Technology to Support Community Living and Integration in Long-Term Services and Supports: An Environmental Scan

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IBM Watson Health

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Introduction & Purpose of Scan

Through the Medicaid Innovation Accelerator Program (IAP), the Center for Medicaid and CHIP Services (CMCS) offers targeted program support to Medicaid agencies seeking to promote community integration for Medicaid beneficiaries using Long-Term Services and Supports (LTSS).

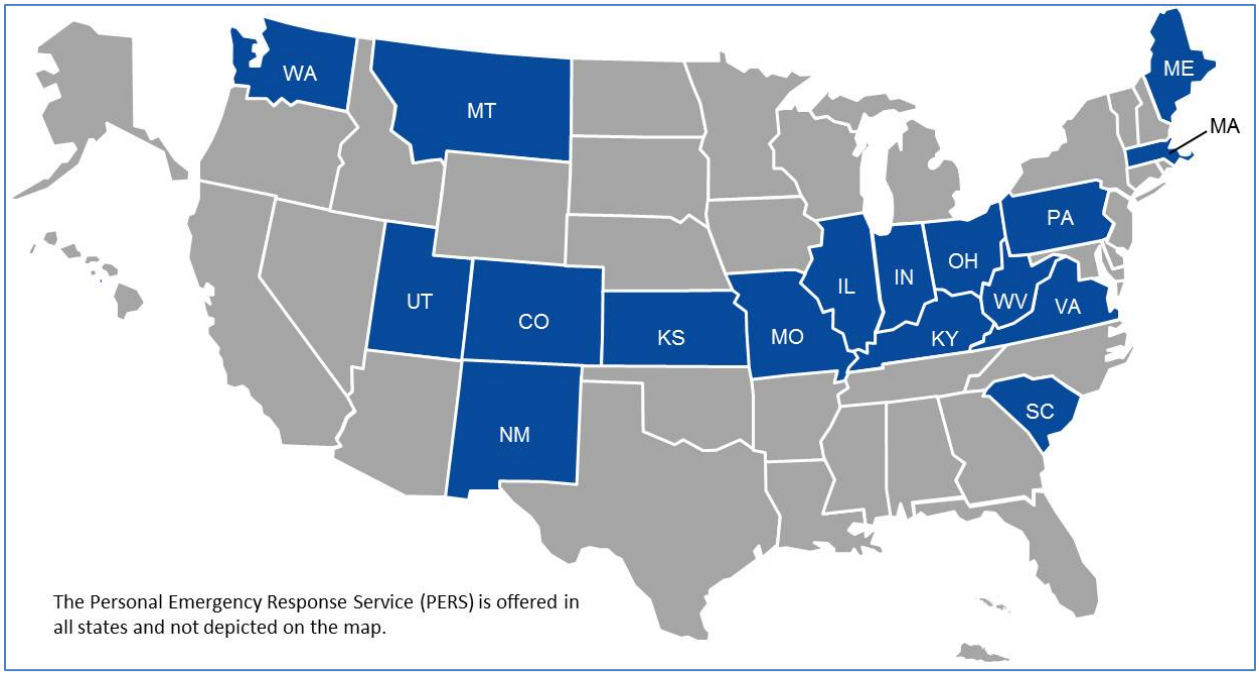
Based on continuing dialogue with states and other stakeholders, the use of technology has presented an opportunity for state Medicaid agencies to promote community inclusion and community living. As CMCS continues to seek ways to support states, IBM Watson Health was asked to conduct an Environmental Scan (referred to as Environmental Scan, or Scan) to identify existing and emerging technologies used to support community living and integration. The Scan provides information on technologies that currently exist and how states are using technology in community-based LTSS programs, as well as providing information about emerging technologies that may prove useful to Medicaid agencies in promoting community inclusion. The Scan also identifies certain technology outcomes as well as public policy issues that states will need to address to successfully leverage evolving technologies.

Scan Approach

In conducting the Environmental Scan, IBM Watson Health staff focused first on existing technology-based services to support community living, rather than technology-based devices that are generally considered durable medical equipment (DME), such as power wheelchairs, communication boards, and hand controls for vehicles.

To do this, staff reviewed *existing and approved* Home and Community Based (HCBS) §1915(c) Medicaid waivers as of June 2017, where technology is used to support community living and integration through either a managed care or fee-for-service delivery system. State Waiver Fact Sheets and waiver applications were reviewed, including detailed descriptions of approved service definitions, service limits, provider standards and reimbursement methodologies for technology-based services. Proposed amendments and proposed new waiver requests were not included in the review. Staff gathered information from 17 states with technology-based services in place; see Figure 1 for a map of states.

Figure 1: Map of States Featured in Environmental Scan with Technology-Based Supports in Addition to Personal Emergency Response Service



The Scan also includes a review of *new and emerging technologies* beyond those currently used through Medicaid 1915(c) waiver programs. New and emerging technologies encompass:

- technology prototypes or those currently being field tested;
- technologies that are new to the market and not yet commonly used or widely available to the general public; and
- technologies that are both device-based and service oriented.

Information on emerging technologies was gathered from sources including:

- public presentations;
- papers and reports;
- websites;
- journals and trade publications;
- media reports; and
- a limited number of interviews.

Since much of the information is proprietary and in the private sector, the section on new and emerging technologies describes the category of technology and provides examples of its use - or its intended use - based on field tests, developer trials, and designer expectations. Finally, because digital healthcare, including telemedicine and digital health records, is an area so broad that it could justify an environmental scan of its own, these technologies are not a focus in the Scan.

Technology-Based Services Currently Available through Approved State Medicaid HCBS 1915(c) Waivers

HCBS provide opportunities for Medicaid beneficiaries to receive services in their own home or community rather than institutions or other isolated settings. These programs serve a variety of targeted population groups, such as older adults and people with intellectual or developmental disabilities (IDD), physical disabilities, and/or mental illnesses.[1] As technology advances, states are incorporating technology-based services into their HCBS programs to offer additional community living supports for older adults and individuals with disabilities.

For services provided through approved Medicaid waivers, we identified four primary categories of technology-based services in addition to Other Technology-Based Supports that include unique services:

I. Personal Emergency Response System;
II. Activity Monitoring;
III. Health Status Monitoring;
IV. Medication Dispensing and Monitoring; and
V. Other Technology-Based Supports.

In this section, each technology-based service category is described and most categories include a table with state specific information.

I. Personal Emergency Response Systems

Personal Emergency Response Systems (PERS) are the most common technological solution utilized in state Medicaid HCBS programs today. These services offer a 24-hour emergency communication link to assistance outside the participant's home. The system consists of two-way voice communications between a base unit and a portable pendant or watch-style device, typically worn by the participant. When activated, the system automatically links the participant to a professionally staffed support center. The support center assesses the situation and directs an appropriate response whenever the PERS is engaged by a participant. While once only used in the event of major falls or medical crises, today many PERS providers are available to provide on-call counseling, and problem solving, as well as immediate response for assistance at the participant's home due to a health or personal emergency. Newer PERS models are also available with satellite-based tracking mechanisms built in so that the user can summon assistance even when away from the home.

All 50 states and the District of Columbia offer the PERS service through one or more of their HCBS Medicaid waiver programs serving older adults and people with disabilities. Most states name the service Personal Emergency Response System; however, some states use other names such as 24-hour Emergency, Lifeline Alert, Emergency Response Services and Crisis Response Services.

In their waiver applications, each state specifies the criteria necessary to benefit from PERS services. Typically, states require that individuals have demonstrated the mental and physical capacity to utilize such systems effectively and live alone or who are alone with no caregiver

[1] Centers for Medicare & Medicaid Services. Home & Community Based Services webpage; accessed 4/3/18.

for extended periods of time. Like other HCBS, the amount, duration and scope of the service is specified in the individual's approved plan of care or service plan. States most commonly reimburse for the PERS using a monthly unit of service plus a one-time equipment installation fee.

