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A standardization Initiative for Mobile Applications

ISO/IEC JTC 1 SWG-Planning

Background

Given the rapid adoption of mobile devices for a growing range of applications, mobile application development and sourcing are becoming even more critical to IT. Mobile carriers and mobile handset and software platform vendors are making it more economical and scalable for businesses to reach out with improved content and value propositions to large numbers of consumers. However these kinds of efforts make some fragmentation problem in today's mobile market in particular for developers. Discrepancies among devices and platform/OS made it exceedingly hard for developers to create hundreds of versions of mobile application in order to reach a worldwide market.

This report investigates the current issues in fields of mobile application includes from the technology perspective to standardization opportunities.

1. Scope

This document intends to provide an overall review on the specified topics of *Mobile Applications* in terms of exploring standardization opportunities. The SWG-Planning will make the report based on this review results.

This report deals with:

- reviewing definition, service type, ecosystem and key feature of the Mobile Applications;
- reviewing the related technologies for Mobile Applications;
- reviewing the development issues for Mobile Applications;
- reviewing business perspectives of Mobile Applications;
- analysing standardization activities of Mobile Applications in relevant SDOs;
- proposing prospective standardization areas and topics toward ISO/IEC JTC 1, and;
- suggest the recommendation to ISO/IEC JTC 1

2. References

This document refers to the following standards, specifications, articles and papers:

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3. Terms and definitions

3.1. Terms defined elsewhere

This document uses the following terms defined elsewhere:

(TBD)

3.2. Terms defined in this report

This document defines the following terms:

(TBD)

4. Abbreviations, acronyms and conventions

This document uses the following abbreviations and acronyms:

3GPP	3rd Generation Partnership Project
API	Application Programming Interface
B2B	Business-to-Business
CSS	Cascading Style Sheet
cHTML	Compact HyperText Markup Language
DAP	Device API and Policy
HTML	Hyper Text Markup Language
HTML5	HTML version 5
HTTP	Hypertext Transfer Protocol
GSMA	GSM (Global System for Mobile Communication) Association
IETF	Internet Engineering Task Force
iOS	iPhone Operating System
LBS	Location-based Service
LTE	Long Term Evolution
MWABP	Mobile Web Application Best Practice
MWBP	Mobile Web Best Practice
NFC	Near Field Communication
OMA	Open Mobile Alliance
OMTP	Open Mobile Terminal Platform
OS	Operating System
OPENGL	Open Graphics Library
OTT	Over-The-Top
RCS	Rich Communication Suite

RIA	Rich Internet Applications
SIP	Session Initiation Protocol
SNS	Social Network Service
SOAP	Simple Object Access Protocol
SVG	Scalable Vector Graphic
UGC	User Generated Contents
W3C	World Wide Web Consortium
WAE	Wireless Application Environment
WAC	Wholesale Application Community
WAP	Wireless Application Protocol
WOFF	Web Open Font Format
WML	Wireless Markup Language
XML	eXtensible Markup Language

5. Introduction to Mobile Applications

5.1. Definition of Mobile Application

It is a term used to describe Internet applications that run on smartphones and other mobile devices. Mobile applications usually help users by connecting them to Internet services more commonly accessed on desktop or notebook computers, or help them by making it easier to use the Internet on their portable devices [1].

Mobile application is a software application that runs in a mobile device such as a smartphone and it runs over the mobile platform or OS such as Android, iOS, Windows Mobile, Symbian and etc.

5.2. Classification of Mobile Applications

Many mobile applications, such as SMS/MMS clients, browsers and music players, pre-installed on mobile phones, whereas others may be provisioned and/or configured post-sales. For example, user can download applications over the wireless network and then install them themselves, or they can have them loaded and installed in the mobile operator’s store. Regardless of how they’re delivered to users, mobile applications are a large and continuously growing market and served by an increasing number of mobile application developers, publishers and providers [4].

In general, the mobile applications have been developed in many ways which rely on the mobile platform or operating system which is referred by the native application. For instance, some applications have been developed by proprietary API supported by mobile platform such as Android, iOS, Windows Mobile etc. Recently, some mobile applications have been developed by Web-based API in order to make sure the platform neutrality. For this approach, there are some related standardization activities such as W3C Device API [23], WAC [24].

From a service point of view, the mobile applications can be categorized in many ways and the Table 1 shows the example of mobile application categories.

Table 1: Example of mobile application categories

Mobile Application Categories	
- Books	- Navigation
- Business	- News
- Education	- Photography
- Entertainment	- Productivity
- Finance	- Reference
- Games	- Social Networking
- Healthcare & Fitness	- Sports
- Lifestyle	- Travel
- Medical	- Utilities
- Music	- Weather

5.3. Ecosystem for mobile applications

Mobile industry probably has one of the most extensive ecosystems. Ecosystem is the set of players who come together to deliver the experience or product to consumer in any industry. The mobile industry has been expanding its scope and hence the number of ecosystem players. Typically, the key actors in the value chain are operators, handset vendors, content owners, developers, publishers, aggregators, content distributors, advertising platform owners, advertisers, mobile platform owners and regulators [5].

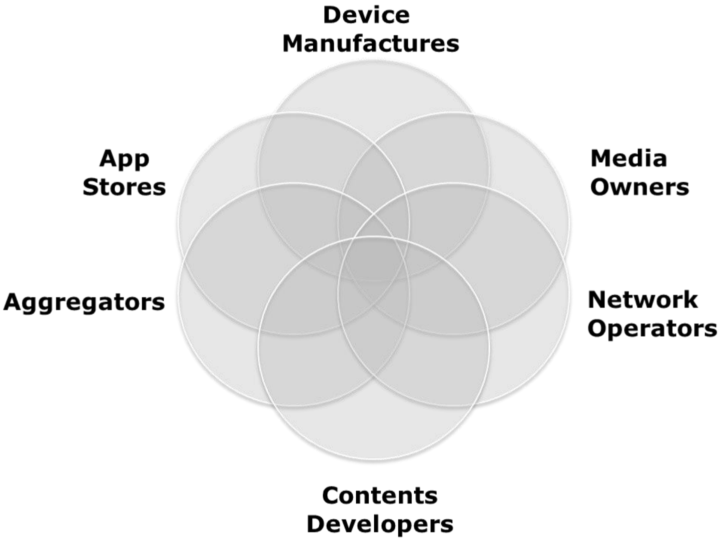


Figure 1: Mobile Ecosystem

Today, the mobile ecosystem consists of device manufacturers, network operators, media owners, content producers, aggregators and App stores [21] (see Figure 1).

- Device Manufacturers: They are continually developing new mobile handset for the market. They are the innovators responsible for using the latest hardware with the software platform that each handset model runs on. The manufacturers determine the Operating System (OS) used by the device, which can also determine the devices' feature and capabilities.
- Network Operators: They manage the network adopted by the consumer. The operators provide the services and channels of content that are accessed by their subscribers.

Operators are also known as carriers. They are always looking for ways to improve services to bring more subscribers to their network.

- Media Owners: They own the right to distribute particular content effectively. Media owners want to be able to distribute their brands to as many domains as possible. Like the manufactures, media owners want to distinguish their brands ensure that they stand out from the crowd.
- Content Producers: They represent the designers and developers who produce mobile content. They often work with the brand guidelines from the media owners to design, develop, and produce mobile contents. Content Producers are also known as application developers.
- Aggregators: They syndicate and distribute mobile content through online portals and also to the network operators ready for consumption by the consumer. Aggregators were early adopters of syndicating mobile contents, who saw great potential of collecting mobile content developed by third-party content producers and distributing it.
- App Stores: Consumers can find content to install on their mobile devices from App stores. Some App store such as the Apple's AppStore allows an individual developer or third-party content producer to sale their content directly without network operators or device manufacturers.

So far, the industry developed in a way that the control over the value chain was that of a mobile operator as in the past, the mobile operator took the onus of taking all the risks in delivering mobile services to the consumer. The other players in the ecosystem could not develop the direct relationship with the consumers as either they were risk averse or the nature of business was such that the direct relationship was not feasible. The situation in the adjacent computer industry is entirely different as the standards are open with unrestricted access to Internet. Under the circumstance, the need of open mobile ecosystem is substantially increased to make sure the various business opportunities.

5.4. A key feature of mobile applications

In general, the application in mobile environment is differentiated with legacy application of wired environment. Most outstanding features of mobile applications can be summarized with mobility, immediacy and sociality:

- Mobility: Consumer can use the application on the move. It means that the application can utilize the location-based information to support differentiated services.
- Immediacy: Consumer can use the application immediately. It means that mobile users expect to have the right application at the right time. Because they are often on the go, they may need to use a mobile application immediately to find a price, transfer funds, or update their status.
- Sociality: Generally, most of mobile applications are running on the phone and there is contact information within phone. Using this information, the mobile consumer expects to have various socialized services such as mobile SNS.

