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The Cable Home is the Wellness and Telemedicine home – lets now deliver these new solutions

A Technical Paper prepared for SCTE by

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1. Executive summary

Telecom for Wellness (T4W) is a multi-trillion-dollar opportunity for cable operators. This opportunity begins with the connectivity and device base that is already in place and expands simply to move into new high-value revenue opportunities in the wellness, telemedicine, and aging-in-place markets. In this paper, we analyze different in-home networking architectures that can be added to the existing Broadband and Wireless networks in the home to support T4W services such as Aging in Place (AIP) and Telehealth. To minimize CapEx investment for this new service evolution we will show how the existing infrastructure can support sensor-based networks, audio networks, video networks, and IoT for medical device networks in a simple incremental architecture from today's quad-play services. The paper will provide an analysis of the home networking components needed for the AIP and Telehealth applications to overlay into existing backend services, processes, and even technician in-home support. This paper will leverage the work done within SCTE Working Groups to derive an outline of the standardization of cable industry premises devices with wellness capabilities used for T4W services. It will highlight the interfaces for wellness solutions to be added to Broadband Gateways, STBs to provide access to resources like BLE and Wi-Fi, such as simple secure onboarding, messages and notifications on the TV / Video and Audio networks. It will also look at the cloud-to-cloud interfaces that can be standardized to allow partnerships between Service Providers and Cloud wellness partners to create inter-industry opportunities.

2. Introduction

The Wellness industry is going through a major transformation to modernize the infrastructure, reduce the cost and increase the quality of care. In a series of articles, we have suggested how the Telecom industry can assist the Wellness industry(Refer to [1], [2], [3], [4], [5], [6], [7]). We call this inter-industry collaboration Telecom for Wellness (T4W). Even though the T4W opportunity is not limited to these two major intersection points ([13]), we focus on Aging in Place (AIP) and Telehealth use cases to illustrate our thoughts on the end-to-end T4W architecture in [8]. (Refer to [9] for six different opportunities that a Telecom operator can address through the T4W architecture covered in this paper.) The SCTE Data Standards Subcommittee, of which the authors are members, is actively working on T4W solutions for the AIP and Telehealth areas in working groups three [10] and four [11].

[1], [2] provides a quick summary of the T4W opportunity and challenges from AIP and Telehealth points of view. Many of the needs, challenges, and Telecom opportunities of both markets are similar (refer to the SCTE working group analysis at [10], [11]). Some of the high-level use cases that need to be supported for these two markets include:

	Aging in Place	Telehealth
Users	Older adults (65+), caregivers	Individuals, providers
Stakeholders	Family members, care givers, doctors, service personnel etc.	All family members, providers, (payors)
Needs	Communicating, monitoring, service, support, integration	Communicating, monitoring, integrating with provider systems
Challenges	Ease of use, provider network integration, problem solving	Ease of use, device and EMR integration, remote monitoring,
Telecom opportunity	End to end solution, managed services, provider integration	End to end solution, managed services, provider integration

Figure 1 Telecom for Healthcare opportunity and challenges summary

A. Providing basic communication between the users and the providers/caregivers
B. Providing seamless communication between the users and the stakeholders
C. Monitoring the users for health, mobility, fall detection, etc.
D. Analyzing the data collected from the users and properly notifying the stakeholders
E. Assisting the T4W service providers with claims by documenting accountability
F. Offering managed services to support installations, product support, and other services to improve adoption and retain customers

Many of these use cases are elaborated on in [9]. In the use cases paper, we presented AIP, independent living, and hospital at-home use cases (the extreme ends of the T4W) with the consideration on what are the opportunities for the cable operators.

In the next sections, we summarize the T4W architectural needs, provide a framework, discuss individual components, and start discussing the **sensor network gateway** concept.

3. End-to-end high-level T4W architecture

Figure 2 provides a high-level end-to-end architecture proposed by Duke Tech Solutions (DTS) in their market analysis [13] based on different T4W market opportunities. The framework is elaborated in [8].

