DevOps (2/2)

Martin Kellogg

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Today’s agenda:

- **The service reliability hierarchy + SLAs/targets**
- Monitoring
- Incident/emergency response
- Post-mortems + learning from failure

Achieving reliability

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- these two properties are related: an unavailable service **cannot** be correct
  - so, availability is the first thing we need to worry about when trying to make a service reliable

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Sometimes SLAs are written into contracts with your customers!

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E.g., consider two systems:

- system A serves 200 requests in every even-numbered second, and 0 requests in every odd-numbered second
- system B serves 100 requests every second

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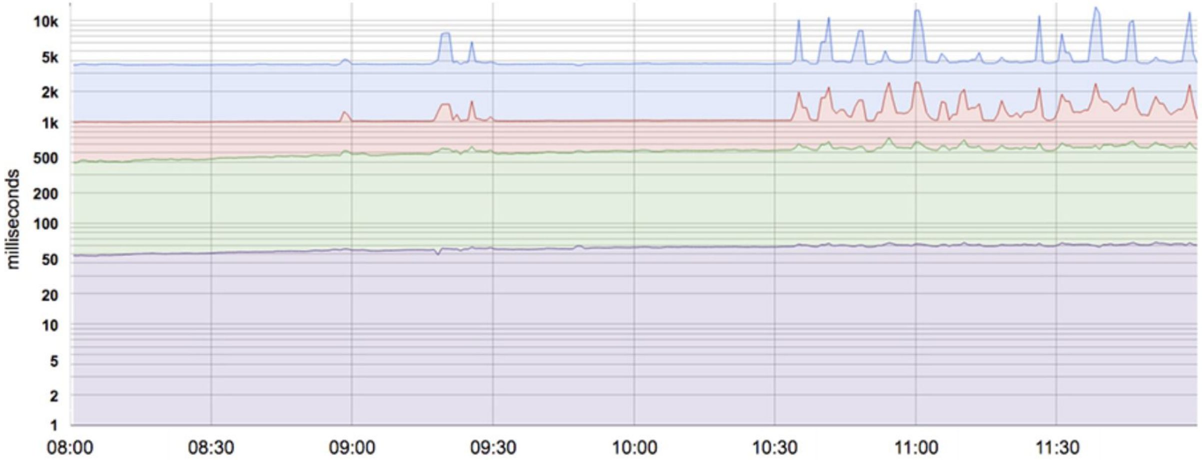

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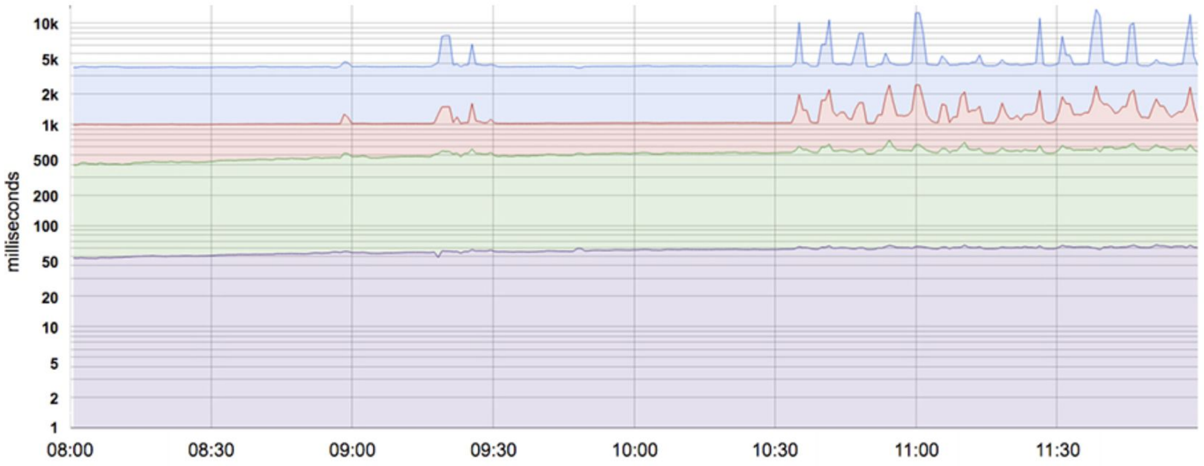

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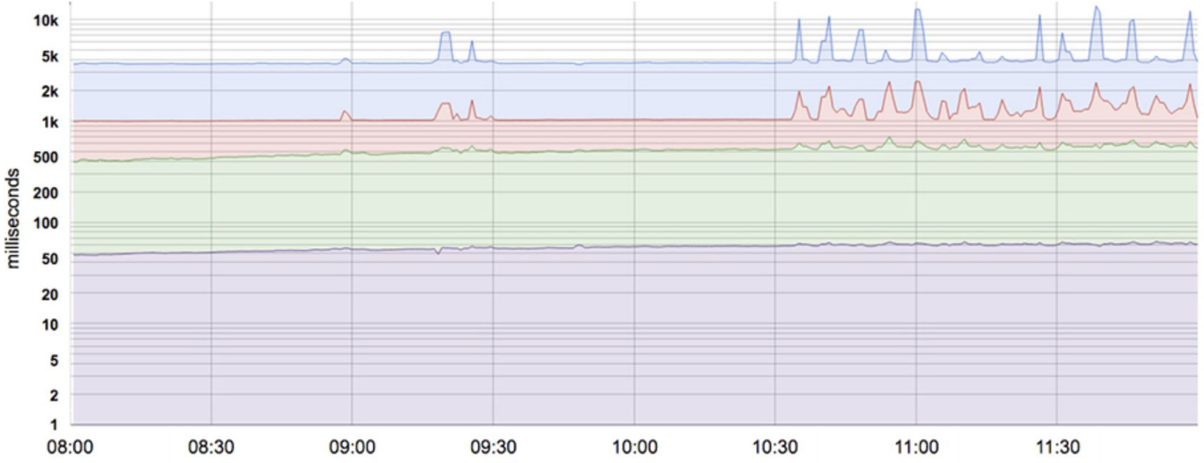

green is 85th % latency

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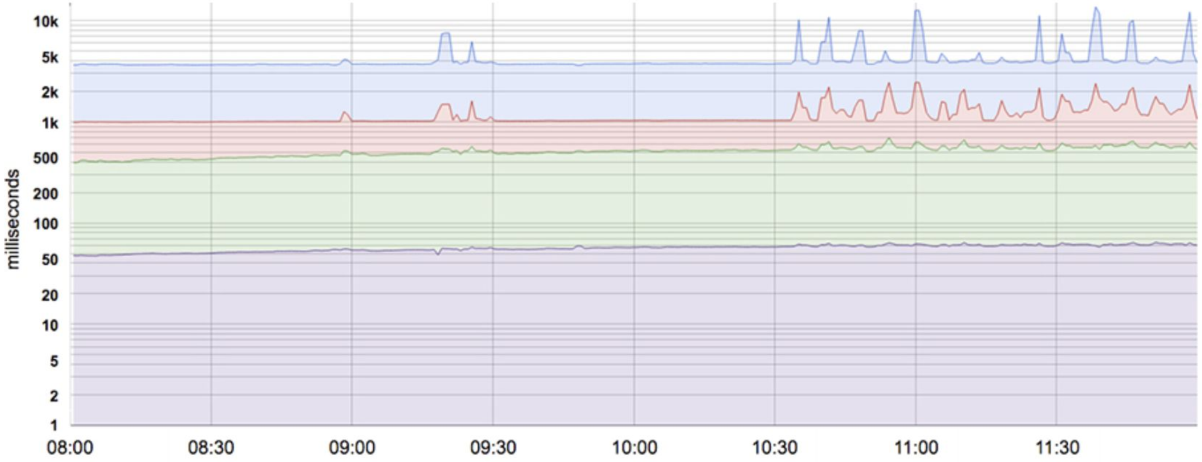

red is 95th % latency

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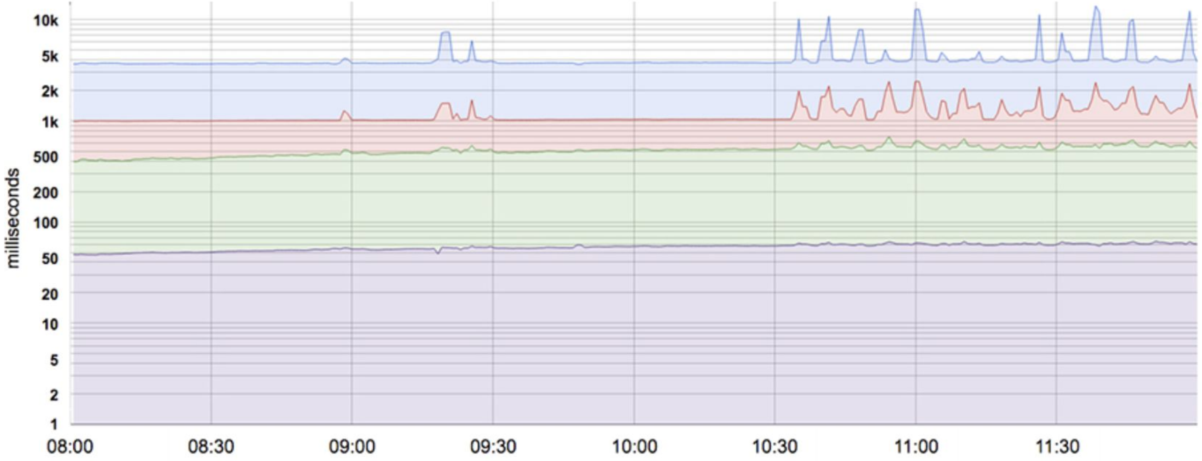

