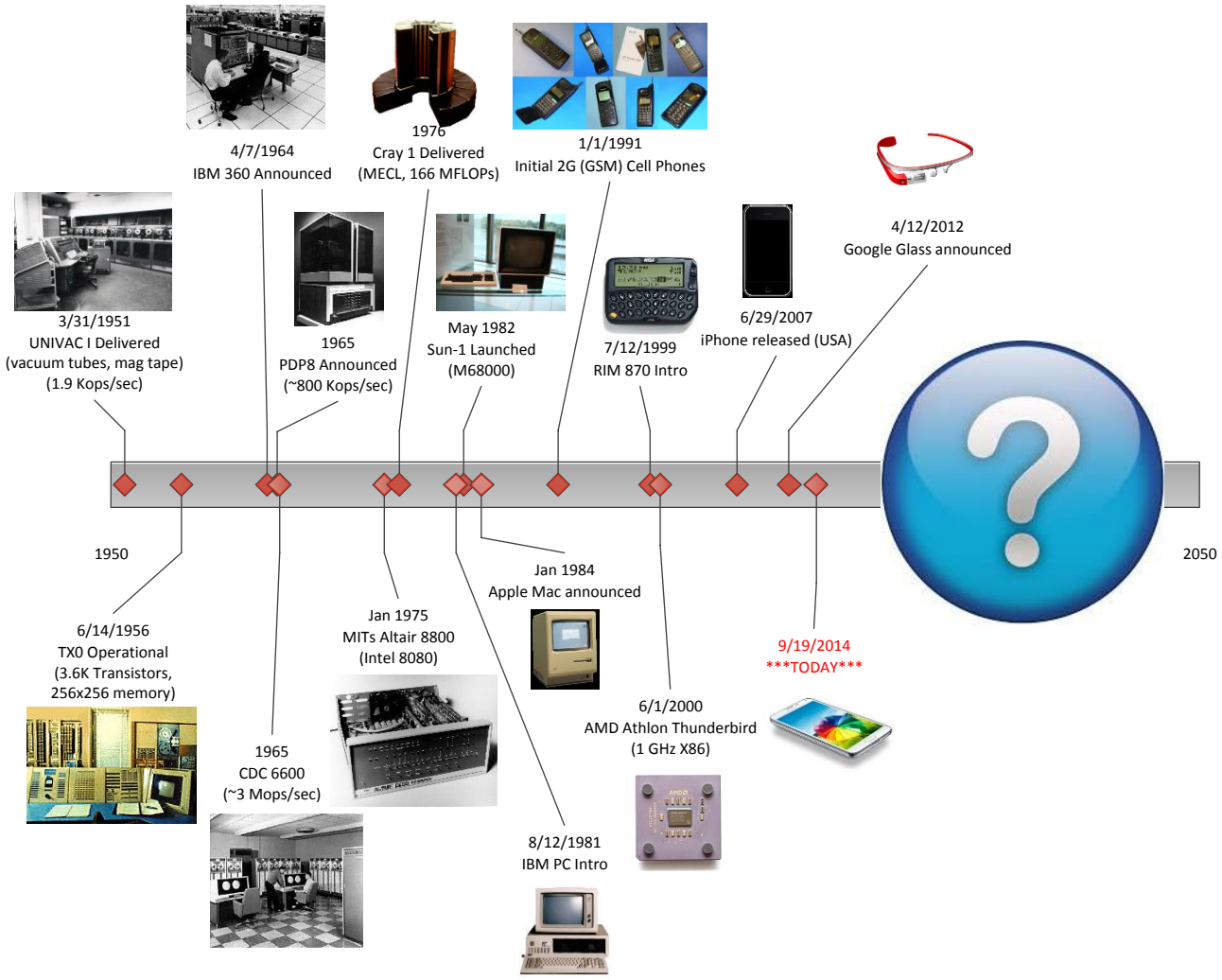
Future Challenges for Computer Architecture

Michael Shebanow
Samsung Research America, Advanced Processor Lab
September 19, 2014

“Visions for the Future”

- “The future” is a rather broad topic
  - The future “when?”
- The past is a good indicator of the potential progression in the future
  - Astonishing progression
- Disclaimer: all opinions are my own, nothing indicative of Samsung future plans

Computing and Communication Timeline



Computer Architecture Themes

- 60s: Big Iron, Minicomputers, Algorithms, Compilers
- 70s: Vector Machines, CISC, Microprogramming, Unix
- 80s: RISC, Superscalar, Cache Coherency
- 90s: "the need for speed…", virtualization
- 00s: Advent of the GPU
- 10s: More GPUs, Power Efficiency, ???

- Next?

So where are we going?

- Near term
  - Clients
  - Cloud
- Long term?
  - Traditional
  - Artificial Intelligence (AI)
  - Intelligence amplification (IA)

Clients

- Diversity
  - Phones, tablets, laptops
  - Wearables
  - IOT









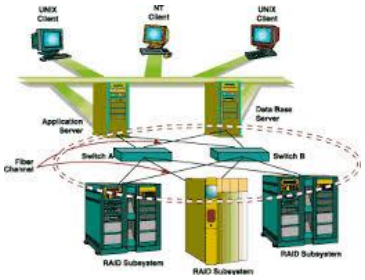
- Cloud integration
  - The internet at your fingertips

Drivers for Client Computer Architecture?

- PPA (performance, power, area)
- Specialization (fixed function)
  - Phones Phone
  - Phones Interact
  - Cameras camera
  - Refrigerators refrigerate
- Rapid time-to-market

Cloud

- PPA again the big driver
  - Aka, perf/watt/$
- Virtualization
- Security
- Storage Architecture
  - Flash, cheap disks, IOPs
  - SANs
- Connectivity
  - 5G, WiFi, BlueTooth, NFC
  - Copper, Fiber



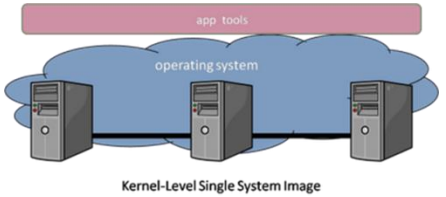
Long Term Trends

- Dangerous ground

- Branches
  - Traditional
  - Artificial Intelligence (AI)
  - Intelligence Amplification (IA)

Traditional Computing

- Client-Cloud Integration
  - A better way to program?
  - SSI?



Kernel-Level Single System Image

OpenSSI

amoebaOS

- Speed, Capacity

- Environmental Integration (IOT)

- Security

Artificial Intelligence (AI)

- Creating artificial entities

- Applications:
  - Robotics…
  - Self driving cars…
  - User interfaces (user anticipation)
  - …

Intelligence Amplification (IA)

- Wikipedia:

  "Intelligence amplification (IA) (also referred to as cognitive augmentation and machine augmented intelligence) refers to the effective use of information technology in augmenting human intelligence. The idea was first proposed in the 1950s and 1960s by cybernetics and early computer pioneers."

- Machine-assisted
- Relative to a human:
  - Output: brain-thought sensing
  - Input: visual, audio, haptic

Non-invasive Thought Detection?

- fMRI brain image reconstruction (http://gallantlab.org/publications/nishimoto-et-al-2011.html - Berkeley)

Presented clip

Clip reconstructed from brain activity

- Clearly not convenient or accurate enough right now
  - 40 years from now?

Impact to Computer Architecture?

- Unknown
  - Technology (quantum devices, new logic tech?)
- My wish:
  - Deep understanding of architected neural networks
  - Highly parallel, SSI-enabled HW and SSI OS (cellular)
  - Clearly better human-machine I/O

Thanks for the opportunity to speak…