With combination of above features, the mobile application can have more business opportunities compare to legacy applications.

Also, Gartner has identified what it believes will be the most important mobile applications in 2012. Focusing on high-end devices with an average selling price (ASP) of more than $300 dollars, analysts have identified the top 10 cutting-edge technologies and trends for 2012 [22].

Mobile applications will be a highly competitive marketplace that attracts the interest of many stakeholders. Increasingly, mobile applications will define the user experience on high-end devices and device vendors that proactively integrate innovative apps and technologies at the platform layer will have the competitive edge.

Gartner's top 10 consumer mobile applications to watch in 2012 include:

- Location-based services (LBSs): Location is one of the main enablers that deliver services to users based on their context and, Gartner expects the total user base of consumer LBSs to reach 1.4 billion users by 2014. LBS strive to deliver features and functionalities in tune with the user's context, taking into account the user's location, personal preference, gender, age, profession, intention and so on, thus offering a more-intelligent user experience than basic location services can. Gartner analysts believe context-aware services are a key trend for mobile apps, and location is a key enabler of that.
- Social networking: Mobile social networking is the fastest-growing consumer mobile app category of the 19 tracked by Gartner. Social network platforms are sucking in increasing amounts of network traffic. They are becoming portals, transit hubs and cloud storage for increasing amounts of messaging and e-mail traffic, videos, photos, games and commerce. As mainstream adoption progresses, global social sites will be driven toward providing services in partnership with third parties using open APIs, and are likely to evolve to a role as infrastructure providers acting as data warehouses and providing user data and access to the more-consumer-facing brands.
- Mobile search: Visual search is usually related with product search to enable price comparisons or to check product information. To bring mobile search to the next level, the app would allow users to take actions based on the result, such as making a call or reservation, buying a ticket, placing an order, and so on. Gartner advises search providers to build the experience around mobile to allow users access to immediate results and to take actions, given the short time span users have. Mobile device vendors should partner with or acquire promising search providers to integrate the technology, preferably at the platform layer, to offer a differentiated user experience.
- Mobile commerce: Today, mobile commerce is more of an extension of e-commerce but in a smaller form factor and with a more-streamlined experience. However, over the next 24 months, Gartner expects the emergence of uniquely mobile functions, such as the ability to "check in" to a store to alert a retailer that you are there, or the ability to add items to a shopping cart simply by taking a photo of an item or bar code in the physical store. In the future, Gartner expects richer mobile commerce capabilities to expand from native apps to the mobile browser as HTML5 starts to be deployed, though this will happen at a much later stage.
- Mobile payment: Although near field communication (NFC) payment will be included in high-end phones from 2011, Gartner does not believe that it will become mainstream before 2015. In order to get consumers on board, payment solution providers need to address ease-of-use for users and ease-of-implementation for customers without compromising security. They also need to increase user awareness, extend the service coverage and address ease-of-use to appeal to end users.
- Context-aware service: Context-aware applications provide improved user experiences by using the information about a person's interests, intentions, history, environment, activities, schedule, priorities, connections and preferences to anticipate their needs and proactively serve up the most appropriate content, product or service. Mobile carriers, along with handset manufacturers, should provide expanded location services to include, among others, directory assistance, mapping, advertising and privacy controls.

- Object recognition (OR): High-end devices have an increased sensor and processing capability that enable sophisticated applications to recognize the user's surroundings, including specific objects of interest. Because OR provides an easy-to-use interface, more apps will come to the market with enhanced capabilities by 2012. Users will rely on the camera, as well as other device sensors as a communication tool when OR capabilities are combined with more-traditional app functions, giving users advanced search capabilities and a plethora of entertainment and productivity functionality.
- Mobile instant messaging (MIM): Gartner expects MIM to attract consumers to new types of unified communication (UC) client, provided by over the top (OTT) service providers such as Skype. These service providers are threatening traditional communications service provider voice revenue. Companies that consider including MIM into new products should consider integrating it with other communications types, such as location and presence, but be cautious about developing other functionality, such as federation of social network activity.
- Mobile e-mail: Smartphones have begun to drive the mainstream adoption of mobile e-mail through a series of technology enhancements enabling low-cost mobile extensions to existing e-mail service. Gartner expects mobile e-mail users worldwide to increase from 354 million in 2009 to 713 million in 2014, to account for 10.6 percent of the global mobile user base. E-mail addresses are personal and potentially extremely sticky, thus provide carriers, e-mail service providers and OTT players with an opportunity to lock in consumers. Technology and service providers should consider how they can make it easier for consumers to use their affiliated mobile e-mail services as a way of ensuring long-term engagement with customers.
- Mobile video: Mobile phones with larger screens and media tablets offer the ideal platform for video consumption and with careful marketing and consumer education, Gartner believes that carriers and content providers would be able to drive mobile video usage in the coming years. Mobile carriers should partner with YouTube and other popular video providers, so that users can replicate their Internet behaviour on their mobile phones, while mobile device manufacturers should integrate HD and 3D capabilities in their high-end devices and look to bundle content either as pre-loaded or as free downloads through an app store.

5.5. Limitation of mobile applications

One of the big challenges of mobile application is its hardware and software platform capability and limitation even getting better. Beside the interesting usability of mobile application they have some more interesting platform problems and limitation. The following are known limitations of mobile application development:

1) Screen size: In mobile device, it is little difficult to view text and graphics like a desktop computer screen due to the small and different screen size in mobile device. Meanwhile, various kinds of mobile devices such as tablet PC have released recently. Therefore, from the mobile application perspective, the user interface design where they have different screen size should be optimized in mobile environments. Regarding this, W3C has initiated to provide the mobile web best practice (MWBP) and mobile web application best practice (MWABP) [27].
2) User Interface: Since the small and various screen size in mobile devices, the application developer should consider the optimized user interface design such as menu design and navigation path.
3) Development API: Since there are many mobile platform and OS which have their own application program interface (API), it is hard for developer to create the mobile application to support those different platform and OS by re-using of source code. Recently, there are

some standards initiatives to provide the common API for mobile application development using Web-based interface from W3C [23], WAC [24].

6. Related technologies

6.1. Mobile Platform & OS

A mobile operating system, also known as a mobile OS, a mobile platform, or a handheld operating system, is the operating system that controls a mobile device or information appliance — similar in principle to an operating system such as Windows, Mac OS, or Linux that controls a desktop computer or laptop. However, they are currently somewhat simpler, and deal more with the wireless versions of broadband and local connectivity, mobile multimedia formats, and different input methods [6].

Typical examples of devices running a mobile operating system are smartphones, personal digital assistants (PDAs), tablet PC and information appliances, or what are sometimes referred to as smart devices, which may also include embedded systems, or other mobile devices and wireless devices.

Table 2: Mobile Platforms [6]

Unix-like	Linux-based	Access Linux ·Android (Baidu Yi ·OPhone ·Replicant) ·bada ·Tizen (MeeGo ·Moblin ·Maemo ·Qt Extended) ·SHR (OpenEmbedded ·Openmoko Linux ·Qt Extended Improved ·Ångström Linux-based) ·webOS
	Other	BlackBerry Tablet OS ·iOS
Other	BlackBerry OS ·GEOS ·Nintendo DSi ·Nintendo 3DS ·Nokia OS (S30 ·S40) ·PSP ·Symbian (History ·MOAP(S) ·UIQ ·S60 ·S80 ·S90) ·Windows CE (Windows Mobile ·Windows Phone)	
Related Platforms	BREW ·Java ME/JavaFX Mobile ·LiMo	

6.2. Mobile Applications Store

With the popularity of Apple's iPhone mobile-application store growing and competitors Palm and Google teeing up their efforts, the number of smartphone users tapping into mobile application stores are expected to reach 100 million in 2013, according to a research report released Tuesday by In-Stat [7].

These smartphones are built on an open platform that can accept applications from any developer who writes programs for that particular mobile operating system and are sold, or distributed freely, via a mobile-application store, rather than through the phone's carrier.

As smartphones become more affordable, emerging markets will widen the opportunity for mobile application stores. As many people in these markets use a mobile phone as their primary computing device, the opportunities will be even wider for developers, but content needs to be appropriate. Local-language support is essential, and incorporating local celebrities, cartoons and so on into content will increase its popularity. Applications must also be priced appropriately as the disposable income of many consumers in these markets is limited.

From the technology perspective, the mobile application stores can be divided into two areas:

1) The native app store such as Apple’s AppStore and Android’s Marketplace etc. For the native app store, the mobile applications in the store are the native applications developed by proprietary platform or OS. (Figure 2)

2) The web store such as Google's Chrome Web Store [25] and OpenAppMkt [26]. For the web app store, the mobile applications in the store are the web application such as widget or URL which is running on the web browsers or web runtimes.

