EBEDDED SYSTEMS ACTIVITIES

@IISc

Main activities

- Research in various departments
- Development support for products
- Support to incubation activities
- Faculty led incubation and startups

Research areas

- System design
  - Design of embedded systems
  - Verification and testing
  - SOC
  - Software for embedded systems
  - Reconfigurable machines....
- Circuit and sensors
  - Low power circuits for embedded applications
  - Design of MEMs sensors and sensor network components
  - Energy harvesting systems

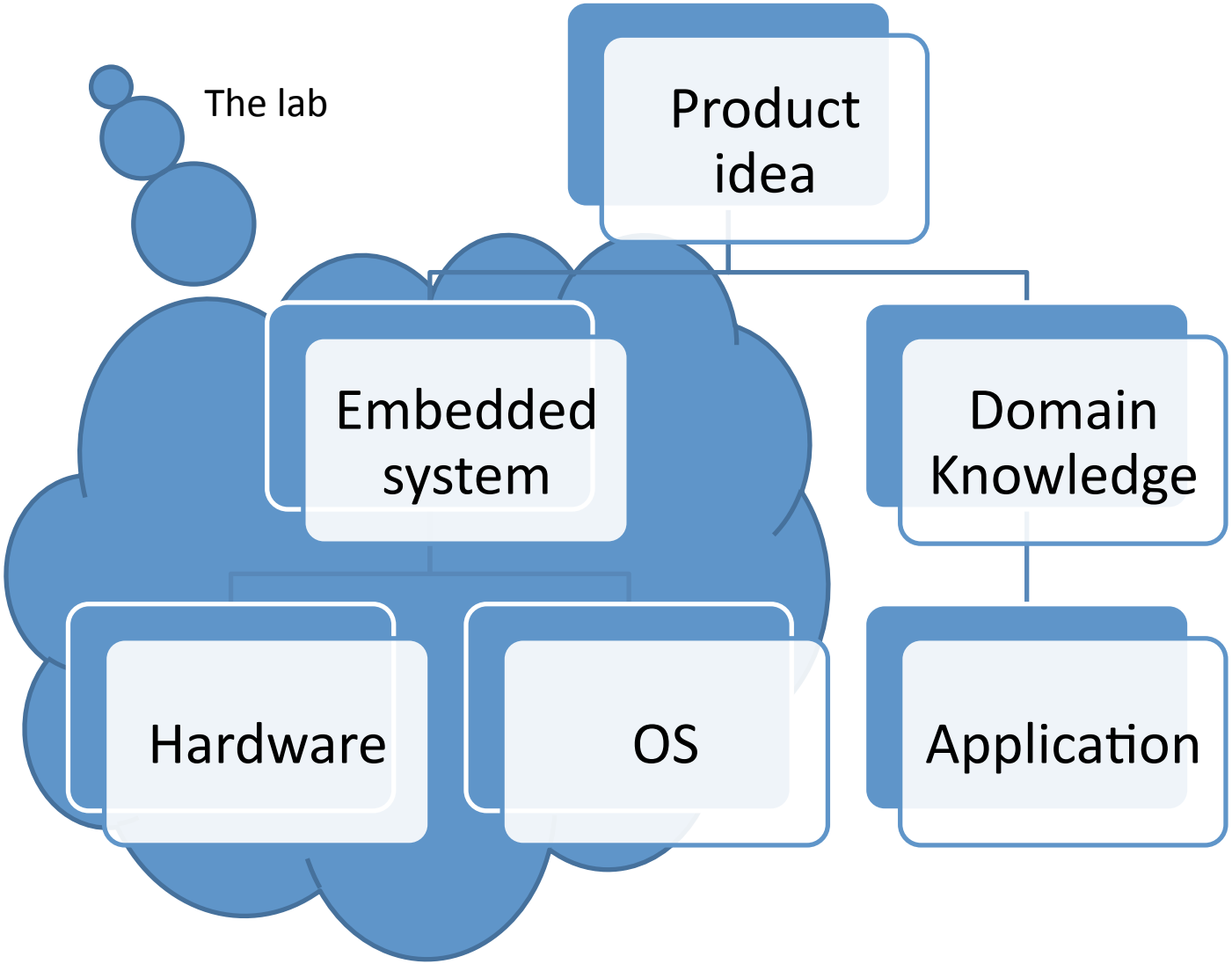
Departments and areas

- CEDT: System design (7)
- CSA: Software for ES (2)
- ECE: Low power SOC and MEMs (2)
- IN: Embedded Instrumentation systems (2)
- ME: MEMs sensors (2)
- SERC: Two faculty members: SOC and verification (2)

Labs in Embedded systems

- Labs supported for their respective Embedded Systems
  - Freescale, Intel, TI, Xilinx
- Labs for design of VLSI with all high-end tools like Synopsis, Cadence, Magma, Mentor, Coware, verification tools....
- MEMS design lab
- Electronics systems lab with instruments to test up to 1 GHz clock rates
- PCB design, fabrication, and assembly lab
- Industrial design studio and Department for product development

Proposed new ATOMBEDDED Lab



Support by the lab

- Design of HW or selection of existing hardware optimally for a given product
- HW development, fabrication, and testing
- Typical embedded OS on hardware
- Application development process and tools
- Help in packaging in collaboration with another lab
- Testing, documentation