II. Activity Monitoring

Activity monitoring is more robust than a standard emergency call button in that it provides active, rather than passive (as with PERS) monitoring and surveillance for safety, security, support and communication. This type of technology works well for participants who don't require 24/7 or face-to-face care but can benefit from remote monitoring and communication to ensure their health and safety. A wide range of technological options are available to monitor a participant's activity in their environment including electronic sensors; video cameras (not used in private areas such as bedrooms or bathrooms); environmental sensors that detect movement, temperature and smoke; microphones and speakers. States that offer activity monitoring services through their HCBS waiver programs may use other names such as Remote Monitoring, Emergency Home Response and Electronic Monitoring.

With the participant's permission, the equipment is installed in a provider or individually owned residence and is monitored electronically by professionals in a remote, centralized location. To qualify as a provider of this service, states typically require the same skills and experience needed to directly support the individuals they monitor; for example, in waivers serving individuals with IDD, the provider qualified to offer residential supports services is typically also qualified to offer activity monitoring services. For this reason, the geographic availability of the service relies heavily on the capacity of qualified providers that are approved to deliver the service.

It's widely known that direct care staff shortages exist across the country, most frequently in rural areas, so activity monitoring technology is often used as a viable replacement for on-site residential staff. Remote staff can monitor many participants at once using this technology, allowing for both access to services and cost efficiency. The service includes an on-site response component that requires staff to respond in person within a given timeframe, such as 15-20 minutes, in the event of an emergency. To prevent duplication of services, states institute policies to prohibit the use of activity monitoring services at the same time as face-to-face supports. For these reasons, the overall cost to using the service is typically the same or less than the cost of direct supports which is favorable for operation of waivers that require an assurance for cost neutrality.

Another benefit of the service is that it offers the participant an opportunity for increased independence to direct the activities of their day. States such as Kentucky and Maine include language in their service definitions indicating the monitoring technology is used to reduce the need for residential staff and promote increased independence without undue risk to an individual's health and safety. In many cases, the service is used for up to three individual participants who reside in a home together. States offering the service to a group of participants have outlined specifications for individualized use of the service and written consent is required from all participants and their representative, as applicable, for the monitoring service to be utilized in the home. Like other HCBS, the frequency and duration of this service are based on the individual's assessed need as documented in the plan of care.

Many states that offer this service establish a minimum set of waiver participant eligibility criteria. These criteria may include the capability to alert staff or call 911 in an emergency and to provide written consent and commitment to the PERS plan. The case manager must document in the individualized service plan that the criteria is met and later adjust the services in the plan as the participant's needs change thereby increasing or decreasing their need for support. Table I summarizes states and their criteria for offering activity monitoring services through a HCBS waiver.

Table I – Activity Monitoring

State Using Technology	Purpose of Service	Target Population	Member Eligibility Criteria for Service	Unit(s) of Service	Funding Source
Indiana	Oversight for participants through off-site surveillance.	Individuals with IDD	Available for adult waiver participants in residential settings.	Hourly	IN 1915c CIH Waiver 0378 Plan date: 9/2016
Kentucky	To increase independence without undue risk to a person's health and safety. For someone who may need ADL reminders or security of staff support.	Individuals with IDD	Authorized for participants with the ability to either call or use a button to alert staff to their needs and can call 911 in an emergency.	Daily	KY 1915c Supports for Comm Living 0314 Plan date: 5/2017
Maine	Habilitation support to increase participant's independence and community integration.	Individuals with IDD or autism	Authorized based upon the participant's assessed needs, consent and commitment to the PERS plan.	Interactive Support: ¼ hour Monitor Only: ¼ hour	ME 1915c Support Services for Adults with ID or Autism 0467 Plan date: 11/2016
Ohio	Equipment used to engage in live two-way communication with the participant.	Individuals with IDD	Subject to a combined services cost limit to allow an individual a choice of services that best addresses their health and safety needs.	Remote Monitoring: hourly Remote Monitor Equipment: monthly	OH 1915c Lvl1 waiver 0380 Plan date: 5/2017
Montana	Oversight and monitoring within the residential setting of a person age 18 and older, through off-site electronic surveillance.	Individuals with IDD	Available for adult waiver participants in residential settings. The individual receiving the service and each person who lives with the individual, and their guardians, shall consent in writing.	Remote Monitoring: hourly Remote Monitoring Equipment: monthly	MT IDD 1915c Waiver 208 Plan date: 11/ 2015

State Using Technology	Purpose of Service	Target Population	Member Eligibility Criteria for Service	Unit(s) of Service	Funding Source
New Mexico	Provides 24-hour response capability and/or prompting through the use of electronic notification and monitoring technologies to ensure the health and safety of the individual.	Individuals with IDD or Autism	Available to individuals who have a demonstrated need for timely response due to health or safety concerns.	Installation fee Device maintenance: monthly Staffing: hourly	NM DD 1915c Waiver 0173 Plan date 10/ 2015
Pennsylvania	Employs sensor-based technology on a 24-hour/ 7-day basis by remotely monitoring and passively tracking participants' daily routines. May report on: wake up times, overnight bathroom usage, bathroom falls, medication usage, meal prep and room temperature.	Individuals age 60+	Available to Aging Waiver participants	One time installation fee Monitoring: monthly	PA 1915c Aging Waiver 0279 Plan date: 9/2016
Virginia	To support greater self-determination and independence, promote inclusion in the community and/or increase the individual's in-home safety	Individuals with IDD and autism	A preliminary needs assessment will be conducted by a technology specialist to help determine the best type and use of technology and the overall cost effectiveness of various options.	Monthly	VA Community Living 1915c Waiver 0372 Plan date: 6/2017
West Virginia	Includes the provision of oversight and monitoring within the residential setting through off-site electronic surveillance.	Individuals with IDD	The individual request for this service must first be assessed and approved by the provider's Human Rights Committee (HRC) and give informed consent to use the service.	Hourly	WV IDD 1915c Waiver 0133 Plan date: 10/2015

III. Health Status Monitoring

Health status monitoring is another type of remote monitoring service that provides waiver participants with increased independence, quality of life and opportunity to live in the community. This service uses existing phone lines or wireless communication technology to provide for remote monitoring and communication between the waiver participant and their healthcare provider. Sensor-based home tele-monitoring equipment collects, records, and transmits physiological data such as vital signs, body weight, heart rate, oxygen saturation, blood sugar and blood pressure. The system can be set to automatically alert monitoring staff of abnormal readings. The healthcare provider uses the data collected through the remote monitoring service to assess the participant's condition and provide education and consultation as appropriate. This service is offered through 1915(c) HCBS waivers in Pennsylvania and South Carolina that specify various provider types as qualified providers of this service.

Like other services offered through HCBS waivers, health status monitoring can be available for individuals with an identified need and desire for the service. Due to the clinical nature of this service, the participant's primary physician must also approve of its use. It's important to note the health status monitoring service is significantly different from telemedicine, which is an interactive web-based medical diagnosis and treatment delivery system, and not covered in the Scan. Additional details for the Health Status Monitoring service are presented in **Table II**.

Table II – Health Status Monitoring

State Using Technology	Purpose of Service	Target Population	Member Criteria for Service	Unit of Service	Funding Source
Pennsylvania	To sustain and promote independence, quality of life and reduce the need for nursing home placement.	Individuals age 60+	Must be ordered by a primary care physician, physician assistant, or nurse practitioner.	Equipment and Installation Fee Monitoring: daily	PA 1915c Aging Waiver 0279 Plan date: 9/2016
South Carolina	To measure and monitor the health status of at-risk participants.	Aged and disabled	Must be approved by a primary care physician who agrees to be solely responsible for receiving and acting upon the information received via the tele-monitoring service.	Daily	SC 1915c Community Choices Waiver 0405 Plan date: 11/ 2016

IV. Medication Dispensing, Monitoring and Reminder Service

Medication Dispensing includes both the electronic pill dispenser device and a reminder service for individuals who need assistance with medication administration. There are various types of dispenser devices available that include features such as lights and alarms to remind the user to take a scheduled dose of oral medication in the form of tablets or pills. The electronic device will dispense controlled dosages of medication at specified times and may include a message back to a central response center if a medication has not been removed from the dispenser, so that appropriate action can be taken.

