EMG Body Area Network

Overview

- EMGBAN setup
- MAC
- Sensor node
- Base station

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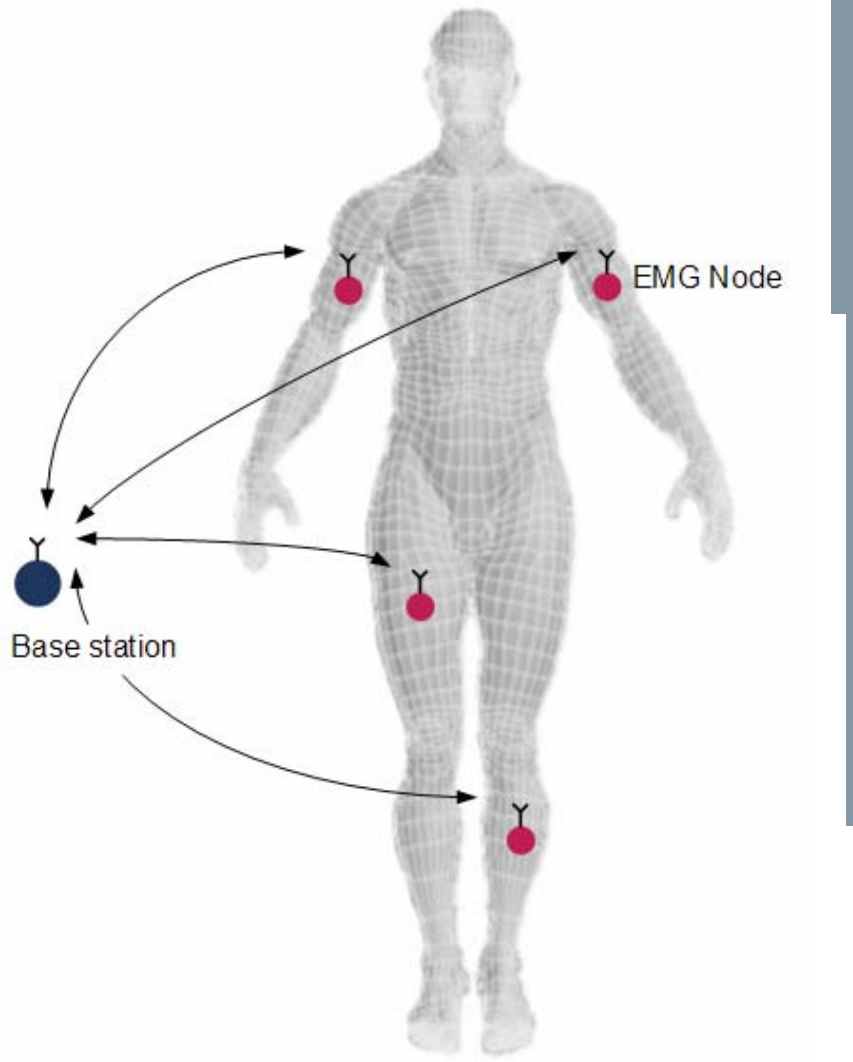
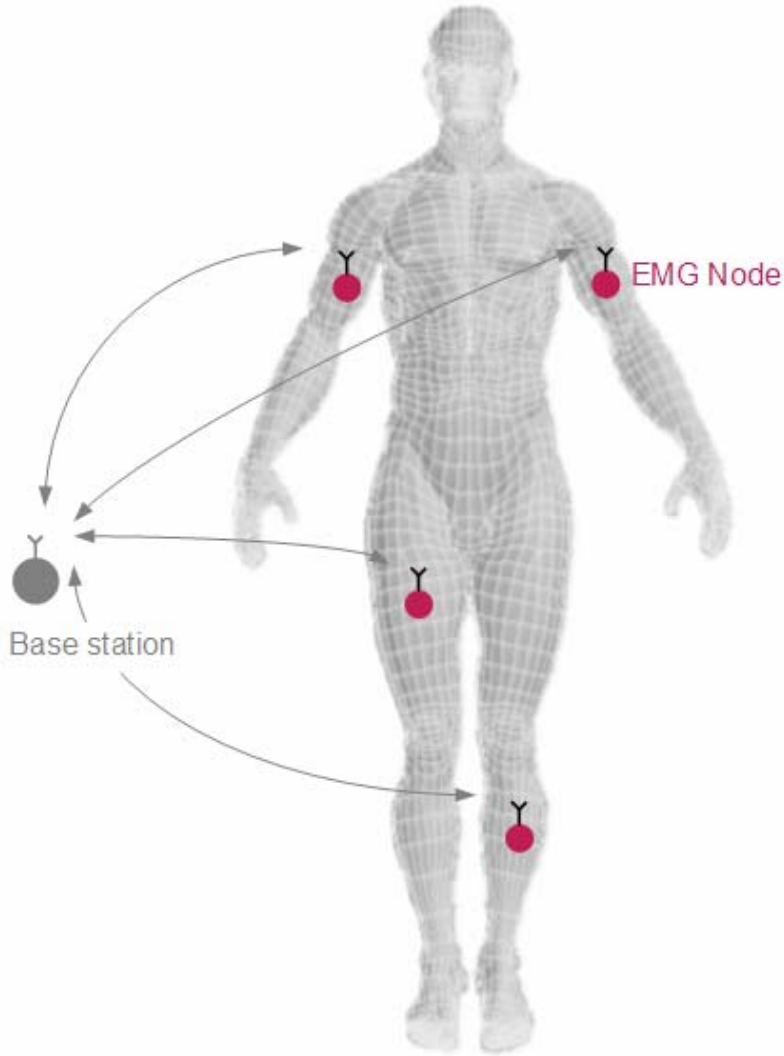
EMGBAN: 1. Network

