Achieving High-Performance Vision Processing for Embedded Applications with Qualcomm SoC Platforms

Qualcomm

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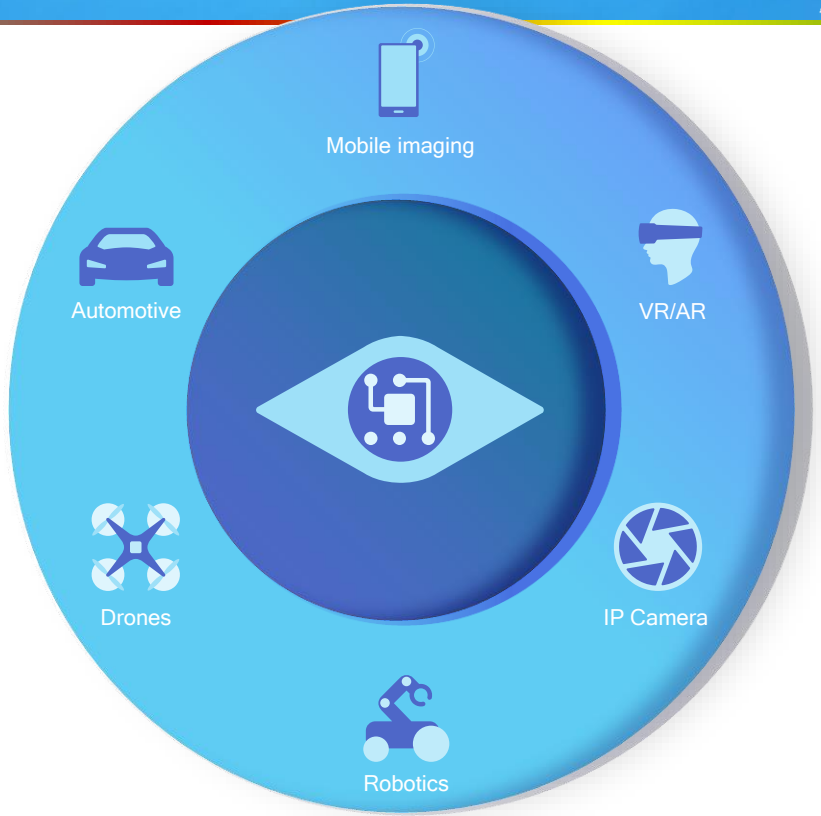
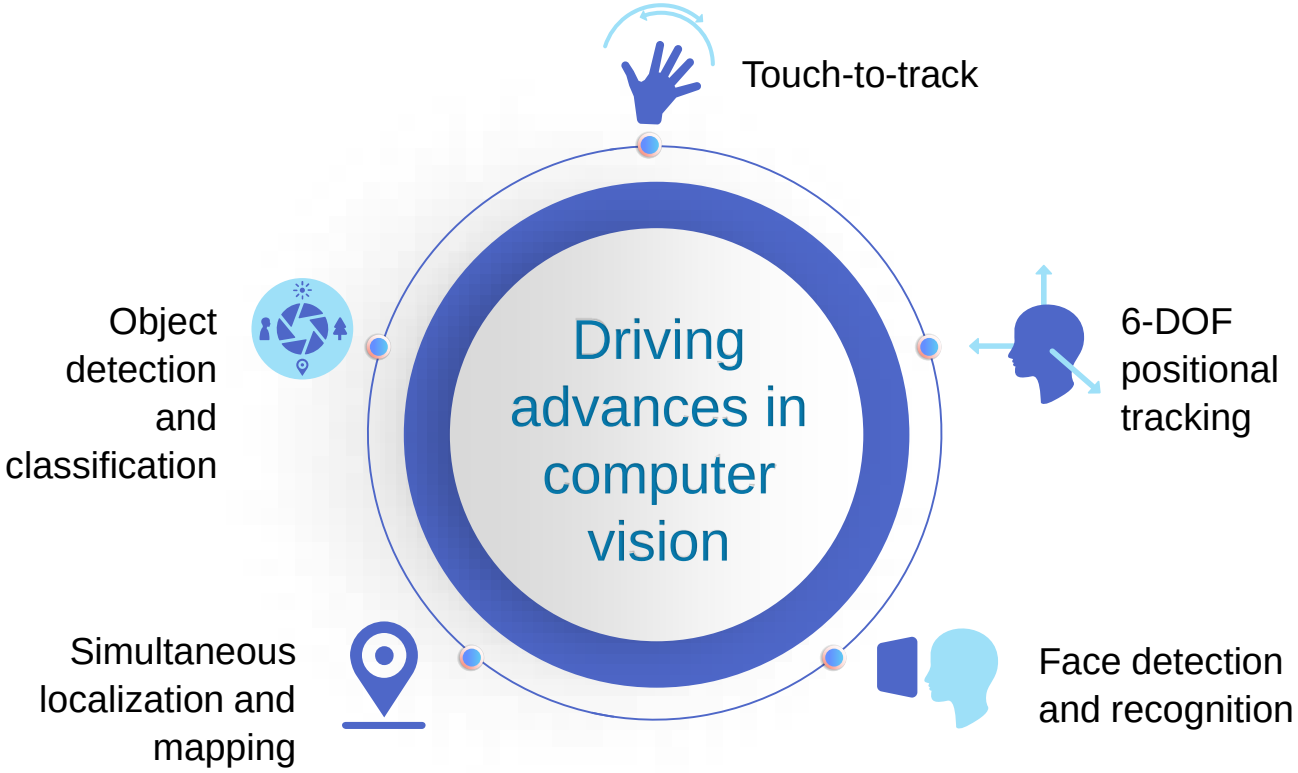
Computer vision is empowering a broad set of applications



