Bringing the Digital World into Our New Reality

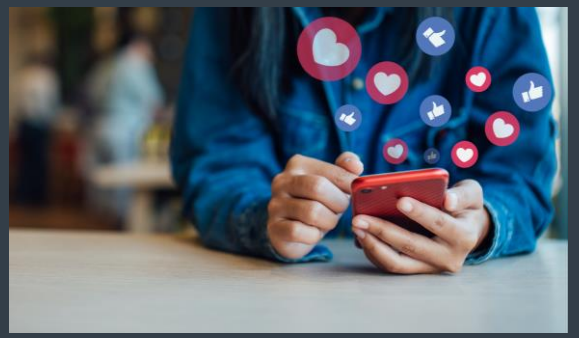
Paul Williamson,
VP & GM of Client Line of Business

May 2020

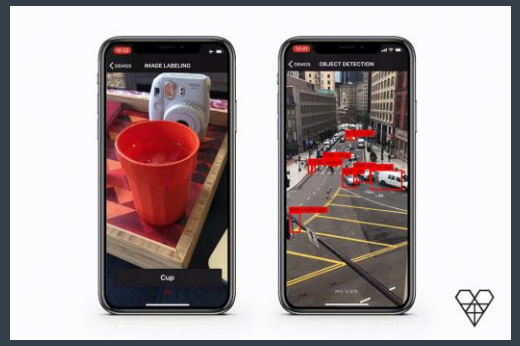
Digital Immersion is Shaping Our Life

Compute Capabilities

Form factor innovation



Connected all-day



Secure on-device Intelligence

Desktop-like mobile gaming

Creating your virtual world

arm

The Smartphone is Becoming Part of Our DNA

New ways of
being productive

Keeping one
step ahead

Expanding beyond
the normal

arm

Machine Learning is About What You Can't See

Advanced image processing

Biometric sensing

Health diagnostics

Power management for greater efficiency

Secure on-device data processing

Pocket-sized supercomputer

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Our Ecosystem Demands are Changing and Arm is Raising the Bar

Delivering Y-o-Y double-digit performance gains through improved efficiency

Extending Android smartphone capabilities with new levels of performance

Creating 5G solutions that allow millions of applications to scale

Pushing performance beyond the traditional for the most demanding use cases

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2020: The Mobile Digital Immersion Solution

Reaching New levels of Scalability

Leap in efficient performance

Life-like graphics for your entertainment

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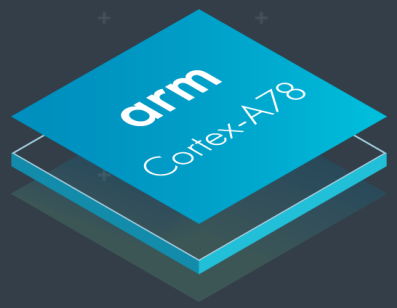
The Next-Gen Smartphone Compute Platform



+20%

sustained performance[1]

+25%

better performance[2]

+25%

performance efficiency[3]

1: Comparing Arm single core performance at 1 watt on Cortex-A78 to Cortex-A77, including architectural and process improvements (compared to 2019 devices). Measured estimates on SPECint*_base2006 (SPECspeed* Integer component of SPEC CPU* 2006) Arm single-core performance estimated for mobile platform. Results are measured estimates using specific computer systems, software, components, operations, and functions and changes to any of these factors will cause the results to vary. 2: Comparing mixed complex workloads on Mali-G78 to Mali-G77, including architectural, process and other improvements (compared to 2019 devices) 3: Average improvement measured as inf/s/mm2 for similar configurations of Ethos-N78 & Ethos-N77. Will vary per neural network

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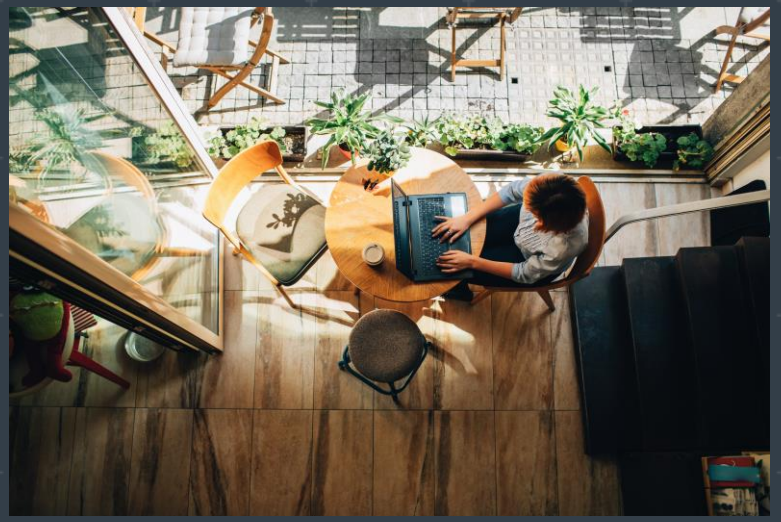
Premium Arm Cortex CPUs Continue to Push New Experiences

