

Assistive Technology Assessment 4
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ICATER Assistive Technology Device/Software Evaluation Form

Device or Software Name:

Amazon Echo is a “smart speaker” product from Amazon that combines voice recognition with "intelligent assistant" capabilities embodied in a persona called Alexa. Alexa’s voice, along with other audio outputs, are delivered through two speakers contained within in a cylindrical speaker form factor (9.25” x 3.25” x 3.25”).

The intelligent assistant capabilities are similar to those of [Apple Siri](#) and [Microsoft Cortana](#). It features seven different microphones with beam-forming technology for picking up voice requests and commands from any direction and any location in a room.

Amazon Echo is capable of controlling devices through WiFi or Bluetooth transmission protocols, which are subsegments of the Radio Frequency (RF) band. It uses these standard protocols to communicate with other devices and as such belongs to the Internet of Things (IoT). Amazon Echo incorporates key characteristics of the IoT that include (courtesy of IBM):

- Instrumented - Digital technologies (sensors and other monitoring devices) are being embedded into many objects, systems and processes
- Interconnected - In the globalized, networked world, people, systems, objects and processes are connected, and they are communicating with one another in entirely new ways
- Intelligent - Leveraging the data generated by digital technology provides intelligence to help us do things better, improving our responsiveness and ability to predict and optimize for future events

It is linked by Amazon Web Services to the Amazon Cloud, which is how it acquires information upon request. It also receives firmware updates through this medium.

amazon echo

Volume ring

Reflex port

Enhances the woofer's output for deeper sounds without distortion

2.5 inch woofer

Delivers deep bass response

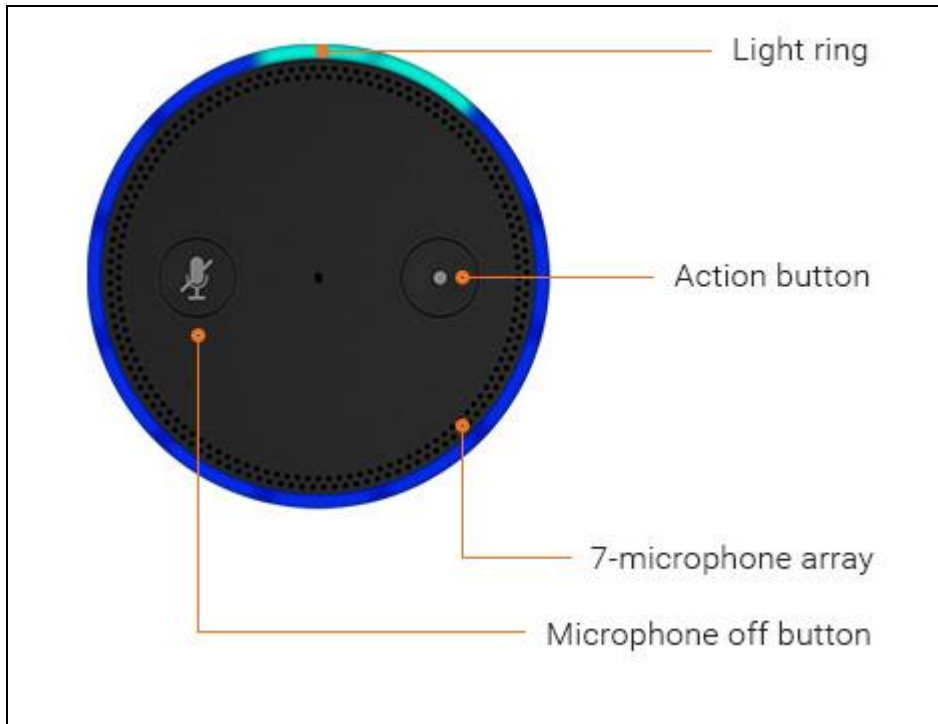
2.0 inch tweeter

Crisply hits the high notes

9.25 in

3.27 in

Amazon Echo - Side View



Amazon Echo - Top View

Device or Software Category (1 Point):

Amazon Echo falls into the Adaptive Environments AT category, since it interprets speech and other commands and renders them into messages to control various devices within their environment. On a secondary level, it also falls into the Instructional Aids AT category (since it can be used effectively in requesting and acquiring information and other tools for academic endeavors), as well as the Recreational AT category (since it can be used to request and deliver news, games, music, video, and many other diversionary resources).

