

# PROJECT DILAW



---

DETECTION AND IDENTIFICATION OF LEGITIMATE PUBLIC  
UTILITY VEHICLES ALONG VARIOUS ROAD NETWORKS

W. M. Tan ([wmtan@dcs.upd.edu.ph](mailto:wmtan@dcs.upd.edu.ph))  
Department of Computer Science  
College of Engineering  
U.P. Diliman

---

# WHAT WE'LL BE DISCUSSING

- ▶ Motivation
- ▶ The DILAW System Architecture
- ▶ System Performance Tests
- ▶ Conclusions
- ▶ Recommendations

MOTIVATION

## THE COLORUM PROBLEM

- ▶ The colorum problem is one of the major issues plaguing the Philippine transportation sector
- ▶ Colorum vehicles refer to vehicles that act as PUVs and yet are not authorized to do so by the government
  - ▶ They also include registered vehicles that ply routes not assigned to them
  - ▶ Colorum vehicles contribute to traffic, pose a danger to commuter safety, and lower the income of legal PUV operators

CELEBRITIES AND SHOWBIZ 620 SHARES    

# Bus hits Kim Chiu's car; actress complains about driver on Instagram

By: [Clarizel G. Abanilla](#) INQUIRER.net / 08:49 PM July 19, 2018

Kapamilya actress Kim Chiu took her complaints to Instagram on Thursday when her car was hit by a bus on Thursday. The driver reportedly refused to provide his license and company ID.

She informed her followers about the incident through Instagram stories.

“Omg binangga kami! Ayaw pa magbigay ng driver’s license and company ID nung driver! Oh m g! Baka naka colorum yung bus nila! (OMG, a bus hit us. The driver refused to provide his license and company ID. Maybe it’s a colorum bus!) LTO please do something to this kind of bus company!” she wrote.

## LATEST STORIES

## MOST READ



NEWSINFO  
#WalangPasok: Class suspensions on Wednesday, July 25  
JULY 25, 2018 08:00 AM



NEWSINFO  
US liquor heiress charged in New York ‘sex slave’ case  
JULY 25, 2018 07:36 AM



ENTERTAINMENT  
Petition wants ‘fat-shaming’ Netflix series scrapped  
JULY 25, 2018 07:33 AM

# ATTEMPTS TO SOLVE THE COLORUM PROBLEM

- ▶ RFID-based system
- ▶ Sensor-based system
- ▶ Operations

# RFID-BASED SYSTEM

- ▶ An RFID-based system was proposed years ago, but was found to be infeasible
- ▶ Utilizing RFIDs would entail significant and impractical investment in infrastructure



