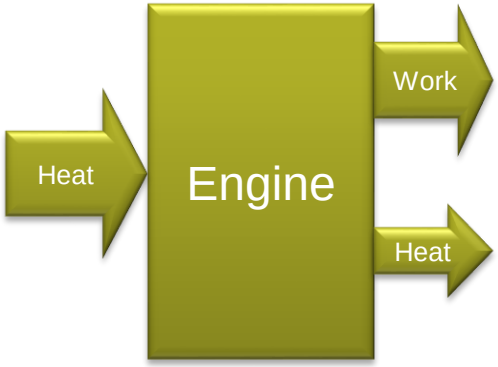
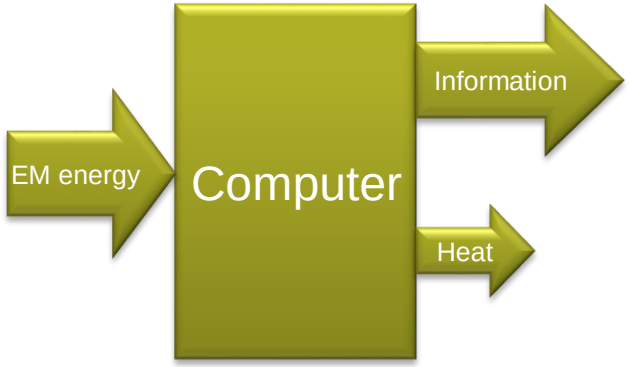

Microsoft® Research
Faculty Summit
10
YEAR ANNIVERSARY

Energy Efficient Computing:

3 observations and 3 lessons from embedded systems

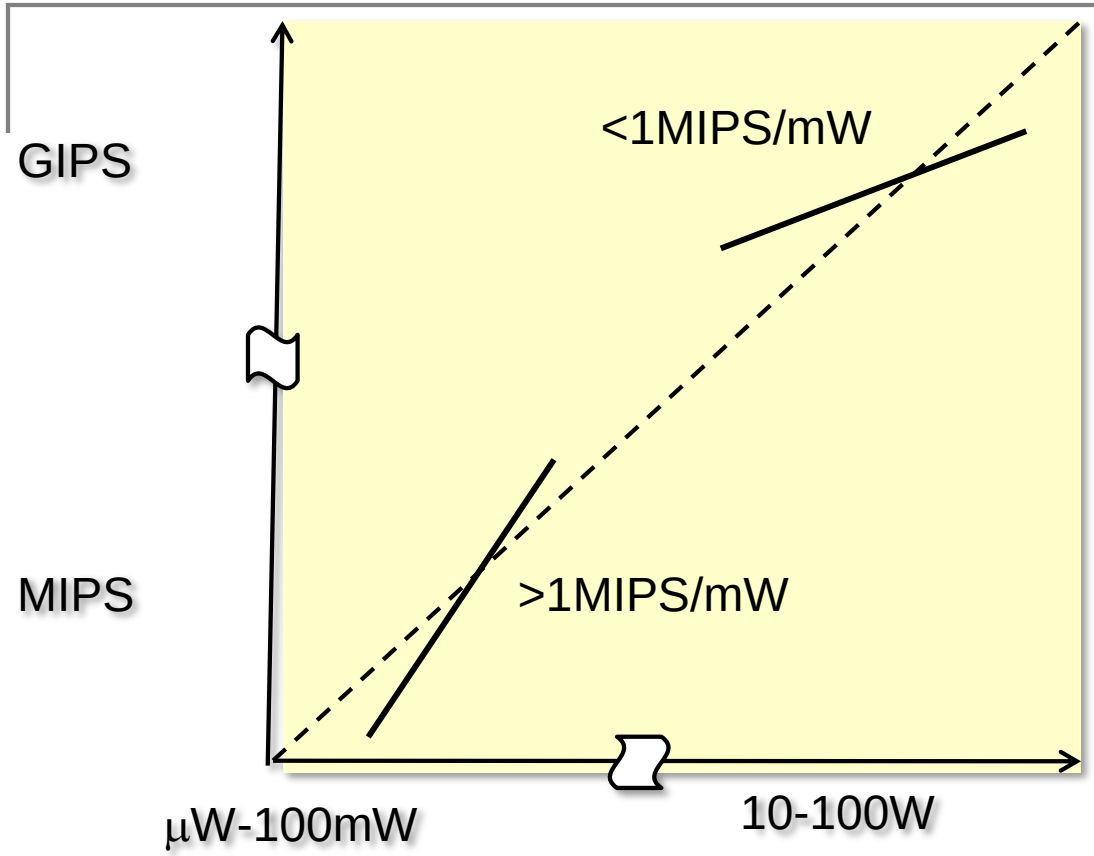




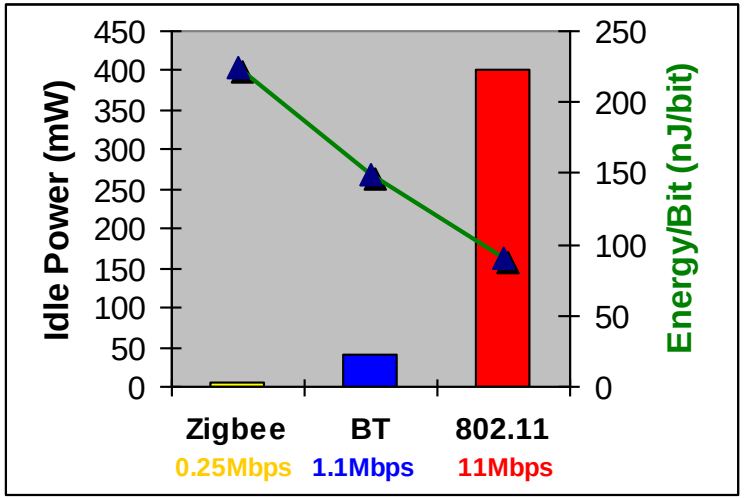
Rajesh Gupta, UC San Diego

http://mesl.ucsd.edu

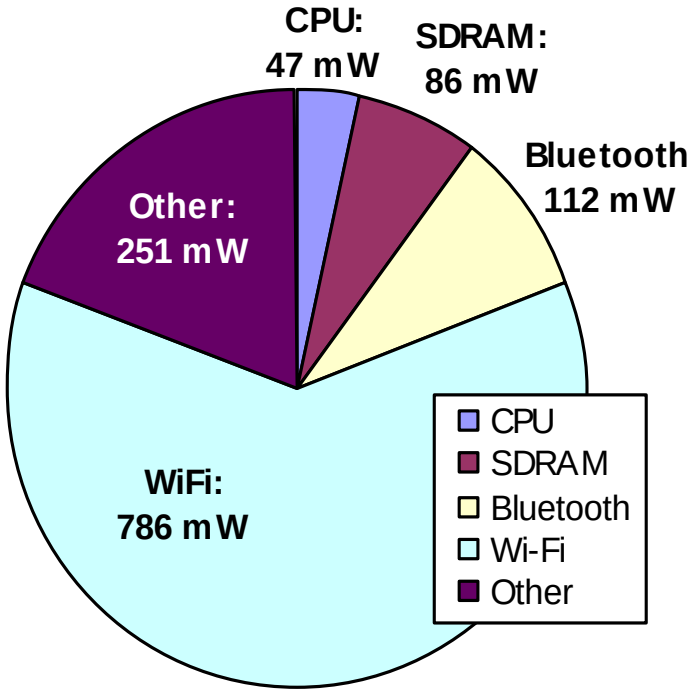
Microsoft, July 2009

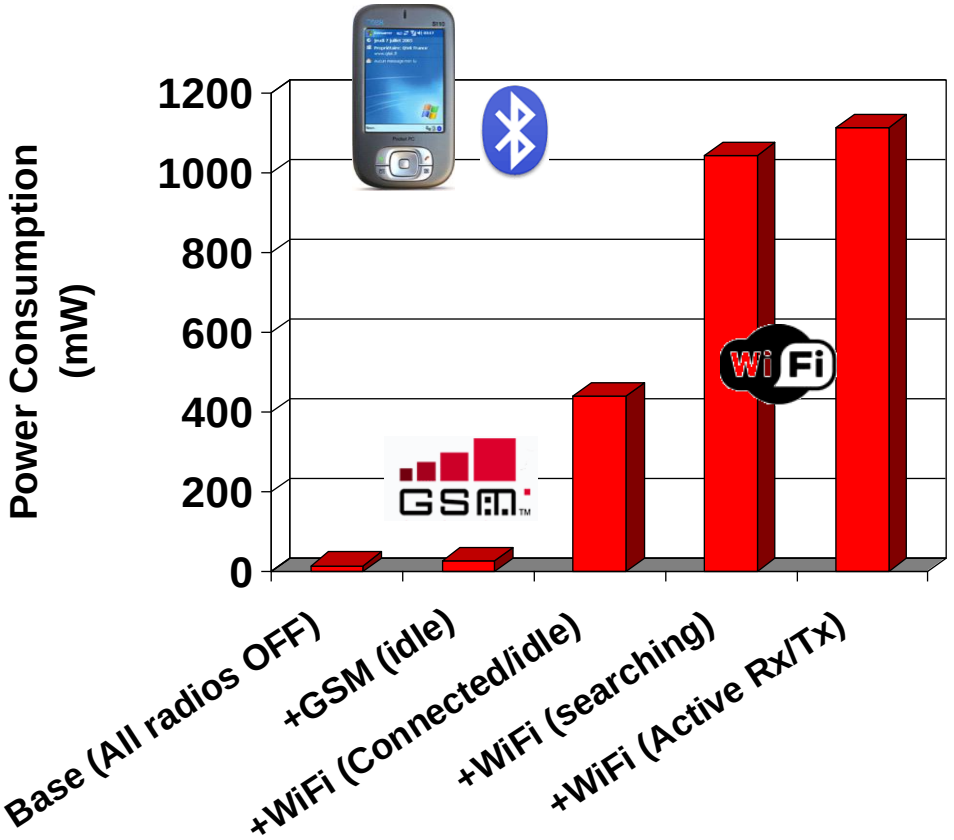


Large Differences between components



O1: Heterogeneity is a fact of life.





Power breakdown for a *fully connected* mobile device in *idle* mode, with LCD screen and backlight turned off.

6-10X variation in power use is common.

- Cellular voice radio (GSM) highly optimized for low idle power
  - Cingular 2125: GSM radio consumes 38 times less power than Wi-Fi !

