



# IoT for Smart Cities: A Data Centric Perspective

Bharadwaj Amrutur

Professor

Robert Bosch Centre for Cyber-Physical Systems,

Indian Institute of Science, Bangalore

[amrutur@iisc.ac.in](mailto:amrutur@iisc.ac.in)



# Smart City Components



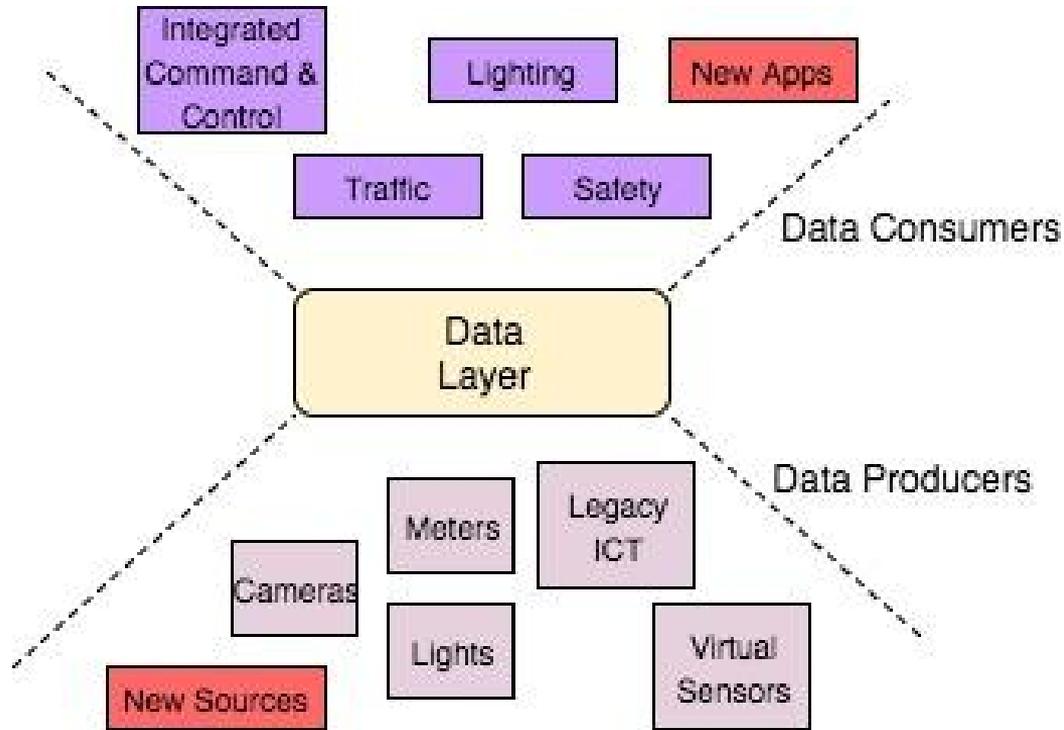
Smart City Component	Devices
Transit Operations Systems (Maintenance and tracking)	Crowd sensors ( <b>cameras</b> /phones/pressurepads), Bus ID and Location sensor (cameras/rfid/gps), Bus Bay Sensor (magnetometer/camera), Signage Actuators, Various other Asset Sensors (doors/lights/humidity/temperature)
Smart parking system	Parking sensors (Magnetometers/ <b>Cameras</b> )
Area based traffic control	Traffic density sensors ( <b>camera</b> /laser/magnetometers/cell tower records/phones), Signal sensors (LDR), Signal actuators (Light Controllers), Crowd sensors,
GPS tracking and optimisation of routes of garbage trucks	GPS sensors, other locationing sensors (UWB, WiFi, LoRa, CellTower Triangulation)
LED Streetlight lighting	LDR sensor, LED Control Actuator, Power Supply Sensor
Traffic analysis or roads and video surveillance inside bus using CCTV surveillance	<b>Cameras</b> , crowd sensing
Fleet management system	Vehicle ID and Locationing Sensors (GPS, and other radio triangulation based sensors, RFID/BLE beacon based sensors)
Automatic fare collection system (transport)	Smart card readers and actuators/ smart phone (NFC) based devices/Biometric sensors
Pedestrian Infra	<b>Camera</b> sensors



