



European Rail Safety Days The future of maintenance

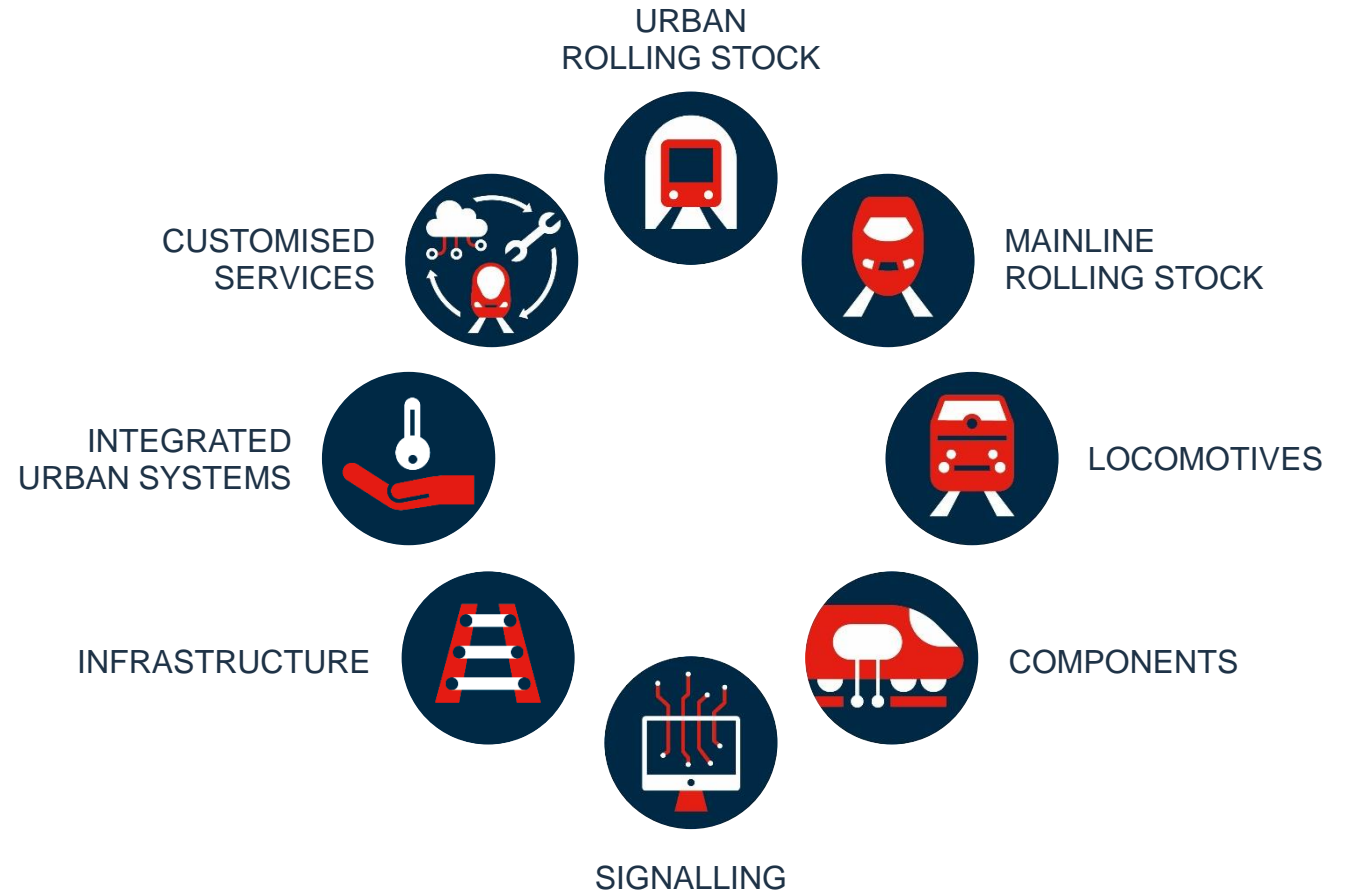
Raymond GROVES
Alstom / UNIFE

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A global leader in the transportation sector in the digital age