Satellites of the lab

- Domain labs
  - Sensor networks
  - Handhelds
  - Automotive
  - Healthcare….
- Analytics in various areas
- Product design and fabrication
- Operating systems lab
- Hardware, co-design, and verification labs

Outcomes of the lab

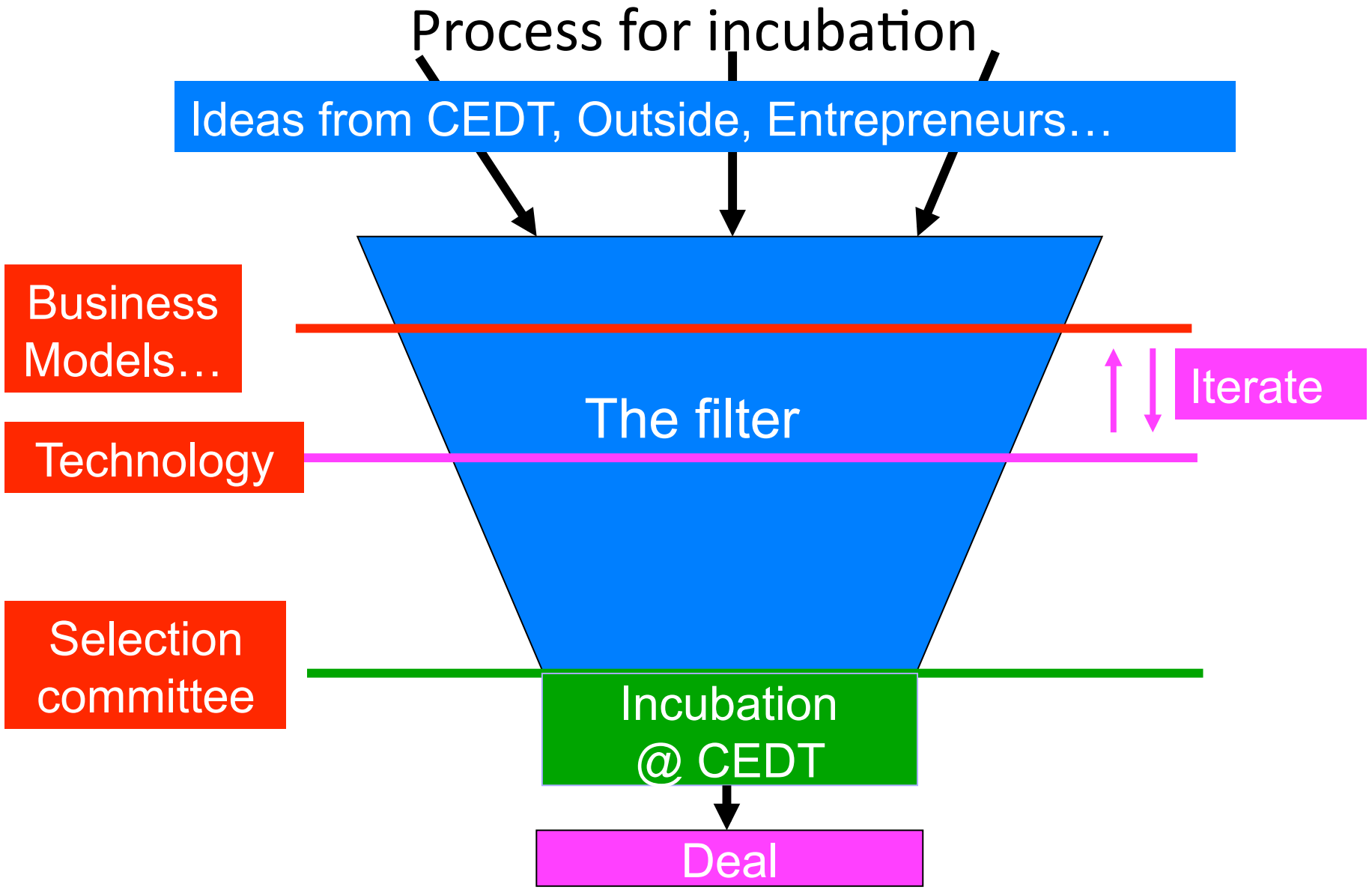
- HW and SW for specific systems
- Applications in collaboration with other labs
- Support to entrepreneurs as an incubation set up
- Interns from institutions
- IISc student projects
- Open source courses: Offering within IISc and elsewhere
- Continuing education courses: Boot camps

