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A Survey on Push based Server Initiated Update Mechanism for Caching in Wireless Network

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Abstract

Data caching between nodes in a Mobile Ad hoc Network (MANET) has been an important consideration now a day. However most of the research works focus on ensuring security, routing, and research on maintaining cache consistency within MANETs. Here we focus on providing cache consistency in a mobile environment so as to increase the probability of data from caching nodes instead of from the server. Moreover, to ensure cooperative cache consistency we go in for Server Initiated Push (SIP) update mechanism in MA-NETS where server maintains a registration table for all registered clients and update those registered, by pushing the updated data, as and when the server gets refreshed. Here only registered clients that have registered are updated frequently, there by not compelling unregistered clients to receive the data update. This cache consistency mechanism for cooperative caching ensures reduced bandwidth utilization, less query latency, besides it also decrease the communication overhead and network traffic at the data server.

Keywords: Cache Consistency, Cache Invalidation, Mobile Ad Hoc Networks, Registration Table

1. Introduction

A computer network is one where the computer nodes that form the network are able to exchange data among them. A computer network can be established in two ways namely[1], using cable wires or wirelessly.

In a wired network the computer nodes are connected to the network physically with the use of wires. These wires can be coaxial cable, twisted pair cable or optical cable each offering varied transmission speeds. Based on the geographic scale of the established computer net-work, they can be classified as Local Area Network (LAN) - inside a building, Wide Area Network (WAN) - covering cities and even countries, Metropolitan Area Network (MAN) – That spans a campus or a city. Based on the size of the network the complexity of establishing a wired network varies. That is, it is easy to set up and maintain a wired network in small scale. As and when the size increases the difficulty and cost of set up and maintenance also increases. Therefore wired network paved way for the wireless network.

A wireless network as the name suggests is used to establish a computer network wirelessly. That is, it eliminates the need for using the cable wires by making use of the electromagnetic radio waves. A radio wave is cable of establishing a connection as far as the space because of its wider spread. Wireless network is therefore is largely used for large areas where wiring is impractical. Some of the most common wireless networks include wireless sensor networks, Wireless Fidelity (Wi-Fi), Cellular Data Service and Mobile satellite Communication.

The advancement to the wireless network is the Mobile Ad hoc NETwork (MANET).The term MANET stands for Mobile Ad hoc NETworks. Here the term mobile represents mobile devices or in other words devices capable of moving. In a MANET, nodes are free to move in and out of the network (i.e.) self-configuring. Hence they form a dynamic or changing network. That is net-work organization and message deliveries are carried out by the nodes themselves. This kind of network is suitable for use in areas where fixed network is not available, unreliable, not trusted. Also there is no need planning of base station

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installation or wiring. MANET has its application in the field of education implementing virtual classrooms and ad hoc communications during meeting or lectures, emergency service such as search and rescue operation, disaster recovery, sensor networks, coverage extensions, military communication and operation, automated battle fields, outdoor internet access etc. In short MANET is a composition of mobile devices communicating via wireless medium. Nodes MANET have no knowledge about the capabilities of or services offered by each other. Hence there must be a proper data accessing and retrieval methods must be ensured for improving data availability. Cooperative caching allows sharing and coordination of cached data among nodes. Due to constraints in amount of bandwidth utilized, network traffic and limited battery power in mobile ad hoc network proper cooperative schemes has to provided. This is achieved by implementing cache consistency schemes within nodes.

Here, data availability can be enhanced only through caching. In this paper we implement a push based server initiated cache consistency mechanism for ensuring the cache consistency in the infrastructure less and dynamic topology based network. The server is destined to push the updated data to the registered clients.

2. Related Works

In paper[2] proposed by L. Yin and G. Coa, proto-cols to enhance the probability of finding data in the cache and to improve its presence within cache were taken into consideration. Here three different schemes for caching were proposed which includes Cache Path, Cache Data and Hybrid cache schemes. In Cache Path the location of the data is store in all intermediate nodes. The nearest node does not need to store the path information of the data and hence the query latency can be avoided when compared to Cache Data where the entire data is cached. Here only the data is stored instead of the path information of the data, so the requesting nodes are served with data directly from the intermediate node rather than getting the data from the far away data server. In Hybrid Cache both the Cache Path or Cache Data can be alternatively employed when and where desired based on some criteria like, if the size of the data item is small then Cache Data is used where as if the size of data is large then data Cache Path can be employed[22].

