BlackBerry Wireless Devices in Computer Science Education

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Introduction

Research In Motion (RIM) is the designer, manufacturer and marketer of wireless solutions, such as the BlackBerry smartphone for the worldwide mobile communications market. The BlackBerry wireless device is a well-engineered general purpose communication device that presents numerous opportunities for educators and students in computer science (cs). It is based on open standards such as the Java platform so that developers can create state-of-the-art mobile applications that leverage the BlackBerry features. The BlackBerry is a unique device because it includes a Java ME virtual machine on every device, and RIM provides free Java development tools.

The BlackBerry is becoming an integral tool of many business users and consumers. And as more and more individuals are opting to use mobile phones as their primary communication device and dropping the home telephone, as well as using these devices as the computing platform of choice, it is important for students in computer related fields to finish post-secondary education equipped with the skills to allow them to take advantage of this industry. The BlackBerry provides a great platform for teaching and learning about computer science concepts at introductory and advanced levels.

With the widespread use of mobile devices such as the BlackBerry smartphone, there is a great need for innovations in the CS education to reflect today's reality. Students in introductory programming courses, for example, usually develop and test their programming assignments on a platform similar to the one on which they will be tested by the instructor or teaching assistant. But this is not the case for mobile applications, which are developed on one platform such as Microsoft Windows or Linux and deployed on a totally different platform such as the BlackBerry. Hence, there exists a great opportunity for introducing students to different programming models, and such experience will be very practical and will inspire students to be excited about learning. Those students will play a key role in driving innovations in the mobile space.

This white paper provides an overview of the BlackBerry platform and the tools that are available for students, and discusses how this platform can be integrated into the computer science curriculum.

Overview of the BlackBerry

The BlackBerry wireless device was first introduced as a mean for instant, secure, mobile access to email. Today, it is becoming an integral tool of many business users and consumers. Not only can it be used as a cellular phone, it provides organizer functionalities and is capable of executing Java-based applications based on Java ME [3]. More recent models are even equipped with built-in digital cameras, media players, Bluetooth and Wi-Fi. With so many features, it is not surprising to see the BlackBerry as one of the most popular mobile devices today.

The BlackBerry is continually evolving with more innovative models released every year. And while RIM has thousands of third party vendors developing applications for this device, with this growth and expansion of subscribers more developers will be needed to create the applications for this platform. Learning about mobile devices in today's classrooms will be beneficial to the students as well as industry.

RIM provides tools that software developers may use to program for the BlackBerry. The majority of these tools are provided free of charge to encourage development on the BlackBerry. Of these tools, perhaps the most popular one would be the BlackBerry Java Development Environment (JDE) [4], which is an integrated development environment (IDE) for the BlackBerry platform. This IDE is also equipped with a device simulator that can be used to load and test programs written for the BlackBerry. Other popular tools include the BlackBerry Email and MDS Services Simulator Package, which can emulate certain aspects of the BlackBerry Enterprise Server. When used in conjunction with a BlackBerry Device Simulator, users can simulate browsing web content, sending and receiving email messages or application data traffic. RIM also provides plug-ins for developers who are comfortable with their existing tools such as Eclipse and Microsoft Visual Studio; a list of all the tools available can be seen at [5].

Java on the BlackBerry

While some BlackBerry devices are based on C++, all new ones support Java ME primarily because Java technology makes developing applications so much easier. Its platform-independence eliminates many porting woes and its automatic garbage collector lets developers concentrate on application logic rather than memory management. RIM's support for Java ME includes development of its own Java Virtual Machine (JVM), which supports the Connected Limited Device Configuration (CLDC), and the Mobile Information Device Profile (MIDP). BlackBerry devices also come with additional BlackBerry specific APIs, however, that enable developers to create applications that have the BlackBerry-native look and feel, and are more sophisticated than standard MIDlets developed using Java ME MIDP. These APIs also provide access to many of the device's functions such as the phone, media player, browser, messaging system, Bluetooth, Wi-Fi, wireless radio, USB, sockets, etc. These classes can be easily integrated as part of any other application as the developer sees fit.

The BlackBerry in CS Education

The ACM Computing Curricula [1] lists wireless and mobile computing as an elective course under the "Net-Centric Computing" body of knowledge, and as a possible consequence few CS departments offer a course on mobile computing at the undergraduate level and those who do the focus of such a course is on theory of wireless local area networks and protocols. We believe that a course on mobile application development should be part of today's CS curriculum [7] and the BlackBerry would represent an ideal device and platform for such a course. In fact, most student activities focus on the social side of computing – instant messaging, e-mail, music, video, Internet and games rather than the basic applications. More and more students are buying wireless laptop computers and most academic computing labs are cabled desktop computers. There is a huge gap between academic environments and how students use their computers. Hence, there is a need to integrate small mobile computing devices into computer courses while maintaining some of the mainstream traditional applications.