Ideas for Innovation Centre @ CEDT

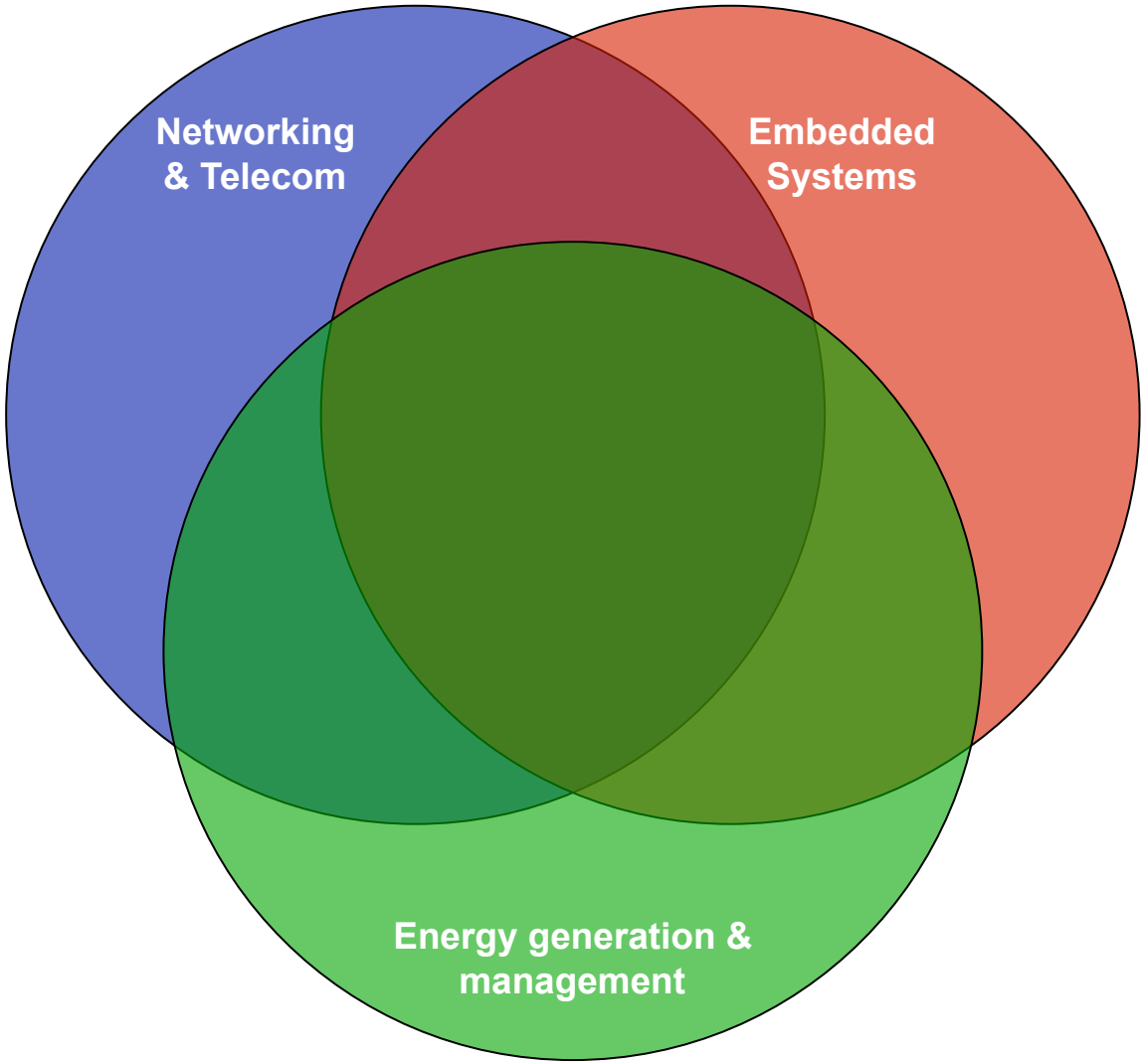
2009

Basic approach

- Partner with a company having access to entrepreneurs, angel investors, business managers, venture capitalists….
- Use students (M Tech) and faculty only for technical development for IP generation
- Provide infrastructure wherever possible
- If idea is successful, offer incentives
  - Financial: One time settlement with entrepreneur
  - Equity in the startup
  - Royalty for a fixed period…..


Process for incubation
Ideas from CEDT, Outside, Entrepreneurs…
Business Models…
Technology
Selection committee
The filter
Iterate
Incubation @ CEDT
Deal

Capabilities: Technology space



Areas of interest …1

1. Personal area networks through cell phones and ad-hoc networking
   a. Personal security
   b. Personnel identification and access control
   c. Personal health care
   d. Personal travel and driving guidance
   e. Synchronization of data across personal devices
2. Low cost embedded computing
   a. For access devices
   b. For low cost machines (such as ATM)

Areas of interest …2

3. Information sharing through social networking
    a. Audio and video
    b. Healthcare
    c. Wildlife
    d. E-learning and tutoring
    e. Public information system
4. Automotive systems
    a. Security and safety device
    b. Guidance and driving assistance

