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End to End Telecom for Healthcare Architecture

A Cable Industry Perspective

A Technical Paper prepared for SCTE by

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Table of Contents

Title **Page Number**

List of Figures

Title **Page Number**

1. Executive summary

The COVID-19 pandemic forced people to consider new ways to manage healthcare and wellness care. One of the first places people turned was to online solutions. Video conferencing provided a way for physicians and other healthcare workers to provide remote care for patients even though opportunities for meeting in-person were limited. This provided a basic form of Telehealth. Many people had to manage their personal health and wellness conditions while primarily remaining at home. Again, network connectivity became essential for these rudimentary Aging in Place (AIP) use cases. While people relied on networking services, most did not really take advantage of the true possibilities of networked services. There are numerous networked sensors available that can measure many important parameters. There are smart home devices that can automate common tasks. More importantly, networks of family, friends and caregivers can be provided with information and contacted under common management. AIP and Telehealth has not nearly met its potential. This is an opportunity for cable operators. While there are piece parts that are available from specialists for smart home components, health management and communication, nobody has yet really integrated these parts into a cohesive service. Cable operators provide networking services to the home, work with existing familiar interfaces (like television) and aggregate services for consumers as core competencies. Therefore, cable operators are well-positioned to work with various partners to provide complete integrated AIP and Telehealth packages. This can increase convenience, reduce costs and improve care for all stakeholders in the healthcare value chain.

2. Introduction

The Healthcare 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 Healthcare industry [1][2][3]. We call this inter-industry collaboration Telecom for Healthcare (T4H). Even though the T4H opportunity is not limited to these two major intersection points, we focus on Aging in Place (AIP) and Telehealth use cases to illustrate our thoughts on the end-to-end T4H architecture. (Refer to [4] for six different opportunities that a Telecom operator can address through the T4H architecture covered in this paper.) The SCTE Data Standards Subcommittee, in which the authors are members, is actively working on T4H solutions for the AIP and Telehealth areas in working groups three [5] and four [6].

Figure 1 provides a quick summary of the T4H 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 [5][6]). Some of the high-level use cases that need to be supported for these two markets include:

A. Providing basic communication between the subscribers (users) and the providers/caregivers
B. Providing seamless communication between the users and the stakeholders
C. Monitoring the subscribers (users) for health, mobility, fall detection, etc.
D. Analyzing the data collected from the subscribers (users) and properly notifying the stakeholders
E. Assisting the T4H 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

The goal of the paper is not to elaborate on the use cases but to use them to motivate the end-to-end architecture. For additional information refer to the working group documents.

In the next sections, we elaborate on the T4H architectural needs, provide a framework, discuss details on individual components, summarize the findings and propose next steps.

3. End-to-end high-level T4H architecture

Figure 2 provides a high-level end-to-end architecture proposed by Duke Tech Solutions (DTS) in their market analysis [4] based on different T4H market opportunities. The framework is further elaborated in this paper with a second level of architectural details.

To understand the end-to-end T4H architecture, first, we need to understand the users, the service providers, and the other stakeholders (refer to Figure 1).

	Aging in Place	Telehealth
Subscribers (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

Subscriber or Users: These are the folks who are the primary subjects of the T4H platform. For AIP, the elders who are aging at home are the primary users. The service infrastructure revolves around the elder's needs in the AIP use cases. For Telehealth, the users are typically the family members who are using the T4H platform at home or the patients who use the platform in the care centers (such as Veterans Administration (VA) satellite healthcare facilities [7]).

- Service providers: In the traditional healthcare industry physicians and nurses in offices and hospital systems are primary service providers. In the proposed T4H emerging system, the intent is to go beyond healthcare to wellness. Here it is important to realize that doctors are not the sole provider of wellness services. Hence, we introduce the concept of T4H service providers. For AIP the service providers include the caregivers (both healthcare and non-healthcare related), network providers and technicians. For Telehealth use cases, doctors are still included. This distinction is important for understanding the relationship between the users and the service providers from different architectural points of view.
- Other stakeholders: In the T4H environment, other stakeholders are also interested in the wellness of the users. These include, for example, family members, friends, and payors.

