

A technical Seminar On

“ARRAY OF THINGS”

By

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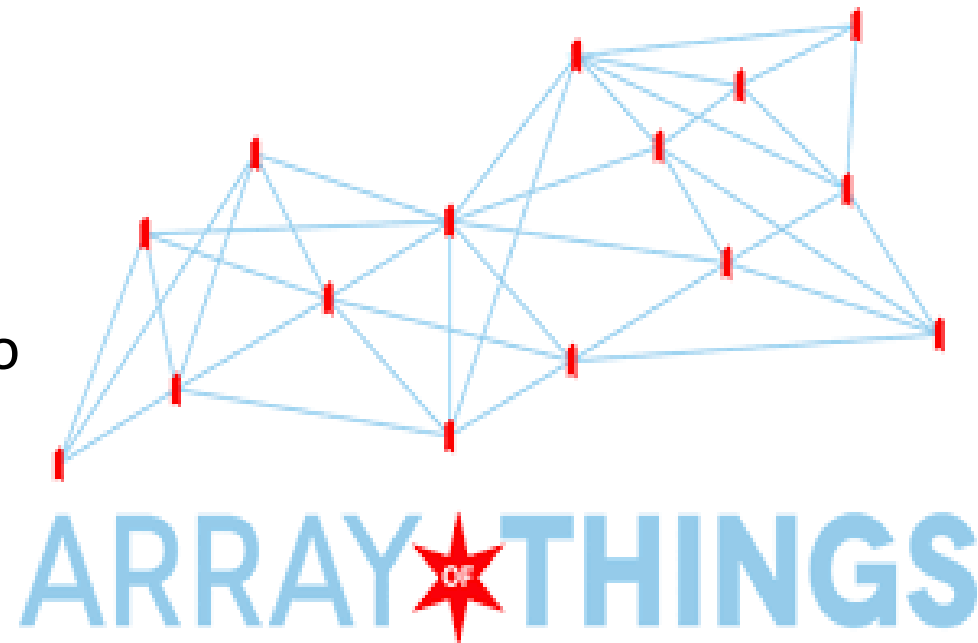
at

Nawab Shah Alam Khan College Of Engineering & Technology

Malakpet, Hyderabad.

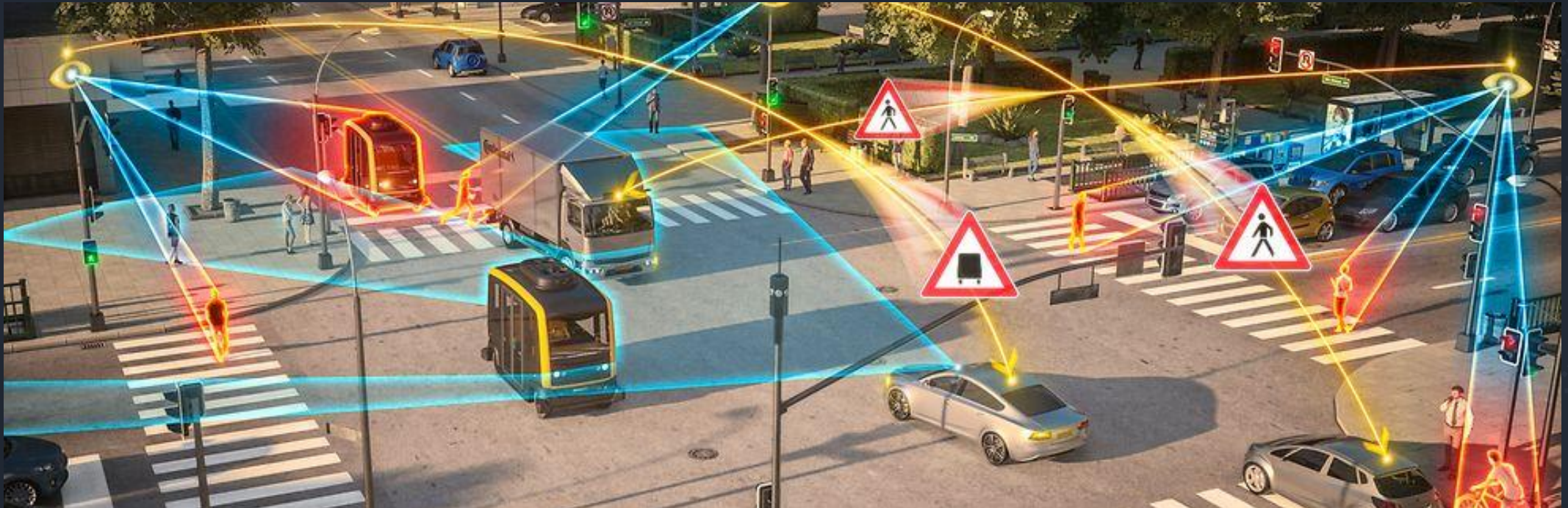
What is AoT ?

