

# APPLICATION PROGRAMMING: MOBILE COMPUTING [ INEA17112W ]

Marek Piasecki PhD

## Introduction, Mobile Platforms & Architectures (L1)

*Choose yourself and new technologies*



**HUMAN CAPITAL**  
HUMAN – BEST INVESTMENT!



Wrocław University of Technology

EUROPEAN  
SOCIAL FUND



Project co-financed from the EU European Social Fund



# Course Description

- **Code:**  
INEA17112
- **Title:**  
Application programming: Mobile Computing
- **Duration:**  
Summer term (3th semester)  
The course carries 5 ECTS credits.
- **Contact hours per week:**
  - 30 hours lecture (2 hrs/week)
  - 30 hours workshop/laboratory (2 hrs/week)



# Course Description

## Assessment and examination:

- **Lecture:** (50%)  
written exam during last week of the term  
(students with excellent laboratory results, could be exempted)
- **Laboratory:** (50%)  
5+1 programming exercises – **Android** / Java or Kotlin  
3+1 programming exercises – **iOS** / Swift  
(~~3 programming exercises – Windows 10 UWP / C#~~)  
  
+ **individual project** (3+1 labs) more serious programming task to solve,  
every student is obliged to create an individual advanced mobile  
application, supplemented with technical documentation.



# Lecture Syllabus

- **Introduction** to Mobile Computing
- **Mobile Platforms** and Architectures
- **Android OS** (~~Mobile Java – J2ME~~)
- **Apple iOS** (~~Symbian S60 OS~~)
- ~~Windows 10 UWP (Windows Phone/Mobile)~~
- **Cross-platform** apps (Flutter, React Native, Xamarin)
  
- **Wireless Telecommunication**
- **Wireless Networks**
- **Mobile Security**
- **Mobile Databases**
- **Mobile Multimedia** Services
- **Emerging Mobile Technologies**





# Possible Dimensions of Mobility

- Mobile devices
- Mobile data
- Mobile code
- Mobile communication
- Mobile services
- Mobile context



# Mobile computing

## What could it be ?

### 1. moving **software**

- moving data → html page
- moving code → applets
- moving program → aglets, agents, computer viruses

### 2. moving **hardware**

- mobile robots
- unmanned cars/vehicles
- portable computer devices

### 3. people **using** computer devices while **being on the move**





# A little of history

## Evolution of small / pocket computers ...





# A little of history (2)

## Evolution of mobile phones . . .



Car-mounted phones



Transportable  
phones



Handportable  
phones



Pocketable  
phones

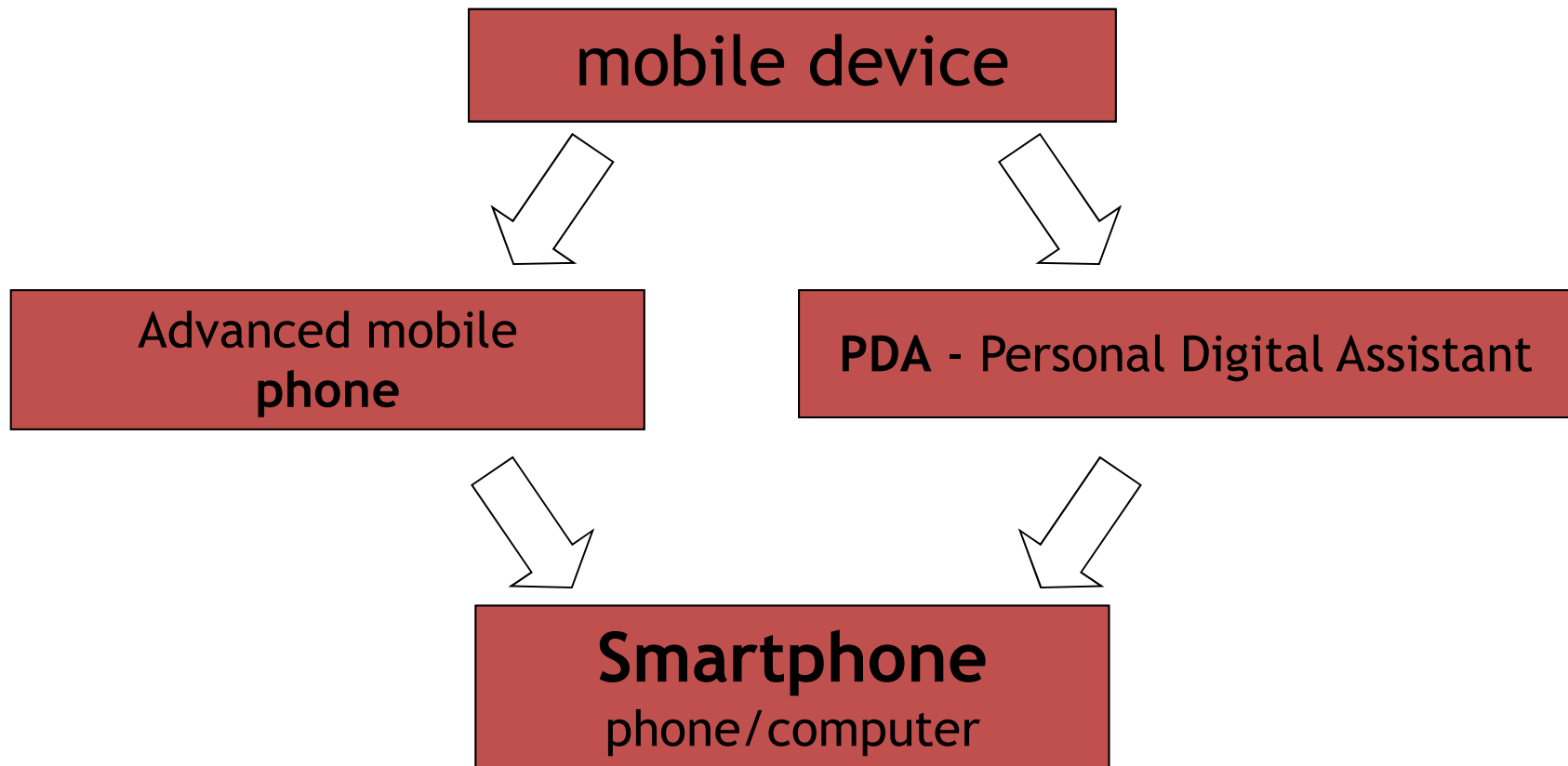


Palm phones





# What's now ?





# Motivation (1): People Buy More Smart Phones than PCs !

Personal Computers, Sold



**236M**

↓ **31%**  
(2009 compared to 2008)

**Soon the number of smart phones will take over PC**

Smart Phones, Sold

**225M** 

↑ **28%** (2009 compared to 2008)

[Ref: Gartner , Competitive Landscape: Mobile Devices, Worldwide, 2Q09]



# Motivation (2): Chaos - Multitude of Mobile Development Platforms





# Motivation (3): Trends in History

Tech Cycles Tend to Last Ten Years  
Entered Next Major Computing Cycle – Mobile Internet – 2 Years Ago

*Mainframe  
Computing  
1960s*



*Mini  
Computing  
1970s*



*Personal  
Computing  
1980s*



*Desktop Internet  
Computing  
1990s*



*Mobile Internet  
Computing  
2000s*



Morgan Stanley

Source: [Computersciencelab.com](http://Computersciencelab.com), Wikipedia, IBM, Apple, Google, NTT docomo, Morgan Stanley Research.





