# Keeping the Connected Car Current with SOTA/FOTA

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# Agenda

- From HW to SW defined systems
  - Increasing amount and complexity of SW
  - Impact of SW updates
  - The need to manage SW updates differently
  - New requirements imposed by the app revolution
- Applying mobile concepts to automotive: FOTA/SOTA
  - Automotive challenges for software upgrades
  - Adaptation of  FOTA/SOTA to automotive needs
- Vehicle Relationship Management (VRM)
  – taking the connected car to the next level
  - VRM portals
  - VRM platform
  - OTA agent
- Summary and Outlook

# From HW to SW defined systems

- Software in vehicles has expanded dramatically
  - Premium vehicles typically have 80-100 Electronic Control Units (ECUs)
  - 100 Mio LoC today, likely to grow to 200-300 Mio LoC within the near future*
  - Increasing number of software problems
  - Increasing need for frequent/urgent fix & update
  - Increasing software maintenance cost

- Increasing system complexity
  - More connections
  - More interfaces
  - More safety services
  - More displays
  - More independent SW suppliers

- Updates happen over the life of the vehicle to
  - Resolve SW issues
  - Introduce new features
  - Improve safety
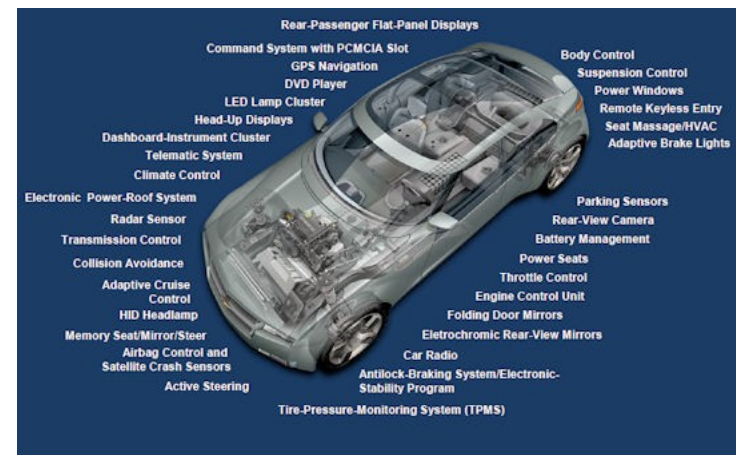
# Impact of SW updates to stakeholders today

**OEM**

- Needs to manage the increasing complexity of multiple versions, interactions, increasing test paths
- Manage distribution of SW updates to the dealerships or consumers
- Car companies repair/recall costs are escalating rapidly

**Dealer**

- An update process for IVI/ECUs can take 30-120 minutes
- Blocks the "normal" garage activities
- Limited number of daily updates due to required time and equipment

**Consumer**

- SW update requires owner to return to dealership, leave the vehicle to be updated (appointments, loaner cars, etc.) or
- Car owner needs to apply SW update by himself (uncontrolled; large customer support burden for OEM)
- Customers are inconvenienced; satisfaction suffers; negative impact on next buying decision

# Need to manage SW updates differently…

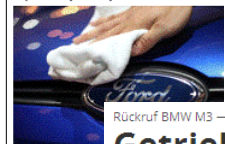## Ford To Send Owners Software Fix For Dashboard Touch Screens

By Keith Naughton - Mar 5, 2012 10:...

Jan 19, 2012 - 11:18AM PT

Ford Motor Co. (F), which h...
than 300,000 owners of the...
loaded with new software t...
company said.

"We know that there's a gr...
Touch that were not workin...
Ford's product-developmer...
these improvements will pu...

Enlarge image

## Fisker recalls electric cars again, due to software glitch

BY Katie Fehrenbacher

2 Comments

Updated. Electric car maker Fisker ...
Karma, this time due to a ...
systems, reports Hybridcars. Fi...
is fixed.

