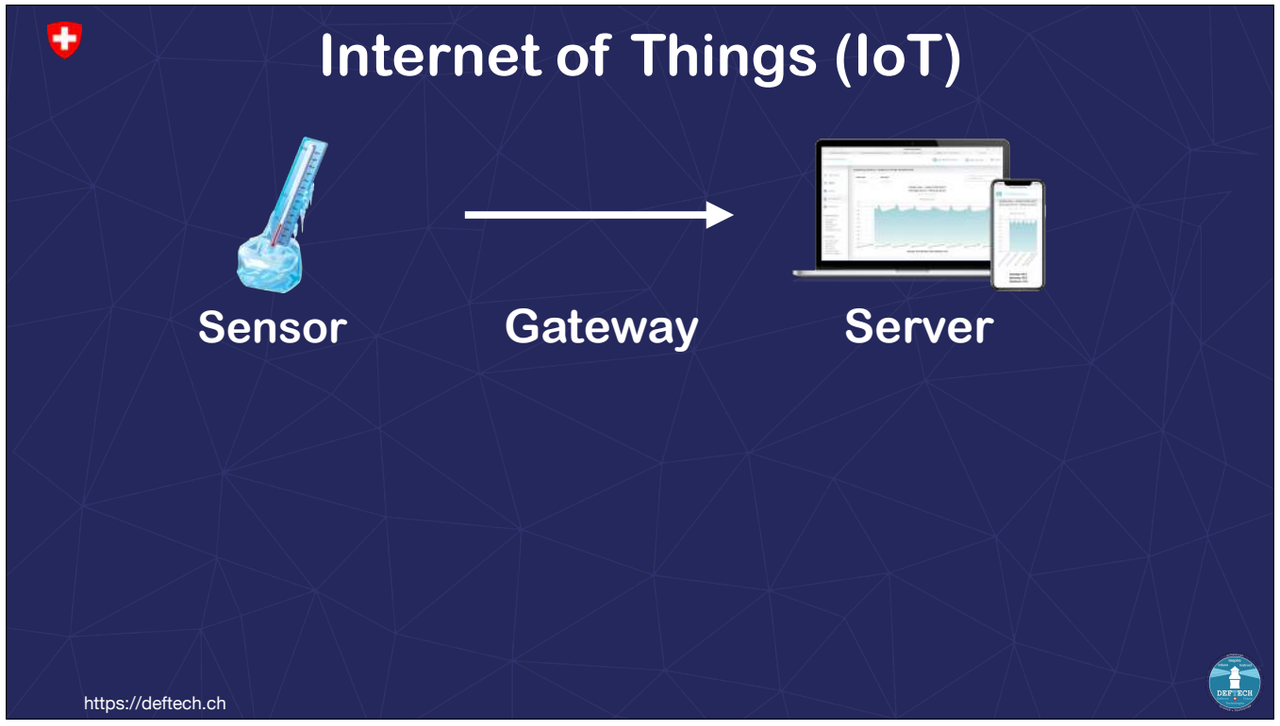
- Thank you for this opportunity, it is a pleasure participating to this event.
- armasuisse Science and Technology is the Technology Competence Center of the Swiss Armed Forces
- I am Quentin Ladetto and I’m in charge of the Technology Foresight research program.
- This presentation will focus on the Internet of Things and one specific application.



- For the Internet of Things to work, you have a sensor measuring specific data (Temperature, properties, humidity, etc), transferring the information to a server where they are stored, analysed
- Initially, a lot of analysis was done at the server level, but this is changing, and a lot of analysis, decision and even actions are now enabled at the sensor level
- This newly computing power at sensor level is called « Edge computing »

Internet of Things (IoT)

Sensor Gateway Server

Yesterday

Sense Transfer Store Analyse Decide Act

https://deftech.ch

Internet of Things (IoT)

Sensor Gateway Server

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Sense Transfer Store Analyse Decide Act

