Event-Driven Architectures for Distributed Crisis Management

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What is a Crisis?

- Usually are uncontrollable, unpredictable, and have dire consequences
  - Airplane crashes, power outages, wildfires, etc.
- Require quick, decisive action
- Require groups of people to work together
  - Police, fire departments, news teams, etc.
  - Distributed due to control issues

Dealing With Crises

- Three primary problems arise
  - Acquiring data
  - Analyzing data
  - Executing actions
- Normal management schemes often are inadequate
  - Rules engines, enterprise computing systems, etc.
- Abstract and concrete models proposed to cover these crises

Abstract Model: Variables

- *External variables* represent real-world quantities
- *Internal variables* are the results of computations concerning other variables
- Special *time* variable reflects progress of time in real world

Abstract Model: Execution

- *When-then rules* sole means of specifying system behavior
  - *When* history-predicate *then* state-change-specification
- When new information becomes available, all when-then rules executed immediately and concurrently
- Cannot be implemented
- Useful as a starting point for a concrete model

Concrete Model Overview

- Three components comprise system: *sensors, actuators,* and *event processors*
  - Sensors generate events based on external properties of the monitored system
  - Actuators consume events and change external properties
  - Event processors consume events and generate new ones
- New information entering the system is represented by *events*

The Role of Sensors

- Send information into the network
- All information specified as attribute-value pairs
  - (subject, earthquake)
  - (time, 9:15:35)
  - (intensity, 3.0)
  - (latitude, 34.057°N)
  - (longitude, 118.834°W)

The Role of Actuators

- Specify reactions to information
- Reaction can notify other software or individuals
  - Can cause change in the real world
- Must be activated via events
  - Cell phones, pagers, sirens, etc.

The Role of Event Processors

- Event processors implement the internal variables and *when* part of when-then rules
- Operate only over local variables
- Specify a set of *input ports*, a *state transition function*, an *event generation function*, and a *timeout* value

Event Processor Specification

- State transition function updates local variables
- Event generation function creates new events
- Timeout acts as an event if none received in specified time
  - Can be changed by state transition function
- Set of input ports dictates information to process
  - Can be prioritized

Example: Blood Supply

- Monitor blood supplies throughout L.A. County
- Event processor for health director implements when-then rule
  - **when**

    one-week moving-point average blood plasma usage in L.A. County exceeds three-quarters of one-week moving-point average blood plasma inventory available in L.A. County,
  - **then**

    send alert

Example: Blood Supply

- Event processor for health director:
  - Has two ports: *blood_available* and *blood_used*
  - Local variables *blood_available[ ], blood_used[ ], avg_blood_available* and *avg_blood_used*
  - State transition function appropriately modifies local variables based on new information
  - Event generation function sends out alert to director when critical condition satisfied
  - *Timeout* is 24hrs

