

# DEFENDING THE GLOBAL FINANCIAL BACKBONE

Euroclear's Reliability Journey



**SRE  
CON** EUROPE  
MIDDLE EAST  
AFRICA

**Dublin, Ireland**  
7-9 October, 2025





## WHO ARE WE.

SRE  
CON EUROPE  
MIDDLE EAST  
AFRICA

### ERIK VAN NOOTEN Euroclear

Euroclear Resiliency Transformation  
Program Leader

Musical Enthusiast / Jazz / Bass Guitar / 🎷 Tenor Sax

<https://be.linkedin.com/in/erikvannooten>



### HAYTHAM ELKHOJA Euroclear / Kyndryl

Euroclear Application Reliability  
Factory Leader

👉 Metal / Jazz / Golf / Snowboard

<https://ae.linkedin.com/in/haythamelkhoja>



*printf('Hello SRECon'25');*



SRE EUROPE  
CON MIDDLE EAST  
AFRICA

***“Trust arrives on foot and  
leaves on horseback”***

*– Old Dutch proverb*



**SRE** EUROPE  
**CON** MIDDLE EAST  
AFRICA

**THE HEART OF EUROPE'S FINANCIAL MARKET.**

**TRUST = RELIABILITY + CONSISTENCY**



**THE HEART OF EUROPE'S FINANCIAL MARKET.**

**SRE** EUROPE  
**CON** MIDDLE EAST  
AFRICA

**BUT FIRST, WHO IS EUROCLEAR.**

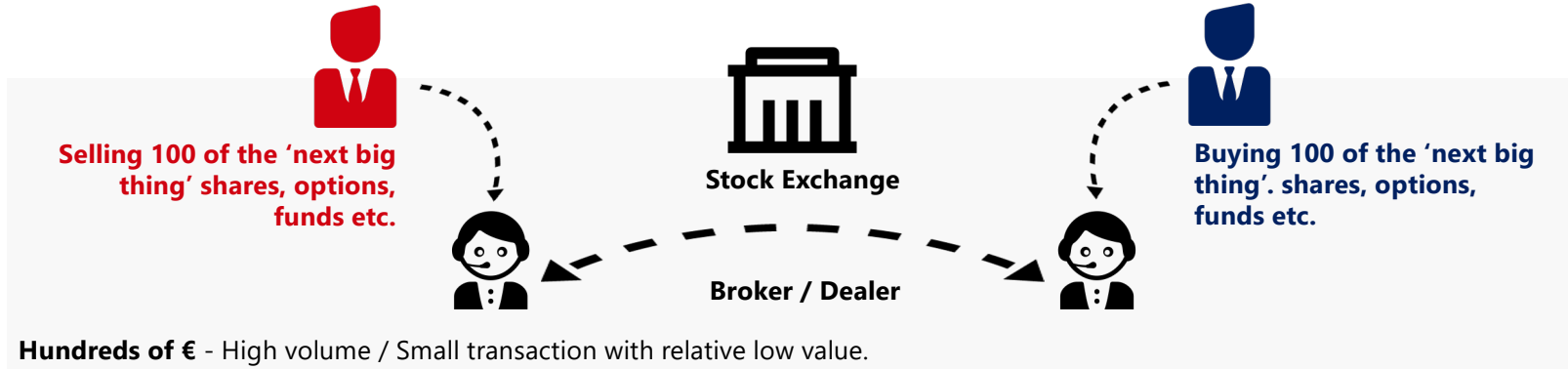
*Most probably the largest European company you've never heard of.*



