GreenDroid

Solution to powerconsumption

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Outline

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What is GreenDroid?

- The GreenDroid is a mobile application processor.
  it is a 45-nm multicore research prototype that targets the Android mobile-phone software stack.
- It can execute general-purpose mobile programs with 11 times less energy than todays most energy-efficient designs, at similar or better performance levels.
- GreenDroid will serve as a prototype for mobile application processors in the next seven to ten years.
- It has a specially built structure that can analyze a current Android phone and determine which apps, and which CPU circuits the phone is using the most.
- Then it can dream up a processor design that best takes advantage of those usage habits, creating a CPU thats both faster and more energy efcient

How it works?

- It does this through the use of a hundred or so automatically generated, highly specialized, energy-reducing cores, called conservation cores.

Necessary

- A key technological problem for microprocessor architects is the utilization wall.
- The utilization wall says that, with each process generation, the percentage of transistors that a chip design can switch at full frequency drops exponentially because of power constraints.
- A direct consequence of this is Dark Silicon

What is Dark silicon ?

- How many transistors you can actually use simultaneously given your power budget the gap between area gains and power gains.
- Dark silicon is necessary, because engineers are unable to reduce chips operating voltages any further to offset increases in power consumption and waste heat produced by smaller, faster chips. This dark silicon limits the utilization of the application processors to the fullest.

Outline

Utilization Wall (1/2)

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Scaling theory

You can also highlight sections of your presentation in a block, with it's own title

Utilization Wall (2/2)

Experimental results

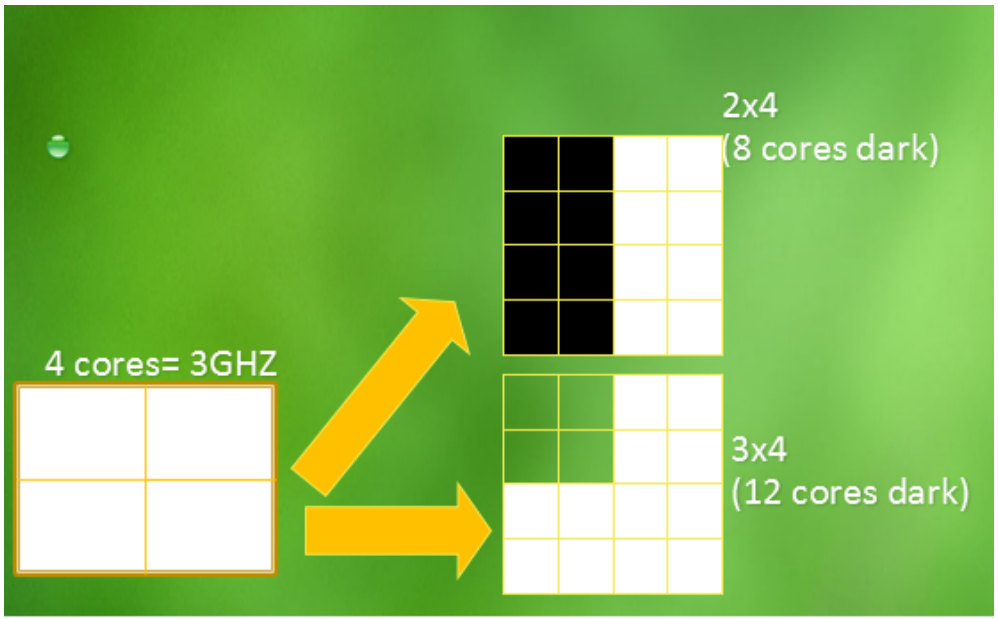
- Replicated small data path
- More Dark Silicon than active

Observations in the wild

- Flat frequency curve
- Increasing cache/processor ratio

Utilization Wall: Dark Implications for Multicore

- Spectrum of tradeoffs between cores and frequency
  e.g.; take
  65 nm32 nm;
  i.e. (s =2)



What we do with dark silicon ?

Insights

- Power is now more expensive than area.
- Specialised logic has been shown as an effective way to improve energy efficiency(10-1000x)

Approach

- Fill dark silicon with specialised cores to save energy on common apps
- These cores are automatically generated from the code base that the processor is intended to runthat is, the Android mobile-phone software stack.
- The cores feature a focused re-configurability so that they can remain useful even as the code they target evolves.

