internet for a specific location, a moving vehicle or route on specific time. The specific location can be represented by either GPS location or name of location address from map.

We will use the following terminology which it is illustrated in Figure 1:

Vehicles Ready List (VRL): it is the list that contains all vehicles ready to provide service. The list has the fields: vehicle ID, current GPS location, and route.

Vehicles Service List (VSL): it contains the selected vehicles to provide the video capture service.

Zone of Service (ZOS): the area where vehicle is able to start video recording;

Cloud Controller (CC): The cloud service manager is responsible for resource allocation and video capture.

The video capture service can be utilized in three different ways. The customer can request video capture service of specific location.

The video capture service is provided in two steps: vehicle registration and resources allocation and management. The vehicle registers with server that it is able to provide the service. The server accepts the request and it adds the vehicle to the VRL. The server sends acknowledgment to vehicle. The vehicle periodically updates its location by sending its GPS location.

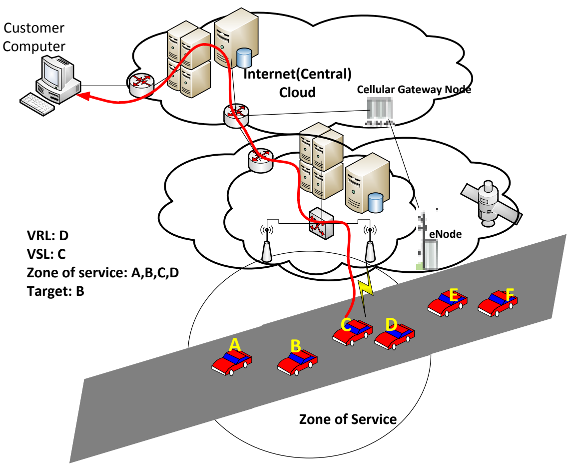

Figure 1: system model

3.2 Video Capture Handoff As a service.

In this section, a video capture service based on cloud computing is proposed. The vehicles can be utilized as cloud to capture real time video of specific location or moving vehicle. The video data is captured and transmitted to a server in Internet. Then, the video data is used when needed. The video data is retrieved using GPS coordination. Group of vehicles are controlled via dedicate server. The server can be private server or public server. The Server, vehicles and customers communicate via public network such as 3G or LTE or private network such as Wi-Fi or WAVE based network.

When customer sends request to server to monitor the specified location, the request should include the GPS information of the location. The server invokes cloud controller to handle the video capture and resource management task. The cloud controller creates the two lists: VRL and VSL. The cloud controller uses the resource allocation and management algorithm to handle vehicles selection and video capture handoff. The cloud controller establishes connection with selected vehicles and the customer. The following algorithm shows the steps of resource allocation and management of specific location.

```
Algorithm: Resource Allocation (Video Capture of Specific Location)
Input: Target GPS location
BEGIN
For each vehicle update in the zone of Service.
{
   Compute Angle Deviation of the vehicle a angle_1
   Compute Distance distance1

 If (distance1 <d OR  angle_1> θ) Then
     Stop video capture.
     Remove from service list
     Remove from Ready List.
     //Select next candidate vehicle.
  End if
 'vehicle move in the direction of the target object
  If(distance1>d AND angle_1< θ) AND Not in Ready List Then
         Add to Ready list
 End if
 If(distance1>d AND angle_1< θ)AND Not in Service List AND Not in Ready List Then
         Add to Service list
         Establish connection
         Start video capture.
 End if

}
END
```

3.3 Compute the Distance and Angle Deviation

Suppose that we have the two GPS points (lat1dd, long1dd) and (lat2dd, long2dd). To compute the distance between two GPS points, the values of Latitude and Longitude should be in Decimal Degrees (dd.ddddd) in order to use the following Excel formula (1):

=3963*ACOS(COS(RADIANS(90-lat1dd))*COS(RADIANS(90-lat2dd))+SIN(RADIANS(90-lat1dd))*SIN(RADIANS(90-lat2dd))*COS(RADIANS(long1dd-long2dd))). … (1)

The result of the above formula is in miles. We can change miles value to meters by multiplying the value in miles by 1609.34. Suppose the target object point is (lat1dd,long1dd) and the vehicle location is (lat2dd,long2dd) as in figure 3. When a vehicle update its point to (lat3dd,long3dd), we can compute the angle of deviation using triangle angle.

