Creating Proactive Environments for Healthy Living

Research and Technology for Aging, Disability and Independence
June 26-27, 2003 London, UK

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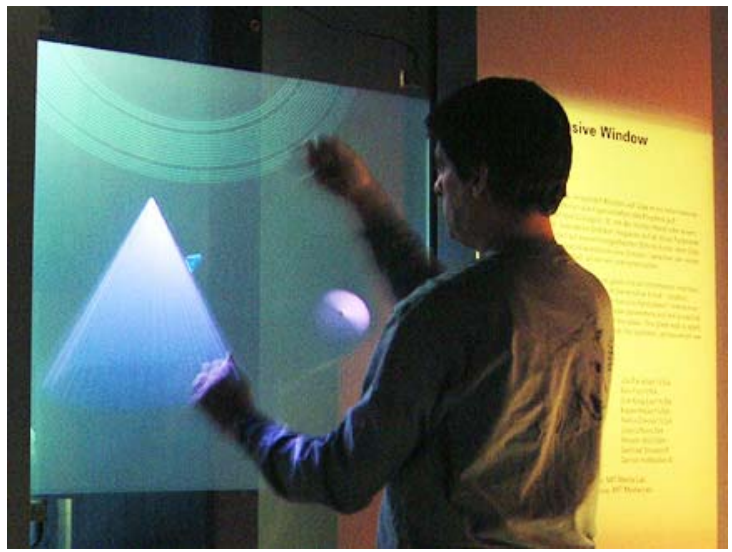
Director, MIT Changing Places Consortium (Department of Architecture + Media Laboratory)

Architecture:

Places ← Technology

Media Lab / AI Lab:

Technology → Places

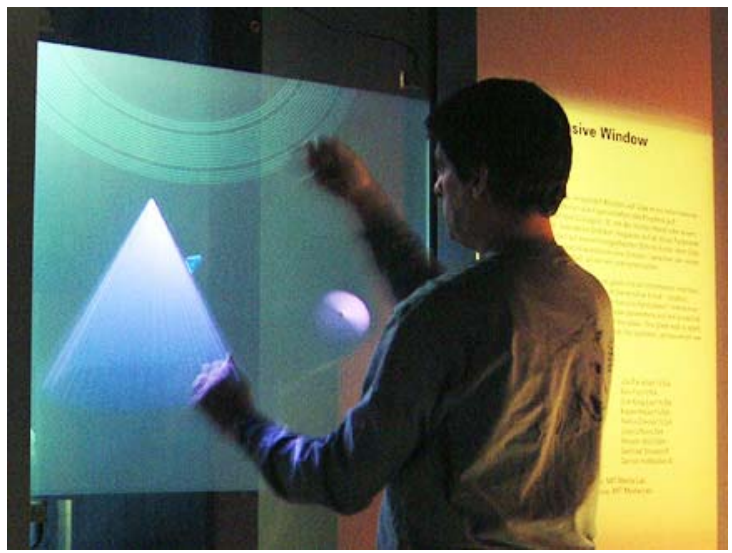


Architecture:

Places ← Technology

Media Lab / AI Lab:

Technology → Places



Buildings:

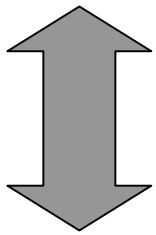
Permanent

Life & Technology:

Change

Buildings:

Permanent



Life & Technology:

Change

The MIT Open Source Building Alliance (OSBA)

Toward standards for creating

low cost
high performance
responsive
agile
buildings

Grants:
NSF (2)
Robert Woods Johnson Foundation
AARP Andrus Foundation
Center for the Integration of Medicine and Innovative Technologies (2)
IBM Research
GE Global Research (DOD sub)

Consortium Sponsors:
Motorola
British Telecom
Intel
Hewlet Packard
Samsung
State Farm Insurance
Salt River Project

Health-related Partners:
Harvard School of Public Health
Boston U. Medical

1

What is Proactive Health?

2

Recognizing activities of daily living:
the portable environmental sensor kit

3

Scenario:
One possible proactive health service

4

PlaceLab: a “microscope” to study technologies and interventions in the context of life.

1

What is Proactive Health?

What is Proactive Health?

Environments, technologies, and services that help people stay:

- **Autonomous**
- **Comfortable**
- **Engaged in Life**
- **Healthy**

Three levels of health at home (in increasing order of difficulty and importance):

1. Responding to crisis (requires a few good sensors)

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2. Early warning of emerging problems (requires ubiquitous sensors)

Three levels of health at home (in increasing order of difficulty and importance):

1. Responding to crisis (requires a few good sensors)

2. Early warning of emerging problems (requires ubiquitous sensors)

3. Proactively keeping people healthy (requires ubiquitous sensors and communication media)

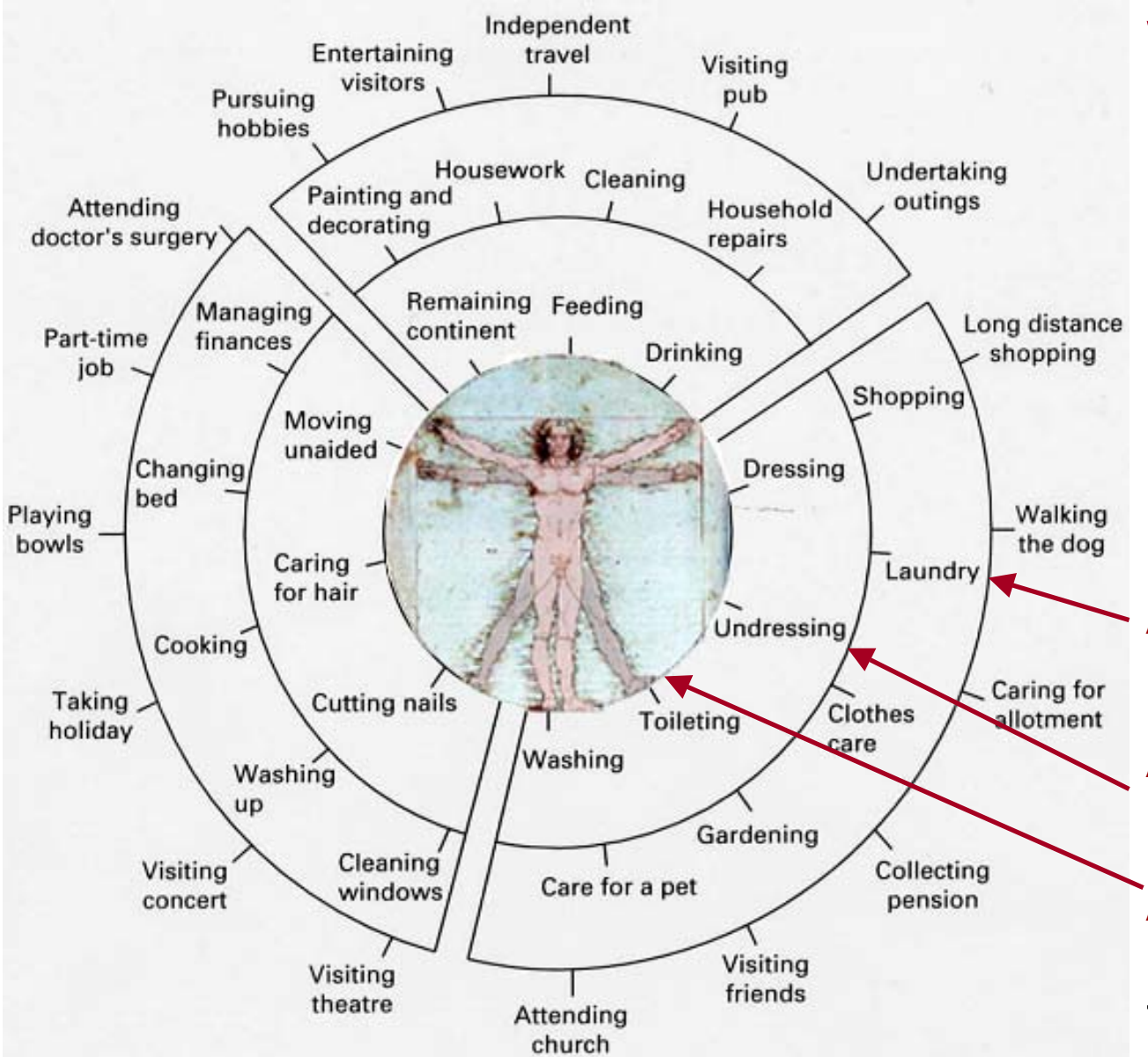


Figure 106-1 A model of social performance levels in older people. (From Williams EI: A Model to Describe Social Performance Levels in Elderly People. Br J Pract; 36:422–3.)

What is Proactive Health?

Proactive health involves maintaining the three rings of social performance

Activity in the community

Activity in the household

Activity related to body

The problem involves more that the health of the body alone.

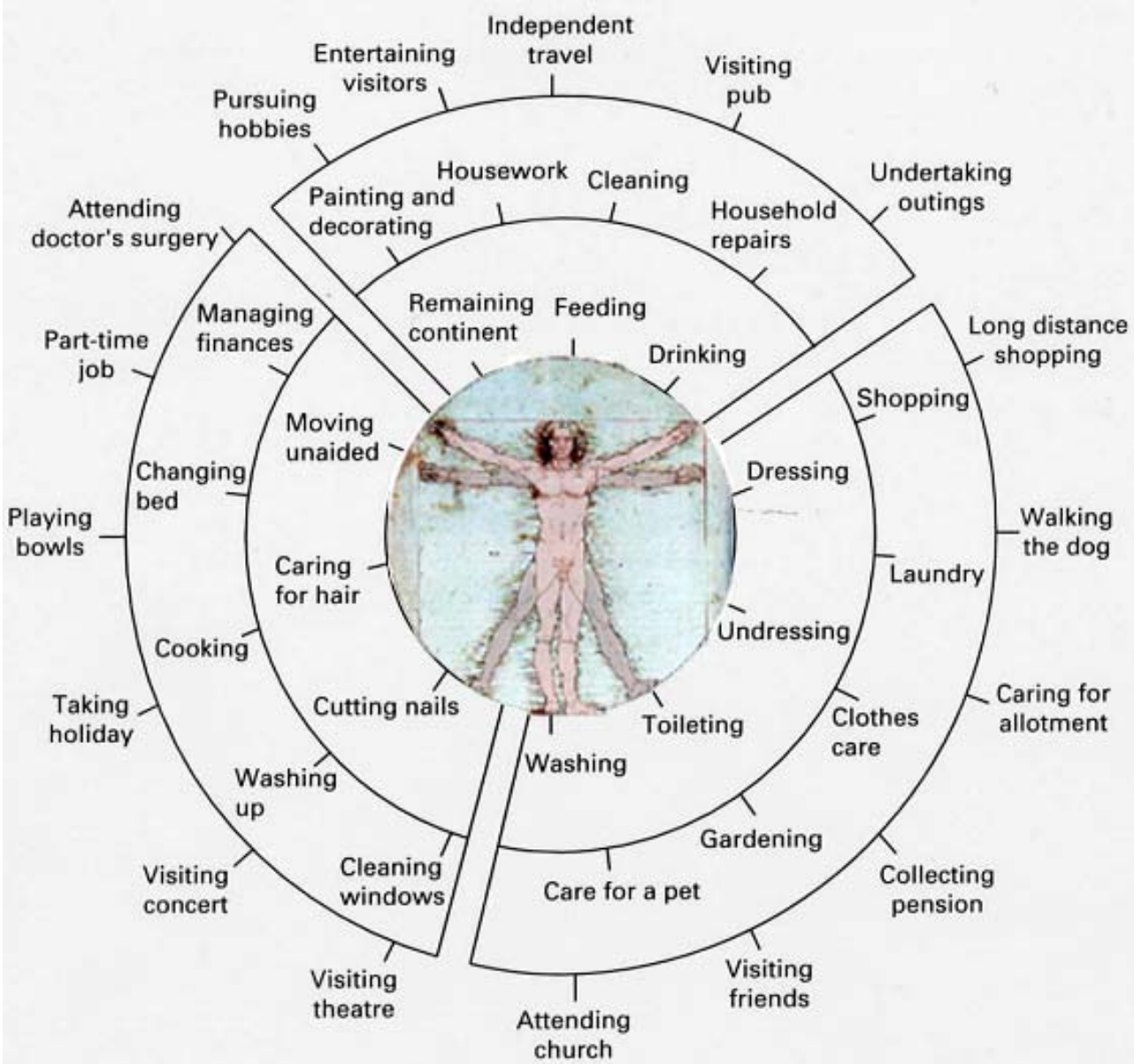


Figure 106-1 A model of social performance levels in older people. (From Williams EI: A Model to Describe Social Performance Levels in Elderly People. Br J Pract; 36:422–3.)

