Compensation-Aware Runtime Monitoring

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Motivation

- Monitoring induces an overhead
- Various approaches have been taken to mitigate this issue
- Sometimes even a small overhead is unacceptable

Dilemma

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  - Slows down system
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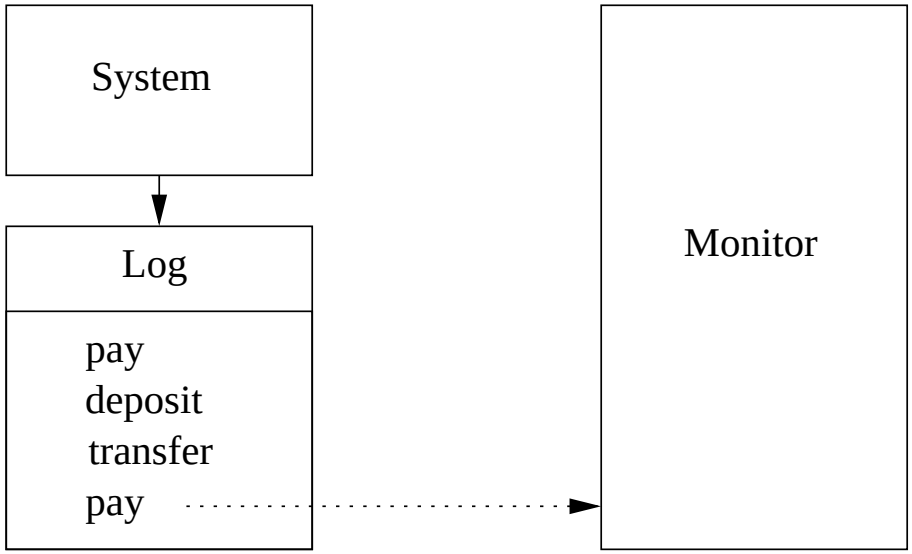
- Synchronise only when a problem is detected

Late Detection



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- In distributed games periodic synchronisation is required
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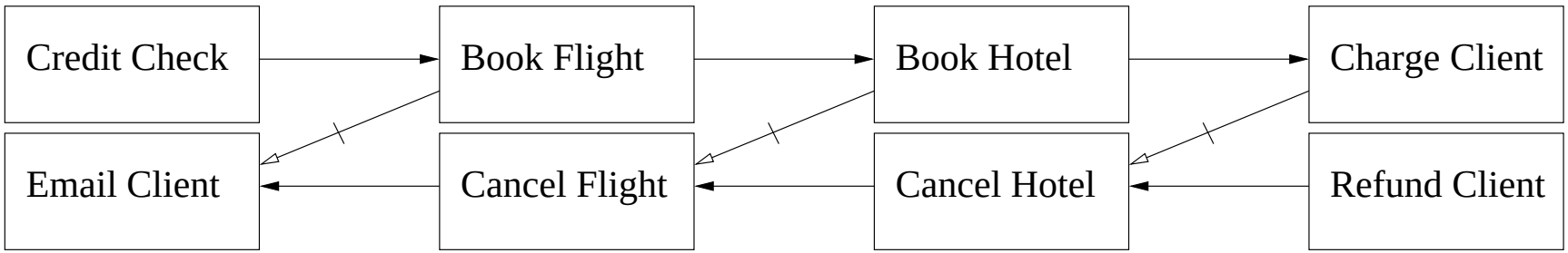
- The game state of a player might have to be "reversed" to match the global state
- Compensations have been devised exactly for this purpose!

