

What is a system?

No 1, *Design of Digital Machines*

Tim Sheiner

Sections in this presentation

- A System Story
- What is a system?
- Characteristics of a system

System Story

Netflix outages affecting cus

www.wxyz.com/dpp/news/netflix-outages-affecting-customers-nationwide-problems-with-amazon-delivery

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Netflix outages affecting customers nationwide, problems with Amazon delivery

SHARETHIS

Posted: 12/25/2012

(CNN) - Netflix is down for some customers this Christmas Eve, thanks to an outage of some of Amazon's cloud infrastructure," the company said on its Twitter account.

A Netflix spokesman added that the outage stretched "across the Americas." Netflix Inc. NFLX -1.22% said its streaming video service was hit by an outage as a result of problems at Web service provider Amazon.com Inc

Amazon's status Web page for its Internet and cloud-computing services acknowledged there were problems out of its Northern Virginia region.

"We are working to resolve issues" with the service, said an Amazon spokeswoman.

Amazon's Web service, known as AWS, operates server systems that deliver Internet service for many companies. It has been hit by several outages this year, knocking out websites such as Pinterest, Instagram and Foursquare.

According to Netflix's cloud architect, Adrian Cockcroft, not all customer devices were affected by the outage.

"Some devices working, others not," he said on his Twitter account. "Still waiting for AWS to fix it."

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katie
A New Daytime Talk Show

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Top Stories

1st day auto show is tops!
More people came out to see the Auto

Sending request...

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The screenshot shows the Netflix homepage with a red header. A large promotional image features a family sitting on a couch watching TV, with a screen above them displaying various movie and TV show thumbnails. A yellow circular badge on the left says "1 MONTH FREE TRIAL". Text on the page reads: "Watch TV shows & movies anytime, anywhere. Only \$7.99 a month." Below this is a blue button labeled "Start Your Free Month". The footer contains links for "Start Your 1 Month Free Trial", "Browse Selection", "How It Works", "Free Trial Offer Details", "Gifts: Buy / Redeem", "About Us", "Affiliates", "Blog", "Contact Us", "Investor Relations", "Jobs", and "Media Center". Small text at the bottom notes: "Use of the Netflix service and this Web site constitutes acceptance of our Terms of Use and Privacy Policy. © 1997-2012 Netflix, Inc. All rights reserved. U.S. Patent Nos. 6,584,450; 7,024,381; 7,631,323; 7,403,910; and 7,617,127. (us-east-1 49ca638 US) []".

The screenshot shows the Amazon.com homepage. The top navigation bar includes links for "Your Account", "Join Prime", "Cart", and "Wish List". A banner for "Ready for Tax?" is visible. The main content area features sections for Kindle devices (Kindle Fire HD and Kindle Paperwhite), clothing (Smooth Sailing), and power equipment (Emergency & Portable Power, Solar Chargers, Wind Power). A sidebar for "Amazon Prime" offers a 30-day free trial. An advertisement for TurboTax is also present.

Huh?

A screenshot of the Netflix sign-up page. The top navigation bar is red with the Netflix logo on the left and 'Questions? Call 1-866-579-7172 24 hours a day' and 'Member Sign In' on the right. Below the header is a large promotional image showing a family of four (two adults and two children) sitting on a couch watching a TV screen displaying the Netflix interface. A yellow circular badge on the left side of the image says '1 MONTH FREE TRIAL'. To the left of the TV, there's a wooden coffee table with some magazines. The bottom of the page has several calls to action and legal disclaimers.

Amazon.com: Amazon Instant Video

Your Amazon.com | Today's Deals | Gift Cards | Help

Shop by Department | Search | Amazon Instant Video | Go

Hello, Sign In | Your Account | Join Prime | Cart | Wish List

Amazon Instant Video | Prime Instant Videos | Most Popular | Video Finder | Getting Started | Your Video Library | Your Watchlist | Get Help | DVD & Blu-ray | Settings & Devices

amazon instant video now playing on **Wii, Wii U, Xbox 360, & PlayStation 3** [Learn more](#)

Amazon Instant Video

Amazon Prime Membership

Start Your Free Trial | **Today's Deals** | Shop All Deals | \$1.99 Rentals | Own for \$5.00 or Less | Free Videos | DVD & Blu-ray Deals | **How to Watch** | Getting Started | Watch Anywhere | Your Video Library | Your Watchlist | Recommendations | Kindle Fire HD | **Movies** | New Releases | Special Releases | SD Movies | HD Movies | [All Movies](#)

TV | Latest Episodes | HD Shows | [All TV Shows](#)

Popular Genres | Action & Adventure | Comedy | Documentary | Kids & Family | Science Fiction | [All Genres](#)

Subtitles & Closed Captioning | English

Amazon Instant Video: New Releases

Paranormal Activity 4 - Rated | Batman: The Dark Knight Returns Part 2 | To Rome With Love | Death Race 3: Inferno | The Awakening (2012) | Taken 2 | Sellebrity

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New TV Episodes

DOWNTON ABBEY SEASON 3

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Golden Globe Winners

Brave | Game Change | Homeland Season 1 | Girls: Season 1 | House of Lies Season 1 | Hatfields & McCoys Season 1 | Masterpiece: Downton Abbey Original... | [Shop now](#)

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In the fifth and final chapter of **The Twilight Saga: Breaking Dawn Part 2** the birth of Bella and Edward's child ignites forces that threaten to destroy them all. Pre-order it today and watch it instantly March 2.

[Shop now](#)

Indie Films On Sale

Black Swan | Paper Man, Ballet Shoes, and other independent films for less through January 27th.

[Shop now](#)

Amazon Instant Video now playing on **Wii, Wii U, Xbox 360, & PlayStation 3** [Learn more](#)

Best Sellers | **Movies & TV : Movies**

Rent top movies to watch tonight. Updated hourly

1. Taken 2 | Luke Grimes | \$4.98

Huh(2x)?

The Netflix Tech Blog: A Closer Look At The Christmas Eve Outage

techblog.netflix.com/2012/12/a-closer-look-at-christmas-eve-outage.html

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NETFLIX

The Netflix Tech Blog

Monday, December 31, 2012

A Closer Look At The Christmas Eve Outage

by Adrian Cockcroft

Netflix streaming was impacted on Christmas Eve 2012 by problems in the Amazon Web Services (AWS) Elastic Load Balancer (ELB) service that routes network traffic to the Netflix services supporting streaming. The postmortem report by AWS can be read [here](#).

We apologize for the inconvenience and loss of service. We'd like to explain what happened and how we continue to invest in higher availability solutions.

Partial Outage

The problems at AWS caused a partial Netflix streaming outage that started at around 12:30 PM Pacific Time on December 24 and grew in scope later that afternoon. The outage primarily affected playback on TV connected devices in the US, Canada and Latin America. Our service in the UK, Ireland and Nordic countries was not impacted.

Netflix uses hundreds of ELBs. Each one supports a distinct service or a different version of a service and provides a network address that your Web browser or streaming device calls. Netflix streaming has been implemented on over a thousand different streaming devices over the last few years, and groups of similar devices tend to depend on specific ELBs. Requests from devices are passed by the ELB to the individual servers that run the many parts of the Netflix application. Out of hundreds of ELBs in use by Netflix, a handful failed, losing their ability to pass requests to the servers behind them. None of the other AWS services failed, so our applications continued to respond normally whenever the requests were able to get through.

The Netflix Web site remained up throughout the incident, supporting sign up of new customers and streaming to Macs and PCs, although at times with higher latency and a likelihood of needing to retry. Over-all streaming playback via Macs and PCs was only slightly reduced from normal levels. A few devices also saw no impact at all as those devices have an ELB configuration that kept running throughout the incident, providing normal playback levels.

At 12:24 PM Pacific Time on December 24 network traffic stopped on a few ELBs used by a limited number of streaming devices. At around 3:30 PM on December 24, network traffic stopped on additional ELBs used by game consoles, mobile and various other devices to start

Links

- Netflix US & Canada Blog
- Netflix America Latina Blog
- Netflix Brasil Blog
- Netflix UK & Ireland Blog
- Open positions at Netflix
- Netflix Website
- Facebook Netflix Page

RSS Feed

About the Netflix Tech Blog

This is a Netflix blog focused on technology and technology issues. We'll share our perspectives, decisions and challenges regarding the software we build and use to create the Netflix service.

Blog Archive

- 2013 (6)
- ▼ 2012 (37)
 - ▼ December (6)
 - A Closer Look At The Christmas Eve Outage
 - Building the Netflix UI for Wii U
 - Complexity In The Digital Supply Chain
 - Hystrix Dashboard + Turbine Stream Aggregator
 - Videos of the Netflix talks at AWS

**Outage:
Christmas Eve,
12:30pm Pacific**

**Amazon Web
Services, Elastic
Load Balancers**

The screenshot shows a web browser window displaying a blog post from The Netflix Tech Blog. The post is titled "A Closer Look At The Christmas Eve Outage" and is dated Monday, December 31, 2012. It is written by Adrian Cockcroft. The main content of the post discusses how Netflix streaming was impacted on Christmas Eve 2012 due to problems in the Amazon Web Services (AWS) Elastic Load Balancer (ELB) service. A large yellow callout box highlights this specific point. The sidebar on the right contains links to other Netflix blogs and a blog archive.

Links

- Netflix US & Canada Blog
- Netflix America Latina Blog
- Netflix Brazil Blog

Blog Archive

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**Outage:
Christmas Eve,
12:30pm Pacific**

**Amazon Web
Services, Elastic
Load Balancers**

Americas only

**TV connected
devices,
primarily**

The screenshot shows a web browser window displaying a blog post from The Netflix Tech Blog. The post is titled "A Closer Look At The Christmas Eve Outage" by Adrian Cockcroft, dated Monday, December 31, 2012. The main content of the post discusses the impact of the outage, stating: "The outage primarily affected playback on TV connected devices in the US, Canada and Latin America. Our service in the UK, Ireland and Nordic countries was not impacted." Below the main content, there is a detailed explanation of how the outage occurred, mentioning the use of AWS services like ELBs. The sidebar on the right contains links to other Netflix blogs and a blog archive.

Links

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- Netflix America Latina Blog
- Netflix Brazil Blog

Blog Archive

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Outage:
Christmas Eve,
12:30pm Pacific

Amazon Web
Services, Elastic
Load Balancers

Americas only

TV connected
devices,
primarily

100's of ELBs

~1:1
ELB: Device Type

The screenshot shows a web browser window with the URL techblog.netflix.com/2012/12/a-closer-look-at-christmas-eve-outage.html. The page title is "The Netflix Tech Blog". The main content is a post titled "A Closer Look At The Christmas Eve Outage" by Adrian Cockcroft, dated Monday, December 31, 2012. The post discusses the use of hundreds of ELBs (Elastic Load Balancers) to support various devices and service versions. A large yellow callout box highlights a quote from the post: "Netflix uses hundreds of ELBs. Each one supports a distinct service or a different version of a service and provides a network address that your Web browser or streaming device calls. Netflix streaming has been implemented on over a thousand different streaming devices over the last few years, and groups of similar devices tend to depend on specific ELBs." Below the quote, there is a snippet of the post's content about Mac and PC streaming. To the right of the main content, there is a sidebar with links to other Netflix blogs: "Links" (Netflix US & Canada Blog, Netflix America Latina Blog, Netflix Brazil Blog), and a sidebar with links to "for Wii U", "Complexity In The Digital Supply Chain", "Hystrix Dashboard + Turbine Stream Aggregator", and "Videos of the Netflix talks at AWS".

NETFLIX

The Netflix Tech Blog

Monday, December 31, 2012

A Closer Look At The Christmas Eve Outage

by Adrian Cockcroft

Links

Netflix US & Canada Blog

Netflix America Latina Blog

Netflix Brazil Blog

"Netflix uses hundreds of ELBs. Each one supports a distinct service or a different version of a service and provides a network address that your Web browser or streaming device calls. Netflix streaming has been implemented on over a thousand different streaming devices over the last few years, and groups of similar devices tend to depend on specific ELBs."

and streaming to Macs and PCs, although at times with higher latency and a likelihood of needing to retry. Over-all streaming playback via Macs and PCs was only slightly reduced from normal levels. A few devices also saw no impact at all as those devices have an ELB configuration that kept running throughout the incident, providing normal playback levels.

