mobile business

Lecture 11

Market Overview of Mobile Operating Systems and Security Aspects
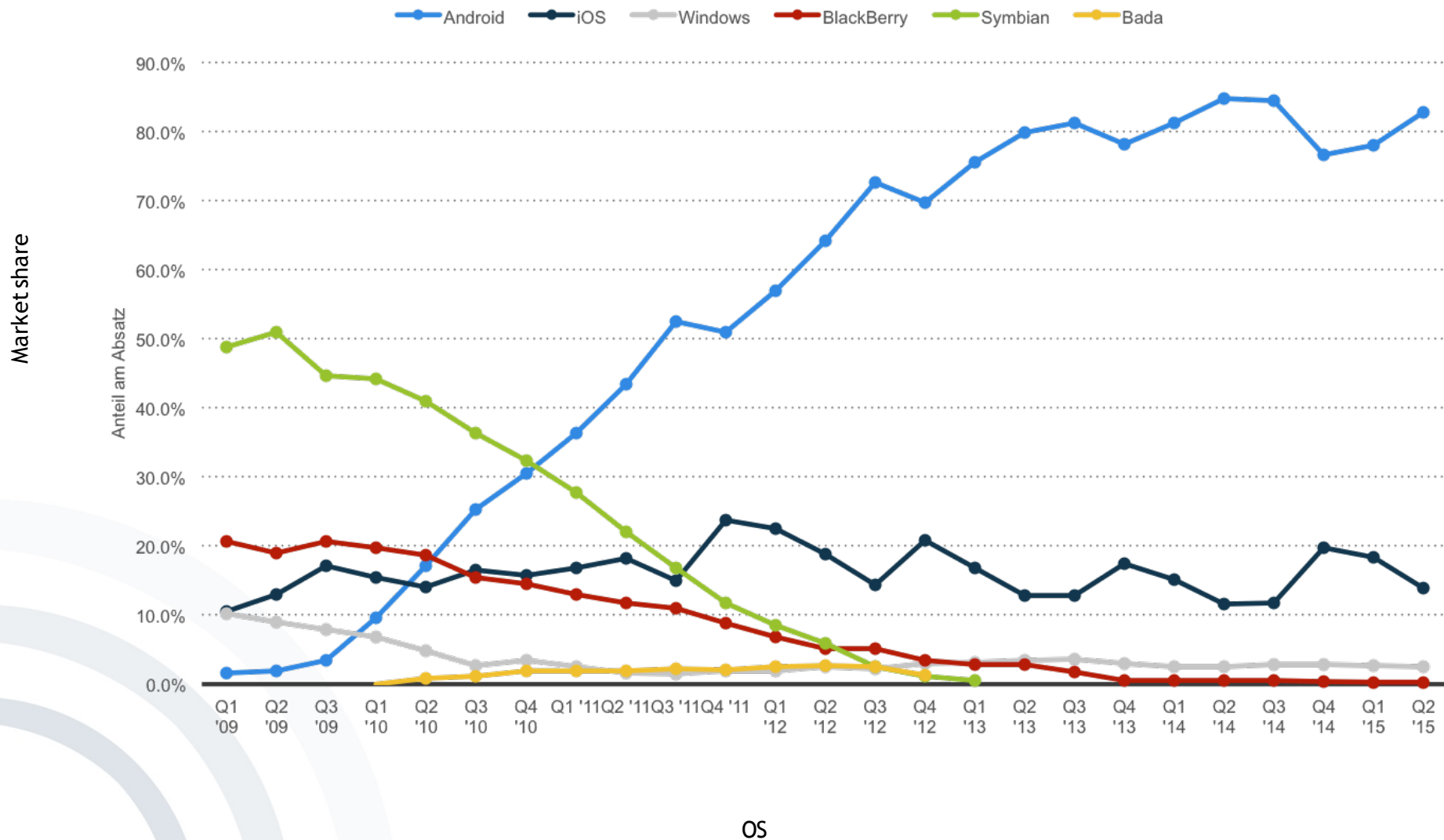
Mobile Business I (WS 2015/16)

Prof. Dr. Kai Rannenberg

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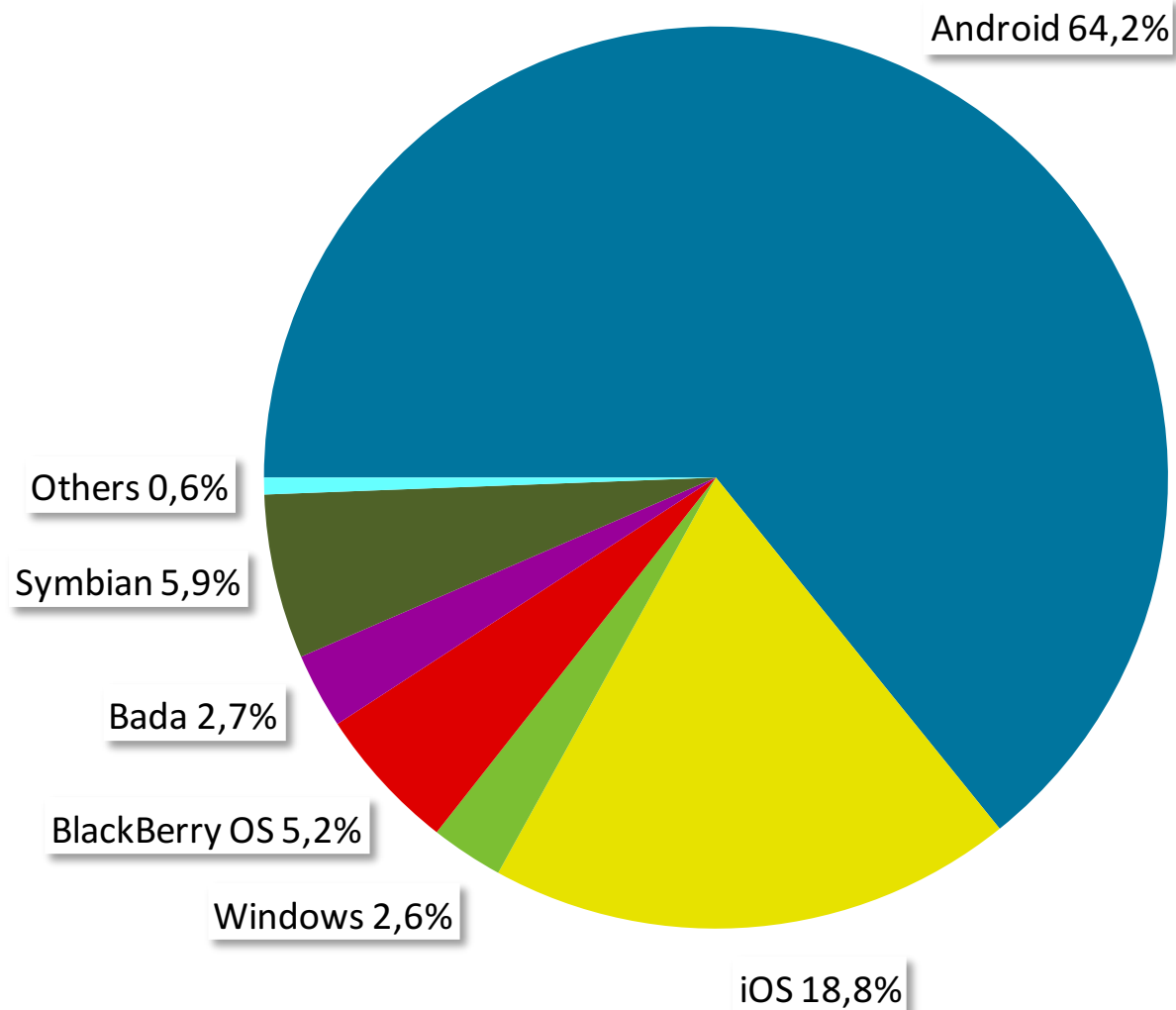Johann Wolfgang Goethe University Frankfurt a. M.

