ISLET: An Attempt to Improve Linux-based Software Training

Jon Schipp, REN-ISAC (2015)

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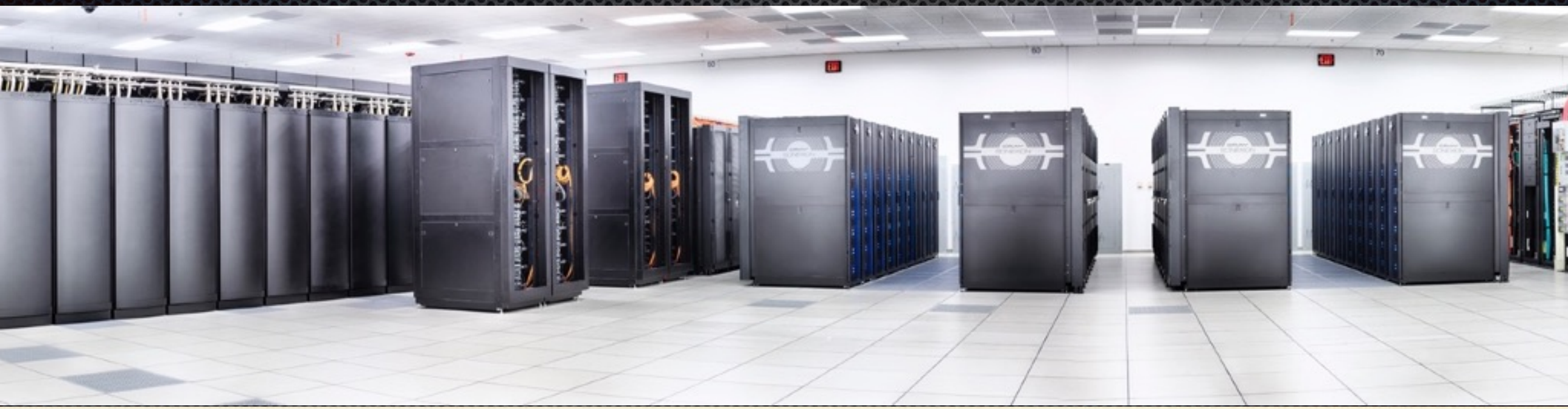
About me:

- Security Engineer for the National Center for Supercomputing Applications



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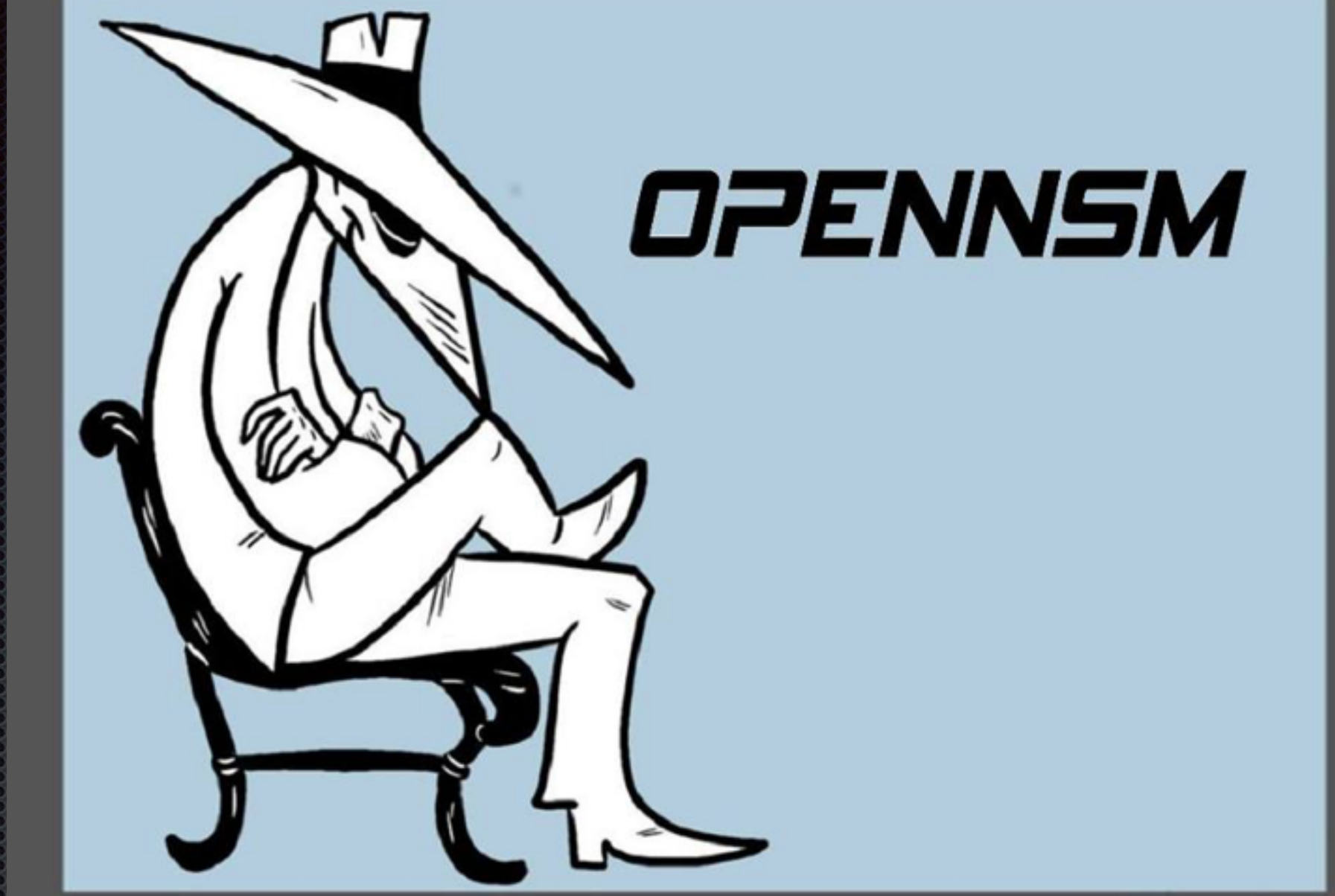
1 quadrillion = 10^{15} = 1,000,000,000,000,000

