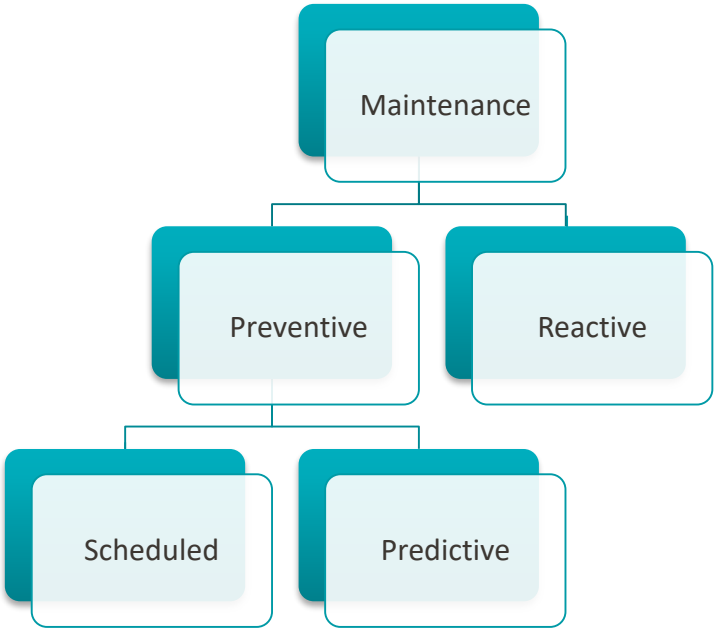
PRODUCTIONALIZATION OF A PREDICTIVE MAINTENANCE SYSTEM FOR RAILWAYS

01. INTRODUCTION

+ DISTINCT MAINTENANCE TYPES
+ MAINTENANCE REALITY PROCESS
+ MAINTENANCE OPTIMIZATION

3 DISTINCT MAINTENANCE TYPES

MAINTENANCE TYPE : REACTIVE, SCHEDULED AND PREDICTIVE



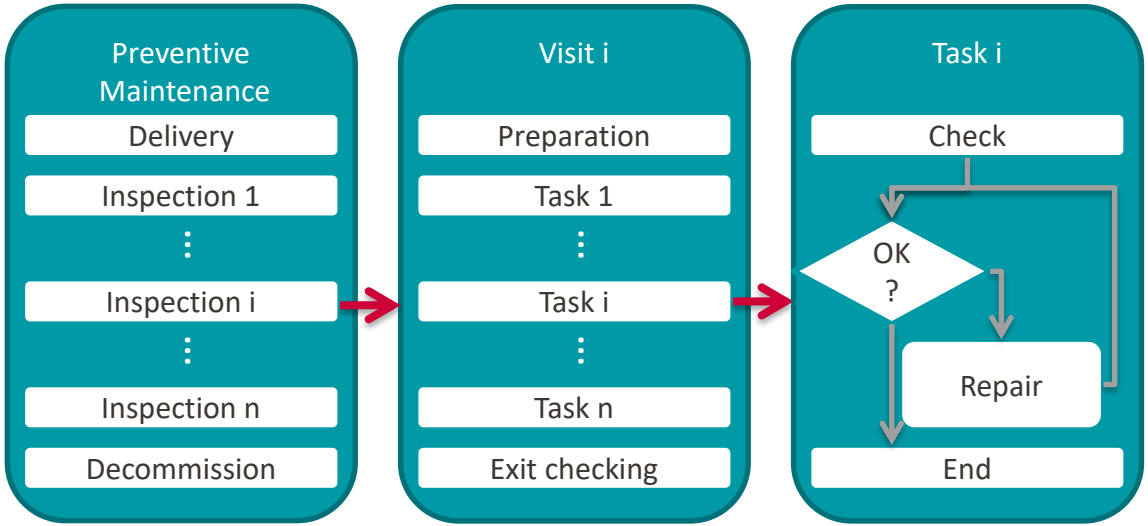
Reliability — “up time” and safety increase

Ownership cost — Minimize maintenance costs

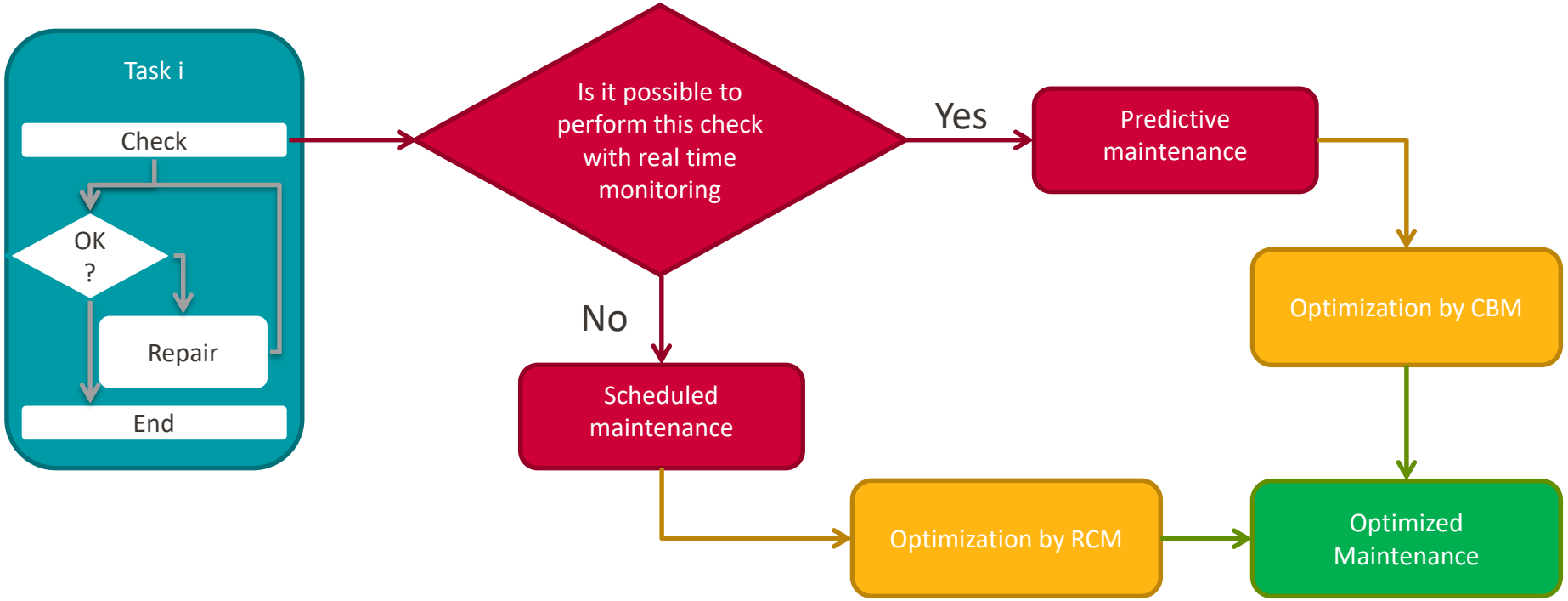
Customers reputations — Up of availability and quality

MAINTENANCE REALITY PROCESS

TODAY'S MAINTENANCE PROCESS IS 100% PREVENTIVE AND CAN BE IMPROVED.



