



Caregivers at Home Lightening the Load

Healthcare, Human Services and Technology
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Agenda

- I.L.S.A. Introduction
- Field Test and Test Subject Description
- Mobility Monitoring Design and Results
- Medication Monitoring Design and Results
- Conclusions



Independent LifeStyle Assistant

Program Objective

Develop an intelligent home automation system with situation awareness and decision-making capability based on integration of diverse sensors, devices, and appliances to support caregivers and enable elderly users to live independently at home.

Co-funded by

Honeywell

And

U.S. Department of Commerce

National Institute of Standards and Technology (NIST)

Advanced Technology Program (ATP)



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



Factors Precipitating Institutionalization

Literature reviews, interviews with adult children caregivers, and discussions with geriatric experts identified the most significant factors that pose a threat to the independence of elders.

- Mobility
- Medication Management
- Eating
- Toileting
- Isolation
- Medical Monitoring
- Cognitive Decline
- Safety
- Caregiver Burnout

Existing monitoring solutions often focus on a single function—little or no integration.



Monitoring Functional Status

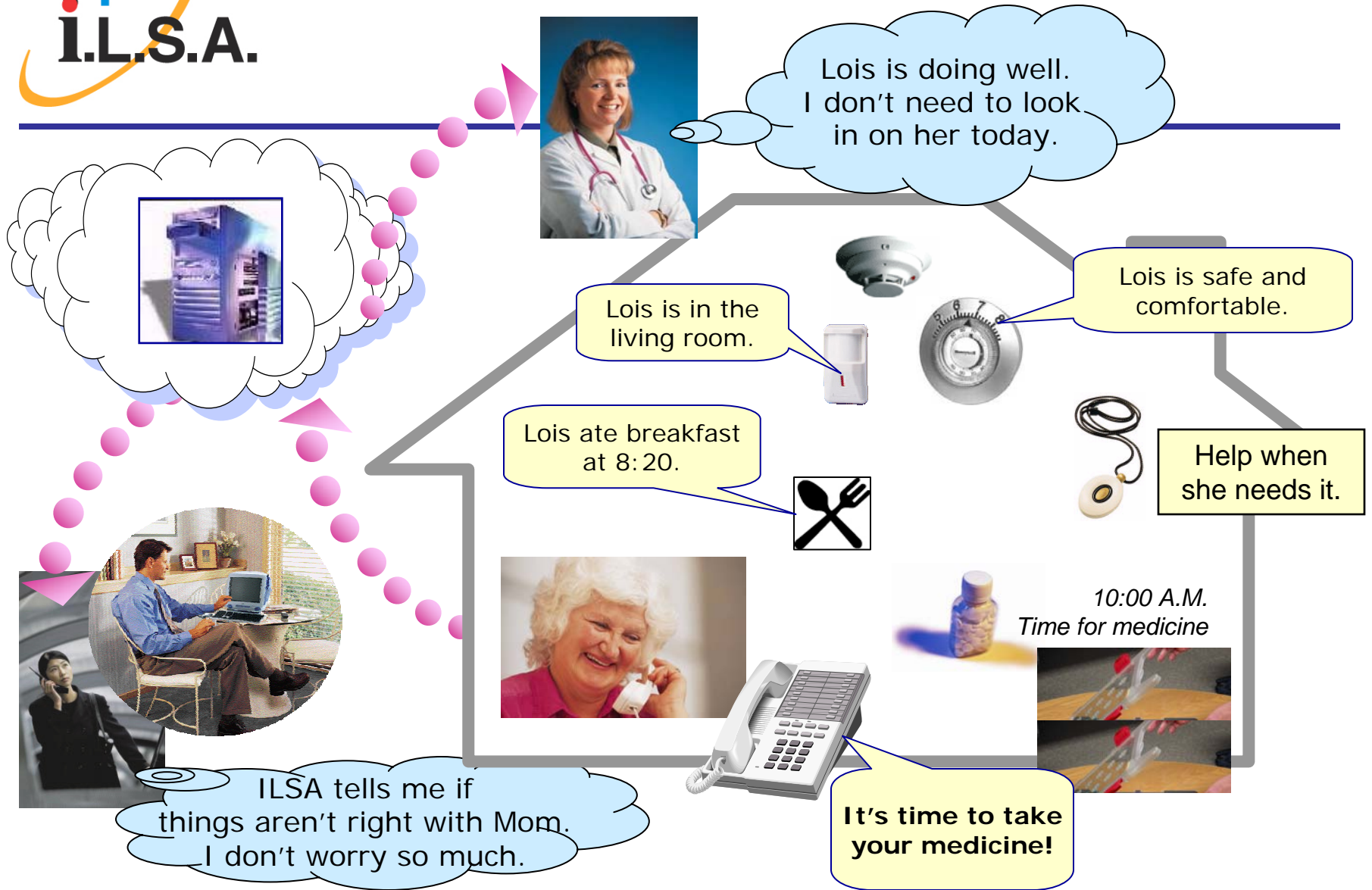
- Ability to stay at home depends on mental and physical ability
- Clinic visits inadequate for functional assessment due to brief visit and out of context
- About 75% of elders maintain a structured life. An elder who has changing or deteriorating structure will probably leave the home soon.
- Changes in eating, drinking, and vital signs typically begin to decline 2 weeks prior to a serious event.

