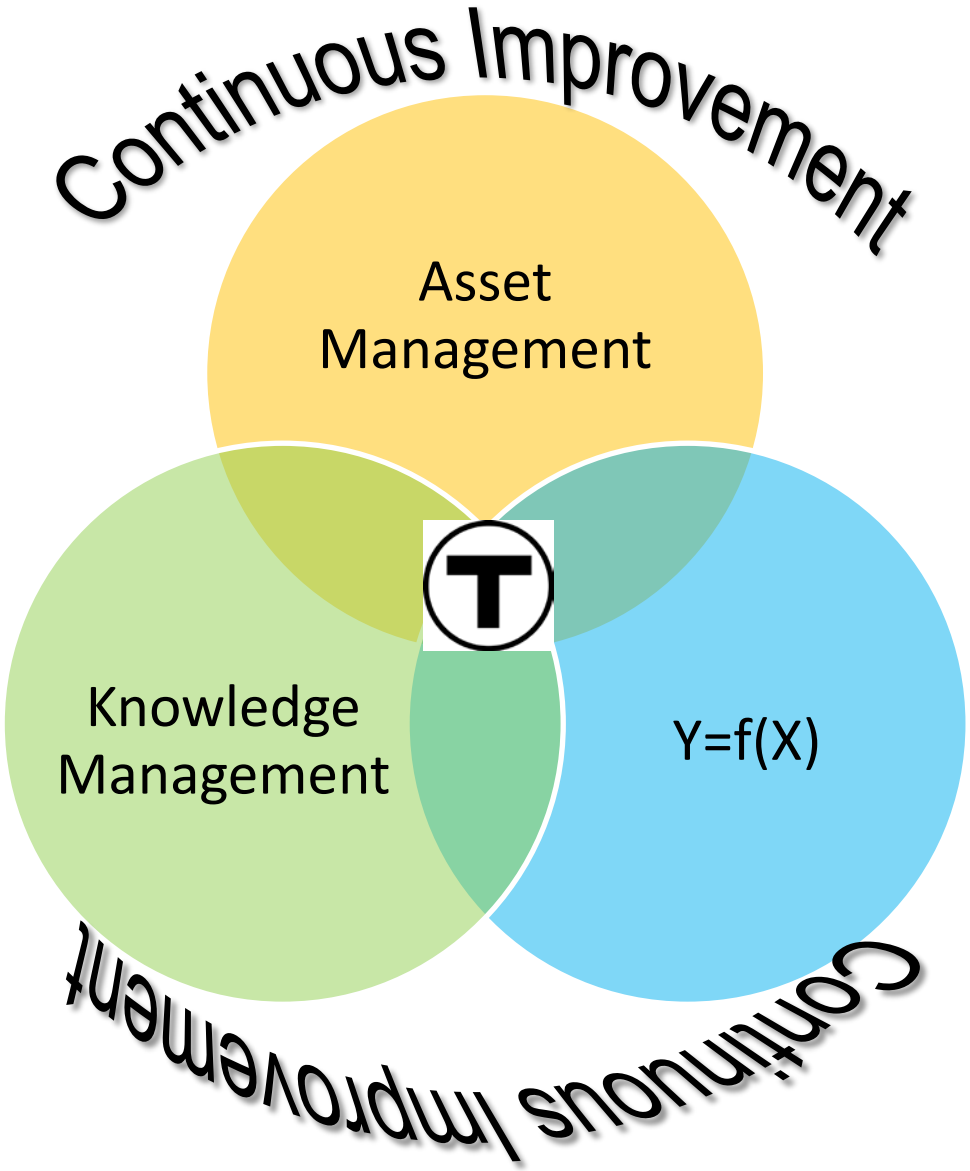
massDOT
Massachusetts Department of Transportation
Rail & Transit Division

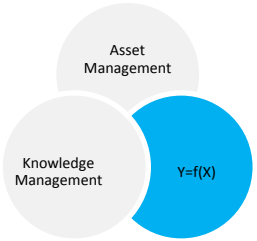
Use of Sensors and Scanning Technology for Asset Inventory, Condition and Service Reliability

Satyen Patel, MBA, CEng, MIET,
Director of Asset Management

The Institute of Asset Management
IAM
PATRON

Core Elements of the Program





Scanners

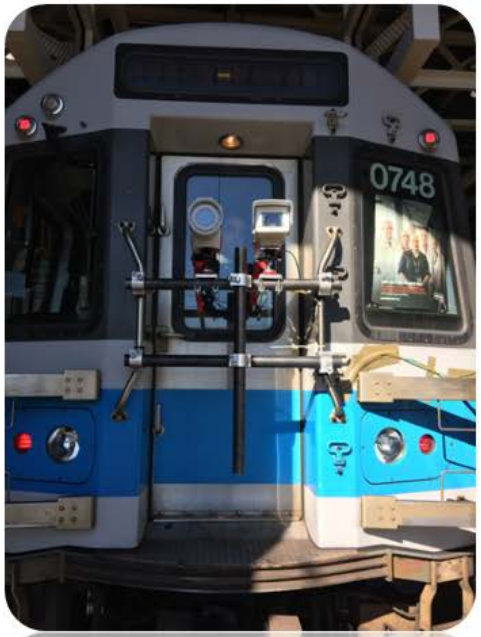
- Thermal Imaging
  - Partnered with JACOBS
  - Mounted Thermal Imaging Camera to the front of a revenue service train
  - Water detection (Leaks!)
  - Hot Spots
  - Heat from poorly bonded C-Bonds!
  - 3rd Rail heat during non-summer months
  - Proactive detection of potential cable fires due to degraded splicing
  - Overheating joints
  - Lights!