Device or Software Cost (1 Point):

Amazon Echo is available through www.amazon.com for \$179.00. A remote control is available for \$49.99.

Place on AT Continuum and Why? (2 Points)

It is somewhat difficult to place Amazon Echo into a particular category. However, it possesses most of the qualities of a Mid-Tech AT device. The reason for this is that it is modestly priced, widely available (I received mine in 2 days), and requires some training (but setup procedures are contained on a single card). Qualities that might place it in the High Tech category are power (it requires a power source and contains no battery) and it

contains sophisticated code (but this is transparent to the user, unless one decides to create Skills (described below)).

Who can this device or software benefit and how? (3 Points)

Anyone who can use a voice-activated, hands-free system can benefit from the Amazon Echo. By issuing a “wake word” (by default the wake word is “Alexa”) the user can then speak a variety of commands to perform many different tasks. For example, Alexa can be instructed to play music, provide information, news, sports scores, weather, traffic, and many other interesting features.

For those with disabilities involving the voice, the Amazon Echo can be controlled through a keyboard or another modality using the Alexa App (described below).

The true strength of the Amazon Echo is in its ability to orchestrate events through the Internet of Things (IoT). Indeed, this area is the key for people with disabilities, ranging from mobility to visual. This is because the Echo makes it possible to control devices without physically accessing or operating them. A voice command will actuate the desired event from a wide (and growing) number of devices, including, lighting, thermostat, security systems, telephony, audio/visual, and more.

One scenario is where there are multiple sets of lights in a home. In a traditional setting, the resident must physically switch each light on and off. With the Amazon Echo, it is possible to automate each light (or cluster of lights) such that a spoken command will turn any of the lights on, off, or down (dimmed). This can be set up to be performed autonomously at a specific hour of the day or night.

Similarly, a security system can be invoked to unlock a door when a friend arrives, and to lock it again once they have entered. All the doors and windows can be activated based on specific events (e.g., leaving the house, going to bed), and de-activated using other commands.

From the [Assistive Technology Blog](#), it was noted that the Amazon Echo has a number of other features that could be of use to anyone with a disability:

1. Tell you the weather and traffic conditions. ("Alexa*, what's the weather like?", "Alexa what's the traffic like?")
2. Read Kindle and Audible books to you, and play music for you. ("Alexa, play the Kindle book 'Be Here Now'", "Alexa, play 'The Beatles'")
3. Look up events and appointments on your calendar and let you know what your day looks like. ("Alexa, what does my day look like?")
4. Help you go to the movies by finding the nearest theater and local timings. ("Alexa, where is Deadpool playing?")
5. Find local businesses and restaurants. ("Alexa, what time does the nearby pharmacy close?")

6. Add items to your shopping list and also re-order previously ordered items from Amazon with just one voice command. ("Alexa, reorder laundry detergent", "Alexa add coffee filters to my cart")
7. Helps you keep track of important tasks. ("Alexa, put 'file taxes' to my to-do list")
8. Control all lights and other devices around your house. ("Alexa, turn on light 1", "Alexa, turn off the TV")
9. Control your thermostat. ("Alexa, set my bedroom temperature to 68")
10. Play games, order an Uber ride, and order a pizza from Dominos!
11. Lots and lots of other things!

Quoted from:

<http://www.assistivetechblog.com/2016/02/amazon-echo-great-internet-of-things.html>

The blog goes on to state that automation can bring "...a much bigger convenience and independence factor to people with disabilities, especially anyone who is blind, in a wheelchair, paraplegic, bed ridden because of a spinal cord injury, or doesn't have good motor skills. It saves them a lot of time and energy by not making them interact with other devices that they may not have skills for or are unable to use them because of various disabilities. The only device they interact with is Echo, through voice, and it provides them with the results and information they are looking for instantly, and thus, saves them a lot of trouble. A person in a wheelchair doesn't have to try to reach a light switch that's in an awkward corner of a room, a person with not good motor skills doesn't have to flip through pages or operate an e-reader to read their books, and a blind person doesn't need to navigate a website on an electronic device to order a pizza anymore."