Project Contributions:

- Netsniff-NG Toolkit

- SecurityOnion

- Bro Team



Open Network Security Monitoring Group

Weekly meetings with presentations, open to all irrespective of location. http://open-nsm.net

The Problem

Problems:

Who's directly affected?
User/Admin/Everyone

- Too much time is spent distributing, downloading, or copying Virtual Machines and other materials.
  1.) Conference networks are slow and VM files are big
- Technical difficulties can occur and often do that end up putting some behind the group
  1.) Hypervisor compatibility e.g. Virtualbox, VMware, etc.
  2.) VM bus and network configuration
- Account management is repetitive and time consuming
- Changes are not easy
  1.) Insertion of wrong exercises, versions, mistakes, etc..
  How is this handled?

Solutions:

Who's directly affected now?
User/Admin/Everyone

- Avoid passing around or downloading VM's if possible. Give user's access to your server. Big time saver!
- Make barrier to participation as thin as possible
  1.) Require only a cross-platform program for access
  2.) Opens possibilities to phones, tablets, etc.
- Automated account management
- Changes can be easily completed
  1.) Add, remove, or modify exercises during event
  2.) Immediately available

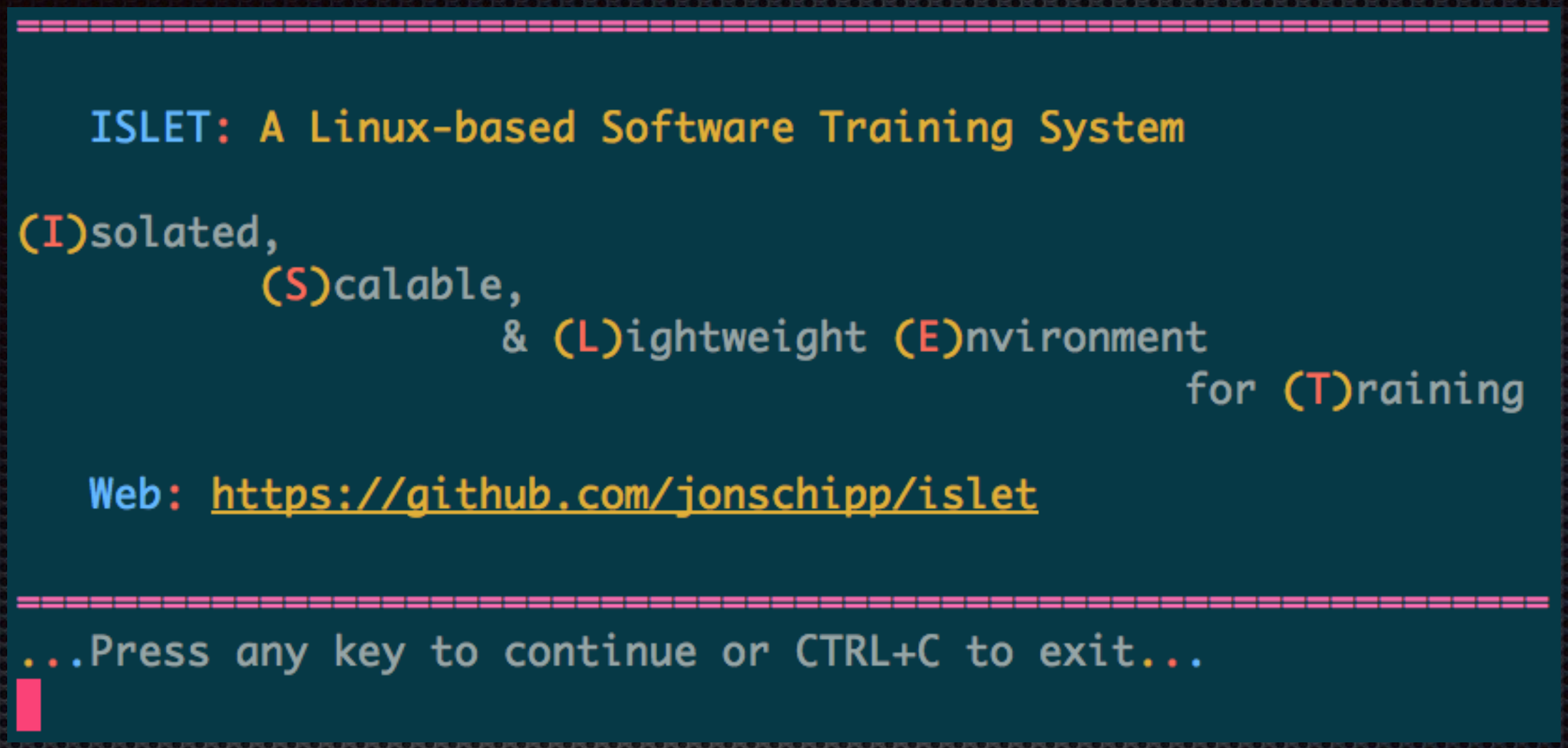
Place the burden on the admins

That’s where it should go. Users should have a smooth experience. (don’t worry, admins will too)

Goal Summary

Admin: make something that is really easy to install, deploy, and configure

User: design an intuitive interface and smooth training experience



Isolated, Scalable, and Lightweight Environment for Training

A container system for teaching Linux based software with minimal participation effort. The participation barrier is set very low, students only need an SSH client.