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- avoid **absolutes**
  - e.g., don’t promise “infinite scaling” or “100% availability”
- include as **few metrics** as possible while still covering what matters
  - avoid metrics that aren’t useful in arguing for priorities

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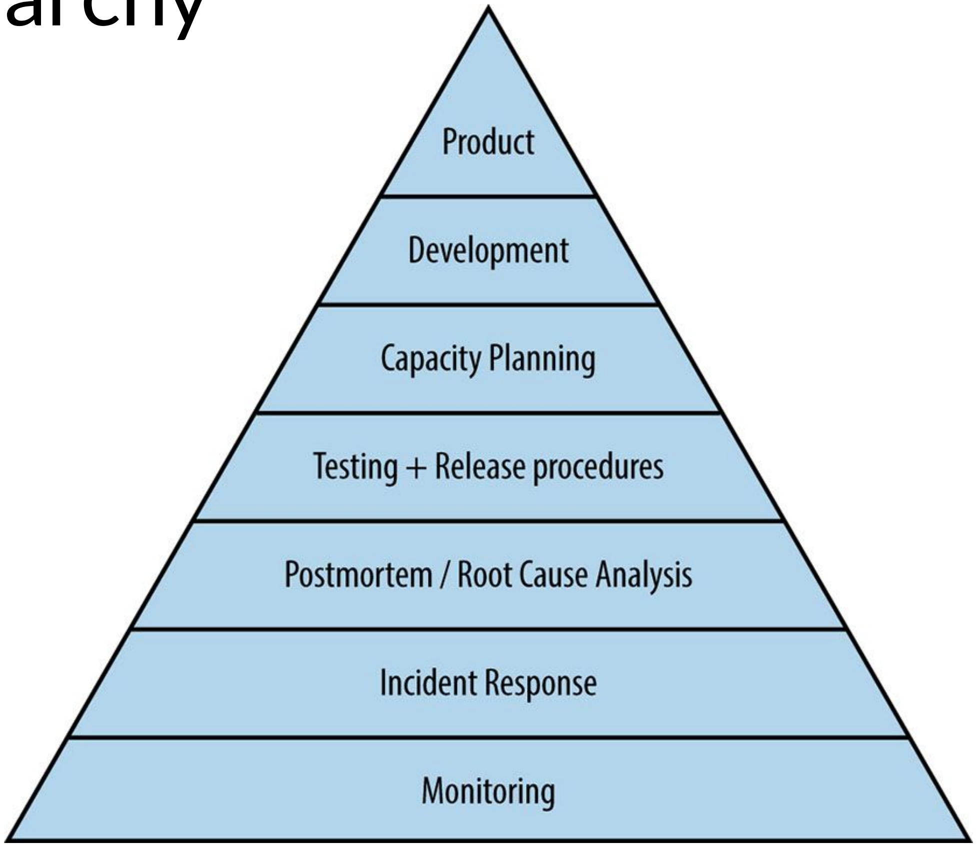
- How do we think about how to do this?
  - **insight**: there is a hierarchy of system components that need to be working well in order to meet an SLA

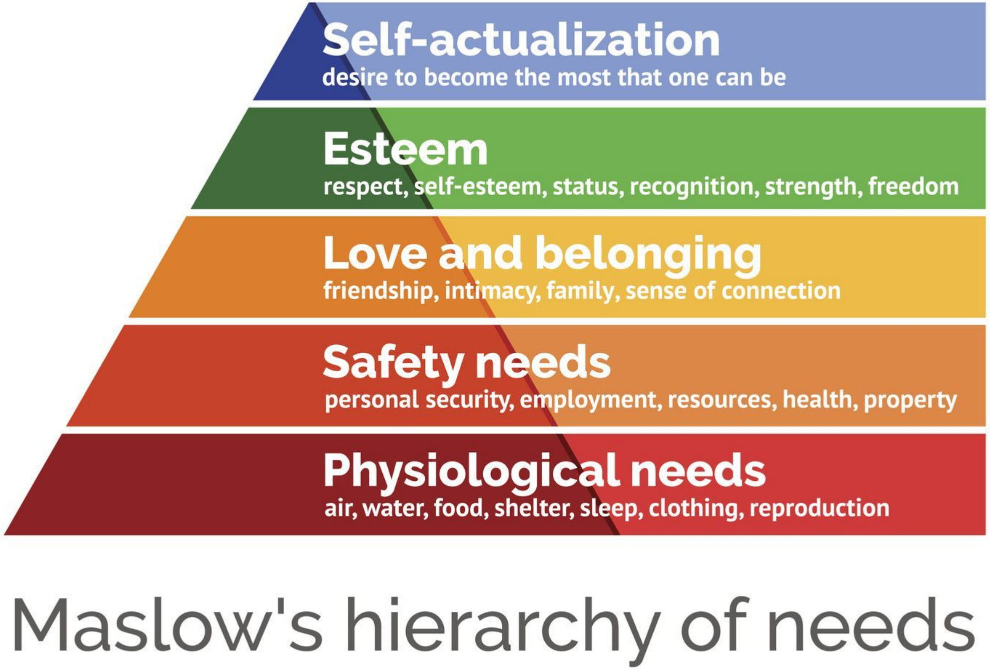
Service Reliability Hierarchy

- analogy to Maslow's "Hierarchy of Needs" for humans



[Image credit: https://sre.google/sre-book/part-III-practices/]

Maslow’s Hierarchy of Needs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desire to become the most that one can be
Esteem
respect, self-esteem, status, recognition, strength, freedom
Love and belonging
friendship, intimacy, family, sense of connection
Safety needs
personal security, employment, resources, health, property
Physiological needs
air, water, food, shelter, sleep, clothing, reproduction
Maslow's hierarchy of needs

[Image credit: https://www.thoughtco.com/maslows-hierarchy-of-needs-4582571]

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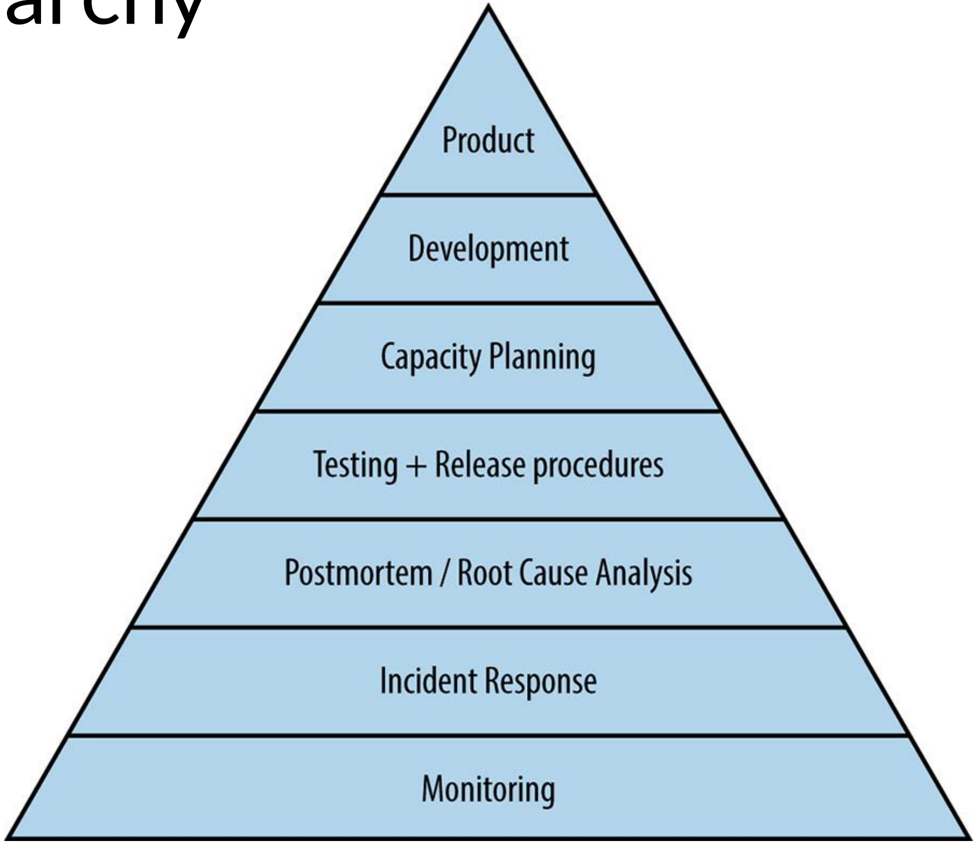

