Chaos Engineering

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Distributed systems are challenging & pervasive

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  - Unreliable communication channels
  - May be allowed to crash
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- And yet the trends (good or bad) are pushing in this direction
  - SOA & Microservices
  - IoT
  - Control systems
  - *coin & smart contracts
  - ...
How do the solutions we know fit in?

• In general
  – Failure is always an option
  – Ordering is hard
  – Agreement is hard
  – The software and what you think it does may differ
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• How do TLA+ and similar tools fit into the picture?
  – Safety
  – Liveness
  – Fairness
  – Actual behavior?
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  - *Actual behavior?*
  - *Performance?*

- Spec. verification still faces challenges on more empirical issues
Focus on experimentation

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  The discipline of *experimenting* on system in order to *build confidence* in the system’s capability to *withstand turbulent conditions in production* [Principles Of Chaos]
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  The discipline of experimenting on system in order to build confidence in the system’s capability to withstand turbulent conditions in production [Principles Of Chaos]

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- Chaos engineering is about finding the latent chaos in the system.
The 8 fallacies of distributed computing

- Common mistakes from Lyon, Deutsch, & Gosling
  1) The network is reliable
  2) Latency is zero
  3) Bandwidth is infinite
  4) The network is secure
  5) Topology doesn't change
  6) There is one administrator
  7) Transport cost is zero
  8) The network is homogeneous
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• Originally, experiments targeted these, but others are inspired by fault injection, race conditions, ...
Coping with failure

- How failure is handled varies depending on a system
  - Logging & continue?
  - Rerouting?
  - Approximation and quality of service degradation?
  - Error reporting?
  - Terminal failure?
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- What impact might fallback strategies have on business performance?

fallback strategies are common
The structure of chaos experimentation

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- NOTE:
  Just as in sequential hypothesis testing, you might want an “early out”
  - Managing the risks is critical even to getting management buy in
Defining your baseline

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[Netflix SPS, 2016]
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- Recognize that the baseline captures a distribution with trends
- Coarser grained metrics focus on business value and avoid getting distracted by details
  - Netflix: CPU load vs SPS? SPS captures availability & business demands
Choosing your stressors

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  - 92% of distributed system failures come from poor error handling
  - One form of failure leads to another, causing failure cascades
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• Examples:
  – Inject random latency on requests
  – Terminate VM instances
  – Force request failures
  – Make entire Amazon regions unavailable
  – Corrupt headers & communication
  – Double send requests, permute orders, etc.
Managing risk

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- Start in test environments & work toward production
Refining the objective of chaos

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- The process should be one of discovery, uncovering unknowns, and making a system more resilient
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- Be careful that the goal is not to add instability to a system
- You are engineering the chaos already in the system, and you want a methodical process to expose it
- The process should be one of discovery, uncovering unknowns, and making a system more resilient
- The goal is to uncover the latent chaos early in a controlled setting
  - By identifying unlikely problems early, you can prevent uncontrolled risk
Popular Tools

- Several tools are available
  - Chaos Monkey (Netflix)
  - Gremlin
  - Chaos Mesh (Kubernetes)
  - ToxiProxy (Shopify)
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- We can explore examples through:
  - (1) Problems, (2) Likely outcomes, and (3) Experiments to test them
Examples: unreliable networks [Gremlin]

- What happens when your channel to a service fails?
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**Likely outcomes:**
- Traffic may be rerouted to alternates
- Fire alarms may trigger if critical
- Application level metrics should be preserved, *but* ...
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- Likely outcomes:
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- An experiment can simply make a service unreachable
Examples: resource exhaustion [Gremlin]

- What happens when you saturate a resource like CPU, Memory, I/O?
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- Likely outcomes:
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  - QoS degradation if possible
  - Load balancer invocation
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- Likely outcomes:
  - Increased error rates
  - Increased latency
  - QoS degradation if possible
  - Load balancer invocation
  - Fire alarm triggers
- An experiment can simply consume CPU cycles
Examples: datastore saturation [Gremlin]

- What happens when a data service specifically becomes saturated?
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Likely effects:
- Increased application latency on data dependent paths
- Metrics on other paths ideally unaffected
- Fire alarms when critical
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This can be implemented by:
- Making the datastore unavailable
- Increasing latency to the datastore
- Actually consuming bandwidth to the store
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- It can discover problems at a small scale before they become larger
- By managing the existing chaos in your apps, you can produce more reliable apps in general