State of Multimedia in 2010's Embedded Linux Devices

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State of Multimedia in 2010's Embedded Linux Devices
Presentation Objectives

- **Find out about multimedia status on today's embedded devices.**
- **Help you make the best choices for your next device's design:**
  - What is the best hardware for you ?
  - Which OS can you run on top of it ?
  - How to get the best out of your SoC ?
  - How to write embedded applications ?
- **Find out more about ”OpenSource” compatibility.**

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About Myself …

Software Architect at Alcatel-Lucent

- Expert on Open source software.
- 7y experience on various embedded devices design.
- From low-level BSP to global software architecture.

Open Source projects founder, leader and / or contributor for:

- *OpenBricks* embedded Linux framework.
- *GeeXboX* embedded multimedia distribution.
- *Enna* EFL Media Center.
- *uShare* UPnP and DLNA Media Server.
- *MPlayer* media player application.

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Hardware Selection
Which SoC for which target ?

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Hardware Selection – Which SoC for which target ?

- **A few simple rules to follow:**
  - **#1:** Think about what your customers really need.
  - **#2:** Now think about features and product's lifespan.
  - **#3:** Only by then, think about shopcost.

- **Always remember:**
  - A SoC is not only a CPU.
  - Define your own criterias.
  - The most powerful SoC is not necessarly the good one for your product.

- **PS:** I'm neither affilitated to any vendor nor related to any ARM shareholder :-)

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Hardware Selection – Which SoC for which target ?

Criteria	Description
CPU	*Main Processing Capabilities (Raw Speed, MHz ...)*
SMP	*Multi-Core Capabilities*
SIMD	*Instruction Set Extensions (MMX, SSE, VFP, NEON ...)*
PSU	*Power Consumption and Management*
NET	*Networking Capabilities (FE, GbE, WiFi, Bluetooth, 3G ...)*
CONNECT	*Extra Peripherals Connectivity Capabilities (USB, (m)PCI(e) ...)*
STORAGE	*Storage Capabilities (NOR, NAND, SDHC, (e)SATA ...)*
2D	*2D Graphics Capabilities*
3D	*3D Graphics Capabilities*
VIDEO	*Video Decoding/Encoding Capabilities*

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Hardware Selection – Which SoC for which target ?

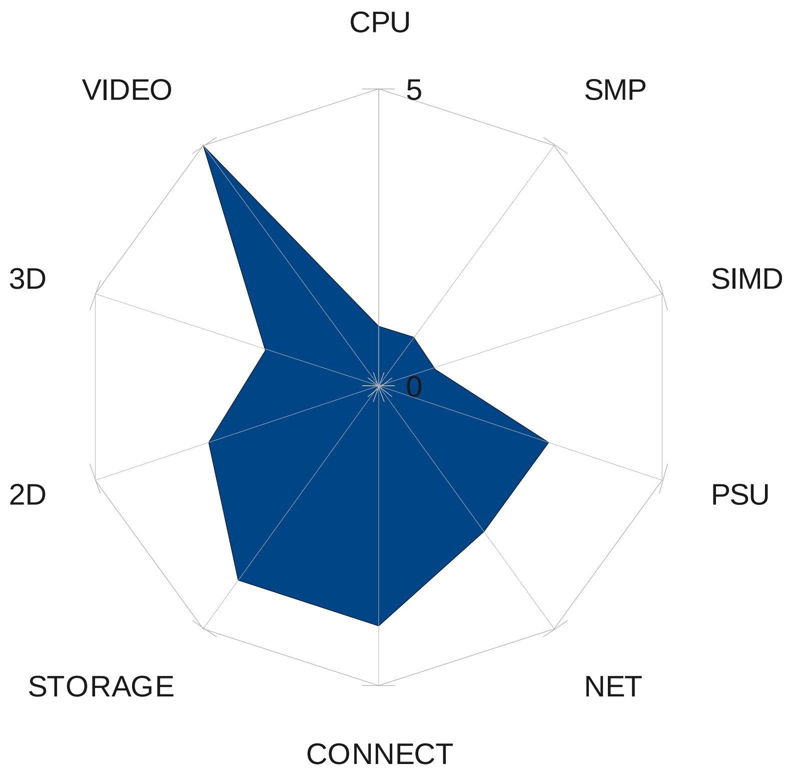
MIPS32 SoCs

- Usually low-end CPUs (< 300 MHz)
- Mostly used with wired equipments.
- Legacy Ethernet networking.
- Good for A/V output.
- Focus on 2D and Video processing.
- Usually comes with regular connectivity: USB, SATA …

SoC Examples

- Sigma Designs

MIPS32-based SoC Capabilities



Typical Usage

- Set-Top-Box, Bluray / DVD Players

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Hardware Selection – Which SoC for which target ?

