What breaks our systems:

A taxonomy of black swans

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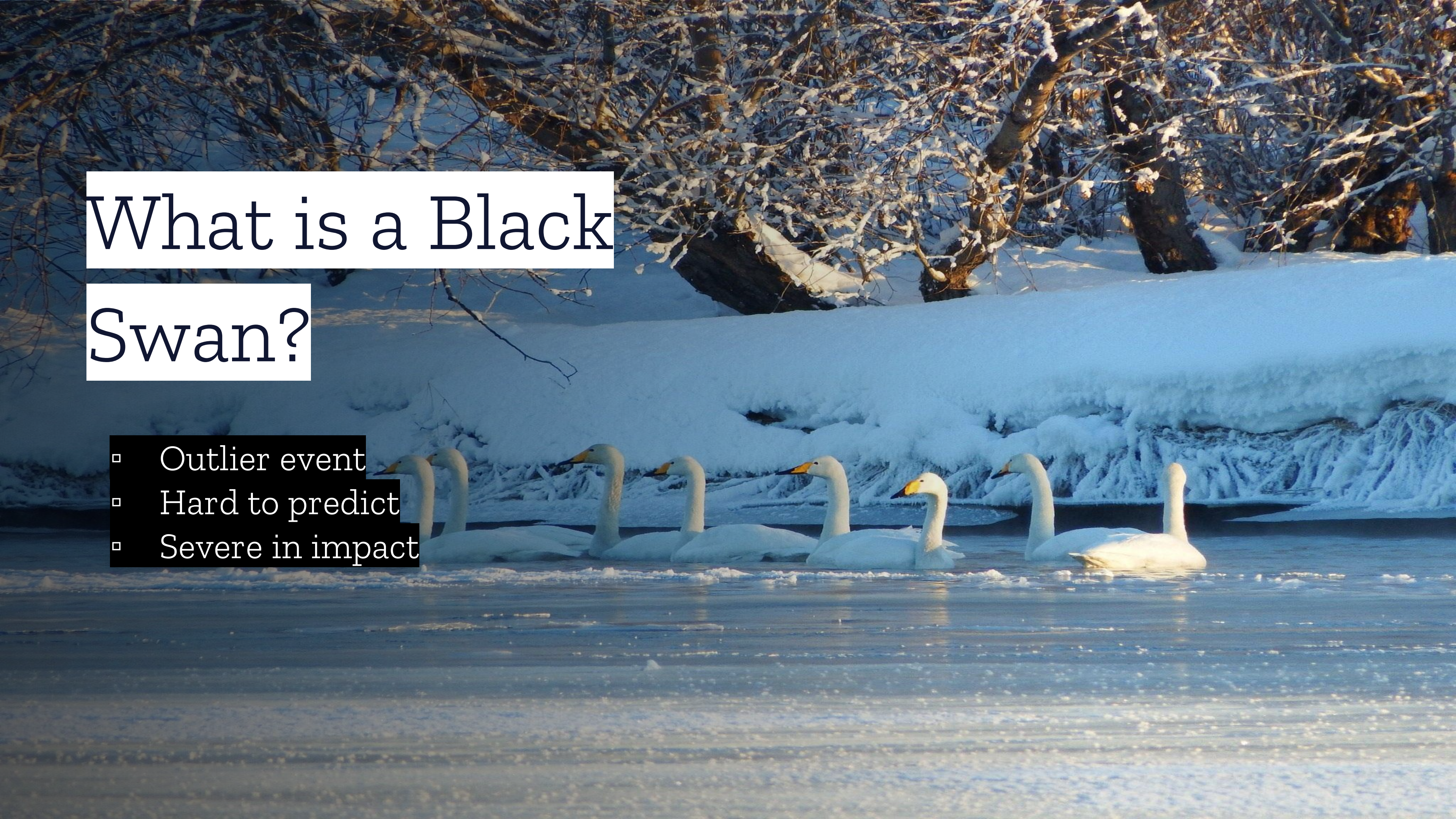


What is a Black Swan?

- Outlier event
- Hard to predict
- Severe in impact

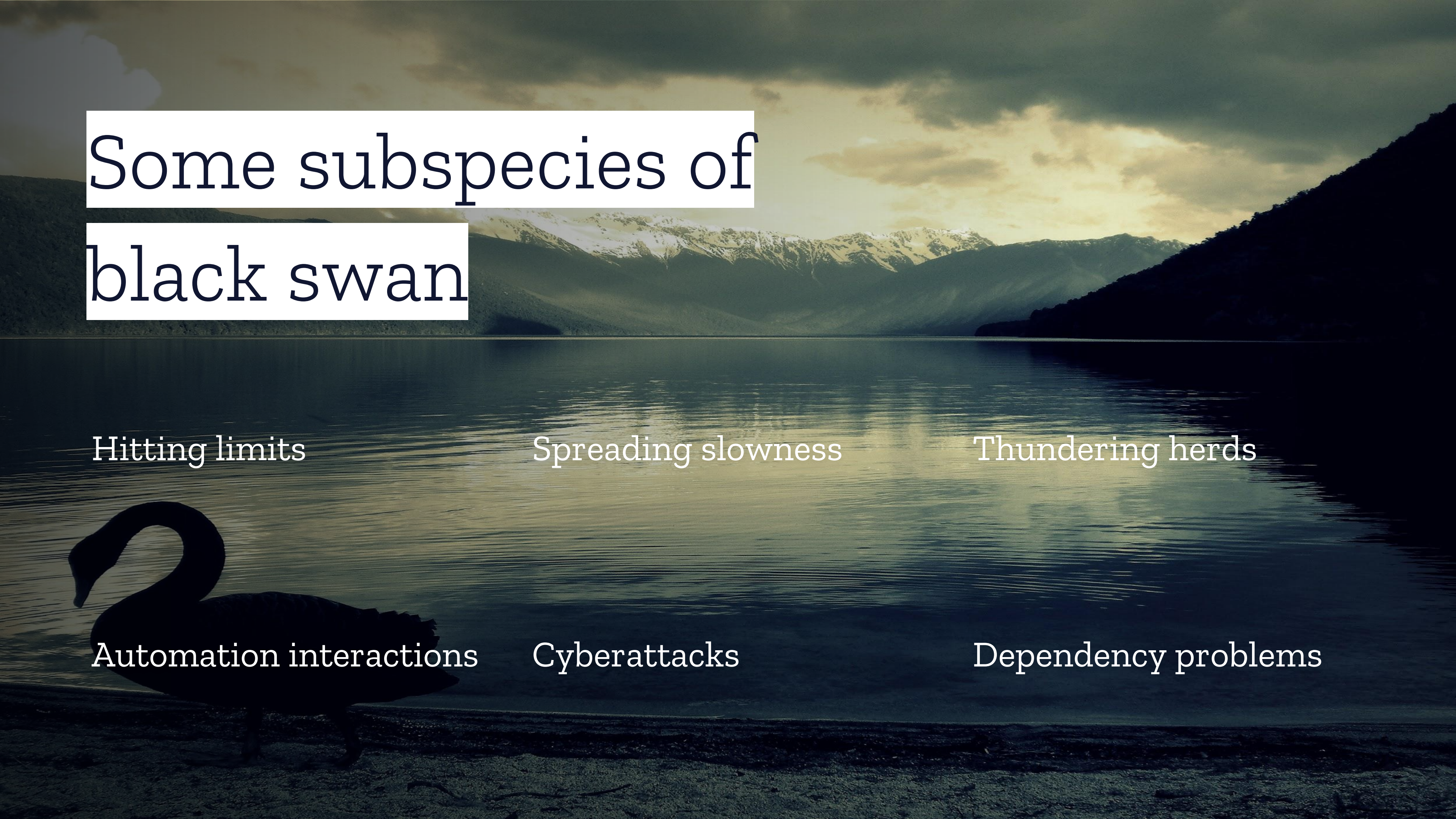
Every black swan is unique

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 caused by change can be mostly defeated with canarying

On sharing postmortems



Some subspecies of black swan

- Hitting limits
- Spreading slowness
- Thundering herds
- Automation interactions
- Cyberattacks
- Dependency problems