- Star topology
  - 1 base station
  - 4 sensors
- 2.4 GHz ISM band
- 250 kbps max @ PHY
- up to 10m coverage



EMGBAN: 2. EMG sensor node

- 3V battery powered
- Power consumption
  - avg: 13 mW
  - peak: 60 mW
- Synchronized sampling
  - 1024 Hz sample rate
  - 12 bit/sample

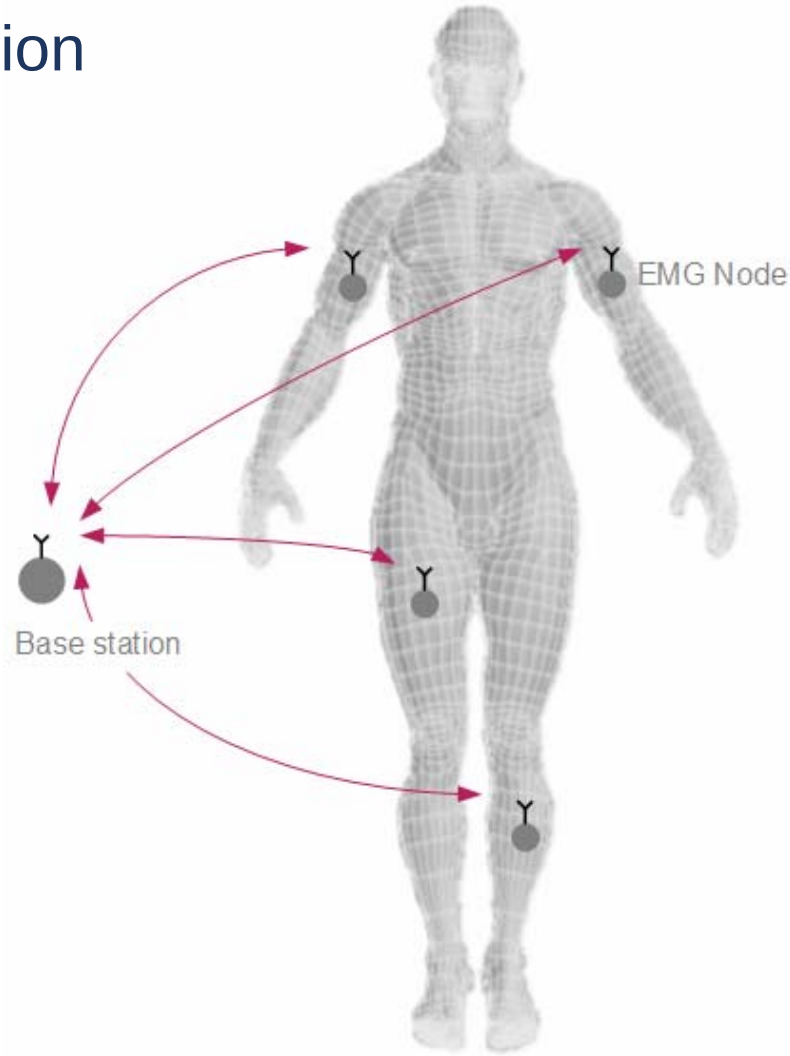


EMGBAN: 3. Medium Access Control

- Bidirectional communication
- Data rate: ~ 70 kbps
  - **4** DL channels @ **16** kbps/ch

