4/60484: Networked Sensor Systems

- Instructor: Surendar Chandra (surendar@nd.edu)
  Room: 381 Fitz (631-8975)
  Office Hours: Wed 2:00-4:00
  (other times, by email appt)
  Email/iChat/AIM is the best way to reach me
  I am usually on AIM, Yahoo, Skype
- TA: William Acosta
- Course Web: cse.nd.edu/courses/cse40484/www
- Mailing list: cse40481-01-fa07@listserv.nd.edu

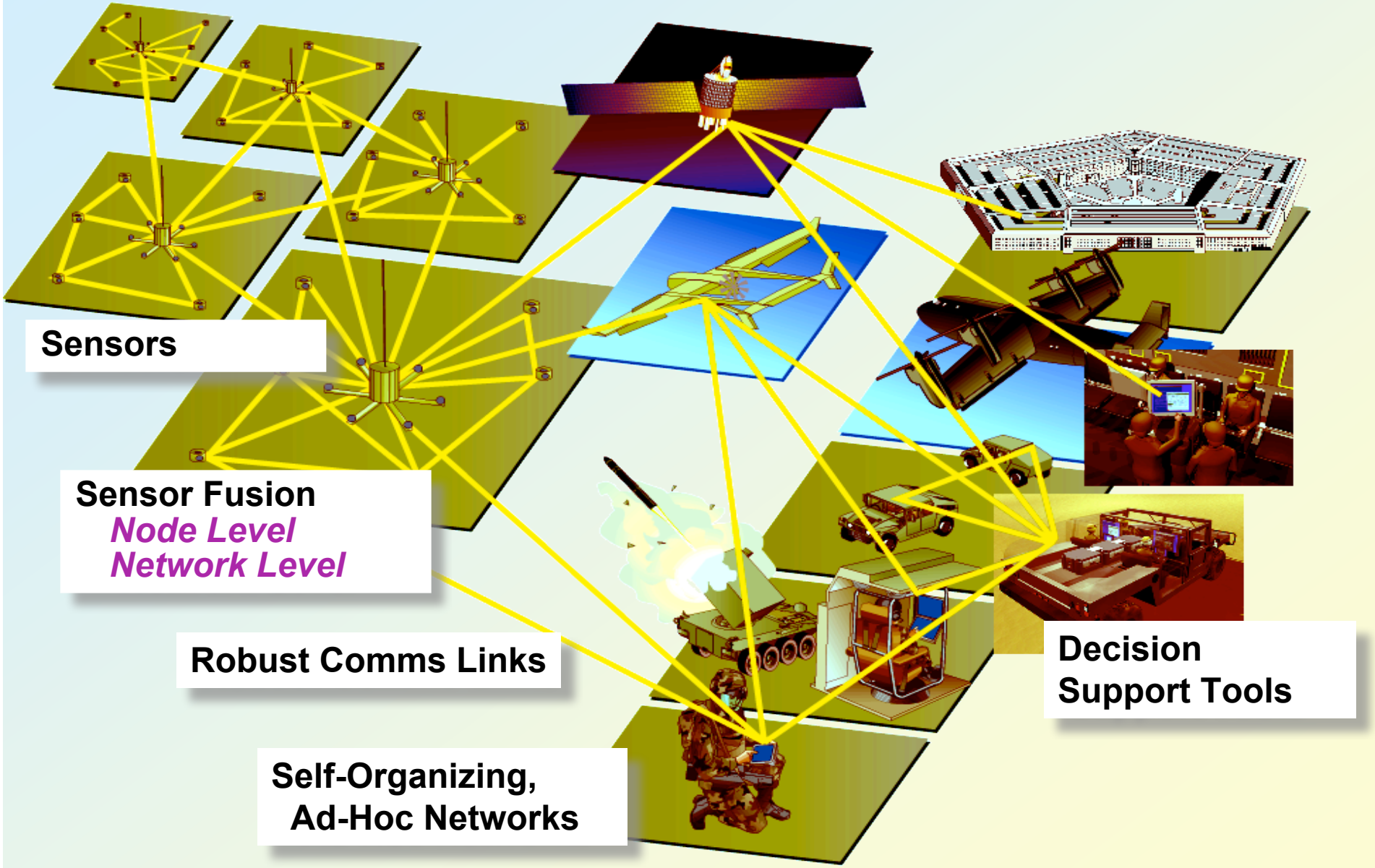
Outline for today

- High level introduction to Sensor Networking
  - Extend computing into the physical world through sensors/actuators
  - Autonomously monitor and interact with (bridge sensor, warfare, environment, …..)
  - Many inexpensive sensors: better coverage + robust
    - Coordination is a challenge
- Course policies:
  - Course goals, organization and expectation
  - Grading policy, late policy, reevaluation policy
  - Academic honesty

What do they mean to you?

