Chapter 16
Cooperative Caching in Wireless Multimedia Sensor Networks

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ABSTRACT

Caching is a technique that transparently stores data nearer to the requester so that future requests for that data can be served faster. In networking environment, caching is a method of storing data in multiple places on the network, typically to reduce response time and network traffic. In wireless environment, through caching we can improve the efficiency. Caching can be utilized to improve the efficiency by storing the data nearer to the requester. Data are stored nearer to the requester, so it will reduce the access latency and bandwidth usage to transmit data to the requester, and reduce the overall cost of accessing data. Wireless environment is infrastructure-less so all nodes directly communicate with their neighbors. In wireless sensor network, nodes have limited resources such as battery, communication bandwidth, storage, etc. Through caching we can reduce the overall cost of accessing data and conserve the scarce resources.

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INTRODUCTION

Wireless multimedia sensor network (WMSN) comprises of the large number of low cost scalar nodes and camera nodes that are deployed in hostile environment. WMSNs communicate over wireless medium and capture scalar as well as multimedia data. These nodes are battery driven devices (Akyldiz et.al. 2002), and it is difficult impossible to replace the batteries in hostile environment. WMSNs are resource constrained, so it is expected that these nodes perform their tasks for the maximum time period.

Maximum of WMSN applications are data centric, which transmit the sensed data to the sink node through single/multi hop transmission. The sink node is located close or inside/outside the sensing field. Sensor nodes sense the data from surrounding and transmit to the sink. Sink collects all data and performs some operation accordance with the application requirement and then transmits to the end user through the internet or some other wireless/wired media. Large numbers of nodes are deployed in sensing field. The large amount of multimedia data is transmitted and received by sink node that leads to higher energy consumption and short network lifetime of WMSN. To prolong the network lifetime, we have to perform less energy consumption tasks, i.e. less data transmission/reception operations are performed. This could be achieved if data communication to the sink is performed only as per the request of user/application via sink node. However, sink node can request data from any region at any time. Therefore, SN needs to perform continuous sensing to fulfill the objective and store these data items either in its own memory or by some other SNs memory in the network, so that data is provided to the sink node as and when the request comes. Since the storage capacity of SN is limited, it can store only the limited amount of data temporarily. However, cooperative caching is helpful for WMSN to maintain the large amount of data.

There are number of applications, such as capture an event, tracking the movement of an object, creating panoramic view of an area, etc. where sink node may require both recent as well as history data. There is another way to fullfill this requirement that sink node stores all history data, and all nodes have to transmit only the recent data to the sink. For this large amount of storage capacity is required at the sink, as the number of SNs continuously transmit sensed data to sink node. Although, many WSN protocols have been discussed in literature Manjeshwar et. al. 2002; Younis et. al. 2003; Poonia et. al. 2011; Yi et. al. 2007; Heinzelman et. al. 2002; Zhu et. al. 2009, it is assumed that sink node has ultimate power, capacity and storage capacity, whereas in other scenarios, it is assumed that sink node has limited resources as in simple SNs.

Figure 1 shows the query processing in wireless multimedia sensor network. An event has occurred, and it is sensed by number of SNs and they transmit data to the sink node. However, sink node requires both recent and history data, such as information regarding the event that took place at time t, where $t = t_c - t_h$, is the current time and $t_h, (h = 1, 2, 3, ...)$ is the history time interval for which data is required by the sink. Number of queries $q_1, q_2, q_3, ...$ are generated by the sink node where q_1 query is generated at $h = 1$, q_2 query is generated at $h = 2$, and so on. Based on both recent and history data, sink node detects the occurrence of an event.

In the recent years, maximum work has been done on data caching in wireless and adhoc networks and lots of caching protocols have been introduced by optimization of cache discovery, cache admission, cache replacement and cache consistency process as discussed in Dunkels et.al. 2004; Ayadi et. al. 2010; Raj et.al. 2007; Xu et. al. 2008; Al-Ameen et.al. 2008; Nikos et. al. 2008; Prabh et.al. 2005; Gupta et. al. 2008. Data caching is the challenging task in WMSN due to (1) limited battery capacity of individual