kerlink
communication is everything

Developments In
Predictive Maintenance Using
Kerlink's MobileHub:

The Track Value Use Case

Nicolas AMIOT   n.amiot@kerlink.fr   July 2025

Kerlink

Hardware

Features	Wirnet™ iZeptoCell & iZeptoCell-cellular	Wirnet™ iFemtoCell & iFemtoCell-evolution	Wirnet™ iStation	Wirnet™ iBTS Compact
Installation	Indoor densification Indoor extension, Data only	Indoor densification Data Only	Outdoor	Outdoor Data high density

Software & Data

Wanesy Management Cockpit 4

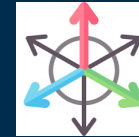- Gateways Administration

- Check health of network

- KPIs & Alerts

Maintain

Operate
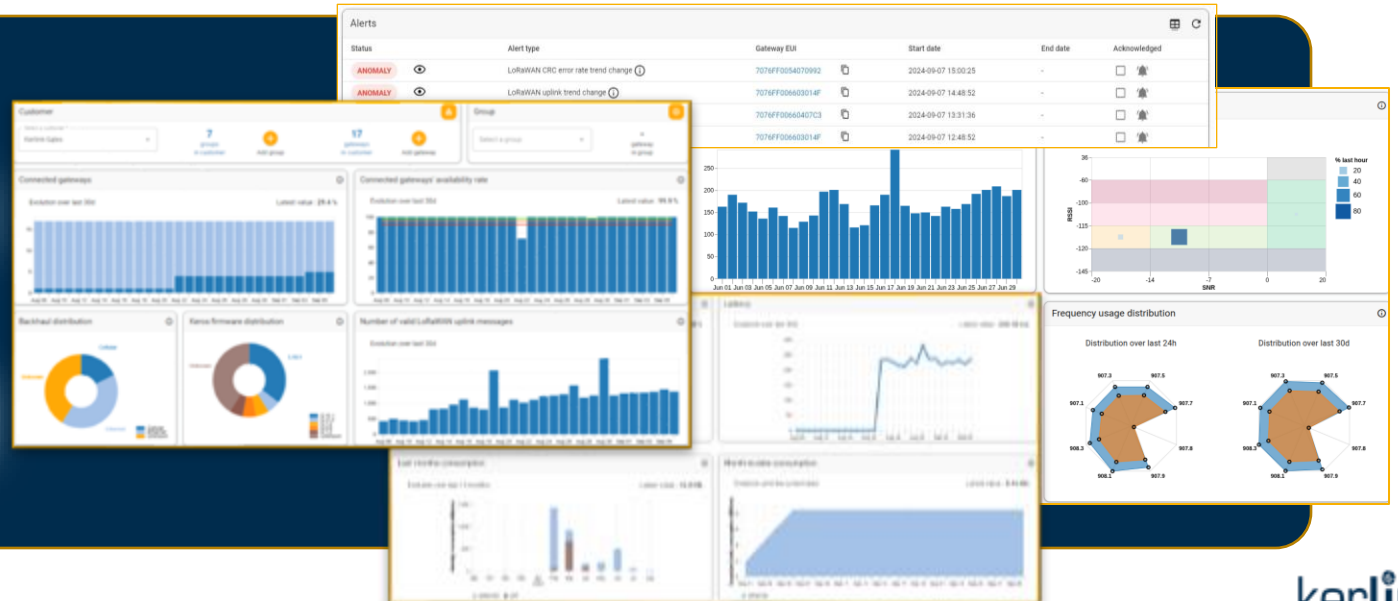
Kerlink's MobileHub

Connectivity

kinéis

GNSS

Bluetooth

LoRaWAN®

Sensors

Accelerometer

Compass

Barometric Sensors

Battery powered

- **An always available geolocation solution (LoRaWAN + Kinéis)**
- **Record autonomy (up to 5 yrs)**

- **Integrated sensors and alarms**
- **Extendable with external wireless sensors**
- **Application Agnostic**

