

Using HBase for Storage



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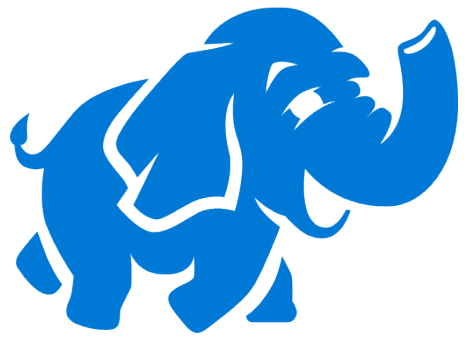
APACHE HBASE



NoSQL database

Scales to **thousands** of nodes

Stores **petabytes** of data



0.98.4

APACHE
HBASE

1.0.1.1



Google Bigtable

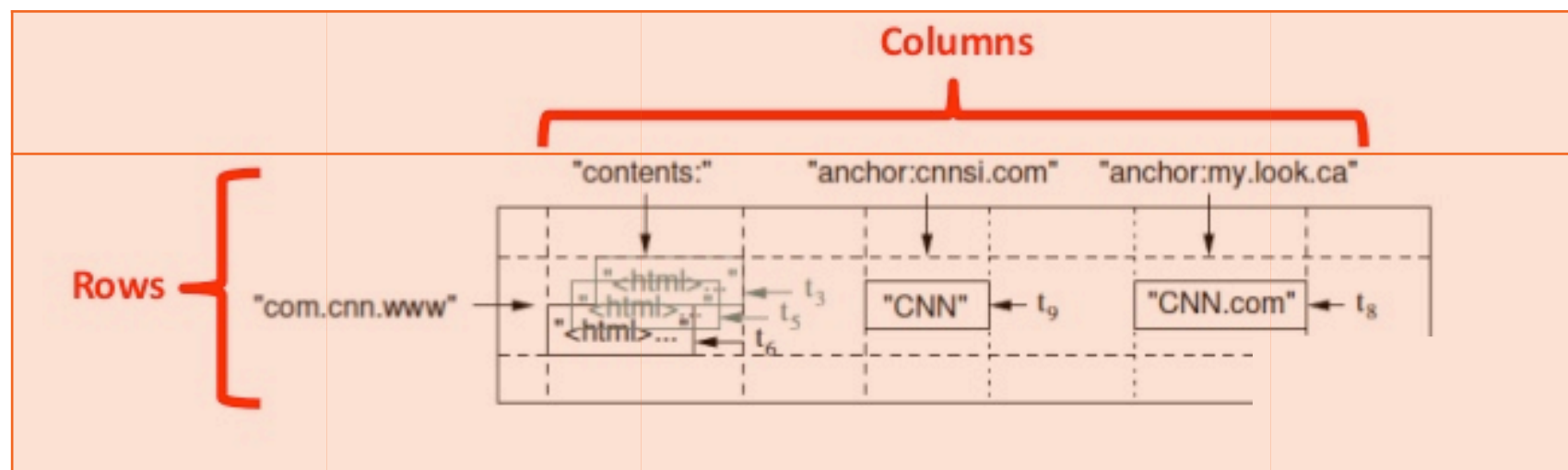
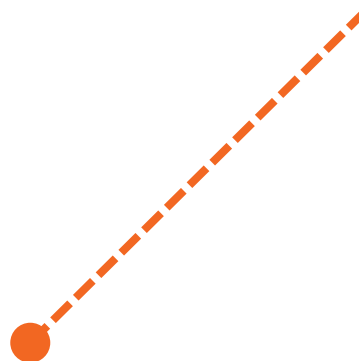


