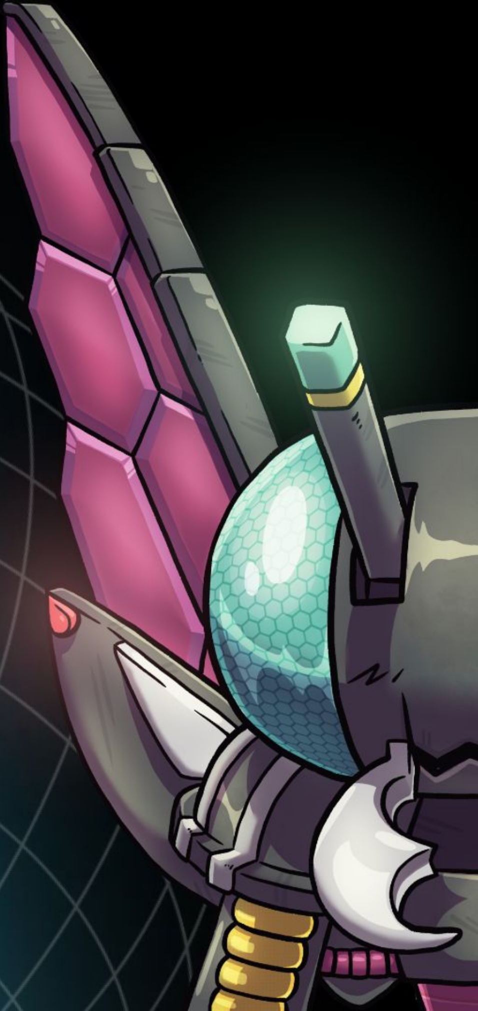
TigerBeetle

1000X WORLD TOUR

13 CITIES | 6 DAYS



Mama Said...
"I ♥ Coffee"

BOOKS NOT BOMBS

TigerBeetle

How I Downgraded a Safety Bug to an Availability bug… using Assertions!

December 4th, 2025

Consensus Protocols

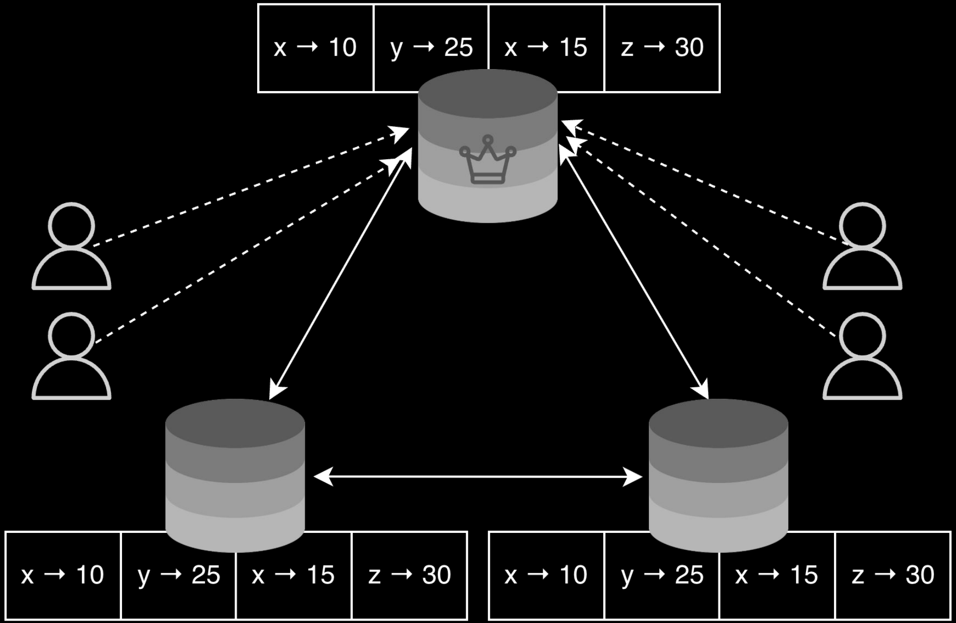
Agreement on the state of the system, even under faults

What do these protocols guarantee?

Fault Tolerance

Ordering

Strict Serializability



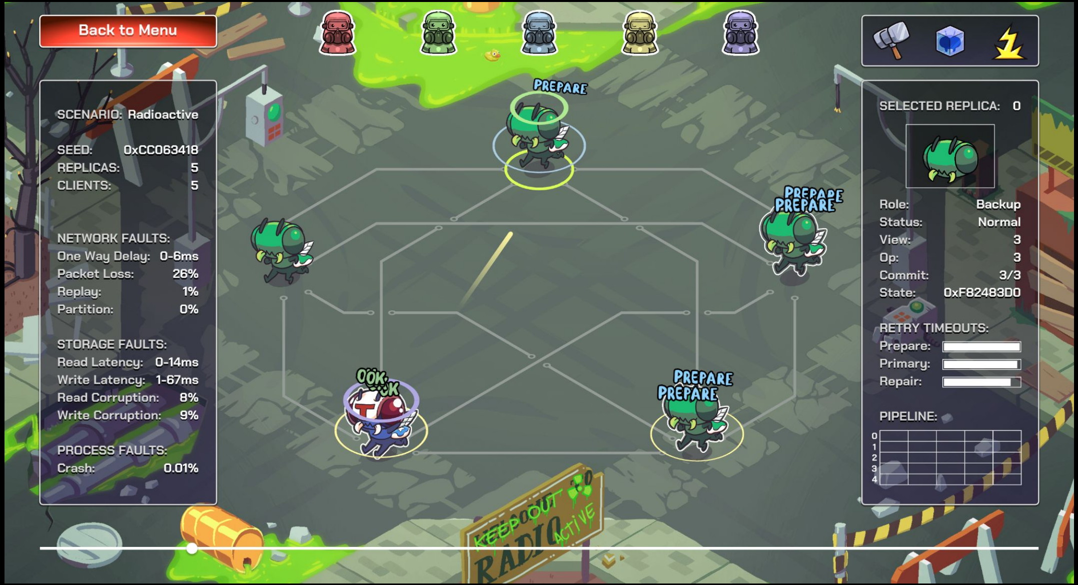
Building Consensus Protocols

Notoriously hard to get right

How we test consensus at

Deterministic Simulation Testing

- Nondeterministic, physical interactions stubbed
- Time sped up
- Finds bugs using *assertions*