Understanding the classification of different stakeholders, we proceed with an explanation of the components in the T4H solution. We adopt the architectural framework provided in [4], DTS's Telecom for Healthcare Environment Framework (DTEF), to evaluate the end-to-end solution components proposed in this paper. We will use AIP and Telehealth use cases (as provided in section 2) in oder to do this.

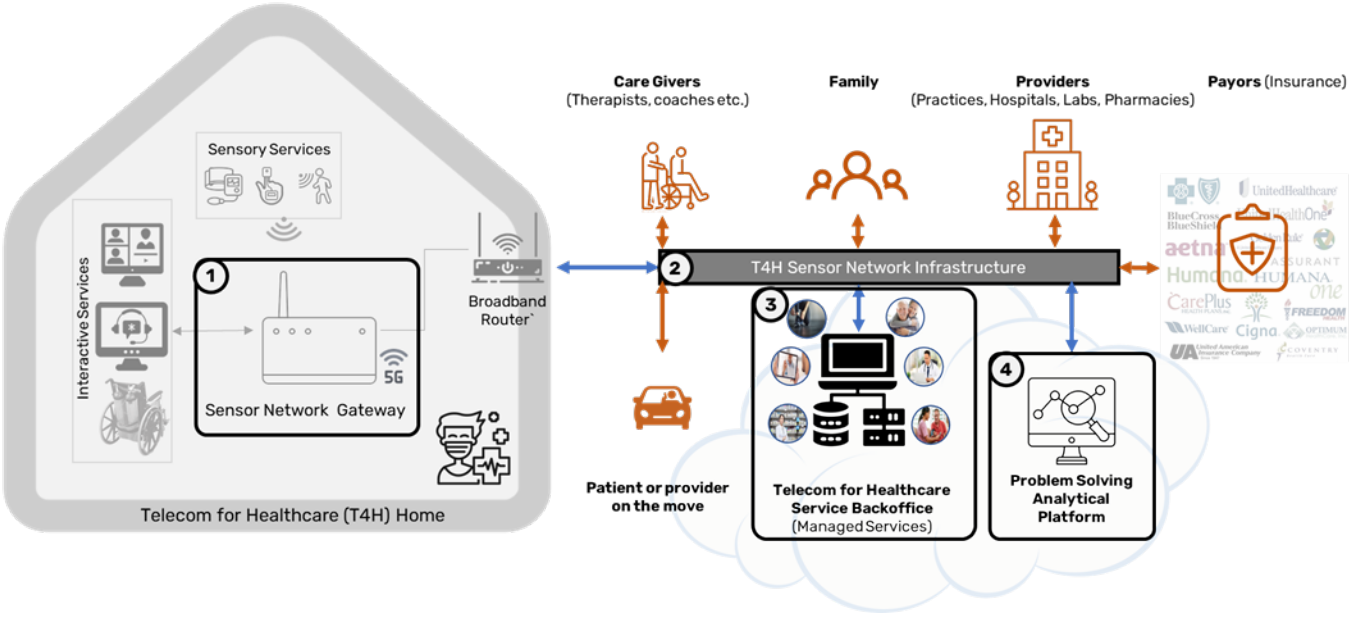

Figure 2 - DTS's Telecom for Healthcare Environment Framework (DTEF) based components

1. In-home healthcare/wellness aware gateway: From use cases A, B, C, it is clear that there needs to be a gateway in the T4H 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** 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. T4H aware network infrastructure: Again from the use cases A, B, C it is clear that the T4H requires to connections between the users, the providers, and the other stakeholders. This requires not only reusing the exiting telecom infrastructure, but will also need to meet reliability, security and privacy requirements specified by the T4H 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 T4H needs, we call this the **T4H Sensor Network Infrastructure**.
3. T4H 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 **T4H Service Backoffice**.

4. T4H 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 infrastructure the telecom operators use today. We call this repurposed analytical platform the **T4H Problem Solving Analytical Platform**.

These solution components are explained in the following sections. Note that in this paper we provide a block diagram level architecture. The detailed architectural specifications will be worked out in more detail at the SCTE DSS WG3 [5] and WG4 [6].

