Towards single Watt and nJoule/bit routing

Amos Nungu, Robert Olsson, Jiannan Guo, Bjorn Pehrson

UbuntunetConnect2014 workshop, Lusaka, November 2014
Bifrost seminar, Stockholm, November 2014

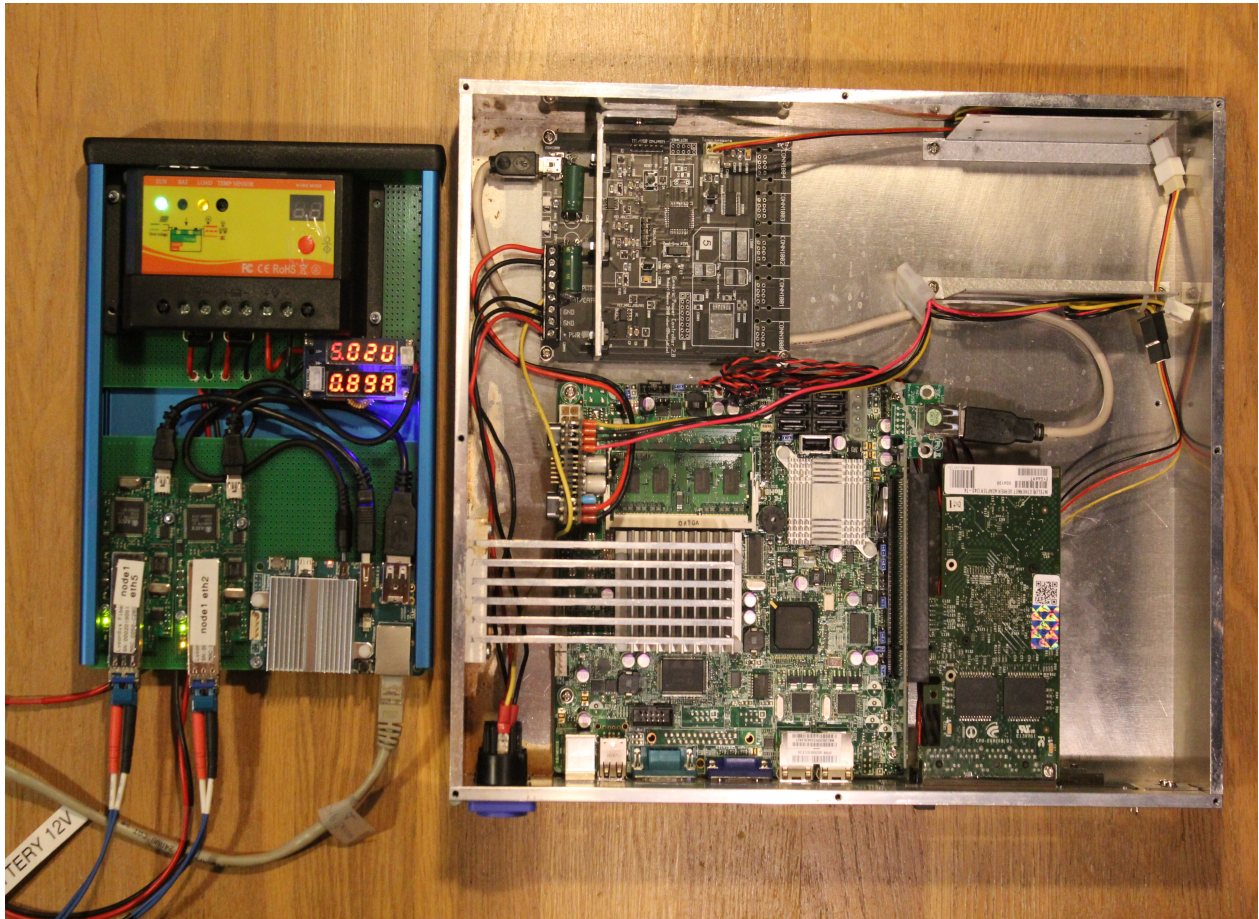
Serengeti Broadband Network

- Now a research network under TERNET, the Tz NREN serving the Serengeti Living Lab

Generations of network elements

Power supply still more of a challenge than capacity

1. Cisco 3750 Switches (>100W, 1GE, > 100nJ/bit)
2. Supermicro/Intel Atom, Int-ms Niagara, PCI Express (20W, 1GE, 20nJ/bit)
3. Odroid U3, Fibergecko100, USB2 (2-5W, 100 Mbps, 20-50nJ/bit)
4. ?, ?, USB3 (<1W?, 1nJ/bit)

