Trend and Analysis of Vision Intelligence and ANN Intelligence Processor

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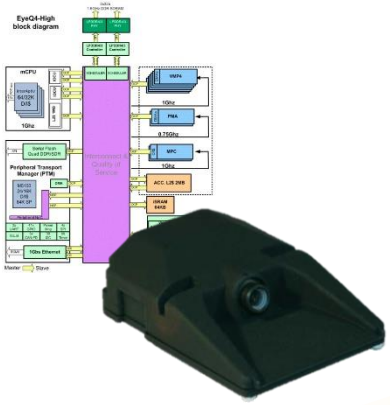
Vision Perception is Crucial

New era of “fast” Automotive Processor... but, is our current technology sufficient to provide *Safety in Self-Driving*?

Google: 3D Scanning with Ridar and map-based self-locating

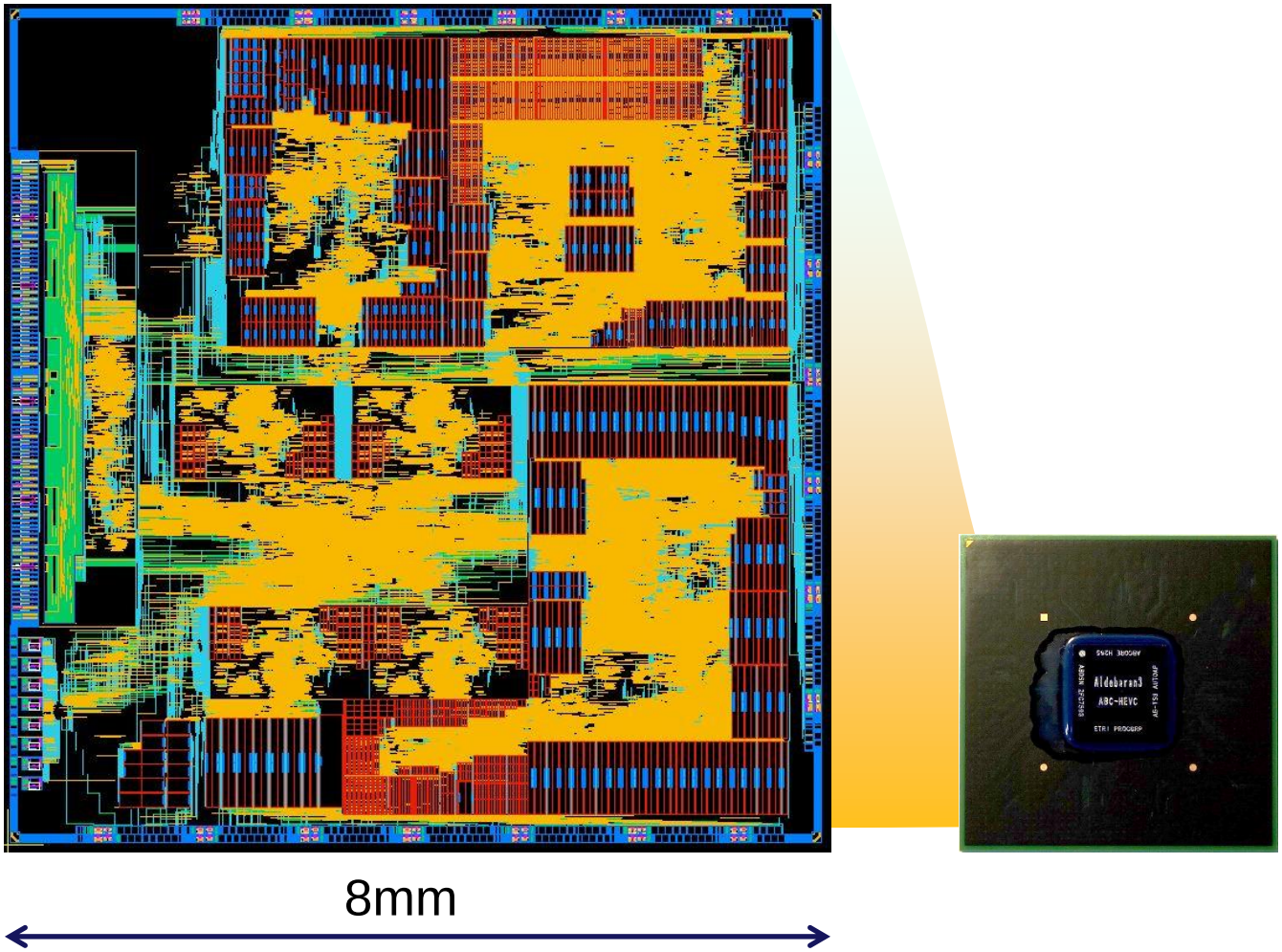
Tesla: Single-lens object detection with Mobileye



