

## ***Lecture 11***

Market Overview of Mobile Operating Systems and Security Aspects

Mobile Business I (WS 2014/15)

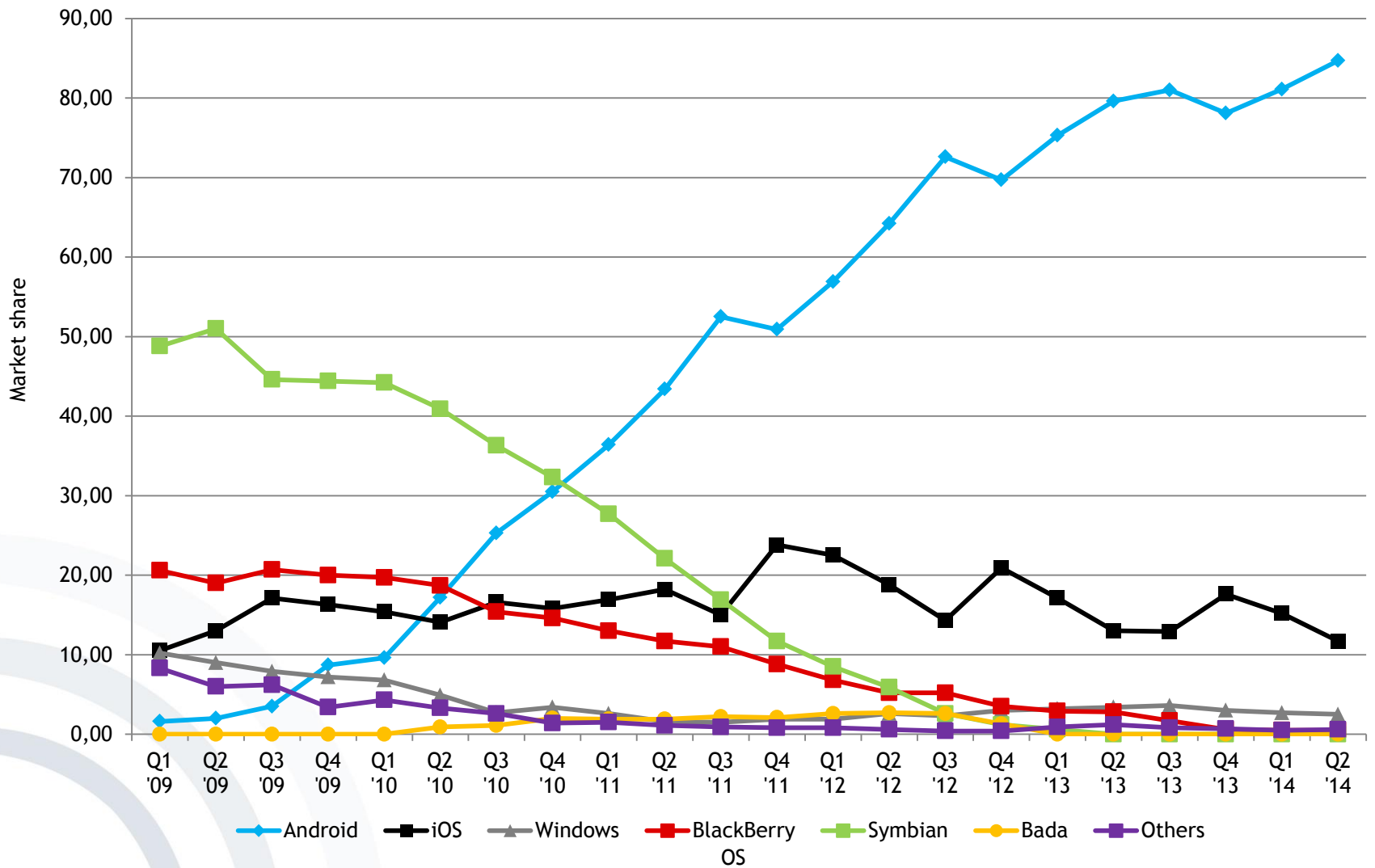
Prof. Dr. Kai Rannenberg

Deutsche Telekom Chair of Mobile Business & Multilateral Security  
Johann Wolfgang Goethe University Frankfurt a. M.



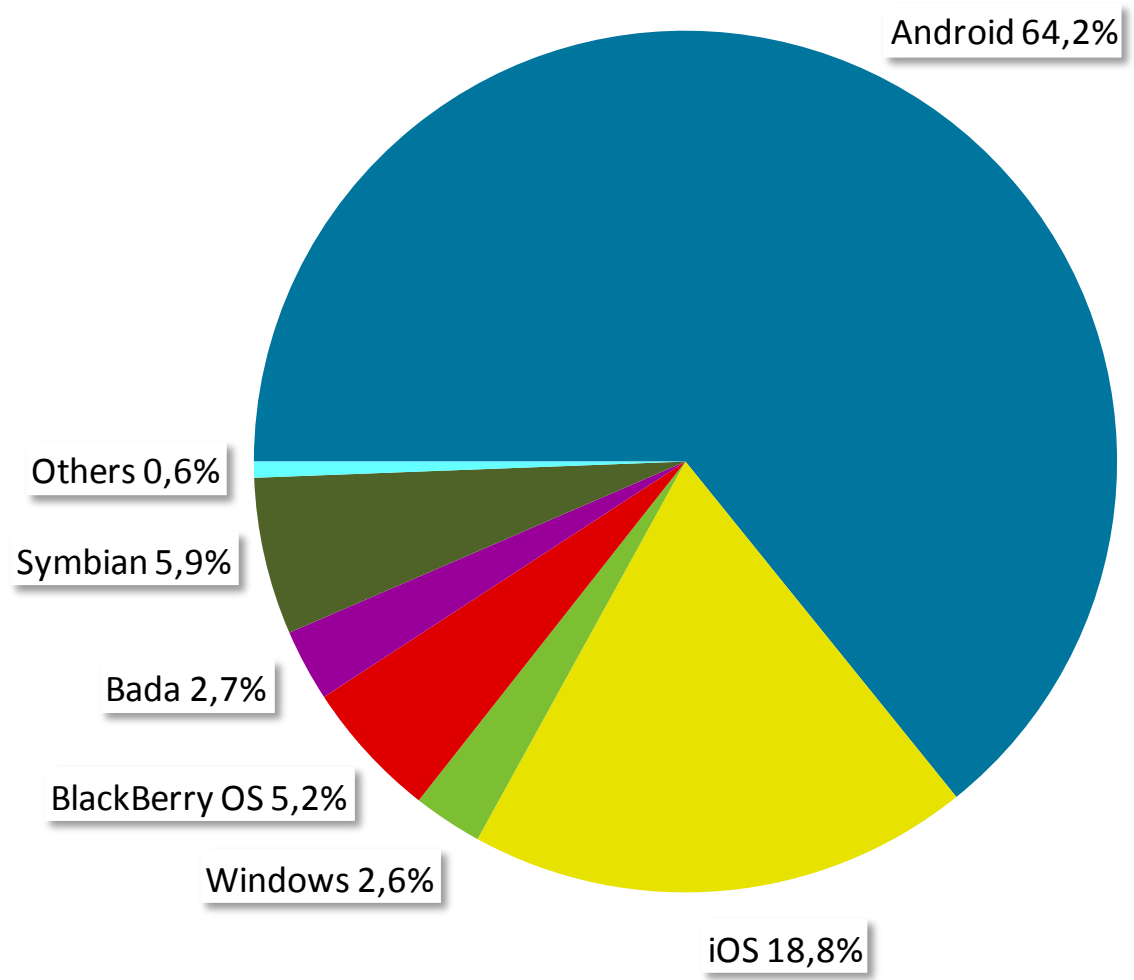
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# Worldwide Smartphone Sales to End Users by Operating System (2009-2014)



