Efficient AI Inference at the Edge with Imagination IP

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Imagination: A Global Technology Leader

A technology powerhouse for multimedia, communications and AI IP

An industry leader since 1985

Developing innovative IP

- Leader in embedded Graphics and GPU compute IP
- Leading the advance in dedicated Vision and AI IP
- Leader in RPU communications IP

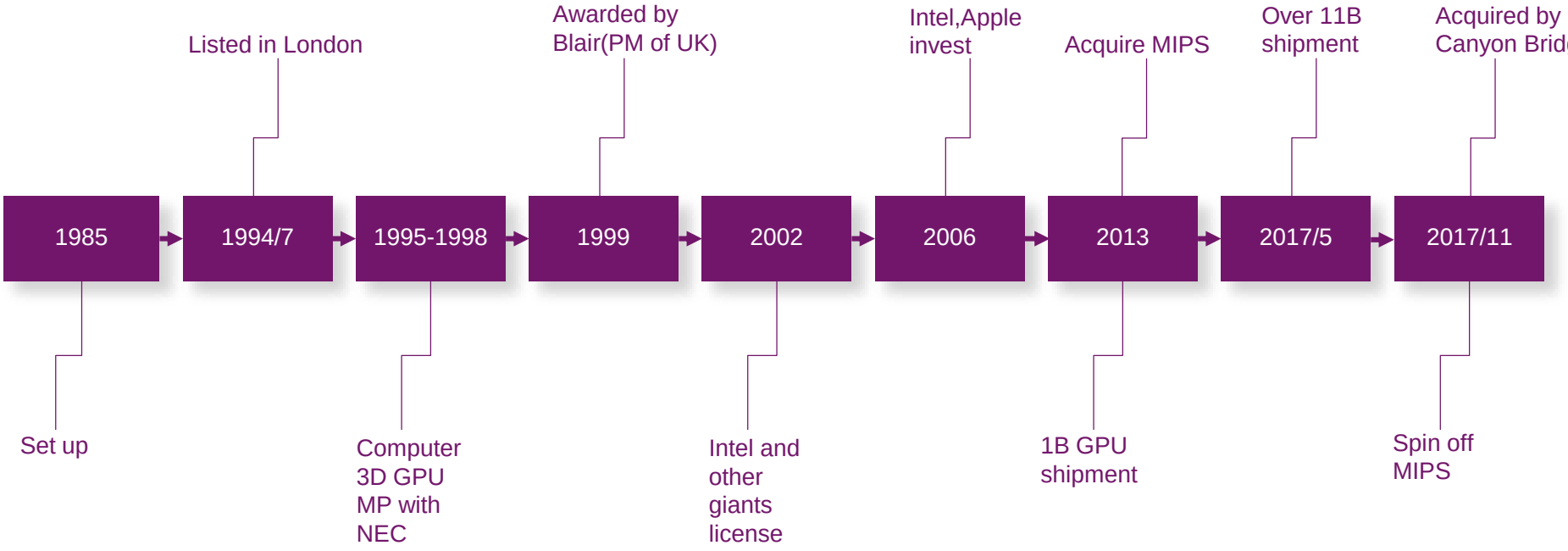
Delivering exceptional service

- Enabling very fast time to market
- Enabling customers to leverage IP to maximise differentiation

Driving major markets

- Helping our partners to create successful solutions
- Influencing new and emerging opportunities
- Showcasing and proving our technology with real products