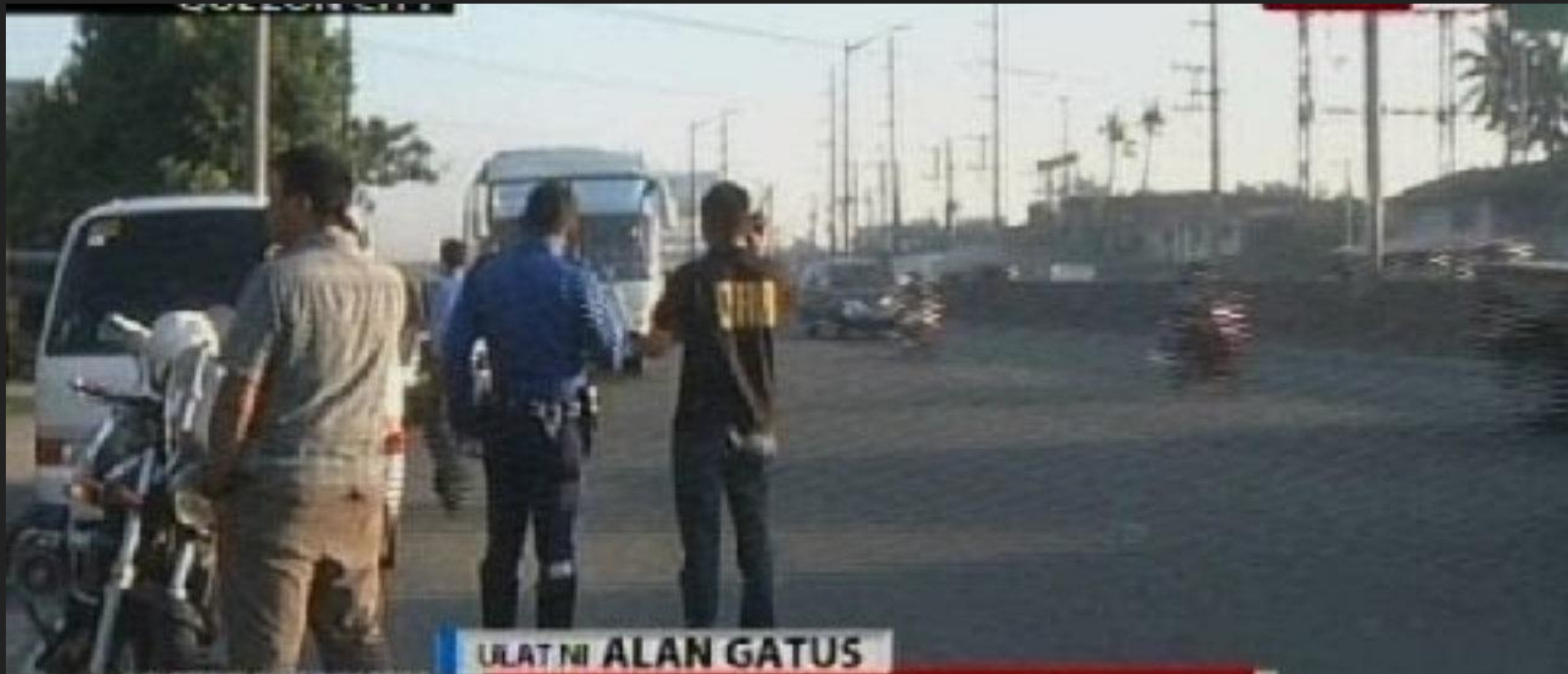
## SENSOR-BASED SYSTEM

- ▶ Sensor-based system mentioned a few years ago (for bidding supposedly) but never panned out



## OPERATIONS

- ▶ During MMDA or LTFRB operation, PUVs in a route are stopped, and their papers inspected
- ▶ Cannot be done everyday – so much so they becomes media-covered events
- ▶ Very inconvenient for commuters as well as legal PUVs



ULAT NI ALAN GATUS

DZBB

[TWITTER.COM/GMANEWS](https://twitter.com/GMAnews)



ANTI-COLORUM OPERATION,  
ISINAGAWA NG LTFRB, DOTC AT MMDA

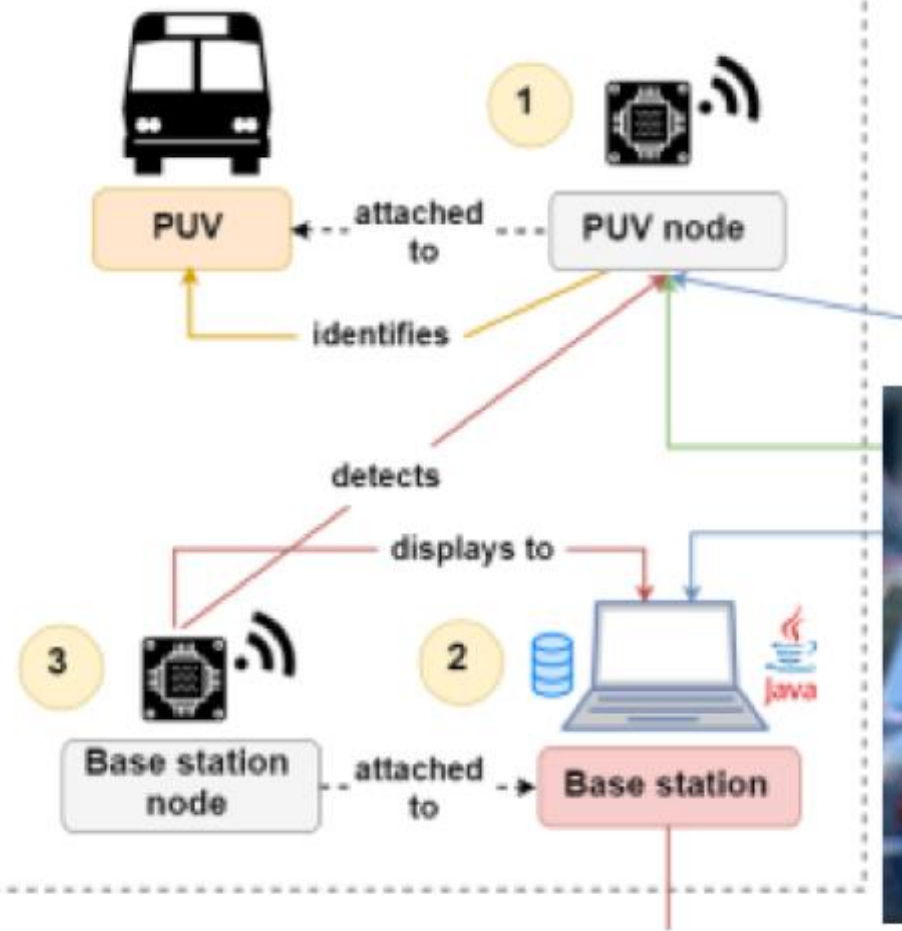
# THE DILAW SYSTEM

## OUR SYSTEM

- ▶ Our system enables contactless detection of legal PUVs, done through a device carried by the PUVs and a base station carried by the traffic official or officer
- ▶ By detecting legal PUVs easily, (possibly) illegal PUVs (colorum vehicles) can be more easily singled out