Kinéis Connectivity

Spatial IoT Connectivity
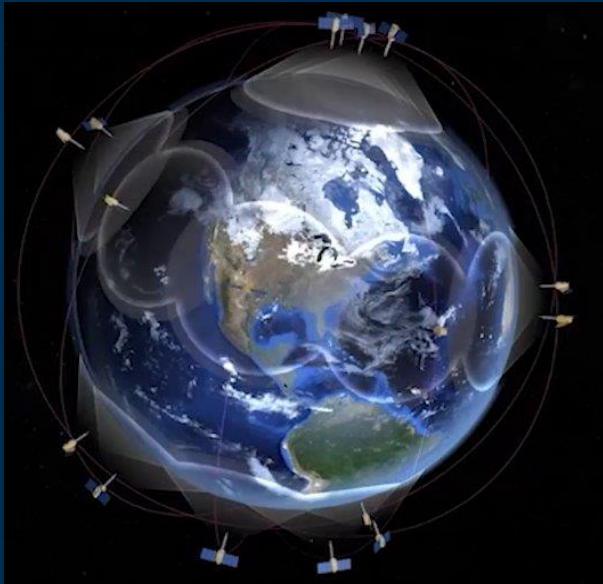
- French Satellite operator
- 25 nanosatellites
- 100 % Earth Connected
- ~ 1 satellite in visibility every 15 minutes

Kinéis end-to-end IoT connectivity

Low-Data transmission

Secured transmission

TRACK, MONITOR, ALERT FROM ANYWHERE

Ground Station

Service Center based in France

Near-real time data delivered

Final user

Devices
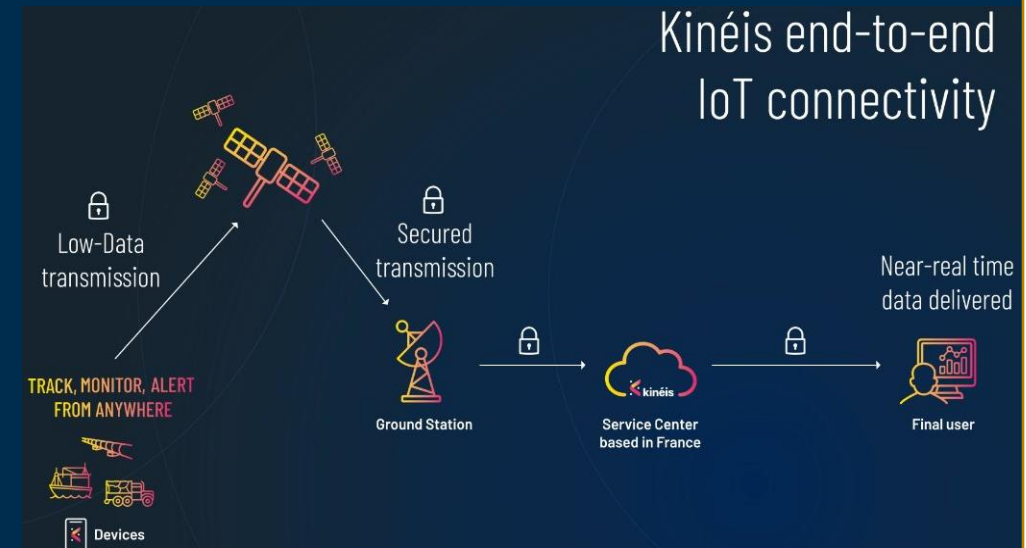
The TrackValue Solution

Use Cases

- **Rail Freight**
- Road Freight
- Sea Freight
- Air Freight

Track Value

Rail Fret Main Features

- Estimated time of arrival (ETA), geolocation, mileage
- Unplanned stop untimely stop
- Business data collection (temperature, humidity, **transported load**)
- Predicitve maintenance (**flat wheel detection**, shock)

The Flat Wheel Detection Problem

In case of **failure** in wagon's **brake system**, the wheels of a single bogie can be locked while the train is moving.

Then, locked wheels rub on the rails and becomes flat.

Flat wheels' wagons are forbidden to move due to **damages** it caused on the **rails**. They must be immobilized and repaired.

The **earliest detection** of this failure is **primordial** for operators.