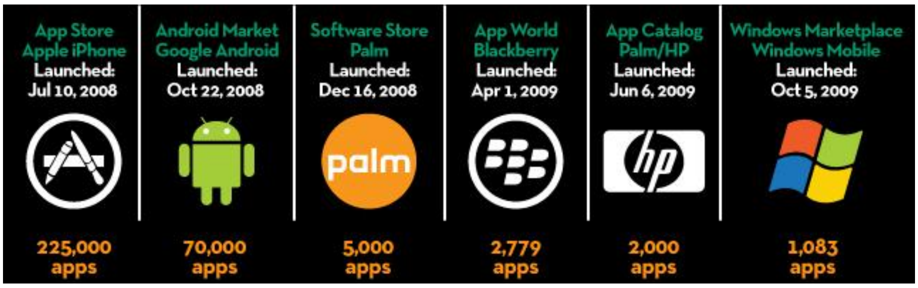


Figure 2: Major mobile application stores

Since there are many mobile application stores, the developer has some limitation to create and deliver the mobile application for every different mobile application store. Thus, it may need to reduce development costs and to maximize the revenues from standardized application store, for instance it allow developers to use single source code by using of common interfaces.

6.3. Mobile Application Protocols & Services

Mobile application protocols are specified in the Wireless Application Protocol (WAP) standard. The WAP standard was created in an attempt to provide real-time interactive data over a mobile network by integrating telephony, wireless data and the Internet so that data transmission conforms to and is accessible by hand-held devices. Four mobile application protocols (WP-TCP, TLS, WP-HTTP) were created for use on IP networks and another three protocols (WSP, WTP, WDP) for use on non-IP networks:

3) Wireless Profiled TCP (WP-TCP)
4) Transport Layer Security (TLS)
5) Wireless Profiled Hypertext Transfer Protocol (WP-HTTP)
6) Wireless Session Protocol (WSP)
7) Wireless Transaction Protocol (WTP)
8) Wireless Transaction Protocol (WTP)
9) Wireless Datagram Protocol (WDP)

However, currently WAP is no longer available due to the many reasons, for instance incompatibility with legacy Web and closed service by operators known as a walled-garden-service.

In 2002 the WAP Forum was consolidated (along with many other forums of the industry) into OMA (Open Mobile Alliance) [28], which covers virtually everything in various development of mobile application protocol and services including in fields of P2P communications, Device Capabilities, Access to Contents, Service Access Interface, Service Customization (See 9.3 for detail information).

For content description in mobile, Wireless Mark-up Language (WML) has been popular since it was born in 1999. WML was developed for WAP with limited connection bandwidth and small screen of mobile devices. It's different than HTML since its programming is more complicated than HTML. For this reason, some carriers and phone manufacturers felt that the wireless mark-up even XHTML Mobile Profile (XHTML MP) should evolve in the direction of HTML to make developers' lives easier.

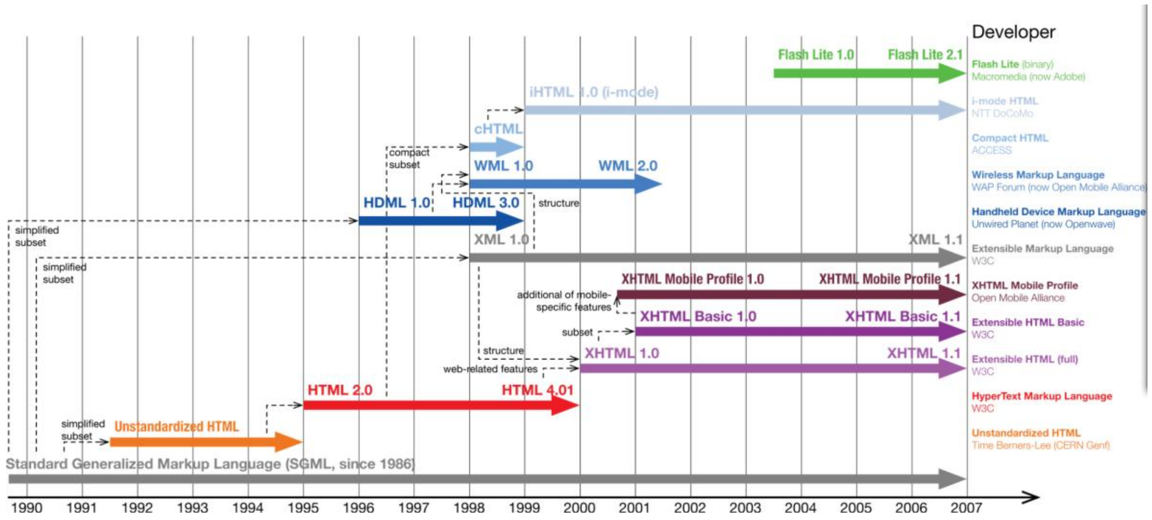


Figure 3: Evolution of Mobile Markup Language [20]

Recently, with wide spread of smartphone in the world, the mobile devices (browsers) can support to use the legacy Web contents and services with some authoring guideline, for instance W3C's Mobile Web Best Practices 1.0 and Mobile Web Application Best Practices [27].

7. Development of Mobile Application

Mobile application development is the process by which application software is developed for mobile devices such as feature phone, smart phone and tablet PC and so on. These applications are either downloaded by customers from various mobile software distribution platforms such as application store or running by web browser such as Web application.

7.1. The types of mobile application development

For mobile application development, there are three ways of implementation method including native application, web-based application and hybrid application.

- **Native mobile applications**: An application designed to run in the mobile environment (machine language and OS) being referenced. The term is used to contrast a native application with an interpreted one such as a Java application that is not native to a single platform. The term may also be used to contrast a native application with an emulated application, which was originally written for a different platform.
- **Web-based mobile applications**: An application in which all or some parts of the software are downloaded from the Web each time it is run. It may refer to browser-based applications that run within the user's mobile Web browser or to rich client applications that resemble local applications.
- **Hybrid mobile applications**: An application designed by Web-based application and run as a native application by using of cross-platform development tools.

7.2. Development environments for mobile applications

Each of the platforms for mobile applications also has an integrated development environment which provides tools to allow a developer to write, test and deploy applications into the target platform environment. Appendix II summarises the elements in each of the development environments.

7.3. Technical Issues on mobile application development

7.3.1. Mobile Fragmentation

In the world of mobile today, there is a vast range of mobile features, applications and services that can be found on an equally wide range of mobile devices and platforms. Because of this wide range however, mobile developers are discovering a key issue in mobile, which is Fragmentation. With mobile being such an exciting and promising venture, it pays to know what exactly mobile fragmentation is, and why it is seen as an issue.

This multiple different platform (different OS) poses a serious issue then. To design and develop applications specific to each of the major platforms and devices around the world is highly inefficient cost wise in both the short term and the long term, especially when we consider that developers would have to provide software updates for the application on each device. Hardware diversities, Software diversities, User Preference diversities, Implementation diversities, and Environment diversities all contribute to a long list of aspects that developers encounter when designing an application for mobile and for the various platforms and devices.

With these diversities just being the general groups, and not even the more intricate obstacles in development, we begin to see a more vivid illustration of just how big an issue mobile fragmentation can be. Some developers believe however that there is in fact a “magic bullet” in the form of potential unifying technology that will make the whole process of development significantly simpler and easier. On the other hand, however, many leading figures in the world of mobile argue that not only is the “magic bullet” a myth but that, mobile fragmentation is not even a true problem and it instead promotes healthy competition and diversity in the mobile world that mobile users actively desire.

What all this means for many developer’s is that when designing an application for instance, they must either focus the application for a single device or platform, or develop the application for the major range of devices and platforms. This poses serious cost inefficiencies and ultimately effects application users, developers, content providers and distributors, network operators and device manufacturers. Despite these seemingly detrimental effects however, there is still a strong debate as to whether mobile fragmentation is indeed ‘detrimental’ or whether it promotes healthy competition for mobile. Only time will tell however, if the developers seeking the “magic bullet” that will allow for ultimate de-fragmentation of mobile, are chasing a mobile innovation or a fantasy [8].

The fragmentation is the inability to "write once and run anywhere". More formally, it is the inability to develop an application against a reference mobile environment (e.g., hardware/software). Within the context of software, the mobile fragmentation can be caused by platform diversity and implementation diversity.

- **Platform diversity**, such as differences in platform/OS, API standards, optional APIs, proprietary APIs, variations in access to hardware (e.g., full-screen support, access to local storage), and differences in multimedia support (e.g., codecs), maximum binary size allowed, etc.
- **Implementation diversity**, such as quirks of implementing standards (different interpretations of the standards, bugs, etc.). Incidentally, fragmentation resulting from implementation bugs/quirks is one of the most tiresome types of fragmentation.

As a result, in order to minimize these kinds of diversity, it might have to identify the common requirements for standardisation in the development of mobile applications.

