SASE: Complex Event Processing Over Streams

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Complex Event Processing

- High-volume event streams
  - Sensing devices
  - Financial services
  - Network monitors
  - …
- Complex event processing (CEP)
  - Filtering
  - Correlation
  - Aggregation
  - Transformation

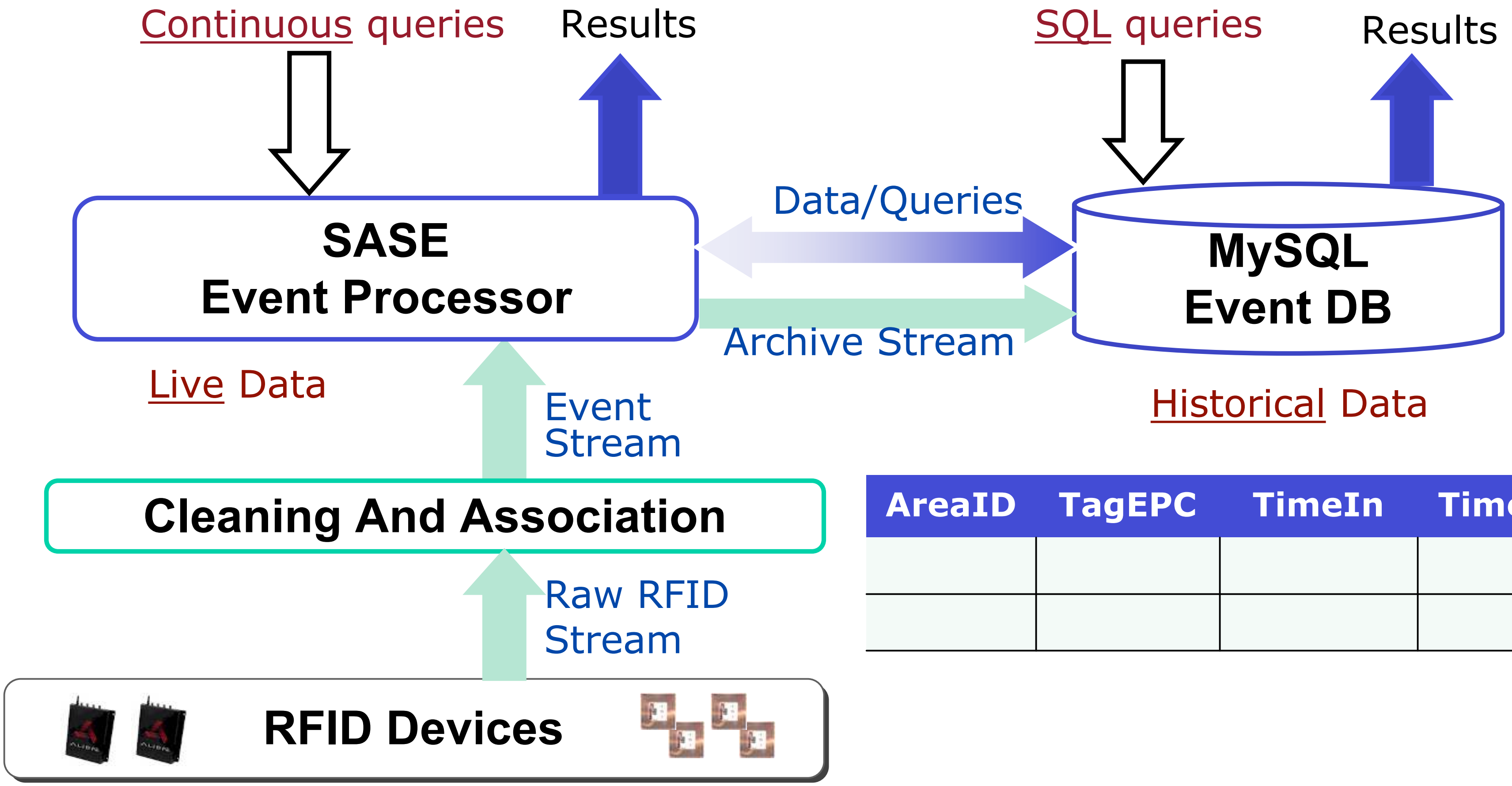
The SASE Event Processor

- SASE: A declarative event language, formal semantics, and an efficient implementation
  - Sequencing
  - Negation
  - Kleene closure
  - Parameterized predicates
  - Sliding window…
- Related Systems
  - Relational stream systems
  - Active databases
  - Commercial event systems
  - …