[Statista 2014a]

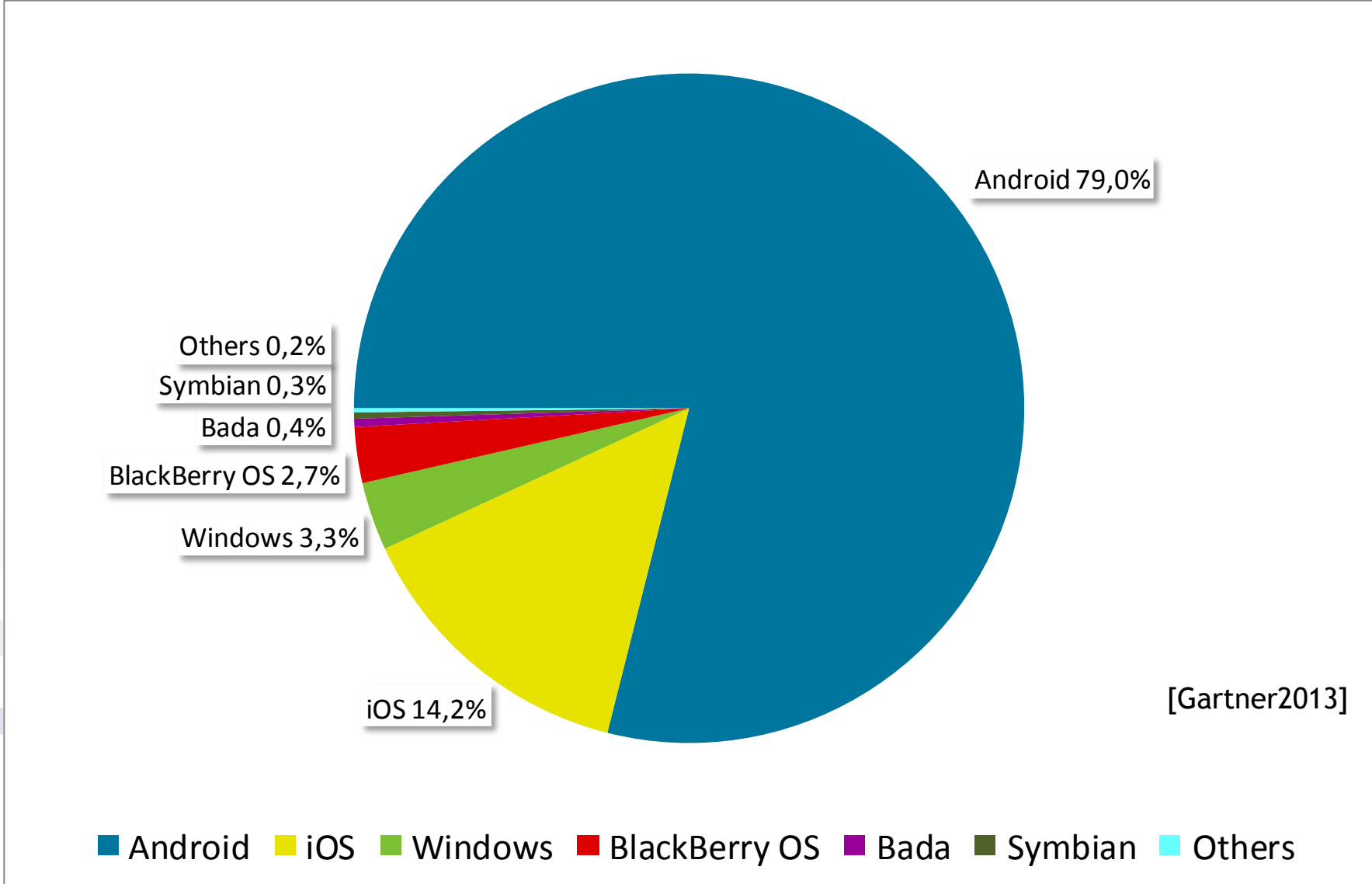
# Worldwide Smartphone Sales to End Users by Operating System (Q2 2012)



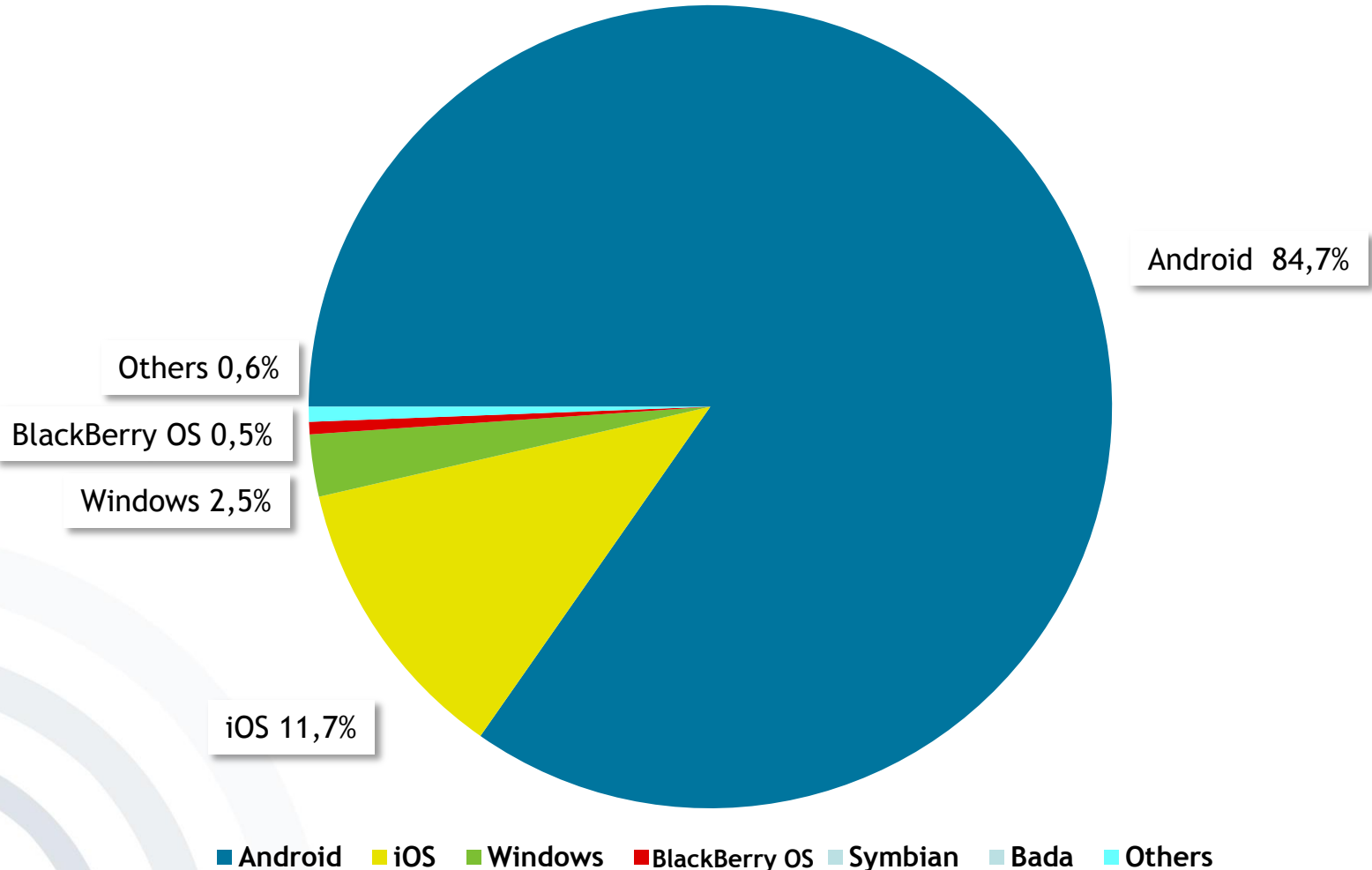
[Gartner2013]