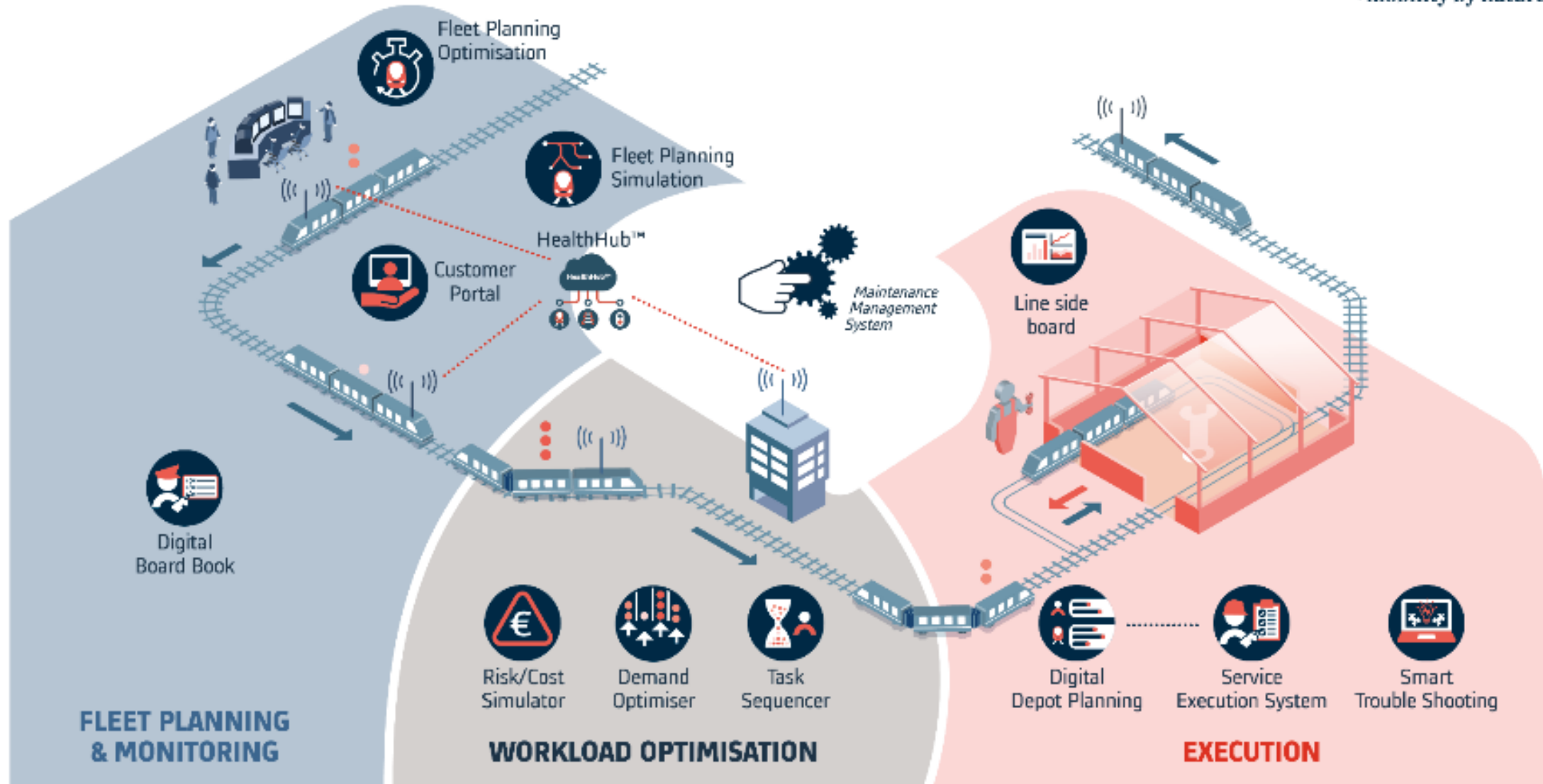
Leading societies to a low carbon future

Alstom develops and markets mobility solutions that provide the sustainable foundations for the future of transportation. Alstom's product portfolio ranges from high-speed trains, metros, monorail and trams to integrated systems, customised services, infrastructure, signalling and digital mobility solutions.



What can we expect for the future - Maintenance?

DYNAMIC MAINTENANCE PLANNING



Will the manufacturer invest more in Maintenance?

Services



Rolling stock maintenance

Alstom guarantees outstanding train availability and reliability, as well as best-in-class passenger experience, for both Alstom and non-Alstom assets



Train operations & System maintenance

Alstom utilizes its global OEM and O&M expertise to offer to clients' scalable TO&SM solutions. An integrated system approach can help our customers ensure maximum value from assets, whilst providing greater system availability in a continuously safe operation



Asset life management

Alstom offers solutions allowing enhanced train performances, extended lifetime, improved energy consumption & comfort and minimised environmental impact



