Security of Linux containers in the cloud

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http://www.flickr.com/photos/21644167@N04/5879497600/
Security of Linux containers in the cloud

Linux container (LXC) seems to be preferred technology for deployment of Platform as a service (PaaS) in cloud. Partly because it's easy to install on top of existing visualization platforms (KVM, VMware, VirtualBox), partly because it is lightweight solution to provide separation and process allocations between separate containers running under single kernel.

In this talk we will take a look at LXC and try to explain how to combine it with mandatory access control (MAC) mechanisms within Linux kernel to provide secure separation between different users of applications.
Presentation overview

● Containers
  ○ namespaces
  ○ cgroups resource management

● Why we need MAC to make LXC secure?

● Overview of security mechanisms
  ○ SELinux, pam_namespace
  ○ libvirt-lxc = API + LXC + SELinux
  ○ libvirt-sandbox, virt-sandbox-service
  ○ systemd
  ○ AppArmor
  ○ Smack
  ○ OpenVZ

● stackato PaaS with free micro cloud
Linux Namespaces

- Mount - mounting/unmounting filesystems
- UTS - hostname, domainname
- IPC - SysV message queues, semaphore/shared memory segments
- Network - IPv4/IPv6 stacks, routing, firewall, proc/net /sys/class/net directory trees, sock
- Pid - Own set of pids
- UID - Not implemented yet.

chroot is filesystem namespace
cgroups resource management

- limits
  - CPU (sched, cpu account, cpuset) - NUMA
  - Memory
  - Block I/O scheduling, limits

- Used to isolate different chunks of processes
  - Android - application isolation
  - Google Chrome - tabs isolation
  - systemd - services isolation
  - LXC - whole system (devices, network interfaces)
  - libvirt-lxc - incompatible with LXC

http://wiki.debian.org/LXC
GRUB_CMDLINE_LINUX="cgroup_enable=memory"
LXC security problems

- Root in container with /proc and /sys access
  - echo s > /proc/sysrq-trigger
  - removing capabilities from container
  - Mandatory access control (MAC) based on paths
- filesystem
  - devpts remount, securityfs, debugfs, bitfmt_misc
  - remount / on host if shared with container
- udev storm on host
  - udevadm trigger action=add

https://wiki.ubuntu.com/LxcSecurity
https://bugs.launchpad.net/ubuntu/+source/lxc/+bug/645625
How to make containers secure?

Which MAC to use?
And this are not all options!

Namespaces in RHEL/Fedora

- pam_namespace - RHEL5/Fedora 6
- SELinux sandbox - RHEL6/Fedora 8
- Systemd - Fedora 17
  - UnitFile: PrivateTmp, PrivateNetwork
- OpenShift - RHEL6
  - Pam_namespace : Private /tmp

http://kernsec.org/wiki/index.php/Linux_Security_Summit_2012/Abstracts/Walsh
libvirt-lxc = API + LXC + SELinux

- Container virtualization
- Boot "init" binary
- sVirt SELinux TE + MCS
- Firewall ebtables/ip[6]tables
- Host FS passthrough bind mounts
- CGroups resource control

RadHat based distributions
libvirt-sandbox
virt-sandbox-service
isolated virtual http server

virt-sandbox-service create -C -u httpd.service apache1

- Config /etc/libvirt-sandbox/service/apache1.sandbox
- Multiple unit files allowed
- SystemD unit file
  - /etc/systemd/system/httpd@apache1.service
- Create state directories or image
  - /var/lib/libvirt/filesystem/apache1
    - Chroot type directory
  - Examines rpm payload
    - Clone - /var and /etc config
    - Share /usr
- Allocate unique MCS security label
**Systemd**

- `systemctl start httpd@apache1.service`
- `systemctl reload httpd.service`
  - Should trigger reload in all `httpd@services`
  - `ReloadPropagatedFrom=httpd.service`
- `systemctl start httpd@.service`
  - Should start all `httpd` services

**Systemd for the User Session**

- `systemctl --user`
AppArmor LSM Update

- basic lxc integration
- lot of userspace work
  - porting to python 3
  - simple policy language improvements/consistency
  - policy compiler improvements
  - refactoring

http://kernsec.org/files/apparmor-update.odp
Smack Veers Mobile

Tizen focused

# smack_label.py -w -r /srv/lxc/lxc1 lxc1
# echo "lxc1" > /proc/self/current/attr
# lxc-start -n lxc1
# echo "_" > /proc/self/current/attr

OpenVZ vs LXC

checkpoints, live migration
ploop - container in a file
VSwap - RHEL-6 based OpenVZ kernel

http://openvz.livejournal.com/

7 years on merging code into mainland kernel!
It's too complicated!
* as a service - buzzword bingo

Infrastructure -> Platform -> Service
Platform as a Service

It's not VM you have to administer but (proprietary) REST API and code push into container!
Stackato PaaS

- appliance PaaS, Ubuntu lucid VM
- deploy through web interface from git repo
- LXC (using liblxc directly)
- aufs for re-use of base installation
- collectd for stats (nothing about containers!)
- no-pay Micro Cloud download
  - [http://www.activestate.com/stackato/download_vm](http://www.activestate.com/stackato/download_vm)
- **Commercial licence required for public deployment!**
Questions?

Are we there yet?

containers suffers from too many different incompatable deployment options

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Virtualizations vs Containers

**different kernels/OS**
- single kernel

**emulation of devices**
- acl+syscall

**many fs caches**
- single fs cache

**limits per machine**
- limits per process

**legacy consolidation**
- service deployment