# Use of Wireless Technologies for Assisted Living at Home

Jennifer C. Hou

Department of Computer Science

University of Illinois at Urbana Champaign

jhou@cs.uiuc.edu

Population Aging

Older Population by Age: 1900-2050
Source: U.S. Bureau of the Census
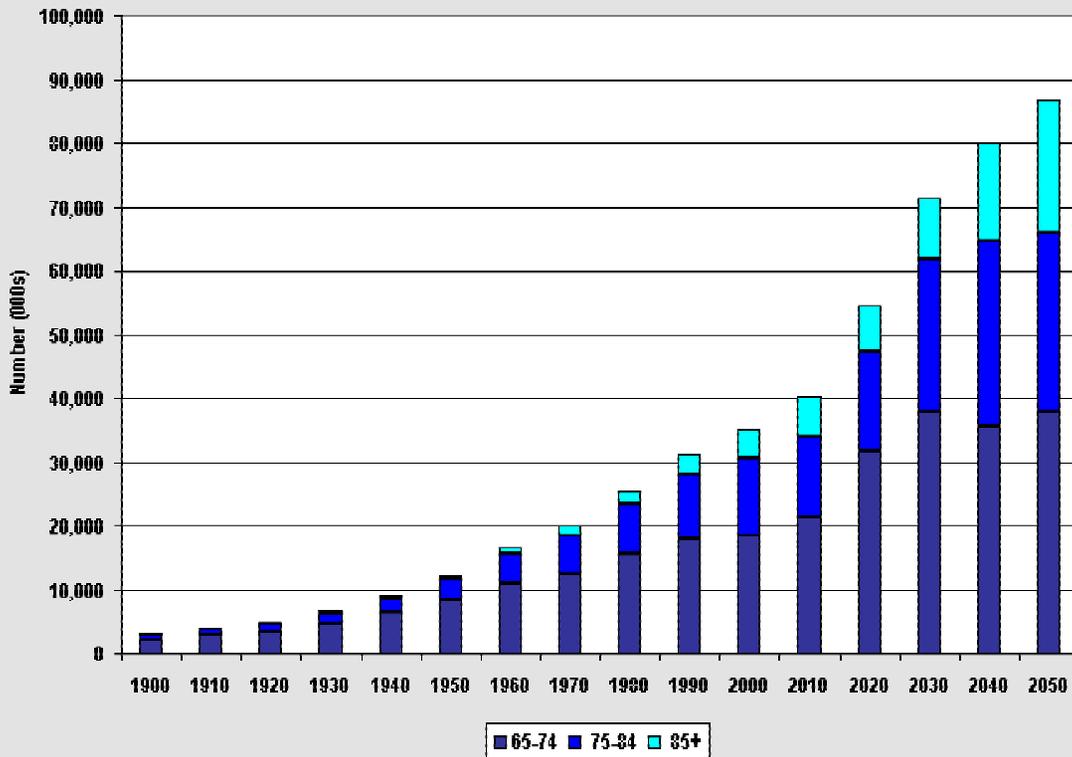
- Aging of the baby boomer has become a social and economical issue.
- In the United States alone, the number of people over age 65 is expected to hit 70 million by 2030, almost doubling from 35 million in 2000.

- **Table compiled by the U.S. Administration on Aging based on data from the U.S. Census Bureau.**