O2: Increasing bandwidth of power consumption.

State	Power
Normal Idle State	102.1W
Lowest CPU frequency	97.4W
Disable Multiple cores	93.1W
“Base Power”	93.1W
Suspend state (S3)	**1.2W**

Desktop PC

Active State : >140W
Idle State : 100W

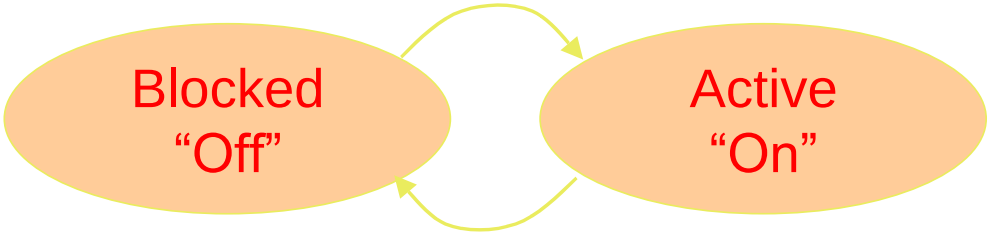
Sleep state : 1.2W
Hibernate : 1W

Large Differences between ON & OFF

O3: Abstraction stacks cost power.

One Lesson in Three Parts

- Exploit Heterogeneity: large differences
  - Between components, power states
- Deliver power when and where needed
  - JIT power delivery
- Match application needs to power availability
  - Differentiated quality of computation



