HETEROGENEOUS COMPUTING PLATFORMS ARE BECOMING PERVASIVE

- EVERY Tablet and Smartphone shipping in 2012 and 2013 is based on a heterogeneous processor
- Of the Top 500 supercomputers in 2012, 52 were based on heterogeneous systems
- Both the major next generation consoles from SONY and Microsoft are shipping with heterogeneous processors
- AMD starting shipping embedded heterogeneous processors in 2011 and has announced that it will ship mainstream heterogeneous servers in 2014

Sources: See Reference slide
HETEROGENEOUS COMPUTING PLATFORMS ARE BECOMING PERVASIVE

AMD HARDWARE TOOLBOX FOR SOC
Ambidextrous Computing

2014

HSA compliant & Lower power APU

28nm 64-bit ARM server processor

2015

- Next-Gen “Puma+” x86 Cores
- Starting in 2015, families of 20nm APUs and ScCes with pin-compatible x86/ARM compute
- Designed for Full HSA support
- AMD Graphics Core Next (GCN)
- Low-power A57 64-bit ARM Cores
- AMD’s first HSA Android platform
1 EXAFLOPS
20 MW
50 GFLOPS DP/W
DATA TO WORK

Since 2007

Not efficient!
Most parallel code runs on CPUs designed for scalar workloads

WASTES POWER
PROGRAMMING HETEROGENEOUS SOC\textsc{s}/AP\textsc{us} IS STILL HARD
HETEROGENEOUS SYSTEM ARCHITECTURE
Brings All the Processors in a System into Unified Coherent Memory

- POWER EFFICIENT
- INDUSTRY SUPPORT
- EASY TO PROGRAM
- OPEN STANDARD
- FUTURE LOOKING
- ESTABLISHED TECHNOLOGY FOUNDATION

AMD
OCTOBER, 2014
From dGPU to SoC

Need for open programming framework for legacy and future-proof codes
GPU Computing Today and Tomorrow

DATA TO WORK
Since 2007
Not efficient!

WORK TO DATA
Beyond 2015
Run indifferently serial and parallel codes
HSA Foundation
Write-once-run-everywhere for heterogeneous systems

- Industry leaders setting an industry standard
- Designed for developers, by developers
- One architecture, differentiated ‘IP’ vendors
  - Multiple hardware solutions to be exposed to software through a common standard low-level interface layer
- Support high-level parallel programming languages and models, including C++ AMP, C++, C#, FORTRAN, OpenCL, OpenMP, Java and Python
AMD JOINED BY FELLOW INDUSTRY LEADERS TO ADVANCE HETEROGENEOUS DESIGN

For more information go to: http://hsafoundation.com/  
Source: http://pinterest.com/pin/193021534001931884

BY 2016, THERE WILL BE ESTIMATE 2.1 BILLION CONNECTED DEVICES

HSA Potential Market Share
INTEL Approx. Market Share
NVIDIA Approx. Market Share

SMART CONNECTED DEVICES SHIPPED TODAY ARE DESIGNED BY HSA FOUNDATION MEMBERS (800 MILLION+ UNITS)
DIVERSE PARTNERS DRIVING FUTURE OF HETEROGENEOUS COMPUTING

Founders
AMD | ARM | Imagination

Promoters
LG Electronics

Supporters
Arteris | codeplay | FABRICENGINE | Kionix | Lawrence Livermore National Laboratory | Argonne National Laboratory | allinea

Contributors
ANALOG DEVICES | apical | BROADCiM | CANONICAL | CEVA | DMP | ETRI

Academic
NTHU Programming Language Lab | NTHU System Software Lab | University of Bristol | University of Illinois | Tampere University of Technology
HSA FEATURES FEED AND EQUALIZE “APU ‘COMPUTE UNITS’”

EQUAL ACCESS TO ENTIRE MEMORY

- hUMA

CPU  GPU

First time ever: GPU and CPU have uniform visibility into entire memory space

EQUAL FLEXIBILITY TO DISPATCH

- hQ

CPU  GPU

Heterogeneous queuing (hQ) defines how processors interact equally

- GPU and CPU have equal flexibility to create/dispatch work

UNLOCKING ALL APU GFLOPS

- Access to full potential of APU compute power

APU GFLOPS

CPU GFLOPS  GPU GFLOPS

UNLOCKS THE COMPUTE POTENTIAL AND EFFICIENCY OF APUs
BENEFITS OF HETEROGENEOUS SYSTEM ARCHITECTURE
UNLEASHING THE GPU

PERFORMANCE
- Reduced latency when performing work on the GPU
- Opens up many more opportunities to accelerate application performance

POWER
- Easier utilization of the GPU leads to power reduction on parallel workloads
- Reducing software layers saves power both from instruction execution and memory copies

PORTABILITY
- Because HSA is a broadly endorsed industry standard, benefits will be available across a broad range of platforms including handheld devices, PCs and servers

PROGRAMMABILITY
- Programming models for the GPU can become equivalent to familiar models available for the CPU
DEVELOPER ECOSYSTEM
OTHER PROGRAMMING LANGUAGES WILL WORK WELL ON APU

OpenCL™ App
OpenCL Runtime
Java App
Java JVM (Sumatra)
Java App
C++ App
Various Runtimes
Python App
Fabric Engine RT

APU with HSA Features
New features give GPUs more freedom to do the work they are designed to do

**Shared Virtual Memory**
Enables host and device kernels to directly share complex pointer-based data structures, eliminating explicit transfers between the host and devices while increasing programming flexibility.