1. Hitting Limits

Instapaper, February 2017

- Prod DB on Amazon MySQL RDS
- Hit a 2TB limit because filesystem ext3 - nobody knew this would happen
- Had to dump 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]

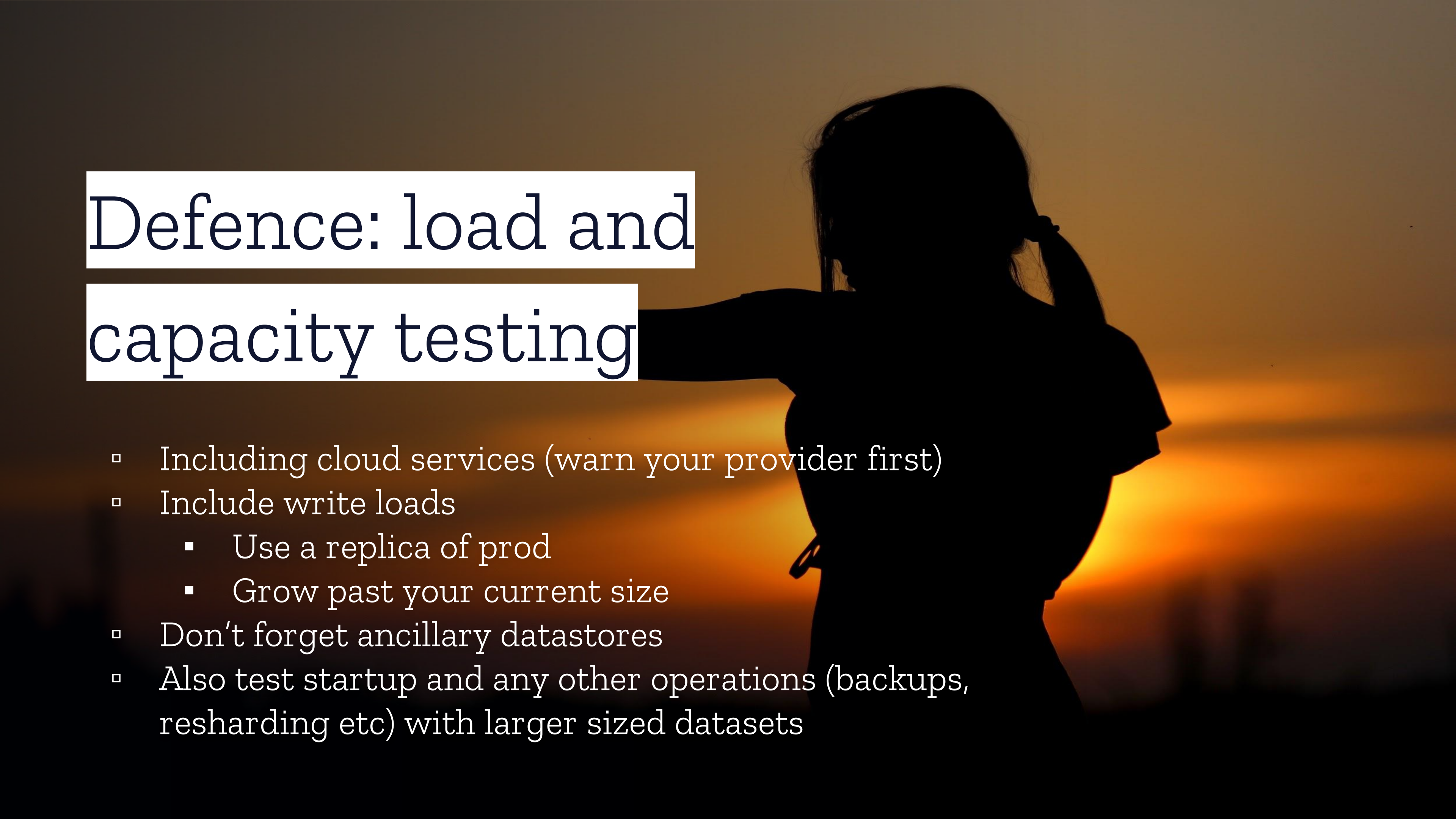
Platform.sh, August 2016

- 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

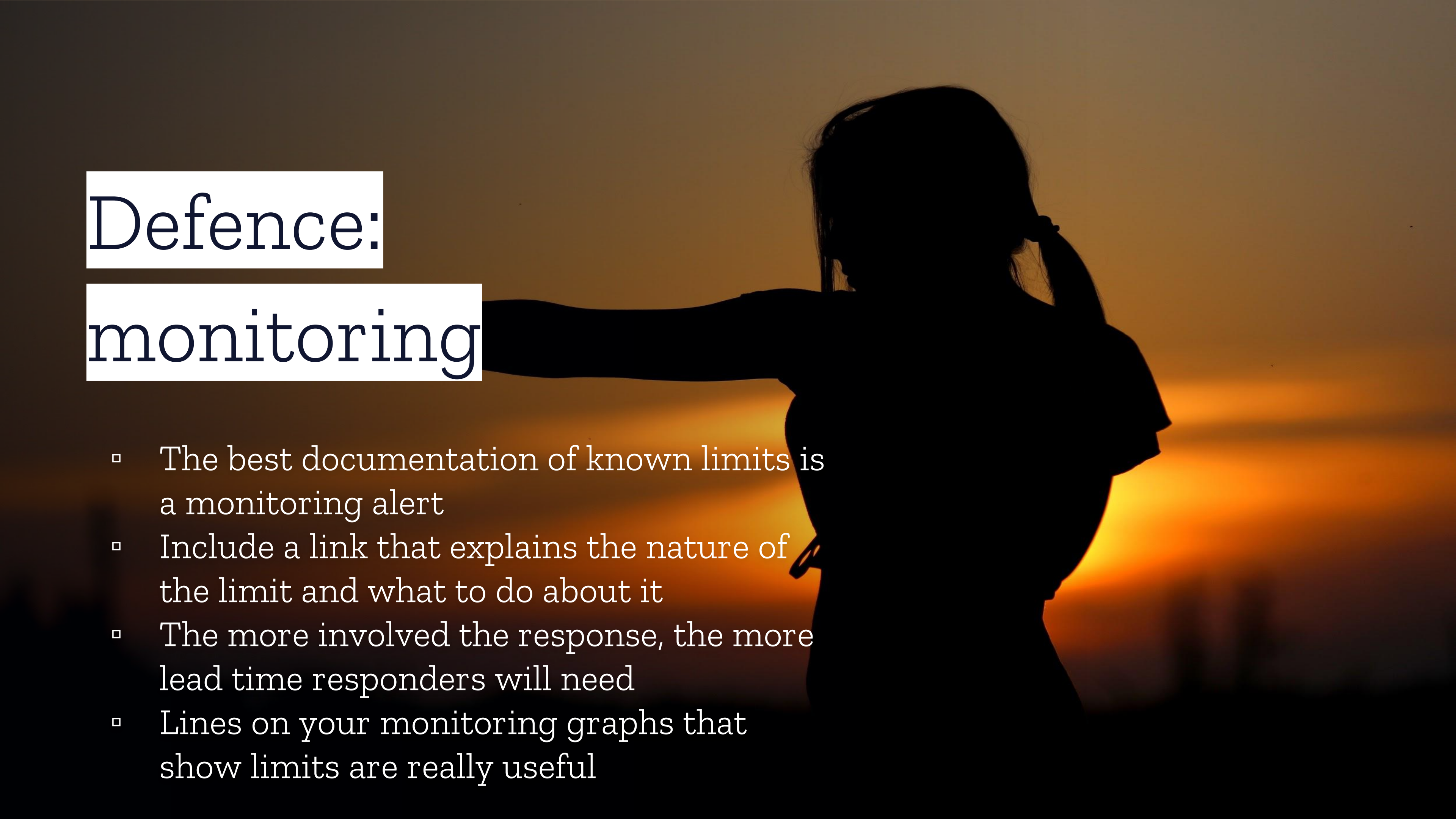
Hitting Limits

