



**2018 Pavement Workshop**  
**May 23-24, 2018**



+ 46 Associate Members

## **Future Technologies**

**Bryan Downing**  
**Caterpillar Paving Products**  
**Global Sales Consultant**

**Develop** ↻ **Collaborate** ↻ **Research** ↻ **Implement** ↻ **Sustain.**

# TECHNOLOGY TRENDS FOR CONSTRUCTION

- Current Technology – The Age of Smart Iron
- Asphalt Paving
  - 3D or 2D Grade Control
  - Asphalt Temperature Measurement / Mapping
  - Material delivery coordination/synchronization
- Intelligent Compaction
  - Asphalt and base materials
  - Smart compaction systems
- Future technologies
  - The Road to Autonomy
- Workplace Tools to plan - work more efficiently

# TECHNOLOGY

## The age of smart iron





LINK

# CAT LINK



CAT® CONNECT TECHNOLOGY





# LINK DELIVERS THE INSIGHT YOU WANT

*Cat Product LINK™ is a comprehensive remote monitoring and asset management solution, with remarkably intuitive web interfaces that transform data from a customer's entire fleet of equipment into the essential information required to boost productivity, reduce costs and manage risks.*

## ➤ Manage Equipment with Real-Time Data

- Equipment Data including machine hours, performance information and more.
- LINK technologies enabling you to monitor the health and status of your machines.

## ➤ Operators Work More Efficiently

- Operators immediate feedback about machine performance and job progress.
- Operators can monitor payloads, load counts, progress to grade and compaction.

## ➤ Track Job Progress, Production and Costs – without Guesswork

- VisionLink gives you timely, actionable information.
- Detailed information about each job, such as production totals, time, and job costs.



Search

Groups > Fleet > 11 Results

Fleet	Alerts	Health	Maint
Fleet Summary			
Asset ID	S/N		Ma
 LOADER 3 C	AB410001		CA
 LOADER 2 SS	AC73001		CA
 TRACTOR 5	EF000432		CA
 LOADER 6	GW432		JCE
 LOADER 1 MT	LU000532		CA
 TRAILER 1	SY034550		CA
 LOADER 10 W	TP023498		CA
 MIXER 1	XQ000378		CA





# CAT PAYLOAD



CAT® CONNECT TECHNOLOGY



# PAYLOAD HELPS DELIVER VALUE

*Cat Production Measurement brings on-the-go weighing to the cab to help operators hit precise load targets and load trucks to optimum payload capacity - increasing the productivity of your entire fleet.*

## ➤ Work Productively

- Integrated into machine display; operator can easily view payload information and make final load adjustments before loading the truck.
- Tip Off allows operator to make final-pass estimated payload adjustments and quickly view adjusted weights in real time.

## ➤ Work Efficiently

- Fill trucks to capacity without overloading; increase payload potential; use fewer trucks to move more material.
- Live Weigh provides a quick, real time estimate of payload without swinging.

## ➤ Improve Operator Performance

- Operators at all experience levels work with confidence and perform at a higher level, producing consistent, accurate loading of materials.

## ➤ Manage Your Business

- Analyze load times, number of passes and daily payload to determine: operator productivity; jobsite changes to optimize efficiency; incentives to meet fuel burn and production targets.







GRADE



# CAT GRADE



CAT® CONNECT TECHNOLOGY





# GRADE FOR EARTH MOVING

*Cat GRADE Technologies combine digital design data, in-cab guidance, and automatic controls to enhance **grading accuracy** brings cut and fill information into the cab to help operators hit elevation and location - **increasing the productivity** of your entire fleet.*



## ➤ Work Productively

- Integrated into machine; operator can easily view grade information on the display, grade control buttons built into joysticks, works with current machine integrated systems

## ➤ Improved Safety

- Removes grade checkers from the job site, out of harms way, improved visibility, theft prevention improved, reduces need to remove components at night

## ➤ Improve Operator Performance

- Operators at all experience levels work with confidence and perform at a higher level, producing consistent, more accurate grades

## ➤ Increase Profitability

- Move more material in fewer trips correctly once, save time, fuel and labor costs; reduce machine wear, minimize sites costs

## ➤ Improved Reliability

- Move components to protected locations, fewer parts, standard design/installation reduces downtime.

# GRADE FOR PAVEMENT

*Cat GRADE Technologies combine easy to use controls with precision to enhance milling accuracy enabling the ultimate **smoothness and uniformity** to the asphalt paving process.*



## ➤ High Accuracy

- Easily performs the work to specifications consistently.

## ➤ Application Flexibility

- Modular grade inputs based on application
  - Sonic sensors, 3D, contact sensors, beams, inboard contact ski's
  - Coming soon Thermal Mapping on asphalt pavers

## ➤ Improve Operator Performance

- Ease of operation with clear feedback on actual grade performance

## ➤ Advanced features

- Cold planer ramp in/out and jump hold features for added application efficiency/productivity
- Asphalt Paver auto material loading

## ➤ Optimize Your Business

- Increased efficiency, Improved smoothness, 3D as-built designs



# TECHNOLOGY

## 3D Grade Control Paving or Milling

# WHAT ARE THE STAKEHOLDER GOALS?

## Owner

- Road quality (smoothness, road lifetime, minimal thickness of layers) at minimal cost

## Main Contractor Paving Contractor

- Minimize material usage
- Meet smoothness and minimal thickness specs
- Meet completion deadline

## Milling Contractor

- Often paid by square meter/yard and then wants productivity
- Meet completion deadline



# ADVANTAGE OF 3D MILLING

- Only mill where needed – Increased production
  - Higher productivity is less Milling cost
- Increased Smoothness – custom mill pattern
  - Remove longitudinal road waves and longitudinal high and low spots
    - No stakes required!
- Variable depth and slope milling enables milling of:
  - Transitions
  - Super-elevated curves
  - Variable drainage slopes
  - Removal of longitudinal waves in the road

# PAVING 3D TERMINOLOGY

- 2D Paving – guidance to grade (elevation-thickness) and/or slope
  - 2D is Ground-up
  - 2D Systems typically place a constant thickness over the base
- 3D Paving – guidance to grade and slope at a known position using a design/model
  - 3D is Design-down and does not use the existing surface for guidance

# ADVANTAGE OF 3D PAVING



- Achieve the highest accuracy and smoothness levels
  - Better material management/yields
- Eliminate the string lines:
  - Reduce staking labor, downtime and errors
  - Reduce costly rework
  - Finish the project faster
- Pave complex designs





# CAT DETECT



CAT® CONNECT TECHNOLOGY





# DETECT HELPS DELIVER VALUE

*Cat DETECT technologies combine safety and monitoring systems to enhance operator awareness. By expanding your view of the working environment around your equipment, you can keep your people and assets safe.*



## ➤ Work Safely

- Vest or Hard hat RFID alerts driver to presence.
- Integrated machine job site cameras output to an operator's display make job sites safer.

## ➤ Work Efficiently

- Live camera views increase efficiency while keeping all personnel safe.

