



# **Essential Concepts of Complex SOC Design for products like OMAP and DaVinci**

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## DaVinci & OMAP SOC “System on a chip”

- **DaVinci & OMAP truly integrate an entire embedded “system” into a single device.**

- ARM, DSP, USB, Video ports ....

- **This integration offers huge benefits:**

- **System Cost**
  - **Power**
  - **Form Factor**
  - **Performance**



Highly integrated  
SOCs enable  
leading edge  
products



## MSP430 vs. OMAP/DaVinci

**So why are OMAP/DaVinci  
“different”?**

**Answer: Complexity**

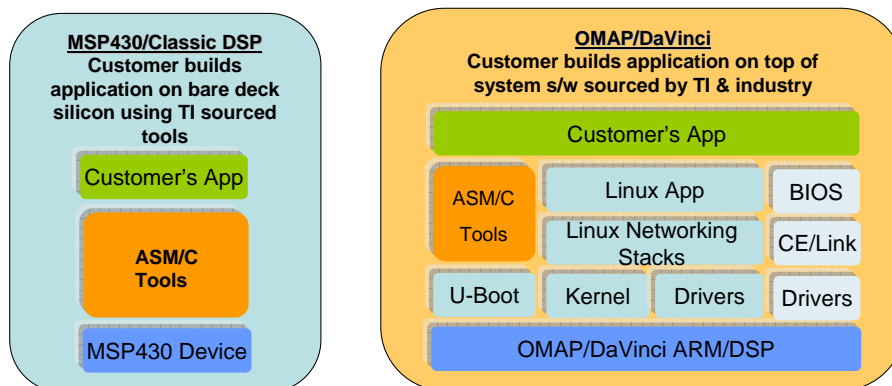
***Question:***

***Have you fully accounted for how this dramatically  
increased integration (and resulting complexity)  
affects your design methodology and the support  
models of your suppliers?***



## So, how can you develop successfully with OMAP/DaVinci?


By using a combination of industry standard and proprietary s/w components, TI enables customers to start their development at the “application level” vs.. starting with the bare deck device.





## Agenda

### Concepts of Complex SOC Design

- Dissection of S/W Architectures
- TI Software Deliverables and Support paths
  - Linux and OS options
  - Codecs
- System Frameworks and Applications
  - Flash, AV sync, GUI's Graphics 
- Best Practices - Conclusion

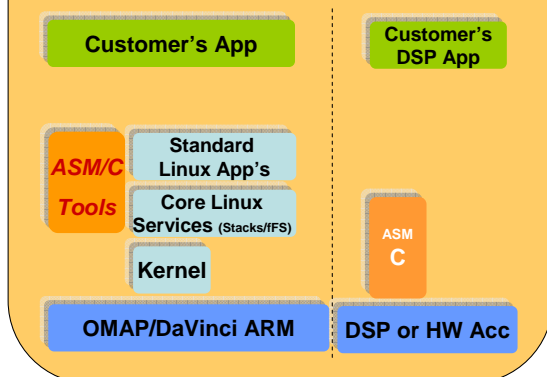


## **Part 1: Dissection of S/W Architectures**



## Dissection of S/W Architectures

### Typical OMAP/DaVinci S/W Architecture



### OSs: Linux/WinCE/other

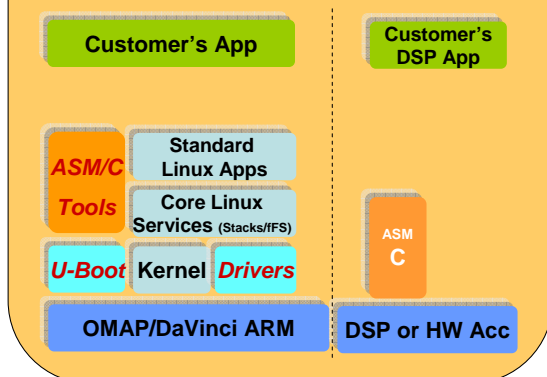
OS's offer customers a "standard" interface to extract useful work from a processor. TI helps establish OS ports and may distribute OS kernels (Linux) as part of our development platforms. However, TI does not have any ownership in creating, maintaining or supporting the core OS components. There are commercial and open source OS options available on OMAP/DaVinci. OS's support many useful services and applications from it's ecosystem.

