



ΑΡΙΣΤΟΤΕΛΕΙΟ ΠΑΝΕΠΙΣΤΗΜΙΟ ΘΕΣΣΑΛΟΝΙΚΗΣ  
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ΠΡΟΓΡΑΜΜΑ ΜΕΤΑΠΤΥΧΙΑΚΩΝ ΣΠΟΥΔΩΝ  
Επιστήμη του Διαδικτύου  
«Web Science»



ΜΕΤΑΠΤΥΧΙΑΚΗ ΔΙΠΛΩΜΑΤΙΚΗ ΕΡΓΑΣΙΑ

# **Business models for Linked Data mobile Web Services**

**Κελεσίδου Κ. Όλγα**

**ΕΠΙΒΛΕΠΩΝ: Μιχαήλ Βαφοπούλος, Ιωάννης Αντωνίου**

**Βέροια , Ιούλιος 2011**





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Οι απόψεις και τα συμπεράσματα που περιέχονται σε αυτό το έγγραφο εκφράζουν τον συγγραφέα και δεν πρέπει να ερμηνευτεί ότι εκφράζουν τις επίσημες θέσεις του Α.Π.Θ.

## **ABSTRACT**

In the past 10 years, mobile phones have changed the way we communicate, play, be informed and live. In the next 10 years, smartphones and Web 3.0 will change the way we do business. In this master thesis, we examine the mainstream mobile technologies, the semantic web and the Linked Data infrastructure. We explore the current market status and the global trend, such as mobile web adoption and mobile services. Studying the mobile ecosystem, the existing mobile and web business models and combining them with the launch of Linked Data technologies, we propose possible upcoming and viable mobile business models for Linked Data web services.

Top innovative businesses, such as Facebook and Google, incorporate semantic technologies, which are deeply connected to the personalization in its nature, to develop mobile web applications. We analyze the way mobile business create and add value and benefits for companies and consumers, such as improving business processes in terms of efficiency, reliability and service quality. Moreover, it is presented potential mobile Linked Data applications and services based on real-life experiences. Finally, we discuss the future challenges trying to bridge the gap between the ideal and the real mobile value-added services.

## **KEYWORDS**

Mobile LD Business Models, Mobile LD Web Services, DBpedia Mobile, semantic mobile applications, smartphones

## ΠΕΡΙΛΗΨΗ

Πριν δέκα χρόνια τα κινητά τηλέφωνα άλλαξαν τον τρόπο με τον οποίο επικοινωνούμε, παίζουμε, ενημερωνόμαστε και ζούμε. Την επόμενη δεκαετία, τα “έξυπνα” κινητά τηλέφωνα (smartphones) και ο Ιστός 3.0 (Web 3.0) θα αλλάξουν το τρόπο άσκησης της επιχειρηματικότητας. Σε αυτήν την διπλωματική εργασία, εξετάσαμε τις κύριες κινητές ηλεκτρονικές τεχνολογίες, τον σημασιολογικό Ιστό (Semantic Web) και το πλαίσιο των συνδεδεμένων δεδομένων (Linked Data). Ερευνήσαμε την τρέχουσα κατάσταση της αγοράς και την παγκόσμια τάση, όπως την υιοθέτηση του κινητού Ιστού (Mobile Web) και τις κινητές υπηρεσίες. Μελετώντας το κινητό οικοσύστημα, τα υπάρχοντα κινητά και διαδικτυακά επιχειρηματικά μοντέλα και συνδυάζοντάς τα με τις τεχνολογίες των συνδεδεμένων δεδομένων, προτείνουμε πιθανά ανερχόμενα και βιώσιμα κινητά επιχειρηματικά μοντέλα για διαδικτυακές υπηρεσίες συνδεδεμένων δεδομένων (Linked Data web services).

Καινοτόμες επιχειρήσεις, όπως το Facebook και η Google, ενσωματώνουν τεχνολογίες του σημασιολογικού ιστού, οι οποίες από τη φύση τους συνδέονται άμεσα με την εξατομίκευση, στην ανάπτυξη κινητών διαδικτυακών εφαρμογών. Αναλύουμε τον τρόπο με τον οποίο οι κινητές επιχειρήσεις δημιουργούν και προσθέτουν αξία και οφέλη σε εταιρείες και καταναλωτές, όπως η βελτίωση των επιχειρηματικών διαδικασιών ως προς την αποτελεσματικότητα, την αξιοπιστία και την ποιότητα των υπηρεσιών. Επιπλέον, παρουσιάζονται πιθανές κινητές εφαρμογές και υπηρεσίες συνδεδεμένων δεδομένων βασισμένες στις καθημερινές συνήθειες των ανθρώπων. Τέλος, αναφέρουμε τις προκλήσεις του μέλλοντος, προσπαθώντας να γεφυρώσουμε το χάσμα μεταξύ των ιδεατών και πραγματικών κινητών υπηρεσιών προστιθέμενης αξίας.

## ΛΕΞΕΙΣ ΚΛΕΙΔΙΑ

Κινητά Επιχειρηματικά Μοντέλα Συνδεδεμένων Δεδομένων, Κινητές Διαδικτυακές Υπηρεσίες Συνδεδεμένων Δεδομένων, Κινητή DBpedia, κινητές σημασιολογικές εφαρμογές, “έξυπνα” κινητά τηλέφωνα

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## 1. INTRODUCTION

Dominant players in global mobile ecosystem will be those in control of web services, and able to provide users a bundle of application, service, handset and network products. Suitable mobile business models and strategies can create business value and meet the market's need. Enterprises can offer intelligent mobile web services tailored to customers' contexts with the help of Linked Data (LD), so that more business-oriented mobile applications can be developed. Mobile companies collect information about their consumers' preferences and thus are best positioned to take comparative advantage of the heterogeneity in customer demand and satisfaction.

This study is guided by the following key research questions:

- Which are the upcoming mobile business models for Linked Data web services?
- How does mobile business create value for companies and consumers?

The scope of this master thesis is to propose specific business models for the commercial adoption of Linked Data at the field of mobile web services. More specifically, it is structured as follows: In Chapter 2, we give an overview of the mobile ecosystem. It is presented the mainstream technologies, the current market status and the characteristics of the mobile business market. Chapter 3 explores the Linked Data Infrastructure, including the Hendler's Models, the Semantic Web and the Goodrelations Ontology. Chapter 4 describes in detail the mobile Linked Data Services, the potential business models for Linked Data mobile web services and proposed semantic mobile applications. In Chapter 5 we discuss the challenges, which must be faced in the near future. Finally, Chapter 6 presents the principal conclusions that can be made from this master thesis.

## 2. PART I: THE MOBILE ECOSYSTEM

### 2.1 Technologies

#### 2.1.1 Wireless Networks

*Wireless network* refer to any type of computer network that is not connected by cables of any kind [48]. It is a way by which telecommunications networks and business, installations avoid the costly process of using cables into to a building, or as a connection between various equipment locations. Wireless telecommunications networks are generally implemented and administered using a transmission system defined *radio waves*.

The popularity of wireless local area networks (wLANs) continues to grow as the mobile users demand access to data and services while on the go. *Wi-Fi (Wireless Fidelity)* is such a wireless local area network which uses radio waves to provide wireless high-speed Internet and network connections based on IEEE 802.11 standards [49]. Users access Wi-Fi through mobile phones, netbooks, laptops, tablets or digital cameras in points (called hotspots when offering public access) such as shopping malls, airports, hotels or coffee shops.

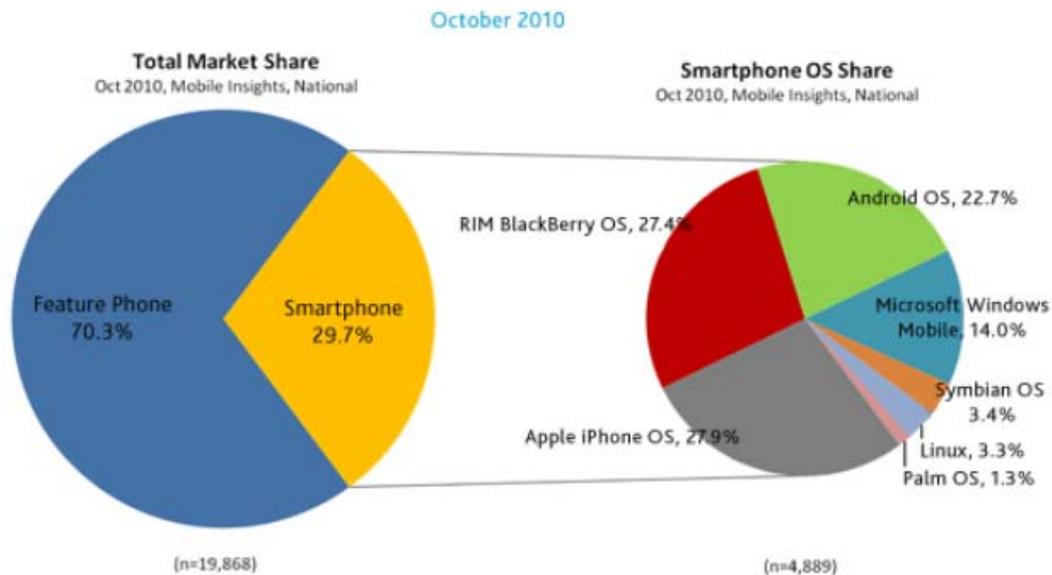
A *3G network* is the 3rd generation of wireless communication, which includes standards for mobile devices and mobile telecommunications services fulfilling the International Mobile Telecommunications-2000 (IMT-2000) specifications by the International Telecommunication Union. 3G is capable of carrying heavy loads of data including video, mobile TV and other intensive media in high speed and better quality. Examples of 3G technology include the Universal Mobile Telecommunication System (UMTS) and wideband-CDMA (wCDMA) [3].

A *4G network* is the 4th generation of wireless communication being developed for premium quality of service, high security and higher speed broadband mobile capabilities. It supports high network capacity with more simultaneous users per cell and interoperability with existing wireless standards. Examples of 4G technology include the Worldwide Interoperability for Microwave Access (WiMAX) and Long-term-evolution Advanced (LTE Advanced). The trend is to provide wireless Internet access to every

mobile device that could incorporate the 4G embedded modules, such as video camera or refrigerator.

2.1.2 Mobile Platforms

The most important software in any mobile device is its operating system (OS). An operating system manages the hardware and software resources of mobile devices. A mobile operating system determines the choice of applications and device functionality. The intense competition in mobile technology brings high importance for mobile operating system. There are numerous types of mobile operating systems. The mobile market is fragmented into the following platforms: Palm, Google Android, Rim Blackberry, Symbian, Windows Mobile, and the iPhone OS. The Nielsen survey [50] measure trends in the mobile landscape (Figure 1). According to October 2010 data of smartphone market share in the U.S.A, the most popular operating systems are iPhone OS (28%), Rim Blackberry (27%), Android (23%) and Windows Mobile (14%)



**Figure 1:** Total U.S Market & Smartphone Market [50]

Canalys Company [51] published its report with the Q4 2010 data of global smartphone market share, as shown Figure 2. Google’s Android has become the leading platform, as Android-based smartphones represent at 32.9%, Nokia was at 30.6%, Apple

was at 16%, RIM was at 14.4% and Microsoft gained 3.1% of the global market share. Google had shipped 33.3 million units in Q4 2010 growing at an impressive 615% rate for the quarter. The rise of Android indicates the popularity of the free operating system with vendors, which do not have to pay a licence fee to use it on their phones. Total worldwide smartphone shipments increase 88.6% between the fourth quarters of 2009 and 2010. “2011 is set to be a highly competitive year with vendors looking to use new technology, such as dual-core processors, NFC and 3D displays, to differentiate their products and maintain value,” said Canals VP and Principal Analyst Chris Jones.

OS vendor	Q4 2010		Q4 2009		Growth Q4'10/Q4'09
	shipments (millions)	% share	shipments (millions)	% share	
Total	101.2	100.0%	53.7	100.0%	88.6%
Google	33.3	32.9%	4.7	8.7%	615.1%
Nokia	31.0	30.6%	23.9	44.4%	30.0%
Apple	16.2	16.0%	8.7	16.3%	85.9%
RIM	14.6	14.4%	10.7	20.0%	36.0%
Microsoft	3.1	3.1%	3.9	7.2%	-20.3%
Others	3.0	2.9%	1.8	3.4%	64.8%

Figure 2: Worldwide Smartphone Market Q4 2010-Q4 2009 [51]

*Palm OS* is a mobile operating system developed by Palm Inc for personal digital assistants (PDAs) in 1996. New versions of the OS have been extended to support smartphones. Palm licensed Palm OS and Windows Mobile until developing webOS as a new platform to replace both [52] and purchased by Hewlett Packard (HP) in 2010. It is approachable, easy to learn and easy to use with a touchscreen-based graphical user interface. There are many software applications, including productivity tools, available for HP-based devices. The webOS uses the Linux kernel and the web browser, simply named “Web”.

*Android* is Google’s open mobile operating system based upon a modified version of the Linux kernel. Google is adding new features to Android at a rapid pace, providing device vendors with the OS code on an open-source basis so they can make it their own.

Android's web browser is based on the same WebKit rendering engine like the iPhone's Safari and also supports flash contents. There are currently over 200,000 apps available free on Android Market. The number of Android devices is expanding rapidly, and includes phones from HTC, Motorola, Samsung and Sony Ericsson. Android 3.0 is a new version of the Android platform that is specifically optimized for devices with larger screen sizes, particularly tablets [53].

*Rim* is BlackBerry's mobile operating system, which is a proprietary multitasking environment [54]. The operating system is designed for use of input devices such as the track wheel, track ball, and track pad. BlackBerry 6 OS is the new version of the platform trying to be seen as more than just an enterprise phone manufacturer by including social feeds that allow users to post status updates to multiple social networks [55]. BlackBerry is well-known for its good email application. It also supports touchscreen commands (instead of constantly pressing the Menu button). The web browser in BlackBerry 6 OS displays and loads web pages faster and richer. RIM's revenue mainly comes from selling BlackBerry phones and deploying email service solutions. Operating system is just a RIM's supporting tool for its main business.

*Symbian* is an open source operating system and software platform designed for smartphones with advanced data capabilities and maintained by Nokia. It is designed to make minimal demands on batteries and to ensure the integrity of data [56]. Symbian devices can be programmed in a variety of languages such as C/C++, Python, Visual Basic and Java ME. The latest version is the Symbian^3 platform. In Nokia, Symbian plays an important role. Operating system and device are two pillars of Nokia's success in smartphone market. In the last quarter of 2010 according to Stephen Elop, CEO of Nokia, Ovi Store, Nokia's application store, had more than 30,000 apps available [57]. Nokia focuses on five key service areas: Games, Maps, Media, Messaging and Music.

*Windows Mobile* is a mobile operating system developed by Microsoft and its last version is Windows Phone 7. Windows Phone features a new user interface, multi-touch technology and a version of Internet Explorer Mobile. The platform is organized to a Hub system, which bring together related content from the Web, applications and services into a single view to simplify common tasks [58]. It includes six hubs: marketplace, people, games, pictures, music & video and office. Windows Phone Marketplace [59] is a service

for Windows Phone 7 platform that allows users to browse and download applications, video, music and podcasts. As the main source of revenue, Microsoft license Windows Mobile to any smartphone maker who is interested in putting Windows Mobile on its mobile phone. Microsoft's ambition is to copy its success in the personal computer industry to the smartphone world.

*iPhone OS (iOS)* is Apple's mobile operating system, initially developed for the iPhone and has been extended to iPod and iPad. It is a closed system, which means Apple has the full control on its software, which cannot be installed on third party devices. The latest version of the platform is the iOS 4.2.1. Apple gets a slice of profit from content providers and application developers through two platforms: iTunes and App Store. The iTunes sells music and movies to customers, and App Store sells application software. Apple's App Store is the richest mobile app store, which contains more than 300,000 applications. iOS 4 supports easy-of-use multi-touch interface, multitasking, better notifications, game center, full-featured web browser called "Safari" and wireless printing [60]. It has become also a useful business tool by syncing of contacts with Internet and email easy and fast. Perhaps the most popular feature of the iPhone among young audiences is the ability to rapid share photos and videos on social networks such as facebook.

