



Embedded Databases in the Mobile Environment

A Raima, Inc. Business Whitepaper

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This article is relative to the following versions of RDM:

- ✓ RDM Embedded: All

Abstract

The number of connected mobile devices continues to increase and will increase at an even faster rate as device prices decrease. With new markets demanding connectivity and high performance, designers are challenged to manage increasing volumes of data. Database decisions will impact the performance level, reliability, speed and accuracy of the device data management and ultimately the device performance and customer satisfaction. The embedded systems market has a long history and offers the mobile market expertise backed by years of experience in highly efficient database management. This white paper addresses a variety of markets and the growing use of embedded database management in the mobile environment.

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The Mobile Environment

Mobile devices are becoming more and more prevalent in today's world. These devices are becoming increasingly capable, while becoming more affordable as prices drop. Their uses are going well beyond early PDAs' main function as an organizer with email. Today's devices are being used in everything from IT, mobile payments, navigation, defense, and traditional consumer applications such as audio and video or gaming.

The key behind this mobile revolution is in both the better hardware technology, and the concept of the 'app'. Hardware technology has dramatically improved in the last ten years with the ability to miniaturize components, produce them efficiently at a lower cost and increase battery life. This allowed hardware to evolve into something with excellent capability, reasonable cost, and usable battery life. This results in a platform that is highly versatile, and suited to many applications.

Once the hardware evolved, the software came right along as well. With the iPhone came the AppStore and the whole concept of the 'app'; a simple program which can be easily installed on a device with usually nothing or very little to configure and setup. On the development side of things, the programs and SDKs were made simple, straightforward, and free or inexpensive, which drastically reduced the barrier to entry for developers. This allowed developers from many different markets to bring apps to the mobile world. This also ensured that mobile devices were versatile in many situations.



Ten years ago, mobile devices were beginning to be used in industrial and commercial areas, such as barcode readers and payment processing. These devices were often specialized and fairly expensive with limited capability. Multiple devices might be required and it was not always easy to install or upgrade software on the devices. Today, a consumer level device can accomplish the same functionality at a much lower cost of ownership. The app stores allow software for many different applications to be easily installed,

upgraded and removed. This also allows the same device to be used for multiple purposes.

Mobile is truly the next revolution in technology. Today devices that you can hold in your hand have the same or even more computing power than a fully loaded computers of the last decade. This, together with better communication technologies, means that data management and storage are now more important than ever.

Industrial

Now that consumer devices are becoming much more capable, they are beginning to gain traction in areas previously filled only by specialized devices such as factory automation or transportation systems. With the lower costs and readily available of commodity hardware, as well as the increase interest in the development of applications, consumer mobile devices are starting to work their way into industrial areas. Consumer devices are increasingly being used to monitor and control systems remotely.

Defense

An important aspect of defense in today's world is an increasing emphasis on information sharing. Militaries are improving the way their different branches work together and share data, whether they are on the ground, in the air, at sea, or in space. The use of consumer mobile devices is already being studied and viewed as an integral part of the 21st century military. They are easy to obtain and most individuals already know how to use them, which helps to minimize training requirements and increases adoption of these devices.

Business & Enterprise

Businesses have always been early adopters of mobile devices and have been the primary market. In the 90s most devices were simply personal organizers with only a few models having email access. Now mobile devices are more powerful than ever, and businesses are still finding new ways to harnessing that power to their advantage. In addition to executives, IT professionals are increasingly using them to control and monitor servers and network equipment remotely.

Consumer

Previously mobile devices were generally only affordable to large businesses. Today, that has all changed, and it is now commonplace for an individual to have a personal mobile device. They are used in all aspects of our life, from gaming and entertainment, to organization and social media.

All of these markets have a common need and that is data. Hardware has made huge advancements over the last ten years but what makes the most significant difference is the need to share data. In addition nearly every one of these device is somehow connected to a network, be it the Internet, WAN, LAN or VPN, and they are connected at all times. The first generations of 'PDAs' had very limited connectivity, if any at all, and what little was available was often extremely expensive. The mobile environment has definitely experienced dramatic changes over the past decade.

Mobile Data

Today mobile devices are almost always connected whether through Wi-Fi or a traditional cellular data network. This means that more data than ever is constantly being shared between devices around the world. The concept of remote data storage off of a device (in the cloud) has gained some traction. Devices which store data purely in the cloud have not really caught on and do not seem completely practical at this point in time. Rather, more of a hybrid model seems to be emerging with many services and data available in the cloud for syncing between devices and continuing to make use of local storage. Wireless networks have advanced greatly in the last ten years, but bandwidth can still be expensive and not always reliable therefore local storage is still important. Remembering that these are mobile devices, they require high performance, efficiency, and reliability when recalling the stored data. A mobile user typically demands an instant or sub second response from the device. With the ever increasing size and complexity of data being stored (photos, music, video, etc.) mobile devices are now in the need of a robust and highly-efficient database.