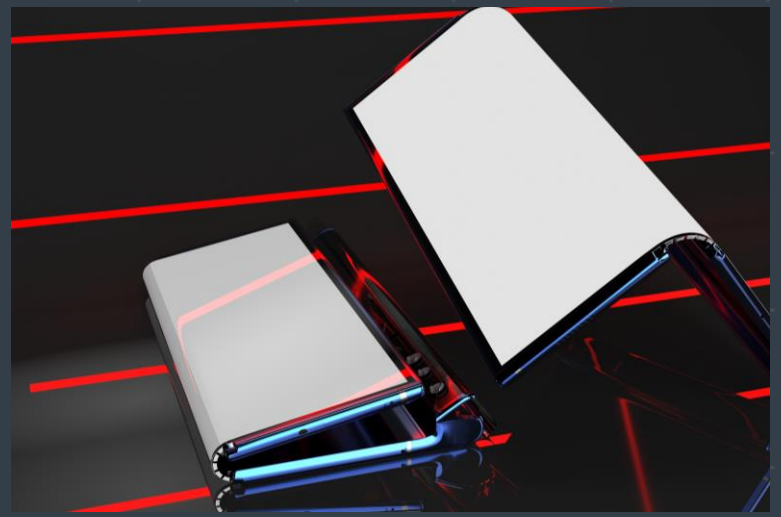
Immersive 5G Experiences

Performance demands increasing



All-day productivity

Always connected with multi-day battery life



New Form Factors

Efficiency key to smartphone innovation

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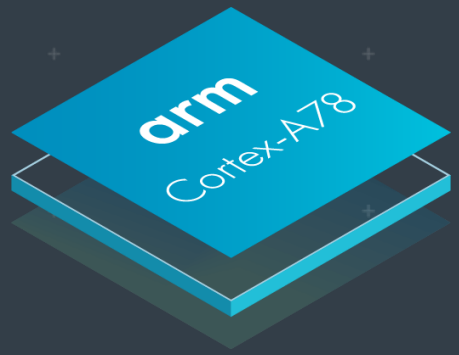
The Most Efficient Premium Cortex-A CPU Ever Designed

- Cortex-A78 is designed for high-end performance at best efficiency
- Optimized all aspects of the microarchitecture for best efficiency
- Support of DynamIQ Shared Unit Compatible with Cortex-A55 for big.LITTLE



+20%

sustained performance

(in the same mobile thermal envelope as previous generation)

Comparing Arm single core performance at 1 watt on Cortex-A78 to Cortex-A77, including architectural and process improvements (compared to 2019 devices) Measured estimates on SPECint*_base2006 (SPECspeed* Integer component of SPEC CPU* 2006) Arm single-core performance estimated for mobile platform. Results are measured estimates using specific computer systems, software, components, operations, and functions and changes to any of these factors will cause the results to vary.

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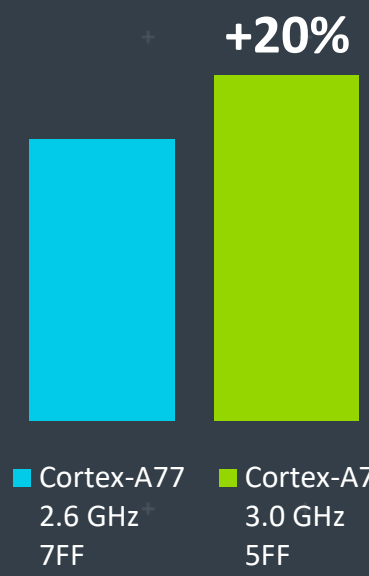
Cortex-A78: Major Push on Efficient Performance

Power efficiency

Cortex-A78 CPU performance in same power envelope



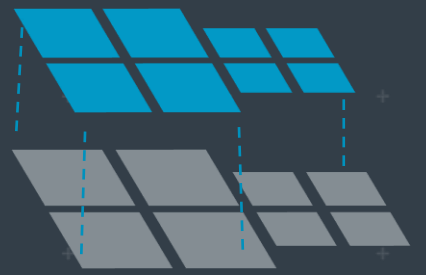
Based on 1W/core

20%
More sustained performance

15%
Smaller Octa-core Cluster

Area efficiency

Cortex-A78 CPU area savings over Cortex-A77



2020
Cortex-A78/Cortex-A55, 5FF

2019
Cortex-A77/Cortex-A55, 7FF

Comparing Arm single core performance on Cortex-A78 to Cortex-A77 in 1W, Cluster comparison using 4MB L3 cache not shown, Including architectural and process improvements (compared to 2019 devices)
Measured estimates on SPECint*_base2006 (SPECspeed* Integer component of SPEC CPU* 2006) Arm single-core performance estimated for mobile platform. Results are measured estimates using specific computer systems, software, components, operations, and functions and changes to any of these factors will cause the results to vary.