- 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

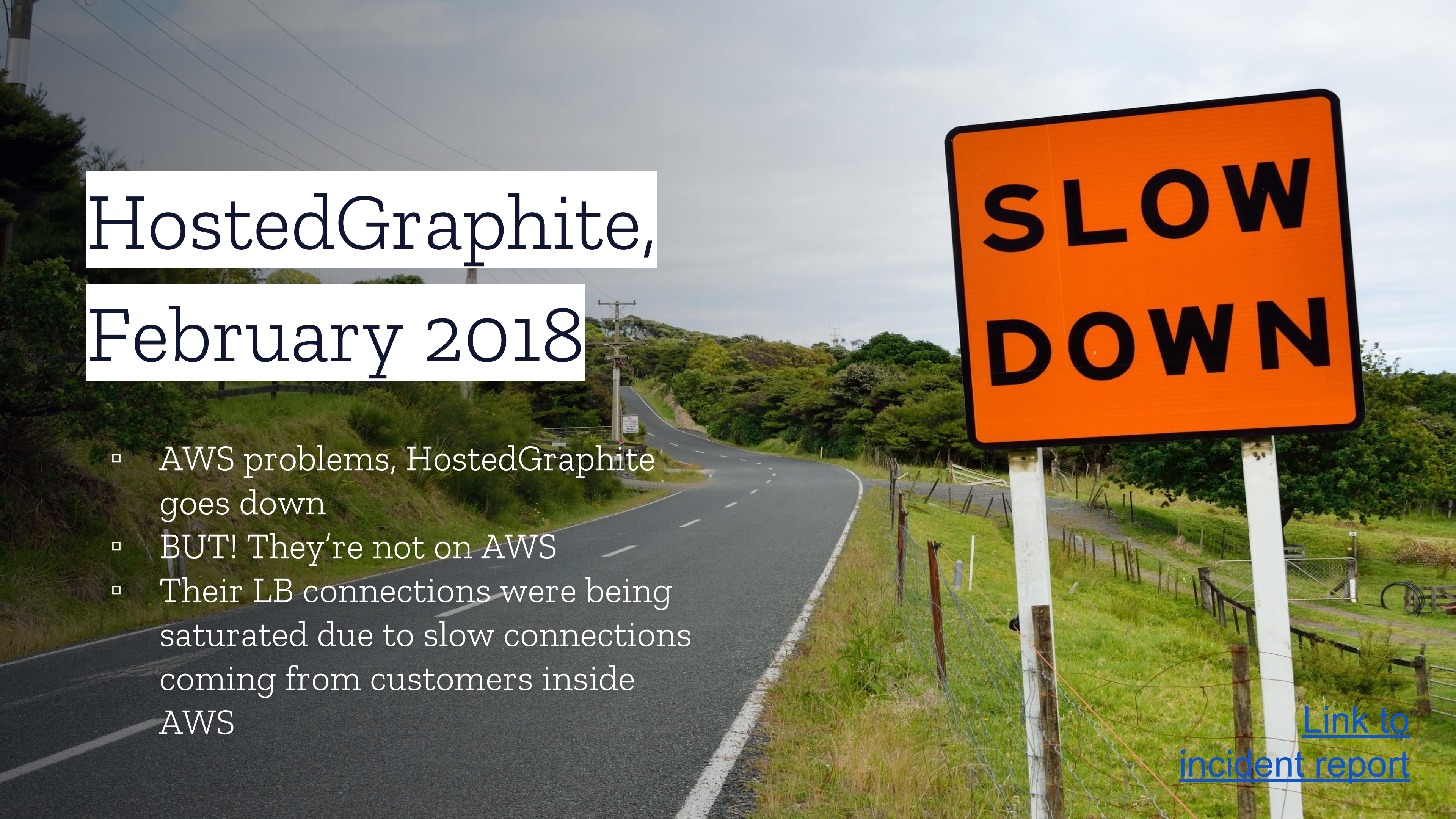


Defence: monitoring

- 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

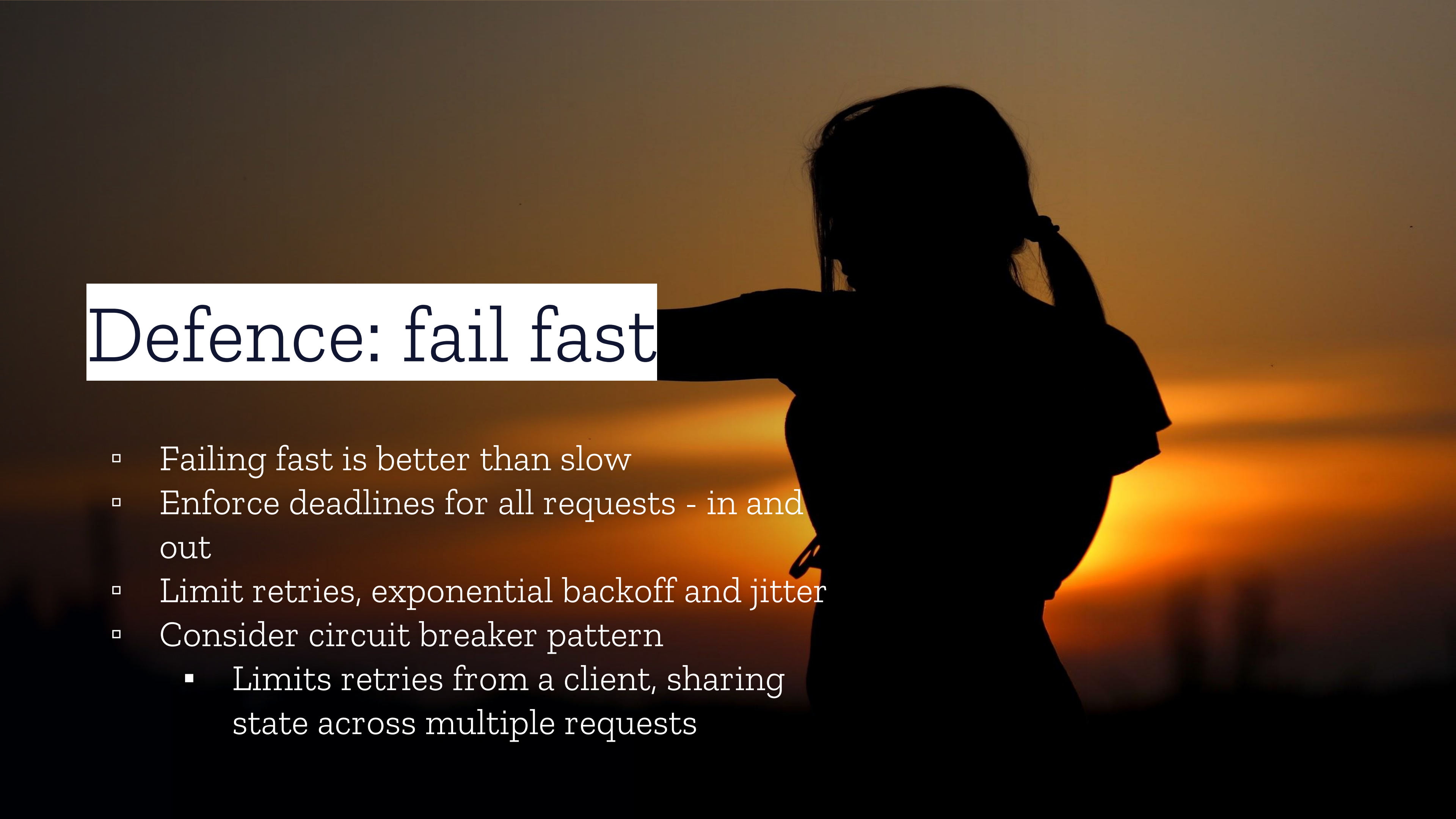
- Playlist service overloaded because another service started using it
- Rolled that back, but huge outgoing request queues and verbose logging broke a critical service
- Needed to be restarted behind firewall to recover

