UNLEASH THE POWER OF LIMITLESS CONNECTIVITY
Internet of Things, Home Networking, Smart Cities, and Emerging Services

Metadata/Telemetry Support to Enable Telecom for Healthcare Opportunities

Dr. Sudheer Dharanikota
Managing Director
Duke Tech Solutions Inc.
Acknowledgement

Co-Author:

Jason Page, Charter Communications
Telecom for Healthcare (T4H) is a multi-trillion-dollar opportunity for the Cable industry. To capitalize on this opportunity operators must differentiate their services with data management capabilities that meet the needs of T4H stakeholders.

- T4H stakeholder’s data needs
  - Quality of experience metrics
  - Telemetry for monitoring patients and adherence to treatments
  - Connectivity state for network devices and applications
  - Service provider accountability metrics

- Analytical framework to manage T4H telemetry and metadata
  - Secure and highly available interface
  - Timely and useful notifications
### T4H Services, Roles, and Data Needs

<table>
<thead>
<tr>
<th>T4H Service</th>
<th>Basic Responsibilities</th>
<th>Users/Patients (Telehealth and AIP)</th>
<th>Family, Legal Guardian, Trusted Circle, etc.</th>
<th>Doctors, Professional Caregivers, etc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication</td>
<td>North and Southbound Connections, Unified Communications</td>
<td>Reliable connection</td>
<td>Access anywhere</td>
<td>Reliable access to customers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Better Quality of Experience</td>
<td>Better Quality of Experience</td>
<td>Capability to service remotely</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ease of use</td>
<td>Ease of use</td>
<td>Fool proof billing capability</td>
</tr>
<tr>
<td>Monitoring</td>
<td>Remote Patient Monitoring, Behavioral Monitoring, Convenience</td>
<td>Healthcare support</td>
<td>Assist family</td>
<td>Monitor the problem remotely</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Independent living</td>
<td>Assist independent living</td>
<td>Assist the users</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Problem solving</td>
<td>Remote support capabilities</td>
<td>Increase relevant follow-ups</td>
</tr>
<tr>
<td>Management</td>
<td>Notification and Governance</td>
<td>Inform the right stakeholder</td>
<td>Get timely notifications</td>
<td>Manage the user status</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Govern the problem</td>
<td>Reduce costs</td>
<td>Demonstrable improvements</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reduce costs</td>
<td>Demonstrable improvement</td>
<td>Billability governance</td>
</tr>
</tbody>
</table>

We need to clearly understand the incentives for the users of the Telecom for Healthcare platform to analyze the data to be collected.
T4H Data Categories

Quality of Experience
Are T4H services meeting stakeholder needs?
Are users engaging with services?
Bandwidth, latency, platform experience for back office and individual connections

Monitoring
Are we capturing the right Telemetry and metadata to provide useful T4H services?
Healthcare and non-healthcare related streams, sensor and UCC flows, network and device status

Accountability
Are providers delivering expected services?
Are patients adhering to treatment plans?
Quality of care, timely resolutions, problem resolution rate, timely status notifications

Connectivity
Are we providing a reliable and highly available platform across all interfaces?
Do we support a robust set of network protocols?
Platform availability, SLA guarantees, service up times, zero touch network provisioning

Based on our analysis we recommend to classify the T4H metadata/Telemetry data into QoE, Monitoring, Connectivity, and Accountability
Quality of Experience (QoE) is measured for the applications that the users are using the platform for. These applications for the T4H environment are sensor and interactive applications. These application’s QoE are measured at in-home for individual usage and at back-office service infrastructure that hosts the applications for aggregate usage.

Generic application metadata

- **Sensor metadata**: Sensor id, type, group, priority (critical, high, medium, low), location in the house, vendor information etc.
- **Interactive applications metadata**: UCC id, type, location (home, care giver, provider, family), vendor information, application experience (e.g., 5-star scale) etc.

