How to write successful research proposals

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Outline of Talk

- Types of research
  - Basic Research
  - Applied Research
- Embedded and Sensor Networks Group
- Wildlife and WSN
  - GPS based tracking
  - GPS-less tracking
  - Image sensor network
  - Acoustic sensor network
- Chandrayaan-II
  - Water on Moon ?
  - Seismic Sensor network

Types of Research

- Understanding broad category of research help
- Two very broad
  - Basic or Fundamental or Pure or "Blue Sky"
  - Applied

Call for "Blue Sky" research

- 05 April 2007 - European Blue Sky Research on Emerging Issues affecting European S&T

- Sep 2008 – South Africa NSF calls for Blue Sky Research

- Mostly funded by Govt agencies – DST, CSIR, MCIT, DBT, …

Bottom-up Vs Top-down[1]

- Bottom-up – Starting from what you know or have gained from others (like a recent research paper) and then see if any opportunity shows up to improve upon existing knowledge – but you need to develop some kind of intuition as to what is do-able in a given time frame

- Top-down – Problem directed , goal oriented or applied
  - One needs to breakdown the needs to achieve the required objective
  - Missing links may be identified and appropriate collaboration sought

Basic Research[2]

- Basic research - driven by a scientist's curiosity or interest in a question
- Motivation - expand man's knowledge of the world and not to invent or create something new
- No obvious commercial value

Basic science research tries to answer questions such as:

- How did the universe begin?
- How has man evolved over time?
- How did moon originate?
- What is the specific genetic code of an earth worm?
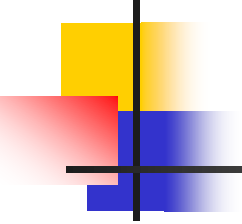- What are protons, neutrons and electrons made of?

Most scientists believe

- Basic understanding of all branches of science is necessary in order for progress to take place

- Basic research lays down the foundation for the applied science that follows

- Basic work must be done first and then the applied can take the research further where applicable
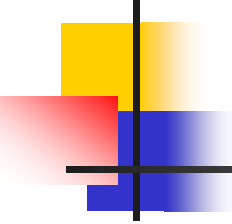
Applied Research

- Designed to solve the practical problems that exist in the modern world, rather than to just acquire knowledge for knowledge's sake

- One main goal - improve human conditions and make the world a better place

  - Healthcare, Environment, Education …

- Applied science may investigate ways to:
  - improve agricultural crop production
  - get better fuel efficiency
  - find alternative energy sources
  - treat or cure a specific disease
  - improve the energy efficiency of homes

- Many feel that there should be a shift in scientific research
- With so many problems facing the world today that more attention needs to be focused on the applied sciences to help solve problems like
  - Global overpopulation
  - Pollution
  - illness and
  - the depletion of the earth's natural resources

- "It is important to understand that both of these branches of science work together, and that without the initial research of how things work, it can be difficult to make the improvements that applied scientists are looking to make"

Shift in today's world

- Earlier a scientist/philosopher would imagine/think and come up with explanation of natural phenomena

- Slowly they started to develop instruments or observation techniques to do quantitative measurements and verify explanations

  - Scientists developed there own instruments to answer basic question

- Today some one (or many) may develop an instrument to make observations which allows another person to answer basic questions

Interdisciplinary and Collaborative work

- It is no longer a small group or an individual trying to do a basic research

- Large number of groups bring to the table a set of expertise to conduct an experiment to answer some fundamental question

- Can you provide a set of expertise that the group needs ?

- International collaboration is the need of hour
  - Internet is the medium that makes this happen
  - Information gap has reduced

Publication driven research

- Many (a very large fraction) does research based on what can be published

- One reads some papers and tries to add incremental value in the hope that it would get published

- Some even let the referee guide them as to what work should be done

- I feel publication is a means to communicate your research but that should not be the sole aim of research

References

1. http://frankmccabe.wordpress.com/2006/12/20/blue-sky-vs-applied-research/
2. http://www.sciencefuse.org/basic-vs-applied-research.html

Research Group

- Embedded Systems and Sensor Networks Group

- Focus is on applications and full development capability

- Applying WSN to wildlife research in collaboration with Wildlife Institute of India among many other projects such as planetary exploration

Wildlife Research

- Biologists and other researchers want to study behaviour of wild life

- Some of this is to help in preserving them

- Sometimes it may be linked to some major projects which are likely to disturb their natural habitat/migration path

- Wildlife studies cover

  - large areas

  - difficult infrastructure-less terrain

How wildlife studied

- Many of the traditional techniques being used for wildlife study is primitive
- Information about
  - Location
  - Movement
  - Activities
  - Food habits
  - Social Behaviour
  - Breeding

Traditional Techniques

- Human observers
- Radio collar
  - Infrequent Data Collection
  - Day light
  - Difficult for species which avoid human contact
- Commercial trackers – GPS+Satellite uploads
  - Only battery, no recharging
  - Only few thousand position data and no biometry available
  - Very expensive so difficult to track many animals

GPS_4400L

GPS_2200 /
3300L /
4400M /
WildCell /
GPS Argos

GPS_4400S / 3300S

WSN for wildlife

- Type of Data
    - Location Tracking
    - Biometric Information
    - Activity Information
    - Photographic Images
- Land/Aquatic coverage
- Continuous monitoring
- No personal tracking
- Data available at Researcher's location
- Long monitoring period
- Wide coverage of area