Unwieldy for use

Unable to express

Demo Architecture



Continuous queries

Results

SASE Event Processor

Live Data

Event Stream

Data/Queries

Archive Stream

SQL queries

Results

MySQL Event DB

Historical Data

Cleaning And Association

Raw RFID Stream

RFID Devices

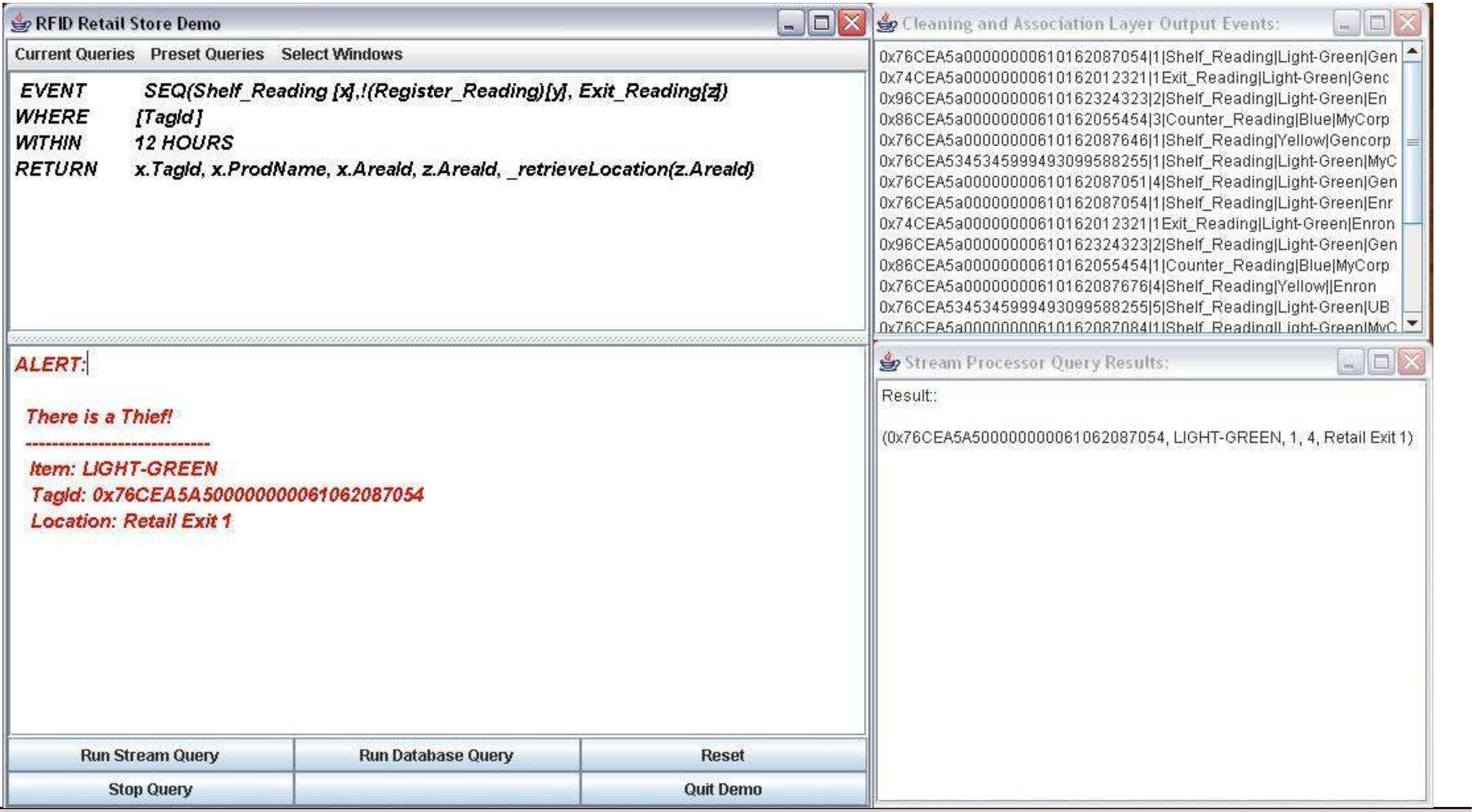
AreaID	TagEPC	TimeIn	TimeOut

Shoplifting

“Item seen at a shelf and then at an exit, but not at any register in between.”

```
EVENT      SEQ(Shelf_Reading x,
               !(Register_Reading y),
               Exit_Reading z)
WHERE      x.TagId = z.TagId AND x.TagId = y.TagID
               /* Equivlanent to [TagId] */
WITHIN     12 HOURS
RETURN     x.TagId, x.ProdName,
           x.AreaId, z.AreaId,
           retrieveLocationName(z.AreaId)
```