Reversing the State of a System



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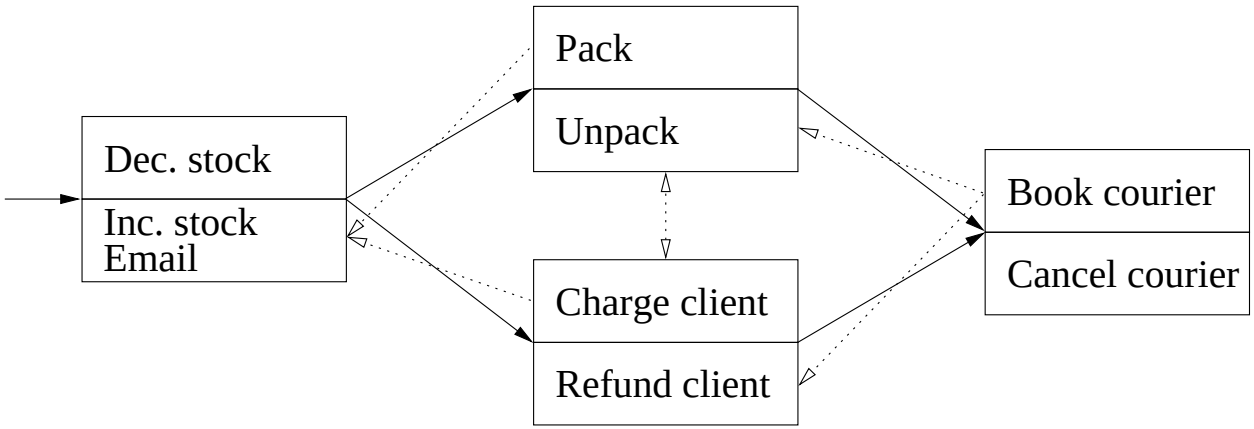
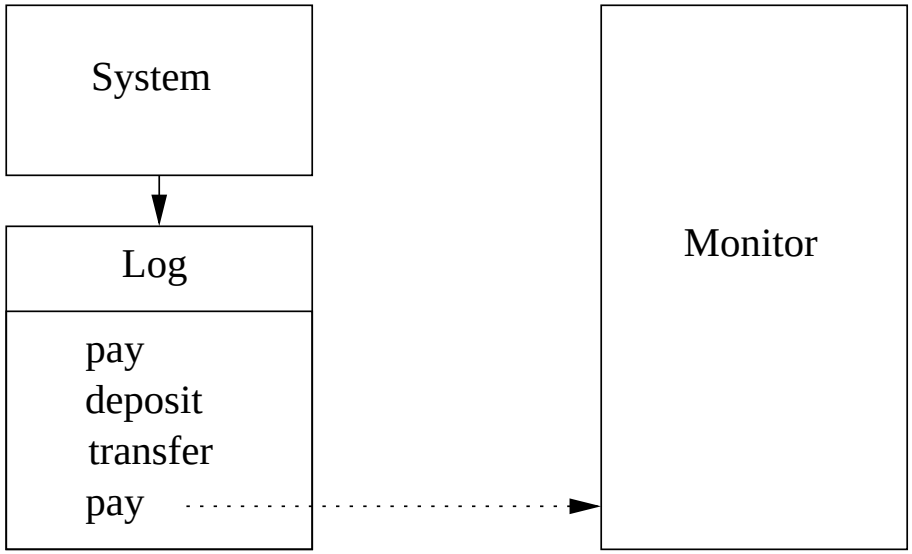
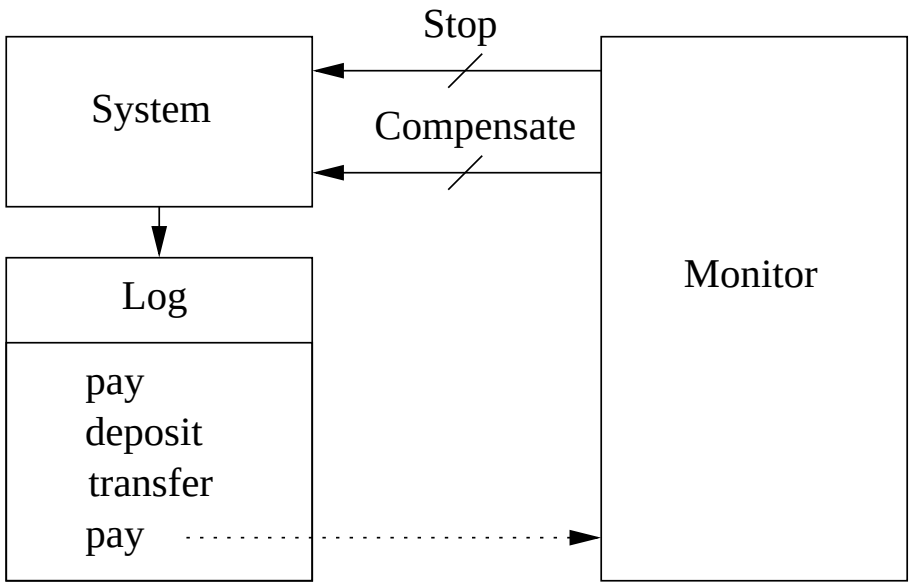