State policies vary as to who is qualified to routinely set up the medications in the dispenser. Some states indicate that a Registered Nurse or other qualified professional must set up the medications, while other states allow for a reliable family member or caregiver to handle the task. The dispenser is often purchased through a Medicaid DME provider.

Medication Reminder Services provide a scheduled reminder to a participant when it is time for them to take medications. The reminder may be a phone call, automated recording, or automated alarm feature of the medication dispenser. Monitoring of medication compliance can be managed using a dispenser alone or a combination of dispenser and phone reminder services. States offering these services are summarized in **Table III**.

Table III – Medication Dispensing, Monitoring and Reminder

State Using Technology	Purpose of Service	Target Population	Member Criteria for Service	Unit of Service	Funding Sources
Colorado	Medication Reminders include devices or items that remind or signal the client to take prescribed medications.	Persons with spinal cord injury Elderly, blind and disabled	For individuals who have the physical and mental capacity to utilize the device requested.	One time installation and monthly	CO 1915c Spinal Cord Injury Waiver 0961 Plan date: 5/2017 CO 1915c EBD Waiver 0006 Plan date: 8/2016
Illinois	Provide medication reminders to promote participant's independence and safety.	Aged and disabled, ages 60+	Services and maximum costs authorized based on the determination of need (DON) assessment score.	One time installation and monthly	IL 1915c Elderly Waiver 0143 Plan date: 11/2016
Kansas	Provides a scheduled reminder to a participant when it is time for the participant to take medications.	Individuals with a brain injury	Participants who live alone or are alone a significant portion of the day and have no regular informal/formal support for extended periods of time.	One time installation and monthly	KS 1915c TBI Waiver 4164 Plan date: 3/2016
Massachusetts	An automated medication dispenser for consumers with medication compliance problems to receive pill form medications at appropriate intervals through audible/visual cueing.	Aged and disabled	Authorized only when a responsible formal/informal caregiver can demonstrate the ability to pre-fill medications and monitor the system.	One time installation and monthly	MA 1915c Frail Elder Waiver 0059 Plan date: 01/2014

State Using Technology	Purpose of Service	Target Population	Member Criteria for Service	Unit of Service	Funding Sources
Missouri	An electronic device programmed to dispense medications or provide a reminder to a participant when medications are to be taken.	Individuals with IDD and autism	For individuals who have been evaluated as able to self-administer medications with a reminder.	One time installation and monthly	MO 1915c Autism Waiver 0698 Plan date: 3/2013
Pennsylvania	Assists participants by dispensing medication and monitoring medication compliance.	Individuals age 60+	The frequency and duration of this service are based upon the participant's needs as identified and documented in the participant's service plan.	One time installation and monthly	PA 1915c Aging Waiver 0279 Plan date: 9/2016
Utah	Provides medication reminder services via phone calls, telecommunication devices or medication dispenser devices with electronic alarms which alert the individual and a central response center staffed with qualified individuals.	Individuals ages 65+	Available to waiver participants who need assistance with managing their medications	Monthly Installation and testing are elements of the Specialized Medical Equipment/ Assistive Technology waiver service	UT Aged 1915c Waiver 247 Plan date: 8/2016

State Using Technology	Purpose of Service	Target Population	Member Criteria for Service	Unit of Service	Funding Sources
Virginia	Medication Monitoring is available as a supplement to the personal emergency response system (PERS) service.	Individuals with IDD and autism	Must be physician-ordered and individuals must be receiving PERS services and medication monitoring service simultaneously.	Monthly	VA Community Living 1915c Waiver 0372 Plan date: 9/2016

V. Other Technology-Based Supports

Many states also cover various DME, adaptive aids and assistive medical devices through their HCBS waivers. Many of these items are technology-based, but do not correspond with direct service delivery and as noted previously, were not included in this Scan. Some DME examples include:

- eating and cooking utensils;
- shower chairs and grab bars;
- talking alarm clocks and teletype phones;
- accessible keyboards and computer screen readers;
- vehicle hand controls and van lifts; and
- power wheelchairs and scooters.

Beyond traditional DME, the state of Washington offers "specialized clothing" through their waiver that serves children with I/DD. The service offers clothing adapted to the participant's individual needs and related to his/her disability. Specialized clothing can include weights, clothing designed for tactile defensiveness, specialized footwear, or reinforced clothing.

Another technology-based service called Electronic Visit Verification (EVV) is used to ensure participants are receiving their authorized services on time and as scheduled. EVV is a telephone and computer-based system that electronically verifies that service visits occur and documents the precise time service begins and ends.[2] While a few states are beginning to introduce EVV technology into their programs, and providers across the country are using these systems, they are primarily deployed as workforce and service management tools, not a participant-oriented delivered service. As such, they were not included in the scope of the Scan.

[2] Texas Health & Human Services Commission, Electronic Visit Verification; accessed 4/4/18.

New and Emerging Technologies

With aging and disability populations growing at unprecedented rates[3] and community living funding resources increasingly strained, policy makers, providers and families are looking towards rapidly changing technology for assistance. The global market for technology products geared towards community living and in-home care is expected to reach $20 billion by 2020[4] and entrepreneurs are taking notice.

While the breadth of technology for use by the LTSS population is vast, the items highlighted in the Scan focus on those that may be of assistance to people with disabilities and older adults residing in community settings, particularly those that have the potential to lower costs by improving health outcomes, addressing workforce shortages, and supporting family and informal caregivers.

The new and emerging technology areas reviewed in the Scan include:

- Sensor-Based Technology;
- Mobile Technology [phones, tablets and their applications (apps)];
- Virtual Reality and Sensory-Related Technology;
- Robotics and Artificial Intelligence;
- 3-D Printing; and
- Tech Clothing.

[3] National Institute on Aging, National Institutes of Health Newsroom, March 28, 2016; accessed 5/10/17.
[4] Orlov, Laurie M. "Technology for Aging in Place: 2018 Market Overview." Aging in Place Technology Watch: March 2018; accessed 4/4/18.

VI. Sensor-Based Technology

Sensors have been around since the 1950's and have been used to support those needing LTSS in everything from monitoring movement in the home to tracking basic health measurements such as blood pressure and body temperature. The effective integration of sensor and health information technologies has the potential to facilitate care delivery across multiple provider settings, generate significant improvements in quality and the patient experience, and help manage health-care costs.[5]

Imagine, for instance, sensors in a person's home that not only record if the person has gotten out of bed (indicating they did not have a health crisis while asleep), if they have gained or lost weight (as an indicator of dehydration or edema), or what their blood pressure is that morning (indicating risk for stroke or heart attack), but also sensors in their shoes, walker or cane to measure if there are slight changes in the person's gait. When analyzed, all this data can provide predictive indicators of an impending fall or other health crisis. Predicting, and then preventing, accidents and major health issues is a primary goal of health-oriented sensor-based technology.

Several systems have recently appeared on the market with the intent of achieving this highly integrated system of data and care and the goal of reducing health crises and costs. The systems usually connect wirelessly through any dedicated Internet connection and communicate with wireless sensors in the residence, the patient's adaptive aids, their clothing, etc. In fact, the underpinning for many advancements in sensor-based technology is a combination of wireless communication ability, increased availability and affordability of high-speed internet service for personal use, and improvements in data management and analytics. Sensor data can now be analyzed in a holistic way, identifying interrelated impacts of health and social activities and experiences.[6]

The remaining sections of the Scan explore other types of emerging technologies that promote community living and integration. Many of the examples highlighted in the Scan rely on one type of sensor or another to achieve their intended purpose. Thus, sensors are an important and central element in our technological future, quickly becoming key elements in supporting community living for elders, people with disabilities and their caregivers.