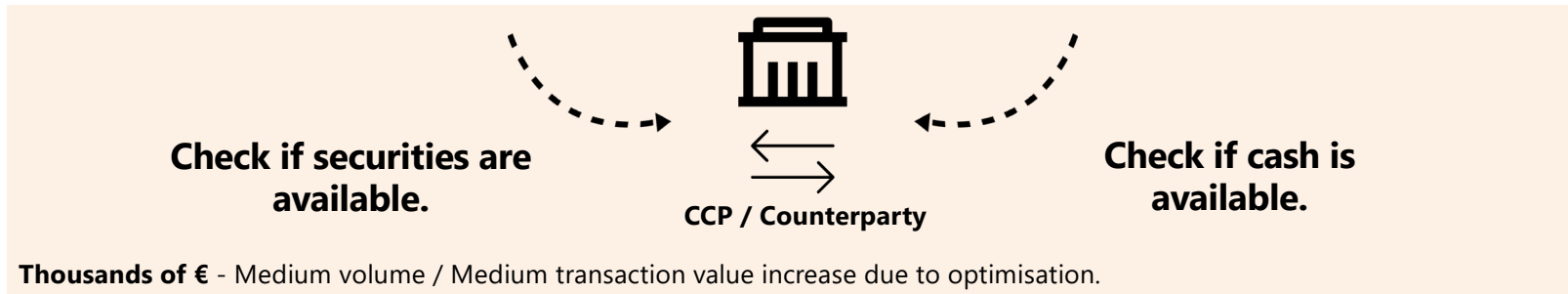
SRE CON EUROPE MIDDLE EAST AFRICA

# THE GLOBAL FINANCIAL BACKBONE ... A CRASH COURSE.

## TRADING



## CLEARING



## SETTLEMENT





SRE EUROPE  
CON MIDDLE EAST  
AFRICA

## THE GLOBAL FINANCIAL BACKBONE ... A CRASH COURSE.

**EVERY NIGHT EUROCLEAR PROCESSES  
6 x THE GDP OF BELGIUM.**

### EUROCLEAR KEY FIGURES

**€1,162 Trillion**  
worth of transactions  
per year.

**€40 Trillion**  
assets under custody.

**3800**  
clients globally.

**€2 Trillion**  
average daily through  
collateral highway.

**+50 markets. +44 currencies.**

*Other types of critical liquid assets include Belgian dubbel, tripel, quadruple beers.*



SRE EUROPE  
CON MIDDLE EAST  
AFRICA

# THERE IS NO UNDO. DATA MUST BE PERFECT.

## WHY 'CONSISTENCY' IS DIFFERENT AT EUROCLEAR.



### SECURITIES OWNERSHIP

#### NOT JUST A DATABASE

Euroclear maintains the **authoritative record** of securities ownership and determines property rights for **trillions** in assets across multiple markets.



### SETTLEMENT FINALITY

#### IMMUTABLE RECORDS

When trades settle through Euroclear, that settlement is legally **final** and **irrevocable**.



### COLLATERAL MANAGEMENT

#### COULD LEAD TO CASCADING CATASTROPHIES

The integrity of these records has a **ripple effect** on global lending and liquidity across multiple financial systems and will **prevent banks** from accessing collateral for overnight funding.

*No fake news, no alternative facts. Only synchronized truths.*



SRE EUROPE  
CON MIDDLE EAST  
AFRICA

## THE STAKES: RELIABILITY MEASURED IN TRILLIONS OF €.

### WHY 'RELIABILITY' IS DIFFERENT AT EUROCLEAR.

- Not a "99.999% uptime" problem → it's a "**global stability**" problem. Regional market closure triggering global settlement freeze can lead to a **domino effect**.
- Settlement disruption in one jurisdiction affecting others could potentially cause **cross-border contagion** (*and a geopolitical mayhem*).
- During outages, chaos may erupt as disputes and confusion over **property rights and asset ownership**.
- Waiting to declare a disaster/failure can potentially lead to unpredictable recovery time, and more importantly, a non-deterministic '**state**'.



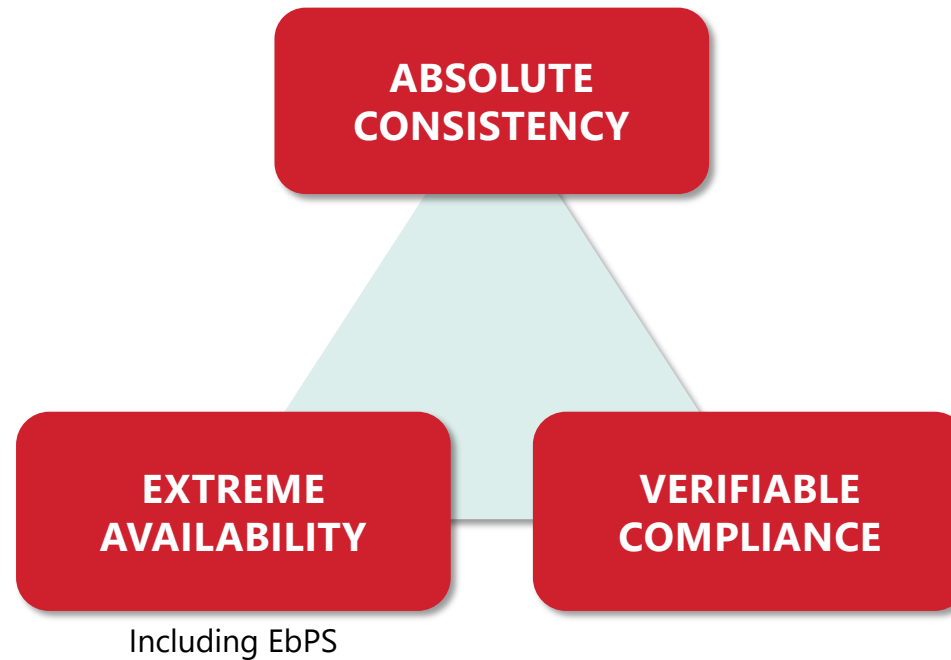
AI Generated

*When a bug can destabilize the entire market.*



SRE EUROPE  
CON MIDDLE EAST  
AFRICA

# THE FINANCIAL RELIABILITY **TRILEMMA.**



**TRADITIONAL TRADE-OFFS ARE NOT AN OPTION.**

*This isn't any triangle. It's the Bermuda triangle where your sanity disappears.*



