Azure IoT Hub for Smart Factory

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twMVC

歡迎參加我們的每週四固定聚會

Challenges

- 多樣化的資料來源
- 不一致的資料格式
- 網路通訊的難易度
- 龐大的資料量

Azure IoT Hub

Scale

- Free:
  - Only 1 per subscription
- Basic:
  - Device-to-cloud
- Standard:
  - Cloud-to-device
  - IoT Edge
  - Device Management

Capability	Basic tier	Free/Standard tier
Device-to-cloud telemetry	Yes	Yes
Per-device identity	Yes	Yes
Message routing, message enrichments, and Event Grid integration	Yes	Yes
HTTP, AMQP, and MQTT protocols	Yes	Yes
Device Provisioning Service	Yes	Yes
Monitoring and diagnostics	Yes	Yes
Cloud-to-device messaging		Yes
Device twins, Module twins, and Device management		Yes
Device streams (preview)		Yes
Azure IoT Edge		Yes
IoT Plug and Play		Yes

(Ref: https://docs.microsoft.com/en-us/azure/iot-hub/iot-hub-scaling)

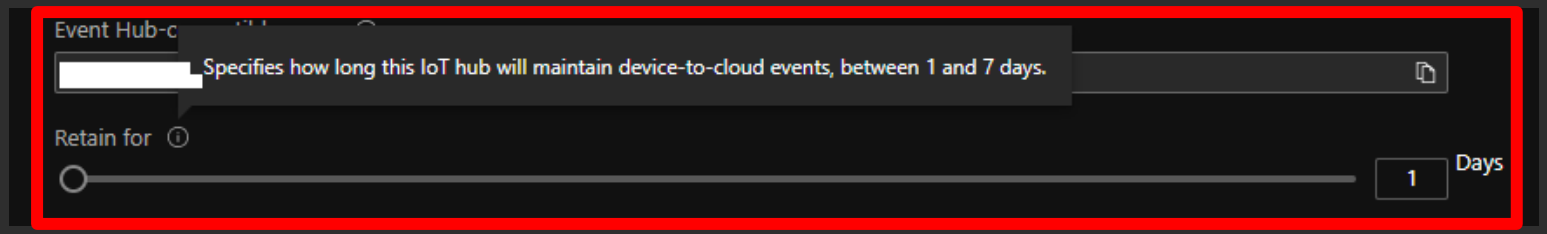
IoT Hub vs Event Hub

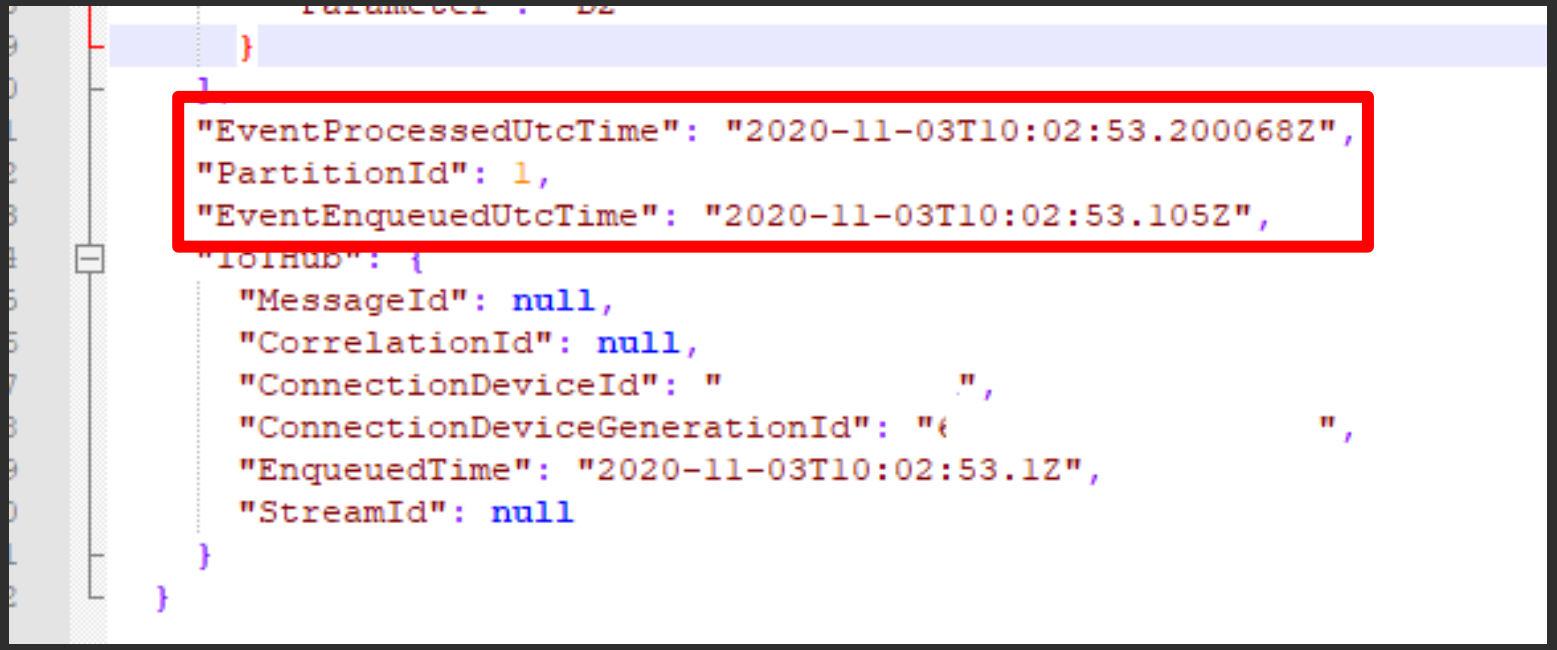
IoT Capability	IoT Hub standard tier	IoT Hub basic tier	Event Hubs
Device-to-cloud messaging	✓	✓	✓
Protocols: HTTPS, AMQP, AMQP over webSockets	✓	✓	✓
Protocols: MQTT, MQTT over webSockets	✓	✓	
Per-device identity	✓	✓	
File upload from devices	✓	✓	
Device Provisioning Service	✓	✓	
Cloud-to-device messaging	✓		
Device twin and device management	✓		
Device streams (preview)	✓		
IoT Edge	✓		

(Ref: https://docs.microsoft.com/en-us/azure/iot-hub/iot-hub-compare-event-hubs)

Telemetry

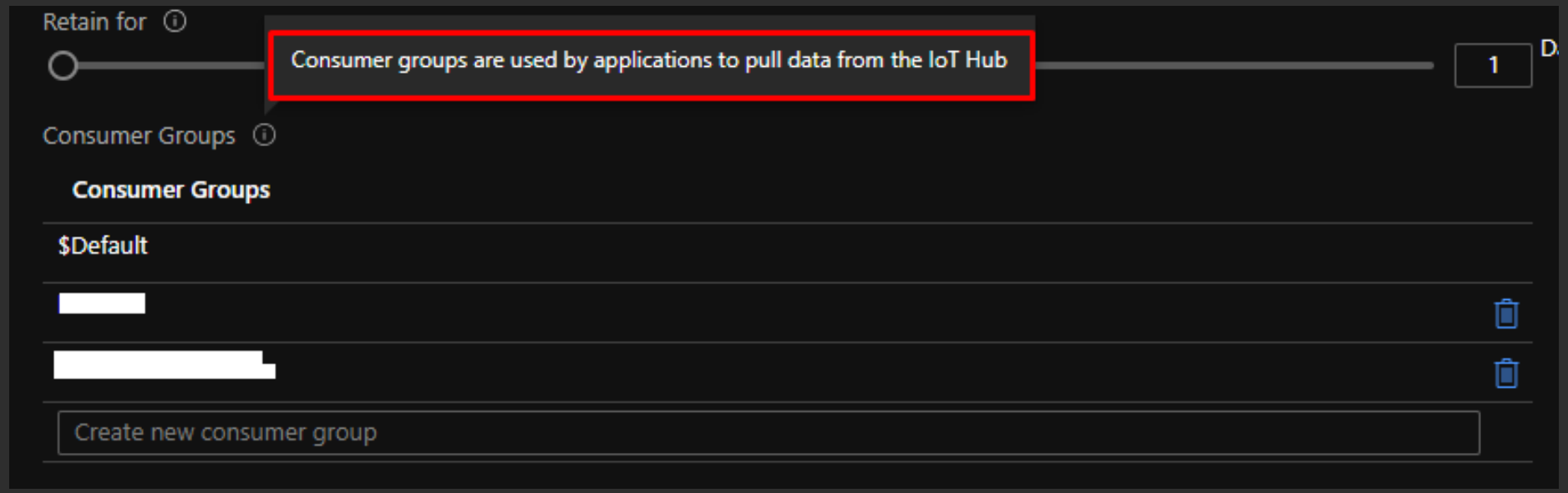
- Cache: 1~7 days
- Unified format
- Unstructured
- Data Centralizing
- 相同事件、相同時間