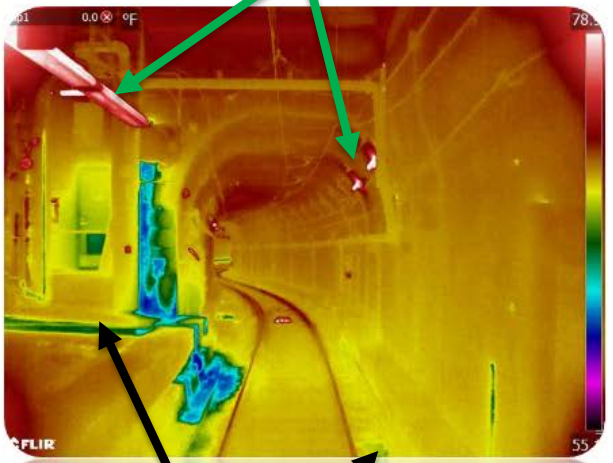
Scanners

- Thermal Imaging

Scanners

- Thermal Imaging



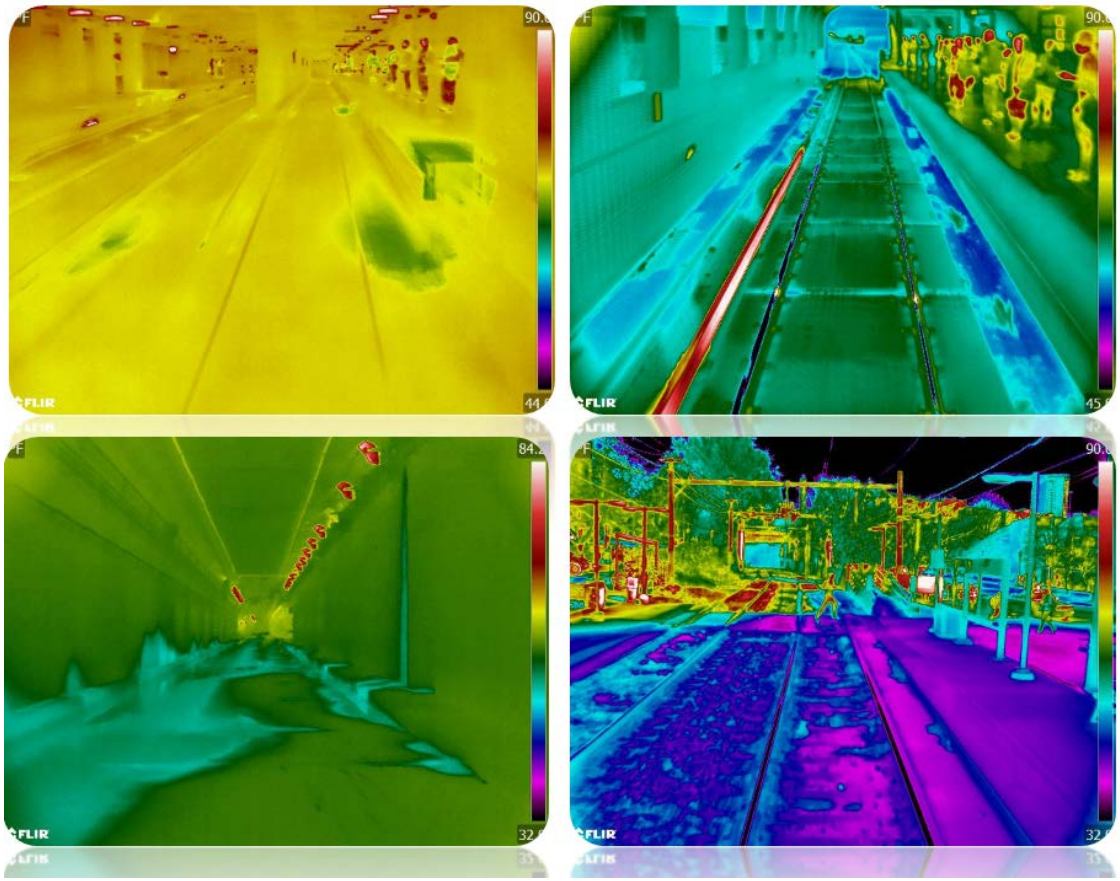


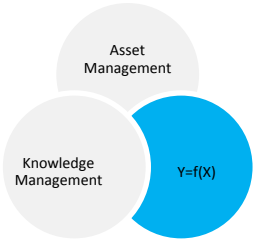
Lights

Leaks!

Scanner

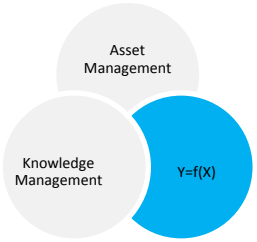
- Thermal Imaging





Scanners

- Other usage
  - Overheating equipment
  - PM activity e.g. overloaded electrical panel
  - Proving the 3rd rail heaters work from a safe distance and not disrupting service!
  - Incorrect calibration
  - Friction in machining
  - Trespassing
  - Combining with track geometry to predict premature rail aging
  - The list goes on!…..



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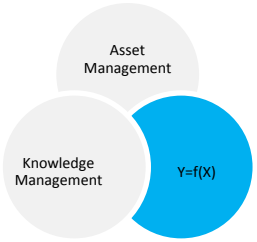
Cleaning Monitoring System

- Requirements
  - MBTA has a penalty based cleaning contract
  - Onus on the MBTA to prove a defect has occurred
  - Paperwork leads to under utilization of personnel
  - We are paying our personnel to do paperwork and not effectively manage the contract



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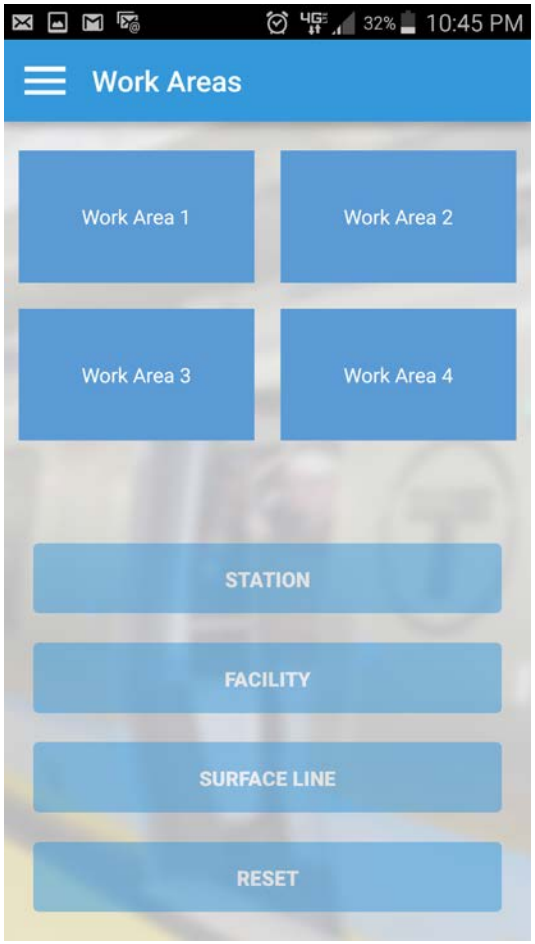
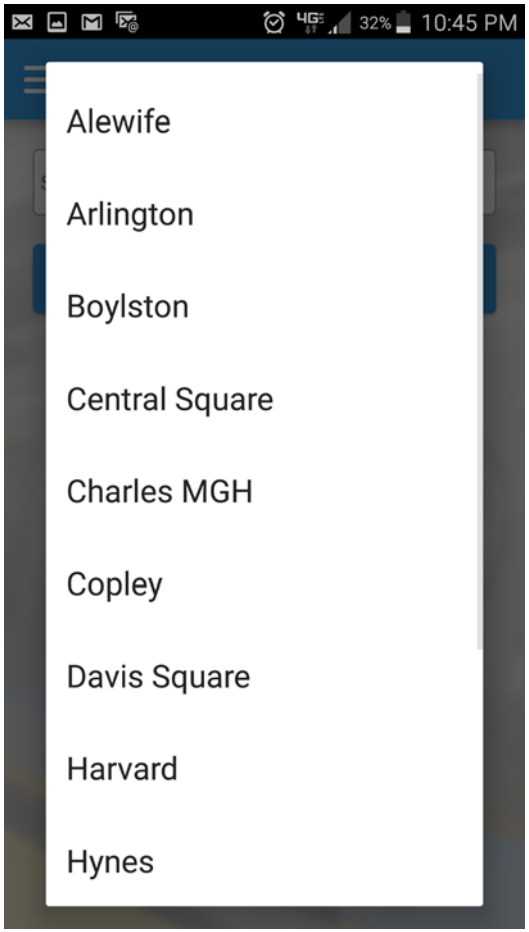
Cleaning Monitoring System

