

The Raspberry Pi Cloud

Experience, Lessons & Opportunities

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where do your music/videos/pictures live?



in the cloud



in the data centres - enormous & costly



Google's Data Centre in Council Bluffs, Iowa
\$600 million

in the data centres - enormous & costly



in the data centres - enormous & costly



**Facebook's Data Centre,
North Carolina
\$606 million**

in the data centres - enormous & costly

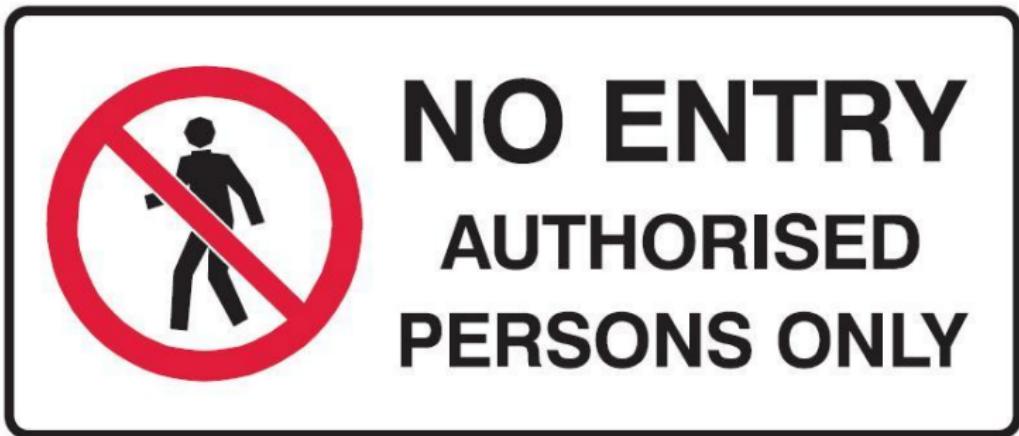


**Apple's Data Centre,
Maiden
\$1 billion**

on the inside - a closer look



wait, authorised persons only!



can't get in, normally

how to find out about it?



acm queue A Guided Tour through Data-center Networking

A good user experience depends on predictable performance within the data-center network.

Dennis Abts, Bob Felderman, Google

The magic of the cloud is that it is always on and always available from anywhere. Users have come to expect that services are there when they need them. A data center (or warehouse-scale computer) is the nexus from which all the services flow. It is often housed in a nondescript warehouse-sized building bearing no indication of what lies inside. Amidst the whirring fans and refrigerator-sized computer racks is a tapestry of electrical cables and fiber optics weaving everything together—the data-center network. This article provides a “guided tour” through the principles and central ideas surrounding the network at the heart of a data center — the modern-day loom that weaves the digital fabric of the Internet.

DATA-CENTER DEVELOPMENT

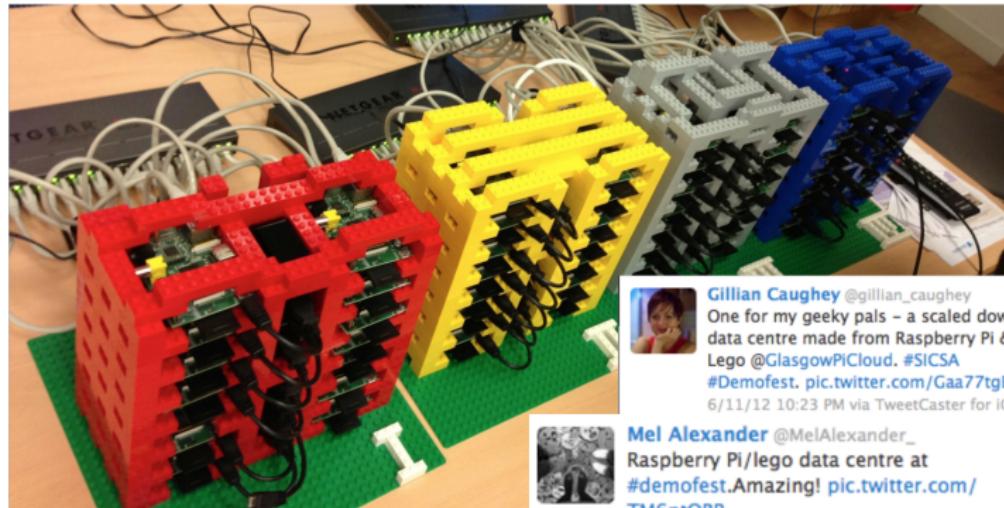
Large-scale parallel computers are grounded in HPC (high-performance computing) where kilo-processor systems were available 15 years ago. HPC systems rely on fast (low-latency) and efficient interconnection networks capable of providing both high bandwidth and efficient messaging for fine-grained (e.g., cache-line size) communication. This zealous attention to performance and low latency migrated to financial enterprise systems, where a fraction of a microsecond can make a difference in the value of a transaction.