 = Industry Standard OS S/W Component





## Dissection of S/W Architectures

### Typical OMAP/DaVinci S/W Architecture



### OS PSP Package (DvSDK):

OS's are created in a generic way so they are not bound to any specific processor. In order to use an OS for any specific device, like OMAP or DaVinci someone must port a device specific PSP/LSP s/w package. This work may be completed by TI, the OS vendor, a 3P, the Open Source community or the customer. This s/w is what connects the OS to the h/w and will regulate the functionality and performance of the system.

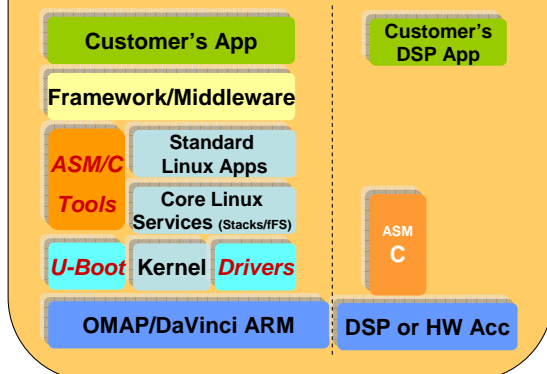
-  = Industry Standard OS S/W Component
-  = PSP/BSP Package: multiple sources








# Dissection of S/W Architectures

## Typical OMAP/DaVinci S/W Architecture



## Frameworks/Middleware

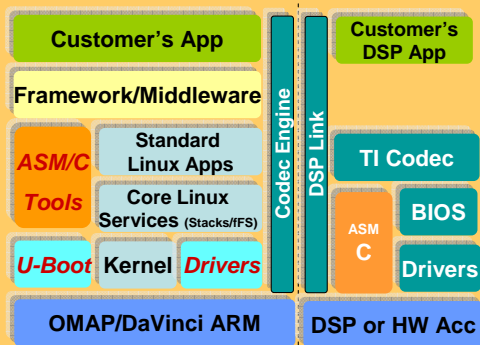
These are application specific s/w packages that use the underlying services enabled by the OS, that enable targeted functionality: MythTV, AVME, browsers (ANT), DRM, VOIP, QT, Flash. There is a large and growing number of these packages from commercial and open source entities. For targeted EE, TI may provide demo or production ready solutions.

-  = Industry Standard OS S/W Component
-  = PSP Package: multiple sources
-  = Frameworks/Middleware: multiple sources



## Dissection of S/W Architectures

### Typical OMAP/DaVinci S/W Architecture



### DaVinci S/W Components

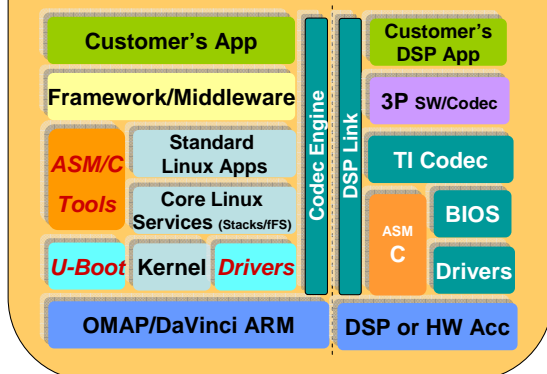
TI provides customers with a standardized s/w method to accelerate applications with our DSP & H/W co-processors. This includes our DSP-specific OS (BIOS), drivers, and the Codec Engine Framework. TI also provides optimized A/V codecs for common applications.

- = Industry Standard OS S/W Component
- = PSP Package: multiple sources
- = Frameworks/Middleware: multiple sources
- = DaVinci S/W components : come from TI








# Dissection of S/W Architectures

## Typical OMAP/DaVinci S/W Architecture



### 3P DSP S/W Components

TI has a large DSP s/w 3P ecosystem with optimized s/w for many different applications: (A/V codecs, AEC, analytics, VOIP, audio effects, image processing). In many cases this s/w is what differentiates our customers products and wins TI the socket.