Updated. Uh-oh. Electric car maker Fisk...
Automotive has issued its second re...
inaugural car the Karma, this ...
software malfunction that affected its

## Toyota to recall Prius hybrids over ABS software

See video, below

By Martyn Williams
February 9, 2010 04:59 AM ET

6 Comments

+ Briefcase

...ews Service - Toyota plans to recall around 400,000 of its Prius hybrid
... replace software that controls the antilock braking system (ABS), the

## ...nda ...s 2.5 million vehicles on software

...5 million cars, small

DETROIT: General Motors has halted the sale
... 60,000 2013 models, including its
... compact car and Equinox
crossover, to repair a software problem that
affects the vehicles' OnStar communication
system.

The cars are now on US dealer lots and the
repairs should be done by early next week, said
GM spokesman Alan Adler on Friday. The fix
takes about 30 minutes.

Eight models are affected, including the 2013
Cadillac XTS sedan and the newly launched
2013 ATS sports sedan, which just started to arrive in showrooms.

Rückruf BMW M3 — 25.11.2008

## Getriebe-Aussetzer

BMW ruft deutschlandweit rund 1000 M3 in die Werkstatt. Betroffen s...
mit Doppelkupplungsgetriebe: Bei schnellem Zurückschalten kann de...
ausgehen. Ein Software-Update soll das Problem beheben.

*...eral Motors has halted ... sale of about 60,000*
*... 3 models to repair a software problem that affects*
*...e vehicles' OnStar communication system.*

2013 ATS sports sedan, which just started to arrive in showrooms.

### Allmost all OEMs are facing similar issues…

- http://www.bloomberg.com/news/2012-03-05/ford-to-send-customers-touch-screen-controls-update-after-rankings-plunge.html
- http://www.computerworld.com/s/article/9153938/Toyota_to_recall_Prius_hybrids_over_ABS_software
- http://www.reuters.com/article/2011/08/05/us-honda-recall-idUSTRE77432120110805
- http://gigaom.com/cleantech/fisker-recalls-electric-cars-again-due-to-software-glitch/
- http://www.autobild.de/artikel/rueckruf-bmw-m3-810959.html
- http://timesofindia.indiatimes.com/tech/news/software-services/Software-glitch-forces-GM-to-halt-sales-of-60k-cars/articleshow/16335551.cms

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# The App revolution

- Vehicles traditionally have focused on firmware based software – i.e. software that is 'burned' into the component at time of manufacture, requiring a complex upgrade process

- The trend of 'bringing Apps' to the vehicle provides the ability for the customer and/or manufacturer to download additional functionality, e.g. user interface, maps, POIs, location based information, applications,  etc.

- New types of software introduce new update requirements, e.g.

  - Firmware storage in read-only memory (ROM) versus software storage in random access memory (RAM)

  - Firmware update sporadically versus app download in real-time

  - Firmware from a controlled source (OEM approved) versus software from a potentially uncontrolled source (app store)

