

Design a Davinci-based Smart IPNC

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Agenda

- Davinci enables various IPNC design for video security
 - Video security requires IPNC
 - Low/medium/high-end IPNC based on IPNC
- Design a IPNC based on Davnici
 - Challenges to building a Video Product
 - System overview
 - Pick codec and Video analytics for a IPNC
 - Leverage Davinci technology for IPNC
- Some examples of Davinci-based smart IPNC
- Conclusion

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Video Security requires IPNC



Video →

... Compress video

... Stream video



BUT:

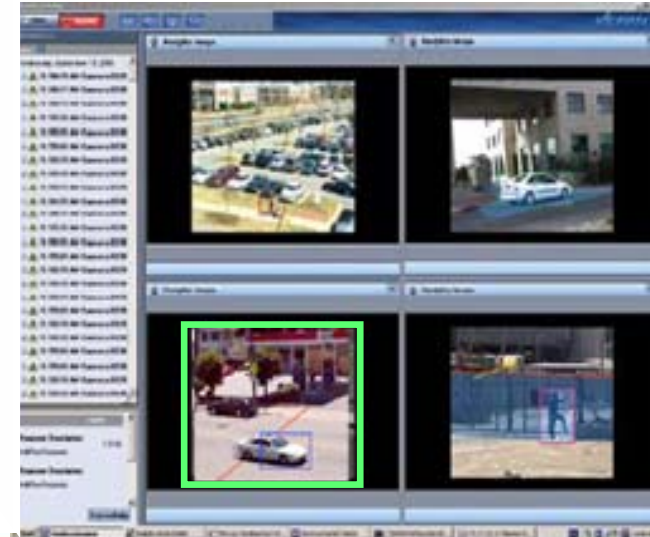
- No one is effectively watching the video
- No one is alerted when something of significance happens
- Events are not being mined
- Network bandwidth and storage used for the 98% of video that is never used
- When something does happen, video is too low quality
- When something does happen, video searching is a manual, real-time process

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Davinci-based IP NetCam Design



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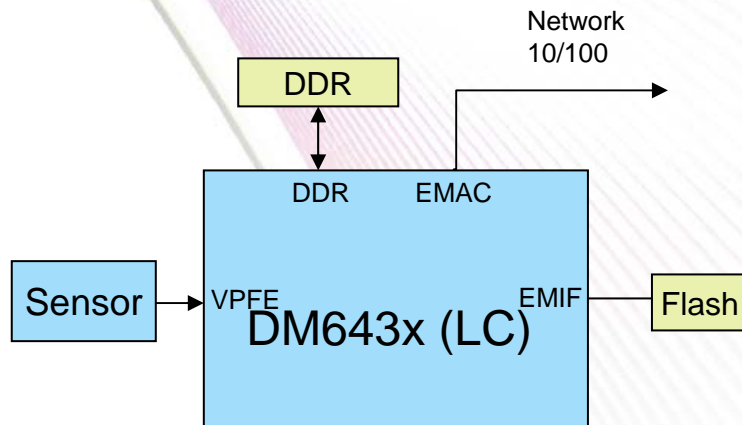
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IP Network Camera Product Features Classification

Product Types	Features
Digital low-end IP cam	<p>Resolution: CIF to D1, ~10-20 fps.</p> <p>Video Compression: MJPEG, MPEG4-SP enc 4Mbps, H.264</p> <p>Multistreaming: None. JPEG images only when event captured.</p> <p>Analytics: Video motion detection. Light on/off detection.</p> <p>Preprocessing: None. Assumes CMOS sensor.</p> <p>Other: IP Streaming</p>
Digital mid-end IP cam	<p>Resolution: D1, 30 fps</p> <p>Video Compression: MPEG4-SP enc, MJPEG, H.264-BP enc</p> <p>Multistreaming:</p> <p>Option1: Hi-res (MPEG4-SP, D1,30fps, 2Mbps) + Low-res(MPEG4-SP, CIF,15fps). JPEG images only when event captured.</p> <p>Option 2: Hi-res(H264-BP, VGA, 25fps, 1.3Mbps) + JPEG images only when event captured.</p> <p>Analytics: Video virtual-wire detection, Object tracking, Object Classification (human/non-human), Object Size Filters, Object Size Change Filters, Camera motion, Saliency Filters, Schedules</p> <p>Preprocessing: De-interlacer, sensor-compensation, (CMOS & CCD camera support), white-balance, auto exposure</p> <p>Other: IP Streaming, Pan, tilt, zoom in and out, local storage, PoE</p>
Digital high-end IP cam	<p>Resolution: 720p, 1080i/p, 10-30fps.</p> <p>Video & Audio Compression: MPEG4-SP, MJPEG, H.264-BP, SVC, Audio (G.711, G.729AB) (optional)</p> <p>Multistreaming: triple streaming</p> <p>Option1: Hi-res (MPEG4-SP, 720p,30fps, 5-8Mbps) + Low-res(MPEG4-SP, D1,15fps). JPEG images only when event captured.</p> <p>Option 2: Hi-res(H264-BP, 720p, 30fps, 5-8Mbps) + Low-res(H264-BP) + JPEG images only when event captured.</p> <p>Analytics: Same as Mid-end + Appears Event Detection, Disappears Event Detection, Loitering detection, behavior detection, human/vehicle counting, speed classification, facial recognition.</p> <p>Preprocessing: white-balance, auto exposure, sensor-compensation, de-noising, low-light compensation, Watermarking</p> <p>Other: Secure IP Streaming with AES, pan, tilt, zoom in and out, local storage, PoE</p>

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Low-End IP Network Camera Solution



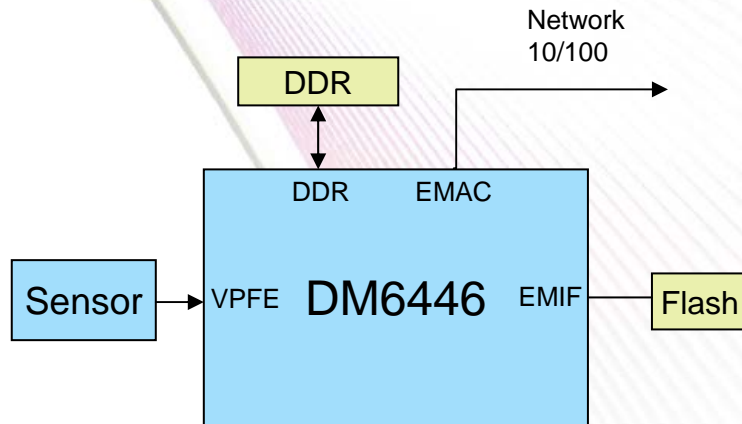
DM643x (LC)

- C64x+ 600MHz
- Signal Processing Layer (SPL)
 - Components
 - MPEG4 encode (up to 720p 24fps)
 - H.264 BP encode, D1 30fps
 - JPEG encode
 - Video Analytics
 - Codec Combos
 - Encode(MPEG4/H264) + VA
- Application Processing Layer (APL)
 - Linux + BIOS
 - Camera Controller
 - Network Interface
- Input Output Layer (IOL)
 - Drivers for all peripherals
 - Image Pipe Control
- Benefits
 - Multi Codec support
 - Multi stream support
 - Video Analytics option

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Mid-end IP Camera



DM6446

- C64x+ 600MHz
- ARM9, 300Mhz
- VICP, VPSS(Image pipe)
- Signal Processing Layer (SPL)
 - MPEG4 encode (up to 720p 24fps)
 - H.264 BP D1 30fps
 - JPEG encode
 - Video Analytics
 - Codec Combos
 - Encode + VA
- Application Layer (APL)
 - Linux Host
 - Camera Controller
 - Network Interface
 - Image Pipe Control
- Input Output Layer (IOL)
 - Drivers for all peripherals