<table>
<thead>
<tr>
<th>Class of applications*</th>
<th>Throughput sensitive</th>
<th>Loss sensitive</th>
<th>Delay sensitive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Onetime measurements</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Video monitoring</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Sensor monitoring</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Video communications</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

(*) Refer to white paper [here](#) for details on the application QoE characteristics

QoE relevant data

- **Bandwidth data**: Bits/second (Peak, Min, Average); Monitoring Location: Sensor hub, Back-office hosting; Granularity: Per session, per aggregate (per sensor or UCC id)
- **Latency data**: One way delay (Peak, Min, Average); Monitoring Location: Back-office hosting; Granularity: Per session; Relevant information: Timestamp the data
- **Loss related data**: Data points lost per minute (Peak, Min, Average); Monitoring Location: Back-office hosting; Granularity: Per session; Relevant information: Time sequence the data
- **Experience related data**: Experience rating per service

Quality of experience measures the fidelity of the communication of the sensor and interactive data to the satisfaction of the players
Monitoring Data Needs

The intuition

The applications that are offered and hence are monitored are again sensor and interactive applications. They can be supporting healthcare and non-healthcare applications. The idea of these data needs does not include the core data streams such as the temperature from a thermometer, but the additional data that supports the players.

Generic application metadata

- **Additional Sensor metadata**: Status (up or down), start time, healthcare or non-healthcare related, etc.
- **Additional Interactive applications metadata**: Start and end times of the sessions, type of session interaction (video, audio, video + audio), number of sessions, etc.

Monitoring relevant data

- **Sensor monitoring data**: Priority of the sensor, privacy level of the data (Generic, provider specific, stakeholder, user alone etc.), urgency level of the notification (such as threshold crossing alarms)
- **Interactive services monitoring data**: Session related (number of legs, number of streams, etc.), stream related (QoE measures, transcriptions, metadata, etc.)

Monitoring locations: The data can be monitored at the aggregation point at the home (sensor network hub) and some of them at the hosted service back office.
Connectivity Data Needs

The intuition

Connectivity focuses on providing a **highly available** service platform with **five 9s reliability**. These measures are very important to support highly emotional and sensitive subjects of healthcare and elderly care. In addition, providing ease of configuration (zero touch configuration) is essential for T4H adoption.

Reliability of the devices, connections and the platform is essential for these critical services.

Availability of the end-to-end services is another measure for these time sensitive T4H services.

Many devices and solutions will be integrated with the T4H services, leading to paying attention to the ease of configuration.

Generic application metadata

**Additional sensor metadata**: Sensor uptime, sensor loss of connectivity, sensor reliability

Metadata

Connectivity relevant data

**Reliability data**: Device reliability metrics, service reliability metrics

**Availability data**: User device uptime (Primary connection, secondary connection), server uptime, percentage availability, service availability

**Zero touch configuration assessment**: Service call during installation, failed self-installs, in-home installation percentage and average installation duration per service offering

**Other connectivity data**: Availability SLA adherence

Reliable and highly available connectivity services with the attention to the ease of configuration is essential for the successful adoption of T4H.
Accountability Data Needs

The intuition

The accountability of the T4H environment is measured on the Quality of Care provided by the service providers, the timely notifications that can be provided by the platform, and the billability of the services offered by the platform (and hence the provider).

Generic application metadata

- **Analytical platform metadata**: Efficacy of the algorithms (problem resolution rate), speed of analysis
- **Notification infrastructure metadata**: Notification statistics, notifications per type of problem

Accountability relevant data

- **Quality of care data**: Time taken to resolve the issue, condition improvement, reduce number of missed appointments, cost reduction (for user, stakeholder, provider)
- **Notifications related data**: Response time (average, peak, minimum), per problem, per provider
- **Billability related data**: Session context (duration, reason, parties involved, provider information etc.), stream context (devices, device performance, potential transcription, additional notes)
- **Other related data**: Other stakeholder accountability, payor accountability measure

Accountability of the providers and the end-to-end systems is an essential feature for the success of a T4H platform...
End to End Data Collection Points and Their Information Scope

In home network interface
- Broadband connection and session monitoring

T4H sensor net interface
- Reliability, availability

Interactive Services

Sensory Services
- Broadband connection and session monitoring

In home device interface
- Sensor and interactive device monitoring, QoE monitoring