Proactive Health

Proactively encouraging healthy behaviors:

diet
exercise
medication adherence
stress reduction
smoking cessation
social contacts

could have a profoundly positive societal effect.

Proactive Health

Encouraging healthy behavior

Intervention at the point of decision can have a dramatic and positive effect:

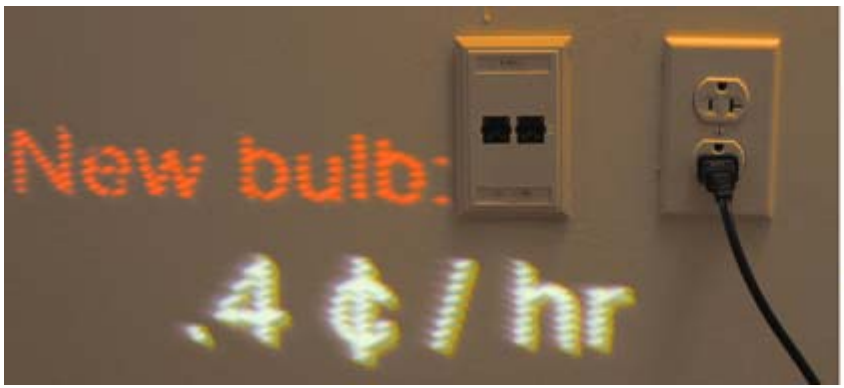
Result = 3x use of stair over escalator

Now installed at 3 Boston subway stations

Empower with information

Information at the point of decision can have many applications

(such as energy conservation)

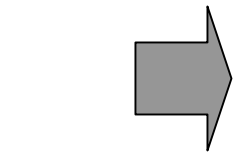


Current proactive health research at MIT

Switch/bend sensors
1. Doors
2. Cabinets
3. Drawers
4. Thresholds
5. Appliances
6. Objects

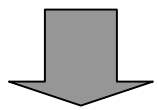
Wearable sensors
1. Accelerometers
2. Heart rate monitor
3. Self report

Multi-purpose sensors
1. People-locator tags
2. Auditory sensors
3. Optical sensors



new algorithms

Activity recognition
- Eating meals
- Talking
- Sleeping patterns
- Taking medications
- Cleaning
- Cooking
- …



health applications

1. Detect change in activity
2. Motivate behavior changes

Best bet: link advice with activity

Simple messages:

Right time ← Requires computational sensing

Right place ← Requires “pixels where you are”

Non-disruptive ← Requires attention to UI design

⇩

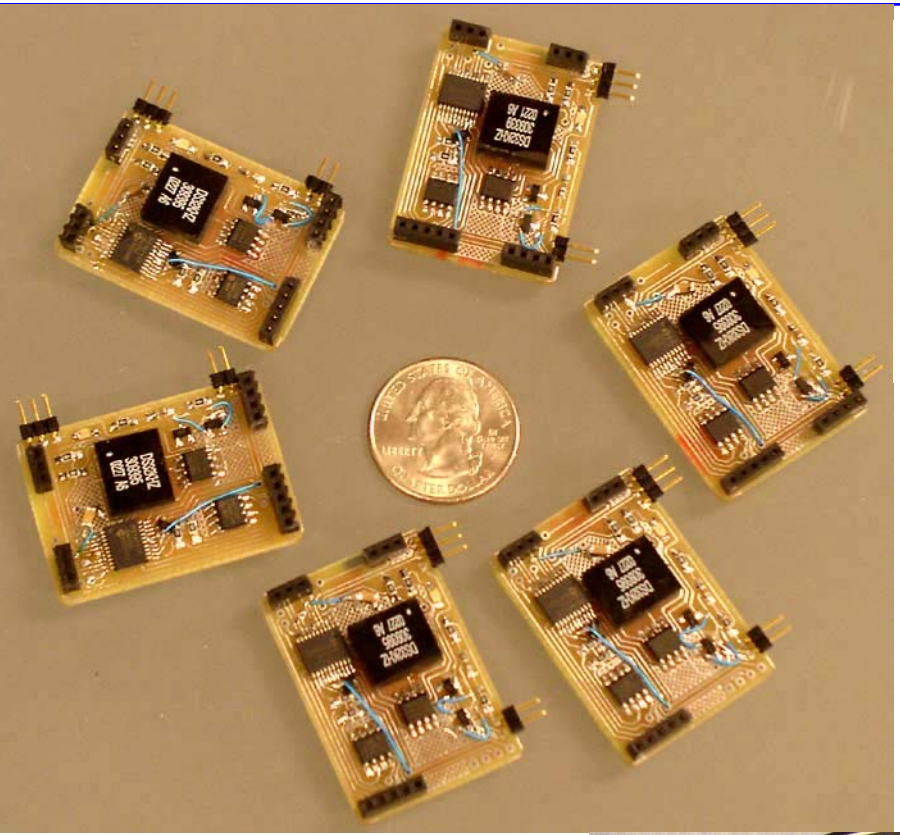
Big impact

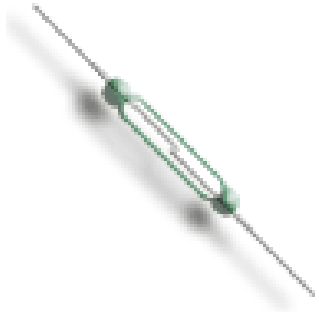
1.20% shown for energy

2.Substantial gains for preventative medicine

2

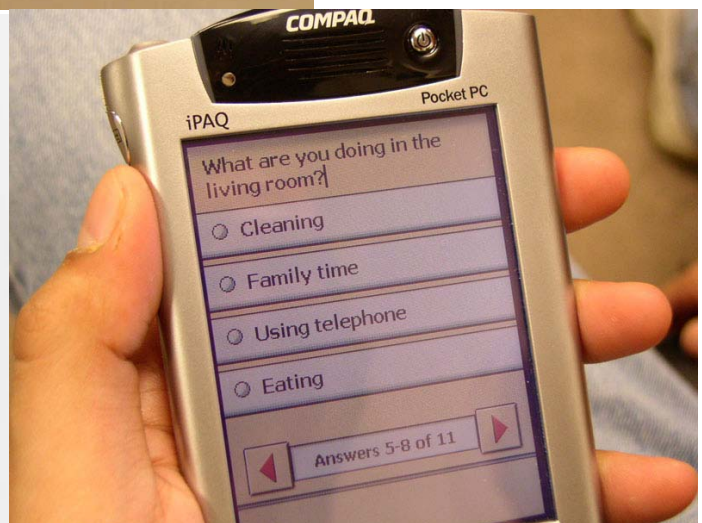
Recognizing activities of daily living: portable environmental sensor kit





Data collection board with swappable sensors

(2 weeks time stamped data)



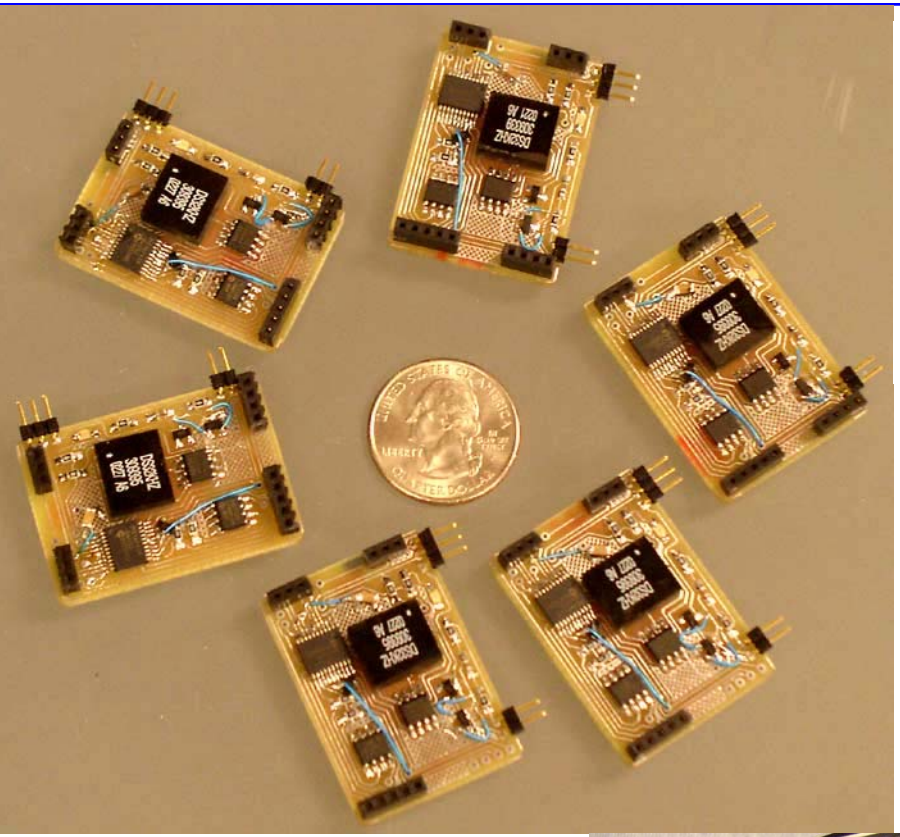
On | Off

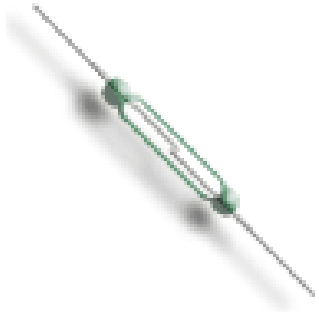
Open | Closed

Identity of People

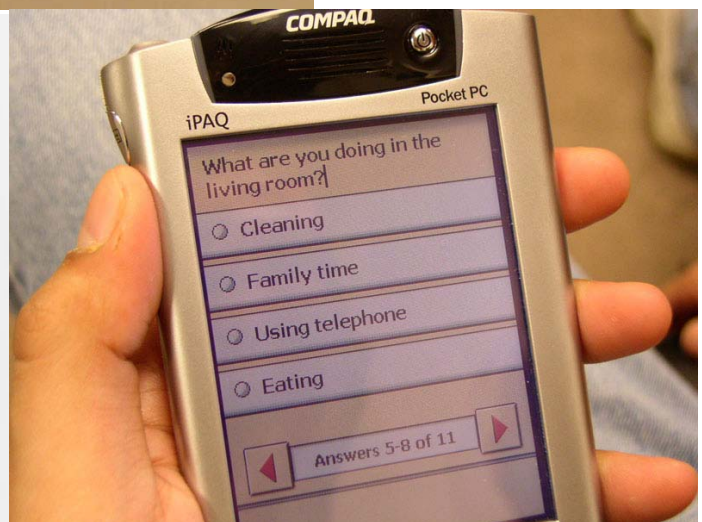
Position of People

Self labeled data





Sensors to study behavior in context



Being used to develop algorithms to detect activities of daily living

Studies complete in four homes of non-researchers

One subject's home

3 hours with small team

Install: tape-on

150 sensors in 4th subject's home

(family of four)

