Developing in Power BI
with Streaming Datasets and Real-time Dashboards

Critical Path
TRAINING

Code and Slides for this Session

- **https://github.com/CriticalPathTraining/RealtimeDashboards**

- **PBI365: Power BI Boot Camp** – 4 Days
  - Audience is Business Users, Analysts and Data Professionals
  - Provides hands-on introduction to the Power BI platform
  - Focuses on build solutions using Power BI Desktop
  - Query design, data modeling and report and dashboard design
  - Apps and App Workspaces

- **PBD365: Power BI Developer Boot Camp** – 4 Days
  - Audience is Professional Developers
  - Teaches developing custom visuals with TypeScript and D3
  - Teaches programming with the Power BI APIs
  - Teaches developing with Power BI Embedded
  - Teaches R programming and integrating R with Power BI
  - Teaches how to develop custom connector using M

Agenda

➤ Introduction to Real-time Datasets

• Creating a Streaming Dataset with the API

• Designing Dashboards with Streaming Data Tiles

• Creating a Push Dataset with Real-time Data

• Integrating Azure Streaming Analytics Jobs

Pull Datasets versus Real-time Datasets

- ## Pull Datasets
    - Imported Datasets
    - DirectQuery Datasets
    - Live Connect Datasets

- ## Real-time Datasets
    - Streaming Datasets
    - Push Datasets
    - Hybrid Datasets
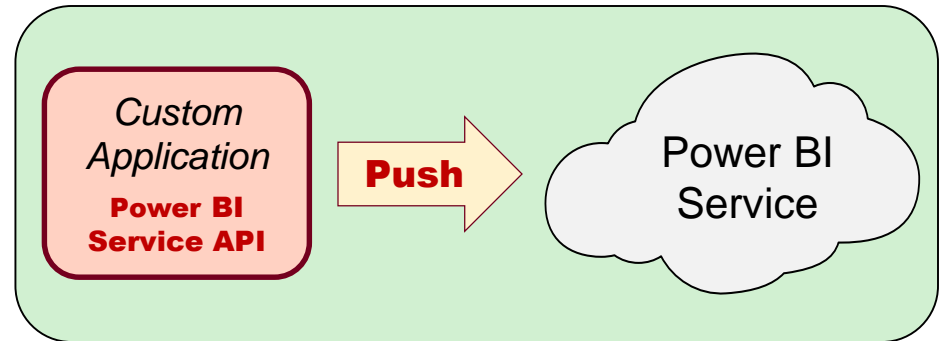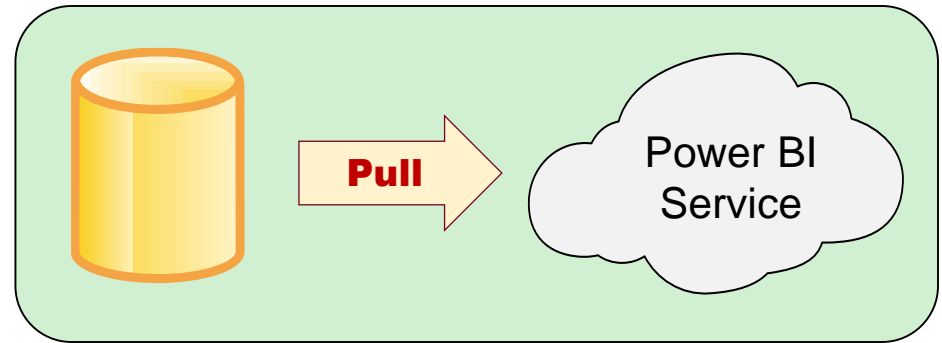
Streaming Datasets

- Data stored in cloud-based cache – not persisted in DB
- Restricted to single table - no rich data modeling
- Not supported by standard Power BI report designer
- Dashboard created using specialized streaming data tiles
- No support for DAX, aggregation or filtering