Recognizing changes in routine daily behaviors is an important predictor of change in status.



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 and the elderly client to help improve the quality and timely delivery of care





Field test aims

- Assess design of interface and interaction
- Assess attitudes and perceptions of elders and family caregivers
- Assess patterns of behavior
- Evaluate system implementation and operation
- Evaluate system effects

For wider coverage of I.L.S.A. results, please visit our official website at <http://www.htc.honeywell.com/projects/ilsa>



Field Test Design

Longitudinal, single group repeated measures

Sites:

- **Minnesota: 7 Assisted Living Apartments**
- **Florida: 4 Independent homes**



Test Subjects

Inclusion criteria:

1. Takes one or more medications daily
2. Independent in ADLs
3. Needs assistance with one IADL
4. Has family caregiver who provides regular support
5. Family caregiver willing to participate



Field Test Measures

- Usability questionnaires-weekly, monthly
- Motion sensors
- Medication caddy sensors
- Elder health: SF-36
- Elder cognition level: MMSE
- Elder comfort with technology
- Focus groups: elders and caregivers



Demographics

Demographics (Minnesota only)

n=7

Age: 83.42 (range 76-96)

Gender: 1 male, 6 female

Marital status: 6 widowed, 1 married (f)

Level of education: 4 HS, 2 College
grads, 1 masters' degree



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 Adoptors” who want to influence technology

Identifying willing elder/caregiver teams was more difficult than anticipated



Test Subjects

Comfort with technology:

40.29 (range 37-45)

Mobility

- One uses wheelchair for long distances, walker in apt.
- Others very active; all but two still drive

Med Adherence:

- One has meds set up
- Others set up own weekly
- Number of meds range from 1-16 per day



Test Subjects

- Elders are living independently
- All were physically active
- 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



Caregiver Profile

- I.L.S.A. test subjects required to have at least one family caregiver
- Total of 17 caregivers registered for 11 clients
 - 8 Men, 9 Women
 - Access to web was a criteria for our test
- Professional caregivers were not targeted in this study



Implementation



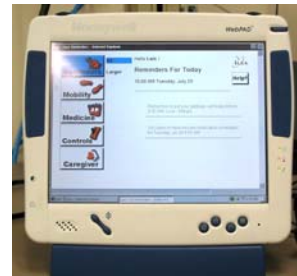
Field Test Features

- **Activity Monitoring**
Sensed and summarized activity level for each time period of the day compared to an expected baseline
- **Medication Compliance**
List of the medications elder should take and whether he or she opened the caddy at the correct time
- **Reminders**
Notes to help elder remember what to do today
- **Control**
Allowed elder to turn the system on/off

