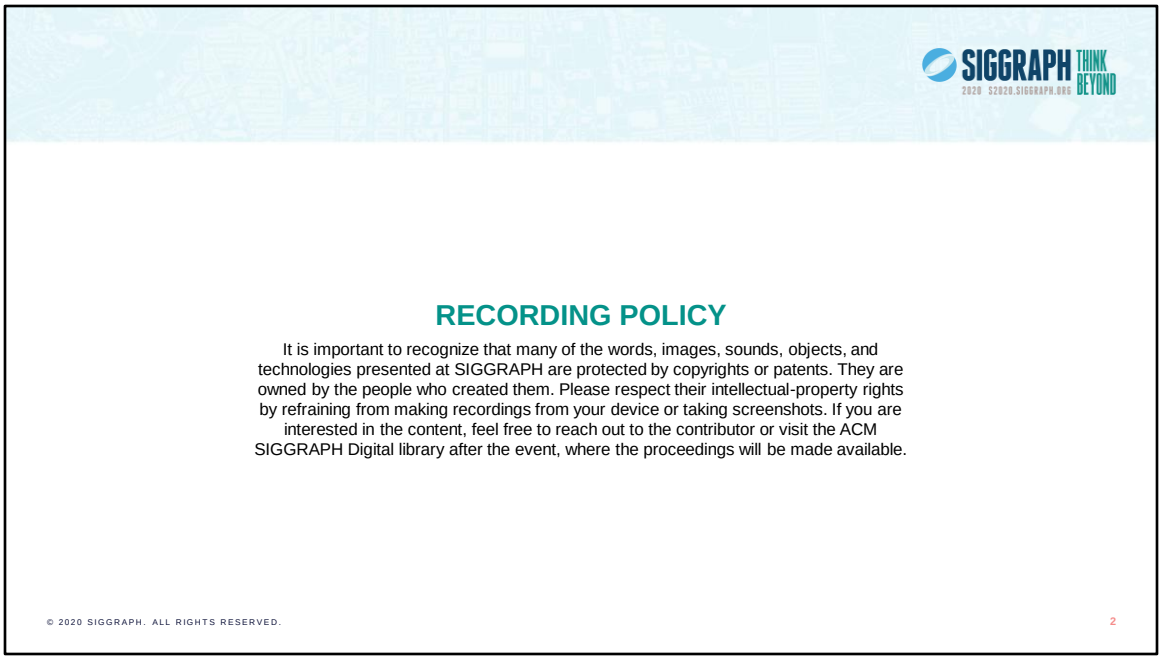
Hello and welcome!

Firstly, I hope everyone is staying healthy.

If this title doesn't look familiar, you might have clicked the wrong link ☺



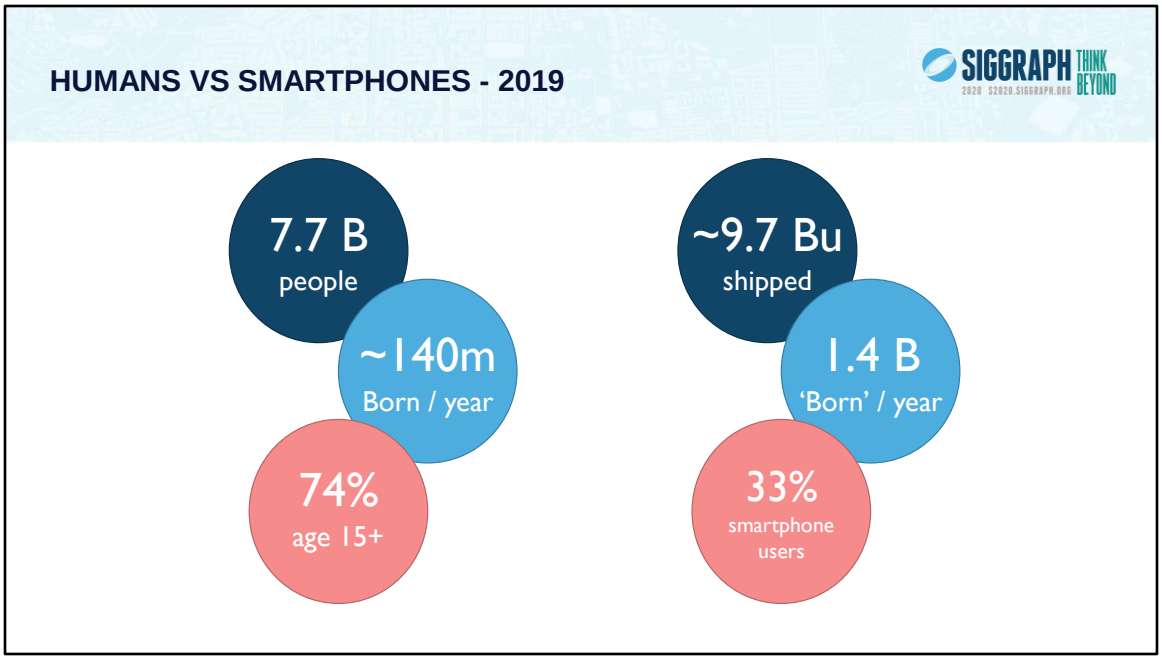
We are generally happy for people to capture or record elements of this course, but please be respectful if individual contributors ask for you not to do so during their respective section.
There is contact info at the end of this introduction should you wish to reach out to us.