- Android
- iOS
- Windows
- BlackBerry OS
- Bada
- Symbian
- Others

# Worldwide Smartphone Sales to End Users by Operating System (Q2 2013)

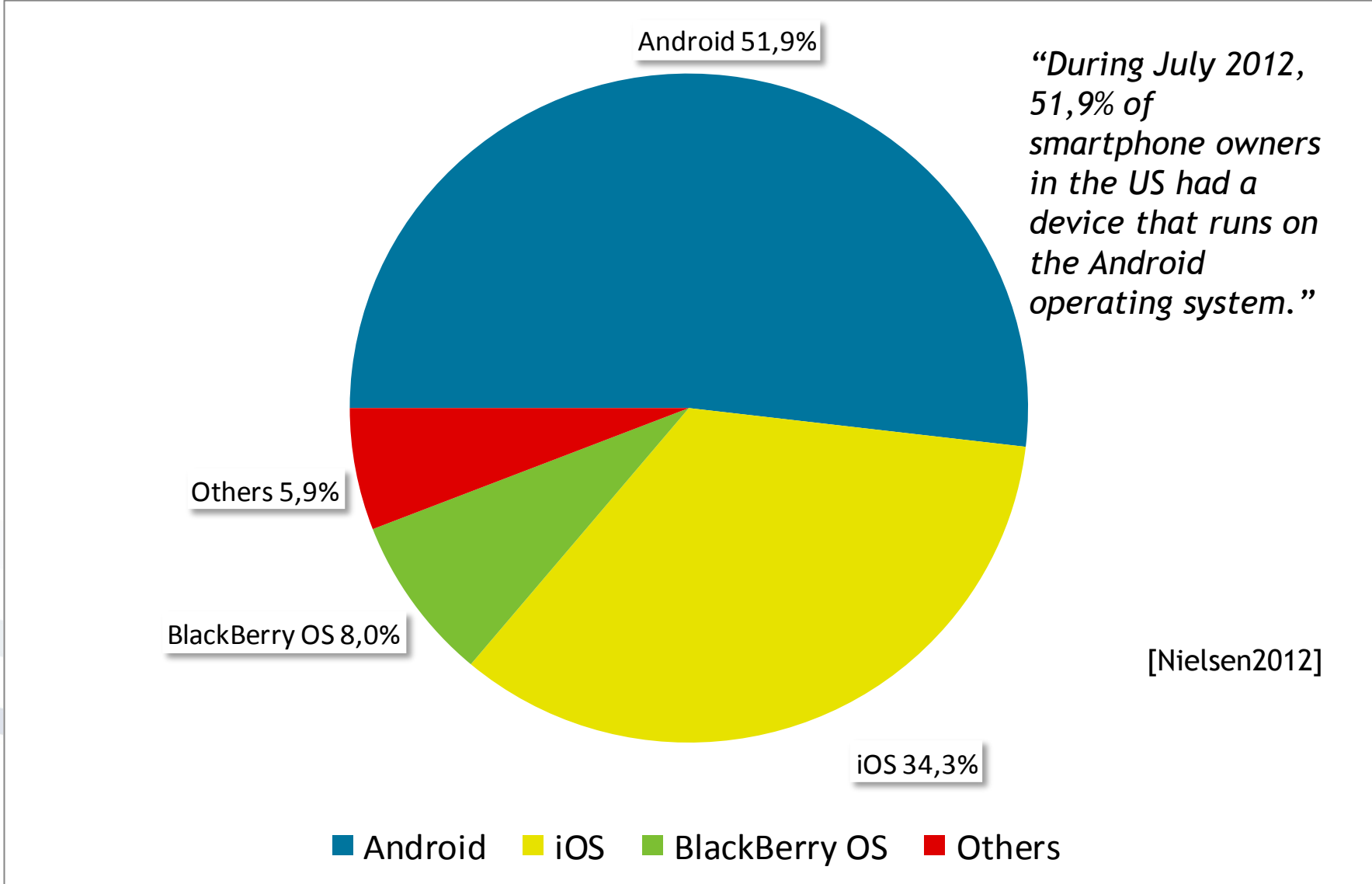


# Worldwide Smartphone Sales to End Users by Operating System (Q2 2014)

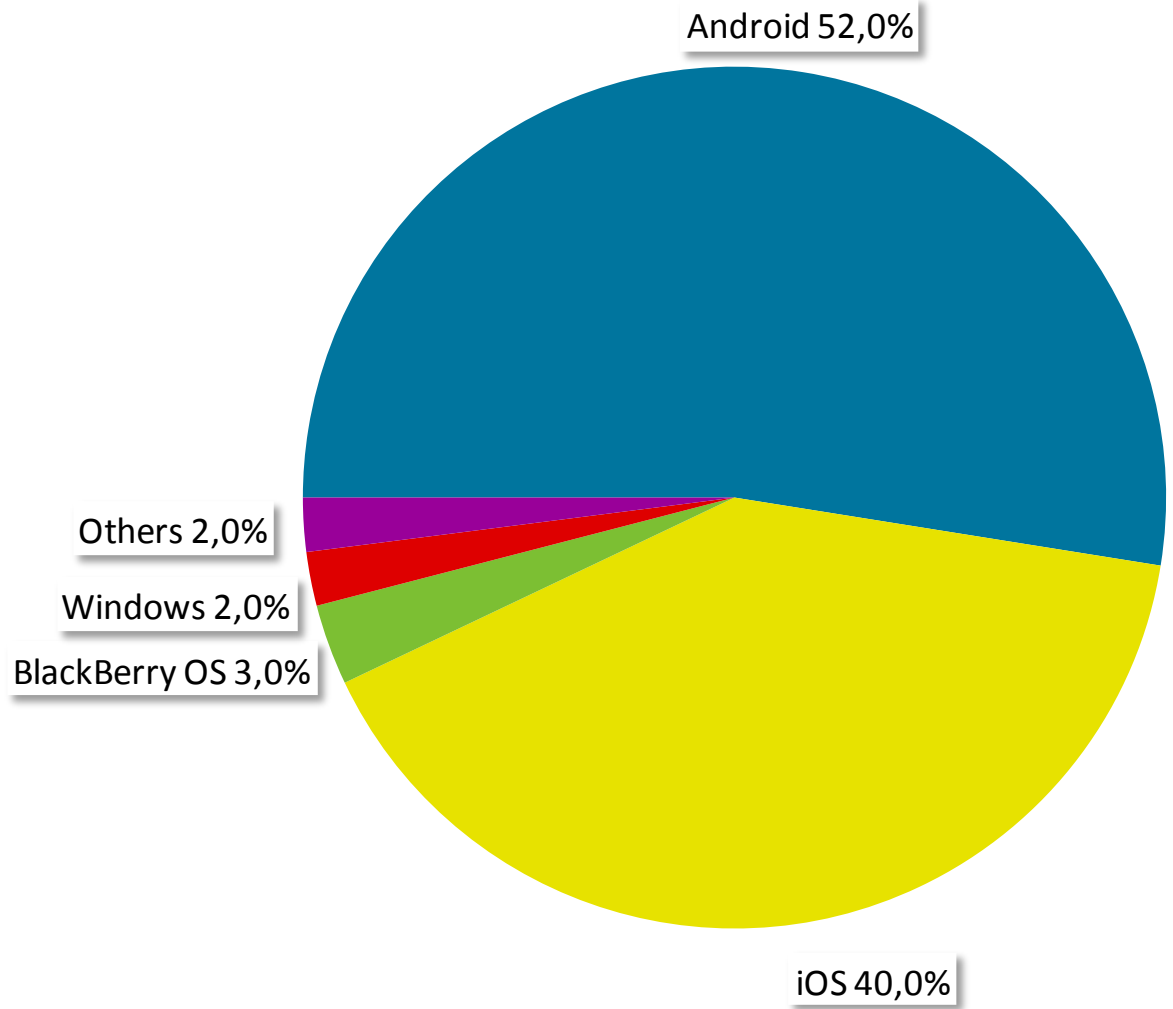


[Statista 2014a]

# US installed smart phone base by Operating System (July 2012)



# US installed smart phone base by Operating System (Q2 2013)



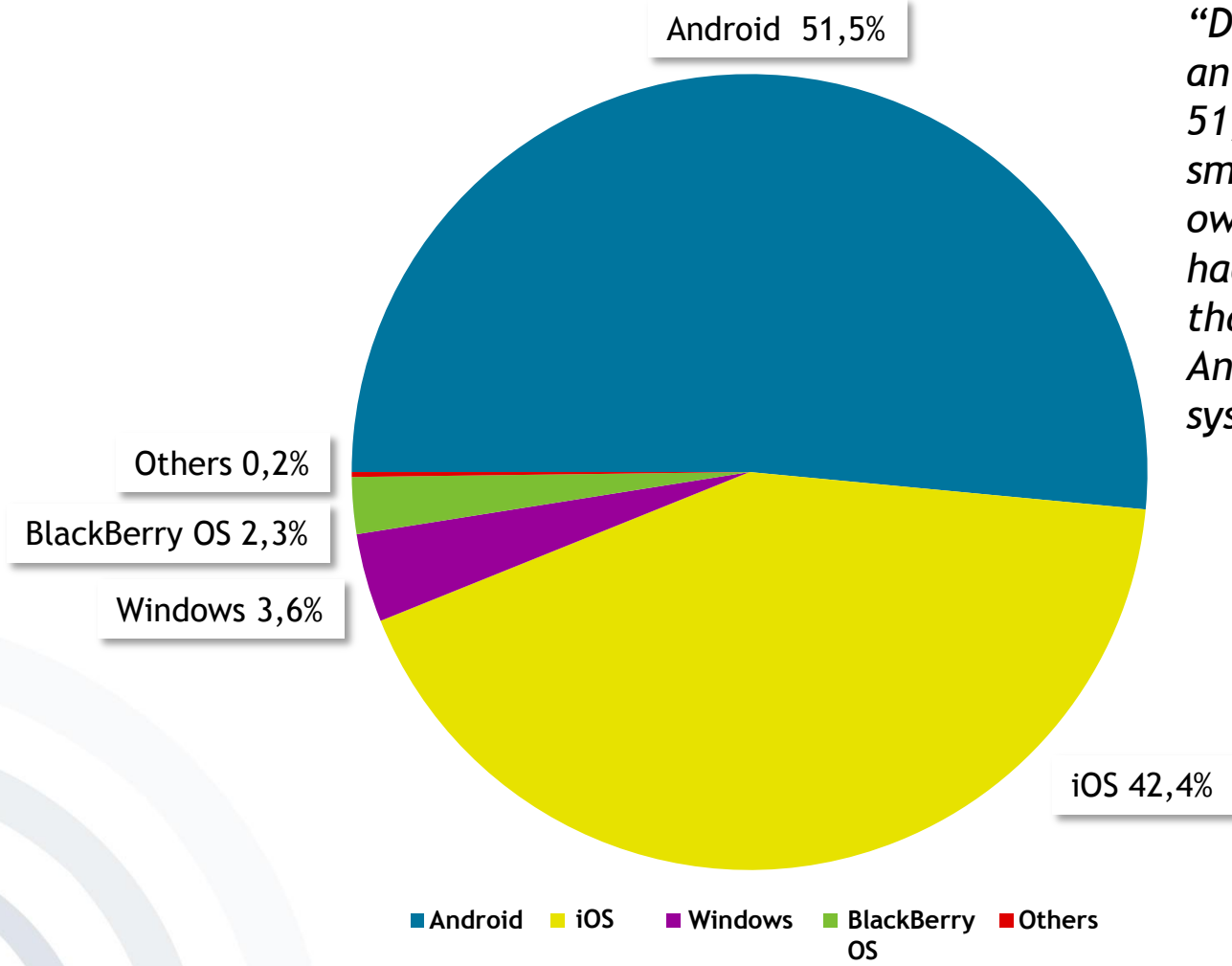
*“During Q2 2013 an average of 52% of smartphone owners in the US had a handset that runs on the Android operating system.”*

[Nielsen2013]

- Android
- iOS
- BlackBerry OS
- Windows
- Others



# US installed smart phone base by Operating System (July 2014)



*“During July 2014 an average of 51,5% of smartphone owners in the US had a handset that runs on the Android operating system.”*

# Worldwide Smartphone Sales to End Users by Operating System Q2-2014 vs. Q2-2013 vs. Q2-2012

In 1.000 Units

Operating System	2Q14 Units	2Q14 Market Share (%)	2Q13 Units	2Q13 Market Share (%)	2Q12 Units	2Q12 Market Share (%)
Android	250,119.1	84,7	177,898.2	79.0	98,664.0	64.2
iOS	34,550.1	11,7	31,899.7	14.2	28,935.0	18.8
Windows	7,382.5	2,5	7,407.6	3.3	4,039.1	2.6
BlackBerry OS	1,476.5	0,5	6,180.0	2.7	7,991.2	5.2
Bada	➔ others		838.2	0.4	4,208.8	2.7
Symbian			630.8	0.3	9,071.5	5.9
Others	1,771.8	0,6	471.7	0.2	863.3	0.6
<b>TOTAL</b>	<b>295,300</b>	<b>100.0</b>	<b>225,326.2</b>	<b>100.0</b>	<b>153,772.9</b>	<b>100.0</b>