Streaming Data Tiles
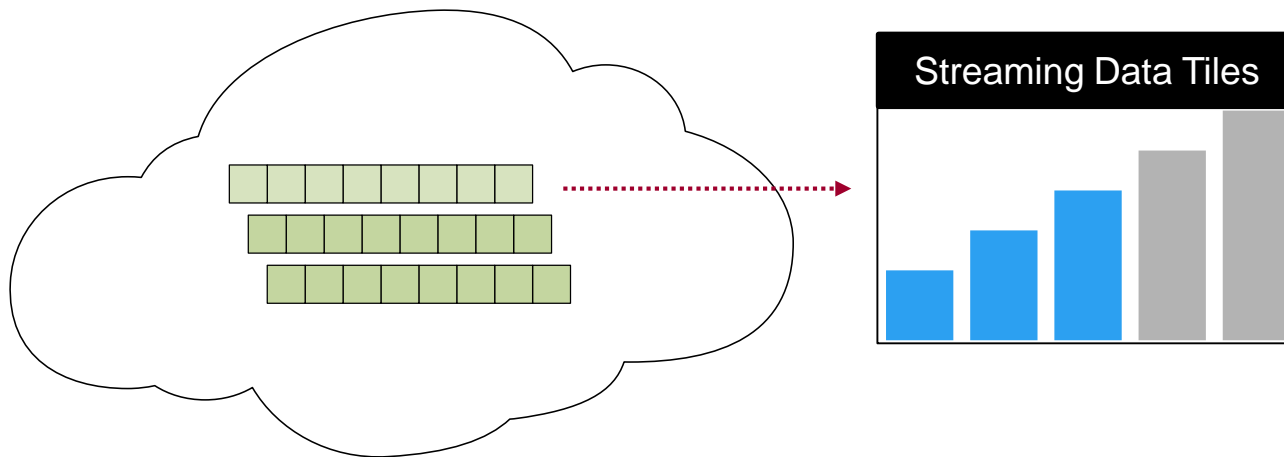
Push Datasets

- Data stored in Azure SQL DB – not in cache
- Supports multiple tables and table relationships
- Supported by standard Power BI report designer
- Supports DAX, measures, aggregation & filtering
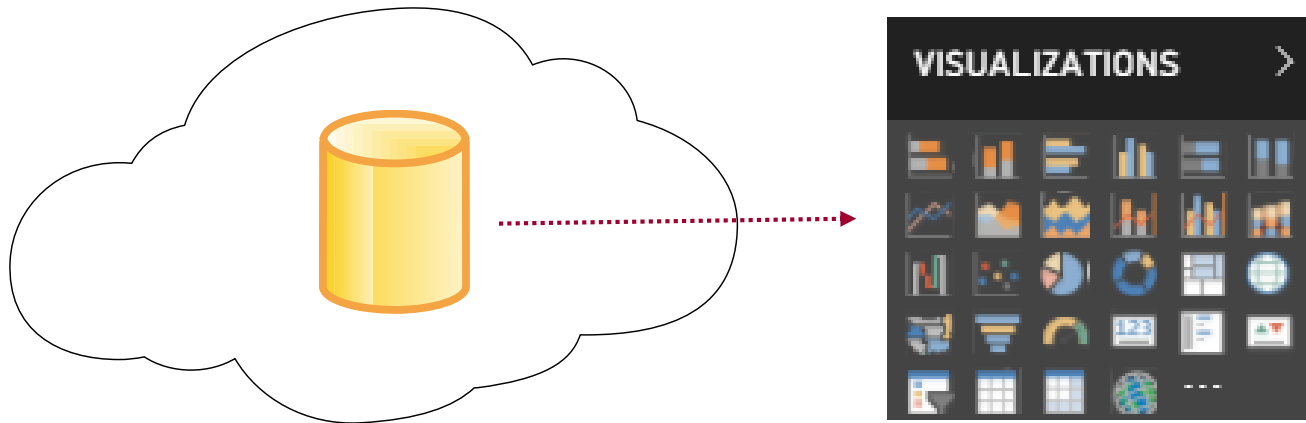
Hybrid Datasets

- Data stored in cloud-based cache **AND** in Azure SQL DB
- Restricted to single table and no rich data modeling
- Supported by streaming data tiles
- Supported by Power BI report designer

Real-time Tiles

VISUALIZATIONS
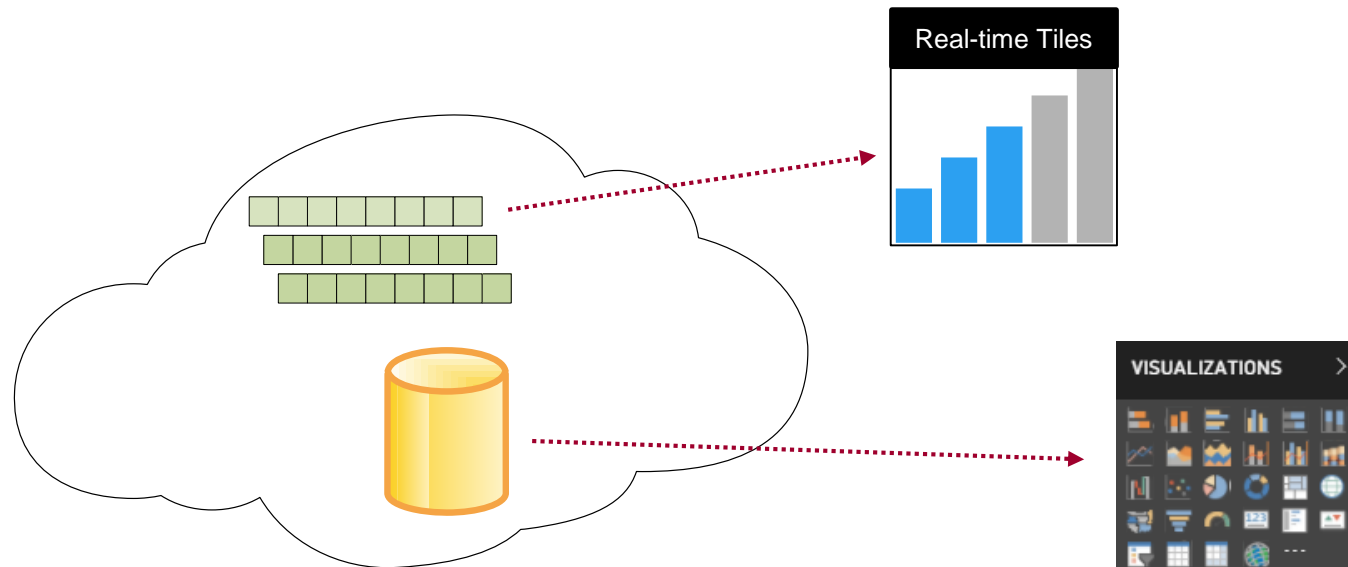
DEMO

Creating a Hybrid Dataset by Hand

Agenda

- ✓ Introduction to Real-time Datasets
- ➢ Creating a Streaming Dataset with the API
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- • Creating a Push Dataset with Real-time Data
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Real-time Scenario Being Simulated