HOW TO OPTIMIZE MAINTENANCE PROCESS WHEN MAINTENANCE IS BASED ON TASK



02. DEFINITION OF CBM

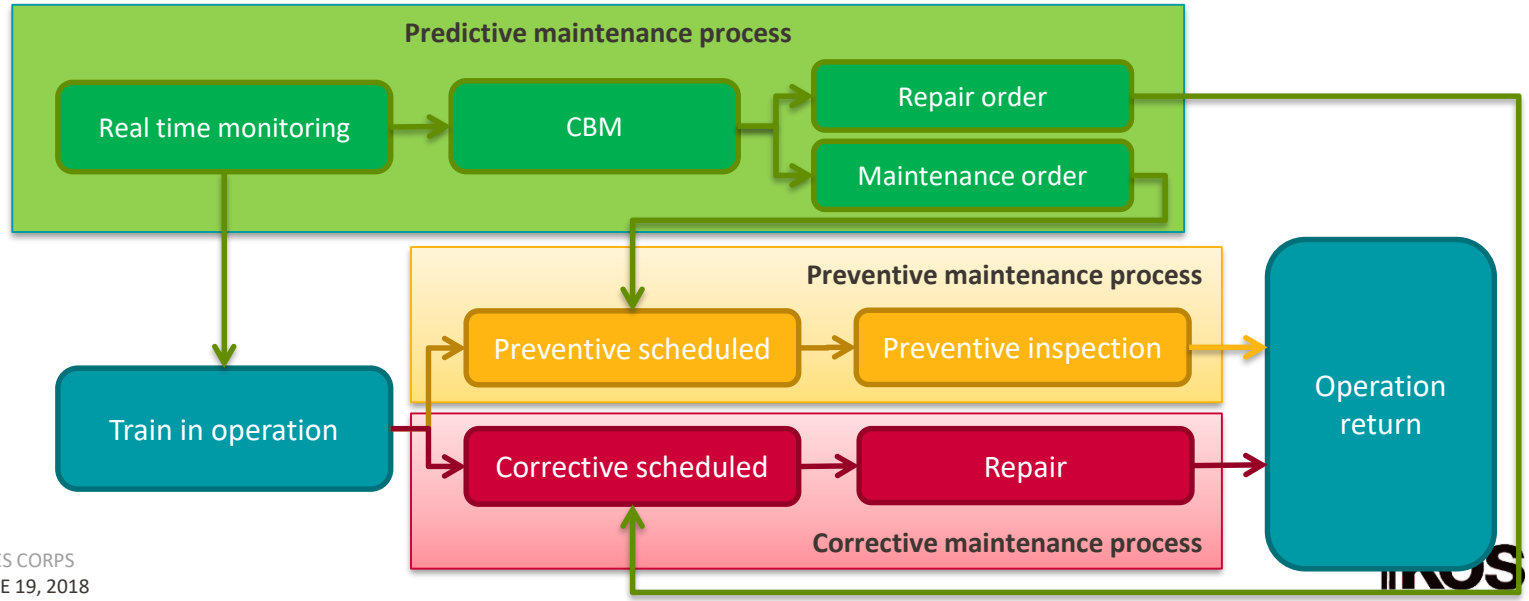
+ MAINTENANCE OPTIMIZATION PROCESS WITH CBM
+ CBM SYSTEM
+ CBM DATA WORKFLOW
+ CBM DETAILED ARCHITECTURE

MAINTENANCE OPTIMIZATION WITH CBM

CBM SYSTEM GIVE ORDERS TO MAINTENANCE CENTER.
THIS ORDER MUST BE INTEGRATED IN THE MAINTENANCE WORKFLOW PROCESS.

In rolling stock railway maintenance, it is almost impossible to completely replace a preventive inspection by a predictive maintenance inspection.

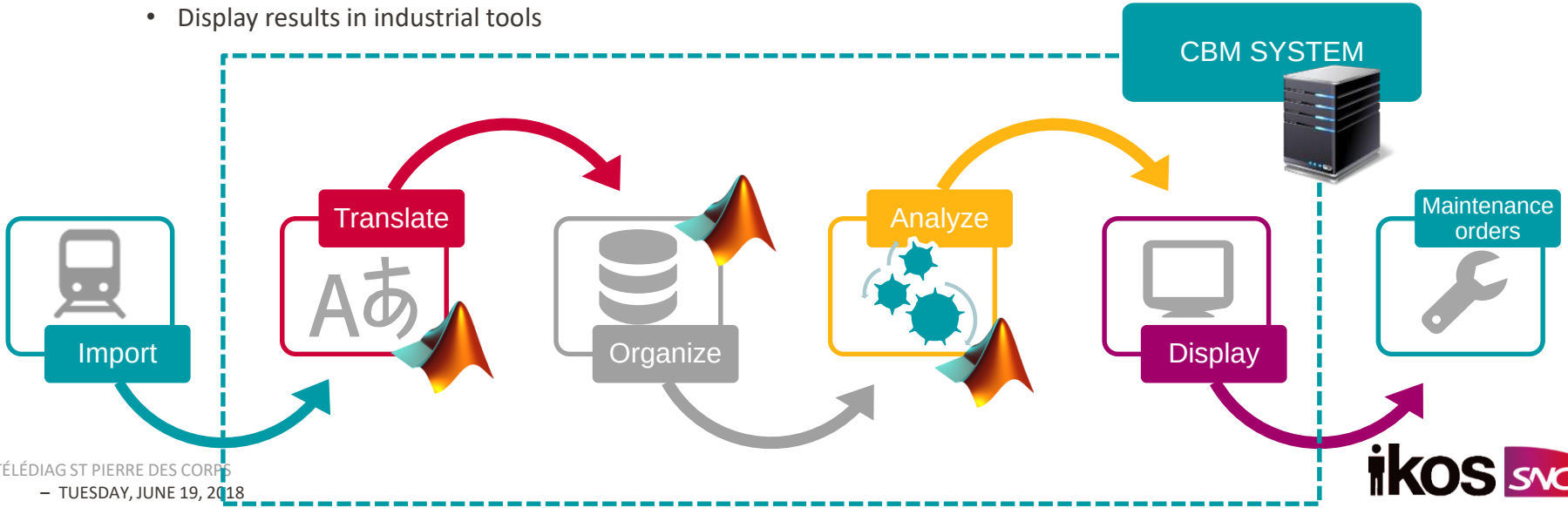
To overcome this issue, predictive maintenance is integrated to preventive and corrective maintenance workflow process.



