

Cloud-Based Driver Monitoring and Vehicle Diagnostic with OBD2 Telematics

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Malintha Amarasinghe, Sasikala Kottegoda, Asiri Liyana Arachchi,
Shashika Muramudalige, H. M. N. Dilum Bandara
Dept. of Computer Science and Engineering,
University of Moratuwa

Afkham Azeez
WSO2 Inc.

Why?



Reckless Driving

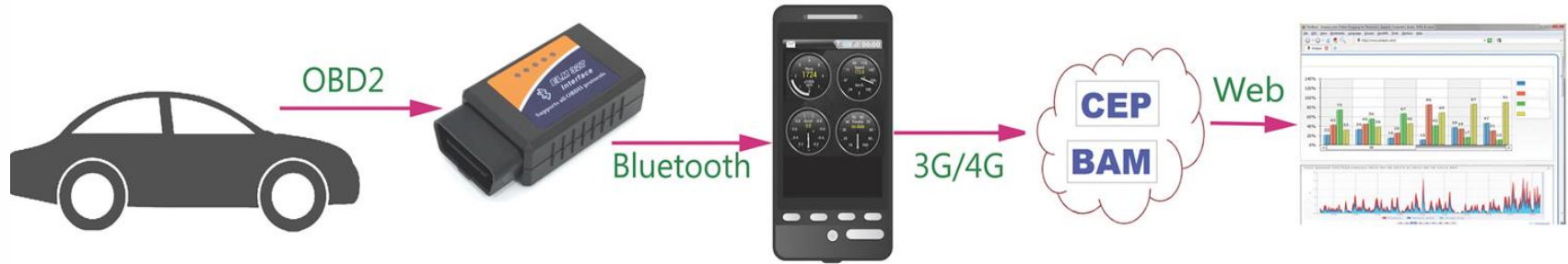


Fault Detection



Driving Anomaly Detection

Proposed Solution



Features:

- Detecting reckless driving
- Identifying driving patterns and anomalies of drivers
- Trip analysis
- Fault analysis on vehicular data

On Board Diagnostics (OBD)

- Modern vehicles consist of lots of sensors
 - Speed, RPM, Oxygen, Mass Air Flow (MAF)
- OBD2 detects stats and failures of those sensors
- Predecessors
 - ALDL 1980
 - OBD 1 1989
 - OBD 2 1994
- Most popular manufacturers have OBD2 after 2005



Data Transmission

- 2 possible approaches
 - Via smartphone as intermediary
 - Through a dedicated hardware



Data Processing

- Data should be processed both in
 - Real time
 - Long term
- Data should be processed at
 - Device / smart phone
 - Cloud
- Complex Event Processing (CEP)
 - CEP on the phone/device
 - CEP on the cloud
- Business Activity Monitoring (BAM)

Mobile App	Back End
Dashboard showing real time OBD2 data	Driver anomaly detection
Trip logs	Reckless driving detection
Coolant temperature monitoring	O2 sensor failure detection
Fuel economy monitoring	MAF sensor failure detection

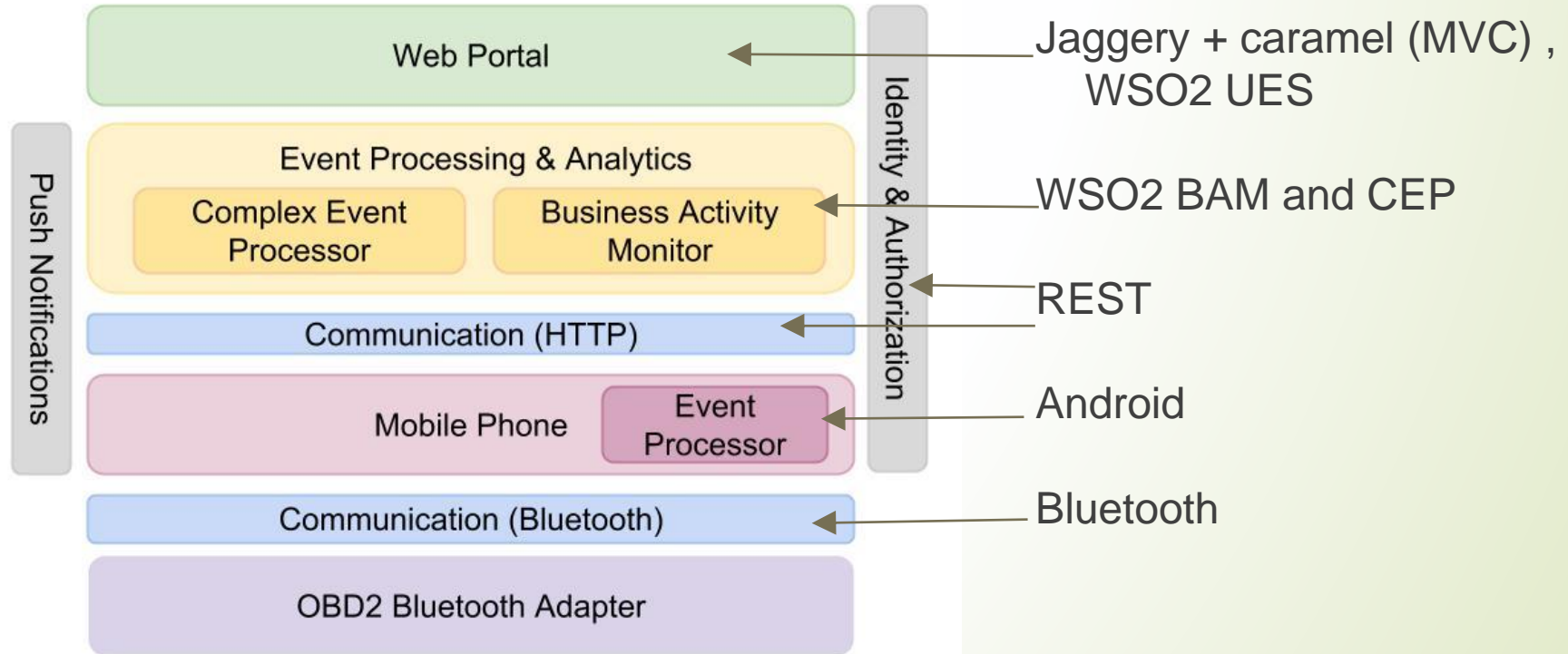
Related Work

- Plainly displays data with little or no processing at edge or cloud
- A driver can't be expected to carry a PC/laptop
- In car navigation system^[1] requires driver to look at navigation pane frequently
- Y. Yang et al.'s system^[2] performs remote monitoring, but analysis not supported
- None of them have the ability to identify impending sensor failures