Digital solutions

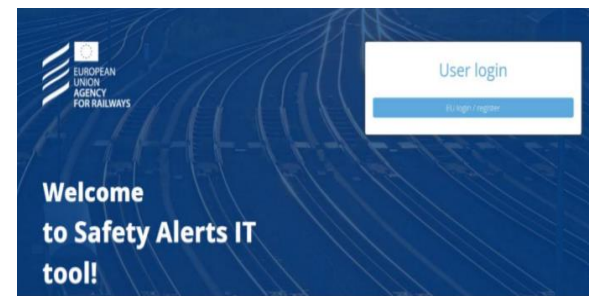
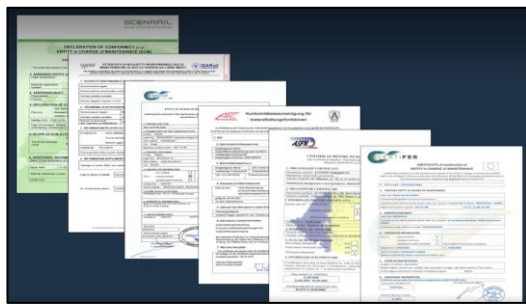
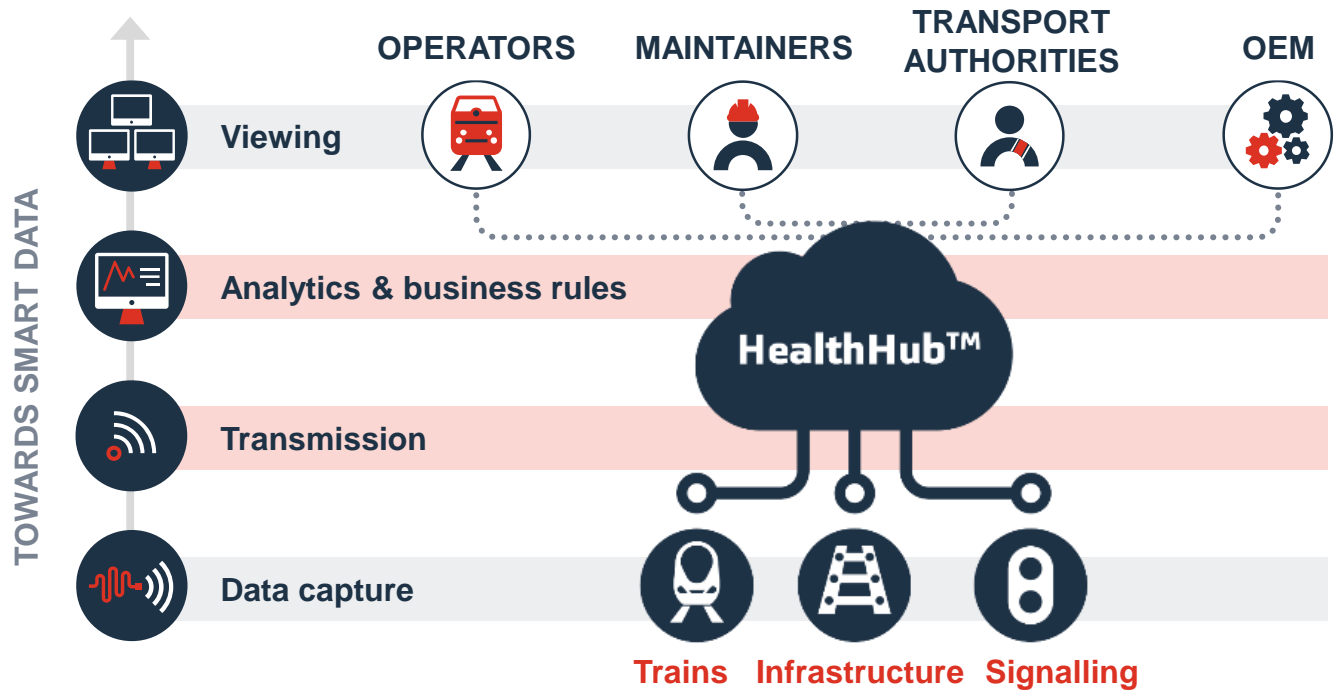
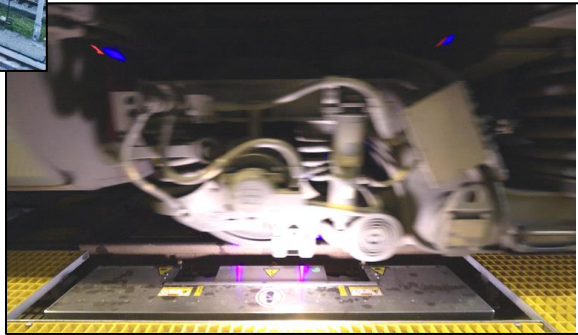
A range of digital solutions and support services to optimise maintenance execution, using the latest and most advanced technologies



Parts & Component overhauls

Building on strong experience in maintenance, our flexible parts and overhaul services support efficient maintenance operations

Do manufacturers intend to develop partnerships with RUs, IMs and ECMs for instance to get access to data and share expertise?