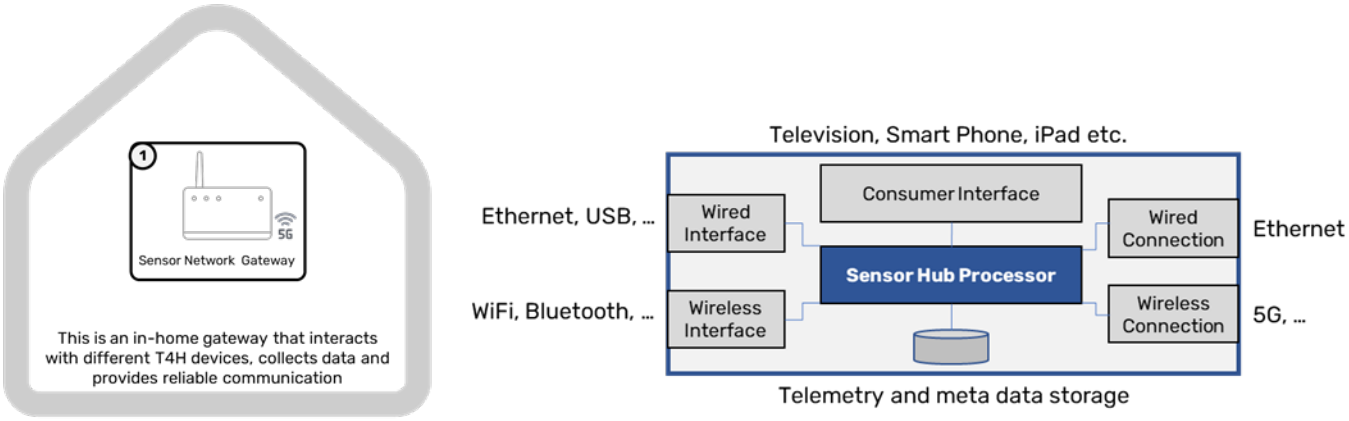

Figure 3 - Sensor Network Gateway architecture

4. In-home T4H architectural components

Figure 2 shows different tasks that need to be done in a T4H capable home. These tasks include:

- Support for different data streams: The AIP and Telehealth infrastructure needs to support typical data streams generated in a T4H home. These include sensor and actuator data streams, streams to record events and real-time streams such as video and audio communication between T4H 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 T4H solutions and for ease of use, the T4H in-home components need to be on the same logical network.

- The T4H 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 T4H 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 and 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.

Based on the above high-level needs, we propose that a Sensor Network Gateway functionality be developed for supporting T4H solutions. The block diagram of such a gateway is presented in Figure 3. This gateway will have wired (Ethernet, USB, etc.) and wireless (WiFi, Bluetooth, BLE, etc.) interfaces to integrate the T4H devices and other IoT devices (such as turning on light, placing a phone call to the family member). They will need limited internal storage for the temporary storage of sensor data and to perform local analytics on time-critical events. The gateway will also need to integrate the consumer access interfaces (TVs, smartphones, iPads, etc.). The gateway shall provide redundant Internet connectivity with an Ethernet interface to wired broadband and a 5G or other wireless connection as a backup. The gateway shall offer an easy installation process and support self-install where possible.

5. T4H communication architecture

Although cable operators already own a capable end-to-end Telecom infrastructure, it may need to be adapted to meet T4H needs. That is the focus of this paper. The T4H sensor network infrastructure is used to provide communication between stakeholders and users, to collect in-home sensor information, to provide intelligent notifications, and to offer T4H managed services. This infrastructure, as shown in Figure 4, will be used in the T4H case for the following:

- Unified communications infrastructure: This is the collaborative software (similar to [8]) that is used to create a communication environment for different players in the T4H ecosystem. The challenge of offering UCC software is the ability to scale it to the individual consumer level and