At 12:24 PM Pacific Time on December 24 network traffic stopped on a few ELBs used by a limited number of streaming devices. At around 3:30 PM on December 24, network traffic stopped on additional ELBs used by game consoles, mobile and various other devices to start

for Wii U

Complexity In The Digital Supply Chain

Hystrix Dashboard + Turbine Stream Aggregator

Videos of the Netflix talks at AWS

Outage:
Christmas Eve,
12:30pm Pacific

Amazon Web
Services, Elastic
Load Balancers

Americas only

TV connected
devices,
primarily

100's of ELBs

~1:1
ELB: Device Type

The screenshot shows a web browser window displaying a blog post from The Netflix Tech Blog. The post is titled "A Closer Look At The Christmas Eve Outage" and is dated Monday, December 31, 2012. It is written by Adrian Cockcroft. The post content discusses an issue where a few ELBs failed to pass requests to servers behind them, while other AWS services remained functional. The browser's address bar shows the URL: techblog.netflix.com/2012/12/a-closer-look-at-christmas-eve-outage.html. The browser interface includes a toolbar with various icons and a sidebar with links to other Netflix blogs.

“Out of hundreds of ELBs in use by Netflix, a handful failed, losing their ability to pass requests to the servers behind them. None of the other AWS services failed, so our applications continued to respond normally whenever the requests were able to get through.”

and streaming to Macs and PCs, although at times with higher latency and a likelihood of needing to retry. Over-all streaming playback via Macs and PCs was only slightly reduced from normal levels. A few devices also saw no impact at all as those devices have an ELB configuration that kept running throughout the incident, providing normal playback levels.

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Complexity In The Digital Supply Chain
Hystrix Dashboard + Turbine Stream Aggregator
Videos of the Netflix talks at AWS

Failure localized
to only some
ELBs

Issue was
requests not
passed through

Outage:
Christmas Eve,
12:30pm Pacific

Amazon Web
Services, Elastic
Load Balancers

Americas only

TV connected
devices,
primarily

100's of ELBs

~1:1
ELB: Device Type

The screenshot shows a web browser window displaying a blog post from The Netflix Tech Blog. The post is titled "A Closer Look At The Christmas Eve Outage" by Adrian Cockcroft, dated Monday, December 31, 2012. The post content discusses the impact of the outage, mentioning that streaming playback via Macs and PCs was slightly reduced but normal levels were maintained for some devices due to ELB configuration. It also notes that game consoles and other devices were impacted for about seven hours. A sidebar on the right lists links to other Netflix blogs: Netflix US & Canada Blog, Netflix America Latina Blog, and Netflix Brazil Blog.

“Over-all streaming playback via Macs and PCs was only slightly reduced from normal levels. A few devices also saw no impact at all as those devices have an ELB configuration that kept running throughout the incident, providing normal playback levels.

... game consoles etc. were impacted for about seven hours.”

and streaming to Macs and PCs, although at times with higher latency and a likelihood of needing to retry. Over-all streaming playback via Macs and PCs was only slightly reduced from normal levels. A few devices also saw no impact at all as those devices have an ELB configuration that kept running throughout the incident, providing normal playback levels.

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Issue was
requests not
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Slight
performance
impact to Mac/
PC

Game consoles
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Outage:
Christmas Eve,
12:30pm Pacific

Amazon Web
Services, Elastic
Load Balancers

Americas only

TV connected
devices,
primarily

100's of ELBs

~1:1
ELB: Device Type

The screenshot shows a web browser window displaying a blog post from 'The Netflix Tech Blog'. The post is titled 'A Closer Look At The Christmas Eve Outage' by Adrian Cockcroft, dated Monday, December 31, 2012. The post content discusses the impact of the outage, mentioning that it affected 'Americas only' and was primarily impacting 'TV connected devices'. It notes that there were '100's of ELBs' involved and had a '1:1 ELB: Device Type' ratio. A large yellow callout box highlights a quote from the post: "It is still early days for cloud innovation and there is certainly more to do in terms of building resiliency in the cloud. We have plans to work on this in 2013. It is an interesting and hard problem to solve, since ... the systems involved ... must be extremely reliable and capable of avoiding cascading overload failures." Below the quote, the blog post continues to explain the outage, mentioning that streaming to Macs and PCs was affected, but devices with ELB configurations maintained normal playback levels. The post also notes that network traffic stopped on a few ELBs used by game consoles at 12:24 PM Pacific Time on December 24.

Failure localized
to only some
ELBs

Issue was
requests not
passed through

Slight
performance
impact to Mac/
PC

Game consoles
impacted 7
hours

The screenshot shows a web browser window for 'The Netflix Tech Blog'. The main content is a post titled 'A Closer Look At The Christmas Eve Outage' from Monday, December 31, 2012. The post discusses a streaming outage caused by problems in the Amazon Web Services (AWS) Elastic Load Balancer (ELB) service. It includes sections on 'Partial Outage' and 'About the Netflix Tech Blog'. On the right side, there's a sidebar with 'Links' to other Netflix blogs and a 'Blog Archive' section showing posts from 2013 and 2012.

The screenshot shows a web browser window for 'Summary of the December 24, 2012 Amazon ELB Service Event in the US-East Region'. The page details a service disruption that began at 12:24 PM PST on December 24th. It explains that a portion of the ELB state data was logically deleted, causing issues with load balancers. The team disabled control plane workflows to prevent further impact, manually recovered some load balancers, and successfully restored the ELB state data by 5:40 AM PST. The page includes sections on the service disruption, its impact, and the recovery process.

Summary of the December 24, 2012 Amazon ELB Service Event in the US-East Region

We would like to share more details with our customers about the event that occurred with the Amazon Elastic Load Balancing Service ("ELB") earlier this week in the US-East Region. While the service disruption only affected applications using the ELB service (and only a fraction of the ELB load balancers were affected), the impacted load balancers saw significant impact for a prolonged period of time.

The service disruption began at 12:24 PM PST on December 24th when a portion of the ELB state data was logically deleted. This data is used and maintained by the ELB control plane to manage the configuration of the ELB load balancers in the region (for example tracking all the backend hosts to which traffic should be routed by each load balancer). The data was deleted by a maintenance process that was inadvertently run against the production ELB state data. This process was run by one of a very small number of developers who have access to this production environment. Unfortunately, the developer did not realize the mistake at the time. After this data was deleted, the ELB control plane began experiencing high latency and error rates for API calls to manage ELB load balancers. In this initial part of the service disruption, there was no impact to the request handling functionality of running ELB load balancers because the missing ELB state data was not integral to the basic operation of running load balancers.

Over the next couple hours, our technical teams focused on the API errors. The team was puzzled as many APIs were succeeding (customers were able to create and manage new load balancers but not manage existing load balancers) and others were failing. As this continued, some customers began to experience performance issues with their running load balancers. These issues only occurred after the ELB control plane attempted to make changes to a running load balancer. When a user modifies a load balancer configuration or a load balancer needs to scale up or down, the ELB control plane makes changes to the load balancer configuration. During this event, because the ELB control plane lacked some of the necessary ELB state data to successfully make these changes, load balancers that were modified were improperly configured by the control plane. This resulted in degraded performance and errors for customer applications using these modified load balancers. It was when the ELB technical team started digging deeply into these degraded load balancers that the team identified the missing ELB state data as the root cause of the service disruption. At this point, the focus shifted to preventing additional service impact and recovering the missing ELB state data.

At 5:02 PM PST, the team disabled several of the ELB control plane workflows (including the scaling and descaling workflows) to prevent additional running load balancers from being affected by the missing ELB state data. At the peak of the event, 6.8% of running ELB load balancers were impacted. The rest of the load balancers in the system were unable to scale or be modified by customers, but were operating correctly. The team was able to manually recover some of the affected running load balancers on Monday night, and worked through the night to try to restore the missing ELB state data to allow the rest of the affected load balancers to recover (and to open all of the ELB APIs back up).

The team attempted to restore the ELB state data to a point-in-time just before 12:24 PM PST on December 24th (just before the event began). By restoring the data to this time, we would be able to merge in events that happened after this point to create an accurate state for each ELB load balancer. Unfortunately, the initial method used by the team to restore the ELB state data consumed several hours and failed to provide a usable snapshot of the data. This delayed recovery until an alternate recovery process was found. At 2:45 AM PST on December 25th, the team successfully restored a snapshot of the ELB state data to a time just before the data was deleted. The team then began merging this restored data with the system state changes that happened between this snapshot and the current time. By 5:40 AM PST, this data merge had been completed and the new ELB state data had been verified. The team then began slowly re-enabling the ELB

US-East Region
ELB

Severe but
localized
interruption

The screenshot shows a web browser window with the URL aws.amazon.com/message/680587/. The page title is "Summary of the December 24, 2012 Amazon ELB Service Event in the US-East Region". The AWS logo is at the top left, and there are navigation links for "Sign Up", "My Account / Console", "English", "AWS Products & Solutions", "AWS Product Information", "Developers", and "Support". A main message box contains the following text:

"We would like to share more details with our customers about the event that occurred with the Amazon Elastic Load Balancing Service ("ELB") earlier this week in the US-East Region. While the service disruption only affected applications using the ELB service (and only a fraction of the ELB load balancers were affected), the impacted load balancers saw significant impact for a prolonged period of time."

Failed to provide a usable snapshot of the data. This delayed recovery until an alternate recovery process was found. At 2:45 AM PST on December 25th, the team successfully restored a snapshot of the ELB state data to a time just before the data was deleted. The team then began merging this restored data with the system state changes that happened between this snapshot and the current time. By 5:40 AM PST, this data merge had been completed and the new ELB state data had been verified. The team then began slowly re-enabling the ELB.

US-East Region
ELB

Severe but
localized
interruption

12:24 PM PST on
December 24

ELB state data
logically deleted

The screenshot shows a web browser window with the URL aws.amazon.com/message/680587/. The page title is "Summary of the December 24, 2012 Amazon ELB Service Event in the US-East Region". The AWS logo is at the top left, and navigation links like "Sign Up", "My Account / Console", "English", "AWS Products & Solutions", "AWS Product Information", "Developers", and "Support" are at the top right. A main heading reads: "The service disruption began at 12:24 PM PST on December 24th when a portion of the ELB state data was logically deleted." Below this, a paragraph states: "Identified the missing ELB state data as the root cause of the service disruption. At this point, the focus shifted to preventing additional service impact and recovering the missing ELB state data." Another paragraph details the team's actions: "At 5:02 PM PST, the team disabled several of the ELB control plane workflows (including the scaling and descaling workflows) to prevent additional running load balancers from being affected by the missing ELB state data. At the peak of the event, 6.8% of running ELB load balancers were impacted. The rest of the load balancers in the system were unable to scale or be modified by customers, but were operating correctly. The team was able to manually recover some of the affected running load balancers on Monday night, and worked through the night to try to restore the missing ELB state data to allow the rest of the affected load balancers to recover (and to open all of the ELB APIs back up)." A final paragraph describes the recovery process: "The team attempted to restore the ELB state data to a point-in-time just before 12:24 PM PST on December 24th (just before the event began). By restoring the data to this time, we would be able to merge in events that happened after this point to create an accurate state for each ELB load balancer. Unfortunately, the initial method used by the team to restore the ELB state data consumed several hours and failed to provide a usable snapshot of the data. This delayed recovery until an alternate recovery process was found. At 2:45 AM PST on December 25th, the team successfully restored a snapshot of the ELB state data to a time just before the data was deleted. The team then began merging this restored data with the system state changes that happened between this snapshot and the current time. By 5:40 AM PST, this data merge had been completed and the new ELB state data had been verified. The team then began slowly re-enabling the ELB."