Flat wheel detection systems already exist on the market, but they rely on either:

- a **complicated** installation directly on the bogie's braking system,
- at the rail level, which means **fixed locations** and **random and late** detection.

The Flat Wheel Detection Problem

The proposal is to opportunistically use the Track Value solution and its internal sensors (**accelerometer**) for flat wheels detection.
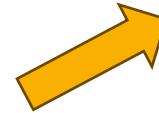
Advantages :

- Wagon are **already equipped** with TrackValue (mileage, position,…)
- **Easy installation** (the product is attached to the wagons with **magnets**)
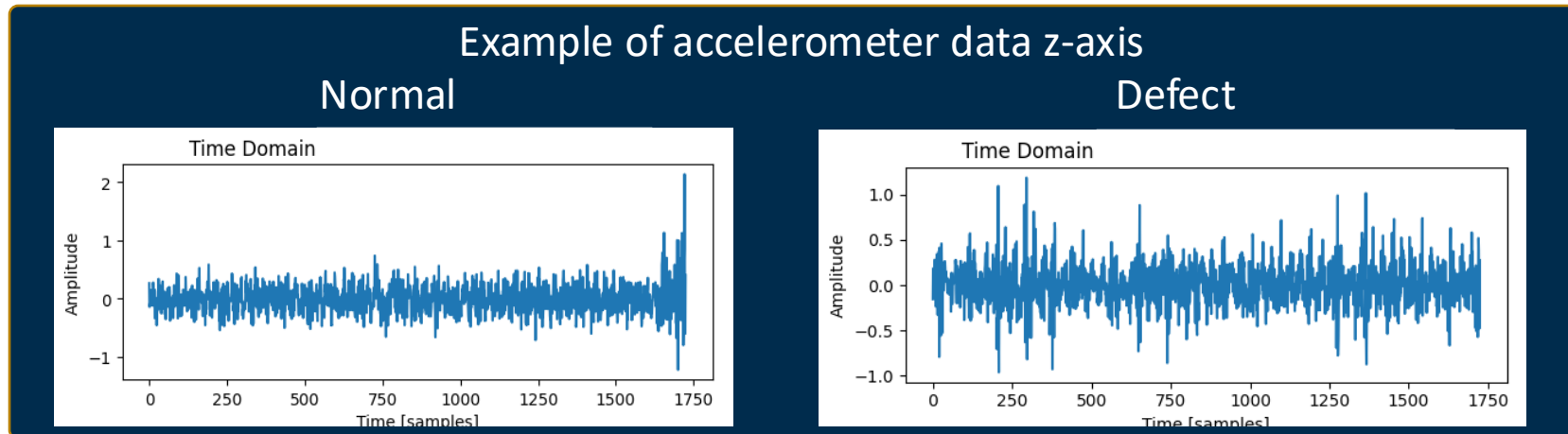- **Early detection**

Accelerometer → MODEL → Anormal / Normal

Data & challenges

- A first **measurement** campaign has been realized in association with Europorte to get **accelerometer** data from few modified TrackValue devices (with ability to log accelerometer data).
- **Qualified data** on the of the wagon's wheel health (normal or defect).

Example of accelerometer data z-axis

- Complex problem:
  - o Uncertainty on Track Value position on wagons
  - o Wagon type diversity (Tank wagon , Flat wagon,...)
- Real world limitations considerations
  - o Consumption
  - o Limited storage capability
  - o Limited amount of data transfer
  - o Embedded architecture

kerlink
communication is everything

Model

- Literature proposes Machine Learning with Neural Network approach.
    - Time series data
    - Less sensitive to devices position than other approaches
    - Model update lighter (weights update)
- Wheel health data are available (Data are labeled) => Supervised Learning

Accelerometer data → **STFT** → **Convolutional Neural Network (CNN)** → **Able to Infer new observables**

Weights computation

Labeled data

Model Learning Procedure

Measurement campaigns

Accelerometer

Wagon's wheel health information

Data Lake Storage

Learning

TensorFlow

Layers weights

$$\begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ a_{m1} & a_{m2} & \dots & a_{mn} \end{bmatrix}$$