# Mobile Devices as 7th Mass Media

## The Seven Mass Media

First Mass Media Channel - **Print** from the 1500s

Second Mass Media Channel - **Recordings** from 1900s

Third Mass Media Channel - **Cinema** from 1910s

Fourth Mass Media Channel - **Radio** from 1920s

Fifth Mass Media Channel - **TV** from 1950s

Sixth Mass Media Channel - **Internet** from 1990s

Seventh Mass Media Channel - **Mobile** from 2000s



# Constraints of Mobile Devices

- Memory and CPU performance (still critical)
- Battery powered - must keep consumption down
- Limited Bandwidth / Unstable connection  
available: mobile (0-50%) vs desktop (90-100%)
- User Interaction and Display
  - Smaller display, drastically different sizes (2" vs 13")
  - Different means of interactions (touch, gestures, speech)
- Security (wireless communication, not educated users)
- A multitude of Operating Systems













## Mobile Constraints: (1) User Input Interface

- Stylus / Pen
- On-screen Keyboard





# Ergonomics of a mobile devices

Device type	Phones	PDAs	Communicators	Wearables
Primary input mechanism	One-handed operation	One hand holds the device; the other operates the devices with a stylus or finger	Both hands hold the device; thumb typing with keyboard	Device is attached to body or clothing; one-handed use
Usage ergonomics				
Sample devices	 Philips Fidio 820	 Sony Ericsson P900	 Nokia 9300 Communicator	 Samsung Wristphone



## Mobile Constraints: (2) User Output

- **Small screen size** – This makes it difficult or impossible to see text and graphics dependent on the standard size of a desktop computer screen
- **Lack of windows** – unsupported multiple windows in the same screen. On a desktop computer, the ability to open more than one window at a time allows for multi-tasking and for easy revert to the previous page.
- **Types of pages accessible** – Many sites that can be accessed on a desktop cannot on a mobile device (e.g. pages with a secured connection, Flash, PDFs, video sites, etc. )
- **Broken pages** – On many devices, a single page as viewed on a desktop is broken into segments, each of which is treated as a separate page. Paired with the slow speed, navigation between these pages is slow.



## Mobile Constraints:

# (3) Wireless Connection

- Connection may not be always available
  - **Recovering** from discontinuous or lost connections is needed
- Connection in mobile environments is subject to different quality in different contexts
- Adapt to low connection quality, by employing:
  - Filtering – download only those elements that you require
  - Paging – download only those items (of an element) that you require
  - Caching – cache locally instead of requesting the same data
- Data transmission was a costly resource



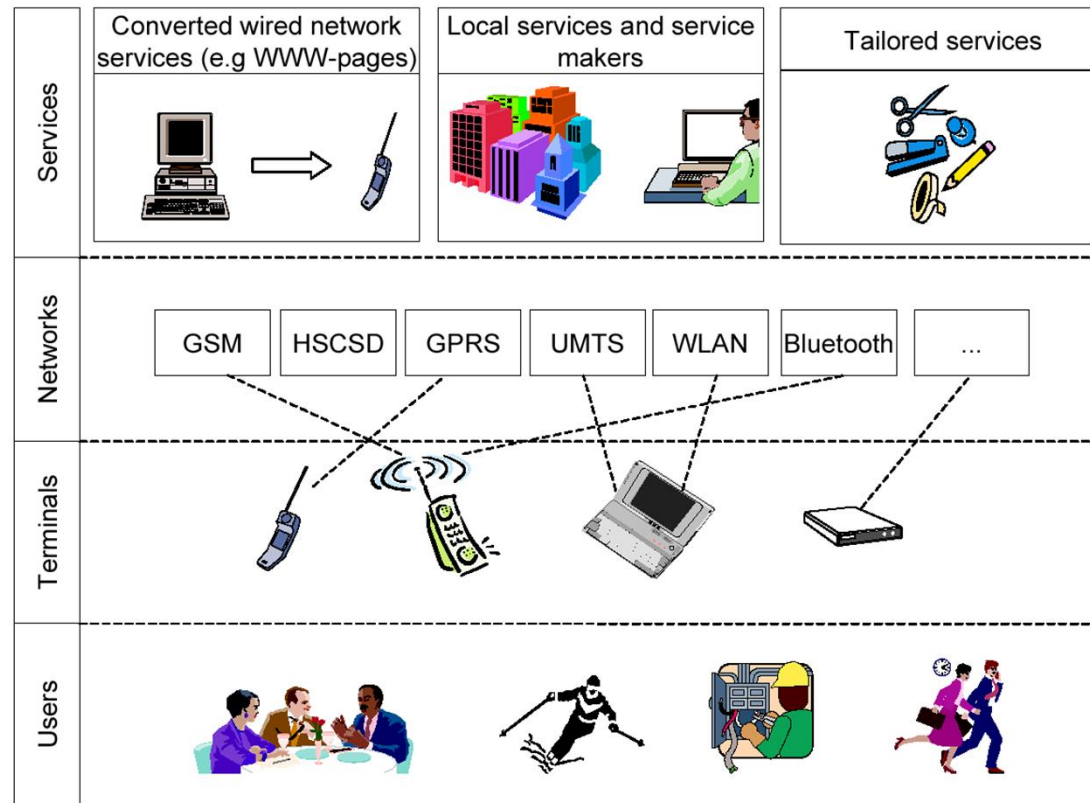
## Mobile Constraints: (4) Web Browsing ?

- Memory constrains → bigger pages could cause a crash
- No multi-document/multi-tab support
- No link target / current page saving
- Weak / non-existing Ajax/JavaScript support
- Java applets (login, authentication) restricted
- Desktop ActiveX not supported
- Flash incompatibility
- Poor CSS support





# Complex mobile environment





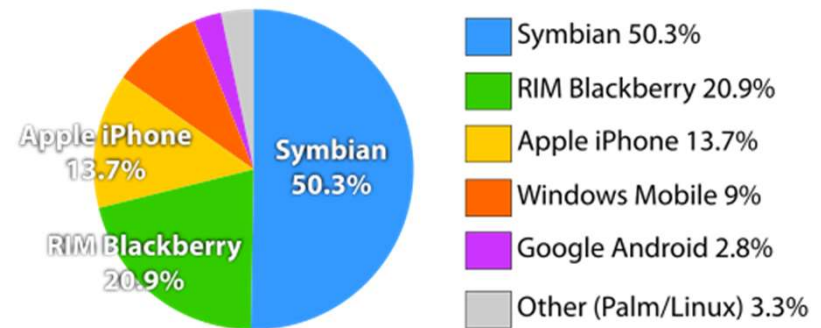


# Eight (Most Popular) Mobile Platforms '09

(in alphabetical order)

- Android
- BlackBerry
- Flash/Flash Lite
- iOS (iPhone),
- Java ME
- Symbian
- Windows Phone,
- mobile web (WAP/XHTML/CSS/JavaScript)

