TRANSLATING SCIENCE TO BETTER HEALTH:
THE POWER OF DIVERSITY AND MULTICULTURAL ENGAGEMENT

TRAINING WORKSHOP VIII
An Overview of Telecommunications Technologies

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An Overview of Telecommunications Technologies

José G. Conde, Craig Locatis and Ramón Sierra

13th RCMI International Research Symposium on Health Disparities
Sheraton Puerto Rico Hotel and Puerto Rico Convention Center
San Juan, Puerto Rico
December 10, 2012

Introduction
José G. Conde

Overview

Modern telecommunications technologies provide novel ways to provide and improve health care; promote healthy behaviors; conduct basic, clinical, social, and behavioral research; facilitate research training and medical education; disseminate health information, and reach out to health disparity communities.

This workshop will present and demonstrate applications of telecommunications technologies relevant to biomedical research, education, professional development and telehealth, with special emphasis on issues that impact successful interactions. Examples will include transmission of endoscopic procedures, "distributed" tumor boards, and virtual computer labs for training and education, among other applications.
An Overview of Telecommunications Technologies

Objectives

• Describe network issues that impact telecommunications interactions in research, telehealth, and education activities.
• Describe the local setup necessary for selected telecommunications applications in biomedical research, education and telehealth.
• Explain examples on how hardware and software elements can be integrated into successful implementations of telecommunications applications in research, telehealth and education for improved health outcomes.

Disclaimers

• The speakers have no financial or other relationships with the manufacturers of any commercial products or providers of any commercial services discussed in this activity.
• Presentations or discussions of commercial products or services during this workshop are intended as examples to illustrate general concepts. They do not represent recommendations or endorsements of any kind.

Special Requests

• Please to turn off cell phones to avoid interruptions.
• Please turn in your evaluations at the end of the workshop.
Telecommunications Technologies from the Outside

An Overview of Telecommunications Technologies
Videoconference Systems and Applications
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A Typical (H.323) Session
Polycom VSX 7000 Back Panel

Analog input for video source (people or content)
S-video

Analog input for video source (people or content)
S-video

Analog output for second monitor
S-video

Analog output for VCR/DVD
S-video

Analog output for main monitor
S-video

Analog output for projector or monitor
SVGA/XGA/SXGA

Tip #1: Video and content resolution capabilities of a system might not be equal, so choose your content display and content display port accordingly.

Endoscopic Video Streaming of HD (1080i) Endoscopic Video from the University District Hospital in San Juan, Puerto Rico to Internet2 Meeting in San Antonio. October 6, 2009.
Setup for HD Endoscopy Transmission

LifeSize Room 200 videoconference unit

Interface

Local network

Endoscopy “tower”

Hardware/software

Local network

LifeSize Room 200 videoconference unit

Display

HD (1080i) Endoscopy Transmission

Olympus Evis Exera II CV-180

Olympus GIF-H180 Endoscope

LifeSize Room 200

Back Panel
Internal Network Test
Endoscopic Trans-Sphenoidal Surgery (SD transmission)

LifeSize Room 200
Back Panel

MacBook Pro Ports
Tip #2: Identify the appropriate input port of your codec in order to transmit any intended video or content at the expected resolution. You may require some type of interface to connect research or medical instrumentation.

Some Issues
- Image freezes or jumpy
- Delay: lip synchronization
- Intermittent audio
- Pixelation: Caused by displaying an image (bitmap) or a section of an image at such a large size that individual pixels are visible.

