Imagination

Java SE Embedded Apps for MIPS Processors

CON5692

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Outline

1 Java SE Embedded

2 Java on MIPS

3 Where Next?

4 Imagination MIPS Overview

Java SE Embedded 8

overview

Java SE Embedded 8

What is it?

- Oracle's commercial product for embedded Java
  - Free for development
- Supports and optimized for range of embedded platforms
  - ARM v5-v8*
  - x86
  - PPC
  - Linux
  - MIPS in progress

Java SE Embedded 8

Where is it used?

- Home + Building automation
- Smart-grid and advanced-metering infrastructure
- E-health systems
- Multifunction printer controllers
- Security Management
- Autonomous marine robots
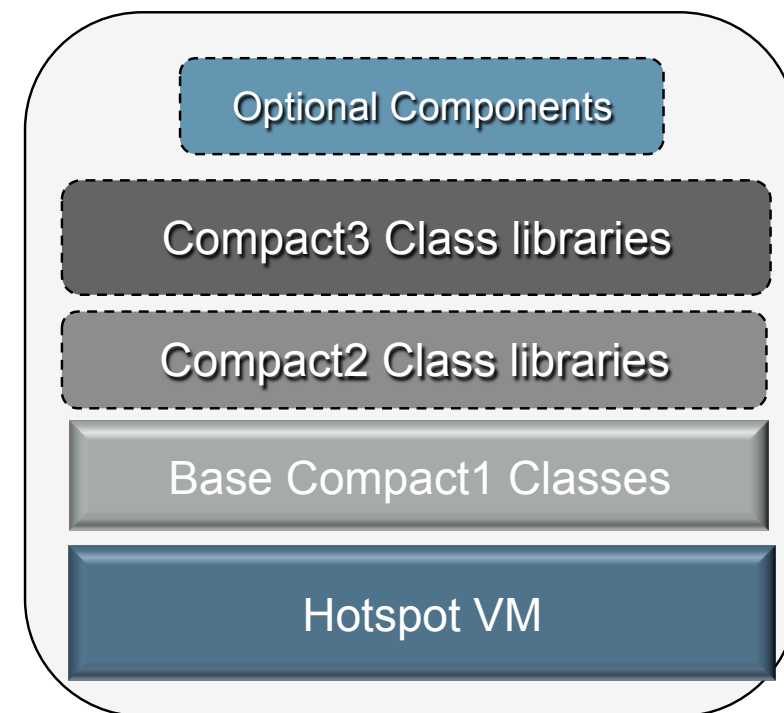- Oracle Sailing team

Java SE Embedded 8

What's in it?

- Headless and headful support
  - Depending on platform
- Full Java SE 8 features
  - Lambda
    - Built on invokedynamic from JDK 7
    - Used in many APIs
  - Compact Profiles

Compact Profiles

compact1	▪ Smallest set of API packages. Logging and SSL included
compact2	▪ Adds XML, JDBC and RMI
compact3	▪ Adds management, naming, more security, and compiler API ▪ More tools - VisualVm, etc.
Full Java SE	▪ Adds Desktop APIs, Web Services and CORBA

SE 8 Compact Profiles

Optional Components

Compact3 Class libraries

Compact2 Class libraries

Base Compact1 Classes

Hotspot VM

Compact Profiles

Sizes (typical)