MOVING MOBILE GRAPHICS

About this course:

- My first SIGGRAPH was 2001, and I spent the whole time holding together SGIs distributed/composited rendering tech.
- What I saw ignited my imagination, and I not only came back for more, but ultimately was driven to volunteer for the conference a number of times.
- I was motivated to serve as mobile chair for the conference by all of the amazing work going on that the SIGGRAPH community seemed painfully unaware of.
- This course hopefully highlights some of that work and raises that awareness
- There is always more work to be done.

The promise and importance of mobile technology is such that the Economist chose to call the smartphone “the defining technology of the age”.
I'd argue it's not really a single technology. There are keystone technologies that enable a device to run untethered to a power supply but…
It’s the product of years of effort in a huge industry, including logistics, new types of stores, new business models.
A raft of industries now sit on top. I think it’s a good reminder that when we say “technology” we sometimes mean technology and business shifting together.



To get a sense of scale, I think it's interesting to compare phones to humans.

(part 1)
Last year the mobile industry shipped 1.4bu smart phones and we can expect to cross 10Bu shipped in total this year. (Arm ship over a billion GPUs a year)
- There are few other industries that compare to this global scale.
- The industry is broadly projected to continue to grow and saturate at around 2bu/year or so.
- No one knows what Covid19 will do to that yet. But initially suggestions are that people are focused more on mobile technology right now than ever before.

(part 2)
Compare this to humans: In 2019, world bank est 7.7b people, of which 3/4ths are 15+ or over.
- The global birth rate was around 140m people/year.
- So each year we make very close to 10x the number of phones than we do people.

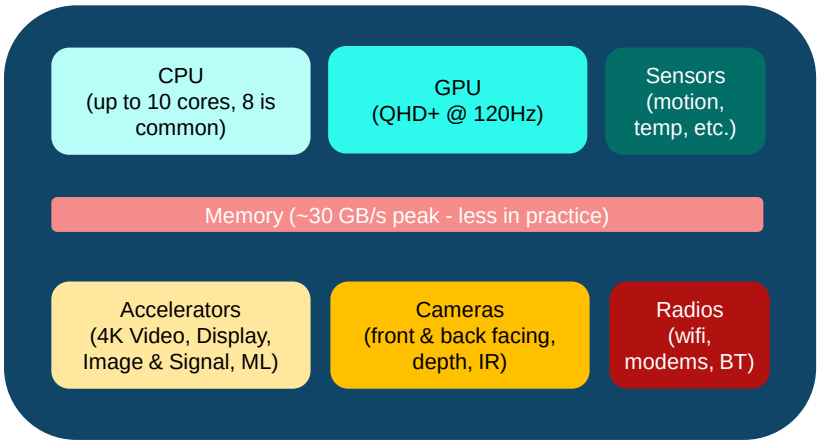
(part 3)

