

The Role of Intelligent Technology in Eldercare

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Thursday
APRIL 8, 1999

Woman, 89, says relocation violates her rights

She sues her nephew and Hennepin County in an effort to remain in her home in Minneapolis rather than be moved to a nursing home in Wisconsin.

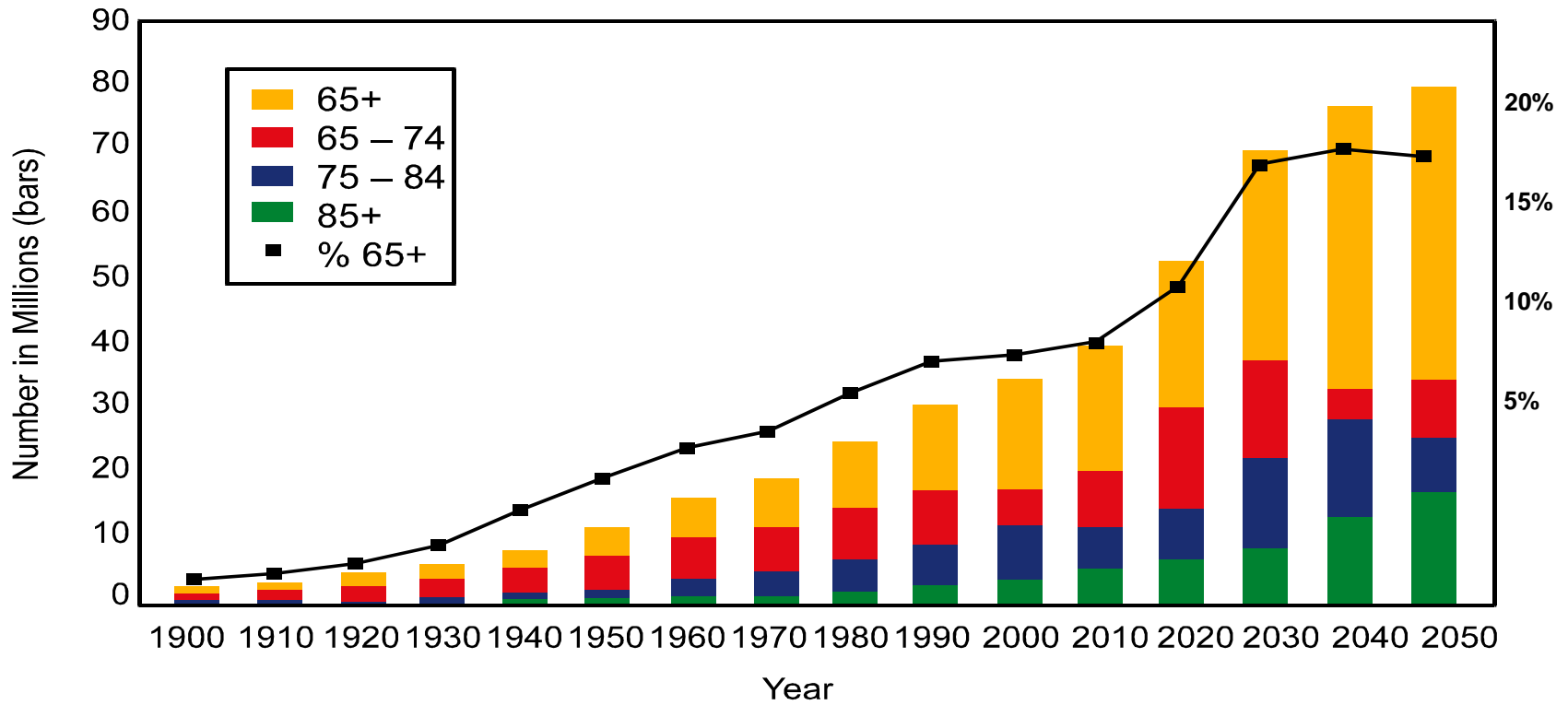
By Warren Wolfe
Star Tribune Staff Writer

Emotionally-laden issue
for both the elder and
the family

Outline

- **Independent Living Issues**
- **Currently Available Technology**
- **Long Term Vision**

The Elder Boom

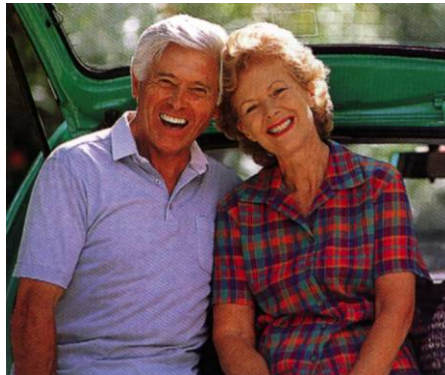


Growth of the 65+ Population by Age Group: 1900 to 2050

Independent Living Issues

Quality of life

- Desire to maintain independence
- Limitations
 - ◆ Arthritis (49%)
 - ◆ Hypertension (35%)
 - ◆ Heart Disease (31%)
 - ◆ Hearing (31%)
 - ◆ Activities of daily living
 - ◆ Falling
 - ◆ Fraud



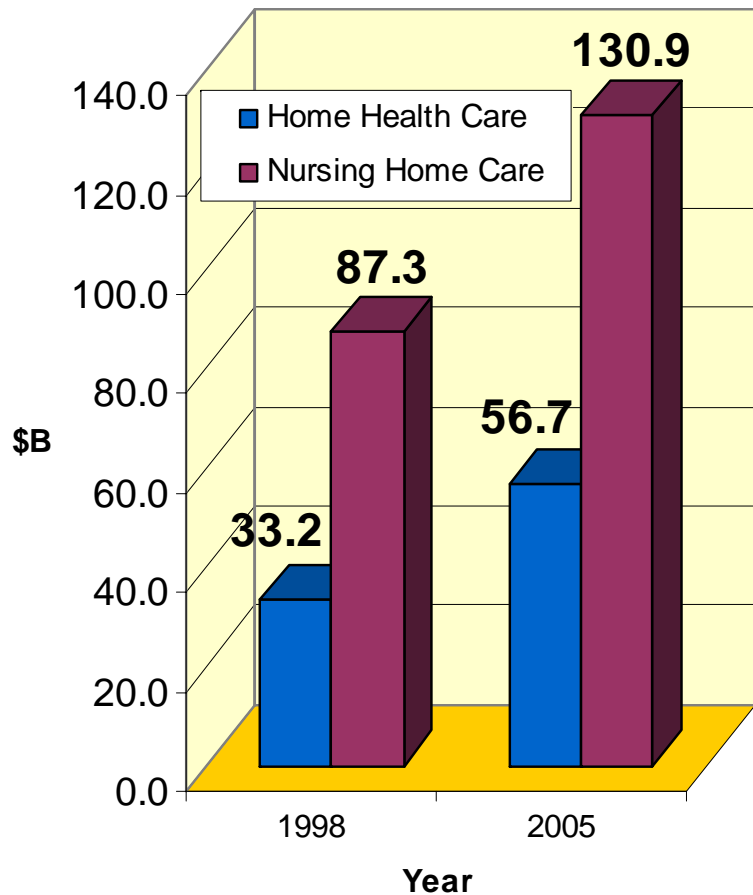
Support systems (Caregivers)

- Institutions are costly
- Remote families
- Decreased availability (aging population)

Technology developments

- Widespread, diverse products and services
- Lack overall, integrated infrastructure
- Resistance to new technology