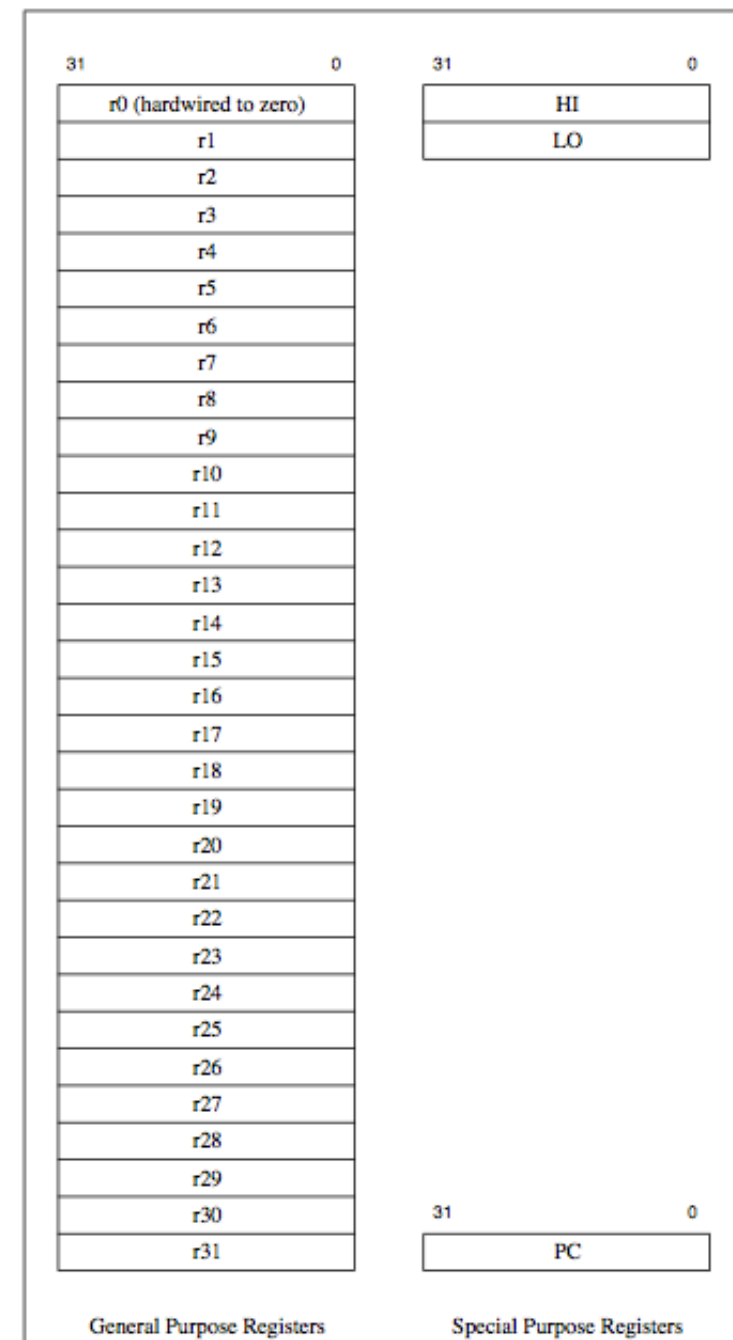|	
compact1	22MB
compact2	28MB
compact3	31MB
JRE	62MB

Java on MIPS

MIPS for Developers

- Classic RISC architecture
  - Similar to SPARC
  - Branch-delay slots!
- 32 GP registers
  - r0 always zero
- BE and LE support
- MIPS32 ⊂ MIPS64

Figure 2.8 CPU Registers

31	0
r0 (hardwired to zero)	
r1	
r2	
r3	
r4	
r5	
r6	
r7	
r8	
r9	
r10	
r11	
r12	
r13	
r14	
r15	
r16	
r17	
r18	
r19	
r20	
r21	
r22	
r23	
r24	
r25	
r26	
r27	
r28	
r29	
r30	
r31	

General Purpose Registers

31	0
HI	
LO	

31	0
PC	

Special Purpose Registers

JavaOne™
ORACLE

MIPS for Developers

Parameters

- 32/64 bit

- glibc/uclibc

- Optional features:

  - FPU - HF/SF

  - MT - multi-threading

  - Multi-core

  - microMIPS - 16-bit instructions

  - DSP/SIMD

Java on MIPS

History

- Java ME CDC
  - OJEC 1.1
  - Blu-Ray players?
- Engineering Services
  - Broadcom 7425 SE6u35 Linux+MIPS32+uClibc+Little Endian headless JVM
  - Many others

Java SE 8 on MIPS

Current Target

- MIPS32r2
- BE
- Soft FP
- linux/uclibc
- Devices for JVM development
  - Not an endorsement

OpenWRT
What is it?

- Linux variant for networking
- Based on "Buildroot" system - generates
  - toolchain
  - kernel
  - root filesystem
  - bootloader
- Tuned for small embedded, flash-based devices
- BusyBox - compressed binary for utils
- uClibc or glibc

uClibc

μClibc

- Smaller replacement for GNU C Library (glibc)
  - Extreme case: 570KB vs 30MB
- Impl optimized for small size
- Some features optional
- Some features left out
- Locale data optimized

uClibc

Issues for Java VM

- Sometimes too stripped down
- Threading
- Floating point
- Backward compatibility
  - "uClibc does not even attempt to ensure binary compatibility across releases"

Development Hardware

- Boards suitable for JVM development
- And testing
- Commercially available
- *Not an endorsement*

Netgear WNDR4300

Typical Home Router

- Atheros 9344 @560MHz
- MIPS32r2
- Big endian
- Soft float
- 128MB RAM / 128MB flash (+ usb drive)
- OpenWrt

Ubiquiti EdgeRouter Lite

"the world's first 1 million packets per second router for under $100"

- Dual-Core 500 MHz

- MIPS64r2

- Cavium OCTEON+ CN5020

- Dual-core

- 512MB RAM

- 4MB NOR flash - U-Boot.