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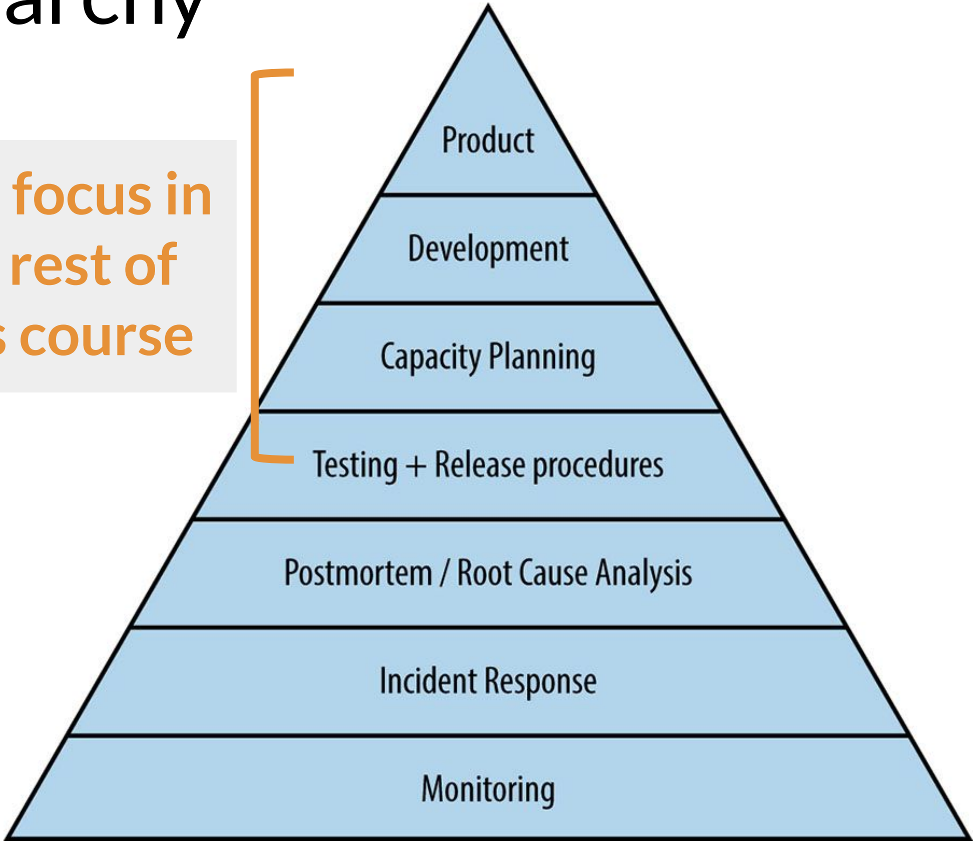

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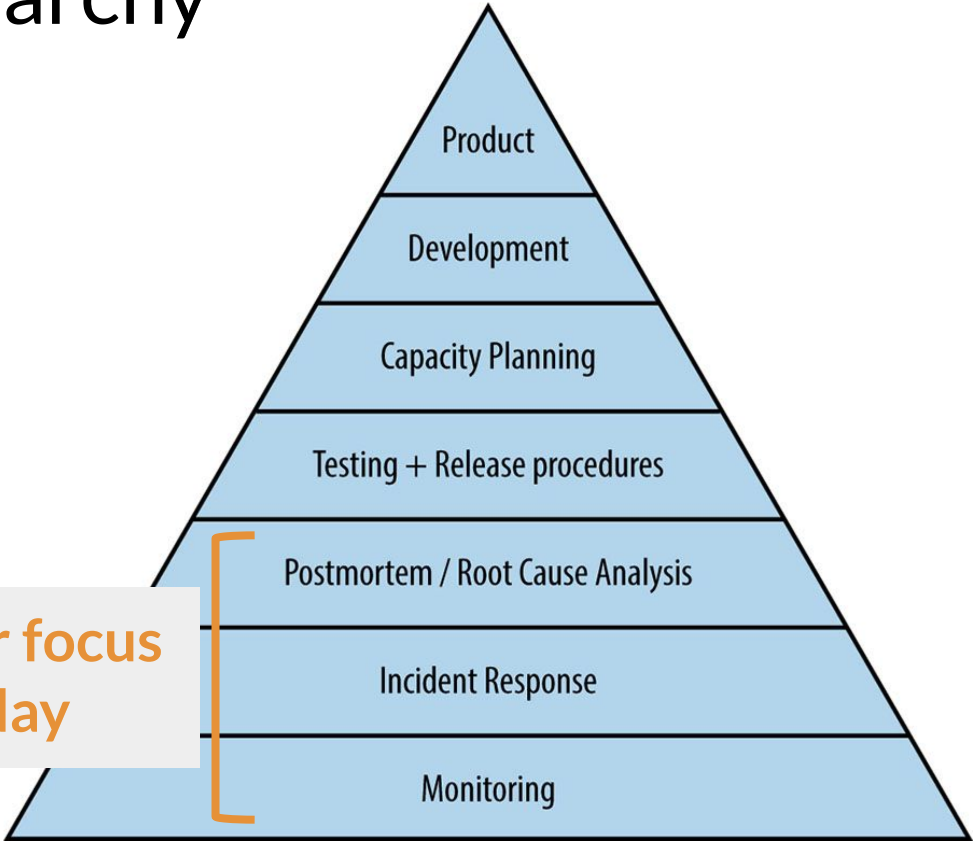

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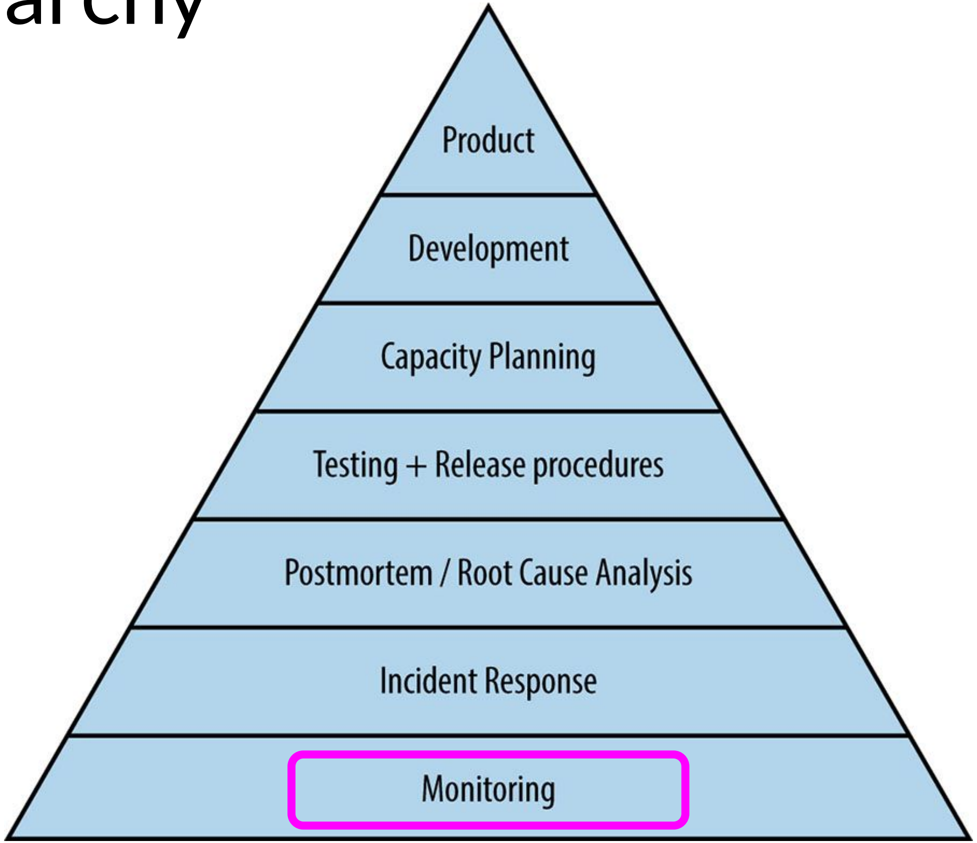

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DevOps (2/2)

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- **Monitoring**
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Monitoring is why logging is so important in practice: if your monitoring depends on your logging framework, it is a very important component of your service!