## OPERATIONAL



# ADVANTAGES OF OUR SYSTEM

- ▶ Contactless
- ▶ Tamper-proof
- ▶ Infuses accountability

CORE  
DILAW  
SYSTEM

DERIVATIVE  
SYSTEMS

COMMUNTER  
APP

ETA  
SYSTEM

DISPATCH  
SYSTEM

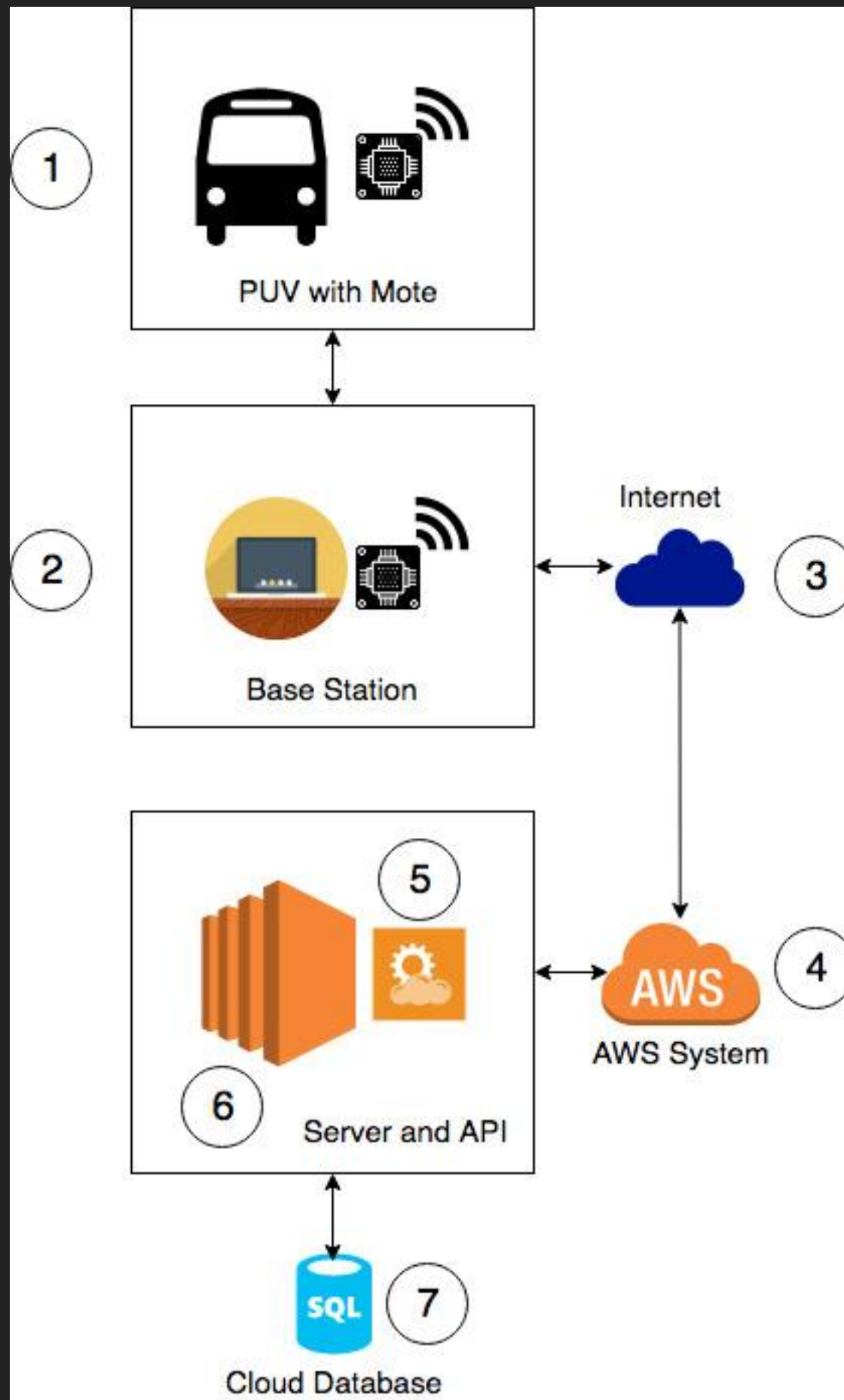
# CORE DILAW SYSTEM



---

MAIN PURPOSE:  
DETECTION OF  
REGISTERED VEHICLES

Project DILAW



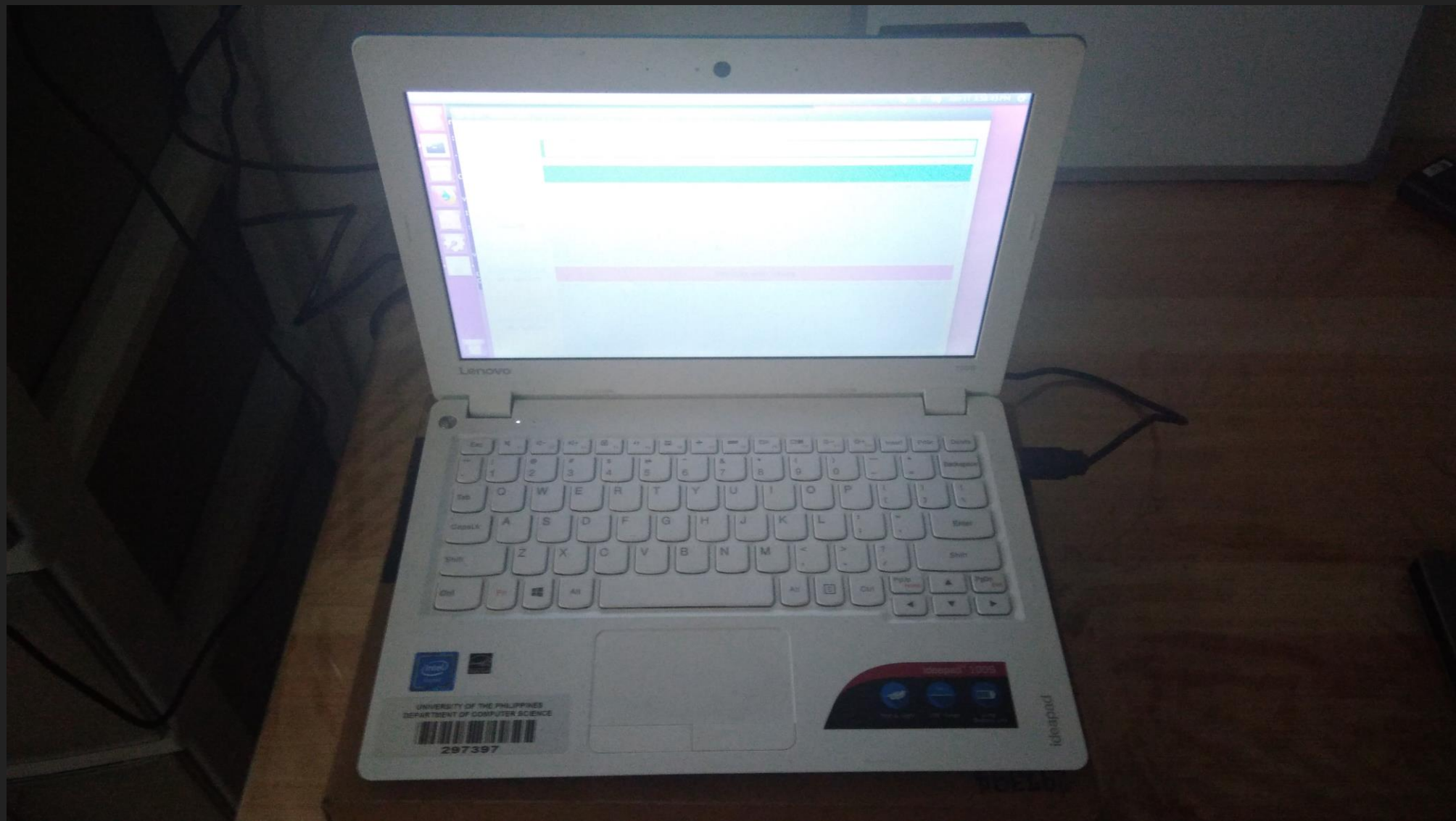
---

# THE BASE STATION



---

# THE BASE STATION



# THE BASE STATION

Yellow GUI

File Edit Settings Help

Connected to remote database.

### Authorized Vehicles

Authorized	UID	Plate Numb...	Vehicle Type	Route Code	Tripwire Int...	Driver First ...	Driver Last ...	Driver Middl...	Driver Lice...	Operator ID
Authorized	11	UHQ 642	Jeepney	1	Valid	Wilson	Tan	M	123456	678990

### Vehicles with Issues

Authorized	UID	Plate Numb...	Vehicle Type	Route Code	Tripwire Int...	Driver First ...	Driver Last ...	Driver Middl...	Driver Lice...	Operator ID
------------	-----	---------------	--------------	------------	-----------------	------------------	-----------------	-----------------	----------------	-------------