Consumer Group

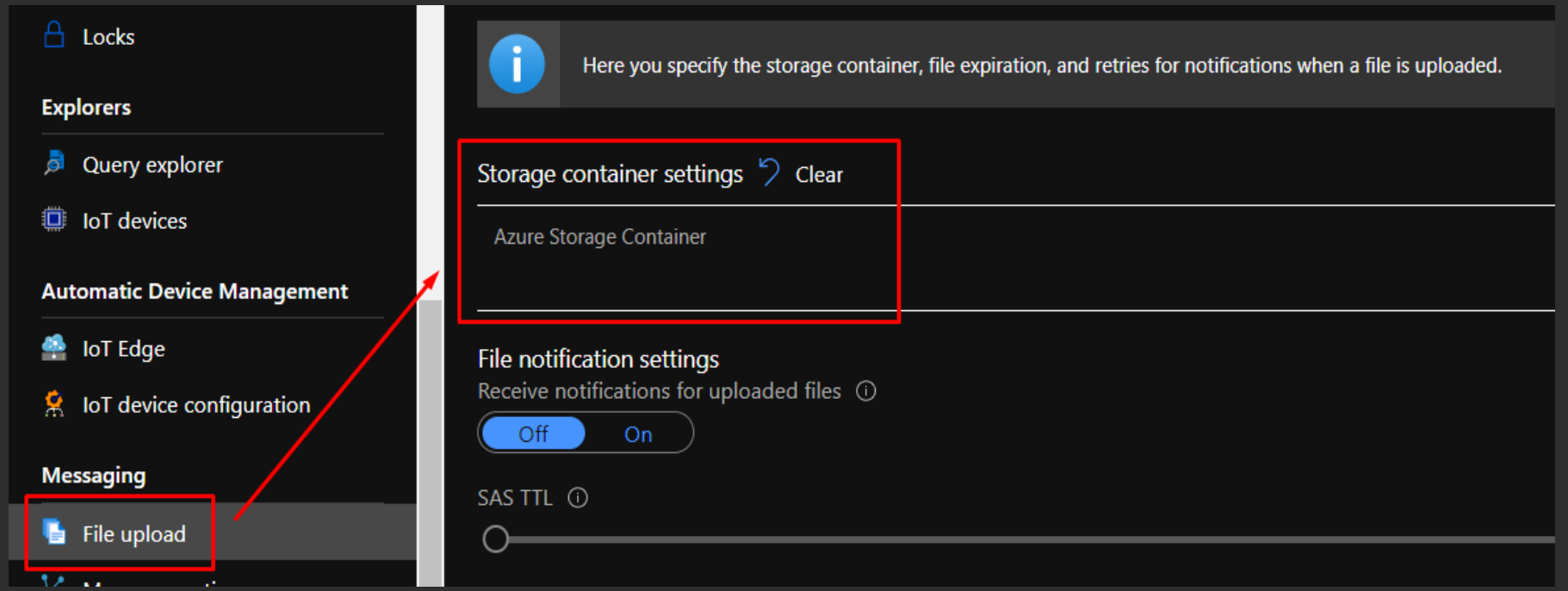
- Pulling data
- Max. 20 consumer groups per IoT Hub
- 5 concurrent readers per group



File Upload

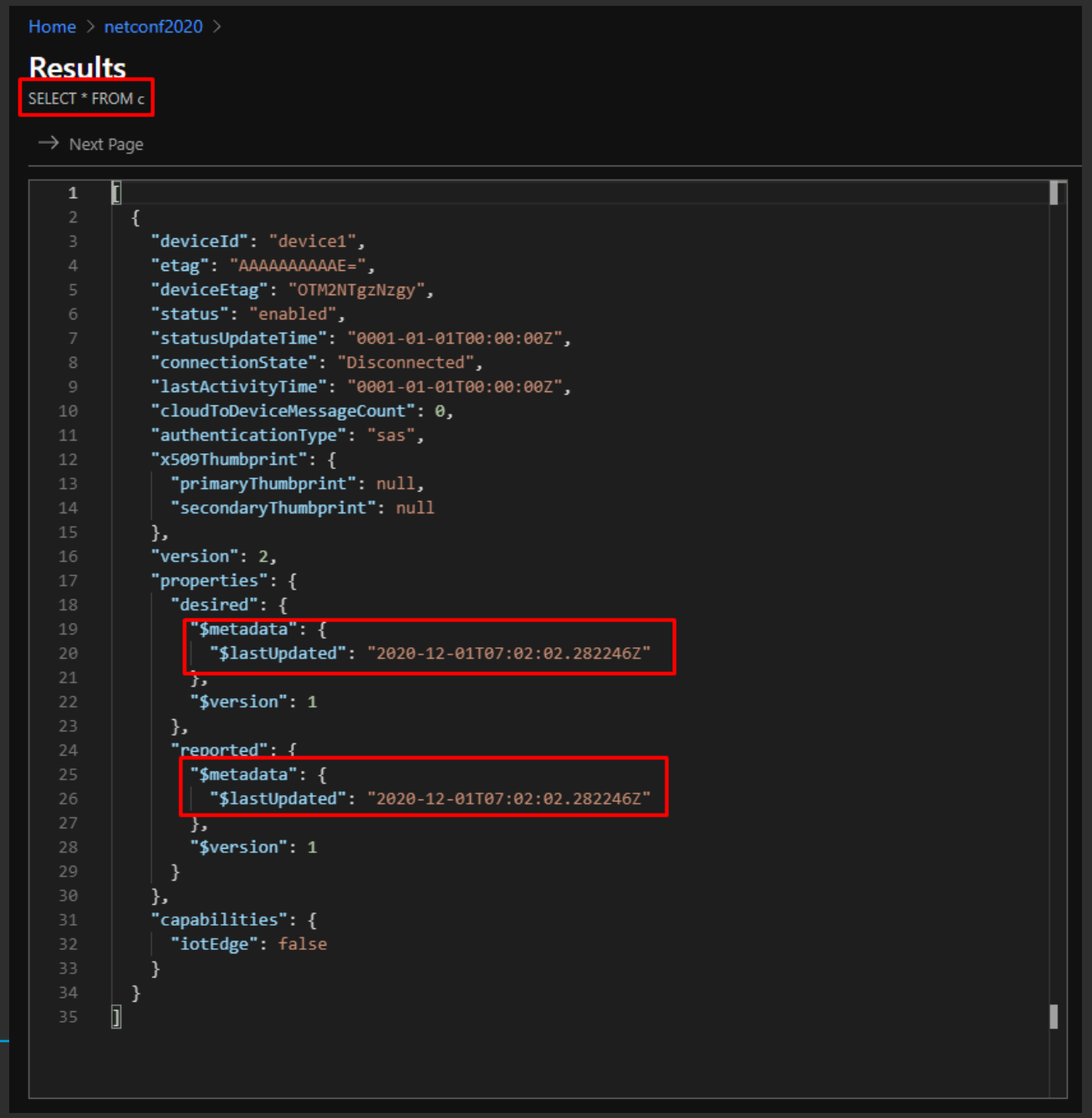
- Only Support Storage Container
- Save data to blob files
- Block Blob Only

