

Innovative
Applications of **IoT**
in Building Operation and
Maintenance

12 Nov 2020



Ir LEE Che Kit
Chief Engineer
EMSD
HKSAR Government

Background of the Electrical and Mechanical Services Department

- Handled O&M starting 1948
- EMSD has over 5,000 staff
- Operating & maintaining over 8,000 government premises & E&M facilities, including:
 - Offices
 - Schools
 - Fire Stations
 - Hospitals
 - Markets
 - Sports Centers



Challenges



- Equipment distributed in many venues across the territory
- Aging assets, aging staff
- Expectation for better and smarter service



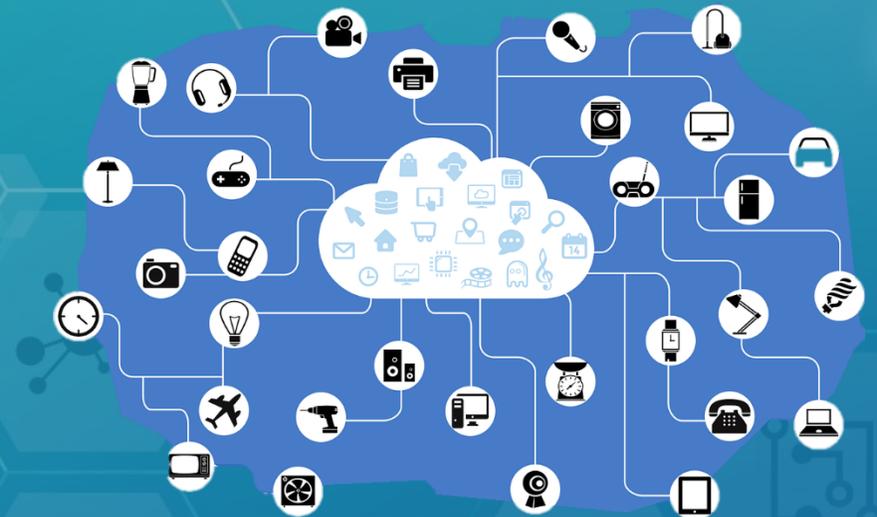
Digitalisation and Technology

Smart Building Management



1010100
1010101
0101011
1110001

Internet of Things



Smart Building Management



Digitized
Asset Management System



Regional digital
monitoring & control centre

- Remote monitor asset efficiency
- Analysis on operational data
- For predictive maintenance & optimization

BIM-AM System – BIM Models with Asset Information & Real Time Data



iPad 15:49 9%

KT-EMSDN-007-LTT-HVAC-AHU-001
AHU

General Information
KT-EMSDN-007-LTT-HVAC-AHU-001
AHU
Model/type SSE603

Location
EMSD HEADQUARTER BUILDING
7153
07
Hong Kong

Gauges & counters
SA Pressure
Overheat Cut Alarm
Static Pressure Set PT (EMSD) 450 Pa
11 Total

Maintenance information
293.01 Investigate temperature issue
246.00 Valve Jammed
214.00 Preventive Maintenance

Documents
CCTV (external fixed IP) HTTP
CCTV (external) HTTP
7 Total

Common Attributes
Asset Code KT-EMSDN
Description AHU
Main Work Centre T2EDA
Manufacturer Saiver
Model / type SSE603
Serial No. BE005-163
Asset Tag No. 414243443

23:50 Sun 17 Nov 84%

Steam Boiler
BIM Model

Steam Boiler

Meters

- 9F_Steam_Boiler_1_CO_Indication
Last reading: 17/11/2019 23:49
Value: 23.6 ppm
Min. / Max.: 0-1500
- 9F_Steam_Boiler_1_O2_Indication
Last reading: 17/11/2019 23:49
Value: 24.98 PPT
Min. / Max.: 0-8000
- 9F_Steam_Boiler_1_Smoke_Density
Last reading: 17/11/2019 23:49
Value: 2.76 PPT
Min. / Max.: 0-8000
- 9F_Steam_Boiler_1_Smoke_Temperature
Last reading: 17/11/2019 23:49
Value: 76.59 °C

Close

Internet of Things (IoT)



Six 'L's of Low Power Wide Area Network (LPWAN)



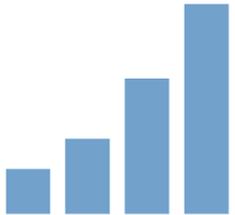
Low Power

Battery powered devices acquiring 3-5 years lifetime



Low Cost

Communication module for HKD50 or less



Long Range

Covering Larger areas with fewer number of base stations



Large Scale

Several thousands of IoT sensors per base station



Low Throughput

From 100bps to some few kbps; Short message once per hour, day or week, ...



