tinyML® EMEA

Enabling Ultra-low Power Machine Learning at the Edge

tinyML EMEA Technical Forum 2021 Proceedings

June 7 – 10, 2021

Virtual Event

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DSP GROUP

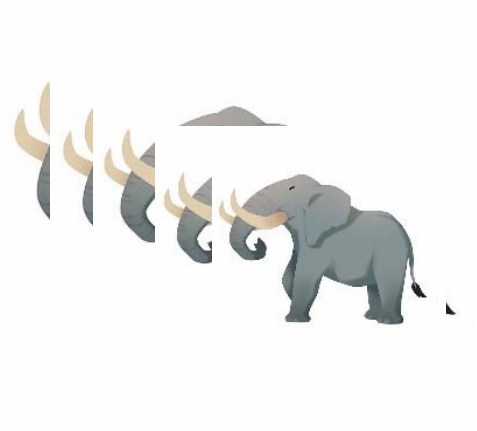
DSP Group
Innovative Minimization of Parameter Memory in small silicon low power devices

June 2021

Moshe Haiut is a principle senior engineer in the CTO team at DSP Group, Herzliya, Israel. His main areas of expertise are communication, video and audio digital signal processing, digital hardware architecture, and neural networks. Moshe holds M.Sc (with honors) and B.Sc. (with honors) degrees in Electrical Engineering from Tel-Aviv University and the Technion, Israel.
Moshe is the architect of the nNetLite – an ultra-low-power H/W engine for NN inference models execution

The Problem – Memory space for the parameters (weights)

- Small-to-medium NN models may have millions of parameters, while the tinyML SOC usually has limited memory (hundreds of KBytes) to store the weights data
- In this presentation we show how this problem was solved by an innovative h/w accelerator (Weights Extraction Unit) combined with a powerful s/w toolchain

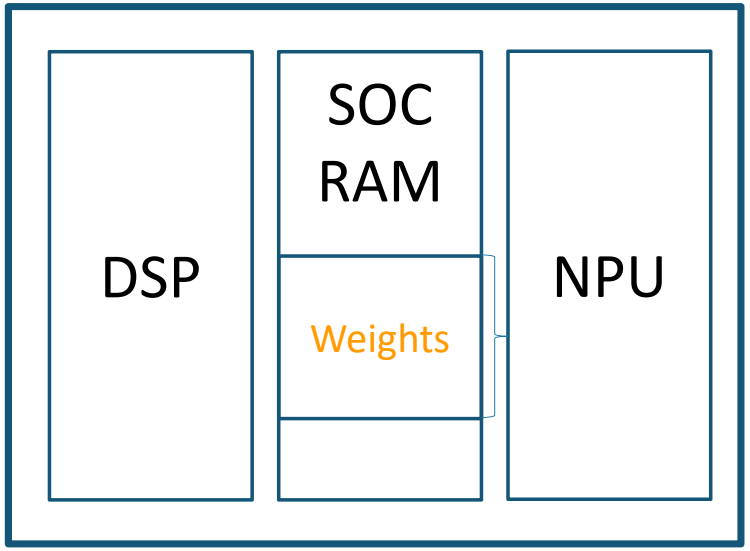


Quantization

Pruning

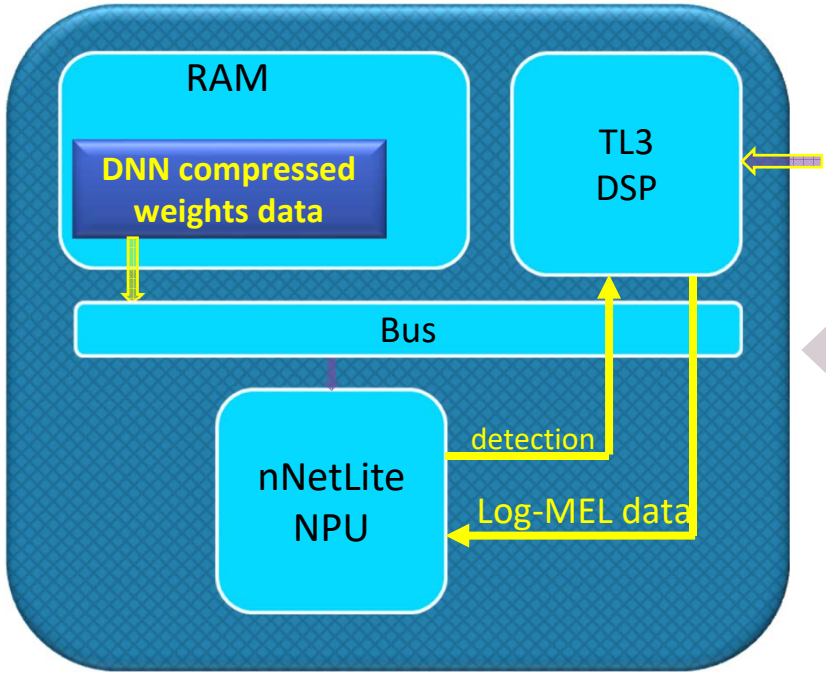
Entropy Coding

Packing



The DSPG nNetLite h/w Engine

- The nNetLite engine is a stand-alone module, planed to be embedded in DSP Group's future SOCs.
- The DBM10L ultra-low-power device comprises the nNetLite engine and the CEVA TeakLite-3 side-by-side