In recent years the mobile computing community has been successful in utilizing academic and industry research efforts to bring products to the commercial market. We have seen a proliferation of consumer electronic devices taking advantage of wireless technology to enrich our daily lives with increased productivity thanks to higher connectivity. When one considers the broad range of wirelessly connected mobile devices used today, from 802.11-connected laptops to personal digital assistants (PDAs) with cellular data modems, it is clear that such network-enabled devices will continue to be increasingly important and widely used.

Integrating mobile devices into CS education can enhance and help students quickly learn and see the results of their work on a newer and more exciting medium. Regular personal computers are an excellent tool for learning and experimenting, but they are too commonplace and students may not feel a strong sense of accomplishment. In developing for a mobile device however, the student would write the software on their computer, then upload it to the device and watch the results quickly and in a novel, and potentially more personal, way.

Providing concrete modules of teaching materials, including lecture notes, labs, assignment suggestions, and tool guidelines would facilitate departments' efforts to integrate the BlackBerry and mobile application development in their curricula. To this end, RIM is supporting the Centre for Mobile Education and Research [6] at the University of Guelph to design and develop an academic kit this this purpose.

The BlackBerry in CS Courses

The BlackBerry is relevant to many of the currently taught subjects within computer science, such as programming, threading, security, distributed objects, distributed file systems, distributed transactions as well as fault tolerance and replication. These categories can be found in everyday life, some more obvious than others, for example, threading. Threading applications on a BlackBerry is essential so that users can continue inputting their data or navigating an application while a background task is attempting to retrieve information from a remote source. Since current mobile devices may not have large storage capacities, using distributed objects and remote method invocation fits in unbelievably well with mobile devices. Including mobile devices in related courses would definitely be beneficial for students to see a practical example of why distributed objects are important and useful.

In computer programming classes, learning about system models is fundamental to the development of mandatory skills required to be a successful developer. At times, applying the models to mobile devices may be more challenging than in a regular application because of the difference between platforms and architectures. Inter-process communication including sockets is best seen with mobile devices when the client must connect to the server, vice-versa or device to device.

Security is an area of great concern within all industries. Because data is transmitted over great distances through a public domain it is susceptible to various attacks; similarly, mobile devices transmit their data primarily over a wireless public medium and are susceptible to various other attacks. In total, both categories of vulnerabilities exist in mobile devices making it an excellent platform to teach and learn about security as well as experiment with.

Building reliable and stable software requires fault tolerance. With any network a standalone application that requires user input in any form can crash or be severely disrupted. Teaching fault tolerance in an environment that can be predictable as well as unpredictable helps instill a sense of thoroughness and a more in-depth skill base for developing. Being able to properly foresee any possible error or potential problems is an asset, knowing how something could possibly fail will help ensure that the program will not fail, and in the worst case provide the user with a user-friendly notice or message box indicating that there was a problem.

The BlackBerry device has been successfully integrated into lower and upper division programming courses [2], advanced courses, and senior capstone projects [7], and it has been shown that such an approach raises the level of students excitement about and satisfaction with the courses; it also increase their employment opportunities.

Introducing new topics or hardware in the curriculum such as mobile application development and mobile devices is challenging for CS departments for a variety of reasons. While creating a new course and adding it to the list of electives is a good start, offering such a course depending on faculty's availability from time to time is not a popular option with students as many of them would graduate without having a chance to take such a course. Several integration strategies have been proposed [7] for all appropriate courses across the CS curriculum.

The BlackBerry in Security Courses

As mobile devices become nearly as common if not more so than computers and laptops, the importance of security on these devices become critical. By integrating BlackBerry devices into cryptography and network security courses, students will have the opportunity to develop secure applications for the BlackBerry. Nowadays, applications that are created require developers to take security into consideration. By allowing students to develop a simple program for mobile devices that uses cryptography, students are able to see the benefits of creating secure applications versus insecure applications when everything is transmitted over the air. It will also give students the chance to solidify their theoretical knowledge of security and networking concepts by applying security concepts to a mobile device. Through this integration, students can see the similarities and differences between mobile devices and PCs with regards to security concepts and implementation.

This will give students the opportunity to learn more about the security aspects of the BlackBerry or other mobile devices. BlackBerry devices in particular are ideal because they are most commonly used in a business setting and are seen as secure devices. By incorporating the BlackBerry, students can examine the security technology used in the development of these devices.

Through the integration of mobile devices in cryptography and network security courses, students will gain a better understanding of security involved in end-to-end communication between mobile devices across various telecommunications networks. This will result in a well rounded experience for students since they will have the familiarity with developing secure applications for either mobile devices or computers.