CBM SYSTEM

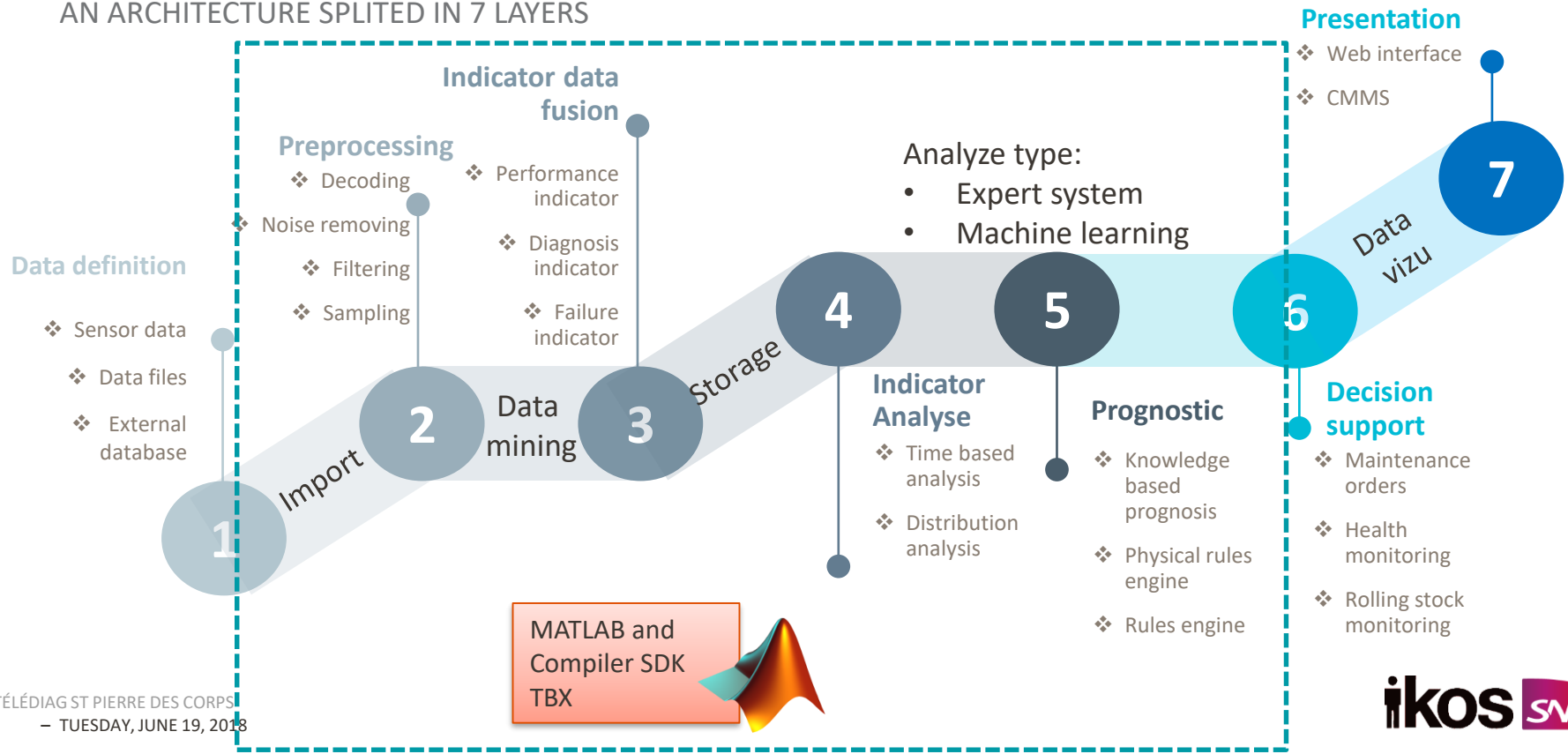
CBM system is a software tool created to organize predictive maintenance task. It is composed by several function :

- Gather data from on board train systems and sub-systems
- Order and link data from studied systems
- Analyze data
- Translate data from analyzed data to obtain maintenance orders
- Display results in industrial tools



CBM DATA WORKFLOW

AN ARCHITECTURE SPLITED IN 7 LAYERS



CBM – DATA IMPORT

DATA IMPORT VS ROLLING STOCK TYPE

1

7

Connected train (native sensors and network)

RER-NG

R2N

NAT

Native data file:

- Sub system data file
  - Passengers access
  - HVAC
- Train data file

Data type:

- Boolean data
- Analog data
- Context data
- Maintenance and operation data

Unconnected train (integrate sensors and network)

TGV

Z2N

Additional sensors:

- IoT
- Data acquisition card

Wired data

CBM off-board server

Volumetry

Transmission type:

Wi Fi ZONE

4G

3G

LoRa

SIGFOX

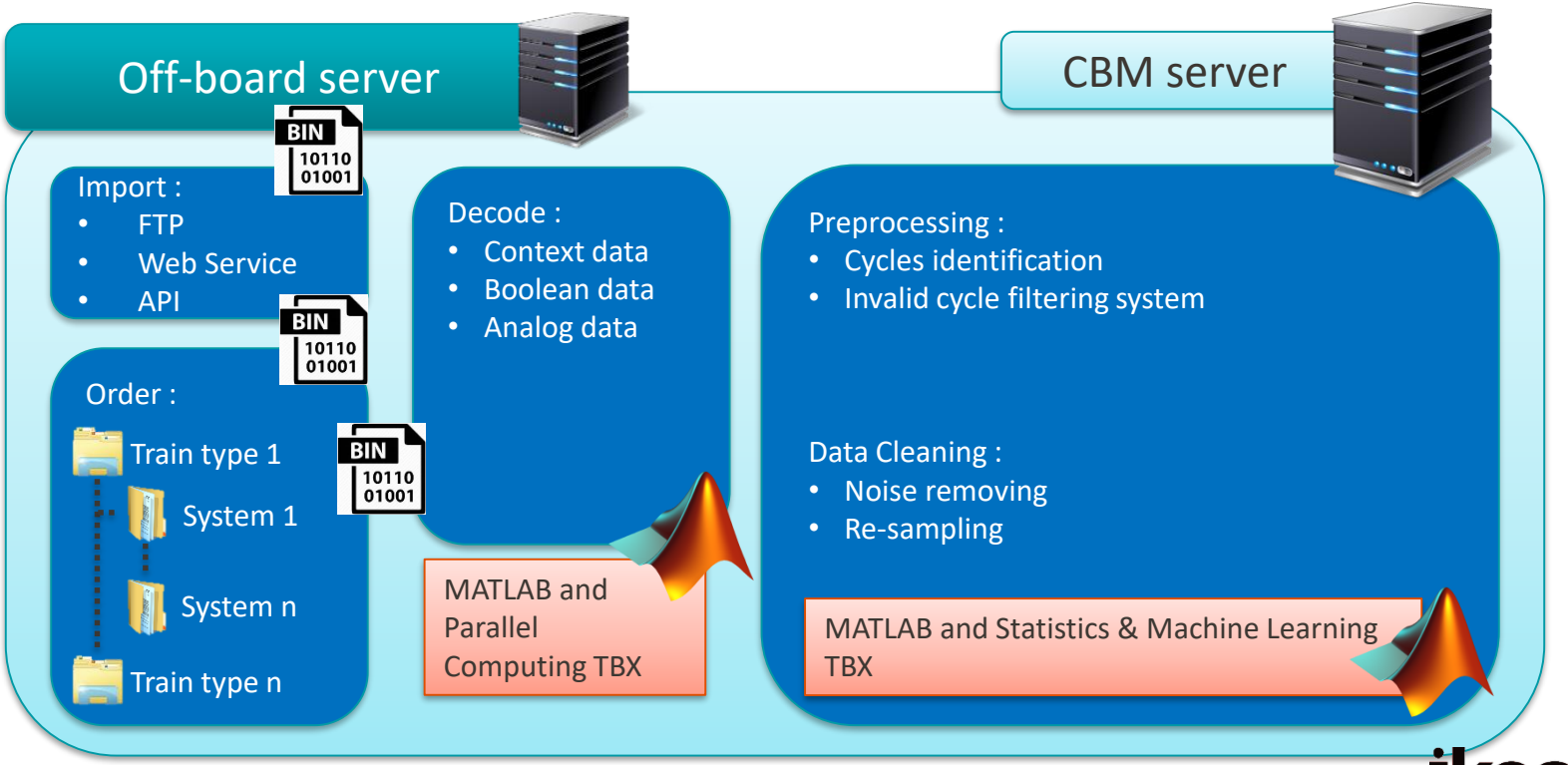
ikos SNCF

CBM – DATA PREPROCESSING

IMPORTATION, CLASSIFICATION, DECODING, FILTERING AND RE-SAMPLING

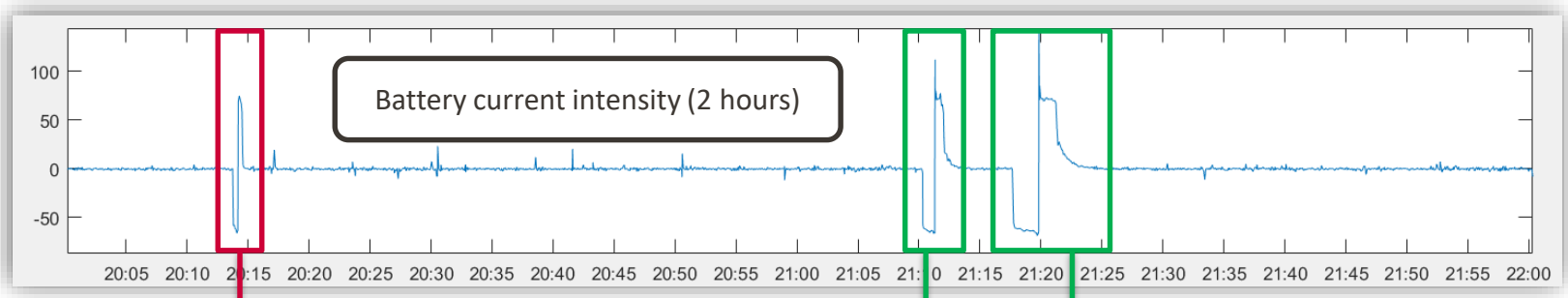
2

7



CBM – DATA PREPROCESSING

CBM BATTERY – CYCLE IDENTIFICATION



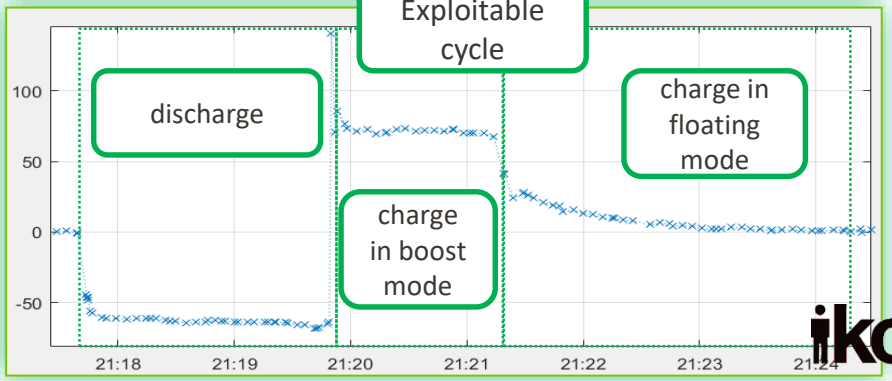
Cycle 1

Too short

Cycle 2

Cycle 3

Exploitable cycle



CBM – DATA PROCESSING

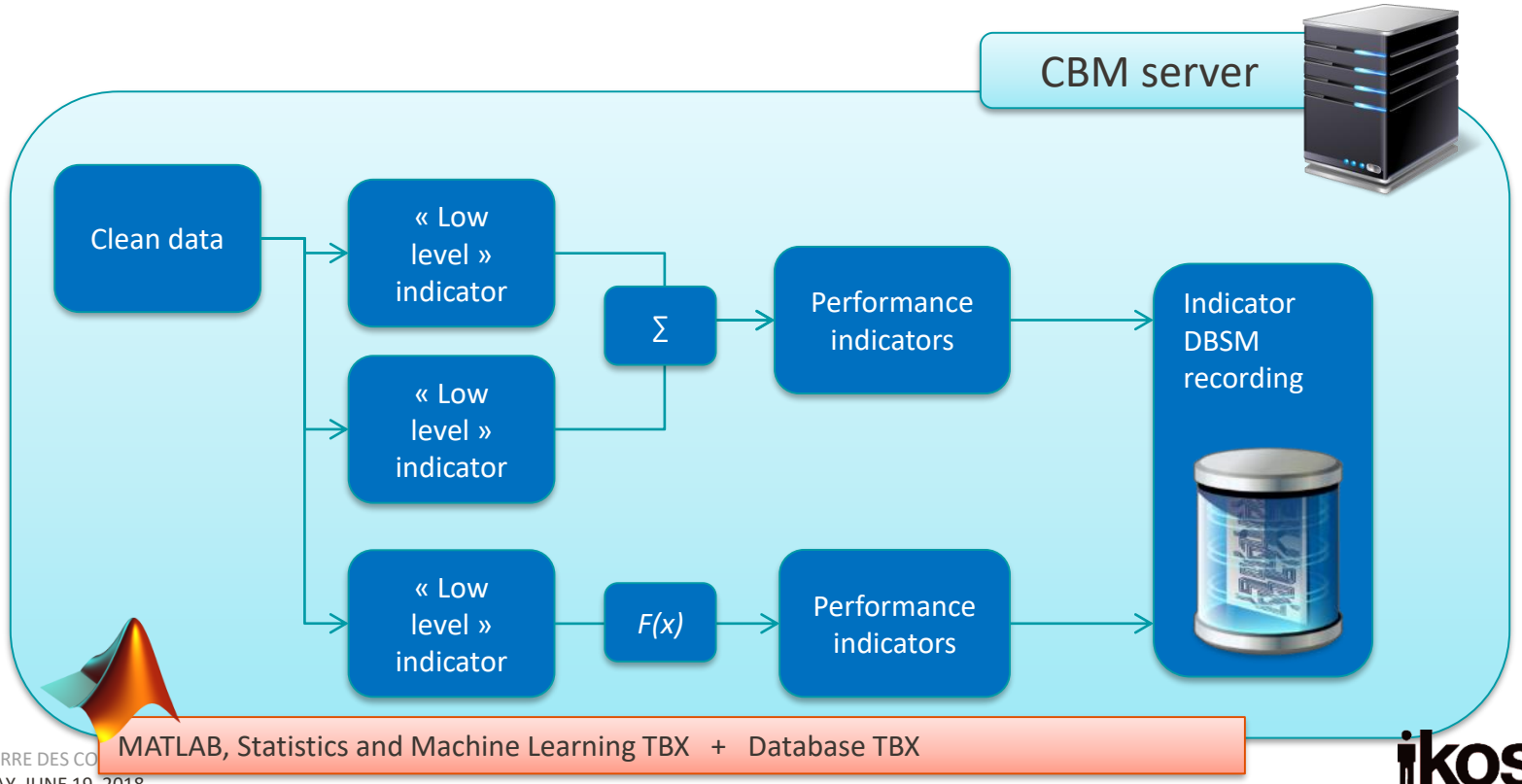
FROM TRAIN SIGNAL TO INDICATORS DATA

2

3

4

7



CBM – INDICATORS PROCESSING EXAMPLE

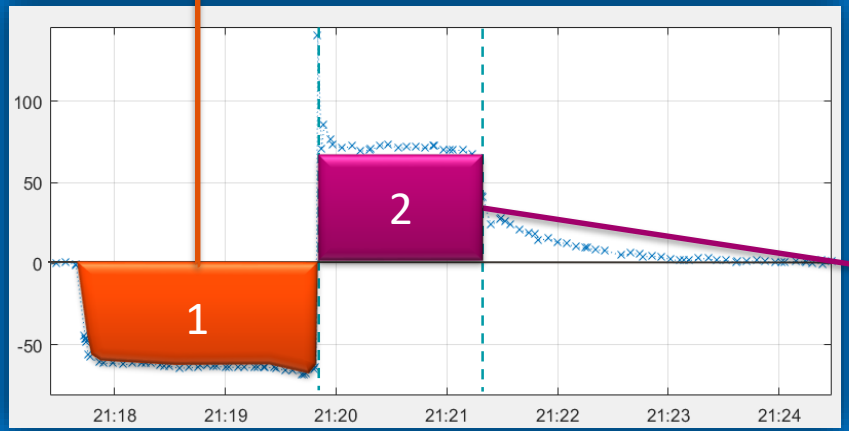
INDICATOR CREATION FOR BATTERY SYSTEM

3

7

CBM Server

Indicator definition :
An indicator is a “simple” calculated value extracted from a time data sensor.
Example :