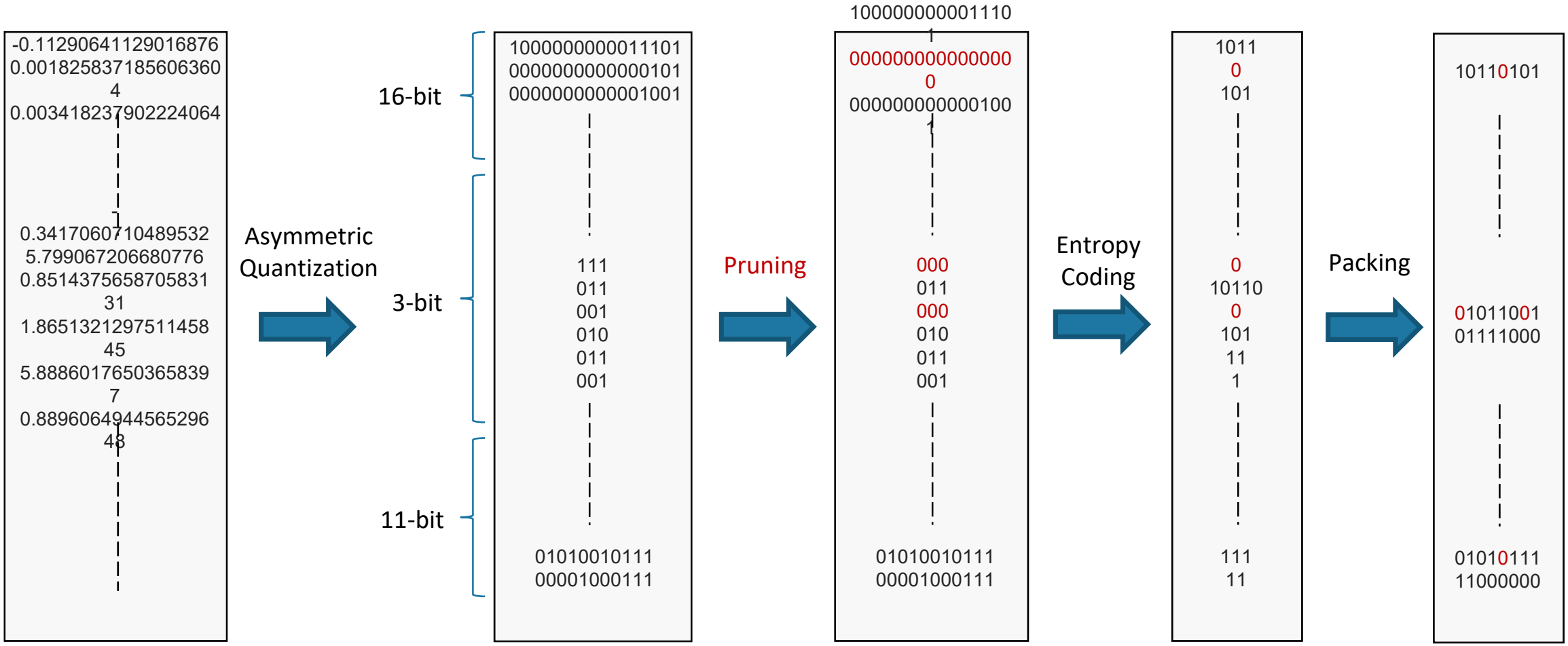
DBM10L incorporates the nNet Lite engine and a DSP

The nNet Lite engine is configured by the DSP and executes concurrent inferences in a stand-alone manner

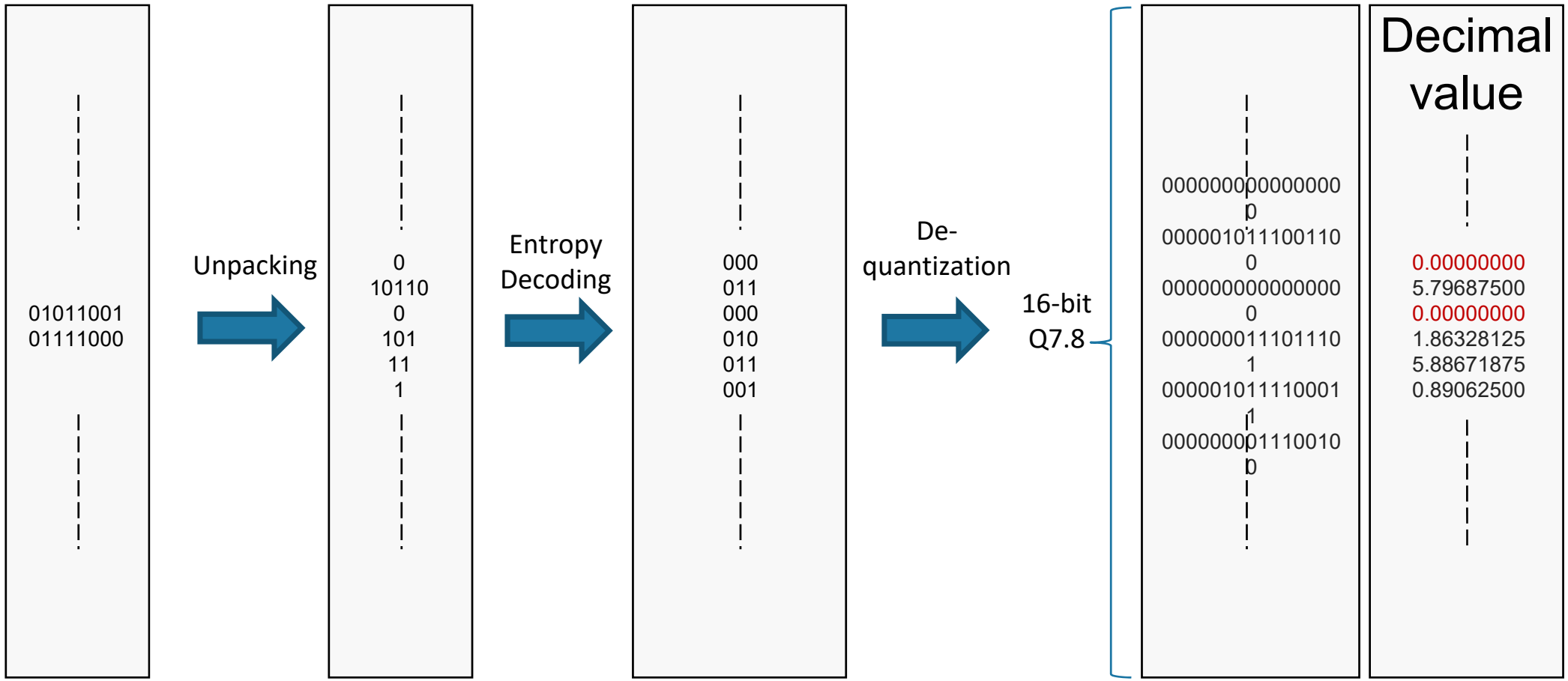
The DSP makes the audio pre-processing (e.g. log-MEL calc.) and the detection post processing to support the concurrent inferences

