Microsoft Azure

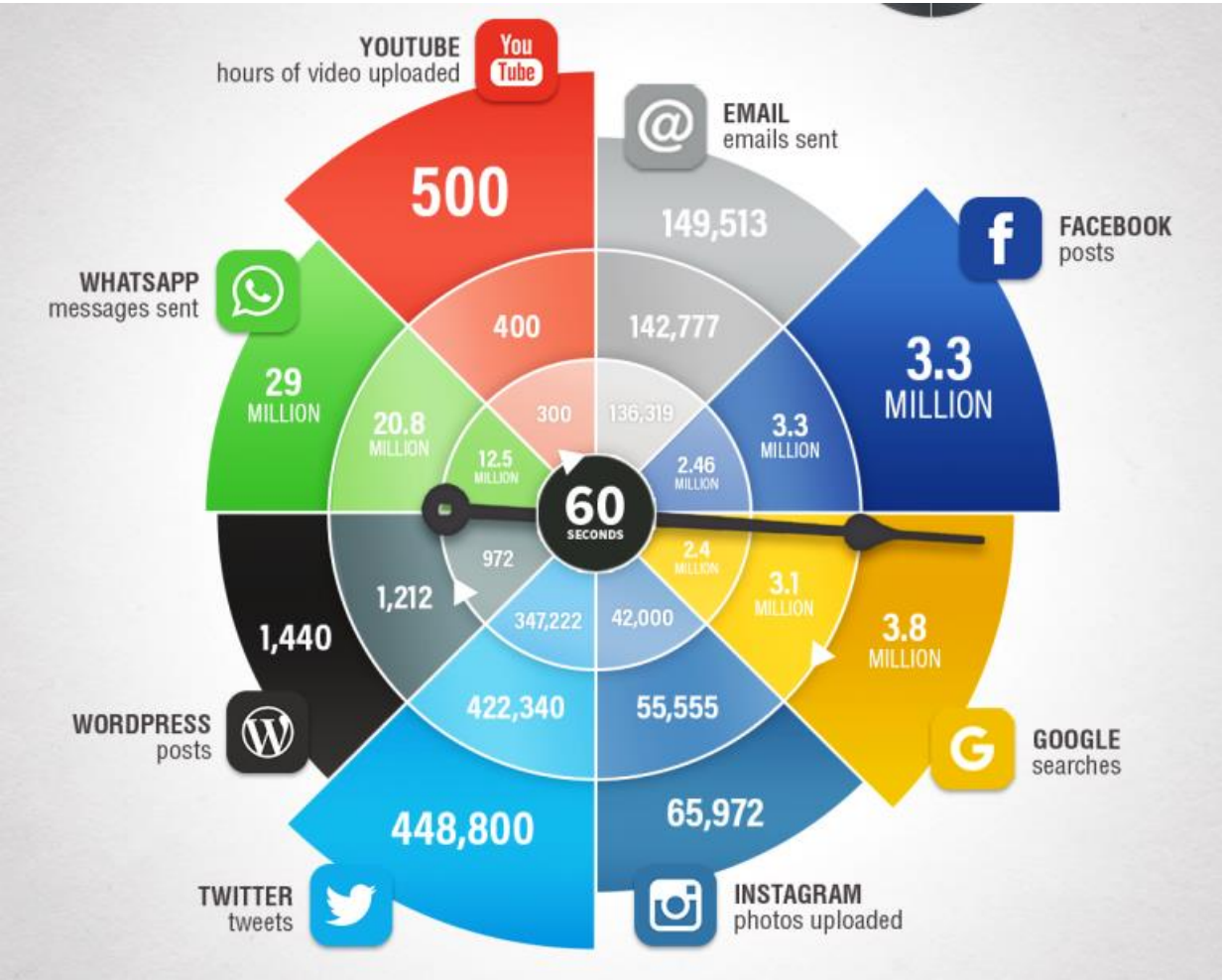
Azure Event Hubs

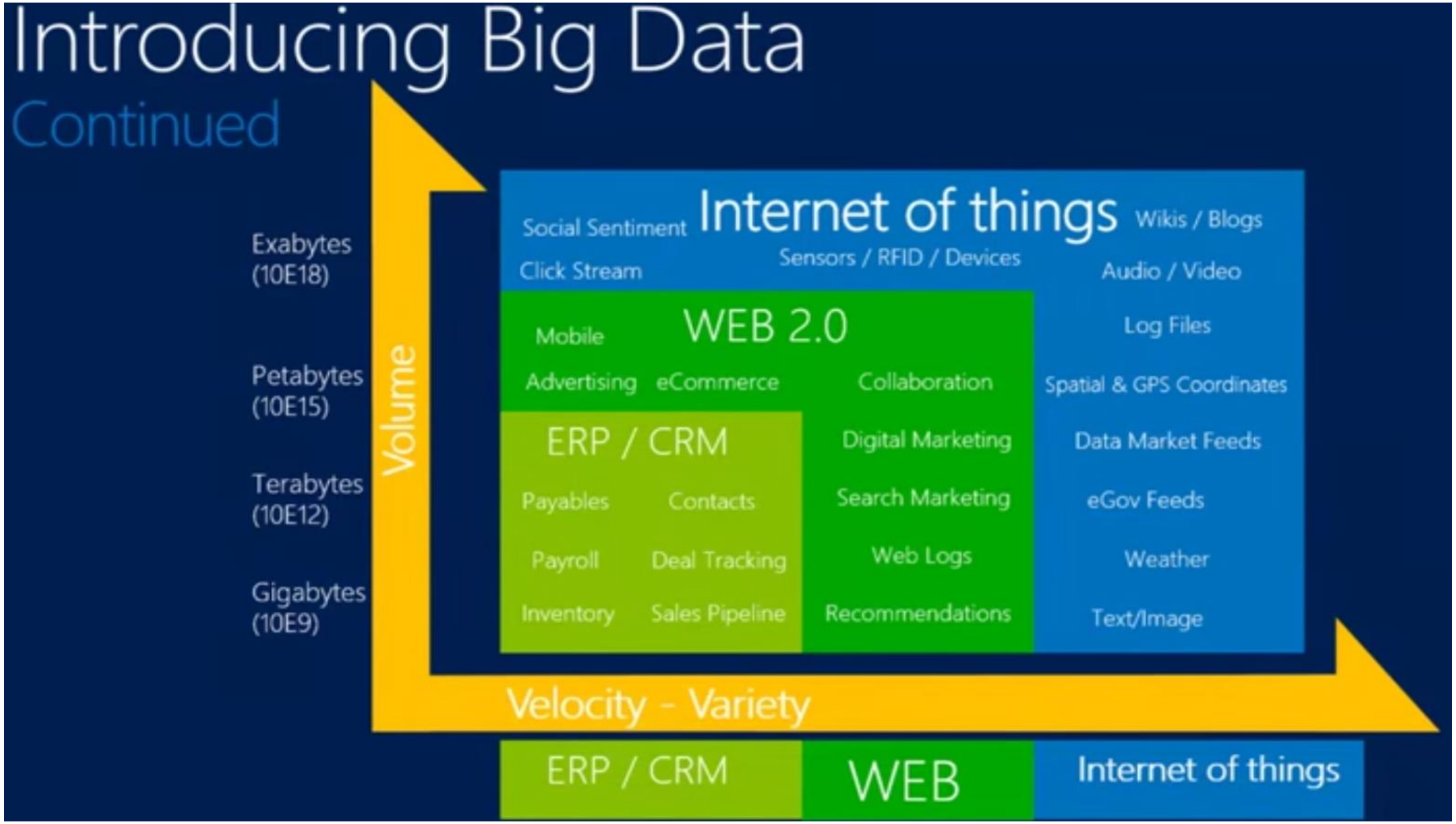
Stream Analytics

Real-time Analytics

datasciencedojo
data science for everyone

What happens in 60 seconds?