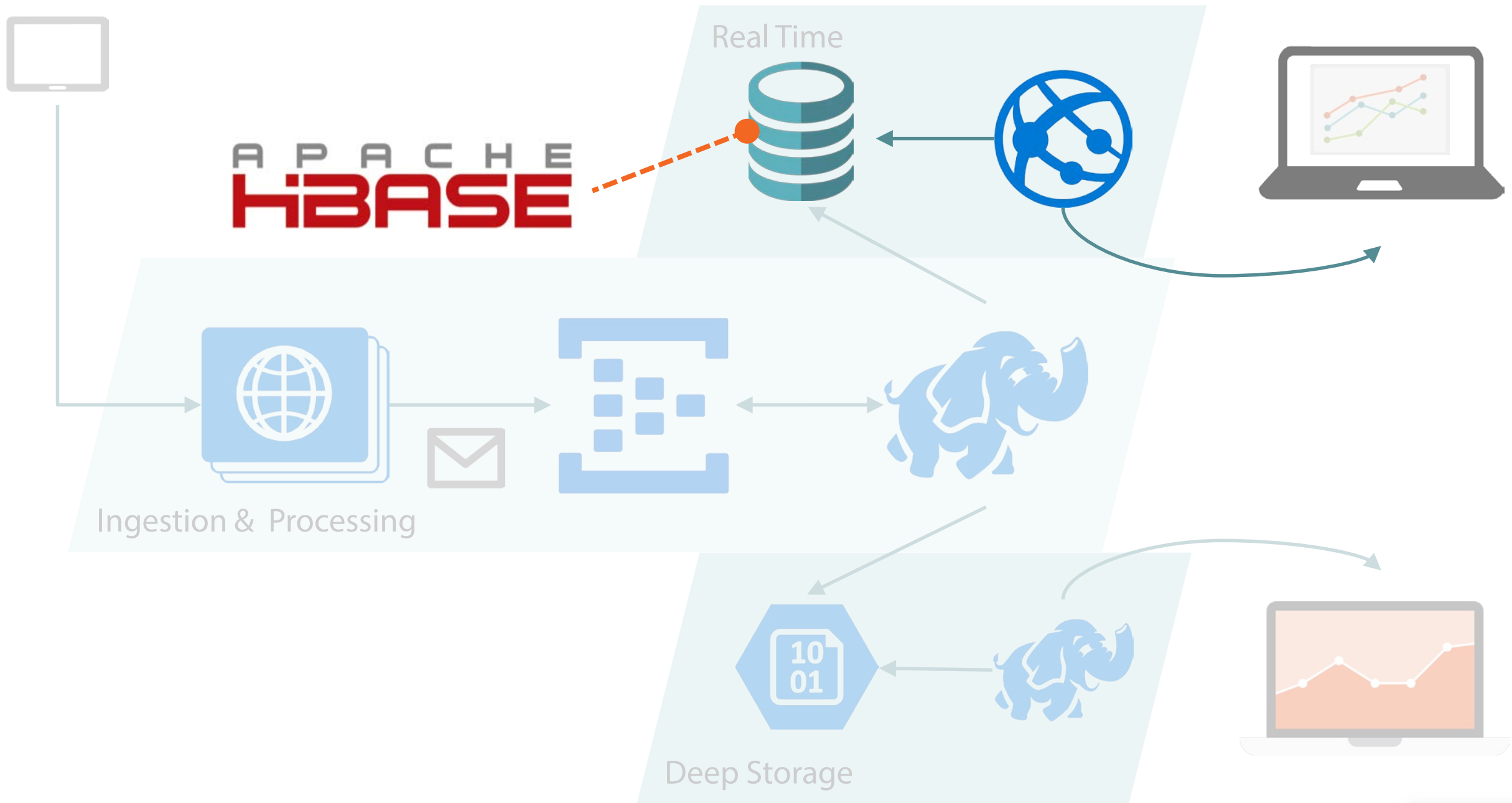


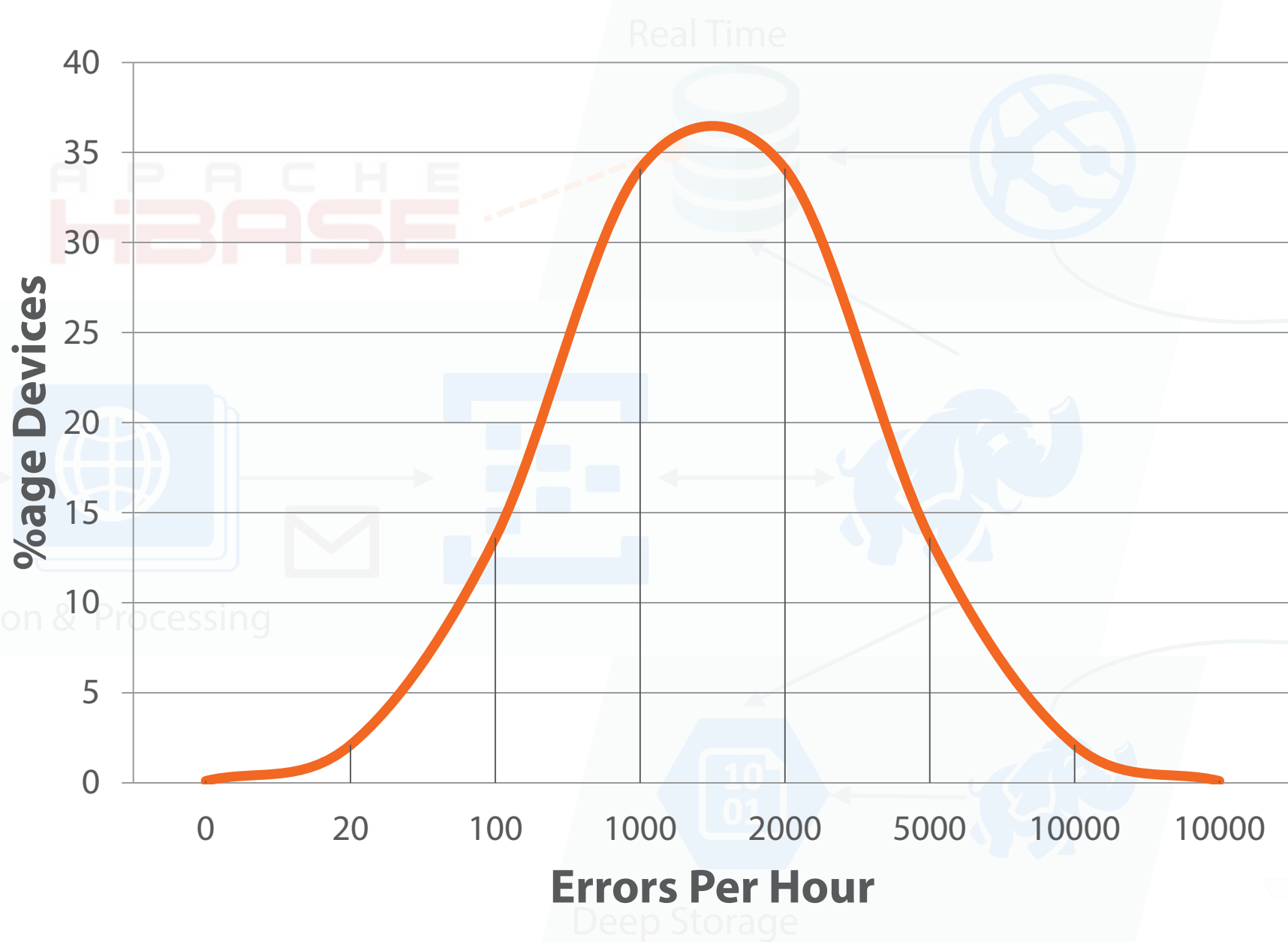


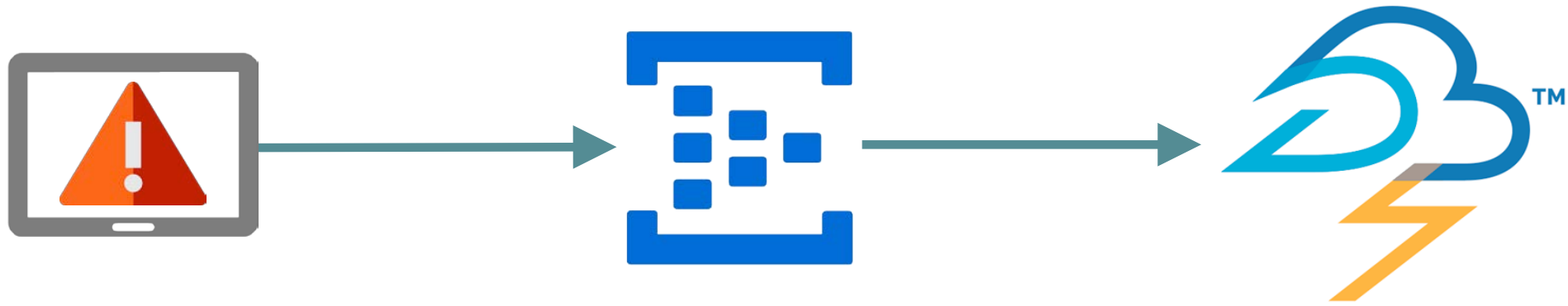
Table structure
Row key design
Column **families**



RowKey	u:id	u:name	d:1	...	d:500
rowkey	19	storm	6464		74







HBase on **HDInsight**
HBase **.NET** SDK
Table design



A P A C H E
HBASE





Aggregated

Period	EventName	Count
2015060807	device.log	1,765,124



Raw

```
{  
  "timestamp": 1415878188000,  
  "message": "Unhandled exception",  
  "eventName": "device.log",  
  "deviceId": "1e565484571752"  
}
```



Period	EventName	Count
2015060807	device.log	1,765,124



```
{  
  "timestamp": 1415878188000,  
  "message": "Unhandled exception",  
  "eventName": "device.log",  
  "deviceId": "1e565484571752"  
}
```





Aggregated

Period	EventName	Count
2015060807	device.log	1,765,124

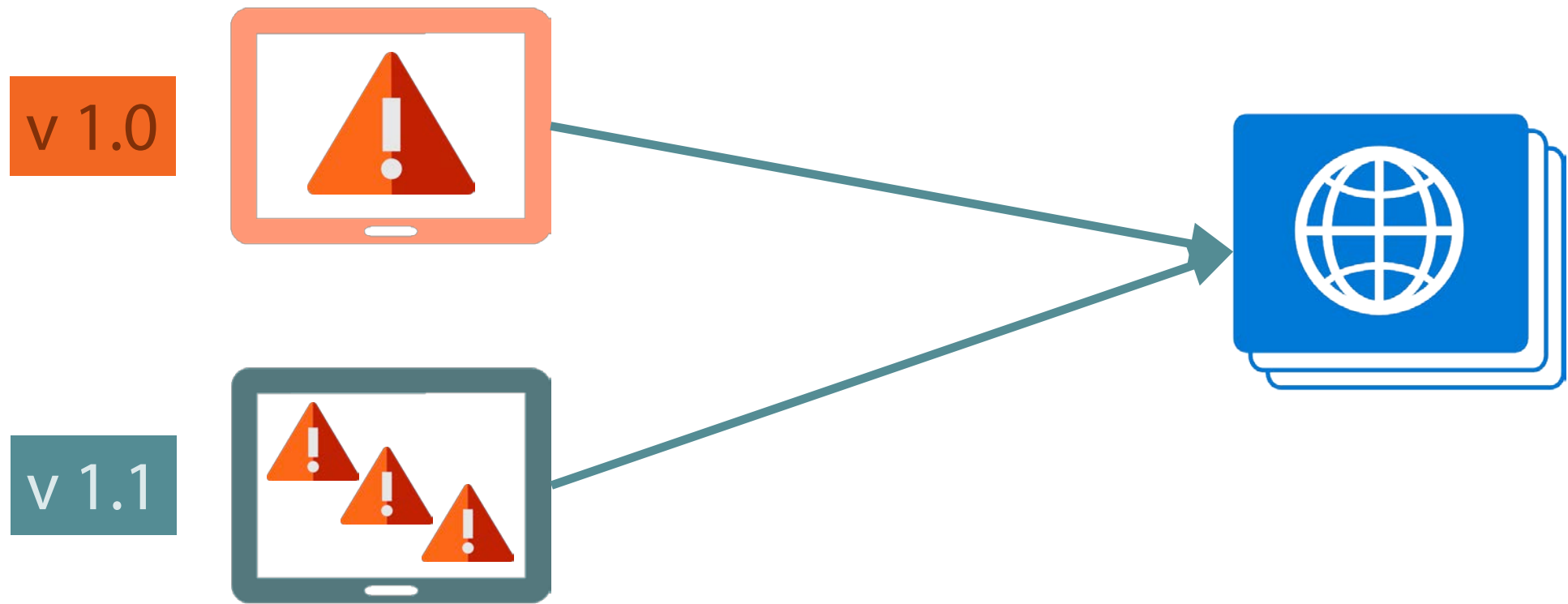
How many devices?
From which **locations**?
95th percentile?

How many devices?
From which locations?
95th percentile?



