What breaks our systems:

# A taxonomy of black swans

# What is a Black Swan?

- Outlier event
- Hard to predict
- Severe in impact

# Every black swan is unique

But there are patterns, and sometimes we can use those to create defences

# Black swans can become routine non-incidents

Example: the class of incidents (or 'surprises') caused by change can be mostly defeated with canarying

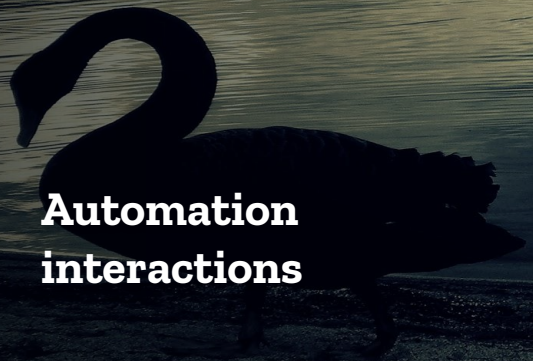
# On sharing of postmortems

# Some subspecies of black swan

**Hitting limits**

**Spreading slowness**

**Thundering herds**



**Automation interactions**

**Cyberattacks**

**Dependency loops**

# Laura Nolan

Fascinated by failure since childhood.

Contributor to the O'Reilly/Google  Site Reliability Engineering book and to Seeking SRE.
Shiny new Production Engineer@Slack.

Member of the International Committee for Robot Arms Control (ICRAC) and the Campaign to Stop Killer Robots.

@lauralifts on Twitter.

CAMPAIGN TO STOP
KILLER ROBOTS

# 1. Hitting Limits

# Instapaper, February 2017

- Prod DB on Amazon MySQL RDS
- Hit a 2TB limit because filesystem ext3 - nobody knew this would happen
- Dumped data and import into a DB backed by ext4
- Down for over a day, limited for 5 days

Link to incident report

# Sentry, July 2015

- Down for most of the US working day
- Maxed out Postgres transaction IDs, fixing this with vacuum process
- Had to truncate a DB table to get back up and running

Link to incident report

# SparkPost May 2017

- Unable to send mail for multiple hours
- High DNS workload
- Recently expanded their cluster
- Hit undocumented per-cluster AWS connection limits

Link to incident report

# Foursquare, October 2010

- Total site outage for 11 hours
- One of several MongoDB shards outgrew its RAM, hitting a performance cliff
- Backlog of queries
- Resharding while at full capacity is hard

Link to incident report

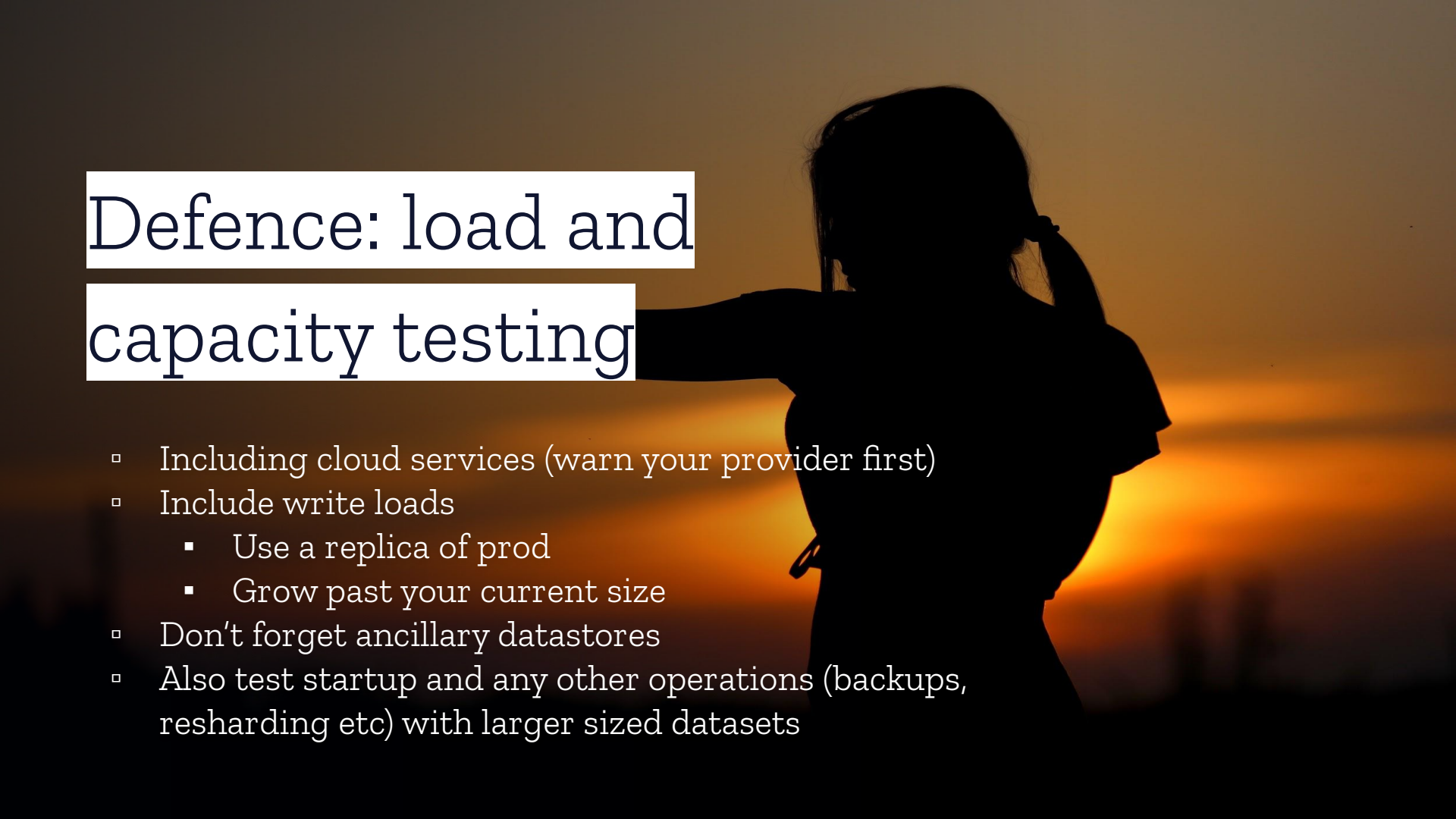
# Platform.sh, August 2016

- EU region down for 4 hours
- Orchestration software wouldn't start
- Library problem: queried all Zookeeper nodes via pipe with 64K buffer
- Buffer filled, exception, fail