Areas of interest …3

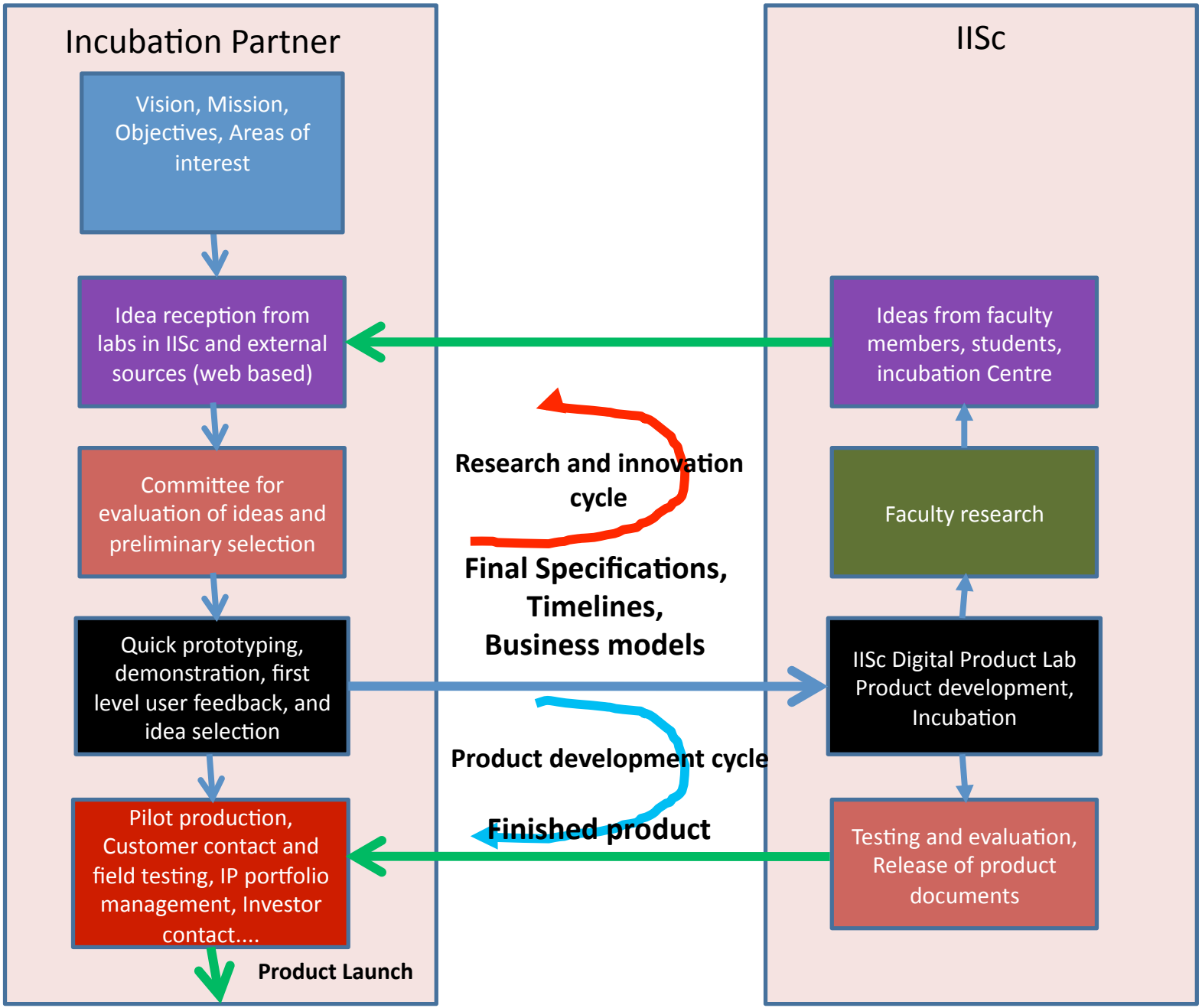
5. Technology for Environmental monitoring
   a. Air pollution monitoring
   b. Farm productivity measurement
   c. Forest management system
   d. Disaster management system
6. Green Energy Systems
   a. Distributed clean energy generation
   b. Energy management and reduction
   c. Phantom power reduction

Some Cautious Observations

1. Students and faculty are hardly entrepreneurial
2. Risk taking is almost nonexistent
3. They are technically sound
4. May develop product for nearly production level
5. IISc focus in on research and **NOT** much on innovation and product development
6. IISc incubation is largely open only to students, alumnae, and faculty… counter to point 1

Ideas for Innovation Centre @ CEDT

An example


Incubation Partner
Vision, Mission, Objectives, Areas of interest
Idea reception from labs in IISc and external sources (web based)
Committee for evaluation of ideas and preliminary selection
Quick prototyping, demonstration, first level user feedback, and idea selection
Pilot production, Customer contact and field testing, IP portfolio management, Investor contact....
Product Launch
IISc
Ideas from faculty members, students, incubation Centre
Faculty research
IISc Digital Product Lab Product development, Incubation
Testing and evaluation, Release of product documents
Research and innovation cycle
Final Specifications, Timelines, Business models
Product development cycle
Finished product

Areas of Interest

- ICT in Energy management, utilization, generation
- WSN and ICT in agriculture
- ICT and electronics in healthcare
- ICT in Automotive Systems

Digital Product Lab (DPL)

- Set up at IISc consisting of
  - Embedded labs (possibly in collaboration with others like Intel, Freescale, Xilinx...)
  - ID Lab (CEDT and CPDM)
  - Rapid prototyping (CPDM)
  - Testing lab with all test facilities
  - Wireless communication systems lab...

