

Multitasking in the Virtual Classroom

Zoom-based Hybrid, Blended, and Virtual Learning on Latest
Generation Windows Notebooks and Chromebooks in K-12 Education

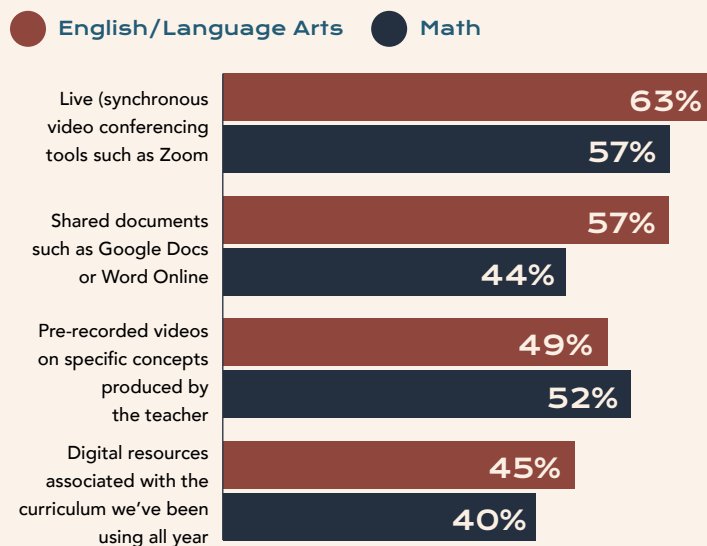


Executive Summary

The use of laptops and other educational technologies by educators and students has exploded into mainstream adoption with 74% of U.S. schools reporting at least one device per student¹, a number which has grown exponentially with the latest round of purchasing by state and local education agencies. To meet the needs of all stakeholders, states and districts are employing various approaches for teaching and learning that are both equitable and safe. Whether districts opt for face-to-face, virtual, blended, or a hybrid (combination of face-to-face and virtual) approach, the goal—to use notebooks and other tools to better engage and connect students and improve learning outcomes—remains the same. In a survey from March 2021, Zoom* reports that 60% of US respondents will conduct education-related appointments (i.e. school classes; parent/teacher conferences; PTA meetings; school board meetings; tutoring; professional development meetings) either using hybrid or fully virtual models.² As students and educators across the country prepare to return to school for the 2021-22 school year, most will come back to buildings that are largely, if not completely, operating with 1:1 devices for students. With many districts and schools continuing to offer optional modalities for learning, having powerful, reliable devices that support seamless teaching and learning experiences is a non-negotiable.

Live videoconferencing tools such as Zoom were seen as the most effective tools for teaching and learning both English/Language Arts and Math.³

Popularity of virtual learning tools



Source: EdWeek Research Center survey, 2020¹

Complex Demands of Multitasking

Just like in a classroom setting, a typical day of virtual learning requires students to use their devices to complete many simultaneous complex tasks. They often join a video conference while having multiple web browser tabs open and applications running on their devices. Students rely heavily on video and live streaming websites and regularly engage with a learning management system, while connected to a video conference on Zoom.[†]

Less Waiting, Fewer Disruptions, and More Time Learning

Devices with processors powered by Intel® technology create a more seamless teaching and learning experience by reducing disruptions and delays, making it easier to connect with others, and allowing students and educators to spend less time waiting for the processor to keep up with learning that requires multitasking.

¹ Source: [CoSN's 2018-2019 Annual Infrastructure Report](#)

² Source: [Zoom - A Message to Our Users](#)

³ Source: [EdWeek Market Brief: Zoom and Google Docs Win Out for Remote Teaching, Survey of Educators Finds](#)

[†] Video conference is complex. Device performance, CPU speed, and network connectivity are all factors that can effect a user's experience.



Key Takeaways

83%
of the time



The Intel® Core™, Intel® Pentium®, and Intel® Celeron® processor-based devices outperformed competitors when tested against AMD* powered notebooks and Chromebooks* to multitask between live streaming content and 3D modeling applications during a Zoom video call.

Up to
5x faster



Performance of Intel® Core™ processor-based Chromebooks and Windows devices during multitasking between live streaming content and 3D modeling applications during a Zoom video call when compared to those powered by AMD* processors.

2x faster



Performance of Intel® Core™ and Intel® Celeron® processor-based Chromebooks when screen sharing live in-game play in Minecraft: Education Edition during a Zoom video call against those powered by Qualcomm* Snapdragon 7c processors.

Speeds up to
2x faster



Performance of the Intel® Core™ i3 processor-based Windows devices compared to those powered by AMD Ryzen* processors.

Speeds up to
49% faster



Performance of Intel® Pentium® processor-based notebooks and Chromebooks compared to those powered by AMD processors.



Video Conferencing for Teaching and Learning

When designing a meaningful virtual learning experience, it's critical for educators to find ways to help students connect, both with content and with each other, with the fewest delays and disruptions. Educators, students, and caregivers rely heavily on videoconferencing tools during synchronous experiences as a means to create engagement and foster connection. Having to wait or work through device delays and disruptions when learning or working on activities at home causes more disengagement than in a structured classroom setting.

According to an October 2020 survey by MDR*, Zoom is rated as the top-used education app by 60% of K-12 teachers.¹

Many educators note challenges across devices when using videoconferencing tools – whether teaching in a completely virtual setting or from a blended or hybrid classroom with some students in-person and

some online. It can be hard to simply have all of their students join a call. Students also often have trouble logging in as an authenticated user, especially on devices in their household with multiple users. These problems seem to persist and even escalate during a video call when using breakout room functionality.

”The problem isn't necessarily the Chromebook, but rather the underpowered CPU's most of them use to make them inexpensive. If you have an i3, i5 or above, they generally do very well.”

— [dasunrule32](#),
Senior DevOps Engineer (Reddit)

These tools also often run into video and audio challenges, especially when the teaching and learning requires multitasking. When engaging in activities that require the use of apps and programs outside the videoconferencing tool itself, such as watching a

¹ Source: [MDR Insights: Teachers Talk Technology](#)

video on YouTube* or a livestream on Twitch*, students often experience very choppy or delayed video feeds and loss of audio. These issues are exacerbated when students are sharing their own screens on devices, especially those with processors not equipped for multitasking. Many videoconferencing tool features, such as shared whiteboards, offer excellent opportunities for collaboration, but can be hard to engage with due to delays and lag on devices with slower processors.



“We have several schools who purchased HP 16W64UT Chromebook 11 G8s with AMD A4 9120C CPUs reporting serious performance issues, which we have been able to consistently replicate. We also got our hands on a Lenovo 100e 82CD0000US model with the same processor and are seeing the same problems. Very choppy video and intermittent loss of audio - in all video conf platforms - which gets progressively worse as the number of meeting participants increases.”

— [u/ritalyny](#) (Reddit)

Devices Used for Testing

Accommodating the needs of students and educators for meaningful virtual and hybrid learning experiences presents numerous challenges. In the K-12 education ecosystem, many institutions choose between two main platforms - Windows 10 from Microsoft* and Chrome OS* from Google*. According to the latest data from [Futuresource Consulting](#), Windows-based systems account for about 22% of the market while Chromebooks account for the majority of device sales in U.S. K-12 education—approximately 60% of the market. For district and school leaders, selecting the right device for teaching and learning can be tough given the ever-increasing number of device choices and configuration options.

This study evaluates processor power needed to reduce delays, make it easier to connect with others, and allow students and educators to spend less time waiting for the device to keep up with learning that requires multitasking. We completed tests for each learning scenario on both Windows-based notebooks operating on Windows 10 Home and Pro and Chromebooks operating on Chrome OS version 91.

Ways of Learning Virtually

Blended learning is an approach that combines a balance of in-person and online learning that are connected to provide an integrated learning experience.

Hybrid learning refers to any combination of approaches that use online components for teaching and learning that replace or act as a substitute for in-person instruction.








¹ Source: Canlys: [Tablets and Chromebooks Set All-time High Shipment Records in Q4 2020](#)

Windows-based Test Devices

	Dell* Inspiron Intel® Core™ i3-1115G4 \$599.99 at time of purchase
	HP* ProBook x360 11 G7 Intel® Pentium® Silver N6000 \$655.99 at time of purchase
	Dell* Inspiron 15 AMD* Ryzen* 5 3450U \$519.99 at time of purchase
	ASUS* VivoBook Flip 14 AMD* Ryzen* 7 5700U \$719.99 at time of purchase
	HP* Stream 14 AMD* A4-9120C \$259.99 at time of purchase
	Lenovo* Ideapad 1 AMD* A6-9220E \$229.99 at time of purchase

Complete details on device specifications and configuration are available in [Appendix A](#).

Chromebook Test Devices

	DeviceASUS* 2-in-1 Intel® Core™ i3-1115G4 \$569.99 at time of purchase
	HP* Chromebook x360 Intel® Celeron® N4020 \$299.99 at time of purchase
	Acer* Spin 513 Qualcomm* Snapdragon 7c \$349.00 at time of purchase
	HP* Chromebook 11 MediaTek* 8183 \$219.00 at time of purchase
	HP* Chromebook 14 AMD* A4-9120C \$239.99 at time of purchase
	Lenovo* Chromebook 3 AMD* A6-9220C \$199.00
	ProcessorLenovo* Duet MediaTek* Helio P60T \$249.00

Complete details on device specifications and configuration are available in [Appendix A](#).

Results of Our Testing

During a device adoption process, purchasing low-cost devices may seem like a bargain; however, the disruptions to learning due to slow and inefficient processing can have detrimental effects on both students and educators. Devices with processors powered by Intel® technology create a more seamless teaching and learning experience by reducing disruptions and delays and supporting better latency, making it easier to connect with others, and allowing students and educators to spend less time waiting for the processor to keep up with learning that requires multitasking.



While multitasking on video calls to live stream content and use 3D modeling and simulation applications, Intel® Core™ and Intel® Celeron® processor-based Chromebooks perform an average of 22 seconds or 59% faster than the device powered by the Qualcomm Snapdragon 7c processor.

The learning scenarios we developed and tested were created to realistically simulate what most students and educators experience when using technology, including videoconferencing tools, during blended, hybrid and virtual learning experiences. The focus of this study is to quantify how more powerful processors have a significant impact on the ability to experience and participate in a seamless, synchronous virtual learning experience.