Sensor Network Gateway

T4H back-office interface
- QoE metrics, aggregate information, notification, governance, Quality of Care

T4H Sensor Network Infrastructure

Telecom for Healthcare Service Backoffice

Problem Solving Analytical Platform

Analytical interface
- Problem resolution, time to respond, success rate

The metadata and the telemetry information gathered on the T4H platform shall understand the players and their incentives

(*) Refer to the 2021 SCTE Expo T4H Architecture Paper for details on the architecture
## Analytical Platform to Manage T4H Data

### Analytical Platform Architecture

<table>
<thead>
<tr>
<th>Sensor Devices</th>
<th>T4H Analytical Platform</th>
<th>Stakeholders</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data collectors</td>
<td>Problem solving analytical platform</td>
<td>IoT</td>
</tr>
<tr>
<td></td>
<td>Analysis engine</td>
<td>Rules engine</td>
</tr>
<tr>
<td>Metadata, Telemetry and event logging storage</td>
<td>Biz rules</td>
<td>Notification engine</td>
</tr>
</tbody>
</table>

- Collect data from devices
- Log different events
- Provide access for analytics
- T4H specific analytics
- Manage thresholds and other rules
- Notify the stakeholders

### What is different for T4H?

<table>
<thead>
<tr>
<th>Component</th>
<th>Status in MSO</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data collectors</td>
<td>Existing for IoT and other service info.</td>
<td>Need to repurpose for T4H data</td>
</tr>
<tr>
<td>Analysis engine</td>
<td>Existing for IoT engines</td>
<td>Need additional development for T4H</td>
</tr>
<tr>
<td>Rules engine</td>
<td>Potentially new function</td>
<td>Need solutioning</td>
</tr>
<tr>
<td>Notification engines</td>
<td>Existing with service assurance tools</td>
<td>Need to extend to T4H</td>
</tr>
<tr>
<td>Data privacy</td>
<td>Existing for PII</td>
<td>Need to extend to PHI*</td>
</tr>
</tbody>
</table>

### Performance

<table>
<thead>
<tr>
<th>Performance</th>
<th>Status in MSO</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scalability</td>
<td>Device level alarms</td>
<td>Need to extend to per sub per stream</td>
</tr>
<tr>
<td>Security</td>
<td>SNMPv3 based</td>
<td>Need to validate if this is enough</td>
</tr>
<tr>
<td>Privacy</td>
<td>PII after collection</td>
<td>Need to validate if we need to anonymize at the collection points</td>
</tr>
<tr>
<td>Reliability</td>
<td>Reliable communication</td>
<td>No additional changes in our opinion</td>
</tr>
<tr>
<td>Responsiveness</td>
<td>Good for current use</td>
<td>Crucial for the success</td>
</tr>
</tbody>
</table>

(*) PHI – Patient Health Information

Cable operators are already implementing many of the T4H analytical platform components, but they need to make some subtle changes.
Conclusions and Next Steps

Understand the T4H players, and their incentives to develop relevant data architecture

- **Know the players** in T4H space – users, stakeholders, and T4H service providers
- **Understand their incentives** - Quality of experience, monitoring, connectivity, accountability
- **Develop purpose driven analytical infrastructure**

Use the cable operator’s data collection capability to their T4H opportunity

- Provide **quality of experience** measures for the sensor and interactive applications
- Monitor healthcare and non-healthcare applications
- Offer a reliable, highly available, and easy to configure **connectivity** services
- Develop QoC, notification, and billing **accountability** metrics

Scale up to the needs of T4H players

- Most of the required T4H data platform is already developed for operator’s current use
- Meeting the needs of scalability, security and privacy is essential to gain T4H share
- Developing a responsive and T4H problem-relevant platform is essential for the success

Take appropriate next steps for T4H opportunity

- Review the **business cases and market analysis**
- **Start building the architectural components** for the T4H needs
- Build relations with the **inter-industry partners for launches**
Thank You!

Sudheer Dharanikota
Managing Director
Duke Tech Solutions Inc.
sudheer@duketechsolutions.com
+1-919-961-6175