SCENARIO: Radioactive

SEED:	0xCC063418
REPLICAS:	5
CLIENTS:	5

NETWORK FAULTS:

One Way Delay:	0-6ms
Packet Loss:	26%
Replay:	1%
Partition:	0%

STORAGE FAULTS:

Read Latency:	0-14ms
Write Latency:	1-67ms
Read Corruption:	8%
Write Corruption:	9%

PROCESS FAULTS:

Crash:	0.01%

SELECTED REPLICA: 0

Role:	Backup
Status:	Normal
View:	3
Op:	3
Commit:	3/3
State:	0xF82483D0

RETRY TIMEOUTS:
Prepare:
Primary:
Repair:

PIPELINE:
0
1
2
3
4

Assertions

Validate system invariants at runtime

Assertions across layers

Assertions in Prod

- Enforce *replica*-level invariants

Assertions in DST

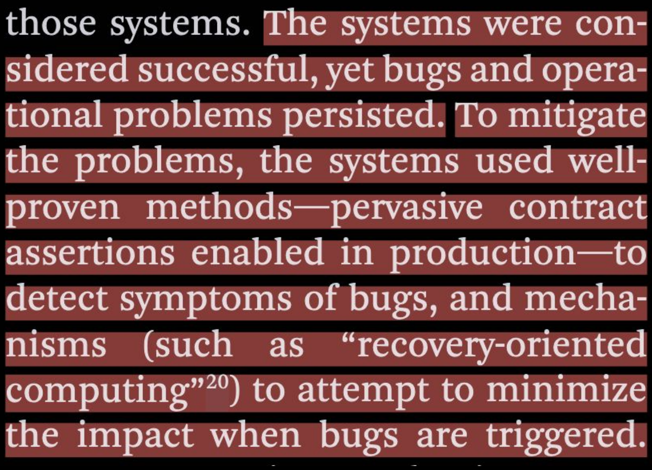
- Check *cluster*-level invariants

```zig
fn on_request_start_view(
    self: *Replica,
    message: *const Message.RequestStartView,
) void {
    assert(message.header.command == .request_start_view);
    if (self.ignore_repair_message(message.base_const())) return;

    assert(self.status == .normal);
    assert(self.view == self.log_view);
    assert(message.header.view == self.view);
    assert(message.header.replica != self.replica);
    assert(self.primary());

    const start_view_message = self.create_start_view_message(message.header.nonce);
    defer self.message_bus.unref(start_view_message);

    assert(start_view_message.header.command == .start_view);
    assert(start_view_message.references == 1);
    assert(start_view_message.header.view == self.view);
    assert(start_view_message.header.op == self.op);
    assert(start_view_message.header.commit_max == self.commit_max);
    assert(start_view_message.header.nonce == message.header.nonce);
    self.send_message_to_replica(message.header.replica, start_view_message);
}
```



those systems. The systems were considered successful, yet bugs and operational problems persisted. To mitigate the problems, the systems used well-proven methods—pervasive contract assertions enabled in production—to detect symptoms of bugs, and mechanisms (such as "recovery-oriented computing"[20]) to attempt to minimize the impact when bugs are triggered.

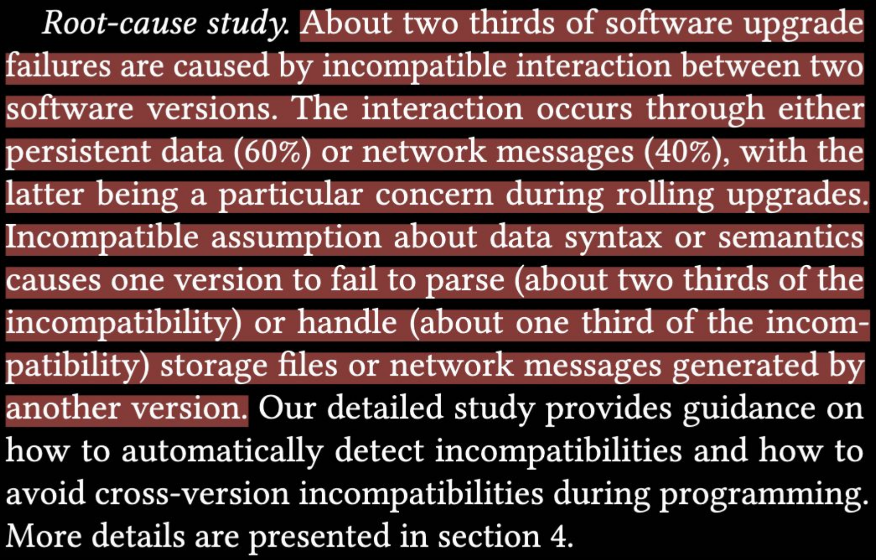
How Amazon Web Services Uses Formal Methods" – Newcombe et al., CACM '15