Use of the DPL

- For developing products requested from the selection process
- For developing ideas of IISc researchers
- For developing products suggested by others and selected by the selection process

Some current examples @ CEDT

Sponsored for Incubation

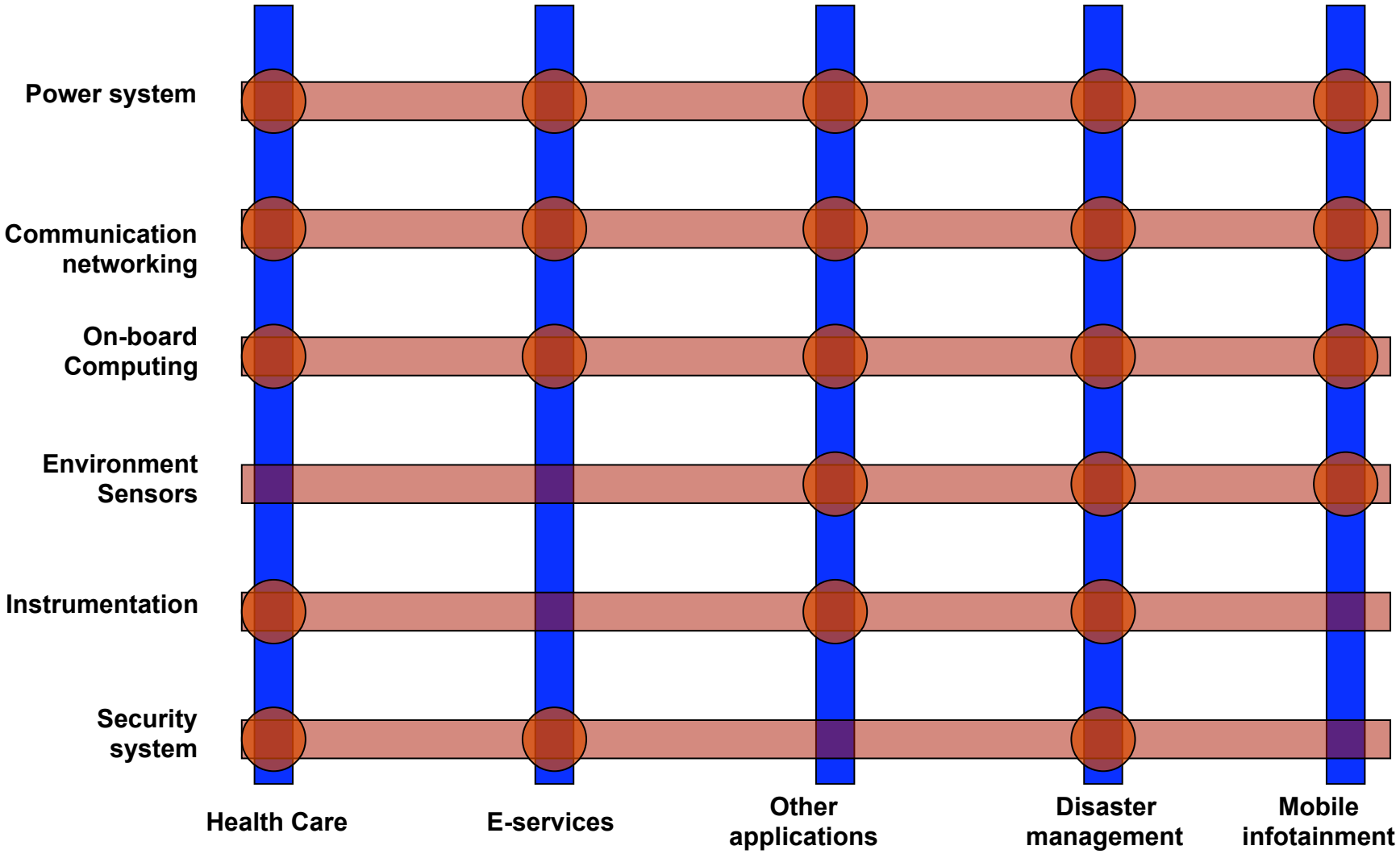
A POWER COMMUNI-CYCLE

A platform for research in various applications

Objectives

- In a BICYCLE
  - Implement a Wireless Delay Tolerant Network (DTN)
  - Generate and Manage power for the system (PV and physical – good old Dynamo)
  - Manage navigation
  - Gather field data from the field and environment and actuate remotely if necessary
  - Allow subsystem selection for a given vertical (application) of the cycle (like a custom made DELL computer!)

Research Platform Matrix



The platform

- A Bicycle
- Custom modified to carry DTN and power generation

Power system

- Rider driven dynamo up to 12 W
- PV panel; typically 10 TO 20 W
- Battery for storage
- Charger for mobile phones, laptops, other electronic gadgets
- Battery management for optimal use

Communication System options

- Wifi access point to act as a local hub and connection to a wired LAN
- Wireless Sensor Network
- Ability to connect to a high speed LAN, CDMA, GPRS, and dial-up lines
- FM transmitter
- AM, FM radio receivers
- TV tuner
- DTH TV

Sensors options

- Weather monitoring system
- Network presence detectors
- Digital cameras
- GPS receiver
- Smoke and dust detectors
- Ultrasonic distance measuring device
- Microphones
- Pollution sensors

Applications

- Mobile station for monitoring parameters for agriculture
- Mobile pollution monitoring
- Mobile e-service provider
- Mobile disaster management
- Mobile healthcare
- Mobile broadcaster
- Mobile e-post service
- ……

E-service provider example

- Carry and deliver documents of local relevance (land records, weather data, prices of commodities, various application forms,…..)
- Carry voice and video messages using DTN
- Provide education and entertainment “uploads”
- Provide high quality photograph storage and exchange service
- …….