Raw

```
{  
  "timestamp": 1415878188000,  
  "message": "Unhandled exception",  
  "eventName": "device.log",  
  "deviceId": "1e565484571752"  
}
```





DeviceErrors

Period	Firmware	Count
2015060807	v1.0	1,032,856
2015060807	v1.1	120



700K devices



5K devices



DeviceErrors

Period	Firmware	Count	Devices
2015060807	v1.0	1,032,856	720,146
2015060807	v1.1	120	5,201



30K errors

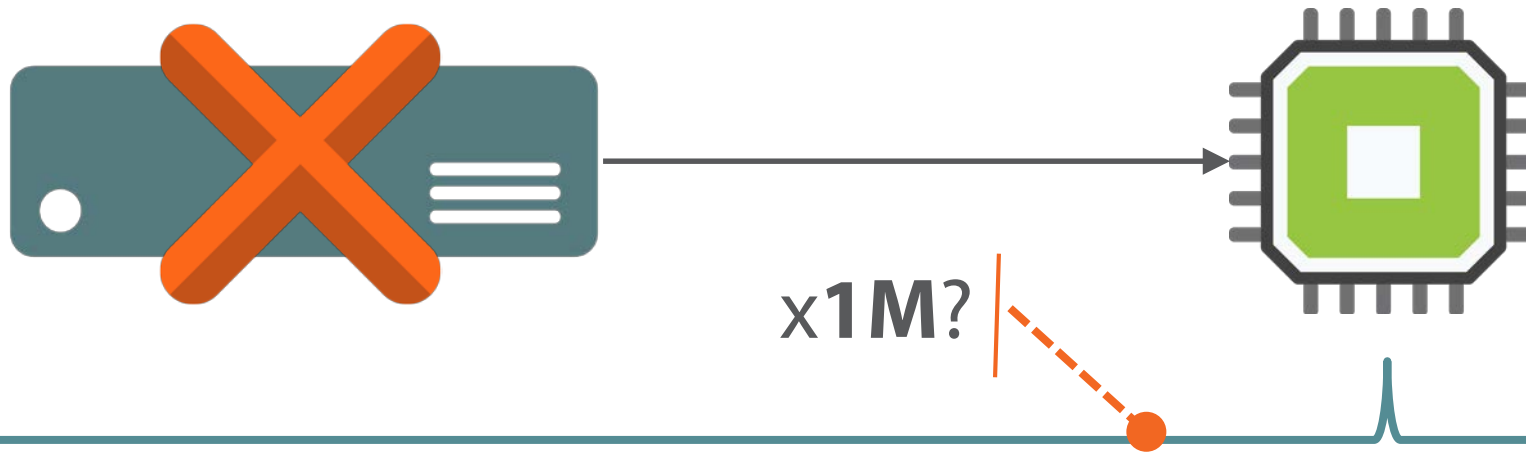


1.4 errors per device



0.02 errors per device

Period	Firmware	Count	Devices
2015060807	v1.0	1,032,856	720,146



```
{
  "period":2015050720,
  "firmware": "v1.0",
  "deviceIds": ["a", "b"],
  "count": 420
}
```

```
{
  "period":2015050720,
  "firmware": "v1.0",
  "deviceIds": ["d", "e"],
  "count": 129
}
```

```
{
  "period":2015050720,
  "firmware": "v1.1",
  "deviceIds": ["f"],
  "count": 6
}
```



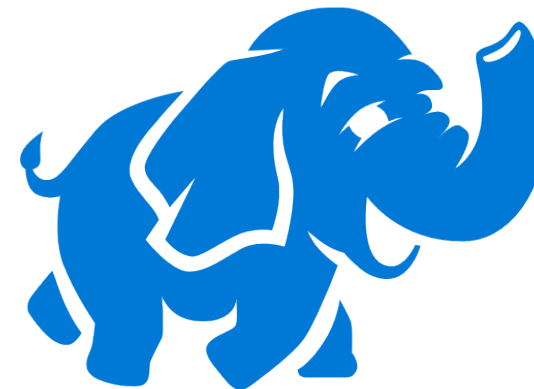
DeviceErrors

Period	Firmware	Count
2015060807	v1.0	1,032,856

Devices

DeviceId
a
b
c

x1M?



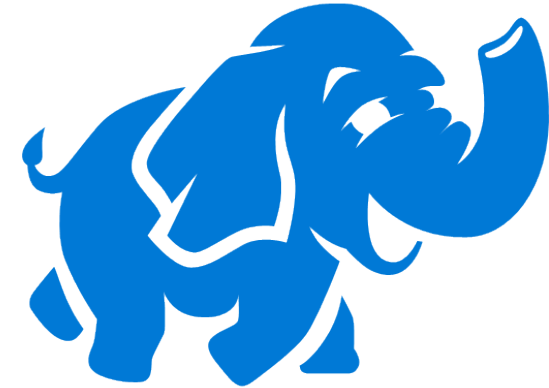
2015060808.json.gz



1 file

1GB JSON

Max **100M** events



2015060*.json.gz



...



7 files

7-10GB JSON

2-3Bn events



Aggregated

Period	EventName	Count
2015060807	device.log	1,765,124



Raw

```
{  
  "timestamp": 1415878188000,  
  "message": "Unhandled exception",  
  "eventName": "device.log",  
  "deviceId": "1e565484571752"  
}
```



Aggregated

Period	EventName	Count
2015060807	device.log	1,765,124

APACHE
HBASE

Detailed
summary

RowKey	d:abc	d:xyz
2015060807-v1.0	120	2,465



Raw

```
{  
  "timestamp": 1415878188000,  
  "message": "Unhandled exception",  
  "eventName": "device.log",  
  "deviceId": "1e565484571752"  
}
```

APACHE HBASE



DeviceErrors	
RowKey	
a6545da436	...
b3242b44d	...
c1312d312e	

Table1	cf1	cf2
--------	-----	-----

RowKey	cf1:col1	cf1:col2	cf2:col1	cf2:col2
a6545da436	120	3,220	18	786

RowKey	cf1:col1	cf1:colA	cf1:col3	cf2:col1	cf2:colB
b3242b44d	45	abc	18,653	19	xyz

