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OPTIMAL CONTENT PLACEMENT IN VEHICULAR DELAY TOLERANT NETWORKS

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Abstract

In this work, weimplement an extensive experiment involving tens of thousands of operational vehicles in Beijing city. Based on this newly collectedBeijing trace and the existing Shanghai trace, we obtain some invariant properties for communication contacts of large scaleRSU-aided VDTNs. Specifically, we find that the contact time between RSUs and vehicles obeys an exponential distribution, while thecontact rate between them follows a Poisson distribution. According to these observations, we investigate the problem ofcommunication contact-aware mobile data replication for RSU-aided VDTNs by considering the mobile data dissemination system thattransmits data from the Internet to vehicles via RSUs through opportunistic communications. In particular, we formulate thecommunication contact-aware RSU-aided vehicular mobile data dissemination problem as an optimization problem with realistic VDTNsettings, and we provide an efficient heuristic solution for this NP-hard problem. By carrying out extensive simulation using realisticvehicular traces, we demonstrate the effectiveness of our proposed heuristic contact-aware data replication scheme, in comparisonwith the optimal solution and other existing schemes.

Existing System

In this system, proposed multihop data replication schemes to deal with the opportunistic mobility. In a VDTN, data dissemination efficiency depends on how the RSUs replicate the mobile data. The vehicular mobility critically influences the opportunistic data transmission.

Disadvantages

- However, these works do not take the mobility patterns of the vehicular with the RSU into the consideration of data replication design.
- How the mobile data are replicated to the targeted RSUs by considering the vehicular mobility and data requirements as well as the RSUs' data storage policy is a critically important problem to be solved.

Proposed System

In this system, formulate the communication contact-aware data replication into an optimization problem with the realistic VDTN settings. An efficient solution is provided for this NP-hard problem of optimal contact-aware data replication by proposing a heuristic algorithm to replicate the mobile data to RSUs' buffers.

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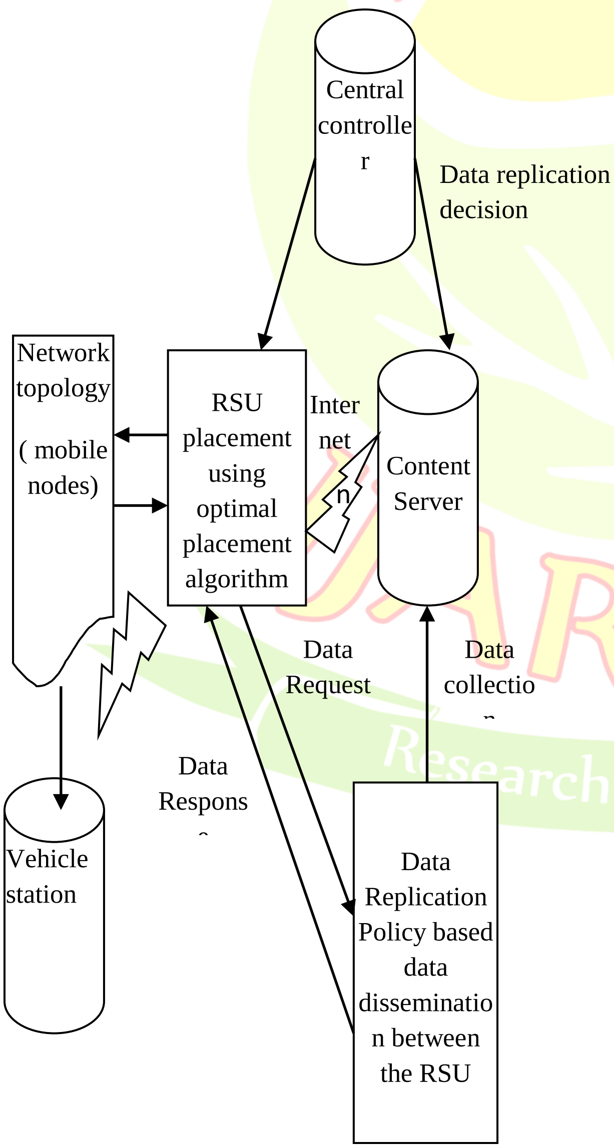
Advantages

- Heuristic algorithm achieves excellent system performance
- Computational cost is reduced
- It can intelligently pre-fetch the mobile data to enhance the data dissemination efficiency.

System Architecture



Module Description

Input System Model

In this module, the real vehicular mobilitytraces of Beijing andShanghai are used. For these traces, by focusing on thedowntown area, we sorted the intersections according totheir average numbers of passing vehicles recorded in theGPS traces, and selected top 25 intersections as the positionsto deploy the RSUs, which is a widely used RSU deploymentstrategy. At the same time, since there were somevehicles that rarely appeared in the selected downtownarea, we only selected the vehicles that had frequentlycontacts with the deployed RSUs as simulation nodes. In allthe experiments, the network simulation of the whole tracewas divided into the warm-up period and the data disseminationperiod. We used the first half of the trace as thewarm-up period for the central controller to accumulate thecontact statistics based on the contact counts and other necessarynetwork information in order to obtain the contactdurations and contact rates of all the RSU-vehicle pairs.During the warm-up period, the controller also collectedthe information of the vehicles' interests, content sizes andbuffer sizes from the users, content servers and RSUs.

Empirical Data Processing

To obtain an accurate contact interval and contact duration,we need to know the exact beginning and ending times ofeach opportunistic contact. However, GPS reports were collectedin discrete time and they may be collected at differenttime intervals as in the case of Shanghai trace. Therefore, thetimes that an opportunistic contact starts and ends, respectively,may not be recorded in timestamps. Consequently,the traces need to be processed in order to extract thecontact duration. In extracting the contact from a GPS trace,we assume that a vehicle is able to communicate with a RSUif their estimated locations are within the given communicationrange and within the same specific time duration,which is called a contact. In reality even if a vehicle is withina RSU's coverage range, they may not be able to successfullytransfer data due to physical layer signal issues and MAClayer association time.

Acquisition of Results

To pre-process the empirical data and to extract the communicationcontacts, we place the RSUs in the intersections ofthe main roads, extract the contacts from the trace andinvestigate the distributions of the contact duration andcontact interval. Specifically, we study the complementarycumulative distribution functions (CCDFs) of the contactinterval and duration. In particular, we focus on the aggregateCCDF of all the vehicles and all the deployed RSUs,which is the CCDF per contact sample over all the distinctpairs of RSU and vehicle.

Contact-aware data replication Using Heuristic Algorithm

In this module, we provide an efficient solution for this NP-hardproblem of optimal contact-aware data replication byproposing a heuristic algorithm to replicate themobile data to RSUs' buffers. By reformulating theproblem, we also propose a benchmark algorithmthat attains the optimal system performance, albeit atthe cost of high computational complexity.

Performance Comparison

In this module, through extensive realistic trace-driven simulations, we demonstrate that our heuristic algorithm achieves excellent system performance in comparison to the optimal and several other existing schemes.

Future work

- Implement and evaluate the proposed heuristics on simulation tools and in different mobility scenarios.
- Propose other heuristics based on network topology foresight.

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