Where do all those smartphones go? Well, a 1/3rd of world population owns a smartphone
- but this % is much higher developed countries – the US 81%, UK 76%, South Korea 95%.
- (worldwide nearly 90% own a phone-like thing but we are only counting smartphones)

This is a market limited only by world population and distribution of wealth.
- Successful advances in graphics technologies that are applicable to mobile will be felt by hundreds of millions of people.
- Successful advances that are cost-effective will be felt across the globe.
- Even at this scale there is room for growth - "only" a 1/3rd of the pop owns a phone. Whereas 3/4 of the world could own one.

Some comments on the data here:
I took population figures from the World Bank.
Phone figures vary a bit, depending on what you are counting.
I took smartphone shipments per year and integrated over 10 years to get total shipments. This has a big error margin but is certainly on the order of humans.
GSMA count all connected devices, and give a higher figure (for 2017 this was 8.7Bu total, 5B unique subscribers. (https://www.gsmaintelligence.com/))
That suggests that while only a 1/3rd own a smartphone, the 89%-ish of everyone 15+ owns a phone-like thing. This is probably an overestimate as it assumes unique connections is 1:1 with humans.

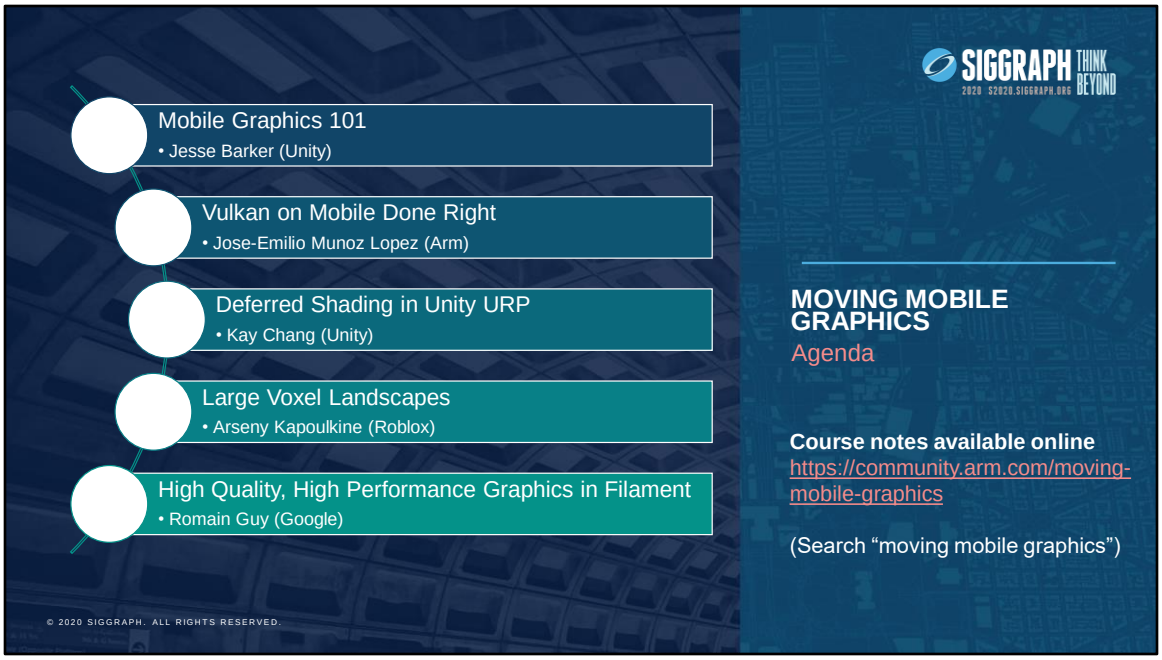
“PREMIUM” SOC



Disclaimer: This diagram does not necessarily describe a specific SoC, but reflects the current “top-tier” market

- Numbers of cores are a bit of a woolly detail as not all cores are equivalent (big.LITTLE and newer tri-cluster designs)
- Similar for GPUs, not all cores are equal, so talking about GPU cores is only meaningful if you are looking at 2 layouts of the same GPU
- While most of what these are used for is smartphones, these SoCs (and smartphone OSs) are capable general purpose computing devices
- What’s pictured here would run circles around the graphics workstations I worked on at Silicon Graphics

Note: Actual DRAM is not technically on the SoC, but the memory network and controllers are. Attached DRAM typically 8GB for an SoC as pictured.



