IPv6 R&D initiatives at ERNET India

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Outline

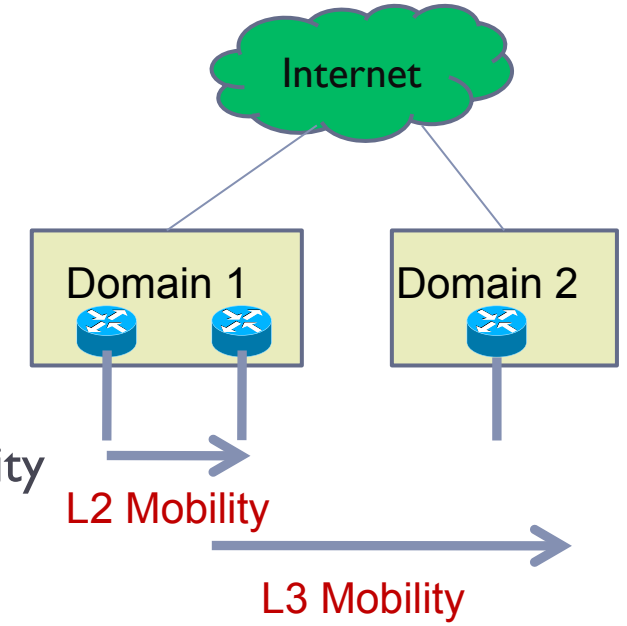
- IPv6 R&D initiatives at ERNET India - Overview
- Mobile IPv6 Test bed for Mobility Management
  - Mobile IPv6 Introduction
  - IEEE 802.21 MIH Services
  - Mobile IPv6 testbed Architecture
  - Access Network Infrastructure (WiMAX, WLAN, & 3G)
  - Mobility experiments
- Managing 6LoWPAN Wireless Sensor Networks
  - 6LoWPAN Introduction
  - SNMP based 6LoWPAN management
  - Agricultural monitoring – application usecase
- Summary

IPv6 R&D initiatives at ERNET - overview

- DIT funded ongoing R&D projects
  - *"Mobile IPv6 Test bed for Mobility Management over heterogeneous access networks"*
  - *"Prototype a 6LoWPAN network towards managing utility-based Wireless Sensor Networks"*
- ERNET India successfully executed DIT funded project in establishing a nationwide IPv6 based QoS network in association with premier institutions including IITs, IISc and C-DAC
- 6 CHOICE - India Europe Cooperation to promote IPv6 adoption
- ERNET is the first network in the country to be IPv6 ready since 2005

Mobile IPv6? (Mobility at Layer 3)

- Link Layer (L2) Mobility
  - Horizontal handovers, Homogeneous network, seamless roaming
- Layer 3 mobility is a routing problem
  - Vertical handovers, Global mobility
- IP address' two functions
  - (1) Identity & (2) Routing
- When Mobile node moves
  - Transparency to upper layers requires fixed identity
  - Optimal reachability requires change in route as point of attachment to Internet changes



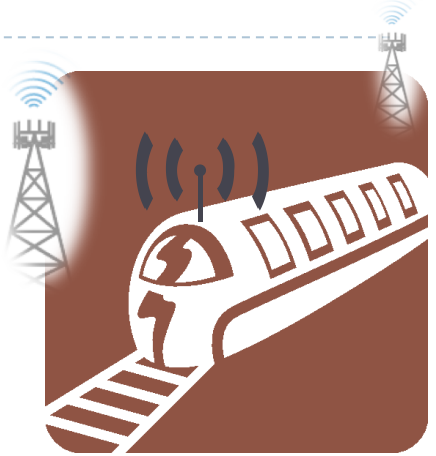
- Mobile IPv6 solves by providing mobile host two addresses
  - One for identity – Fixed Home address
  - Other for routing – New Care-of address for every new attachment

Motivation

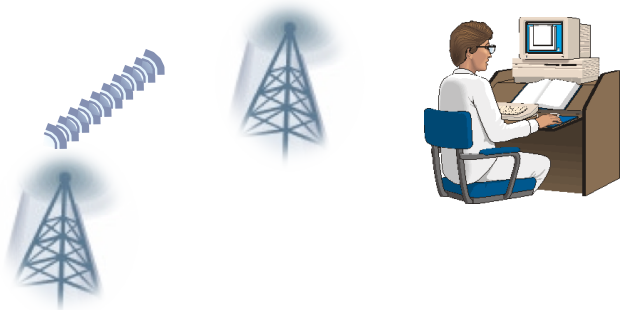
- Mobile Internet access on the increase
  - 851million mobile users in India (TRAI, Jun 2011)
  - New mobile internet services
    - High-bandwidth content services like Video on Demand, IPTV, Mobile TV
    - Value Added Services – Mobile commerce and mobile banking
  - Future access technologies will be heterogeneous
    - Dual/Multimode Next Generation Mobile terminals
    - "Always Best Connected" – Enable User to choose best available network among WLAN, WiMAX, GSM/GPRS etc.