- The **Array of Things (AoT)** is an application of **Internet Of Things(IoT)** for building "cities with senses".
- Essentially, the **Array of Things (AoT)** is a network of sensors that **monitor** different factors in the city's **environment and infrastructure**, which can be used to analyze changes in trends over time.
- **AoT** will serve as a “**fitness tracker**” for the city, measuring factors that impact **livability** in the host city such as **climate, air quality and noise**.

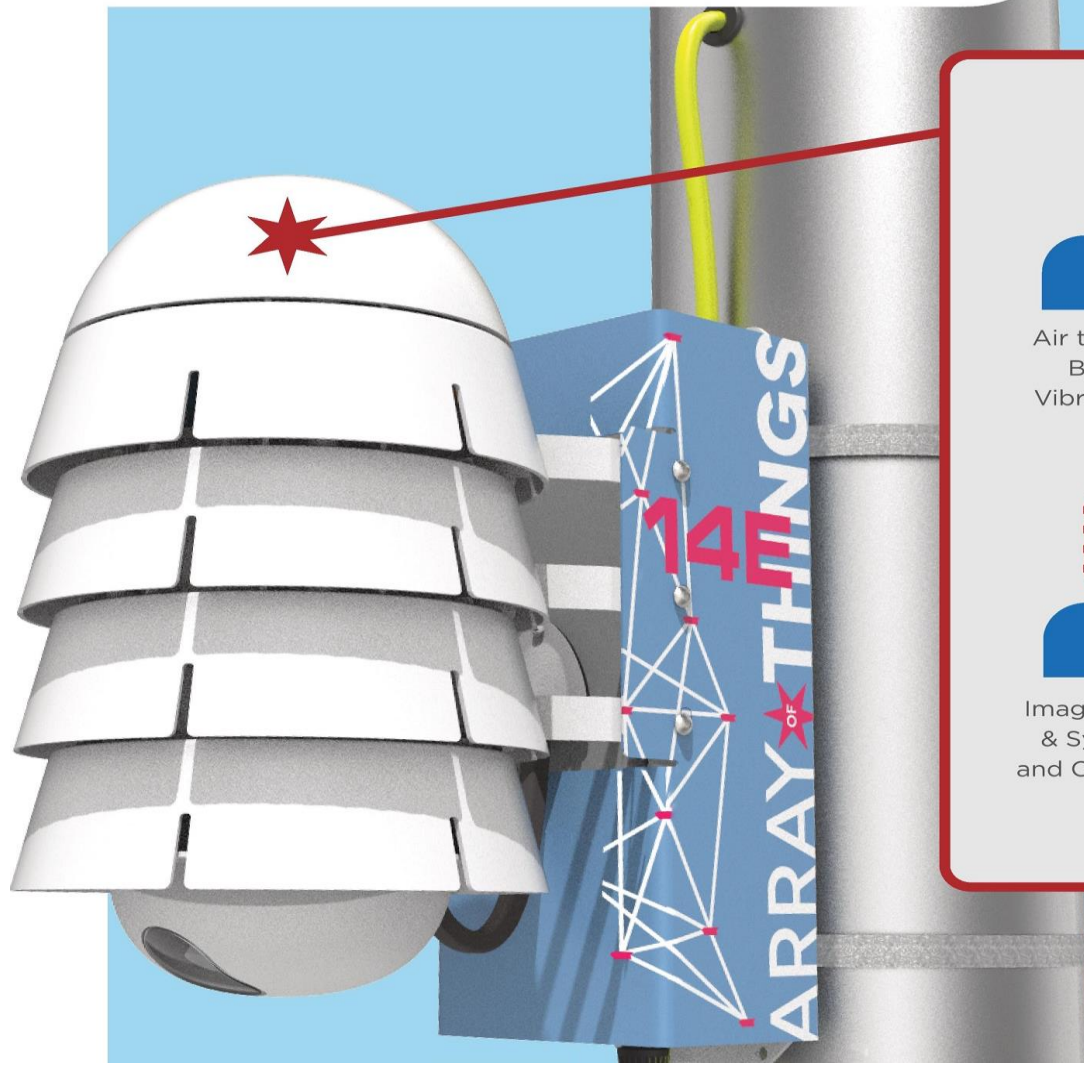


Lets Visualize!