US-East Region
ELB

Severe but
localized
interruption

12:24 PM PST on
December 24

ELB state data
logically deleted

ELB control
plane manages
configurations

Tracking hosts
for traffic
routing

The screenshot shows a web browser window titled "Summary of the December 24, 2012 Amazon ELB Service Event in the US-East Region". The page includes the AWS logo, navigation links for "Sign Up", "My Account / Console", "English", "AWS Products & Solutions", "AWS Product Information", "Developers", and "Support". The main content area contains a large blue box with yellow text explaining the event. Below this box is a smaller white box with black text providing technical details about the event's impact and recovery.

Summary of the December 24, 2012 Amazon ELB Service Event in the US-East Region

We would like to share more details with our customers about the event that occurred with the Amazon Elastic Load Balancing Service.

"This data is used and maintained by the ELB control plane to manage the configuration of the ELB load balancers in the region (for example tracking all the backend hosts to which traffic should be routed by each load balancer). "

At 3:02 PM PST, the team disabled several of the ELB control plane workflows (including the scaling and descaling workflows) to prevent additional running load balancers from being affected by the missing ELB state data. At the peak of the event, 6.8% of running ELB load balancers were impacted. The rest of the load balancers in the system were unable to scale or be modified by customers, but were operating correctly. The team was able to manually recover some of the affected running load balancers on Monday night, and worked through the night to try to restore the missing ELB state data to allow the rest of the affected load balancers to recover (and to open all of the ELB APIs back up).

The team attempted to restore the ELB state data to a point-in-time just before 12:24 PM PST on December 24th (just before the event began). By restoring the data to this time, we would be able to merge in events that happened after this point to create an accurate state for each ELB load balancer. Unfortunately, the initial method used by the team to restore the ELB state data consumed several hours and failed to provide a usable snapshot of the data. This delayed recovery until an alternate recovery process was found. At 2:45 AM PST on December 25th, the team successfully restored a snapshot of the ELB state data to a time just before the data was deleted. The team then began merging this restored data with the system state changes that happened between this snapshot and the current time. By 5:40 AM PST, this data merge had been completed and the new ELB state data had been verified. The team then began slowly re-enabling the ELB.

US-East Region
ELB

Severe but
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12:24 PM PST on
December 24

ELB state data
logically deleted

ELB control
plane manages
configurations

Tracking hosts
for traffic
routing

Inadvertent
maintenance
process

production
environment
access

Unaware of
error

The screenshot shows a web browser window titled "Summary of the December 24, 2012 Amazon ELB Service Event in the US-East Region". The page includes the AWS logo, navigation links for "Sign Up", "My Account / Console", "English", "AWS Products & Solutions", "AWS Product Information", "Developers", and "Support". The main content area contains a large blue box with white text stating: "The data was deleted by a maintenance process that was inadvertently run against the production ELB state data. This process was run by one of a very small number of developers who have access to this production environment. Unfortunately, the developer did not realize the mistake at the time." Below this box, smaller text provides details about the restoration efforts.

Summary of the December 24, 2012 Amazon ELB Service Event in the US-East Region

We would like to share more details with our customers about the event that occurred with the Amazon Elastic Load Balancing Service.

"The data was deleted by a maintenance process that was inadvertently run against the production ELB state data. This process was run by one of a very small number of developers who have access to this production environment. Unfortunately, the developer did not realize the mistake at the time."

through the night to try to restore the missing ELB state data to allow the rest of the affected load balancers to recover (and to open all of the ELB APIs back up).

The team attempted to restore the ELB state data to a point-in-time just before 12:24 PM PST on December 24th (just before the event began). By restoring the data to this time, we would be able to merge in events that happened after this point to create an accurate state for each ELB load balancer. Unfortunately, the initial method used by the team to restore the ELB state data consumed several hours and failed to provide a usable snapshot of the data. This delayed recovery until an alternate recovery process was found. At 2:45 AM PST on December 25th, the team successfully restored a snapshot of the ELB state data to a time just before the data was deleted. The team then began merging this restored data with the system state changes that happened between this snapshot and the current time. By 5:40 AM PST, this data merge had been completed and the new ELB state data had been verified. The team then began slowly re-enabling the ELB.

US-East Region
ELB

Severe but
localized
interruption

12:24 PM PST on
December 24

ELB state data
logically deleted

ELB control
plane manages
configurations

Tracking hosts
for traffic
routing

Inadvertent
maintenance
process

production
environment
access

Unaware of
error

High latency &
error rates

API calls

No impact to
running ELBs

The screenshot shows a web browser window titled "Summary of the December 24, 2012 Amazon ELB Service Event in the US-East Region". The URL is aws.amazon.com/message/680587/. The page includes the Amazon Web Services logo and navigation links for "Sign Up", "My Account / Console", "English", "AWS Products & Solutions", "AWS Product Information", "Developers", and "Support". A sub-header states: "We would like to share more details with our customers about the event that occurred with the Amazon Elastic Load Balancing Service." The main content is a large blue box containing the quote: "After this data was deleted, the ELB control plane began experiencing high latency and error rates for API calls to manage ELB load balancers. In this initial part of the service disruption, there was no impact to the request handling functionality of running ELB load balancers because the missing ELB state data was not integral to the basic operation of running load balancers." Below this box, a smaller text block provides additional context: "began). By restoring the data to this time, we would be able to merge in events that happened after this point to create an accurate state for each ELB load balancer. Unfortunately, the initial method used by the team to restore the ELB state data consumed several hours and failed to provide a usable snapshot of the data. This delayed recovery until an alternate recovery process was found. At 2:45 AM PST on December 25th, the team successfully restored a snapshot of the ELB state data to a time just before the data was deleted. The team then began merging this restored data with the system state changes that happened between this snapshot and the current time. By 5:40 AM PST, this data merge had been completed and the new ELB state data had been verified. The team then began slowly re-enabling the ELB".

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"The team was puzzled as many APIs were succeeding (customers were able to create and manage new load balancers but not manage existing load balancers) and others were failing. As this continued, some customers began to experience performance issues with their running load balancers. These issues only occurred after the ELB control plane attempted to make changes to a running load balancer. "

Inadvertent
maintenance
process

production
environment
access

Unaware of
error

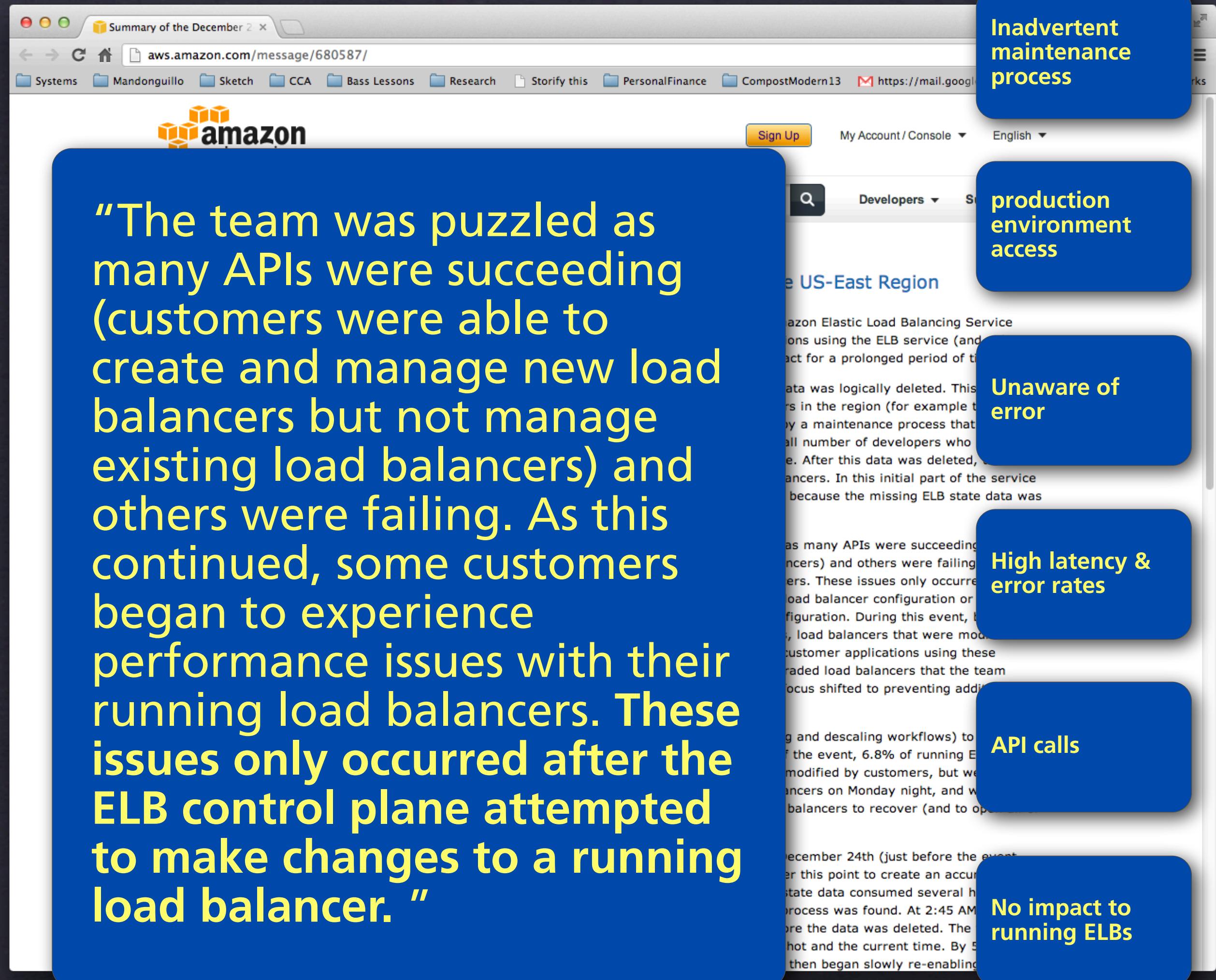
High latency &
error rates

API calls

No impact to
running ELBs

Create new, but
not manage
existing

Failure on
attempt to scale



US-East Region
ELB

Severe but
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"At 5:02 PM PST, the team disabled several of the ELB control plane workflows (including the scaling and descaling workflows) to prevent additional running load balancers from being affected by the missing ELB state data. At the peak of the event, 6.8% of running ELB load balancers were impacted. The rest of the load balancers in the system were unable to scale or be modified by customers, but were operating correctly."

The screenshot shows a web browser window titled "Summary of the December 24th event" at aws.amazon.com/message/680587/. The page is a summary of an incident in the US-East Region. It includes sections on the maintenance process, production environment access, unawareness of errors, high latency and error rates, API calls, and no impact to running ELBs. The page also mentions that 6.8% of load balancers were directly impacted.