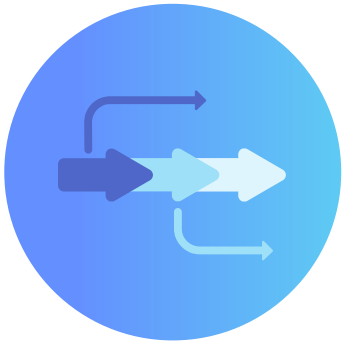


Deep learning benefits vs traditional CV

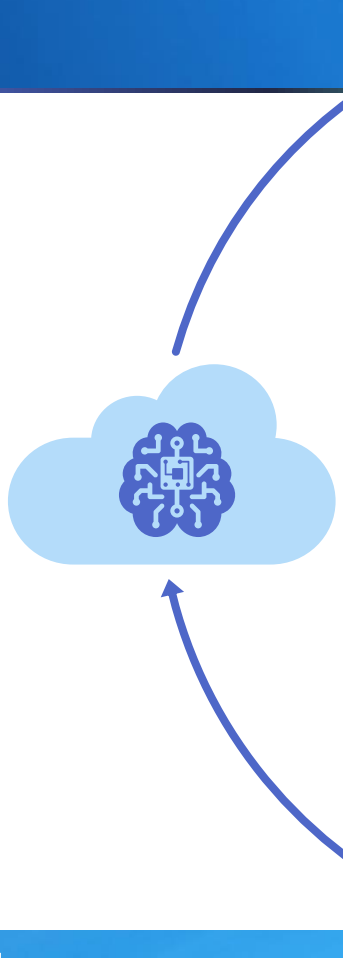
Ease of development

Greater accuracy

Better utilization of big data

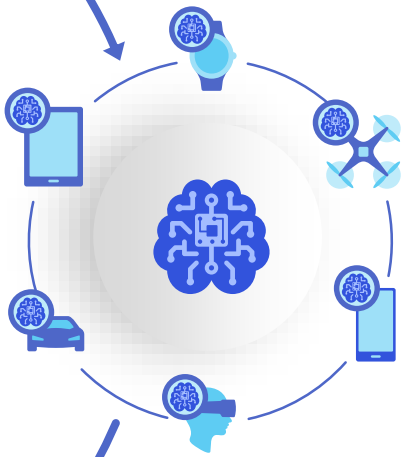


Versatility across use cases



On-device intelligence is paramount

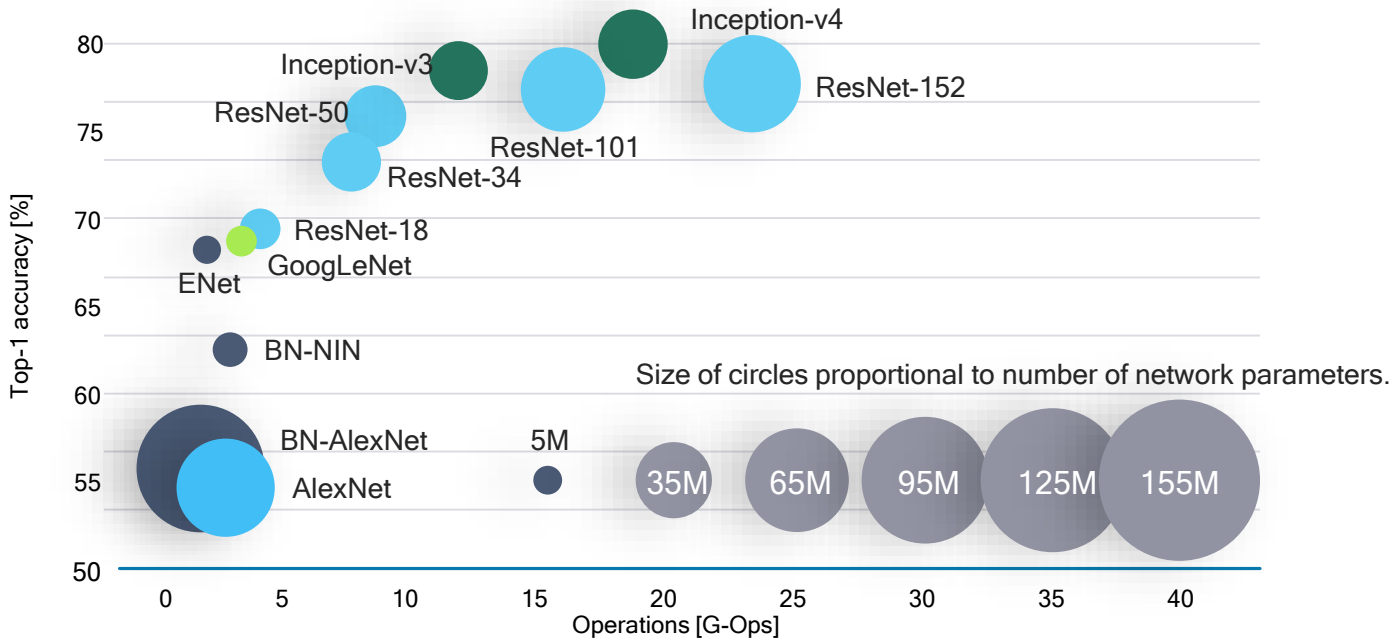
Process data closest to the source, complement the cloud