- What if a light pole told you to watch out for an icy patch of sidewalk ahead?
- What if you could get weather and air quality information **block-by-block**, instead of city-by-city?
- AoT makes it possible to do micro monitoring of a city to ensure **civil security, environmental monitoring and real time event mapping**.



A Typical AoT Sensor Device



Node Components



Environmental Sensors

Air temperature, Humidity, Barometric Pressure, Vibration, Sound Intensity, Magnetometer



Air Quality Sensors

Nitrogen Dioxide, Ozone, Carbon Monoxide, Hydrogen Sulfide, Sulfur Dioxide



Light & Infrared Sensors

Light intensity, infrared (CLOUD COVER; SURFACE TEMPERATURE), camera, vehicle and pedestrian traffic. Images processed in-situ and discarded.



Linux Node Controllers

Image Processing Computer & System Health Manager and Control/Communications Computer



Node Power Manager

Node health monitoring and resilience functions

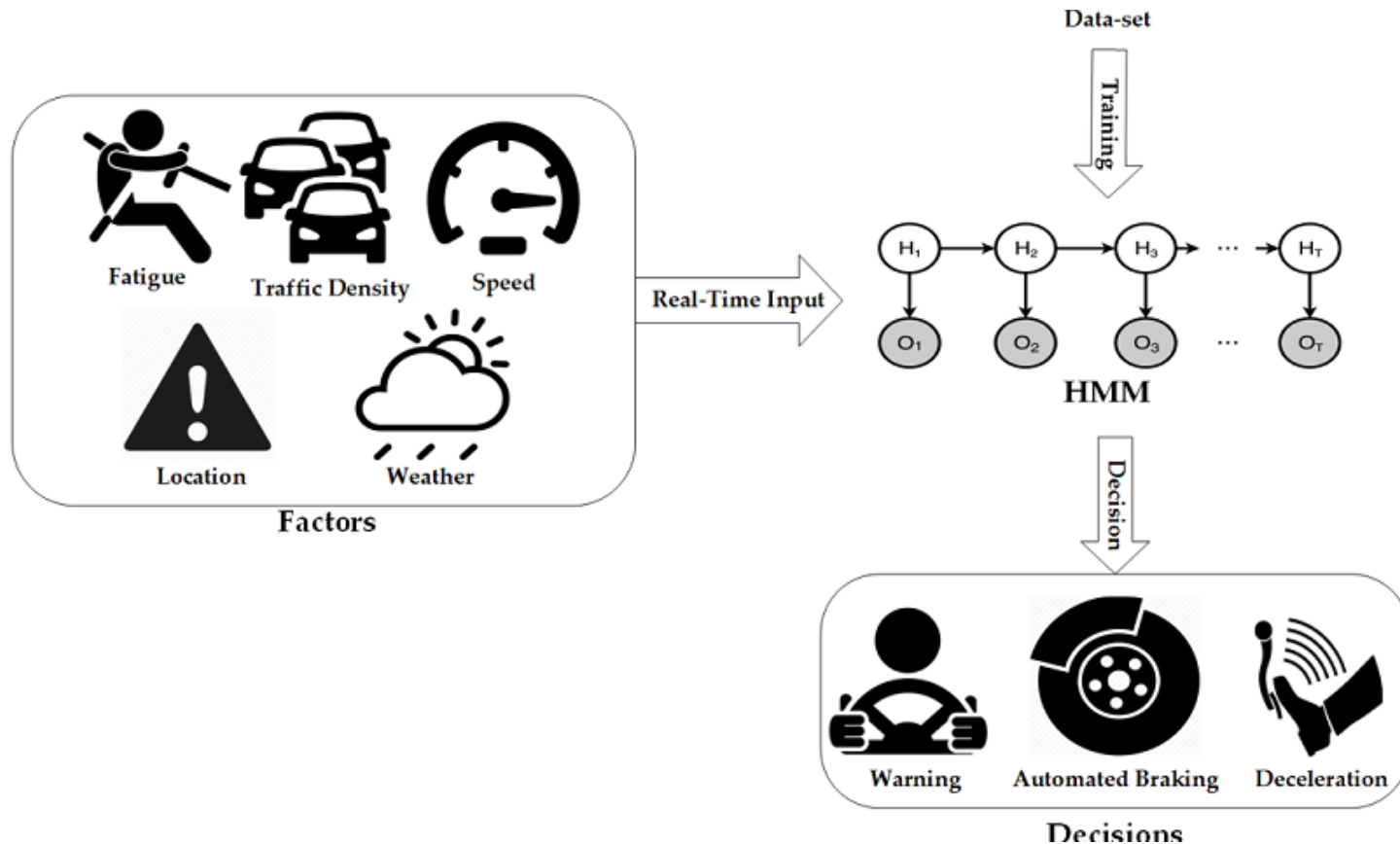
How AoT Works ?