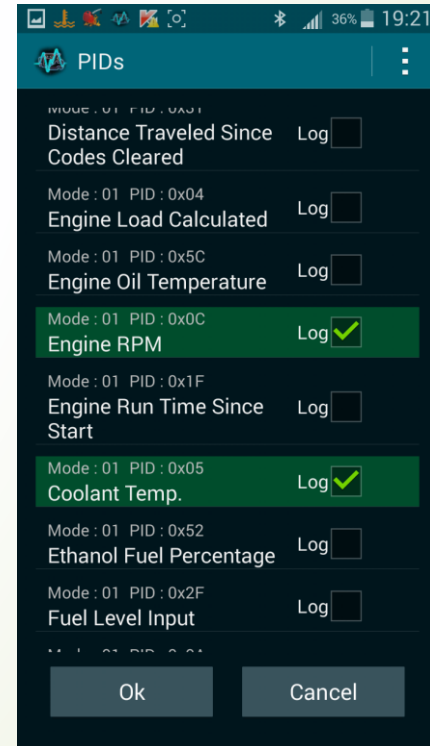
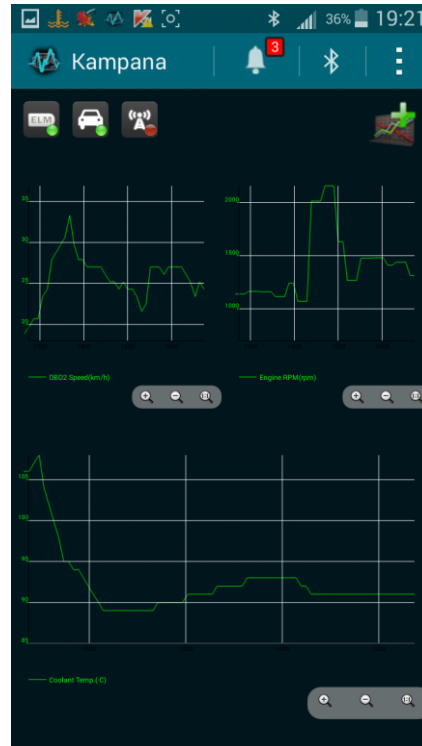
[1] M.J. Kim, J. W. Jang and Y. S. Yu, —A Study on In-Vehicle System using OBD-II with Navigation.

[2] Y. Yang et al., —Research and Development of Hybrid Electric Vehicles CAN-Bus Data Monitor and Diagnostic System through OBD-II and Android-Based Smartphones