7.3.2. General Architecture for mobile application

A mobile application will normally be structured as a multi-layered application consisting of user experience, business, and data layers in the client side (mobile client application). And it also communicates with server side (mobile support infrastructure) to exchange the information. Figure 4 shows an example of common mobile application architecture with components grouped by areas of concern.

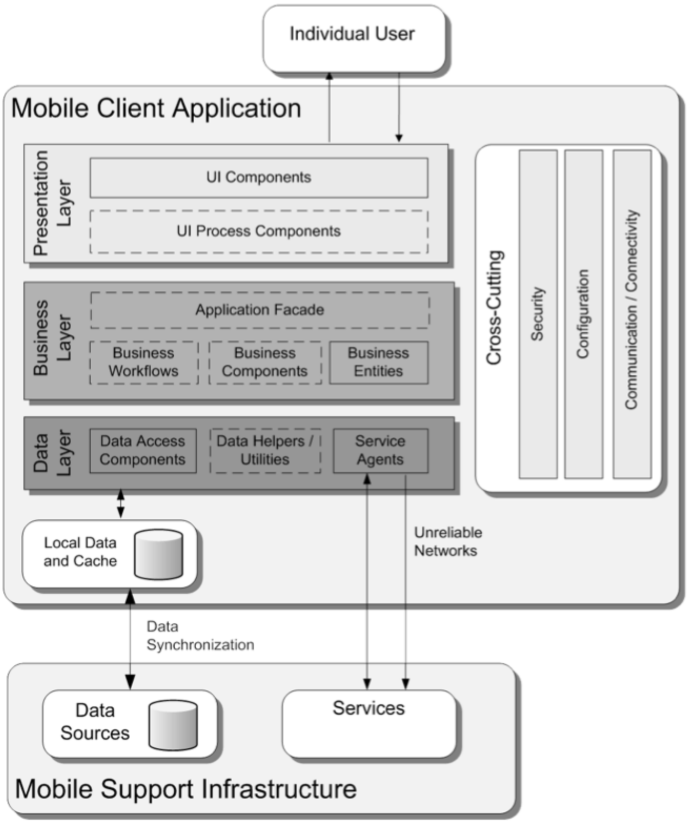


Figure 4: Example of common mobile application architecture [31]

For development of mobile application perspective, generally there are lots of issues to be considered such as authentication/authorization, caching and synchronization, internal and external communication, configuration management, data access, device information, user interface (UI), application packaging/delivering/store, security, etc.

Therefore, it might have to identify the common requirements for standardisation in the development of mobile applications as well.

7.3.3. Mobile Security

Rapid adoption of mobile devices and mobile applications has created a significant and unbounded security risk for the enterprise. The mobile application threat is quickly progressing from simple “premium SMS and call” attacks that directly monetize by running up the victims bill, to full-blown mobile botnet functionality, such as the recently discovered Geinimi Trojan for Android phones [29]. Enterprises must recognize the need to enable a mobile workforce with meaningful applications that allow them to be productive while maintaining the security of sensitive data on the device and internal networks.

There are 2 main categories of mobile application security risks. The category of *Malicious Functionality* is a list of unwanted and dangerous mobile code behaviours that are stealthily placed in a Trojan app that the user is tricked into installing. The user thinks they are installing a game or utility and instead get hidden spyware, phishing UI, or unauthorized premium dialling. The category of mobile security *Vulnerabilities* are errors in design or implementation that expose the mobile device data to interception and retrieval by attackers. Mobile code security Vulnerabilities can also expose the mobile device or the cloud applications used from the device to unauthorized access [30].

- Malicious Functionality

1. Activity monitoring and data retrieval
2. Unauthorized dialling, SMS, and payments
3. Unauthorized network connectivity (exfiltration or command & control)
4. UI Impersonation
5. System modification (rootkit, APN proxy config)
6. Logic or Time bomb

- Vulnerabilities

1. Sensitive data leakage (inadvertent or side channel)
2. Unsafe sensitive data storage
3. Unsafe sensitive data transmission
4. Hardcoded password/keys

Increasing smartphone adoption rates coupled with the rapid growth in smartphone application counts have created a scenario where private and sensitive information is being pushed to the new device perimeter at an alarming rate. The smartphone mobile device is quickly becoming ubiquitous. While there is much overlap with common operating system models, the mobile device code security model has some distinct points of differentiation.

The mobile code security stack can be broken up into four distinct layers (Figure 5). The lowest layer of the stack is the infrastructure layer, followed upward by the hardware, operating system and application layers. These security stack layers each define a separate section of the security model of a smartphone or mobile device.

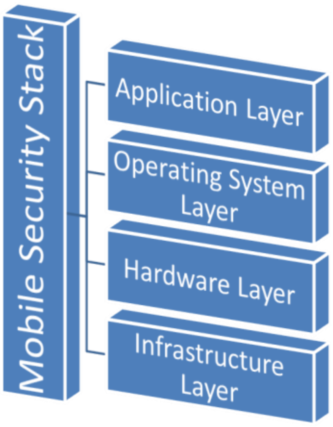


Figure 5: The Mobile Application Security Stack

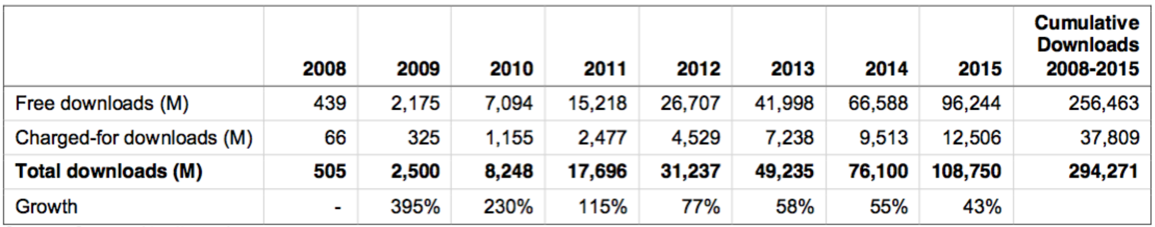
Currently, there is still under development of the security technologies in mobile area due to the new way of security attacks. For this reason, there is less progress to develop the standardization activities in mobile security. Therefore it is urgently required to identify the common security requirements in various aspects of mobile environments.

8. Business perspectives of Mobile Applications

8.1. Market estimation

Worldwide mobile application store downloads are forecast to reach 17.7 billion downloads in 2011, 117 % increase from an estimated 8.2 billion downloads in 2010, according to Gartner, Inc. By the end of 2015, Gartner forecast over 108 billion applications will have been downloaded from mobile app stores, since the launch of the first one in July 2008 [10].

Table 3: Numbers of Downloads From Mobile Application Stores, Worldwide, 2008-2015

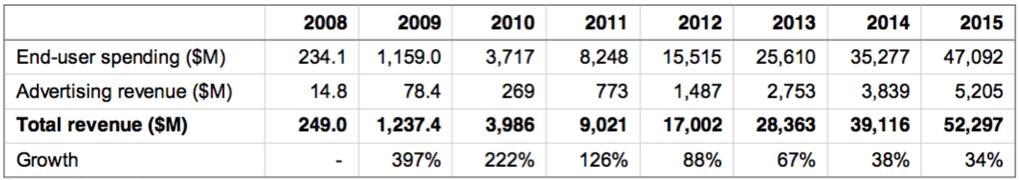


	2008	2009	2010	2011	2012	2013	2014	2015	Cumulative Downloads 2008-2015
Free downloads (M)	439	2,175	7,094	15,218	26,707	41,998	66,588	96,244	256,463
Charged-for downloads (M)	66	325	1,155	2,477	4,529	7,238	9,513	12,506	37,809
Total downloads (M)	**505**	**2,500**	**8,248**	**17,696**	**31,237**	**49,235**	**76,100**	**108,750**	**294,271**
Growth	-	395%	230%	115%	77%	58%	55%	43%	

Source: Gartner (April 2011)

Worldwide mobile application store revenue is projected to surpass $9 billion in 2011, both from end users buying applications and applications themselves generating advertising revenue for their developers. This is 126 % increase from 2010 revenue of $3.9 billion.

Table 4: Revenue from Mobile Application Store Downloads, Worldwide, 2008-2015



	2008	2009	2010	2011	2012	2013	2014	2015
End-user spending ($M)	234.1	1,159.0	3,717	8,248	15,515	25,610	35,277	47,092
Advertising revenue ($M)	14.8	78.4	269	773	1,487	2,753	3,839	5,205
Total revenue ($M)	**249.0**	**1,237.4**	**3,986**	**9,021**	**17,002**	**28,363**	**39,116**	**52,297**
Growth	-	397%	222%	126%	88%	67%	38%	34%

Source: Gartner (April 2011)

The download rate for consumers is initially increased by the novelty of using a new device and accessing an application store - this leads to initially high levels of use — but it stabilizes during the following months as the novelty wears off and users decide what applications they want to keep on their devices.