Testing Methodology

To simulate an authentic, synchronous virtual learning experience we used a total of 24 notebook computers, both Chromebooks and Windows devices, to create an online classroom environment. During testing, one device was used as an educator device, while the others were used as student devices. The educator device served as the host for each Zoom videoconferencing session, while each student device joined the video call using a shared access link. We completed a series of tests to capture both quantitative data on processor speeds during learning tasks and multitasking, as well as qualitative data about how processor speeds affect a device's ability to offer a seamless teaching and learning experience.¹

While multitasking on video calls to screen share live streaming in-game play in Minecraft: Education Edition, the Intel® Core™ i3 processor-based Windows device performs on average 5.3 seconds or 17% faster than devices powered by AMD Ryzen 5 and Ryzen 7 processors.

¹ For complete testing workflows, see [Appendix B](#).

Table of Results

Windows-based Device Results						
Total Scenario Time	Intel® Core™ i3-1115G4	Intel® Pentium® Silver N6000	AMD* Ryzen* 5 3450U	AMD* Ryzen* 7 5700U	AMD* A4-9120C	AMD* A6-9220E
11th Grade <i>Engineering Solutions to Real-world Problems with 3D Modeling and Simulation</i>	16.6 secs	35.3 secs	33.1 secs	32.8 secs	44.5 secs	83.7 secs
7th Grade <i>Programming Machines Using the Physics of Minecraft: Education Edition</i>	25.3 secs	63.5 secs	30.3 secs	31 secs	117.9 secs	126.1 secs

Chromebook Results							
Total Scenario Time <i>In seconds</i>	Intel® Core™ i3-1115G4	Intel® Celeron® N4020	Qualcomm* Snapdragon 7c	MediaTek* 8183	AMD* A4-9120C	AMD* A6-9220C	MediaTek* Helio P60T
11th Grade <i>Engineering Solutions to Real-world Problems with 3D Modeling and Simulation</i>	13 secs	17.7 secs	38 secs	25.6 secs	34.3 secs	29.6 secs	37.1 secs
7th Grade <i>Programming Machines Using the Physics of Minecraft: Education Edition</i>	11.1 secs	20.5 secs	21 secs	24 secs	36.4 secs	33.7 secs	25.4 secs

Learning Scenarios and Outcomes

The following sections outline typical K–12 learning scenarios that compare the learning experience for both educators and students using devices with the featured processors. Each scenario explains the educator or student tasks involved in the activity, gives the outcomes and highlights of the test results, and describes the functionality differences and the timed results for performance.

High School Classroom Scenario

Engineering Solutions to Real-world Problems with 3D Modeling and Simulation

At a Glance

Grade Level

11th grade

Subject Area

Career and Technical Education (CTE)

Class

Principles of Engineering

As a culminating project for their engineering and social change unit, student groups are tasked with identifying a real-world problem that they would like to design a solution for. Students identify and research the topics related to their problem, interview experts and others who provide helpful perspectives, and work together to formulate designs for their solutions using 3D modeling and simulation software.

Learning Skills

- Simulation and modeling
- Design thinking
- Digital content creation
- Digital communication and collaboration

Applications and Tools

- Zoom
- Zoom Whiteboard
- 3D Object Maker*
- Sketchfab*
- Tinkercad*
- Twitch*
- YouTube*
- Google Chat*
- Google Classroom*
- Google Drive*
- Google Drawings*

Throughout the semester, students in Principles of Engineering have explored mechanisms, the strength of structures and materials, and automation. As a culminating project for their unit on engineering and social change, student groups are tasked with identifying a real-world problem that they would like to design a solution for. Students identify and research the topics related to their problem, interview experts and others who provide helpful perspectives, and work together to formulate designs for their solutions. After curating their research and interview materials and meeting to discuss next steps, students join a weekly Zoom work session. Their teacher begins the Zoom video call, making sure to record it, and students are able to join via a link shared in Google Classroom. After joining the call, students do a quick pair-share exercise in predetermined breakout rooms to discuss what they've discovered so far about the problem they want to solve. While students are engaged in their discussions, the teacher broadcasts time reminders so that each student will have ample time to share. After five minutes, the teacher closes the breakout rooms and students are redirected back to the main session to begin the day's activities.

In order to bring their solutions to life, students will design and build a 3D model and simulation. Before they move to breakout rooms to work, the teacher uses screen sharing to play an instructional video for the 3D modeling and simulation software students will use. The video offers students an entry point for how to navigate the software to design and build their models. Students use the chat and raise hand features in Zoom to ask questions during the video. After the mini lesson, students are sent to their breakout rooms to work in small project groups. The teacher is able to move from one breakout room to another in order to assist and check on each group's progress.



To begin sketching their designs, groups use either the Zoom Whiteboard or Google Drawings. They are able to annotate in real time, and see changes on the screen. Once they have settled on their design, students utilize 3D modeling and simulation software to build the first version of their solution. When they are done, they export these models as obj files and save them on their devices. After exporting, students open Sketchfab in the browser. This tool allows students to animate and showcase their 3D models. The educator closes the breakout rooms, redirecting students back to the main room to share their models with the class.

Qualitative Testing and Evaluation Highlights

Screen Sharing 3D Modeling and Simulation Software	
Windows-based Device Results	Chromebook Results
<ul style="list-style-type: none"> The Intel® Core™ i3 processor-based device performed well when using Zoom's screen share feature to share and receive video when manipulating 3D models and simulations. This device experienced little to no lag, delay, or disruption in quality. Both the AMD A4-9120C and AMD A6-9220E -based devices experienced slight to noticeable delay and lag when receiving screen sharing from other devices. Both the AMD A4-9120C and AMD A6-9220E -based devices would not respond when attempting to access Zoom's screen share menu and were unable to complete this test. 	<ul style="list-style-type: none"> The Intel® Core™ i3 processor-based device performed well when using Zoom's screen share feature to share and receive video when manipulating 3D models and simulations. This device experienced little to no lag, delay, or disruption in quality. The AMD A6-9220C and MediaTek Helio P60T -based devices experienced noticeable delay in sharing their screens with other devices. Once their screens populated on the receiving devices, there was slight to noticeable lag when manipulating 3D models and simulations. There was a noticeable lag on the AMD A4-9120C when screen sharing. This lag appeared when manipulating the 3D object on the device and caused an extended lag on all other devices.
Latency	
Zoom recommends a latency of 150ms or less as higher latency values result in noticeable delays between sending and receiving video and audio. ¹	
Windows-based Device Results	Chromebook Results
<ul style="list-style-type: none"> The Intel® Core™ i3 processor-based device, as well as the Intel® Pentium® Silver N6000, the AMD Ryzen 5 3450U, and the AMD Ryzen 7 5700U -based devices, have an average latency of 67ms, over 2x times lower than the recommended rate. 	<ul style="list-style-type: none"> The Intel® Core™ i3 processor-based device had the lowest latency at 25ms. The Qualcomm Snapdragon 7c-based device had a latency of 256ms, 106ms or almost 2x higher than recommended.

¹ Source: [Zoom Meeting and Phone Statistics](#)

Joining a Breakout Room

Windows-based Device Results	Chromebook Results
<ul style="list-style-type: none"> Both the Intel® Core™ i3 and the Intel® Pentium® Silver N6000 processor-based devices were able to join a preassigned breakout room and one of their own choosing with no delay. The AMD A4-9120C and AMD A6-9220E -based devices joined the breakout room with noticeable to significant delays, with both devices having a high CPU usage warning from Zoom. 	<ul style="list-style-type: none"> The Intel® Core™ i3 processor-based device was able to successfully join a breakout room and experienced no delay or lag when accessing and manipulating 3D Object Maker or when switching between browser tabs and loading and playing Twitch. The AMD A4-9120C-based device showed a noticeable delay and lag in both 3D Object Maker and browser tabs after joining the breakout room. 3D Object Maker also lost some of its functionality. There was a slight delay when switching between browser tabs and loading and playing Twitch on the Qualcomm Snapdragon 7c, AMD A6-9220C, and MediaTek Helio P60T -based devices.

Latency

Zoom recommends a latency of 150ms or less as higher latency values result in noticeable delays between sending and receiving video and audio.¹

Windows-based Device Results	Chromebook Results
<ul style="list-style-type: none"> The Intel® Core™ i3 processor-based device had the lowest latency at 34ms. The AMD Ryzen 5 3450U and AMD Ryzen 7 5700U -based devices had latency rates of 58 and 57ms respectively; approximately 1.7x higher than the Intel® Core™ i3 processor-based device. 	<ul style="list-style-type: none"> The Intel® Core™ i3 processor-based device had the lowest latency at 32ms. Other devices had latency 5-32x the recommended rate with the MediaTek Helio P60T-based device at 788ms, the Qualcomm Snapdragon 7c-based device at 1023ms, and the AMD A4-9120C-based device at 4920ms.

¹ Source: [Zoom Meeting and Phone Statistics](#)

Quantitative Testing and Evaluation Highlights

Windows-based Device Results						
	Intel® Core™ i3-1115G4	Intel® Pentium® Silver N6000	AMD* Ryzen* 5 3450U	AMD* Ryzen* 7 5700U	AMD* A4-9120C	AMD* A6-9220E
Joining the Zoom video conference	5.8 secs	11.5 secs	14.8 secs	17.4 secs	19.4 secs	30.1 secs
	The Intel® Core™ i3 processor-based device performed 11.6 seconds or 66.5% faster than the AMD Ryzen 7 5700U-based device.					
	The Intel® Core™ i3 processor-based device performed 9 seconds or 60.6% faster than the AMD Ryzen 5 3450U-based device.					
Joining a breakout room	5.5 secs	7.8 secs	7.4 secs	8.5 secs	10.9 secs	29.1 secs
	The Intel® Core™ i3 processor-based device performed 3 seconds or 35.5% faster than the AMD Ryzen 7 5700U-based device.					
	The Intel® Core™ i3 processor-based device performed 23.6 seconds or 81.1% faster than the AMD A6-9220E-based device.					

