VIRTUAL REALITY HARDWARE

Prepared for Virtual Reality Industry Forum

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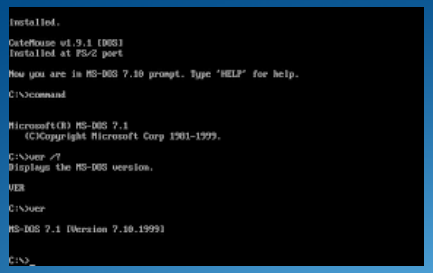
VR IS A NEW PARADIGM FOR COMPUTING

Command Line → **GUI** → **Touch** → **VR**



- VR will permeate all segments & markets
  - Consumer: gaming, education, travel, entertainment
  - Commercial: real-estate, medical, productivity
- VR will take on many form factors and a range of price points
  - HMD tethered to PC
  - Mobile phone insert
  - Stand-alone HMD

There will be many winners:
Hardware OEMs, VR Platform Providers, Content Creators, Silicon Providers
But this diverse ecosystem will require standards!

BARRIERS TO VR ADOPTION

Problem

"It cost too much"

"There's nothing to play"

"It makes me feel sick"

" I can't move! There's too many wires!"

"It's uncomfortable"

"It's too hard to set up"

"I'm in VR, but I still have to sit, or stand in a small space"

"How do I do this? There's no keyboard or mouse"

"I feel isolated when I play. And my friend sitting next to me feels left-out"

"I can't see my legs!"

But there are many barriers to adoption…

BARRIERS TO VR ADOPTION

Problem		Opportunity
"It cost too much"	→	Drive good VR experiences to mainstream PCs with iGFx Drive Inside-out tracking to reduce lighthouse/beacon costs
"There's nothing to play"	→	Partner with app developers, content providers, VR platform providers and game engines to optimize content Create new VR experiences (e.g. Intel TrueVR and Intel Replay)
"It makes me feel sick"	→	Improve tracking/reduce latencies through faster, more accurate 6DoF calculations Support higher frame rates and higher resolution through better performing SoC Graphics specific features to improve rendering performance/quality
" I can't move! There's too many wires!"	→	Single Wire solution and compatible standard for HMDs
"It's uncomfortable"	→	Lighter weight displays; new types of display technology
"It's too hard to set up"	→	Inside-out tracking; Dynamic room mapping
"I'm in VR, but I still have to sit, or stand in a small space"	→	Wireless HMDs, Stand-alone HMDs VR systems with cameras that are aware of environment
"How do I do this? There's no keyboard or mouse"	→	Speech command and control; speech recognition and natural language processing; gesture recognition, more natural controls; body tracking accessories (e.g. gloves)
"I feel isolated when I play. And my friend sitting next to me feels left-out"	→	More social VR & interaction Mixed reality with depth capture & reconstruction to enable viewing environment AI to provide better context, CV for understanding of scenes/objects/people
"I can't see my legs!"	→	More sensors, haptics, biometrics, body suits!

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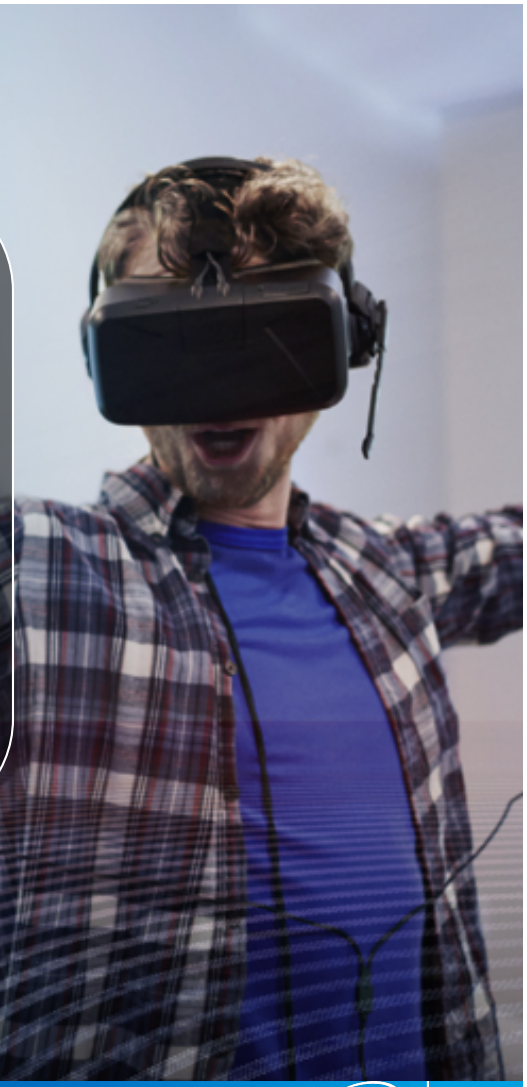
1 BRING VR TO MAINSTREAM PCs