- Privacy
- Reliability
- Low latency
- Efficient use of network bandwidth

DL challenge — High computational requirements

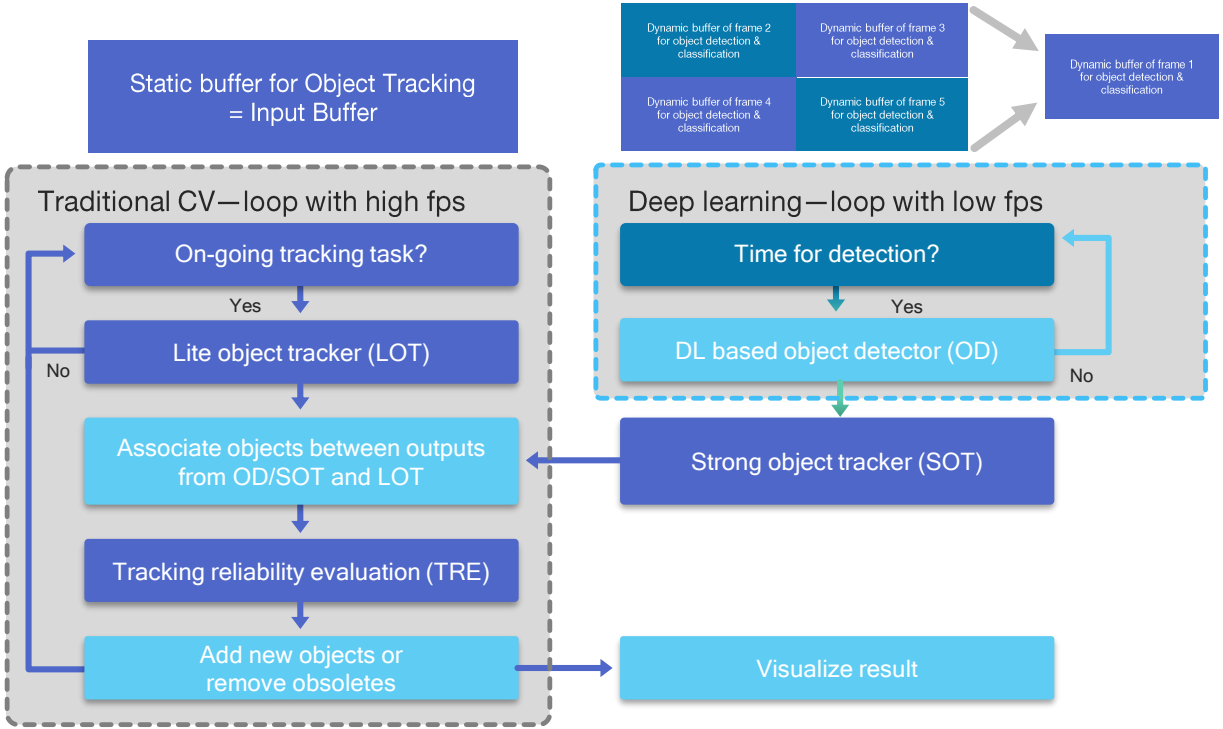
Higher accuracy requires greater processing capabilities



Note: Size of circles proportional to number of network parameters
Source: Alfredo Canziani et al., https://arxiv.org/abs/1605.07678

