

# A Survey on Cache Consistency Schemes Adopted in Manets

S. Lilly Sheeba<sup>1</sup> and R. Udayakumar<sup>2\*</sup>

<sup>1</sup>Department of Information Technology, Jerusalem College of Engineering, Chennai - 600100, Tamil Nadu, India;

slilly\_sheeba@yahoo.com

<sup>2</sup>Department of Information Technology, Bharath University, Chennai - 600073, Tamil Nadu, India;

udayakumar.it@bharathuniv.ac.in

## Abstract

Mobile Ad hoc Network is a wireless communication network. It is a self configuring infrastructure less network of mobile devices. The mobile nodes in general access data from remote source from a wireless network. Hence any mobile nodes access latency is increased. To avoid this latency, mobile node cooperatively cache data in their local cache memory. Since Mobile Ad hoc Networks are dynamic in nature we must maintain consistency between the remote source and caching nodes. Some of the cache consistency schemes like pull based or client based and push based or server based are used to improve consistency of data. However, the main issue of concern is maintaining consistency such that the data at the server and the caching nodes are exact replicas at any point of time. Hence, this survey describes various schemes used to improve consistency between the server and the caching nodes to reduce delays and network latencies. Moreover hybrid schemes that can make use of the advantages of both the push based and pull based schemes can be implemented for maintaining cache consistency.

**Keywords:** Cache Consistency, Cache Node, Mobile Ad hoc Network, Pull Based

## 1. Introduction

A network is a group of two or more computer systems linked together. This can be classified into two groups, wired network and wireless network. All computers on a wired network must be connected by Ethernet cable. Running Ethernet cables can be a significant challenge. Wireless network on the other hand provides the flexibility to connect your computers to the network using wireless network adapter devices. Data is sent and received using radio waves that eliminate the need for Ethernet cables. You can connect to the network from anywhere within range of the wireless router. Wireless networks trade speed, greater flexibility and ease of use. Figure1 explains the general taxonomy of networks.

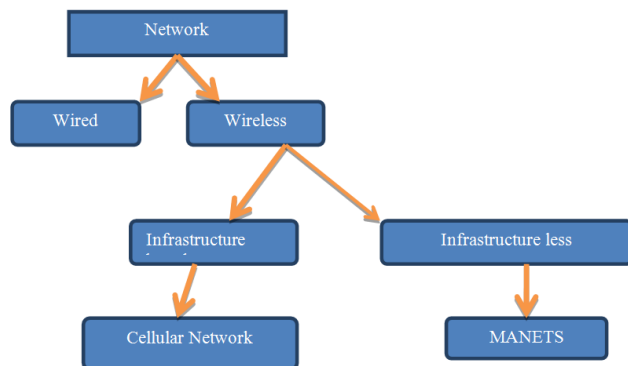
Wireless network can be classified either Infrastructure or Ad hoc. Mobile Ad hoc Network (MANET) is a self-configuring infrastructure less. Network of mobile device. MANETs are dynamic in

nature, so a reliable caching scheme is difficult. Data cache is important because it improve the performance. Another aspect of data cache is cache consistency. Cache consistence increase the probability of serving from the cache data items that should be same as those presented with the server.

A Mobile ad hoc network is a wireless communication network, where nodes that are not within direct transmission range of each other will require other nodes to forward data. It can operate without existing infrastructure, supports mobile users, and falls under the general scope of multi-hop wireless networking. Mobile Ad-hoc Network (MANET) is a self configured network of mobile terminals connected by wireless links. Mobile terminals such as cell phones, portable gaming devices, PDAs (Personal Digital Assistants) and tablets all have wireless networking capabilities. MANETs can also be utilized in the disaster rescue and recovery. One primary issue with continuous participation in MANETs is the

\* Author for correspondence

network lifetime, because the aforementioned wireless terminals are battery powered, and energy is a scarce resource.



**Figure 1.** Network Taxonomy.

Mobile ad hoc networks have potential applications in civilian and military environments such as disaster recovery efforts, group conferences, wireless offices, mobile info stations (in tourist centers, restaurants, and so on), and battlefield. In ad hoc networks, mobile nodes communicate with each other using multi hop wireless links. Since they are infrastructure less, each node acts as a router, forwards the data packets for other nodes.