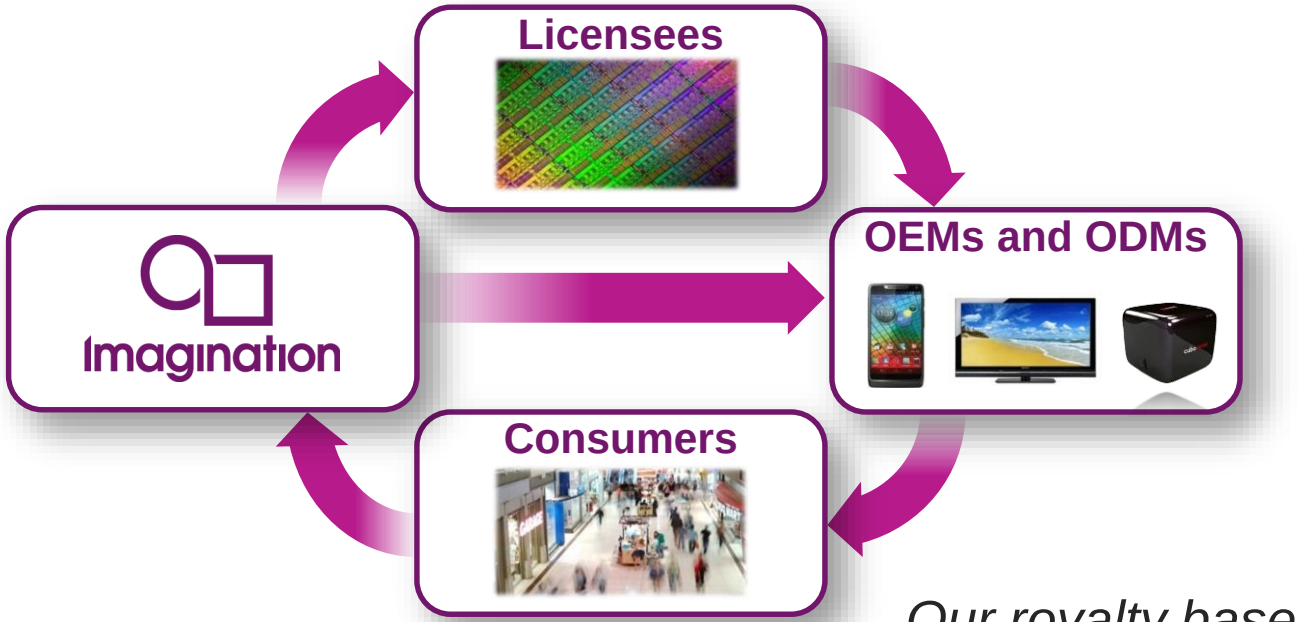
Company



CANYON BRIDGE

Imagination

Business Model



Our royalty based business model means we only succeed if our customers succeed

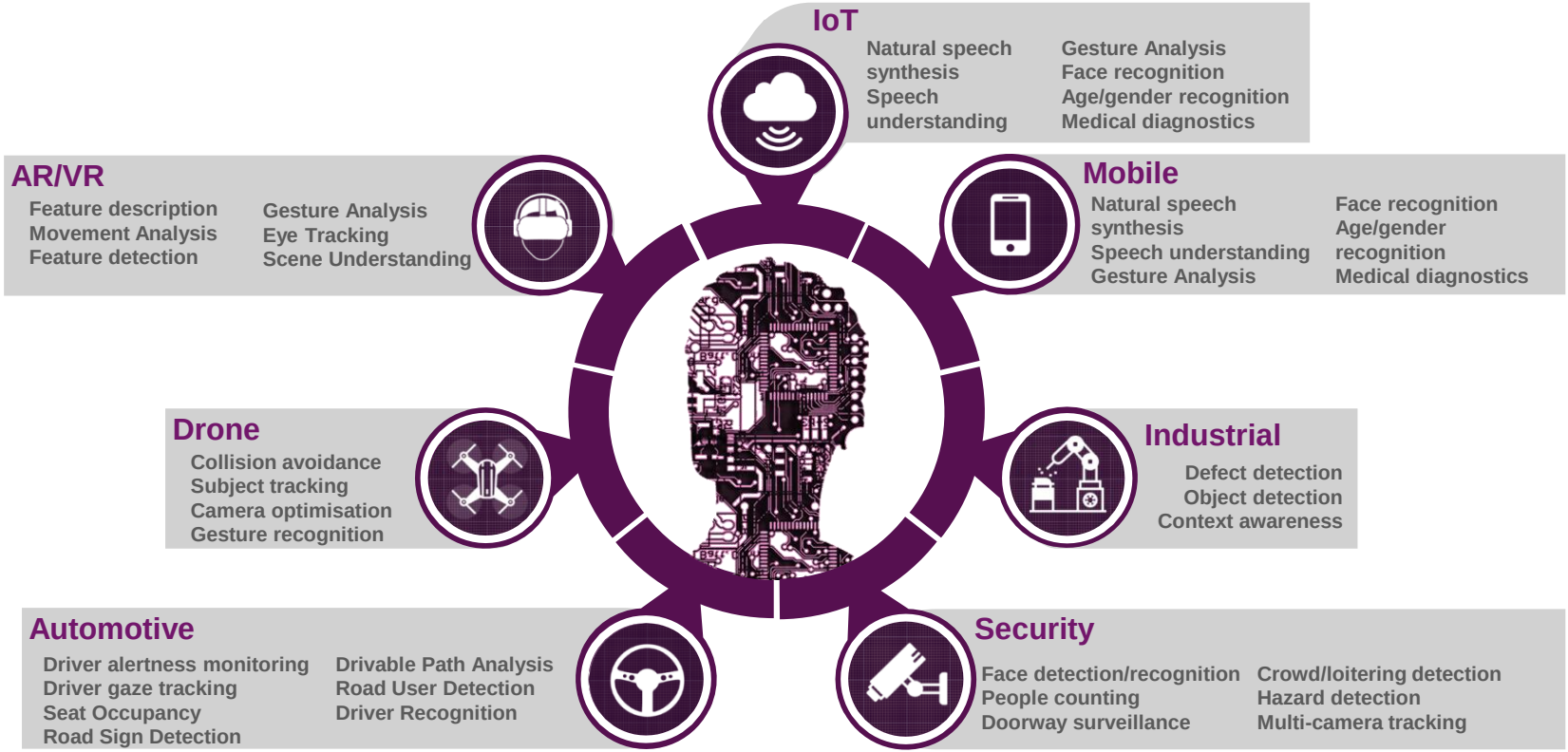
Licensees and Partners

Key Licensees

Strategic Partners

Neural Network Landscape & Growth Opportunity

Large variety of Edge AI Applications across many different Markets



Imagination Product Portfolio

Imagination

The best solution for embedded graphics, vision, AI and communications

PowerVR GPU

Leading graphics IP cores for embedded devices

PowerVR Vision & AI

Dedicated AI and Computer Vision IP Products

Ensigma

Connectivity and broadcast communications

High performance, low power

XE/XM GPU

Focused Features

Fillrate/mm^2 & Performance/mm^2

XT GPU

Feature rich

Performance/mW

PowerVR 2NX

Neural Network Accelerator

Performance/mm2

Performance/mW

PowerVR ISP

Low area, high quality & highly power efficient