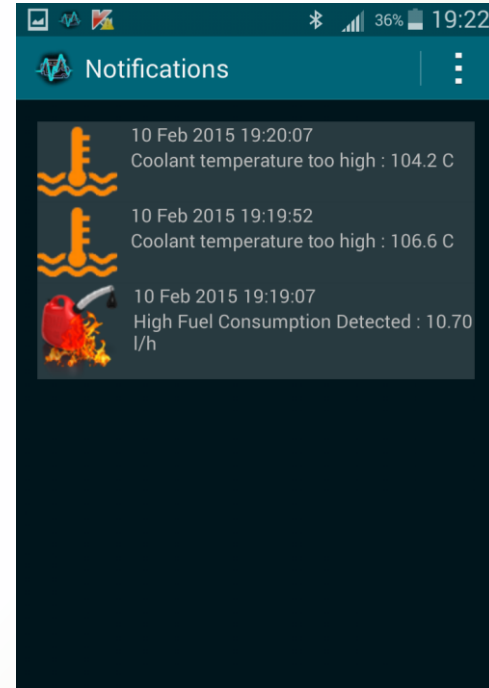
Solution Architecture



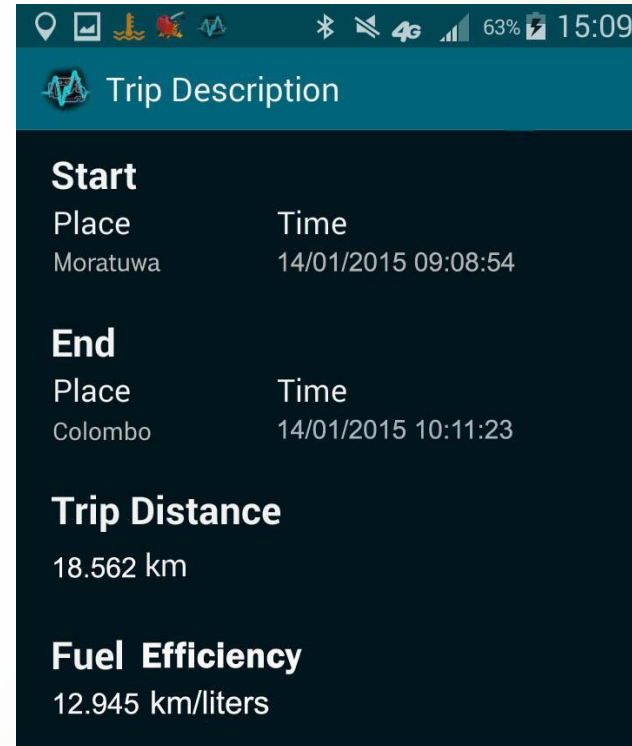
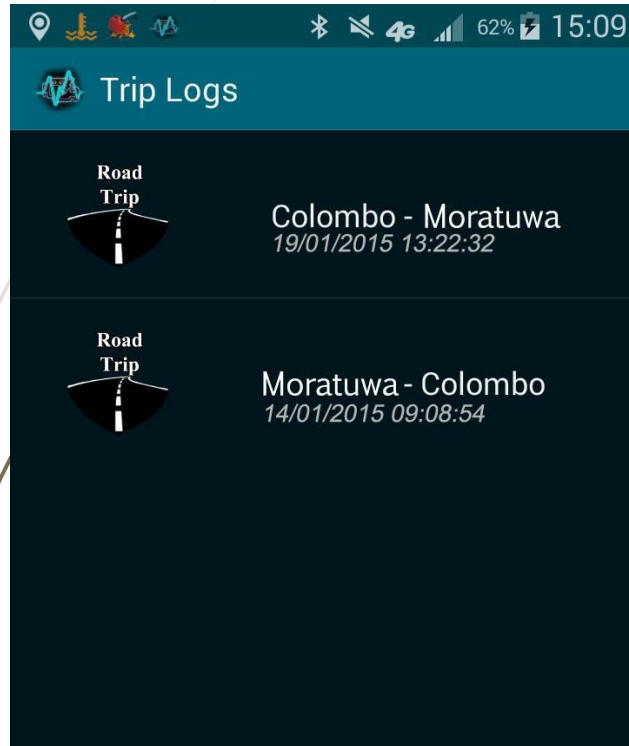
Android App



Fuel Economy & Coolant Temperature Monitoring



Trip Logs

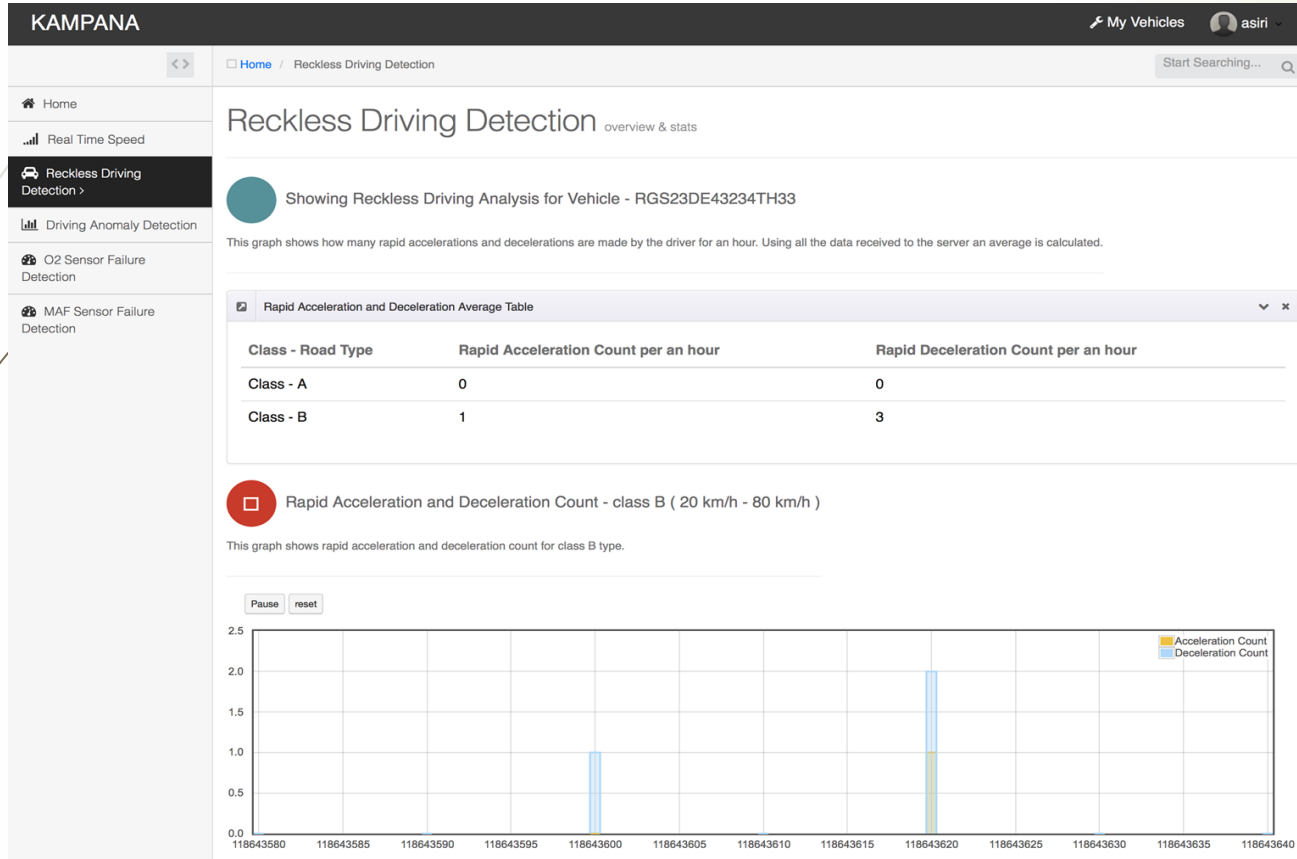


Monitoring Reckless Driving

- Based on hard accelerations and decelerations
- Calculate acceleration count and deceleration per time unit beyond a predefined threshold^[1]
- Classification of above count depend on average speed of vehicle in last t seconds
 - Implemented using Siddhi library
- Summarize periodically and store the data in a relational database
- Show an average rapid acceleration and deceleration count per hour