- 2GB USB flash drive (encased)

- "Debian" or OpenWRT/Buildroot

Also…

- Good dev boxes for IoT gateway
- Hub for local devices

Simple Demo

- SpecJVM98
- Classic Java test
  - *Not a compliant benchmark run

Where Next?

**Possible opportunities for You, Java, and MIPS**

Current Opportunities

- Interesting possibilities
  - Prototyping IoT systems with networking devices
    - Inexpensive
    - Active developer community around these device
  - Add-on Java functionality to existing devices?
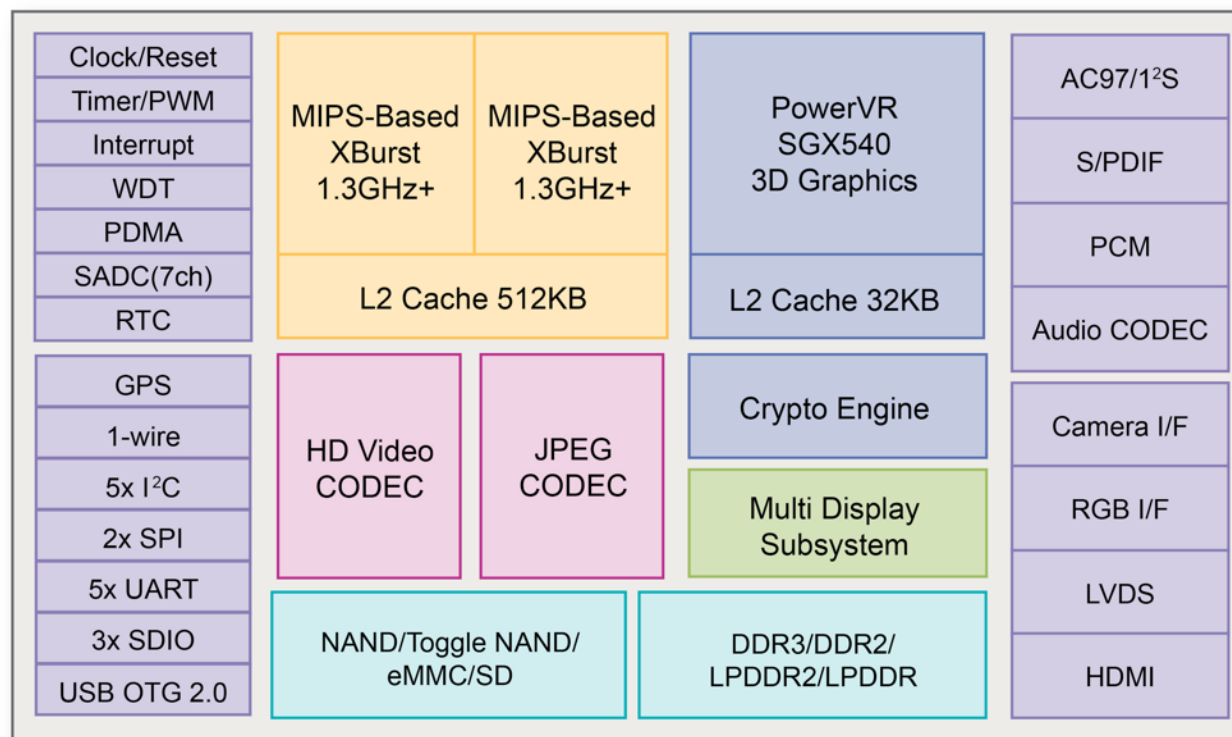   - Millions of devices out there in homes and businesses