Methodology



- **Step1:** AoT devices/sensors collect ground attribute data from the environment.
- **Step2:** The data may or may not be transmitted to the cloud via Gateways.
- **Step3:** Once the data is collected, real time actionable insights are generated.
- **Step4:** The processed data (Information) is made to the end-user by providing alerts to the user (E-Mails, text, notification).

How AoT Works ?



- **Step5:** To **utilize the data** collected over the time, **data analytics** makes use of the historical data to provide **actionable insights**.
- **Step6:** Data mining can be done to **predict future events** that may occur.
- Smart decisions can be taken to implement **real time speed limits**, road condition warnings and other **environmental hazard warnings**.

Lets Conceptualize!

- The basic elements of the AoT are devices that gather data and have an IP address.
- They range in complexity from autonomous vehicles that haul products around factory floors to simple sensors that monitor the temperature in buildings.
- Collecting the data is done by transmitting it from the devices to a gathering point.
- Moving the data can be done wirelessly using a range of technologies or on wired networks.
- The data can be sent over the internet to a data center or a cloud that has storage and compute power or the transfer can be staged, with intermediary devices aggregating the data before sending it along for data processing.
- Processing the data can take place in data centers or cloud, but sometimes that's not an option(as in AoTs).
- The round-trip time for sending data, processing it, analyzing it and returning instructions can take too long.
- Unlike IoT devices, an AoT device can aggregate data, analyze it and take decisions if necessary, all within relatively close physical distance, thereby reducing delay.

RESULTING DATA

NO₂ & O₃ Measurements March 1st -15th

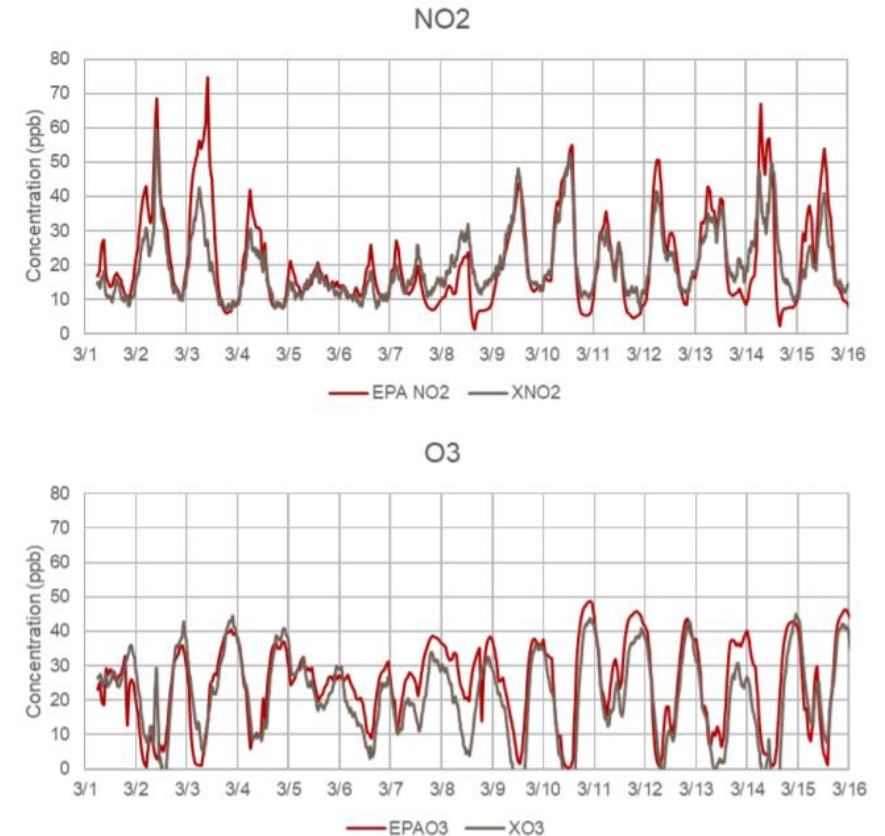
Hi/Low Temp
-1 to 10 °C
Hi/Low Rh
19.5 to 88.8 %

For March 1st to May
10th 2018 the Correlation
Values (Excel Corr())

- NO₂ 0.73
- O₃ 0.80

Data is 5 minute
samples with 1 hour
exponential smoothing.

