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"La Técnica al Servicio de la Patria"

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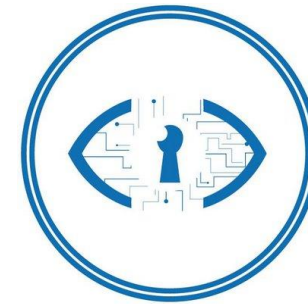
Laboratorio de Ciberseguridad

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Mobile Security

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What is a smartphone?

❑ A phone that is smart:

➢ Non-phone capabilities

➢ Computer that make phone calls

➢ ???

➢ "A multifunctional cell phone that provides voice communication and text messaging capabilities and facilitates data processing as well as enhanced wireless connectivity" [Zheng and Li, 2006]

What is "smart" in a Smartphone?
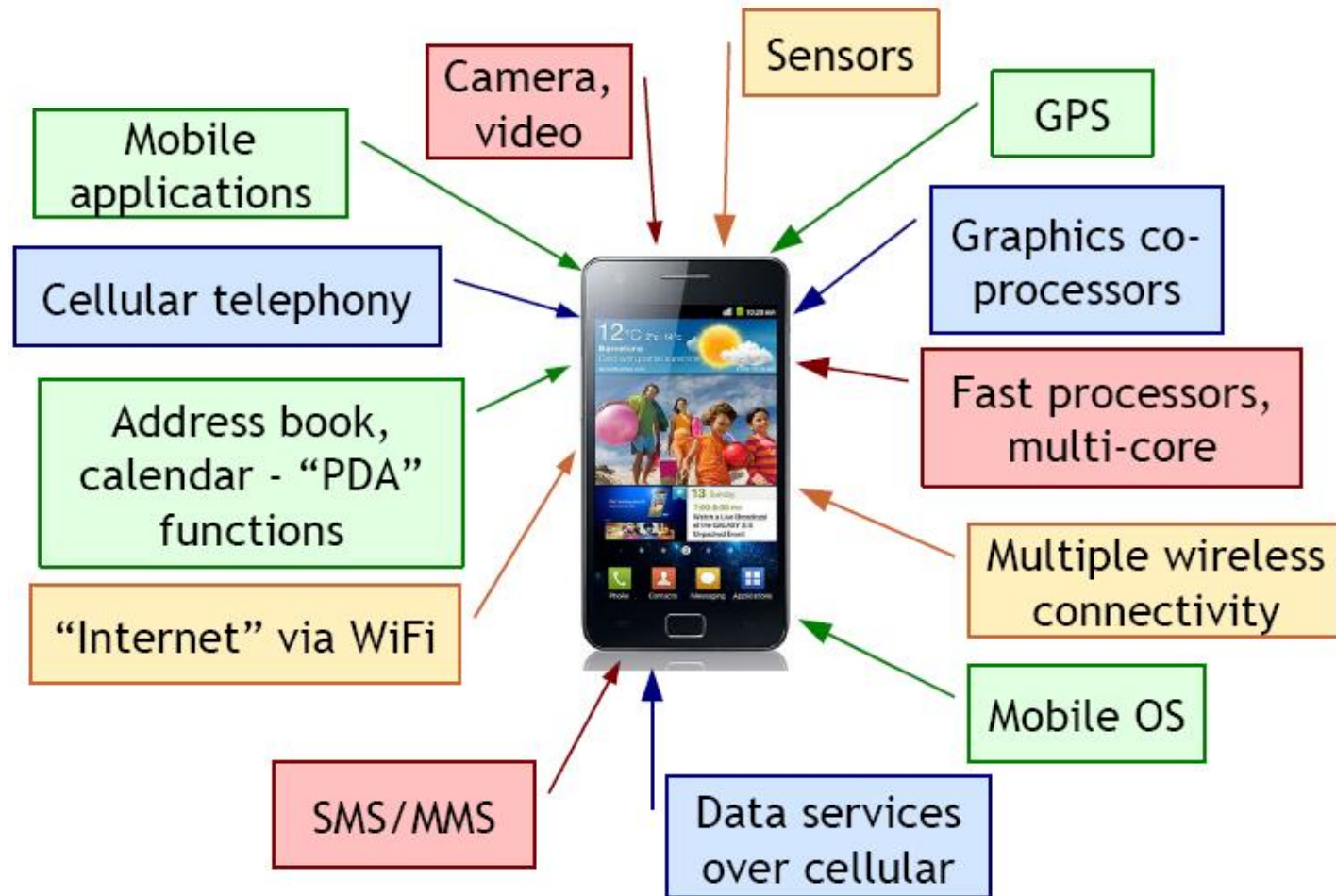
Too many sensors, not enough smarts?