Entity in Charge of Maintenance

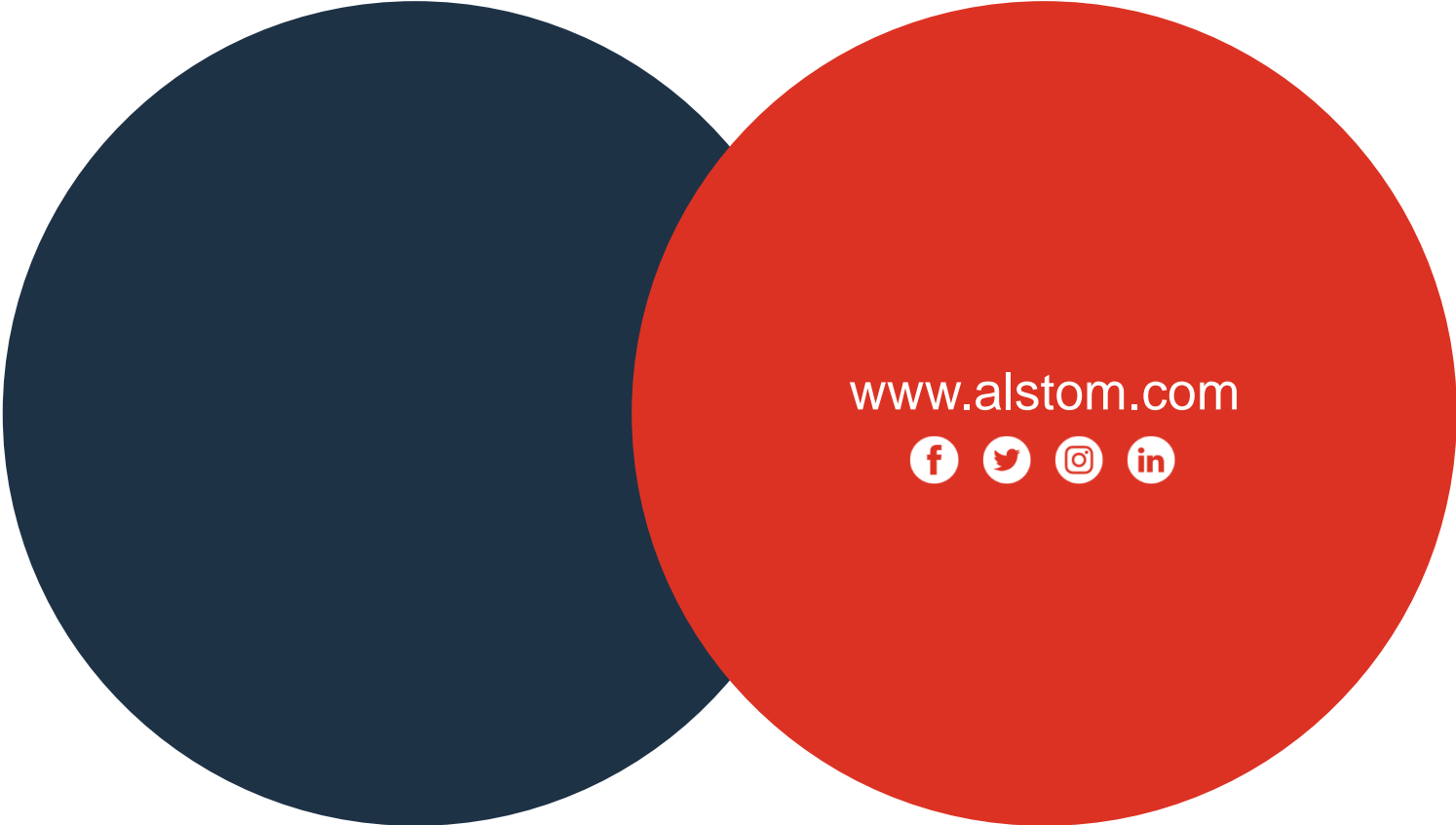
How can manufacturers help for a greener maintenance?

1. Reducing the resource intensity
 - Less maintenance = Less energy and fewer materials. Also, reduction in travelling for maintenance
2. Circular Economy
 - End of life and disposal of parts
 - Reuse wherever possible, Repair, Recondition
 - At end of life – reclaim and recycle with green partners and actors



Lower environmental footprint and energy savings:

- energy mapping
- traction and auxiliary systems enhancement
- hybrid system and hydrogen re-tractioning based on iLint know-how (world's first hydrogen train)



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• mobility by nature •

Questions:

F - Are there experiments implemented now?