VII. Mobile Technology

Mobile devices have become incredibly popular for their ability to weave modern conveniences such as Internet access and social networking into the fabric of daily life. For older adults and people with disabilities, however, these devices and their applications (apps) have the potential to unlock unprecedented new possibilities for communication, navigation and independence by providing flexibility, portability and customization. "The emergence of mobile 'assistive'

[5] Office of the Assistant Secretary for Planning and Evaluation, U.S. Dept. of Health and Human Services. "Report to Congress: Aging Services Technology Study", June 2012; accessed 4/3/18.

[6] "SimpleC: Helping Seniors Stay Connected and Stay Engaged with IBM Watson and Mobile;" accessed 4/3/18.

technologies, influenced heavily by the passage of the Americans with Disabilities Act (ADA) 25 years ago, marks a major step forward for people with disabilities."[7] And, as the saying goes, no matter what one wants to do, it seems that "there's an app for that!"

Today, nearly all new computers and mobile devices have integrated accessibility features to facilitate their use. For instance, mobile screen readers read aloud information from a phone or tablet as the user passes a finger over icons and text, voice recognition software allows operating the mobile device using voice commands rather than touch, and "assistive touch" applications help users unable to perform certain gestures, such as multi-finger swiping typically required to use standard touch screens.

Table IV highlights just a few examples of emerging technologies that have the potential to further transform today's popular mobile devices into tools that support community living and integration by delivering even greater levels of freedom and independence to people with any number of disabilities.

[7] Office of the Assistant Secretary for Planning and Evaluation, U.S. Dept. of Health and Human Services. "Report to Congress: Aging Services Technology Study", June 2012; accessed 4/3/18.

Table IV – Emerging Technology Examples: Mobile Tech

Emerging Technology: *Mobile Tech*	Description
Refreshable Braille Displays	These new devices use electromechanically controlled pins, as opposed to the lights in a conventional computer monitor, to convey information. Each time a person reads the row of braille with their fingers (left to right), the pin configurations refresh to represent the next line of a page's text, and so on.[8] This allows the user to access the internet and read documents in quiet environments such as an office or library where voice readers may be disruptive to others or the material being read is confidential.
Hover Detection/Onscreen Keyboard Augmentation	Researchers are experimenting with "hover detection" capabilities that will allow mobile device displays to detect a finger before it even touches the screen. This builds on the gesturing functions some keyboards already offer, but is being designed to allow functionality without the user actually touching the keyboard.[9] For people with tremors, neuropathy, and other physical challenges with their hands, when perfected, this technology, combined with voice commands, could open up a world of software and possibilities.
Bar Code Scanners	Bar code scanners are now available as mobile phone-based scanners applications. Traditionally used for inventory maintenance, the mobile technology is now available for everyday use for a range of tasks from on-the-spot comparison shopping, to prescription refills, to online grocery orders.[10] This can be an especially useful tool for people with visual impairments to help identify store items, as well as for people with memory challenges or those shopping for others. It is also a useful app for caregivers as they are now able to scan and retain medication bar codes and other essential health information for their loved ones, ordering prescription refills and parts for adaptive aids easier and improving accuracy.

[8] Greenemeier, Larry. "5 Mobile Technologies Help Level the Playing Field for People with Disabilities." Scientific American Online, August 2015; accessed 4/3/18.
[9] Ibid.
[10] Ibid.

Emerging Technology: *Mobile Tech*	Description
GPS Tracking for Wanderers	Mobile technologies aimed at monitoring wandering behaviors among older adults and others with cognitive impairment are leveraging GPS[11] technology to help caregivers. Wearable systems that combine GPS and cellular technologies have the potential to increase safety and prolong independence among cognitively impaired adults. The ability of a local or remote caregiver to track a loved one over his or her home computer or cell phone using GPS technology has far-reaching implications for the ability of these caregivers not only to preserve the independence of loved ones, but also to substantially reduce both the direct and indirect costs associated with their caregiving.[12]
Wearable Finger Reader	A finger-worn device (about the size of a 50 cent piece with a hole in the center) that people with vision impairments can use to turn any text into audio, even under dim lighting conditions, has recently been developed. It can also be used for language translation. Wearers scan a text line with their finger and receive audio feedback of the words and a haptic feedback of the layout: start and end of line, new line, and other cues. The Finger Reader algorithm knows to detect and give feedback when the user veers away from the baseline of the text, and helps them maintain a straight scanning motion within the line. While not yet on the market, three different prototypes using a variety of cameras, vibrations and musical tones are currently being tested and refined.[13]

[11] GPS is defined as Global Positioning System: a global system of U.S. navigational satellites developed to provide precise positional and velocity data and global time synchronization for air, sea, and land travel. It can also be used to determine the position of a vehicle, person, etc. Dictionary.com; accessed 4/3/18.

[12] Greenemeier, Larry. "5 Mobile Technologies Help Level the Playing Field for People with Disabilities." Scientific American Online, August 2015; accessed 4/3/18.

[13] Ibid.

Mobile Technology: Social Media

One primary use of mobile technology is social media. Social media is defined as "forms of electronic communication (such as websites for social networking[14] and microblogging[15]) through which users create online communities to share information, ideas, personal messages, and other content (such as videos)."[16] The interconnectedness afforded through social media means we can just as easily know our next door neighbor as someone on the other side of the globe. Appropriate use of the internet and social media can combat isolation, assist with communication and support caregivers. **Table V** below notes four examples of the type of new social media applications that can be particularly useful in promoting or enhancing community living and integration for older adults and people with disabilities.

Table V – Emerging Technology Examples – Mobile Tech: Social Networking

Emerging Technology: *Mobile - Social Networking*	Description
For People Who Use Wheelchairs	Many public sites are not equipped with wheelchair accessibility. More than an inconvenience for people using wheelchairs, it could serve as a real danger during an emergency. One crowdsourced[17] map app shares information about wheelchair-accessible ramps and restrooms in public places such as restaurants, hotels, stores and more. The app also carries information about how well-designed these facilities are with the help of star ratings provided by other apps users who have visited or used the public sites.[18]
For People with Vision Impairments	Apps that that helps people with vision loss and blindness to "see" the world are becoming increasingly available in various forms. One social media model works by making a network that connects the user with volunteers from around the world. It is an easy way to ask for help for simple tasks like checking on the expiration date on a milk carton.[19]

[14] Social Networking is defined as the creation and maintenance of personal and business relationships especially online. Merriam-Webster Dictionary; accessed 4/3/18.
[15] Microblog is defined as a blog that is smaller than a traditional blog – a website containing a writer's or group of writers' own experiences, observations, and opinions – and often having images and links to other websites. Dictionary.com; accessed 4/3/18.
[16] "Social Media," Merriam-Webster Dictionary Online; accessed 4/3/18.
[17] Crowdsourcing is defined as "the practice of obtaining needed services, ideas, or content by soliciting contributions from a large group of people and especially from the online community rather than from traditional employees or suppliers." Merriam-Webster Dictionary Online; accessed 4/4/18.
[18] Gadgets. "10 Assistive Tech for People With Disabilities." Gadgets by Agus. Available online; accessed 4/3/18.
[19] Ibid.

Emerging Technology: *Mobile - Social Networking*	Description
For People with Disabilities Needing "Real-Time" Help	New apps that help people with disabilities to get assistance in real-time are now available. One app connects service providers and caregivers with people who may need their assistance at a moment's notice. Services include getting a ride somewhere, help getting to work, assistance shopping for essentials or help with travel. Volunteers sign up to receive notifications or requests for help, and if they are too busy, the app can find someone else to step in and help. Each request will trigger a video call to volunteers so they can help the user [20]
For Older Adults to Address Isolation and Loneliness	Hardware and apps have been designed specifically for adults who are not tech savvy and have poor coordination and vision. Screens are large with simplified user interfaces that rely on touch screen technology instead of a mouse. The programs require minimal data collection and include resource information for topics pertinent to the aging population, such as maps, transportation, community resources, health and medication trackers, games, and directories for connecting with peers and friends. Increasingly, these solutions are also available via tablet and smart phone apps.[21]

VIII. Virtual Reality and Sensory-Related Tech

Virtual reality is a rapidly developing technology, defined as a computer-generated simulation of a three-dimensional image or environment that can be interacted with in a seemingly real or physical way by a person using special electronic equipment, such as a visor or gloves fitted with sensors.[22]

Virtual reality (VR) is considered to have begun in the 1950's but early elements of it can be traced back to the 1860's and long before the development of digital technology. Early examples include large, 360 degree murals, the world's first flight simulator developed in 1920, and the first form of multimedia developed in the 1970s that enabled people to virtually walk through the town of Aspen, Colorado.[23] Today, while VR is probably most well-known for use in games and entertainment, it also has numerous community living applications. Home use of VR for self-directed physical therapy has existed for a few years and its use and efficacy has steadily grown.

