DevOps (part 2)

Martin Kellogg

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- **A.** having multiple people watch or confirm the operation
- **B.** having ops people standing by in case of disaster
- **C.** having a human perform manual error checking
- **D.** none of these

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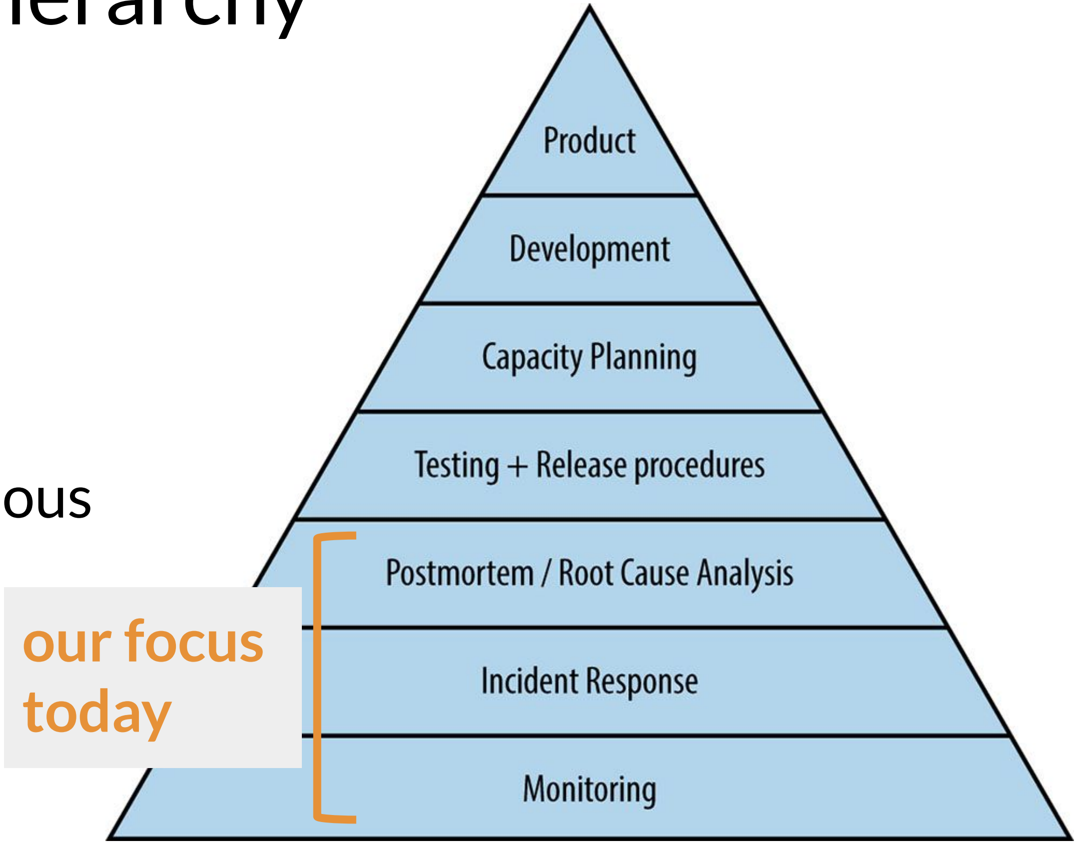
GITC 1100 (this room!)

Service Reliability Hierarchy

- analogy to Maslow's "Hierarchy of Needs" for humans
- just like in Maslow's hierarchy, if there is a serious deficiency in a lower level achieving the higher level becomes a lot harder