JEPSEN

TigerBeetle 0.16.11

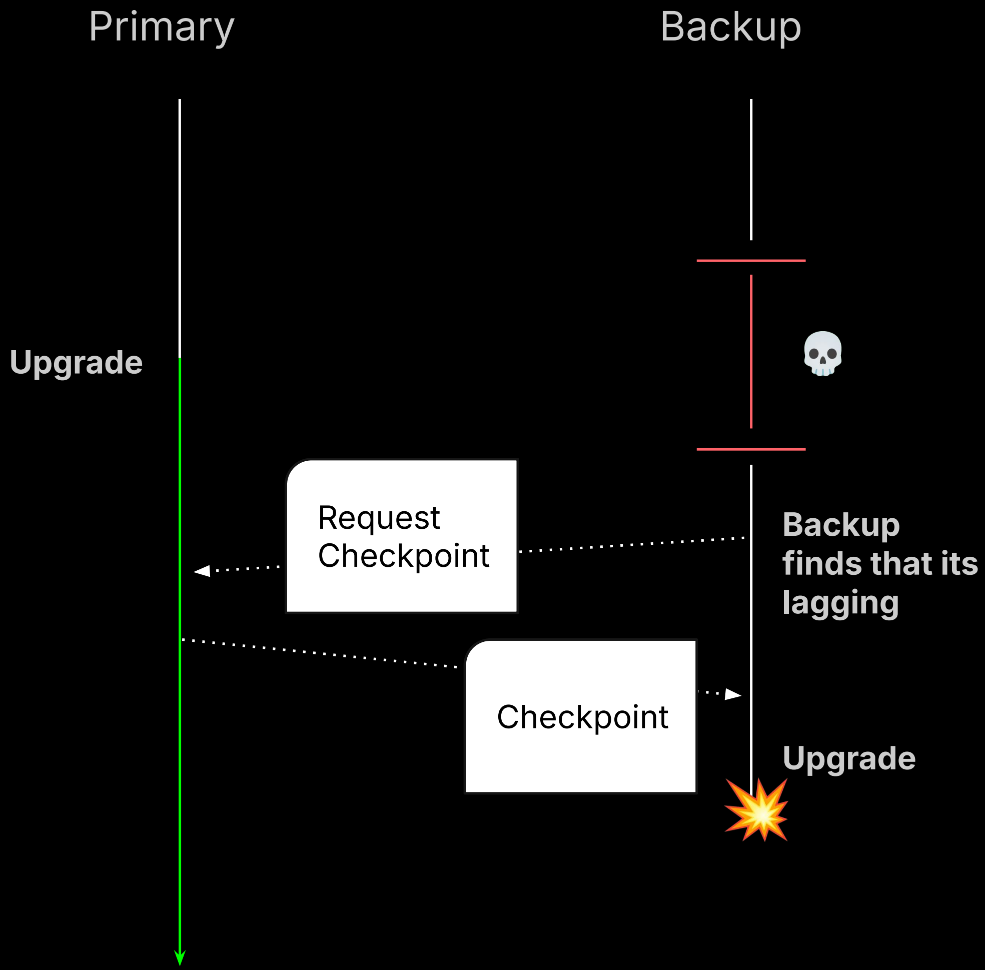
Kyle Kingsbury
2025-06-06

TigerBeetle is a distributed OLTP database oriented towards financial transactions. We tested TigerBeetle 0.16.11 through 0.16.30. We discovered seven client and server crashes, including a segfault on client close and several panics during server upgrades. Single-node failures could cause significantly elevated latencies for the duration of the fault, and requests were intentionally retried forever, which complicates error handling. We found only two safety issues: missing results for queries with multiple predicates, and a minor issue with a debugging API returning incorrect timestamps. TigerBeetle offered exceptional resilience to disk corruption, including damage to every replica's files. However, it lacked a way to handle the total loss of a node's data. As of version 0.16.30, TigerBeetle appeared to meet its promise of Strong Serializability. As of 0.16.45, TigerBeetle had addressed every issue we found, with the exception of indefinite retries. TigerBeetle has written a companion blog post to this work. This report was funded by TigerBeetle, Inc., and conducted in accordance with the Jepsen ethics policy.

