# Performance Impact of Flash Memory on Multi-Core Android-Based Smartphone

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# Motivations

- Many cell phone makers facing “Power Wall”
- Need to run more applications for a longer time
- Is Flash Memory a option?
- Created a Virtual Platform for Performance and Power Optimization
  - Enable Performance and Power Profiling and Tuning with running real Java Applications on Android
    - Application : Android application written in Java
    - SW Platform : Android SDK
    - HW Platform on VisualSim: ARM9/11 Library, Memory Libraries, etc.
- Huge expectations on Android Market
  - Many chip vendors are porting and demonstrating Android
    - ARM, TI, Qualcomm, NEC, Freescale, Marvell, Renesas

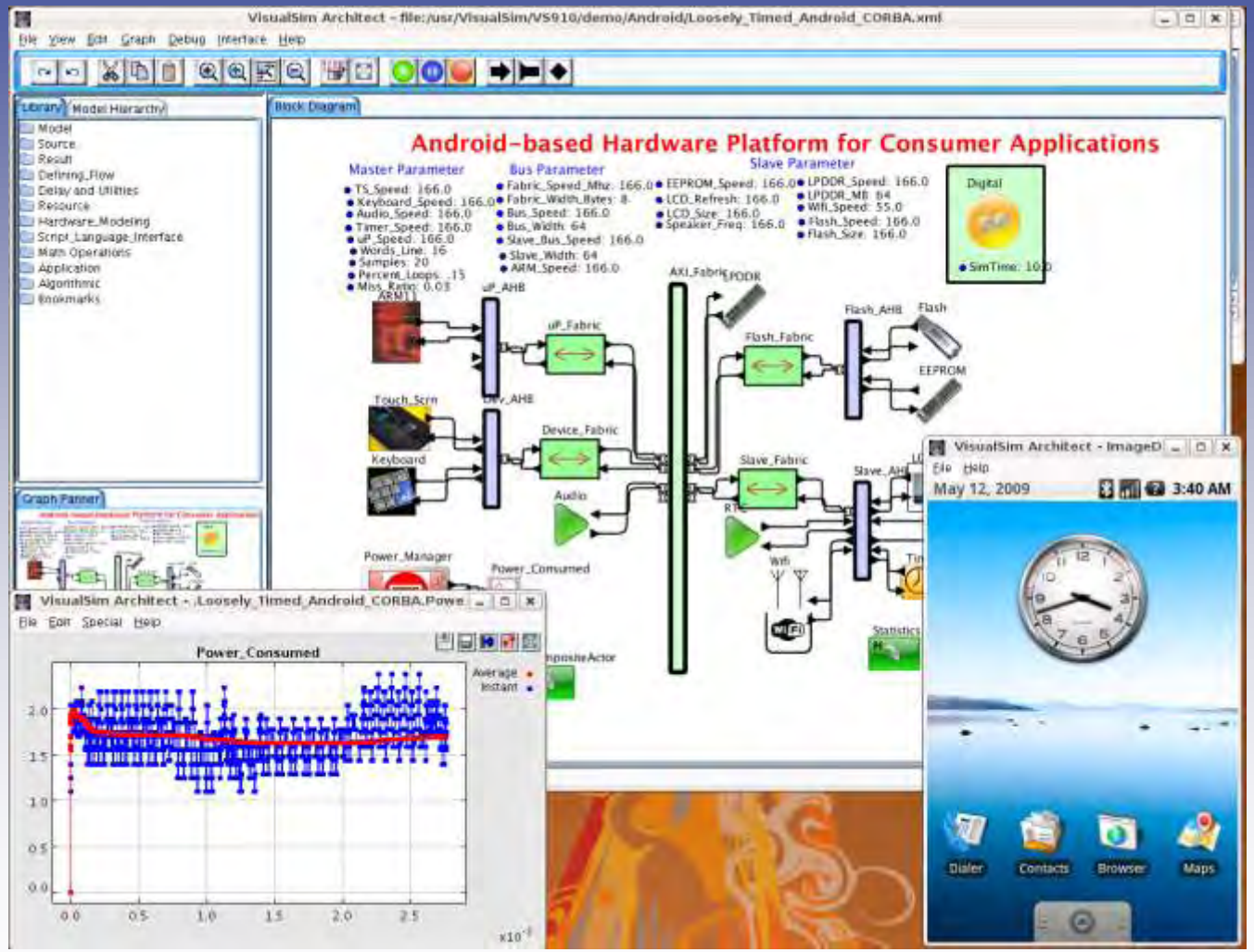
# What is “Android on VisualSim”?