In recent years, Ethernet networks have made significant progress toward bridging the

build a scale model



Raspberry Pi Cloud



Gillian Caughey @gillian_caughey

One for my geeky pals - a scaled down
data centre made from Raspberry Pi &
Lego @GlasgowPiCloud. #SICSA
#Demofest. pic.twitter.com/Gaa77tgB
6/11/12 10:23 PM via TweetCaster for iOS



Mel Alexander @MelAlexander_

Raspberry Pi/lego data centre at
#demofest.Amazing! pic.twitter.com/
TM6ptOBR

6/11/12 6:18 PM via Twitter for Android ☆



where to start?

- putting together hardware is an easy task.

cost of labour: 5 quids worth of cookies



time spent: one afternoon

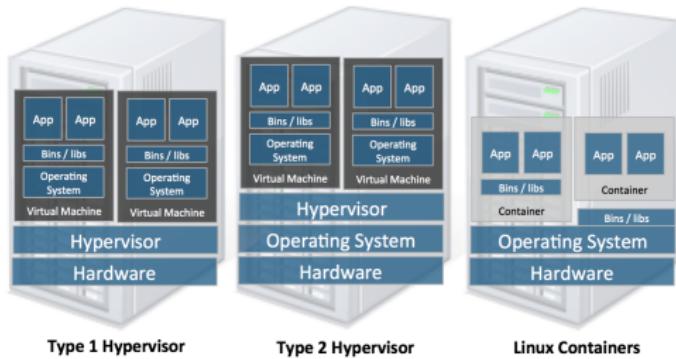
where to start?

- putting together hardware is an easy task.
- today's cloud means virtualisation.
 - ▶ Options? - KVM, Xen, and LXC.
- we need cloud stack that could run on ARM platforms.
 - ▶ Options? - OpenStack, CloudStack ...

where to start?

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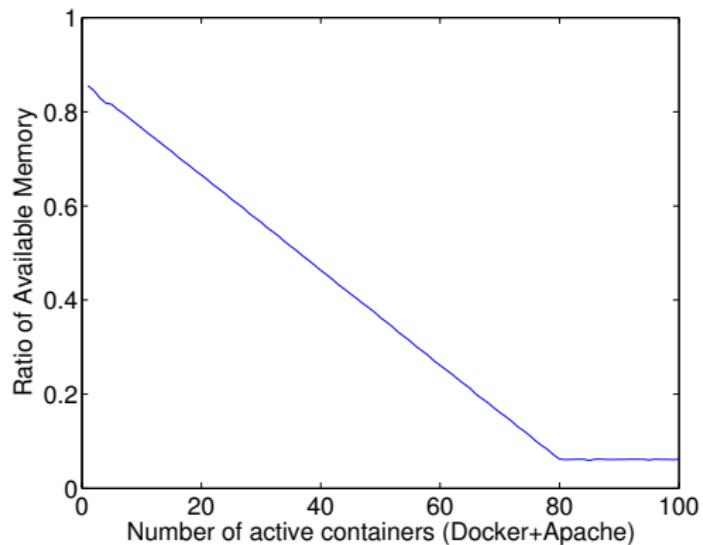
Virtualisation - Hypervisor vs. Container