New Opportunities

New development boards

- MIPS Creator CI20
- Dual-core MIPS32 @ 1.3GHz
- Debian linux
- 1GB RAM, 8GB flash
- 'RPi compatible' expansion
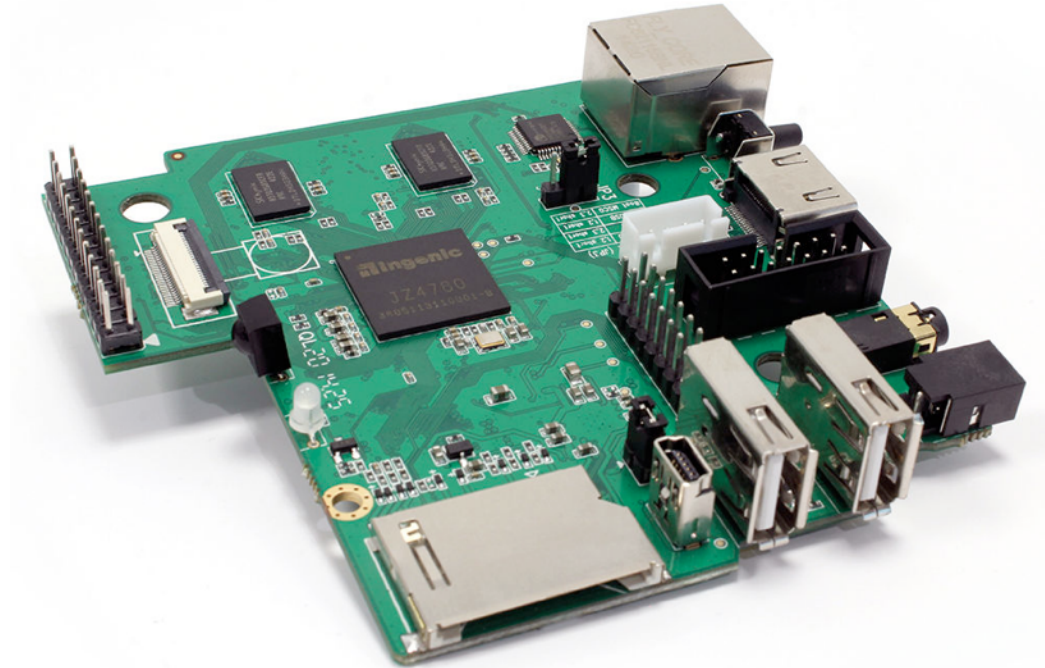
Ingenic JZ4780 SoC

Benefits - Java on MIPS

- Opens range of MIPS devices to Java developers
  - Small embedded to servers
- Use common skills
- Access wide world of Java libraries
- Common code between IoT devices, gateways, back end services
- Access normal Java developer tools:
  - IDEs, Debugger, Profilers,
 - Management - Java Mission Control

MIPS Overview

JavaOne 2014
Majid Bemanian

About Imagination

- **Leading silicon, software & cloud IP supplier**
  - Multimedia, processors, communications, cloud
  - Licensing & royalties based business model
- **Targeting high volume, high growth markets**
  - Semiconductor manufacturers and OEMs
  - Mobile, home consumer, automotive, storage, networking, infrastructure, IoT
- **Pure: our strategic product division**
  - Digital radio, connected audio, home automation
- **Established technology powerhouse**
  - Founded 1985; London FTSE 250 (IMG.L)
  - UK HQ; global operations with ~1,600 employees
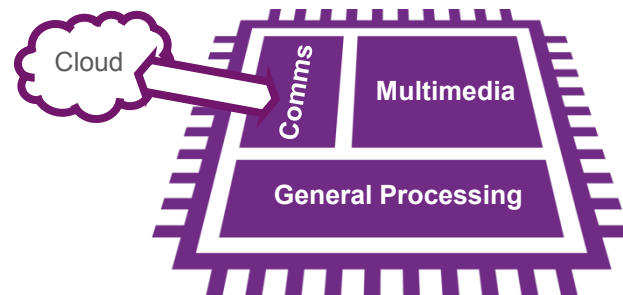
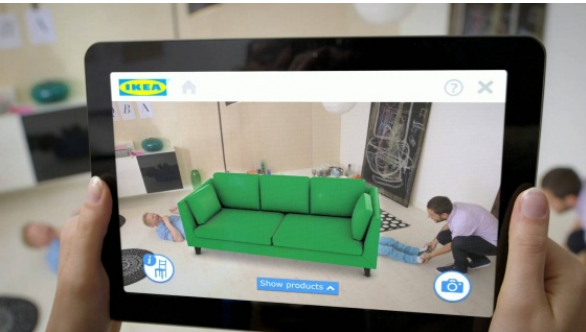*Comprehensive IP portfolio for SoCs & cloud connectivity*

IP business pathfinder Market maker/driver

Imagination is driving innovation

We have the IP that enables new products and markets

▪ **The next waves: wearables; IoT; smart homes; eHealth; ADAS…**

Imagination by the numbers

Mobile

Consumer

Mobile Multimedia

Mobile Computing

Networking

Automotive & Emerging

Imagination by the numbers

Mobile

Over **1.2 billion** smartphones

Consumer

1.5 billion TVs and set top boxes

Mobile Multimedia

Over **700 million** media players, digital cameras and games consoles

Mobile Computing

250 million tablets and e-readers

Networking

Over **2 billion** networking products

(inc. **1 billion** access points)