The forecast covers two categories of revenue: 1) End-user spending, for those applications that users pay for either through an app store's billing system (such as iTunes for Apple's App Store) or by credit card (for the Android Market) or through their mobile operator's billing system (for Nokia's Ovi Store and the Android Market in some countries). 2) Advertising revenue, for those applications that are free to users but (in most cases) sponsored by in-app advertising — for example, full-screen adverts shown between the levels of a game or banners displayed at the top or bottom of the screen.

8.2. Future of mobile application business (Value Propositions)

The success of Apple’s Application Store has not only established the salability of mobile applications, but has also shown that the most excellent applications offer the potential to generate large amount of revenues. Several telecom giants have thus begun providing dedicated application stores for their users, so much so that more than 2 million applications are currently available for communications, games, multimedia, productivity, travel, and utility purposes.

About 6.4 billion (free, paid, and ad-supported) application downloads were made globally in 2009 alone from native (on-deck) and third-party (off-deck) application stores, generating revenues of $4.5 billion in the same year. Apple, with 2.5 billion downloads, dominated the applications market in 2009. However, new players like Google, Nokia, and RIM are rapidly entering the applications market space, as the increasing uptake and usability of smartphone devices further boosts the mobile applications market. According to our estimates, the global mobile applications market is expected to be worth $25.0 billion in 2015, growing at a CAGR of 29.6% from 2010 to 2015 [3].

Mobile and wireless devices are enabling organizations to conduct business more effectively. Mobile applications can be used to support e-commerce with customers and suppliers, and to conduct e-business within and across organizational boundaries. Despite these benefits, organizations and their customers still lack an understanding of the value of mobile applications. Value is defined here as the principles for evaluating the consequences of action, inaction, or decision. The value proposition of mobile applications can be defined as the net value of the benefits and costs associated with the adoption and adaptation of mobile applications [17].

Although mobile applications present tremendous opportunities to companies, their proliferation is still limited. The advantages of using such applications include:

- Mobility: Users can conduct business anytime and anywhere.
- Flexibility: Data can be captured at the source, or point of origin, and “reverse wireless” services can be provided, including problem area alerts. Since mobile devices are inherently portable, users can engage in other activities, such as traveling, while conducting business or transactions via their Internet-enabled wireless devices.
- Dissemination: Some wireless infrastructures support simultaneous delivery of data to mobile users within a specific geographical region. This functionality offers an efficient means of disseminating real-time information to a large user population, thus providing another avenue to enhance and improve customer service.

9. Relevant standardization activities

9.1. W3C

The W3C has taken a step toward gathering all the information relevant to the mobile web, as authored by its disparate working groups, under one umbrella as a singular (recurring) reference source: Standards for Web Applications on Mobile: February 2011 current state and roadmap [11].

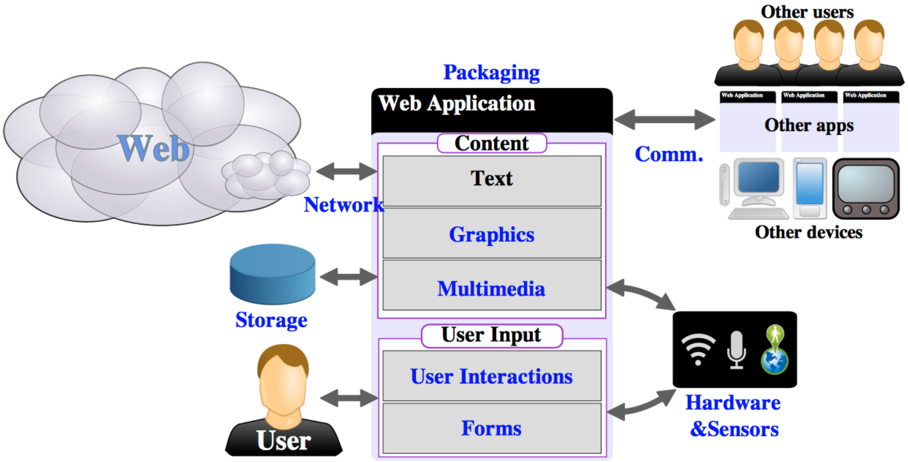


Figure 5: The Web as an application development platform by W3C

The document outlines a series of categories of technologies that apply to the web, including the relevant technology for each. These categories are:

- Graphics, which includes SVG, CSS, WOFF and other acronymns. (HTML WG, CSS WG, SVG WG, WebFonts WG, etc.)
- Multimedia, such as audio and video. (HTML WG, DAP WG, etc.)
- Forms, including the new input types and attributes like pattern and placeholder. (HTML WG)
- User interactions such as touch and speech events and even a vibration API (no specs, just working groups). (DAP WG, Web Events WG, Web Notification WG, etc.)
- Data storage such as the different file APIs and local vs. web storage. (Web Application WG, DAP WG, etc.)
- Sensors and hardware integration which will lean on the geolocation API and eventually APIs for using your phone's camera and microphone. (Geolocation WG, DAP WG, etc.)
- Network, which covers XMLHTTPRequest (level 1 and 2) and the WebSocket API. (Web Application WG, HTML WG, DAP WG, etc.)
- Communication using the messaging API to allow SMS and emails from web apps. (DAP WG, Web Application WG, etc.)
- Packaging, consisting of HTML5's ApplicationCache and W3C Widgets. (HTML WG, Web Application WG)
- Performance & Optimization such as the Mobile Web Application Best Practices along with support timing and threading. (Web Performance WG, Web Application WG, Mobile Web Application Best Practice WG, etc.)

Each of these items includes a table that outlines the appropriate specification, working group, maturity, stability, draft status, current implementations and test suites for each feature.

When it's all gathered in one place for us to review, it's a pretty compelling list of features in the pipe, even if we all know it will be quite some time before most of them shake out. I look at this roadmap as more than just a reference source, but as a path to shedding the costs and limitations imposed by building custom apps for each device (iOS, Android, desktop, television, etc.)

In particular, W3C's HTML5 [32] specification (currently working draft in last call) is used as a core technology to create the platform neutral mobile application with many advanced features.

9.2. OMA [13]

OMA is the leading industry forum for developing market driven, interoperable standards for mobile service enablers. The mission of the Open Mobile Alliance is to facilitate global user adoption of mobile data services by specifying standards for market driven mobile service enablers that ensure service interoperability across devices, geographies, service providers, operators, and networks, while allowing businesses to compete through innovation and differentiation.

Nearly 200 companies including the world's leading mobile operators, device and network suppliers, information technology companies and content and service providers formed OMA in June 2002. OMA is the focal point for the development of standards for mobile service enabler specifications, which support the creation of interoperable end-to-end mobile services. Toward that end, OMA develops test specifications, encourages third party tool development, and conducts test activities that allow vendors to test their implementations.

OMA has created over 200 specifications since its inception. The combined set of OMA enabler specifications are presented in a consistent architecture with a modular group of logical technical entities, interfaces and interactions.

OMA’s technical work is grouped in six categories, or suites of enablers:

- Architecture, Security and Charging
- Person-to-Person Communications
- Device Capabilities
- Access to Content
- Services Access Interface
- Service Customization

Architecture, Security and Charging

This suite of enablers provides functions and tools for the support of services enabled by OMA. These enablers have different natures and include provisioning of parameters and services, data synchronization, service platform common architecture, interconnections and some other horizontal activities such as security, privacy, charging or network APIs, etc.

Some current specification highlights:

- Application Layer Security Common Functions
- Global Permission Management
- Charging Data Elements
- General Service Subscription Management
- Categorization Based Content Screening

Person-to-Person Communications

This suite of enablers represents messaging and other communications means in various forms. Fundamentally, these enablers facilitate or encourage communication among users. Some current specification highlights:

- Mobile Email
- Presence Data Elements
- Mobile Spam Reporting
- Multimedia Messaging System
- Converged IP Messaging
- SIMPLE Instant Messaging

Device Capabilities

This suite of enablers provides functions and tools related directly to the user experience on a terminal. These enablers may be used in conjunction with other OMA enablers for the support of additional services and applications outside of the device management enablers. Some current specification highlights:

- Management of Software Components

- Diagnostics and Monitoring of Terminals
- Evolution of Device Profiles
- Management of Device Capabilities
- Scheduling
- Lock and Wipe
- Device Smart Card Management
- Device Management
- Software and Application Control
- Converged Personal Network Services
- Managing Terminals as Gateways
- Client Side API Framework

Access to Content

This suite enables access to digital content through multiple terminals so that the terminals become entertainment devices. These architectures and functionalities enable users to subscribe to, and/or be able to receive multimedia content. Some current specification highlights:

- Push
- Push Point to Multipoint
- Push over SIP
- Games Services Client/Server Interface
- In Game Advertising
- Secure Removable Media
- Content Management Interface
- Dynamic Content Delivery
- Digital Rights Management
- Mobile Search Framework
- Customized Multimedia Ringing
- Mobile 2D Bar Codes
- Mobile Advertising

Services Access Interface

This suite includes enablers that facilitate the exposure of functionality in a secure and controlled way. Such exposure may occur towards other OMA enablers or to third party services, applications and specifications. This domain includes Network APIs and Device APIs. Some current specification highlights:

- RESTful binding for OMA Push Access Protocol
- Policy Evaluation, Enforcement and Management
- Next Generation Service Interface

- SOAP bindings for Next Generation Service Interface
- RESTful Bindings for Web Services

Service Customization

This suite of enablers provides access to service resources within networks and their exposed functionality. Some current specification highlights:

- Services User Profile Management
- Presence and Presence SIMPLE
- XML Document Management
- Secure User Plane Location Services
- Mobile Location Services
- Location in SIP/IP Core
- Location and Positioning Protocol Extensions
- Presence Access Layer
- Key Performance Indicators in OMA
- Enhanced Visual Voice Mail Service
- Converged Address Book

9.3. WAC [14]

The Wholesale Applications Community (WAC) is an open, global alliance formed from the world's leading telecoms operators. WAC will unite a fragmented applications marketplace and create an open industry platform that benefits the entire ecosystem, including applications developers, handset manufacturers, OS owners, network operators and end users.