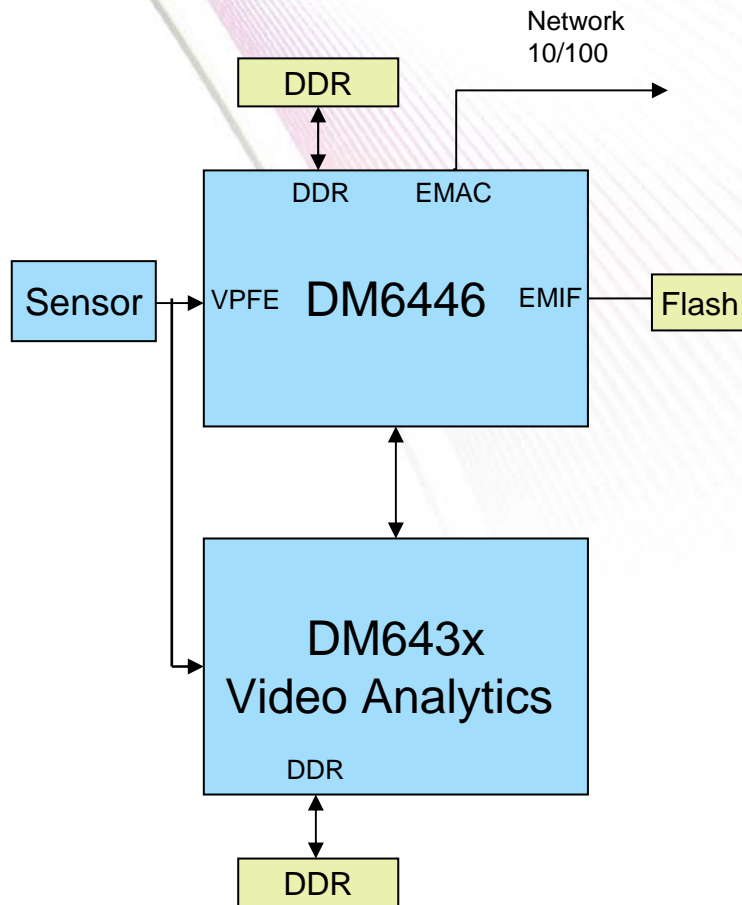
Benefits

- **Encode with Video Analytics capabilities**
- **Multi streaming support**
- **Tightly integrated**

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TI | Developer Conference Hi-end IP Camera with Video Analytics



DM6446 + DM643x

- C64x+ 600MHz
- ARM9, 300Mhz
- VICP, VPSS(Image pipe)
- Signal Processing Layer (SPL)
 - MPEG4 encode (up to 720p 24fps)
 - H.264 BP D1 30fps
 - JPEG encode
 - Video Analytics
 - Codec Combos
 - Encode + VA
- Application Layer (APL)
 - Linux Host