LXC - LinuX Container

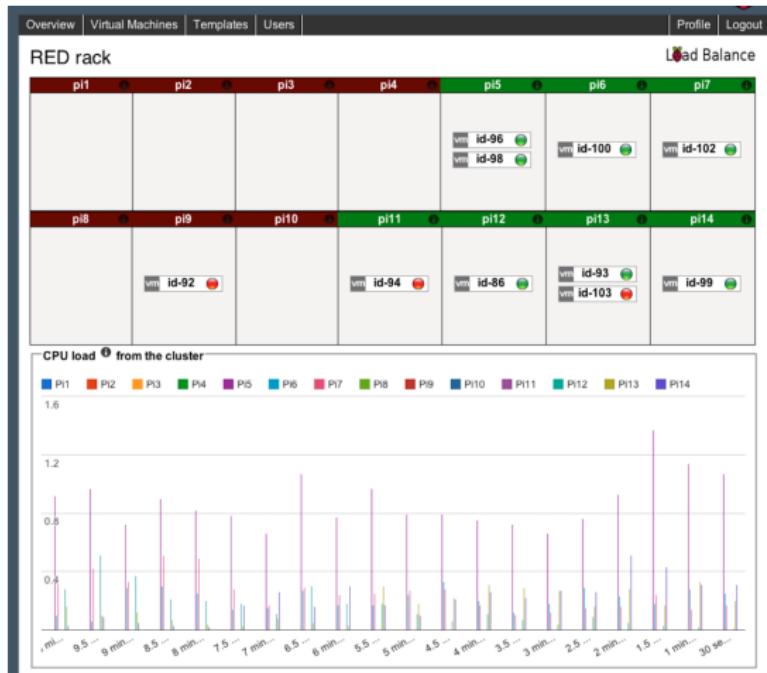
- OS level virtualisation.
- low overhead (?)
- enabled by modern kernel features.
- we use docker.

low overhead virtualisation



RPi B+ can run 80 (idle) web servers in parallel.

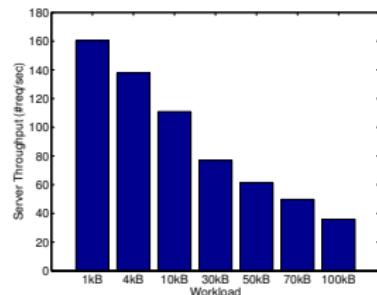
lightweight management stack



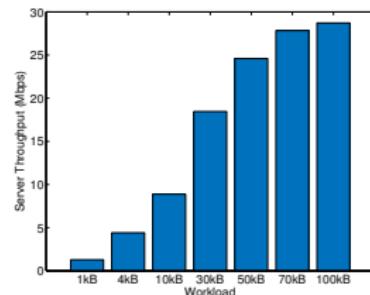
Web-based management (w/ libvirt and Django)

what can a RPi (model B+) do?

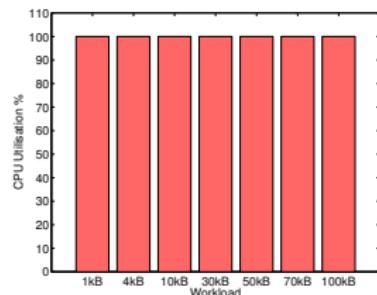
-*httpref* performance benchmarking



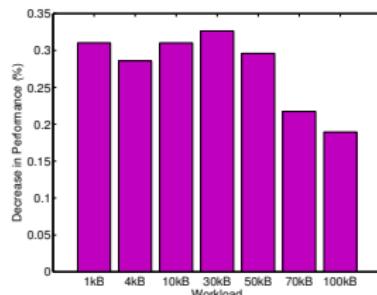
(d) Work Throughput



(e) Network Throughput



(f) CPU Utilisation



(g) Virtualisation Overhead

a peek into Big Data (Hadoop)¹

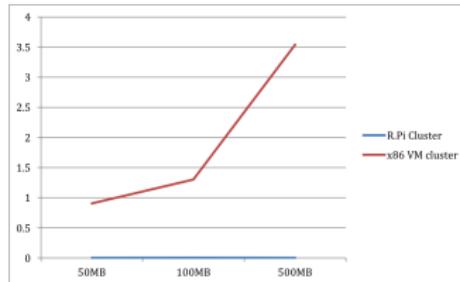
- we try to be more ambitious.

- 14 RPis vs. 3 x86 VMs (Core i5@2.6GHz, 1 core, 1GB RAM)
- Metric: data processed per second ($DPS = \frac{InputDataSize}{Executiontime}$)
- Scenarios: WordCount, Sort, TeraSort

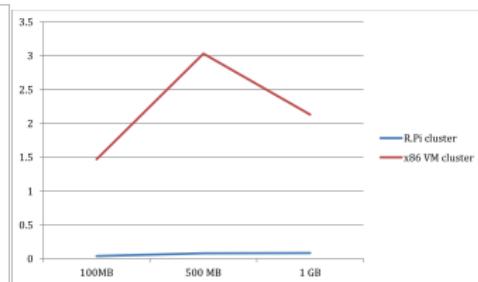
¹*Big Data on Mini Computers*, Qibing Cheng, MSc thesis, University of Glasgow, 2014

a peek into Big Data (Hadoop)¹

- we are too ambitious.