In paper[4] proposed by K. Mershad and H. Artail, focuses on handling node disconnections in MANET and the ways to handle when the disconnected node, both the Query Directory Node (QD) and Cache Node (CN), re-enters the MANET. They also estimated the cost incurred by this scheme based on average response time and bandwidth utilization.

The Smart Server Update Mechanism (SSUM) is built on CO-operative and Adaptive Caching Systems (COACS) architecture. This approach differs from the ordinary push based system by employing a server that maintains a directory to keep track of what data items are cached, when the node enters and leaves the network[21]. Server can still say which Caching Node (CN) has cached what data item. This method also helps to reduce the network traffic by keeping a watch on update rate to request rate for cached data.

Request and Response Scenario in COACS employs nodes that request data items called Requesting Node (RN) and the Query Directory (QD) which maintains a table that has details of CN that has cached some data item. When a RN makes a request for a data item, the query is submitted to the nearest QD, if the QD knows the location it forwards the request to the corresponding CN which pushes the data item to RN. And if it is not found a cache miss occurs from all the QDs in MANET, which in turn leads the request to be forwarded to the server, which in turn sends the data items back to the RN. This information is updated in the QD and that node now becomes and Caching Node[23].

In paper[5] Wenzhong Li, Edward Chan, Ylin Wang and Daoxu Chen proposed cache invalidation strategies for Mobile Ad hoc NETworks. In this paper three cache invalidation strategies were proposed. They are Pull On Demand (POD), Push-based Amnesic Terminal (PAT) and Modified Amnesic Terminal (MAT).

Pull On Demand (POD) is a polling method. In this method when a query is initiated, a node approaches the Mobile Support Station (MSS) to verify the cached items validity before it can respond to the query. That is, first the requesting node checks its local cache for the data item. If it is not found it sends a request for the data to the miss. If it is found then node send a verification message to the mss along with the time the data is cached to receives an verification message. On receiving the verification message the server checks its database for the data then compares whether the time of data updated in the cache node is greater than or equal to the last time the item

updated in the server[1]. Then the server considers the data to be valid and sends a conform message[24].

In the Modified Amnesic Terminal (MAT) the Mobile Support Station (MSS), broadcasts the (IR) for every l seconds. Only the Mobile Terminals (MTs) which are found within its range receive the IR directly. These mobile terminals upon receiving it, invalidates the data items cached and then the IR is broadcasted only to its mobile terminals that are found adjacent to it. By this it is ensured that IR packets are not flooded over the net-work.

In the Push based Amnesic Terminal (PAT) the node and the server maintains an IR queue. The server has an IR queue which contains the list of the last items updated. A node requesting for an item in PAT first checks its local cache. If found in its cache checks the IR queue. If node has all the IRs, invalidation of the cache items takes place and verified from MSS[25].

In pods though very simple to implement has the disadvantage of reduced cache hit ratio though it provide for reduced query latency. In MAT which is Sem Fawaz and broadcasting scheme suffers from very high latency. POD which is a pull based strategy ensures only delta-consistency of the data items that are cached. It also provides for low query latency as POD and high cache hit ratio than MAT[26].

In paper[6] proposed by K. Fawez and H. Artail, provides a cache consistency mechanism for mobile ad hoc environment was devised. They have implemented three methods and they are adaptive TTL, piggy banking and pre fetching to enhance the cache consistency. Here TTL (Time To Live) values are involved. There are in general two types of cache consistency schemes, namely push based and pull based techniques. While pull is a client based scheme, push is server based one, where server takes care of cache updating. The next technique most commonly employed is piggybacking where in, if any node in a MANET needs to send request to the server, if does so by riding at the back of packets passing through it.

Pre-fetching is another technique under highlight. Here the client node sends the data request to the server with pre fetch bit set on. The server immediately responds as whether the data is valid or invalid. If valid it means the data in the cache and the data server is same and if invalid it replies that the data in the cache and server does not match. If the pre fetch bit is set on, then the server besides sending the invalid or valid reply responds again with the actual data.

H. Artail, H. Safa, K. Mushad, Z. Abou-Atme and Suleeman proposed in[1] a system that uses multiple nodes to store and retrieve data. This eliminates the need of service manager, pushing the need for distributing the functions among multiple nodes. This in turn provides reliable caching.

Here a node can either be a CN or QD. A requesting node becomes a CN when it receives and caches the data item. The RN sends request with the QD which directs to the CN which has the requested data item. When the data reaches the RN it becomes a CN. Supposing the data item is not found in local QD, the request is forwarded to other QDs using the MDPF algorithm and once again data item if found sent and cached. Thereby becoming a CN, otherwise the request is forwarded to server which will always return the requested data item.