Introducing Big Data
Continued
Exabytes (10E18)
Petabytes (10E15)
Terabytes (10E12)
Gigabytes (10E9)
Volume
Internet of things
Social Sentiment
Click Stream
Sensors / RFID / Devices
Wikis / Blogs
Audio / Video
WEB 2.0
Mobile
Advertising
eCommerce
Collaboration
Log Files
Spatial & GPS Coordinates
ERP / CRM
Payables
Contacts
Payroll
Deal Tracking
Inventory
Sales Pipeline
Digital Marketing
Search Marketing
Web Logs
Recommendations
Data Market Feeds
eGov Feeds
Weather
Text/Image
Velocity - Variety
ERP / CRM
WEB
Internet of things

Defining Real-time

Within seconds…

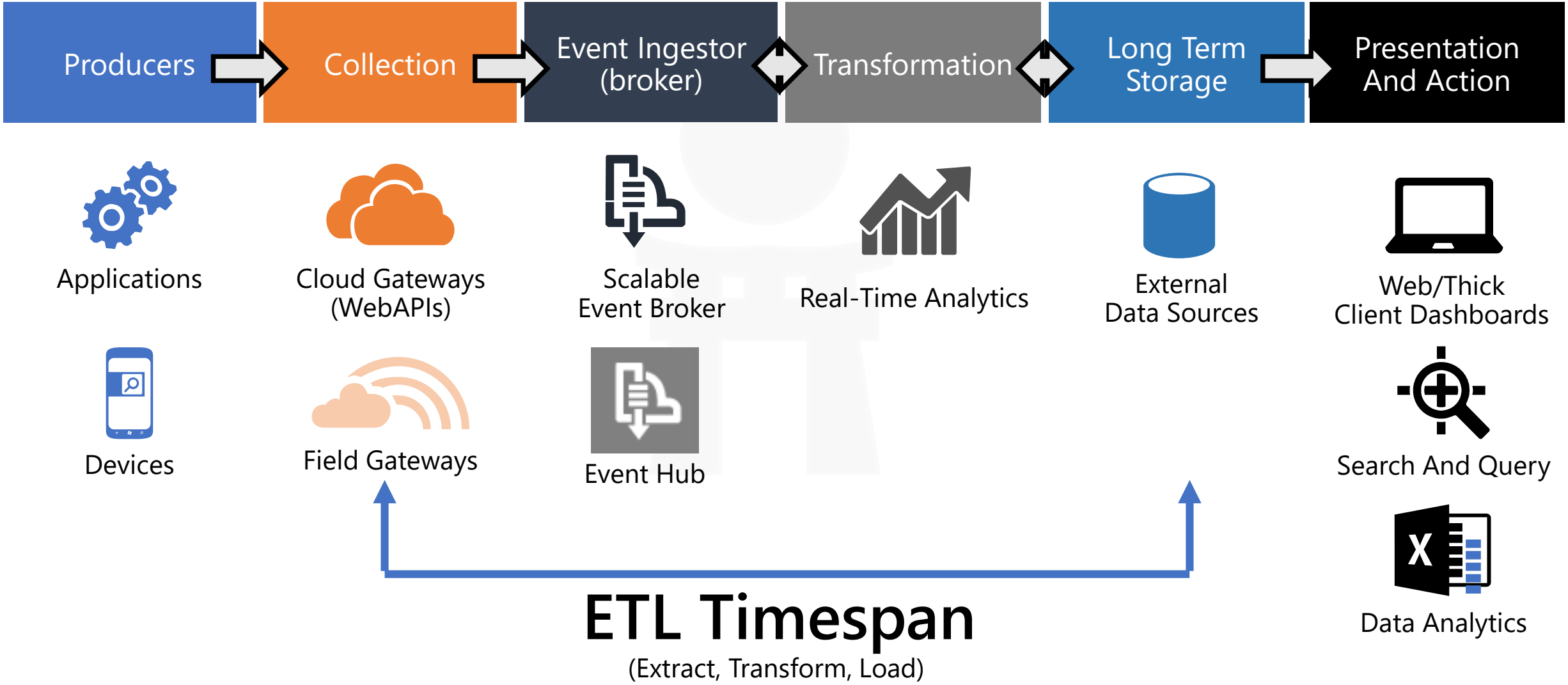
or…

Within minutes…

of an event occurring

Up to 2 hours

Typical Event Processing

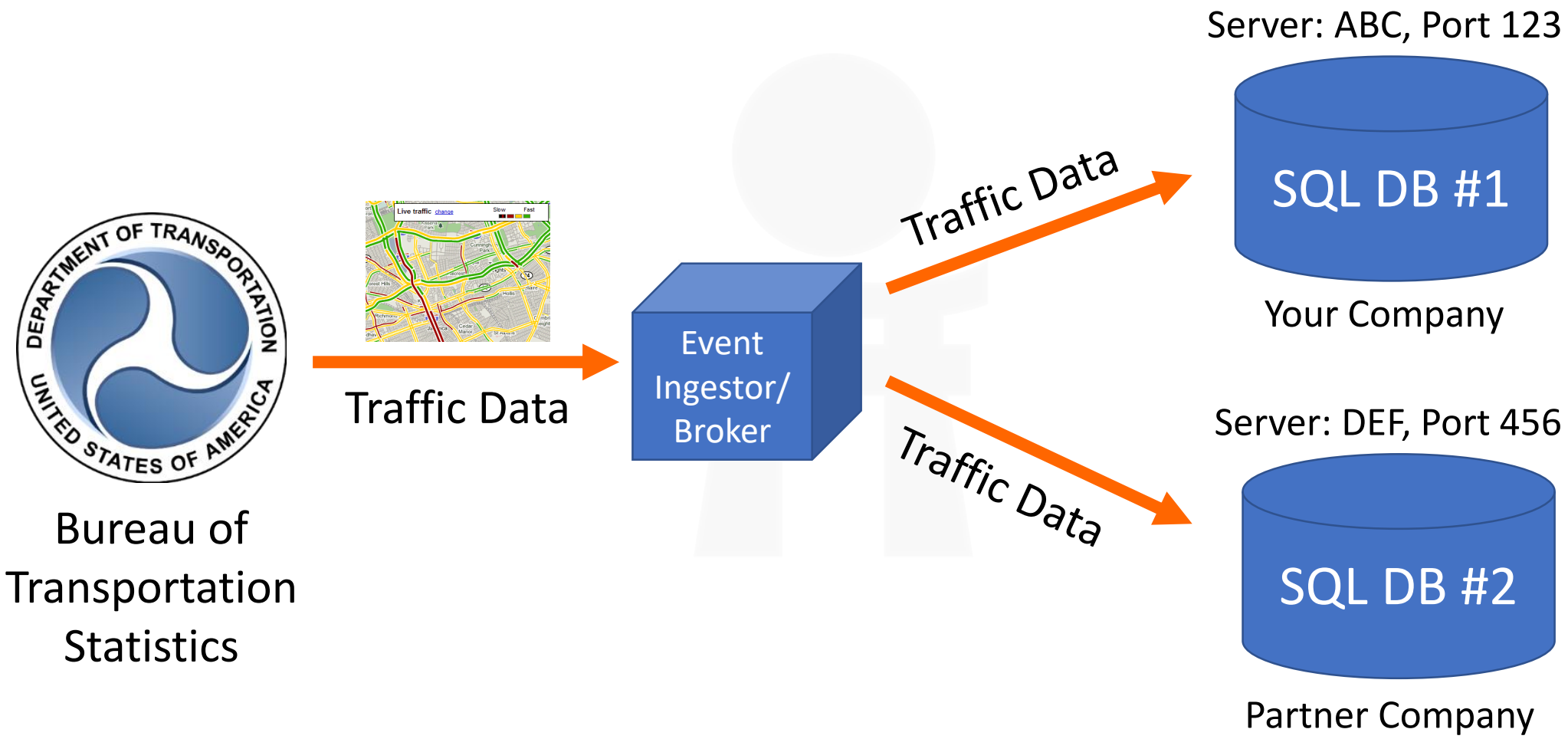


DATA INGESTION

The Post Office & Shipping Centers

- Tracks address changes
- Tries again tomorrow if send failed
- Holds packages in short term
  - Too many failed deliveries
  - Vacations
- Reduces complexity through specialization
- Optimized to send, receive, and temporarily house packages

