Stream-based Monitoring

Asynchronous Events
STREAM-BASED MONITORING

ASYNCHRONOUS EVENTS

Spec

Runtime Monitor

Static Guarantees
THE STREAMLAB FRAMEWORK

RTLola Spec

Static Analyzer

Runtime Monitor
SPECIFICATION LANGUAGES

Logics

Formal Guarantees

RTL

Expressiveness

OLA

Programming Languages
input altitude, TAS, pitch: Float

Assert: Do not fly below 2000ft.
**input** altitude, TAS, pitch: *Float*

**trigger** altitude < 2000 “Flying too low.”

Assert: Cover at least 200 miles per hour.
input altitude, TAS, pitch: Float

trigger altitude < 2000 "Flying too low."

output gnd_spd := cos(pitch) * TAS

output gnd_dist @5Hz := gnd_spd.aggr(over: 1h, using: ∫)

trigger gnd_dist < 200 "Flying too slow."

Assert: Altimeter samples with at least 10Hz.
**RTLola in a Nutshell**

**Input**

```plaintext
input altitude, TAS, pitch: Float
```

**Trigger**

```plaintext
trigger altitude < 2000 "Flying too low."
```

**Output**

```plaintext
output gnd_spd := cos(pitch) * TAS
output gnd_dist @5Hz := gnd_spd.aggr(over: 1h, using: ∫)
```

**Trigger**

```plaintext
trigger gnd_dist < 200 "Flying too slow."
```

**Trigger**

```plaintext
trigger @10Hz altitude.aggr(over: 1s, using: count) < 10 "Few samples."
```
**EXPERIMENTS**

**SPECIFICATION:**
- GPS frequency validation
- GPS/IMU jump detection
- Hover phase detection

**RESULTS:**
- 433,000 events
- 1,545ns per event @ 146%
- Stack size < 1kB, no heap
Download + Tutorial:

stream-lab.eu

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APPENDIX

Details on Sliding Windows
**Appendix: List Homomorphisms**

List Homomorphism:

\[ \gamma : (\circ, \varepsilon, \text{map}, \text{fin}) \]

\[ \gamma(a_1, \ldots, a_n) = \text{fin}(\text{map}(a_1) \circ \ldots \circ \text{map}(a_n)) \]

Integral:

\[ \varepsilon = \bot \]

\[ \text{map}(v, ts) = \]

\[ \bot \circ = \]

\[ \text{fin}(v) = \text{vol}(M) \]

Meertens; Algorithmics: Towards programming as a mathematical activity; 1986
Li, Maier, Tufte, Papadimos, Tucker; “No pane, no gain: efficient evaluation of sliding-window aggregates over data streams”; SIGMOD 2005