Global Smartphone Sales, Q2 2009





# Smartphone OS Competitive Landscape

	iPhone OS (Apple)	BlackBerry OS (RIM)	Window Mobile (Microsoft)	Android (Google)	Symbian (Nokia)
Platform	<ul style="list-style-type: none"> <li>• Closed</li> </ul>	<ul style="list-style-type: none"> <li>• Closed</li> </ul>	<ul style="list-style-type: none"> <li>• Open</li> </ul>	<ul style="list-style-type: none"> <li>• Open</li> </ul>	<ul style="list-style-type: none"> <li>• Open</li> </ul>
Source Code	<ul style="list-style-type: none"> <li>• Closed</li> </ul>	<ul style="list-style-type: none"> <li>• Closed</li> </ul>	<ul style="list-style-type: none"> <li>• Closed</li> </ul>	<ul style="list-style-type: none"> <li>• Open</li> </ul>	<ul style="list-style-type: none"> <li>• Open (in future)</li> </ul>
2009 WW Market Share [Gartner]	<ul style="list-style-type: none"> <li>• 14.4%</li> </ul>	<ul style="list-style-type: none"> <li>• 19.9%</li> </ul>	<ul style="list-style-type: none"> <li>• 8.7%</li> </ul>	<ul style="list-style-type: none"> <li>• 3.9</li> </ul>	<ul style="list-style-type: none"> <li>• 46.9%</li> </ul>
Smartphone traffic share [AdMob]	<ul style="list-style-type: none"> <li>• WW: 46%</li> <li>• US: 39%</li> </ul>	<ul style="list-style-type: none"> <li>• WW: 5%</li> <li>• US: 7%</li> </ul>	<ul style="list-style-type: none"> <li>• WW: 1%</li> <li>• US: 1%</li> </ul>	<ul style="list-style-type: none"> <li>• WW: 25%</li> <li>• US: 46%</li> </ul>	<ul style="list-style-type: none"> <li>• WW: 21%</li> <li>• US: 1%</li> </ul>
Pros	<ul style="list-style-type: none"> <li>• Early momentum</li> <li>• Data hungry early adopters</li> <li>• Powerful distribution channel</li> </ul>	<ul style="list-style-type: none"> <li>• Strong reach (particularly in US)</li> </ul>	<ul style="list-style-type: none"> <li>• Manufacturer / carrier agnostic</li> </ul>	<ul style="list-style-type: none"> <li>• Manufacturer / carrier agnostic</li> <li>• Open source innovation</li> </ul>	<ul style="list-style-type: none"> <li>• Massive global reach</li> <li>• Open source innovation</li> </ul>
Issues	<ul style="list-style-type: none"> <li>• Apple dependant</li> </ul>	<ul style="list-style-type: none"> <li>• BlackBerry dependent</li> <li>• Distribution</li> </ul>	<ul style="list-style-type: none"> <li>• Distribution</li> </ul>	<ul style="list-style-type: none"> <li>• Late to market</li> <li>• Uncertain consumer demand</li> </ul>	<ul style="list-style-type: none"> <li>• Limited reach in US</li> <li>• Distribution</li> </ul>
Application ecosystem [Distimo]	<ul style="list-style-type: none"> <li>• iTunes Apps Store</li> <li>• &gt;185K apps</li> <li>• More than 3B downloads</li> </ul>	<ul style="list-style-type: none"> <li>• BlackBerry App World</li> <li>• 5,5k apps</li> </ul>	<ul style="list-style-type: none"> <li>• Windows Marketplace</li> <li>• 1k apps</li> </ul>	<ul style="list-style-type: none"> <li>• Android Market</li> <li>• 50k apps</li> </ul>	<ul style="list-style-type: none"> <li>• OVI Market</li> <li>• 7k apps</li> </ul>



# Historical Leaders

**2000** Java 2 Micro Edition → was on ~100% of phones

**2005** Pocket PC / Windows Mobile 5/6 → ~50% business

**2010** Symbian → 50-70% of the market (now Dead)

**2020** Android → 70% , iOS → 28%

## QUESTION:

What is the probability that Android or iOS devices will completely **disappear from the market** ?



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# ARCHIVES

Archival presentations  
from previous editions of this course  
from years 2010-2017



Project co-financed from the EU European Social Fund



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Master programmes in English  
at Wrocław University of Technology



**Some archival slides  
to illustrate technological changes  
at the period  
2000 - 2010 - 2020**



Project co-financed from the EU European Social Fund



# Example application (1) Real Estate Industry

- Access to property information
  - Pictures / lot info / seller info / price / Showing schedule
- Real Estate applications
  - Mortgage calculator, etc.
  - Form in-fill info (applications)
- Sales Force Management
  - Appointment Management
  - Schedule visibility
  - Client information
- Web site Offer's Visualisation







## Example application (2) FMPC Barcode PDA Solution





### Example application (3)

# Mobile Assistant for Tourist

Touristic map, computer database of hotels and resaturants

**Macau Map**  
<=>All Temples=>  
A-Ma Temple  
Hong Kung Miu  
Kun lam Tong  
Lin Fung Miu (Tem..  
**Lin Kai Miu**  
Pak Tai  
Menu Back

**Macau Map**  
Temple Guide  
  
Name: Lin Kai Miu  
District: Macau  
Address: Travessa da Corda  
Description: Dating from the 17th century, also known as the Stream of Mourning Temple.  
Map Back

**Macau Map**  
Temple Guide  
Name: Lin Kai Miu  
District: Macau  
Address: Travessa da Corda  
Description: Dating from the 17th century, also known as the Stream of Mourning Temple.  
Map Back

Calculation of a public transport connection, route planning

**Hotel Kingsway**  
(1a,3,3a,10,10A,10B,12,23,28a,28b,28bx,28c,32,AP1)  
More Back

Set As Source  
Set As Destination  
Cancel  
Ok Cancel

Take 10 10A 3 3a from Hotel Kingsway to Almeida Ribeiro. Get off after 7 bus stop(s).  
Ok Cancel



## Example application (4)

# Pharmacy - Drug Inventory Management

- Drug Inventory Stock Management (re-order)
- Minimize data entry error on drug code
- Drug Condition (expiration date)
- Drug order history
- Next arrival quantity



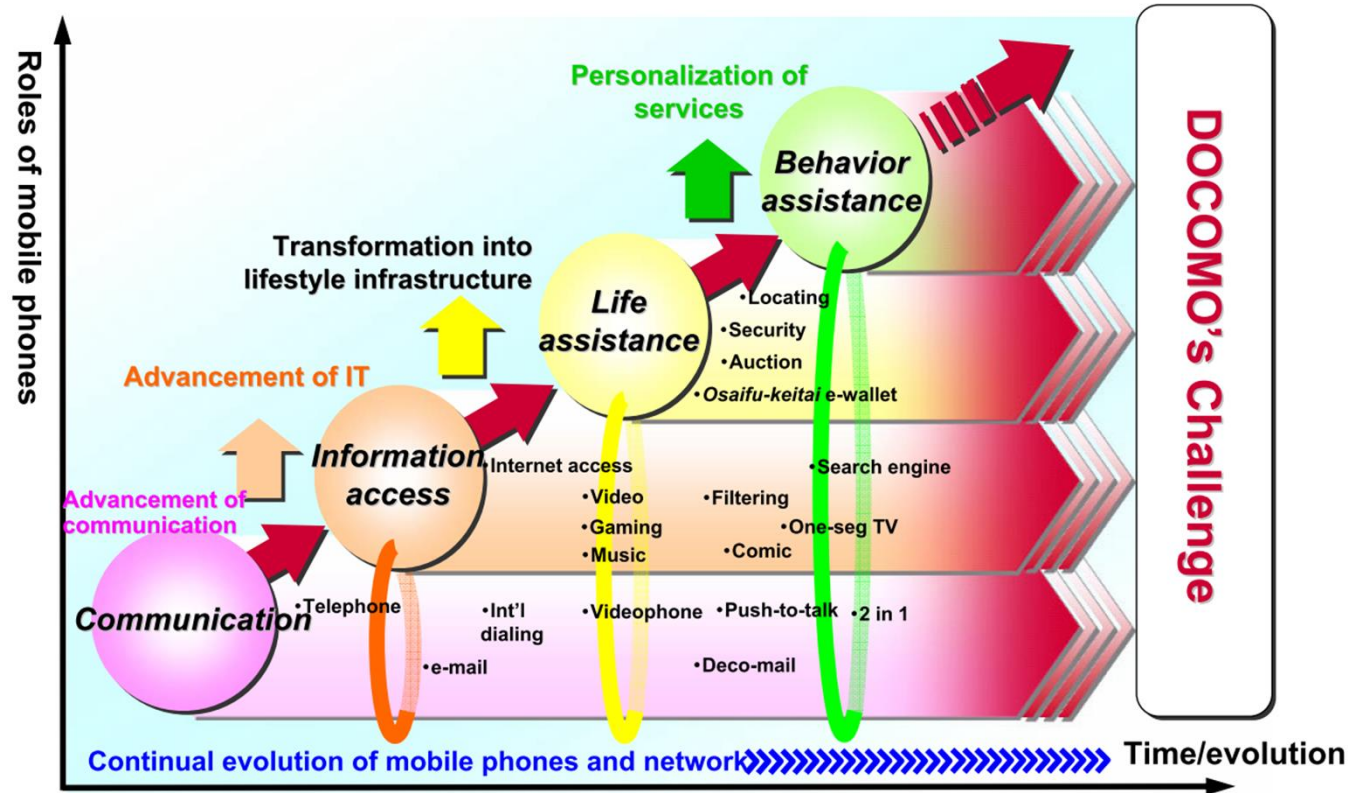




NTT DOCOMO, INC. / Japan  
World's leading mobile  
communications company.  
56 million customers in 2010

