

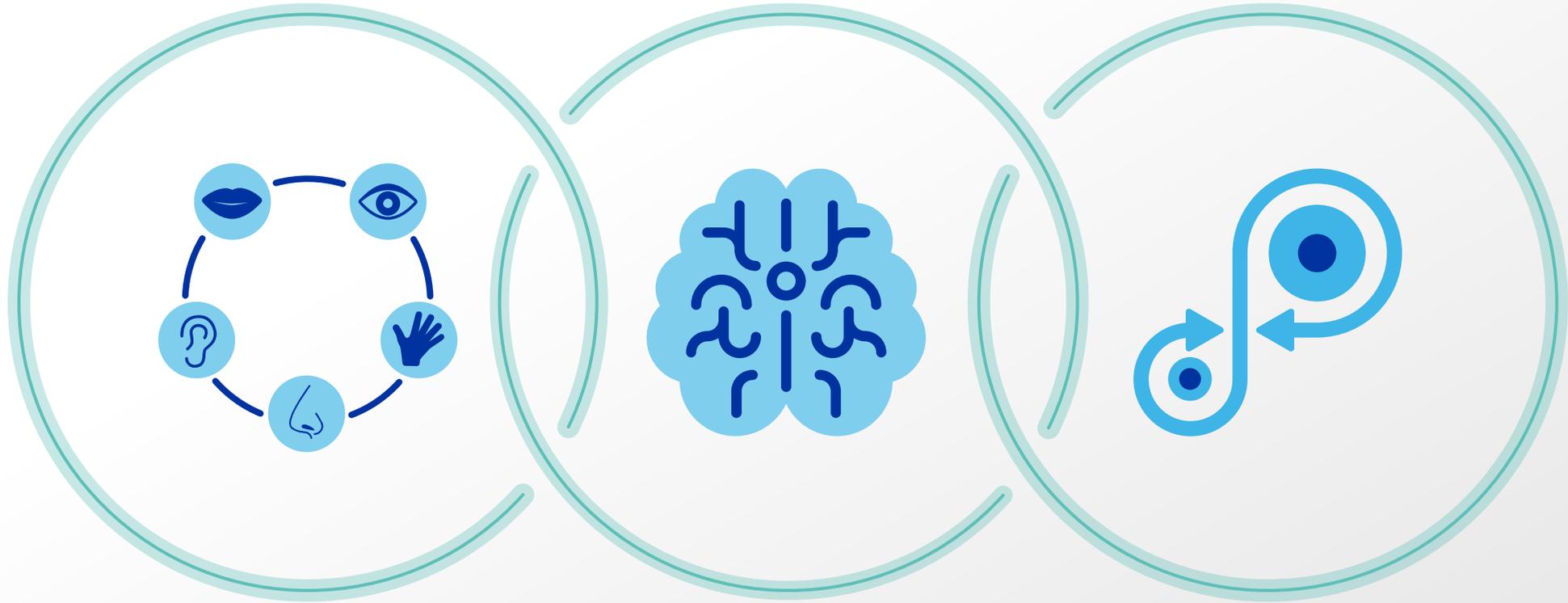


Making on-device AI ubiquitous

Qualcomm Technologies, Inc.
September 2017



Offering new capabilities to enrich our lives



Perception

Hear, see,
monitor, observe

Reasoning

Learn, infer
context, anticipate

Action

Act intuitively, interact
naturally, protect privacy

Mobile is becoming THE pervasive AI platform

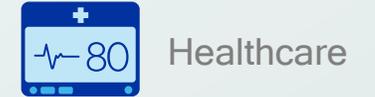
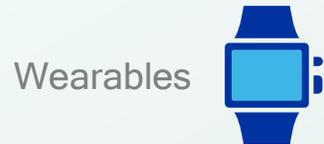
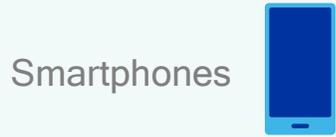
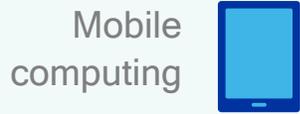
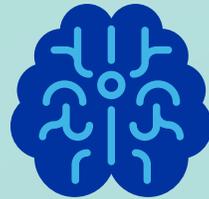
>8.5 Billion