SENSEC SWITCH

Incubation project

Power management in Buildings

- Current Scenario
  - Voluntary
  - Many devices on power drawing vampire power
  - Many users have conflicting control methods
  - Often not need based
  - Often not based on “informed” energy usage pattern
- Result
  - Loss of 5% power and energy due to phantom users
  - Up to 30% excess usage due to improper and un-informed usage
  - Occasional safety hazards due to bad practices
  - Poor maintenance: based in failures rather than preventive maintenance
  - Higher energy costs

Safety and security in buildings

- Almost none in homes
- Some security in public building
- Poor safety even in public buildings

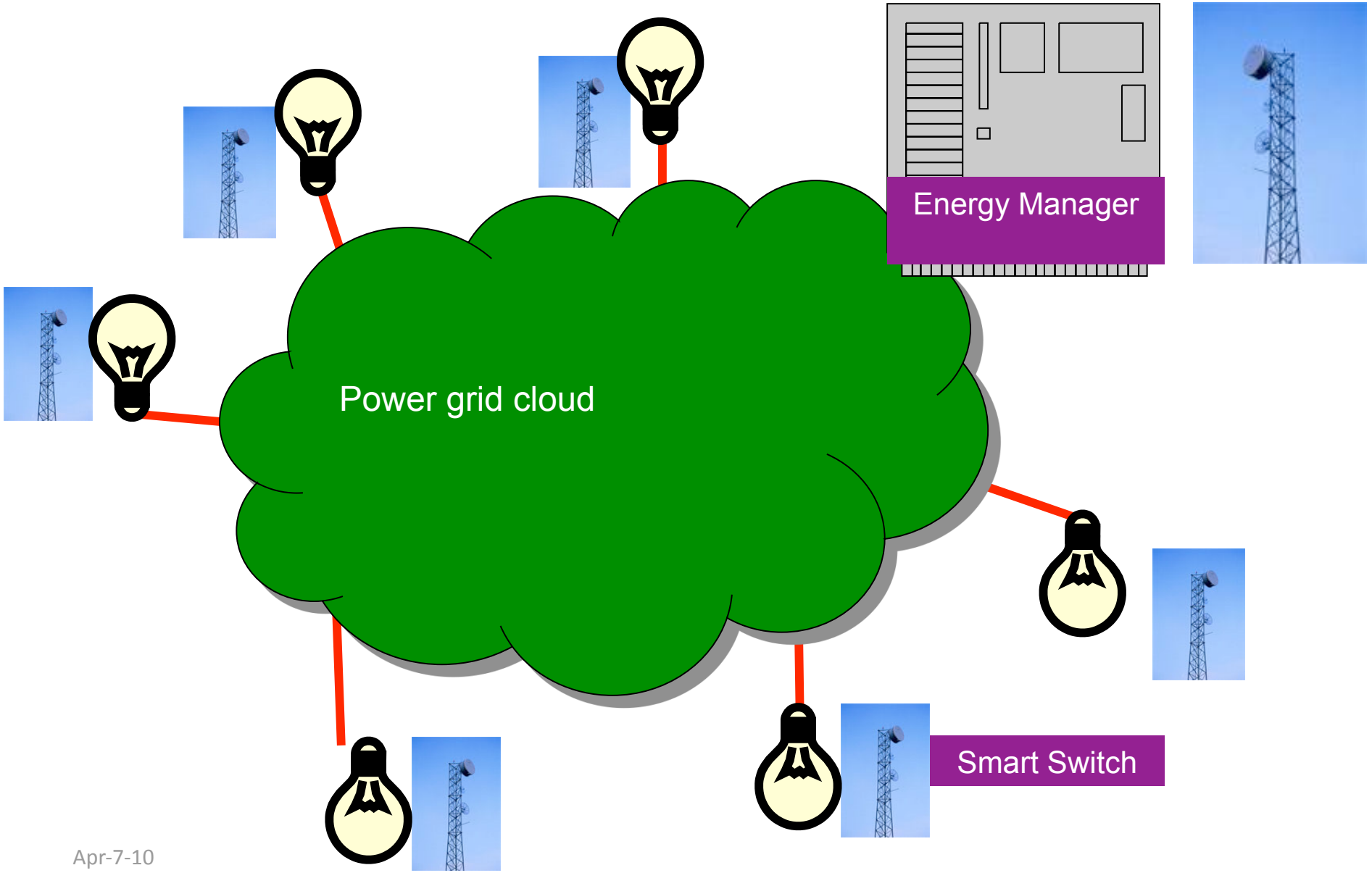
Sensor Switch

- All switches are replaced by “Sensec Switches”
  - Switches power on and off through a solid state switch
  - Each switch is controlled by a wireless access from a central “Energy Manager”
- Integrate safety and security devices in sensor switches
  - Mange safety and security by an aggregating device
- Aggregate Energy manager with safety and security manager into one controller