VIEW VEHICLES

MANAGE

VIEW REPORTS

VIEW HISTORY



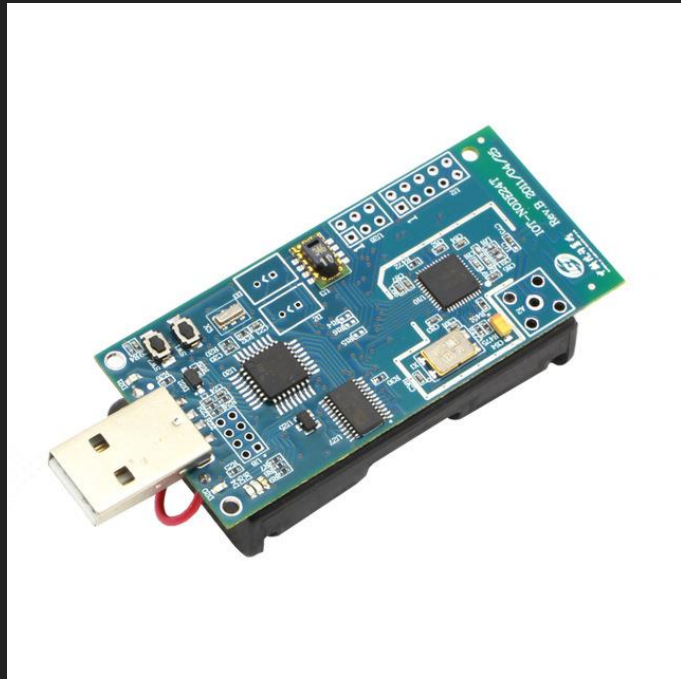
---

# THE PUV NODE

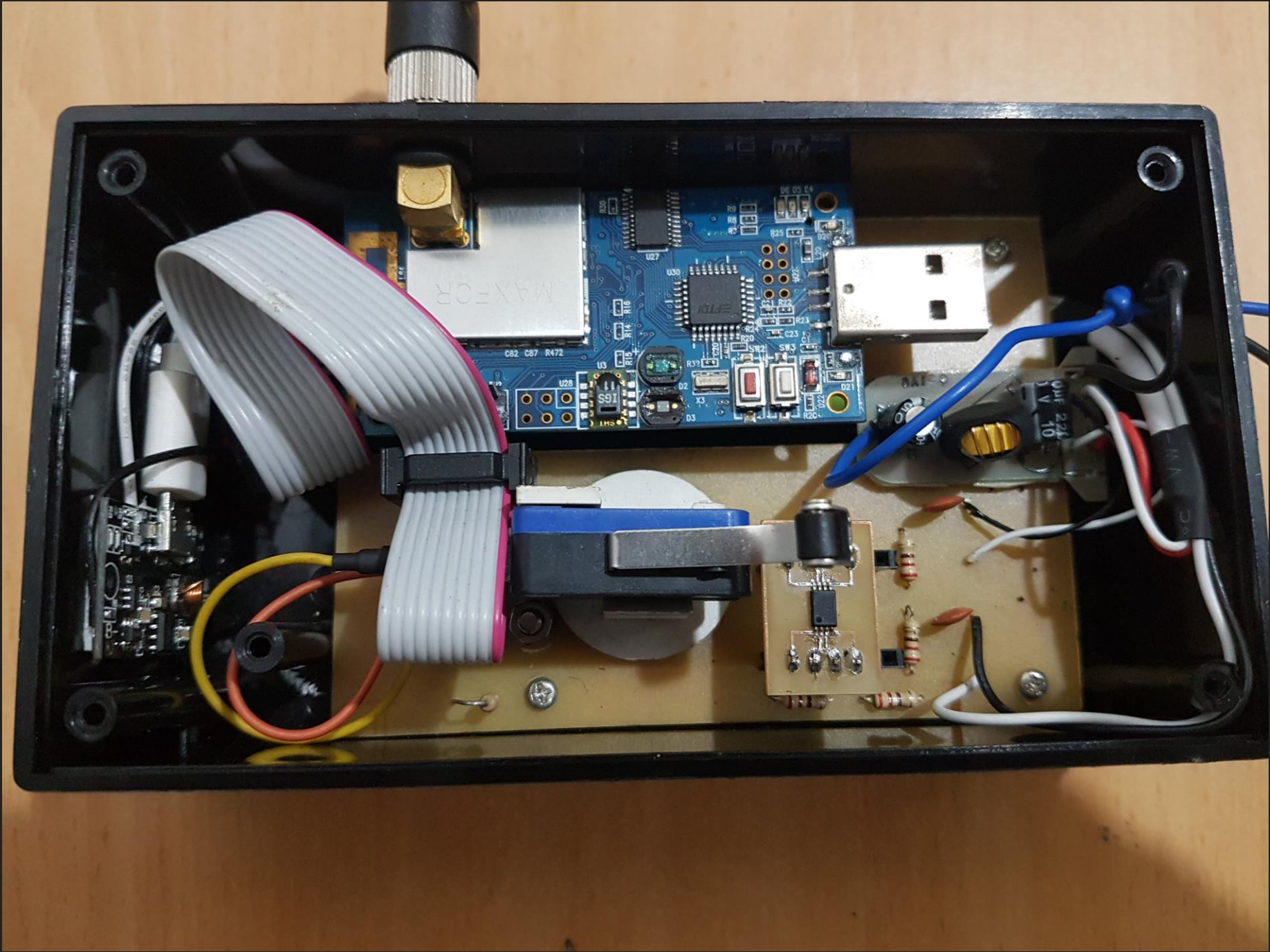


## THE PUV NODE

- ▶ The PUV node is based on the TelosB WSN platform and runs TinyOS
  - ▶ Microcontroller is Texas Instruments MSP430
  - ▶ Radio is ChipCon CC2420 (IEEE 802.15.4)
- ▶ The TelosB WSN platform has been extended with a daughter board







## ANTI-TAMPERING MECHANISM

- ▶ Since legitimacy comes with the PUV node, there is great incentive for colorum operators to transfer and tamper with the device
- ▶ To prevent this from happening, PUV node has been fitted with tripwires that detect when the device has been removed (transferred) or opened
- ▶ Tampering/transfer is reported to the base station