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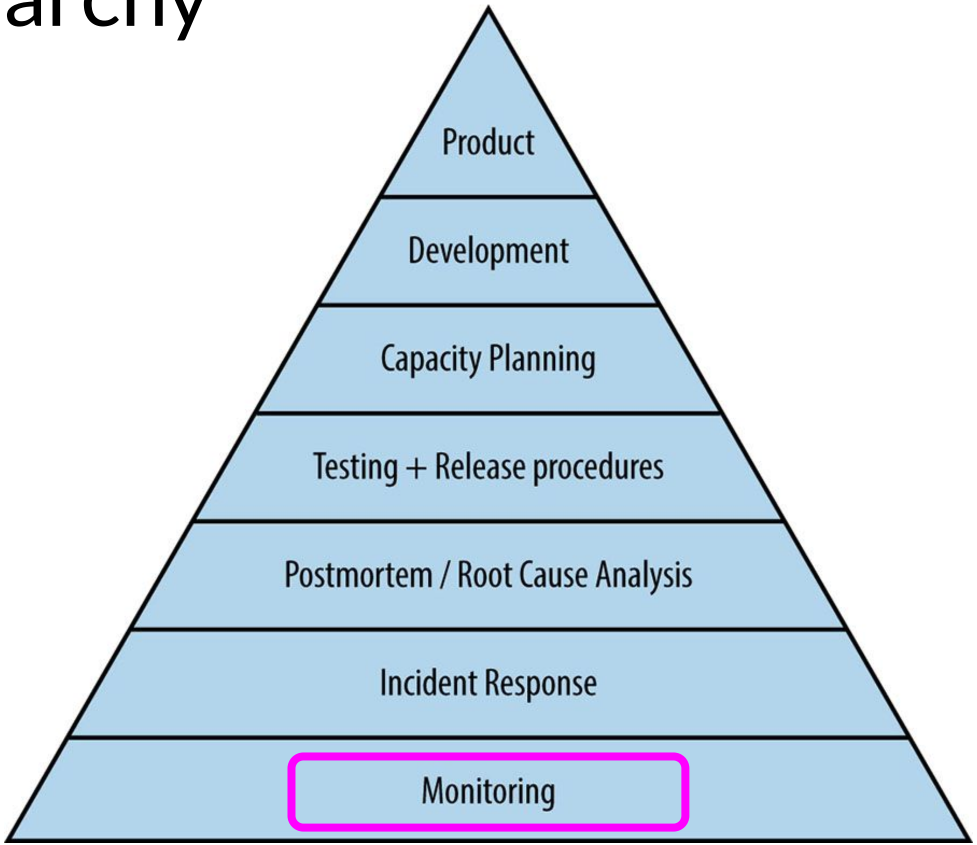

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Monitoring is why **logging** is so important in practice: if your monitoring depends on your logging framework, it is a very important component of your service!

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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

DevOps

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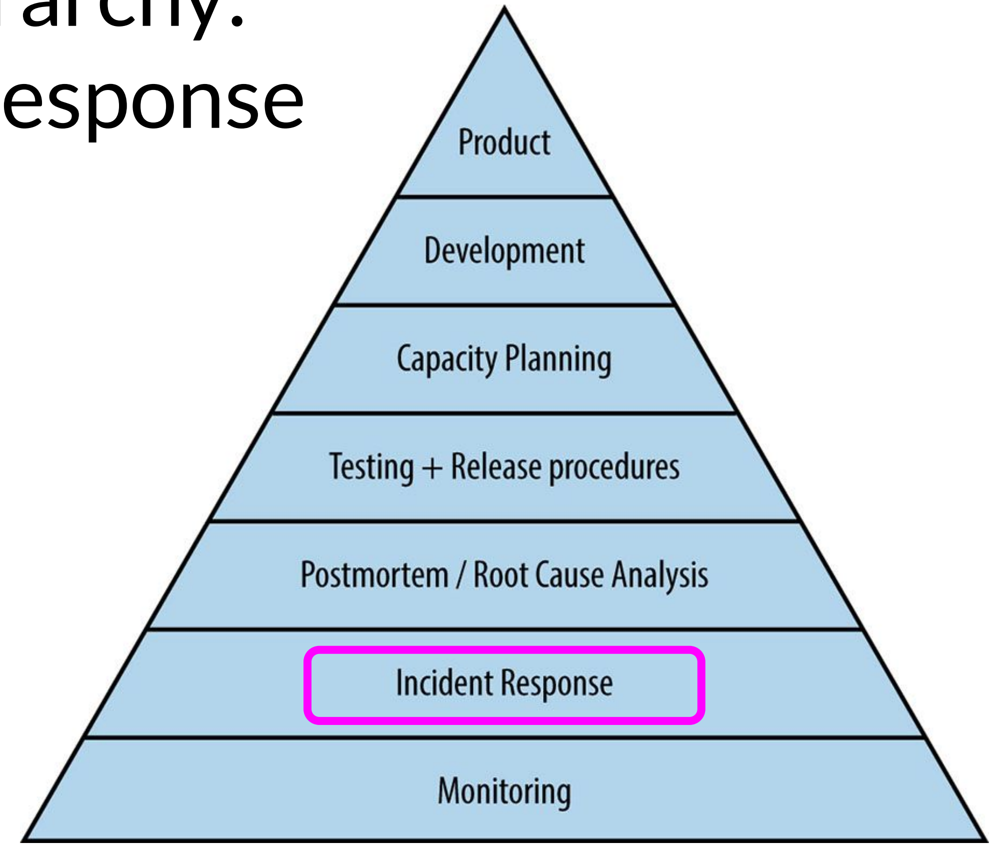
- Operations, Toil, and the DevOps philosophy
- Achieving reliability
    - the service reliability hierarchy + SLAs/targets
    - monitoring and reliability testing
    - **incident/emergency response**
    - preventing problems before they occur
    - post-mortems + learning from failure