Cumulative smartphone unit shipments
forecast between 2017-2021



Mobile scale changes everything

Bringing AI to the masses



Rapid replacement cycles

Superior scale

Integrated and optimized technologies



The platform for efficient on-device machine learning

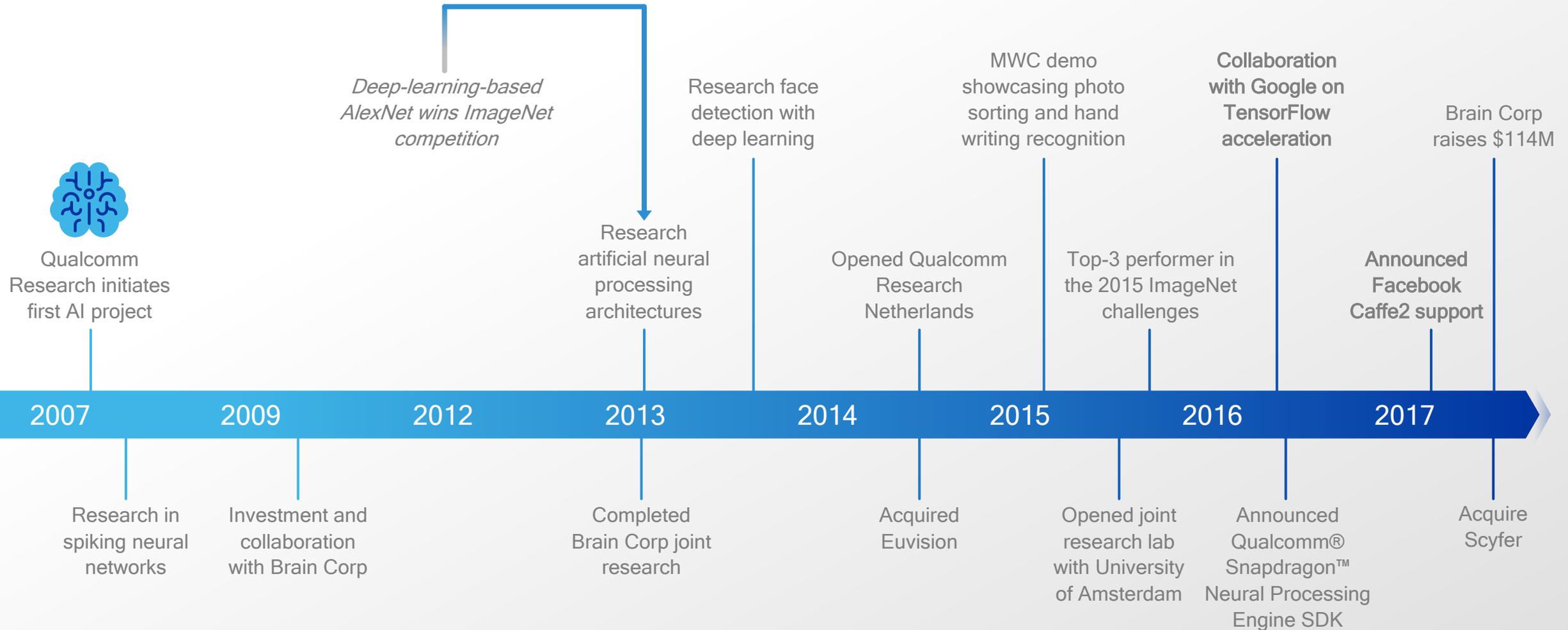
Qualcomm® Artificial Intelligence Platform

A high-performance platform designed to support myriad intelligent-on-device-capabilities that utilize:

- Snapdragon platform's heterogeneous compute capabilities within a highly integrated SoC
- Innovations in machine learning algorithms and enabling software
- Development frameworks to minimize the time and effort for integrating customer networks with our platform