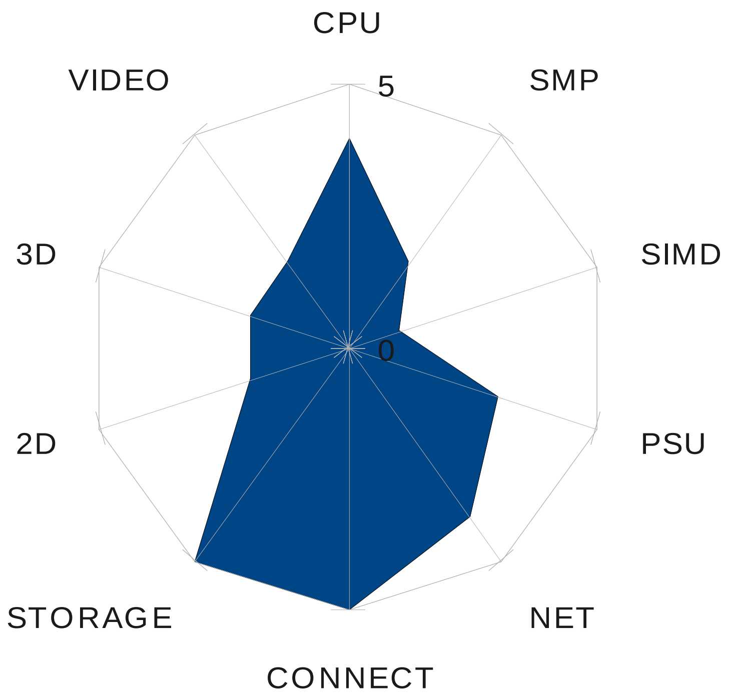
ARM9 SoCs

- Old mobile phones SoCs (< 300 MHz)
- Still in the wild, clocked up to 1.5+ Ghz.
- Mostly used with wired equipments.
- Usually comes with enhanced Eth networking.
- Good for storage: usually USB / PATA / (e)SATA.

SoC Examples

- TI OMAP 1, Freescale i.MX2x, Marvell Kirkwood

ARM9-based SoC Capabilities



Typical Usage

- NAS, Routers, Network equipments.

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Hardware Selection – Which SoC for which target ?

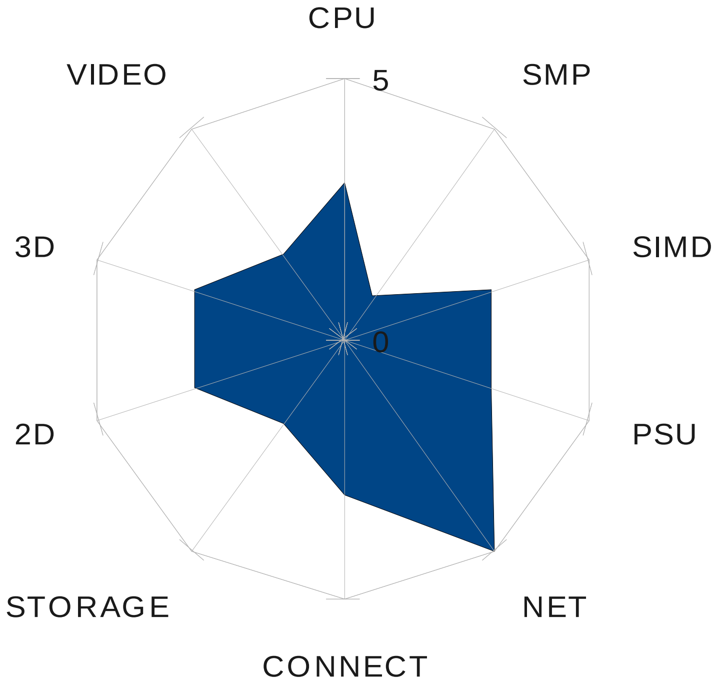
ARM11 SoCs

- Mid-end CPUs (400-700 Mhz)
- Mostly seen with 2007+ smartphones.
- Used with both wired and mobile equipments.
- Focus on multimedia with 2D/3D features.
- Focus on networking capabilities.