Motivating Real-life application use cases

- Healthcare
  - Enabling specialists from hospital intranet, remote access to patients medical data stored at medical camps
  - Monitoring patient travelling in ambulance

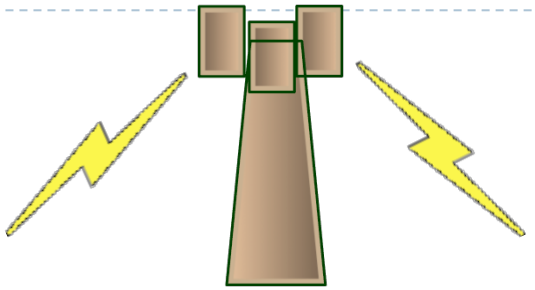


- Vehicular Networks (NEMO)
  - Realtime broadband access in railway network, buses, aircrafts/space crafts etc.
  - Disaster management applications (e.g., rescue mission, highway road safety)



- Instruction On-Demand
  - On-campus or Off-campus network-based le

Seamless Mobility in Heterogeneous Networks

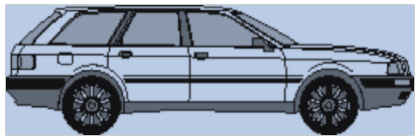


WiMAX

Cellular

WiFi
Hotspot

Office / Home



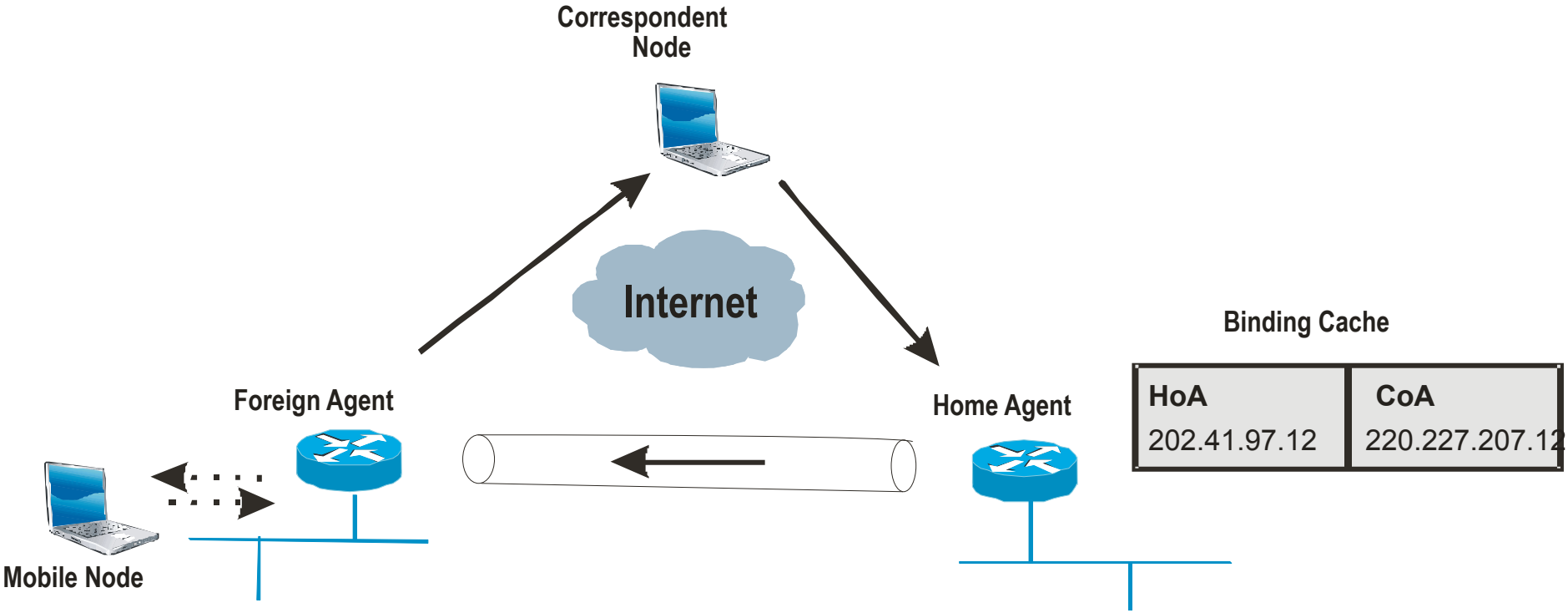
On Road

Airport

Network Initiated handover from WiMAX to 3G

Mobile Node initiated handover from 3G to WiFi

Mobile IPv4



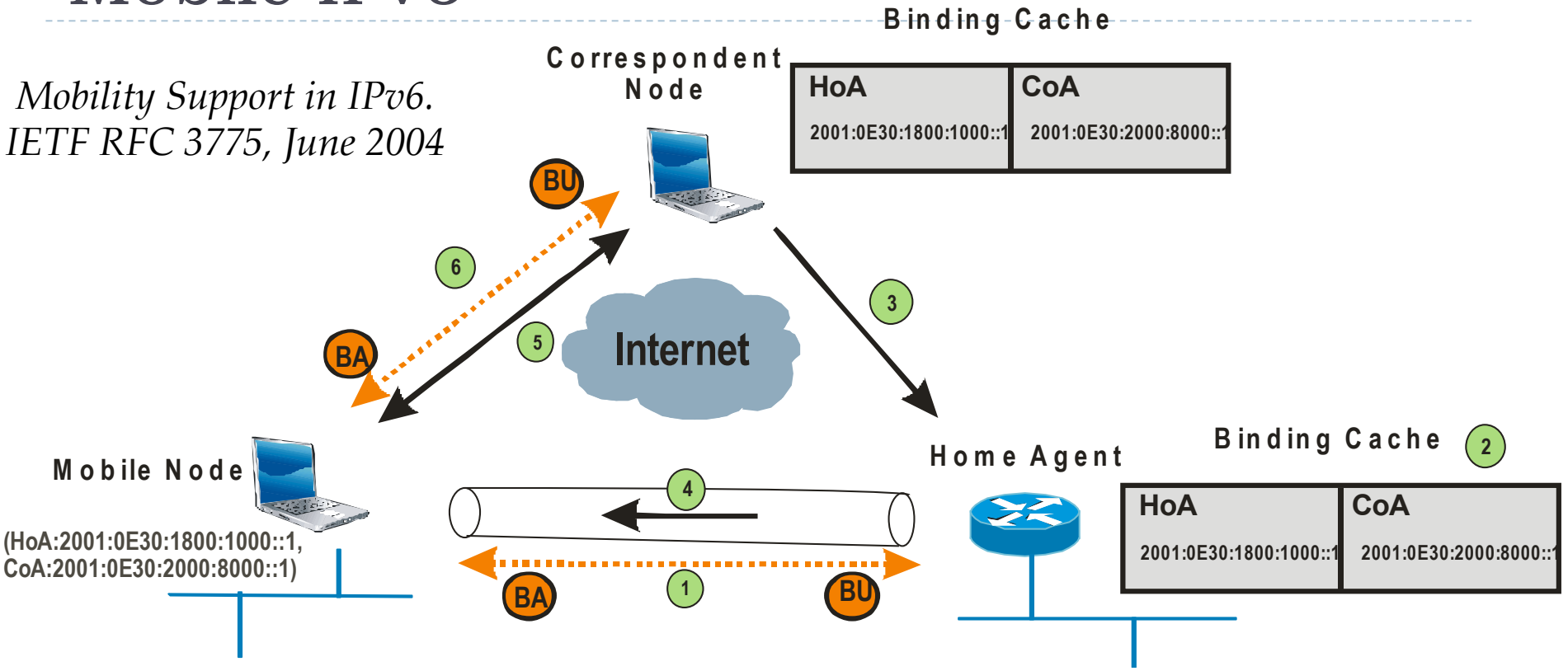
Limitations:

(1) Triangular routing
(2) Ingress filtering
(3) Foreign agent Requirement
(4) Security
(5) Address space

IP Mobility support for IPv4. IETF RFC 3344, Aug 2002

Mobile IPv6

Mobility Support in IPv6.
IETF RFC 3775, June 2004



- 128 bit address space – can cater to large number of mobile hosts
- No foreign agent required – Auto config. by Neighbour Discovery protocols
- Triangular routing - Route optimization support
- Ingress filtering – Header option to carry MN's home address
- IPSec is mandatory for IPv6