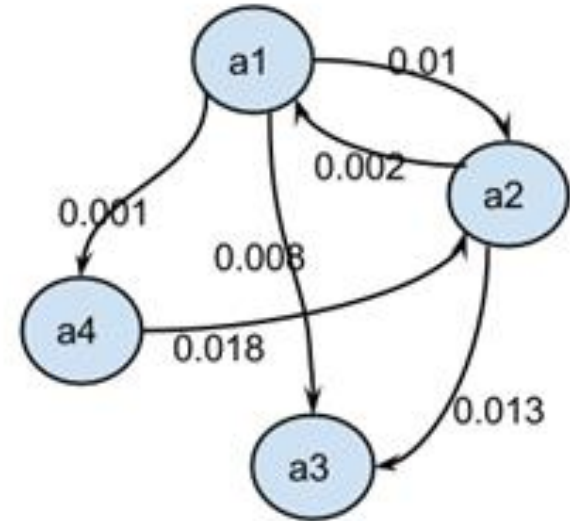
[1] MA.Z . Zeeman and M.J. Booyesen - Measuring recklessness using speed and acceleration.

Reckless Driving Interface

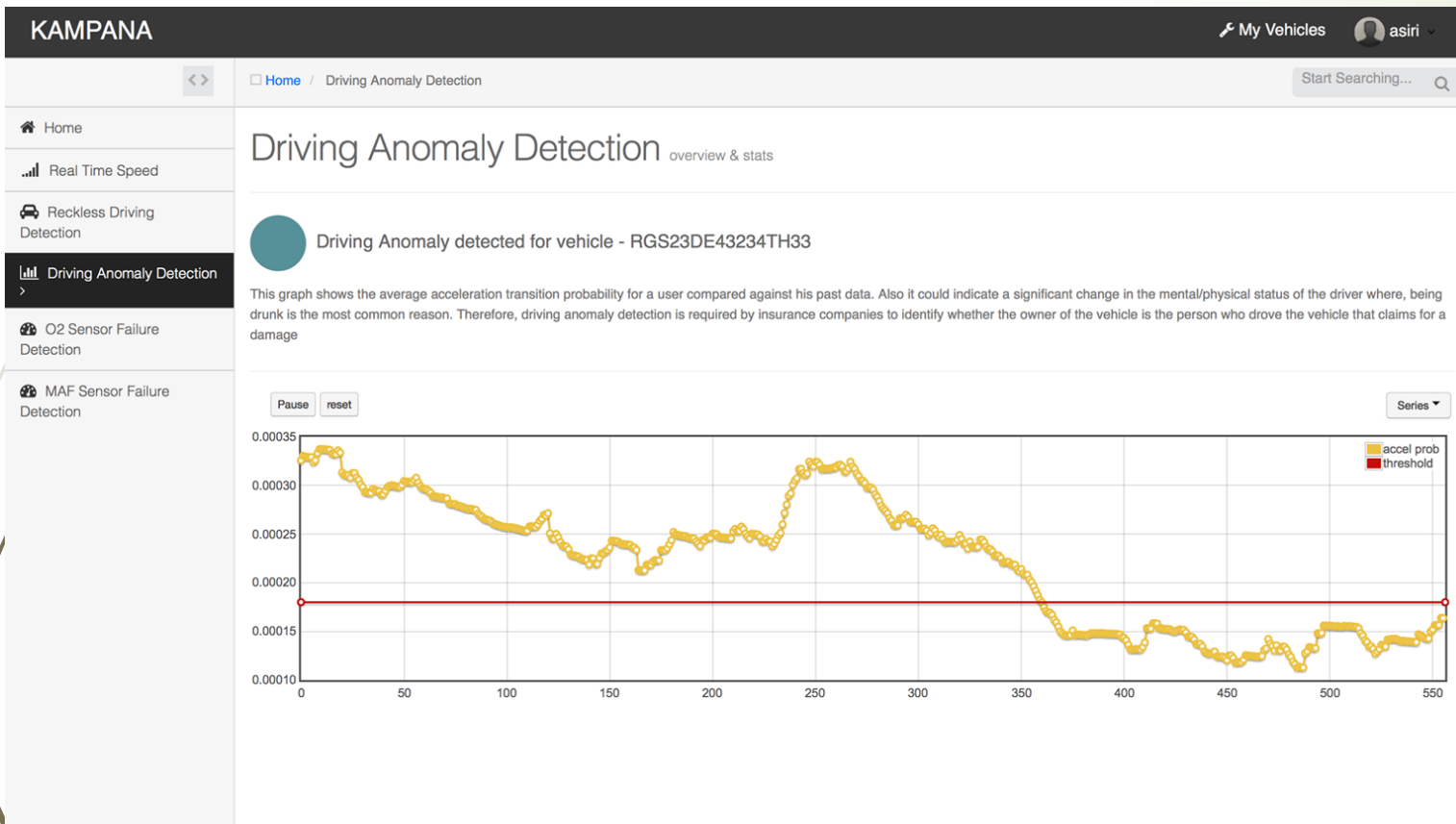


Detecting Driving Pattern Anomalies

- Detection of anomalies
 - Markov Model
 - Model implemented in BAM
 - Validator implemented in CEP