    (header + EMG data)
  - **1** Uplink channel: **5** kbps

    (*multicast from base station)*
- TDMA based MAC
- Synchronized sampling



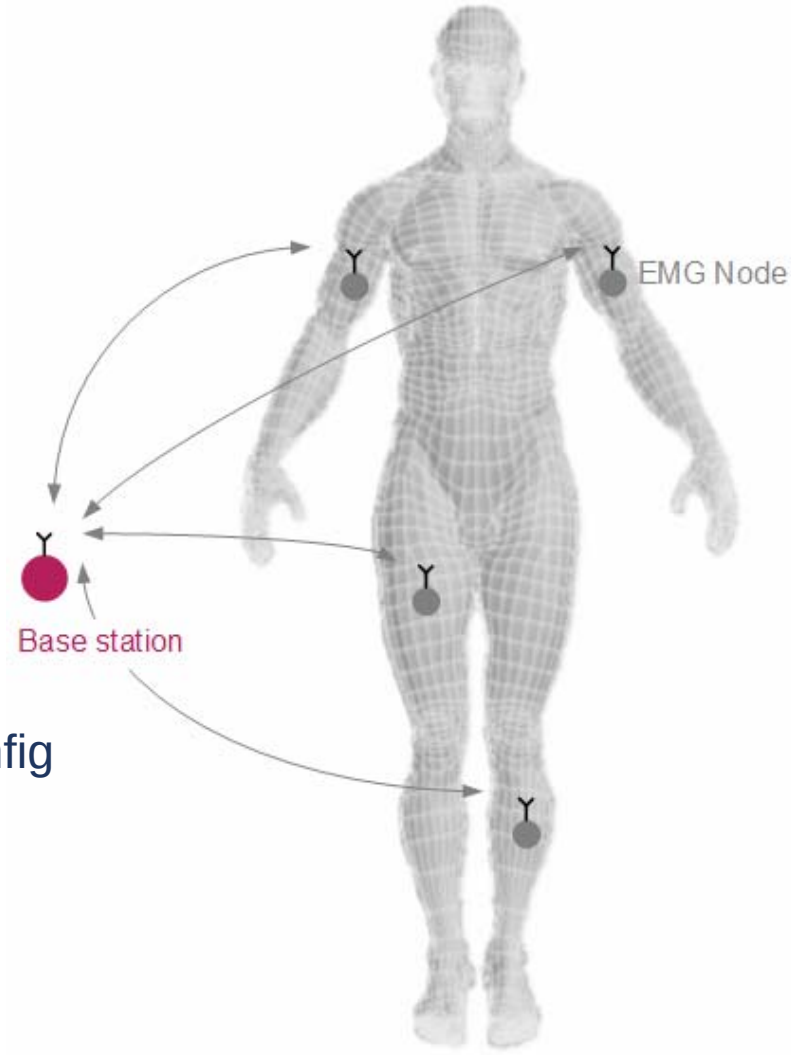
EMGBAN: 4. Base station

- USB stick interface

  host PC ↔ wireless network

- MAC control

- Host application
  - Network control & sensor config
  - Real time data view
  - Off-line storage



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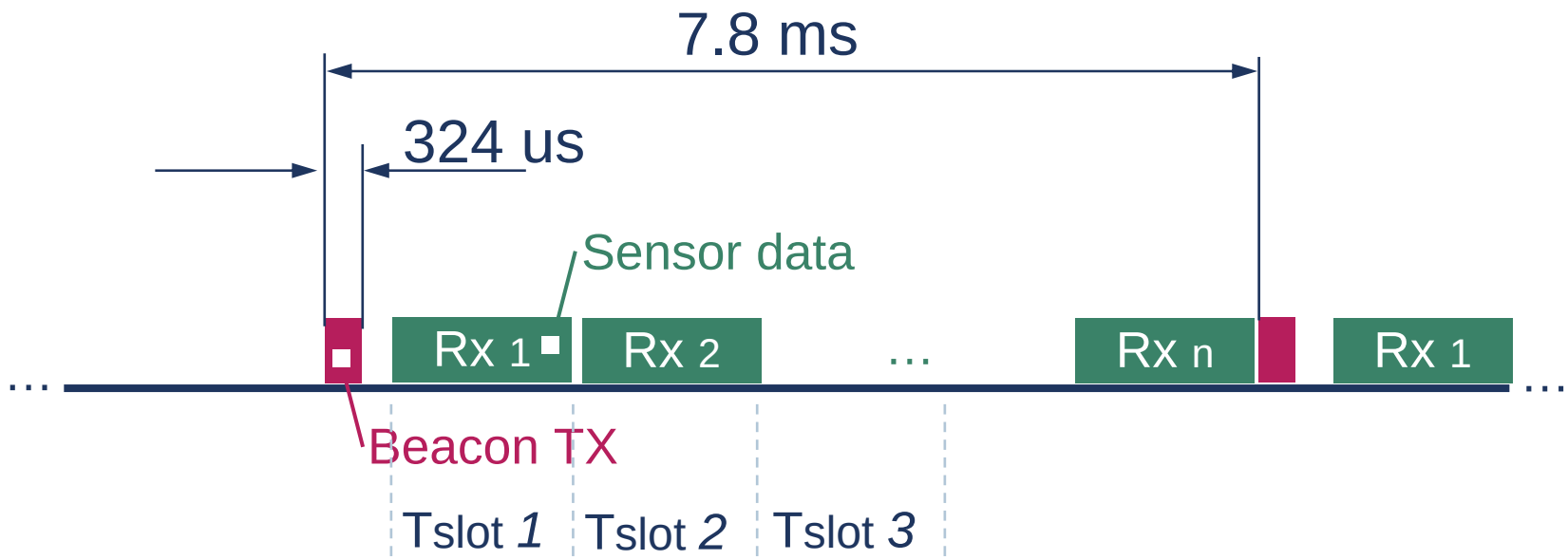
MAC implementation on base station

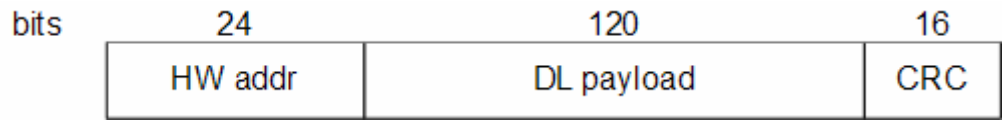
- Periodic beacon transmit (UL)
  - every 7.8 ms
  - size: 80 bit
  - air time: 324 us