To understand the end-to-end T4W architecture, first, we need to understand the users, the service providers, and the other stakeholders as shown in Figure 1. We adopt the architectural framework provided in [8], DTS's Telecom for Wellness Environment Framework (DTEF), to evaluate the in-home components proposed in this paper. We will use AIP and Telehealth use cases (as provided in section 2) to do this.

1. In-home healthcare/wellness aware gateway: From use cases A, B, and C, it is clear that there needs to be a gateway in the T4W home. This gateway, as shown in Figure 2, acts as an integration point for monitoring the sensor devices (e.g., motion sensors, remote patient

monitoring equipment) and integrating with the interactive services endpoints (such as unified communication services). This **Sensor Network Gateway** (SNG) can be a standalone device or integrated with other vendor equipment such as the set-top box or residential gateway. In this paper, we treat it as a logically separate device.

2. T4W aware network infrastructure: Again from the use cases A, B, and C it is clear that the T4W requires connections between the users, the providers, and the other stakeholders. This requires not only reusing the existing telecom infrastructure but will also need to meet reliability, security, and privacy requirements specified by the T4W architecture. The communications infrastructure will have to meet the needs of the sensor network traffic, unified communications traffic, and notifications to the different stakeholders. To differentiate (or to keep the focus on) the T4W needs, we call this the **T4W Sensor Network Infrastructure**.

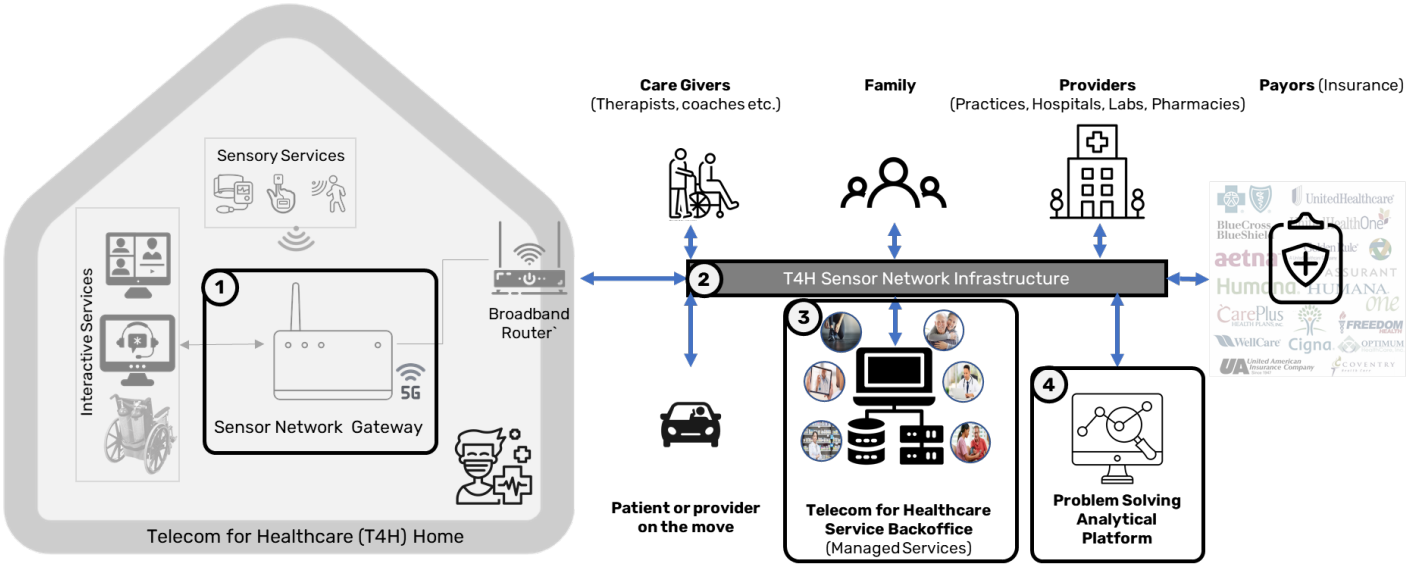


Figure 2 DTS's Telecom for Wellness Environment Framework (DTEF) based components