# Worldwide Smartphone Sales to End Users by Vendor Q2-2014 vs. Q2-2013 vs. Q2-2012

In 1.000 Units

Company	2Q14 Units	2Q14 Market Share (%)	2Q13 Units	2Q13 Market Share (%)	2Q12 Units	2Q12 Market Share (%)
Samsung	74,415.6	25.2	71,380.9	31.7	45,603.8	29.7
Apple	35,140.7	11.9	31,899.7	14.2	28,935.0	18.8
LG Electronics	14,469.7	4.9	11,473.0	5.1	5,827.8	3.8
Lenovo	15,946.2	5.4	10,671.4	4.7	4,370.9	2.8
Huawei	20,375.7	6.9				
Others	135,247.4	45.8	99,901.2	44.3	69,035.4	44.9
<b>TOTAL</b>	<b>295,300</b>	<b>100.0</b>	<b>225,326.2</b>	<b>100</b>	<b>153,772.9</b>	<b>100.0</b>

- Big players (originally from neighbouring fields) often have some (sometimes relatively modest) market share due to high investment:
  - Microsoft: Architectures, operating systems
  - Nokia: Feature phones
- Killer Application Champions are very successful for some time until their killer application is also available from the big players:
  - Palm: 1st small and affordable PDA with address book, calendar, and PC connectivity
  - RIM Blackberry: 1st PDA phone with push email

- Due to the limitations of the mobile devices, mobile operating systems also have to cope with the following challenges:
  - Limited device capabilities and resources (storage, memory, processing time, etc.)
  - Usability issues
  - Security and system integrity issues

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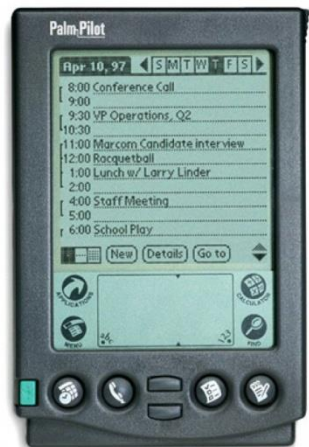
# Mobile OS unavailable to other device manufacturers

- Originally, most mobile phone manufacturers used their own “closed” operating systems for their mobile devices.
- Later, more and more platforms switched to more open and interoperable operating systems (e.g. Windows CE, Symbian OS, Android).
- Some manufacturers (still) rely on own OS, e.g. RIM Blackberry OS, Apple iOS.
- **Advantage:** Tend to be not as much affected by malware than “open” operating systems
- **Disadvantage:** Less flexible, as 3<sup>rd</sup>-party software cannot be easily installed and executed

- Palm OS (Garnet OS)
  - Latest release: Most devices equipped with Palm OS 5.4
- Apple iOS (Unix-based)
  - Latest release: iOS 8
- BlackBerry OS
  - Latest release: BlackBerry OS 10.3
- Nokia Series 40, Asha
  - Latest release: Asha 1.4
- Samsung bada
  - Latest release: 2.0



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All screens are simulated.

- The operating system is made by *palmsource*

- Several device manufacturers:

- Palm (e.g. Treo series)
- Handspring
- Garmin (navigation devices)
- Fossil
- Samsung
- Sony
- ...



- Current version 6.1 (Cobalt)

- There are no devices using version 6.1 on the market. Most of the devices are equipped with Palm OS 5.4 (Garnet), such as the Tungsten series.

- Communication:
  - IrDA
  - Bluetooth
  - WiFi (IEEE 802.11)
  - GSM/GPRS
  - CDMA
- Support of the TCP/IP network protocol
- Integrated personal information management (PIM)
- Support for several encryption and security algorithms (e.g. RSA, SHA1, RC4)
- Large choice of 3rd party software available
- Long battery life



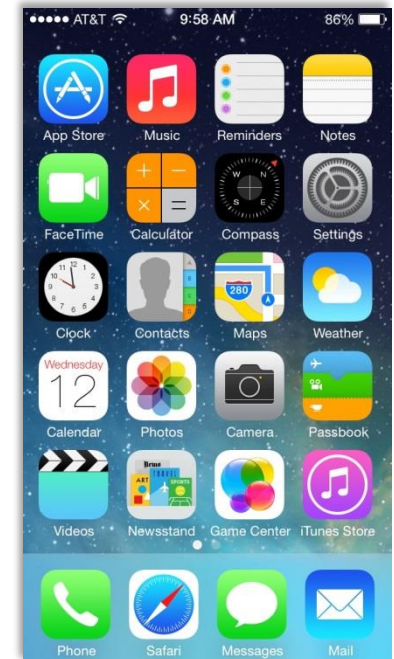
- 1996: Palm Pilot 1000, first device using Palm OS
- 1998: Palm III using Palm OS v3
- 2000: Palm IIIc, first device using Palm OS and a colour display
- 2003: Palm OS 5
- 2004: Palm OS 6.1 (Cobalt) and Palm OS 5.4 (Garnet)
- 2006: Palm's "*Treo Smartphones*" with Windows Mobile
- Name change to Garnet OS - future versions to be based on the Access Linux platform
- 2010: Hewlett-Packard acquired Palm for \$1,2 billion, name change to HPwebOS
- 2011: HP announced to stop the production of all HPwebOS devices, including smart phones and tablets

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## Apple iOS








- Developed by Apple for iPhone, iPod Touch, iPad and Apple TV
- Latest release: iOS 8
- iOS derived from Mac OS X, a Unix-based operating system
- Apple does not permit the OS to run on third-party hardware
- User-interface uses multi-touch gestures



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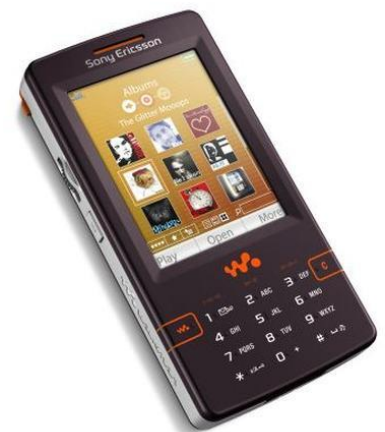
- Linux: LiMo (Linux Mobile), Openmoko Linux, Qt Extended (Qtopia) 
- Symbian platform
  - Latest release: “Nokia Belle Feature Pack 2” for Symbian^3 devices
- Android (by Open Handset Alliance) 
  - Latest release: 5.0 (Lollipop)
- Windows Mobile
  - Latest release: Windows Mobile 6.5.5
- Windows Phone
  - Latest release: Windows Phone 8.1
- Maemo (by Nokia) → MeeGo (by Nokia, Intel) → Sailfish OS (by Jolla) 
  - Latest release: Sailfish OS v1.1.0.39 (October 2014)
- Tizen (by Samsung, Intel, Linux Foundation) 
  - Latest release: 2.3 (November 2014)
- Firefox OS (by non-profit organisation Mozilla) 
  - Latest release: 1.4 (August 2014)
- China-Focused Mobile OS
  - Currently under development by Taiwan-based HTC [WSJ2013]

