# Mobile P2P Databases[1]

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A mobile peer-to-peer (P2P) database is a complex spatial-temporal system, in which information is stored in the peers of a mobile P2P network. The mobile peers communicate with each other via short range wireless protocols, such as IEEE 802.11, Bluetooth, Zigbee, or Ultra Wide Band (UWB). These protocols provide broadband (typically tens of Mbps) but short-range (typically 10-100 meters) wireless communication. On each mobile peer there is a local database that stores and manages a collection of data items, or reports. A report is a set of values sensed or entered by the user at a particular time, or otherwise obtained by a mobile peer. Often a report describes a physical resource such as an available parking slot. All the local databases maintained by the mobile peers form the mobile P2P database. The peers communicate reports and queries to neighbors, and these propagate by transitive multi-hop transmissions.

Mobile P2P databases enable matchmaking or resource discovery services in many application domains, including social networks, transportation, mobile electronic commerce, emergency response, and homeland security.

Traditionally search databases have been implemented by a centralized architecture. Google is preeminent example of such architecture. However, mobile P2P databases have several advantages over centralized ones, including higher reliability, better privacy and performance, lower cost, and independence of a fixed infrastructure. Their disadvantage is that they do not guarantee answer completeness.

The concept of mobile P2P database is proposed for searching local information, particularly information of a temporary nature, i.e. valid for a short duration of time [1].
There are two main paradigms for answering queries in mobile P2P databases. One is pulling reports by sending queries on search missions in the network, and the other is pushing the reports to the right queries. Combination approaches seem most promising.

There are many research challenges in mobile P2P databases:

1. **Prolong network lifetime:** Currently, some approaches e.g. ranking and cluster-based-methods, are proposed to prolong the lifetime of sensor networks, mobile ad hoc networks, and mobile P2P databases. The future research question is how to employ the redundancy of networks and the density of peers in order to maximally extend the network lifetime.

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2. **Sparse networks**: Currently, the performance of many algorithms and systems heavily depends on the density of peers in mobile P2P networks. They do not perform very well if the network is sparse. Therefore, how to design and develop mobile P2P databases for sparse networks is an important and difficult challenge. Recent work that heads in this direction includes Delay Tolerant Networks, store and forward flooding, and mobile peers whose sole function is to provide connectivity.
3. **Rapid topology changes:** Highly mobile peers pose problems, e.g. how to efficiently disseminate queries and answers, and how to reconfigure rapidly when the topology of networks changes frequently. Stateless approaches seem most suitable to address these problems.
4. **Emergent global behavior from local knowledge:** Mobile P2P databases can be treated as a special type of distributed system. Each peer maintains a local database and all the local databases form the virtual mobile P2P database. Therefore, peers can only use the local knowledge to predict or affect the global behavior of the whole mobile P2P database. The future research direction is how to employ the local knowledge and propose adaptive local algorithms to direct or affect the global behavior of mobile P2P databases.
5. **(Self-) Localization techniques:** Location-based approaches are increasingly popular and necessary, and location information of peers is useful for efficiently storing and managing information. However, self-localization techniques are still not efficient and effective enough due to the limitation of peers or localization techniques. For example, GPS is not available indoors and the accuracy of GPS is not enough for some mobile P2P databases. Therefore, efficient and effective self-localization technique for mobile P2P databases is an important research direction.
6. **Mathematical modeling of data dissemination:** Many query processing and data dissemination algorithms may benefit from a mathematical model of data propagation. For example, a formula giving the number $n$ of mobile peers having a report that was generated at time $t$ at location $l$ would be very useful in ranking of such a report. The number $n$ is a function of the density of mobile peers, motion speed, bandwidth and memory availability at the peers, memory management, etc. Related work done in epidemiology about the spread of infectious diseases would be a good starting point for this research. Results in random graphs are also applicable.

Other important research directions include incentives for broker participation in query processing, transactions/atomicity/recovery issues in databases distributed over mobile peers, answering specialized queries that are amenable to specific optimization, and integration with the fixed infrastructure.


[1] B. Xu and O. Wolfson, "Data Management in Mobile P2P Networks", *Springer Verlag Lecture Notes in Computer Science, Proc. of the 2nd International Workshop on Databases, Information Systems, and P2P Computing (DBISP2P'04)*, Toronto, Canada, Aug 2004.

[2] M. Motani, V. Srinivasan, and P. Nuggehalli, "PeopleNet: Engineering a Wireless Virtual Social Network," *International Conference Mobile Computing and Networking (MobiCom'05)*, Aug 2005.