The NN weights are stored in the shared RAM in a compressed form and fetched by the nNet Lite engine via DMA

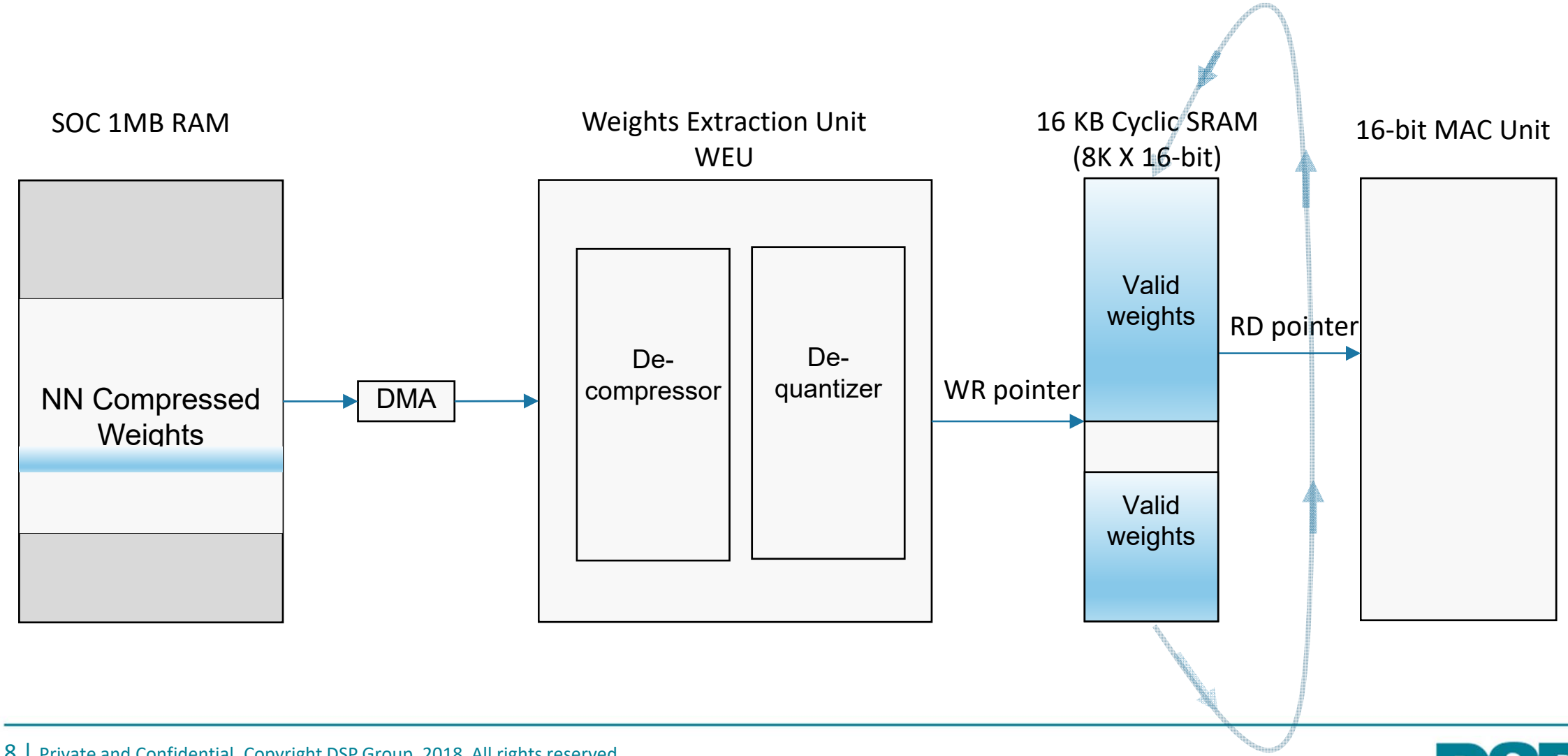
Weights Compression by the nNetLite Compiler



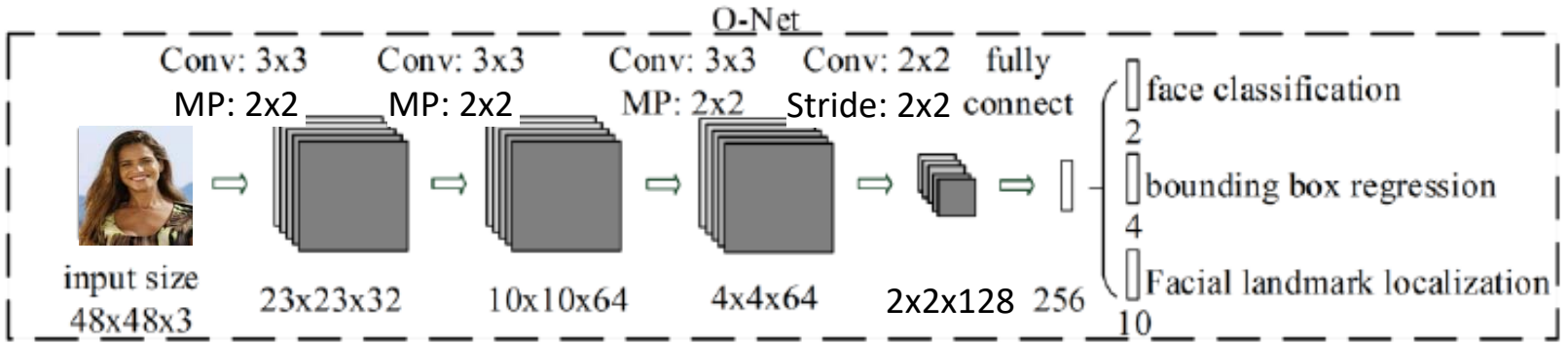
Weights De-compression by the nNetLite WEU h/w module