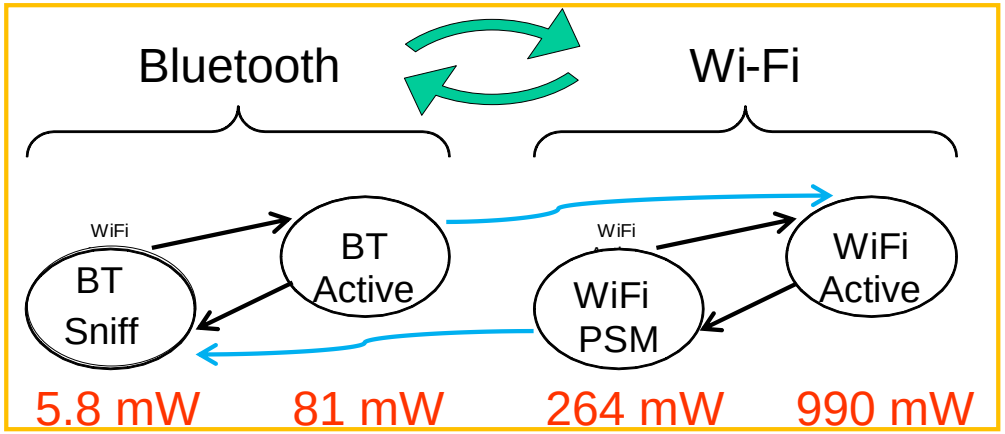
T_{block} T_{active} ideal improvement = $1 + T_{block}/T_{active}$

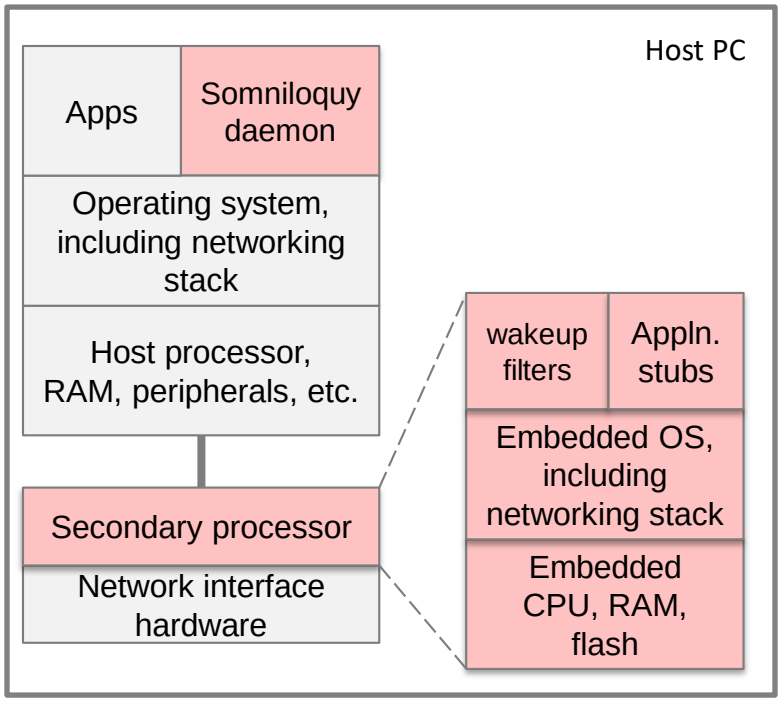
Beyond all low power tricks, duty-cycle keeps on giving

Easier Said Than Done

- Reliability? Availability? Usability?