- **The Market for mobile devices and mobile OS**
- **Mobile OS unavailable to other device manufacturers**
  - Overview
  - Palm OS
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  - Firefox OS
- **Security features of selected mobile OS**

Worldwide Smartphone Sales to End Users by Operating System (2009-2015)

[Statista 2015a]

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

Android 64,2%

Others 0,6%

Symbian 5,9%

Bada 2,7%

BlackBerry OS 5,2%

Windows 2,6%

iOS 18,8%

[Gartner2013]

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

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

Android 79,0%

Others 0,2%
Symbian 0,3%
Bada 0,4%
BlackBerry OS 2,7%
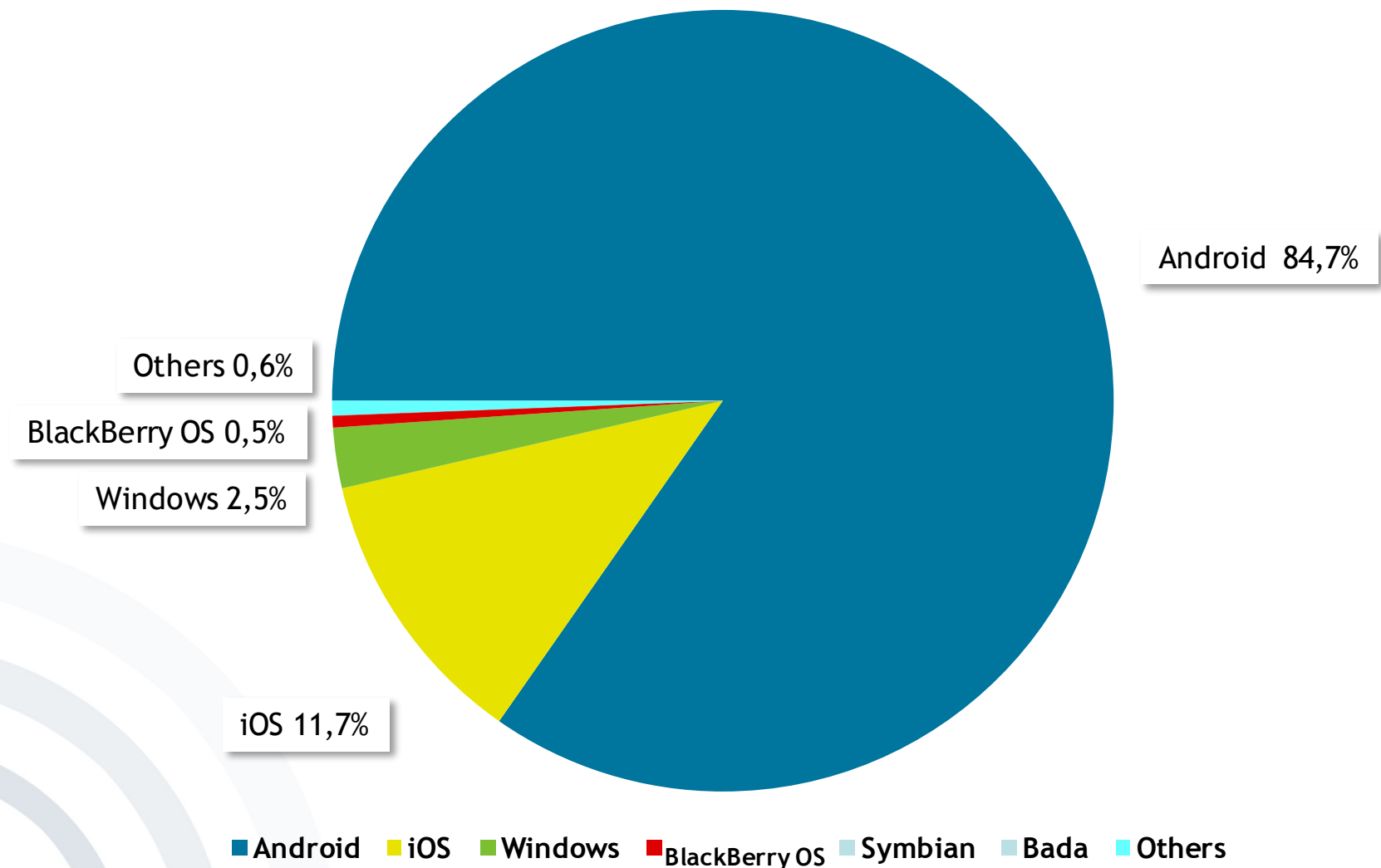Windows 3,3%
iOS 14,2%

[Gartner2013]

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

5

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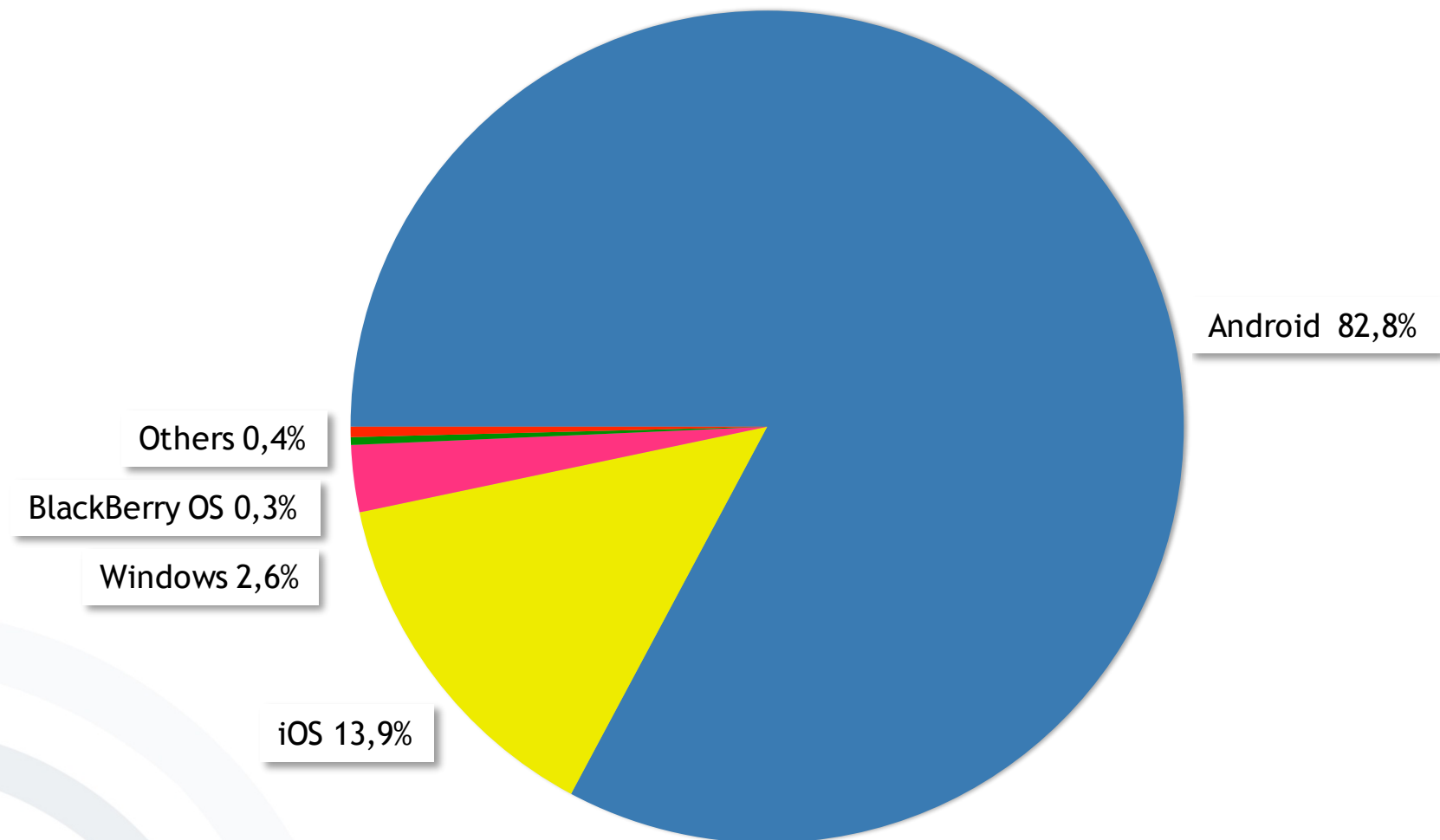
Worldwide Smartphone Sales to End Users by Operating System (Q2 2014)