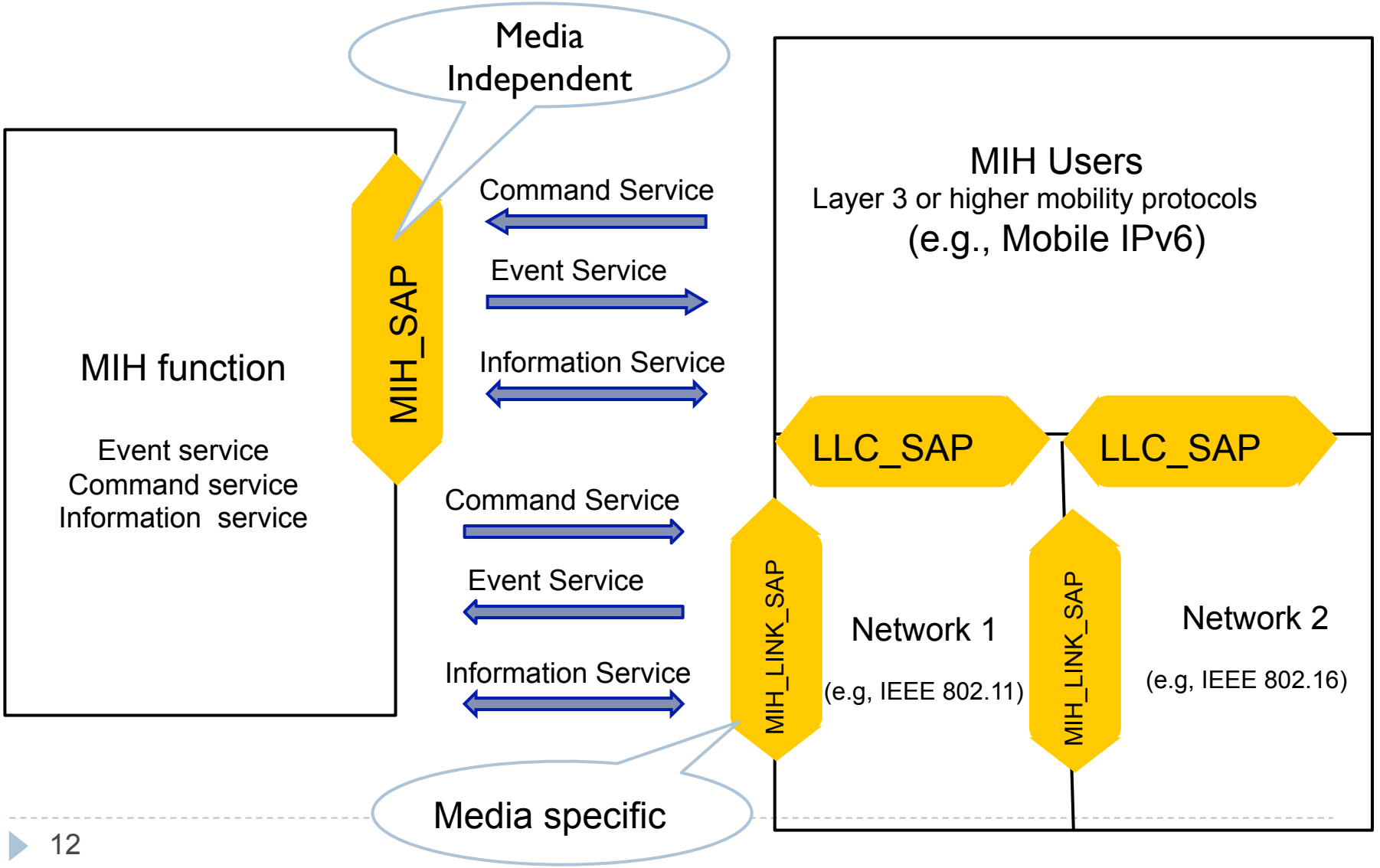
IETF Mobility extensions - update

- **IETF *mext*** and ***netext*** WG activities are relevant
- Distributed Mobility Management:
  - Current mobility protocols are centred around Home Agent
  - New architecture will address *single point failure, inefficient routing & signalling, latency consideration* issues
- Flow Mobility:
  - Basic Mobile IPv6 protocols don't allow binding multiple CoA to HoA
  - Multi-homed mobile nodes can instruct HA, CN to direct the inbound flows to specific CoA
- Logical Interface support:
  - Useful for multi-mode terminals providing single logical interface over multiple access technologies
  - Useful scenarios: *inter-technology handoffs, multi-homing, flow mobility*
- *We are in touch with IETF mobility experts to share some of their Home Agent services supporting Dual stack mobility (DSMIP6) and Flow mobility for our experiments*