- Health Hub
- AVIS / Orbitor

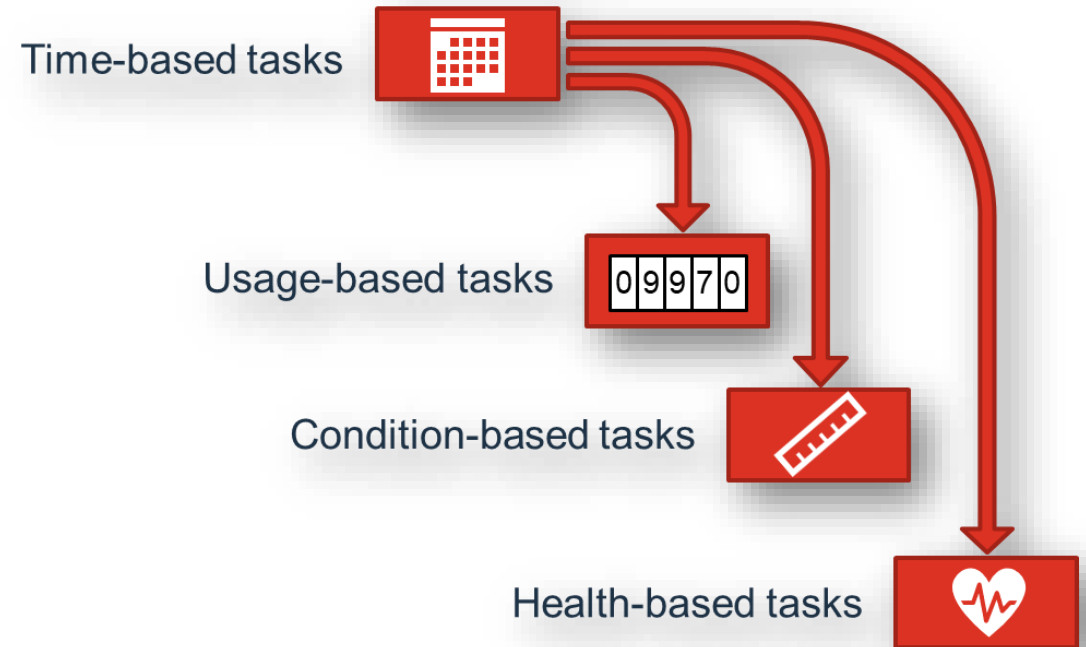
• See Nicolas PAGNARD

Mission and goals of Advanced Maintenance Analytics

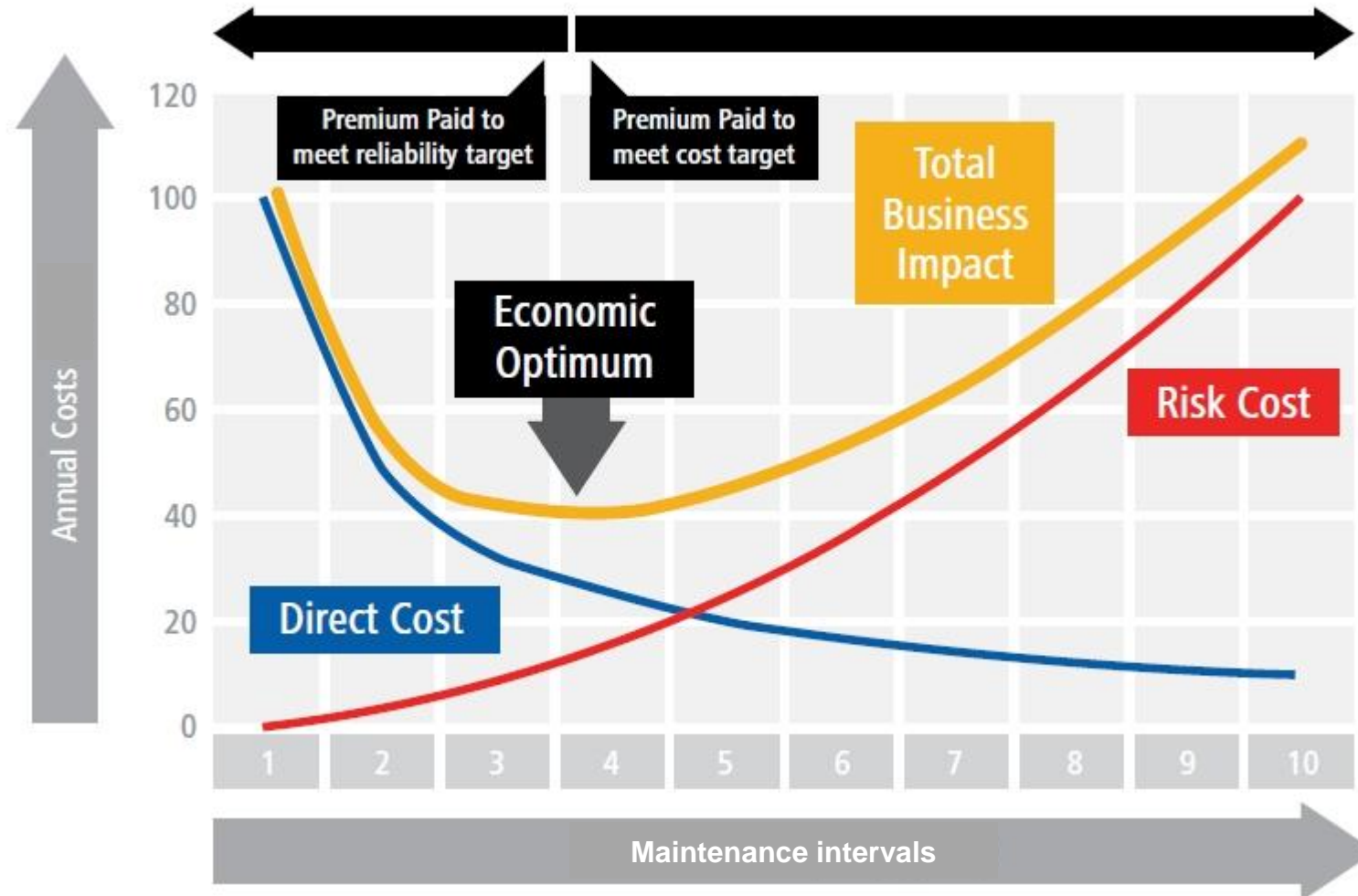
“Improve the performance of our products in terms of cost to maintain, availability and reliability, through the design, deployment and validation of Analytics Strategies.”

An Analytics Strategy is a set of Rules, Algorithms, Alerts, and Reports which support the Customer in the optimisation of the Maintenance Process (preventive, corrective, predictive) with an agreed level of confidence.

- Impact on Corrective Maintenance
 - Reduce troubleshooting time
 - Reduce repair time
 - Improve depot scheduling
 - Reduce SAF by anticipating failures
- Impact on Preventive Maintenance
 - Move tasks from scheduled to on-condition
 - Increase overhaul intervals
 - Remove inspections covered by algorithms