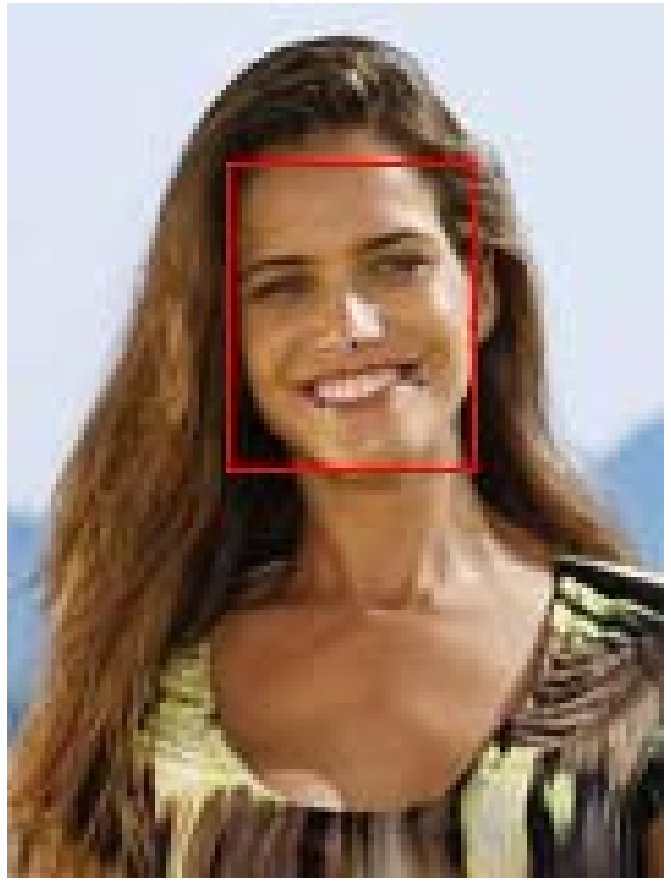


Weights De-compression by the nNetLite WEU h/w module



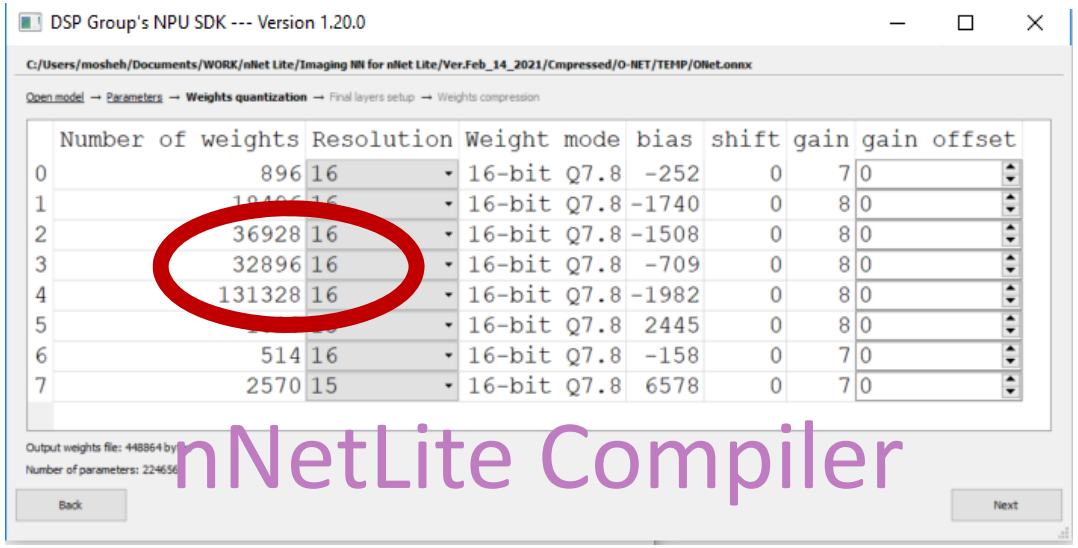
Example: Face Detection NN



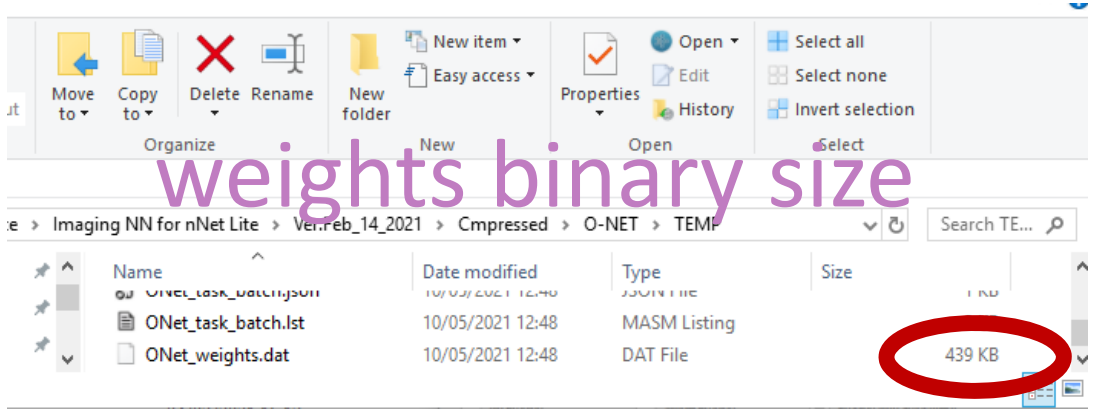


- Number of layers: 8
- Number of MAC ops: ~12M / Inference
- Number of Weights: 224,656
- Available memory: 280KB