# DOCOMO Vision

## Evolving Role of Mobile Phone





# Advanced Mobile Devices (smartphones/tablets)

## Symbian



Nokia N97



Nokia E61

## Windows Mobile



HTC Pure



Samsung Omnia

## iPhone



iPhone



iPad

## Android



Motorola DROID



Kyocera Zio





# Mobile Java – J2ME (Sun)

## Advantages:

- Former leader of mobile development community.
- Extensive market penetration (almost 100% phones)
- Can work on mobile devices with less than 1 MB of storage
- A popular option for creating games for mobile phones

## Disadvantages:

- No access to all of devices resources
- Not as fast as native code







# Symbian (Nokia)



## Advantages:

- Most popular mobile operating system, accounting for about 50% of smartphone sales
- Symbian devices can also be programmed using Python, Java ME, Flash Lite, Ruby, .NET, Web Runtime (WRT) Widgets and Standard C/C++
- In 2009, Nokia started the Symbian Foundation, which will be an independent force for the future development of Symbian OS
- Native GUI, Access to native APIs, very good performance
- Being open source could help accelerate pace of innovation (like Android)

## Disadvantages:

- Long learning curve,
- More difficult application distribution (in comparison to iPhone's app store)
- Limited market penetration in the US



# Windows Mobile (Microsoft)



## Advantages:

- Large user base
- Interface similar to desktop versions of Windows OS
- Supports a variety of languages including:
  - o Visual C++
  - o Visual Basic .NET
  - o Visual C# using .NET Compact Framework
- many applications on the market

## Disadvantages:

- Current version on the market (WM6) lacks support for some popular technology enablers (e.g., multi-touch, GPS, accelerometer)
- Less developer enthusiasm vs. that for iPhone and Android
- Difficult application distribution (in comparison to iPhone's app store)



# Mobile .NET



## Advantages:

- Microsoft's solutions come in a number of mobile flavors:
  - o Windows CE
  - o Window Mobile/Pocket PC
  - o Windows Tablet PC Edition
- Interface similar to popular desktop systems: Windows 2k, XP, Vista, 7

## Disadvantages:

- Average market penetration
- The platform must support the Microsoft .NET Compact Framework runtime



# iPhone OS (Apple)



## Advantages:

- Strong user growth and data-hungry user base
- Application store creating a vibrant app ecosystem with great momentum  
More than 85K applications (~20% free), more than 1 million downloads
- Powerful technology enablers (e.g., multi-touch, GPS, accelerometer)

## Disadvantages:

- App approval process is largely a black-box to developers
- Apps viewed as competitive to Apple are often shut down
- Downloads highly dependent on “featured” or “top download” promotion in store
- Apple / hardware dependent
- App store is the only authorized distribution channel
- If you plan on releasing application, you'll need to sign up for the iPhone Developer Program



# BlackBerry OS (RIM)



## Advantages:

- Large and data-hungry user base
- Blackberry Java Development Environment available for free
- Developers not limited to single distribution channel

## Disadvantages:

- Only Java ME supported with some additional Blackberry-specific APIs
- Less popular outside of North America
- Users more email focused vs. web consuming iPhone users
- Developer momentum appears to be shifting to iPhone





# Android (Google)



## Advantages:

- Open source → could help accelerate the pace of innovation
- Manufacturer-independent → could help accelerate consumer adoption
- New technology support (e.g., touchscreen, GPS, accelerometer, video and still cameras)

## Disadvantages:

- Late to market relative to iPhone
- At least initially, demand is expected to trail iPhone demand



# Flash Lite (Macromedia)

## Advantages:

- A lightweight version of popular Adobe Flash Player
- Easy converting of web-based (desktop) Flash content to mobile
- Rapid development. Like in normal Flash.
- Technology implemented at the client-side
- Packs more animation and graphics into the same file size

## Disadvantages:

- Small market penetration, only a minority of phones offer support for Flash Lite.
- Relatively poor graphical performance
- Poor handling of sound



# Mobile Software Distribution

	Apple App Store	Android Market	Ovi Store	Handango	GetJar
<b>Fundamentals</b>					
Owner	Apple	Google	Nokia	Handango	Getjar Networks
Distribution model	via App Store on iPhone and iPod Touch	via Market on Android devices (closed source)	via download, and pre-loaded from 4Q09	via web mostly (direct + white label)	via web only (direct + white label)
Platforms	OSX	Android	S60, S40	Java, S60, RIM, WinMo, Palm, Android	Java, Flash, Android, RIM, WinMo, Palm, Android
<b>Key figures</b>					
Installed base of on-device storefront (2009 est.)	60M	5M	2M (preload on S60 + some S40 from 4Q09)	< 1M	0 (plans to pre-load icon shortcut on phones)
Downloads per month as of end of 2009 (est.)	200M	30M	5M	3M	50M
Applications to end of 2009 (est.)	110,000	16,000	4,000 apps 1,500 themes	140,000 apps	50,000 apps
Annual revenues (2009 est.)	\$700M/year	\$20M/year	N/A	N/A	N/A
Revenue model	70% to developer	70% to developer 30% optional to operator	70% to developer (less w/ carrier billing)	30-40% to developer + rev share to channel	Ad-based apps + paid placement

App Store comparative analysis (end- 2009). Source: VisionMobile



# Some Technical Facts from Real Life Practical Experience

- There's no big secret to mobile application development!
  - Languages are very similar to desktop ( C / C++ / C#, Java / J2ME, ... )
  - Software life-cycles are essentially the same.
- Brute force testing on the device is the only assured way of ensuring the apps work on the phones  
(You can develop on emulators and it will work fine. Put it on a phone, it will fall over)
- No stdout or stderr stream for error output.
  - Need to draw on the screen.
  - Do as much as you can on the emulator!
- Testing → Don't use a high-end phone as your baseline!
  - Find the most restrictive devices you want your app on and do them first
  - You'll need two baseline phones for each screen size template
    - One with lowest CPU power
    - One with smallest memory



# Definitive Mobile Developer Survey

The most important figures from survey:

## „Making sense of a fragmented world - Mobile Developer Economics 2010 and Beyond”

by **VisionMobile**

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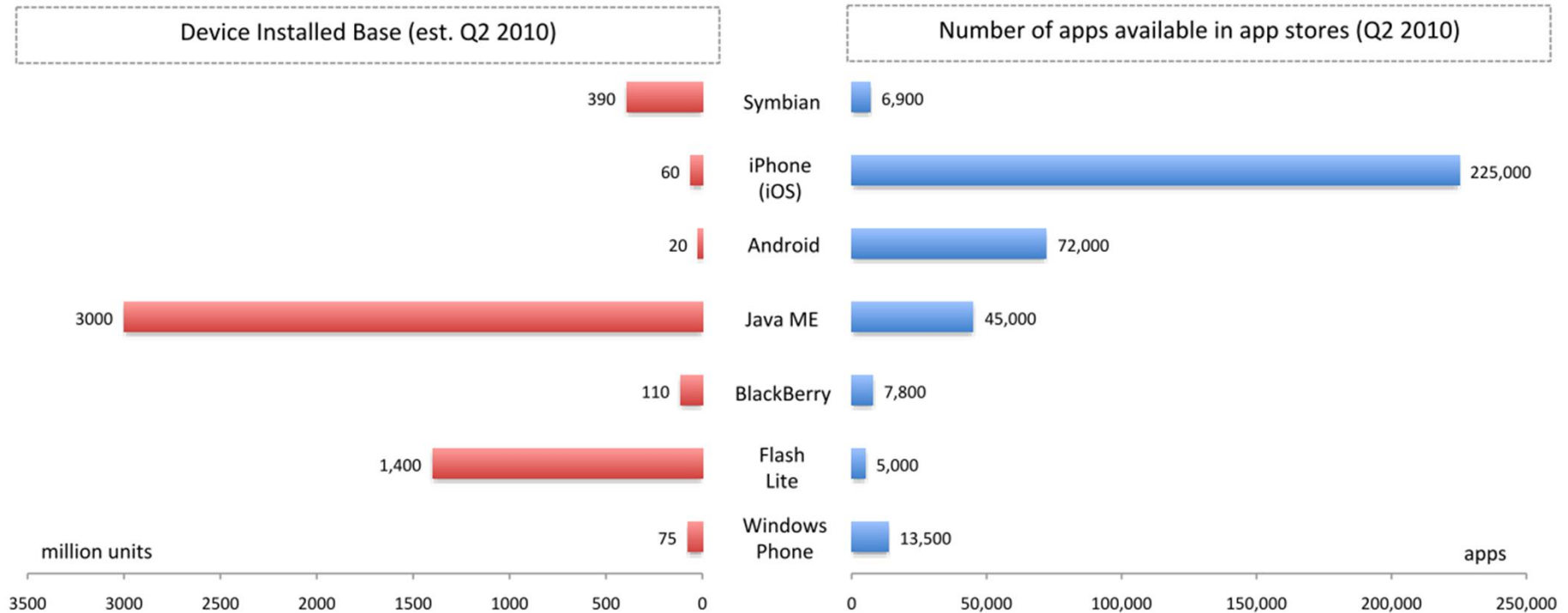
Any reuse or remixing of the work should be  
attributed to the **VisionMobile** Developer  
Economics Report sponsored by Telefonica  
Developer Communities.