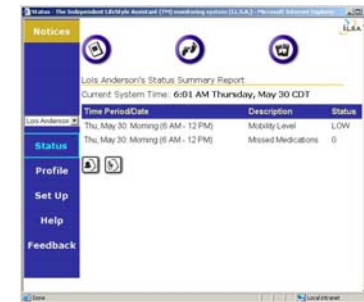


I.L.S.A. System

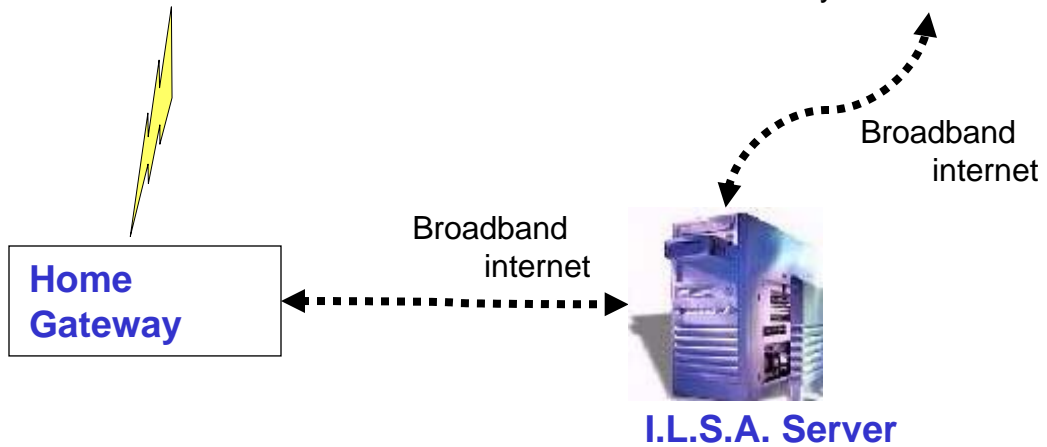
Wireless Sensors
monitor general or
specific activities