As will be noted below, the Amazon Echo can be extended to accomplish many other tasks and functions due to its highly extensible set of programming tools.

Create a comprehensive list of device or software features and explain how each works: (4 Points)

To configure the Amazon Echo, download the Echo app from the alexa.amazon.com site. The setup process is quite intuitive, and requires an Internet connection. Once it is complete, you can begin using the Amazon Echo.

The external design of the Echo is quite easily understood. A light ring at the top of the device indicated the mode of operation. White indicates it is booting up, orange indicates it is in configuration mode, and blue indicates that Alexa is ready to engage the user.

There is also a microphone button and an action button on the top of the device. The microphone button toggles the microphone off and on, while the action button commands the device to accept new commands from the Alexa App (described below).

The Echo has two internal speakers – a 2.5” woofer and a 2” tweeter – to deliver voice, sound, and music. It also has a reflex port to enhance the lower registers without distortion. At the top of the device is a volume ring, which increased or decreases volume by turning clockwise or counterclockwise. As will be shown below, Alexa can be commanded to do the same.

There are hundreds of commands that Amazon Echo can process right out of the box, through the Alexa persona. To engage Alexa, you simply speak the “wake word”. The default wake word is “Alexa”.

However, there are certain functions that require the Alexa app. One of these is changing the wake word. To do so:

1. Open the Alexa app.
2. Open the left navigation panel, and then select **Settings**.
3. Select your device from the menu.
4. Scroll down and select **Wake Word**.
5. Use the drop-down menu to select a wake word, and then select **Save**. When you change the wake word, the light ring on your device flashes orange briefly.

Below is a sample of the key commands that Alexa will understand. Note that where a <Device Name> is cited, this implies that the Alexa is aware of the device, whether it is operational, and that is communicating with the Echo. If any of these conditions are not met, Alexa will inform you by saying “unreachable”.

Note that all of the commands below follow the syntax of “Alexa, <action word> <target>”. To extend this beyond what Alexa knows, applications can be created (called Skills), using the Amazon Echo SDK (Alexa Skills Kit). An example of this is shown at the end of this section.

Command Type	Feature	Description and Syntax
ON	Turn On	<i>Alexa, turn on <Device Name></i>
ON	Start	<i>Alexa, start <Device Name></i>
ON	Unlock	<i>Alexa, unlock <Device Name></i>
ON	Open	<i>Alexa, open <Device Name></i>
ON	Boot Up	<i>Alexa, boot up <Device Name></i>
ON	Run	<i>Alexa, run <Device Name></i>
ON	Arm	<i>Alexa, arm <Device Name></i>
OFF	Turn Off	<i>Alexa, turn off <Device Name></i>
OFF	Stop	<i>Alexa, stop <Device Name></i> (this one is tricky to get right)
OFF	Stop Running	<i>Alexa, stop running <Device Name></i> (also very tricky)
OFF	Lock	<i>Alexa, lock <Device Name></i>
OFF	Close	<i>Alexa, close <Device Name></i>
OFF	Shutdown	<i>Alexa, shutdown <Device Name></i>