# Quantity: **Devices** ↔ **Applications**

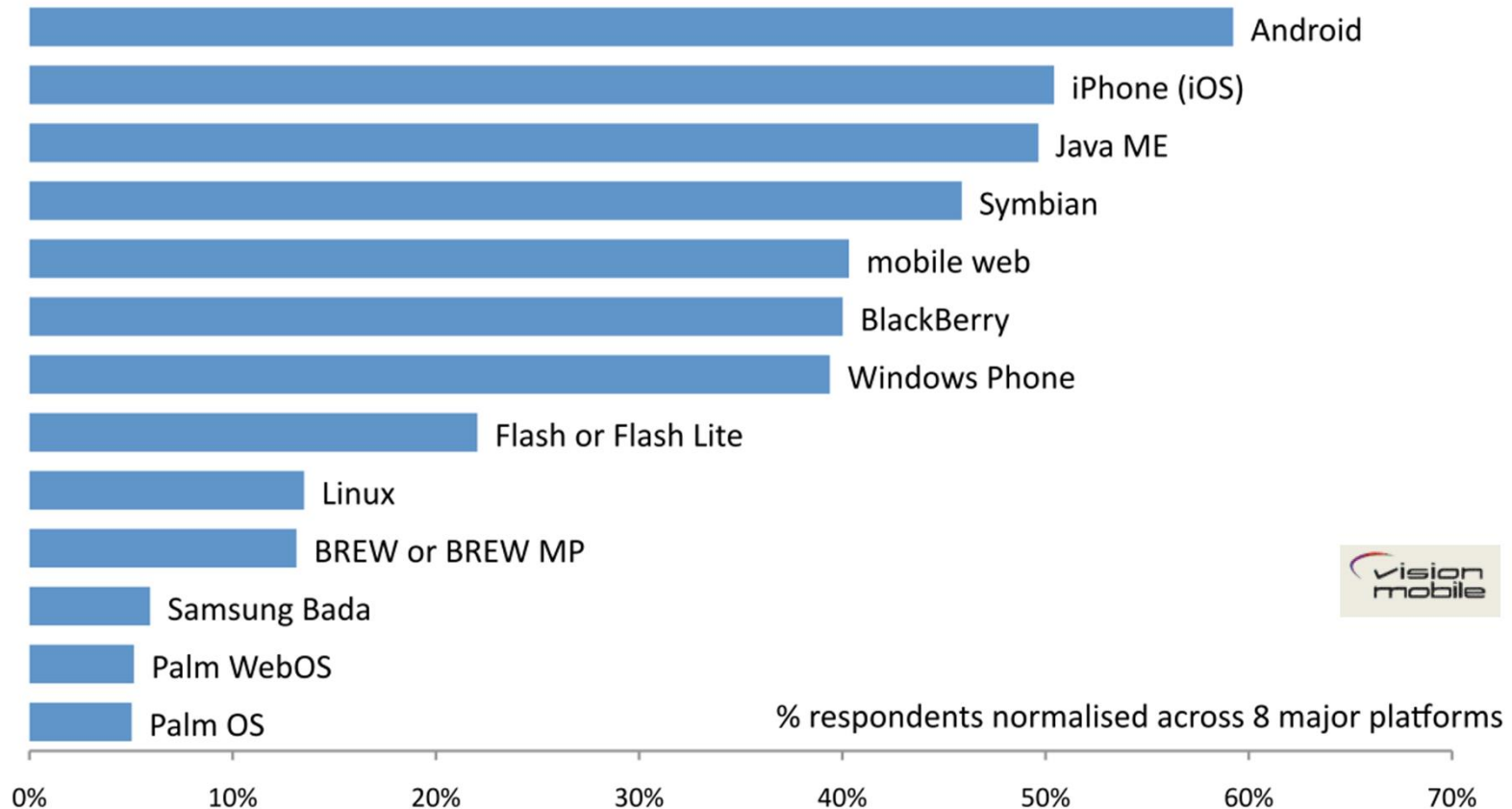


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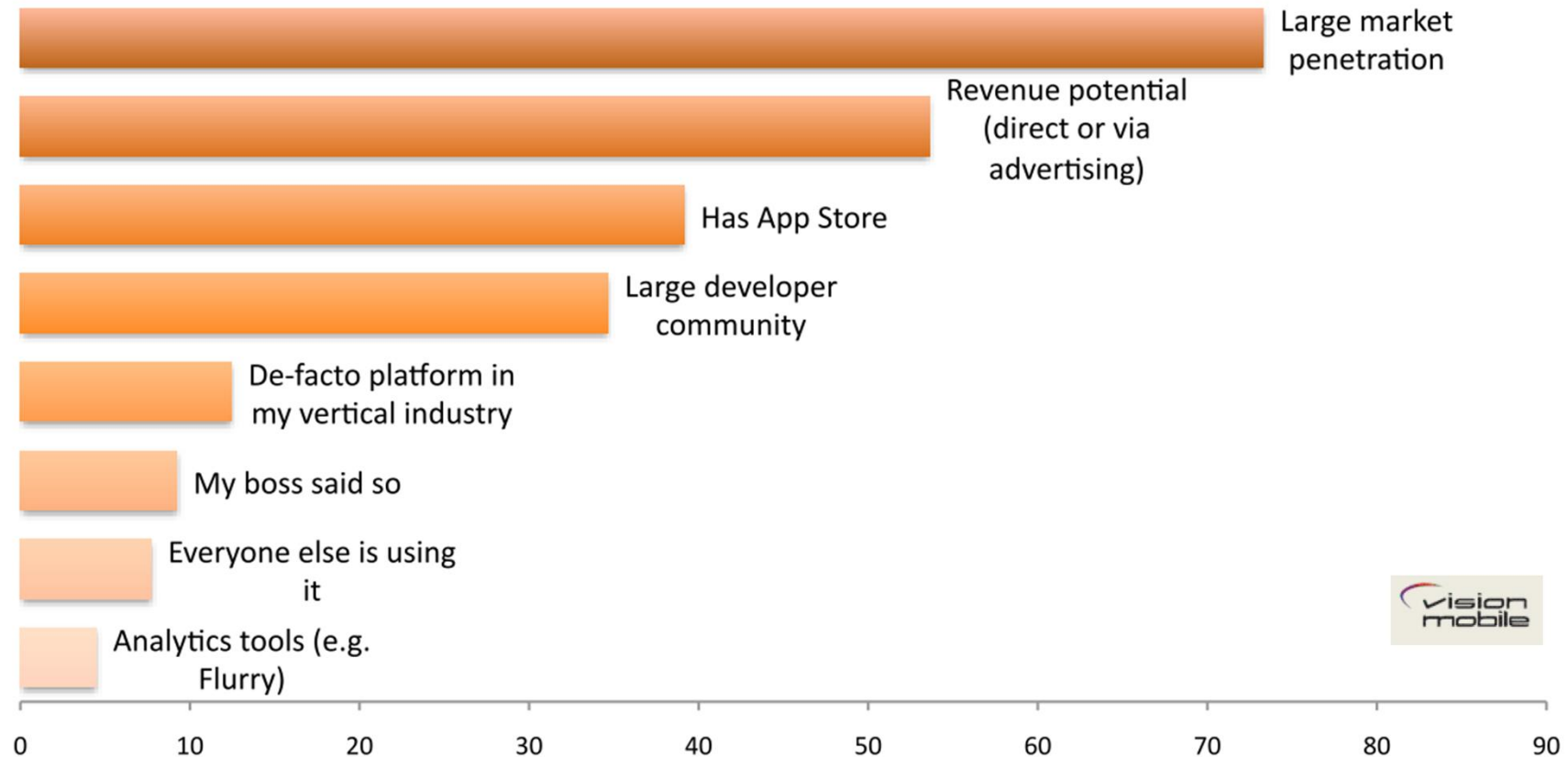
Platforms most used by mobile developers in early 2010