Preventative Solution: Middleware



Popular Event Brokers

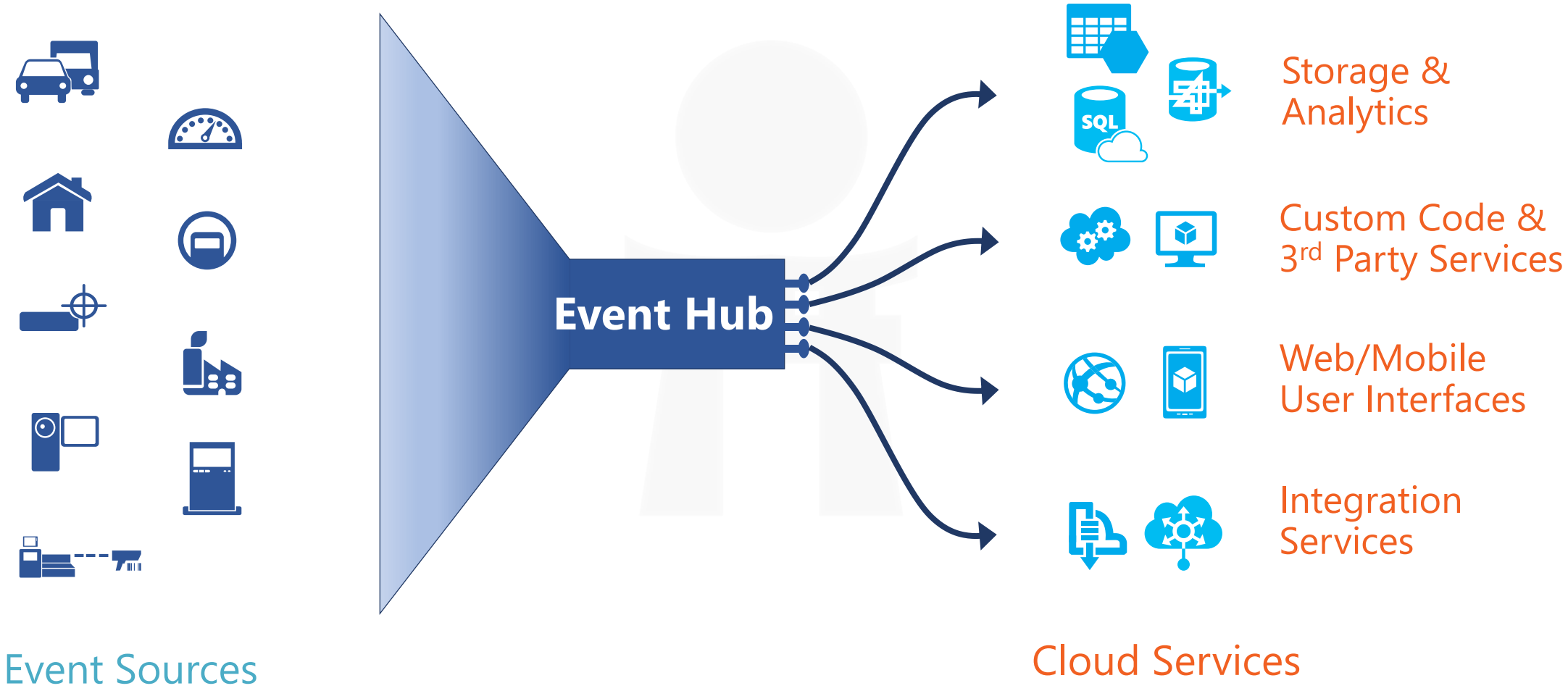
RabbitMQ™

Azure Event Hubs

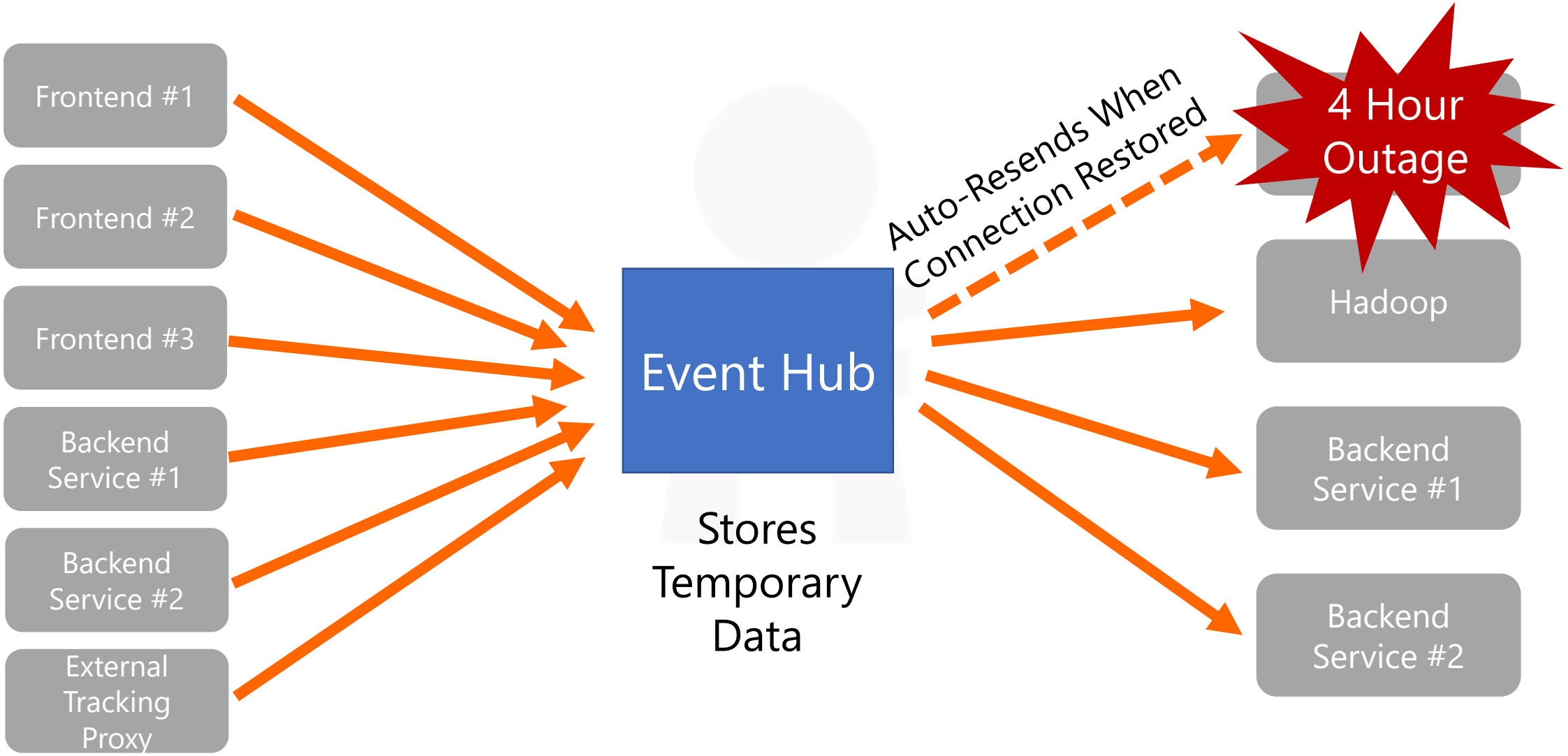
IBM WebSphere. software

kafka

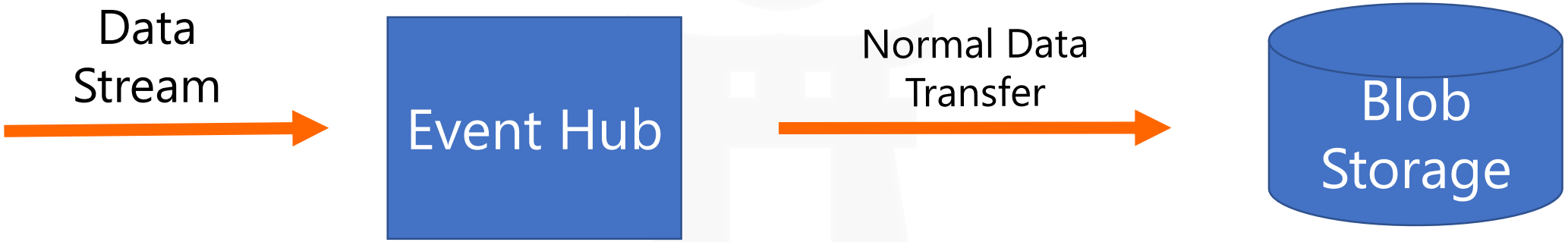
Event Hub for IoT: Big Data Ingestion



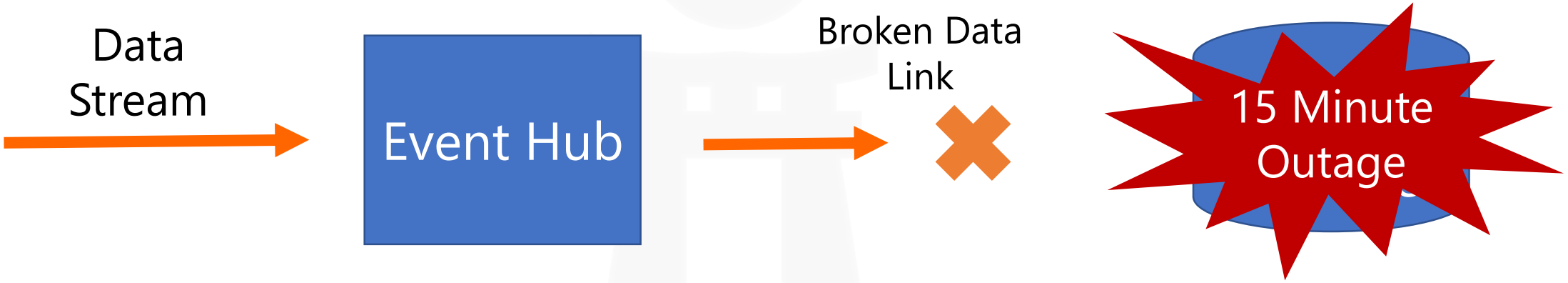
Temporary Storage



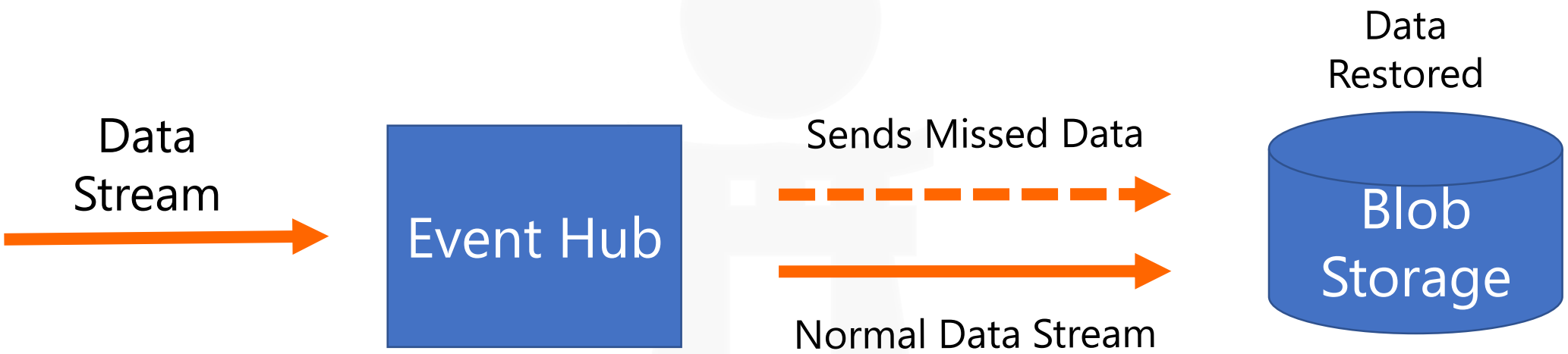
Demo: Normal Scenario



Demo: Output Downage



Demo: Output Restored



The Post Office

- Tracks address changes
- Tries again tomorrow if send failed
- Holds packages in short term
  - Too many failed deliveries