- I'm going to give you a little primer on mobile graphics
- Then, Jose-Emilio will tell us about efficient Vulkan for mobile
- Next, Kay Chang will talk about optimized deferred shading
- After that, Arseny is going to cover Large Voxel Landscapes
- Last, but not least, Romain is going to talk about high fidelity rendering for mobile

THANKS!

Many thanks to all our speakers

Special thanks to:

- The SIGGRAPH committee
- All of you for attending!

Stay safe during these strange times!

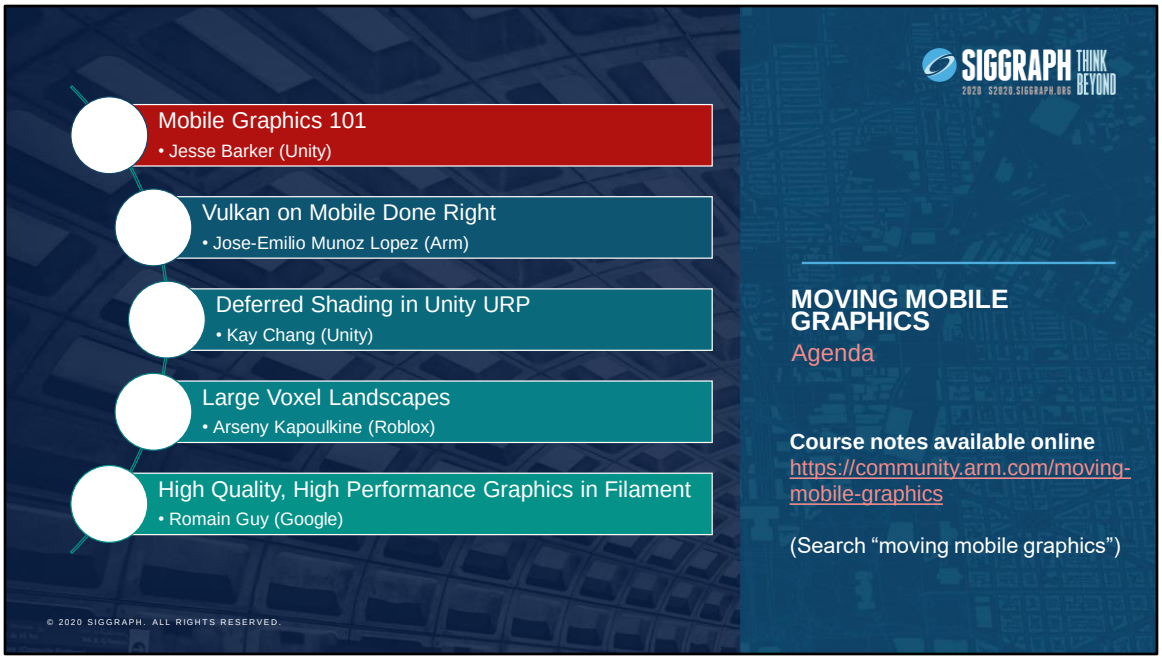
We'd love to know your thoughts
Let us know!