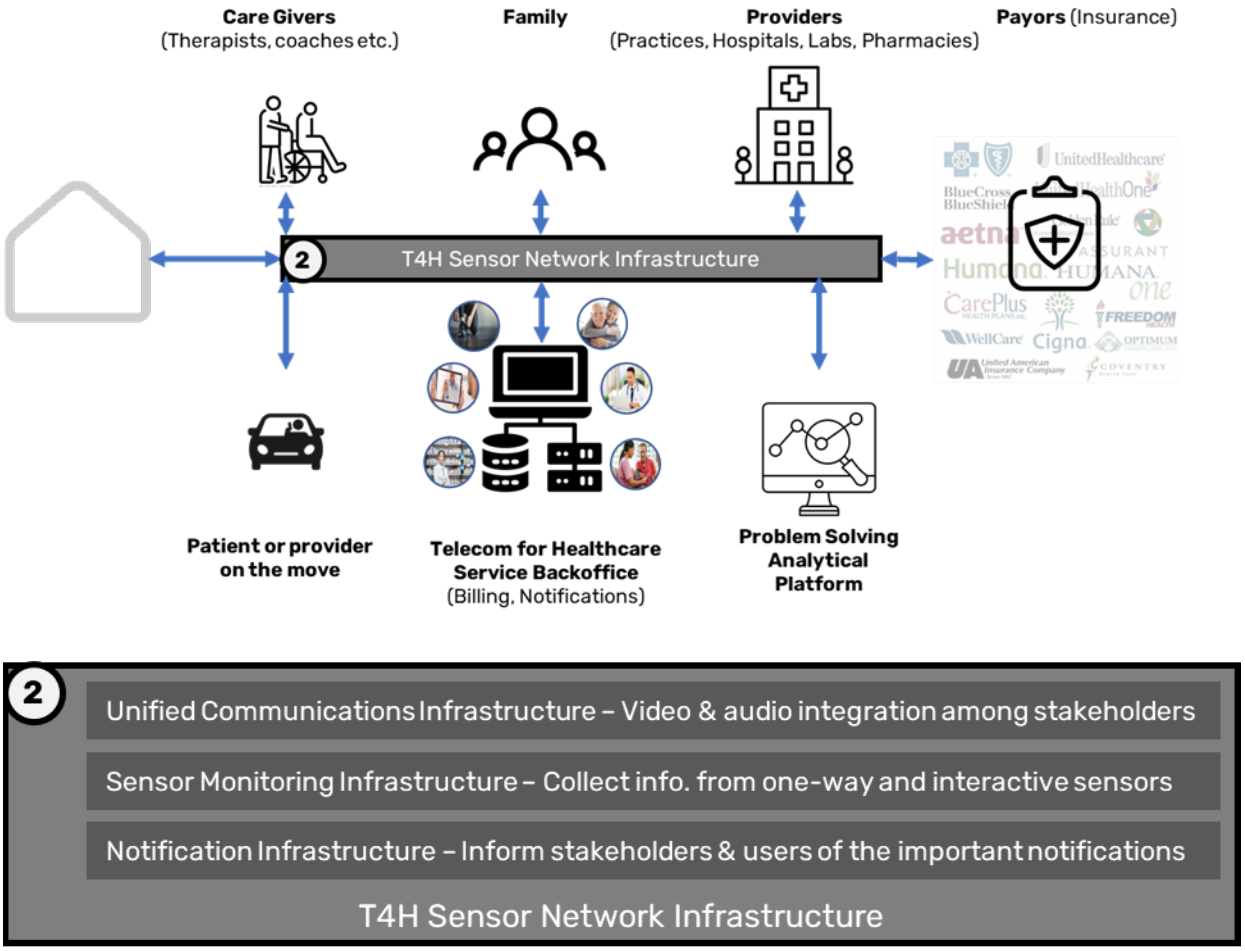

Figure 4 - UCC, sensor monitoring, and notification traffic on T4H Network Infrastructure

still host it for a large volume of deployments. Current UCC software may need to be enhanced for the healthcare market in order to be compliant with HIPAA. UCC software must seamlessly offer secure communication between parties in the communication session and still provide privacy to protect the shared and recorded content. Launching the UCC solution on different consoles (such as TVs, smart devices, etc.) is also an important requirement.

