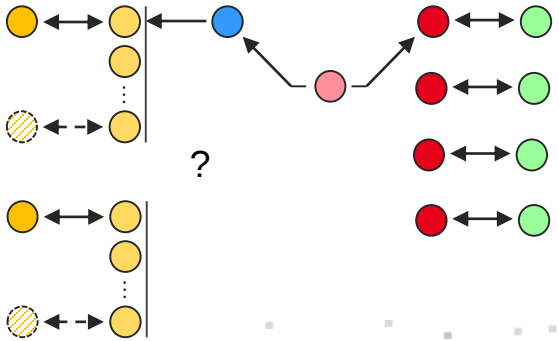


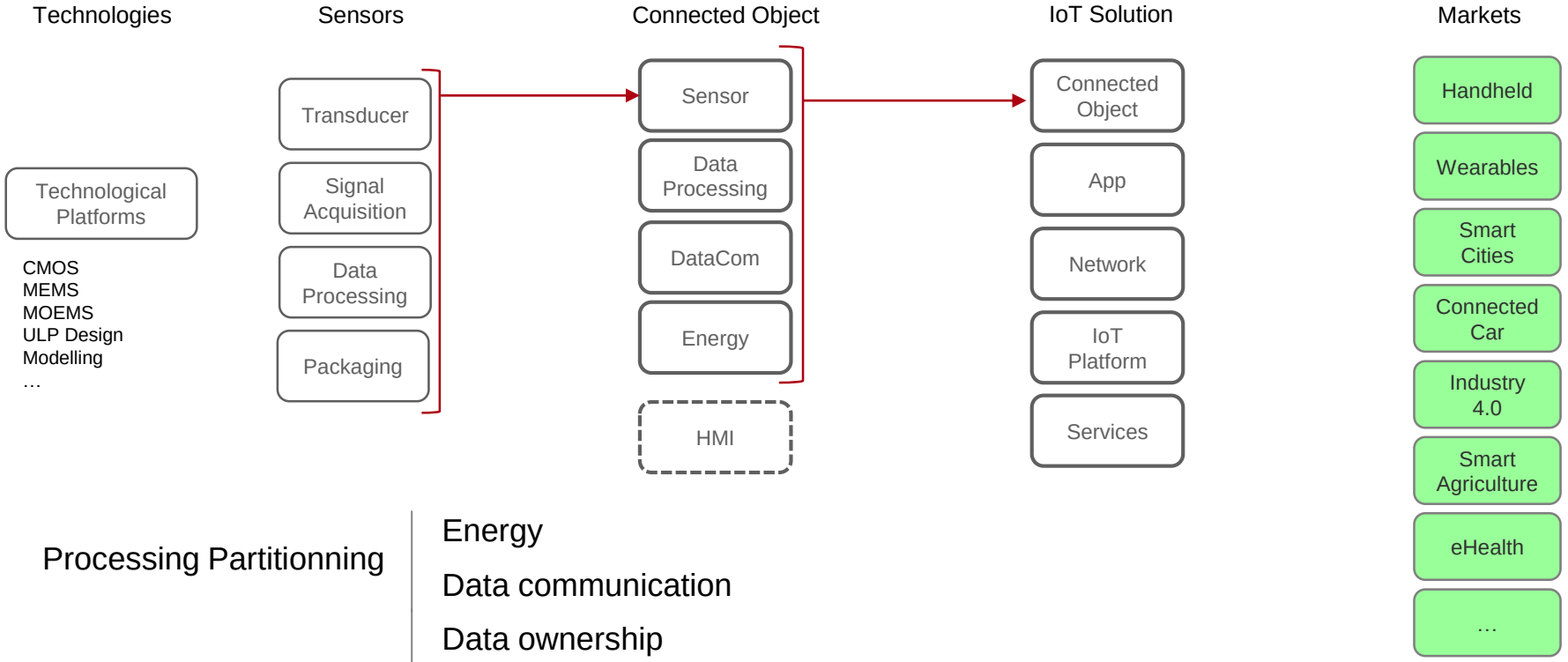
FROM SYSTEM PERSPECTIVE TO HARDWARE TECHNOLOGY INNOVATION

AGENDA

How to use a system level perspective to anticipate the right innovation for hardware technologies ?

- **Connected Sensors Value Chain Modelling**
- **Good practice proposal for System to Silicon Hardware innovation**
- **LETI Ultrasonic Sensor Value offer**