3. T4W aware service back office: The cable operators have all the required infrastructure for managing end-to-end services. As mentioned in use case F, it is essential to turn the fragmented, gadget-oriented point solutions into a well-oiled managed service. This can only be accomplished by Telecom operators who have access to such infrastructure and have been managing communications infrastructure for 90+% of the households in the US. We call such infrastructure as **T4W Service Backoffice**.
4. T4W aware problem solving analytical platform: Finally, as mentioned in use cases D and E, this infrastructure attempts to solve the problems stakeholders are facing. These problems and related algorithms may be unique to the healthcare/wellness industry, but the infrastructure is similar to the infrastructure the telecom operators use today. We call this repurposed analytical platform the **T4W Problem Solving Analytical Platform**.

In the following sections, we highlight the sensor network gateway's hardware, software, and cloud interface needs to enable inter-industry opportunities.

4. Sensor network gateway components

Figure 3 shows different tasks that need to be done in a T4W capable home, as briefly discussed below:

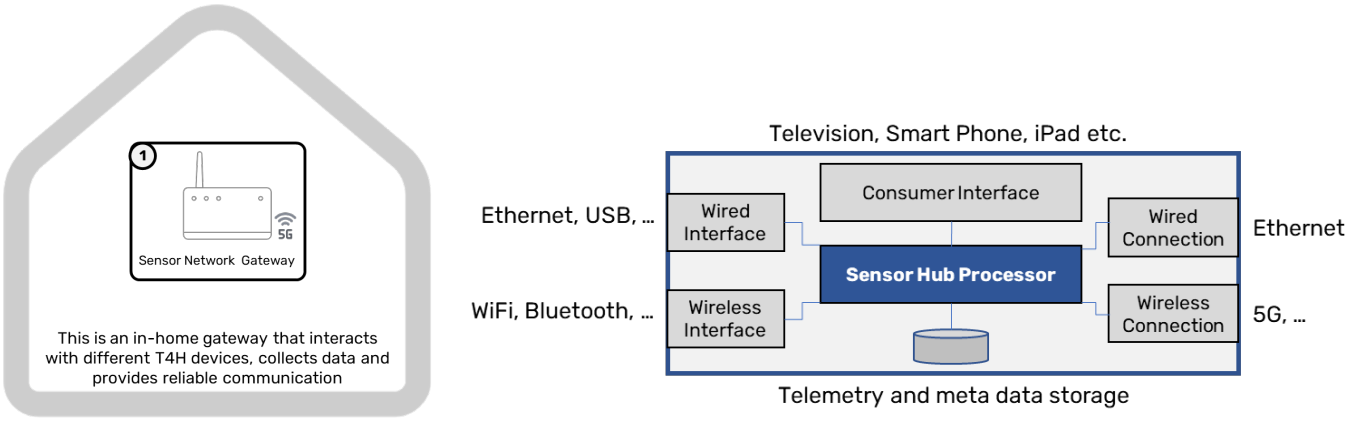


Figure 3 Sensor Network Gateway architecture

- Support for different data streams: The AIP and Telehealth infrastructure needs to support typical data streams generated in a T4W home. These include sensor and actuator data streams, streams to record events, and real-time streams such as video and audio communication between T4W stakeholders.
- Communication with existing in-home broadband devices: These might include consumer consoles (such as TVs or smart speakers), and smart home devices (such as smart locks, lights, or video doorbells). To increase the adoption of T4W solutions and for ease of use, the T4W in-home components need to be on the same logical network.
    - The T4W physical networking can be dependent upon the use case for any particular device. Most components are likely best connected with an in-home broadband network, but certain devices (such as a locator device) may need to be connected even if the user is beyond the limits of the in-home network. The important thing is that the networked devices can communicate with each other on a secure logical network. Critical components may require a secondary backup network connection in case the primary network fails. Cloud-based services also protect against exclusive dependency on the in-home network.
    - The in-home solutions shall integrate remote patient monitoring devices, sensor devices (such as fall detection, motion sensors, etc.), and other IoT devices that are used for wellness needs.
    - Additionally (to increase the utility and ease of use of the system), the T4W solutions shall be integrated with the frequently used consumer consoles (such as Television for the elderly), smartphones, and other handheld devices. Again, a cloud-based solution simplifies an experience that can be duplicated on whatever console is convenient.
- Provide installation and support services: The operator shall also streamline the installation and support services to improve the ease of use of the integrated solution.