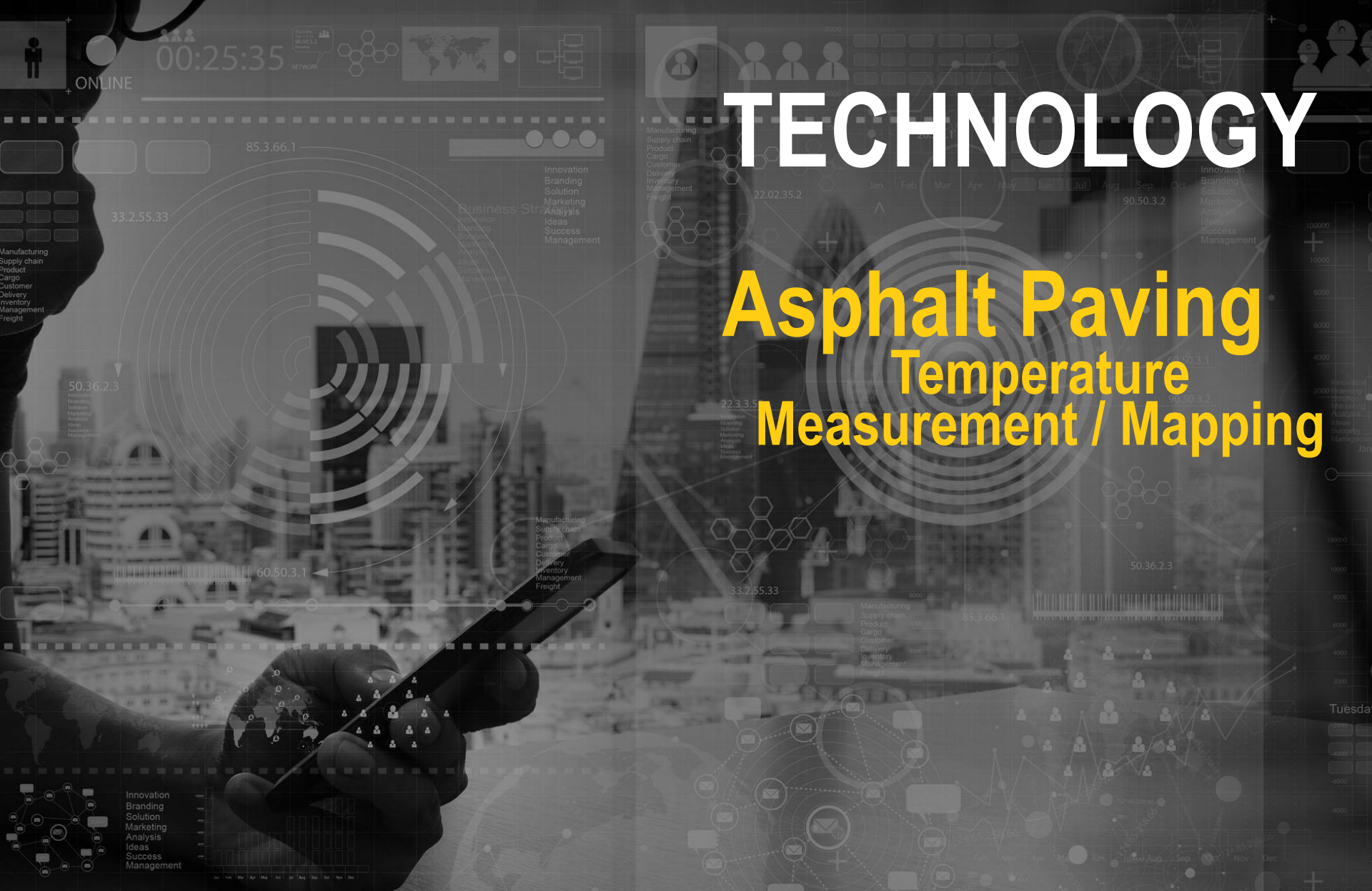
## ➤ Improve Operator Performance

- Operators at all experience levels work with confidence and perform at a higher level, producing consistent, safely loaded trucks.



# TECHNOLOGY

## Asphalt Paving Temperature Measurement / Mapping



# PAVING TECHNOLOGY

## ASPHALT PAVERS



Machine Telematics

Eco Mode



Integrated Electric Generator  
w/Diagnostic Capability

Auto-fill Feeder System



Asphalt Thermal Mapping



Integrated 2D Grade Control  
3D ready



# TECHNOLOGY

## Material Delivery Coordinated and Synchronized

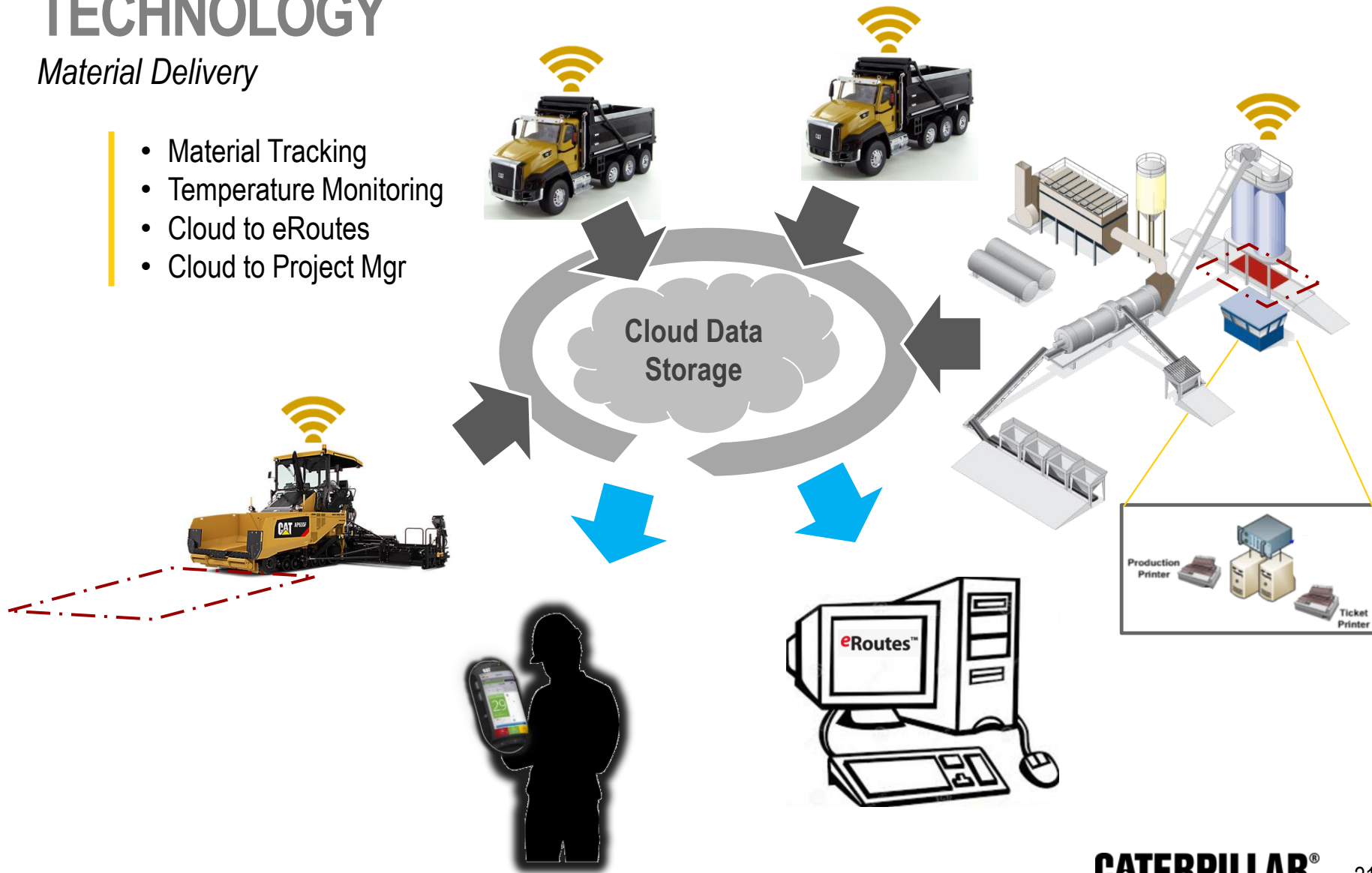




# PLANT TO PAVER TECHNOLOGY

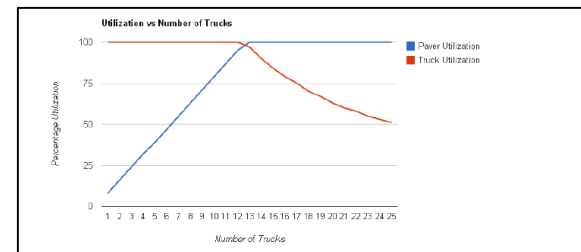
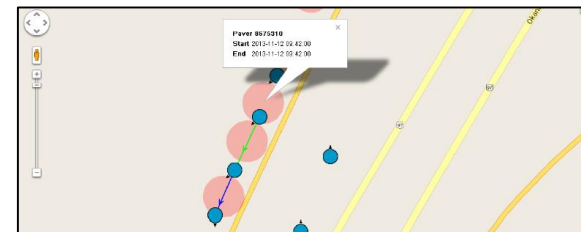
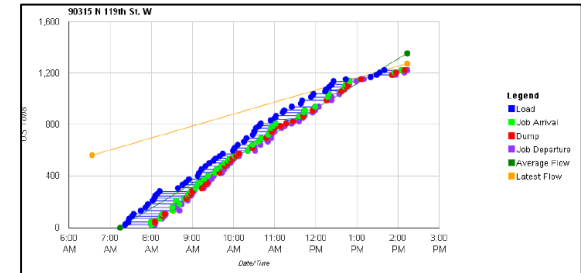
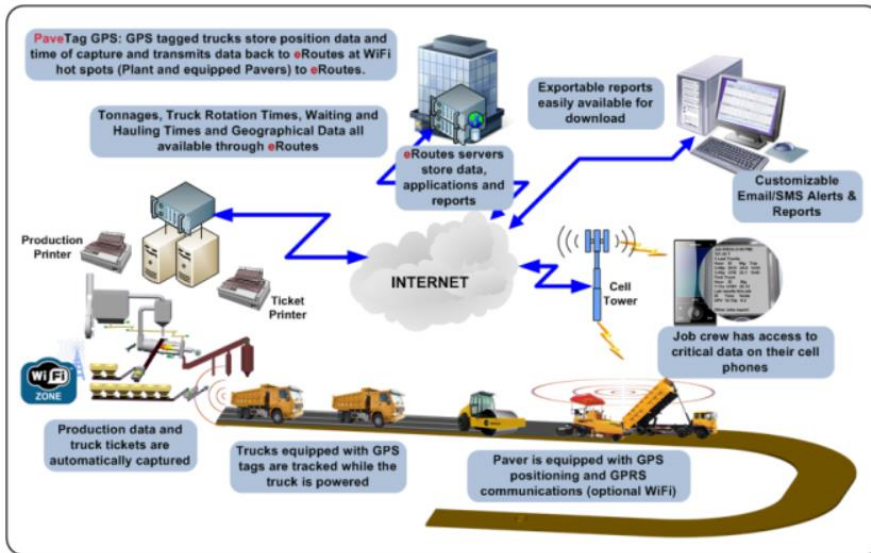
## Material Delivery

