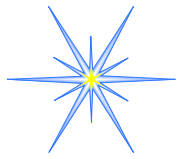
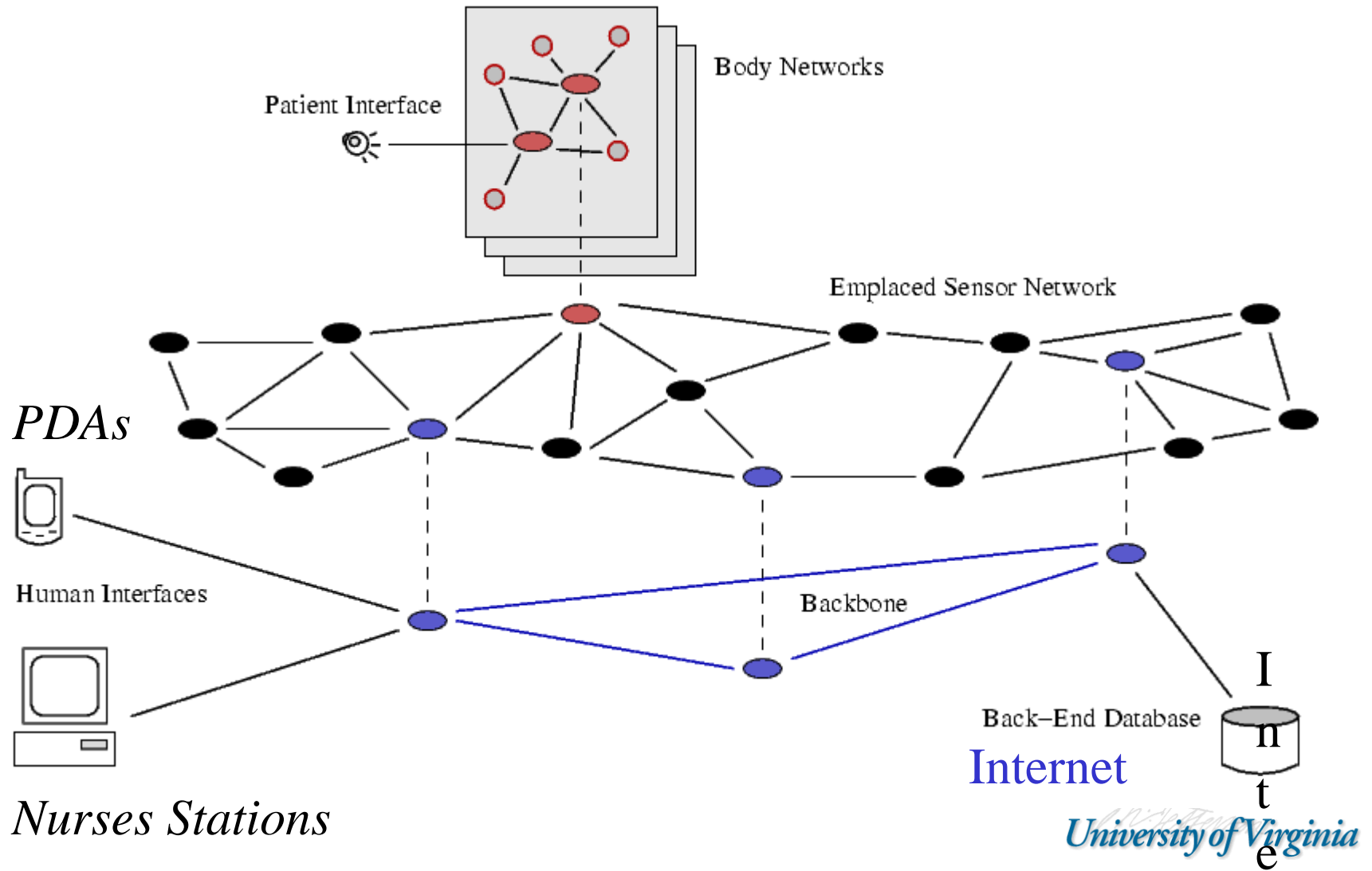