Low Responsiveness

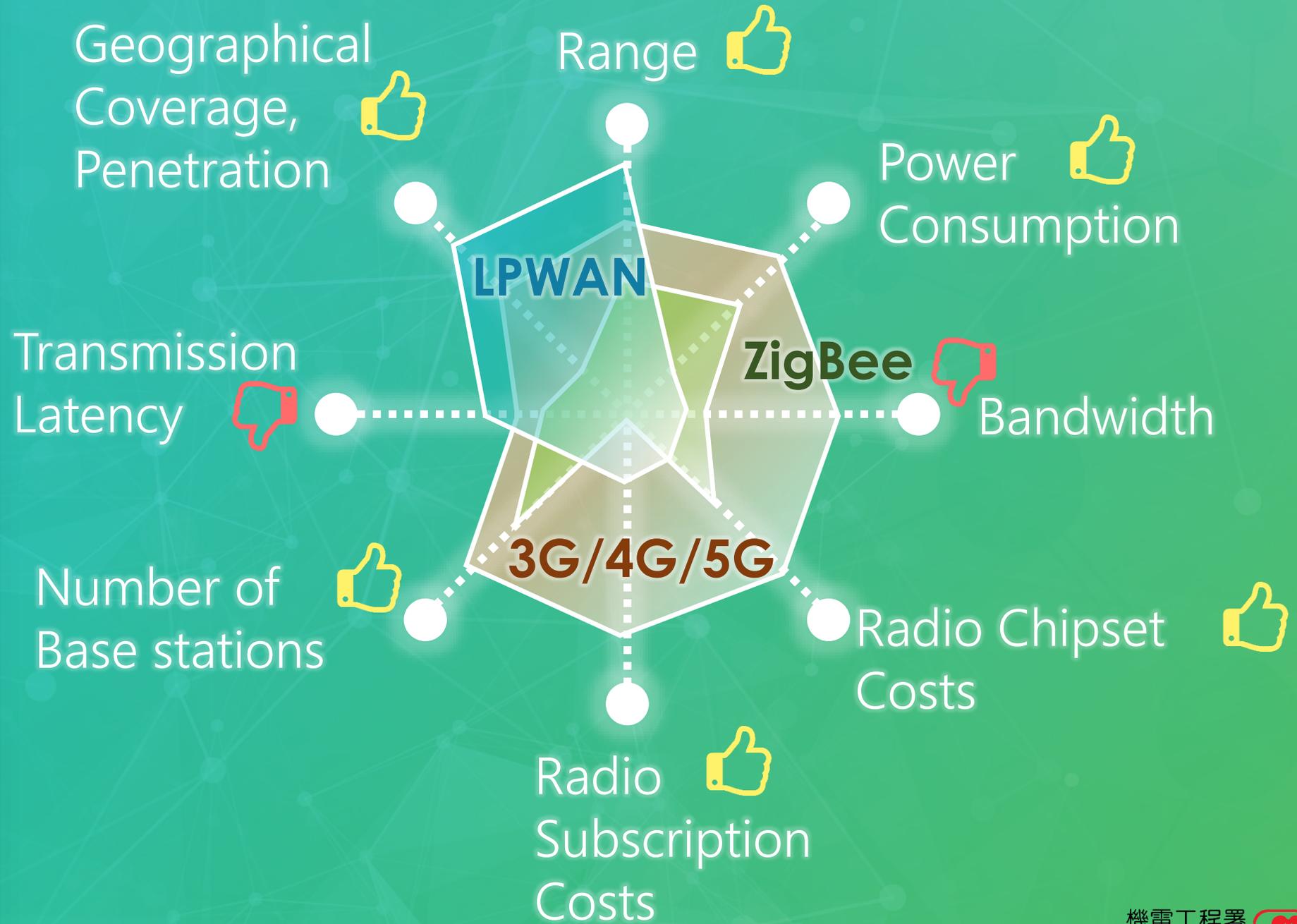
Relaxed requirements regarding Responsiveness of a device