Inadvertent maintenance process

production environment access

Unaware of error

High latency & error rates

API calls

No impact to running ELBs

Create new, but
not manage
existing

Failure on
attempt to scale

6.8% directly
impacted, rest
no scaling

US-East Region
ELB

Severe but
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ELB state data
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ELB control
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"The team attempted to restore the ELB state data to a point-in-time just before the event began. By restoring the data to this time, we would be able to merge in events that happened after ... to create an accurate state. ... the initial method used by the team to restore the ELB state data ... failed to provide a usable snapshot of the data. This delayed recovery until an alternate recovery process was found. "

Inadvertent
maintenance
process

production
environment
access

Unaware of
error

High latency &
error rates

API calls

No impact to
running ELBs

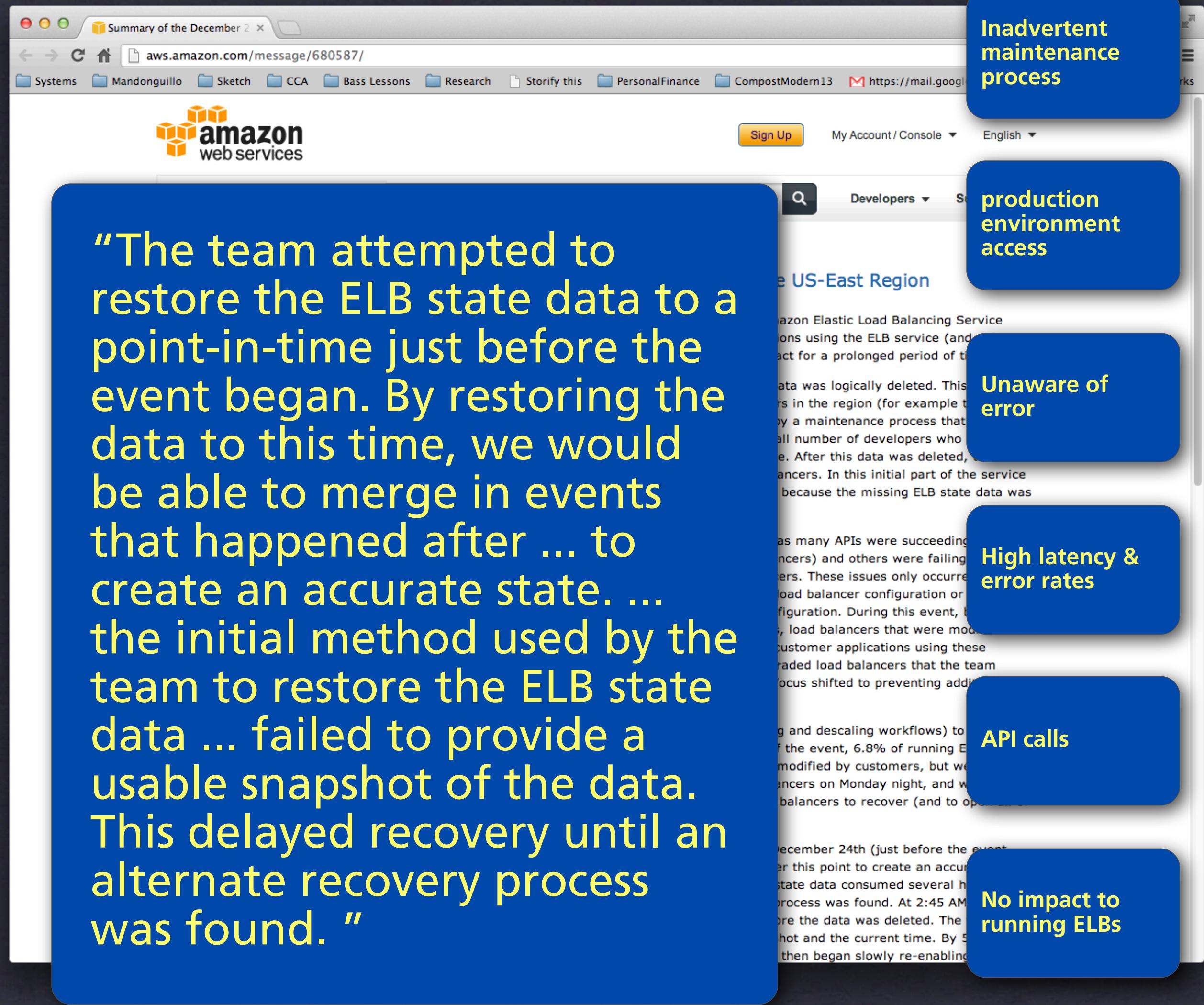
Create new, but
not manage
existing

Failure on
attempt to scale

6.8% directly
impacted, rest
no scaling

Merge old state

Initial recovery
plan failed



US-East Region
ELB

Severe but
localized
interruption

12:24 PM PST on
December 24

ELB state data
logically deleted

ELB control
plane manages
configurations

Tracking hosts
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“The system began recovering the remaining affected load balancers, and by 8:15 AM PST, the team had re-enabled the majority of APIs and backend workflows. By 10:30 AM PST, almost all affected load balancers had been restored to full operation. While the service was substantially recovered at this time, the team continued to closely monitor the service before communicating broadly that it was operating normally at 12:05 PM PST. ”

Inadvertent
maintenance
process

production
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access

Unaware of
error

High latency &
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Merge old state

Initial recovery
plan failed

10:30 am
substantial
recovery; 20
hours

US-East Region
ELB

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“We have made a number of changes to protect the ELB service from this sort of disruption in the future.

- modified the access controls on our production ELB state data
- modified our data recovery process to reflect the learning we went through in this event

We will also incorporate our learning from this event into our service architecture. We believe that we can reprogram [to] allow the service to recover automatically from logical data loss.”

Inadvertent
maintenance
process

production
environment
access

Unaware of
error

High latency &
error rates

API calls

No impact to
running ELBs

Create new, but
not manage
existing

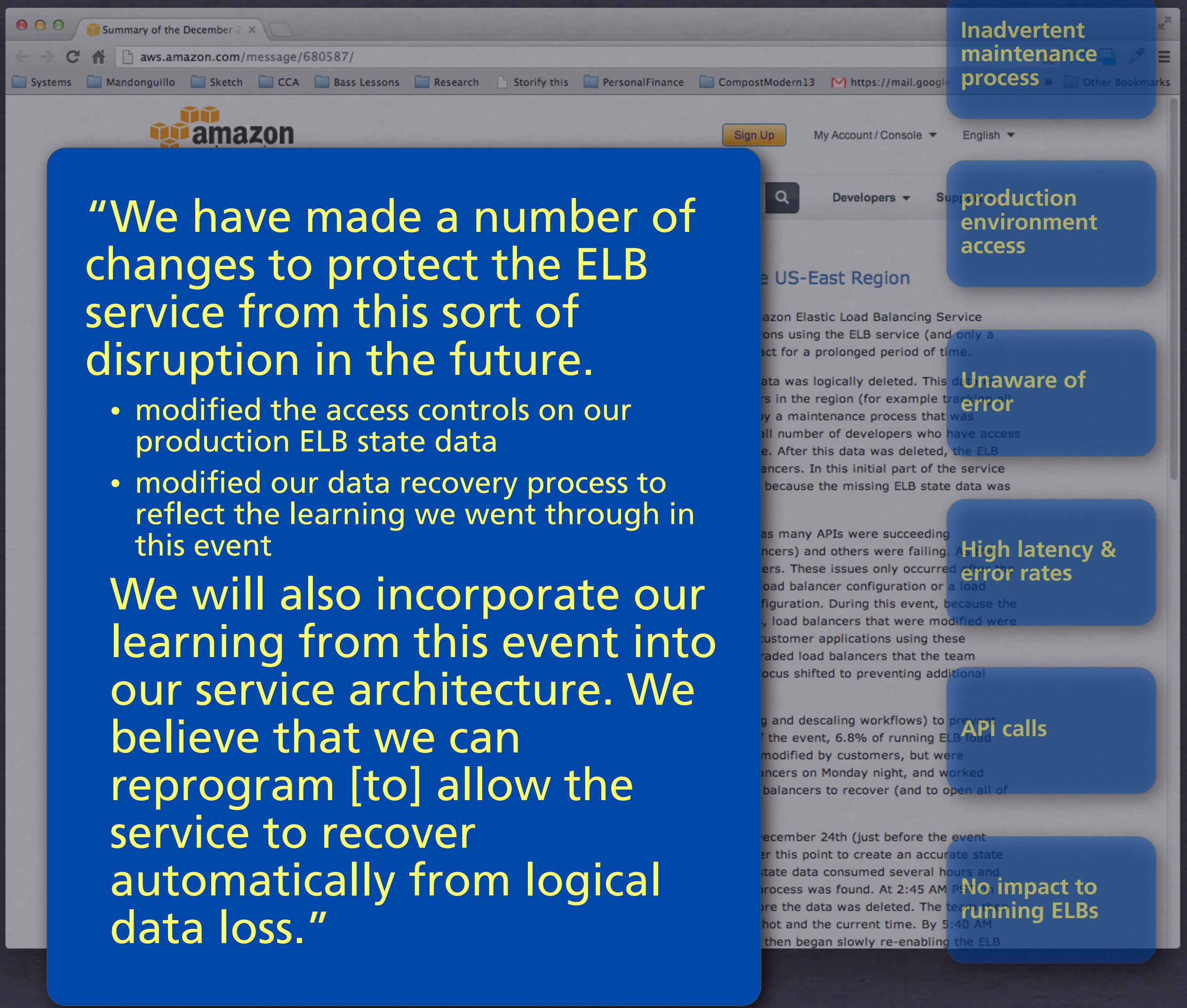
Failure on
attempt to scale

6.8% directly
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no scaling

Merge old state

Initial recovery
plan failed

10:30 am
substantial
recovery; 20
hours



Outage:
Christmas Eve,
12:30pm Pacific

Failure localized
to only some
ELBs

US-East Region
ELB

Inadvertent
maintenance
process

Create new, but
not manage
existing

Amazon Web
Services, Elastic
Load Balancers

Issue was
requests not
passed through

Severe but
localized
interruption

production
environment
access

Failure on
attempt to scale

Americas only

Slight
performance
impact to Mac/
PC

12:24 PM PST on
December 24

Unaware of
error

6.8% directly
impacted, rest
no scaling

TV connected
devices,
primarily

Game consoles
impacted 7
hours

ELB state data
logically deleted

High latency &
error rates

Merge old state

100's of ELBs

ELB control
plane manages
configurations

API calls

Initial recovery
plan failed

~1:1
ELB: Device Type

Tracking hosts
for traffic
routing

No impact to
running ELBs

10:30 am
substantial
recovery; 20
hours

Events

Outage:
Christmas Eve,
12:30pm Pacific

Americas only

TV connected
devices,
primarily

12:24 PM PST on
December 24

Severe but
localized
interruption

US-East Region
ELB

ELB state data
logically deleted

Objects & Relationships

Amazon Web
Services, Elastic
Load Balancers

100's of ELBs

~1:1
ELB: Device Type

ELB control
plane

ELB control
plane manages
configurations

Tracking hosts
for traffic
routing

{(Netflix) + (Amazon)}

Structural Explanation

Inadvertent
maintenance
process

production
environment
access

Unaware of
error

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not manage
existing

Failure on
attempt to scale

Merge old state

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plan failed

10:30 am
substantial
recovery; 20
hours

Patterns

Failure localized
to only some
ELBs

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Services, Elastic
Load Balancers