The smartphone operating system market is comparatively new and unstable. There is no obvious monopoly, and market shares change rapidly. It offers great opportunities for new mobile operating systems to survive and thrive. Android is a recent and good example, although it still needs time to prove itself. In mobile platforms, only those companies (e.g Google) with established reputations, well-known brand names, and ready visible access are likely to choose an open and free system strategy.

### 2.1.3 Mobile Web Browsers

Web browsing becomes one of the main tasks that users run out on their smartphones. Mobile web browsers have different features and capabilities. There are basically two types of mobile web browsers available, those that are platform or operating system specific and those that are multi-platform. Examples of multi-platform mobile browsers include Opera Mini and Skyfire. Many websites also optimizes their content especially for mobile devices.

- *Opera Mobile* supports [61] multiple tabs, zoom features and is available on Android, Symbian and Windows Mobile platform.
- *Opera Mini* includes multiple tabs, zoom and uses compression technology to compress Web content before it gets to the device for fast browsing. The Opera Mini received the 2010 Reader's Choice Award Winner [62] at About.com as the best mobile browser.
- *Skyfire* [63] displays rich websites with flash or widgets like YouTube and supports customizable zoom. It can be installed free on Android, iPhone, Symbian and Windows Mobile operating system.
- *Safari* [64] supports rich websites like YouTube, zoom facilities and excellent touch-based user interface, although it doesn't support Flash. It runs on iPhone operating system. It has the ability to print the current webpage using AirPrint [65].
- *Firefox Mobile* [66] offers data compression, add-on support, location-aware browsing and fast user interface. It is available for Nokia N900 and Android phones (2.0 and above).

#### 2.1.4 Smartphones, Tablets

A *smartphone* is a mobile phone that provides more advanced computing ability and connectivity than a contemporary feature phone [67]. A smartphone run complete mobile operating system, such as iPhone OS, Android or Windows Mobile OS, and also is able to run multitask mobile applications. Smartphones have powerful processors, mobile browsers, large screens (now touch screens), embedded memory storage, GPS (global positioning system), easy email access and offer high-speed Internet access through Wi-Fi and 3G networks [68]. The competition between smartphones' manufacturers is increasing as there are numerous models (e.g. iPhone, HTC, Nokia, Samsung).

A *tablet* is a complete portable computer, larger than a smartphone or personal digital assistant, integrated into a flat touch screen, primarily operated by touching the screen, which allows high flexibility and dynamic usage. It is generally lighter than a notebook, has low-heat processor, longer battery life and often uses an onscreen virtual keyboard or a

digital pen rather than a physical keyboard [69]. Software applications for tablets include office suites, web browsers, games and a variety of applications [70]. Tablets are comfortable e-readers and suitable for meetings and travels. The iPad 2, which is Apple's tablet, remains the king of the category.

#### 2.1.5 To the future: Internet of Things

The term Internet of Things (IoT), also called sensor network, spawned from the idea of Radio Frequency Identification Tags (RFID) in every object, allowing them to be identified, tracked, traced, monitored and possibly located [71]. It is about a vision of blurring the lines between the real world and the digital world, offering accurate information about situations and status of places, things and people in digital format through the use of very diverse technologies. Information generated by the Internet of Things can be interconnected, organized and stored with the support of semantic technologies [72]. RDF allows linking data and describing properties and relations of objects. The Internet of Things should become in fact the *Semantic Web of Things* [73].

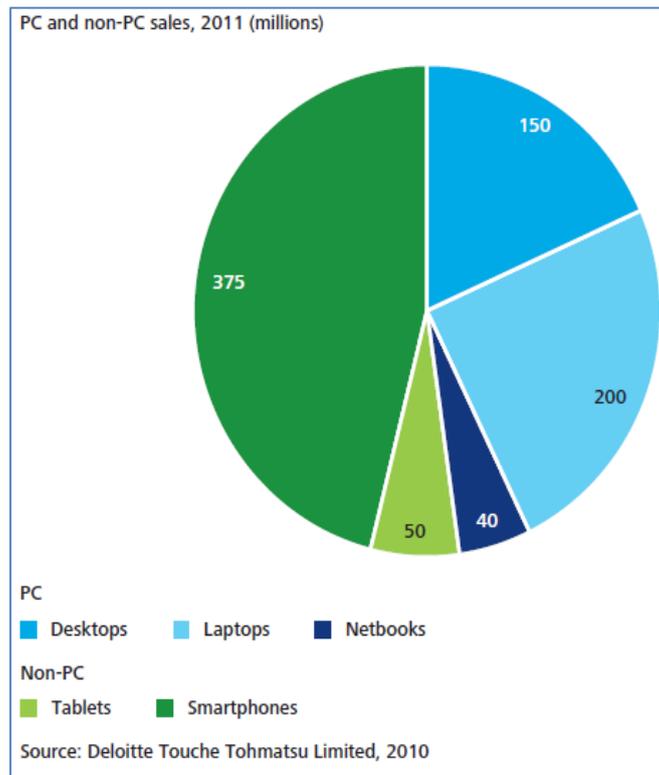
The user can communicate with the surrounding environment and get information and services by wirelessly reading tags and sensors embedded to everyday objects and the environment itself through mobile devices. Each smartphone can be a sensor on the Internet of Things. The Internet of Things is another aspect of the digital transformation of the world [74]. Healthcare, entertainment, transport, urban living, business processes and automation, security forces the list goes on, are all application spaces that can benefit from the Internet of Things and at the same time will grow the Internet of Things from within their domains using technology that suits their requirements.

## **2.2 Current Market Status**

### **2.2.1 Mobile Web Adoption**

The explosion in user adoption of mobile devices has revolutionized the Web. The rapid growth and success of smart phones and tablets improved user experience across mobile devices. It is obvious that mobile technology will continue to grow as one of the most powerful and encompassing platforms. Spurred on by the success of Facebook's mobile platform, YouTube's iPhone-friendly mobile application and Twitter's mobile popularity, a growing number of designers, site owners and entrepreneurs are beginning to believe that it is necessary to make their web presence accessible by mobile phones [75]. The mobile Web is quickly becoming one of the most effective marketing platforms and will see significant growth due to major enhancements over the next years.

Deloitte [76] predicts that in 2011 more than 50% of computing devices sold globally will be smartphones, tablets and netbooks (Figure 3) and combined sales will be over 400 million. In January 2011, during the annual State of the Union speech to the U.S.A Congress, Barack Obama said [77]: "Within the next five years, we will make it possible for business to deploy the next generation of high-speed wireless coverage to 98 percent of all Americans. This isn't just about a faster Internet and fewer dropped calls. It's about connecting every part of America to the digital age. It's about a rural community in Iowa or Alabama where farmers and small business owners will be able to sell their products all over the world. It's about a firefighter who can download the design of a burning building onto a handheld device; a student who can take classes with a digital textbook; or a patient who can have face-to-face video chats with her doctor."



**Figure 3:** *Computing device market forecast for 2011 [76]*

Mobile and social media are the always-on, on-demand platforms through which businesses can reach and communicate with their customers in real time. Companies reach the mobile customer who can purchase directly over the mobile commerce platform or the in-store customer who is receiving information via mobile messages. The mobile wealth creation cycle (Figure 4) is in its earliest stages [78]. Although it may be stating the obvious, smartphone adoption will continue to increase at even faster rates during 2011, while tablet devices will see an increase in adoption rates as well. Having better services and smaller, cheaper devices has led to a huge explosion in mobile technology that far outpaces the growth of any other computing cycle.

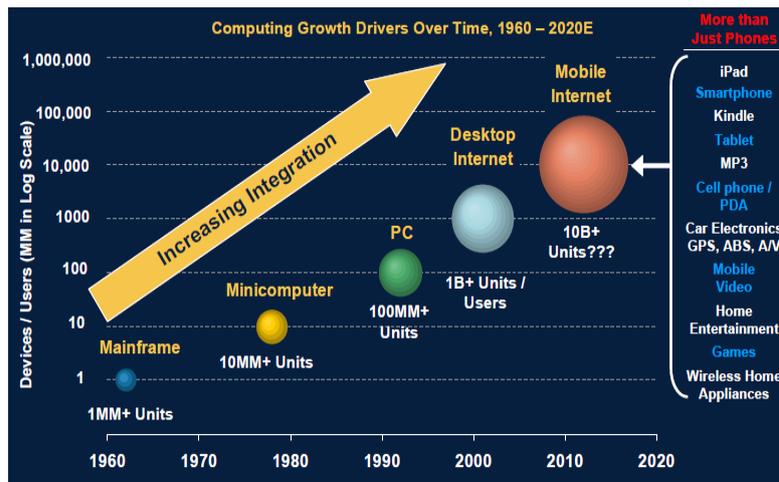


Figure 4: *New Computing Cycles [79]*

2.2.2 Mobile Users and Mobile Services

It is expected that mobile users will surpass desktop users in the next years (Figure 5). Nielsen Company announced in December 2010 its report [80], which includes data about mobile young users’ habits and key trends in the global mobile phone industry. Favorite mobile services for young users are messaging, using browsers, emails, downloaded apps, social networking and games. The interesting point is that young people around the world are more immersed in the mobile technology than any previous generation and they consider smartphones not luxury expenditure but a necessity. UK has over 20% more mobile Internet young users than other European countries (Figure 6). According to Bret Taylor [81], Facebook CTO, mobile is the social network’s main priority for 2011, as people who engage with Facebook on mobile devices are twice as active as people who only use it on their computers.

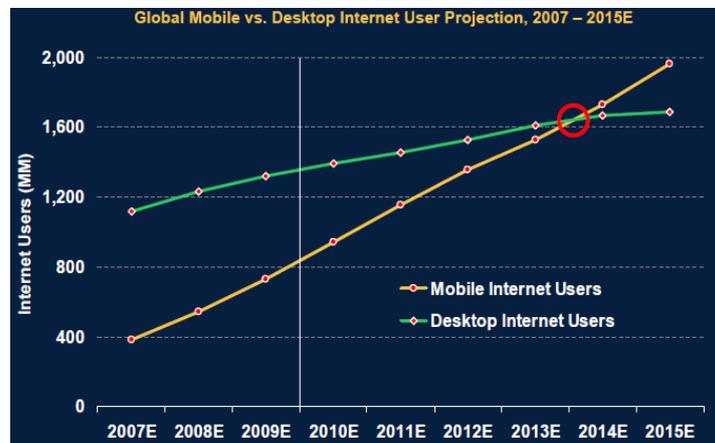
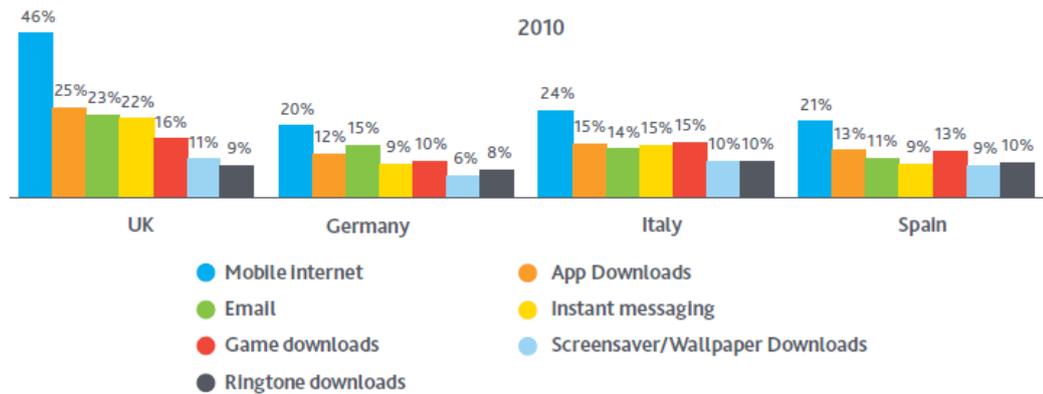


Figure 5: *In future mobile users will surpass desktop users [79]*



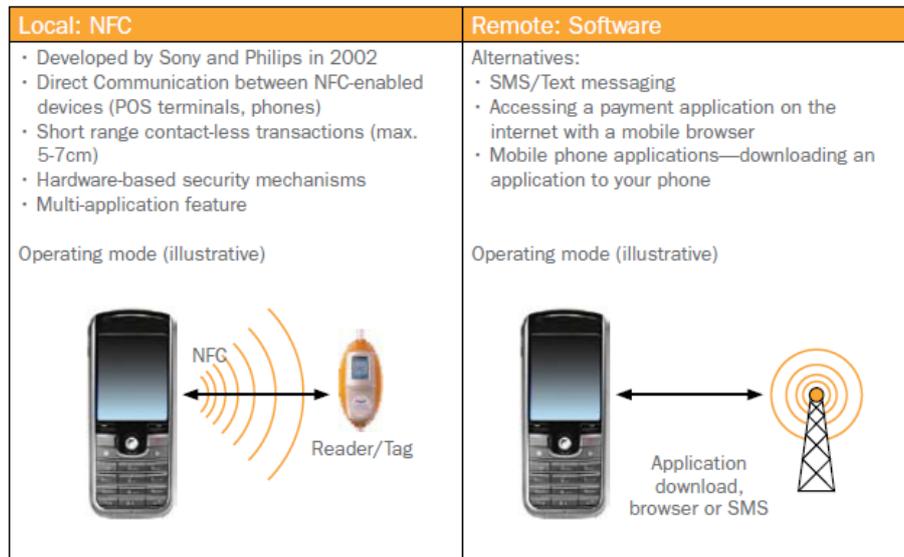
Source: The Nielsen Company

Figure 6: Features Used in Age 15-24 [80]

### 2.2.3 Mobile Payments

A mobile payment (m-payment) can be defined [82] as any payment transaction, whether in-store or remote, executed on a mobile device, usually a smartphone. Instead of paying with cash, cheque, credit or debit cards, a consumer can use a mobile phone to pay for a wide range of products and services. Banks, Cards Issuers, Merchants, Payment Processors, Alternate Payment Providers and Mobile Operators are each striving to build revenue models that meet their needs [83]. There are four models for m-payments:

- *Premium SMS* [84] is a mobile-based payment method which enables the customer to pay for purchases by means of SMS sent to a special short code. The SMS payment is billed to consumer's mobile phone account.
- *Direct Mobile Billing* [85] is a payment mechanism at a mobile site to make a purchase, by charging the consumer's mobile account. It is an alternative method, which does not require the use of credit or debit cards.
- *Mobile Phone Applications* are downloaded and installed on users' smartphone to make a payment. The use of a credit or debit card or pre-registration at online payment solution such as PayPal is still required just as in a desktop environment.
- *Near Field Communication (NFC)* [86] is the leading standard for contactless transactions within a hardware chip embedded into the mobile device and is used mainly in paying for purchases made in physical stores or transportation services.



**Figure 7:** M-Payment enabling technology options [87]

#### 2.2.4 e-Wallet

Electronic wallet allows users to perform electronic transactions quickly and securely and payments are sent and received online in real-time. Visa Europe and Wireless Dynamics Inc. announced on January 2011 that they intend to launch a mobile contactless payment solution that will bring Visa contactless payments to iPhone users across Europe. iPhone users easily attach the Wireless Dynamics iCarte accessory, available through their bank or mobile operator, to their iPhone and also download the companion Visa Mobile application for iCarte App from the App Store [88]. Once the Visa mobile card is activated, users can start making purchases by simply opening the app and touching their iPhone on any contactless-enabled point of sale terminal across Europe. The trial is one of the first steps taken to turn the iPhone into a viable e-wallet, and is the latest indication of Apple's plans to establish itself in the promising mobile payments sector.