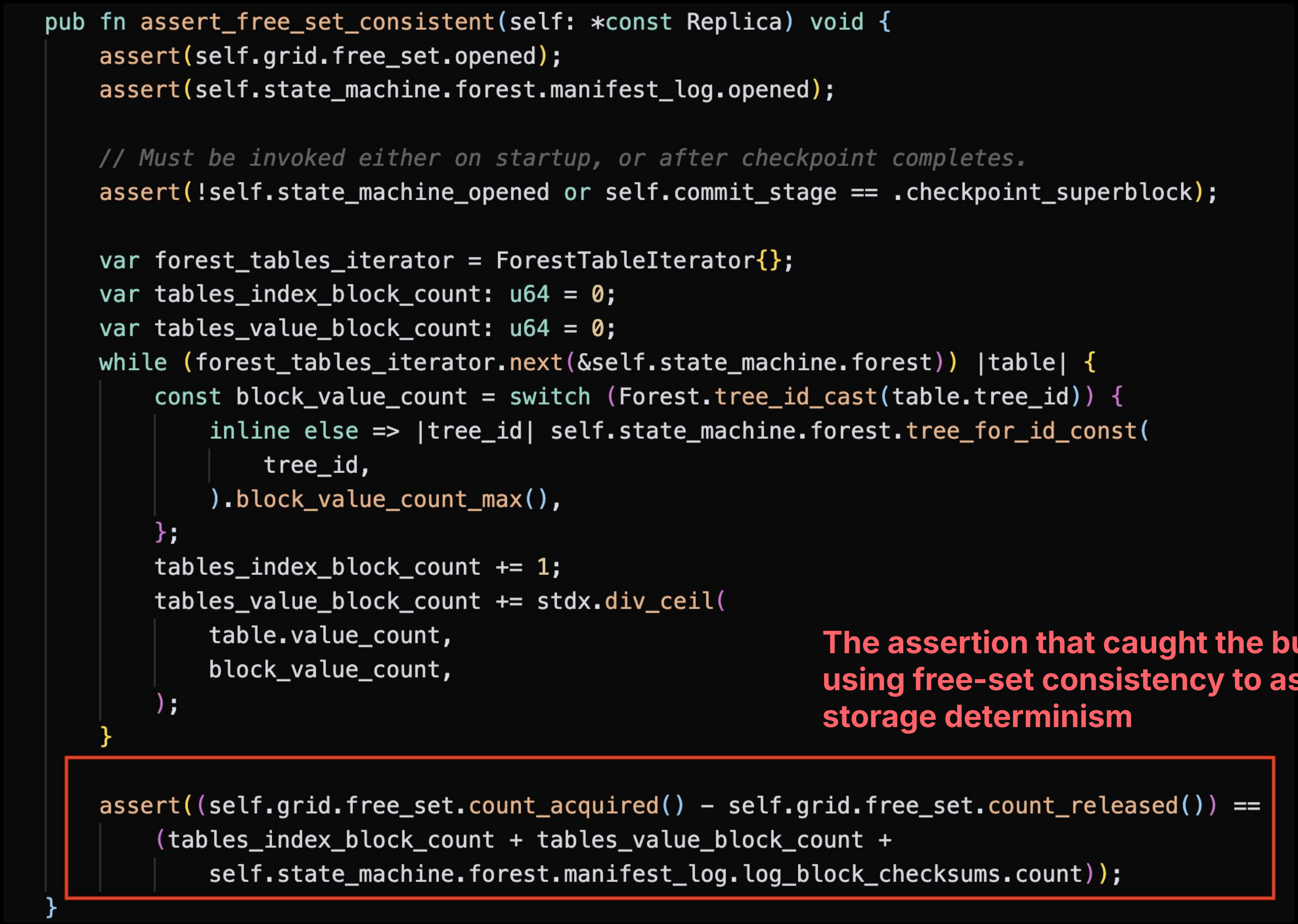


Root-cause study. About two thirds of software upgrade failures are caused by incompatible interaction between two software versions. The interaction occurs through either persistent data (60%) or network messages (40%), with the latter being a particular concern during rolling upgrades. Incompatible assumption about data syntax or semantics causes one version to fail to parse (about two thirds of the incompatibility) or handle (about one third of the incompatibility) storage files or network messages generated by another version. Our detailed study provides guidance on how to automatically detect incompatibilities and how to avoid cross-version incompatibilities during programming. More details are presented in section 4.

Understanding and Detecting Software Upgrade Failures in Distributed Systems - Zhang et al., SOSP 2021



Primary
Backup
Upgrade
💀
Request Checkpoint
Backup finds that its lagging
Checkpoint
Upgrade
💥



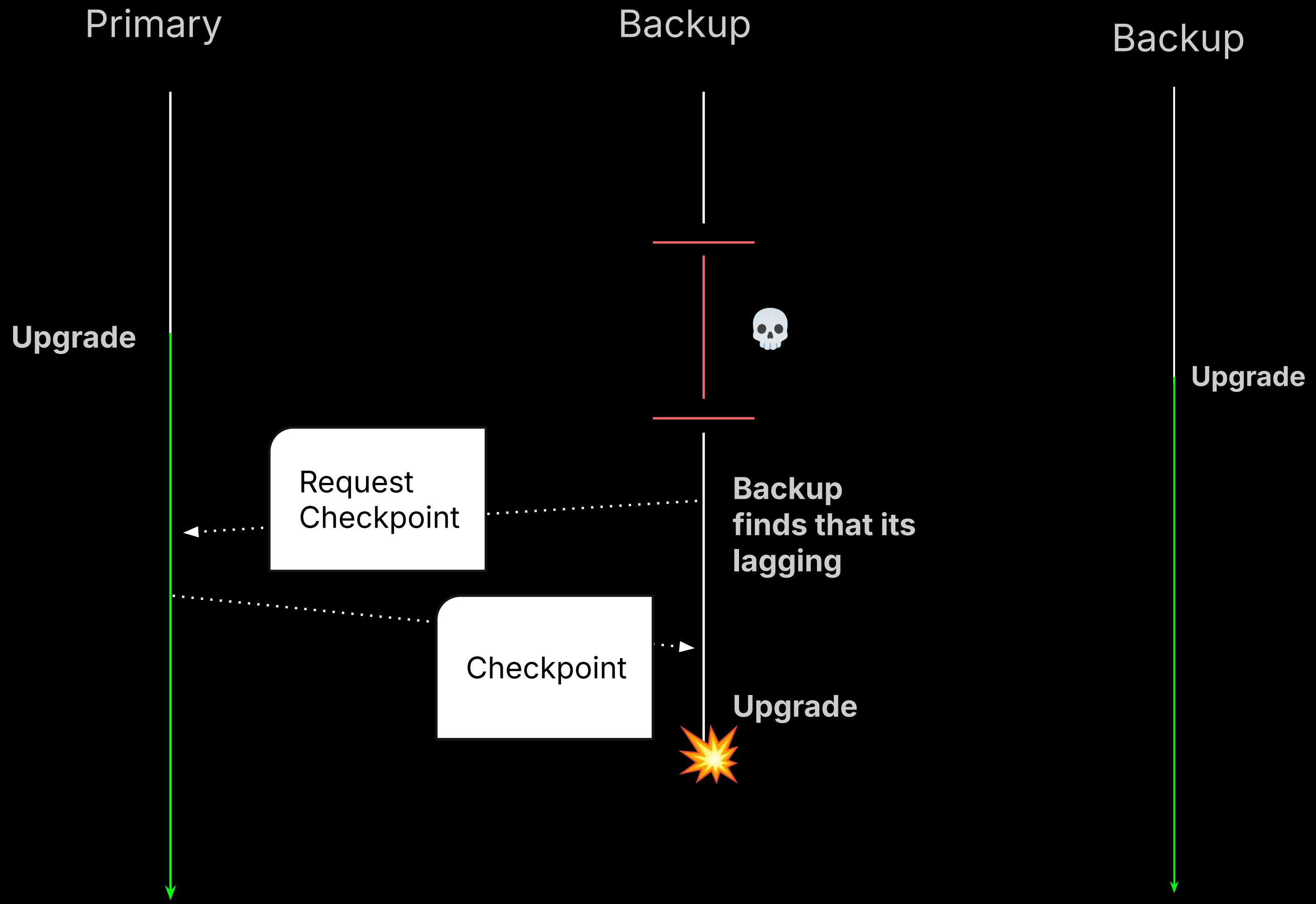
```zig
pub fn assert_free_set_consistent(self: *const Replica) void {
    assert(self.grid.free_set.opened);
    assert(self.state_machine.forest.manifest_log.opened);

    // Must be invoked either on startup, or after checkpoint completes.
    assert(!self.state_machine_opened or self.commit_stage == .checkpoint_superblock);

    var forest_tables_iterator = ForestTableIterator{};
    var tables_index_block_count: u64 = 0;
    var tables_value_block_count: u64 = 0;
    while (forest_tables_iterator.next(&self.state_machine.forest)) |table| {
        const block_value_count = switch (Forest.tree_id_cast(table.tree_id)) {
            inline else => |tree_id| self.state_machine.forest.tree_for_id_const(
                tree_id,
            ).block_value_count_max(),
        };
        tables_index_block_count += 1;
        tables_value_block_count += stdx.div_ceil(
            table.value_count,
            block_value_count,
        );
    }

    assert((self.grid.free_set.count_acquired() - self.grid.free_set.count_released()) ==
        (tables_index_block_count + tables_value_block_count +
            self.state_machine.forest.manifest_log.log_block_checksums.count));
}
```