Today, some systems are able to track patients' use and compliance with therapy orders and transmit that information to healthcare professionals, while other systems remain as separate

[20] Gadgets. "10 Assistive Tech for People With Disabilities." Gadgets by Agus; accessed 4/3/18.
[21] Safran, Charles. "Using Health IT to Improve Care Planning and Communication." Webinar presentation for Agency for Healthcare Research and Quality, Rockville, MD, 7/17/17; accessed 4/3/18.
[22] Google Dictionary. Definition of Virtual Reality; accessed 4/3/18.
[23] Virtual Reality Society. "How did virtual reality begin?" Virtual Reality Society Online; accessed 4/3/18.

in-home options. Building on these ideas, there are some other exciting and promising emerging uses of VR for the LTSS population, as described in **Table VI** below.

Table VI – Emerging Technology Examples– Virtual Reality

Emerging Technology: *Virtual Reality*	Description
VR Games for Physical Therapy	With the help of a virtual reality rehabilitation system, people who need physical therapy, rehabilitation and disease management can now go mountain climbing, snowboarding, or do a number of other activities without leaving the hospital, rehab center or physical therapy office. The system uses green-screen gesture technology to immerse patients in prescribed sporting or gaming environments that also test for and build balance, mobility and endurance. Patient's therapy can be tracked and customized for each user's needs. Unlike traditional exercise programs, VR therapy is often more engaging and therefore, more preferred by younger patients.[24] Other researchers are finding that people who exercise while engaging in a virtual experience, such as riding a stationary bike through the virtual streets of Paris, may be able to slow cognitive impairment, potentially extending years of independent community living.
Touchable Virtual Maps for the Blind	A new system that converts video into virtual, touchable maps for the blind has been developed by researchers in Greece. The three-dimensional maps use force fields to represent walls and roads so the visually impaired can better understand the layout of buildings and cities. Architects sometimes create three-dimensional models for the blind, but those replicas can only be used by one person at a time. Paper maps with ridges signifying roads are not ideal either, because they cannot convey enough information. With this new system, a digital version of a diorama can be accessed simultaneously by people around the world. Extra information is presented in audio clips.[25]
VR Experiences to Reduce Depression and Isolation	Reducing depression and isolation of older adults is the focus of new VR work out of the Massachusetts Institute of Technology (MIT). Currently in effectiveness trials, residents in assisted living environments are provided with cell phone-based virtual reality visors and are able to experience a variety of VR programs. Fulfilling a "bucket list" wish experience, traveling to see other countries, or visiting familiar neighborhoods where they used to live can create great joy and help improve the elders' sense of wellbeing. Early research results show improvements in the participant's sense of well-being and reduced depression.[26]

[24] CBC News. "Digital tools help young patients recover in Calgary." CBC News Online, 2012; video available; accessed 4/3/18.

[25] Ross, Rachel. "Getting in Touch: Virtual Maps for the Blind." Scientific American Online, April 2007; accessed 4/4/18.

[26] Details based on phone interview with Dennis Lally of Rendever on May 10, 2017; accessed 4/3/18.

Emerging Technology: *Virtual Reality*	Description
Virtual Environment Mapping	Researchers are developing ways to use survey and video equipment to create highly accurate 3D virtual reality maps of patients' home, work and social environments.[27] Using these VR maps, therapists are able to work with patients with significant physical impairments (such as paraplegia, neurological damage, etc.) who often require months of rehabilitation as part of the recovery process, as if they were in the patient's own environment. In this way, barriers that can jeopardize successful community living – such as wheelchairs and walkers that don't fit through the bedroom door and counters that are too deep to reach the faucet from a seated position – are able to be identified during the rehabilitation and discharge planning process when alternative equipment and approaches can be tried and perhaps when there is time to make the necessary environmental changes to the home to ensure post-rehabilitation community living success.

Virtual Reality has a bright future ahead and there seems to be no limit to the ways in which it will be used not only for entertainment, but also to improve our daily lives and help people who need LTSS live more successfully in the communities of their choosing.

[27] Gustafson, David, et.al. "Staying Alive with Elder Tree." University of Wisconsin. Webinar presentation for Agency for Healthcare Research and Quality, Rockville, MD, 7/17/17; accessed 4/3/18.

Sensory-Related Tech

While VR engages many of our senses at once, technology is also being developed to address specific sensory deficits. Examples of new technology that address challenges faced by people with limitations in sight, hearing, touch and speech are presented in **Table VII** below.

Table VII – Emerging Technology: Sensory-Related Tech

Emerging Technology: *Sensory-Related Tech*	Description
Intelligent Canes	Intelligent canes use an attached ultrasonic transmitter and a sensor that vibrates the cane to warn its users when an obstacle is within three meters. Researchers are also developing a cane that can identify acquaintances as they approach. This feature will include an embedded digital camera that analyzes the faces of people walking by and compares their images against a database stored on a memory card in the cane's handle. If there's a facial recognition match, the cane will alert the user's smartphone via Bluetooth. The phone could then identify the approaching person to the user via its speaker or earbuds.[28]
American Sign Language Interpreter	A two-way sign language communication tool for the deaf uses gesture and speech technology to detect hand and finger movements with its specialized camera algorithm. It then quickly converts those movements to text to provide the meaning of a given signed word or phrase. The program is also equipped with voice recognition software that can convert speech into text for two-way communication. The software enables the user to create their own sign language with its sign builder, so it is easy to add custom language to the dictionaries. It is a subscription-based app with two versions, one that requires a data connection and another that does not.[29]
Speech Translators	Innovative applications help people with speech and language disorders to communicate with someone else. Over time, the program learns the user's speech patterns and associates it with input entered by the user or caregiver. The program is then able to translate generally unintelligible pronunciation into speech that others can understand, despite the speech difficulties. This can open up experiences and opportunities previously inaccessible to people with severe speech disorders.[30]

[28] Greenemeier, Larry. "Smart Cane Could Help Blind ID Faces." Scientific American Online, May 2015; accessed 4/3/18.
[29] Ibid.
[30] Ibid.

Emerging Technology: *Sensory-Related Tech*	Description
Bluetooth Hearing Aids	Small, discreet and Bluetooth-enabled, the new generation of hearing aids looks more like something out of a spy movie than a doctor's office. These devices can connect wirelessly with smartphones, allowing a person to hear a phone conversation directly through his or her hearing aid without needing to hold the phone against an ear. The same thing goes for listening to music or watching television; instead of listening in with headphones, users with Bluetooth hearing aids can pair their devices directly with smartphones, TVs and computers.[31] The latest versions on the market are also rechargeable.
Braille Smartwatch	Researchers have developed the first Braille smartwatch that allows its users to access messages, tweets, social media and books anywhere and at any time. The watch functions with six dots on four cells found on the surface of the smartwatch. These dots rise or lower to form 4 letters in Braille. It can connect via Bluetooth to any smartphone then retrieve and translate the text (from an email or messaging app) into Braille for its owner.[32]

As technology continues to develop, people with sensory deficits and disabilities will surely have an increasing number of options to help overcome those deficits and promote independence.

[31] Greenemeier, Larry. "Hearing Aids Meet the Future with Bluetooth Tech." Scientific American Online, July 2015; accessed 4/3/18.

[32] Gadgets. "10 Assistive Tech for People With Disabilities." Gadgets by Agus; accessed 4/3/18.

