



Submitted on: 6/6/2014

Empowering the Library Patron: The Public Libraries of Singapore's experience with transactional services delivered through a mobile application

Ian Ong

Technology & Innovation, National Library Board, Singapore
ian_ong@nlb.gov.sg

Cindy Goh

Technology & Innovation, National Library Board, Singapore
cindy_goh@nlb.gov.sg

Lilian Chua

Technology & Innovation, National Library Board, Singapore
chua_lay_lian@nlb.gov.sg

Peter Pak

Technology & Innovation, National Library Board, Singapore
peter_pak@nlb.gov.sg



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Abstract:

The mobile phone is moving well beyond its role as a communication device. It is constantly evolving, becoming the primary enabler for a broad range of services. The attitudes and behavioural patterns of Singaporeans towards information and services have evolved to one that demands instant gratification. It is this changing lifestyle that drives the National Library Board (NLB) of Singapore's outreach strategy into the mobile space and in particular, through the use of mobile applications.

The National Library Board of Singapore (NLB) has successfully launched a mobile application that allows library patrons to check-out books using the built-in camera on their mobile phone. This article introduces the application and provides insights into how this was achieved. It also seeks to demonstrate that innovations such as this do not always need cutting edge technologies but a well architected infrastructure that focuses on service delivery.

Keywords: mobile, check-out, app, lifestyle, RFID.

1. Introduction

The National Library Board of Singapore (NLB) oversees the National Library, the Public Libraries and the National Archives. Its mission is to provide a trusted, accessible and globally-connected library and information service through the National Library and a comprehensive network of Public Libraries.

Technology is a key pillar that supports the NLB's mission of ensuring that library users have access to a rich array of information services and resources that are convenient, accessible and relevant. To that end, the NLB has put various digital and technological strategies in place to ensure that the organisation is always able to meet its obligation and commitment to deliver a top-notch user experience for all library patrons.

2. Idea Exploration

In the early part of 2012, a small group of enthusiasts from the Technology and Innovation Division of the NLB got together to brainstorm about how library services could be made even more seamless and readily accessible to the patrons. Recognizing that Singapore had one of the world's highest mobile penetration rates¹ (156.0% in Dec 2013), the team was of the mind that new innovations should revolve around mobility. The team's thought processes were then focused on the problem statement "The NLB needs to explore ways of availing our services to our patrons through their mobile devices in order to be relevant to their increasingly mobile lifestyle".

At the time, the NLB had already implemented a mobile website called 'Library In Your Pocket' (LiYP)² that allowed users to check their current loans, suss out the latest library events, read online content and so on. However, the team realised that mobile devices offer more service potential than simply accessing the LIYP functions in a mobile application. Any impetus to move to a mobile application had to be based on abilities that only a mobile application could deliver compared to a web application. A low-hanging fruit to using a mobile application would be the potential to deliver more timely and cost-effective reminder and overdue notices to the patrons. Other possibilities then began to float in our minds.

A breakthrough finally came in the form of a video that demonstrated the use of a mobile phone as an interface to an RFID-based (Radio Frequency Identification) check-out system. The NLB had already embarked on the use of RFID-based technologies some 15 years ago and this seemed to be a natural extension of that capability. The problem with this potential service was that it still required the user to bring all the items to be checked-out to a fixed location. This was no different from the current self-check stations. The team then explored the possibility of making use of Near Field Communication (NFC) technology in mobile phones to check-out items.

While that seemed like a great idea, several factors made it impractical in the NLB context. Firstly, the NLB has about 10 million RFID tagged items which are tagged withICODE 1 based RFID tags which require NXP Semiconductors based NFC hardware. This is no longer ubiquitous among NFC enabled devices. The NLB had already begun tagging new items with ISO 15693 RFID-based tags. To retag 10 million items was simply not a feasible option.

The second issue was with the availability of NFC mobile devices. StatCounter³, which measures traffic collected across a network of 3 million websites, calculated that Apple's

share of mobile devices in Singapore was at an all time high of 71.8 percent in January 2012 compared to Android's 20.38 percent. This meant that a large number of mobile device users in Singapore would not be able to benefit from the initiative since iOS devices do not have NFC capabilities without having to rely on third-party accessories. Interestingly, Android has progressively chipped away at iOS's share of the pie with 56.36 percent and 37.54 percent market share respectively.