Client Interface
Honeywell Webpad™
anywhere in client's home



Caregiver Browser
From any internet connection





Installation

Example apartment layout with sensor locations

- Zones 11-16
IR motion detectors

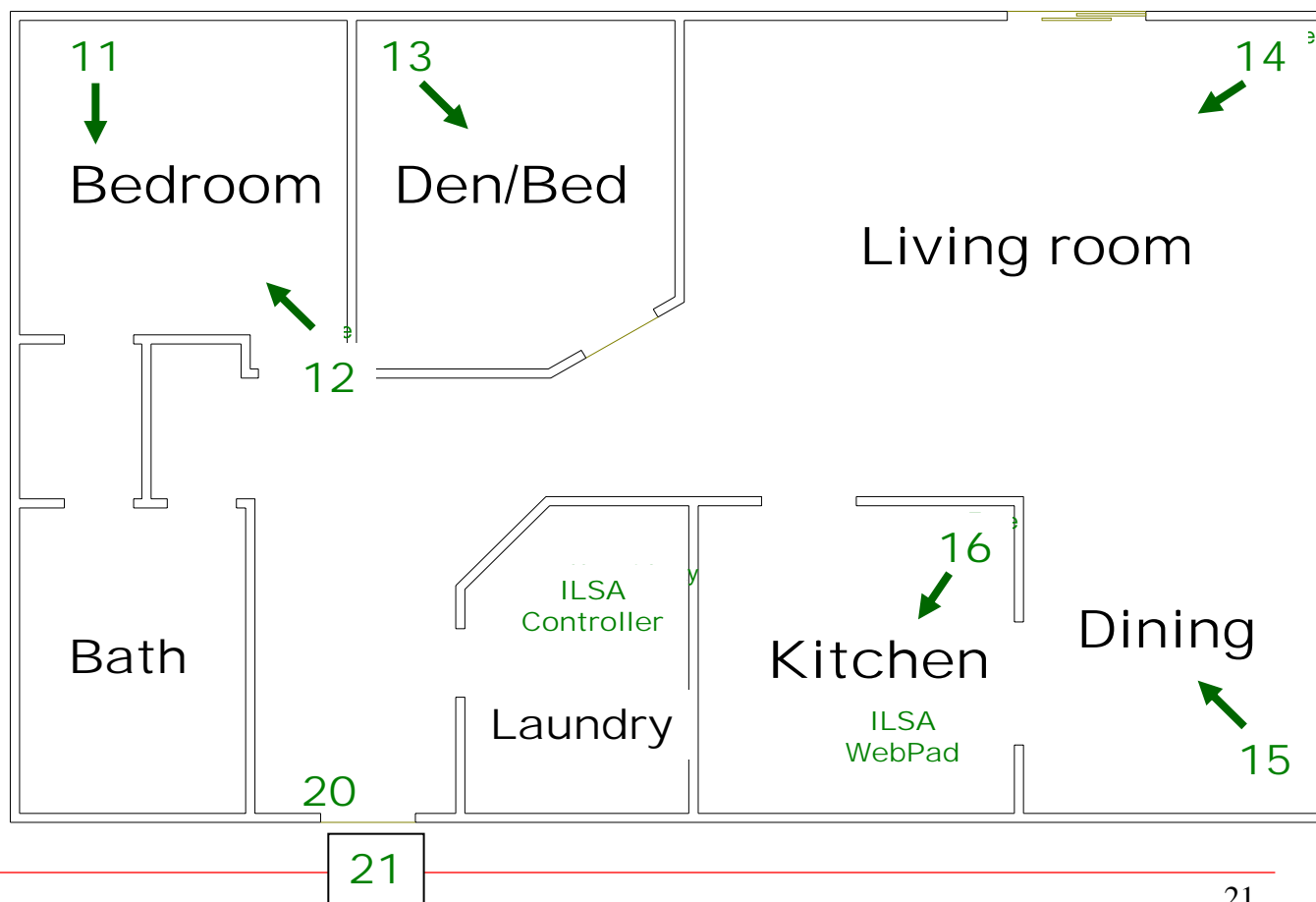


- Zone 20
Entry Door contact switch

- Zone 21
Hallway Pressure Mat



- Zone 10
med caddy contact switch





I.L.S.A. Client Interface





Design Philosophies

- **Passive**
Allow elders to follow regular routines without imposing new ones
- **No worn devices**
Panic buttons not adequate in many instances (not handy, unconscious patient)
- **Minimal intrusions**
No noises from system except automated reminders (as needed) via telephone
- **Web Pad optional**
No requirement for them to use the Webpad™ for proper system behavior.



Activity Monitoring Design

- Alerts for “No Activity”
 - The complete lack of sensor events (from all sensors in the home) for a configurable duration. (e.g., 5 hours) during waking hours.
- Alerts for significant change in pattern
 - 50% increase or decrease sustained for three days, as compared to the previous seven days.
- Up-at-Night Notification
 - Sensor readings during the time when the client was normally asleep
- Communication
 - Telephone alerts to caregiver and listed on the web site
 - Web site or telephone status reports available on demand.
 - Clients could see alerts issued in the last 48 hours



Activity Monitoring Conclusions

- *Accurate* mobility reports can provide value to both clients and caregivers.
- An accurate and passive means of detecting occupancy of the residence is essential to providing useful activity information.
- Access to reports has the potential to increase elder interaction and acceptance of monitoring.
- Activity sensors by themselves cannot provide 100% accurate detection of normal or abnormal events.
- Installation and configuration of activity sensors is the single most significant barrier to cost-effective application of this technology.
- Machine learning and other artificial intelligence techniques can improve accuracy and simplify configuration.