# Mobile : Components of a FOTA/SOTA system
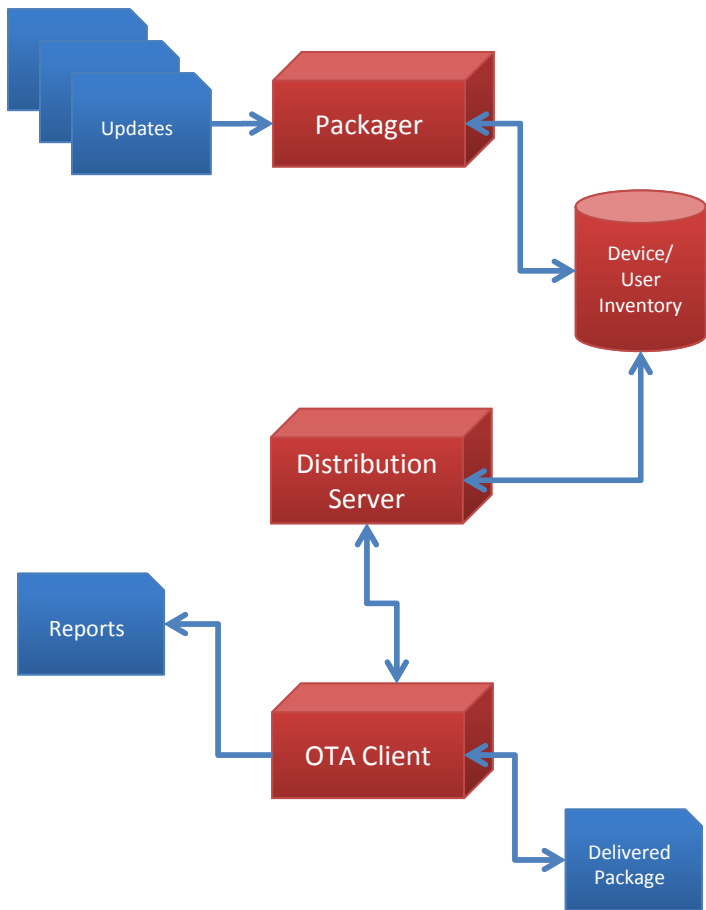


- Packager
  - Packages multiple software updates into a single update package for the target device(s)
  - Can be a single package for a number of devices, or personalised down to the individual device

- Device / User Inventory
  - Inventory of known registered devices and users
  - Enables the system to be aware of the target devices and current software installed on those devices
  - Enables 'delta' updates to be shipped to the device

- Distribution Server
  - Server side distribution of the data package – e.g. using 3G network

- Device OTA Client
  - Receives the software package, unpacks it, and runs through the process of installation
  - For a firmware installation this includes backup, copy firmware, reboot phone and initialize the new software
  - For application installation this initiates the app install routines

- Reporting
  - Successful round trip reporting

# Automotive challenges for software upgrades

| Dimension | Mobile | Automotive |
|---|---|---|
| Safety | Updates are not affecting public safety | Updates MUST NOT impact safe operation of the vehicle |
| Security | Protection against unauthorized device access + threats from apps / Internet | Protection against unauthorized device access and threats from apps / Internet; Protect safety-critical functionality |
| Convenience | Updates typically under user control and relatively small | Updates SHOULD NOT impact the operation of the vehicle, e.g. cause long downtimes |
| Dynamic Environment | User can control to be in wireless coverage when updates occur | Vehicle may be moving in and out of coverage during an update |
| Complexity | Single software image | Multiple software components with specific order of upgrades and dependencies, trim levels and geographical deltas |
| Robustness | Option to reboot or visit retailer if update fails | Requires automated recovery on failure with roll back |
| Distribution Models | Over the air or tethered to PC | Multiple models including OTA, dealership, post- and pre- production, USB and tethered device |