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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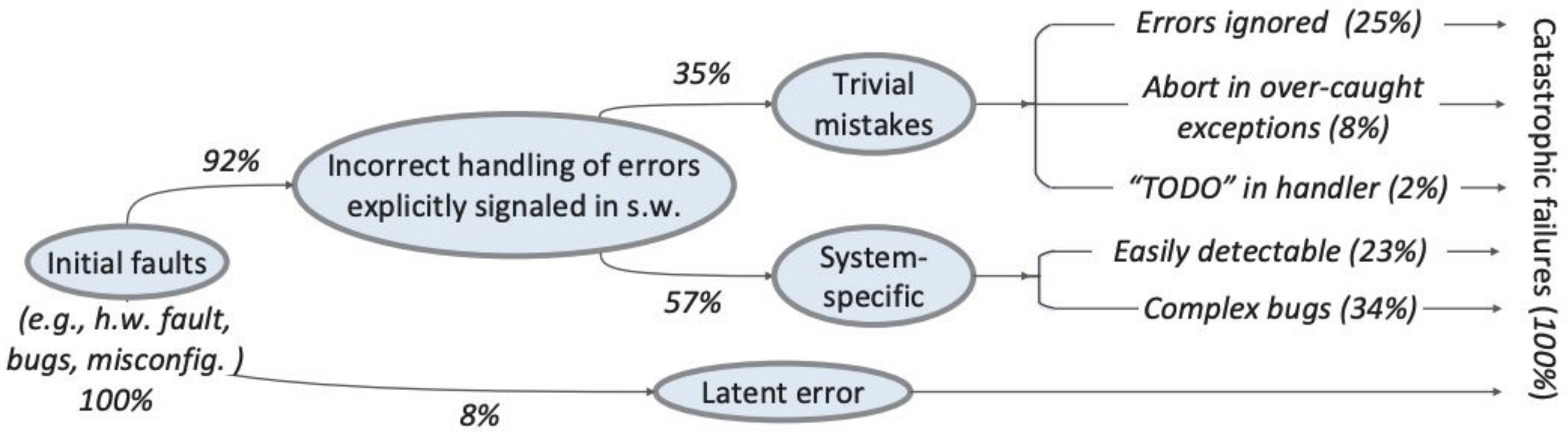

[*Simple Testing Can Prevent Most Critical Failures: An Analysis of Production Failures in Distributed Data-Intensive Systems*. Yuan et al. OSDI 2014.]