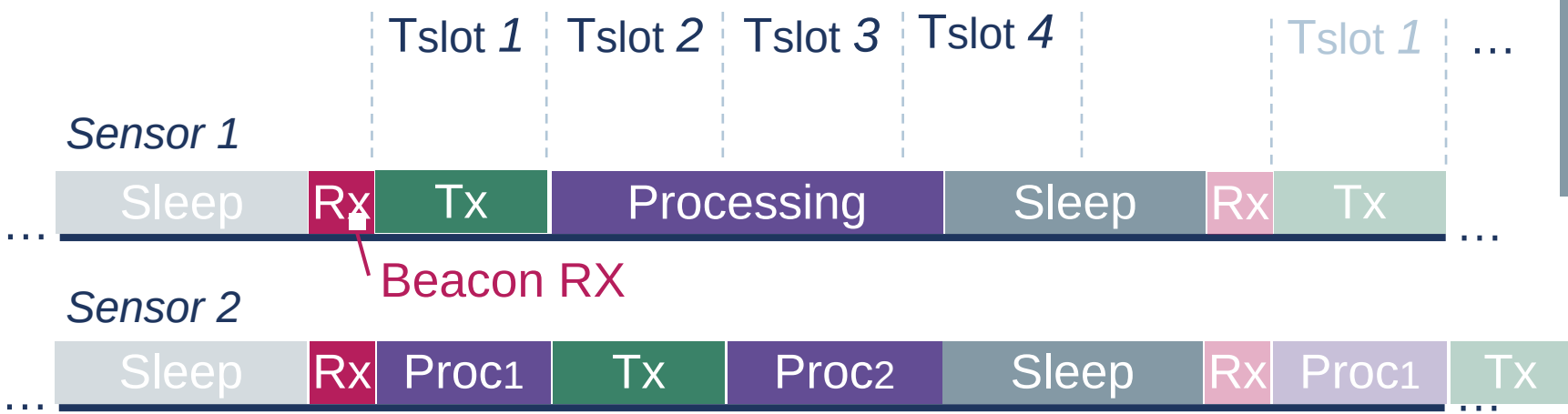
- Receive time-multiplexed sensor data



MAC implementation on sensor node

- Synchronize to beacons
  - sampling timer
  - transmit timer
  - wakeup timer
- Transmit data in assigned time slot (DL)
  - size: 160 bit
  - air time: 644 us





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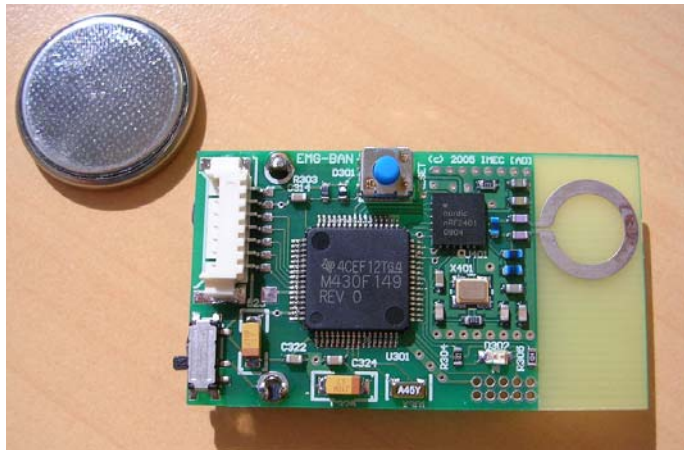
Sensor node specifications

- Small form factor:
  25x42 mm
- Operates > 1 day on single battery
  - CR2032 (235 mAh) battery powered
  - 4.4 mA average power consumption
- Local signal processing:
  - RAW
  - MAV (Mean Absolute Value)
  - RMS



Node has a 4 task execution cycle

1. Beacon RX

   receive UL from base station (cfg params)

2. Process data

   preprocess EMG data (RAW, MAV of RMS)