Trend

Sense Analyse Decide Act Transfer Store

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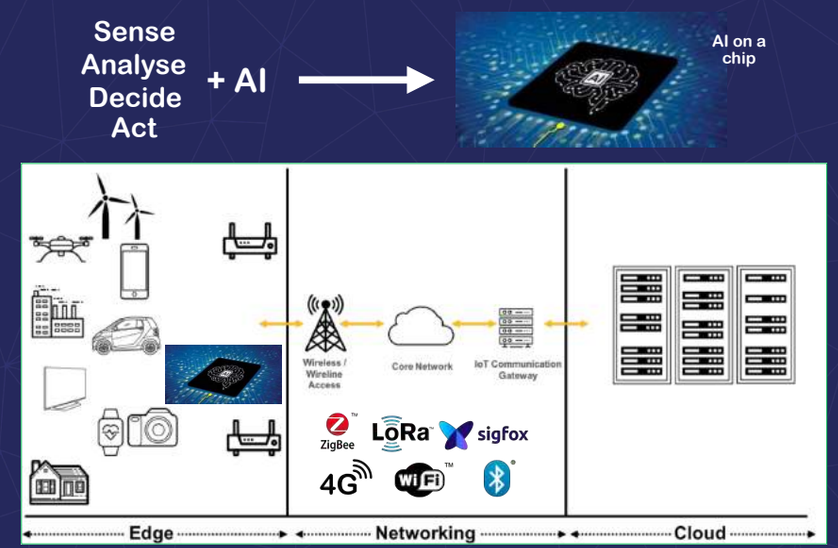
Towards Edge computing

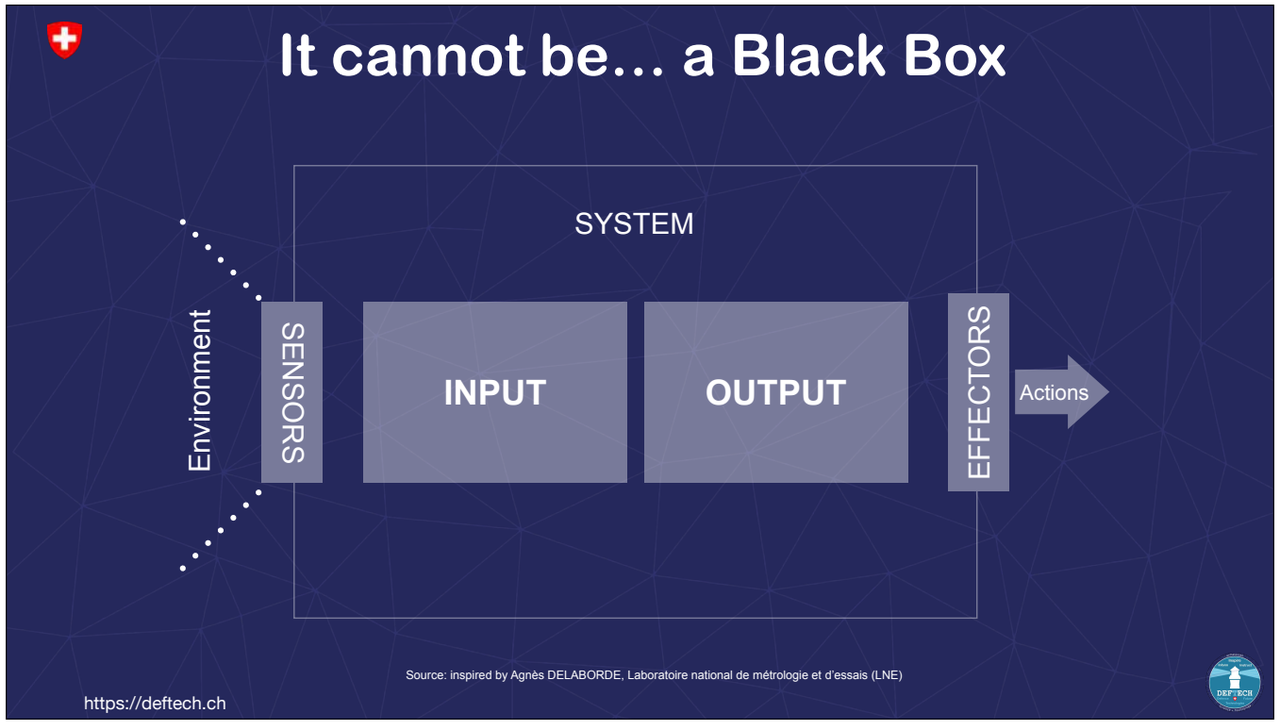


Accelerating Implementation of Low Power Artificial Intelligence at the Edge, A Lattice Semiconductor White Paper, November 2018
http://www.latticesemi.com