The assertion that caught the bug; using free-set consistency to assert storage determinism


Primary
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Request Checkpoint
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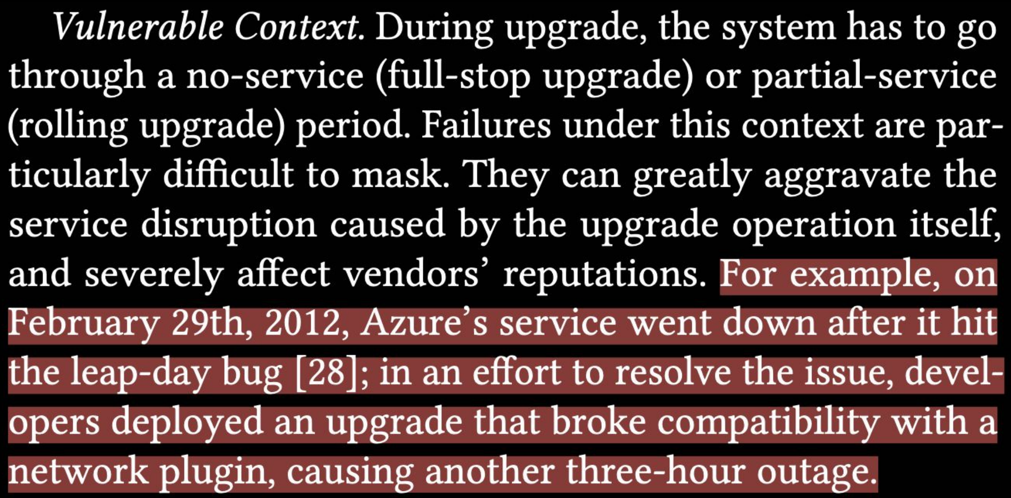
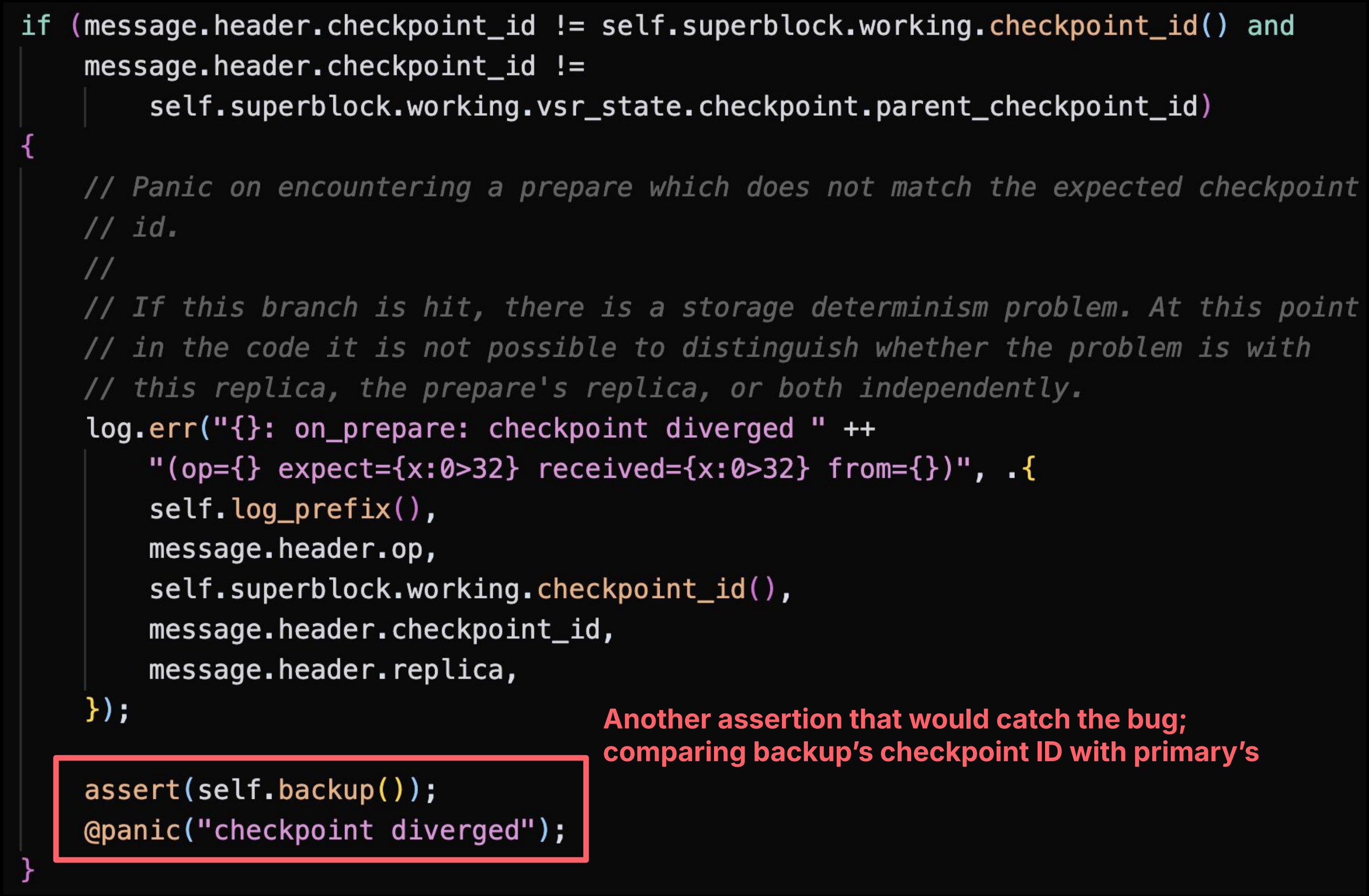