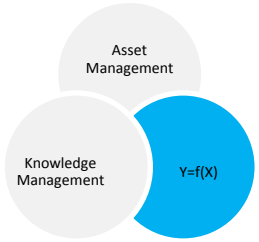
- Worlds first cleaning app for transit
  - Developed by the MBT and DBE
  - For the frontline pers l
  - 100% Elimination of
  - Personne ied”
  - Easy to use,
  - Cycle time savin e inspection process
  - Supervisor porta
  - Statistical analy
  - Effective mana ent

App Demo

Cleaning Monitoring System – App







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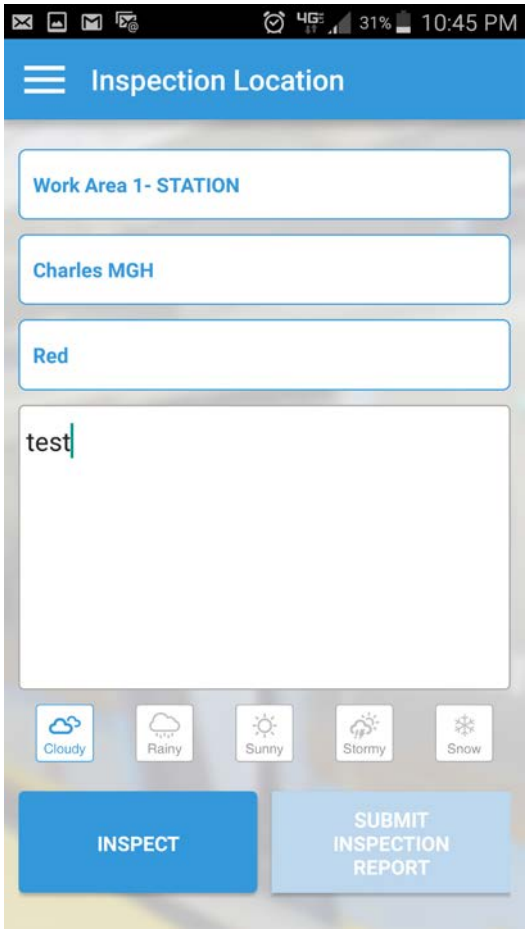
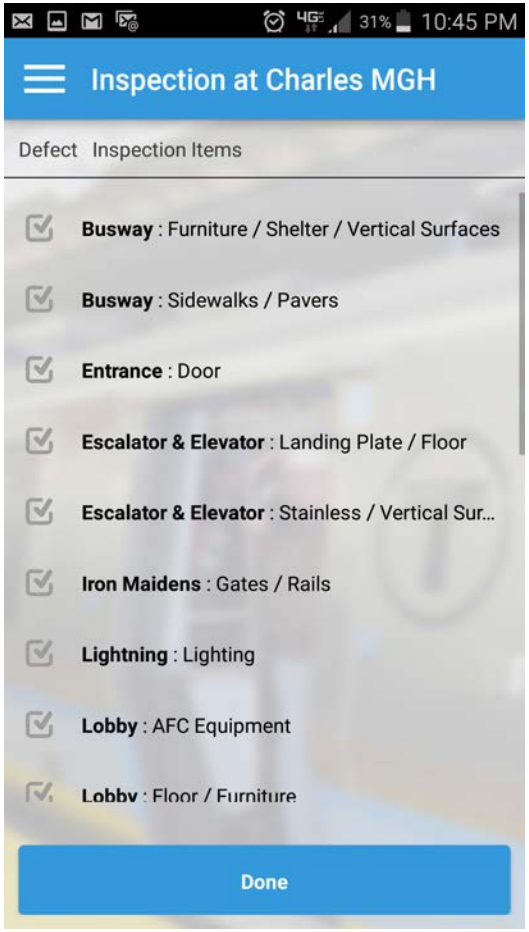
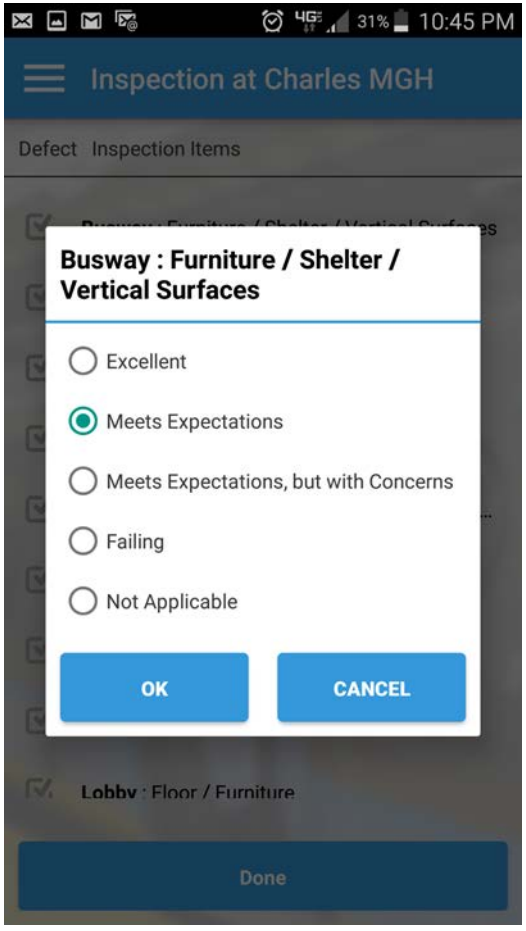
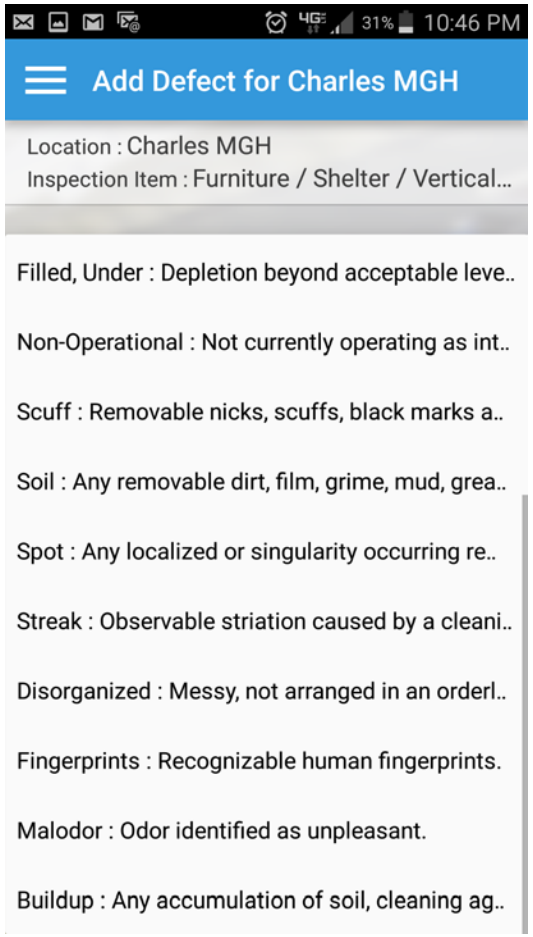
Cleaning Monitoring System – App

