Air quality monitoring: an ICN use case?

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In 2012, WHO estimated that: around 4.3 million deaths linked to indoor air pollution while around 3.3 million deaths linked to outdoor air pollution (WHO, 2014).
Haze Crisis in Northern Thailand

**Harmful Particles in the Air**

These figures show levels of PM2.5 – hazardous substances in smog that can lead to many health issues – have been well over the international safe limit in the North.

- **151 micrograms** Chiang Rai’s Muang district
- **156 micrograms** Chiang Mai’s Muang district
- **153 micrograms** Lamphun’s Muang district
- **117 micrograms** Lampang’s Mae Moh district
- **110 micrograms** Tak’s Mae Sot district

- **25 micrograms** World Health Organisation’s safe limit

Source: [http://aqicn.org/](http://aqicn.org/)

NATION GRAPHICS

[Image of air pollution and burning fields]
Actions

- Air quality station - Pollution Control Department
- Satellite images taken twice a day only — hot spots
- Ban open burning after harvesting season
  For example, Mae sot, Tak (Thailand)

“60 days forbidding from open burning (10 Feb – 10 Apr 2018)”
Proposed Solution: IoT

This study focuses on the use of IoT ground level monitoring of PM$_{2.5}$ level to provide timely warning to the local communities.

[Links: (https://www.ccsinfo.com/) (http://www.acalbfi.com/uk/IoT)]
Why ICN/NDN?

- Names are more attractive than IP Addresses
- Decentralized: Internet availability can be intermittent - uploading data to the cloud can be disrupted and warning messages not delivered in time
- Real-time multiple data sources (Sensor DB) and, at any given time, many communities in affected area can send their queries
Step I: Can we use IoT for PM2.5 ground level monitoring?

Study area (Mae Sot, Tak)
## Type of PM Sensor

**PLANTOWER PMS7003**

### Technical Index

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Index</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range of measurement</td>
<td>0.3<del>1.0; 1.0</del>2.5; 2.5~10</td>
<td>Micrometer (μ m)</td>
</tr>
<tr>
<td>Counting Efficiency</td>
<td>50%@0.3μ m 98%@≥0.5μ m</td>
<td></td>
</tr>
<tr>
<td>Effective Range (PM2.5 standard)</td>
<td>0~500</td>
<td>μ g/m³</td>
</tr>
<tr>
<td>Maximum Range (PM2.5 standard)</td>
<td>≥1000</td>
<td>μ g/m³</td>
</tr>
<tr>
<td>Resolution</td>
<td>1</td>
<td>μ g/m³</td>
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<tr>
<td>Maximum Consistency Error (PM2.5 standard data)*</td>
<td>±10%@100~500μ g/m³</td>
<td></td>
</tr>
<tr>
<td></td>
<td>±10 μ g/m³ @0~100 μ g/m³</td>
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</tbody>
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Canarin Node

- IoT node: Canarin
- UDOO Neo with 1GHz ARM Cortex-A9
- SD Card storage
- WiFi connection with GPS module
- Sensors: PM1, PM2.5, PM10 and UVI
Upload data to the cloud.

https://canarin.net/seahazemon/map.html
Data analysis

MG = Mae Gasa
TS = Thai Samakkhi
TS2 = Thai Samakkhi2
MS = Mae Sot

Zoning
Data analysis
Burn-day (21 Mar) / No-burn (5 Apr.) day
PM$_{2.5}$ actual vs. prediction @Mae Gasa
PM2.5 level vs open burning
Step II: In-network computation with NDN

- Air-quality is meaningful for people in the affected area
- Programmable

Example:

- To search for possible sources of the fire — find higher PM reading and compute path towards sources of fire
- To predict PM level in community X, X sends interests for PM streams from neighbouring sites as well as wind direction information to feed into its prediction model
Using IoT for ground level monitoring and detection

ultimately with sufficient coverage, we should be able to characterise haze from agricultural burning or forest fire

PM detection & real-time warning
Future plan: SEA-HAZEMON

- ScaleUp the network
- Deploy Canarin node in 4 countries
  - Thailand
  - Laos
  - Philippines
  - Indonesia
Future plan: SEA-HAZEMON

- Forest fires
- Forest fires fighter
- Haze impacted area
- Agricultural-related burns

SEA HAZEMON
Data Cloud on TEIN

Realtime Monitoring

SEA HAZEMON Edge Computing Node

Sea HAZEMON Sensors
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