Percentage of People of 65+ and 85+

Older Population by Age: 1900-2050 - Percent 65+ and 85+
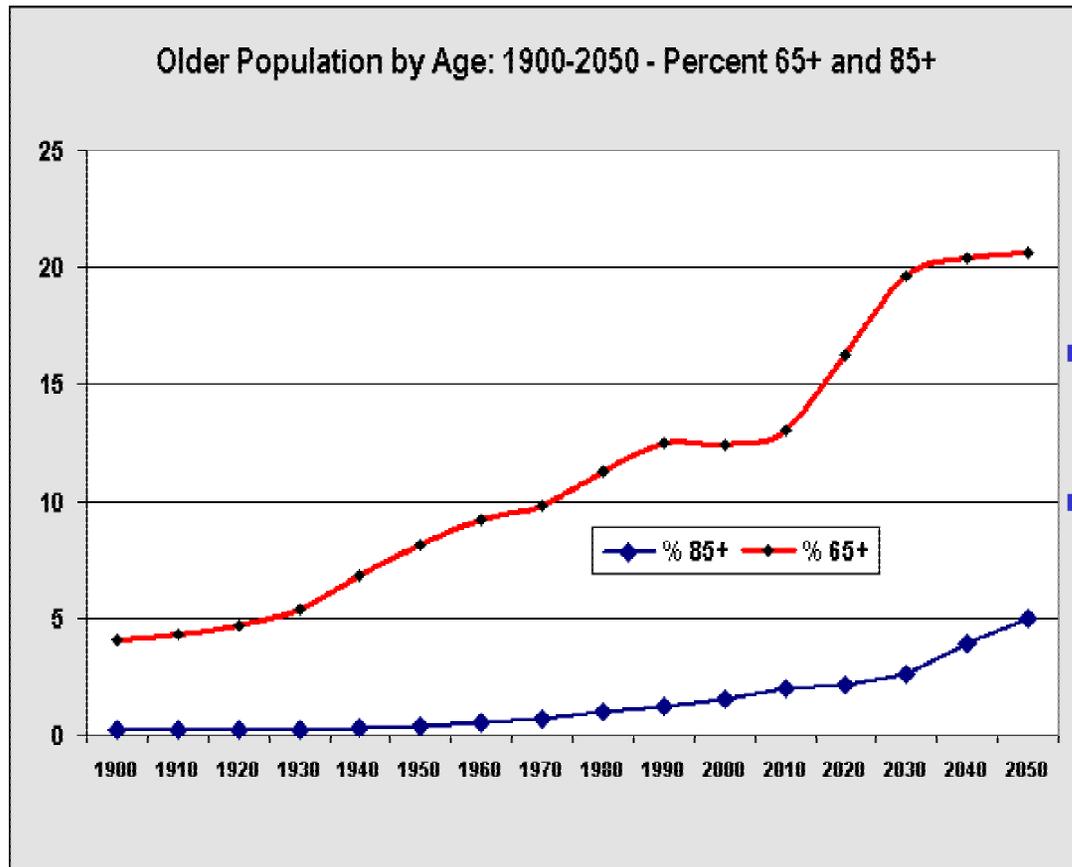
People over age 65 are expected to constitute 20% of the population in 2030.

Similar increases are expected worldwide.

Table compiled by the U.S. Administration on Aging based on data from the U.S. Census Bureau.