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- **page** = alert send directly to a human (via a pager)

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- Example from earlier: "cleaning up a service's alerting config" = fixing **what corresponds** to pages vs email alerts vs tickets

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  - but can (**and should**) page other team members in an emergency

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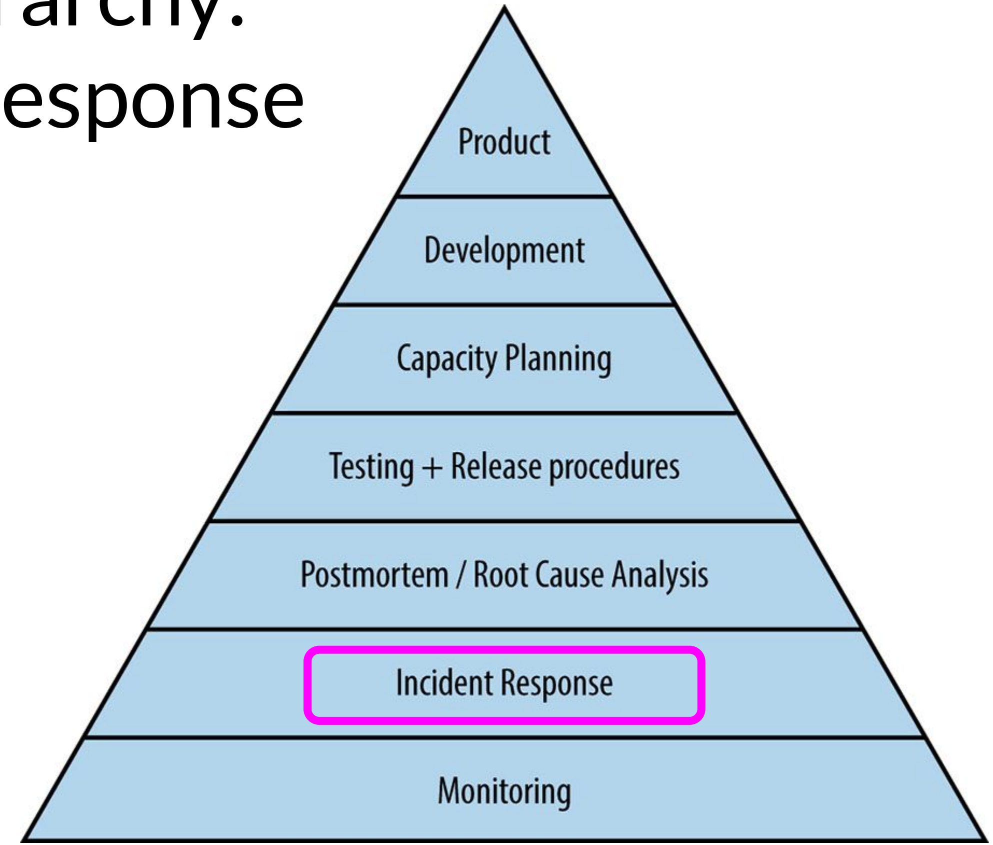
Service Reliability Hierarchy: Incident/Emergency Response



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- What constitutes an emergency?
  - depends on your service, but typically these qualify:
    - big % of user requests aren't getting responses
    - big % of user requests have really high latency
    - lots of your servers are unavailable/down (even if users aren't yet impacted)

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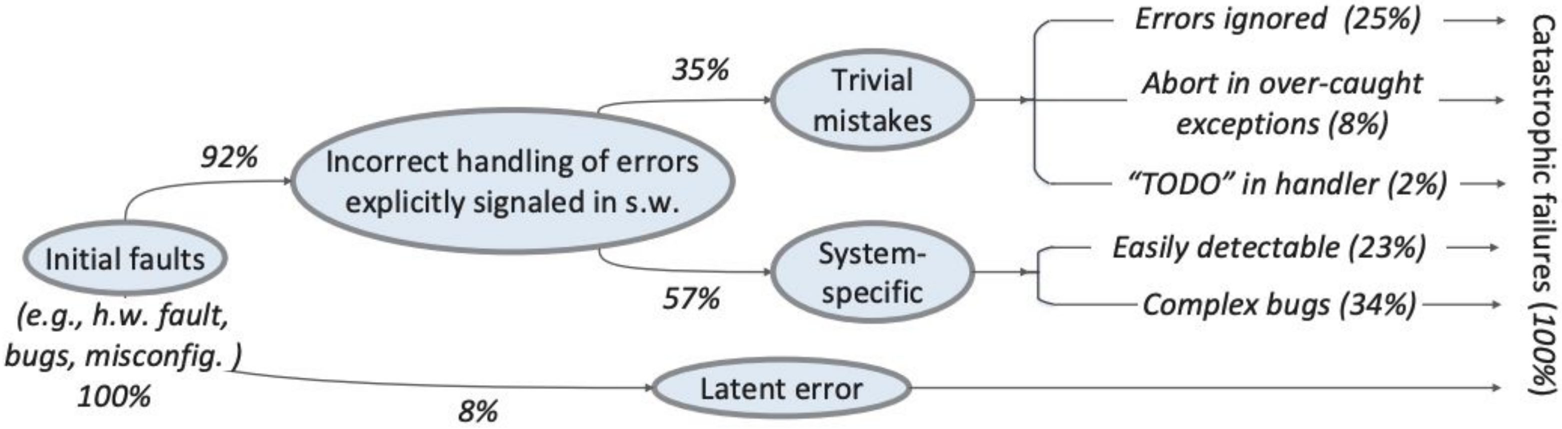
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92%
Incorrect handling of errors explicitly signaled in s.w.
35%
Trivial mistakes
57%
System-specific
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Latent error
Errors ignored (25%)
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"TODO" in handler (2%)
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Complex bugs (34%)
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[*Simple Testing Can Prevent Most Critical Failures: An Analysis of Production Failures in Distributed Data-Intensive Systems*. Yuan et al. OSDI 2014.]

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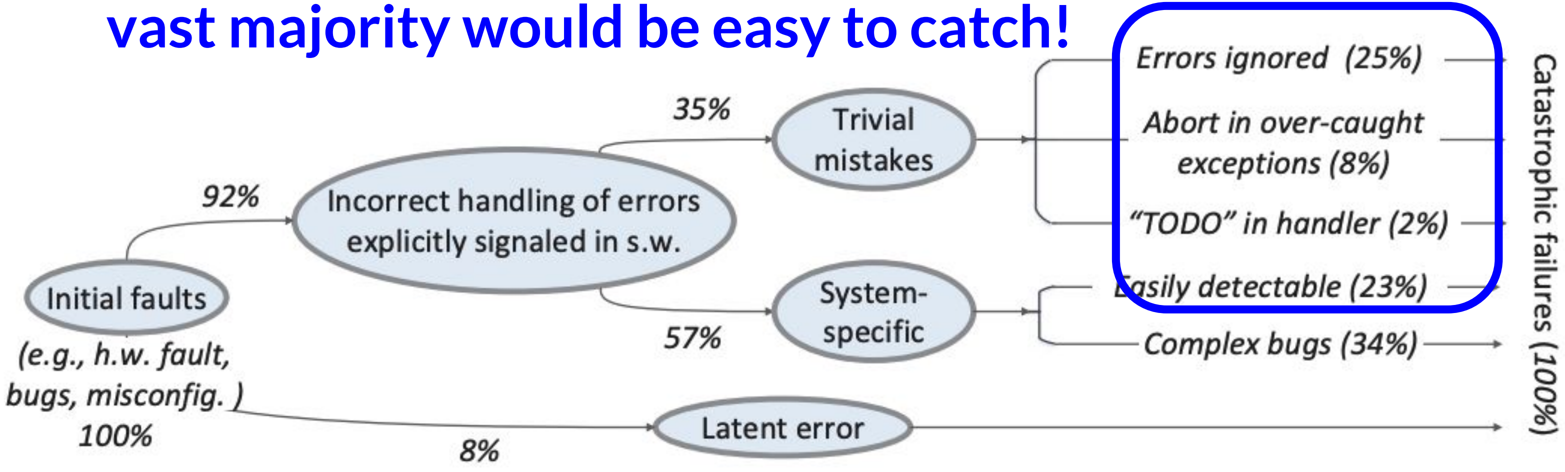
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    - changes to the infrastructure (e.g., adding or removing servers) are just as risky as changes to the code
        - but testing them is harder!