4.1. Hardware and software components

As shown in Figure 4, the cable operators already have been deploying many standardized protocols, interfaces, and devices for different in-home solutions. Extending them to T4W solutions will be a natural extension for them. But they have to offer many subtle features to be adopted by the wellness industry. These extensions are elaborated on in the following section. The required tasks of the solution are broken into the device-facing interface, network connectivity interface, in-home controller interface, internal

capabilities, and inter-industry collaboration interfaces (represented by the Cloud2Cloud interface in the figure).

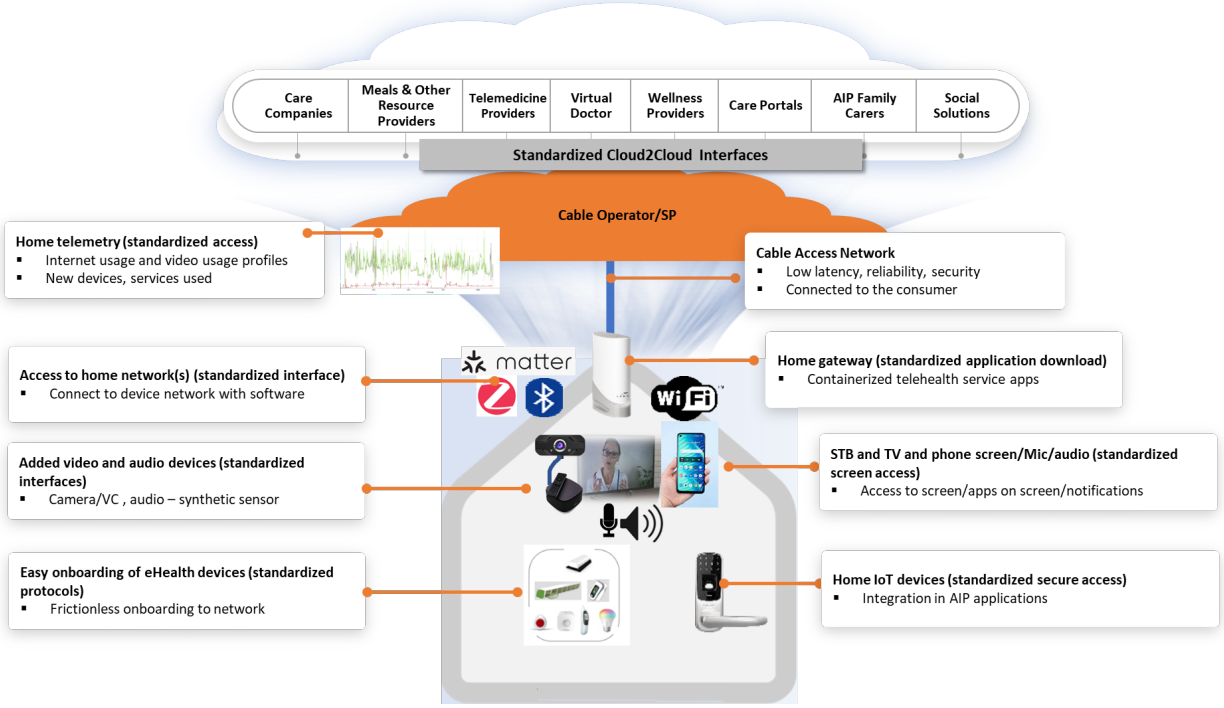
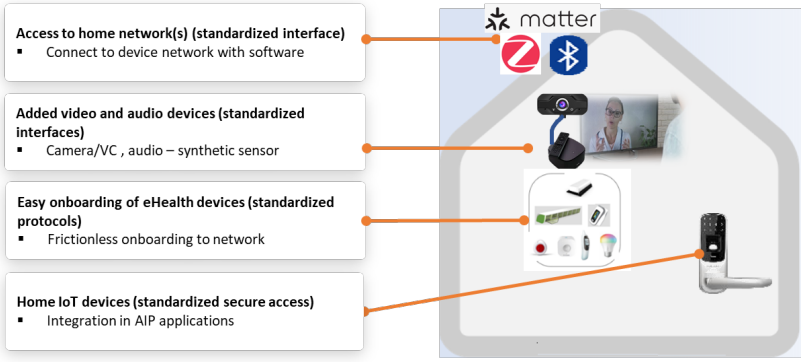