Shoplifting Screenshot



```
EVENT     SEQ(Shelf_Reading [x],!(Register_Reading)[y], Exit_Reading[z])
WHERE     [TagId]
WITHIN    12 HOURS
RETURN    x.TagId, x.ProdName, x.AreaId, z.AreaId, _retrieveLocation(z.AreaId)
```

```
ALERT:

 There is a Thief!
 ---------------------------
 Item: LIGHT-GREEN
 TagId: 0x76CEA5A50000000000610620870 54
 Location: Retail Exit 1
```

```
0x76CEA5a00000000610162087054|1|Shelf_Reading|Light-Green|Gen
0x74CEA5a00000000610162012321|1Exit_Reading|Light-Green|Genc
0x96CEA5a00000000610162324323|2|Shelf_Reading|Light-Green|En
0x86CEA5a00000000610162055454|3|Counter_Reading|Blue|MyCorp
0x76CEA5a00000000610162087646|1|Shelf_Reading|Yellow|Gencorp
0x76CEA5345345999493099588255|1|Shelf_Reading|Light-Green|MyC
0x76CEA5a00000000610162087051|4|Shelf_Reading|Light-Green|Gen
0x76CEA5a00000000610162087054|1|Shelf_Reading|Light-Green|Enr
0x74CEA5a00000000610162012321|1Exit_Reading|Light-Green|Enron
0x96CEA5a00000000610162324323|2|Shelf_Reading|Light-Green|Gen
0x86CEA5a00000000610162055454|1|Counter_Reading|Blue|MyCorp
0x76CEA5a00000000610162087676|4|Shelf_Reading|Yellow||Enron
0x76CEA5345345999493099588255|5|Shelf_Reading|Light-Green|UB
0x76CEA5a00000000610162087084|1|Shelf_Reading|Light-Green|MyC
```

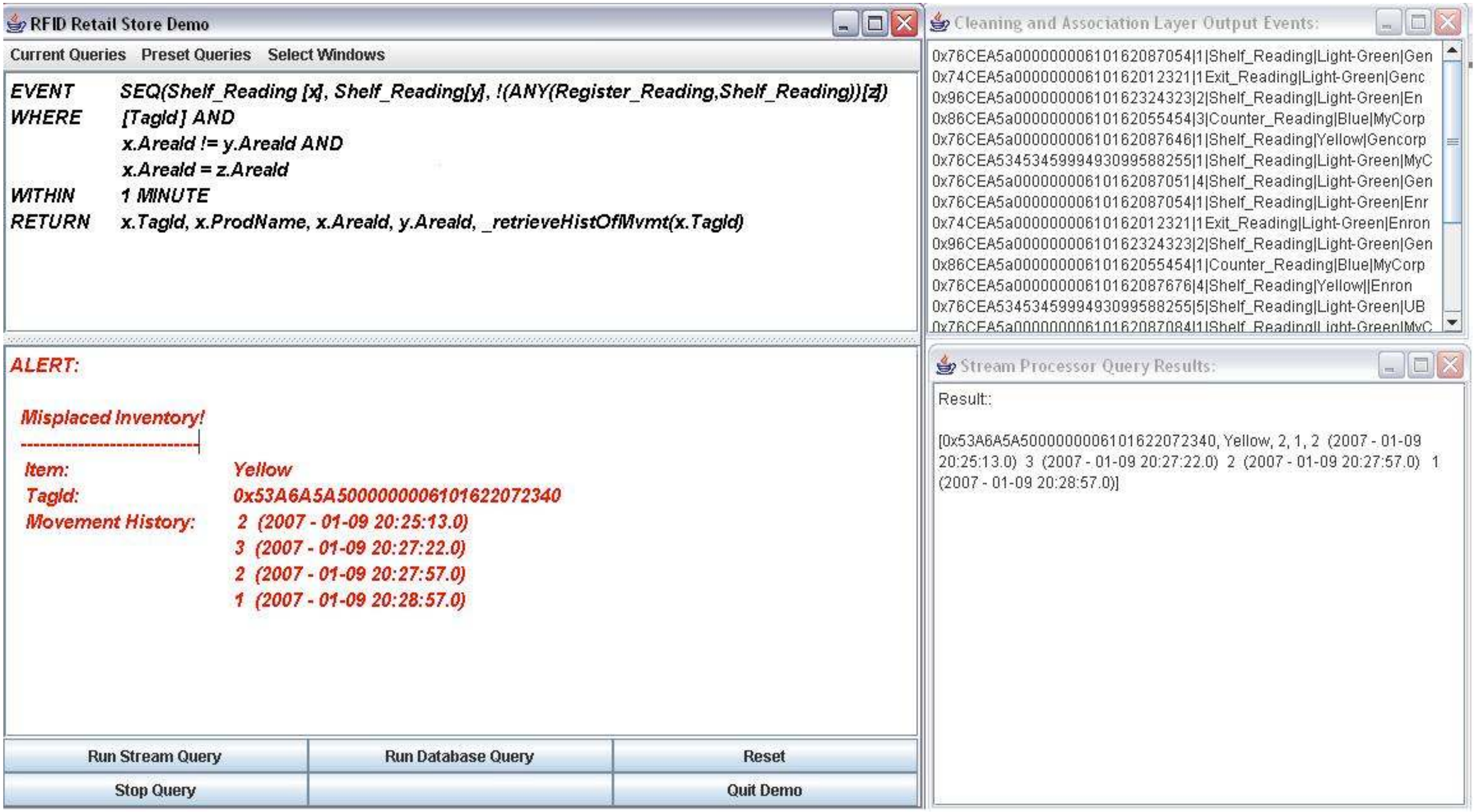
```
Result::

(0x76CEA5A50000000000610620870 54, LIGHT-GREEN, 1, 4, Retail Exit 1)
```

