ARM Cortex-A9 performance in HPC applications
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- ARM gaining market share in embedded systems and SoCs
- Current processors include the ARM9 series, the Cortex-A8, and the Cortex-A9
- ~15 Billion ARM chips shipped to date

- Thumb / Thumb-2
  - More efficient instruction encoding, better code density
  - Higher performance for select applications
- VFP v3
  - Floating point co-processor
- NEON
  - SIMD Extensions
  - Up to 4x 32-bit floating point operations per instruction
  - No double precision
ARM Cortex-A8 and Cortex-A9

- Uses the ARMv7-A architecture
  - Thumb-2, NEON, VFP v3
- Systems
  - TI BeagleBoard (1GHz)
  - Genesi Efika-MX (800MHz)
  - Gumstix Overo Earth (600MHz)

- Uses ARMv7-A architecture
  - Thumb-2, NEON, VFP v3
- Available in single and dual core packages, quads upcoming (A6, Tegra 3)
- Systems
  - TI PandaBoard (dual 1GHz)
  - NuFront NuSmart (dual 1.2GHz)
TI PandaBoard Results

- 3.0 Gflop/s SP NEON, 1.2 Gflop/s DP (HPL)
- Power consumption
  - Idle: ~4 Watts / board, Full load: ~7.5 Watts / board

- Software & Hardware Challenges
  - Most libraries assume x86 / x86-64, No precompiled binaries (unavailable or unoptimized), Compiler support immature (-mcpu=cortex-a9, -mhard-float)
  - Limited RAM on some systems, Low-quality networking hardware and software, Few possibilities for expansion, Reliability issues

- Energy Efficiency
  - 2 Gflop/s / Watt gets you #1 on Green500
  - PandaBoard is $175, and 18 square inches
  - \( \frac{0.4 \text{ Gflop/s}}{\text{Watt}} \), 0.0074 Gflop/s / $, and 0.072 Gflop/s / square inch
Looking Ahead: Embedded GPUs

- Most SoCs include a GPU, e.g. PVR SGX 540 (PandaBoard)
- Potential for mixed CPU-GPU computation
- OpenCL support, pending release of drivers on TI SoCs, available for Apple Hardware
- ARM Cortex-A15 with PVR series 6 GPU
  - Much more powerful and better suited for computation
- Tegra 3 & 4
  - Potential for Cuda Support