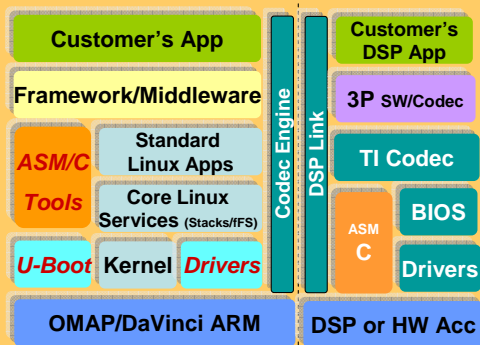
-  = Industry Standard OS S/W Component
-  = PSP Package: multiple sources
-  = Frameworks/Middleware: multiple sources
-  = DaVinci S/W components : come from TI
-  = 3P DSP S/W components : multiple sources





# Dissection of S/W Architectures

## Typical OMAP/DaVinci S/W Architecture



## Customers Application

Ultimately you, the customer, is responsible for integrating this complex matrix of s/w components. As you can imagine the challenges in debugging s/w problems in these types of systems are very high.

- Industry Standard OS S/W Component
- PSP Package: multiple sources
- Frameworks/Middleware: multiple sources
- DaVinci S/W components : come from TI
- 3P DSP S/W components : multiple sources
- Customer App : customer






## **Part 2: TI codecs, OS, S/W collateral and support models on OMAP and DaVinci**

**What should you expect from TI.**



# Codec Bundles Available on eStore

[www.ti-estore.com](http://www.ti-estore.com) - click on DSP – Embedded Software  
or [www.ti.com/codecbundles](http://www.ti.com/codecbundles)

 **TEXAS INSTRUMENTS**

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DSP

Starter Kits

Software Development Tools

Development Platforms

Evaluation Modules (EVM)

Daughter Cards

Emulators

Embedded Software

Literature

Analog

Development Boards and EVMs

Daughter Cards

**Ti eStore**

Shopping Cart

Checkout

Order Status


Help


**Ti eStore**

**DSP: Embedded Software**


Code	Name	Price Availability	
DM355SBAUDIO1P	DM355S Codec Bundle AUDIO – PRODUCTION (MP3, WMA, AAC LC, AEC)	\$10,000.00 FREE with Discount Code	<input type="button" value="Add to Basket"/>
DM643XBB01P	DM643x Codec Bundle BASIC – PRODUCTION (H.264, MPEG-4, MPEG-2, JPEG, G.711, NDK)	\$20,000.00 FREE with Discount Code	<input type="button" value="Add to Basket"/>
DM644XBB01P	DM644x Codec Bundle BASIC – PRODUCTION (MPEG-4, MPEG-2, JPEG, G.711)	\$20,000.00 FREE with Discount Code	<input type="button" value="Add to Basket"/>
DM646XBB01P	DM646x Codec Bundle BASIC – PRODUCTION (H.264, MPEG-2, JPEG, G.711)	\$20,000.00 FREE with Discount Code	<input type="button" value="Add to Basket"/>
DM648BB01P	DM647/8 Codec Bundle BASIC – PRODUCTION (H.264, MPEG-4, G.711, NDK)	\$20,000.00 FREE with Discount Code	<input type="button" value="Add to Basket"/>
TMD5NDK	Network Developer's Kit (NDK) TCP/IP Stack	\$5,000.00 In Stock	<input type="button" value="Add to Basket"/>

**NOW AVAILABLE!** – Get started today with FREE\* production-ready, easy-to-use audio and video codec bundles for digital media processors based on DaVinci™ technology. Bundles include NDK, G.711, JPEG, MPEG-2, H.264 BP and MPEG-4 SP codecs.  
\* Production license fee will be waived if customer accepts electronic production click-wrap license and receives software via download from TI.

 **TEXAS INSTRUMENTS**

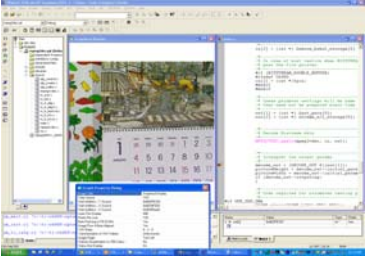


## TI Codec Software Products



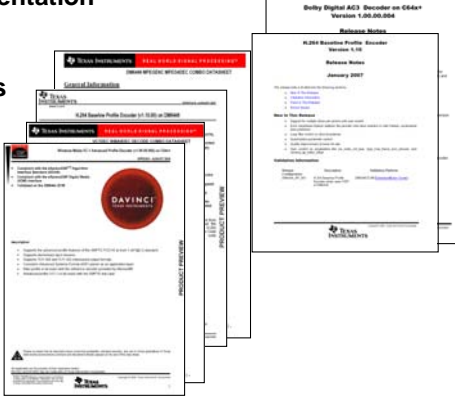
- **eXpressDSP Digital Media Software follows eXpressDSP Digital Media (xDM) Standard**
  - Includes complete documentation requirements
- **xDM is an extension to the earlier eXpressDSP Algorithm Interface Standard (xDAIS) specification, providing additional support for codecs**