Paging Radios

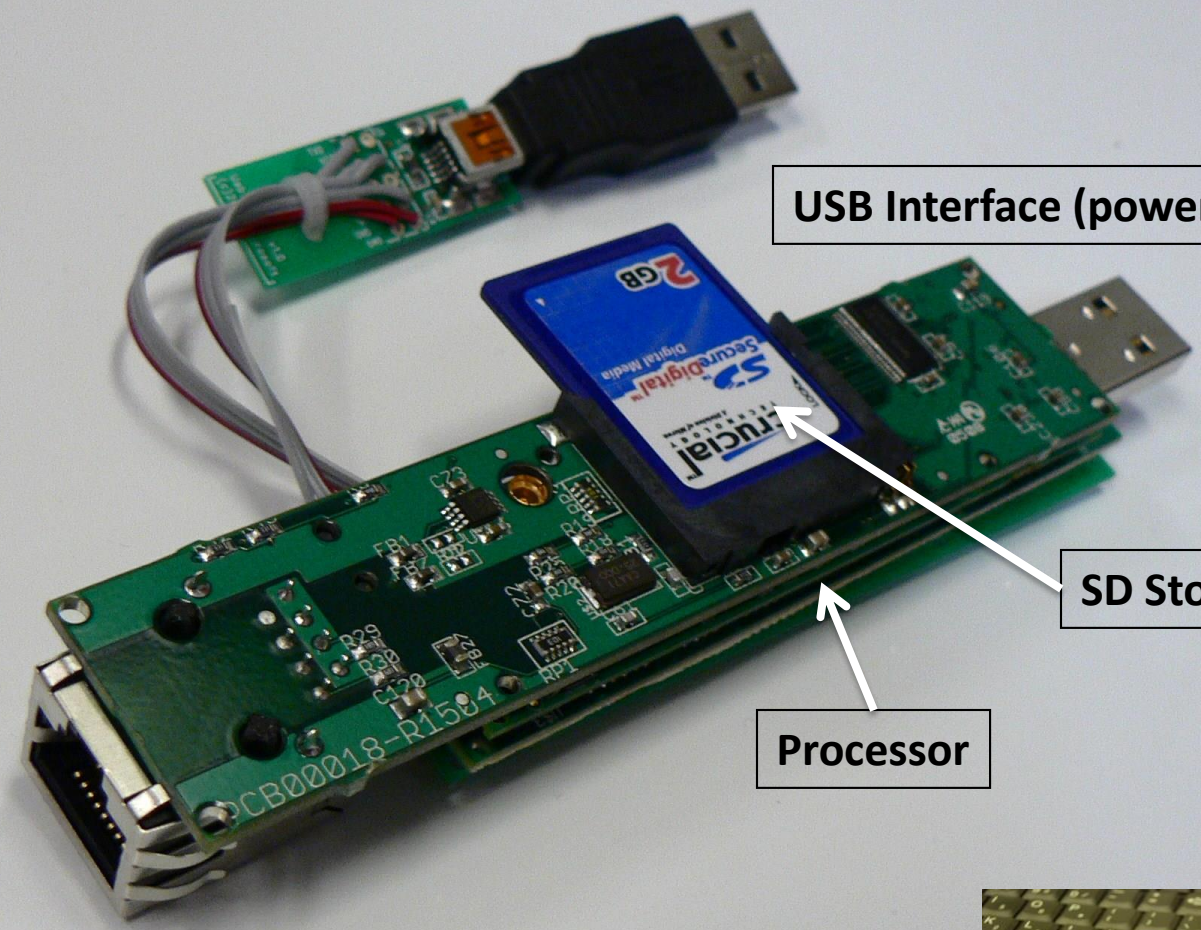




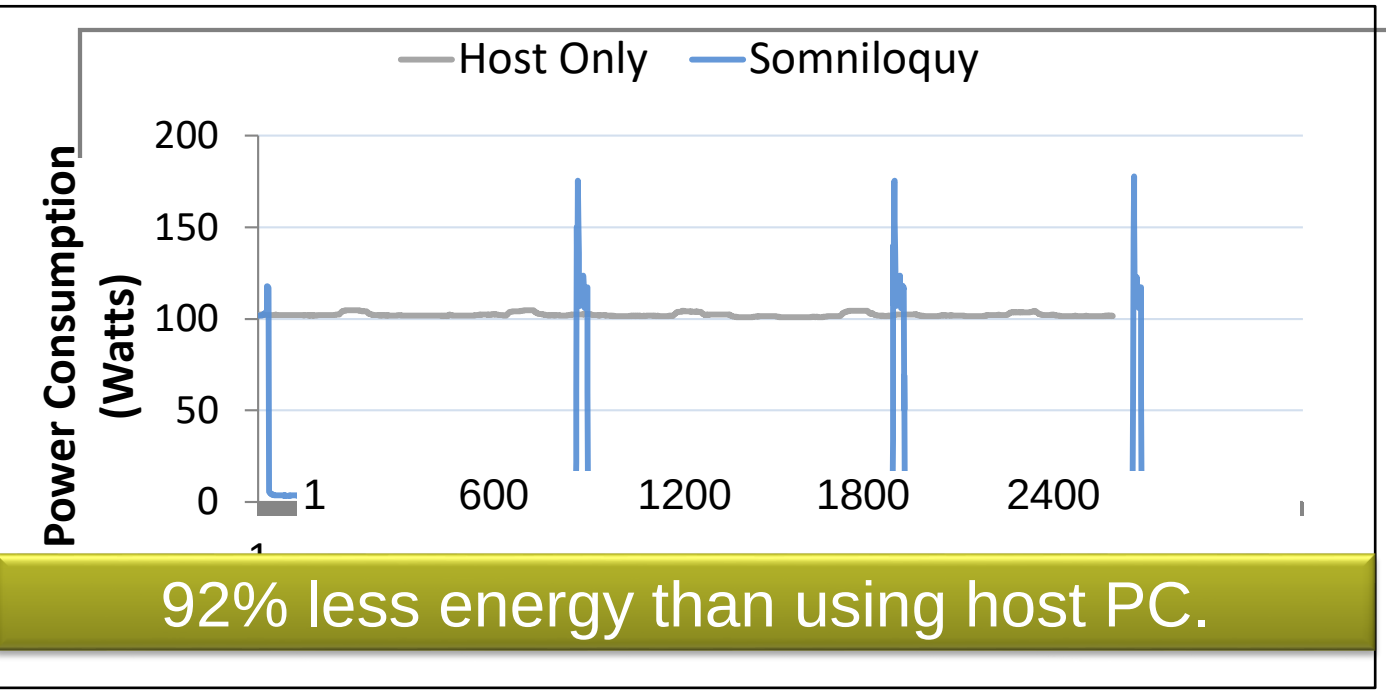
Sleep Talking Processors

Exploit heterogeneity to lower power by duty cycling.

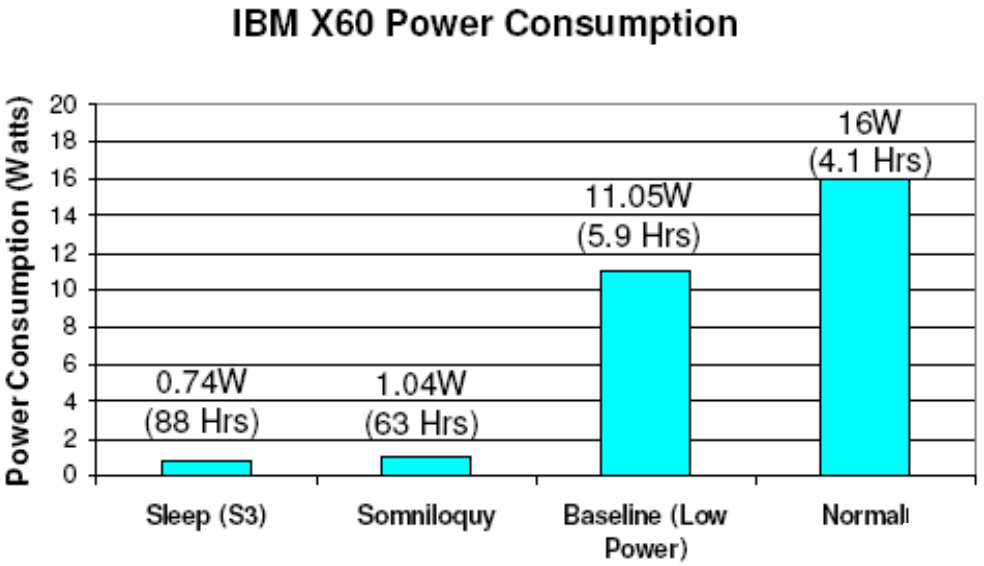
Somniloquy



In collaboration with Microsoft Research



92% less energy than using host PC.



Increase battery life from <6 hrs to >60 hrs

From Embedded Systems to HPC: We KNOW duty cycling is useful.

Takeaways

- Slowdown or low power design ultimately reaches a limit
- Duty-cycling keeps on giving
  - But causes non-trivial problems in availability, usability, reliability
- Challenge for the community
  - Algorithms: what are the right combination of slowdown and shutdown strategies?
  - Architectures: what is the right organization of components for maximal duty cycling?

"Future lies in system architectures built for aggressive duty-cycling"

“Koala Class” Computing

“Size Your Brain Power, Storage, and Sleep Cycles to Your Problem,” Tom DeFanti