



# Condition Based Maintenance through Advanced Data Analysis

**Joe Becker**

585-414-0564

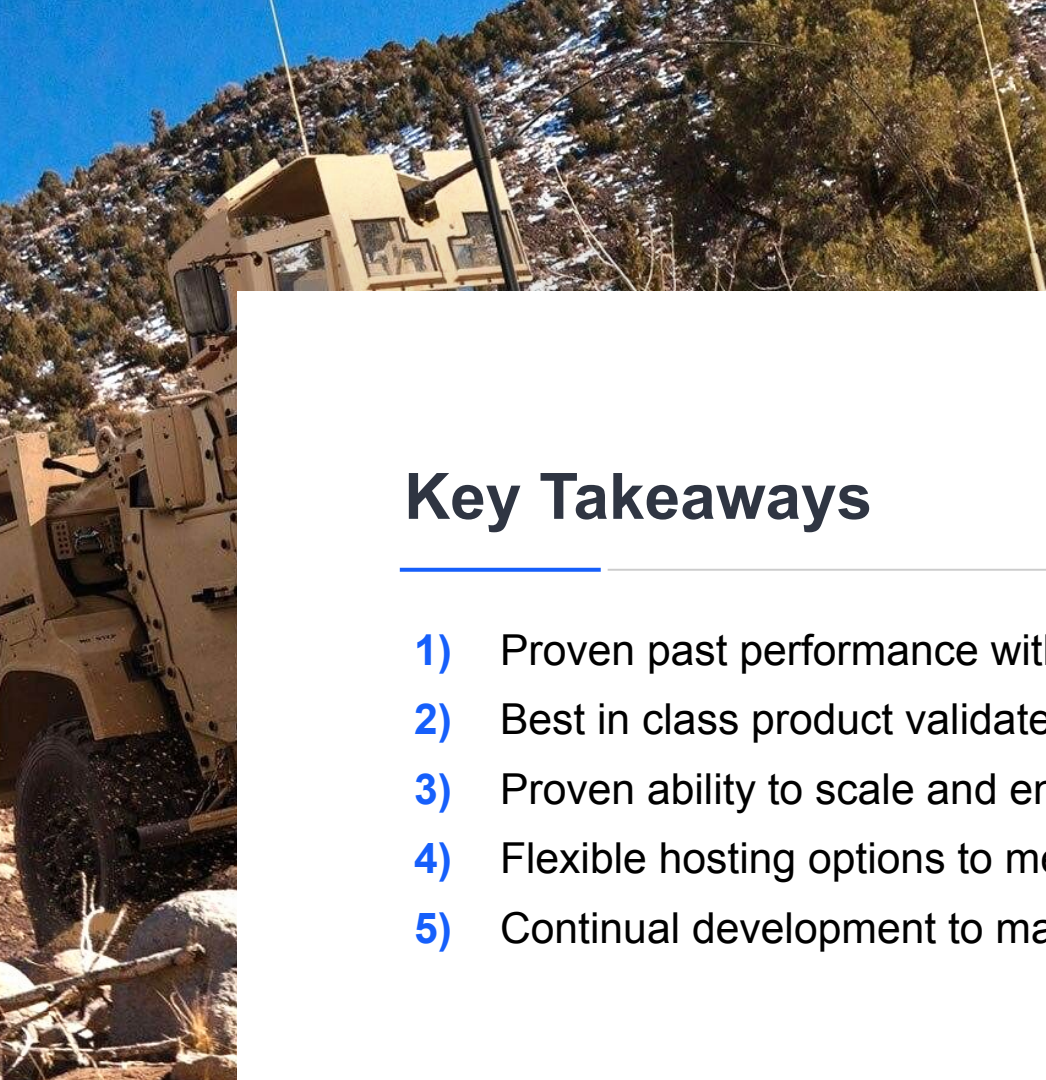
joe.becker@uptake.com

**Uptake Technologies**

---

UEI: YXGDM5CK5GW7

CAGE Code: 7YZN6



## Key Takeaways

---

- 1) Proven past performance with USMC CBM+ Team
- 2) Best in class product validated by Fleet USMC users
- 3) Proven ability to scale and enhance predictive coverage
- 4) Flexible hosting options to meet USG security needs
- 5) Continual development to maintain Best-in-Class status



# Product Overview:

## Field Proven with Years of USMC Feedback





## UPTAKE

---



**200**

Insight Types



**309**

Make/Models



**307 Billion**

Data Points  
(Faults + Sensors)



**3 Billion**

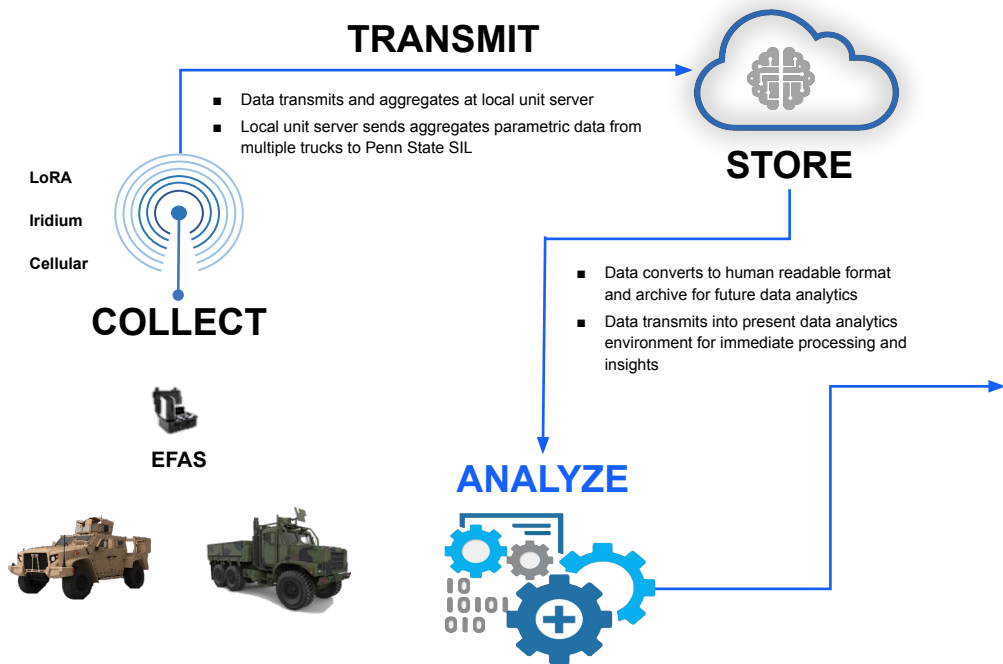
Observed  
Miles



**1 Million**

Insights  
Generated

# Uptake Federal was built to support the Marines' CBM+ strategy



## ACT

### Maintenance Chief Action



- Schedule Maint. Actions
- Source parts
- Assign maintainers
- Assign operators

### Maintainer Action



- Do the "right" repair the first time
- Avoid over maintenance on healthy parts
- Touch more vehicles w/ reduced troubleshooting time
- Targeted LTI on at-risk components

### Logistician Action



- Order parts proactively w/ advance warning
- Build blocks w/ analytical backing

### Program Office Action



- Adjust PMCS intervals on specific parts
- Source relevant data for analyze
- Enterprise and trend analysis

\* Metrics from III MEF PMCS study indicates cost and technician efficiencies are conservative figures