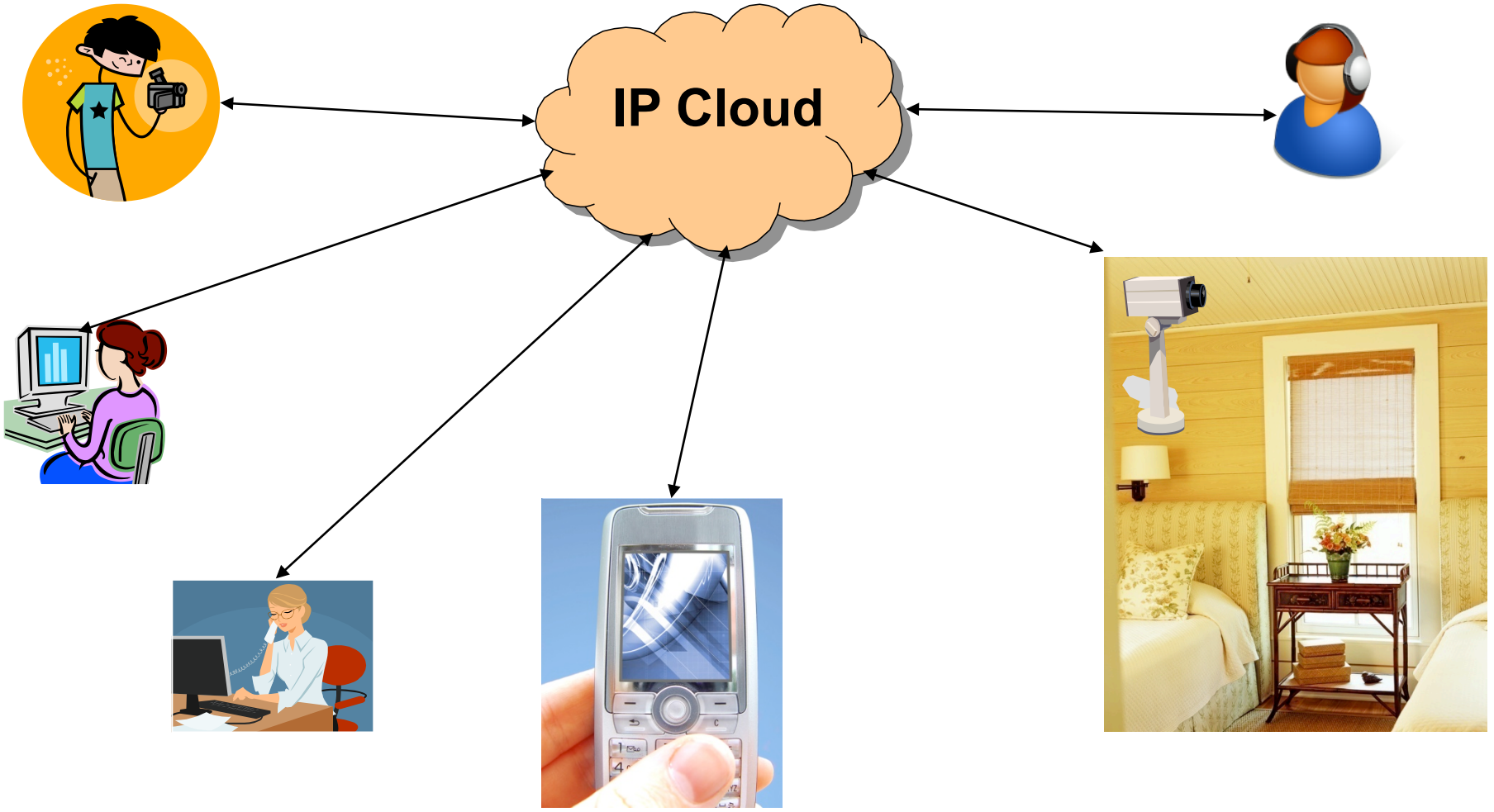
Sensors in switches

- Temp sensor for switch temp monitoring
- Current sensor
- PIR sensor
- Camera
- Smoke detector
- Gas detector
- …….