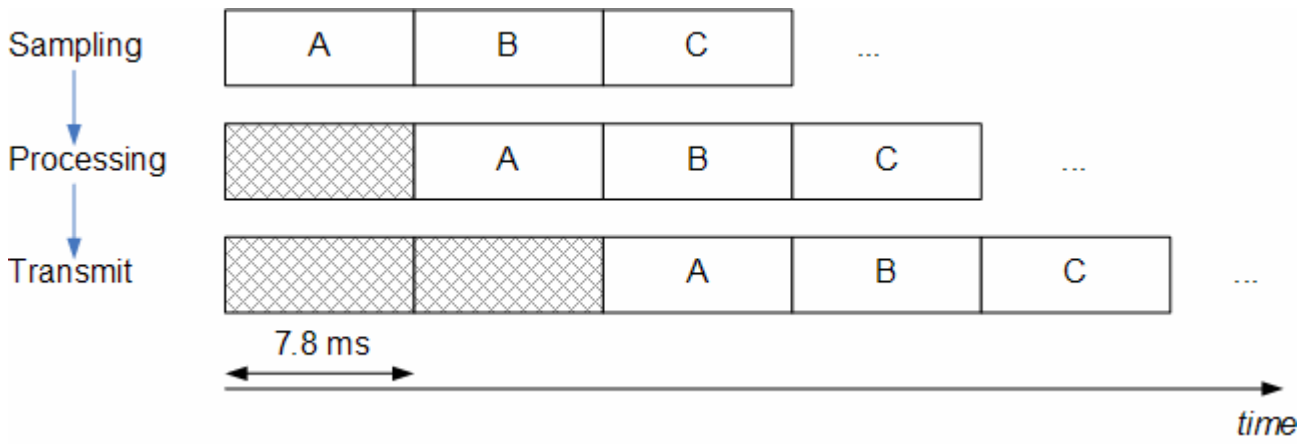
3. Data transmit

   download processed data to base station

4. Suspend

   power save mode

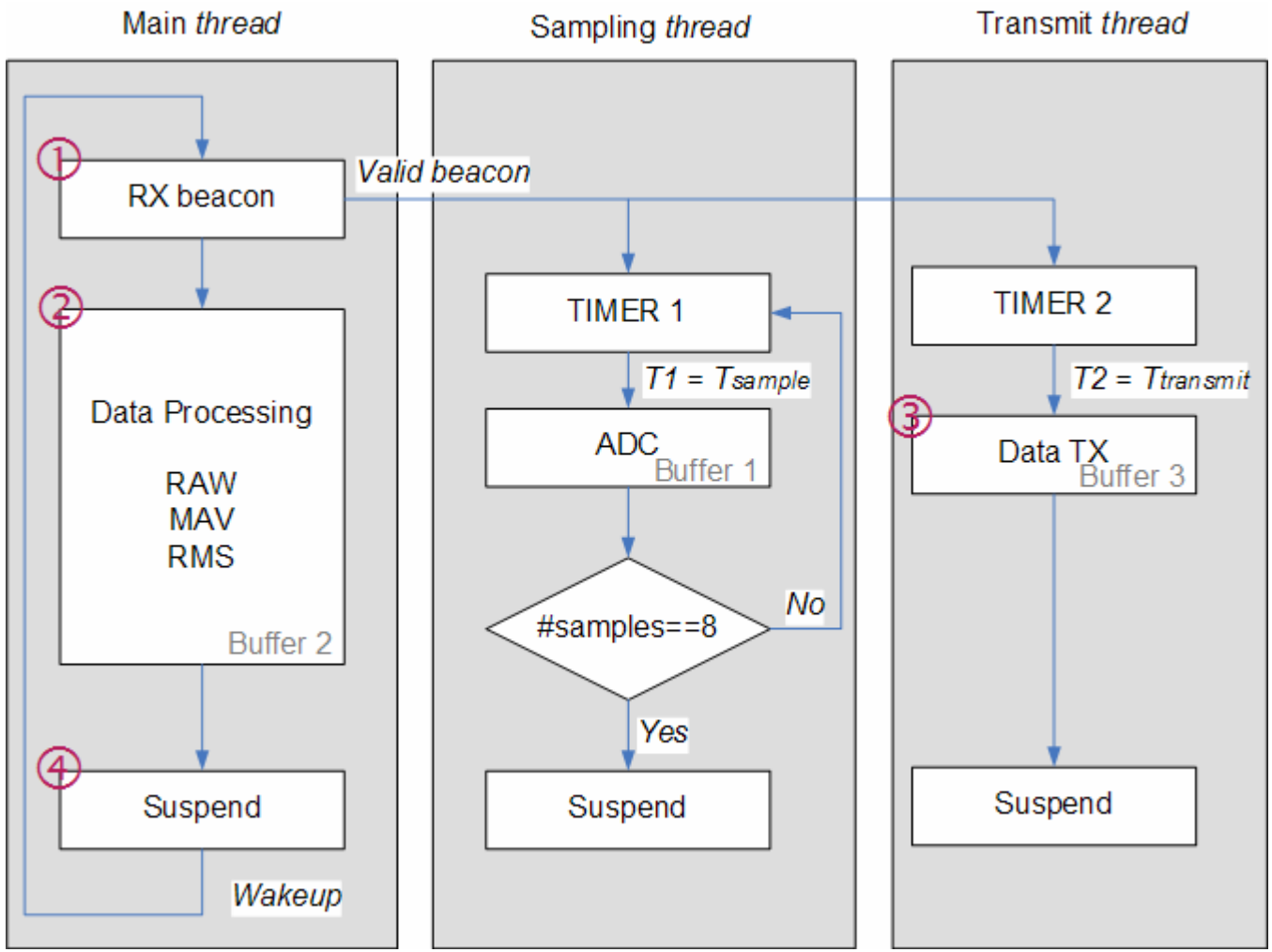
Data path has a triple buffering pipeline



Concurrent execution of:

	Read	*Write*
■ Sampling	(Sample)	BUF 1
■ Local data processing	BUF 1	BUF 2
■ Timed data transmit	BUF 2	BUF 3

Multi thread operation controls program flow



Multi thread operation controls program flow (cont.)