# Similar Expenses Worldwide
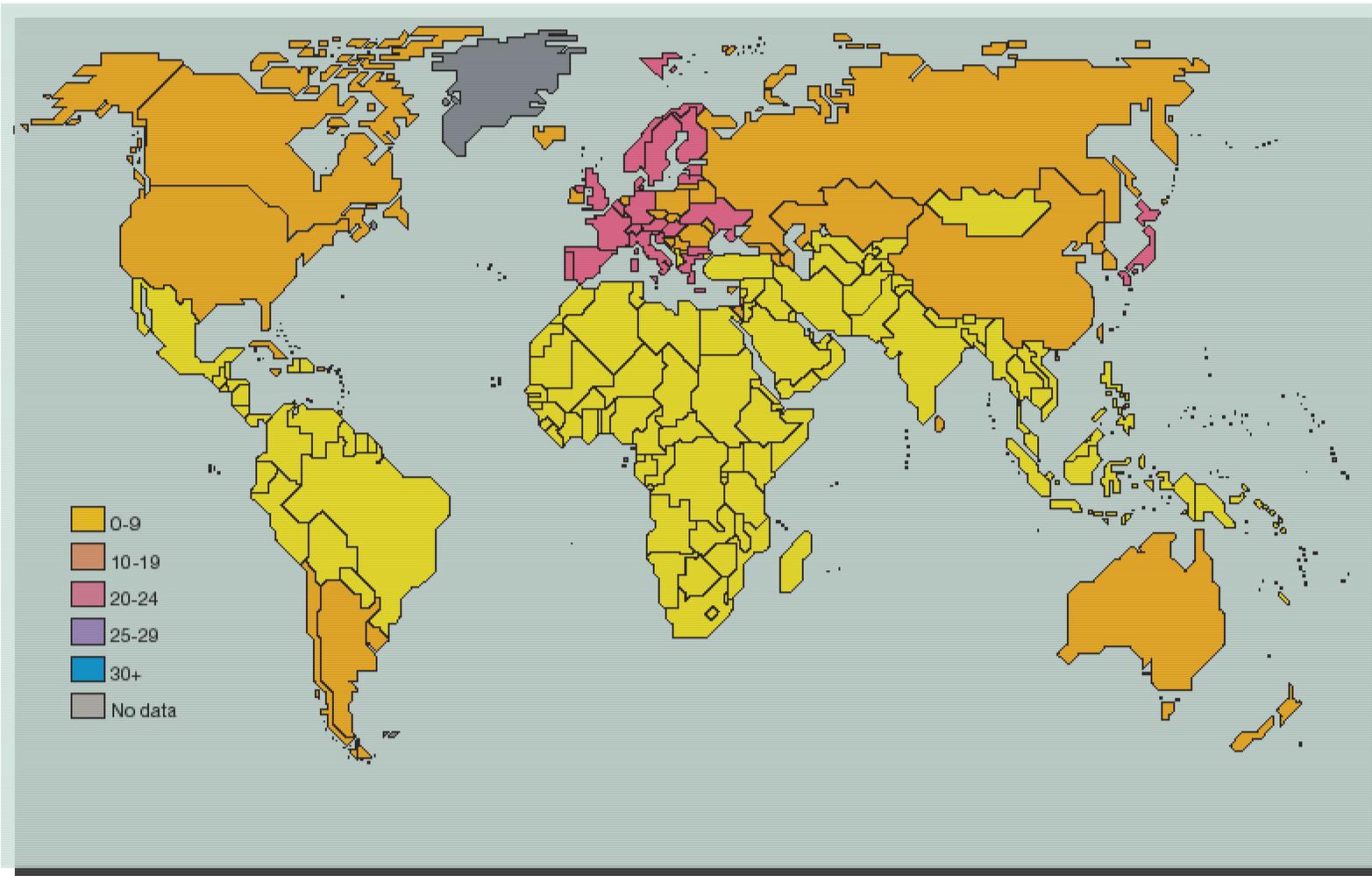
SOURCE: United Nations ▪ "Population Aging ▪ 2002"

Similar Expenses Worldwide
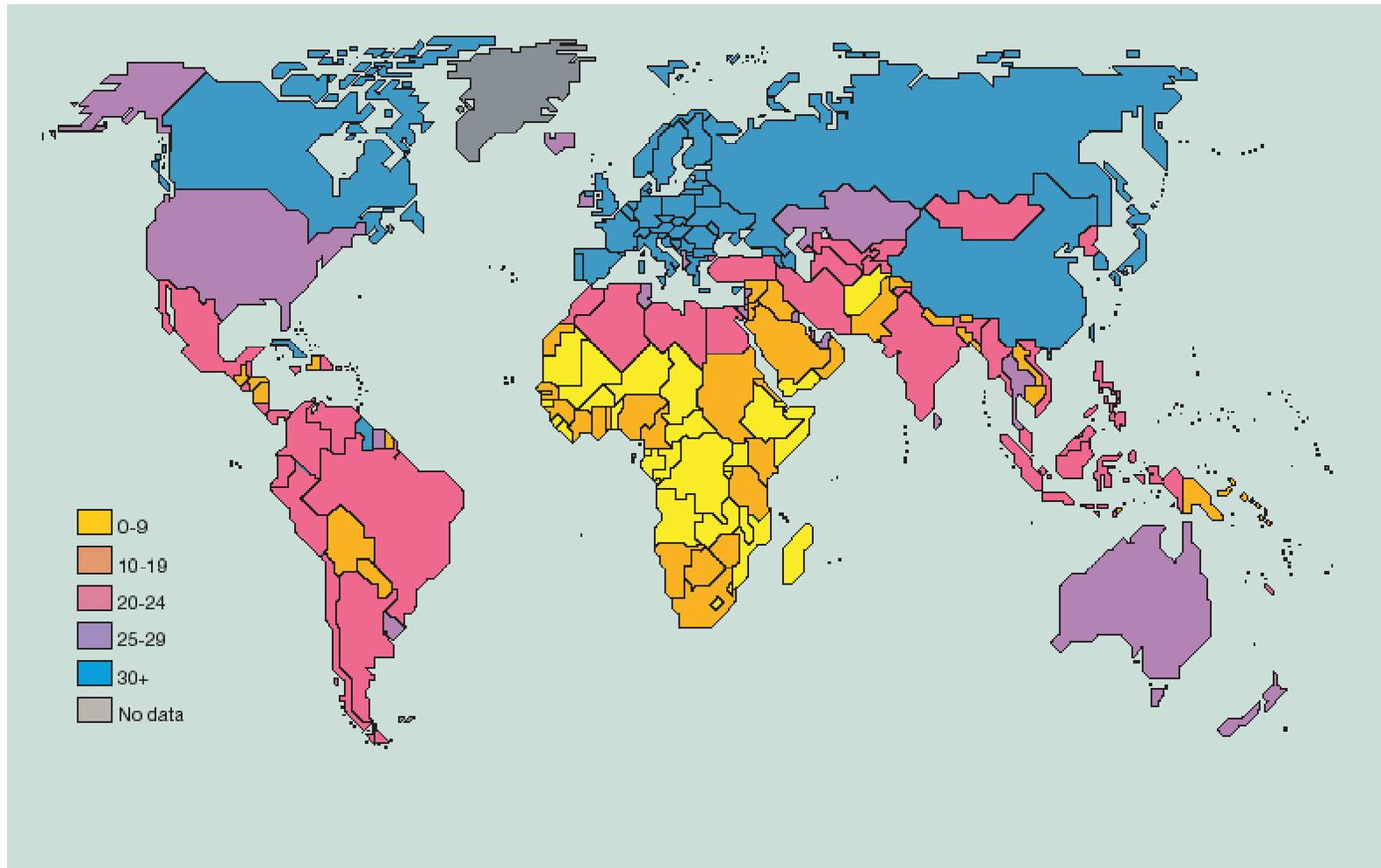
SOURCE: United Nations ▪ "Population Aging ▪ 2002"
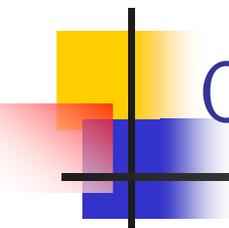
Consequences Are .....