IX. Robotics and Artificial Intelligence

A robot (sometimes also called a "droid" or "bot") is a machine—especially one programmable by a computer—capable of carrying out a complex series of actions automatically.[33] Robots can be guided by an external control device or the control may be embedded within. Robots may be constructed to take on human form but most robots are machines designed to perform a task with no regard to how they look.[34]

Artificial (or augmented) intelligence (AI) is intelligence exhibited by machines. In computer science, the field of AI research defines itself as the study of "intelligent agents"- any device that perceives its environment and takes actions that maximize its chance of success at some goal.[35] Colloquially, the term "artificial intelligence" is applied when a machine mimics "cognitive" functions that humans associate with other human minds, such as "learning" and "problem solving."[36]

The term "robot" was first used in a play in 1920 to describe a fictional humanoid.[37] While there may be concerns in today's world about robots used to automate jobs once performed by people, and the combination of robotics with AI taking over humanity, this developing technology actually offers considerable opportunities and possibilities to help those with physical and cognitive disabilities to experience the highest levels of independence and community integration. From the simple task of feeding oneself, to helping a person with leg paralysis to walk, robotics and AI offer a world of possibilities for people with specific needs. **Table VIII** below provides a few examples of emerging robotic and AI tech that will be useful to those needing LTSS.

[33] Oxford English Dictionary. Definition of "robot". Retrieved June 27, 2017.
[34] Wikipedia; accessed 4/3/18.
[35] Russell, Stewart and Norvig, Peter. "Artificial Intelligence: A Modern Approach." Upper Saddle River, New Jersey: Prentice Hall, 2003, ISBN 0-13-790395-2.
[36] Ibid.
[37] Kurfess, Thomas R. "Robotics and Automation Handbook." Taylor & Francis, January 2005.

Table VIII – Emerging Technology: Robotics and AI

Emerging Technology: *Robotics & AI*	Description
Robotic/AI Hybrid Exoskeletons	An exoskeleton assists people with mobility impairments to move and enable him or her to exert more motor energy than usual. The newest development in hydraulic-assisted exoskeletons is the hybrid assistive limb exoskeleton, designed to support individuals with impaired mobility by detecting and reacting to neural signals on the skin. Wearing the hybrid exoskeleton leads to a "fusion" of the person, machine, and information. When an individual moves their body, they first think about the motions in their brain. By thinking "I want to walk," the brain transmits signals to muscles necessary for the motions through nerves. Signals sent to muscles by the brain leak onto the skin surface as very faint signals called "bio-electric signals." Exoskeletons are able to read these bio-electric signals through sensors on the surface on the wearer's skin. By processing a large variety of data, these new exoskeletons recognize what sorts of motions the wearer intends. The brain then confirms how the body moved in reaction to those signals. Once the exoskeleton has appropriately assisted in the motion of walking, the feeling/sensation that "I can walk!" is fed back to the brain. Through this feedback loop, the brain gradually learns how to emit the necessary signals for walking. With ongoing therapy (and if physiologically possible), the exoskeleton robot can help the body learn or re-learn to walk. The robotics behind the hybrid exoskeleton is also being tested for other tasks like providing assistance for heavy work in factories.[38] If successful, such broad applicability could provide increased employment and community living opportunities for many people with physical disabilities.
Feeding Robot	Robots have been designed to help people with disabilities feed themselves with less assistance. The newest tabletop models are about the size of the average dinner plate, have a weighted base, plate or bowl, interchangeable spoons (for easy clean-up), portion control settings, and can learn where to position the food after being shown just once by a caregiver. The robotic arm is highly articulated and self-adjusting based on the food being used, and is designed to detect and avoid collisions.[39] While units are a bit costly now (approx. $4,000) they should become more cost-effective over time, especially when compared to ongoing home care attendant costs. A model using chopsticks is also under development in Japan.

[38] Cyberdine website. "What's Hal? The world's first cyborg-type robot."; accessed 4/3/18.
[39] Singleton, Micah. "Obi is a robotic dining companion for people with disabilities." Circuit Breaker, July 20, 2016; accessed 4/3/18.

Emerging Technology: *Robotics & AI*	Description
Interactive Robotic/AI Companion for Older Adults	Researchers continue to work on developing robotic companions for people. Focused on facilitating independent living by providing services to older adult users in a motivating and socially acceptable manner, the new system being tested will provide physical, cognitive and social assistance in everyday home tasks. Services to the user are delivered through socially interactive, acceptable and empathic interaction, building on computational models of robot social cognition and interaction. The envisioned relationship of the user with the robot is that of a co-learner – robot and user providing mutual assistance so the user is not to be dominated by the technology, but is physically, cognitively and socially empowered by it. Older adults will participate in establishing user requirements and ways to measure user acceptance of the robot. Results from user studies will then be fed back to adapt the technology so that it better suits user demands and preferences.[40]
Self-Driving Vehicles	The last example of developing tech that addresses multisensory needs simultaneously through both robotics and AI, seems to be right out of a science fiction novel - the driverless vehicle. Several companies have developed models, with some currently being tested in select cities across the U.S. Driverless vehicles operate on a combination of information from GPS (global positioning satellites) and street view mapping technology, with artificial intelligence processing hordes of data gathered by numerous sensors and cameras mounted on the vehicle. With a safety record expected to exceed that of human drivers, this emerging technology offers great promise for those unable to drive due to sensory deficits or physical and cognitive limitations.[41]

While mechanical robots have been around for many years, we are still some time away from the androids depicted in space and science fiction movies. But progress is being made and at the rate of technological development, we are sure to see some exciting advancements in robotics and AI in the next few years.

[40] Rehabilitation robotics website; accessed 4/3/18.

[41] BBC News. "Google driverless cars free to public in Phoenix." BBC News Online, April 25, 2017; accessed 4/4/18.

X. 3D Printing

The use of additive manufacturing, commonly known as "3D printing," is growing across many industries. Analysts estimate the overall 3D printing market will reach $30.2 billion by 2022.[42] With the ongoing need to reduce healthcare costs, 3D printing has great potential to deliver high-quality, customized results in a cost-effective manner.

A 3D printer builds three-dimensional objects from a digital model by placing successive layers of material on top of one another. This "additive process" entails less waste than other manufacturing processes that rely on the removal of material by carving or drilling. To reduce costs, a 3D design can be refined on the computer or in prototype before production, and 3D printed items can be customized easily to fit users' specific requirements.[43]

In 2017, new advances in 3D printing were made when developers used a printing technique where the first component of a product could be printed *inside* the casing of a second component without the two pieces touching or being connected in any way. This new development means that gears within a sealed casing or electronics *inside* a container can now be 3D printed. With an increasing number of people using mobility devices like rolling walkers and wheelchairs, parts are sure to wear out and break, requiring repair. But in the past, replacing those parts could be time consuming and expensive. Today, a local DME provider with a computer and 3D printer could simply print the needed parts in a few hours and can have the repair completed in a day or two, rather than weeks. The cost of 3D printers has dropped dramatically in the last 5 years, to the point that a high quality, fast and accurate printer is now under $5,000 and is a reasonable investment for businesses that wish to support the LTSS community. With a variety of printing mediums ranging from plastic to wood to metal, it seems clear that 3D printing will play an increasing role in our lives and society.

Some of the most dramatic advances in 3D printing are in healthcare and things that affect every day living. Medical professionals increasingly explore 3D printing because it can cut costs and improves healthcare.[44] **Table IX** below shows just a few examples of 3D printing that help promote community living and independence.

[42] Markets and Markets. "3D Printing Market Worth 30.19 billion USD by 2022," press release issued in April 2016 on research report issued by Markets and Markets; accessed 4/3/18.
[43] Marlin Finance. Cost-Effective, Customized Healthcare with 3-D Printing. April 11, 2017; accessed 4/3/18.
[44] InformationWeek. "3D Printing Reshapes Healthcare," InformationWeek Online, 2014; accessed 4/4/18.