OFF	Shut	<i>Alexa, shut <Device Name></i>
OFF	Disarm	<i>Alexa, disarm <Device Name></i>
CHANGE	Brighten	<i>Alexa, brighten <Device Name> to <Position></i>
CHANGE	Dim	<i>Alexa, dim <Device Name> to <Position></i>
CHANGE	Raise	<i>Alexa, raise <Device Name> to <Position></i>
CHANGE	Lower	<i>Alexa, lower <Device Name> to <Position></i>
CHANGE	Set	<i>Alexa, set <Device Name> to <Position></i>
CHANGE	Turn Up	<i>Alexa, turn up <Device Name> to <Position></i>
CHANGE	Turn Down	<i>Alexa, turn down <Device Name> to <Position></i>
CHANGE	Turn Up Down %	<i>Alexa, turn <Device Name> [up down] by <n percentage></i>
ALARM	Set Alarm	<i>Alexa, set <Alarm> for <day> <time></i>
ALARM	Set Repeating Alarm	<i>Alexa, set <Alarm> for <cadence> <day> <time></i>
MUSIC	Play Song	<i>Alexa, play <song title> from <service></i>
MUSIC	Play Genre	<i>Alexa, play <genre> from <service></i>
MUSIC	Play Radio	<i>Alexa, play <station></i>
MUSIC	Pause	<i>Alexa, <pause>.</i>
MUSIC	Stop	<i>Alexa, <stop></i>
MUSIC	Resume	<i>Alexa, resume></i>
MUSIC	Mute	<i>Alexa, <mute></i>
MUSIC	Skip	<i>Alexa, <skip> <this/next> <song/track></i>
MUSIC	Next	<i>Alexa, <next> < song/track> "</i>
MUSIC	Previous	<i>Alexa, <previous> < song/track> "</i>
MUSIC	Shuffle	<i>Alexa, <shuffle></i>
MUSIC	Unshuffle	<i>Alexa, <unshuffle></i>
MUSIC	Set Volume	<i>Alexa, <volume> < [1-10]></i>
MUSIC	Change Volume	<i>Alexa, <volume> < up/down></i>
MOVIES	List of Movies	<i>Alexa, what movies are playing in <city>?"</i>
MOVIES	Movies by Genre	<i>Alexa, what <genre> movies are playing in <city> "</i>
MOVIES	Movies on a Provider (theater, channel)	<i>Alexa, what movies are playing between <timeframe> on <provider>?"</i>
MOVIES	Movies playing during a Timeframe by Provider	<i>Alexa, when is <movie title> playing <today / tomorrow / this weekend> on <provider>?"</i>
MOVIES	Acquire Movie	<i>Alexa, purchase <movie title> from <provider></i>
CALENDAR	Add Entry	<i>Alexa, add <entry> for <date> <time></i>
CALENDAR	Communicate Entry	<i>Alexa, send <entry> for <date> <time> to <person> at <email address></i>
CALENDAR	Invite	<i>Alexa, send <invite> of <entry> for <date> <time> to <persons> at <email address></i>

To begin to use the Amazon Echo to orchestrate devices as part of an Internet of Things configuration, you must first make Alexa aware of them. Doing so requires using the Alexa app. For example, to connect a smart home service (i.e., a light, a thermostat, etc.) to Alexa:

In the Alexa app, select **Smart Home**.

1. Under **Device Links**, select **Link with [Service]**. A third-party login page pops up in the app.
2. Sign in with your third-party information and follow the prompts to complete setup.
3. After you connect the smart home service, Alexa must discover the smart home devices before you can control them with your voice. To enable Alexa to do so:
 - On your mobile device, download the manufacturer's companion app for your smart home device.
 - Use the manufacturer's companion app to set up the smart home device on the same Wi-Fi network as your Alexa device.
 - Download and install the latest software updates for your devices.
 - Some smart home devices are connected to Alexa through a cloud-based service, and/or hub, instead of directly to the Alexa device. For these devices, link your third-party account to Alexa.

To enable Alexa to discover your devices:

1. Say, "Discover my devices." Or, use the Alexa App and select **Discover devices**. Alexa confirms the start of the search.
2. After Alexa searches for your devices, it confirms how many devices it found or states that it didn't find any devices.
3. After a successful discovery you can then control the device with your voice. If Alexa can't discover your device, you see **(Unreachable)** next to the device in the app.

If you have a number of devices that are similar (e.g., all the lights in the basement), a useful feature is to create a Group. Once you have done so, you can control all devices in the group with simple commands like "Turn on Basement Lights" or "Set Bedroom Lights to 80%." A best practice involves to only add similar devices to a group. For example, keep thermostats separate from lights and switches.