- 10 concurrent keys in queue
- 同時10台裝置上傳，超過就會失敗



Query Explorer

- Only in Standard Tier
- Device Twins/Jobs information
- Help to manage devices



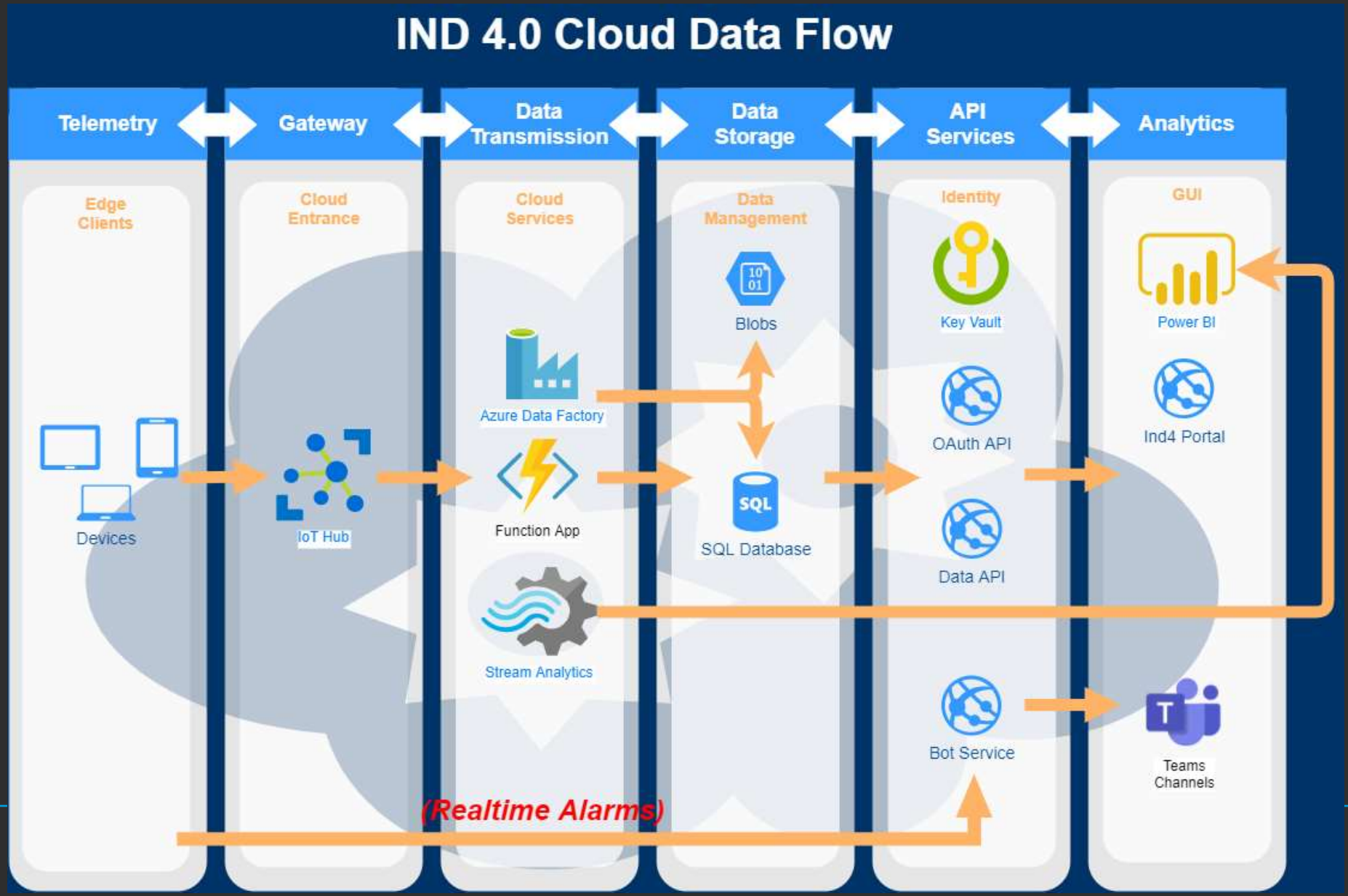
SDKs for Client

- C: https://github.com/Azure/azure-iot-sdk-c
- Python: https://github.com/Azure/azure-iot-sdk-python
- Node.js: https://github.com/Azure/azure-iot-sdk-node
- Java: https://github.com/Azure/azure-iot-sdk-java
- .NET C#: https://github.com/Azure/azure-iot-sdk-csharp

