Fuel Measurement Informing Business Improvement

SmartRView

A measurement and data analytics platform differentiated by high precision direct fuel measurement

Developed to facilitate the immediate execution of business improvement use cases. SmartRView is an all inclusive subscription based service including instrumentation, software, support and consultation.

Every other high-horsepower diesel industry uses in-service fuel measurement to better understand and improve their business

Why?

Direct measurement outperforms ECM fuel consumption estimates by as much as 10X in accuracy and repeatability

High frequency measurement enables several use-cases not supported by tank fill measurement

Why Not Mining?

Established offerings are designed for process environments, not mobile mining equipment
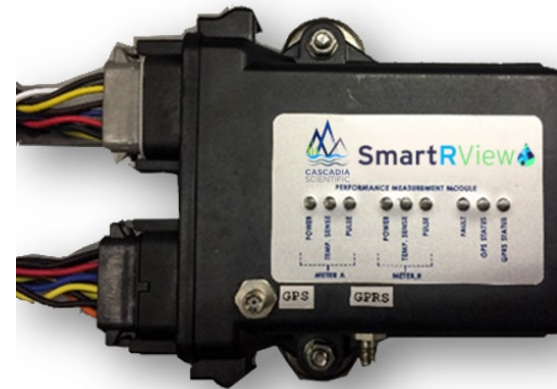
- 💧 Required: Protected dry environment, clean power, data Management
- 💧 Absent: ECM connectivity, WAN access, store and forward, motion sensing

In-service fuel measurement

SmartRView Controller

- IIoT capable
- Environmentally sealed
- Extensively tested
- Vehicle network connected

Blutip Fuel Meters

- Highly accurate
- Ruggedized for mining
- Density corrected
- Linearized for viscosity
- Sized per application

SmartRView

Hardware Components

- Fuel Meters
- Harnesses/Hoses
- GPS/GPRS Antennas
- SmartRView Controller

Data Collection

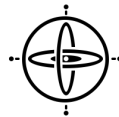## System inputs

In service fuel measurement

Pressure based Altimeter

On board vehicle network
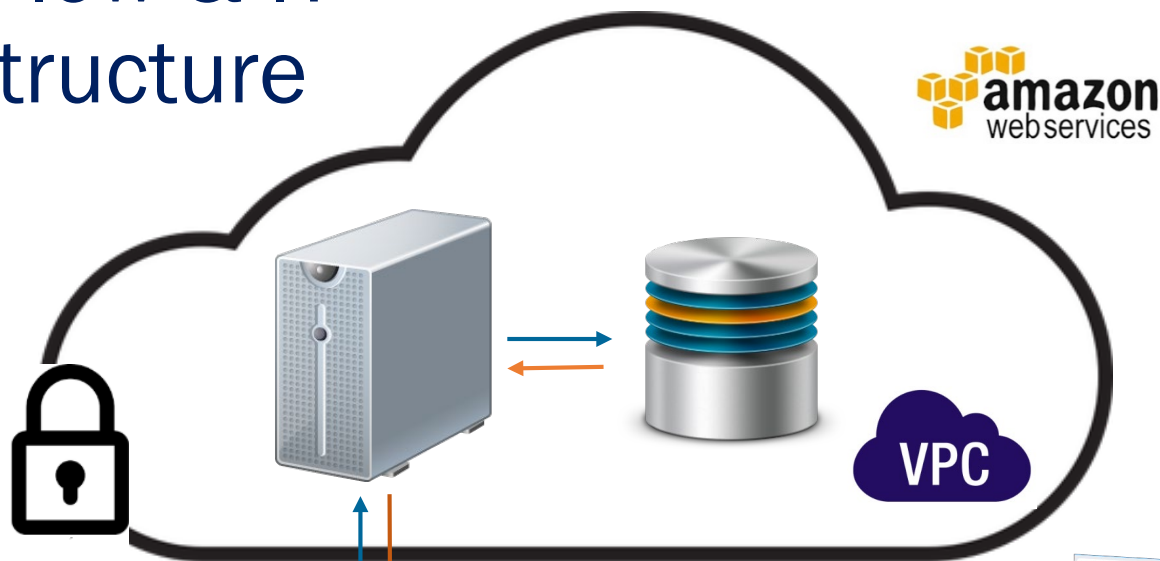
9-Axis Motion Sensing