To create a smart home device group:

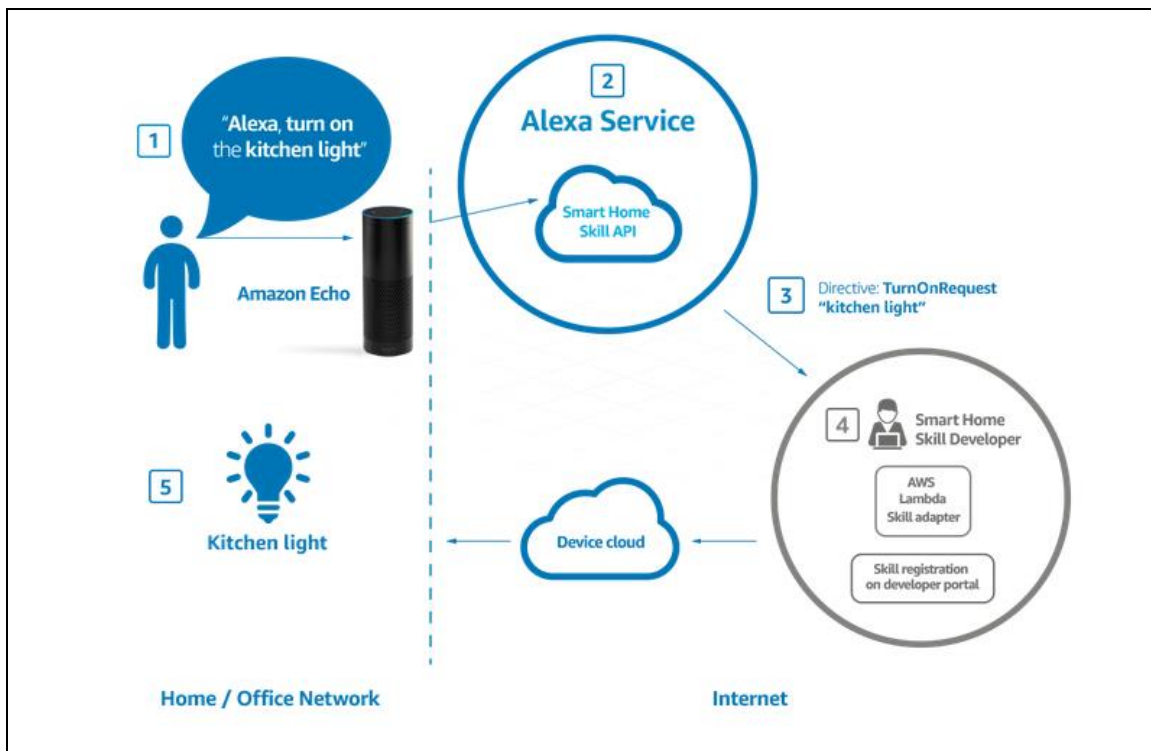
1. In the Alexa app, open the left navigation panel and select **Smart Home**.
2. Under **Groups**, select **Create group**.
3. Enter the name of the group into the text field.
Tip: Give your group a recognizable name for Alexa to identify. Use names that have at least two to three syllables. If you have multiple groups, give each group a different name. For example, if you have devices in your living room and

- bedroom, you could name the groups "Living Room" and "Bedroom" respectively.
4. Select the smart home device(s) you want to add to the group, and then select **Add**.

To edit a smart home device group:

1. Under **Groups**, select your smart home group.
2. Make changes to your group:
3. To edit the name, select the text field and then update the existing name.
4. To add or remove smart home devices, select the checkboxes next to each device.
5. To delete the group, select **Delete**.

In addition to the relatively straightforward commands cited above, the Amazon Echo is quite extensible. It is capable of fully participating in the IoT framework, to control nearly any device. A conceptual view of the smart home ecosystem that a developer might create new applications for, utilizing the Amazon Web Services SDK, is illustrated below.



Amazon Web Services – Smart Home Ecosystem

Assistive technologies can be developed through this same methodology. One example of this involved leveraging the Amazon Echo SDK, to create an app to control a power wheelchair. The key aspects of the SDK that were utilized included the Amazon “To Do” list (e.g., “Alexa, add <activity> to <My ToDo list>”). Then, by using the IFTTT (if this then that) service, it becomes possible to connect a series of ToDo lists, each of which expresses a commands to the power wheelchair (e.g., go forward, turn left, continue for 3 seconds). For example, by stating “Alexa, add ‘left three’ to my To Do list”, IFTTT sees the item added to the list. The app can then trigger an HTTP request, in this case directed to a Raspberry Pi card that is connected to the wheelchair control device.