- What do you think?

Networked Sensors: Technology Enablers



Sensor nodes

- Technology evolution is allowing for integrating

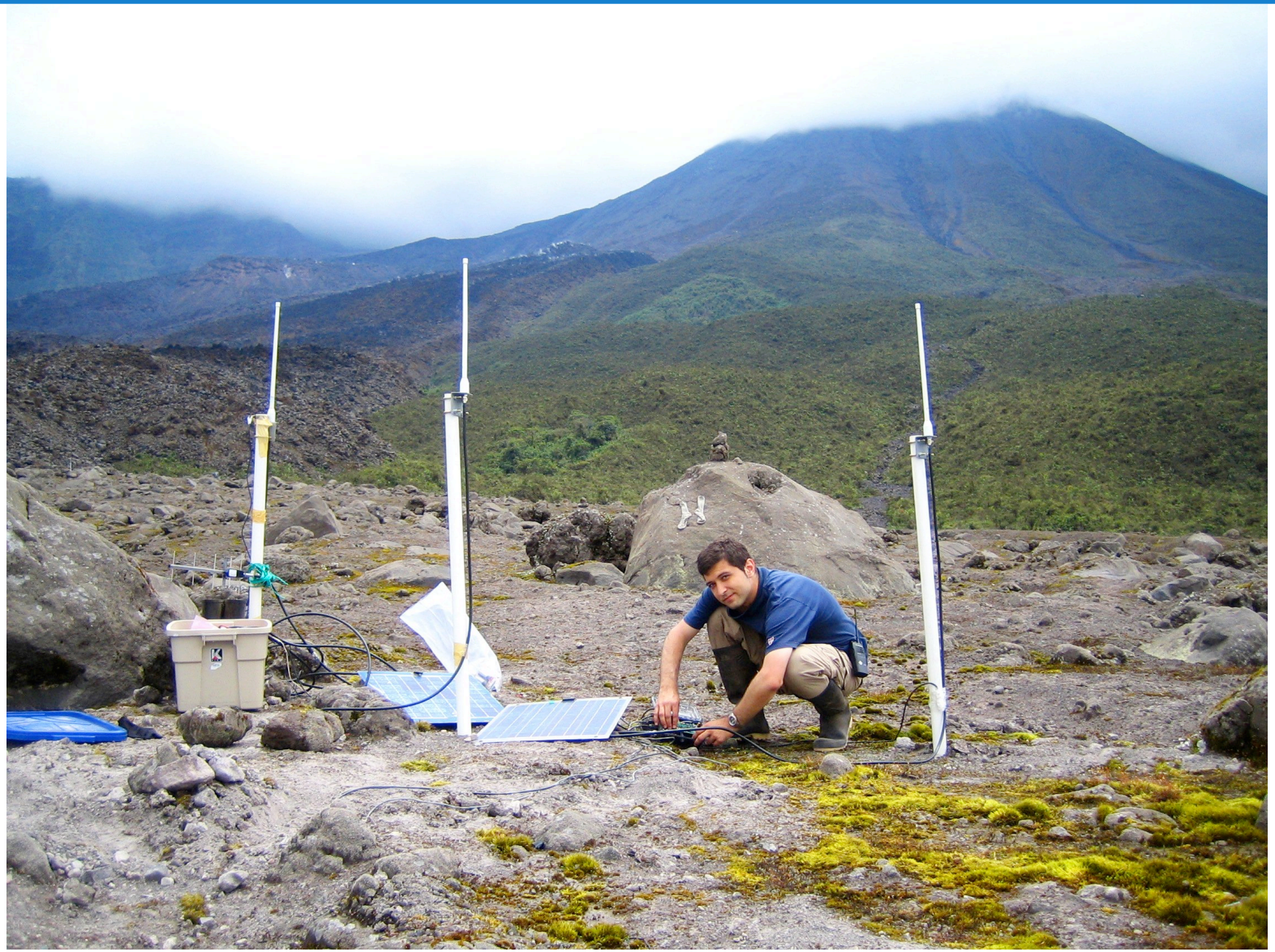
Sensor + computation + networking capabilities-> small package