**Usage Examples**



**Complete Documentation**

- Datasheets
- User Guides
- Release Notes













eXpressDSP digital media software is xDM compliant

Another important component to software as a product is complete documentation, which we have specified as a requirement for every algorithm sold through this program.

Preliminary datasheets and user guides are available, but can only be shared with customers under NDA.

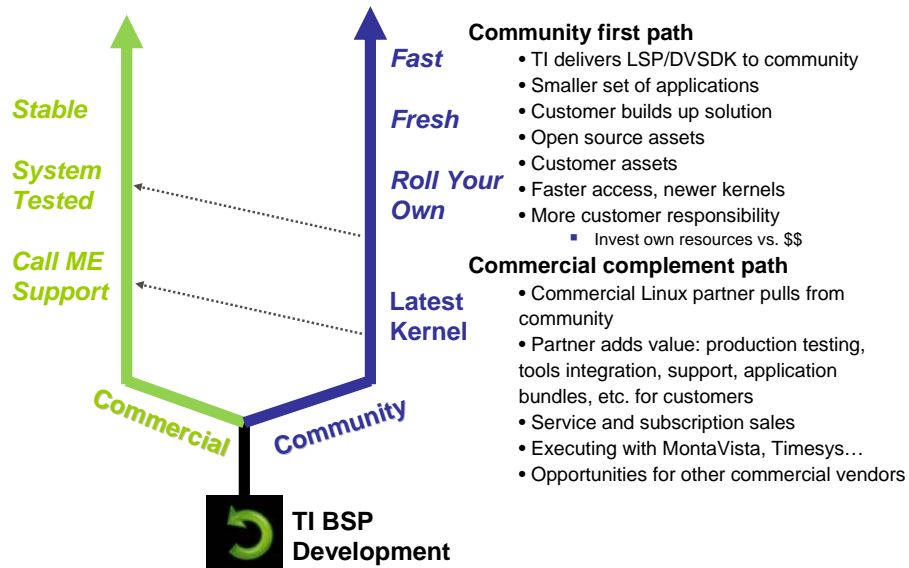
<div>  <h2>Popular Operating System Options</h2> </div>			
Tool / Top features	OS	Device Support	Key Features
	DSPBIOS	DaVinci™, OMAP™, C6000™, C5000™, C2000™	<ul style="list-style-type: none"> <li>IDE and royalty free DSPBIOS</li> <li>Low level debug of ARM</li> <li>DSP development and Debug</li> <li>Co-debug of ARM &amp; DSP</li> </ul>
	Linux	DM644x, DM6467, DM335, DM355	<ul style="list-style-type: none"> <li>stable, pre-tested, supportable code base</li> <li>Production licensing through TI</li> <li>Indemnification</li> </ul>
	Integrity Linux	DM644x, OMAP35x	<ul style="list-style-type: none"> <li>MULTI debug environment for DSP and ARM</li> </ul>
	Linux	DM644x, DM6447, DM3x, OMAP35x	<ul style="list-style-type: none"> <li>GNU Toolchain</li> </ul>
	Linux	OMAP35x, DM6467 and DM644x (coming soon)	<ul style="list-style-type: none"> <li>web-based software subscription</li> <li>An initial Linux platform, pre-compiled for the processor</li> <li>Customize-able Eclipse-based IDE</li> </ul>
	WinCE	OMAP35x	Extensive experience and expertise with WinCE development
	WinCE	DaVinci	WinCE 6 BSP
<div>  </div>			

- Here is a one page summary of our current OS offering and map to the processors.
- This is not a complete list of all the embedded OS vendors that are working with TI today as many are in the process of implementing their ports based on investment and customer demand.
- You have a couple of options for Linux including not shown here and Open Source Linux following that was kicked off in June.
- See me afterward to discuss Open Source.