# There is real and documented impact from Uptake analytics

JUL 2019	<b>BFV TOW Missile Failure</b> <sup>A</sup> Alert provided 5 weeks notice. <b>BFV Turret Malfunction</b> Averted ring damage & failure during gunnery.
JAN 2020	<b>M88 Engine Oil Contamination</b> High levels of Fe, Al, Ni, Cr; dirt caused advanced wear.
FEB 2020	<b>M88 Engine Malfunction</b> Fuel dilution detected; led to test revealing cracked piston. <b>M88 Engine Fire</b> <sup>B</sup> Detected anomalies 9 days before fire.
MAR 2020	<b>M88 Multiple Anomalies Detected</b> Detected cylinders misfiring which presaged a small engine fire.
APR 2020	<b>M88 Fluids</b>
MAY 2020	<b>M88 Fuel Pressure</b>
AUG 2020	<b>MTVR ABS Power Reduction</b>
SEP 2020	<b>JLTV Engine Coolant Temperature Sensor</b> <b>JLTV Engine Overheating</b> <b>MTVR Low Coolant Level</b> <b>MTVR ABS Power Reduction</b> <b>MTVR Low Cranking Voltage</b>
OCT 2020	<b>JLTV Low Cranking Voltage</b> <b>JLTV Engine Overheating</b> <b>JLTV ABS Power Reduction</b> <b>MTVR Anti-Slip Regulation (ASR) Power Reduction</b> <b>MTVR Engine Coolant Temperature</b> <b>MTVR High Transmission Oil Temp</b> <b>MTVR Low Operating Voltage</b> <sup>C</sup> Saved battery, made mission-ready, prevented deadline.
NOV 2020	<b>JLTV Engine Overheating</b> <b>MTVR Brakes &amp; ABS Anomalies</b> <b>MTVR Transmission Pressure Control</b>
DEC 2020	<b>MTVR ASR Power Reduction</b>
MAR 2021	<b>JLTV ASR Power Reduction</b> <b>JLTV Oil Filter Blockage</b> Alert on "severely clogged oil filter" prompted replacement.
APR 2021	<b>JLTV ASR Power Reduction</b>
MAY 2021	<b>JLTV ASR Power Reduction</b> <sup>D</sup> Throttle position 100% open but JLTV not responding with power in off-road mode due to suspension geometry issue
AUG 2021	<b>MTVR Fuel in Engine Oil</b> <sup>E</sup> Total engine replacement saved by identifying fuel leaking through injector o-rings.
SEP 2021	<b>JLTV ASR Power Reduction</b>



8%



Maintenance Cost \*

17%



Technician Efficiency \*

5%



Vehicle Availability \*

\$10k



Value per vehicle \*

5%



Supply Availability

\* Metrics from III MEF study indicates cost and technician efficiencies are conservative figures



# Uptake Radar

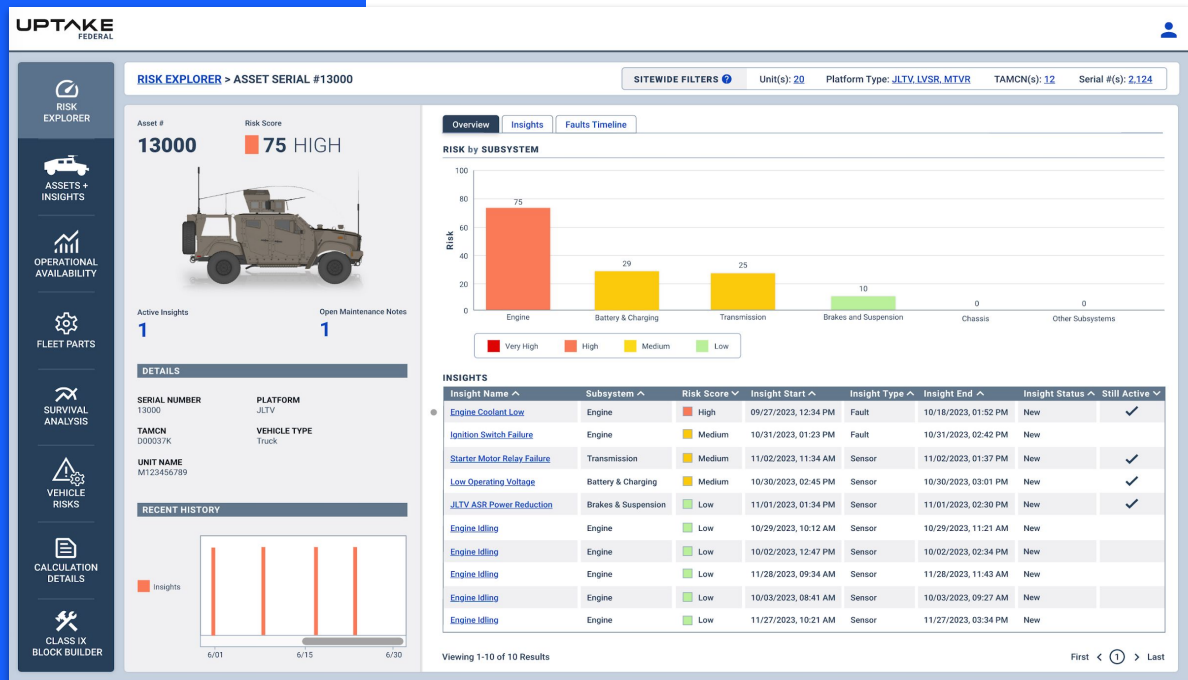
## Sensor-based Analytics

### Example Outcomes

Surface supporting evidence to make specific component level failure recommendations like:

- Battery/Charging Failures
- Internal Engine Component Failures
- Coolant, Turbo, Suspension Failures

*Uptake brings 200+ commercial predictive sensor models to bear; 90+ field-tested models on JLTV and MTVR with USMC.*



*"I logged in to the system last night and found vehicles we need to immediately action, we confirmed the issues this morning. Not bad for the first 24hrs of access"* CWO, 3d Marines