CV + DL — Improved detection and tracking in distance

Engineered to support high fps detection and tracking of small objects



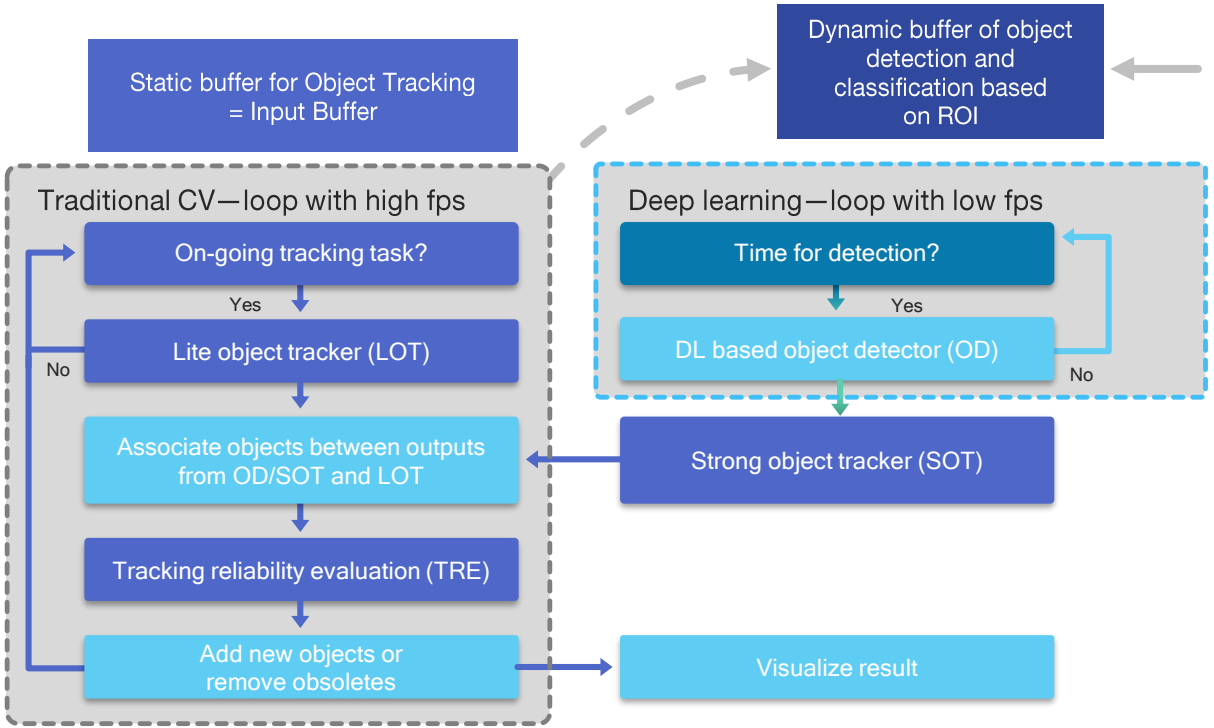
Two Sizes of Buffer

- Smaller buffer for DL wrt object detection/Classification use-case
- Larger buffer for CV wrt tracking use-case

Greater control detection and tracking in distance

CV + DL — Improved detection and tracking in distance

Engineered to support high fps detection and tracking of small objects



Two Sizes of Buffer

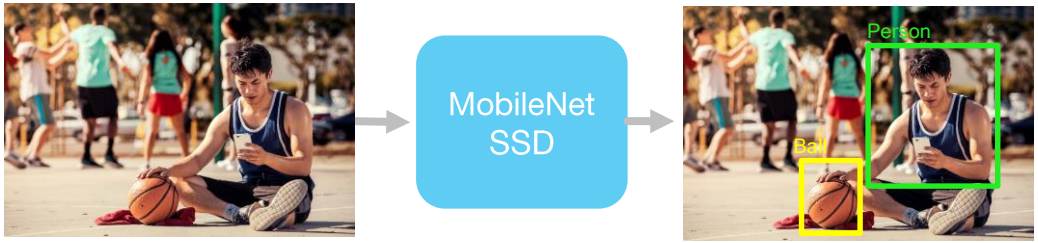
- Scaling factor and location of the smaller working buffer of DL for object detection can be based on feedback from the tracker or other clues
- Larger buffer for CV wrt tracking use-case

Greater control detection and tracking in distance

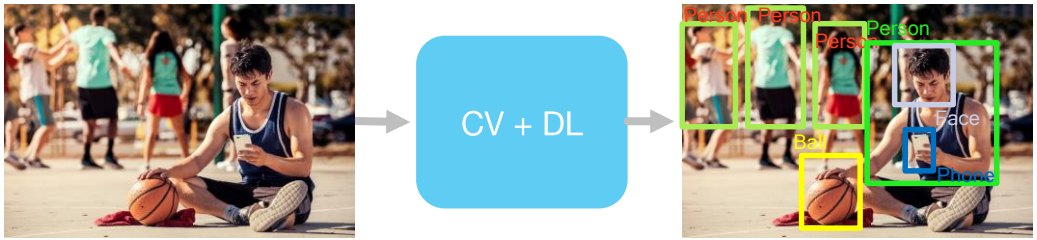
CV + DL — Improved detection and tracking in distance

CV + DL vs. MobileNet-SSD

Tradeoff between Speed and Detectable Distance



Speed: 1 X
Detectable Distance: 1 X



Speed: 1X (per 5 frames)
Detectable Distance: 2 X

CV + DL vs. MobileNet-SSD

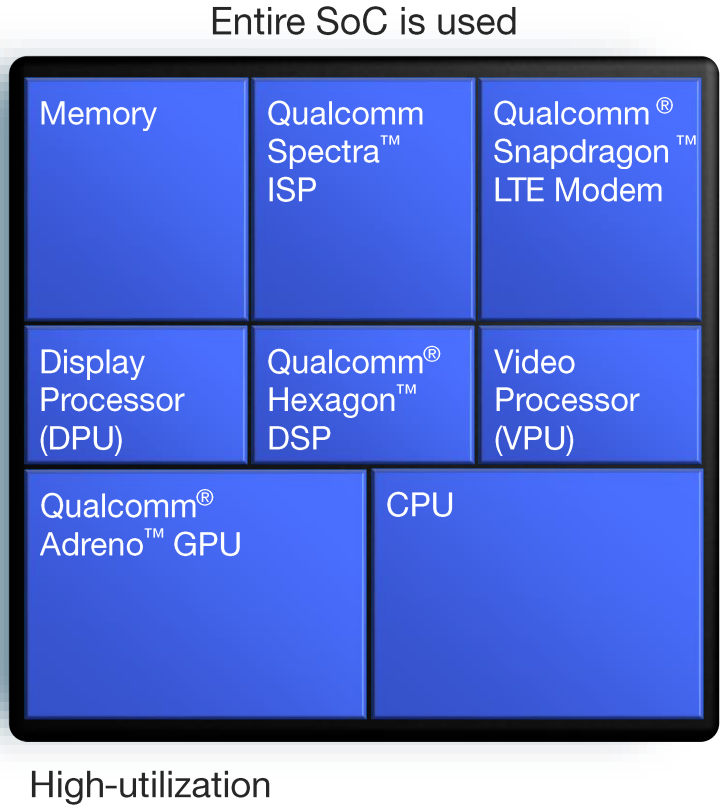
KPIs	CV + DL (CV+ MobileNet-SSD)	Pure DL Solution (MobileNet-SSD)
MACs	1.9G	1.9G
Processing frame rate	5	28
Memory BW (MBps)	190	845
CPU Utilization	33%	33%
Distance	12-20 feet	6-10 feet
Inf#/sec	30 with tracking	28 (30 with tracking)
Accuracy	75% MAP with Pascal VOC	75% MAP with Pascal VOC