Main application

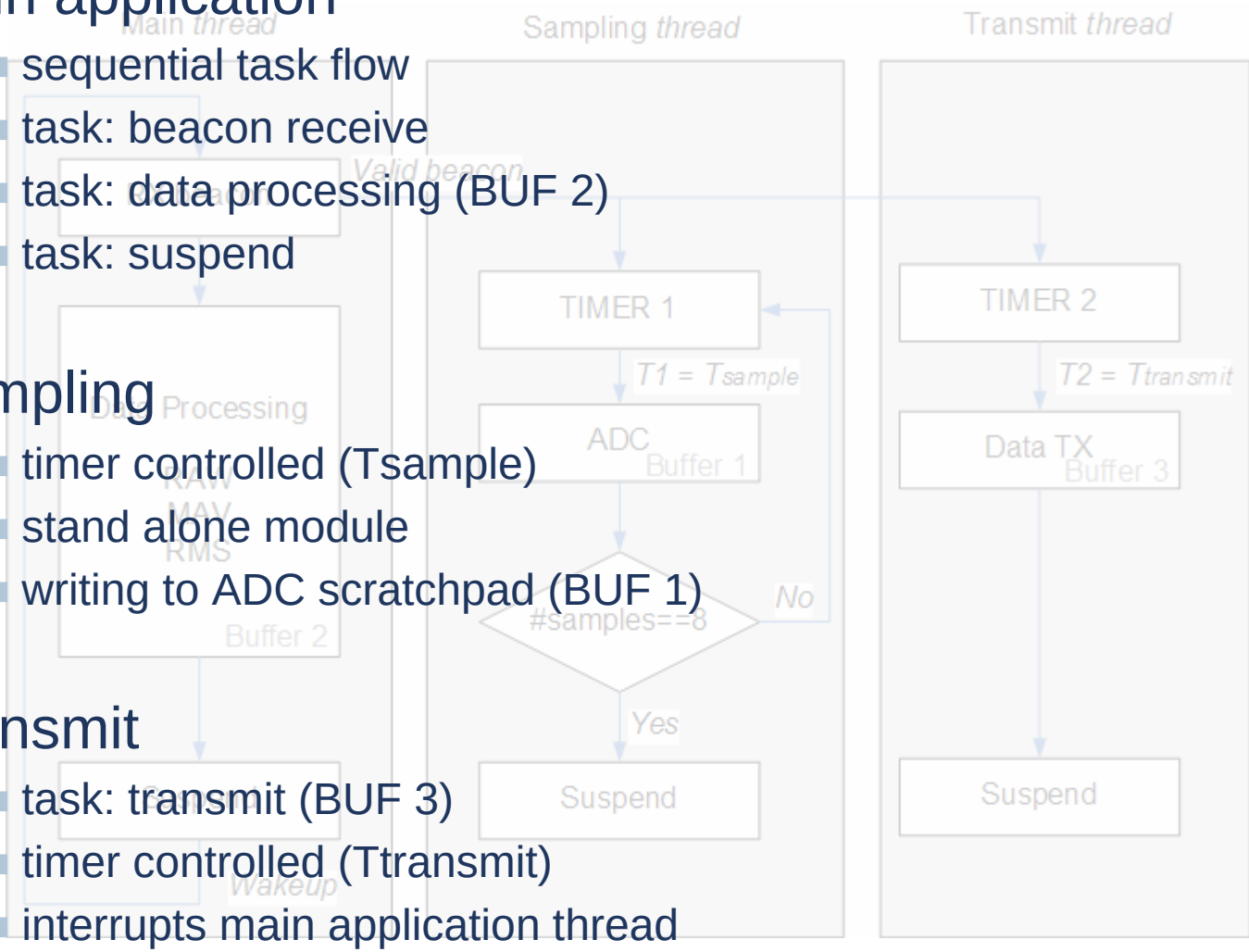
- sequential task flow
- task: beacon receive
- task: data processing (BUF 2)
- task: suspend