# Automotive: Enhanced FOTA/SOTA system
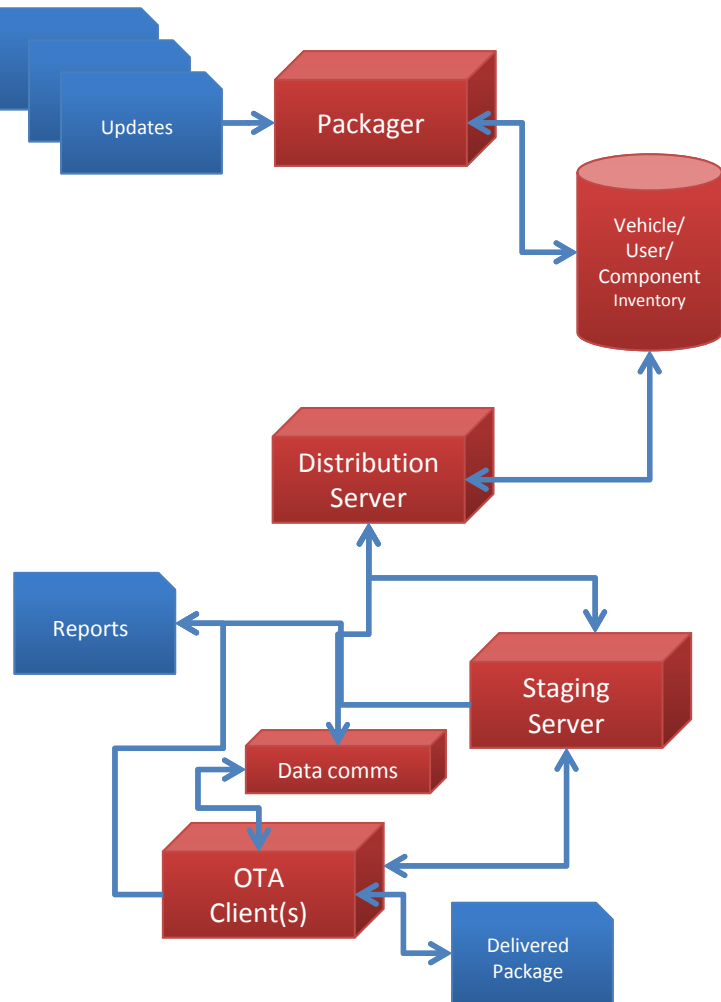


- Packager
  - The packaging process may also define a workflow for each distribution package including pre and post load commands, and package sequencing.
  - The packaging solution supports firmware and application updates from multiple OEM's, including versioning support and extensive metadata for targeting of updates

- Vehicle/User/Component Inventory
  - Device Configuration Management may be configured from multiple sources

- Staging Server
  - The staging server may be a PC within the service centre, or a dedicated mobile unit to be plugged directly into the vehicle

- Data Comms
  - 3G/4G/WiFi communications module in vehicle

- Vehicle OTA Client
  - The vehicle may have multiple OTA clients across the various software/hardware modules communicating over the CAN bus or equivalent to the communications module

# From SOTA/FOTA to VRM

**Vehicle Relationship Management** (VRM) is the cloud based management of vehicle data, comprising

- VRM Portals
  - Content Management, Administration and Reporting
  - Access to admins, suppliers, dealers, consumers
  - Fully branded, optional integration to existing backend

- VRM Platform
  - Cloud-based, multi-tenant
  - Robust and secure software management & distribution
  - Data analytics / management
  - Vehicle / user / component management

- SOTA Agent
  - Resident in target device or car
  - Resident in programming unit
  - Delivers the software payload to target device
  - Report on success and inventory
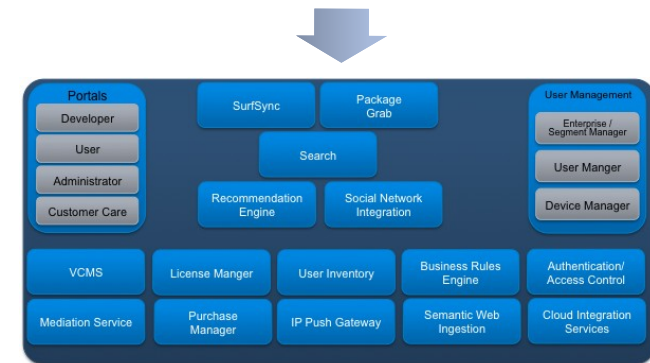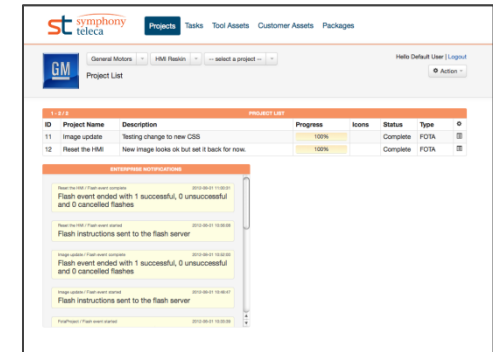
# VRM Portals



- The VRM platform must provide a number of portals for management of the solution; the key portals are…

- OEM Administration Portal
  - Ability to configure vehicle configurations,
  - Load / rollback and manage software distributions with full reporting
  - Main management console for providing/allowing 3rd party access