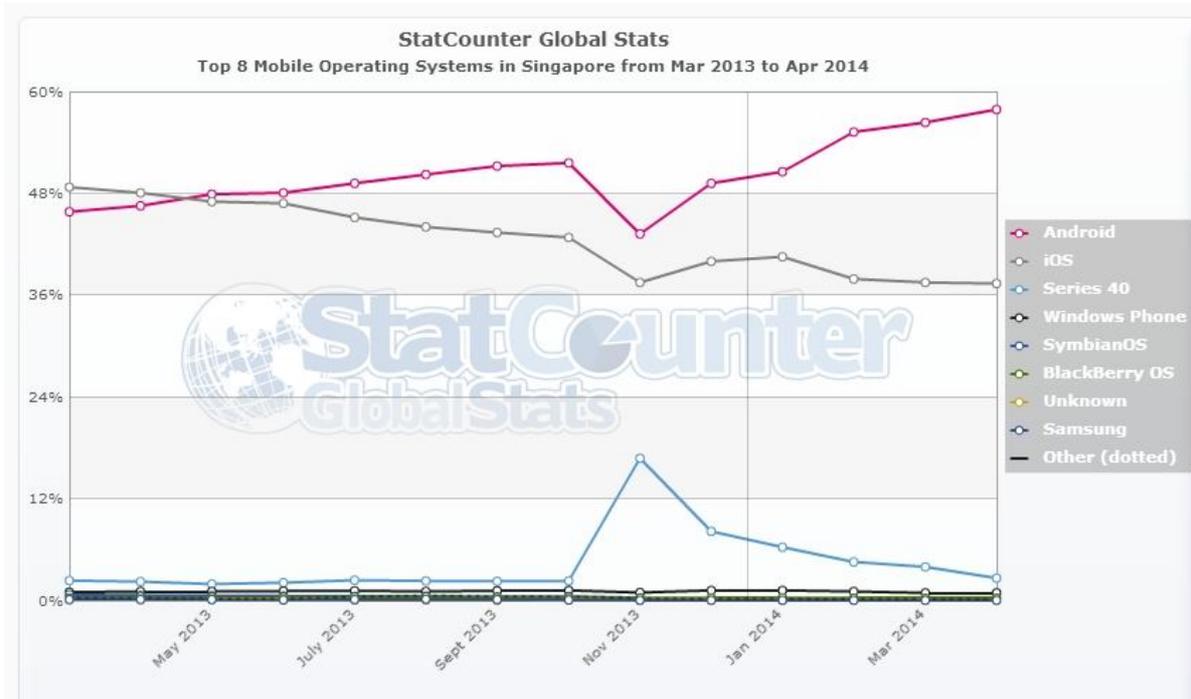


Figure 1: Top 8 Mobile Operating Systems in Singapore from Mar 2013 to Apr 2014

Common to both mobile platforms was the fact that in-device cameras, as well as the scanning of barcodes were already commonplace. Barcode scanning applications were a dime a dozen in the major app stores. This led the team to consider the use of QR codes which had the potential to expand the service beyond mere self-check because of the myriad of data types that the format supported. Unfortunately, this again required a massive retagging exercise and was not a viable option.

However all was not lost. As a legacy from the days where the NLB made use of laser scanners to check-out library materials, all items in NLB's collection have a 1D barcode with the accession number printed on both the spine label and the inner pages of books. Quick tests of barcode scanning software development kits (SDKs) on both platforms showed that most mobile devices with cameras were capable of detecting and decoding these barcodes. Thus the concept of a mobile self-check application was born.