Chromebook Results

	Intel® Core™ i3-1115G4	Intel® Celeron® N4020	Qualcomm* Snapdragon 7c	MediaTek* 8183	AMD* A4-9120C	AMD* A6-9220C	MediaTek* Helio P60T
Joining the Zoom video conference	8.4 secs	13.8 secs	17.8 secs	15.4 secs	22.4 secs	17.2 secs	17.1 secs
	The Intel® Core™ i3 processor-based device performed 9.4 seconds or 52.7% faster than the Qualcomm Snapdragon 7c-based device.						
	The Intel® Core™ i3 processor-based device performed 14 seconds or 62.4% faster than the AMD A4-9120C-based device.						
Joining a breakout room	3.4 secs	2.7 secs	5.8 secs	7.4 secs	9.8 secs	11.2 secs	9.8 secs
	The Intel® Celeron® processor-based device performed 3.1 seconds or 52.8% faster than the Qualcomm Snapdragon 7c-based device.						
	The Intel® Core™ i3 processor-based device performed 7.7 seconds or 69.2% faster than the AMD A6-9220C-based device.						

Middle School Classroom Scenario

Programming Machines Using the Physics of Minecraft: Education Edition

At a Glance

Grade Level

7th grade

Subject Area

Career and Technical Education (CTE)

Class

Computer Science Discovery

In their Computer Science Discovery class, 7th graders work in small teams of three to compete in the North American Scholastic Esports Federation (NASEF) Rube Goldberg Digital Minecraft* Contest. Teams of students study physics principles and simple machines, use coding to build inside the Minecraft: Education Edition environment, and demonstrate their finalized machines for the class before submitting them to the contest.

Learning Skills

- Game-based learning
- Computational thinking
- Digital content creation
- Digital communication and collaboration

Applications and Tools

- Zoom
- Minecraft: Education Edition
- Twitch
- Google Chat
- Google Classroom
- Google Drive
- Google Slides*



In their Computer Science Discovery class, 7th graders work in small teams of three to compete in the North American Scholastic Esports Federation (NASEF) Rube Goldberg Digital Minecraft Contest. Teams of students study physics principles and simple machines, use their coding skills to build inside the Minecraft: Education Edition environment, and demonstrate their finalized machines for the class before submitting them to the contest.

To begin the class's work session, the teacher starts the Zoom video call, making sure to record it, and students are able to join via a link shared in Google Classroom. Before diving into their shared Minecraft: Education Edition worlds, the teacher asks students to do a quick SEL check-in. Students begin by changing their virtual backgrounds to videos to demonstrate how they're feeling about their contest submissions so far. After each student's virtual background is set, the teacher sends them to breakout rooms to share one thing they love about their submission, and one



thing that is proving to be challenging. While students are discussing, the teacher moves between breakout rooms to engage with the class.

After five minutes, the teacher closes the breakout rooms and students are redirected back to the main session to begin the day's activities. Each week the class tunes in for a "How To" livestream on Twitch for building and coding simple machines inside of the Minecraft: Education Edition environment. The teacher opens the team breakout rooms and sends students to watch the livestream and get started building and coding.

Once the livestream concludes, students open their project hyperdoc in Google Slides so they can synchronously add artifacts such as screenshots and short screencast videos of the day's work for their teacher to review. Students work together in their shared world to design and add this week's featured simple machine—the lever. As they are working, students take turns sharing their screens to demonstrate their designs, partner code, and problem solve.

When the small group work session is done, the teacher closes the breakout rooms and redirects students back to the main room. Each group uses screen share to take turns showcasing their progress on their Rube Goldberg machine. They show this in-world, explaining their designs and exhibiting the coding they are using to bring their machine to life.

Qualitative Testing and Evaluation Highlights

Screen Sharing Live In-Game Play	
Windows-based Device Results	Chromebook Results
<ul style="list-style-type: none"> The Intel® Core™ i3 processor-based device is able to screen share live in-game play with no delay and only has a slight lag when making considerable movements while manipulating the game. The Intel® Pentium® Silver N6000 processor based device is able to screen share live in-game play and manipulate the game with only a slight delay and lag. Twitch is unable to load on the AMD A6-9220E-based device for this test. This device also froze while the AMD Ryzen 5 3450U-based device was screen sharing and was unable to complete this test. The AMD A4-9120C froze while the AMD Ryzen 7 5700U-based device was screen sharing, then gave a not responding message, and was unable to complete this test due to dropping the Zoom call. 	<ul style="list-style-type: none"> The Intel® Core™ i3 and Intel® Celeron® processor-based devices both had only a slight delay when screen sharing live in-game play and little to no lag when manipulating the game during screen sharing. The AMD A4-9120C and AMD A6-9220C -based devices both had considerable lag when manipulating the game during screen sharing live in-game play, with the AMD A4-9120C based device showing extended delays with considerable in-game movement.
Latency	
<p><i>Zoom recommends a latency of 150ms or less as higher latency values result in noticeable delays between sending and receiving video and audio.¹</i></p>	
Windows-based Device Results	Chromebook Results
<ul style="list-style-type: none"> All of the devices, except the AMD A4-9120C and A6-9220E-based devices, had latency rates at least 2x lower than recommended. Both the AMD A4-9120C and A6-9220E-based devices were unable to complete this test as they were frozen and not responding. 	<ul style="list-style-type: none"> The Intel® Core™ i3 processor-based device had the lowest latency at 57ms. The AMD A4-9120C based device had a latency rate of 2473ms, 16x higher than the recommended rate.

¹ Source: [Zoom Meeting and Phone Statistics](#)

Joining a Breakout Room

Windows-based Device Results

- All of the devices, except the AMD A4-9120C and AMD A6-9220E-based devices, were able to join the breakout room and choose their own breakout room with little to no delay.
- The AMD A6-9220E-based device is able to join the breakout room with a noticeable delay and had a high CPU usage warning from Zoom.
- The AMD A4-9120C-based device froze and was unable to complete this test.

Chromebook Results

- The Intel® Core™ i3 and Intel® Celeron® processor-based devices both showed no delay when joining a breakout room and no lag in switching between Minecraft: Education Edition and browser tabs.
- When switching between Zoom and browser tabs, the AMD A4-9120C-based device dropped the Zoom video call and closed the application.

Latency

Zoom recommends a latency of 150ms or less as higher latency values result in noticeable delays between sending and receiving video and audio.¹

Windows-based Device Results

- The Intel® Core™ i3 and Intel® Pentium® Silver N6000 processor-based devices had latency rates 2.5x lower than recommended.

Chromebook Results

- The Intel® Core™ i3 processor-based device had the lowest latency at 54ms.
- The Qualcomm Snapdragon 7c-based device had a latency rate of 313ms; over 2x the recommended rate.

¹ Source: [Zoom Meeting and Phone Statistics](#)

Quantitative Testing and Evaluation Highlights

Windows-based Device Results						
	Intel® Core™ i3-1115G4	Intel® Pentium® Silver N6000	AMD* Ryzen* 5 3450U	AMD* Ryzen* 7 5700U	AMD* A4-9120C	AMD* A6-9220E
Joining the Zoom video conference	8.8 secs	16.9 secs	13.7 secs	15.2 secs	41.1 secs	29.5 secs
	The Intel® Core™ i3 processor-based device performed 5 seconds or 36.1% faster than the AMD Ryzen 5 3450U-based device.					
	The Intel® Core™ i3 processor-based device performed 32.4 seconds or 78.6% faster than the AMD A4-9120C-based device.					
Joining a breakout room	6.1 secs	19.5 secs	8.8 secs	8.7 secs	47.9 secs	71.4 secs
	The Intel® Core™ i3 processor-based device performed 2.7 seconds or 30.4% faster than the AMD Ryzen 5 3450U-based device.					
	The Intel® Core™ i3 processor-based device performed 65.3 seconds or 91.4% faster than the AMD A6-9220E-based device.					

Chromebook Results

	Intel® Core™ i3-1115G4	Intel® Celeron® N4020	Qualcomm* Snapdragon 7c	MediaTek* 8183	AMD* A4-9120C	AMD* A6-9220C	MediaTek* Helio P60T
Joining the Zoom video conference	7.8 secs	15.1 secs	14.1 secs	15.1 secs	20.8 secs	19.8 secs	15.8 secs
	The Intel® Core™ i3 processor-based device performed 6.3 seconds or 44.8% faster than the Qualcomm Snapdragon 7c-based device.						
	The Intel® Core™ i3 processor-based device performed 12 seconds or 60.5% faster than the AMD A6-9220C-based device.						
Joining a breakout room	2.2 secs	3.6 secs	4.5 secs	4.4 secs	8.5 secs	9.5 secs	6.7 secs
	The Intel® Core™ i3 processor-based device performed 2.3 seconds or 51.4% faster than the Qualcomm Snapdragon 7c-based device.						
	The Intel® Core™ i3 processor-based device performed 6.3 seconds or 74.4% faster than the AMD A4-9120C-based device.						

The analysis in this document was done by Clarity Innovations, Inc. and commissioned by Intel®.

Results have been simulated and are provided for informational purposes only. Software and workloads used in performance tests may have been optimized for performance only on Intel® microprocessors.

Any change to those factors may cause the results to vary. You should consult other information and performance tests to assist you in fully evaluating your contemplated purchases, including the performance of that product when combined with other products. For more complete information about performance and benchmark results, visit www.intel.com/benchmarks.