IEEE 802.21 Media Independent Handover services

- IEEE standard to provide seamless handover between heterogeneous access networks
- Defines new link layer SAP that is media independent
- For each technology, it is mapped to technology specific primitives
- **MIH services**: (1) Information (2) Event (3) Command
- Higher layer Mobility protocols such as Mobile IP utilize Media Indepedent Handover Function (MIHF) to perform enhanced handovers
- **Other goals**: *network discovery, network selection, service continuity, power management, QoS etc.*
- **Amendments to IEEE 802.21**
  - **Security, Broadcast services and Single Radio Handover**

MIH service interfaces

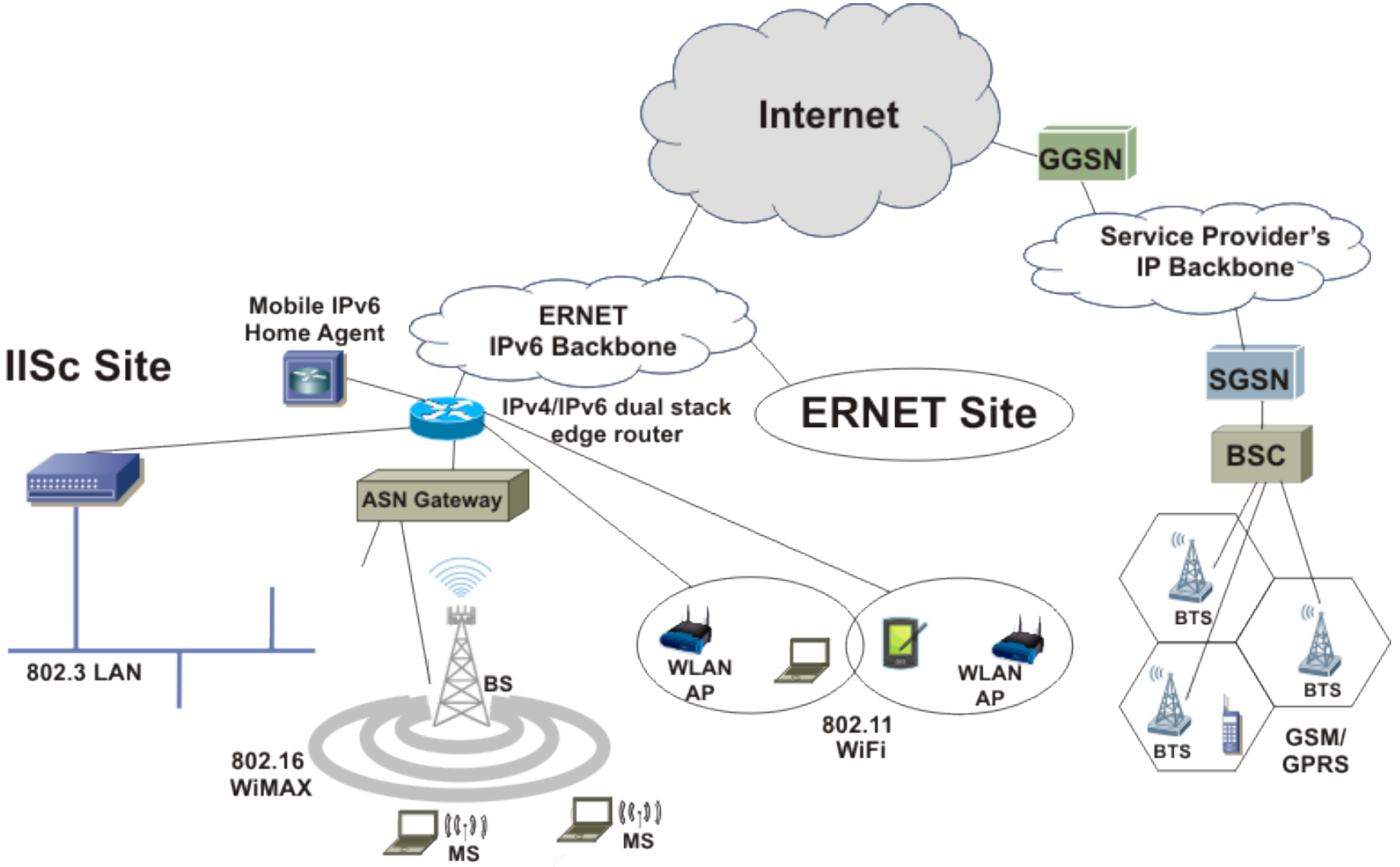


Media Independent Information Service (MIIS)