Tip #3: When troubleshooting, consider:
- Network issues (packet loss, jitter) - Jitter is the change in latency with time. This is a network problem that is very important to video quality. Significant jitter destroys video.
- Network connection (wired vs. wireless)
- Codec issues (limited capabilities or competing processes [another source of jitter], resolution limitations, input/output port limitations)
- Display issues (refresh rate, resolution capabilities, output port)
- Content precedence
- Cabling
Audio

- The most underestimated element in video conferencing
- Delay:
  - 50-100ms delays are detectable but tolerable
  - 150-250ms delays are annoying
  - 450+ms delays are unacceptable for fast, interactive exchanges
- Delays of up to several seconds are not a problem for asymmetrical conferences.
- External noise: muting of microphones
- Echo: cancellation strategies

Echo Cancelation

Tip #4: Use of echo cancellation equipment may improve the user experience. Also, participants in a session should mute microphones except when speaking.
An Overview of Telecommunications Technologies

Software as a Services (SaaS) Systems

Supporting Remote Tumor Boards with SaaS

What is a Tumor Board?

A treatment planning approach in which a number of physicians who are experts in different specialties review and discuss the medical condition and treatment options of a patient.
Architecture

Security Features

- SSL-encrypted website
- End-to-end 128-bit AES encryption
- Automatic inactivity time-out
- Strong passwords
- Safety-oriented user interface
Security Features

- Encryption of data end-to-end with 256-bit AES encryption keys.
- Protection of encryption keys which aren’t revealed to users or escrowed to third parties and are discarded when the session ends.
- Use of credential-based identities and end-to-end encryption to make 'man-in-the-middle' attacks very unlikely.

HIPAA

The Health Insurance Portability and Accountability Act of 1996 (HIPAA)

The Privacy Rule
The HIPAA Privacy Rule establishes national standards to protect individuals' medical records and other personal health information and applies to health plans, health care clearinghouses, and those health care providers that conduct certain health care transactions electronically.

The Security Rule
The HIPAA Security Rule establishes national standards to protect individuals' electronic personal health information that is created, received, used, or maintained by a covered entity.
HIPAA

http://www.hhs.gov/ocr/privacy/hipaa/administrative/index.html

Security Features

Be aware that videoconference units and other systems also have security features.

Polycom VSX 7000 Security

- Independently tested for endpoint security
- Enhanced integration for independently certified, classified encryption devices
- Account validation number entry
- Secure password authentication
- Unique factory default passwords
- Administrator password
- Chair/leader password
- Standards-based H.243 MCU password
- Do not disturb feature
- Do not disturb feature while in a call
- Ability to disable remote interlocks (FTP, filenet, HTTP)
- Ability to disable mixed protocol multipoint calls
- Auto-AutoPoint to Point (On/Off)
- Auto-AutoPoint MultiPoint (On/Off)
- Allow access to user settings (On/Off)
Tip #5: Learn about and use the security features of your equipment and/or service when necessary.

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Desktop and Server-Based Videoconference Systems
Coordinated Care

Definition

The deliberate organization of patient care activities between two or more participants (including the patient) involved in a patient’s care to facilitate the appropriate delivery of health care services. Organizing care involves the marshalling of personnel and other resources needed to carry out all required patient care activities, and is often managed by the exchange of information among participants responsible for different aspects of care.

Tip #6: Healthcare is moving towards **coordinated systems** to lower costs and improve access. Telemedicine/telehealth may provide additional opportunities for healthcare coordination and improved access.

An Overview of Telecommunications Technologies

Other Tools

Streaming of Endoscopic Videos from the UPR Experimental Surgery Lab and from the Johns Hopkins Hospital to Viva la Vida Symposium. March 10, 2008
Setup for Multipoint Streaming Live SD Endoscopy Video

- Open source
- Uncompressed Firewire over IP
- Low latency
- SD resolution
- Works on 100Mb LAN
- 30 fps
- Portable
- Clients for sending or receiving endoscopy video at each site

Setup: SD (480) Transmission

- Canopus ADVC110
- Datavideo SD-500 at symposium site
- H.323 Endpoints
- Codian MCU 4205

Clients for sending or receiving endoscopy video at each site
Tip #7: Display area, lighting and viewing distance from the display are important elements in the user experience.
Setup for Multipoint Streaming
Live SD Endoscopy Video

- Shared source
- Compressed or uncompressed video
- Secure connections
- Low latency
- Multicast/unicast capabilities
- SD and HD resolution
- Portable
- Clients for sending or receiving endoscopy video at each site
- Multicast venue server and reflector (unicast)
- Streams can be managed in the receiving laptop
Setup: SD (480) Transmission

Endoscopy Stream

Client on laptops on each end. Server/reflector to connect.

