Developing Methods Using Google Fiber for In-Home Monitoring in Support of Caregivers for Patients with Dementia

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Today’s Objectives

• Background and motivation for this research
  – Convergence of Engineering, Clinical (Nursing, Alzheimer's), Informatics, and Good Fortune

• Identify current video and network technologies available within the home
  – What’s coming to Kansas City with Google Fiber

• Describe regulatory requirement and privacy concerns that emerge as we connect patient controlled environments to health care providers’ technologies
  – The research uses dementia monitoring as a case study for understanding if prior networking research addresses such challenges as well as measures the impact on home network capacity

• Discussion regarding ways providers and caregivers of patients could use technology.
...something is changing in Kansas City...
Google Fiber is coming to KCMO and KCK!!

- Bidirectional gigabit fiber to the home [http://fiber.google.com](http://fiber.google.com)
  - Record ten TV shows at the same time, preview with your Nexus7, etc...

- **Our Responsibility**: find something useful for health to do with it... besides LOLCats and multiplayer 3D video games.

NSF USIgnite Grant: [http://us-ignite.org](http://us-ignite.org)

“In-Home Monitoring in Support of Caregivers for Patients with Dementia”

Multidisciplinary: Informatics/Telehealth Engineering, Nursing, Alzheimer’s Center
Technical Background: Home Networking

Cable Internet (top speeds ideal)
- **Down speed** (more is better): 25 to 100 megabits per second
- **Up speed** (more is better): 2 to 8 Mbps
- **Latency**: (less is better) 150 to 500 ms, depending on your area

Asynchronous Digital Subscriber Line (Phone)
- Down speed: 1.5 to 15 Mbps
- Up speed: 128 kbps to 1.0 Mbps
- Latency: (less is better) 75 to 400 ms, depending on your area

3G/4G Wireless Cell Phone Internet
- Down speed: 0.4 to 50 Mbps
- Up speed: 0.2 to 6 Mbps
- Latency: (less is better) 250 to 800 ms, depending on your area

http://en.wikipedia.org/wiki/Home_network
Home Networking Use: Video Monitoring

My D-link Cloud Services

Stay connected to what matters most

Throughout your busy week, stay connected to everything you love 24/7. View your home and keep an eye on your kids, your pets and your valued possessions from anywhere over the Internet. Enjoy the peace of mind that comes from knowing everything is safe and secure. Whether you’re out for an evening, at the office or away on vacation, D-Link Cloud Cameras let you keep a close eye on all that’s important to you.

Anywhere Access - mydlink™ Cloud Services makes it easy

To make home monitoring a truly simple experience, we created mydlink.com so you can access live video feeds of your home or office from any Internet-connected computer, iPhone®, iPad®, or Android® device anytime and anywhere. All Cloud Cameras can be viewed and managed on your personal account via mydlink.com so you can enjoy the freedom of remote monitoring on your terms.
http://www.mydlink.com ~$200 per camera
http://www.dropcam.com  $149 camera

- $149 per camera
- $99/year for 7 day DVR on the cloud
- $299/year for 30 day DVR on the cloud
- Added camera DVR $49/yr or $149/yr

60-Second setup
Plug it in. Select your Wi-Fi network. Name your camera. And that’s it. Dropcam HD is online in three fast, pain-free steps. Learn More

Watch on the go
With the free Dropcam apps, you can watch from anywhere. Just download the app, login, and start watching on your iPad, iPhone, or Android. Learn More
Example: DropCam and Timmy

Basic Motion Detection: notices every time he rolls over on the couch
“Cloud Computing”, overused buzzword?

- Basically, newer technologies in the last 10 years make it easier to create computer applications at remote (or your local) data centers that lets you more dynamically allocate computer hardware to programs. Think of it like buying computer power like you buy electrical power: buy the amount of juice by the hour.

- Allow software developers more flexibility to focus on build their application, not worrying as much about how to plan for the hardware if their application is really successful.

There are many flavors of how dynamic “cloud” platforms may be

- Examples: Amazon.com, Rackspace.com, Facebook, Dropcam
Background: Google Fiber announced March 2011
Google Fiber: University of Kansas a Partner, TeleHealth Nutrition Consults during Initial Rally

Visit Us at the Fiber Space

Drop by the Fiber Space in Kansas City to experience Google Fiber firsthand. You’ll get to try out Internet at gigabit speeds, watch crystal-clear high-definition TV, and chat with fiber team members.

Also, check out our Fiber Space events where you can learn about how Google Fiber can positively impact the community from leaders in education, government, health care, and law.