- Synergistically combine traditional computer vision techniques along with deep learning to leverage benefits of both
- Distribute varying workloads of CV + DL on heterogeneous compute platform based on use-case requirements

Heterogeneous computing key for on-device intelligence

Designed to deliver performance and efficiency improvements

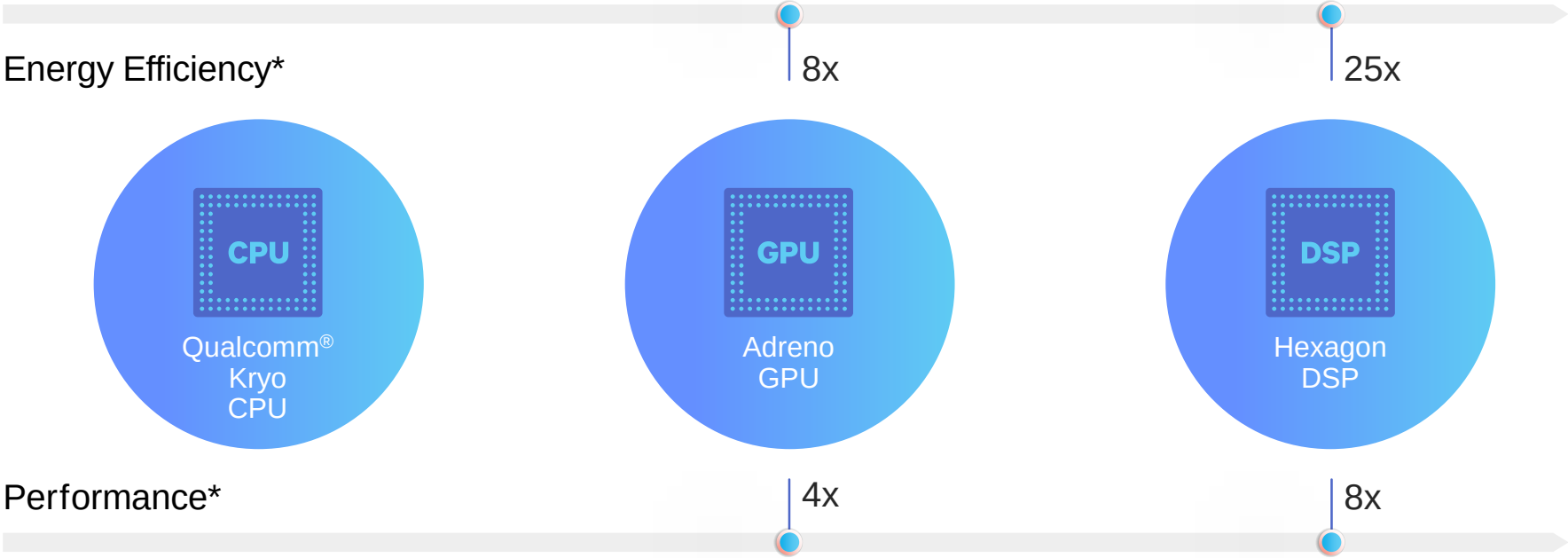
Broad portfolio of SoCs addresses different levels of performance and price points



Graphic not to scale

Optimal power and performance for DNN workloads

Choose the core to match the user experience



*Based on APQ8098 estimates

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Qualcomm® Vision Intelligence Platform

Qualcomm Vision Intelligence Platform

Purpose-built 10nm SoCs for next-gen robots, smart cameras and smart home

Qualcomm AI Engine

- Hardware + Software to accelerate on-device AI
- Up to 2.1 TOPS for DNN inferences

Superb image with our most powerful camera processor ever

- Dual 14-bit Spectra™ ISP supporting dual 16 Mpix sensors
- Up to 4K video @ 60 FPS, or 5.7K @ 30 FPS
- Staggered HDR, electronic image stabilization, de-warp, de-noise and more

Heterogeneous compute and key features

- Up to 8x Kryo™ 360 CPU, Adreno™ 615 GPU, Hexagon 685 Vector Processor
- Up to WQHD touch display, 2x2 11ac Wi-Fi®, Bluetooth® 5.1, advanced audio
- Hardware-based security

Qualcomm Vision Intelligence Platform with Qualcomm Artificial Intelligence Engine

What is AIE?

Hardware

- Hexagon Vector Processor — INT8 precision networks
- Adreno GPU — FP32 and FP16 precision networks
- Kryo CPU — FP32 and INT8 8bit precision networks

Tools

- Snapdragon Neural Processing Engine
- Android NN
- Hexagon NN

Frameworks

- Caffe/Caffe2
- TensorFlow/TensorFlow Lite
- ONNX

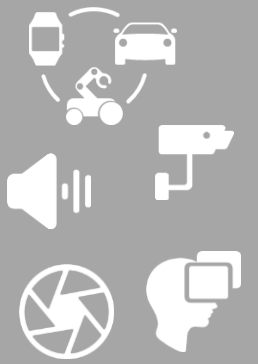
Qualcomm QCS605

With Qualcomm AI Engine

Ecosystem

- OEMs/ODMs
- ISVs
- Dev

Applications & Features



Qualcomm Vision Intelligence Platform

Sampling now

VR 360 camera reference design available today

Industrial security camera reference design expected 2H'18

Ecosystem of technology providers

www.qualcomm.com/IoT

AI in here.
And everywhere.