Automotive & Emerging

Wearables

IoT and M2M

Automotive

Imagination by the numbers

Mobile

Consumer

Mobile Multimedia

Over 7 billion products shipped

Mobile Computing

Networking

Automotive & Emerging

Now more than 3m per day

Our licensees and partners drive our business

By region, by market, throughout the supply chain

Over 100 customers:
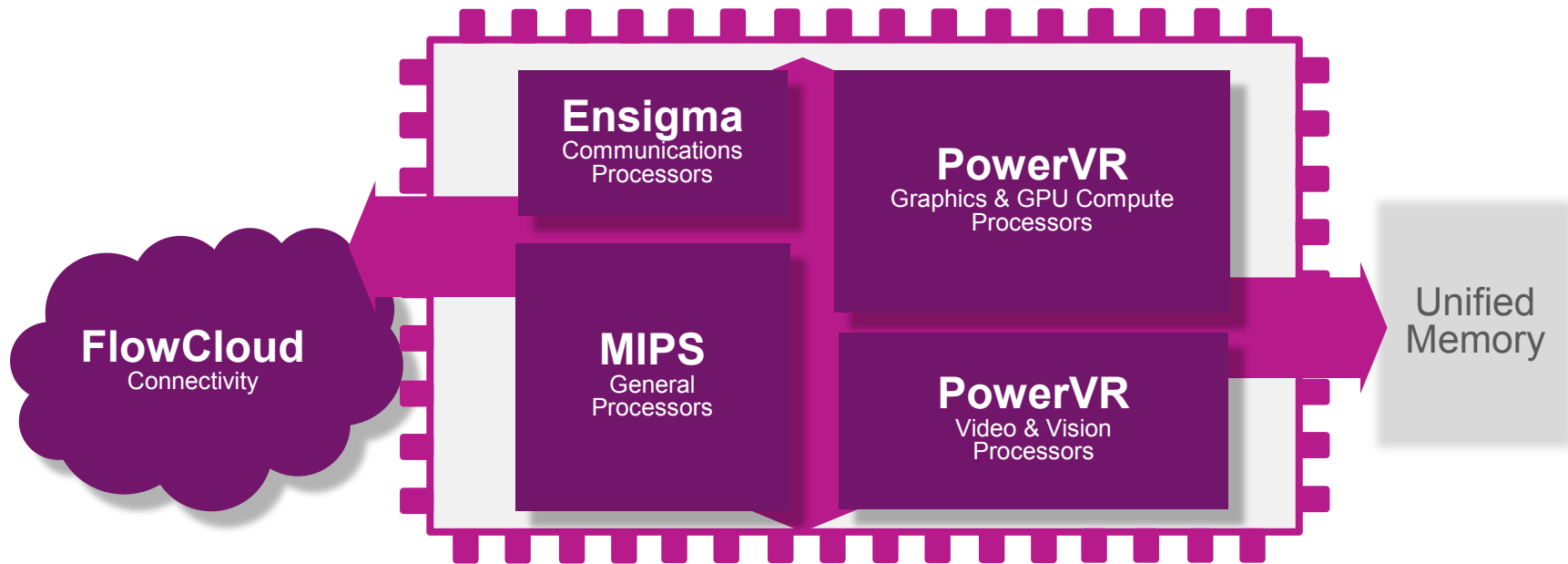
>50% licensed IP from us in FY14
>20% licensed multiple IPs

