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# Telemetry Data analysis using Microsoft Azure

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**ABSTRACT:**In light of these IoT challenges, organizations increasingly recognize the advantages of leaving certain data right where it is captured—at the edge—and analyzing it there. The result is the ability to take instant action and affect immediate control over the connected things.
Data from the Internet of Things originates remotely. Depending on the industry, the edge might be on a plant floor, in a field, on an oil rig, or in a warehouse. The data from connected things at these remote sites has the potential to generate valuable business, engineering, and scientific insights
In this paper detailed telemetry tracking system and its design is explained in detail.

**KEYWORDS:** Big Data, telemetry, Microsoft Azure, Big Data Analysis, RFID, Beacon

## I.INTRODUCTION

One of the key topics surrounding the concept of "big data" is the availability of massive time-based or telemetry data. With the appearance of low cost capture and storage devices, it has now become possible to get very detailed data to be used for further analysis. The very high detail resolution concerns mainly time. Nowadays, time streaming data can be recorded from almost any device, calling for interpretation to know more about the underlying system or to predict future events with higher accuracy.
Here Harvester is attached with RFID Tag and workers are with Beacon. RFID reader will collect the RFID information from both the Beacon and Harvesters. System is working as a Better workers tracking system for eachworkstation.

## II.OVERALL ARCHITECTURE

Overall architecture shows various components listed below

- Bluetooth beacons are hardware transmitters - a class of Bluetooth low energy (LE) devices that broadcast their identifier to nearby portable electronic devices.
- Radio-frequency identification (RFID) uses electromagnetic fields to automatically identify and track tags attached to objects. The tags contain electronically stored information. RFID tags can be either passive, active or battery-assisted passive. An active tag has an on-board battery and periodically transmits its ID signal. Passive tags collect energy from a nearby RFID reader's interrogating radio waves. This solution uses passive RFID tags.

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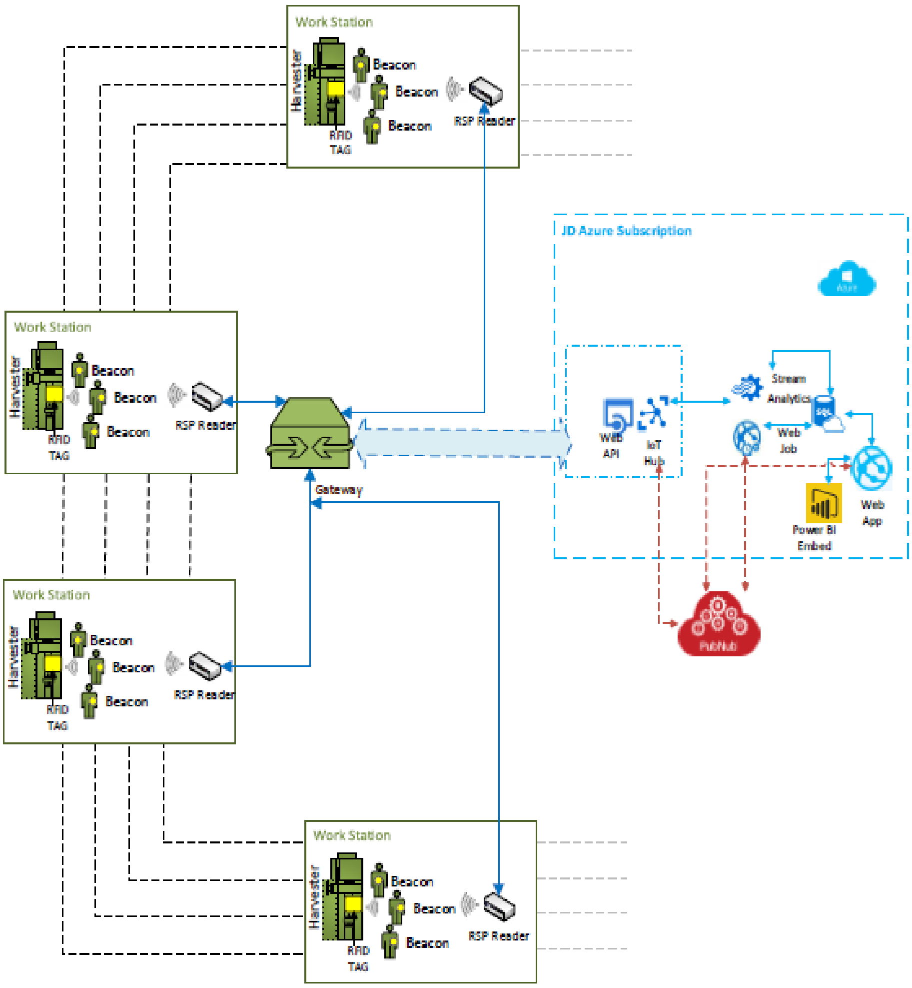


