Cairo University

Electronics and Communications Department

Computer Arithmetic:

Linking the past to the future

Hossam A. H. Fahmy

Remember the roadmap
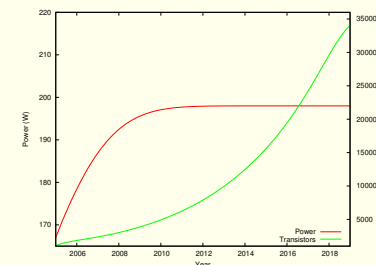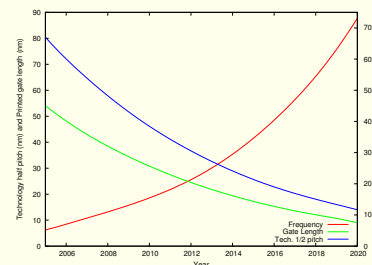
Minimum gate length and maximum clock frequency.

Maximum allowable power and number of transistors.

Trends in high performance chips. (Original data from http://public.itrs.net)

Remember the realities

- Scaling the transistors comes with some cost: more leakage power and more defects.

- A new fabrication facility costs billions of dollars.

- With less than 100nm gate length, wires are more important than gates in the delays.

Remember the market

- Mobile computation and communication.

- Integration of voice, graphics, still and moving photos.

- Data security: availability, correctness, privacy.

What does all that mean?

We are moving away from an integrated circuit to an integrated system.

- Integrate all the different media in a single system on a chip.
  - Not just general purpose FPUs, but also graphics and signal processing on the same chip.
  - Each unit is tuned to its own "optimum".

- Supply all the arithmetic units with the required data. This is hard if you want to go full-speed all the time.
  - hard because the bandwidth is limited (wires, cache misses, mispredicted branches, . . .).
  - hard because the power is limited.

Arithmetic for multi media

Throughput is of high importance.

Pipelined integer and FP units.

Sub-word concurrency: partitioned adders and multipliers.

Divide, Square root, and trigonometric functions are important.

Tools

Current CAD tools do not provide us with the ability to "tune" the arithmetic circuits easily.

Can we really tune millions of transistors?

Reconfigurable and high performance

- What about reconfiguration/programability?

- Can it still be efficient (speed, area, and power)?

Most of the energy consumed in modern processors or DSPs goes into moving bits from one part to another, not in performing arithmetic. How can we change that?

See the stream architecture paper for a discussion.

Beyond the speed, area, and power, the definition of performance will include

1. testability,

2. reliability,

3. availability,

4. maintainability,

5. . . .

- We have opened the door. It is up to you to go through and continue learning.

- There are several opportunities for improvements, however the whole system must be the focus not just the arithmetic unit.