- Material Tracking
- Temperature Monitoring
- Cloud to eRoutes
- Cloud to Project Mgr



# INFORMATION OUTPUT

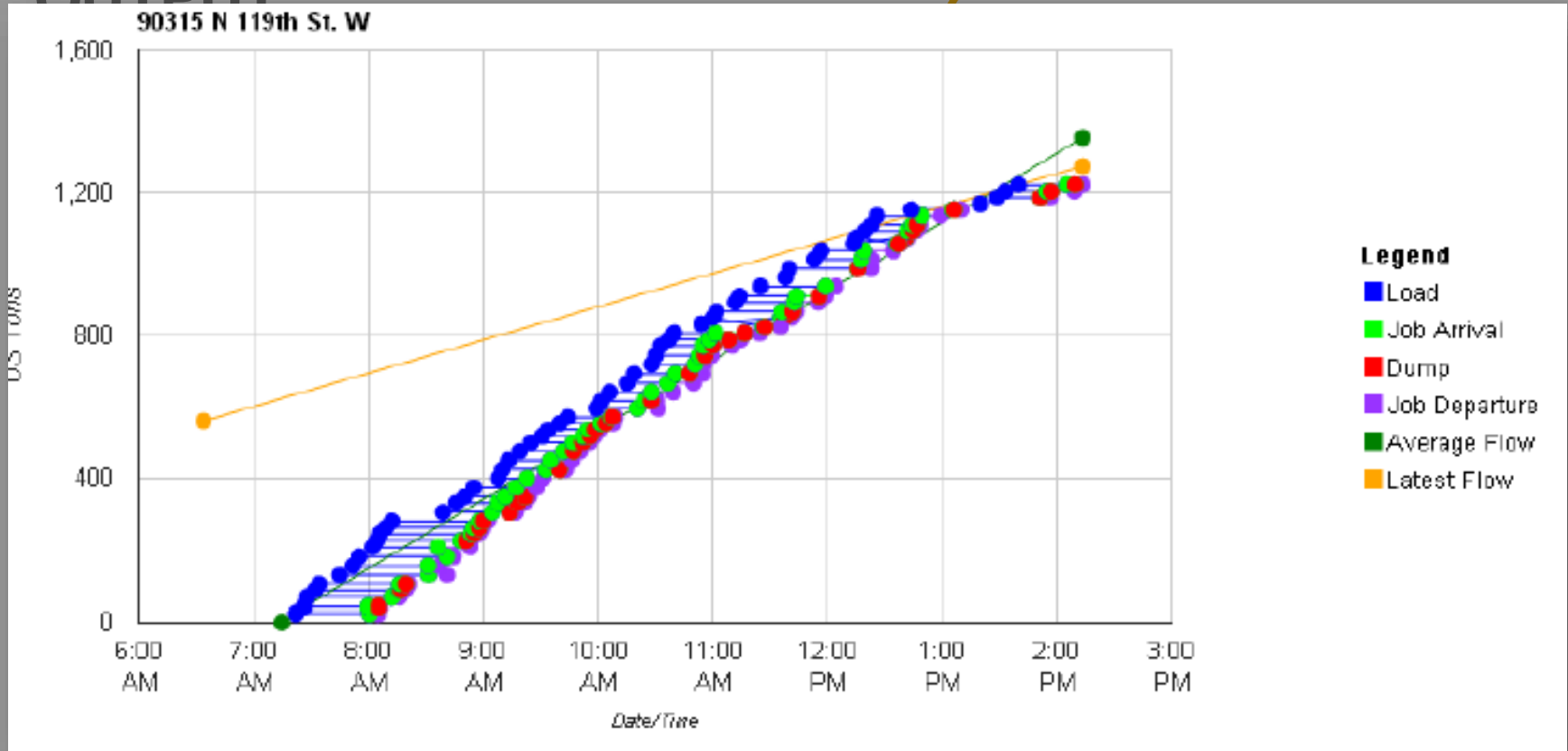
## Software Part



Displaying results for Root,demo, Plant ID: Demo1  
2013-11-12 00:00:00 - 2013-11-12 23:59:59  
Showing page 1 of 1 (120 complete loads)

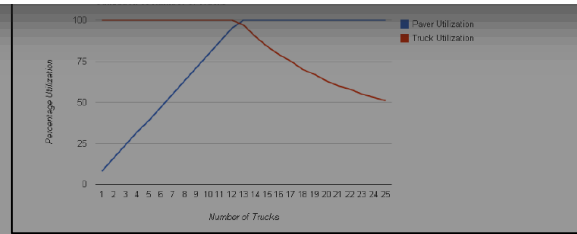
Plant	Truck	Ticket	Material	Job	Mat. Weight	Plant Arrival	Load	Plant Departure	Time on Job	Job Departure	Paver ID	Job Departure	Time on Paver	Round Trip	MPG
Plant ID: 90315 (X complete loads)					1176.99				11:54:29				00:28:49	00:28:49	
Plant ID: 90676 (X complete loads)					102.76			08:56:29					00:28:44	01:49:01	
Plant ID: 90676 (X complete loads)	10016	227226	AC/E	9026	26.46	07:31:24	07:52:09	07:52:16	00:29:42	09:28:57	08:31:19	Paver 667020	08:36:47	00:58:44	
Plant ID: 90676 (X complete loads)	10016	227226	AC/E	9026	35.48	08:38:12	08:59:03	08:59:10	00:20:24	09:21:11	09:32:47	Paver 667020	09:40:31	01:18:20	
Plant ID: 90676 (X complete loads)	10016	227220	AC/E	9026	20.72	10:14:19	10:28:39	10:28:39	00:14:19	09:22:05	10:50:43	Paver 667020	10:56:36	01:17:02	
Plant ID: 90676 (X complete loads)	10016	227223	AC/E	9026	26.09	11:24:23	11:49:33	11:49:37	00:16:54	09:39:20	12:18:37	Paver 667020	12:21:01	01:12:38	
Plant ID: 90676 (X complete loads)					102.76			08:56:29					00:28:44	01:49:01	
Plant ID: 90676 (X complete loads)					80.28			08:28:49					00:28:49	00:59:26	
Plant ID: 90676 (X complete loads)	10016	227222	AC/E	9026	17.9	08:37:16	08:52:29	08:52:30	00:26:11	09:41:02	08:57:43	Paver 667020	09:02:26	00:51:40	

# INFORMATION OUTPUT



Displaying results for Root,demo, Plant ID: Demo1  
2013-11-12 00:00:00 - 2013-11-12 23:59:59  
(Showing page 1 of 1 (100 complete loads))

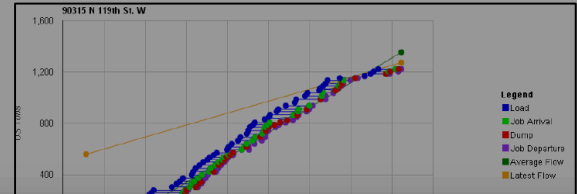
Start ID	Truck ID	Truck Model	Model ID	Job ID	Job Name	Plant Arrival Date/Time	Load Time	Plant Departure Date/Time	Time Zone	Job Travel Date/Time	Job Arrival Date/Time	Plant Job ID	Job Departure Date/Time	Time Zone	Round Trip Time	Map
18814	22722	ACME	3036	2646	07:31:24	07:52:09	07:52:09	08:29:41	08:29:57	08:31:10	Plant 667020	08:36:57	08:56:44	-	↓	
18815	22722	ACME	3036	2648	08:36:12	08:53:03	08:53:03	09:33:24	09:33:31	09:32:47	Plant 667020	09:40:38	09:58:54	9:19:26	↓	
18816	22720	ACME	3036	2672	10:14:19	10:28:03	10:28:03	10:14:19	09:22:05	10:30:43	Plant 667020	10:50:46	09:54:52	9:17:02	↓	
18818	22722	ACME	3036	2669	11:24:23	11:39:03	11:39:03	11:14:14	09:39:21	12:16:37	Plant 667020	12:22:49	09:57:34	9:17:38	↓	
Totals for Truck ID: 18815 (4 complete loads)																
18815																
Totals for Truck ID: 18814 (4 complete loads)																
18814																