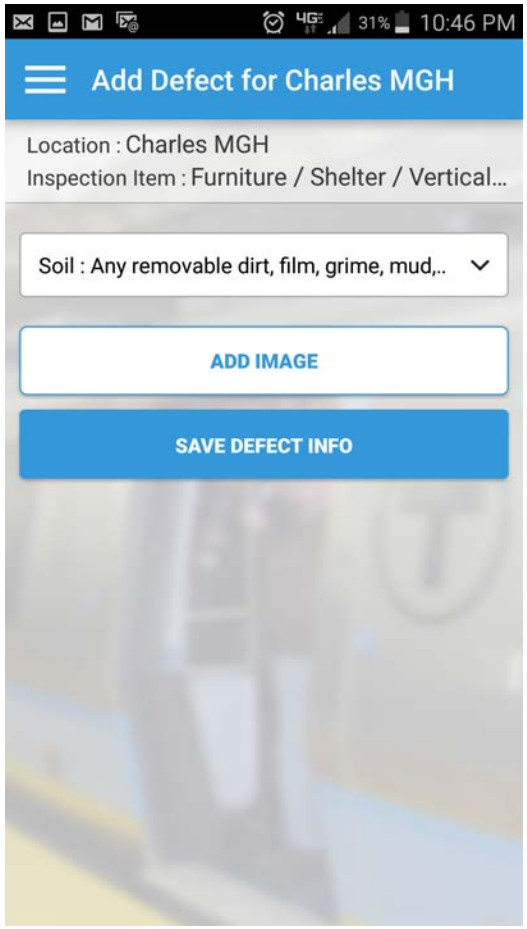






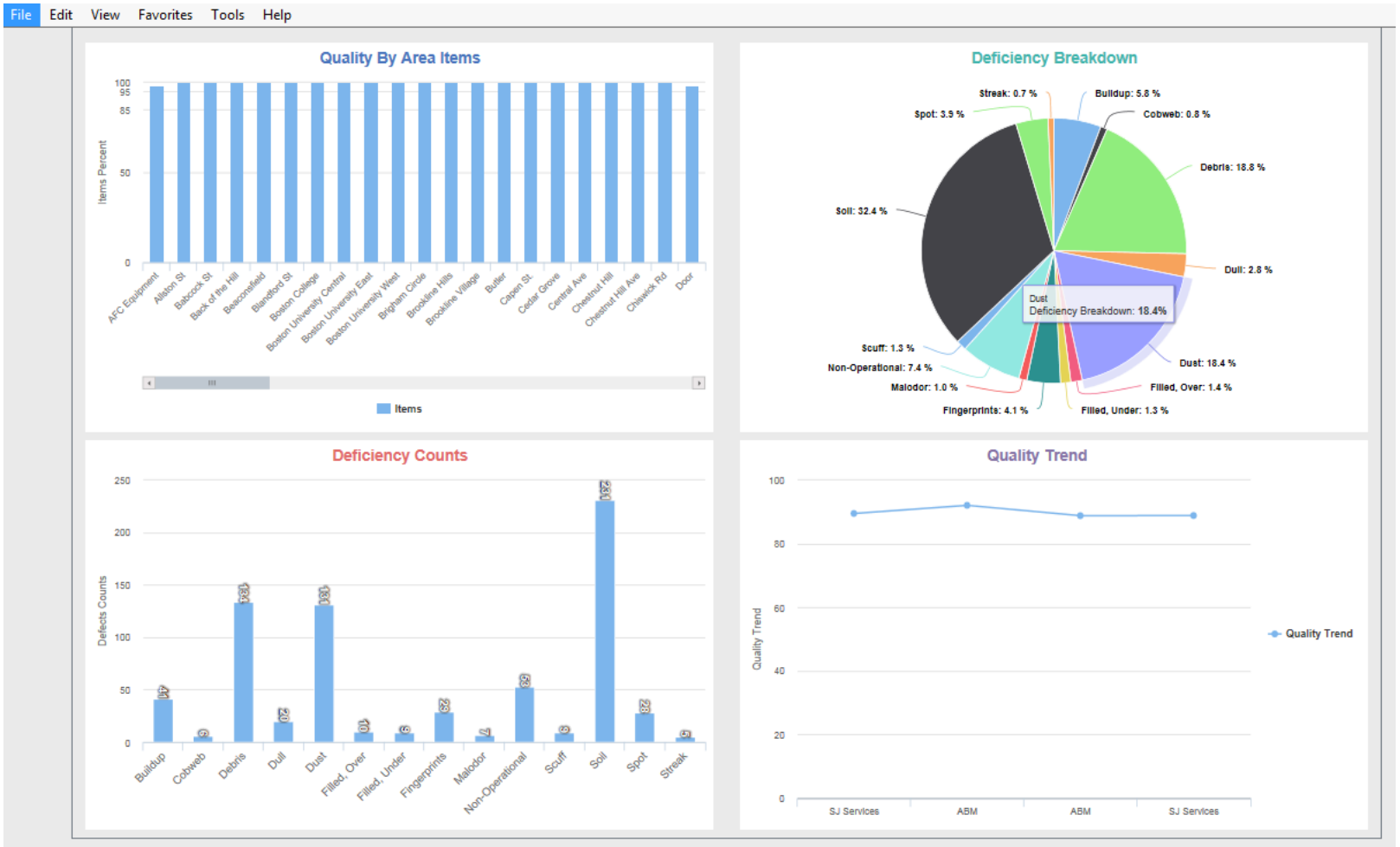
Cleaning Monitoring System – App

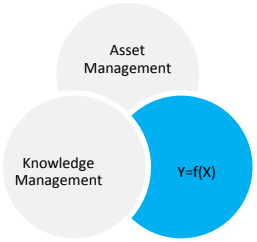




Cleaning Monitoring System - Portal

Cleaning Monitoring System - Portal





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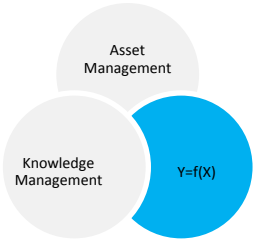
Cleaning Monitoring System - Portal

INSPECTION REPORT

From 06/02/2016 to 07/02/2016 Select Contractor Select Workarea

Select Type Select Area Typ Select Location Submit Reset

Note*:-In Graph Green Line Indicates Location pass score.