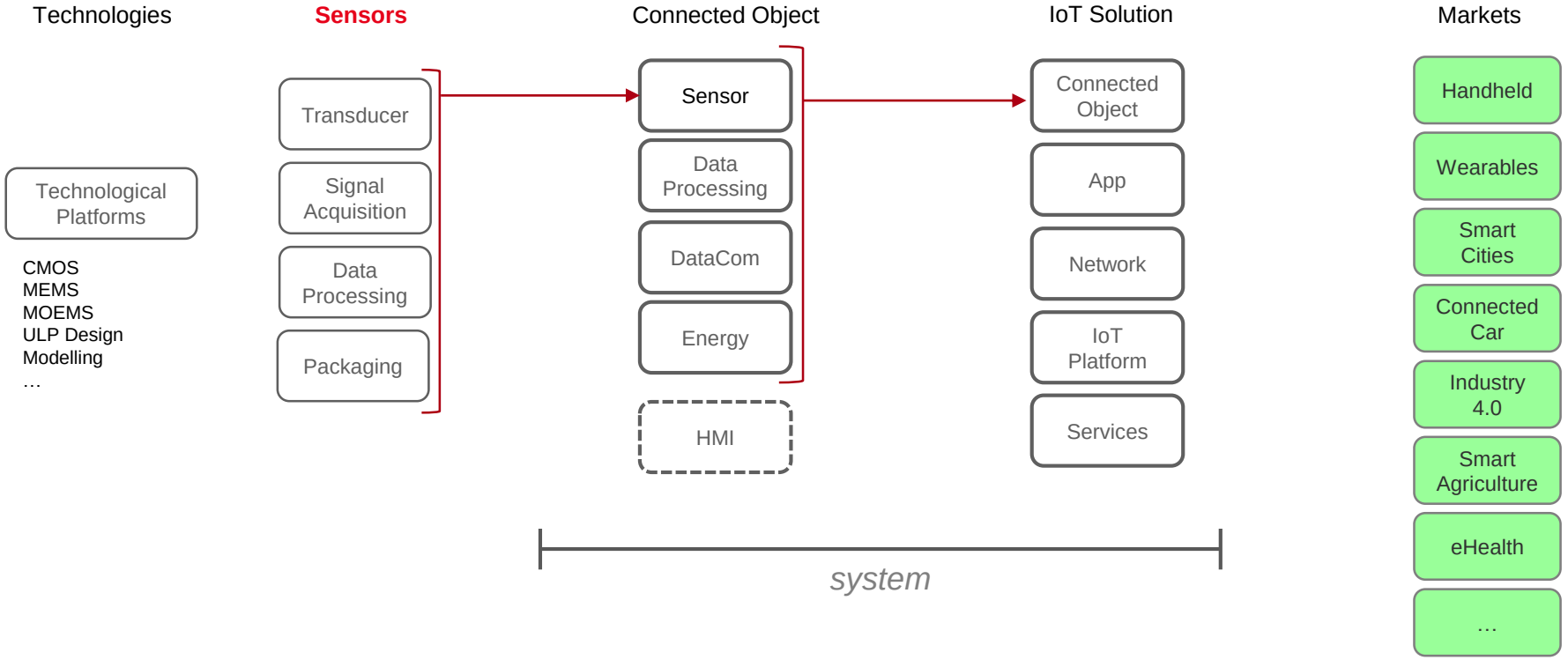
CONNECTED SENSORS - VALUE CHAIN AND MARKETS