Richard Doherty, director of consulting firm Envisioneering Group, reports [89] that Apple will add Near-Field Communication technology to this year's anticipated iPhone 5, providing users the ability to have their mobile device serve as an e-wallet for wireless transactions. Doherty also said [90] that customers could walk into a store or restaurant and make payments straight from an iPad or iPhone and they could also receive loyalty rewards and credits for purchases, such as when referring a friend. Moreover, Apple has created a

prototype of a payment terminal that small businesses, such as hairdressers, could use to scan NFC-enabled iPhones and iPads.

According to Google chief executive officer Eric Schmidt [91], the newest version of mobile operating system Android, Gingerbread, integrate the near field communication (NFC) technology. Google's new smartphone will support NFC and will be a mobile wallet. A NFC chip already appears in the Google Nexus S, which debuted in the U.S. on December 2010. Near Field Communication uses a combination of hardware and software to turn a phone into a wallet that can beam and receive information at a distance of up to 4 inches. Future phones will have NFC chips built in and the Android Gingerbread will provide the software needed to allow them to function [92]. Users will be free from their wallet, debit and credit cards. New smartphone will be placed near to a compatible payment station or a special terminal in order to buy products or pay for services.

### 2.2.5 Observatory Data for Europe

#### *a. In Electronic Commerce*

Even in the current economic recession, electronic commerce continues to be one of the fastest growing markets in Europe. According to Kelkoo's report [93], including 11 European countries, online sales grew by 19.4% or €27.9 billion in 2010, representing 5.9% of overall European retail trade. Online shopping could reach 6.9% by the end of 2011. Between countries (Figure 8), the UK (€ 52.1 billion), Germany (€39.2 billion) and France (€31.2 billion) accounted for 71% of total online sales in Europe in 2010. The countries with the lowest overall online spend were Poland (€3.4 billion), Norway (€4 billion) and Denmark (€4.5 billion). European online consumers spent an average of €1,072 each and purchased 25 items.

Richard Stables, chief executive officer of Kelkoo, said: "European online retail sales now exceed those in the US and are expected to continue to grow at a much faster rate over the coming years. 2011 will see online sales achieving a significant share of retail trade in most European countries, with 7 cents in every €1 being spent online on average. While the retail industry is showing slow signs of recovery, the online shopping sector bucked the

trend in 2010, delivering double-digit growth, and is expected to continue to perform strongly in 2011. There is also evidence that online shoppers' confidence is increasing, with consumer spending set to rise by almost 15% in 2011."

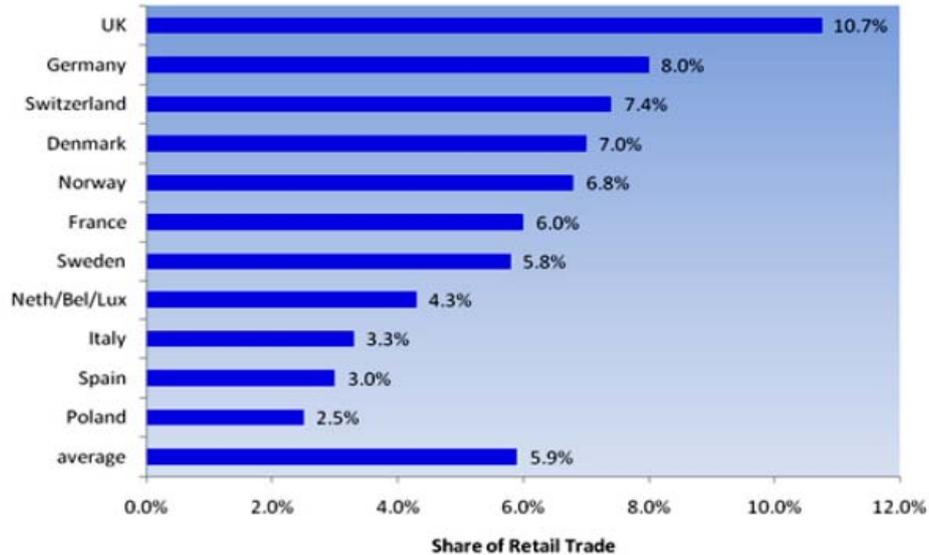


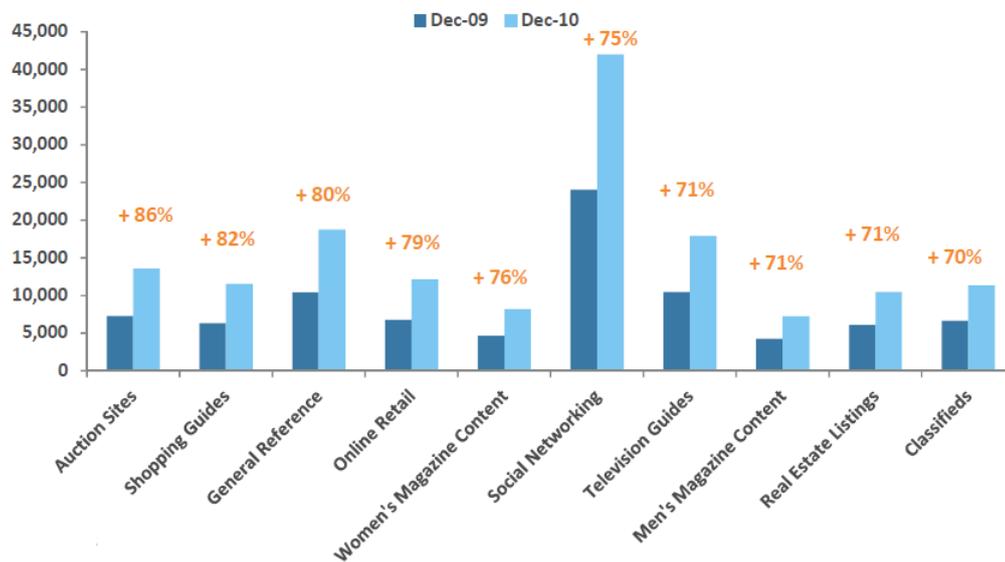
Figure 8: Online Share of European e-Commerce 2010 [94]

#### *b. In Mobile Commerce*

According to a survey among 6 European countries (France, UK, Germany, Italy, Spain and Sweden), conducted by IDC Retail Insights for Akamai [95], reveals that 30% of European citizens currently use or plan to use their mobile phones for online purchasing during 2011. 10% of Europeans are already using their mobile devices for retail search, price comparison or online shopping. The group of highest European spenders online (each spending around €1,500 per year) tend to be aged between 35 to 54 years. Most of consumers expect a website to load in less than four seconds and in some cases two seconds. In case they encounter slow websites, around 70% of respondents said they would switch to other websites [96].

Despite the low penetration rate of mobile commerce in Europe, Thomas Husson [97], analyst of Forrester Company, believe that mobile presents a growing market opportunity. He mentions [98]: "Smartphone adoption in Europe is growing fast, which

makes traffic to Web sites through mobile devices easier. European consumers are starting to show interest in mobile commerce activities, and many retailers across Europe, like La Redoute, Fnac, eBay, Amazon.com, Tesco, and Carrefour, are starting to improve their mobile Web sites and creating mobile applications for the iPhone." In Europe, mobile retail-related categories grew significantly in 2010 over the past year, as shown Figure YU. Auctions sites increased by 86%, shopping guides by 82% and online retail by 79%.



**Figure 9:** Fastest Growing Mobile Categories in EU [99]

### 2.2.6 Observatory Data for Greece

Greeks show to be cautious and skeptical towards online transactions based on data of 2010. Nevertheless they seem to improve gradually their relationship with the electronic commerce. Below it is presented some statistical data of 2010, concerning the electronic commerce in Greece [100]. The survey was conducted by the Hellenic Statistical Authority.

- 18.4% of Greeks, who used the Internet during the first quarter of 2010, made online purchases.
- 13.6% is the increase of online shopping for the period 2009-2010.

- The average annual rate of change for purchases over the Internet for the five-year period from 2006 to 2010 comes to 20.8%.
- Two in three online Greek consumers are males (65.2%).
- One in two online Greek consumers (52.3%) has higher education.
- 77.4% of Greek consumers via Internet are less than 45 years old.
- 27.8% of online purchases concerns electronic devices such as digital cameras, mobile phones, television sets, dvds etc.
- 27.8% online purchases concerns tourist services (e.g. tickets, car renting)
- 59.5% of Greeks purchased products or services through Internet from Greece, while 35.3% from European Union and 21.8% from the rest of the world.

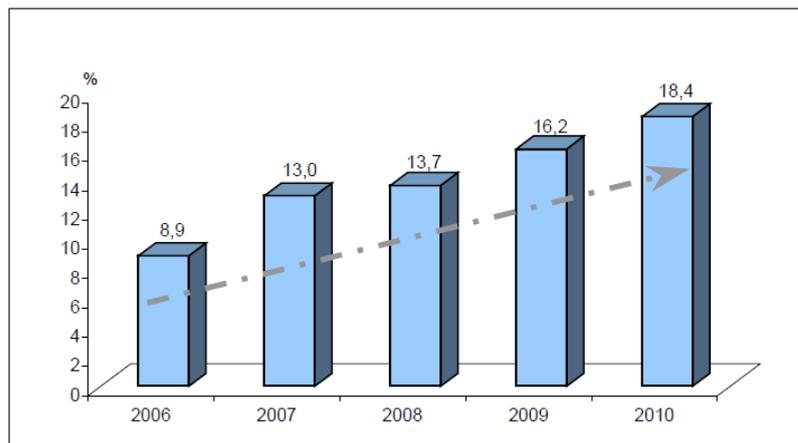


Figure 10: Electronic Commerce (First Quarter 2006-2010) [100]

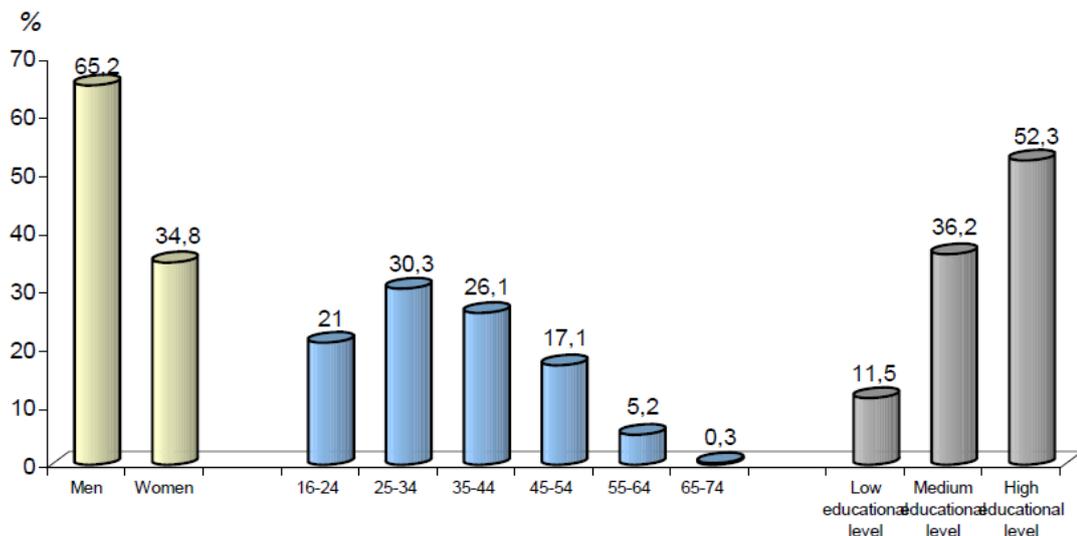


Figure 11: Electronic Purchases by gender, age group and educational level

(First Quarter 2010) [100]

## 2.3 The Business Framework

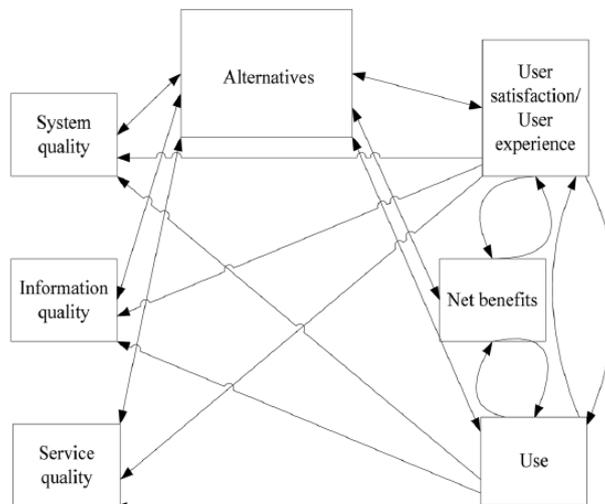
### 2.3.1 Factors for Mobile Commerce Success

For mobile commerce to become commonplace, it needs to build on established habits, preferences and infrastructure with added specific mobile value. The added value can be instant access and delivery, usefulness, ease of use, flexibility, convenience, personalization, location-based services, time and cost saving, security and privacy. Once consumers use the mobile commerce for shopping, they will be more open to adopt the mobile payment method for their transactions [22]. The challenge is to implement a secure payment mechanism so that it remains convenient and simple to use.

Salehi, Keramati and Didehkhani propose [26] a model to investigate the mobile Web success variables in the context of ecommerce, extending the Updated D&M IS Success Model through the Analytic Network Process (ANP) approach to search the relative importance of the different success variables and to rank the alternative mobile webs. ANP is a new mathematical theory, which deals systematically any kind of dependence and feedback, capable of simplifying and managing complex decision problems. The elements of the model are presentment below as shown in Figure 12.

- *Service Quality* can be defined as the extent to which a mobile website facilitates effective and reliable shopping, purchasing and delivery of goods and services. Its meaning is higher than before since users are now customers and poor user support will rapidly translate into lost customers and lost sales.
- *System Quality* measures characteristics of the mobile commerce ecosystem such as customization, ease of navigation, privacy and security. Privacy is the protection of personal information, while security relies on protecting consumers from the risk of fraud and financial loss.
- *Information Quality* includes the mobile commerce content issue, such as updated and personalized content, customization and variety of information. Customization of mobile Web eliminates information load by filtering unnecessary information.
- *System Use* is measured as the number of mobile commerce site visits, the duration of stay, the number of repeating customers and the amount of purchases completed.

- *User Satisfaction* covers the entire customer experience cycle including purchase, receipt, payment, loyalty, support and service.
- *Net Benefits* measure whether the usage of the mobile commerce website has saved time and money for the consumers. Net Benefit will occur as a result of certain Use and User Satisfaction. Similarly, positive/negative Net Benefits will increase/decrease Use and User Satisfaction.



**Figure 12:** The mobile web success variables [25]

### 2.3.2 Personalization

Consumers leverage mobile devices to search for information or make purchases while they are on-the-go or make purchase decisions while in a retail store. Accessibility in several dimensions include that users should get exactly (1) *what* they need, (2) *when* they need, and (3) *how* (in what quality) they need. Users simply seek convenience, direction, and purchase confidence in every mobile Web interaction with no walled garden environment. Mobile business needs to differentiate products and services against competition while driving improved revenue per unit customer. Mobile personalization offer relevant customization capabilities [5]. Profile information and feedback are gathered explicitly based on user behavior, attitude and current situation.

User profile information can be either provided by customers voluntary (such as phone number, residential address), or constructed from previous purchase transactions,

historical interactions with the store [101]. Personalized Services may include alerts, notifications, targeted advertising, recommendations, dramatically improved mobile messaging and others. Personalization of mobile web services intends to provide the right content in the right format to the right person at the right time in the right location. The location of a mobile device can be found through sensor devices or technologies such as the global positioning system (GPS) [44]. Location-based services achieve a higher personalization level. Location-based personalization is used to differentiate mobile personalization from web personalization [47].

Personalization relies on three dimensions [27], which are the user, one or several mobile devices and the services. The *User-service relationship* includes the information produced and consumed by the user through this service, known as user's attitude. The *User-device relationship* is characterized by information about which devices a user has at his possession, and particular settings of this device towards that specific user. The *Device-service relationship* relies on information about how a particular mobile device should behave towards a specific service and vice versa.

