

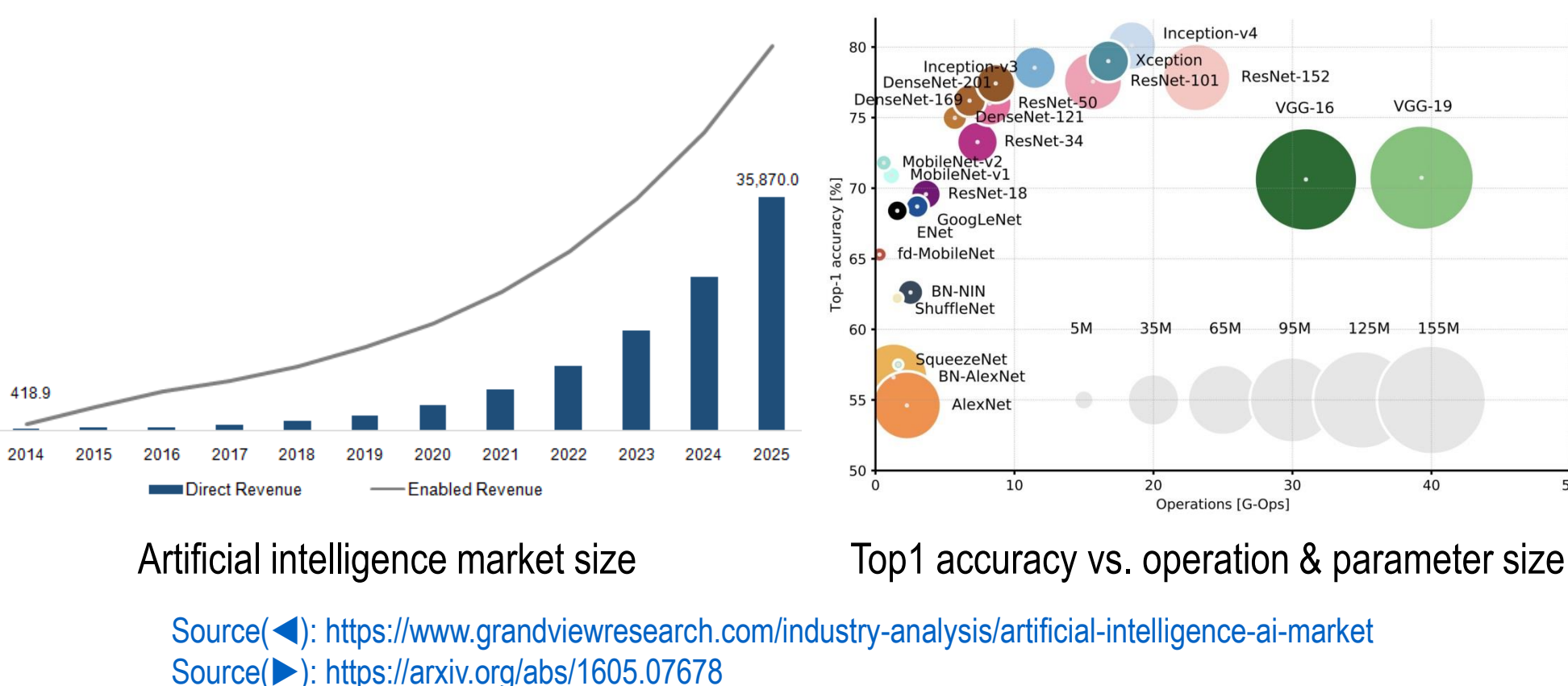


# A Scalable, Configurable Neural Network Accelerator Supporting On-device Training

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## Why LG develop Neural Network Accelerator?

- Machine learning (ML) market has been exponentially growing in the recent years.
- Home Appliance (HA) manufacturers are pushed to provide ML features in their products to satisfy customers' needs.
- Many ML tasks, such as image classification and speech recognition, are based on neural networks (NNs) that require heavy computation as well as a high volume of parameters.
- Unfortunately, conventional CPUs and GPUs are not suitable for HA, Smart Home, Smart City, Robot, and Automotive In-Cabins to deal with NNs.