# Platform Approach to Smart City IoT Framework

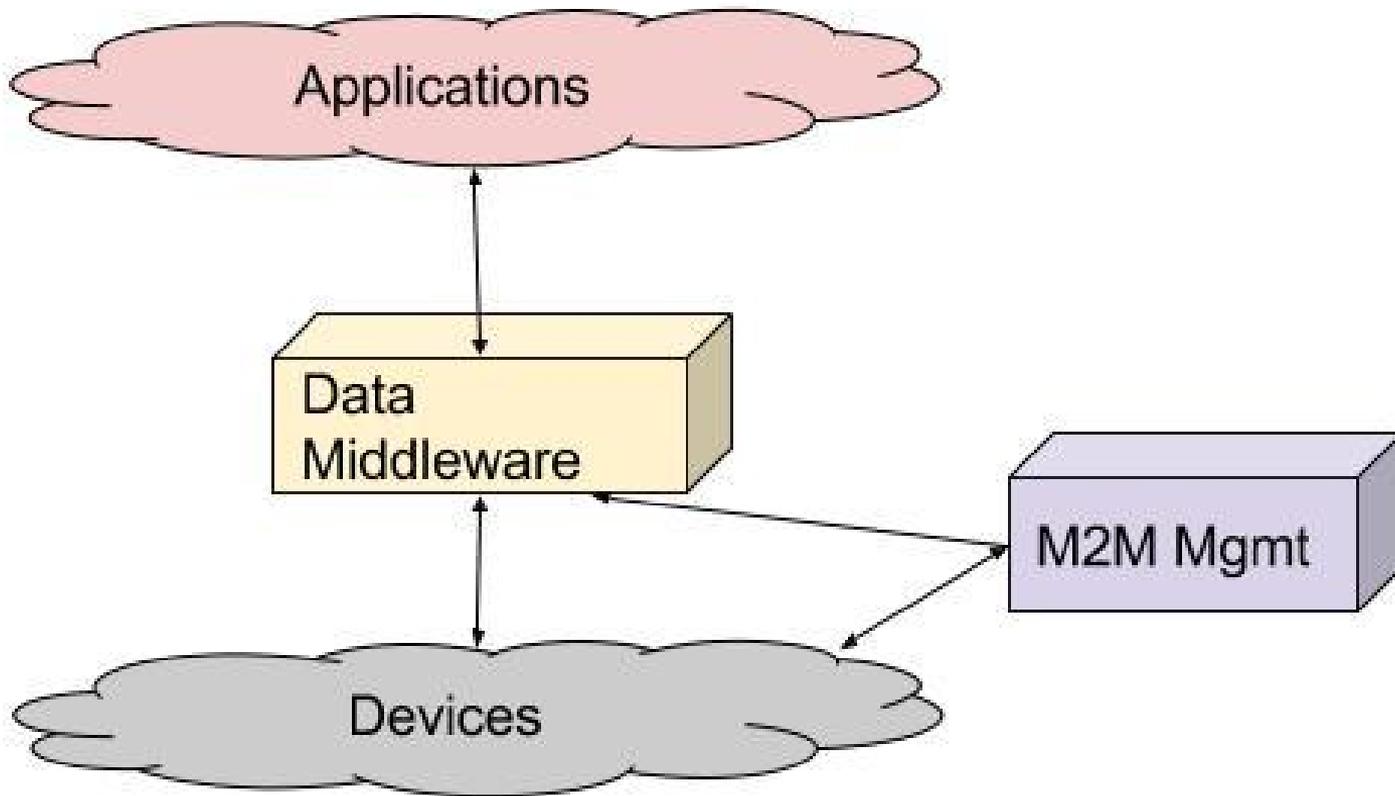


- Focus on Data & APIs
- Extensible & Scalable
- Secure & Privacy preserving
- Sustainable & Maintainable
- Enable new cross-domain (real-time) applications
- Application & Device portability