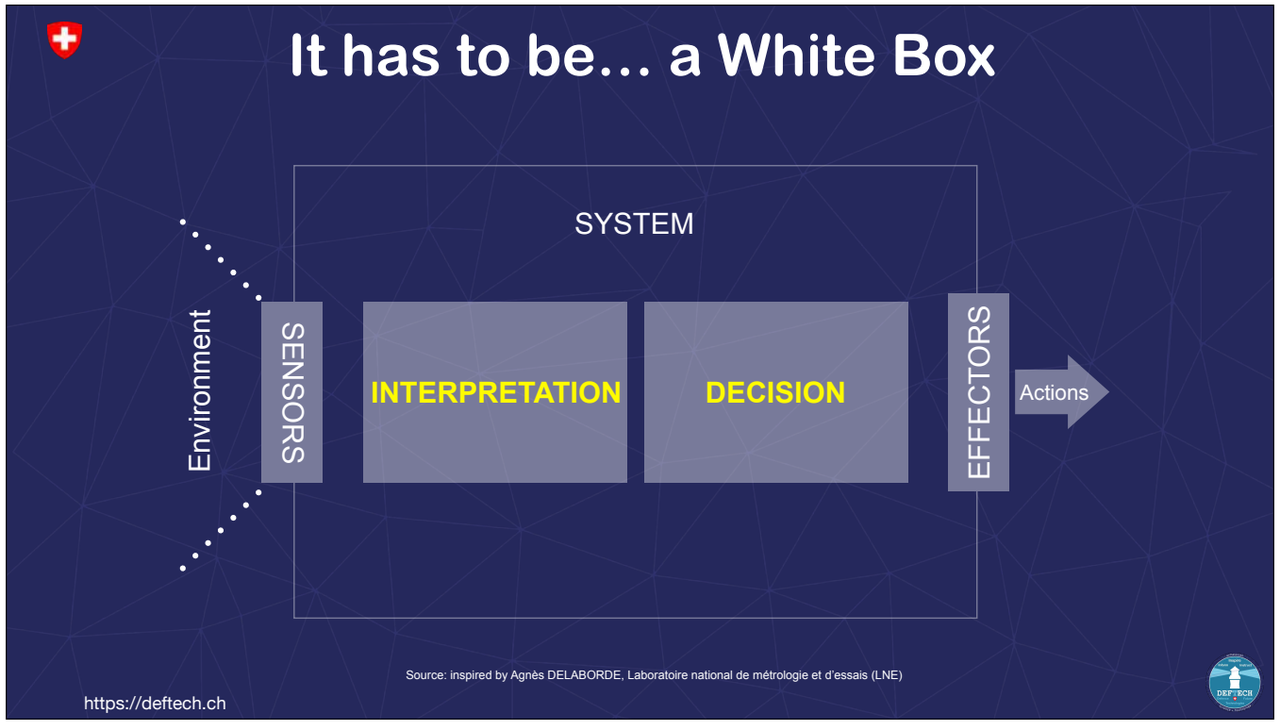
https://deftech.ch

- Edge computing also includes nowadays - and even more in the future - also some Artificial Intelligence, which is directly enabled thanks to new design in the chipset.
- We see that the available processing power at sensor level allows a lot of possibilities (and also responsibilities) at sensor level already.

- In short the IoT allows you to have the OODA (Observe - Orient - Decide - Act) loop running at sensor level
- This is enabling new possibilities, but also requires the importance of testing of the algorithms, especially if we are integrating « Artificial Intelligence » at the module level.