Android 84,7%

Others 0,6%

BlackBerry OS 0,5%

Windows 2,5%

iOS 11,7%

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

[Statista 2014a]

Worldwide Smartphone Sales to End Users by Operating System (Q2 2015)

mobile business

Android 82,8%

Others 0,4%

BlackBerry OS 0,3%

Windows 2,6%

iOS 13,9%

[Statista 2015a]
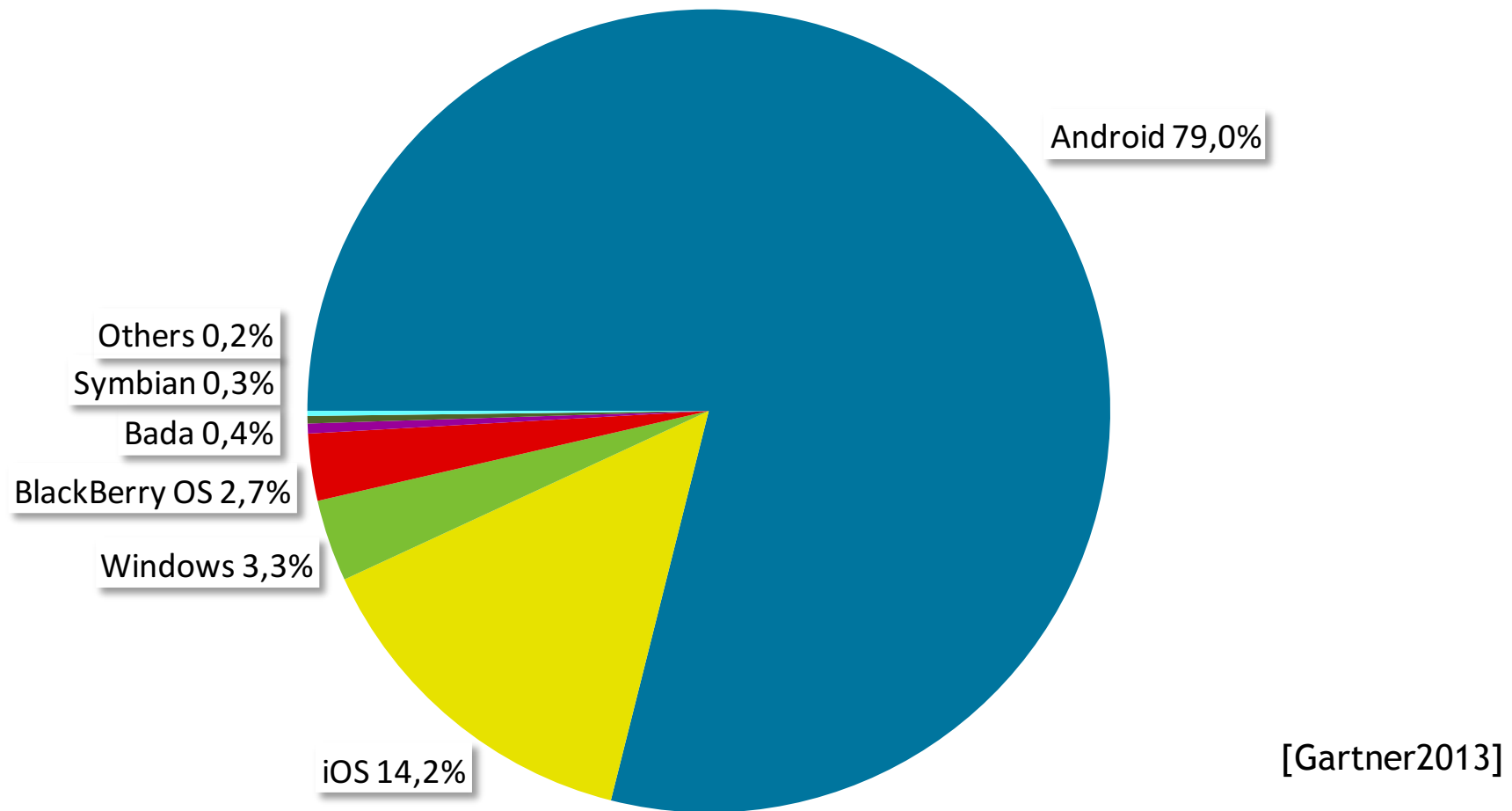
US installed smart phone base by Operating System (July 2012)

Android 51,9%

Others 5,9%

BlackBerry OS 8,0%

iOS 34,3%

"During July 2012, 51,9% of smartphone owners in the US had a device that runs on the Android operating system."

[Nielsen2012]
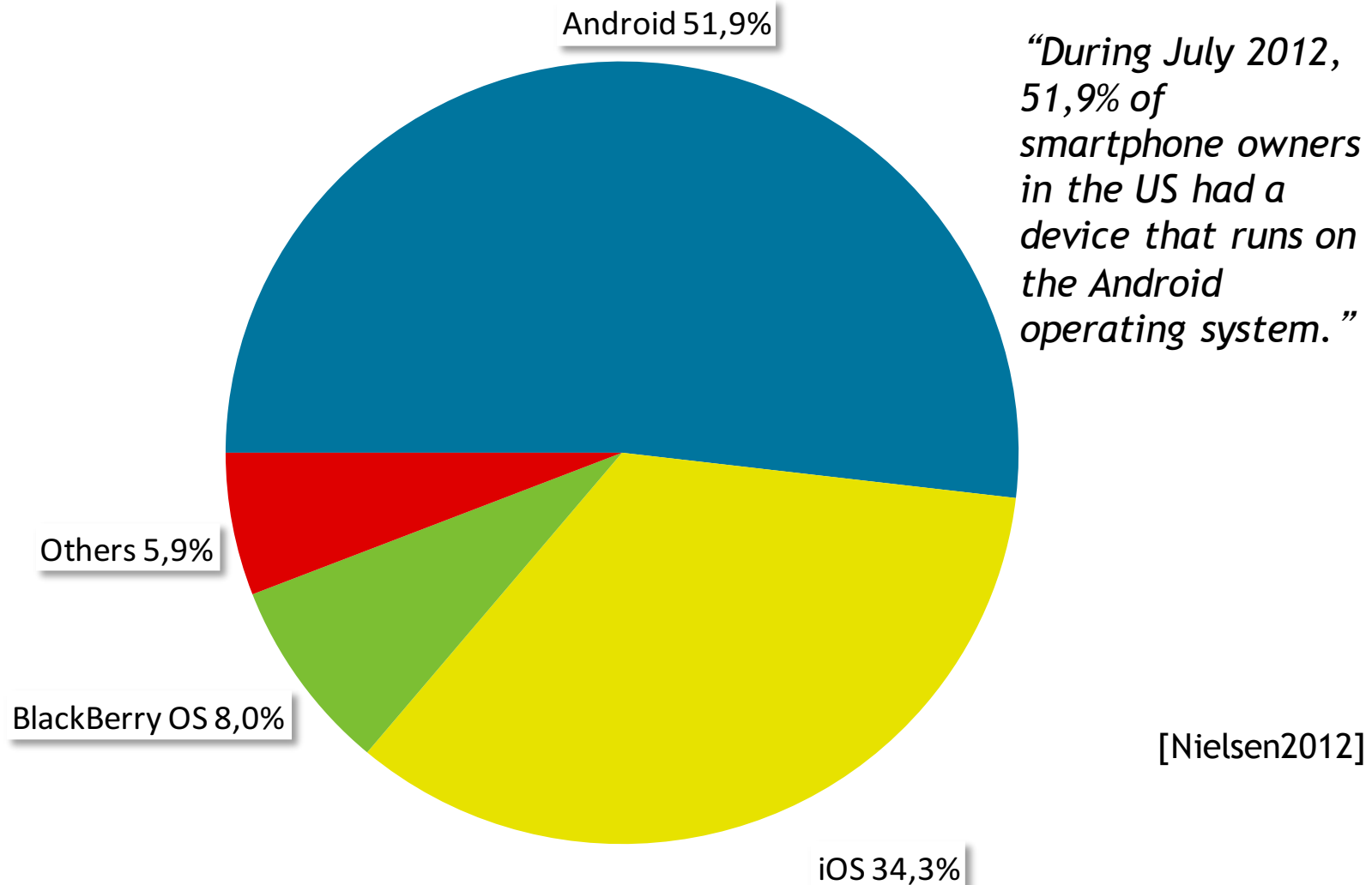
■ Android ■ iOS ■ BlackBerry OS ■ Others

