How to Write a Reliable Collaborative Activity Without Even Trying

An optimistic look at what we can do to make writing collaborative software easy. Really easy.

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What is collaboration?

Unified abstract state.

“If two people are working on two different documents, they're not collaborating.”

Story: Buggy Sharing

What does Telepathy guarantee?

Integrity

Causality

What does it not guarantee?

Nonexistence of parallel universes

Message delivery across split+merge

(Netsplit!)

StopWatch

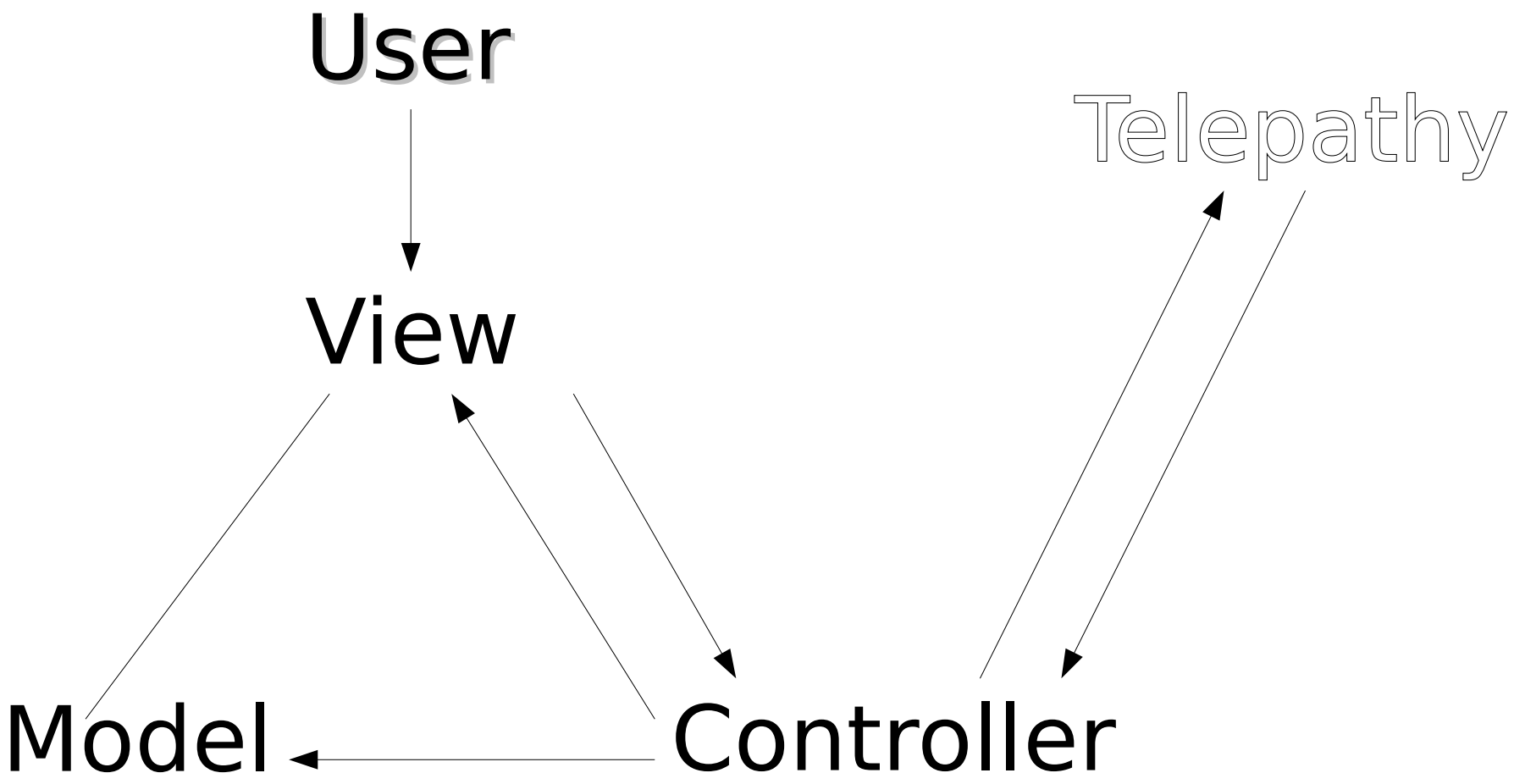
Every button click generates an Event.
e.g. (“Pause”, 1207194405.190577072)

Each stopwatch is a state machine over Events.

The order in which Events are received *does not matter*.

When users join or merge, they get sent the history.

StopWatch-1 Control Flow



It works!

but hey, who put this D-Bus call in my perfectly good program logic! Now it's all ugly.