TECHNOLOGY COMPARISON

LPWAN

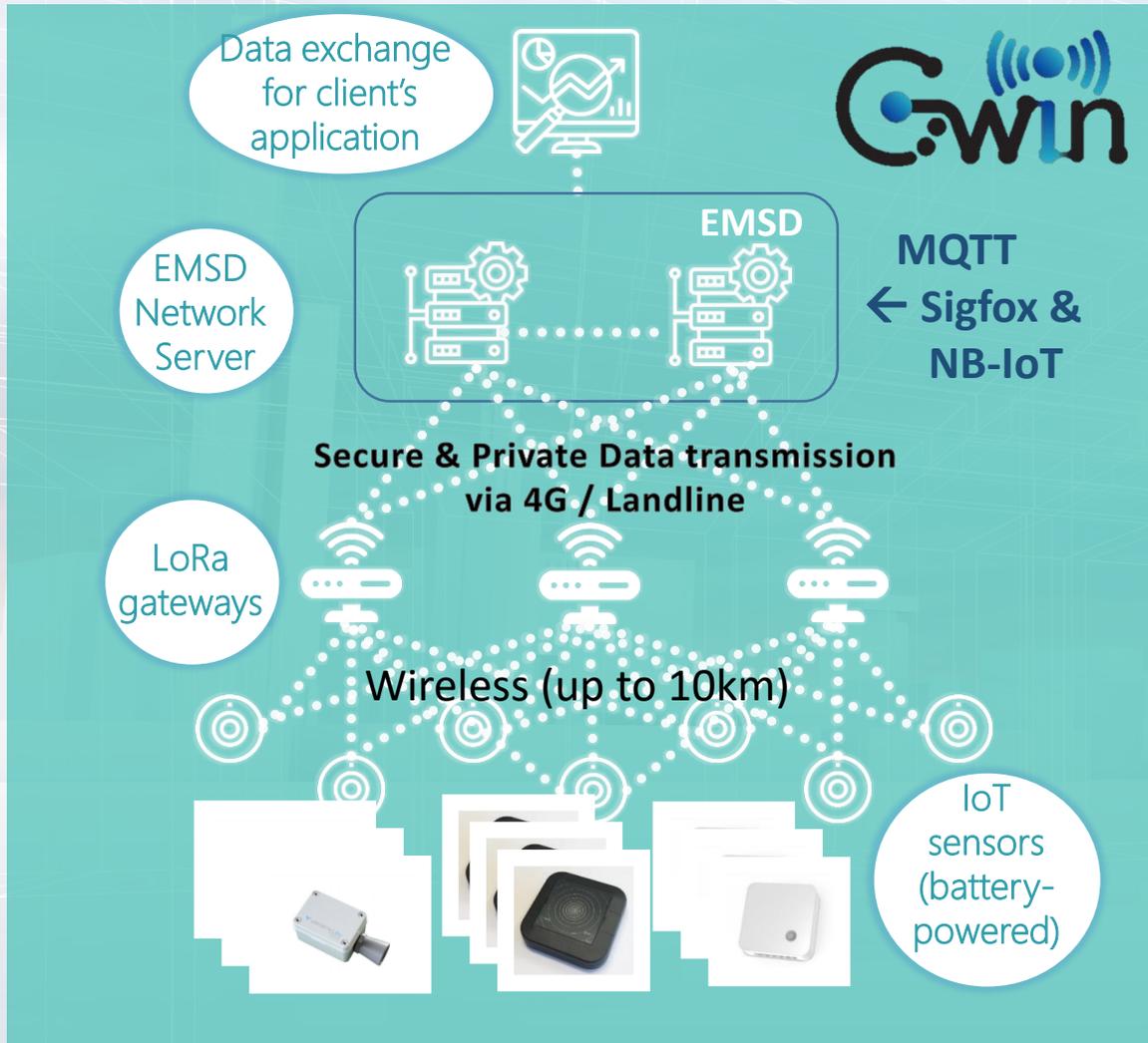
VS

Other coms methods



Reference: <http://www.techplayon.com/low-power-wide-area-networks-lpwan/>

Government Wide IoT Network (GWIN)



Characteristics of IoT Technology with LoRa

- Low powered IoT sensor (battery powered)
- Long range wireless transmission between sensors & LoRa gateways (up to 10km)
- Private network connection between IoT sensors and gateways for stability & information security
- Suitable for lower data rate & less frequent data transmission applications
- Rapid & cost effective deployment
→→→ Massive sensors deployment for digitization and data analytics applications