RowKey	cf2:col1	cf2:col2
c1312d312e	120	3,220

Table2

cf1

RowKey	cf1:col1	...	cf1:col10
a6545da436	120		3,220

10KB

RowKey	cf1:col1	...	cf1:col100000000
b3242b44d	19		74

100MB

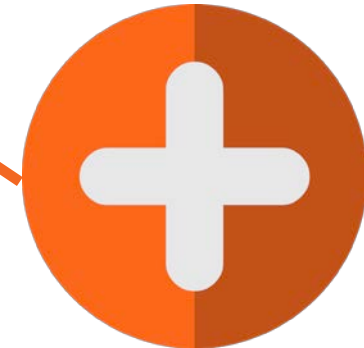
DeviceErrors

d

Row key = {firmwareVersion}|{period}

Column family **d** = **devices**

RowKey	d:xyz
v1.0 2015060810	421



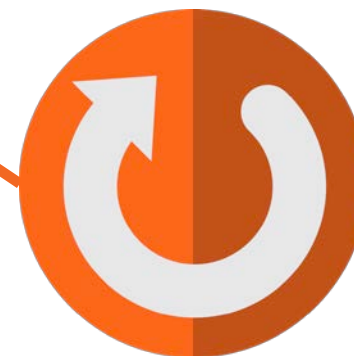
DeviceErrors

d

Row key = {firmwareVersion}|{period}

Column family **d** = **devices**

RowKey	d:xyz	d:abc
v1.0 2015060810	421	1



DeviceErrors

d

Row key = {firmwareVersion}|{period}

Column family **d** = **devices**

RowKey	d:xyz	d:abc
v1.0 2015060810	421	2



DeviceErrors

d

RowKey	d:xyz	d:abc
v1.0 2015060810	421	2

RowKey	d:abc
v1.0 2015060811	1



DeviceErrors

d

RowKey	d:xyz	d:abc
v1.0 2015060810	421	2

RowKey	d:abc
v1.0 2015060811	1

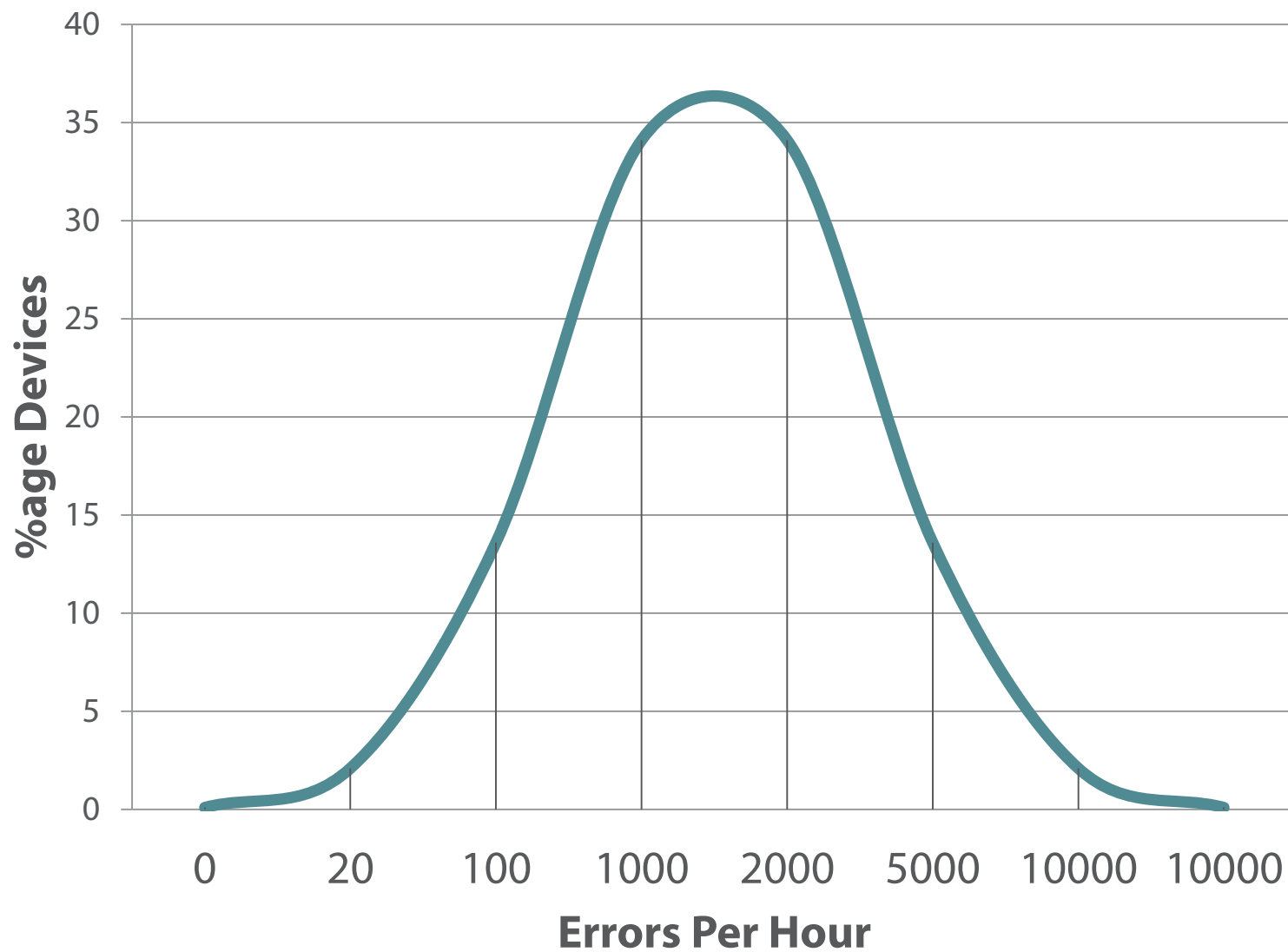
Error count = sum of values

Device count = number of columns

DeviceErrors **d**

RowKey	d:xyz	d:abc
v1.0 2015060810	421	2

RowKey	d:abc
v1.0 2015060811	1



DeviceErrors

d

MILLIONS of columns

BILLIONS of rows

RowKey	d:xyz	d:abc
v1.0 2015060810	421	2

RowKey	d:abc
v1.0 2015060811	1

5 versions @ 24 hours

120 rows per day

44K rows per year

1Bn rows = **22,700** years

DeviceErrors

d

MILLIONS of columns

BILLIONS of rows

RowKey	d:xyz	d:abc
v1.0 2015060810	421	2

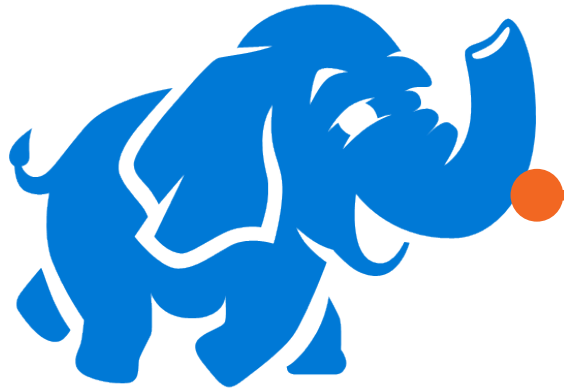
RowKey	d:abc
v1.0 2015060811	1

5 versions @ 1440 minutes

7K rows per day

2.6M rows per year

1Bn rows = **384** years



APACHE
HBASE



APACHE
HBASE



→ CREATE
PUT
GET
SCAN
DELETE

```
> create 'device-errors',  
        'd'
```

device-errors

d

APACHE
HBASE



→ CREATE
PUT
GET
SCAN
DELETE

```
> put 'device-errors',  
      'v1.0|2015060816',  
      'd:abc',  
      '1'
```

device-errors

d

RowKey

d:abc

v1.0|2015060816

1

APACHE
HBASE



→ CREATE
PUT
GET
SCAN
DELETE

```
> get 'device-errors',  
      'v1.0|2015060816'
```

device-errors

d

RowKey

d:abc

v1.0|2015060816

1

RowKey

d:abc

v1.0|2015060817

2

APACHE
HBASE



CREATE
PUT
GET
→ SCAN
DELETE

```
> scan 'device-errors',  
      { STARTROW =>  
        'v1.0|20150608' } }
```

device-errors

d

RowKey

d:abc

v1.0|2015060816

1

RowKey

d:abc

v1.0|2015060817

2

APACHE
HBASE



CREATE
PUT
GET
SCAN
→ DELETE

```
> delete 'device-errors',  
        'v1.0|2015060817',  
        'd:abc'
```

device-errors

d

RowKey

d:abc

v1.0|2015060816

1

RowKey

v1.0|2015060817


```
> put 'device-errors', 'v1.0|2015060816',  
      'd:abc', '2'
```

device-errors

d

RowKey	d:abc
v1.0 2015060816	1

```
> put 'device-errors', 'v1.0|2015060816',  
      'd:abc', '2'
```



device-errors

d

RowKey	d:abc
v1.0 2015060816	2

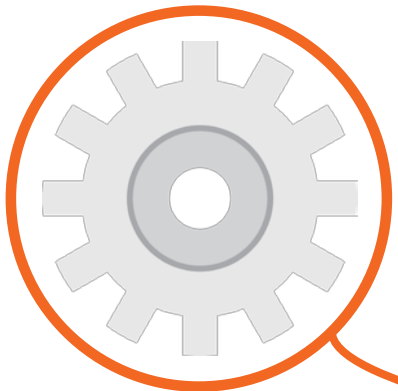
```
> put 'device-errors', 'v1.0|2015060817',  
      'd:abc', '1'
```

device-errors

d

RowKey	d:abc
v1.0 2015060816	2

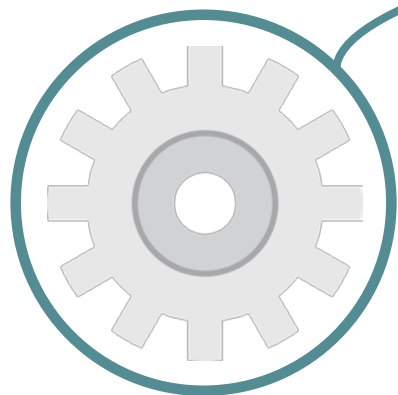
RowKey	d:abc
v1.0 2015060817	1

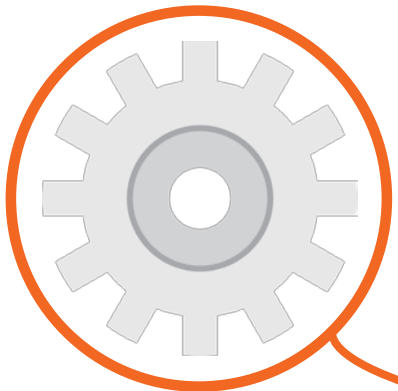


```
> insert 't1', 'rowkey',  
         'd:1', 'value'
```



```
> insert 't1', 'rowkey',  
         'd:1', 'value'
```

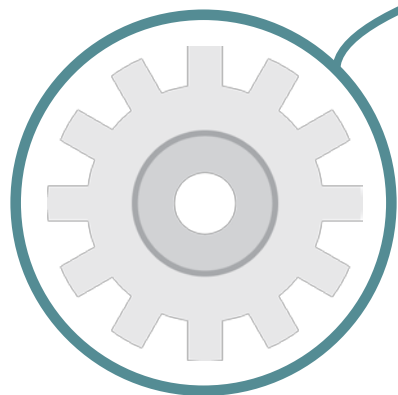


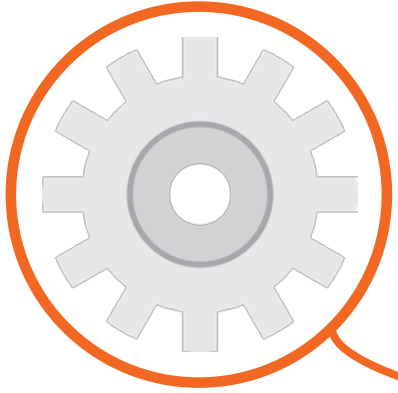


```
> put 't1', 'rowkey',  
      'd:1', 'value'
```



```
> put 't1', 'rowkey',  
      'd:1', 'value'
```



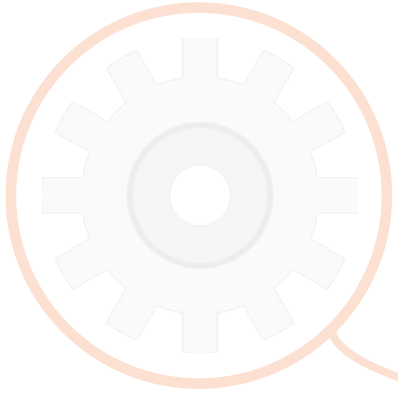


```
> get 't1', 'rowkey',  
      'd:1'
```