Fig1:Overall architecture of Telemetry analytic application

- RSP Readers mounted on each work stations detects inventory movements and other data for analysis. It will be connected thru PoE switch to the Gateway.
- The edge application running on the Gateway device located at the back end of the store will push each message to the Azure IoT Hub.
- Microsoft Azure with PaaS subscription comes with services like Azure IoT Hub, Stream Analytics, App services etc. that will be used for hosting all provider hosted apps.
- PubNub utilizes a Publish/Subscribe model for realtime data streaming and device signaling which lets you establish and maintain persistent socket connections to any device and push data to global audiences in less than ¼ of a second.

## III.MICROSOFT AZURE

Microsoft Azure is a cloud computing platform and infrastructure, created by Microsoft, for building, deploying and managing applications and services through a global network of Microsoft-managed datacenters. It provides both PaaS and IaaS services and supports many different programming languages, tools and frameworks, including both Microsoft-specific and third-party software and systems.

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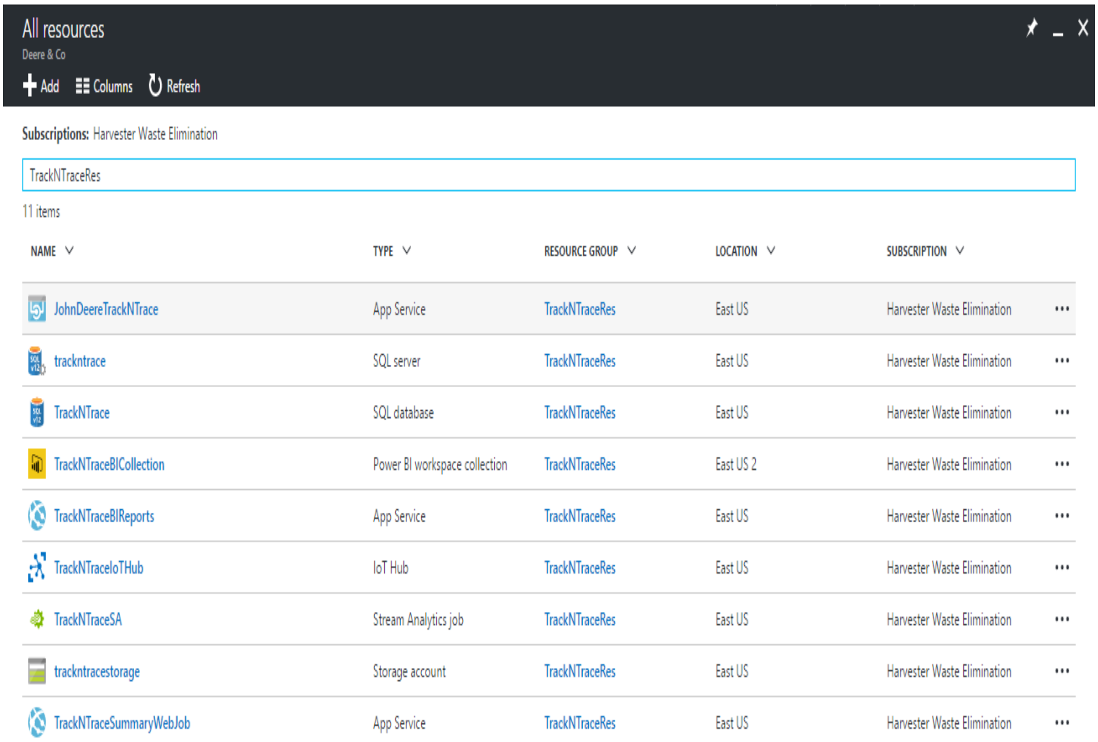
We would be using Azure as a PaaS service. The services that are available in Azure PaaS are shown in from Azure Management portal screen.