Link to incident report

Square, March 2017

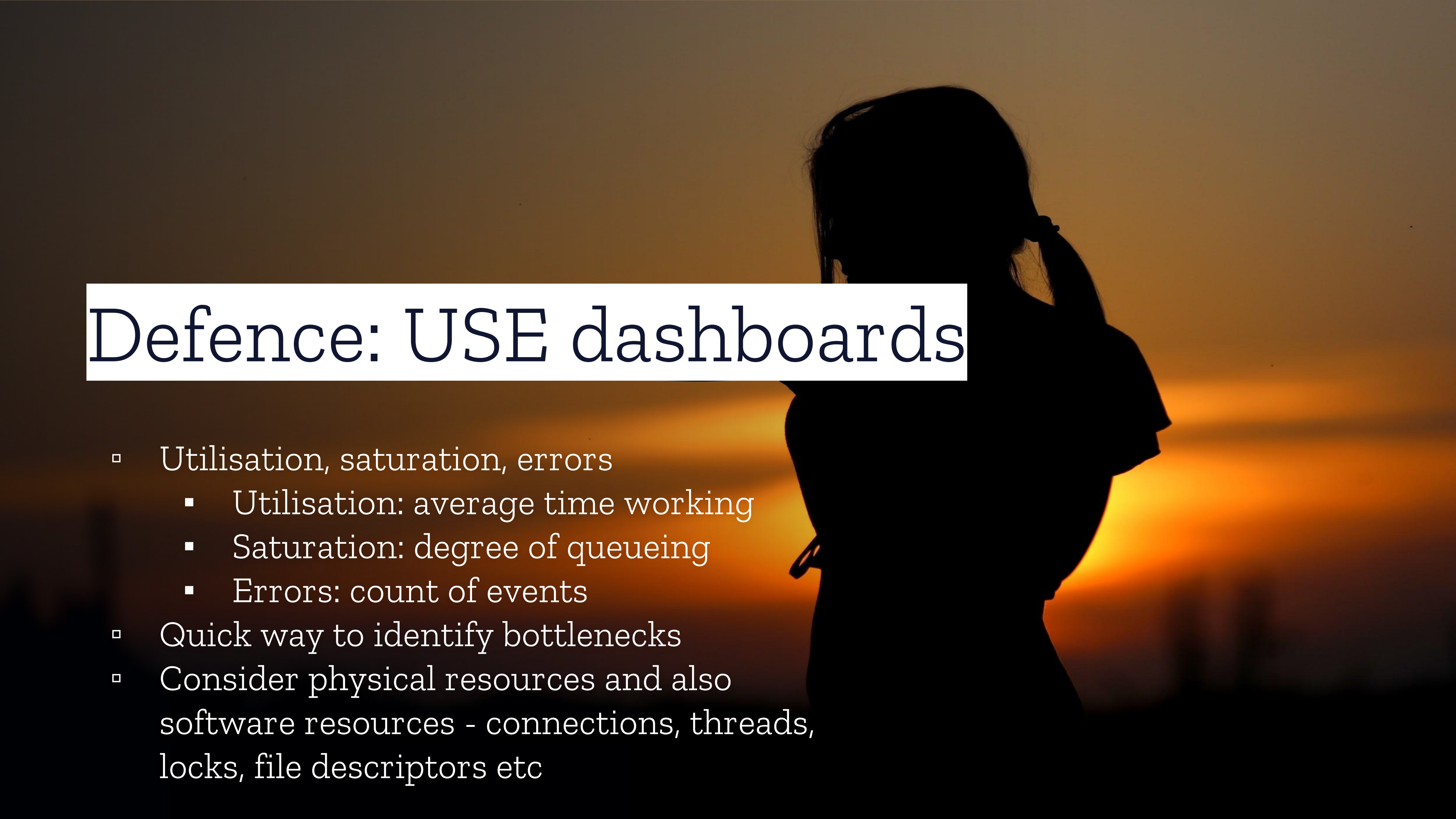
- Auth system slowed to a crawl
- Cause: Redis had gotten overloaded
- Clients were retrying Redis transactions up to 500 times with no backoff

Link to incident report



Defence: fail fast

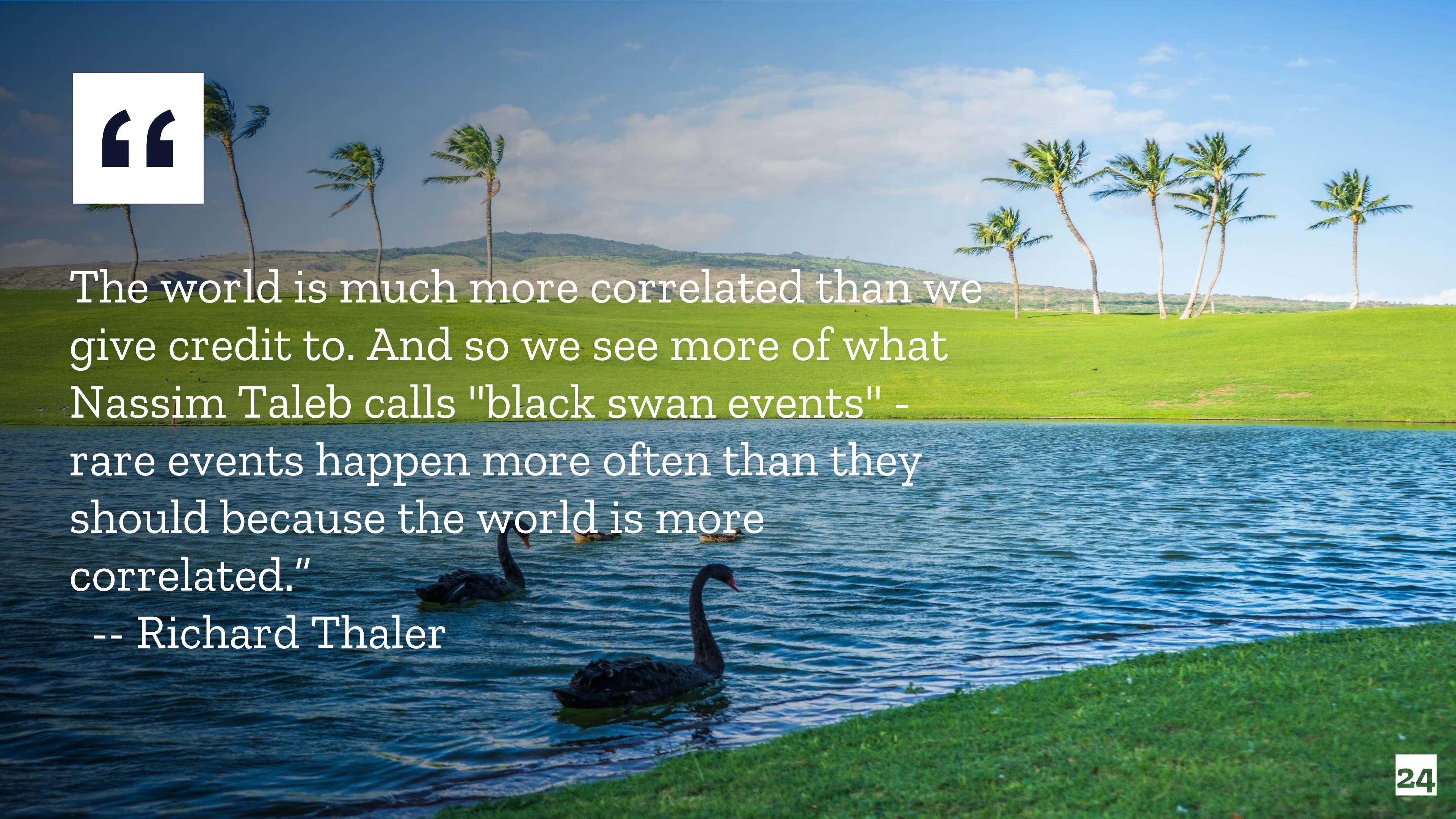
- Failing fast is better than slow
- Enforce deadlines for all requests - in and out
- Limit retries, exponential backoff and jitter
- Consider circuit breaker pattern
  - Limits retries from a client, sharing state across multiple requests