- Sensor: temperature, humidity, magnetometer, acoustic, acceleration, blood sugar level, video, radiation monitor etc.
  - Some sensors are inherently large
- Computation: Less than corresponding desktops
  - Video sensing requires some CPU capabilities
- Networking: Wired or wireless, less than desktops
  - Bridge monitors can be part wireless/wired
- Cost: Cheaper than desktop components

- Number: Larger than desktop components
  - Specific parameters depend on the device and what is being monitored
  - E.g. smart dust vs radiation monitor
- Energy consumption important in some scenarios
  - Sensor attached to a tank not the same as smart dust

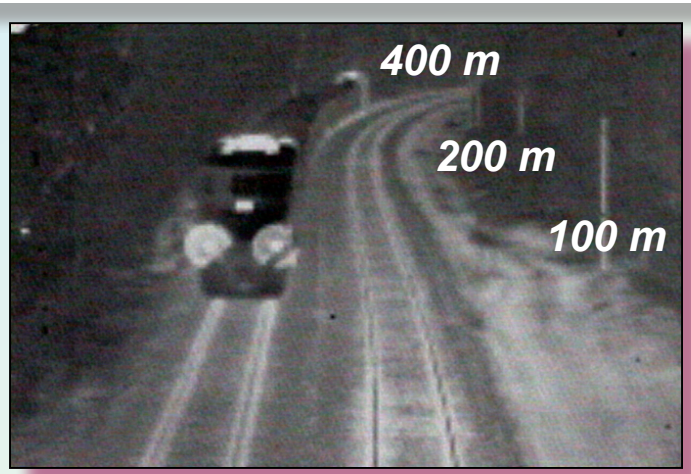
Sensor nodes

Volcano monitoring



IR Sensor

- Low cost imager
- Low power / size
  - *90 grams (including optic)*
  - *600 mW @ 3.5V*
- Excellent target identification



Detection of Walking Man Target

FPA	Sensor Field of Regard/Range	
	40° FOV	15° FOV
160x120	FOR = 164m/ Range= 240m	167m/ 640m
320x240	328m/ 480m	334m/ 1280m

Target: Walking Man (0.75m/2.0° C)
50% Detection/0.75 cycles on target
Atmosphere: 80%/km