Indicator 1 : Current discharge quantity

Coding : current discharge area

Indicator 2 : Current charge quantity in boost mode

Coding : current charge area

%

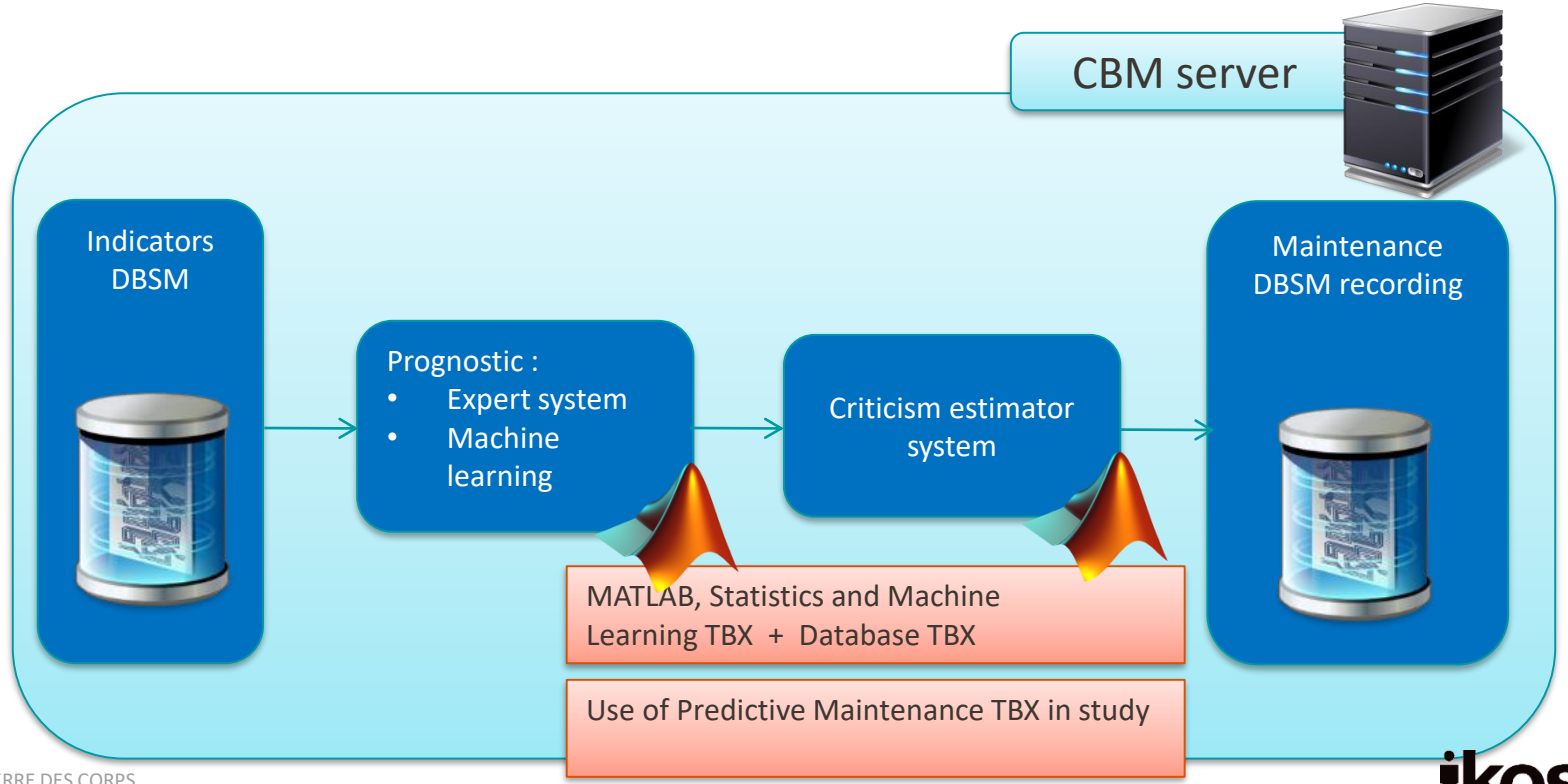
Performance indicator : discharge / charge ratio

SGBD Recording

MATLAB, Statistics and Machine Learning TBX + Database TBX

CBM – MAINTENANCE DATA PROCESSING

FROM INDICATORS DATA TO MAINTENANCE DATA



4

5

6

7

CBM – PROGNOSTIC

INDICATOR ANALYSIS (TIME AND DISTRIBUTION)

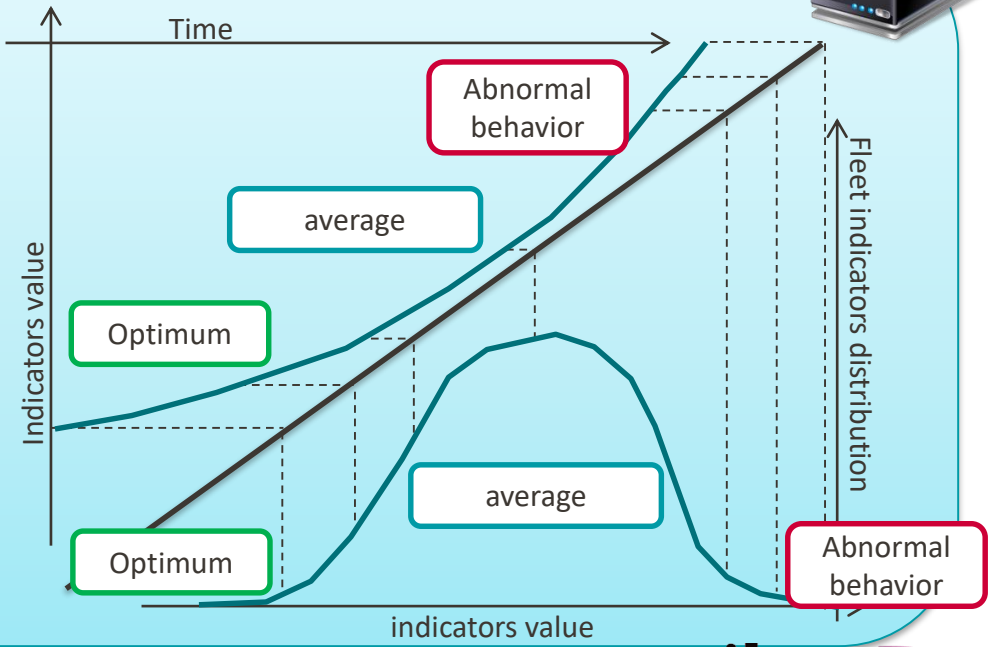
4

7

CBM Server

Time analysis :
how evolve an indicator during time

Distribution analysis :
how indicator values are distributed among rolling stock fleet