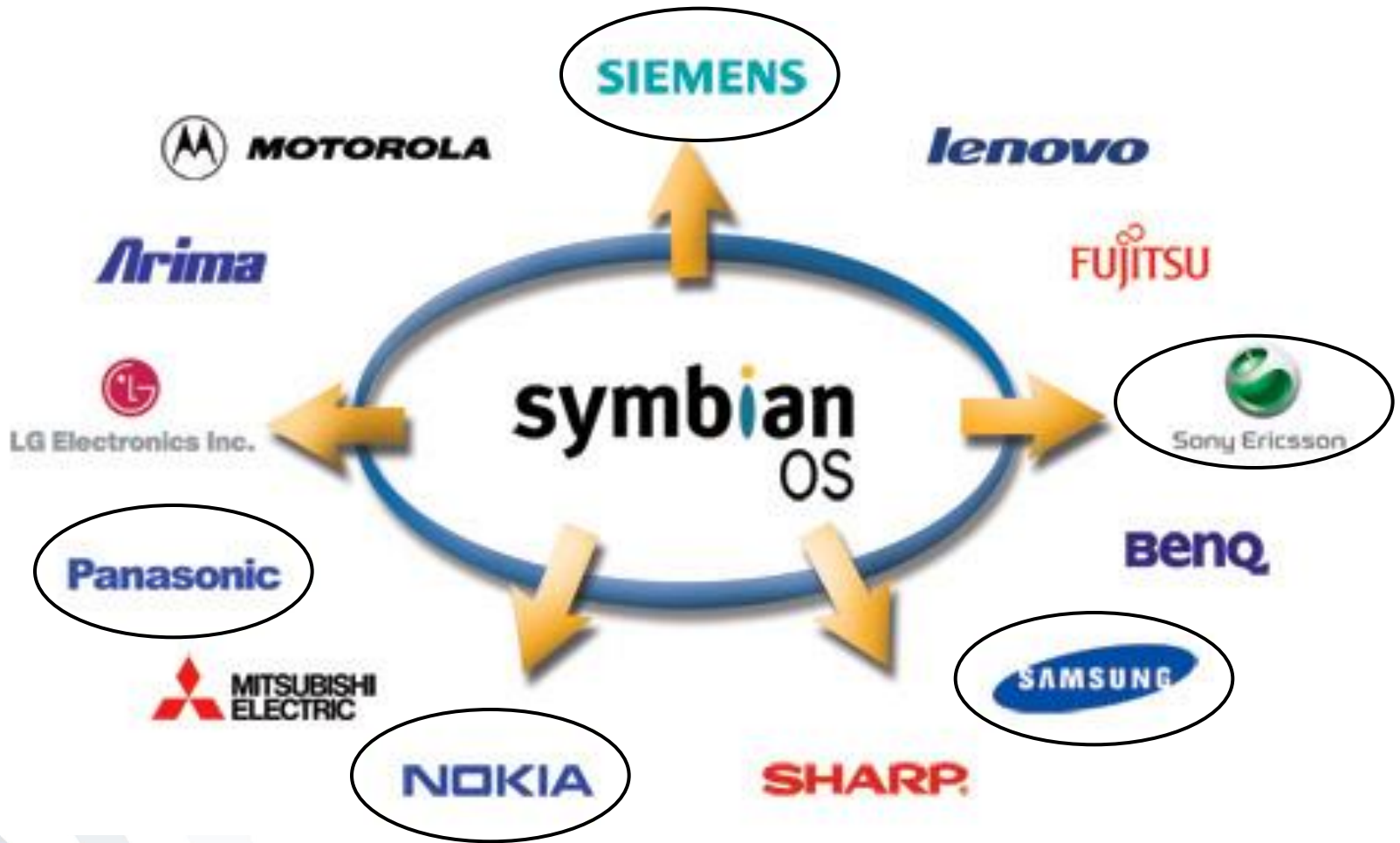
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# symbian

Symbian OS - the mobile operating system





In 2006, Symbian was owned by 

- Symbian was founded as a privately owned company in June 1998.
- Owner: Ericsson, Nokia, Panasonic, Psion, Samsung Electronics, Siemens and Sony Ericsson
- „Open“ Symbian OS telephones were available since 2001
  - „Open“: It is possible to install 3<sup>rd</sup>-party applications.
  - Beginning of 2001: Nokia 9210 Communicator
- 2004: Symbian OS 8.0
- 2005: Symbian OS 9.1 (S60 3rd edition)
- 2006: Symbian OS 9.3 released, extending the OS with WiFi and HSDPA
- 2007: Symbian OS 9.4 (S60 5th edition) = Symbian^1 („Symbian One“)
- 2008 June: **Symbian Foundation** announced
- 2008 December: **Nokia** buys Symbian Ltd. and becomes the **major contributor** to code of Symbian platform



- 2009: Symbian Foundation founded  
Symbian platform successor to Symbian OS and Nokia Series 60.
- 2010: Symbian OS 9.5 (Symbian^3). Nokia N8 first smartphone to run Symbian^3.
- 2010 November: Due to a lack of support from funding members, Symbian Foundation transition into a licensing-only organisation. Nokia takes over governance of the Symbian platform.
- 2011: Symbian Anna and Symbian Belle as an update to Symbian^3
- 2011 February: Nokia collaborates with Microsoft and adopts Windows Phone 7 for their smartphones. **Relevance of Symbian platform, especially in the mobile app market, drops significantly.** Market share in sharp decline, notably in the high priced smartphone segment
- 2011 September: Nokia **outsources** Symbian software development and 2,300 employees to Accenture
- 2012: Symbian Belle renamed to Nokia Belle
- 2013: Nokia Belle Feature Pack 2 (latest version)
- 2014 January: No new applications can be published in the Nokia Store (store.ovi.com) [Nokia2013]



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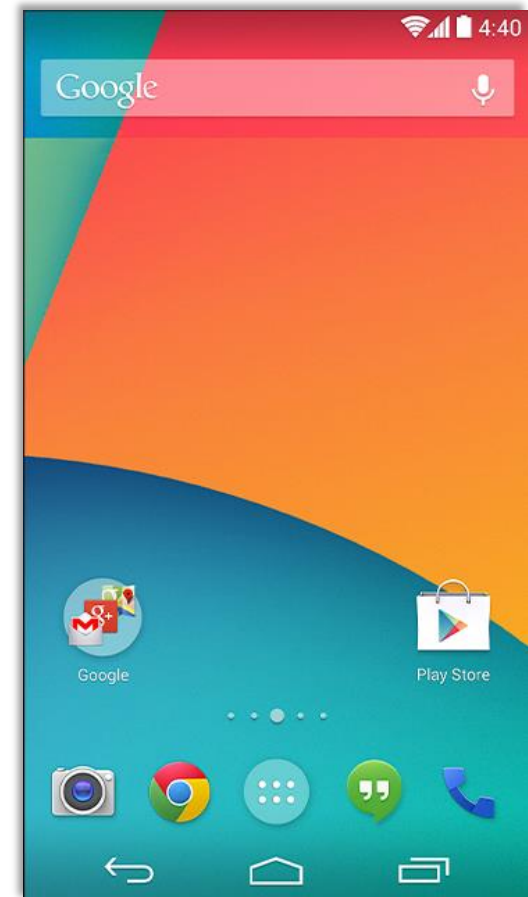




- Linux is an „*Open Source*“ operating system.
- Only a limited amount of device manufacturers were offering devices with a pre-installed Linux solution (e.g. Motorola, NEC, Panasonic).
- However, there are several Linux distributions, such as  $\mu$ CLinux, that can be installed on existing devices (e.g. iPAQ).
- Motorola, as one of the major mobile phone manufacturers, was using Linux as (one) of their OS platforms.