- What we do not want is a Black Box, where nobody really understand what is going on in term of analysis. A Black Box would be a sensor that getting an Input, you get an Output, but without really being able to fully understand how you get it.
- This means that if you want to certify such a device, you would have to test all the possible Inputs… which could be quite impossible.
- Instead, what you should be aiming at, is a White Box…



- A White Box allows you to clearly identify the interpretation of the data you get from the sensors, and follow the decision process.
- You can understand and certify the logic without having to test all possible solutions.

Internet of Things in Logistics

- Vehicle diagnosis : optimisation of maintenance
- Delivery management : optimisation of the route
- Legal compliance : location, speed, driving time
- Temperature of cargo : Protection of sensitive goods
- Geofencing and theft prevention

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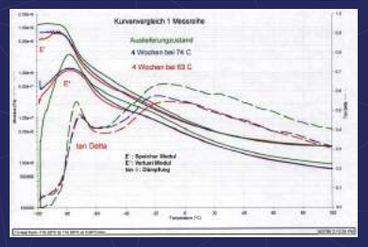
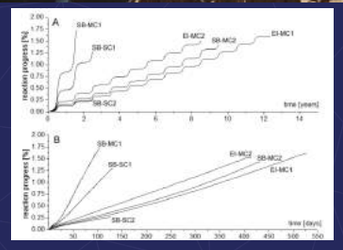
- The Internet of Things can be used in the armed forces in a lot of similar ways as in the civilian applications, and specially linked to « fleet management »

IoT in Ammunition Surveillance

Tracking the environmental conditions allows accurate life-cycle diagnostics
Vibration, Temperature, Humidity





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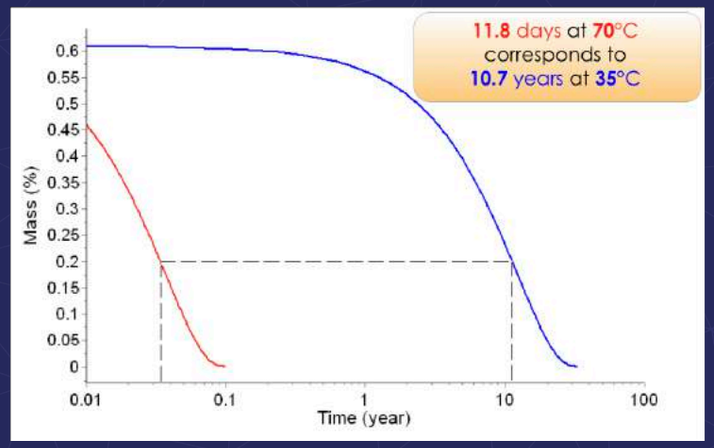
- The example we will consider today is an application developed for the surveillance of the ammunition, which can be used for various other elements.

Get the Shelf Life Right!

Simulated change of the stabiliser content at different temperatures
(How long can you store ammunition at a given temperature?)