Table IX – Emerging Technology: 3D Printing – Community Living

Emerging Technology: ***3D Printing- Community Living***	**Description**
Prosthetics	Home printing of prosthetics is a growing phenomenon across the world. It's generally considered to have started when, in the early part of this century, a British man's son was born without fingers. A traditional prosthetic would have cost around $10,000 (at that time). The father was looking for a functional prosthetic hand for his son when he found an online video from an inventor who had created and posted free plans for a 3D printed prosthetic hand that anyone could make. The father reportedly spent approximately $2,000 to purchase the 3D printer, and about $10 on materials. He printed the model and gave his son a working hand. A teenager today, the son still likes to think of himself as a "Cyborg" and says that his friends at school think he looks cool, like a movie character. Not only does the hand work well, but the father loves the idea that he can customize it over time by printing a different finger or attachment for different tasks and it only costs him a few dollars. Thus, as his son ages, his 3D printed prosthetic hand has grown with him.[45]
Dentures	Dental implants and dental prosthetics are very costly. Most insurers, including Medicare (and most Medicaid programs) do not cover the cost of dentures. In 2016, the FDA approved 3D printing of partial dentures, using the same metal-free materials that dentists would normally use.[46] With an intra-oral scanner, the appropriate 3D software and a $5,000 printer, dentists can print a replacement crown, implant, or upper denture plate while the patient waits, and at far less expense than with traditional dentistry.[47] As this technology becomes mainstream, it should make dentures more affordable for and accessible to everyone.
Clip-On Cup Holder	A common but important addition to most wheelchairs and walkers is a cup holder. While typically not an expensive item, standard wheelchair cup holders still range from $6 - $40, with customized versions costing much more. However, with a 3D printer, some specialized printing plastic and about five hours (using open source plans), a cup holder in any color can be generated and customized to fit the user's mobility device and needs perfectly, at a cost just under $4.50 for materials.[48]

[45] Donnell, Peter. "Dad 3D Printed A Prosthetic Hand For His Son." eTeknix, 2014; accessed 4/3/18.
[46] Scott, Clare. "Arfona and Valplast International Corp. Unveil the r.Pod: New FFF Technology for 3D Printing Partial Dentures." 3D Print.com, Sep 23, 2016; accessed 4/3/18.
[47] Cook, Leslie. "3D Printing Helps Seniors." 3D Printing Informational, Op-Ed on 3D Universe.org, April 16, 2015; accessed 4/3/18.
[48] 3D Printer Chat. Blog: 3D Printing: 3D Printing for People with Disabilities. Available online as blog, webpage, and podcast; accessed 4/4/18.

Emerging Technology: *3D Printing- Community Living*	Description
Tactile Paintings and Books for the Blind	3D printing is used to produce tactile versions of famous paintings and picture books, meaning that anyone can now *feel* Mona Lisa's smile or George Washington crossing the Delaware, opening up an entire new world for those with visual impairments. Similarly, for blind children, finding tactile reading material is difficult, so the University of Colorado at Boulder has started the Tactile Picture Books Project, producing 3D printing files for popular children's books. Once printed, the books will have tactile pictures and braille and can be produced and read anywhere, unlocking the wonders of the printed word to children of all ages.[49]
Stress Reduction and Tactile Stimulation Toys	Some people with autism need a lot of tactile stimulation to help calm them. Others with Post Traumatic Stress Disorder (PTSD) and many with chronic pain can use a handheld fidget device to help relieve stress and refocus the mind when having a difficult time. For this type of sensory feedback, 3D printing can produce fidget "toys" that individuals can use to hold in their hand(s) or rub on their arms or body to calm themselves and take their mind off of the distressing situation or thoughts.[50] The device design and colors can be customized to the users' needs and preferences, and the low cost means individuals can have multiple devices for travel, home, school, etc.
3D Printed Food	When 3D printers started printing food, it looked colorful and had interesting shapes, but everything had the consistency of mashed potatoes and didn't taste as good. Today, 3D printing is on its way to the promise of sci-fi replicators! In addition to soft food and special diets, ready-to-bake cookies, pizzas, meat pies and scones are currently being printed for consumption in China and Australia.[51] As this technology and food variety and quality continues to develop, it could create a real option for increased independence for people with limited abilities to prepare meals or where there is a shortage of in-home workers.

It appears that the possibilities of 3D printing are limitless and that, with appropriate use, it can have a very positive impact for people who need LTSS.

XI. Tech Clothing

E-textiles, also known as tech clothing, smart garments, smart clothing, electronic textiles, smart textiles, or smart fabrics, are fabrics that enable digital components (including small computers), and electronics to be embedded in them.[52] This market is growing quickly, especially in exercise and performance sportswear. For the purposes of the Scan, however, we looked at examples of emerging tech-embedded or tech-enabled clothing designed to assist people with disabilities in

[49] Ibid.
[50] Ibid.
[51] Digital Trends. "From pixels to plate, food has become 3D printing's delicious new frontier." ; accessed 4/4/18.
[52] Wikipedia; accessed 4/4/18.

remaining independent and helping to support community living and integration. Promising examples of tech clothing are described in **Table X** below.

Table X – Emerging Technology: Tech Clothing

Emerging Technology: *Tech Clothing*	Description
Artificial Muscle Suits	For people with limited muscular function, artificial muscles that are silent, soft, and compliant, with performance characteristics similar to those of skeletal muscle, are the dream. By combining one of humankind's oldest technologies, weaving, with modern day high tech cellulose yarns and electroactive polymers, researchers have demonstrated the feasibility of wearable, soft artificial muscles. The newly created fabric has performed extremely well in tests for form and strain and has exhibited considerable structural stability. The textile can now be scaled for use as wearable artificial muscles, and enables novel ways to design assistive devices.[53] While this is still an emerging technology, and nothing is available on the market yet, the artificial muscle suit theorized is now a possibility for researchers and those with muscular limitations alike.
Self-Tying Adaptive Shoes	Initially conceived for kids who had trouble tying their shoes, a new concept of footwear for people of all ages was launched in 2017. The shoes are embedded with sensors, air bladders, and other technology so that when the wearer slips their foot into the shoe and steps on the heel, the shoe tightens around the foot and the laces snug up. While still considered somewhat of a concept piece, improved versions, styles, and reduced costs are expected in the future.[54] Donning shoes is a struggle faced by millions of people every day due to chronic disease, disability, injury, and even pregnancy. The creation of self-tying shoes will go a long way towards promoting independence for many individuals with LTSS needs.
Wearable Wi-Fi Hotspot and Air Purifier	Developers in Asia have created a prototype of a wearable Wi-Fi hotspot with GPS, music library, and air purifier built into an outfit. Electrical yarns are woven into the body and legs of the garments to create Wi-Fi capabilities, while the long sleeves and a hood are made from standard textiles. The air quality sensor at chest level is connected to a hidden platform chip that tracks and transmits data that counts the particles of carbon monoxide, methane and dust around the body, providing a portable option for people with respiratory issues.[55]

[53] Ali Maziz, Alessandro Concas, Alexandre Khaldi, Jonas Stålhand, et.al.. "Knitting and weaving artificial muscles." Science Advances 25 Jan 2017: Vol. 3, no. 1, e1600327, DOI: 10.1126/sciadv.1600327; accessed 4/4/18.

[54] Heater, Brian. For Nike, the HyperAdapt self-tying shoes are the first step toward something larger, 11/30/16; accessed 4/4/18.

[55] GPS World Staff. "The New Wearable? Clothing with GPS, Wi-Fi Woven In." GPS World, 12/2/14; accessed on 4/4/18.

As has been shown in the Scan, states are already using some technology to support community living among their LTSS populations, and there are some interesting and exciting emerging technologies that could prove to be of considerable assistance to people with LTSS needs. The following section looks to what lies ahead and considerations for states as they think about how to best leverage technology for the maximum benefit of the LTSS populations they serve.