- Sensor monitoring infrastructure: This is a stream of information coming from the T4H from sensor devices. The traffic can be from remote patient monitoring (RPM) devices (typically medical devices), and other sensory devices (such as motion sensors, door openers, etc.) used for both AIP and Telehealth. The communication infrastructure will need to assist in bringing the devices online, providing secure communication of the information to the analytical platform, and potentially track metadata from the sensor devices. The platform must implement HIPAA requirements and offer privacy similar to what operators provide for PII. In healthcare, privacy extends to PHI (Personally identifiable Healthcare Information). Note that the overall QoE (Quality of Experience) for such streams is essential to understand. We refer you to [9] for our preliminary thoughts on consumption patterns for the T4H data.
- Notification infrastructure: The other major data streams included in the T4H communication infrastructure are the notifications. To enable this notification infrastructure, the endpoints (stakeholder, software, etc.) shall be registered to receive specific events. The infrastructure will

need to provide secure communication between the communication platform and the stakeholders.

6. T4H service back-office architecture

The T4H service back office, as shown in Figure 5, is used for providing managed T4H services. This includes installation, support, troubleshooting, connectivity management, billing, and more importantly business rule management. Note: The Cable operators already have much of the T4H infrastructure in place for managing their existing broadband and other in-home services. In the remainder of this section (as shown in Figure 6) we provide a discussion on what tasks need to be completed in order to implement the above-mentioned service components. We also discuss why cable operators are suitable for providing these services and what additional capabilities they need to develop.

- Connectivity management: The operator needs to manage basic connectivity services. These include the UCC, in-home sensor devices, notifications, etc. Cable operators have already been

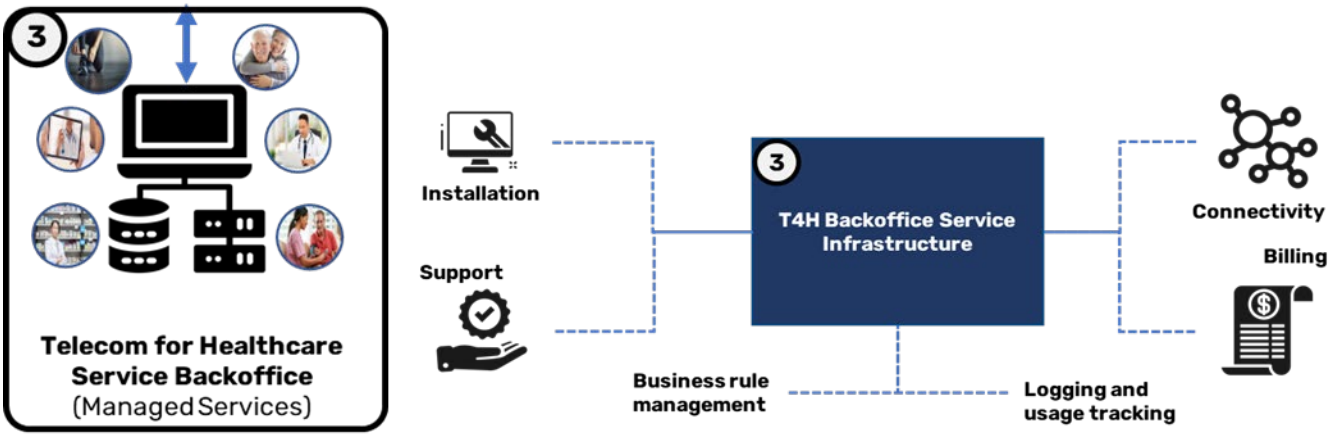

Figure 5 T4H service back-office infrastructure components

- managing such in-home services in many cases. Lately, operators are assuming the management of more extended services such as video surveillance, IoT-based services, etc. for a large customer base. The connectivity services that are offered to regular customers need to be extended for T4H services.
- Business rule management: Managing T4H customers, stakeholders, and service providers is done through business rules. This requirement will add new rules-based management. These include the user service enablement, the stakeholder notification management, and other per user management. This is similar to the Cable operator subscriber management. The cable operators have been managing such business/subscriber rules for more than 70M subscribers in the US. Extending similar concepts to T4H healthcare/wellness needs is the new challenge that cable operators face.
- Logging capabilities: Metadata and telemetry data collection are essential for T4H services. This data is required to enable new problem-solving capabilities for AIP and telehealth use cases. Additional information on such data gathering requirements can be found in [10]. Cable operators are used to gathering and analyzing gigabytes of customer and network-specific daily data. Extending the same capability for T4H services is a new opportunity and challenge for cable operators.