Offline Monitoring



Asynchronous Monitoring with Synchronisation Capability



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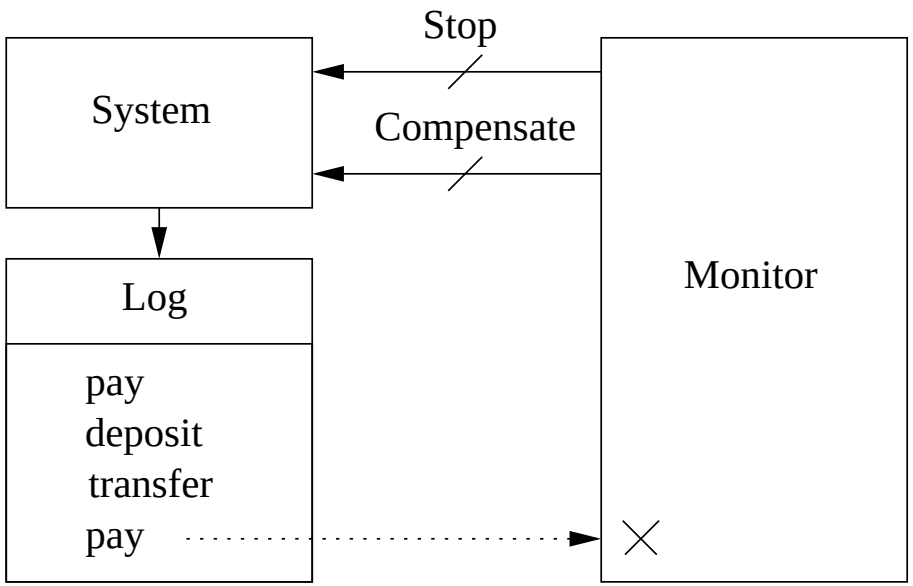

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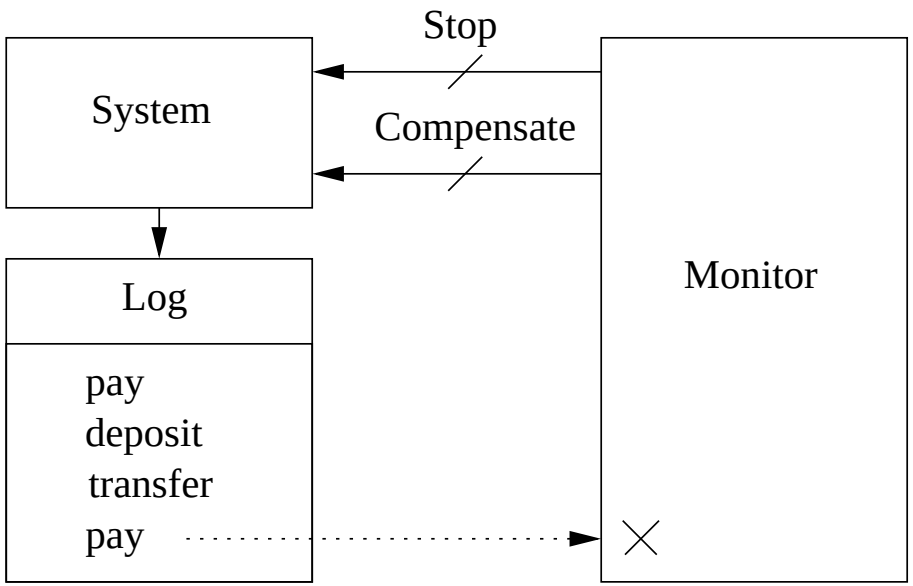