Emergency Response: causes of emergencies

- **hardware**:
    - pop quiz: how long does an average hard disk last?

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Implication: in large systems, you **must plan for hardware failures**, because they **will occur**

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        - of course you have! we all make mistakes sometimes!
    - it is a mistake for a human to repeatedly perform a task that could lead to catastrophic failure if it is not done perfectly
        - computers are good at this!
        - analogy: just like hardware components sometimes fail, any step carried out by humans should be assumed to have a non-zero failure rate

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    - playbooks also have a psychological function: **prevent panic**

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    - **preserve evidence**: save logs, etc., for post-mortem analysis
- **Practice** makes perfect
    - don't wait for an actual emergency to find out if your playbook works: simulate one instead!

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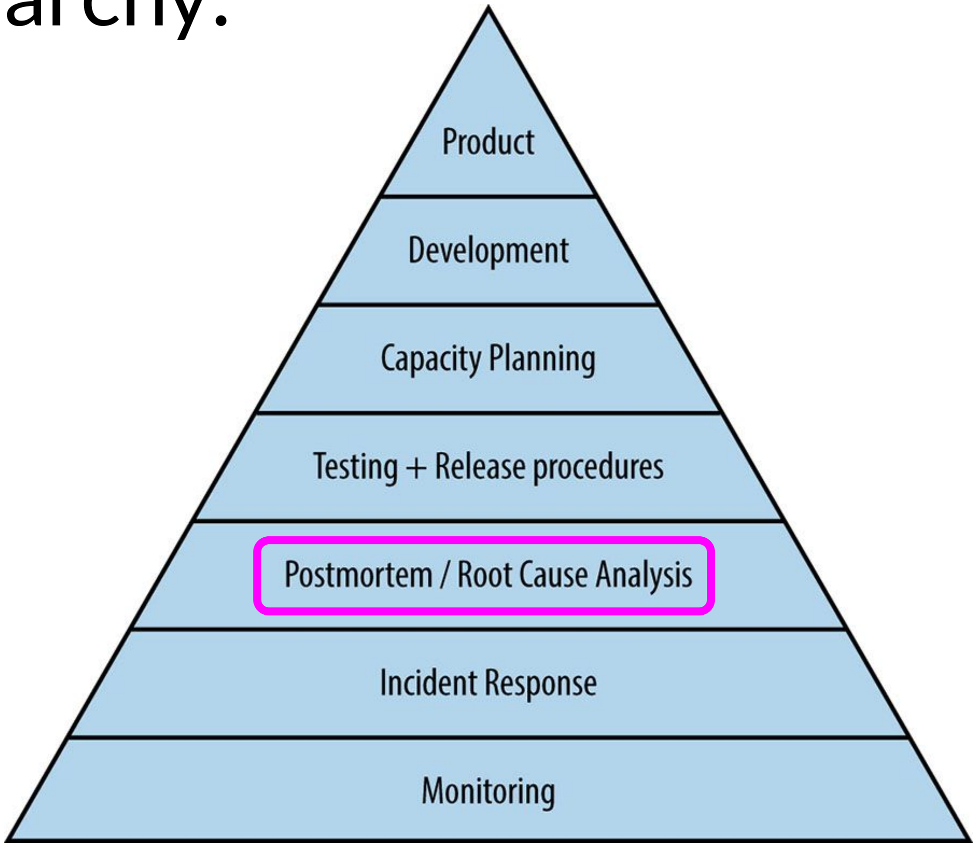
Easy rollbacks are one motivation for "**infrastructure-as-code**": if your infrastructure configuration is in version control, it's easy to go back to the last working one!

DevOps (2/2)

Today’s agenda:

- The service reliability hierarchy + SLAs/targets
- Monitoring
- Incident/emergency response
- **Post-mortems + learning from failure**

Service Reliability Hierarchy: Post-mortems



[Image credit: https://sre.google/sre-book/part-III-practices/]

Post-mortems

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  - "**blameless**" = find the faults in the process, not the people
  - "**actionable**" = give specific guidance for how to avoid the problem in the future (these become tickets)

Post-mortems: blameless

- Why not assign blame after an incident?
  - After all, **someone** should be responsible, right?

Post-mortems: blameless

- Why not assign blame after an incident?
    - After all, **someone** should be responsible, right?
- Some reasons:
    - Gives people **confidence to escalate** issues without fear
    - Avoids creating a culture in which incidents and issues are **swept under the rug** (which is worse long-term!)
    - **Learning experience**: engineers who have experienced an incident won’t make the same mistakes again
    - You can’t "fix" people, but you can fix **systems and processes**

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Historically, software engineering adopted a lot of “blameless culture” from **aviation and medicine**, where mistakes can be fatal! We might not have the same stakes, but **all complex systems are similar** in a lot of ways.

Post-mortems: peer review

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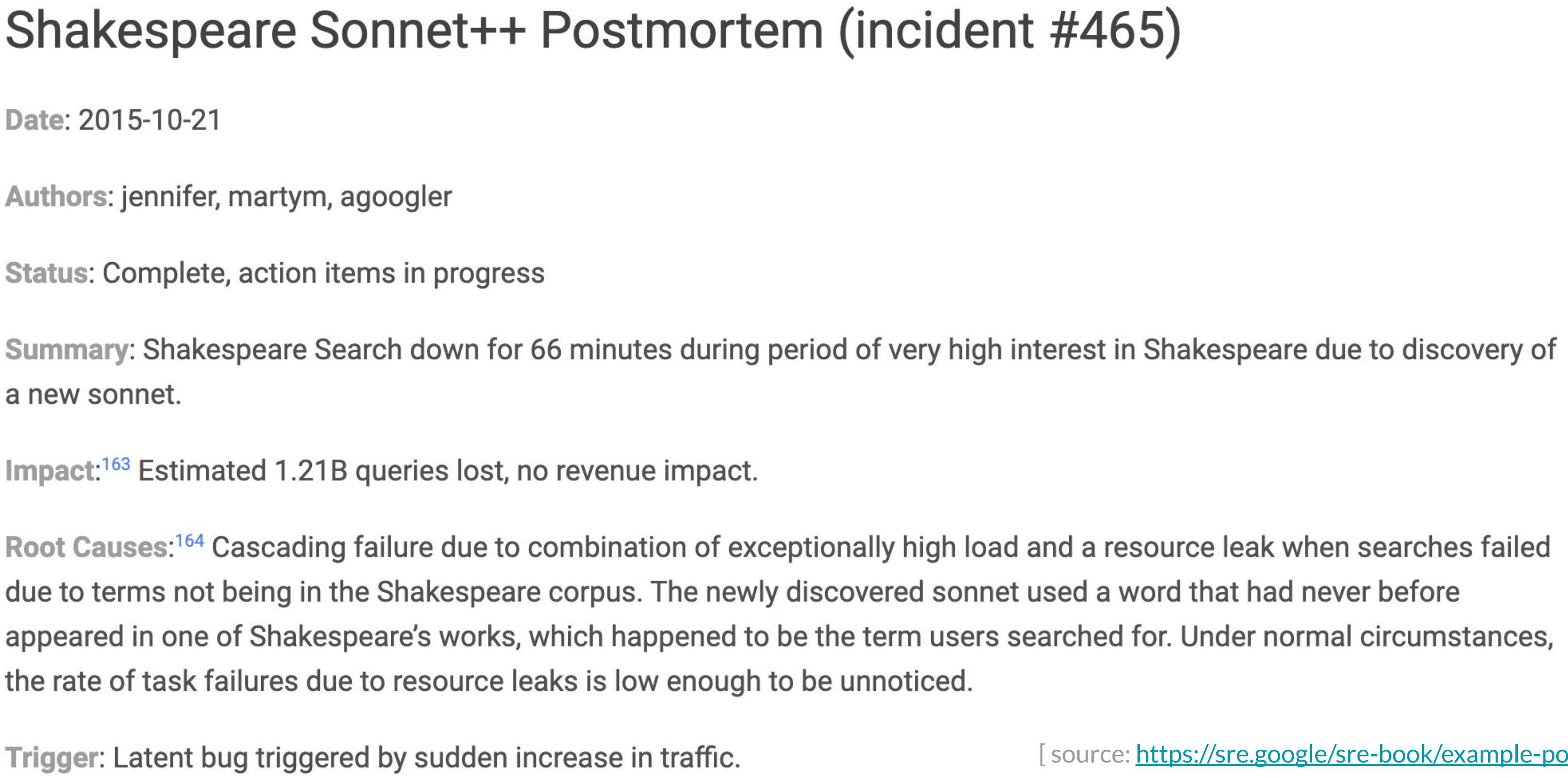
  - leads to more actionable takeaways and better understanding of what went wrong
  - also enables engineers on different teams to learn from each others’ mistakes

Post-mortems: example



Shakespeare Sonnet++ Postmortem (incident #465)

Date: 2015-10-21

Authors: jennifer, martym, agoogler

Status: Complete, action items in progress

Summary: Shakespeare Search down for 66 minutes during period of very high interest in Shakespeare due to discovery of a new sonnet.