 - Camera Controller
 - Network Interface
 - Image Pipe Control
- Input Output Layer (IOL)
 - Drivers for all peripherals

Benefits

- **Encode with Video Analytics capabilities**
- **Multi streaming support**
- **Tightly integrated**

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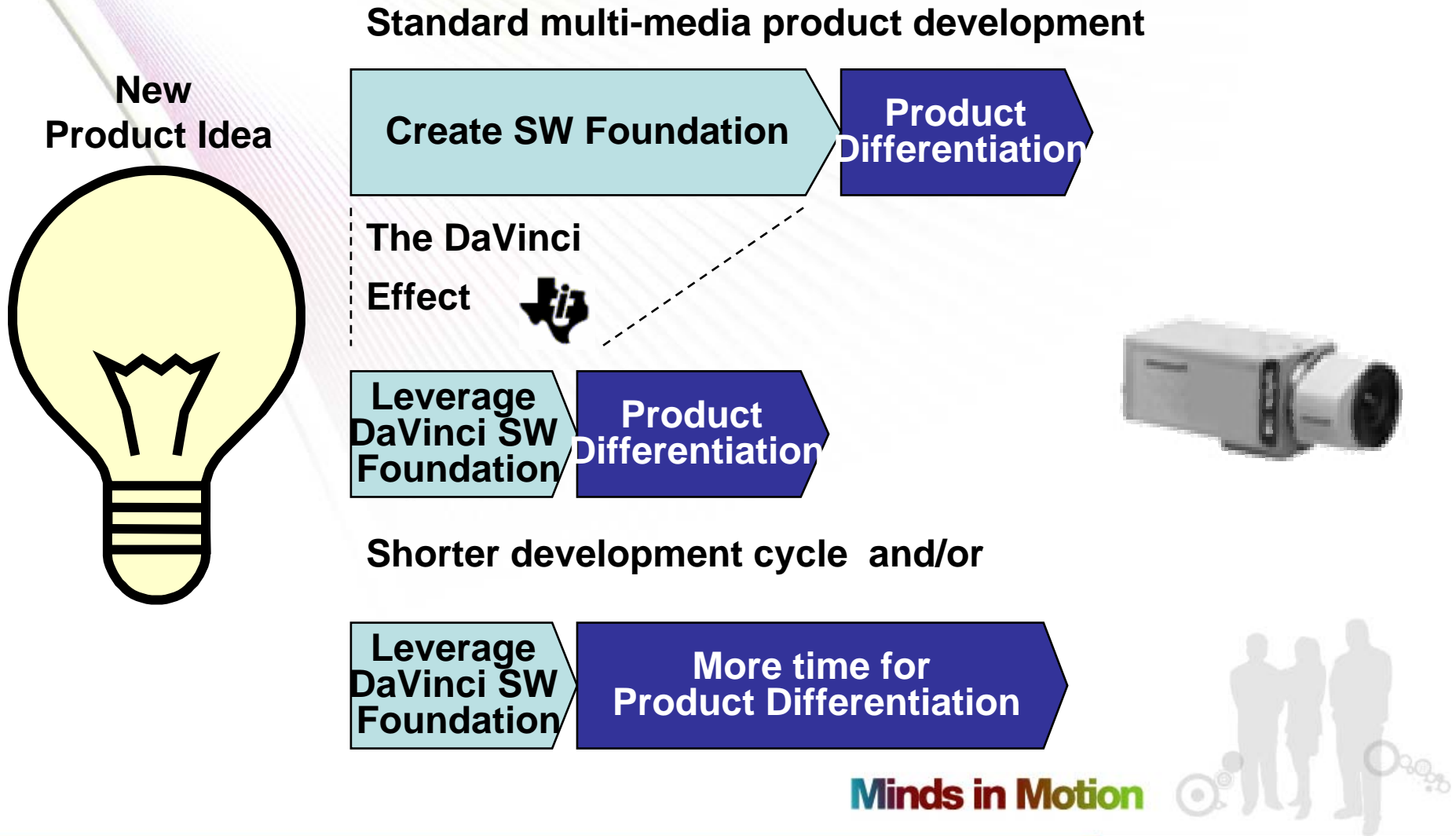
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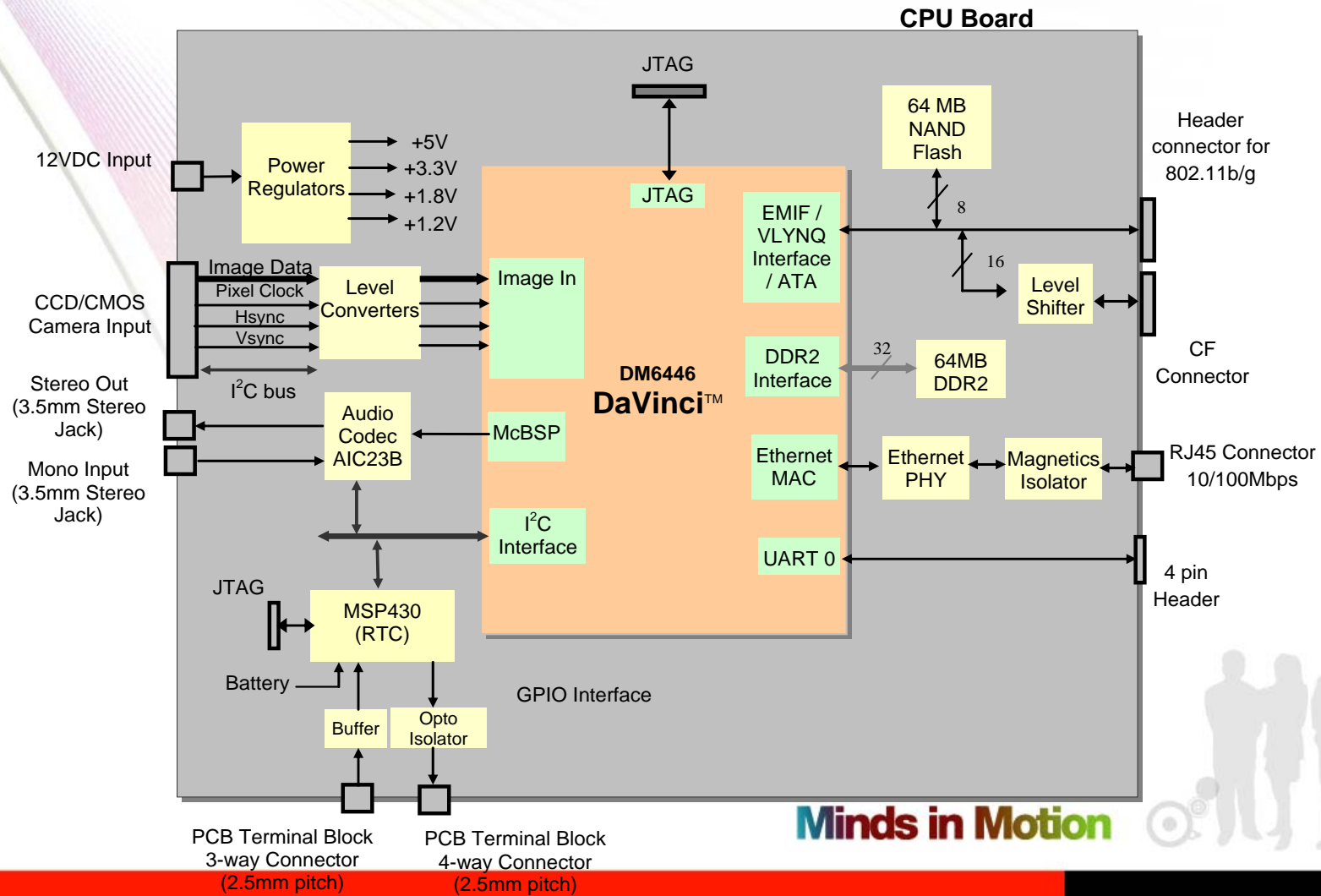
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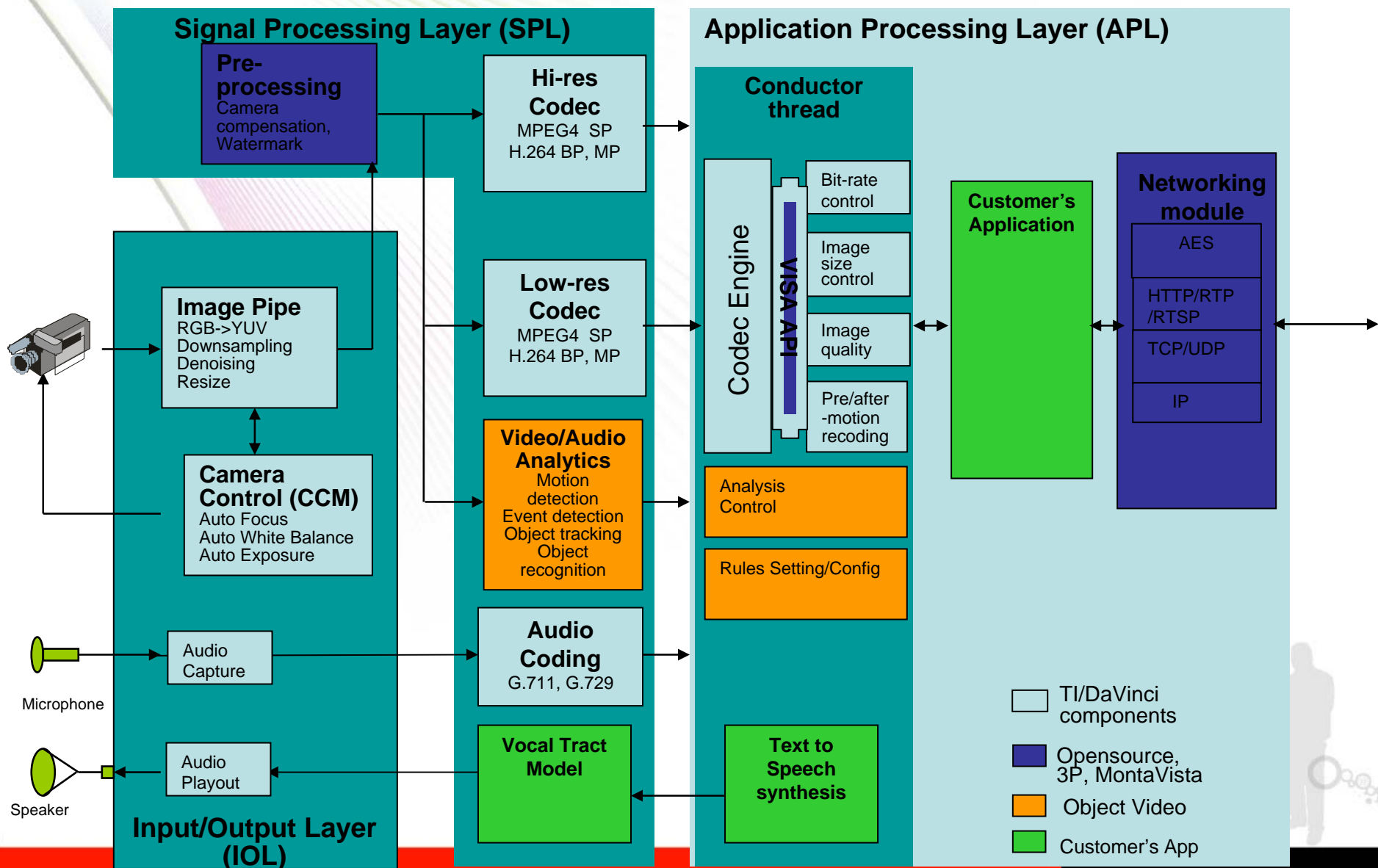
Goal: Accelerate Time to Market