The Raspberry Pi card appears to Echo as a wheelchair controller, and Raspberry Pi forwards the command on to the wheelchair. In this way, the developer could control the wheelchair directly through commands delivered from the Echo device directly to the wheelchair (rather than through the Amazon Cloud). This improved performance by eliminating the inevitable latency that occurs by sending messages though the Internet to AWS and back again.

The developer notes that this app is incomplete and retains some highly risky qualities. For example, it contains none of the safety features that would be necessary for commercial application (e.g., obstacle detection, impact detection). However, it does provide a baseline for a power wheelchair manufacturer to create a robust, hardened, and reliable application for the Amazon Edge. For more information, see:

<https://bobparadiso.com/2015/07/17/amazon-echo-controlled-wheelchair/>

A more generic approach (not involving Amazon Echo) involving voice recognition and powered wheelchair controls, can be found at:

<https://www.csail.mit.edu/videoarchive/research/robo/autonomous-wheelchair>

And for a list of Alexa skills now available, see:

https://www.reddit.com/r/amazonecho/comments/4154uf/is_there_an_online_list_of_echo_skills/

Describe the interface the user interacts with when using this program, how is this beneficial, what parts of it are confusing, and how it affects people with multiple disabilities (ex those with physical and visual impairments)? (3 Points)

For the most part, the user interacts with the Amazon Echo through spoken commands as illustrated in the sections above. This provides the user with a rich array of functions that are available, and customizable, in a highly intuitive manner.

I found nothing confusing about working with the Alexa persona. The key is in knowing the right commands and speaking in a normal, even cadence. Even when I spoke quickly and changed my voice, Alexa still understood me.

It is important to position the Echo in a clear area, one unfettered with plants and other objects. Even though it has 7 high-gain microphones, by positioning it incorrectly leads to suboptimal recognition. And if there is substantial background noise, Alexa can misinterpret speech. To test this, I turned my stereo up to around 50 db, and found that at that level, Alexa failed to understand my commands, even though I was relatively close to the unit.

I researched the use of the Echo (and in particular in the interaction with Alexa by people with speech impairments), and discovered that voice recognition capability is geared upon word detection and also on silence detection. There are ways to configure Alexa's understanding by calibrating the amount of silence expected between words, as well as to account for accents, and even conditions like apraxia.

In one blog, I read about the experience of a man with Cerebral Palsy. He speaks with a definite accent due to his disability, and was pleasantly surprised that Alexa understood him on the first try.

For those who still have issues in being understood by Alexa, they can use the Voice Training feature in the Alexa App. The app provides a list of 25 phrases to speak, and Alexa repeats what was said. The steps involve:

1. Open the Alexa app.
2. Open the left navigation panel, and then select **Settings**.
3. Select **Voice Training**.
4. Select **Start Session**.
5. Speak the phrase in the Alexa app, and then select **Next**. To repeat a phrase, select **Pause**, and then **Repeat Phrase**.
6. When you reach the end of your session, select **Complete**. If you need to end your session at any time, select **Pause**, and then **End session**.

According to the Amazon Echo portal, this will increase Alexa's ability to understand words in over 90% of the cases documented. If even this fails to provide good results, apps are available that purport to help further. One such app is available at <https://alexaweb.herokuapp.com/>. This app helps to further train Alexa in unique diction, pauses, etc.

People who have cognitive issues may be able to benefit from the Echo as well. They could Alexa the day, the time, the weather, about current events, or to use the Echo keep track of appointments and to use alarms to signal when to prepare for or to leave for an event.

People with auditory disabilities can use either a standalone speech-to-text application, or a custom Skill that displays Alexa's responses on a computer screen. Such an app can be developed through the Amazon Voice Services API.

Compare and contrast this device or software to one similar product: (4 Points)

Interestingly enough, there are no direct competitors to the Amazon Echo, although several companies including Google and Microsoft (Cortana) are developing them. The closest product to Amazon Echo and its persona Alexa, is Apple's Siri.