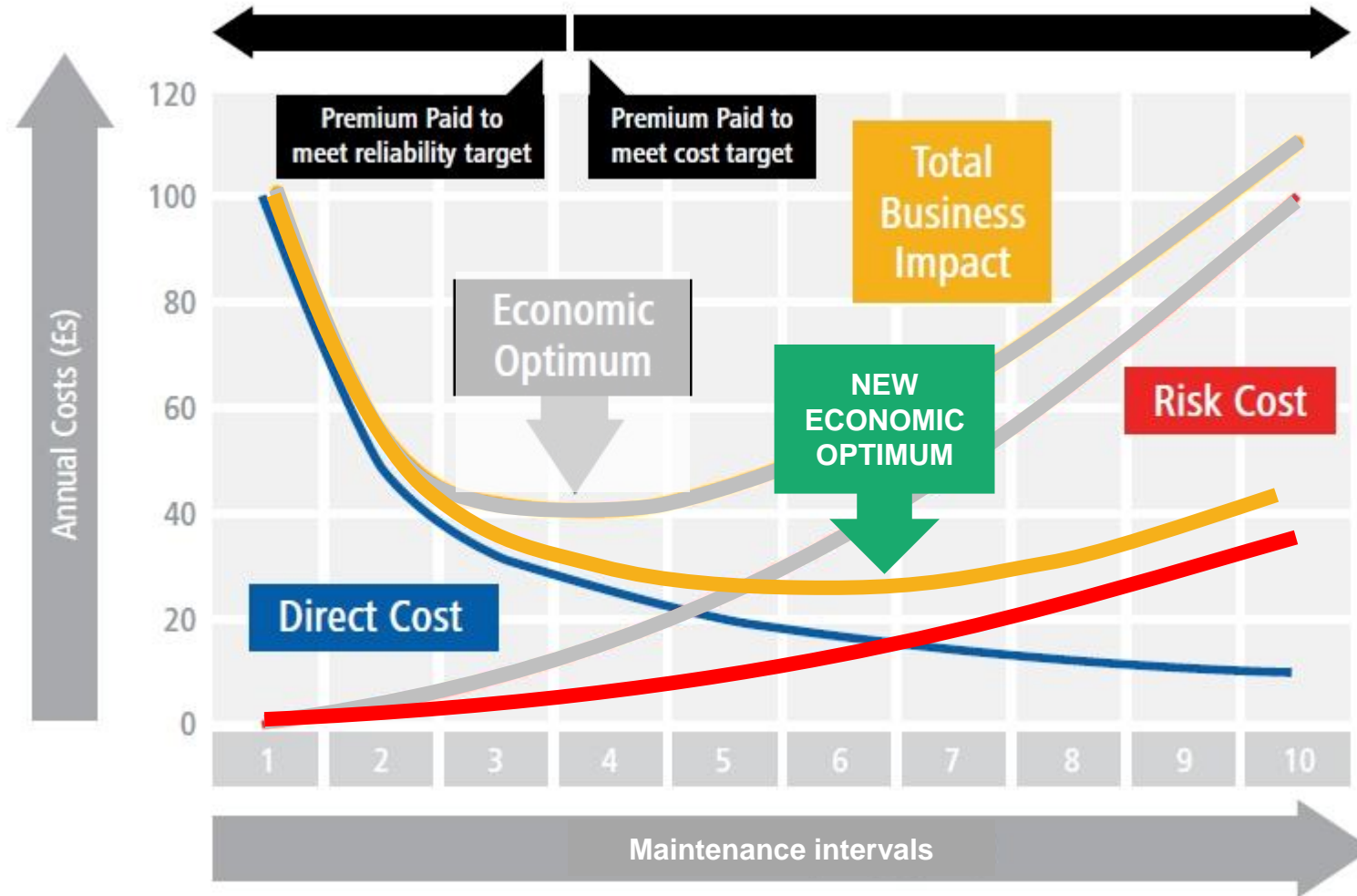


The cost side: optimized maintenance plan



Adapted from: Institute of Asset Management

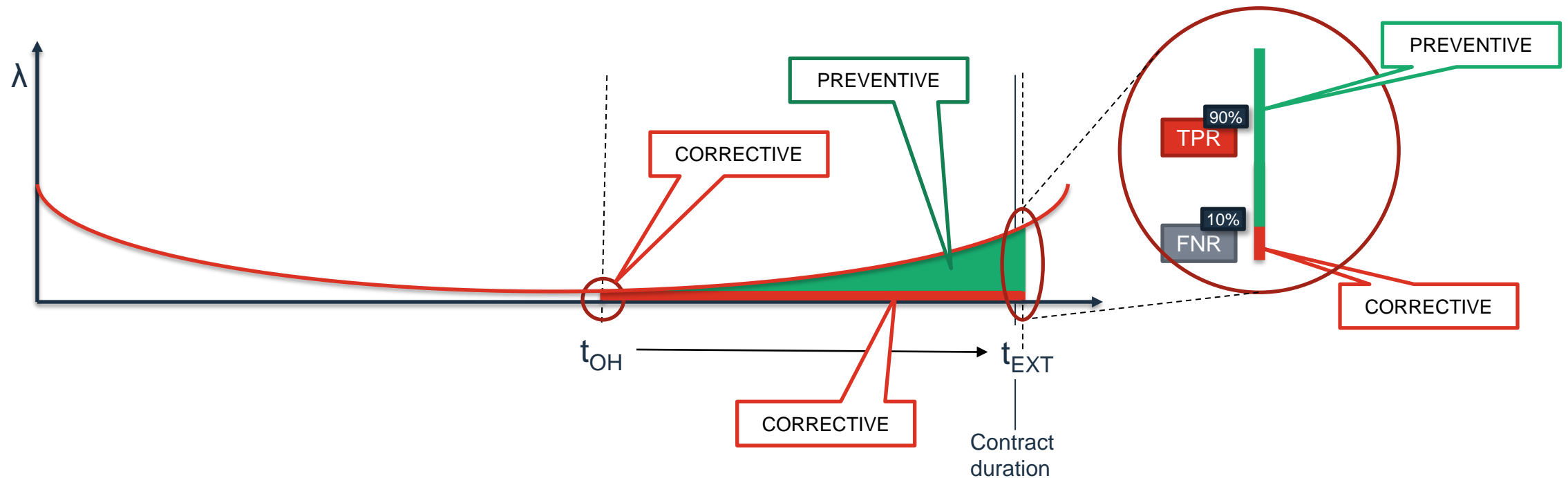
Impact of PHM



Adapted from: Institute of Asset Management

Example: impact on overhauls

- Adding PHM allows to extend the OH step while keeping a comparable percentage of undetected failures. Most of the additional degradations of the asset are detected before they become failures and fixed with preventive tasks.
- Savings are realised for all those assets whose OH step is pushed out of the contract duration and do not require preventive nor corrective maintenance