Key Licensees

Strategic Partners
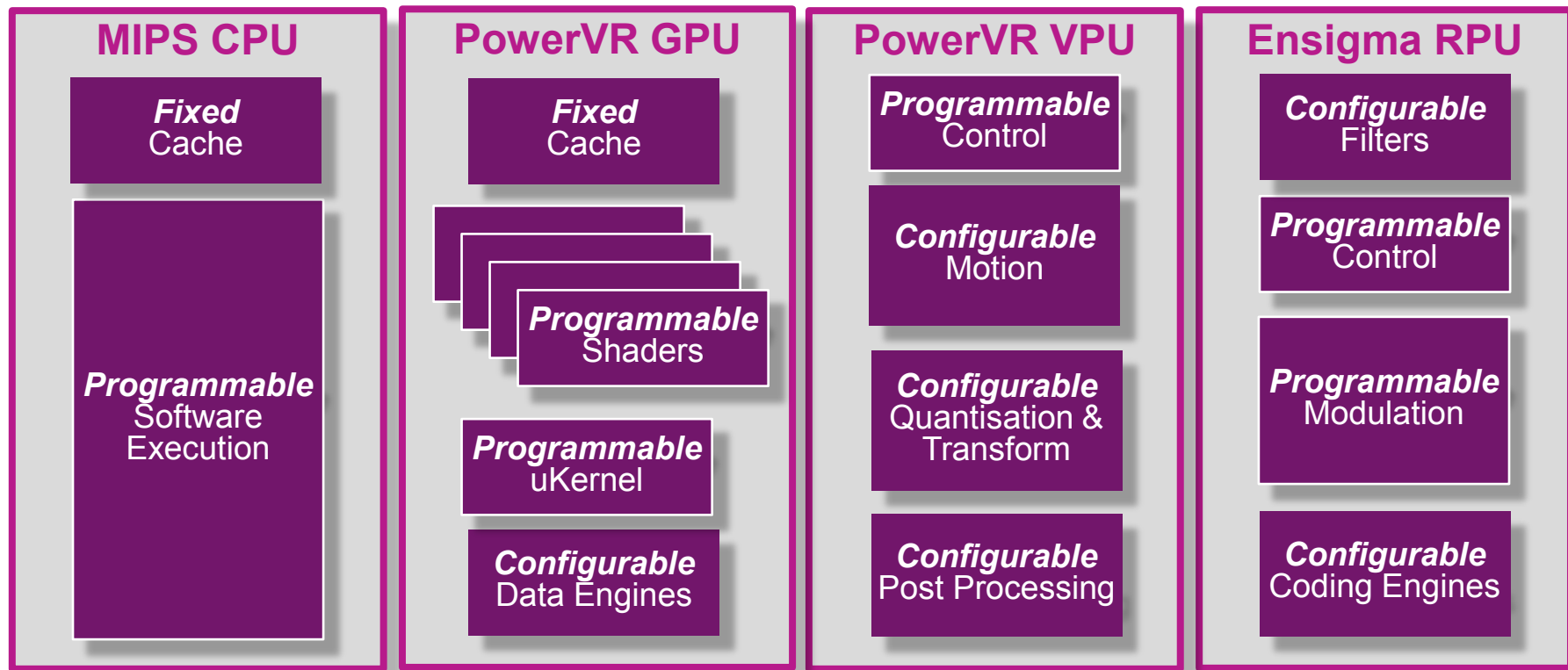
Imagination's IP portfolio

Everything needed to create connected SoC solutions

FlowCloud
Connectivity

Ensigma
Communications
Processors

PowerVR
Graphics & GPU Compute
Processors

MIPS
General
Processors

PowerVR
Video & Vision
Processors

Unified
Memory

Each IP core is a class leader - when used with <u>any</u> other processors
Lowest power - under <u>all</u> operating conditions
Smallest silicon area - for <u>any</u> performance point

Imagination

Each processor's architecture highly tuned

Optimised blend of programmable, configurable and fixed function hardware

MIPS CPU	PowerVR GPU	PowerVR VPU	Ensigma RPU
Fixed Cache	**Fixed** Cache	**Programmable** Control	**Configurable** Filters
Programmable Software Execution	**Programmable** Shaders	**Configurable** Motion	**Programmable** Control
	Programmable uKernel	**Configurable** Quantisation & Transform	**Programmable** Modulation
	Configurable Data Engines	**Configurable** Post Processing	**Configurable** Coding Engines

The "Internet of Things" will reach everywhere

Everything is getting "smart"