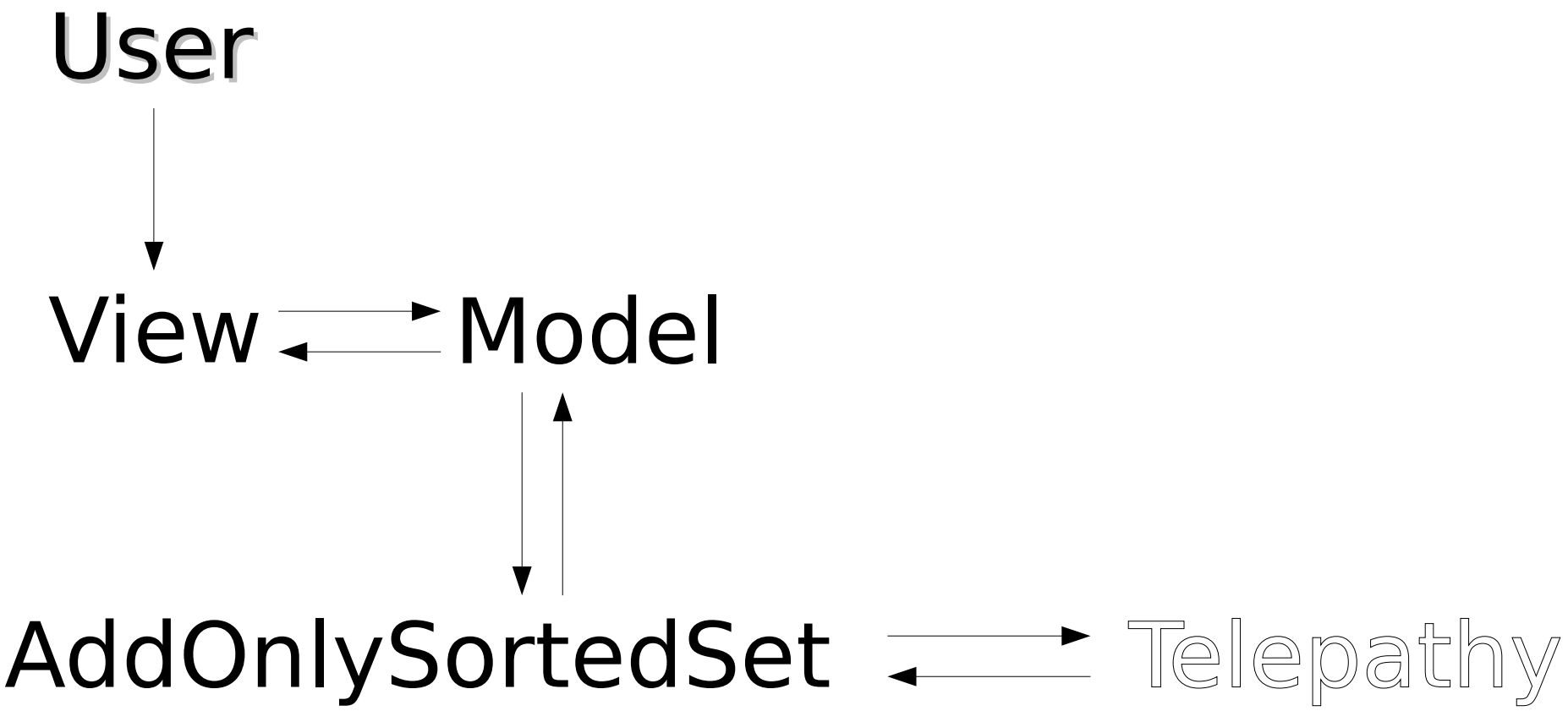
Yuck.

Hard to write. Not reusable.

Problem: You hate networking code.

Solution: Put it in a library.

StopWatch-3 Control Flow



Distributed D-Bus Objects

Original idea: 3 Kinds of DObjects

1. Unordered. No ordering.
   Archetype: AddOnlySet

2. Causal. There is a total order, but messages may arrive out of order.
   Archetype: Distributed Dict

3. Strongly Ordered: Global lock to enforce ordering.
   Archetype: Card Game

Realization #1

CausalObject can be implemented as a layer over UnorderedObject.

Strongly Ordered is *hard* (see PAXOS).

You can do almost anything with Unordered and Causal!

dobject.py

Provides: HighScore, AddOnlySet, AddOnlySortedSet, CausalDict, Latest

(coming soon: DstringIO, a new name)

Realization #2

D-Object is perfect for offline collaboration:

No merge ever fails.
Shared copies never diverge.

Vision

Activities store state in objects provided by DObject. DObject handles the rest:

tracking Joins and Quits
syncing with an upstream server
serializing to the datastore
providing an Undo GUI

Criticism: Efficiency

Space Efficiency:
Naïve DObjects might keep every message.
Solution: Keep only what is necessary to interpret future messages (already done).

Network Efficiency:
Current implementation broadcasts too much. O(N) join, O(N^2) “unsplit”. Better behavior is possible.

Criticism: Power

“My collaboration can't be expressed as a set of independent messages.”

Perhaps.

(If you don't like it, you don't have to use it.)

dobject.py Unordered API

handler.send(msg): broadcast a message

receive_message(msg): accepts and processes a message sent via handler.send().

get_history(): returns an encoded copy of all non-obsolete state

add_history(state): accept and process the state object returned by get_history()

dobject.py Causal API

Exactly the same, except:
handler.send(msg) returns an index for the message

receive_message(msg, index)

The handler generates each index as a tuple: (monotonically increasing int, random 64-bit tiebreaker)

CausalDict: Interface

Three components:
1. Complete standard python dict interface
2. CausalObject interface
    - Requires that CausalDict constructor take a CausalHandler
3. Callbacks
    - When someone else makes a change, the callback is triggered.

CausalDict: Implementation

2 Messages:
(ADD, key, value), index
(DELETE, key), index

ADD:
if not key in ind or ind[key] < index:
    d[key] = value; ind[key] = index

DELETE:
if not key in ind or ind[key] < index:
    del d[key]; ind[key] = index

DELETE works even if it arrives before ADD

CausalDict: Implementation

CausalDict.get_history() returns a serialization including both d and ind.

CausalDict can forget deleted values, but not deleted keys.