Figure 4 Unifying the wellness resources with the in-home and access networks

4.1.1. Device facing interface

Based on the above high-level needs, we propose that a Sensor Network Gateway (SNG) functionality be developed for supporting T4W solutions. The block diagram of such a gateway is presented in Figure 3 with a bit more details and how it interacts with other devices visually in Figure 4. This gateway will have wired (Ethernet, USB, etc.) and wireless (Wi-Fi, Bluetooth, BLE, etc.) interfaces to integrate the T4W devices and other IoT devices (such as turning on a light, placing a phone call to a family member). Note that if the SNG functionality is integrated with the residential gateway these requirements apply to the residential gateway.



Functionalities

At a broad level, there will be two types of southbound facing devices to the SNG. These are the two-way communication devices such as the devices used for Telehealth and the one-way communication devices such as sensor devices used typically for monitoring. The following discussion applies to both such categories.

The SNG should have the device-facing capabilities to:

- **Register** a new device and **onboard** with proper credentials before letting it use the network
- Learn the **capabilities** of the device as part of the device registration
- **Authenticate** a device against the registered credentials
- **Detect** the wired and wireless devices when they either come alive or connected
- **Securely** communicate with the device for different information exchanges for status gathering, data collection, etc.
- Identify the **status** and different levels of availability of the device during the communication.
- **Collect** on-demand and continuous **data** from the device

Types of interfaces

The SNG will act as a gateway to the T4W applications. This requires the SNG to support some of the following interfaces. Note that only some of the interfaces are required depending on the positioning of the SNG. It is not in the scope of this document to provide the number of such interfaces.

The SNG should support the device-facing (Note that it is not in the scope of this paper to recommend one protocol or the other):

- **Wired** interfaces such as Ethernet or USB connection with potential hub functionality
- **Wireless** interfaces such as Wi-Fi, Bluetooth, BLE, Matter, etc. with potential hub functionality

Serviceability

The serviceability of the SNG and its subtended devices are essential for making the T4W services more sustainable. In this section, we highlight the serviceability needs of the subtended devices.

The SNG should support different protocol serviceability constructs such as:

- **Monitoring the reachability/connectivity** status of different wired and wireless devices
- **Debugging the connectivity** and other **serviceability** issues for the subtending devices

Other requirements

Other requirements from the SNG towards the device interface include:

- **Charging** the connected devices where possible for high-priority devices, and