The Semantic Web is deeply connected to the idea of personalization in its very nature. The use of inferencing mechanisms, which is supported by Linked Data, is envisioned as a fundamental means for performing a content-aware navigation, producing an overall behavior that is closer to the user's intuition and desire. In other words, when machines understand things in human terms, and can apply that knowledge to users' attention data, we will have a Web that knows what we want and when we want it [102]. Modelling the published data and the user profile with ontologies allows expressing more effectively the user interests and the relations between the pieces of information, by leveraging the features of Semantic Web.

### 2.3.3 Benefits for Business

An increasing number of websites and applications are based on Semantic Web technologies and the amount of information available on the Web in the form of RDF is continuously growing. The adaption of the Semantic Web and the increasing desire for mobility create new opportunities to mobile business. It is important for mobile business to

create value for customers in a manner that is differentiated from conventional business. As increasing number of companies expose their services as web services, the Semantic Web is a suitable framework that allows data to be shared and reused across applications and community boundaries. People can always access the right information at the right time anywhere. Users can also explore the mobile Web with its new features, services, and applications.

Linked Data can help enterprises reduce manual classification, moderation and analysis work, reduce editorial time, win new business, launch new products, improve audience insight, increase revenues, usability and advertising targeting [103]. Moreover, a mobile device with a GPS can host a service to track its exact location anytime and this type of mobile service can be used in a variety of enterprises or organizations. Shipping companies can track the delivery of commodities and estimate the arrival time. In emergency or disaster situations, skilled people like doctors and nurses can be located using mobile Web services and can be informed about climate conditions (e.g. temperature, humidity) or traffic in the area with the help of Linked Data.

Semantic Web technology will initially be used to enhance work efficiency and improve productivity within firms, particularly for electronic and mobile commerce applications. To unlock the real power of Linked Data, enterprises must do more than publish structured data. Enterprises manage better the large amount of information they handle on a daily basis, as by enriching content with semantic technology they are able to automatically classify, tag and categorize content based on customized criteria. They also need to use ontologies, which other people will recognize and use to publish or relate their data too. A company's semantically website enables content to be more intelligent and to be integrated into other platforms, such as social media. The interlinked Web of data is the real vision [29].

Semantic technologies increase the visibility of products and services of firms. With data such as store name, address, store hours being marked up using RDFa, search engines are now able to identify each of those data components more easily and put them into context [104]. The use of semantic technology increases traffic and better service to its customers. They provide right knowledge at the right time, at the right place for the right person. The search user experience is significantly more effective because a user can, for

example, retrieve only what he is looking for through search by meaning, or leverage the linguistic relationship between concepts to retrieve all information that is really relevant for them.

#### 2.3.4 Business Model Framework

The concept of business model is a method of how a company buys and sells products and services and earns money. According to Osterwalder [43], “a business model is a conceptual tool that contains a set of elements and their relationships and allows expressing a company's logic of earning money.” It is a representation of the value a business offers to one or several segments of customers and the architecture of the company and its network of partners for creating, marketing and delivering this value and relationship capital, in order to generate profitable and sustainable revenue streams.

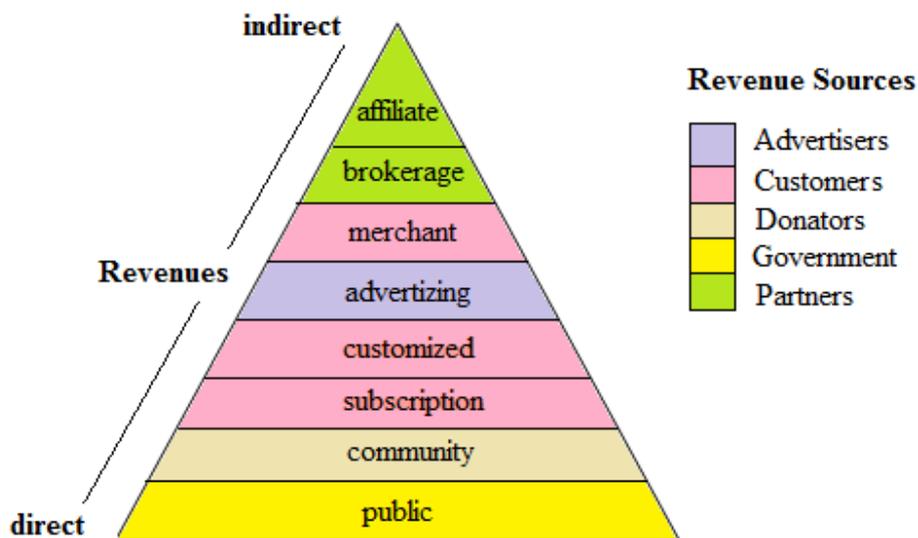
Smartphones are packed with sensors, bridging the gap between the real and virtual worlds: GPS, Wi-Fi, accelerometer, ambient light detector, microphone, camera or thermometer. Modern mobile devices support the Linked Data technologies in the mobile portals and mobile applications. Using Linked Data mobile applications are automatically updated in real time; mobile user is always informed and have access to a wide range of information wherever. The abilities of smartphones play a basic role in the upcoming mobile business models.

It is important mobile Linked Data services to deliver the most relevant and appropriate data to mobile user and companies based on their needs and preferences. Mobile services are now personalized, dynamic and location-based with the benefits of Linked Data technologies. Semantics in Web pages do the Web more intelligent and business-oriented. We study the Linked Data principles and opportunities, the mobile ecosystem, the mobile and web business models and we propose business models for Linked Data mobile Web Services.

*A business model for Linked Data mobile web services* describes how a mobile business creates, delivers and captures economic and social value with the help of the semantic technologies. This business model represents core aspects of a mobile company, including organizational and financial structures, offerings and a customer base. Linked

Data will be beginning to enter the mainstream in near future, to enhance and enable planet scale networks and we will have rich, intelligent added value mobile services. The ubiquity of access, overload of information and heterogeneous sources of data make Linked Data even more critical and essential. Everything will become a service, and be tradable.

The expansion of mobile Web, Linked Data and cloud computing, the widespread use of sensors, advances on mobile phones (e.g. bigger screens, better processing power) and the development of new mobile services and applications contribute to the creation of new mobile business models. Below we look into and propose the different possible conceptual ways of monetizing these mobile web services (Table 1) with appropriate business models based on Michael Rappa’s classification [105] and Osterwalder’s business model ontology. The proposed business models (Figure 13) and their real-life applications and services are analyzed in the section 4.4.4 Business Models for mobile Linked Data Web Services.



**Figure 13: Proposed Mobile Linked Data Business Models [46]**

**Table 1:** Business Models for Linked Data mobile Web Services based on Michael Rappa’s classification.

*Adapted from the Osterwalder framework [43].*

		<b>Advertising Model</b>	<b>Brokerage Model</b>	<b>Subscription Model</b>	<b>Customized Model</b>	<b>Merchant Model</b>
<b>Value Proposition</b>		multimedia mobile messages and coupons, offers, personalized and location-based services and goods, cost and time saving	personalized and location-based services and goods, best prices, offers	valuable and specialized services	professional and location-based services and products, cost and time saving	mobile services and products, offers, physical store, service quality
<b>Target Customer</b>		mobile user on streets	mobile user on the go	mobile user, professionals, companies	professionals, companies	mobile user, companies
<b>Distribution Channel</b>		mobile Web, mobile device, social networks	mobile Web, mobile device, mobile app, mobile site, brokers	mobile Web, mobile device, mobile app	mobile Web, smartphones, mobile portal	mobile Web, mobile device, social networks, partners, mobile portal
<b>Relationship</b>		one-to-one, one-to-many, acquisition, cross-selling	one-to-one, retention, cross-selling	one-to-one, one-to-many, acquisition, retention	one-to-one, one-to-many, retention	one-to-one, one-to-many, acquisition, retention
<b>Value Configuration</b>		Medium value integration	High value integration	High value integration	High value integration	High value integration
<b>Core Capabilities</b>	<b>Technology</b>	Linked Data, mobile Web, ambient intelligence	Linked Data, mobile Web, cloud computing, ambient intelligence	Linked Data, mobile Web, cloud computing, ambient intelligence	Linked Data, mobile Web, ambient intelligence	Linked Data, mobile Web, cloud computing
	<b>Services</b>	LBS, personalization, real time, on-demand	LBS, personalization, mobile auction	LBS, real time, on-demand	LBS, personalization	LBS, personalization
<b>Partner Network</b>		MNO, CP, MSP, AP	MNO, CP, AP, MDM, sellers	MNO, CP, MSP	MNO, CP, MSP, MDM	MNO, CP, MSP, AP
<b>Revenue Model</b>		Advertisements	Fees, sales of goods and services	Subscription fees	Sales of professional services	Sales of products and services

MNO: Mobile Network Operator, CP: Content Provider, MSP: Mobile Service Provider, AP: Application Provider, MDM: Mobile Device Manufacturer

**Table 1:** *Business Models for Linked Data mobile Web Services based on Michael Rappa's classification. Adapted from the Osterwalder framework [43].*

		<b>Affiliate Model</b>	<b>Community Model</b>	<b>Public Model</b>
<b>Value Proposition</b>		personalized and location-based services and goods	LD, personalized and location-based services	Linked Data
<b>Target Customer</b>		mobile user, mobile business	mobile user on the go	mobile users, mobile business
<b>Distribution Channel</b>		affiliates, mobile Web, mobile device	mobile Web, mobile device	mobile Web, mobile device
<b>Relationship</b>		one-to-one, one-to-many, acquisition, cross-selling	one-to-many, acquisition, retention	one-to-one, acquisition, retention
<b>Value Configuration</b>		Medium value integration	Low value integration	Low value integration
<b>Core Capabilities</b>	<b>Technology</b>	Linked Data, mobile Web, ambient intelligence	Linked Data, mobile Web	Linked Data, mobile Web, ambient intelligence
	<b>Services</b>	LBS, personalization	LD, LBS, personalization	LD, LBS
<b>Partner Network</b>		MNO, CP, MSP, AP	MNO, CP, AP, MDM	MNO, MDM
<b>Revenue Model</b>		Commissions	Donations	Public Subsidies

MNO: Mobile Network Operator, CP: Content Provider, MSP: Mobile Service Provider, AP: Application Provider, MDM: Mobile Device Manufacturer

The Osterwalder's business model ontology [43] is a set of business model elements and their relationships that aim at describing the money earning strategy of a mobile business. Below they are presented.

- *Value Proposition*: A Value Proposition represents value for one or several target customers and is based on several resources. It is about customer's value perceived based on products and services that are provided by a mobile business.
- *Target Customer*: The Target Customer refers to whom a mobile company delivers its value proposition. In other words, defining a firm's target customers is all about segmentation.
- *Distribution Channel*: A Distribution Channel describes how a mobile business gets in touch with its clients and how it interacts with them.
- *Relationship*: The Relationship element concerns the relationship a mobile business builds with its target customers. Relationship mechanisms concerns personal or mass communication, acquisition, retention or cross-selling activities.
- *Value Configuration*: The Value Configuration can be defined as by the degree of integration of the business model. It describes the arrangement of main activities and how they relate to each other.
- *Core Capabilities*: A Core Capability is the ability to execute a repeatable pattern of actions in the use of assets or resources of the mobile business to create, produce and offer products and services to the market in order to create value for the customers. The Core Capabilities in a mobile business are the application of several technologies and the creation and offer of services and goods, based on company's vision and strategy.
- *Partner Network*: A Partner Network is a voluntarily initiated cooperative agreement formed between two or more independent enterprises in the mobile landscape in order to carry out a project jointly by coordinating the necessary capabilities and activities.
- *Revenue Model*: A Revenue Model describes the ability of a mobile business to translate the value it offers its customers into money and incoming revenue streams.

### 2.3.5 Business Cases

#### a. iMarket

iMarket [106] is an e-commerce portal that provides an electronic trading infrastructure, facilitating access to insurer services by intermediaries in the United Kingdom insurance market over a secure network. Brokers can log on to iMarket via the Internet using one ID and password to access the full range of products and services on individual insurer extranets without further signing on. Services available vary by insurer but include online quotations, immediate cover confirmation, policy issue, and such things as stationery requests. In 2008, 3000 broker firms have been registered to iMarket. Moreover, there is no charge for using iMarket.

iMarket offers a most cost effective and efficient way for providing the necessary connectivity for all parties. Brokers are responsible for giving their users access to services. These services are effectively business transactions between an insurer and a broker, and cover a wide variety of functions. Because the services offered are diverse, iMarket allows brokers to decide whether all users access to all services available to broker's firm, or whether there be restrict access to services according to your users' needs [107].

iMarket can create a mobile website and a mobile web application for a mobile presence. In addition, imarket can deploy Semantic Web technologies that allow data to be shared and processed by automated tools as well as by people. With Linked Data, the information that links one service description to another doesn't need to rely on the luck of having a common term in natural language to merge on. An outside source can express mapping information. Questions like "*How many business transactions do we carry out with insurer z on an average day?*" can be answered on a semantic level based on suitable knowledge representation techniques.

iMarket can use semantic technologies to reduce the cost of transacting business between insurers and brokers and to increase productivity of decision making by processing higher volumes of information than previously and improve the effectiveness of knowledge discovery. This allows to flexibly modifying and extending the portal's functionality. Brokers enable smarter and personalized mobile web apps to their users.

b. Facebook

Facebook has created a platform, called Open Graph [108] that allows enterprises to integrate their websites into the social graph, and also allows websites that use the platform to be added to facebook search. The Open Graph is a set combination of publisher plug-ins (such as “Like” buttons), semantic markup and a developer API, which helps facebook to collect structured data on every user.

In addition, facebook launched Facebook Places, a location-based application, and Facebook Deals. Facebook Places allows users to share where they are, find friends and discover places nearby. Facebook Places also offers a presence for business’s physical store locations, encouraging your customers to share that they have visited your business by “checking in” to your Place [109]. Facebook Deals are pushed to users’ mobile phones through Places to let them know what bargains are available in the nearby area. The social distribution is an extra benefit for the business: as customers check-in and redeem deals, stories are published to their profile about that deal.

Erick Tseng, Facebook’s head of mobile products, believes [110] the semantic platform help businesses boost brands among on-the-go consumers through location-based mobile apps developed for the site. Walking near a coffee shop and getting a location-aware notification on mobile facebook that there’s a music event there, you’ll probably be even more inclined to visit it if the notification comes bundled with recommendations from your Facebook friends. Companies can use Facebook Insights, a tool that provides deeper analytics on user demographics, “Likes”, shares and reshares, to evaluate the effectiveness of its facebook presence.

According to Mark Zuckerberg [111], “if you like a band on Pandora [112], that information can become part of the graph so that later if you visit a concert site, the site can tell you when the band you like is coming to your area.” Moreover, when you connect to sites like Yelp [113] via your Facebook profile, Yelp will have access to any information you’ve made publicly available about your favorite foods or bands, and will be able to take that into account when giving you information about restaurants or music events. For example, Yelp could provide information about your favorite band from data that Pandora added to the graph when you favorited a song on its site.

The Semantic Web can link and aggregate multiple data on facebook, in order to produce more useful and meaningful results. The Open Graph protocol should allow companies to target their ads more effectively to the users who love their products. The target of facebook is to become a place where users and businesses can interact. The success of Facebook's plans depends directly on web firms' willingness to add the social features along with consumers' willingness to click a "Like" button frequently, or ignore it. Facebook has essentially launched the semantic search engine of the future.

### c. Android Market

Google's Android mobile platform has revolutionized open applications development for the mobile platform. The four main features of Android are [114]: open nature, application hierarchy, ability to combine information from the Web with data on the phone, and Software Development Kit. Mobile phones will have an increasingly access to the semantic-enabled applications to exploit the benefits of semantic technology. Users must have flexible mobile access through android platform to distributed web resources for advanced personalization and localization features.

Android market follows the iOS, as it start using Linked Data into its applications. Android market incorporates semantic technologies to develop scalable and useful semantic mobile applications. Time, geo-location, personalization, users' interests and application context are all ingredients for integration with other data sources, public and private. Information is produced within a context and it helps users to reuse the information outside of the context in which it is produced. The revolution is that you can find a restaurant to eat nearby using your mobile phone based on your friends' recommendations on a social network.