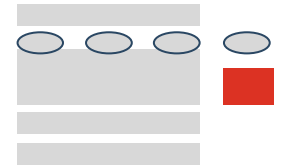


PHM – value generation

| | Reduction of inspections and preventive tasks | Optimization of Overhaul intervals | SAF avoidance |
|-----------|--|---|---|
| HVAC | <ul style="list-style-type: none"> • Filters replacement • Leakages check • Heat Exchanger cleaning | <ul style="list-style-type: none"> • Compressor OH • Condenser Coil OH • Evaporator OH | <ul style="list-style-type: none"> • Compressor • Refrigerant pipes • Thermostat |
| Doors | <ul style="list-style-type: none"> • Lubrication • Adjustments • Visual inspection | <ul style="list-style-type: none"> • Motor OH • Bearings OH • Sliding blocks OH | <ul style="list-style-type: none"> • Main cylinder • Locking • Misadjustment |
| Bogies | <ul style="list-style-type: none"> • Wheel reprofiling • Vertical damper • Primary damper | <ul style="list-style-type: none"> • Gearbox OH • Suspensions • Dampers | <ul style="list-style-type: none"> • Gearbox • Dampers • Wheelset |
| Batteries | <ul style="list-style-type: none"> • Module/cell replacement instead of string/battery replacement (corrective) | <ul style="list-style-type: none"> • Battery OH | <ul style="list-style-type: none"> • Battery module |

...plus everything we still do not know.

PHM – value generation Impact on Project (expl. Regional train)

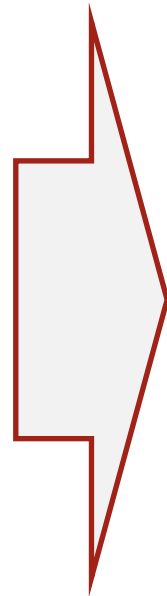


Coradia Stream

(4 cars, 100 trains, 20 y Maintenance)



- No NRC from suppliers thanks to Catalogue approach
- RC increase included in BCs
- average contractual perf. requirements & penalty assumptions



PREVENTIVE MAINTENANCE COST HVAC

- Air filter replacement on condition
- Heat Exchanger OH extension to 30y for 75% of the fleet
- Heat Exchanger cleaning on condition
- Sensors check removed from plan
- Compressor OH extension to 30y for 40% of the fleet

Doors

- Extension of lubrication intervals
- Motor OH extension to 20y for 65% of the fleet
- Sliding blocks OH extension to 20y for 50% of the fleet
- Extension of bearings OH to 20y for 95% of the fleet

-25% of SAF for HVAC
-40% of SAF for doors

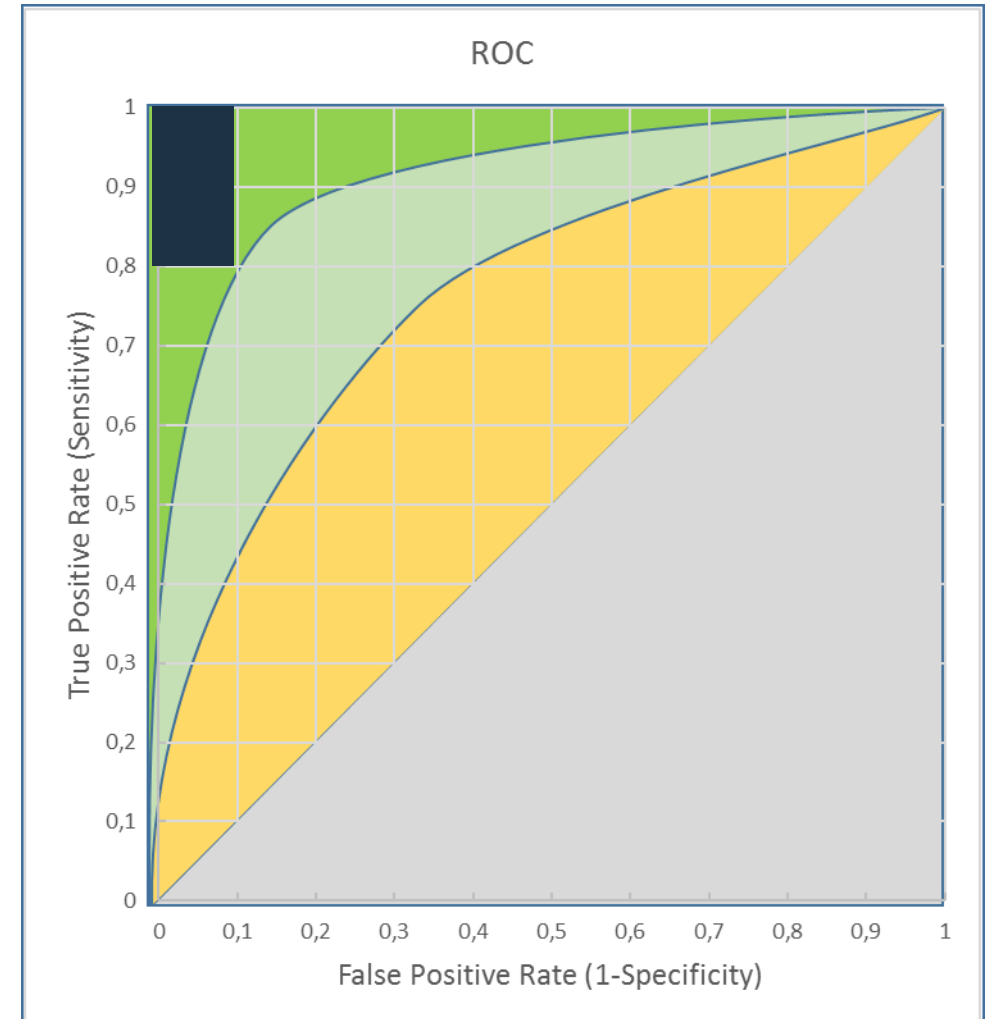
-32% of LCC for HVAC
-5% of LCC for doors