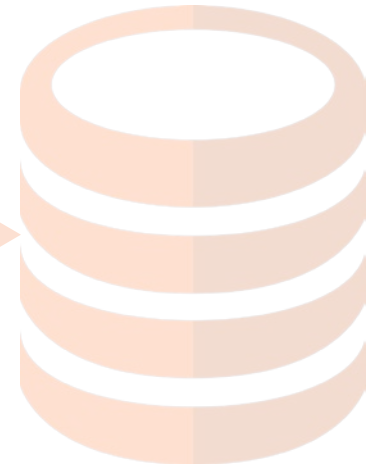


t1	u	d
----	---	---

RowKey	u:id	u:name	d:1	...	d:500
rowkey	19	storm	6464		74

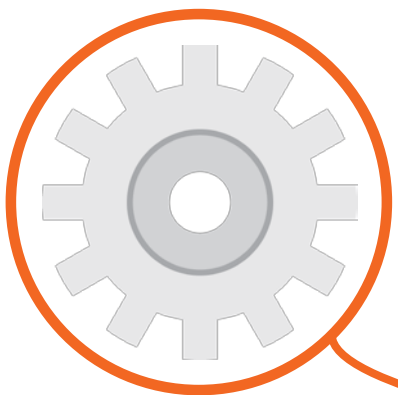


```
> get 't1', 'rowkey',  
      'd:1'
```



t1	u	d
----	---	---

RowKey	u:id	u:name	d:1	...	d:500
rowkey	19	storm	6464		74



```
> scan 't1',  
{ STARTROW => 'r122',  
  ENDROW => 'r124' }
```



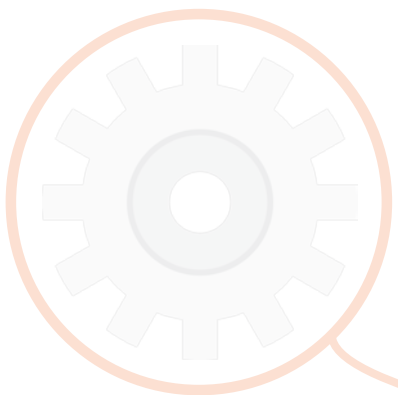
t1

u

d

RowKey	u:id	u:name	d:1	...	d:500
r122	19	storm	6464		74

RowKey	u:id	u:name	d:1	d:2
r123	328	hbase	6464	3252



```
> scan 't1',  
{ STARTROW => 'r122',  
  ENDROW => 'r124' }
```



t1	u	d
----	---	---

RowKey	u:id	u:name	d:1	...	d:500
r122	19	storm	6464		74

RowKey	u:id	u:name	d:1	d:2
r123	328	hbase	6464	3252



Devices		

ErrorPeriods

DeviceErrors	



Devices		

ErrorPeriods

DeviceErrors	





Row key = {eventName}|{period}

event-metrics

d

RowKey	d:abc	...	d:xyz
gps.on 2015060817	1		6

RowKey	d:efg	...	d:tuv
gps.on 2015070818	3		1

RowKey	d:adg	...	d:ghk
device.on 2015060818	14		45



Row key = {eventName}|{period}

```
> scan 'event-metrics',  
{ STARTROW => 'gps.on' }
```

event-metrics **d**



RowKey	d:abc	...	d:xyz
gps.on 2015060817	1		6



RowKey	d:efg	...	d:tuv
gps.on 2015070818	3		1




RowKey	d:adg	...	d:ghk
device.on 2015060818	14		45



Row key = {eventName}|{period}

```
> scan 'event-metrics',  
{ STARTROW =>  
  'gps.on|201506' } }
```

event-metrics **d**



RowKey	d:abc	...	d:xyz
gps.on 2015060817	1		6



RowKey	d:efg	...	d:tuv
gps.on 2015070818	3		1




RowKey	d:adg	...	d:ghk
device.on 2015060818	14		45



Row key = {eventName}|{period}

```
> scan 'event-metrics',  
{ STARTROW =>  
  'gps.on|2015' }
```

event-metrics **d**



RowKey	d:abc	...	d:xyz
gps.on 2015060817	1		6



RowKey	d:efg	...	d:tuv
gps.on 2015070818	3		1



RowKey	d:adg	...	d:ghk
device.on 2015060818	14		45



Row key = {eventName}|{period}

```
> scan 'event-metrics',  
{ STARTROW => '2015' }
```

event-metrics **d**

RowKey	d:abc	...	d:xyz
gps.on 2015060817	1		6

RowKey	d:efg	...	d:tuv
gps.on 2015070818	3		1

RowKey	d:adg	...	d:ghk
device.on 2015060818	14		45



Row key = {period}|{eventName}

event-metrics

d

RowKey	d:abc	...	d:xyz
2015060817 gps.on	1		6

RowKey	d:efg	...	d:tuv
2015070818 gps.on	3		1

RowKey	d:adg	...	d:ghk
2015060818 device.on	14		45



Row key = {period}|{eventName}

```
> scan 'event-metrics',  
{ STARTROW => '2015' }
```

event-metrics **d**

RowKey	d:abc	...	d:xyz
2015060817 gps.on	1		6

RowKey	d:efg	...	d:tuv
2015070818 gps.on	3		1


RowKey	d:adg	...	d:ghk
2015060818 device.on	14		45



Row key = {period}|{eventName}

```
> scan 'event-metrics',  
{ STARTROW =>  
  '2015060817|gps' }
```

event-metrics **d**



RowKey	d:abc	...	d:xyz
2015060817 gps.on	1		6



RowKey	d:efg	...	d:tuv
2015070818 gps.on	3		1



RowKey	d:adg	...	d:ghk
2015060818 device.on	14		45



Row key = {period}|{eventName}

```
> scan 'event-metrics',  
{ STARTROW =>  
  '2015|gps.on' }
```

event-metrics **d**

RowKey	d:abc	...	d:xyz
2015060817 gps.on	1		6

RowKey	d:efg	...	d:tuv
2015070818 gps.on	3		1

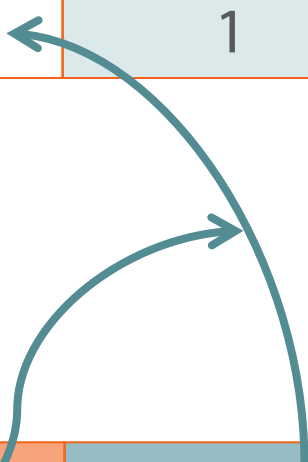
RowKey	d:adg	...	d:ghk
2015060818 device.on	14		45

event-metrics **d**

RowKey	d:abc	...	d:xyz
2015060817 gps.on	1		6

period-metrics **p**

RowKey	e:2015060817	...	e:2015060915
gps.on	6,765		82,043,523





Row key = {firmwareVersion}|{period}

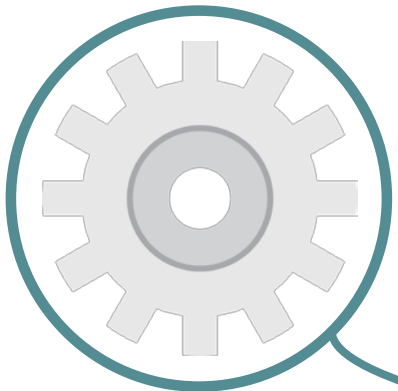
device-errors

d

RowKey	d:abc	...	d:xyz
v1.0 2015060817	21		78

RowKey	d:efg	...	d:tuv
v1.0 2015070818	17		36

RowKey	d:adg	...	d:ghk
v2.0 2015060818	45		98



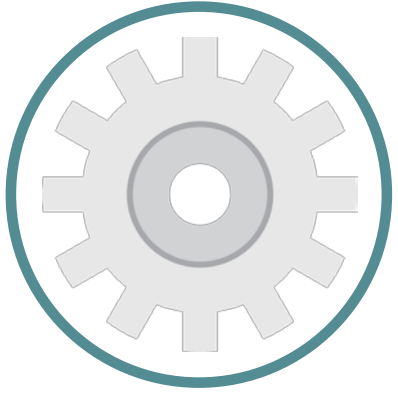
```
> increme 't',  
      'r', 'y', 'd:1'
```



APACHE
HBASE

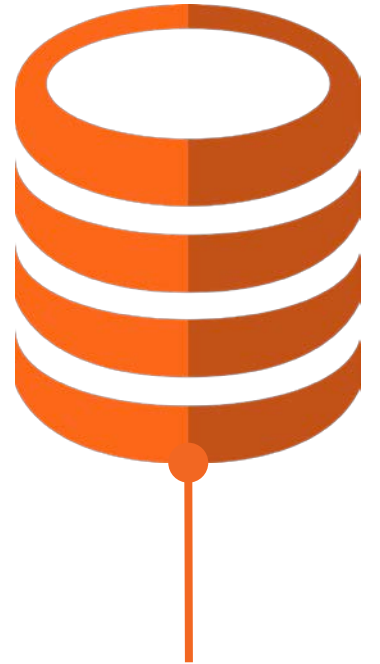


.NET SDK

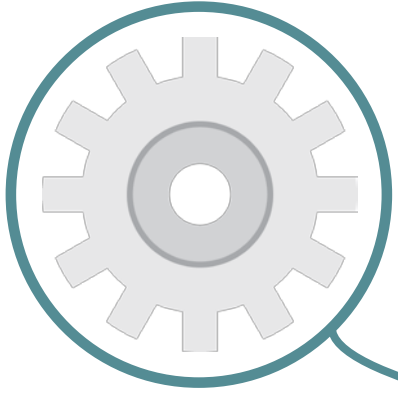


```
> increment 't1',  
           'rowkey', 'd:1'
```