Some key points of comparison:

- Both Alexa and Siri have very good voice recognition capabilities. Neither one can do so independently, as both of them rely upon the Cloud to fulfill this function.
- Siri comes built in to every recently released Apple iPhone and iPad. Amazon Echo retails for \$179, with add-ons available for \$49 (for the remote) to \$99 (for the Dot).
- The Alexa app can work in concert with the Echo on a computer, iPad, iPhone, Android, and many other devices. By contrast, it was announced that Siri would be deployed as part of the Mac OS X.
- The ability to pick up a voice signal without distortion is a key advantage of the Echo. It has an array of seven high-gain microphones designed and calibrated to pick up voice signals under a variety of conditions. On the other hand, most Apple devices, including Macs, have a single microphone, and thus have limited ambient noise correction (recent iPhones use a second mic for noise cancelling). Siri thus works at a significant disadvantage to Alexa in this capacity.
- While the Echo has a single point of control (or multiple coordinated ones if several Echos or Dots coexist) and manages its response to the Alexa wake word harmoniously, Siri would have to decide which of the potentially many Apple devices (e.g., iPhone, iPad, Watch) is being addressed, and if that device is capable of dealing with the user's request. Siri would need to manage the correct device to trigger when the wake word is used. Could it be that, as one observer put it, we would "be greeted by a chorus of Siri responses from all our various gadgets?"
- Amazon has a massive advantage in both the Cloud through Amazon Web Services, as well as being on the vanguard of the Internet of Things movement. Apple has been slower to develop these core competencies, which disadvantages any Apple client, such as Siri.

In summary, this market is far from mature, and there is still plenty of room for well-funded competitors such as Apple, Microsoft, and Google to enter and to compete effectively. There is little dispute, however, that Amazon has staked out a sizable advantage by providing a sound, cost-effective product, supported by a broad array of development partners and users.

What difficulty would someone using this program encounter? (2 Points)

As noted in a previous section, anyone with a severe speech disability may find the Echo unusable, or only partially functional. Even after the voice training, there may be unsatisfactory results.

Another difficulty could ensue for those with cognitive impairments. By not knowing or remembering the commands, the Alexa persona will not perform the functions that the user intends or wants.

Finally, although there are remote units available (called the Amazon Dot), and though multiple Echo units can be positioned around a space, it is quite possible for someone to be out of range of the Echo, and be unable to communicate with it. This is particularly true in the event of an emergency when the person may be unable to speak strongly or understandably.

Discuss the amount of training necessary to use this properly. (1 Point)

Aside from the setup of the Echo, and the configuration of the IoT devices around the house, the amount of training needed to fruitfully engage the Echo is minimal, assuming the user has reasonable cognitive skills. I found setup to be very straightforward, and the setup of lighting (Lutron Caseta) to be quite simple as well. As noted previously the key is in knowing the commands. The Echo comes with a card with a number of typical commands the user can refer to.

What changes to the device or software need to be made to make it better work for its target population? (2 Points)

Assuming the target population is a broad spectrum of people with disabilities, then the changes are not so much with the device or the software, but with the number of external assistive technology devices that are directly supported by the Echo. Currently, in order to bring specialized devices (e.g., powered wheelchairs) under the control of the Echo, some relatively complicated programming and deployment practices were needed to create Skills, by leveraging the Alexa API. All of the articles I read involved doing this kind of work. The promise is that future implementations of assistive technology devices will come pre-configured for use with the Echo, and that it becomes a relatively simpler matter of Alexa discovering those devices, and bringing them under the Echo's control.

What factors of this device may lead to abandonment? (2 Points)

The major factors that could lead a user to abandon the Amazon Echo are threefold: frustration with its capabilities; frustration with its performance; and frustration with the support. Any of these are sufficient to cause any user to slow or halt their use of the Echo. In my evaluation of the Echo, I found its capabilities to be adequate for my needs, but I was also aware that for someone with disabilities, the Echo might not deliver

everything they may need. In terms of performance, it must be remembered that Alexa processes voice recognition through an Internet connection up to the Amazon cloud. Any distortion or interruption of service essentially brings the Echo to a grinding halt. In terms of support, I must say that Amazon has made a strong commitment to the overall usability of the Echo, and is committed to working with both users and the development community to support and address issues and concerns. There are numerous message boards and support lines available, and I found them to be widely used and largely successful in keeping users and developers productive.