Computer
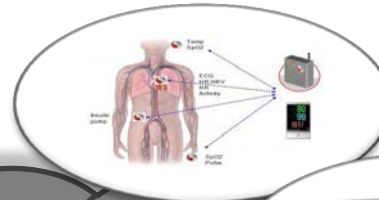
Phone

TV/Radio

Car

Healthcare

Security

Home Automation

Toys

Industrial

We need connected solutions for everything!
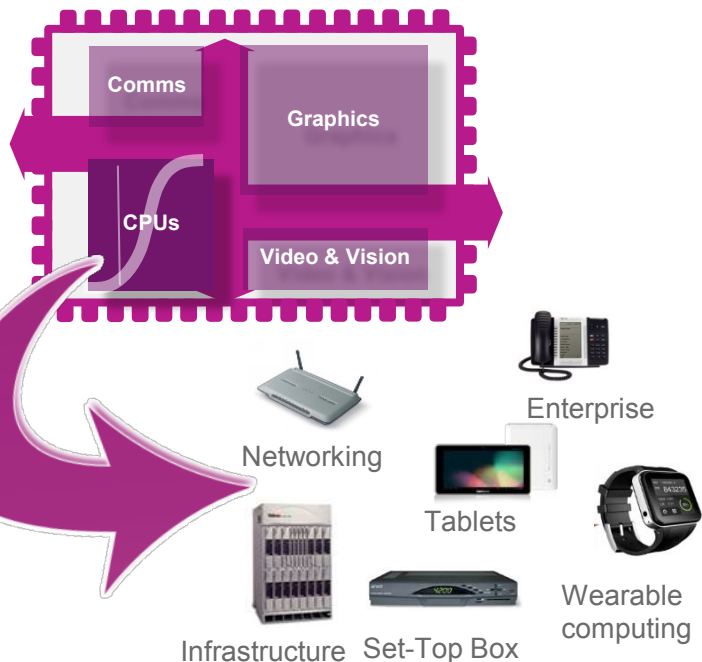
Ensigma   MIPS   PowerVR
Flow   HelloSoft

...and more to come...

Everything!

Imagination

MIPS: changing the game

Powering the connected SoC

Comms

Graphics

CPUs

Video & Vision

Networking

Enterprise

Tablets

Wearable computing

Infrastructure   Set-Top Box

- **World's most mature 64/32 bit architecture**
- **MIPS Warrior CPU core portfolio:**
  - M-class: ultimate embedded
  - I-class: ultimate power/performance
  - P-class: ultimate performance
- **Industry leading PPA* across the range**
- **Area up to 40% less than competitors**
- **Unique multi-threading for multi-core**
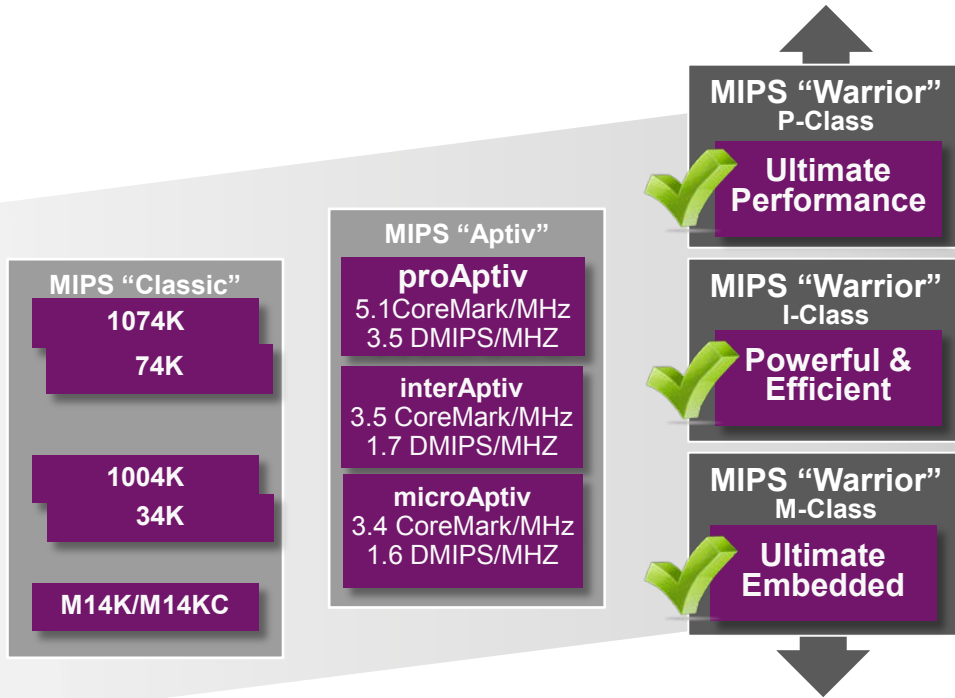- **Strengthening Android, Linux, RTOS support**

* PPA: Power, Performance, Area

Changing the CPU landscape from low to high end – welcomed by industry

We defined a new way forward for MIPS

A proven, efficient 64/32bit architecture - 5 generations over 30 years…

MIPS by Imagination

MIPS "Warrior" P-Class
Ultimate Performance

MIPS "Warrior" I-Class
Powerful & Efficient

MIPS "Warrior" M-Class
Ultimate Embedded

MIPS "Classic"
1074K
74K
1004K
34K
M14K/M14KC

MIPS "Aptiv"
proAptiv
5.1CoreMark/MHz
3.5 DMIPS/MHZ
interAptiv
3.5 CoreMark/MHz
1.7 DMIPS/MHZ
microAptiv
3.4 CoreMark/MHz
1.6 DMIPS/MHZ