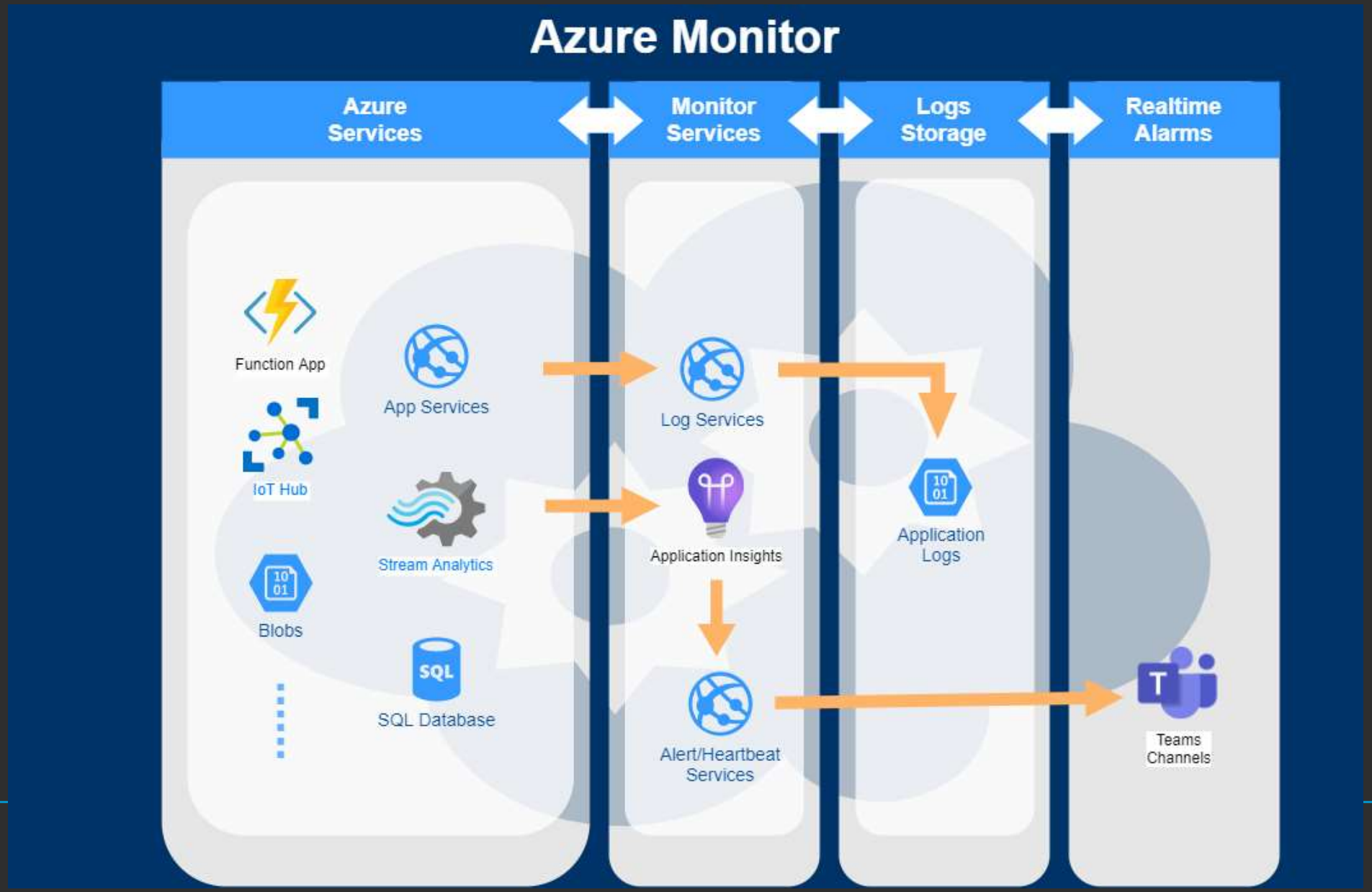
Architecture

- Data Flow
- Monitor
- Authentication

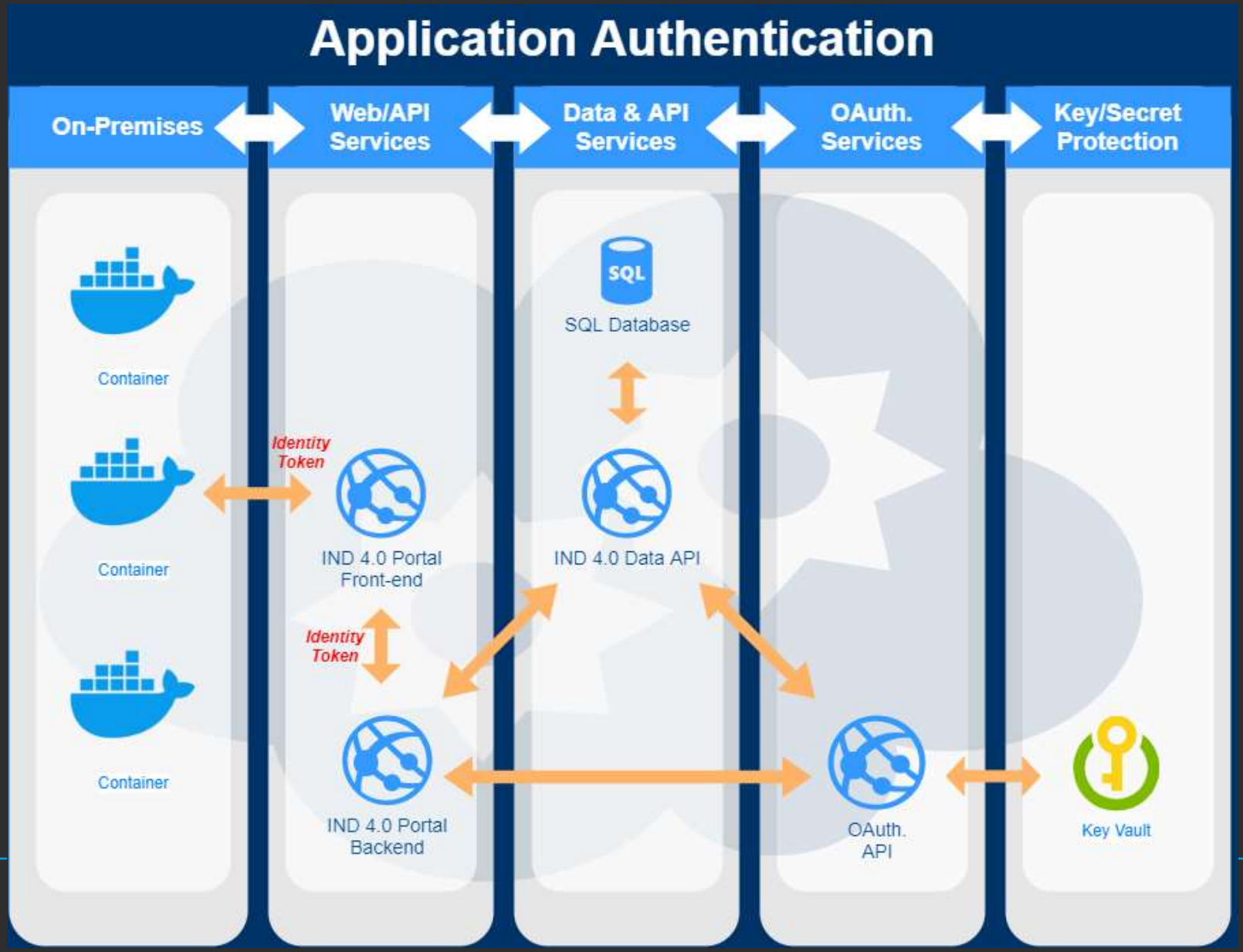
Data Flow


IND 4.0 Cloud Data Flow
Telemetry
Gateway
Data Transmission
Data Storage
API Services
Analytics
Edge Clients
Cloud Entrance
Cloud Services
Data Management
Identity
GUI
Devices
IoT Hub
Azure Data Factory
Function App
Stream Analytics
Blobs
SQL
SQL Database
Key Vault
OAuth API
Data API
Bot Service
Power BI
Ind4 Portal
Teams Channels
(Realtime Alarms)

Monitor


Azure Monitor
Azure Services
Monitor Services
Logs Storage
Realtime Alarms
Function App
IoT Hub
Blobs
App Services
Stream Analytics
SQL
SQL Database
Log Services
Application Insights
Alert/Heartbeat Services
Application Logs
Teams Channels

Authentication



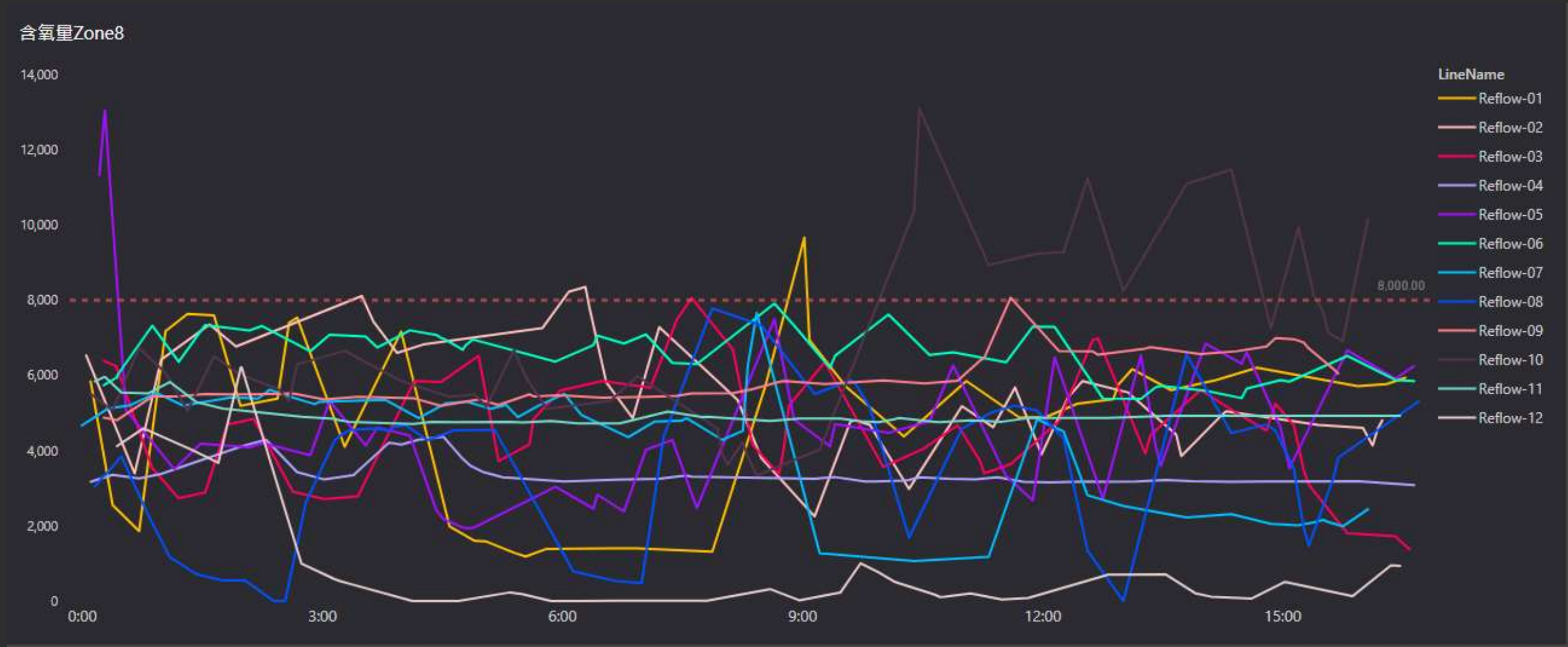
Data

要用資料做什麼?