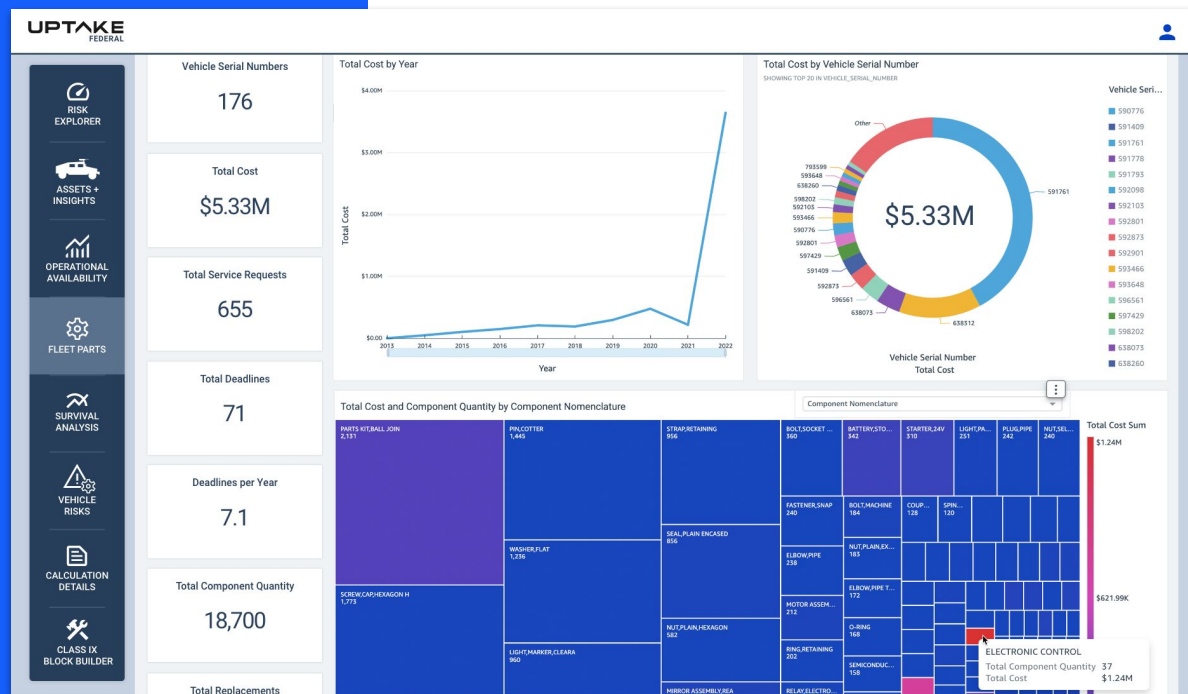
# Uptake Compass Work Order Analytics

## Key Data Inputs (GCSS-MC)

- Bumper number / Serial
- Date times (cleansed)
- Part cost
- Locations

## Analytical Approach

- Downtime analysis and tracking
- Component survival analysis
- Part cost analysis
- OEM Benchmarking
- Maintainer work prioritization



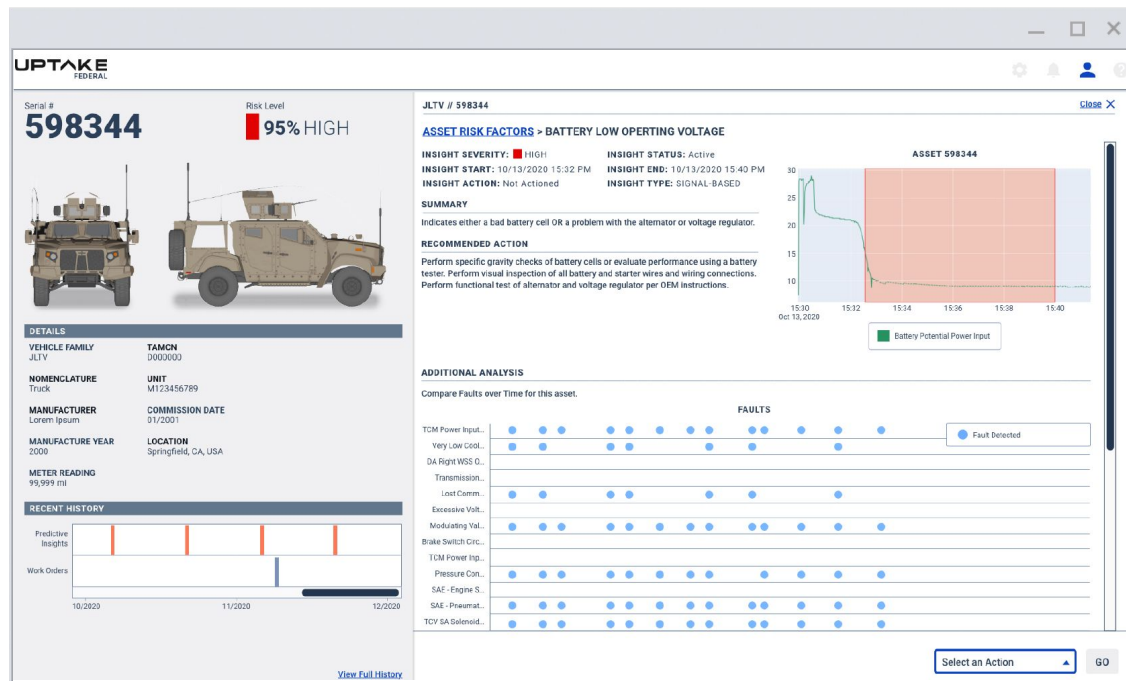


ESD Proof Point:

# Battery Low Operating Voltage

## JLTV 598344

Typically JLTVs operate between 20-24 volts. This model monitors the battery during operations to identify points where the voltage starts indicate a potential battery failure.



**Field Impact:** In this case the Uptake model predicted a battery failure and we alerted the team at ESD. They performed a vehicle check and discovered that the communications unit was left on which drained the battery. This proactive alert ensured the battery could be properly charged, and prevented a deadlining of this JLTV.

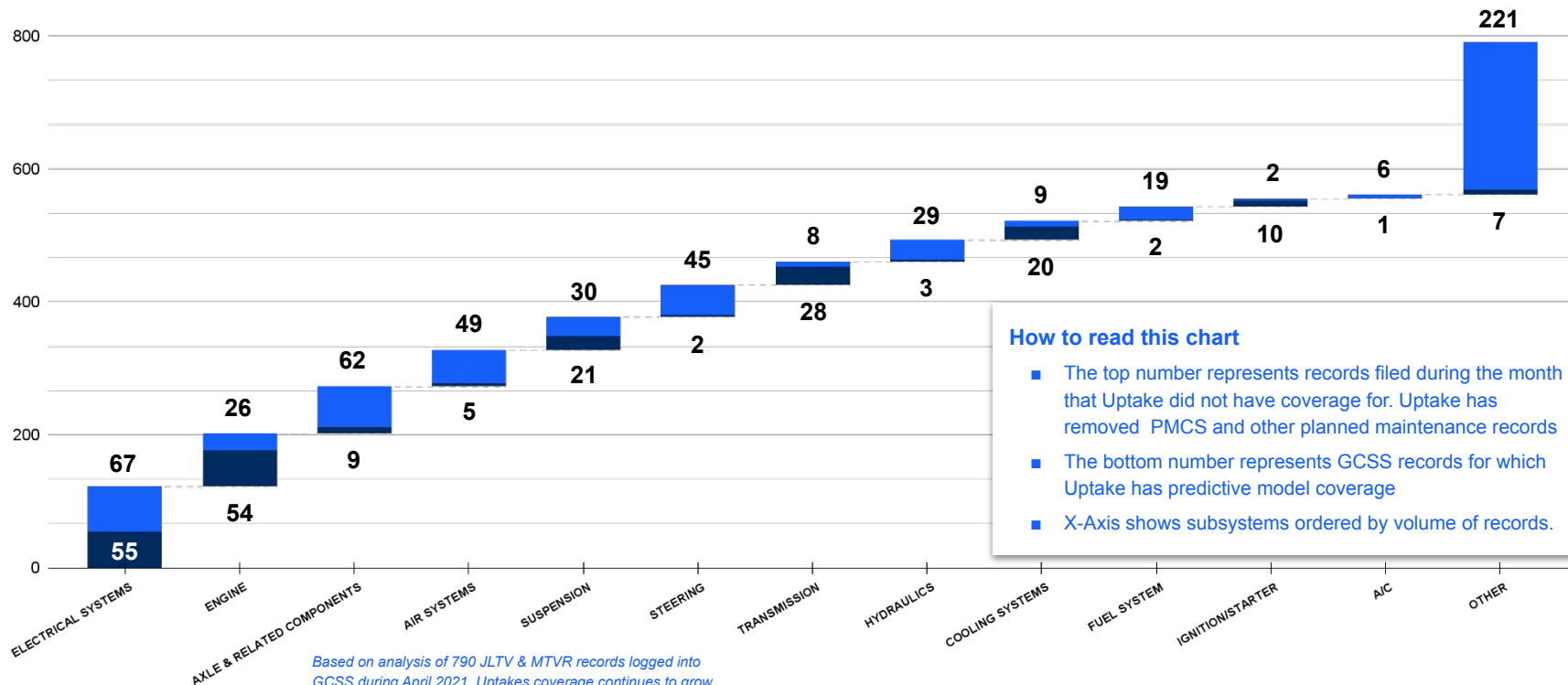
## Ensuring Mission Readiness

Consider a critical asset like NMESIS: when you're dealing with high-value JLTV variants, it's often not possible to just "grab the next on the line."