ISLET is

- It gets all the components to work together in a way that solves our problems.
- Provides an easy 3-step process for deploying new training environments.

Uses:

Excels at teaching command-line software on Linux

- Event training (intended design)
- Internal software training
- Capture the flag competitions
- Trying out tools in a containerized environment
- Development environments

Real World Use Cases:

- Launched the precursor at BroCon 14.
  Used to teach Bro scripting. ~50 users had shell access to Bro and unix tools in a container simultaneously on a lower end (m3.xlarge) EC2 VM, no problem.
- University of Illinois Digital Forensics 2 course
- FlowCon Bro training ~100 users
- Used to teach Linux tools at UIUC LUG meetings

Feedback loop

Container logs show user's actions e.g. mistakes which can be used to improve future training

Compare

Contrast

Remote Container Training

Multiple training environments per user

Scalable

Immediate revisions

Low Participation Barrier

Server maintainance

Remote Access (e.g. ssh)

Isolation

Shell Access

Remote Host Account Training

Account Management

Privileged training limitations

Single training environments per user

Local Virtual Machine Training

Effortful

Hypervisor configuration and compatibility

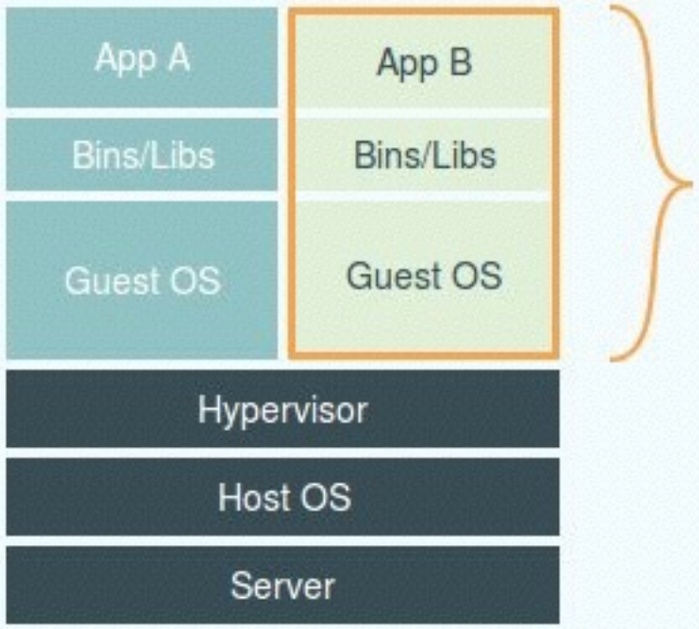
Possession of training environment

VM Distribution time

Technical Part

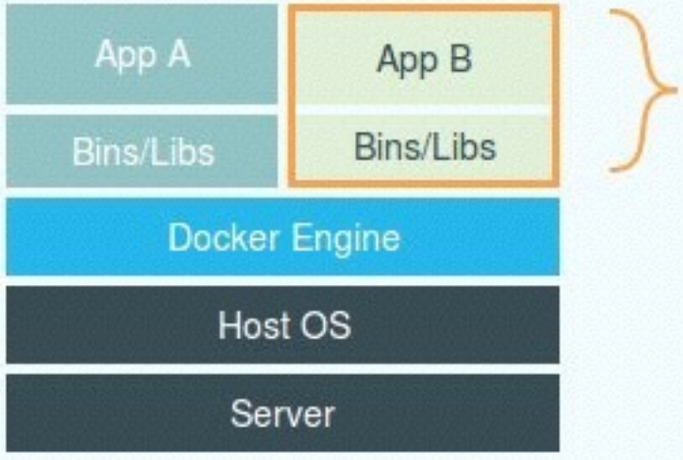
Linux Containers

The technology behind ISLET



Virtual Machines

Each virtualized application includes not only the application - which may be only 10s of MB - and the necessary binaries and libraries, but also an entire guest operating system - which may weigh 10s of GB.