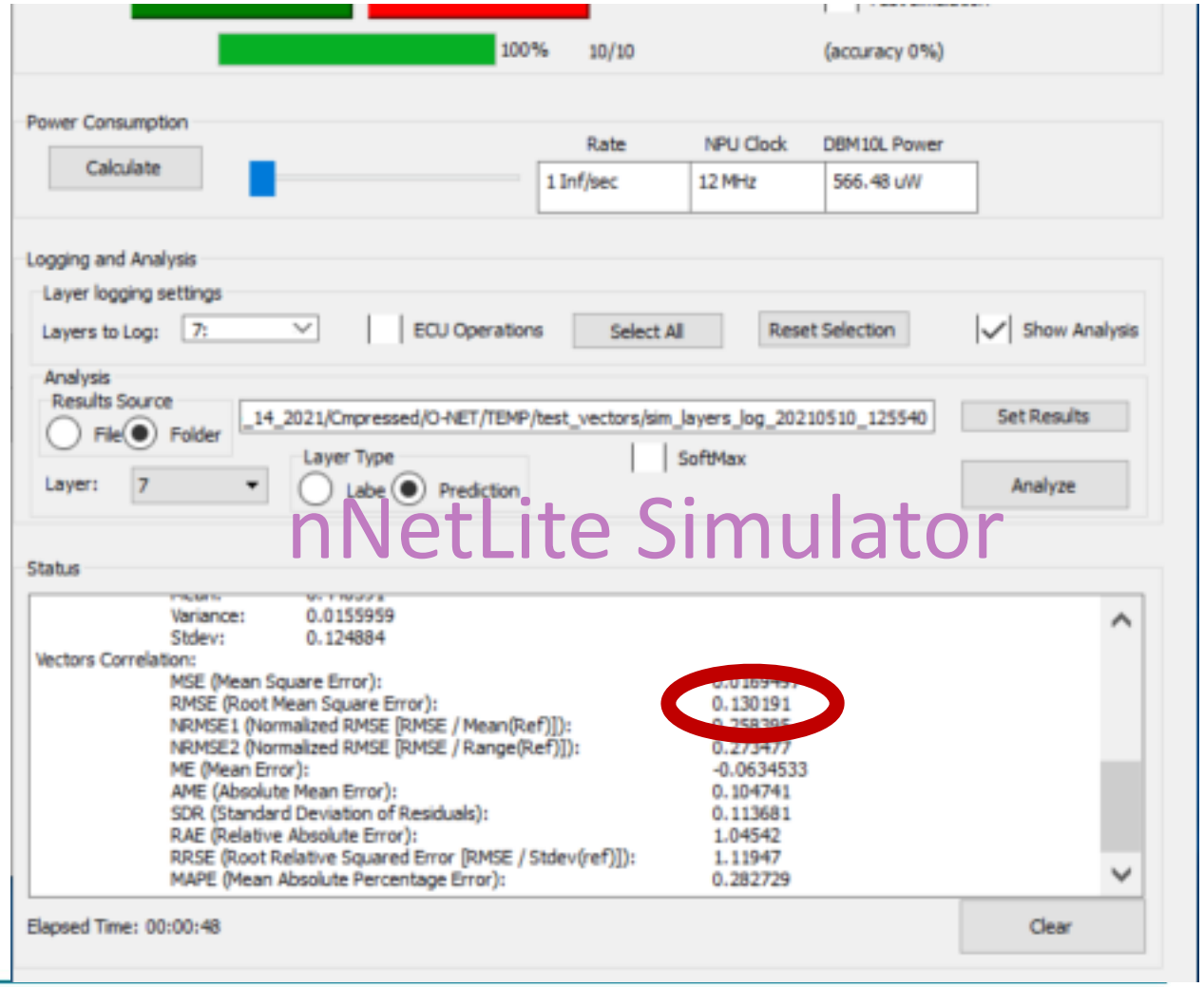
w/o Compression. Weights: 439 KB, RMSE: 0.130191