Vulnerable Context. During upgrade, the system has to go through a no-service (full-stop upgrade) or partial-service (rolling upgrade) period. Failures under this context are particularly difficult to mask. They can greatly aggravate the service disruption caused by the upgrade operation itself, and severely affect vendors' reputations. For example, on February 29th, 2012, Azure's service went down after it hit the leap-day bug [28]; in an effort to resolve the issue, developers deployed an upgrade that broke compatibility with a network plugin, causing another three-hour outage.

Understanding and Detecting Software Upgrade Failures in Distributed Systems - Zhang et al., SOSP 2021



```zig
if (message.header.checkpoint_id != self.superblock.working.checkpoint_id() and
    message.header.checkpoint_id !=
        self.superblock.working.vsr_state.checkpoint.parent_checkpoint_id)
{
    // Panic on encountering a prepare which does not match the expected checkpoint
    // id.
    //
    // If this branch is hit, there is a storage determinism problem. At this point
    // in the code it is not possible to distinguish whether the problem is with
    // this replica, the prepare's replica, or both independently.
    log.err("{}: on_prepare: checkpoint diverged " ++
        "(op={} expect={x:0>32} received={x:0>32} from={})", .{
        self.log_prefix(),
        message.header.op,
        self.superblock.working.checkpoint_id(),
        message.header.checkpoint_id,
        message.header.replica,
    });

    assert(self.backup());
    @panic("checkpoint diverged");
}
```

Another assertion that would catch the bug;
comparing backup's checkpoint ID with primary's

Are we feeling assertive yet?

Tiger Style

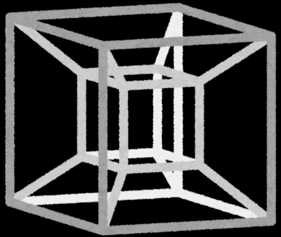
TigerBeetle

TigerSales: Building Trust That Lasts

December 4th, 2025

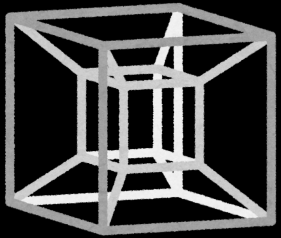
What is trust? (dictionary definition)

Assured reliance on the character, ability, strength, or truth of someone or something.



What is trust? (our own definition)

The undeniable feeling you get when you know someone will raise their hand to take accountability through the good and the bad times. The emotional conviction to know the task at hand will get done well and with unshakeable conviction and character.



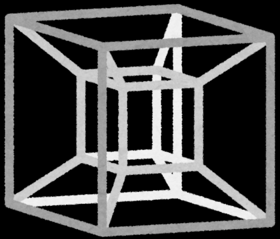
What does it feel like to trust?

- Your spouse
- Your friends
- Your kids
- Your family
- Your colleagues
- Your manager

At TigerBeetle, we want to build genuine trust that lasts.

Trust is nuanced and deep

The undeniable feeling you get when you know someone will raise their hand to take accountability through the good and the bad times. The emotional conviction to know the task at hand will get done well and with unshakeable character.



Revenue is straightforward, but one-dimensional

The total income produced by a given source.

Most businesses make **revenue** the goal.

They think trust is ***“boring”***

But making revenue the goal, ***erodes*** trust and sets up a transactional relationship.

Building trust ***is*** our goal.

Trust is the input, Revenue is the output.

Trust builds revenue, not the other way around.