- Light
- Proximity
- 2 cameras
- 3 microphones (ultrasound)
- Touch
- Position
  - GPS
  - WiFi (fingerprint)
  - Cellular (tri-lateration)
  - NFC, Bluetooth (beacons)
- Accelerometer
- Magnetometer
- Gyroscope
- Pressure
- Temperature
- Humidity

Smartphones computing power

❑ Today's smartphone has the same computing power as the Desktop we used in 2000, but with better graphics, more memory and better connectivity.

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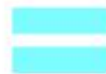
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Smartphones are used for a wide range of tasks

- ❑ Ubiquitous data collection
- ❑ Accessing the full Internet including social networking, e.g. Facebook, YouTube, and MySpace
- ❑ Creating and consuming multimedia including HD video, and accessing full online content using Adobe's Flash Player
- ❑ GPS navigation and location based services
- ❑ Gaming
- ❑ Messaging from SMS to Email
- ❑ Phone calls

Smartphone components

Communication / networking

Computation / processing
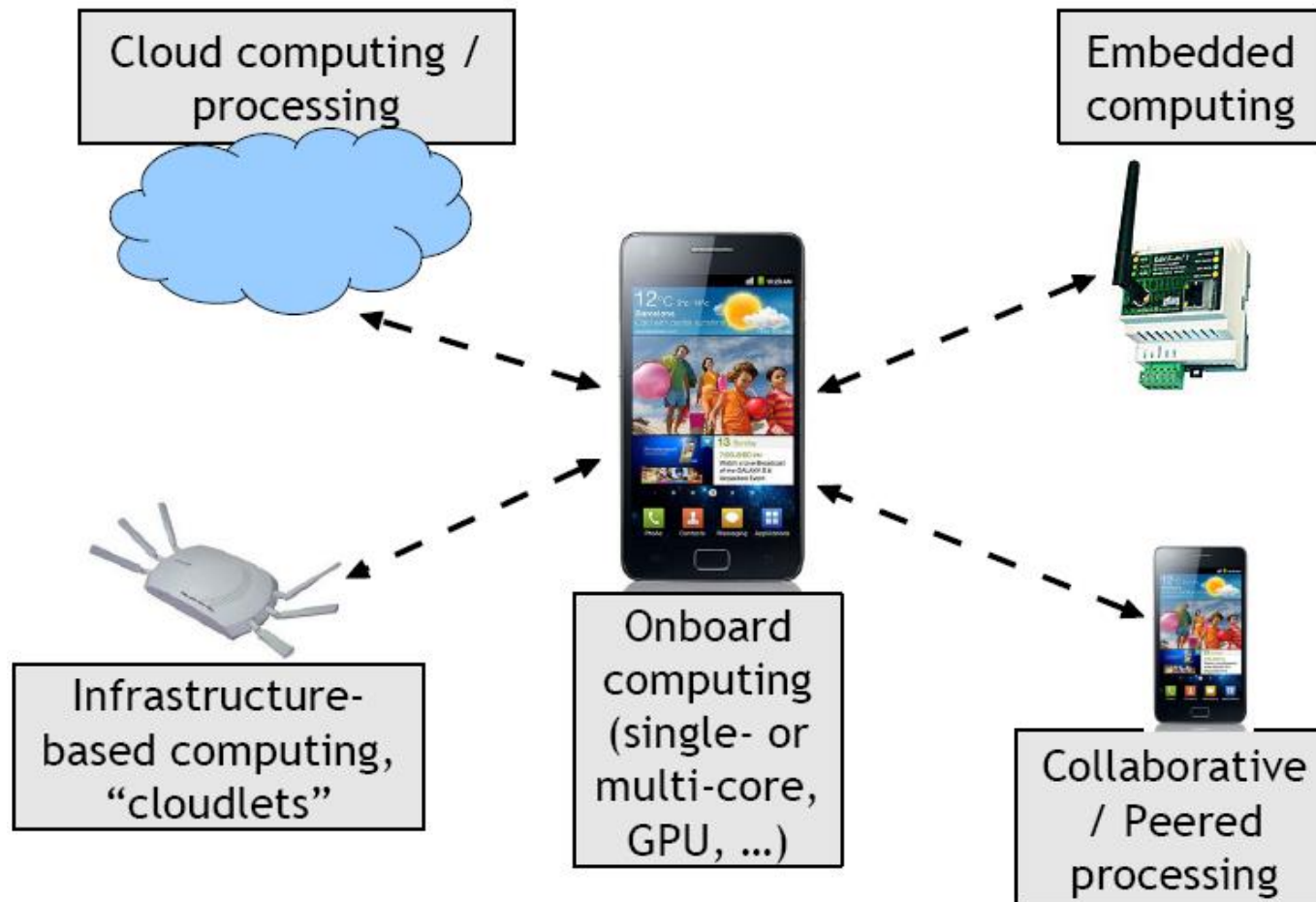
Sensing / actuating / control

