HealthHub™
Smart asset monitoring for optimised life-cycle cost
Frédéric Le Corre
14 March, 2019
1. **Introduction**

2. HealthHub™ overview

3. Rolling Stock Data Capture and Processing

4. Infrastructure Data Capture and Processing

5. Condition Monitoring Tools for Data Analysis

6. Various application cases
Introduction
Alstom in maintenance activity

Services is the entity in charge of Maintenance activity
  - Represents about 25% of Alstom turnover
  - It includes maintenance, modernisation, overhaul, renovation, parts

Maintenance activities covers:
  - Rolling stock: Alstom and non-Alstom
  - Infrastructure: 5,000 Km of track maintained
  - Signalling: services focus on availability improvements and allowing continuous safe operation
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What is HealthHub?

HealthHub is a comprehensive solution for the condition monitoring and predictive maintenance of all the rail transportation assets.

**SERVICES OPTIMISATION**
- Maintenance Management Information System
- Dynamic Maintenance
- Fleet Management
- Risks-based asset management

**HEALTHHUB DATA ANALYSIS**
- Fleet Support Centers
- HealthHub Data Factory
- HealthHub Rule Engine
- Predictive Maintenance
- Condition Monitoring
- Predictive model
- Corrective rules
- Health Indicators & Prognostic
- Health Index & Diagnostic

**DATA PROCESSING & VALIDATION**
- Clustering
- Formatting
- Cybersecurity
- Automatization
- Geolocation
- Filtering

**DATA CAPTURE & TRANSMISSION**
- TrainTracer
- TrainScanner
- Motes
- TrackTracer
- CatenaryTracer
- Turnouts
- Rolling stock data
- Wayside data

**TOOLS**

**OUTPUT / REPORTING**

**SERVICES**

**OPTIMISATION**

**TOOLS**

**OUTPUT / REPORTING**

**SERVICES**

**OPTIMISATION**

**TOOLS**

**OUTPUT / REPORTING**

**SERVICES**

**OPTIMISATION**

**TOOLS**

**OUTPUT / REPORTING**
# HealthHub™ Objectives

## Maintenance Operations

<table>
<thead>
<tr>
<th>Condition Monitoring</th>
<th>Health Diagnostic</th>
<th>Trouble Shooting</th>
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<tbody>
<tr>
<td>Patrolling, Measuring, Inspecting</td>
<td>Health Diagnostic</td>
<td>Trouble Shooting</td>
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</table>

## Predictive Maintenance

<table>
<thead>
<tr>
<th>Health Prognostic</th>
<th>Health Management</th>
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<td>Health Prognostic</td>
<td>Health Management</td>
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## HealthHub Objectives

<table>
<thead>
<tr>
<th>Automation</th>
<th>Higher Frequency</th>
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<tr>
<td>Remote and Real Time</td>
<td>Accurate GeoLocalization</td>
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<td>False Alerts Reduction</td>
<td>Failing Asset Identification</td>
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<tr>
<td>Remaining Useful Life Rules</td>
<td>Asset Lifetime Increase</td>
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<td>Dynamic Maintenance Planning</td>
<td>Safety Reduction</td>
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## Benefits

<table>
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<tr>
<th>Time Savings</th>
<th>LCC Savings</th>
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<tr>
<td>KPI</td>
<td>KPI</td>
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6. Various application cases
Data capture and processing solution for rolling stock

**Train Tracer**
- Collect on-board TCMS data
- Equipment status and events
- Position of alerts and events
- Data transmission to ground
- Data compilation per fleet

**Train Scanner**
- Automatic train inspection for wheels, brake pads and pantograph carbon strip
- Automatic train integrity check

**Motes / IOT**
- Monitor vibration
- Monitor temperature
- Monitor pressure
- Wireless data (LORA/Wi-Fi)
TrainScanner: data capture for train wayside parameters

- **Wheel** - Diameter, Flange Height, Flange Width, Tread Rollover, False Flange, Steps in Flange, Flange Profile Radius, Back to Back, Conicity.

- **Brake Pad** - Presence, Thickness.

- **Pantograph** - Carbon thickness, chips, cracks and grooves.

- **Integrity Check** - over 25 measurement types, looking at component presence, position and damage. Includes an underframe and side gauge check.

Measurements Include: Parameters, 3D Profiles, 2D Profiles and HD images.

