Life BEYOND the ILLUSION of PRESENT

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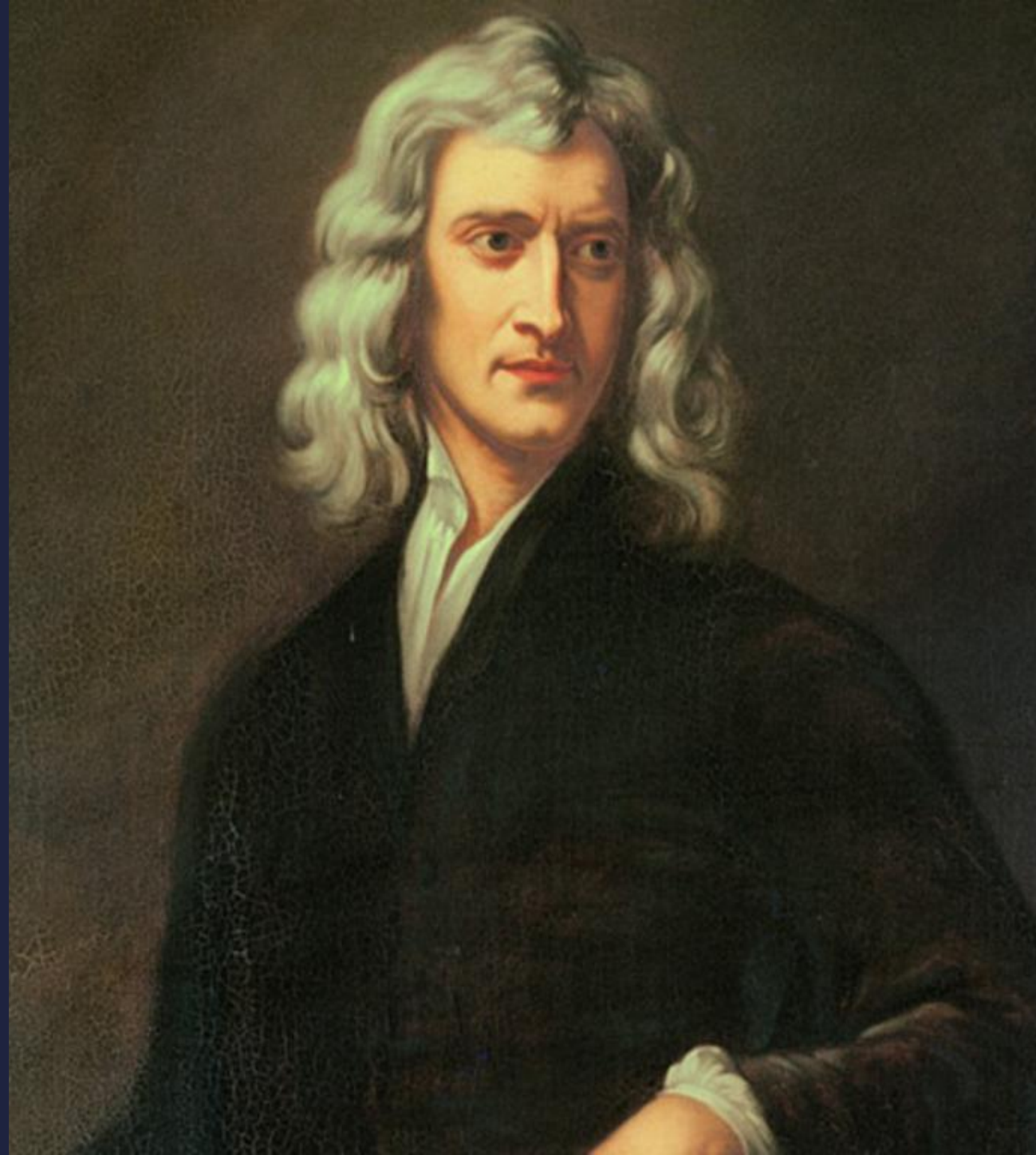
CTO Typesafe
@jboner

"Time is what prevents everything from happening at once."