Entertainment / gaming

. . .

System interactions

Smartphone wireless network interfaces

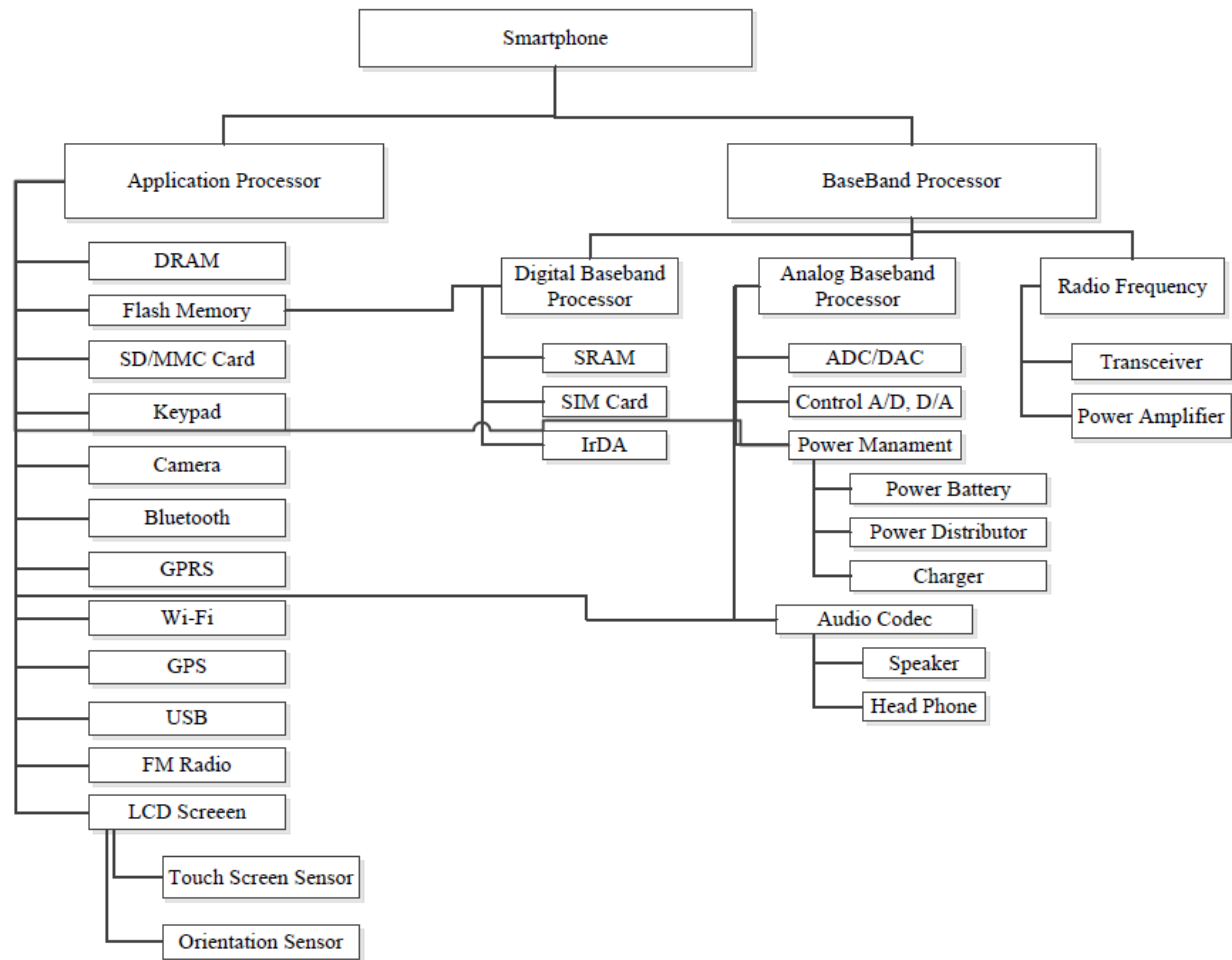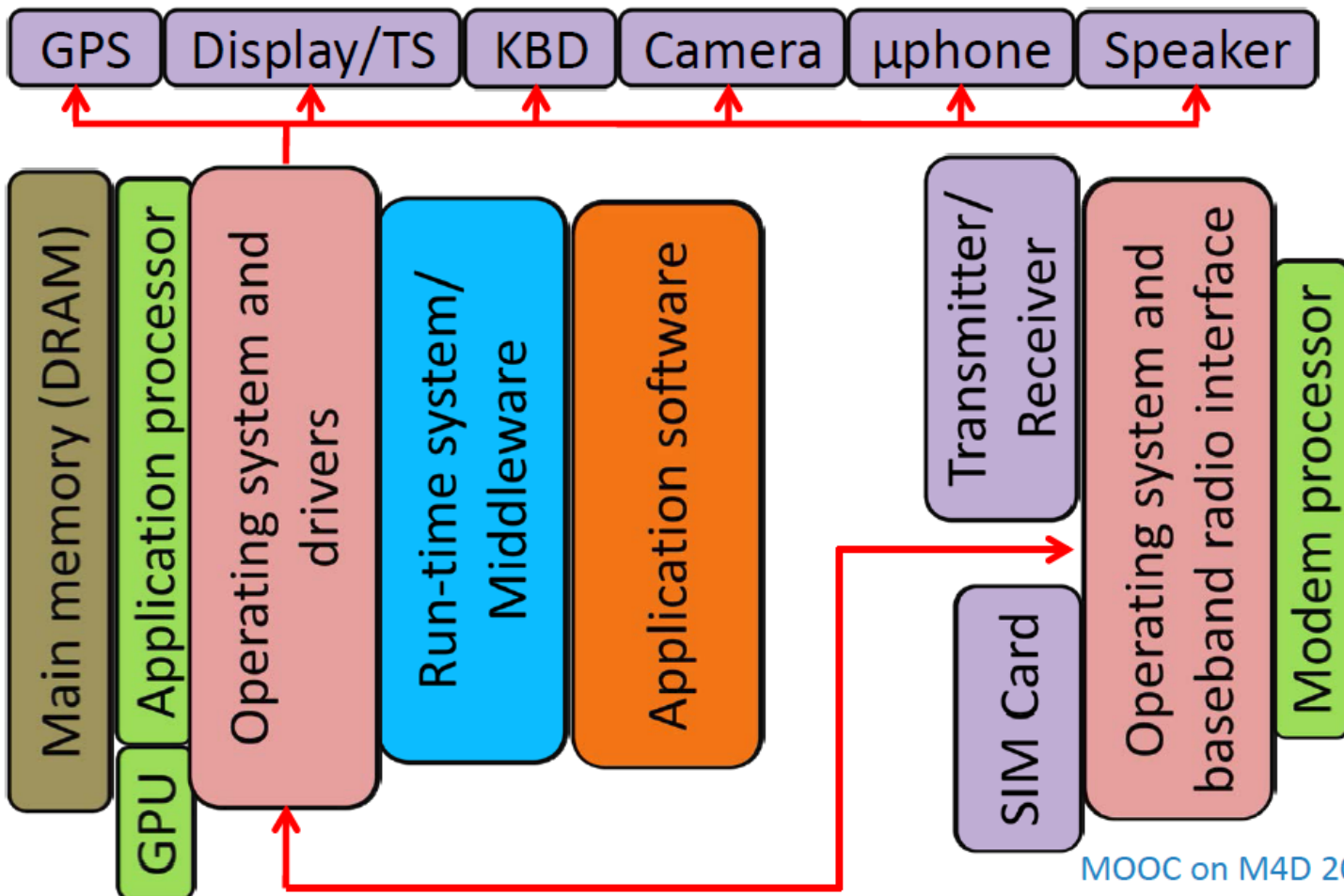# Mobile computing

