Enabling Multiple Controllable Radios in OMNeT++ Nodes

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Motivation

- Wireless devices commonly have multiple radios
  - Cellular, WiFi, Bluetooth, Zigbee, NFC, ...
  - Different capabilities
    - Range, rate, communication mode, discovery, energy, ...

- Dynamically exploiting radio hierarchies
  - Vertical handovers
  - Cognitive radio
  - Energy-efficiency
Energy-efficient radio subsystem

- 802.11: High energy consumption even in idle mode
- Dual controllable radios:
  - Low power, low bitrate discovery radio
  - High power, high bitrate data radio
    - HP radio suspended when idle
- Goal:
  - Enable simulation of multi-radio nodes
  - Radios should be *controllable*
  - How does it affect energy consumption
- We use *MiXiM* and the *Energy Framework*
Design overview: Host

NICs draw energy from Battery
Controllable radios

● Three states per radio
  ● ON: Full energy consumption
  ● SLEEP: Low energy consumption, short wakeup
  ● OFF: No energy consumption, long wakeup

● NIC is controlled via Blackboard

● Facilitates flexibility in control
  ● Application
  ● Session layer
Implementation

- **NicController**
  - Receive ctrl commands from BB
  - Simulate wakup delay
  - Turn on/off mac & phy
  - Publish state changes on BB
IControllable interface

```cpp
class IControllable {
public:
    enum Controls {TURN_ON, SLEEP, WAKE_UP, TURN_OFF};
    enum Status {TURNED_ON, SLEEPING, TURNED_OFF};

    virtual bool isOn();
    virtual bool isSleeping();
    virtual bool isOff();

protected:
    virtual bool turnOn() = 0;
    virtual bool sleep() = 0;
    virtual bool wakeUp() = 0;
    virtual bool turnOff() = 0;
};
```

- Interface implemented by NIC modules
  - Extend existing MiXiM mac & phy classes
  - Does not break any existing code
class PhyLayerControl
    : public PhyLayerBattery, public IControllable
{
public:
    virtual void initialize(int stage);
    virtual void finish();
    virtual void receiveBBItem(int category, const BBItem *details, int scopeModuleId);

protected:
    virtual void handleUpperCtrlMessage(cMessage* msg);

    virtual bool turnOn();
    virtual bool turnOff();
    virtual bool sleep();
    virtual bool wakeUp();
};
Conclusion

- Dual radio for opportunistic networking
  - MiXiM 802.15.4 for control radio
  - MiXiM 802.11 for data radio
- Evaluate content distribution performance
  - Energy savings vs performance decrease
  - Effect of range disparency in control & data radios
  - Effect of neighbor discovery delay
  - See paper for prel. results on a simplified system
- Generic framework applicable to different mobile wireless services/applications
- Our MiXiM fork available at https://github.com/olafur/mixim