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."

- Android 52,0%
- iOS 40,0%
- BlackBerry OS 3,0%
- Windows 2,0%
- Others 2,0%

[Nielsen2013]

Legend: Android | iOS | BlackBerry OS | Windows | Others
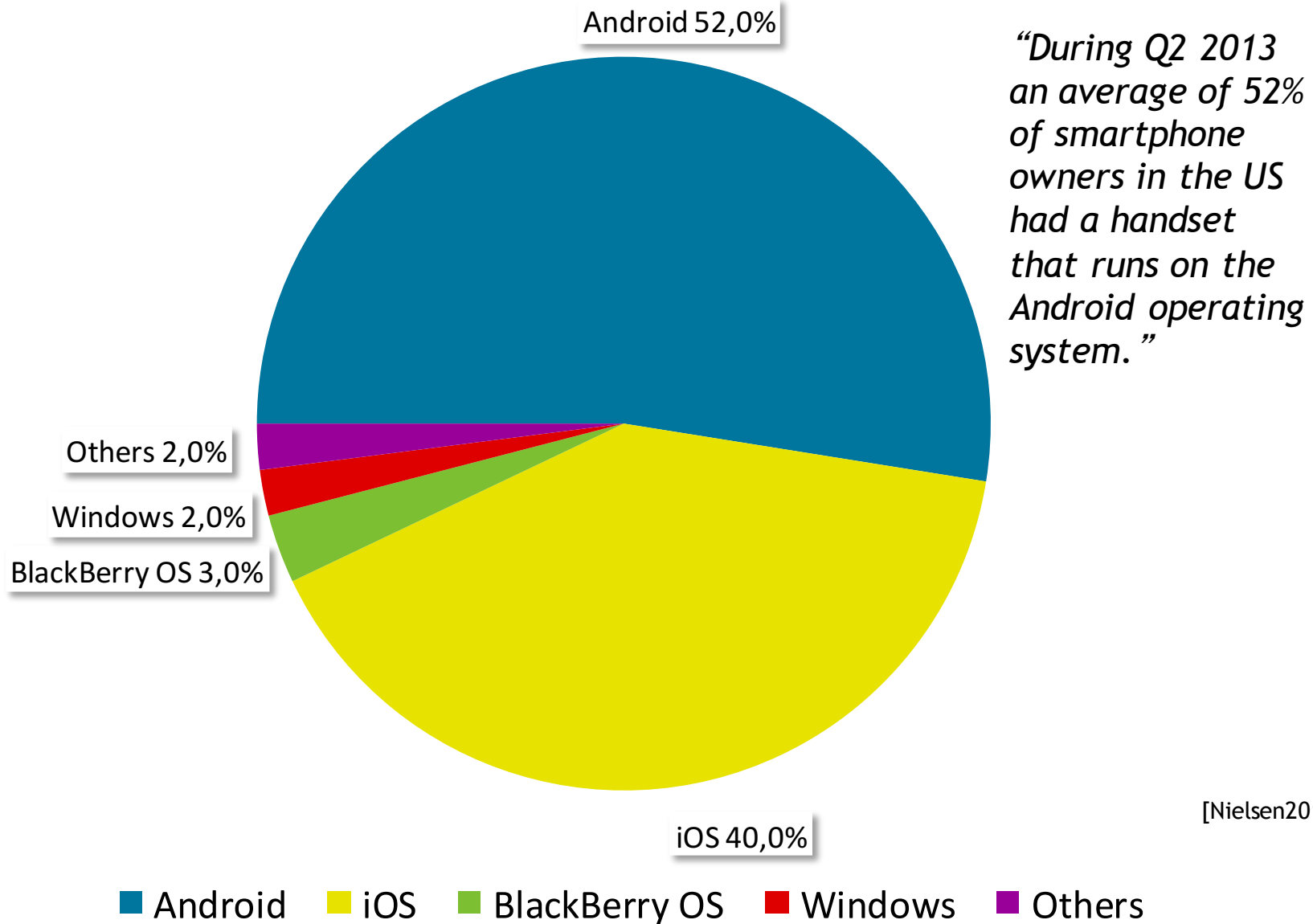
US installed smart phone base by Operating System (July 2014)

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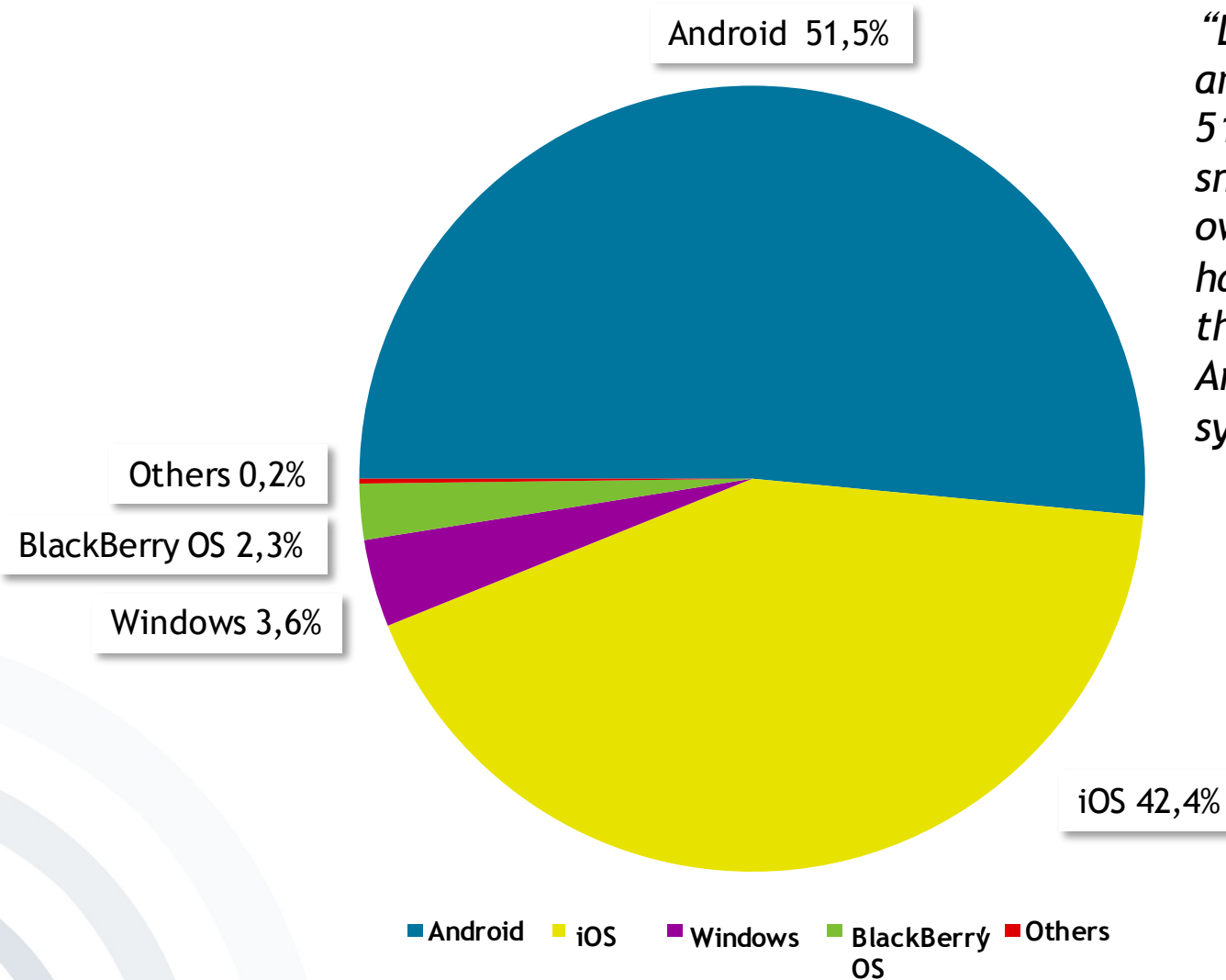
"During July 2014 an average of 51,5% of smartphone owners in the US had a handset that runs on the Android operating system."