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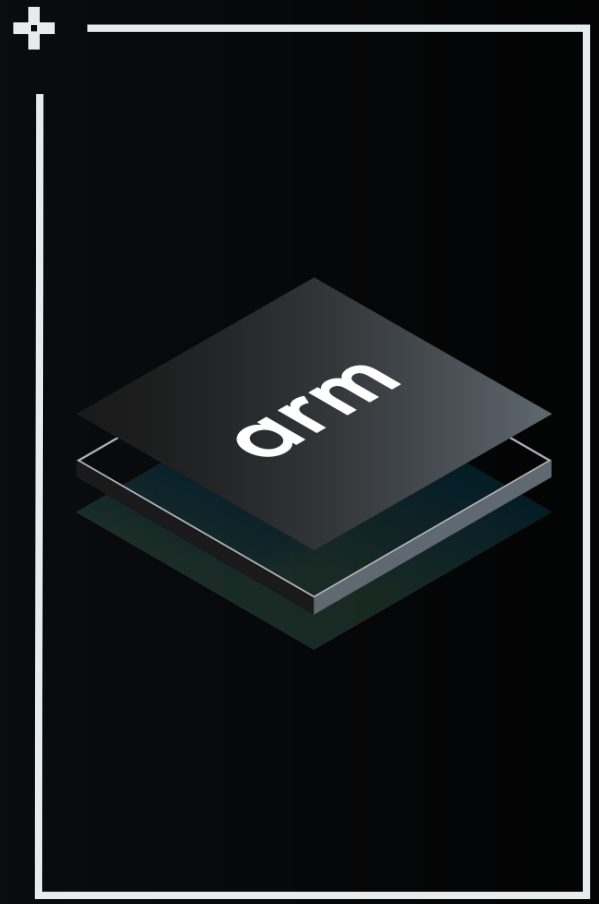
Taking the Best of Arm and the Industry to the Next Level

Building on top of our standard cores, we are filling an ecosystem requirement with a more custom approach



Introducing the **Cortex-X Custom Program**

- Evolution of "Built on Arm Cortex Technology" program
- Cortex-X Custom Program allows partners to **customize** and **differentiate** beyond standard Arm Cortex products
  - Performance first design approach
  - Requires early engineering collaboration
  - Deliver off roadmap performance
- Enables our partners with market specific solutions
- Will deliver CPUs under the **Arm Cortex** brand
  - A new category of CPU from Arm, available only to Cortex-X Custom program partners

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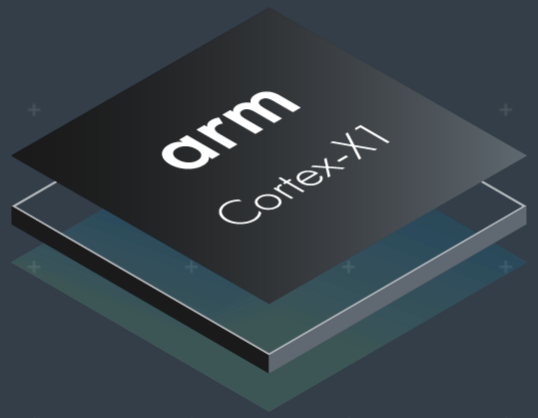
Introducing Arm Cortex-X1: The Most Powerful Cortex CPU

The 1st CPU from the **Cortex-X Custom** program to bring ultimate performance



+30%

peak performance

(compared over previous Cortex-A generation)

Designed for **ultimate performance** for next-generation custom solutions

Comparing Arm single core peak performance at 3.0GHz. Cortex-X1: 1MB priv-L2, 8MB L3 cache vs Cortex-A77: 512KB priv-L2 , 4MB L3 cache, including architectural and process improvements (compared to 2019 devices) Measured estimates on SPECint*_base2006 (SPECspeed* Integer component of SPEC CPU* 2006) Arm single-core performance estimated for mobile platform. Results are measured estimates using specific computer systems, software, components, operations, and functions and changes to any of these factors will cause the results to vary.

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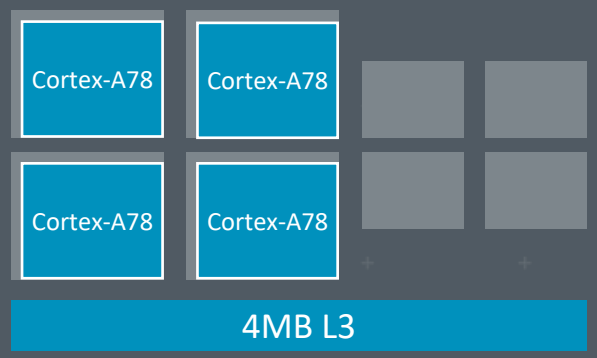
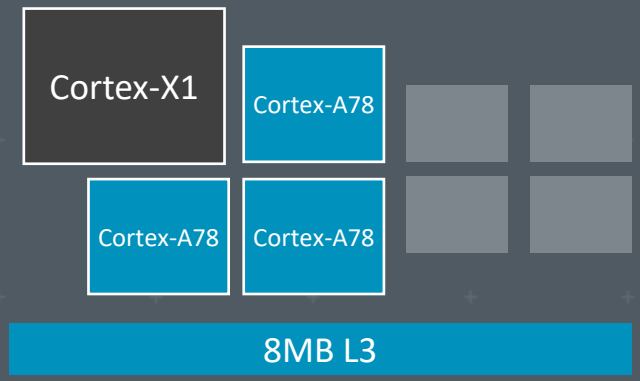
Meet Future Needs with more Scalable Solutions





