

## Part 1

# Evolution of the mobile graphics world

# Mobile evolution (1/3)



DynaTAC 8000X  
Motorola

**1980s**

Talk time of 30 minutes and 10 hours to re-charge.



S1  
Siemens

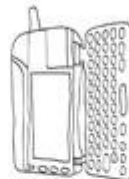
**1990s**

Bigger screens and smaller smarter phones.



StarTAC  
Motorola

The first clamshell and with vibrate function.



GS 88 "Penelope"  
Ericsson

The term "smart-phone" was first pronounced in 1997.



S10  
Siemens

First colour screen phone, displaying red, green, blue and white.



5110  
Nokia

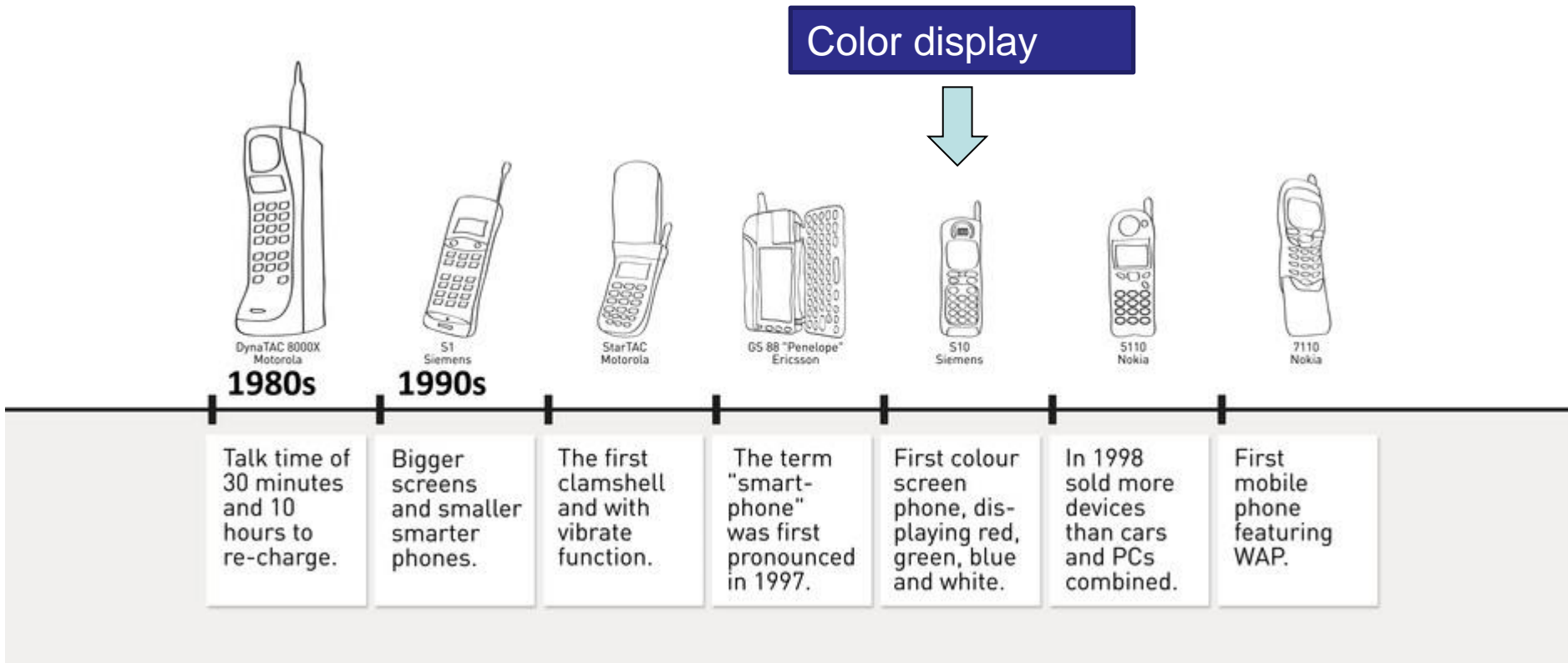
In 1998 sold more devices than cars and PCs combined.



7110  
Nokia

First mobile phone featuring WAP.

# Mobile evolution (1/3)



# Mobile evolution (2/3)



3210  
Nokia



J-SH04  
Sharp



7280  
Nokia



5310  
Nokia



N95  
Nokia



iPhone 1  
Apple

2000s

The first mobile phone with T9 Predictive text.