# INFORMATION OUTPUT

## Software Part

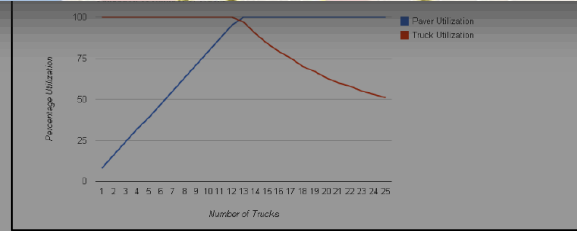


PaveTag GPS: GPS tagged trucks store position data and time of capture and transmits data back to eRoutes at WiFi



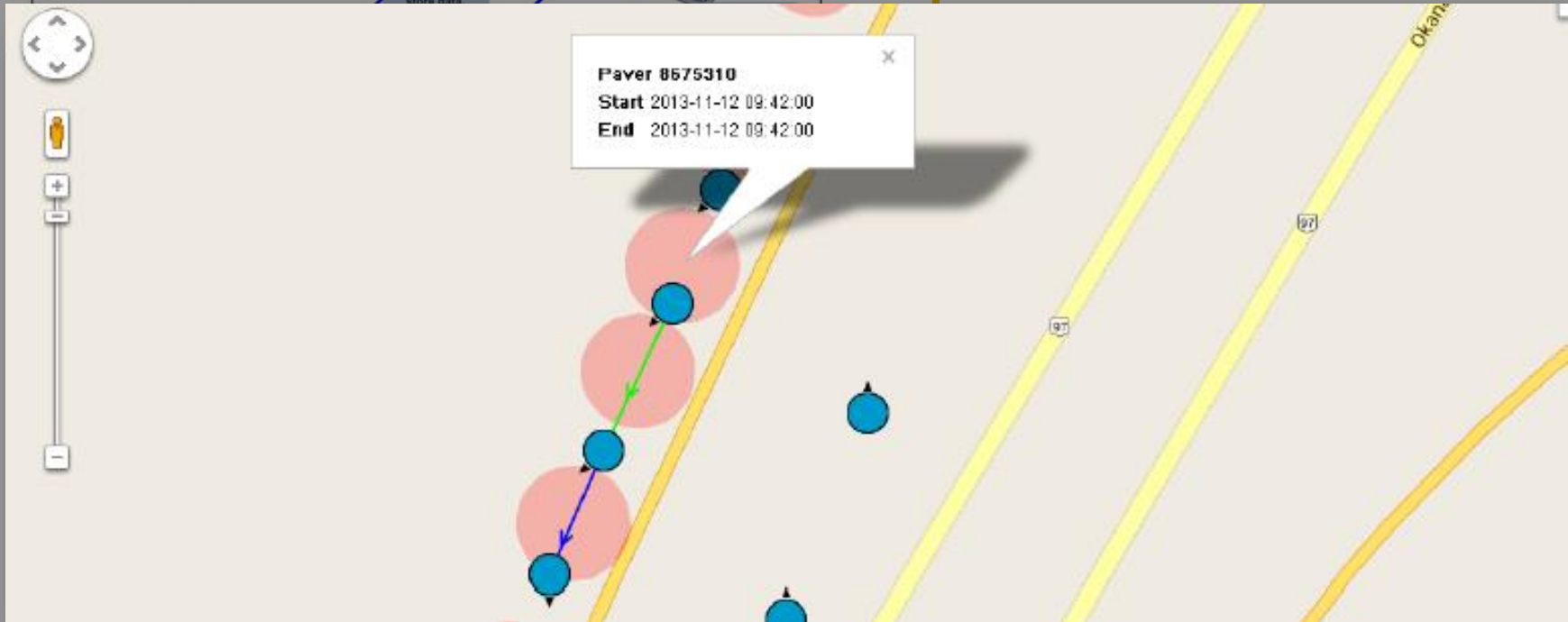
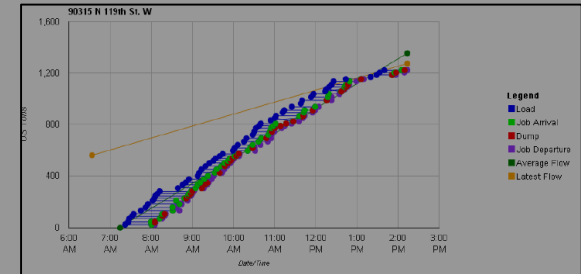
Displaying results for Root.demo, Plant ID: Demo1  
2013-11-12 00:00:00 - 2013-11-12 23:59:59  
Viewing page 1 of 1 (100 records shown)

Start	Truck	Truck	Truck	Model	Job	Job	Plant	Plant	Plant	Job	Job	Job	Job	Job	Time	Round	Round
ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID
1001	1001	1001	1001	1001	1001	1001	1001	1001	1001	1001	1001	1001	1001	1001	1001	1001	1001
1002	1002	1002	1002	1002	1002	1002	1002	1002	1002	1002	1002	1002	1002	1002	1002	1002	1002
1003	1003	1003	1003	1003	1003	1003	1003	1003	1003	1003	1003	1003	1003	1003	1003	1003	1003
1004	1004	1004	1004	1004	1004	1004	1004	1004	1004	1004	1004	1004	1004	1004	1004	1004	1004
1005	1005	1005	1005	1005	1005	1005	1005	1005	1005	1005	1005	1005	1005	1005	1005	1005	1005
1006	1006	1006	1006	1006	1006	1006	1006	1006	1006	1006	1006	1006	1006	1006	1006	1006	1006
1007	1007	1007	1007	1007	1007	1007	1007	1007	1007	1007	1007	1007	1007	1007	1007	1007	1007
1008	1008	1008	1008	1008	1008	1008	1008	1008	1008	1008	1008	1008	1008	1008	1008	1008	1008
1009	1009	1009	1009	1009	1009	1009	1009	1009	1009	1009	1009	1009	1009	1009	1009	1009	1009
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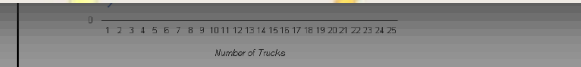


# INFORMATION OUTPUT

## Software Part



Serial	10016	22222	ACME	8006	3549	08:08:12	08:10:00	08:11:30	08:24	08:21:11	08:22:47	Paver	867530	08:16:14	08:18:25
Serial	10016	22222	ACME	8006	3072	10:14:19	10:20:00	10:20:30	08:14:19	08:22:05	10:30:43	Paver	867530	08:14:02	08:17:02
Serial	10016	22222	ACME	8006	2609	11:24:23	11:30:00	11:31:37	08:14:54	08:39:21	12:18:37	Paver	867530	08:17:16	08:17:38
Totals for Truck ID: 10016 (3 complete loads)					10276				08:04:29				08:26:04	08:40:01	
Total for Truck ID: 10016 (3 complete loads)					8678				08:26:00				08:38:57	08:51:26	
Serial	10016	22222	ACME	8006	179	08:37:19	08:39:00	08:40:30	08:38:11	08:41:52	08:57:43	Paver	867530	08:38:26	08:41:40



# eROUTES MOBILE APP

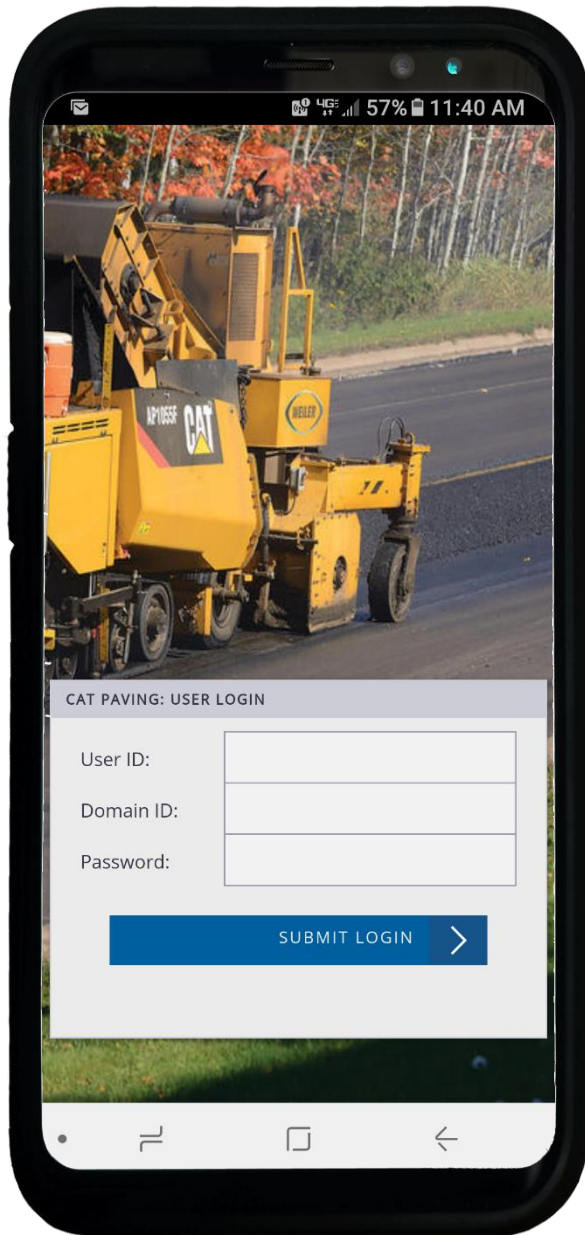
## Login

Developed for ....