- Installation and support services: One major issue facing the T4H industry is their fragmented way of handling the market space. No single company is responsible for the quality of care. We recommend that Telecom companies extend their installation and support services to include T4H. Refer to [2][3] for the business case behind such an offering. Cable operator's experience in providing end-to-end installation services, their service assurance tools, and their "boots on the ground" to manage on-premise services can be effectively leveraged to support T4H services. This will require cable operators to expand the use of some tools and train additional teams to handle T4H services.
- Billing services: One of the challenges facing the next generation healthcare and wellness industry is billing capabilities for next-generation products. The Telecom industry is experienced in creating products for in-home services, billing for them, and collecting payments from customers. Extending the same capabilities for T4H services is required.

7. T4H analytical service architecture

It is necessary to tune the analytical platform to meet the needs of the T4H problem space by collecting the right data [10], providing appropriate analytics to solve problems, and offering a flexible notification engine for stakeholders. Such a platform is essential to add value to the raw data.

Some of the reference AIP and Telehealth problems that need attention include:

- Trend analysis: Providing trend analysis for basic time-series information gathered from an IoT

	Connectivity	Rule Management	Logging	Installation	Support	Billing
Tasks to perform	UCC, In home sensor devices, end to end services	Service, notification, PHI, and other per sub rules	Different T4H related meta data and Telemetry info.	UCC, IoT (Healthcare and non-healthcare devices)	T4H healthcare and non-healthcare services	User and stakeholder service billing and collection
Why Cable operators?	Extensive experience with in-home service mgmt.	Have been managing 70M+ customers	Used to managing tera bytes of customer specific info.	Highly experienced with in home, e2e service installs	Boots on the ground, service management tools and org.	Elaborate systems to offer and manage service models
Capability development for Cable operators	Need to tune the connectivity focus to T4H	Healthcare/wellness related rules	Collect T4H specific data and address the right problems	Repurpose to T4H vertical (RPM, monitoring installs, ...)	Repurpose to manage T4H	Repurpose to manage T4H

Figure 6 - Why MSOs are suited for T4H services, and what capabilities do they need to develop?

- sensor or telemetry information gathered from different RPM systems.

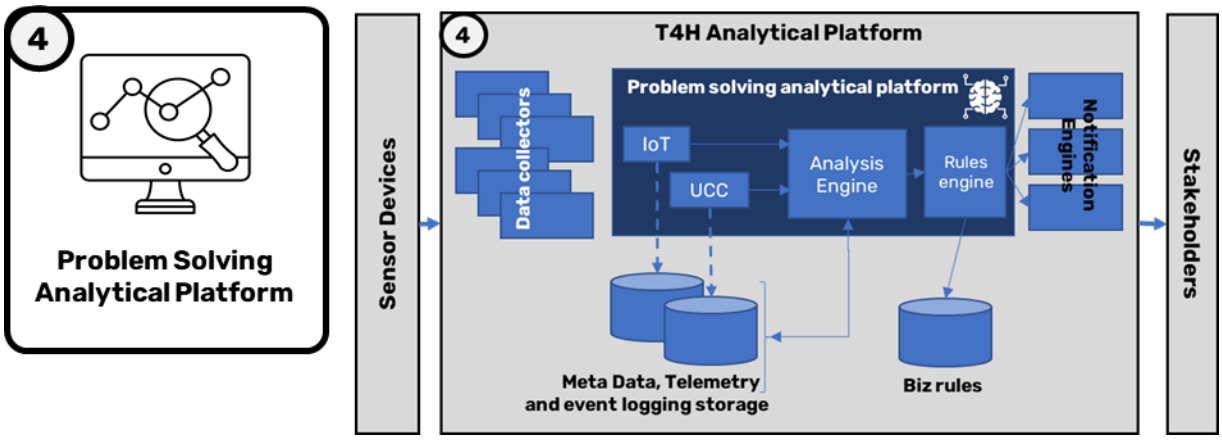

Figure 7 - T4H analytical plaform that manages problem-solving notification infrastructure