EPA reports at 1 hour
intervals.



NO2 & O3 Measurements Apr.20th-May.5th

Hi/Low Temp
4 to 26 °C

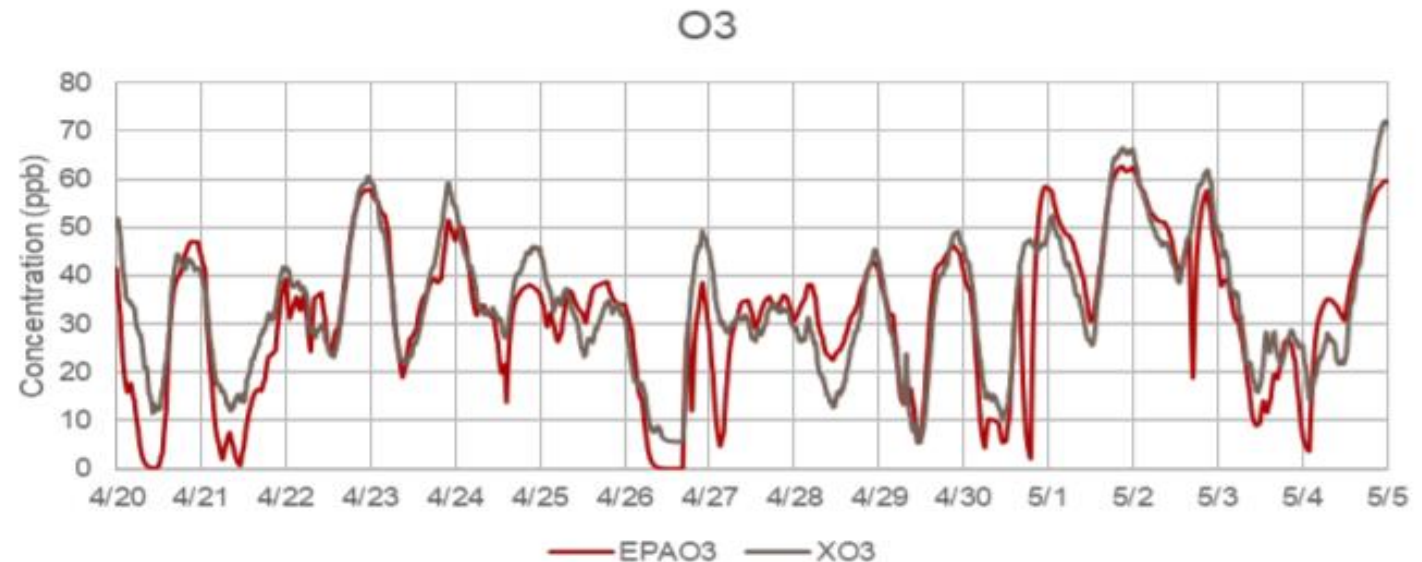
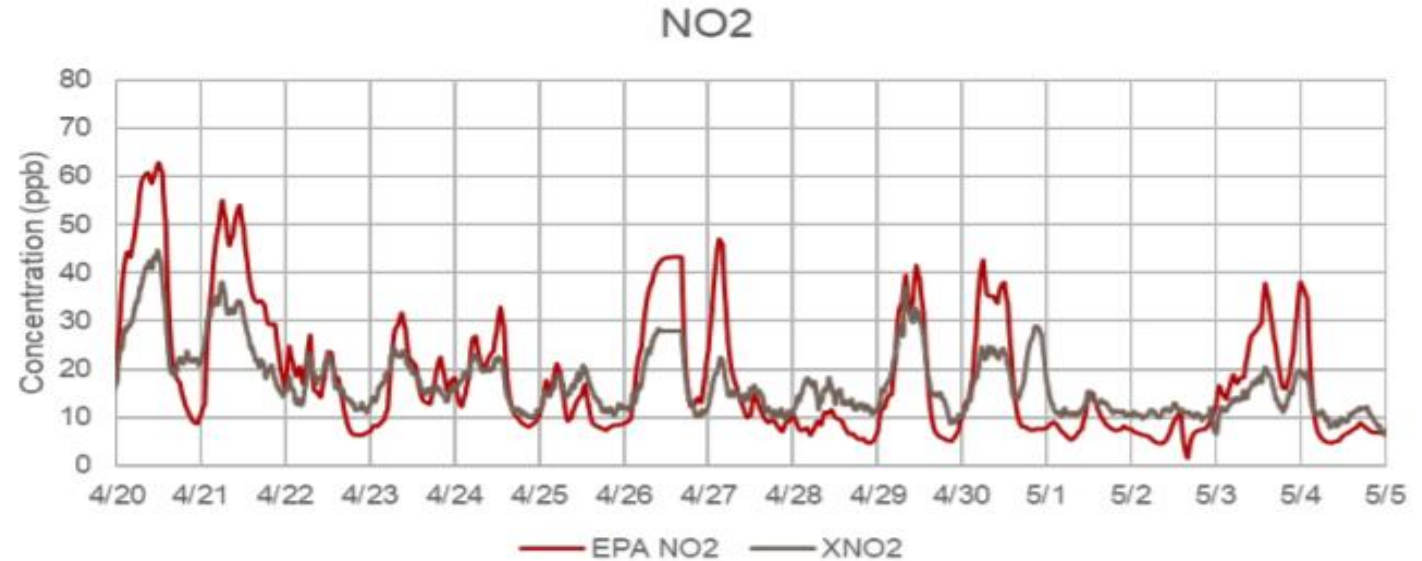
Hi/Low Rh
13.2 to 97.6 %

