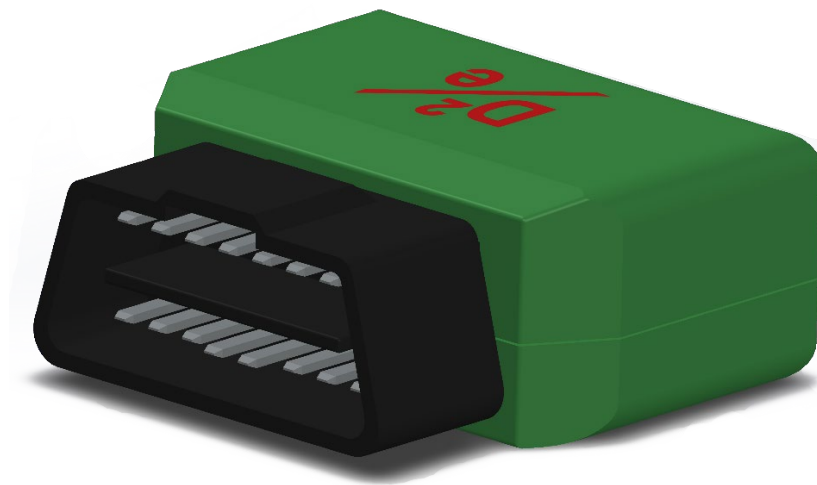# DuxBox™ + DuxApp™

Technical User Guide

Document Information

Revision History

v.0.1 April 13, 2022 Initial Draft

v.0.2 May 30, 2022 Legal Notice added

v.0.3 June14, 2022 DuxBox™ and DuxApp™ branding harmonized

Legal Notice

Disclaimer

Drive Square, Inc ("D^2") provides this Technical User Guide as part its commitment to help reduce driver risk and injury, potentially benefiting the driver's employer ("DE"). However, this guide is not intended in any way to replace or substitute regular safety measures, professional and safety driver training, nor is it intended to provide any warranty, promise, guarantee, assumption of risk or duty, release, or indemnity. DE shall always retain responsibility for their drivers, and D^2 further assumes no liability for driver's or DE's negligence. Product modification or misuse can be dangerous. D^2 disclaims all liability for the consequences of product alterations or modifications, as well as for the consequences which might result from the use of this product in the combination of this product with other products, whether supplied by D^2 or by other manufacturers, unless such a combination has been specifically endorsed by D^2. The design of DuxBox™, the accompanying Manuals and Guides, and the labeling on the device, take into consideration that the purchase and use of the equipment is restricted to trained professionals who understand the safety and security implications of such use. Instructions, warnings, and caution statements are therefore limited to the specifics of the DuxBox™. Any liability based upon product warranty is limited regardless of any fault attributable to D^2 and the nature of the action (including breach of warranty, negligence, and strict liability). The written warranties are in lieu of all other warranties, expressed or implied, including, without limitation, warranties of merchantability, fitness for any purpose, or non-infringement. D^2 shall not be liable for any special incidental or consequential damage incurred by the buyer to a third party. The buyer shall not be entitled to make liability recoveries from D^2 due to such situations.

Warranty

The DuxBox™ warranty does not apply for/ in case of defects caused by misuse, mishandling, tampering, or by modifications not authorized by D^2 or its representatives. Any product which proves during the warranty period to be defective in terms of workmanship or material, will be replaced, credited, or repaired. D^2 retains the discretion to select the most suitable of these options. D^2 is not responsible for deterioration, wear, or abuse. In all cases, D^2 will not be liable beyond the original selling price. Application of this warranty is subject to the following conditions: a) D^2 or its authorized representatives must be promptly notified upon detection of defective material or equipment. b) Defective material or equipment must be returned to D^2 or its authorized representative. c) Examination by D^2 or its authorized representatives must confirm that the defect is covered by the terms of this warranty. The above is the sole warranty provided by D^2. No other warranty, expressed or implied, is intended. Representatives of D^2 are not authorized to modify the terms of this warranty. In no way does this or any of D^2 policies, training materials, guidelines, or instructions create an obligation for D^2 to perform any services.