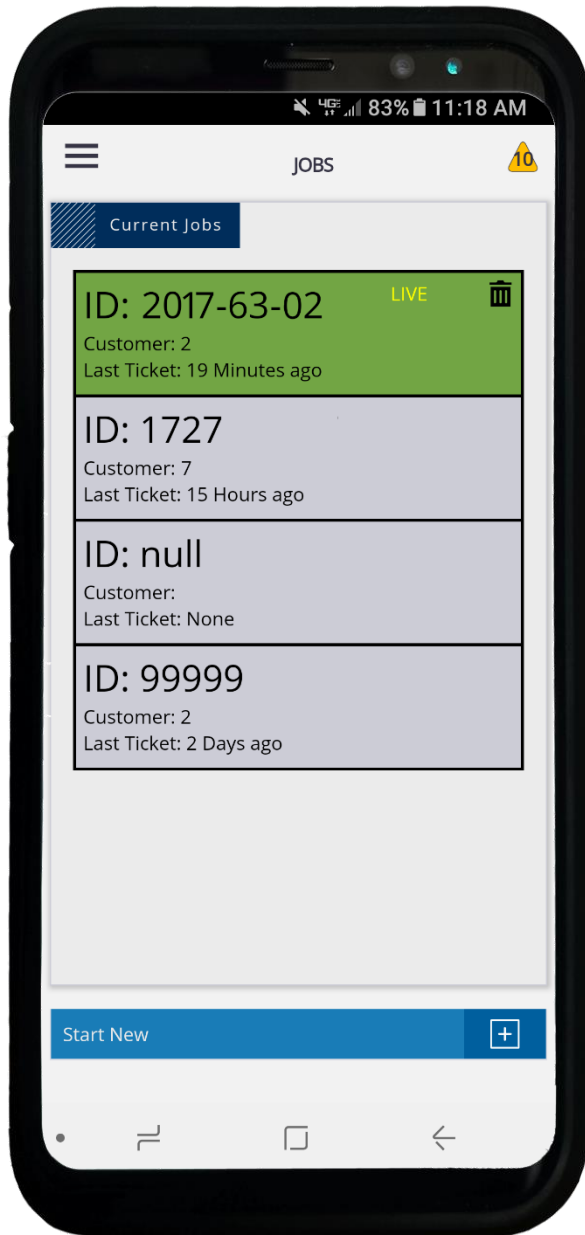
- Superintendents
- Job Foremen
- Paving Foremen
- Paving Crews

Real-time information in the hands of those who need it most

Remotely monitor the jobs of the day







# eROUTES MOBILE APP

## Jobs

Developed for ....

- Superintendents
- Job Foremen
- Paving Foremen
- Paving Crews

Real-time information in the hands of those who need it most

Remotely monitor the jobs of the day

# eROUTES MOBILE APP

## Dashboard

Main navigation screen summarizing critical information about the job

Based on user input

- Tons/day
- Time
- Distance
- Number/Capacity of trucks

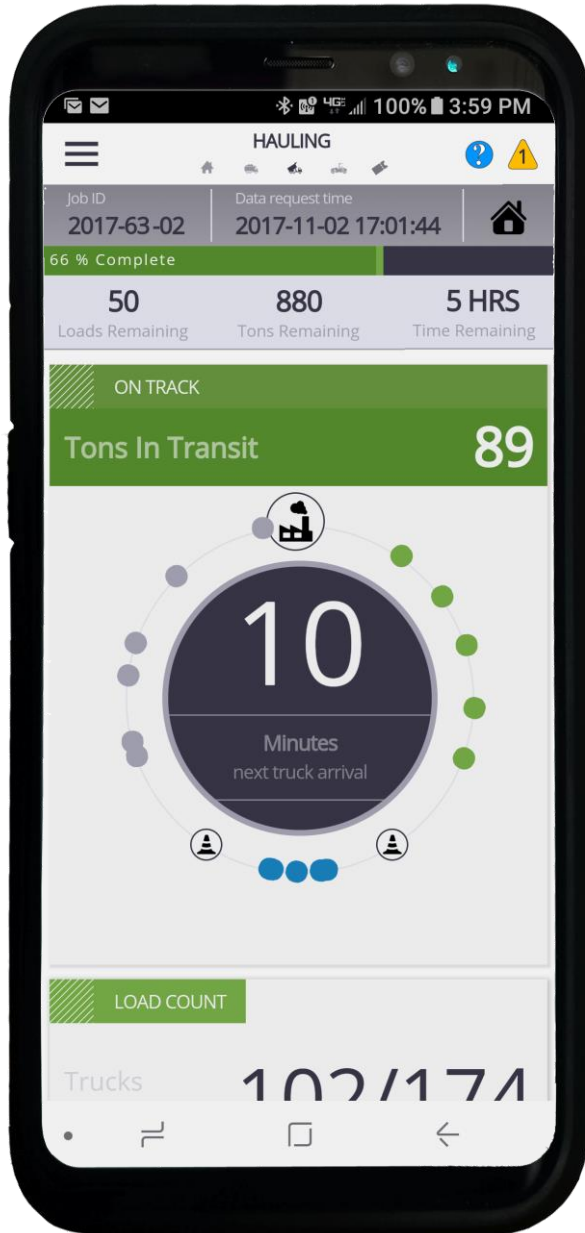
Information includes:

- LIVE truck arrival times at paver
- Trucks at plant, paver, and in transit
- Tons paved, loaded, and in transit
- Ticketed loads



# eROUTES MOBILE APP

## Hauling



Detailed information of trucking cycle

- Tons in transit
- Next truck arrival time

Broad view of all trucks

- Green – Ticketed and in transit
- Blue – On the jobsite
- Gray – Returning to plant

Selecting a truck indicates Truck ID with the ability to scroll through the trucks

Swiping down shows number of loads versus a target

Last, average, and estimated cycle times



# eROUTES MOBILE APP

## Loadout

Detailed information of loading process

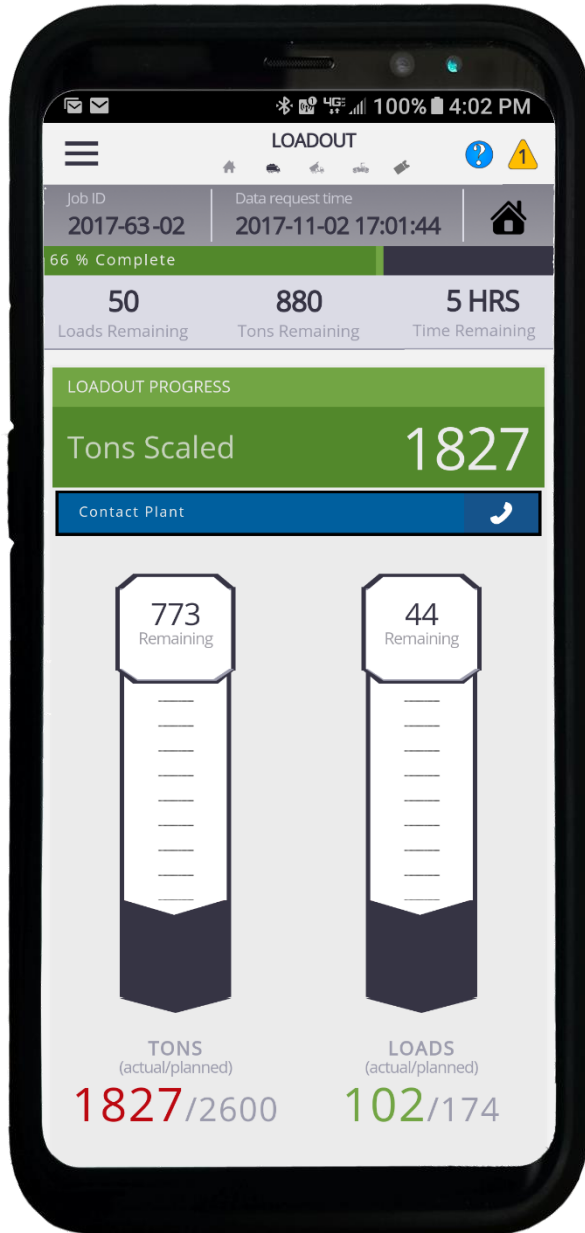
- Tons scaled
- Tons/Loads remaining versus the target