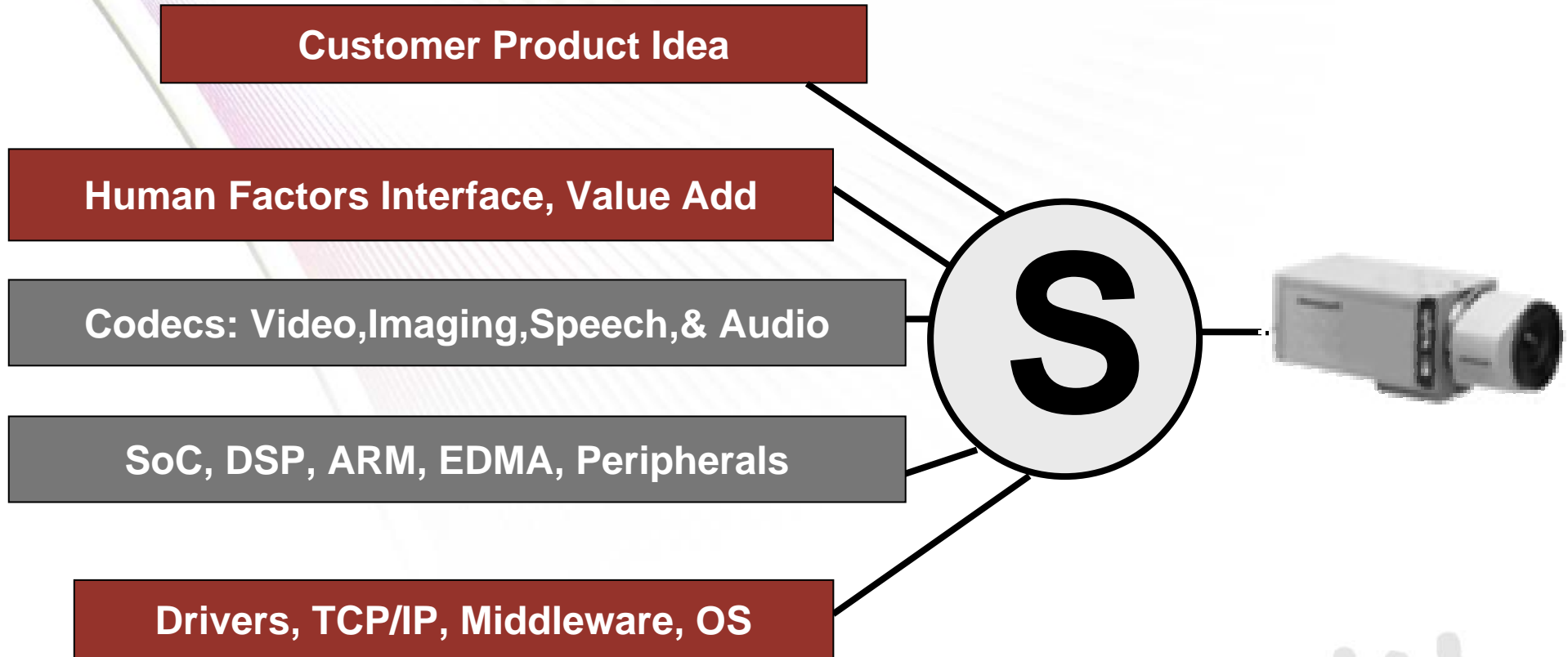
IPNetCam Hardware Block Diagram



TI | Developer Conference IP Network Camera Processing modules



Software Challenges to Building a Video Product

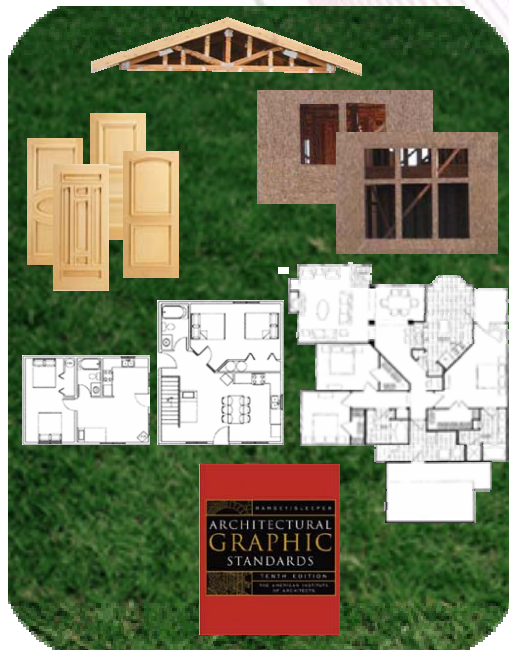


- ◆ Requires expertise in a variety of different domains
- ◆ Several man years to have a hardened codebase

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Transitioning from Bare-deck Silicon to Silicon with Component SW



	Silicon	Silicon + SW
Device	✓	✓
EVM	✓	✓
Tools	✓	✓

Pretested Component-ware <i>(windows, walls, doors)</i>		✓
Drivers		✓
Codecs		✓
Pretested subsystem-ware <i>(floor plans)</i>		✓
Codec combos		✓
Integrated drivers in OS		✓
Ease of Use and Rules <i>(building codes)</i>		✓
Rules for <u>replacing</u> components		✓
APIs, Framework <i>(Abstraction ware)</i>		✓

Pick video codec/VCA for a IPNC

	A	B	C	D	E	F	G
1	Signal Processing modules	Res.	FPS	coding mode	bitRate	Average MHz	Peak MHz
2	MPEG4 (TI version 1.1)	D1	30	CVBR	2Mbps	308	320
3	MPEG4 (TI version 1.1)	CIF	15	CVBR	256Kbps	45	49
4	H.264 (TI version 1.1)	D1	30	CVBR	1.3Mbps	373	431
5	H.264 (TI version 1.1)	VGA	25	CVBR	1.3Mbps	291	327
6	JPEG (TI version 1.1)	D1	15	constant QP	QP=50	65	66
7	VCA (ObjectVideo)	QVQA	10			190	210
8							
9	Application case						
10	MPEG4 D1 @30fps + MPEG4 CIF @ 15fps + JPEG D1 @ 15fps					418	435
11	MPEG4 D1 @30fp + VCA QVGA 10fps					498	530
12	H.264 VGA 25 @ 25fps + VCA QVGA 10fps					481	537

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TI | Developer Conference **DaVinci Programmers Model**

- ◆ Three layers ... Application layer, IO layer, and Signal Processing layer
- ◆ Signal Processing layer
 - ◆ presents VISA APIs to all other layers
 - ◆ implement codecs using xDM APIs,
 - ◆ implements all other algorithms using xDAIS APIs
 - ◆ *buffer based processing, decoupled from all other layers*
 - ◆ delivered as
 - ◆ .lib for uniprocessor SoCs,
 - ◆ .out for multiprocessor SoCs
- ◆ Input output layer
 - ◆ presents EPSI APIs to all other layers
 - ◆ implements peripheral drivers
 - ◆ generates an interrupt to APL whenever a buffer is full
 - ◆ buffers in shared memory, only pointers are passed
- ◆ Application layer
 - ◆ implements the conductor thread, GUI, middleware, etc.
 - ◆ orchestrates all input and output streams to other layers
 - ◆ *interfaces with the other layers as built-in library functions*

