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Power-aware data retrieval protocols for indexed broadcast parallel channels☆

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Abstract

In pervasive and mobile computing environments, "timely and reliable" access to public data requires methods that allow quick, efficient, and low-power access to information to overcome technological limitations of wireless communication and access devices. The literature suggests broadcasting (one-way communication) as an effective way to disseminate the public data to mobile devices. Within the scope of broadcasting, the response time and energy consumption of retrieval methods have been used as the performance metrics for measuring the effectiveness of different access methods. The hardware and architecture of the mobile units offer different operational modes that consume different energy levels. Along with these architectural and hardware enhancements, techniques such as indexing, broadcasting along parallel channels, and efficient allocation and retrieval protocols can be used to minimize power consumption and access latency.

In general, the retrieval methods attempt to determine the optimal access pattern for retrieving the requested data objects on parallel broadcast channels. The employment of heuristics provides a methodology for such ideal path planning solutions. Using informative heuristics and intelligent searches of an access forest can provide a prioritized cost evaluation of access patterns for requested data objects and, hence, an optimal path for the access of requested data on broadcast air channels.

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This paper examines two scheduling methods that along with a set of heuristics generate and facilitate the access patterns for retrieving data objects in the presence of conflicts in an indexed parallel broadcast channel environment. A simulation of the proposed schemes is presented for analyzing the relationship between response time and power consumption.

Keywords: Pervasive computing; Information retrieval; Mobile access systems; Broadcasting; Power aware access protocols

1. Introduction

The conventional standard for timely and reliable access to global information sources is rapidly changing. This is mainly due to the advances in communication and computation technologies, availability of small mobile devices, and the sophistication of users. As a result, users have become much more demanding in their desire to access information "anytime, anywhere" in pervasive computing environments.

Multidatabase systems (MDBS) were designed to allow timely and reliable access to heterogeneous/homogeneous data sources in an environment that is characterized as "sometime, somewhere". Within the scope of multidatabases, where clients and servers are connected over a reliable network infrastructure, researchers have addressed issues such as autonomy, heterogeneity, transaction management, concurrency control, transparency, and query resolution [1,19]. With the introduction of pervasive computing and mobile devices into global computing, mobile clients can now have the higher flexibility of accessing the information from different locations with varying network connectivity. The concept of mobility and rapidly expanding technology is making available a wide breadth of access devices with different physical characteristics. However, this has introduced additional complexities and restrictions in a multidatabase system, i.e., reduced capacity and unreliable network connectivity, and reduced processing and power resource.

An MDBS with such additional physical constraints is referred to as a Mobile Data Access System (MDAS) [8]. The uncertain and unpredictable temporal and spatial characteristics of the mobile devices and wireless communication often result in an undesirable quality-of-service. As a result, processes that stay connected to the network for the least amount of time will have more successful completion rates. Therefore, the access time of the mobile unit in the network is an important factor in evaluating the performance of the unit in an MDAS environment. Processing power, memory, storage, display capabilities, and power limitations are all common restrictions for mobile units, and these restrictions reduce their computational capabilities. Energy consumption, in particular, greatly impacts the performance of a mobile device. This is due to the fact that temporary power sources such as batteries are the main source of power in mobile devices and the rate of increase in the battery capacity is lower than the rate of increase in chip density. As mobile technology advances and computing complexity increases, energy consumption must be minimized to retain efficient and effective usage of battery power.

Architectural enhancements allow mobile units to operate in different operational modes to improve energy consumption. When not actively retrieving information, or performing any computation, the device may operate in the reduced power mode and conserve