Embedded Databases

Embedded systems were in existence long before the mobile revolution and will be for many years to come. They are often highly specialized and frequently custom made, as opposed to consumer mobile devices. However, they share many of the same requirements with mobile devices; they are often

resource constrained and must be as fast and efficient as possible. Therefore, it makes sense to apply many of the technologies and methods from the embedded systems world to the mobile world. In fact, it is becoming increasingly common for the two to be working together where an embedded system is controlled by, or shares data with, a mobile device.

Embedded systems have always been required to efficiently store data. This requirement has been addressed through embedded databases such as Raima’s RDM Embedded database. This system has been proven through years of use and refinement in traditional embedded systems, often with very strict requirements which exceed those of any mobile device. This same database technology can fit seamlessly into a mobile device regardless of the application.

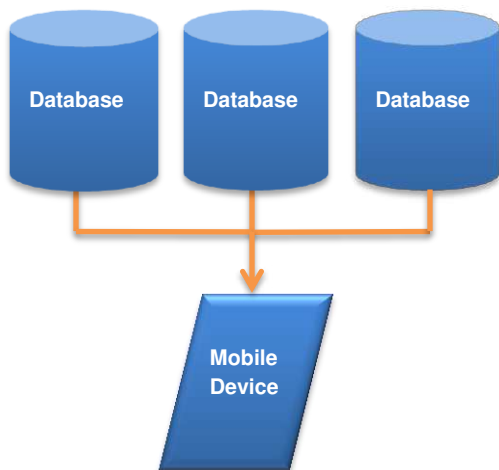
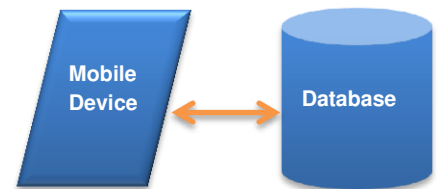
Scenarios

There are several potential use cases for an embedded database in the mobile environment. An embedded database such as RDM Embedded (RDMe) has flexibility through its versatile design to meet the database requirements of any mobile device. RDMe gives the option of using a remote database, or one built directly into the application. In situations where performance outweighs the safety of data a very fast, non-transactional database mode can be used.

Using RDMe as a model, there are three configurations described below: Remote Database, Built-in Database, and Standalone.

Remote Database

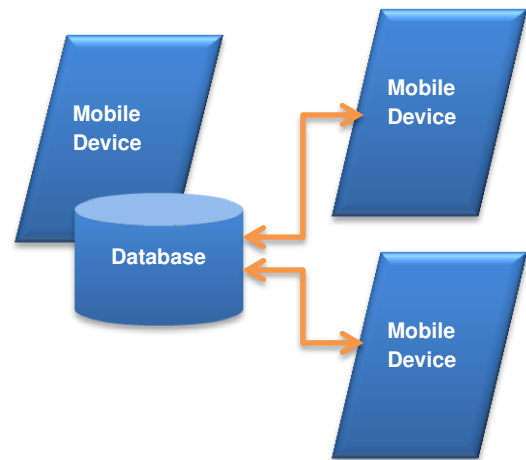
In this configuration, the database is located on another machine and the application on the device is essentially a client. The database is hosted by a Transactional File Server (TFS) which is an integral part of the RDMe design. Data can be inserted or queried from the database, but it is sent over TCP/IP and stored elsewhere. This highlights the potential use of mobile devices in tandem with embedded devices. RDMe is currently used for database storage in many of these embedded devices allowing a mobile device to easily be used to control and monitor data on the embedded device. Often times these embedded devices are in places which are difficult to access, and this remote connectivity allows a much easier way to ensure that they are continuing to operate correctly.



This client mode can also be used to connect to multiple distributed databases, but be viewed as a single database to the device. For example, take an address book database for a company. A large company may have several divisions around the world and each office may have their own address book. A mobile device could connect to this distributed network of address lists and view them as a single list. The same thing could also be done on a smaller scale for performance. With RDMe, a very large database can be easily split into several smaller ones, distributing the load. The client mobile devices could then still view this data as a single database.

Built-In Database

This scenario would be used when the application needs to store data locally on the device, but in a way that is safe and ACID compliant. Many mobile devices only allow an application to have a single process, for better memory and processor resource management. This is often a requirement of traditional embedded systems. The built-in Transactional File Server (TFS) operates in its own thread from within the same process as the application, allowing it to take advantage of multi-core processors, yet still being self-contained. In addition, this configuration can also allow external connections to the database hosted on the device itself. Imagine a multi-player game which stores its data in a database. A user could host a game without the need of an external server and other devices nearby could directly connect through a Wi-Fi or Bluetooth connection and join the game.



Standalone

There are also occasions where neither ACID (atomicity, consistency, isolation, and durability) compliance nor external connectivity is important, however speed is critical. Take for example, a non-multi-player game. Performance usually must be excellent, however the stored data may not be that important if the device loses power, the game crashes, or quits abruptly. The stored data may be temporary for use during the current session only. In these cases, the standalone configuration of RDMe works well. There is no TFS at all, and data is directly stored allowing for extremely fast insertion and querying.

Conclusion

One can clearly see that mobile devices are the next revolution in technology. They share many of the same requirements as embedded systems which have been in existence for many years. There are many potential applications for mobile devices to work together with embedded systems. The advances and lessons learned in traditional embedded systems can directly apply to the mobile device market.

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