Embed the model with weights
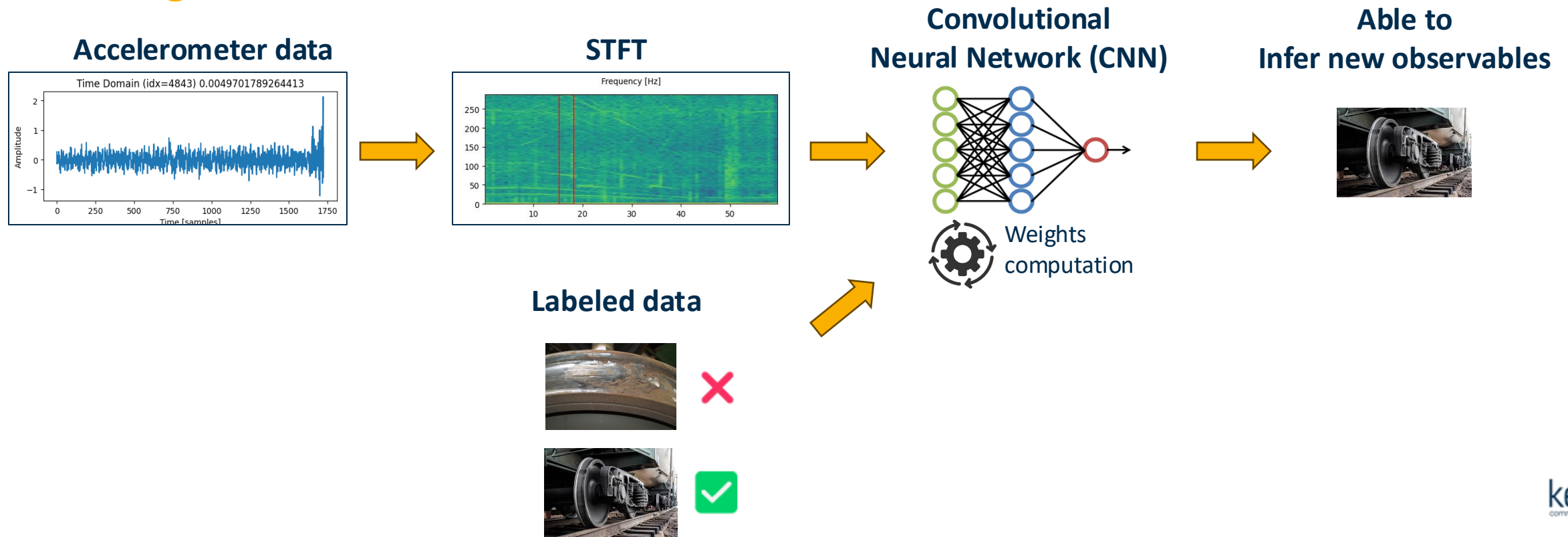
TensorFlow Lite