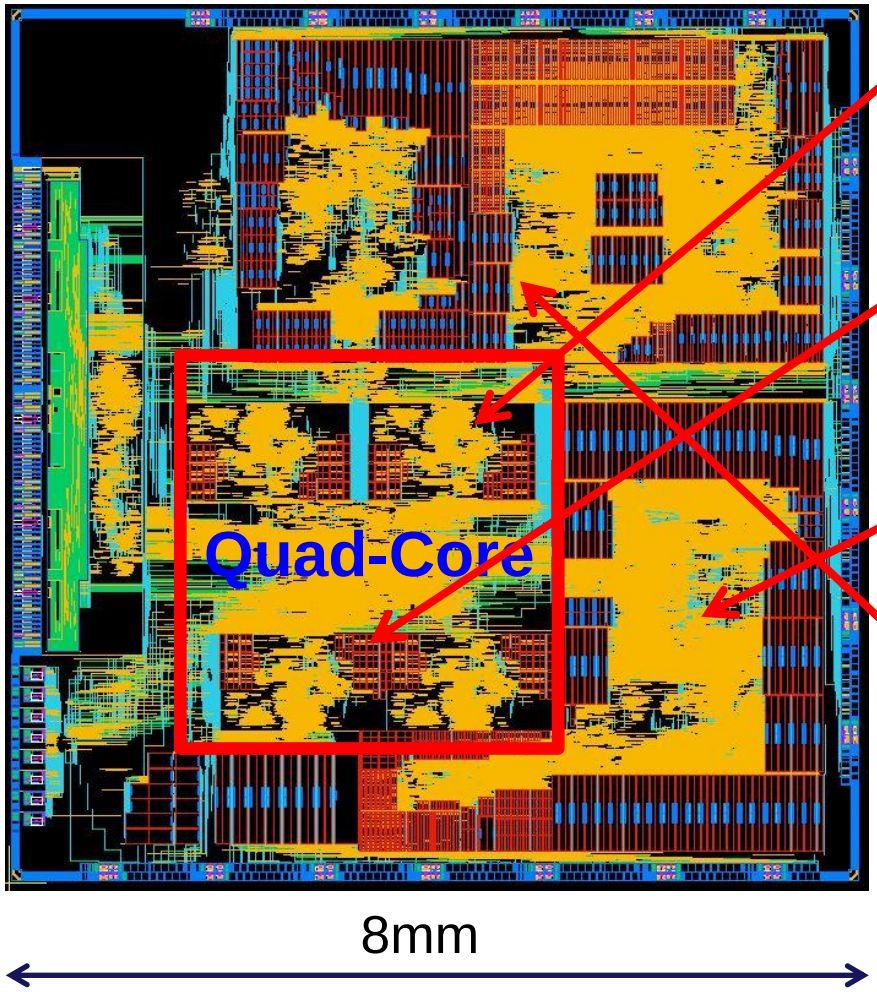
Mobileye EyeQ4

AUDI zFAS with NVIDIA K1

Aldebaran3: ISO26262-Compliant Vision Processor



Aldebaran3 Features



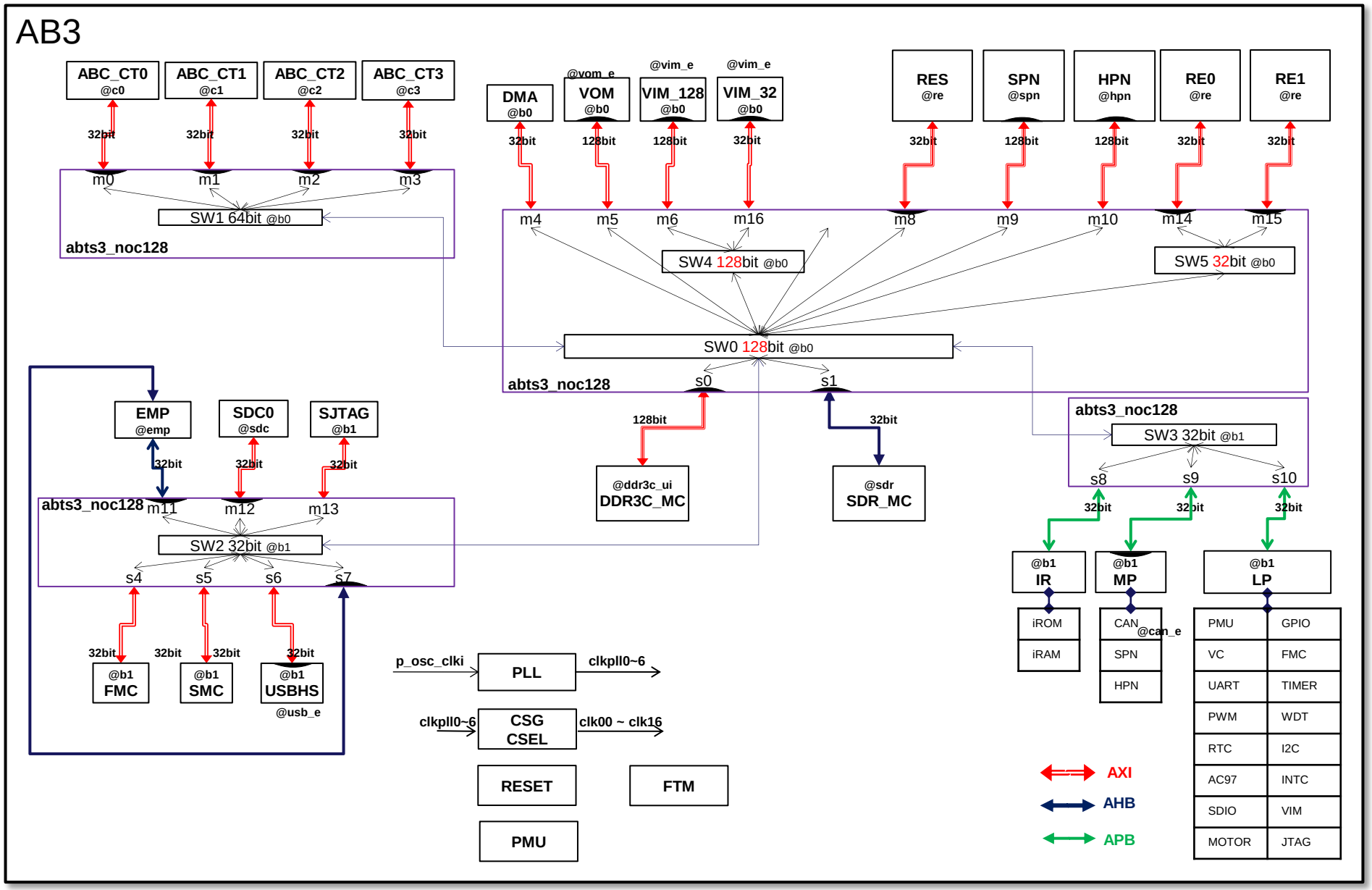
ABC_CT with Cache-ECC and Recovery

CAN 1.0A/B and FD for fast auto network

Recognition Engine (Now transitioning to ANN)

H.265 Video Encoder and Decoder for Video Storage

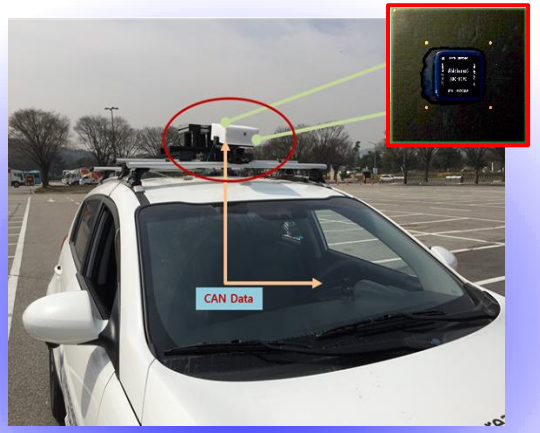
Aldebaran3: ISO26262-Compliant 1GHz Processor