SoC Examples

- TI OMAP 2, Freescale i.MX3x,
  Qualcomm MSM72xx, Broadcom BCMring

ARM11-based SoC Capabilities



Typical Usage

- Telecommunication Industry Smartphones and wired phones with low-end multimedia.

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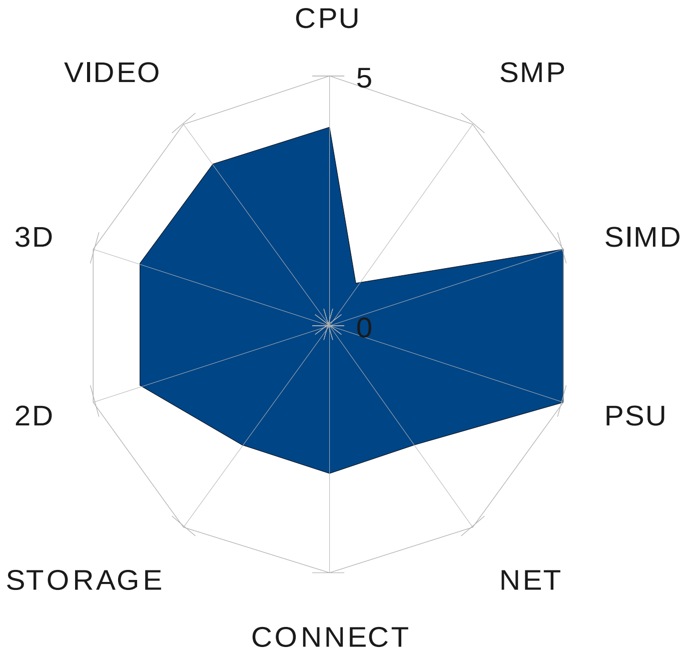
Hardware Selection – Which SoC for which target ?

ARM Cortex-A8 SoCs

- High-end CPUs (600 Mhz – 1 GHz)
- Mostly seen with 2009+ smartphones.
- Designed for mobile equipments only.
- Introduced NEON instructions optimizations.
- Enhanced multimedia 2D / 3D / Video features.
- Mobile-only networking capabilities, lack of Ethernet and external storage.

ARM Cortex-A8 SoC Capabilities



SoC Examples

- TI OMAP 3, Freescale i.MX5x, Apple A4, Marvell ARMADA, Qualcomm SnapDragon QSD86xx.

Typical Usage

- High-end smartphones, Tablet PCs.

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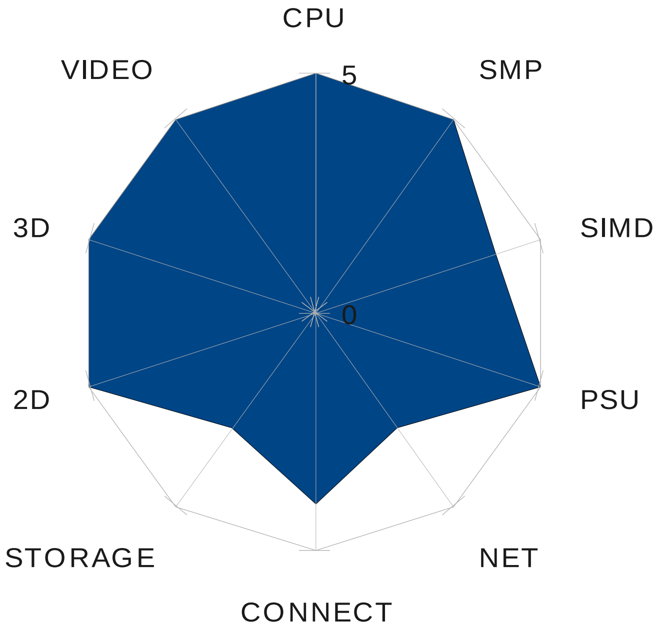
Hardware Selection – Which SoC for which target ?

ARM Cortex-A9 SoCs

- Ultra high-end CPUs (700 Mhz – 1.5 GHz)
- Mostly seen with Q4 2010+ smartphones.
- Designed for mobile and wired equipments.
- Introduced SMP Optimizations: 1-4 Cores.
- Optional SIMD instructions
- Ultra high-end multimedia 2D/3D/Video features.
- Enhanced networking capabilities, mini-PCIe.