+20% Sustained Performance

-15% Cluster Area

- Improves sustained performance
- Saves silicon area

+30% Peak Performance

+15% Cluster Area

- Gets additional peak performance
- Incremental area growth

Cortex-A78 and Cortex-X1 further increase the scope of the DynamIQ cluster

Comparing Arm single core performance at 1 watt on Cortex-A78 to Cortex-A77, and Arm single core peak performance on Cortex-X1 vs Cortex-A77.
Including architectural and process improvements (compared to 2019 devices)

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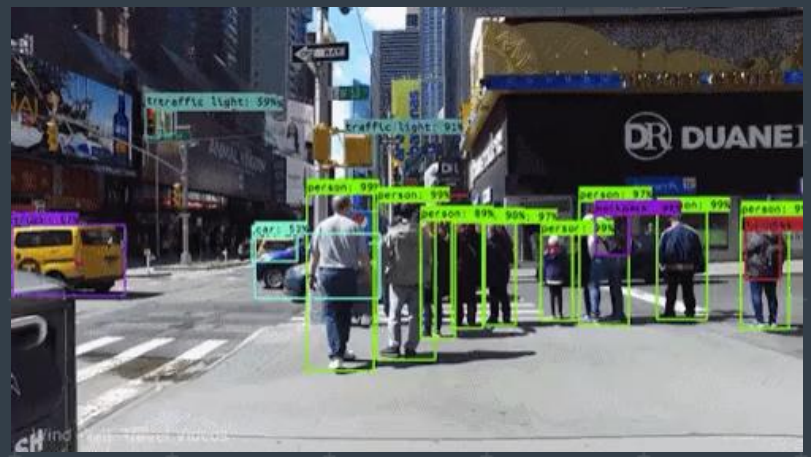
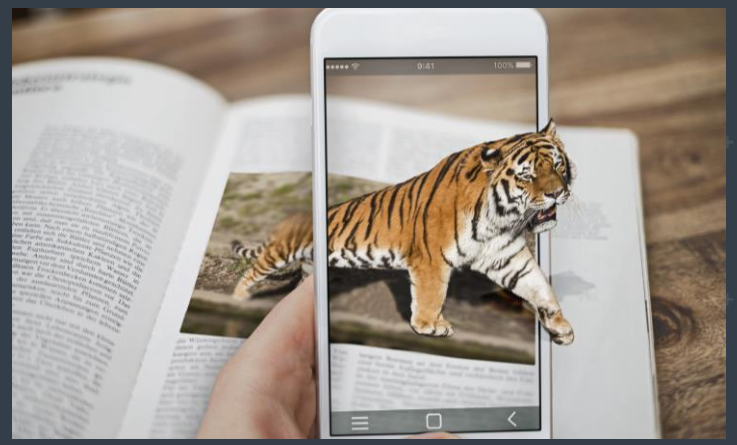
Immersive Experiences Made Possible by Mali GPUs

PC and Console-Like Gaming

Machine Learning



XR



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Arm's Highest Performing Mali GPU Designed for Better, Longer Mobile Entertainment

+25%

better performance

- Support for up to 24 cores allows highest ever performance point
- New Async technology improves scalability and reduces energy consumption
- 30% reduction in energy for key math unit in the GPU which reduces overall power consumption
- Highest performing GPU based on Valhall architecture

Comparing complex content on Mali-G78 to Mali-G77, including architectural and process improvements (compared to 2019 devices)