Ability to quickly call the plant

Swiping down shows tons loaded in the last hour

Next truck arrival time to plant

Average wait time at the plant



# eROUTES MOBILE APP

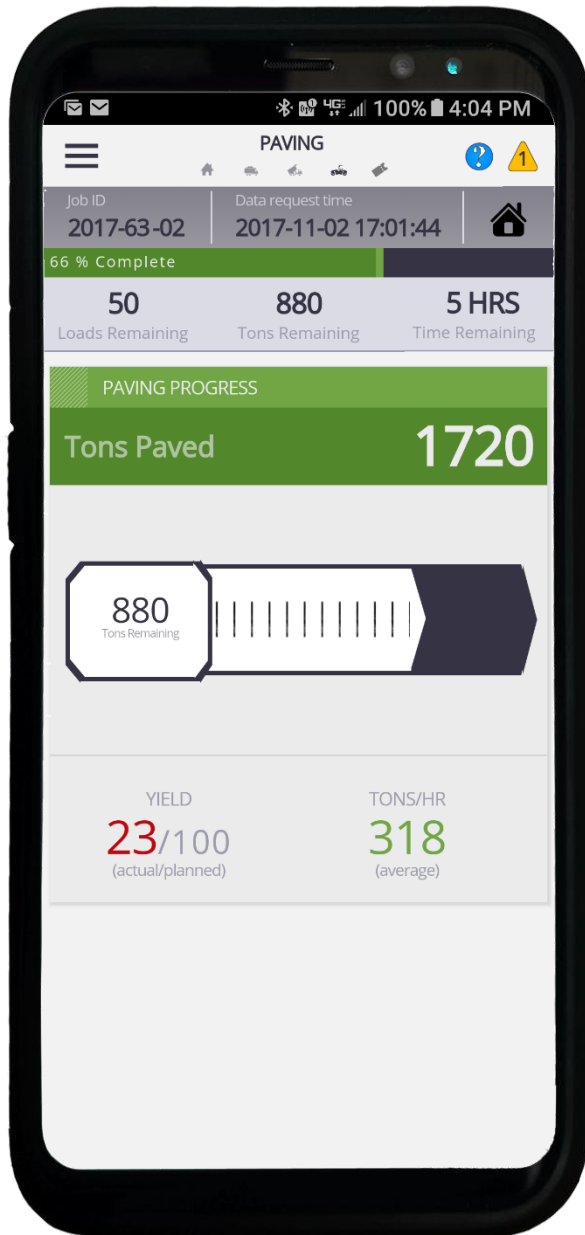
## Paving

Detailed information of paving process

- Tons paved
- Tons remaining versus the target

Estimated yield

Average tons/hr paved

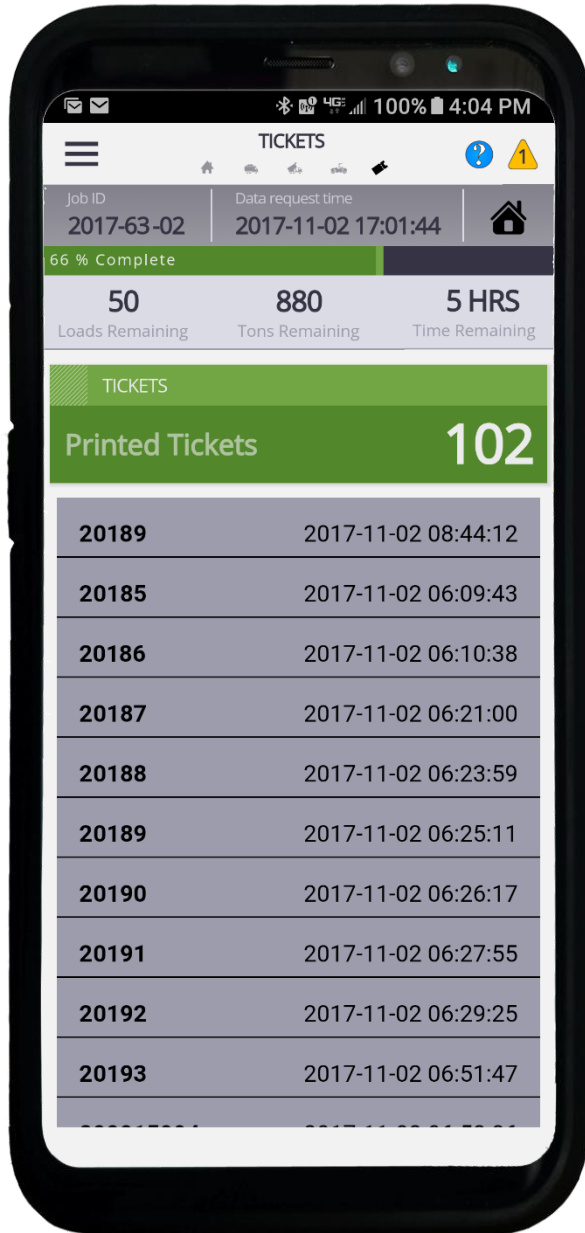


# eROUTES MOBILE APP

## Tickets

List of printed tickets with time/date of printing

Select from list to view the ticket



# Why eROUTES?

## *Customer Value*

### **Quickly see the whole process**

- Merge paver/truck/ticket data into real-time information
  - Cycle times/waiting times per job/truck/plant
  - Tons loaded, in-transit, and paved

### **Driver performance comparison**

- Hire trucks/Company trucks? (Performance you expect?)
- “Where are my trucks!” (mystery solved!!!)

### **Help eliminate paver stops**

- Your bonus depends on it!
- Balance laydown and delivery

### **Balance plant production for multiple crews**

- The right mix produced at the right time
- Reduce plant wait times



# ASPHALT PAVING CONNECTED SYSTEMS



Increasing **Customer value** by offering **solutions** that **optimize** processes to generate **profits** via data communication and **productivity** technologies that provide **real time** job site management.



# TECHNOLOGY

# Intelligent Compaction





# CAT COMPACT



CAT® CONNECT TECHNOLOGY





# COMPACT HELPS DELIVER VALUE

*Cat® COMPACT technologies combine advanced compaction measurement, in-cab guidance and reporting capabilities to help you consistently meet compaction targets faster, more uniformly, and in fewer passes—saving on fuel and reducing rework and material costs in both soil and asphalt applications.*

## ➤ Uniformity + Confidence = Quality

- Empowers operators with documentation of the work completed.

## ➤ Measure

- Measurement for base compaction; CMV and/or MDP
- Measurement for asphalt compaction; CMV and/or Temperature

## ➤ Document – GNSS Mapping

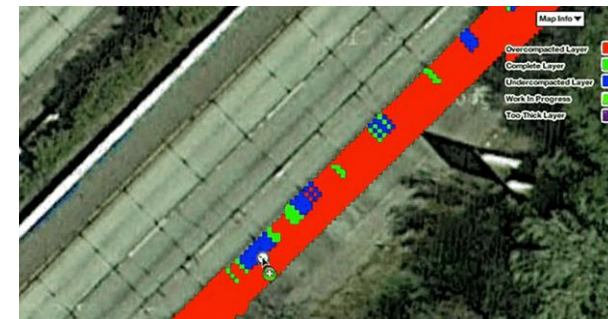
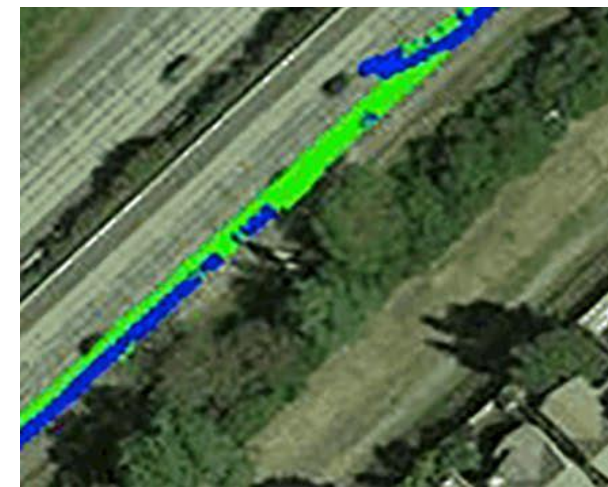
- Measurement plus Pass Count mapping

## ➤ Analyze

- Meet target pass count
- Asphalt Paver auto material loading

## ➤ Make every pass count

- Increased efficiency and Improved layer smoothness
- Documentation of compaction process ensures uniformity