Caching is necessary in order to provide corresponding information to the clients request from access server in MANET environment. The queries are submitted by the Requesting Nodes (RN) to the special nodes called Query Directories (QD). This QD act as a local server to fetch the query from other Cache Node. The RN sends the query to the nearest QD. The QD search the data in the nearest Cache Node (CN). If cache hits; the CN returns the data

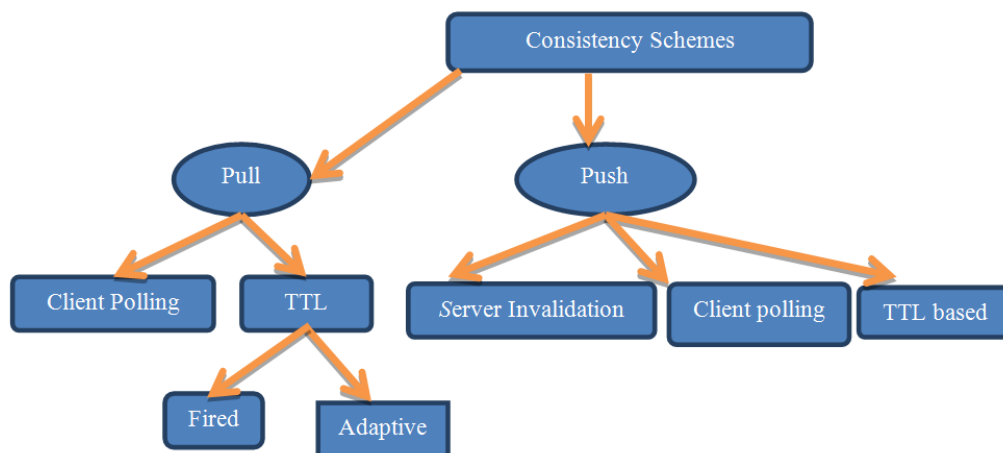
to the corresponding RN. If it misses, then it can get its data directly from server through wireless links. Since MANETs have mobility in nature, the mobile nodes get disconnected from the network coverage. The main goal of the ad hoc network is to the mobile nodes access the required information by overcoming the disadvantages of MANET. Mobile nodes in MANET are communicate in multi-hop manner, so each node act as router, and nodes have entry list of time stamp, query ID, routed directories ID, and its neighboring nodes address.

In MANET nodes communicate with remote server through Access Point (AP) called gateway. Server has two invalidation strategy. They are Stateless and Stateful. In stateless nodes will get disconnected from the network due to their mobility, so server sends the invalidation report to the client to validate their data. In the stateless server approach, the server is not aware of the state of the client's cache. The clients need to query the server to verify its validity of its caches before use. In stateful the server has the information about the cache nodes that is which cache node has what kind of data. If the data item has been changed the server sends the invalidation report to the requested client. Thus the server maintains the table, which has the node's address, time when the data has been updated, and the time when the data has to be updated.

## 2. Cache Consistency Schemes

In general cache consistency schemes can be broadly categorized as in Figure 2 into

- Pull Based Schemes
- Push Based Schemes



**Figure 2.** Cache Consistency Schemes.

Pull based schemes highly depend on a request response way of acquiring up to date data. The client here initiates a request to the server in case it desires to receive some information of its own interest. On the other hand push based schemes purely depend on server validation to acquire recent update of any data. Here the server pushes all recent updates of data in a well streamlined manner.

## 2.1 Pull based Schemes

In push-based data delivery, the server tracks all cache nodes that have requested data. If the data has been modified, it notifies each cache node and when the client requests for the file, it is served from the cache node instead of the request going directly to the server. This improves network utilization. Several push-based schemes are introduced to reduce the redundancy and network traffic. The push based-consistency algorithms are Cache Invalidation Schemes, IR-Based algorithm, Bit-sequences algorithm, Cooperative and adaptive caching Scheme; Greedy walk based selective push protocol and Pull-based Protocol.

Khaleel Mershad et al.<sup>1</sup> proposed a push based scheme, in which the server sends data to the client on update. Here Smart Server Update Mechanism (SSUM) makes use of Query Directories and Caching Nodes. Here control mechanisms are devised to get accustomed to caching of data which gets updated by the server. This in turn assists can scale moderately. SSUM tries to improve request response rate, update latency, cache hit ratio and bandwidth utilization.

Zhuijg Wang proposed IR-based algorithm in <sup>2</sup>, mainly directed to reduce network traffic. Server based approaches generally employ Invalidation Reports (IRs) that are periodically broadcasted by the server. An IR entry list normally carries the IDs of the updated data items and the time stamps of the updated history. When a query is generated from the requesting node, the node from sender waits for the periodic IR to invalidate its cache (if connected) or not. If it is valid, then the query is transmitted. If the requested data item is invalid or modified, it usually waits for the periodic IR. In some proposed mechanism, like the Modified Time Stamp (MTS) mechanism<sup>3</sup>, request packets are forwarded to the server without waiting for their periodic IR. Such scheme generally gets affected by large average delays imposed by the waiting mechanism for updating IRs. Hence new improved technique was developed by Cao<sup>4</sup>, in which

time between two IRs are divided into intervals at the beginning of the proposed scheme, server broadcasts Update-Invalidation Reports (UIR), consists of last IR updated ID. Since a node which has to answer the query waits for periodic IRs to see whether the items are updated instead of waiting for next IRs. These approaches consequently reduce the generated network traffic by saving a list of submitted queries.