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Appendix

A. Device Specifications

Windows-based Test Devices

Device	Dell Inspiron	HP ProBook x360 11 G7	Dell Inspiron 15	ASUS VivoBook Flip 14	Lenovo Ideapad 1	HP Stream 14
Model Number	3501	3N8TOUT	i3505-A542BLK-PUS	TM420UADS71T	81VS009GUS	14-CB188NR
Operating System	Windows 10 Home	Windows 10 Pro	Windows 10 Home	Windows 10 Home	Windows 10 Home	Windows 10 Home
Processor	Intel Core i3-1115G4	Intel Pentium Silver N6000	AMD Ryzen 5 3450U	AMD Ryzen 7 5700U	AMD A6-9220E	AMD A4-9120C
Processor Frequency	3.0 GHz	1.1 GHz	2.1 GHz	1.8 GHz	1.6 GHz	1.5 GHz
Storage	256 GB	256 GB	256 GB	512 GB	64 GB	32 GB
Memory	8 GB	8 GB	8 GB	8 GB	4 GB	4 GB
Battery Capacity	45 Wh	47 Wh	45 Wh	45 Wh	45 Wh	41 Wh
Display Size	15.6 in	11.6 in	15.6 in	14"	14 in	14 in
Graphics	Intel UHD Graphics	Intel UHD Graphics	AMD Radeon Vega 8	AMD Radeon	AMD Radeon R4	AMD Radeon R3
Networking	802.11ac	802.11a/b/g/n/ac	802.11a/b/g/n/ac	802.11a/b/g/n/ac	802.11ac	802.11.b/g/n
Price at Time of Purchase	\$599.99	\$655.99	\$519.99	\$719.99	\$229.99	\$259.99

Chromebook Test Devices

Device	ASUS 2-in-1	HP Chrome- book x360	Acer Spin 513	HP Chrome- book 11	HP Chrome- book 14	Lenovo Chrome- book 3	Lenovo Duet
Model Number	C536EA-B13T3	7PD76UA	CP513-1H-S60F	11A-NA0015WM	6CD26UA	82H40000US	ZA6F0016US
Operating System	Chrome OS 91.0.4472	Chrome OS 91.0.4472	Chrome OS 91.0.4472	Chrome OS 91.0.4472	Chrome OS 91.0.4472	Chrome OS 91.0.4472	Chrome OS 91.0.4472
Processor	Intel Core i3-1115G4	Intel Celeron N4020	Qualcomm Snapdragon 7c	MediaTek 8183	AMD A4-9120C	AMD A6-9220C	MediaTek Helio P60T
Processor Frequency	3.0 GHz	1.1 GHz	2.4 GHz	2.0 GHz	1.6 GHz	1.8 GHz	2.0 GHz
Storage	128 GB	32 GB	64 GB	64 GB	32 GB	32 GB	128 GB
Memory	8 GB	4 GB	4 GB	4 GB	4 GB	4 GB	4 GB
Battery Capacity	45 Wh	47 Wh	46 Wh	47 Wh	37 Wh	42 Wh	35 Wh
Display Size	15.1 in	11.6 in	13.3 in	11.6 in	14 in	11.6 in	10.1 in
Graphics	Intel UHD Graphics	Intel UHD Graphics 600	Qualcomm Adreno 618	MediaTek Integrated Graphics	Intel HD Graphics	AMD Radeon	ARM G72 MP3 Graphics
Networking	802.11ax	802.11a/ac/b/g/n	802.11a/ac/b/g/n	802.11a/ac/b/g/n	802.11a/b/g/n/ac	802.11ac	802.11a/b/g/n/ac
Price at Time of Purchase	\$569.99	\$299.99	\$349.00	\$219.00	\$239.99	\$199.00	\$249.00

B. High School Classroom Scenario Quantitative Results†

Test 1 Details

Joining a Zoom call

1. Click host meeting to start the Zoom* video call.
2. When the video call fully connects, simultaneously start the timer and click the link for the Zoom* video call on student device.
3. When the video call fully connects, stop the timer.

Test 1 Timed Results (seconds)		1	2	3	avg
Chromebook Devices	Intel Core i3-1115G4	8	7.2	10.1	8.4
	Intel Celeron N4020	12.3	13.1	16.1	13.8
	Qualcomm Snapdragon 7c	17.3	17.2	19	17.8
	MediaTek 8183	15	16	15.2	15.4
	AMD A4-9120C	24.1	22.1	21.1	22.4
	AMD A6-9220C	20.2	15.3	16.2	17.2
	MediaTek Helio P60T	17.2	16.1	18.1	17.1
Windows-based Devices	Intel Core i3-1115G4	8	5.3	4.2	5.8
	Intel Pentium Silver N6000	16.2	10.1	8.1	11.5
	AMD Ryzen 5 3450U	14.2	8.2	22.1	14.8
	AMD Ryzen 7 5700U	13.1	17.1	22.1	17.4
	AMD A6-9220E	24	14.1	20.2	19.4
	AMD A4-9120C	47	23.1	20.1	30.1

Test 2 Details

Joining a breakout room

1. Click breakout rooms in the Zoom* menu.
2. Set rooms to create 5 breakout rooms that assign automatically.
3. Click create.
4. Simultaneously start the timer and click join on each device.
5. When the device connects to the room, stop the timer.

Test 2 Timed Results (seconds)		1	2	3	avg
Chromebook Devices	Intel Core i3-1115G4	3.0	2.2	5.1	3.4
	Intel Celeron N4020	4.0	2.1	2.1	2.7
	Qualcomm Snapdragon 7c	6.1	3.2	8.1	5.8
	MediaTek 8183	8.0	8.1	6.1	7.4
	AMD A4-9120C	7.2	14	8.1	9.8
	AMD A6-9220C	10.2	11.1	12.2	11.2
	MediaTek Helio P60T	7.0	13.2	9.2	9.8

Table continues on next page

Test 2 Timed Results (seconds)		1	2	3	avg
Windows-based Devices	Intel Core i3-1115G4	6.1	5.2	5.2	5.5
	Intel Pentium Silver N6000	8.1	8	7.2	7.8
	AMD Ryzen 5 3450U	8.1	7.2	7	7.4
	AMD Ryzen 7 5700U	10.1	8.2	7.3	8.5
	AMD A6-9220E	11.3	10.3	11.2	10.9
	AMD A4-9120C	29.2	18.1	40	29.1

Test 3 Details

Rejoining main room

1. Click breakout rooms in the Zoom* menu on educator device.
2. Simultaneously start the timer and click close all rooms.
3. When the device connects to the room, stop the timer.

Test 3 Timed Results (seconds)		1	2	3	avg
Chromebook Devices	Intel Core i3-1115G4	1.1	1.1	1.2	1.1
	Intel Celeron N4020	1.2	1.1	1.2	1.2
	Qualcomm Snapdragon 7c	12.1	16	15.1	14.4
	MediaTek 8183	4.3	2	2	2.8
	AMD A4-9120C	2	2	2.3	2.1
	AMD A6-9220C	1.2	1.2	1.3	1.2
	MediaTek Helio P60T	9.1	11.1	10.2	10.1
Windows-based Devices	Intel Core i3-1115G4	6.2	3.3	6.3	5.3
	Intel Pentium Silver N6000	8.2	31	9	16.1
	AMD Ryzen 5 3450U	8.2	16.2	8.2	10.9
	AMD Ryzen 7 5700U	9.2	4.1	7.2	6.8
	AMD A6-9220E	9.1	19.2	14.1	14.1
	AMD A4-9120C	26.1	17.3	30.1	24.5

Scenario totals

Scenario Totals (seconds)		1	2	3	avg
Chromebook Devices	Intel Core i3-1115G4	12.1	10.5	16.4	13.0
	Intel Celeron N4020	17.5	16.3	19.4	17.7
	Qualcomm Snapdragon 7c	35.5	36.4	42.2	38.0
	MediaTek 8183	27.3	26.1	23.3	25.6
	AMD A4-9120C	33.3	38.1	31.5	34.3
	AMD A6-9220C	31.6	27.6	29.7	29.6
	MediaTek Helio P60T	33.3	40.4	37.5	37.1
Windows-based Devices	Intel Core i3-1115G4	20.3	13.8	15.7	16.6
	Intel Pentium Silver N6000	32.5	49.1	24.3	35.3
	AMD Ryzen 5 3450U	30.5	31.6	37.3	33.1
	AMD Ryzen 7 5700U	32.4	29.4	36.6	32.8
	AMD A6-9220E	44.4	43.6	45.5	44.5
	AMD A4-9120C	102.3	58.5	90.2	83.7

C. Middle School Classroom Scenario Quantitative Results[‡]

Test 1 Details

Joining a Zoom call

1. Click host meeting to start the Zoom* video call.
2. When the video call fully connects, simultaneously start the timer and click the link for the Zoom* video call on student device.
3. When the video call fully connects, stop the timer.

Test 1 Timed Results (seconds)		1	2	3	avg
Chromebook Devices	Intel Core i3-1115G4	7	7.1	9.3	7.8
	Intel Celeron N4020	16	13.3	16.1	15.1
	Qualcomm Snapdragon 7c	14.2	15.1	13.1	14.1
	MediaTek 8183	16	14.2	15.2	15.1
	AMD A4-9120C	22.1	21.2	19.2	20.8
	AMD A6-9220C	17.1	23.2	19	19.8
	MediaTek Helio P60T	14.2	19.1	14.2	15.8
Windows-based Devices	Intel Core i3-1115G4	8.1	8.2	10	8.8
	Intel Pentium Silver N6000	14.2	13.1	23.3	16.9
	AMD Ryzen 5 3450U	14.1	14.1	13	13.7
	AMD Ryzen 7 5700U	6.2	20.2	19.1	15.2
	AMD A6-9220E	72	25.1	26.3	41.1
	AMD A4-9120C	34.3	25	29.2	29.5

Test 2 Details

Joining a breakout room

1. Click breakout rooms in the Zoom* menu.
2. Set rooms to create 5 breakout rooms that assign automatically.
3. Click create.
4. Simultaneously start the timer and click join on each device.
5. When the device connects to the room, stop the timer.

Test 2 Timed Results (seconds)		1	2	3	avg
Chromebook Devices	Intel Core i3-1115G4	2.1	2.2	2.2	2.2
	Intel Celeron N4020	3.3	4.3	3.1	3.6
	Qualcomm Snapdragon 7c	7.1	3.2	3.1	4.5
	MediaTek 8183	5.2	3	5.1	4.4
	AMD A4-9120C	10.2	7.1	8.1	8.5
	AMD A6-9220C	12.1	6.2	10.1	9.5
	MediaTek Helio P60T	9.0	3.1	8	6.7

Table continues on next page

Test 2 Timed Results (seconds)		1	2	3	avg
Windows-based Devices	Intel Core i3-1115G4	6.1	6.1	6.1	6.1
	Intel Pentium Silver N6000	21.2	18.2	19	19.5
	AMD Ryzen 5 3450U	8.2	9.1	9	8.8
	AMD Ryzen 7 5700U	6.1	8.1	12	8.7
	AMD A6-9220E	88.2	31.1	24.5	47.9
	AMD A4-9120C	97.2	47	70.1	71.4

Test 3 Details

Rejoining main room

1. Click breakout rooms in the Zoom* menu on educator device.
2. Simultaneously start the timer and click close all rooms.
3. When the device connects to the room, stop the timer.