Source: Mobile Developer Economics 2010 and Beyond. Produced by VisionMobile. Sponsored by Telefonica Developer Communities. June 2010. Licensed under Creative Commons Attribution 3.0 License. Any use or remix of this work must retain this notice.



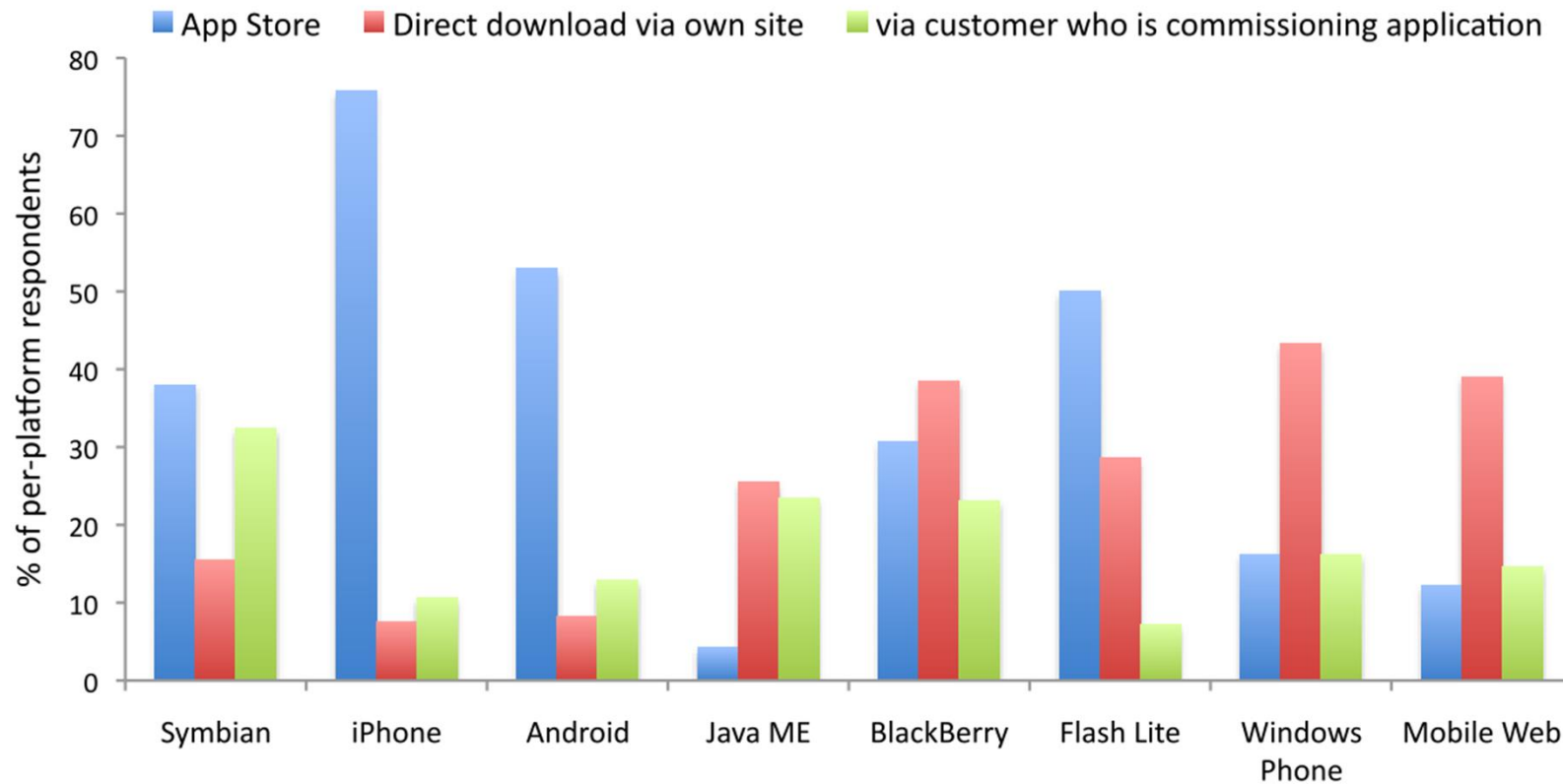
Marketing reasons that mobile developers consider important in selecting a platform



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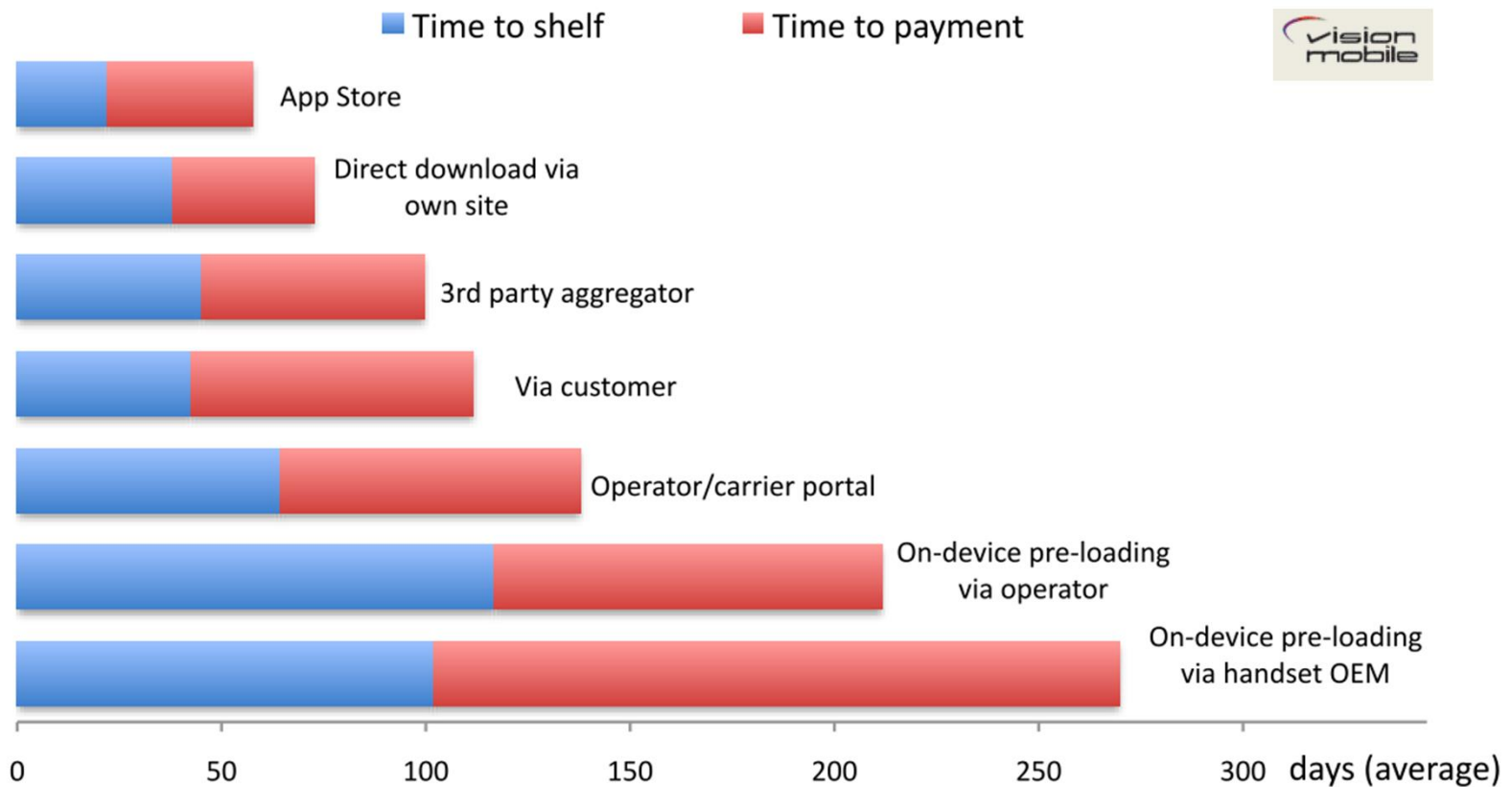
Main channels used by mobile developers to sell their apps (per platform)