Trials of IoT Sensors at EMSD HQs



sigfox



NB-IoT

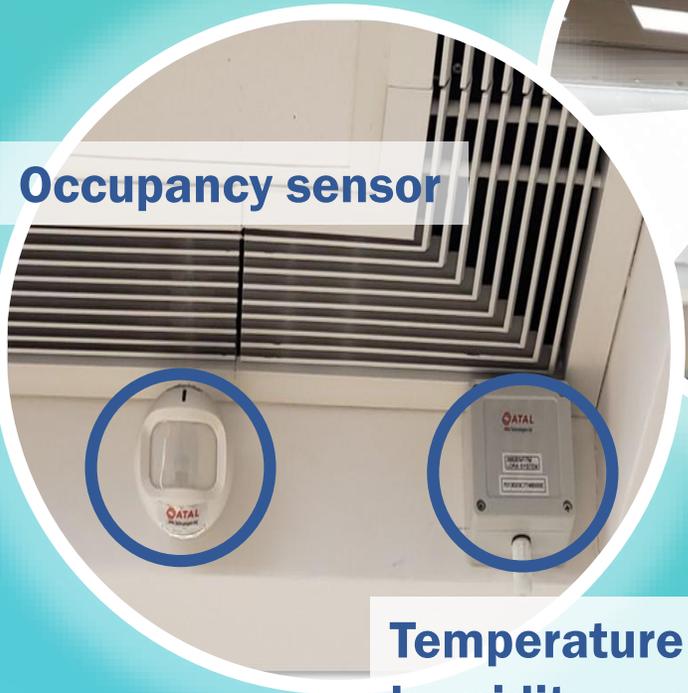
Soap Dispenser Sensor



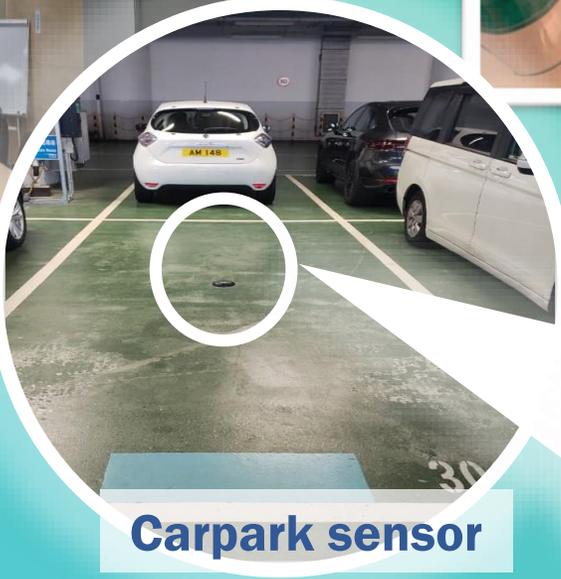
Air Quality Sensor



Occupancy sensor



Temperature & humidity sensor



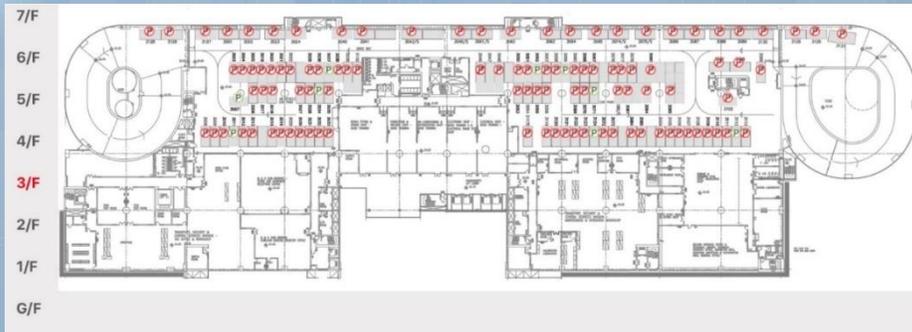
Carpark sensor



GWIN Deployment at EMSD HQs

7-storey building:

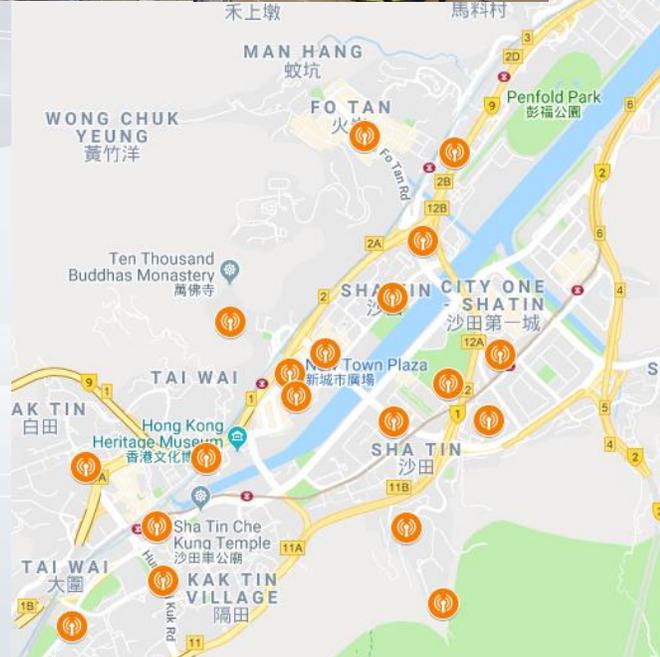
- 7 nos. Indoor Gateways
- 2 no. Outdoor Gateways