The BlackBerry in Software Engineering Courses

Embracing mobile devices in a software engineering course is an important transition to make for multiple reasons. Mobility is an obvious industry trend and so it is important to incorporate the most current devices in programs in order to have trained graduates available for hire. Creating software for BlackBerry devices is also more appealing to students and so taking a mobile approach to a course generates enthusiasm which translates to productivity. In turn, students will become more engaged and be in prime position for the job market upon entering the workforce.

In a typical software engineering course there is usually reference to just a few traditional software life-cycle models such as Waterfall and Spiral. However, it is valuable to be aware of all of the models to see how the evolution of software development has occurred. The awareness of all the models is also beneficial because different models are better for certain applications such as mobile applications.

Testing is a component of all software development life-cycles. However, creating applications for mobile devices introduces an additional phase in the testing stages because testing should occur with a device simulator as well as the physical device itself. Simulators speed up development time but testing on the actual device itself is essential for quality products.

With the growth of mobile devices as target platforms, conventional software requirements have expanded to encompass those specific to mobile device applications. Some business requirements that have been adopted due to the inclusion of mobile devices are: (1) consistent operation online or offline; (2) seamless connectivity; (3) multi-platform support for clients; and (4) optimized power use and performance.

In a conventional distributed software programming course, mainstream network architectures are discussed such as client-server and peer-to-peer. With a mobile approach in mind, it would be convenient to discuss network architectures as they relate to accepted mobile protocols such as WAP, Bluetooth, Wi-Fi, Infrared, and Radio.

Typical desktop applications rely solely on the local resources such as processing and memory. If taking a mobile-centric approach then an emphasis should be put on service-based and browser-based models. In addition, the graphical interfaces and usability of mobile devices differs drastically from desktop applications. There are many more factors that must be taken into account such as screen size, color, and navigation.

The BlackBerry in Database Courses

Most standalone and Web applications utilize some sort of database system for managing various amounts of data in a structured environment. For mobile clients, the use of databases doesn't necessarily change but the type of database does. Most database vendors provide mobile editions of their database products such as MySQL Embedded and Microsoft SQL Compact Edition. They compare similarly in function to their full-fledged versions but differ in footprint (size), administration, and features.There are many opportunities for an instructor willing to explore the integration of mobile devices within a database systems focused course. The BlackBerry device has several options available to it with respect to interacting with database systems. The database may be localized on the BlackBerry device, as is the case with its Personal Information Management (PIM) data, and Java provides the ability to create local data storage using the Record Management System (RMS), or the database may be on a remote server. The student will be able to learn how databases on mobile devices differ from those found on standalone computers. Students will gain insight into the challenges that exist when creating databases on mobile devices because of the characteristics of such a device.The student may be asked to create mobile applications that will interact with databases on remote servers. This will provide an opportunity for the students to perform database work on the BlackBerry device as well as on the standalone machine. Interacting between two databases on the machines will further highlight the differences in database structures.

The BlackBerry in Operating Systems Courses

Given the explosive growth of mobile devices and the operating systems that empower them, covering such topics is becoming essential in operating systems courses. The BlackBerry is empowered by the BlackBerry OS which is a multi-tasking operating system that is based on ARM XScale. XScale is the implementation of the fifth generation of ARM that is based on the RISC architecture.

The BlackBerry OS is an innovative operating system that provides many features that would be very useful in an operating systems course.

The BlackBerry in Network Programming Courses

Integrating the BlackBerry into a network programming course would be relatively simple, and would not come at the expense of removing other topics to make up for the limited number of classes. Instead, the BlackBerry can be used as the platform students are to develop for during labs and assignments rather than the traditional networked desktop platforms. The instructor may choose to allocate several classes to devote to the BlackBerry or even have the entire course taught on the BlackBerry platform. Some of the mobile networked applications that students can easily develop include retrieving stock quotes from a remote server and displaying the results on the screen.

To test their application, students may use the BlackBerry Simulator along with the Email MDS Services Simulator to see how their application would look on different BlackBerry devices and in different network environments. For a more complicated assignment or project, students may develop a multiplayer game using the provided Bluetooth API.

Conclusion

As we all know, today every career path open to a Computer Science bachelor's student encompasses aspects of mobile devices and mobility. System administrators need to configure email servers for mobile users; programmers need to build applications to run on mobile devices; web developers need to port an interface for mobile users; and project managers must understand the cost and benefits of porting a system to a mobile device. The BlackBerry wireless device represents an ideal platform for introducing and teaching mobile application development in the computer science curriculum. Mobile application development need to be introduced in early courses and discussion should continue across the curriculum.

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