How WSN benefits

- Optimize
    - Power Consumption
    - Size
    - Cost
- Lack of real life application experience
- High data value means we can relax cost factor optimization (need not be few dollars per node)

Projects

- GPS based sensor nodes to monitor behavior of a group
    - Zebranet (USA - Princeton)
    - WildCense (India – DA-IICT, WII)
- GPS less tracking of small animals
    - TurtleCense (India – DA-IICT, WII)
- Image sensor network based
    - TigerCense (India – DA-IICT, WII)
- Acoustic sensor network based
    - Cane Toad (Australia – UNSW, NICTA)
    - Purple frog (India – DA-IICT, WII)

GPS based systems

- Add a collar on a group of animals of interest – can be heterogeneous

- Collar has GPS, RF Tx/RX, microcontroller, power supply, energy harvesting, flash based local storage ..

- When animals come close to each other data migration takes place and finally reaches receiving station(s)

Zebranet

- Based on
  - "Hardware Design Experiences in ZebraNet" - Pei Zhang, Christopher M. Sadler, Stephen A. Lyon, and Margaret Martonosi
  - Margaret Martonosi (www.princeton.edu/~mrm/zebranet.html)

Butyl Belt

mpala):

ERTE 20

remote

WildCense

- Inspired by ZebraNet project – started in 2006 and later supported by WII

- Design choices
  - Traditional collar design - battery pack hanging and rest of the device on top
  - 2.4 GHz Tx/RX
    - Worldwide ISM band
    - Smaller antenna
    - Higher data rate
    - Lower range
  - Added Temp, Humidity, Light and activity sensor
  - Not dependent on solar cells – but can be used to enhance lifetime
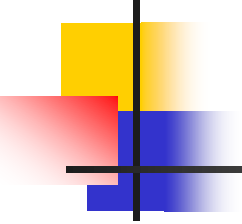
Node design
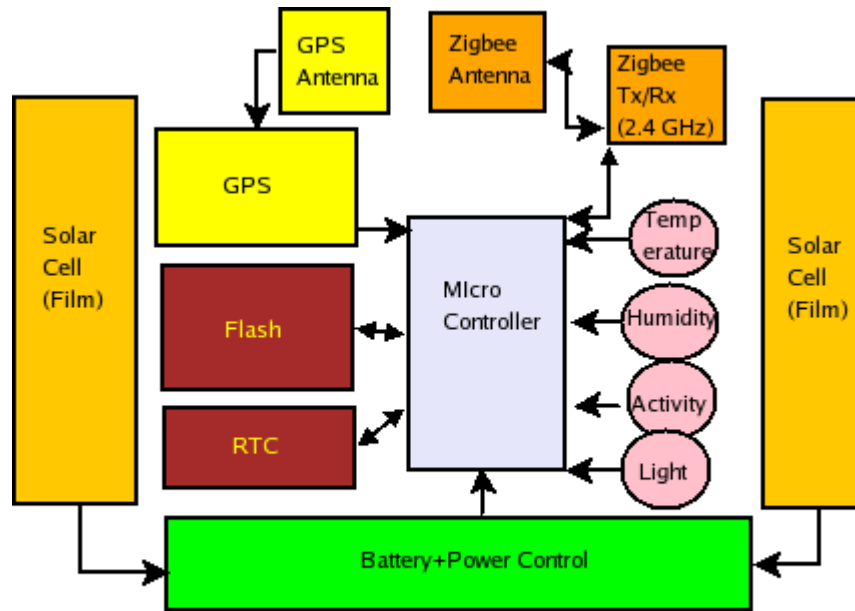
wildCENSE : Block Diagram