APACHE
HBASE



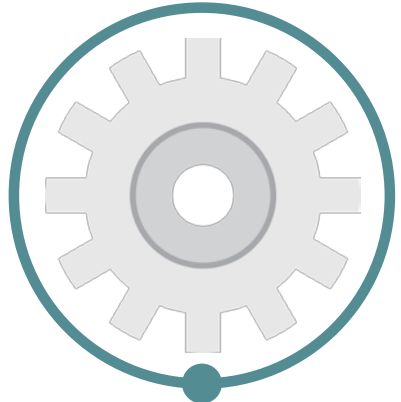
increment



```
> get 't1', 'rowkey', 'd1'
```

APACHE
HBASE



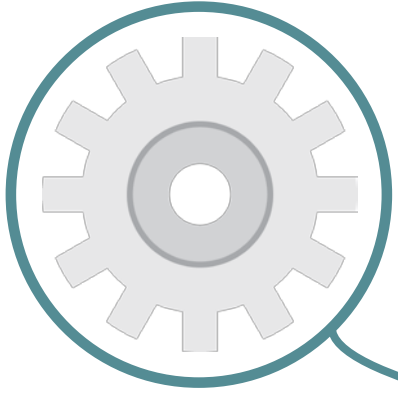


increment



APACHE
HBASE





```
> put 't1', 'rowkey',  
      'd1', {incremented}
```

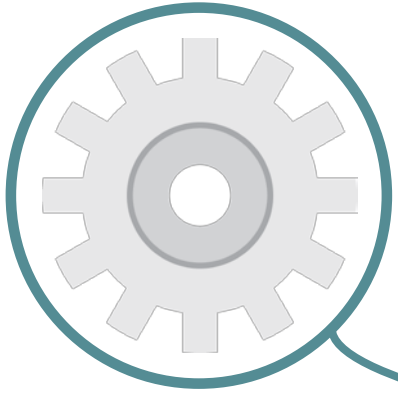
APACHE
HBASE



```
var credentials = new ClusterCredentials(new Uri(clusterUrl),  
                                         userName, password);  
_client = new HBaseClient(creds);
```

HBaseClient

.NET wrapper for REST API



```
> increment 't1',  
           'rowkey', 'd:1'
```



Java SDK



.NET SDK



```
var cells = _client.GetCells(TABLE_NAME, rowKeyBytes);
```

Get cells

Returns all columns for row key

```
var filter = new QualifierFilter(  
    CompareFilter.CompareOp.Equal,  
    new BinaryComparator(columnNameBytes));
```

Server-side Filter

QualifierFilter to include columns by name


```
var scanner = new Scanner() {  
    startRow = rowKeyBytes,  
    endRow = rowKeyBytes,  
    filter = filter.ToEncodedString() };
```

Scanner object

Define scan criteria

```
existingCells.rows[0].values[0].data =  
    BitConverter.GetBytes(currentErrorCount);  
_client.StoreCells(TABLE_NAME, existingCells);
```