Technology-Related Considerations and Looking Ahead

Technology has become an indispensable aspect of modern life. In addition to currently used approaches discussed in the first section of this document, new technologies continue to emerge that will likely improve the efficiency and quality of our lives. As states work towards maximizing opportunities for independence and community living for LTSS populations, they do so while also grappling with increasing workforce shortages, rising healthcare costs, and rapidly growing numbers of older adults and people with disabilities. Some states may look to leverage technology as a way to address these challenges and in doing so, will quickly realize that there are a number of policy and infrastructure issues to consider in order to take full advantage of the technological opportunities the future holds.

Technology-Related Considerations

In 2012, the Assistant Secretary for Planning and Evaluation, in the U.S. Department of Health and Human Services, identified many LTSS technology-related considerations and issued a report to Congress about "the potential use of new aging services technology to assist seniors, individuals with disabilities, and their caregivers throughout the aging process." [56] The report includes a detailed discussion about technology-related issues for the development and adoption of aging services technology. While the report focused on services to older adults, the challenges for states are very similar for all LTSS populations. Most of the challenges discussed in the report still hold true today and it can be instructive for states planning to add new technology to their LTSS systems to consider the following:

- **Lack of awareness** by individuals, providers, and policy makers about the existence of the technology and how it might help the LTSS population;
- **Lack of evidence** of the technology's effectiveness;
- **Stigma of needing assistance** is a challenge for technology users, especially when the technology in question is visible to others and indicates that the user needs extra assistance;
- **Privacy and security concerns** are important to technology users, providers, program administrators and policy makers, as individuals are increasingly aware of how much personal information is being shared with others and states need to ensure appropriate safeguards are in place;
- **Technology usability** is a challenge, because if, for example, the individual who is the intended user needs two hands to make the technology work, but usually has one hand occupied with the controls of their power chair, the best technology in the world is essentially useless to that individual;
- **Provider liability concerns** are real, can limit participation, and will likely require a multi-faceted approach to alleviate them; and

[56] Office of the Assistant Secretary for Planning and Evaluation, U.S. Dept. of Health and Human Services. Report to Congress: Aging Services Technology Study, June 2012; accessed 4/4/18.

- **Affordability** is an essential issue for most people needing LTSS, and many new and emerging technologies will likely be, at least initially, out of the financial reach of those who need them the most.

While several of these issues are partially or wholly within the state's purview to address, technology developers themselves will need to do more to provide the evidence base necessary for states to justify including specific technological modalities into their LTSS systems. Currently, many new and emerging technologies look promising but lack the peer reviewed research necessary to meet states' needs. Certain developers do, however, recognize the need to demonstrate the efficacy of their products and are diligently moving to conduct the necessary research. States should encourage such efforts and may be able to help ensure that developers are measuring the elements most useful to states by working with those involved in testing the effectiveness of the technology.

Technology Infrastructure

In addition to program and policy issues, preparing to incorporate new technologies may also mean that policy makers must contend with challenges related to their state's technological infrastructure. Beyond state and provider computer capacity (which may also need to be addressed), in order to be able to effectively use many of the emerging technologies noted in the Scan, a strong internet backbone, including affordable broadband accessibility, will be necessary. For mobile technology-based services, cellular service with adequate bandwidths to support an increase in user traffic will be essential. This could prove especially challenging for states with significant frontier, rural and/or tribal areas and populations.

Another aspect of a technological infrastructure that states may find helpful in order to leverage technologies of the future includes a modernized eligibility and enrollment system. As part of CMS' effort to support states in modernizing state Medicaid eligibility systems, a 2011 regulation was revised. On December 3, 2015, CMS issued a final rule titled: "Mechanized Claims Processing and Information Retrieval Systems (90/10) Final Rule (CMS 2392-F)." This rule indicates that "enhanced federal financial participation (FFP) will be available, under certain circumstances, for costs of such systems at a 90 percent federal match rate for design, development and installation (DDI) activities, and at a 75 percent federal match rate for maintenance and operations (M&O) activities." The final rule also extends this enhanced FFP through 2025.

"These changes will support states in developing more efficient Medicaid eligibility and enrollment systems, as well as Medicaid Management Information System (MMIS) claims systems, through initiatives such as automating the application and renewal process, processing claims more efficiently,

integrating with human services programs, retiring outdated legacy systems, and enhancing program reporting and management tools to support program integrity."[57] States should contact their CMS Regional Office for additional guidance.

Looking Ahead

The advancement of technology, and our increasing ability to leverage it to improve opportunities for community living and integration, is exciting! It is now possible to envision a future where people with blindness are able to drive themselves to work. We can imagine that a person with limited flexibility and mobility is able to dress themselves, including tying their own shoes. People who previously could not be verbally understood will find their voice through applications on their smartphone or tablet. We'll smile with joy as those with physical disabilities, dementia and other cognitive impairments delight in their virtual reality hot air balloon ride or visit to the Eiffel Tower. And finally, parents will beam with pride as they watch their 10-year old, who was born with one hand, catch a football using the prosthetic hand – 3D printed in his favorite team's colors – that he helped his dad make in their basement. But these technologies are already on their way. What comes next?

All of the areas noted in the Scan are experiencing dramatic growth, and new technologies are sure to emerge. While we are still a few years away from robots fixing us dinner and doing the laundry, the next 5-10 years will see major advances in AI and robotics. The latest development in human robotics with AI was introduced in 2017 and the robot's ability to learn is impressive. Virtual reality is another area that will continue to refine the quality and affordability of both the hardware and software available to mainstream America. Universities are currently researching virtual reality's effectiveness to reduce depression, isolation and promote a sense of well-being, especially among older adults with dementia. It's quite easy to envision the eventual widespread use of virtual reality in assisted living and skilled nursing facilities, by families caring for loved ones of all ages at home, and even by college freshmen (vision impaired or not) using online virtual maps to navigate their campus and new environment.

But the area that may experience the most dramatic growth in the near future is 3D printing. The Scan highlighted some of the emerging uses of 3D printing that can help promote community living. While not the focus of this Scan, researchers are also making significant advances in using 3D printing to address medical needs such as printing bones, skin, and organs. But other than medical use, what is the future of 3D printing? How about 4D printing?

The concept behind 4D printing is that at some future point, a 3D printed object will be able to automatically self-assemble or change shape when confronted with a change in its environment, such as temperature or moisture. This is the considered the "fourth dimension." This 4D technology is currently being pioneered and has wide-ranging implications for consumers and industries. What will a 4D printed item look like? Imagine a construction brick that is light as paper, only reaching its full weight

[57] Medicaid Program; Mechanized Claims Processing and Information Retrieval Systems (90/10): A Rule by the Centers for Medicare & Medicaid Services on 12/04/2015; accessed 4/4/18.

and structure after water is added to it, in the exact location where it will be used. Envision hydraulic pipes that automatically repair themselves within minutes of springing a leak. And get ready to wear sneakers that have rubber soles for hard surfaces and then grow cleats if you walk on grass. While this 4D technology is still under development, it promises to take 3D printing to an entirely new dimension. And when it does, imagine the possibilities for people with disabilities to more fully engage in their communities and in community living than ever before!

Conclusion

States and other stakeholders see the use of technology to promote community inclusion and community living as an issue facing state Medicaid agencies. As CMCS continues to seek ways to support states, this Scan was developed to help identify existing and emerging technologies used to support community living and integration. The Scan provides information on technologies that currently exist and how states are already using technology in community-based LTSS programs. It also includes information about new and emerging technologies that may prove useful to Medicaid agencies in promoting community living and inclusion. A discussion about the technology-related program and infrastructure issues that states will want to consider to successfully leverage evolving technologies, as well as information for states working to modernize their Medicaid eligibility and technology infrastructure has also been included. The Scan finishes with a brief look ahead at what is on the technology horizon that may help promote community living and integration.

Technology has become an indispensable aspect of modern life and holds the promise to provide even greater opportunities for dignity, independence, and community living and integration for LTSS populations. As states work towards maximizing these opportunities, they will face a number of program, policy and infrastructure issues in order to take advantage of emerging technologies. Without doubt, technology is advancing quickly and states that position themselves to benefit from the enormous opportunities ahead will be best able to meet the changing needs of their growing LTSS populations while managing workforce shortages and rising healthcare costs.