Docker

The Docker Engine container comprises just the application and its dependencies. It runs as an isolated process in userspace on the host operating system, sharing the kernel with other containers. Thus, it enjoys the resource isolation and allocation benefits of VMs but is much more portable and efficient.

Isolation

via kernel namespaces and cgroups

The user can’t tell the difference.

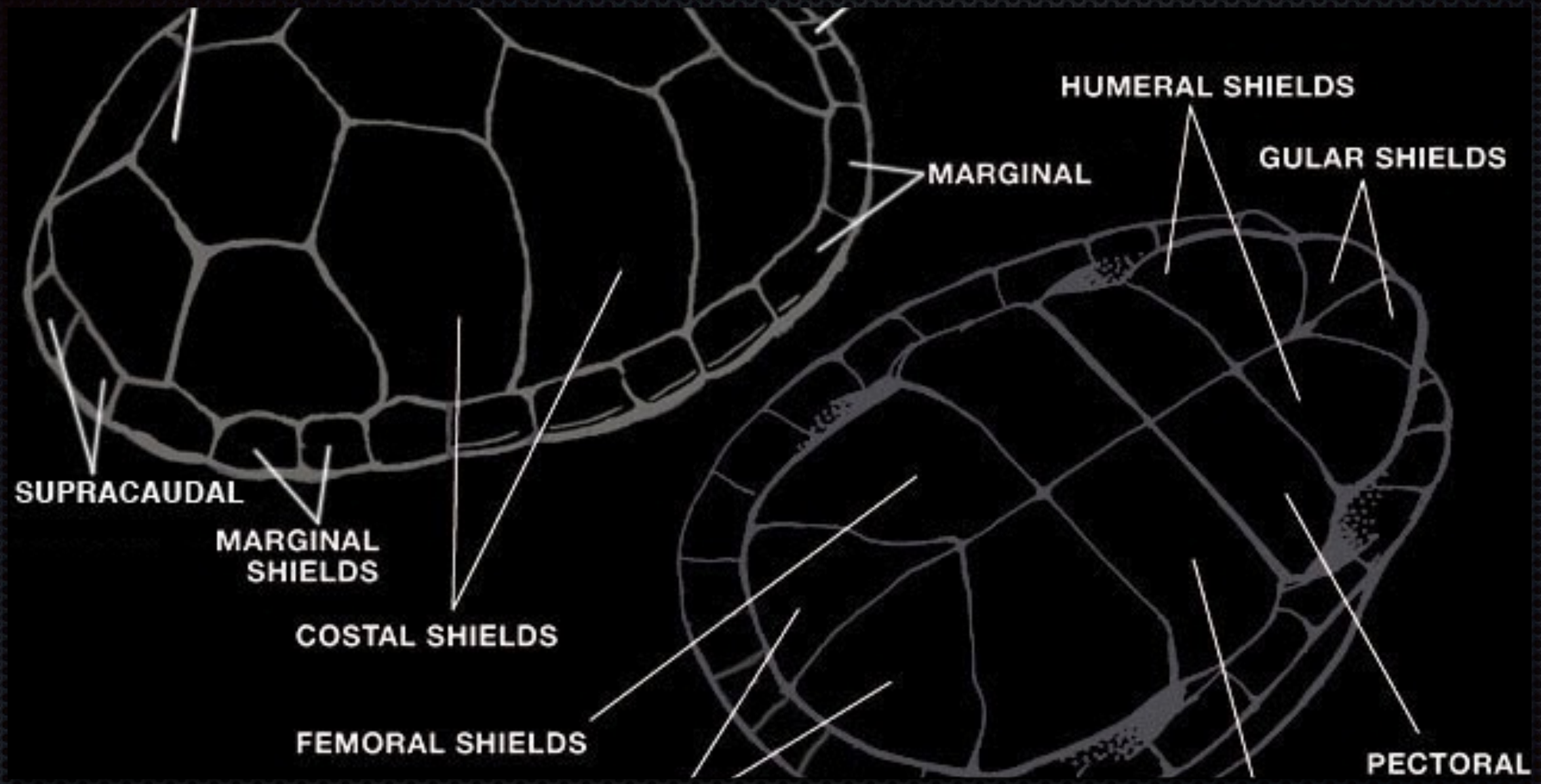
Scalability

Could virtual machines teach all these people?

