UbiqStor: A Remote Storage Service for Mobile Devices

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Abstract. In Ubiquitous computing environment the mobile devices such as PDAs necessarily connect to remote storage servers. We present an iSCSI caching system that localizes iSCSI target to overcome the shortcomings of iSCSI performance dropping sharply as the latency increases.

1 Motivation

Mobile devices such as PDAs are evolving to be incorporated into Ubiquitous computing environment. Due to lightly equipped storage, they lack enough capacity to process application of large data, thus it has been necessitated supplying vast storage capacity from remote machine. For mass storage service, SCSI has been representative protocol in its widespread application. We have built a remote storage system for mobile appliances using iSCSI protocol, which mobile devices can use the storage of a remote server through wireless link but just as their own local storage. It enables mobile appliances to overcome the limitation of storage capacity, as well as the ability to adapt various applications of wired environment in need of mass scale data.

1.1 iSCSI

The iSCSI (Internet Small Computer System Interface) is an emerging standard storage protocol that can transfer a SCSI command over IP network. Since the iSCSI protocol can make clients access the SCSI I/O devices of server host over an IP Network, client can use the storage of another host transparently without the need to pass through a server host's file system[1]. Fig. 1 illustrates iSCSI protocol linkage.

In iSCSI layer common SCSI commands and data are encapsulated in the form of iSCSI PDU (Protocol Data Unit). The iSCSI PDU is sent to the TCP layer for the IP network transport. The encapsulation and the decapsulation of SCSI I/O commands over TCP/IP enable the storage user to access a remote storage device of the remote server directly[2].

1.2 iCache

iCache is developed to improve iSCSI performance using local cache of a client system. Initiator's systems have specific cache space for iSCSI data, and iSCSI block

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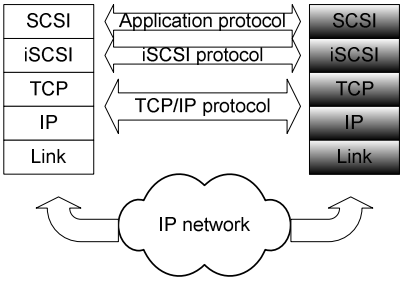

Fig. 1. Remote Storage Service with iSCSI protocol

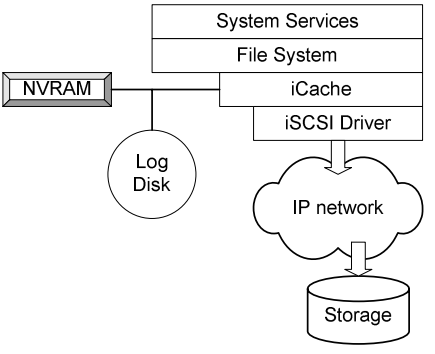

Fig. 2. iCache Architecture

data is cached to minimize network block I/O. Thus iSCSI does not send I/O requests through the network every time the disk I/O happens. Instead it reads cached blocks or sends blocks cached in LogDisk at once to the server for improving iSCSI performance. iCache's buffer space consists of two hierarchical caches comprising Non-Volatile RAM and LogDisk. Data is stored sequentially in NVRAM. When enough data is gathered, iCache process moves data from NVRAM to LogDisk. Blocks which are frequently accessed, are kept in NVRAM where access speed is fast. iCache stores less accessed data in the LogDisk. Caching techniques used in iCache are based on DCD technology, [3] proposed to improve Disk I/O performance. However storage subsystem like iCache is not adequate to mobile devices since it needs additional NVRAM and LogDisk to embody the local cache.

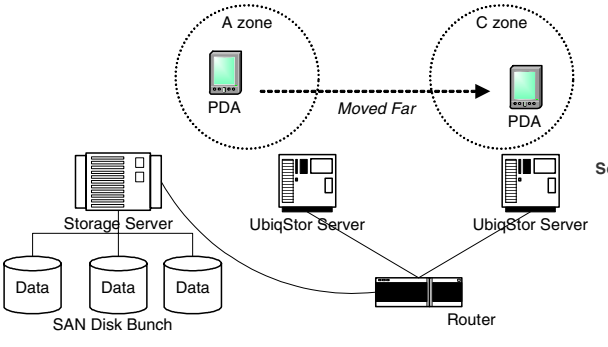

Fig. 3. iSCSI Target Localization by UbiqStor

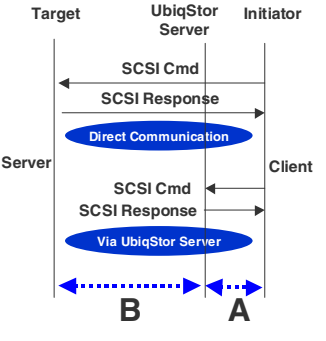

Fig. 4. SCSI Response Time Reduction

2 Cache Server for Ubiquitous Storage Service

We developed *UbiqStor*, an iSCSI cache server, for reduced the packet transfer delay time between a storage server and the mobile client, and higher practical utilization of the network bandwidth. UbiqStor prefetches the next block to be used by the client

for iSCSI read operations and can give quick responses for iSCSI write operations. The nearest UbiqStor server from mobile client is selected by iSNS and the client connects to the UbiqStor that has an iSCSI connection with a remote storage server. By using this caching service response delay times of I/O requests shortens, instead of those of a long-distant remote storage. Fig. 3 illustrates the UbiqStor working.