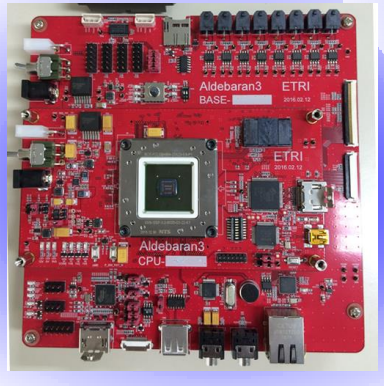


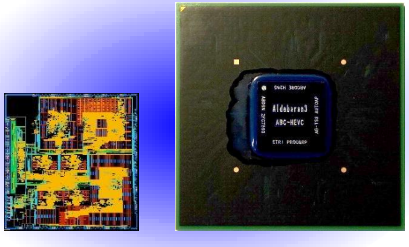
Aldebaran3: Automotive Vision Processor

Vertical Integration :

ECU-SW-System-Chip

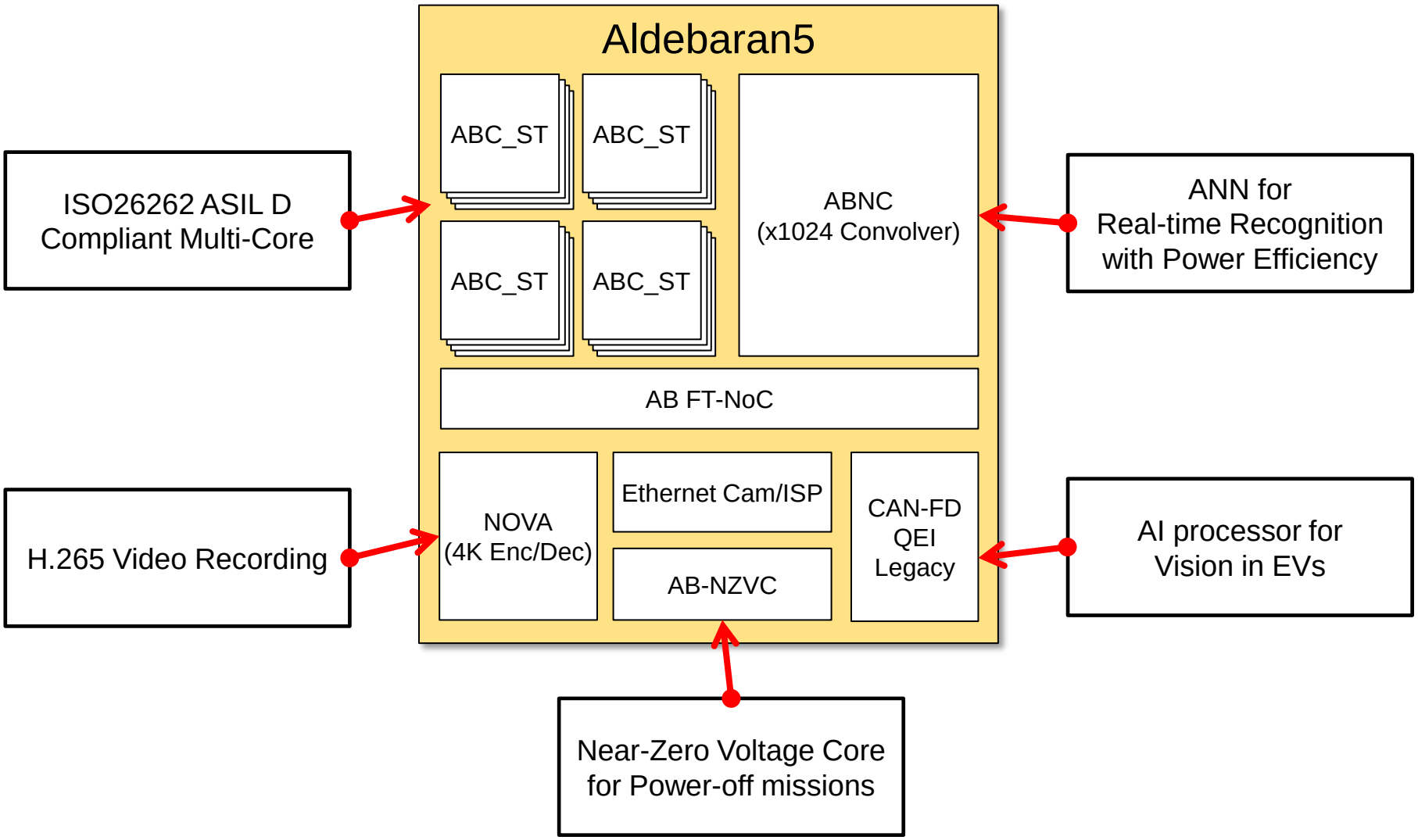




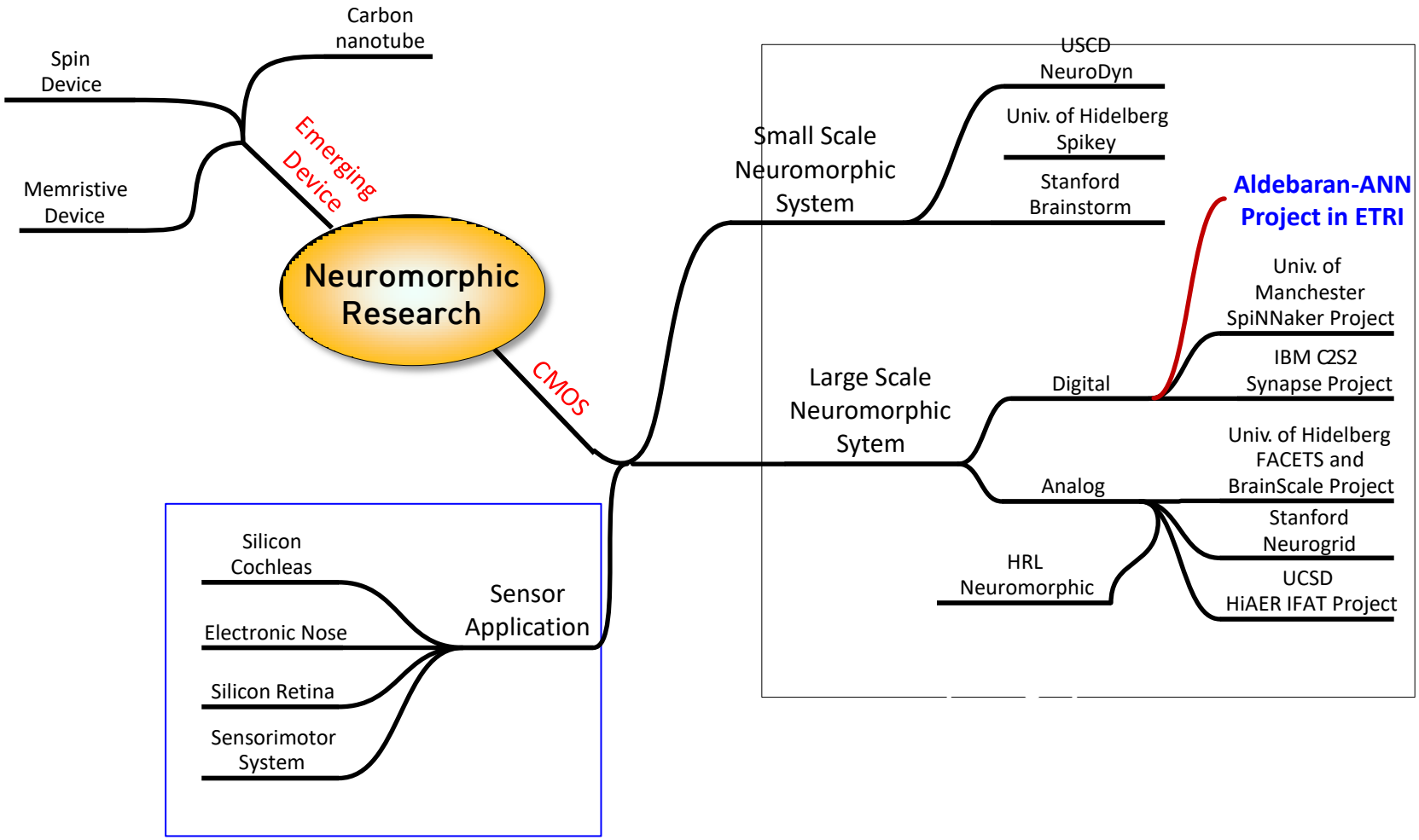


Aldebaran5: Automotive ANN Processor

* AI Processor for Autonomous Vehicle & Driver Assistance



Searching for a Practical Way to ANN Processor



Practicality

Excerpts from Yann LeCun's

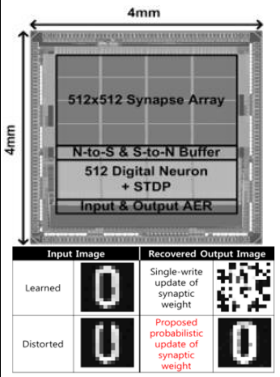
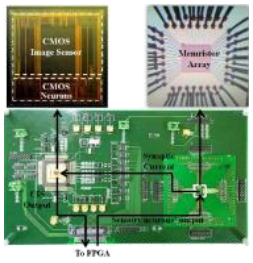
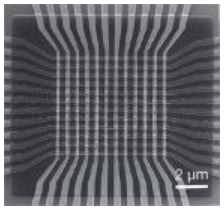
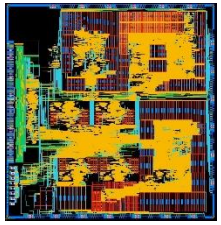
- It's nice to imitate Nature,
- But we also need to understand
  - How do we know which details are important?
  - Which details are merely the result of evolution, and the constraints of biochemistry?
- For airplanes, we developed aerodynamics and fluid dynamics.
  - We figured out that feathers and wing flapping weren't crucial.
- Question: What is the equivalent of aerodynamics for understanding intelligence?