- Along with the increase of elderly people population, the expenditures of the United States for health care will project to rise to 15.9% of the GDP ($2.6 trillion) by 2010.

  -- Health care industry study, Digital Foresight

- Many elderly people will stay at home, rather than being consigned to expensive retirement homes.
  - Even today, only 10% of elderly people of age 65-85 and 25% of those of age >= 85 are institutionalized.
 - Many elderly people choose to stay at home also for privacy/dignity issues.
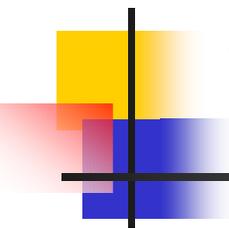
What Does This Have to Do with Us?

- Oh, well, we are next (or next to next) in line to be classified as elderly people.

- Can do we create a wireless environment for elderly people (who are capable of independent living with modest assistance) at home?

How Can Wireless Technology Help?

- **Time Driven Reminders of Daily Activities**
  - **PC serving as the intelligence.**
  - **Sending reminder messages to wireless-enabled appliances.**
  - **Closing the loop with monitoring: Whether or not the resident has taken the medicine can be monitored.**
  - **Taking action in the lack of response: A reminder can go on 2 more times, until a designated helper is notified.**
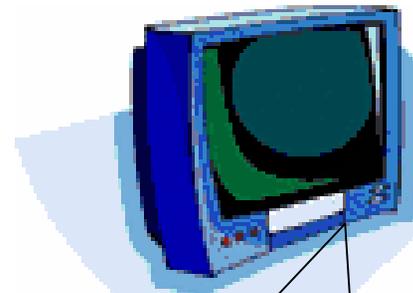
**Jennifer, It is 11:30am.
Time to take your Insulin injection before meal.**

Technologies Needed

- A secure Internet channel for sending/updating the prescription record to/at the home PC

- Electronic appliances equipped with wireless capabilities

- RFID tags (40c each) on clothes, eyeglasses, shoes, medical bottles, dinnerware, etc, and portable/fixed RFID readers with wireless capability in the environment.

RFID READER: Housed on a PC card module that contains a transmitter, receiver and digital control module and communicates with a PC through an RS232 interface. The module is connected to an antenna that constantly transmits and, when it senses a card, wakes it up, interrogates it, decodes data and passes it on to a host system over a wired intranet or VSAT system used by retailers.