Defence: USE dashboards

- Utilisation, saturation, errors
  - 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

Slack, October 2014

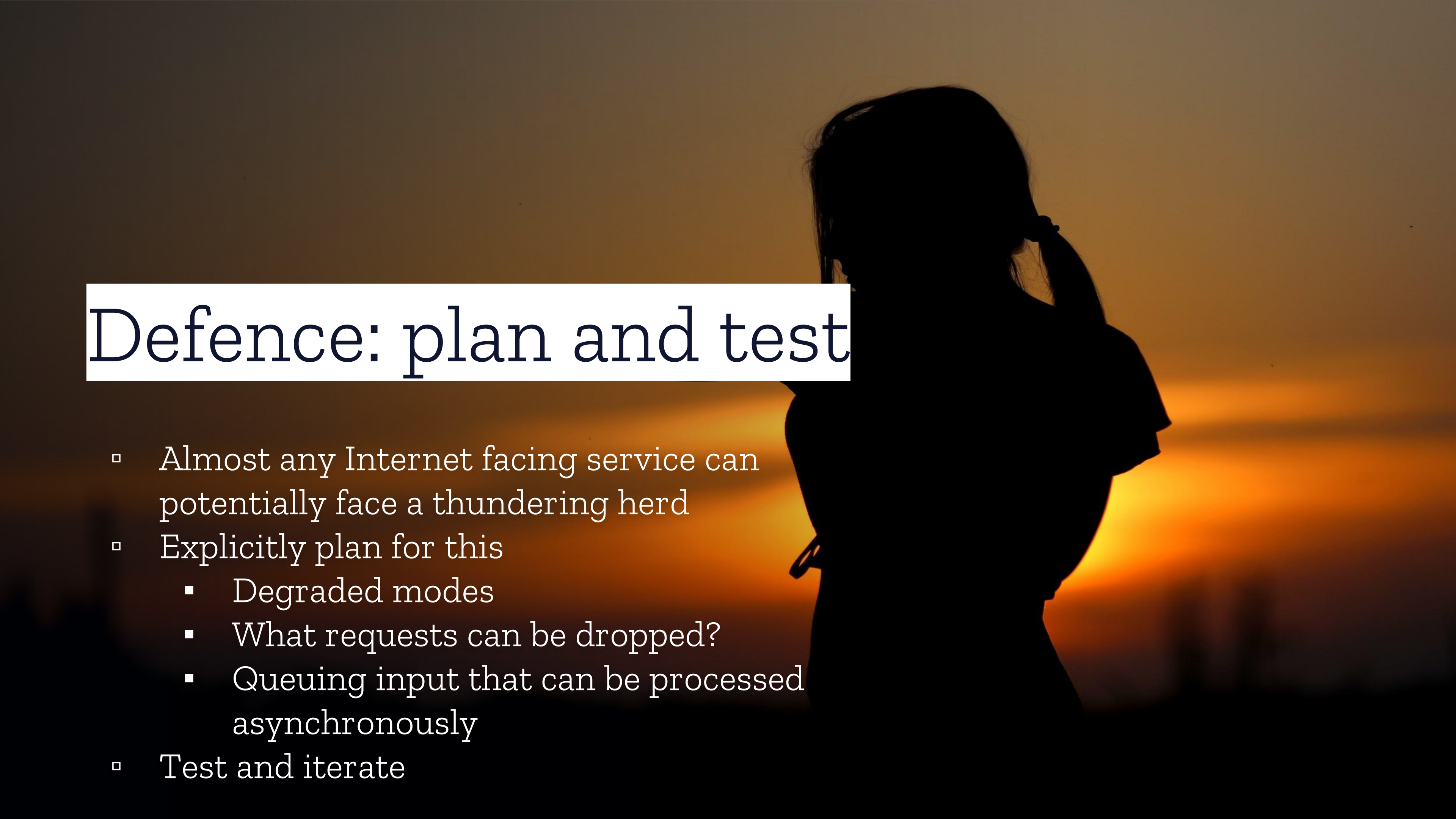
- Two separate incidents caused significant numbers of users to be disconnected
  - WebSockets based API - long running sessions
- Simultaneous reconnect caused saturation in their databases

Link to incident report

CircleCI, July 2015

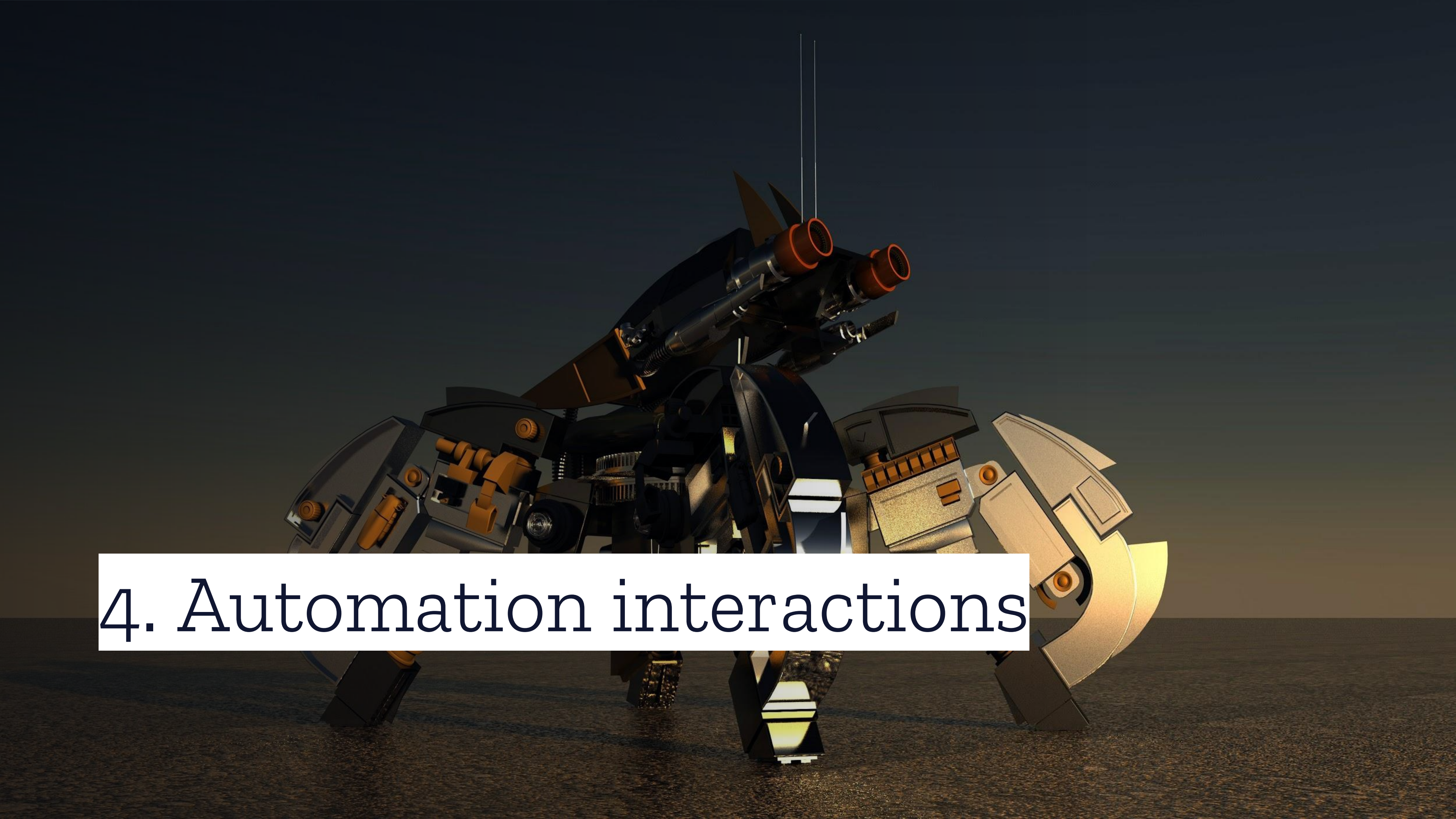
- GitHub was down for a while
- When it came back traffic surged
- Requests are queued into their DB
  - Complex scheduling logic
- Load resulted in huge DB contention

