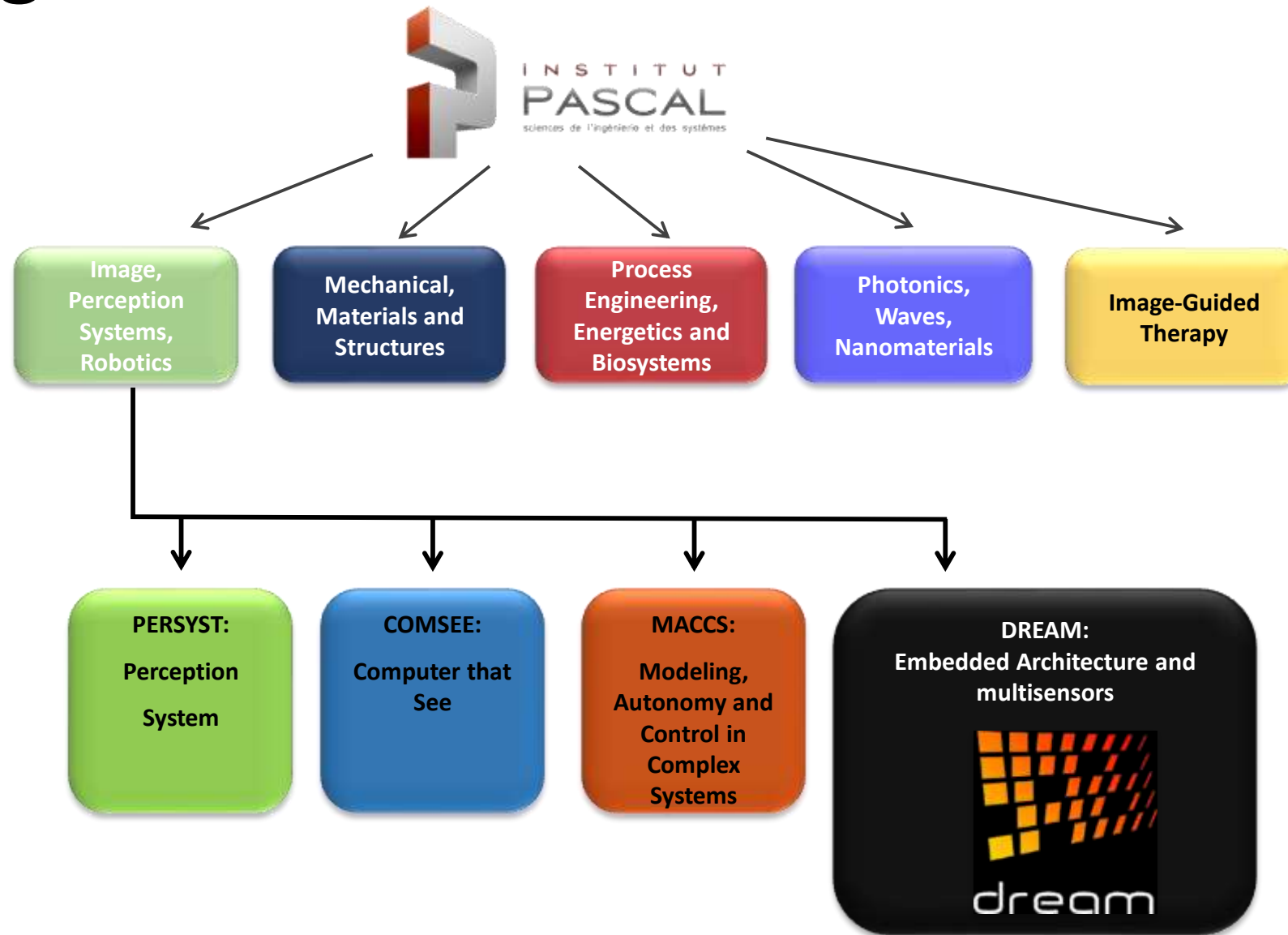




Ultra-distributed networked cameras

Lobna Ben Khalifa, François BERRY

Organization





Our team in a nutshell

Design Hardware and Software tools for Embedded Perception



Hardware

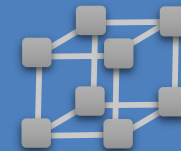
Smart camera, Multisensor, Sensors Network, Embedded systems, Many-core architecture



Specific hardware architecture for vision and multisensing

Software

Methods and tools for Language for High-Level Synthesis (HLS), Codesign, Parallel architecture