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- Google and other members of the **Open Handset Alliance** collaborated to develop and release Android.
- Open Handset Alliance (OHA) established in 2007
- Android based on modified version of Linux kernel
- October 2008: First commercially available phone running Android: T-Mobile G1
- November 2014: Version 5.0 Lollipop



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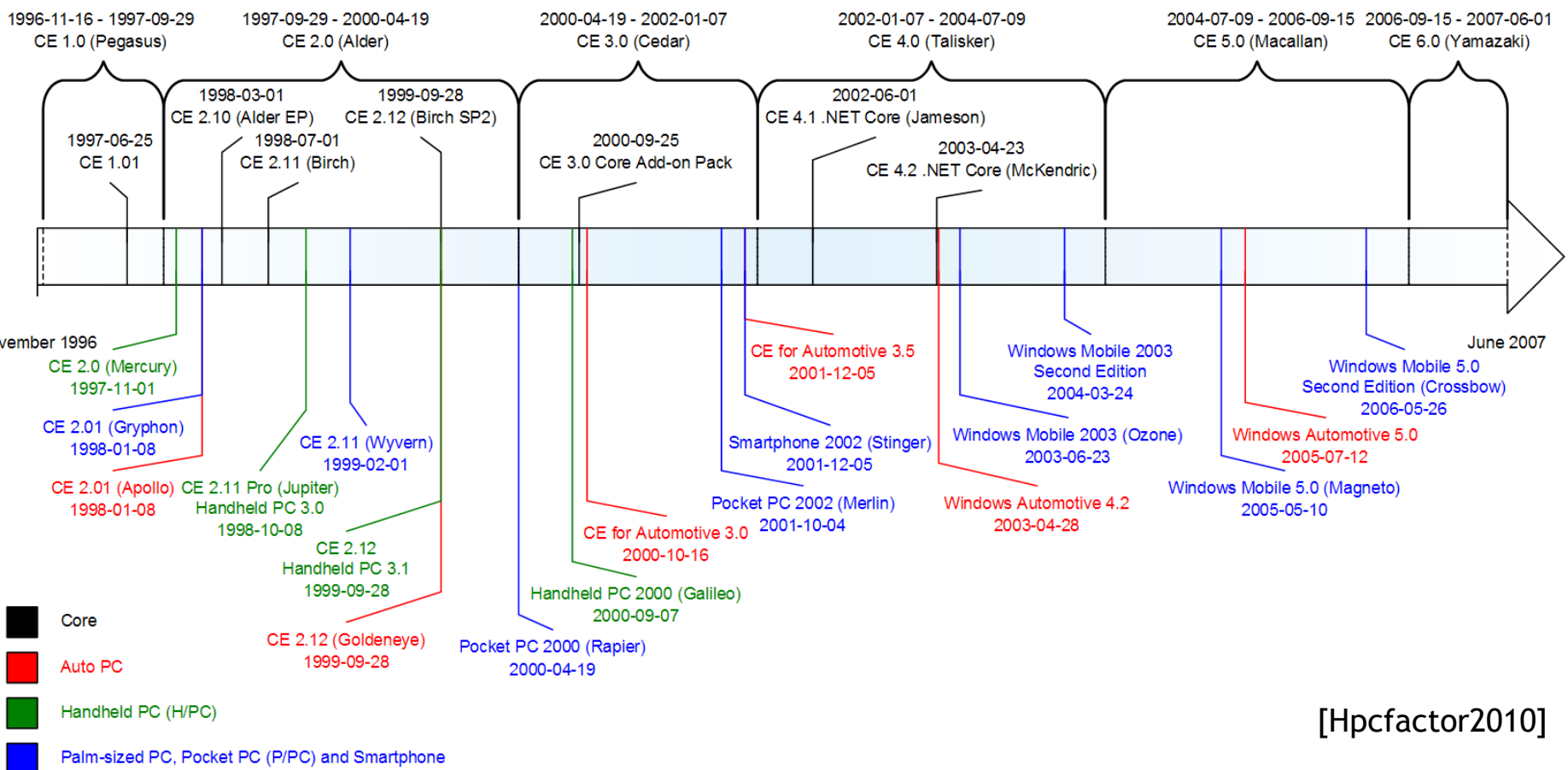


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## Windows CE Timeline

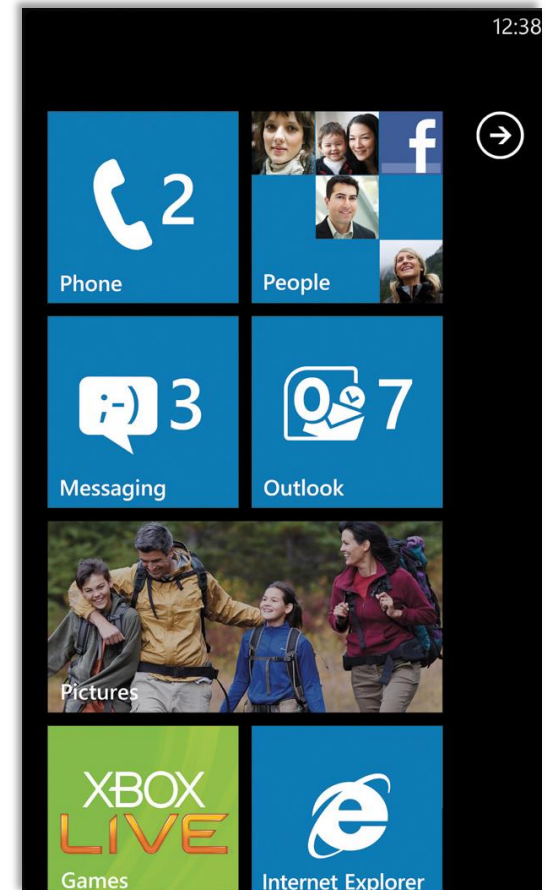
Source: "A Brief History of Windows CE" (<http://www.hpcfator.com/support/windowsce/>), HPC:Factor, retrieved May 21, 2007



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- Launched in October and November 2010
- Successor to Windows Mobile platform, but **technically a new and different platform without backward compatibility**
- Aimed at consumer market instead of enterprise market unlike Windows Mobile
- New user interface





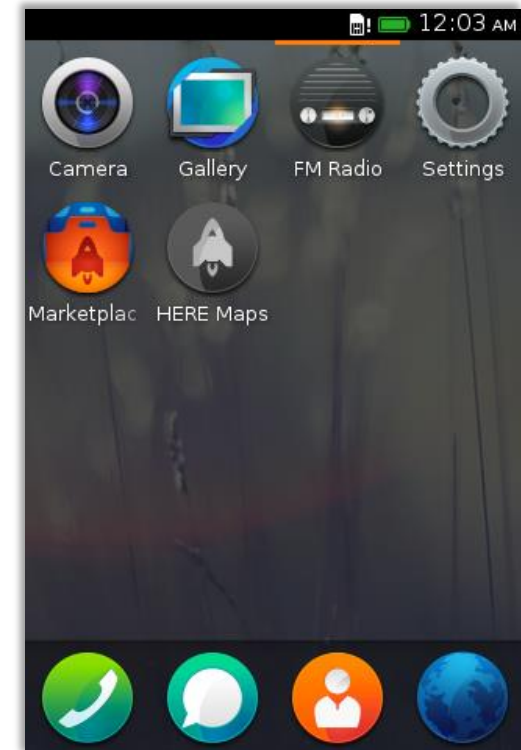
## Windows Phone

- Windows Phone 8 launched in October 2012 together with Windows 8 with similar optics
- Successor to Windows Phone 7
- Latest release: Windows Phone 8.1 in April 2014