## INSTALLATION

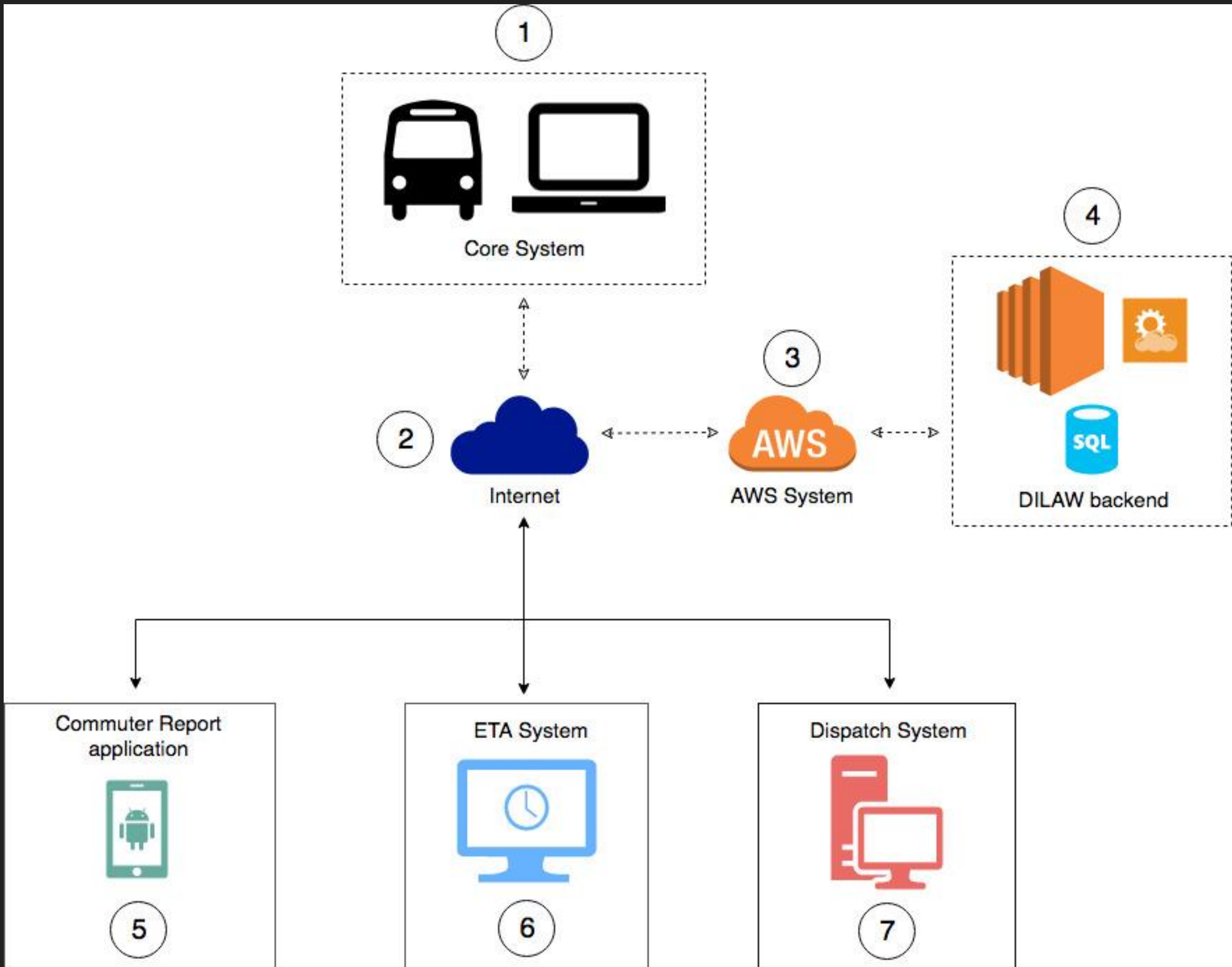
- ▶ PUV node is to be attached to the vehicle dashboard
- ▶ Power is drawn from the vehicle (12 V or 24 V)
- ▶ To prevent node shutdown when engine is off, device is fitted with with a rechargeable secondary power supply, as well as an autoswitching multiplexer

# DERIVATIVE SYSTEMS

---

COLLECTION OF SYSTEMS  
USING THE SAME  
APPLICATION LOGIC AND  
HARDWARE

Project DILAW



# THE ETA SYSTEM

CUBAO: BUS ARRIVAL SCHEDULE				
Internet Connected - System is OK				
ETA	Route	Bus Plate #	Last Seen At	Remarks
13:06	TRINOMA-GLORIETTA 5	AB 1234	CUBAO	ARRIVED
15:30	SM NORTH-MEGAMALL	XY 0000	QUEZON AVE.	




# THE COMMUTER APP

GLOBE 3G 85% 3:47 AM

← Commuter AIR

Plate Number: XYZ - 098

Bus ▼



SUBMIT

dilaw PROJECT



# THE DISPATCH SYSTEM

## CUBAO: DISPATCH SYSTEM

Order #	Status	Plate Number	Last Seen At	Last Updated At
1	✓	ABC 1234	GUADALUPE	10:37
2	X	MLO 0946	SHAW	10:46
3	X	TXV 628	ORTIGAS	11:08
4	...	BC 1743	GMA-KAMUNING	11:03
5	...	NP 3357	TRINOMA	10:59