Fast prototyping of Applications on Dedicated HW

Smart Camera research group

OmniMOS



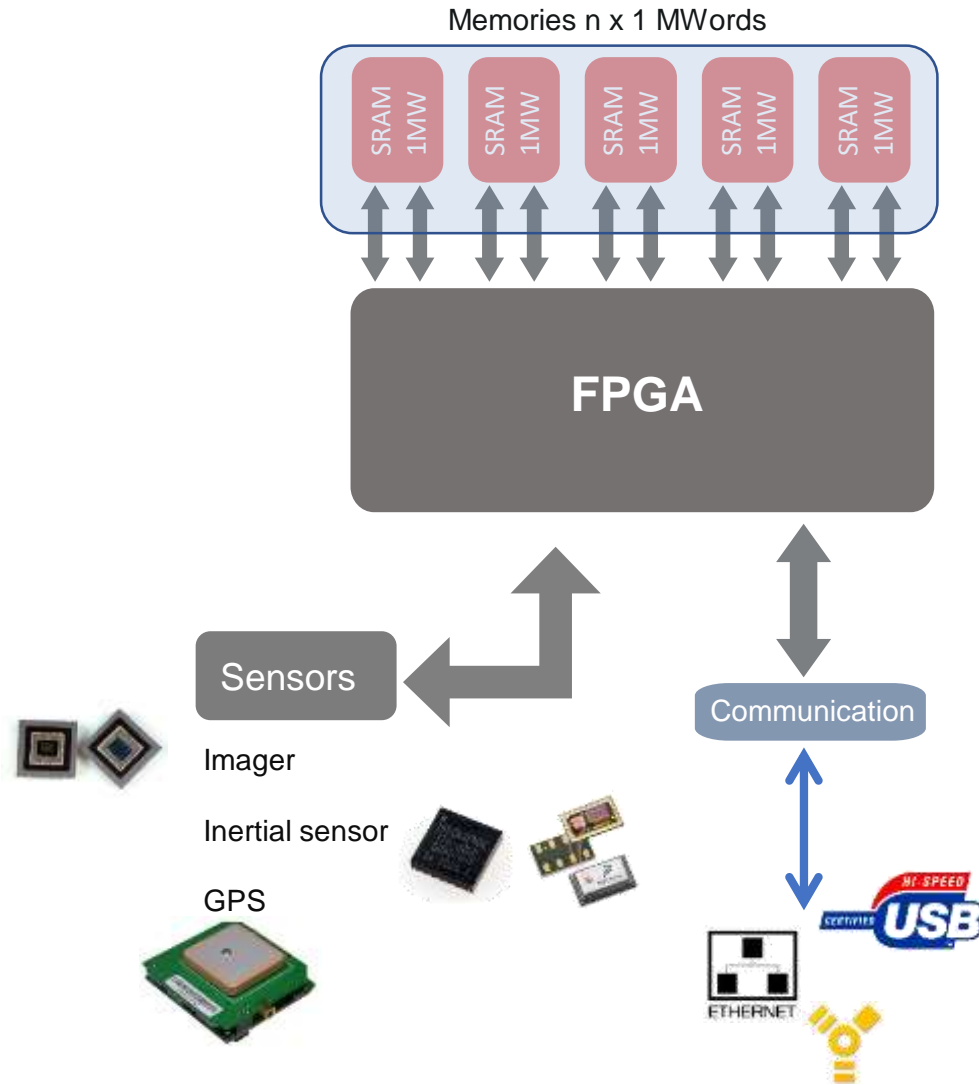
BiSeeMOS



PanaMOS

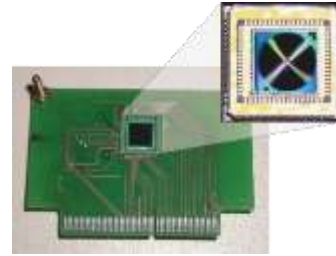


DreamCam



Smart Camera research group

OmniMOS



BiSeeMOS



a) Left Frame



b) LoG Frame



c) Depth Frame