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1-877-224-7708 ext. 3

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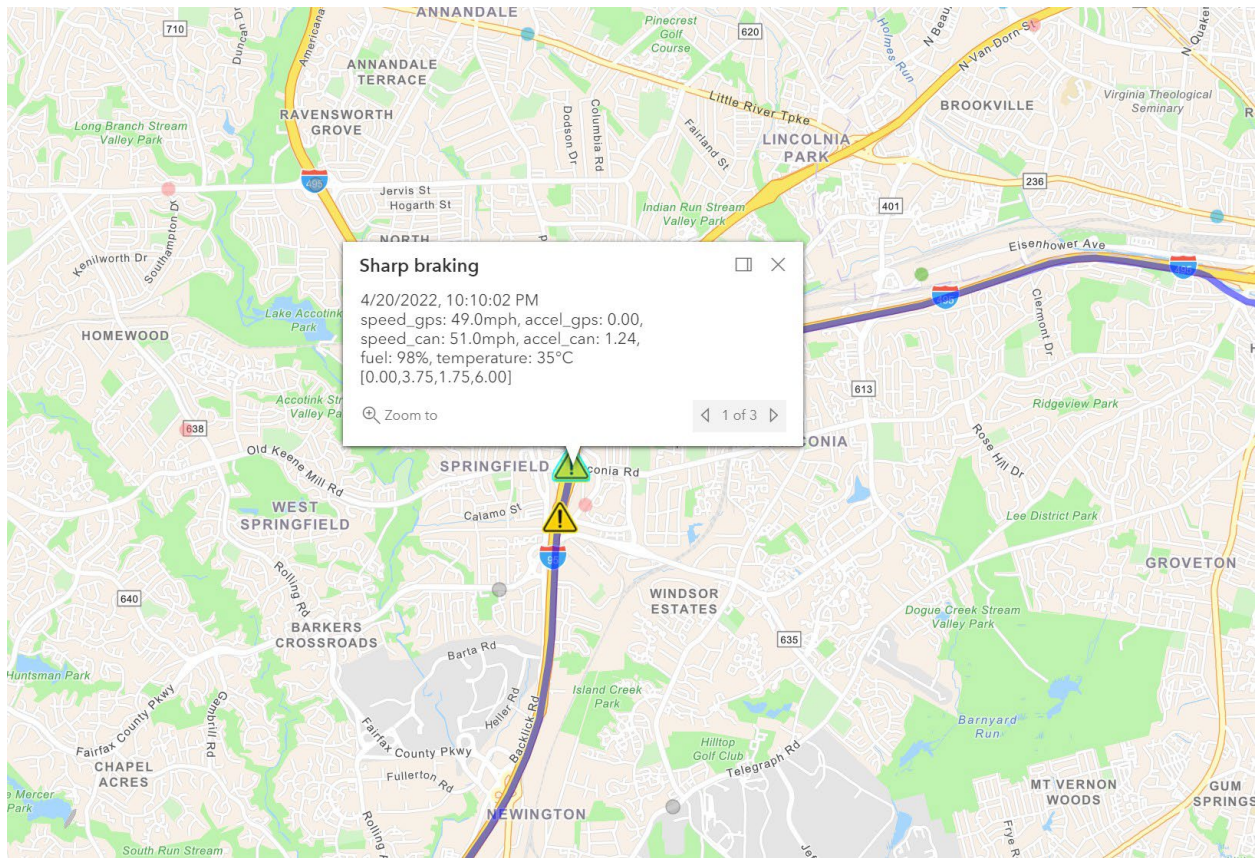
info@dux.eco

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Introduction

According to the National Safety Council over 42,000 lives are lost annually in road collisions resulting in over $470 Billion in losses[i]. Fleets of large, 18-wheeler trucks alone are responsible for over 130,000 injuries[ii]. 77-90% of collisions are attributed to driver error. These numbers suggest that increased driver training and practice aimed at anticipating varying driving conditions, will save lives. Drive Square, Inc. has designed, developed and successfully used driving simulators for driver training for over 20 years.

