VITAL Telehealth

A Home and Assisted Living Monitoring System for Large-Scale Patient Populations

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What is innovative about VITAL Telehealth?

- Provides live streaming of medical data through the integration of Bluetooth and USB medical devices for capturing vital signs and other measurements as well as automatic device polling.
- Provides secure video calls with embedded vital signs measurements using FIPS PUB 140-2[1] compliant cryptographic modules, including AES-128, AES-192, and AES-256.
- Provides support for firewall traversal when patients and clinicians or service providers are using devices that reside on different networks through a Cisco Video Communication Server (VCS) Expressway and a Cisco VCS Control.
- Provides interoperability and secure transmission of H.323 audio and video between patients' tablets and physicians' H.323 or SIP-enabled devices.
- Provides customizable options for home and assisted living monitoring based on the integration with multiple Disease Management Protocols (DMPs) that include support for patients suffering from Co-Morbidity and Tri-Morbidity.

Why telemedicine with VITAL Telehealth?

Improving patients' experience of care, self-management skills and education, reaching populations of patients in non urban areas, and reducing rehospitalization rates are some of the benefits provided by remote patient monitoring (RPM) that increase the overall patients' quality of life and decrease the cost of healthcare [1, 2]. Yet, these home and assisted living monitoring systems introduce new security and privacy challenges that range from protecting against adversaries at home to withstanding attacks over the communication links when transferring electronic medical records (EMRs) [3]. The Virtual Interactive Telehealth Application Link (VITAL) [4] platform emerges as a new technology for large-scale patient populations commended to address those challenges.

What is VITAL Telehealth?

VITAL Telehealth includes three primary components: VITAL Web, VITAL Home, and VITAL Infrastructure. VITAL *Web* is a web-based, real-time collaboration platform and portal designed to serve as an information hub for patients and devices. VITAL *Home*, shown in Figure 3, is a Windows-based, multitouch tablet for Bluetooth medical device telemetry, disease management protocols administration, medicine intake tracking, and secure transmission of H.323 audio and video between patients' tablets and physicians' H.323 or SIP-enabled devices. VITAL *Infrastructure* supports multiple video call scenarios between patients and health-care providers, where calls received and initiated from the medical video (MeVi) application in the tablet are secure using FIPS PUB 140-2[1] compliant cryptographic modules.

[1] FIPS PUB 140-2 stands for the Federal Information Processing Standard (FIPS) Publication 140-2, a U.S. government computer security standard used to accredit cryptographic modules.

References

[1] A. Broderick and D. Lindeman, Scaling Telehealth Programs: Lessons from Early Adopters, The Commonwealth Fund, January 2013.
[2] A. Broderick and V. Steinmetz, Centura Health at Home: Home Telehealth as the Standard of Care, The Commonwealth Fund, January 2013.
[3] M. D. Green and A. D. Rubin, "A Research Roadmap for Healthcare IT Security Inspired by the PCAST Health Information Technology Report," in *HealthSec '11: Proceedings of the 2nd USENIX Workshop of Health Security and Privacy*. Berkeley, CA,: USENIX Association, 2011.
[4] VITAL Telehealth, "Virtual Interactive Telehealth Application Link (VITAL)," http://www.vitaltelehealth.com/.
[5] OpenEMR, http://www.open-emr.org/.

Case Study: U.S. Department of Veteran Affairs — Pilot for Multiple Sclerosis Patients

Overview

- Sponsored by the Department of Veteran Affairs (VA) Office of Rural Health (ORH) and the Multiple Sclerosis (MS) Program.
- Initially, 50 MS patients and 2-3 physicians over a 12-month period. Ultimate target population, 44,000 MS patients.
- Initial locations, North Florida/South Georgia Veterans Health System and Maine Veterans Services.

Main Challenges

- Interoperability with H.323 and SIP-enable devices used by clinicians.
- As shown in Figure 1, provide support the following call scenarios:
  1. MS patient *outside* of VA to provider *outside* of VA network.
  2. MS patient *outside* of VA to provider *within* VA network.
  3. MS patient *within* VA network to provider *within* VA network.
- Transmit medical data from a patient to a provider without requiring installation of *any* extra software on the provider's computer.

Connectivity Evaluation

- Call routing and firewall traversal, tested by simply calling diverse Cisco phones while replicating all required call scenarios.
- Initial focus, six (6) coastal communities in Maine—Kittery, York, Ogunquit, Wells, Kennebunk, and Biddeford; and three (3) communities in North Florida—Gainesville, Jacksonville, and Lake City.
- Measure uplink/download speed and latency at each location, also recording the number of signal bars (1 to 5) available.