RFID TAG

RADIO WAVES:

RFID READER

Intranet or VSAT

HOST SYSTEM
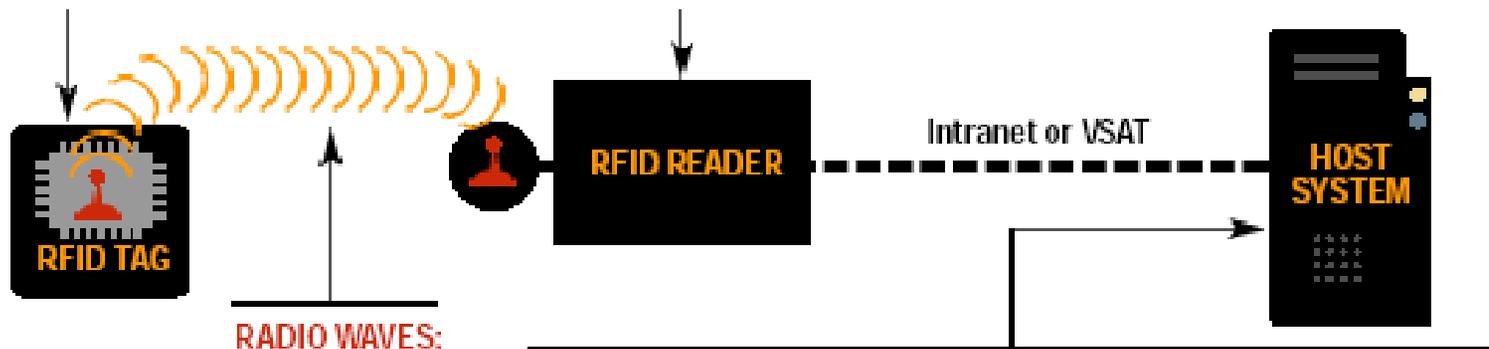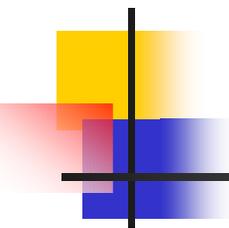
How Can Wireless Technology Help?

- Role and location based memory aids:
    - RFID readers can be used to locate personal belongings with tags.
- Detection of early warning signs for depression and/or other chronic diseases:
    - The motion of residents and their daily routines are profiled by RFID-based (or Ubisense-based) motion sensing and tracking over the time.
    - Logged data is analyzed for
        - Early warning signs for severe depression (e.g., not taking medicine, not eating, staying in bed for very long time)
        - Preventive measures (behavior changes) for chronic diseases commonly seen in elderly people (such as Parkinson's disease and/or Alzheimer's disease).
- Real-time wireless channels for notifying on-site caregivers and/or designated relatives in the case of emergency situations.

What is Missing?

- **A software infrastructure that integrates sensing, communication, and event/information management.**
  - Understand, analyze, structure and control the complex interactions across the layers of IT, computing, communication and sensing along the dimensions of robustness, reliability, QoS, device co-existence, security and privacy.