- Ecosystem Portal
  - Provided to trusted 3rd parties such as component vendors, to enable these vendors to upload/update software packages, report and analyze their specific subset of data

- Service Center Portal
  - Provided to service centers (and customer service) enabling the service center to list vehicle history, initiate vehicle updates and provide a range of reporting options

- End User Portal
  - Provided to the end users, enabling them to view the vehicle status, initiate available updates to the vehicle, view upcoming updates and communicate with the manufacturer
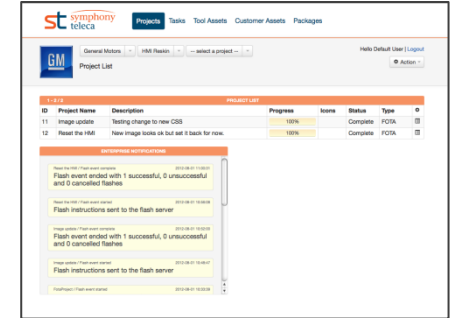
# VRM Platform



The VRM platform consists of the following key components

- Management Framework
  - Portal Integration
  - Management Consoles
  - Monitoring / Logging
- Inventory Management
  - Software Configuration Management
  - Vehicle Inventory Management
- Content Management
  - Software store
  - Package manager
- Client Communication Module
  - Synchronization Services
- Integration Services
  - Package Distribution
  - Customer Care
  - Advertising

# SOTA Agent



Software Payload
Software Agent
Operating System
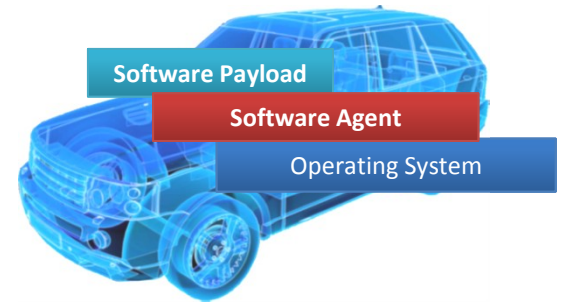
The SOTA agent consists of the following components:

- **Device Manager**
  - Supports OTA &  media protocol stack
  - Support device settings availability
  - Supports server-side push for server initiated update session
  - Supports client-side pull for user/vehicle initiated session
  - Performs UI interactions and user interactions
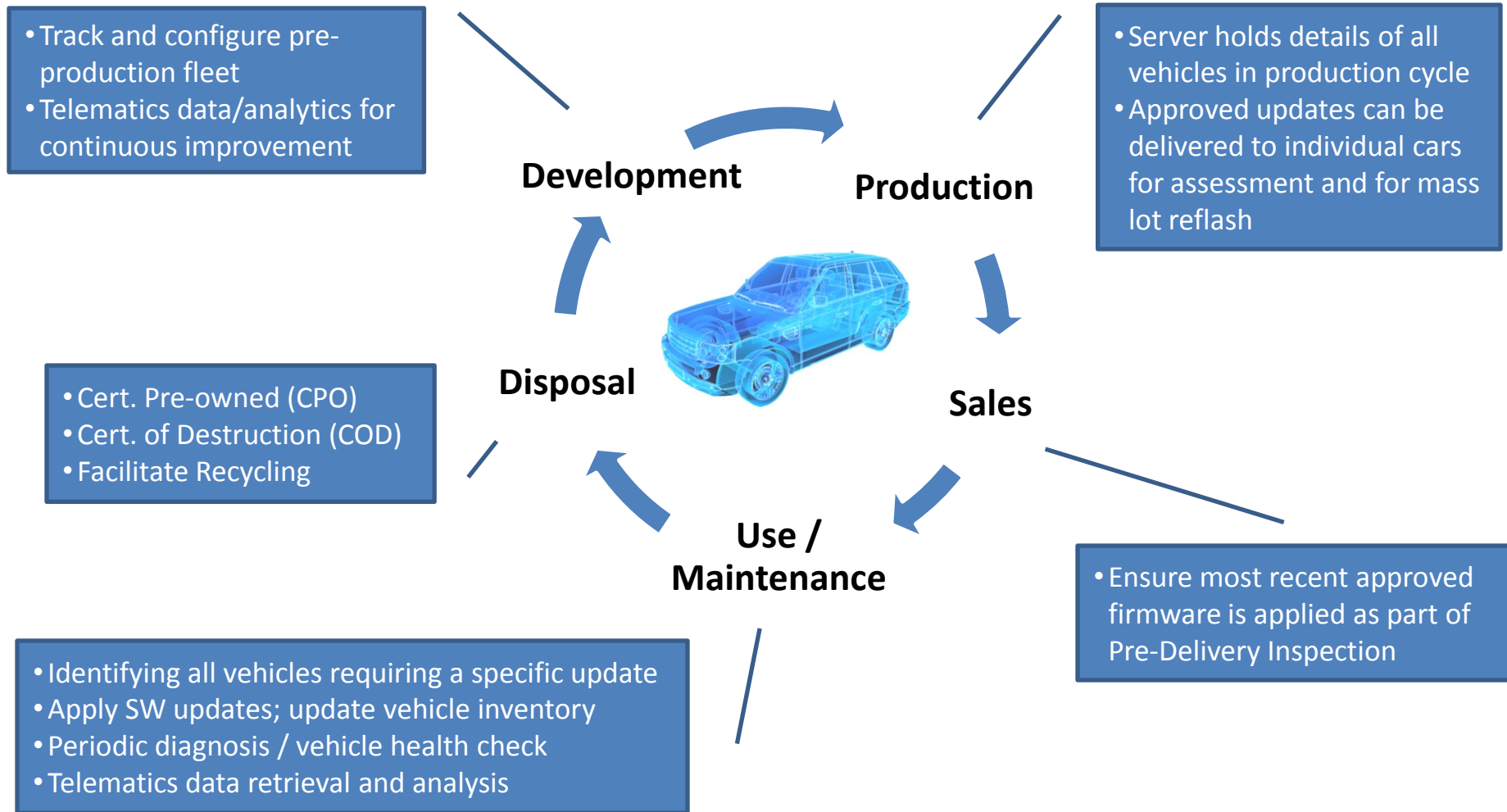
- **Download Manager**
  - Update package download along with resume
  - Update package placement to secured partition
  - Optional signing / encryption of packages

- **Update Agent**
  - Firmware update procedure to combine current image with update received
  - Transactional success / failure process
    - Handles errors to complete process
  - Roll back
  - Reporting

# VRM use cases throughout the vehicle life cycle

- Track and configure pre-production fleet
- Telematics data/analytics for continuous improvement

**Development**

**Production**

- Server holds details of all vehicles in production cycle
- Approved updates can be delivered to individual cars for assessment and for mass lot reflash

**Disposal**

- Cert. Pre-owned (CPO)
- Cert. of Destruction (COD)
- Facilitate Recycling

**Sales**

**Use / Maintenance**

- Ensure most recent approved firmware is applied as part of Pre-Delivery Inspection

- Identifying all vehicles requiring a specific update
- Apply SW updates; update vehicle inventory
- Periodic diagnosis / vehicle health check
- Telematics data retrieval and analysis

# Summary and Outlook

## Summary

- Proliferating software in vehicles requires new mechanisms for deploying software updates
- FOTA/SOTA mechanisms as proven in the mobile industry are being adapted to automotive
- VRM takes the connected car to the next level
  - enables OEM to extend the software update process to its component vendors and service partners
  - enables the use of vehicle data in all stages of the vehicle life cycle

## Outlook

- Sourcing and use of information about
  - Consumers (preferences, driving behaviour, travel profile, etc)
  - Use of vehicle features across regions, user groups, etc.

  by OEMs and suppliers
- Crowd-sourcing of data including weather, traffic condition, parking availability, etc.
- Extending VRM ecosystem to
  - Insurance companies
  - Advertisers (captive to OEM, or more open)
  - New service providers …

# Thank you

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