  - Vacations
- Reduces complexity through specialization

Event Hub, Stream Management

Device Sets PartitionKey to its ID

A

B

Messages always go to same partition based on PartitionKey

Event Hub

Partition 1

Partition 2

Partition N

f(x)

Event Hub uses a static hashing function to map PartitionKey to partition

Reader 1

Reader 2

Reader N

Output 1

Hadoop

Reader 1

Reader 2

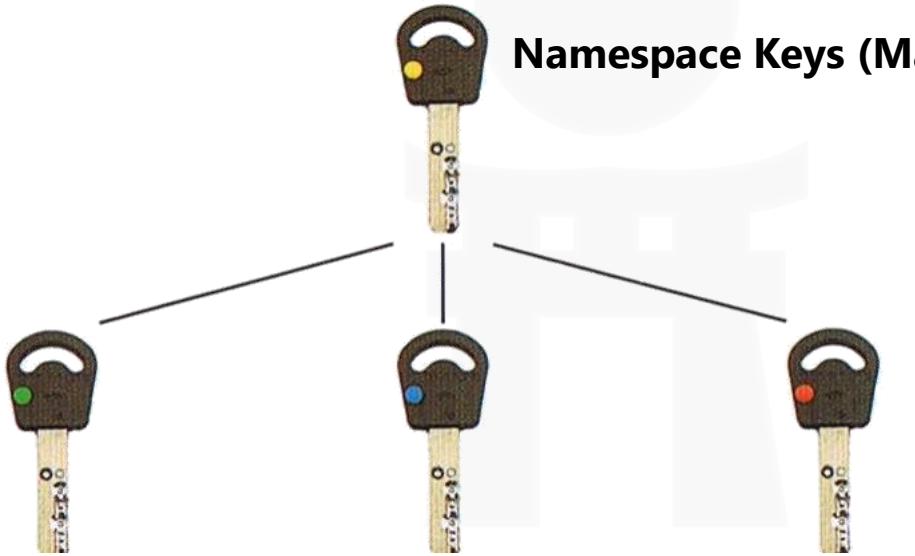
Reader N

Output 2

Data Warehouse

Service Bus Namespace

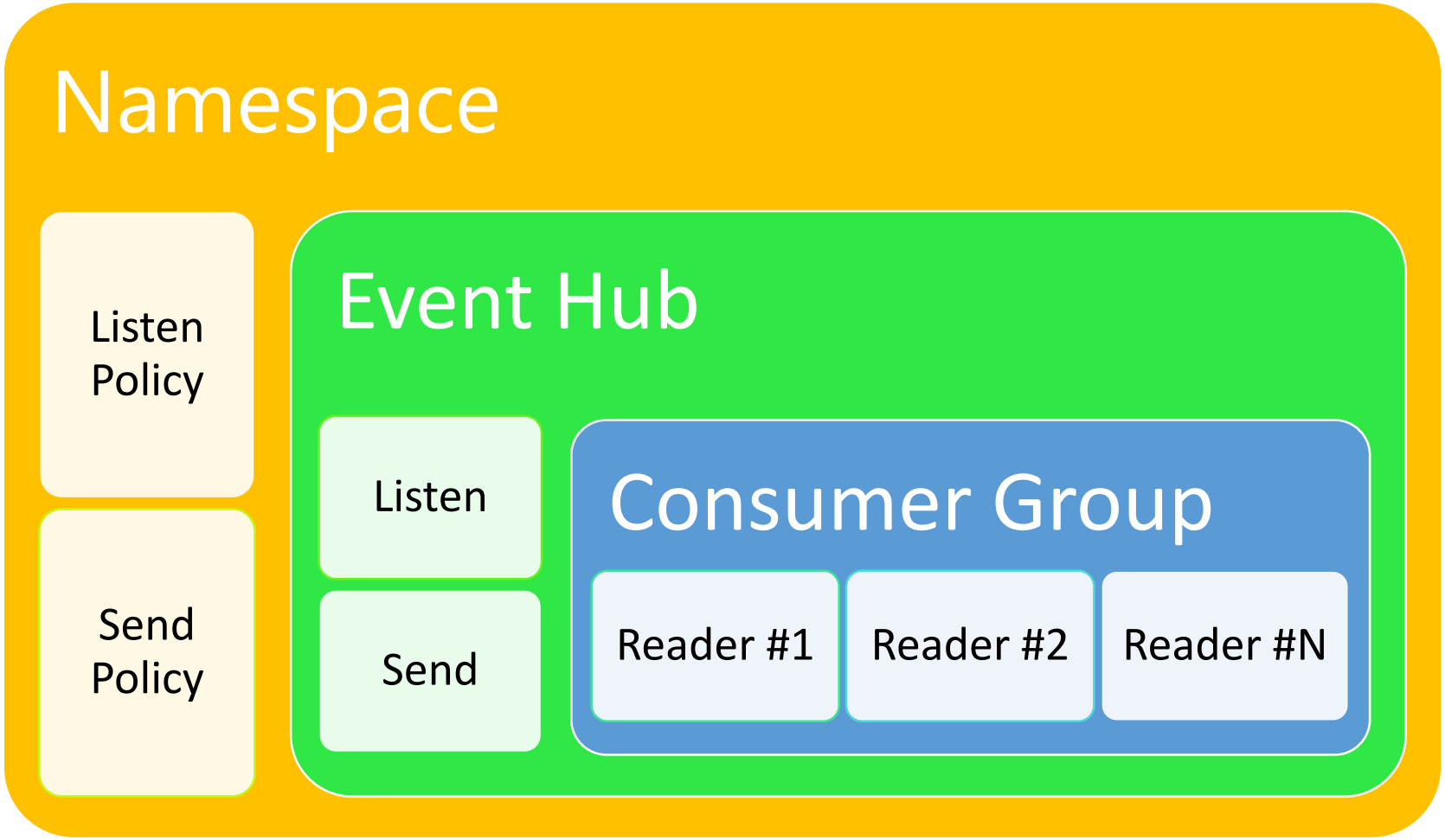
Access Rights, Policy, Keys



Namespace Keys (Master Key, God Key)