The first cellphone to feature an internal camera.

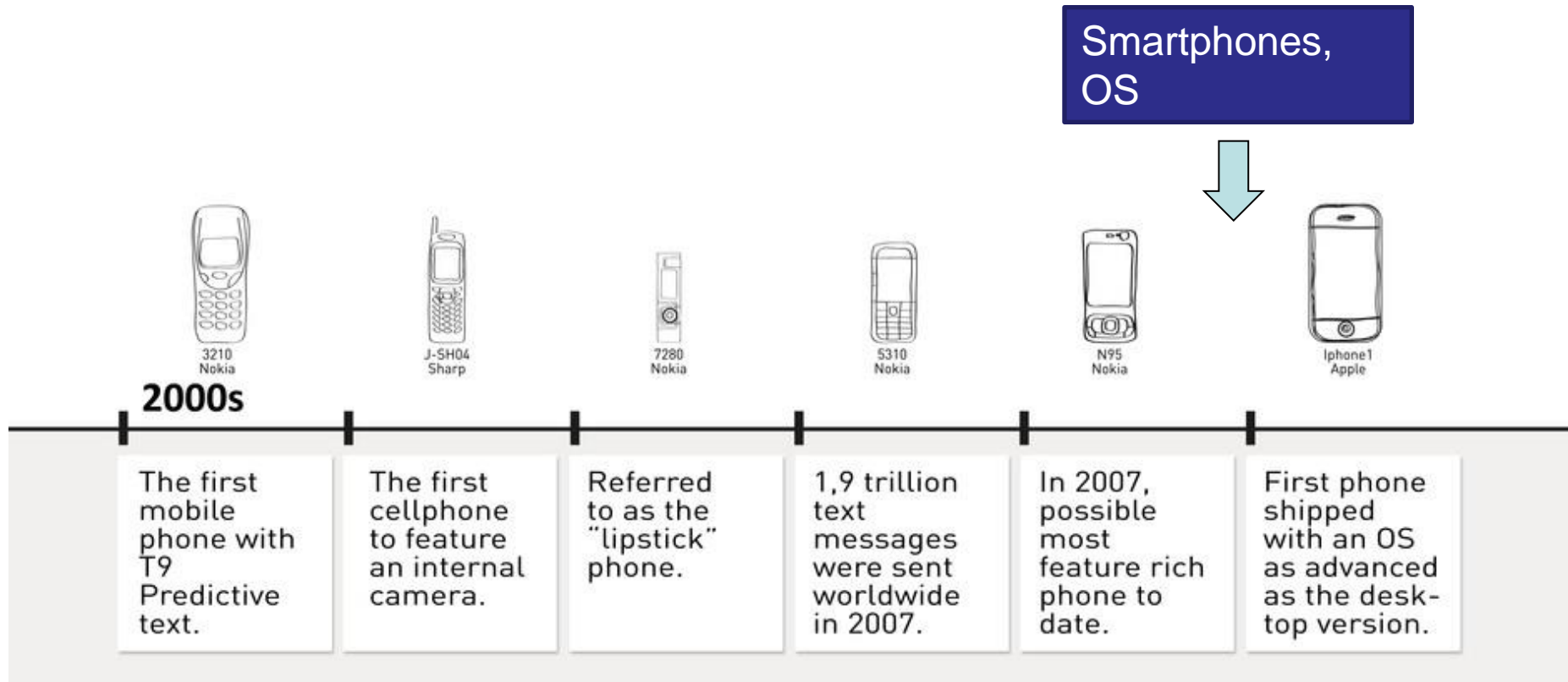
Referred to as the "lipstick" phone.

1,9 trillion text messages were sent worldwide in 2007.

In 2007, possible most feature rich phone to date.

First phone shipped with an OS as advanced as the desktop version.

# Mobile evolution (2/3)



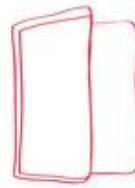
# Mobile evolution (3/3)



Galaxy  
Samsung



Xperia Z  
Sony



YOUM  
Samsung



**2010s**

Samsung developed a phone with "Smart Stay" and "Smart Alert" and S Voice.

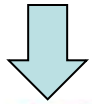
In 2013 Sony announced the world's first waterproof phone.