Multi camera capable ISP

RF

Wi-Fi, Bluetooth

Connectivity

Wi-Fi, Bluetooth

IEEE 802.15.4

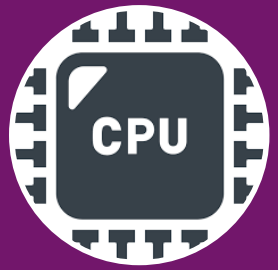
GNSS

Broadcast

TV, Digital Radio

Edge Neural Network Processing Resources

Why GPU and Neural Network Accelerators are Best

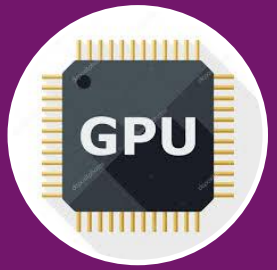


CPU

- Fully Flexible
- BUT inefficient and slow for high compute workloads

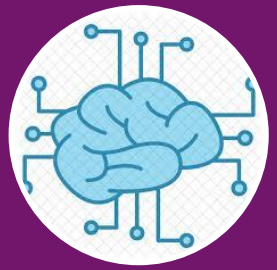
DSP

- Fully Flexible
- BUT hard to program – no standardisation, INT focussed



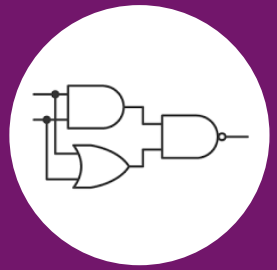
GPU

- Fully Flexible
- Standardised APIs for Compute, Float and INT support



Neural Network Accelerator

- Configurable
- Lowest power with domain specific flexibility



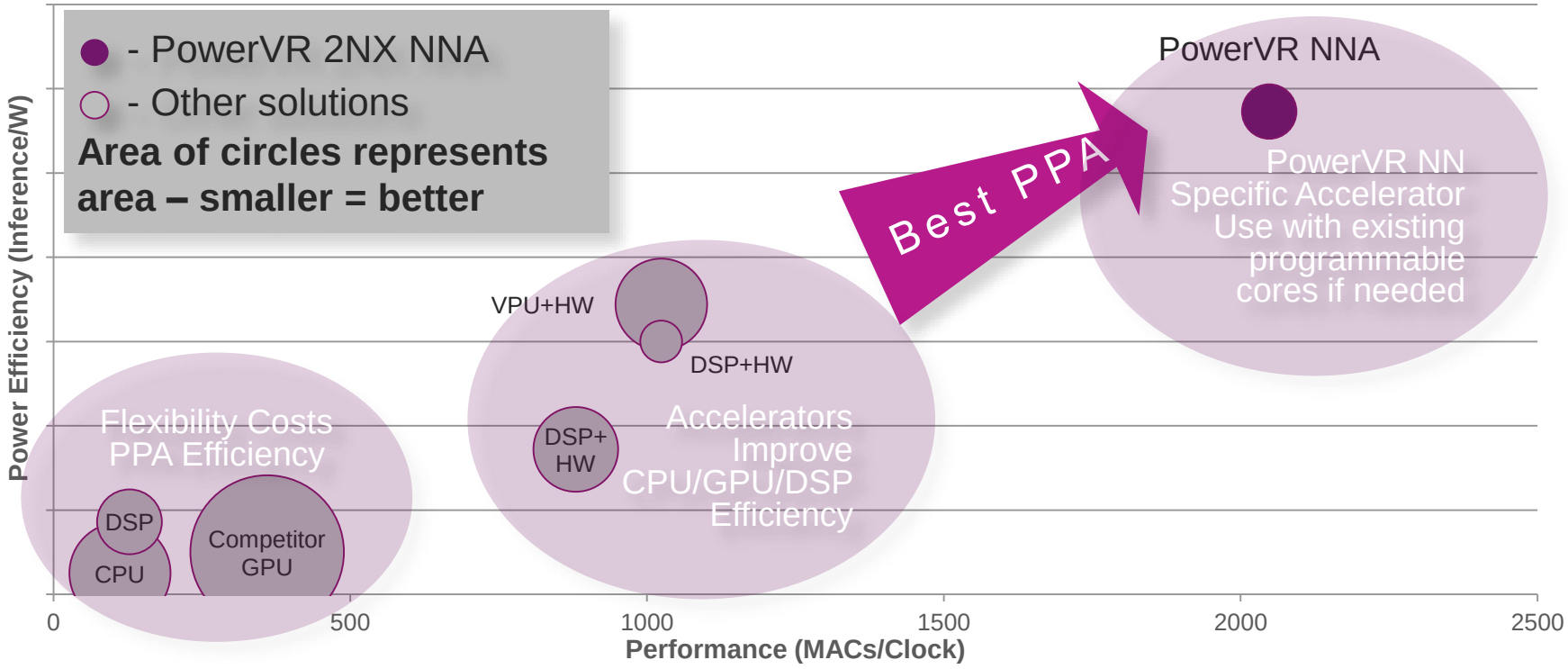
Fixed Function

- Single usage case
- Lowest power BUT zero flexibility

Efficiency sweetspot

PowerVR NNA Leading Position

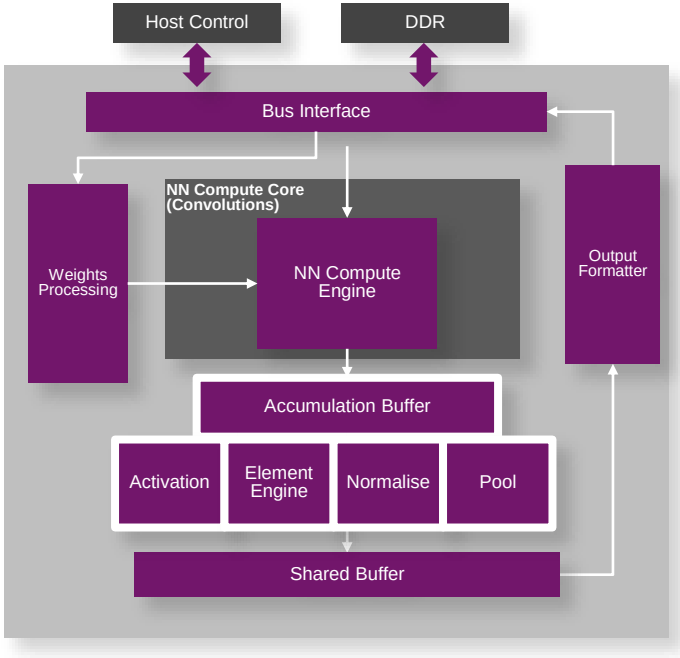
Only a dedicated hardware solution offers required PPA for long battery life



PowerVR 2NX NNA – Architecture and Features

IP core to enable efficient inferencing of neural networks in SoCs at the "edge"

- **Scalable architecture**
  - 2048 8-bit MACs/clock equals **4Tops/core**
  - Multi-core scalable achieves beyond performance
  - Architected for creation of future cores with different performance points and feature sets to address multiple markets and applications
- **Flexible bit-depth data type support**
  - 16, 12, 10, 8, 7, 6, 5, 4-bit support – covering different markets taking advantage of the benefits of lower precision
  - Per layer adjustment for both weights and activations
  - Maximum performance at minimum power and bandwidth
- **Variable precision internal data formats**
  - High precision, where required, inside the accumulator
  - Quantisation for following layers for efficient power/processing efficiency
  - Ensures optimum accuracy for results