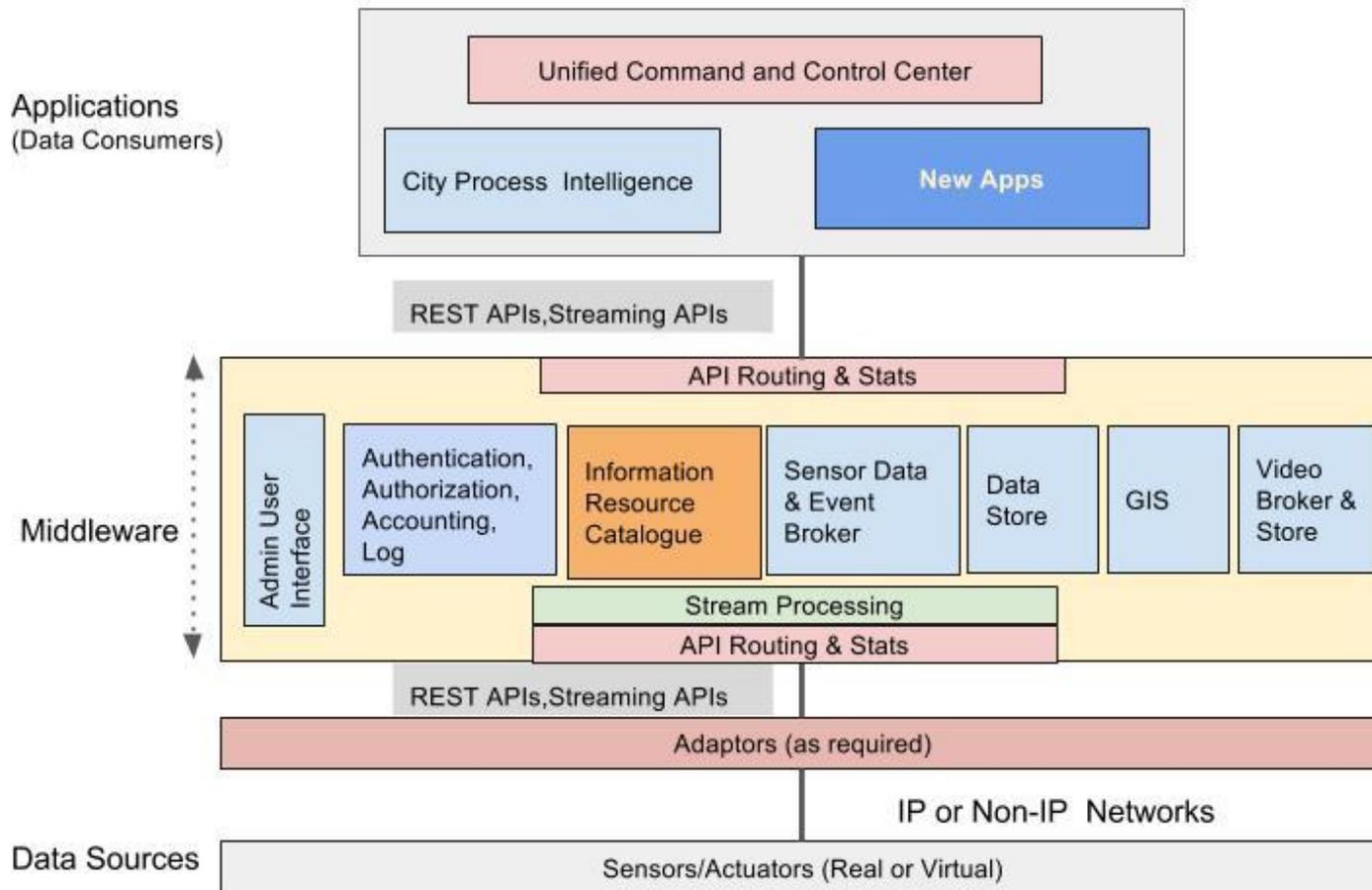


# Separation of Concerns: Data vs Devices



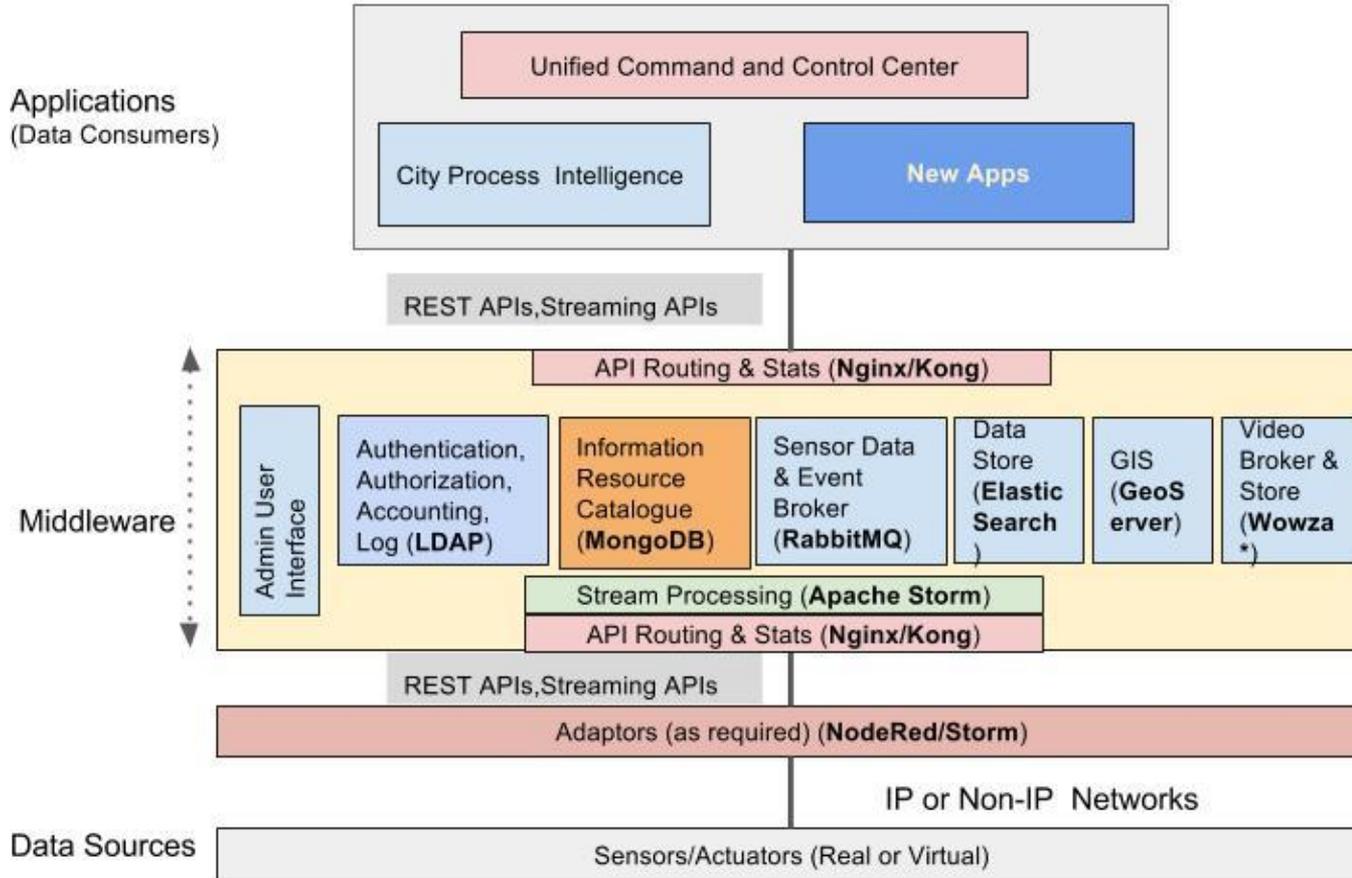


# Data Middleware Platform





# Data Middleware Platform

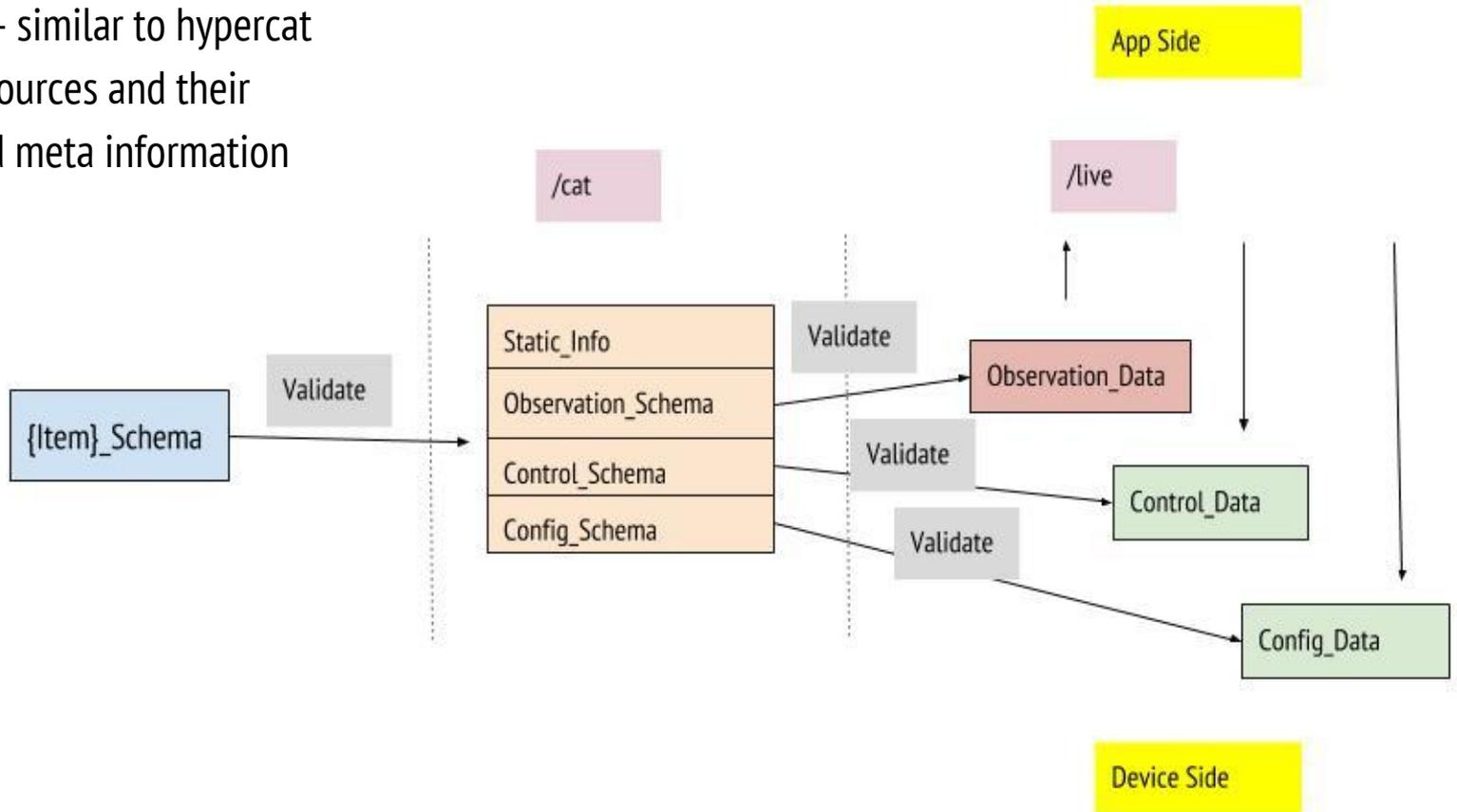




# Catalogue



- Directory - similar to hypercat
- List of resources and their associated meta information
- REST API





# Catalog Item: Streetlight - 1



```
"item-metadata": [
  {
    "refCatalogueSchema": "generic_iotdevice_schema.json",
    "id": "70b3d58ff0031de5",
    "resourceSchemaVersion": "1.0.0",
    "resourceType": "streetlight",
    "tags": [
      "onstreet",
      "Energy",
      "still under development!"
    ],
    "latitude": {
      "value": 13.0143335,