Trial in Sept 2008 on Cow

Date: 2008-09-03 Time: 08:13:41
Temp: 32.01 Hum: 75.78 Light: 5237
Or_x,y: -11.7, -31.7 Seq : 4430
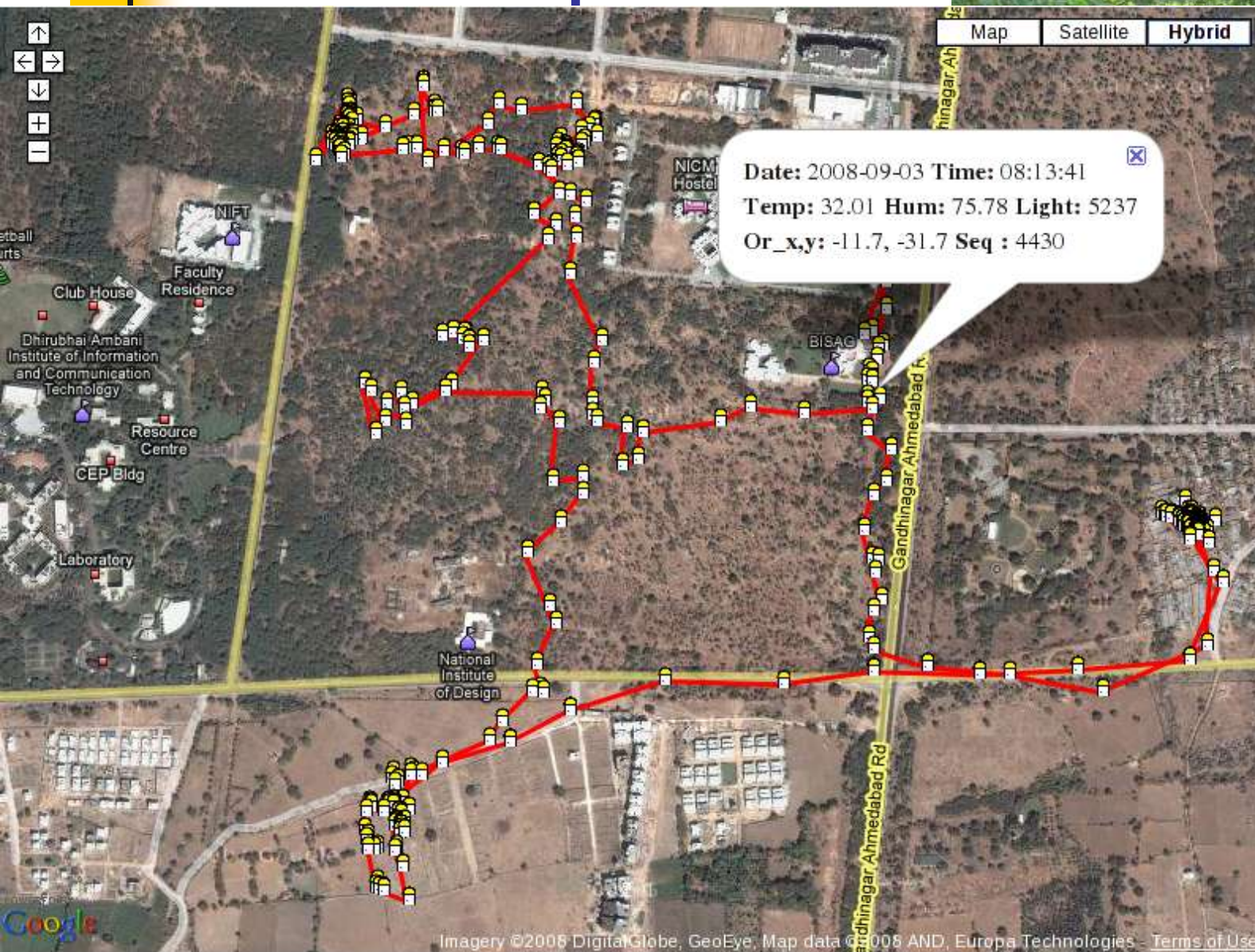
- Would be used to monitor "Swamp Deer" migration

- First trials are being done on "Spotted Deer" in Sariska Forest Reserve, Rajasthan

TurtleCense : GPS-less tracking of small animals

- Small turtles weighing less than 500 gms, cannot use GPS

- Hibernate in winter – period to be recorded along with microclimate

- Habitat – WII campus forest with lot of trees and bushes
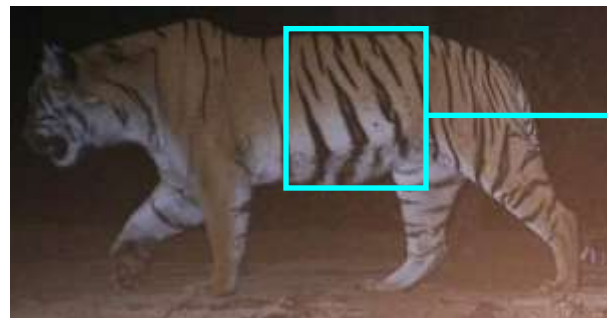
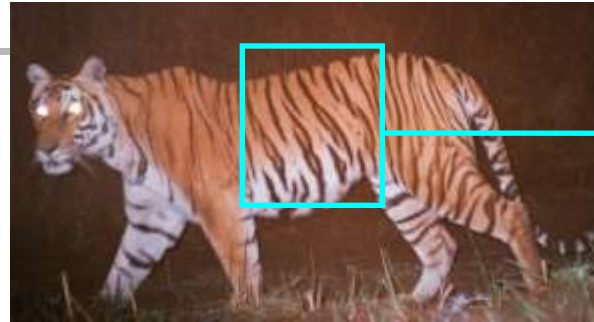19/05/2006