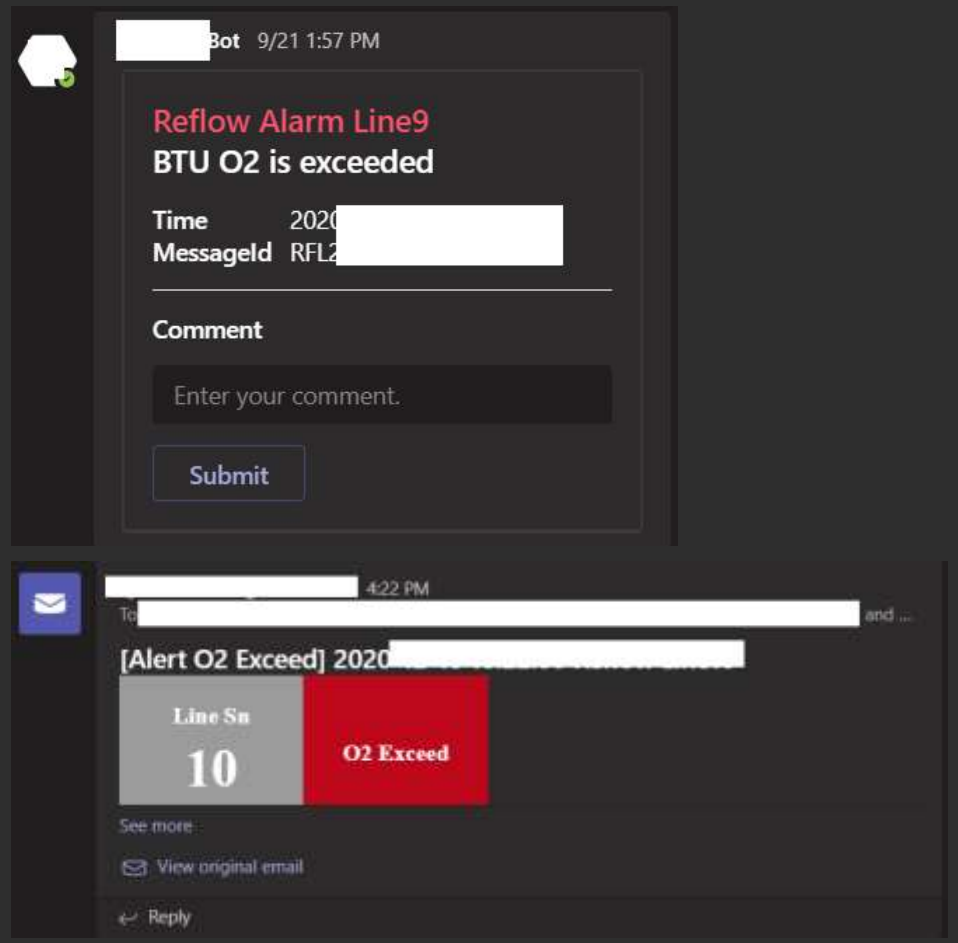
分析、警示、統計?

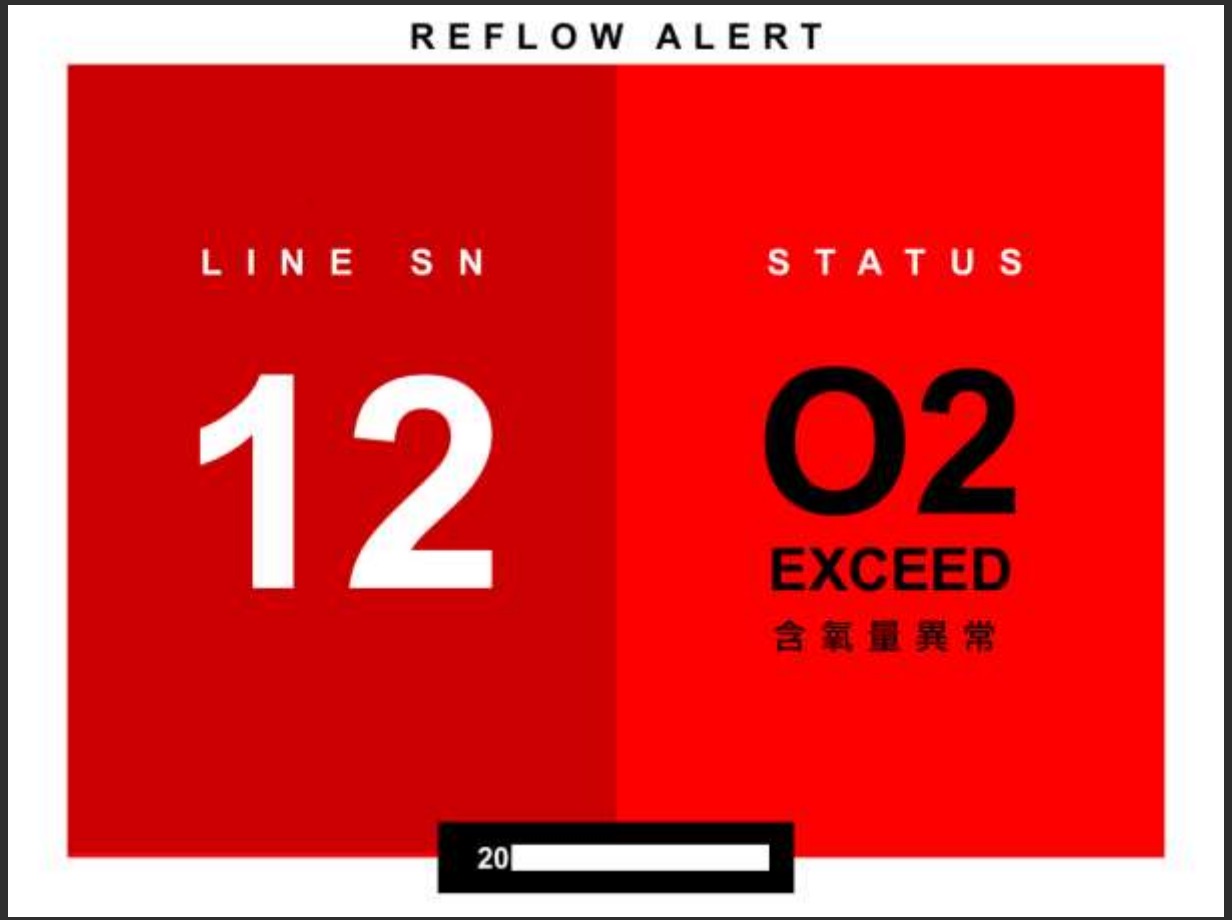
我們全都要!

分析 – 以O2為例


含氧量Zone8
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
0:00
3:00
6:00
9:00
12:00
15:00
8,000.00
LineName
Reflow-01
Reflow-02
Reflow-03
Reflow-04
Reflow-05
Reflow-06
Reflow-07
Reflow-08
Reflow-09
Reflow-10
Reflow-11
Reflow-12

警示– 以O2為例


[redacted] Bot 9/21 1:57 PM
Reflow Alarm Line9
BTU O2 is exceeded
Time 2020
MessageId RFL2
Comment
Enter your comment.
Submit
[redacted] 4:22 PM
[Alert O2 Exceed] 2020
Line Sn
10
O2 Exceed
See more
View original email
Reply


REFLOW ALERT
LINE SN
12
STATUS
O2
EXCEED
含氧量異常
20[redacted]

統計 – 以WIP為例


Line Reflow-1
Line Reflow-2
Line Reflow-3
Line Reflow-4
Line Reflow-5
Line Reflow-6
Line Reflow-7
Line Reflow-8
Line Reflow-9
Line Reflow-10
Line Reflow-11
Line Reflow-12
WIP
13:00
14:00
15:00
16:00

資料從哪裡來?

OCR、Devices、Machine Logs?

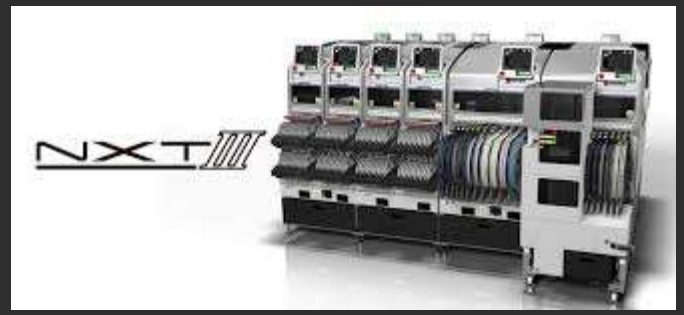
我們選擇Machine Logs!