**Nested Parallelism**
Updated for improved programmability and increased application efficiency.

**Generic Address Space**
Enables functions to be written without named address spaces which increases flexibility and saves time by eliminating the need for multiple functions to be written.

**AMD FirePro™ Graphics is Ready...**

...For access Email to FirePro.Developers@amd.com

OpenCL™ 2.0 conformance expected. AMD plans to release OpenCL 2.0 drivers for enabled AMD FirePro S9150 server cards in Q4 2014; conformance testing is planned at that time. Previous generation AMD FirePro products may not support OpenCL 2.0.
NEW – SUPPORT FOR HETEROGENEOUS C++ LANGUAGE

Proposing several options for C++
- C++ with extensions
- C++ AMP compatible
- SyCL
- GCC

Several open source projects on going and to be announced
NEW – SUPPORT FOR OPENMP 4.0 & OPENACC 1.0

- OpenMP 4.0 & OpenACC 1.0/2.0 support coming for all Hawaii and Tahiti-based FirePro cards with C, C++, Fortran.
  - S10000, S9150/S9100, S9050/S9000, W9100, W9000, W8100, W8000
- Exposes GPU compute capability for new markets
- Beta in Q4/14, Production release Q4/14 or Q1/15
  - For access Email to FirePro.Developers@amd.com
- Supported via partnership with Pathscale

"Pathscale’s ENZO Compiler with OpenMP 4.0 and support for C, C++, and Fortran is used by customers in the Oil and Gas, Computational Science, Computer Aided Engineering, and other HPC segments. Our support for the AMD FirePro S9150 will enable these customers to benefit from the tremendous compute performance of the S9150 while leveraging their existing investment in OpenMP software."

Christopher Bergstrom, CTO, Pathscale
Heterogeneous Optimized Libraries (work in progress)

Math libraries
- BLAS
- FFT
- RNG
- Solvers
- Sparse matrix

Language Specific Libraries
- C++ Template Libraries (sort, scan, reduce, transform)
- Python libraries (Anaconda, NumPy, SciPy)
- R packages

Domain Specific Libraries
- Media encode/decode/transcode: FFmpeg, X264, H.265, etc.
- Image processing
- Computer Vision: OpenCV, OpenNI
- Simulation: Bullet Physics, Ray Tracing, Sparse Solvers
- Big Data: Hadoop/Mahout frameworks and associated libraries
SPIR AS COMPILER-ORIENTED MIDDLEWARE

- C++ AMP
  - Uses Clang and LLVM
- OpenCL HLM
  - C++ syntax/compiler extensions
- WebCL
  - JavaScript binding to OpenCL for initiation of OpenCL C kernels
- Aparapi
  - Java language extensions for parallelism
- River Trail
  - Language extensions to JavaScript
- PyOpenCL
  - Python wrapper around OpenCL
- Harlan
  - High level language for GPU programming

OpenCL provides vendor optimized, cross-platform, cross-vendor access to heterogeneous compute resources.
OPEN SOURCE AND OPENCL

OpenSource efforts actively supported by AMD

- OpenCV
- GMAC – Global memory for accelerators
- TM – Task Manager
- Aparapi – A parallel API (for Java)
- Crypto++
- X264/Handbrake
- VLC
- ImageMagick
- GIMP
- Bullet physics library

700+ projects in Sourceforge, Github, Google Code, BitBucket refer to OpenCL
Accelerated Parallel Processing (APP) SDK around Heterogeneous computing

- Complete development platform for heterogeneous computing
- Fully utilize the potential of modern APUs and GPUs
- Supports open industry standards and embraces open source software
  - OpenCL
  - Aparapi (Java)
  - C++ / SyCL
  - OpenCV
  - OpenNI
  - Bolt C++ template library
- Enables development for cross-OS and cross-platform heterogeneous solutions
- Comprehensive set of programming samples show best practices for benefiting from heterogeneous computing
  - Includes Sample Code Browser for quickly finding relevant samples
- For access Email to FirePro.Developers@amd.com
AMD FIREPRO™ FOR GPU COMPUTE – HW & SW ECOSYSTEM

Developer Tools
- CodeXL
- APP SDK

Programming Languages
- OpenCL 2.0
- OpenMP 4.0
- C++ / SyCL
- Python
- Java

Optimized Libraries
- BLAS, FFT, RNG
- Solvers
- SpMV
- Language Specific
- Domain Specific

HSA APU

CPU

GPU
QUESTIONS

THANK YOU

GAMING EFFECTS

NEW USER EXPERIENCES

SMALL FORM FACTOR

ULTRA HD MEDIA

QUESTIONS

GAMING EFFECTS

NEW USER EXPERIENCES

SMALL FORM FACTOR

ULTRA HD MEDIA

QUESTIONS

THANK YOU

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SMALL FORM FACTOR

ULTRA HD MEDIA
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