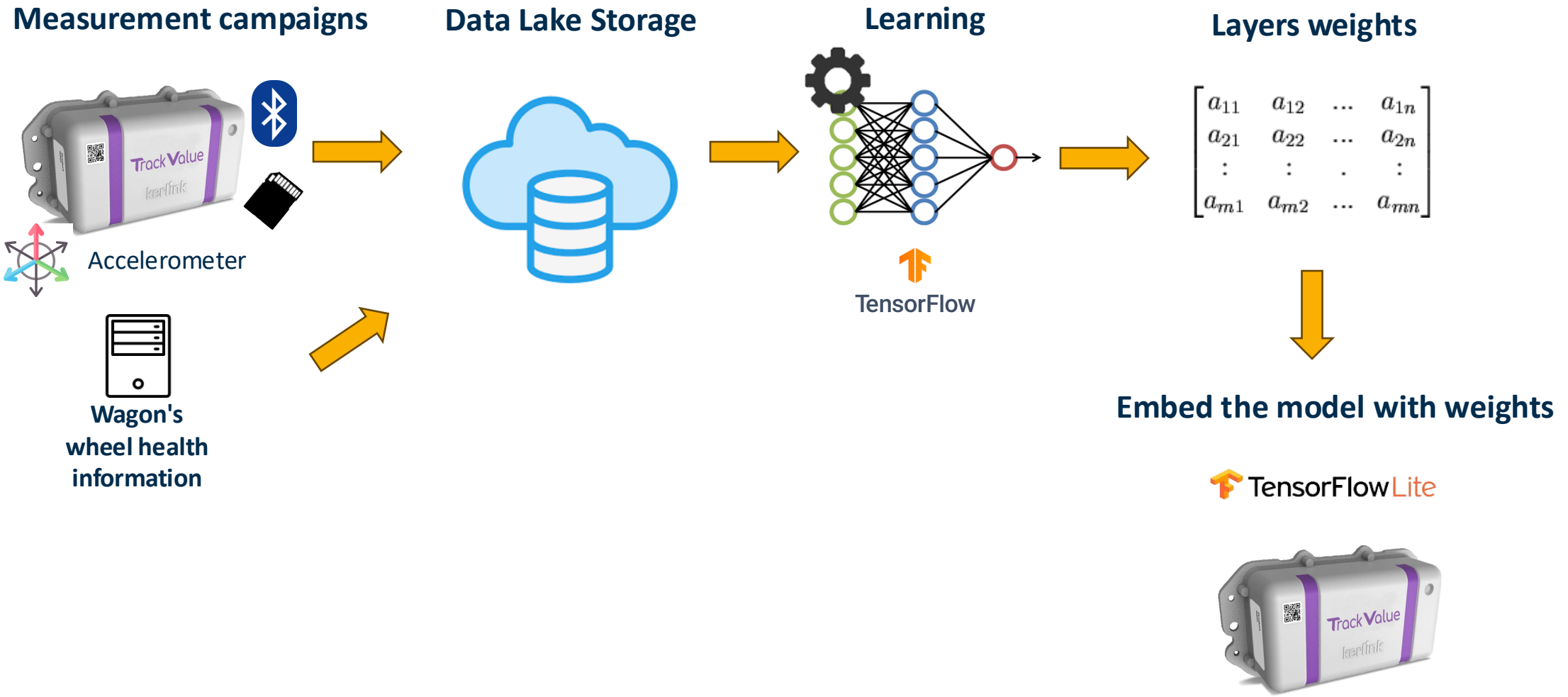
Model Learning Procedure (challenges)