# PAVING TECHNOLOGY

## ASPHALT COMPACTION



Machine Telematics



Compactor to Compactor  
Data Communication

Cat Compaction Control  
GPS Temperature, Pass Count  
and Compaction Mapping



Object Detection

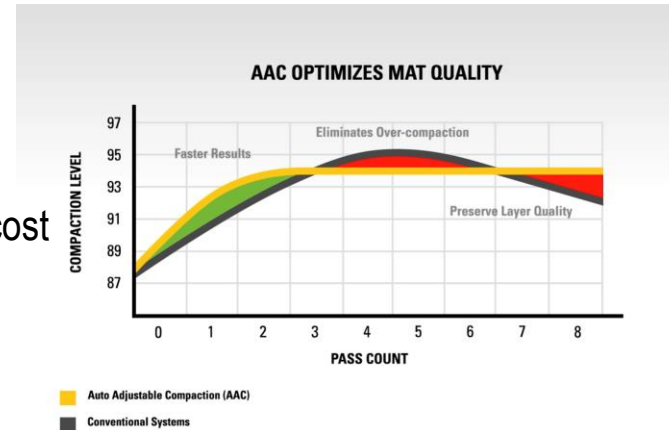
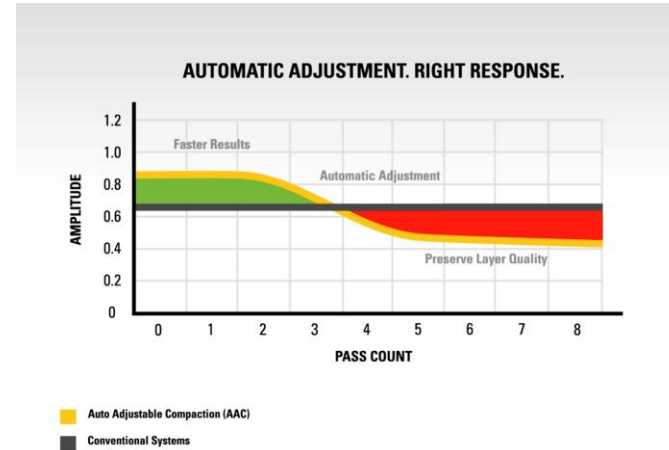
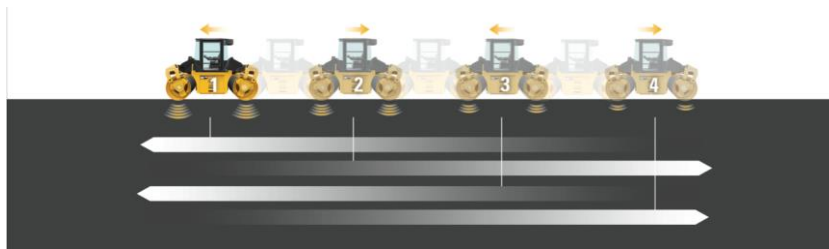
Automatic Compaction  
Control

**CATERPILLAR**<sup>®</sup>

# COMPACTION TECHNOLOGY

## AUTOMATIC COMPACTION CONTROL

- Operational Simplicity - Automatic control
  - Ensures the amplitude is optimized
  - Easy to use for all operators – Simple operation
  - Operators see the system value immediately
  - Ensures inexperienced operators do not damage the asphalt.
- Increased Productivity - Do More
  - Intelligent compaction next to sensitive structures
  - The system prevents decoupling / damage to asphalt
  - Sensitivity customized for different bitumen stiffness.
- Quality Compaction
  - Homogeneous, uniform compaction creates compaction with less cost
  - Reduced risk of over-compaction