Grid of receiving station
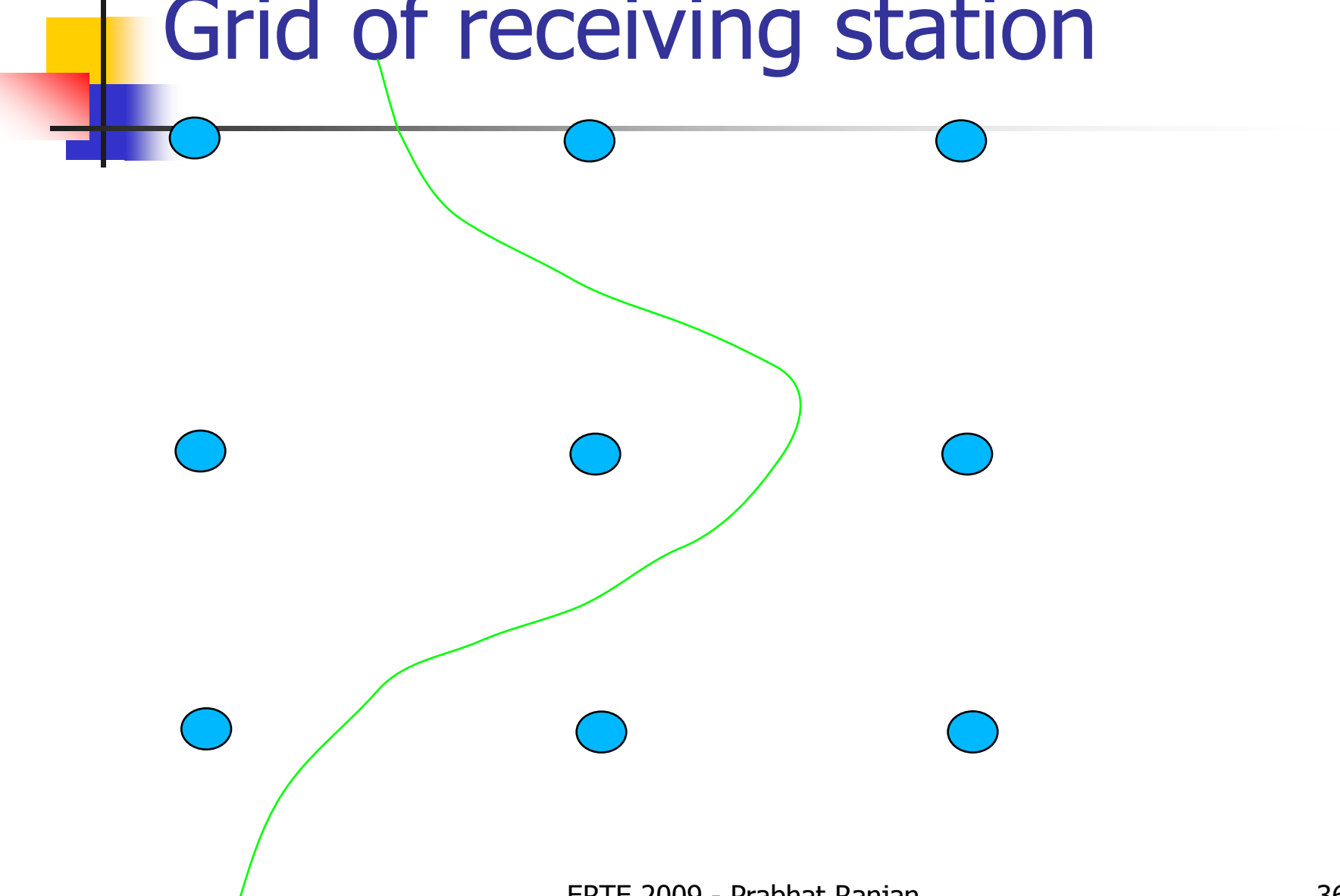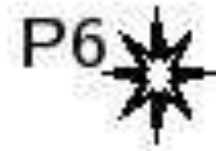
TigerCense – IR Image Sensor Network