Event Hub Keys

Access Rights



Access Rights

HANDS-ON LAB

Credit Card Transactions (swipes)

- Credit card transactions are usually done in batch as an end-of-the-day send.
- Stream process for insights now.
- US mainland transactions

Streaming to Event Hub

Swipes

Credit Card Reader (Synthetic)

Message Broker (DataScienceDojo's Webpage)

Data Ingestor (Azure Event Hub)

The Data

{
"swipe_date":"2015-05-22T20:16:27.122Z",
"transaction_id":3127484,
"card_type":"VISA",
"card_number":"4913419738164560",
"expiration_month":"02",
"expiration_year":"18",
"cvv_code":"520",
"user_id":"972288",
"user_gender":"male",
"user_first_name":“Alexander",
"user_last_name":“Hamilton",
"merchant":“McDonald’s",
"transaction_amount":13.64,
"balance":336.48,
"merchant_fee":.5,
"swipe_city":"New York",
"swipe_state":"New York",
"swip_city_state":"New York, NY",
"InstanceNo":1
}

The Streamer

- http://demos.datasciencedojo.com/app/credit-card-streamer/

Credit Card Streamer

This app will simulate the kind of data streams that banks would encounter, credit card swipe data. The app will generate synthetic data from a credit card transaction (swipe) and pushes it into a given Azure Event Hub as a JSON. The application logic for this app is written entirely in JavaScript so the speed and interval of the transactions is dependent on the processing power of the user device.

Event Hub Credentials

Event Hub Name (Need help? PDF Guide)

field required

Service Bus Namespace (Need help? PDF Guide)

field required

Shared Access Policy Name (Need help? PDF Guide)

field required

Output Preview

Display Format (Data is still sent as a JSON): JSON List

```
Successfully loaded database. Ready to simulate data.
```

Inside the Event Hub

Credit Card Reader (Synthetic)

Swipes →

data science dojo

Message Broker (DataScienceDojo's Webpage)

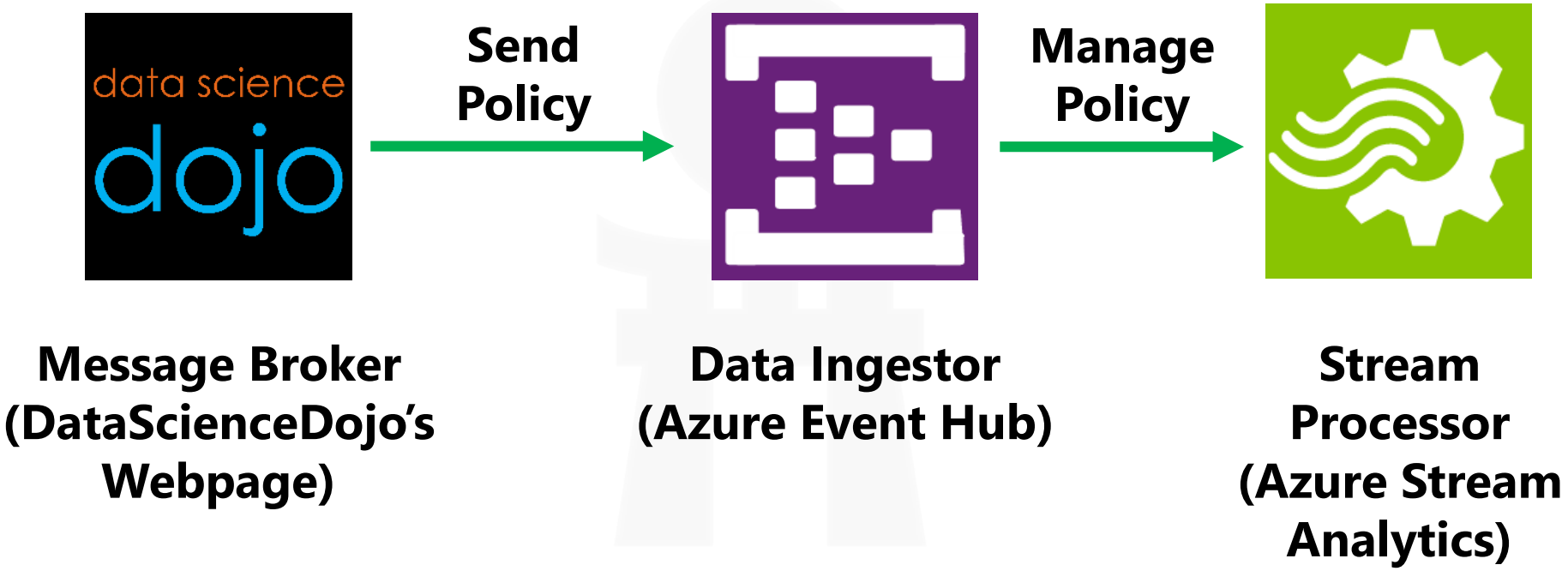
→

Service Bus Namespace: YourNameSpace

Event Hub 1:

- Credit Card Swipes

Setting Policies



STREAM PROCESSING

Popular Up and Coming Event Processors

APACHE STORM™
Distributed • Resilient • Real-time

Cloud Dataflow Beta

Google DataFlow

Azure Stream Analytics

Spark Streaming

Amazon Kinesis

DEMO

Credit Card Transactions (swipes)

- Credit card transactions are usually done in batch as an EOTD send.
- Stream process for insights now.
- US mainland transactions

Previously…

Swipes

Credit Card Reader (Synthetic)

Message Broker (DataScienceDojo's Webpage)

Data Ingestor (Azure Event Hub)

The Streamer

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Event Hub Credentials

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Service Bus Namespace (Need help? PDF Guide)

field required

Shared Access Policy Name (Need help? PDF Guide)

field required

Output Preview

Display Format (Data is still sent as a JSON): JSON List

```
Successfully loaded database. Ready to simulate data.
```

The Data


```
{
  "swipe_date":"2015-05-22T20:16:27.122Z",
  "transaction_id":3127484,
  "card_type":"VISA",
  "card_number":"4913419738164560",
  "expiration_month":"02",
  "expiration_year":"18",
  "cvv_code":"520",
  "user_id":"972288",
  "user_gender":"male",
  "user_first_name":“Alexander",
  "user_last_name":“Hamilton",
  "merchant":“McDonald’s",
  "transaction_amount":13.64,
  "balance":336.48,
  "merchant_fee":.5,
  "swipe_city":"New York",
  "swipe_state":"New York",
  "swip_city_state":"New York, NY",
  "InstanceNo":1
}
```

Data vs Events

{
"swipe_date":"2015-05-22T20:16:27.122Z",
"transaction_id":3127484,
"card_type":"VISA",
"card_number":"4913419738164560",
"expiration_month":"02",
"expiration_year":"18",
"cvv_code":"520",
"user_id":"972288",
"user_gender":"male",
"user_first_name":“Alexander",
"user_last_name":“Hamilton",
"merchant":“McDonald’s",
"transaction_amount":13.64,
"balance":336.48,
"merchant_fee":.5,
"swipe_city":"New York",
"swipe_state":"New York",
"swip_city_state":"New York, NY",
"InstanceNo":1
}

An event is just data with a timestamp

Inside the Event Hub

Credit Card Reader (Synthetic)

Swipes →

data science dojo

Message Broker (DataScienceDojo's Webpage)