[Link to incident report]



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

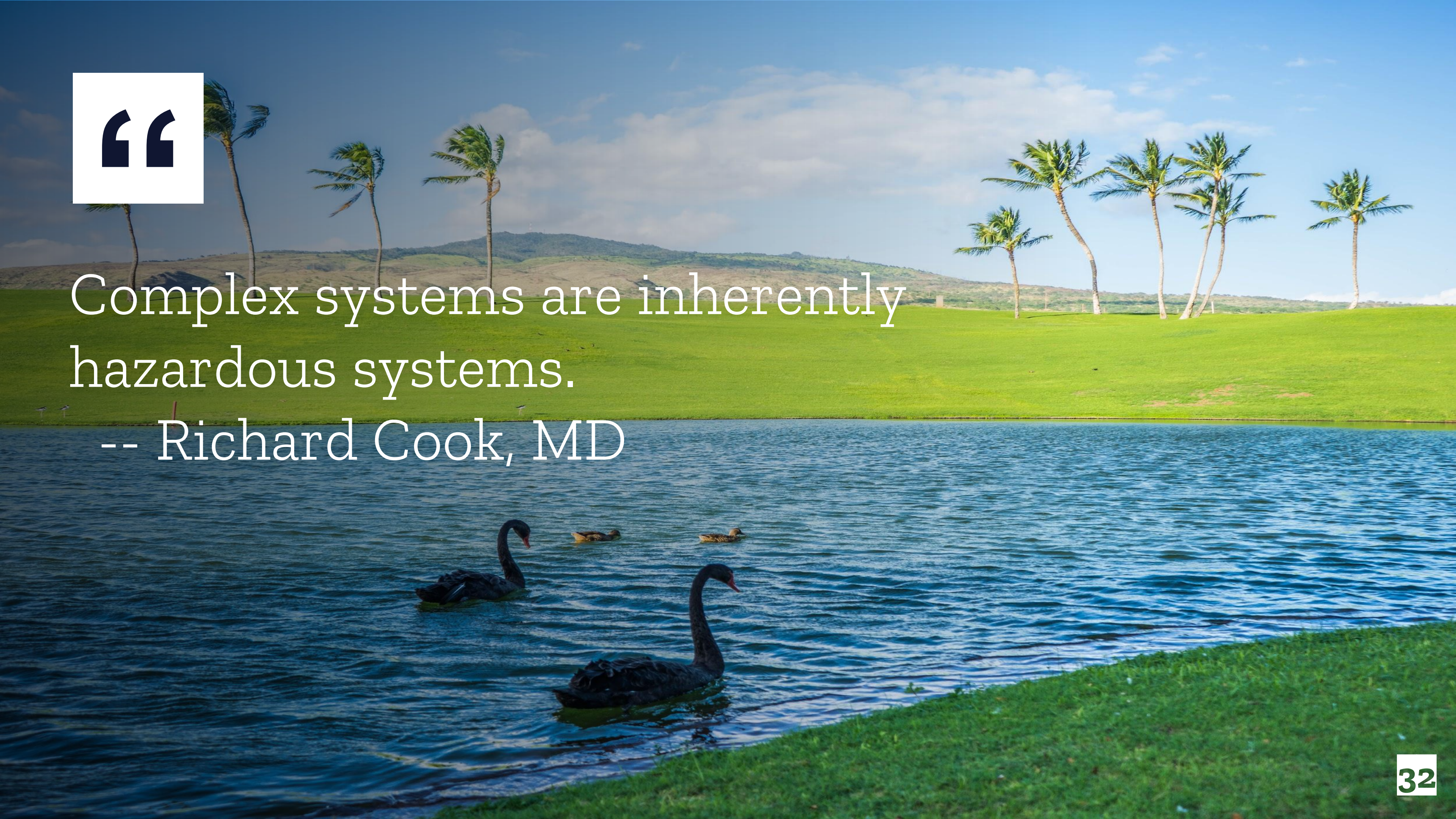
- Engineer tries to send 1 rack of machines to disk erase process
- Accidentallies the entire Google CDN
- Slower queries and network congestion for 2 days until system restored

[Link to incident report]