| NAME | TYPE | RESOURCE GROUP | LOCATION | SUBSCRIPTION |
|---|---|---|---|---|
| JohnDeereTrackNTrace | App Service | TrackNTraceRes | East US | Harvester Waste Elimination |
| trackntrace | SQL server | TrackNTraceRes | East US | Harvester Waste Elimination |
| TrackNTrace | SQL database | TrackNTraceRes | East US | Harvester Waste Elimination |
| TrackNTraceBICollection | Power BI workspace collection | TrackNTraceRes | East US 2 | Harvester Waste Elimination |
| TrackNTraceBIReports | App Service | TrackNTraceRes | East US | Harvester Waste Elimination |
| TrackNTraceIoTHub | IoT Hub | TrackNTraceRes | East US | Harvester Waste Elimination |
| TrackNTraceSA | Stream Analytics job | TrackNTraceRes | East US | Harvester Waste Elimination |
| trackntracestorage | Storage account | TrackNTraceRes | East US | Harvester Waste Elimination |
| TrackNTraceSummaryWebJob | App Service | TrackNTraceRes | East US | Harvester Waste Elimination |

Fig2: Microsoft Azure management Portal xx

### A.AZURE IoT HUB

Microsoft Azure IoT Hub allows to easily and securely connect the Internet of Things (IoT) assets. Use device-to-cloud telemetry data to understand the state of the devices and assets and be ready to take action when a device needs your attention. In cloud-to-device messages, reliably send commands and notifications to your connected devices—and track message delivery with acknowledgement receipts. Device messages are sent in a durable way to accommodate intermittently connected devices.
Client will use IoT Hub to connect to the Gateway devices located at the backend of the stores.

1)

### B.AZURE STREAM ANALYTICS

Azure Stream Analytics allows to rapidly develop and deploy low-cost solutions to gain real-time insights from devices, sensors, infrastructure, and applications. Stream Analytics is integrated out-of-the-box with Azure Event Hubs to ingest millions of events per second. Stream Analytics processes ingested events in real-time, comparing multiple streams or comparing streams with historical values and models. It detects anomalies, transforms incoming data, triggers an alert when a specific error or condition appears in the stream, and displays this real-time data in your dashboard.

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**C.Azure App Services**

Azure web site is one of the services of Azure PaaS model that allows building, deploying and hosting web apps.These sites can scale quickly to handle high traffic loads, and the built-in load balancing and traffic manager provide high availability.

Developers can publish code and other web content into Websites using FTP, FTPS, or Microsoft's WebDeploy technology. These websites also supports publishing code from source control systems, including Git, GitHub, CodePlex, BitBucket, Dropbox, Mercurial, Team Foundation Server, and the cloud-based Team Foundation Service. Any client will use Visual Studio Online integrated with Azure to publish the apps to Azure App services.

**2)**

**D.Azure SQL**

A managed cloud database for app developers. Makes building and maintaining applications easier and more productive. With built-in intelligence that learns app patterns and adapts to maximize performance, reliability and data protection, SQL Database is a cloud database built for developers

Any business user can use the Azure SQL for storing the tracking information and other data needed for the solution.

**3)**

**E.AzurePowerBI Embedded**

Power BI Embedded allows to create impactful and interactive data visualizations against the application data in Power BI Desktop. Visualize very large data sets directly from a wide variety of cloud sources like Azure SQL Database and Azure SQL Data Warehouse, using Direct Query to ensure your data is always up to date without moving your data to Power BI. Easily embed interactive visuals in web apps using REST APIs and the Power BI SDK. Offer customers consistent high-fidelity interactive data visualization experiences, rendered in HTML5, across any device. Seamlessly use App Tokens based authentication and authorization instead of explicit end-user authentication. Realize faster time-to-value without redesigning your app.

## IV. Implementation

Microsoft Azure will act as a hosting environment for all the custom components to be developed for the Track and Trace Solution.

### A.TELEMETRY CAPTURING

The RSPs mounted on each workstation will have their scanning agent up and running to detect the movements of subjects' wearing BLE Beacons and RFID tags. With extensive experimentation it was concluded to use BLE Beacons based tracking for Operators and RFID based tracking for Harvesters. And two RSPs will be mounted parallel per station.

### B.RFID SCANNING

RSPs has their inbuilt scanning agent for scanning the RFID tags. The passive RFID tags continuously emit the signal by collecting energy from a nearby RSPs. The payload captured by the RSP from this RFID signal will be of below JSON format. The RSPs will publish this payload to the configured MQTT topic.