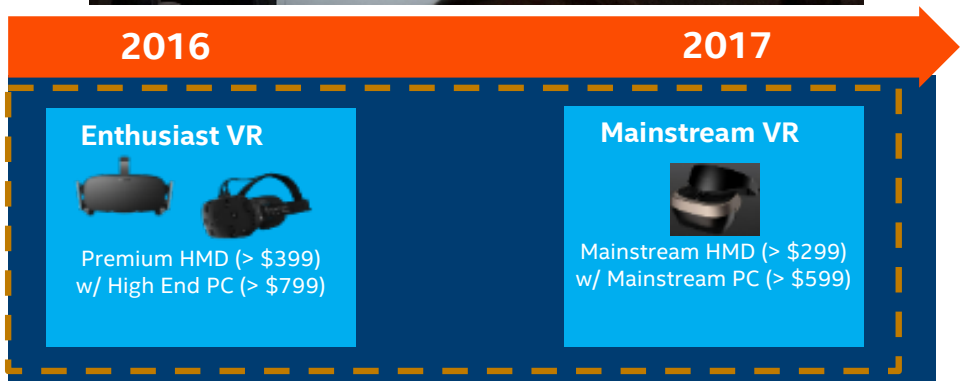
Requirements:

- Reduce price to $399 for HMD & controllers
- Experience quality VR on Intel Core i5, 7th Gen
- Eliminate need for discrete graphics card
- Run VR @60fps without getting sick
- Eliminate expense of lighthouses/sensors used for outside-in tracking



BRING VR EXPERIENCES TO THE BROADER MARKET

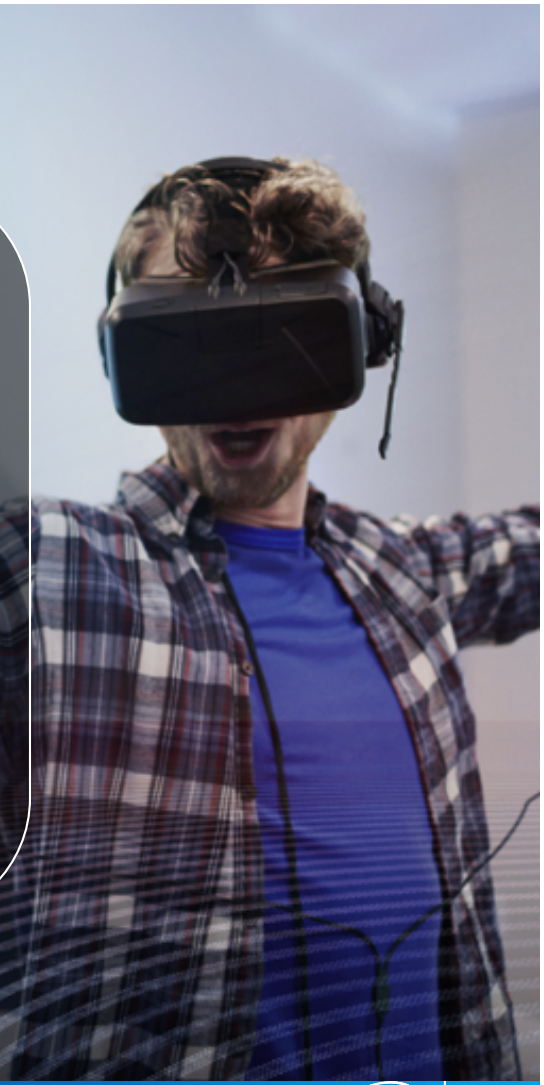
- Collaborating with Microsoft on Windows Mixed Reality and ecosystem development
  - Bring Mainstream VR to the 400+ Million Windows 10 users
- Intel and Microsoft announce minimum specifications for PCs and HMDs for mainstream users and “Ultra” premium users
- Microsoft announced partnerships with major OEMs to build HMDs supporting Windows Mixed Reality. Starting at US$299
- Products started shipping in Oct 2017