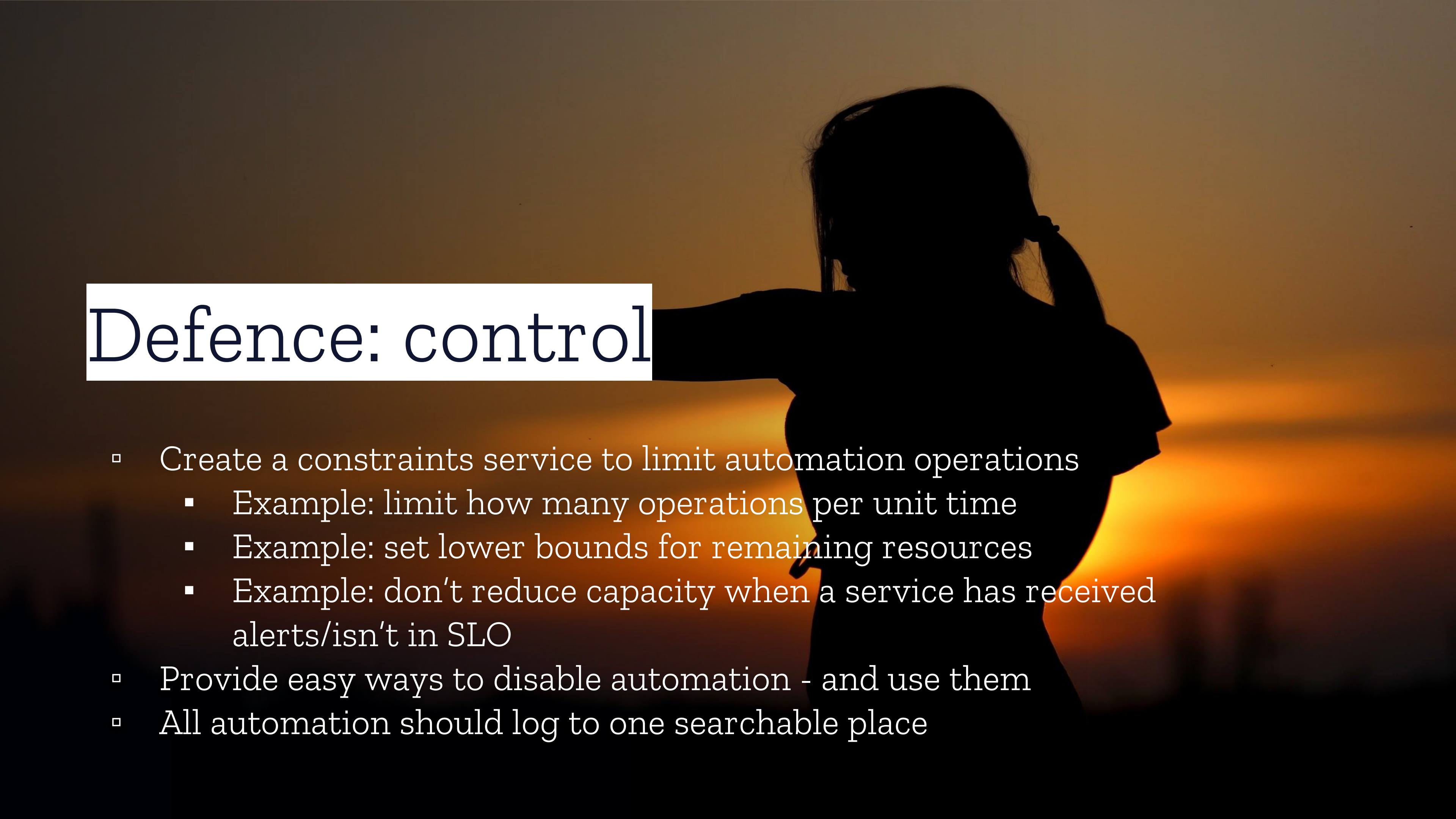
Reddit, August 2016

- 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

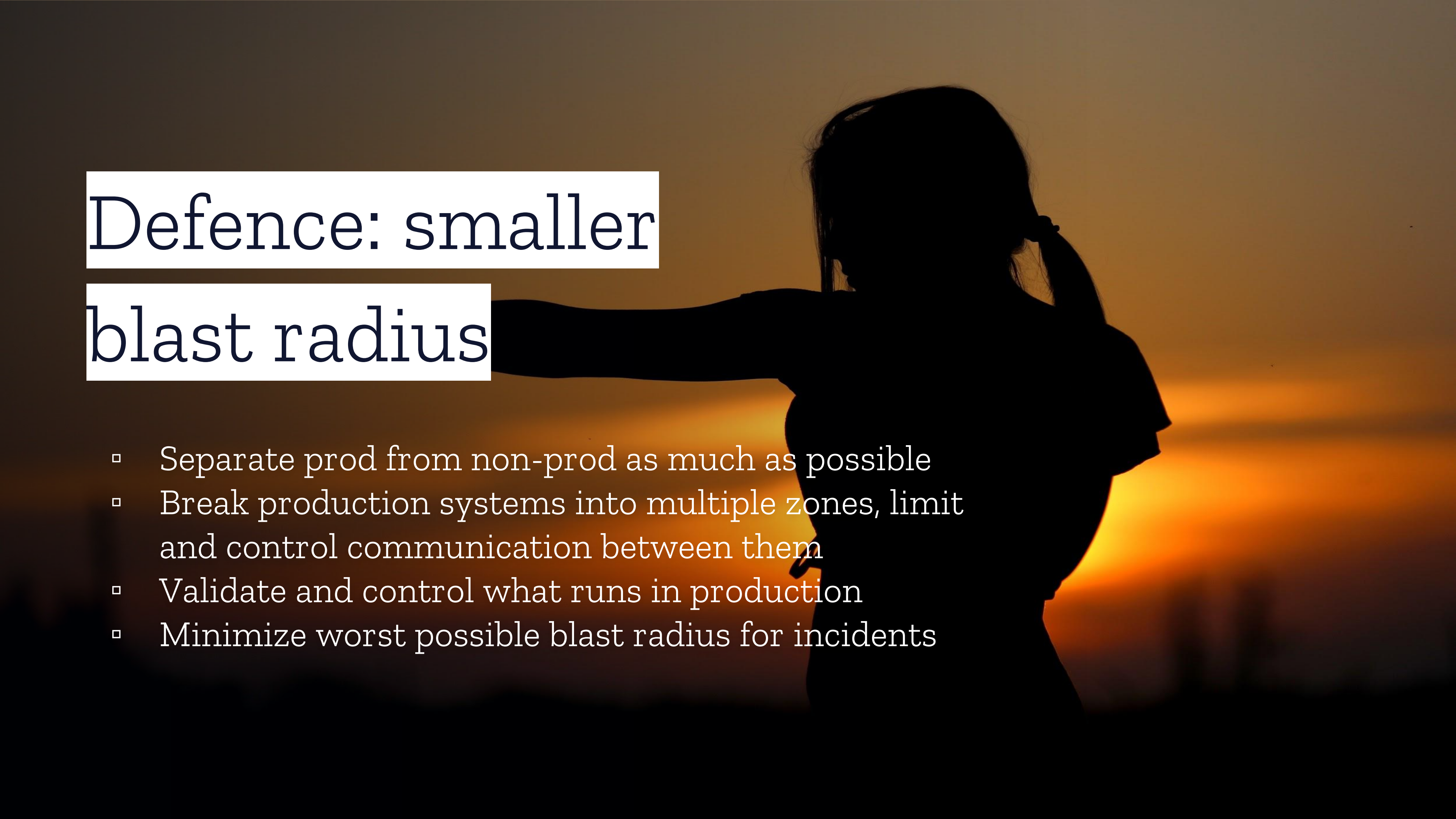
- Create a constraints service to limit automation operations
  - Example: limit how many operations per unit time
  - Example: set lower bounds for remaining resources
  - Example: don’t reduce capacity when a service has received alerts/isn’t in SLO
- Provide easy ways to disable automation - and use 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