You be the judge. 1000+ containers is possible

Lightweight

~100ms startup time, near bare metal performance, JeOS



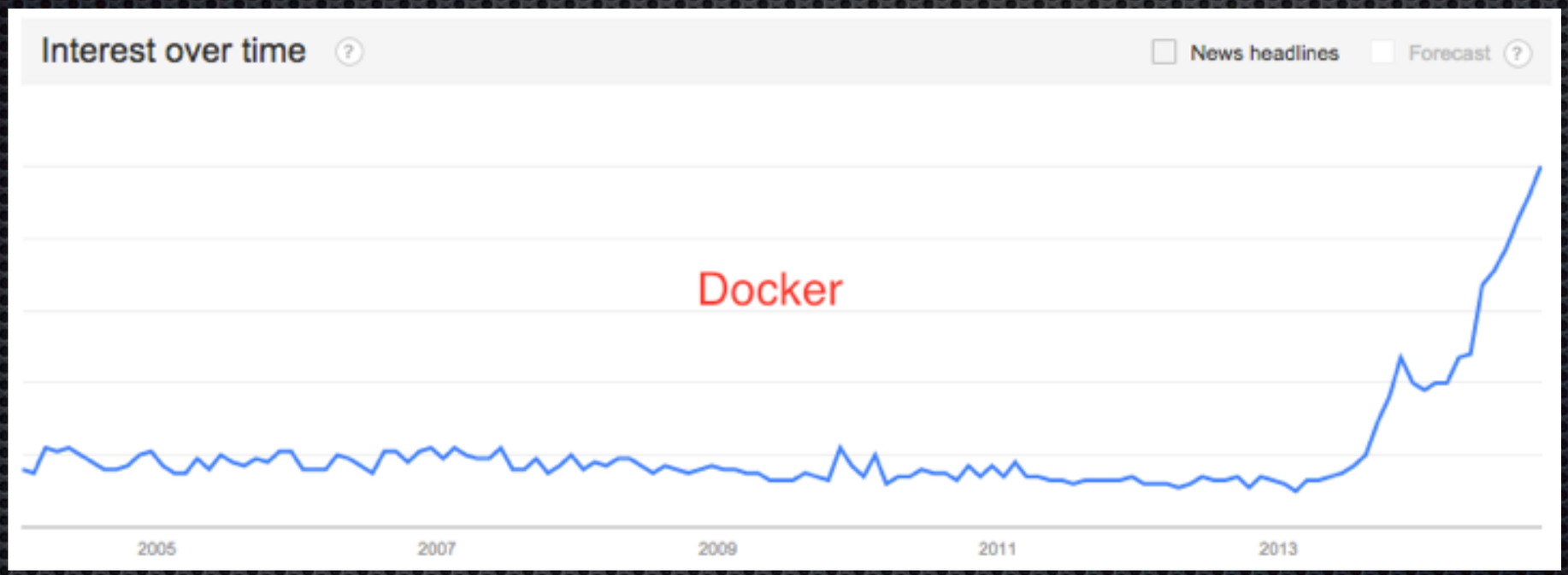
Environments

Provides shell access with the necessary pieces

Research Moment

"In general, Docker equals or exceeds KVM performance in every case we tested."

– IBM Research Report: An Updated Performance Comparison of Virtual Machines and Linux Containers
< http://domino.research.ibm.com/library/cyberdig.nsf/papers/0929052195DD819C85257D2300681E7B/$File/rc25482.pdf>