U.S. Financial Statistics



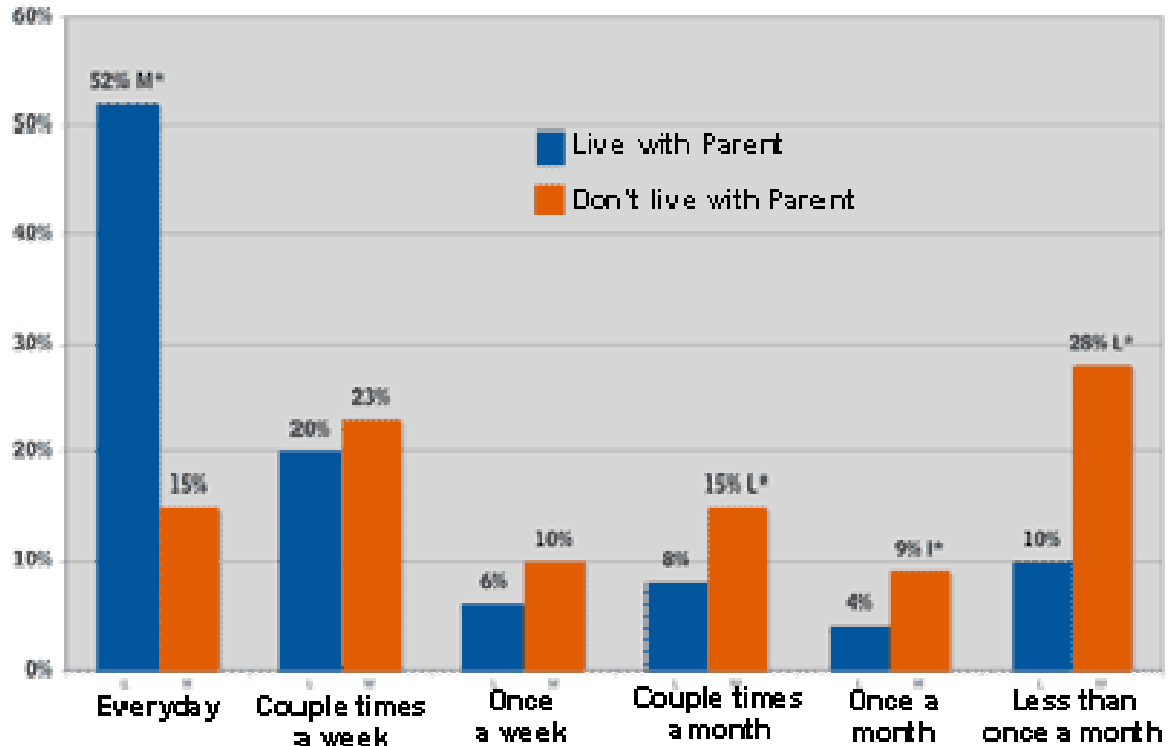
- Federal government pays 57% of nursing home and home health care costs (primarily Medicaid)
- 43% of those over 65 will enter a nursing home
- Average nursing home cost per patient is \$47K
- 1.6 million home care patients in 1996 will increase to 2.0 million in 2005
- 7 million Americans provide remote care to an elder (12 hours per week or more)

Caring for Aging Parents

- **Thirteen million Boomers caring for aging parents**
- **Account for at least 36 percent of total U.S. health care spending over the past five years**
 - Conservative estimate is about \$100 billion a year

SeniorJournal.com Oct 19, 2005

2005 survey from Campbell-Ewald Health.



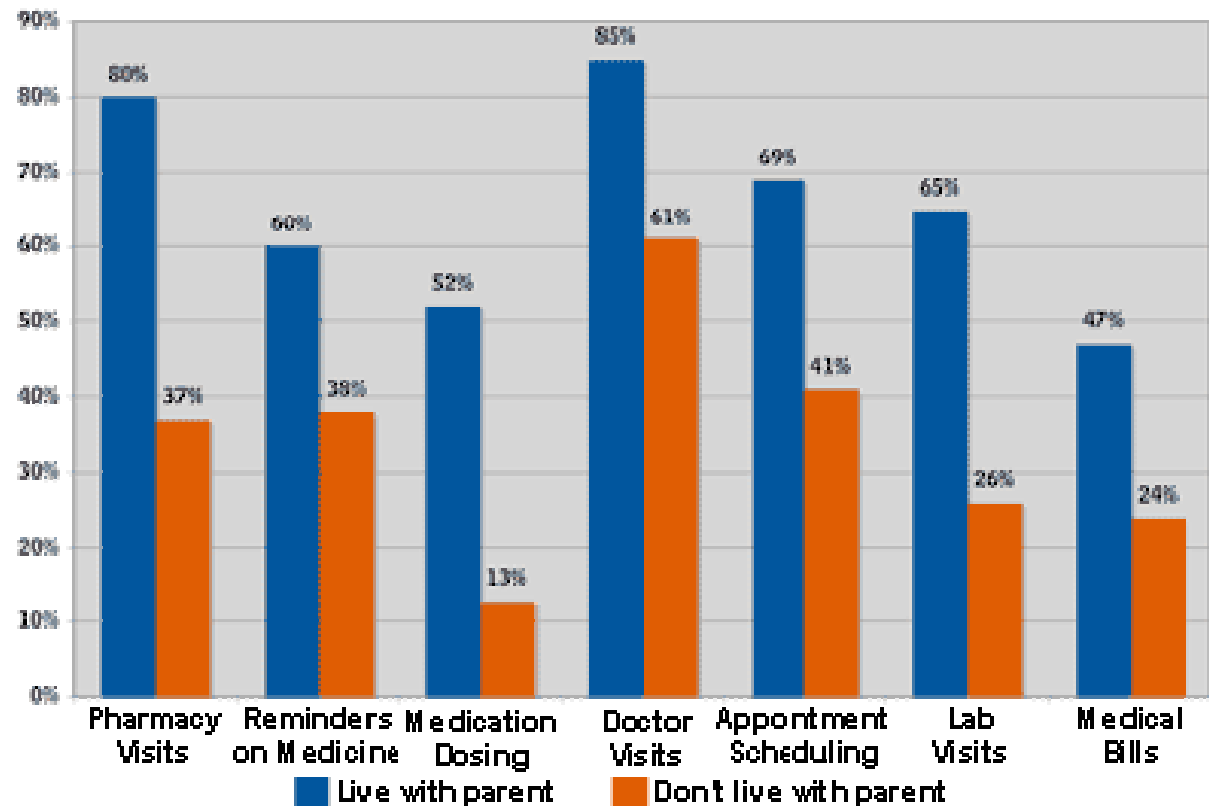
How frequently do you support your parents?

Caring for Aging Parents

- Caregivers: 49% female, 51% male
- Report frustration (45%), being overwhelmed (40%) and guilt (25%)
- 25% live with parent

SeniorJournal.com Oct 19, 2005

2005 survey from Campbell-Ewald Health.



How do you support your parents each month?

Threats to Independent Living

- Physical, psychological, and social factors
 - Physical and mental condition of the elder
 - Stress placed on caregivers
 - Isolation of the elder
- Social, economic and cultural issues
 - Accessibility to alternative care resources
 - Financial constraints
 - Cultural beliefs regarding elder care

Goal: Find better ways to keep elders independent longer

Technology Opportunities

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- Medical Monitoring
- Elder “general” health
 - Activities of daily living (ADLs), such as eating, toileting, bathing, and dressing
 - Instrumental activities of daily living (IADLs), such as mobility, medication management, and grocery shopping.
- Caregiver Burden
 - automate some caregiver tasks
 - ways to coordinate multiple caregivers
- Socialization
- Control within the home
 - e.g. Turn off stove, (un)lock doors, pathlighting

Only area with viable commercial products

Currently available technology

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Monitoring Components and Services

Personal Emergency

Passive



Active



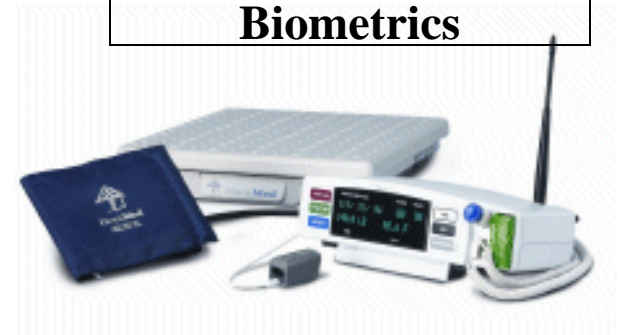
Activity



Health Trending



Biometrics



ADL Assistance



Security & Environmental



Personal Emergency Response Services (PERS)

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24/7 coverage

Panic button

No activity (24 hrs)

Med reminders w/o devices

Some provide scheduled calls for socialization or ADL support

Call programs expensive



Most PERS providers expanding service offerings in one or more of the following directions:

- Medication compliance (MD.2 most popular) has PERS built in
- Reminding (via local alarms or operator calls)
- “Care Calls” – enhanced contact with the clients

- **Lifeline** 350,000+ clients

- **Healthwatch, Pioneer, American Medical Alert**
~50,000 clients each

- **Many small regional offerings**
~10,000 or fewer clients
HealthCom, ResponseLINK, Mainstreet

- **Many use platforms manufactured by other hardware suppliers (Tunstall, Attendo, Linear, others)**

Passive PERS: (Body Worn) Fall Sensing

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- **Detect falls that may render a patient unconscious or otherwise unable to use the panic button feature of their PERS system.**

Passive
Emergency
Detection



- Sense orientation
- Sometimes sense lack of motion (24 hrs)
- Accelerometer-based sensors are more reliable

- **Leading technology from iLife Systems, but not yet on the market. Most other fall sensors not popular due to high incidence of false alarm.**

Bio-Metrics

- Enhance telehealth or home-health (self-administered vitals) through increased communication with the client
- Generally offer packages of:
 - Weight
 - Blood pressure
 - Glucose
 - Pulse ox
- Combination of wireless and wired devices
- Some PERS companies are aligned with suppliers to provide these devices
 - e.g. AMAC/Health Hero, Pioneer



Biometrics continued

- **Biometrics market slow to grow**
- **Still some significant expense**
- **Generally require a clinical base – health network must purchase the software and hardware**
- **Channel for biometric monitoring not suited to handling personal emergencies**
- **Many companies in this space, ranging from simple physiological monitoring to telemedicine applications including video and two-way nurse interaction for remote or home-bound patients.**
 - **Honeywell HomMed (Sentry™ and Genesis™ monitors)**
 - **American Telehealth**
 - **Medstar**
 - **Many others**

Medication Compliance Systems

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Dispense pills

Provide Reminders

Current Shortcomings:

- Require home nurse or family member to set up
- Usability is marginal for both client and caregiver
- Devices often too rigid in their dispensing, and difficult to change if prescriptions change mid-cycle.