For example, Evri [115], a real content search engine, offer content discovery android applications using the semantic technology. Evri's platform analyses thousands of web sources to automatically categorize content into intelligent and manageable streams, based on users' search needs. The company analyzes text of unstructured content (web pages, Twitter feeds etc.) to identify entities and extracts entity networks of related concepts. The acquisition of another semantic focused startup, Radar Networks, and its

product Twine, gives users a smarter way to share, organize and find information. Evri is like a mix between Google Trends and Google News, with liberal sprinklings of Twitter and Facebook [116].

Evri launched a tech news reader on Android phones called Everi Thing Tech [117]. It delivers the latest technology news articles, videos, photos, tweets from thousands of content sources on the Web with semantic matching algorithms. Users also search topics they're interested in and Evri understand and return what content is popular, but also what it means. Similar Android apps are EvriThing Gossip, EvriThing Football, EvriThing Rock and EvriThing Baseball. The business will continue to invest in this application to add more capabilities and more external data sources to link against.

#### d. Amazon Kindle

The launch of innovations such as e-Books and e-Readers based on software, hardware, and infrastructure resources offers an opportunity to create new business models. Although those efforts, emerging mobile business models, which concerns the eBook market is still scarce. E-Reader is a small and portable device specialized for reading electronic books [118]. It is expected [38] that more and more book consumers will adopt e-Readers in the near future, as shown in Figure 14.

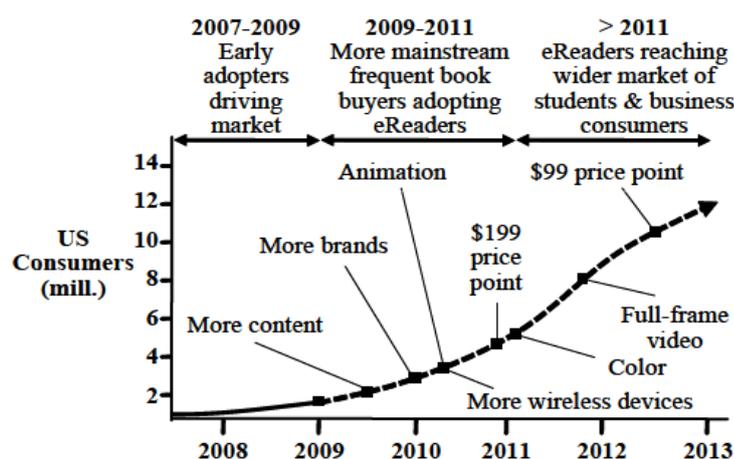


Figure 14: Predicted e-Reader Demand [38]

The Amazon Kindle is an e-reader that allows user to download and read a variety of publications, including books, newspapers, blogs and magazines. User can also access the Internet to browse the Amazon Kindle store to browse, purchase and download new publications on the go. The new web browser is much better than previous and its main feature is the “article mode” that optimizes pages to be viewed as plain text for reading, focusing on the content in the main article body and removing some ads and extra columns. Users can share passages from ebooks with friends via social networks like Facebook and Twitter by posting the passage directly from a Kindle.

Kindle is likely to become a promising investment and an important component of Amazon’s retail portfolio. Amazon’s Kindle differentiation against its competitors (e.g. Sony Reader) lies in implying a *direct connection between hardware sales (eReader) and eBook content delivery*. In other words, Amazon builds a direct link between selling an innovative e-Reader and globally branded e-Book content. Kindle users buy e-Books exclusively from the Kindle store. This creates a constant flow of revenue for Amazon. On the other hand, this method is a potential obstacle to extent its customer base.

Due to the book publisher's DRM policies, Amazon states that there is no right of first sale with e-books. Amazon claims they are licensed, not purchased. Unlike paper books, buyers do not actually own their e-books according to Amazon [119]. Many users believe that Kindle’s model is a “closed” ecosystem. Recently Amazon announced Kindle Book Lending, a feature that lets user loan book once to anyone for a period of 14 days and the lender cannot read the book during this period [120].

The social networking aspects of the Kindle suggest that Amazon is looking for ways to make its e-reader more than just a simple display device. Amazon introduced a software application allowing Kindle books to be read on PC, Mac, iPhone, iPad, BlackBerry or Android Phone in order to reach out to more audience. The Kindle application insures that users can buy, automatically sync and read Kindle books across Kindle-enabled reading devices. That means any book will open to the last page read regardless of the device last used. Jeff Bezos, CEO of Amazon, in January 2011 said [121]: "Kindle books have now overtaken paperback books in the U.S as the most popular format on Amazon.com."

Amazon’s strategy for Kindle will become eventually more open. Its web browser will be even more power in order to support all kinds of web pages and to provide a

convenient navigation. The introduction of Semantic Web technology to Kindle's application is a necessary and innovative tool. For example, books can be searched and categorized automatically based on genre of literature or author. The application can also propose to users books or magazines based on preferences of their facebook's profile.

#### e. iPhone App Store

The iPhone App Store [122] is a digital application distribution platform for iOS developed and maintained by Apple and has more than 350.000 applications. Users can download applications, 37% are free or at a cost, from the iTunes Store to their iPhone. The iPhone value chain offer incentives for its partners and monetization opportunities for Apple. For example, the App Store's revenues go 30% to Apple and 70% to the application developer. Apple Store provides a variety of innovative, functional, personalized and high quality applications, which improve user's satisfaction and offer real value. In other words, it is a way to create long term customer loyalty.

Apple's value proposition for the iPhone built upon the iTunes music and video service. iTunes provides reliable sales of high-quality music with clearly defined and allocated property rights. The success of the iPhone was the meeting of needs of users for new wireless services, its competencies in hardware, software and system design [39]. Apple's differentiation is based on selling services via its own controlled sites. As a consequence, Apple can both guarantee the quality of provided services and build its own relationship with its users.

App Store is a self-contained application store, which means apps are available from inside the site or device itself [123]. It also provides updated information about an application to the vendor and potential customers through public feedback such as ratings and reviews, in order to innovate and improve the offering. The distribution and delivery of applications is controlled by the platform owner to ensure safety to the customer. There are three business models for iPhone Apps [124].

- *Free Apps*: Many applications are provided free, for many reasons rather than monetization. In these cases, application developers are interested in reputation, career development or the satisfaction of releasing an application.

- *Big-fast sales*: The most popular paid applications, named “big-fast sales”, are priced between \$0.99 and \$3.99 and they are predominantly entertainment. Most users download them and use them once or twice. They offer small value to the user, but the mass download provides great initial revenue.
- *Sustained sales*: In this category, applications are more special, suitable for scientific use and help customers in their daily personal or professional life. Users are willing to pay \$9.99 or more in order to satisfy their expert needs with a useful and convenient application.

iPhone also faced a number of criticisms by its competitors, including the \$400 price, the lack of third-party applications and Flash middleware. In response to the success of the iPhone App Store, competitor Google announced its own application downloading services in August 2008, called Android Market. Global mobile ecosystem players will be those in control of smart applications and semantic services.

App Store supports applications with the use of Linked Data technology. For example, Siri is a mobile virtual assistant available in App Store [125]. This application helps users to book restaurants, movies, events, taxis based on their location, through natural language voice or text queries using semantic search. Using GPS and speech-recognition technology Siri personalizes and localizes user’s results. Siri answers commands like “find a table for 2 next Sunday at 8 pm in Thessaloniki” or “send a taxi to my house”. It is about a mobile Linked Data service that creates new value for consumers.

### **3. PART II: THE LINKED DATA INFRASTRUCTURE**

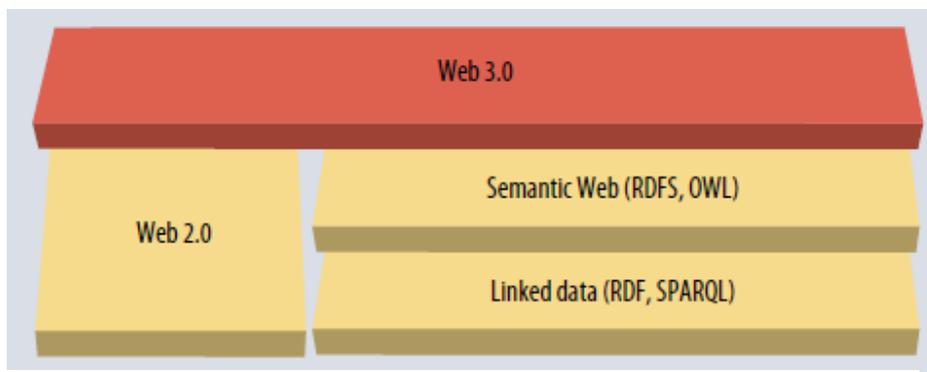
#### **3.1 Hendler’s Model for Web 2.0 and 3.0**

Web 2.0 refers to the second generation of web-based communities and hosted services that found ways to deliver the functionality of the “read-write Web” to large user groups, and to great effect. According to James Hendler and Ora Lassila [126], “Web 2.0 is mostly a social revolution in the use of Web technologies, a paradigm shift from the Web as a publishing medium to a medium of interaction and participation”. Web 2.0 has several dominant applications including blogs, wikis, RSS, mashups, podcasts, multimedia sharing,

social networks (e.g. Facebook, Flickr, Twitter, LinkedIn). The arrival of Web 2.0 has added many new features to the web applications, such as rich user experience, information sharing, dynamic content, interoperability on the Internet.

Web 3.0 is the next phase of the Web evolution, an intelligent Web in a cloud computing setting based upon linking, integrating and analyzing data from various data sources into new information streams. Linking of data in Web 3.0 is achieved with the help of Semantic Web technologies like Resource Distribution Framework (RDF) and SPARQL. RDF Schema (RDFS) and the Web Ontology Language (OWL) provide the ability to infer relationships between data in different applications or in different parts of the same application [31]. As Figure 15 shows, Web 3.0 extends current Web 2.0 applications using Semantic Web technologies and Linked Data.

Based on Hendler's analysis [127], Semantic Web efforts provide an approach to constructing flexible, intelligent information systems and applications. Nevertheless, it couldn't be predicted what the Semantic Web's "killer application" would be.



**Figure 15:** *Web 3.0 is based on Web 2.0, Semantic Web and Linked Data [31]*

### 3.2 Semantic Web

The Semantic Web is a Web 3.0 technology, a way of linking data between entities that allows to find, share and combine information from disparate sources across the globe on the Web [128]. The Semantic Web is about making links, so that people and machines can explore the Web of data. A more interactive user experience can be created via the use of Semantic Web technologies by the integration of external data sets to create a more

valuable product, the display of supplementary data which could take many forms (e.g. YouTube video, images, podcasts)

Linked Data is simply about using the Web to create typed links between data from different sources and to publish structured data in such a way that it is machine-readable using URIs (Uniform Resource Identifier) and RDF (Resource Description Framework) [31]. Tim Berners-Lee [129] described four principles of Linked Data, that provide a basic context of publishing and connecting data: a) Use URIs as names for things b) Use HTTP URIs so that people can look up those names c) When someone looks up a URI, provide useful information, using the standards (RDF, SPARQL) and d) Include links to other URIs so that they can discover more related information on the Web.

The RDF model encodes data in the form of subject, predicate, object triples. The subject and object of a triple are both URIs that each identifies a resource, or a URI and a string literal respectively. The predicate specifies how the subject and object are related, and is also represented by a URI. Everything expressed in RDF means something, whether a reference to a physical object, an abstract concept, or a fact. Standards built on RDF describe logical inferences between facts. The Linking Open Data project [130] contains various open data sets, such as GeoNames, DBpedia or YAGO.

The Semantic Web is the next step in the evolution of the Web. There are many opportunities in a number of fields:

- Opening up the Web of data to artificial intelligence processes
- Businesses, organizations and individuals can publish their data freely, in an open standard format [131]
- Enterprises can use data already available on the Web to increase their functionality
- Semantic applications will be build on top of this data in order to generate a valuable output for the end user
- Enhance discoverability and visibility of websites' content [132]
- Enterprises and organizations could assess risks with greater accuracy because of more relevant data available.

Semantic Web incorporates a lot of potential for enterprises. Revenue flow and generated value are some of the main demands and requirements of businesses and Linked

Data can contribute at this direction [32]. Web 3.0 is the next generation framework for enterprise integration and interoperability. Two crucial issues are linked to the quest of personalization and the effective knowledge management. Semantic Web technologies are lower-risk in the medium-term timescale, and in the short-term they are also most likely to become the roadmap for traditional data technologies [133].

Semantic Web also provides a framework for control of cloud usage [4]. Linked Data can replace the disparate cloud database models. By using ontologies, Semantic Web aims at collecting structured information from web pages and redirect the information to client side to satisfy needs and preferences of the users. The demand of security, one of the major obstacles in the success of cloud computing, is resolvable by a wide range of security mechanisms that the Semantic Web provides. The semantic cloud on mobile platform may promote the need for efficient, semantic access to cloud data on mobile.

### **3.3 Linked Data as an Infrastructure**

Data is what drives commerce on the mobile Web and what help companies search and find what they are looking for. This is why Linked Data is made freely available and open without restrictions from copyright, patents or other mechanisms of control, unleashing new innovations and business ideas [10]. The importance of open Linked Data can also be conducted from a simple but significant analogy: just as the supply of basic physical infrastructure, such as power, transport, telecommunications, is essential to the traditional economy, so the supply of basic information “infrastructure” (e.g. Linked Data of weather or transport) is essential to the ‘knowledge’ economy [45].

Governments, such as USA and UK, start to represent and release public-sector information in order to support integration of heterogeneous information sources by the government, the business and the citizen. Individuals and enterprises easily access and use public Linked Data that are generated as an infrastructure for commercial purposes. Open Linked Data provides social, business and economic value and is made available as quickly as necessary to preserve the value of data (e.g. traffic, temperature).

An increasing number of companies are selling added-value services that build on open government data (e.g. data.gov.uk, data.gov) [134]. If a private business is in receipt

of public funds to run a public service then the data it uses to run these services should be open. Open Linked Data can reduce integration costs, improve transparency, offer instant connectivity between partners and harness the innovation of others. Access to better information about demand and supply makes it easy for both suppliers and traders to evaluate risks, plan, organize, economise and improve their activities.

The most critical value of open Linked Data comes from the companies' ability to carry out its own analyses of raw data in order to meet their needs, rather than relying on a government's or organization's own analyses. If the existing ontologies can not satisfy the company's context needs, a mobile business can also create its own ontology and make it public, so others can make use of it. There is also an added value in processing and combining open Linked Data with user data and creating useful mobile applications. Mobile semantic services can be created based on semantic content [135].

### **3.4 Linked Data Mashup**

Mashup is the web aggregation framework constructed upon the web services and open Application Programming Interface (API). Mashup is an application that uses and combines data from more than one web source to create new services [136]. Graphical user interfaces, components for data extraction, analyzing tools and engines for data merging offer a powerful toolkit for web mashup applications. Linked Data mashups (or "meshups") are simply statements linking items in related data sets. These items are identified by URIs starting "http://", each of which may have been minted in the domain of the data publisher, meaning that whenever anyone looks up one of these URIs they may be channeled back to the original data source [137]. It is this characteristic that creates the business value in Linked Data compared to conventional Web APIs.

Linked Data mashups are mashups using data from the Linked Data cloud and provide many opportunities to generate business value. Many mashups at the mapping category uses the Google Maps API, while others at the video category uses the YouTube API. There are also mashups based on semantic APIs, such as ClearForest Semantic Web Services<sup>1</sup>, Evri, MusicBrainz etc. For instance, the Music Artist Cloud mashup [138], for

Android smartphones, based on MusicBrainz API, presents videoclips and biography of artists and bands.

Business mashups integrate enterprise and data services (e.g customer relationship management software), as business mashups technologies offer the ability to develop new integrated services quickly, to combine internal services with external or personalized information, and to make these services tangible to the business user through user-friendly Web browser interfaces. In addition, many of the available business mashups applications focus on easy integration into existing IT infrastructures and provide a set of tools and widgets for easy mashup creation by employees [28]. Apart from that, enterprise mashup applications set higher requirements concerning security, privacy and reliability.

