

Software development for Smartphones/tablets



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In a few years time tablets and smartphones will be running PC applications / on PC hardware

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Promised for a long time

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- Promised for a long time
- Progress, but a limit is reached (or will be soon)



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PCs in future: only at work, probably for hardcore gaming



Android

iOS (iPhone, iPad)

Other

Firefox, Ubuntu

- Blackberry OS
- Windows



- Android (>50%)
- iOS (iPhone, iPad)
- Other (<10%)
 Firefox, Ubuntu
 Blackberry OS
 Windows



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 - Firefox, Ubuntu
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CPUs: Arm

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CPUs: Arm

GPUs

- Imagination Technologies PowerVR (market leader)
- Arm Mali
- Qualcomm Adreno (former: ATI)
- NVIDIA Tegra



- Chip-producer
 - Texas Instruments
 - Qualcomm
 - ST Ericsson (?)
 - Samsung
 - NVIDIA (ARM+Tegra)
 - Apple (ARM+PowerVR)



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- Current Maximum: 1.8 Ghz, 2 Mbytes of memory

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PC architecture



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Embedded System architecture



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PCs
 Several, star-organized busses
 Mobile Gaming
 One central bus

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- PCs
 - Several, star-organized busses
 - Distributed memory and caches

- Mobile GamingOne central bus
 - Centralized memory, small caches (if at all)



- PCs
 - Several, star-organized busses
 - Distributed memory and caches
 - Might be multicore, might have accelerators (GPU, modem) connected at periphery

- Mobile Gaming
- One central bus
- Centralized memory, small caches (if at all)
- Multicore, contains tightly coupled accelerators (System-on-a-Chip



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Optimized for Performance

Optimized for Efficiency

Generally

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Code optimization very important

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Generally

- Code optimization very important
- Bus and memory are bottlenecks, more so than in PCs

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- Only 32 (or 16) bit: avoid double precision

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Generally

- Code optimization very important
- Bus and memory are bottlenecks, more so than in PCs
- Only 32 (or 16) bit: avoid double precision
- Use fixed-point instead of float wherever possible
- Use the multicores & accelerators
- Low-level programming if possible



- iOS: Objective-C
- Android: JAVA





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- iOS: Objective-C
- Android: JAVA
- Both object-oriented





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- iOS: Objective-C
- Android: JAVA
- Both object-oriented
- Apps run in sandboxes (due to security reasons)



iOS

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- Model: manages and modifies data
- View: renders to screen
- Controller: handles inputs and outputs





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Delegates

Do a task on behalf of another

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iOS

Advantages

- Low-level programming possible
- Easy-to-use toolchain, e.g. editor for screen layout, ready-touse objects for user interaction

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iOS

Advantages

- Low-level programming possible
- Easy-to-use toolchain, e.g. editor for screen layout, ready-touse objects for user interaction
- Disadvantages
 - Limited freedom





- Services
- Content providers
- Broadcast receivers
- Activities



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Services

- Run in background
- Mostly computational

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- Content providers
 - Access to shared resources, e.g. file-system, network
- Broadcast receivers
 - e.g. rotation, energy-saving mode



Activities

- Control user in- and output
- Several per screen possible
- Contain at least on view



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Activities

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Android

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View / Viewgroups



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- JNI (Java Native Interface)
 - Low-level programming (C, C++) in Java
 - Often faster, but might not be
 - May have to be recompiled for different architectures
 - Complicated data- and thread-sharing



Advantages

- More freedom
- Works on different architectures (mostly)



Advantages

- More freedom
- Works on different architectures (mostly)

Disadvantages

- More complicated to use
- Less easy-to-use tools
- Java really good language for embedded systems? (Double as standard? No unsigned or fixed-point data-types?)



Object-oriented

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Data grouped by abstract objects

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Object-oriented vs. data-driven

- Object-oriented
 - Data grouped by abstract objects
- Data-driven
 - Data grouped by access patterns





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Object-oriented vs. data-driven

- Object-oriented
 - Data grouped by abstract objects
- Data-driven
 - Data grouped by access patterns
- Data-driven approach can be implemented by using objects



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Android

- Up to developer
- Threads, barriers, atomic commands etc.
- Flexible, but can get complicated



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Android

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- Up to developer
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iOS

- Only asynchronous
- Waiting queues, managed by the OS
- Less freedom, but easy to use



Android

- More flexible, but more complicated
- Odd language choice
- Biggest, fastest growing market





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Android

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iOS

- Easy to learn and use, but locked to the apple-way
- Most important market?



Android

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iOS

- Easy to learn and use, but locked to the apple-way
- Most important market?

• Other?



- Be aware of limitations
 - Optimize as much as possible
 - Avoid bus- and memory-usage
 - Be efficient! Try to make the most of it!