# PERFORMANCE TESTS

CORE SYSTEM TEST





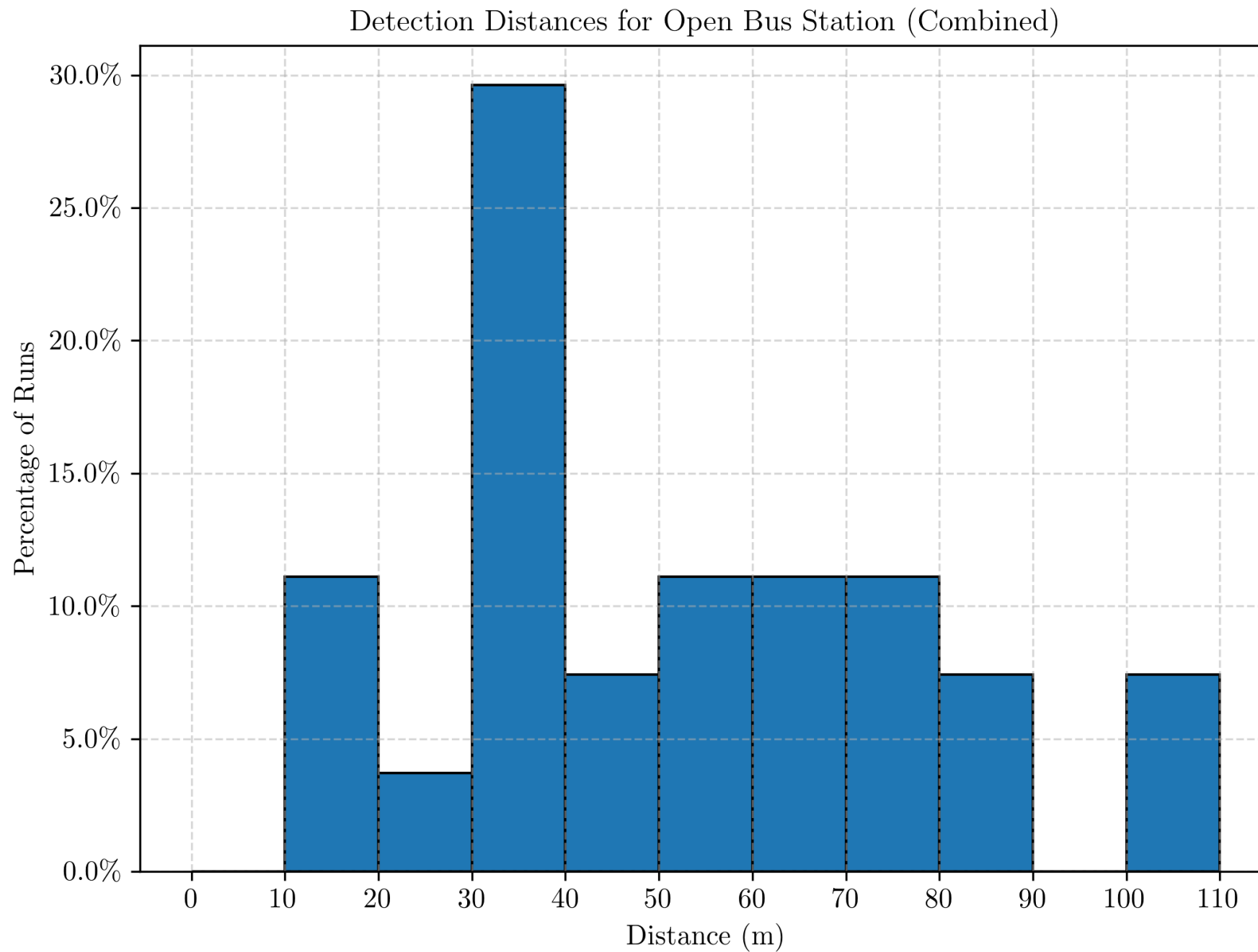
CORE SYSTEM TEST

---





# RESULTS: QUANTITATIVE DISTANCES

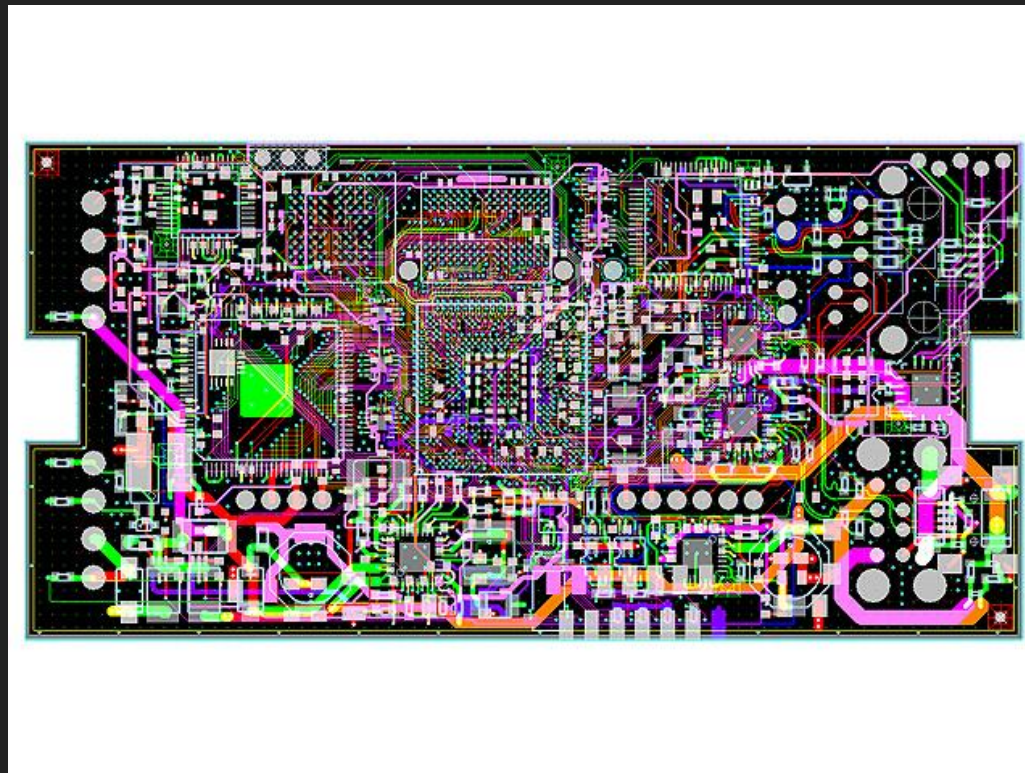


---

RECOMMENDATIONS

# ADD INTEGRATED LAYOUT FOR THE PUVV NODE

- ▶ Currently main board + daughter board setup – a new integrated layout complete with sensors, power mux, etc. would drastically shrink the node size by half, roughly





# A MORE COMPACT PLATFORM FOR THE BASE STATION

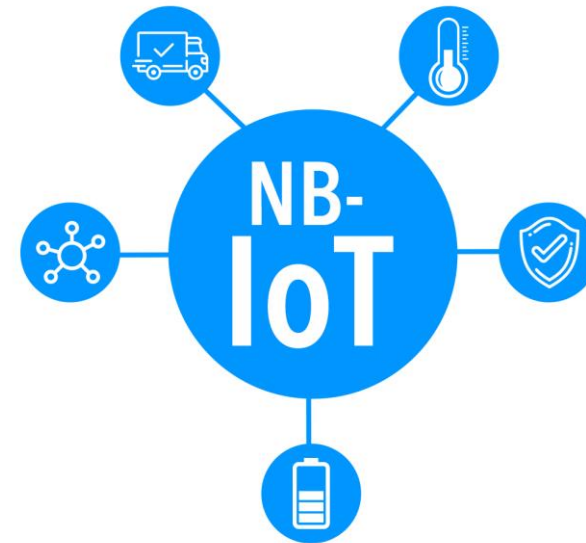
- ▶ Currently netbook, but can be ported to phones (+OTG-connected dongle), tablets, dedicated handheld device, etc.



## TESTING OF NEW RADIO TECHNOLOGIES

- ▶ DILAW utilizes IEEE 802.15.4 which is for Personal Area Networks
- ▶ Since DILAW began almost 3 years ago Low Power Wide Area Networks (LPWAN) technologies have become cheaper and more accessible
- ▶ LPWAN can potentially enable longer detection distances

**LoRa**<sup>TM</sup>

The LoRa logo features the text "LoRa" in a bold, black, sans-serif font. The letter "o" is partially overlaid by a blue signal wave icon consisting of five horizontal lines of varying lengths, radiating from the center of the "o". A small "TM" trademark symbol is positioned to the upper right of the "a".

# AUTOMATED DILAW

- ▶ DILAW base stations are currently carried by traffic officers
- ▶ DILAW base stations can be installed in PUV stops, and along with CCTVs and image processing + machine learning techniques enable automatic detection of legal and (possibly) illegal PUVs



SUMMARY OF PROJECT

---

CONCLUSIONS