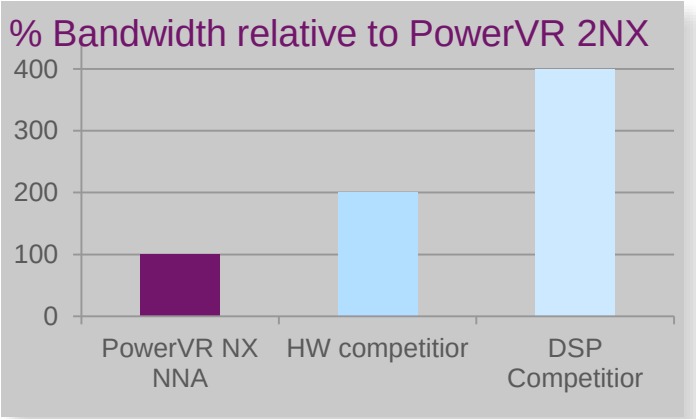


Research on Low bit Benefit

PowerVR 2NX – precision flexibility for optimised performance, power and bandwidth

Only fully connected weights (bits)	Relative inference/s	Relative bandwidth	Relative energy/ inference	Relative accuracy
8	100%	100%	100%	100%
4	160%	54%	69%	99%

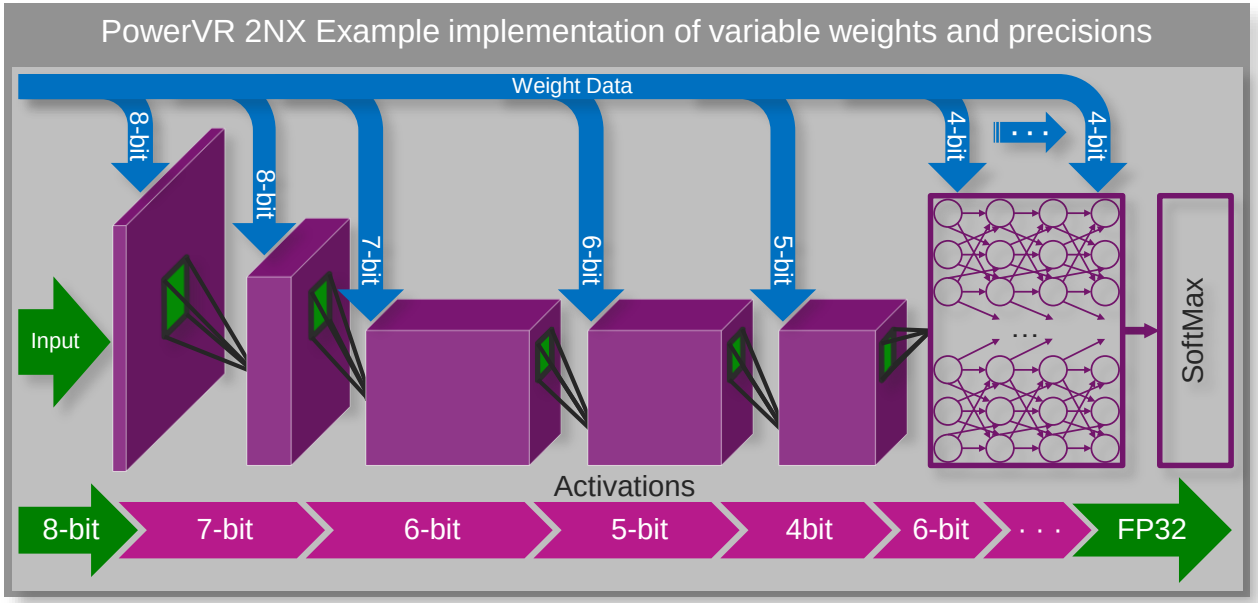
PowerVR precision flexibility enables 60% performance increase, at 54% of the bandwidth, 69% of the power with less than 1% drop in accuracy



PowerVR precision flexibility means requiring as little as 25% of the bandwidth compared with competing solutions