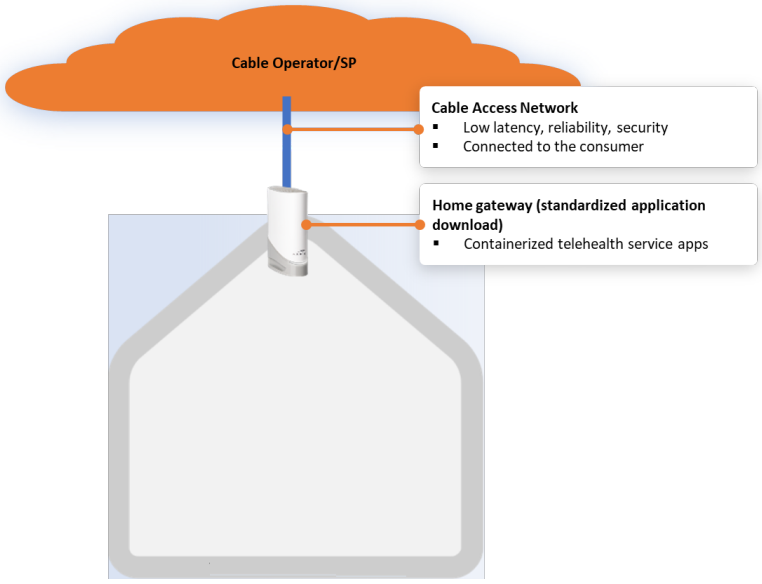
4.1.2. Network connectivity interface

The gateway shall provide high-quality redundant Internet connectivity such as with an Ethernet interface to wired broadband and a 5G or other wireless connection as a backup.

Functionalities

The SNG will have northbound facing internet connectivity for providing access to the network or for in-home devices. The following discussion applies to both such categories of connectivity.

The SNG should have the network-facing capabilities to:



- Provide **high-quality differentiated communication** based on the priority of the application
- Offer differentiated services to both for **one way and two-way communications**
- Provide **high availability connectivity** based on the importance of the communication (for example, backup the cable connectivity with the 5G connectivity for some of the sensor devices as opposed to the Telehealth video communication solutions)
- Provide per **session-based secure communications** at the device level (Note that there may be multiple stakeholders for every session)

Types of interfaces

The SNG should support Quality of Service (QoS) supported redundant interfaces for high availability connectivity, such as:

- A **wired primary interface** for high QoS enabled interface (for example, Ethernet, DOCSIS, PON based)
- A **wireless secondary interface** (for example, 5G interface) for high-priority traffic communication during primary interface failure
- A **failover mechanism** that provides the service continuity protection for high-priority traffic during primary interface failures

Serviceability

The SNG should support different techniques to monitor and test service continuity, such as

- Remote access loopbacks (e.g., using 802.1x)
- Service level network connectivity polling

Interaction with other northbound interfaces

In addition, the SNG should interface with different in-home components, such as

- The **wiring closet**, as discussed in [14]
- The **broadband router**, if SNG is not integrated into the router, and

- An external or internal device that provides a failover redundant communication

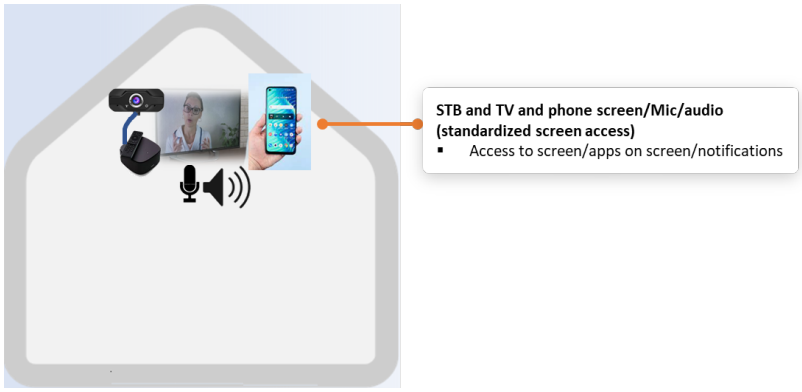
Other requirements

The SNG and its downstream applications may also require an accurate time of day and date. This can only be achieved if the SNG has access to the

- Network timing information through the timing protocols as a pass-through from the router

4.1.3. In-home controller interface

The SNG will also need to integrate the consumer access interfaces (TVs, smartphones, iPads, etc.) to increase the adoption of the T4W applications.