Link to incident report

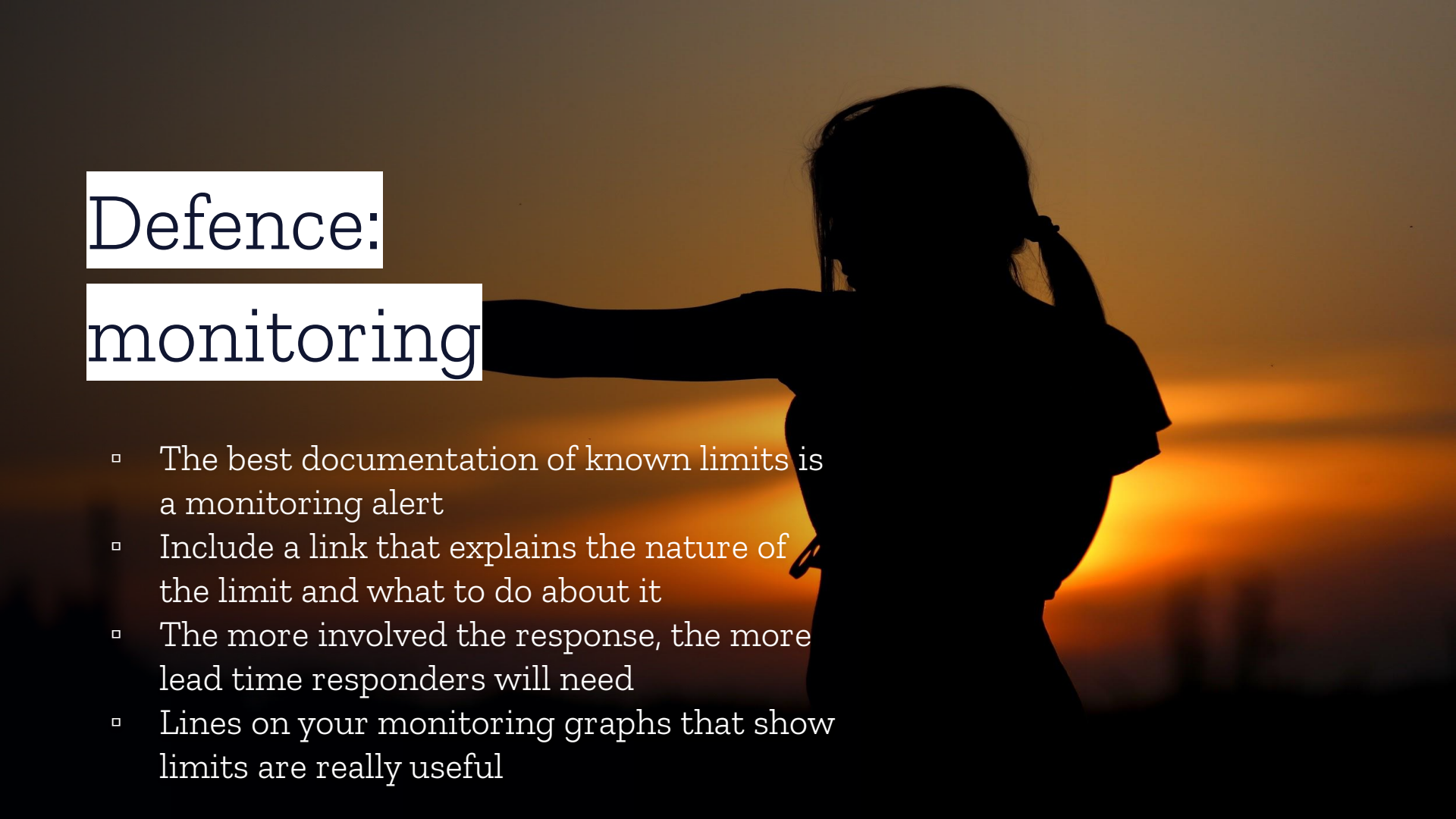
# Hitting Limits

- Limits problems can strike in many ways
- System resources like RAM, logical resources like buffer sizes and IDs, limits imposed by providers and many others



# Defence: load and capacity testing

- Including cloud services (warn your provider first)
- Include write loads
  - Use a replica of prod
  - Grow past your current size
- Don't forget ancillary datastores
- Also test startup and any other operations (backups, resharding etc) with larger sized datasets



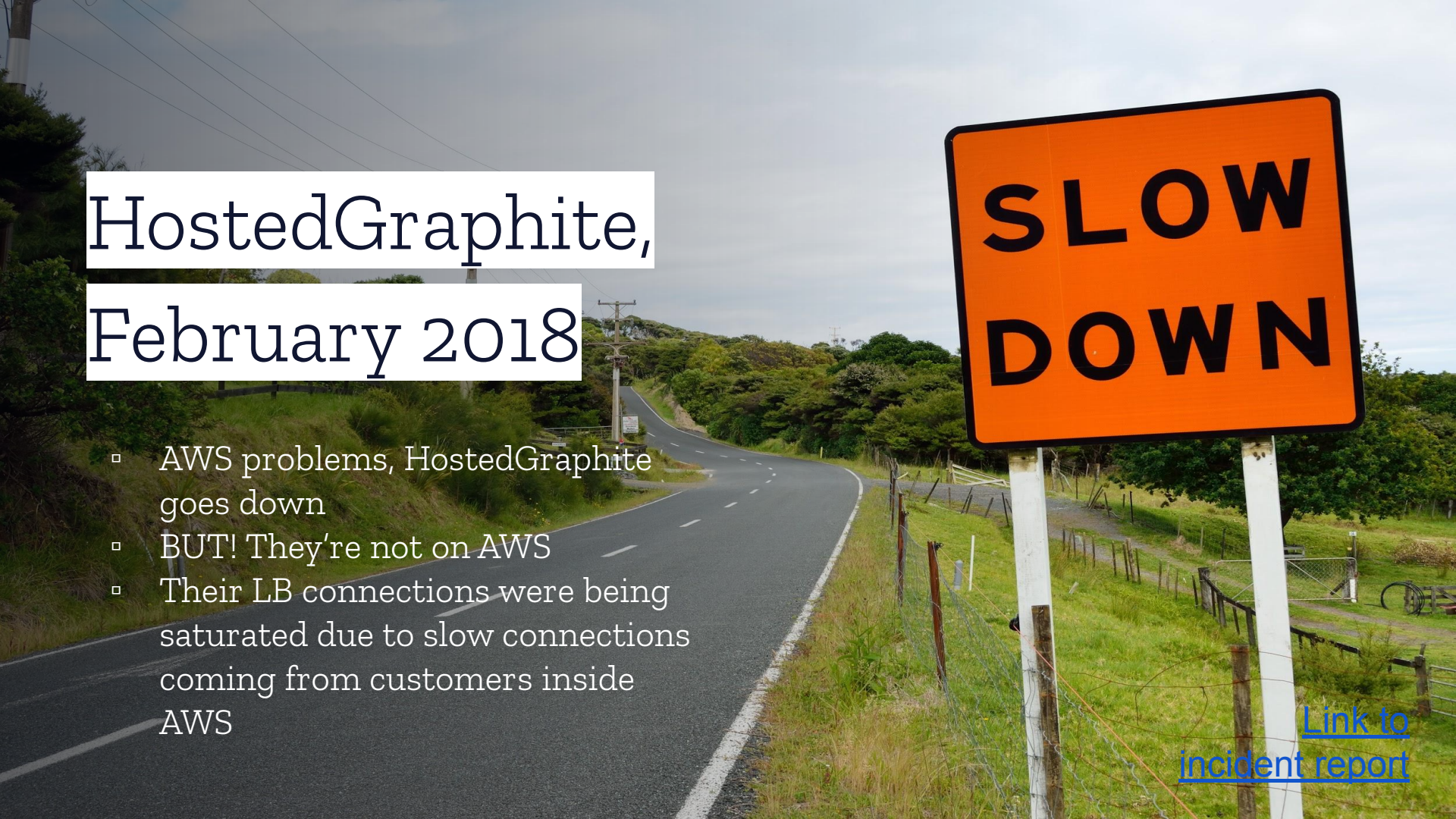
# Defence: monitoring

- The best documentation of known limits is a monitoring alert
- Include a link that explains the nature of the limit and what to do about it
- The more involved the response, the more lead time responders will need
- Lines on your monitoring graphs that show limits are really useful