- Provides network information within a geographical area for network selection in handover decisions
- Support for various information elements
  - Neighbour maps, link layer parameters, higher layer services etc.
- Common representation – TLV, XML

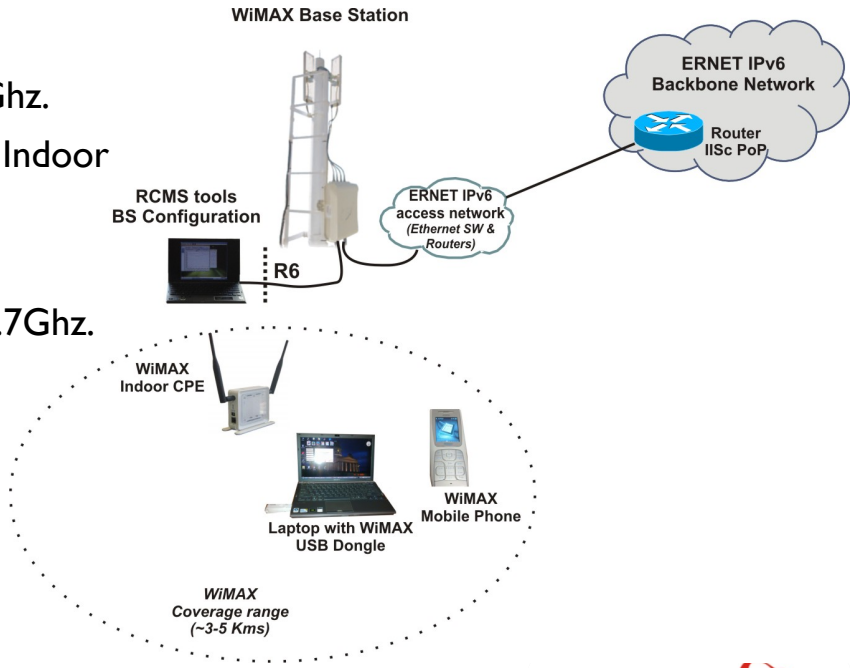
Network Type	SSID/ Cell ID	BSSID	Operator	Security	EAP Type	Channel	QoS	Physical Layer	Data Rate
GSM	13989	N/A	Oper-1	NA	NA	1900	N/A	N/A	9.6 Kbps
802.11n	Enterprise	00:00:…	Oper-2	.11i	EAP-PEAP	6	.11e	OFDM	100 Mbps
802.16e	NA	NA	Oper-3	PKM	EAP-PEAP	11	Yes	OFDM	40 Mbps

Mobile IPv6 Test bed - Architecture

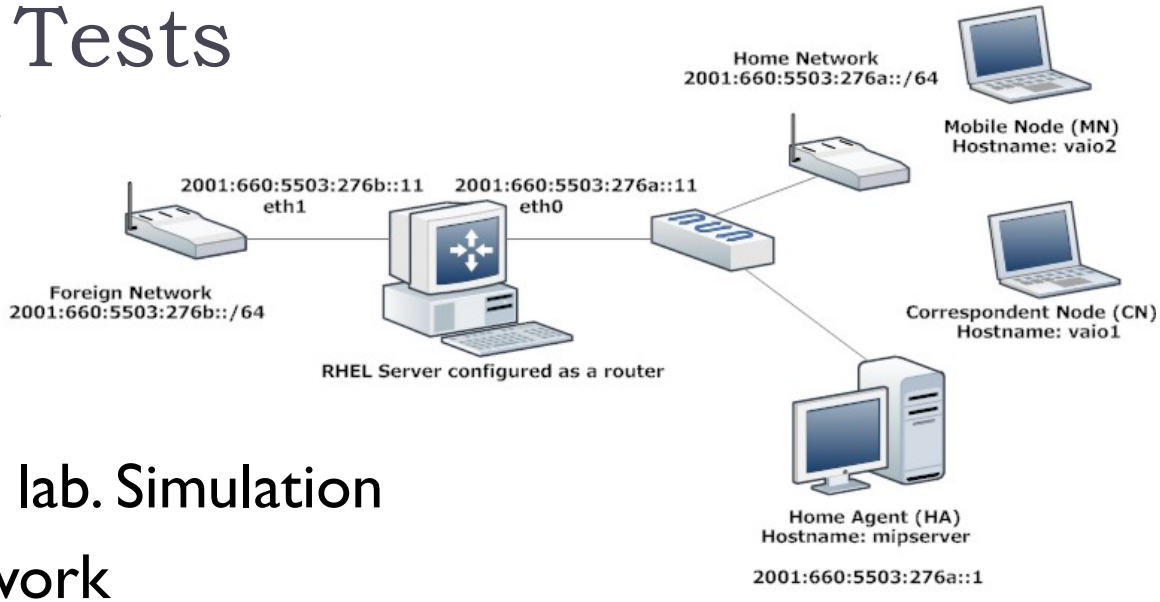


WiMAX access network

- WiMAX access network hardware details
  - Runcom RNU Base station (RNU4000)
    - WiMAX forum certified IEEE802.16e Wave2.
    - Outdoor Pico-base station, operates 2.3~2.7Ghz and bandwidth up to 20Mhz.
    - BS configured to operate in stand alone mode without ASN-GW
  - Indoor CPE
    - Provides Indoor WiMAX coverage, operates 2.3~2.7Ghz.
    - Inbuilt DHCP, NAT, routing functions available in both Indoor CPE/Outdoor CPE.
  - Outdoor CPE
    - For outdoor deployment, supporting frequency 2.3~2.7Ghz.
- Terminal Devices for mobility testing
  - WiMAX USB Dongle - Operating frequency 2.5Ghz
  - WiMAX/WiFi VoIP Phone