Our AI leadership

A decade of consistent AI research and investment



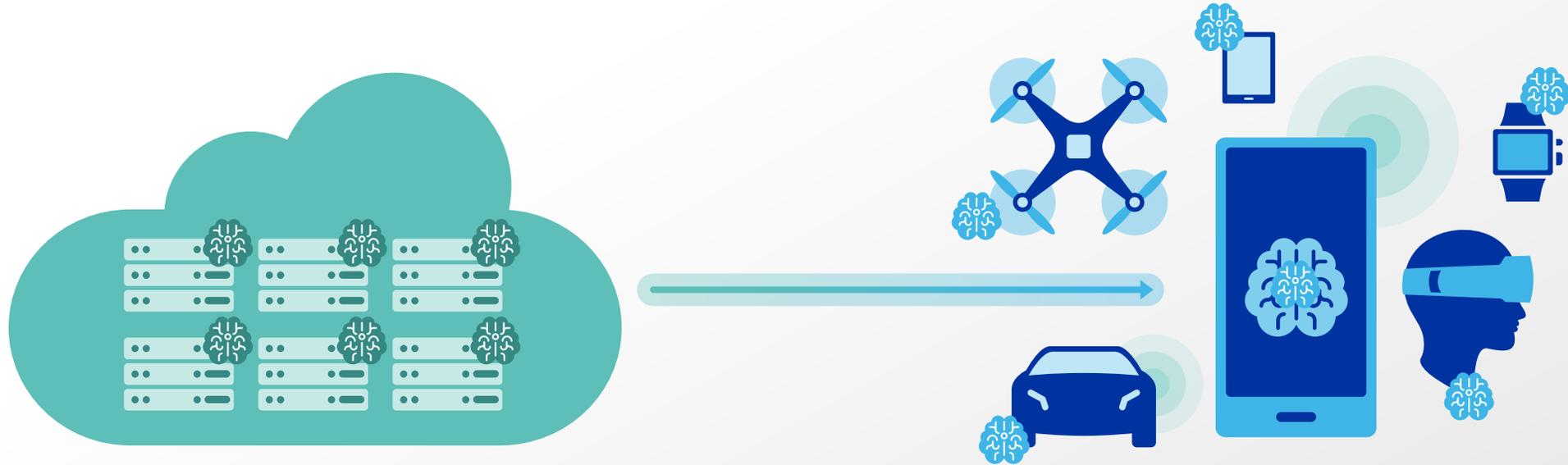
Scyfer acquisition: Strengthening our AI R&D

Another piece to the AI puzzle

- Scyfer is a leading AI company in Amsterdam, spun out of the University of Amsterdam (UvA)
- Max Welling, a founder of Scyfer, is a renowned professor at the UvA and a leading AI researcher. He is joining Qualcomm Research
- Scyfer focuses on applying a wide range of machine learning techniques to real world problems
- Scyfer employees will join the Qualcomm Research team in Amsterdam



Intelligence is moving to the device



Server/Cloud

Training
Execution/Inference

Devices

Execution/Inference
Training (emerging)



On-device intelligence

is paramount

Process data closest to the source, complement the cloud

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

Power and thermal efficiency are essential for on-device AI

The challenge of AI workloads

-  Very compute intensive
-  Large, complicated neural network models
-  Complex concurrencies
-  Always-on
-  Real-time



Constrained mobile environment

Must be thermally efficient for sleek, ultra-light designs



Requires long battery life for all-day use



Storage / Memory bandwidth limitations



Making on-device intelligence pervasive

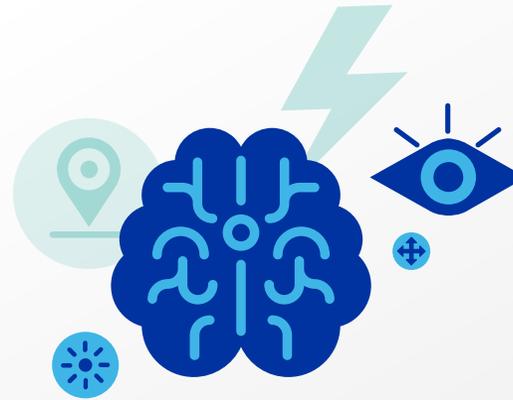
Focusing on high performance HW/SW and optimized network design