# AlarmNet: Assisted Living and Residential Monitoring Network

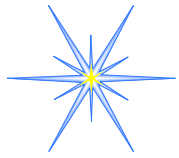
Professor Jack Stankovic  
Department of Computer Science  
University of Virginia  
August 7, 2006



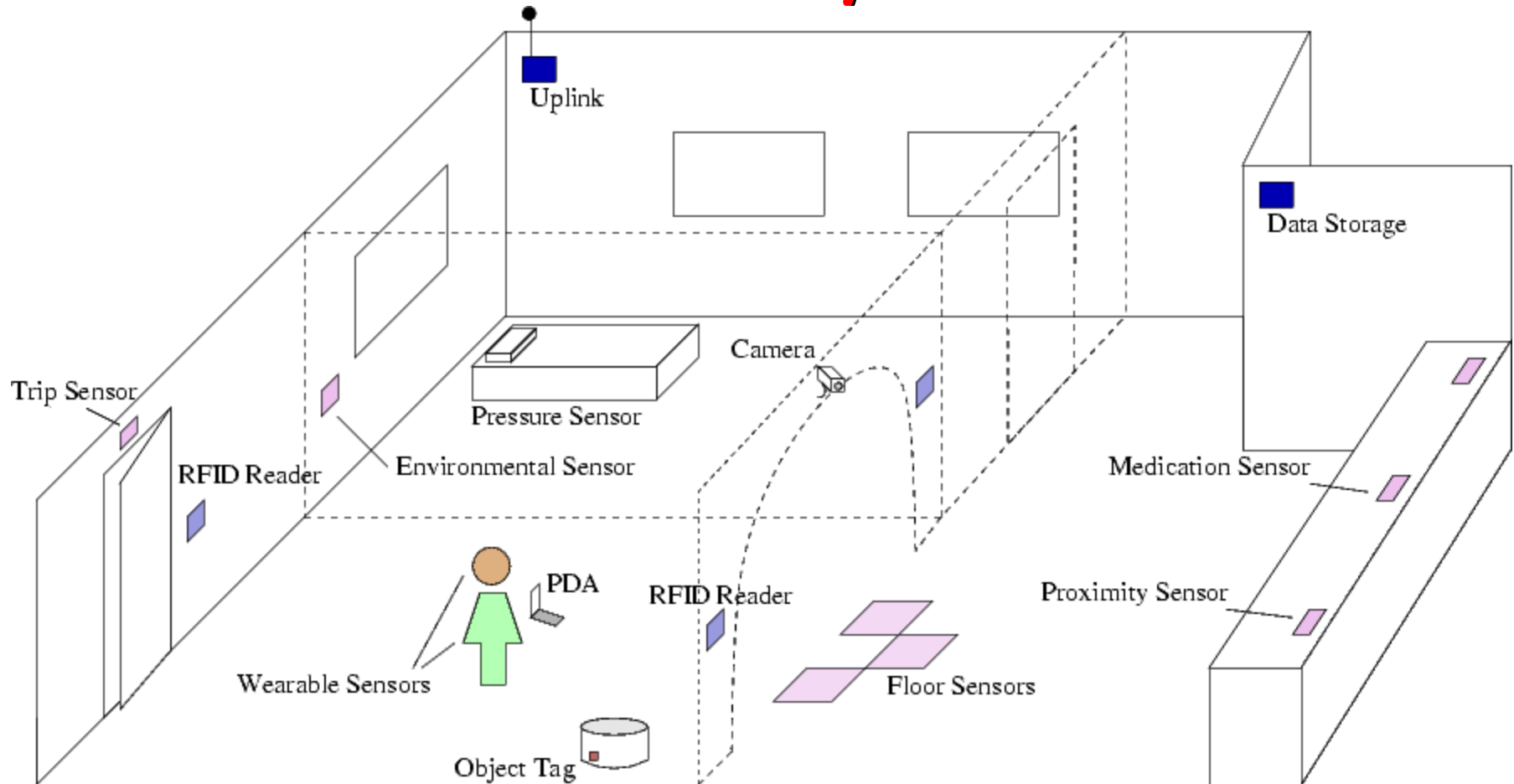
# Medical System Architecture

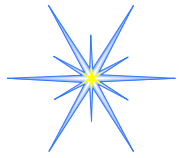




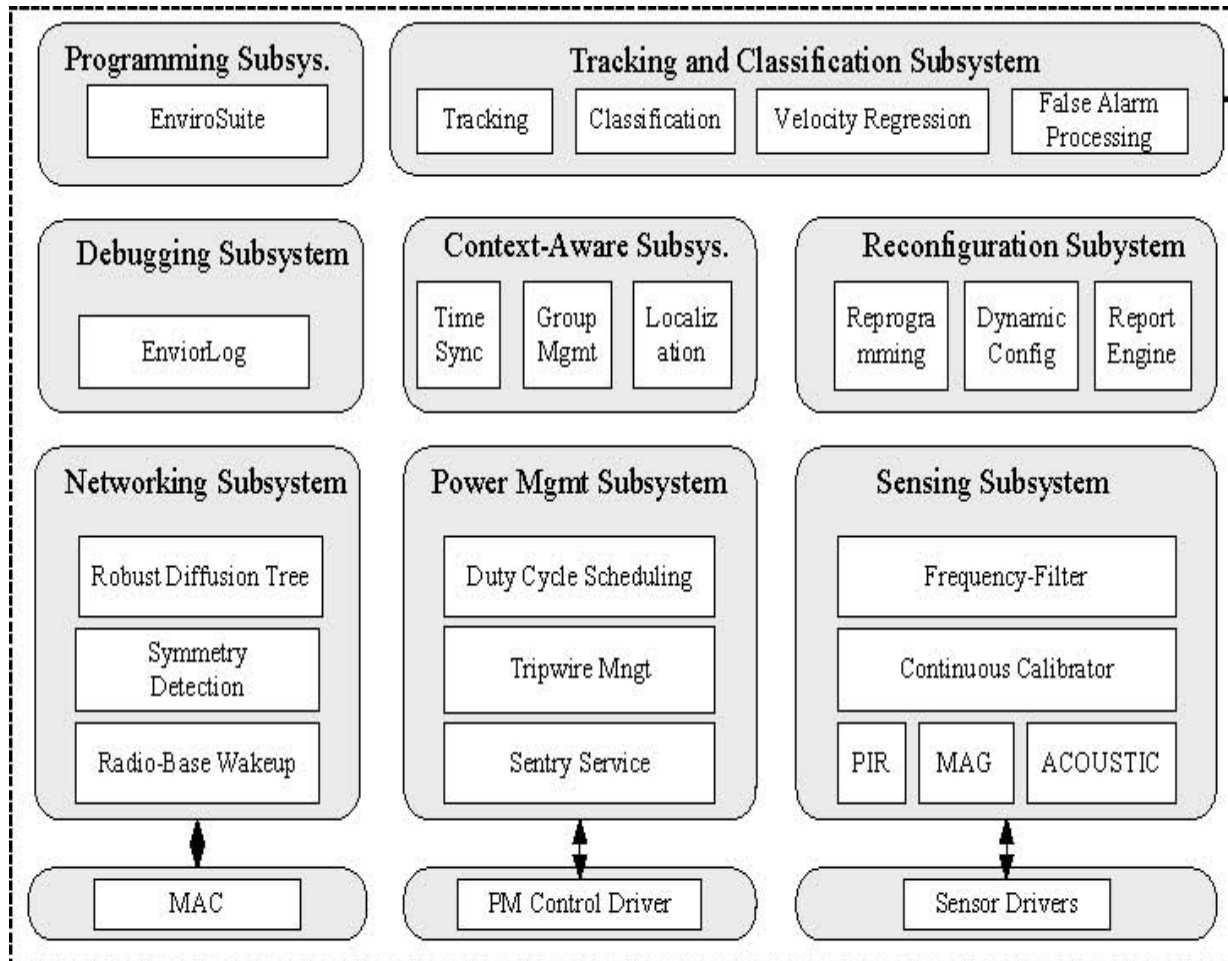


# Smart Living Space/Scale to Many Units





# VigilNet Architecture

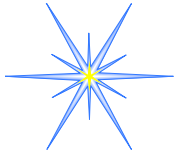


MICA2 / XSM / XSM2 / MICA2DOT Motes



User Interface & Control Subsystem





# Lesson 1

- Could not use much/any of the previous system

## *VigilNet*

*Homogeneous*

*No security*

*No Privacy*

*Outdoors*

*No query system*

*Sensor Fusion*

## *AlarmNet*

*Heterogeneous*

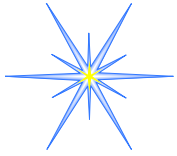
*Security*

*Privacy*

*Indoors*

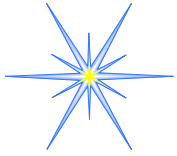
*Queries*

*No sensor fusion*



# Lesson 2

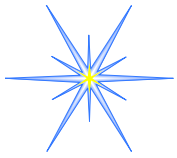
- Crowded spectrum and will get worse
  - Microwave oven interferes with motes
  - Overlapping networks -> multi-channel transceivers required