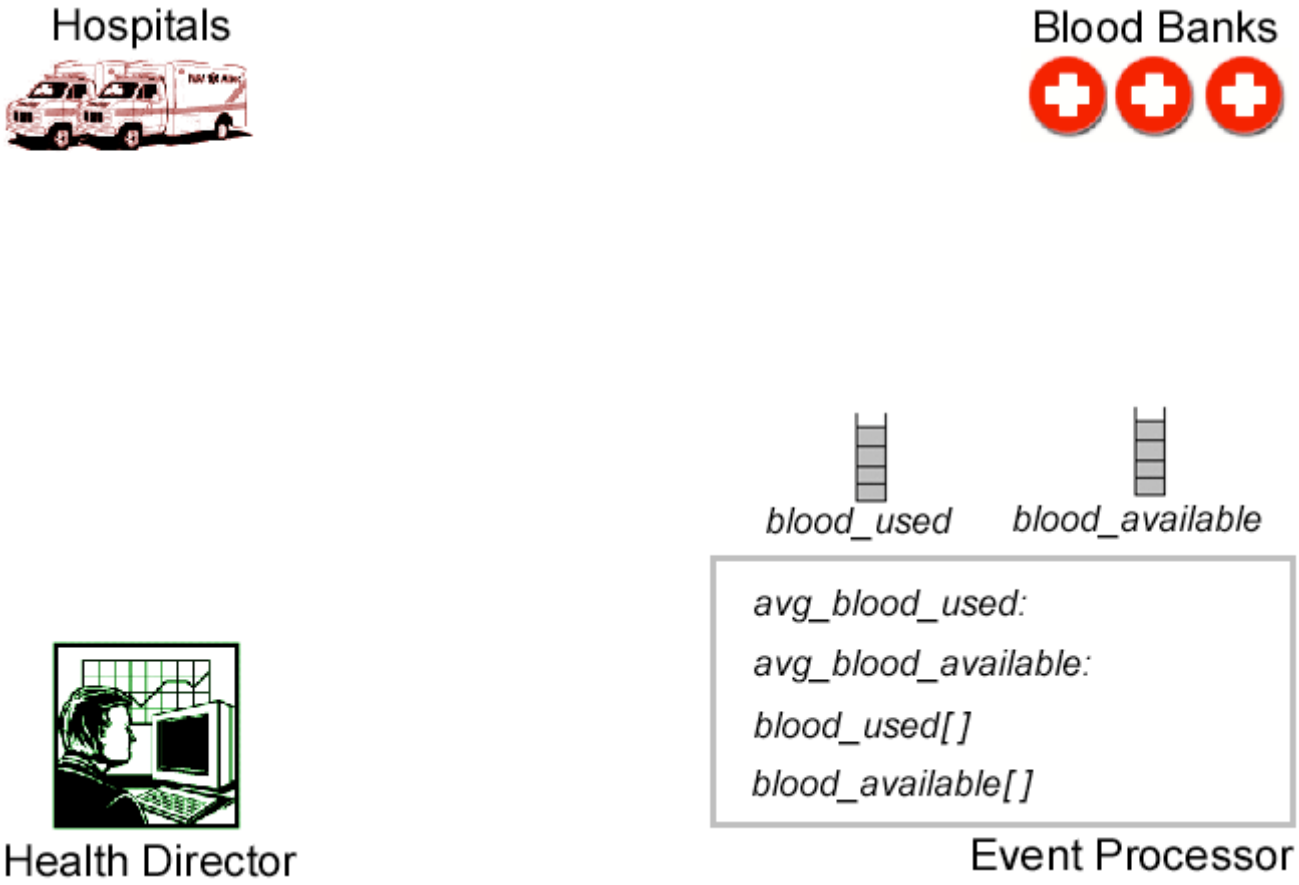
Example: Blood Supply

Hospitals

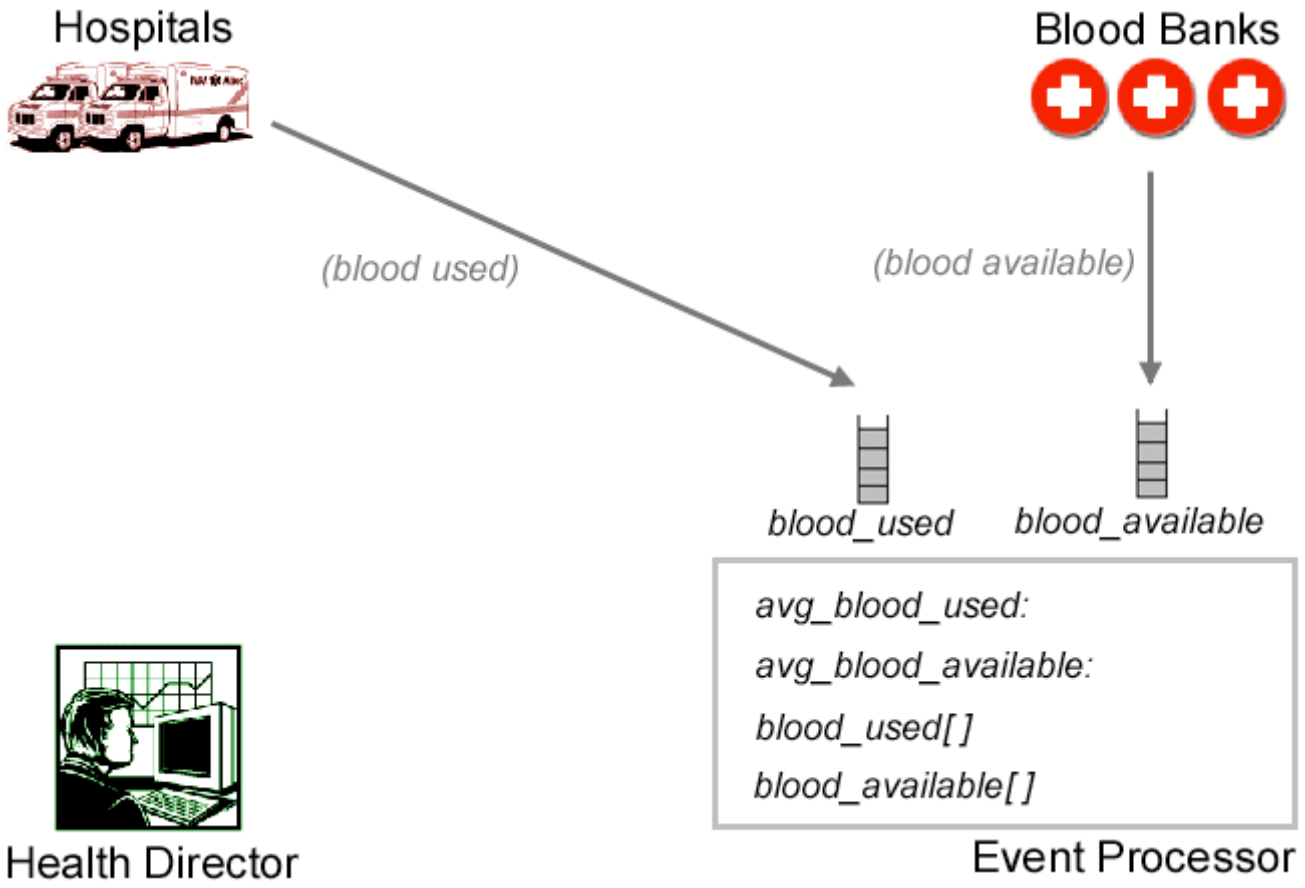
Blood Banks

Health Director

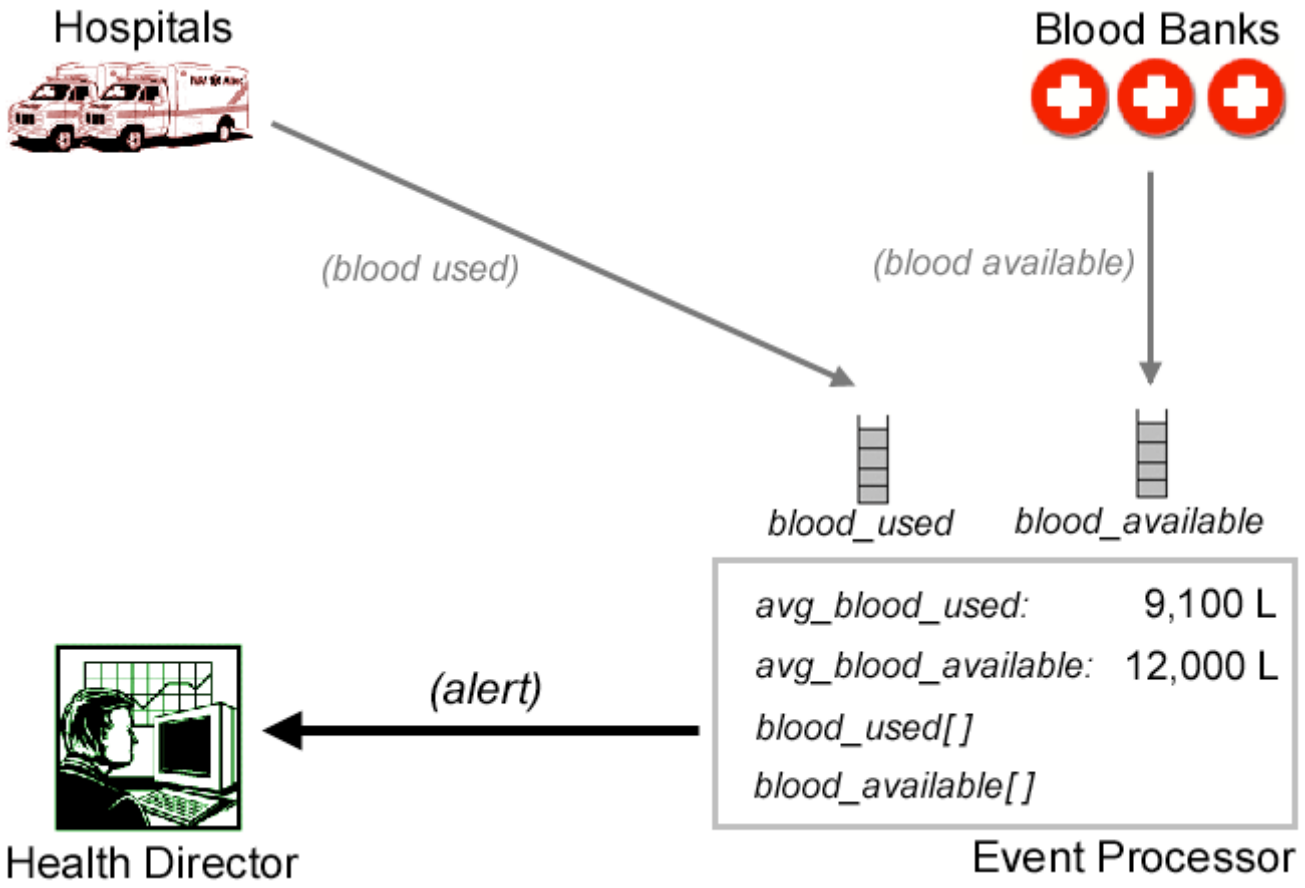
Example: Blood Supply



Example: Blood Supply



Example: Blood Supply



Implementation

- Messages implemented in XML
- States for processors implemented in XML, transitions implemented in XSLT
- System implemented in Java
- Persistent storage used to catalog information

Further Work

- Increase system robustness and fault tolerance
- Address security issues
- Create simpler interface for use by non-technical personnel

Conclusions

- *When-then rules* provide a simple way to help emergency response teams deal with dynamic, complex crises
- When-then rules can be adequately approximated by *event processors*
- First step towards a truly generic crisis management system

Questions?