MD2™



MedTime™



Honeywell
HomMed
MedPartner™

www.epill.com is a good reference point for medication management technology.

MD2 is a registered trademark of Interactive Medical Developments

MedTime is a registered trademark of American Medical Alert.

Research & The Long Term Vision

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Maintaining Elder Independence with Technology

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- **Program Aims**

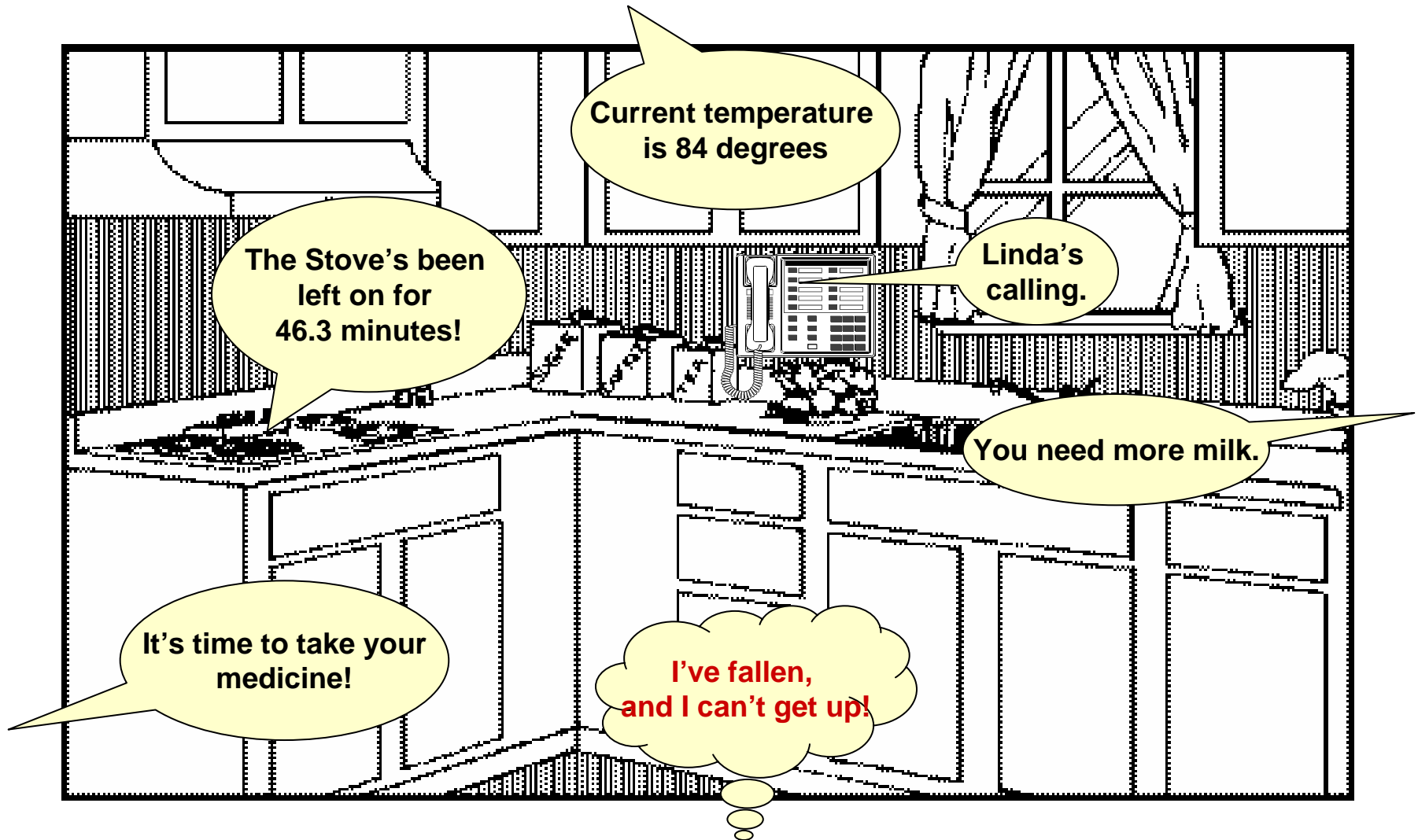
- **Support elder independent living**
- **Provide peace of mind to caregivers**
- **Support efficient quality of care for caregiving organizations**
- **Provide cost savings for government and industry**

Objective: Develop an intelligent home automation system with situation awareness and decision-making capability that can be easily integrated with a diverse set of sensors, medical devices and "smart" appliances to enable elderly and infirm users to live and function safely at home.

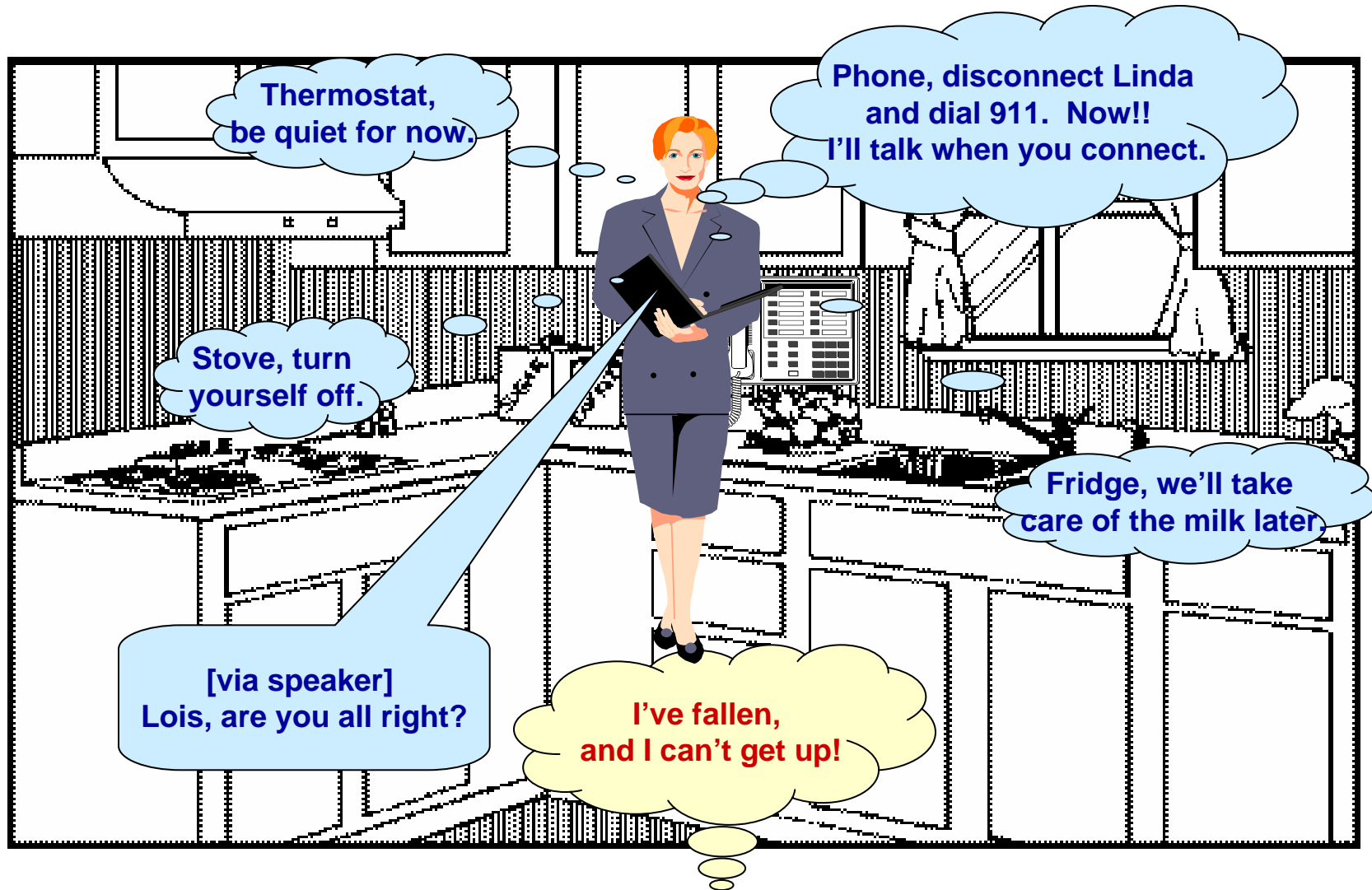
The I.L.S.A. Vision

- **Gather** information about elder, activity, and home status by listening to the home and communicating with devices
- **Assess** the need for assistance based on the system's understanding the elder's condition and what activities are going on inside the home
- **Respond** to a given situation by providing assistance to the elder and getting help when necessary
- **Share** health and status information with authorized caregivers to help improve the quality and timely delivery of care