d) Depth Frame with a Threshold of 64/120

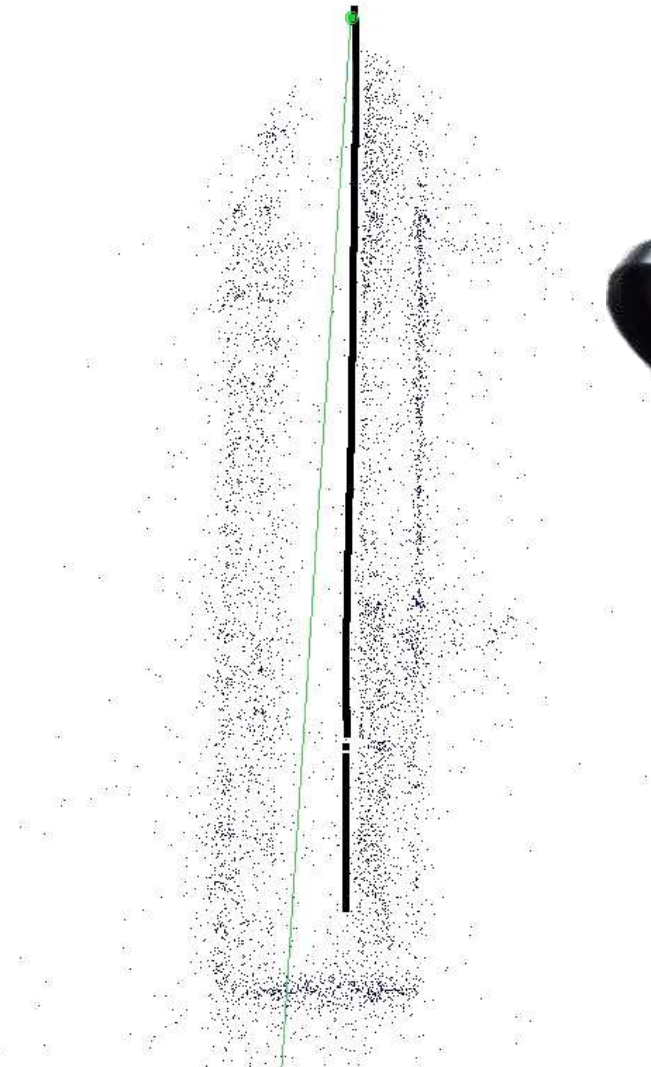
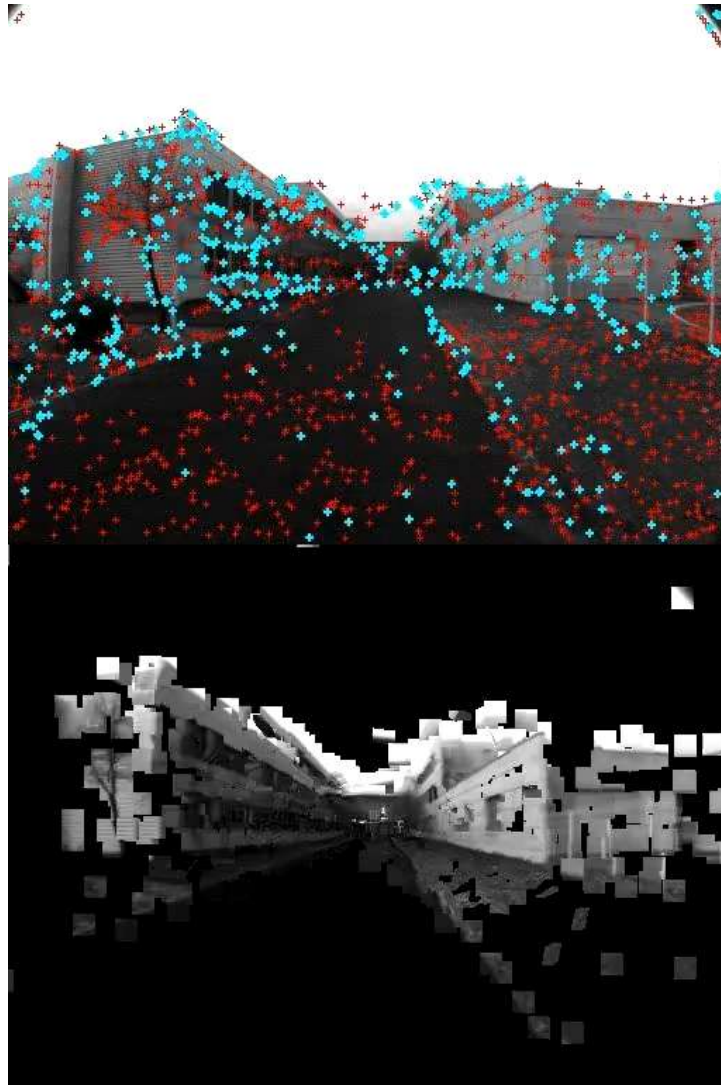
PanaMOS



DreamCam



Embedded features extraction



Cameras are ubiquitous

Advantages of Networking:

- Enlarged Field of View,
- Resolve Occlusions,
- Redundancy,...