OPEN HOURS: MON-SAT 11AM-6PM, SUN CLOSED
Google Fiber offers more than just a fiber optic cable.
A terabyte of cloud storage

Things happen. But no matter what happens to your computer or mobile devices, your files are safely stored in Google Drive. Keep everything. Share anything. Google Drive is everywhere you are - on the web, in your home, at the office and on the go.

Fast and powerful Wi-Fi

Enjoy super fast Wi-Fi speeds with 802.11a/b/g/n including 3x3 MIMO antennas and dual concurrent radios. Extend your access to Google Fiber all over your home with the integrated Wi-Fi Access Point and Ethernet port in your TV Box.
The Global Environment for Network Innovations (GENI) is a nationwide suite of infrastructure for “at scale” experiments in networking, distributed systems, security, and novel applications.

Concept of deep programmability and slices.

http://www.geni.net/
• GENI Racks serve as programmable routers, distributed clouds, content distribution nodes, caching or transcoding nodes, etc.
• Federated with GENI control framework and aggregate managers.
• Provides sliceable compute and network resources through aggregate managers.

Background: InstaGENI Rack installed at Lawrence
2011: White House Office of Science and Technology Policy (OSTP), National Science Foundation (NSF) and representatives from industry, academia, broadband infrastructure projects and providers.

- Goal: advance applications and services for next-generation networks across America.
- NSF sponsors small grants as well as contests in partnership with places like Mozilla Foundation (Firefox web browser).
- We are in an ideal position to participate given Google’s deployment to Kansas City:
  - Steve Fennel attends key events and discussions.

http://us-ignite.org/what-is-us-ignite/
Technology from Behavior Imaging Solutions (specializing in autism diagnosis)

Uses “Store and Forward” where video is saved on the laptop and then uploaded to Behavior Connect for review by the Coach

Laptop belongs to KUMC (KUMC IT HSC HIPAA policies apply)
  - Configuration issues and rebooting in the home leading to failure to capture video
CTSA Pilot: Capture and Review Applications

- Behavior Capture
- Behavior Connect
Pilot: Feasibility Study with 5 Families

• Each used Home Monitoring to collect and submit video recordings over 3 months

• Weekly feedback was provided by our team of dementia care experts

• Caregivers reported:
  – Better skill and confidence in providing care
  – Reduced stress
  – Reduced disruptive behaviors
  – Would recommend home monitoring to others
Pilot: Contextual Findings

• Environmental Issues
  – Noise, TV, dogs, kids, cell phones
• Ways to streamline care/use resources
• Communication
• Longstanding interpersonal/family relationship dynamics
• Education about dementia/expectations
• Need to maintain autonomy
• Caregiver needs reassurance
• Health Insurance Portability and Accountability Act (HIPAA)
  – Original motivation was letting patients access their information
  – HITECH (electronic medical records) added regulations wrt liability,
    limitations on resale, and individual access to patient information

• Privacy and Security Requirements

• Covered Entities (providers, plans, clearing houses) must
  follow certain practices as must their “Business Associates”
  – Business Associate Agreements: responsibility to notify if there’s a
    breach of information

• Privacy: What’s protected information, notification of use or disclosure,
  appropriate use, penalties
HIPAA Security Rule recognizes:
- both the wide variety in size/sophistication of health care providers and that
- Technology always advances.
- Organizations must consider (Risk Analysis)

HIPAA requires
- Administrative safeguards (training, security officer, access management, evaluation)
- Physical safeguards (data centers, workstations, media)
- Technical safeguards controls (access: usernames/passwords, audit: logging, integrity: prevent alteration/destroyed, transmission security)
- Organizations Requirements, Policies and Procedures

For this research, we want to understand how new technology might improve technical safeguards between the home and provider
• In contrast to Behavior Imaging Pilot, the camera and storage of video is on the patient/family’s systems.
  – Not a HIPAA regulated environment

• What are people comfortable with balanced with convenience?
  – Store video locally in the home? Then only forward when event occurs to provider
  – Use convenience of cloud storage. Also good for security monitoring (if power cut, can still see last video capture)

• How is this changing over time and generationally?
  – Elderly Caregivers versus younger caregivers or a mix
USIgnite: Grant Idea

• Define a project that would be in the **home** so that we, Google, USIgnite, and NSF support a project that uses Google Fiber

• From initial project ideas, which applications need high bandwidth?
  – Video, video storage and retrieval

• Commercial Off the Shelf (COTS) Technology in the Home is rapidly advancing.
  – This is an application grant, not a device grant
  – Realistically, target what people can afford