Advanced camera processing, powerful machine learning, and computer vision at the edge will allow new applications that push the boundaries of our connected world.

Intelligent cameras monitor and track what's inside.

Local at the edge processing means low latency and max efficiency.

Neural networks watch and learn your preferences.

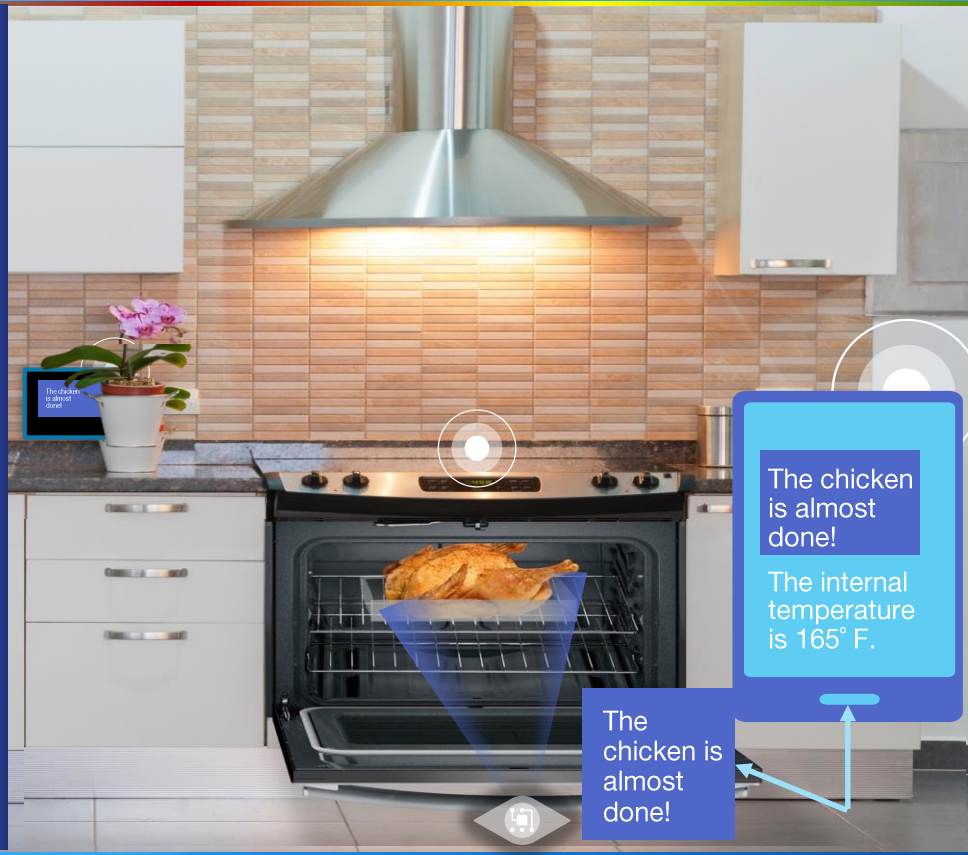
Ubiquitous connectivity helps you avoid running out of critical food supplies