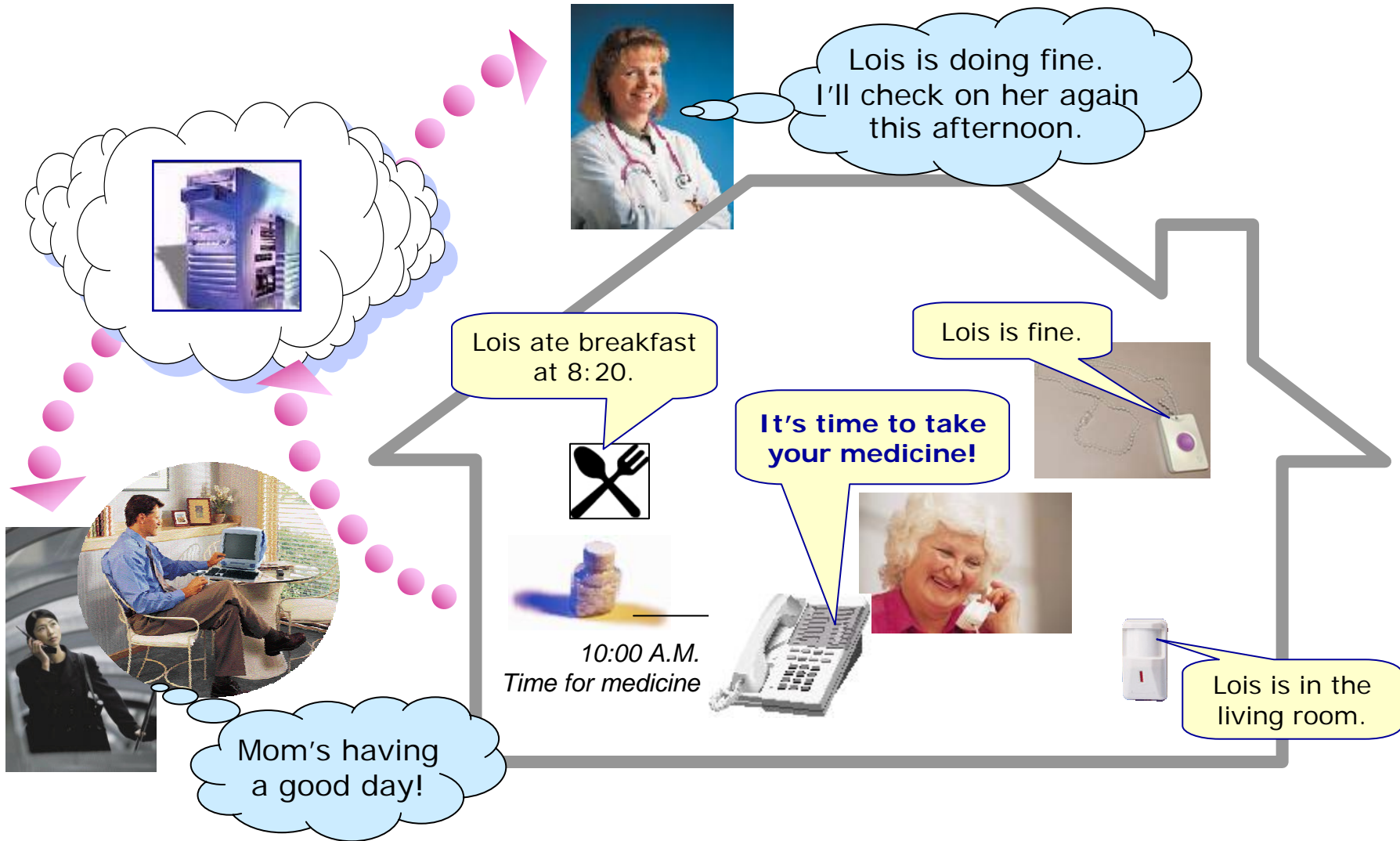
Smart Devices



I.L.S.A. Assistance



The Vision



High Priority Features

- **Monitoring**

- Intrusion detection
- Mobility (general activity level)
- Toileting
- Falls
- Verify medication taken
- Home and away
- Panic button activation
- Environmental conditions

- **Response**

- Alarms, alerts, notifications, reports
- Auto-contact help
- Path lighting

- **Services**

- Reminders
- To-Do lists
- Remote access to information
- Coordinate multiple caregivers
- Reduce false alarms

- **Usability Features**

- Acknowledge with exceptions
- Operational modes (vacation, guests, sick...)
- Muting (cameras, reminders...)
- Password-free elder interactions

I.L.S.A. Field Study: Eligibility

- Living Alone
- Competent in all ADLs
- Could be dependent in one IADL
- MMSE > 24
- Takes one or more medications
- Has family or formal caregiver who provides regular assistance
- Caregiver willing to participate in study
- Only small pets
- Access to high-speed internet

Netted interested clients, not needy clients

Test Subject Demographics

Location	N	Situation	Gender	Age
Minnesota	7	1 assisted apartment 6 independent apartment	1 male, 6 female	Ave: 83.42 Range 76-96
Florida	4	All in own homes	1 male 3 female	Ave: 70 Range (56-76)

- Relatively high education, High School to PhD
- Relatively high acceptance of technology
- “Early Adopters” who want to influence technology