# 2. Spreading Slowness

# HostedGraphite, February 2018

- AWS problems, HostedGraphite goes down
- BUT! They're not on AWS
- Their LB connections were being saturated due to slow connections coming from customers inside AWS




Link to incident report

# Spotify, April 2013

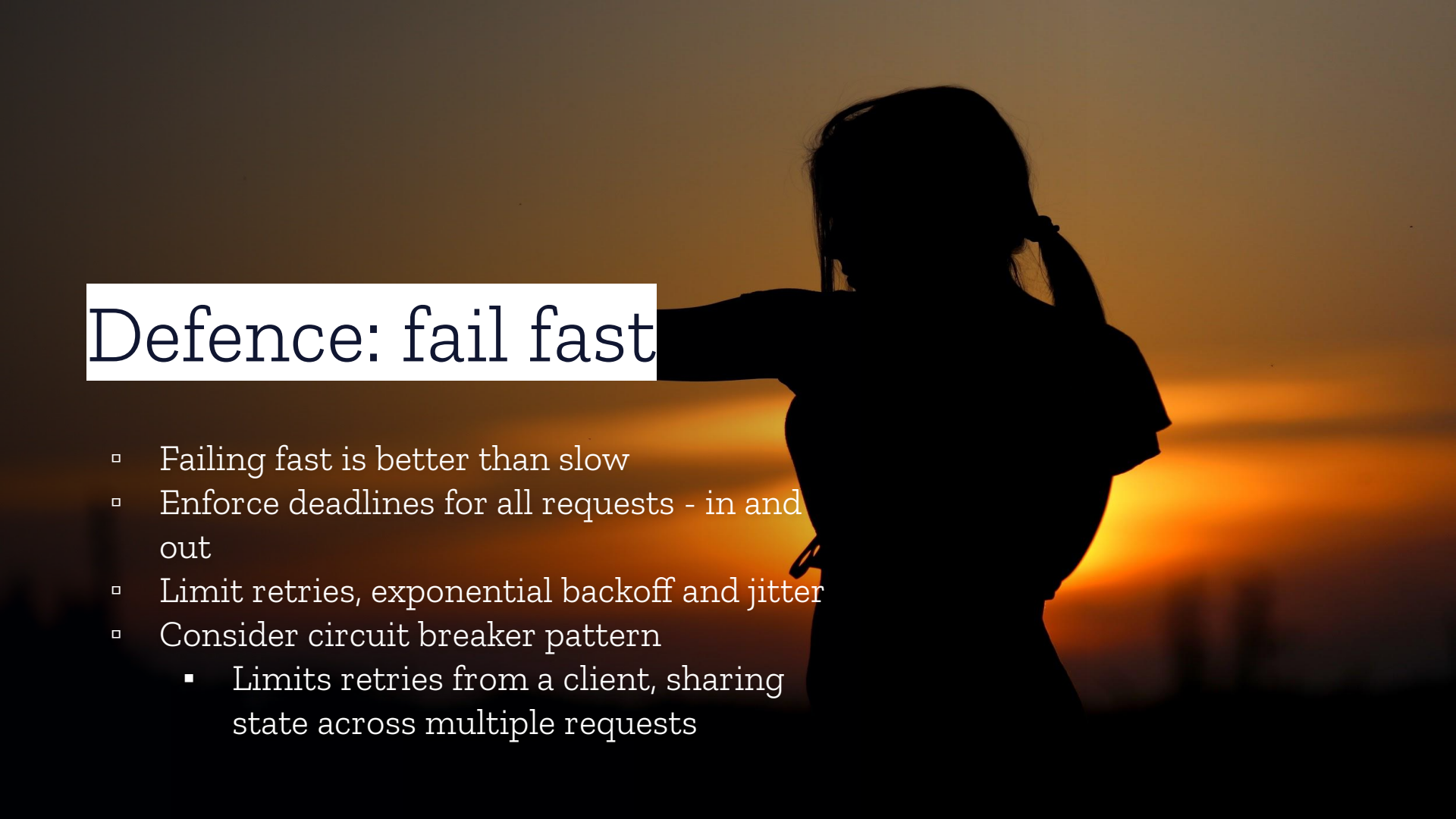
- Playlist service overloaded because another service started using it
- Rolled that back, but huge outgoing request queues and verbose logging broke a critical service
- Needed to be restarted behind firewall to recover


Link to incident report

# Square, March 2017


- Auth system slowed to a crawl
- Redis had gotten overloaded
- Clients were retrying Redis transactions up to 500 times with no backoff

Link to incident report



# Defence: fail fast

- Failing fast is better than slow
- Enforce deadlines for all requests - in and out
- Limit retries, exponential backoff and jitter
- Consider circuit breaker pattern
  - Limits retries from a client, sharing state across multiple requests

# Defence: good dashboards

- Latency and errors - golden signals
- Utilisation, saturation, errors (USE metrics)
  - Utilisation: average time working
  - Saturation: degree of queueing
  - Errors: count of events
- Quick way to identify bottlenecks
- Consider physical resources and also software resources - connections, threads, locks, file descriptors etc

# 3. Thundering Herds


“
The world is much more correlated than we give credit to. And so we see more of what Nassim Taleb calls "black swan events" - rare events happen more often than they should because the world is more correlated.”
-- Richard Thaler

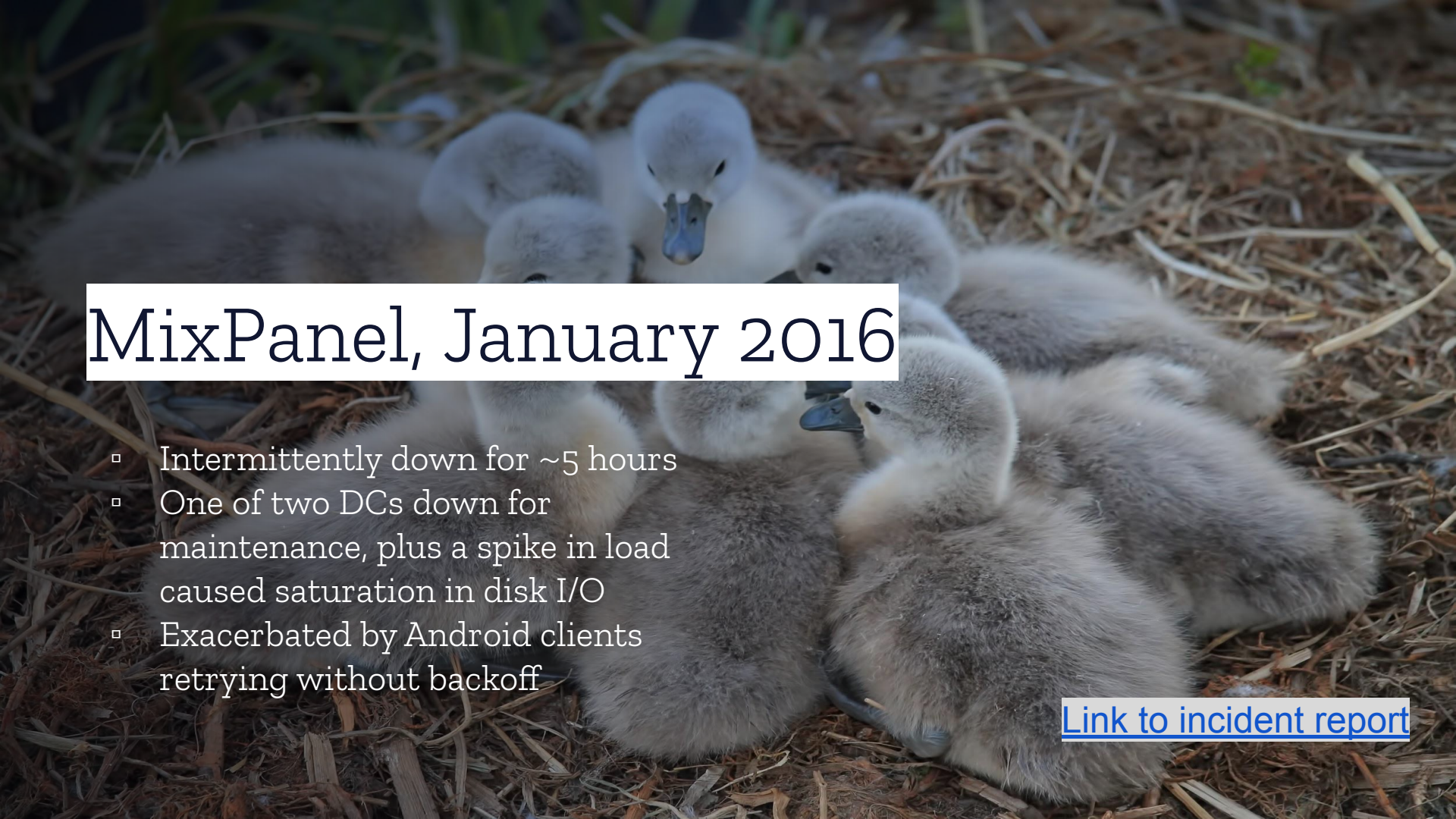
# Where does coordinated demand come from?