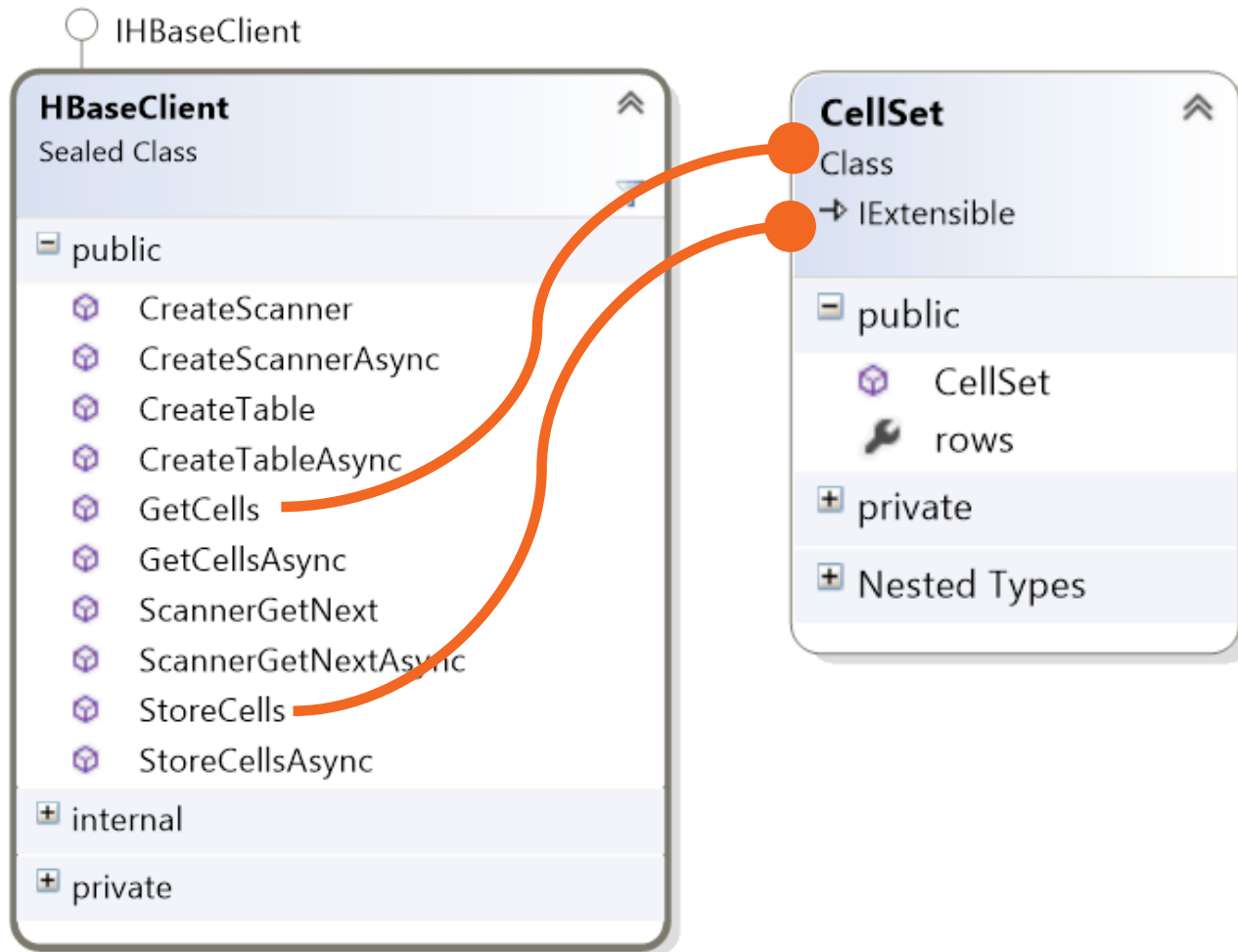
Update existing data

StoreCells to put changes to HBase

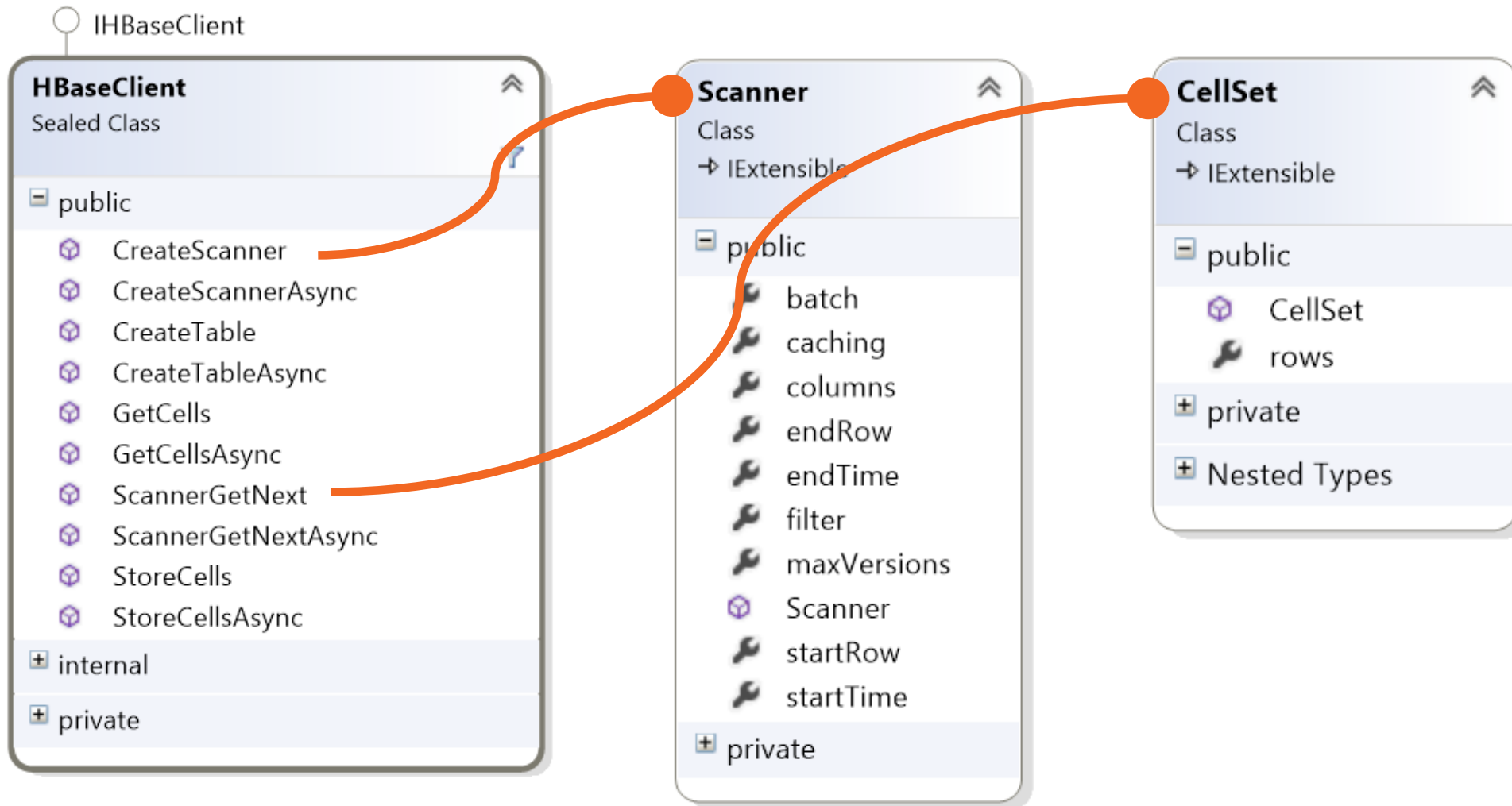
```
var value = new Cell {  
    column = Encoding.UTF8.GetBytes(columnName),  
    data = BitConverter.GetBytes(1) };  
row.values.Add(value);  
_client.StoreCells(TABLE_NAME, set);
```

Insert new data

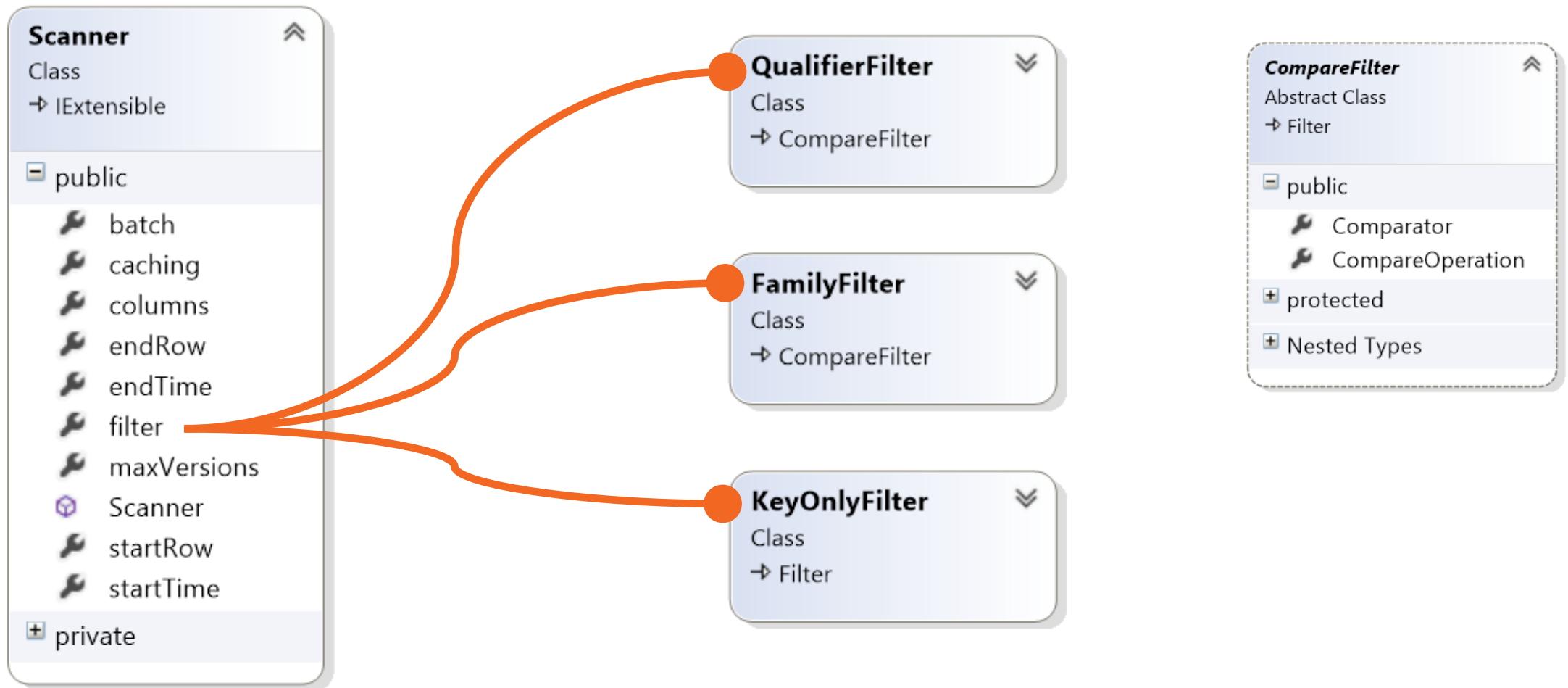
StoreCells to put new row/column/value to HBase



.NET HBase SDK – client & cells



.NET HBase SDK – client & cells



.NET HBase SDK – scanner & filters



APACHE
HBASE

HDInsight cluster
Interactive **HBase Shell**
.NET SDK

Table2

cf1

Row key = unique row identifier

Column family = variable collection

RowKey	cf1:col1	...	cf1:col10
a6545da436	120		3,220

RowKey	cf1:col1	...	cf1:col10000000
b3242b44d	19		74

Table2

cf1

Row key = unique row identifier

Column family = variable collection

x BILLIONS

RowKey	cf1:col1	...	cf1:col10
a6545da436	120		3,220

RowKey	cf1:col1	...	cf1:col10000000
b3242b44d	19		74

x MILLIONS



Row key => access to data

No column value querying

device-errors

d

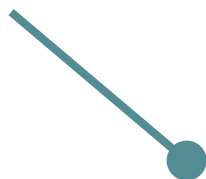
RowKey	d:abc	...	d:xyz
v1.0 2015060817	21		78

RowKey	d:efg	...	d:tuv
v1.0 2015070818	17		36

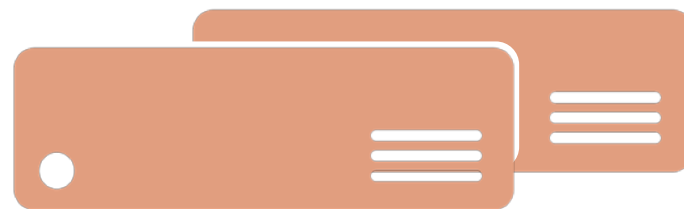
RowKey	d:adg	...	d:ghk
v2.0 2015060818	45		98

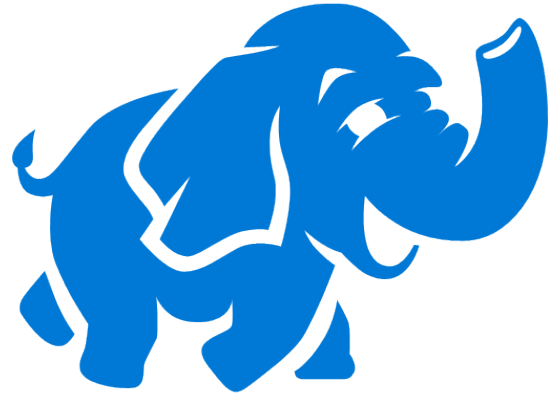
```
> scan 'device-errors',  
{ STARTROW => 'v1.0' }
```

```
> get 'device-errors',  
    'v2.0|2015060818'
```