Functionalities

The SNG functionality and many other T4W solutions require some of the following functionalities for ease of use. The SNG should

- Provide **video console** (such as TVs, iPads, etc.) **integration** to offer as a console to the management of the T4W services.
  - This includes all the unified communication aspects of the interactions such as the notifications, two-way conversations, and certain process flows such as interrupting the activity that is being performed on the video console.
- Interact with an **easy-to-use remote controller** to manage the on-screen process flows
- Offer, where possible, **voice-enabled interactions** with the SNG
- Be able to **split the feeds among the stakeholders, on-demand** basis, based on the stakeholder privileges

Types of interfaces

The SNG shall offer different interfaces to communicate with the in-home controller device. It should

- Provide a **wired interface** to connect with the video console (such as USB, Ethernet, etc.)
- Provide a **wireless interface** to connect with the video console (such as discovering and connecting to the Smart TV over Wi-Fi)

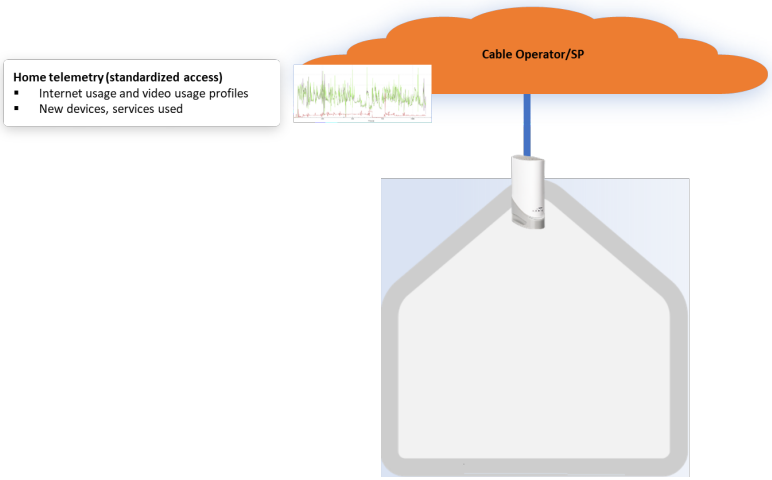
Serviceability and debugging

The SNG should extend the service continuity evaluation to the in-home controller interface for ease of service assurance.

4.1.4. Internal functionalities

The SNG will need limited internal storage for the temporary storage of sensor data and to perform local analytics on time-critical events. The gateway shall offer an easy installation process and support self-install where possible.

Functionalities



The SNG should

- **Register** the gateway device with the T4W platform for different service capabilities that it can enable and is allowed to perform
- Provide support for the **unique addressability of the device** (IP address, etc.)
- Be capable of providing different **QoS** marking, prioritization, and fulfillment capabilities
- Be capable of **self-installing** during initial bootstrapping and later during the upgrading
- Provide a **management interface** to configure and manage different features of the device
- Provide **extensive stats collection** capabilities as highlighted in [12]
- Support some **basic analytics** to perform local analysis and notification capabilities
- **Store and provide access** to the information collected for at least **one day** in case of loss of internet connectivity

Types of interfaces

The SNG should

- Support **service** (a physical or a logical) **interface** to access the management interface
- Support a local **interface** for the field technician if the device is not reachable through the internet
- Allow **access to different debugging tools and statistics** that are collected on the gateway

Other requirements

The SNG should support

- AC and DC power with potential for battery backup based on the scope of the product

4.2. Inter-industry collaboration interfaces

The SNG is the customer-facing part of the end-to-end Telecom for Wellness solutions as shown in Figure 2. A cable operator or someone working along with the operator can create a platform with these components. Once the platform is created, it can be used to enable different stakeholders and solve their problems, and also can be used as a conduit for different services from other value-added wellness-related service providers.