nNetLite Compiler

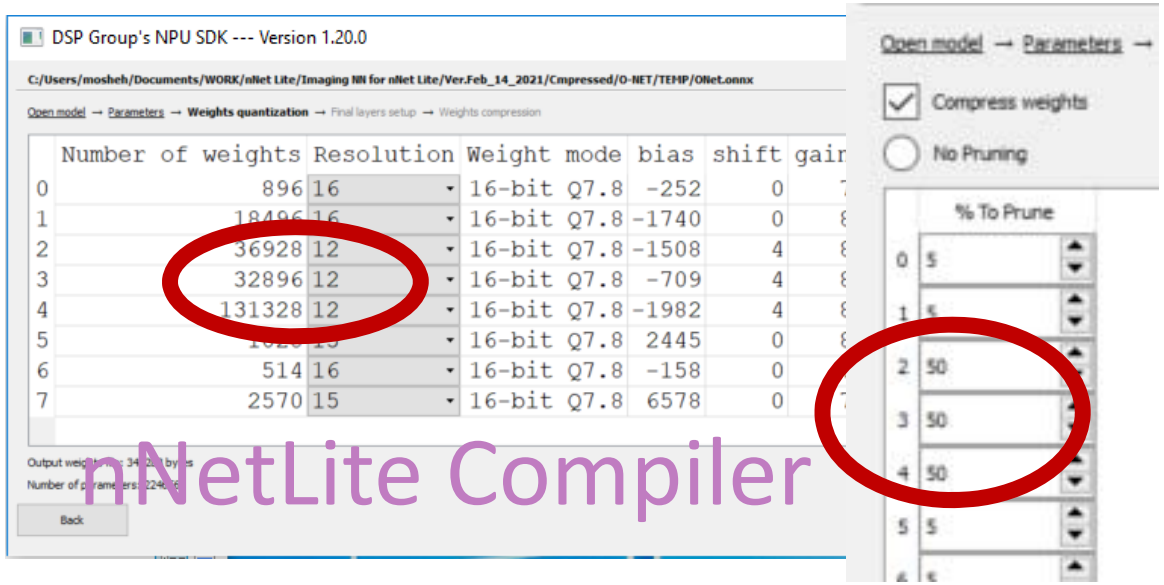


weights binary size

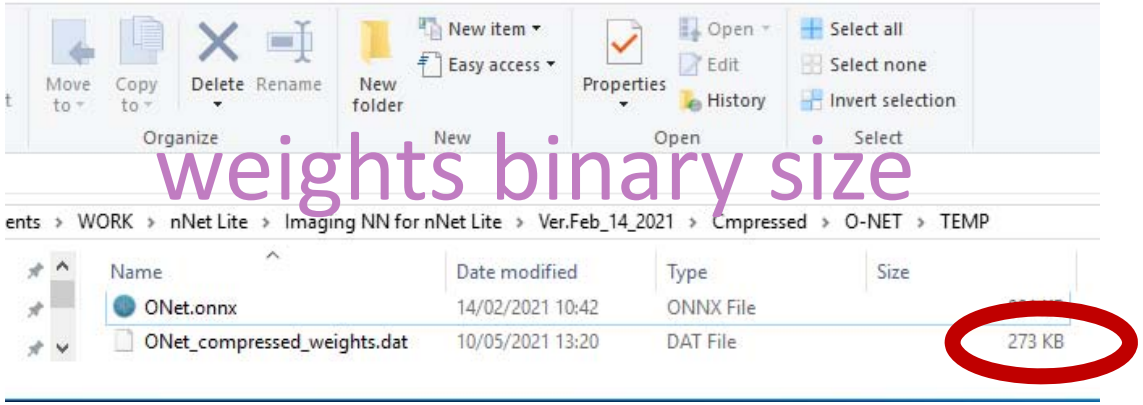


nNetLite Simulator

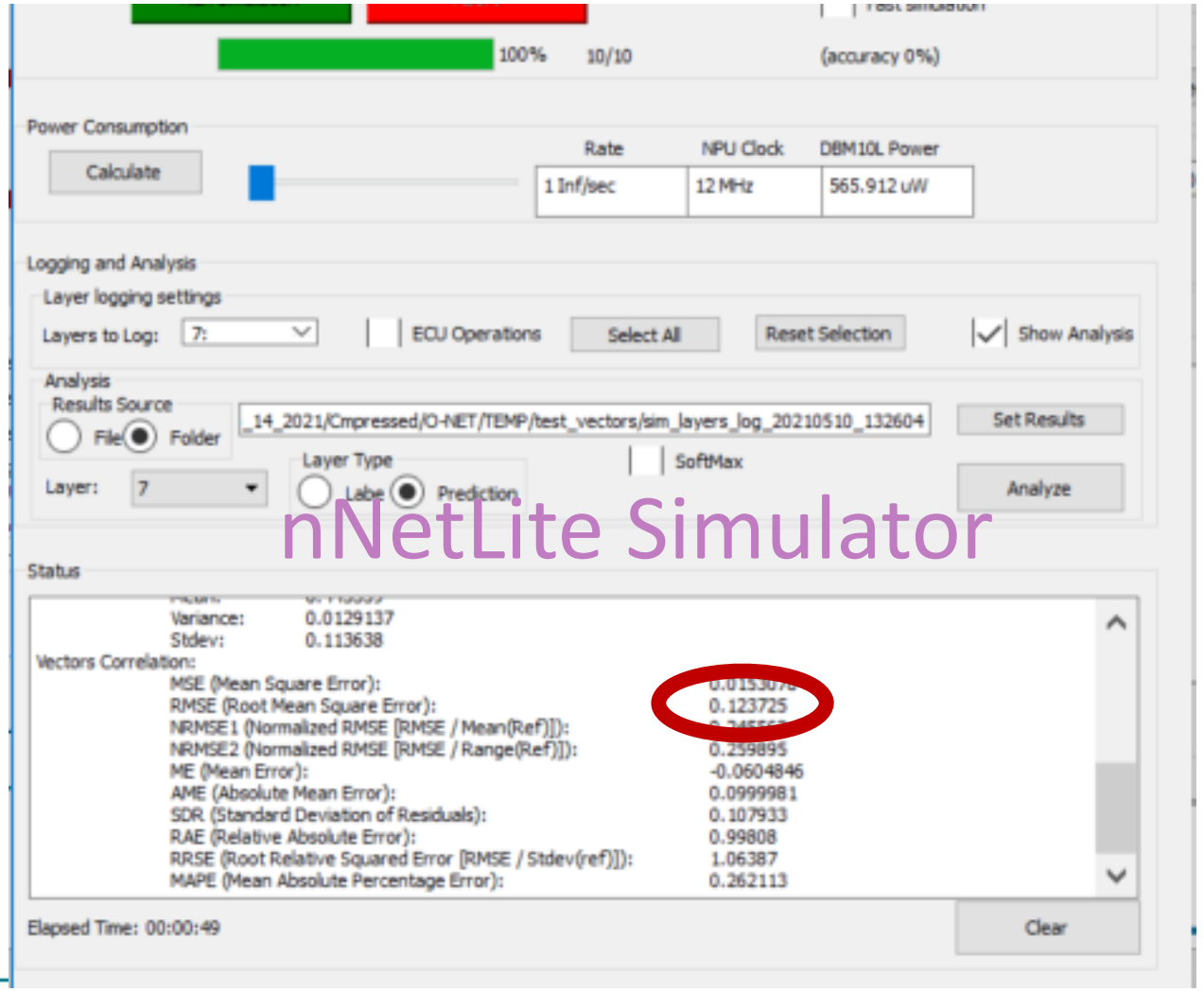
12-bit weights, 50% Prun. Weights: 273 KB, RMSE: 0.123725