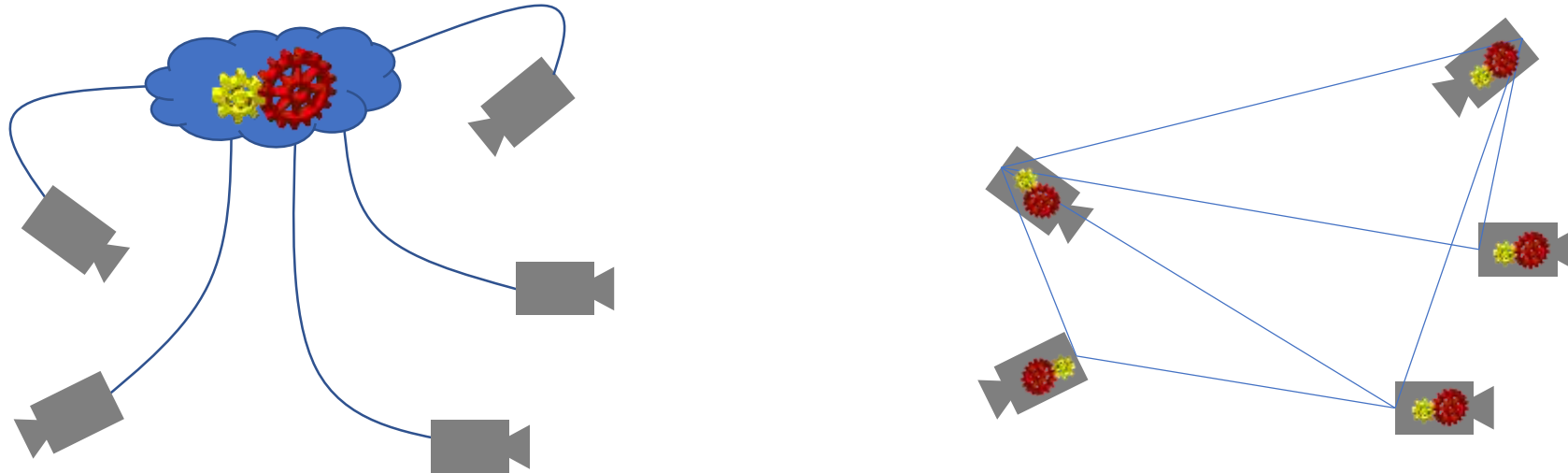
Challenges:

- Amount of Data
- Energy & data processing
- Structure (calibration,...)

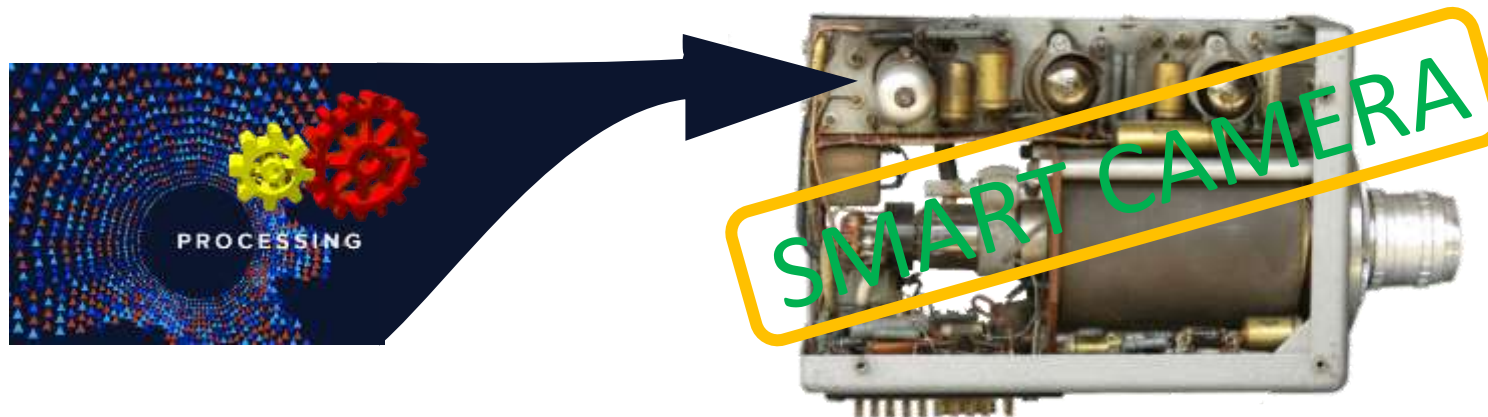


Edge-computing with smart cameras

Move computing from computer (or cloud) to sensor (edge)



Transferring data (much) more expensive than processing it



Advantages of distributed smart cameras

- **Scalability**

- no central server as bottleneck



- **Real-time capabilities**

- Short round-trip times... “active vision”



- **Reliability**

- High degree of redundancy



- **Energy and Data distribution**

- Reduced requirements for infrastructure; easier deployment?