Impact:[163] Estimated 1.21B queries lost, no revenue impact.

Root Causes:[164] Cascading failure due to combination of exceptionally high load and a resource leak when searches failed due to terms not being in the Shakespeare corpus. The newly discovered sonnet used a word that had never before appeared in one of Shakespeare's works, which happened to be the term users searched for. Under normal circumstances, the rate of task failures due to resource leaks is low enough to be unnoticed.

Trigger: Latent bug triggered by sudden increase in traffic.

[source: https://sre.google/sre-book/example-postmortem/]

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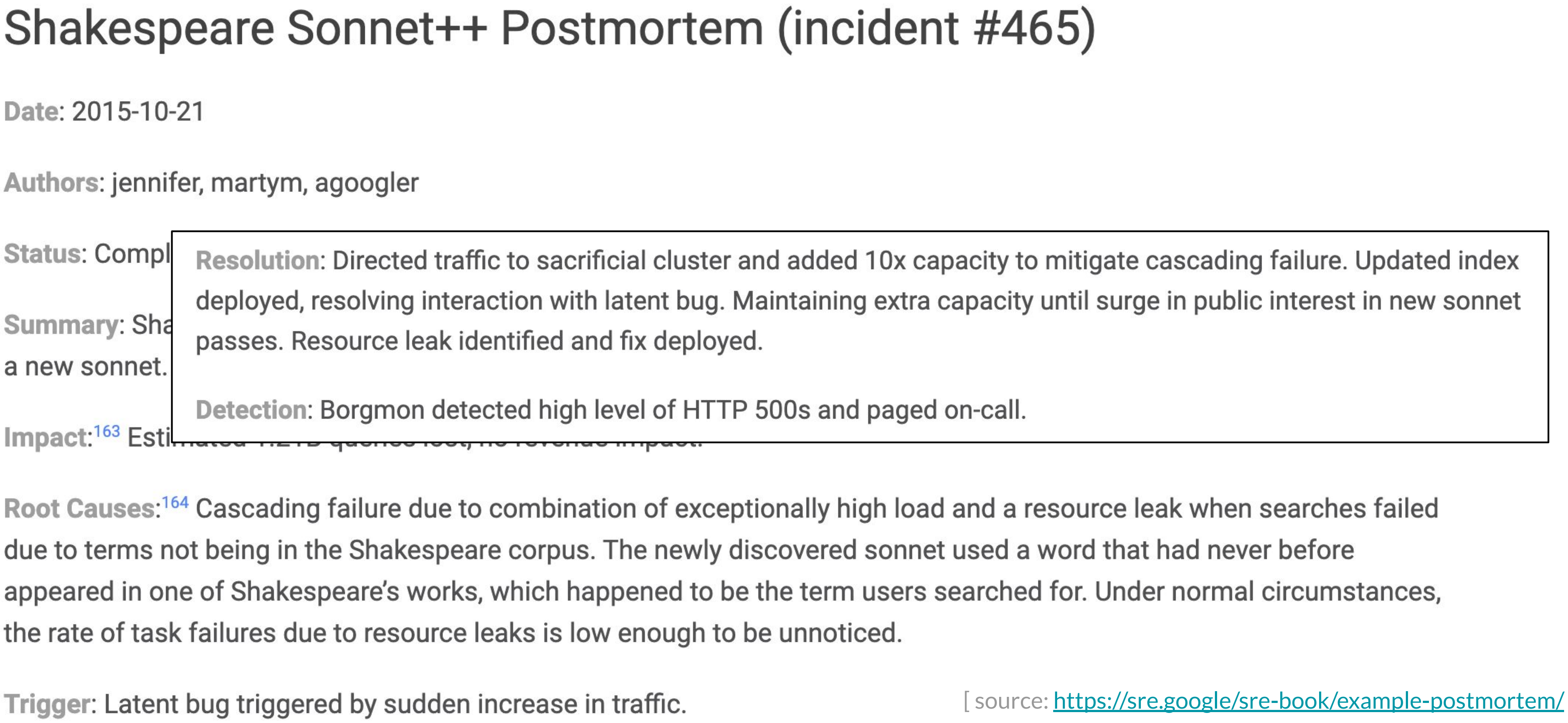

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Resolution: Directed traffic to sacrificial cluster and added 10x capacity to mitigate cascading failure. Updated index deployed, resolving interaction with latent bug. Maintaining extra capacity until surge in public interest in new sonnet passes. Resource leak identified and fix deployed.

Detection: Borgmon detected high level of HTTP 500s and paged on-call.

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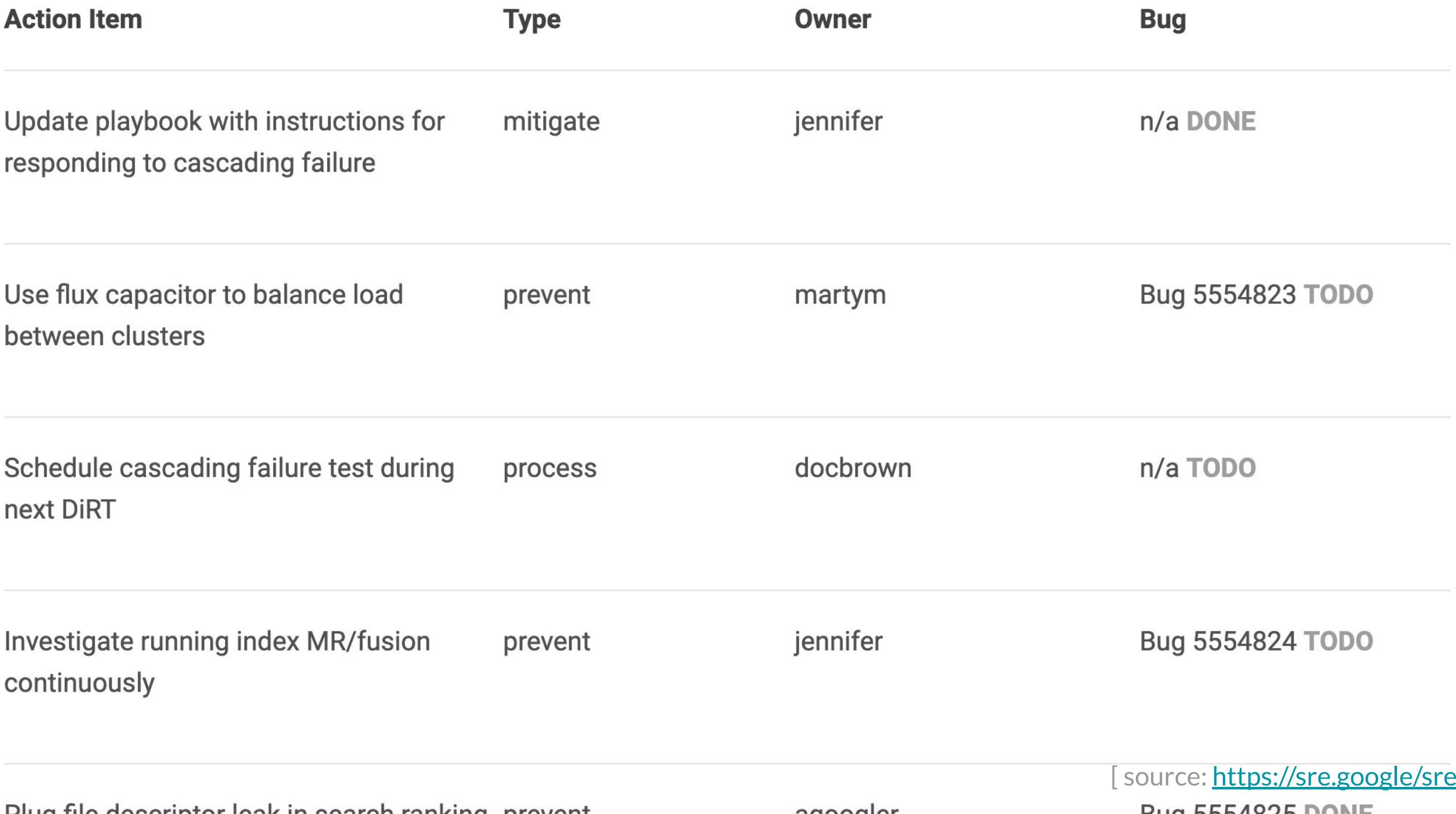