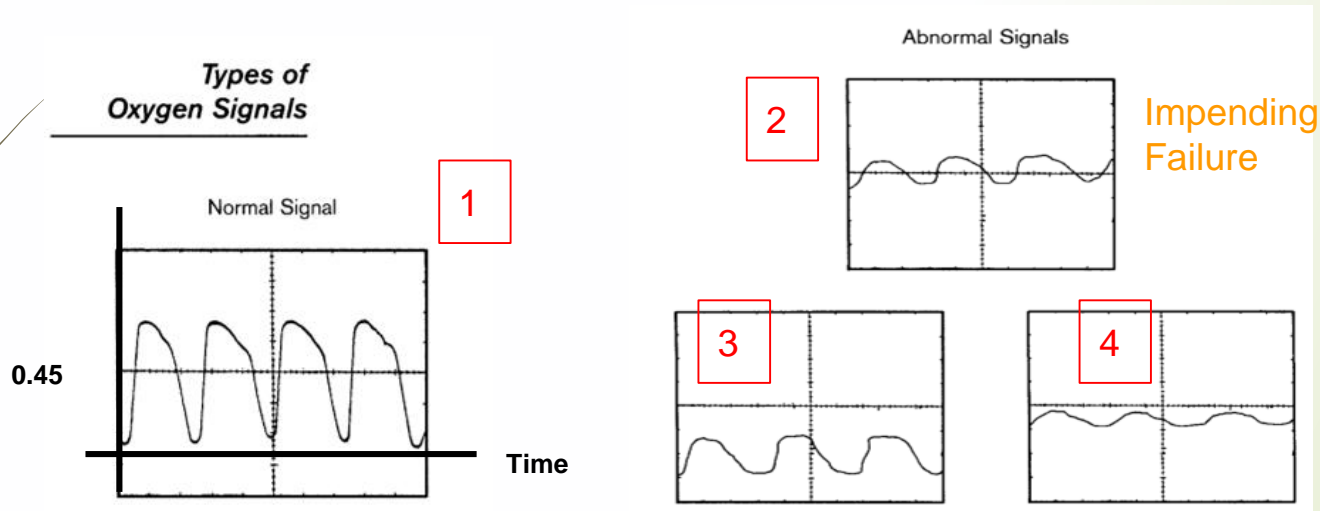


Driving Pattern Anomalies Interface



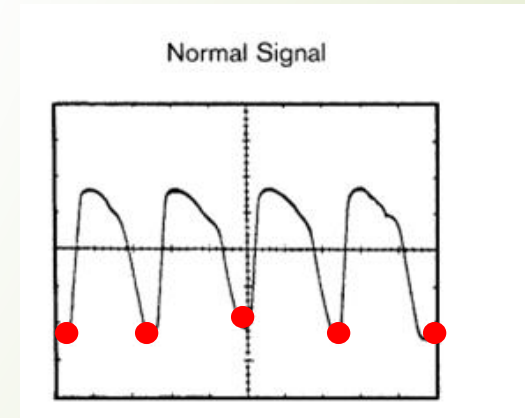
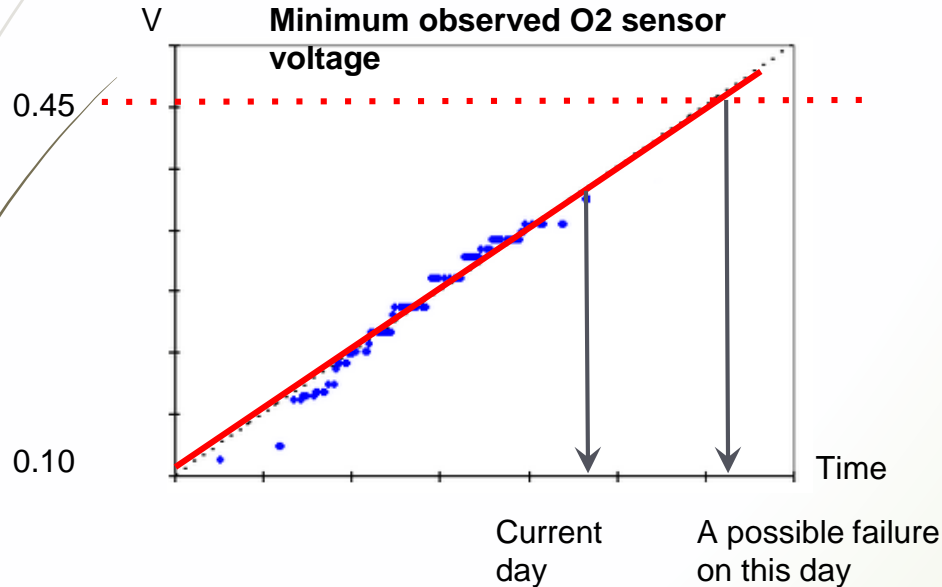
Sensor Failures - O2 Sensor

- Good sensor should fluctuate between 0.2V and 0.8V in lean and rich conditions respectively^[1]