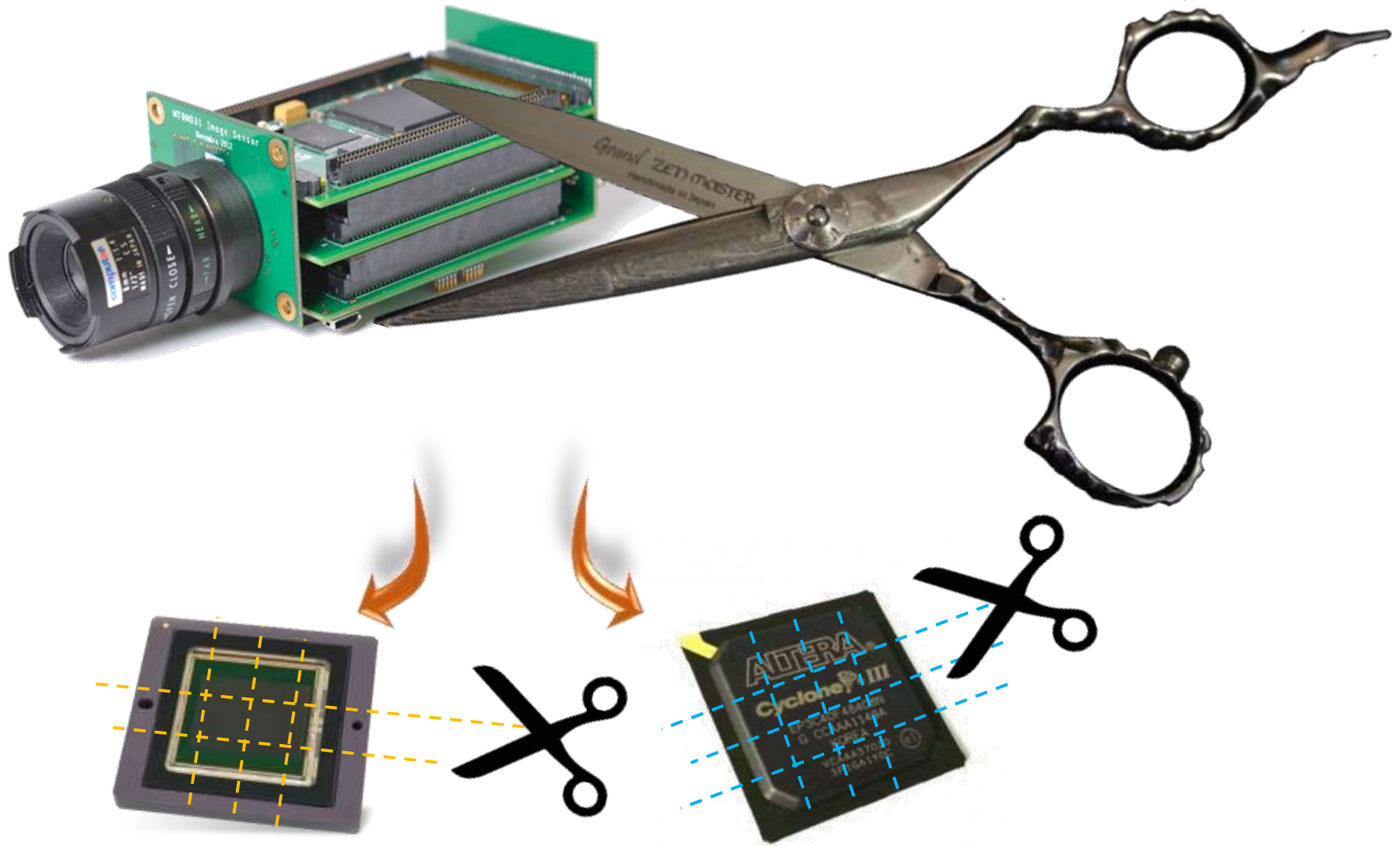


- **Sensor coverage**

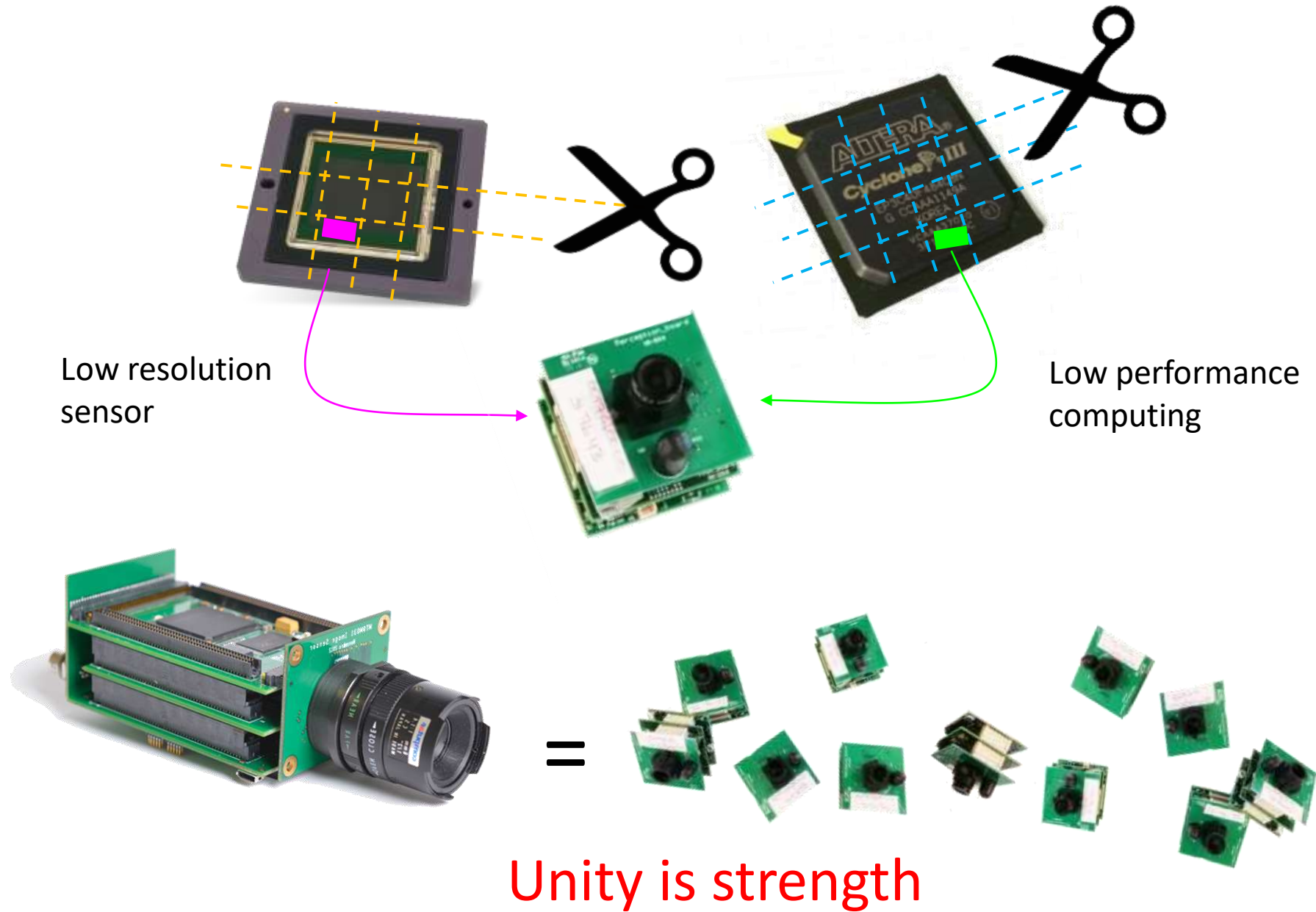
- Many (cheap) sensors closer at “target”; improved SNR



Smart camera to tiny smart camera



Smart camera to tiny smart camera



Tiny Cam anatomy



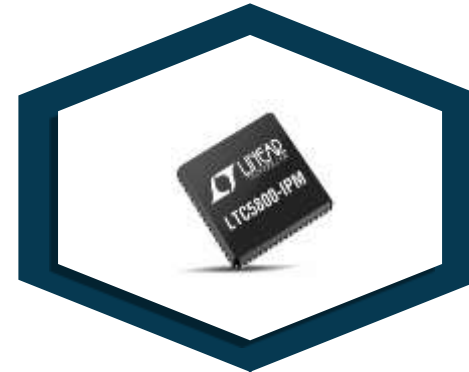
Max10 From Altera
Cortex M3

Processing level



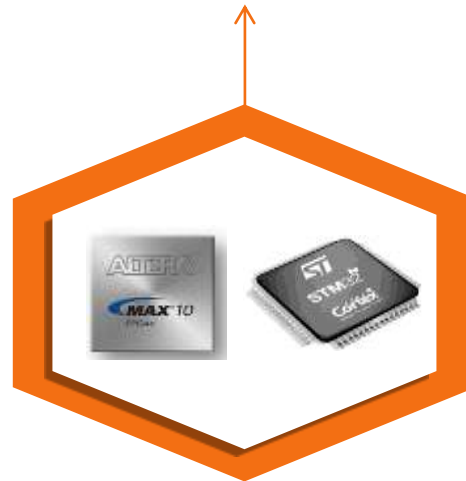
- ADNS3080 from Avago
- 30*30 pixels/ 5fps
- AMN from Panasonic
- Detection distance 10m

Sensing level



- Ultra low power
- 802.15.4 + Ipv6 ready
- Multihop

Communication level



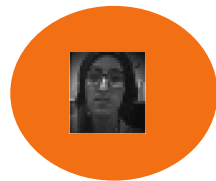
Ant world and Network of motes



Mote is an Ant-cam

Ant-Cam features

Low resolution



Light processing

Talkative

Ant-cam discussion: Pheromone analogy

- Each event (on a cam) is broadcasted in the network
- An event is a visual modification in the scene
- Broadcasting is :