*As vehicle customization increases, the need for predictive maintenance monitoring does as well*



Uptake starts ahead of the curve; our predictive coverage approached 70% within major platform subsystems during the MVP and will continue to grow.



# Uptake's suite of predictive models for ground vehicles like JLTV and MTVR

Accelerator Pedal Position Sensor  
Air Filter  
Air Fuel Ratio Sensor  
Alternator  
Anti Lock Braking  
Battery  
Coolant Filter Plugging  
Coolant Pump Control  
Cylinder Issue  
DOC Efficiency  
DOC Intake Temperature Sensor  
DOC Temperature  
EGR Cooler  
EGR Cooler Ineffective  
EGR Differential Pressure  
EGR Mass Air Flow  
EGR Mass Flow Rate Sensor  
EGR Pressure Sensor  
EGR Temperature Sensor  
EGR Valve  
Engine Charge Air Cooler Intake Temperature Sensor  
Engine Coolant Filter Differential Pressure Sensor  
Engine Coolant Level Sensor  
Engine Coolant Pressure Sensor  
Engine Coolant Temperature Sensor  
Engine Crankcase Pressure  
Engine Crankcase Pressure Sensor

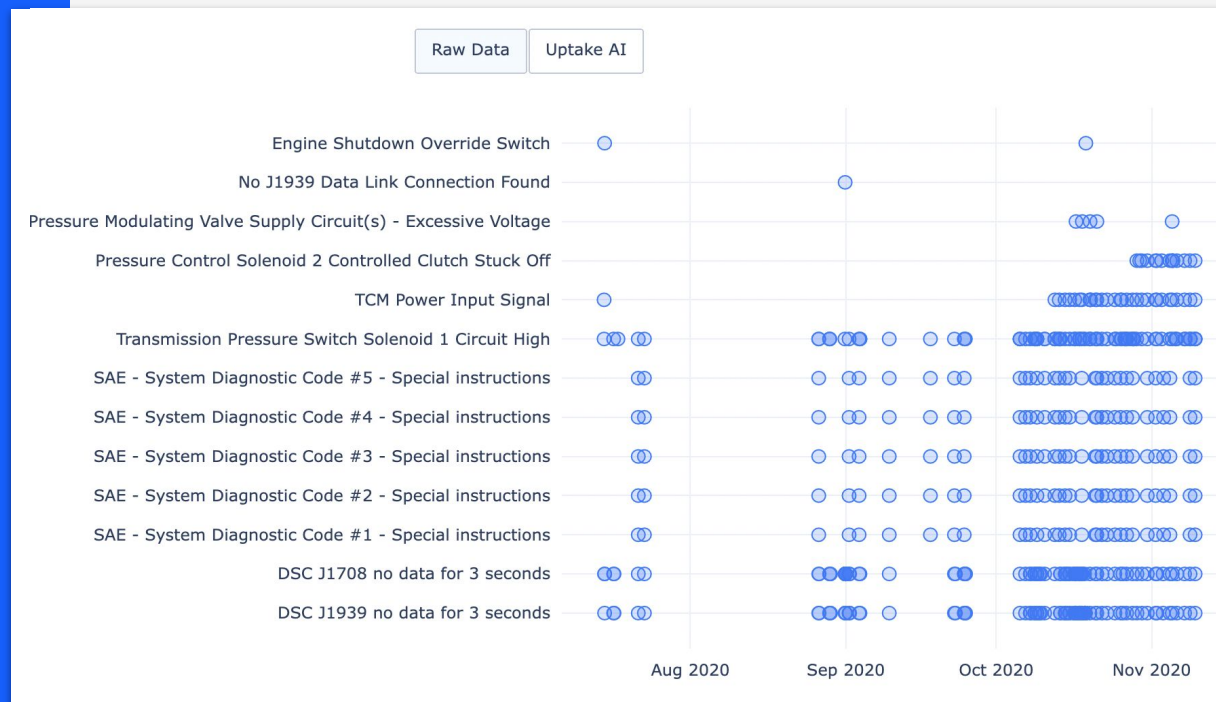
Engine Cylinder Misfire  
Engine Fuel Leak  
Engine Intake Air Pressure Sensor  
Engine Intake Air Temperature Sensor  
Engine Intake Manifold Pressure Sensor  
Engine Intake Manifold Temperature Sensor  
Engine Knock Sensor  
Engine Oil Level  
Engine Oil Level Sensor  
Engine Oil Pressure Sensor  
Engine Oil Temperature Sensor  
Engine Overcooling  
Engine Protection Derate  
Exhaust Gas Temperature Sensor  
Fan Clutch Control  
Faulty Ignition Coil  
Fuel Filter Differential Pressure Sensor  
Fuel Filter Plugging  
Fuel Injection  
Fuel Level Sensor  
Fuel Pressure  
Fuel Pressure Sensor  
Fuel Temperature  
Fuel Temperature Sensor  
Fuel Valve  
Generator Coolant Temperature Sensor  
High Coolant Pressure

High Coolant Temperature  
High Engine Oil Pressure  
High Engine Oil Temperature  
High Turbocharger Oil Pressure  
High Turbocharger Oil Temperature  
Ignition Control  
Low Coolant Level  
Low Coolant Pressure  
Low Cranking Voltage  
Low Engine Oil Pressure  
Low Engine Oil Temperature  
Low Transmission Oil Temperature  
Low Turbocharger Oil Pressure  
Mass Air Flow  
Mass Air Flow Sensor  
NOx Anomaly  
NOx Sensor Faulty  
O2 Anomaly  
O2 Sensor  
Oil Leak  
SCR Conversion Efficiency  
SCR Dosing Air Assist Valve  
SCR Temperature  
SCR Temperature Sensor  
Spark Voltage and Plug Issue  
Starter  
Thermostat Control

Transmission Oil Level  
Transmission Oil Level Sensor  
Transmission Oil Pressure Sensor  
Transmission Oil Temperature Sensor  
Transmission Turbine Speed Sensor  
Turbocharger Actuator  
Turbocharger Boost Pressure  
Turbocharger Compressor Intake Pressure  
Turbocharger Compressor Intake Pressure Sensor  
Turbocharger Compressor Intake Temperature  
Turbocharger Compressor Intake Temperature Sensor  
Turbocharger Compressor Outlet Temperature  
Turbocharger Oil Pressure Sensor  
Turbocharger Oil Temperature Sensor  
Turbocharger Speed  
Turbocharger Turbine Intake Temperature  
Turbocharger Turbine Intake Temperature Sensor  
Turbocharger Turbine Outlet Temperature  
Turbocharger Valve  
Turbocharger VGTA Stuck  
Turbocharger Wastegate Actuator  
Washer Fluid Level  
Water in Fuel  
Water in Fuel Sensor