Action Item	Type	Owner	Bug
Update playbook with instructions for responding to cascading failure	mitigate	jennifer	n/a **DONE**
Use flux capacitor to balance load between clusters	prevent	martym	Bug 5554823 **TODO**
Schedule cascading failure test during next DiRT	process	docbrown	n/a **TODO**
Investigate running index MR/fusion continuously	prevent	jennifer	Bug 5554824 **TODO**
Plug file descriptor leak in search ranking	prevent	agoogler	Bug 5554825 **DONE**

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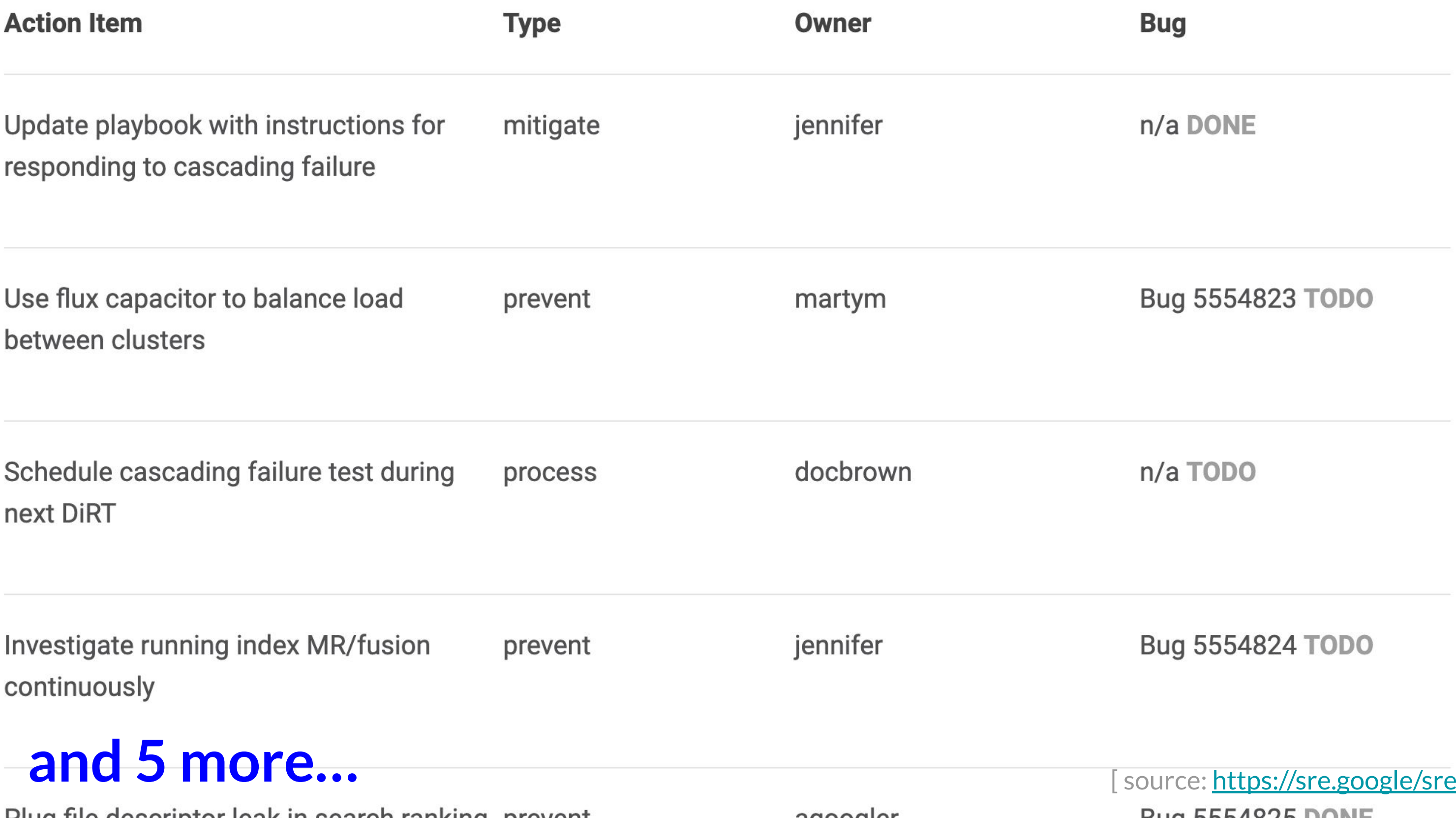

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and 5 more...

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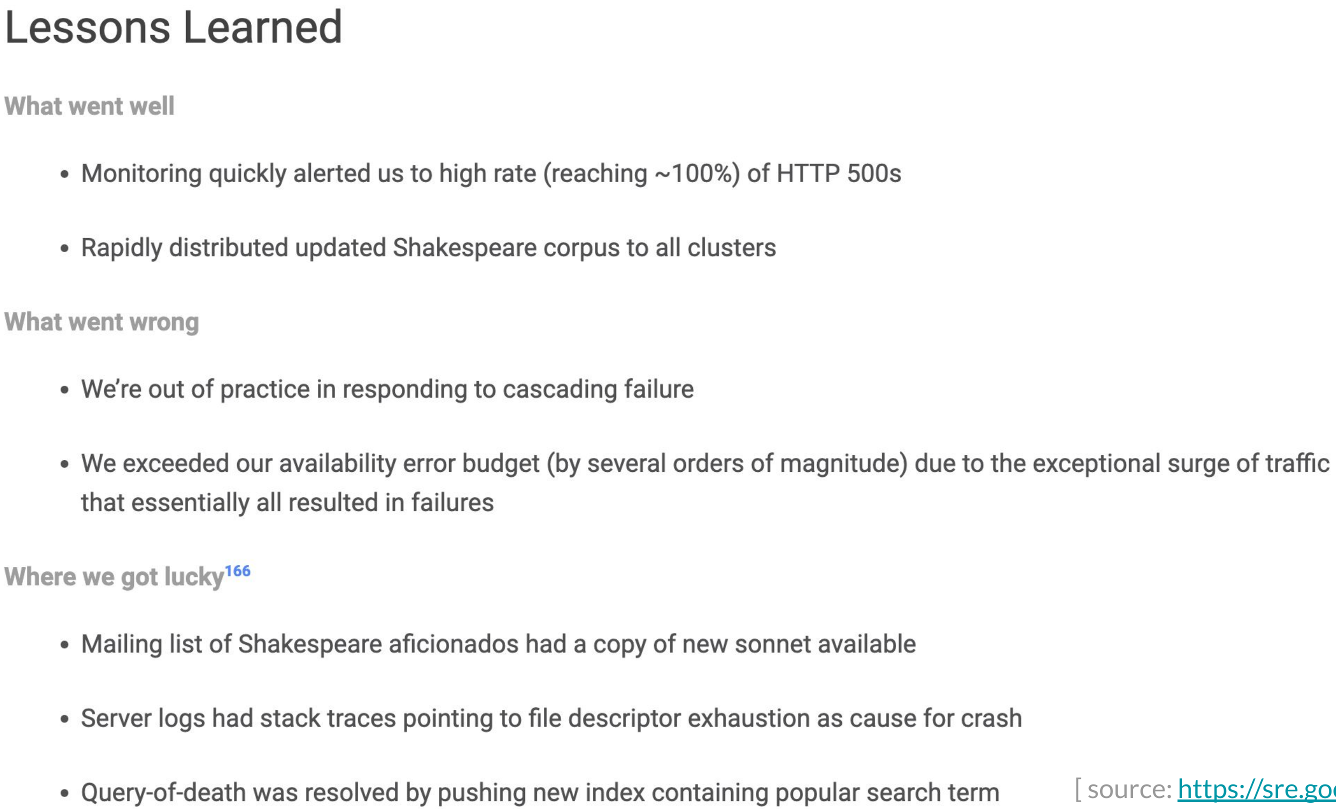