- John Archibald Wheeler

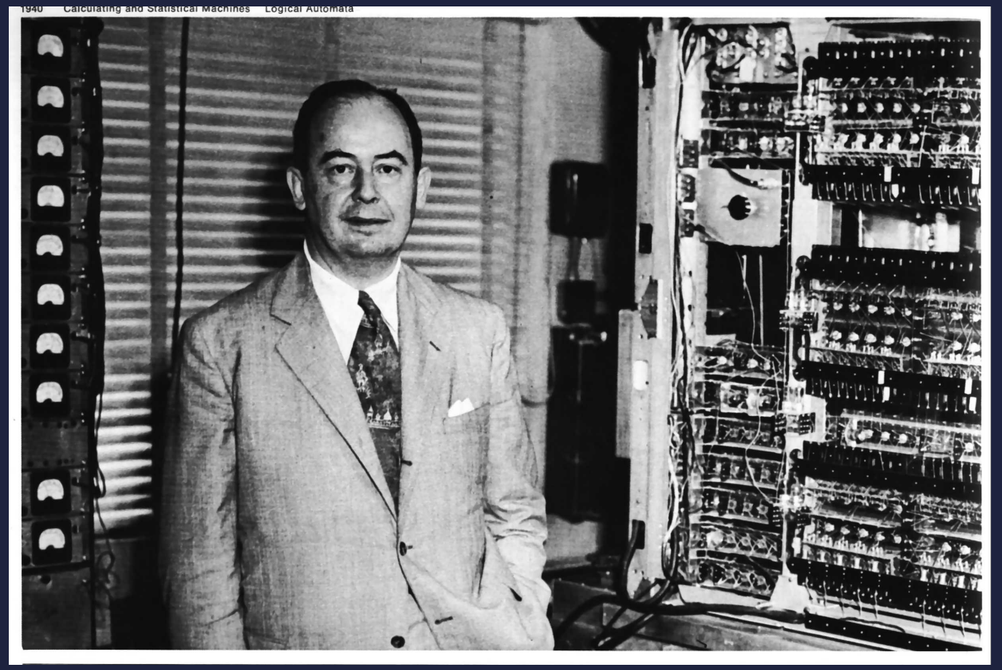
Newton's PHYSICS



THIS SIMPLIFIED MODEL IS VERY APPEALING TO US

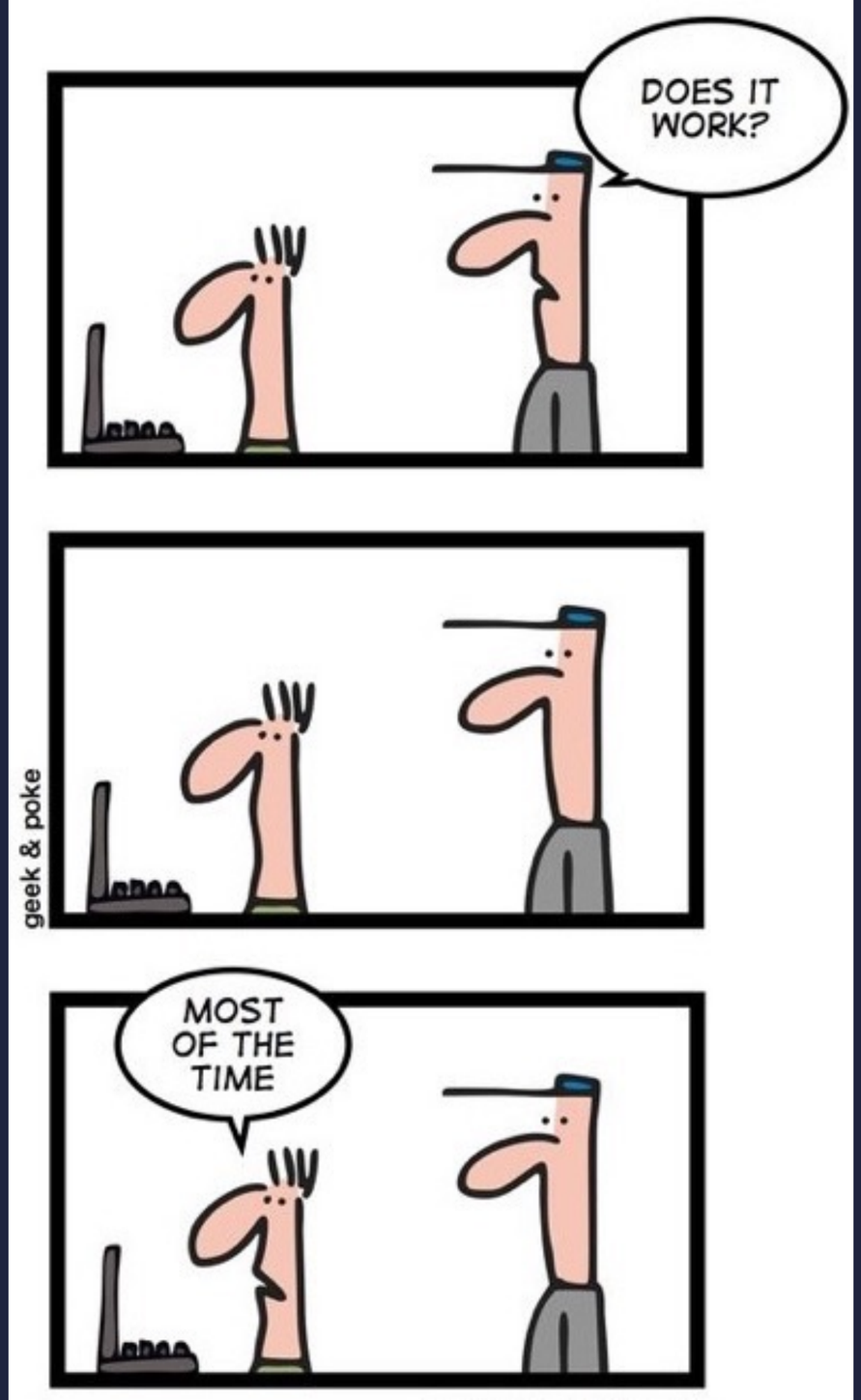
von Neumann

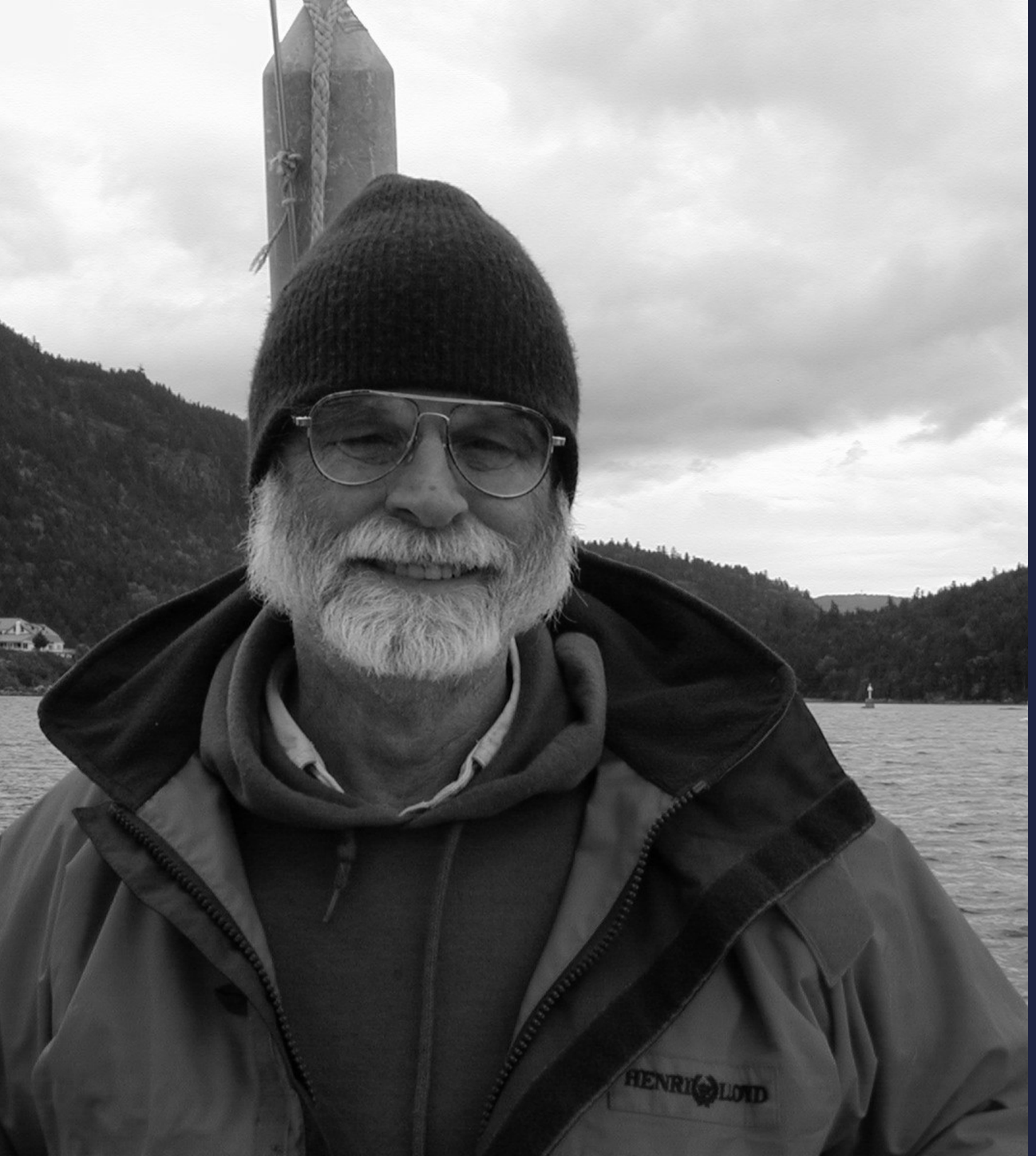
ARCHITECTURE



BACK THEN
LIFE WAS GOOD

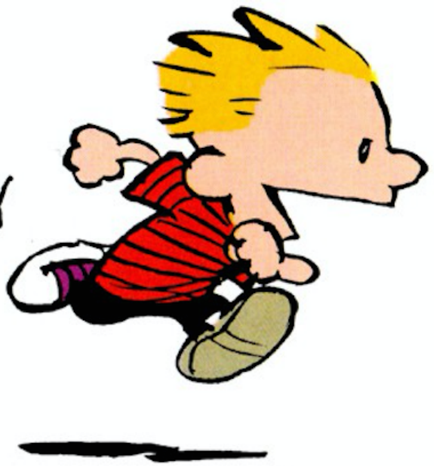
THEN, ALONG CAME CONCURRENCY MADE LIFE MISERABLE