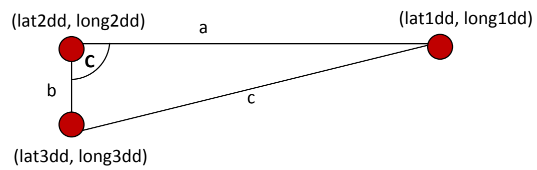

Figure 2: the angle of deviation.

The angle C of a triangle in figure 2 can be calculated from its sides using cosine law as in the following formula (2):

$$C = \cos^{-1}((a^2 + b^2 - c^2)/2ab) \quad \text{…. (2)}$$

3.4 Handoff Decision

The handoff decision is based on one of two metrics: the distance, and the angle deviation. We assume that d is the distance. The value of d should be 2 meters or more than two meter. If the distance d is less than 2 meters, Handoff decision should be invoked and a candidate vehicle should be selected. The value d can be given by user. We assume that θ is the angle deviation of the vehicle. The value of θ should be 45 degree or higher. If the angle deviation of the vehicle is greater than 45 degree, Handoff decision should be invoked and a candidate vehicle should be selected.

3.5 Candidate Vehicle Selection

We propose different schemes for candidate vehicle selection. The first one is random selection. In this scheme, any vehicle in the ready list can be selected. The handoff delay associated with scheme will be the propagation time from first vehicle to cloud controller server, propagation time from cloud controller to candidate vehicle, and the propagation time from first vehicle to user computer..

The second scheme is that the cloud controller should select the candidate vehicle before handoff. The candidate vehicle should start video capture before handoff and added to service list. When handoff occurs, the cloud controller forward the video capture data to user. The delay will be the propagation time from first vehicle to the user computer.

The problem in the above resource allocation is either the large number of vehicles in the zone of Service needs high bandwidth network to transfer the captured video or no vehicle in the zone of service. The network load makes network slow. If the server records all the traffic, it need hug storage. The solution to this problem is to use one source of data capture in each direction. If there are many vehicles in zone of video capture, the server should compute for each vehicle the following: 1-Direction 2-distance 3- Deviation of the vehicle. The server selects the best candidate vehicle which has the best distance and angle deviation of the vehicle.

Figure 3(a) shows the video capture of moving vehicle A before the handoff. We can see that vehicle B is in the VSL. Vehicle C and Vehicle D are in the VRL. Figure 3(b) shows that vehicle B turned right with angle deviation greater than θ. In this case, the CC adds the vehicle C to the VSL. It establishes connection with Vehicle C. Then, Vehicle C starts video capture service.

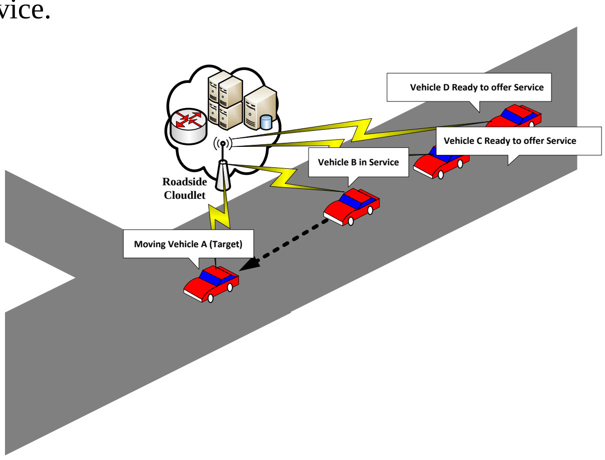

Figure 3(a): video capture handoff (Before handoff)

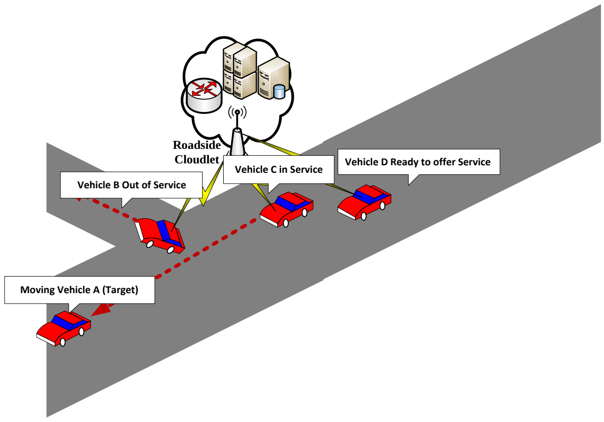

Figure 3(b): video capture handoff (After handoff)

4. Simulation Model

In order to evaluate the performance of the proposed scheme, the performance of UDP is analyzed and compared with video CBR model. The network simulator OPNET is used to measure the total number of packet loss and handoff delay using Video data traffic.