The Wholesale Applications Community will:

- Accelerate and expand the market for applications – Simplify application development by enabling developers to write an application once and deploy it everywhere, regardless of device or OS, and address a global market of more than 3 billion users.
- Create more compelling applications – Enable developers to utilise both device and network capabilities to create the next generation of applications
- Provide greater choice for users – Enable portability of applications across devices, operating systems and network operators.

Currently, there are over 69 members of the WAC organisation in our five membership categories.

The Wholesale Applications Community is establishing a business model that will provide a revenue share for participants in the applications value chain from the application store owner through to the application developer. This model will enable application and service monetisation, and will also enable revenue to be generated from the use of telecoms operator assets.

The Wholesale Applications Community does not intend to be a profit-making operation and will only generate revenues as necessary to cover its operational costs.

WAC will achieve this goal by:

- Simplifying application development by giving developers the opportunity to write applications that can be deployed across multiple platforms and multiple operators, and to address a potential global market of more than 3 billion users.
- Help create more compelling applications – Enable developers to utilise both device and network capabilities to create the next generation of applications.
- Providing greater choice for users – Enable portability of applications across devices, operating systems and network operators.

WAC applications, also known as WAC widgets, utilize Web technologies. The widget packaging format is based on W3C Widget Packaging specification and introduces some extensions to meet WAC requirements, such as specifications for billing. WAC widgets can optionally utilize a comprehensive handset API. A code-signing security system ensures that widgets can only access APIs that are suitable to their level of trust.

Key components of the WAC architecture include:

- Widget contents, which are the various widgets which created by the developer community.
- Widget platform, which is the software that renders widgets and addresses the requirements identified in the documents detailed above.
- WAC Common Web Services (aka, Network Resources), which provides capabilities hosted by the operator, such as billing, account balance lookup, etc. A common protocol is defined as a recommendation for communication between the widget platform and the WAC services gateway, although operators can decide to implement a different API.

In addition to these components, WAC also provides the following components in support of the widget ecosystem:

- Developer Website, which provides access to SDKs, forums, widget uploading, code signing, and other developer support services.
- Widget SDK, which provides emulators, documentation and other tools required to develop WAC widgets.
- Reference widget platform, which is a complete widget platform that serves as a definitive reference for the proper implementation of the specifications.
- WAC Signing Server, which provides code signing services to widget developers through the developer web site.

The WAC has announced the availability of the WAC 1.0 specification in October 2010 which is based on JIL 1.2.2. In year 2011, the WAC also announced the new 2.0 specification, which now includes HTML5 and multimedia support. This in turn will enable better widgets and apps that mimic native apps' capabilities. And that's like a start, with WAC 3.0 promising to include billing support and user identification to the mix. The WAC now supports SDKs and runtime in various mobile platforms.

9.4. GSMA [15]

GSMA OneAPI

GSMA's OneAPI is intended to complement existing client-side and Web APIs by providing a missing piece: access to network capabilities and information, regardless of operator, and via Web applications rather than simply device clients.

There are already APIs defined to accelerate application developments for the mobile world, most notably with Parlay X Web Services. The GSMA OneAPI Group has collaborated with the OMA (Open Mobile Alliance) to revisit these specifications and to develop them to be far easier for Web developers to use. The improvements include RESTful bindings, a choice of JSON and XML response.

GSMA OneAPI supports the following APIs:

- Version 0.91 Canadian Pilot; SMS, Location, Payment and Privacy
- Version 1.0; SMS, MMS, Location and Payment
- Version 2.0 release planned for late 2010;
  - Data Connection profile
  - Remaining Credits lookup
  - In-app billing
  - Click-to-call
  - Call notification

An operator requires an SDP (Service Deployment Platform) with access to the following Enablers:

- Messaging
- Charging
- Location

Rich Communication Project

The GSMA’s Rich Communications project is a substantial joint industry project supported by over 100 of the leading mobile operators, device vendors and client application developers to develop new service packages for today's 'always-on' mobile users. These packages offer an innovative approach for customers to effortlessly access multimedia communications that enhance and expand mobile interaction in their address book community.

All of the Rich Communications solutions build on three central features: Enhanced Address Book; Rich Call and Rich Messaging. For operators, a Rich Communication service package gives them an opportunity to excite their customers with compelling new product offerings that are in tune with the modern lifestyle communication needs of a wide range personal and business users.

The existing RCS (Rich Communication Suite) specifications have been supplemented in February 2011 with the announcement of the RCS-e Advanced Communications specification that focuses on the communications service aspects of the GSMA RCS Release 2 specification.

The original RCS specification has been enhanced over time and is now detailed over four Release versions: Releases 1, 2, 3 and most recently, Release 4. RCS features are described in a series of specification release documents that cover service definition, functional description and technical realisation. The following features are at the core of RCS:

- Enhanced Address Book: mobile phonebook enhanced with contact presence and status
- Rich Call: mobile voice calls enriched with multimedia content such as image files and video
- Rich Messaging: mobile messaging enhanced through a conversational experience

9.5. OMTP BONDI [16]

Founded in June 2004 by a group of eight mobile operators, the Open Mobile Terminal Platform (OMTP) was set up with the aim of simplifying the customer experience of mobile data services and improving mobile device security.

OMTP transitioned into the Wholesale Applications Community (WAC) on 1st July 2010 and is now not open for membership. Its activities are now being delivered within WAC or within other industry organisations.

BONDI Project

During 2007 and 2008, it became increasingly apparent that the future direction and success of the mobile web could be harmed without a concerted effort to drive a standardized approach to how web applications access the key local capabilities on the mobile device. If web applications had to use different APIs (for the same capability) on different devices and platforms, then development of web applications which work on any mobile device would not happen. On top of this, the risk of malicious web applications having free access to local mobile capabilities is unacceptable. Therefore, a need to create some form of security layer to protect the user from harm was essential.

It is with this background that OMTP launched its BONDI project with the aim of acting as a catalyst to drive the standardization of a small set of key interfaces from web services to mobile devices and also to put in place a well understood and user controlled security policy with which to protect the user.

From 1st July 2010, the BONDI initiative will move into the Wholesale Applications Community. The BONDI technology, alongside that from JIL and GSMA OneAPI will go to form a consistent set of Web based technology that will enable developers not only to write a web application which can function across different platforms and devices, but also can be deployed across the many different applications stores supplied by the WAC platform.

The BONDI 1.1 release define the composite specifications to allow web applications (widget and web pages) to interoperate over BONDI defined execution environment (widget runtime and web user agent). BONDI technology enables web based content to access native device capability, intermediated through a robust, but flexible security framework. There are three elements to the 1.1 release

- APIs: defines the JavaScript functions that expose the underlying accessible device capability
- Architecture and Security Specifications: defines the security layer and required architectural components that insulate the web application against risk
- Compliance: define the compliance process that allows a widget runtime or web user agent to declare compliance against the BONDI specifications

9.6. ISO/IEC JTC 1

ISO/IEC JTC 1 has developing the standards which related to mobile environments in various areas.

- SC 31 has developing the Mobile Item Identification and Management related standards. This group is to develop the standards of automatic identification and data collection techniques that are anticipated to be connected to wired or wireless networks, including sensor specifications, combining RFID with mobile telephony, and combining optically readable media with mobile telephony.