Sampling

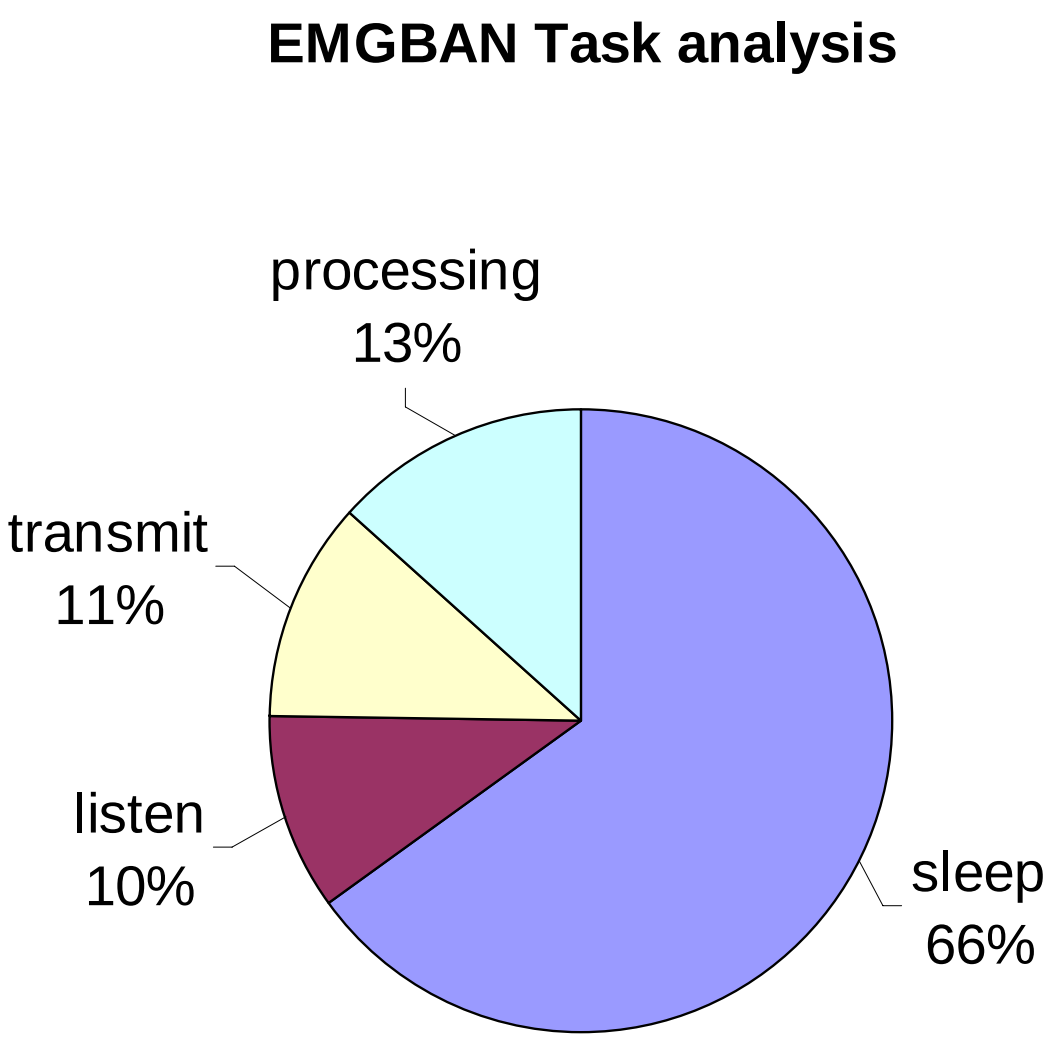
- timer controlled (Tsample)
- stand alone module
- writing to ADC scratchpad (BUF 1)

Transmit

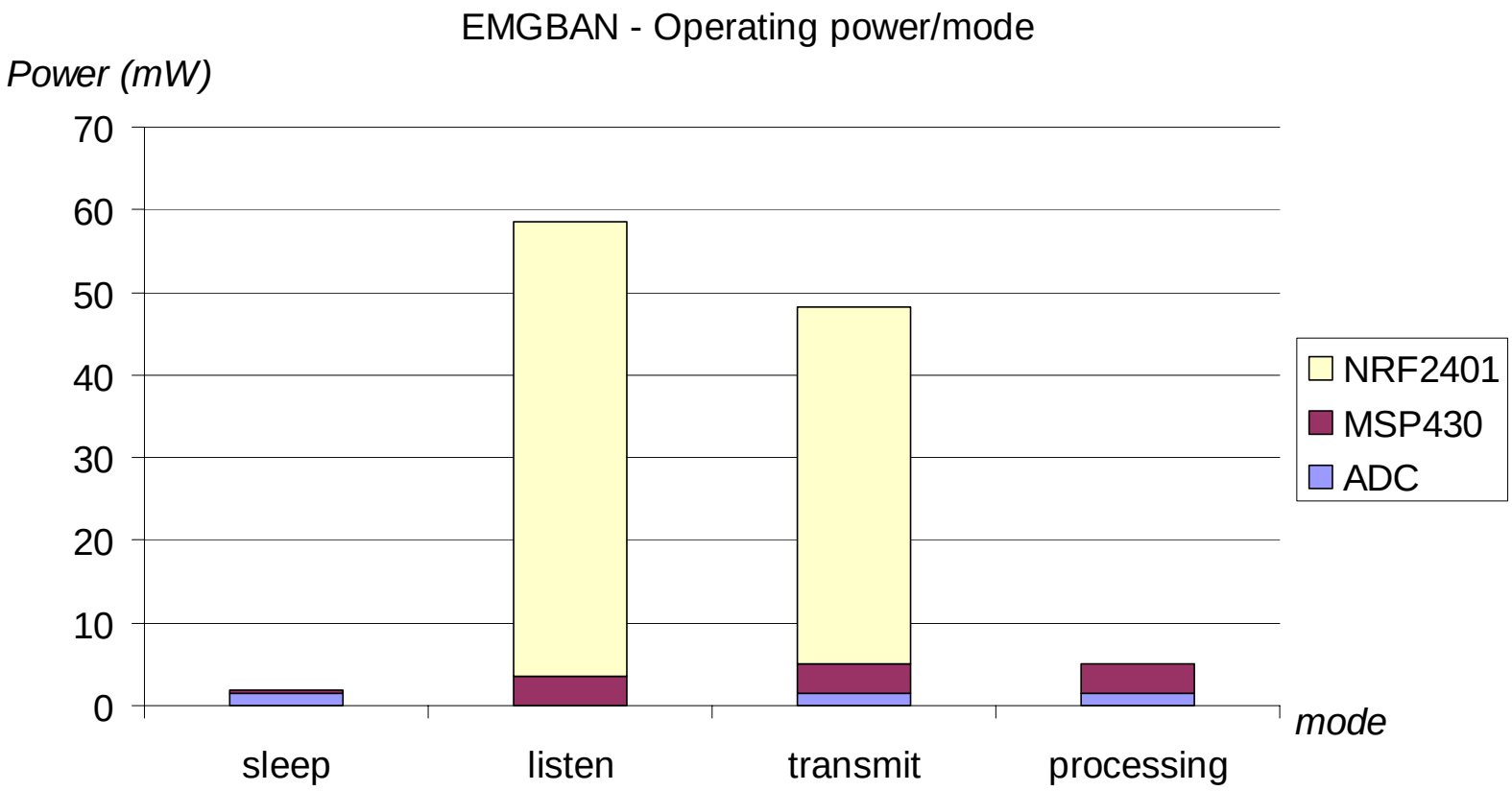
- task: transmit (BUF 3)
- timer controlled (Ttransmit)
- interrupts main application thread