L'avion III (Aquilon) de Clément Ader. Musée des Arts & Métiers - Paris 2012

L'Avion III de Clement Ader, 1897

His Eole(Avion) took off from the ground in 1890, 13 years before the Wright Brothers, but you may have never heard of it.

Neuromorphic Researches in Korea

Institute	POSTECH Circuit	GIST Sensor/ Circuit	POSTECH Memristor	ETRI ExoBrain (SW)	ETRI DeepView (SW)	ETRI Neurmorphic Vision Processor (Chip)
Contents	Low Power Neural Cell and STDP-based 512 Neuron Core	Memristor-Synapse integrated into **image sensor**	Memristor synapse for neuromorphic device	Exobrain is a SW for Knowledge learning and sharing	Real-time video recognition for vision intelligence	Mobile ANN Processor for Vision intelligence
						

Huddles ahead

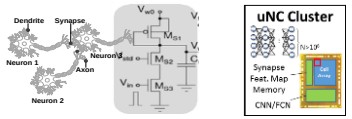
Over $15x10^9$ Neuron computation per second requires specialized computing techniques for single-chip applications.

State-of-the-Arts	Hardware Configuration	Power/Energy
Google, Andrew Ng, ICML 2012 	**1000** server machines Total **16,000** Processor 1 billion connections 10 million images (200x200) 3 days Training 	**1.6 MW**
Google, Andrew Ng, ICML 2013	**3** Server Machine [**4GPU**s, GTX680, 3Tflops, 300W]+ 2xQuadCore CPU]/server 3-5 days Training 	**1.5 kW** **(36Tflops)**
Oxford, VGG ILSVRC 2014	**1** server machine [**4GPU**s, Titan Black, 5Tflops, 300w] 16-19 layers 1.2 million images 2-3 weeks Training 	**1.2 kW** **(20Tflops)**

Synapse Compiler

Synapse Compiler produces a Neural Network by
restructuring, conversion, compression of state-of-the-art NNs

NN Architecture Model



SNN, CNN/FCN circuits u-Neural Core

Learning/Recognition Algorithm

Hardware Neural Net. (HNN)
Localization (Obj. Region Proposal)
Quantized Synapse Neural Net

Neural Network Model

AlexNet, VGG, GoogleNet, ResNet,
…etc.,

Optimization CONSTRAINTs

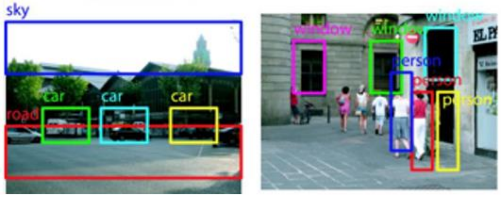
Memory Capacity & Bandwidth
Synapse Capacity
Processing Performance (GSOPS)
Target Perception Performance