In January 2013 Samsung launched their flexible OLED displays, calling them YOUM.

It is predicted that the smartphone or tablet of the future will be as flexible as paper.

# Mobile evolution (3/3)

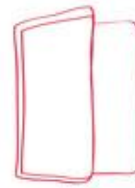
High resolution  
displays



Galaxy  
Samsung



Xperia Z  
Sony



YOUM  
Samsung



2010s

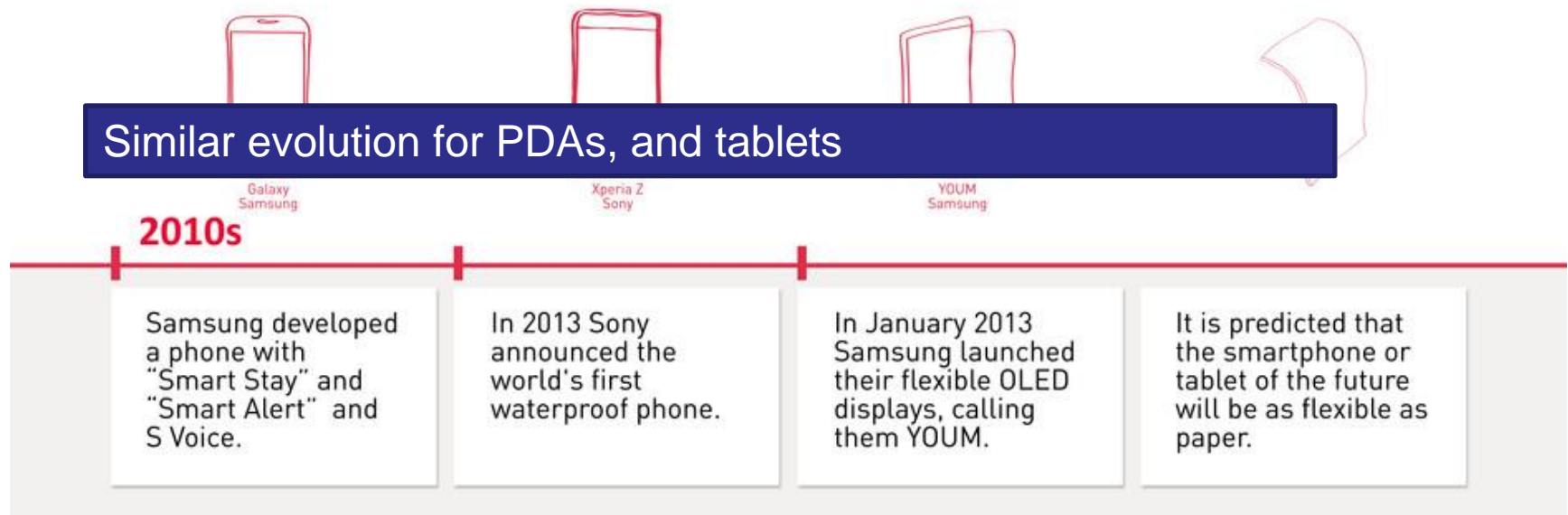
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# Mobile evolution (3/3)





# Mobile evolution.... in movies

Money never  
sleeps.....This is your  
wake-up call, pal...  
**GO TO WORK**



- **Motorola DynaTac**

- Nickname “brick phone”
- Weight: over 2 pounds
- Cost: thousands of dollars
- Battery life: around 35 minutes.

**Wall Street, 1987**  
Michael Douglas in  
Gordon Gekko

# Mobile evolution... in movies

**Hello Neo...  
Do you know who  
this is?**

- **Nokia 8110**

- Nickname “banana phone”
- 145g, display monochrome, Smart SMS
- It costed 1000 eur



**The Matrix, 1999**  
Laurence Fishburne in  
Morpheus

# Mobile evolution... in movies



- **Sony Xperia T**
  - Smartphone Android
  - Display 4.6" 1280x720
  - It costed 600 eur
  - 13 Mpixel camera + position sensors



**Skyfall, 2012**  
Daniel Craig in James  
Bond

# Mobile evolution... in movies



- **Future devices?**
  - Transparent and foldable high resolution screens
  - Gesture interfaces
  - Wearable / integrated to body

