Transaction Management in Mobile Computing Systems

Elisa Bertino Elena Pagani* Gian Paolo Rossi
Dipartimento di Scienze dell'Informazione
Università degli Studi di Milano
e-mail: {bertino, pagae, rossi}@dsi.unimi.it

Extended Abstract

Through wireless networks, mobile personal machines have the ability to access data and services that can be located on both mobile and wired servers. Unlike wired hosts, mobile hosts can be temporarily unreachable as a consequence of their movements across different cells, their energy limitations or unavailable wireless channels. Mobility forces mobile hosts to alternate connected and disconnected work. When connected, they perform personal communications and access shared data and services; when disconnected, they can process locally cached data objects.

Analogously to wired networks, data replication is the key element to ensure high data availability and to increase performance. However, disconnected work and the uncertainties of the underlying wireless network introduce new issues that have been recently addressed in literature [IB94, BAI93, BPR97]. There are three main aspects that we wish to discuss in this work:

- how to provide a fault-tolerant architecture addressing data access and management despite mobility and disconnected work;
- how to manage data replication to ensure data consistency, integrity, durability, according to the application requirements;
- to which extent the general requirement of network independency can be met or otherwise the application awareness of mobility can be effectively exploited to provide the level of quality of service needed.

In this work we investigate how the problem of managing a distributed database and guaranteeing data consistency is affected by the characteristics of the mobile setting. We discuss the impact of mobility and disconnections on fault-tolerance and recovery. We investigate how fault-tolerance can be ensured, by analyzing some of the algorithms proposed for database management in mobile systems.

The study shows that the techniques that have been identified for wired distributed systems are still applicable in the presence of mobility without introducing substantial modifications. As long as mobile hosts are intended just to query data, the implementation of

*Supported in part by MURST 40%.

these techniques greatly benefit of the presence of base stations connected through a wired infrastructure [CYW94, IVB94, CB94]. However, we show that this is not the only environment that can be encountered. Firstly, requirements of performance and data availability suggest that, for a class of applications, data should be replicated on both mobile and fixed hosts [BG94, JBE95, KS92]. Secondly, in some cases, such as vehicle traffic control and emergency disaster relief, the availability of the fixed stations cannot be always assumed. We believe that data replication over both fixed and mobile hosts introduces new fault-tolerance issues that can be addressed by the design of a novel communication platform that includes mobility and group oriented services. In this work, we have compared some of the classical techniques to manage data replica and we used simulations to obtain some preliminary performance evaluation.

References

[BAI93] Badrinath B. R., Acharya A., Imielinski T., "Impact of Mobility on Distributed Computations". *ACM Operating Systems Review, Vol. 27, No. 2*, pages 15-20, Apr. 1993.

[BG94] Barbará D., Garcia-Molina H., "Replicated Data Management in Mobile Environments: Anything New Under the Sun ?". *Proc. IFIP Conf. on Applications in Parallel and Distributed Computing*, Caracas, Venezuela, Apr. 1994.

[BPR97] Bertino E., Pagani E., Rossi G. P., "Fault-Tolerance and Recovery in Mobile Computing Systems". *To appear in "Recovery in Database Management Systems", Eds. V. Kumar and M. Hsu*, Prentice-Hall, 1997.

[CYW94] Chen M., Yu P. S., Wu K., "Index Allocation for Sequential Data Broadcasting in Wireless Mobile Computing". *IBM T. J. Watson Research Center Technical Report*, 1994.

[CB94] Cho K., Birman K. P., "A Group Communication Approach for Mobile Computing". *Proc. Mobile Computing Workshop*, Santa Cruz, CA, Dec. 1994.

[IB94] Imielinski T., Badrinath B. R., "Mobile Wireless Computing: Solutions and Challenges in Data Management". *Rutgers University Tech. Rep. DCS-TR-296/WINLAB-TR-49*, 1994.

[IVB94] Imielinski T., Viswanathan S., Badrinath B. R., "Energy Efficient Indexing on Air". *ACM SIGMOD*, pages 25-37, May 1994.

[JBE95] Jing J., Bukhres O., Elmagarmid A., "Distributed Lock Management for Mobile Transactions". *Proc. 15th Intl. Conf. on Distributed Computing Systems*, pages 118-125, Vancouver, British Columbia, Canada, Jun. 1995.

[KS92] Kistler J. J., Satyanarayanan M., "Disconnected Operation in the Coda File System". *ACM Trans. on Computer Systems, Vol. 10, No. 1*, pages 3-25, Feb. 1992.