Canopus ADVC110

H.323 Endpoints

Codian MCU 4205

Collaboration Stream

Viva la Vida Symposium. San Juan, Puerto Rico. March 17, 2010

Tip #8: Test, test, ... test.
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Network Issues in Videoconferencing
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What is a computer network?

A computer network, or simply a network, is a collection of computers and other hardware components such as switches, bridges and routers interconnected by communications channels that allow sharing of resources and information.

LAN

A local area network (LAN) is a network that connects computers and devices in a limited geographical area such as home, school, computer lab, office building or closely positioned group of buildings.
A wide area network (WAN) is a computer network that spans a relatively large geographical area. Typically a WAN consists of two or more local area networks (LANs). The largest WAN in existence is the Internet.

Network Connection Types

Wired: Use Ethernet cables and network adapters. Wired LANs generally required at least one switch to accommodate or connect more computers.
Network Connection Types

**Wireless** - Provides the flexibility to work without the need of route cables from the computer to the network switch. There are different standards with different specs.

<table>
<thead>
<tr>
<th>Standard</th>
<th>Download</th>
<th>Upload</th>
</tr>
</thead>
<tbody>
<tr>
<td>802.11b</td>
<td>11 Mbps</td>
<td>54 Mbps</td>
</tr>
<tr>
<td>802.11a</td>
<td>54 Mbps</td>
<td>~230 Mbps</td>
</tr>
<tr>
<td>802.11g</td>
<td>54 Mbps</td>
<td>300 Mbps</td>
</tr>
</tbody>
</table>

**802.11 Standards**
- **802.11a**: 25 - 75 ft
- **802.11g**: 100 - 150 ft
- **802.11n**: ~230 ft

**Range (ft)**
- **100 - 150 ft**
- **25 - 75 ft**
- **~230 ft**
- **100 - 150 ft**
- **~230 ft**

**MDR**
- **11 Mbps**
- **54 Mbps**
- **~230 Mbps**

**Network Devices**

**Mobile Connectivity**
Currently we are using new technologies which bring network services such as web, email, voice over IP, and others to our mobile devices. Two of the most known technologies are 3G and 4G. They are based on different standards and data transfer rates.

<table>
<thead>
<tr>
<th>Standard</th>
<th>Download</th>
<th>Upload</th>
</tr>
</thead>
<tbody>
<tr>
<td>3G UMTS</td>
<td>144 Kbps</td>
<td>64 Kbps</td>
</tr>
<tr>
<td>WCDMA</td>
<td>2 Mbps</td>
<td>153 Kbps</td>
</tr>
<tr>
<td>HSPA 1.1</td>
<td>1.6 Mbps</td>
<td>144 Kbps</td>
</tr>
<tr>
<td>HSPA+ 2</td>
<td>7.2 Mbps</td>
<td>1 Mbit/s</td>
</tr>
<tr>
<td>HSPA+ 5</td>
<td>14 Mbps</td>
<td>1.6 Mbps</td>
</tr>
<tr>
<td>HSUPA</td>
<td>56 Mbps</td>
<td>22 Mbps</td>
</tr>
<tr>
<td>HSPA</td>
<td>6 Mbps</td>
<td>384 Kbps</td>
</tr>
<tr>
<td>LTE</td>
<td>100 Mbit/s</td>
<td>50 Mbps</td>
</tr>
</tbody>
</table>

Source: [http://www.ict-pulse.com/2001/07/edge-wimax-3g-4g-whats-the-difference](http://www.ict-pulse.com/2001/07/edge-wimax-3g-4g-whats-the-difference)
Network Devices

Basic Network Elements

Server - A server is a software program, or the computer on which that program runs, that provides a specific kind of service to client software running on the same computer or other computers on a network.