Others 0,2%

BlackBerry OS 2,3%

Windows 3,6%

iOS 42,4%

■ Android ■ iOS ■ Windows ■ BlackBerry OS ■ Others

[Statista2014b]

10

mobile business

US installed smart phone base by Operating System (July 2015)

Android 51,4%

Others 0,2%

BlackBerry OS 1,3%

Windows 2,9%

iOS 44,2%

During July 2015 an average of 51,4% of smartphone owners in the US had a handset that runs on the Android operating system.

[Statista2015b]

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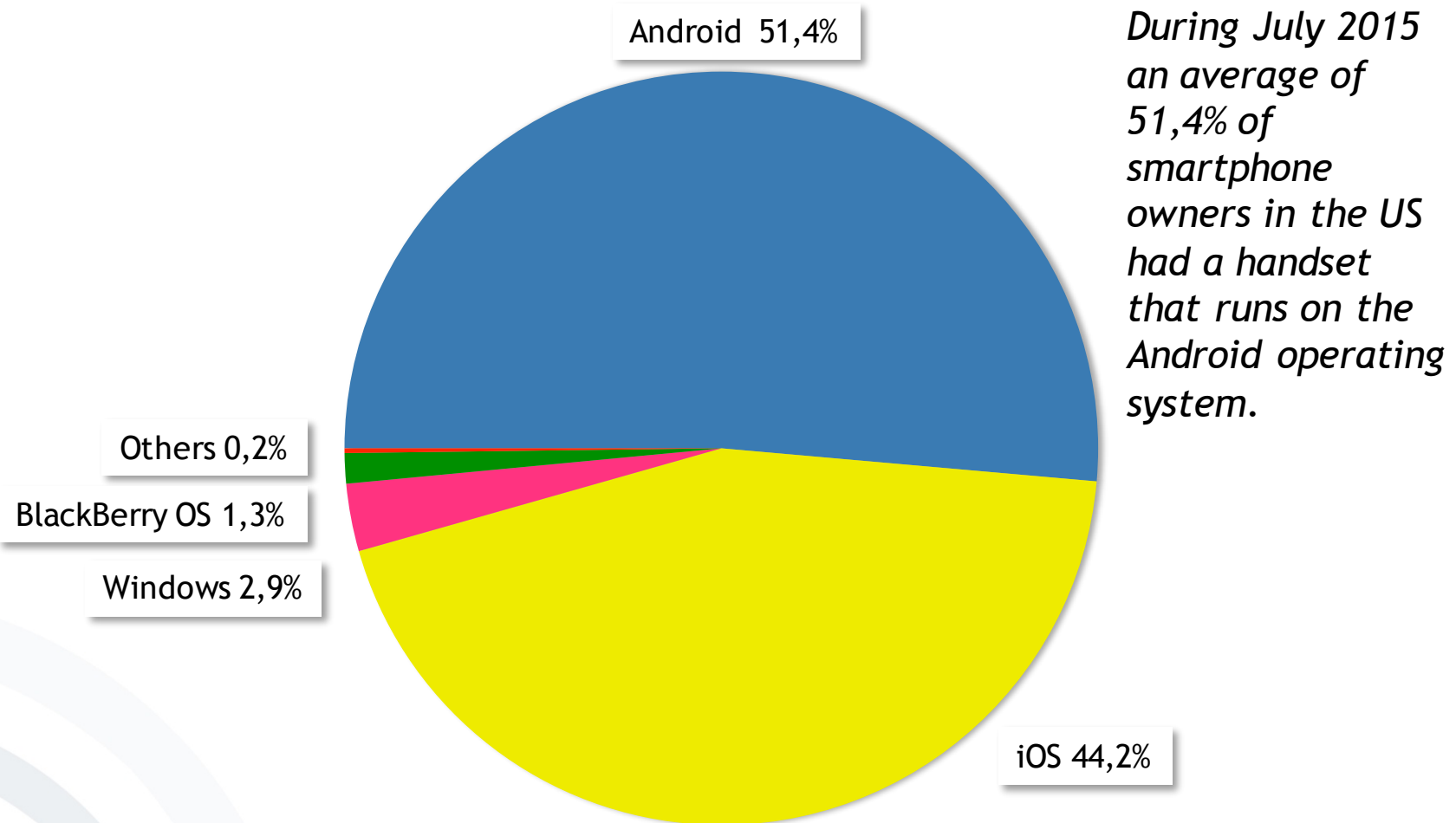
In 1.000 Units

Operating System	2Q15 Units	2Q15 Market Share (%)	2Q14 Units	2Q14 Market Share (%)	2Q13 Units	2Q13 Market Share (%)
Android	271,010	82.2	243,484	83.8	177,898.2	79.0
iOS	48,086	14.6	35,345	12.2	31,899.7	14.2
Windows	8,198	2.5	8,095	2.8	7,407.6	3.3
BlackBerry OS	1,153	0.3	2,044	0.7	6,180.0	2.7
Bada	others		others		838.2	0.4
Symbian					630.8	0.3
Others	1,229.0	0.4	1,416.8	0.5	471.7	0.2
TOTAL	329,676.4	100.0	290,384.4	100.0	225,326.2	100.0

[Gartner2015, Gartner2013]

In 1.000 Units

Company	2Q15 Units	2Q15 Market Share (%)	2Q14	2Q14 Market Share (%)	2Q13	2Q13 Market Share (%)
Samsung	72,072.5	21.9	76,129.2	26.2	71,380.9	31.7
Apple	48,085.5	14.6	35,345.3	12.2	31,899.7	14.2
Huawei	25,825.8	7.8	17,657.7	6.1	others	
Lenovo*	16,405.9	5.0	19,081.2	6.6	10,671.4	4.7
Xiaomi	16,064.9	4.9	12,540.8	4.3	99,901.2	44,3
Others	151,221.7	45.9	129,630.2	44.6		
TOTAL	329,676.4	100.0	290,384.4	100	225,326.2	100

[Gartner2013,Gartner2015]

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- 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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- Originally, most mobile phone manufacturers used their own "closed" operating systems for their mobile devices.