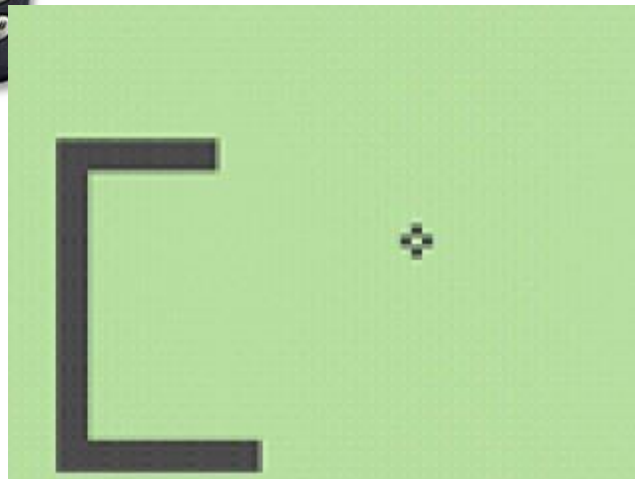
**Iron Man 3, 2013**  
Robert Downey Jr in  
Tony Stark

# Mobile evolution... in games

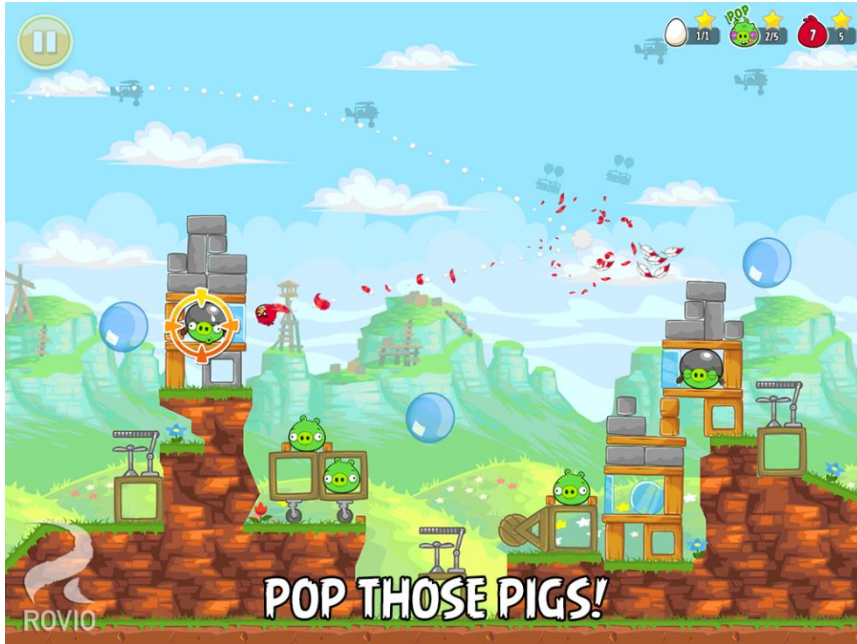


- **Nokia Snakes**

- From 1997 an estimated 350 Mdevices, making it one of the most widely distributed games ever created.
- Installed on Nokia devices until 2007



# Mobile evolution... in games



- **Angry Birds (Rovio)**

- first released for Apple's iOS in December 2009
- 2 billion downloads across all platforms
- widespread diffusion and popularity
- Adventure parks (Finland and Malaysia)



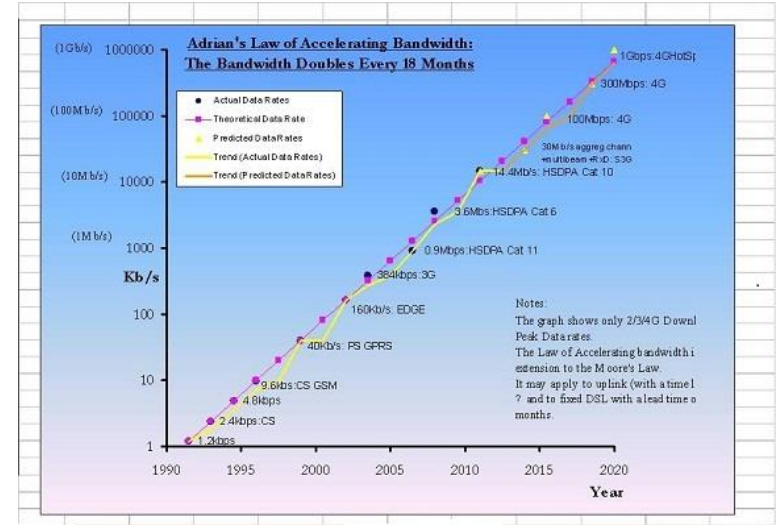
# Mobile evolution... in games

- **Unreal Engine (GDC & Google I/O 2014)**
  - running on an [Nvidia](#) Tegra K1 processor
  - will support Google Tango and Samsung Gear VR
  - easy porting of games
  - sophisticated 3d effects