Test 3 Timed Results (seconds)		1	2	3	avg
Chromebook Devices	Intel Core i3-1115G4	1.1	1.1	1.3	1.2
	Intel Celeron N4020	1.2	2.1	2.2	1.8
	Qualcomm Snapdragon 7c	3	2	2.1	2.4
	MediaTek 8183	9	2.1	2.2	4.4
	AMD A4-9120C	5.1	12.1	4.1	7.1
	AMD A6-9220C	2	9.1	2.2	4.4
	MediaTek Helio P60T	3.1	3.1	2.3	2.8
Windows-based Devices	Intel Core i3-1115G4	17.3	7	7	10.4
	Intel Pentium Silver N6000	27.2	27.1	27.1	27.1
	AMD Ryzen 5 3450U	7.2	8.2	8.1	7.8
	AMD Ryzen 7 5700U	7.2	7	7.1	7.1
	AMD A6-9220E	33.1	28.3	25	28.8
	AMD A4-9120C	26.2	24.2	N/A ⁰	25.2

⁰ Couldn't complete test; device is frozen and didn't get the breakout room popup

Scenario totals

Scenario Totals (seconds)		1	2	3	avg
Chromebook Devices	Intel Core i3-1115G4	10.2	10.4	12.8	11.1
	Intel Celeron N4020	20.5	19.7	21.4	20.5
	Qualcomm Snapdragon 7c	24.3	20.3	18.3	21.0
	MediaTek 8183	30.2	19.3	22.5	24.0
	AMD A4-9120C	37.4	40.4	31.4	36.4
	AMD A6-9220C	31.2	38.5	31.3	33.7
	MediaTek Helio P60T	26.3	25.3	24.5	25.4
Windows-based Devices	Intel Core i3-1115G4	31.5	21.3	23.1	25.3
	Intel Pentium Silver N6000	62.6	58.4	69.4	63.5
	AMD Ryzen 5 3450U	29.5	31.4	30.1	30.3
	AMD Ryzen 7 5700U	19.5	35.3	38.2	31.0
	AMD A6-9220E	193.3	84.5	75.8	117.9
	AMD A4-9120C	157.7	96.2	99.3	126.1

D. High School Classroom Scenario Qualitative Results

Test 1

Narrative

Setting a virtual background

1. Click video in the Zoom* menu.
2. Click choose virtual background or choose virtual filter.
3. Set and click to exit settings menu.

Chromebook Overall Notes

Twitch and YouTube paused when joining Zoom meeting on all devices except the AMD A6.

Windows Overall Notes

Twitch paused on the AMD A4 and AMD A6 when joining the Zoom meeting.

Chromebook Devices	Intel Core i3-1115G4	No option to change virtual background
	Intel Celeron N4020	No option to change virtual background
	Qualcomm Snapdragon 7c	No option to change virtual background
	MediaTek 8183	No option to change virtual background
	AMD A4-9120C	No option to change virtual background
	AMD A6-9220C	No option to change virtual background
	MediaTek Helio P60T	No option to change virtual background
Windows-based Devices	Intel Core i3-1115G4	Device is able to set a virtual background by choosing blur (comes installed with Zoom) or by downloading and choosing an image. Virtual background loaded with no issues. Video filters are unavailable, but studio effects can be changed. CPU Usage - Low - Zoom; Low - CPU Zoom Settings - 15 FPS; 72ms Latency; 5ms Jitter
	Intel Pentium Silver N6000	Device is able to set a virtual background by choosing blur (comes installed with Zoom) or by downloading and choosing an image. Virtual background loaded with a slight delay. Video filters are unavailable, but studio effects can be changed. CPU Usage - Low - Zoom; High - CPU Zoom Settings - 14 FPS; 106ms Latency; 5ms Jitter
	AMD Ryzen 5 3450U	Device is able to set a virtual background by choosing blur (comes installed with Zoom) or by downloading and choosing an image. Virtual background loaded with no issues. Video filters are unavailable, but studio effects can be changed. CPU Usage - Low - Zoom; Low - CPU Zoom Settings - 15 FPS; 71ms Latency; 5ms Jitter

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Windows-based Devices	AMD Ryzen 7 5700U	<p>Device is able to set a virtual background by choosing blur (comes installed with Zoom) or by downloading and choosing an image. Virtual background loaded with no issues.</p> <p>Video filters are unavailable, but studio effects can be changed.</p> <p>CPU Usage - Low - Zoom; Low - CPU</p> <p>Zoom Settings - 13 FPS; 72ms Latency; 3ms Jitter</p>
	AMD A6-9220E	<p>Device is able to set a virtual background by choosing blur (comes installed with Zoom) or by downloading and choosing an image. Virtual background loaded with a slight delay.</p> <p>Video filters are unavailable, but studio effects can be changed.</p> <p>There is a slight delay when accessing the Zoom settings.</p> <p>CPU Usage - Low - Zoom; High - CPU - Got message "High CPU usage may be affecting your meeting experience; please close other applications."</p> <p>Zoom Settings - 1 FPS; 129ms Latency; 5ms Jitter</p>
	AMD A4-9120C	<p>Device is able to set a virtual background by downloading and choosing an image. The blur option is not available during this test. Virtual background loaded with a significant delay.</p> <p>Video filters are unavailable, but studio effects can be changed.</p> <p>There is a slight delay when accessing the Zoom settings.</p> <p>CPU Usage - Low - Zoom; High - CPU - Got message "High CPU usage may be affecting your meeting experience; please close other applications."</p> <p>Zoom Settings - 0 FPS; 133ms Latency; 5ms Jitter</p>

Test 2

Narrative

Whiteboard test - Screen share Google Drawings*

1. Click share screen in Zoom* menu.
2. Choose Google Drawings tab or whiteboard application.

Starting and collaborating on a whiteboard

1. Click share screen in Zoom* menu.
2. Click whiteboard.
3. Click share.

Chromebook Devices	Intel Core i3-1115G4	<p>When screen sharing, Google Drawings tab appears with no delay on other devices.</p> <p>There is no noticeable lag on other devices during screen sharing when manipulating the drawing.</p> <p>Zoom Settings - 4 FPS; 25ms Latency; 5ms Jitter</p>
	Intel Celeron N4020	<p>When screen sharing, Google Drawings tab appears with no delay on other devices.</p> <p>There is no noticeable lag on devices during screen sharing when manipulating the drawing, except on the Qualcomm and AMD A4 where there was a slight lag.</p> <p>Zoom Settings - 4 FPS; 78ms Latency; 19ms Jitter</p>

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**Collaborating on a whiteboard
(other student devices)**

1. Choose view options from the top Zoom* menu.
2. Choose annotate.

Chromebook Overall Notes

There was slight and noticeable lag on both the Qualcomm and AMD A4 when completing this test.

Windows Overall Notes

N/A

Chromebook Devices	Qualcomm Snapdragon 7c	<p>When screen sharing, Google Drawings tab appears with a slight delay on other devices.</p> <p>On the i3, Celeron, and MediaTek 8183, there is a slight lag during screen sharing when manipulating the drawing.</p> <p>On the AMD A4, AMD A6, and MediaTek Helio, there is a noticeable lag during screen sharing when manipulating the drawing.</p> <p>Zoom Settings - 3 FPS; 178ms Latency; 36ms Jitter</p>
	MediaTek 8183	<p>When screen sharing, Google Drawings tab appears with no delay on other devices, except for the Qualcomm and AMD A4 where there is a slight delay.</p> <p>On the i3, and Celeron there is a no lag during screen sharing when manipulating the drawing.</p> <p>On the AMD A4, AMD A6, and MediaTek Helio, there is a slight lag during screen sharing when manipulating the drawing.</p> <p>On the Qualcomm, there is a noticeable lag during screen sharing when manipulating the drawing.</p> <p>Zoom Settings - 4 FPS; 72ms Latency; 28ms Jitter</p>
	AMD A4-9120C	<p>When screen sharing, Google Drawings tab appears with noticeable delay on all other devices.</p> <p>There is noticeable lag on all devices during screen sharing when manipulating the drawing.</p> <p>Zoom Settings - 3 FPS; 73ms Latency; 43ms Jitter</p>
	AMD A6-9220C	<p>When screen sharing, Google Drawings tab appears with noticeable delay on all other devices.</p> <p>There is a slight lag on the i3 and Celeron and a noticeable lag on all other devices during screen sharing when manipulating the drawing.</p> <p>Zoom Settings - 3 FPS; 43ms Latency; 14ms Jitter</p>
	MediaTek Helio P60T	<p>When screen sharing, Google Drawings tab appears with a slight delay on all other devices.</p> <p>There is a slight lag on the Qualcomm and AMD A4 and no lag on all other devices during screen sharing when manipulating the drawing.</p> <p>Zoom Settings - 4 FPS; 43ms Latency; 15ms Jitter</p>
Windows-based Devices	Intel Core i3-1115G4	<p>When sharing, Zoom whiteboard appears with no delay on other devices, except the AMD A6 which has a noticeable delay.</p> <p>There is no noticeable lag on other devices when annotating the whiteboard, except on the AMD A4 and AMD A6 which have a slight delay.</p> <p>CPU Usage - Low - Zoom; Low - CPU</p> <p>Zoom Settings - 12 FPS; 64ms Latency; 7ms Jitter</p>

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Windows-based Devices	Intel Pentium Silver N6000	<p>When sharing, Zoom whiteboard appears with a slight delay on other devices.</p> <p>There is a slight lag on other devices when annotating the whiteboard.</p> <p>CPU Usage - Low - Zoom; High - CPU - Got message "High CPU usage may be affecting your meeting experience; please close other applications."</p> <p>Zoom Settings - 12 FPS; 149ms Latency; 54ms Jitter</p>
	AMD Ryzen 5 3450U	<p>When sharing, Zoom whiteboard appears with no delay on other devices, except on the AMD A4 and AMD A6 which have a slight delay.</p> <p>There is no lag on other devices when annotating the whiteboard, except on the AMD A4 and AMD A6 which have a slight lag.</p> <p>CPU Usage - Low - Zoom; Low - CPU</p> <p>Zoom Settings - 19 FPS; 76ms Latency; 9ms Jitter</p>
	AMD Ryzen 7 5700U	<p>When sharing, Zoom whiteboard appears with no delay on other devices, except on the AMD A4 and AMD A6 which have a slight delay.</p> <p>There is no lag on other devices when annotating the whiteboard, except on the AMD A4 and AMD A6 which have a slight lag.</p> <p>CPU Usage - Low - Zoom; Low - CPU</p> <p>Zoom Settings - 4 FPS; 61ms Latency; 5ms Jitter</p>
	AMD A6-9220E	<p>When sharing, Zoom whiteboard appears with a significant delay on other devices.</p> <p>There is a noticeable lag on other devices when annotating the whiteboard.</p> <p>CPU Usage - Low - Zoom; High - CPU - Got message "High CPU usage may be affecting your meeting experience; please close other applications."</p> <p>Zoom Settings - 1 FPS; 120ms Latency; 7ms Jitter</p>
	AMD A4-9120C	<p>When sharing, Zoom whiteboard appears with a significant delay on other devices.</p> <p>There is a noticeable lag on this device when it annotates the whiteboard.</p> <p>There is a noticeable lag on other devices when annotating the whiteboard.</p> <p>CPU Usage - Low - Zoom; High - CPU - Got message "High CPU usage may be affecting your meeting experience; please close other applications."</p> <p>Zoom Settings - 1 FPS; 105ms Latency; 121ms Jitter</p>

Test 3

Narrative

Sharing screen (video or audio)

1. Open appropriate file, application, or browser tab.
2. Click share screen in the Zoom* menu.
3. Choose the appropriate display.
4. Click share.