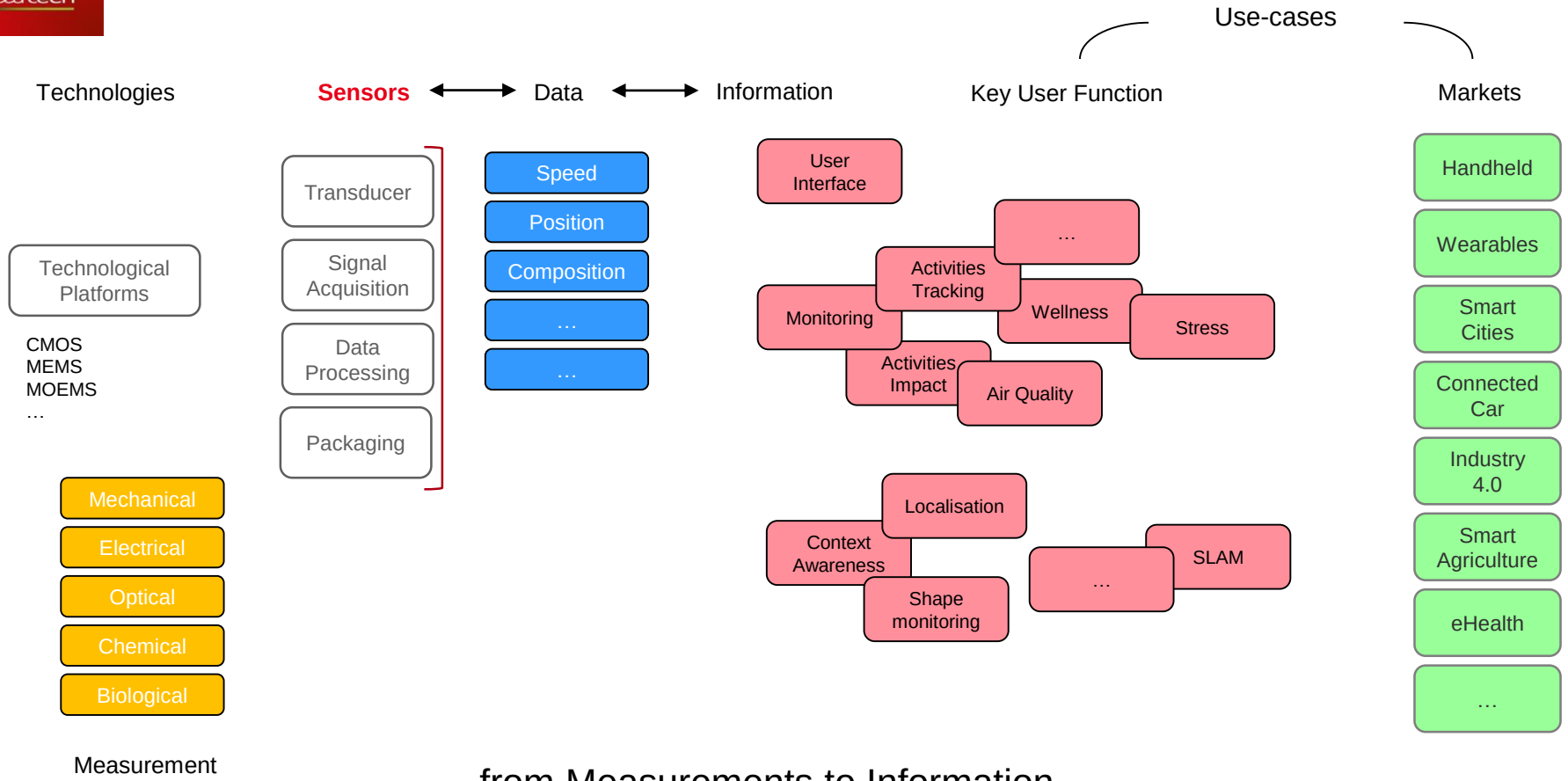
Processing Partitionning

- Energy
- Data communication
- Data ownership
- Privacy

CONNECTED SENSORS - VALUE CHAIN AND MARKETS



CONNECTED SENSORS

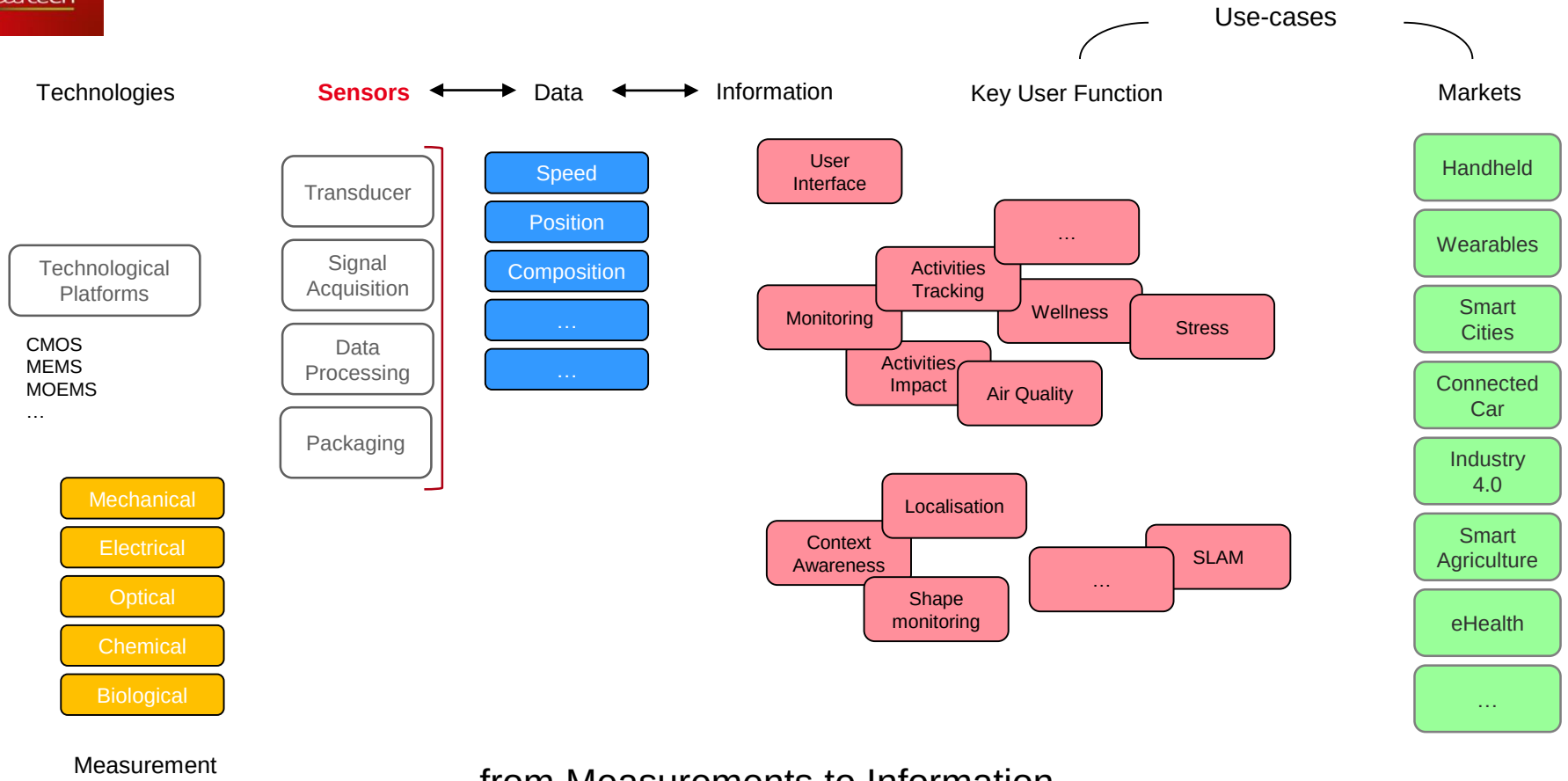


from Measurements to Information

AGENDA

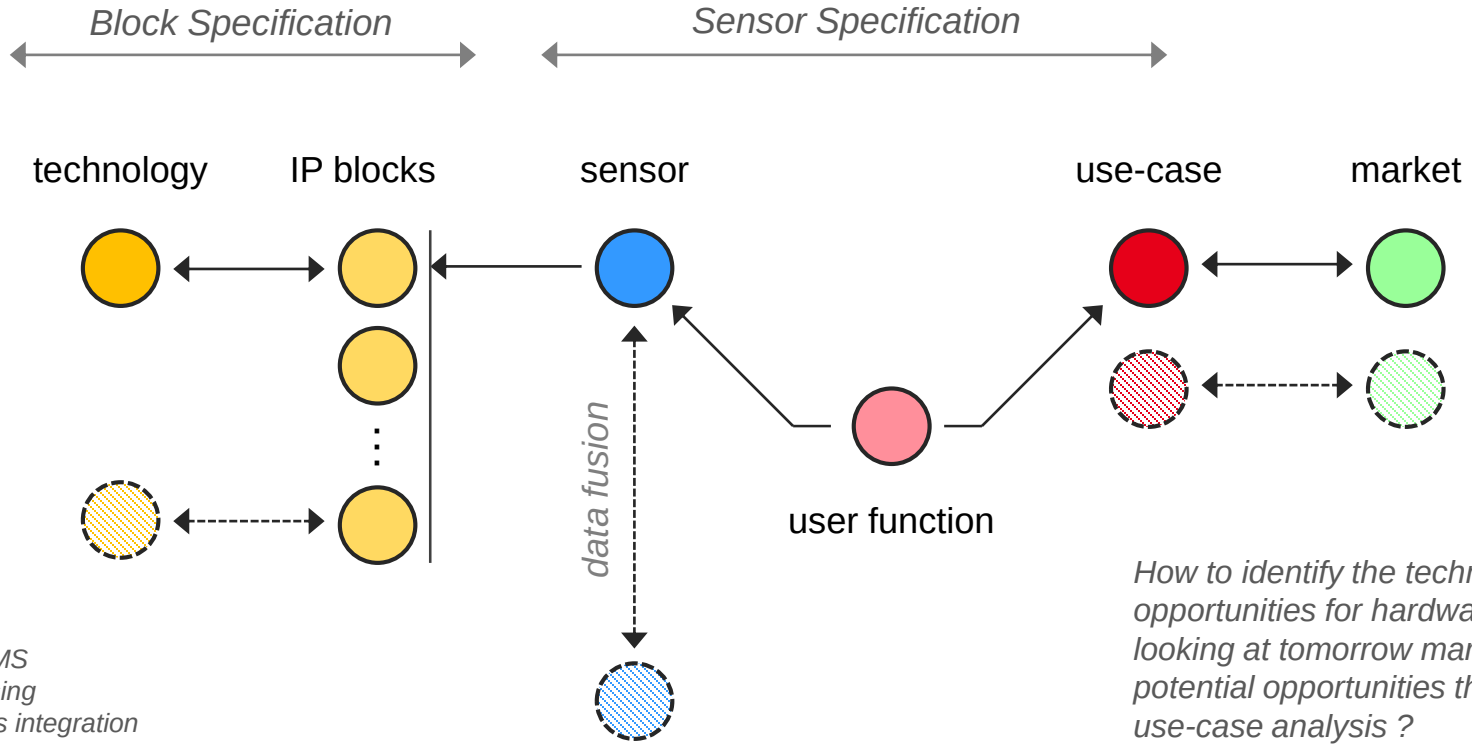
- *Connected Sensors Value Chain Modelling*
- **Good practice proposal for System to Silicon Hardware innovation**
- **LETI Ultrasonic Sensor Value offer**

CONNECTED SENSORS



from Measurements to Information

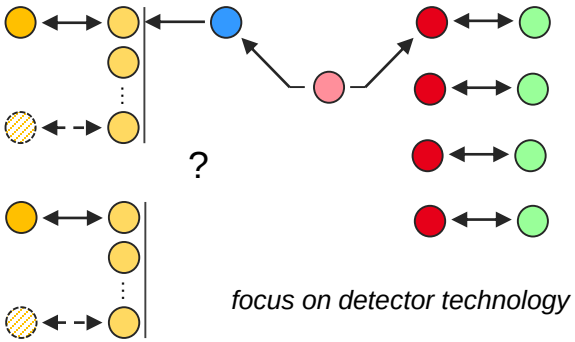
GOOD PRACTICE DIAGRAM



MEMS / MOEMS
Signal processing
Heteregeneous integration
Data fusion
…
Machine learning

How to identify the technological opportunities for hardware blocks looking at tomorrow market potential opportunities through use-case analysis ?