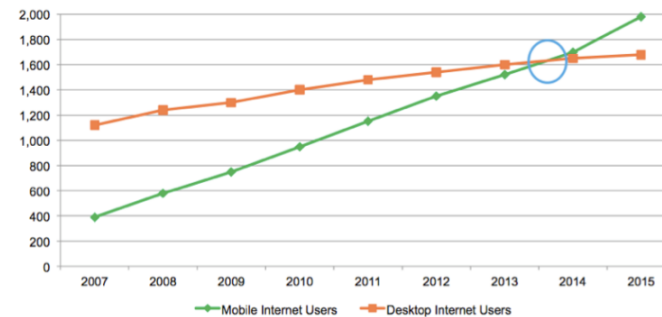
# Mobile connectivity evolution

- Bandwidth is doubling every 18 months
- Mobile internet users overcame desktop internet users
- 2017 smartphone traffic expected at 2.7 GB per person per month

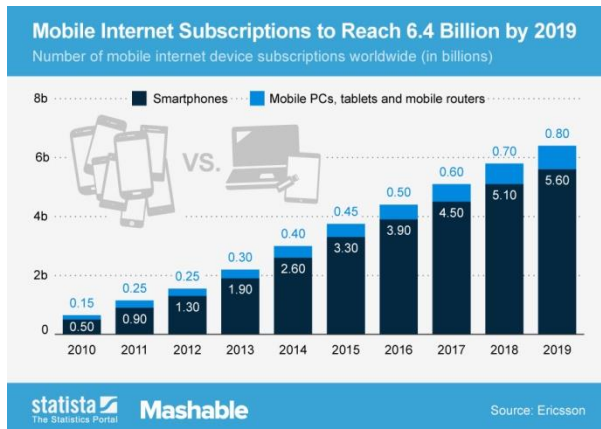


## Mobile Web Usage Growing

Forward Projection: Mobile Web Browsing vs. Desktop Web Browsing (2007-2015)



Source: Mary Meeker, Morgan Stanley, "Internet Trends," April 12, 2010





# Displays and User Interface

- **Before 2007 – old days**
  - PDA → Palm OS/ Windows Pocket / Windows CE
  - Stylus interaction (touch screens at early stages)
- **Touch era**
  - 2007 – iOS /iPhone
  - 2008 – Android / HTC Dream or G1
  - Touch-enabled devices (no stylus required)
- **Nowadays**
  - Wearables → <2”
  - Smartphones → 3-6”
  - Tablets → >7-10”
  - DLP projectors integrated