- Can arise from users
- Very often from systems
  - Cron jobs at midnight
  - Mobile clients all updating at a specific time
  - Large batch jobs starting (intern mapreduce)
  - Re-replication of data

# CircleCI, July 2015

- GitHub was down for a while
- When it came back traffic surged
- Requests are queued into their DB
  - Complex scheduling logic
- Load resulted in huge DB contention

Link to incident report



# MixPanel, January 2016

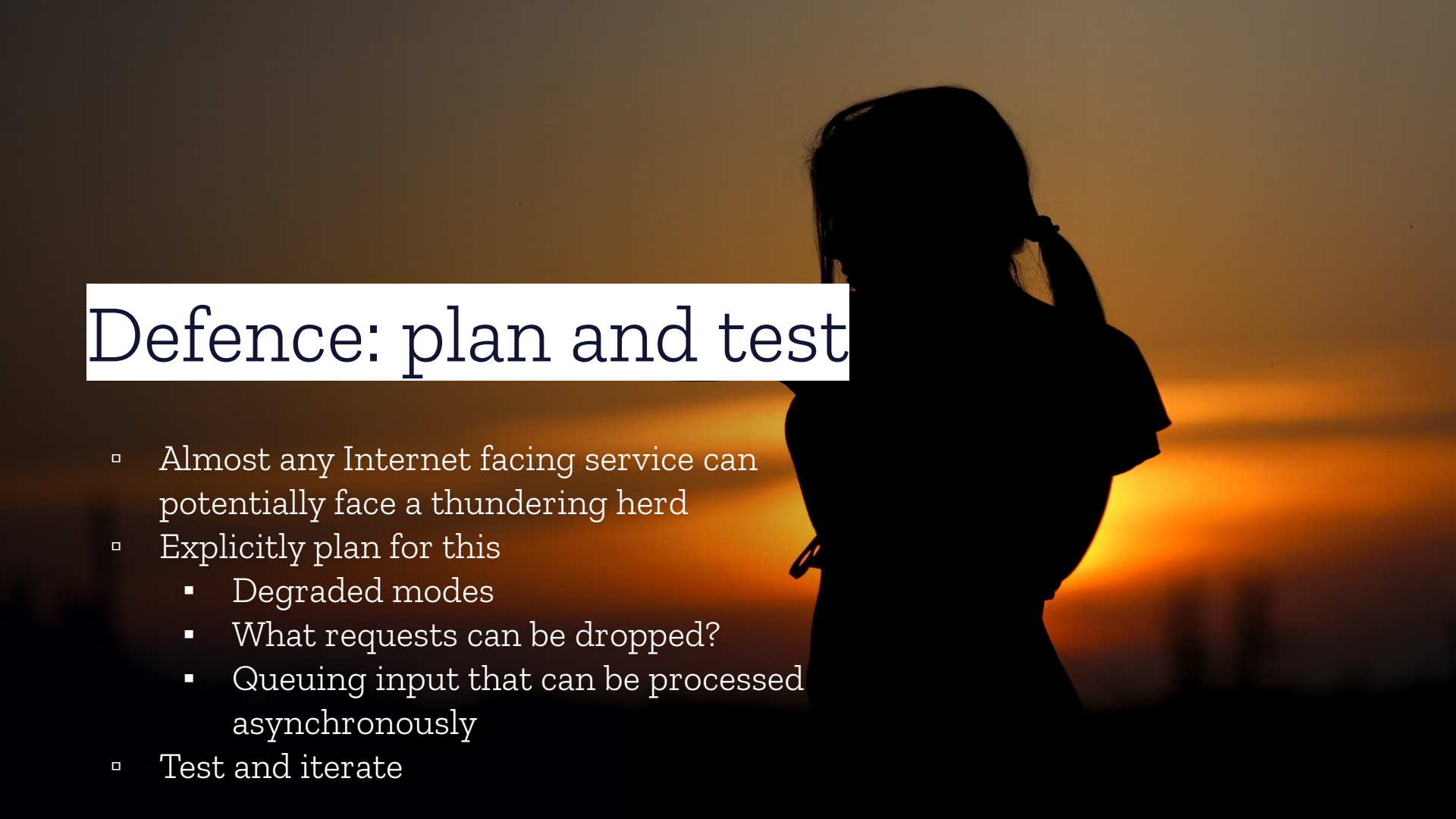
- Intermittently down for ~5 hours
- One of two DCs down for maintenance, plus a spike in load caused saturation in disk I/O
- Exacerbated by Android clients retrying without backoff