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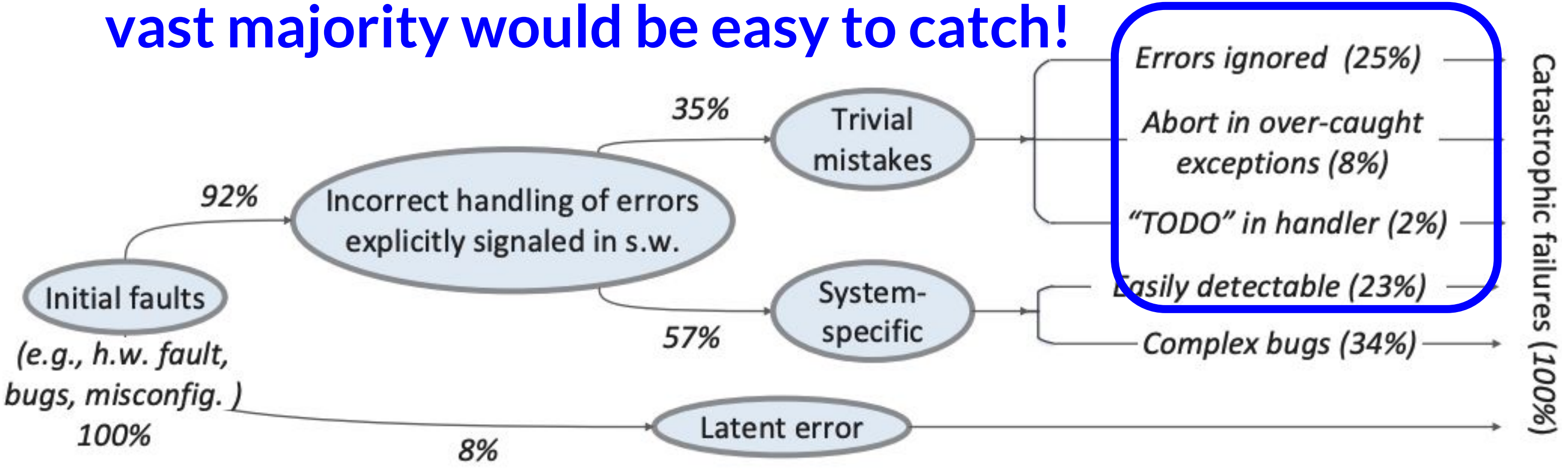
vast majority would be easy to catch!



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  - especially for services, how the servers that run the system are configured is often as important as the code itself
  - changes to the infrastructure (e.g., adding or removing servers) are just as risky as changes to the code
    - but testing them is harder!

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

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    - 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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- **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!

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  - integrating testing and monitoring
  - stress testing services
  - canaries and "baking the binary"

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- Chaos Monkey is one example of a stress testing technique

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- *"Imagine a monkey entering a "data center", these "farms" of servers that host all the critical functions of our online activities. The monkey **randomly** rips cables, destroys devices and returns everything that passes by the hand. The challenge for IT managers is to **design the information system** they are responsible for **so that it can work despite these monkeys**, which no one ever knows when they arrive and what they will destroy."*

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- *“We have created Chaos Monkey, a program that randomly chooses a server and disables it during its usual hours of activity. Some will find that crazy, but we could not depend on the random occurrence of an event to test our behavior in the face of the very consequences of this event.*

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    - one important goal of Chaos Monkey is to detect such cascading failures before they actually happen in production

Stress Testing

Definition: a ***stress test*** is any test designed to find the limits of the external conditions under which a service can safely operate

- Stress tests answer questions like:
  - “How full can a database get before writes start to fail?”
  - “How many queries a second can be sent to an application server before it becomes overloaded, causing requests to fail?”
- **Chaos Monkey** is one example of a stress testing technique
- Others include intentionally **scaling up** another service
  - i.e., simulate a spike in demand with artificial traffic

Canaries and Staged Deployments

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This incubation period while the fleet is partially upgraded is sometimes called "***baking the binary***".

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> Note that *C*, *R*, and *K* should all be **measurable** by your monitoring system.

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    - U=3: the randomly damaged data is also a valid identifier to a previous request.

