# MAPLE: A Mobile Scalable P2P Nearest Neighbor Query System for Location-based Services

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## Abstract

*In this demonstration we present MAPLE, a scalable peer-to-peer Nearest Neighbor (NN) query system for mobile environments. MAPLE is designed for the efficient sharing of query results cached in the local storage of mobile peers. The MAPLE system is innovative on its ability to either fully or partially compute location-dependent nearest neighbor objects on each host. The demonstration illustrates how cooperative data sharing and distributed processing among mobile peers results in a considerable reduction of the load on remote spatial databases.*

## 1. The MAPLE Infrastructure

The MAPLE (Mobile scAlable Peer-to-peer NN query system for Location-based sErvices) system[1] is a prototype of the design in [2] that implements a novel Sharing-based Nearest Neighbor ($SN^2$) query model. The MAPLE system visualizes the execution of $SN^2$ among peers in a step-by-step manner. It demonstrates that $SN^2$ query model leverages P2P sharing to achieve scalability in terms of the number of peers and to reduce the access frequency to remote spatial database servers. With higher mobile host density, more queries can be answered by peers.

We are focusing on mobile peers, such as cars, that are instrumented with a GPS to provide continuous location information. Furthermore, we assume that two tiers of wireless connections are available on mobile peers. Cellular-based networks allow medium range connections to base-stations that interface with a remote spatial database. A second type of short-range networks, such as IEEE 802.11x, allows ad-hoc connections with neighboring mobile clients.

In our design, previous query results can be cached in the local storage of mobile peers. Such peers move on road networks and autonomously launch location-based NN queries with adjacent peers. The $SN^2$ algorithm is applied to verify whether data received from neighboring peers provide a complete, partial, or irrelevant answer to the posed query. If only partial or irrelevant data items are collected, the query is forwarded to remote spatial database servers. The complete query result is then also cached in the local memory.

[1] http://dmrl.usc.edu/maple/

## 2. The MAPLE Components

The MAPLE system consists of three components: i) The **multiple peer simulation module** concurrently models a predefined number of mobile hosts. It implements all the functionality of a single mobile host and provides the communication facilities among peers and from peers to remote spatial database servers. ii) The **server module** is responsible for storing points of interest. It performs NN queries from peers and records the I/O load and access frequency of the spatial database server. iii) The **$SN^2$ query visualization module** provides a rendering of the verification process of a $SN^2$ query in a step-by-step manner. Users can arbitrarily select a mobile host and launch a location-based $SN^2$ query within the simulation region. We describe details of MAPLE components in [1].

## 3. Conclusions

We have described MAPLE, a system to aid in the study of scalable peer-to-peer data sharing for location-based services in mobile environments. The objective of MAPLE is to provide a platform for the evaluation of our ongoing research into the novel design of P2P sharing techniques for location-based services. MAPLE demonstrates the excellent scalability and effectiveness of our current algorithm in high density mobile environments.

## References

[1] W.-S. Ku, C.-N. W. Roger Zimmermann, and H. Wang. A P2P Simulation Model to Support Mobile, Scalable Nearest Neighbor Queries for Location-based Services. Technical Report USC-CS-TR05-843, University of Southern California, 2005.

[2] W.-S. Ku, R. Zimmermann, and C.-N. Wan. Location-based Spatial Queries with Data Sharing in Mobile Environment. Technical Report USC-CS-TR05-843, University of Southern California, 2005.