Jim Gray's TRANSACTIONS SAVE THE DAY

Y OH BOY OH BOY OH BOY OH BOY OH BOY OH BOY OH BOY OH BOY OH BOY OH BOY



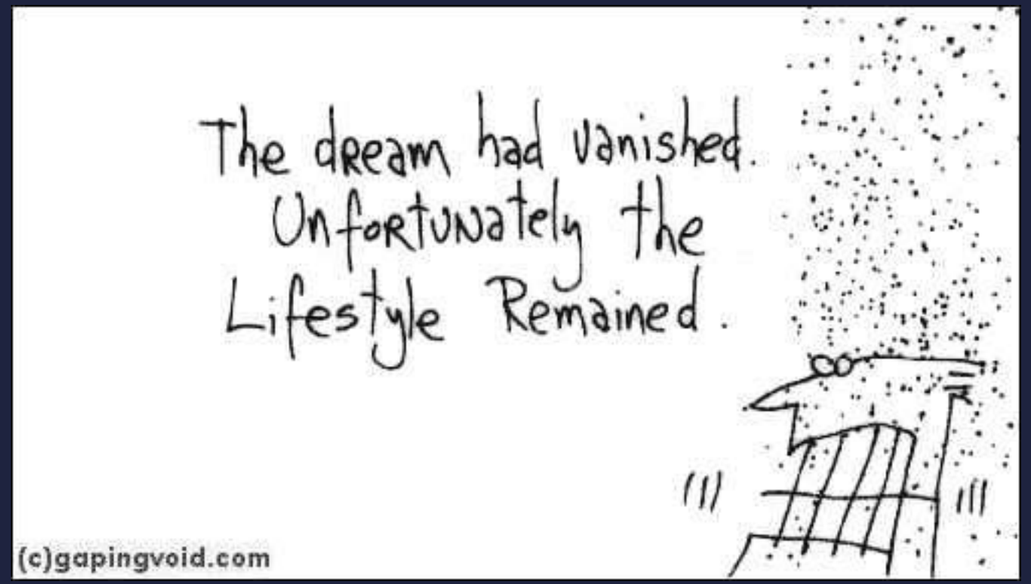
WELL, ALONG CAME DISTRIBUTION

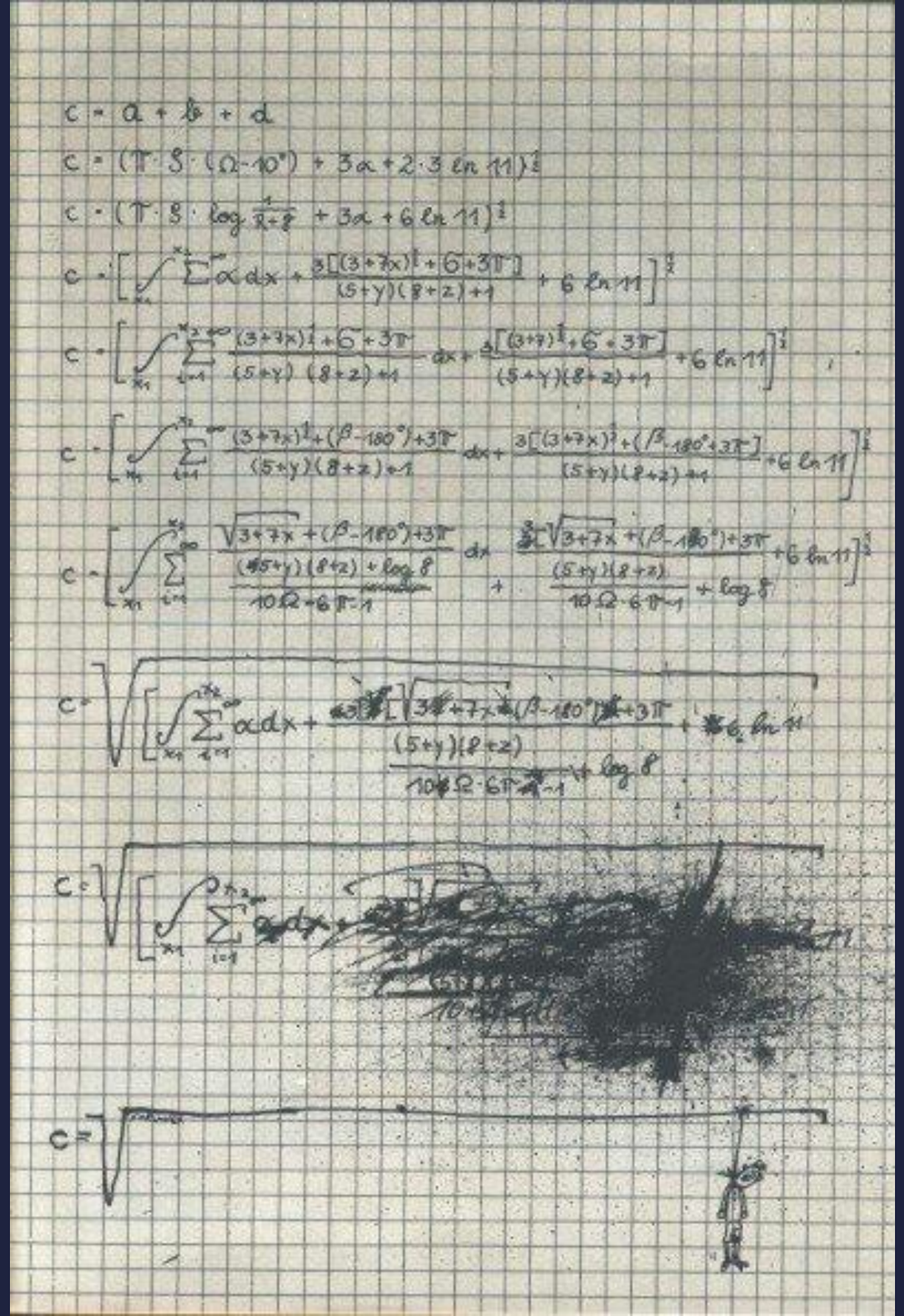
MADE LIFE MISERABLE, *again...*

But don't be surprised

UNFORTUNATELY, THIS IS NOT

HOW THE WORLD WORKS





"The future is a function of the past."

- A. P. Robertson

"The (local) present is a merge function of multiple concurrent pasts."

– Me

```
val newLocalPresent = observedPasts.
  foldLeft(oldLocalPresent) { _ merge _ }
```

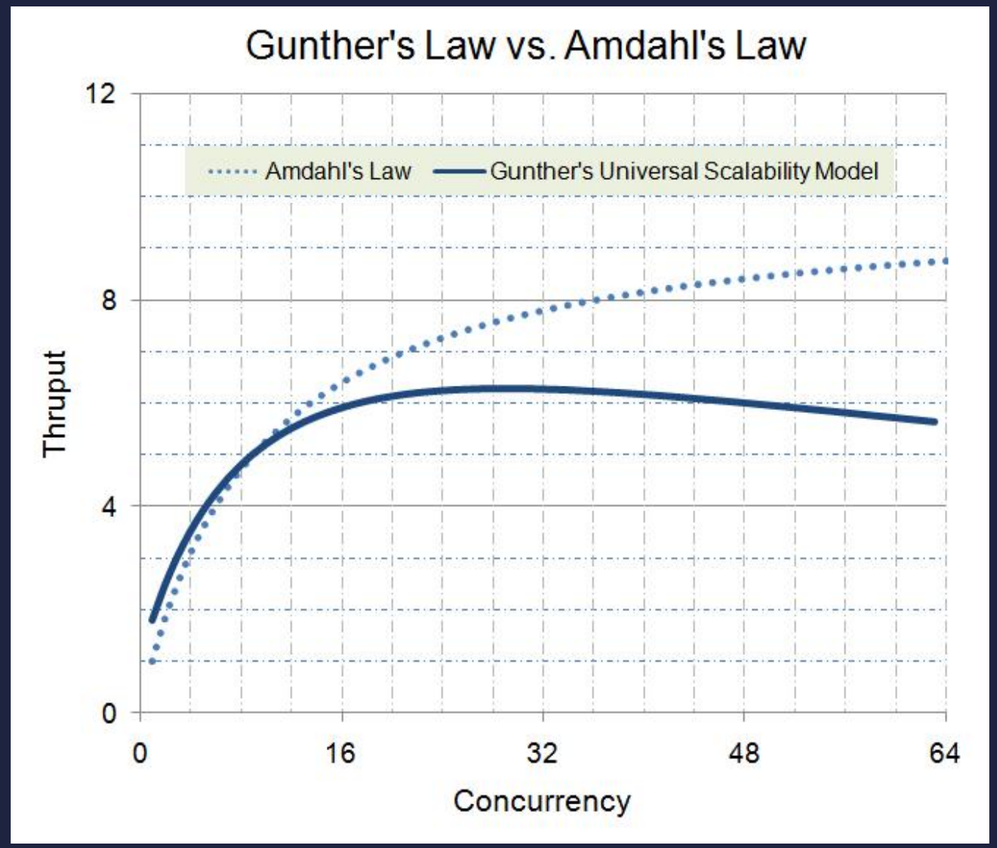
WE NEED TO EXPLICITLY MODEL THE LOCAL PRESENT AS FACTS DERIVED FROM THE MERGING OF MULTIPLE CONCURRENT PASTS

INFORMATION IS ALWAYS FROM THE PAST

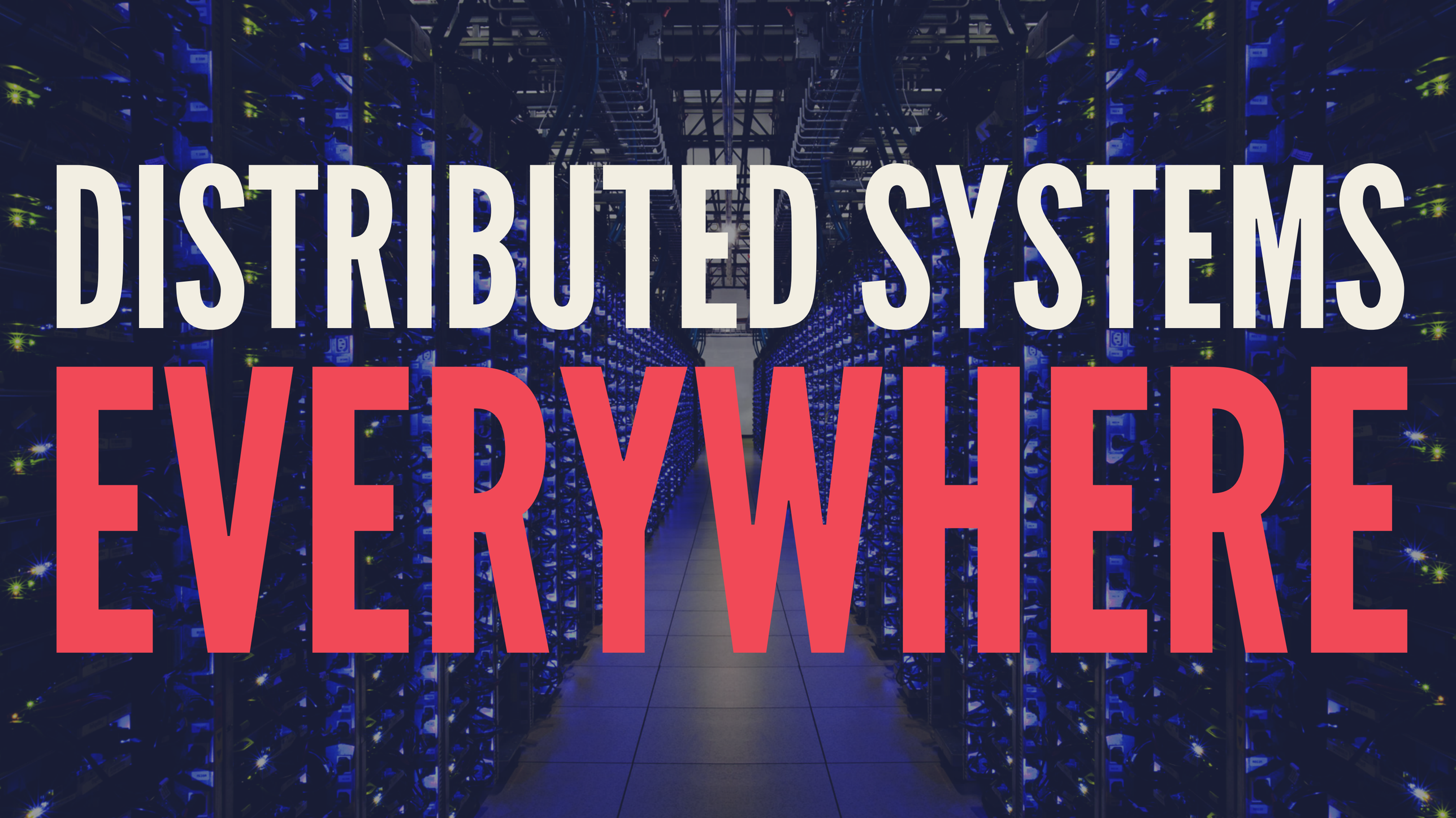
THE TRUTH IS CLOSER TO EINSTEIN'S PHYSICS

INFORMATION HAS LATENCY

THE COST OF MAINTAINING THIS ILLUSION IS INCREASED CONTENTION & COHERENCY




AS LATENCY GETS HIGHER, THE
ILLUSION CRACKS EVEN MORE


DISTRIBUTED SYSTEMS
EVERYWHERE


THE NETWORK IS RELIABLE...NAT


"If a tree falls in a forest and no one is around to hear it, does it make a sound?"
– Charles Riborg Mann