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{
"jsonrpc": "2.0",
"method": "inventory_data",
"params": {
"sent_on": 978309554459,
"period": 500,
"device_id": "RSP-8021cc",
"facility_id": "Zone2",
"motion_detected": false,
"data": [
{
"epc": "000000000000228510000410",
"antenna_id": 0,
"last_read_on": 978309554248,
"rssi": -608,
"phase": 76,
"frequency": 917250

Fig3: RFID JSON message Format

Table1. RFID JSON Message Format Fields Explanation

| | |
|---|---|
| device_Id | The device id of the RSP which captured the signal |
| epc | The uniqueId (Assembly Name) to trace the Harvester |
| last_read_on | Signal Captured time in UTC |
| rssi | Indicates the signal strength received |

### C.BLE BEACON SCANNING

To support the BLE scanning the RSPs will be installed with Bluetooth module (BlueZ 4.9 or higher) and custom written script (*BLEBeaconScanner_v1*) to parse the beacon signal payloads. The frequency interval of the BLE signal emitted by the beacons are configured for every 1sec. The payload captured by the RSP from this BLE signal will be of below JSON format. The RSPs will publish this payload to the configured MQTT topic.

{
"MAJOR": "7",
"UUID": "2f234454cf6d4a0fadf2000000023567",
"POWER": "-76",
"MAC_ADDR": "0c:f3:ee:09:17:13",
"TIME": 1480576085,
"RSSI": "-85",
"MINOR": "9",
"DEVICE_ID": "RSP-954ffd"
}

Fig4: Beacon JSON message Format

Table2. RFID JSON Message Format FieldsExplanation

| | |
|---|---|
| DEVICE_ID | The device id of the RSP which captured the signal |
| UUID | The uniqueId (Worker.UID) to trace the Operator. The last six bytes of the UUID carries the Worker UID. |
| TIME | Signal Captured time in UTC (Epoch format) |
| RSSI | Indicates the signal strength recieved |

**4) D.GATEWAY AGENT**

The gateway agent running on the Gateway device will be subscribed to the MQTT topics of each RSPs on the floor. The agent will get authenticated by the Azure App service to communicate with the IoT Hub, it will pass the DeviceId and certificate thumbprint. After it gets authenticated it will collect the list of RSP listeners' details by calling the Api/Device Listener service. This service will provide information about which RSP is mounted on which work station and what its threshold signal strength for BLE Beacons.
The agent will then parse each message received from the RSPs for both kind of tags (RFID and BLE Beacons) and push it to the IoT Hub. Based on the experimentation it is configured to ignore any BLE signal received whose signal strength is weaker than -85dbm.
To determine the health of the agent running of the gateway it is made to send its heartbeat every 1min by invoking the Api/Devices/Heartbeat API.

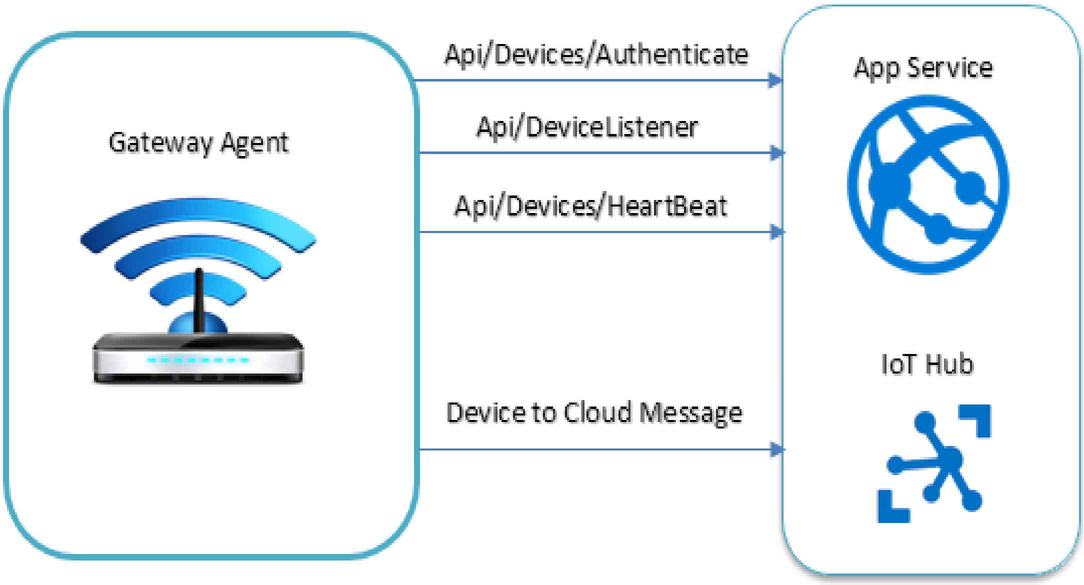


Fig5: Gate way Agent Architecture


```
{
   "readerId": "Station-1",
   "tagId": "23567",
   "readOn": "12/1/2016T07:08:05.113z",
   "type": "1"
}
```


Fig6: Gate way Agent Functionality, the payload JSON format.