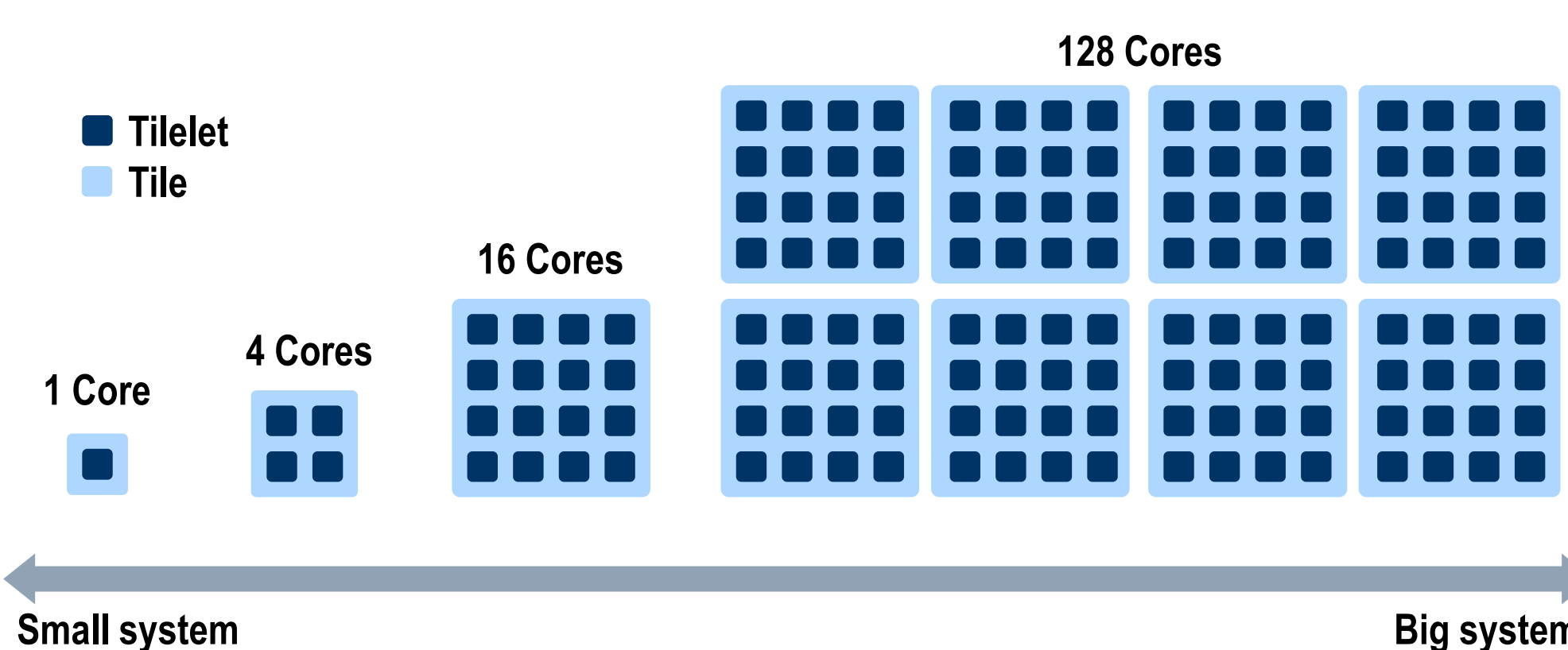


- As the global leader in the consumer electronics market, LG has developed a novel NN accelerator, named LG Neural Engine (LNE), which is optimized for smart consumer electronics environments.