Measurement campaigns

Accelerometer

Wagon's wheel health information

👷 Amount of data

Data Lake Storage

👷 CNN Architecture design

Learning

TensorFlow

Layers weights

$$\begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{m1} & a_{m2} & \dots & a_{mn} \end{bmatrix}$$

Embed the model with weights

TensorFlow Lite

👷 Model conversion

👷 Limited Resources

kerlink
communication is everything
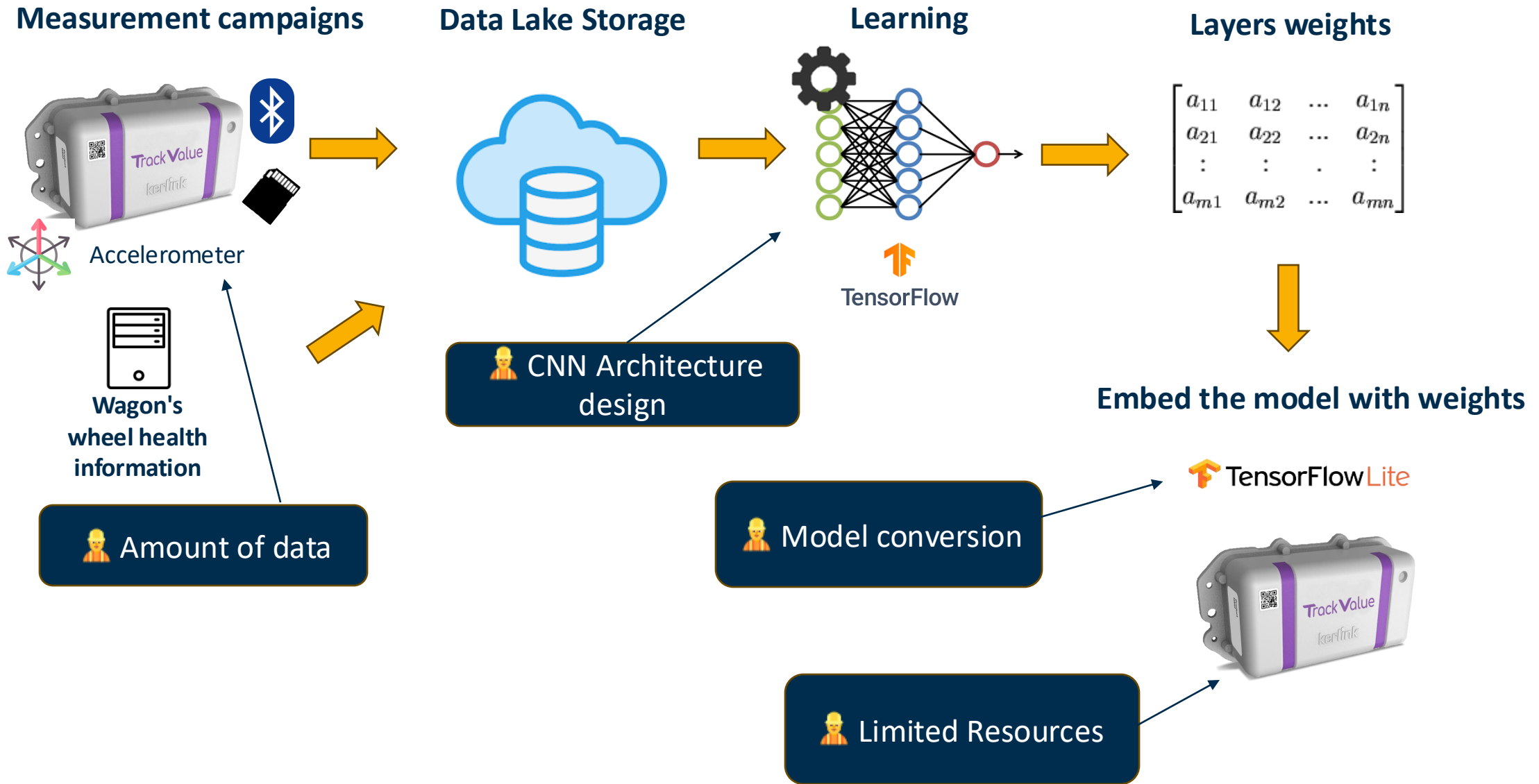
Inference On The Edge

Wagon reach target speed
(Once a day)

Get accelerometer data

Accelerometer

Run model inference
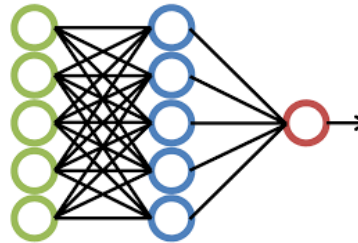
**Send alert
If anomaly detected**

Model Learning Weights Update Procedure

Measurement campaigns

Accelerometer

Wagon's wheel health information

Real world

Accelerometer
Few limited samples

DataLake Storage

Learning

TensorFlow

Layers weights Updated

$$\begin{bmatrix} a_{11} & a_{12} & \ldots & a_{1n} \\ a_{21} & a_{22} & \ldots & a_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ a_{m1} & a_{m2} & \ldots & a_{mn} \end{bmatrix}$$