Observe that ***order*** here is like big-O notation:

- U=1 means that only the request itself is impacted
- U=2 means that a linear-ish number of other requests will be impacted
- U=3 means exponentially more requests will be impacted
- etc.

know

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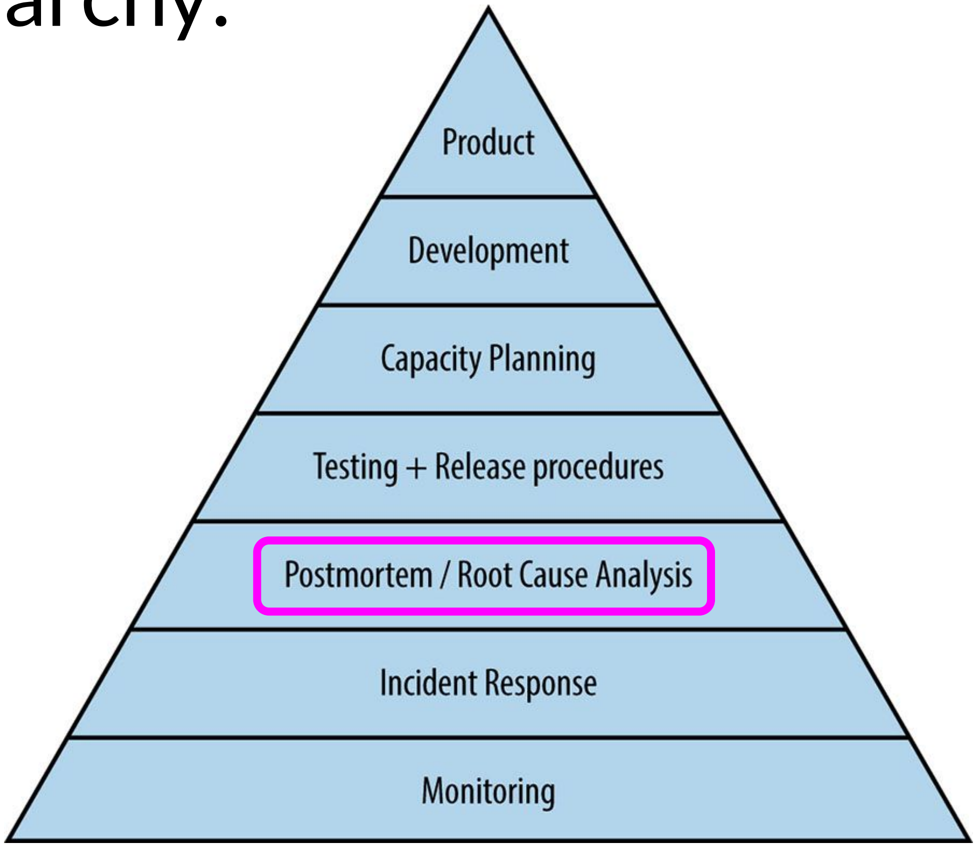
- As we do all of this, it's important to **keep records**
  - they'll be useful later for **writing the post-mortem** (next topic!)

DevOps

Today's agenda:

- Operations, Toil, and the DevOps philosophy
- Achieving reliability
    - the service reliability hierarchy + SLAs/targets
    - monitoring and reliability testing
    - incident/emergency response
    - preventing problems before they occur
    - **post-mortems + learning from failure**

Service Reliability Hierarchy: Post-mortems



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

Post-mortems

Definition: a ***postmortem*** or ***post-mortem*** (from Latin for “after death”) is a written record of an incident, its impact, the actions taken to mitigate or resolve it, the root cause(s), and the follow-up actions to prevent the incident from recurring

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- good postmortems are **blameless** and **actionable**:
  - "**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**

Post-mortems: blameless

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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

- Post-mortems are most effective when they are **peer-reviewed**

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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/]

Post-mortems: example

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Status: Compl

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.

Summary: Sha

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Post-mortems: example

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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and 5 more...

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

Post-mortems: example

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

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

Post-mortems: example

Timeline[167]

2015-10-21 **(all times UTC)**

- 14:51 News reports that a new Shakespearean sonnet has been discovered in a Delorean's glove compartment
- 14:53 Traffic to Shakespeare search increases by 88x after post to **/r/shakespeare** points to Shakespeare search engine as place to find new sonnet (except we don't have the sonnet yet)
- 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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Post-mortems: example

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this goes on for several pages!

- **shows importance of keeping records**

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

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!