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## **“Visual M2M” Monitoring and analysis tool for vehicle**

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### **Summary**

Electric and new technology e.g. IoT, are becoming popular in automotive industry. It means the way manufacturer's development processes and its usages are different from what they were/are, and leads to complexity to them. To make them efficient and simple, we developed vehicle monitoring system “Visual M2M for automotive professional” with aptpod, Inc. In this manuscript, we are presenting unique features of Visual M2M and its application so as to understand what Visual M2M is.

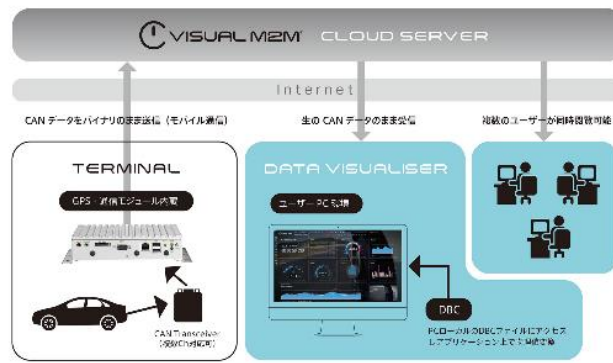
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### **1 Introduction**

Visual M2M is a vehicle data logging/monitoring tool that you can monitor and analyse the vehicle which is developed by aptpod Inc. It consists of VTC terminal hardware which is connected to a vehicle and Cloud server. 3G or 4G connection is available (Depending on network availability) Obtained data will be automatically sent to the cloud server, so you can watch vehicle's real time data wherever/whenever you are. It is basically using as logging tool for vehicle, but it is focusing on real-time. Where development process need to be command globally, it is important to work close together for development team which spread all around the world. Visual M2M is enable you to achieve that and make them faster and easier.

### **2 System**

The monitoring system utilizes an on-vehicle dedicated data processing device that logs various data through a network of on-board devices configured on a CAN Bus and implements a data monitoring system cloud system. This system logs max 4 CAN channel data simultaneously and concurrently executes subsampling and compression processing from raw data of a few msec maximum to resolution of 100msecs, and upload the data to the cloud system via 3G/4G (depending on network conditions) in a real time thus making the real-time monitoring of high-speed data in a remote environment available.



Figur1: Visual M2M System outline

## •2-1 Hardware and Software

To achieve aforementioned system, hardware and software needed to be develop specifically for this usage. In this section, we are presenting specific feature of hardware and software,

### •2-1-1 Hardware: [Visual M2M Terminal system]

To obtain vehicle information and upload cloud server, we need to on-board device which is enables to upload obtained data in real-time.

On board device isVTC100/VTC1000 manufactured by NEXCOM, enable you to log data on multiple CAN Bus simultaneously. Not only data from CAN Bus but data from digital/analogue sensor such as gyroscope and accelerometer sensor can obtainable. To avoid having impact on CAN Bus, device has designated CAN-USB transceiver. VTC fix somewhere in the vehicle which is usually in the glovebox. It is connected to 12v socket, so you have to do is turning vehicle’s power on, wait 6 seconds and hit the road.



Figure 2: Visual M2M Hardware

Table 1: VTC100 specification

<b>MPU</b>	ARM® Cortex®-A8 Processor with 720MHz frequency
<b>Memory</b>	On-board DDR2 256MB
<b>Expansion</b>	1 x CAN Bus 2.0B function, optional OBDII module (SAE J1939/J1708)1 x mini-PCIe socket (USB) x 1 for WWAN option1 x on-board uBlox NEO-6Q GPS module
<b>I/O Interface-Front</b>	2 x USB 2.0 host type A connector1 x Line-out, 1 x Mic-in1 x System reset button2 x LED's for power, storage1 x Power button1 x SIM card socket4 x Antenna hole reserved for SMA-type antenna connector (WWAN/WLAN)