- Designed to monitor movement of Tiger
- Can be used on other animals with well known trails having patterns on body
- No sound or visible flash disturbance
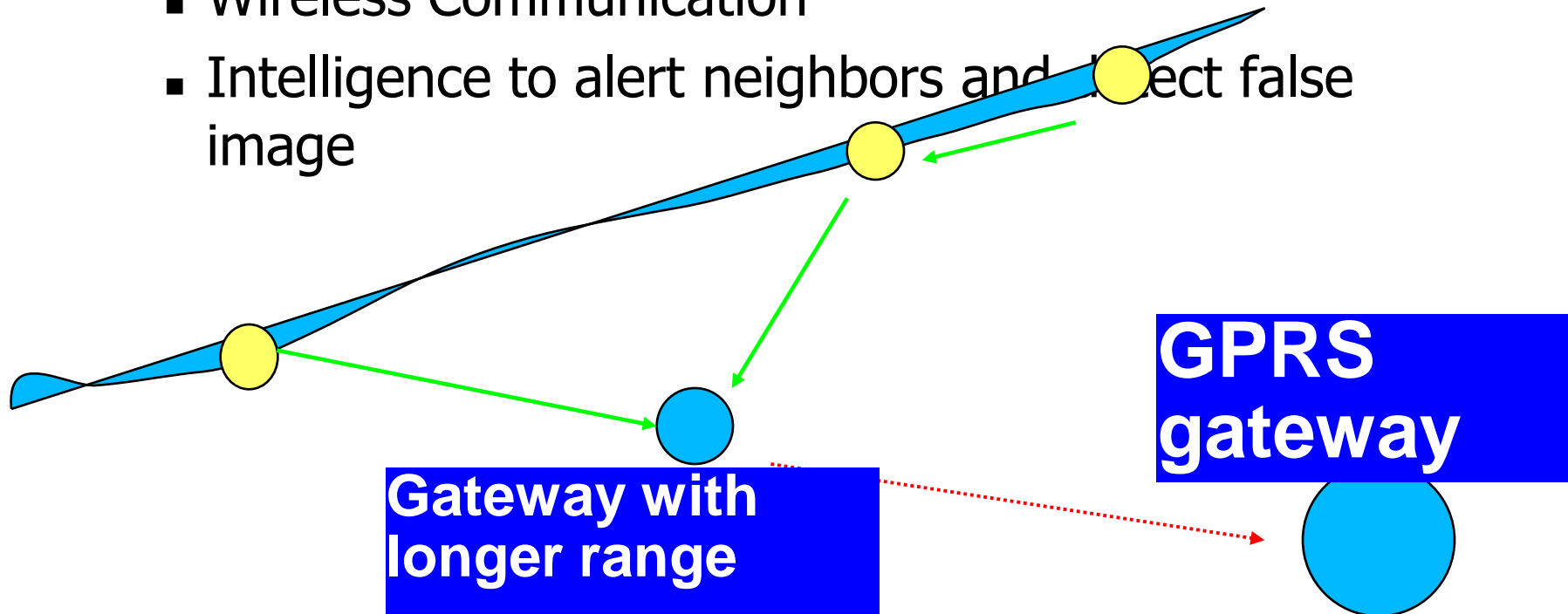
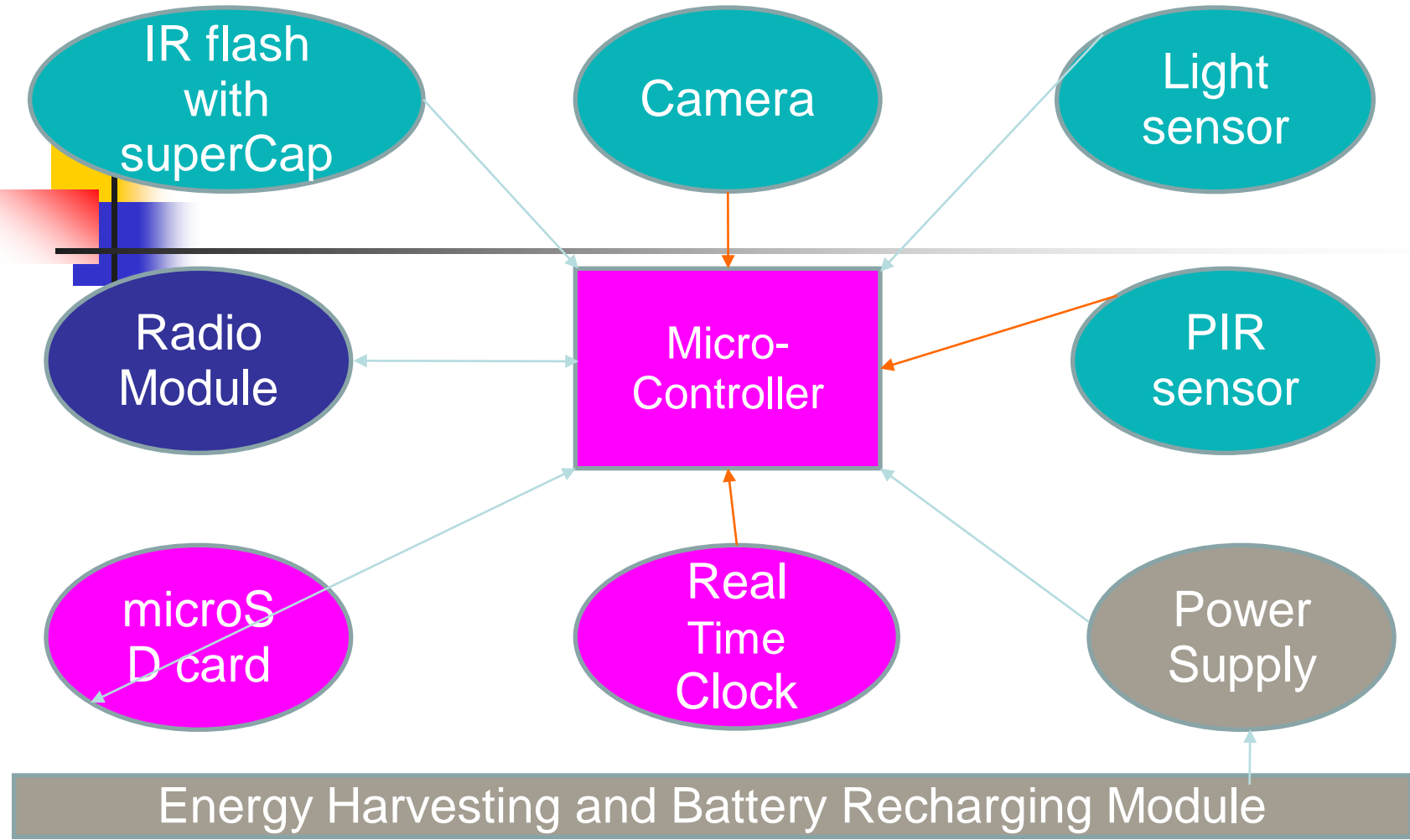# Camera traps