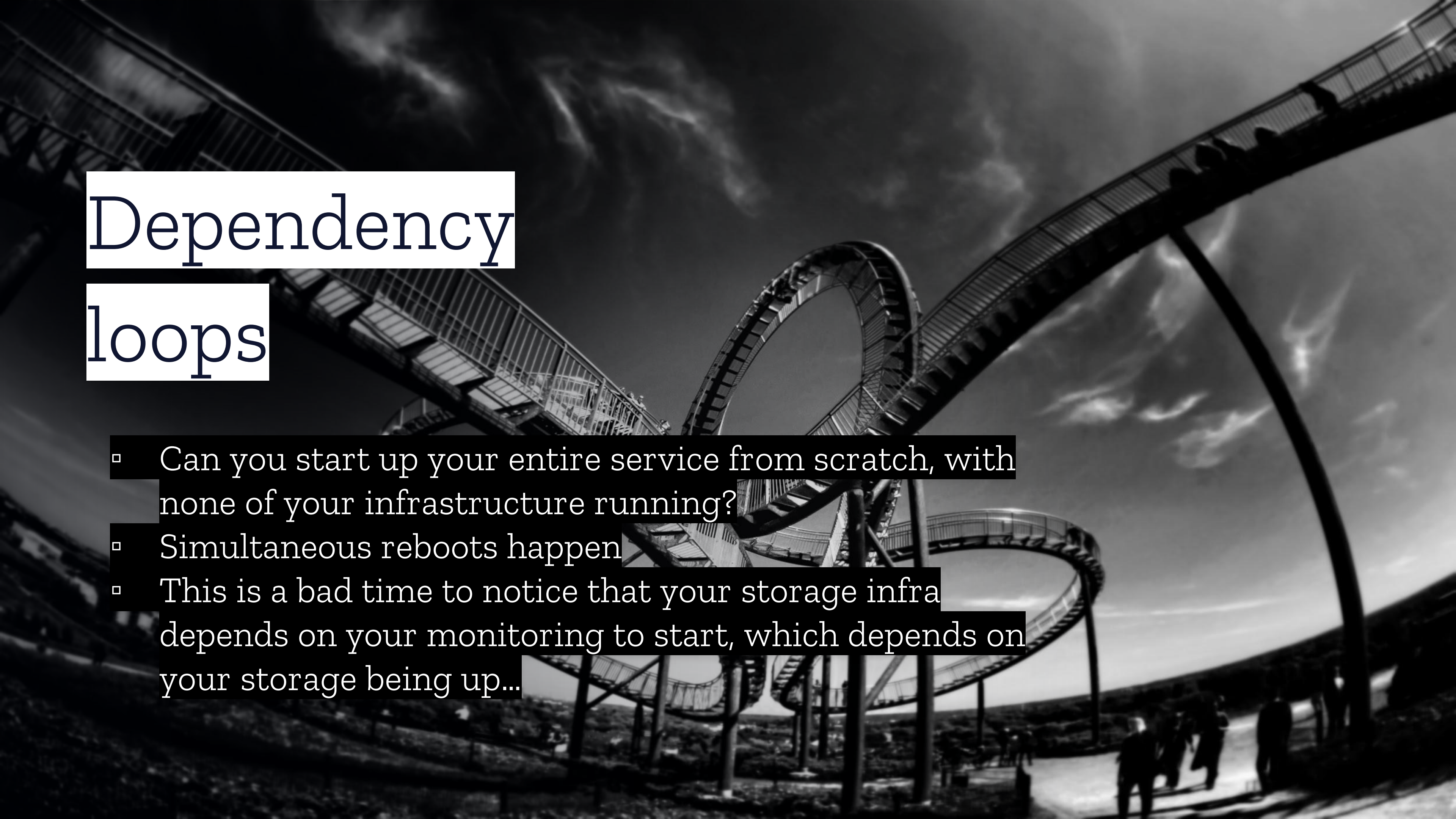
Link to incident report



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 problems



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

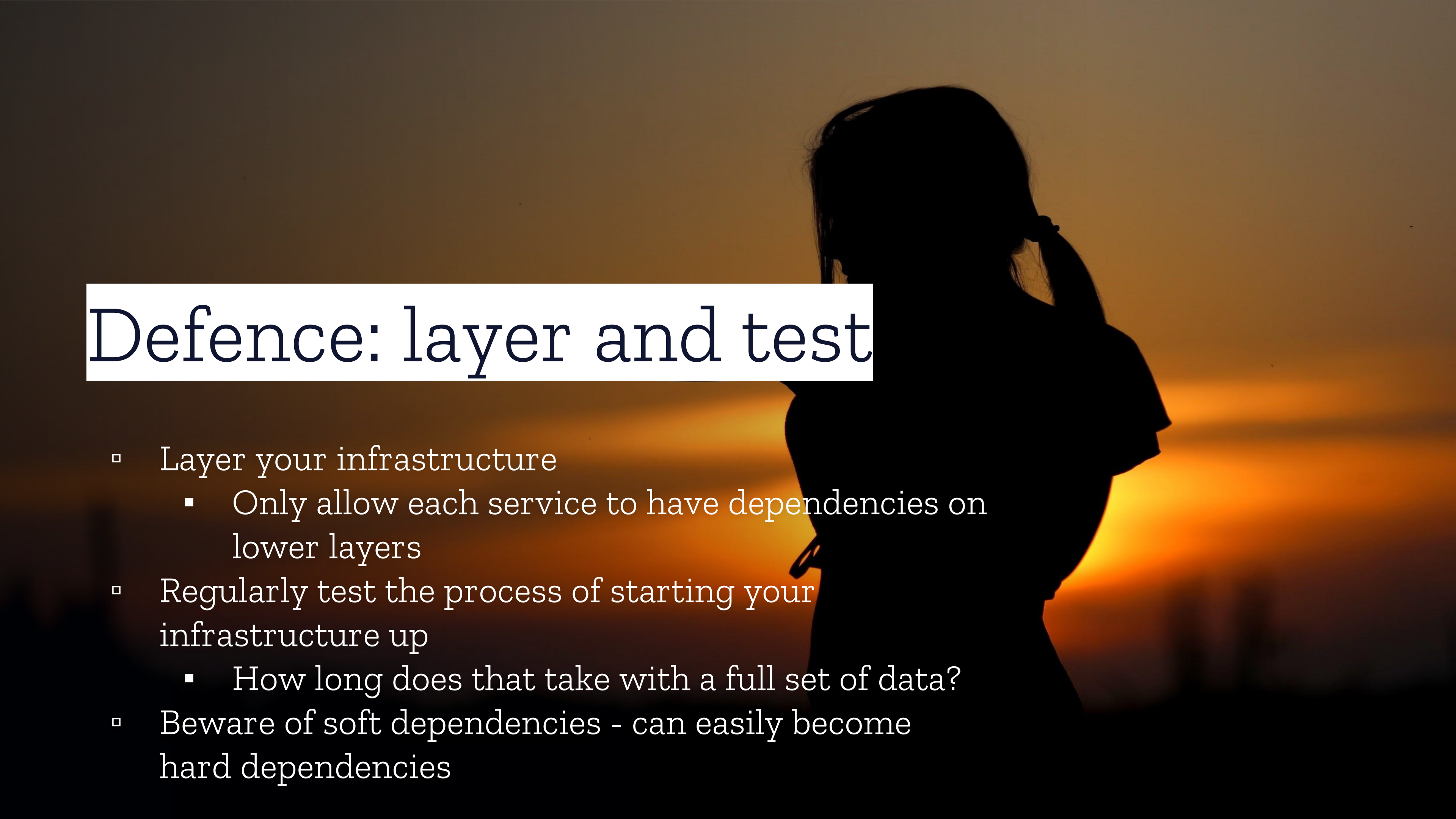
- 2 hour outage
- Power disruption led to 25% of their main DC rebooting
- Some machines didn’t come back
- Redis clusters unhealthy
- Main application backends wouldn’t start due to unintentional hard Redis dependency

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?
- 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

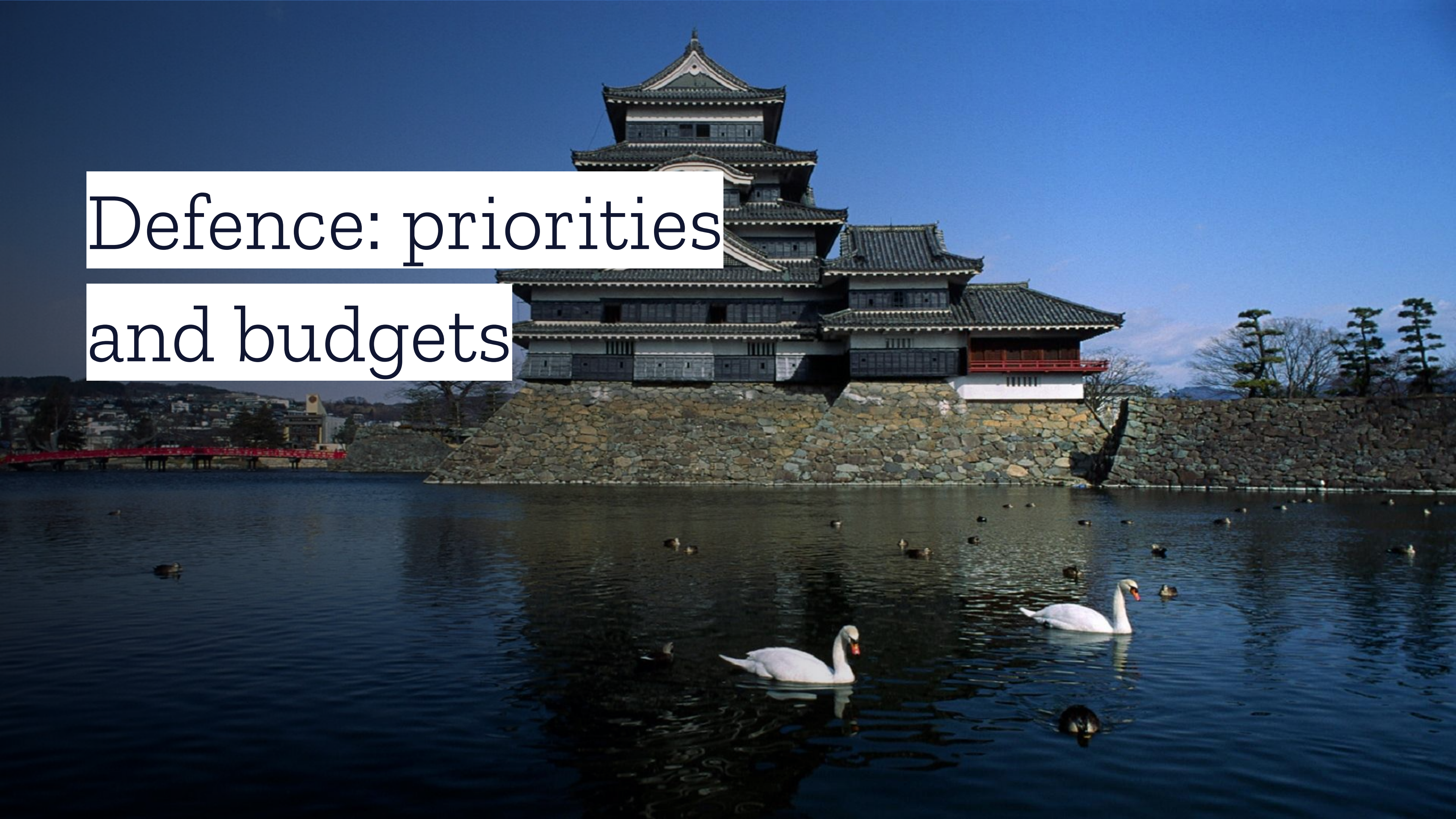
Defence: incident management process

- 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/

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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

Questions?

Or you can find me at @lauralifts

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