Synapse Compiler

Re-Configuration
Synapse Optimization
Synaptic Op. Scheduling
Neural Net. Optimization

Neuro-Synaptic Code
Network Connection
Synapse Weight
Operation Scheduling

Synapse Weights
Neural Op. Scheduling



Aldebaran5 ANN Processor

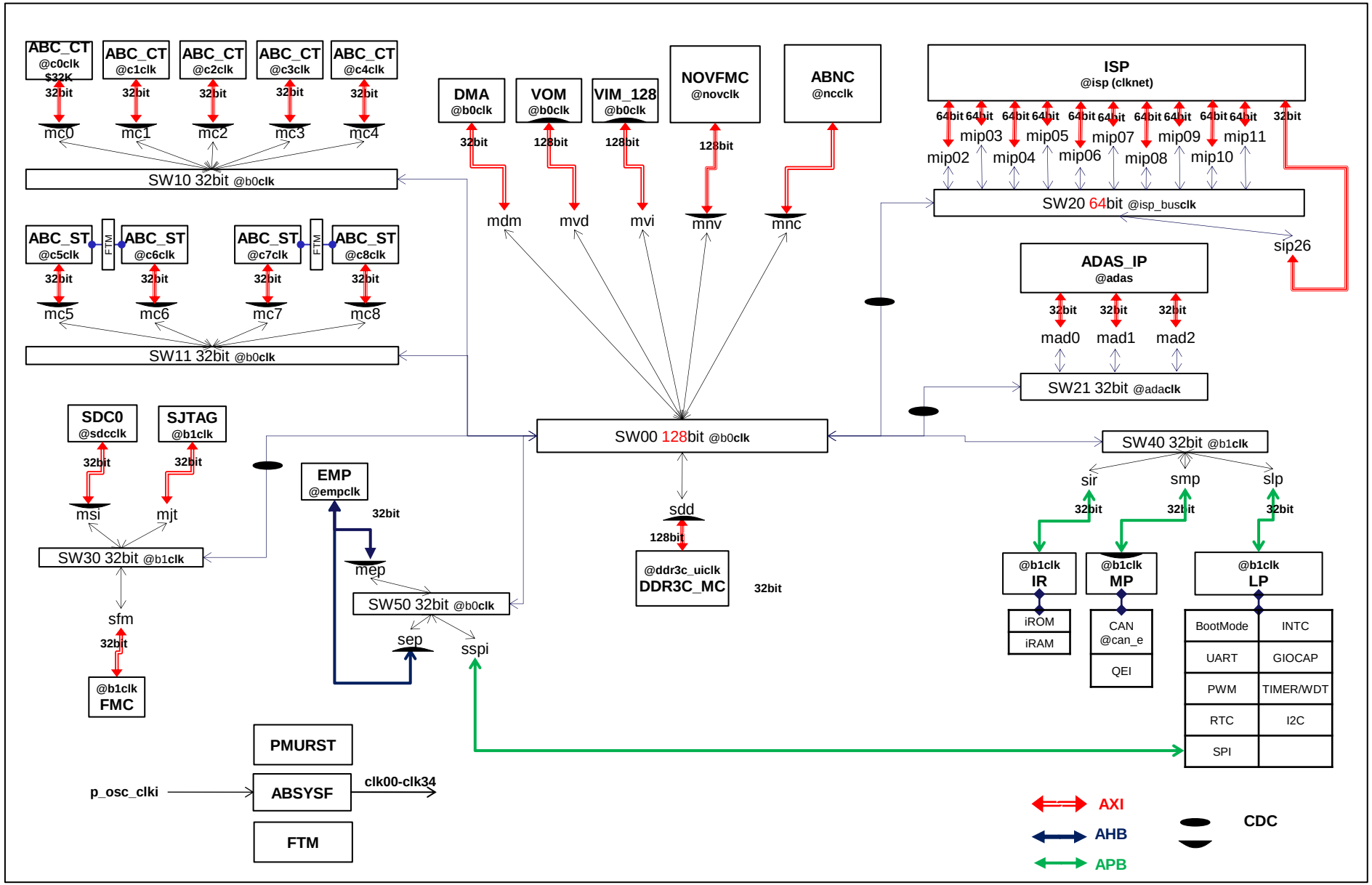
Sensor (ISP)

stream-in

uNC

Internal NC Network

Aldebaran5: A Practical ANN Processor



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