GPS

Cloud Connectivity

SmartRView
Controller

Installed on Vehicle

Collection is event triggered
and aligned to mining activity

Data Flow & IT Infrastructure

Cycle Aligned Packet flow

Fuel analytics

Data Modelling and Analytics

Approach and Techniques

- Extract model observations from raw record sets (Haul cycles, pushes, loading events)
- Characterize observations
  Fuel use, duration, distance, tonnage, vertical travel, operator, equipment etc.
- Train and run statistical Models

Linear Regression

Neural Networks

Gradient Boosted Trees

How the platform delivers value

- Subscribers identify opportunities for improvement
- Cascadia's data scientist collaborate with users to establish baselines and evaluate strategies
- The SmartRView web portal is used to track and model performance
- Subscribers implement fully informed changes to drive business improvement
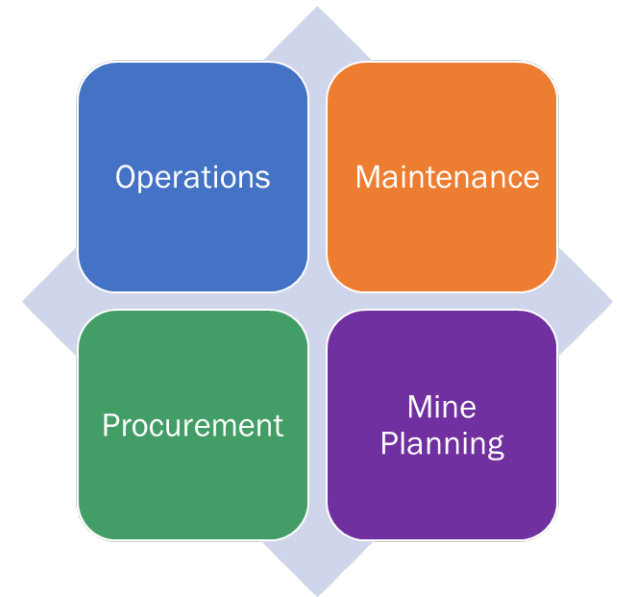
Operations Case Study:
Operator Coaching and Ranking

- 6 months, 10 trucks, 30 operators
- ½ the roster received simulator training
- GBT used to model and rank operators
- Operator performance impact 7%
- Average possible improvement 2.7%
- 8 of the best 10 operators had received training

Model Variables:

- Operator ID
- Truck ID
- Month of Year
- Cycle Duration
- Cycle Distance
- Net Loaded Vertical
- Gross Loaded Vertical
- Tonnage
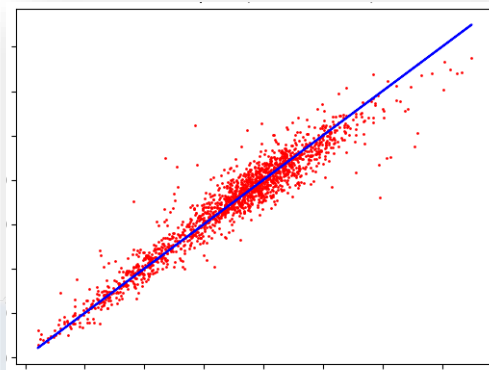
Other Operations Use Cases

- 💧 Operate to efficiency
- 💧 Equipment alarms
- 💧 Optimized equipment allocation

Operations | Maintenance
Procurement | Mine Planning

Maintenance Case Study: Maintain to Fuel Burn

Day 1   Maintenance Event

← 21 day maintenance intervals →

- Standard deviation in fuel burn per day 26%
- Daily fuel burned varied by as much as 350%
- Variation in fuel burn across maintenance intervals was 24%

Results: premature maintenance and/or overdue maintenance events

Conclusion:
Evidence strongly supports economic justification for inclusion of fuel-use factor in maintenance scheduling strategy.
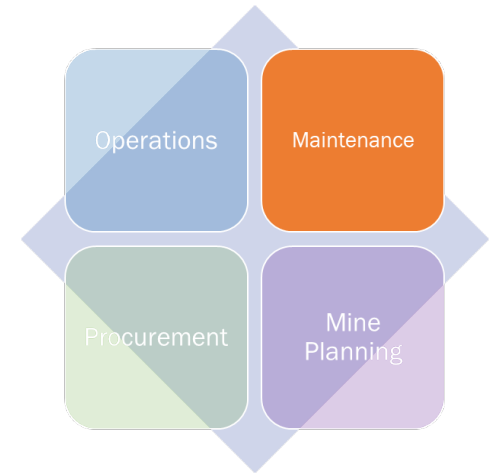
Other Maintenance Use Cases
- Maintain to efficiency
- Fuel-system condition based maintenance