Link to incident report

# Discord, March 2017

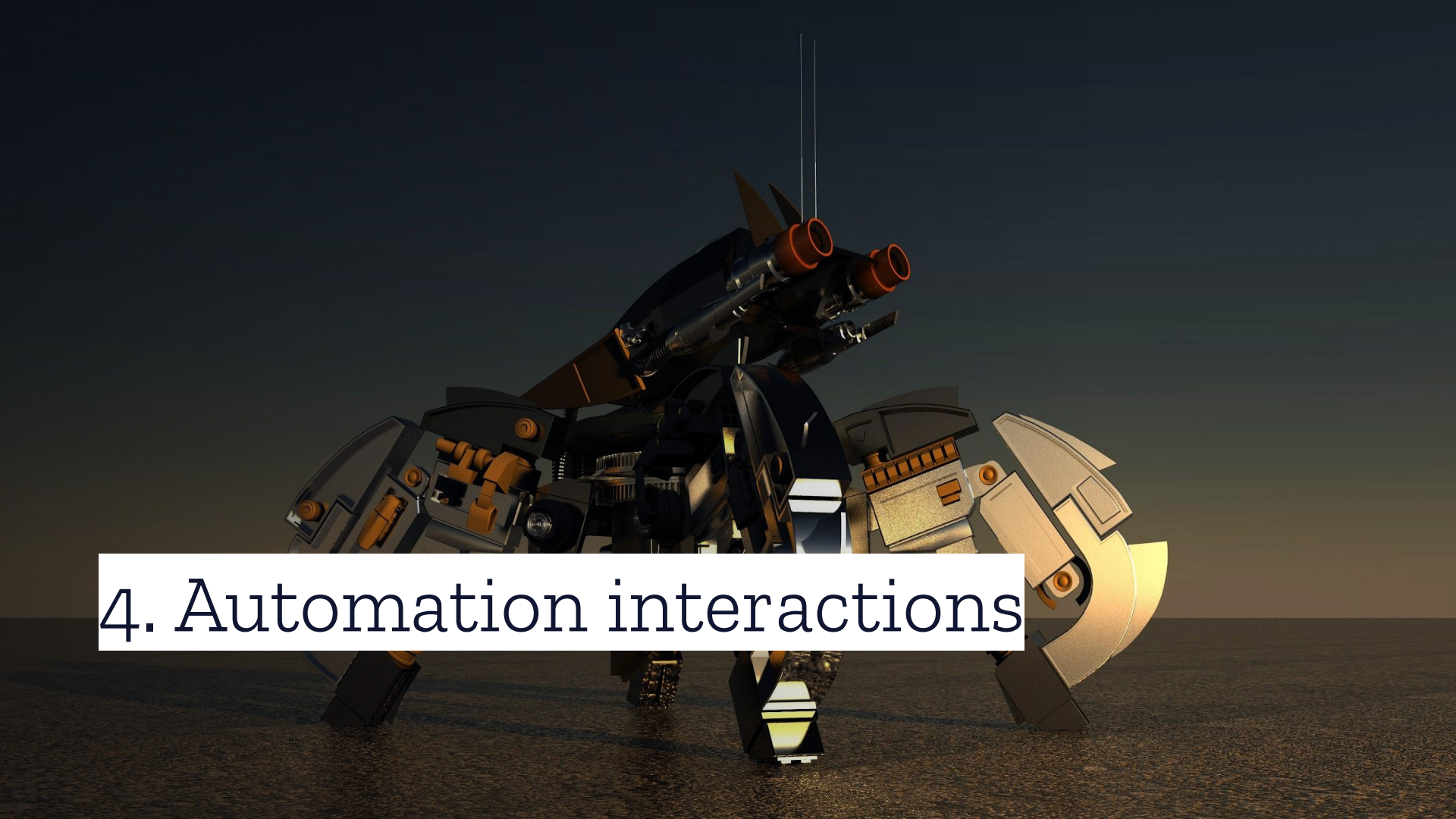
- Experienced 2 2-hour incidents on one day (down, then DMs broken)
- Sessions service depends on presence service
- One instance of presence service disconnected from cluster, and immediate sessions reconnection caused thundering herd

Link to incident report



# Defence: plan and test

- Almost any Internet facing service can potentially face a thundering herd
- Explicitly plan for this
  - Degraded modes
  - What requests can be dropped?
  - Queuing input that can be processed asynchronously
- Test and iterate



# 4. Automation interactions

# Google erases its CDN

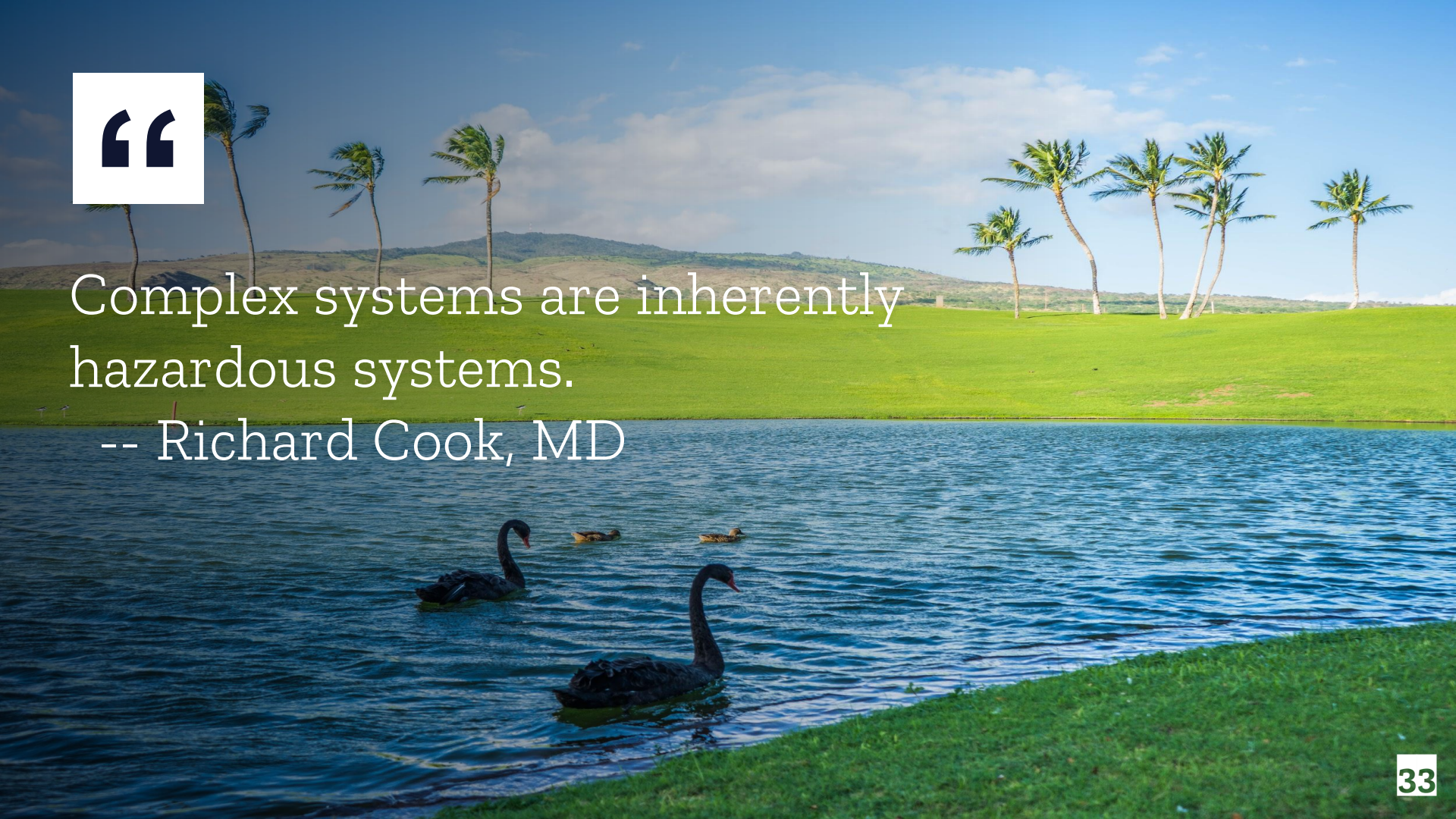
- Engineer tries to send 1 rack of machines to disk erase process
- Accidentallies the entire Google CDN
- Slower queries and network congestion for 2 days until system restored