Outline

Introduction

- The GreenDroid architecture uses specialized, energy-efficient processors, called conservation cores, or c-cores to execute frequently used portions of the application code.
- Collectively, the c-cores span approximately 95 percent of the execution time of teams test Android-based workload.

CONSERVATION CORES

Specialized cores for reducing energy

- Automatically generated from hot regions of program source
- Patching support future proofs HW

Fully automated tool chain

- Drop-in replacements for code
- Hot code implemented by C-Core, cold code runs on host CPU
- HW generation/SW integration

Energy efficient

- Up to 16x for targeted hot code

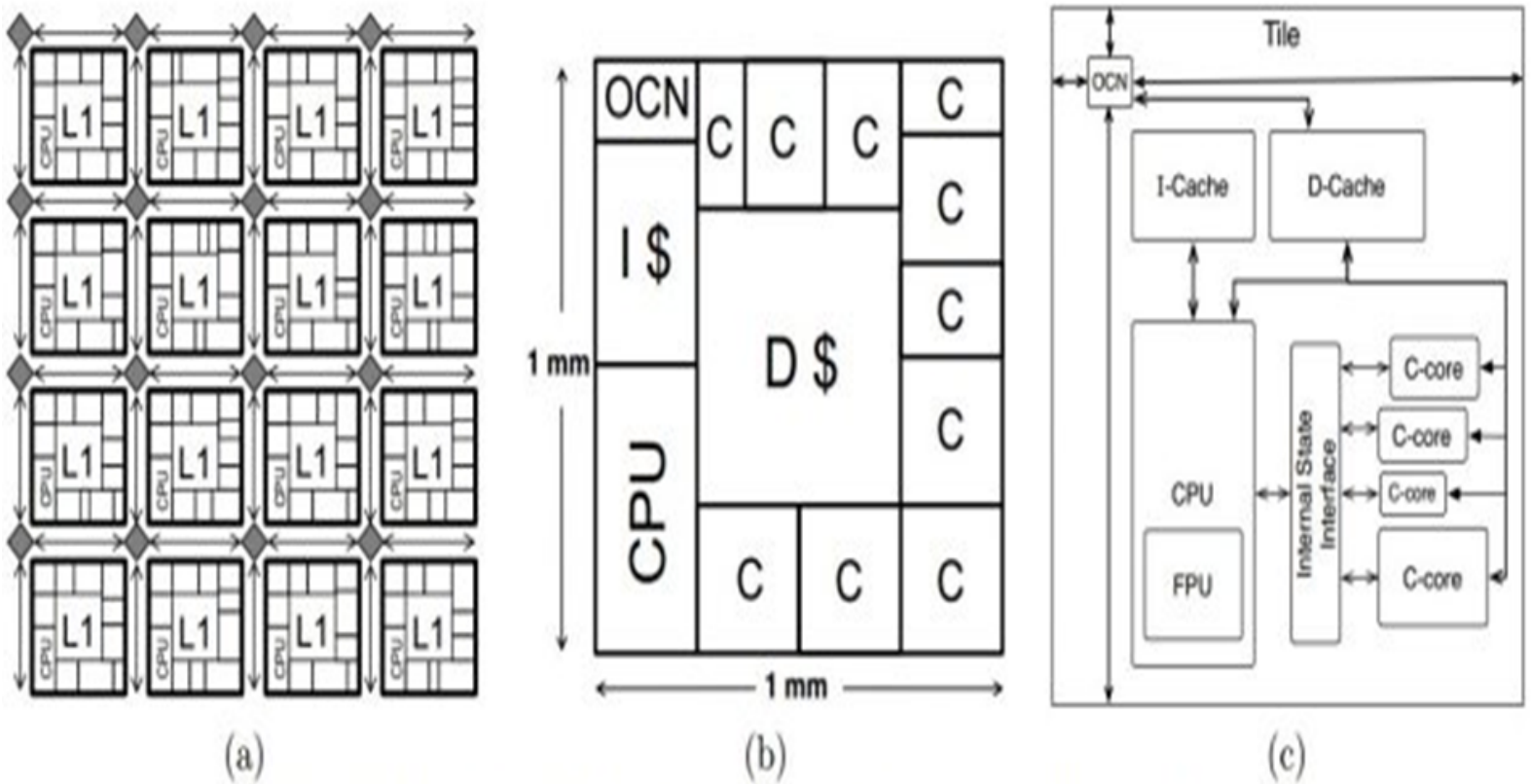


Figure 2: **The GreenDroid architecture, an example of a Coprocessor-Dominated Architecture (CoDA).** The GreenDroid Mobile Application Processor (a) is made up of 16 non-identical tiles. Each tile (b) holds components common to every tile—the CPU, on-chip network (OCN), and shared L1 data cache—and provides space for multiple c-cores of various sizes. (c) shows connections among these components and the c-cores.

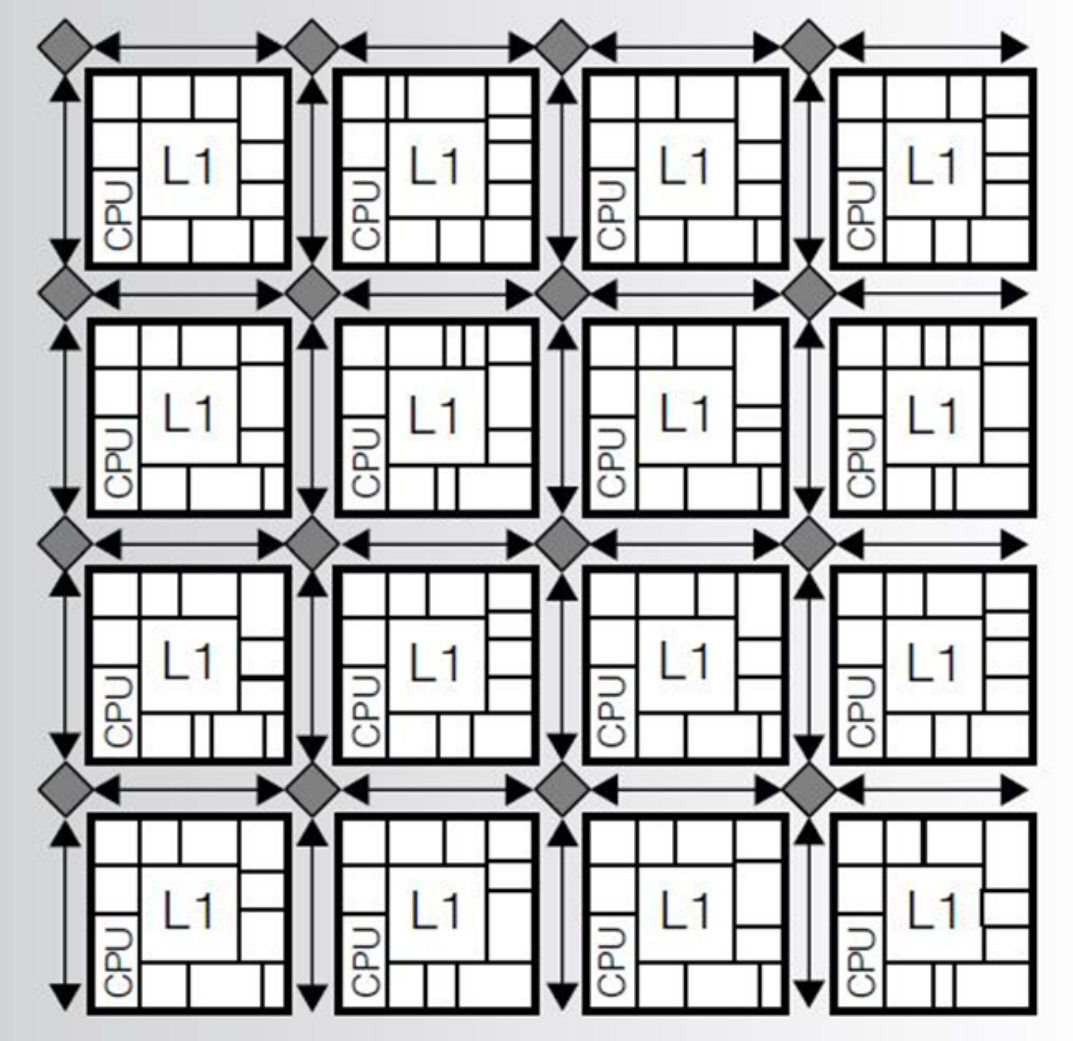


Figure: The system comprises an array of 16 non-identical tiles.