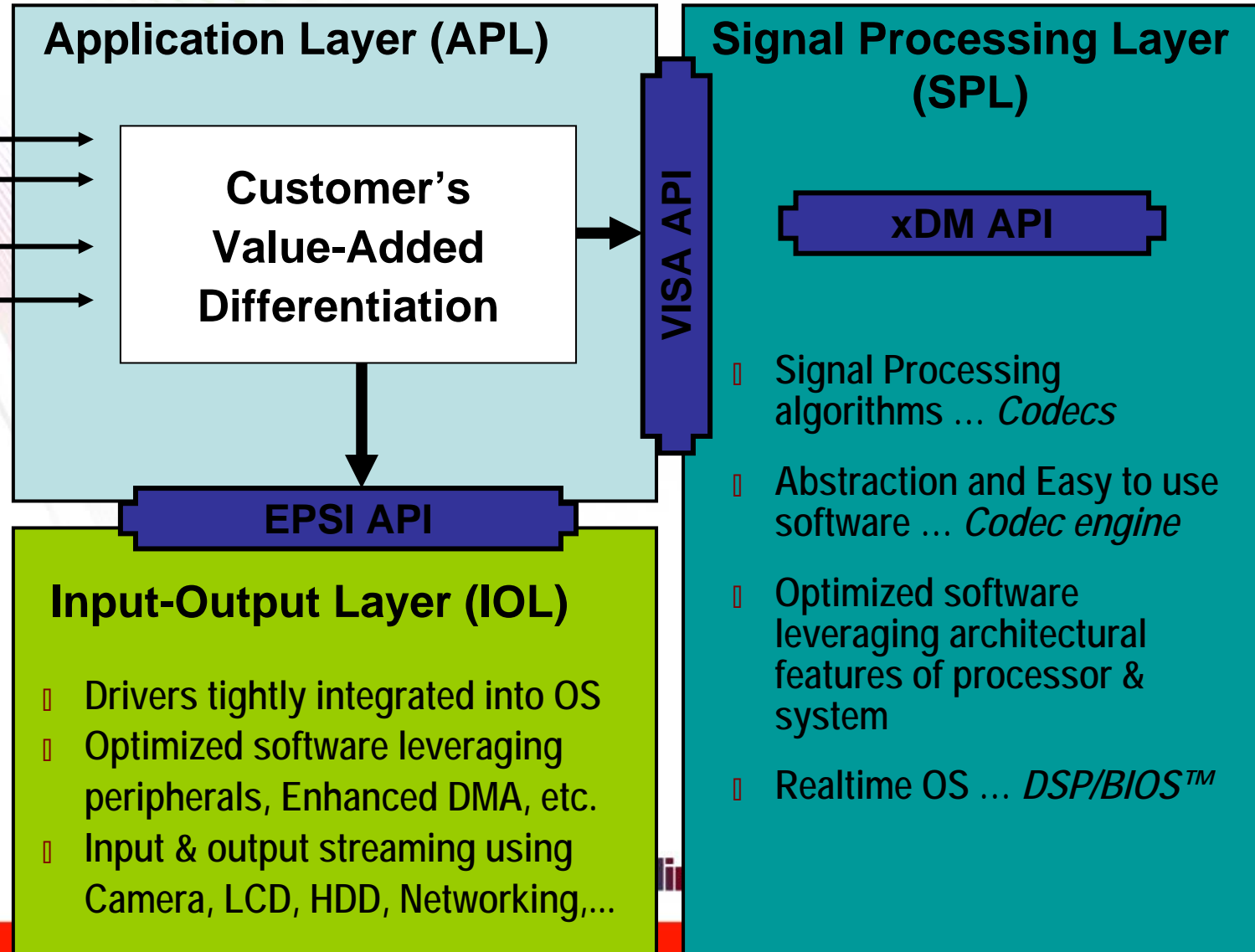
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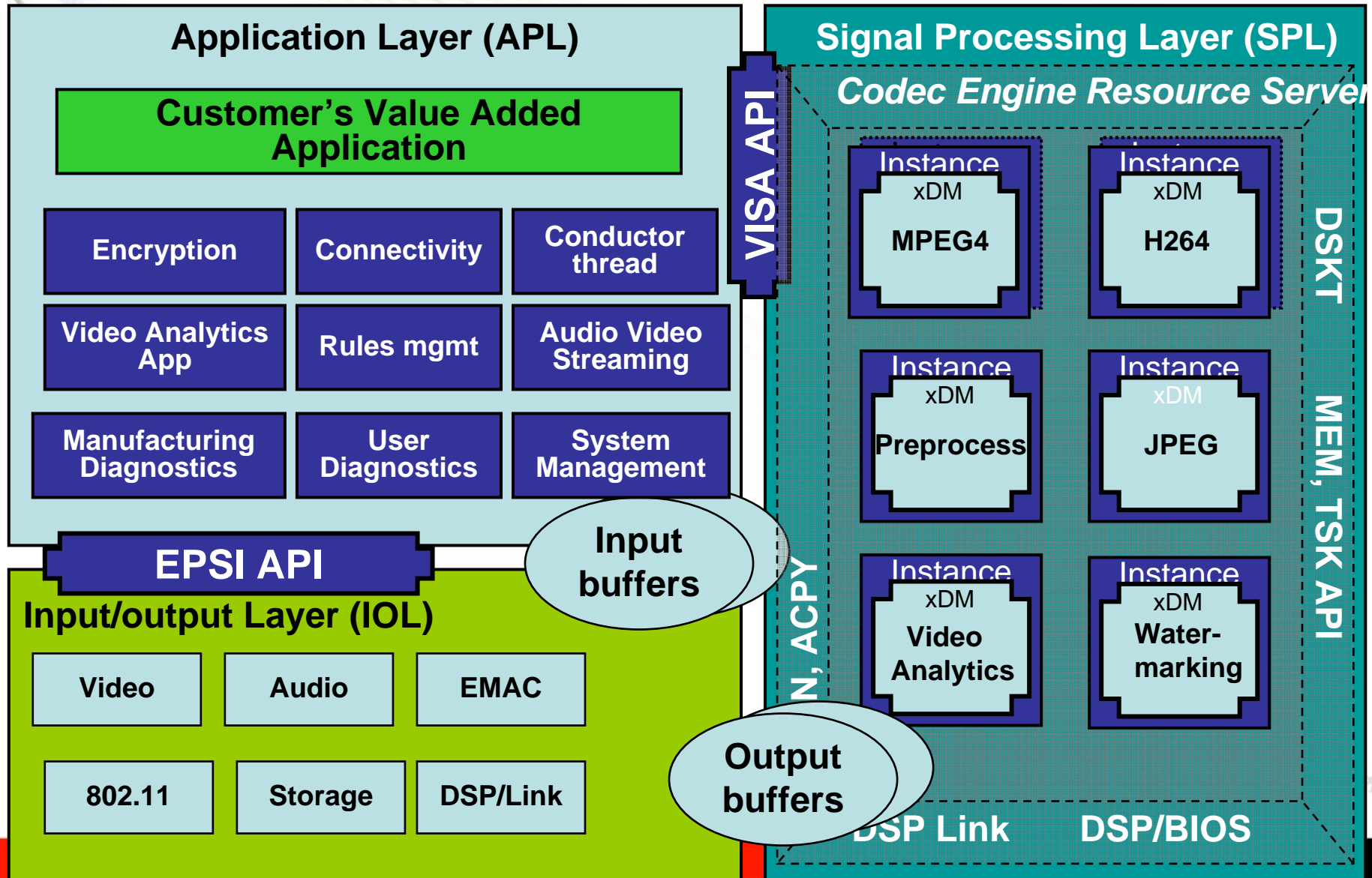
TI|Developer Conference DM644x™ Software Architecture