- **Proven MIPS architecture**
- **Total compatibility 32 => 64-bit**
- **Hardware virtualization in all cores**
- **Superior multi-domain security**
- **Hardware multi-threading**
- **Compiler-aware 128-bit SIMD**
- **Advanced SP/DP FPU**
- **Consistent tool chains**
- **Extensive 64 & 32-bit ecosystems**

# MIPS64 *AND* MIPS32 processor

MIPS64

MIPS32

Instructions dealing with 64-bit data

- *MIPS64*
  - Is MIPS32, plus instructions for 64-bit data types
  - Runs MIPS32 software without mode switching

- *MIPS64/32 Release 6*
  - Streamlining a highly efficient architecture
  - Modernization of architecture through:
    - Additional instructions for enhanced execution on modern software workloads =
    - JITs, VMs, PIC, etc. commonly found in Javascript, Browsers, abstracted compiler technologies (i.e. LLVM)

MIPS: the ultimate 64/32-bit architecture

MIPS64 *I6400* base core microarchitecture

Optimized for efficiency and maximizing pipeline utilization
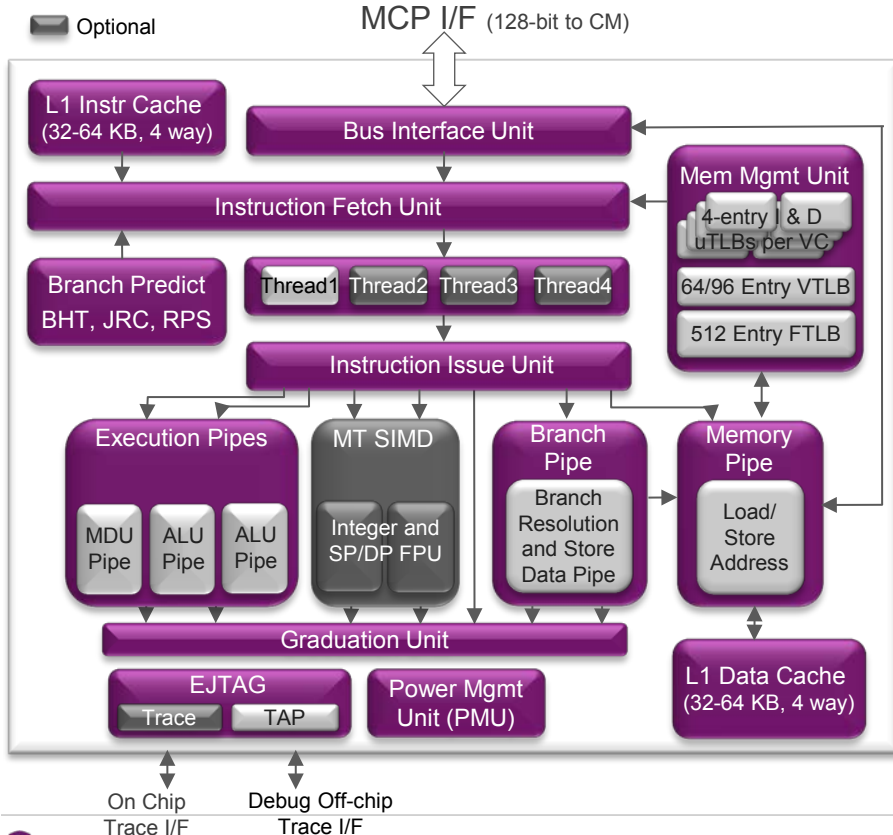
- **Dual-issue In-order design with MT**
- **Compact, balanced 9-stage pipeline**
- **Dual issue 128b SIMD (Int, SP/DP FPU)**
  - IEEE 754-2008 compliant FPU
- **Instruction bonding on integer, FP ops**
  - Doubles throughput on memcopies
- **Instruction and Data L1 caches w/ ECC**
  - 64 byte cache lines
- **Advanced branch prediction**
- **Low latency 128b core:CM interface**

Investing in the MIPS open source community

Open-source, community-driven, collaborative, non-profit foundation supporting the MIPS architecture – and open to others

- **Datacenter, networking & storage, connected consumer and embedded/IoT**

- **Industry leaders from across the MIPS community**

- **Innovation in efficiency, portability and compatibility**

Building the MIPS ecosystem

- **Long-term relationship to ensure full support for Java on all 64-bit and 32-bit MIPS platforms**

- **Collaboration on solutions from datacenter to IoT device**
  - Also collaborating on support for PowerVR GPUs

- **Covers Oracle JDK, Java SE Embedded and more**

Imagination

Thank you

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