However, mandatory annual driving safety training for every driver in a fleet is not economically viable for businesses. Consequently, fleet safety departments switch to initial driver training upon hire followed by remedial driver training when the driver has been involved in an accident.

Numerous dash cam devices (such as Lytx, Samsara and others) have been developed to address driver monitoring and fleet safety use cases. Some of these solutions also incorporate machine vision. However, their performance is impacted by road and marking quality, weather conditions, time of day and amount of sun glare. These solutions also require always-on mobile connectivity incurring significant mobile service, cloud traffic and storage costs. Given the intrusive nature of driver monitoring provided by these devices, they raise privacy and security concerns for many organizations and drivers. With high incidence of false warnings, the value to drivers and DE over the additional risk introduced by distraction during driving is not always clear.

DuxBox™ is a simple, low-cost sensor that does not attempt to provide any real-time warnings or driver coaching. The solution does not use video/audio monitoring and never distracts the driver. Using DuxBox™ sensors and the DuxApp™ allows Fleet Safety Managers (FSM) to focus their driver training efforts and personnel action only on the drivers who have experienced near-miss situations before a real collision happens. It can often help to detect such conditions as drowsy and fatigued driving, distracted driving flagging them as adverse events.

With DuxBox™, the FSM can monitor the driving behavior of the drivers in near-real time and also see analytic insights on driving behavior of individual drivers or the fleet over time across overlaid on their route maps. DuxApp™ will provide recommendations on remedial training and identify hot-spots along the routes where adverse events are likely to occur. These insights and recommendations can help the FSM with both operational and long-term planning.

Sharp braking

4/20/2022, 10:10:02 PM
speed_gps: 49.0mph, accel_gps: 0.00,
speed_can: 51.0mph, accel_can: 1.24,
fuel: 98%, temperature: 35°C
[0.00,3.75,1.75,6.00]

Zoom to   ◁ 1 of 3 ▷

DuxApp™ is a tool to help fleet safety management to take remedial steps before an actual collision occurs, reducing losses and saving lives.

Description

DuxBox™ is a simple "Black box recorder"- type device that collects GPS data and vehicle acceleration / adverse event data. The data that is then fused with other relevant data sources gives fleet safety management a view into the safety habits of its drivers.

Wi-Fi connectivity allows for the automatic upload of data when the vehicle returns to the garage or otherwise has internet connectivity. Using opportunistic data upload process makes it possible to operate DuxBox™ without on-going charges to mobile data connectivity provider.

Based on the collected driving data, Drive Square can recommend certain driving scenarios to put a driver through to improve their driving.

The data collected by DuxBox™ can be used in the following ways:

- Sent to any AWS IoT Core based data analysis system to be integrated into a fleet management system. This data analysis occurs in the fleet management system. There are no ongoing costs incurred.
- Analyzed automatically by state-of-the-art D^2 DuxApp™ using proprietary data fusion, heuristic algorithms and AI running on AWS cloud (small subscription cost)
- Manually reviewed by D^2 experts for comprehensive in-depth analysis (higher subscription cost)

By combining the device data with the intersections mapping, historic NHTSA crash, weather, and other data, we flag adverse events and "near-miss" events and develop recommendations for driver improvement.

Such recommendations might include a choice of specific driving-simulator-based driving scenarios that can be indicated for the driver.

FSM and driver trainers can run driver remediation training using Drive Square Driving Simulator or take any other personnel action as appropriate.