Trust is determined across multiple phases in sales

TRUST IN SALES

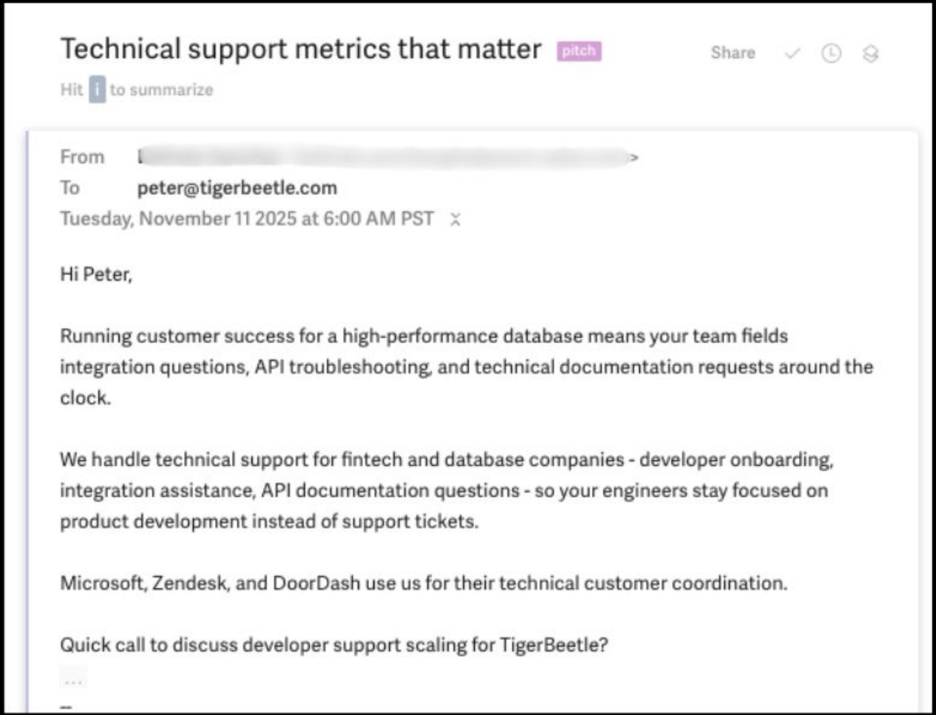
- Pre-call research
- Cold outreach engagement
- First call connection
- First meeting follow-up
- Subsequent virtual & in-person meetings
- Team dynamics
- Technology delivery over contract term

What cold outreach from sales looks like today

COLD OUTREACH
No prior relationship

Automated	“Set it and forget it”
Structured and templatized	“Use these three options”
Focused on sender’s product	“Make sure you list our benefits”
High volume	“We’re warming up 20 domains”
CTA-centric	“Make sure you get that 15 minute call booked”

What are your thoughts on this cold email?



Technical support metrics that matter pitch

Share

Hit i to summarize

From [redacted]>

To peter@tigerbeetle.com

Tuesday, November 11 2025 at 6:00 AM PST

Hi Peter,

Running customer success for a high-performance database means your team fields integration questions, API troubleshooting, and technical documentation requests around the clock.

We handle technical support for fintech and database companies - developer onboarding, integration assistance, API documentation questions - so your engineers stay focused on product development instead of support tickets.

Microsoft, Zendesk, and DoorDash use us for their technical customer coordination.

Quick call to discuss developer support scaling for TigerBeetle?

...

--

Assuming where my pain is vs. knowing

Focused on them vs. me

Assuming I care about these logos

Asking for a meeting on first email

Today’s cold email templates are hurting your brand and your chances at building trust.

And it doesn’t get much better after the first meeting, either.

“***Just*** following-up on our first meeting..”

“I haven’t heard from you so is this not a priority?…”

“Can you let me know which *fits your situation?:*

A. I offended you in my first meeting
B. You’ve been on a vacation island for the past 2 weeks
C. You’re still interested in chatting”

What if you changed how your prospects got to know you?

COLD
No prior relationship

Often automated	→	Highly curated and intentional
Structured and templatized	→	Experimental and creative
Focused on sender’s product	→	Focused on trends
High volume	→	High on human connection
CTA-centric	→	Solution-centric