Reminders/social interaction		Monitoring		Emergency event processing Telemedicine	
Interface mgmt	Dependability	Evolvability	Real-time	Security & Privacy	
Events/data management					
Communication					
Sensing					
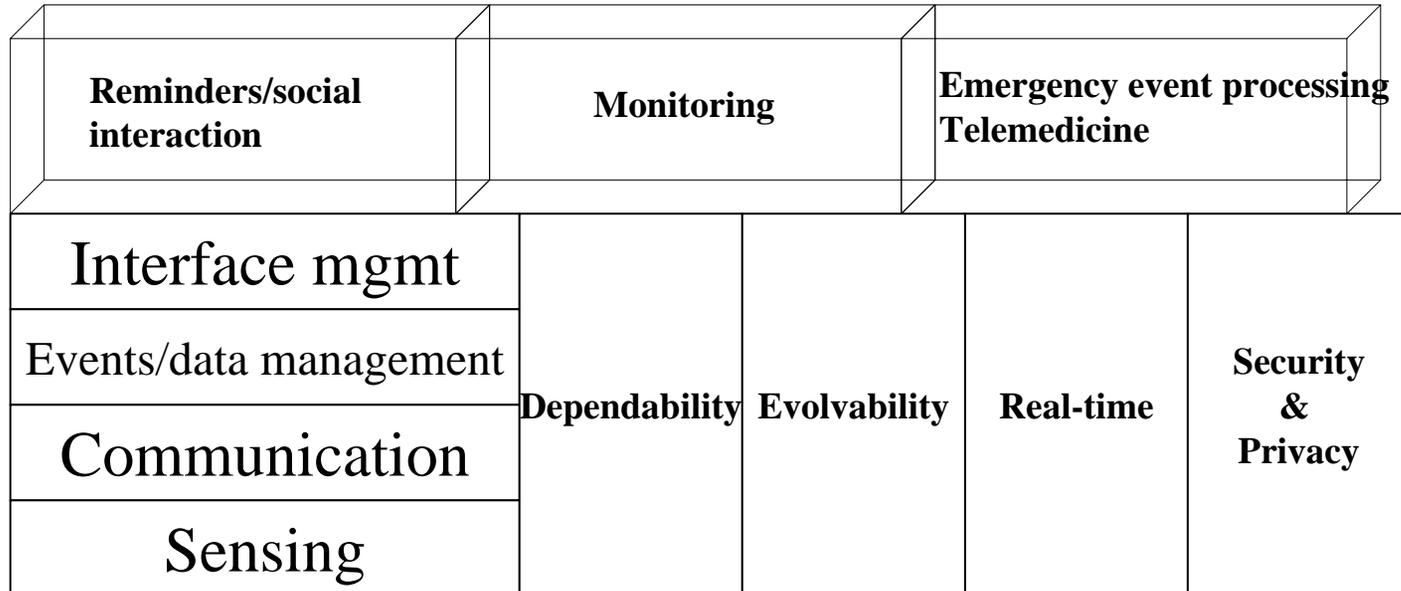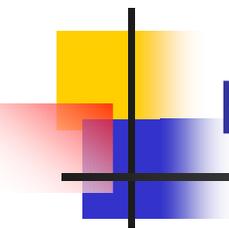
Research for the CISE Community at Large

- Software safety, robustness and availability
    - Management and control of dependency relations between software components
- Evolvability and interoperability
    - Interface engineering
- Security and privacy
    - Security for information storage and wireless communication facilities
    - Role-based trust management: who can gain access to what information
- QoS provisioning
    - Both system-wide QoS and wireless QoS for a wide variety of reminder, monitoring, localization, and time-critical emergency services
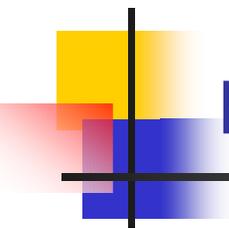
Research for the CISE Community at Large

- Wireless networking
    - Monitoring and localization
    - Device co-existence and interference mitigation
    - Power control and management for battery-powered wireless devices
- Human computer interfaces
    - Ease of use for technology naïve users
    - Accommodating with respect to user mistakes
    - Different control levels of information disclosures