Table3. Gate way Agent Functionality, the payload JSON format Fields Explanation

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| | |
|---|---|
| readerId | The Workstation Id in which the RSP is mounted |
| tagId | The unique Id of the operator / harvester |
| readOn | Signal Captured time in UTC |
| type | Flag to determine the type of subjects (1- Operator; 2- Harvester) |

**E.CATEGORIZING THE EVENTS**

Azure Stream Analytics Job will process the stream received at the IoT Hub and categorize the signal received into four types. This categorization is later used for determining the time spent by each subject against the work station.

Table4. Azure SQL Window Tracker table

| | |
|---|---|
| FirstInWindow | First found signal of a specific tag in that window (1hr) |
| LastInWindow | Last found signal of a specific tag in that window (1hr) |
| Transition | The signal is moved from its current workstation to an other |
| ReEntrant | The current signal received is more than 10sec from its previous instance |

This categorized event data is then saved to Azure SQL Window Tracker table

**F.SUMMARIZING THE TRACKER DATA**

A web job hosted in the App service will run in every configured interval (1 min) to consolidate the data captured in Window Tracker table by the Stream Analytics. In case of any overlapping signal, the application will figure out the duration of time the overlap was noticed and determine the actual workstation based on the RunOps information or based on the signal received pattern (whichever is applicable).

**G.REGISTERING RSP LISTENER DEVICE WITH TRACK & TRACE SOLUTION**

The details of the RSP Device will be registered with the Track and Trace solution using the below URL. http://clientdevice.net/deviceListener.
This details will be used by the Gateway agent for mapping the RSPs with appropriate WorkStation and also to get the threshold signal strength for the BLE beacons.

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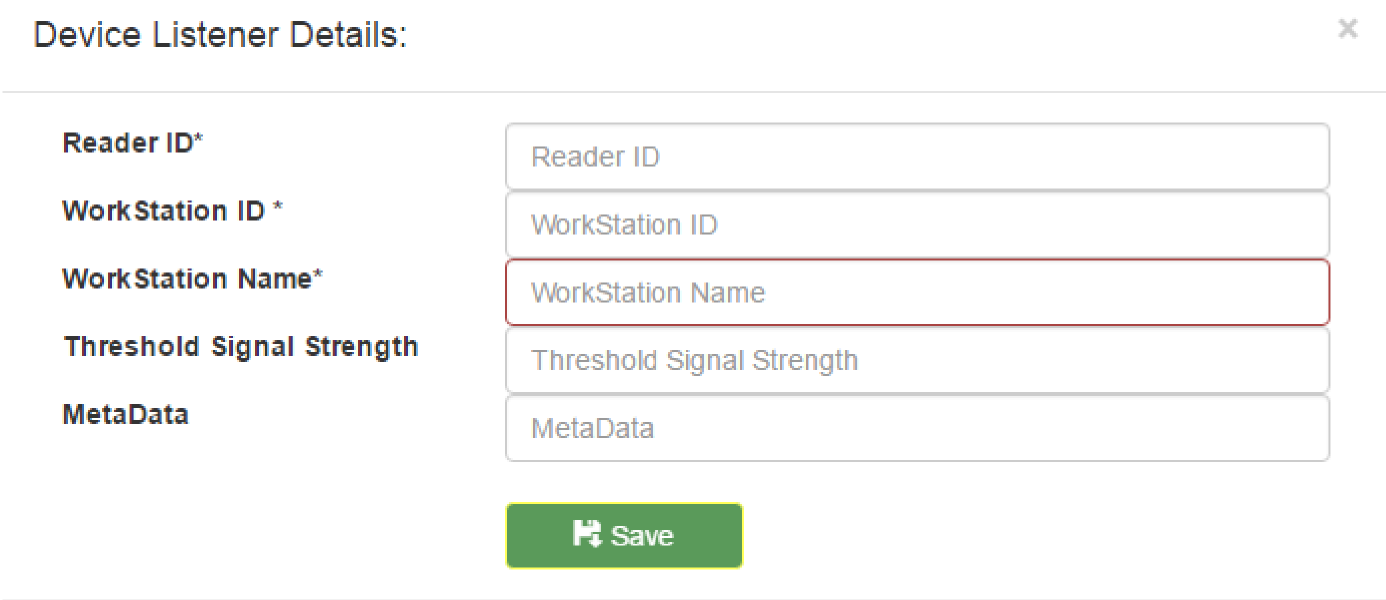