2 CREATE GREAT CONTENT

Requirements:

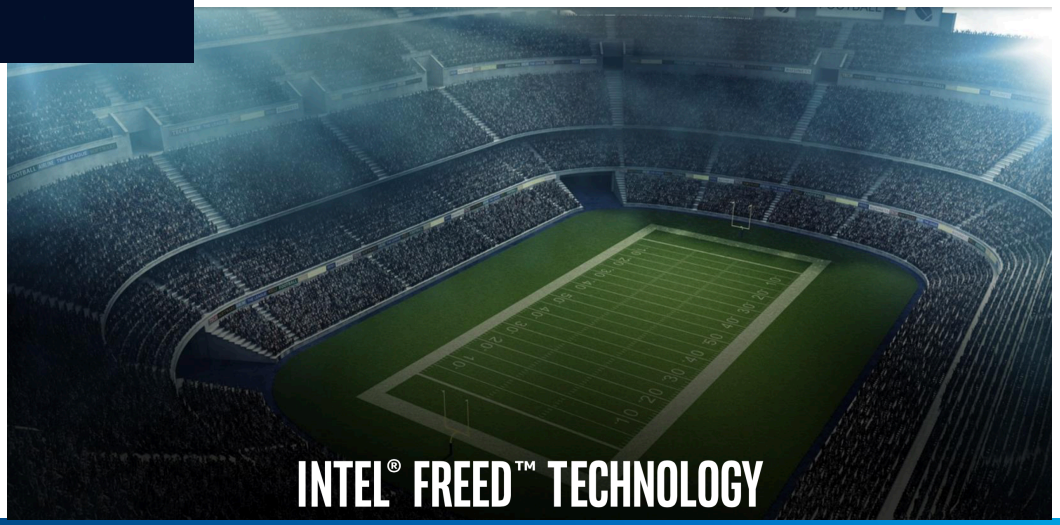
- Introduce new immersive experiences, designed specifically for VR (e.g. Intel® True VR)
- Write once and play on multiple platforms
- Make VR more social/less isolating
- Accelerate commercial VR usages



INTRODUCE NEW VR EXPERIENCES

Pick your unique vantage point and watch the action in Virtual Reality

- VR experiences
- Personal points of view
- Real-time stats and updates

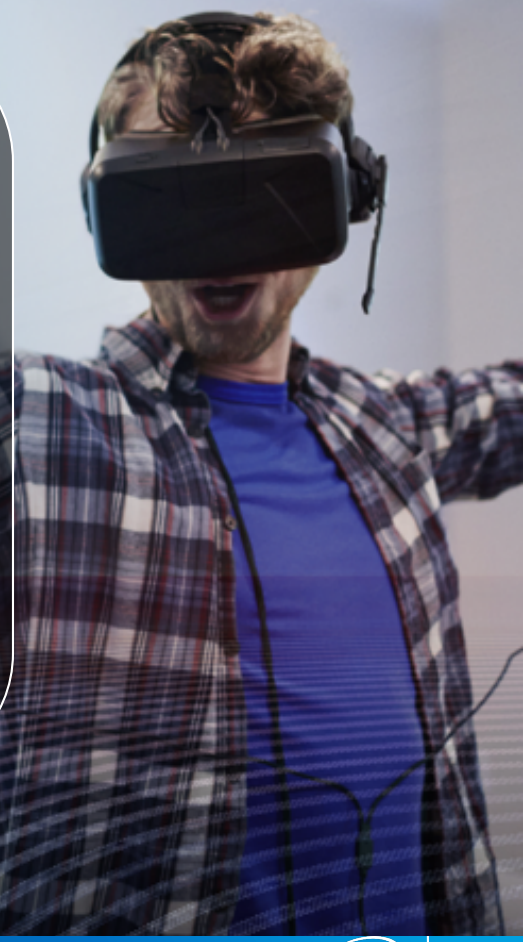


Watch the biggest moments in sports from virtually every angle

3 IMPROVE IMMERSIVE EXPERIENCE

Requirements:

- Higher resolutions & frame rates
  - 2K@90fps per eye expected soon
  - Goal: 8K@120fps per eye by 2022
- Reduce latencies for 6DoF calculations
- Alternative rendering techniques, e.g. foveated rendering
- Content optimized for end-to-end system (HMD + PC + cloud)
- Content scales according to hardware performance capabilities
- Support latest codecs and standards for 360 & 6DoF video



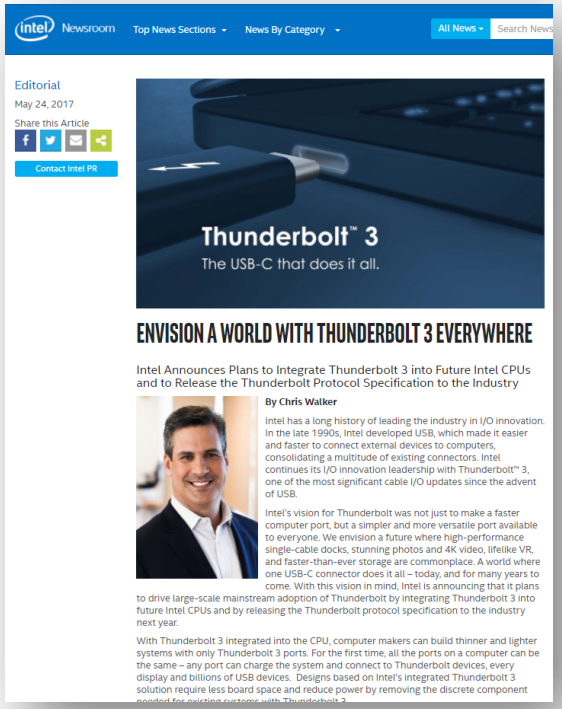
4 SINGLE WIRE SOLUTION

Requirements:

- Support higher resolutions/frame rates required for next generation HMDs
- Support existing standards to prevent user confusion/dongles
- Support connection to discrete card and integrated graphics outputs
- Support bi-directional transport for camera data back to PC for 6DoF and other computer vision workloads
- Low cost so as to continue to drive VR to mainstream users
- Support 5m+ cable length
- Fit with in HMD power envelope

Envision a World with Thunderbolt™ 3 Everywhere

Intel Announcement at Computex 2017



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Editorial

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Thunderbolt™ 3

The USB-C that does it all.

ENVISION A WORLD WITH THUNDERBOLT 3 EVERYWHERE

Intel Announces Plans to Integrate Thunderbolt 3 into Future Intel CPUs and to Release the Thunderbolt Protocol Specification to the Industry