Misplaced Inventory

“Item seen at Shelf A and then Shelf B, without being purchased or put back to the original shelf afterwards.”

```
EVENT       SEQ(Shelf_Reading x,
                Shelf_Reading y,
                !(ANY(Register_Reading, Shelf_Reading) z) )
WHERE       [TagId] AND
            x.AreaId != y.AreaId AND
            x.AreaId = z.AreaId
WITHIN      1 minute
RETURN      x.TagId, x.ProdId, x.AreaId, y.AreaId,
            retrieveHistOfMvmt(x.TagId)
```

Misplaced Inventory Screenshot



```
EVENT     SEQ(Shelf_Reading [x], Shelf_Reading[y], !(ANY(Register_Reading,Shelf_Reading))[z])
WHERE     [TagId] AND
          x.AreaId != y.AreaId AND
          x.AreaId = z.AreaId
WITHIN    1 MINUTE
RETURN    x.TagId, x.ProdName, x.AreaId, y.AreaId, _retrieveHistOfMvmt(x.TagId)
```

ALERT:

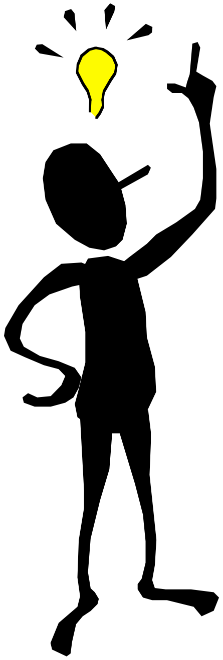
Misplaced Inventory!

Item:	*Yellow*
TagId:	*0x53A6A5A5000000006101622072340*
Movement History:	*2 (2007 - 01-09 20:25:13.0)* *3 (2007 - 01-09 20:27:22.0)* *2 (2007 - 01-09 20:27:57.0)* *1 (2007 - 01-09 20:28:57.0)*

```
0x76CEA5a000000000610162087054|1|Shelf_Reading|Light-Green|Gen
0x74CEA5a000000000610162012321|1Exit_Reading|Light-Green|Genc
0x96CEA5a000000000610162324323|2|Shelf_Reading|Light-Green|En
0x86CEA5a000000000610162055454|3|Counter_Reading|Blue|MyCorp
0x76CEA5a000000000610162087646|1|Shelf_Reading|Yellow|Gencorp
0x76CEA534534599949309958825 5|1|Shelf_Reading|Light-Green|MyC
0x76CEA5a000000000610162087051|4|Shelf_Reading|Light-Green|Gen
0x76CEA5a000000000610162087054|1|Shelf_Reading|Light-Green|Enr
0x74CEA5a000000000610162012321|1Exit_Reading|Light-Green|Enron
0x96CEA5a000000000610162324323|2|Shelf_Reading|Light-Green|Gen
0x86CEA5a000000000610162055454|1|Counter_Reading|Blue|MyCorp
0x76CEA5a000000000610162087676|4|Shelf_Reading|Yellow||Enron
0x76CEA534534599949309958825 5|5|Shelf_Reading|Light-Green|UB
0x76CEA5a000000000610162087084|1|Shelf_Reading|Light-Green|MyC
```

```
Result::

[0x53A6A5A5000000006101622072340, Yellow, 2, 1, 2  (2007 - 01-09
20:25:13.0)  3  (2007 - 01-09 20:27:22.0)  2  (2007 - 01-09 20:27:57.0)  1
(2007 - 01-09 20:28:57.0)]
```

Questions



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