Activity Monitoring Reactions

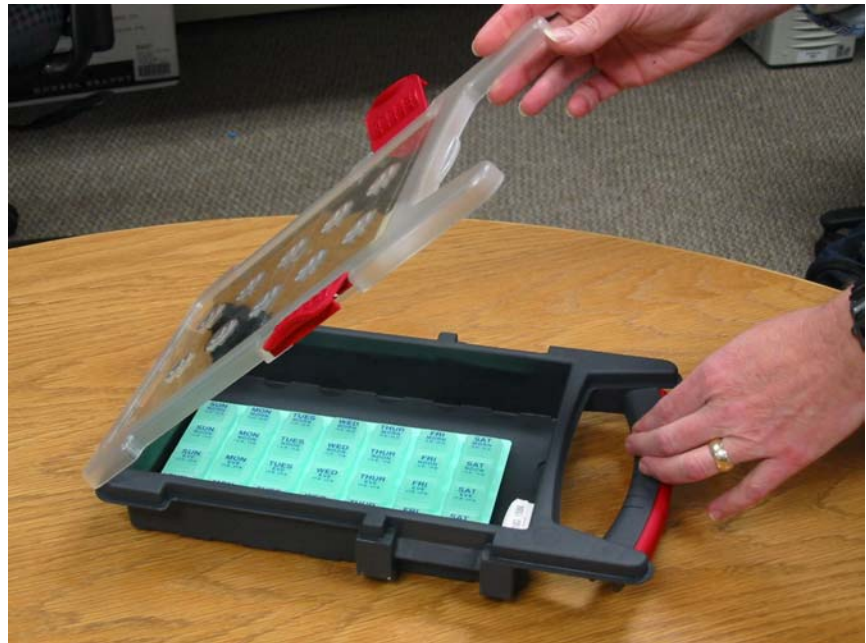
- Little disruption from current habits
- Did not feel their privacy was invaded
- Actively interested in the reports
- Did not want to use Home/Away mode
- Too many false alerts when they were away
- Caregivers did not like being the first call on an alert



Medication Compliance Monitoring Design

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)





Client Medication View

Lois: Your Medication Today - Microsoft Internet Explorer

Reminders

Mobility

Medicine [Today](#) [Yesterday](#)

Controls

Caregiver

Medicine Today

02:08 PM Monday, July 14

[Help?](#)

Medicine	Time	Status
Prednisone	8:00 AM	OK
Zoloft	8:00 AM	OK
Vitamins	8:00 AM	OK
Aspirin	8:00 AM	OK
Clomipramine	10:00 PM	
Lipitor	10:00 PM	
Atenolol	10:00 PM	

Medication was last accessed on Monday, Jul 14 11:09 AM

Local intranet



Medication Compliance Monitoring Design

- Time window for compliance is flexible and set in cooperation with the senior
- Time window approach greatly reduces the number of unnecessary reminders compared to fixed time approaches
- Elder can view schedule and compliance for the day
- Reminders consisted of phone call and recorded voice message, as well as text message on Webpad™
- 24 hours of noncompliance prompts an alert to caregiver



Medication Monitoring Results

- Most clients showed a reduction in missed medications while using I.L.S.A.
- Clients disliked the telephone reminders so much that they became more compliant to avoid them
- Encouraged them to exercise their own memory
- For most clients, incidence of missed medications did not significantly increase when reminders were turned off near the end of the test period
- Elders were able to continue to manage their own medications using this simple system
- Clients want multiple caddies so they can keep their meds distributed throughout the home



Medication Monitoring Reactions

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



Measurements



SF-36

Short Form-36 (SF-36)

Physical Health

Physical functioning

Role-physical

Bodily pain

General health

Mental Health

Vitality

Social functioning

Role-emotional

Mental health



Scores

Field Test Results: SF-36

SF 36 FACTORS	T1	T2	T3	p
Physical Function	62.9 (21.6)	59.3 (22.9)	50.7 (20.3)	.38
Role-Physical	53.6 (44.3)	53.6 (36.6)	57.1 (34.5)	.97
Pain	76.8 (25.4)	84.9 (19.2)	72.3 (27.8)	.51
General Health	71.6(35.9)	66.9 (21.0)	65.9 (23.8)	.76