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\$500+ /month



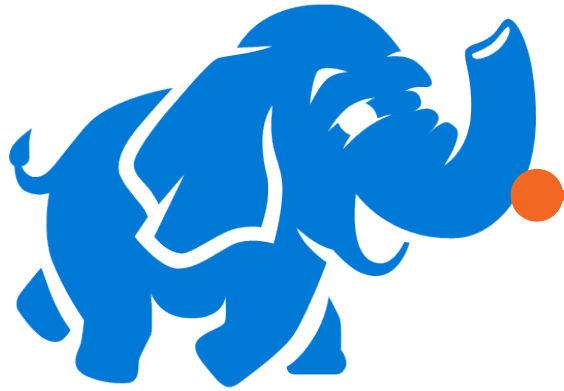
Head x2



Region x1



Zookeeper x3



APACHE
HBASE



Table2

cf1

RowKey	cf1:col1	...	cf1:col10
a6545da436	120 [v3] 119 [v2] 110 [v1]		3,220 [v2] 1,860 [v1]

Versioned
column values

RowKey	cf1:col1	...	cf1:col10000000
b3242b44d	19 [v2] 12 [v1]		74



Aggregate

Period	EventName	Count
2015060807	device.log	1,765,124



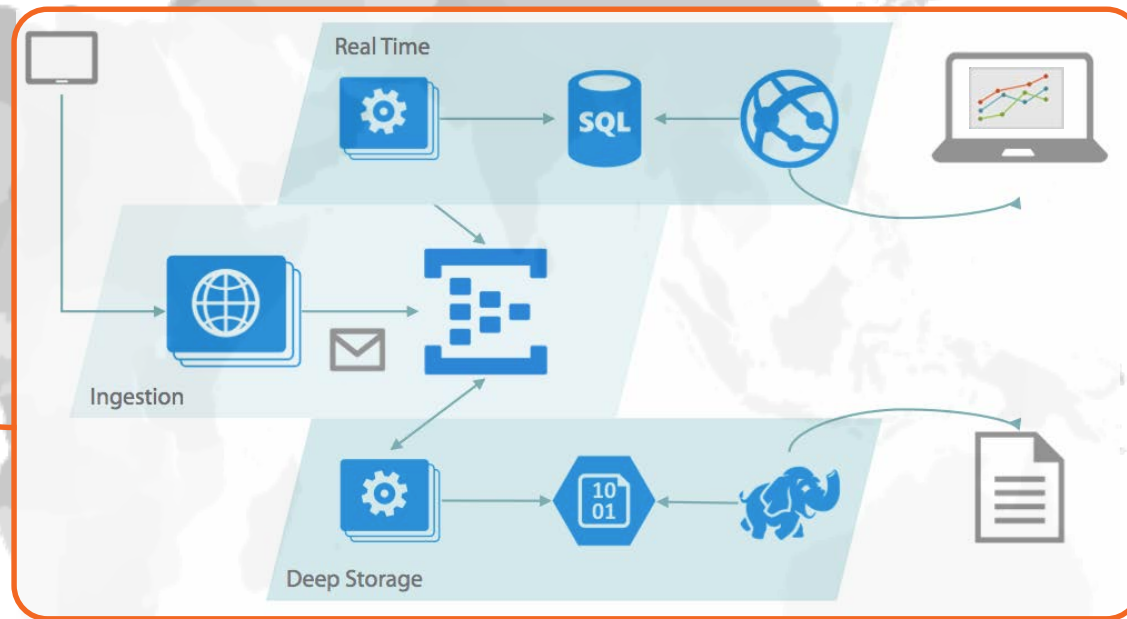
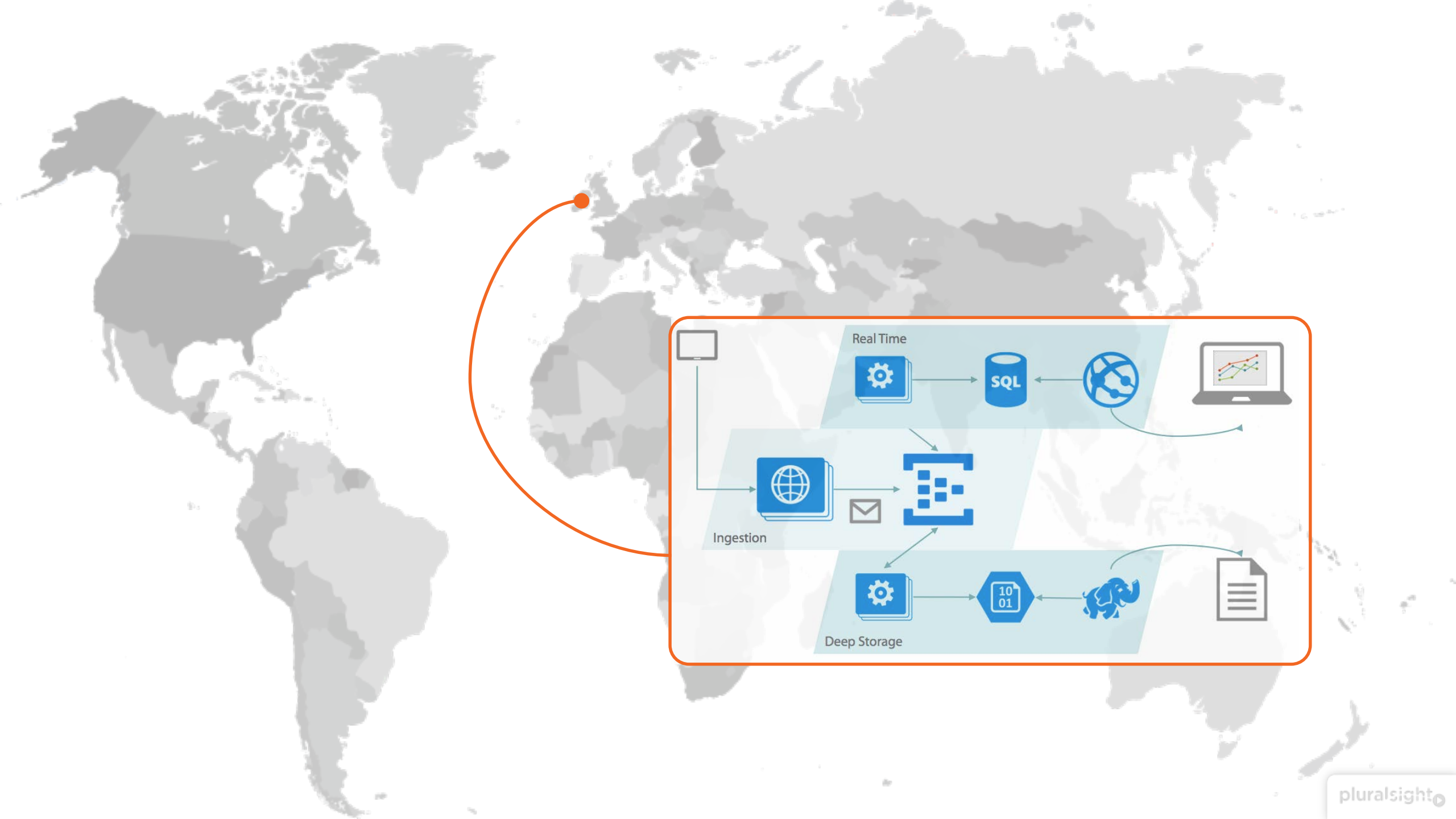
Detailed
summary

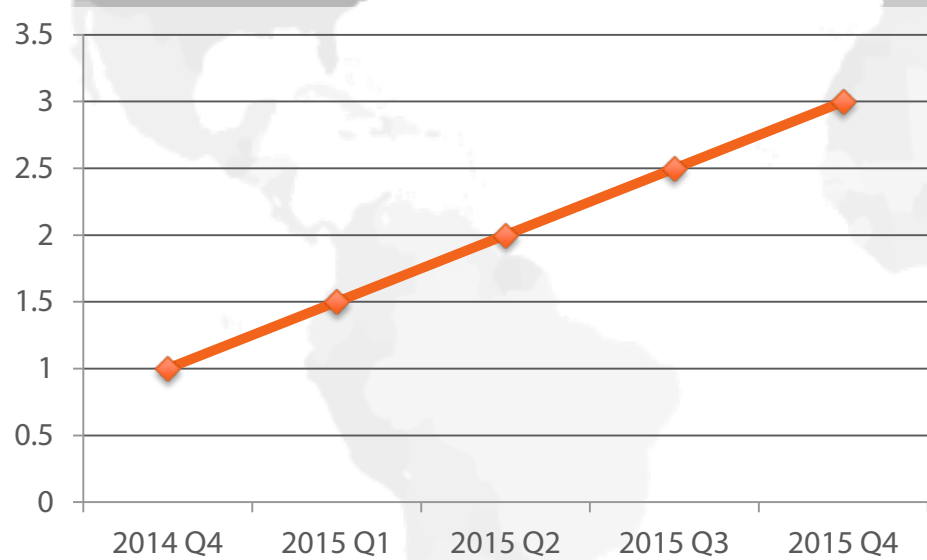
RowKey	d:abc	d:xyz
2015060807-v1.0	120	2,465



Raw

```
{  
  "timestamp": 1415878188000,  
  "message": "Unhandled exception",  
  "eventName": "device.log",  
  "deviceId": "1e565484571752"  
}
```



Bn /day