On | Off

Open | Closed

Position | Identity

One subject's home


69

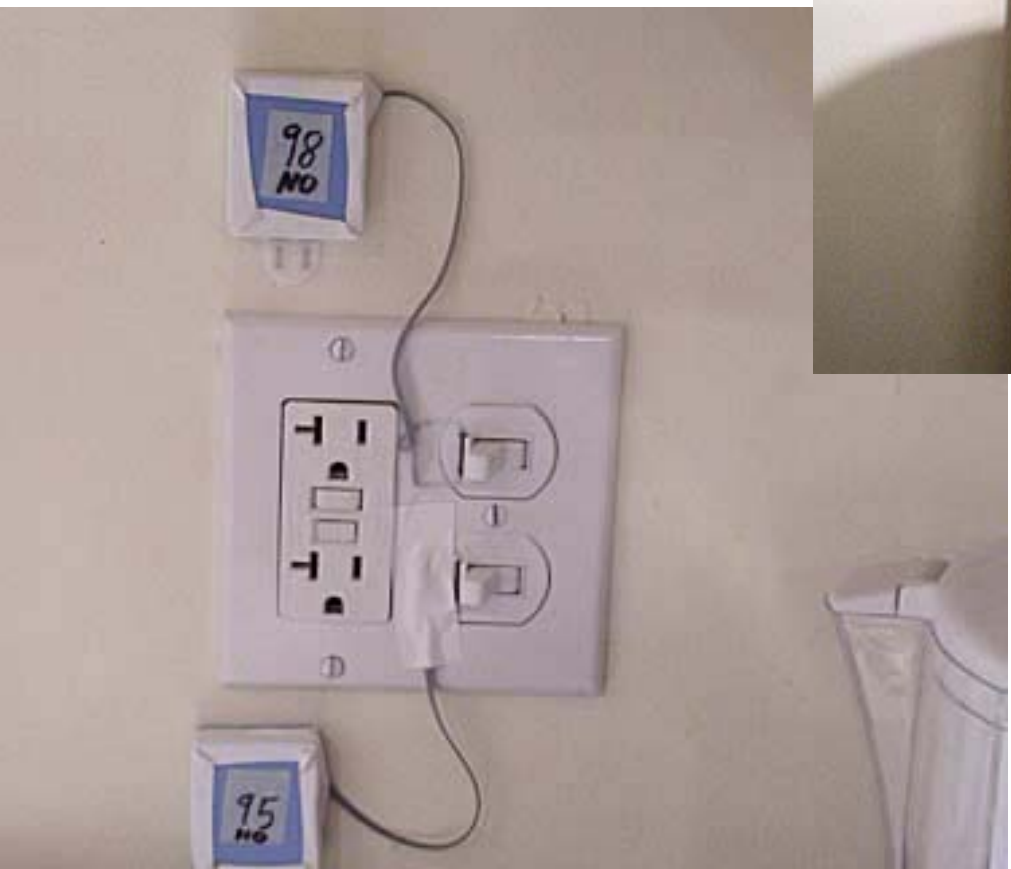

93
No
OFF


OFF
REAR
FRONT
OFF
LITE
LO
HI
hb


143
HC


141
HC


64
NC


98
NO
95
NO

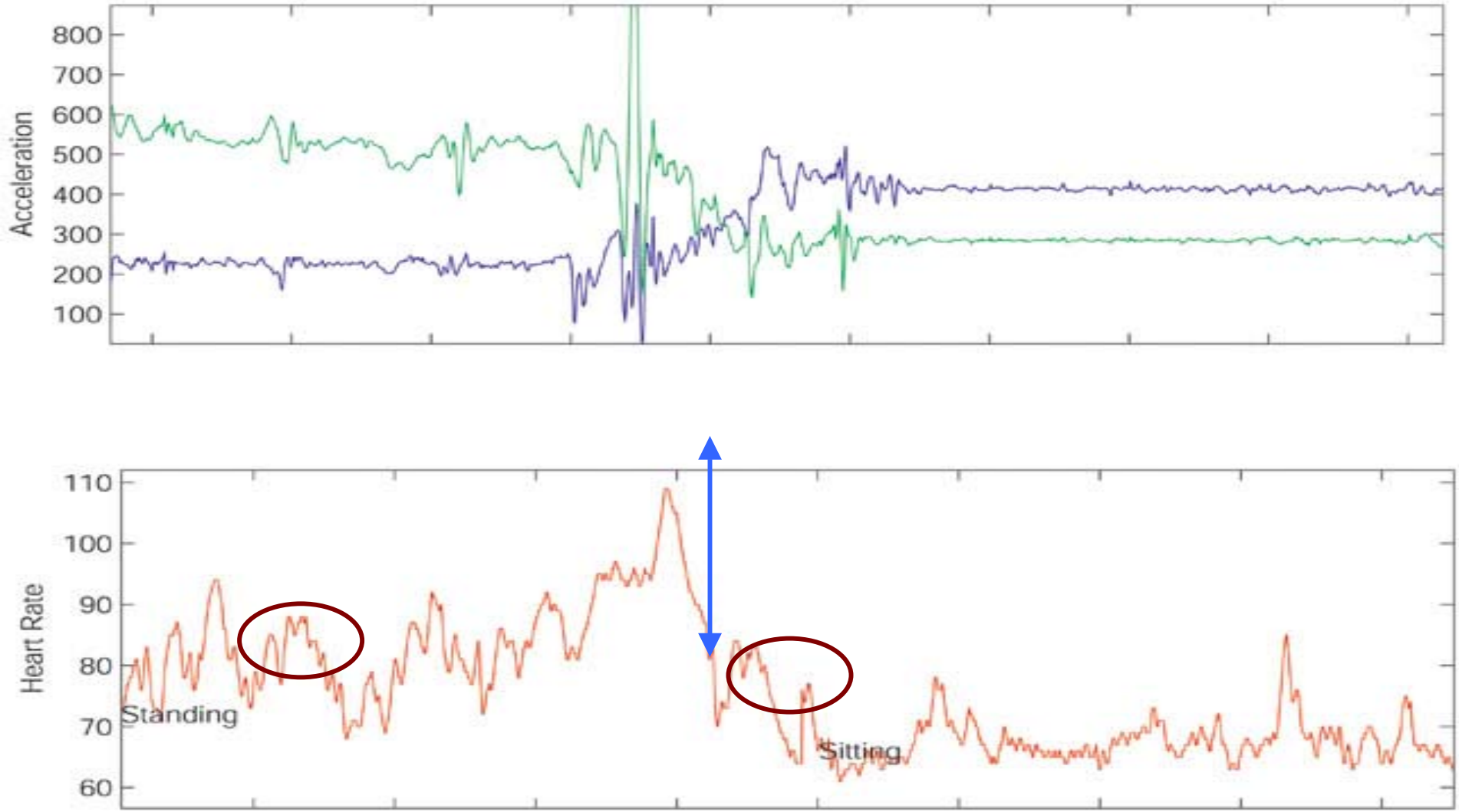

GUARD
GUARD
136
2C

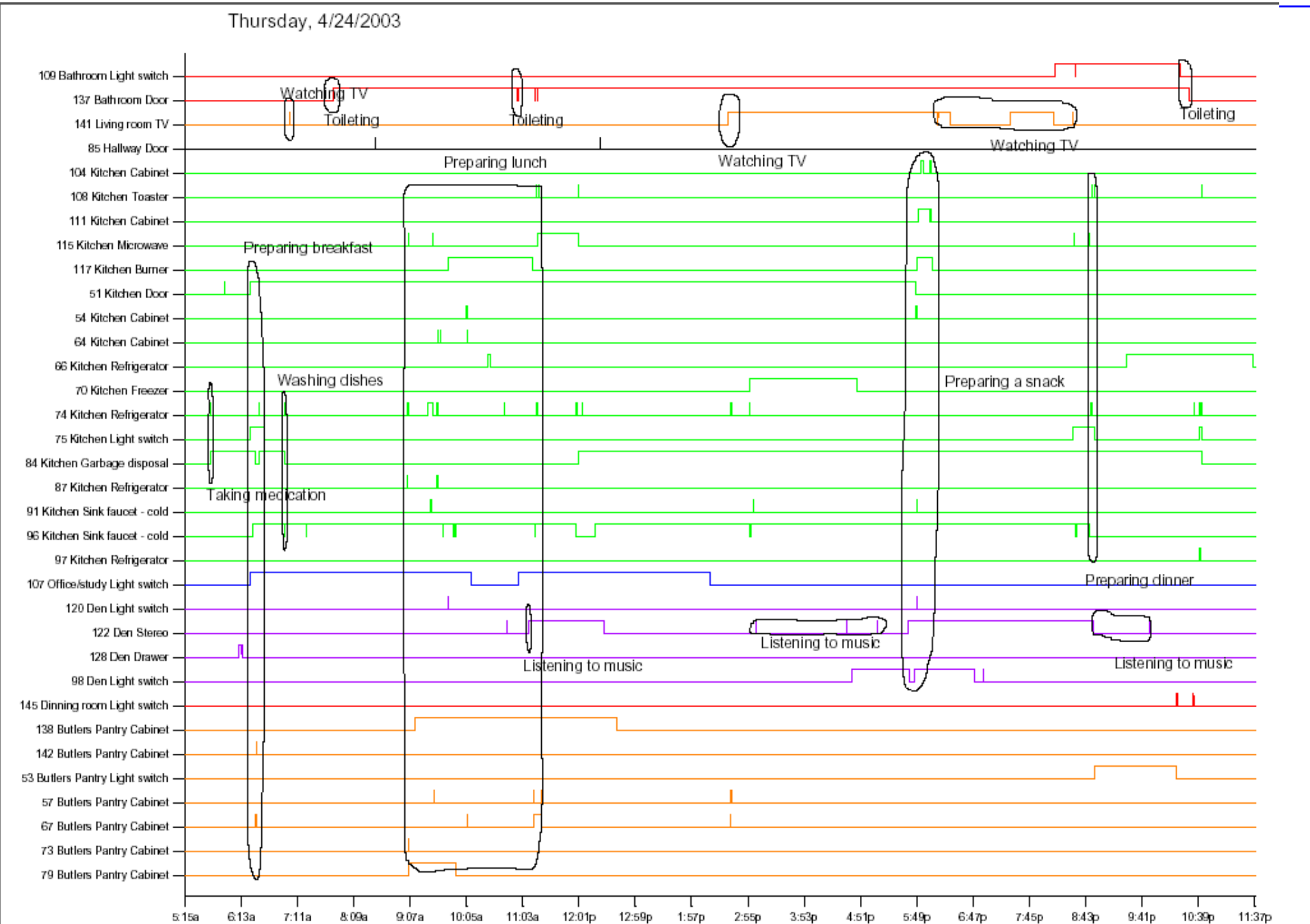
Fixed interval queries – PDA experience sampling