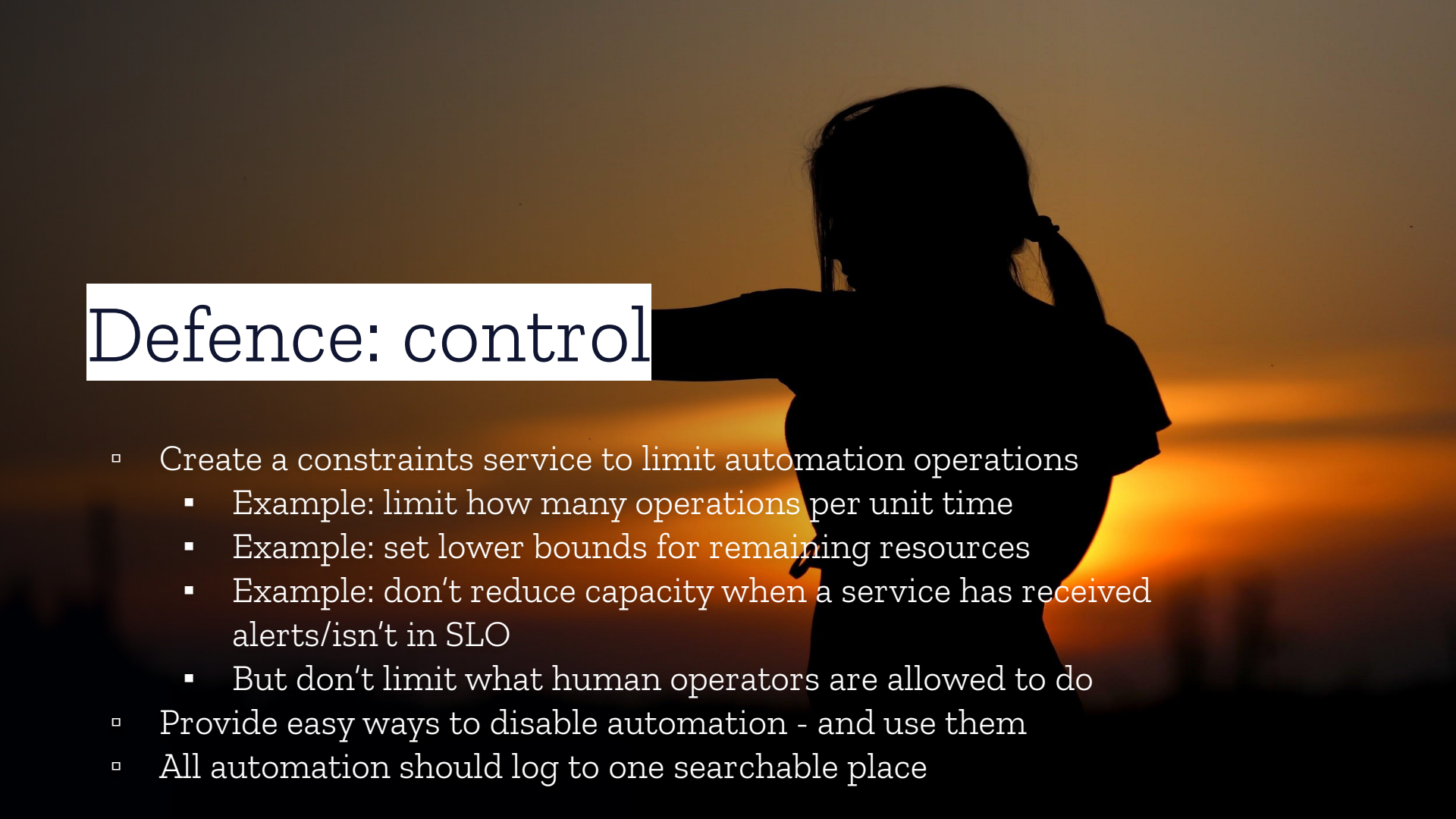
Link to incident report

# Reddit, August 2016

- Performing a Zookeeper migration
- Turned off their autoscaler so it wouldn't read from Zookeeper during migration process
- Automation turns autoscaler back on
- Autoscaler gets confused and turns off most of the site

Link to incident report


“
Complex systems are inherently hazardous systems.
-- Richard Cook, MD



# Defence: control

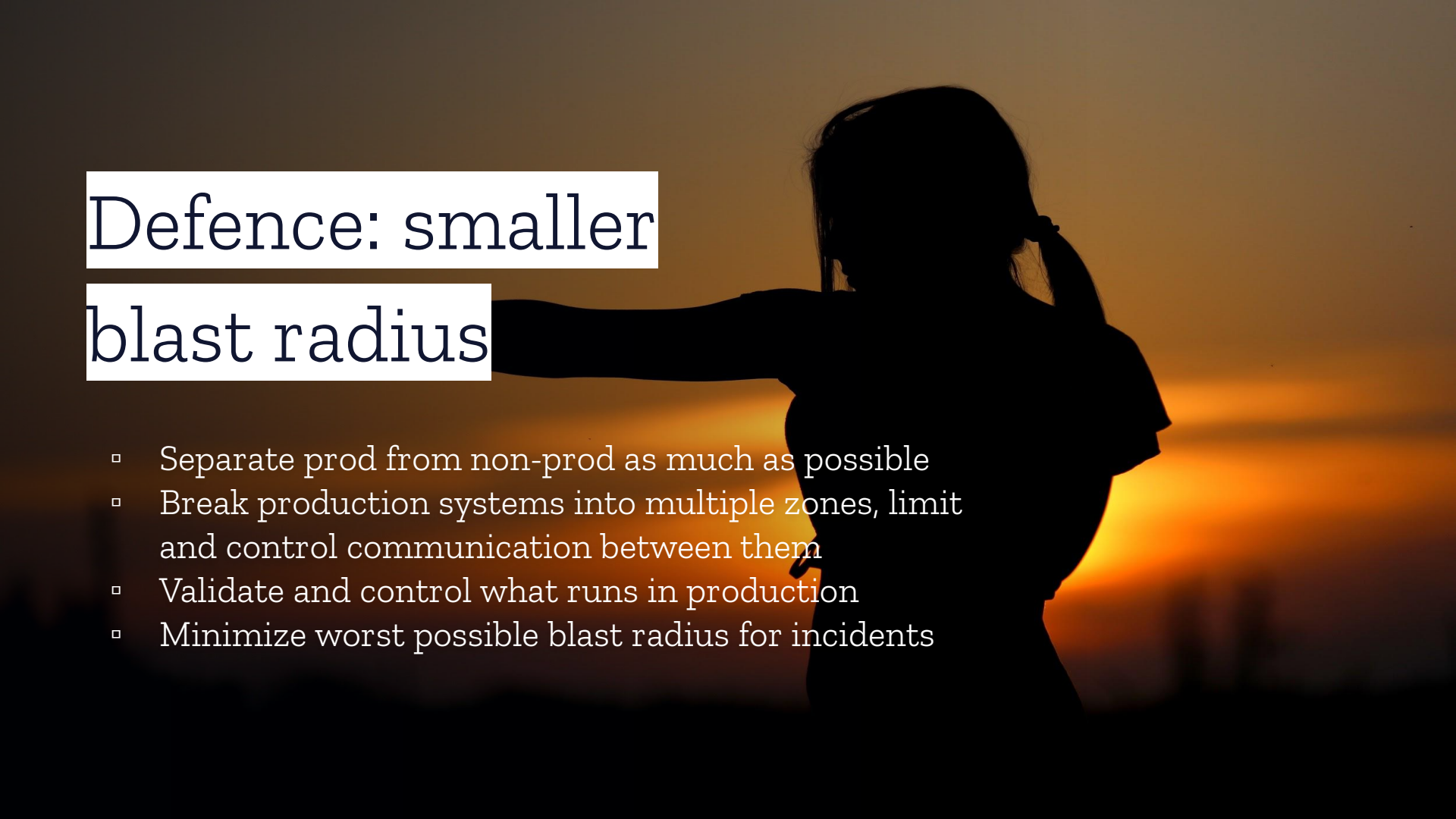
- Create a constraints service to limit automation operations
  - Example: limit how many operations per unit time
  - Example: set lower bounds for remaining resources
  - Example: don't reduce capacity when a service has received alerts/isn't in SLO
  - But don't limit what human operators are allowed to do
- Provide easy ways to disable automation - and use them
- All automation should log to one searchable place