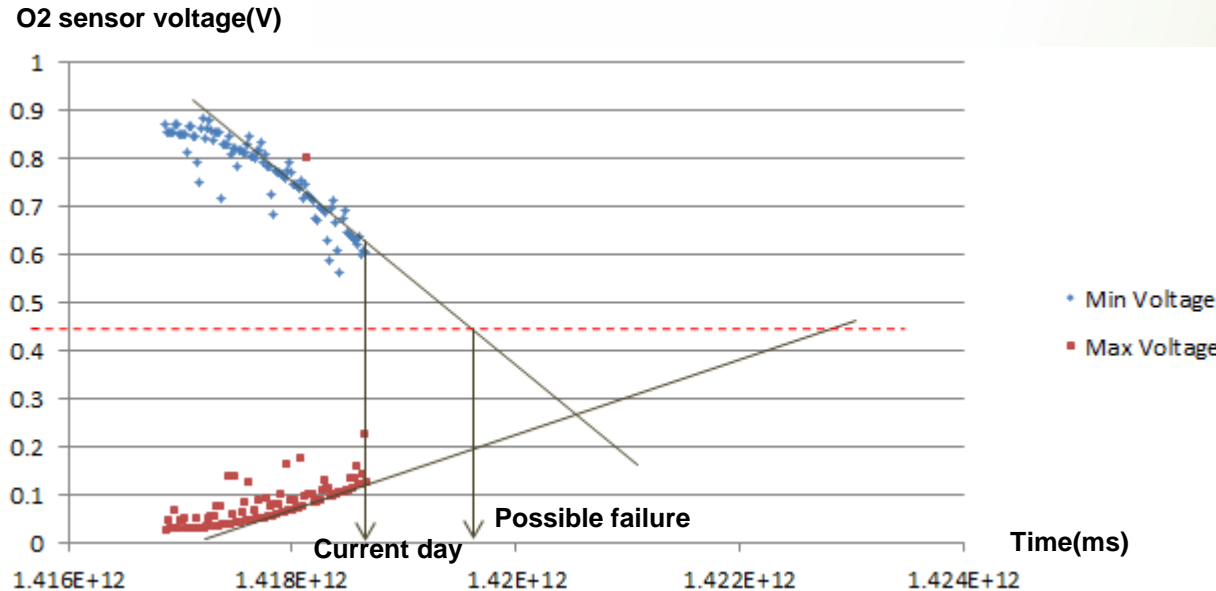


[1] U. I. Toyota Motor Sales, "OXYGEN / AIR FUEL SENSORS," [Online].
Available: oto.teknik.ummgl.ac.id/wp-content/uploads/2013/.../h37-oxygen-sensor.pdf

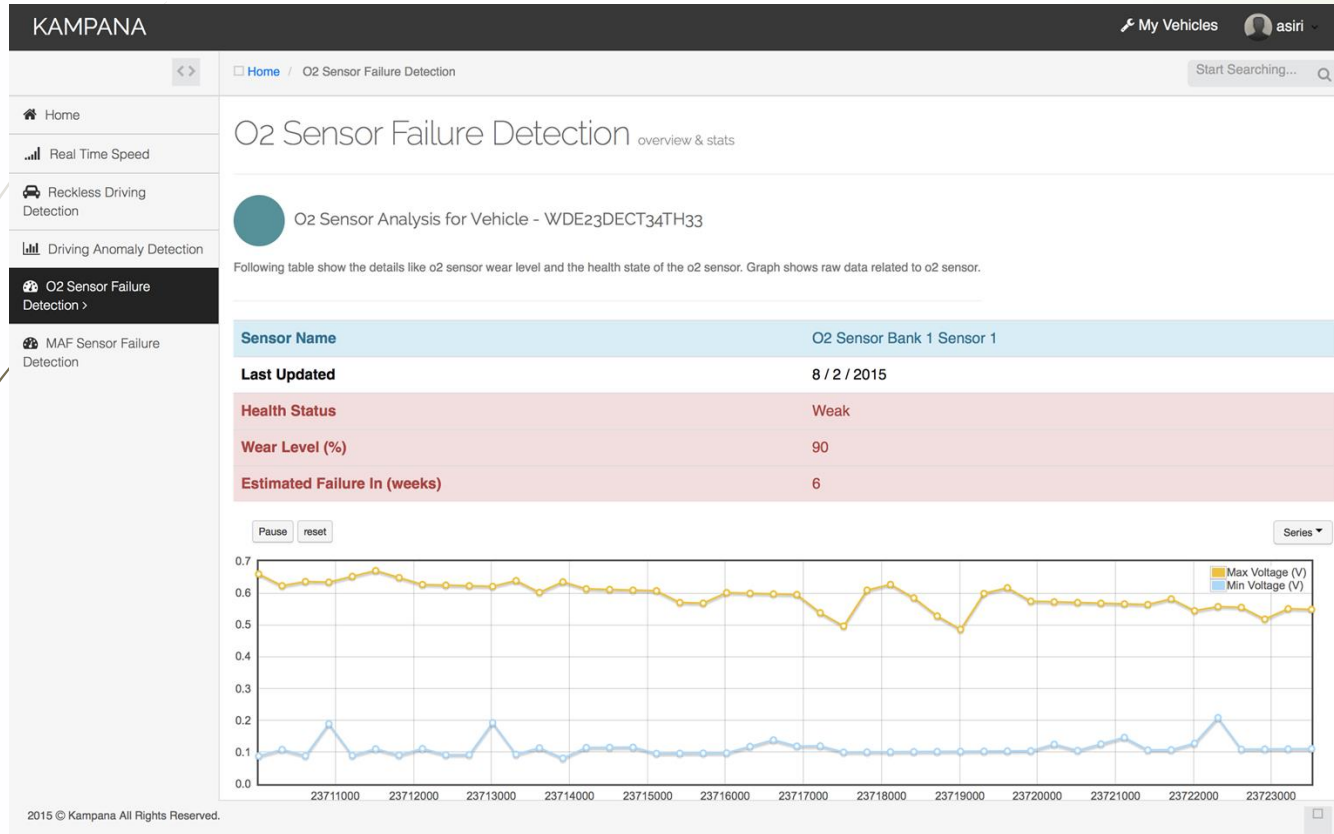
Impending O2 Sensor Failure Detection



Impending O2 Sensor Failure Detection (Cont.)

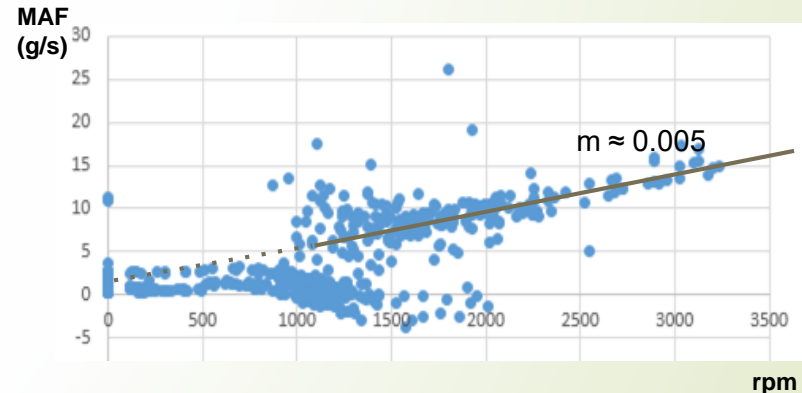
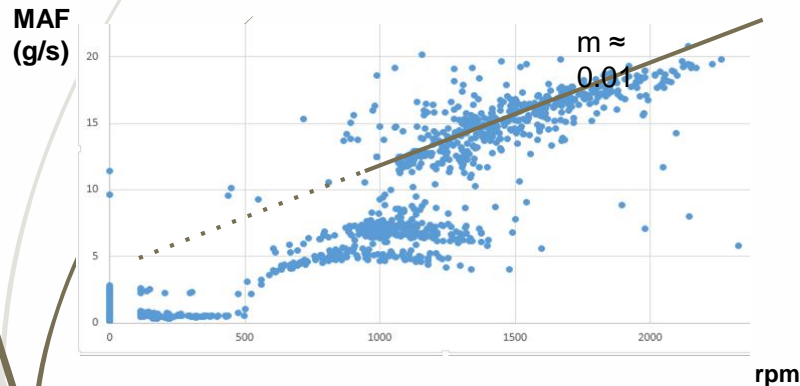