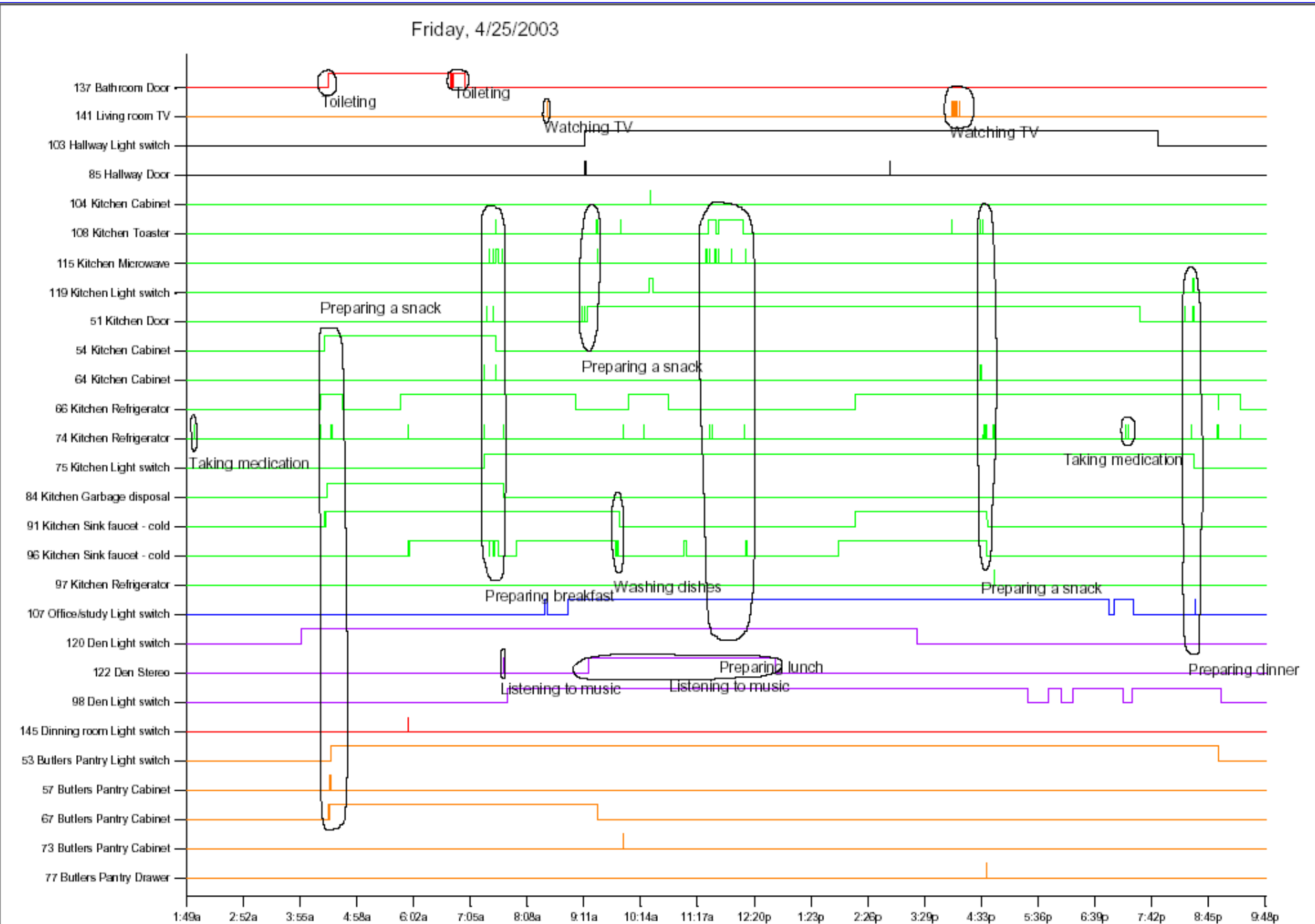
Image-based experience sampling

Position-base context-aware experience sampling

Heart rate/ accelerometer-based context-aware experience sampling




Thursday, 4/24/2003
109 Bathroom Light switch
137 Bathroom Door
141 Living room TV
85 Hallway Door
104 Kitchen Cabinet
108 Kitchen Toaster
111 Kitchen Cabinet
115 Kitchen Microwave
117 Kitchen Burner
51 Kitchen Door
54 Kitchen Cabinet
64 Kitchen Cabinet
66 Kitchen Refrigerator
70 Kitchen Freezer
74 Kitchen Refrigerator
75 Kitchen Light switch
84 Kitchen Garbage disposal
87 Kitchen Refrigerator
91 Kitchen Sink faucet - cold
96 Kitchen Sink faucet - cold
97 Kitchen Refrigerator
107 Office/study Light switch
120 Den Light switch
122 Den Stereo
128 Den Drawer
98 Den Light switch
145 Dinning room Light switch
138 Butlers Pantry Cabinet
142 Butlers Pantry Cabinet
53 Butlers Pantry Light switch
57 Butlers Pantry Cabinet
67 Butlers Pantry Cabinet
73 Butlers Pantry Cabinet
79 Butlers Pantry Cabinet
Watching TV
Toileting
Toileting
Watching TV
Toileting
Watching TV
Preparing lunch
Preparing breakfast
Washing dishes
Preparing a snack
Taking medication
Preparing dinner
Listening to music
Listening to music
Listening to music
5:15a
6:13a
7:11a
8:09a
9:07a
10:05a
11:03a
12:01p
12:59p
1:57p
2:55p
3:53p
4:51p
5:49p
6:47p
7:45p
8:43p
9:41p
10:39p
11:37p


Friday, 4/25/2003
137 Bathroom Door
141 Living room TV
103 Hallway Light switch
85 Hallway Door
104 Kitchen Cabinet
108 Kitchen Toaster
115 Kitchen Microwave
119 Kitchen Light switch
51 Kitchen Door
54 Kitchen Cabinet
64 Kitchen Cabinet
66 Kitchen Refrigerator
74 Kitchen Refrigerator
75 Kitchen Light switch
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Toileting
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Watching TV
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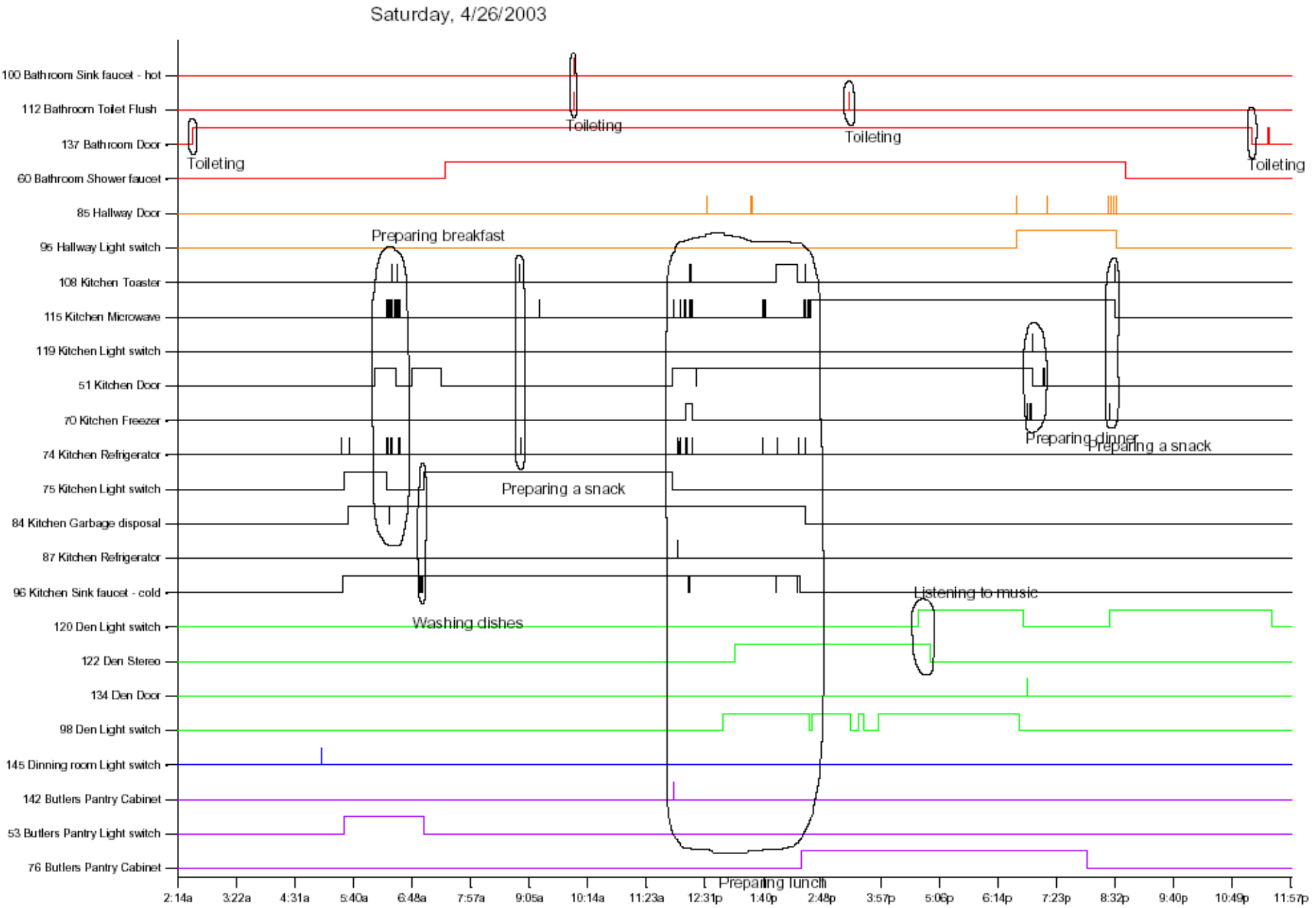
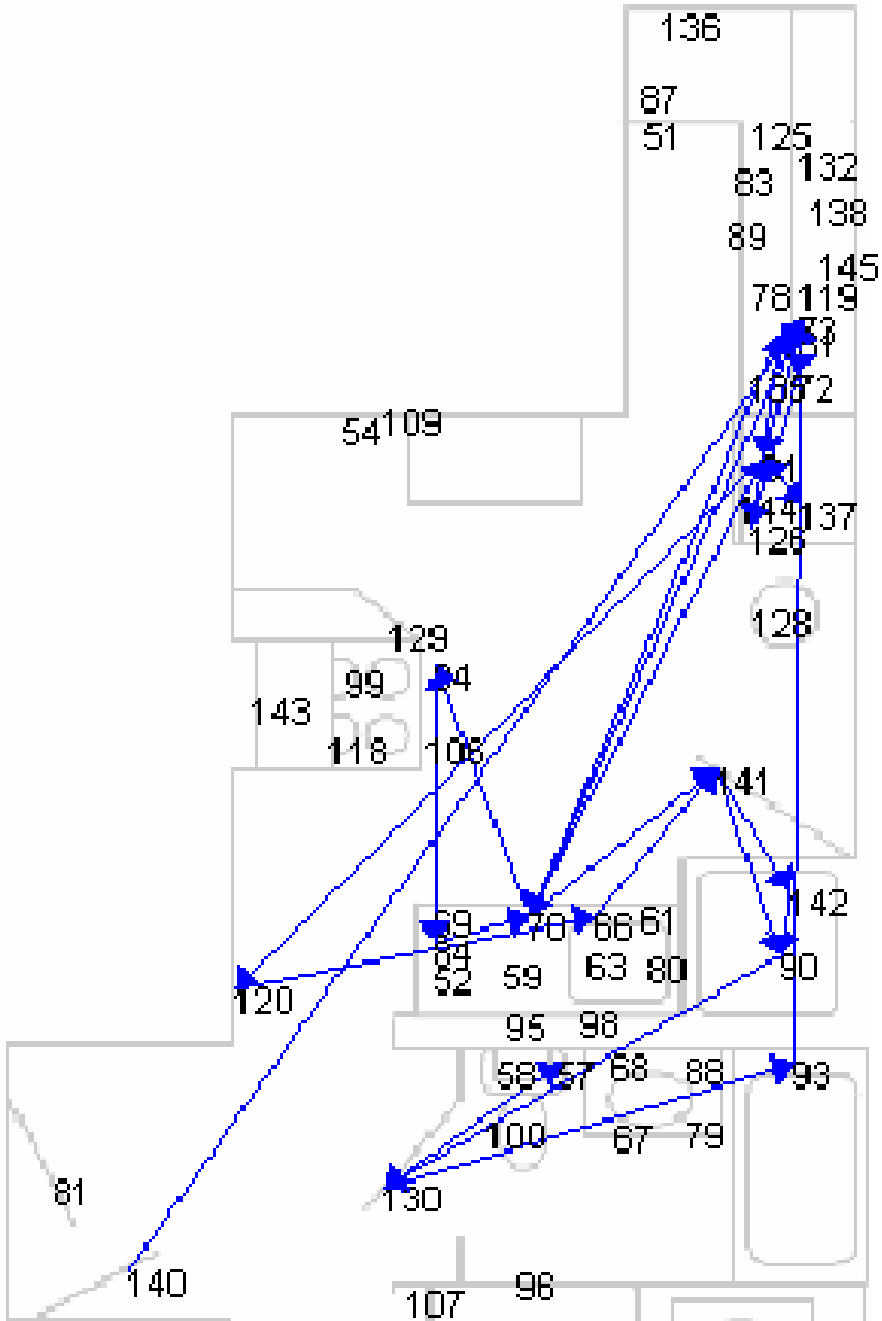
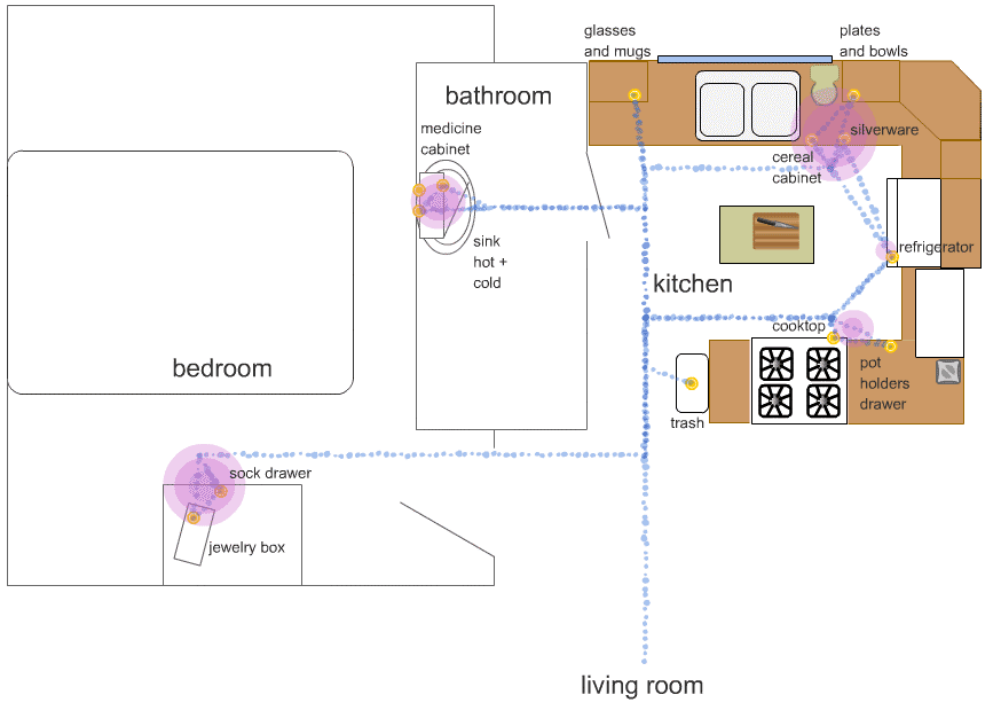
Preparing a snack
Taking medication
Taking medication
Preparing breakfast
Washing dishes
Preparing a snack
Preparing lunch
Listening to music
Listening to music
Preparing dinner
1:49a
2:52a
3:55a
4:58a
6:02a
7:05a
8:08a
9:11a
10:14a
11:17a
12:20p
1:23p
2:26p
3:29p
4:33p
5:36p
6:39p
7:42p
8:45p
9:48p