Any feedback, thoughts, ideas:

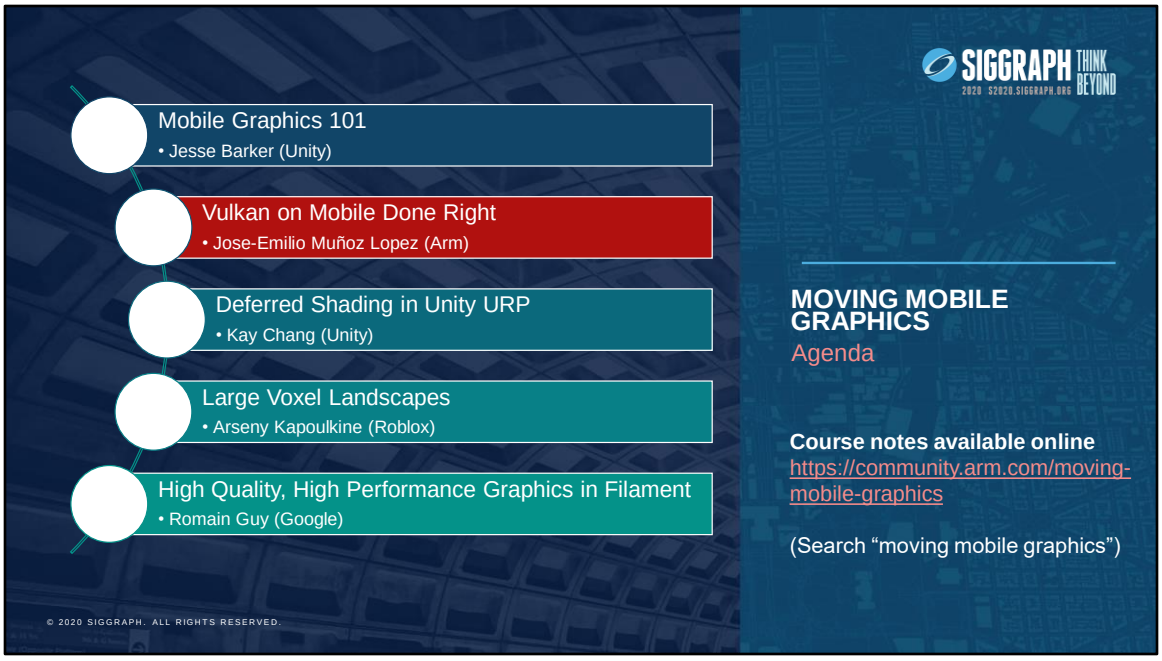
- sam.martin@arm.com
- @palgorithm

Course notes will be available online:

https://community.arm.com/graphics/b/blog/posts/moving-mobile-graphics

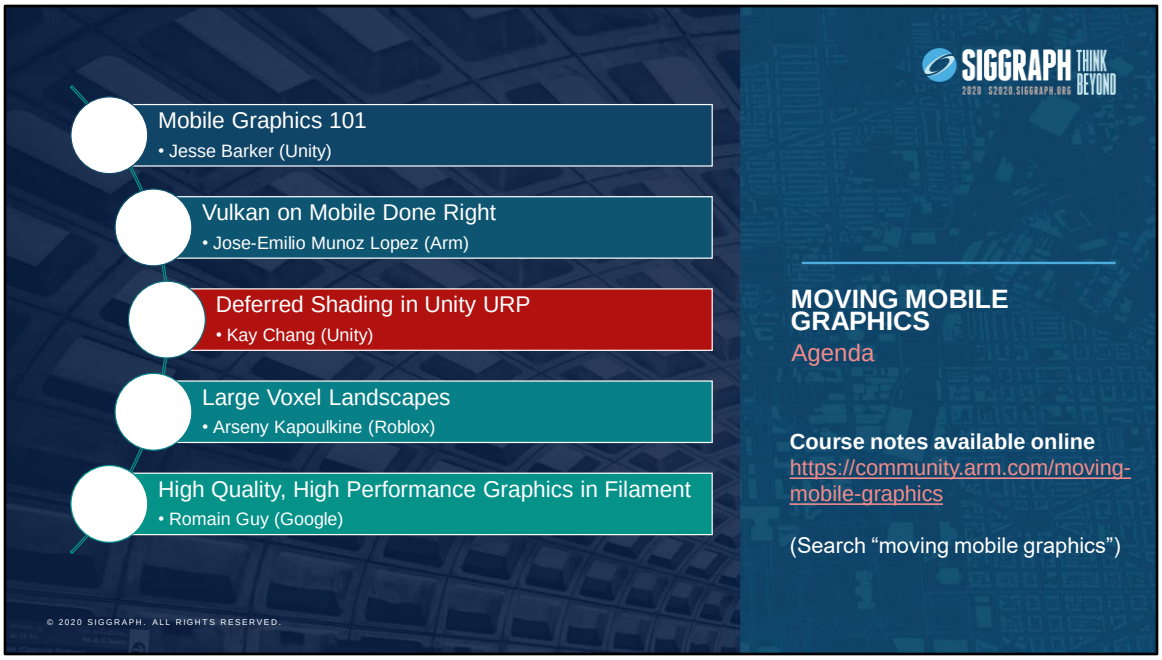


Jesse Barker is the HD Mobile Pipeline Lead at Unity Technologies, focusing on bringing high-fidelity visuals to mobile platforms.
Prior to Unity, Jesse spent a couple of decades working on low-level GPU software and doing advanced feature development for GPUs at companies like Arm, Silicon Graphics, and ATI.
Real-time graphics and mobile technologies are near and dear to him, having chaired both Mobile and Real-Time Live! programs at SIGGRAPH.
He will give you a primer on mobile graphics to provide some context for the other talks.



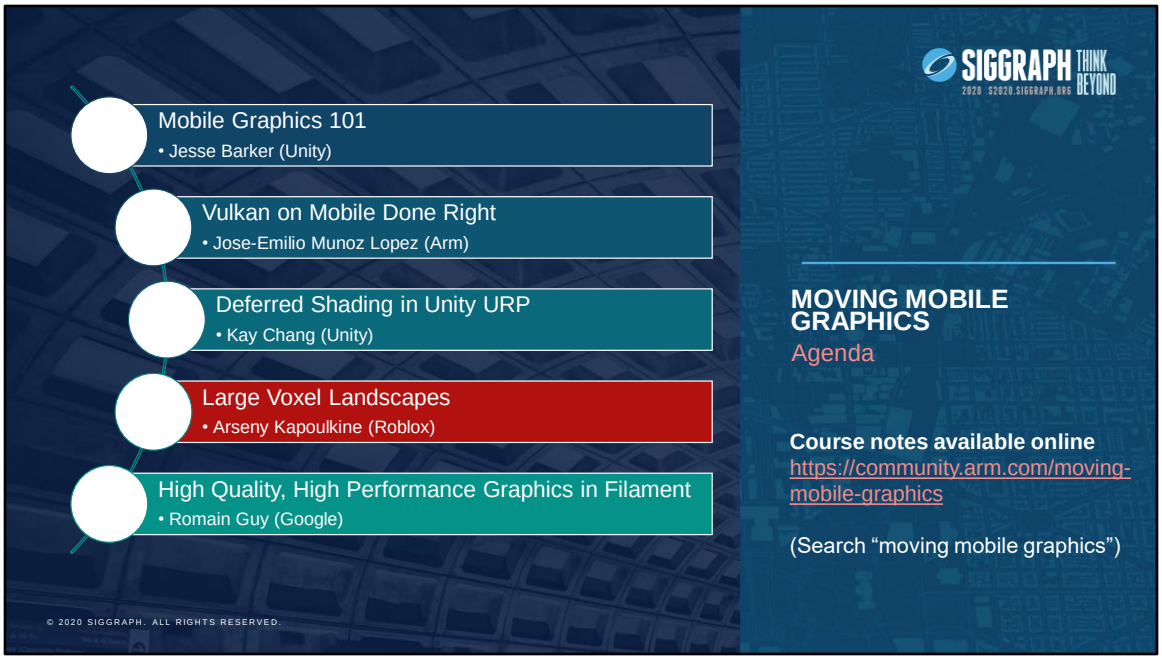
Jose-Emilio Muñoz-Lopez will tell us about how to efficiently leverage the Vulkan API for mobile platforms

After completing a master's degree in Electronics and Computer Science at the University of Edinburgh, José Emilio joined Arm to work on the Mali family of GPUs. Initially he was involved in their driver development and instrumentation tools, and two years later he had the opportunity to take his passion for computer graphics to a new level at the Graphics and Gaming team.
For the past three years he has been working with Vulkan both internally and at multiple collaborations with game developers and ecosystem partners to find ways of achieving the best visual fidelity at maximum performance on mobile.