O2 Sensor Failure Detection Interface



MAF Sensor Failure Detection

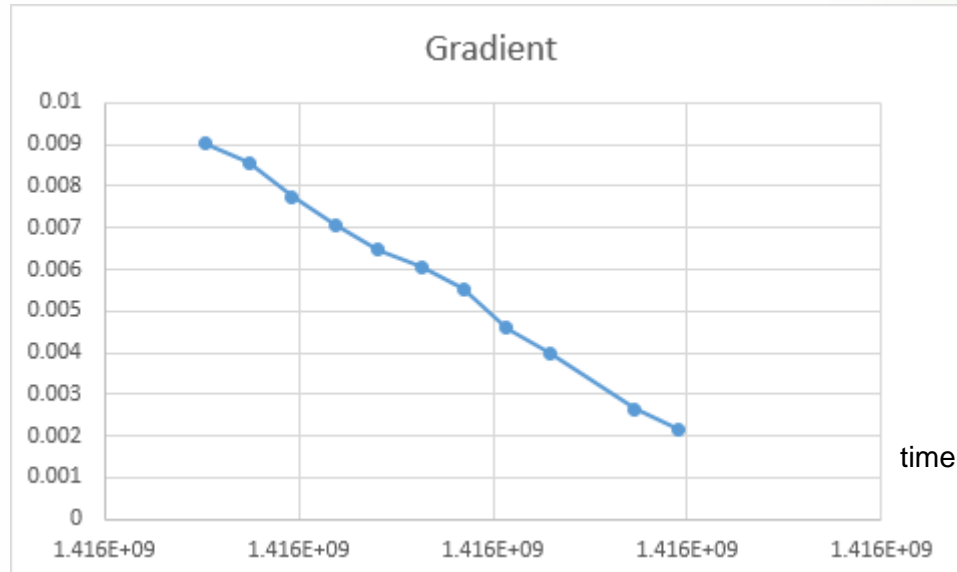
- Mass air flow value has a linear relationship with rpm^[1]
- When sensor fails, gradient between MAF and RPM reduces with time



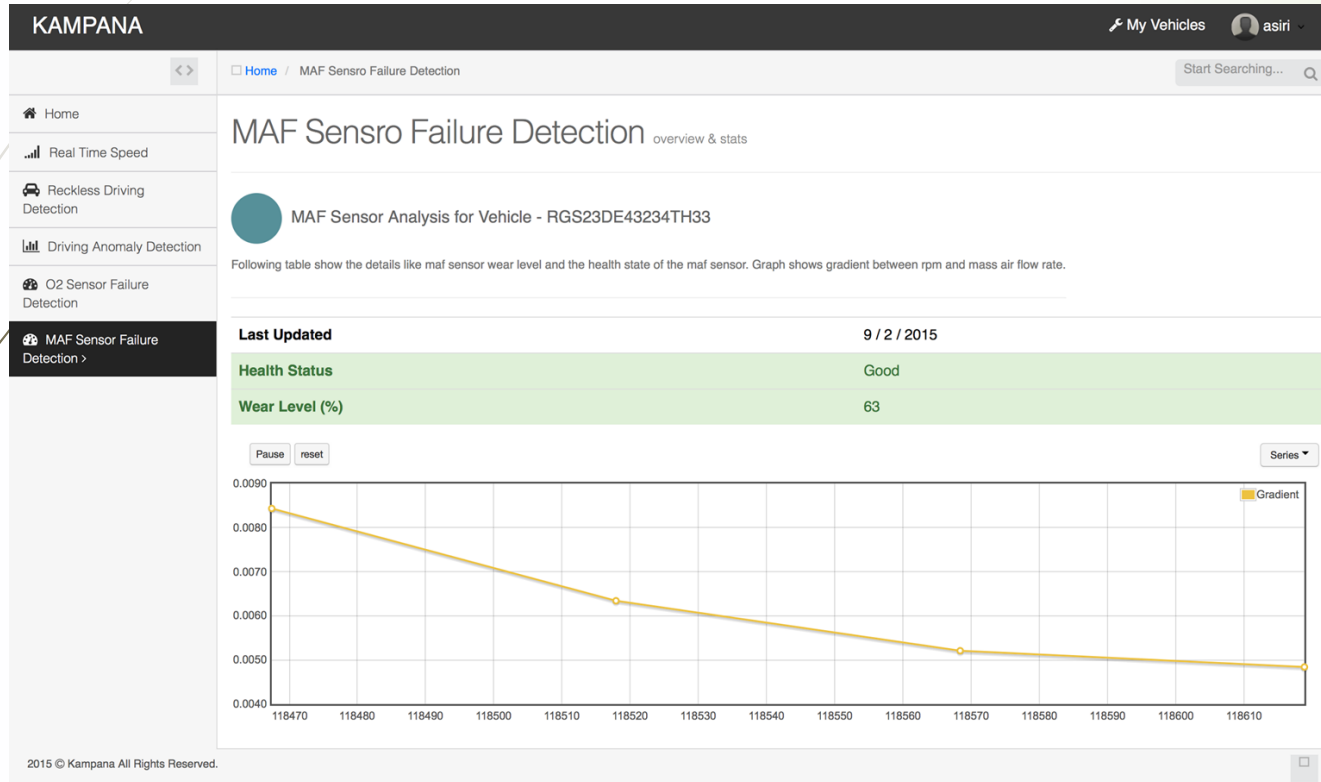
[1] "Volumetric Efficiency and Engine Airflow," EPI Inc., 18 11 2011. [Online].
Available: [http:// www.epi- eng.com/piston_engine_technology/volumetric_efficiency.htm](http://www.epi-eng.com/piston_engine_technology/volumetric_efficiency.htm)