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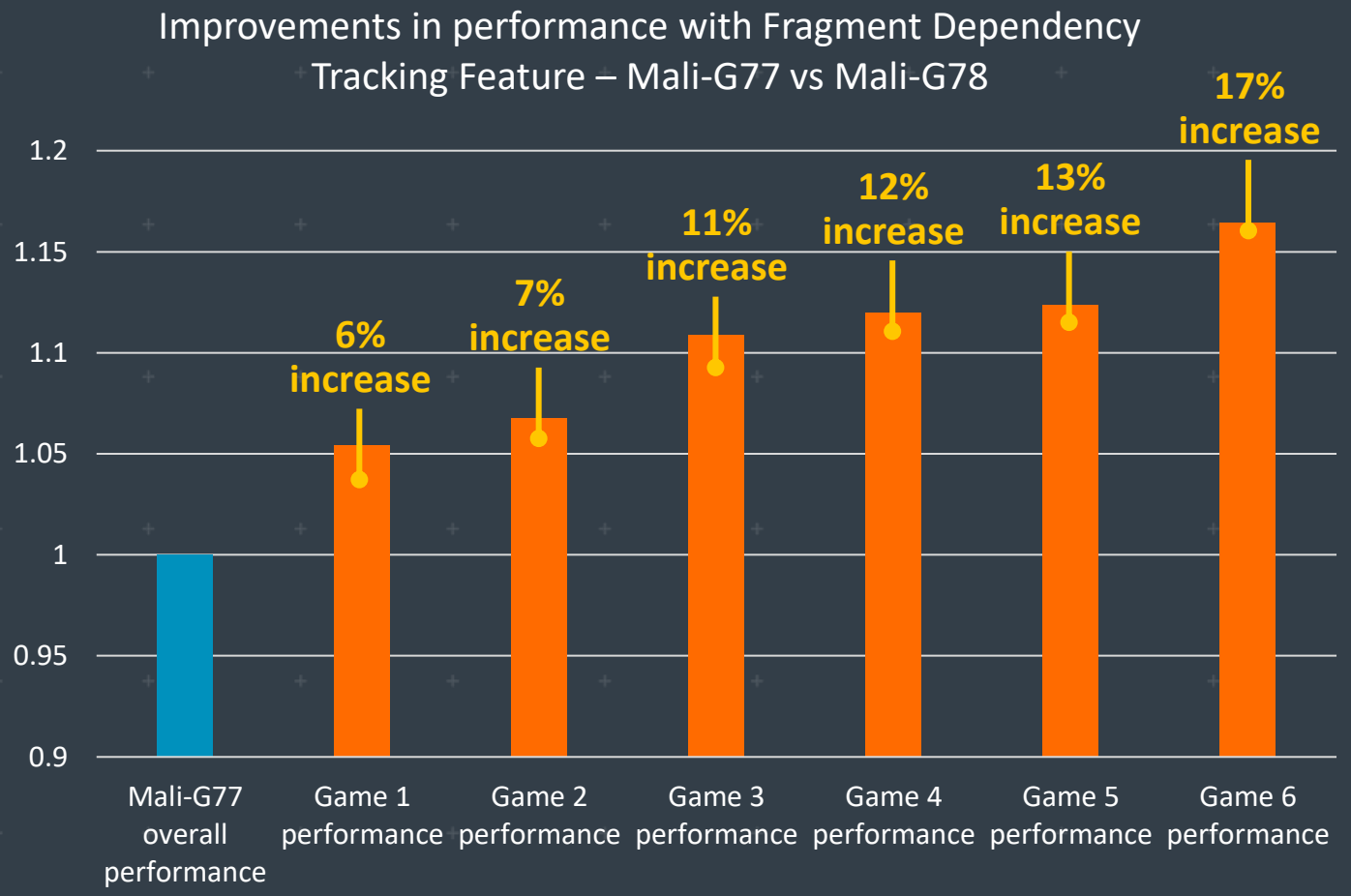
Making Complex Gaming Content Come to Life

- Focused on performance improvements to complex gaming scenes involving:
  - Smoke
  - Grass
  - Trees
- Optimizing this content yields 5 to 17% improvements to these scenes



Comparing six game workloads on Mali-G78 to Mali-G77 on same process node under similar conditions

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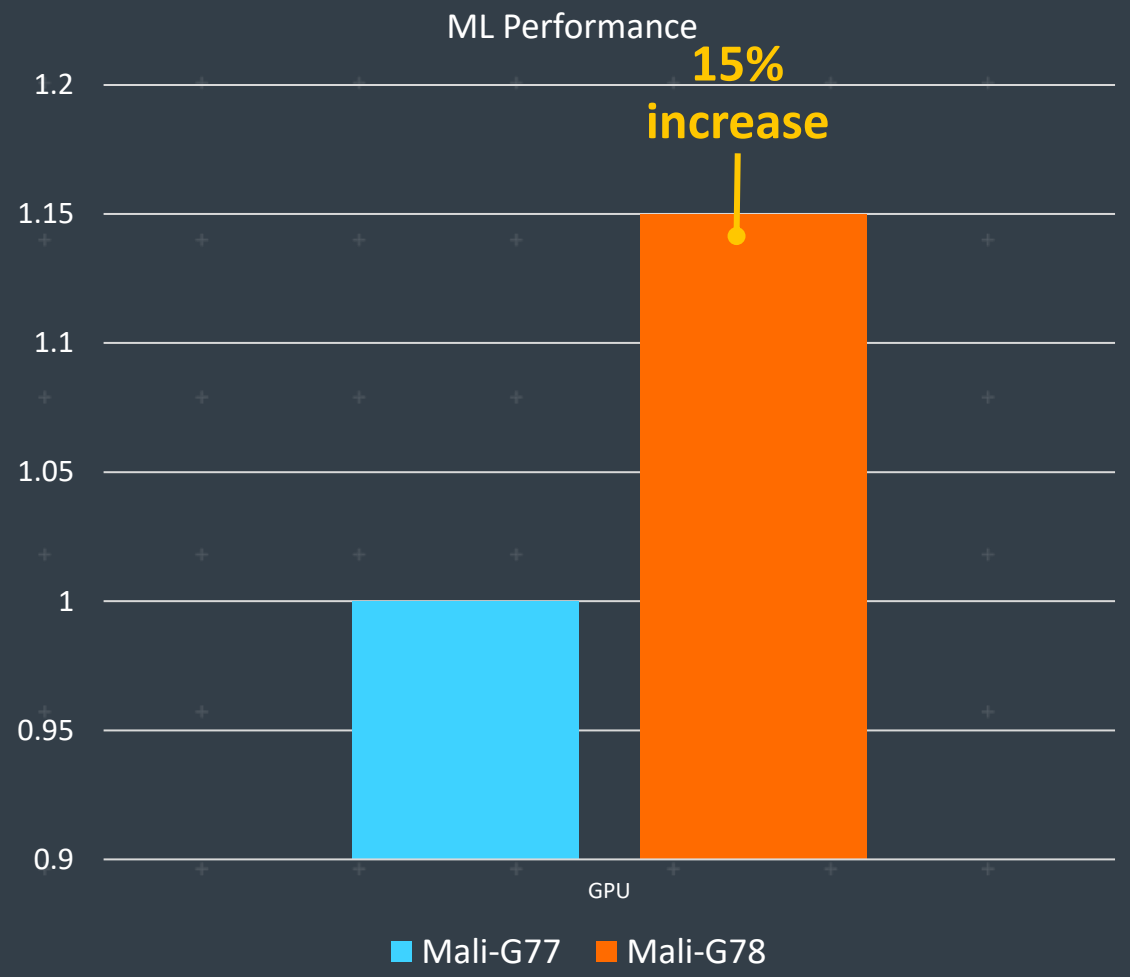
Performance Boost for On-Device Machine Learning