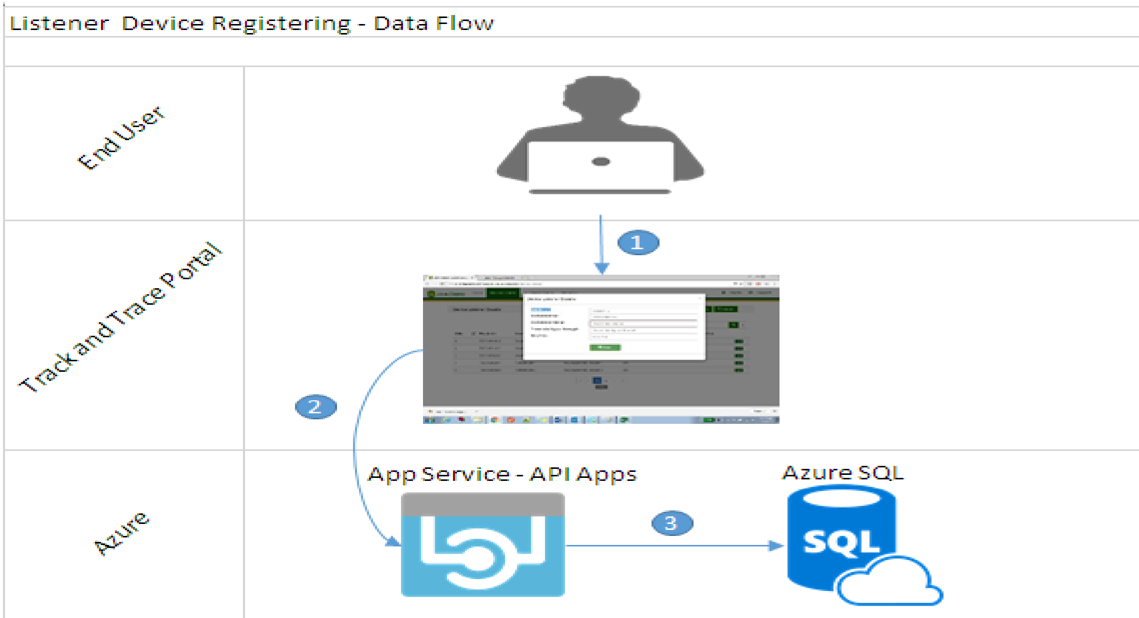


Fig6: Data Flow in Device Listener

**H.LISTENER DEVICE REGISTERING - DATA FLOW**

1. User will login to the portal and navigate to the “Device Listener” tab and hit “Create New” button.
2. The data entered will be posted to the Device Listener API.
3. The Device Listener API will process the data and it will get saved in Azure SQL.

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## V.CONCLUSION

In the Internet of Things (IoT) paradigm, many of the objects that surround us will be on the network in one form or another. Radio Frequency Identification (RFID) and sensor network technologies will rise to meet this new challenge, in which information and communication systems are invisibly embedded in the environment around us. This results in the generation of enormous amounts of data which have to be stored, processed and presented in a seamless, efficient, and easily interpretable form.

Computing can provide the virtual infrastructure for such utility computing which integrates monitoring devices, storage devices, analytics tools, visualization platforms and client delivery. The cost based model that Cloud computing offers will enable end-to-end service provisioning for businesses and users to access applications on demand from anywhere. Smart connectivity with existing networks and context-aware computation using network resources is an indispensable part of IoT.

With the growing presence of WiFi and 4G-LTE wireless Internet access, the evolution towards ubiquitous information and communication networks is already evident. However, for the Internet of Things vision to successfully emerge, the computing paradigm will need to go beyond traditional mobile computing scenarios that use smart phones and portables, and evolve into connecting everyday existing objects and embedding intelligence into our environment.

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