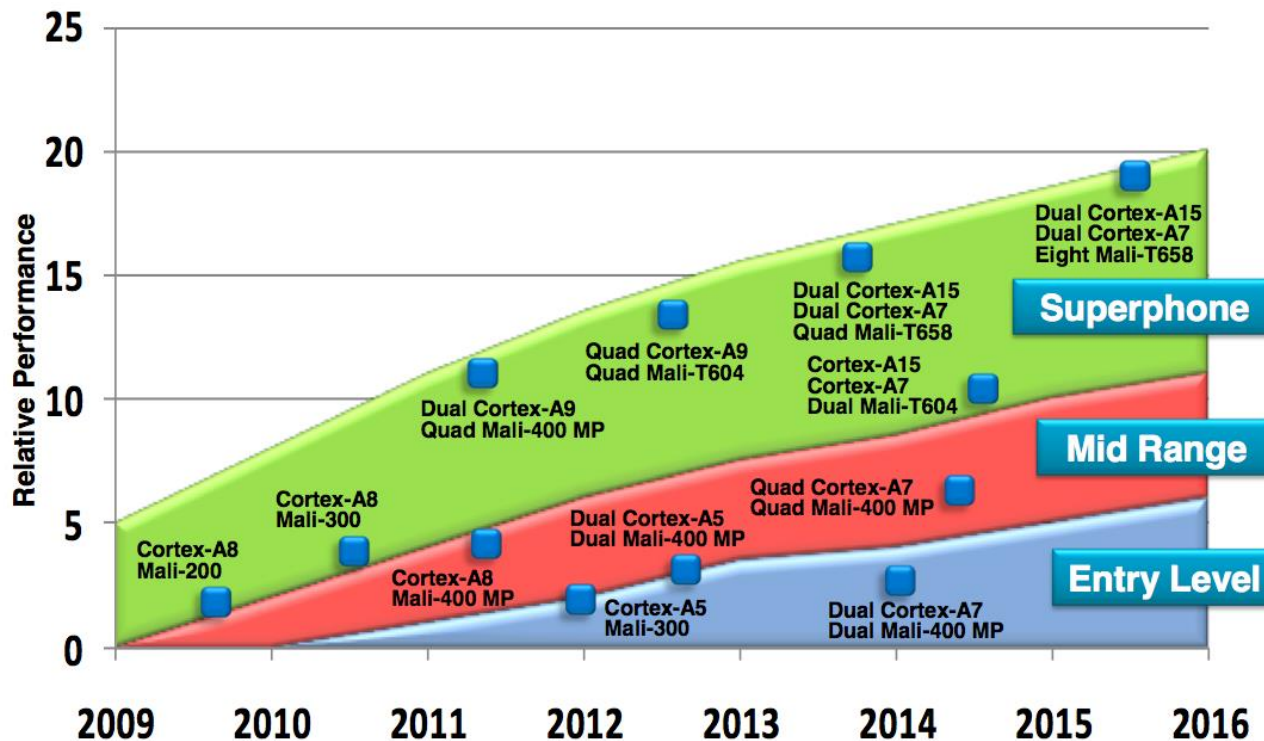


# Display characteristics

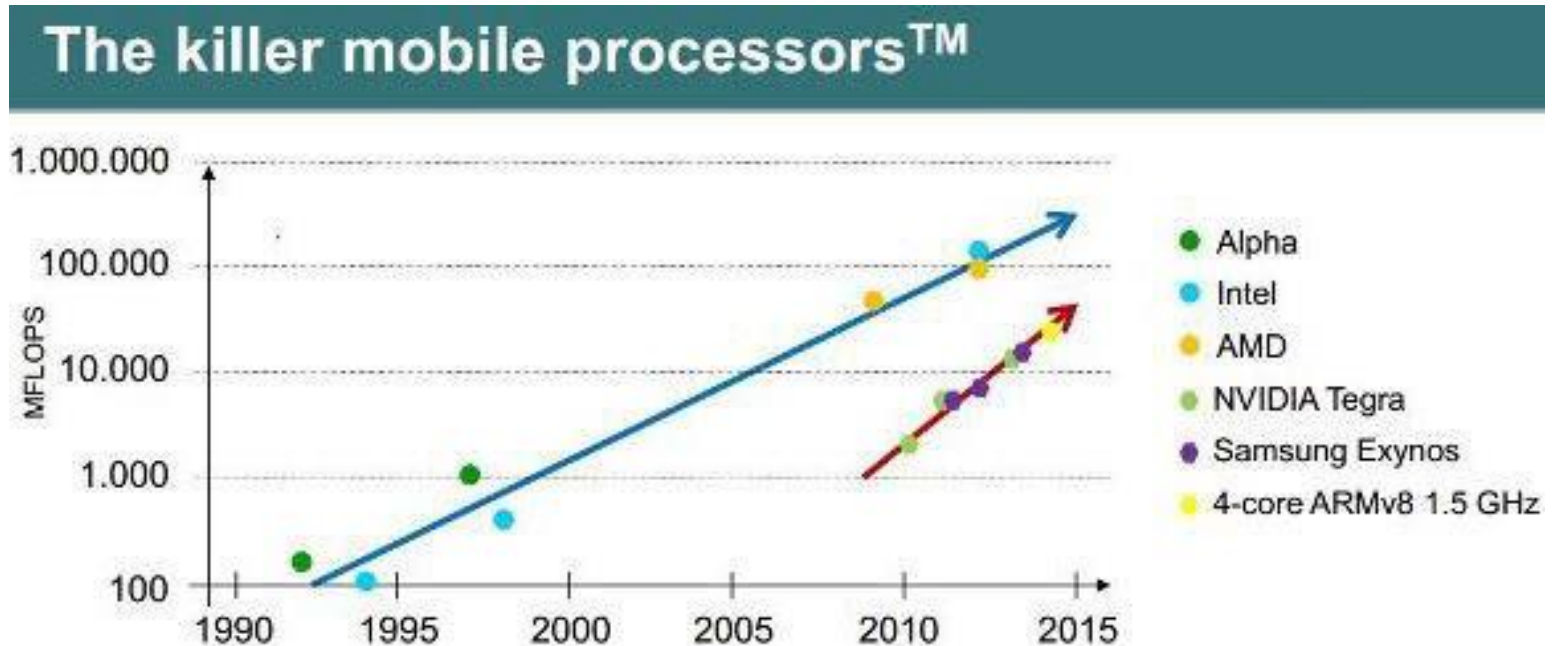
	Application	100 PPI	150 PPI	200 PPI	250 PPI	300 PPI	400 PPI	500 ppi	
20 cm	Smart Phone	3.5" 400 × 234 (132 PPI)	3.5" 480 × 320 (164 PPI)	→		3.5" 800 × 480 (266 PPI)	3.5" 960 × 640 (326 PPI)	3.5"/3.7" 1280 × 800 (400+ PPI)	5.1"/5.5" 2560x1440 (>500 PPI)
30 cm	Tablet PC	7" 800 × 480 (133 PPI)	7" 1024 × 600 (169 PPI)	→		7" 1280 × 800 1366 × 768 (215 PPI)			
		9.7" 1024 × 768 (132 PPI)	→		9.7" 1600 × 1200 (206 PPI)	9.7" 2048 × 1536 (264 PPI)			
		10.1" 1024 × 600 (118 PPI)	10.1" 1280 × 800 1366 × 768 (150 PPI)	10.1" 1920 × 1080 1920 × 1200 (210 PPI)	→		10.1" 2560 × 1600 (300 PPI)	10.1" 3840x2160 (438 PPI)	