Services may include email, websites, mailing lists and videoconferencing, among others.

*The Linux Information Project; http://www.linfo.org/server.html

Switch - A network switch, commonly referred to as just a switch, is a network device that is used to connect segments of a LAN or multiple LANs and to filter and forward packets among them.

The Linux Information Project; http://www.linfo.org/network_switch.html

Router - A router is an electronic device and/or software that connects at least two networks and forwards packets among them.

The Linux Information Project; http://www.linfo.org/network_router.html
Network Devices

Network Devices
Security, Policy, Quality of Service

Firewall - Firewalls prevent unauthorized Internet users from accessing private networks connected to the Internet, especially intranets. All messages entering or leaving the local network must pass through the firewall, which examines each message and blocks those that do not meet the specified security criteria.

Traffic shaper - Traffic shaping is an attempt to control network traffic in order to optimize or guarantee performance, low-latency, and/or bandwidth. Traffic shaping deals with concepts of classification, queue disciplines, enforcing policies, congestion management, quality of service (QoS), and fairness.

How do computer networks work?

Network Devices
Security, Policy, Quality of Service

Traffic shaper - Traffic shaping is an attempt to control network traffic in order to optimize or guarantee performance, low-latency, and/or bandwidth. Traffic shaping deals with concepts of classification, queue disciplines, enforcing policies, congestion management, quality of service (QoS), and fairness.

www.knowplace.org
http://www.knowplace.org/pages/howtos/traffic_shaping_with_linux.php

How do computer networks work?

Network Devices
Security, Policy, Quality of Service

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Knowplace dot org
http://www.knowplace.org/pages/howtos/traffic_shaping_with_linux.php
**IP Address**

An IP (Internet Protocol) address is a unique numeric identifier for a computer or other device on a network. 

**ie. 192.168.1.17**

A **static IP address** is an IP address for a computer or other device that remains the same every time the device is connected to the network and does not change unless it is changed manually.

A **dynamic IP address** is one that changes every time a device is connected to the network.

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**Private versus public addresses:** The Internet Assigned Numbers Authority (IANA) has reserved the following three blocks of the IP address space for **private networks**. These cannot be accessed from the general Internet.

**Private Addresses Blocks:**
- 10.0.0.0 – 10.255.255.255 (10/8 prefix)
- 172.16.0.0 – 172.31.255.255 (172.16/12 prefix)
- 192.168.0.0 – 192.168.0.255 (192.168/16 prefix)

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**IP’s and NAT**

NAT (Network Address Translation). Allows a single or small number of public IP addresses to be shared by a large number of hosts using private addresses. Translates an IP address used within one network (Private Network) to a different IP address known when another network (Public Network).

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IP and NAT

• Why use NAT?
  – Security
  – IP addresses shortage
  – Administration

Video Streaming Modes: Multicast vs. Unicast

Multicast vs. Unicast

Unicast:
A unicast stream is a one-to-one connection between the server and a client, which means that each client receives a distinct stream and only those clients that request the stream receive it.
Multicast vs. Unicast

Multicast:
Multicast streaming is a one-to-many relationship between a server and the clients receiving the stream.

Multicast Pros and Cons

- Benefits
  - Reduced server and CPU load
  - Reduced network bandwidth and load
  - Enhanced Efficiency
  - Increased scalability

- Concerns
  - Packets flooding every interface on the switch
  - IGMP snooping, GARP
  - Vendors specific protocols: CGMP
  - Security
  - Data encryption
  - Authentication

Internet2

What is Internet2?
Internet2 is a not-for-profit organization with the goal of developing and deploying advanced network applications and technology.
The Internet2 Network

Internet2 members take advantage of:
• A network dedicated to specialized R&E traffic
• A network engineered to allow wide reachability across the R&E community with abundant "headroom" optimized for peak performance. The goal of this service is for users to never experience the dropping packets, jitter, or other underperformance characteristics of commodity networks.
• A network that’s highly reliable, and connects to a fabric of other national research and education networks around the globe

Due to the nature of its design and capabilities, the Internet2 Network provides better transmission rates and lower latency than what we have over commodity Internet.