- Heisenberg labs processes chemicals
    - Required to monitor temperatures during processing
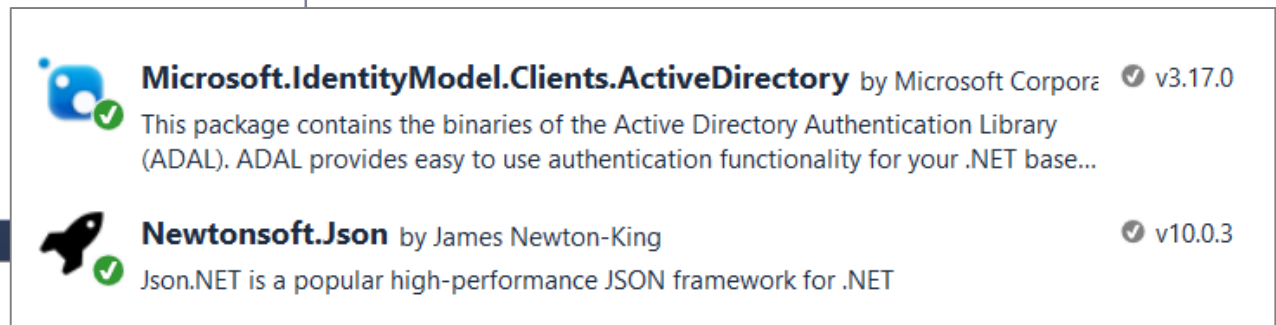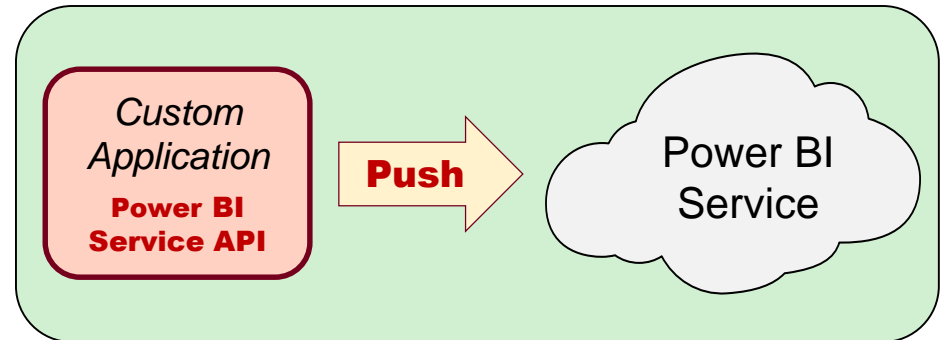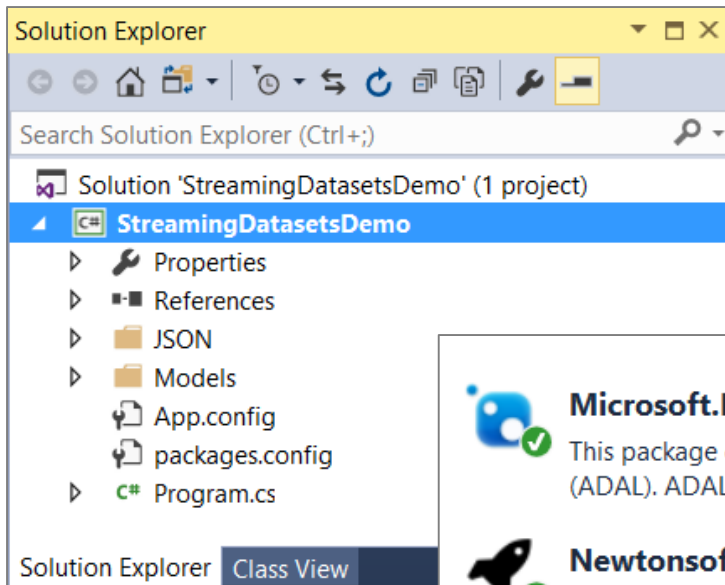   - Temperature must be monitored on per-second basis
    - Send alerts if temperature exceeds preset threshold

The StreamingDatasetsDemo Project

- Console application project in Visual Studio 2017
  - Installed package for Azure AD Authentication library
  - Installed package to serialize .NET objects to JSON

Custom Application **Power BI Service API** → **Push** → Power BI Service

Solution Explorer

Search Solution Explorer (Ctrl+;)

Solution 'StreamingDatasetsDemo' (1 project)
- **StreamingDatasetsDemo**
  - Properties
  - References
  - JSON
  - Models
  - App.config
  - packages.config
  - Program.cs

Solution Explorer | Class View

Microsoft.IdentityModel.Clients.ActiveDirectory by Microsoft Corpora   v3.17.0
This package contains the binaries of the Active Directory Authentication Library (ADAL). ADAL provides easy to use authentication functionality for your .NET base...

Newtonsoft.Json by James Newton-King   v10.0.3
Json.NET is a popular high-performance JSON framework for .NET

Executing Power BI Service API Calls

- Generic helper methods designed to execute HTTP operations

```csharp
private void ExecutePostRequest(string restUri, string postBody) {
  // prepare REST call
  HttpContent body = new StringContent(postBody);
  body.Headers.ContentType = new MediaTypeWithQualityHeaderValue("application/json");
  HttpClient client = new HttpClient();
  client.DefaultRequestHeaders.Add("Accept", "application/json");
  client.DefaultRequestHeaders.Add("Authorization", "Bearer " + AccessToken);

  // execute REST call
  HttpResponseMessage response = client.PostAsync(restUri, body).Result;
}
```