TECHNOLOGIES BENCHMARK - PM SENSOR



focus on detector technology

Air Quality

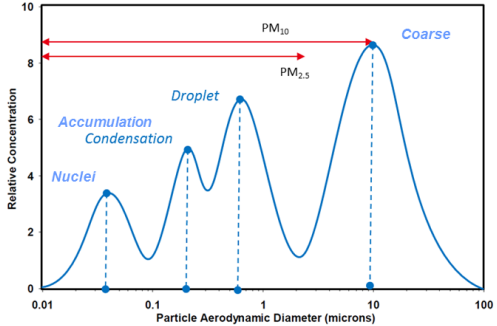
AQI

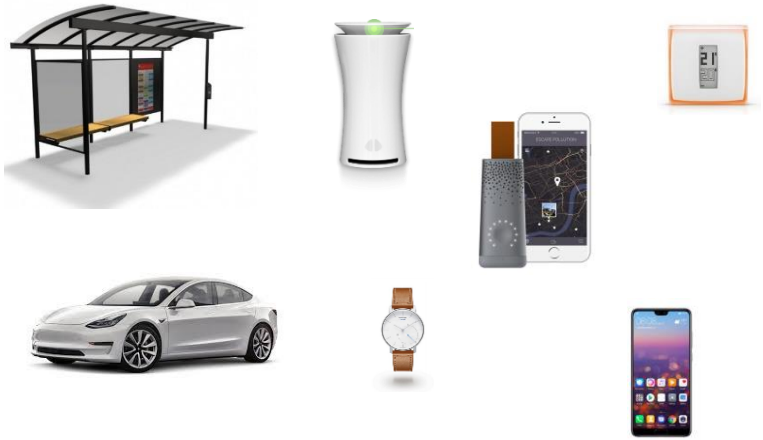
Particulates

- Range / Resolution / LOD
- Stability
- Time response
- Power Consumption
- Energy per Data / Sampling rate
- Size / Volume
- Cost