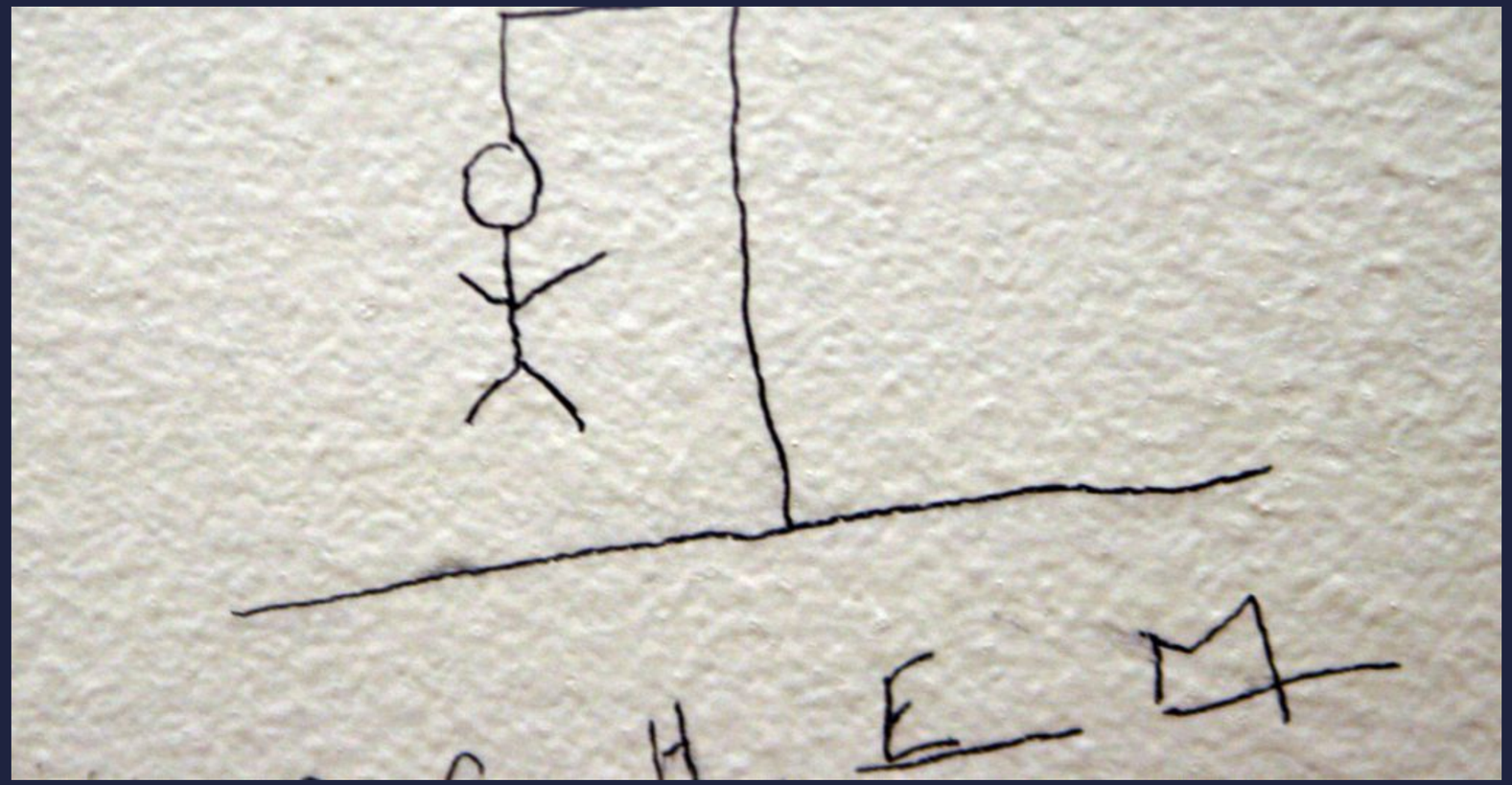
Information CAN (and will) GET LOST

HOW DO WE DEAL WITH INFORMATION LOSS IN REAL LIFE?

WE USE A SIMPLE PROTOCOL OF

Confirm, Wait & Repeat

We fill in THE BLANKS



...AND IF WE ARE WRONG, WE TAKE

COMPENSATING ACTION

APOLOGY-ORIENTED PROGRAMMING - PAT HELLAND (IN MEMORIES, GUESSES, AND APOLOGIES)

The bottom line:

WE CAN'T FORCE THE WORLD INTO A SINGLE GLOBALLY CONSISTENT PRESENT

Should we just GIVE UP?


I BELIEVE THAT THERE IS A
PATH FORWARD

WE NEED TO TREAT TIME AS A FIRST CLASS CONSTRUCT

WHAT IS TIME, *really*?

TIME IS THE SUCCESSION OF CAUSALLY RELATED EVENTS

How can we MANAGE TIME?


Think in FACTS

What is a FACT?

"A Fact is something that truly exists or happens: something that has actual existence, a true piece of information."

– Merriam Webster

IMMUTABILITY

is a requirement

So, do variables

HAVE A PURPOSE IN LIFE?

"The assignment statement is the von Neumann bottleneck of programming languages and keeps us thinking in word-at-a-time terms in much the same way the computer's bottleneck does."

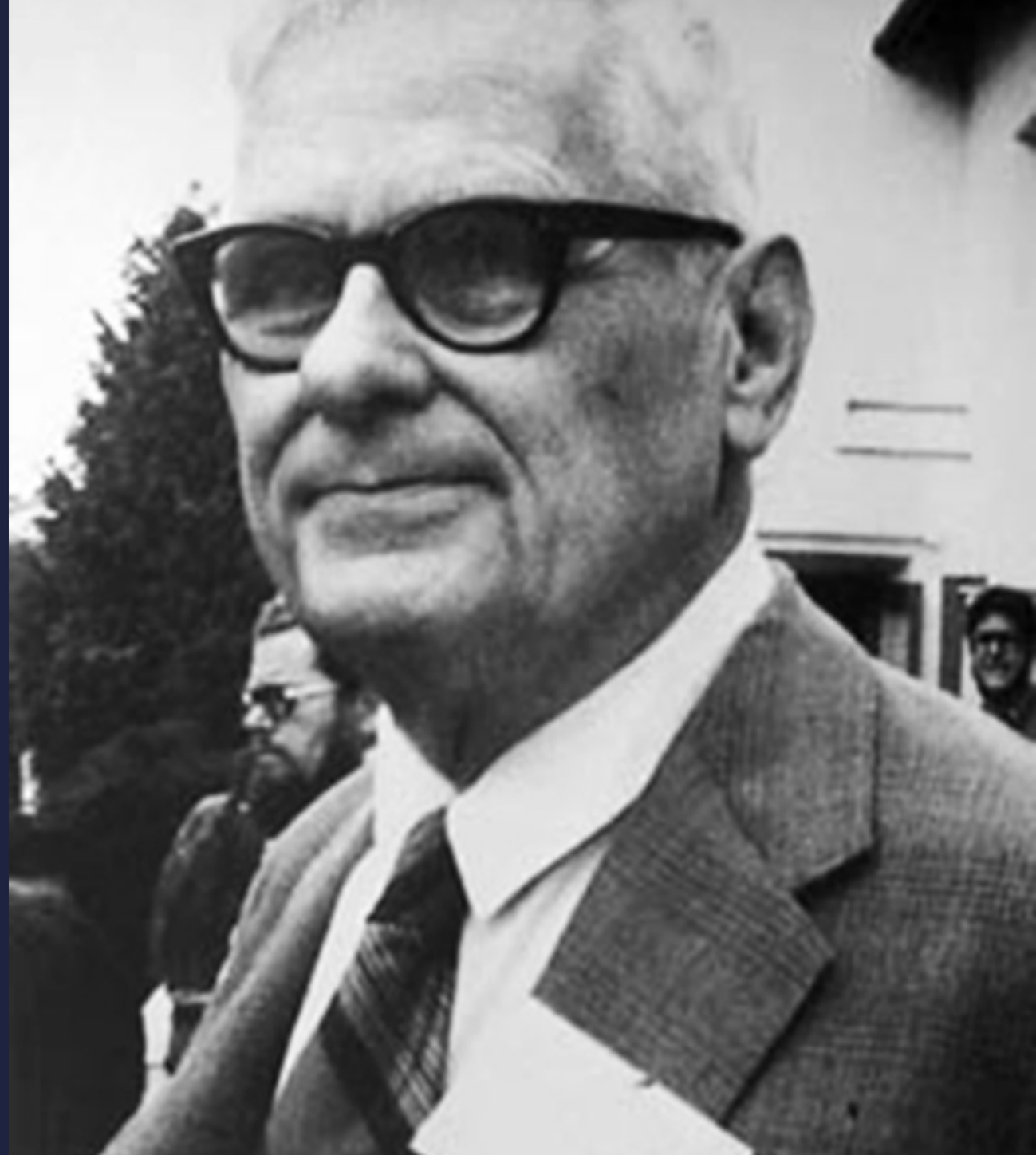
– John Backus (Turing Award lecture 1977)

MUTABLE STATE NEEDS TO BE CONTAINED

Ok, but how should we

MANAGE FACTS?