# THE REGULATORY REALITY.

SRE EUROPE  
CON MIDDLE EAST  
AFRICA

## REGULATORS ARE STILL TRYING TO CATCH UP.

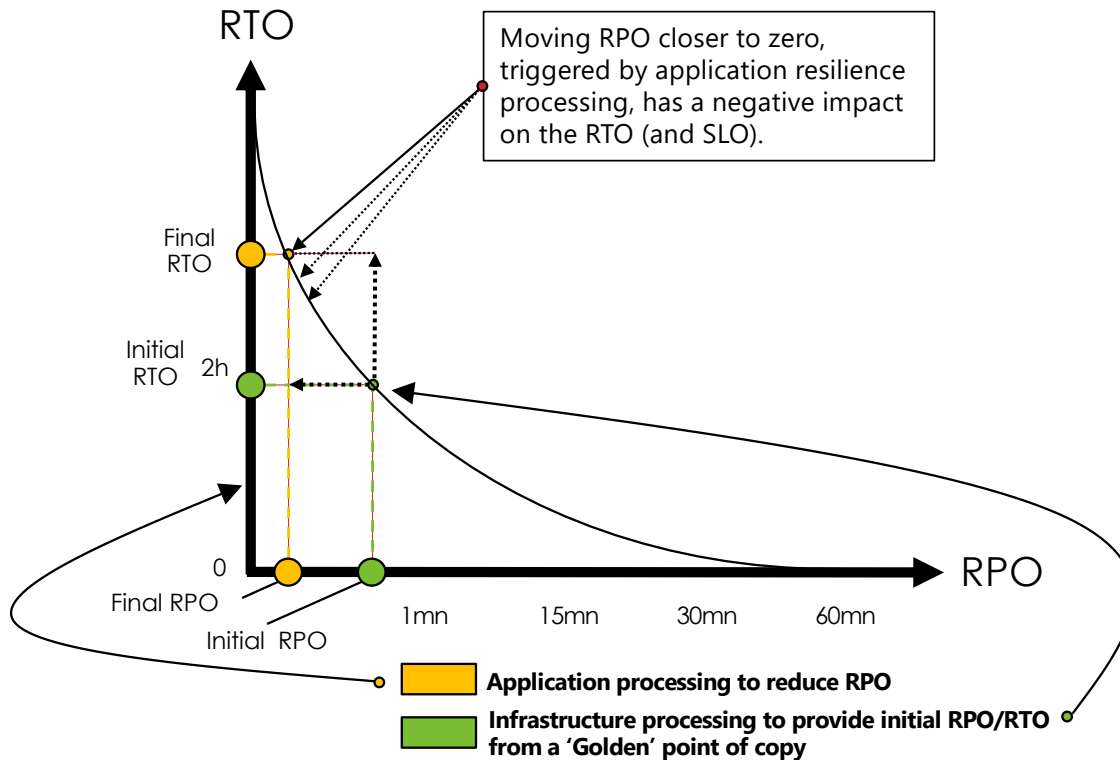
- Regulators' focus remain on security and hardening systems against external threats.
- RTO < 2 hours.
  - This mindset is optimized for monolithic systems and physical site failures, not complex, distributed "in-place" failures.
- When it comes to 'Regulatory' there isn't one framework; it's a global web of rules. We juggle compliance with **40+** distinct regulatory frameworks and local laws:
  - CPMIO/IOSCO (PFMI 17), Swift Customer Security Programme (CSP), ISAE 3402, French Military Law: ANSSI rules / ANSI TIA-942C etc.
- DORA's mandate: *"Must recover quickly"*.
  - In our world, recovering quickly **without correctness** is a global financial catastrophe.

*Say 'Blameless' three times in front of an auditor and see what happens.*



SRE CON EUROPE MIDDLE EAST AFRICA

# SPEED V/S CORRECTNESS.



## OUR WORLD IS NOT EVENT-DRIVEN ... YET.

- Any attempt to lower RTOs and Availability SLOs may potentially negatively impact RPO.
- In our case, SLOs/SLAs refer to the availability of a system providing the correct data.
- Data loss = Potentially in € Billions.
- Correct '**state**' is EVERYTHING.

*Life would be much easier if we could simply "publish-and-pray."*



**SRE** EUROPE  
**CON** MIDDLE EAST  
AFRICA

# WHAT DO WE MEAN BY 'STATE'?



SRE CON EUROPE MIDDLE EAST AFRICA

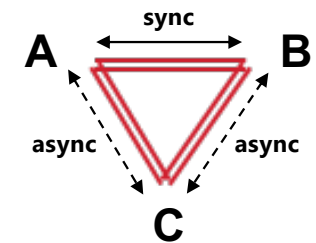
# THE ADVENT OF THE ALL-IN-ONE CONSISTENCY GROUP... IN THE PAST.