Research Specific to the Mobiquitous Community

A virtual devise driver layer is needed to integrate various wireless devices and provide wireless QoS
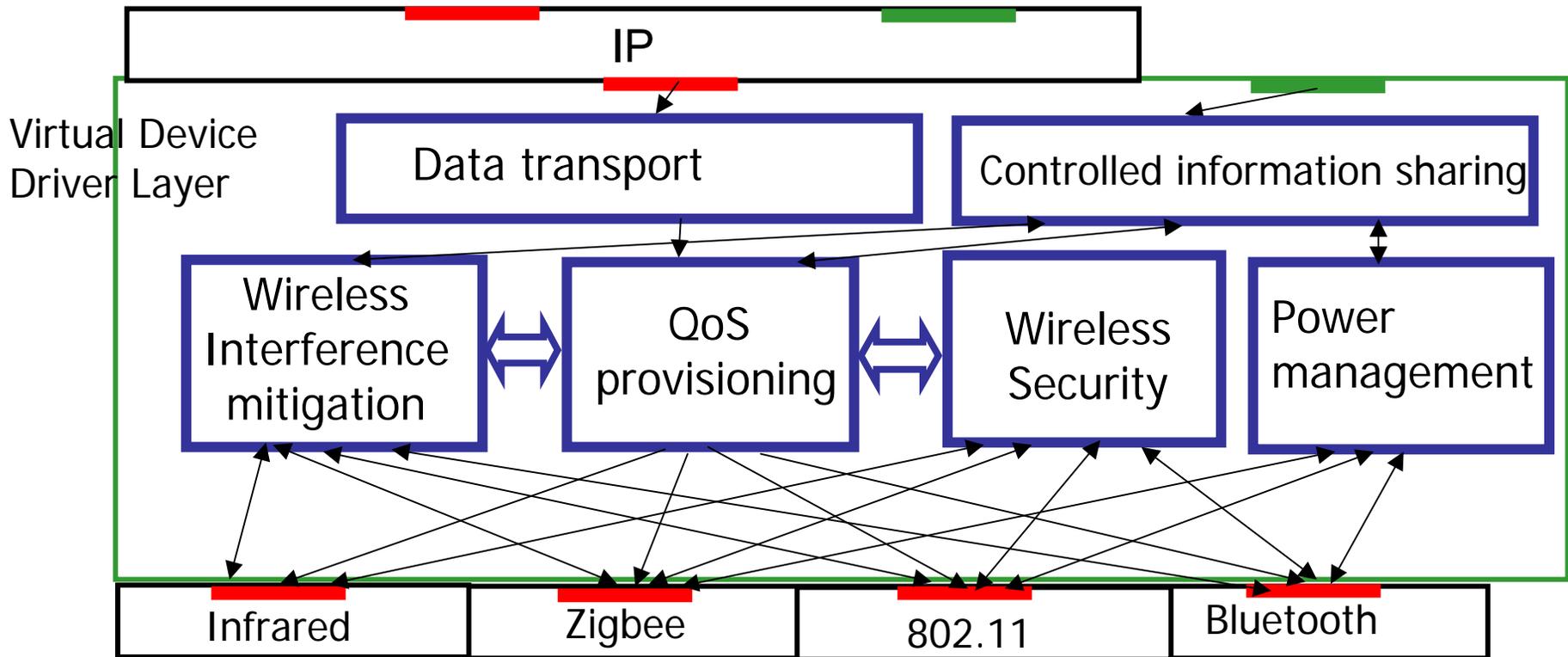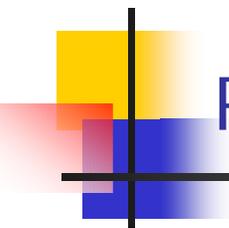
# Research Specific to the Mobiquitous Community

- QoS provisioning even in the presence of interference.
  - All the bluetooth (IEEE 802.15.1) devices, IEEE802.11 devices, and cell phones operate in the 2.4 GHz unlicensed frequency band.
  - MAC protocols in these devices are designed only to yield to (and coordinate with) the other devices that use the same protocol.
  - When devices that use different protocol suites are integrated, they interfere with each other's transmission activities and the throughput performance significantly degrade.
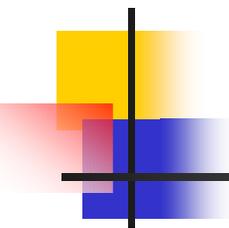
Interference Mitigation

- IEEE 802.11 has chartered a Wi-Fi alliance group, and starts to look into the interference mitigation issues.

- Bluetooth specification 1.2 has included an adaptive frequency hopping mechanism to avoid use of bad channels (i.e., frequencies at which a device detects strong received signal strength).

- However, there has not been any systematic study that defines and implements a unified, *protocol-neutral* mechanism for system integration of various devices.

Research Specific to the Mobiquitous Community

- Which wireless technology should be used to support communications among different devices?