ARM Cortex-A9 SoC Capabilities



SoC Examples

- TI OMAP 4, nVidia Tegra 2, Qualcomm SnapDragon MSM86xx and QSD86xx.

Typical Usage

- High-end smartphones, Set-Top-Box, Connected TVs.

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State of Multimedia in 2010’s Embedded Linux Devices
Hardware Selection – Which SoC for which target ?

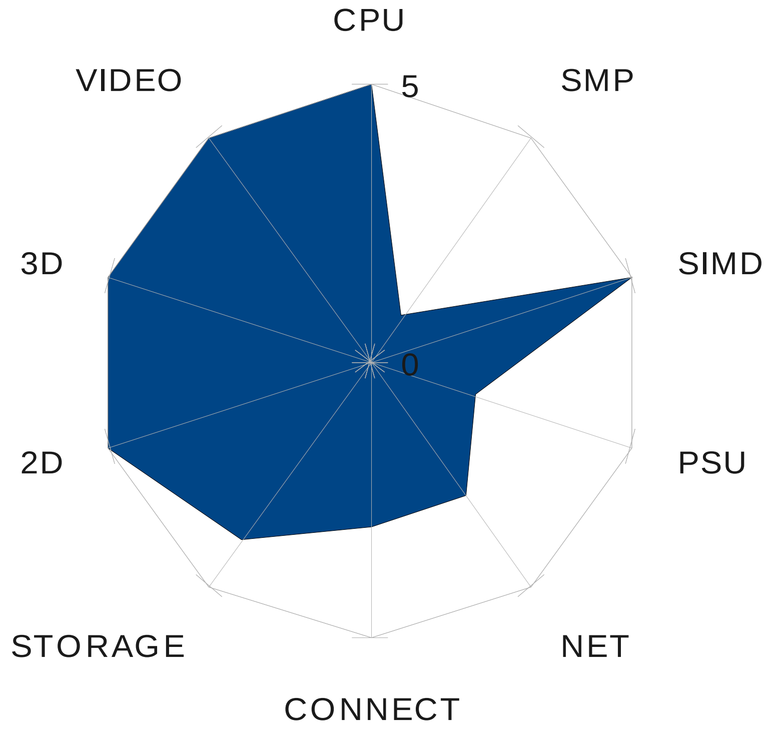
Intel Embedded ATOM SoCs

- Ultra high-end CPU (1200 MHz)
- Introduced with 2010 Set-Top-Boxes.
- Designed for wired equipments.
- Consequent power consumption (7W).
- Single-Core, x86 instructions set and large SIMD optimizations.
- Ultra high-end multimedia 2D / 3D / Video features.

SoC Examples

- Intel CE4100 and CE4200.

Embedded ATOM x86 SoC Capabilities



Typical Usage

- Set-Top-Box (*Boxee*), Connected TVs (*GoogleTV*).

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State of Multimedia

State of Multimedia – 2D Raster Graphics

2D Raster Graphics

- Usually raw basic kernel framebuffer driver support.
- Occasionally, DirectFB drivers:
  - Limited hardware acceleration for framebuffer.
  - Rarely supported by semiconductor vendors.
- May come with proprietary X11 driver:
  - Basic implementation
  - Restricted to a given X.Org ABI (i.e deal with it!)
  - Why would you need X11 for embedded device ??
- Most of the time implemented through OpenGL|ES.
- Hopefully addressed by application framework, when supported ...

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State of Multimedia – 2D Vector Graphics

- **2D Vector Graphics**
  - Useful for Flash and SVG rendering.
  - *Though rarely supported at all !!*
  - Most of the time implemented through OpenVG hardware acceleration framework.
  - Mostly rely on proprietary drivers and libs.
  - Supported by some application frameworks:
    - Android
    - MeeGo (Qt)
    - Cairo
    - Adobe Flash

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State of Multimedia – 3D Graphics

- **3D Graphics: OpenGL|ES**

  - Complete hardware graphics acceleration.
    - Limited by GPU capabilities.
    - Sometimes slower than software rendering.
    - Available through proprietary drivers and libs only.
  - Relies on EGL:
    - Usually comes through vendor-specific implementation.
    - And many vendor-specific extensions.
  - Applications support heavily varies:
    - Imagination PowerVR SGX is best (only?) supported.
    - No MediaPlayer support GLES as video output yet !!