## ALL-OR-NOTHING OPERATIONS ACROSS MAINFRAME AND OPEN SYSTEMS.

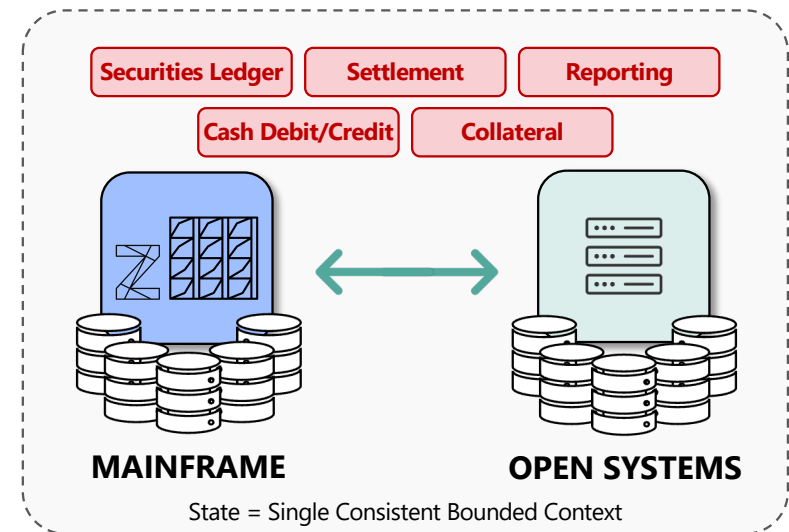
- Enforced atomic unit ... across all data stores.
- Prevents 'fractured' states, even in async.
- Point-in-time consistency. If data is lost, it's lost everywhere.
- One-of-a-kind solution, purpose-built for Euroclear.

## SERVED EUROCLEAR WELL. GREW MASSIVELY, BUT ... DOESN'T SCALE IN THE NEW WORLD.

- Single, yet distributed Source of Truth. Tightly coupled. Infrastructure-dependent. Big Fat Monolith.
- Made applications resiliency provisions non-existent.



PRIORITIZES AVAILABILITY IN-REGION.  
PRIORITIZES CONSISTENCY CROSS-REGION



*Our Enterprise Consistency Group is so massive, Eric Brewer would google how to undo the CAP theorem.*



SRE EUROPE  
CON MIDDLE EAST  
AFRICA

## OUR CATALYST TO TRANSFORM.

### AT THE MERCY OF THE REGULATOR.

- Assessment:

*“From a risk perspective [...] must improve beyond the likely threats (e.g. severance of cables, rogue colocation tenants) but is still exposed to the highest impacting threats (e.g. natural disasters, weapons of mass destruction, terrorist attacks) [...]”*

- **Must** adopt autonomous Multi-Region / Multi-DC.
- **Must** swap regions for prolonged durations.
- **Must** limit cascading failures / limit blast radius.

### AT THE MERCY OF TECHNICAL DEBT.

- Vendor ending support of our purpose-built storage-based **All-In-One Consistency Group**.
- **Must** Auto Heal and Auto Swap.
  - Unplanned failures.
  - More frequent planned tests.
  - More frequent planned zero downtime maintenance.
  - Much bigger scope of workloads.
- **Must** decouple:
  - Resilience and reliability is end-to-end stack.
  - Preparation for the modern world.

*Archaeologists will study what used to exist.*



SRE EUROPE  
CON MIDDLE EAST  
AFRICA

# EUROCLEAR'S RELIABILITY TRANSFORMATION JOURNEY.

## ARCHITECTURAL SHIFT

- MVFMI: Reduce the size of problem
- From monolithic to granular consistency.
- Application-based reliability and resilience patterns.

## FUTURE-PROOF

- Autonomous AZs (Cloud-Prem).
- Infrastructure decoupling.
- Technical debt remediations (When possible).
- Stay aligned with 'Resilience-focused' regulations.

## INDUSTRIALIZED

- Standardized architectures and patterns (Not artisanal).
- Repeatable resiliency archetypes and transformation runbooks.
- Apps must adopt modern Consistency framework.
- One App at a time.

*Because nothing says 'digital mid-life crisis' like duct-taping APIs to a 30-year-old system.*



SRE EUROPE  
CON MIDDLE EAST  
AFRICA

# TRANSFORMATION JOURNEY FOCUSED ON 2 PILLARS.

## PILLAR 1

### GUARANTEE FAULT ISOLATION.

#### Deep Dive 1: About Reliability.

Prevent a single component failure from causing a systemic and cascading outage.

## PILLAR 2

### GUARANTEE EVERY MESSAGE.

#### Deep Dive 2: About Consistency.

Ensure atomic, exactly-once processing for every transaction across isolated services.