CBM – VISUALIZATION

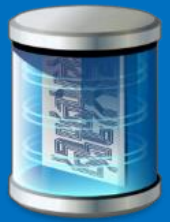
FROM MAINTENANCE DATA TO MAINTENANCE ORDERS GMAO SYSTEM

6

7

CBM server

Maintenance DBSM



Train criticism estimator

Visualization of maintenance orders and maintenance data in maintenance factory

TM

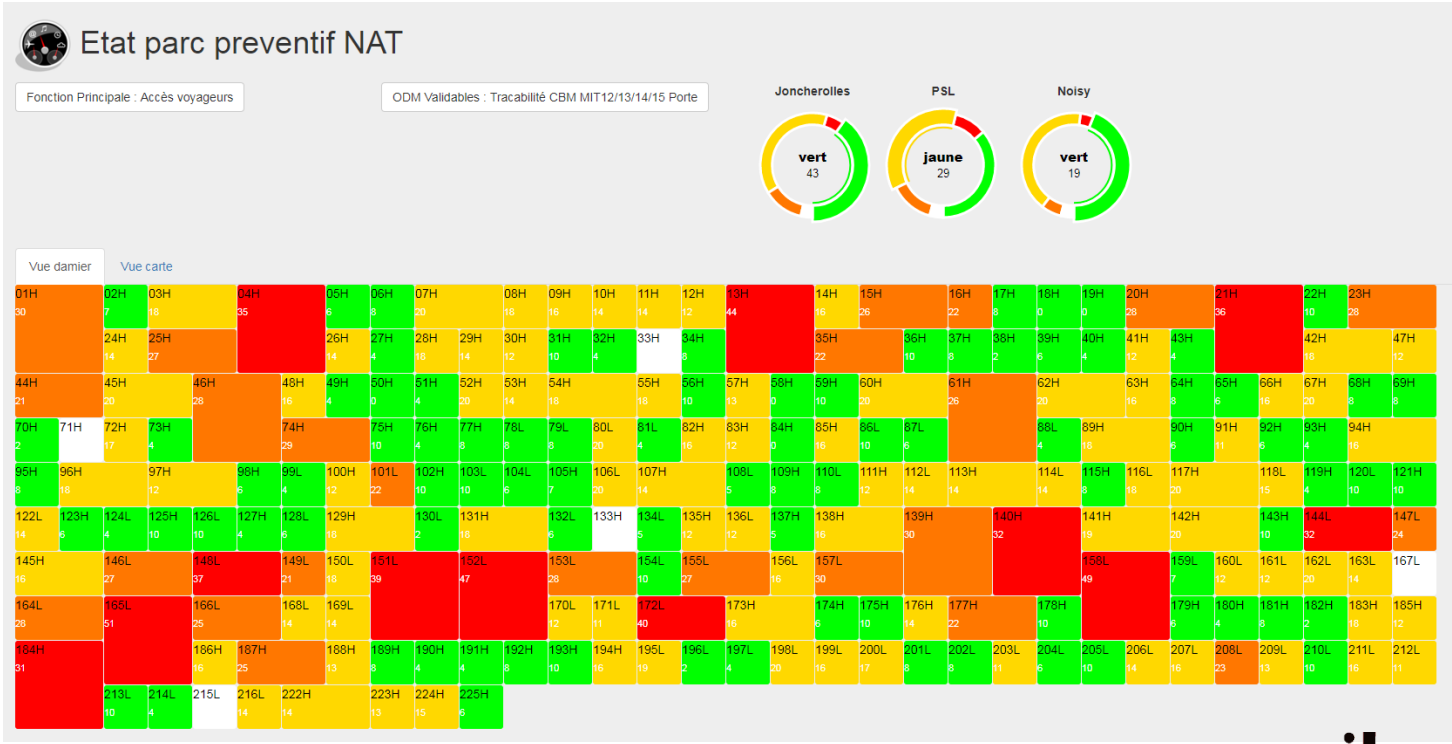
STF

CBM – VISUALIZATION TOOLS

VISUALIZATION TOOLS FOR CONDITION-BASED MAINTENANCE

6

7



CBM – VISUALIZATION TOOLS

VISUALIZATION TOOLS FOR CONDITION BASED MAINTENANCE

6

7

Operation Tracabilité CBM MIT12/13/14/15 Porte sur rame 13H 50025

Tracabilité éditée le 2018-03-30 08:29:55

Communication train	✔

Taches validées par CBM

Tâches	V1 50025		V2 501025		V3 502025		V4 503025		V5 504025		V6 505025		V7 506025		V8 50026	
Com de la DCU	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Date (jours)	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
	G	D	G	D	G	D	G	D	G	D	G	D	G	D	G	D
Z50-AAAA-NB-01-02-03AAA-310A-A Côte de passage	✘	✘	✔	✔	✔	✔	✔	✔	✔	✘	✔	✔	✔	✔	✔	✔
Z50-AAAA-NA-00-00-01AAA-300A-A Hauteur brosses seuils de portes	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Z50-AAAA-NB-01-03-02AAA-361A-A Courroie du mécanisme de porte	✘	✔	✘	✔	✘	✔	✘	✘	✔	✔	✔	✔	✔	✘	✔	✘
Z50-AAAA-NB-01-04-00AAA-300A-A Fin de course fermeture porte (S1)	✘	✔	✘	✔	✘	✔	✘	✘	✔	✔	✔	✔	✔	✘	✔	✘

CBM – VISUALIZATION TOOLS

VISUALIZATION TOOLS FOR CONDITION BASED MAINTENANCE

6

7

Accès voyageurs

Gauche

Porte

Version du Soft de la DCU	*Date dernier cycle: 2018-03-01 16:39:00*
Rebond à la fermeture Porte (cause DCU)	*Date dernier cycle: 2018-03-01 16:39:00*
Réglage du FCF ou de la courroie porte	*Date dernier cycle: 2018-03-16 20:48:00*
Effort O/F Porte	*Date dernier cycle: 2018-03-16 20:48:00*
Réglage butée Porte	*Date dernier cycle: 2018-03-16 20:48:00*
Frottement périphérique joint porte	*Date dernier cycle: 2018-03-16 20:48:00*
Fonctionnement O/F Porte	*Date dernier cycle: 2018-03-16 20:48:00*
Réglage brosse porte	*Date dernier cycle: 2018-03-16 20:48:00*

UFR

Fonctionnement O/F UFR	*Date dernier cycle: 2018-03-16 20:48:00*
Effort O/F UFR	*Date dernier cycle: 2018-03-16 20:48:00*
Réglage du FCF UFR	*Date dernier cycle: 2018-03-16 20:48:00*
Réglage de la courroie UFR	*Date dernier cycle: 2018-03-16 20:48:00*

PMR

Fonctionnement O/F PMR	*Date dernier cycle: 2018-03-16 20:37:00*
Effort O/F PMR	*Date dernier cycle: 2018-03-16 20:37:00*
Réglage du FCF PMR	*Date dernier cycle: 2018-03-16 20:37:00*
Réglage butée PMR	*Date dernier cycle: 2018-03-16 20:37:00*
Réglage de la courroie de la PMR	*Date dernier cycle: 2018-03-16 20:37:00*