Flexibility on Low-bit

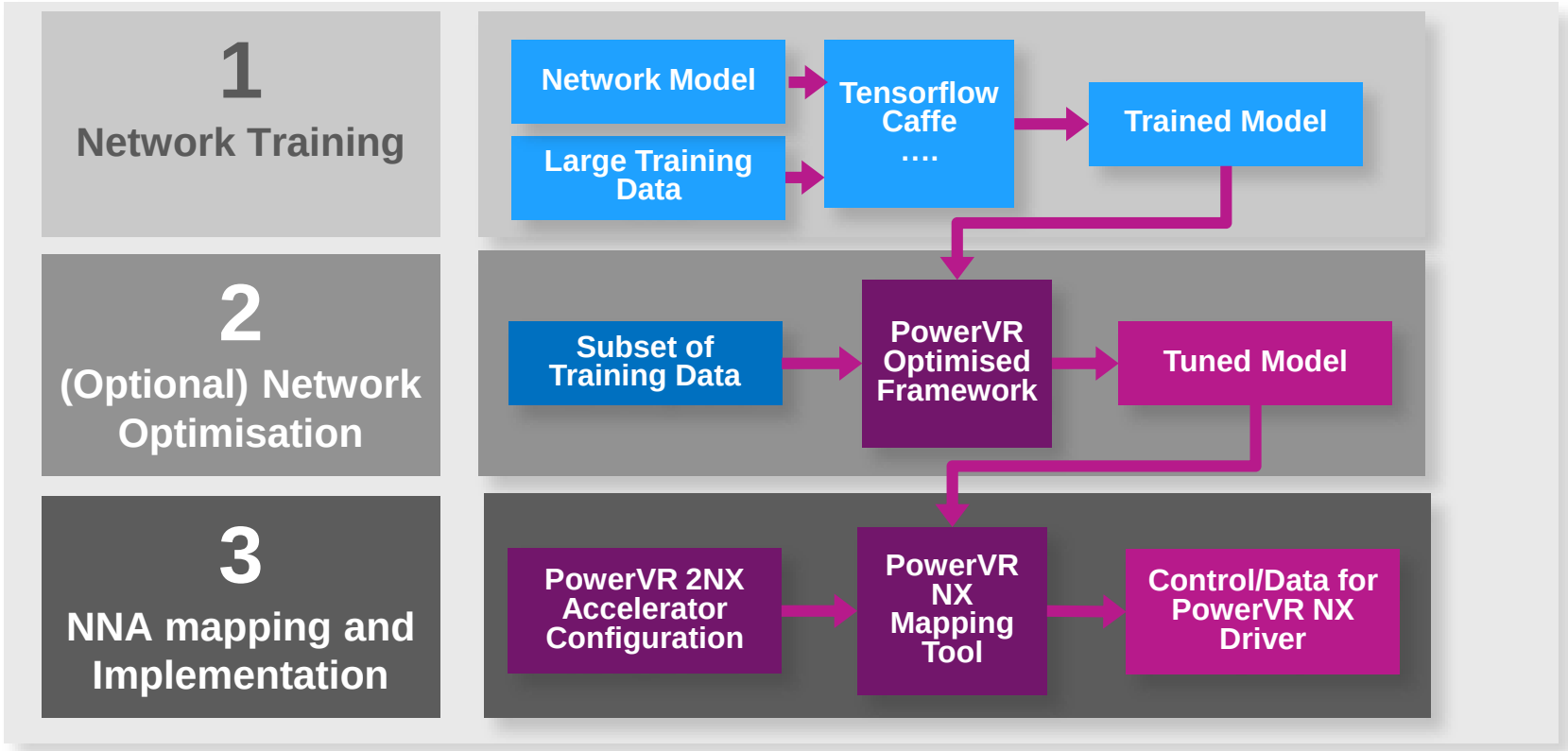
Maximises performance, maintains accuracy, minimises power and bandwidth



- **PowerVR 2NX NNA supports variable (including low) precisions for data and weights**
- **High Internal precision maintains network accuracy**
- **Allows higher performance at lower bandwidth and power**
- **Configurable output format enables CPU/GPU/DSP compatibility**
- **PowerVR 2NX is the only solution on the market with this level of flexibility – unique benefit**

Easy Going on PVR Platform

It's as easy as 1 .. 2 .. 3 - PowerVR 2NX workflow

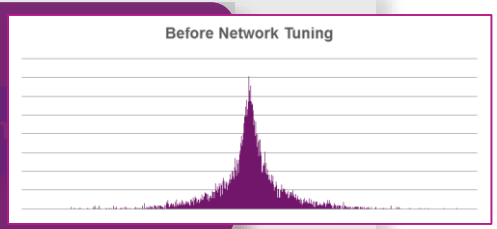


Performance & Bandwidth(compiler)

It's as easy as 1 .. 2 .. 3 - PowerVR 2NX workflow

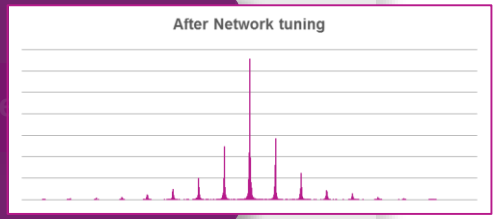
1
Training

Network Model
Large Training Data
Floating point 32-bits



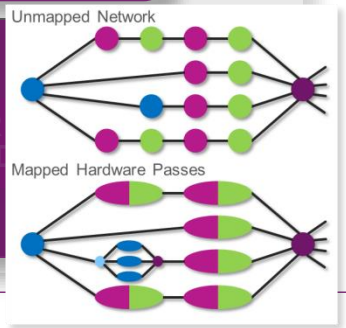
2
Tuning (Optional)