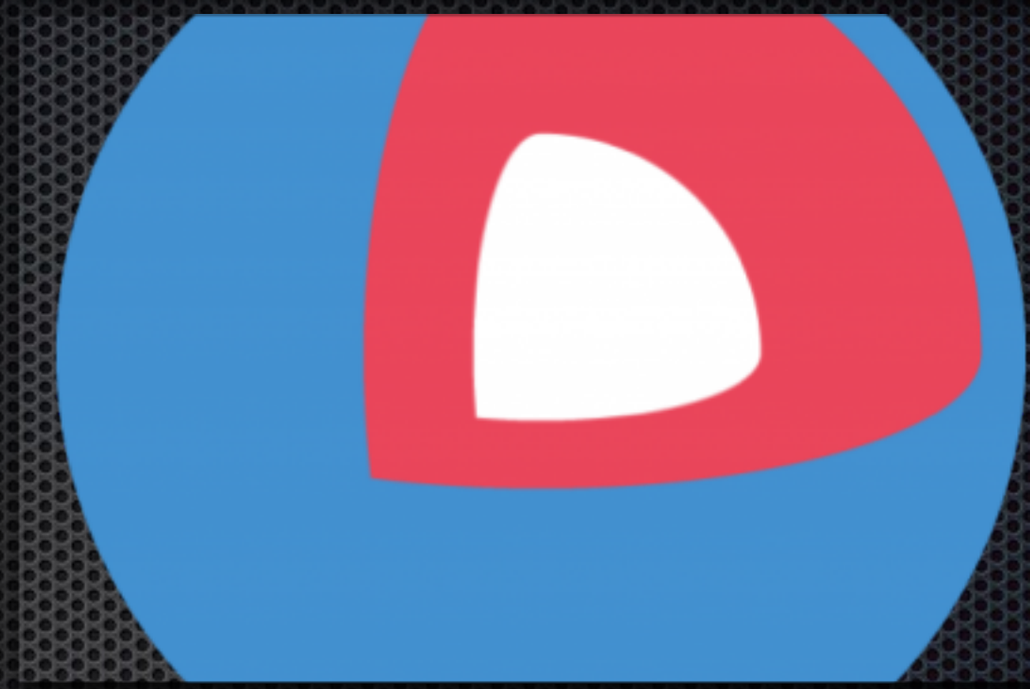
Popularity

It’s making waves and for good reason

Deployment Tools/OS's

Kubernetes

CoreOS



Project Atomic

Cloud hosting, many more…

openstack™

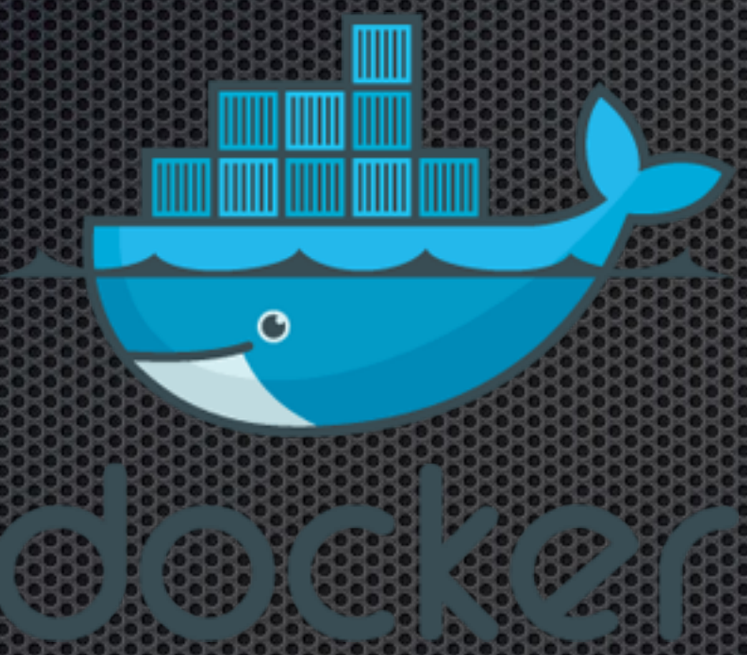
CLOUD SOFTWARE

Google Cloud Platform

Heroku

Linux Containers?

Docker popularized the technology.
It's actually been around for 7 years.



- Automates the deployment of Linux based container
- Provides layers of abstraction
- Various methods of container creation
- Docker hub and registries for sharing and deployment

Containers

- Important: "Linux Based Containers"
  There is no container specification
- There are different container (and like) technologies
  Linux: LXC, OpenVZ, Google containers, etc.
  Non-Linux: BSD Jails, Solaris Zones, AIX WPAR, etc.
- What do containers do?
  Light-weight process virtualization
- What do virtual machines do?
  Hardware virtualization

Linux Kernel Stuff

- Support: 3.8 introduce the building block for containers
  Namespaces: Process isolation
  Currently available: *pid, net, ipc, uts, mnt, and user*
  Control Groups: Resource management
  e.g. cpu, cpuset, blkio, memory, etc.

- It's not magic, you can create namespaces and cgroups directly from your shell by modifying procfs and sysfs. That's how they were deployed before userland tools like LXC and Docker existed.