(Standard Deviation)



Scores

Field Test Results: SF-36

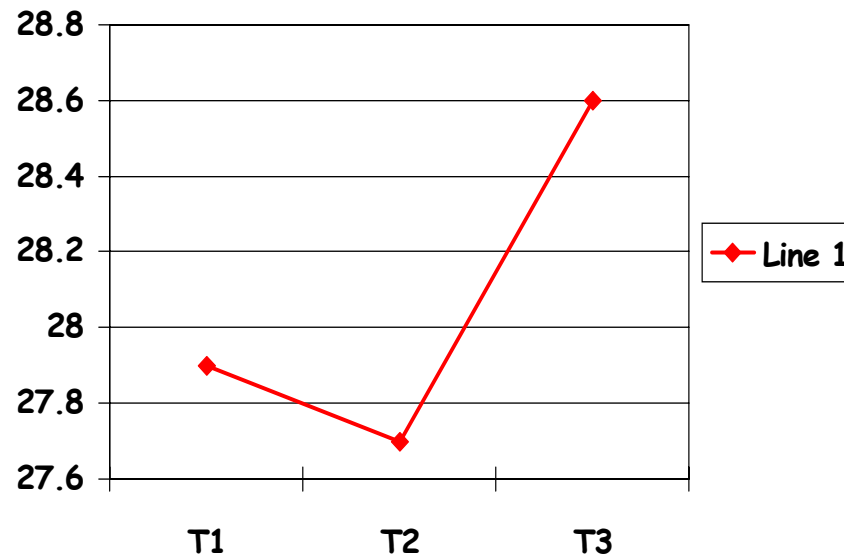
SF 36 FACTORS	T1	T2	T3	p
Vitality	52.9 (24.8)	58.6 (20.3)	49.3 (15.4)	.29
Social Function	87.5 (17.7)	91.1 (15.7)	75.0 (22.8)	.21
Role-Emotional	83.3 (27.9)	90.5 (25.2)	76.2 (46.0)	.75
Mental Health	82.9 (11.9)	86.9 (6.8)	76.6 (14.7)	.09

(Standard Deviation)



Mini Mental Results

Mini Mental Status Exam Results





Correlations

Age with general health	.245	.487	.721
Age with pain (p=.023)			.823
Gender (f)with PF	-.618	-.612	-.618
Gender (f) with MMSE	.683	.642	.642
Comfort with MH	-.430	-.731	-.542



Summary

- Clients were keenly interested in the reports of their activity and wanted to send feedback about the accuracy of reports.
- Clients did not appear to become dependent on medication reminders
- Clients were engaged by I.L.S.A. throughout the testing period
- Automated calls were universally disliked and not properly acknowledged (did not confirm delivery)



Conclusion

Our experience with I.L.S.A. highlighted topics for further study:

- System interaction concepts for elderly users
- Further study of machine learning algorithms in this domain
- Revised models of activity monitoring and sensor selection/placement
- Reminder behavior and adaptability
- Market questions:
 - how to overcome barriers to acceptance of “invasive” technologies
 - how to overcome reimbursement / cost / incentive barriers within current marketplace



Acknowledgements

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- Honeywell ACS Labs thanks LifeLine Systems, Inc. for providing emergency personal response coverage for the Florida-based clients.



Thank You for sharing your time with us.

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<http://www.htc.honeywell.com/projects/ilsa>



Test Criteria

ILSA Test Subject Inclusion Criteria

- Living alone
- MMSE > 24
- Availability of high speed internet service
- Agreement of participation from a family member/caregiver



Test Subject Demographics

Location	N	Situation	Gender	Age
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Field Test Participants

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



Field Test Measures

- Usability questionnaires-weekly, monthly
- Motion sensors
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- Elder health: SF-36
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 - Pre-install, midpoint, end
- Elder comfort with technology
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