Procurement Case Study:
Fuel and Lube Evaluation

- Large scale synthetic drive-line lube analysis currently underway in NV
- Phase 1: 10 Haul trucks instrumented to establish baseline
- Phase 2: Population divided in half with one group reconfigured with new petrochemical product
- Modelling is used to quantify the efficiency Impact attributable to change

Conclusion:
Previous diesel trial demonstrated
- 3.8% +- 1.9% impact with 95% confidence (LR)
- 2.5% +- 0.9% impact with 95% confidence (GBT)
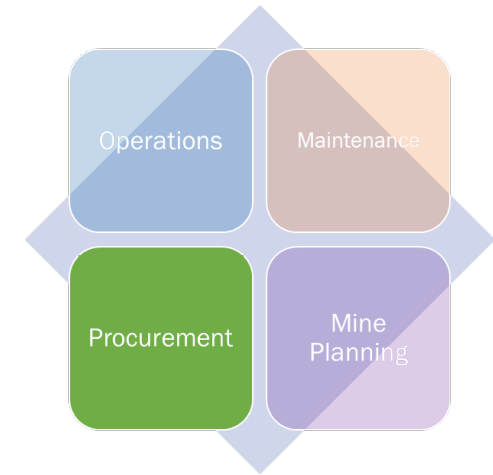
Other Procurement Use Cases

- Equipment Comparisons
- Aftermarket Technology evaluation

Mine Planning Case Study: Fuel Use Forecasting:

- Collect data and build observations sets across an operation
- Stratify data as necessary to examine specific areas of the operation and improve modelling accuracy
- Build model in terms of: Pit depth, distance to processing, payload targets etc
- Run the models to predict the impact of planned mine evolution on fuel consumption and production levels
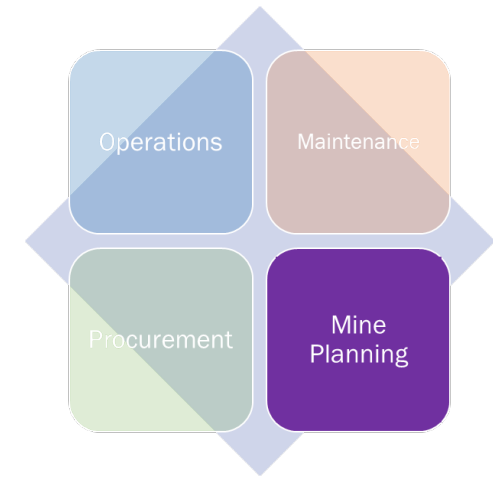
Other Mine Planning Use Cases

- Haul route design support
- Production Forecasting

Conclusion

The SmartRView platform is unique in its ability to deliver high accuracy in-service fuel measurement to the mining sector.

With the platform, advanced data science techniques and motivated subscribers are combining to drive exciting business improvement

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SmartRView Technical Specifications

Connectivity:

- CAN BUS
  CAT Data Link
  Komatsu PLM
  Hitachi CAN

- RS232, RS485

- MODBUS RTU

- GPRS - Penta-Band HSPA, LTE

- EGPRS / WCDMA / HSDPA / HSUPA
  protocol stack

- GPS

I/O and Sensor Package:

- 9 axis motion sensor (pitch, roll, yaw)

- 3 axis 16bit gyroscope

- 3 axis 14bit accelerometer

- 3 axis magnetometer

- Altimeter

- Relay control outputs (with expansion module)

- Digital and Analogue I/O (with expansion module)

Certifications:

- FCC Part 15, Subpart B, Class A – Unintentional
  Radiators

SmartRView Technical Specifications

Materials & Design:

- Glass-filled thermoplastic resin enclosure for reliability and durability

- UL 94V-0 rated circuit boards & wiring (Self-extinguishing)

- GXL silicone-based wiring, copper stranded

- Stainless steel hardware

- Magnetically mounted

- Plug and Play harnessing comprised of GXL silicone wiring, braided nylon sheathing, and Deutsch connectors

- Seamless integration with no splicing of existing OEM harnesses

Ruggedization:

- IP67 rated – Dust tight, water immersion capable

- Salt fog/salt spray approved - SAEJ1455

- Temperature rated from -40C through +65C ambient operating – SAEJ1455

- Storage temps from -40C through +85C non-operating – SAEJ1455

- Relative humidity levels of 0-99%, Condensing – SAEJ1455

- Vibration tested to 6g – As per SAEJ1455 & MIL810F

- Shock (Mechanical) tested to 20g – As per MIL810F

- Pressure wash testing