Enabling Tele-Health & Connected Hospital

Sid Ahuja
Vice President, Joint Ventures
Alcatel-Lucent Ventures
**Evolution of Networks**

**Telephony**
- End points are People
  - 6 B People
  - Voice ..64Kbits/sec
  - Few calls per hr
  - Point to Point comm.

**Data Networks**
- Endpoints are Computers
  - >100B computers
  - Video and data .. 1 Mbit/sec
  - 10’s transactions per hr
  - Server to many client comm.

**Sensor Networks**
- Endpoints are sensors
  - >1000B devices
  - Voice, video, sensor data
    - (10 mbits/sec)
  - 100’s of transactions per hr
  - Many sensors to ‘data fusion server’
Wireless Digital Stethoscope with Diagnostic Support

Digital Stethoscope:
- Auscultation of cardiovascular/pulmonary sounds
- Recording & Monitoring of the sounds
- Automated Detection
  - Breathing cycles, specific markers or sequences
  - Wheezes, crackles, murmurs
- Enhanced graphical man-machine interface

Based on:
- Bluetooth Cordless technology
- Signal Processing Algorithms (Voice Activity Detection, Head noise suppression, ambient noise cancellation)
- Signal Analysis (Diagnosis Support)
Tele-Sensing technology

- Measures Precise Displacement of the Chest
- Housed within a Cell Phone
- Range of a Few Meters

at 1 meter - $f = 2.4 \text{ GHz}$, $P_{source} = 10 \text{ dBm}$
Sense, Analyze

Sensors monitor:
- Intra-disc pressure
- PH value
- Loads at facet joints
- Strains in ligaments
- Clearance in spinal canal
- Fractures
- ...

Sensors monitor:
- Electrical activity in muscles surrounding the spine
- Strains in the muscles
- ...

Sensors monitor:
- Stresses, strains, forces and motions in spinal implants (both external and internal)
- ...

Devices/sensors that also allow patient to communicate directly with the monitoring system
Sensor Network Framework

- Healthcare Provider
- Data collection/Routing
  - Hosted at Service Provider Facilities
- Home Sensor Gateway

[Diagram showing the network framework with interconnected healthcare providers and data collection/routing nodes hosted at service provider facilities]
Salveo - Joint Venture with Saskatchewan Telecom

**The Problem:**
- **Help people with chronic disease**
  - Difficult to check regularly vital signs
  - Not only when at home
  - Human interactions and proximity

**The Solution:**
- **Salveo articulates communication technologies to benefit patients care**
  - Current focus on Diabetes and Hypertension
  - Leverages standard BlueTooth devices & cell-phones
  - Enables home or mobile check
  - Data collection - once or twice a day
  - Regularly triggers patient for control
  - Securely transport, stores, compare vital infos
  - Human assistance
  - Integrated solution with TelCo infrastructures (billing, Service platform, Billing, ...)
  - ISO 13485 certified (Healthcare)
Remote Patient Monitoring Solution Architecture

- Home Aggregation
  - Devices, sensor, controls
  - Roam aggregation

- Analysis Apps
  - Contact center apps
  - Clinical/EPR integration
ALU Tele-assistance service (Telefonica)

Users

Outdoors

Indoors

Mobile

STB/TV

Modem/Router

ADSL

Video assistance centre (VAC).

Resources

Emergency Services

Experts

Home Care

Family

STB/TV

Modem/Router

ADSL

Video assistance centre (VAC).

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Telestroke Assessment
Telestroke Assessment

Audebert et al. Cerebrovasc Dis 2005
The Environment
Tele-mentoring / Remote Consulting (UPMC)

- IP-DICOM
- IP-Ethernet
- IP-DICOM
- BMC / VGA
- VLAN
- USB
- HD - RTP (720P)
- Multi-media Bridge / Single Session Control Collaboration Platform

Dr. Amin Kassam, UPMC
Smart Surgery Suite & Collaboration - Proposed multi-stream screen Layout

OR1 - Dr Fred, Patient - John Public

Clear
Full
Setup
Close
Logout

OR1
OR12
OR25
OR4
Asset Management (collaboration with UPMC)

- People and Things
- Big and Small

- Optimized Physical Inventories
- Audit Trails
- Staff Notification & Management
- Patient Safety & Management
- Status and Queries
- Home or Hospital
- Timely and Better Patient Care

Camera
RFID
WiFi
Infrared
GPS
Barcode
Zigbee
UWB

Multi-modal Gateway

WiFi ID Tag
Goal of autonomic networks is to enable functionality in the background and through decentralized agents without the need for control by the user/operator or explicit knowledge of its exact mechanisms. It is purposeful, it adapts and is extensible.

**Autonomic (peripheral) Nervous System.** Is the control system maintaining homeostasis/equilibrium in the body without conscious control. Heart rate, and digestion are part of ANS functions.
Simple Rules Based Logic

Is Michael available, and how?

Raw user Presence/Location

User Preferences

Michael is on freeway between office and home

Michael has pre-provisioned his preferences

If working, let co-workers see me

Decision, e.g., Michael is available to Sally by cell only

Relevant Data Sources (e.g., Calendar, Corp. Directory, …)
Context-Based Networking Overview

- **Clinical Database**
- **Sensor Nets**
- **Self-Configuring**
- **People**
- **Devices**
- **Patient Data**
- **Contextual Identity**
- **Contextual Resources**
- **Inference Engine**

### Policies
- Persona / Sharing
- Enclave
- Community (Collaborative Filtering)
- Promotion / Solicitations

### Meta-Data
- Assignment (Collected Knowledge)
- Association
- Searching / Finding

### Content Virtualization
- Persona / Sharing
- Enclave
- Community (Collaborative Filtering)
- Promotion / Solicitations

### Inference Engine
- Privacy
- Trust
- Authentication

### Resources
- Appliances
- Media-bridging (packaging)
- Asset tracking (People & Objects)
- Cloud Computing
Computer Vision

Video Search
- LogoTrax™: Logo spotting in sports broadcasts

People and Object Tracking
- Glove tracking in boxing matches
- Body pose estimation
- Generating virtual avatars for games and animated movies
ALU Face Tracking and Recognition

- Real Time
- Minimal Training Time
- Superior Recognition Performance
Alliance Smart Senior: Architecture Overview

![Diagram showing the architecture of Alliance Smart Senior]

- **Internet**
- **Managed Core Network**
  - 2G/3G/IMS/Call Session Control
- **Applications**
  - Voice & Video Communication
  - Video
  - Conferencing
  - LBS
  - Content Services
- **Telemedical-Service (Genesys)**
  - Dieticians
  - Hospital
  - Reha Centers
- **Other Portal Operators**
  - Partner
  - User
  - Admin
- **Home Network Gateway**
  - PAN ~ m (WiFi)
  - BAN ~ cm Bluetooth
  - Sensor
  - IP-TV
  - Appliances
  - Sensors
  - Home Care
- **At Home**
- **In-House Public Buildings**
  - BSR
  - WiFi Hotspot
  - Applications
- **On the Move**
  - Car, by Feet: Wireless & Universal Mobile Assistance
  - By Feet: WiFi, BSR & Universal Mobile Assistance

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SUMMARY

• Sensors will enable ‘new’ constant communication
• New devices and new types of data
• Video for monitoring > video for entertainment
• Edge intelligence to filter data, video
• Broadband at the edges for new apps
• Healthcare - major user of broadband
• Autonomic/Intelligent networks to handle the flood of sensor data
“We are buried beneath the weight of information, which is being confused with knowledge”

Tom Waits, 2008