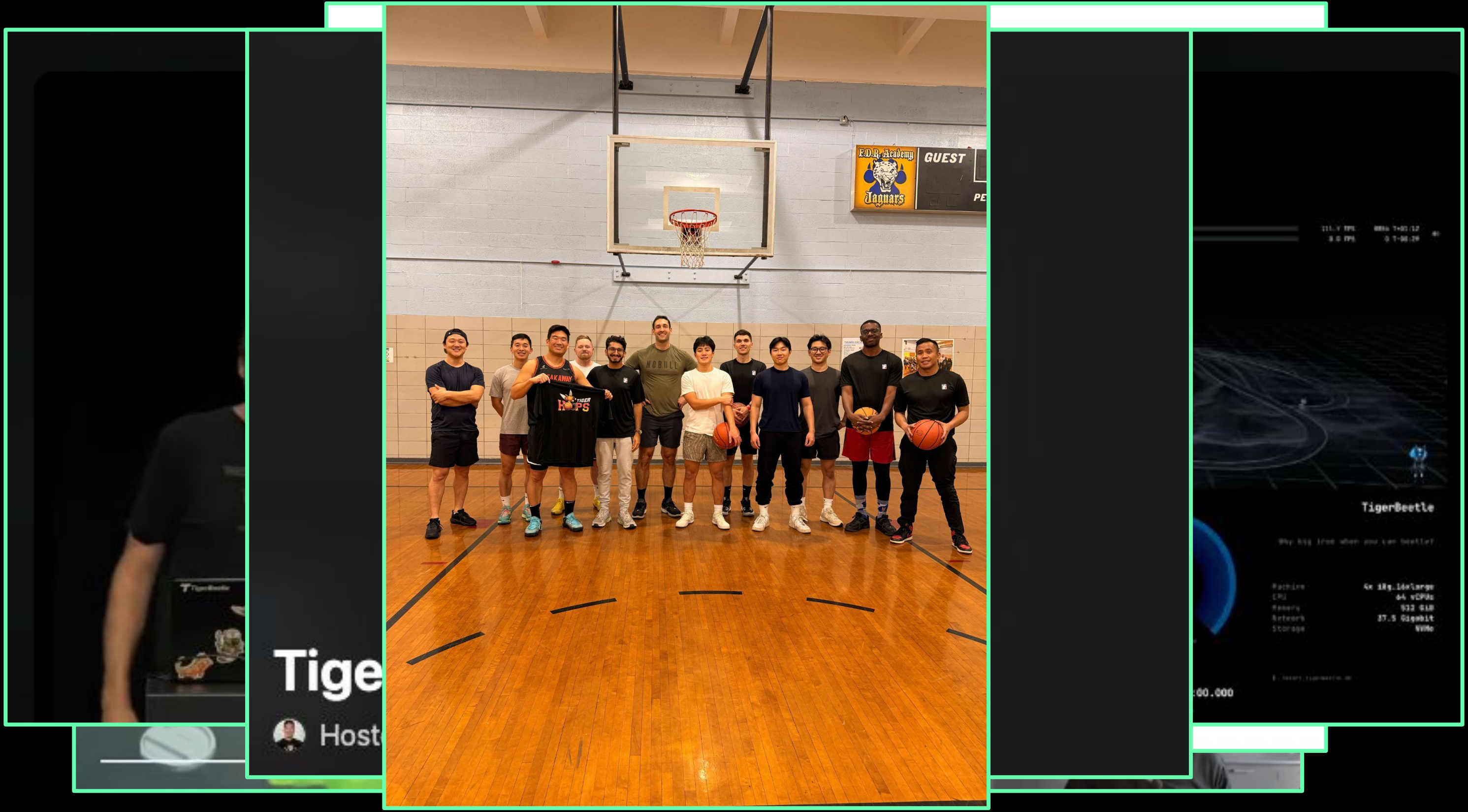
Here’s how we’d like to get to know you

COLD
No prior relationship

Highly curated and intentional	“We’re hosting something for the community…”
Experimental and creative	“We created a racer game to demonstrate TigerBeetle’s performance”
Focused on universal pains	“Realtime is only increasing”
High on human connection	“We’d love to meet you…”
Solution-centric	“Here’s what we believe is the path..”

TigerBeetle

BTHF: Be There Have Fun!



What you won’t see us do

X Automated cold sequences

X Multiple follow-ups after the first call

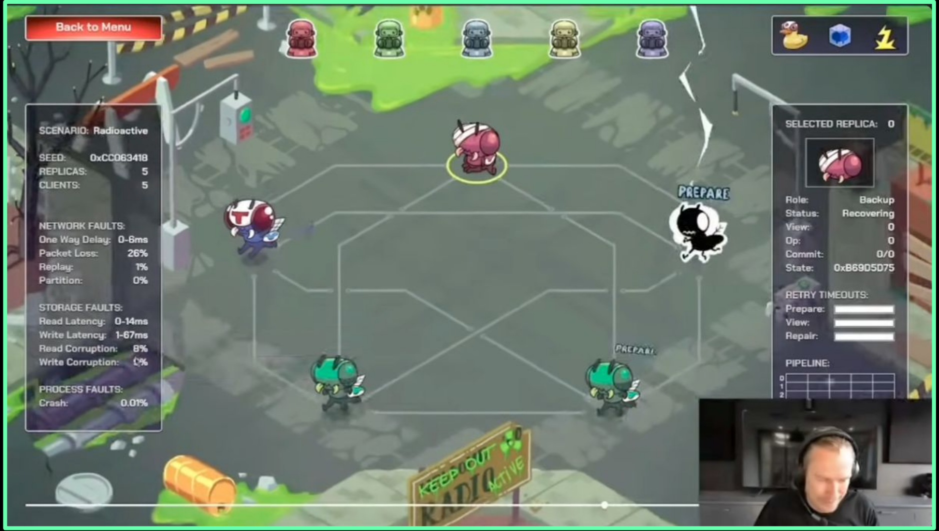
What we *will* do

Continue to bring the community together

Create authentic 1:1 relationships

BTHF!

TigerBeetle



```
SCENARIO: Radioactive

SEED:              0xCC063418
REPLICAS:                   5
CLIENTS:                    5

NETWORK FAULTS:
One Way Delay:          0-6ms
Packet Loss:              26%
Replay:                    1%
Partition:                 0%

STORAGE FAULTS:
Read Latency:          0-14ms
Write Latency:         1-67ms
Read Corruption:           8%
Write Corruption:          0%

PROCESS FAULTS:
Crash:                  0.01%
```

```
SELECTED REPLICA:   0

Role:              Backup
Status:        Recovering
View:                   0
Op:                     0
Commit:               0/0
State:         0xB69D5D75

RETRY TIMEOUTS:
Prepare:
View:
Repair:

PIPELINE:
0
1
2
```

Thank you!

APPENDIX

Now think about the technology partners and vendors you work with...do you trust them?

We'd like to share a thing or two about how we think about building it.

Trust is also hard to measure, takes time, and is subjective.

Trust is determined across multiple phases in sales

TRUST

- Pre-call research
- Cold outreach engagement
- First call connection
- First meeting follow-up
- Subsequent virtual & in-person meetings
- Team dynamics
- Technology delivery over contract term

REVENUE

- Post contract transaction

What you won’t see us do

X Automated cold sequences

X Multiple follow-ups after the first call

X Sticking around when relationships lack mutual respect

X Compromising our values when faced with a shiny logo

What we *will* do

Continue to bring the community together

Create authentic 1:1 relationships

Help support the transition to realtime

BTHF!

TigerBeetle