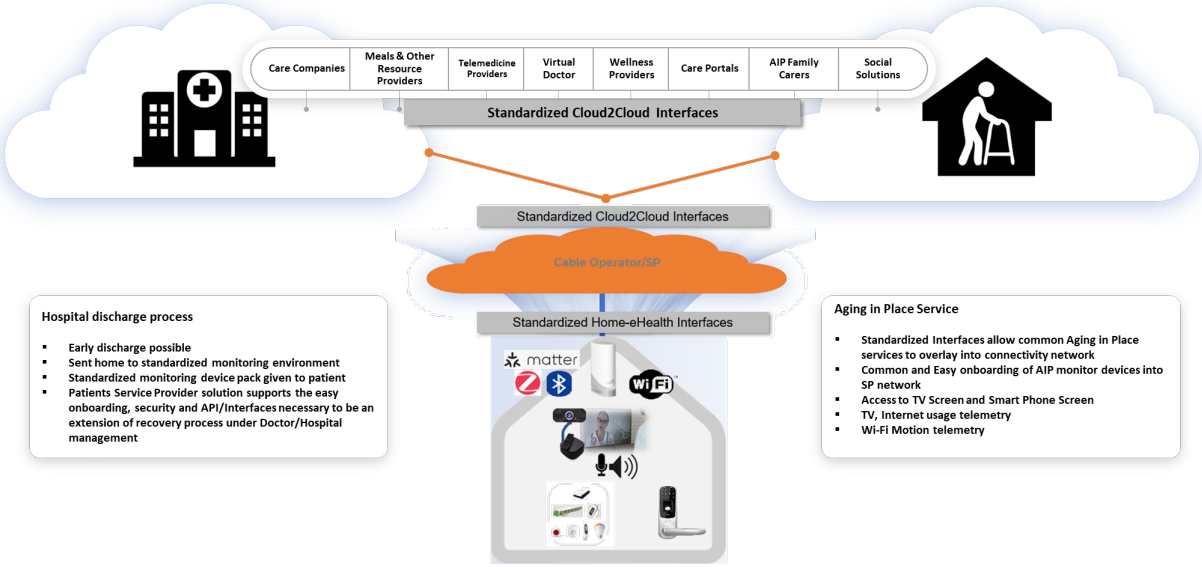


Figure 5 Making a home an extension of Telehealth services through standardized interfaces

The T4W provider can offer this platform for internal use and to the marketplace of the service providers through a set of services. Figure 5 provides two such use cases that can be enabled using an inter-industry collaboration. More information on these use cases and the opportunity for the cable operators are detailed in [9]. The SNG will in this case work as the subtended device in the house for the set of newer services. In this case, the SNG and the cloud platform shall support the following functionality through different service enablement constructs:

- Faster service enablement
  - **Onboarding** newer service providers
  - Establishing the service capabilities with the **same look and feel**
  - Creating constructs for **single billing** capabilities
  - **Extending** the proposed **serviceability interface** to the external service providers
- Knowledge sharing
  - Enabling **access to different monitoring** points based on the registration
  - Creating different status monitoring and **data collection points per service** (or provider)
  - Setting threshold crossing alarms and providing **access to those notifications**
- Giving access to the T4W platform's problem-solving infrastructure based on the service agreements
- Enable cloud-to-cloud interface between service providers through standardized interfaces

5. Conclusions and recommendations

As presented in the previous papers, T4W is a multi-trillion dollar opportunity for cable operators. In this paper, we extended the details of the DTEF framework's in-home component, namely the SNG, requirements to enable T4W. These requirements highlighted can be implemented in a standalone device or the functionalities can be integrated with one of the intelligent in-home devices (such as a residential gateway or a Set Top Box). The cable industry and partners are uniquely positioned to standardize and

implement such solutions with their ubiquitous presence, in-home deployments, service management workforce, and end-to-end infrastructure. To bring this opportunity to life, we recommend developing standardized SNG solutions that

- Enables different one-way and two-way communicating devices,
- Offers standardized, redundant north-bound interface,
- Provides an in-home customer (and their service) management interface,
- Offers constructs to different data collection, problem-solving, and management of the device
- Provides standardized cloud-to-cloud interfaces to enable inter-industry collaborations

We would like the cable operator ecosystem to actively engage with us at the SCTE working groups, implement these solutions and enable the Telecom for Wellness opportunities.

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