Upon error detection:

- Stop system
- Compensate for transfer, deposit, pay

Synchronous Monitoring

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$$\textsc{Comp}\ \frac{}{(\odot, wa, \otimes) \xrightarrow{\overline{a}}_{C} (\odot, w, \otimes)}$$

Soundness of Compensation-Based Approach

- The system and the monitor running asynchronously with compensations for synchronisation

exhibits the same behaviour as

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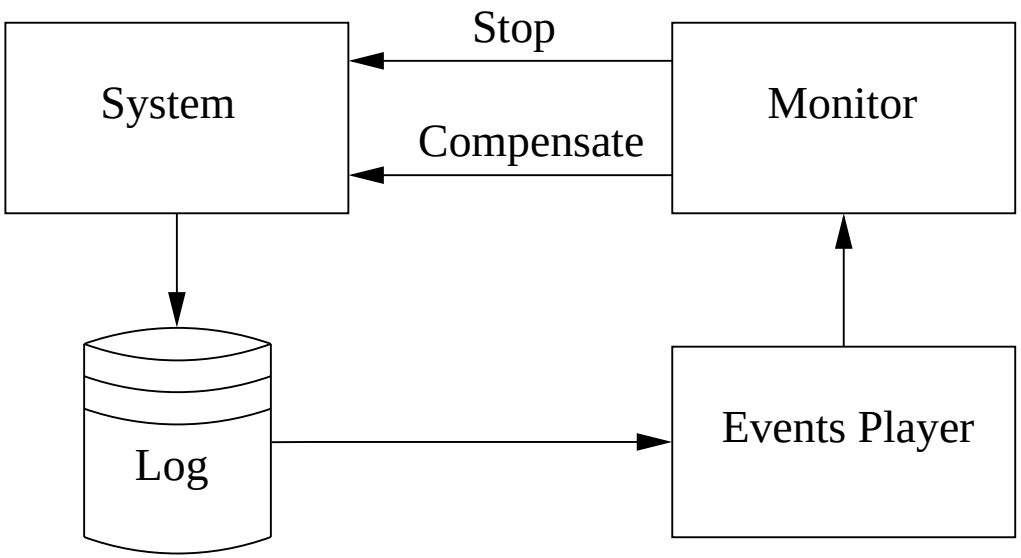
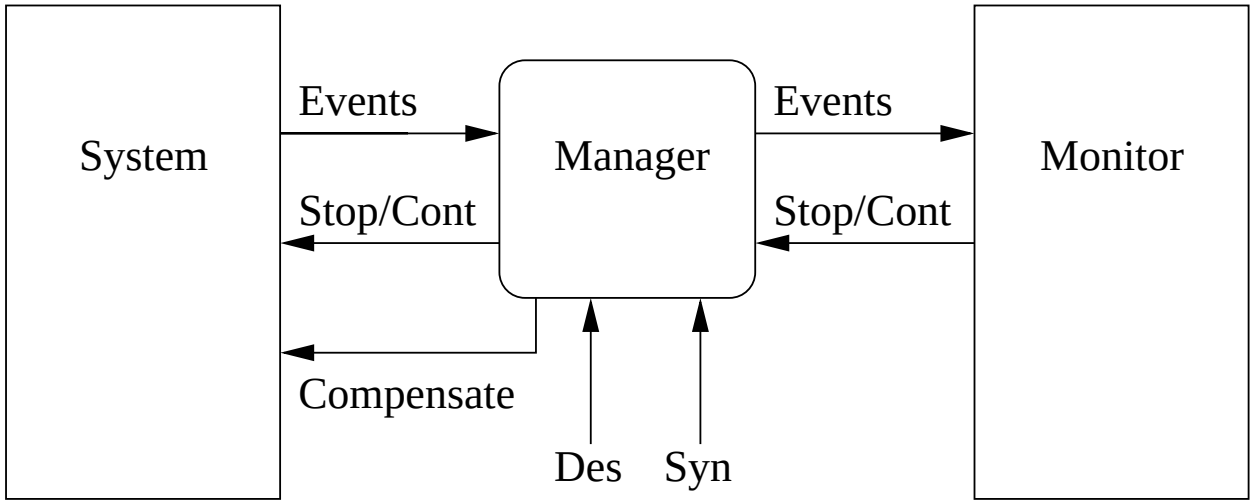
Architecture 1