**SRE** EUROPE  
**CON** MIDDLE EAST  
AFRICA

# **DEEP DIVE 1: ABOUT RELIABILITY.**

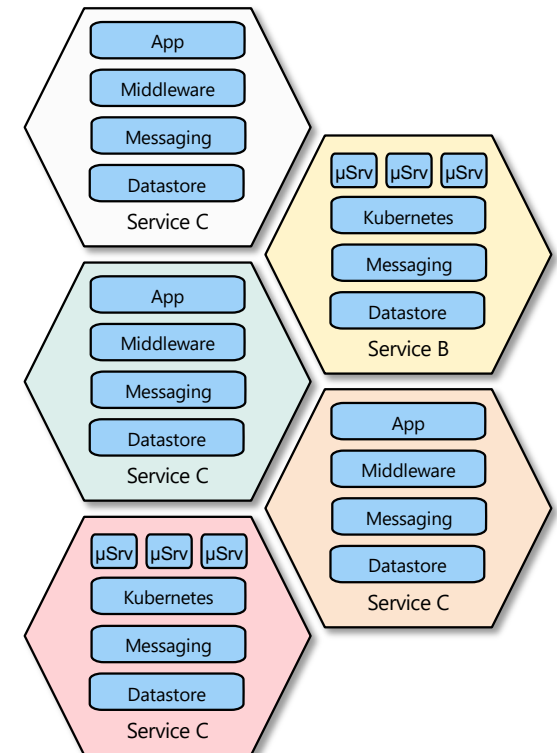


SRE EUROPE  
CON MIDDLE EAST  
AFRICA

# COMPARTMENTALIZED CELL ARCHITECTURE.

## OUR PRINCIPLES FOR RELIABILITY.

- Share-Nothing. Stretch-Nothing in Compartmentalized Cells.
- Each App/Service (and dependencies) makes a Cell ... The critical transactional path is in a single **bounded-context**.
- Cells are redundant, distributed and **active everywhere**:
  - Multi-DCs and AZs
  - Multi-Regions
- Traffic entering a Cell follows a sticky 'Swimlane'.
- Failure isolation/Blast radius at the Cell level.
- Cell size and location-scope depends on App (and its dependencies).



*Paranoia is just good engineering.*

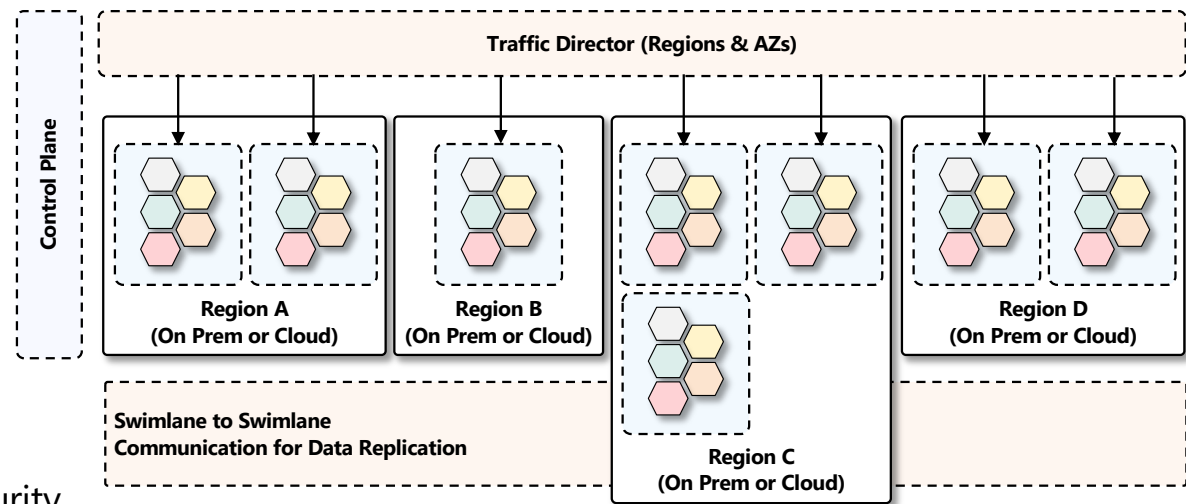


# STAY IN YOUR SWIMLANE!

SRE CON EUROPE MIDDLE EAST AFRICA

## RELIABILITY OPERATIONAL MODEL MUST BE WELL UNDERSTOOD.

- DC/AZ-aware workload placement:
  - Cells confined to one DC/AZ.
  - Cells spanning multiple DC/AZ (must avoid).
- Advanced routing with DC/AZ awareness.
  - Hide/bypass failures. Avoid recovery when possible.
- Automation and Cell lifecycle management.
- CDNs, DMZ, Third-party/partner connections and security.
- Maintenance/Updates/Releases: **One Cell at a time.**
- Global services and coordination must have their own model..