Anurag Kahol et al.,<sup>8</sup> proposed the problem of management of cache consistency. In this there are two approaches are proposed that makes use of asynchronous invalidation message. To buffer invalidation message from server at the MH's Home Location Cache (HLC). This scheme is called as AS that is (A) synchronous (S)tateful. This cache maintenance strategy minimizes the overhead in preserving bandwidth, reducing the number of uplinks requests and average latency. But here maintaining state information at MSS can be considered as an overhead.

Jinet al.,<sup>9</sup> presents Greedy Walk-based Selective Push (GWSP) scheme that attempts to decrease the redundancy in conventional push schemes by pushing data updates only if the caching node is likely to serve queries and also if there is no more data updates ahead of the Time-To-Refresh (TTR) time expires. The source maintains cached data id, state, TTR and query access rate. The source selects the caching nodes based on these factors to receive updated cached data<sup>16</sup>.

## 2.2 Pull based Schemes

In the pull-based approach, the cache node is entirely responsible for maintaining consistency. The cache node maintains data consistency by accompanying a TTL value along with the document cached and this copy is served until the TTL expires<sup>17</sup>.

Jiannong Cao et al., proposed data consistency for cooperative caching in mobile environments. In this paper a 3D model has been proposed which captures many features of traditional cache consistency scheme, and includes a relay-peer-based cache consistency<sup>18</sup>. Here nodes are classified as Cache nodes, Relay peers, Relay peer candidates. This strategy allows sharing and coordination, reduces query latency, lowers communication overhead and energy consumption. But here certain nodes are just deployed as interfaces.

Hassan Artail et al.,<sup>9</sup> proposed COACS (COoperative and Adaptive Caching System), a distributed caching scheme which highly depends on using indexes for

cached queries and enables easy way to locate the desired data more efficiently<sup>19</sup>. Here, nodes are classified as QD and CN, i.e., that is (Q)ueries (D)irectories, and (C)ache Node. COACS suggest schemes for cache invalidation, cache replication and cache reuse.

Xuenyan Tang et al.,<sup>13</sup> proposed a TTL based consistency mechanism in unstructured peer-to-peer network. In this network millions of nodes are inter connected to share data through searching and replication. In this approach each replica is assigned to a Time-To-Live (TTL) value. When TTL expires, a replica will not be allowed to be served unless the data gets validated. Replication improves consistency maintenance which also motivates improvement in system performance.

G. Cao et al.,<sup>12</sup> proposed an IR-based cache invalidation algorithm, which can significantly reduce the query latency and efficiently utilize the broadcast bandwidth. The IR-based cache invalidation solution has two major drawbacks, which have not been addressed in previous research. First, there is a long query latency associated with this solution since a client cannot answer the query until the next IR interval. Second, when the server updates a hot data item, all clients have to query the server and get the data from the server separately, which wastes a large amount of bandwidth. This scheme can significantly improve the throughput and reduce the query latency, the number of uplink request, and the broadcast bandwidth requirements.

Kassem Fawaz et al.,<sup>15</sup> proposed the pull based scheme where cache node monitors the TTL information and accordingly triggers the cache updating and validation process. Pull-based algorithms implements adaptive time to live, piggybacking, and pre-fetching, and provide near strong consistency. The cached data items as well as unexpired ones are grouped invalidation requests to the server, which sends the cache devices the actual items that have changed, or invalidates them, based on their request rates. But in this scheme network traffic will be more and also there will be the message overhead.

### 3. Conclusion

The main focus on this survey is to provide an insight into various cache consistency schemes employed to access information in MANET. In push based cache consistency schemes, server initiates the process of pushing data to the clients where as in a pull based scheme the client initiates the request query for attaining desired data item from the

server. In a push based scheme the server compels all the caching clients to receive the up to date data, even against the wish of the client. It is quite unlikely that all clients are expecting recent updates on data at all times. This might lead to unnecessary band width utilization as the requestor node is not interested in receiving regular frequent updates of data. Hence a hybrid approach that makes use of the advantages of both the schemes can be adopted to mitigate the drawbacks existing in these two schemes.

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