<b>I/O Interface-Rear</b>	1 x 9 ~ 36VDC input with Ignition and 6W typical power consumption 1 x DB9 RS-232 (COM1) 1 x DB9 RS-485 (COM2) 1 x DB9 female connector for 3GPI and 3GPO 1 x DB15 VGA 1 x RJ45 with LEDs for 10/100/1000Mbps Ethernet 1 x SMA-type GPS antenna connector 1 x Antenna hole reserved for SMA-type antenna connector (WWAN/WLAN)
<b>Expandable Storage</b>	Micro SDHC Slot (Bundle with 4GB)
<b>Power Management</b>	Selectable boot-up & shut-down voltage for low power protection HW design ready for 8-level delay time on/off at user's self configuration Power on/off ignition, software detectable
<b>Operation System</b>	Windows Embedded Compact 7 Linux 3.2
<b>Dimensions</b>	180mm (W) x 110mm (D) x 45mm (H) 0.5 Kg (1.10 Lb)
<b>Construction</b>	Aluminum top case with metal sheet
<b>Environment</b>	Operating temperatures: Ambient with air -20°C to 70°C Storage temperatures: -40°C to 80°C Relative humidity: 10% to 90% (non-condensing) Vibration (random): 2g @5 ~ 500 Hz Vibration: Operating: MIL-STD-810G, Method 514.6, Category 20, Ground Vehicle – Highway Truck Storage: MIL-STD-810G, Method 514.6, Category 24, Integrity Test Shock: Operating: MIL-STD-810G, Method 516.6, Procedure I, Trucks and semi-trailers=20g Crash hazard: MIL-STD-810G, Method 516.6, Procedure V, Ground equipment=75g
<b>Standards/ Certifications</b>	CE approval FCC Class B

## •2-1-2 Software

### •2-1-2-1 Visualizer/Dashboard

It has a compatibility with HTML5, so you can monitor logging data through [Visual M2M Visualizer] which can be accessed from typical web browser. It has many function to make logging and analysing easier.

1. Design: Though typical logging device is systematic, but it is not simple and one-glance distinguishable design. Our design goal is simple and easy operation. Visualizer consists of some unites which is visualized logging data. We careful designed overall dashboard and visualized unit, it is easy to understand to vehicle data.



Figure3: Monitoring Dashboard 1

2. Customisable: We offer various visual units supporting various data such as map, GPS data, movie from action camera, meters and graph. And you can customise dashboard for your preferences.

Visual unit' location and size aren't limited so you can locate anywhere in the dashboard in any size.

Furthermore, each visual part is compatible with SVG (Scalable Vector Graphics), you always have a clear dashboard regardless of unit size.



Figure4: Monitoring Dashboard 2

3. Obtainable data:

CAN Bus data mapping and displaying GPS data, tracing mobile GPS, and video captured by an action camera and any analogue data from sensor attached to vehicle. Due to limitation of network line speed, it is unable to upload captured video in real-time. But by integrating captured video into obtained data afterward, you can see and analyse past stream data with captured video.

4. Security

Though we don't restrict its usage, but many users tend to use this system for their development. It means its obtained data have to be away from public. Our advanced client parse processing, authentication of the terminal of vehicle and data transferring method (SSL encrypted communication) keep data secret.

5. Accessibility

Real-time data and past vehicle data are stored in cloud server. Our service is not limited the number of account furthermore the number of account don't affect cost at all. People from all over the world who have an account of certain vehicle can monitor real-time or past vehicle data simultaneously as long as you are in a range of mobile line.

### 3 Function

#### 3-1 Driving data logging

Driving data acquired from vehicle are retained in the cloud system. Analyzing driving data helps to understand performance and conditions of vehicle and to predict subsequent conditions thus contributes to stable operation and making testing much easier and efficient. For example, Figure 7 the year-round power consumption characteristics of based on driving data acquired from Electric bus which is operated by northern region. You can see difference of monthly average which could be caused by temperature and road condition difference by season.