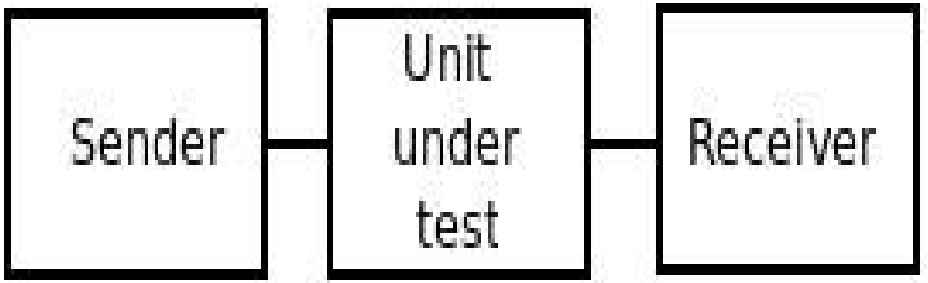


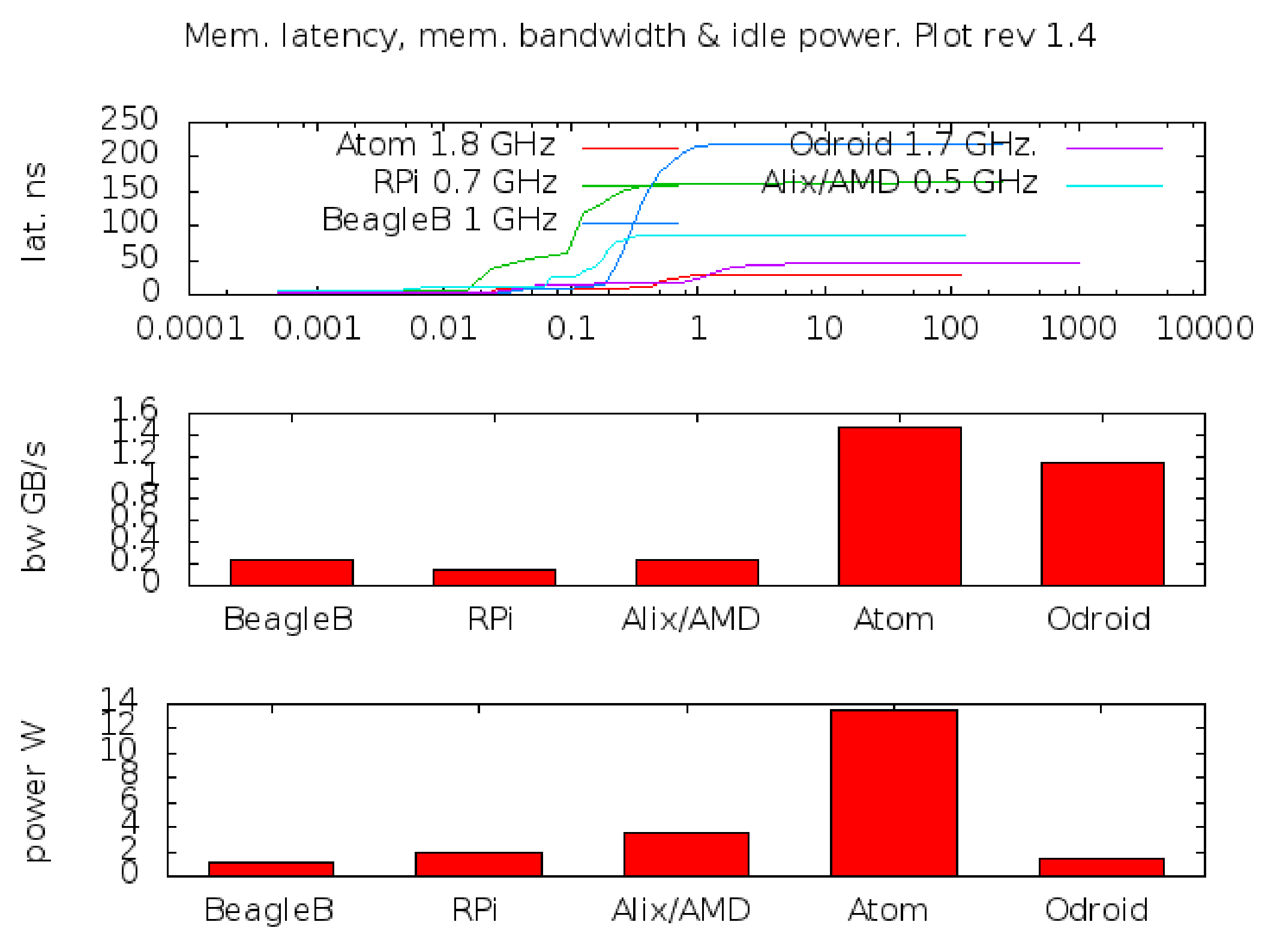
Generation 3 Contestants

- **Alix**
  - AMD Geode, ISA-style I/O bus,
  - 3 10/100 Mbps RJ45 and 2 USB2 ports
- **Raspberry Pi**
- **BeagleBoneBlack**
- **Odroid U3**
  - 2GByte RAM,
  - 10/100Mbps RJ-45 LAN and 3 USB2.0 host ports
  - GPIO/UART/I2C ports.
  - Samsung Exynos 4412 ARM Cortex-A9 Quad Core 1.7GHz CPU
  - Physical motherboard size : 83 x 48 mm, Weight : 48g including heat sink

Measurements

- Power consumtion measured with Wattson instrument
- Forwarding is essentially table lookup.
- Memory latency and bandwidth key parameters
  - L1, L2, Main memory
  - Measurements using the LMBench tool below
- Throughput measured using iperf3
  - Loopback: Odroid 5Gbps
  - Network: all wirespeed 100Mbps. USB2 bottleneck




Mem. latency, mem. bandwidth & idle power. Plot rev 1.4
lat. ns
250
200
150
100
50
0
0.0001
0.001
0.01
0.1
1
10
100
1000
10000
Atom 1.8 GHz
RPi 0.7 GHz
BeagleB 1 GHz
Odroid 1.7 GHz.
Alix/AMD 0.5 GHz
bw GB/s
BeagleB
RPi
Alix/AMD
Atom
Odroid
power W
BeagleB
RPi
Alix/AMD
Atom
Odroid

Conclusions and Future work

- USB2 bottleneck (480Mbps)
- USB3 emerging (5 Gbps)
  - Odroid XU3 under study
- Power consumption still decreasing
  - Autonomous power source/storage under study based on Hybrid ultracap/solar/fuelcell battery