



www.chameleoncloud.org

CHAMELEON: HOW TO BUILD A CLOUD++

Kate Keahey

Mathematics and CS Division, Argonne National Laboratory

CASE, University of Chicago

keahey@anl.gov

September 10, 2019

PPAM 2019

CHAMELEON IN A NUTSHELL

- ▶ We like to change: testbed that adapts itself to your experimental needs
 - ▶ Deep reconfigurability (bare metal) and isolation (CHI) – but also ease of use (KVM)
 - ▶ CHI: power on/off, reboot, custom kernel, serial console access, etc.
- ▶ We want to be all things to all people: balancing large-scale and diverse
 - ▶ Large-scale: ~large homogenous partition (~15,000 cores), 5 PB of storage distributed over 2 sites (now +1!) connected with 100G network...
 - ▶ ...and diverse: ARMs, Atoms, FPGAs, GPUs, Corsa switches, etc.
- ▶ Cloud++: leveraging mainstream cloud technologies
 - ▶ Powered by OpenStack with bare metal reconfiguration (Ironic) + “special sauce”
 - ▶ Chameleon team contribution recognized as official OpenStack component
- ▶ We live to serve: open, production testbed for Computer Science Research
 - ▶ Started in 10/2014, testbed available since 07/2015, renewed in 10/2017
 - ▶ Currently 3,500+ users, 500+ projects, 100+ institutions

LEAVING NO EXPERIMENT BEHIND...

The collage includes:

- A bar chart titled "miniFE(95% Confidence Interval, lower is better)" showing runtime in seconds versus the number of physical machines (1, 2, 4, 8, 16, 32, 64) for three virtualization technologies: Base-metal (blue), Docker (yellow), and KVM (red).
- A photograph of two researchers standing next to a poster at a conference.
- A diagram of a network path from Source (Src) to Destination. "Arriving Flows" enter Src. A decision point labeled "DeepRoute decides which path to allocate on" leads to three paths: Path 1 (red arrow), Path 2 (orange arrow), and Path 3 (green arrow). Path 1 leads directly to Dest. Paths 2 and 3 lead to a common intermediate node before reaching Dest.
- A researcher pointing to a poster titled "Evaluation of Virtualization and Containerization Techniques for High Performance Computing".
- A photograph of a researcher standing next to a poster.
- A hierarchical diagram showing a central node connected to multiple endpoint nodes.
- A text box explaining "Our Method: hierarchical hybrid featuring 'collapsed' second-level index (SLI)":
 - SLI references endpoints, not docs, and contains a summary subset of terms
 - Some storage burden on endpoints, but still very low per endpoint
 - Lower storage burden on central servers
 - SLI returns a smaller subset of endpoints to which queries must be distributed
- A photograph of two women standing in front of the SC17 logo.
- Four line graphs showing system performance metrics over time: Enclosure Power, Node Power (mW), Node Temperature, and Node Frequency.
- A photograph of two researchers working at a booth with a large screen displaying network or system monitoring data.
- A detailed diagram of the Chameleon Testbed Setup:
 - SDN Controller (RYU)
 - CLIENT connected to Chameleon@UC
 - CROSS TRAFFIC
 - CIRCUIT1 and CIRCUIT2 connected to Chameleon@TACC
 - CENTRALIZED NETWORK MANAGEMENT AND CONTROL
 - DISTRIBUTION NETWORK
 - Networking details: All instances are bare-metal machines with Ubuntu 16.04; Client uses Python hyper library for HTTP/2; Server uses Apache2; SDN Controller is RYU; Cross Traffic is lperf3.

TOWARDS A REPRODUCIBILITY ECOSYSTEM

Should I invest in making my experiments repeatable?



Should I invest in more new research instead?

- ▶ Combining the ease of notebooks and the power of a shared platform
 - ▶ Storytelling with Jupyter: ideas/text, process/code, results – but limited containers
 - ▶ Chameleon: sophisticated experimental containers in need of “storytelling”
- ▶ Reproducibility by default: Chameleon + JupyterHub
 - ▶ Integrated Jupyter server
 - ▶ Python and bash interfaces for all the main testbed functions
 - ▶ Working with named containers
- ▶ Integration with Zenodo
 - ▶ Import/export of code/notebooks
 - ▶ Publishing via Zenodo: store your experiments and make them citable!



PARTING THOUGHTS

- ▶ Physical environment: a rapidly evolving platform implemented as cloud++
 - ▶ Specially adapted cloud with support for advanced cloud computing research
 - ▶ Originally: “Adapts to the needs of your experiment”
 - ▶ Now also: “Adapts to the needs of its community and the changing research frontier”
- ▶ Towards an Ecosystem: a meeting place of users and providers sharing resources and research
 - ▶ Testbeds are more than just experimental platforms
 - ▶ Common/shared platform is a “common denominator” that can eliminate much complexity that goes into systematic experimentation, sharing, and reproducibility...
 - ▶ ... as well as education!
- ▶ Be part of the change: tell us what capabilities we should provide to help you share and leverage the contributions of others!