## How scalable & flexible LG Neural Engine is?

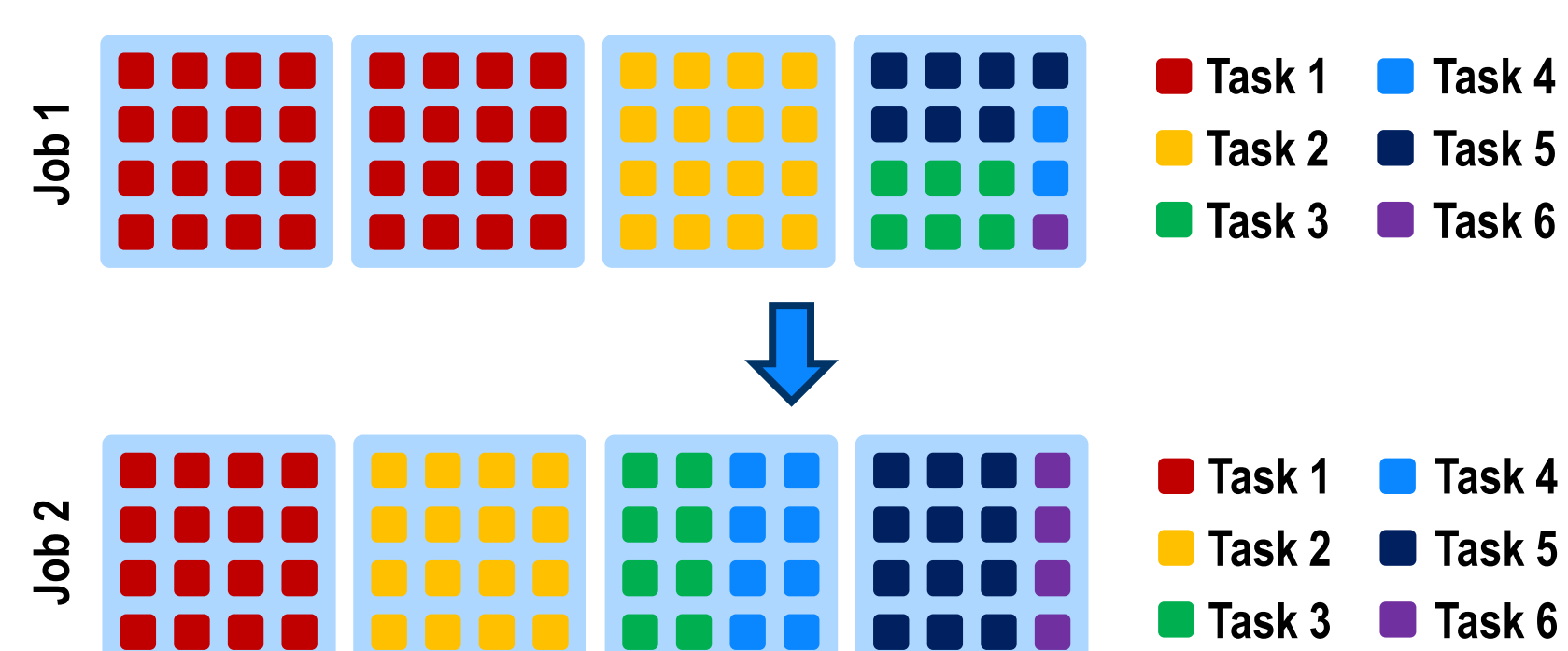
### Scalability

LG Neural Engine architecture is scalable up to 128 cores. A system has 1 – 8 Tiles (upper level hierarchy), and each Tile can contain up to 16 Tilelets (lower level hierarchy).