  - *Palm OS (Garnet OS)*
    - *Latest release: 6.0 for most devices*

  - Apple *iOS* (Unix-based)
    - Latest release: iOS 9

  - *BlackBerry OS*
    - Latest release: BlackBerry OS 10.3.1

  - *LuneOS* (formerly WebOS, initially developed by Palm, later HP)
    - Latest release: LuneOS Café de Olla
   - Not to be confused with Palm OS (now: Garnet OS) that was also initially developed by Palm

  - *Samsung bada*
    - Latest release: v2.0, e.g. on Samsung Wave 3 S8600

- *Advantage:* Tend to be not as much affected by malware than "open" operating systems

- *Disadvantage*: Less flexible, as 3rd-party software cannot be easily installed and executed

- Later, more and more platforms switched to more open and interoperable operating systems (e.g. Windows CE, Symbian OS, Android).

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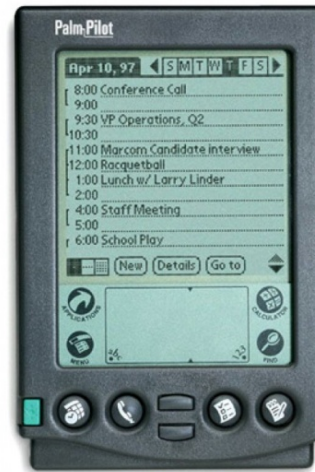
All screens are simulated.

- ## 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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- Developed by Apple for iPhone, iPod Touch, iPad and Apple TV

- Latest release: iOS 9

- 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
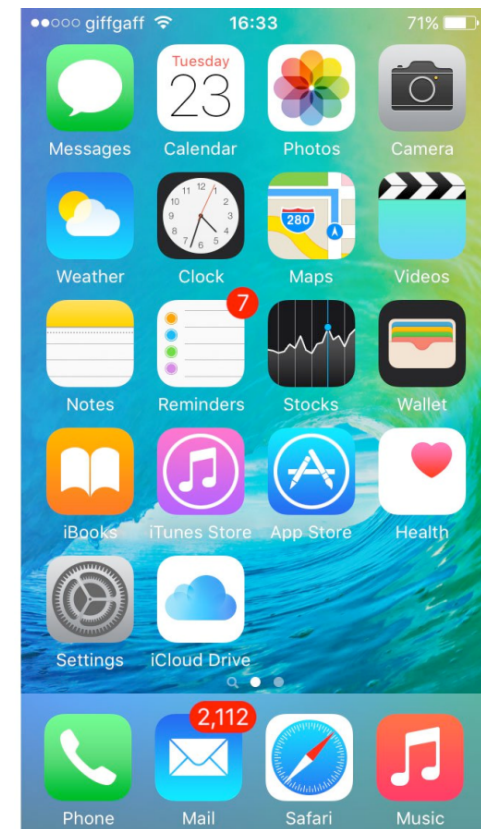
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- Linux: LiMo (Linux Mobile), Openmoko Linux, Qt Extended (Qtopia)
- Symbian platform
  - Latest release: "Nokia Belle Feature Pack 2" for Symbian^3 devices
- Android (by Open Handset Alliance)
  - Latest release: 6.0 (Marshmallow)
- Windows Mobile
  - 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 v1.1.2.16 (February 2015)
- 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]

= Linux-based

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mobile business

SIEMENS

MOTOROLA

lenovo

Arima

FUJITSU

LG Electronics Inc.

symbian OS

Sony Ericsson

Panasonic

BenQ

MITSUBISHI ELECTRIC

SAMSUNG

NOKIA

SHARP.

In 2006, Symbian was owned by ◯

[Symbian2006]

- 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 3rd-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

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mobile business

- 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]

- 2015 January: Nokia Store discontinued and partially transferred to Opera Mobile Store.
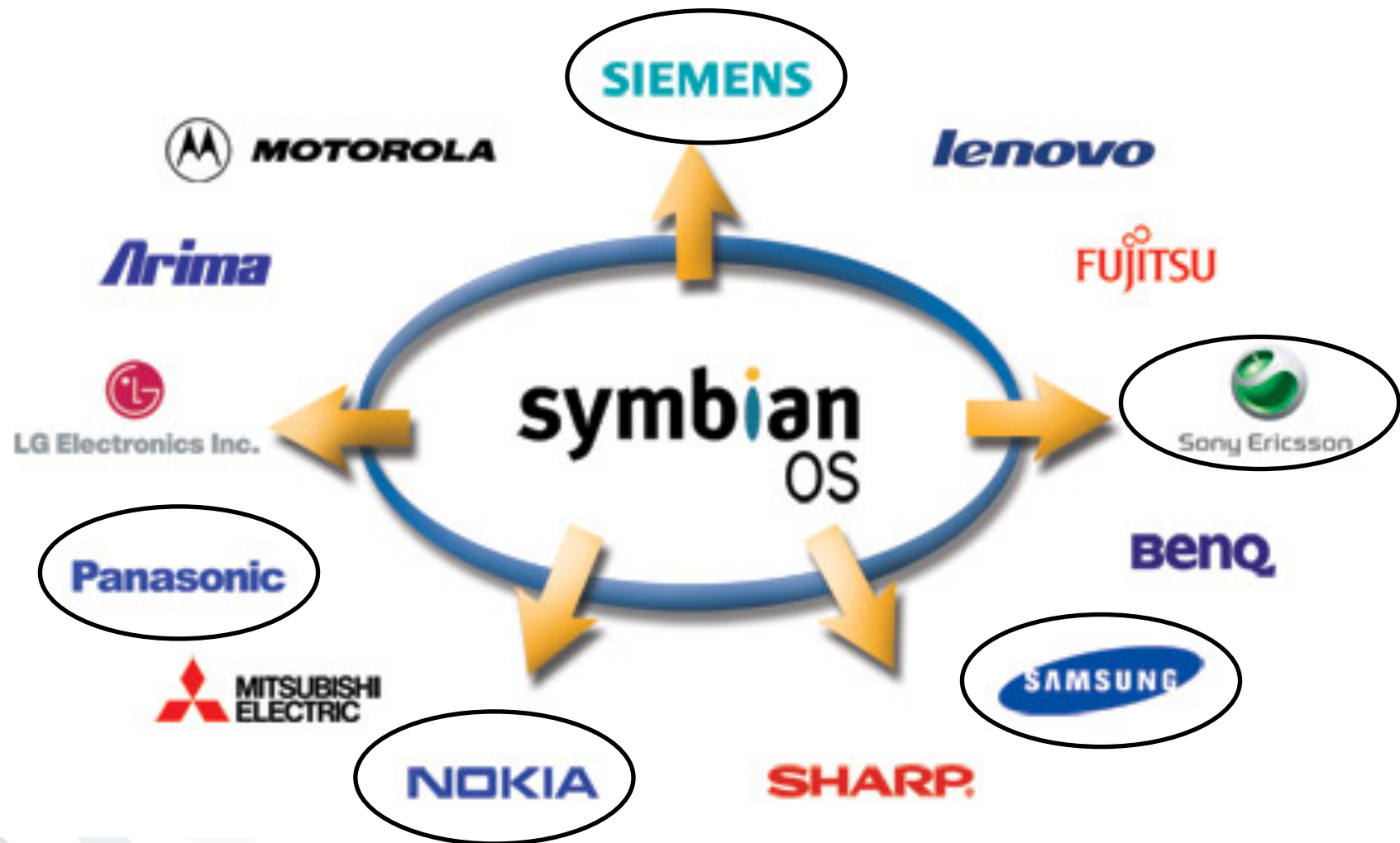
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business

- 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 µCLinux, 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** collabora-ted 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