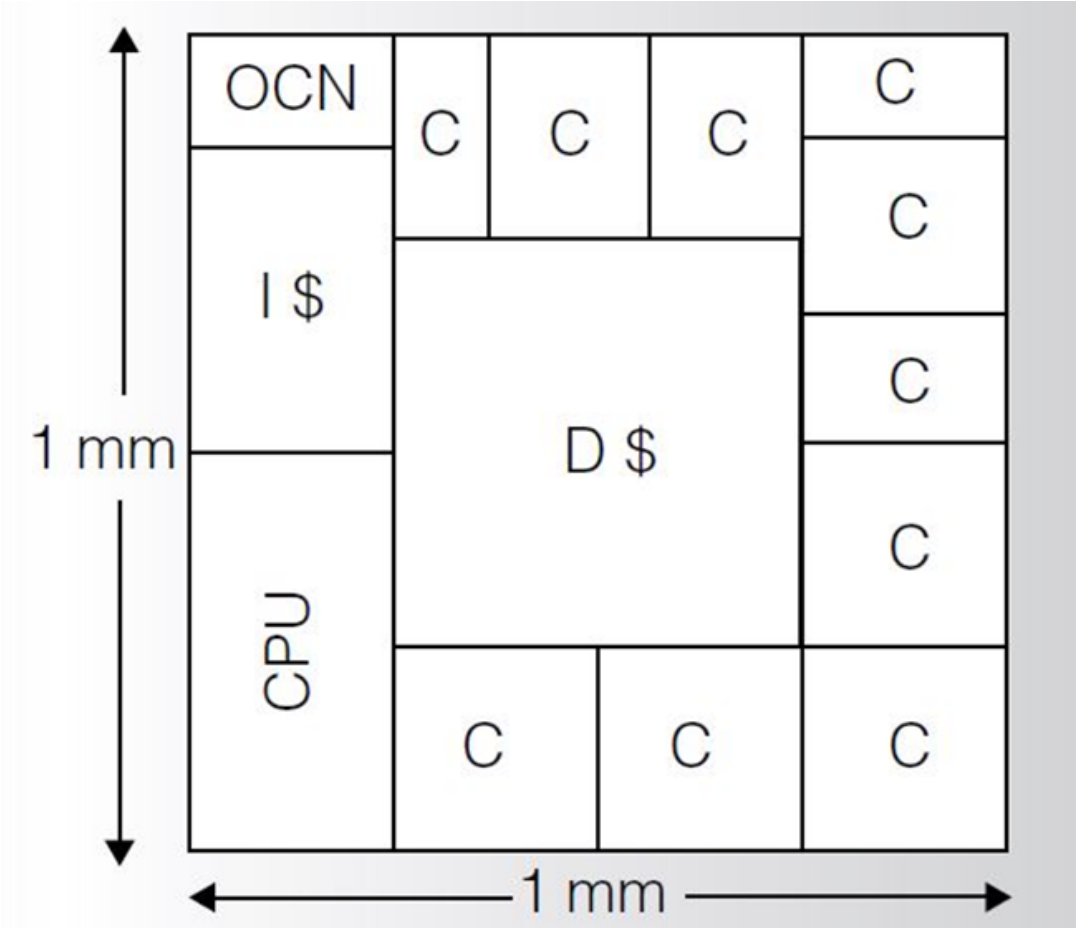


Figure: Each tile holds components common to every tilethe CPU, on-chip network (OCN) and shared Level 1 (L1) data cacheand provides space for multiple conservation cores (c-cores) of various sizes.