## CONCLUSION 1

- ▶ Project DILAW has been able to design, produce, and test a complete end-to-end system which enables the detection and identification of legal PUVs
- ▶ Enabling 24/7 operations + minimizing inconvenience to commuters and legal PUV operators

# CONCLUSION 2

- ▶ The DILAW system is end-to-end, and takes into account processes such as registration, data uploading, special trips, etc., and situations such as slow or absent Internet connections
  - ▶ PLUS, the DILAW system has security measures against transfers and tampering

### CONCLUSION 3

- ▶ The DILAW system has been extensively tested to be functional, and has been shown to provide enough reaction time for for the officers to hail or flag down vehicles that may be colorum or may be problematic for other reasons



# CONCLUSION 4

- ▶ The DILAW system has produced derivative systems, one of which is the ETA-system can provide ETA data for transport ecosystems where the hardware and recurring cost of a GPS-based system can be prohibitive in terms of cost

# PUBLICATIONS AND PRESENTATIONS

- ▶ Presented, 3rd International Conference on Computer and Communication Systems in Nagoya Institute of Technology, Nagoya, Japan
- ▶ Paper included at the Proceedings of the 3rd International Conference on Computer and Communication Systems (ICCCS 2018) – IEEEXPLORE indexed
- ▶ Presented, 2nd International Conference on Intelligent Systems Engineering (ICISE), International Islamic University, Kuala Lumpur, Malaysia
- ▶ Paper included at the Proceedings of the 2nd International Conference on Intelligent Systems Engineering (ICISE) – IEEEXPLORE indexed

THANK YOU