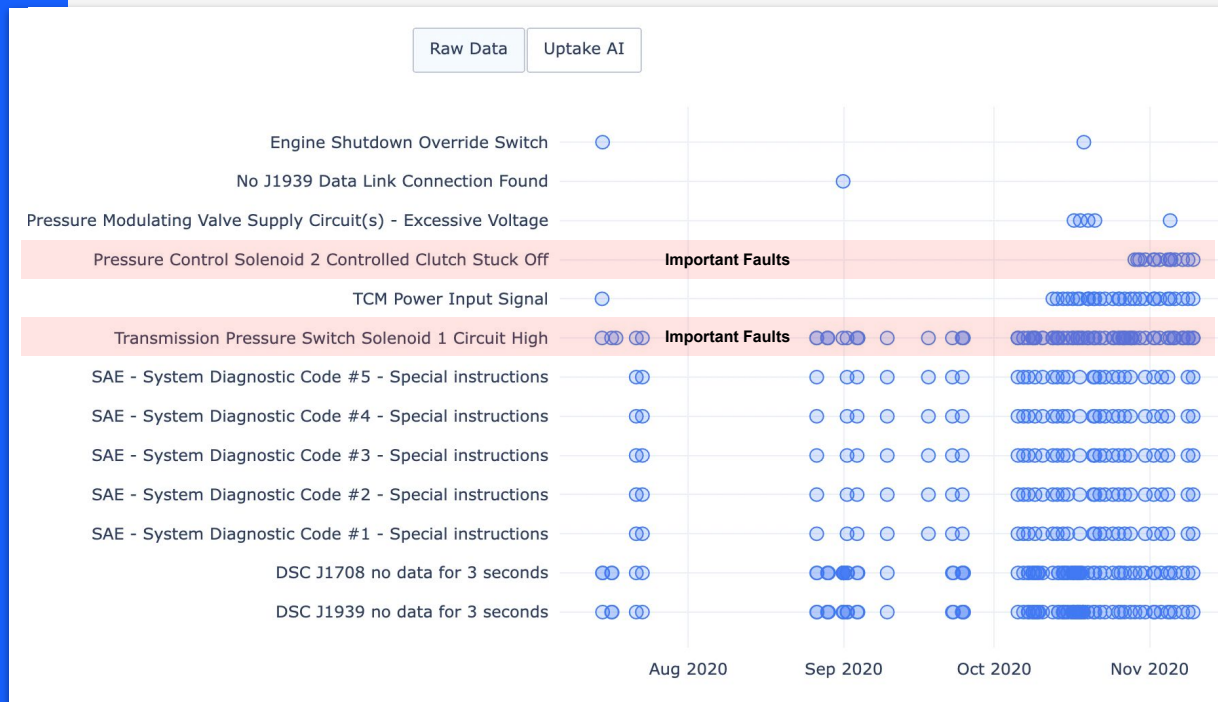
# What about raw fault codes rather than telemetry signals?

*Faults can be valuable but they are **very noisy**. How do you know what is important?*



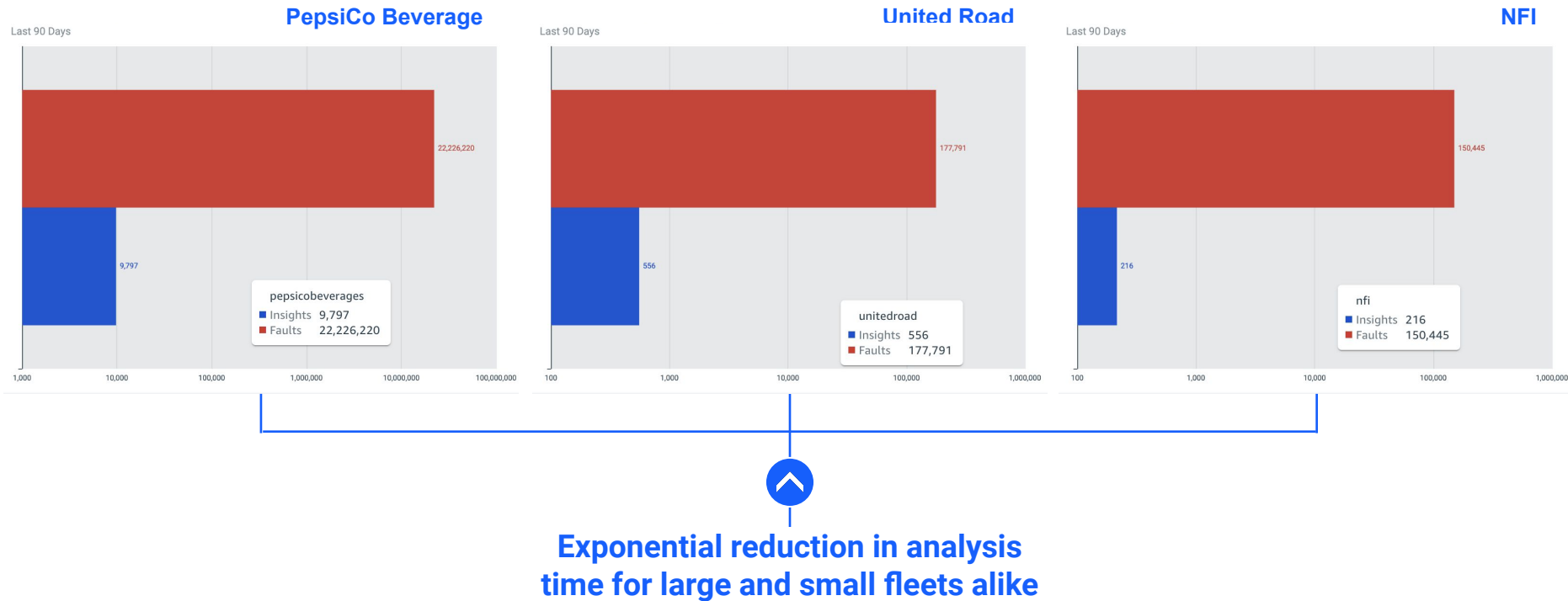
Uptake's AI/ML filters meaningless faults to highlight only the important combinations that require action.

*One insight generated (shown on the right) came from ~1,000 faults that fired over four months.*





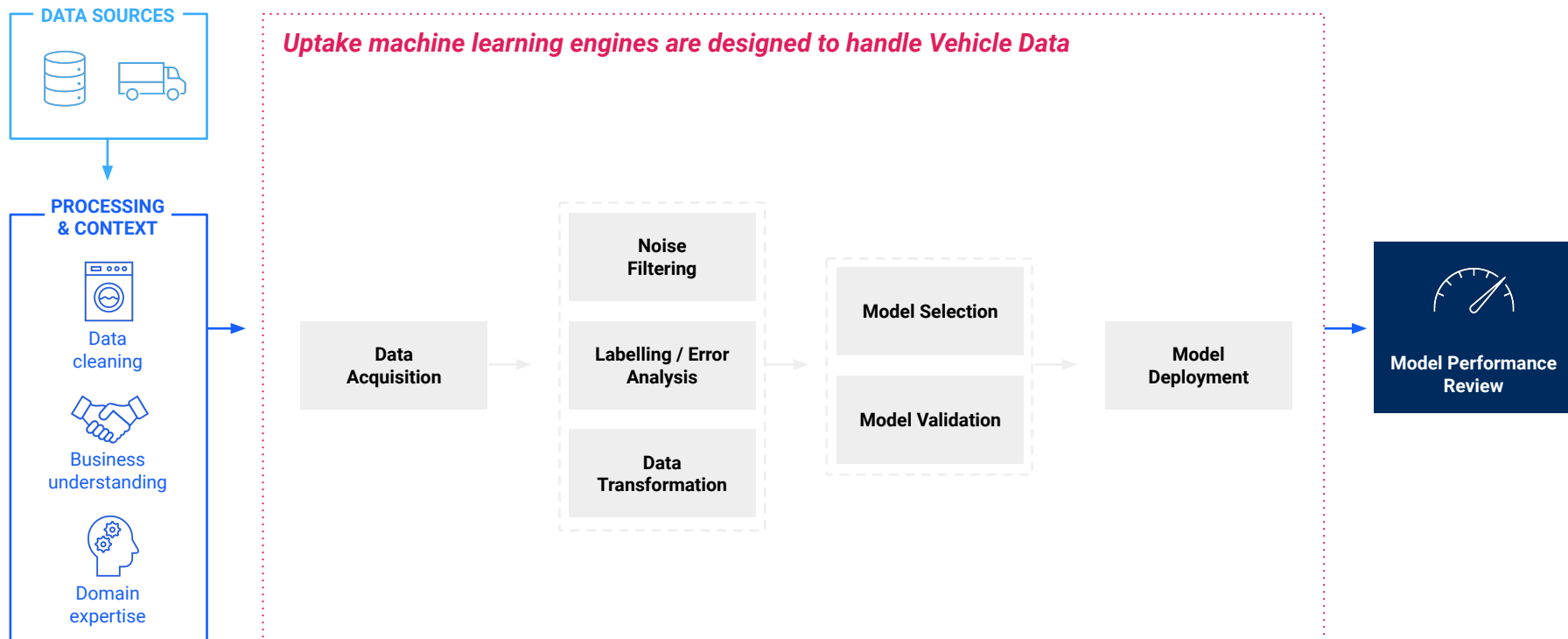
# Uptake is a best practice: Commercial fleets trust Uptake's fault algorithms