AKTS

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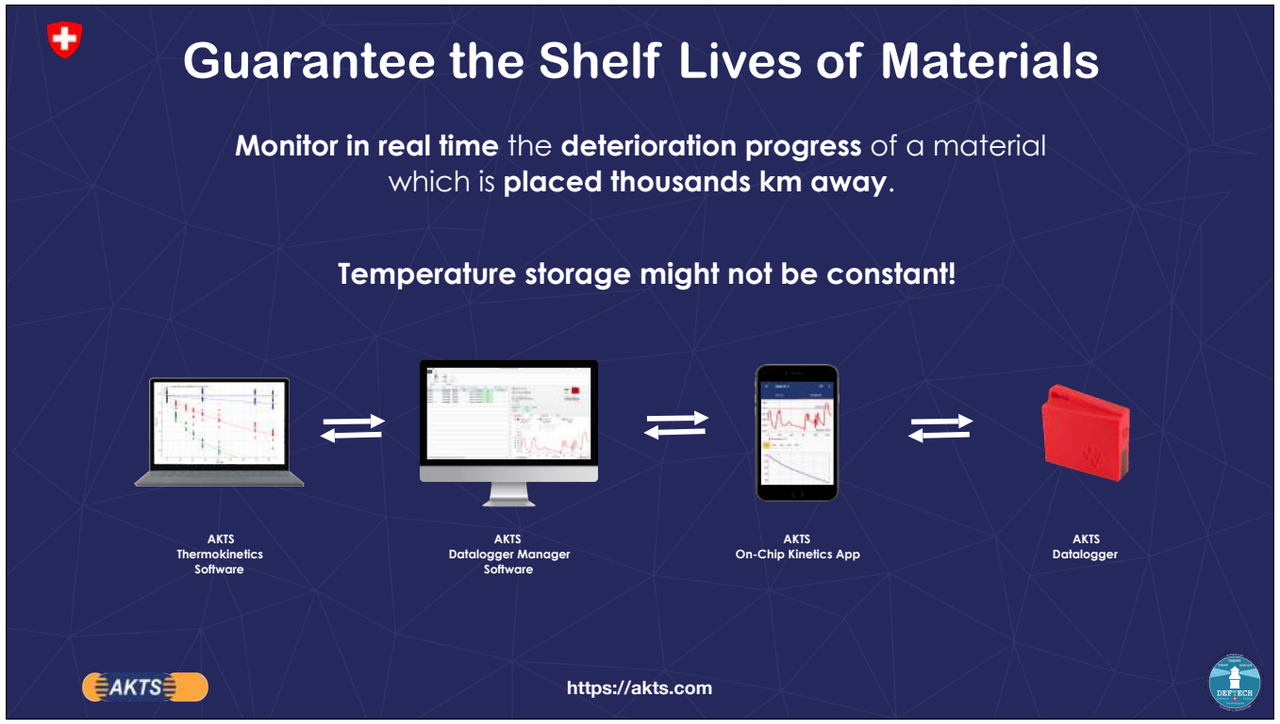
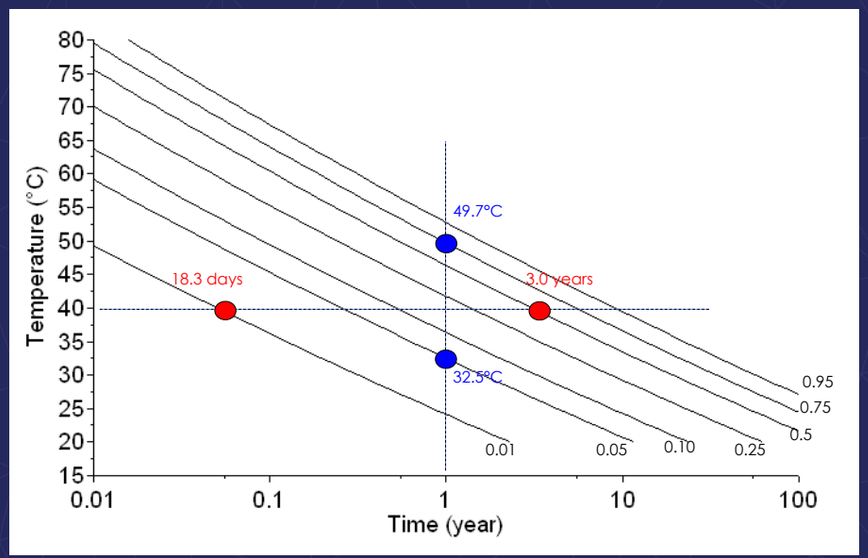
- The challenge when you have to store materials, is to know how long
  i) the quality of the material you have on the shelves remains acceptable under specified conditions and
  ii) the materials can be used without any restriction.
- The shelf life depends on the degradation mechanism of the product and is mainly influenced by the temperature, and the humidity present during the storage room
- We see here an example the influence of the Temperature on the process of the stabilizer depletion in the propellant used in some missile.



- How to monitor the shelf lives of different materials?
- We have developed an application to track in real-time the deterioration process of a specific material
- The challenge is especially important when the temperature of storage is not constant