For March 1st to May
10th 2018 the Correlation
Values (Excel Corr())

- NO2 0.73
- O3 0.80

Data is 5 minute
samples with 1 hour
exponential smoothing.

EPA reports at 1 hour
intervals.

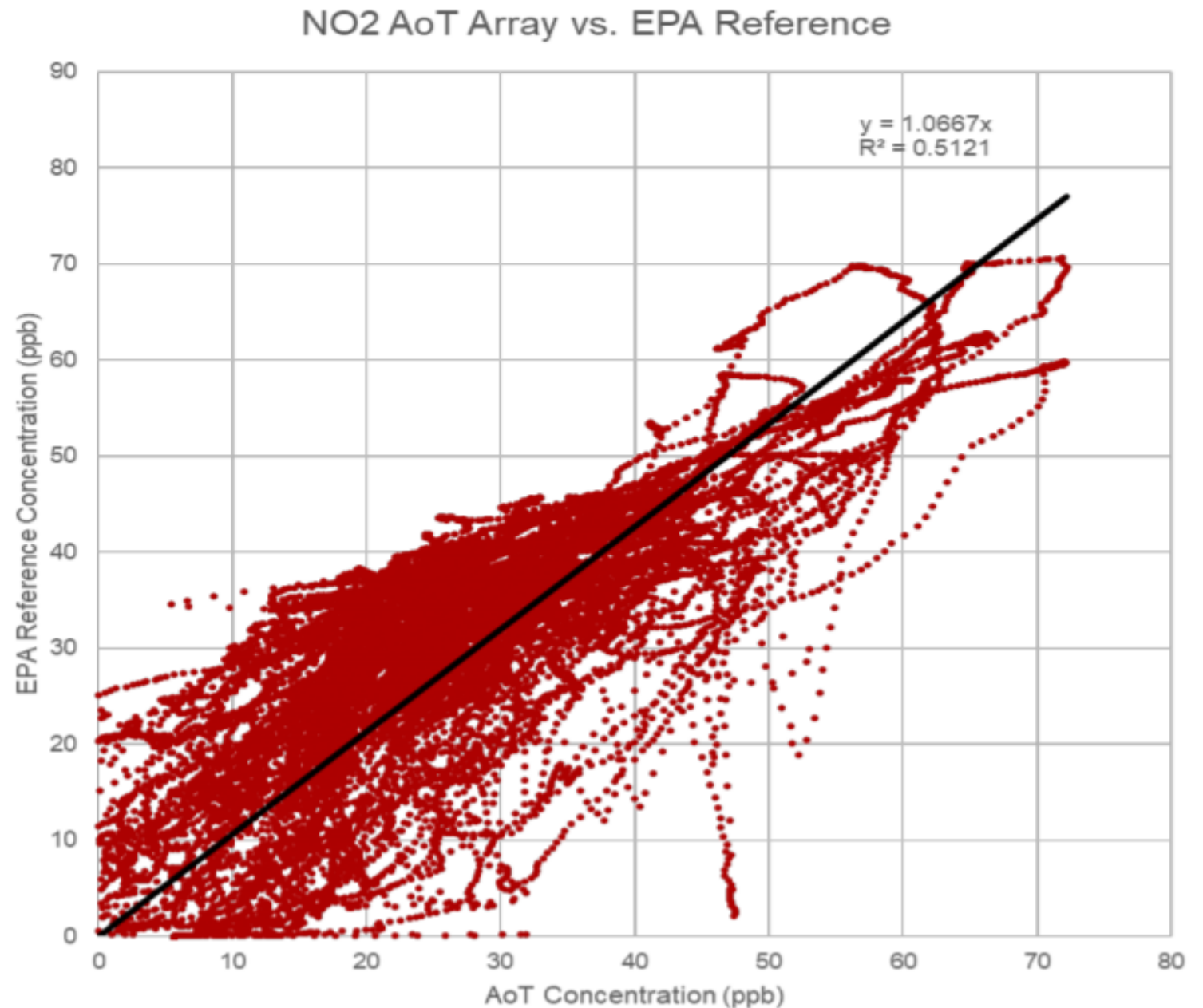


NO2 Total Correlation March 1st -May 10th

Hi/Low Temp
-1.6 to 26.0 °C