★ Visual features

Eigen-vectors on grayscale images



★ Temporal information

Detection time or time needed to move from one camera to another



★ Spatial information

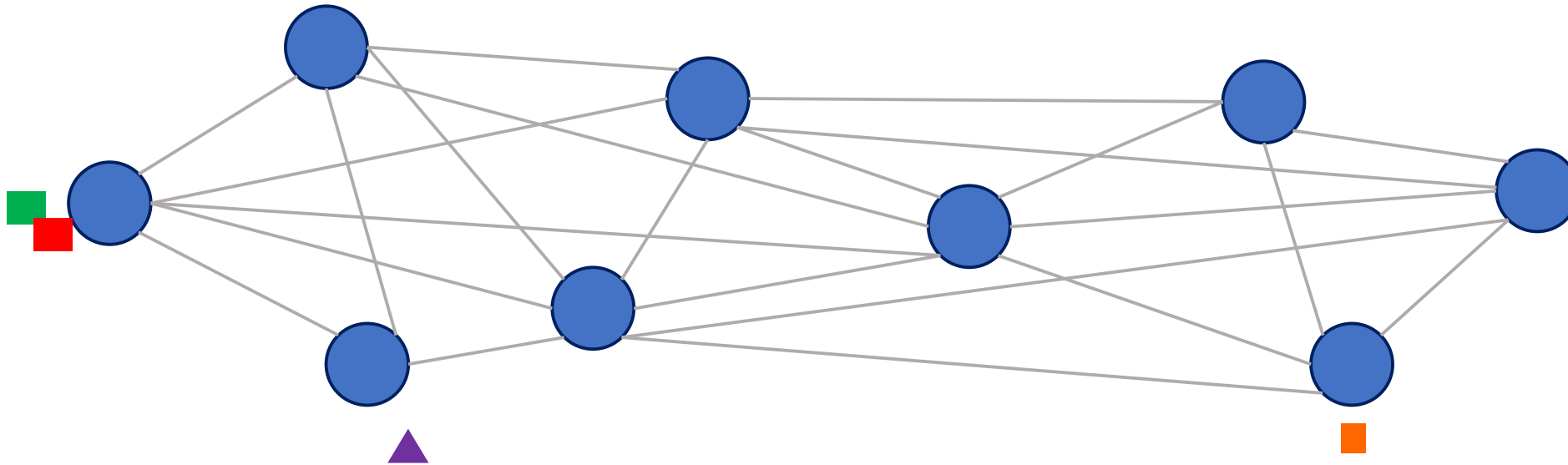
Path through the network followed by the path



Event-based self organization

2 stages:

- Unsupervised learning of events consistency

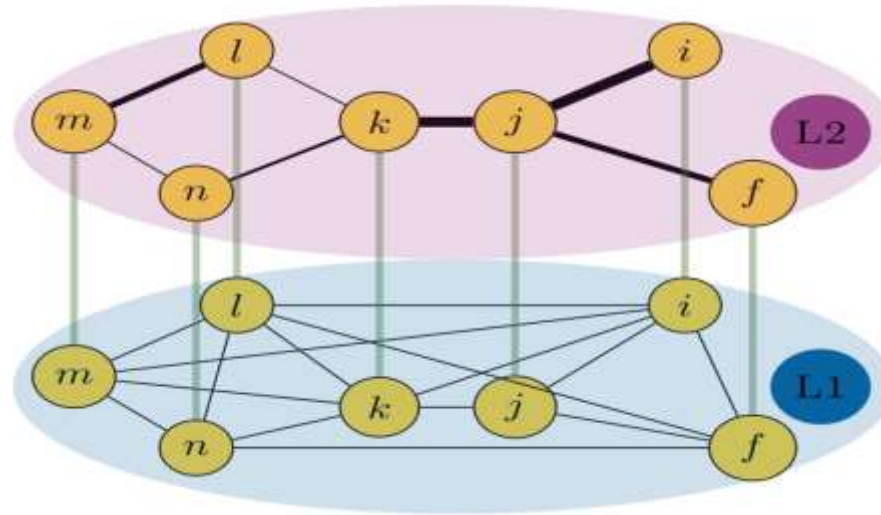


- Creation of an ontology for tracking, detection,....