- Cloud computing / processing
- Embedded computing
- Infrastructure-based computing, "cloudlets"
- Onboard computing (single- or multi-core, GPU, ...)
- Collaborative / Peered processing

Cloud computing

Anatomy of a smartphone

Smartphone hardware architecture

GPS | Display/TS | KBD | Camera | μphone | Speaker

Main memory (DRAM) · GPU · Application processor · Operating system and drivers · Run-time system/Middleware · Application software · Transmitter/Receiver · SIM Card · Operating system and baseband radio interface · Modem processor

MOOC on M4D 2013

Smartphone hardware architecture

❑ A system-on-chip architecture with three primary components

- o An application processor executing the end-user's application software with assistance from the middleware and operating system (OS)

- o A modem or baseband processor with its own operating system components responding to the baseband radio activities (transmission and reception of audio, video, and other data contents)

- o A number of peripheral devices for interacting with the end-user

Communications: Reception

❑ The receiver hardware (part of the modem) senses incoming signals and generates interrupts for the radio interface logic of the operating system

  ➢ The radio interface and the operating system software run on a baseband or modem processor

  ➢ Once the reception begins (after a physical layer handshake), the incoming audio, video, and other data are processed by the modem processor

  ➢ The radio OS components talk to the peripheral device drivers to present the incoming data to the user through appropriate devices (display, speaker, etc.)

Communications: Transmission

❑ The data to be transmitted are collected by the radio OS components from memory regions populated by the device drivers

  ➢ For example, audio data captured by the microphone driver or an image or a video captured by the camera or a position information captured by the GPS device

❑ These data can be further processed by the modem processor to suite the transmission protocol

❑ A transmission is initiated by the radio interface logic through the modem transmitter hardware

❑ The subscriber identification module (SIM) plays an important role in reception and transmission

Application execution

❑ Application processor executes the user applications and the related OS services

➢ Applications include audio/video codec and players, games, image processing, speech processing, internet browsing, text editing, etc.

➢ Application processor takes help from graphics accelerators as and when needed

o Most handheld applications are graphics-intensive

➢ Handhelds come with reasonably large amount of storage in the form of volatile SDRAM (1-2 GB) as well as non-volatile compact storage (10+ GB)

➢ The OS is mostly a traditional one, stripped down and optimized to cater to smartphone applications

Important peripheral devices

❑ I/O devices through which the end-user interacts with the handheld

  ➢ The OS needs to have the driver software installed for each such device

  ➢ Typical peripheral devices

    o LCD screen, keyboard, camera, GPS, speaker and audio output for headset/earphone, microphone, bluethooth, WiFi, HDTV

Processors

❑ Need to balance performance, power consumption, and cost

❑ ARM-based processors are very common

- ➢ Optimized for battery life as well as performance
- ➢ Remarkably low area and transistor count
  - o Important for small form factors and low energy drain
- ➢ Modem processor is either a separate ARM core or a DSP extension of the application processor ARM core
  - o Some architectures use a modem accelerator along with the application processor core