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State of Multimedia – Software A/V Processing

- **Audio / Video Software Implementation**

  - Fully supported by OpenSource software:
    - FFmpeg: multi-codecs audio/video encoding/decoding library
    - Codec specific libs: *libvpx, libmad, libvorbis, libfaad, libmpeg2* ...
  - Various proprietary software vendors.
  - Limited by CPU processing only and wide A/V codecs range support.
  - Optimized for VFP / NEON / SSE instructions and multi-core decoding.
  - Sometimes requires Integer-specific implementation for audio codecs (many ARM chips lack of FPU).
  - May have software patent issues in a few countries.

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State of Multimedia – Hardware A/V Processing

- **Audio / Video Hardware (DSP) Implementation**
  - 100% CPU offloading.
  - Limited A/V codecs support.
  - Mostly closed-source:
    - Usually vendor-specific drivers and libs.
    - Never hit mainstream Linux.
    - Proprietary firmware, libs and DSP code.
  - Rarely supported by OpenSource projects.
  - Vendor-Specific DSP API (hard to support).
  - Generally available through OpenMAX IL / VAAPI abstraction layer.

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State of Multimedia – Hardware A/V Processing

- **OpenMAX**
  - Portable DSP abstraction API.
  - Generic implementation from MediaPlayer side.
  - Slower than native DSP access, less robust, but more portable.
  - Only supported by GStreamer and VLC OpenSource mediaplayers.
- **VA-API**
  - FreeDesktop equivalent to OpenMAX, mostly for x86.
  - Limited to X.Org video output.
  - Better support mostly due to x86 Desktop orientation.

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State of Multimedia

- **State of 2D / 3D / Video Support**
  - Theorically fully h/w supported, full CPU offloading.
  - Usually relies on proprietary implementation.
  - Limited capabilities and support, either due to h/w or s/w implementation.
  - Few commitment from semiconductor vendors to provide regular Linux mainstream support.
  - Possible h/w video decoding but semi-s/w rendering.
  - Only 100% usable on industry's mobile "standard" OS:
    - Google Android
    - Maybe Nokia / Intel MeeGo some day ?

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The Underlying OS

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The Underlying OS

- **Half-Commercial OS:**
  - *WindRiver, Montavista ...*
  - *Android, MeeGo, Ubuntu ...*
- **Homebrew OS:**
  - *OpenEmbedded, OpenBricks*
  - *OpenWrt, Buildroot*
  - ...
- **Linaro Foundation**
  - Not really an OS but helps in making your devices works with Open Source Software.

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State of Multimedia in 2010’s Embedded Linux Devices
The Underlying OS

- **Half-Commercial OS:**
  - Based on OSS but with deep commercial tights.
  - Take it the way it is:
    - Follow the project / product's philosophy.
    - Follow its lifecycle and roadmap.
    - Hard to change the overall software architecture.
    - Adapt your apps and skins to existing framework.
- **PROS:**
  - Potentially impressive Time-To-Market (TTM) and Long-Term-Support (LTS)
  - Good for rapid product deployment and basic applications development.
- **CONS:**
  - May not be adapted to custom and very specific apps.
  - Vendor roadmap follow-up may imply OS upgrades and API changes.

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The Underlying OS

- **Homebrew OS:**
  - Fully based on OSS with barely no support.
  - Take it as your next design's framework:
    - Fine-tuning for on-demand custom OS creation.
    - You're on your own: fix it, debug it, adapt it.
    - Easy to create the software architecture you want.
    - Pray for your whole hardware to be fully supported in upstream Linux kernel :-(
- PROS:
  - Complete control over your product’s global software roadmap.
  - Good for autonomous system and application deployment.
- CONS:
  - You're on your own from the very beginning to the end (no or very bad LTS).
  - Security threat and fixes workload