Architecture 2

```
c = ok                          ;set default control to ok
while (c != stop)
  if (synch_mode)
    e = in_event()              ;read event from system
    c = out_event(e)            ;forward to monitor and get its resulting state
    out_control(c)              ;relay control to system
  else
    par                         ;parallel execution
      e1 = in_event()           ;read from system
      addToBuffer(e1)           ;store in buffer
      out_control(c)            ;return control to system
    with
      e2 = readFromBuffer()     ;read from buffer
      c = out_event(e2)         ;forward to monitor and get its resulting state
end
```

Architecture 3



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- Real-time properties
- Rights
- Amounts

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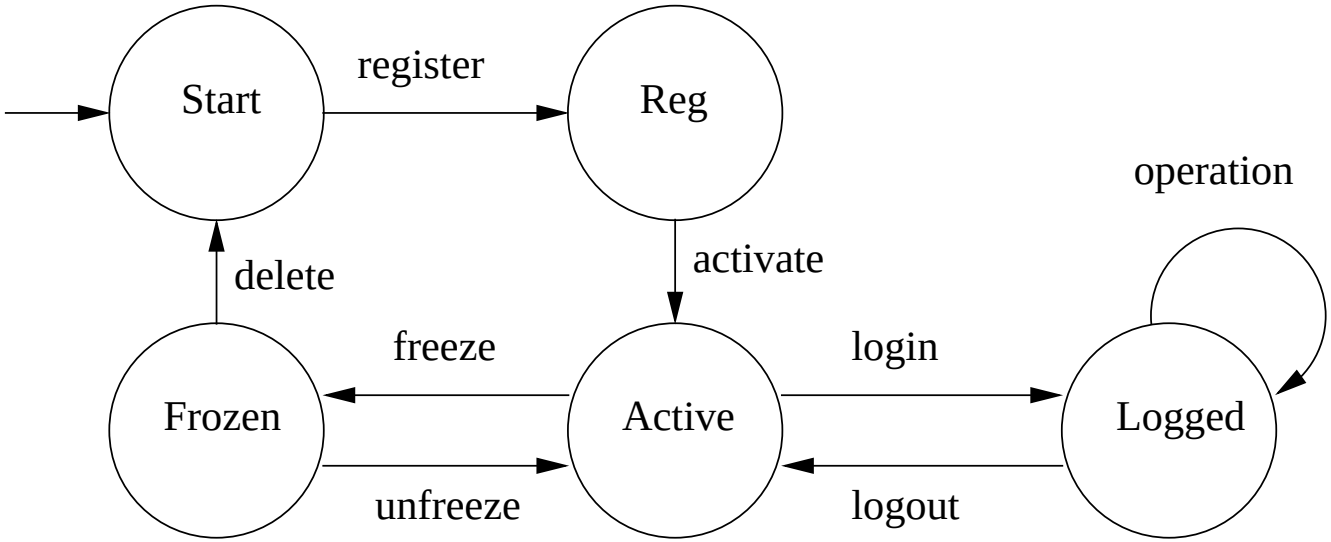

Conclusions

- The use of compensations to synchronise a system with its monitor
- A theory showing that monitoring asynchronously with compensation synchronisation produces the same observed behaviour as synchronous monitoring
- An architecture supporting monitor desynchronisation and resynchronisation
- The application of the architecture to an industrial case study

Future Directions

- Heuristics for deciding when to desynchronise and resynchronise
- Support a more sophisticated structure of compensations rather than the simplistic approach of having a compensation for each action

Questions