MAF Sensor Failure Detection (Cont.)

- Use regression analysis to detect MAF sensor failure
- Then get the gradient of each line



MAF Sensor Failure Detection Interface



Achievements

- Kampana Android app available on Google Play
- 1,000+ downloads and counting!
- In the process of commercializing

Updated
February 8, 2015

Size
2.5M

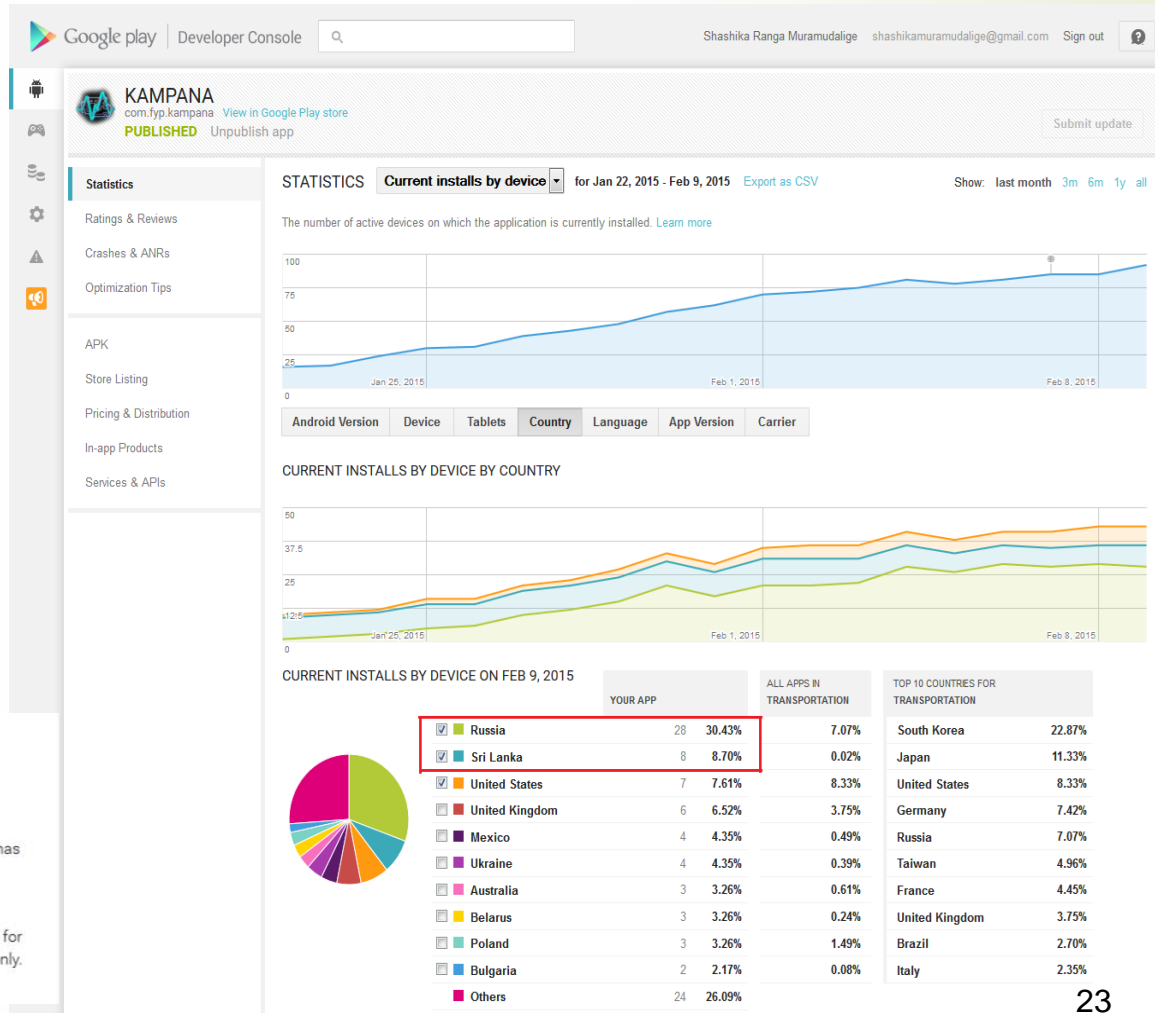
Installs
1,000 - 5,000

Current Version
1.1

Requires Android
4.0 and up

Content Rating
Unrated
Warning – content has not yet been rated. Unrated apps may potentially contain content appropriate for mature audiences only. [Learn more](#)

As of Aug 2015



Limitations And Future Work

- Black box hardware device that can be plugged directly to OBD2 port
 - Required for fleet vehicles
 - OBD2 + GPRS (M2M)
- Support extended PIDs
- Integration with other sensors
- ELM327 adapter doesn't support certain vehicle models
- Comprehensive performance analysis and tuning
 - Thresholds for Reckless driving, MAF failure and Driver anomaly detection
 - Collection of large datasets
- Vehicular data analytics platform



THANK YOU !