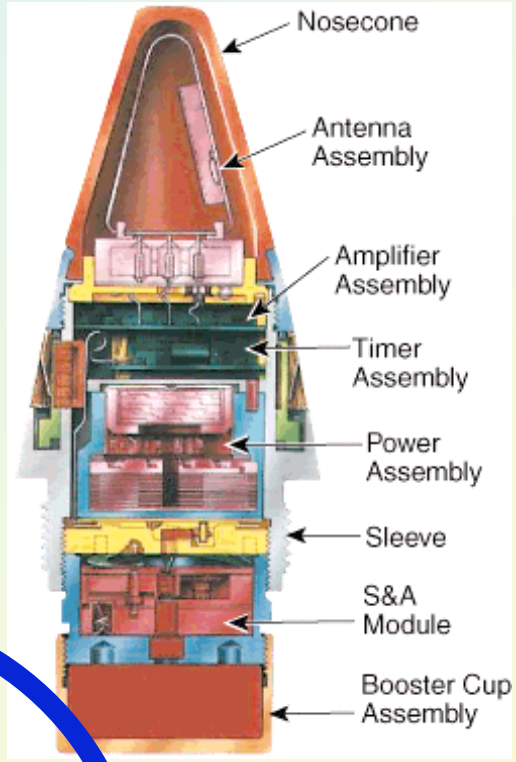
Using ATR - Simple ID messages

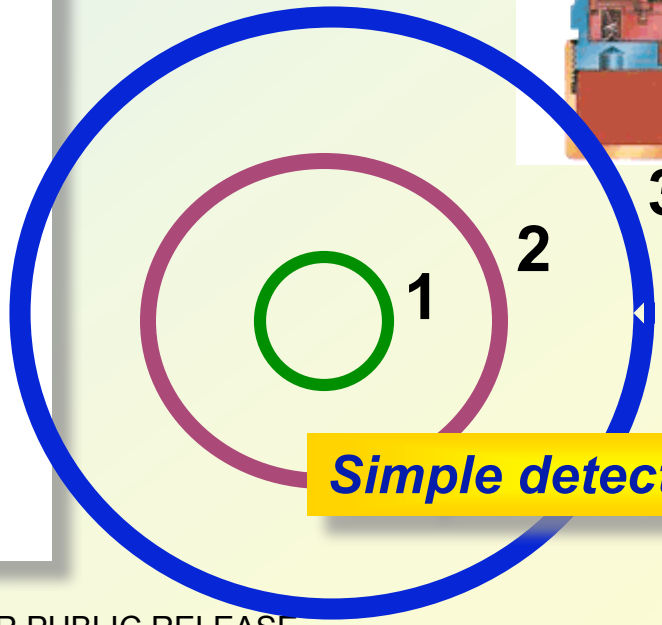
Send images only when essential

Moving Target Indicator (MTI) Radar Sensor

- 360^{O}, NLOS monitoring
- Low cost
- Small, low power
- Detection of moving targets based on Doppler
- Excellent target range information out to > 500m
- Concepts based on Army proximity fuzes
- Simple- multi range cell design

$$P_r = \frac{P_t G_t G_r \lambda^2 \sigma}{(4\pi)^3 R^4}$$





Simple detect message

Challenges

- Limited hardware: Processing, communications, energy supply
- Limited network support: Remote locations means data might travel through other peers before reaching gateway/base station
- Limited software development tools: Massively distributed, autonomous systems
  - Updating sensors even more trickier - failed patch can bring down the whole system
  - Calibration is important
- Security should be a big concern
  - Privacy?

Applications

- Environmental monitoring (e.g., traffic, habitat, security)
- Industrial sensing and diagnostics (e.g., supply chain, factory)
- Infrastructure protection (e.g., power grid, water distribution)
- Battlefield awareness (e.g., multitarget tracking)
- Context-aware computing (e.g., intelligent home)

Course Goals

- Understand the state of the art in sensing systems.
  - Focus on more capable sensors (video, storage) than smart dust etc.
  - Read topical research literature
  - Text book should bring us up to speed
  - Follow course web page for lecture schedule
    - Send me a note if you would like particular topic covered
- As much hands on experience as possible
- Course project should help

Course Organization

- Course text
- Sensor applications (from research papers)
- Specific challenges in video, storage, security …

Grade distribution

- Exams - 35%
  - Midterm (15%)
  - Final (20%)
- Take home assignments – 20% (2*10)
- Course project - 45%
  - By end of next week: form groups, discuss ideas with me
  - proposal - 5 pt (1 month)
  - mid-semester report - 5 pt (after fall break)
  - technical work - 25 pt
  - final report - 5 pt (before exam week)
  - final presentation - 5 pt
  - Somewhat interrelated - if you give an excellent presentation about ducks, would get 0% because technical work would be 0 (presentation could be 5)

Reevaluation policy

- Arithmetic errors, missed grading will be reevaluated promptly
- I encourage you to discuss concerns with your solution with me
- I discourage re-evaluation of partial credits (partial credits are based on the complexity of your solution and the overall class performance):
  - Football penalty policy:

    If you think you deserve a better partial grade, write down the reason why you think that you deserve a better grade and how many extra points you think you deserve. If I agree, you could get up to this many extra points. If I disagree, you will lose this much points. You can increase your odds by performing experiments to prove your answer

Late policy

- None –homework are due at 2:00 pm (right before the beginning of class). **I do not accept late submissions** (not even a second)

- Please contact me regarding unforeseen emergencies

Academic Honesty

- Freedom of information rule:
  - Collaboration is acceptable (even for individual efforts such as take home assignments as long as you follow the rules of this course)
  - To assure that all collaboration is on the level, **you must always write the name(s) of your collaborators on your assignment.** Failure to adequately acknowledge your contributors is at best a lapse of professional etiquette, and at worst it is plagiarism. Plagiarism is a form of cheating.

Academic Honesty – Gilligans Island Rule

- This rule says that you are free to meet with fellow students(s) and discuss assignments with them. Writing on a board or shared piece of paper is acceptable during the meeting; however, you may **not take any written (electronic or otherwise) record away from the meeting**. This applies when the assignment is supposed to be an individual effort. After the meeting, engage in half hour of mind-numbing activity (like watching an episode of Gilligan's Island), before starting to work on the assignment. This will assure that **you are able to reconstruct what you learned from the meeting, by yourself, using your own brain**.