Hi/Low Rh
13.2 to 97.6 %

For March 1st to May
10th 2018 the Correlation
Values (Excel Corr())

• NO2 0.73

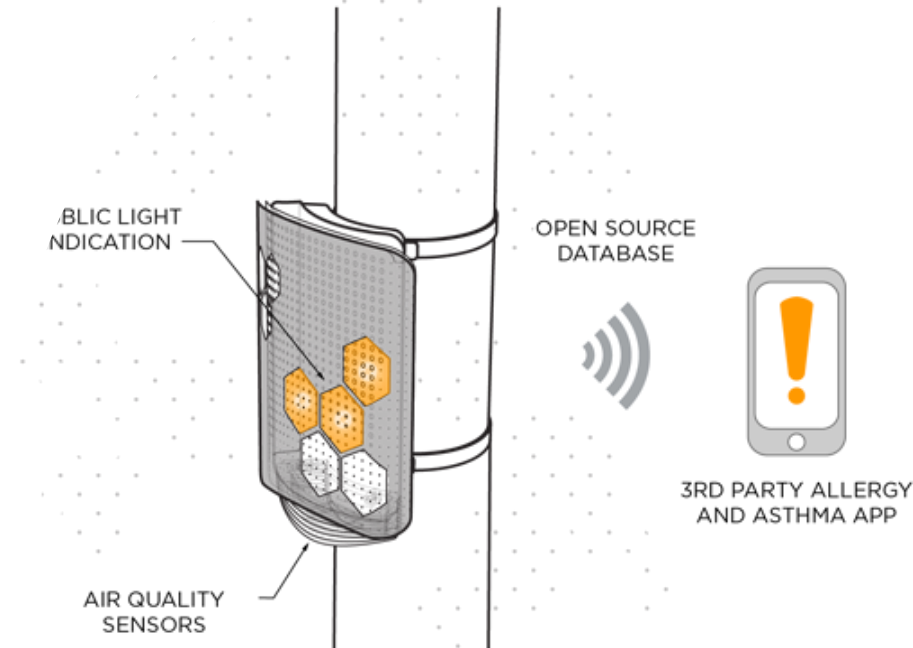


AoT Ground Applications



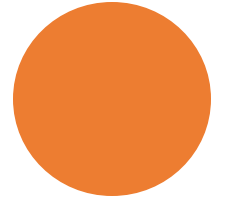
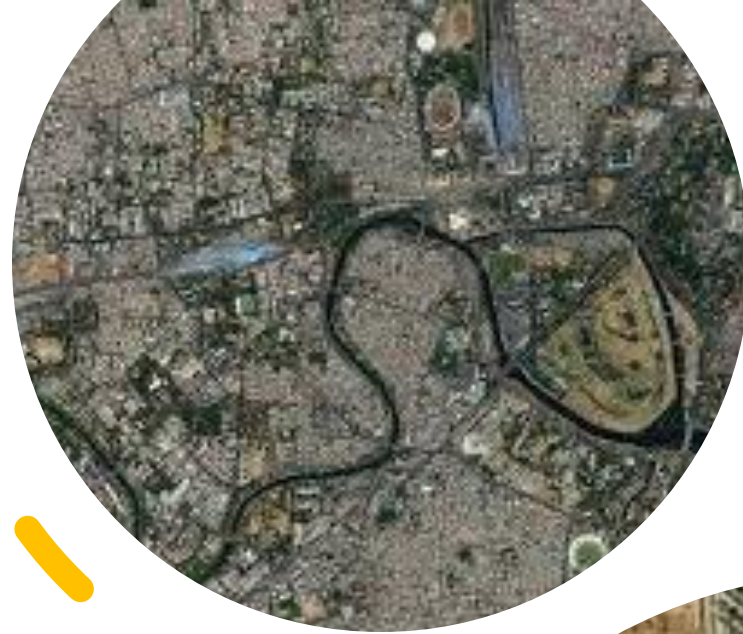
Applications of AoT-Smart Lamp Post