Identifying willing elder/caregiver teams was more difficult than anticipated

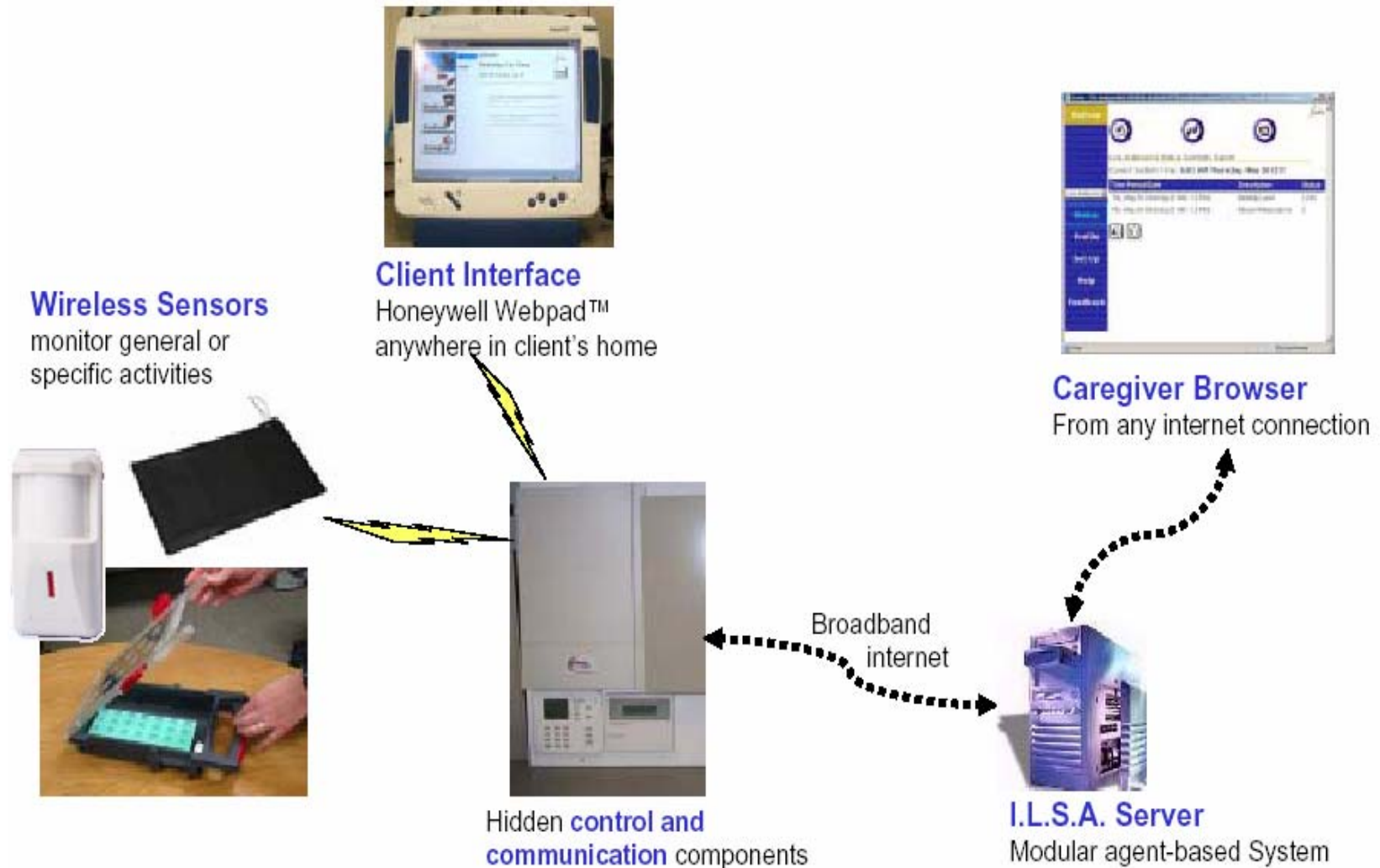
Field Test Participants

- **Elders were living independently**
- **All were physically active**
 - Assisted living resident used a walker in her apartment and a wheelchair for some transports in the facility.
- **All were “healthy” with at least one chronic illness**
- **All were comfortable with remotes, programmable appliances**
- **Five had some computer literacy; wide variation in abilities**
- **All but one (assisted living) still managed own medications**
- **Medications ranged from 1-16 doses per day**

I.L.S.A. Field Study: What did it do?

- **Functions¹**
 - **Reminders:** Notes to help elder remember what to do today
 - **Mobility²:** Summary of elder activity level for each time period of the day
 - **Medicine²:** List of the medications elder should take and whether he or she opened the caddy at the correct time
 - **Controls:** The status of I.L.S.A. in elder's home (on/off)
 - **Help:** What to do in an emergency and who to call if elder required assistance
 - **Support**
 - **Caregiver/family member, user guides, and technical support**
- 1** Critical to have accurate information
2 Thresholds have been established to issue alerts for these functions

I.L.S.A. Field Study System





Installation

Example apartment layout with sensor locations

- Zones 11-16
IR motion detectors

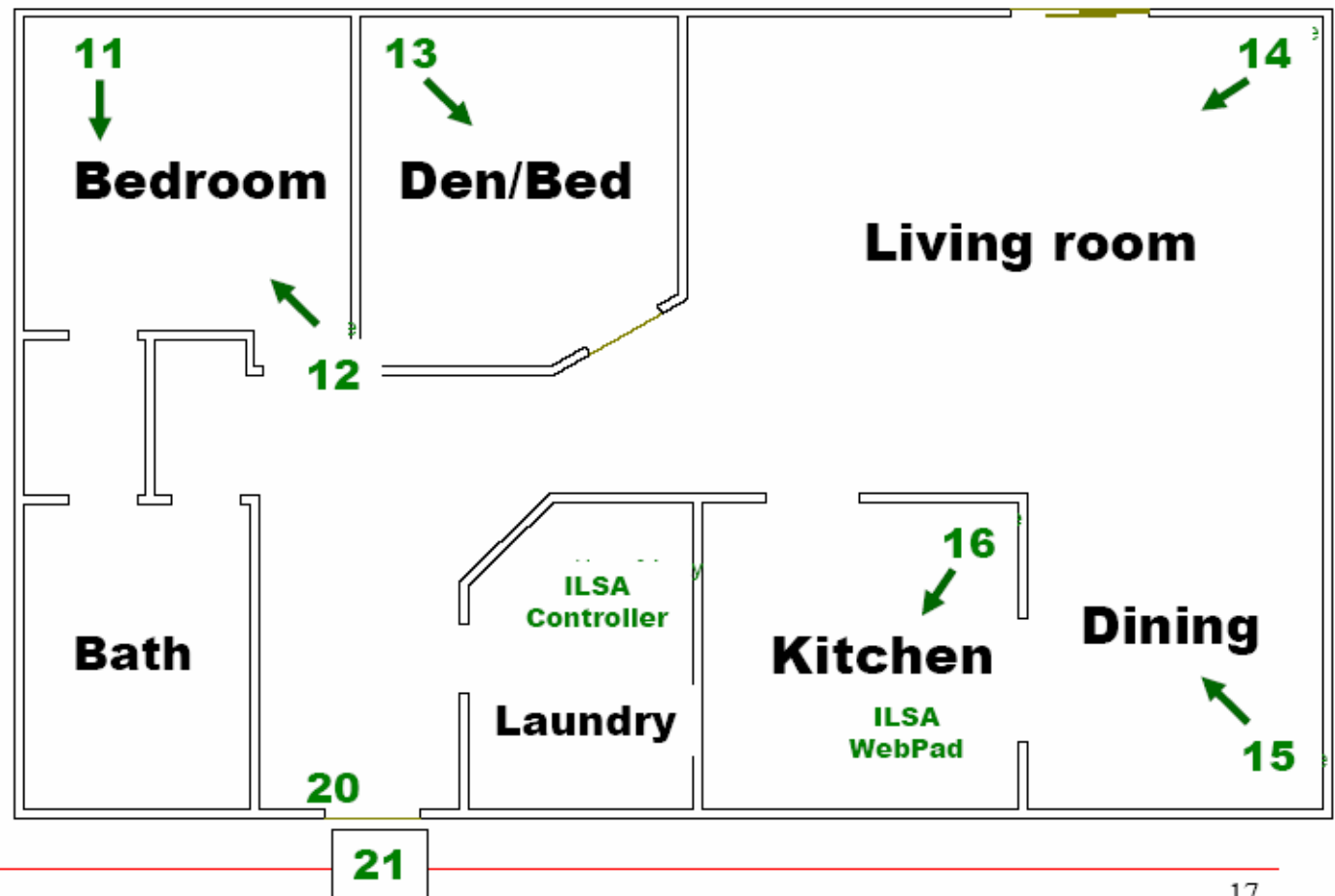


- Zone 20
Entry Door contact switch

- Zone 21
Hallway Pressure Mat



- Zone 10
med caddy contact switch



What I.L.S.A. Looked Like to the Elder



What I.L.S.A. Looked like to the Caregiver

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Managing Prescription Information

- As the designated caregiver for your parent, you will have access through your web browser to change medication schedules. If you are uncomfortable with this, you may call the support number we will provide and we can manage this data for you.

The screenshot shows a web browser window titled "Profile New - The Independent LifeStyle Assistant (TM) monitoring system (I.L.S.A.) - Microsoft Internet Explorer". The interface has a blue sidebar with navigation links: Notices, Status, Profile (highlighted), Set Up, and Help. The main content area is titled "Profile" and includes a "Save" and "Cancel" button. Below this is a section for "New medication information" with a dropdown menu for "Lois Anderson". The form fields include: Condition, Medication, Form (set to "Pill"), Dosage, and six Dose No. fields (all set to "N/A"). The Prescribing Physician is set to "Dr. Jeff Morgan". The Starting date is "07/11/2002". There are also fields for Ending and Comments. The bottom of the browser shows "Done" and "Local intranet".

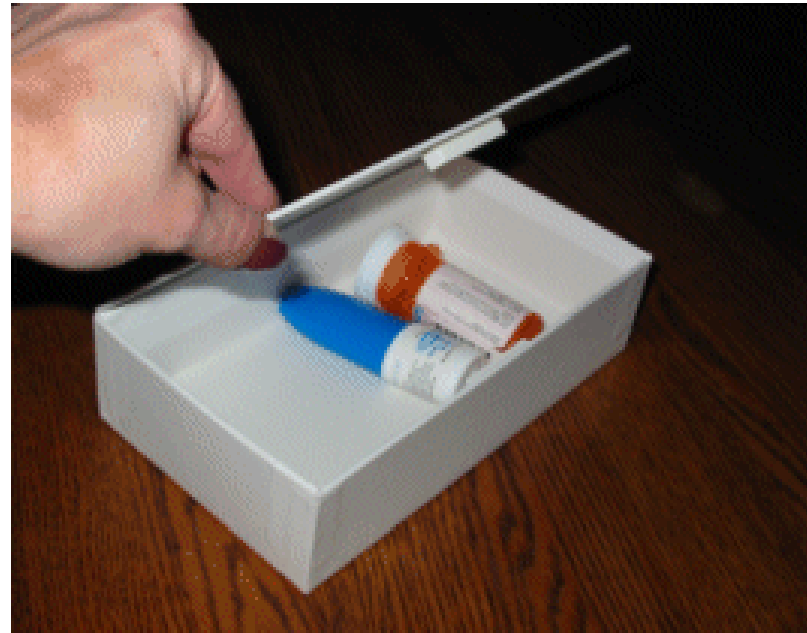
Medication Compliance Monitoring Design

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Simple approach.....