Sources

- Various:
  - Bar Code Scanner:
    - Device Support
    - Weak Integration
  - OCR:
    - Visual Identification Machine
  - Machine Logs:
    - Native Machine Software Support
    - Stable







資料如何處理?

Various Data Structures

- Various Data Schema:
  - Keep useful data
  - Re-organize structure
  - Merge/Divide Values
  - Use CSV for exchanging

```
Category,"Auto","1000"CRLF
Name,"MD4NA1X7_270"CRLF
WO,"8785505"CRLF
Amount,"0"CRLF
Action,"Start","1"CRLF
Message,"Program = MD4NA1X7_270"CRLF
Datetime,"5/14/2020 05:44:45"CRLF
User,"ME"CRLF

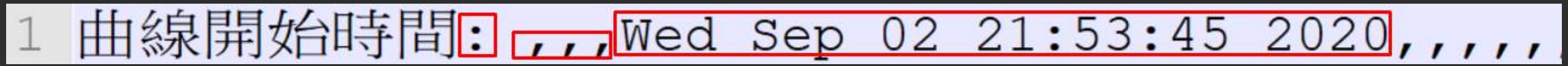
```

```
曲線開始時間: ,,,Mon Oct 21 03:19:23 2019,,,,,,,,,,,,,,,,,CRLF
,,,,,,,,,,,,,,,,,,,,,CRLF
產品名稱: ,,,5640D-58LS-150NZ12,,,,,,,,,,,,,,,,,CRLF
制程界限名稱: ,,,INDIUM 58LS,,,,,,,,,,,,,,,,,,CRLF
爐子名稱: ,,,Line2,,,,,,,,,,,,,,,,,CRLF
制程界限描述: ,,,,,,,,,,,,,,,,,,,,CRLF
爐子食譜名稱: ,,,,,,,,,,,,,,,,,,,,CRLF
溫度曲線描述: ,,,"INDIUM 5.8LS   a. Room temperature ramp up to 110 ℃, the slope is < 2.2 ℃/sec  b. Pre-heat time 110  150 ℃
產品長度 (公分): ,,,0,,,,,,,,,,,,,,,,,CRLF
產品闊度 (公分): ,,,0,,,,,,,,,,,,,,,,,CRLF
產品重量 (克): ,,,0,,,,,,,,,,,,,,,,,CRLF
傳送帶速度單位: ,,,公分/分,,,,,,,,,,,,,,,,,CRLF
溫度標度: ,,,攝氏,,,,,,,,,,,,,,,,,CRLF
SetpointAlignmentMethod=0,,,PercentageOfProfileToLookForFirstZone=33,,,,,,,,,,,,,,,,,,CRLF
MaxSlopeWidthInPointsToAlignSetpoints=5,,,,,MinFirstSetpointPosition=0.0,,,,,MaxFirstSetpointPosition=25.0,,,,,,,,,,,,CRLF
fAirTCPeakShouldBeTheHottestByAtleastThisManyDegrees=5.0,,,,,fAirTCIncreasedByThisManyDegrees=0.0,,,,,,,,,,,,,,,,CRLF
fReportAnErrorIfAirTCPeakIsCoolerByMoreThanThisManyDegrees=10.0,,,,,,,,,,,,,,,,,,,,,,CRLF
,,,,,,,,,,,,,,,,,,,,,CRLF
```

```
V1.09,MultiLanguageCRLF
EN,Program Name,Program Comment,Start Time,Finish Time,Board Count Max,Board Serial No,Finish Flag,Print CT,Trar
Time,Mask MarkRec Count,Cleaning Count,Inspection Count,Board Inspection,Board Distortion Check,Board Remove,Boa
Time,Other Lane Wait Time,NG Blocks,Production Model,Surface Info,Production LotCRLF
EN,3364_YAM1,,2020/07/02 23:56:12,2020/07/03 00:55:53,0,1,0,11.42,10.90,3514.36,0.00,1.22,0.00,0.00,24.48,0,0,0,
EN,3364_YAM1,,2020/07/03 00:55:53,2020/07/03 01:14:50,0,2,0,11.29,10.99,1074.80,0.00,1.22,0.00,0.00,24.50,0,0,0,
```

Format

- Not consistent:
  - 欄位分隔符號不一致: 先replace、再Divide
- Abnormal Values:
  - 多個數值: 只留真正的資料
- Value Type:
  - Read with STRING type first



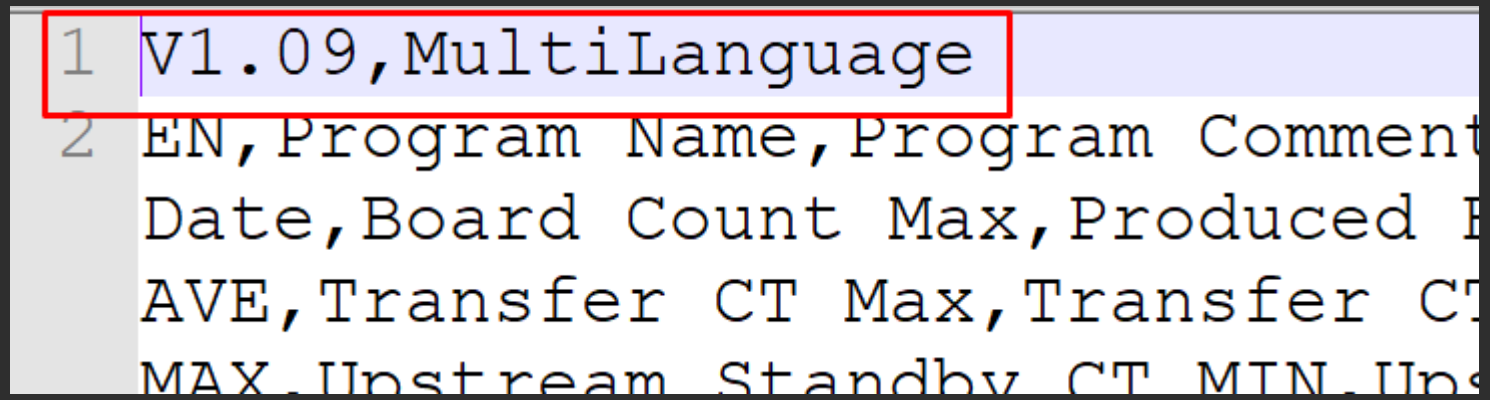
Format

- Multiple columns:
  - Use the column name closed to value
- Hierarchy:
  - Set with real data hierarchy

```
1 Category,"Production","1000"
```

Format

- Extra Information:
  - Remove it
  - Use it on-premises



Format

- Column in value:
  - Manually Input
  - Confirm with user
  - Parse Value

```
1  Category,"Auto","1000"CRLF
2  Name,"MD4NA1X7_270"CRLF
3  WO,"8785505"CRLF
4  Amount,"0"CRLF
5  Action,"Start","1"CRLF
6  Message,"Program = MD4NA1X7_270"CRLF
7  Datetime,"5/14/2020 05:44:45"CRLF
8  User,"ME"CRLF
9
```

Frequency

- Scenario:
  1. File Rename:
     - Ex. Test.csv -> Test.tmp
  2. Append data per 1s
  3. File Rename:
     - Ex. Test.tmp -> Test.csv



File Lock/Missing

- Create/Update:
  - Sol:
    - Copying file first
- Delete/Rename
  - Sol:
    Filtering by full name
    (ex. *.csv) then copying
  - Sol:
    Filter by modify time
- **Hint: 不要跟機台比速度!**