- ML on GPU covers variety of mobile use-cases, including security (e.g. face unlock), video and camera modes, gaming and Augmented Realty (AR)
- **ML performance uplift of 15%,** on average, across different industry benchmarks
- Asynchronous Top Level boosts ML performance through clocking shader cores



Comparing mixed complex workloads on Mali-G78 to Mali-G77 on same process node under similar conditions

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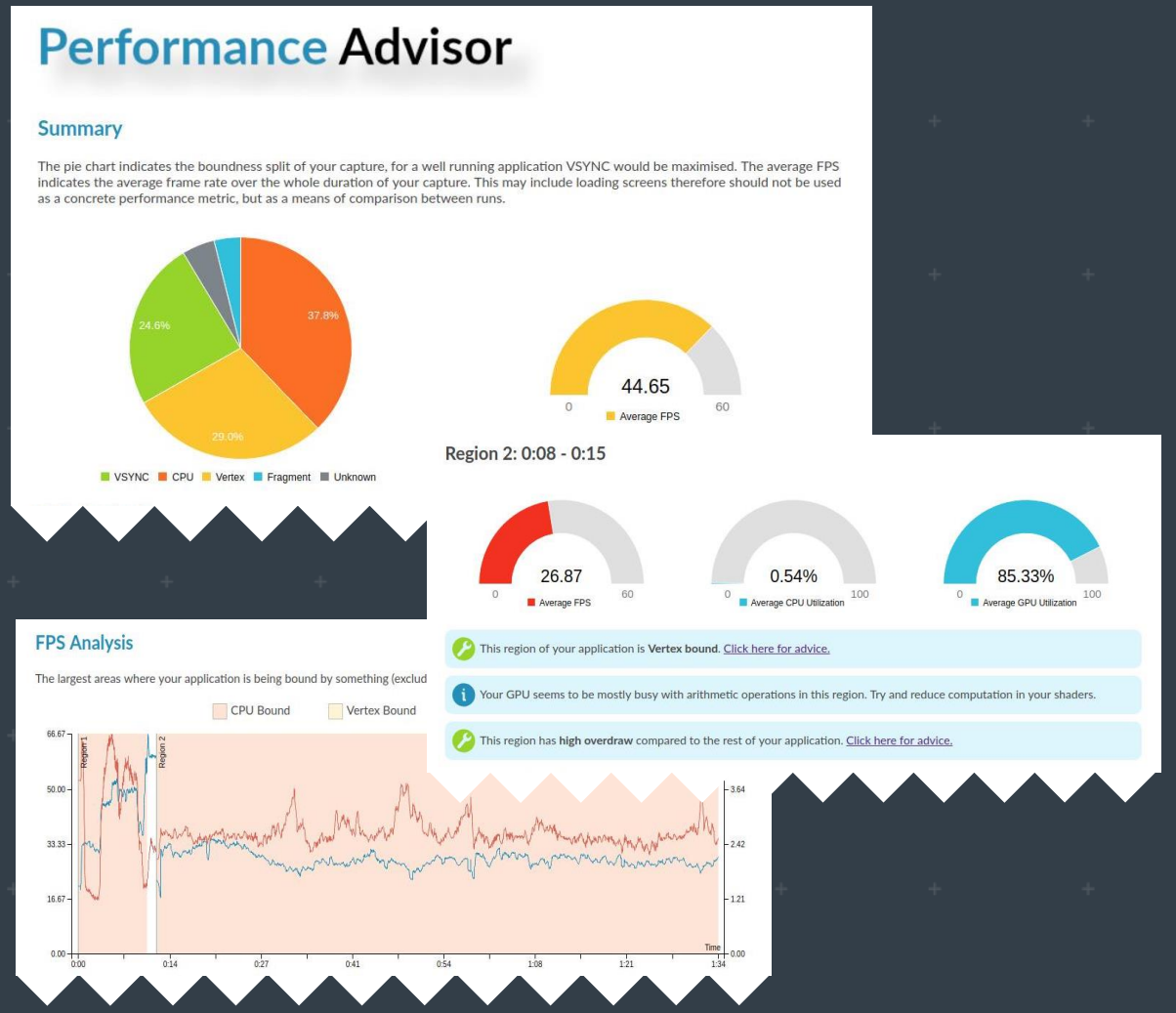
Performance Advisor: Putting Game Developers First