WLAN Mobility Tests



- WLAN subnets in the lab. Simulation
  Home & Foreign network
- UMIP MIPv6 entitites configured
  - Home agent services on Linux server
  - Laptops configured as MN & CN for the experiment
- Seamless mobility tests between WLAN subnets
  - Various mobility tests while MN getting video stream, and other use case scenario

3G mobility experiments

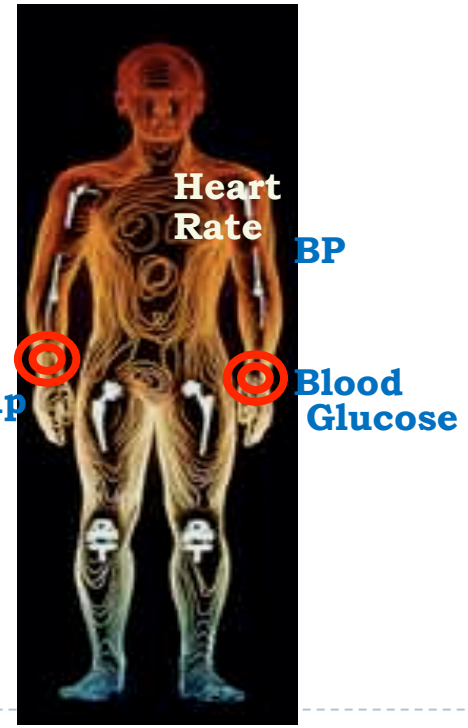
- Currently we are in touch with cellular service providers and will be holding a workshop in eliciting our requirements and seeking their ideas in the following
  - Subscription to 3G services supporting **IPv6 address** assignment to mobile node (USB dongle).
  - A well provisioned Virtual Private Network (VPN) to connect ERNET India IPv6 backbone network and service providers' backbone.
  - Mobile IPv6 Home agent services for Layer 3 handover will be running in ERNET India backbone for seamless handoff from service provider 3G network to ERNET backbone and vice versa.

Managing IPv6 based LoWPAN network

- Large number of sensors collectively provide data about the environment they are deployed
- 6LoWPAN enables managing them over internet using standard protocol – SNMP
  - Topology control, sensing mode selection etc.
- Development of generic monitoring framework
  - Enable remote monitoring
  - Support for definition of application specific data
  - Enable wide ranging monitoring applications

Motivating Application Use Cases

- Healthcare
  - Remote patient monitoring
  - Elder care
  - Continuous monitoring for critical conditions
  - Effective use of clinical resources



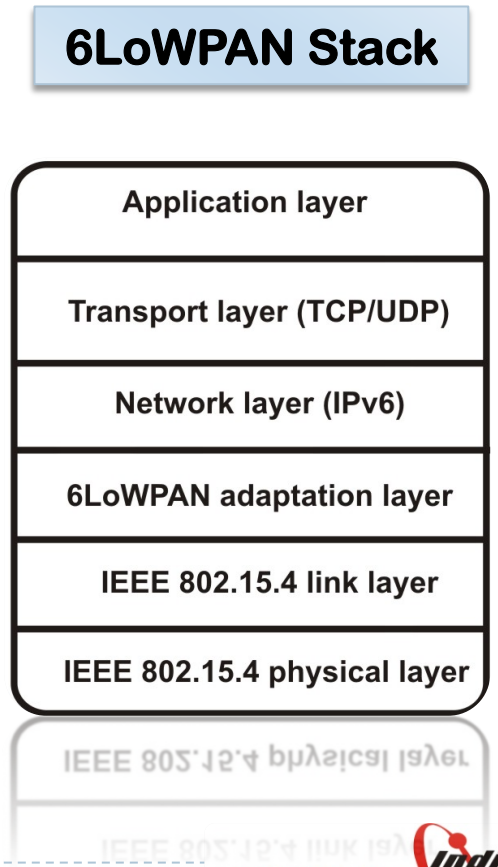
- Agriculture
  - Remote monitoring of temperature, humidity, soil conditions, etc.
  - Enable Precision farming & optimized irrigation

6LoWPAN Overview

- IETF RFC 4944 – Transmission of IPv6 packets over 802.15.4 LoWPAN networks
  - Challenges:

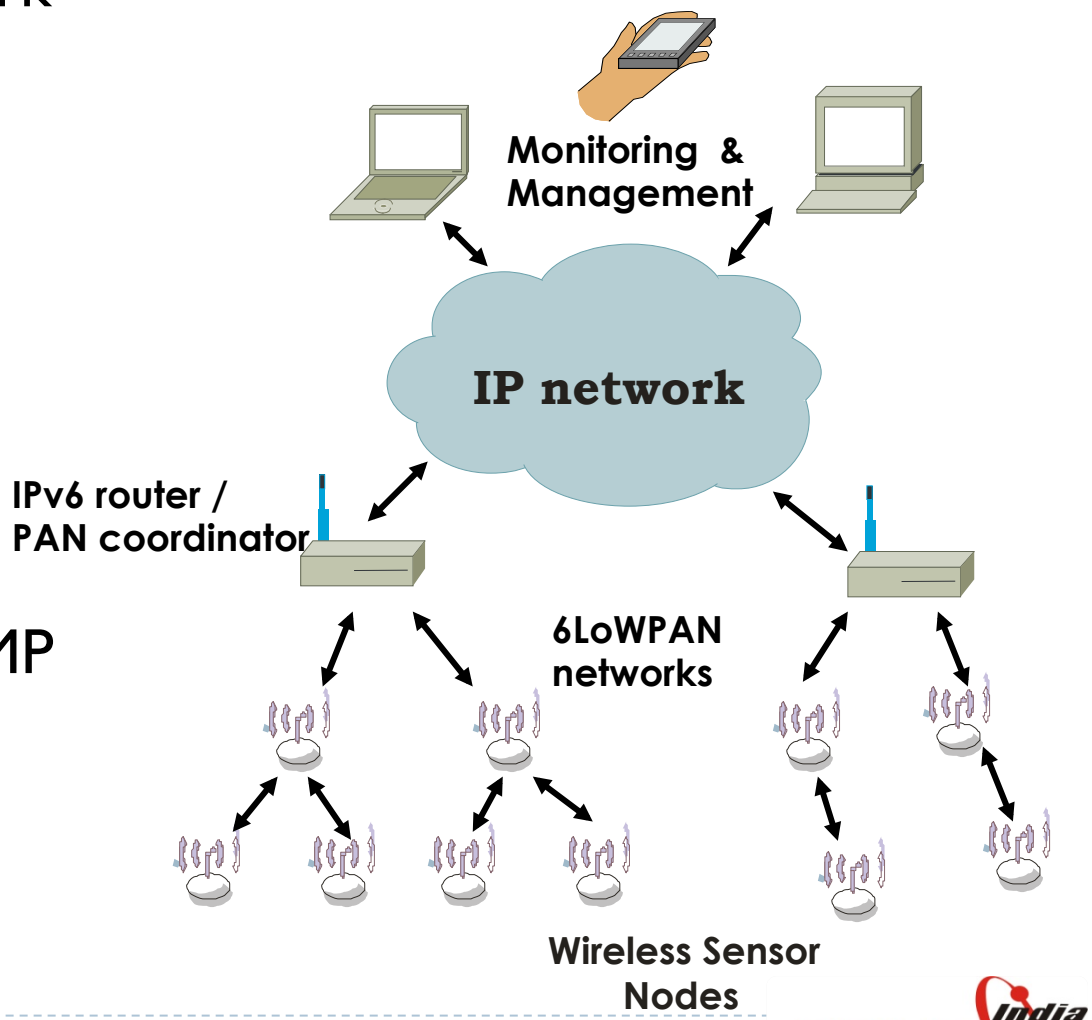
	IPv6 network	LoWPAN
MTU	**1280 bytes**	**127 bytes**
Data rate	**Mbps/ Gbps**	**Max 250 Kbps**
Comm. distance	**> 100 mts**	**10 mts**
Topology	**Broadcast**	**Mesh / Star**

  - 6LoWPAN Adaptation Layer
    - Header compression
    - Fragmentation
    - Layer 2 forwarding



6LoWPAN management / monitoring

- Reusing established network management tools
- Framework with limited overhead considering the resource constraints
  - Transmission, memory and processing power of sensor nodes
- Light-weight management architecture based on SNMP
  - Light weight agent
  - 6LoWPAN specific MIBs
  - Light weight manager queries (less frequent polling etc.)
  - Suitable security model



SNMP-based management – Architecture choices

(1) End-to-End SNMPv3

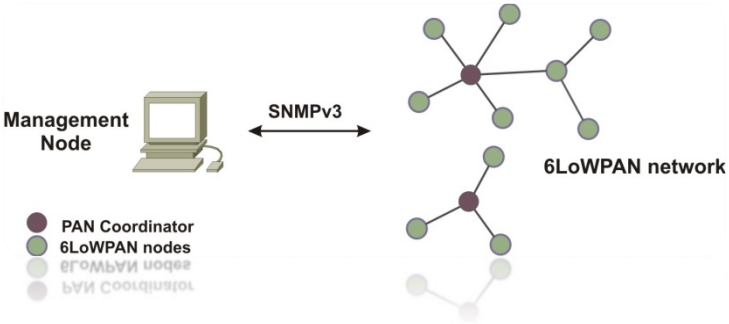
- Too heavy and expensive

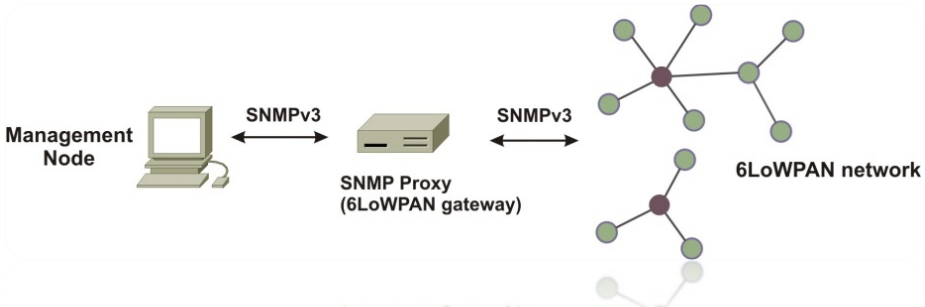
(2) SNMP-Proxy performing compression and encoding