- **Sensors** monitoring **air quality, sound, and vibration** might be used to suggest the **healthiest and unhealthiest** walking times and routes through the city.
- **Real-time** detection of urban **flooding** can improve city services and infrastructure to **prevent property damage** and chaos.
- Measurements of **micro-climate** in different areas of the city, so that residents can get up-to-date, high-resolution "**block-by-block**" weather and climate information.
- Observe which areas of the city are heavily populated by pedestrians at different times of day to suggest safe and efficient routes for walking late at **night** to improve **pedestrian safety** and reduce **congestion-related pollution**.



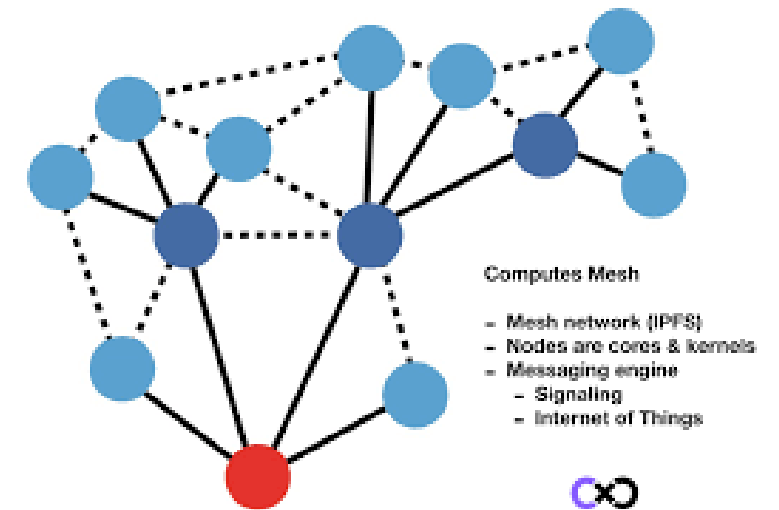
Applications of AoT- E-governance & Border Security

- **Sensors** monitoring a micro land area for **national security**.
- **Gas/Chemical** transmissions radiation transmissions, magnetic fields, **vibration currents** to detect **enemy intrusions, cyber intrusions, gun shots, cease fire violations**, etc.
- **Real-time** detection of border security to make "smart" decisions.
- Monitor problem areas for **malicious activities**.



How AoT is better?

- **AoT Devices** collect and store data **within** the device and may not transmit sensitive information via internet/gateway.
- Unlike IoT structure, **AoT network mesh** can operate successfully even after **failure** of few devices in the mesh.
- AoT don't rely on **external nodes/Servers** to take smart decisions.



Challenges

Cyber security

- As our cities are becoming more and more **saturated with sensors**, they are becoming **smarter and smarter**.
- However, we must also take into account citizens' degree of tolerance for the **invasion of data** collection equipment – as the number of equipment increases, the citizens feel more **supervised**.

Technological Limitations & more

- IoT enthusiasm is often tempered by the **connectivity problems** that the equipment are faced with.
- Internet situations can create frustration. Humans understand and know they can appear. But when we talk about **electronic equipment**, they **cannot understand**, and the effects of their misunderstanding can produce less pleasant effects for citizens or the environment.

Conclusion & References

- IoT is a remarkable symbiosis between society and technology.
- We need International Laws to keep a check on AoT, IoT and other fields that collect citizens' data.

References

[1]<http://arrayofthings.github.io/>

[2]<https://www.uchicagotechteam.com/blog-posts/2017/4/10/array-of-things-presentation>

[3]<https://theconversation.com/internet-of-things-data-will-help-us-predict-the-future-62158>



Thanks