Chromebook Overall Notes

There was a noticeable lag on the AMD A4 when screen sharing. This lag appeared when manipulating the 3D object on the device and caused an appx. 10 second lag on all other devices.

Windows Overall Notes

N/A

Chromebook Devices	Intel Core i3-1115G4	<p>When screen sharing, 3D Object Maker appears with no delay on other devices.</p> <p>There is no lag on other devices during screen sharing when manipulating the 3D object, except on the Qualcomm which has a slight lag.</p> <p>Zoom Settings - 5 FPS; 25ms Latency; 5ms Jitter</p>
	Intel Celeron N4020	<p>When screen sharing, 3D Object Maker appears with no delay on other devices, except on the Qualcomm which had a slight delay.</p> <p>There is no lag on other devices during screen sharing when manipulating the 3D object, except on the Qualcomm which has a slight lag.</p> <p>Zoom Settings - 4 FPS; 58ms Latency; 24ms Jitter</p>
	Qualcomm Snapdragon 7c	<p>When screen sharing, 3D Object Maker appears with no delay on other devices, except on the AMD A4 which had a slight delay.</p> <p>There is no lag on other devices during screen sharing when manipulating the 3D object, except on the AMD A4 which has a slight lag.</p> <p>Zoom Settings - 4 FPS; 256ms Latency; 42ms Jitter</p>
	MediaTek 8183	<p>When screen sharing, 3D Object Maker appears with a slight delay on other devices.</p> <p>There is no lag on other devices during screen sharing when manipulating the 3D object, except on the Qualcomm and AMD A4 which have a slight lag.</p> <p>Zoom Settings - 4 FPS; 52ms Latency; 21ms Jitter</p>
	AMD A4-9120C	<p>When screen sharing, 3D Object Maker appears with a noticeable delay on other devices.</p> <p>When manipulating the 3D object during screen sharing, it moved on this device with a slight lag, but took appx. 10 seconds to move on the other devices.</p> <p>Zoom Settings - 3 FPS; 97ms Latency; 48ms Jitter</p>
	AMD A6-9220C	<p>When screen sharing, 3D Object Maker appears with a noticeable delay on other devices.</p> <p>There is a slight lag on other devices during screen sharing when manipulating the 3D object.</p> <p>Zoom Settings - 2 FPS; 63ms Latency; 40ms Jitter</p>

Table continues on next page

Chromebook Devices	MediaTek Helio P60T	<p>When screen sharing, 3D Object Maker appears with a noticeable delay on other devices.</p> <p>There is a slight lag on other devices during screen sharing when manipulating the 3D object, except the Qualcomm and AMD A4 which have a noticeable lag.</p> <p>Zoom Settings - 4 FPS; 48ms Latency; 19ms Jitter</p>
	Intel Core i3-1115G4	<p>When sharing, Sketchfab appears with no delay on other devices, except the AMD A6 which has a noticeable delay.</p> <p>There is no lag on other devices when manipulating the 3D object, except on the AMD A6 which has a slight delay.</p> <p>CPU Usage - Low - Zoom; Medium - CPU</p> <p>Zoom Settings - 1 FPS; 70ms Latency; 3ms Jitter</p>
	Intel Pentium Silver N6000	<p>When sharing, Sketchfab appears with a slight delay on other devices.</p> <p>There is a no lag on other devices when manipulating the 3D object, except on the AMD A4 and AMD A6 which have a slight lag.</p> <p>CPU Usage - Low - Zoom; Medium - CPU</p> <p>Zoom Settings - 1 FPS; 68ms Latency; 15ms Jitter</p>
	AMD Ryzen 5 3450U	<p>When sharing, Sketchfab appears with no delay on other devices.</p> <p>There is no lag on other devices when manipulating the 3D object, except on the AMD A4 and AMD A6 which have a slight lag.</p> <p>CPU Usage - Low - Zoom; Low - CPU</p> <p>Zoom Settings - 16 FPS; 73ms Latency; 3ms Jitter</p>
	AMD Ryzen 7 5700U	<p>When sharing, Sketchfab appears with no delay on other devices.</p> <p>There is a slight lag on other devices when manipulating the 3D object, except on the AMD A4 and AMD A6 which have a noticeable lag.</p> <p>CPU Usage - Low - Zoom; Low - CPU</p> <p>Zoom Settings - 24 FPS; 60ms Latency; 4ms Jitter</p>

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Windows-based Devices	AMD A6-9220E	<p>Device is not responding when accessing the screen sharing menu.</p> <p>Unable to complete this test as Zoom meeting is not responding.</p> <p>Unable to check Zoom settings.</p> <p>CPU Usage - N/A - Zoom; N/A - CPU</p> <p>Zoom Settings - N/A FPS; N/Ams Latency; N/Ams Jitter</p>
	AMD A4-9120C	<p>Device is not responding when accessing the screen sharing menu.</p> <p>Unable to complete this test as Zoom meeting is not responding.</p> <p>Unable to check Zoom settings.</p> <p>CPU Usage - N/A - Zoom; N/A - CPU</p> <p>Zoom Settings - N/A FPS; N/Ams Latency; N/Ams Jitter</p>

Test 4

Narrative

Joining breakout rooms

1. Click breakout rooms in the Zoom* menu on educator device.
2. Set breakout rooms to automatically have students join.
3. Open all rooms.

Chromebook Overall Notes

Twitch pauses when joining breakout rooms on all devices.

Twitch pauses when switching from the browser back to Zoom.

Windows Overall Notes

N/A

Chromebook Devices	Intel Core i3-1115G4	<p>There is no delay or lag in 3D Object Maker or on any browser tabs.</p> <p>Zoom Settings - 19 FPS; 32ms Latency; 2ms Jitter</p>
	Intel Celeron N4020	<p>There is no delay or lag in 3D Object Maker and a slight delay when switching between browser tabs and loading Twitch.</p> <p>Zoom Settings - 9 FPS; 171ms Latency; 28ms Jitter</p>
	Qualcomm Snapdragon 7c	<p>There is no delay or lag in 3D Object Maker and a slight delay when switching between browser tabs and loading Twitch.</p> <p>Zoom Settings - 19 FPS; 1023ms Latency; 25ms Jitter</p>
	MediaTek 8183	<p>There is no delay or lag in 3D Object Maker or browser tabs.</p> <p>Zoom Settings - 19 FPS; 76ms Latency; 19ms Jitter</p>
	AMD A4-9120C	<p>There is a noticeable delay and lag in 3D Object Maker and some of the functionality won't work.</p> <p>There is a noticeable delay and lag in loading and switching between browser tabs and noticeable load time for both Twitch and YouTube.</p> <p>Zoom Settings - 23 FPS; 4920ms Latency; 253ms Jitter</p>
	AMD A6-9220C	<p>There is no delay or lag in 3D Object Maker and a slight delay and lag when loading Twitch and YouTube.</p> <p>Zoom Settings - 6 FPS; 424ms Latency; 67ms Jitter</p>

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Chromebook Devices	MediaTek Helio P60T	<p>There is no delay or lag in 3D Object Maker and a slight delay and lag when loading Twitch.</p> <p>Zoom Settings - 12 FPS; 788ms Latency; 34ms Jitter</p>
Windows-based Devices	Intel Core i3-1115G4	<p>Device is able to join preassigned breakout room with no delay.</p> <p>Device is able to choose and join a breakout room when prompted in Zoom meeting.</p> <p>CPU Usage - Low - Zoom; Medium- CPU</p> <p>Zoom Settings - 13 FPS; 34ms Latency; 4ms Jitter</p>
	Intel Pentium Silver N6000	<p>Device is able to join preassigned breakout room with no delay.</p> <p>Device is able to choose and join a breakout room when prompted in Zoom meeting.</p> <p>CPU Usage - Low - Zoom; Medium - CPU</p> <p>Zoom Settings - 15 FPS; 65ms Latency; 4ms Jitter</p>
	AMD Ryzen 5 3450U	<p>Device is able to join preassigned breakout room with no delay.</p> <p>Device is able to choose and join a breakout room when prompted in Zoom meeting.</p> <p>CPU Usage - Low - Zoom; Low - CPU</p> <p>Zoom Settings - 15 FPS; 58ms Latency; 3ms Jitter</p>
	AMD Ryzen 7 5700U	<p>Device is able to join preassigned breakout room with no delay.</p> <p>Device is able to choose and join a breakout room when prompted in Zoom meeting.</p> <p>CPU Usage - Low - Zoom; Low - CPU</p> <p>Zoom Settings - 15 FPS; 57ms Latency; 4ms Jitter</p>
	AMD A6-9220E	<p>Device is able to join preassigned breakout room with noticeable delay.</p> <p>Device is able to choose and join a breakout room when prompted in Zoom meeting.</p> <p>CPU Usage - Low - Zoom; High - CPU - Got message "High CPU usage may be affecting your meeting experience; please close other applications."</p> <p>Zoom Settings - 15 FPS; 91ms Latency; 4ms Jitter</p>

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Windows-based Devices	AMD A4-9120C	<p>Device is able to join preassigned breakout room with significant delay.</p> <p>Device is able to choose and join a breakout room when prompted in Zoom meeting.</p> <p>CPU Usage - Low - Zoom; High - CPU - "High CPU usage may be affecting your meeting experience; please close other applications."</p> <p>Zoom setting unavailable; all reading 0.</p> <p>Zoom Settings - 0 FPS; 0ms Latency; 0ms Jitter</p>
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E. Middle School Classroom Scenario Qualitative Results

Test 1

Narrative

Setting a virtual background

1. Click video in the Zoom* menu.
2. Click choose virtual background or choose virtual filter.
3. Set and click to exit settings menu.