These capabilities developed and deployed by the Internet2 community enables completely new applications such as:
- digital libraries
- virtual libraries
- distance learning
- telemedicine
- HD videoconference

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Potential Network Issues

Firewall

Some of the uses of a traffic shaper is to reserve, allocate and/or prioritize traffic. For example, if your Internet link is being used for almost 100% of its capacity, we may decide to reserve bandwidth for our most important/critical services and applications (see image below). If it is not set up properly or according to institution needs, problems could occur due to link saturation.

Traffic Shaper

- Non-critical services
- Video Conferencing (H.323), VoIP (SIP)
- Critical Services and Applications (e.g., Distance Learning, etc.)

(Some) Troubleshooting and Diagnostic Tools
Troubleshooting (User)
What to check when something goes wrong (ie. no Internet connection)?
Sometimes problems arise and we need to find a way to solve them. Here is a flow chart that could help us determine where the problem could be.

Troubleshooting

Diagnostic Tools
Windows
- ipconfig: displays all current network configuration values (IP, MAC Address, etc.)
- ping: used to test reachability of a host on an IP network and to measure round trip time.
- tracer: diagnostic tool for displaying the route (path) and measuring transit delays of packets.
- nslookup: tool for querying the Domain Name System (DNS) to obtain domain name or IP address mapping.

Mac, Linux
- ipconfig
- ping
- tracert
- host
Diagnostic Tools

ipconfig

ping

Diagnostic Tools

tracert

nslookup

Network Utility on the MAC
The Need to Test, Test, Test …

Given all of these potential problems, what can you do about them? It is best to make no assumptions at all about your network’s readiness for videoconferencing. You should discuss your videoconferencing plans with your network staff early on in your decision process, and ask them if your network will support videoconferencing in the locations you have in mind, including off-campus locations.

In general, it is strongly advisable to talk to the network staff at both ends of a planned videoconference. They can advise you of potential issues, monitor the network for problems, and possibly engineer a better setup for you.

CRAIG LOCATIS
National Institutes of Health

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Content and Computer Sharing in Collaborative Videoconferencing

Craig Locatis

Content Sharing Options

- H.323/H.239 (content as video)
- Server/Cloud Systems (screen sharing)
- Cloud Services (screen sharing/control)
- Computer Sharing (control)

H.323/H.239: Sending content as video

Appliance System Set-Up/Use
Computer Sharing: Interactivity and Control

- Options:
  - T.120 Legacy systems (Netmeeting/ Polycom PVX)
  - Virtual Network Computing (VNC)
- Not Always Needed
- Security Issues
Virtual Network Computing (VNC)

- Computers running server software enable computers running client software access.
- The server can be installed as a service or activated manually on-demand (preferred).
- Access can be password protected.
Virtual Computer Lab

- Collaboration between the National Library of Medicine and University of Puerto Rico Medical Campus.
- Provides distance education on biomedical technology resources.
- Addresses the problems of low latency distant display of complex resources (3D manipulable models) and remote machine access.

Virtual Computer Lab Video [View]

Virtual Computer Lab Distance Education Participants

- University of Puerto Rico Medical Campus at San Juan
- Charles R. Drew University of Medicine and Science at Los Angeles
- University of Maryland Health Science Center at Baltimore
- University of North Carolina Health Science Center at Chapel Hill
- University of Tennessee Health Science Center at Memphis
- Virginia Commonwealth Health Science Center at Richmond

Panel Discussion / Q&A

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Thank you for participating!