# Data Science Foundations



## Uptake's machine learning engines then accelerate the deployment of data science models



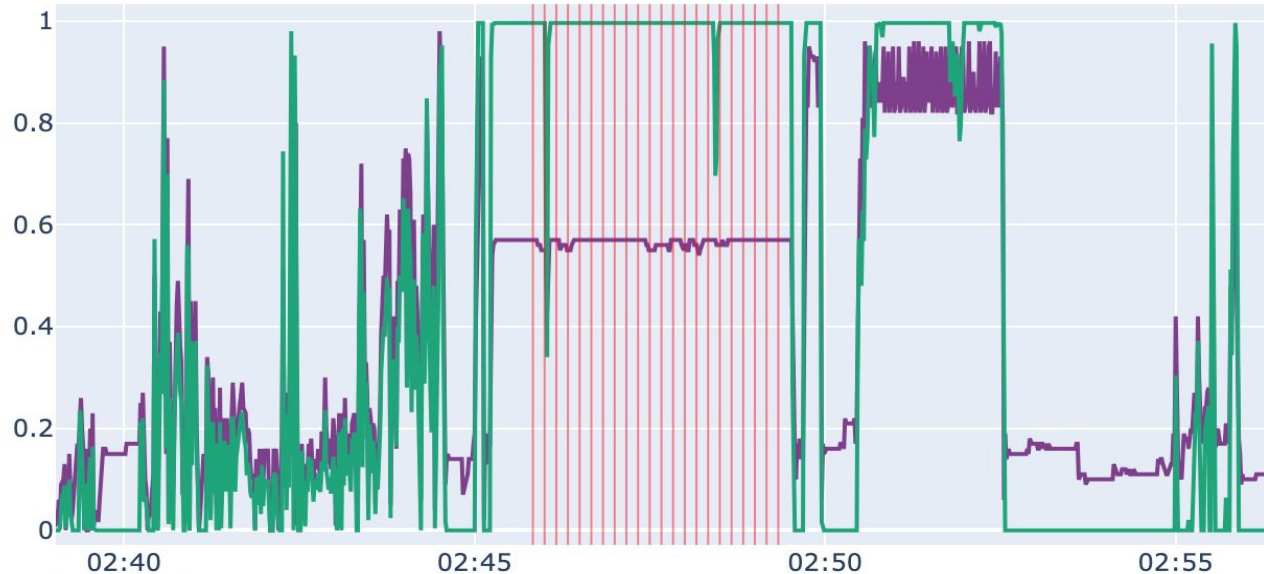
# Uptake identified 33 insights on 23 vehicles in our first 10 months



# Uptake supports continuous product enhancement based on USMC feedback and Fleet observations...like this new JLV Prognostic model

## Model Architecture

- Uptake's [ASR Power Reduction Model](#) determines when the engine torque does not match the accelerator position, indicating that the ASR is causing a sustained reduction in engine power.
- This model ensures that low-power conditions occurs for a significant period of time before it fires an alert.
- It only looks at periods when the vehicle is NOT in Off-Road mode.
- In the plot (right) the driver is applying the accelerator to the max, but the engine torque never responds accordingly during the alert period.



**JLV 794104 - ASR Insight**

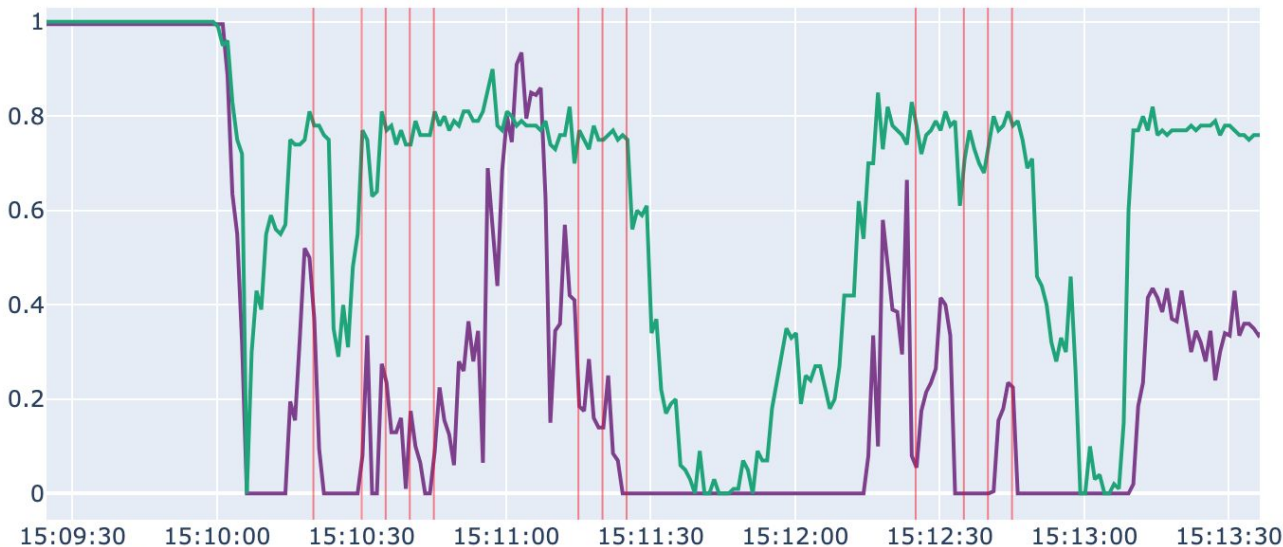
*Here we see a high number of instances where the engine torque does not match the accelerator position in a 5 minute period between 02:45 and 02:50*

# Uptake uses multivariate analysis rather than a simple rules-based approach to deliver higher precision to the FMF

## Model Architecture

- In the plot (right) the driver is applying the accelerator to the max and generating a request for a high percentage of engine torque, but the engine load does not respond to this request during the alert period
- The model ensures the low-power condition occurs for a significant period of time before it fires an alert
- The model also takes into account:
  - 1) the brake pedal being off
  - 2) the ASR brake control being off
  - 3) the ABS off-road switch being off