- Android HW/SW running on VisualSim platform
  - Execute any Android applications
  - Visualize what’s happening on SW and HW platform
    - Where is the bottle neck
- Visualize the Performance and the Power
  - “Performance Meter”
    - Performance Profile : Flash, CPU, SDRAM, WiFi
  - “Power Meter”
    - Power profile : CPU, SDRAM, Flash, WiFi, LCD, Touch Screen
- Optimize Application Software for Performance and/or Power
  - Need power control, smart
- Optimize Hardware architecture for Performance and/or Power
  - need Multi-Core, Low-Power memory, Back Light Control, etc.

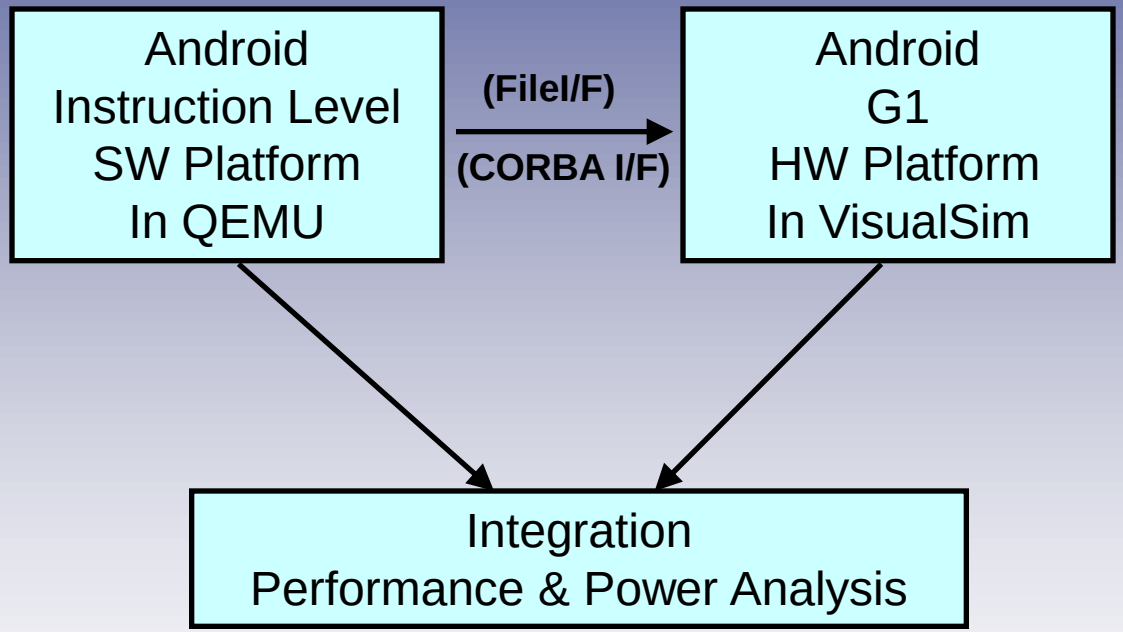
# TOPS Systems Corp.

- Established in 1999, Tsukuba, Japan
- TOPS Systems provides:
  - Heterogenerous multi-core Solutions: wide range of energy-efficient and scalable Multi-Core solutions. These cores provide distinct advantages from optimizations through Architecture-Algorithm Co-Design and Hardware-Software Co-Design for Systems and SoC developers.
  - Heterogeneous multi-core processor IP: TOPSTREAM™ - based products are used in higher performance and lower power applications ranging from battery-driven information appliances.
  - Development service: in Japan a range of services from initial architecture definition and software development through design verification as their extension to reduce total development costs and speed time to market.