Model performance validation

LoRaWAN

Model weights updated by LoRaWAN

mlflow

kerlink
communication is everything
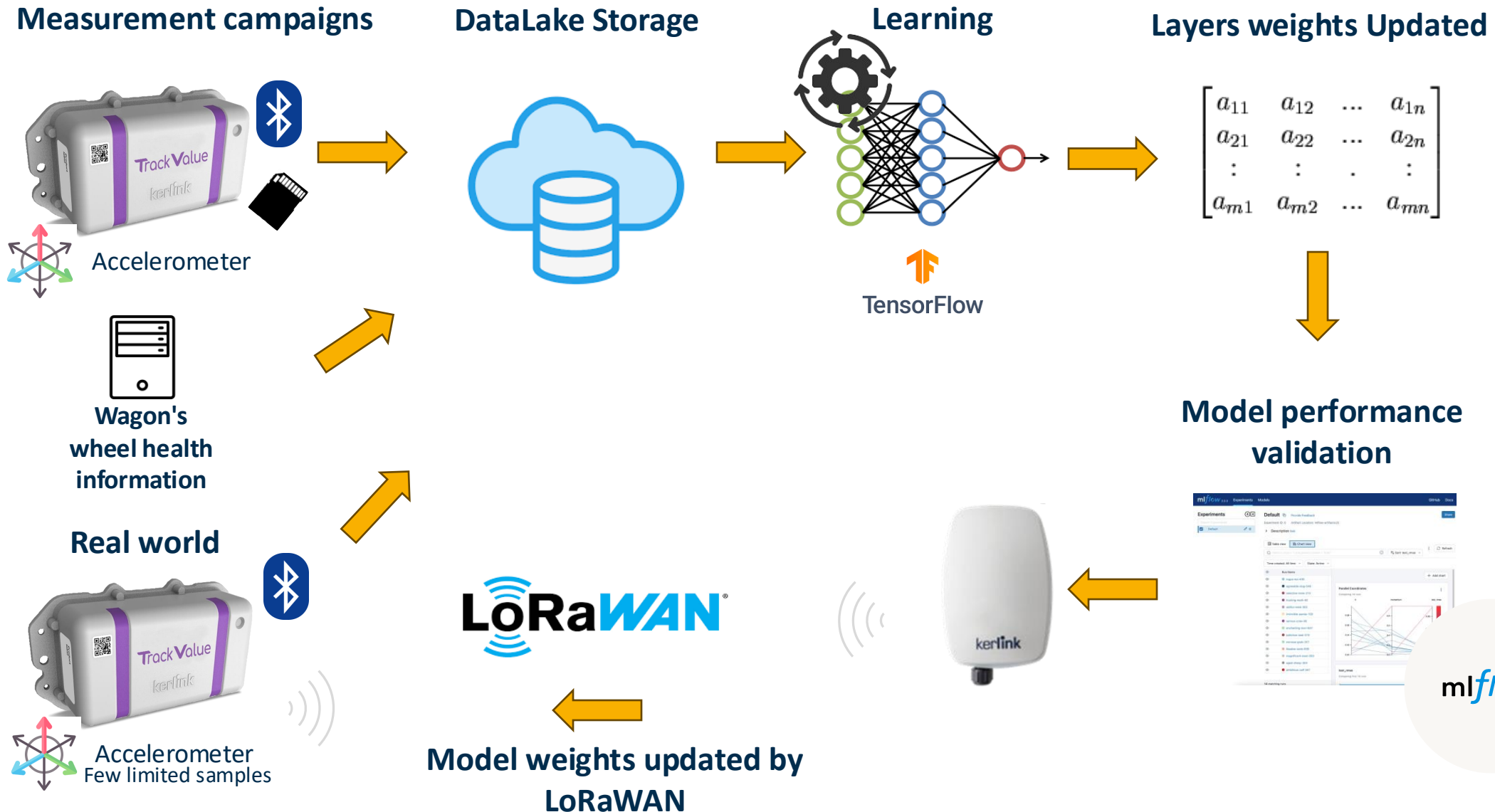
Conclusion & perspectives

- The Mobile Hub Track Value is an IoT hub featuring:
  - o Battery-powered (up to 5 years)
  - o Integrated sensors (location, vibration, etc.)
  - o Versatile connectivity options (Kinéis, LoRaWAN, BLE)
  - o Edge computing capabilities (enabling predictive maintenance)

- Introduction of flat wheel detection for rail freight applications

- Additional edge-based machine learning algorithms are scheduled for implementation.

kerlink
communication is everything

Thank You

Questions ?

n.amiot@kerlink.fr

kerlink
communication is everything

🌐 www.kerlink.com

[in] kerlink

🐦 @kerlink_news

▶️ kerlink