- Easy to understand Frame Analysis allows quick detection of bottlenecks
  - More time to focus on those performance issues
- Detailed reports generated show performance improvement suggestions
- Continuous Integration Support enables faster workflow
- Freely available as part of Arm Mobile Studio



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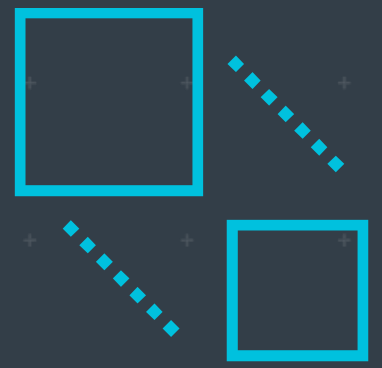
Extending the Benefits of Mali for the Sub-Premium Tier

- Customized based on partner feedback:
  - **Greater scalability:** Premium partners want to scale premium features & technology across their portfolio of devices
  - **Cost reduction:** Premium partners want to reduce the design & layout work required for multiple designs
  - **Tier differentiation:** between Premium & Sub-Premium
- Helps developers target higher performing gaming to a wider consumer audience



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Arm Mali-G68: Inherits All Features from Mali-G78

- First Mali GPU in the Sub-Premium tier for 2021 devices
- Inherits all features from Mali-G78
- Key unit built from ground up with energy efficiency in mind:
  - 30% energy reduction to unit
- Supports up to 6 cores instead of 24
  - Less performance but designs can be scaled to lower silicon area

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High Performance On Device Machine Learning

Creating a Digital Reality Through Intelligence

Extending the Capabilities of your Phone

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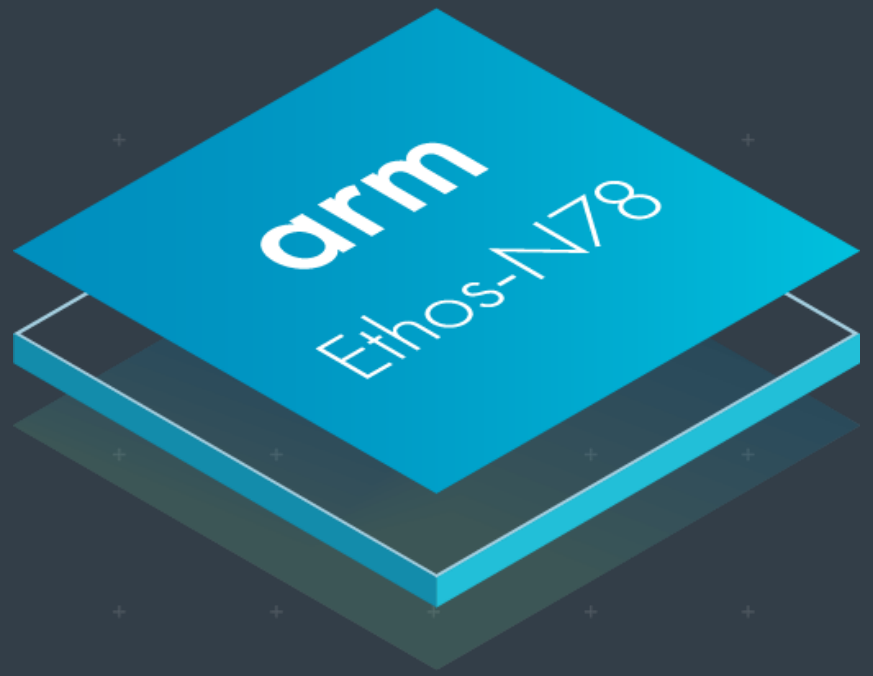
Advances in Performance and Efficiency

Main design themes: Efficiency in data & configurability



> 2X
Peak performance[1]

> 25%
Performance efficiency[2]

> 40%
DRAM bandwidth efficiency[2]

> 90
Unique Configurations

1. Comparing maximum number of MACs versus Ethos-N77
2. Variable based on network type

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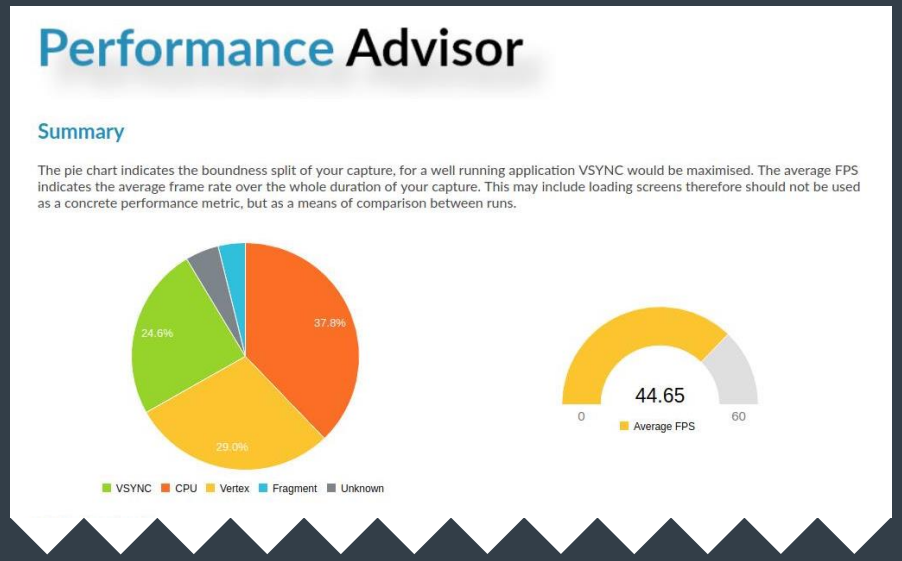
New ML Capabilities in Arm Developer Tools