100's of ELBs

~1:1
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{Netflix + Amazon}

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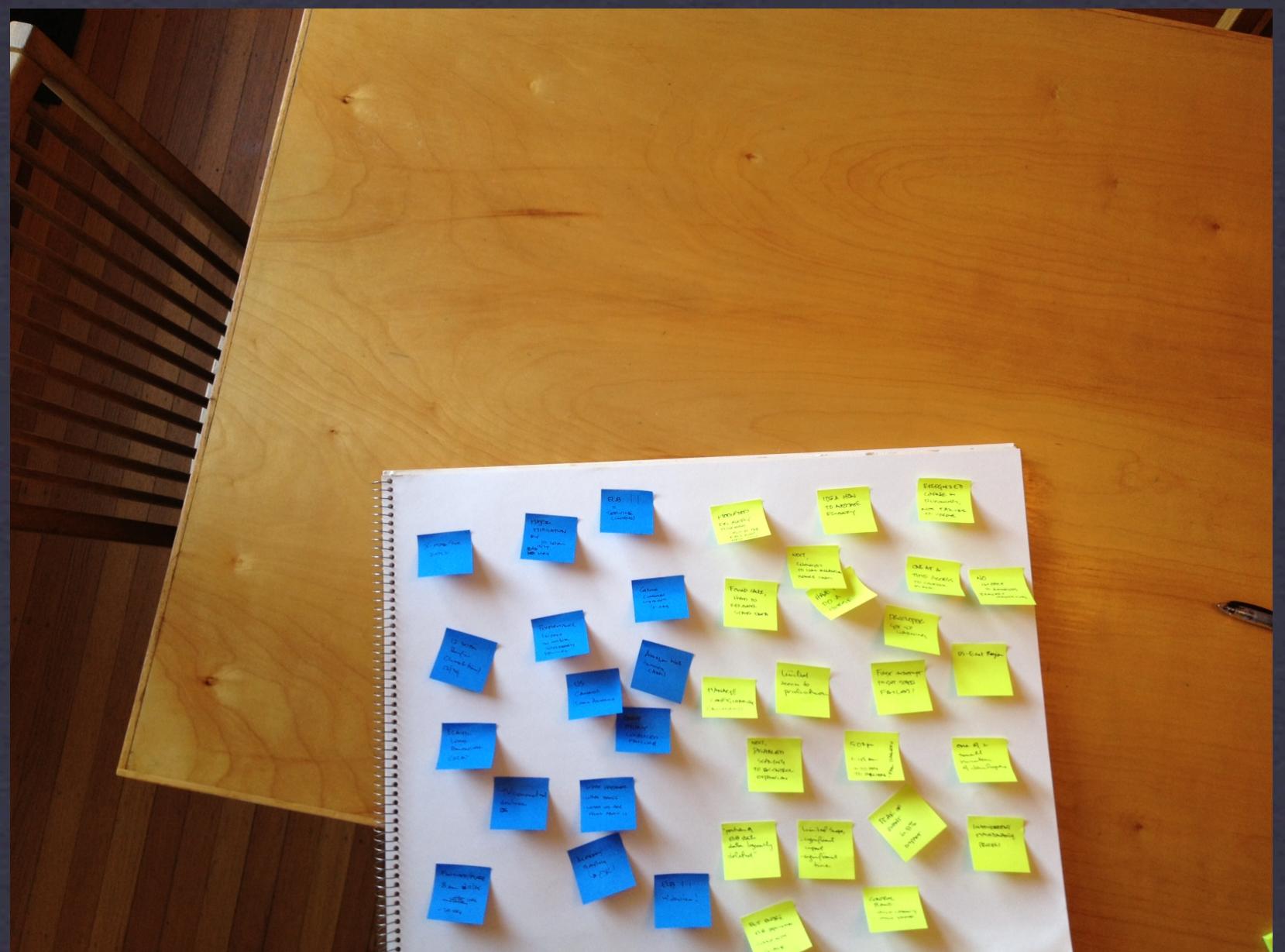
Game consoles
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error rates

API calls

No impact to
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no scaling



What is a system?

Bricks



Brick Systems or Brick Collections?

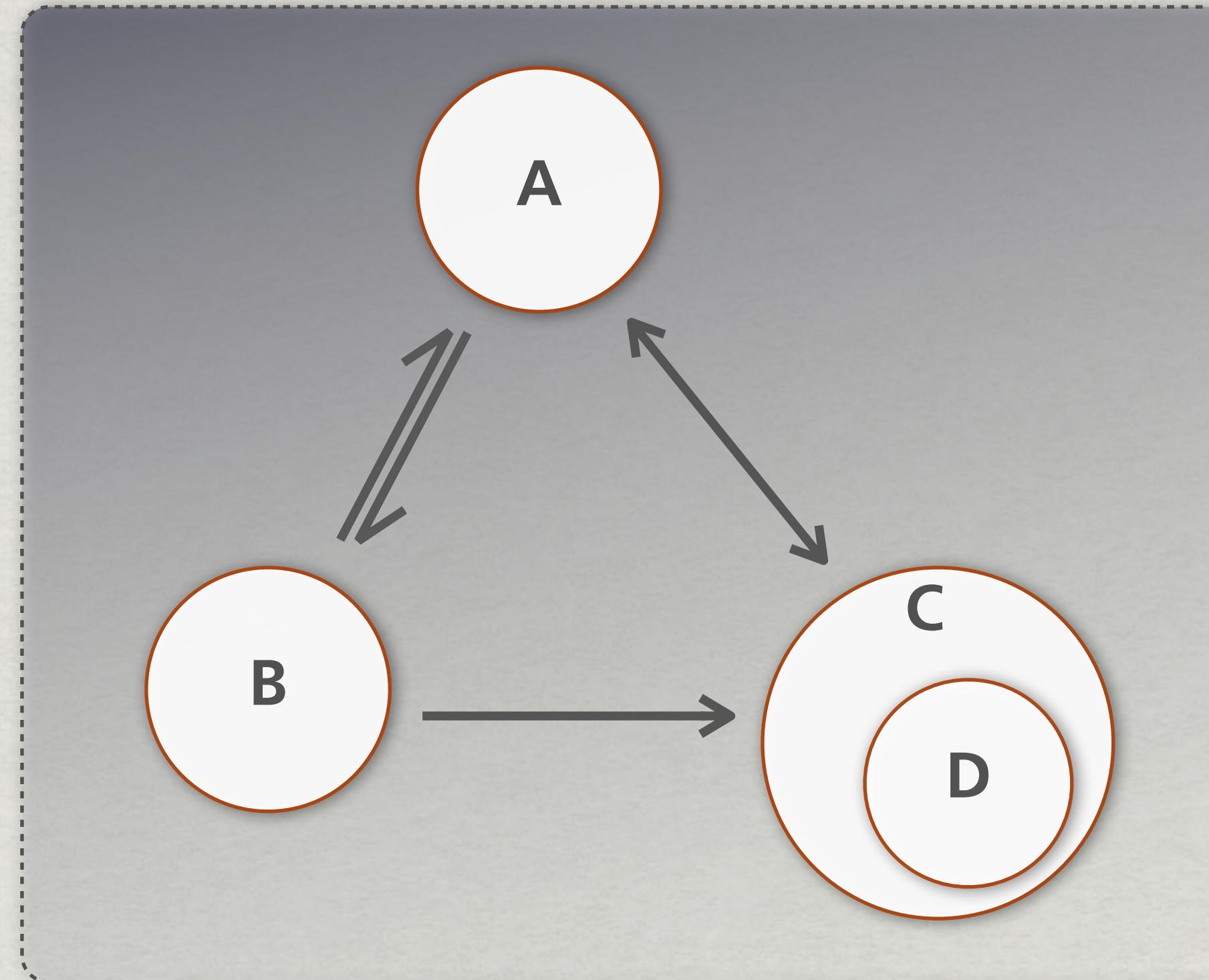


A system is an interconnected set of elements that is coherently organized in a way that achieves something.