## TI processor customers can CHOOSE your Linux path: Community or Commercial





## Good References

**Greg Kroah Hartman on kernel development**

– <http://www.youtube.com/watch?v=L2SED6sewRw>

**Cost of Deployment Models**

– See: “Embedded Linux Total Cost of Development Analyzed”

– At: <http://www.embeddedforecast.com/>

**DaVinci™ technology & OMAP™ platform community resources**

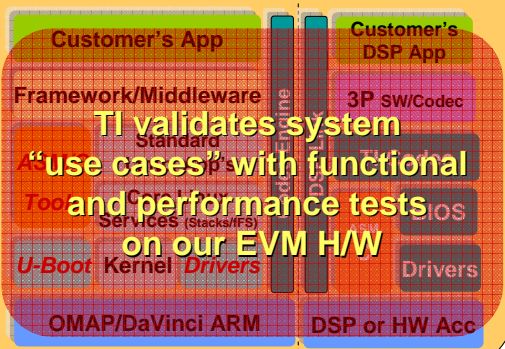
– wiki: <http://wiki.davincidsp.com/> or <http://wiki.omap.com/>

– Wiki documents mailing list, git repositories, etc



## Use Cases and the “Tool Chain Reaction”

### Typical OMAP/DaVinci S/W Architecture



### Use Cases

A use case defines the specific h/w and s/w configuration TI used to test the functionality of the PSP s/w on the EVM. Customers should be able to reproduce similar results from the PSP.

If customers deviate from either the TI tool chain or the tested modes of functionality TI will be able to provide very limited support.

Make sure you review TI's supported PSP use cases





## Appendix from Linux Driver Data Sheet

### Texas Instruments DM644x/DM355

- 1.1 Device Drivers Summary
- 1.2 Limitations Summary
- 1.3 Linux Base Port Overview
  - 1.3.1 Toolchain and Version Information
  - 1.3.2 Tested Modes
  - 1.3.3 Timers
- 1.4 LSP/PSP Version Information
- 1.5 Documentation Support
- 2 Linux Kernel Device Drivers
  - 2.2 Video Drivers
    - 2.2.2 Video Display Driver-V4L2
    - 2.2.3 Video Display Driver-FBDev
    - 2.2.4 Video Capture Driver
    - 2.2.5 IPIPE Driver
    - 2.2.6 Previewer Driver
    - 2.2.7 Resizer Driver
    - 2.2.8 H3A Driver
  - 2.3 Audio Driver
  - 2.4 Ethernet Drivers
  - 2.5 USB Drivers
  - 2.6 IDE ATA Driver
  - 2.7 MMC/SD Driver
  - 2.8 NAND Driver
  - 2.9 NOR Driver
  - 2.10 UART Driver
  - 2.11 I2C Driver
  - 2.12 SPI Driver
  - 2.13 PWM Driver
  - 2.14 Watchdog Driver
  - 2.15 GPIO
  - 2.16 EDMA
  - Appendix A – U-Boot Overview



## Each Software component/supplier has it's own unique support model

S/W Component	Support Options	Comments
Core OS (Linux, WinCE...)	OS Vendor (MV), Open Source	Monta Vista, Greenhills(Integrity), Mistral, Bsquare, Communities
PSP Package	Supplier of PSP package	<b>TI for Linux DvSDK(PSP) only*</b> Otherwise it's the PSP vendor or OS community
Frameworks Middleware	Suppliers of framework or middleware package	Huge number of options depending on the customers s/w ecosystem.
DaVinci S/W components*	Mainly TI, potentially a 3P*	TI supports issues with DSP tools, BIOS, Codec Engine....
TI Codecs*	TI or ASP (Authorized SW Partner)*	TI direct support limited. Customers may need to contract ASP for support
3P S/W or Codecs	3P	Customers should make sure 3P's are contractually bound to support
Customers App (System integration)	<i>The customer (and everybody involved in the deal.)</i>	Incredibly difficult to isolate system failures. Resolutions are case specific.