*And now split-brain is a lifestyle.*



**SRE** EUROPE  
**CON** MIDDLE EAST  
AFRICA

# **DEEP DIVE 2: ABOUT CONSISTENCY.**

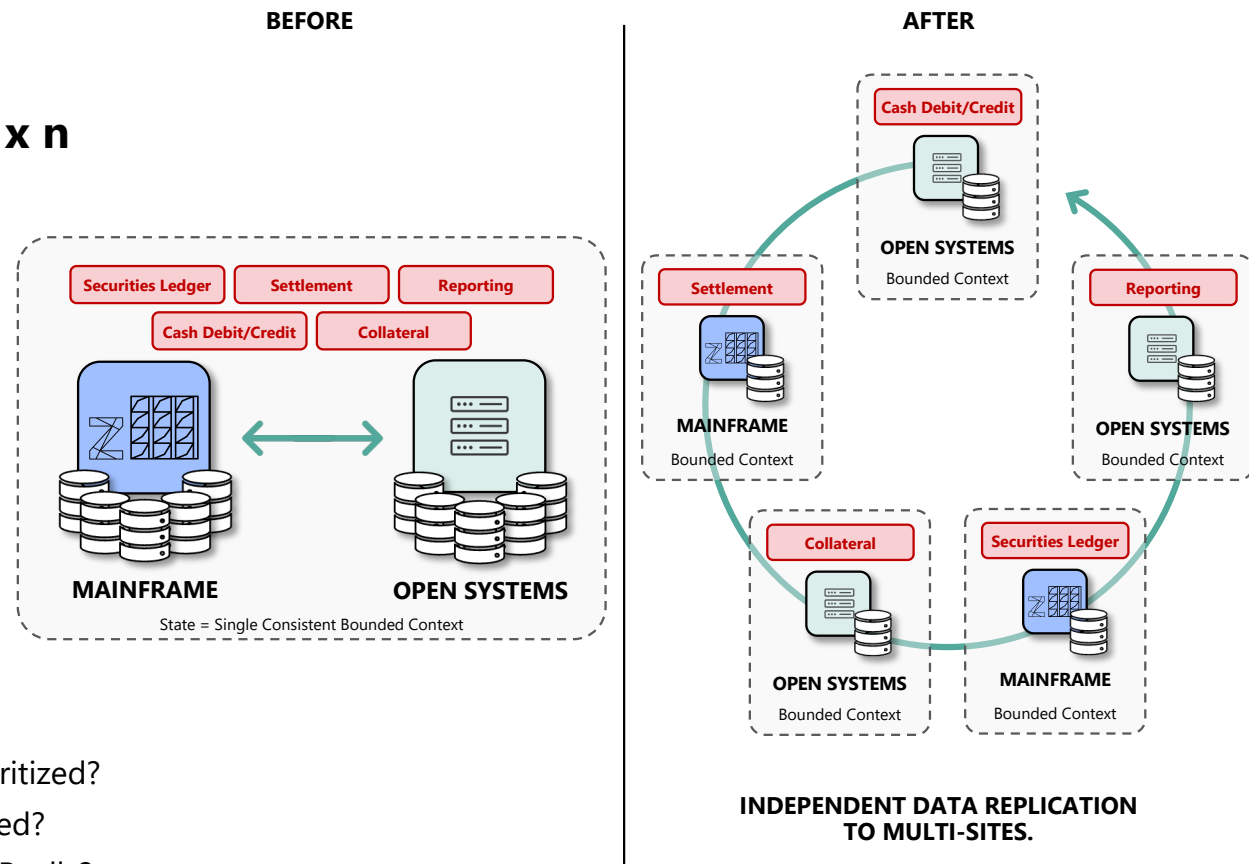


SRE EUROPE  
CON MIDDLE EAST  
AFRICA

# DECOUPLING THE ALL-IN-ONE CONSISTENCY GROUP.

## FROM CAP THEOREM to CAP THEOREM x n

- 2 choices when trying to achieve consistency in a distributed manner:  
**ADD LATENCY**, or **RECONCILE**
- **RECONCILE:**
  - Service/Data store autonomy.
  - Guaranteed delivery/consumption.
  - Per App **AP** and **CP** choices (and latency).
- Trade-offs & Unknowns:
  - Complexity... Loss of global atomicity.
  - OK to read stale data in case **Consistency** was prioritized?
  - OK to ignore data in case **Availability** was prioritized?
  - Does Biz understand the difference and impact? ... Really?



*Memes are the only use case where eventual consistency is a crime.*



SRE CON EUROPE MIDDLE EAST AFRICA

# FROM GLOBAL ATOMICITY TOWARDS RELIABLE DISTRIBUTED STATE MANAGEMENT.

## CROSS-CONTEXT AND RECONCILE CONSISTENCY.

- Outbox-Inbox framework:

**Outbox Pattern:** Reliable Event Publishing during **atomic** Writes.

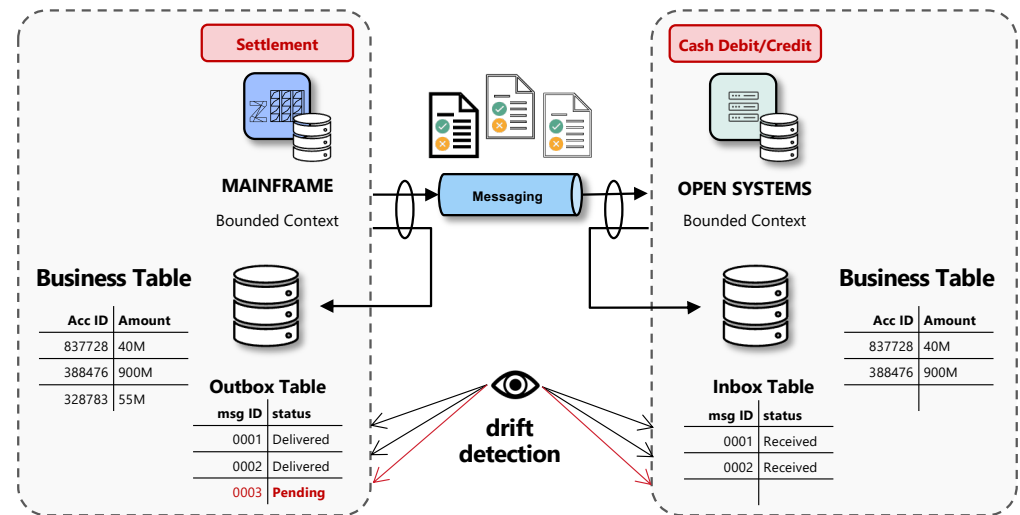
Sent messages are saved on a local 'Outbox' Table atomically in the same transaction.

**Inbox Pattern:** Reliable Event Consumption during **atomic** Reads.

Received messages are saved on a local 'Inbox' Table in the same processing transaction.

- Consistency observability and replay gateway:

- After failures, a 'gateway' detects drifts between Bounded Contexts and 'notifies' or 'acts'.
- Reconciliation/Replay mechanisms are invoked to guarantee Bounded Contexts are in-sync and in a consistent state.

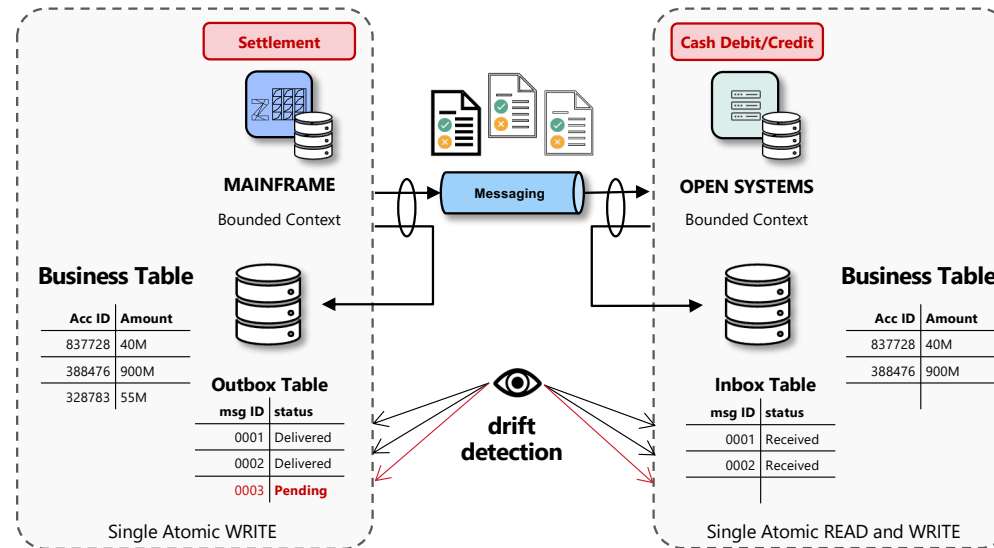


Meet: Eventual strong consistency.



SRE CON EUROPE MIDDLE EAST AFRICA

# FROM GLOBAL ATOMICITY TOWARDS RELIABLE DISTRIBUTED STATE MANAGEMENT.



## Step 1. Settle & Record (In the SETTLEMENT Service)

Start a single database transaction.

BEGIN TRANSACTION

- Action A: Update the Settlements table.
- Action B: Write a "to-do" message in the Outbox table.

COMMIT

Both actions succeed or fail together.  
Data is always consistent locally.

## Step 2. Relay the Message (Using a MQ)

- A background process constantly watches the Outbox table.
- It finds new messages and publishes them to the Message Queue
- Marks the message as "sent" only after the MQ confirms it.

Guarantees the message will eventually be sent.

## Step 3. Receive & Process (In the CASH Service)

- The CASH service listens for messages from MQ.
- It uses an Inbox table to check if it has seen the message ID before.
  - If yes -> Ignore it (prevents duplicates).
  - If no -> Process the cash debit and record the ID in the Inbox.