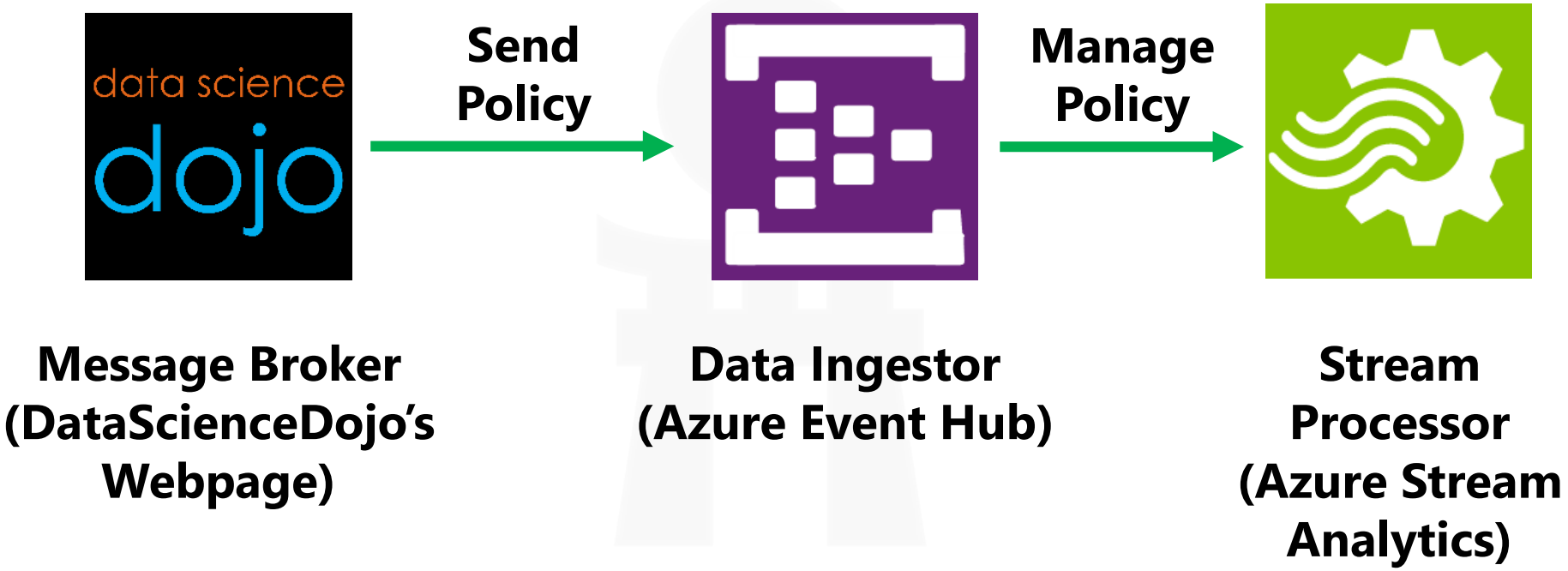
→

Service Bus Namespace: YourNameSpace

Event Hub 1:

- Credit Card Swipes

Setting Policies



With Stream Processor

Swipes

Credit Card Reader (Synthetic)

Message Broker (DataScienceDojo's Webpage)

Data Ingestor (Azure Event Hub)

Stream Processor 1 (All Data)

Long-term Storage (Azure Storage)

More Processors

Credit Card Reader (Synthetic)

Swipes

Message Broker (DataScienceDojo's Webpage)

Data Ingestor (Azure Event Hub)

Stream Processor 1 (All Data)

Dashboard (PowerBI)

Long-term Storage (Azure Storage)

Stream Processor 2 (Filter/Aggregate)

Anomaly Detection Event Hub

SQL with Data at Rest

- **Question** "Show me VISA transactions from last month."
- **Answering with a relational database**
  No problem! Here you go!
- **SELECT** *
  FROM credit_db
  WHERE card_type **like** 'VISA'

SQL Data in Motion

- **Different Question** "Show me VISA transactions in the past 2 minutes."
- **Answering with a relational database** I'm not ready yet… Ask again later…. Or tomorrow (after batch)…
- **Not a great solution…**

Temporal System

- Every event is a point in time, and thus must come with a timestamp
  - Remember how relational DBs need a PK? Temporal systems need a timestamp as its unique identifier.
  - Temporal integrity and referential integrity
- Stream Analytics can append your events with a timestamp (bad practice if standalone)
  - The default timestamp will be when the event enters Stream Analytics
  - Can be skewed by network and hardware latency, or legacy processing
- Users can define application time stamps with the TIMESTAMP BY clause

Which Timestamp?


```
{
  "swipe_date":"2015-05-21T22:47:55.0770000Z",
  "transaction_id":222301082,
  "card_type":"VISA",
  "card_number":"40265691066025560",
  "expiration_month":"06",
  "expiration_year":"22",
  "cvv_code":"3310",
  "user_id":"690548",
  "user_gender":"male",
  "user_first_name":"Caden",
  "user_last_name":"Hatton",
  "merchant":"Macy's",
  "transaction_amount":4.98,
  "balance":7223.9,
  "merchant_fee":0.5,
  "swipe_city":"New York",
  "swipe_state":"New York",
  "swip_city_state":"New York, NY",
  "InstanceNo":1,
  "EventProcessedUtcTime":"2015-05-21T22:47:50.0879821Z",
  "PartitionId":3,
  "EventEnqueuedUtcTime":"2015-05-21T22:47:49.9850000Z"
}
```


Time of event

Time processed by stream processor

Time entered broker

Same Event…


```
{
    "swipe_date":"2015-05-21T22:47:55.0770000Z",
    "EventProcessedUtcTime":"2015-05-21T22:47:50.0879821Z",
    "EventEnqueuedUtcTime":"2015-05-21T22:47:49.9850000Z"
}
```


According to these timestamps, the event happened 5 seconds AFTER the event was processed and queued.

- How can that be?
- The event was not confined to the physical laws of space and time.

The clock on your device matters.

Azure Stream Query Language

- Show me transactions as they happen. Write it to a blob AND powerBI.

```
SELECT *
INTO MyBlob
FROM SwipeStream TIMESTAMP BY swipe_date;
SELECT *
INTO PowerBI
FROM SwipeStream TIMESTAMP BY swipe_date;
```

StreamQL: Calculations

- What was our commission on each transaction?

```
SELECT
    transaction_id,
    merchant_fee / transaction_amount AS Commision
FROM SwipeStream
    TIMESTAMP BY swipe_date
```

StreamQL: Filter Queries

- Show me only VISA transactions that made over $5 revenue.

```
SELECT
        swipe_date,
        card_type,
        merchant_fee AS revenue
FROM SwipeStream
        TIMESTAMP BY swipe_date
WHERE card_type LIKE 'VISA'
AND merchant_fee < 5
```

SWIPE_DATE	CARD_TYPE	REVENUE
2015-05-21T2...	VISA	6.2
2015-05-21T2...	VISA	10.31
2015-05-21T2...	VISA	11.72
2015-05-21T2...	VISA	7.82
2015-05-21T2...	VISA	9.91
2015-05-21T2...	VISA	7.62
2015-05-21T2...	VISA	5.25

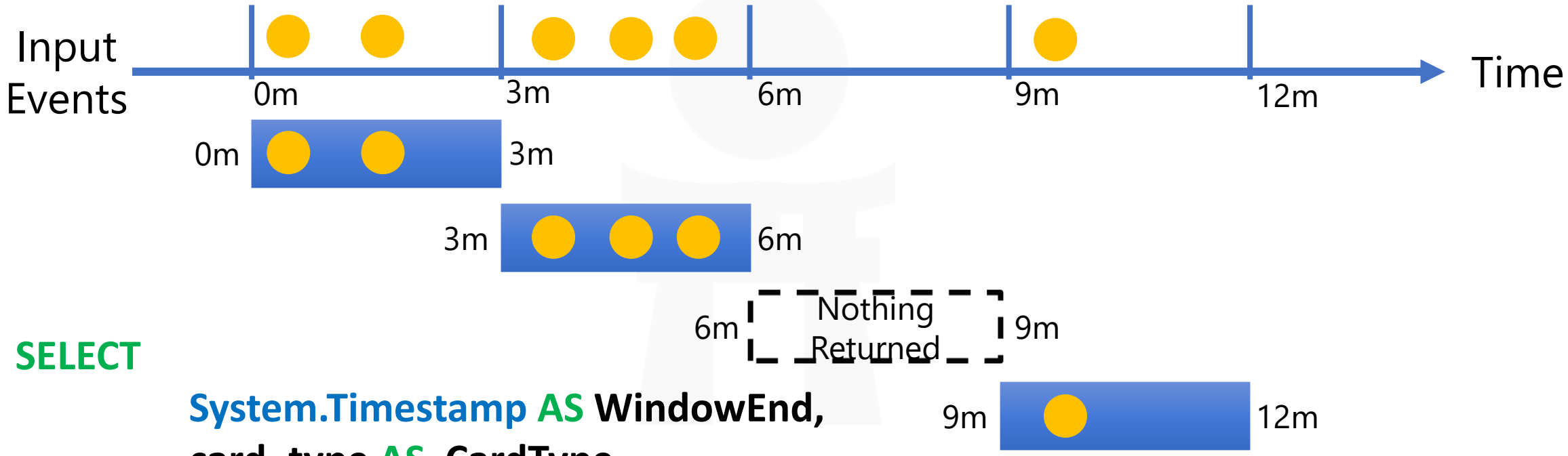
Temporal Questions

Count the number of transactions….