Container Security

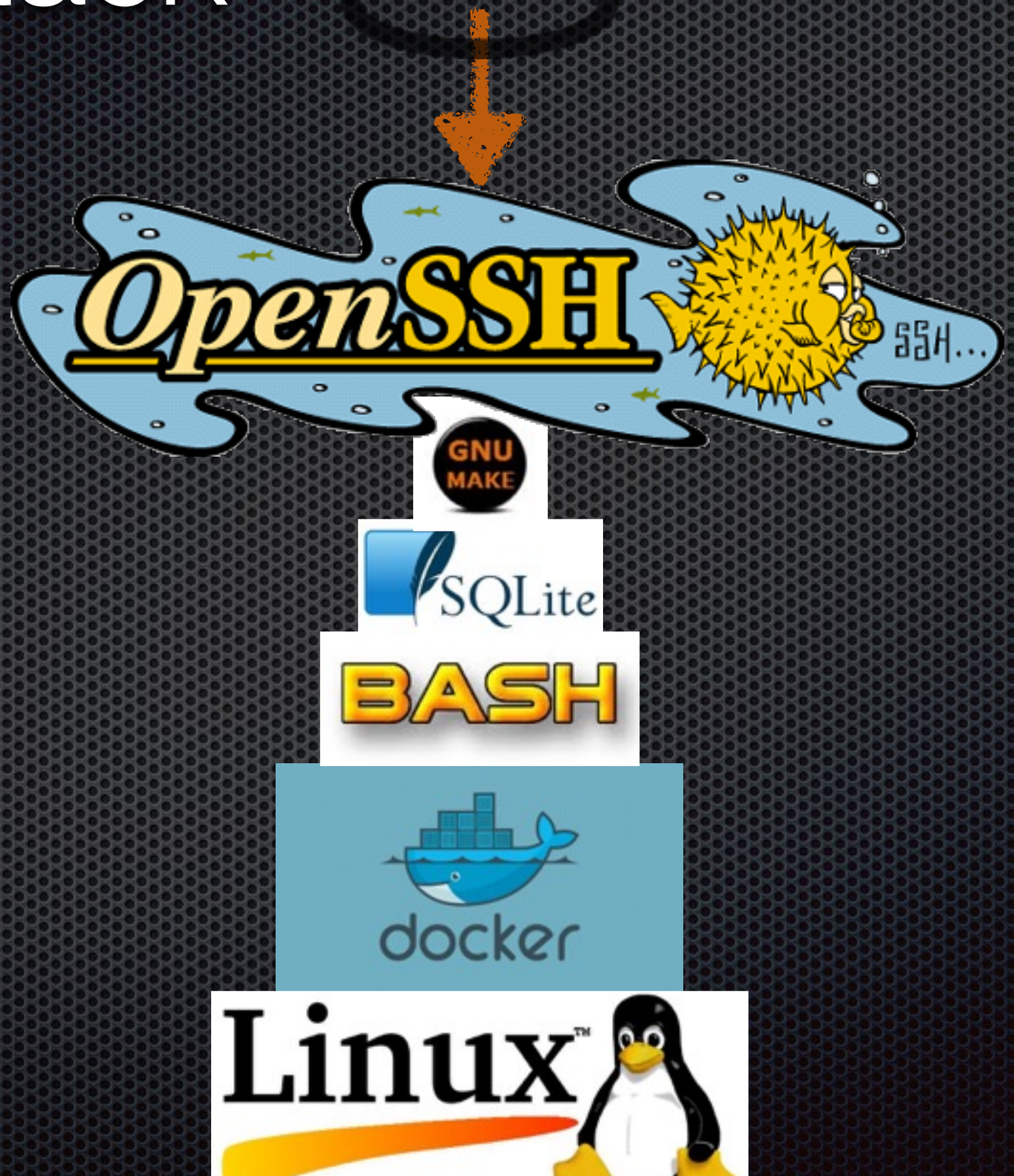
- Networking can be disabled
- Don’t run processes as root
- Control CPU and RAM allocation
- Automatic cleanup is possible
- Devicemapper backend can also limit disk space
- Finer environment controls via ulimit for Docker processes: fsize, nproc, etc.

Host Security

- grsecurity patches
- sshd hardening - e.g. disable port forwarding, X11 forwarding, etc.
- iptables rate limiting to prevent excessive connections
- Least privileged user
- Run a HIDS like OSSEC

Working with ISLET

The Stack



Platform

- Linux only (currently), 64-bit only (because of Docker)
- Debian family is preferred but will work on others that support Docker. I do nearly all of my testing on Ubuntu so I recommend using that for the best experience.

$ git clone

http://github.com/jonschipp/islet

Configuration & Workflow

- Global: configuration file i.e. /etc/islet/islet.conf
- Per-image: configuration files per image /etc/islet/*.conf

- Creating a new training environment (3 steps)

1. Build Docker image with the software for training
2. Create configuration file and point to new image
3. Place in /etc/islet/ e.g. new_image.conf

Other things

- Ability to port forward to containers to do things like web interfaces for training where each container is running a web interface that only the user is accessing. Requires user to have a unique IP address (e.g. no PAT device)

- Direct X11 works if user is running an X server and *trusts* connections from the ISLET server. You could train GUI applications using this method.
export DISPLAY="192.168.1.100:0" && wireshark

Easy updates

```
$ make update
```

Demo

"F*** it, we'll do it live"