Source: Mobile Developer Economics 2010 and Beyond. Produced by VisionMobile. Sponsored by Telefonica Developer Communities. June 2010. Licensed under Creative Commons Attribution 3.0 License. Any use or remix of this work must retain this notice.



Time-to-market for apps (per channel)

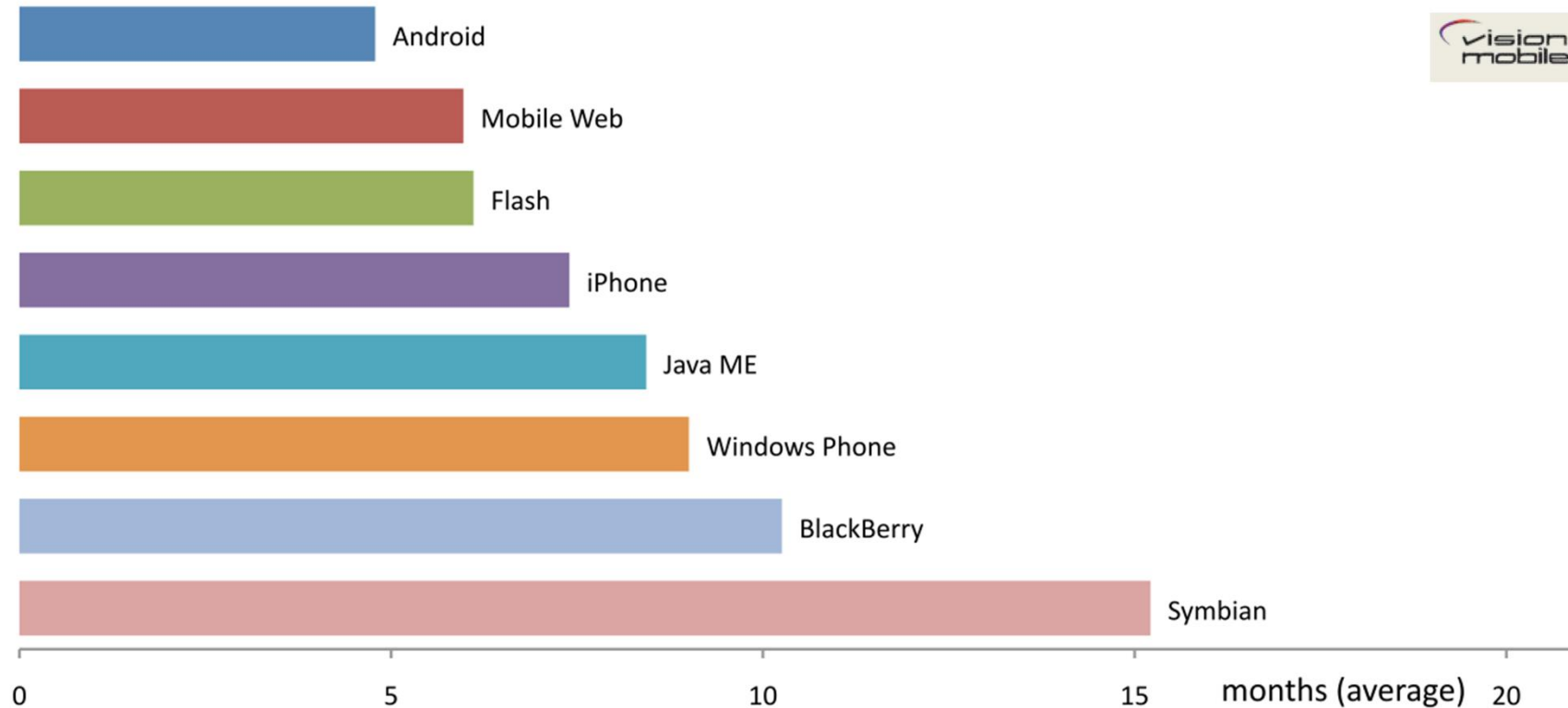


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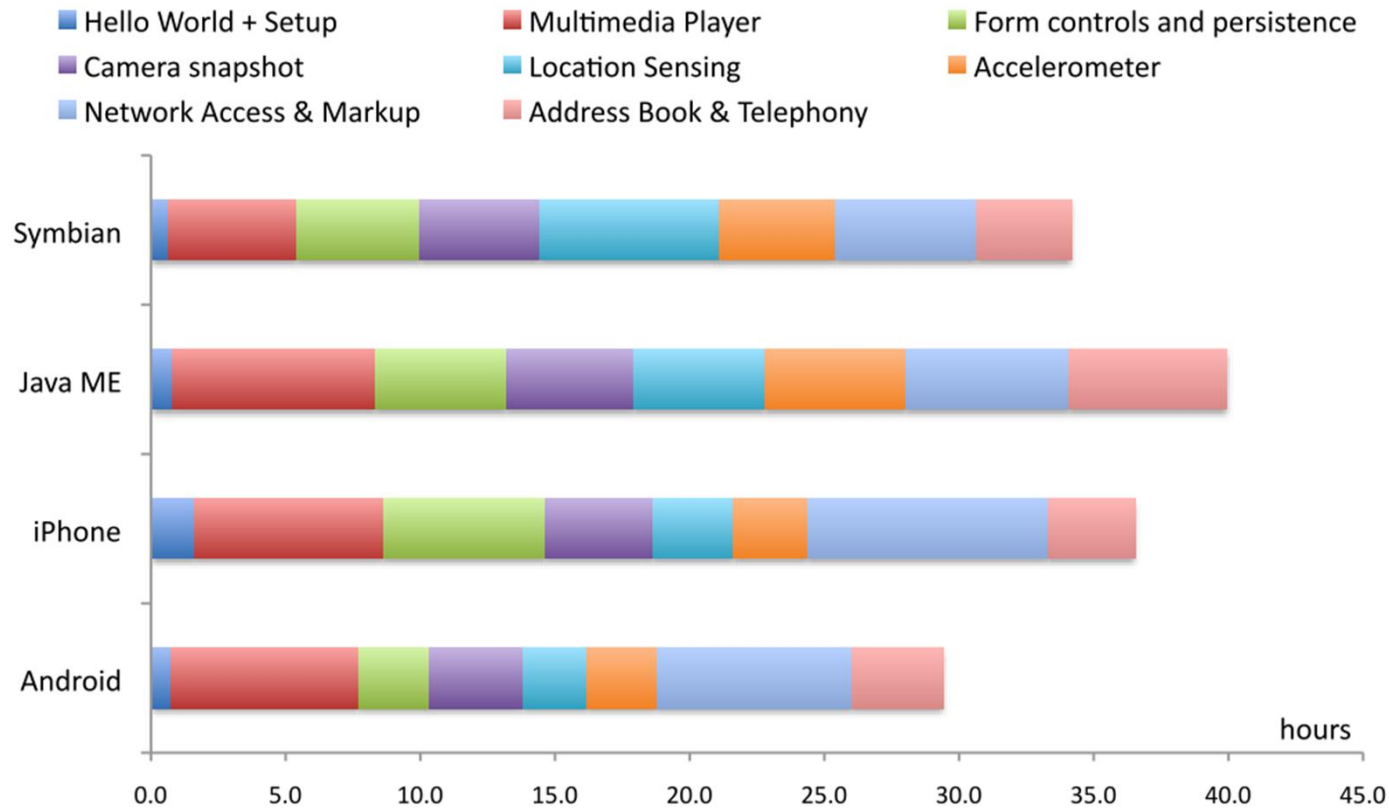
Average time required to master each platform