40 cm	Mini-Note	10.1" 1024 × 600 (118 PPI)							
50 cm	Notebook PC	15.6" 1366 × 768 14.0" 1366 × 768 (110 PPI)							
60 cm	LCD MNT	21.5" 1920 × 1080 (100 PPI)							

# Chip evolution (1/2)

## Scalable Mobile Processor Evolution



# Chip evolution (2/2)

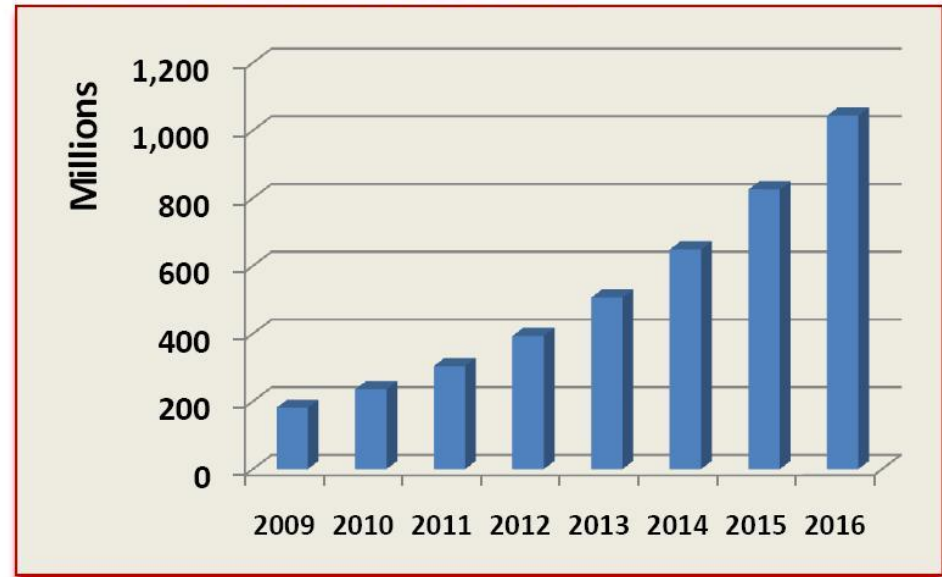


- Microprocessors killed the Vector supercomputers
  - They were not faster ...
  - ... but they were significantly cheaper and greener
- History may be about to repeat itself ...
  - Mobile processor are not faster ...
  - ... but they are significantly cheaper