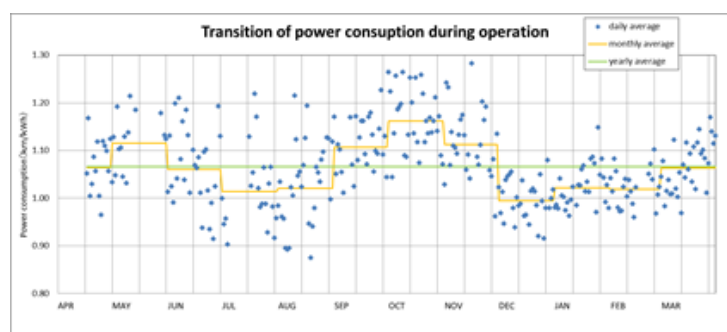


Figure5: Power consumption characteristics

### 3-2 Management

#### 3-2-1 Vehicle Administration

A maintenance system utilizing the vehicle monitoring system helps to support the maintenance service provider by remote vehicle management. Besides the real-time monitoring function, the vehicle monitoring system can distribute set items via e-mail hence it allows service engineers to quickly respond to vehicle abnormality even when they are not monitoring at all times.

Other than the real-time monitoring, the vehicle monitoring system function includes a function that distributes pre-arranged items as an operation summary via e-mail. This function helps engineers to understand vehicle conditions even though they don't monitor vehicle condition all the time,

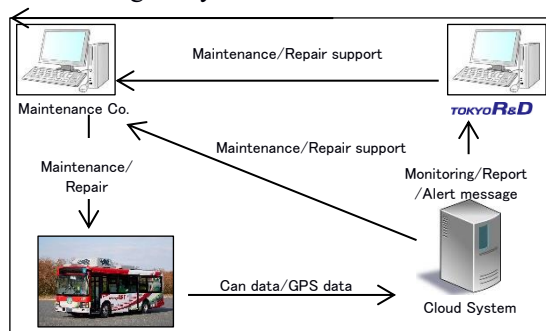


Figure6: Maintenance system utilizing vehicle monitoring system

### 3-3 Other management function

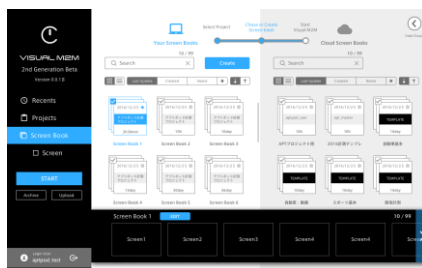


Figure7: Project Administration image

### 3-4 Infinite possibilities for any usage

Visual M2M has wide range of customisation, so there are various applications that we also never come to mind. For example, Visual M2M is already use in various fields: automotive industry, fitness spots industry, robotics industry. Furthermore, basis of visual M2M (It is PaaS solution while Visual M2M is SaaS solution.): intdash has an ability of interactive communication, “remote control” would broad its possibilities. These flexibility is result from customers demand. Our customer purpose is different. They want to do something from obtained data rather than just monitor vehicle information. For example, Visual M2M has its mobile app. This app can show obtained data as secondary monitoring device. This app even has a ability to act as remote controller for something. As another customise case is introduced in section 4, there is another example customisation. It can be arranged according to customer needs, requirements, and purposes. Development, operation or any usage of vehicle including EV become easy and efficient as far as Visual M2M is applicable for customer's requirements.

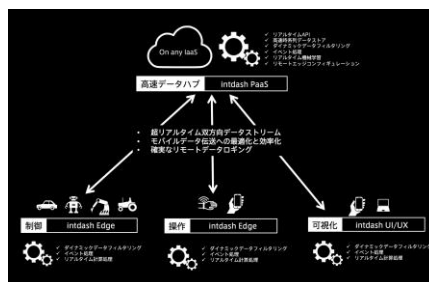


Figure8: intdash system

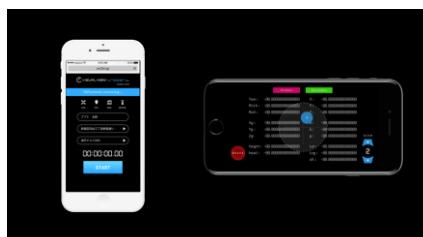


Figure9: Visual M2M Mobile App

## 4 Application for EV

Visual M2M is already used on the road. We are presenting some application (including ICU vehicle) in order to understand how Visual M2M is used.