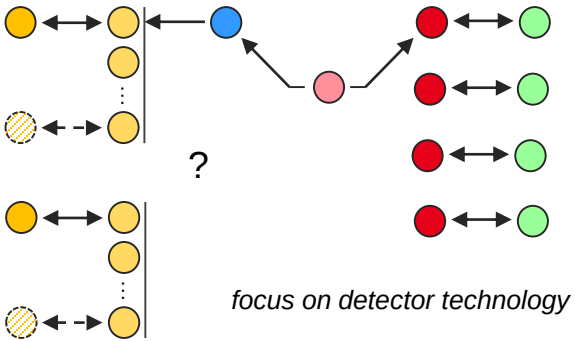
US - µg/m³ – 24h

PM2.5	PM10
12	54
35.4	154
…	
500	604





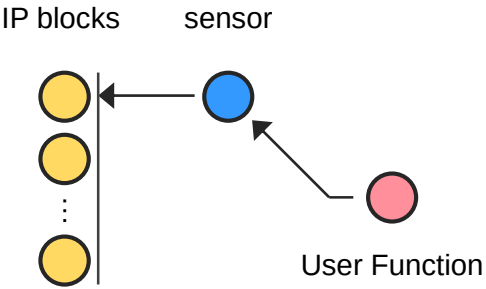
TECHNOLOGY BENCHMARK



focus on detector technology

- State of the art
- Key Use-cases Analysis

Market opportunities

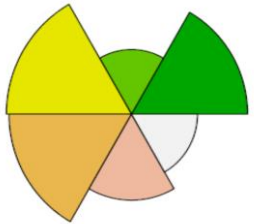


- sensor / blocks modelling

R&D Market opportunities

- Identification of the (6) main challenges
- Analysis of the (32) technologies

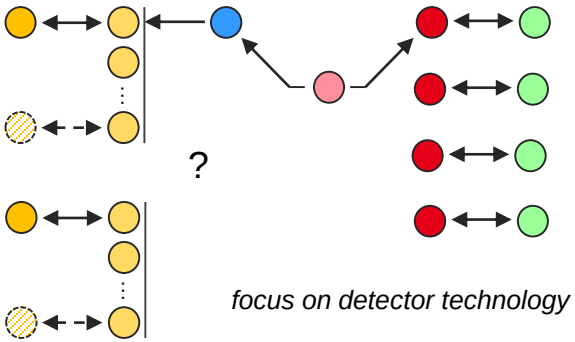
Technology rating on 6 challenges



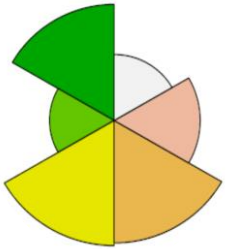