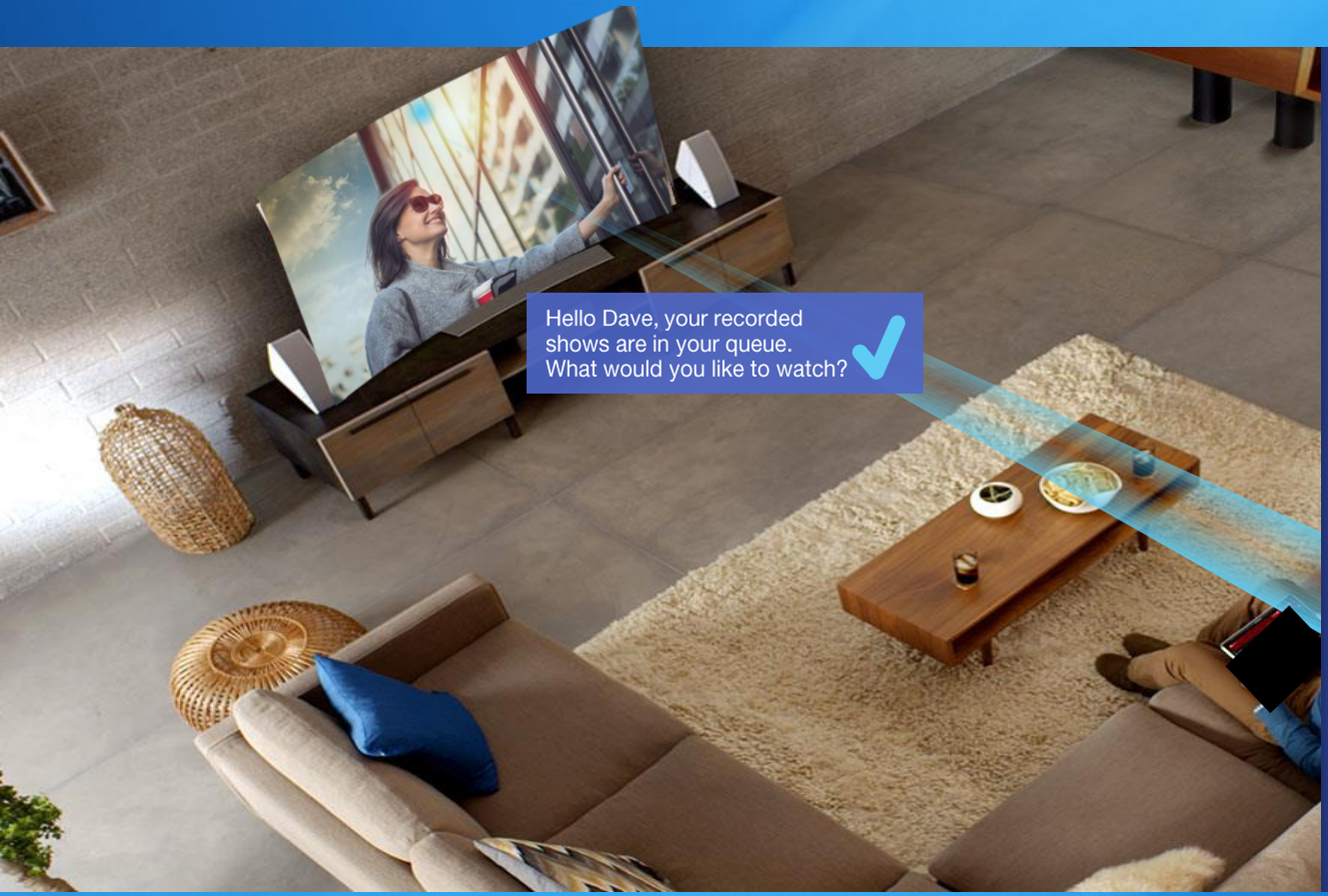
Dinner made simple.

Instant inventory with live images from inside your refrigerator combined with clever neural networks tuned to keep essential groceries in your home and meals on the table. Easy.

Smarter appliances deliver cooked to perfection every time. It learns how you like your food prepared. Integrated machine learning will take the guesswork out of cooking.

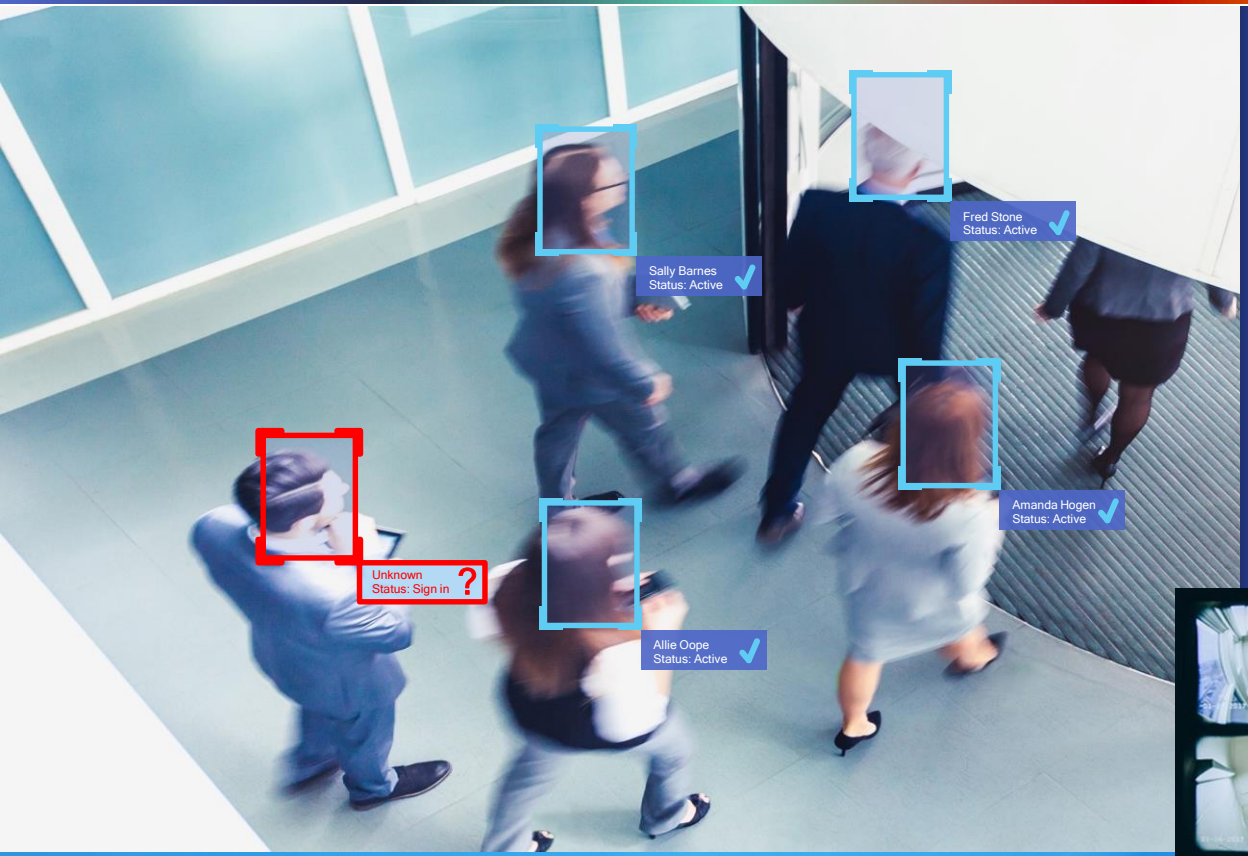
With **smart assistants** to keep things coordinated, get ready to enjoy perfect culinary bliss.