### **3.5 GoodRelations Ontology**

GoodRelations is a retail ontology that can be used to describe very precisely what a business is offering. It can express commercial and functional details of e-commerce scenarios and procedures. It is expressed in *RDFa* which adds a set of attributes in HTML/XML language for embedding rich metadata within Web documents. GoodRelations can create a small data package that describes company's products and their features and prices, company's stores and opening hours, quantity discounts, payment and delivery options and so on [139]. For example, *RDFa* can create rich relationships between company's products, which will in turn create a deeper visibility to additional products and services when a customer is shopping online.

GoodRelations increases the visibility and improves the ranking of business products and services in the latest generation of search engines, recommender systems, and other novel applications. Since its official release in August 2008, it has gained substantial popularity and is experiencing very fast adoption. GoodRelations is already in use by companies like Google, Yahoo, BestBuy, Overstock.com, O'Reilly Media and many others [140]. Jay Myers, Lead Web Development Engineer at BestBuy.com, said [141] that "there isn't a noticeable difference to the users of Best Buy's website; however all of the *RDFa* data is very visible to humans via search engine results and its store locator tool." He also remarked that it had resulted in a 30% increase in search traffic.

## **4. PART III: MOBILE LINKED DATA SERVICES**

### **4.1 Mobile Web 3.0**

The Web is an open standard, the links data web will be an open standard and mobile devices will profit of that [142]. As more users are increasingly turning to their mobile devices to browse the Web, Mobile Web 3.0 provides them a mobile browsing experience that's closer to their desktop usability experience than ever before. Mobile Web 3.0 brings advanced personalization and the opportunity to increase the selection of content a user can access on his mobile device [42]. Having mobile phones access to semantic-enabled applications offer location-based services and advertising.

Topical information, such as traffic information, weather forecasts, last-minute theatre ticket deals, turned to be important to the users while they are on the move. The mobile Web can also identify locations frequently visited by the user and then assist the user in associating information with these places. As a result of the above, many mobile commercial applications can be created based on Linked Data. Mobile users can also easily participate in the content creation and sharing instead of being passive information consumers.

### **4.2 Mobile Web Services and Linked Data**

The adoption or rejection of a mobile service is determined by users' perceived value. Web services and Linked Data on mobile devices bring convenience for users to administrate and manage their business services anytime and anywhere. Many services require significant processing power and memory in the mobile devices. The mobile cloud computing can help to reduce the workload of mobile devices by exploiting remote resources on the cloud and promises the adoption by the enterprises in future [30].

*Mobile Web Services* apply Web Services technology to the mobile environment, enabling exciting new services to be offered to consumers on their mobile phones, tablets and netbooks [2]. *Semantic Web Services* (SWS) [143] employ Semantic Web technology in the Web Services area: All are expressed in knowledge representation languages,

referring to shared ontological vocabularies. Semantic Web services demand the ability to make not just assertions but also more complex ones, with the appropriate inferences about elements such as temporal durations and quantities.

A semantic enterprise can be defined as an organization that uses the standards as well as the language of Semantic Web technology, such as OWL, SPARQL, RDF, RDFS, to integrate existing information assets, using the best practices of Linked Data and the open world assumption, and targeting knowledge management applications [144]. Suitable applications include data federation, data warehousing, data from wearable sensors, search, enterprise information integration, business intelligence, competitive intelligence, knowledge representation, and so forth. In the knowledge domain, the benefits for embracing the semantic enterprise can be summarized as greater insight with lower risk, lower cost, faster deployment, and more agile responsiveness [16].

The uses of semantic technologies support internationalization and localization, which are means of adapting computer software to different languages and regional differences. According to Soren Auer, “internationalization is the process of designing a software application so that it can be adapted to various languages and regions without engineering changes”. Localization is the process of adapting internationalized software for a specific region or language by adding local-specific components and translating text [145].

### **4.3 DBpedia Mobile**

DBpedia Mobile allows users to discover, search and publish Linked Data from their current location using their mobile devices as well as standard web browsers. DBpedia Mobile is a location-centric DBpedia client application for mobile phones, as shown in Figure 16, which allows users to access information about DBpedia resources with appropriate labels and icons, located in their nearby physical surroundings, from where they can explore links to other resources on the Semantic Web [8]. DBpedia Mobile consists of a map view, the Marbles Linked Data Browser and a GPS-enabled launcher application. Users can access the application through a mobile phone’s web browser and they can

publish their location, photos and reviews. Published data is interlinked with nearby DBpedia location [13].

Web content includes geospatially referenced information so as it is arranged by geographic location. The *Geospatial Semantic Web* is created by applying the Linked Data architecture to geographic locations, which are represented as original web resources. The Geospatial Semantic Web interlinks data locations with web resources and relates locations to each other. For example, the GeoNames database contains geographical names of towns, regions and countries in various languages and queries such as “all museums in Athens” are easier to process. People, public transports, hospitals or churches can be related to places, as an example of interning between data sources and locations. According to Becker and Bizer, “as the traditional document Web can be crawled by following hypertext links, the Semantic Web can be crawled by following data links [14].”

Locations are depicted with labels based on a mapping of selected YAGO [146] data sets, which provide information for places such as public transports, organizations or museums. Clicking on a resource user can read a short view of the selected item, which includes: a) a summary describing the resource b) an image, which is provided by DBpedia or the flickr<sup>TM</sup> wrappr [147], which provides image collections concerning locations c) a link to the resource’s homepage d) reviews of the resource from Revyu [148], which collect users’ reviews about anything such as locations, hotels etc. DBpedia Mobile has the possibility to access all web resources that are or will in the near future be interlinked with DBpedia or other data sources. For instance, from a location the user may navigate to a person within the DBpedia dataset that was born, died or worked at the place or to local products that are produced at the area.



**Figure 16:** DBpedia Mobile running on an iPhone 4 and showing a map view of resources at Thessaloniki City in the user’s proximity

### 4.3.1 Search Tools

DBpedia Mobile's RDF store initially includes only DBpedia data sets that are prerequisite to create the displayed map [7]. The user can search the map for specific resources defining specific filters. A Filter Builder supports two categories of filters: a) Simple Filters consist of one or more conditions that are applied in conjunction and concern resource types and ratings that are associated with resources. Resource types can be predefined sets from YAGO categories. b) SPARQL Filters are SPARQL queries whose resulting RDF graph is used to generate the map display. In Figure 17, the Simple Filter Builder interface restricts resources at type of restaurants and hospitals in Thessaloniki City.

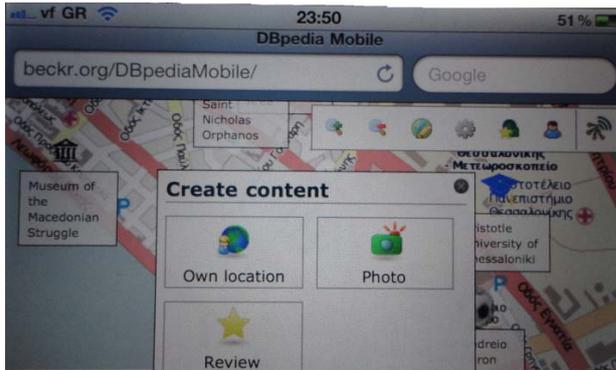


**Figure 17:** *The simple filter builder interface*

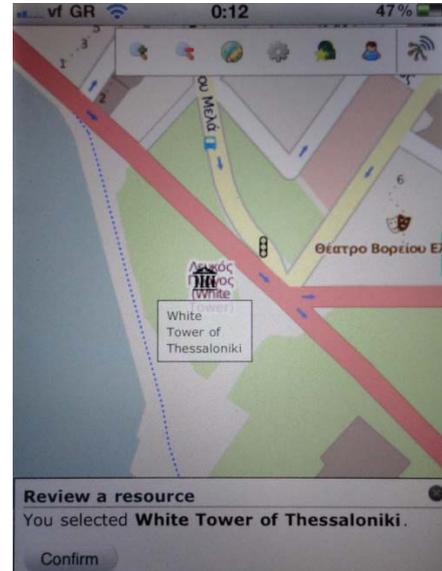
### 4.3.2 Publishing Content

DBpedia Mobile enables user to create content, such as his current location, photos and reviews, directly from his mobile device. The published content is interlinked with DBpedia web resources. User need initially to sign up in order to acquire a DBpedia Mobile account [12]. User has a personal resource URI in the form <http://beckr.org/DBpediaMobile/users/username>, which is associated with all content created by him. User logs in and opens the Content Creation Panel (Figure 18) in order to publish content. He selects the type of content to upload (e.g. location, photo, review) and chooses a DBpedia location to be used to tag the published content. For example we choose

to review the White Tower of Thessaloniki (Figure 19). Based on user's position, nearest DBpedia resources are automatically suggested.



**Figure 18:** *The Content Creation Panel*



**Figure 19:** *Review of White Tower of Thessaloniki*

#### 4.4 Business Models and Value in mobile Linked Data

In the next sections it is proposed a structure for Linked Data mobile web services, based on Kevin Hao Liu's designed framework [37]. He uses 4 building blocks to describe a comprehensive business model: organization, services/products, customer/user and finance.

##### 4.4.1 Organization

The mobile business market is highly fragmented and as enterprises possess different resources, they must collaborate with each other for a typical mobile service/product offering. We analyze business networks on the basis of the roles and relationships between the actors involved. The use of value network to examine actors within the mobile industry is necessary. Actors concerned with mobile commerce's activity include network operator, content provider, service provider, application provider and device manufacturer.

Actors in value networks typically have one shared goal: developing and offering a service/product that adds value for customers. Network openness indicates the degree to which new business actors can join a value network and are allowed to provide additional

services and products to customers by other partners within the network [19]. The value of being part of the network increases as the network expands and the number of its users gets bigger [21].

#### a. Mobile Network Operator

*A mobile network operator (MNO)* is a telephone company that operates the access network infrastructure, delivers basic services to the user, provides mobile devices and controls the billing systems for the customers' usage [33]. They provide the access network and charging infrastructure and hold one key for value creation by offering different mobile services based on their pricing strategies [17]. Operators can also have a mobile portal, facilitating customers to locate appropriate service providers and enabling content providers to reach users via the operators' mobile portal.

They offer typical mobile services like voice call, SMS, MMS, Internet services (email, instant messaging, chat, blog, news etc.) enriched by context information of the user (e.g., presence, location), digital contents (e.g., ringtones, images, games, applications) through their portals [11]. MNOs have some advantages over other portal actors, as they have an existing customer relationship and personal data and they can identify the location of the subscriber [44]. Moreover the services can be personalized based on the user preferences. Mobile network operators act as bridges among all other actors through their network and subscriptions. No one can live without operators in the mobile industry.

#### b. Content Provider

*Content providers (CP)* are the mobile players that create mobile data, information products and services for delivery and use, as well as facilitate the content exchange [33]. Nowadays, although users are no longer passive content consumers and they create also content and publishes it, professionals usually produce content of better quality [34]. Content providers include business which produce, organize, publish and distribute multimedia content (such as video, television, music, images, books, games, news). CP is

divided into content developer (CD) and content aggregator (CA) according to their companies.

Content developer (i.e. CNN) produces services based on their self-developed content. Content aggregator (i.e. Yahoo) collects content from other companies and spread information in Internet with packaging and organizing content from all sources [35]. The main characteristics of CP which supply value for consumers are usefulness, convenience, personalization, location and flexibility. They earn revenue from subscription fees, usage fees, mobile advertising fees and revenue split with operators and manufactures.

#### c. Mobile Service Provider

*Mobile service provider* (MSP) is mainly active on the overall management of contents and services, having an intermediary role between network operators and content providers [25]. Service providers integrate the data offered by content provider and their own mobile information into services, supply to end user through the network provided by mobile operator. Mobile content can be adapted to the user's contextual situation (location, presence) or his preferences.

For example a location-based weather report service that is regularly updated is highly personalized, and involves a continuous relationship between user and provider. MSP has a high impact by generating network traffic and content consumption in user communities [17]. Moreover, it is important services to be secure with high quality. They earn revenue streams from subscription fees, usage fees and syndication agreements.

#### d. Application Provider

The *application provider* offers software platform for whole mobile ecosystem's running and mobile applications. They develop new applications or provide a new version of the application that integrates updated context. Their business partners often are network operators, in order to gain access to essential network services (i.e. location information) and device manufacturers, in order to ensure compatibility with existing and future mobile devices [21]. They must innovate early and differentiate their offerings. The expected

revenues will be from sale of license fees, installation fees, rental agreements for hosting, consulting services.

e. Mobile Device Manufacturer

The *mobile device manufacturers* (MDM) are the actors that offer the physical mobile devices (mobile phones, personal digital assistants (PDA), tablets, netbooks) to users that enable them to access a mobile network and to run mobile applications [21]. Devices are provided via various channels, such as MNOs' stores, devices retailers and manufacturers' own stores. They should communicate with network operators and users at the same time, meet the technical requirements of operator and the needs of user [35]. Mobile devices must provide a guarantee of compatibility and interoperability between and across elements of the mobile ecosystem such as mobile applications, services and networks. They are developing chips that can turn mobile phones into mobile wallets able to carry and exchange electronic money securely [41]. Manufacturers' revenue mainly comes from the device sale and portal activities.

4.4.2 Services/Products

Services and products describe all aspects of what a company offers its customers. Actors provide products and services to end users, and they should position their products or services at a definite value. The value provided to target consumers from enterprises through their products and services is defined as *value proposition*. This means that they offer valuable goods for target customers based on their abilities. Companies must be able to innovate and constantly transform their value proposition for achieving a competitive position at mobile marketplace [43]. The value can be described with many ways depending on the context. Actors should consider several aspects such as value level, price level, and optional life cycle.

Mobile business value means the value arising from *mobility*, which is the main advantage upon which mobile applications can build their value proposition. Mobile business also has several unique benefits such as (1) *ubiquity*: services are available

“anywhere, anytime” (2) *convenience*: mobile devices are always at hand (3) *instant connectivity*: real time easy and quick connection to the Internet through mobile devices (4) *personalization*: uses customer preferences (5) *context-awareness*: uses the users’ context or that of relevant other entities to adapt the behavior of services automatically (6) *localization*: user’s location information can be exploited to provide location-based services [18], [15], [20].

The growth of mobile commerce depends on widely accepted mobile payment systems. Security is an important prerequisite for any type of mobile transaction. However, there is a trade-off between the customization and personalization of mobile services on the one hand, and security and privacy on the other. Several efforts and technologies have been made available to protect users’ personal data, payment information and privacy. For example, the integration of a tamperproof chip card inside the mobile phone offer security and trust for handling valuable data [41].

#### 4.4.3 Mobile Customer/User

Customers are also important players in the mobile landscape, because they ultimately determine the success or failure of mobile business. In the mobile ecosystem, the user is any individual or organization who consumes content provided via a mobile device for reasons of communication, information, education, entertainment, or commerce. The customer relationship element refers to the way an enterprise goes to mobile market, how it actually reaches its customers and how it interacts with them. A company with a large number of users, and a way of rapidly extracting feedback and information from those users, may be able to improve its products and services faster than its competitors. Firms introduce new relationship mechanisms, such as personalization and trust, through mobile devices to reach new customers.

The nature of targeted individual and business customers along with their wants and needs are also crucial issues [3]. A market segment is a relatively homogeneous collection of prospective buyers. Targeting involves the selection of a market segment for which a service/product is created. Segmentation can be based on geographical, demographical (e.g. age), psychographic (e.g. lifestyle) or behavioral characteristics (e.g. frequency of use),

market size. User profiles, which contain information such as personal data, needs and preferences, are gathered and stored in large databases or now in the semantic cloud in order to offer personalized services [18].