# Scenario

- **Modern smartphones (tablets) are compact visual computing powerhouses**
- **DIFFUSION: more than 4.6 billion mobile phone subscriptions**
  - [Ellison 2010]
- **NETWORKING: High speed internet connection (typical 1GB/month plan)**
  - 3G - < 0.6-3Mbps ~ 100KB/s - 400KB/s (latency ~ 100-125ms)
  - 4G – < 3-10Mbps ~ 400KB/s - 1MB/s (latency ~ 60-70ms)
  - 5G - 1Gbps (from 2016?)
- **MEMORY: Increasing RAM and storage space**
  - RAM 1-3GB
  - Storage 8-64GB
- **COMPUTING: Increasing processing power**
  - CPU 4-8 core @ 2.5Ghz
  - GPU 72-192 cores (~ALUs)

Global Smartphone Sales, 2009-2016



Source: Telecom Trends International, Inc.

# Scenario

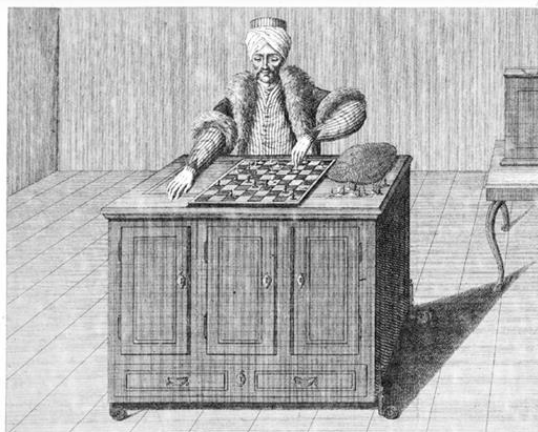
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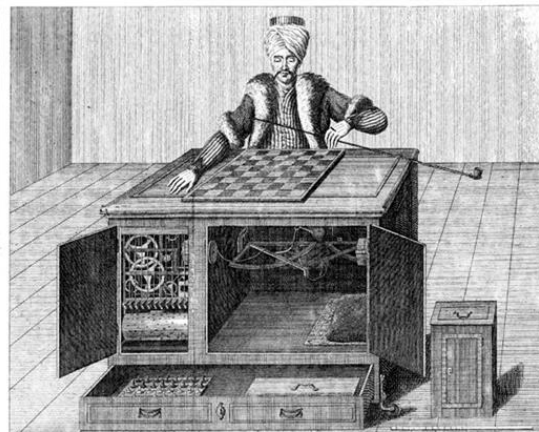
<http://unity3d.com/es/unity/multiplatform/mobile>

# Where are we going?

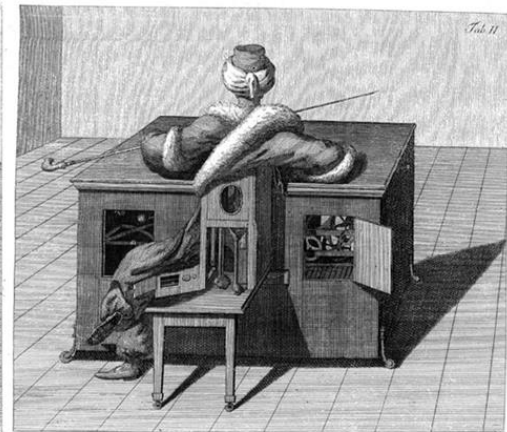
- Powerful devices for acquiring, processing and visualizing information
- Accessibility of information (anybody, any time, anywhere)
- Immense potential (integration of acquisition, processing, visualization, cloud computing, and collaborative tasks)



Die Schachspieler im Spiele begriffen. L'Amour et l'honneur tel qu'on le voit pendant le jeu.



Die Schachspieler in der ersten Pause. Spiel und Spielwerk sind verbunden. L'Amour et l'honneur tel qu'on le voit au moment de la première pause.



Tafel II.

**Next Session**

# **MOBILE GRAPHICS TRENDS: HARDWARE ARCHITECTURES & APPLICATIONS**