TTT (Transformation Time Temperature) Diagram for HPLC* test



* HPLC : High-performance liquid chromatography

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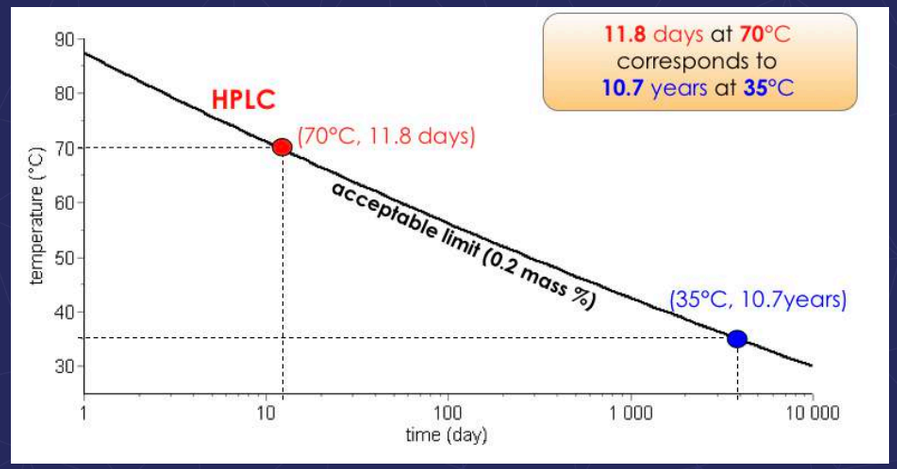
- Introducing the Transformation-Time-Temperature relationships
- At 40°C a reaction progress of 0.01 is reached after ca. 18 days and 0.5 after 3 years.
- After 1 year a reaction progress of 0.05 is reached at 32.5°C and 0.75 is reached at 49.7°C.

TTT (Transformation Time Temperature) Diagram for HPLC* test



Calculated from the **best** kinetic model applied for the **estimation of the shelf life**

* HPLC : High-performance liquid chromatography

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- For us let's consider that the acceptable limit of the stabilizer content is 0.2 mass %.
- This line presents the dependence between time and temperature for the acceptable limit of stabilizer depletion.

Kinetic Parameters to predict better!