(1) *(points to the "prepare REST call" section)*

(2) *(points to the "execute REST call" section)*

Custom App → **HTTP POST** (Access Token, JSON) → Power BI Service
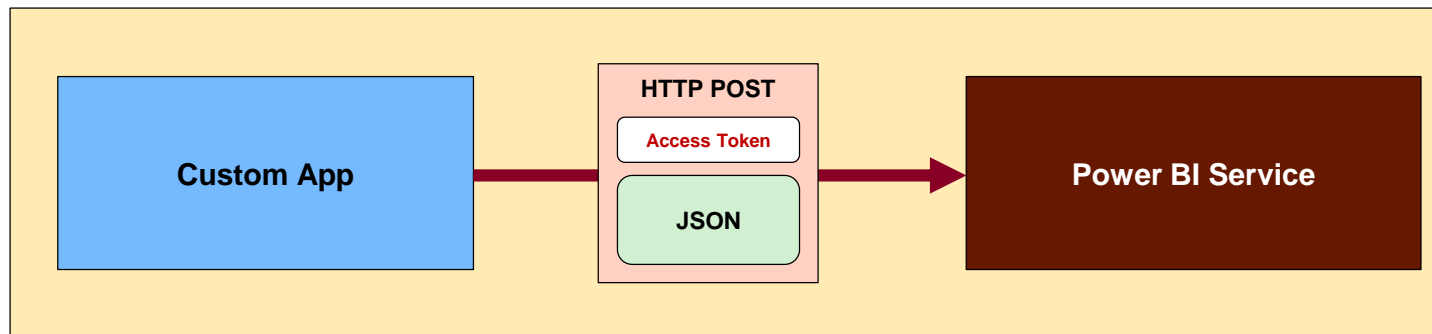
Creating a Streaming Dataset

- Streaming dataset created using JSON schema definition
  - Streaming dataset limited to a single table
  - Columns defined using name and datatype
  - No support for any other column properties (e.g. formatting)

```json
DemoStreamingDataset.json
{
  "name": "TemperatureReadings",
  "defaultMode": "Streaming",
  "tables": [
    { "name": "TemperatureReadings",
      "columns": [
        { "name": "Run", "dataType": "string" },
        { "name": "Time", "dataType": "Datetime" },
        { "name": "TimeWindow", "dataType": "string" },
        { "name": "TargetTemperature", "dataType": "Double" },
        { "name": "MinTemperature", "dataType": "Double" },
        { "name": "MaxTemperature", "dataType": "Double" },
        { "name": "BatchA", "dataType": "Double" },
        { "name": "BatchB", "dataType": "Double" },
        { "name": "BatchC", "dataType": "Double" }
      ]
    }
  ]
}
```
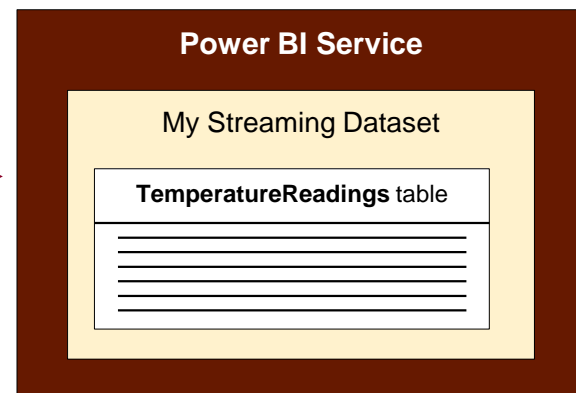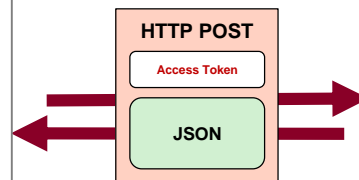
Creating a Custom Dataset

- Dataset created by executing HTTP POST operation
  - One-time operation done as application begins running

```
// prepare call to create new dataset
string restUrlDatasets = ProgramGlobalConstants.PowerBiServiceRootUrl + "datasets";
string jsonNewDataset = Properties.Resources.NewDataset_json;
// execute REST call to create new dataset
string json = ExecutePostRequest(restUrlDatasets, jsonNewDataset);
// retrieve Guid to track dataset ID
Dataset dataset = JsonConvert.DeserializeObject<Dataset>(json);
CustomDatasetId = dataset.id;
```

DemoStreamingDataset.json

```json
{
  "name": "TemperatureReadings",
  "defaultMode": "Streaming",
  "tables": [
    { "name": "TemperatureReadings",
      "columns": [
        { "name": "Run", "dataType": "string" },
        { "name": "Time", "dataType": "Datetime" },
        { "name": "TimeWindow", "dataType": "string" },
        { "name": "TargetTemperature", "dataType": "Double" },
        { "name": "MinTemperature", "dataType": "Double" },
        { "name": "MaxTemperature", "dataType": "Double" },
        { "name": "BatchA", "dataType": "Double" },
        { "name": "BatchB", "dataType": "Double" },
        { "name": "BatchC", "dataType": "Double" }
      ]
    }
  ]
}
```

HTTP POST

Access Token

JSON

Power BI Service

My Streaming Dataset

TemperatureReadings table

Adding Rows by Converting C# to JSON

```csharp
TemperatureReadingsRow row = new TemperatureReadingsRow {
  Run = RunName,
  Time = DateTime.Now,
  TimeWindow = currentTimeWindow,
  TargetTemperature = 212,
  MinTemperature = 100,
  MaxTemperature = 250,
  BatchA = temperatureBatchA,
  BatchB = temperatureBatchB,
  BatchC = temperatureBatchC,
};

TemperatureReadingsRow[] rows = { row };
TemperatureReadingsRows temperatureReadingsRows = new TemperatureReadingsRows { rows = rows };
string jsonNewRows = JsonConvert.SerializeObject(temperatureReadingsRows);
string restUrlTargetTableRows = string.Format("{0}/{1}/tables/TemperatureReadings/rows", restUrlDatasets, DatasetId);
string jsonResultAddExpenseRows = ExecutePostRequest(restUrlTargetTableRows, jsonNewRows);
```

```csharp
public class TemperatureReadingsRow {
  public string Run { get; set; }
  public DateTime Time { get; set; }
  public string TimeWindow { get; set; }
  public double TargetTemperature { get; set; }
  public double MinTemperature { get; set; }
  public double MaxTemperature { get; set; }
  public double BatchA { get; set; }
  public double BatchB { get; set; }
  public double BatchC { get; set; }
}

class TemperatureReadingsRows {
  public TemperatureReadingsRow[] rows { get; set; }
}
```

```json
{
  "rows": [
    {
      "Run": "Run 06",
      "Time": "2017-10-05T22:43:40.364569-04:00",
      "TimeWindow": "22:43:30",
      "TargetTemperature": 212.0,
      "MinTemperature": 100.0,
      "MaxTemperature": 250.0,
      "BatchA": 152.73999999999995,
      "BatchB": 152.78,
      "BatchC": 152.25
    }
  ]
}
```