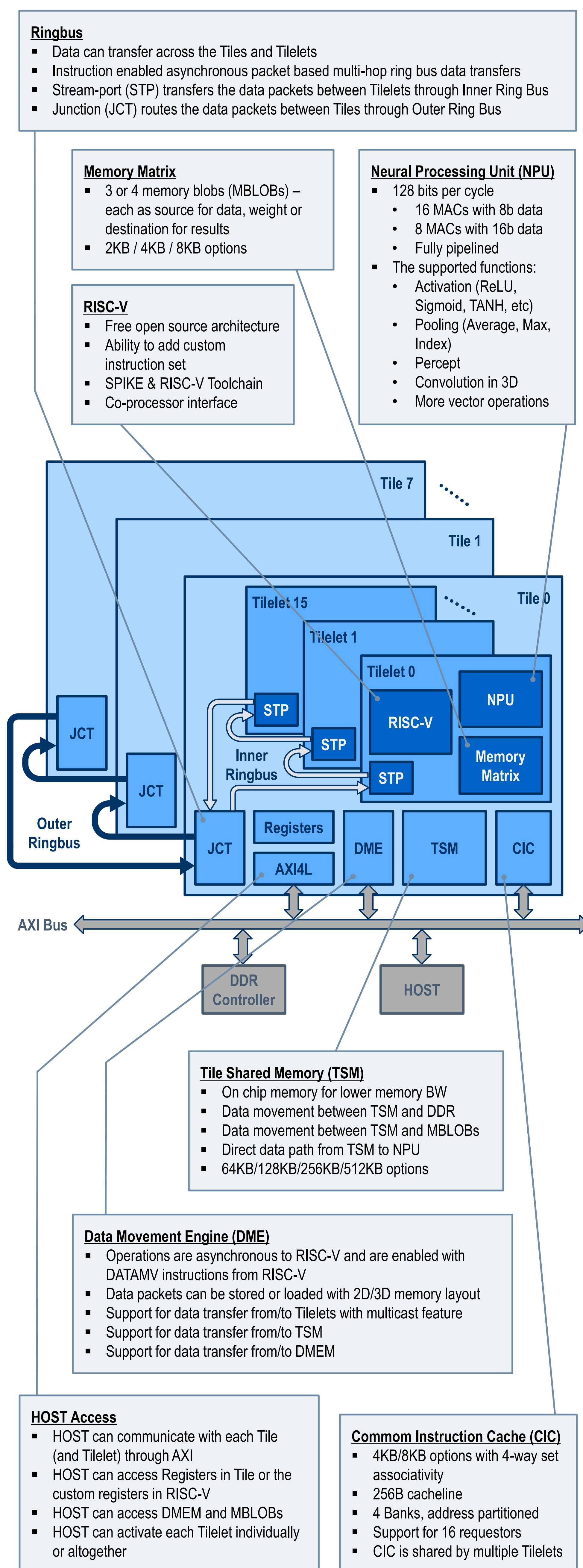


### Flexibility

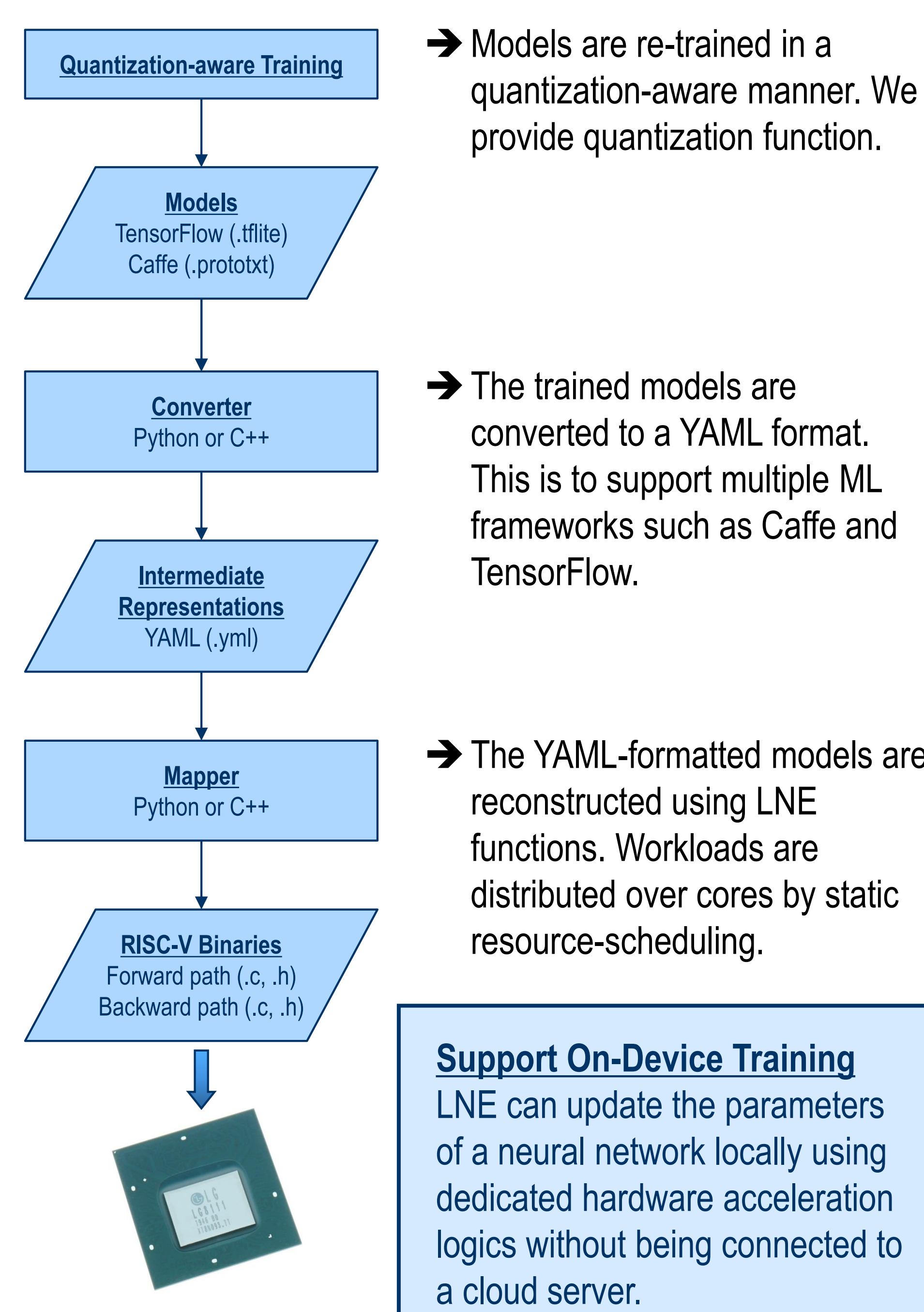
Each core can be programmed independently. Within a Tile, several tasks can be performed simultaneously with flexible & dynamic grouping.



## How unique is LG Neural Engine architecturally?



## How is LG Neural Engine utilized in Software?



## What have we achieved with LG Neural Engine?

LG Neural Engine has been fabricated and packaged using high-end CMOS process node, and verified with over 30 popular neural networks.

4 Tiles x 8 Tilelets = 32 Cores

Sensor Input & System I/O	Wi-Fi
Camera Processing	CPU Security
	LG Neural Engine
	Voice Vision

**Image Classification**  
 GoogLeNet, MobileNet, VGG-16, ResNet-50, SqueezeNet, ...

**Object Detection**  
 Tiny-Yolo, SacNet, SacNet-yolo-tiny, ...

**Image Segmentation**  
 SegNet, ErfNet, Enet, ...

Model	Product A	Product B	Product C	LG Neural Engine
GoogLeNet [fps]	20.27	21.66	12.60	42.50
AlexNet [fps]	6.95	7.66	6.82	20.80

## Where can we find LG Neural Engine?

LG will soon adopt LNE in many LG products such as Smart TV, Robot Vacuum Cleaner, Laundry Washer and others.



### Smart TV

Super resolution: generating a high-resolution images from one or more low-resolution ones.

### Robot Vacuum Cleaner

Continuous learning: adapting to customer-specific environments by applying reinforcement learning.



### Laundry Washer

Intelligent object detection: analyzing the load status to control the agitator movement and water flow for energy efficiency.

## What will be the future of LG Neural Engine?

LG Neural Engine will be evolved in many different ways:

### Features Enhancement

LNE will be enhanced to support upcoming state-of-the-art neural networks, and continue providing better performances.

### Open Source IP

LG plans to make LNE available to publics by providing architecture and SDK for building and contributing to open source community.

### Evolution to Next Generations

The next generation technology such as Spiking Neural Network will be supported.