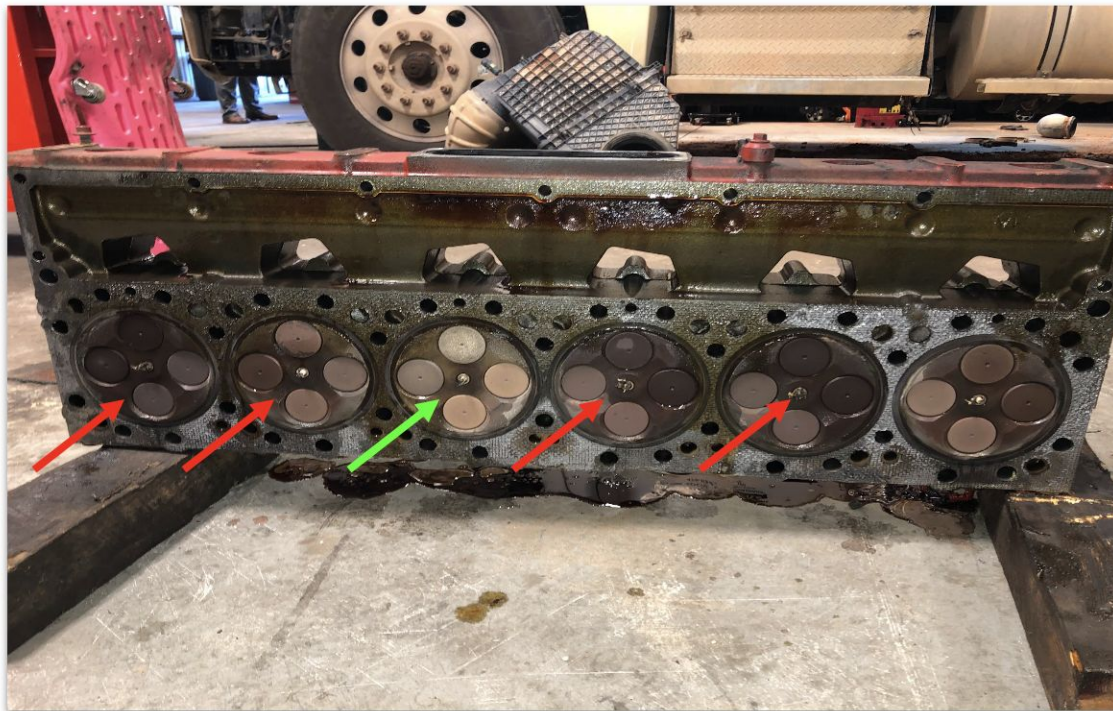
[This ensures the alert is not occurring due to normal braking operations](#)



MTVR 598222 - ASR Insight

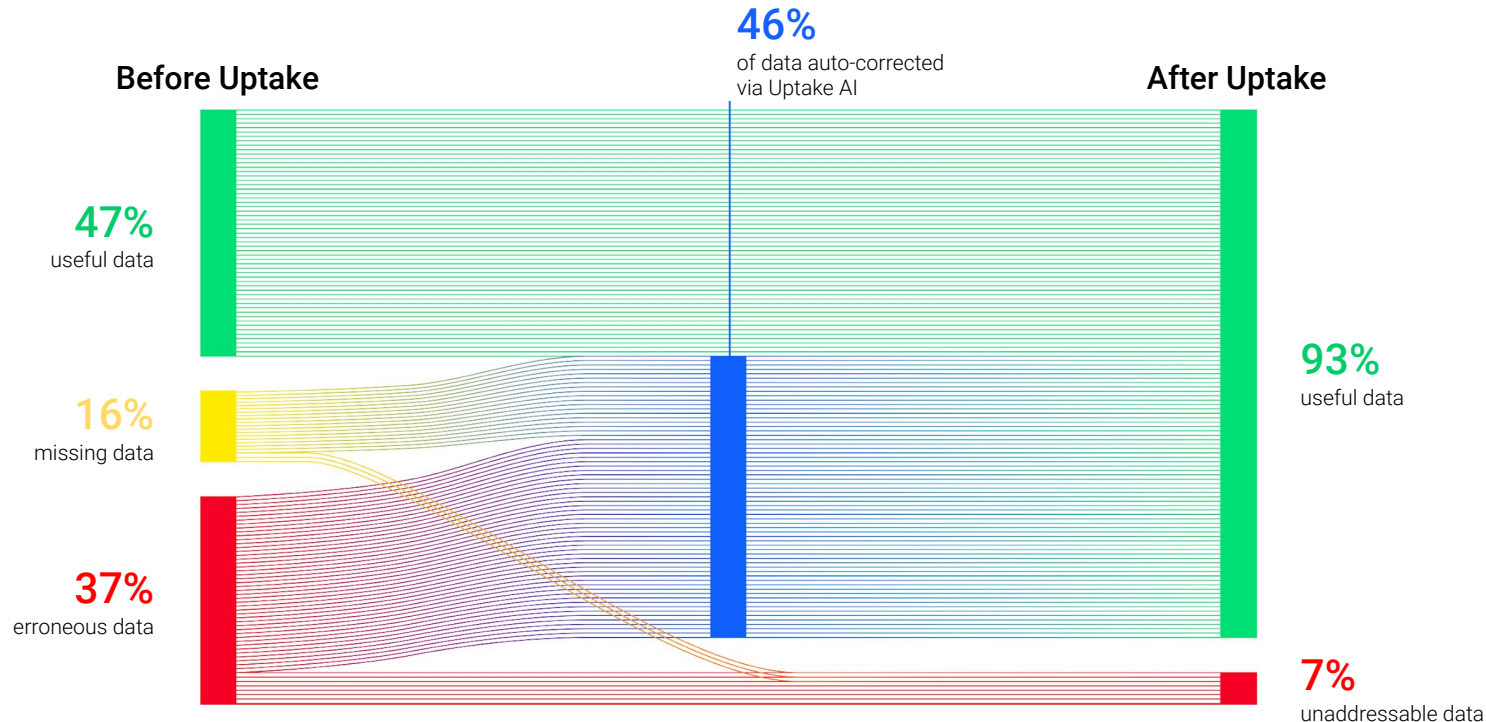


## Example: You can't hide from your data analysis!



# Transactional Data is extremely useful, but it's messy and must be cleansed

Uptake's data science makes much of the unusable data into a readable form



# Label Correction Engine reduces data quality issues inherent in GCSS data feeds

## What does it do?

Identifies errors

Automatically suggests improvements to fill in missing values in records

Uses text mining and unsupervised and supervised machine learning techniques

## Features and Abilities

- Ingests high-volume, high-frequency data from many sources
- Highly configurable
- Cutting edge machine learning techniques
- Cons: Requires lot of failure labels to generalize

## Correcting a Record

Possible mismatch detected

**Asset Health Record**

Oil System Health: **Good**

Electrical System Health: **Bad**

Repair Code: **Electrical Failure**

Repair Comments:

Unit having oil issues, Replaced filter and added fluid.

Corrected

**Asset Health Record**

Oil System Health: **Bad**

Electrical System Health: **Good**

Repair Code: **Lubrication Failure**

Repair Comments:

Unit having oil issues, Replaced filter and added fluid.

To be effective as possible, data science models (prediction models, especially) require correctly labeled instances of failure events. Models can only perform as accurately as data used to train them.

# Data Quality Checks & Automated Validation Logic

Uptake developed a new strategy for cleansing USMC data which is illustrated in this sample Taxonomy Processing Report.

## Process:

1. New file ingested by Uptake
2. Automated pipeline processes data and parses units against unit file
3. Automated report identifies duplicate unit names

***These Techniques are scalable across all GCSS-M Records***

```
=====
==          Taxonomy Processing Report          ==
=====
```

Duplicate Leaf Objects included in Taxonomy. This may not be an issue, but is notable.

