Power and Performance Analysis of PDA Architectures

6.893 Advanced VLSI Computer Architecture

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Motivation

- Provide standard performance and power benchmarks for PDA architectures
- Run benchmarks on existing platforms and hypothesize areas of weakness

- Performance Benchmarks
  - Task switching
  - GUI window operations
  - JVM (SPECjvm98)
  - MPEG playback
- Power Analysis code sequences
  - Simple ALU operations
  - Memory Loads/Stores
  - Procedure call overhead
  - Branch Prediction

- Task Switching-

  Enumerate through top ten window handles in the operating system queue.

  Cycle 1000 times activating each handle and measure time to completion.

- GUI window operations-

  Creation of single window with multiple MFC elements (command bar, text fields, label…etc).

  Repositioned window forcing system to redraw 1000 times and measured time to completion.

- JVM (SPECjvm98)

  -jess: LISP like expert shell system

  -jack: parser generator modeled after yac

  -mpeg: MPEG layer-3 decoding

- MPEG playback

  Used PocketTV to play an MPEG clip (1.06MB).

  Measured power and subjectively judged quality of playback.

- ALU Test-

  Chose two distinct registers and performed addition, subtraction, and multiplication operations.

  Measured power during loop of instructions.

- Memory Loads/Stores-

  Read value from memory and write value back to same address. Ensures 100% cache hit.

  Measured power during loop of instructions.

- Procedure Call Overhead-

  Motivation: After looking at assembly code generated by GUI benchmarks, large percentage of instructions were related to operating system level or shared library call outs.

  Called a procedure with four arguments. Action of procedure was to simply return.

  Measured power during loop.

- Branch Prediction-

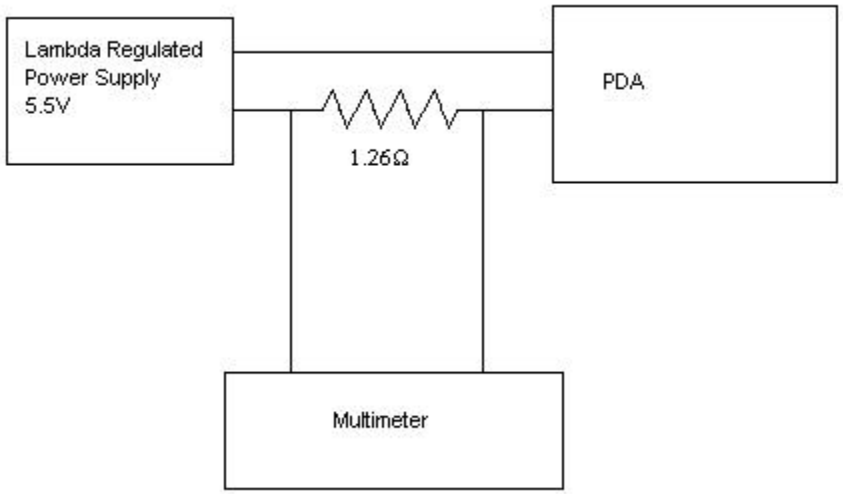
  Randomly jump between 8 lines of code. After jumping program moves back to initial position through an unconditional branch.

  Measured power during loop.

- # Methodology for Power Measurement:

  -Used lab power supply of 5.5 V

  -Placed 1.26 ohm resistor in series with power supply, and measured voltage drop across it.



- PDA Overviews:

  -Aero 2100 series:

    MIPS4K Family, 70 Mhz

    16 MB RAM

    32 GP registers

    8K direct mapped data cache (WB)

    32-entry TLB (fully associative)

- PDA Overviews:

  -Casio E-115:

    MIPS4K Family, 131 Mhz

    32 MB RAM

    32 GP registers

    8K direct mapped data cache (WB)

    32-entry TLB (fully associative)

- PDA Overviews:

  -iPAQ H3600:

    Intel StrongARM SA-1100 series, 206Mhz

    32 MB RAM

    27 GP registers

    8K 2-way set associative data cache (WB)

    2 32 entry fully associative TLB’s

- PDA Overviews:

  -Jornada 540 Series:

    SH3 Processor, 133 Mhz

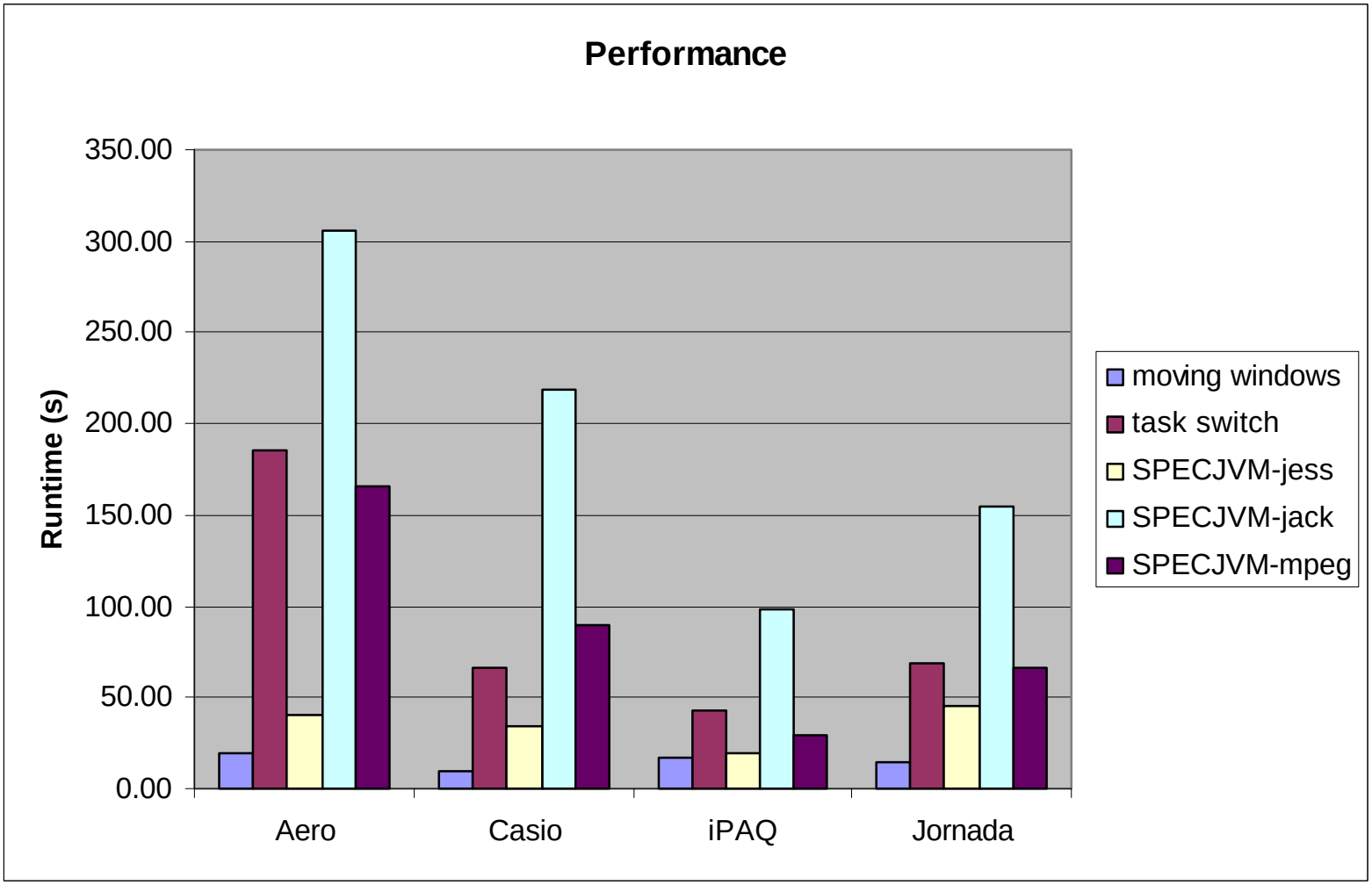
    16 MB RAM

    16 GP registers

    8K 2-way set associative data cache (WB)

    128 entry TLB (4-way set associative)

- Results
  - Performance Tests
  - General Power Measurements
  - Runtime Power Measurements
  - Architecture Power Measurements


Performance
Runtime (s)
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
Aero
Casio
iPAQ
Jornada
moving windows
task switch
SPECJVM-jess
SPECJVM-jack
SPECJVM-mpeg

Poor performance on jack & mpeg:

- Require access to large input files

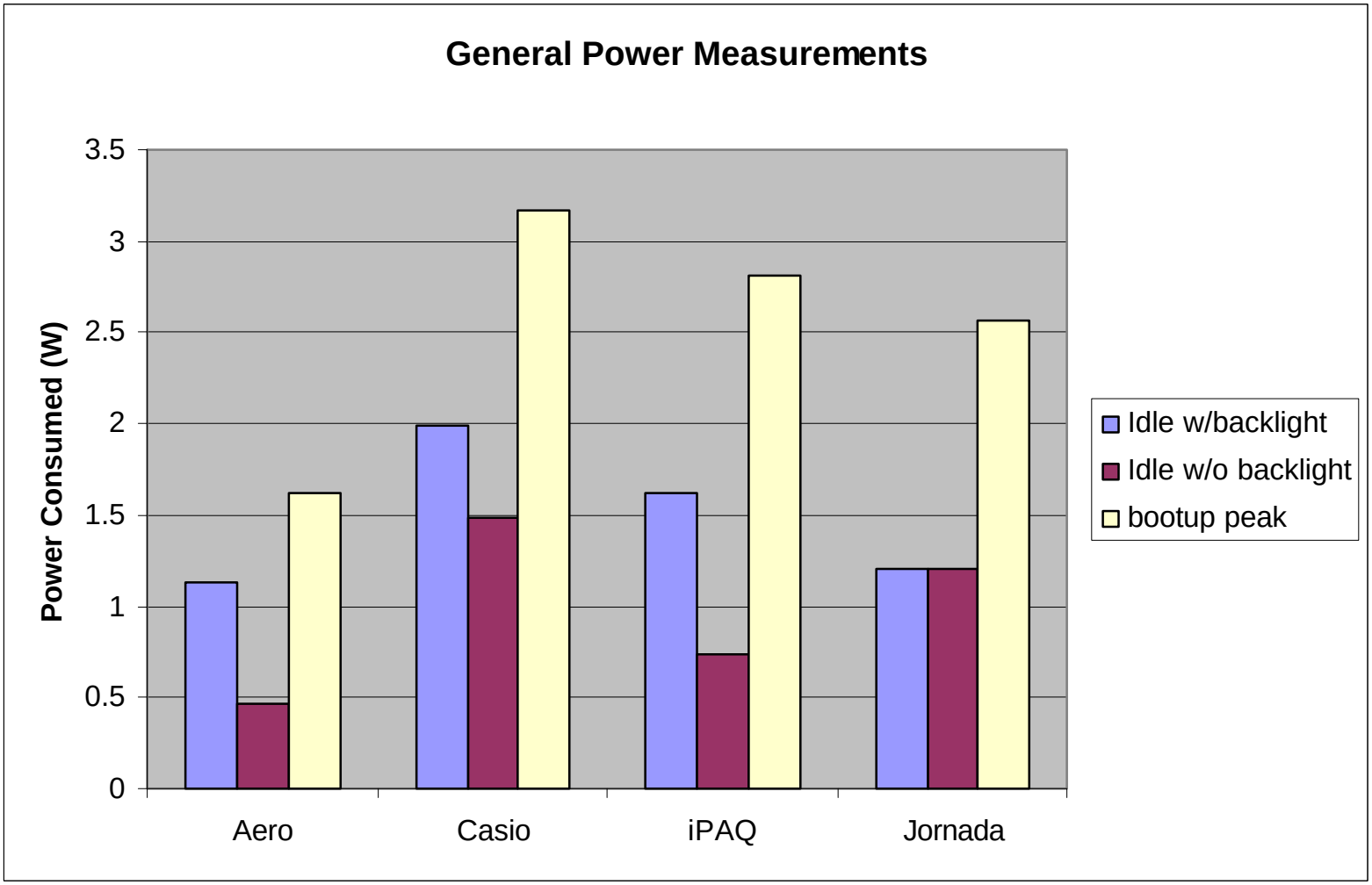
- Both performance tests scale proportionally per platform