Functional PROGRAMMING



Logic

PROGRAMMING

Dataflow PROGRAMMING


NEVER
DELETE
FACTS

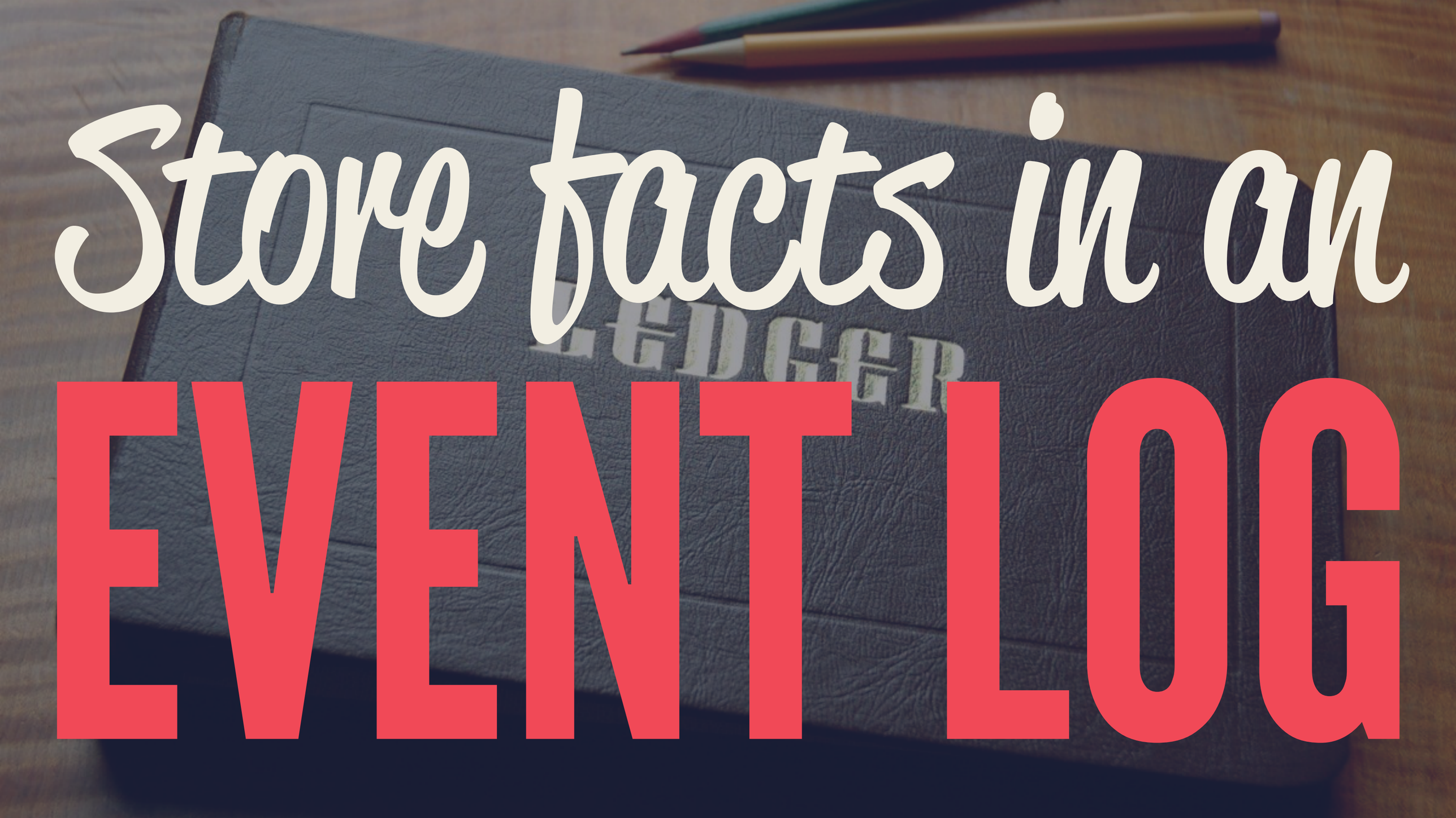
"When bookkeeping was done with clay tablets or paper and ink, accountants developed some clear rules about good accounting practices. One never alters the books; if an error is made, it is annotated and a new compensating entry is made in the books. The books are thus a complete history of the transactions of the business. Update-in-place strikes many systems designers as a cardinal sin: it violates traditional accounting practices that have been observed for hundreds of years."

– Jim Gray (1981)

CRUD

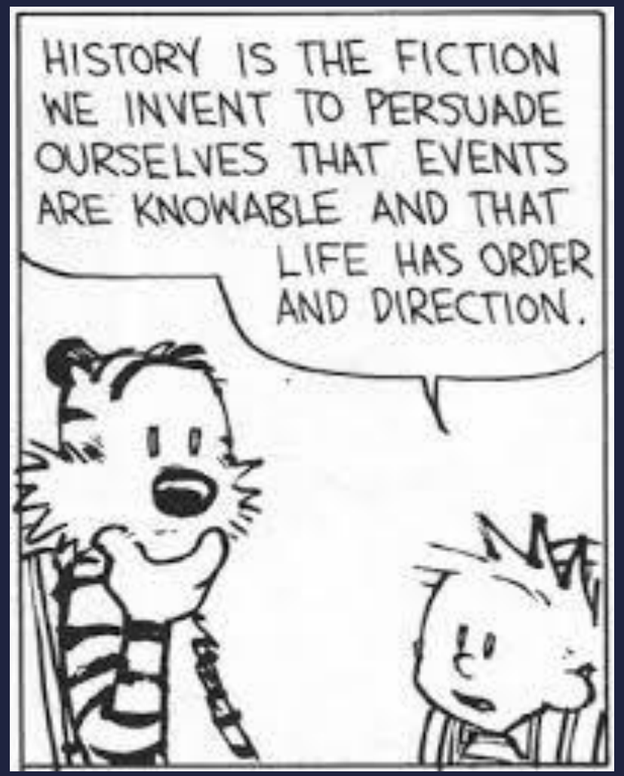
"Database is a cache of a subset of the log."

– Pat Helland (2007)

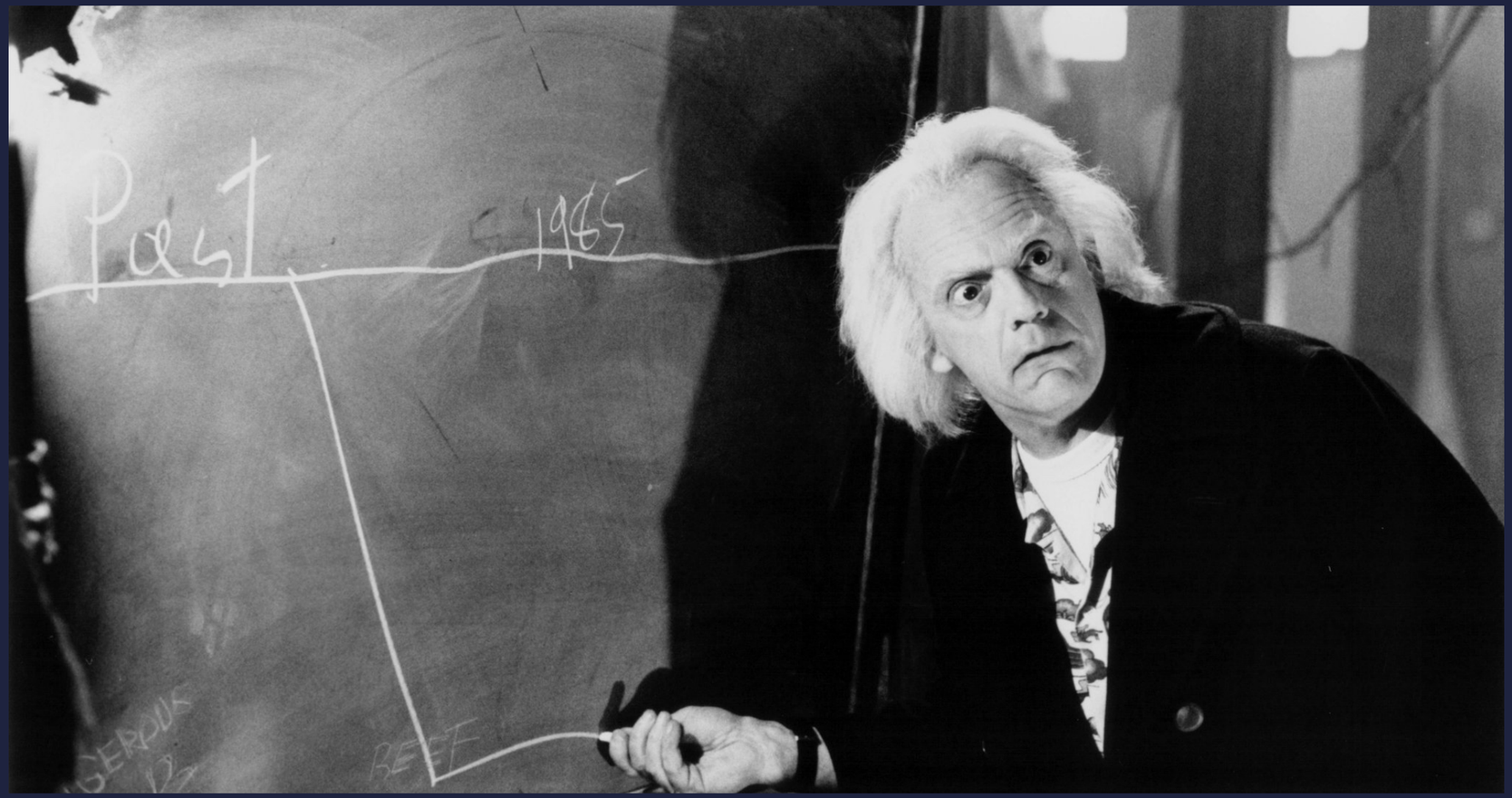

Store facts in an
EVENT LOG

The log allows

TIME TRAVEL



Can we REWRITE THE PAST?