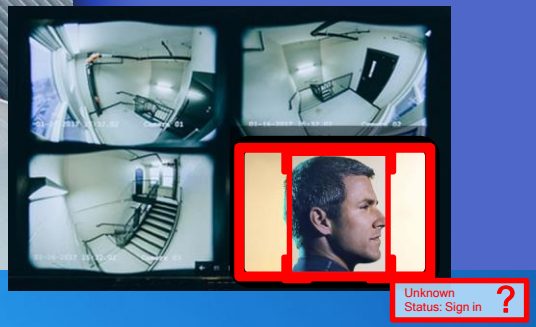
In Your Living Room

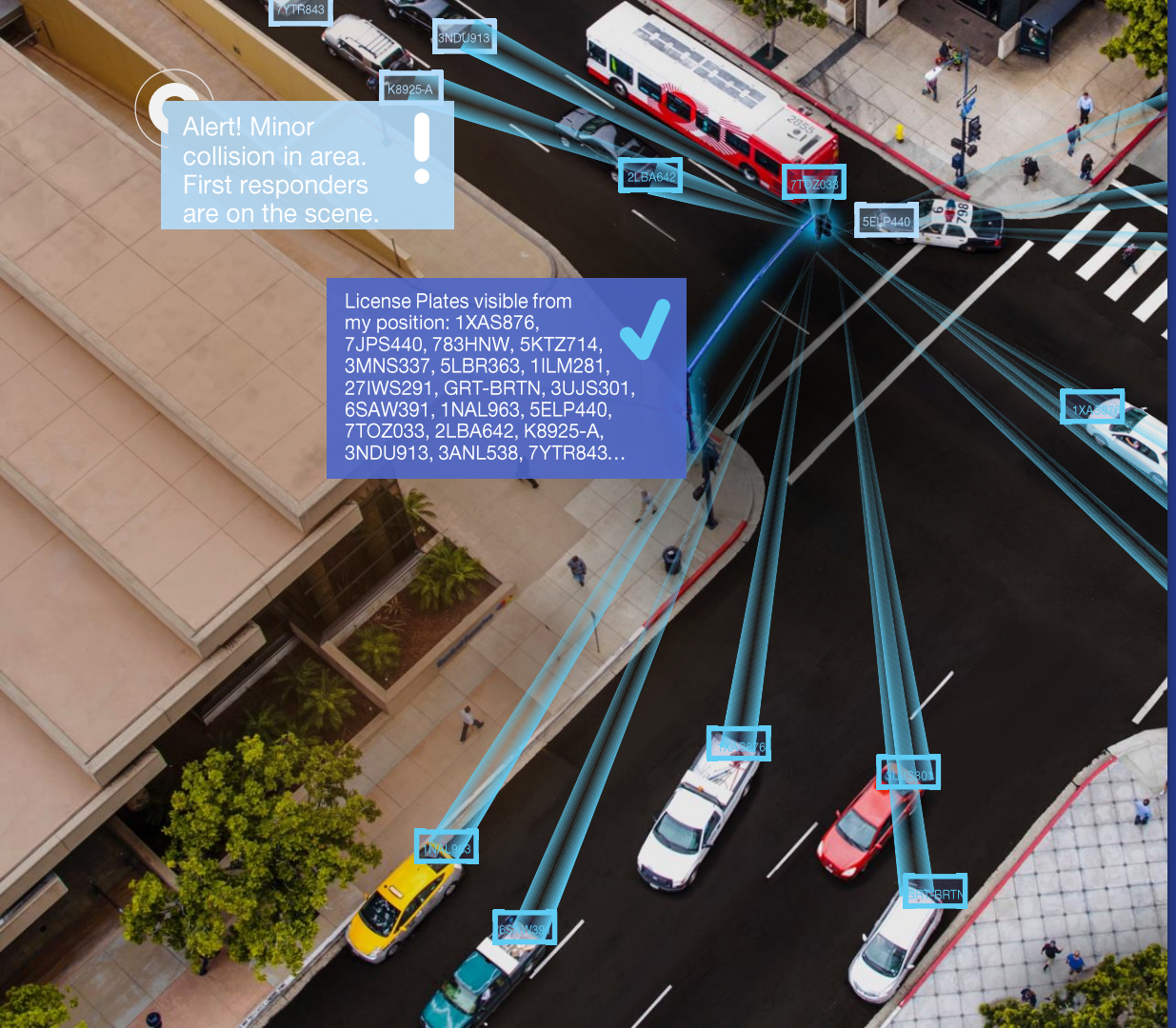
- **Voice/Face Recognition** knows between you and other members of the family
- **Home Control and Automation** for intelligent personalized lighting and climate control
- **Home Security** video surveillance and intelligence to better protect your home



Enterprise Security

- Improve security with automated AI screening using people detection, facial recognition and facial detection
- Unknown faces are automatically flagged for security assessment





Intelligent Smart Cities

- Scene Classification
- License Plate Recognition
- Target Sound Detection

Qualcomm

Thank you!

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