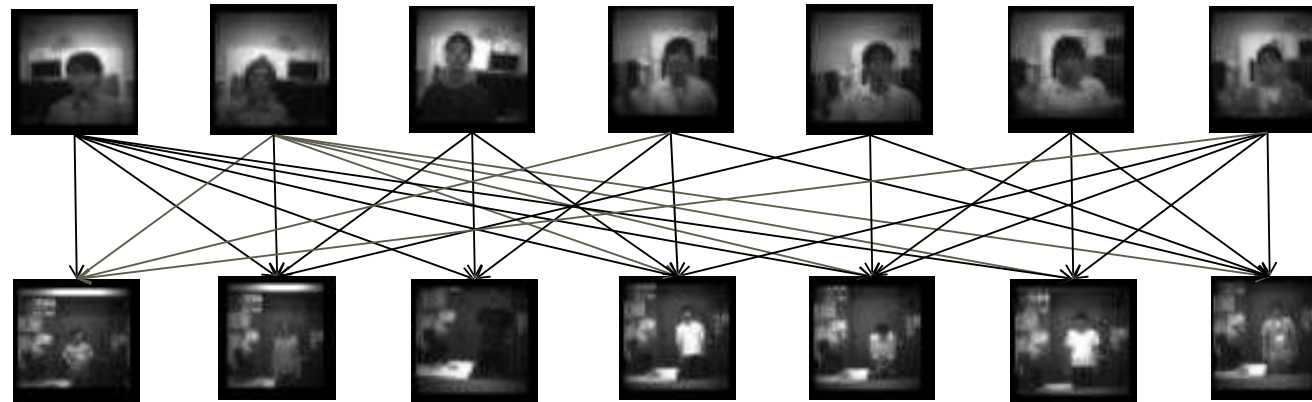
Challenge of this approach: Make the best re-identification!

Network of ant-cam

Events-based
connectivity graph



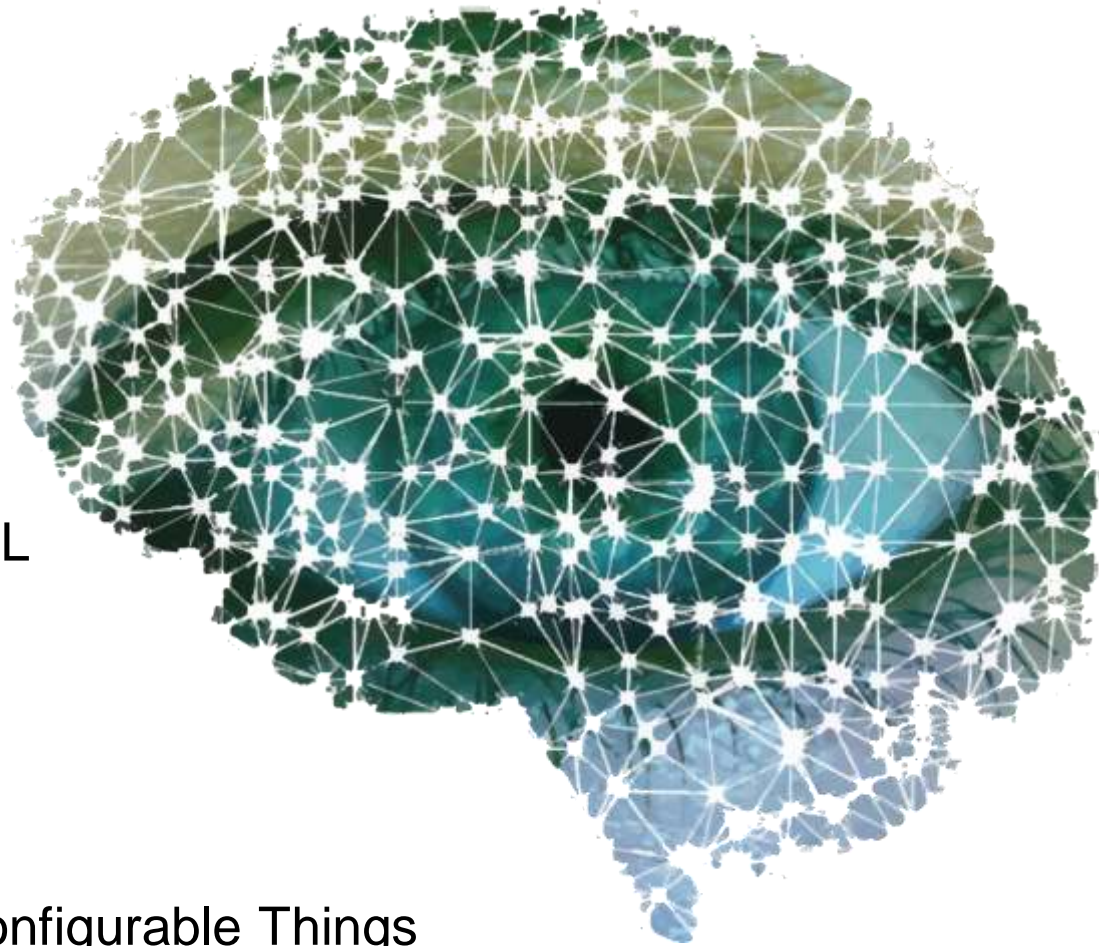
Technology-based
graph
(Wifi, LoRa..)



90% of good re-identification !!!

Future works...

- Deploying a deep neural network through the motes
- Each mote is a sensor AND a processor
- Revisiting of distributed computing in the context of DL
- HW reconfiguration of the motes through the network
- Self-reconfiguration of mote: towards Internet of Reconfigurable Things





ANY QUESTIONS?