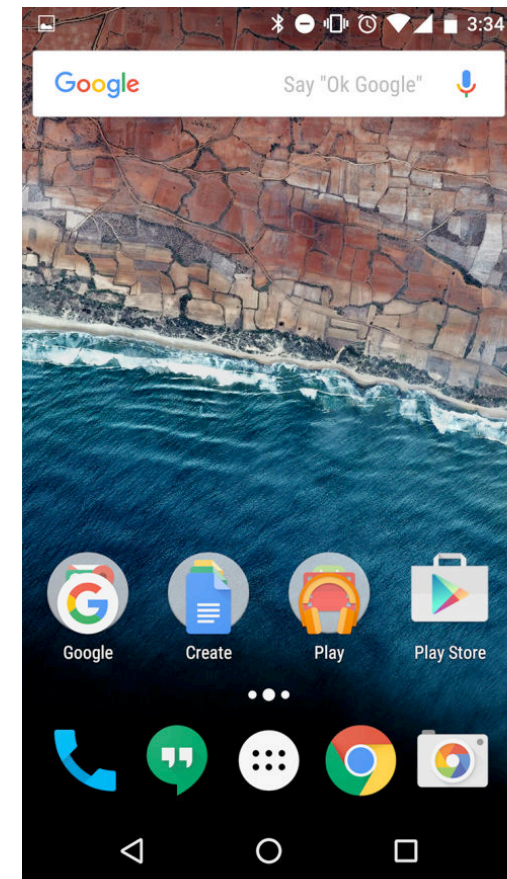- September 2015: Version 6.0 Marshmallow

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Windows CE Timeline

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

1996-11-16 - 1997-09-29
CE 1.0 (Pegasus)

1997-06-25
CE 1.01

1997-09-29 - 2000-04-19
CE 2.0 (Alder)

1998-03-01
CE 2.10 (Alder EP)

1998-07-01
CE 2.11 (Birch)

1999-09-28
CE 2.12 (Birch SP2)

2000-04-19 - 2002-01-07
CE 3.0 (Cedar)

2000-09-25
CE 3.0 Core Add-on Pack

2002-01-07 - 2004-07-09
CE 4.0 (Talisker)

2002-06-01
CE 4.1 .NET Core (Jameson)

2003-04-23
CE 4.2 .NET Core (McKendric)

2004-07-09 - 2006-09-15
CE 5.0 (Macallan)

2006-09-15 - 2007-06-01
CE 6.0 (Yamazaki)

November 1996

June 2007

CE 2.0 (Mercury)
1997-11-01

CE 2.01 (Gryphon)
1998-01-08

CE 2.01 (Apollo)
1998-01-08

CE 2.11 Pro (Jupiter)
Handheld PC 3.0
1998-10-08

CE 2.11 (Wyvern)
1999-02-01

CE 2.12
Handheld PC 3.1
1999-09-28

CE 2.12 (Goldeneye)
1999-09-28

Pocket PC 2000 (Rapier)
2000-04-19

Handheld PC 2000 (Galileo)
2000-09-07

CE for Automotive 3.0
2000-10-16

CE for Automotive 3.5
2001-12-05

Smartphone 2002 (Stinger)
2001-12-05

Pocket PC 2002 (Merlin)
2001-10-04

Windows Mobile 2003
Second Edition
2004-03-24

Windows Mobile 2003 (Ozone)
2003-06-23

Windows Automotive 4.2
2003-04-28

Windows Mobile 5.0
Second Edition (Crossbow)
2006-05-26

Windows Automotive 5.0
2005-07-12

Windows Mobile 5.0 (Magneto)
2005-05-10

Legend:
- Core
- Auto PC
- Handheld PC (H/PC)
- Palm-sized PC, Pocket PC (P/PC) and Smartphone
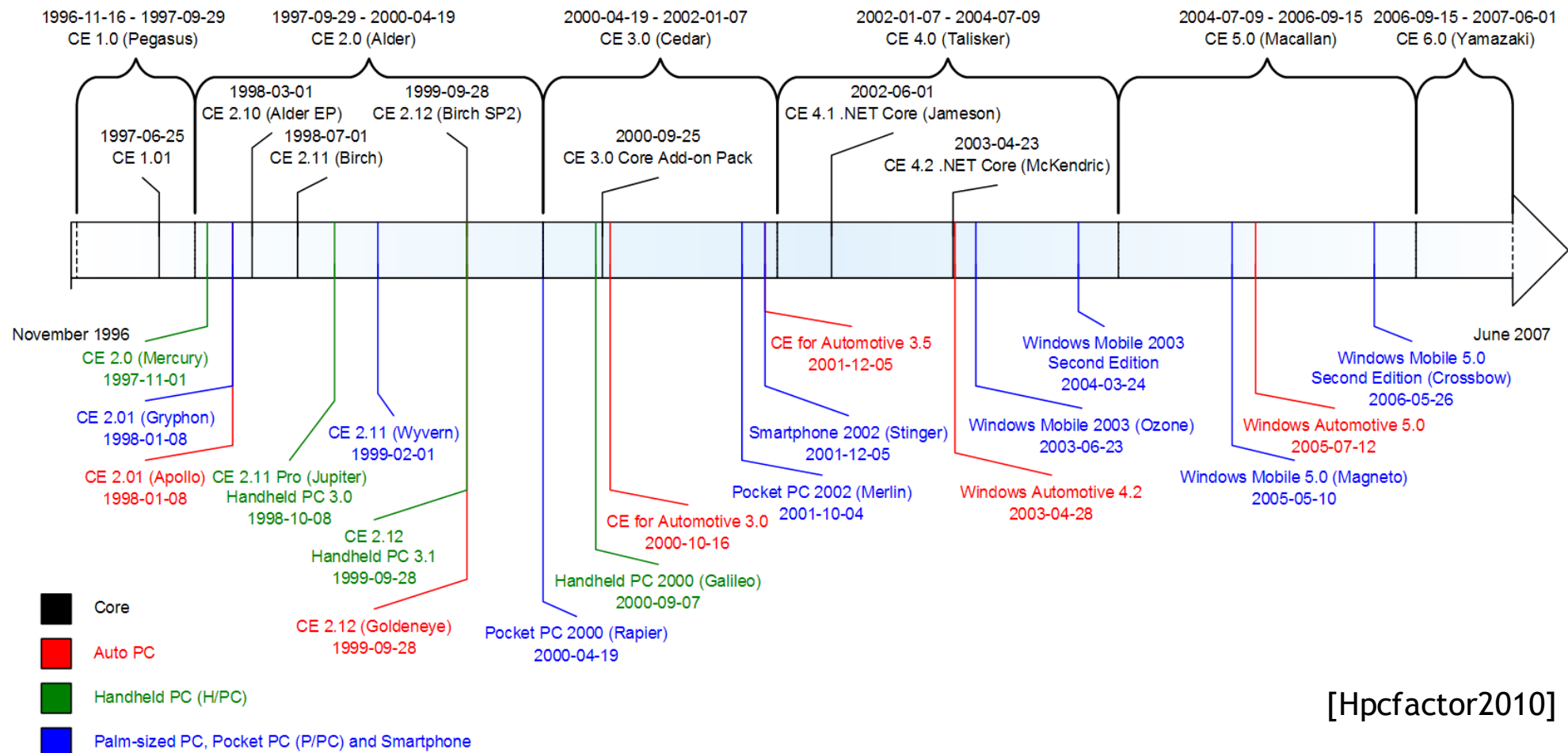
[Hpcfactor2010]

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Windows Phone

- 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 8

- Latest release: Windows Phone 8.1 in April 2014

- Windows 10 Mobile Insider Preview available in July 2015.

- November 2015: Supported phones include HTC One (M8) and 36 Lumia models.

- The full version is expected in December 2015.