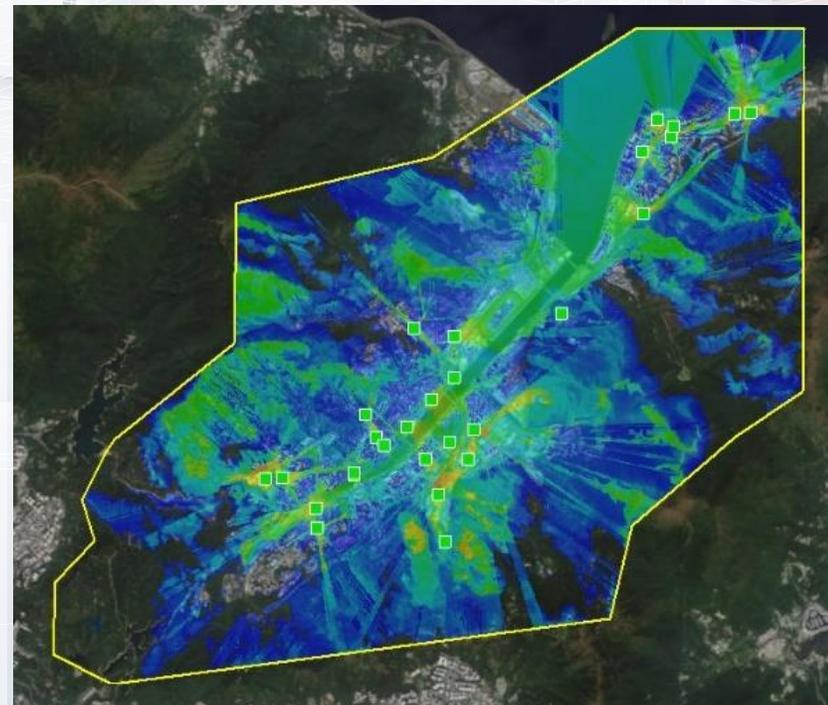
GWIN Deployment at Shatin District



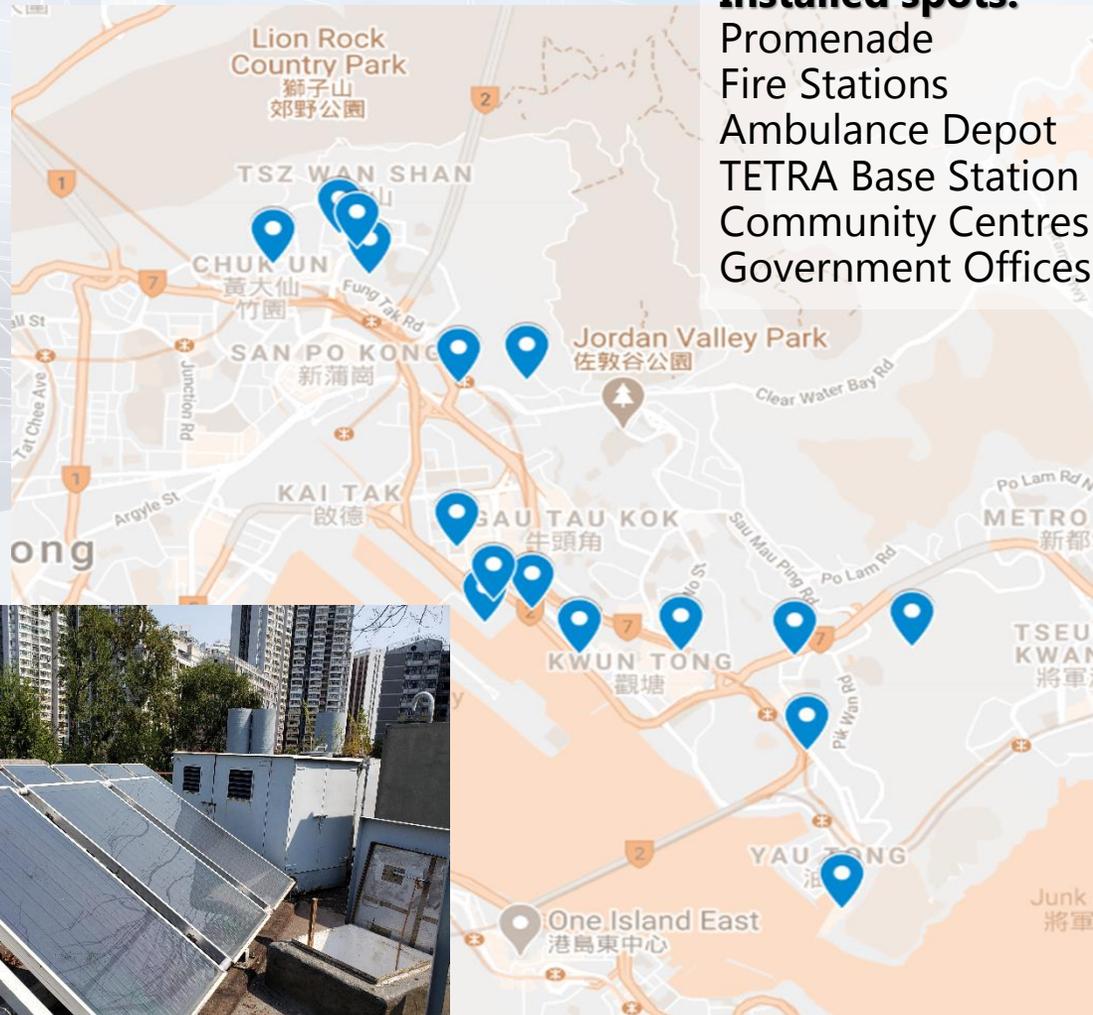
47 Gateways installed in Shatin
Exceed 80% outdoor coverage
Around 200 sensors installed