Saturday, 4/26/2003
100 Bathroom Sink faucet - hot
112 Bathroom Toilet Flush
137 Bathroom Door
60 Bathroom Shower faucet
85 Hallway Door
96 Hallway Light switch
108 Kitchen Toaster
115 Kitchen Microwave
119 Kitchen Light switch
51 Kitchen Door
70 Kitchen Freezer
74 Kitchen Refrigerator
75 Kitchen Light switch
84 Kitchen Garbage disposal
87 Kitchen Refrigerator
96 Kitchen Sink faucet - cold
120 Den Light switch
122 Den Stereo
134 Den Door
98 Den Light switch
145 Dinning room Light switch
142 Butlers Pantry Cabinet
53 Butlers Pantry Light switch
76 Butlers Pantry Cabinet
Toileting
Toileting
Toileting
Toileting
Preparing breakfast
Preparing a snack
Washing dishes
Preparing lunch
Preparing dinner
Preparing a snack
Listening to music
2:14a
3:22a
4:31a
5:40a
6:48a
7:57a
9:05a
10:14a
11:23a
12:31p
1:40p
2:48p
3:57p
5:06p
6:14p
7:23p
8:32p
9:40p
10:49p
11:57p

Patterns of movement



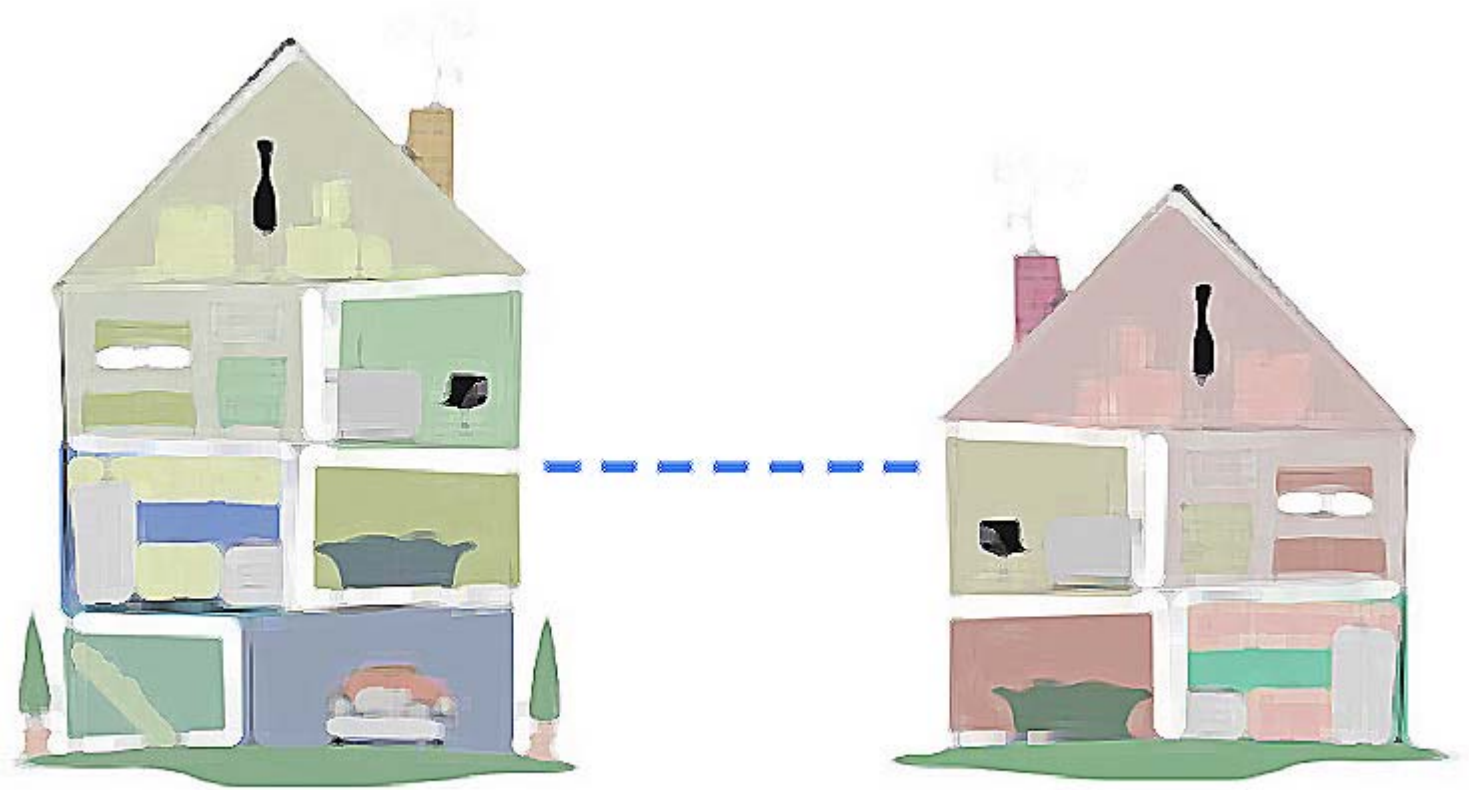


3

Scenario: One possible proactive health service

ActivityLink:

Providing peace of mind communication



The family: adult children and kids

The single aging parent

First a broken ring

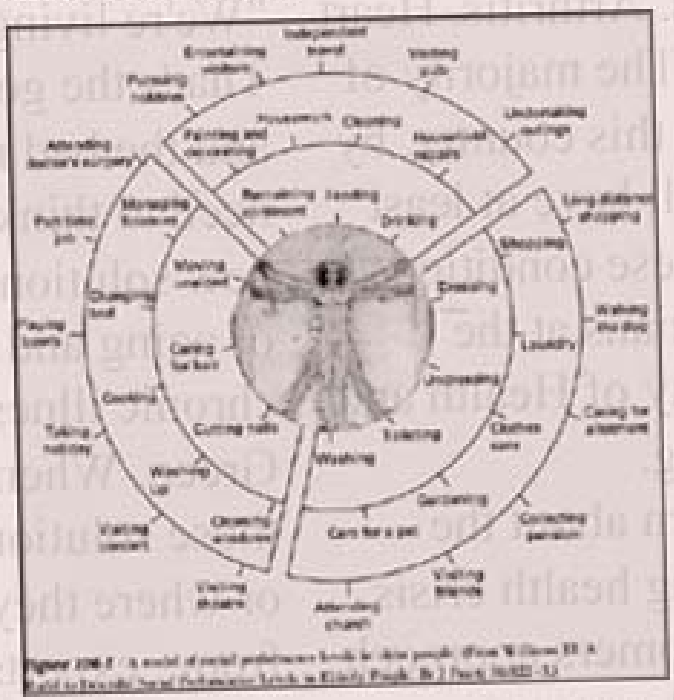
LESS INVOLVEMENT SIGNALS HEALTH DOWNTURN IN OLDER ADULTS

Early detection permits better interventions

By Megan Carrigan

When her mother stopped attending church every Sunday, Linda knew that something

Experts talk about 3-rings that describe an individual's healthy life activities.



In the outer ring, are activities

Neighbor tells adult son that she hasn't noticed his mother gardening lately, and son sees that garden is untended

… and then neighbor concerns

Lots of gadgets to pick from???????????

Client presses button

Button signa

Client needs help

ter calls for help

emergency

Base Unit calls monitoring center

WATCHING OUT FOR EACH OTHER

NEW PRODUCT GIVES SANDWICH GENERATION PEACE OF MIND

By: Anna Crawford, AP Reuters

Most adults see themselves living out their lives in their own homes, but for the children that care for and worry about them, independent living may seem too difficult to achieve.

The sandwich generation, adults who are caring for both their children and their parents, are having face tough decisions: the stress of moving in together, the heartbreak of assisted living, or the danger of accidents and depression that comes with older adults living alone.

A new product now available, ActivityLink, has its roots in research conducted at the MIT PlaceLab. Unlike other products which are stigmatizing and fragile, ActivityLink benefits from a thoughtful approach to issues such as privacy, flexibility, and personal control.

ActivityLink consists of a kit of simple sensors that are easily installed on furniture, appliances, and household fixtures

Dignified piece of mind: a standout

ActivityLink available at home stores

Hundreds of sensors: a kit of parts

Cost:Just a few hundred dollars and $20 a month

Installation elder's home

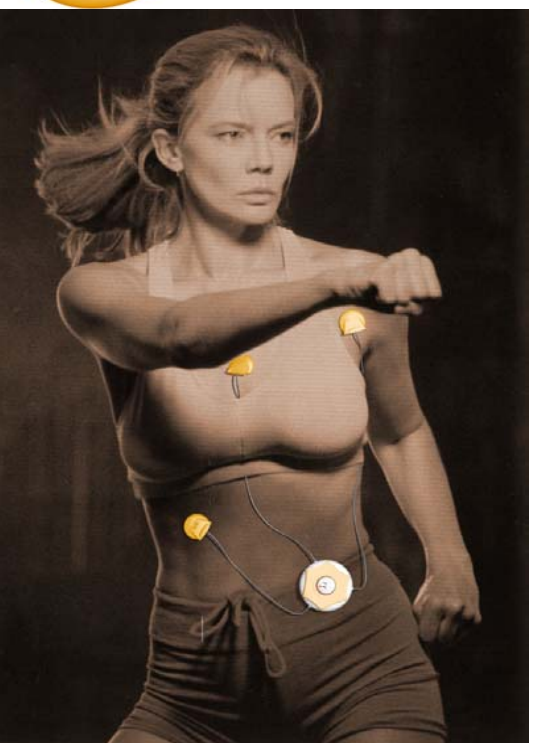
Stick-ems easy, wireless … everyone helps.