- Amtrak: 7,500 → 15,000 km
- WCML: 20,000 → 56,000 miles

- Wheels
- Brake pads
- Carbon strips

- Integrity Check
- Missing parts
- Avoidance of SAF

Increase of use of Components Life

Increase of Maintenance Intervals

Safety
The Motes

Mobile Data Capturing System:

- Full train length Coverage
- Enhanced Autonomy (>3 years)
- Enhanced Acceleration Sensor (±50g, 5KHz)

- LoRa wireless connectivity
- Ultra Low Power
- Short Range Communications
- Industrial Wired Bus

- Monitors vibration, temperature, pressure
- Easy installation
- Sensible data security is always enabled via encryption
- Immediate analysis feedback
Rolling Stock references

More than 30 fleets with 2000 trains monitored since 2006

Metros:
- Riyadh
- Mumbai
- Sydney
- Santiago
- Lima
- Panama
- Mexico
- Montreal
- Barcelona
- Amsterdam

Tramways:
- Ottawa
- Rio
- Dublin
- Reims
- Nice
- Bordeaux
- Barcelona
- Sydney
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Data acquisition and condition monitoring for Infrastructure

**Track & Catenary Tracer**
- Measure track geometry
- Measure rail corrugation
- Measure rail profile & wear
- Measure catenary geometry
- Measure contact wire wear

**APS & 3rd Rail Tracer**
- Measure APS rail shocks
- APS rail video inspection
- Measure 3rd rail position
- Measure 3rd rail profile & wear

**Wayside Signaling**
- Point machine health monitoring
- Track circuit health monitoring
A basic approach to detecting degradations

1. Storage of a « reference curve »
2. Setup of a set of thresholds around the reference curve with test benching
3. Creation of an alert when the signal acquired exceeds the threshold
Track data capture: measurement and inspection systems

Track Geometry Measurement systems

Rail Profile / Wear

Rail Corrugation

Track Video Inspection systems

Rail (Broken) Video Inspection systems
Catenary/ 3rd rail / APS data capture: measurement and inspection systems

Catenary Geometry & Wear Measurement systems

Catenary Video Inspection systems

3rd Rail Position Measurement systems

APS rail position inspection system
TrackTracer and CatenaryTracer: 2 types of installation

Installation on train

- Bogie equipped with a laser beam and inertial platform
- Odometer installed on the axle
- Accelerometers installed on the axle
- Power supply and data acquisition system

Preferred for mainlines and long urban networks

Installation on dedicated vehicle

Preferred for tramways and short urban networks

Data are geo-localized with GPS and odometer combination
Infrastructure references

5000 km of lines monitored since 2015

- **REM Montreal Metro**
  - 67 km – 32 years

- **Ottawa LRT**
  - 40 km – 30 years

- **Sydney LRT**
  - 25 km – 15 years

- **Grand Paris**
  - 132 km – 2 years

- **Sydney Metro SRS**
  - 36 km – 15 years

- **ONCF PRIMA Locos**
  - 2700 km – 15 years

- **PRASA Suburban**
  - 90 km – 18 years

- **REMS Montreal Metro**
  - 12 km – 27 years

- **E.Locos INDIA**
  - 10 000 km – 15 years

- **Riyadh Metro**
  - 72 km – 10 years

- **Singapore Metro CCL**
  - 40 km – 5 years

- **ONCF PRIMA Locos**
  - 2700 km – 15 years

- **Point Machine**

**Audits**

- **Riyadh Metro**
  - 72 km – 10 years

- **E.Locos INDIA**
  - 10 000 km – 15 years

- **Reims LRT**
  - 12 km – 27 years

- **Corrugation / shocks**

- **3rd rail geometry**

- **Track geometry / wear**

- **Track video inspection**

- **Catenaries geometry / wear**
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Rolling stock alerts and events management

Monitoring and Service orders

Visualization of alerts for the whole fleet

Visualization of alerts on a map

Variables and preventive counter
Fleet management

Fleet usage

Availability and autonomy

Service diagram

Depot usage
Infrastructure alerts, diagnostic and health index

Alerts

Diagnostic

Health Index
Examples of reports

- Alerts report
- MMIS report
- Compressor report
- Weather report
- Availability report
- Passenger counting report

185 reports generated per day
Some figures

- Applied on 2900 trains
- 1787 Alerts, 344 health index
- 60 000+ alerts generated last month
- 54 000+ alerts SMS sent in 2018
- 436 different users
- 44 TB of data
- Total 482 month of history (i.e. 40 years cumulated)
Some references with key figures

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<th>X60</th>
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<th>NTV</th>
<th>AVE-S100</th>
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The agenda includes the following topics:

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HealthHub turnkey application

SYDNEY METRO NORTH WEST RAIL LINK TURNKEY MONITORING

- Monitoring of 13 point machines in real time
- Monitoring of 22 metro trains in real time
- Monitoring of 36 km of track and catenary with real time alerts
- Integrated HealthHub Web platform with OCC alert viewer
HealthHub application on infrastructure

TRACK GEOMETRY MONITORED ON WEST COAST MAIN LINE UK

Bogie equipped with a laser beam and inertial platform

Odometer installed on the axle

Accelerometers installed on the axle

Power supply and data acquisition system

> Data geolocation validation compared to NR Yellow trains
> Daily reports against monthly reports
> Data processing automation saving 10 data analysts
> Statistical analysis allowing track prognostic
HealthHub application on point machines

POINT MACHINES MONITORING FOR BNSF ACROSS USA

> Diagnostic of obstacles, lack of lubricant, rail deformation
> Detection of exceptional weather conditions impacts
> Saving of patrolling technicians on root cause analysis
> Prognostic of Service Affecting Failure