ML performance insights in Arm Development Studio for profiling and debugging across Arm IP (CPU/GPU/NPU)

Enhanced performance analysis on Arm NN with event trace visualizations in Arm Mobile Studio



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The World's Largest ML Ecosystem

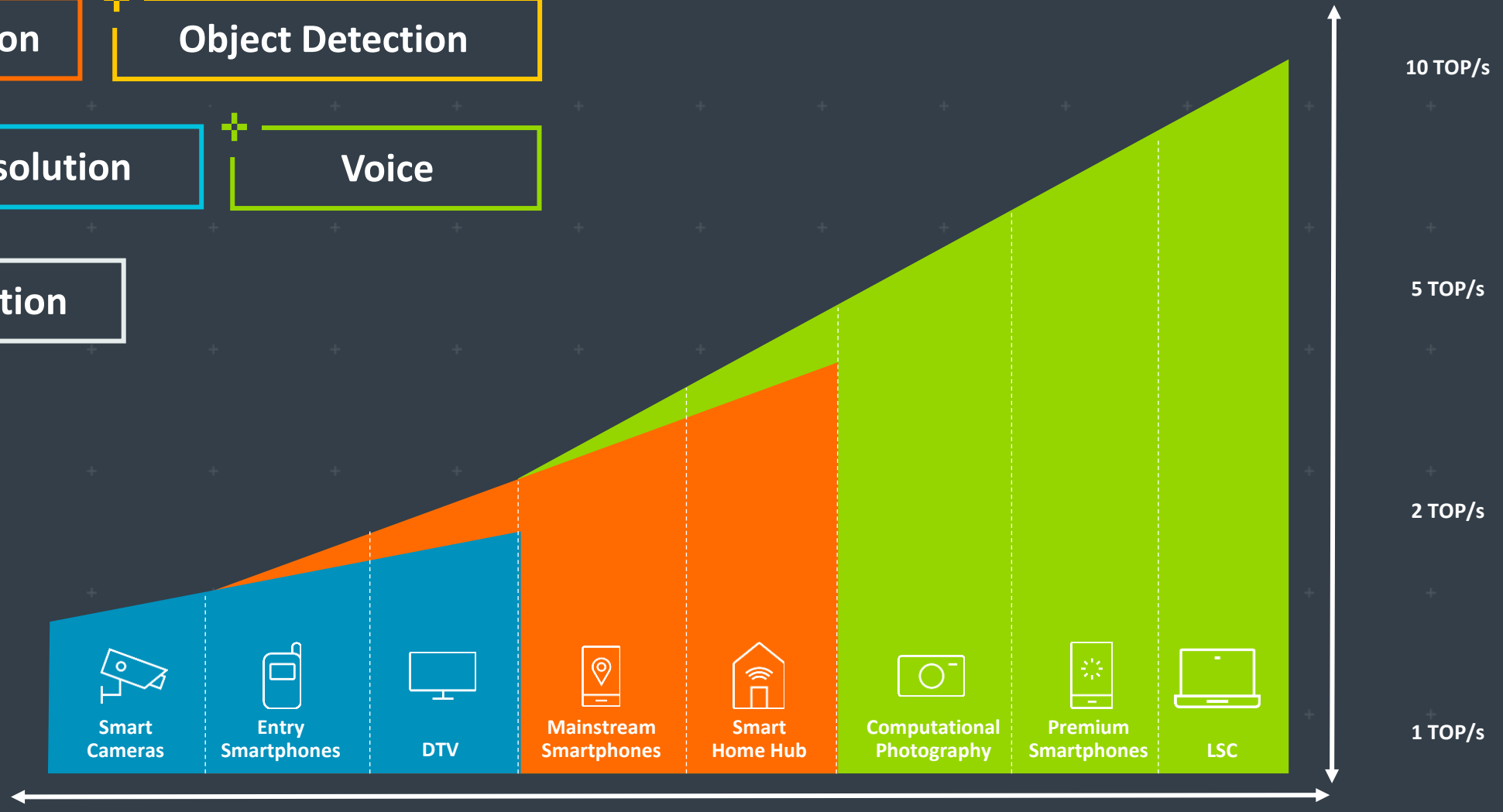
Classification

Object Detection

Super Resolution

Voice

Segmentation



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Digital Immersion: Driving Innovation in Mobile & Beyond

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Thank You
Danke
Merci
谢谢
ありがとう
Gracias
Kiitos
감사합니다
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شكرًا
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