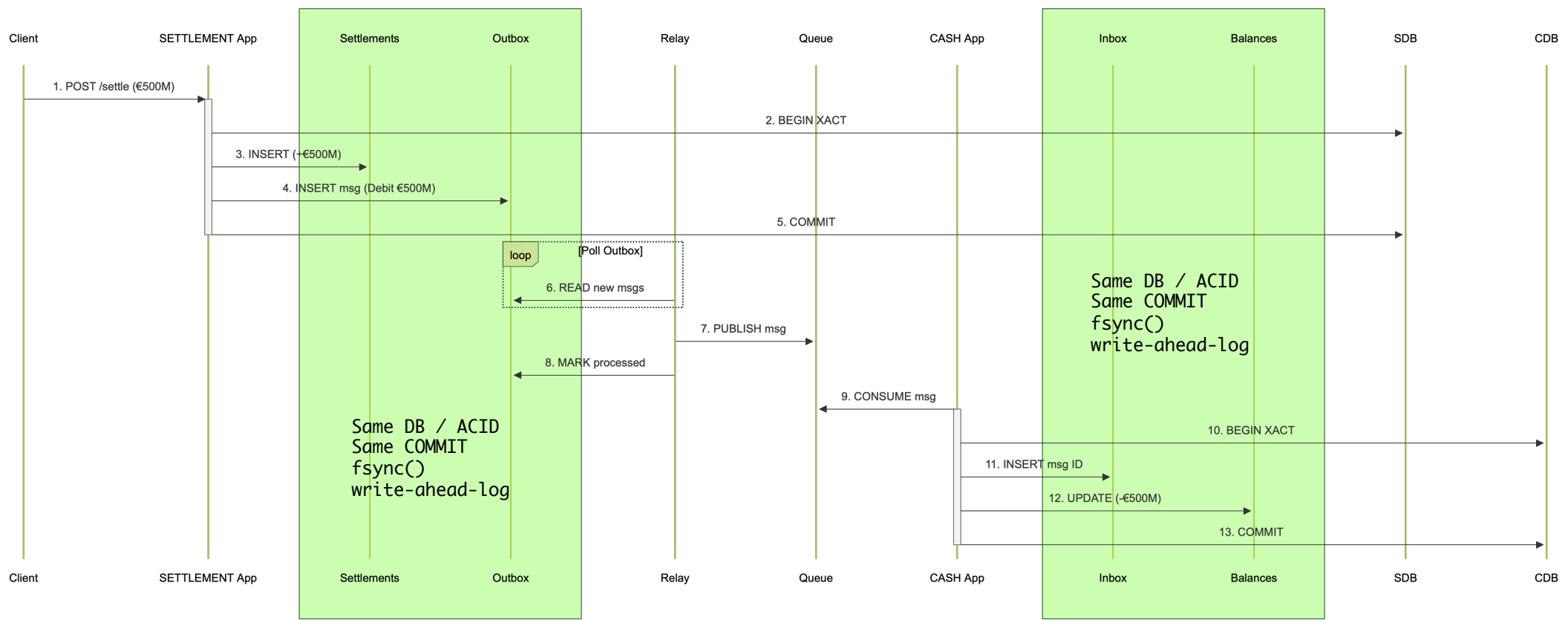
Message is processed only once.

*Meet: Eventual strong consistency.*



SRE CON EUROPE MIDDLE EAST AFRICA

# HOW IT WORKS. PATH OF A €500M INSTRUCTION.



*Not YOLO'ing this one in a demo anytime soon.*



**SRE** EUROPE  
**CON** MIDDLE EAST  
AFRICA

**SO ... HOW TO GET THERE.**



# HOW TO GET THERE.

**SRE** EUROPE  
**CON** MIDDLE EAST  
AFRICA

## DESIGN & TECHNOLOGY.

- Understand what makes your 'Shared-Fate'.
- Don't throw away battle-tested 'old' monoliths.
- Boring is good. Microservices? ... Ask yourself why.
- Industrialize using an 'Application Reliability Factory'.
  - Architect, document, and socialize.
  - Certified resiliency patterns.
  - Certified deployment archetypes.
  - Certified technology standards.
  - Ensure conformity.
  - Architecture as Code towards IaC.

## CULTURE & UNKNOWN UNKNOWNNS.

- Everyone now owns reliability.
- Don't underestimate how difficult Knowledge Transfer and Institutional Memory is. Not everyone has the same context, culture, experience.
- Think once, deploy many.
- Challenge yourself (and keep testing...). Eventually will 'Chaos test'. Evidence = Confidence.
- New scenarios will always doubt your knowledge and confidence about what you know and what you design.
- Accept it. No absolute visibility on how failures will occur ...

*Because Gartner said so, and who are we to argue?*



## COOL READINGS.

SRE EUROPE  
CON MIDDLE EAST  
AFRICA

### AVAILABLE AT YOUR FAVORITE BOOKSTORE.

- **Patterns of Enterprise Application Architecture** (Martin Fowler)
- **Patterns of Distributed Systems** (UnMesh Joshi)
- **Designing Data-Intensive Applications** (Martin Kleppmann)
- **Strategic Monoliths and Microservices** (Vaughn Vernon and Tomasz Jakula)
- **Cloud Adoption for Mission Critical Workloads** (Haytham Elkhoja)