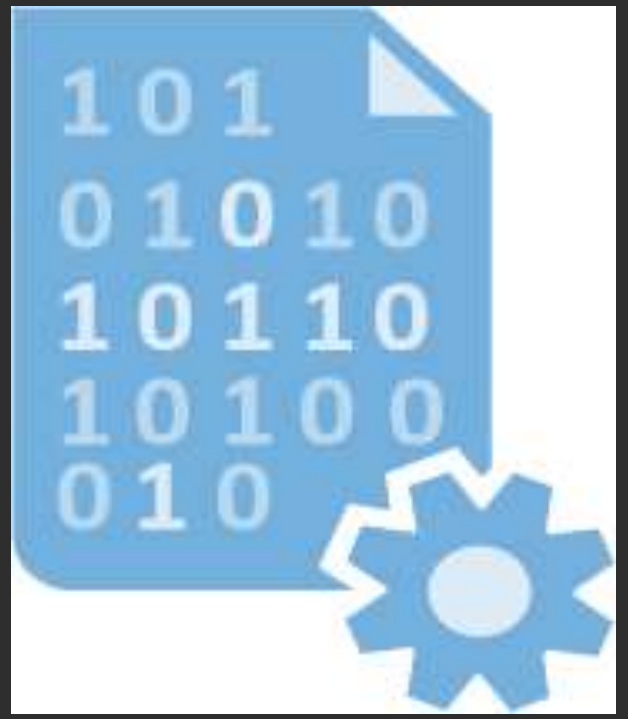


優化

If it can be …
else …

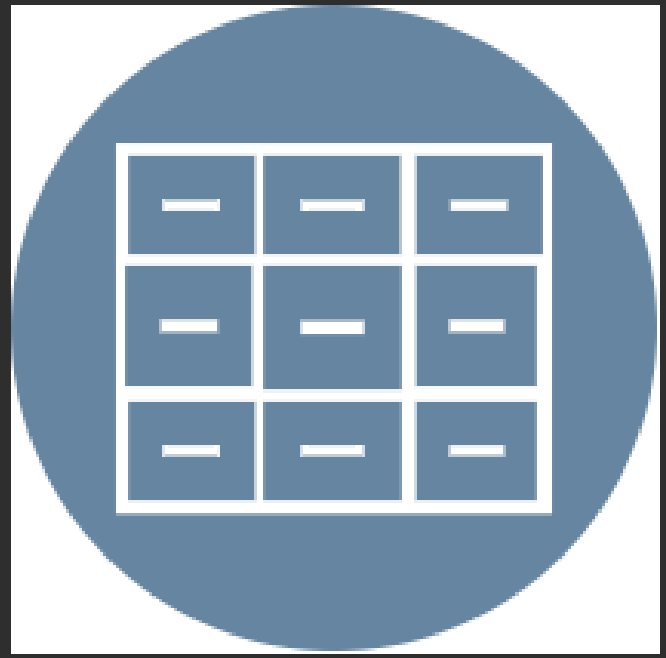
Optimization:

- Create/Update:
  - Create file instead of update, even if only one record
- Delete/ Rename :
  - Not allowed



Read Local File

- Network latency
- Data Size
  - Divide & Conquer
  - 單一檔太大，分開寫檔/讀檔。
- Read/Write Frequency
  - 讀寫檔案速度一定是本地端最快、最穩。
  - 提升Host的I/O效能。



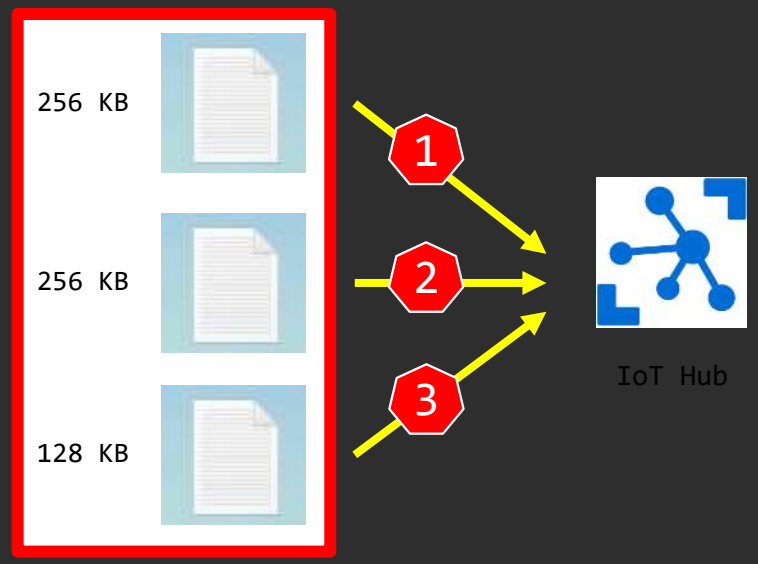
資料往哪裡送?怎麼送?

On-premises: DB/REDIS…etc

Cloud: Services?

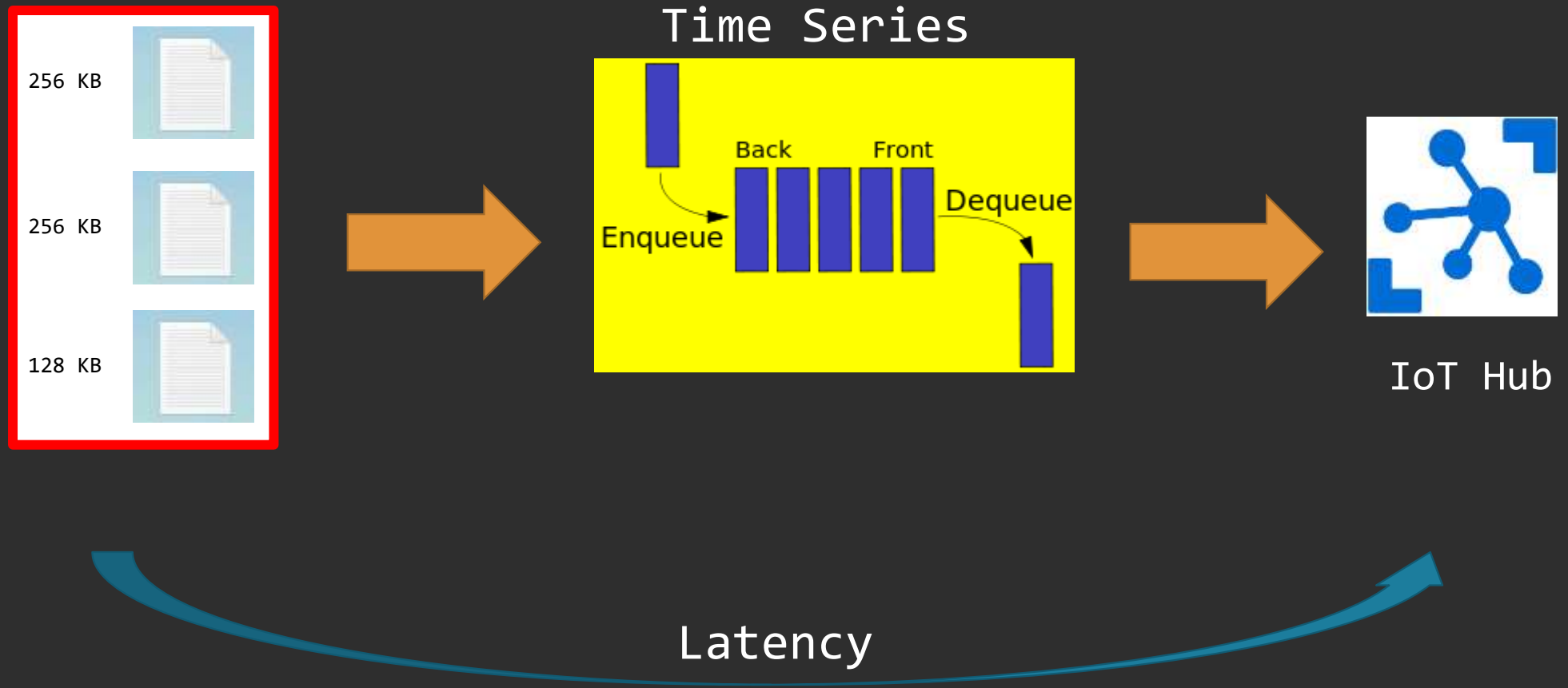
Principals for IoT Hub

- 256 KB per message
  - Make data size closed to 256 KB in each request
- 4 KB per unit
  - Reduce data size as possible, ex. \u0022