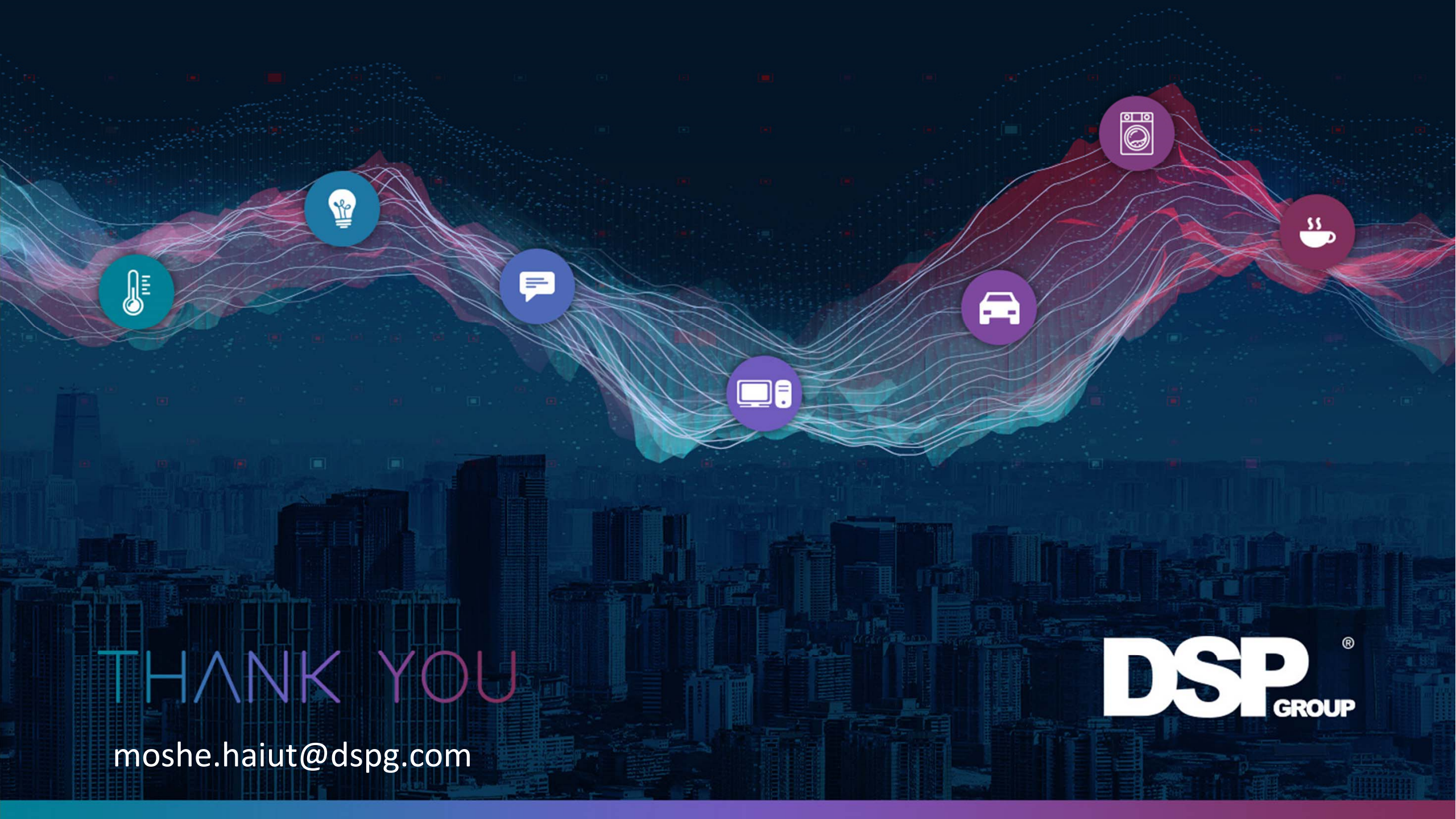
nNetLite Compiler



weights binary size



nNetLite Simulator



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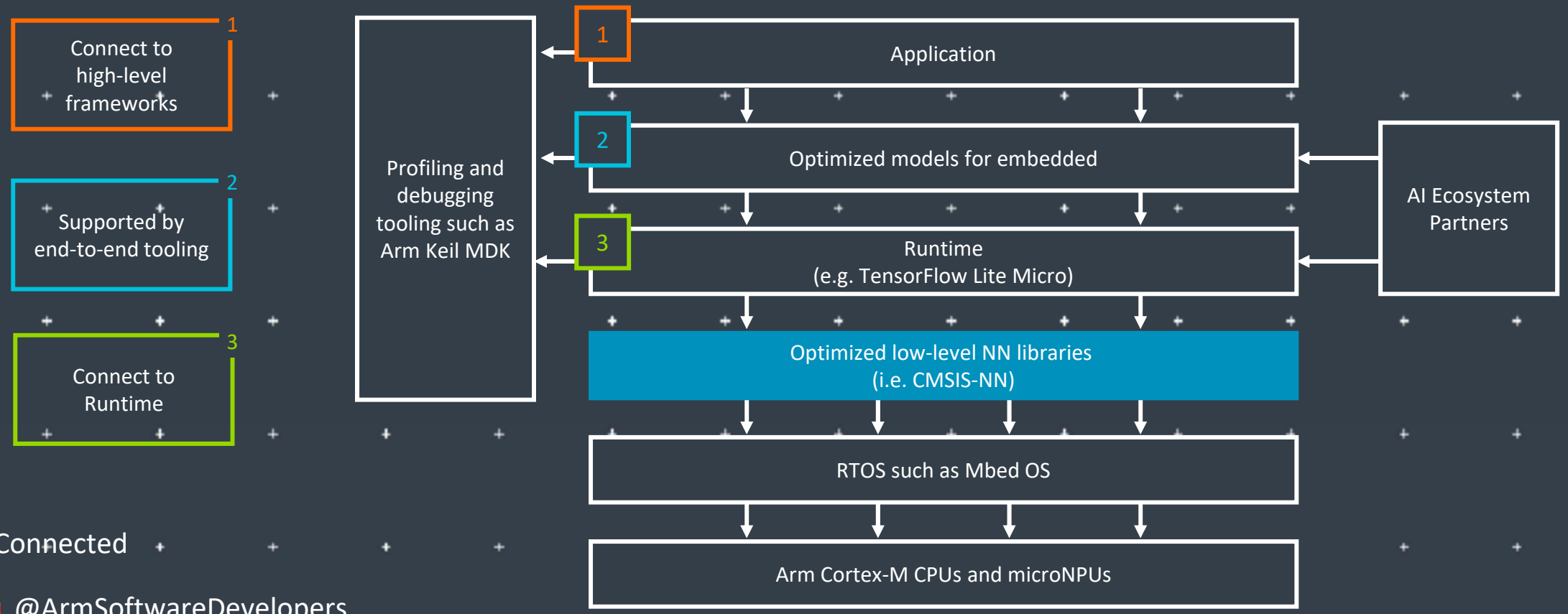

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Resources: developer.arm.com/solutions/machine-learning-on-arm

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Arduino library

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Enrich data and train ML algorithms