CURRENT REACTION EXTENT	0.5					
SET TEMPERATURE	40	35	30	25	20	°C
REMAINING SL	1.5	3.6	9.3	24.5	67.3	yrs

Set the **temperature** according to the remaining Shelf Life

CURRENT REACTION EXTENT	0.5			
MAX TEMPERATURE	33.3	29.7	27.6	°C
SET REMAINING SL	05.0	10.0	15.0	yrs

Set the **remaining Shelf Life** and get the maximal temperature of storage

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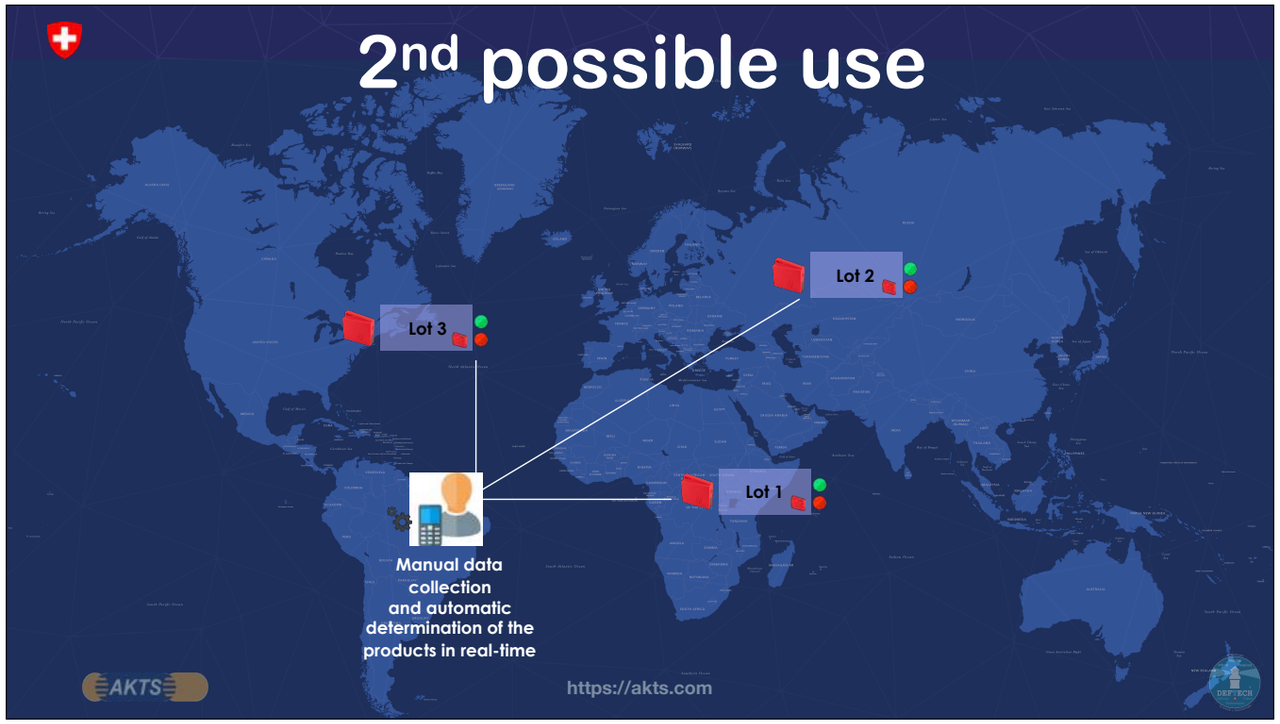
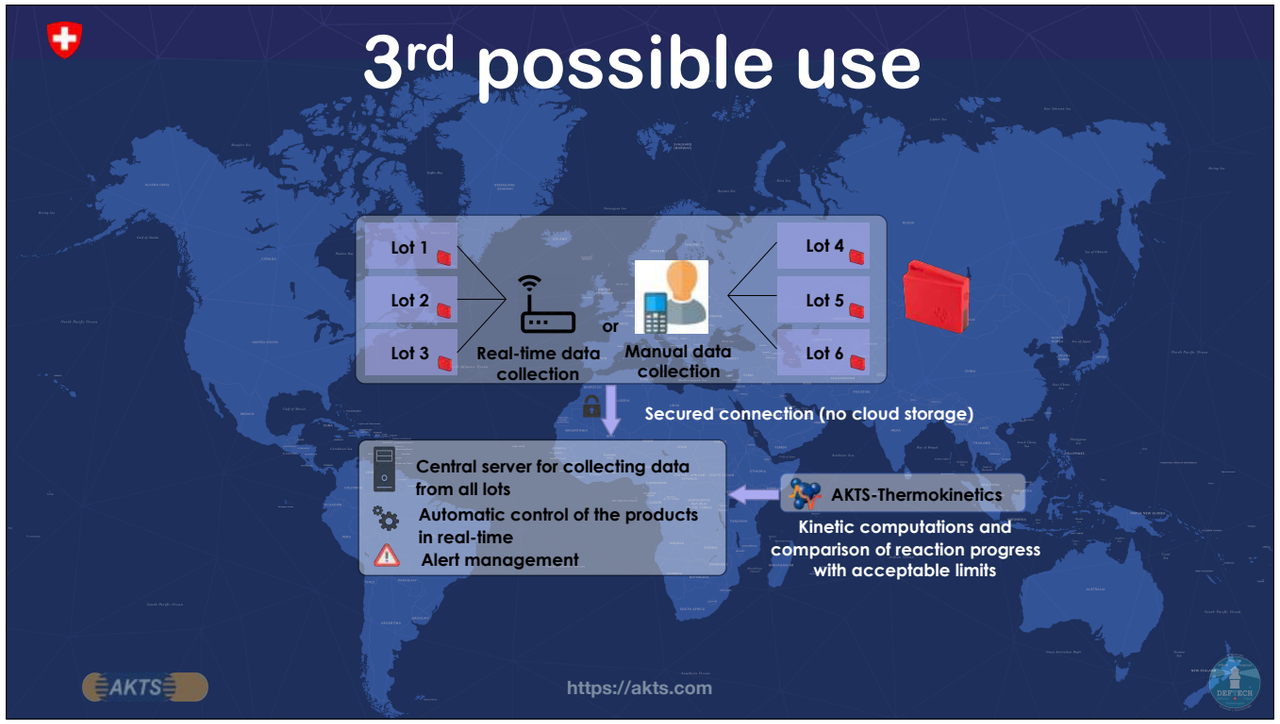
- The models developed using the specific Kinetic Parameters for every materials allow to consider 2 scenarios
  1. You can set the temperature of storage, and the remaining shelf life is evaluated : at e.g. 30°C the shelf life of the material amounts to 9.3 years.
  2. For the required shelf value one can determine the maximal storage temperature: if e.g. the shelf life should be 5 years, then the maximal storage temperature should not be higher than 33.3°C.