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Cleaning Monitoring System
Cost Savings - minimum

Average Hours Saved (monthly)			
	Paper	Tablet	App
Stations	26.56	25.21	16.45
Facilities	15.73	23.42	9.85
Surface Line	4.84	7.41	2.50
Total	15.71	18.68	9.60
Cost Savings	$511.40	$608.05	$312.48
Annual Cost Per inspector	$6136.80	$7296.60	$3749.76

39% annual labor cost savings per person

- Does not include savings experienced by supervisors minimum of 4 days saved on data entry and paperwork

Bus Wash - Water Consumption Reduction Pilot

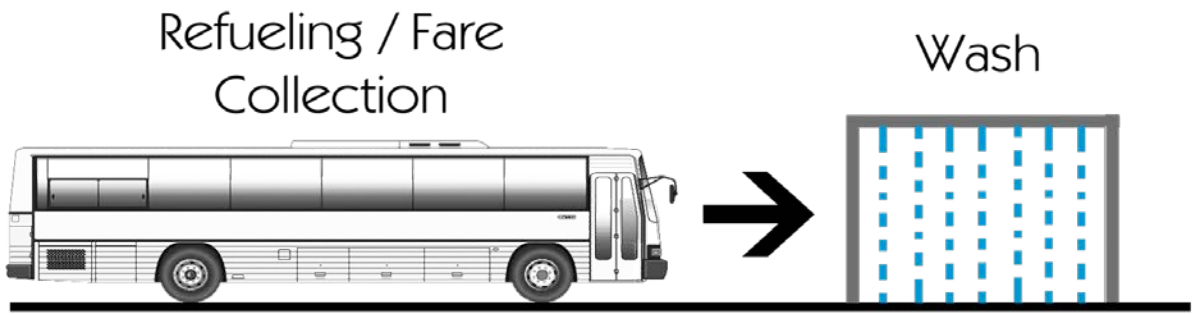
- Problem Statement: - find ways of reducing the MBTA operating budget without effecting service delivery and be sustainable

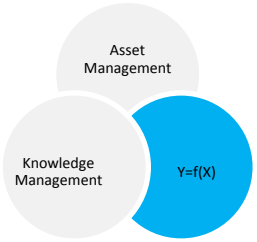
Example:

- Water consumption of washing the 40ft bus fleet at Lynn Garage (pilot site) =

42.45 Gallons (avg per wash) x $0.0188 x 75 (40ft busses) x 365 = **$21,845** for the fleet annually, or **1,162,069 Gallons**

- Physical limitations –





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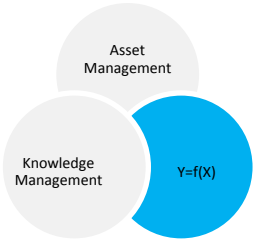
Bus Wash - Water Consumption Reduction Pilot

- Problem Statement: - find ways of reducing the MBTA operating budget without effecting service delivery
  - Observations:
    - Busses must be fueled!
    - Busses seem to be washed a minimum of twice a day
    - Triggers the bus wash – when the bus does not need washing = waste of $$
    - Bus wash does not turn off or have the ability to turn off when a bus approaches that has been washed
    - MBTA Policy to wash buses only once a day or unless needed.
  - MBTA has no active water reclamation system installed



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Bus Wash - Water Consumption Reduction Pilot

- 1 year pilot – Building local innovation with the MBTA
  - Enlisted Wentworth Institute of Technology students
    - Now created a company as a result – Intellah-Wash
    - Wentworth – Accelerate Program – sponsor
    - 4 students – now 3, small business owners

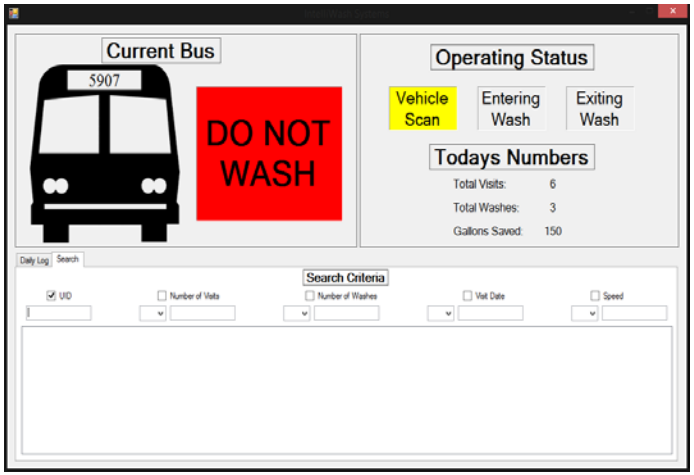
WENTWORTH INSTITUTE OF TECHNOLOGY

Intellah-Wash

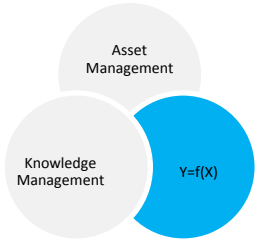
  - Intellah-Wash developed

Click to access

Online Cloud data (click for link)



Local Interface



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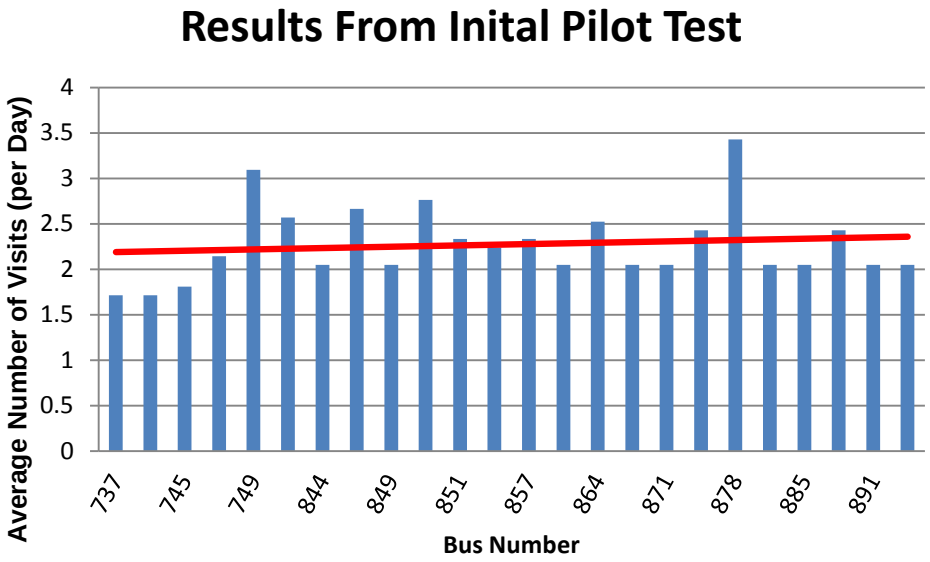
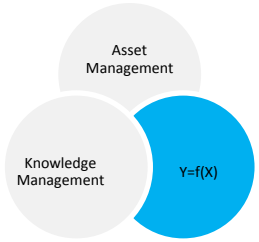
Bus Wash - Water Consumption Reduction Pilot