Edge Device

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Open source SDK

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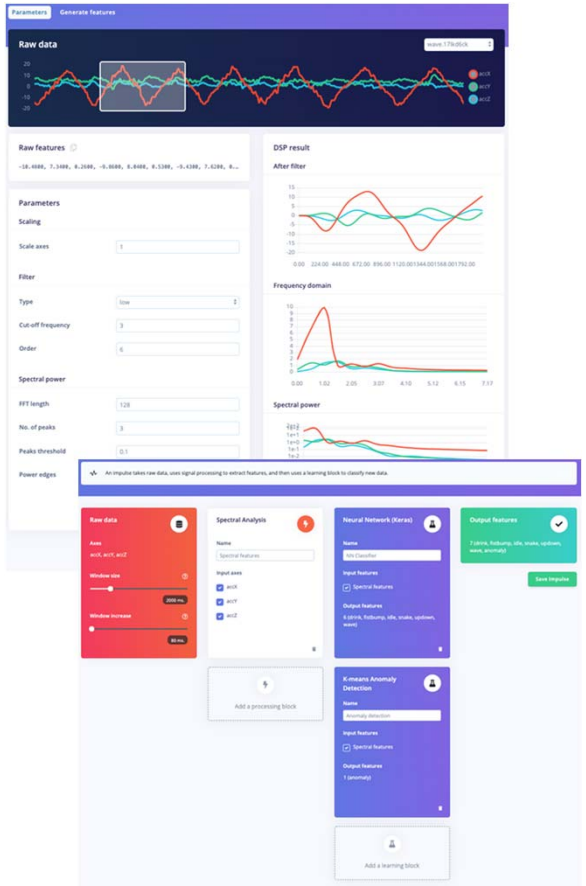
Test



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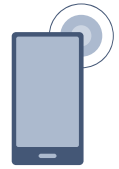

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Founded in 2017 and headquartered in Irvine, California, the company is backed by Amazon, Applied Materials, Atlantic Bridge Capital, Bosch, Intel Capital, Microsoft, Motorola, and others. Syntiant was recently named a CES® 2021 Best of Innovation Awards Honoree, shipped over 10M units worldwide, and unveiled the NDP120 part of the NDP10x family of inference engines for low-power applications.

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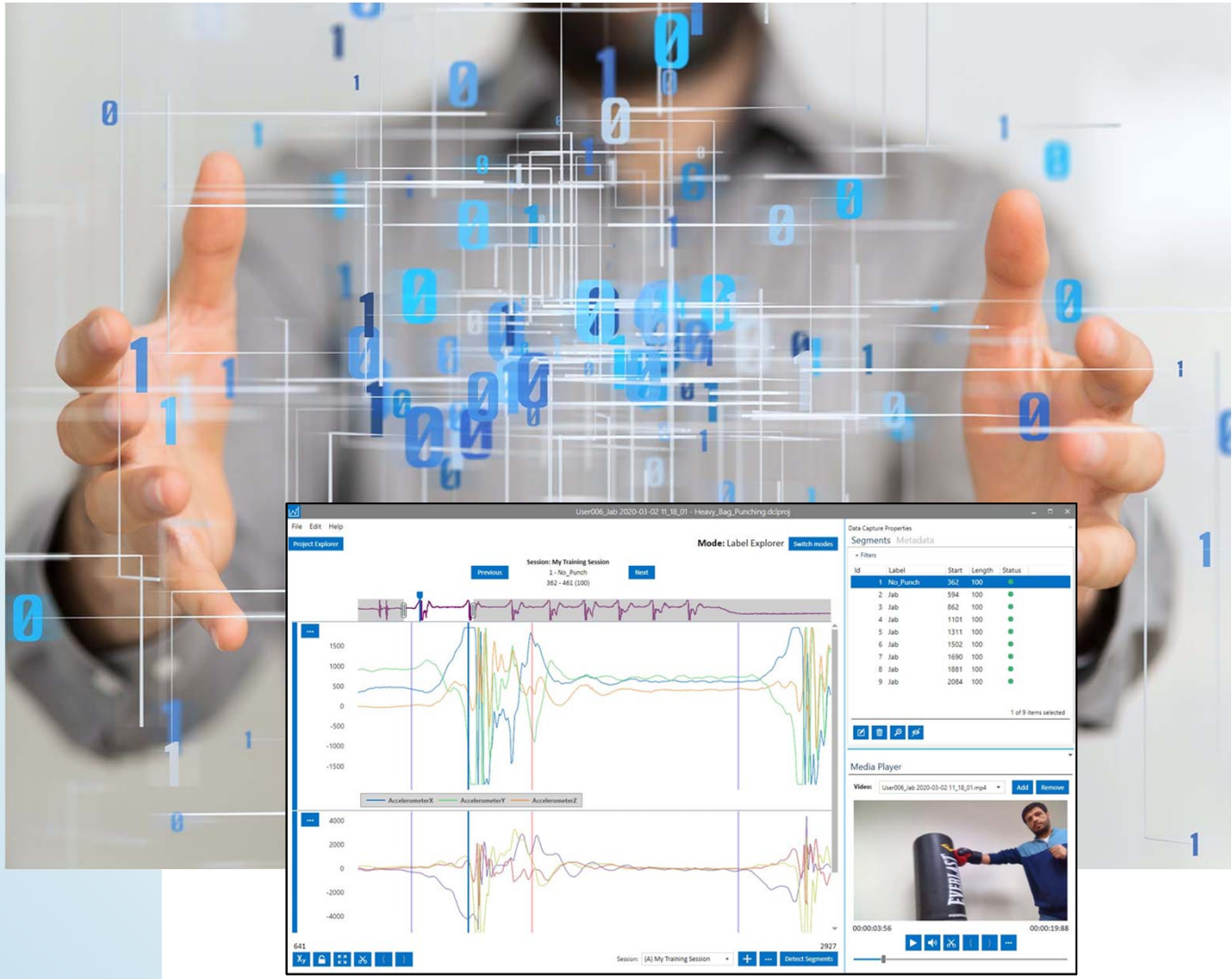

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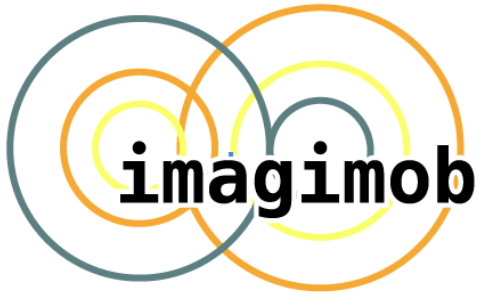

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