Optimised ARM Smartphone Block Diagram
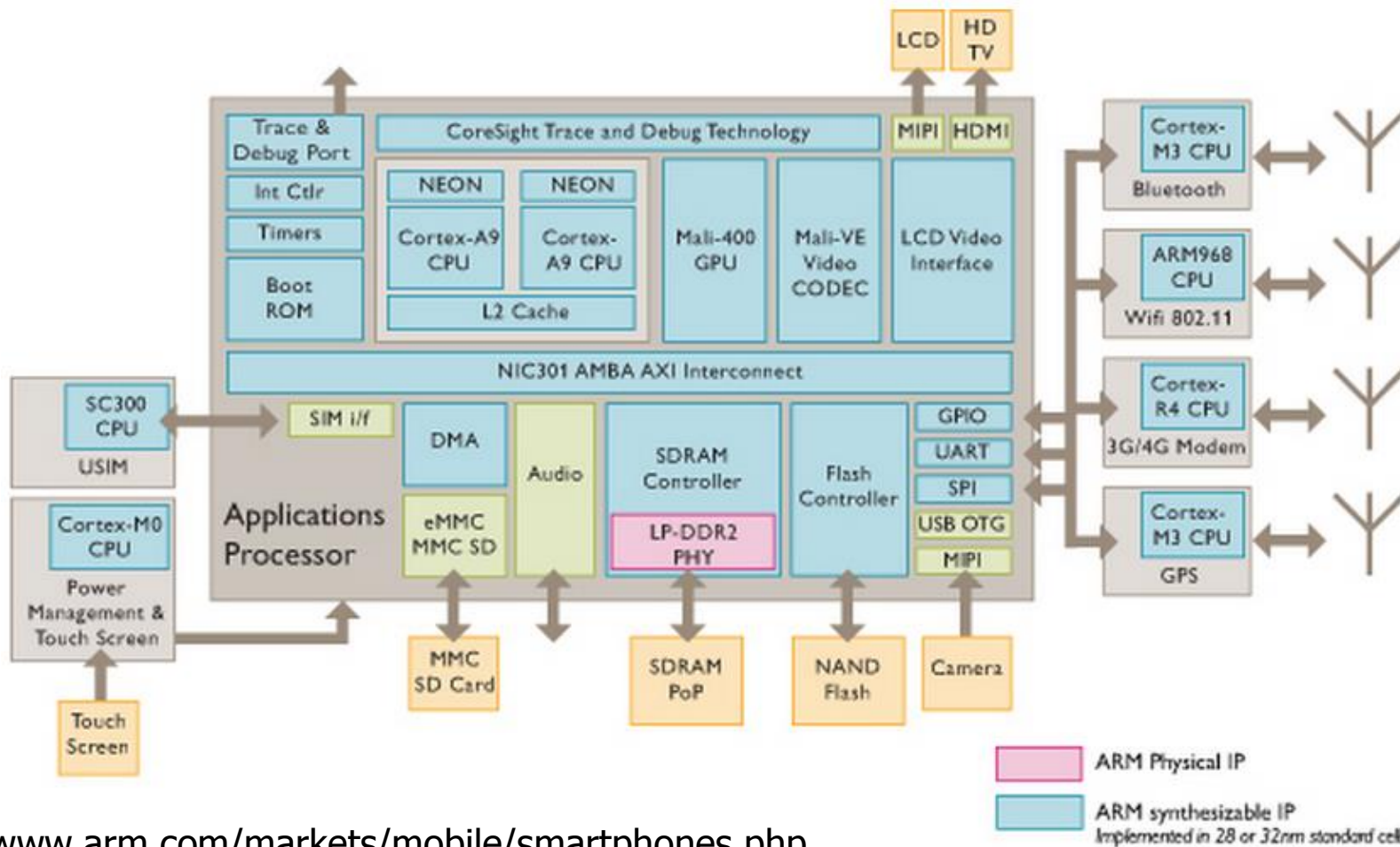
http://www.arm.com/markets/mobile/smartphones.php

Processors in handheld mobile devices

❑ Modern handhelds include multiple application processor cores (two, four, or eight)

  ➢ Samsung Galaxy S4 i9500 comes in two possible configs

    o 1.9 GHz quad-core ARM Krait + Qualcomm's Adreno GPU

    o 1.6 GHz quad-core ARM Cortex-A15 + 1.2 GHz quad-core ARM Cortex-A7 + Imagination's PowerVR GPU (only four cores out of the eight app. cores can be active at a time)

Processors in handheld mobile devices

❑ Modern handhelds include multiple application processor cores (two, four, or eight)