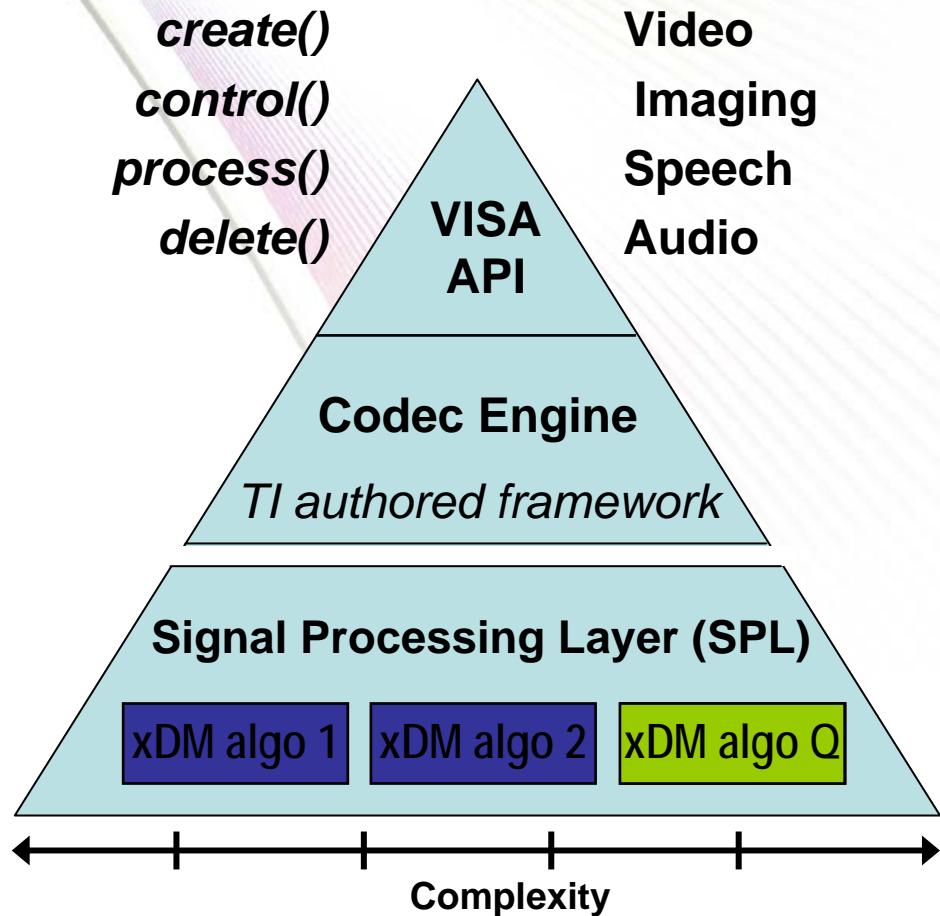
Linux Open
Source
Community
Software

- ◆ Gstreamer
- ◆ FFmpeg
- ◆ OpenHelix
- ◆ Mplayer
- ◆ etc



Scalable IPNetcam SW Architecture based on xDM and Codec Engine





Reducing dozens of API to 4 sets

VISA

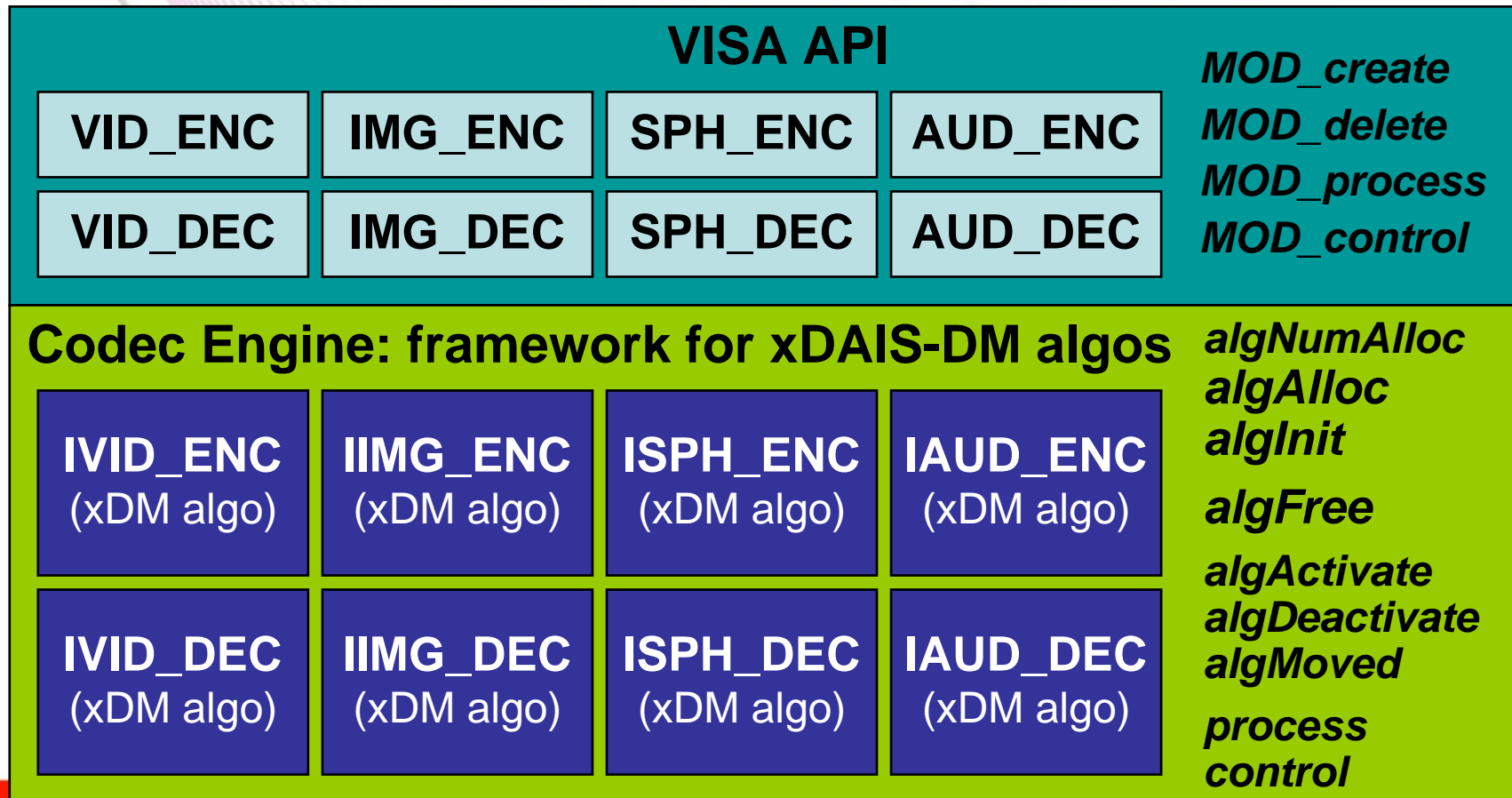
- Complexities of the Signal Processing Layer “SPL” are abstracted via the Codec Engine and VISA API
- VISA API are the user interface to the Codec Engine
- VISA = 4 processing domains :
Video Imaging Speech Audio
- Separate API set for encode and decode
- Thus, a total of 8 API classes:
VIDENC IMGENC SPHENC AUDENC
VIDDEC IMGDEC SPHDEC AUDDEC
- Key API in each set (where “xxx” is one of the groups above):
xxx_create xxx_delete
xxx_process xxx_control
- The experienced DSP programmer can employ a ready-made Signal Processing Layer, create an SPL from packaged or ‘raw’ xDM algos, or author their own algos depending on their needs and skills with DSP

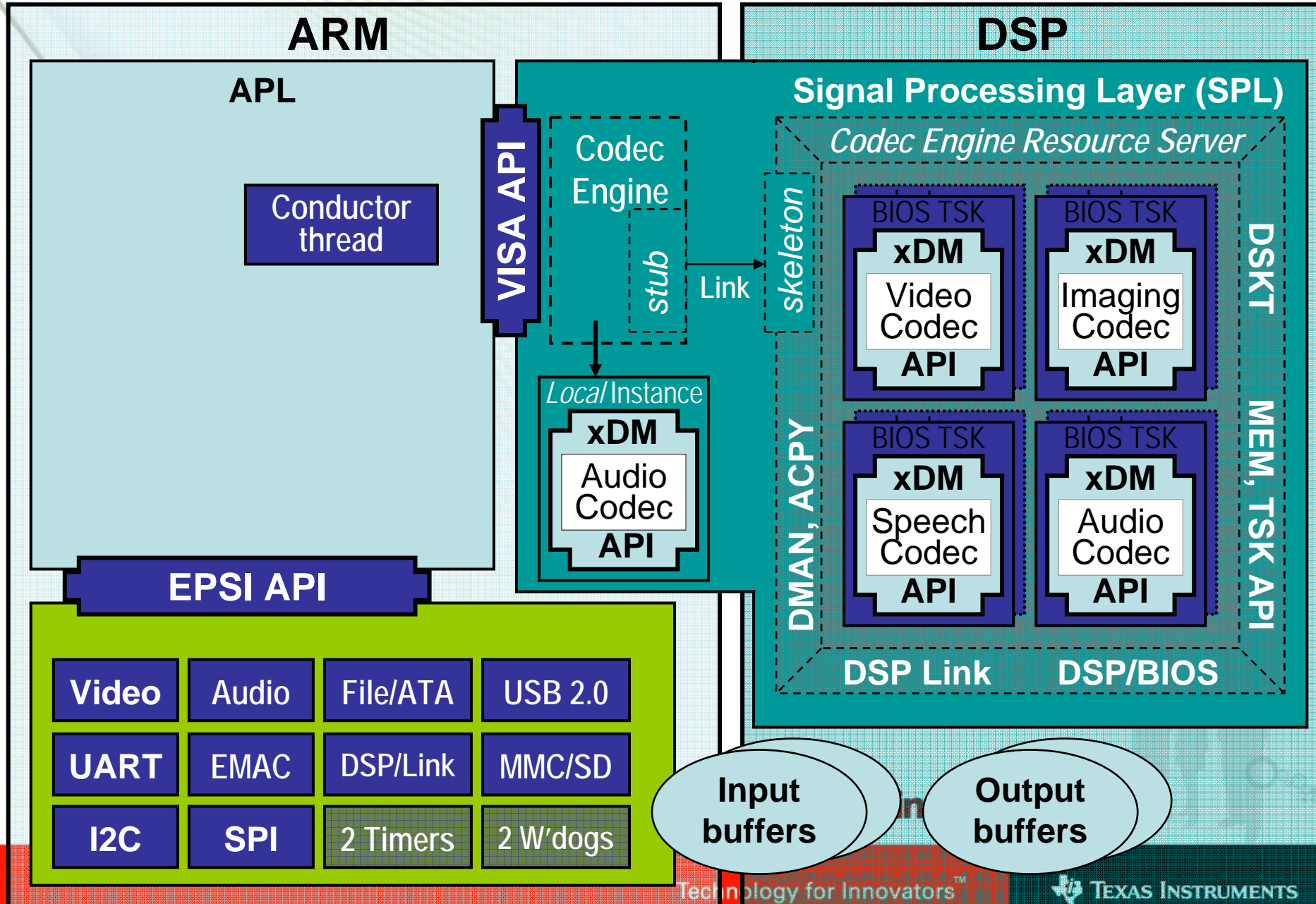
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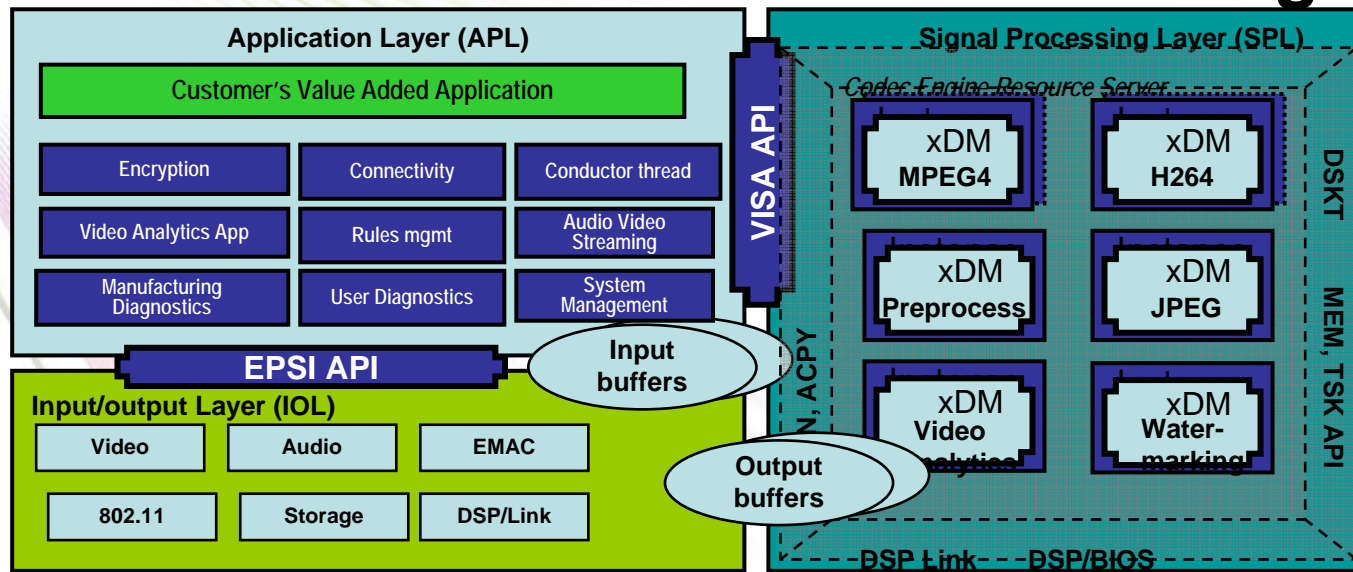
TI | Developer Conference VISA Abstracts Details of xDM Algos