Lessons Learned so Far

- Replication of the VA video infrastructure is a *must* to achieve proper call routing and firewall traversal.
- Connectivity tests for rural areas and remote locations require road testing with possible remapping of data coverage published by services providers such AT&T and Verizon.
- By connecting directly to the Internet, VITAL Home tablets with built-in 4G LTE provide better connectivity than tablets connected through MiFi 3G or 4G modem/router devices.
- Implementation of an automatic diagnostic tool to determine connection status is another *must*.
- User interface design requires not only considering mobility impairment of patients and use of the accessibility support provided by the operating system, but gathering feedback from actual patients through prototyping.

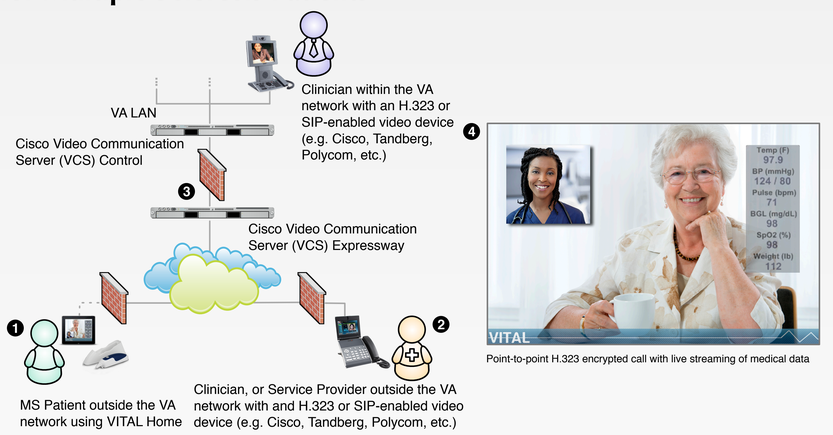


Figure 1. **A Typical Call Scenario used by the VA ORH and the MS Program**. 1) An *MS patient* using a VITAL Home tablet registers with the Cisco VCS Expressway residing within the VITAL Telehealth Private Cloud Infrastructure through a Wi-Fi (802.11 a/b/g/n network) or a Mobile Broadband (AT&T, Verizon, Sprint, etc.) network connection. 2) A *clinician* or *service provider* using an H.323 or SIP video device (e.g. Cisco, Polycom, Tandberg, etc.) or a software client also registers with the Cisco VCS Expressway. 3) Once the *MS patient* and the *clinician* or *service provider* are registered, the VCS Expressway is used to support firewall traversal to allow the video call to connect through the firewall. 4) The *MS patient* uses the MeVi app to securely call the clinician or service provider, who has the option to accept or reject the video call.

Location	Downlink	Uplink	Latency	Signal Bars
Kittery, ME (Tangier Outlets)	3.14 Mbps	0.91 Mbps	115 ms	3 bars
York, ME (Meadowbrook Plaza)	5.39 Mbps	0.69 Mbps	147 ms	4 bars
York, ME (So. Maine Lobster)	4.31 Mbps	0.64 Mbps	120 ms	2 bars
Ogunquit, ME (Welcome Center	1.07 Mbps	0.11 Mbps	134 ms	1 bars
Wells, ME (Wells Public Library)	2.88 Mbps	1.33 Mbps	141 ms	3 bars
Kennebunk, ME (I-95 Service Area)	17.35 Mbps	13.34 Mbps	148 ms	5 bars
Biddeford, ME (Home Depot)	5.45 Mbps	0.46 Mbps	134 ms	2 bars
Benchmark*	> 0.768 Mbps	> 0.256 Mbps	< 250 ms	2 bars

* Benchmark represents the minimum baseline parameters needed to support VITAL Video.

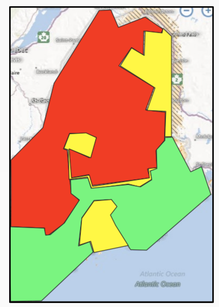


Figure 2. **Results of Connectivity Tests for the Maine Veterans Services**. **Green** area – sufficient connectivity, **Yellow** area – connectivity may be sufficient, **Red** area – insufficient connectivity.



Figure 3. **A Sample VITAL Home Kit**. A Windows-based tablet together with a set of devices depending on the assigned DMP that acts as information and communication hub for patients and devices.