- Weight on each challenge

Technologies benchmark

TECHNOLOGY BENCHMARK

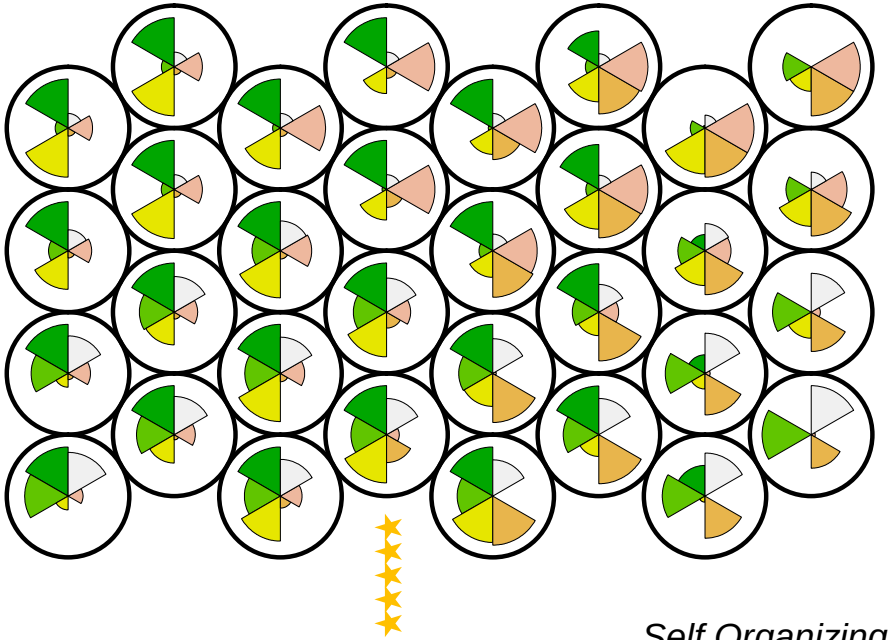


focus on detector technology



Technology rating on 6 challenges

Example of technology mapping

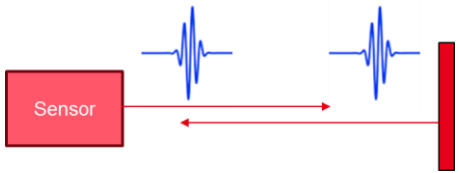


Self Organizing Map

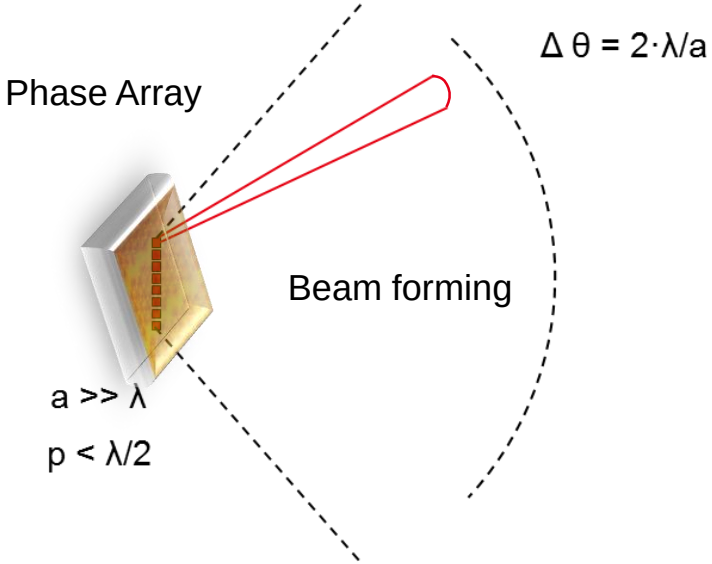
AGENDA

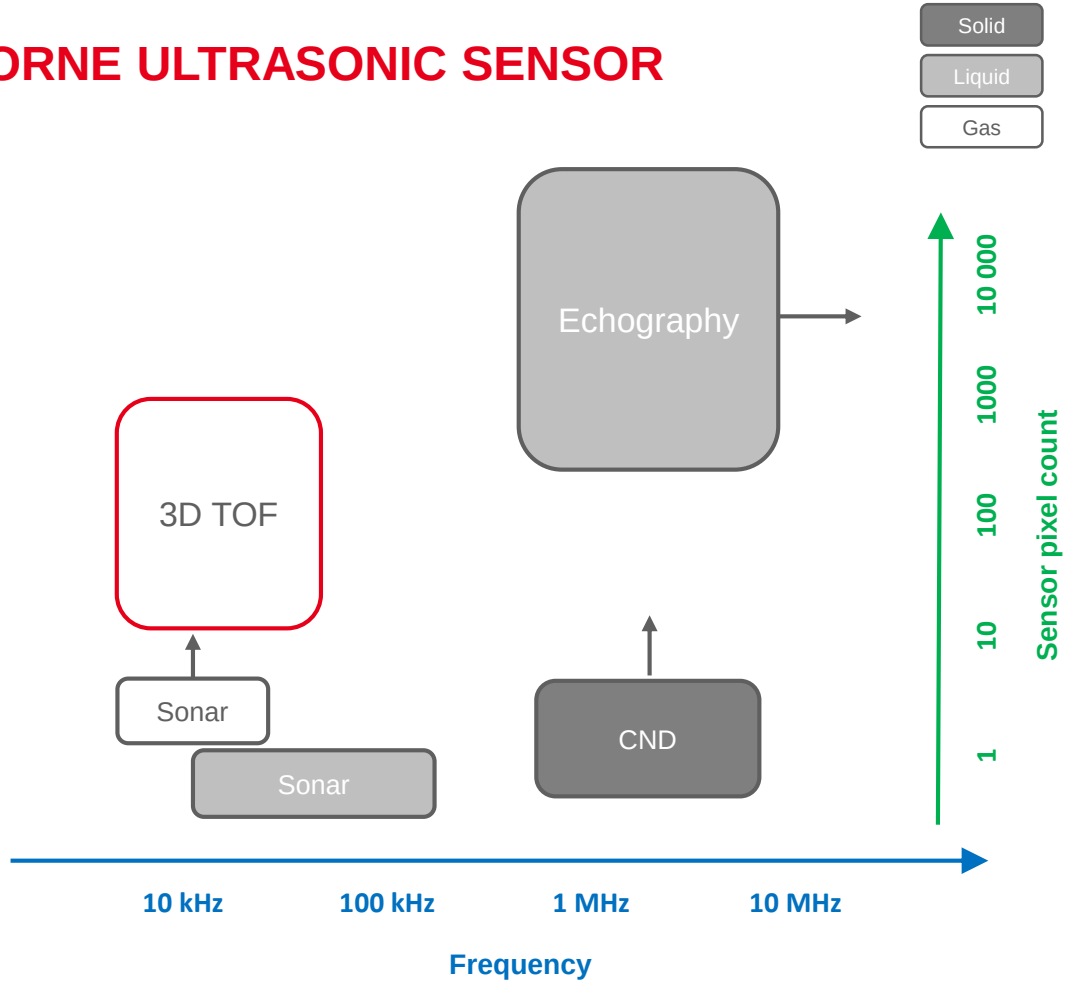
- *Connected Sensors Value Chain Modelling*
- *Good practice proposal for System to Silicon Hardware innovation*
- **LETI Ultrasonic Sensor Value offer**