- Anamoly detection: Identifying different anomalies such as fall detection, etc. based on the collected sensor data.
- Correlation: Correlating different health and wellness-related conditions with indicative data.
- Resolution analysis: Assisting with different analytical algorithms and the data collected, then tying that data to T4H problem resolution.
- Quality of care forecasting: Providing different success metrics to quantify the quality of care provided by the cable operator's T4H solution.

To meet the above needs the cable operator will have to create the following architectural components, as shown in Figure 7:

- Metadata collectors: Collectors for different types of metadata for interactive systems (such as UCC), sensor networks (such as IoT), and telemetry data per customer. The operators need to adjust their existing monitoring capabilities to meet T4H needs.
- Analytical engine: An analytical engine is required to solve the problems highlighted earlier. This is accomplished using data collected from the various sources. These analytical tools need to consider the Protected Health Information (PHI) [11] restrictions and offer solutions for the classes of problems considered previously.
- Rules engine: Different business rules must be programmed for classes of services offered to the T4H customer for different classes of problems the platform needs to solve.
- Notification engines: The relevant observations from analysis must be communicated to the stakeholders through this infrastructure. Such a notification infrastructure is generally present and tuned for the SLA (Service Level Agreement) needs of the customers.

8. Conclusion and next steps

In order to realize the promise of Aging in Place and Telehealth, all parts of the ecosystem need to be integrated in a way that is convenient for all stakeholders. Cable operators are well-positioned to be this integrator because they already provide network and television services to customers and they have the underlying infrastructure that can install, support and manages such services. However, there is still a lot of work to be done to realize this vision.

In this paper, we propose and architecture capable of supporting AIP and Telehealth use cases and providing key features to users, caregivers, payors and other stakeholders. Some companies will undertake this integration opportunity eventually, but there is currently an opportunity for cable operators to step up and assume this role.

The challenges are not insignificant, but the cable industry has already shown an aptitude for this sort of work as they have created widely adopted standards, aggregated services, created an army of installation and support personnel, and formed trusted billing relationships with millions of consumers and businesses.

SCTE is already working on AIP and Telehealth within their standards development organization. With serious engagement and active participation, cable operators can agree on the problems that need to be solved and come up with solutions and strategies to create a new and potentially lucrative revenue source in AIP and Telehealth for operators around the world.

9. References

[1] Sudheer Dharanikota, Ayarah Dharanikota, *Why are cable operators natural fit to support Telehealth – An inter-industry perspective*, 2020 SCTE Expo, available here
[2] Sudheer Dharanikota, Ayarah Dharanikota, Dennis Edens, Bruce McLeod, *Aging in Place business case for cable operators*, SCTE Journal, June 2021, available here
[3] Sudheer Dharanikota, Ayarah Dharanikota, Dennis Edens, Bruce McLeod, *Telehealth business case for cable operators*, SCTE Journal, September 2021, available here
[4] Duke Tech Solutions market Research, *Telehealth market report – A Telecom based opportunity analysis*, available here
[5] Data Standards Subcommittee, Working Group 3, Aging in Place, available here
[6] Data Standards Subcommittee, Working Group 4, Telemedicine, available here
[7] US Department of Veterans Affairs, *South Texas Veterans Health Care System (STVHCS) – Satellite clinic division*, Available here
[8] Cisco, Unified Communications and Collaboration, available here
[9] Sudheer Dharanikota, *What are the impacts of changing consumption patterns on bandwidth usage?* DTS white paper, available here
[10] Sudheer Dharanikota, Jason Page, Metadata/Telemetry support from Cable Operators to address Telecom for Healthcare opportunity, 2021 SCTE Expo, available here
[11] HHS.gov, *Health Information Privacy*, available here