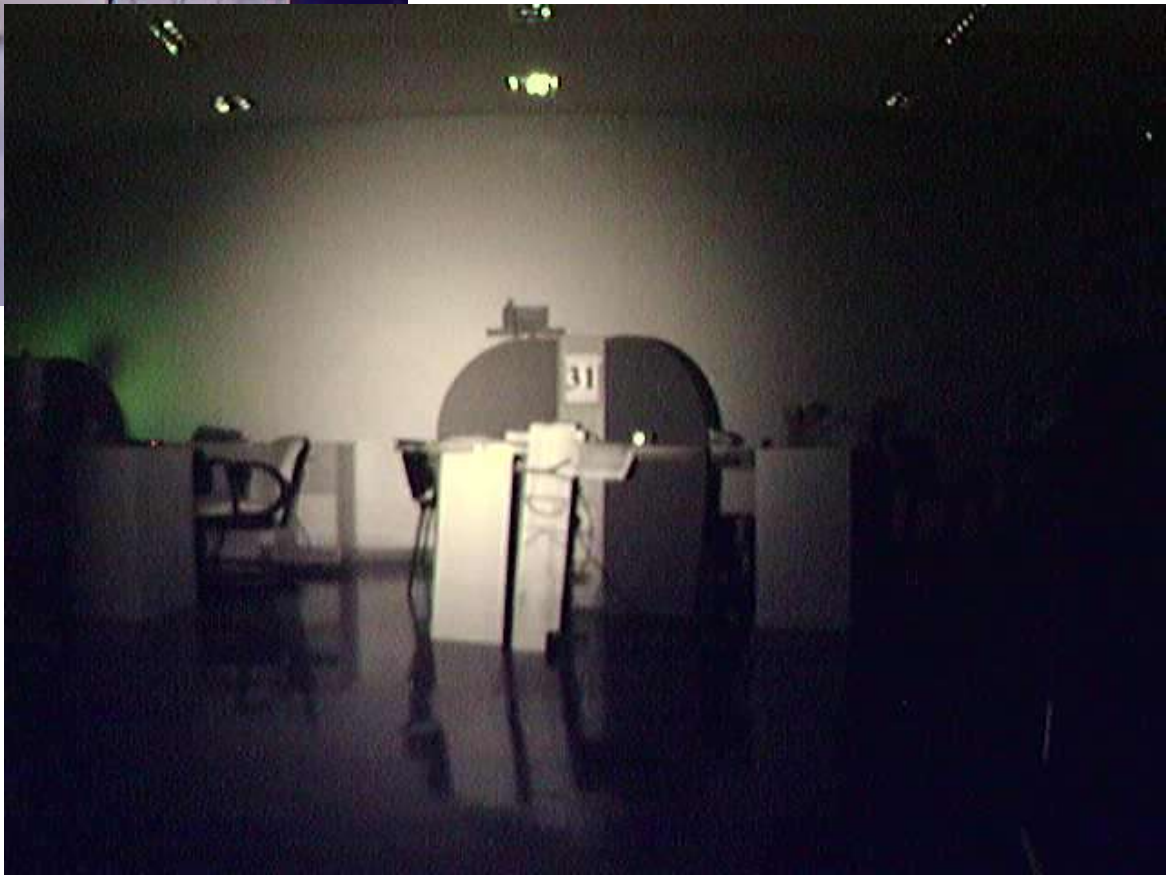# Individual Animal Identification

Courtsey : WII,

IR Image Sensor Network

Miniature intelligent Camera

- IR sensing with IR flash
- Wireless Communication
- Intelligence to alert neighbors and detect false image