      "ontologyRef": "http://www.w3.org/2003/01/geo/wgs84_pos#"
    },
    "longitude": {
      "value": 77.5678424,
      "ontologyRef": "http://www.w3.org/2003/01/geo/wgs84_pos#"
    },
    "owner": {
      "name": "IISC",
      "website": "http://www.iisc.ac.in"
    },
    "provider": {
      "name": "Robert Bosch Centre for Cyber Physical Systems, IISc",
      "website": "http://rbccps.org"
    },
    "geoLocation": {
      "address": "CV Raman Road, Bangalore, 560012"
    },
    "accessMechanism": {
      "requestAccessSite": {
        "describes": "URI for getting permissions to access the device",
        "value": "http://rbccps.org/middleware/requestAccess"
      },
      "accessEndPoint": {
        "value": "https://smartcity.rbccps.org/api/0.1.0/db",
        "describes": "End point to access the archived values (database access endpoint)"
      },
      "subscriptionEndPoint": {
        "value": "http://smartcity.rbccps.org/api/0.1.0/subscribe",
        "describes": "End point for subscribing to LIVE data"
      },
      "updateEndPoint": {
        "value": "http://smartcity.rbccps.org/api/0.1.0/update",
        "describes": "End point for subscribing to LIVE data"
      },
      "resourceAPIInfo": {
        "value": "https://rbccps-iisc.github.io/",
        "describes": "Information on how to use various APIs (access, update, cat) associated with this resource"
      }
    }
  }
]
```