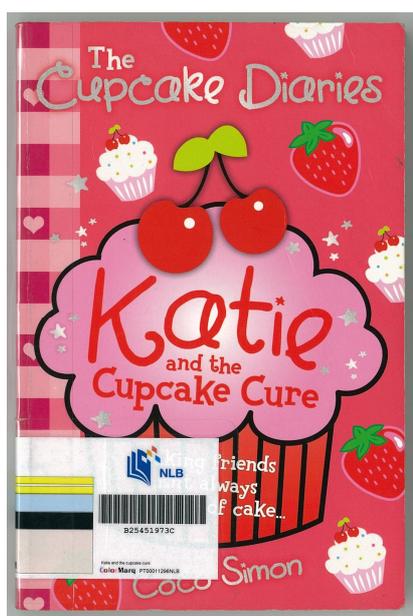


Figure 2: Barcode on cover of a book

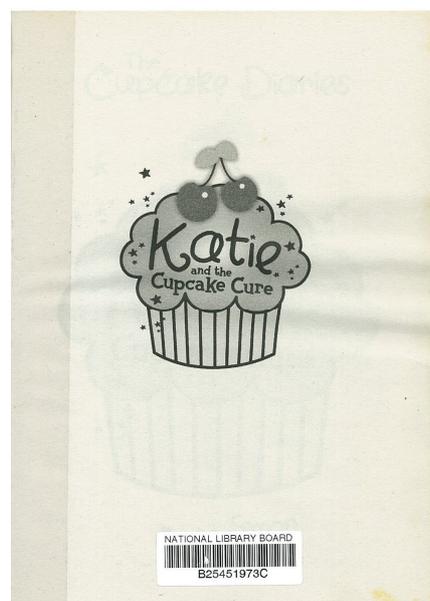


Figure 3: Barcode on inner page of a book

3. Challenges

This idea was not without its own set of challenges, key of which was related to the updating of the Electronic Article Surveillance (EAS) and Application Family Identifier (AFI) security bits on the ICODE 1 and ISO 15693 based RFID tags respectively. As previously mentioned, a solution was required to make the entire user check-out experience different from what library patrons were already used to, something that was still intuitive and did not inadvertently introduce inconveniences to them.

The search for a possible solution began sometime in November 2012 where a few ideas were explored; including even the possibility of boosting the detection field of the RFID anti-theft gates and enhancing them to disarm the items as the patron walks through gates carrying checked-out items. Whilst this was ideal, it required major infrastructural changes to be made. For example, the existing tags and gates were based on High Frequency (HF) technologies whereas Ultra High Frequency (UHF) RFID technology was needed to accomplish this task.

4. Pushing Known Boundaries

The team then made a most radical move to explore the possibility of allowing an item to be checked out without disarming the tag. This would require the security gates to then be aware of the checked-out status of these items and not sound the alarm when a patron walked through the gates. This was an idea that many team members had doubts about. Concerns over detection rates, response times, replication speeds and so on were raised. Various scenarios and possibilities were explored and tested before the final solution was chosen.

5. Final Design

The system that was finally implemented made use of no new state-of-the-art technologies. Rather it was designed around the innovative use of existing technologies and infrastructure. The diagram below provides an overview of the mobile check-out ecosystem.