- A bus is, on average, washed twice a day at this location

Bus Number	Number of Visits	Duration(days)	Washed	Average number of visits (per Day)
737	36	21	21	1.714285714
738	36	21	22	1.714285714
745	38	21	18	1.80952381
746	45	21	21	2.142857143
749	65	21	21	3.095238095
823	54	21	23	2.571428571
844	43	21	19	2.047619048
846	56	21	24	2.666666667
849	43	21	19	2.047619048
850	58	21	24	2.761904762
851	49	21	23	2.333333333
855	47	21	19	2.238095238
857	49	21	19	2.333333333
862	43	21	19	2.047619048
864	53	21	22	2.523809524
865	43	21	17	2.047619048
871	43	21	21	2.047619048
872	51	21	22	2.428571429
878	72	21	24	3.428571429
882	43	21	19	2.047619048
885	43	21	23	2.047619048
887	51	21	21	2.428571429
891	43	21	18	2.047619048
900	43	21	19	[illegible]
Total				2.275793651



- Costing the MBTA a minimum of twice as much or **$43,690** and **2,324,138 Gallons**



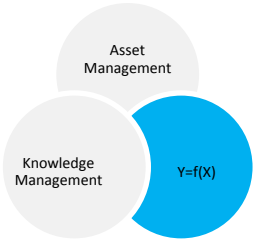
Bus Wash - Water Consumption Reduction Pilot

- **Expected Savings** (based on assumptions and validated data thus far):

Lynn Bus Garage	All Authority Bus Garages (theoretical minimum, for 40ft busses annually)
•Fleet: 75 Buses •Annual consumption: 2,324,138 gallons •Annual Cost: $43,694 **Minimum Annual Savings:** $21,874 or 1,162,069 Gallons	•11 Bus Garages •Fleet: 915 Buses •Annual consumption: 30.3M gallons •Annual Cost: $570,359 **Minimum Savings:** $285,179 or 15.2M Gallons

*Numbers are based on estimates provided by MBTA Environmental Department

- What do you do with the cost savings? – Invest in your system and find more ways to innovate!

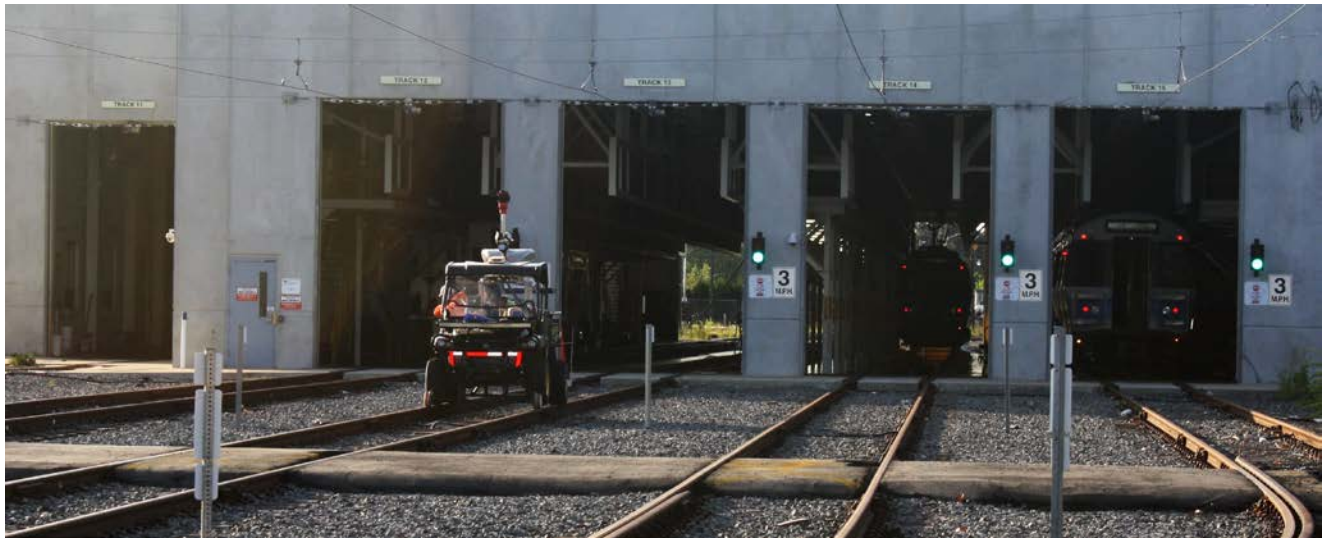


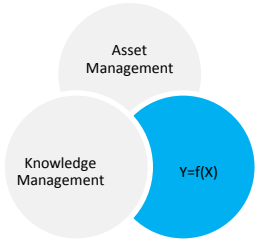
Bus Wash - Water Consumption Reduction Pilot

- Data – Validate, Validate, Validate!!
- Assumptions for pilot
  - We are washing busses more than once
  - We are using 42.45 of gallons per bus to wash
  - Our bus wash instantly turns on and off with no redundancy
  - Potential of 50% savings in water consumption
  - Lynn Chosen as one of the smallest to trail the technology
  - Buses traveling through the bus was system per procedure
- How are we validating??
  - Intellah-Wash counts the busses going through the wash and the number of visits each bus makes
  - Flow meter to measure actual water flow and gallons used
  - Infield observations of the wash system
  - Verifying the cost data of the asset as a utility
  - Intellah-Wash system turns off bus wash automatically when bus has already been washed in 24 hours
  - Frequency and speed of travel of bus in the system

LiDAR – multiple usage of data

- Data Collected on all 4 lines
- Yard to terminus
- Above and below ground
- Partnered with HNTB & SSI surveying solutions, inc.