# Catalog Item: Streetlight - 2



```
"data_schema": {
  "type": "object",
  "properties": {
    "dataSamplingInstant": {
      "type": "number",
      "description": "Sampling Time in EPOCH format",
      "units": "seconds",
      "permissions": "read",
      "accessModifier": "public"
    },
    "caseTemperature": {
      "type": "number",
      "description": "Temperature of the device casing",
      "units": "degreeCelsius",
      "permissions": "read",
      "accessModifier": "public"
    },
    "powerConsumption": {
      "type": "number",
      "description": "Power consumption of the device",
      "units": "watts",
      "permissions": "read",
      "accessModifier": "public"
    },
    "luxOutput": {
      "type": "number",
      "description": "lux output of LED measured at LED",
      "units": "lux",
      "permissions": "read",
      "accessModifier": "public"
    },
    "ambientLux": {
      "type": "number",
      "description": "lux value of ambient",
      "units": "lux",
      "permissions": "read",
      "accessModifier": "public"
    },
    "targetPowerState": {
      "type": "string",
      "enum": [
        "ON",
        "OFF"
      ],
      "units": "dimensionless",
      "description": "If set to ON, turns ON the device. If OFF turns OFF the device. Writeable parameter. Writeable
red for authorized apps",
      "permissions": "read-write",
      "accessModifier": "protected"
    }
  }
}
```



# Catalog Item: Streetlight - 3



```
"targetBrightnessLevel": {
  "type": "number",
  "description": "Number between 0 to 100 to indicate the percentage brightness level. Writeable only allowed
d apps",
  "units": "percent",
  "permissions": "read-write",
  "accessModifier": "protected"
},
"targetControlPolicy": {
  "enum": [
    "AUTO_TIMER",
    "AUTO_LUX",
    "MANUAL"
  ],
  "units": "dimensionless",
  "permissions": "read-write",
  "description": "Indicates which of the behaviours the device should implement. AUTO_TIMER is timer based,
; ambient light and MANUAL is controlled by app. Writeable only allowed for authorized apps",
  "accessModifier": "protected"
},
"targetAutoTimerParams": {
  "type": "object",
  "permissions": "read-write",
  "properties": {
    "targetOnTime": {
      "type": "number",
      "description": "Indicates time of day in seconds from 12 midnight when device turns ON in AUTO_TIMER.
y allowed for authorized apps",
      "units": "seconds",
      "accessModifier": "protected"
    },
    "targetOffTime": {
      "type": "number",
      "description": "Indicates time of day in seconds from 12 midnight when device turns OFF in AUTO_TIMER.
y allowed for authorized apps",
      "units": "seconds",
      "accessModifier": "protected"
    }
  }
},
"targetAutoLuxParams": {
  "type": "object",
  "permissions": "read-write",
  "properties": {
    "targetOnLux": {
      "type": "number",
      "description": "Indicates ambient lux when device turns ON in AUTO_LUX. Writeable only allowed for
ps",
      "units": "lux",
      "accessModifier": "protected"
    }
  }
},
```



# Streetlight Observation & Control Data



```
{  
  "dataSamplingInstant": 77475,  
  "caseTemperature": 21,  
  "powerConsumption": 0,  
  "luxOutput": 781,  
  "ambientLux": 546  
}
```

```
{  
  "dataSamplingInstant": 138321,  
  "caseTemperature": 21,  
  "powerConsumption": 21,  
  "luxOutput": 36,  
  "ambientLux": 24  
}
```

```
{  
  "targetBrightnessLevel": 70,  
}  
  
{  
  "targetControlPolicy": "AUTO_TIMER",  
  "targetAutoTimerParams": { "targetOnTime":  
343434, "targetOffTime": 606400},  
}
```



# Summary



- Enable Cities to easily generate, manage, disseminate data, in a safe, secure, privacy-preserving, scalable way
- Take a platform approach to middleware:
  - Agree on APIs on North and South Sides
  - Agree on Data Schemas from IoT Devices
- Develop Open Information Models for various City Processes and Structures
  - Will provide additional context to data
  - Will enable next generation of Smart and Intelligent Applications



**Thank You!**