Donella Meadows, Thinking in Systems

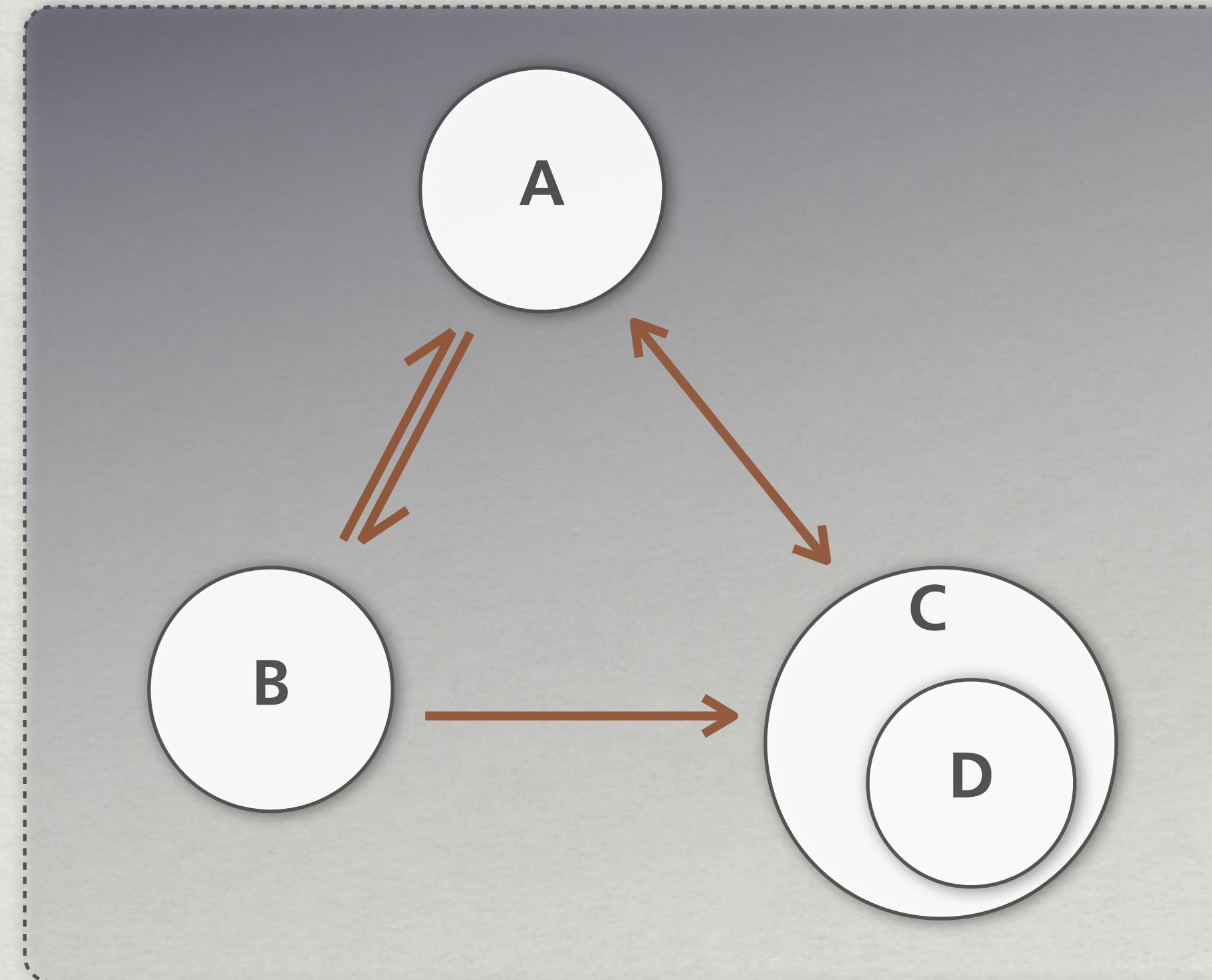
Operational View of a System

1. Objects



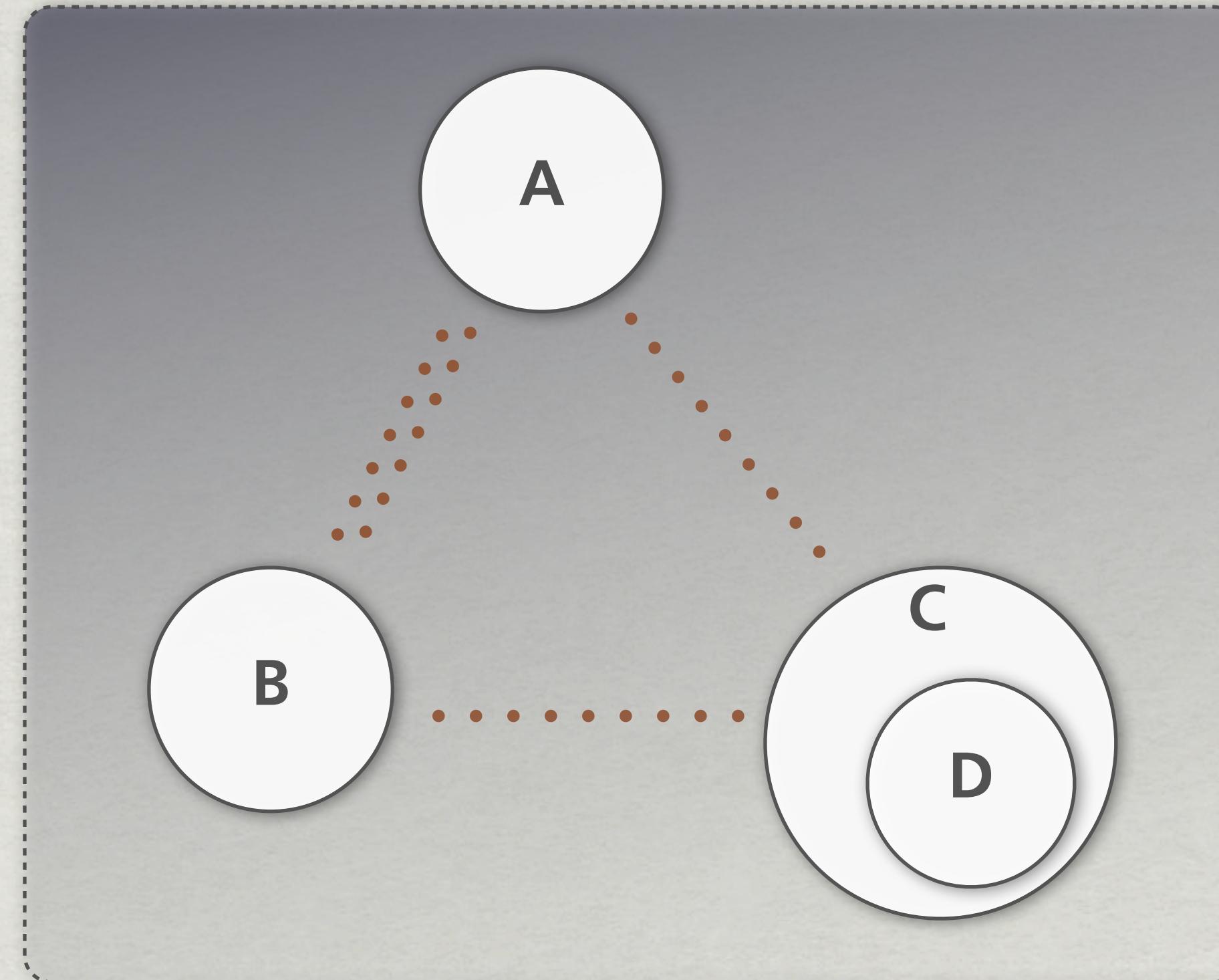
Operational View of a System

1. Objects
2. Relationships



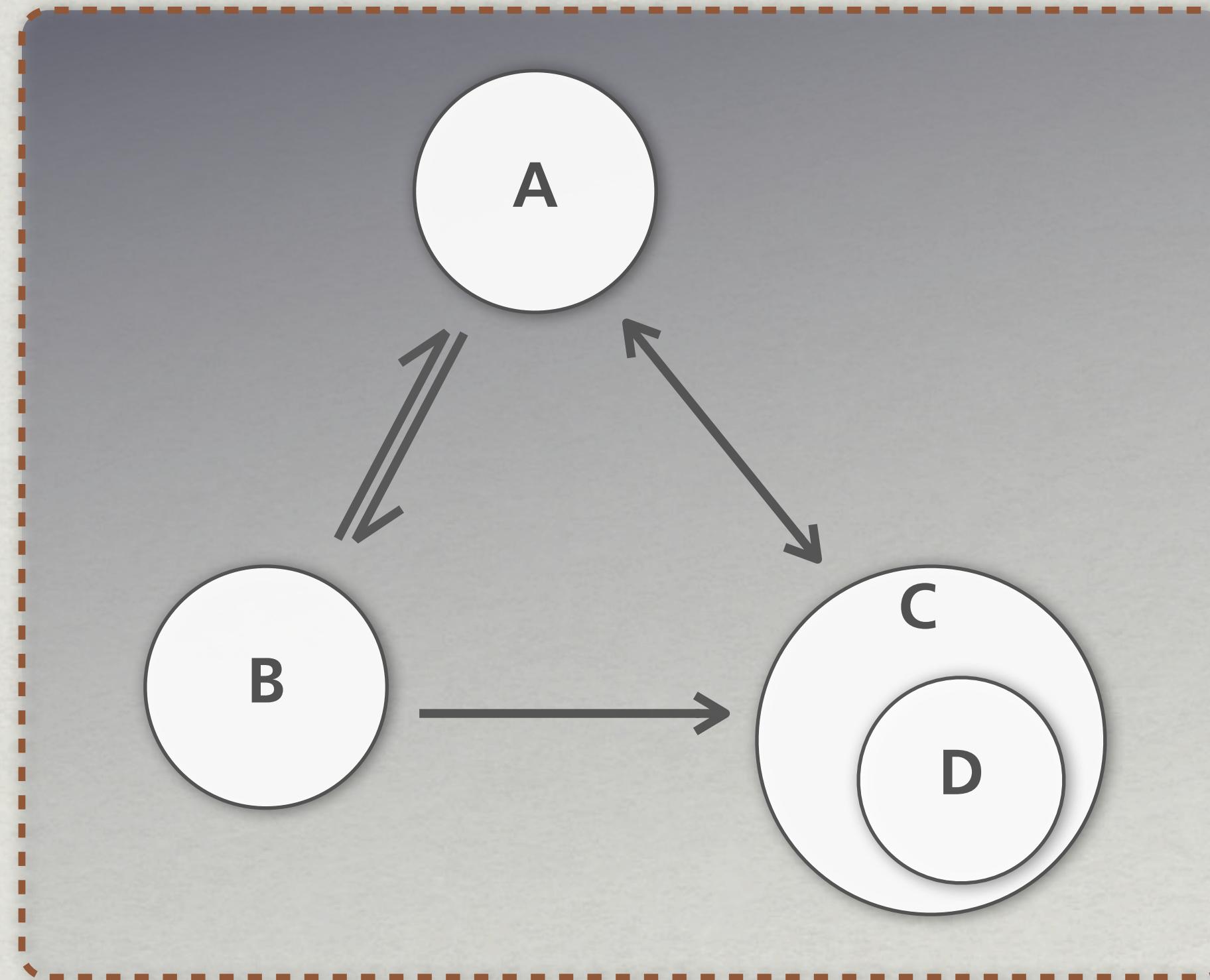
Operational View of a System

1. Objects
2. Relationships
3. Currency



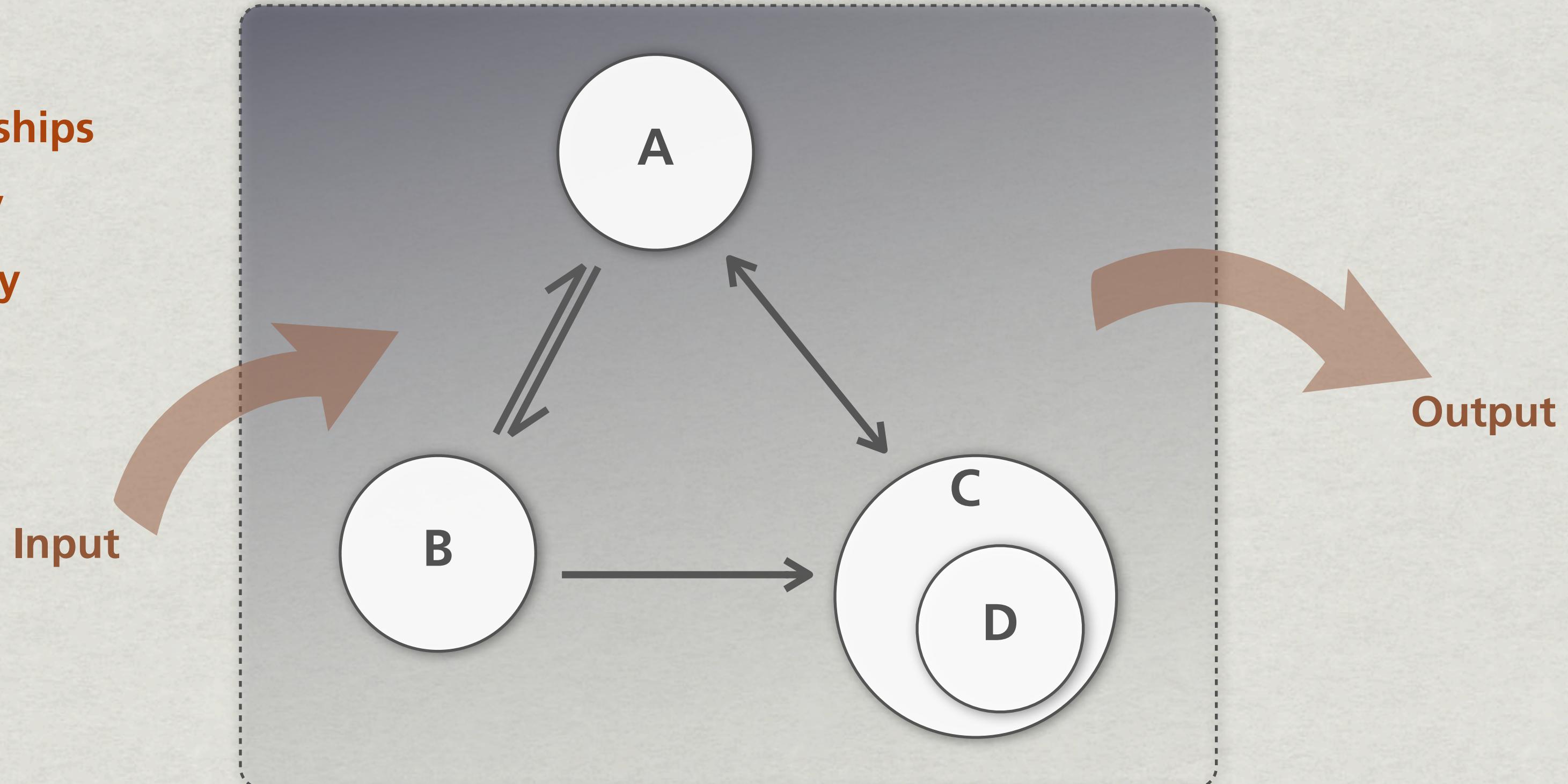
Operational View of a System

1. Objects
2. Relationships
3. Currency
4. Boundary

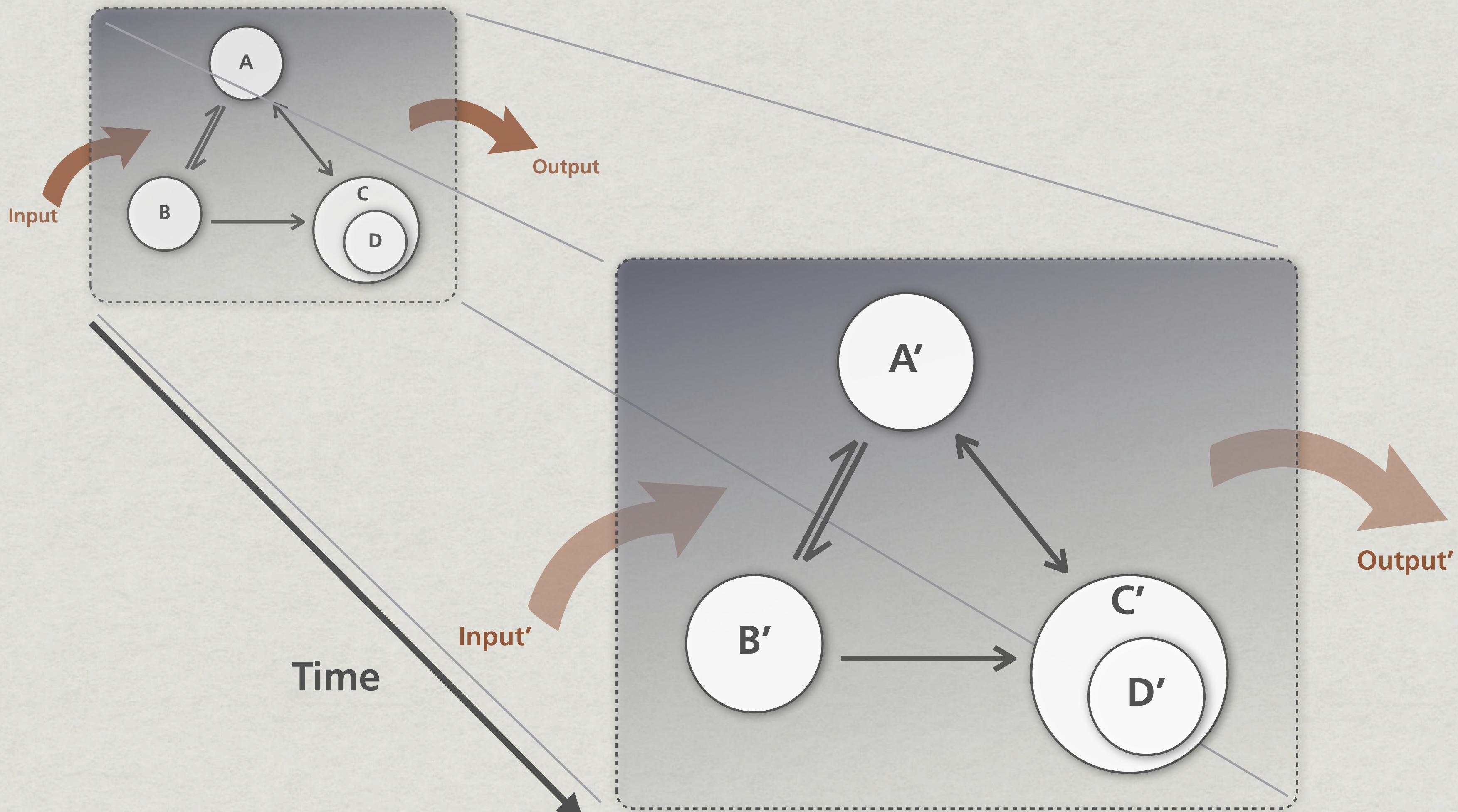


Operational View of a System

1. Objects
2. Relationships
3. Currency
4. Boundary
5. Purpose

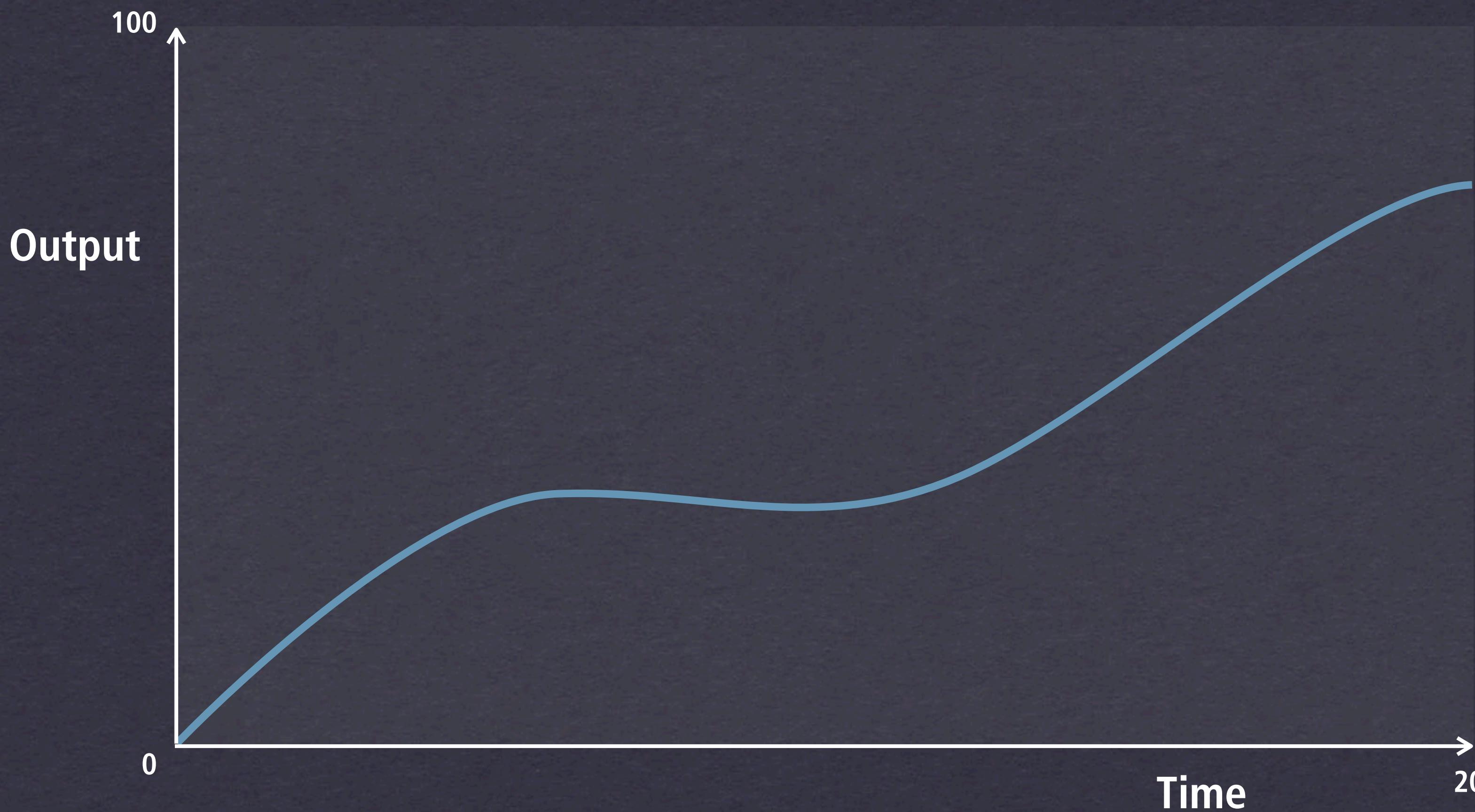


Dynamic View of a System

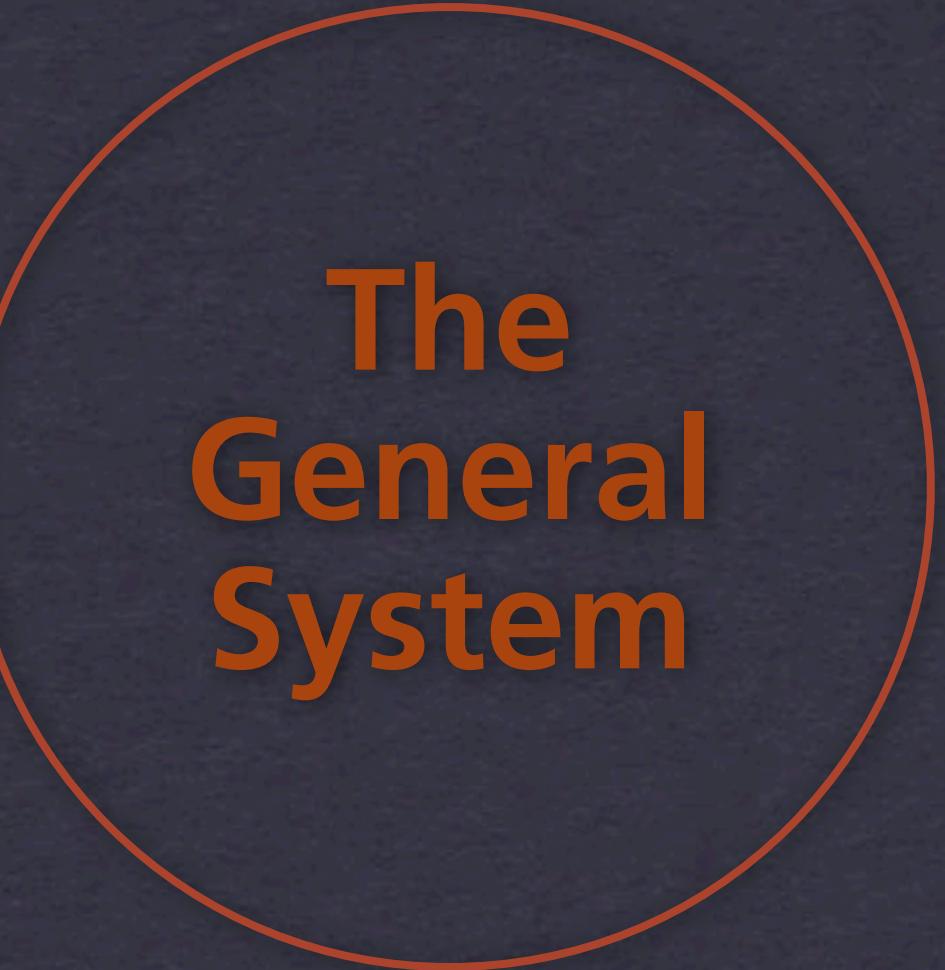