3a\\u0022,\\r\\n \\u0022ReflectedType\\u0022: \\u0022System.Net.Http.HttpResponseMessage, System.Net.Http, Version=4.2.2.0, Culture=neutral, PublicKeyToken=b03f5f7f11d50a3a\\u0022,\\r\\n \\u0022MemberType\\u0022: 8,\\r\\n \\u0022MetadataToken\\u0022: 100664068,\\r\\n \\u0022Module\\u0022: {\\r\\n \\u0022MDStreamVersion\\u0022: 131072,\\r\\n \\u0022FullyQualifiedName\\u0022: \\u0022D:\\\\\\\\\\\\WindowService\\\\\\\\\\Depanel.Binner\\\\\\\\\\System.Net.Http.dll\\u0022,\\r\\n \\u0022ModuleVersionId\\u0022: \\u0022390a9276-f934-4614-8a29-2bd4fbfd5203\\u0022,\\r\\n \\u0022MetadataToken\\u0022: 1,\\r\\n \\u0022ScopeName\\u0022: \\u0022System.Net.Http.dll\\u0022,\\r\\n \\u0022Name\\u0022: \\u0022System.Net.Http.dll\\u0022,\\r\\n \\u0022Assembly\\u002

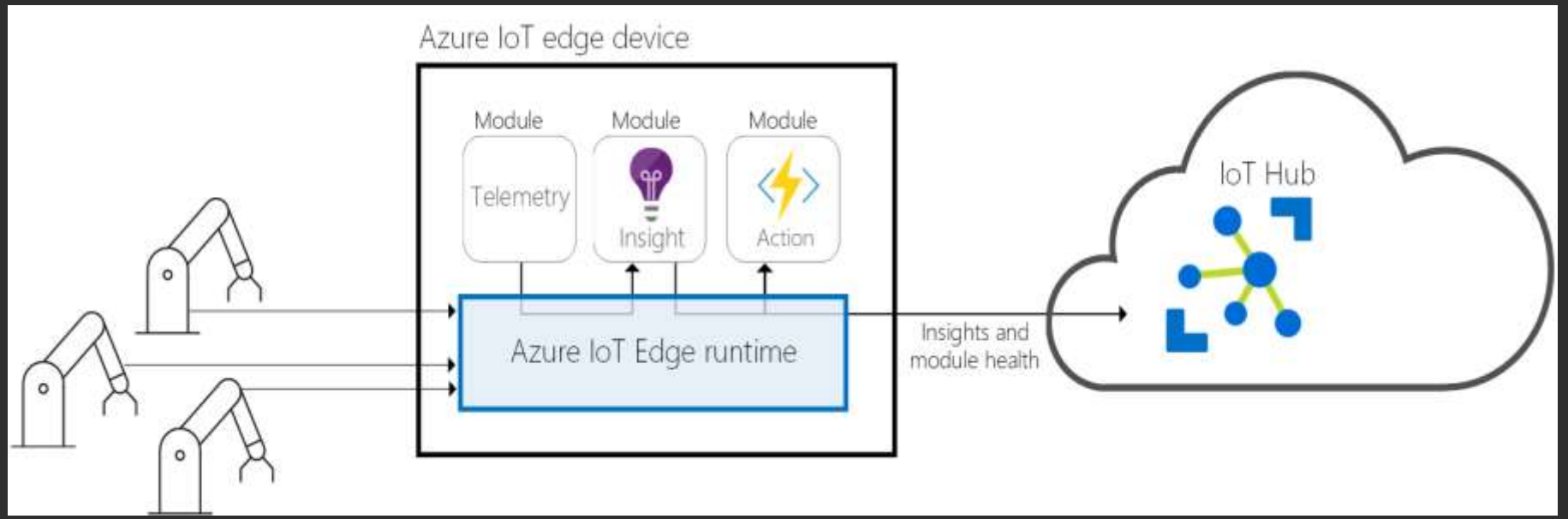
Memory Queue



Application

IoT Edge

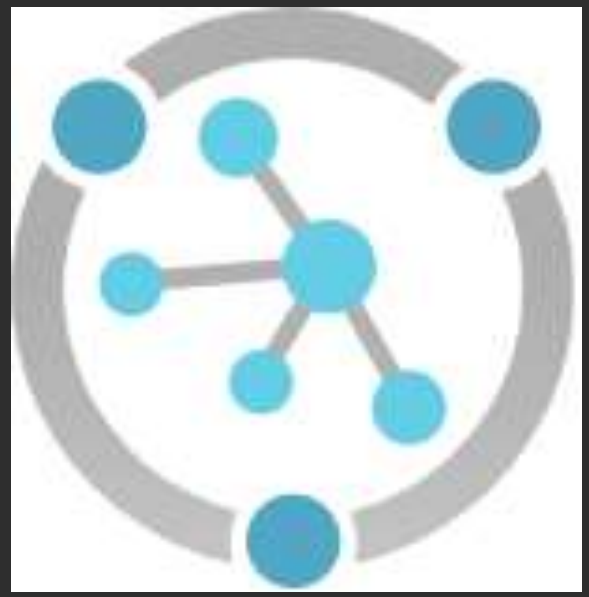
- 最接近資料來源的機器
- 分散式計算
- 獨立運算能力
- 網路通訊能力



IoT Devices or Edge?

- 政策
- 遠端裝置管理
- 雙向通訊
- Device Client作業環境
- Device Client的網路環境





政策

- 資料安全性
- 作業系統
  - Win 10 1809+ & IoT Edge Runtime & Docker
- 設備
  - 效能: 運算能力、I/O、Storage
- 通訊

遠端裝置管理

- 軟體更新、大量部署
- IoT Edge
  - Application Insights Module
    - 外部通訊
  - 路由
    - 模組間的通訊方式
  - Telemetry
    - 資料存取

雙向通訊

- Device to cloud
  - Telemetry遙測資料
- Cloud to device
  - Notification
  - Modules Update

Device Client作業環境

- Windows/Linux
- Embedded System
- Mobile Device(Android/iOS)

Device Client的網路環境

- 通訊協定
  - https、AMQP、MQTT…etc
- Firewall/Proxy
- 網路通訊
  - 頻寬(ex. 只允許100/10 MB夠不夠用?)

Win Services or Container?

- Docker
  - Memory Process，注意使用量。
  - Windows環境下，盡可能不使用大量的I/O處理。
- Windows Services
  - 管理不易
  - Debug資訊不充足
  - 系統整合性佳

Cost

Basic or Standard tier?

地區：東南亞　　貨幣: 新台幣 (NT$)

版本類型	每一 IOT 中樞單位的價格 (每月)	每一 IOT 中樞單位的每日訊息總數	訊息計量大小
B1	NT$300.542	400,000	4 KB
B2	NT$1,502.71	6,000,000	4 KB
B3	NT$15,027.10	300,000,000	4 KB

標準層次

版本類型	每一 IOT 中樞單位的價格 (每月)	每一 IOT 中樞單位的每日訊息總數	訊息計量大小
免費	免費	8,000	0.5 KB
S1	NT$751.355	400,000	4 KB
S2	NT$7,513.55	6,000,000	4 KB
S3	NT$75,135.50	300,000,000	4 KB

(Ref:https://azure.microsoft.com/zh-tw/pricing/details/iot-hub/)

Azure IoT Hub Quota

- Charge Unit: 4KB
- Batch Daily Volume:
  - Type1: 0.18 KB x 60s x 60m x 24H x 12 Lines = 186,624 KB
  - Type2: 0.98 KB x 60/10s x 60m x 24H x 12 Lines = 101,606 KB
  - Total: 288,230 / 4 KB = 72,057 Units
- Real-time Daily Count:
  - Type1: 60s x 60m x 24H x 12 Lines = 1,036,800 records
  - Type2: 60/10s x 60m x 24H x 12 Lines = 1,036,80 records
  - Total: 1,036,800 + 1,036,80 = 1,140,480 Units

Summary

沒有最好的架構、只有最合適的架構

經驗不是放諸四海皆準的規則、只是借鏡

因地制宜！

- Contact:
  - Carl_yang@kingston.com.tw
- PPT:
  - https://github.com/carlyang920/twMVC2021-42.git

Thanks for joining!



歡迎參加我們的每週四固定聚會