Containers, Docker, and Security: State of the Union

Who am I?

- Jérôme Petazzoni (@jpetazzo)
- French software engineer living in California
- Joined Docker (dotCloud) more than 4 years ago
  (I was at Docker *before it was cool!*)
- I built and scaled the dotCloud PaaS
  (millions of containers, no *known* security issues)
- I learned a few things about running containers
  (in production)

Outline

- Yesterday
- Today
- Tomorrow

Yesterday

Containers and Security yesterday

- "Is it safe to run applications in containers?"

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  really meant

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- Main concern: isolation

What was the answer?

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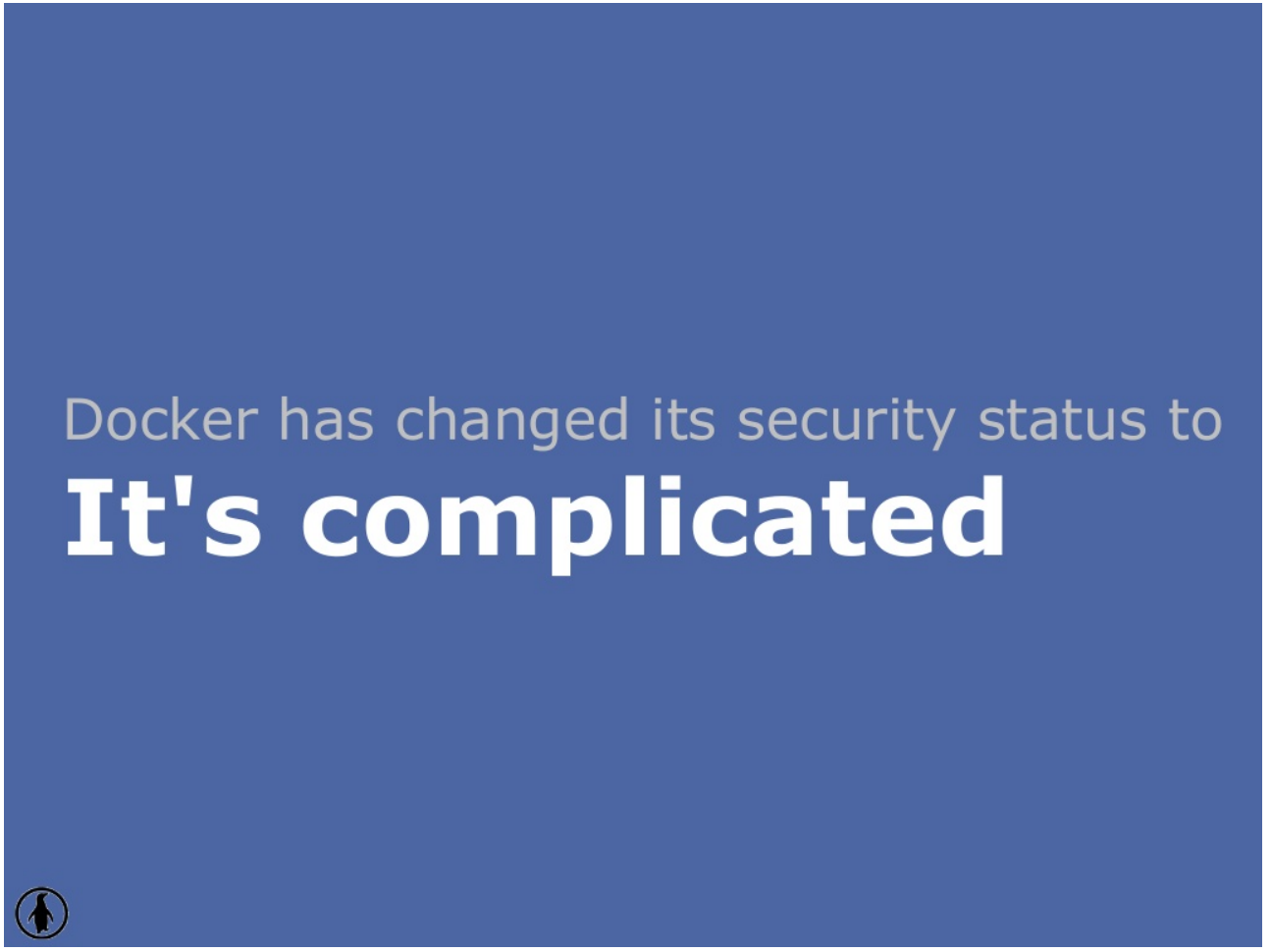

What was the answer?

- "It's complicated"
- Long list of recommendations
  - some were easy
    (and automatically enforced by Docker)
  - some were not obvious
    (and had to be enabled manually)
  - some were hard to deploy
    (or required missing kernel features)

How is this different today?