Chromebook Overall Notes

Twitch paused when joining Zoom meeting on all devices.

All devices joined call with cameras off.

Windows Overall Notes

Twitch paused when joining the Zoom meeting on both the AMD A4 and A6.

Ryzen 7 had lowest CPU usage during this test.

The AMD A4 and A6 dropped the Zoom call during this test.

Chromebook Devices	Intel Core i3-1115G4	No option to change virtual background
	Intel Celeron N4020	No option to change virtual background
	Qualcomm Snapdragon 7c	No option to change virtual background
	MediaTek 8183	No option to change virtual background
	AMD A4-9120C	No option to change virtual background
	AMD A6-9220C	No option to change virtual background
	MediaTek Helio P60T	No option to change virtual background
Windows-based Devices	Intel Core i3-1115G4	<p>Device is able to set a virtual background by choosing blur (comes installed with Zoom) or by downloading and choosing an image. Virtual background loaded with no issues.</p> <p>Video filters are unavailable, but studio effects can be changed.</p> <p>CPU Usage - Low - Zoom; Low - CPU</p> <p>Zoom Settings - 15 FPS; 65ms Latency; 5ms Jitter</p>

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Windows-based Devices	Intel Pentium Silver N6000	<p>Device is able to set a virtual background by downloading and choosing an image. There is a slight delay in choosing a virtual background.</p> <p>Settings display stalled when loading virtual background and test had to be redone. It loaded the virtual background without any issues on the second try.</p> <p>Video filters are unavailable, but studio effects can be changed.</p> <p>CPU Usage - Low - Zoom; High - CPU - Recieved message "CPU usage may be affecting your meeting experience; please close other applications."</p> <p>Zoom Settings - 14 FPS; 67ms Latency; 5ms Jitter</p>
	AMD Ryzen 5 3450U	<p>Device is able to set a virtual background by choosing blur (comes installed with Zoom) or by downloading and choosing an image. Virtual background loaded with no issues.</p> <p>Video filters are unavailable, but studio effects can be changed.</p> <p>CPU Usage - Low - Zoom; Low - CPU</p> <p>Zoom Settings - 15 FPS; 62ms Latency; 5ms Jitter</p>
	AMD Ryzen 7 5700U	<p>Device is able to set a virtual background by choosing blur (comes installed with Zoom) or by downloading and choosing an image. Virtual background loaded with no issues.</p> <p>Video filters are unavailable, but studio effects can be changed.</p> <p>CPU Usage - Low - Zoom; Low - CPU</p> <p>Zoom Settings - 14 FPS; 74ms Latency; 6ms Jitter</p>
	AMD A6-9220E	<p>When trying to access setting to change virtual background, Zoom froze and gave a "not responding" message. When Zoom loads again you can access the video settings menu, but immediately Zoom froze a second time.</p> <p>Device is unable to set a virtual background because the Zoom meeting is "not responding" and can't access the settings menu.</p> <p>Unable to complete the test, as the device dropped the Zoom meeting.</p> <p>CPU Usage - N/A - Unable to test.</p> <p>Zoom Settings - N/A FPS; N/Ams Latency; N/Ams Jitter - Unable to test.</p>

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Windows-based Devices	AMD A4-9120C	When trying to access setting to change virtual background, Zoom had noticeable delay and lag.
		Device is able to access virtual background menu, but freezes and won't allow you to set a virtual background by downloading and choosing an image.
		Unable to complete the rest of this test as the device dropped the Zoom call.
		CPU Usage - N/A Unable to test. Zoom Settings - Zoom Settings - N/A FPS; N/Ams Latency; N/Ams Jitter - Unable to test.

Test 2

Narrative

Whiteboard test - Screen share Google Drawings*

1. Click share screen in Zoom* menu.
2. Choose Google Drawings tab or whiteboard application.

Starting and collaborating on a whiteboard

1. Click share screen in Zoom* menu.
2. Click whiteboard.
3. Click share.

Collaborating on a whiteboard (other student devices)

1. Choose view options from the top Zoom* menu.
2. Choose annotate.

Chromebook Overall Notes

There was noticeable lag on both the Qualcomm and AMD A4 when completing this test.

Windows Overall Notes

When other devices are annotating as the viewer of screen sharing, there is no noticeable delay in using

Chromebook Devices	Intel Core i3-1115G4	When screen sharing, Google Drawings tab appears with no delay on other devices. There is no noticeable lag on other devices during screen sharing when manipulating the drawing. Zoom Settings - 4 FPS; 54ms Latency; 17ms Jitter
	Intel Celeron N4020	When screen sharing, Google Drawings tab appears with a slight delay on other devices. On the Intel i3 and MediaTek Helio there is no noticeable lag during screen sharing when manipulating the drawing. On the Media Tek 8183, AMD A4, and AMD A6, there is a slight lag during screen sharing when manipulating the drawing. On the Qualcomm there is a noticeable lag during screen sharing when manipulating the drawing. Zoom Settings - 5FPS; 71ms Latency; 58ms Jitter
	Qualcomm Snapdragon 7c	When screen sharing, Google Drawings tab appears with a slight delay on other devices. There is a noticeable lag on other devices during screen sharing when manipulating the drawing. Zoom Settings - 4FPS; 428ms Latency; 86ms Jitter
	MediaTek 8183	When screen sharing, Google Drawings tab appears with a slight delay on other devices. On the i3, Celeron, and MediaTek Helio, there is no lag during screen sharing when manipulating the drawing. On the Media Tek 8183 and AMD A6, there is a slight lag during screen sharing when manipulating the drawing. On the AMD A4 and Qualcomm there is a noticeable lag during screen sharing when manipulating the drawing. Zoom Settings - 4 FPS; 107ms Latency; 76ms Jitter

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annotation tools, except on the AMD A4 and AMD A6 which have a slight delay.

Zoom quit unexpectedly on the i3 during this test and had the device had to rejoin the meeting.

Ryzen 7 had lowest CPU usage during this test.

Chromebook Devices	AMD A4-9120C	<p>When screen sharing, Google Drawings tab appears with noticeable delay on other devices.</p> <p>There is noticeable lag on other devices when manipulating the drawing.</p> <p>When screensharing, there is a lag on this device when manipulating the drawing.</p> <p>Zoom Settings - 3 FPS; 127ms Latency; 28ms Jitter</p>
	AMD A6-9220C	<p>When screen sharing, Google Drawings tab appears with noticeable delay on other devices.</p> <p>There is noticeable lag on other devices when manipulating the drawing, with considerable lag on Qualcomm and AMD A4.</p> <p>Zoom Settings - 2FPS; 57ms Latency; 8ms Jitter</p>
	MediaTek Helio P60T	<p>When screen sharing, Google Drawings tab appears with noticeable delay on other devices.</p> <p>There is noticeable lag on other devices when manipulating the drawing, except on the Qualcomm and AMD A4, which have considerable lag.</p> <p>Zoom Settings - 4FPS; 85ms Latency; 27ms Jitter</p>
Windows-based Devices	Intel Core i3-1115G4	<p>When sharing, Zoom whiteboard appears with no delay on other devices.</p> <p>There is no noticeable lag on other devices when annotating the whiteboard, except on the AMD A6 which have a slight lag.</p> <p>CPU Usage - Low - Zoom; Low - CPU</p> <p>Zoom Settings - 9 FPS; 54ms Latency; 7ms Jitter</p>
	Intel Pentium Silver N6000	<p>When sharing, Zoom whiteboard appears with a noticeable delay on other devices.</p> <p>There is no noticeable lag on other devices when annotating the whiteboard, except on the AMD A6 which have a slight.</p> <p>CPU Usage - Low - Zoom; Medium - CPU</p> <p>Zoom Settings - 1 FPS; 64ms Latency; 6ms Jitter</p>
	AMD Ryzen 5 3450U	<p>When sharing, Zoom whiteboard appears with no delay on other devices, except for the AMD A4 and AMD A6 which have a slight delay.</p> <p>There is no noticeable lag on other devices when annotating the whiteboard, except on the AMD A4 and AMD A6 which have a slight lag.</p> <p>CPU Usage - Low - Zoom; Low - CPU</p> <p>Zoom Settings - 17 FPS; 59ms Latency; 7ms Jitter</p>

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Windows-based Devices	AMD Ryzen 7 5700U	<p>When sharing, Zoom whiteboard appears with no delay on other devices, except for the AMD A4 and AMD A6 which have a slight delay.</p> <p>There is no noticeable lag on other devices when annotating the whiteboard, except on the AMD A4 and AMD A6 which have a slight lag.</p> <p>CPU Usage - Low - Zoom; Low - CPU</p> <p>Zoom Settings - 24 FPS; 54ms Latency; 6ms Jitter</p>
	AMD A6-9220E	<p>There is a noticeable delay when accessing the screen sharing menu.</p> <p>When sharing, Zoom whiteboard takes appx 60 seconds to load on this device and screen sharing loaded appx 60 second after that on other devices.</p> <p>During whiteboard screen sharing, the Zoom controls froze on this device until screen sharing populated on all other devices.</p> <p>There is a noticeable lag on this device when annotating the whiteboard.</p> <p>There is a noticeable lag on other devices when annotating the whiteboard.</p> <p>There is a slight delay in accessing the settings.</p> <p>CPU Usage - Low - Zoom; High - CPU - Got the message "High CPU usage may be affecting your meeting experience; please close other applications."</p> <p>Zoom Settings - 1 FPS; 81ms Latency; 7ms Jitter</p>
	AMD A4-9120C	<p>There is a noticeable delay when accessing the screen sharing menu.</p> <p>When sharing, Zoom whiteboard takes appx 180 seconds to load on this device and screen sharing loaded appx 30 second after that on other devices.</p> <p>There is a slight lag on this device when annotating the whiteboard.</p> <p>There is a slight lag on other devices when annotating the whiteboard.</p> <p>There is a slight delay in accessing the settings.</p> <p>CPU Usage - Low - Zoom; High - CPU - Got the message "High CPU usage may be affecting your meeting experience; please close other applications."</p> <p>Zoom Settings - 1 FPS; 74ms Latency; 8ms Jitter</p>

Test 3

Narrative

Sharing screen

1. Open appropriate file, application, or browser tab.
2. Click "share screen" in the Zoom* menu.
3. Choose the appropriate display.
4. Click share.