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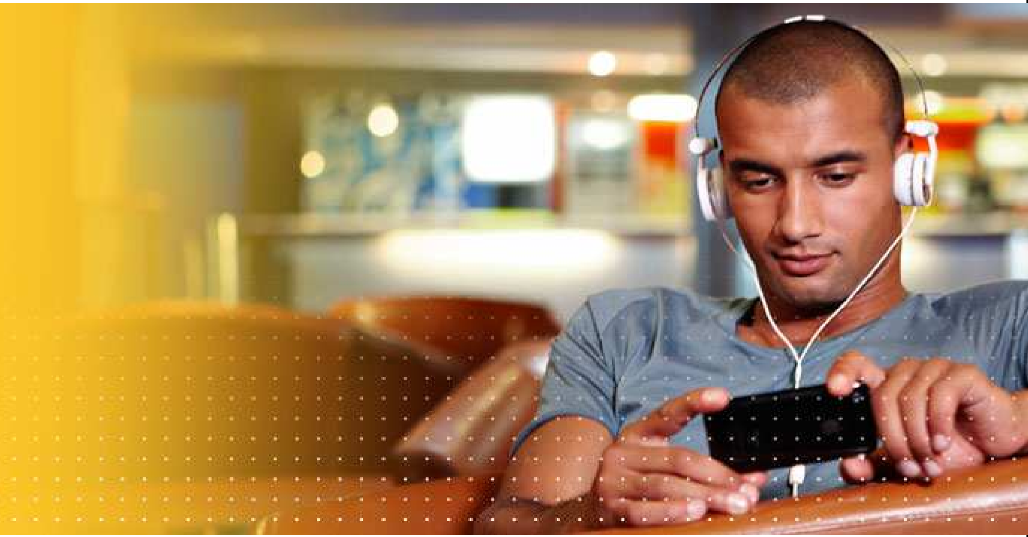
Embedded
Applicative Framework



Embedded Applicative Framework

- **How to write applications and user interfaces ?**
  - Google's Android native applications framework.
  - Nokia's Qt (MeeGo, KDE ...)
  - GTK+ (Gnome)
  - Enlightenment Foundation Libraries (EFL)
  - Simple Direct Media Layer (SDL)
  - Web Technologies

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Embedded Applicative Framework

- **Questions you may ask yourself:**
  - Has it to be a tradeoff between
    code efficiency and programming convenience ?
  - Native compiled code or interpreted one ?
  - Is my code meant to run on multiple devices ?
  - MVC Approach: should I distinct middleware / core from user interface ?
  - SDK or Open Source collaboration:
    what if I want to gather developers around my project ?

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State of Multimedia in 2010's Embedded Linux Devices
Embedded Applicative Framework (based on personal feedback)

	Android	Qt	GTK+	EFL	SDL	Web
Language	Java	C++	C	C	C	JS, CSS, HTML
Maturity	Average	Good	Good	Weak	Good	Average
Portability	Weak	Good	Average	Average	Good	Average
Footprint	N.A	Weak	Average	Good	Good	Good
Performance	Good	Average	Average	Good	Good	Weak
System-Wide	Good	Good	Weak	Average	Weak	Weak
Community Followers	Good	Good	Average	Weak	Average	Good
Multimedia Integration	Good	Good	Average	Average	Average	Good
OpenGL|ES	Yes	Yes	No	Yes	No	No
OpenVG	Yes	Yes	No	No	No	No
MVC Mode	Yes	Yes	No	Yes	No	Yes

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Conclusion

Designing your new device: Questions to be raised ...

- **Questions to be raised:**
  - Which features do you **really** need ?
  - What is your project's expected lifespan ?
  - Do you target TTM or LTS ?
  - Do you need complete code mastership ?
  - Do you need SDK / external apps openess ?
  - Is regular upstream Linux support mandatory for your application ?

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Conclusion – State of Embedded Linux

- **Multimedia on embedded Linux rocks !**
  - Maybe even more than on desktop Linux …
  - But unfortunately mostly relies on 100% proprietary software.
- **Linux now supports so many SoCs …**
  - But h/w vendors rarely contribute upstream.
  - Mostly comes with Android-only software.
    - Usually provided under binary form only
    - You have to stick to first (and last) BSP release.
  - Need to sponsor MeeGo / Linaro-like initiatives to upstream SoC support on Linux.

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Annex – Some references

- DirectFB: http://directfb.org/
- OpenVG: http://www.khronos.org/openvg/
- OpenGL|ES: http://www.khronos.org/opengles/
- OpenMAX: http://www.khronos.org/openmax/
- VA-API: http://www.freedesktop.org/wiki/Software/vaapi
- FFmpeg: http://www.ffmpeg.org/
- SDL: http://www.libsdl.org/
- GTK+: http://www.gtk.org/
- Qt: http://qt.nokia.com/
- EFL: http://www.enlightenment.org/

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Annex – Some references

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- OpenEmbedded: http://wiki.openembedded.org/index.php/Main_Page
- OpenBricks: http://www.openbricks.org/
- OpenWRT: http://www.openwrt.org/
- Buildroot: http://buildroot.uclibc.org/
- Linaro: http://www.linaro.org/

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