Typical Scenario



Safety Architecture



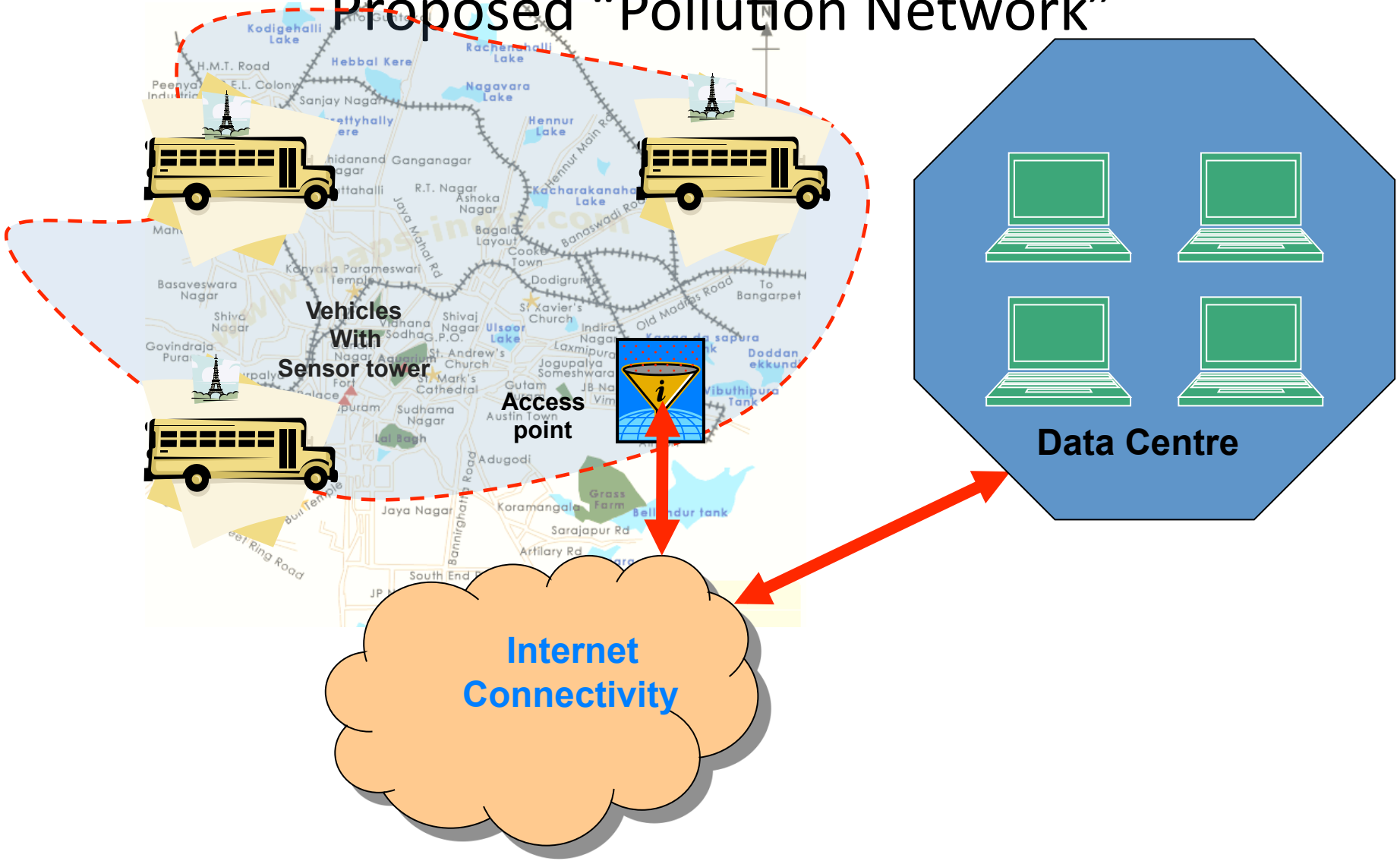
System features

- Energy management
  - Controls all switches based on programmable configuration
  - Aggregates data from all switches
  - Generates usage scenarios, power and energy profiling of each switch, provides power and energy analysis for the building….
  - Remote control through Wireless and Web
  - Configuration through Web and hand held device
- Safety and security
  - Receives all data, processing, connecting to IP
  - Alerts to user on safety and security breaches by SMS, Stream pictures, alerts to police….
  - Action buttons through SMS, key pressing…..
  - Integration into Social network for “neighbourhood watch”

Air Quality Monitoring

CiSTUP

Proposed “Pollution Network”



Technology Modules

- Sensor Unit
- Data collection network
- Data Centre
- Simulation and pollution profiling
- Website and information dissemination

Sensor Unit

- Sensors
  - CO, Particulate matter, CO_2, NOX, Temperature, humidity, digital camera, GPS…
  - Emission sensors
- Data storage
  - Capacity to store 1 week data (100 times per day, 128 bytes per sample: 100 KB minimum, 100 MB with pictures)
- Wifi connectivity
  - Access point
- Power unit
- Embedded computer

Automotive Safety Device

An integrated device

Product proposal

- An integrated computer in automobile with
  - Cameras at the front and back
  - Pollution sensors
  - Wifi access point
  - Motion sensor
  - Speed sensor (typically an accelerometer)
  - Ambient light sensor
  - GPS receiver

Applications

- Safety device for vehicle reversing
- Providing images for safe cruising
- Video recording of events in road at low speed or when standing
- Pollution and traffic jam advisories
- Safety management by networking with other vehicles
- Entertainment thorough network
- Headlight management based on road conditions
- Position reporting for safety

Product development for emerging markets

Some issues

Pressures due to Growing population

- Drinking water
- Food
- Housing
- Energy
- Health care
- Education
- Agriculture
- Transportation
- Communications: telephony, postal service……
- Small businesses
- Banking

The business side

- Growing population leads to a lucrative market
- Therefore, convert services to businesses even in traditional service sectors like education
- Therefore, services become expensive
- Limited non-renewable resources become expensive (land and water for example)
- Both not available to those at the bottom of the economic pyramid

Other “growing” issues

- New threats
  - Spread of new deceases: AIDS, Dengue, Ebola, Malaria, TB
  - Militancy
  - Globalization
  - Climate change
  - Urban migration….
- Need for more jobs
- Equal opportunity
- Inclusion……

Who suffers?

- The victims are the poor at the bottom of the economic pyramid

Technology for the BOP?

- Creation of inexpensive services through ICT
- Cost reduction of development through open sources
- Not-only-for-profit operations
- Rapid development and deployment
- Using scaling due to numbers……..

Desiderata

- No subsidy regime
  - Else, a permanent dependence
- For-profit
  - Scaled on numbers
  - Reasonable profits
- Not-only-for-profit
  - Reasonable reinvestment for future business
  - No compromise in quality of products and services