**PHM on HVAC & doors : 8 M€ Project GM impact
(4,5 M€ cost avoidance on penalties + 3,5 M€ savings on maintenance)**

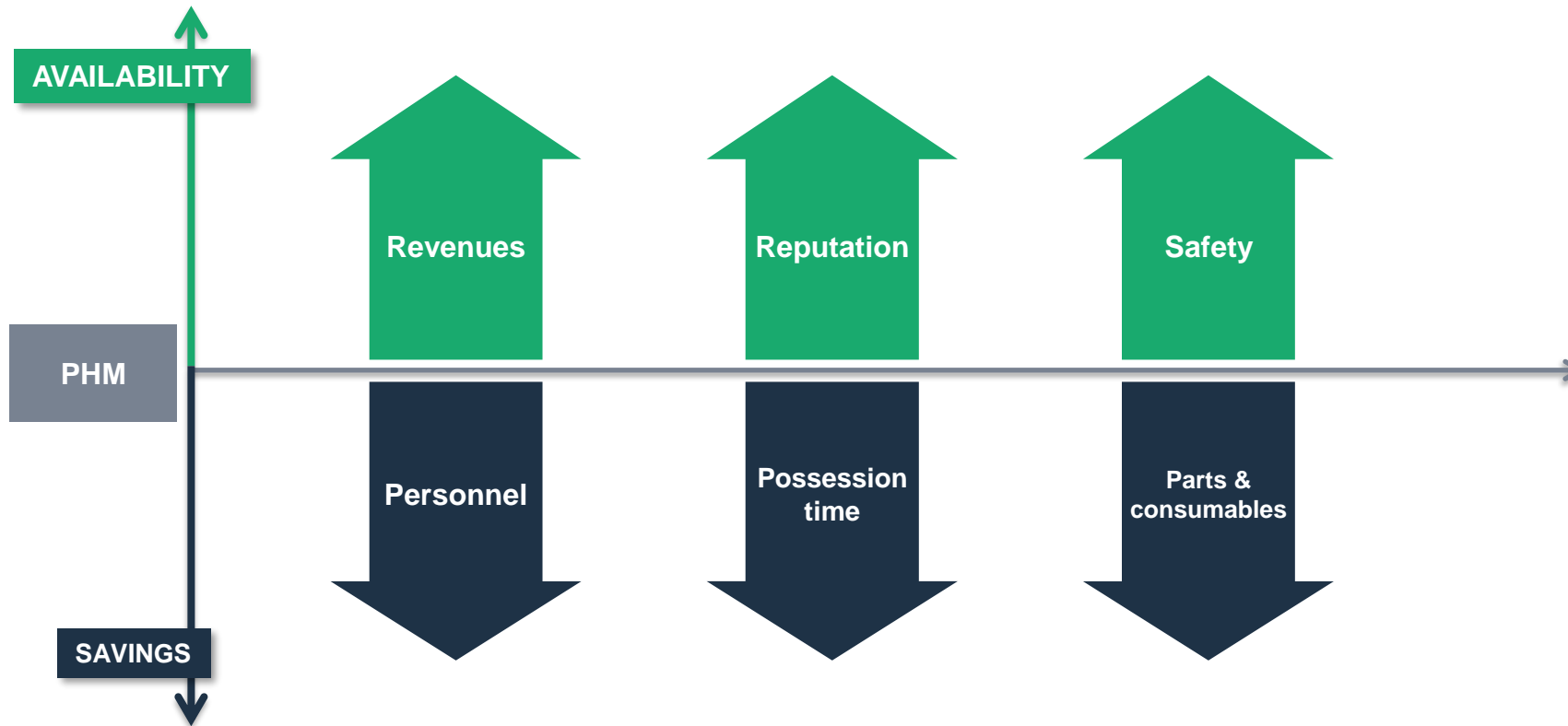
KPI: where we want to be

- The ROC chart gives a clear indication of the quality of a diagnostic test.
- A good test must have **high sensitivity** (detect the issue when it's present), hence a **high TP Rate**
- A good test must have **high specificity** (avoid to react to irrelevant data causing false alarms) and hence a **low FP Rate**
- A mediocre algorithm will not give mediocre results: **it will not be adopted at all.**

This is where we want to be



Potential gains



The need to validate and get to adoption