  - ISO/IEC 29143, 29172, 29173, 29174, 29175, 29176, 29177, 29178, 29179: Automatic identification and data capture techniques

- SC 37 WG 2 (Biometric Technical Interfaces) has developed most of its standards with a platform-independent view. There are mainly four related projects that are applicable to mobile devices [19]
  - ISO/IEC 29164 – Embedded BioAPI
  - ISO/IEC 19784 – BioAPI
    - ✓ Part 1: BioAPI Specification
    - ✓ Part 2: Biometric Archive Function Provider Interface
  - ISO/IEC 30106 Object Oriented BioAPI
    - ✓ Part 1: Architecture
    - ✓ Part 2: Java Implementation
    - ✓ Part 3: C# Implementation
  - ISO/IEC 19785 Common Biometric Exchange Framework Format (CBEFF)
    - ✓ Part 1: Data Element Specification (initial version published in 2006)
    - ✓ Part 2: Procedures for the Operation of the Biometric Registration Authority(initial version published in 2006)
    - ✓ Part 3: Patron Format Specifications (initial version published in 2007)
    - ✓ Part 4: Security Block Format Specifications (published in 2010)
- SC 6 has developing the NFC related standards which can be used in future mobile applications.
  - ISO/IEC 18092: Near Field Communications
- SC 24 and SC 29 have developing the graphics, image, audio and video processing standards and some specification can be used in mobile application. Recently, SC 24 has a plan to develop the new standards for mobile visual content.
- SC 35 has developing the User Interface (UI) related standards and SC 35 WG 4 is in charge of the user interface for mobile device.

Appendix 1 shows the relevant activities on mobile applications for each different Sub Committee (SC) of JTC 1 roughly.

9.7. Khronos Group

The Khronos Group is a not-for-profit member-funded industry consortium focused on the creation of open standard, royalty-free APIs to enable the authoring and accelerated playback of dynamic media on a wide variety of platforms and devices.

The Khronos Group was founded in 2000 by a number of media centric companies, including ATI Technologies, Discreet, Evans & Sutherland, Intel Corporation, NVIDIA, Silicon Graphics (SGI), and Sun Microsystems. Today the Khronos Group has roughly 100 member companies, over 30 adopters, and twenty-four conforming members.

Khronos Group is developing the following standards related to graphic processing on the mobile devices:

- OpenGL (Open Graphics Library): It is a standard specification defining a cross-language, cross-platform API for writing applications that produce 2D and 3D computer graphics. The interface consists of over 250 different function calls which can be used to draw complex three-dimensional scenes from simple primitives. OpenGL was developed by Silicon Graphics Inc. (SGI) in 1992 and is widely used in CAD, virtual reality, scientific visualization, information visualization, and flight simulation.

- OpenGL ES (OpenGL for Embedded Systems): It is a subset of the OpenGL 3D graphics API designed for embedded devices such as mobile phones, PDAs, and video game consoles. Several versions of the OpenGL ES specification now exist. OpenGL ES 1.0 is drawn up against the OpenGL 1.3 specification, OpenGL ES 1.1 is defined relative to the OpenGL 1.5 specification and OpenGL ES 2.0 is defined relative to the OpenGL 2.0 specification.

- OpenGL SC(OpenGL for Safety Critical applications): It is a subset of the OpenGL 3D graphics API designed to meet the needs of the Safety Critical market for avionics, industrial, military, medical and automotive applications including DO-178B certification.

- OpenCL (Open Computing Language): It is a framework for writing programs that execute across heterogeneous platforms consisting of CPUs, GPUs, and other processors. OpenCL includes a language (based on C99) for writing kernels (functions that execute on OpenCL devices), plus APIs that are used to define and then control the platforms. OpenCL gives any application access to the Graphics Processing Unit for non-graphical computing. OpenCL is analogous to the open industry standards OpenGL and OpenAL, for 3D graphics and computer audio, respectively.

- OpenKODE: It is a set of native APIs for handheld games and media applications providing a cross-platform abstraction layer for other media technologies such as OpenGL ES, OpenVG, OpenMAX AL and OpenSL ES. Besides of being an umbrella specification of the other APIs, OpenKODE also contains an API of its own, OpenKODE Core. OpenKODE Core defines POSIX-like functions to access operating system resources such as file access.

- OpenVG : It is a standard API designed for hardware-accelerated 2D vector graphics. It is aimed primarily at mobile phones, media and gaming consoles such as the PlayStation 3, and other consumer electronic devices. It will help manufacturers create flashier user interfaces that are less dependent on energy-hungry CPUs.

- OpenMAX (Open Media Acceleration): is a royalty-free, cross-platform set of C-language programming interfaces that provides abstractions for routines especially useful for audio, video, and still images. It's intended for devices that process large amounts of multimedia data in predictable ways. OpenMAX provides three layers of interfaces: Application Layer (AL), Integration Layer (IL) and Development Layer (DL).

- OpenSL ES (Open Sound Library for Embedded Systems): It is a royalty-free, cross-platform, hardware-accelerated, C-language audio API for 2D and 3D audio. It provides access to features such as 3D positional audio and MIDI playback. It is made for developers in the mobile and gaming industry and is working toward allowing for easy porting of applications across multiple platforms.

- OpenWF (Open Windowing Foundation): It is a royalty-free, cross-platform API that provides a low-level hardware abstraction interface for composited windowing systems to make use of composition and display hardware. OpenWF is targeted primarily at handheld devices that require portable acceleration of composition whilst minimizing memory bandwidth usage and power levels.

- Open Media Library (OpenML): It is a free, cross-platform programming environment designed by the Khronos Group for capturing, transporting, processing, displaying, and synchronizing digital media (2D and 3D graphics, audio and video processing, I/O, and networking).
- WebGL (Web-based Graphics Library): It is a software library that extends the capability of the JavaScript programming language to allow it to generate interactive 3D graphics within any compatible web browser. WebGL is a context of the canvas HTML element that provides a 3D computer graphics API without the use of plug-ins. The specification was released as version 1.0 on March 3, 2011.
- COLLADA (COLLAborative Design Activity for establishing) is an interchange file format for interactive 3D applications. COLLADA defines an open standard XML schema for exchanging digital assets among various graphics software applications that might otherwise store their assets in incompatible file formats.
- EGL: It is an interface between Khronos rendering APIs such as OpenGL ES or OpenVG and the underlying native platform window system. It handles graphics context management, surface/buffer binding, and rendering synchronization and enables "high-performance, accelerated, mixed-mode 2D and 3D rendering using other Khronos APIs."

9.8. Quick review of analysis results

According to the review of relevant standardization activities for mobile application, Table 5 summarizes the status of standardization for each area of mobile application from application to security. Note that this review is a just high-level overview for standardization activities of mobile application area among the relevant SDOs, so that some of information may not be corrected due to recent updates of their roadmap or work-plan.

Table 5: The status of standardization for mobile application area

SDOs Area	W3C	OMA	WAC	GSMA	Khronos	JTC 1
Application Store	△	△				
User Applications		○				
User Interfaces	○			△		
Multimedia	○	△			○	○
Network & Comm.	△	○	○	○		△
Platform & OS		△	△			
Device H/W	○	△				
Security	△	○	△			△

○ Mostly Covered, △ Partially Covered.

10. Recommendations to JTC 1

- According to investigation work on mobile application area, it needs to initiate a dialogue with relevant SDOs and consortia with a view to establishing the state of the work on mobile application.
- In particular, from a standardization perspective in JTC 1, it should take into account the following considerations:
  - It is required to identify the common requirements on mobile application area and standardization gaps among other SDOs and consortia.
  - It is required to identify the common architecture and related interfaces to develop the platform independent mobile application with global consensus.
  - It is required to identify the new work items and to develop the relevant International Standards for mobile application area if necessary.
  - It is also needed for JTC 1 to consider the collaboration and liaisons with other relevant SDOs including PAS submitters.
- In conclusion,
  - SWG on Planning recommends that JTC 1 should initiate the relevant activity to investigate the current state of standardization and to explore a possible role for JTC 1 through the JTC 1 tools such as Study Group or Incubator Group.