Gateway with longer range

GPRS gateway

IR flash with superCap

Camera

Light sensor

Radio Module

Micro-Controller

PIR sensor

microSD card

Real Time Clock

Power Supply

Energy Harvesting and Battery Recharging Module

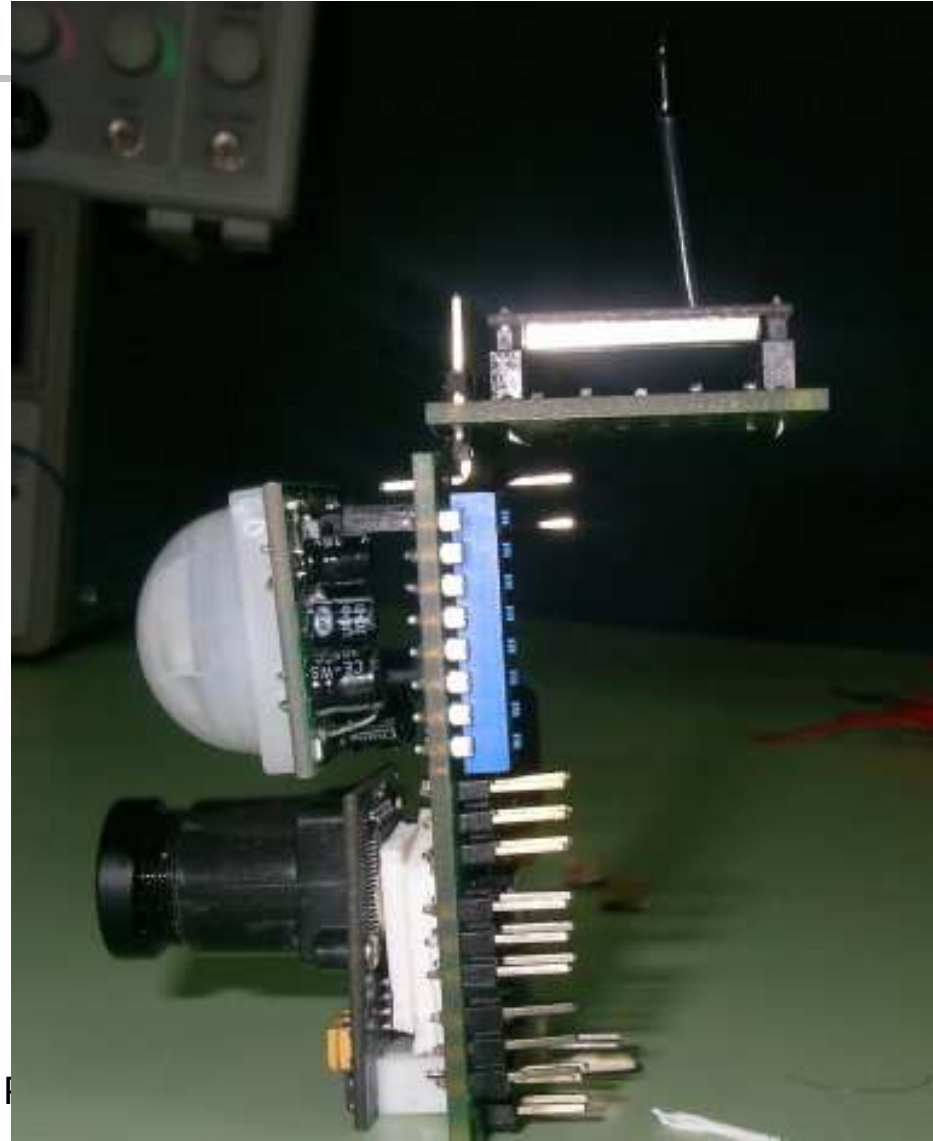Communication   Powe   Sensing   Processing

Tiger Trophy

Current Prototype : Top view

Side View

Tiger Image in Zoo (June 2009)

Trial

- Trial to be carried out in January in Ranthambore National Park

- Data collected by a mobile base station

- Data transferred to a MySQL database

- Visualization software would allow easy access to image

- Images would use EXIF2 format to embed digital data in the image for easier processing

Acoustic Sensor Network

- Cane toad – Australia
- Purple Frog – India

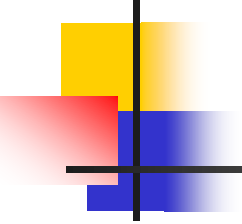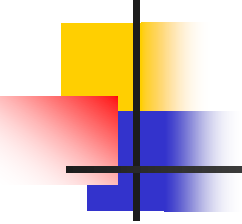# FrogCense : Purple Frog Monitoring

S.D. Biju

- Discovered in October 2003 in western ghats of south India and was found to be unique for the geographic region

- Frog spends most of the year underground, surfacing only for about two weeks, during the monsoon, for purposes of mating

- Frog's reclusive lifestyle is what caused the species to escape earlier notice by biologists

- Acoustic sensor networks to monitor
  - Species recognition being tried on low cost node
  - Dual voice recording chips and Floating point coprocessor
  - Processing and recognition would be carried out without loosing data
  - Only identified species vocalization sample would be compressed and transmitted along with time-stamp and location info

- Project is at an early stage right now
- Technique can be used to monitor arrival of migratory birds

Detecting presence of water on Moon using WSN
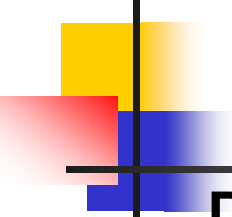
India's Chandrayaan Mission

- Starting 2008 every 4 years one space craft would be sent to moon

- Chandrayaan-II would look for confirmation of water on surface of moon

- Water very important for Lunar colony and space exploration from moon

Water on moon ?

- Experiments not conclusive so far

- Some positive and some negative

- Expected only in permanently shaded areas of moon – such as polar craters

- Temperature very low – acts as cold trap

- Recently water was detected on MARS
- Possibility to use MARS like rover to carry out measurements in PSR is almost nil (?)
- No sun light to support power generation
- Extremely difficult unknown terrain
- WSN based method seems appropriate