According to Osterwalder [43], a distribution channel describes how a firm delivers a value proposition to a target customer segment. A distribution channel allows an enterprise to deliver value to its customers, either directly or indirectly through intermediaries. Moreover, customer's buying cycle is divided into four phases: (a) *customer's awareness* (e.g. advertising) (b) *evaluation of his needs and the matching to the company's value proposition* (e.g. company information) (c) *the moment of purchase* (e.g. offer) and (d) *after sales* (e.g. maintenance).

#### 4.4.4 Business Models for mobile Linked Data Web Services

##### a. Advertising Model

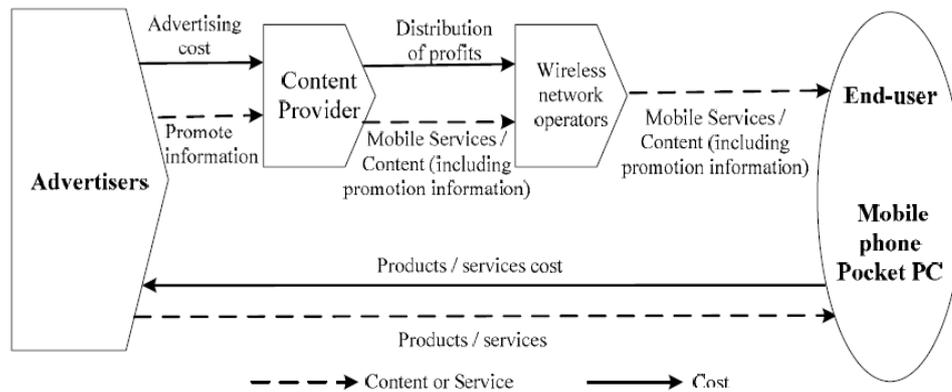
The mobile advertising model is an extension of the web advertising model. Advertisers desire to promote products, services or ideas. The broadcaster can be anyone who wants to send a multimedia message through mobile device to a target group or user [149]. The broadcaster may be a network operator, a content/service/application provider or generally a company. A mobile website includes, except of services and products, advertising messages in the form of banner ads [150].

In addition, location-based and semantic mobile advertising is a new type of advertising that uses location-tracking technology in mobile networks to target consumers with the support of semantic technology [149]. It means that enterprises reach their customers more easily and personally than ever before, based on their preferences and needs analyzing the semantic content of mobile websites they have visited.

The value proposition of the advertising model includes multimedia mobile messages and coupons, offers, personalized, real-time and location-based services and goods, cost and time saving. The target group is the mobile user on streets. The main distribution channels are the mobile Web, mobile devices (especially smartphones) and social networks. This model supports one-to-one and one-to-many communication, as it can reach a pre-

determined target audience. Advertising model is interested in acquiring new customers and in selling new and complementary goods and services to existing customers. It has medium value integration. The revenue streams come from advertisements.

For example, a woman gets an advertising message (sms/mms/banner) on her phone from a nearby shopping center, while walking down the street. She is able to download a special coupon to get 20% discount in products she is interested in. This coupon is in an electronic format on her mobile phone and it will be read by a reader at the cash desk, if she buys a product. Enterprises that insert into the mobile advertising arena now have the advantage of being new, exciting and grab people’s interest early.



**Figure 20:** The structure of the mobile advertising model [36]

b. Brokerage Model

At the heart of the brokerage model is third parties known as brokers, who bring sellers and buyers together and facilitate transactions. The broker usually charges a fee or a commission for each transaction it enables. According to Feijoo [1], brokerage models of interest for mobile content are: services for marketplace exchange (e.g. orbitz), virtual marketplaces (e.g. amazon), buy and sell fulfillment (e.g. carsdirect), transaction brokers (e.g. paypal), distributors, and auction brokers (ebay). Brokers provide their products and services to users through convenient applications for mobile phones.

The value proposition of the brokerage model includes personalized and location-based services and goods, the advantage of competitive prices and specialized offers. The target group is the mobile user on-the-go. The main distribution channels are the mobile Web, mobile devices, mobile applications, mobile sites and brokers. This model supports one-to-one communication. Brokerage model intends to keep the existing clients and sell new and complementary products and services to customers. It has high value integration. The revenue streams come from fees, sales of goods and services.

For example, downloading the ebay application to iphone, users have many possibilities. Ebay can make data available in RDF format and can use the GoodRelations ontology [151], a Semantic Web vocabulary for e-commerce that describes product, price, and company data. RDF can ultimately create rich relationships between products, which will in turn create a deeper visibility to additional products when a user is shopping. Users can buy and sell easily whenever and wherever they are. Users can compare prices at the store against eBay prices using the handy barcode scanner. Simply scan the item's barcode with the iphone's camera and search price comparisons in stores. Moreover, you pay for most transactions from your phone through paypal.



**Figure 21:** *Scanning item's barcode*

### c. Subscription Model

The subscription model is a revenue model where a customer must pay a subscription fee (daily, monthly or annually) to have access to products or services [152]. It is a common practice for sites to combine free content with premium content. People will pay for valuable data, and will pay more for data that has been linked to a global Web of information. This model will gain new life as Linked Data standards make it easier for people to consume and mash-up data in novel mobile applications [149]. Subscription is frequently combined with advertising.

The value proposition of the subscription model includes valuable, on-demand and specialized services. The target group is the mobile user, professionals and companies. The basic distribution channels are the mobile Web, mobile devices and mobile applications. This model supports one-to-one and one-to-many communication, as it can reach a pre-determined target audience. Subscription model is interested in acquiring new customers and in keeping satisfied the existing clients. It has high value integration. Cloud computing and ambient intelligent play an important and basic role in this model. The revenue streams come from subscription fees by users and companies.

A consumer sees an offer for a new product in a magazine. The advertisement contains a 2d bar code with the company's website. The shopper scans the bar code with his mobile phone, enters the website and signs up to the loyalty program. Once registered, customer receives coupons directly to his mobile phone which can be redeemed at the point of sale. A mobile coupon [153] is an electronic ticket solicited and/or delivered by mobile phone that can be exchanged for a financial discount or rebate when purchasing a product or service. Juniper Research released a study [154] predicting that mobile coupon usage would triple by 2014, with more than 300 million people expected to adopt the technology.

### d. Customized Model

In the customized model, enterprises create, edit, publish and re-use Linked Data in order to support specific mobile business needs and preferences [46]. These firms provide complete mobile Linked Data business support services, deliver on-demand mobile

business solutions and advices, improve organizations' mobile operations, enrich the possibilities of the remote workforce by giving them effective access to the internal business systems, while away from the office. For example, it can be provided mobile Linked Data Customer Relationship Management (mLDCRM), which handles and manages efficiently the customer base.

The value proposition of the customized model includes professional and location-based services and goods, cost and time saving. The target group is especially professionals and enterprises. The main distribution channels are the mobile Web, smartphones and mobile portals. This model supports one-to-one communication. Customized model is interested in selling new and complementary goods and services to new and existing customers. It has high value integration. The revenue streams come from the sales of professionals services by companies. It results in minimizing total mobile technology cost expenditures and maximizing mobile technology resource usage.

#### e. Merchant Model

A merchant is a wholesaler or retailer of mobile content goods and services. The merchant provides a mobile website or/and a mobile application with product/service information and a mobile ordering mechanism. Prices can be fixed or negotiable. The merchant can directly reach customers and sell to them without intermediaries via mobile devices. They can either have only virtual presence or combine a mobile website with a physical store. Moreover, firms can create business profile on social networks (e.g. twitter, facebook) to reach an audience near and far, 24 hours a day, 7 days a week. Through social networking, company leads people to its mobile website, maintains contact with clients and keeps a consistent presence. According to Jay Emmet, general manager of OpenMarket [155], "the ability to purchase physical goods on mobile devices is poised for growth in 2011."

The value proposition of the merchant model includes mobile goods and services, offers, physical stores and high service quality. The target group is mobile users and companies. The main distribution channels are the mobile Web, mobile devices (especially smartphones), mobile portals, social networks and partners. This model supports one-to-one

and one-to-many communication, as it can reach a pre-determined target audience. Merchant model is interested in acquire new customers and in selling more goods and services to existing customers. It has high value integration. The revenue streams come from the sales of products and services to individuals and companies.

For example Pizza Hut, the largest restaurant company in the world, in 2009 created an iPhone application to increase sales and brand loyalty. According to Brian Niccol, chief marketing officer at Pizza Hut, mobile and social media plays a big part in the company's multichannel strategy [156]. After being live in the App Store for three months, the Pizza Hut application for Apple's iPhone and iPod has surpassed \$1 million in sales and has been downloaded more than 2 million times. Users can build their own pizza and each time a user orders using the application they get 20 percent off their entire order. Moreover, looking to your mobile phone's map, small tabs highlighting the direction and distance of Pizza Hut locations nearby. Just like Pizza Hut did, businesses can use their website, youtube, facebook, twitter, and App Store rankings to promote their application.

#### f. Affiliate Model

The mobile affiliate model is an extension of the affiliate model. The affiliate model (e.g. Amazon) consists of three core players: the merchant, the affiliate and the customer. Affiliates promote merchant's products and services and get paid a commission for promoting them. They simply get rewarded for sending customers to a retailer when a sale is made. Affiliate makes money by driving traffic to merchant's website [157]. Variations include banner exchange, pay-per-click, and revenue sharing programs. This business model is highly complementary with advertising.

Mobile affiliate model is now beginning to develop and can adopt Linked Data technologies. There are certain ways for affiliates to get into the mobile marketing arena: displaying banners, links or coupon codes on mobile websites and applications and SMS campaigning. For example, affiliates might build mobile Linked Data application directories and make a revenue-share on every application download they generate. MobPartner [158] is a mobile affiliate platform with links into a range of merchants including Jamster, Wild Jack Mobile Casino and Nexva (mobile games). Merchants simply

define the cost-per-acquisition that they are willing to pay for each “action” (e.g. subscription, download, lead, registration) and will only pay when a conversion is achieved.

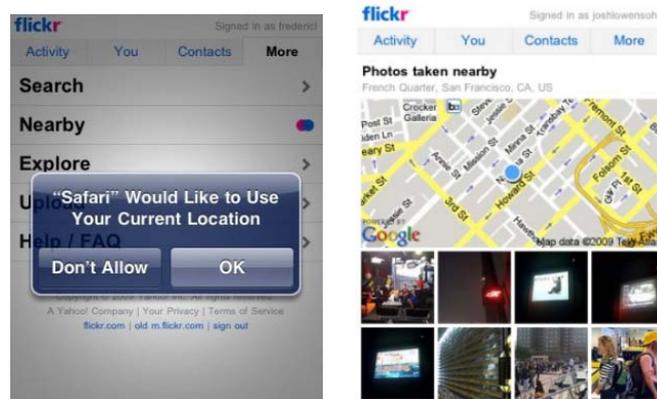
The value proposition of the affiliate model includes personalized and location-based services and goods. The target group is the mobile user and mobile business. The main distribution channels are the affiliates, the mobile Web and mobile devices (especially smartphones). This model supports one-to-one and one-to-many communication. Affiliate model is interested in acquiring new customers and in selling new and complementary goods and services to existing customers. It has medium value integration. The revenue streams come from commissions.

#### g. Community Model

Community model is based on user loyalty. Revenue can be based on donations and the sale of ancillary products and services or voluntary contributions (e.g. flickr, wikipedia). It is typically complementary with advertising and subscriptions for premium services. This is one of the more fertile areas of development in mobile Linked Data landscape too, due to the rise of social networking. A mobile community [159] is a network of interpersonal ties that provides sociability, support information, a sense of belonging, social identity, and which always connects its members regardless of where they go.

The mobile site of Flickr has been completely redesigned and can be accessed at [m.flickr.com](http://m.flickr.com). Images tagged with human-provided keywords are a valuable source of data and are expressed using RDFa. Tag-based image search is an important approach to accessing the image content on websites. The use of visual features together with different types of associated texts should provide valuable information to semantic inference of Web images [160]. Flickr also uses location as a means to organize photos. In 2009 the company announced [161] that it hosts over 100 million geotagged photos. In order to make the photos more accessible, Flickr also announced a new 'nearby' page on its web site, which displays a map with images that were taken close to another photo. If you have a smartphone, you can now see images at Flickr that were taken close to your current location.

The value proposition of the community model includes Linked Data, personalized and location-based services. The target group is the mobile user on the go. The main distribution channels are the mobile Web and the mobile devices (especially smartphones). This model supports one-to-many communication. Community model is interested in acquiring new customers and in keeping the existing clients. It has low value integration. The revenue streams come from donations.



**Figure 22:** Flickr asks your location and show 'nearby' images

#### h. Public Model

Public model makes Linked Data available to the public for any use. Data are made available free in raw, machine-readable format, ready to be processed, recombined, mashed up and displayed visually. In this model, Linked Data are provided by governments (e.g. data.gov.uk/), organizations and public sector [10]. Linked Data can be delivered in real time to smartphones. Public information can be used with many ways in the mobile sector by users and companies, as it is easily searchable and accessible.

The value proposition of the public model includes Linked Data. The target group is the mobile user and the mobile business. The main distribution channels are the mobile Web and the mobile devices (especially smartphones). This model supports one-to-many communication. Public model is interested in acquiring new customers and in keeping the existing clients. It has low value integration. The revenue streams come from public subsidies.

#### 4.4.5 Customer Value

The way in which a mobile business communicates its value proposition to potential customers is central to the price consumers are willing to pay. Consumers are different and they want to use services for many different tasks. However, potential application fields in mobile business industry can be found in areas such as tourist services, shopping, entertainment, health or specialized services. Below it is referred the customer value from the consuming of semantic mobile web services.

- Linked Data promise to bring mobile business closer to its consumers and deliver to customers *more relevant content, personalized and customized services* than ever before.
- Semantic technologies can support more efficiently a variety of mobile user tasks such as *improved search and question answering*.
- Creating intelligent mobile services that *solve real problems in real time*, such as emergency situations, disasters or health demands, will make customers to correspond to those innovative ideas.
- *Location-based Services* can also be offered to users' mobile devices to meet their needs and preferences for localized content and services.
- The mobile user can receive a bundle of qualitative mobile services and applications with *cost and time saving*.
- Consumers can *communicate and send feedback to business easier and faster* than ever before in order to make complaints about poor services or comment the quality of provided services.
- Users can also participate simply and easy in the *content creation* instead of being passive information consumers.

### **4.5 Proposed Applications**

#### 4.5.1 Semantic Mobile Website for Hotels

The tourism industry is one of the more successful application areas of the Semantic Web as well as e-commerce because it is a consumer-oriented industry where services and

information play a large part in transaction processes. It is important for hotels all over the world, and especially in Greece, to promote tourist attractions and interesting places such as museums, archeological sites, monasteries, theatrical productions, festivals or beaches. Information and services about public transport, weather, banks, hospitals, pharmacies, food and entertainment must also be provided from hotels. Presenting services that visitors need or want can make the difference on the amount of income that a hotel may receive. As a communication tool hotels can provide to visitors their mobile site or application with information about them and their surroundings. A mobile application based on semantic technology offer customized tourist information and recommendations based on visitors' profile, needs and desires. It could be applied the brokerage model.

Information about visitor's tastes can be selected from his profile at social networks, his location or from a form which is completed by the user. The returned results collect the required data from existing updated databases in RDF format. Users have also the opportunity to compare prices at restaurants, museums etc. Moreover, user is informed everyday about special offers and discounts on shops. Application shows all places, which are proposed to the visitor, on a map helping user to find them easy. Hotels can reach visitors providing more detailed information through mobile application than traditional advertising. It also makes information available for distribution through RSS Feeds. There is an "Add This" or "Share This" button in the mobile app, allowing visitors to share interesting pages with their friends on social networks.

According to a survey, which was conducted on December 3-5, 2010 by GfK Roper Public Affairs & Corporate Communications [162] for SapientNitro [163], consumers are increasingly empowered by their mobile devices while holiday shopping in a variety of ways, as shown in Figure 23: find deals, research products, solicit opinions from friends and family on products of interest, share information about a shopping experience with friends on a social network and, of course, buy products. Half used their smart phones to find a store location (52%), one in three looked for discounts, deals, coupons, or discount codes on their mobile phones (35%) and three in ten say that, while at a store looking at a product, they tried to find a better deal elsewhere on their phone (30%).