Trained Model
Subset of Training Data
Quantisation 4 to 16 bits



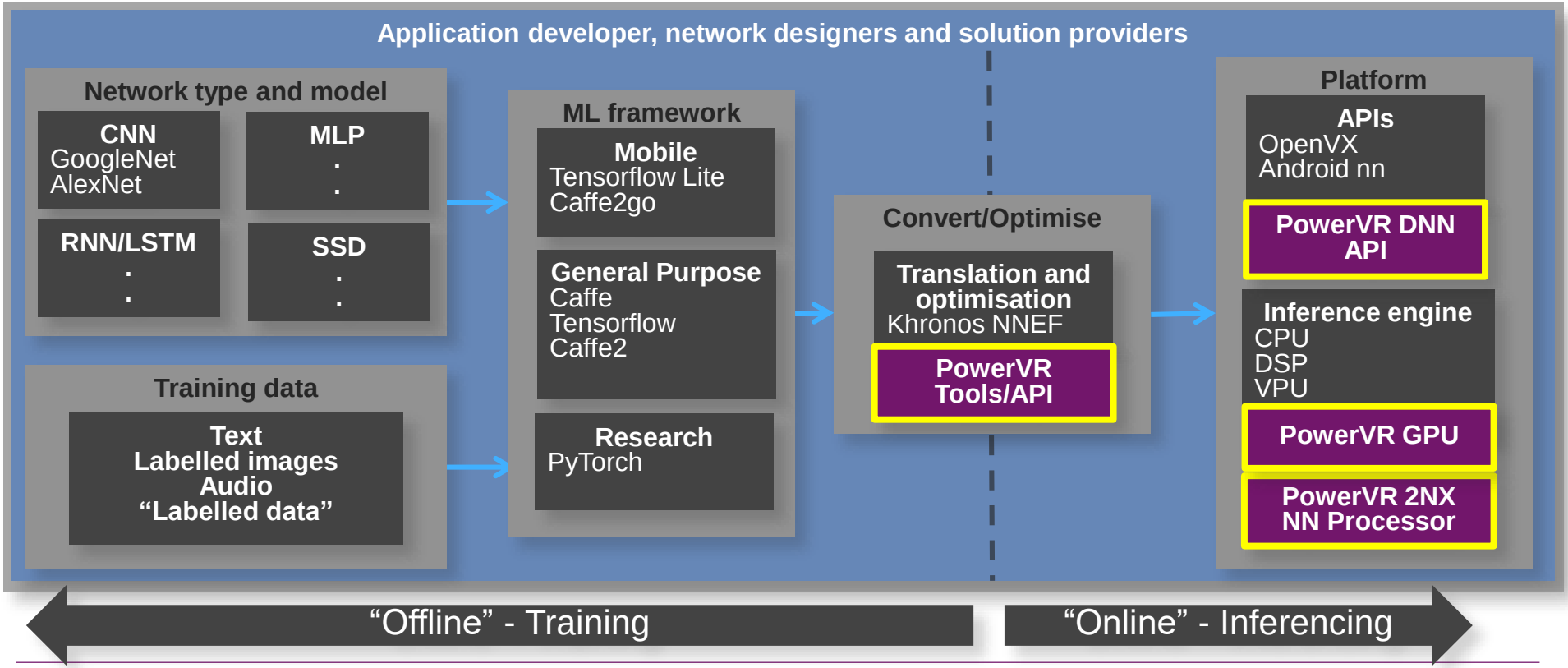
3
Mapping

(Tuned) Model
PowerVR 2NX Configuration
Optimal usage of Hardware (Bandwidth, Performance Tuning)