DEMO

Creating a Streaming Dataset using the Power BI Service API

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- ✓ Introduction to Real-time Datasets
- ✓ Creating a Streaming Dataset with the API
- ➢ Designing Dashboards with Streaming Data Tiles
- • Creating a Push Dataset with Real-time Data
- • Integrating Azure Streaming Analytics Jobs

Streaming Data Tiles

- Streaming Data surfaced using Streaming Data Tiles
  - Used to surface data values from streaming dataset cache
  - Optimized to provide smooth animations for real-time data

- Available set of streaming titles as of today
  - Card
  - Gauge
  - Line chart
  - Cluster Bar Chart
  - Cluster Column Chart

Creating Dashboards with Streaming Datasets

- You cannot use the Power BI report designer
  - Instead, you add real-time data tiles directly to a dashboard
  - Real-time data tiles different from standard set of Power BI visuals
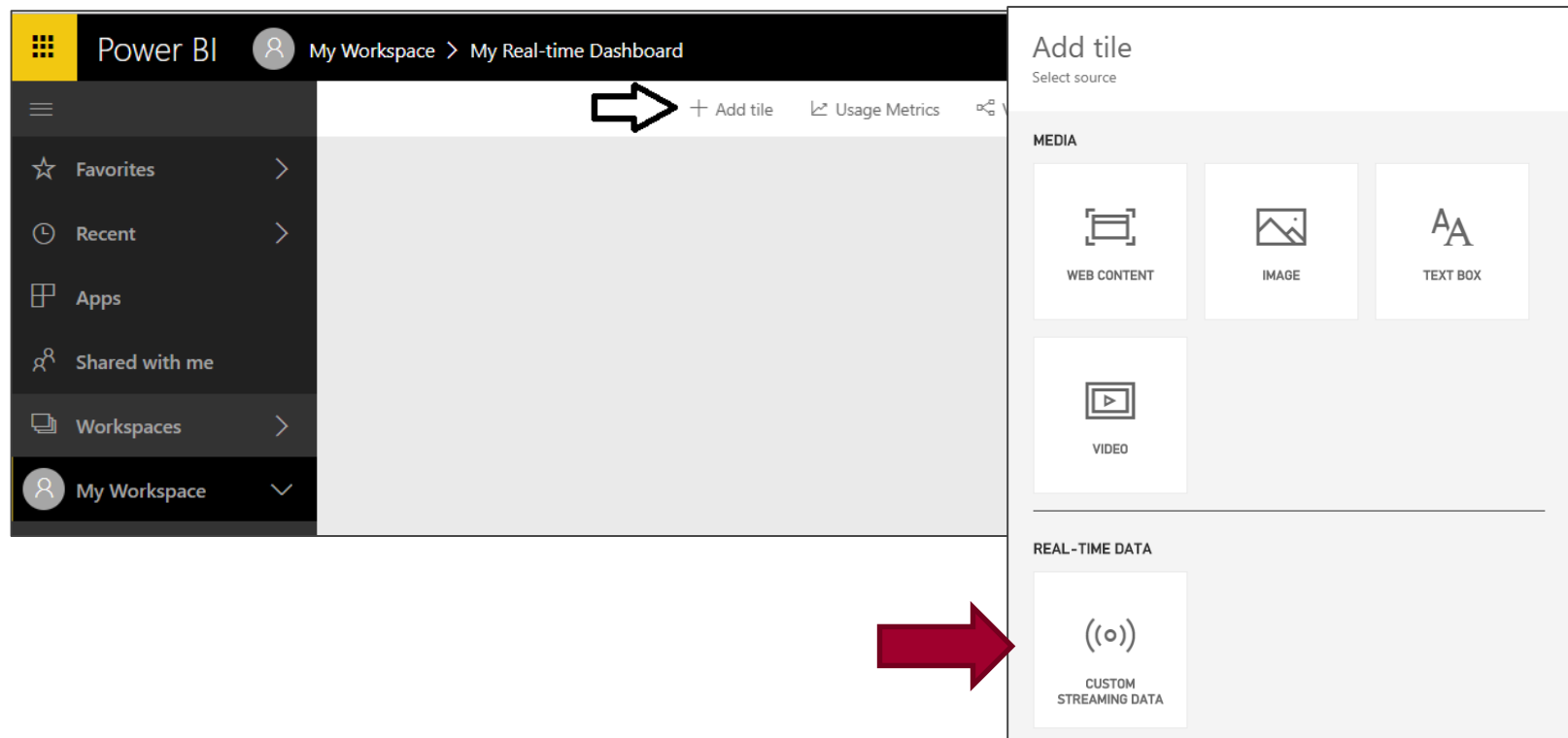
Creating a New Streaming Data Tile

- When creating a streaming data tile…
    - Select dataset that is a streaming dataset or a hybrid dataset
    - Choose the type of data streaming tile