Sharing screen (video or audio)

1. Open appropriate file, application, or browser tab.
2. Click share screen in the Zoom* menu.
3. Choose the appropriate display.
4. Click share.
5. While screen sharing, record Zoom* settings.

Chromebook Overall Notes

The AMD A4 had the most lag when completing this test. Chromebook Overall Notes

Windows Overall Notes

Twitch pauses on Pentium and AMD A4 when joining Zoom meeting.

Twitch is unable to load on AMD A6 for this test.

Zoom quit unexpectedly on the i3 and AMD A4 during this test each device has to rejoin the meeting.

The AMD A6 is unable to rejoin the meeting and is not responding.

The AMD A4 froze when the Ryzen 7 stopped screen sharing. It takes appx 120 seconds for the device to show the main room screen in the Zoom meeting.

Chromebook Devices	Intel Core i3-1115G4	When screen sharing, Minecraft Education Edition appears with a slight delay on other devices, and a noticeable delay on the AMD A4. There is slight lag on devices during screen sharing when manipulating the game, with noticeable lag on the Qualcomm and AMD A4. Zoom Settings - 4 FPS; 57ms Latency; 7ms Jitter; 0% Packet loss
	Intel Celeron N4020	When screen sharing, Minecraft Education Edition appears with a slight delay on other devices. There is slight lag on devices during screen sharing when manipulating the game, with noticeable lag on the Qualcomm and AMD A4. Zoom Settings - 4 FPS; 105ms Latency; 7ms Jitter; 0% Packet loss
	Qualcomm Snapdragon 7c	When screen sharing, Minecraft Education Edition appears with a slight delay on other devices. There is slight lag on devices during screen sharing when manipulating the game, with noticeable lag on the AMD A4. Zoom Settings - 5 FPS; 140ms Latency; 30ms Jitter
	MediaTek 8183	When screen sharing, Minecraft Education Edition appears with a slight delay on other devices. There is slight lag on devices during screen sharing when manipulating the game, with noticeable lag on the AMD A4. Zoom Settings - 5 FPS; 181ms Latency; 21ms Jitter
	AMD A4-9120C	When screen sharing, Minecraft Education Edition appears with a noticeable delay on other devices. There is noticeable lag on devices during screen sharing when manipulating the game. When making considerable movement in the game there is an considerable lag on all devices. Zoom Settings - 3 FPS; 2473ms Latency; 183ms Jitter
	AMD A6-9220C	When screen sharing, Minecraft Education Edition appears with a slight delay on other devices. There is noticeable lag on devices during screen sharing when manipulating the game. Zoom Settings - 2 FPS; 126ms Latency; 40ms Jitter
	MediaTek Helio P60T	When screen sharing, Minecraft Education Edition appears with a slight delay on other devices. There is slight lag on devices during screen sharing when manipulating the game, with a noticeable lag on the AMD A4. Zoom Settings - 5 FPS; 270ms Latency; 57ms Jitter

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Windows-based Devices	Intel Core i3-1115G4	<p>When sharing, Minecraft Education Edition appears with no delay on other devices, except the AMD A6 which has a noticeable delay.</p> <p>There is a slight lag on other devices when manipulating the game, except on the AMD A6 which have a noticeable lag.</p> <p>CPU Usage - Low - Zoom; Low - CPU</p> <p>Zoom Settings - 17 FPS; 71ms Latency; 6ms Jitter</p>
	Intel Pentium Silver N6000	<p>When sharing, Minecraft Education Edition appears with a slight delay on other devices, except the AMD A4 and AMD A6 which have a noticeable delay.</p> <p>There is a slight lag on other devices when manipulating the game, except on the AMD A4 and the AMD A6 which have a noticeable lag.</p> <p>CPU Usage - Low - Zoom; High - CPU - Got message "High CPU may be affecting your meeting experience; please close other applications."</p> <p>Zoom Settings - 1 FPS; 66ms Latency; 7ms Jitter</p>
	AMD Ryzen 5 3450U	<p>When sharing, Minecraft Education Edition appears with a noticeable delay on other devices, except the AMD A4 which has a significant delay and the AMD A6 which is frozen and unable to rejoin the meeting.</p> <p>There is a slight lag on other devices when manipulating the game, except on the AMD A4 which has a noticeable lag.</p> <p>CPU Usage - Low - Zoom; Low - CPU</p> <p>Zoom Settings - 15 FPS; 57ms Latency; 5ms Jitter</p>
	AMD Ryzen 7 5700U	<p>When sharing, Minecraft Education Edition appears with a slight delay on other devices, except the AMD A4 which has a noticeable delay and the AMD A6 which is frozen and unable to rejoin the meeting.</p> <p>There is a slight lag on other devices when manipulating the game.</p> <p>CPU Usage - Low - Zoom; Low - CPU</p> <p>Zoom Settings - 24 FPS; 55ms Latency; 4ms Jitter</p>
	AMD A6-9220E	<p>There is a noticeable delay in accessing screen sharing menu.</p> <p>When sharing, Zoom meeting is not responding and device is unable to share its screen with other devices.</p> <p>Unable to check zoom meeting settings. Got message "Screen-sharing is unable to start; please try again later. Error Code: 1."</p> <p>The device drops the Zoom meeting after receiving the error message.</p> <p>CPU Usage - N/A - Zoom; N/A - CPU</p> <p>Zoom Settings - N/A FPS; N/Ams Latency; N/Ams Jitter</p>

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Windows-based Devices	AMD A4-9120C	<p>Unable to complete this test as the device dropped the Zoom meeting and is unable to rejoin. Device is not responding.</p> <p>Unable to check Zoom meeting ettings.</p> <p>CPU Usage - N/A - Zoom; N/A - CPU</p> <p>Zoom Settings - N/A FPS; N/Ams Latency; N/Ams Jitter</p>
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Test 4

Narrative

Joining breakout rooms

1. Click breakout rooms in the Zoom* menu on educator device.
2. Set breakout rooms to automatically have students join.
3. Open all rooms.

Choosing a breakout room

1. Click breakout rooms in the Zoom* menu on educator device.
2. Set breakout rooms to let students choose which one to join
3. On student device, click breakout rooms in the Zoom* menu.
4. Choose breakout room and click join.
5. Click join room.

Chromebook Overall Notes

Twitch paused when joining breakout rooms on all devices.

Twitch pauses when switching from the browser back to Zoom.

Windows Overall Notes

The AMD A4 is frozen from previous tests and unable to rejoin the Zoom meeting.

Chromebook Devices	Intel Core i3-1115G4	<p>There is no delay or lag in Minecraft Education Edition or on any browser tabs.</p> <p>Zoom Settings - 19 FPS; 54ms Latency; 3ms Jitter; 0% Packet loss</p>
	Intel Celeron N4020	<p>There is no delay or lag in Minecraft Education Edition or on any browser tabs.</p> <p>Zoom Settings - 10 FPS; 95ms Latency; 12ms Jitter; 0% Packet loss</p>
	Qualcomm Snapdragon 7c	<p>There is no delay or lag in Minecraft Education Edition and a slight delay when loading browser tabs.</p> <p>Zoom Settings - 20 FPS; 313ms Latency; 15ms Jitter</p>
	MediaTek 8183	<p>There is no delay or lag in Minecraft Education Edition or on any browser tabs.</p> <p>Zoom Settings - 10 FPS; 95ms Latency; 12ms Jitter</p>
	AMD A4-9120C	<p>There is a slight delay and lag in Minecraft Education Edition.</p> <p>When switching from Zoom to browser tabs, Zoom closed and dropped the video call.</p> <p>Could not check Zoom settings because Zoom closed.</p>
	AMD A6-9220C	<p>There is no delay or lag in Minecraft Education Edition.</p> <p>There is a slight delay and lag in loading browser tabs.</p> <p>Zoom Settings - 5 FPS; 205ms Latency; 37ms Jitter</p>
	MediaTek Helio P60T	<p>There is no delay or lag in Minecraft Education Edition or on any browser tabs.</p> <p>Zoom Settings - 13 FPS; 312ms Latency; 15ms Jitter</p>

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Windows-based Devices	Intel Core i3-1115G4	<p>Device is able to join preassigned breakout room with no delay.</p> <p>Device is able to choose and join a breakout room when prompted in Zoom meeting.</p> <p>CPU Usage - Low - Zoom; Low - CPU</p> <p>Zoom Settings - 15 FPS; 58ms Latency; 3ms Jitter</p>
	Intel Pentium Silver N6000	<p>Device is able to join preassigned breakout room with no delay.</p> <p>Device is able to choose and join a breakout room when prompted in Zoom meeting.</p> <p>CPU Usage - Low - Zoom; High - CPU - Got message "High CPU may be affecting your meeting experience; please close other applications."</p> <p>Zoom Settings - 15 FPS; 59ms Latency; 3ms Jitter</p>
	AMD Ryzen 5 3450U	<p>Device is able to join preassigned breakout room with no delay.</p> <p>Device is able to choose and join a breakout room when prompted in Zoom meeting.</p> <p>CPU Usage - Low - Zoom; Low - CPU</p> <p>Zoom Settings - 23 FPS; 58ms Latency; 3ms Jitter</p>
	AMD Ryzen 7 5700U	<p>Device is able to join preassigned breakout room with no delay.</p> <p>Device is able to choose and join a breakout room when prompted in Zoom meeting.</p> <p>CPU Usage - Low - Zoom; Low - CPU</p> <p>Zoom Settings - 14 FPS; 24ms Latency; 2ms Jitter</p>
	AMD A6-9220E	<p>Device is able to join preassigned breakout room with a noticeable delay.</p> <p>Device is able to choose and join a breakout room when prompted in Zoom meeting.</p> <p>There is a slight delay when accessing the Zoom meeting settings.</p> <p>CPU Usage - Low - Zoom; High - CPU - Got message "High CPU may be affecting your meeting experience; please close other applications."</p> <p>Zoom Settings - 1 FPS; 71ms Latency; 6ms Jitter</p>
	AMD A4-9120C	<p>Device is frozen and not responding and is unable to complete this test.</p> <p>CPU Usage - N/A - Zoom; N/A - CPU</p> <p>Zoom Settings - N/A FPS; N/Ams Latency; N/Ams Jitter</p>