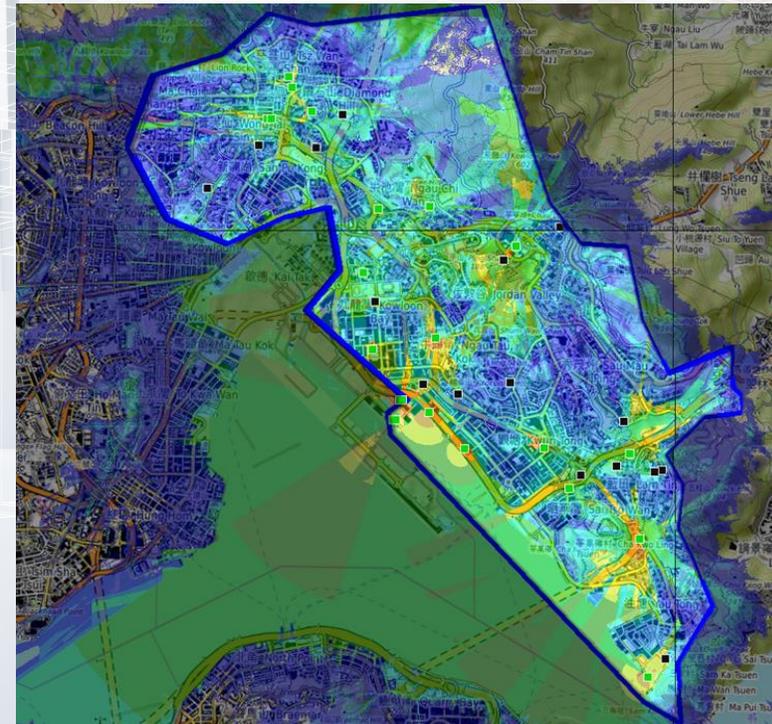
- Installed spots:**
- Public Transport Interchange
 - Footbridges
 - Municipal Buildings
 - Clinical Buildings
 - Fire Stations
 - Community Halls
 - Government Offices
 - Public Toilets
 - Water Service Reservoirs



GWIN Deployment at Kowloon East Region



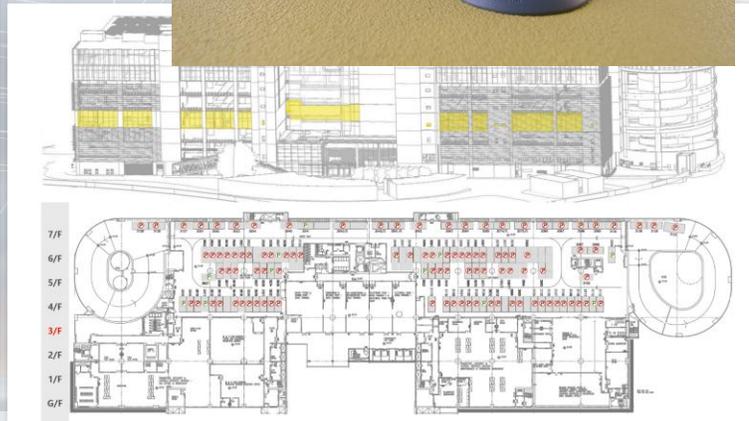
29 Gateways installed in KE Region
Exceed 70% outdoor coverage
Around 100 sensors installed



IoT and Smart Building



EMSD IoT Trials on Smart Facility Management



EMSD Demo Site



Smart Meeting Room

Smart Carpark System

Smart Toilets





Video

Predictive Maintenance

A.I. Vibration Monitoring



- ❑ **Edge processing vibration sensor**
- ❑ **Self-learning vibration pattern** and send out alert signal for predictive maintenance



Trial-axis vibration monitoring



Fresh Air Fan at Tai Wai PTI



Air-cooled Chiller at Sha Tin Government Office



Chilled Water Pump at Sha Tin Government Office



Primary Air Handling Unit at Sha Tin Government Office



Predictive Maintenance

A.I. Vibration Monitoring



- On-premise processor to collect **complex and comprehensive vibration spectrum (Sample frequency up to 25.6kHz)**
- Local support and on site baseline measurement by **Certified Vibration Analyst** (Category III ISO 18436-2)
- Machinery Fault Diagnosis (**Bearing & Misalignment**)