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- Linux-based open-source mobile OS for smartphones and tablet computers
- Developed by **Mozilla**, a non-profit organization known for Firefox web browser
- Focus on open standards, e.g. HTML5 applications
- 2012 February: Firefox OS first publicly demonstrated
- 2013 July: First commercial Firefox OS based phones launched:
  - *ZTE Open* in Spain by Telefónica
  - *Alcatel One Touch Fire* in Poland by Deutsche Telekom (also sold in Germany by subsidiary *Congstar*)
  - *LG Fireweb* in Brazil by Telefónica brand *Vivo*
- **Mozilla has strong position on user privacy**
  - Upon installation of applications, a reason is stated why certain rights are necessary and need to be granted by the user.
  - User data will be analysed locally on the device, not transferred to servers, exploited or traded.
- Latest release: 1.4 in August 2014



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- Many mobile operating systems allow the execution of 3<sup>rd</sup>-party software:
  - Malware can be executed on mobile operating systems, either intentionally or by security leaks inside the mobile operating system (exploits).
- Possible threats for the user are:
  - Device malfunction
  - Loss of data (malware erasing data)
  - Loss of money (e.g. malware sending SMS to premium services )
  - Shorter battery runtime (more processing/resource usage)

## Beginnings of Mobile Malware

- **09/2000:** Liberty Horse Trojan
- **12/2000:** Telefonica SMS Mailer
- **08/2001:** Flooder sends unwanted SMS
- **09/2001:** Phage erases data on Palm devices
- **02/2003:** Nokia V-Card exploit
- **09/2004:** First Symbian OS malware
- ...

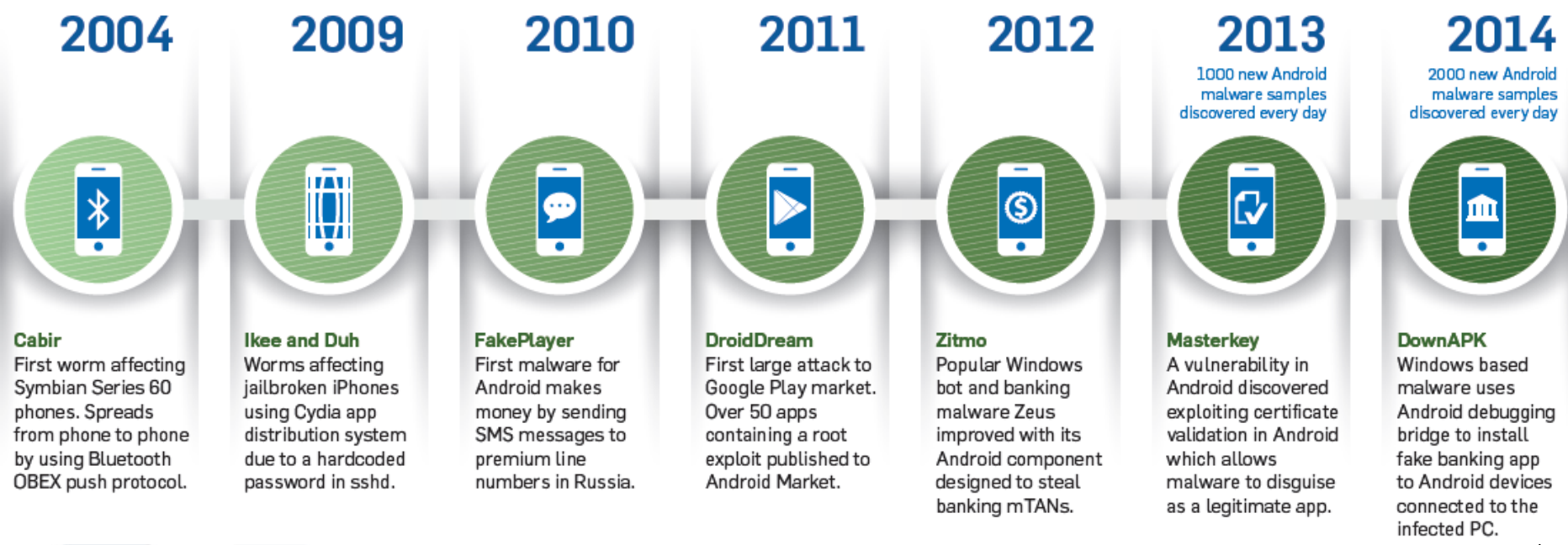
## Strong growth of Mobile Malware

- The number of malware programs masquerading as legitimate mobile apps grew by more than 600 percent in 2012
- Most popular target: Android



[ATD2013]

## 10 years of malware for mobile devices



1000 new Android malware samples discovered every day

2000 new Android malware samples discovered every day

- Memory protection
  - Processes are not able to access the memory of other processes.
- File protection
  - Encryption
  - Access control
- Access controls
  - Definition of access rights and monitoring of their enforcement.
- Support for security modules
- Secure I/O
- Code integrity management: Integrity of programs is checked before they are started by e.g.
  - Checking certificates
  - Proof Carrying Code
- Additional Security Software may be needed, e.g.
  - Virus scanners
  - Firewalls



- Every user has certain assigned access rights, e.g.
  - Reading a file
  - Writing a file
  - Accessing a peripheral device
- The OS controls that users or the processes started by a user, can only execute those actions, which they are allowed to.

<i>Object</i> <i>User</i>	<i>F1</i>	<i>F2</i>	<i>F3</i>	<i>Device's Periphery</i>
<b>U1</b>	Read		Read	
<b>U2</b>				Print
<b>U3</b>		Read	Execute	
<b>U4</b>	Read Write		Read Write	

# Security of Operating Systems

Operating System	Memory Protection	File Protection	Access Control	Support for Security Modules	Secure I/O	Code Integrity Management
Android 4.4	✓	✓	✓	(✓)	x	x
Apple iOS 8	✓	✓	✓	(✓)	x	✓
Firefox OS 1.3	✓	✓	✓	(✓)	x	✓
Blackberry OS 10	✓	✓	✓	(✓)	x	✓
Windows Phone 8.1	✓	✓	✓	(✓)	x	✓
Windows CE 6.2 Windows Mobile 6.5	✓	✓	✓	(✓)	x	✓
PocketPC 2003 Phone Edition	x	x	✓	(✓)	x	x
Symbian^3	✓	✓	✓	(✓)	x	✓
Garnet OS 5.5	✓	x	x	(✓)	x	x
Embedded Linux	✓	(✓)	✓	(✓)	x	x
J2ME	✓	x	x	(✓)	x	✓

(✓) → Feature is available, depending on the available hardware (e.g. availability of a card reader).

- [ATD2013] Juniper Study Finds Mobile Malware Grew 600 Percent, Targets Android Most, <http://allthingsd.com/20130626/juniper-study-finds-mobile-malware-grew-600-percent-targets-android-most/>, accessed 2013-11-26.
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- [Statista2014a] <http://de.statista.com/statistik/daten/studie/73662/umfrage/marktanteil-der-smartphone-betriebssysteme-nach-quartalen/>, accessed 2014-10-07.
- [Statista2014b] <http://de.statista.com/statistik/daten/studie/77324/umfrage/marktanteile-der-betriebssysteme-fuer-smartphones-in-den-usa/>, accessed 2014-10-07.
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