Dynamic View of a System

Behavior vs Time



A system is an interconnected set of elements that is coherently organized in a way that achieves something.



The
General
System

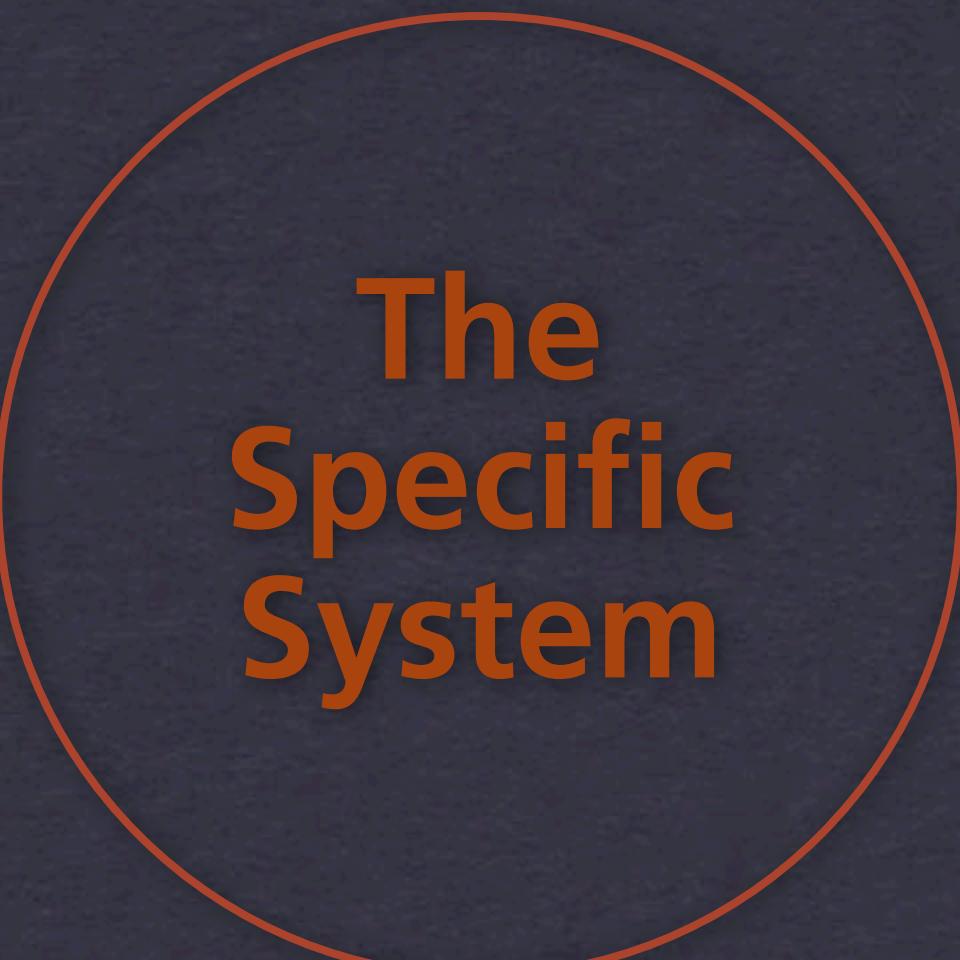
These elements.

Those connections.

This organization.

That boundary.

This purpose.



The
Specific
System

Seeing systems

If it looks like a duck...

- A system's parts must all be present for the system to carry out its purpose optimally.
- A system's parts must be arranged in a specific way for the system to carry out its purpose.
- Systems have specific purposes within larger systems.
- Systems maintain their stability through fluctuations and adjustments.
- Systems have feedback.