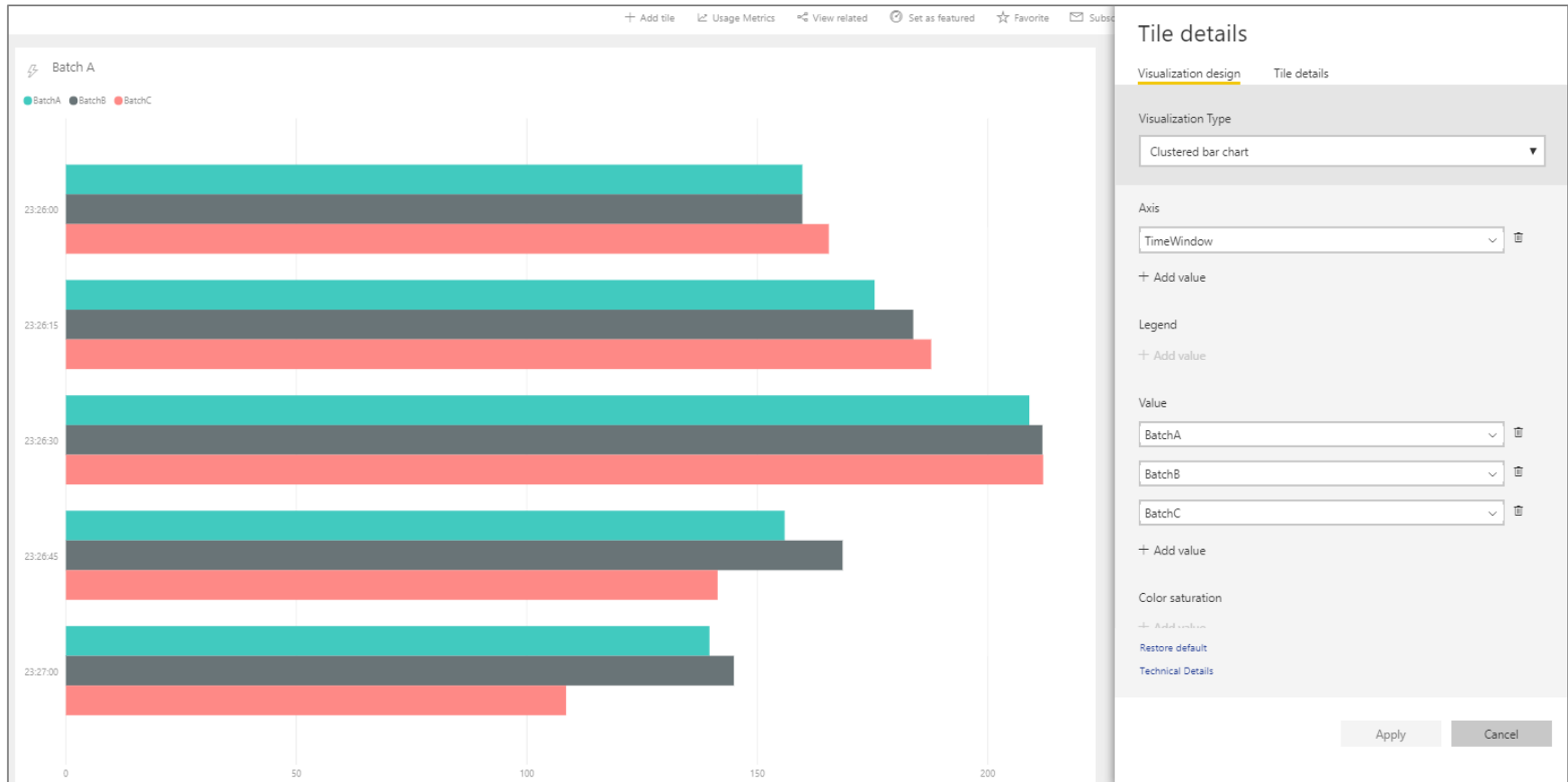# Real-time Data Tile Field Pane

Real-time Data Tile Format Pane

Streaming Gauge Tile

Streaming Line Chart Tile

Streaming Clustered Bar Chart Tile

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Real-time Scenario Being Simulated

- Contribution website accepts contributions from donors
  - Website calls web service to process credit card transaction
  - Website calls to Power BI REST API to create & update dataset
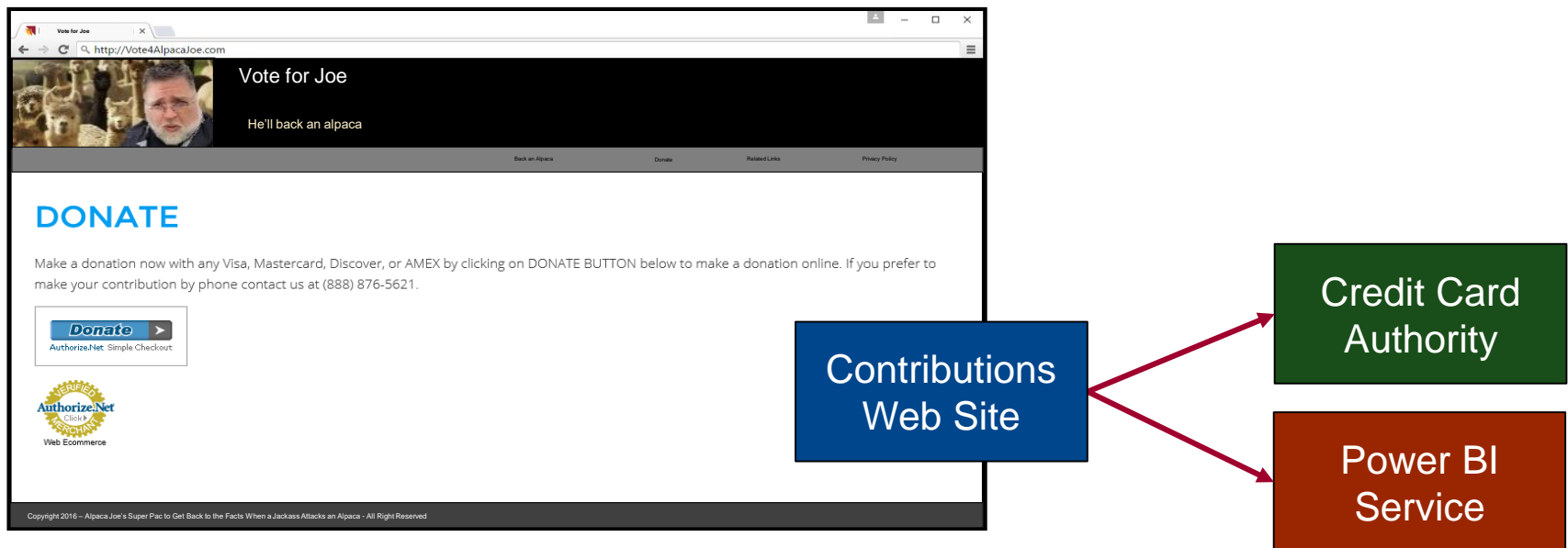
Creating a Push Dataset