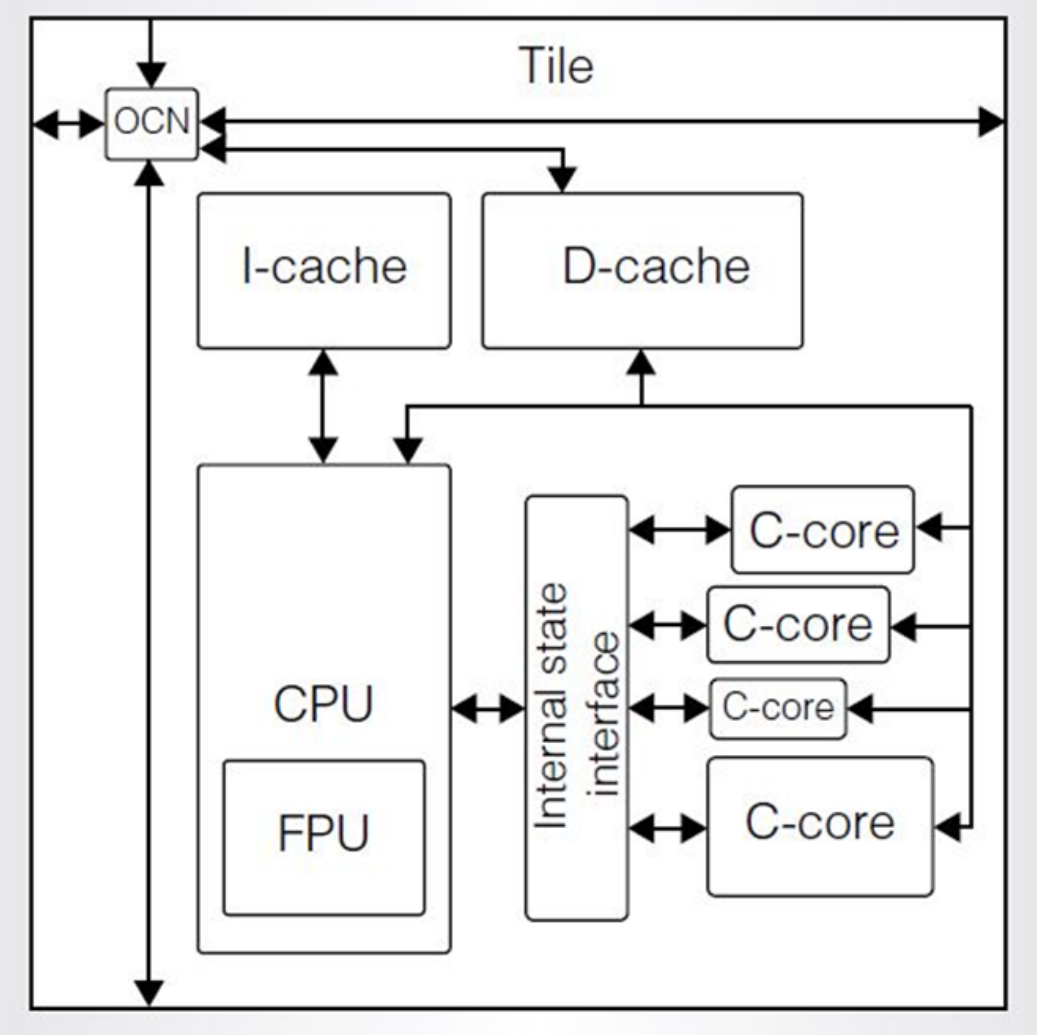


Figure: The c-cores are tightly coupled to the host CPU via the L1 data cache and a specialized interface

Energy Saving

- c-cores dont require instruction fetch, instruction decode, a conventional register file, or any of the associated structures. Removing these reduces energy consumption by 56 percent.
- The second source of savings (35 percent of energy) comes from the specialization of the c-cores data path.

Conclusion

- Over the next five to 10 years, the breakdown of conventional silicon scaling and the resulting utilization wall will exponentially increase the amount of dark silicon in both desktop and mobile processors.
- The Green Droid prototype demonstrates that c-cores offer a new technique to convert dark silicon into energy savings and increased parallel execution under strict power budgets.
- The estimate that the prototype will reduce processor energy consumption by 91 percent for the code that c-cores target, and result in an overall savings of 7.4 X.

Reference I

- http://greendroid.ucsd.edu/
- seminarprojects.org/q/greendroid-ppt
- N. Goulding et al., GreenDroid: A Mobile Application Processor for a Future of Dark Silicon, HotChips, 2010.