# 5. Cyberattacks

# Maersk, June 2017

- Infected by NotPetya malware - one of their office machines ran vulnerable accounting software
- Maersk turned off its entire global network
- They couldn't unload ships, take bookings for days - 20% hit to global shipping
- Cost billions overall

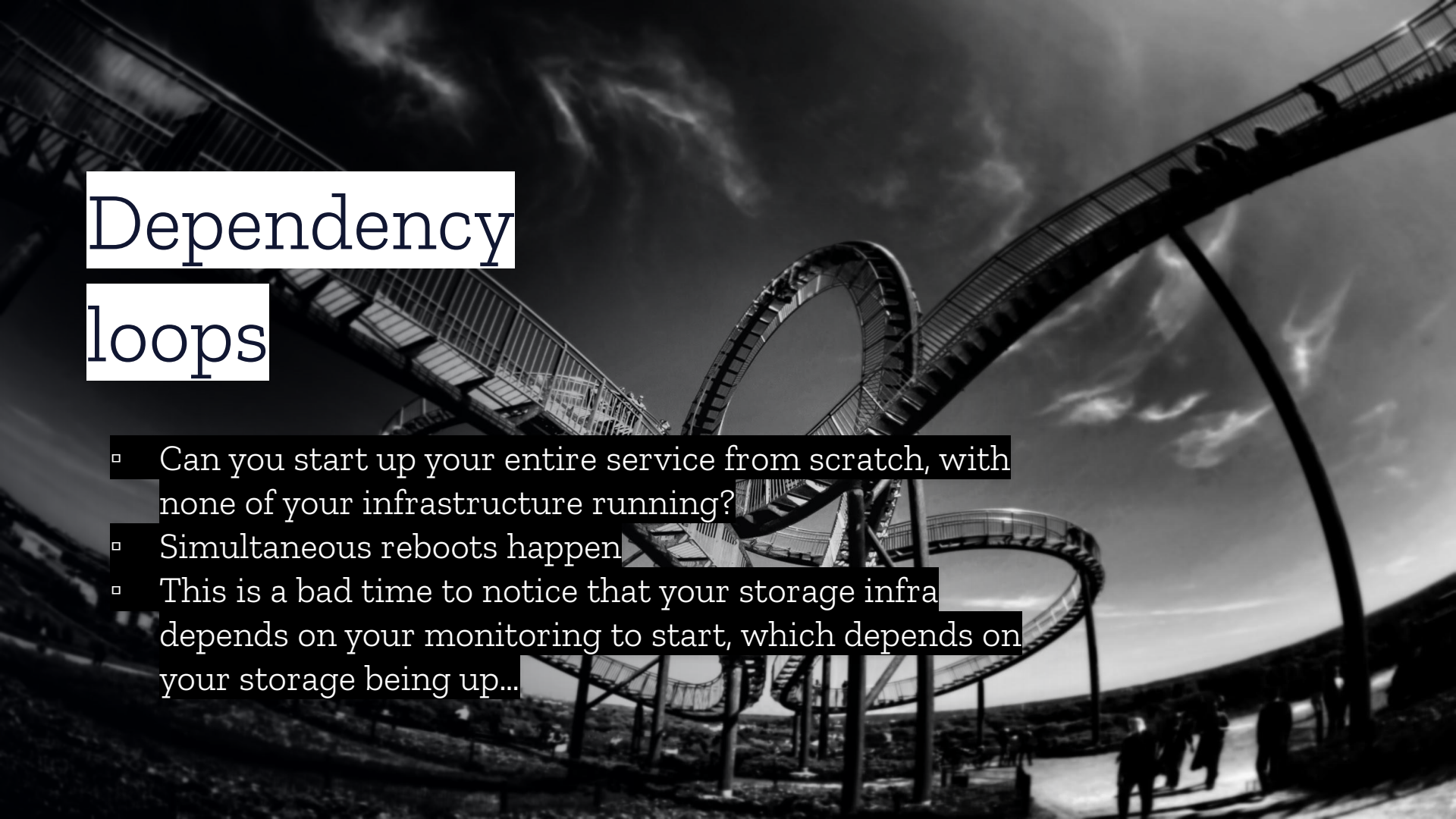
Link to incident report



# Defence: smaller blast radius

- Separate prod from non-prod as much as possible
- Break production systems into multiple zones, limit and control communication between them
- Validate and control what runs in production
- Minimize worst possible blast radius for incidents

# 6. Dependency loops



# Dependency loops

- Can you start up your entire service from scratch, with none of your infrastructure running?
- Simultaneous reboots happen
- This is a bad time to notice that your storage infra depends on your monitoring to start, which depends on your storage being up...

# Github, January 2018

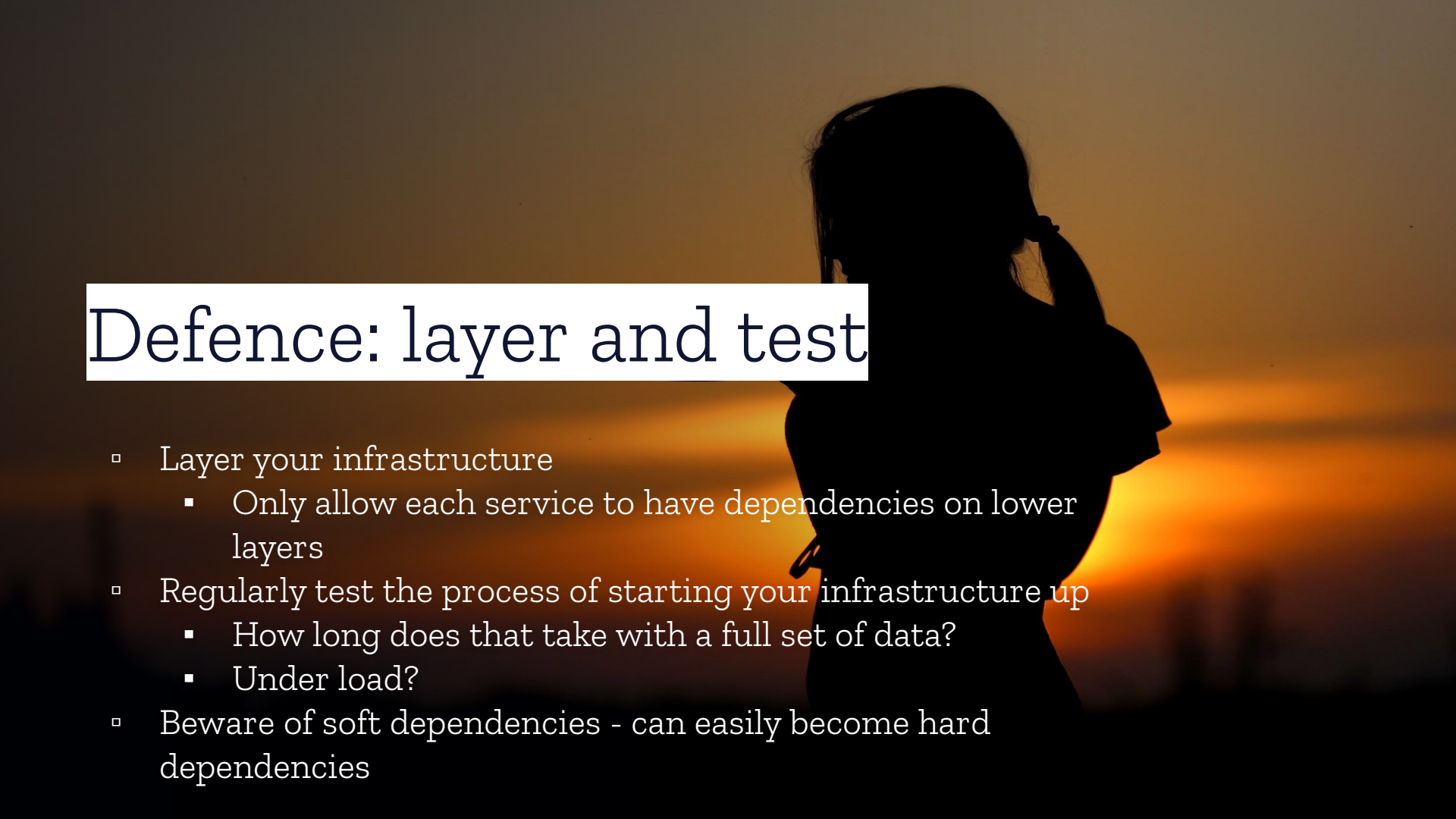
- 2 hour outage
- Power disruption led to 25% of their main DC rebooting
- Some machines didn't come back
- Cache clusters (Redis) unhealthy
- Main application backends wouldn't start due to unintentional hard Redis dependency