- ◆ Application author controls algos via high level VISA API
- ◆ xDAIS-DM (xDM) algorithms implement an enhanced xDAIS interface
- ◆ Codec Engine is a *framework* that implements VISA fxns on xDM algos
 - ◆ eg: MOD_create() = algNumAlloc() + algAlloc() + MEM_alloc() + algInIt()





Scalable Architecture based on xDM and Codec Engine

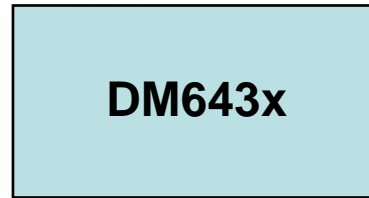


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DM644x

ARM + DSP



DM643x

DSP

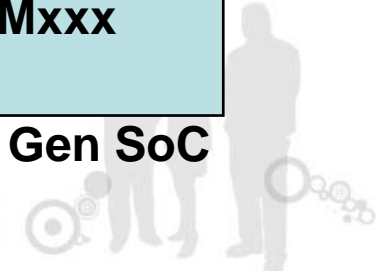


DMxxx

Next Gen SoC

- ◆ Select device based on feature/performance requirements
- ◆ Similar SW developer *experience* across devices

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Benefits of xDM and Codec Engine

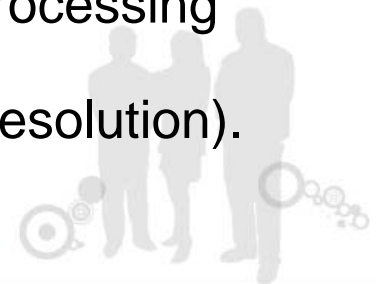
xDM

- ◆ xDM is a standard interface for Signal Processing functions.
- ◆ Insulates Application Layer from Signal Processing Layer
 - ◆ APL developer can continue to develop in parallel to SPL
- ◆ Easily replace SPL components
 - ◆ newer versions can be easily plugged in without changes to APL
 - ◆ replace one member of a class with another eg H264 with MPEG4

Codec Engine

- ◆ abstracts interprocessor communication
- ◆ high level abstraction of the complexities of signal processing layer
- ◆ low-level control of algorithms (bit-rate, frame-rate, resolution).

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TI Digital Media Software

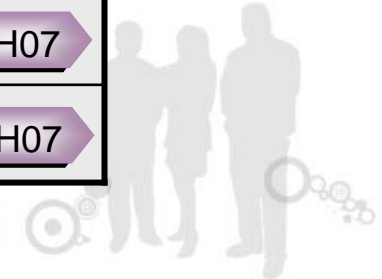
TI Digital Media Software	DM644x	DM643x
Video / Imaging		
Decoders MPEG-4 SP, H.263 p0, H.264 BP, H.264 MP, MPEG-2 MP, WMV9 MP/AP, VC1, JPEG	Now	2007
Encoders MPEG-4 SP, H.264 BP, JPEG	Now	2007
Voice / Speech		
G.711	Now	1H07
Wireline Voice Codecs G.722, G.726, G.723.1, G.729AB	1H07	2H07
Wireless Voice Codecs GSM-AMR, GSM-FR, GSM-EFR, EVRC, WB-AMR – G.722.2	1H07	2H07
Audio		
Decoders MP3, WMA9, AAC LC, HE-AAC, AC-3	Now	1H07
Encoders WMA8, AAC LC, HE-AAC	Now	2H07

Production

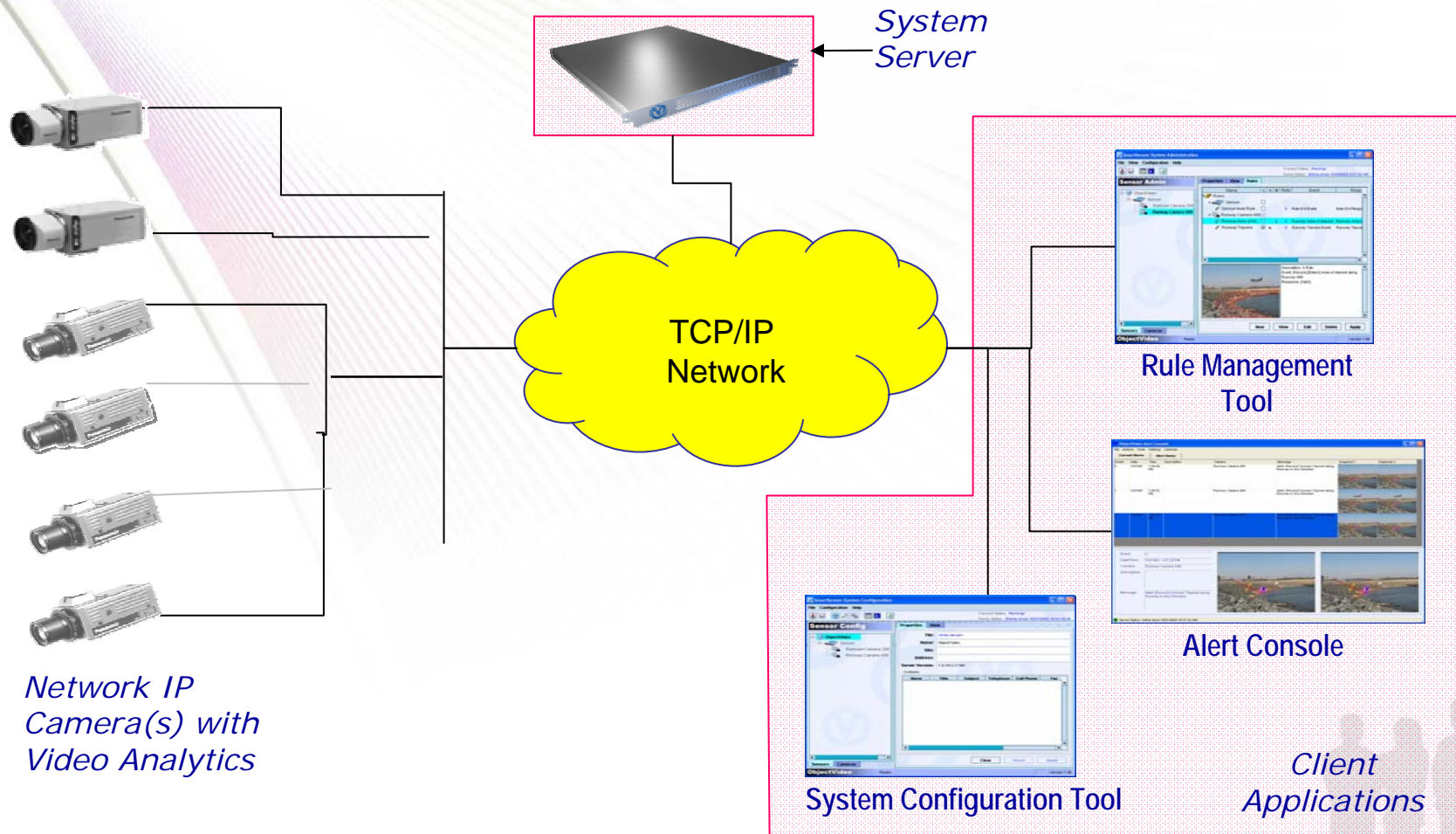
In Development

Future

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Video Analytics System Architecture