Allows us to shift our focus from

DATA AT REST, to DATA IN MOTION

Stream Processing

CONSTRUCTING A SUFFICIENTLY CONSISTENT

LOCAL PRESENT

MEANS EMPLOYING

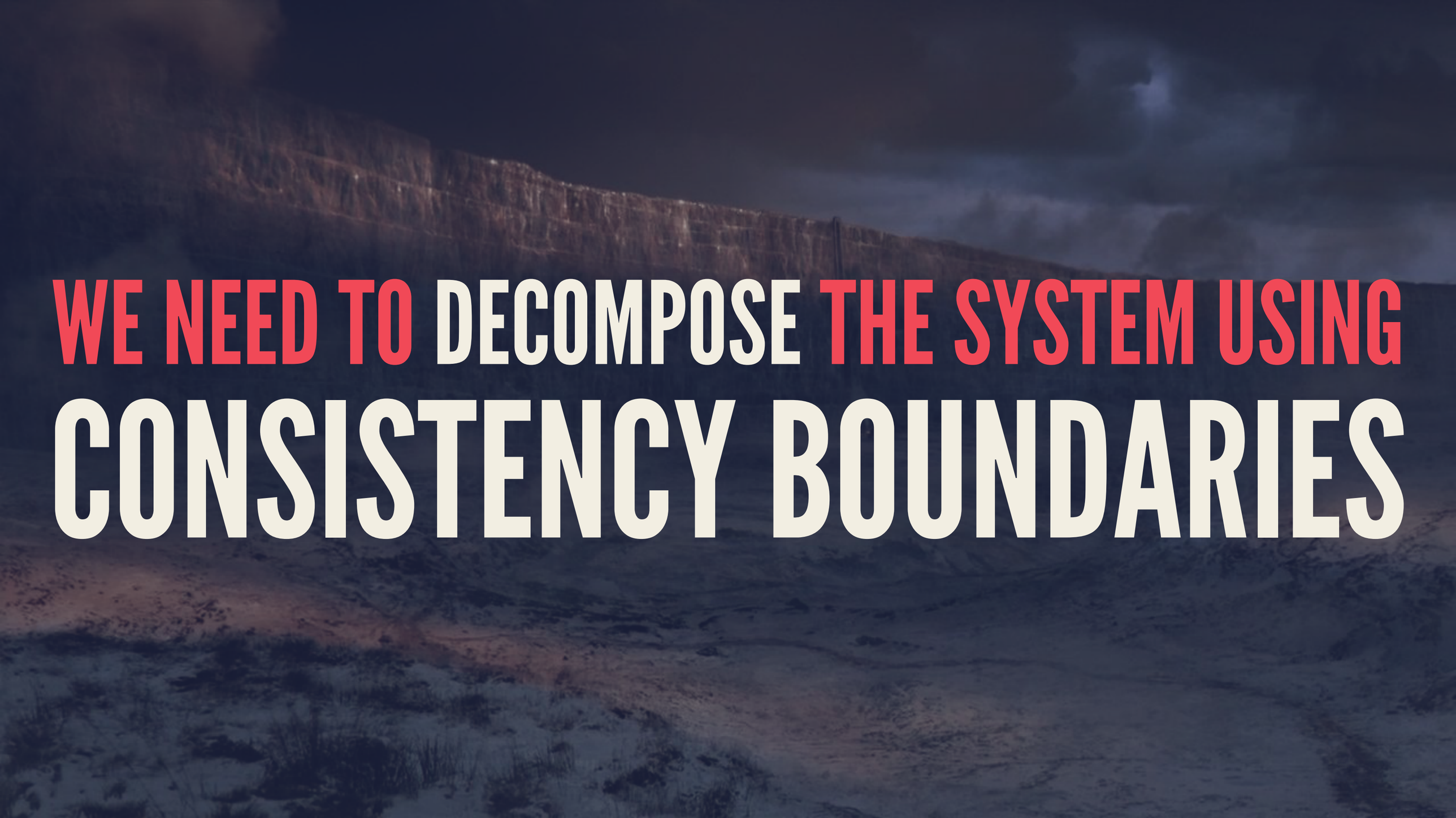
CONSISTENCY MECHANISMS

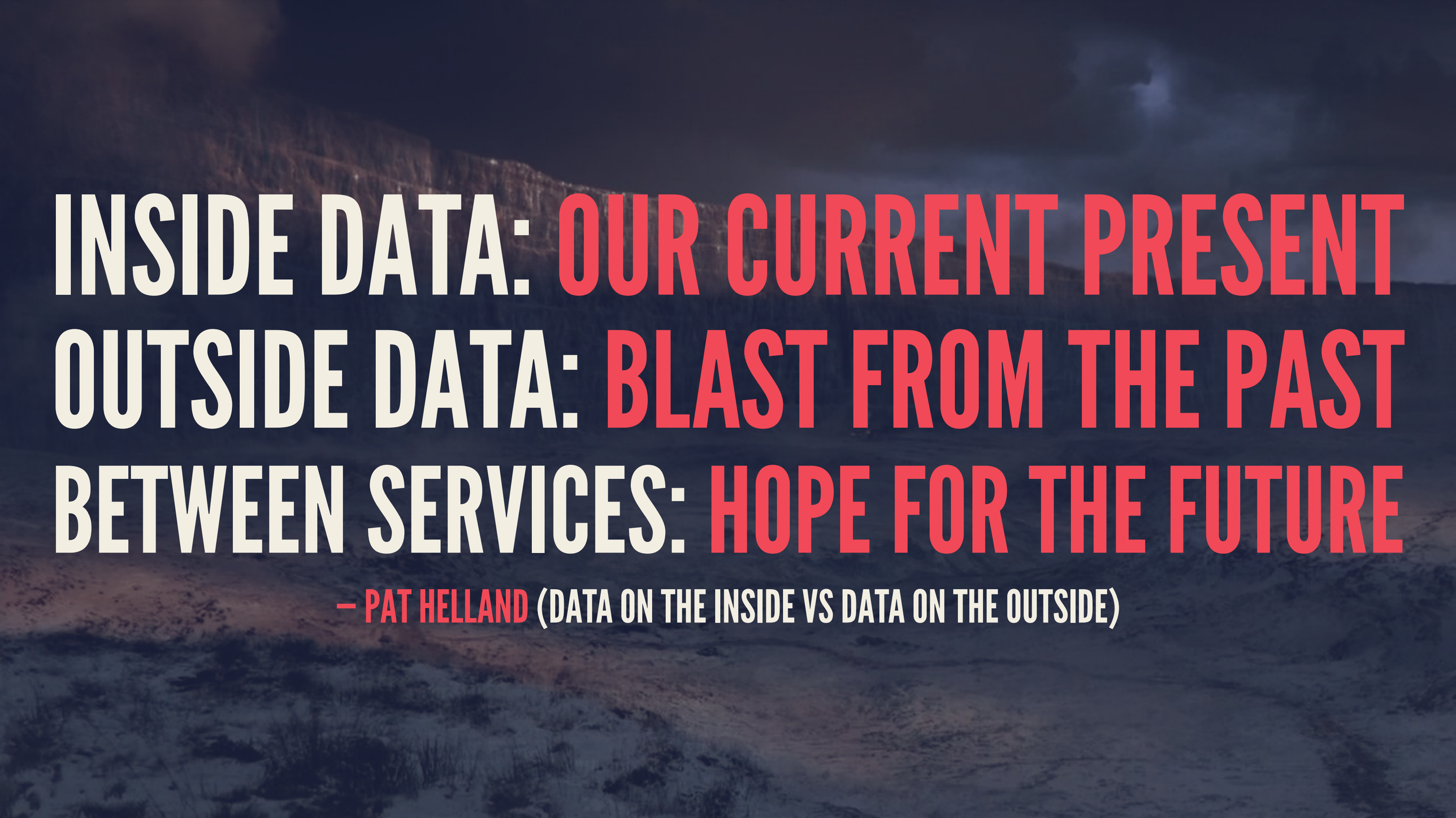
Consistency

WHAT?

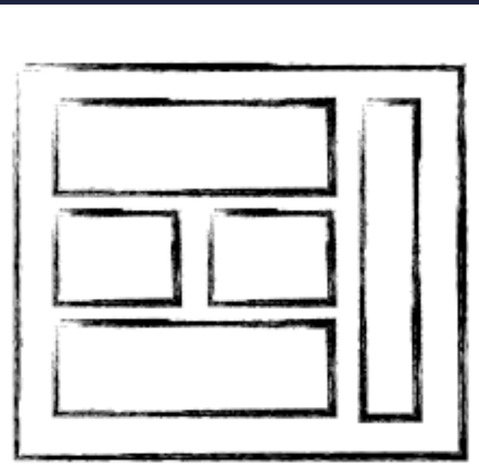
WHY?

WHEN?


WE NEED TO DECOMPOSE THE SYSTEM USING
CONSISTENCY BOUNDARIES


INSIDE DATA: OUR CURRENT PRESENT
OUTSIDE DATA: BLAST FROM THE PAST
BETWEEN SERVICES: HOPE FOR THE FUTURE
– PAT HELLAND (DATA ON THE INSIDE VS DATA ON THE OUTSIDE)