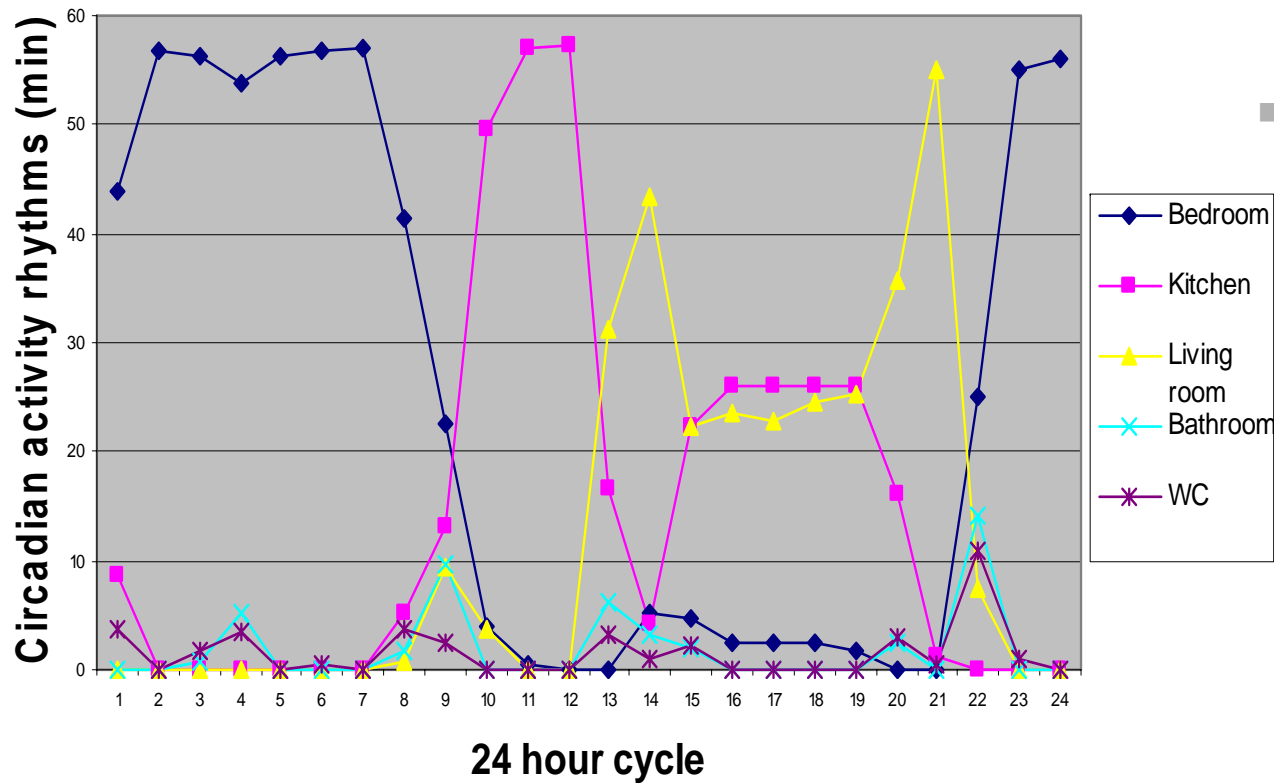
# Lesson 3

- Big gap between collecting and analyzing (raw) data and linking it to disease and disease prediction



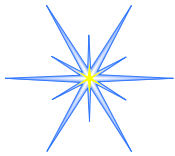


# Behavioral Profile



- Same calculation applied to all the rooms  $\Leftrightarrow$  patient behavioral profile  $\Leftrightarrow$  habits life

Circadian activity rhythm per room for a stay of 70 days



# Detection of Behavioral Deviation

Diurnal/nocturnal activity

**SAMCAD**  
File Help

**Current alerts per hour**

	<<	<	Regular Behavior	>	>>
Bedroom	☾	☾	☀	☾	☾
Living R.	☾	☾	☀	☾	☾
Kitchen	☾	☾	☀	☾	☾
Shower	☾	☾	☀	☾	☾
Bathroom	☾	☾	☀	☾	☾
Hallway	☾	☾	☀	☾	☾
Doorstep	☾	☾	☀	☾	☾
Office	☾	☾	☀	☾	☾
Laundry	☾	☾	☀	☾	☾
Dining R.	☾	☾	☀	☾	☾
Basement	☾	☾	☀	☾	☾

**Daily alerts for the day 04/03/2005**

	D.<<	D.<	D.>	D.>>	N.<<	N.<	N.>	N.>>
Bedroom	0	0	0	0	0	0	0	0
Living R.	0	0	0	0	0	0	0	0
Kitchen	0	0	0	0	0	0	0	0
Shower	0	0	0	0	0	0	0	0
Bathroom	0	0	0	0	0	0	0	0
Hallway	0	0	0	0	0	0	0	0
Doorstep	0	0	0	0	0	0	0	0
Office	0	0	0	0	0	0	0	0
Laundry	0	0	0	0	0	0	0	0
Dining R.	0	0	0	0	0	0	0	0
Basement	0	0	0	0	0	0	0	0

**Time left**  
0% 50% 100%