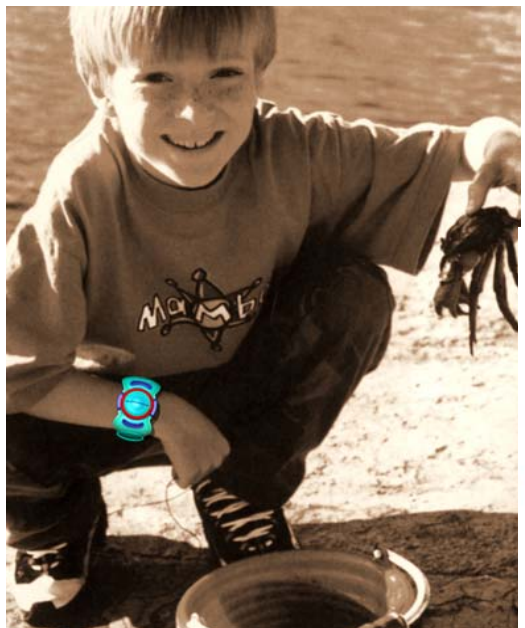
Sensors installed in
home of adult children

Devices are invisible

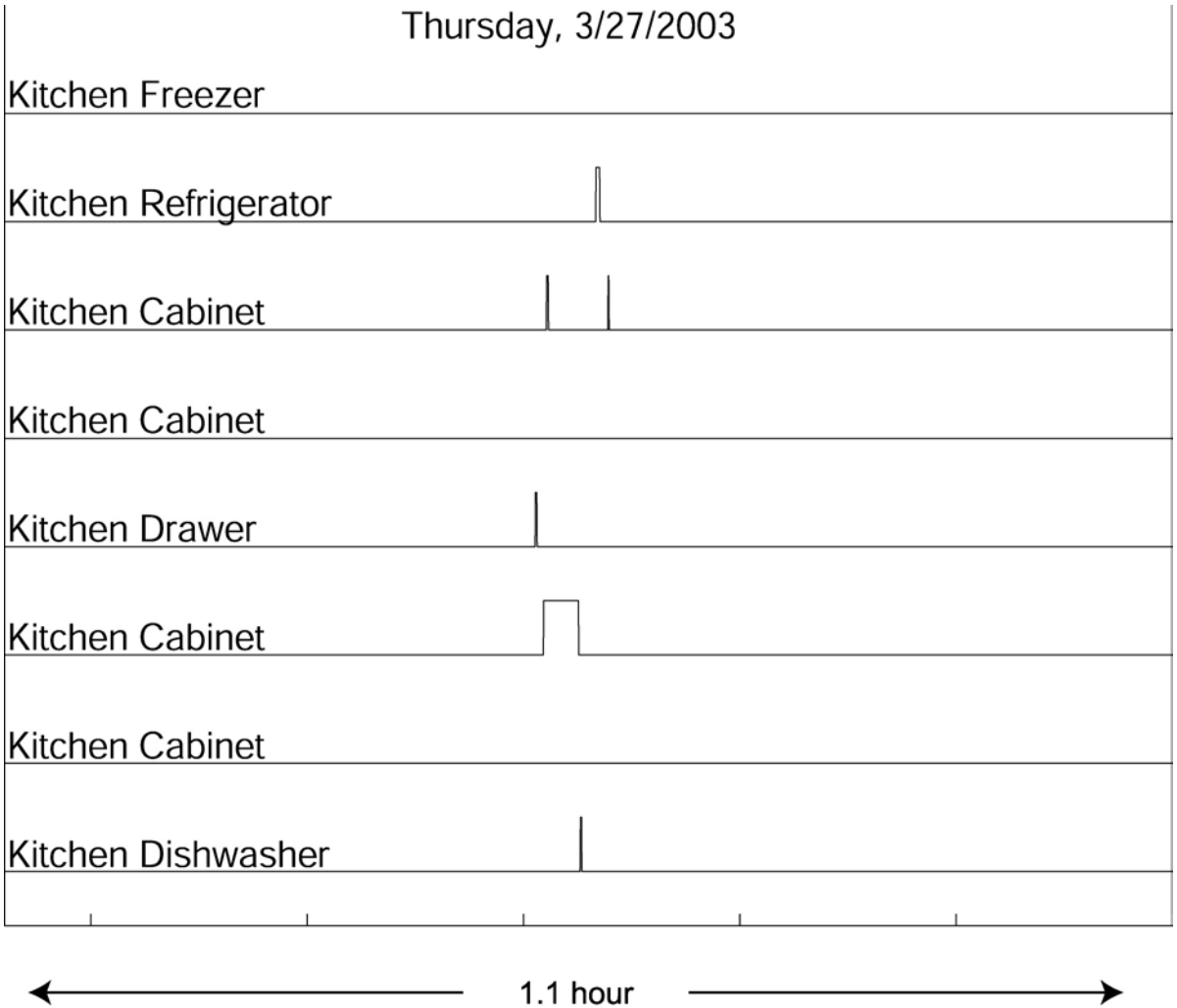
Install in just a few hours

Wearable devices for all in the family are also available





System models overall activity



Software detects "important" (3-ring) changes

Change detected

"Something's changed … you might give her a call"

System lifestyle benefits

Conversations don't always start with…

"Are you still getting exercise?"

Not stigmatizing

Both households use system

Infrastructure enables other applications

Fun

Communication

New proactive applications for keeping people:

1. Active
2. Mindful
3. Empowered

4

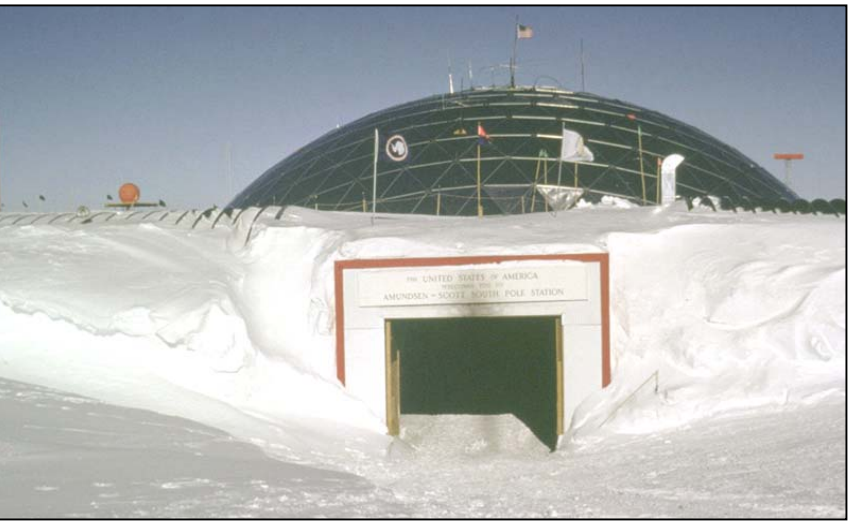
PlaceLab

Technology development is the "easy part."

Big Question: How can we develop effective strategies that people will accept into their lives.

Needed: A shared research facility to study people and their use of technology in natural environments

Shared Research Facilities



Amundsen-Scott South Pole Station

Fermilab Accelerator

“Get Away Special” Payload Program

PlaceLab ⟷ PlaceLab

Testing of Infrastructure

"Plug and Play" Architecture

Digital Infrastructure

Fine grained sensing of people, objects, and activity

Ubiquitous displays

Testing with People

Proactive Health.

Interface (Single Mental Model)

Models of Behavior

Technology in Context

Just-In-Time Information

Not a prototype

Not a demonstration

The PlaceLab is a "microscope" to study people and their relationship to:

new technologies

and

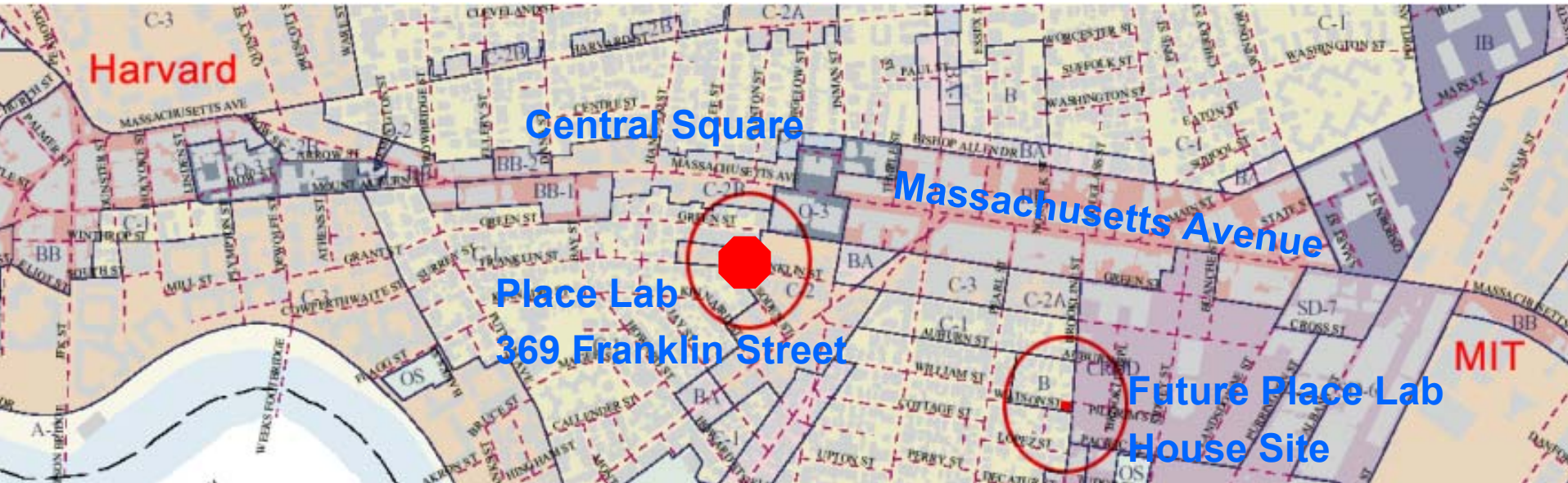
new approaches to design

in natural settings . . .

with occupants going about their real life activities

Location

The PlaceLab is at 369 Franklin Street in Cambridgeport, Cambridge (between Harvard and MIT)



Location

A lower floor unit of full-service condominium building, now under construction.

The apartment can be entered both from the lobby and from the side yard.

PlaceLab

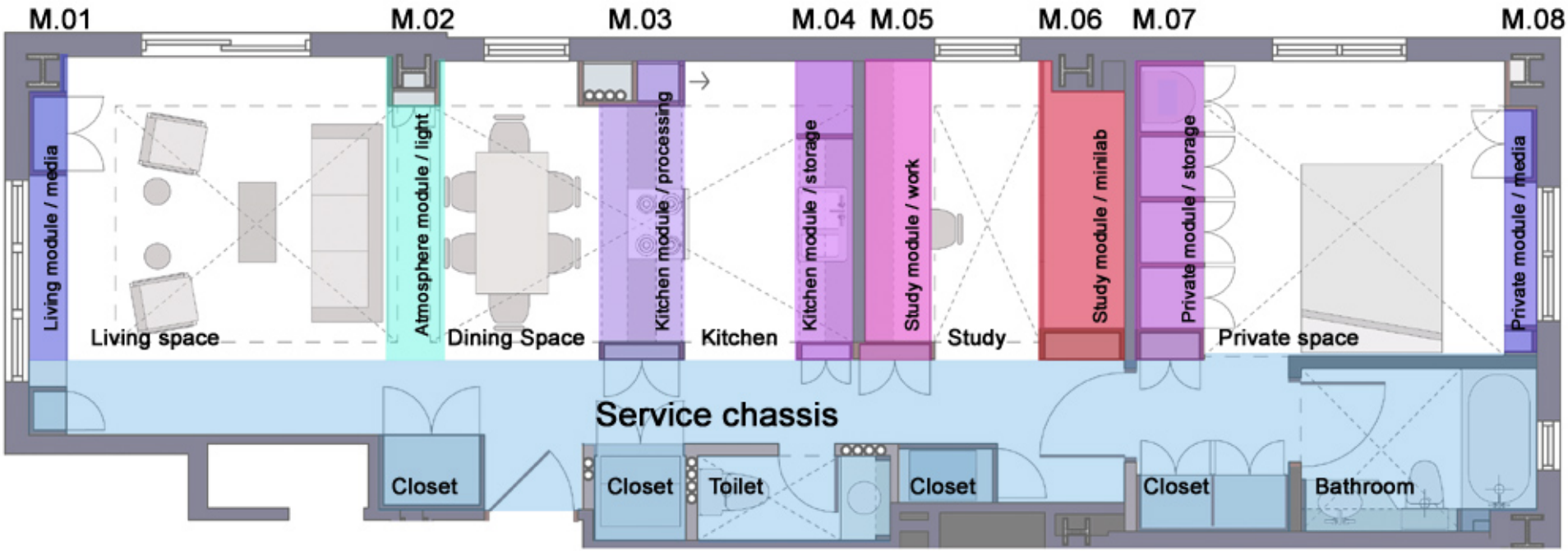
PlaceLab Infrastructure:

Modular interior cabinetry with embedded technologies

PlaceLab Infrastructure:

Modular interior cabinetry with embedded technologies

PlaceLab Infrastructure:
Interior cabinetry with embedded technologies



PlaceLab

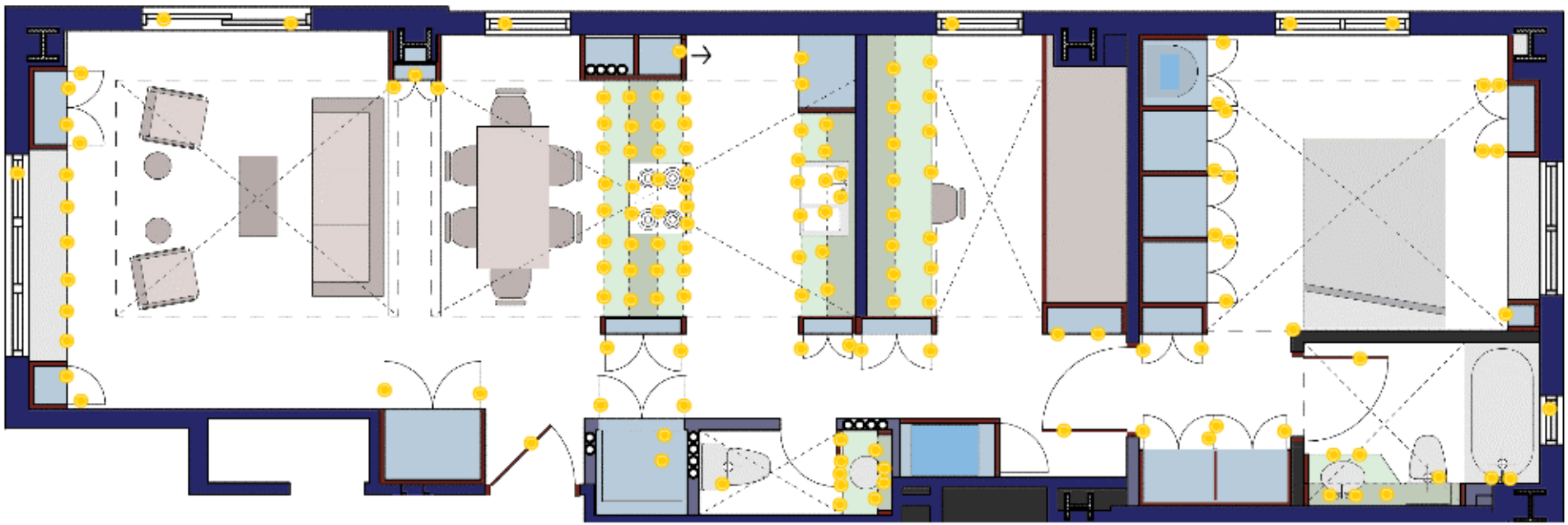
Agile facility to develop and test – in a natural environment – tools for:

- identity of people
- location of people
- what they are doing
- their physiological state
- their psychological state

and

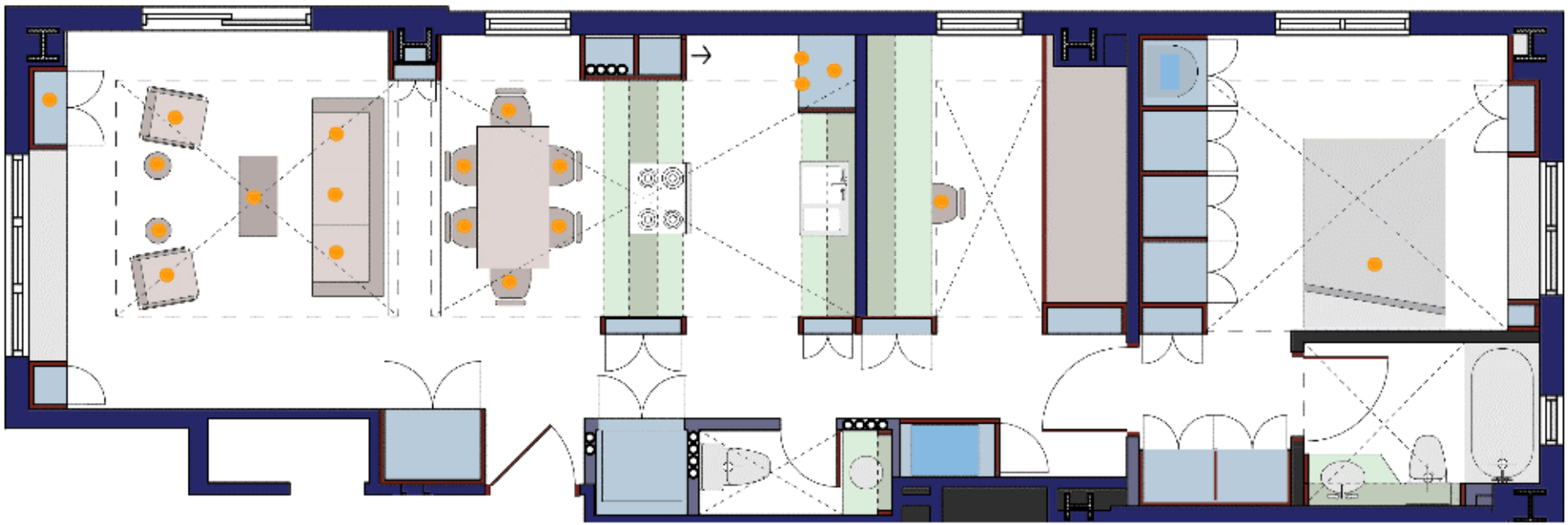
- A suite of tools to test communication - in non-irritating and effective ways - at just the right time.

PlaceLab Infrastructure:
State of fixed things



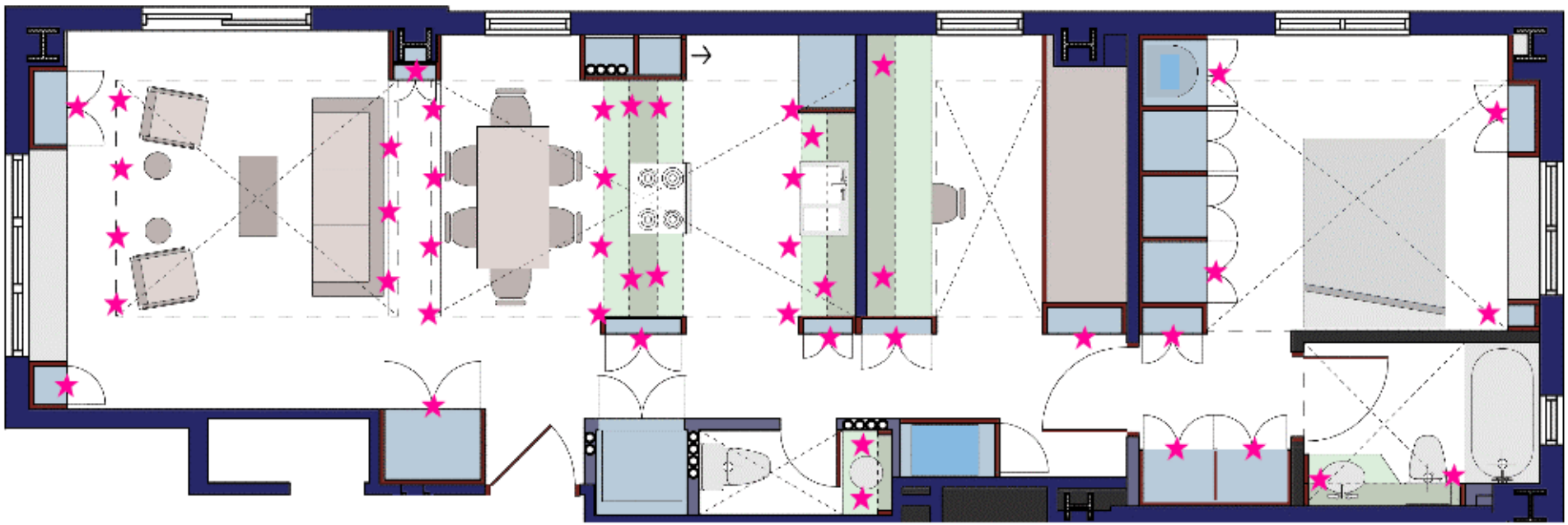
Switch sensors in
cabinets and appliances