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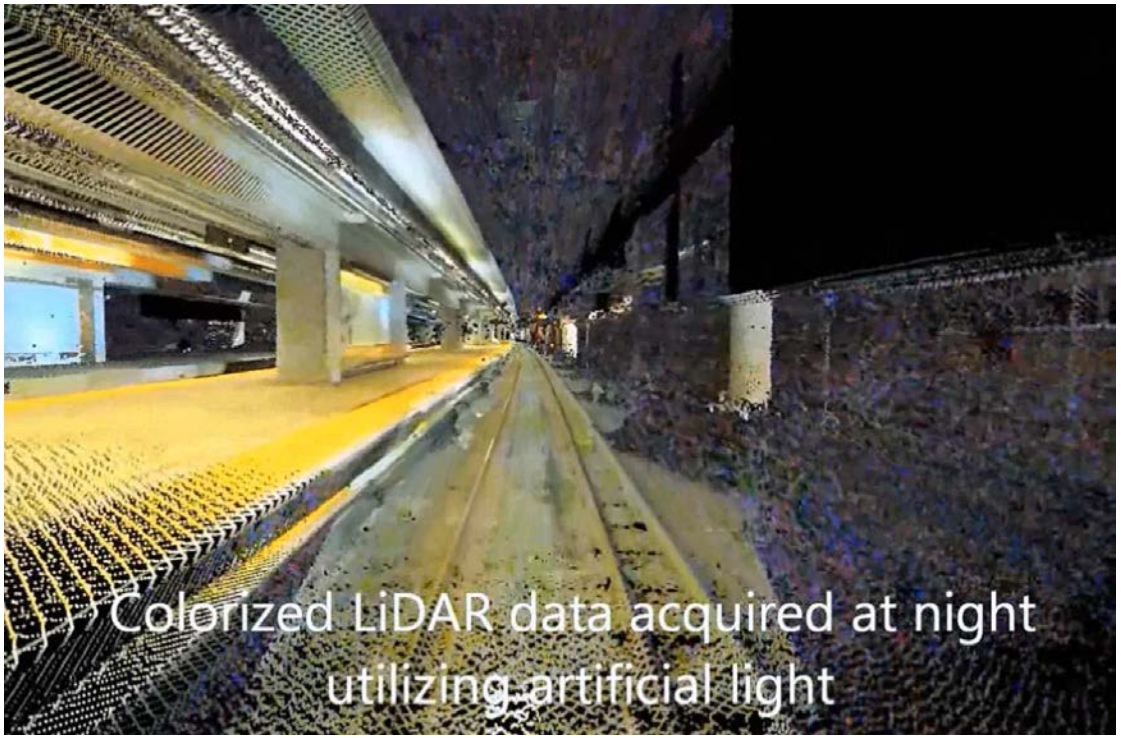
LiDAR