- People still ask about container isolation
- Much more frequently, they ask about *image security* and provenance
- They want to know:
  - if `docker pull debian` is what it claims to be
  - if `jpetazzo/dind` has vulnerabilities
  - if a given image has been vetted by their sec team

Why has it changed?

- Who cares about container isolation?
  - hosting providers (more density = more $$$)
  - PAAS (for rapid deployment; on-demand activation)

  → early adopters

- Who doesn't care about container isolation?
  - people who use VMs only because autoscaling
  - people who would put multiple components per machine anyway

  → second wave of users

Today

Docker and Containers Security Today

- Improving what we had yesterday
  (fine-grained permissions, immutable containers)
- Addressing new challenges
  (provenance, content verification, notary)
- Defense in depth
  (containers + VM)
- The infosec mindset
  (better upgrades, security benchmarks, policies)

Finer-grained permissions

- Per-container ulimit
- Capability reduction
  `--cap-drop` / `--cap-add`
  e.g.: `--cap-add net_admin`
- Device access restrictions
  `--device` (better than `--privileged`!)
- Improved handling of LSM
  (SELinux, AppArmor)

Smaller attack surface

- Hardware management done on the host
  (no kernel, drivers, device handling... in containers)
- Package management is optional
  (once a container is built, it doesn't need to be changed)
- Minimal distros can be used
  (e.g. buildroot, Alpine Linux...)
- Less software = less risk

Immutable containers

- `docker run --read-only`
  (makes it impossible to entrench in a container)
- Helps with vulnerability detection
  (audit can be performed on offline images)
- Even without `--read-only` flag:
  - copy-on-write prevents changes from being permanent
  - break a container when hacking it → it gets recycled
  - `docker diff` allows easy audit of changes

Image provenance

- How can I trust `docker pull debian`?
  - I must trust upstream
    (i.e. Debian and whoever maintains the image)
  - I must trust Docker Inc.
    (operator of the Hub)
  - I must trust the transport
    (between the Hub and my Docker host)

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  - I must trust the transport
    (between the Hub and my Docker host)
- That's a lot of trust

"I don't want to trust anybody!"

- If you don't trust upstream, you have to ...
  - stop using `apt-get` and `yum` with public repos
  - rebuild everything from source
  - verify source integrity
    (full audit + review all changes)
- If you don't trust Docker Inc., you probably should ...
  - audit the whole Docker Engine code
  - audit every single patch that goes into Docker
    (if you can do that ... we're looking for reviewers)

Security reminder

It's OK to be paranoid, but beware of:

- Bumps in the carpet
  (moving a problem rather than solving it)
- Usability
  (if security makes it hard/impossible to work,
  people *will* work around it!)
- Tinfoil hats

Can we trust the transport?

- Registry v1 protocol had serious issues:
  - arbitrary layer IDs
  - no integrity check
    (other than TLS transport integrity)
- Registry v2 protocol has:
  - content-based layer IDs
  - signed image manifests

Is that enough?

Notary: a better trust framework

- Sign content with offline key
- Distribute signed content on (potentially insecure) servers
- Based on TUF (The Update Framework)
- Some features:
  - don't fail hard when a key is compromised
  - guarantee freshness
  - trust thresholds (=Red October for signed content)
  - leverage existing (insecure) transport and mirrors

Launched at DockerCon a few weeks ago!

Defense in depth

So, VM or containers?

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*VM **and** containers!*

Defense in depth

So, VM or containers?

*VM **and** containers!*

- Reduce number of VMs
  (when security perimeter allows it)
- Colocated containers are safer than colocated processes
- Malicious code has to escape both layers
- Docker provides an extra layer of isolation
- Applications are *safer* with containers than without

The infosec mindset

- Better upgrades
- Accurate, actionable security benchmarks
- Clear, sensible security policies

Better upgrades

- `Dockerfile` = easy, fast, reliable builds and rebuilds
- "But now I have 1000s of container images to upgrade!"
- Yes, but that's way better than the 100s of server images that you had before
- The *organizational risk* is lower
  (reliable rollbacks)

Security benchmarks

- CIS (Center of Internet Security) Docker Benchmark
- Docker Bench: automated assessment tool to check compliance https://dockerbench.com

Policies

- Docker Inc. (the company) and the Docker Project (open source) have clear security guidelines
- Mandatory code reviews (see CONTRIBUTING.md) to ensure quality of code base
- Quarterly security audits and pen tests of our infrastructure
- We support responsible disclosure

Tomorrow

Container security in the future

Personal predictions - not Docker Inc.'s roadmap!

Container security in the future

Personal predictions - not Docker Inc.'s roadmap!

- Offline image audit
- Hardening of immutable containers (noexec, nosuid)
- Better GRSEC, PAX, LSM integration
- User namespaces (eventually!)
- Better default seccomp profiles

Resources

- Docker security page
- Docker security presentation at DockerCon 2015 SF
- Docker Security CheatSheet
- Notary on GitHub
- Docker Bench for Security

Thanks!
Questions?

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@docker