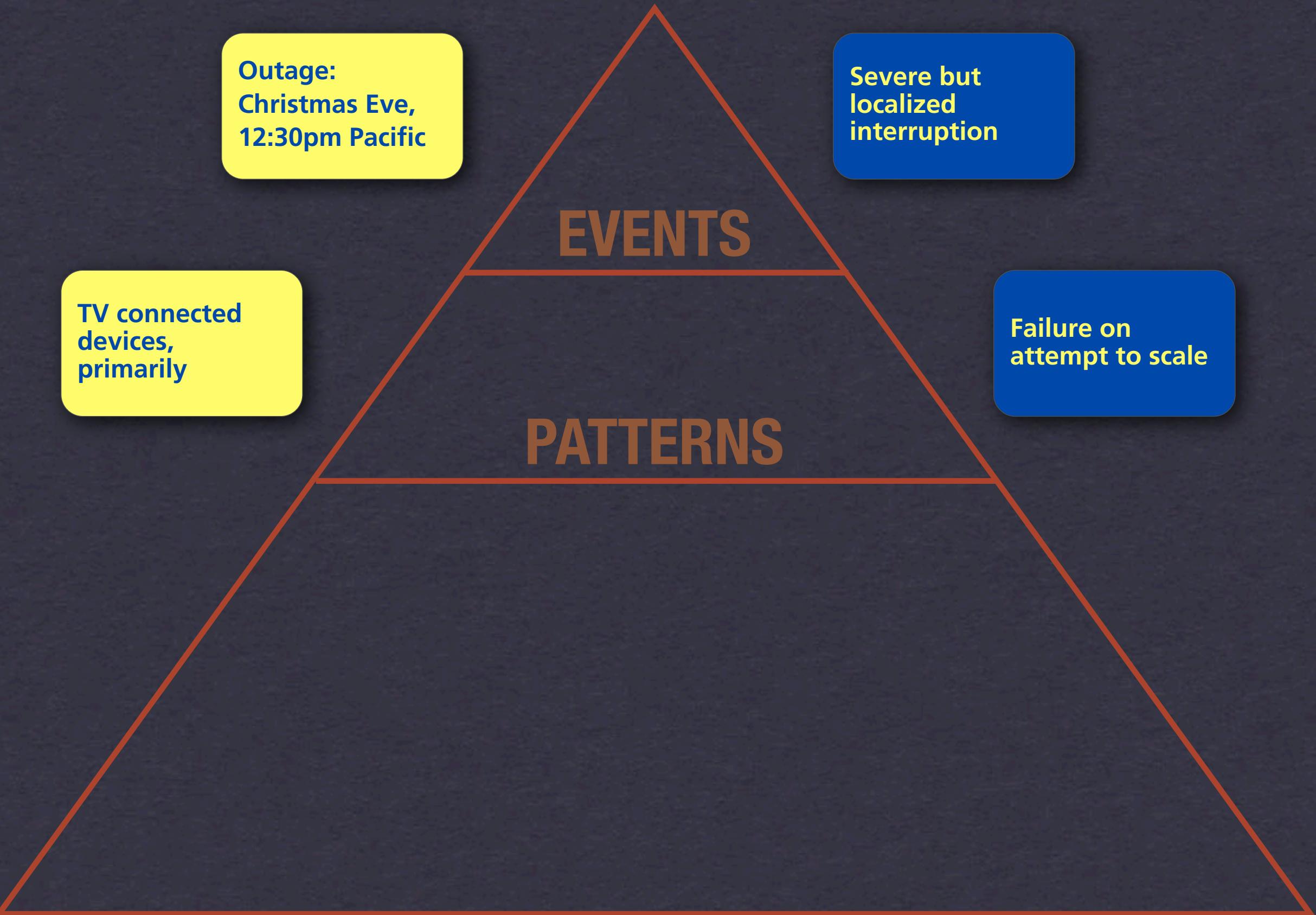
The nature of systems is that
your understanding of a
particular one gets more precise
over time.

Seeing Systems



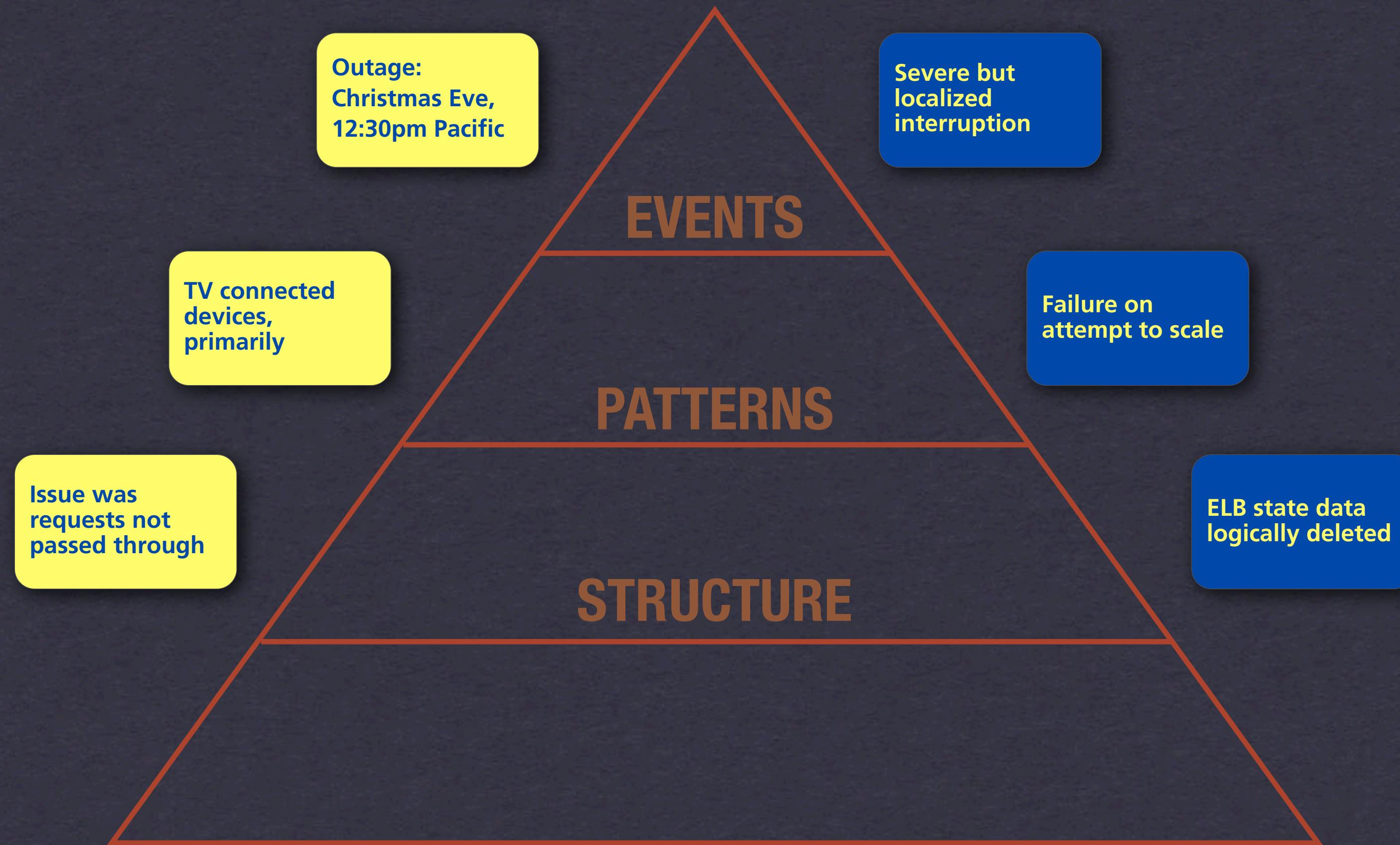
Events are what we notice first.

Seeing Systems



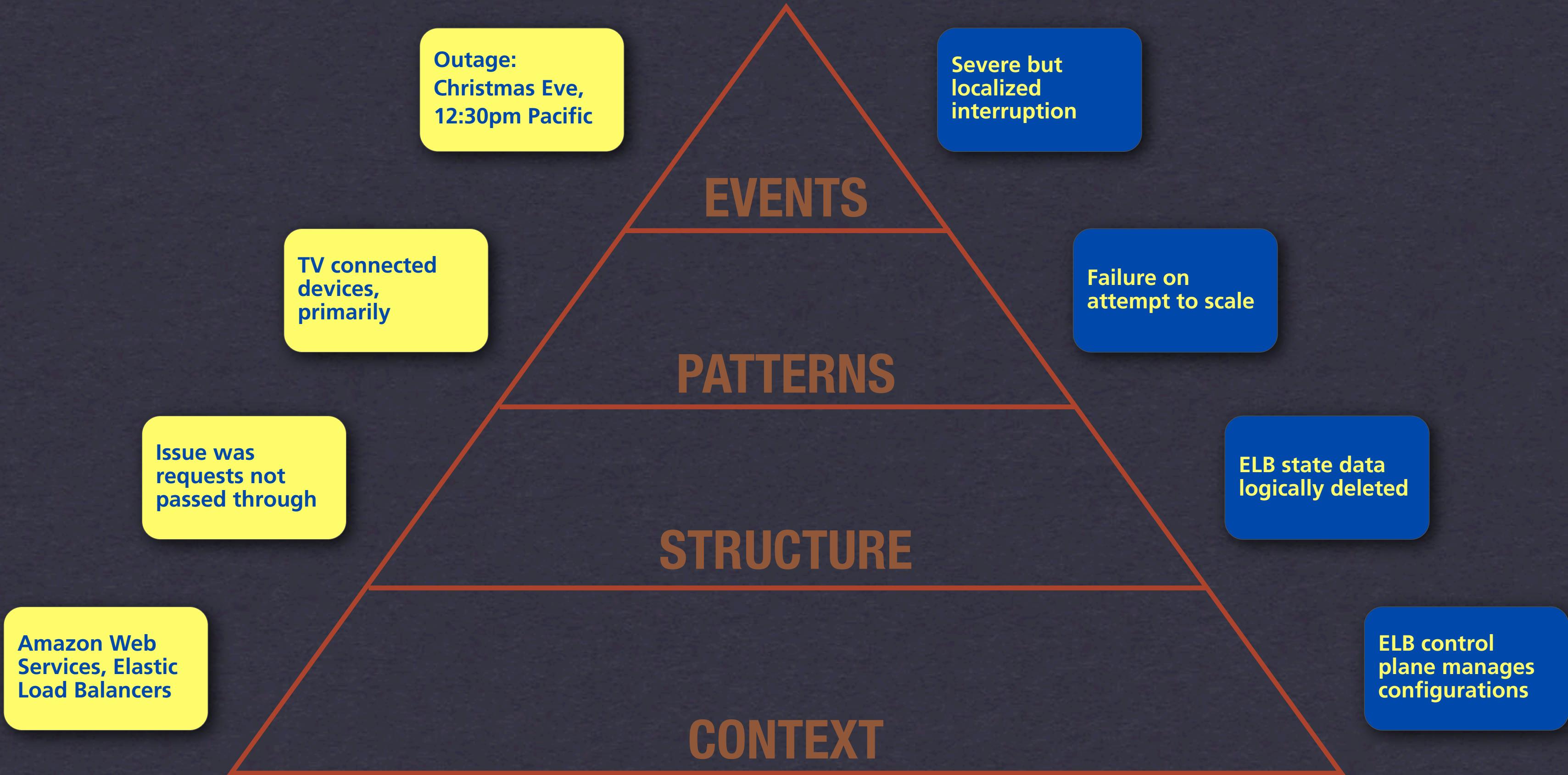
Patterns = Observation(Events + Time)

Seeing Systems



From patterns we deduce structure via 'black box' process

Seeing Systems



Context helps us discriminate the isomorph

Fin

1. Objects
2. Relationships
3. Currency
4. Boundary
5. Purpose