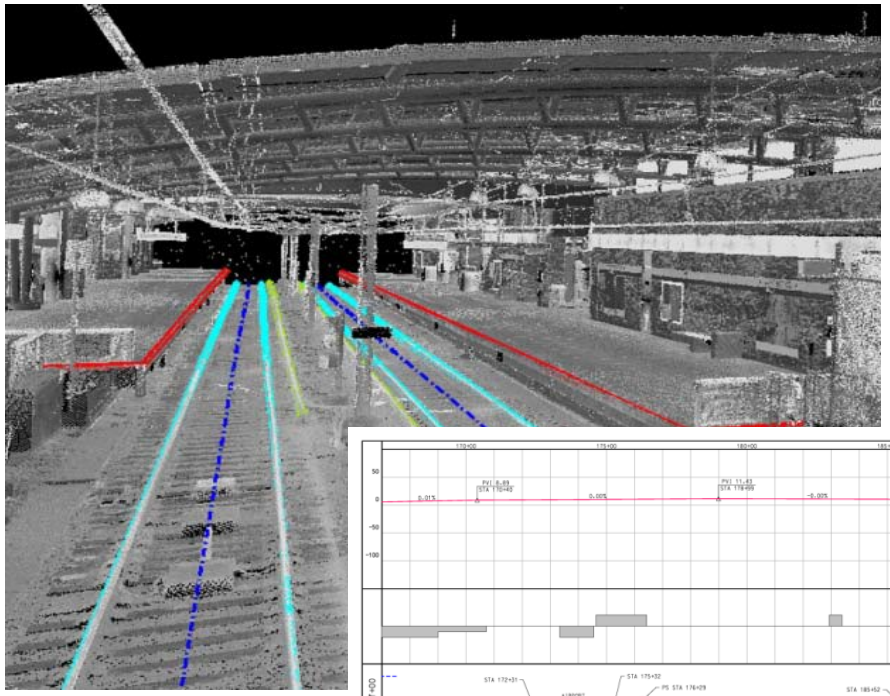
LiDAR

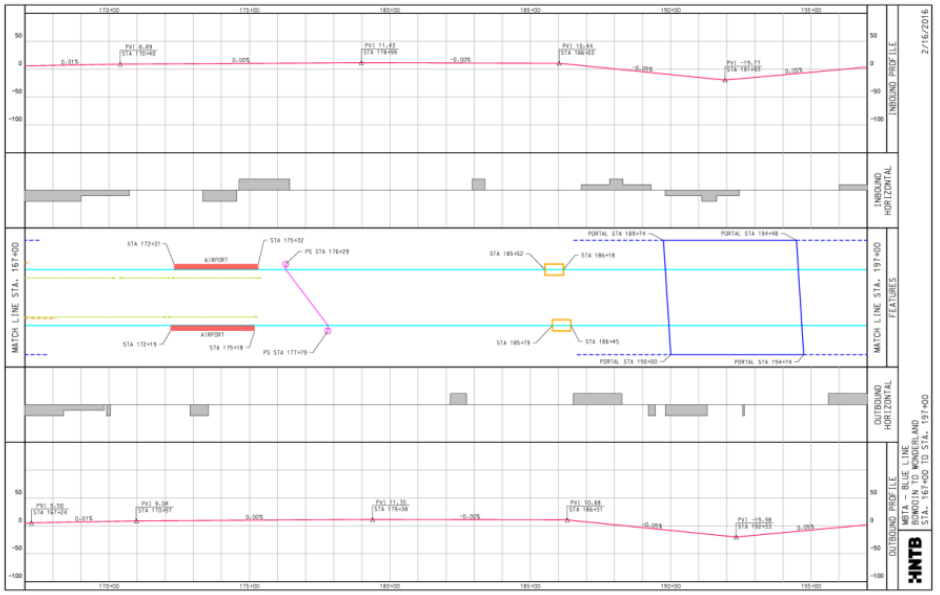

Map
Satellite
Hybrid


3D extruded linework with point cloud overlay

LiDAR – Example Usages

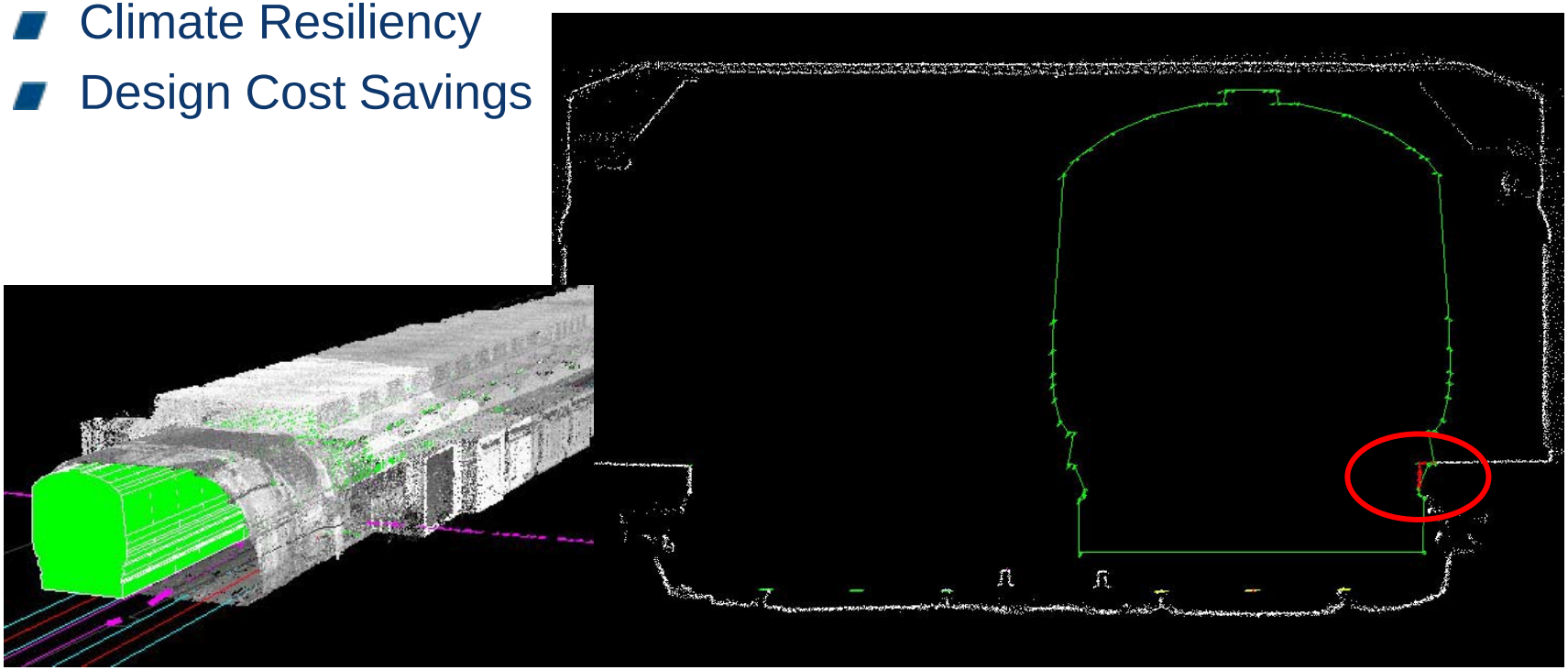
- Track Charts
- Point Cloud
- Inventory
- GIS
- BIM



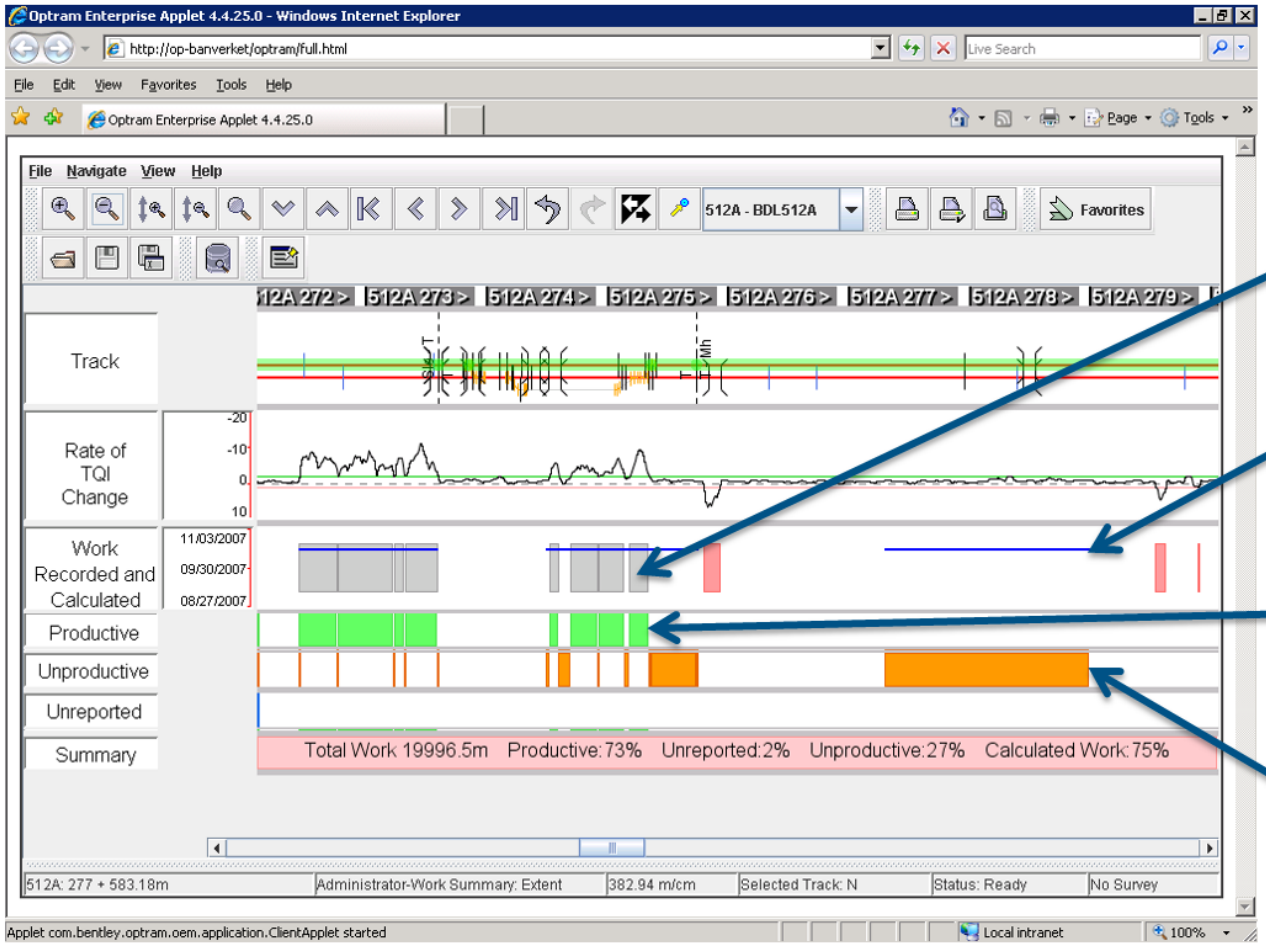


LiDAR – Other Example Uses

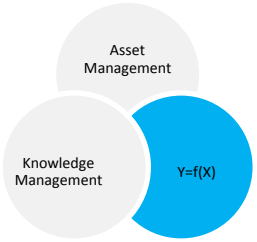
- Design out Engineering Problems
- Survey Cost Savings (present and future)
- GIS / Point Cloud mapping of assets
- Climate Resiliency
- Design Cost Savings



Optram - Bentley



Note, data is not the MBTA and was provided by Bentley for demonstration purposes



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Research currently Underway

- Uptime Elements!
- Acoustic Emissions
- Vibration
- Wireless sensors
- Non contact
- Non des
- Defect code
- Energy consu
- Innovation proje on establishments
- Data mining ex
  - Switch throw
- Environmental alysis
- Systems IPO

Remember
Collect once use many times!
Think about your business and how it could be used by others

MBTA – A System of Systems

All of this work would not have been possible without the cooperation of departments, stakeholders and teams across and outside the MBTA

Thank you to our partners inside and outside of our business…

We still have allot to do and more partners to work with!

Thank you
Any Questions?

Satyen Patel, Director of Asset Management,
SPatel@mbta.com