**Figure 23:** *Smartphones activities performed during the holidays, according to US smartphones owners, Dec 2010 [164]*

Mobile users become more acclimated to sharing their whereabouts via mobile devices. Mobile media company JiWire [165] examines market trends around audience data over public Wi-Fi during the second quarter of 2010. Findings from report prove that Wi-Fi usage continued to grow quarter over quarter, with an increase of 17.3% across all venues. Especially hotels saw a significant increase in total visits quarter over quarter (Figure 24), growing 22.5%. Mobile users are likely to use location-based services in their homes as they are while on the go. Consumers not only show high likelihood to consume entertainment content while on-the-go, but they are also interacting with the content by looking up show times and nearest movie theaters, as shown in Figure 25.

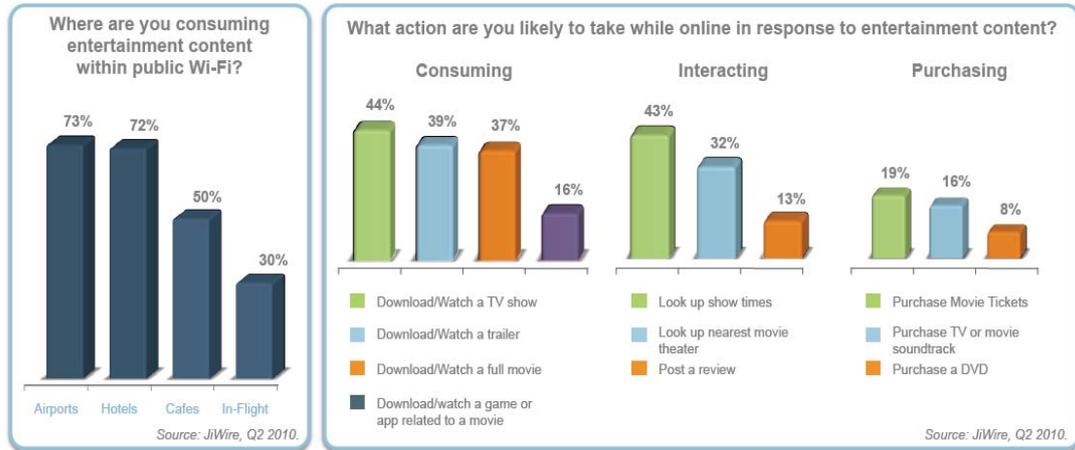


Figure 24: Public Wi-Fi Usage - Where people are getting connecting [165]



Figure 25: On-the-Go Audience: On-the-Go Media Consumption and Location [165]

#### 4.5.2 Semantic Mobile Website for Mobile Operators

The mobile network operator has a natural advantage in claiming ownership of the customer through the definite convenience it can provide in a well-designed default website. Operators try to attract and retain high-value subscribers, who have a greater tendency to download and use mobile data services and applications. Mobile Operators can incorporate Linked Data into their mobile website or application about mobile phones, manufacturers and accessories which are presented on the application. It adds additional context to data about phones, manufacturers and accessories which can include anything from new features, software updates, special downloads, previous models, latest news and more. To make a semantic mobile app, the contextual information surrounding mobile phones and accessories is imported to the mobile operator's page. It use sources from mobile phones' and manufacturers' sites, DBpedia and technology websites.

Operators' mobile website provides a web identifier for every mobile phone, manufacturer and accessory the operator has an interest in. This means content can be discovered by users in many different ways. In addition, mobile website renders a map containing information about nearby operators' stores and suggesting a route to them based on current user's location. User can contact with the nearby store using a GUI widget (call/SMS/email) embedded in the portal. Mobile website uses the semantic technology to integrate and organize data from different sources easy and quickly. A crucial question is if mobile operators replace banks as the leaders in customer transactions. It is obvious that a customer mobile phone bill may contain many of data-related charges, nonvoice service transactions that the bank never sees. Merchant model can be suitable.

Mobile operators are adding mobile commerce offerings to existing voice and messaging services, so they are selling incremental features to an existing customer base, who expect high levels of human assistance [40]. For mobile operators, application stores can be an important element to grow data revenues by leveraging direct revenue streams through application downloads, mobile traffic as well as indirect revenues such as advertising and provision of billing services. Below Figure 26 presents the expectations about revenue and consumer penetration of various mobile services worldwide until 2013.

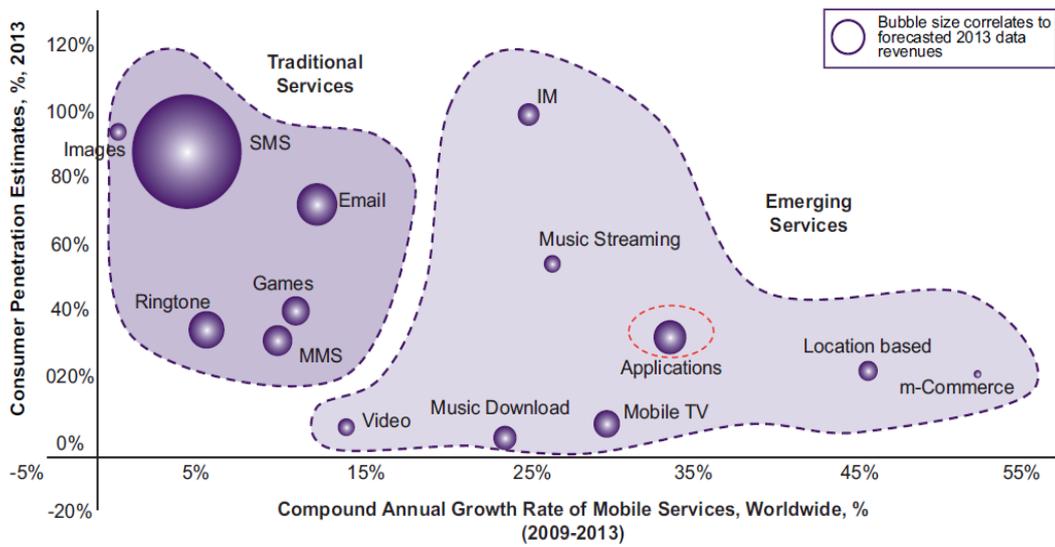


Figure 26: Revenue and Consumer Penetration of Various Mobile Data Services, Worldwide, 2009-2013 [40]

*Pricing Strategy:* Mobile Operators need to create optimal and suitable monetization strategies in order to gain revenues and also remain competitive. Pricing models must be adapted to the nature and the popularity of the application (Figure 27). For example, medical or financial applications are highly customized and in a limited number. These applications are suitable for subscription pricing, as the user willingness to pay is fairly high. Moreover, applications in categories such as games, lifestyle and entertainment are popular, but have low user willingness to pay for them. Consequently, such mobile services are better suited for advertising model.

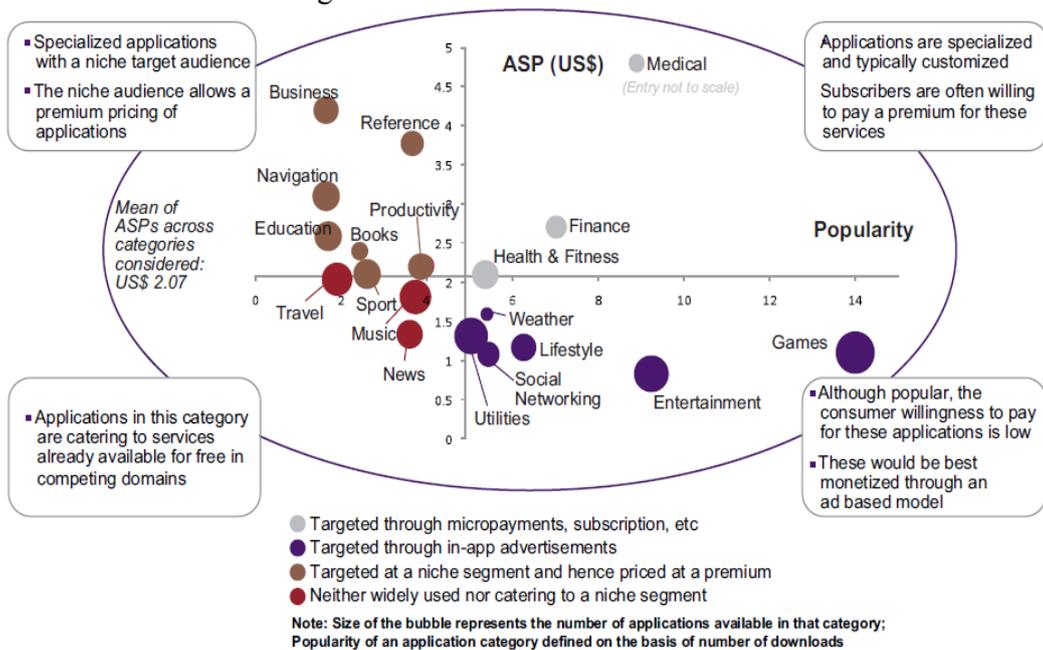


Figure 27: Monetization Model for Various Applications [40]

#### 4.5.3 Semantic Mobile Healthcare Sector

The Semantic Web has many applications in the healthcare sector, with the possibility of using the smartphone with RFID-sensor capabilities as platform for monitoring of medical parameters and drug delivery. The great advantages are to be seen firstly in prevention and easy monitoring and secondly in case of accidents and the need for ad hoc diagnosis [24]. Hospitals can increase the efficiency of their services by monitoring patients' health and progress at doctors' mobile phones and by performing automatic analysis of activities in their rooms at guards' mobile phones. They can also increase safety and reduce cross-infection by, for example, only allowing authorized personnel and patients to gain access to specific areas and devices [9].

The combination of sensors (e.g. RFID, NFC, Bluetooth, WiFi) will allow significantly improved measurement and monitoring methods of vital functions (e.g. temperature, blood pressure, heart rate). Implantable wireless identifiable devices could be used to store health records that could save a patient's life in emergency situations especially for people with diabetes, cancer, coronary heart disease, stroke and Alzheimer's as well as patients with complex medical device implants, such as pacemakers, stents, joint replacements and organ transplants and who may be unconscious and unable to communicate for themselves while in the operating theatre [166].

Attaching smart labels to pharmaceutical products, tracking them through the supply chain and monitoring their status with sensors has many benefits: Drugs requiring specific storage conditions (e.g. maintenance of a cool space) can be continuously monitored and returned if conditions were violated during transport or products are counterfeited. Moreover, patients are informed about the remaining dosages, the expiration date and the authenticity of the medication. In conjunction with a mobile phone, that reads information transmitted by the drug label, patients can be reminded to take their medicine at appropriate intervals. For this case it is suitable the subscription model.

#### 4.5.4 Applications along the entire mobile business value chain

Linked Data can provide the intelligence to achieve the level of speed, knowledge, and collaboration in mobile business transactions and alleviate the existing difficulties of demand forecasting, providing more opportunities for businesses to find the right markets when they need it. Enterprise items can be considered as information entities stored according to ontologies in a semantic database, which are connected to other information entities according to their semantic meaning [6]. Semantic Web provides great opportunities in mobile business at the fields of Customer Relationship Management (CRM), Knowledge Management and Supplier Relationship Management (SRM).

Mobile CRM is a business strategy used for integrated management of relationship with customers through mobile marketing, mobile sales force automation and mobile customer service, now with the help of semantics [167]. Supply chain integration means to bring supply chain partners or network partners in contact with each other. Integration is one answer to the information sharing issue in enterprises, which must happen in real time, if business wants to be competitive. Knowledge management becomes more precise and flexible, as the elaboration, generation, navigation and retrieval of knowledge modeling is easier and faster with the Linked Data [168]. Knowledge represents added value and contributes as a key factor in assuring sustainable economic growth and increased profit levels.

With smart sensors production processes can be optimized and the entire lifecycle of items, from production to disposal can be monitored. By tagging products and containers, greater transparency can be gained about their status, the location and disposition of goods and the status of production machines [169]. With RFID-equipped products and smart shelves that track the present products in real time, a retailer can optimize many applications through his mobile device: information for product design, automatically checking of items receipt, real time monitoring of stocks, fast payment solutions like automatically check-out using biometrics, tracking out-of-stocks, the detection of shoplifting, as well as end-of-life decision-making for safe and environmentally friendly recycling, remanufacture or disposal of the product [23].

## **5. CHALLENGES & PROPOSALS FOR FURTHER RESEARCH**

The challenges for the adoption of the Linked Data in mobile business are observed from the point of view both of the Linked Data as a new technology that has yet to reach its full potential, and of mobile business as a digital presence and application and a large and heterogeneous user base of customers. What should be the mobile business' agenda and key priorities in the creation of customer-focused mobile web services? Are the semantic mobile business strategies and plans really innovative so as to establish new business models? Will customers accept the proposed business model and realize the upcoming benefits from the use of mobile web services?

Because of the gap between the ideal and the real, we have questioned whether the Linked Data can benefit the business and give value to the consumers. The main concern is if the proposed business models will change the philosophy of business by delivering mobile value-added services. Can mobile Web, semantic technologies and mobile devices, which are constantly converging, to alter retailer strategies? Which new business application areas could emerge from the fusion of Linked Data with other technologies and sciences? Mobile web services also handle users' private data and they need to provide not only privacy guarantees, but trust and security as well to keep safe this sensitive information and to increase the consumer confidence in the mobile commerce.

Smartphones and the mobile Web are now allowing people to be more connected than ever and also provide closer and more personalized relationships between companies and consumers. We expect to be able to do things anywhere, anytime we want and smartphones are revolutionary and ideal devices enabling this expectation to be fulfilled. Ergonomics of mobile phones is also a main issue for the growth of such mobile services. A key challenge is the adoption of smartphones as a necessary tool by the majority of mobile users. How to improve adoption of mobile applications? What are the services expected by the mobile users from the mobile business? It is just a start; Linked Data is on the doorstep to become central parts of the mobile applications.

## 6. CONCLUSIONS

This master thesis presents a framework for provisioning mobile business models promising to create semantic mobile web services in the near future. It is common sense that Semantic Web and mobility are the next steps in the Web evolution. Mobile commerce is becoming increasingly pervasive. Linked Data will simplify even more the use of services on the mobile Web. Mobile business models can help new firms and traditional businesses to acquire competitiveness and comparative advantages. Nowadays, firms seek more capable approaches for gaining, managing, and utilizing knowledge required for their mobile business processes and services, and the Semantic Web offers promising solutions.

Mobile web services are quickly penetrating everyday life. Customer preferences migrate from “whenever and wherever” to “right here and now”, meaning access to the data and services in the semantic cloud anywhere, which will generate new types of service. The rapid changes in mobile landscape are impacting how users shop online, consume content, download applications, connect with friends, and all other aspects of mobile web life. Look forward to the years we will be doing old things in radically new ways. Trends in the mobile commerce, technical evolution and end-user behavior affect the pace of mobile Web growth.

Smartphones are becoming smaller and smaller, but with faster processors, lower power consumption and larger storage capacity. The mobile operating system race is just getting started, and that is a long-term game in which device manufacturers and software developers need to apply different and innovative strategies. Mobile devices also need to be modified in order to suit the requirements of new business models (e.g. supporting NFC technology, scanning barcodes). Moreover, the location-based mobile services suggest totally new applications areas, in which the user location information is used in order to add value to the service as a whole.

Incentives, such as interoperability, quality, effective asset tracking, flexibility, reduced costs and complexity, need to be provided to encourage adoption and integration of Linked Data into the existing mobile business industry. As some benefits may be intangible and difficult to quantify (e.g. improved communication, timely decision making, improved customer satisfaction through increased responsiveness) it may be challenging for a

company to have sufficient evidence in support of adopting mobile semantic technology. We can arrive at the conclusion that the wide usage of semantics in mobile business processes will be somewhere between then and a decade later, firstly in sectors such as smart life and healthcare.

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