Link to incident report

# Trello, March 2017

- AWS S3 outage brought down their frontend webapp
- Trello API should have been fine but wasn't
  - It was checking for the web client being up, even though it didn't otherwise depend on it

Link to incident report



# Defence: layer and test

- Layer your infrastructure
  - Only allow each service to have dependencies on lower layers
- Regularly test the process of starting your infrastructure up
  - How long does that take with a full set of data?
  - Under load?
- Beware of soft dependencies - can easily become hard dependencies

# This was not an exhaustive list

But it's a set of problems that we can do something useful about

# Further general defensive strategies

Disaster testing drills

Fuzztesting

Chaos engineering

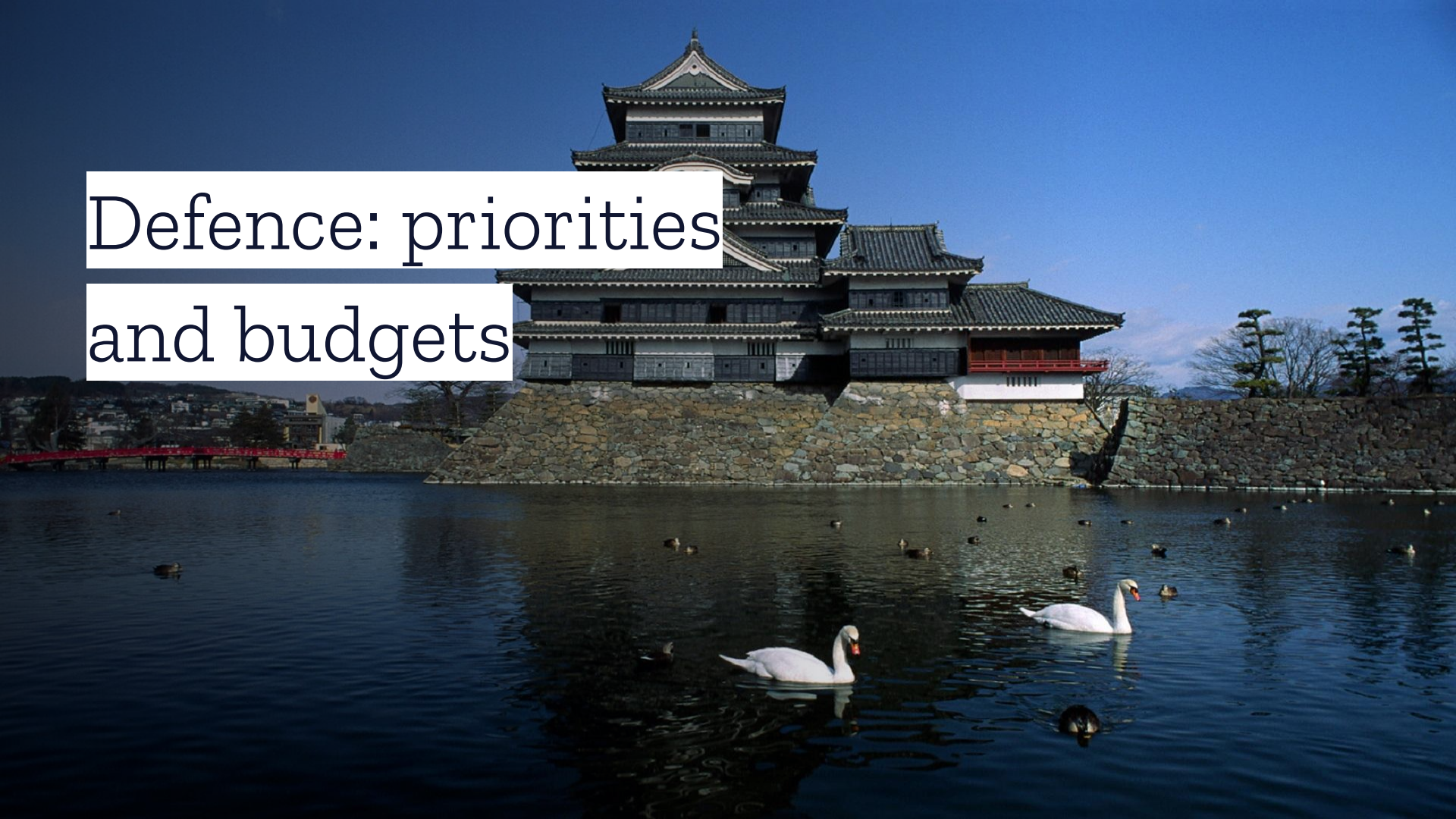
# Defence: incident management process

- FEMA's incident management system
- Practice using it for any nontrivial incident
- Any oncaller should be able to easily summon help
  - Pager alias for a higher-level cross-functional incident response team

# Defence: communication

- Shouldn't rely on your infrastructure
  - Or its dependencies
- Phone bridge, IRC etc are good backups
- Make sure people (key technical staff, executives) know how to use it
  - Laminated wallet cards work
- Practice using it

# Defence: priorities and budgets




Psychology
of battling the black swans

Further reading:

- Michael T. Nygard's 'Release It!', 2nd edition
- Other people's postmortems:
  - github.com/danluu/post-mortems
  - sreweekly.com/

# We're hiring!


Slack is used by millions of people every day.
We need engineers who want to make that experience as reliable and enjoyable as possible.

## https://slack.com/careers

# Links

- Safety constraints: https://www.usenix.org/conference/srecon18americas/presentation/schulman
- USE method: http://www.brendangregg.com/usemethod.html
- Load shedding: https://www.youtube.com/watch?v=XNEIkivvaV4
- Layering: https://www.youtube.com/watch?v=XNEIkivvaV4
- Incident management: https://landing.google.com/sre/book/chapters/managing-incidents.html


Questions?
Or you can find me at @lauralifts

# Credits

Special thanks to all the people who made and released these awesome resources for free:

- Presentation template by SlidesCarnival
- Photographs by Pixabay
- And all the authors of the postmortems, articles and talks referenced throughout