IEEE 802 LAN/MAN Standards Committee

… … …

802.1
Higher Layer
LAN Protocols
Working Group

…

802.11
Wireless Local
Area Network
Working Group

…

802.15
Wireless Personal
Area Network
Working Group

…

802.20
MBWA
Working
Group

TG1
WPAN/Bluetooth
Task Group

TG2
Coexistence
Task Group

TG3
WPAN High Rate
Task Group

TG4
WPAN Low Rate
Task Group
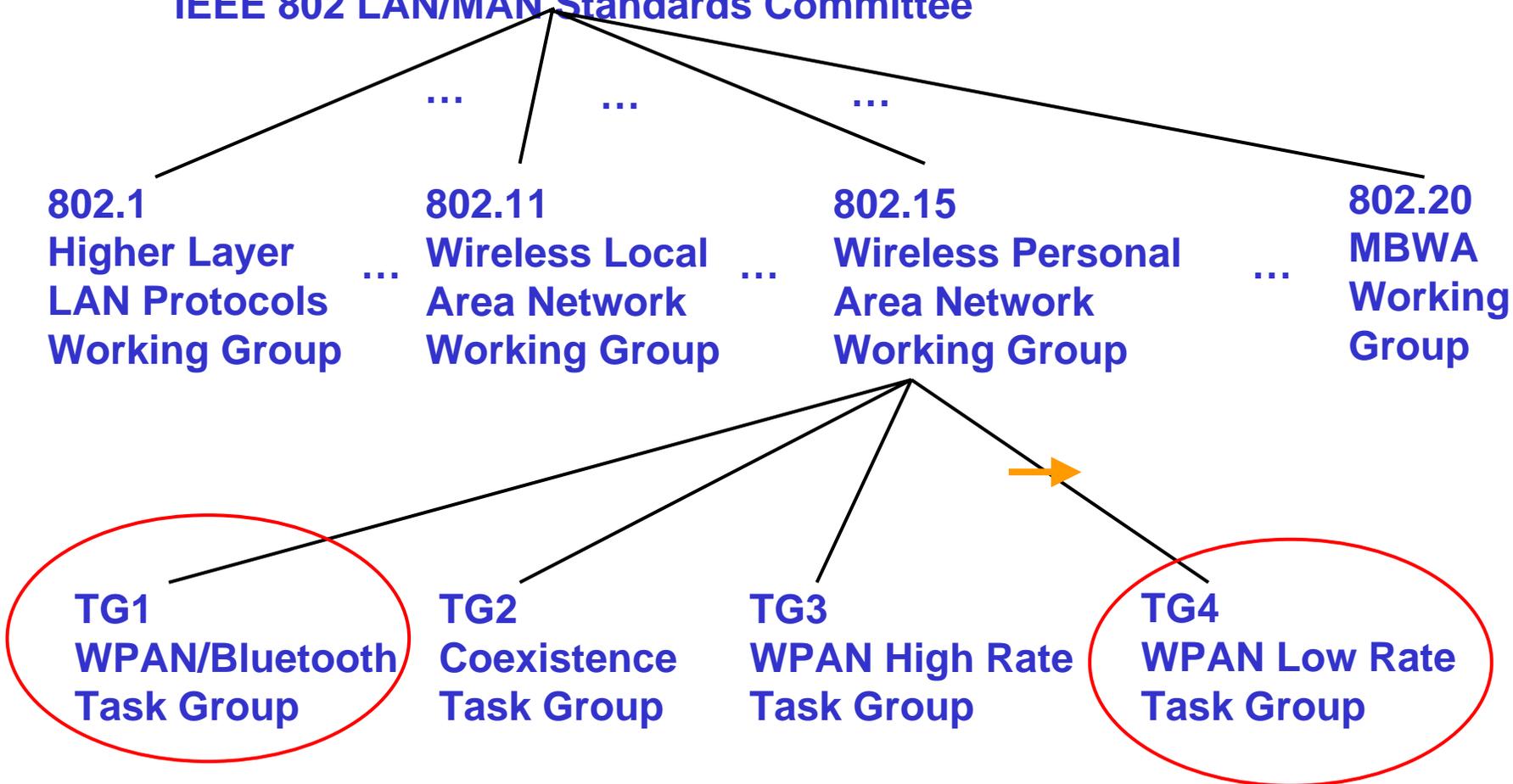
Choosing Adequate Wireless Protocols

- Tradeoff analysis between cost, power, throughput (support of voice traffic), latency, based on application needs and constraints of physical devices.

- What IEEE 802.15.4 is:
  - An WPAN standard optimized for low (0.01-115.2 kb/s) data throughput applications with simple or no QoS requirements
  - Lower power, lower cost than other WPANs (e.g., Bluetooth)
  - PHY and MAC layers only (upper layers defined by ZigBee)

- What it is not:
  - A WLAN
  - A Bluetooth replacement (e.g., no isochronous voice capability)
  - Optimized for multimedia, TCP/IP, or other high data rate applications
  - A system, network, or application set

MCU requirements: 8-bit, 4 MHz, 32 kB ROM, 8 kB RAM