By Chris Walker

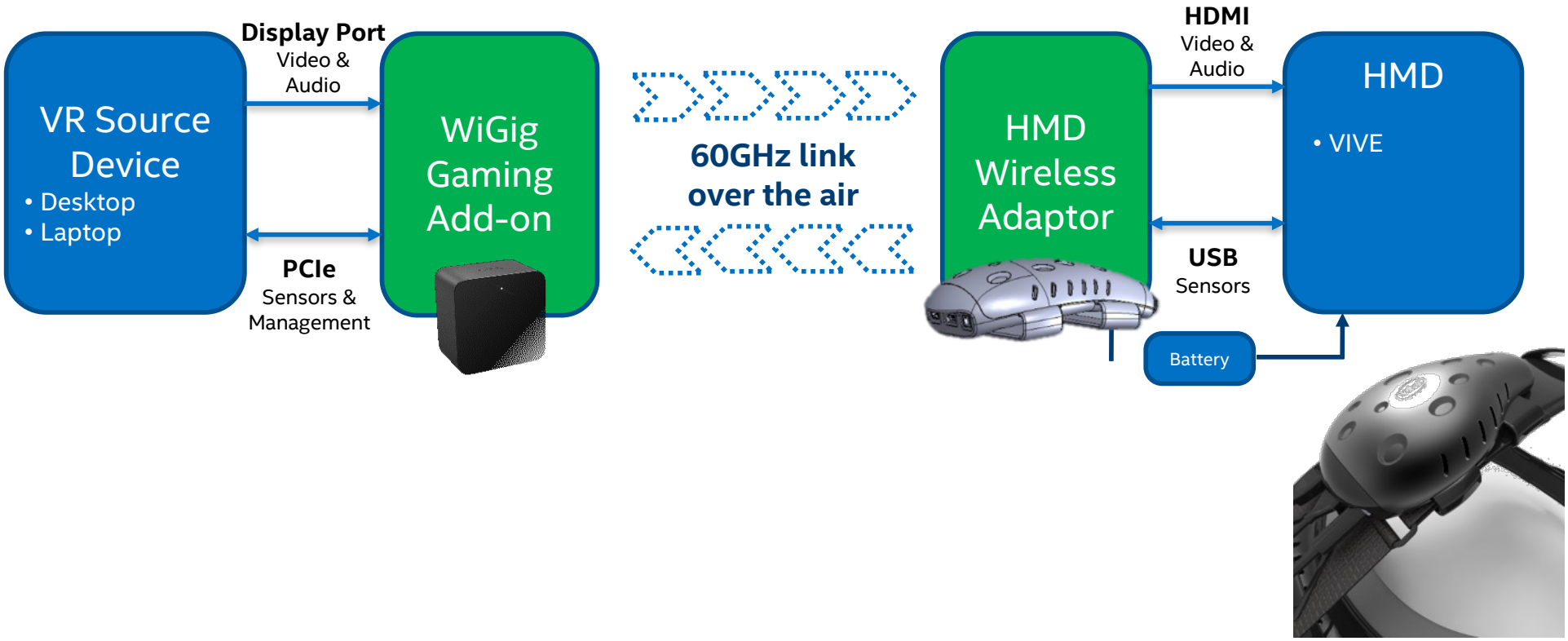
Intel has a long history of leading the industry in I/O innovation. In the late 1990s, Intel developed USB, which made it easier and faster to connect external devices to computers, consolidating a multitude of existing connectors. Intel continues its I/O innovation leadership with Thunderbolt™ 3, one of the most significant cable I/O updates since the advent of USB.

Intel's vision for Thunderbolt was not just to make a faster computer port, but a simpler and more versatile port available to everyone. We envision a future where high-performance single-cable docks, stunning photos and 4K video, lifelike VR, and faster-than-ever storage are commonplace. A world where one USB-C connector does it all – today, and for many years to come. With this vision in mind, Intel is announcing that it plans to drive large-scale mainstream adoption of Thunderbolt by integrating Thunderbolt 3 into future Intel CPUs and by releasing the Thunderbolt protocol specification to the industry next year.

With Thunderbolt 3 integrated into the CPU, computer makers can build thinner and lighter systems with only Thunderbolt 3 ports. For the first time, all the ports on a computer can be the same – any port can charge the system and connect to Thunderbolt devices, every display and billions of USB devices. Designs based on Intel's integrated Thunderbolt 3 solution require less board space and reduce power by removing the discrete component

"Intel plans to drive large-scale mainstream adoption of Thunderbolt by **integrating** Thunderbolt 3 into future Intel CPUs, and by **releasing** the Thunderbolt Protocol specification to the **industry** next year"

Enabling VR over WiGig



2017 Map of VR Related SDOs and SIGs

Software & SW/HW Interface

OpenXR™ WebVR

Industry Trade, Advocacy

Consumer Technology Association™ THE IMMERSIVE TECHNOLOGY ALLIANCE IVRA DASH Industry Forum

Media Codecs

MPEG Alliance for Open Media JPEG

Definitions, Guidance, Regulation

IEEE SMPTE SCTE

Content & Experience

BAFTA VR INDUSTRY FORUM VR SOCIETY

Hardware

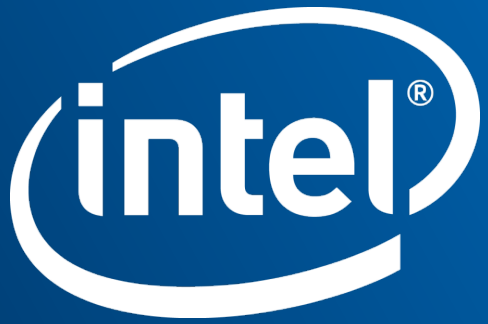
VESA® mipi® SUPERSPEED+ CERTIFIED USB 10Gbps ICVR

QOS and Transmission

3GPP™ A GLOBAL INITIATIVE atis ETSI IETF® ITU QUALINET cost IC1003

Broadcast Video

ATSC ADVANCED TELEVISION SYSTEMS COMMITTEE DVB® VQEG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