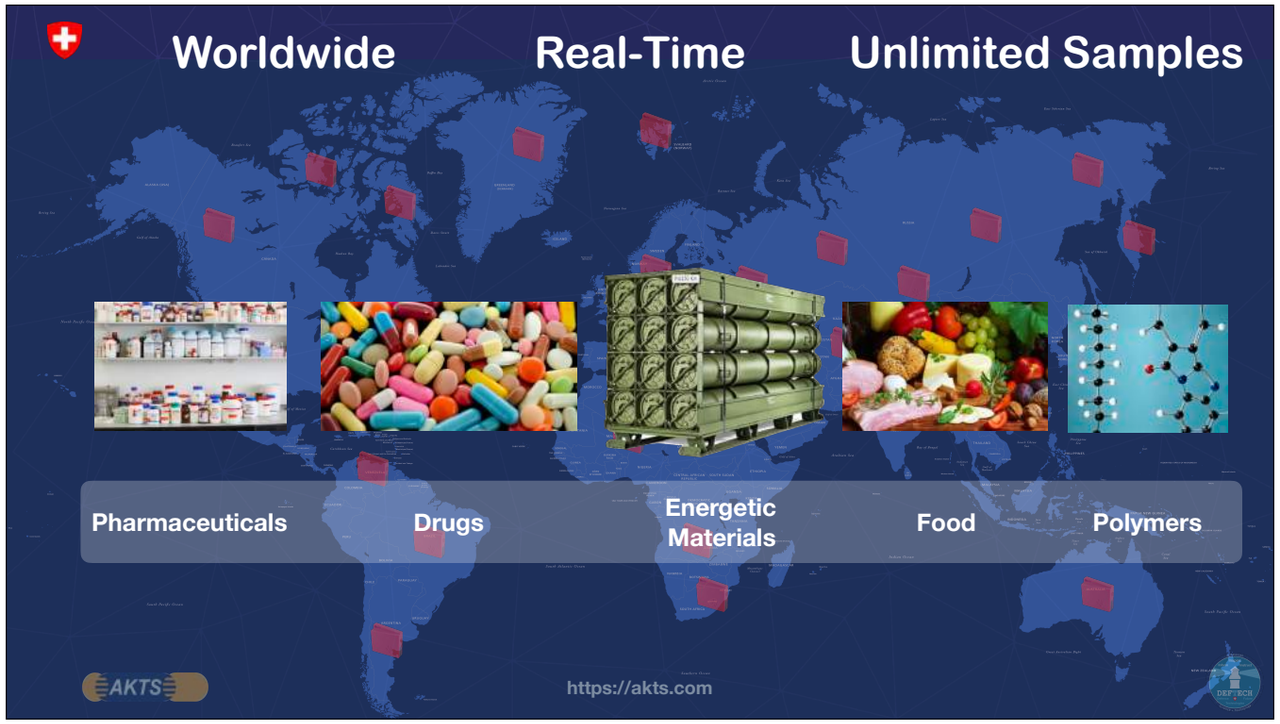

1st possible use
Lot 1
Automatic determination of the products in real-time. Displaying a LED information if product is safe or not safe.
AKTS
https://akts.com

2nd possible use



3rd possible use





- The product developed by the company AKTS allows to continuously monitor the shelf lives of unlimited materials, worldwide and in real-time, all from your mobile.
- This approach developed for energetic materials, can be applied for Pharmaceuticals, Drugs, Food, Polymers and numerous other materials, potentially saving significant amount of money (in case you want to destroy still usable materials) or reducing the risks in using them resulting from the overestimation of their the shelf live.

- I thank you very much for your attention and don’t hesitate to check our various publications and activities on https://deftech.ch or directly contact me at quentin.ladetto@armasuisse.ch