- Push dataset created using JSON schema definition
  - Push dataset can contain multiple tables and table relationships
  - Tables can contains measures as well as columns
  - Columns & measures can be defined with formatString & dataCategory

```json
{
  "name": "@DatasetName",
  "defaultMode": "Push",
  "tables": [
    {
      "name": "Contributions",
      "columns": [
        { "name": "ContributionID", "dataType": "Int64" },
        { "name": "Contributor", "dataType": "string" },
        { "name": "State", "dataType": "string", "dataCategory": "StateOrProvince" },
        { "name": "City", "dataType": "string", "dataCategory": "Place" },
        { "name": "Zipcode", "dataType": "Int64", "dataCategory": "PostalCode" },
        { "name": "Gender", "dataType": "string" },
        { "name": "Time", "dataType": "Datetime", "formatString": "hh:mm:ss" },
        { "name": "TimeWindow", "dataType": "string" },
        { "name": "Amount", "dataType": "Double", "formatString": "$#,##0" }
      ],
      "measures": [
        { "name": "Total Contributions", "expression": "SUM(Contributions[Amount])", "formatString": "$#,##0" },
        { "name": "Contribution Count", "expression": "COUNTROWS(Contributions)", "formatString": "#,##0" },
        { "name": "Max Contribution", "expression": "MAX(Contributions[Amount])", "formatString": "$#,##0" },
        { "name": "Average Contribution", "expression": "AVERAGE(Contributions[Amount])", "formatString": "$#,##0.00" }
      ]
    },
```

Creating a Tumbling Time Window

ContributionID	Contributor	City	Zipcode	Gender	Time	Amount
1	Travis Solomon	Lutz, FL	33559	Female	12:03:00	50.00
2	Rudolph Harris	Tarpon Springs, FL	34688	Female	12:03:00	100.00
3	Josh Franco	Davis Island, FL	33606	Male	12:03:00	250.00
4	Tim Duffy	Largo, FL	33774	Female	12:03:00	200.00
5	Napoleon Frye	Lutz, FL	33558	Male	12:03:30	50.00
6	Rodrigo Hart	Largo, FL	33774	Female	12:03:30	100.00
7	Will Levine	Tarpon Springs, FL	34688	Female	12:03:30	75.00
8	Eddie McCullough	Lutz, FL	33558	Male	12:03:30	100.00
9	Kirk Herrera	Lutz, FL	33558	Male	12:03:30	150.00
10	Antonia Bridges	Lutz, FL	33558	Female	12:03:30	100.00
11	Preston Cote	Davis Island, FL	33606	Female	12:03:30	1,000.00
12	Lonnie McCarty	Largo, FL	33774	Female	12:03:30	50.00
13	Humberto Parsons	Lutz, FL	33558	Female	12:03:30	50.00
14	Abel Perkins	Odessa, FL	33556	Female	12:03:30	1,000.00
15	Ernesto McLaughlin	Odessa, FL	33556	Female	12:03:30	150.00
16	Elbert Kinney	Macdill Air Force Base, Port Tampa, FL	33621	Male	12:03:30	50.00
17	Coleman Petersen	Lutz, FL	33558	Male	12:03:30	125.00
18	Nicky Roberson	Odessa, FL	33556	Female	12:03:30	100.00
19	Fritz Parrish	Lutz, FL	33558	Female	12:03:30	50.00
20	Freddie Sparks	Largo, FL	33774	Male	12:03:30	50.00

DEMO

Designing a Real-time Dashboard using a Push Dataset

Real-time Dataset Matrix

| Feature	Streaming	Hybrid	Push
Updates in real-time	Yes	Yes	Yes
Smooth animations	Yes	Yes	No
Backed by Azure SQL DB	No	Yes	Yes
Report Designer Support	No	Yes	Yes
Allow Rich Data Modeling	No	No	Yes
Ingestion Rate	5 request/sec 15KB/request		1 request/second 16MB/request