- ILSA knows the med schedule
- Senses when med caddy opens
- If caddy is not opened within X minutes of scheduled time, a reminder is delivered.
- Displays schedule and access record for client and caregiver(s)

Selected boxes for each client based on the size of their pill sorter or bottles.



I.L.S.A. Test Results: Medication Monitoring Results

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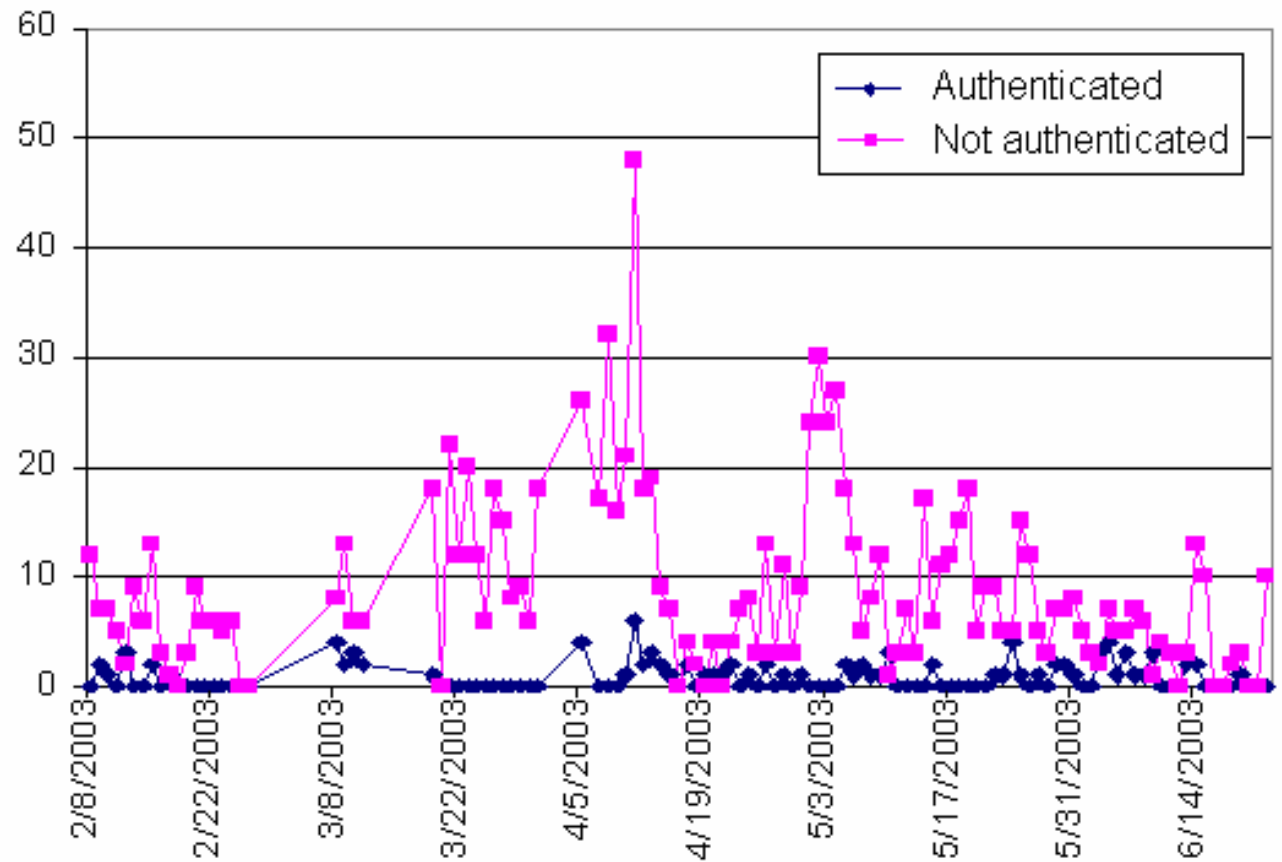
- **Reduction in missed medications for most clients**
- **Clients disliked the telephone reminders**
 - Became more compliant to avoid them
- **Some clients used I.L.S.A. to confirm that they took their medication**
- **For most clients, incidence of missed medications **did not significantly increase** when reminders were turned off near the end of the test period**
- **What seniors liked about it:**
 - Little disruption from current habits
 - No additional interaction required beyond normal medication handling
 - Time window reduced unnecessary reminders
 - Exercised senior's cognitive faculties
 - Device was simple and familiar-looking
- **Clients want multiple caddies so they can keep their meds distributed throughout the home**

I.L.S.A. Test Results: Med Reminders

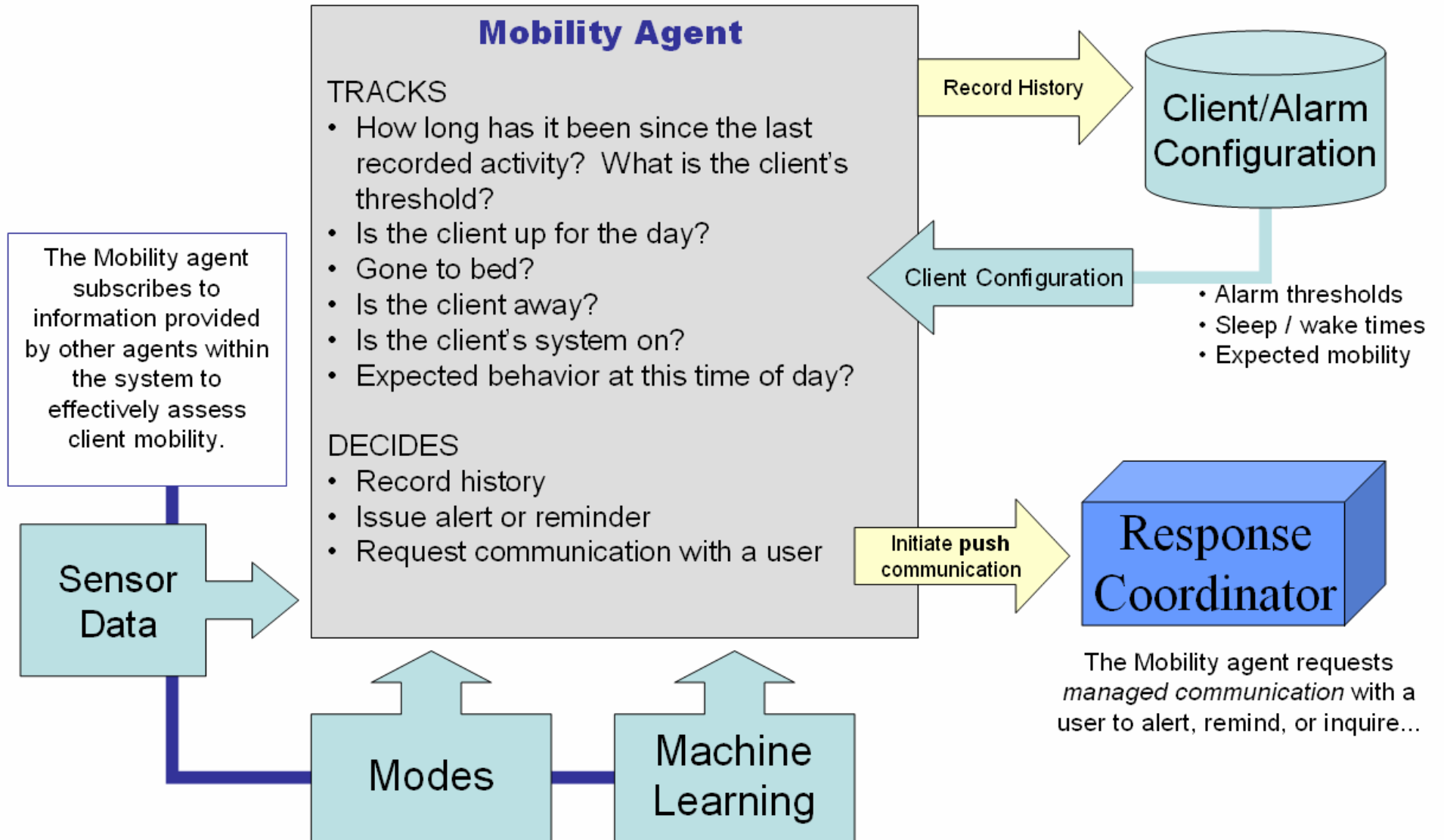
- **Disliked telephone reminders:**
 - Tried to “beat the system”
 - **Became more compliant**

Is it better to have polite friendly phone interactions, or deliberately keep them less acceptable??