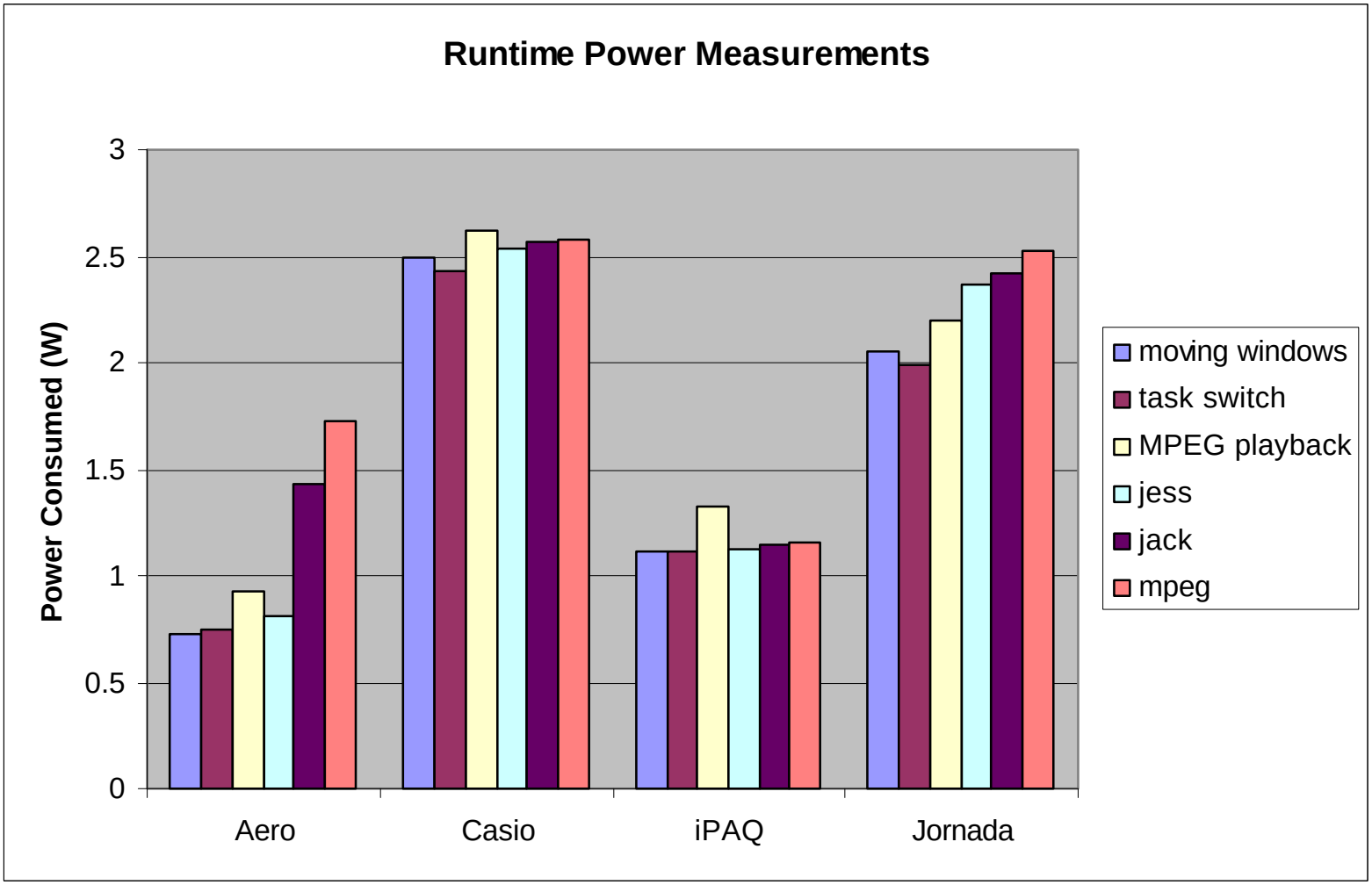
- We therefore believe poor performance is due to slow memory access

Poor performance on task switching:

Possible causes:

- Proportionally smaller data cache as compared to other consumer level CPU's such as desktop machines and laptops, which forces memory access.