Yung Fung Shee Memorial Centre



Kowloon Bay Health Centre

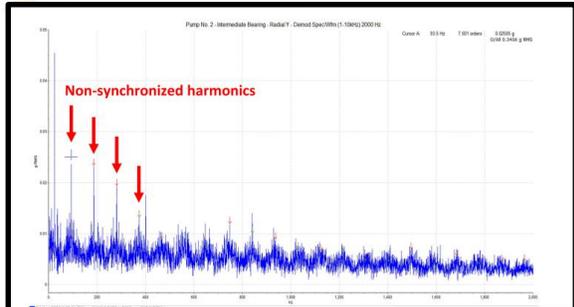


Figure 13: Vibration Demodulated Spectra - Pump No. 2 - Intermediate Bearing

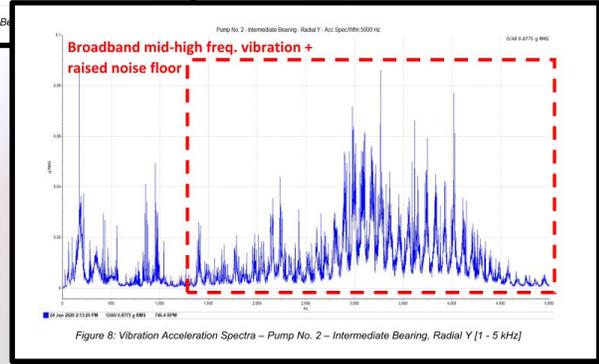


Figure 8: Vibration Acceleration Spectra - Pump No. 2 - Intermediate Bearing, Radial Y [1 - 5 kHz]

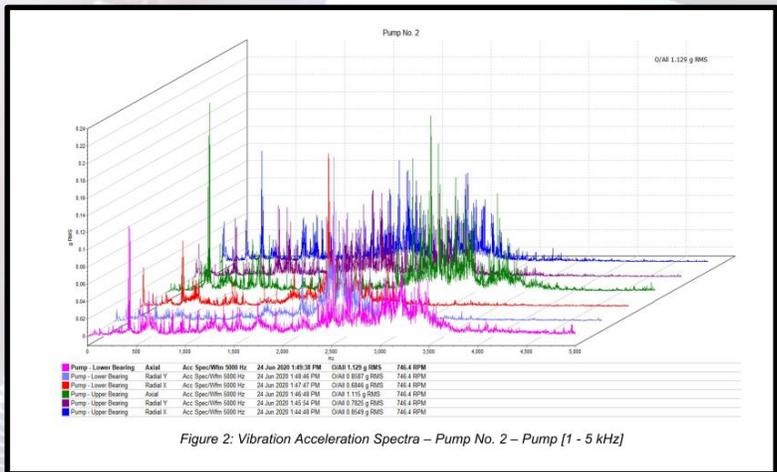


Figure 2: Vibration Acceleration Spectra - Pump No. 2 - Pump [1 - 5 kHz]