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VCA Packages

- Package A:
 - Tripwire Event Detection
 - Object Classification (standard)
 - Object Size Filters (standard)
 - Object Size Change Filters (standard)
 - Saliency Filters (standard)
 - Schedules (standard)
- Package B - All of Package A plus
 - Appears Event Detection
 - Disappears Event Detection
 - Scene Change Event Detection

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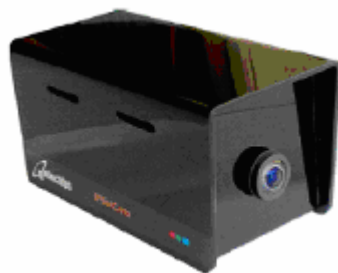
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Examples of Davinci-based IPNC



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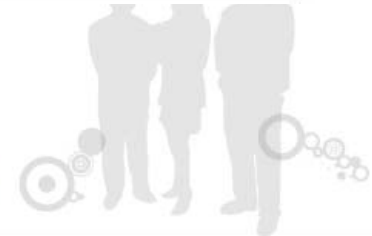


Configuration of a Davinci-based IPNC

The screenshot shows the eInfochips web interface. The top navigation bar includes 'CONFIGURATION' (highlighted with an orange circle), 'VIDEO', 'RULES', 'ALERTS', and 'HELP | LOGOUT'. Below the navigation bar, there are tabs for 'SYSTEM MANAGEMENT', 'CONTROL CENTER', 'MONITORING OPTIONS', and 'ALERT OPTION'. The main content area is titled 'FIRMWARE UPGRADE' and contains a 'Upgrade Firmware' field with a 'Browse...' button, a 'Take Backup of Firmware' checkbox, and four buttons: 'SOFTWARE UPGRADE', 'CAMERA RESTART', 'RESTORE FIRMWARE', and 'VIEW SYSTEM LOG'. A 'SAVE' button is located at the bottom of the section.

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Video streaming of a Davinci-based IPNC



The screenshot shows the eInfochips web application interface. At the top, there is a navigation bar with the eInfochips logo on the left and several menu items: CONFIGURATION, VIDEO (highlighted with an orange circle), RULES, ALERTS, and HELP | LOGOUT. Below the navigation bar is a large video player window. The video shows an airplane flying over a body of water with a rocky shoreline in the foreground. Below the video player, there are small controls for 'Play' and 'Stop'.

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VCA setup of a Davinci-based IPNC

The screenshot shows the 'MONITORING FOR EVENTS' section of the Infochips interface. It features a navigation bar with 'CONFIGURATION', 'VIDEO', 'RULES', 'ALERTS', and 'HELP | LOGOUT'. Below the navigation, there are two tabs: 'CAMERA' and 'MONITORED'. The 'MONITORED' tab is active, displaying a video feed of a rocky shoreline. A 'REFRESH' button is located below the video feed. To the right of the video feed is a 'RULES' panel titled 'Rules Area'. This panel contains a list of rules with checkboxes and 'Edit | Delete' links. The rules are:

- tripwire1 if anything crosses tripwire
- appear if anything appears

Below the rules list are 'ADD' and 'UPDATE' buttons. At the bottom of the interface, there is a checkbox labeled 'Always Monitor for Events' which is checked.

The screenshot shows the 'ADDING A NEW RULE' configuration screen in the Infochips interface. It features the same navigation bar as the previous screenshot. The 'RULES' tab is active, and the 'ADDING A NEW RULE' form is displayed. The form includes the following fields and options:

- RULE NAME:** tripwire1
- DETECT WHEN:** Camera View Changes (Lights On)
- Any of:** Anything (dropdown), Crosses Tripwire (dropdown)
- SCHEDULE:** Default (dropdown), Show Default Schedule (link)
- SIZE FILTER:** On (radio), Off (radio), Show Default Filter (link)
- RESPONSES:** ALERT MESSAGE (text area)

Below the form is a video feed of the same rocky shoreline. A 'TRIPWIRE' button with a crosshair icon is overlaid on the video. Below the video, there is a 'Tripwire Guideline' section with the text: 'To draw tripwires, first click on the tripwires button then specify start and end points of the Tripwires by clicking at appropriate places on the image.' At the bottom of the form are 'SAVE' and 'CANCEL' buttons.

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Alerts of a Davinci-based IPNC

The screenshot shows the Infochips monitoring interface. At the top, there is a navigation bar with buttons for CONFIGURATION, VIDEO, RULES, ALERTS, and HELP | LOGOUT. Below this is a section titled 'MONITORING FOR EVENTS' which is highlighted with a blue box. The main content area contains a table with the following data:

DATE	TIME	ALERT MESSAGE	SNAPSHOT	LINK
02 Jan 2007	03:52:21	Human crosses trip-wire from direction left to right if anything crosses trip-wire		Snapshots
02 Jan 2007	03:52:16	Vehicle crosses trip-wire from direction right to left if anything crosses trip-wire		Snapshots

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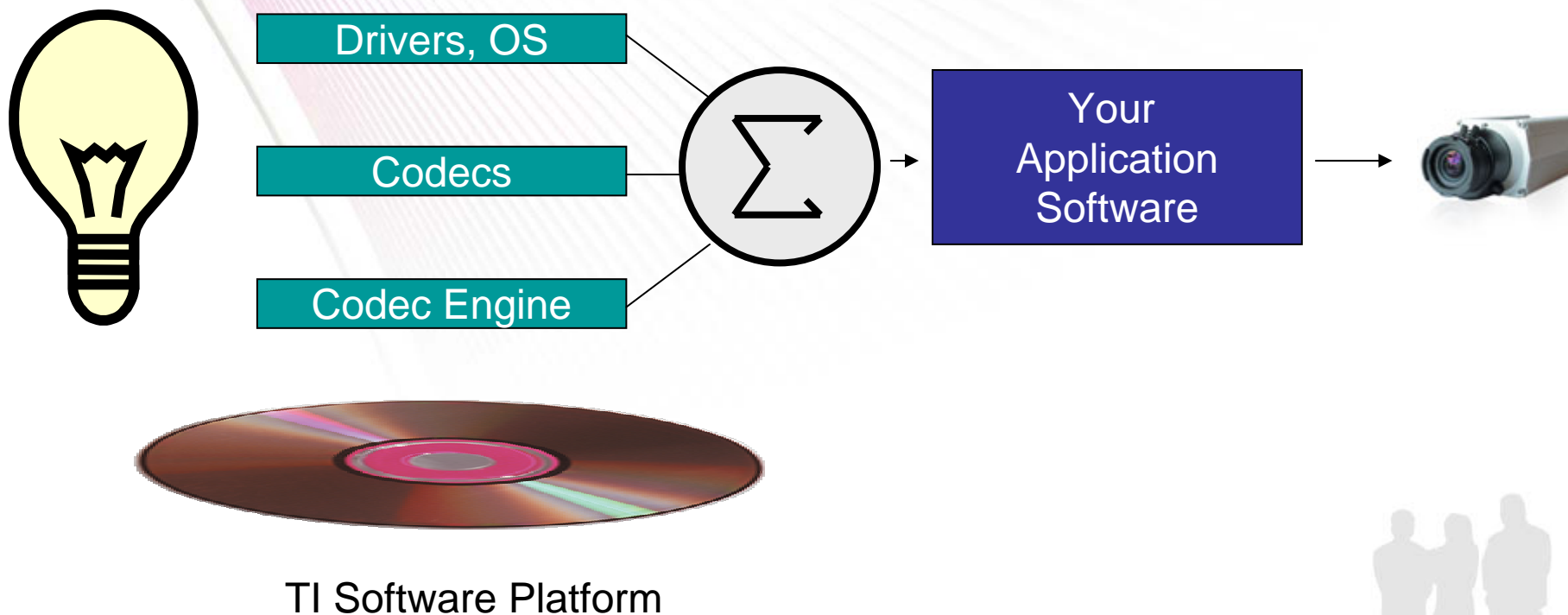
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Conclusion: Accelerating Video Innovation From Idea to Realization



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Thanks!

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