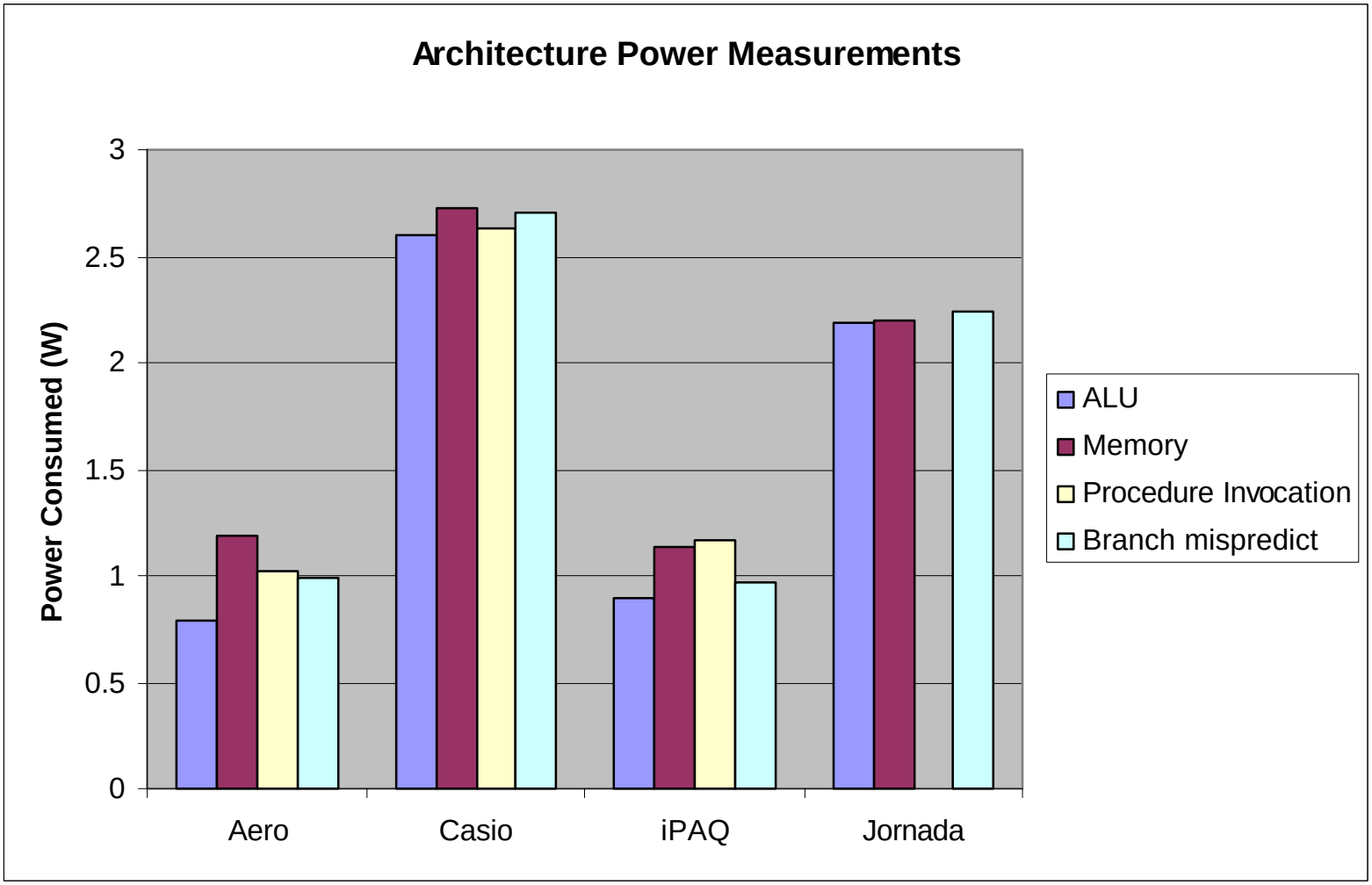

General Power Measurements
Power Consumed (W)
3.5
3
2.5
2
1.5
1
0.5
0
Aero
Casio
iPAQ
Jornada
Idle w/backlight
Idle w/o backlight
bootup peak


Runtime Power Measurements
Power Consumed (W)
3
2.5
2
1.5
1
0.5
0
Aero
Casio
iPAQ
Jornada
moving windows
task switch
MPEG playback
jess
jack
mpeg

General trends between platforms seem similar. Interesting observation:

Aero and Jornada peak more on memory intensive tests.

Both have 16 MB of RAM as opposed to 32 MB of iPAQ and Casio. Could be due to memory fragmentation.


Architecture Power Measurements
Power Consumed (W)
3
2.5
2
1.5
1
0.5
0
Aero
Casio
iPAQ
Jornada
ALU
Memory
Procedure Invocation
Branch mispredict

Conclusions

- Current PDAs suffer issues similar to issues in desktop and laptop computers (memory latency, data caching…)
- Particularly weak areas seem to be task switching and file I/O