• Intersection of Patient Controlled Digital Life and Providers

• Second test case is multipoint video which might use other grants’ technology
Goals: Evaluate and Measure Tradeoff Choices

- Technology/science grant for a usable application more so than a clinical study
- Pilot with 2 to 3 healthy elderly volunteers after development
  - Dr. Williams creating scripts and scenarios of behaviors and coaching
- Family/Caregiver Storage preferences
  - Store video in your home as if on Google StorageBox
  - Store video on the cloud, like www.dropcam.com
- Evaluate NSF GENI technology separating the data from the control planes for enhancing HIPAA Security Rule Technical Safeguards
- Quantify bandwidth consumption using NSF GENI infrastructure to measure. Single, multi-camera, multi-point video conferencing
- Consider how this environment might expand to encompass personal health records, other devices to collect vital signs/signals, expand to other conditions and use cases.

© Google Fiber 2012
Proposed Environment

Primary Application: send, review, feedback of behavior

- Caregiver
  - Wifi webcam
  - Google Fiber TV Box
- Patient
  - Wifi webcam
  - Sensors
- Patient
  - Google Fiber TV Box
- Caregiver

Secondary Application: real-time video based coaching

- Provider "Coach"
- Physician
- Occupational Therapist: Social Worker

InstaGENI Rack (provider)
EHR System (provider)
Future expansion
Current Test Bed Environment

Primary Application: send, review, feedback of behavior

Secondary Application: real-time video based coaching
Our Test Bed: Camera

- D-Link Cloud Camera
- Commercial but reasonably high resolution 720p
- Configurable (good for testing and development relative to dropcam)

Our Test Bed: Network and Storage Box

- Zotac NANA AD10 miniPC
  - Very configurable
  - LINUX based
- Approximates Network and Storage Box all in one.

Current Technology by Engineering: Mobile Web Application to trigger video upload

1. RECORD REQUEST
2. CAPTURE REQUEST
3. MEDIA CONTENT
4. MEDIA UPLOAD
5. NOTIFICATION
6. VIEW REQUEST
7. ACCESS GRANT
8. MEDIA STREAMING
9. FEEDBACK
10. FEEDBACK

CAMERA

VIDEO PROCESSING SYSTEM

MEDIA RECORDING MODULE

MEDIA EDITING MODULE

WEB SERVER/EVENT PROCESSOR

STORAGE MANAGEMENT SYSTEM

MEDIA STORAGE WITH METADATA

ACCESS CONTROL MODULE

FEEDBACK CAPTURE MODULE

CLINICAL EXPERT

CAREGIVER

RTSP/RTP STREAMING
Next Steps: “HouseCalls” to Connect Caregivers to Providers/Coaches using “Behavioral Imaging”

Initial Development Prototyped

Forward from home or Use GENI “cloud” at Lawrence

Establish Account/Relationship

Right side: Copyright © 2013 Behavior Imaging Solutions
See http://autismresearch.org
Behavior Imaging Solutions: Autism

• Leading expertise in store and forward technology for observing, assessing and treating behavioral disorders

• Awarded an NIH SBIR grant from National Institute Of Mental Health of the National Institutes of Health under Award Number R44MH099035:
  - http://autismresearch.org/
  - http://www.behaviorimaging.com

• Home based example to right

Copyright © 2013 Behavior Imaging Solutions
Behavior Imaging Solutions: Assessment

- School based behavior example to the right
- Interesting insight from their founder that currently their main customers are with schools and institutions, not families

Behavior Connect for Behavior Assessment

Through Behavior Connect web portal the Clinician and/or therapist can prescribe goals and give feedback that help the treatment process.

1. A prescription can be made for therapist/teacher/parent to fulfill requirement

2. The clinician can see that the requirement is fulfilled and can send feedback back.

3. A more detailed analysis happens at the “Data Viewer” where each frame of the video can be combed through and annotated. Other related files may be associated for easy access.

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• How do you see caregivers and society embracing a greater digital presence? Providers?

• Could you use such technology today?
  – Are patients approaching you about this technology now?
  – Technically, some can happen right now though requires manual steps or establishing logins for providers to people’s home cameras or emailing videos

• Other conditions or uses?

• What do you see as the barriers?
  – Provider barriers examples: reimbursement, workflow
  – Caregiver/patient examples: ease of use, familiarity with technology, privacy concerns

• Any recommendations on finding health volunteers?
  – Will want someone who is in a neighborhood with Google Fiber
    • Grant help subsidize costs
Select References