- When should the counting of transactions begin?
- When should the counting of transactions end?
- How long should the transactions be counted for?
- How often do transactions need to be counted?

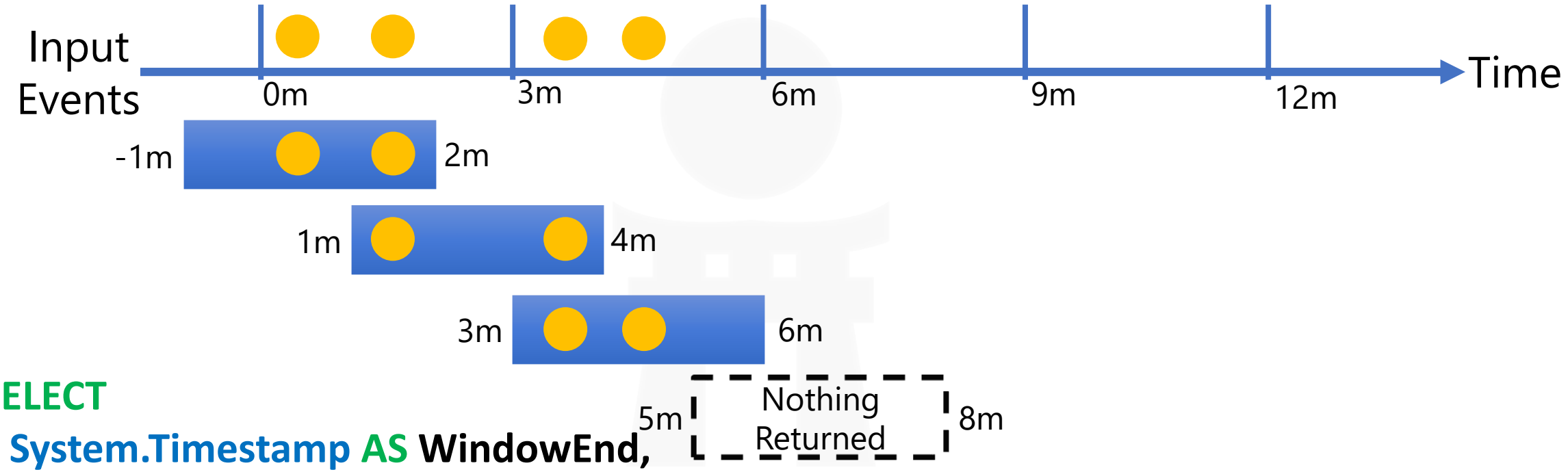
Tumbling Window

How many transactions were made for each card type every 3 minute?



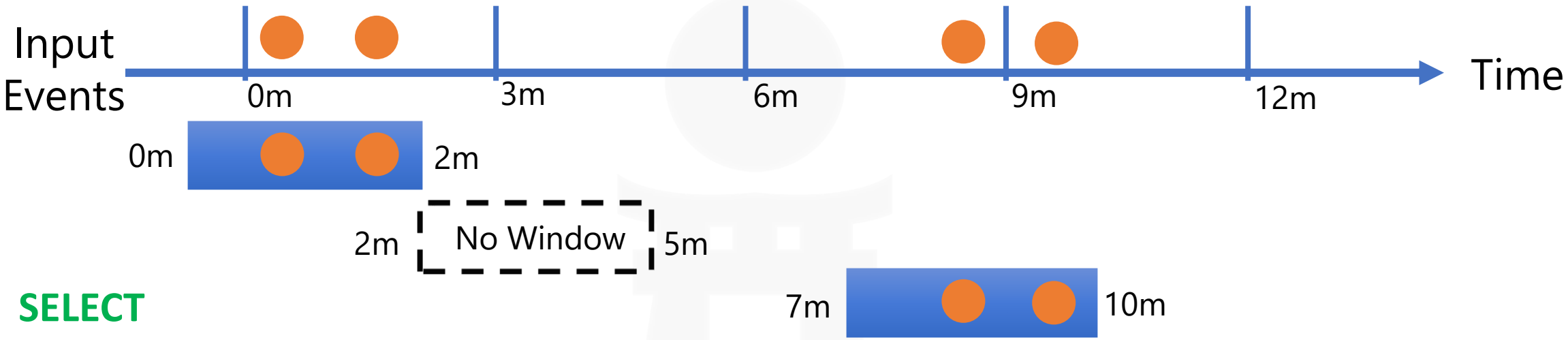

```
SELECT
        System.Timestamp AS WindowEnd,
        card_type AS  CardType,
        Count(*) AS Frequency
FROM SwipeStream TIMESTAMP BY swipe_date
GROUP BY TUMBLINGWINDOW(minute, 3), card_type
```

Hopping Window



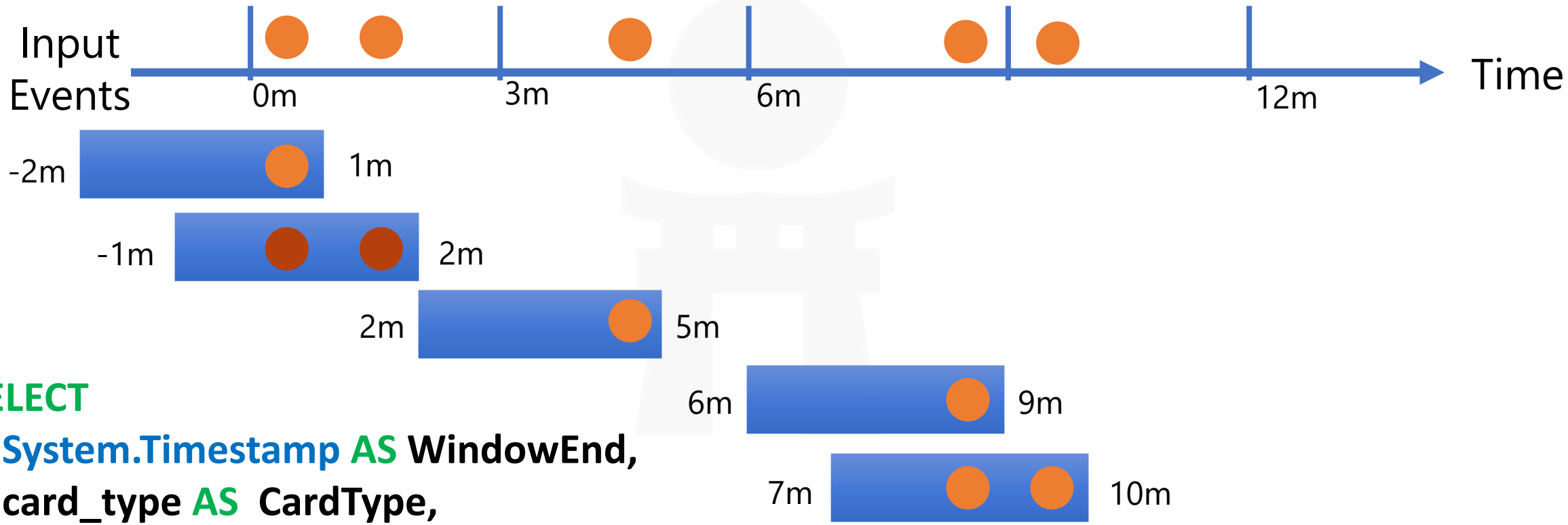

```
SELECT
  System.Timestamp AS WindowEnd,
  card_type AS  CardType,
  Count(*) AS Frequency
FROM SwipeStream TIMESTAMP BY swipe_date
GROUP BY HoppingWindow(minute, 3, 2), card_type
```