➢ Apple iPhone 5

    o 1.3 GHz dual-core Swift (ARMv7-based) + PowerVR GPU

➢ Nokia Lumia 920T

    o 1.7 GHz dual-core Qualcomm Krait + Adreno GPU

➢ Lenovo K900

    o 2.0 GHz dual-core Intel Atom Z2580 + PowerVR GPU

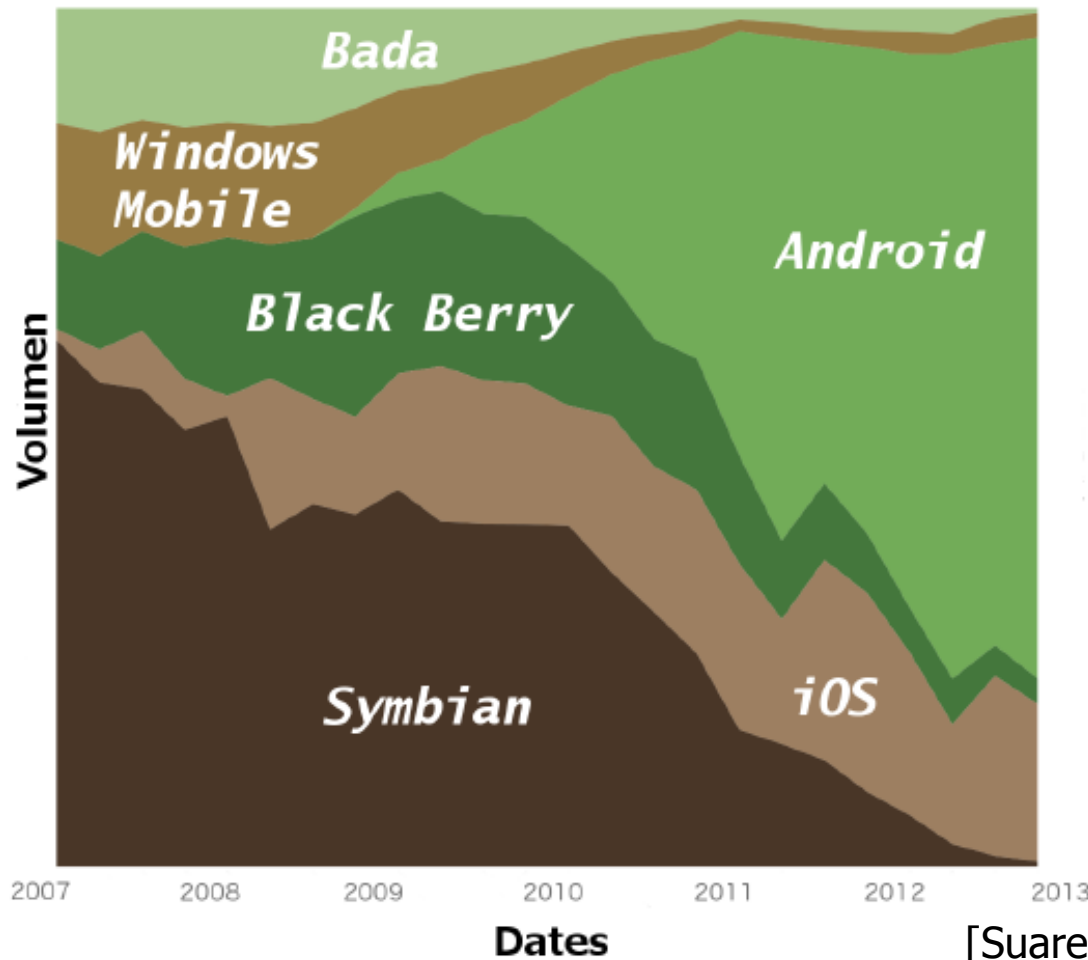# Processors in handheld mobile devices

❑ Modern handhelds include multiple application processor cores (two, four, or eight)

➢ Samsung Nexus 10

  o 1.7 GHz dual-core ARM Cortex-A15 + ARM Mali-T604 GPU

➢ Asus Nexus 7

  o Nvidia Tegra 3 platform with 1.2 GHz quad-core ARM Cortex-A9 + ultra-low-power Nvidia GeForce GPU

➢ These multi-core app. processors can deliver excellent performance although low-power remains a primary goal for longer battery life

Mobile operating systems

❑ A variety of Operating Systems (OS), in order to deal with a variety of systems, services and applications

➢ Aliyun, Android, bada, BlackBerry, Boot2Gecko,Brew, GridOS, iOS, Linux, Maemo, MeeGo, MXI, Palm, QNX, Symbian, Windows (Mobile/Phone/8), webOS

❑ Each OS has different standards, services, styles, behabiors, foci, interactions, etc

❑ Each OS has different vulnerabilities

Mobile OS market share

[Suarez-Tangil et al., 2013]