(h) WordCount



(i) Sort

- Raspberry Pi Cloud spent hours to finish jobs - minutes for x86 testbed.
- on average, x86 is 100-250 times faster.
- lack of equipment to measure power consumption :(

¹Big Data on Mini Computers, Qibing Cheng, MSc thesis, University of Glasgow, 2014

we learned a lesson

We set our expectation too high - RPi is too limited.

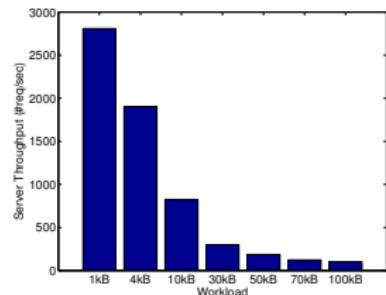
Raspberry Pi Cloud Version 2

- a new Raspberry Pi Cloud comprised of RPi2s
- funded by TAE's Faculty Research Pump Priming, £10k

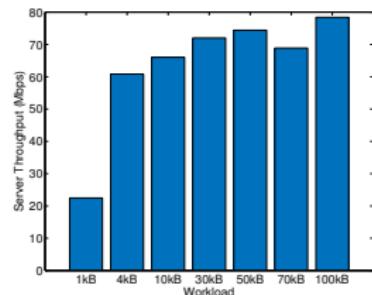
- the new Raspberry Pi 2 has a 900MHz quad-core ARM Cortex-A7 CPU.
- the CPU supports hypervisor-based virtualisation, e.g. KVM, and Xen.

what can a RPi 2 do?

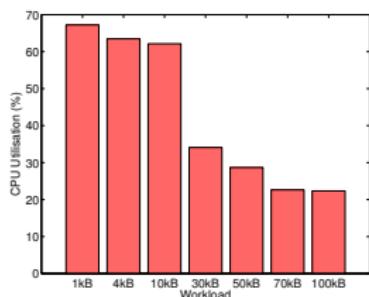
- significant CPU and network bandwidth headroom



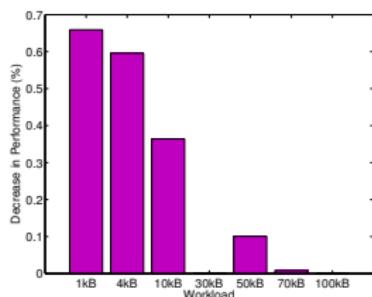
(j) Work Throughput



(k) Network Throughput

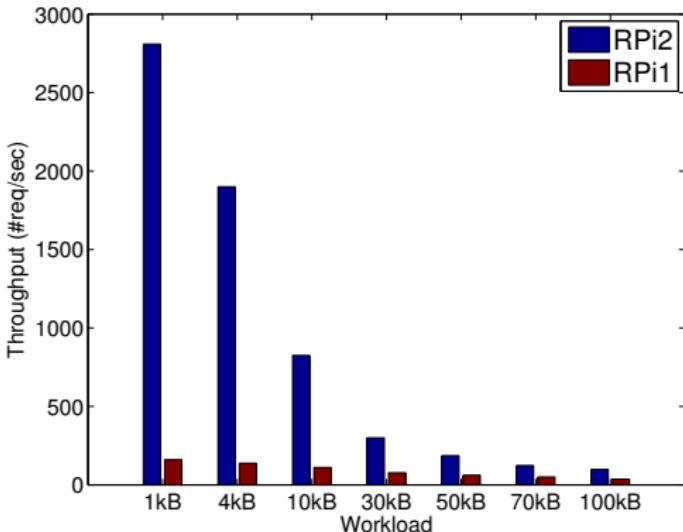


(l) CPU Utilisation



(m) Virtualisation Overhead

RPi2 vs. RPi1



RPi2 is 3 to 18 times better than RPi1.

what next?

- and I need volunteers too

- KVM/Xen on RPi2 (we're close)
- "software defined" cloud.
- cloud federation - connecting to its sister project at the University of Glasgow.
- big data processing using ARM cores.
 - ▶ legacy tools are designed for x86.
- from "cloud" to "fog". E.g.:
 - ▶ real-time micro-data mining.
 - ▶ network function optimisation.

if you're interested in these projects, please get in touch.

Thank You!

slides available at:

<http://www.poscotso.info>

<https://github.com/posco/rpitalk>