And what would you do with ten thousand Raspberry Pis?

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Massive aggregation of low-cost, low-power, commodity infrastructure to form an efficient and effective compute fabric for key distributed applications
From dozens of million-node datacenters ...
To millions of dozen-node datacenters...
Applications

- Education
- Edge Compute
- Expendable Compute
- Resource Constrained Compute
- Next Generation Data Center
- Portable Clusters

- S. Johnson et.al, “Commodity Single Board Clusters and their Applications” (submitted)
<table>
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<tr>
<th>Name</th>
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<td>Los Alamos National Lab (USA)</td>
<td>750 Pi3</td>
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<td>Free University of Bolzano (ITA)</td>
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<td>Education, research, &amp; deployment in developing countries</td>
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<td>The Beast [25]</td>
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Challenges on Hardware

Extremely small form factor
Mounting and cable management
Remote power/console management

- J. Singer et.al., “Next Generation Single Board Clusters”, NOMS 2018
https://www.kickstarter.com/projects/pisupply/pi-poe-switch-hat-power-over-ethernet-for-raspberry

https://ebay.com
- J. Singer et.al., “Next Generation Single Board Clusters”, NOMS 2018
Federated Management

- S. Johnson et.al, “Commodity Single Board Clusters and their Applications” (submitted)
Challenge: System Update

• Update system is critical
• Limited (or no) physical access
• Heterogeneous Network
  • Some nodes are behind NATs (e.g. residential) or Firewalls (e.g. university)
• Single-point of failure
• Scalability
  • Denial of Service attack on update server
• Existing tools
  • Requires direct SSH access
  • Needs well-connected server
Peer-to-Peer Secure Update

P2P Update System
- Agent
- NAT-TM
- BitTorrent Client
- Deployment Manager

OS

Node 1
- STUN Server

Node 2
- Private Network

Internet
- NAT
- Firewall

Node 3
- Private Network
- IP3:Port3

Node 4

Herry et.al, “Peer-to-Peer Secure Updates for Heterogeneous Edge Devices”, DOMINO Workshop, NOMS 2018
- H. Herry et al., “Peer-to-Peer Secure Updates for Heterogeneous Edge Devices”, DOMINO Workshop, NOMS 2018
A lean Linux OS distribution for Raspberry Pi

- A/B Root Partitions
- Over-the-Air, Peer-to-Peer Secure Update
- Remote Declarative Configuration Management
- Docker and Singularity Containers
- Support Raspberry Pi Zero, 1, 2, 3

https://fruit-testbed.org/os/edge/releases/armhf/
Applications

• Sensor data processing and machine learning
• BOINC volunteer computing
Others

• Federated workload management
  • Federated Kubernetes

• Federated monitoring
  • Centralized vs Distributed
how can you help?

• Current: 500+ nodes across 4 sites
• donate your unwanted pi boards
  • see picycle.org

• suggest use cases (workloads) for the platform
• (1) Put your Raspberry Pi back into its original box.
• (2) Put your packaged Pi into a Jiffy bag.
• (3) Address the parcel FREEPOST PICYCLE
• (4) Optionally, include a note with:
  • your email address
  • your full name
• (4) Drop your parcel in a Royal Mail post box
Thank you!