DCU

Com de la DCU	*Date dernier cycle: 2018-03-16 21:01:00*

Droite

Porte

Version du Soft de la DCU	*Date dernier cycle: 2018-03-09 12:09:00*
Rebond à la fermeture Porte (cause DCU)	*Date dernier cycle: 2018-03-09 12:09:00*
Réglage du FCF ou de la courroie porte	*Date dernier cycle: 2018-03-16 20:55:00*
Effort O/F Porte	*Date dernier cycle: 2018-03-16 20:55:00*
Réglage butée Porte	*Date dernier cycle: 2018-03-16 20:55:00*
Frottement périphérique joint porte	*Date dernier cycle: 2018-03-16 20:55:00*
Fonctionnement O/F Porte	*Date dernier cycle: 2018-03-16 20:55:00*
Réglage brosse porte	*Date dernier cycle: 2018-03-16 20:55:00*

UFR

Fonctionnement O/F UFR	*Date dernier cycle: 2018-03-16 19:07:00*
Effort O/F UFR	*Date dernier cycle: 2018-03-16 19:07:00*
Réglage du FCF UFR	*Date dernier cycle: 2018-03-16 19:07:00*
Réglage de la courroie UFR	*Date dernier cycle: 2018-03-16 19:07:00*

PMR

Fonctionnement O/F PMR	*Date dernier cycle: 2018-03-16 20:55:00*
Effort O/F PMR	*Date dernier cycle: 2018-03-16 20:55:00*
Réglage du FCF PMR	*Date dernier cycle: 2018-03-16 20:55:00*
Réglage butée PMR	*Date dernier cycle: 2018-03-16 20:55:00*
Réglage de la courroie de la PMR	*Date dernier cycle: 2018-03-16 20:55:00*