# VALUE OF

# ROLLER MAPPING – INTELLIGENT COMPACTION

## Rolling Pattern Analysis

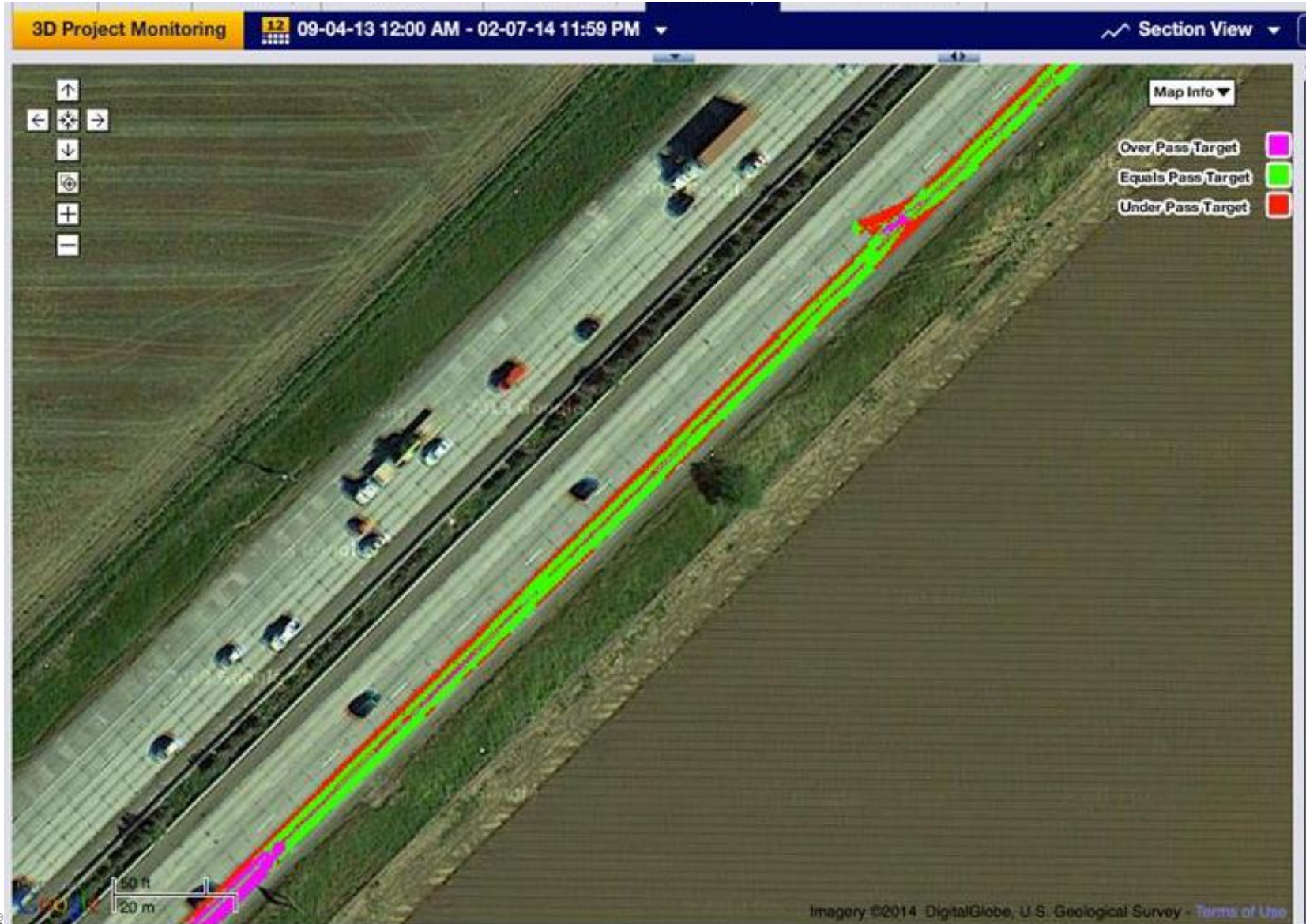




# VALUE OF

# ROLLER MAPPING – INTELLIGENT COMPACTION

## Rolling Pattern Analysis

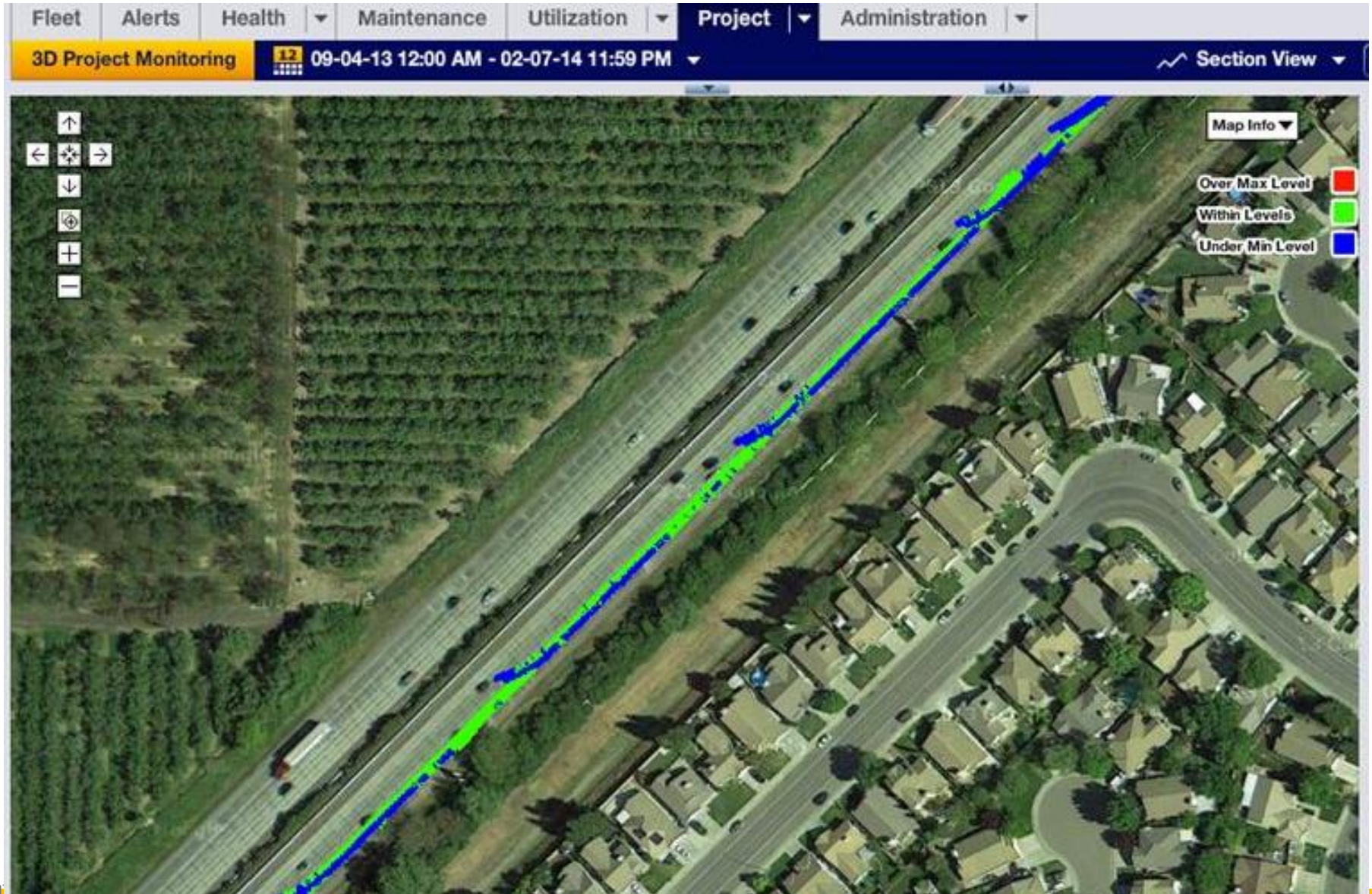




# VALUE OF

# ROLLER MAPPING – INTELLIGENT COMPACTION

## Temperature Variation





# VALUE OF ROLLER MAPPING – INTELLIGENT COMPACTION

## CMV Analysis



# TECHNOLOGY

# Future Development





# ROAD TO AUTONOMY



CONVENTIONAL CONSTRUCTION



## 1. AUTOMATION

OPERATING OR CONTROLLING A PROCESS BY HIGHLY INDEPENDENT MEANS, REDUCING HUMAN INTERVENTION AT THE SITE LEVEL



## 2. SEMI-AUTONOMY

REMOTE CONTROL OF EQUIPMENT AND OPERATIONS FROM AN OFFICE OR OFF-SITE LOCATION

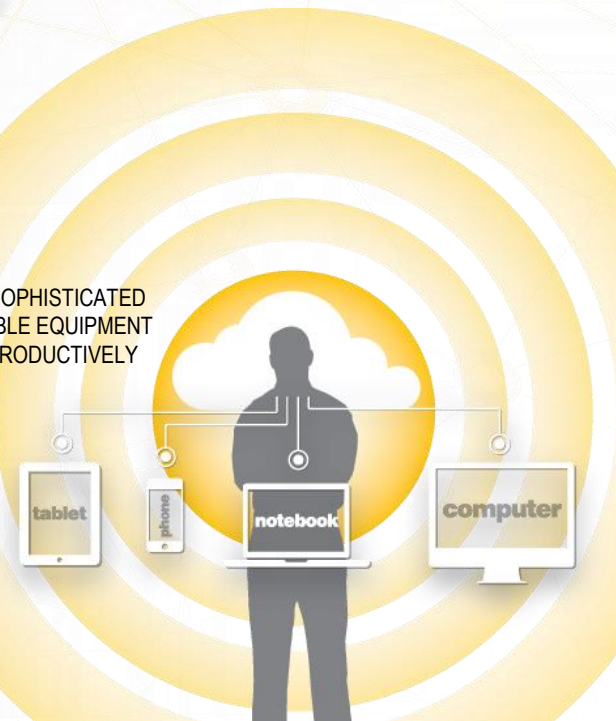


## 3. AUTONOMY

TAKES ADVANTAGE OF SOPHISTICATED TECHNOLOGIES TO ENABLE EQUIPMENT TO WORK SAFELY AND PRODUCTIVELY WITH MINIMAL INPUT

ENTERPRISE  
SITE  
SYSTEM  
MACHINE

JOBSITE OF THE FUTURE





# THE NEXT GENERATION SEMI / FULL AUTONOMY

TRADITIONAL CONSTRUCTION

29.5 HRS

LAYOUT EARTHMOVING

GRADING

PAVING

TECHNOLOGY CONSTRUCTION

16.0 HRS

31%

LESS  
MAN HOURS

REDEPLOYED

Built in Safety – Less people on the jobsite

Efficient equipment utilization – ROI

Increased efficiency – enables more work

Increased Quality/Bonus – uniformity and consistency

Increased PROFIT potential – due to cost control, process efficiency

Real time project monitoring

12

ACRES  
SUSTAINABILITY  
FOREST SAVED

LOWER AS % OF  
BUSINESS

Semi-AUTONOMOUS + TECHNOLOGY CONSTRUCTION

12.0 HRS ?



LESS  
MAN HOURS

REDEPLOYED



LESS  
EQUIPMENT  
HOURS

REDEPLOYED



LESS  
PROJECT HOURS

GROW BUSINESS



LESS  
FUEL  
CONSUMPTION

LOWER AS % OF  
BUSINESS



ACRES  
SUSTAINABILITY  
FOREST SAVED

# TECHNOLOGY IS... REDEFINING INDUSTRY STANDARDS



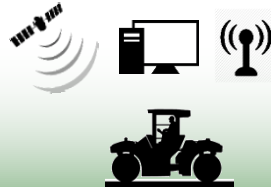
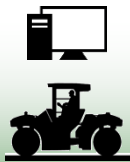
## Telematics

Products Condition  
External Environment  
Products Operation  
Products Usage



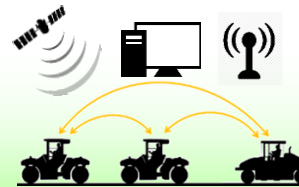
## Performance

Enhance product performance  
Allow predictive diagnostics



## Connectivity

Enhance product performance  
Through the Value Chain



## Autonomy

Full Jobsite Automation  
of Machines



### Product

Compaction Mapping  
AAC (Automatic  
Adjustable  
Compaction)

### Smart Product

Compaction  
Efficiency &  
Utilization

### Smart Connected Product

Compaction Optimization

### Smart Connected Products Part of a Product System

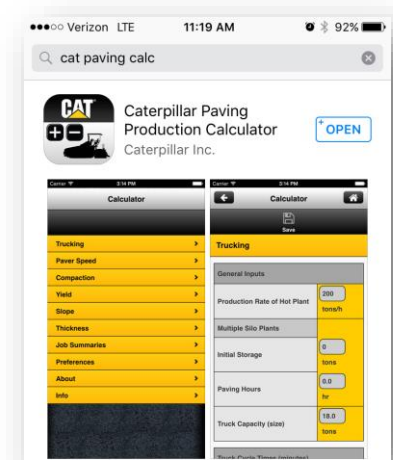
Roller to Roller M2M  
Compaction Map Sharing – full  
documentation

# APPLICATIONS FOR MOBILE DEVICES

*Plan the work – Tools to aid the PLAN*

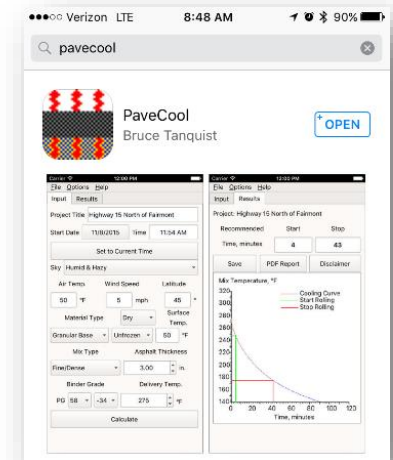
## Production Calculator App

- Our popular Production Calculator as a mobile app for iPad/iPhone and Android.
- Allows the customer to enter production numbers and generate a report for calculating trucks, paving speed and compaction specs.
- Download from iTunes and Google Play.
  - Search for “Caterpillar Paving Calc”



## Industry Developed PaveCool

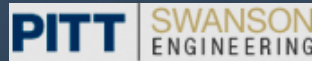
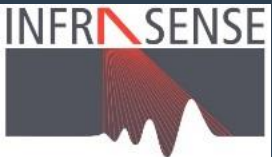
- A productivity tool that helps determine the cooling rate for asphalt layers and provides guidance for the compaction time window.
- Download from iTunes and Google Play.
  - Search for “Pavecool”



**NRRRA**  
National Road Research Alliance



Thank  
You



Develop → Collaborate → Research → Implement → Sustain.