Duplicate for: M05371

I MEF,3D MAW,MAG-13,MWSS-371,M05371

I MEF,3D MAW,MAG-37,MWSS-371,M05371

Duplicate for: M05372

I MEF,3D MAW,MAG-37,MWSS-372,M05372

I MEF,3D MAW,MAG-39,MWSS-372,M05372

Duplicate for: M20910

II MEF,2D MARDIV,MARSOC,2D MAR RDR BN,M20910

MARFORSOC,MARFORSOC,MARFORSOC,MAR RAD TRGN CTR,M20910

Duplicate for: M20980

MARFORSOC,MARFORSOC,MAR SPEC OPS SPT GRP,1ST MAR SPEC OPS SPT  
BN,M20980

MARFORSOC,MARFORSOC,MAR SPEC OPS SPT GRP,2nd MAR SPEC OPS SPT BN,M20980

Duplicate for: M27110

II MEF,2D MLG,2D SUP BN,2D SUP BN,M27110

II MEF,2D MLG,2ND SUP BN,2D SUP BN,M27110

Duplicate for: M27140

II MEF,2D MLG,2D MAIN BN,2D MAINT BN,M27140

II MEF,2D MLG,2D MAINT BN,2D MAINT BN,M27140

```
=====
The following lines in the source CSV were not able to be processed and EXCLUDED from the taxonomy.
II MEF,2D MARDIV,2D MAR REG,2D BN, 2D MARINES,M12160
=====
```

## Uptake Oil Analysis

The assets shown in the upper right corner have moderate to severe dirt entry issues. This can increase the wear of engine internals and is a symptom of worn seals/dust boots.

Uptake determines this condition by studying levels of Aluminium and Silicon levels in the oil.

Assets within the severe condition category would benefit from an oil change and visual inspection; assets in the moderate condition category should be watched.

Oil Samples | Dirt Entry





# Solution Architecture: Flexible Deployment





# Uptake's solution can coexist, utilize, and provide interoperability with the DoD's Advana/Jupiter Cloud environments

MARCORSYSCOM could refine requirements for Uptake to pull data from, or funnel raw data into, the Advana cloud or Jupiter data enclave for further analysis by USMC (or others) leveraging existing Uptake services.






# Testimonials



Uptake led a visit to PepsiCo in Las Vegas to show Marine personnel our Commercial product in action





*As far as Frito-Lay goes, and PepsiCo, we don't spend any money without a return on investment. So we're paying for this program; the repair and maintenance savings, the towing savings...we're making money off of this system. You guys can too.*

~ [Pepsi-FritoLay](#)

*A few months after installing data loggers on our vehicles, UPTAKE started delivering useful insights. For instance, we discovered low battery voltage issues just in time before deploying to the First Island Chain (FIC). This allowed us to either ensure supplies were on hand at the FIC or preposition them, giving us a strategic advantage.*

*UPTAKE's software has given us the necessary decision-making space for supply chain management and repairs while at the FIC. Its models are finely tuned for USMC vehicles -- boosted by commercial data -- helping us establish a reliable maintenance model for our weapon systems.*

**~ LtCol Osman Sesay**  
 (Former) Commanding Officer  
 3d LLB, 3d MLR, 3d MARDIV

*The predictive maintenance strategy enabled by Uptake is not just a preferred option; it is the only choice that ensures we stay ahead of equipment failures and maintain a high state of readiness. Uptake's tool has already demonstrated its efficacy in real-world operational environments, providing insights and foresight that are critical to 3d MLR's mission success.*

**~ CWO3 Tyler Horton**

*Supply Chain Mgmt Ops Officer  
3d LLB, 3d MLR, 3d MARDIV*



# 2022 Completion Memo (USMC / DIU)

---

*“Uptake demonstrated the feasibility and utility of their predictive maintenance, failure analysis, and user interface technologies in an operational environment. The technology was integrated with operational hardware and software systems and Marine Corps maintenance workflows.*

*“Use of the platform **reduced maintenance costs by 8%, increased technician efficiency by 17% and increased vehicle availability by 15%.**”*

**Uptake’s current OTA could be immediately transitioned to Production**





# Near Term Roadmap

(What's Next)



## Uptake's Tire Insights

Uptake learns the normal behavior of each tire and compares them with the other tires on the same axle

### Automatically handles:

- Fluctuating tire pressures (from cold days or different operating conditions)
- Different tire types / pressures (semi trucks, vans, cars)
- Different pressures across axles (drive vs steer)

On this truck, Uptake provides three months of lead time



BLOCK BUILDER

Exit

NEW BLOCK 06/2021

Edit Name

Step 3 of 3: Review/Edit Suggestions



Uncheck unwanted NSNs or add NSNs and download Parts Lists.

7 Weeks  
\$500k

Edit

23  
VERY LOW

RISK LEVEL

MISSION TOTALS

Unique NSNs	10
Total NSNs Count	27
Avg Cost Per Part	\$18,511
Total Cost	\$462,778

VIEW PARTS

DOWNLOAD PARTS LIST (XLS)

74  
HIGH

RISK LEVEL

MISSION TOTALS

Unique NSNs	7
Total NSNs Count	42
Avg Cost Per Part	\$15,561
Total Cost	\$653,584

VIEW PARTS

DOWNLOAD PARTS LIST (XLS)

40  
MEDIUM

RISK LEVEL

BLOCK 3 MISSION TOTALS

	VS	BLOCK 1	BLOCK 2
Unique NSNs	10	0	-3 ▼
Total NSNs Count	28	-1 ▼	+14 ▲
Avg Cost Per Part	\$14,270	+\$4,241 ▲	+\$1,291 ▲
Total Cost	\$399,568	+\$63,210 ▲	+\$254,016 ▲

VIEW/EDIT PARTS

DOWNLOAD PARTS LIST (XLS)

PARTS LIST: MY BLOCK

Search by NSN or Nomenclature

SEARCH

+ Add Part

NSN	Nomenclature	Quantity	Cost Per	Total Cost	Associated TAMCNs
<input checked="" type="checkbox"/> 6140014851472	Kit, Biennial PM	<input type="text" value="3"/>	\$4,930	\$14,790	D00487K, D00467K
<input type="checkbox"/> 2510015988311	BPMTU Kit	<input type="text" value="2"/>	\$39,000	\$0	D00037K, D00467K, D01987K
<input checked="" type="checkbox"/> 2510016421027	Tire, Pneumatic, Vehicle	<input type="text" value="4"/>	\$6,000	\$24,000	D00037K, D00467K, D01987K
<input checked="" type="checkbox"/> 2510016776618	Transmission with Container	<input type="text" value="1"/>	\$89,780	\$89,780	D00487K, D01987K, D00037K
<input checked="" type="checkbox"/> 2530014745785	Engine, with Container	<input type="text" value="1"/>	\$84,560	\$84,560	D00037K, D00467K, D01987K
<input checked="" type="checkbox"/> 2541015750886	Steering Gear, Miter	<input type="text" value="2"/>	\$12,748	\$25,496	D00037K, D00467K, D01987K
<input checked="" type="checkbox"/> 2541016482602	Parts Kit, Ball Joint	<input type="text" value="3"/>	\$5,800	\$17,400	Loram, Insom, Dolor Sit

The logo graphic consists of two overlapping chevron shapes pointing upwards, creating a stylized 'U' or mountain-like form. The top chevron is a lighter shade of blue, and the bottom one is a slightly darker shade.

UPTAKE