Lessons Learned

What went well

- Monitoring quickly alerted us to high rate (reaching ~100%) of HTTP 500s
- Rapidly distributed updated Shakespeare corpus to all clusters

What went wrong

- We're out of practice in responding to cascading failure
- We exceeded our availability error budget (by several orders of magnitude) due to the exceptional surge of traffic that essentially all resulted in failures

Where we got lucky[166]

- Mailing list of Shakespeare aficionados had a copy of new sonnet available
- Server logs had stack traces pointing to file descriptor exhaustion as cause for crash
- Query-of-death was resolved by pushing new index containing popular search term

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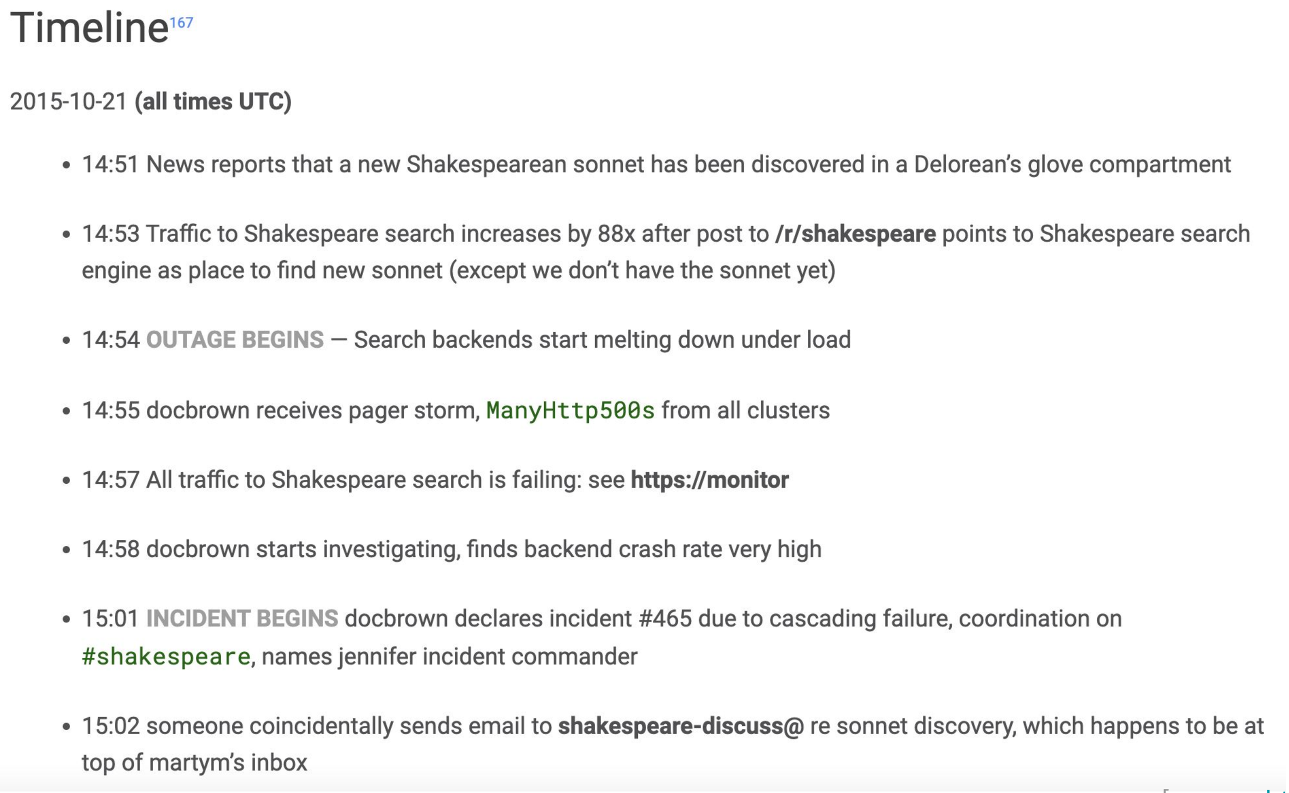

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- 14:54 **OUTAGE BEGINS** — Search backends start melting down under load

- 14:55 docbrown receives pager storm, `ManyHttp500s` from all clusters

- 14:57 All traffic to Shakespeare search is failing: see **https://monitor**

- 14:58 docbrown starts investigating, finds backend crash rate very high

- 15:01 **INCIDENT BEGINS** docbrown declares incident #465 due to cascading failure, coordination on `#shakespeare`, names jennifer incident commander

- 15:02 someone coincidentally sends email to **shakespeare-discuss@** re sonnet discovery, which happens to be at top of martym’s inbox

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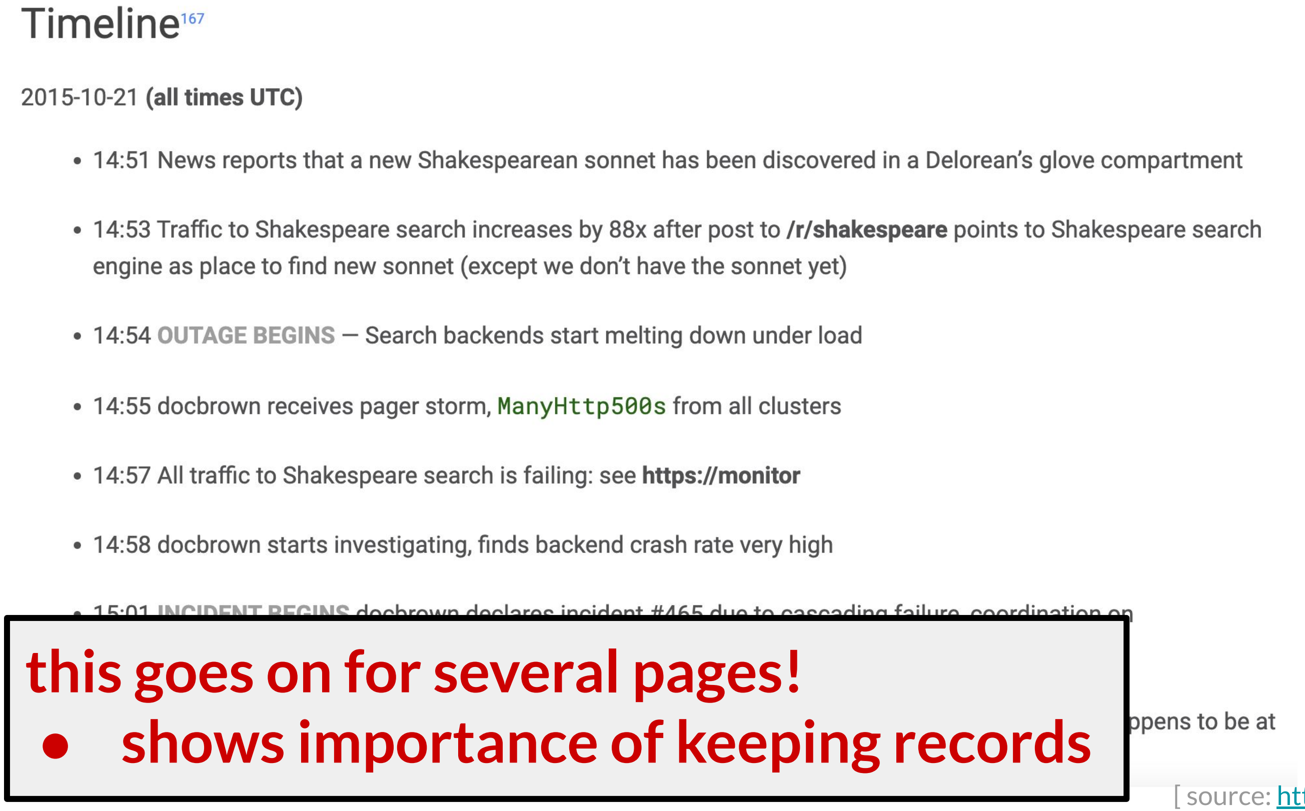

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this goes on for several pages!

- **shows importance of keeping records**

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DevOps: takeaways

- Many modern engineering organizations prefer to combine, rather than separate, development and operations
  - this works best when most systems are services
- Major benefit of DevOps approach is elimination of toil
  - developers are best at building automation
- Planning for incidents/emergencies is critical
  - Monitoring allows on-call to quickly identify problems
  - Have a plan (ideally, in a playbook) for incidents
  - Use post-mortems to learn from prior emergencies
    - not to blame people for causing them!

Reading Quiz: DevOps (2)

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Q2: Suppose you’re about to make a risky configuration change to a system. Dan Luu (author of the second article we read) would recommend that you (write all that apply):

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