DCU

Com de la DCU	*Date dernier cycle: 2018-03-16 20:55:00*

05. USE CASES

+ ALL OUR USE CASES
+ DOORS USE CASE
+ HVAC USE CASE
+ PANTOGRAPH USE CASE

ALL OUR USE CASES

FEW EXAMPLES OF OUR USE CASES

Compressor

Performance

Battery

Capacity ratio

Pantograph

Taring and up/down time

HVAC

Performance

Doors and Steps

Performance and adjustement

Traction

Engine performance

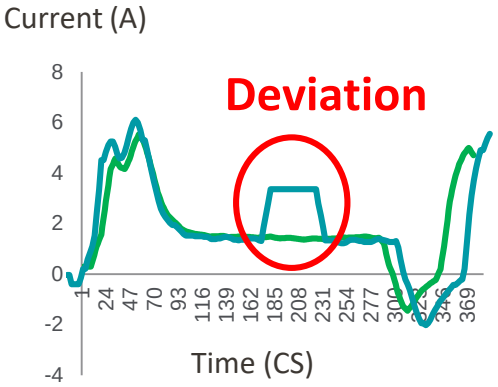
Brake

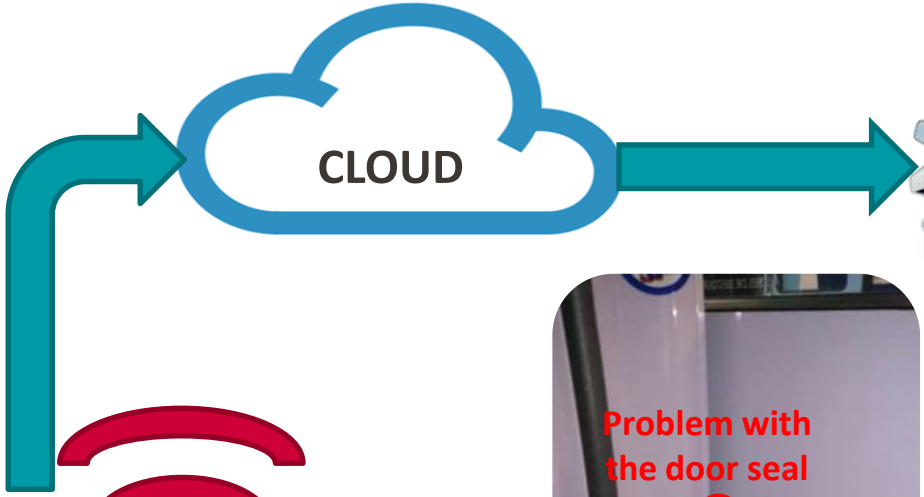
Brake performance

Toilette

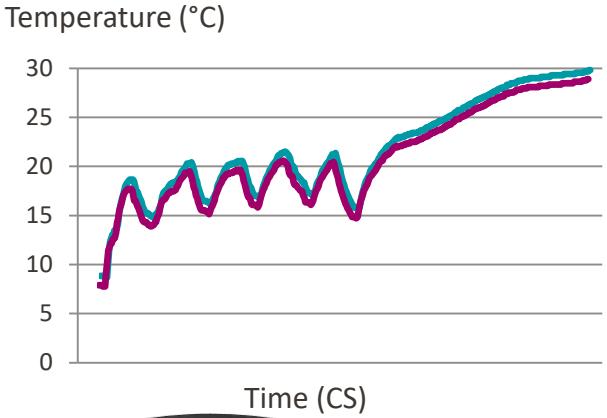
Reservoir levels

DOORS USE CASE



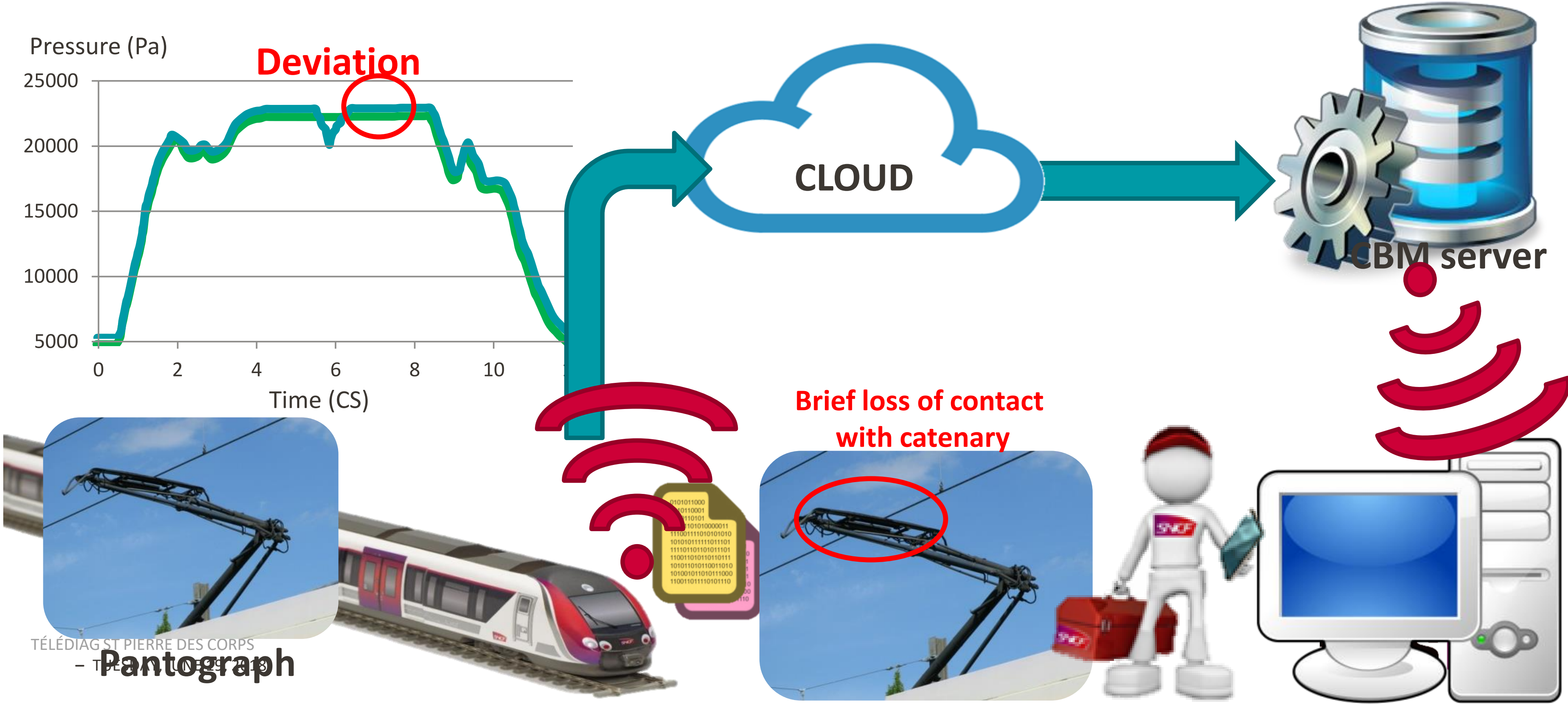


HVAC USE CASE



HVAC

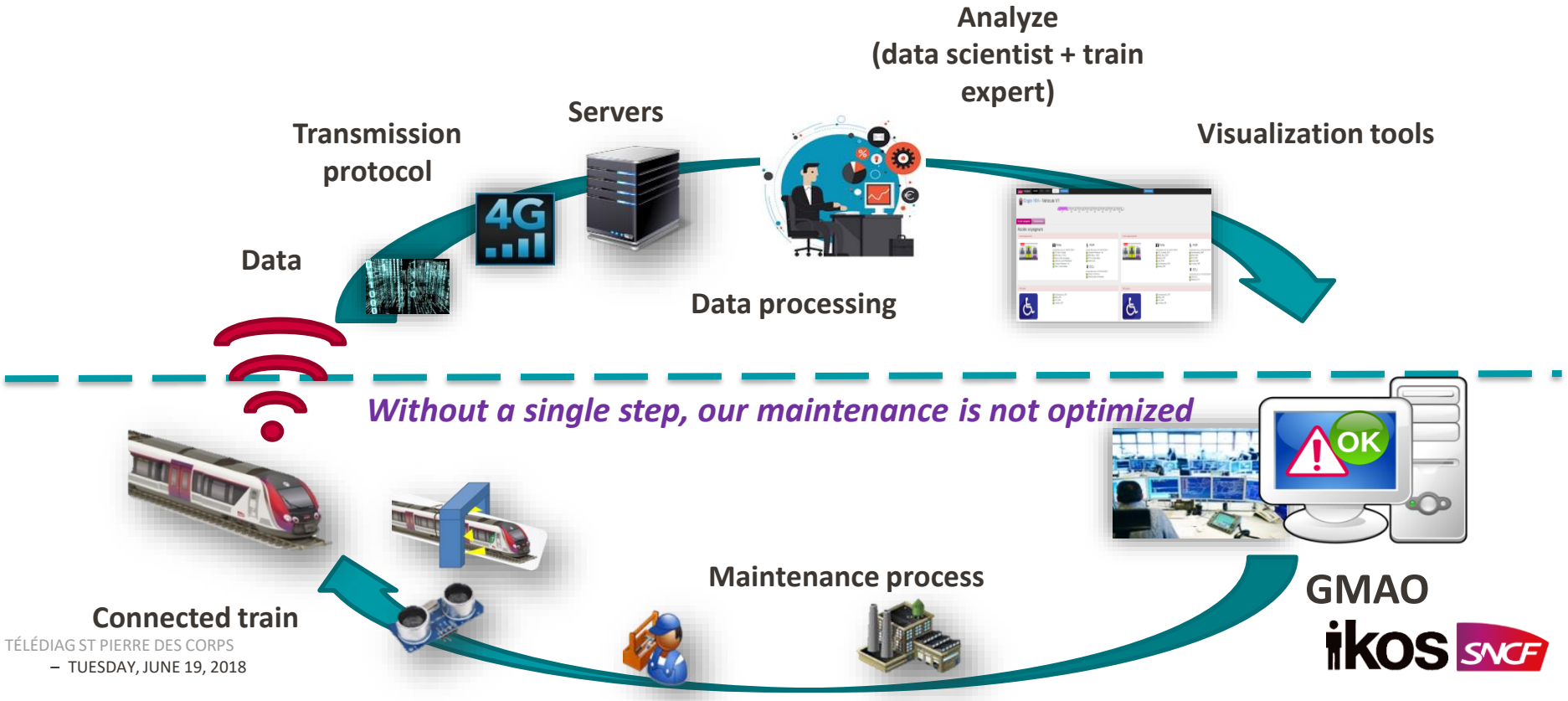
PANTOGRAPH USE CASE



06. CONCLUSION

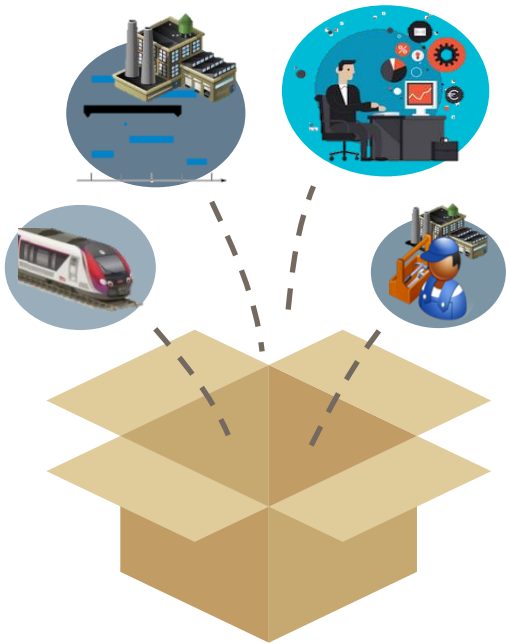
+ OUR LIFE CYCLE
+ OUR PRODUCT

CONCLUSION : OUR LIFE CYCLE



CONCLUSION : OUR PRODUCT

A SOLUTION IN ADEQUACY WITH ROLLING STOCK FLEET CONSTRAINTS



A new maintenance process, centered on data

Our solution is a complete turnkey for SNCF. It optimizes the whole maintenance process without breaking the existent process. Our product use native train sensors when it’s possible and replace already existing maintenance task.

Data analysis

Understand and process data from train

Scheduling helper

Give information based on data to schedule maintenance center operation.

Native connected rolling stock fleet

All train with on board / off board communication systems and sensors

Maintenance helper

Give tool to optimize maintenance process

CONCLUSION : PROSPECTS

MAINTENANCE 4.0 FROM CBM TO THE WHOLE MAINTENANCE PROCESS CENTERED ON DATA

New train

Standardize and expand our CBM system to all rolling stock

Connect resources

Connect stock availability maintenance order and human resources to find the best possible maintenance order

Connect schedule

Use operational data to optimize the callback of rolling stock in maintenance center accordingly with connected resources

Technology

Always move forward with new tech BigData, AI, new algorithm…

Industrialize

Even if our system is in production we have to study how to grow our tech to absorb and compute always more data

Reactive Maintenance

Speed up (real-time data) data process to optimize reactive maintenance