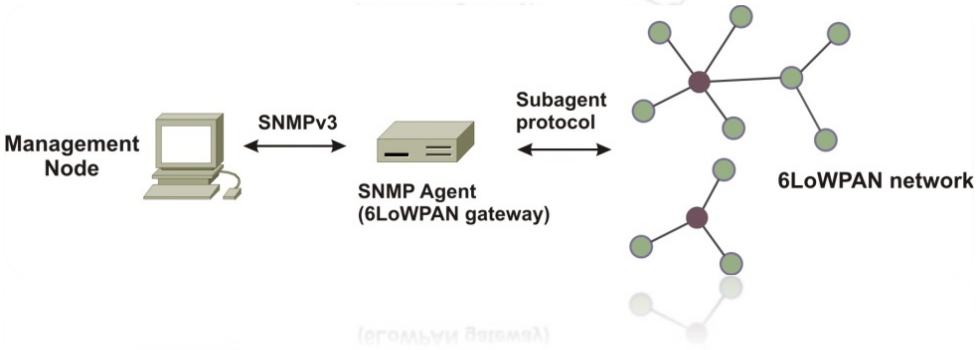
- Reduced message overhead

(3) Subagent protocol running at 6LoWPAN gateway

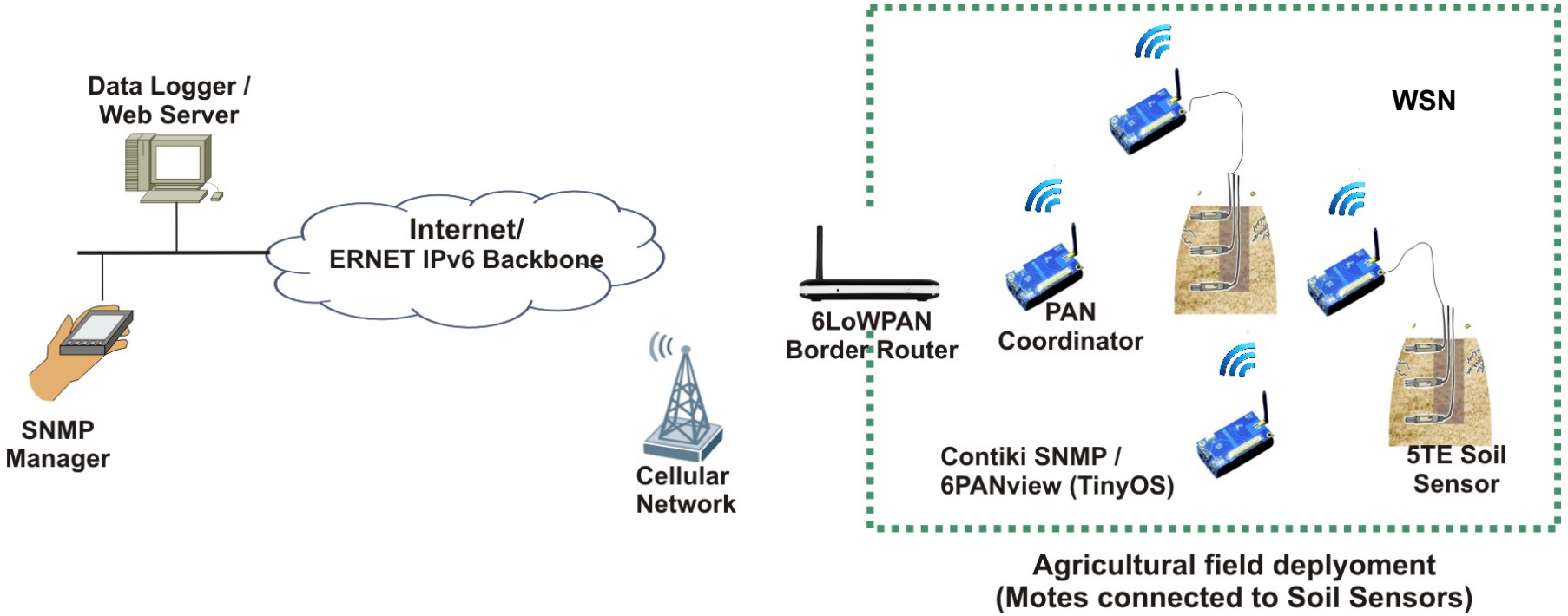
- IETF Drafts
  - "SNMP Optimizations for 6LoWPAN"
  - "6LoWPAN Management Information Base"







Agricultural Monitoring - Proposed architecture



- **WSN**: Wireless Sensor network comprises of motes running a WSN application and a light-weight snmp agent software
- **3G/Wi-fi wireless router**: IPv6-6LoWPAN tunnel converts IPv6 packets to 6LoWPAN packets and vice-versa as specified in RFC4944.
- **PAN Coordinator:** central controller for the WSN
- **SNMP Manager:** It is located remotely over the IPv6 network and enquire the WSN by invoking commands like snmpget to the SNMP agent
- **Database/Web Server:** Used for logging sensor data for offline access (by the farmers or scientists)

6LoWPAN - field deployments

- In consultation with ICAR/TNAU precision agriculture experts 6LoWPAN network will be deployed in farms practicing precision agriculture.
- The agricultural field measurements currently being considered
  - Soil temperature,
  - Electrical conductivity
  - Soil moisture/ VWC(Volumetric Water Content)
- WSN nodes integrated with “5TE” soil sensors / Data loggers EM50 will be deployed

Summary

- ERNET India R&D projects
  - DIT funded Mobile IPv6 testbed project supporting heterogeneous access network environment
  - DIT funded 6LoWPAN network management/monitoring
- Nation-wide IPv6 QoS testbed project
- Participates in various European initiatives
  - 6CHOICE
  - MyFIRE
- ERNET India also contributes to various working groups formed by Department of Telecom (DoT) for the smooth transition of IPv4 to IPv6 in India