# VisualSim Model Screen Shot



# Development Flow



# Android Instruction Level SW Platform


**Android SW Stack**

**Boot Message**

**Applications (Java)**

**FLASH**

**UART**

**File System**

- **Generate Bus Transactions**
- **Instruction Type**

***porting***

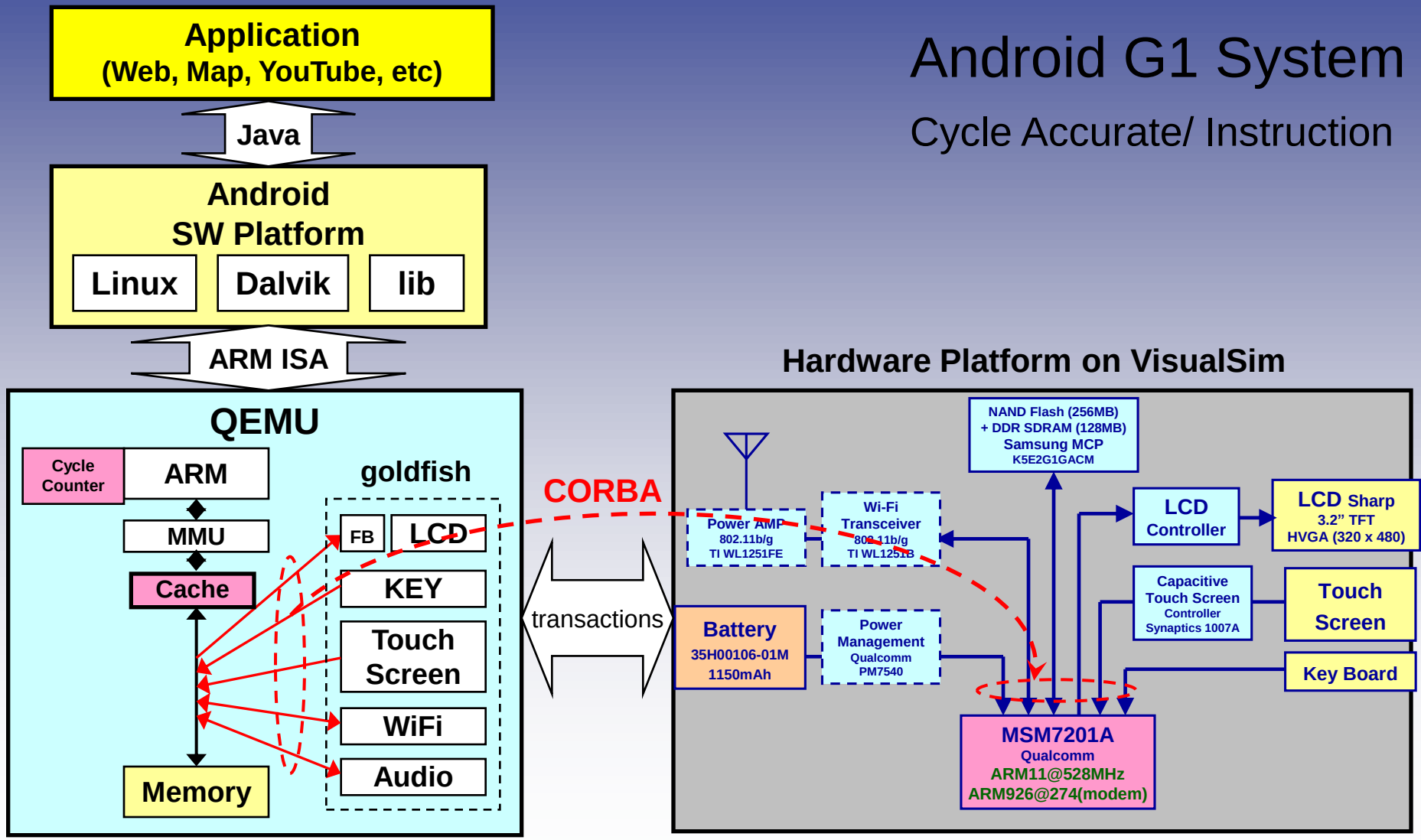
**ARM11 ISS (QEMU)**

**Instruction Level**

# Connection between SW model and HW model

## Android G1 System

Cycle Accurate/ Instruction



# Summary

- Released “Android™ on VisualSim” architecture exploration platform for multi-core phone design.
- Systems designers of Android devices can use this platform for hardware-software architecture exploration and power and performance analysis of consumer devices.
- Achieved 10-20 MIPS for a cycle-based and Approximately-Timed simulation running software applications.