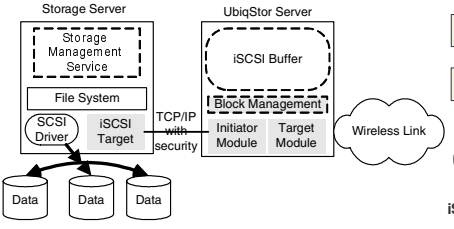

Fig. 5. iSCSI Caching System

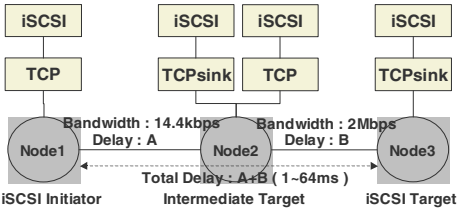

Fig. 6. The Configuration of Network Simulator 2

Fig. 5 shows a modular diagram of the iSCSI caching system. The system consists of iSCSI initiator, target, and block management module. An UbiqStor server has two iSCSI connections. One is a connection between the UbiqStor server and mobile client and the other is the connection with the storage server. The *target module* has an iSCSI session with a mobile client's iSCSI initiator and the *initiator module* has one with the iSCSI target module of the storage server. Two modules perform the same role, such as general iSCSI Target/Initiator module. However, the first iSCSI connection between mobile client and UbiqStor server is used for I/O requests of the client, and the latter is used to prefetch next blocks to be used by the client from the storage server or to deliver write blocks back to the storage server. The target/initiator module of an UbiqStor server is controlled by a block management module.

3 System Simulations

In Fig. 6, the network of an iSCSI initiator, a target and the UbiqStor server is simulated using a Network Simulator 2.27. The bandwidth of the link between node1 and node2 is limited by 14400bps to simulate wireless network (CDMA 2000 1x). The change in iSCSI performance according to the distance between iSCSI initiator and target Performance is measured by the delay times from 1ms to 64ms under the supposition that delay is proportional to distance. We selected 512 bytes as data size that is SCSI block size used in PDA of MS-Windows CE-based.

Fig. 7 and 8 show the difference in iSCSI performance by data type. No intermediate is the case the UbiqStor server has not intervened. In cases where iSCSI has a short delay, and when the distance of iSCSI initiator from target is short, the transmission delay is much bigger than the difference of propagation delay by introducing UbiqStor. Therefore it has little influence on iSCSI performance. However, when the iSCSI initiator is distant from the target, the difference of propagation delay time is much longer than that of transmission delay. Fig. 8 shows that iSCSI performance

difference gets greater as propagation delay between the iSCSI initiator and target gets longer. Performance differences according to data type are due to the fact that the iSCSI buffer hit rates for a read block are different. We suppose that the hit ratio of multimedia data, which is accessed sequentially, is 90 percent and 80% and 50% for text and application data, respectively. In each case of distance ratio, A:B = 5:5, A:B = 3:7, and A:B = 1:9, performance elevation of 25%, 40%, and 59% was achieved, respectively. Therefore, we know that proposed method show improved performance when the iSCSI caching server is close to the initiator.

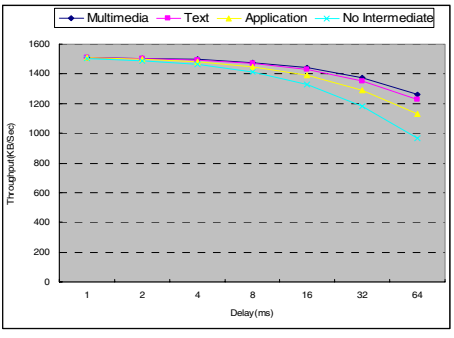

Fig. 7. Read Operations with Data Types

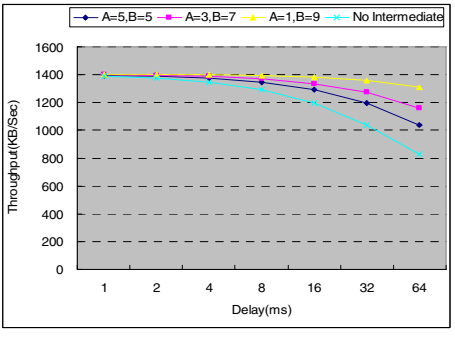

Fig. 8. Write Operations by Distance Ratios

4 Summary

In the presented system localizing the iSCSI target improved the link utilization and iSCSI performance when the target come closer to the initiator(mobile client). Through this storage subsystem the mobile devices is supplied with fluent delivery of vast storage space, which would lead to broad migration of various applications from wired environment to wireless environment that is evolving into Ubiquitous computing environment.

References

1. Y. Lu, D. H.C. Du: Performance Study of iSCSI-Based Storage Subsystems, IEEE Communication Magazine. (2003)
2. T. Clark: IP SANs: A Guide to iSCSI, iFCP, and FCIP Protocols for Storage Area Networks. Addison-Wesley (2002)
3. Y. Hu and Q. Yang: DCD-disk caching disk: A New Approach for Boosting I/O Performance. Proc. of 23rd Annual Intl. Symposium on Computer Architecture. (1996)