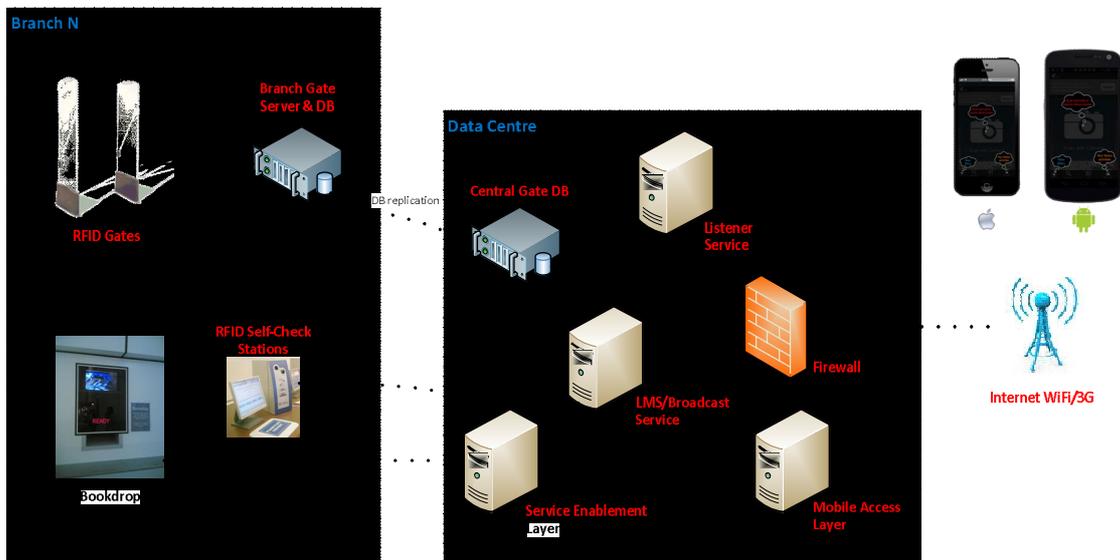


Figure 4: Overview of the Mobile Check-out Ecosystem

Smart Gates

A key highlight of the solution was the enhancements of the RFID gates. This involved making small firmware changes to make the gates go beyond simply just checking for armed security bits and sounding the alarm if detected. The gates now also check if an item is listed in an onsite local database of borrowed items before sounding the alarm. For every item that is checked-out or checked-in, the LMS broadcast service will send out this information which is received by the listener service. The listener service then writes this information to the central database which is then replicated to all 26 branches almost instantaneously. At a peak of some 80,000 transactions in an hour, the impact on the detection and response speed of the RFID gates was negligible.

A side benefit of the solution was the complete removal of gate alarm incidents where items were checked-out but not successfully disarmed due to aging or damaged RFID tags.

Mobile Enablement of Library Transactions

Like any typical mobile application for libraries, the application allows patrons to:

- Perform library catalogue searches
- Make reservation of items that are not available

- Track search histories
- Have recommendations made based on their loan history
- View the latest arrivals to the libraries
- Locate nearby libraries based on their current location
- Easily obtain library addresses, operating hours and directions
- View library events for each library

In addition, the application also provides patrons with the ability to setup multiple library accounts as profiles and gain quick access to individual account statuses.

A Mobile Check-out System

The service industry is increasingly turning to self-service as a means to manage manpower scarcity. Supermarkets were one of the early pioneers in this area. In Singapore, there are now trials to allow customers to check-out items while they shop, paying only after they have finished shopping.

Similarly, the mobile check-out application will help reduce waiting at the self-check stations, which would in turn speed up the borrowing experience, and avoid the need for paper receipts since patrons would be issued digital receipts instead.

Because patrons are now able to check-out items by simply scanning the barcode on library books, they no longer need to bring their national identity or library cards with them when they visit the library. This also simplifies the borrowing of items using multiple cards – a very common practice in the Singapore where entire families would visit the libraries.