– Bill O'Reilly

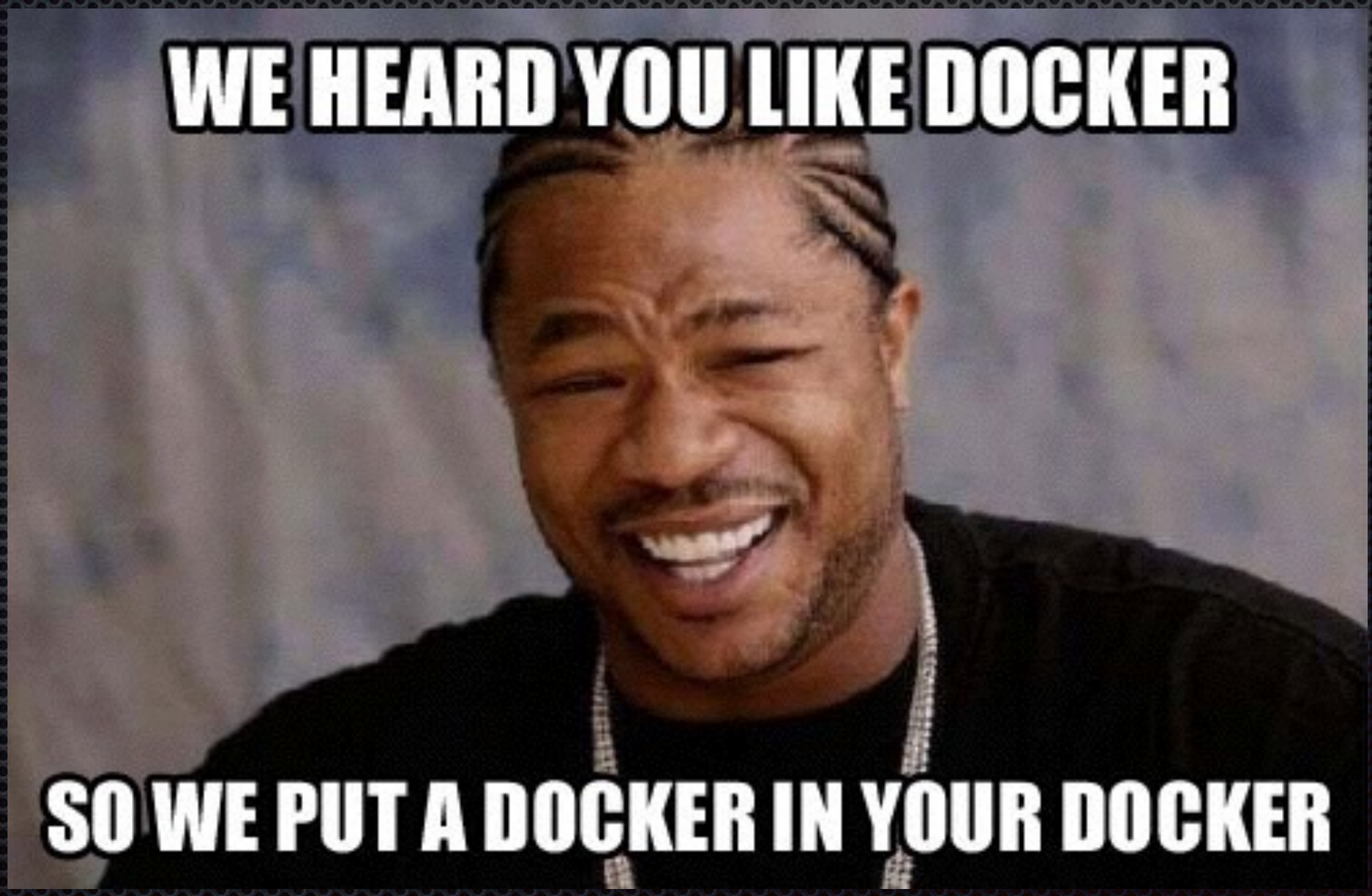
REN-ISAC Special:

$ ssh demo@islet1.jonschipp.com
$ ssh demo@islet2.jonschipp.com

Password: demo

Roadmap:

- Run ISLET from a container (Complete)
  1.) No modification to host system



Roadmap:

- Publish paper
- Port to FreeBSD using jails
- Security/penetration testing
- Autoconf scripts
- POSIX compliance (?)
- Export containers and exercises
  1.) Users can save their work or continue at home
      like they can with VM training
- Scalability testing beyond 1000+ containers, distributed setup

Contributing

Send me pull requests, patches, feature requests, and issues.

Use it and tell me what you think!

Testing & Dev

$ git clone http://github.com/jonschipp/vagrant
$ cd vagrant/islet
$ vagrant up
$ ssh -p 2222 demo@127.0.0.1

Communication

- **jonschipp@gmail.com**
- http://jonschipp.com
- @JonSchipp #ISLET #NoMoreVMs
- keisterstash on freenode

References:

- IBM Research Report: An Updated Performance Comparison of Virtual Machines and Linux Containers < http://domino.research.ibm.com/library/cyberdig.nsf/papers/0929052195DD819C85257D2300681E7B/$File/rc25482.pdf >
- Realizing Linux Containers (LXC): Building Blocks, Underpinnings, and Motivations < http://www.slideshare.net/BodenRussell/realizing-linux-containerslxc >
- Resource management: Linux kernel Namespaces and cgroups. < http://www.haifux.org/lectures/299/netLec7.pdf >
- Linux Containers and the Future Cloud. < http://www.haifux.org/lectures/320/netLec8_final.pdf >
- Lightweight Virtualization with Linux Containers (LXC) < http://www.ciecloud.org/2013/subject/07-track06-Jerome%20Petazzoni.pdf>
- www.docker.com
- https://images.google.com