- **Significant cognitive cost to telephone interface**
 - “Press one if you are Lois”
 - See [Haigh et al 2006] for more discussions on Speech



Mobility Monitoring



I.L.S.A. Test Results: Mobility

- **Access to reports increased elder interaction and acceptance of monitoring.**
- **Clients were very interested in the reports, but**
 - Monitoring was too general: “no motion”
 - Monitoring was not accurate enough: sensor placement, entry/exit, time-window for alerts
- **Greatest fear is falling, then safety**
 - Body-worn fall sensor is best bet now, but longer term we need a completely passive fall sensor
- **Accurate mobility reports can provide value to both clients and caregivers.**
- **Installation and configuration of activity sensors is the single most significant barrier to cost-effective application of this technology.**

I.L.S.A. Test Results: Privacy

- The number one barrier to finding willing participants
 - Caregivers often had more significant negative reaction to privacy than the elders did
- Initial concerns about privacy were forgotten within a day or so of installation
- **Having access to the information shared with caregivers may have made elders feel less spied upon.**

Salesmanship is key: misunderstanding and mistrust of technology is common

I.L.S.A. Test Results: Engagement & Interest

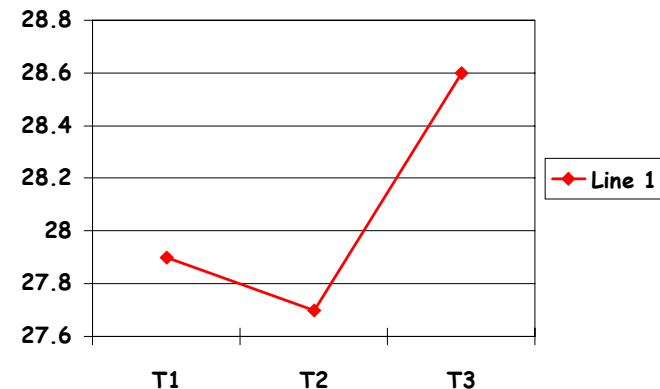
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- **70% of clients used webpad several times a week or daily**
 - Even at the end of the 6-month study
- **Clients asked for more capabilities**
 - e.g. instant messaging
 - e.g. comment on reports (why they didn't take meds, sensor errors)

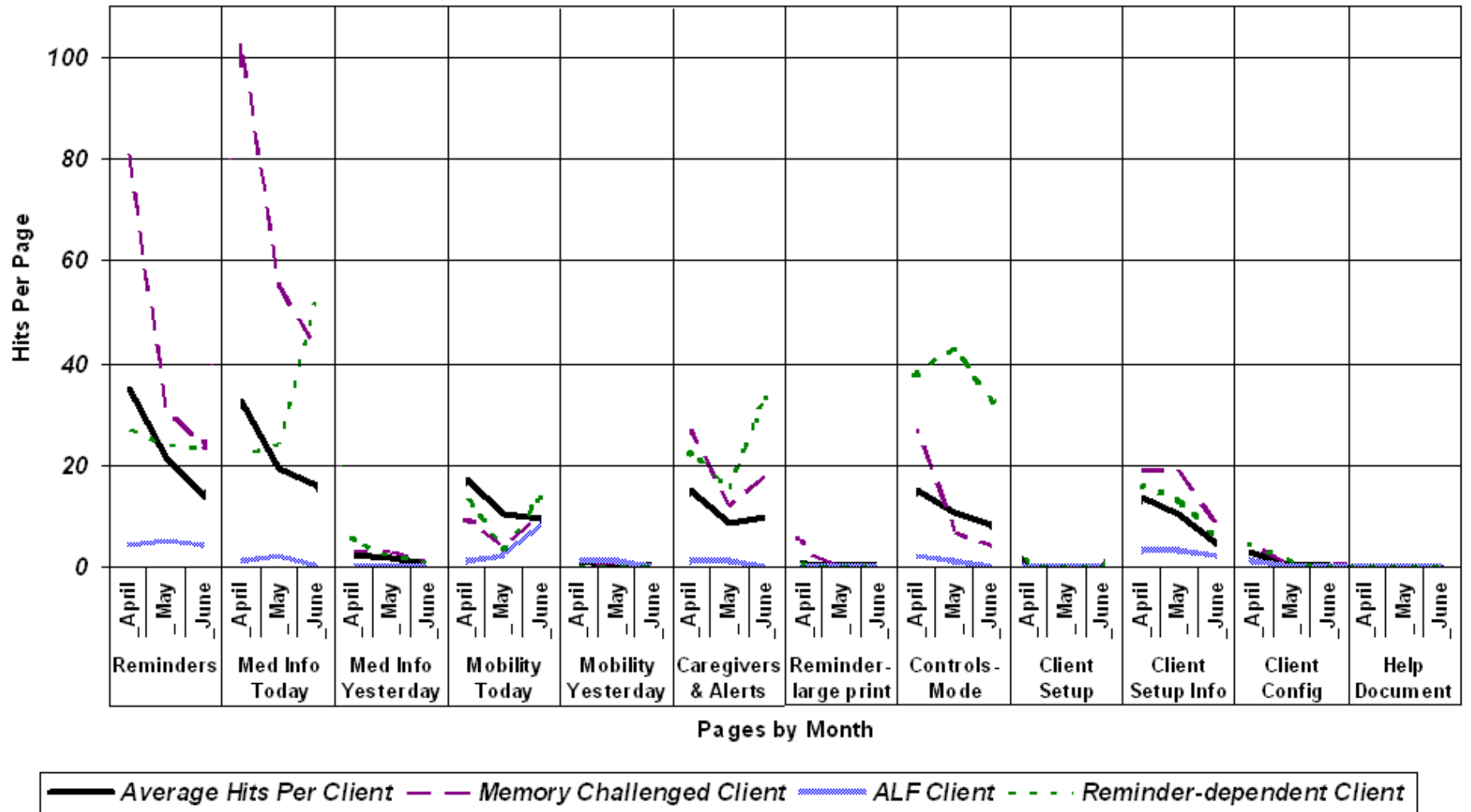
- **Increased Mini-Mental scores**

Not statistically significant due to sample size

Mini Mental Status Exam Results



I.L.S.A. Test Results: Client Web Use



I.L.S.A. Test Results: Summary

Clients capable and interested

- **Reminders**
 - Liked webpad reminders; universally disliked the phone reminders
- **Medication**
 - Liked being able to check whether they had taken their meds
 - Schedules need to be adaptive & better
 - Really liked our medication caddy (simple & portable)
- **Mobility reporting**
 - Keenly interested
 - Wanted to be able to send feedback about the accuracy of reports.
- **Controls (On/Off Modes)**
 - Did not like: Afraid they'd forget to reset I.L.S.A. when they returned.
- **Help**
 - No interest from any clients at all

Results – Caregiver Reactions

- **Privacy**

- Most responded negatively to the idea of placing video cameras in their parent's home as an alternative to motion sensors.

- **Interest in Reports**

- Few I.L.S.A. caregivers took routine notice of mobility data.
- Family caregivers did not look for trend information -- relied on I.L.S.A.'s short-term assessments, e.g., alerts and status reports.

- **Effectiveness**

- Nighttime activity reports prompted one caregiver to question the behavior and uncovered a urinary tract infection.
- Daytime activity status reports alleviated the concerns of one caregiver when her parent was in a particularly frail condition.
- **Most believed that this information could provide value when their parent became more frail *IF* the methods were improved.**