Efficient hardware

Developing heterogeneous compute to run demanding neural networks at low power and within thermal limits

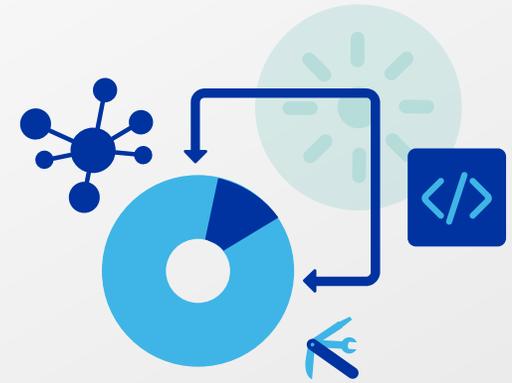
Selecting the right compute block for the right task



Algorithmic advancements

Algorithmic research that benefits from state-of-the-art deep neural networks

Optimization for space and runtime efficiency

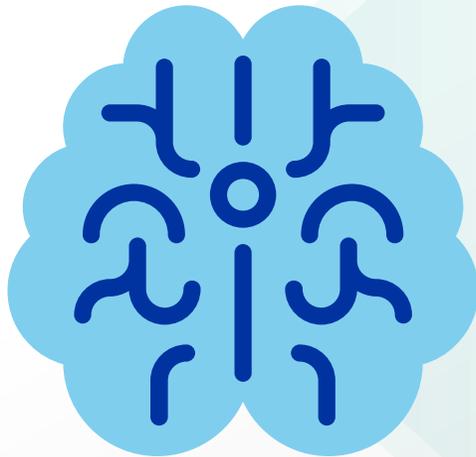


Software tools

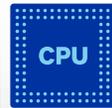
Software accelerated run-time for deep learning

SDK/development frameworks

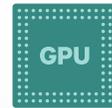
Snapdragon Neural Processing Engine



Available at: developer.qualcomm.com



Qualcomm®
Kryo™ CPU



Qualcomm®
Adreno™ GPU



Qualcomm®
Hexagon™ DSP

Efficient execution on Snapdragon

- Takes advantage of Snapdragon heterogeneous computing capabilities
- Runtime and libraries accelerate deep neural net processing on all engines: CPU, GPU, and DSP with HVX

Model framework/network support



- Convolutional neural networks and LSTMs
- Support for Caffe/Caffe2, TensorFlow, and user/developer defined layers

Optimization/debugging tools



Offline
conversion tools



Analyze
performance



Sample
Code



Ease of
Integration

- Offline network conversion tools
- Debug and analyze network performance
- API and SDK documentation with sample code
- Ease of integration into customer applications

Software accelerated runtime for the execution of deep neural networks on device

We will be the platform for ubiquitous on-device intelligence

On-device intelligence is expanding to many new industries



Intelligence distributed from cloud to device



Automotive



Computing



Networking



Media consumption



Industrial IoT



Smart homes

Low power, efficient integrated computing platforms

5G for high speed, low latency connectivity

Comprehensive security

AI offers enhanced experiences and new capabilities for smartphones

True personal assistance



Extended battery life



Enhanced connectivity



Superior photography



Natural user interfaces



Enhanced security

A new development paradigm where things repeatedly improve



AI is revolutionizing the car of the future

Redefining the in-car experience

- Natural user interfaces
- Personalization
- Driver awareness monitoring

Paving the road to autonomy

- Surround view perception
- Sensor fusion
- Path planning
- Decision making

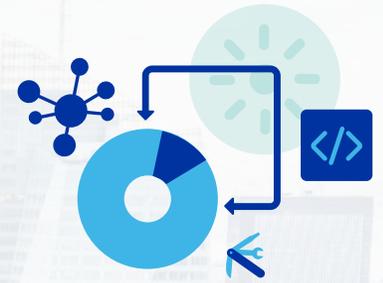
What's next?