4.1 Simulation Environment

To study and evaluate the proposed scheme, the OPNET simulator is used [21], which is a tool to simulate the behavior and performance of any type of Network. The network topology used in this simulation is shown in Figure 4. In this network topology each wired connection is modeled as 10Mb/s duplex link with 5ms delay. The mobile host communicates with the access point using IEEE 802.11b MAC enabled wireless link with 11Mbps data rate. Simulation area is 100X100 [21].

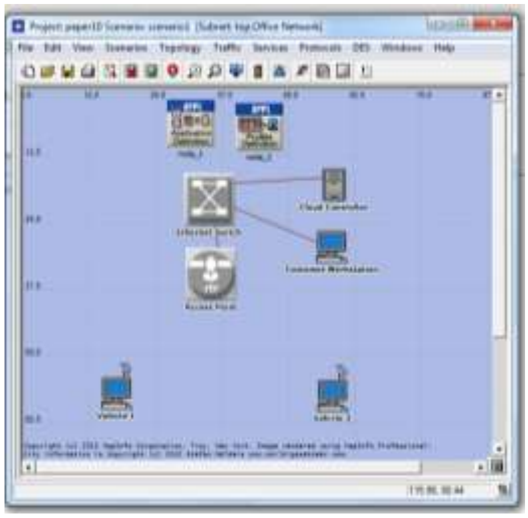

Figure 4: OPNET simulation Model

4.2 Simulation Results and Discussion.

UDP with CBR (Constant bit rate) video conferencing as traffic source is used in this simulation to model real-time video Internet Applications. The vehicle mobile node acts as a CBR source, which is streaming video data packets over UDP to the server (cloud controller) and then to customer workstation. The UDP packet size used was 160byte. Data rate used is

179kb/s. the customer computer acts as a sink for the data packet.

To evaluate the proposed handoff scheme, we study the video capture handoff delay. We create two models application configuration and profile configuration for video as a constant data rate. The vehicle 1 is the source of the video. The workstation is the sink. The vehicle 1 sends video to server, then server redirect the video to the workstation. The vehicle 1 sends message periodically to server (the vehicle GPS information). In the same time, vehicle 2 sends message periodically to server (the vehicle 2 GPS information). We simulate the GPS information to any data that can be used as indicator to server to make handoff decision. The handoff delay = propagation delay from vehicle1 to server + propagation delay from server to vehicle 2.It is the time from when vehicle 1 stop video capture until the time that vehicle 2 start video capture.

The service disruption time is the most important to study and evaluate the performance of the proposed scheme. Currently we are implementing our scheme. The results will be published in further research paper.

5. CONCLUSION

In this article, a cloud-based video capture handoff in the Intelligent Transportation System is presented which handle the video capture service from one vehicle to another. A novel approach for video capture handoff algorithm is proposed to change service from one vehicle to another with minimum service disruption and delay. Finally, the proposed video capture handoff is evaluated and discussed using OPNET simulator.

6. ACKNOWLEDGMENTS

A substantial part of this research was financed by Alandalus University, Republic of Yemen. I am grateful to University of Alandalus for having believed that this might be a real and reasonable investment.

References

[1] Research and Innovative Technology Administration (RITA), U.S. Department of Transportation (US DOT) 1200 New Jersey Avenue, http:/ /www.its.dot.gov /data_capture/ data_capture.htm, last time accessed 5/3/ 2013.

[2] ERTICO Intelligent Transport Systems and Services stakeholders in Europe: http://www.ertico.com/ertico-its-europe/, last accessed on June 10th, 2014.

[3] Ministry of Land, Infrastructure, Transport and Tourism in Japan: http://www.mlit.go.jp/en/index.html, last accessed on June 10th, 2014.