The distributed caching scheme, COACS Co-operative and Adaptive Caching System, indexes the queries in nodes called as Query Directory (QD).the selection of query directory depends upon certain factors such as time, battery life, the available bandwidth and the available memory that is nodes which can stay long in the network. The QD will change only when node in large number joins the network. The QD act as an index of addresses containing the CNs and their data it holds. To distribute the QDs evenly in the MANET, the paper uses Minimum Distance Packet Forwarding (MDPF) algorithm. By using this, the QD that should be used or forwarded to, can be identified when the local QD does not have information on the request query.

The hit ratio of the system is increased because of using QDs but the increased hit ratio comes at the cost of higher utilization of bandwidth.

In paper[3] J. Cao, G. Cao have proposed schemes for cooperative caching is used to share and access the data that are being cached by the nodes and it can be used by other nodes in the mobile environment for data accessibility. Moreover, the data that is accessed must be an updated one, identical to that present in the server. This is achieved by going for appropriate consistency schemes. It deals with both push based and pull based techniques. Each node assumes any three state transitions. They are Relay peer, Relay peer candidate and Cache node. Cache node is the node which contains the required data. The cache node becomes a relay peer candidate when the cache node satisfies some criteria like update rate by request rate, etc. Then the relay peer candidate will become relay peer if the relay peer candidate can gets

the invalidation message send form the source node. The main disadvantage of this scheme is that only that relay peer candidate will be functioning as interface between the cache node and the relay peer.

In paper[7] a new cache consistency scheme pro-posed by Lingamaiya et all, depends on three features. They are

- Standard bits utilization,
- Local Cache Standard utilization and
- Make valid entry into nodes. They implemented the above features by using an algorithm called "Scalable Distributed Cache Indexing (SDCI)". This is a hybrid of Stateless and a state-full approach. Where three stateless algorithms were used they are Timestamps (SSUM), Amnesic Terminals (AT) and Signature (SIG). A stateless approach is one where the Server is not aware of the Client node's content, but this approach is not scalable.

A state-full approach makes use of a Central Data Provider (CDP), which is essentially a database of which Cache Node has what data item. This SDCI scheme needs the CDP to only maintain the validity of those data items. The CDP will maintain records all cached data objects for every nodes in the environments'. So a node can be able to download data objects which the node requested using the uplink. Hence the approach is made much simpler than the state-full scheme. The sleep wake-up patterns and mobility are also addressed by this algorithm. This scheme also requires only less broadcast messages. Performance analysis of this algorithm shows that it is more efficient that the SSUM [Smart Server Update Mechanism for Maintaining Cache Consistency in Mobile Environment] scheme proposed by Kaleel Mershad et all.

2.1 Analysis on the Existing System

Sl. no	Paper	Protocol/algorithm	Advantages	Disadvantages
1.	Supporting Cooperative Caching in Ad Hoc Networks."	Cache Path Cache Data Hybrid Cache	High cache hit ratio Low query latency	High Space Utilization No cache consistency mechanism
2.	COACS: A Cooperative and Adaptive Caching System for MANETS."	Query Node(QN) Caching Node(CN)	Ability to increase hit ratio rapidly As more request for data are submitted	High Space Utilization High communication overhead
3.	Data Consistency for Cooperative Caching in Mobile Environments.	Relay peer Relaypeer candidate Cache node	Less network traffic Low query latency	Only one node act as interface
4.	DCIM: Distributed Method for Maintaining Cache Consistency in Wireless Mobile Networks	Adaptive TTL Prefetching Piggybacking	Increase the accuracy of its estimation to reduce both network traffic and query latency	Compelling the client to receive the recent updates
5.	SSUM: Smart Server Update Mechanism for Maintaining Cache Consistency in Mobile Environment	TTL (Time To Live) Updating the nodes depends on threshold value	Reduces the wireless traffic by tunning the cash update rate to request rate for cached data	Cache placement strategy No cache replication
6.	Cache Invalidation Strategies for Mobile Adhoc Networks."	Pull On Demand(POD) Modified Amnesic Terminals(MAT) Pull based Amnesic Terminals(PAT)	Message cost is low	Cache hit ratio is low Long query latency Higher bandwidth usage High network traffic
7.	SDCI: scalable distributed cache indexing for cache consistency for mobile environments	Stateless approach. state-full approach.	Requires only less broadcast messages No cache replication	Server is not aware of the Client node's content Not scalable.

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