Figure 5: Barcode Scanning to Check-out an Item

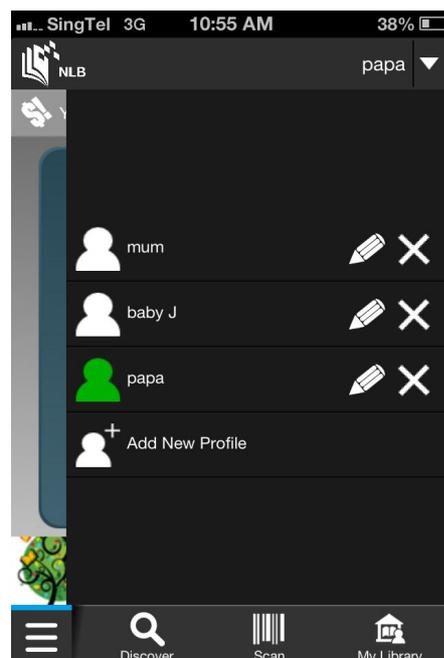


Figure 6: Multiple Patron Profiles

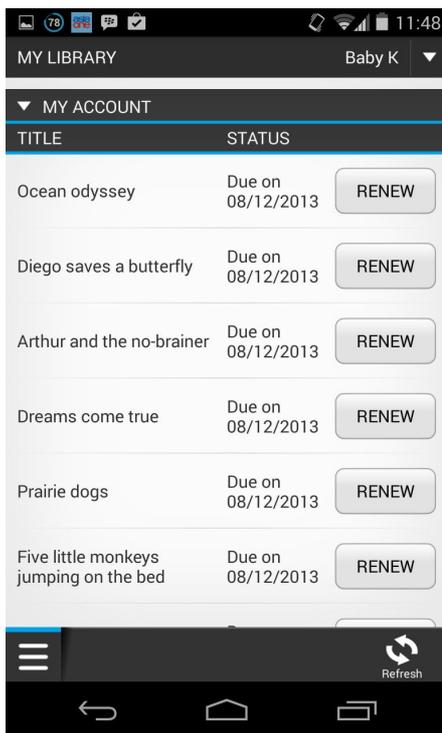


Figure 7: Current Loans and Renewal

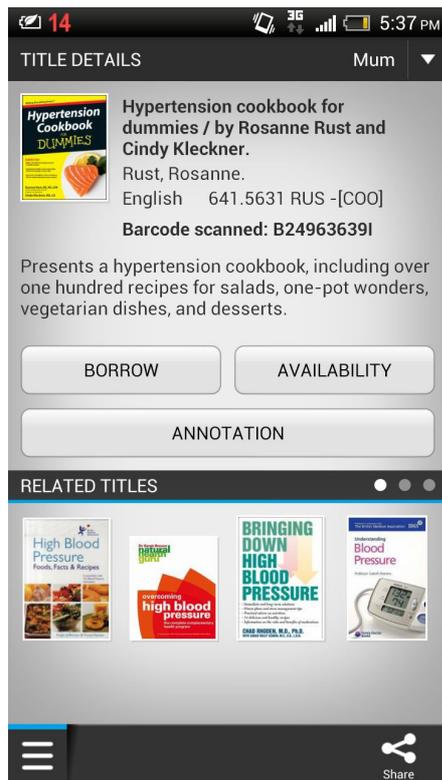


Figure 8: Item Details and Check-out



Figure 9: Library Details

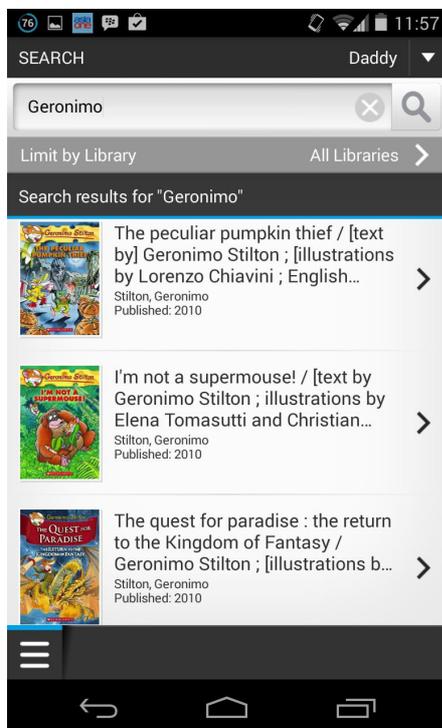


Figure 10: Catalogue Search

6. Refining the User Experience

Prior to the launch of the application, the team embarked on a week long public user trial. This trial was intended to gain an insight into how library patrons from all walks of life might use the system and how the app might be tweaked to improve its usability and interface.

This trial highlighted several interesting points:

- Despite a smartphone penetration rate of 78% in 2013⁴, several users, particularly the elderly, use their smartphones only to make phone calls. They have little experience in using apps
- Data caps of 2 - 5GB⁵ imposed by the local telecommunications service providers have resulted in some users being unwilling to use the service
- User experience of the app varies across mobile phones - in particular Android devices
- Even amongst identical mobile phone models, the reliability of the camera to focus on the barcode varies

7. Beware of Feature Creep

The temptation to develop apps that behave like Swiss Army Knives is great. Organisations that want to roll out mobile apps often have to grapple with this dilemma which also presents the risk of feature creep. To curb this tendency, the team had to constantly remind itself that one of the reasons why mobile apps are so popular is because they are designed to carry out common tasks quickly and efficiently.

A poll⁸ commissioned by EffectiveUI, a user experience (UX) agency found that mobile phone users downloaded apps based on recommendations and good user experience rather than the reputation of the company behind the app. 73 percent of mobile app users expected a mobile app to be easier to use than the website of the organisation. 74 percent thought that a mobile app should be easy to use and 75 percent thought that it should do exactly what they need it to do.