Sliding Window




```
SELECT
        System.Timestamp AS WindowEnd,
        card_type AS  CardType,
        Count(*) AS Frequency
FROM SwipeStream TIMESTAMP BY swipe_date
GROUP BY SlidingWindow(minute, 3), card_type
HAVING Frequency > 2
```

Sliding Window: Without 'Having' Clause




```
SELECT
    System.Timestamp AS WindowEnd,
    card_type AS  CardType,
    Count(*) AS Frequency
FROM SwipeStream TIMESTAMP BY swipe_date
GROUP BY SlidingWindow(minute, 3), card_type
```

Sum Aggregation

- How much revenue is being accumulated from merchants every 3 minutes?

```
SELECT
   System.Timestamp AS WindowEnd,
   Sum(merchant_fee) AS IntervalRevenue
FROM SwipeStream TIMESTAMP BY swipe_date
GROUP BY TUMBLINGWINDOW(minute, 3), WindowEnd
```

Sum Aggregation: With Filtering

- Which 3-minute time interval made more than $10?

```
SELECT
    System.Timestamp AS WindowEnd,
    Sum(merchant_fee) AS IntervalRevenue
FROM SwipeStream TIMESTAMP BY swipe_date
GROUP BY TUMBLINGWINDOW(minute, 3), WindowEnd
Having IntervalRevenue > 10
```

Descriptive Statistics

- Generate descriptive statistics for revenue every 3 minutes (car count, min, max, average, standard deviation, and total revenue).

```
SELECT
        System.Timestamp AS WindowEnd,
        count(merchant_fee) AS CarCount,
        min(merchant_fee) AS MinRev,
        max(merchant_fee) AS MaxRev,
        avg(merchant_fee) AS AvgRev,
        stdev(merchant_fee) AS VarRev,
        sum(merchant_fee) AS TotalRev
FROM SwipeStream TIMESTAMP BY swipe_date
GROUP BY TUMBLINGWINDOW(minute, 3)
```

DateDiff and Time

- What is the duration between the first transaction in the window and the last transaction in the window? What was the duration between the first transaction in the window and the end of the window?

```
SELECT
   System.Timestamp AS WindowEnd,
   count(*) AS Frequency,
   datediff(second, min(swipe_date), max(swipe_date)) AS FirstLastDuration,
   datediff(second, min(swipe_date), System.Timestamp) AS FirstEndDuration
FROM SwipeStreamTIMESTAMP BY swipe_date
GROUP BY TUMBLINGWINDOW(minute, 3)
```

Joining Stream with Reference Data

- Say we had a list of stolen credit card numbers. Let's run each transaction against this list and get the locations.

```
SELECT
        SwipeStream.swipe_date as SwipeTime,
        SwipeStream.card_number as CardNumber,
        SwipeStream.merchant as Store,
        SwipeStream.swipe_city_state as Location,
        StoleList.Stolen as Stolen
FROM SwipeStream TIMESTAMP BY swipe_date
JOIN StolenList
ON SwipeStream.card_number = StolenList.card_number
WHERE StolenList.Stolen = '1'
```

Joining Streams, Temporally

- How long did it take for each transaction to get approval from the bank?
  - Joining on events through time
  - JOIN operator requires specifying a temporal wiggle room describing an acceptable time difference between the joined events
  - If two transactions occurred within the same join interval, then consider them the same event.

Joining Streams

- How long did it take for each transaction to get approval from the bank?

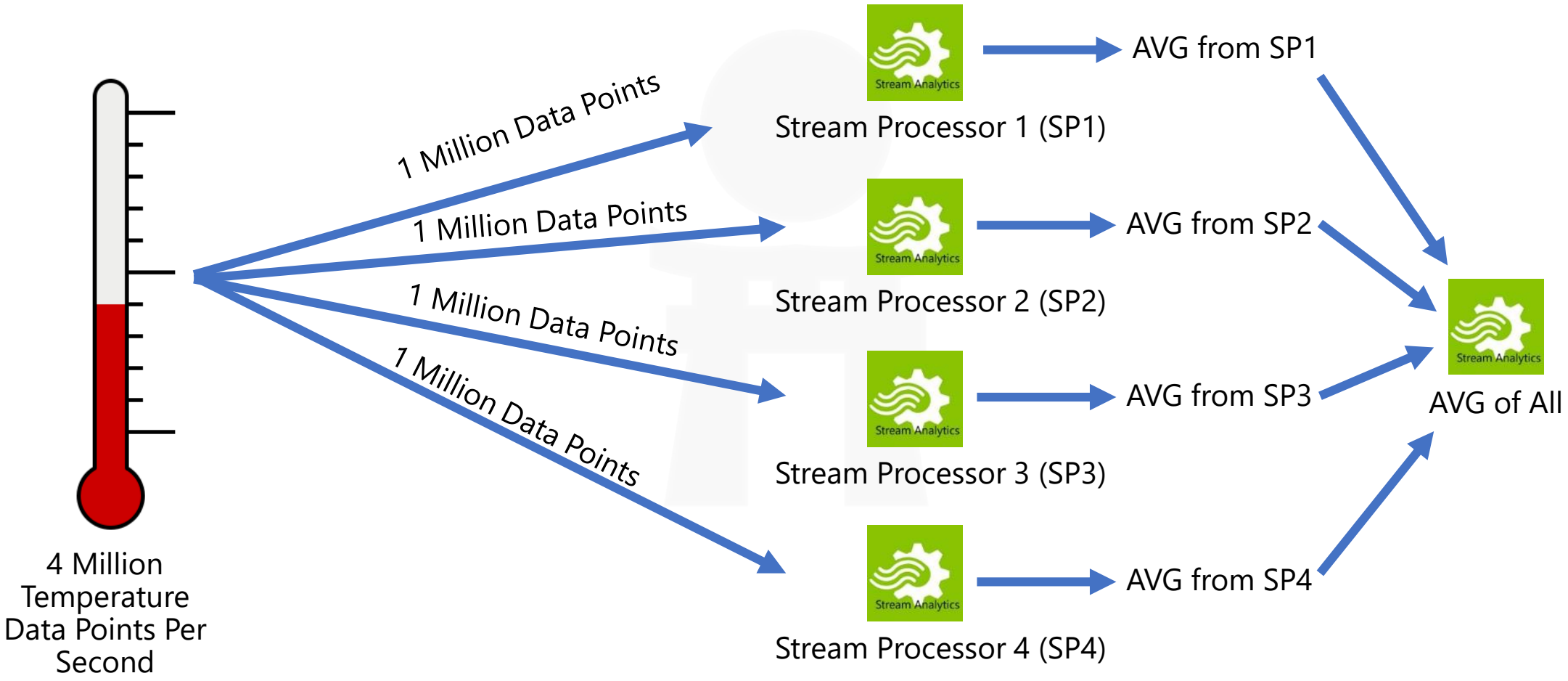
```
SELECT
    swipe.transaction_id
    swipe.swipe_date,
    bank.approval_time,
    DATEDIFF ( second, swipe.swipe_date, bank. approval_time) AS DurationInSeconds
FROM SwipeStream AS swipe TIMESTAMP BY swipe_date
JOIN BankStream AS bank TIMESTAMP BY approval_time
ON (swipe.transaction_id = bank.transaction_id)
    AND DATEDIFF ( minute, swipe, bank ) BETWEEN 0 AND 15
```

Joining Streams, by Window

- What was the average time that it took for transactions to get approved every 3 minutes?

```
SELECT
   System.Timestamp AS WindowEnd,
   avg( DATEDIFF ( second, swipe.swipe_date, bank.approval_time )) AS ApprovalTime
FROM SwipeStream AS swipe TIMESTAMP BY swipe_date
JOIN BankStream AS bank TIMESTAMP BY approval_time
ON (swipe.transaction_id = bank.transaction_id)
   AND DATEDIFF ( minute, swipe, bank ) BETWEEN 0 AND 15
Group by TumblingWindow( minute, 3)
```

Average of Average Approximations



Built-In Functions And Supported Types

Aggregate functions

Count, Min, Max, Avg, Sum

Scalar functions

Cast

Date and time

Datename, Datepart, Day, Month, Year, Datediff, Dateadd

String

Len, Concat, Charindex, Substring, Patindex

QUESTIONS