MicroSERVICE

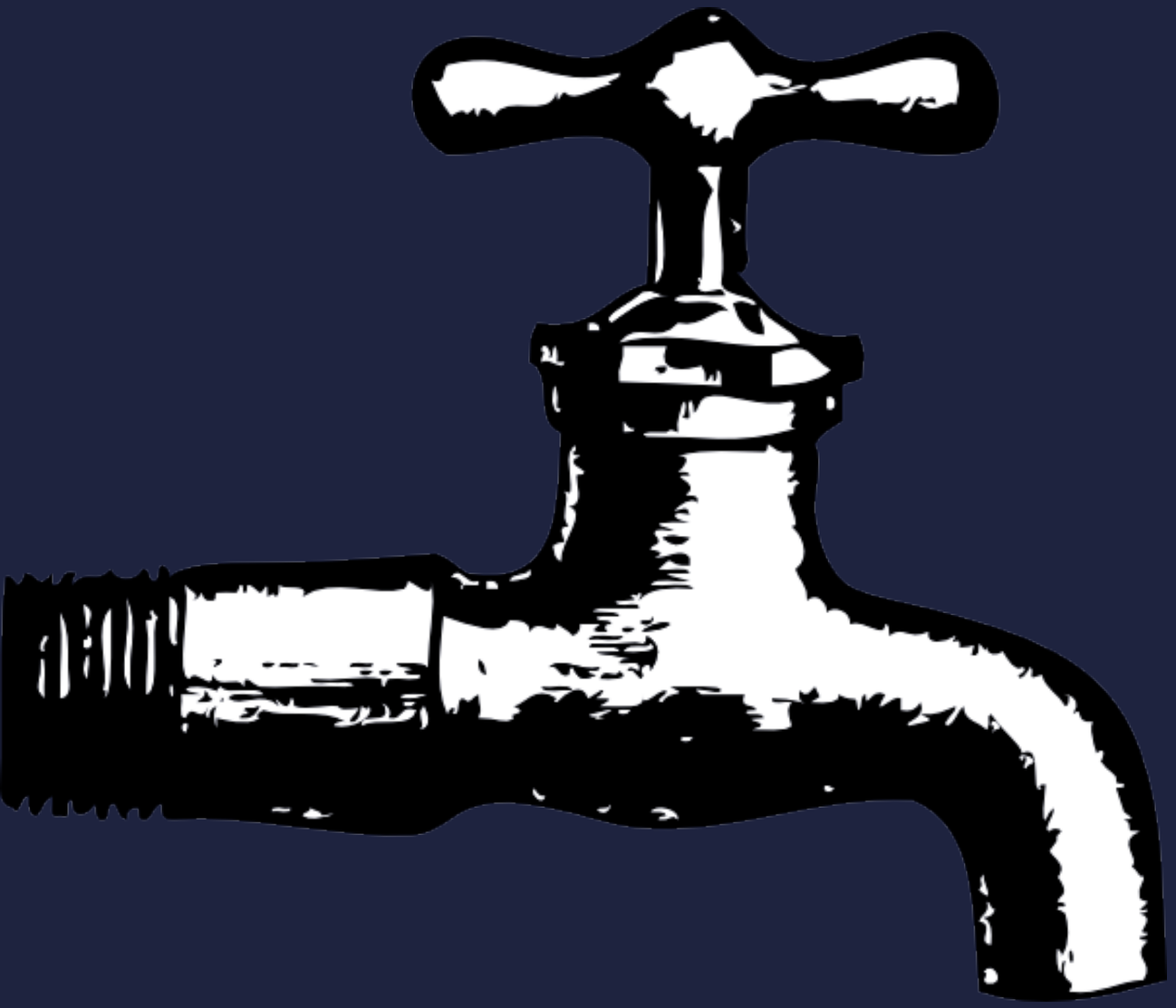


Monolithic/Layered

Micro Services

AGGREGATE *Root*


WITHIN THE CONSISTENCY BOUNDARY



EVENT

Sourcing

BETWEEN THE

Consistency

Boundaries

IT'S A ZOO

Decoupling in

TIME / SPACE

STRONG CONSISTENCY

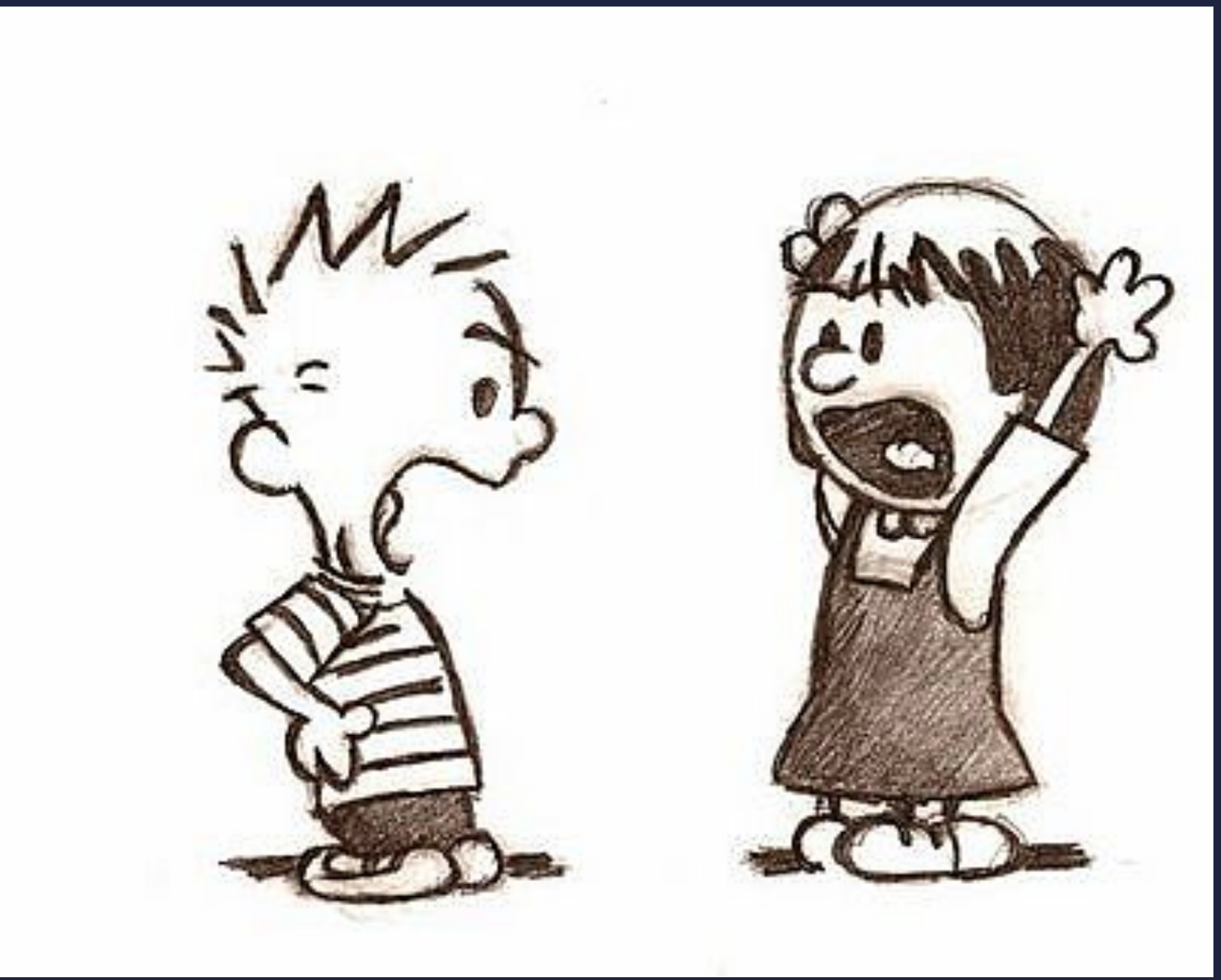
The wrong default

Here, we are living in the

LOOMING SHADOW OF

IMPOSSIBILITY

THEOREMS



FLP

CONSENSUS IS IMPOSSIBLE

PROTOCOLS CLIMB THE LADDER OF KNOWLEDGE

Cϕ: Common Knowledge (infinite number of i)