8. Service Enablement Layer

With the service concept better crystalised in our heads, requirements gathering to develop the service began in March 2013. The very first prototype was ready for testing one month later. This rapid development would not have been possible without the adoption of agile development principles and NLB's own Service Enablement Layer.

NLB adopted the concept of a Service Enablement Layer some 15 years ago and that has since evolved to become the foundation of almost 90% of all of NLB's public facing systems. The aim of this layer is to have an agile and adaptive architecture to support the rapid changes of Singapore's landscape. Having this architecture in place has helped NLB to promote solution/software reuse and standardization, allowing for a more optimized use of IT resources and cost savings.



Figure 11: NLB's Service Enablement Layer

9. What's Next

The discovery of the new service possibilities have encouraged the team to push the envelope of the technology even further. Several enhancements are already in the pipeline for subsequent releases, not least of which is the use of notification services from Google Cloud Messaging (GCM)⁶ and Apple Push Notification Service (APNS)⁷ for the Android and iOS versions of the application respectively. The potential cost savings from this implementation would average some \$100,000 a year, based on NLB's current volume of about 4 million SMS messages per year in the form of reminder notifications.

Online payment has long been on the wish list of library patrons that will be enabled in a future update. The idea is to allow patrons to quickly and simply pay outstanding fines or charges that would otherwise bar them from borrowing more items from the library.

10. Conclusion

Libraries need to constantly adapt their services to meet the needs of their patrons. With society adopting an increasingly mobile lifestyle, it is imperative that libraries also focus on the mobility of its services to match this lifestyle.

Furthermore, by leveraging on the fundamentals of self-service and BYOD (bring your own device), the NLB has managed to take one bold step towards addressing the twin challenges of escalating costs and manpower dependency.

The innovative approach stretches the potential of a mature technology without the need for the massive deployment of expensive new infrastructure. All that was required was a well architected design and supporting infrastructure that allowed for a simple tweak of existing native capabilities of the technology to achieve the desired outcome.

It is gratifying to note that the application itself can be readily adapted to meet other service requirements that involve the online check-out of books such as mobile book kiosks and pop-up libraries. We are excited by the prospect that the app may one day replace the comparatively bulky self-check stations.

As we journey on in our bid to further our mobile service agenda, we are mindful that app and service design is not without its challenges. Rolling out a mobile app is neither a precise technical discipline or a walk in the park. Much planning and testing is required to develop an app that is user friendly and useful. After all, the whole point of rolling out the library app is to improve the patron's library experience. All apps or services must be designed with the end-user in mind.

References

1. Statistics on Telecom Services for 2013 (Jul – Dec) – Infocomm Landscape – Infocomm Development Authority of Singapore.
Available from: <http://www.ida.gov.sg/Infocomm-Landscape/Facts-and-Figures/Telecommunications/Statistics-on-Telecom-Services/Statistics-on-Telecom-Services-for-2013-Jul-Dec>
2. Library in Your Pocket
Available from: <http://m.nlb.gov.sg>
3. StatCounter Global Stats
Available from: <http://gs.statcounter.com>
4. Aaron Tan. Smartphones and tablets a growing hit among Singaporeans. The Straits Times Jun 18, 2013
Available from: <http://www.straitstimes.com/breaking-news/singapore/story/smartphones-and-tablets-growing-hit-among-singaporeans-20130618>
5. StarHub to follow SingTel's move to cut data for consumers. DigitalOne Jun 4, 2012
Available from: <http://www.digitalone.com.sg/news/article/19237>
6. Google Cloud Messaging for Android | Android Developers
Available from: <http://developer.android.com/google/gcm>

7. Apple Push Notification Service – Apple Developer
Available from:
<https://developer.apple.com/library/ios/documentation/NetworkingInternet/Conceptual/RemoteNotificationsPG/Chapters/ApplePushService.html>
8. New Study Finds Mobile Application Users Prefer Usability and Good User Experience Over Brand Names Alone. EffectiveUI, Inc. Nov 10, 2010
Available from: <http://www.effectiveui.com/newsroom/press-releases/11-10-2010.php>