Clients not *needy*; caregivers
do not yet perceive need

(Big) Remaining Technical Hurdles

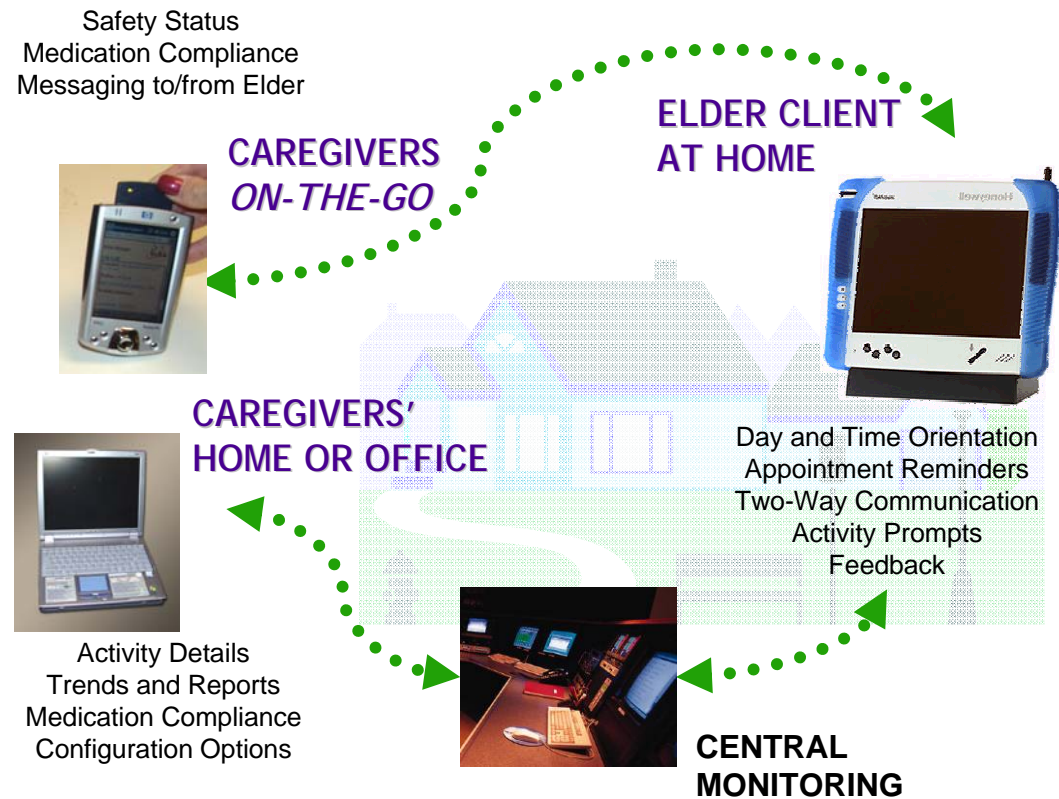
- **Sensing**
 - Passive, easy to install, accurate
- **Multiple users with differing needs and goals**
 - Elder client, family members, Formal Caregivers
- **Ongoing configuration**
 - Configuration parameters can be expected to change over time both for the client and the home
 - ◆ user entered changes
 - ◆ dynamic adaptations based on living patterns
- **User Acceptance**
 - Will it do what I need?
 - Will it be hard to learn?
 - What if it doesn't work?
 - Will it violate my privacy?



Increased Connectivity

Connecting the Support Network

- Simplified internet-enabled communication for the elderly
- Concise reports for concerned family members
- Direct connect to primary professional caregivers
- 24x7 remote monitoring



Activity Sensing

- **Most commercially available technology is remote medical sensing**
- **BIG GAP: Reliably, passively detecting ADLs**
 - Falls
 - Sleeping
 - Eating
 - Wandering
 - Toileting
 - ...
- **Many current research efforts**
 - Honeywell's I.L.S.A, GA Tech, MIT, U Wash, U of Virginia, etc
- **Commercial:**
 - **Living Independently (sold by ADT) uses motion to track the person's activity level at home.**
 - **BodyMedia uses an armband to track activities & health conditions**

See http://www.htc.honeywell.com/projects/ilsa/content/weblinks_researcherTechnology.html

Activity Sensing

- **Goal: Employ a variety of sensors for detecting action, motion, or physical presence to recognize normal activities and identify potential symptoms of decline.**

- Traditional security sensors (motion, door switches)
- Pressure pads
- Weight detectors
- Water flow, heat, other home safety
- Practical only for those living alone

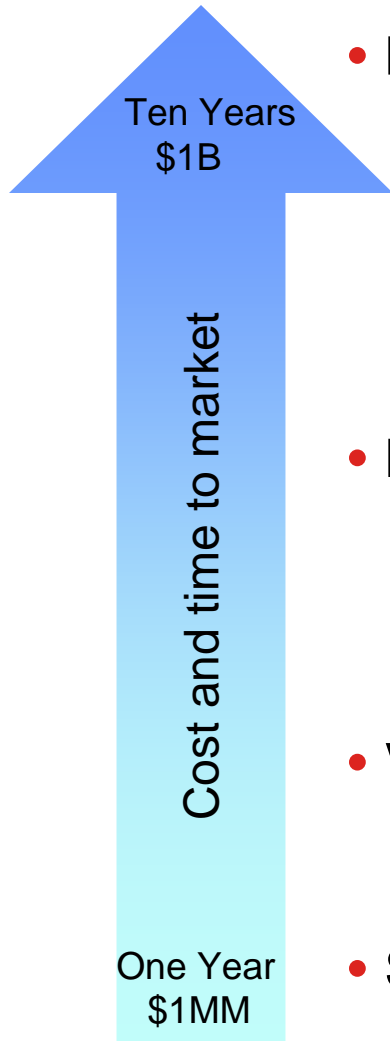
Wireless devices



Current Shortcomings:

- Accurate configuration to individual living patterns is problematic. Makes systems expensive to deploy.
- Need many sensors and other types of evidence to confirm what motion sensor data really means
- Difficult to filter out evidence associated with visitors vs. the occupant
- Simple reliable means of tracking individuals

Emerging Sensing Technologies



- **Nanotechnology**
 - Nanotech describes the smallest bits of matter than humans can fashion into a device. Nano-devices are measured and studied on the same scale as single atoms a human hair is 50,000 nanometers in diameter
 - biosensors, drug delivery, molecular motors, revolutionary electronic systems
- **MEMS**
 - Micromechanical devices
 - filters on a chip, engines, robots, measured in microns (1000 nanometers)
 - Handheld micro bolometer
- **Video processing**
 - Reliable and cost-effective facial recognition
 - Diagnostics
- **Sensing advancements**
 - Smart sensors (embedded intelligence – fall sensor)

Examples of Interesting Sensors

- **Fall / Gait sensor (Univ Virginia, Madj Alwan)**
 - **Acoustic sensor that attaches to the floorboard**
 - **Gait**
 - ◆ Distinguishes people
 - ◆ Precursor for stroke
 - **Falls**
 - **Location**
- **“Up at Night” sensor (Univ Florida, Meredith Rowe)**
 - **For the *caregivers* of Alzheimer’s patients & ADHD children**
 - **Zones for alerting**
 - ◆ In bed, In house, Leaving house

Socialization

- How do we find out what is engaging and fun to elders?
- Discover what activities seniors who are still independent like to do (gardening, knitting, golfing, fishing, games....)
- Find or invent virtual analogues for these activities that scale to the mental and physical limitations of older, more frail seniors.
- Discover and characterize their current social circle and how they can maintain social contact through technology.

Interview → Prototype → Focus group or test → Refine Concepts

Group Interviews With Seniors

- **Strong recurring themes (topics that raised the decibel level in the group discussion)**
 - **Volunteer activities** (organizing and doing) are a major source of social interaction and occupy a great amount of their time. Seniors also believe that these are among the first activities they would have to stop if they became homebound.
 - **Sharing personal perspectives** on history is a way they connect with their peers and with younger generations.
 - **Games and puzzles** are great if they provide the opportunity to interact with other people (by means of organizing the game or playing the game)

Socialization technical challenges

- **Do our analogue forms of interaction really capture the essence of social interaction? What's good? What's missing? Does audio help? Does video help?**
- **Need to replicate some of the dynamics of social interactions in much the same way as happens spontaneously in real life.**
 - e.g. Provide users the ability to turn down invitations to join an activity or event, contingent on who else is invited; automatic matching with people of similar interests; provide capability to initiate and organize activities with others.
- **User interfaces need to be adaptable to the changing psychomotor and cognitive abilities of aging people**
 - UI's need to be simple
 - Games need to be "decelerated"
- **Auditory interface may be necessary**
- **Screen size is issue for some applications**
- **Security for vulnerable participants**

The Virtual Community Center

December 16th, 2005

St. Andrew's community center

The
daily
jigsaw

Play
bingo

Organize
A game

Send a
greeting

Share
a story

Go
home

August 16th, 2005

On this day in 1951

President Truman signed a treaty that ended
The Korean War.

Where were you at the time?

**Speak into the microphone and
tell your story**

**Memory
joggers**

**Play
back**

**Send to
group**

Return

Conclusion

- **Need better sensing technologies**
 - Passive, reliable, accurate
- **Need better inference technologies**
 - Situation assessment, behavior modelling
- **Need better interface technologies**
 - Engaging interfaces & Socialization
- **Need to solve the installation & configuration issue**
 - Cheap, fast, accurate. Can a nurse do it in an hour?
 - Ongoing changes.
- **Need *good* clinical studies to determine cost savings & quality of life improvements**
- **Need to figure out how to market & sell the ideas**
 - Privacy
 - Who will pay?
 - Who will service?
 - Where are the incentives now, what will change them in the future?

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I.L.S.A.	www.htc.honeywell.com/projects/ilsa/

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