\*Yellow text indicates what TI directly supports





## Do your own research!

- There is no one right choice
- Each project and team has its own needs
- However, many people underestimate what it takes to “DIY”?
  - Make an informed choice
  - Think about what is required for the whole product and product lifecycle
  - Learn from others



## **Part 3: System Frameworks and Applications Flash, AV sync, GUI's Graphics**

**Things above and beyond what TI  
provides as standard support  
software and chip collateral.**



## Conquering the SW Complexity



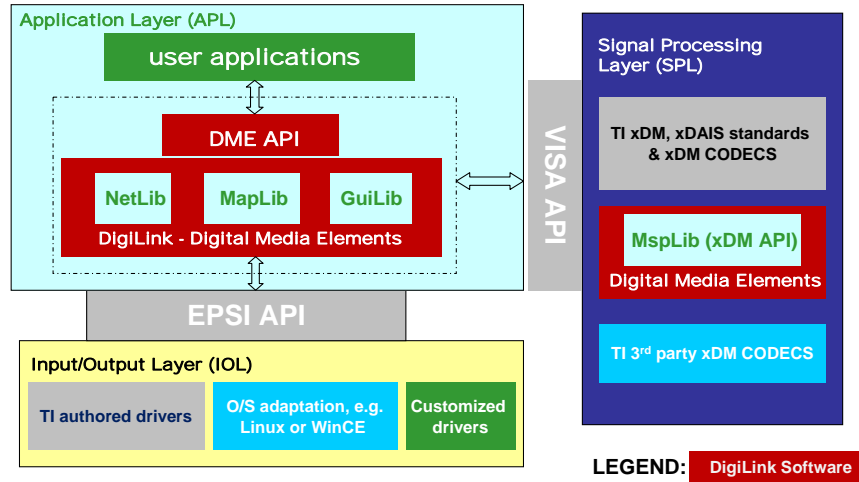
- **Linux application development and integration**
  - Graphics, enhanced user experience
  - Multiple UI framework: native & flash-based
- **Audio / Video Framework**
  - Adding AV sync and Media container support
    - TI offers only elementary stream codec I/O
- **Expanded video codec offering**
  - Flash video support: Sorenson Spark 3, On2 VP6/7, H.264
  - Proprietary algorithms
- **Custom development services**
  - Porting, optimization, customization on ARM or DSP
- **Key to success is working together**
  - Customer, DigiLink & TI
  - Objective: bringing product quickly to market







# DME SW Framework





## DME SW on TI DaVinci/OMAP



- **MapLib**
  - Standard file container support
    - Flash Video (FLV)
    - MPEG-2 Program Stream
    - MPEG-2 Transport Stream
    - MP4 File Format
  - A/V De-muxing & synchronization
- **MspLib**
  - A/V codecs
    - Spark3 decoder
    - VP6 decoder
    - MP3 decoder
    - H.264 encoder/decoder
    - MPEG4 encoder/decoder
    - AAC/LC encoder/decoder
    - JPEG encoder/decoder
  - Advanced video enhancement
- **GuiLib**
  - DirectFB (DFB)-based GUI
  - Adobe FlashLite-based GUI
- **NetLib**
  - Streaming support
    - HTTP
    - RTSP





## DME Application Areas



### Major Verticals

- Video on Demand
- In-Flight Entertainment
- Automotive Entertainment
- Digital Signage
- Video Surveillance

### Consumer Products

- IP-Set Top Box
- Digital Media Adapter
- Portable Media Player
- Smart Phone
- Networked Appliances

Expanded applications based on ARM only DaVinci/OMAP Parts





## Case Study 1

### Previous Generation

- Analog solution
- Simple user interface
- Standalone
- Hard to upgrade
- Hard to maintain
- Product only

### Next Generation

- Digital solution
- Rich media experience
- Networked
- Easy to upgrade
- Easy to maintain
- Service platform

### DigiLink

- Digital media player software license (MapLib)
- Displayer manager (GuiLib)
- Firmware development service
- Full customer development & integration
- On-going maintenance and support





## Case Study 2

### Previous Generation

- Old compression
- Simple user interface
- Hard to integrate
- Hard to upgrade
- Hard to maintain

### Next Generation

- Advanced compression
- Rich media experience
- Easy to integrate
- Easy to upgrade
- Easy to maintain