Operation

DuxBox™ collects data as it becomes available. Inertial Measurement Unit (IMU) and vehicle's Controller Area Network (CAN) Bus data is being collected only when vehicle engine is running. GPS data is being collected as soon as a satellite fix is obtained.

Data Buffering

DuxBox™ device contains a large data buffer that can accumulate data for several days of driving without being connected to a network. Once the device is connected to a network, the data is published to the appropriate MQTT broker topics and the buffer is emptied. If the internal buffer is full, the old data will be overridden with new, hence keeping about the last 3 days' worth of driving data to be transmitted.

Regardless of when the data is published to MQTT topic, each JSON message contains a time and data stamp as to when a measurement has been taken. The time is UTC epoch time.

Network Connectivity

DuxBox™ contains a list of known Wi-Fi networks (see provisioning). Periodically it checks if any of the networks are available. Once the connection has been successfully established, the device publishes the data on the MQTT broker.

Since the amount of data being transferred is relatively small, the driver's mobile phone Wi-Fi hot spot can be used to transmit the data.

MQTT Publish – Subscribe Topics

Initially, the DuxBox™ device will publish its JSON data messages into the following topics: *DeviceSerialNumber*/GPS, *DeviceSerialNumber*/IMU, *DeviceSerialNumber*/CAN.

Once the device successfully reads the Vehicle Identification Number (VIN) upon a start of a vehicle's CAN Bus, which usually happens upon the engine start, the messages will be posted into *VIN*/GPS, *VIN*/IMU, *VIN*/CAN topics respectively.

DuxBox™ devices will respond with configuration changes to JSON messages published either on *DeviceSerialNumber*/Control or *VIN*/Control topics.

Provisioning of the device

Connect any terminal or terminal emulator to the USB connector on the back of the DuxBox™. A computer will recognize the USB device as a COMXX port. Set the baud rate to 115200, n, 1. Using simple 1-character commands one can provision the device to work with an appropriate cloud service. Type "H" for help menu.

The following connection parameters can be provisioned:

1. List of up to 64 known Wi-Fi network hot spots to connect to. The device will try to connect to the AWS cloud using any of the known networks.
2. AWS endpoint in format xxxx.amazonaws.com
3. Amazon Root Certificate of Authority (Root CA)
4. Device Certificate
5. Device RSA Private Key
6. MQTT Thing Name
7. MQTT topics to post device messages to
8. MQTT topic for the device to subscribe to. Device subscribes to only one control topic. This allows you to set several parameters on the device, such as alert thresholds for a particular driver + vehicle combination.
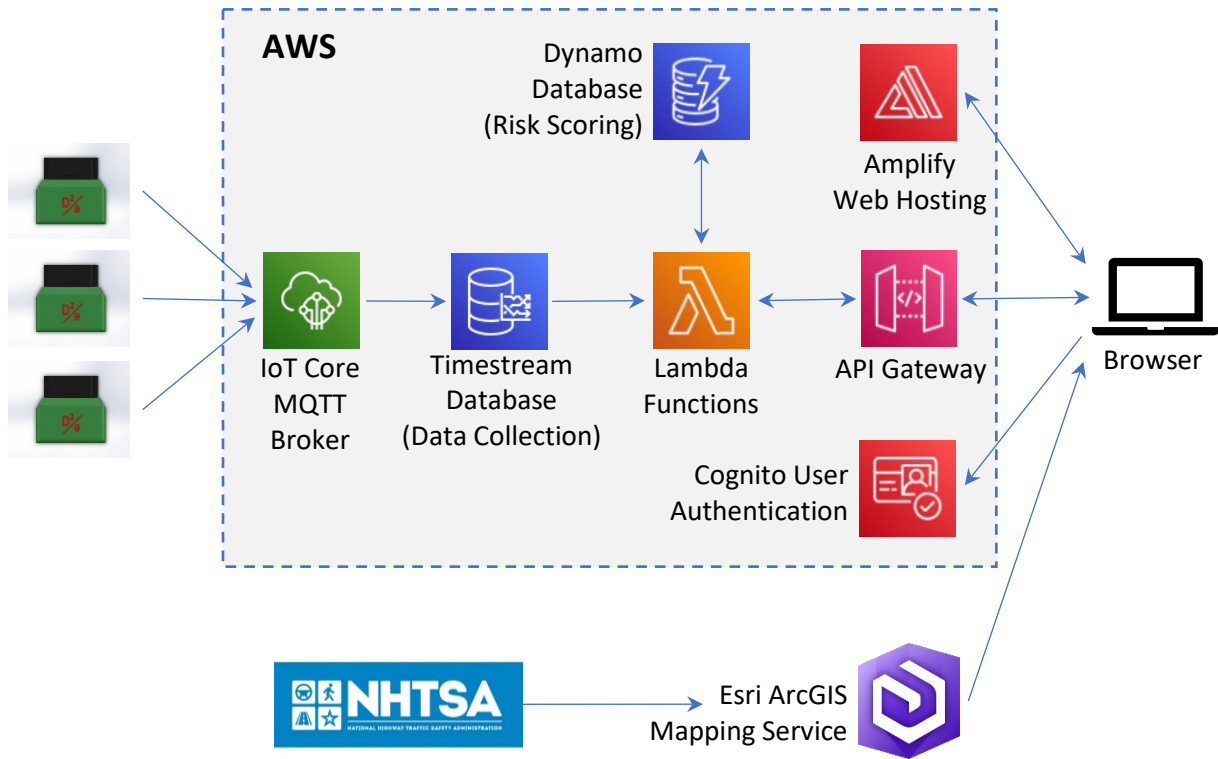
List of terminal commands:

W – Upload List of known Wi-Fi networks and passwords
A – Set AWS endpoint
R – Upload Amazon Root CA
C – Upload Device Certificate
K – Upload device's RSA Private Key
N – Print Thing Name
P – Set subtopic names to publish. Default: /GPS, /IMU, /CAN
S – Set subtopic name for Control functions. Default: /config

DuxApp™

Currently DuxApp™ is a serverless sample application running on AWS cloud.

Every corporate fleet operator has their individually built apps created to comply with corporate safety, security, privacy and data governance policies. Alternatively, DuxApp™ safety scoring functionality is being integrated with customer's existing ERP, logistics, trucking and fleet management applications.

DuxApp™ comprises IoT Core, Timestream database for data collection, a Lambda function for data processing and driver scoring, DynamoDB database for storage of driver risk scoring, a RESTful Gateway and Amplify-based website for access and visualization of driver risk scores by the safety managers. User login is currently supported by Cognito database. DuxApp™ is currently using ArcGIS/ESRI mapping system and is capable of displaying a statistical crash data from the NHTSA's FARS database.

AWS

Dynamo Database (Risk Scoring)

Amplify Web Hosting

IoT Core MQTT Broker

Timestream Database (Data Collection)

Lambda Functions

API Gateway

Cognito User Authentication

Browser

NHTSA
National Highway Traffic Safety Administration

Esri ArcGIS Mapping Service

Technical Data

Dimensions:

Wi-Fi:

- 2.4GHz dual-mode IEEE 802.11 b/g/n-compliant

Power:

- 12V DC via OBD2 connector
- 5V DC via USB connector
- Built-in rechargeable 150 mAh Li-Po battery with power management

Vehicle interface, CAN Bus:

- OBD2 Connector, 16-pin, rectangular
- SAE J1939, 9-pin round connector via an adapter cable

GPS:

- GNSS, 22 satellites, 66-channel, sensitivity -165 dBm

6DOF Event Tracking:

- Accelerometer + gyroscope sensor fusion

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[i] NSC: https://injuryfacts.nsc.org/motor-vehicle/overview/introduction/
[ii] FMCSA: https://www.fmcsa.dot.gov/safety/data-and-statistics/large-truck-and-bus-crash-facts