PlaceLab Infrastructure:
State of movable things



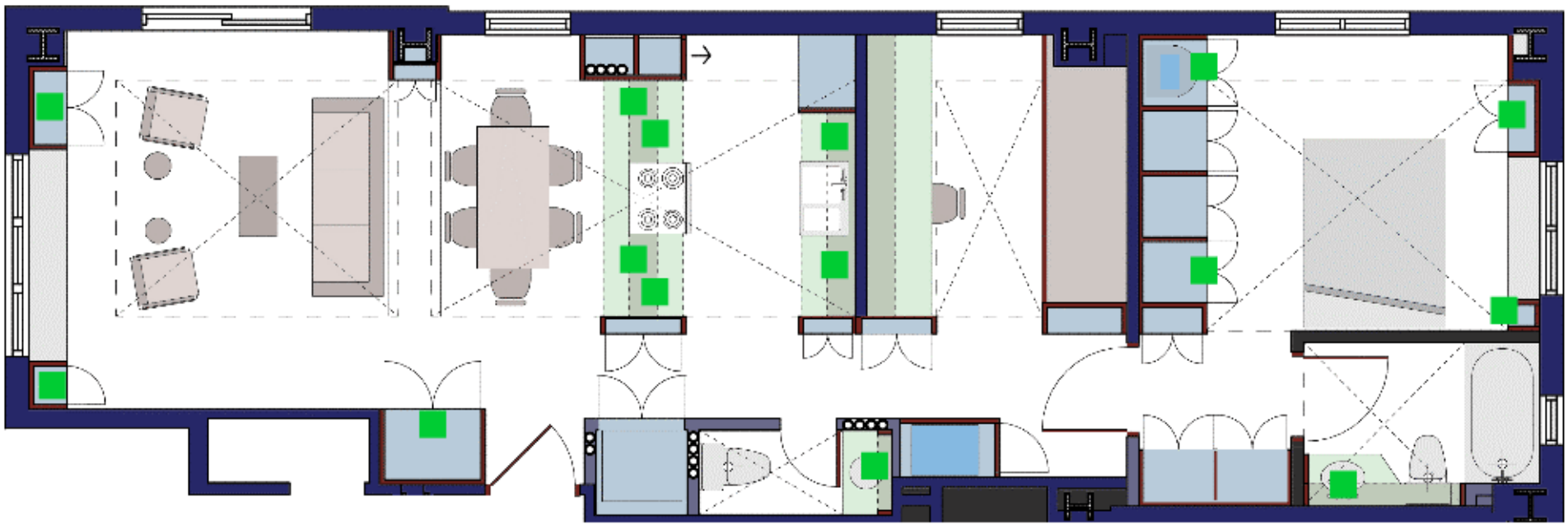
Wireless sensors in
movable furniture

PlaceLab Infrastructure:
Location/identity of People



IR transmitters

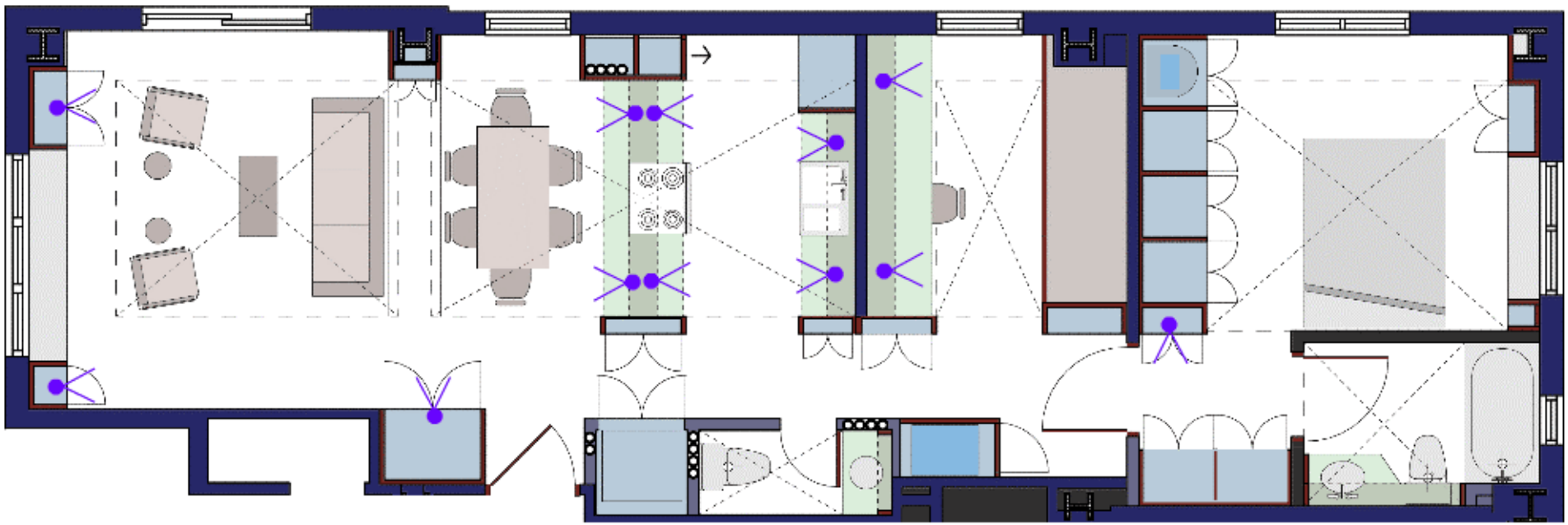
PlaceLab Infrastructure: Environmental conditions



Locations of temperature, humidity, CO, CO2, and smoke sensors

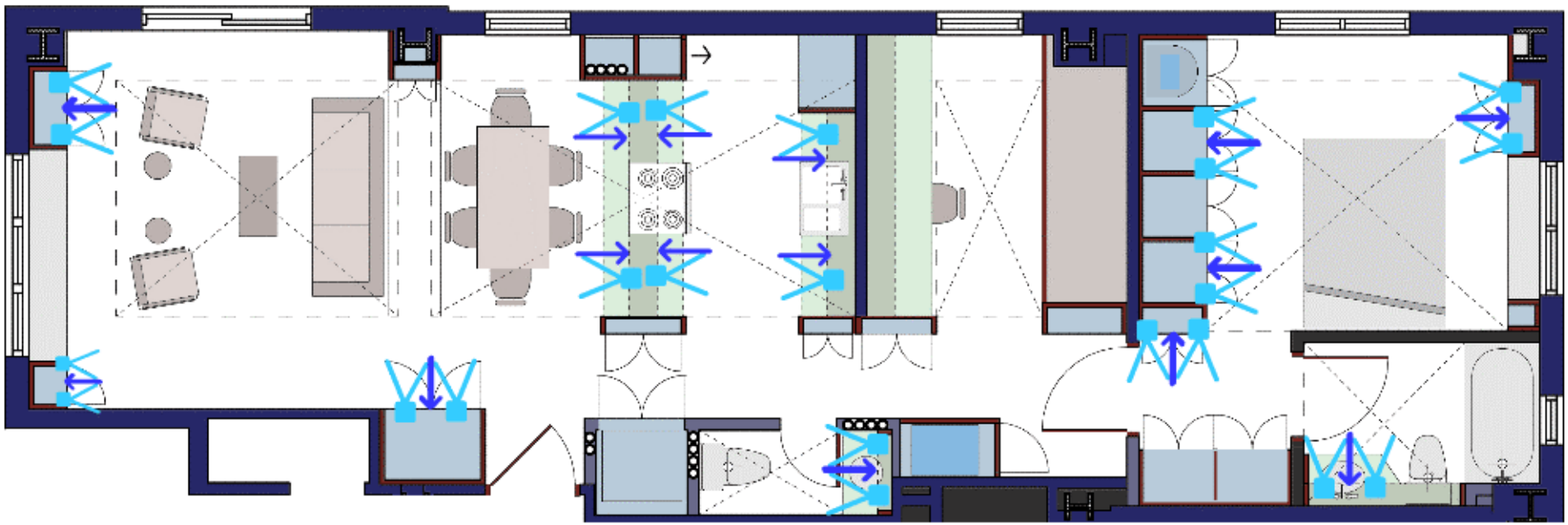
PlaceLab Infrastructure:

Optical sensors (IR and visible light)



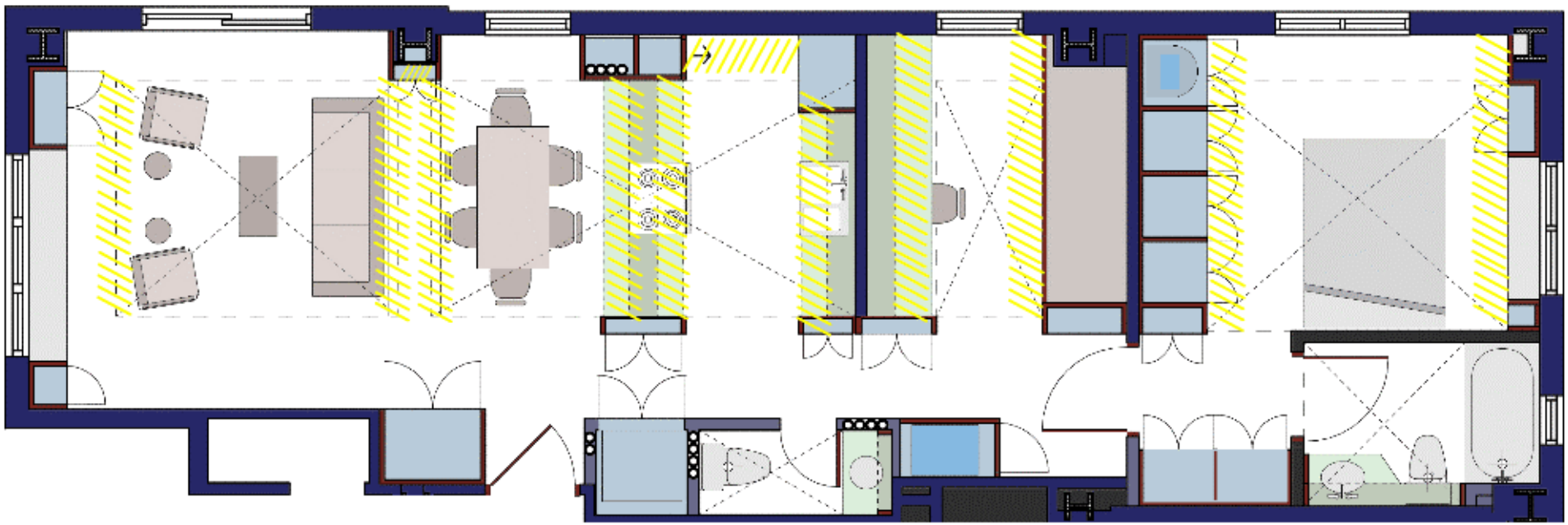
IR and visible light sensors

PlaceLab Infrastructure:
Communicating with directed audio



Speakers and microphones

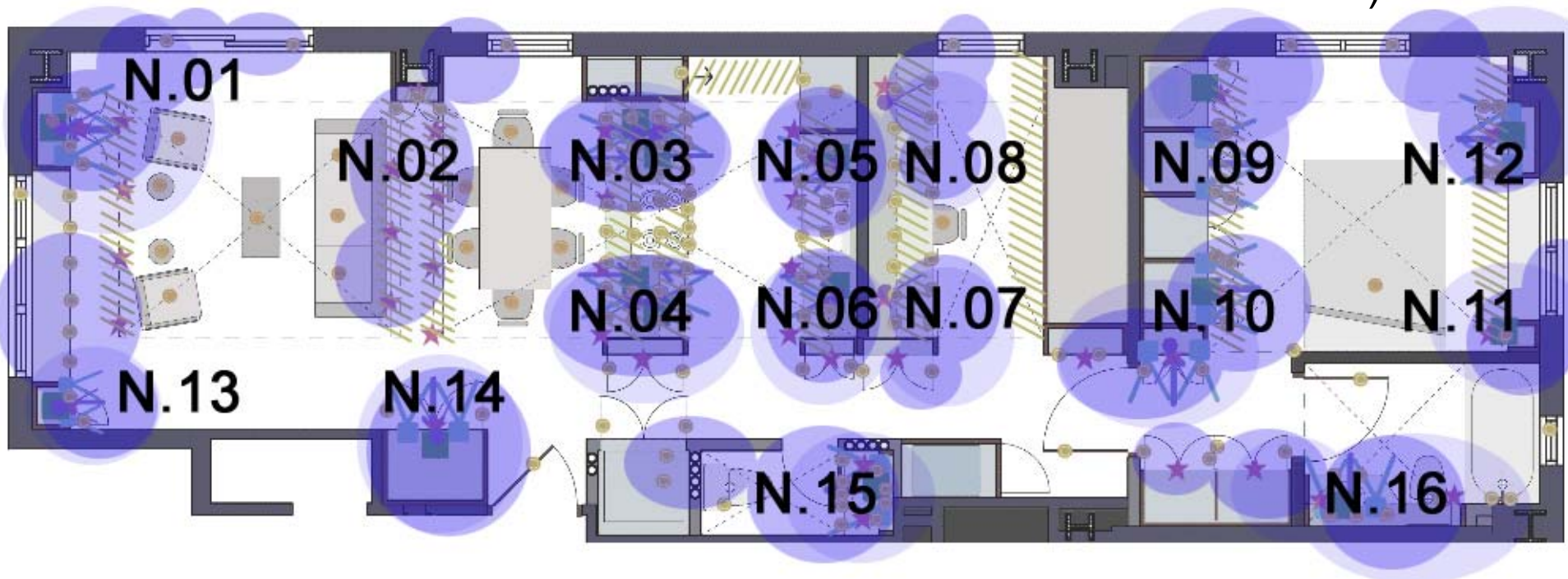
PlaceLab Infrastructure:
Communicating with ambient light, pixels



Addressable LED 24bit lighting

PlaceLab Infrastructure:

Local sensor networks (also for communication with wearables)



Sensor networks located in prefabricated cabinetry

PlaceLab Infrastructure:

Pixels everywhere
(initially lab demo only)

PlaceLab Attributes

1) Common Infrastructure

Sensing, communication, and recording infrastructure used by all researchers

2) Smart occupants (not smart homes).

Give people information and control rather than automate

3) Context of Life

Evaluate technologies in natural settings (not lab)

4) Agile

Allow for change

5) Shared Research Facility

Any sponsor or academic researcher may apply

PlaceLab research possibilities (a few)

1) Techniques to encourage healthy behaviors

2) Viability and acceptance of wearable systems

3) Novel sensors and low-cost sensor networks

4) Activity recognition

5) Lighting and energy management

6) Privacy and trust

7) Learning at home

8) Indoor air quality

8

Application Process: PlaceLab Studies

Submit proposal

Non-profit (research) or CP/OSBA members

Academic review
(scientific merit)

Industrial review
(societal impact)

Project directors (MIT+TIAX)
(selection, scheduling)

PlaceLab study runs
(overlapping studies when possible)

PlaceLab

A Shared Research Facility

Opening Fall 2003
Research Proposals Now Being Accepted

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