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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:
  - Consumers: v1.4 (September 2014) with Symphony GoFox F15
  - Developers: v2.5 (September 2015)
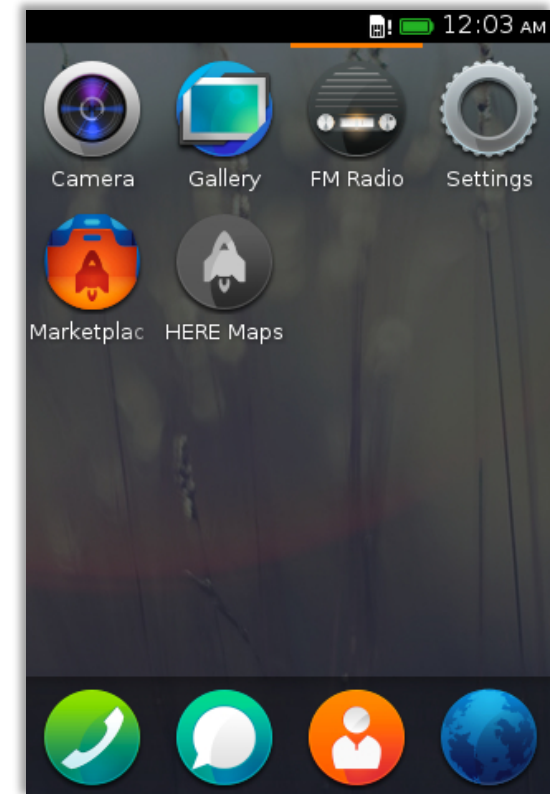
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- Many mobile operating systems allow the execution of 3rd-party software:

  ➢ 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
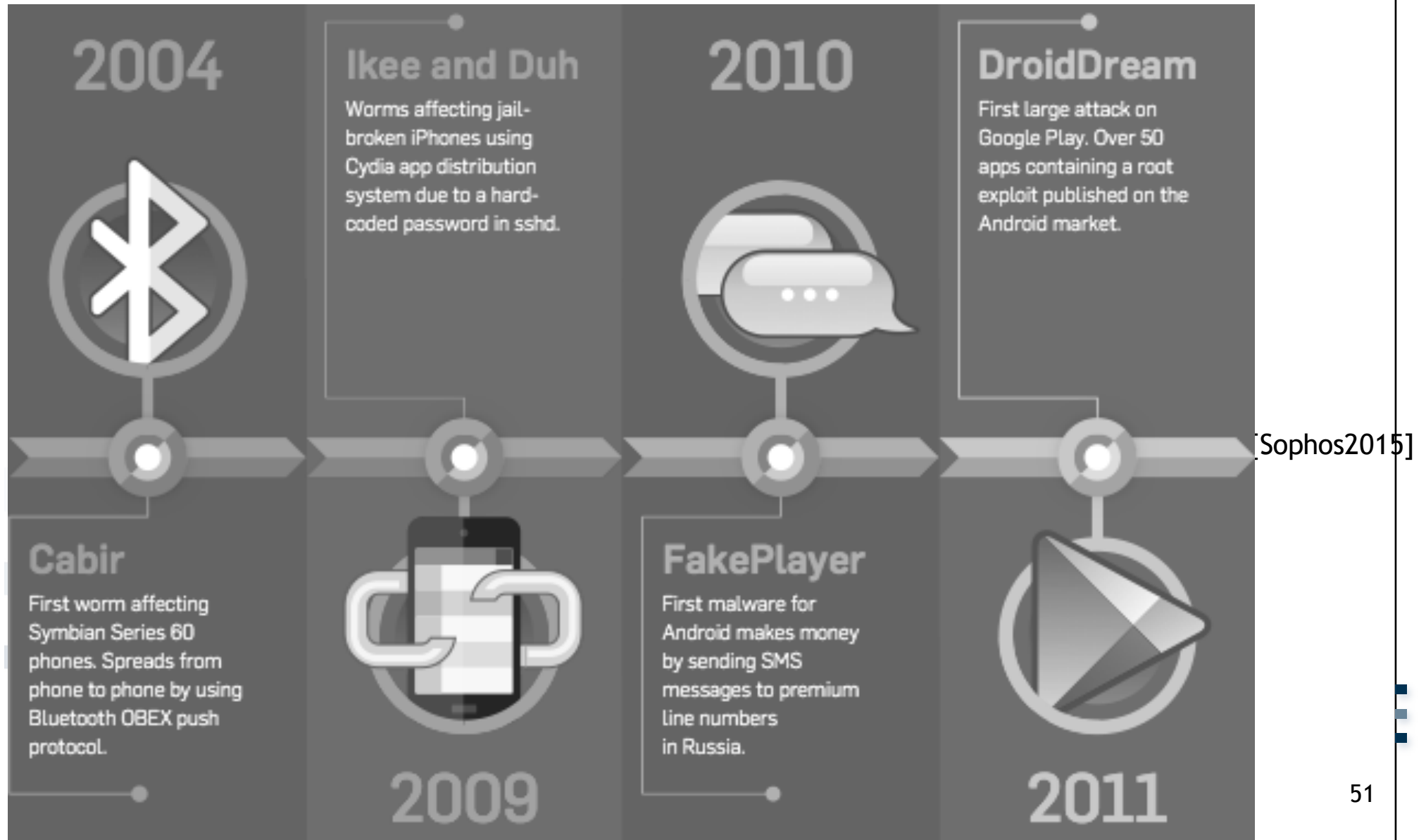- *09/2004*: First Symbian OS malware
- …

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]

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Malware Goes Mobile: Timeline of Mobile Threats, 2004 – 2015

2004

Ikee and Duh
Worms affecting jail-broken iPhones using Cydia app distribution system due to a hard-coded password in sshd.

2010

DroidDream
First large attack on Google Play. Over 50 apps containing a root exploit published on the Android market.

2012

Masterkey
A vulnerability in Android exploiting certificate validation, allowing malware to disguise itself as a legitimate app.

1000 new Android malware samples discovered every day.

2014

Gazon
Android virus spams all your contacts via SMS with a link to install a phony Amazon rewards app.

2 million cumulative samples of Android malware and potentially unwanted apps.

Cabir
First worm affecting Symbian Series 60 phones. Spreads from phone to phone by using Bluetooth OBEX push protocol.

2009

FakePlayer
First malware for Android makes money by sending SMS messages to premium line numbers in Russia.

2011

Zitmo
Popular Windows bot and banking malware Zeus improved with its Android component designed to steal mobile transaction authentication numbers (mTANs).

2013

DownAPK
Windows based malware uses Android debugging bridge to install fake banking app to Android devices connected to the infected PC.

2000 new Android malware samples discovered every day.

2015

[Sophos2015]

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2010

FakePlayer

First malware for Android makes money by sending SMS messages to premium line numbers in Russia.

DroidDream

First large attack on Google Play. Over 50 apps containing a root exploit published on the Android market.

2011

[Sophos2015]

[Sophos2015]

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- 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 the 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.

Object\User	F1	F2	F3	Device's Periphery
U1	Read		Read	
U2				Print
U3		Read	Execute	
U4	Read Write		Read Write	

Security measures	Apple iOS	Google Android	BlackBerry	Windows Phone
▶ Access-control options	PIN, passcode, fingerprint	PIN, passcode, swipe, FaceLock	PIN, smartcard	PIN, passcode
▶ MDM-configurable PIN/passcode policy	Yes	Yes	Yes	Yes
▶ Full-device encryption	iPhone 3GS+ every iPad	Selected tablets (Android 3+) Selected phones (Android 4+)	All BlackBerry phones	Windows Mobile 6.5 Windows Phone 8
▶ SD card encryption	No SD cards	OEM proprietary	Yes	No
▶ Remote wipe	Removes encryption keys	Resets to factory defaults	Removes encryption keys Optionally scrubs memory	Varies by OEM/OS version

[SM14]

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