Eiϕ: (Everyone knows * i) ϕ

E3ϕ: (Everyone knows * 3) ϕ

E2ϕ: Everyone knows Everyone knows ϕ

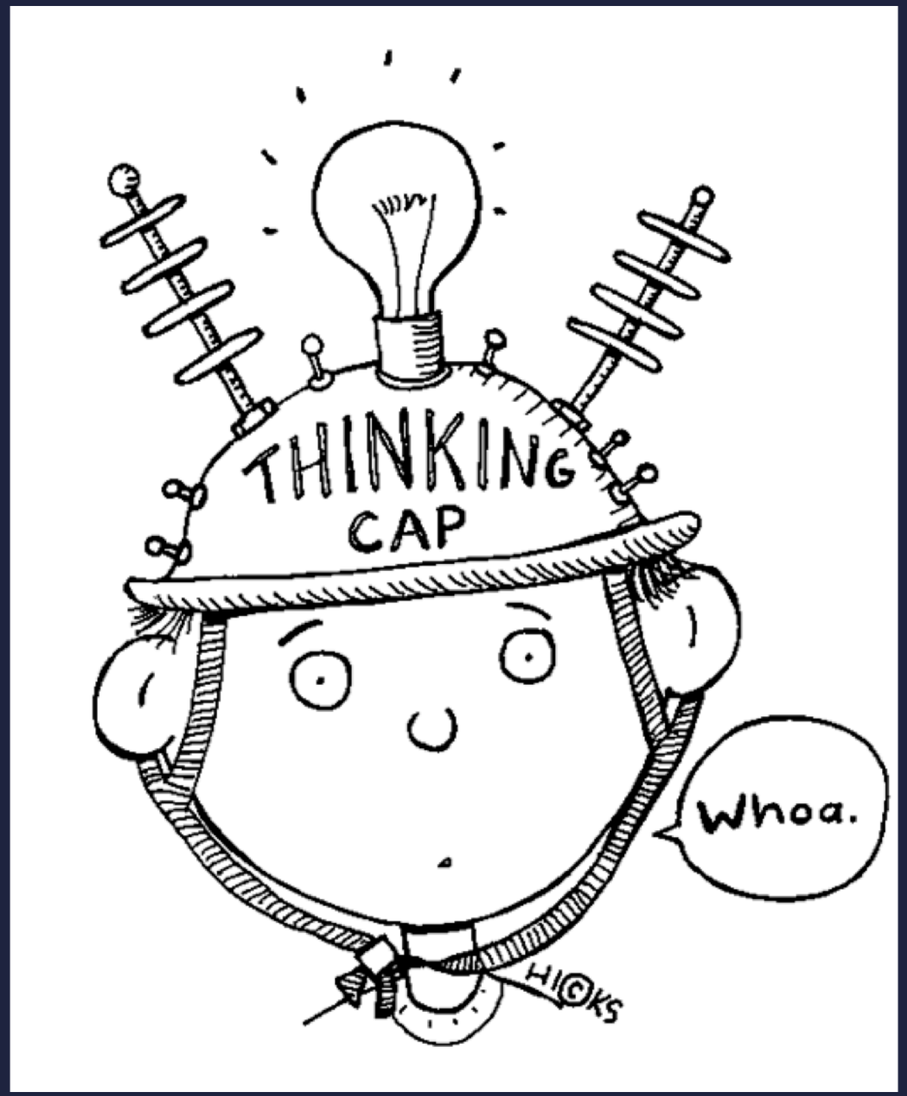
E1ϕ: Everyone knows ϕ

Sϕ: Someone knows ϕ

COMMON KNOWLEDGE

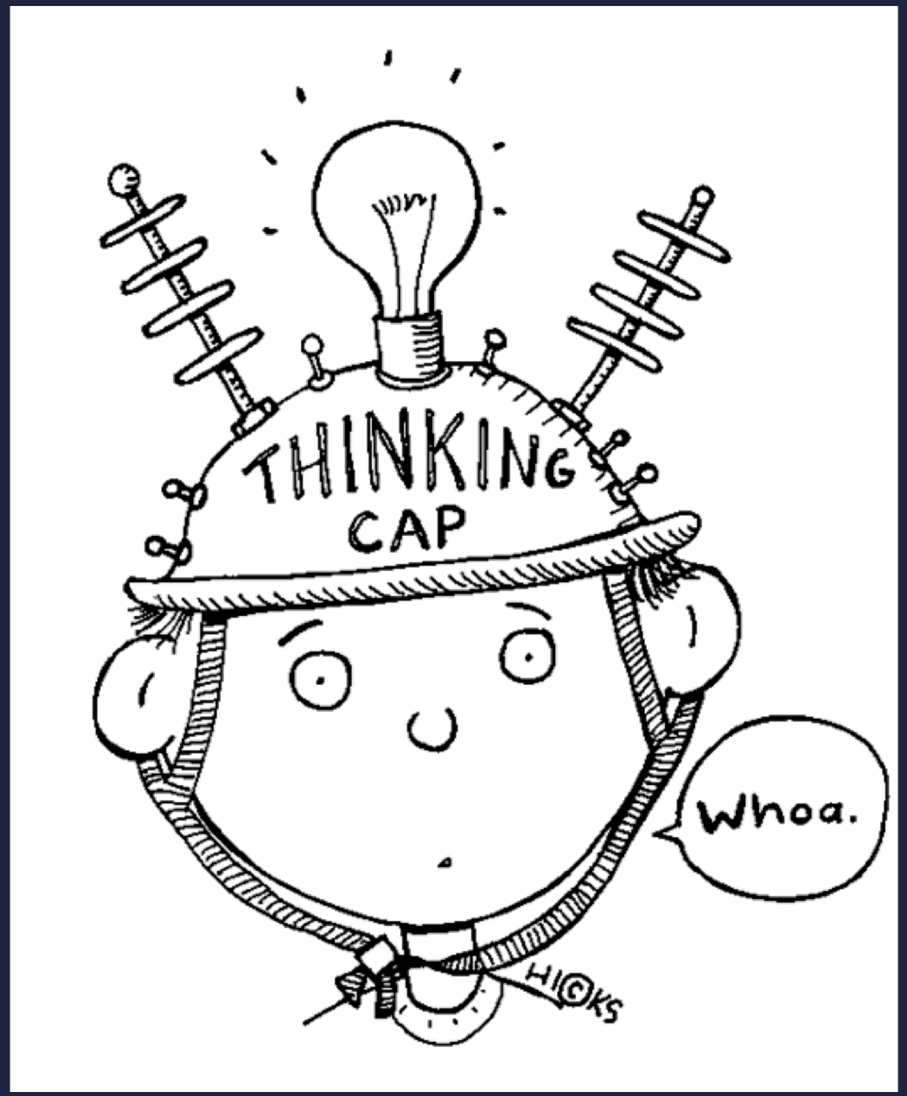
IS NOT ATTAINABLE VIA PROTOCOL

- JOSEPH HALPERN



CAP

CONSISTENCY IS IMPOSSIBLE



Dissecting CAP

"The first principle of successful scalability is to batter the consistency mechanisms down to a minimum."

– James Hamilton

EVENTUAL CONSISTENCY

What does it really mean?

Tracking TIME is tracking CAUSALITY

RELYING ON TIMESTAMPS IS A BAD IDEA

Instead, rely on

LOGICAL TIME

Lamport

CLOCKS

GLOBAL CAUSAL ORDERING BETWEEN

Vector CLOCKS

PARTIAL CAUSAL ORDERING BETWEEN EVENTS

Causal

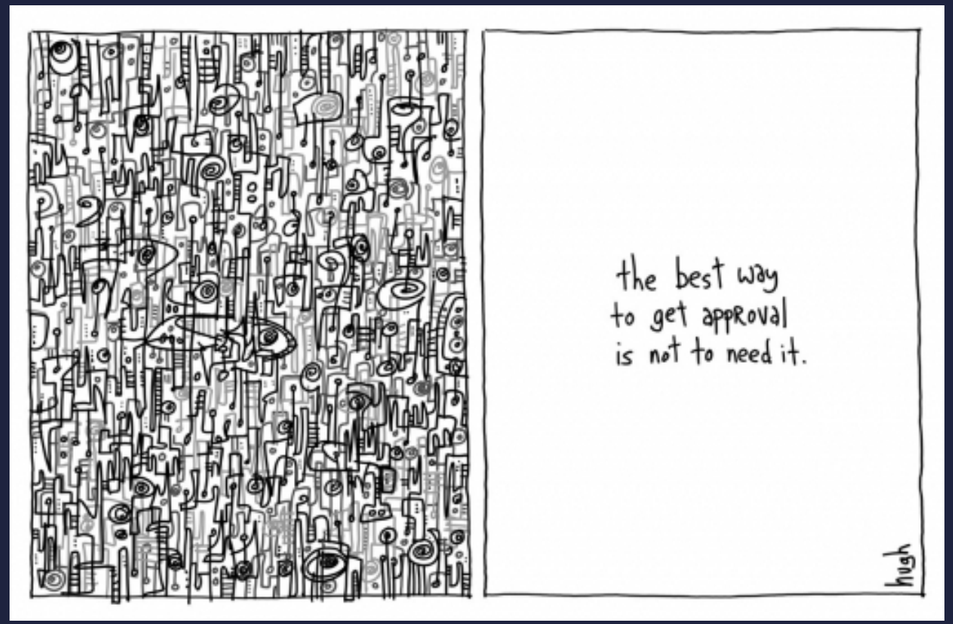
CONSISTENCY

What

CONSISTENCY

DO YOU REALLY NEED AND

when?



ACID 2.0

ASSOCIATIVE

COMMUTATIVE

IDEMPOTENT

DISTRIBUTED

CONFLICT-FREE REPLICATED DATA TYPES

DISORDERLY PROGRAMMING

CALM THEOREM

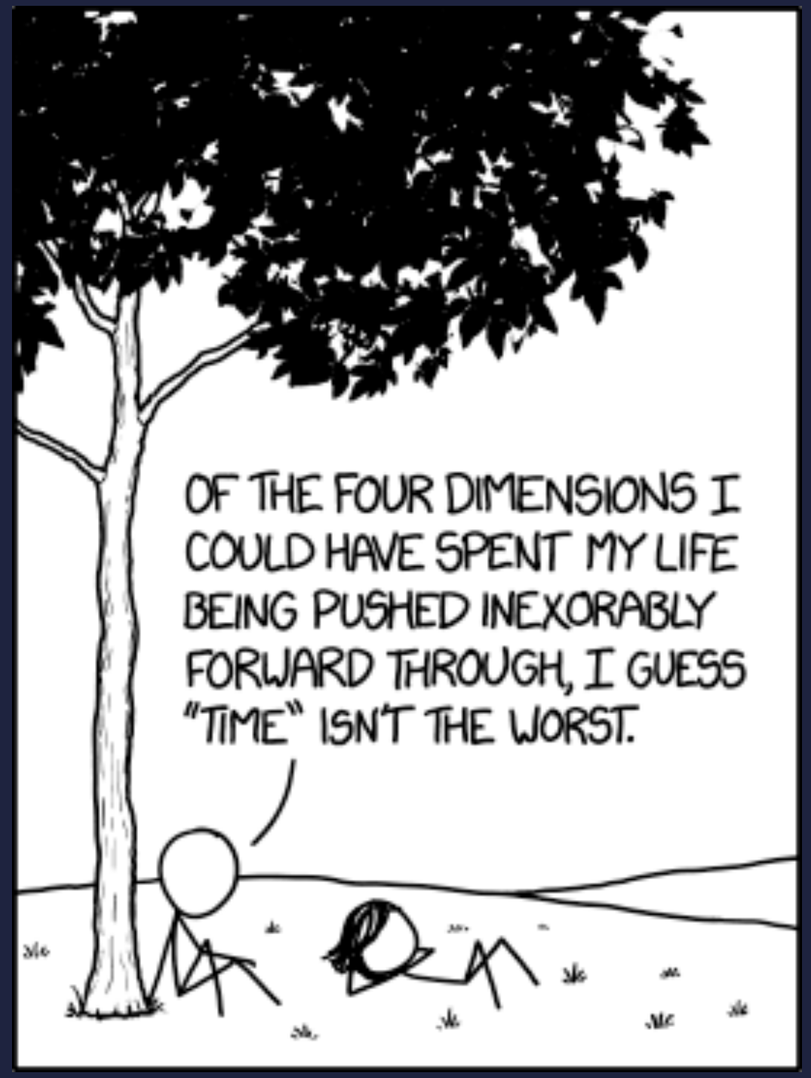
WE ARE JUST GETTING STARTED


WE HAVE A LONG ROAD AHEAD OF US...


...LET'S GO EXPLORING!

Thanks

FOR LISTENING



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