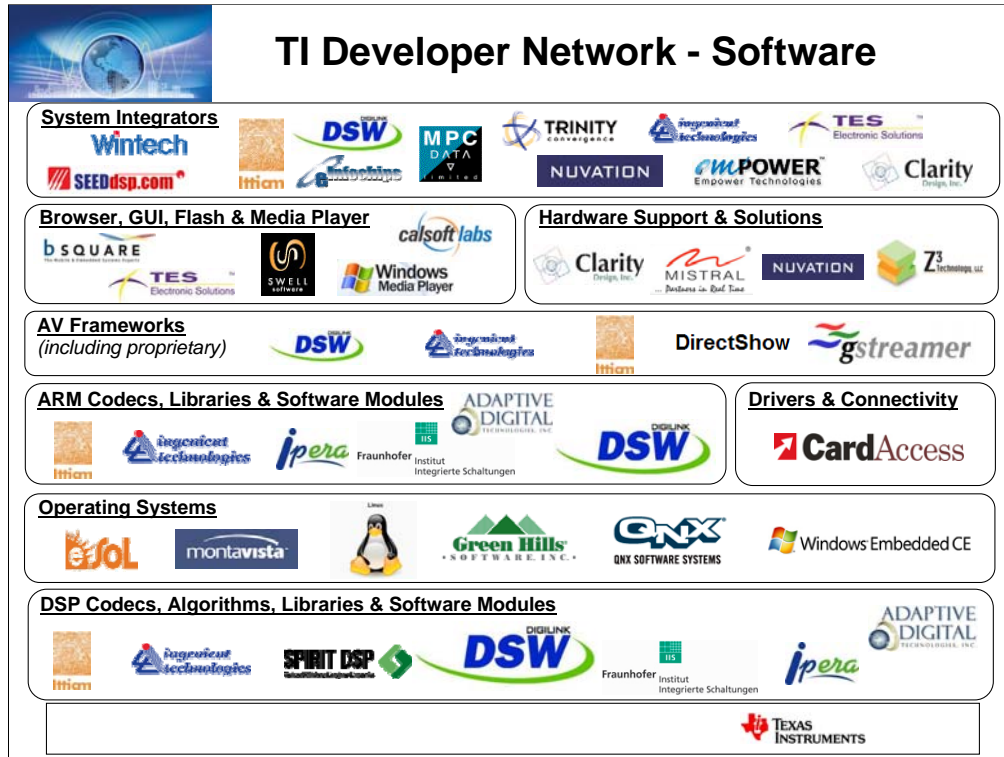
### DigiLink

- End-to-end streaming media software license (MapLib & NetLib)
- Displayer manager (GuiLib)
- Firmware development service
- On-going maintenance and support





## **Part 4: Best Practices and Conclusions**



Baseport – Code Compatible

Bridge

Bridge is ported alpha 9/30

IVA shuttle is eliminated by Helios4

IVA Codecs to be ported

DSP Codecs move to IVA2

Graphics Code Compatible

Theia Code Compatible



# Best Practices

- Fully understand your S/W architecture before selecting your h/w or engaging in any s/w licensing contracts.
  - Have detailed use cases documented for all peripherals, codecs and GUIs!
  - Test codecs before you license them! (*especially TI codecs*)
  - Have clear compliance testing specifications outlined for all major s/w components, especially ones you are outsourcing.
  - What OS makes the most sense? (Cost, boot time, security, framework...)
  - What codec do you really need? Where is your content coming from?
  
- Be realistic about s/w integration complexity, scope of internal expertise, and development schedules.
  - Cost of Third Party s/w and support may be justified.
  - The best solution might be to engage with multiple third parties.
  
- Get some training
  - Take TI's 4-Day classes – DaVinci Workshop, C6x Code Opt workshop...
  - Industry training (Bsquared, Free Electrons...)
  
- Plan ahead - what if things don't work - the development schedule slips?
  - Have clearly outlined support terms in place with all your s/w providers.
  - Have clauses in place to extend support beyond initial support period!
    - What if you have field failures with a 3P s/w codec 2 years from now?

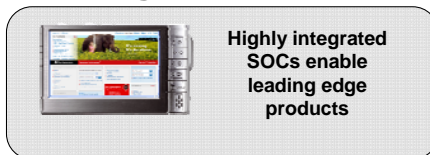
**Ultimately system integration is owned by you “the customer”**





## Who moved my cheese?

- DaVinci & OMAP truly integrate an entire embedded “system” into a single device.
  - ARM, DSP, USB, Video ports ....
- This integration offers huge benefits:
  - System Cost
  - Power
  - Form Factor
  - Performance
- This integration also introduces new challenges:
  - *The key to successful product development is to fully understand your S/W architecture and have a bullet proof s/w integration plan.*





**Thank You**