### 4-1 Better Place EV Taxi - battery-charging and battery switching services for EV taxi.

Better Place, established in 2007 in United States and bankrupted and liquidated in 2013 is a venture-backed international company that offered battery switching service. In 2010 90 days switchable battery EV taxis demonstration project started in Roppongi, Tokyo. We converted Qashquai (Dualis in Japan) into EV including EV systems. But we have one more thing to do with its vehicle. We've been asked to develop vehicle monitoring system. With monitoring system, Operator needs to know vehicle's position and vehicle's condition such as battery SOC for efficient operation. But we didn't have an ability to develop such system, so we affiliate with aptpod Inc. to co-develop monitoring system.

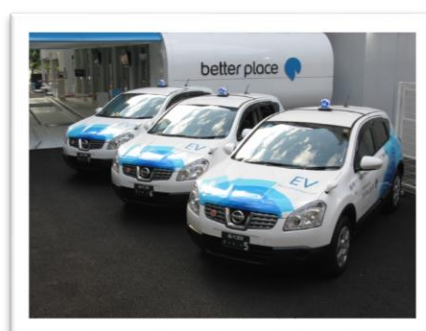


Figure10: Battery Switchable taxi



Figure11: Battery Switching

#### 4-2 BRT (Bus Rapid Transit) at Tohoku region

This BRT run in Tohoku coastal area instead of train where was hit by Great East Japan Earthquake on March 11 2011. Due to its impact of tsunami, coastal railway was destroyed but there was a demand alternative transportation system. At first, it was temporary measurement while restoring train which was given up and become permanent service. Our usually make vehicle for test, evaluation. But this vehicle is for usual bus operation, so we need to ensure that this vehicle has same reliability as ICE bus. While we carefully built vehicle to ensure its reliability, it is necessary that we constantly know vehicle's condition in order to deal with trouble quickly.

#### 4-3 Demonstration testing of EV charging technologies in Republic of the Marshall Islands.

This demonstration testing in Marshall Islands aim for increasing self-sufficiency and reduce energy costs including transportation cost which have been challenges facing the country. Marshall Islands rely on imports for most of its energy supply and facing rising sea level, therefore it is critical to take some measurement against global warming by reduction of CO2 emissions.

Honda and Japan government team up to introduce 3 FIT EVs in Marshall Islands. These 3 EVs are first electric vehicle introduced in Marshall. It means there are no EV experts in Marshall and no know-how to maintain EV. While it need to educate local people to be able to maintenance the vehicles, it needs to do back up service from Japan.



Figure12: FIT EV and Charger

To achieve smooth operation, we implemented Visual M2M to the system. Figure4 shows how visual M2M work in this project. Engineer in Japan can always watch vehicles condition whether is there any serious problem they have to take care. While they don't have to send resident engineer to Marshall Island,



Figure13: Network System

#### 4-3 Smart Hydrogen Station (SHS)

SHS is packaged hydrogen create, store, and supply device which is developed by Honda. There is one project that operating SHS without commercial power supply which is using wind power generation, photovoltaic generation and Fit EV as stationary battery pack. Fit EV store power from photovoltaic and send power to SHS when needed. The purpose is to use unstable renewable energy efficiently. Visual M2M is installed to Fit EV in order to monitor battery conditions.

## **4-4 Application for non-EV vehicle**

Its usage is not limited to EV. There are unique applications for ICE vehicle. In this section, we are presenting unique application for ICE vehicle include future plans.

### **4-4-1 Driving evaluation system**

As mentioned in section 3-4, Visual M2M has wide range of customisation by using lot of API. Driving evaluation system demonstrates its customisation capability. It enables you to evaluate and score your driving skills such as handling, acceleration/deceleration, judgment ability while you are driving at a dedicated closed course. It helps to educate skilful driver for the road and manufacturer's test driver.

### **4-4-2 ADAS Monitoring System (Under development)**

Driving assistant technologies are becoming popular for aiming autonomous driving. There are some vehicles equipped with semi-autonomous level technology on the market. When you develop semi-autonomous or even fully autonomous vehicle, scrutinize vehicle already on the market (Reverse engineering) is important. Therefore, we are developing ADAS monitoring system that makes comparison much easier. Integrating vehicle information and data from sensor into Visual M2M to monitor vehicle/sensor response to the situation,

## **References**

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