Specialized hardware



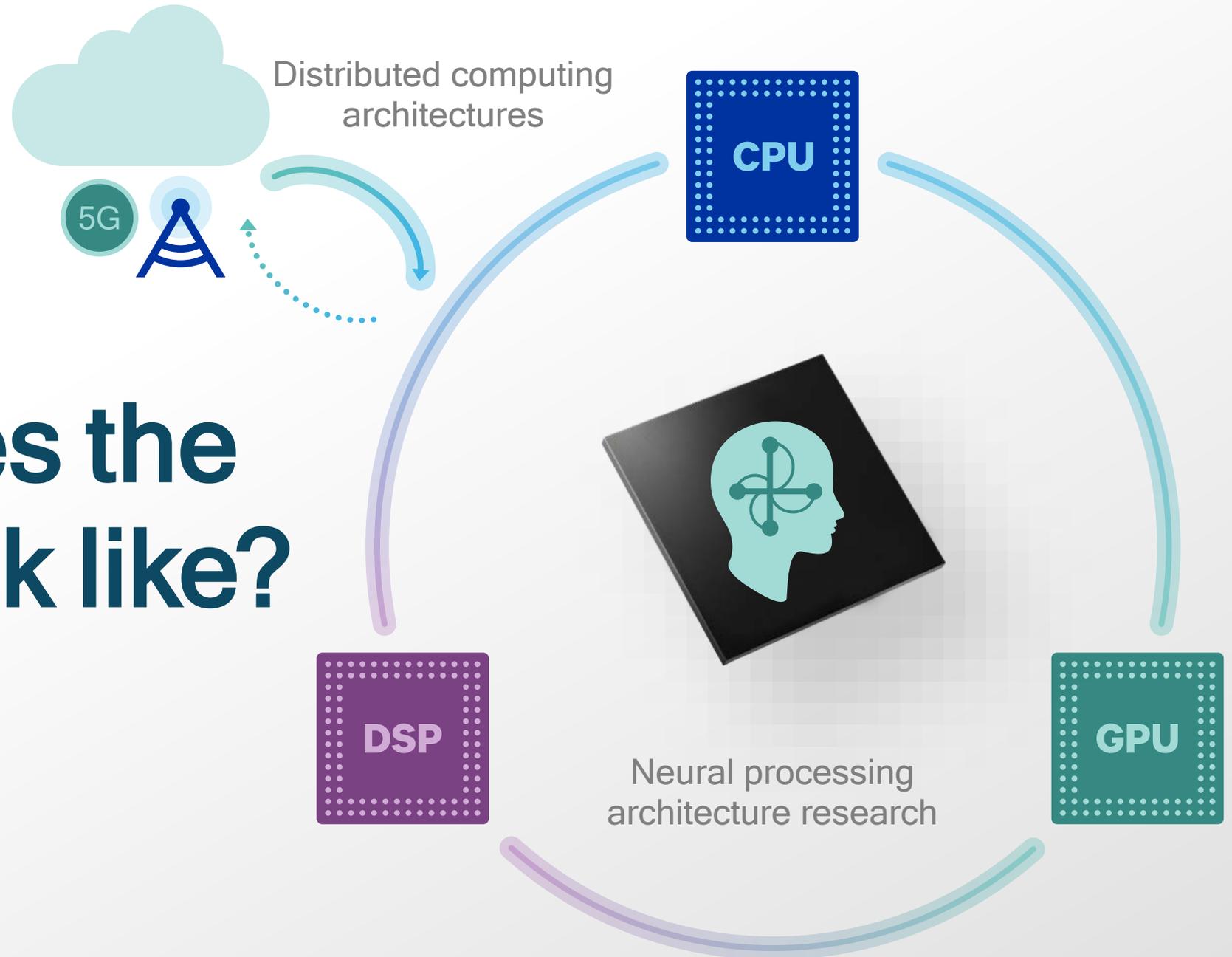
Algorithmic advancements



Improved optimization strategies

AI hardware

What does the future look like?



Thank you

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