OPPORTUNITY – AIRBORNE ULTRASONIC SENSOR



TOF





OPPORTUNITY – AIRBORNE ULTRASONIC SENSOR

ULP HMI

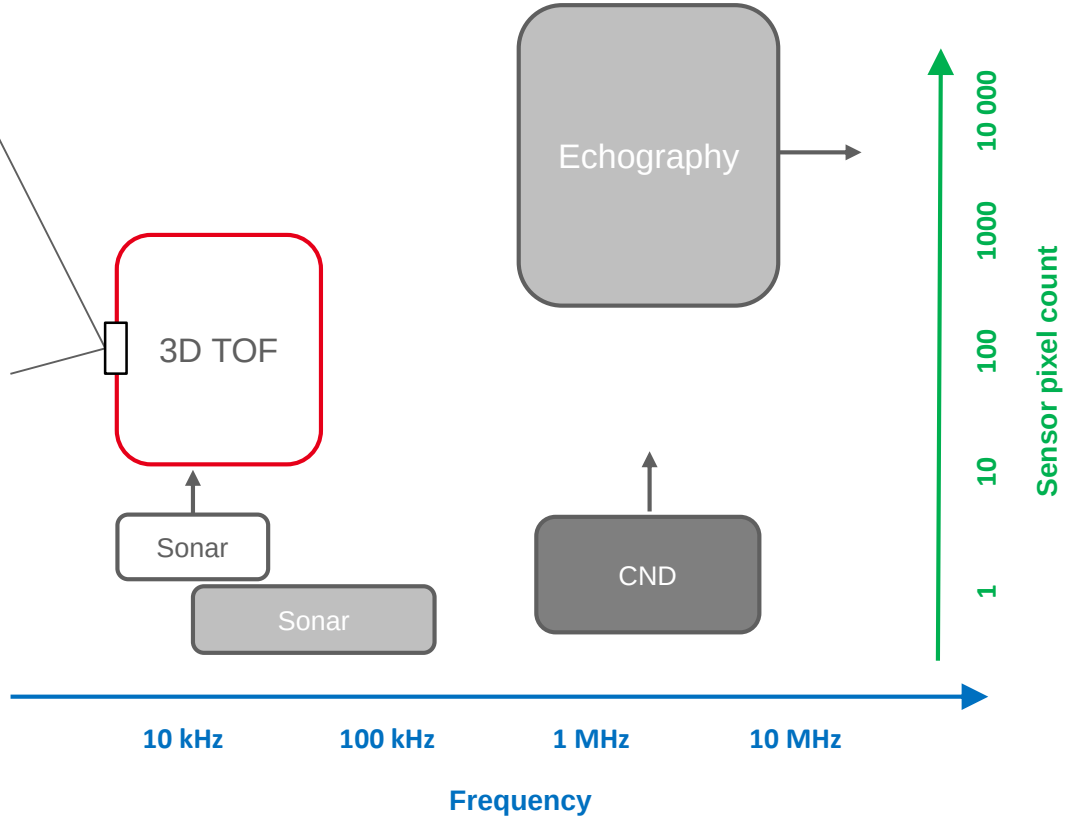
Parking Assist

Robotics

Home Robots

Drones

Augmented Reality



LETI ASSETS ON ULTRASONIC SENSORS

Tx

- Wave form
- Beam Forming
- Transducer

Acoustic signal propagation and back scattering

Rx

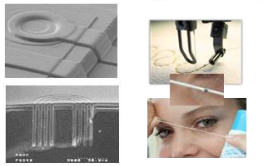
- Transducer
- Signal acquisition
- Beam Forming
- Filtering
- Data Processing
- Grid calculation

Transducer & Packaging

Material | MEMS MOEMS | WLP - SiP | Housing

Material integration
Layer transfer
Meta materials

3D Toolbox
Hermetic Si packaging
Two wires packaging



3D SOI MEMS
pressure sensor
high perf. Gyrometer
cMUT

NEMS resonator
gaz detector
spectrometer for biology
µbolometer
cellular force sensor

Optical sensing
ULP NDIR sensor
QCL on Si

Electrochemistry
sweat monitoring
ionic sensors

Microfluidic
µGC - µTCD - concentrator
gaz analyser
liquid analyser

piezoMEMS
pMUT array
haptic plate
piezoelectric scanner
digital loud speaker

M&NEMS
accelerometer / magnetometer
gyrometer
pressure sensor
microphone


6 DOF sensor

Signal Processing & Data analysis

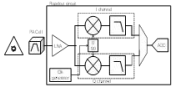
ADC | MUX | Modeling | Data Fusion

Event driven detection
Compress sensing
Custom ADC
Very High Speed Multiplexer
Analog to Information Conversion

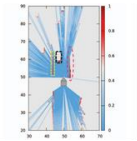
Sensor modeling
Polymodal sensing
Database quality assessment

Particle filter
Crowd sourcing

Low Power algorithms
Algorithms benchmark


Fully integrated digital output lock-in amplifier


Magnetic positionning (ISKN)


ULP Occupancy Grid

- Piezoelectric material integration on 200 mm wafers
- MEMS state of the art 200 mm line
- Strong background in phase array system
- Unique experience in imagers – from pixel to image analysis
- Assets in data fusion
- Embedded Software expertise

LETI CO-INNOVATION PROPOSAL

Tx

- Wave form
- Beam Forming
- Transducer

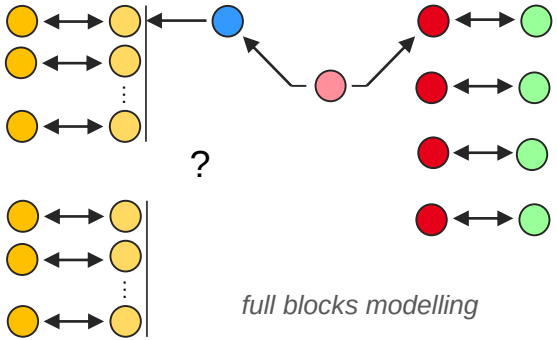
Acoustic signal propagation and back scattering

Rx

- Transducer
- Signal acquisition
- Beam Forming
- Filtering
- Data Processing
- Grid calculation

Use-case Experimentation

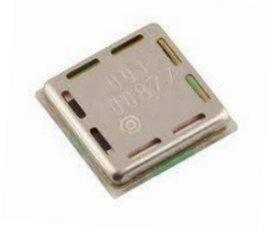
System Optimization



full blocks modelling

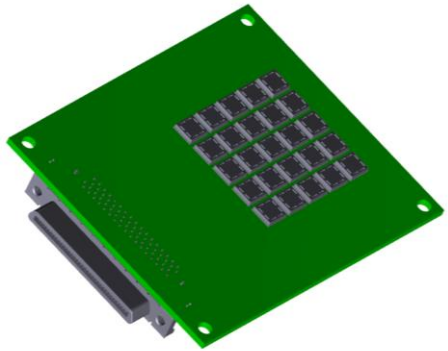
(Integrated) Demonstrator

Murata 40H1S-R
Surface Mount Ultrasonic Sensor



5 x 5 mm^2 – 40 kHz

5 x 5 array – Emission - Reception
Software defined beam forming



SUMMARY

- **Presentation of a good pratice proposal**
  - Innovation based on use-cases analysis
  - Identification of the relation between IP blocks and sensor specification
  - Example on PM sensors

- **LETI ultrasonic sensor value offer**
  - Strong background in key technologies
  - On-going demonstration of fully integrated solution
  - Use-case experimentation … Come to innovate with us

- **And we also a lot to propose on other sensor technologies !**

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