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Total development time per application



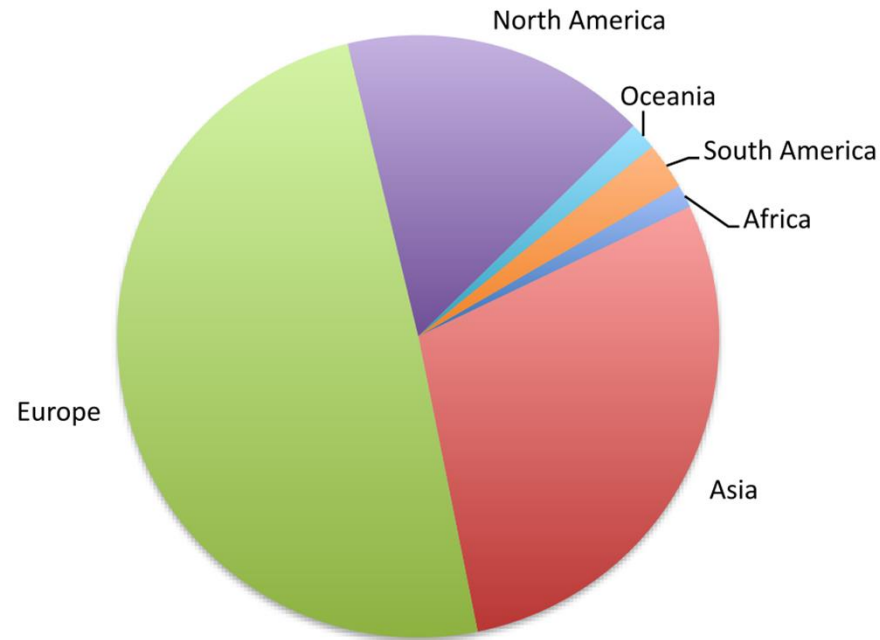
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# Geographical Distribution of 400 Respondents of Survey

Top-10 countries	
Country	Respondents
India	56
UK	55
USA	43
Germany	29
Canada	21
France	18
Israel	16
Spain	16
China	12
Greece	10



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# Summary

- the new era of mobile technology is coming
- mobile computing: definitions, characteristics, constraints, applications
- several mobile platforms – there isn't evident leader
- unbalanced relation: devices ↔ applications
- various channels for software distribution



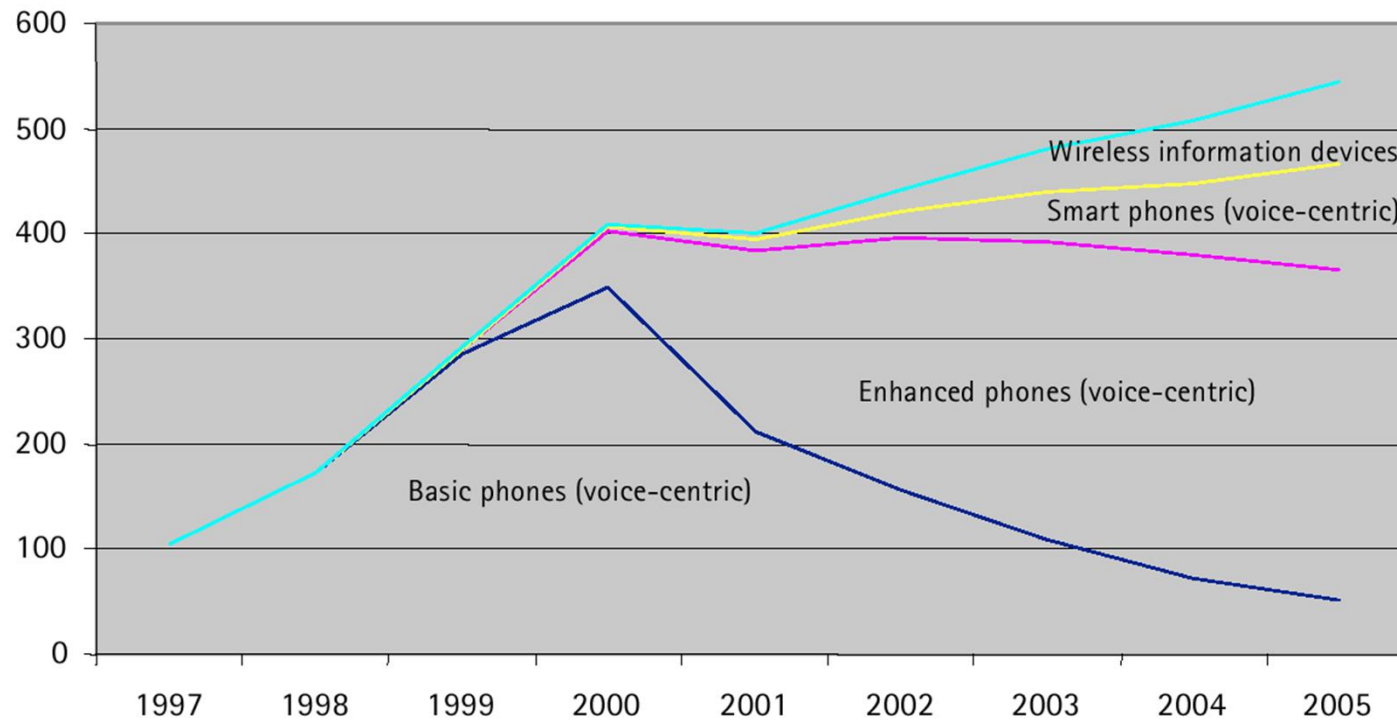
# References

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- [4] P. Golding „Next generation wireless applications: creating mobile applications in a Web 2.0 and Mobile 2.0 world”
- [5] R. Rischpater „Beginning Java ME Platform”
- [6] P. Coulton, R.Edwards, H. Clemson „S60 Programming: A Tutorial Guide”
- [7] A. Wigley, D. Moth, P. Foot „Microsoft® Mobile Development Handbook”
- [8] R. Rogers, J. Lombardo, Z. Mednieks, B. Meike „Android Application Development: Programming with the Google SDK”





# Historical sales forecast (2003)





# Mobile Computing Definition (1)

- generic term describing one's **ability to use technology while moving**, (as opposed to portable computers, which are only practical for use while deployed in a stationary configuration).
- **Taking a computer out into the field** and all necessary files and software
- use technology 'untethered', that is **not physically connected**, or in remote or mobile (non static) environments
- Mobile computing **usually implies wireless transmission**, but wireless transmission does not necessarily imply mobile computing.



# Mobile Computing Definition (2)

- The term is evolved in modern usage such that it requires that the mobile computing activity **be connected wirelessly to and through the Internet** or to and through a private network.
- This connection ties the mobile device to centrally located information and/or application software through the use of **battery powered, portable**, and wireless computing and communication devices.
- This includes devices like laptops with wireless LAN or wireless WAN technology, **smart mobile phones, wearable computers** and **Personal Digital Assistants** with Bluetooth/IRDA interfaces.



# Mobile Computing Definition (3)

- any application in which the used **computing system is not assigned a specific location.**
- In some cases the **movement of the system is an essential element** of the application; for example the system may be mounted in a vehicle,
- or may be used by someone whose work demands visits to different **locations with no on-site computing facilities.**
- In other cases it is the end-user who may **move from place to place, each equipped with computing facilities,** along the way the user is able to use any network-connected workstation that will automatically reconfigure itself reconstructing the environment which was used.