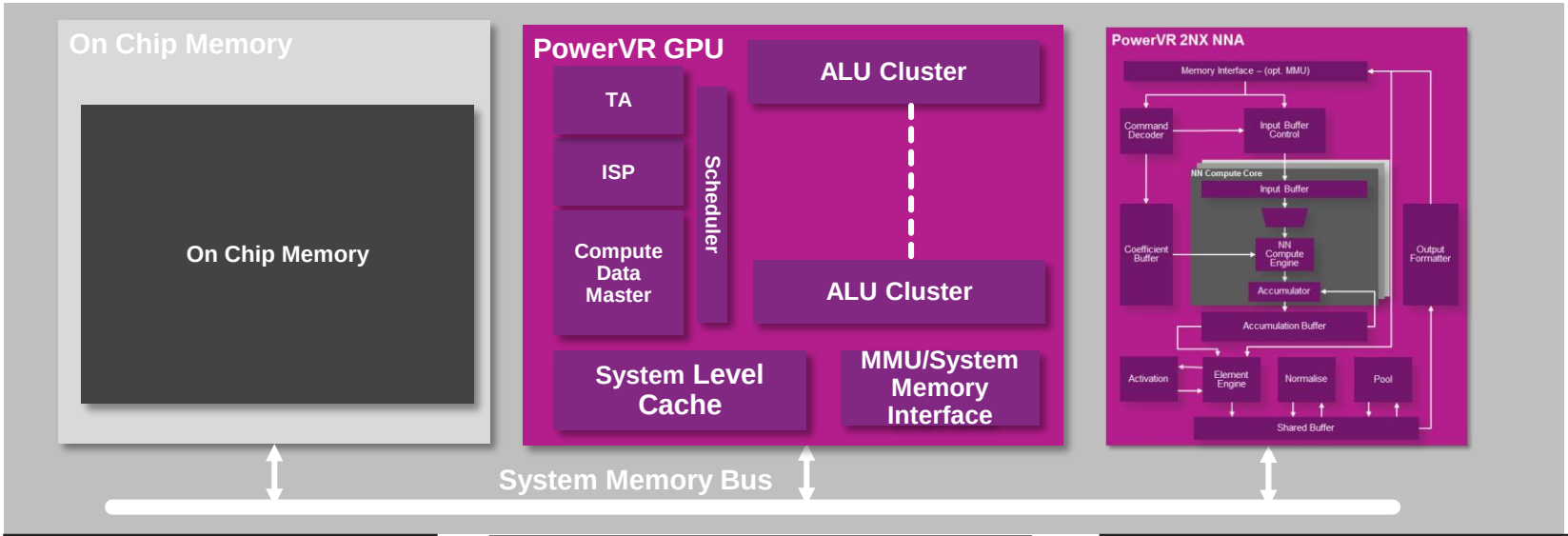
Cross Platform API

Training, network types and models, frameworks, inference engines, APIs …



Complete Imagination AI System

PowerVR GPU, PowerVR NNA (Neural Network Accelerator)



On Chip Memory

- Optional
- Reduces bandwidth of Neural Network Processing
- Can be used by other system components and other usage scenarios e.g. GPU Graphics

PowerVR GPU

- Reuse existing hardware (if applicable)
- Fast performance
- No extra silicon area (vs. graphics)
- Can run all layer types
- Low power

PowerVR Neural Network accelerator

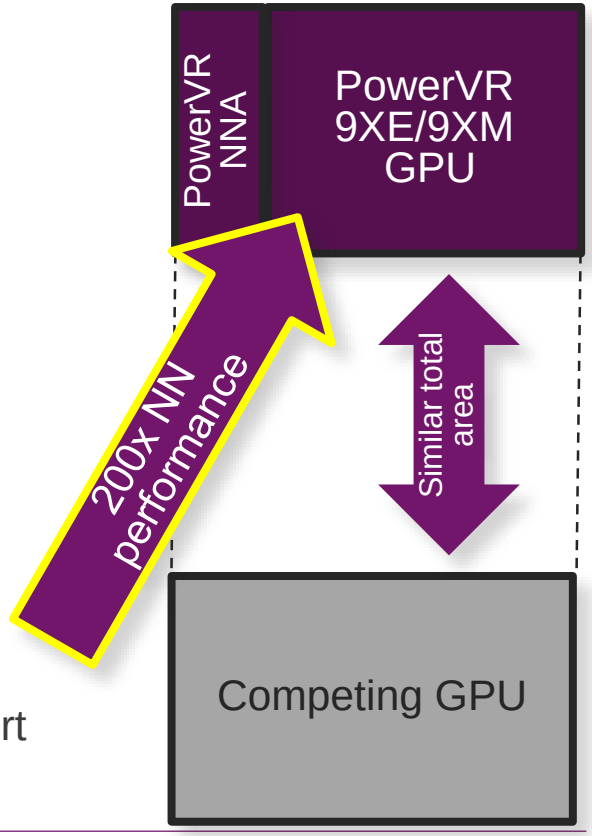
- Dedicated hardware
- Fastest performance
- Smallest silicon area
- Lowest power and bandwidth
- Works with PowerVR GPU or 3rd Party IPs

PowerVR the Best for Business

PowerVR 2NX designed for mobile and Android

- **PowerVR 2NX is the only IP solution in the market that can deliver against all the requirements for a deployable mobile solution**
- **Low area for PowerVR 2NX combined with the low area of the PowerVR 9XE GPU provides a GPU+NNA solution in the same footprint as a competing GPU alone**

- **Requirements met with PowerVR 2NX**
  - Low power – full hardware ensures lowest power/inference
  - Low area – most efficient solution in terms of inferences/mm^2
  - MMU – easy integration in SoCs supporting high level OSs
  - Android support - PowerVR has long history of Android support



Thank you

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