Multi-tier Architecture for Shackleton Crater

Node Deployment

- Rover/Lander
- Wireless Sensor Nodes
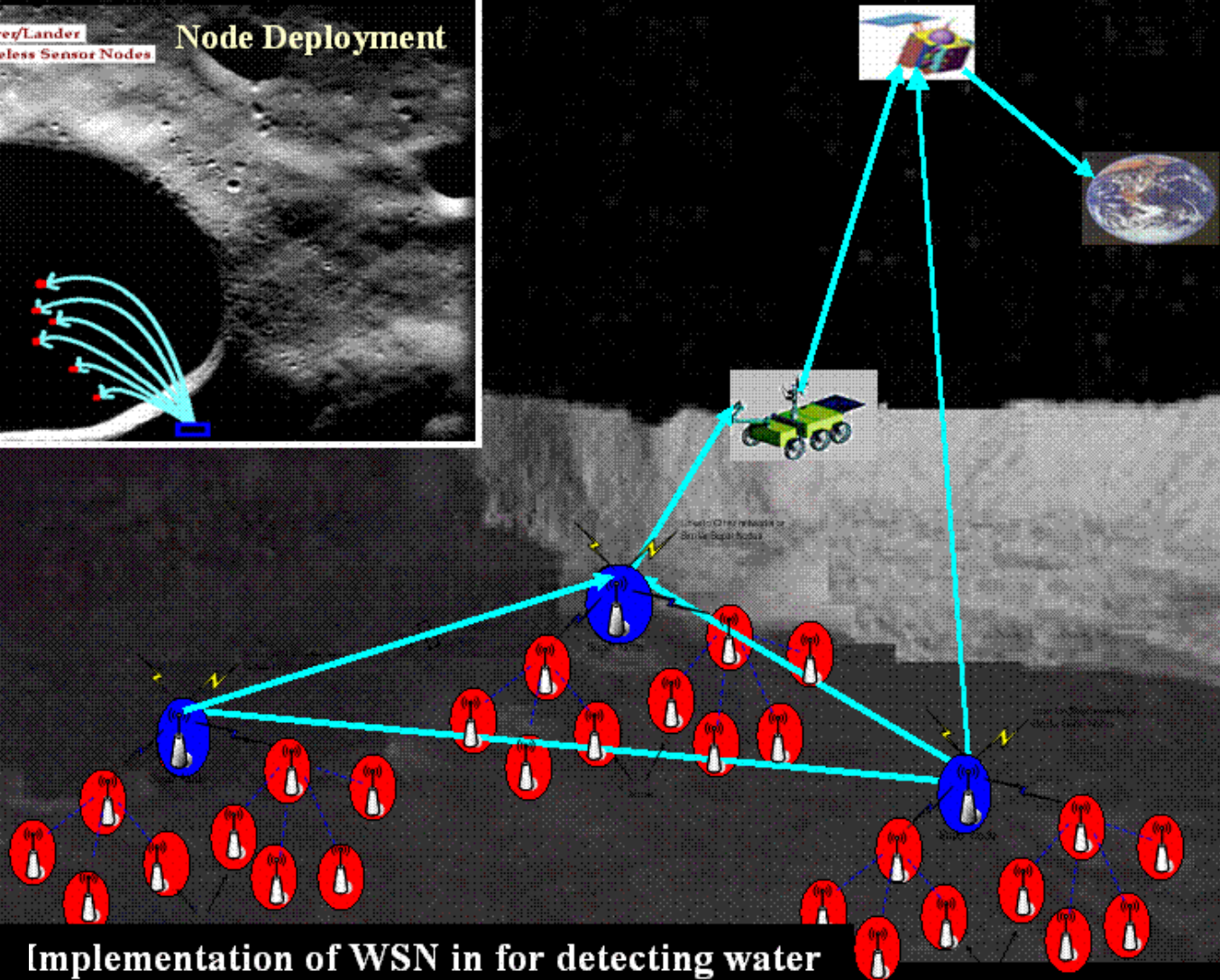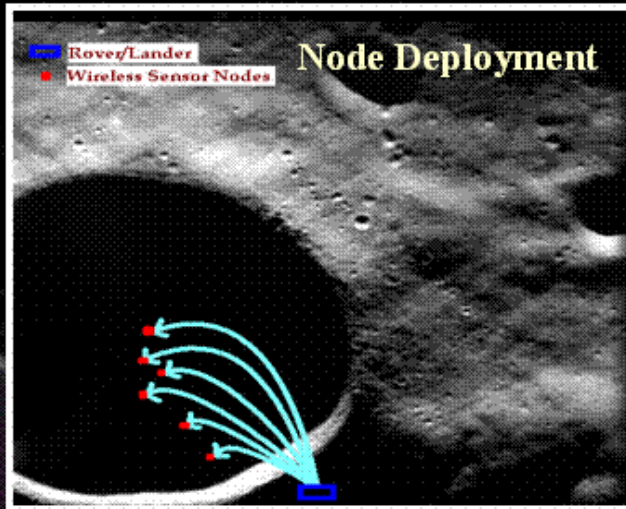
Implementation of WSN in for detecting water

Crater Characteristics:

Coordinates 89.9° S, 0.0° E

Diameter 19 km

Depth 2 km

Crater Topography

SHACKLETON CRATER RIM

South Pole

Monthly illumination (southern winter)
- 50-60%
- 60-70%
- >70%

EARTH

Lunar Seismic Sensor Network

- New proposal made to ISRO
- Development of Seismic Sensor Nodes for Lunar polar region having permanently sunlit area
- Seismic activity monitoring gives information about origin of moon
- Apollo mission had setup a seismic network of four station
- Deploy very large numbers in clusters

Coral Reef Monitoring

- Joint project with Australia to monitor Great Barrier Reef and Lakshwadweep

- 3-D sensor network to monitor temperature, ambient light, salinity etc

Healthcare and old age

- Cerebral Palsy

- Tilt sensor based Universal Infrared Control

- HP Innovate 2009 award

Conclusion

- We have many needs that ICT can server for nation and society

- Close interaction with domain experts

- Very good for generating grant

- Embedded Systems(6 Sem)/SN Devices (7th Sem)/SN Systems (8th Sem) – RI + BTP – UG students contribute maximum

Thanks