Regional Digital Control Centre



EMSD HQs



Watercraft Tracking

HK Children Hospital



Automatic Meter Reading



Environmental Monitoring & Education



Rain Gauge for Slope Monitoring



PV Panel Efficiency Monitoring



Smart City



Flood Monitoring



U/G Water Leakage Monitoring

West Kowloon Government Building



Air Quality Monitoring



Tree Monitoring

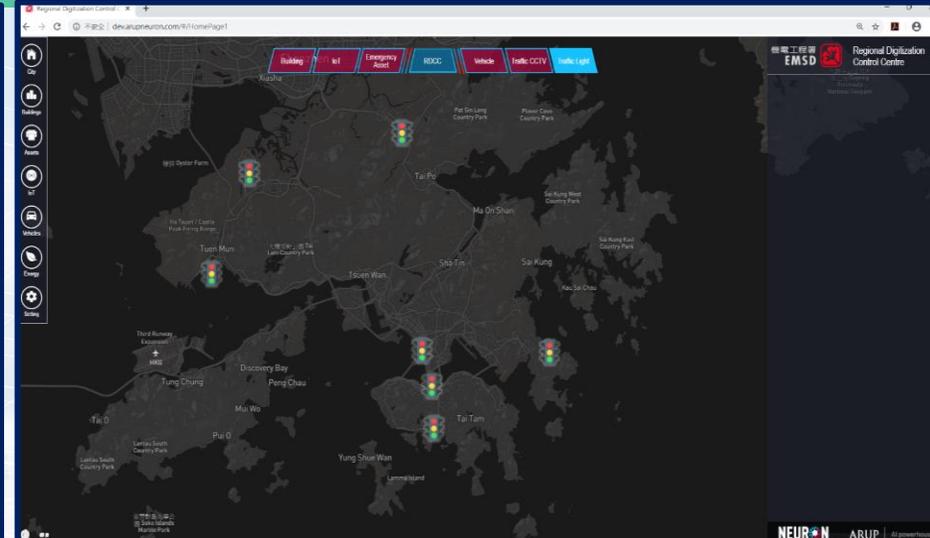
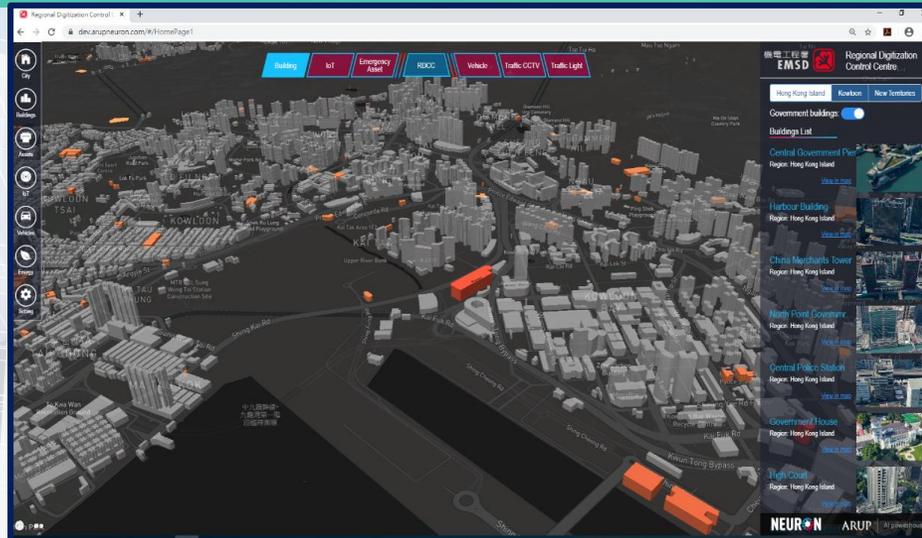


Sludge Container Tracking

Tin Shui Wai Hospital



Regional Digital Control Centre (RDCC)





Device List

TL-KLE-A05	12 km	
TL-KLE-A06	17 km	
TL-KLE-A07	23 km	
TL-KLE-A08	38 km	
TL-KLE-A09	46 km	
TL-KLE-A10	74 km	

Building Summary – West Kowloon Government Office



CCTV Footage



Video Analytics Alarm



EMSD Headquarter



GFA	81,000 sqm	Floors	7
Temperature	22.6 C	Humidity	74%
WQ CO2	329 ppm	WQ PM 2.5	45

54.7 MWh Daily Electricity Consumption

Good Indoor Air Quality

West Kowloon Government Office



GFA	115,000 sqm	Floors	18-19
Temperature	23.1 C	Humidity	76%
WQ CO2	406 ppm	WQ PM 2.5	37

83.4 MWh Daily Electricity Consumption

Good Indoor Air Quality

Hong Kong Children's Hospital



GFA	185,000 sqm	Floors	11
Temperature	22.7 C	Humidity	77%
WQ CO2	453 ppm	WQ PM 2.5	48

75.0 MWh Daily Electricity Consumption

Good Indoor Air Quality

Kai Tak Cruise Terminal



GFA	72,000 sqm	Floors	4
Temperature	22.4 C	Humidity	83%
WQ CO2	328 ppm	WQ PM 2.5	38

49.1 MWh Daily Electricity Consumption

Good Indoor Air Quality

Sensor Deployment



LoRa Alliance®

IoT Sensors from >500 LoRa Alliance Member & Local Market



Retrofit existing sensor based on standard interface by EMSD MoC partners in Hong Kong



TAILOR-MADE Products from Local Market

Universities
I&T Organizations
I&T Solution Supply



機電工程署

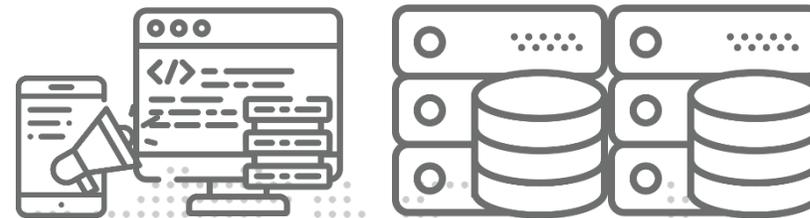
EMSD



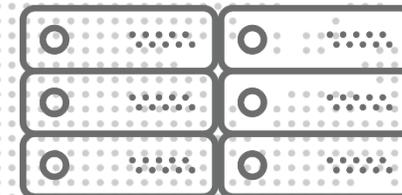
IoT Ecosystem

APPLICATION

Data Analytic & AI
Predictive
Maintenance



Network
Server



GATEWAY
INFRA.



IOT SENSOR

Sensor
Deployment



A night cityscape with a network overlay of glowing blue lines and nodes. The text "Co-Own" is prominently displayed in the center-left.

Co-Own

Co-Create