Appendix I. The mapping table between SCs and issues of Mobile Applications

SC No.	The title of SCs	Relationship to Mobile Applications
SC 2	Coded character sets	N/A
SC 6	Telecommunications and information exchange between systems	• Network, transport and future network (WG 7)
SC 7	Software and systems engineering	N/A
SC 17	Cards and personal identification	N/A
SC 22	Programming languages, their environments and system software interfaces	N/A
SC 23	Digitally Recorded Media for Information Interchange and Storage	N/A
SC 24	Computer graphics, image processing and environmental data representation	• Mobile Visual Content (Study Group)
SC 25	Interconnection of information technology equipment	N/A
SC 27	IT Security techniques	N/A
SC 28	Office equipment	N/A
SC 29	Coding of audio, picture, multimedia and hypermedia information	• MPEG eXtensible Middleware (MXM) (WG 11)
SC 31	Automatic identification and data capture techniques	• Mobile Item Identification and Management (MIIM) (WG 6)
SC 32	Data management and interchange	N/A
SC 34	Document description and processing languages	N/A
SC 35	User interfaces	• User Interface for Mobile Device (WG 4)
SC 36	Information technology for learning, education and training	N/A
SC 37	Biometrics	• BioAPI for mobile applications (WG 2)
SC 38	Distributed application platforms and services (DAPS)	N/A

Appendix II. Development Environment for Mobile Applications [2]

	Programming Language	Debuggersavailable	Emulatoravailable	Integrated Development Environmentavailable	Cross-platform Deployment	Installer Packaging Options	Development Tool Cost
AirplaySDK	C, C++ but no threads	Yes	Yes	Visual Studio, Mac OS SDK	All native: BREW, Android, iPhone, Windows Mobile, Symbian, Samsung bada, Maemo, Palm/Web OS	The native distribution format of each platform	Commercial licenses available
alcheMo	Java	Debugger integrated in Visual Studio, Eclipse or XCode	Emulator is available in corresponding IDE	Visual Studio,Eclipse,XCode	BREW, Android, iPhone, Windows Mobile	The native distribution format of each platform	Commercial licenses available
Android	Java but portions of code can be inC, C++. Visual Basic variant.	Debugger integrated in Eclipse, Standalone debugging monitor also available	Yes	Eclipse,Undroid (Plugin for Netbeans),Basic4android	Android only, because of Dalvik VM (march 09)	apk	Free
Appcelerator	Javascript	?	Emulator is available using 3rd party tools	Internal SDK	Android, iPhone. BlackBerry planned	The native distribution format of each platform	Apache 2.0 license/Commercial licenses available
Celsius	Java	Yes	Yes	Eclipse,NetBeans	Java ME, BlackBerry, iPhone, Android, Windows Mobile, Symbian	The native distribution format of each platform of a Java binary	Commercial licenses available
Bedrock	Java	Yes	Yes	Eclipse	Java ME, BREW, BlackBerry, iPhone, PSP, DS, Android, Windows Mobile, Palm	The native distribution format of each platform	Commercial licenses available
BlackBerry	Java	Debugger integrated in JDE	Free Emulator	JDE - BlackBerry Java Development Environment	BlackBerry only because of the RIM API	alx, cod	Free
Blueprint (programming language)	XML routed through Yahoo Mobile servers and displayed in native browsers	None beyond a schema check	N/A, translates to web or mobile as needed	N/A, any XML editor	N/A, translates to web or mobile as needed	Combined config upload at Yahoo with self-hosted dynamic XML	Any XML editor
BREW	C (the APIs are provided in C with a C++ style interface)	Debugger support for the native ARM target code.Can use Visual Studio to debug the x86 testing code.	No Emulator for the target ARM code, has a simulator for the x86 testing code.	Visual Studio 6.0, Visual Studio 2003 .net, Visual Studio 2005	Compile for the specific BREW version available on the handset.	OTA	Related Dev Fees Typically Required for Brew App Certification - VeriSign annual fee for becoming a certified developer. Realview ARM compiler for BREW (The free GNU C/C++ is also available, but with limited function and support). TRUE BREW

							testing fee for distributing the application.
DragonRAD	No Programming Required (Drag & Drop Development)	Yes	Uses 3rd Party Emulators	Proprietary IDE	BlackBerry, Android, Windows Mobile	OTA Deployment	Free & Commercial Licenses Avaliable
iOS (Apple)	Objective-C	Debugger integrated in Xcode IDE	Bundled with iPhone SDK, integrated with Xcode IDE	Xcode	iPhone, iPod Touch, and iPad.	Only via App Store, requires review and approval by Apple Inc..	Tools are free for an Intel-based Mac. Simulator testing is free, but installing on a device requires a fee for a developer signing key.
Java ME	Java	Yes	Free Emulator,Sun Java Wireless Toolkit,mpowerplayer	Eclipse,LMANetBeans Mobility Pack	Yes although many VM implementations have device specific bugs necessitating separate builds	Jad/Jarpackaging; PRC files under Palm OS	Free
JMango	JMango Language	N/A	N/A	JMango Flash IDE	Java ME, BlackBerry, iPhone, Android, Windows Mobile 6, Bada, (Windows Phone 7 will be available soon)	The native distribution format of each platform	Free
Lazarus	Object Pascal	Yes. Can debug on the IDE via ActiveSync for Windows CE	Uses the emulators of the platforms	Lazarus IDE, including integrated GUI designer and debugger	Compiled language available forWindows CE, linux-based devices and a SymbianOS port is under development.	The native distribution format of each platform	Free
Macromedia Flash Lite	ActionScript	Yes	Bundled with IDE	Macromedia FlashMX2004/8 / Eclipse	Yes	SIS / CAB deployment orOTA/IR/Bluetooth SWF files	Varies (Free but limited with MTASC)
MicrobrowserBased	XHTML (WAP2.0), WML(WAP 1.2)	Yes	Many	Many	Basic Page rendering with per page customizations for different browsers.	N/A	Free
MobiFlex	Visual Drag & Drop Fields	N/A	N/A - runs on phone in seconds	Web Portal, comes with data management Add-Ins	iPhone, Android	N/A	Free for development only
MoSync	C, C++	Yes	Yes	Eclipse, MoBuild (w/ text editors), Visual Studio 2005 and later	Windows Mobile, Symbian, Java ME, Moblin, Android, Smartphone 2003, Pocket PC	SIS, CAB, JAD, JAR, APK, OTA deployment	Free (GPL 2.0). Commercial licenses also available
.NET Compact Framework	C#, VB.NET,Basic4ppc	Yes	Free emulator (source code available), also bundled with IDE	Visual Studio 2008, 2005, 2003,Basic4ppc IDE	Windows Mobile, WindowsCE, Symbian-based devices (via third party tools)	OTA deployment, CAB files, ActiveSync	Most tools free (but commercial editions of Visual Studio required for visual designers)
Palm OS	C, C++, Pascal	Yes	OS 1.0 - 4.1: Free Emulator provided by PalmSource (Access); OS 5.0: - 5.4 Device-specific Simulators	Palm OS Development System (Eclipse),CodeWarrior,Pocket Studio, HB++	Palm OS handhelds, or Windows Mobile with StyleTap emulator	PRC Files, Palm Source Installer (.psi)	Free (POSE or GCC for Palm OS), or commercial (CodeWarrior), or various commercial rapid-development frameworks

			provided by Palm (palmOne)				
Phonegap	HTML, CSSand JavaScript	Yes	No, 3rd party tools	No, 3rd party tools	iPhone, Android, BlackBerry, Symbian, Palm	The native distribution format of each platform	MIT License
Python	Python	Yes	Add-on to Nokia Emulator	Several, including plugins forEclipse	Interpreted language available natively only on Nokia Series60(and desktops) though there are ports to other mobile platforms, including PalmOS	Sis deployment with py2sis or can use Python Runtime	Free
Rhomobile	Ruby withHTML interface features compiled through an interpreter into native applications.	Yes	N/A, applications can run in Win32 runner, or in device emulators for supported platforms.	xCode or Eclipse, on-demandRhoHubversion includes full IDE	Yes, supports iOS (incl. 3.0) on iPhone and iPad, Windows Mobile 6.1 Professional, Mobile Windows 6.0 Standard, BlackBerry 4.6, 4.7, 5.0, 6.0; Note: BlackBerry 4.2 and 4.5 are supported but database access is very slow on this devices, Symbian and Android 1.6 and greater	OTA deployment, iOS through App store, .SIS, .CAB, .APK, .COD	Free for GPL, Commercial Licenses Available. Subscription for RhoHub
Smartface Platform	Drag-and-Drop tools and action editing.	No (Not Required)	Yes	Smartface Designer	Yes (J2ME, Symbian S60, BlackBerry, Android)	The native distribution format of each platform	Community Licenses Available
Symbian	C++	Yes	Free Emulator	Many choices	Compile per target	SIS deployment	Commercial and free tools available
TotalCross	Java	Yes	Yes	Eclipse	BlackBerry, Android, Windows Mobile, Palm OS, iPhone/iPad. Windows Phone 7 and Symbian planned	The native distribution format of each platform (cab, jad, apk, pdb/prc, deb)	SDK is open source and free for desktop development. VM for target devices must be licensed
webOS	JavaScript, CSS, HTML, C and C++ through the PDK	Yes	Free emulator	Eclipse	webOS, Palm only	OTA deployment, webOS through App store, Web URL, Precentral, .ipk	Free
Windows Mobile	C, C++	Yes	Free emulator (source code available), also bundled with IDE	Visual Studio 2010, 2008, 2005, eMbedded VC++ (free)	Windows Mobile, WindowsFU, WindowsCE	OTA deployment, CAB files, ActiveSync	Free command-line tools or eMbedded VC++, or Visual Studio (Standard edition or better)
WorkLight Mobile Platform	A combination of standard web dev skills such as HTML,CSS andJavaScript and native languages.	Yes	Bundled with the IDE	Eclipse-based plug-in	Yes (Supports iOS, BlackBerryand Android)	The native distribution format of each platform	Downloadable free evaluation version. Commercial licenses available