**Alerts caption**  
D: Diurnal  
N: Nocturnal  
<<: Sub-presence critical  
<: Sub-presence benign  
>: Sup-presence benign  
>>: Sup-presence critical

**Stay duration (days)**  
61

**Date of departure**  
03/01/2005

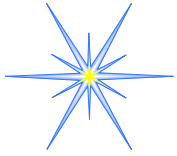
**Date of arrival**  
04/03/2005

**Database**  
d:\Univ\Post-Doc. US\MARC\SAMCAD

**Quit** **Run**

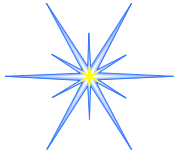
**Circadian Activity Rhythms (CAR)**

**Behavioral Deviation**



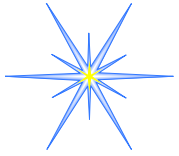
# Lesson 4

- Security - full set of solutions won't fit
  - Target Realistic Attacks
    - Eavesdropping
    - Interject (messages) mis-information
    - Disrupt routing
    - Destroy/violate privacy policies or other data
    - Disclosure of private data
  - Then evolve (via self-healing)



# Lesson 5

- Data Association from trivial to impossible and all places in between
  - RFIDs
  - Cameras (but not acceptable in many situations)
  - Probabilistic - but **MUST** be highly reliable
  - Lose data when association can't be done
  - Prevent mistakes: wife puts on husband's jacket



# Other Research Issues

- Privacy
- In-situ sensor (re)calibration