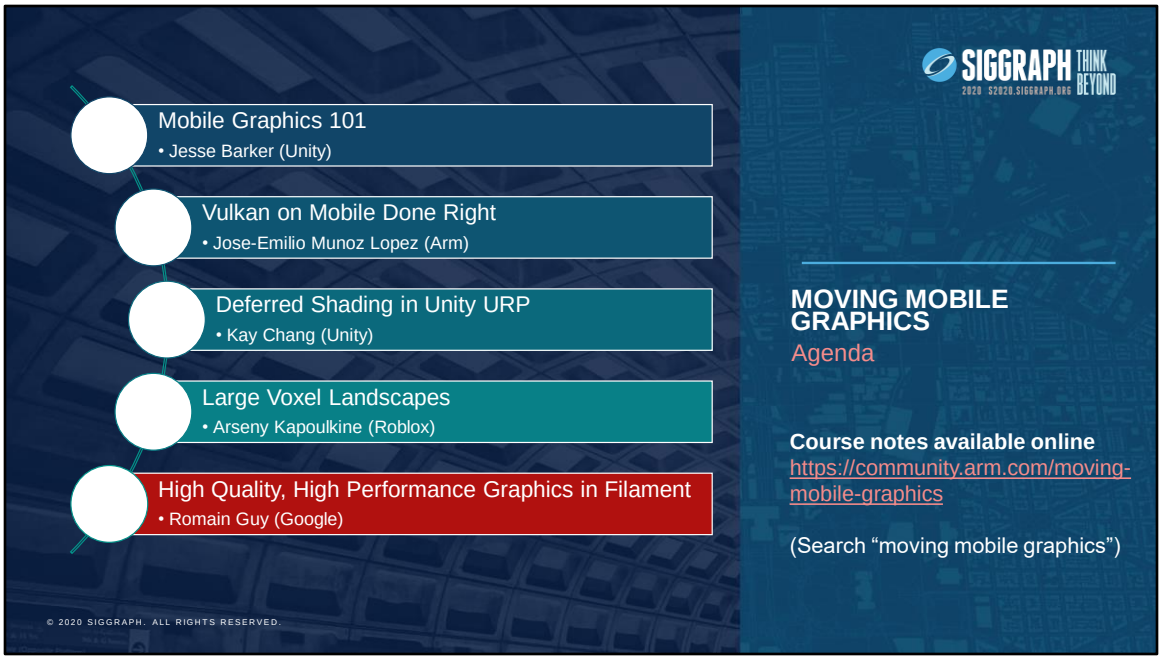
Kay Chang will tell us about the deferred shading path in Unity's Universal Render Pipeline.

Kay Chang is a Console R&D Engineer working at Unity.
He has been in the Video Games industry for 15 years and honed his skills as a Graphics Programmer working on several AAA games spanning a large variety of game consoles.
Prior to Unity, he worked at Square Enix where he was actively involved in the development of Final Fantasy XV graphics engine and responsible for many graphical features used in the game.



Arseny Kapoulkine will tell us about Large Voxel Landscapes.

Arseny has worked on game technology for the past decade.
Having worked on rendering, physics simulation, language runtimes, multithreading and many other areas, he is still discovering exciting problems in game development that require low-level thinking.
After helping ship many titles on PS3 including several FIFA games, he joined Roblox in 2012 and has been working on the in-house engine ever since, helping young game developers achieve their dreams.



Romain Guy will tell us about Filament, a high-quality, high-performance renderer for Android (as well as other platforms).

Romain leads the Android Toolkit team at Google, responsible for the UI toolkit and a suite of libraries called Jetpack.
One of the projects of his team is Filament, a real-time cross-platform physically based renderer mainly targeted for mobile devices.
Previously Romain worked on various parts of the Android graphics stack, including designing and writing the hardware accelerated 2D rendering pipeline for the UI, and color management.