[4] Intelligent Transportation Systems Society of Canada: http://www.itscanada.ca, last accessed on June 10th, 2014

[5] Connie Ribeiro, Bringing Wireless Access to the Automobile: A Comparison of Wi-Fi, WiMAX, MBWA, and 3G, 21st Computer Science Seminar, http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.149.9385.

[6] Sherali Zeadally, Ray Hunt, Yuh-Shyan Chen, Angela Irwin, Aamir Hassan, Vehicular ad hoc networks (VANETS): status, results and challenges, Springer Science+Business Media, LLC 2010.

[7] Gerlach, M. (2006). Full paper: assessing and improving privacy in VANETs. www.network-on-wheels.de/downloads/escar2006gerlach.pdf (accessed: May 29, 2010).

[8] Jiang, D., Delgrossi, L., IEEE 802.11p: Towards an International Standard for Wireless Access in Vehicular Environments, IEEE Vehicular Technology Conference, 2008. VTC Spring 2008., May 2008, , pages: 2036 – 2040.

[9] Yunpeng Zang, Erik Weiss, Lothar Stibor, Bernhard Walke, Hui Chen, Xi Cheng, Opportunistic Wireless Internet Access in Vehicular Environments Using Enhanced WAVE Devices, International Journal of Hybrid Information Technology, 2008.

[10] Yougui Liu; Baoxing Bai; Research on GPRS vehicle location network service system, International Conference on Computer, Mechatronics, Control and Electronic Engineering (CMCE), Changchun,china 2010.

[11] European Telecommunications Standards Institute 2010, ETSI TS 102 636-3 V1.1.1, Intelligent Transport Systems (ITS); Vehicular Communications; GeoNetworking; Part 3: Network architecture, Technical Specification, (2010-03), http://www.etsi.org

[12] S. Olariu, M. Eltoweissy and M. Younis, “Towards Autonomous Vehicular Clouds,” ICST Transactions on Mobile Communications and Applications, vol. 11, no. 7-9, pp. 1-11, 2011.

[13] D. Bernstein, N. Vidovic and S. Modi, “A Cloud PAAS for High Scale, Function, and Velocity Mobile Applications - With Reference Application as the Fully Connected Car, in Proc. Fifth International Conference on Systems and Networks Communications (ICSNC), pp. 117-123, 2010.

[14] Md Whaiduzzaman , Mehdi Sookhak, Abdullah Gani, Rajkumar Buyya, A survey on vehicular cloud computing, Journal of Network and Computer Applications, Elsevier, 2013.

[15] Ke Xu, Ryan Izard, Fan Yang, Kuang-Ching Wang, and Jim Martin, Cloud-based Handoff as a Service for Heterogeneous Vehicular Networks with OpenFlow,

[16] Xing Liu, Zhen Yang ; Zhongwei Hu ; Chaowei Yuan, Seamless service handoff based on

Delaunay triangulation for Mobile Cloud Computing, 16th International Symposium on Wireless Personal Multimedia Communications (WPMC), 2013.

[17] Tran, T., Kuhnert, M. ; Wietfeld, C, Cloud voice service for seamless roaming in heterogeneous networks, IEEE 23rd International Symposium Personal Indoor and Mobile Radio Communications (PIMRC),2012.

[18] Xu, K. ; K. Xu, Wang, K.; Amin, R. ; Martin, J., A Fast Cloud-based Network Selection Scheme Using Coalition Formation Games in Vehicular Networks, IEEE Transactions on Vehicular Technology, 2014.

[19] Fekri M. Abduljalil, Ali Alsharafi," An Efficient Digital Video Recording Scheme for Intelligent Transportation Systems", World Congress on Computer and Information Technology (WCCIT'2013), IEEE Computer Society, Sousse, Tunisia, June 22-24, 2013.

[20] Fekri M. Abduljalil," A Framework for Vehicular Accident management using Wireless Networks",13th IEEE International Conference on Information Reuse and Integration (IEEE IRI-2012), Las Vegas, USA, August 8-10, 2012.

[21] OPNET IT Guru Academic Edition software, http://www.opnet.com/university_program/ itguru_academic_edition/, last time accessed on 21/01/2015.