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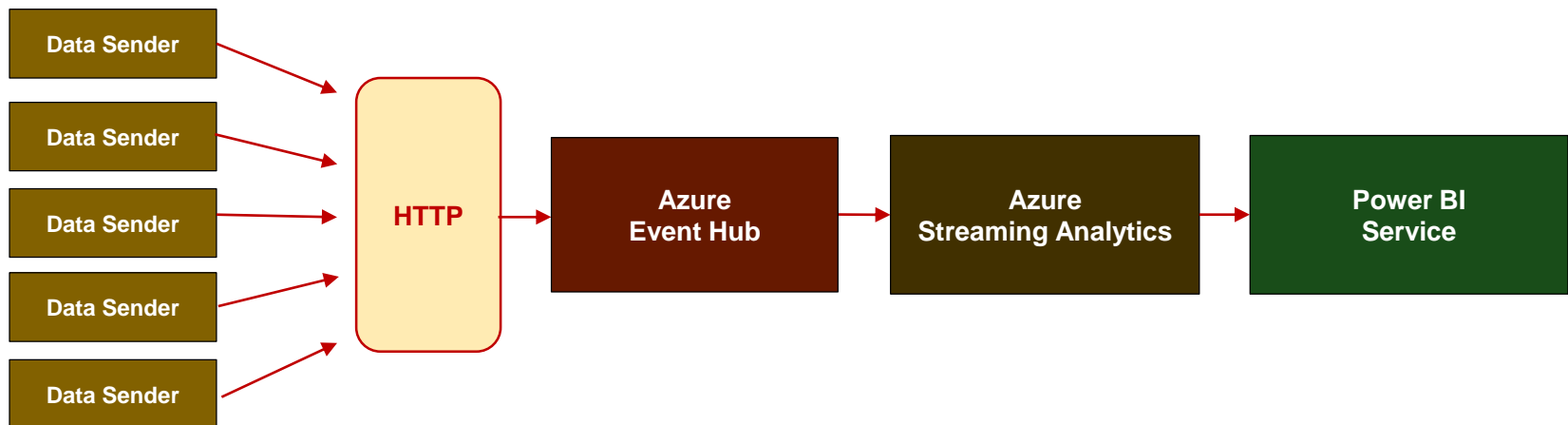- ➢ Integrating Azure Streaming Analytics Jobs

Scaling a Real-time Dashboard
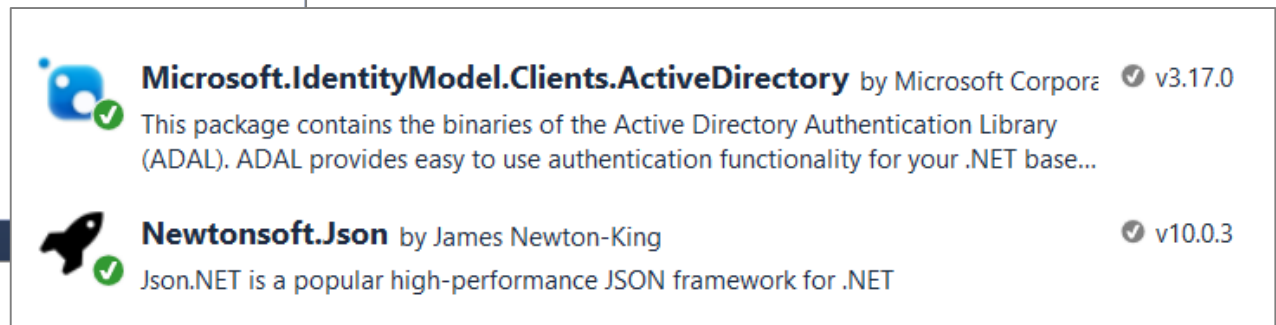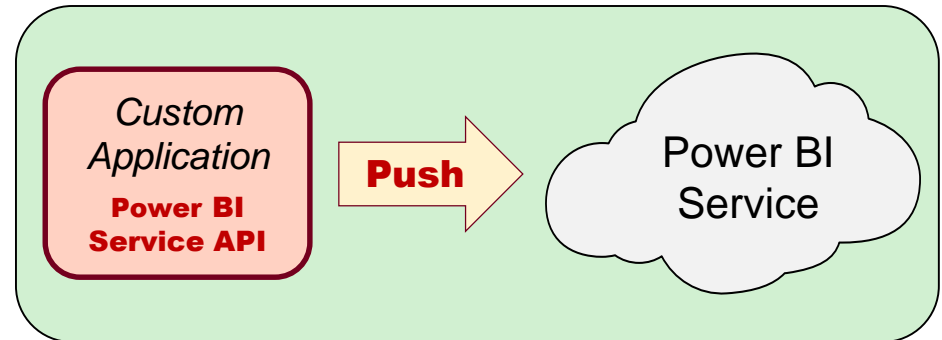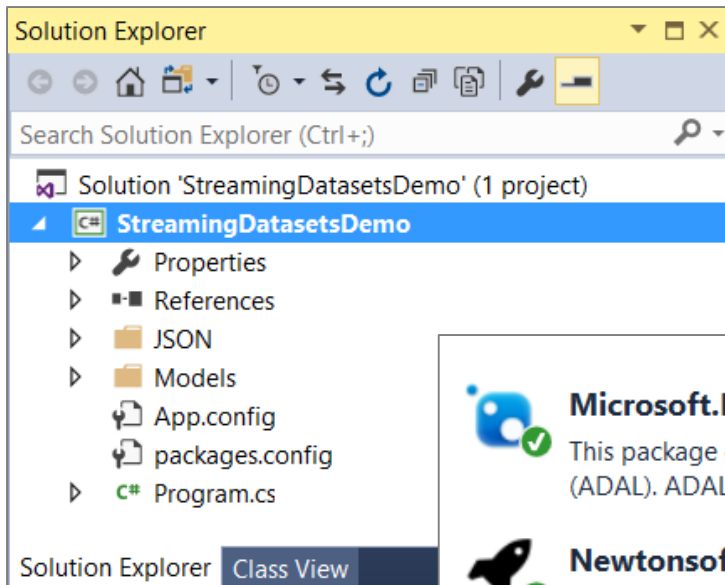
- Low velocity data scenario
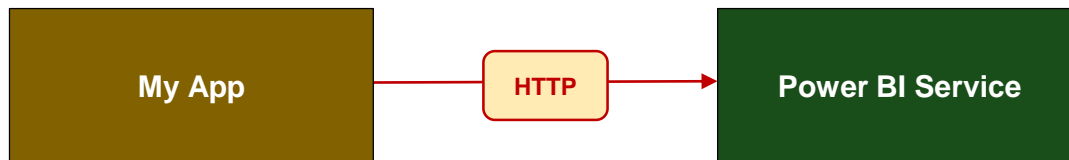
- High velocity data scenario

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DEMO

Creating Streaming Datasets using Azure Streaming Analytics Jobs

Summary

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