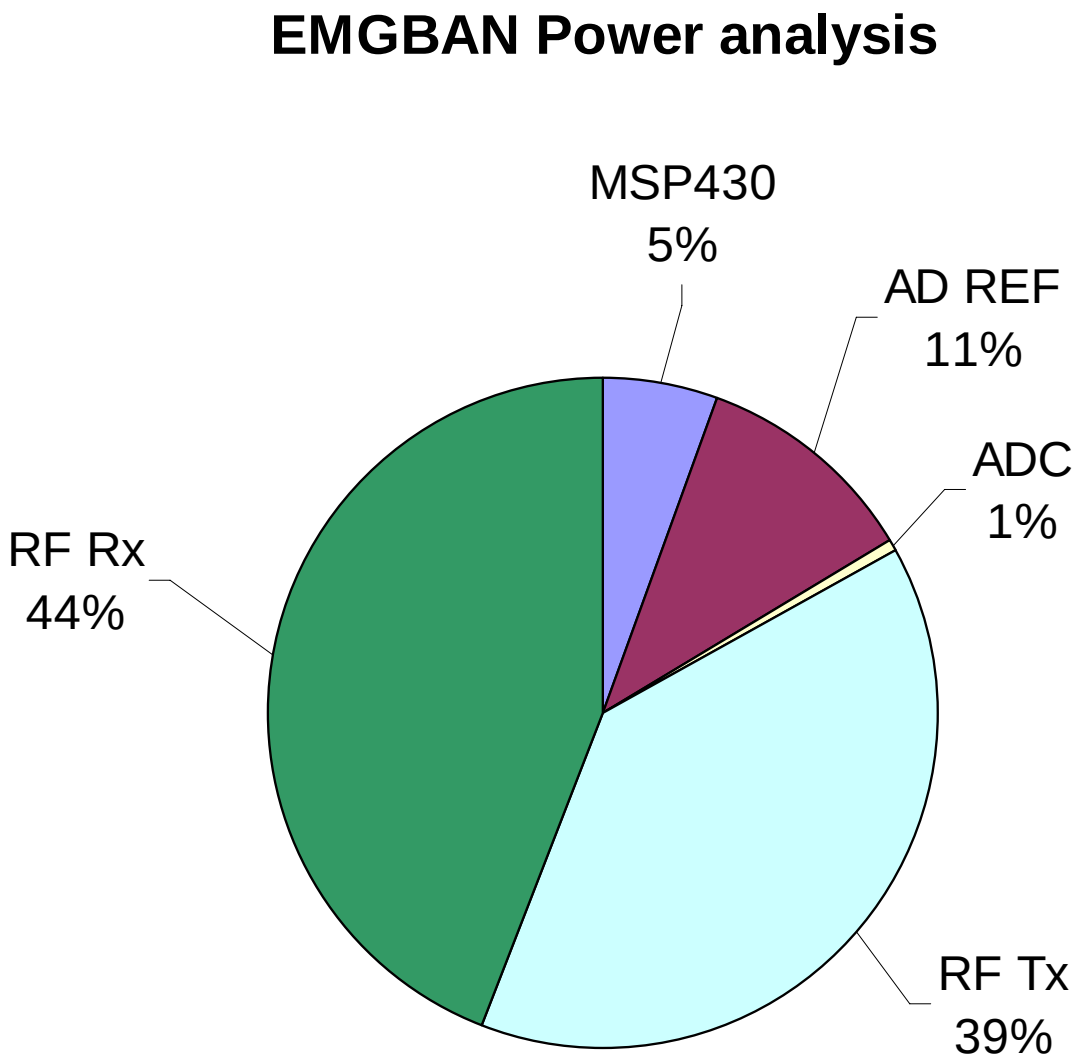
Sensor node sleeps 66% of the time



Power consumption peaks to 60 mW in listen mode



Wireless interface accounts for 83% of the total power budget



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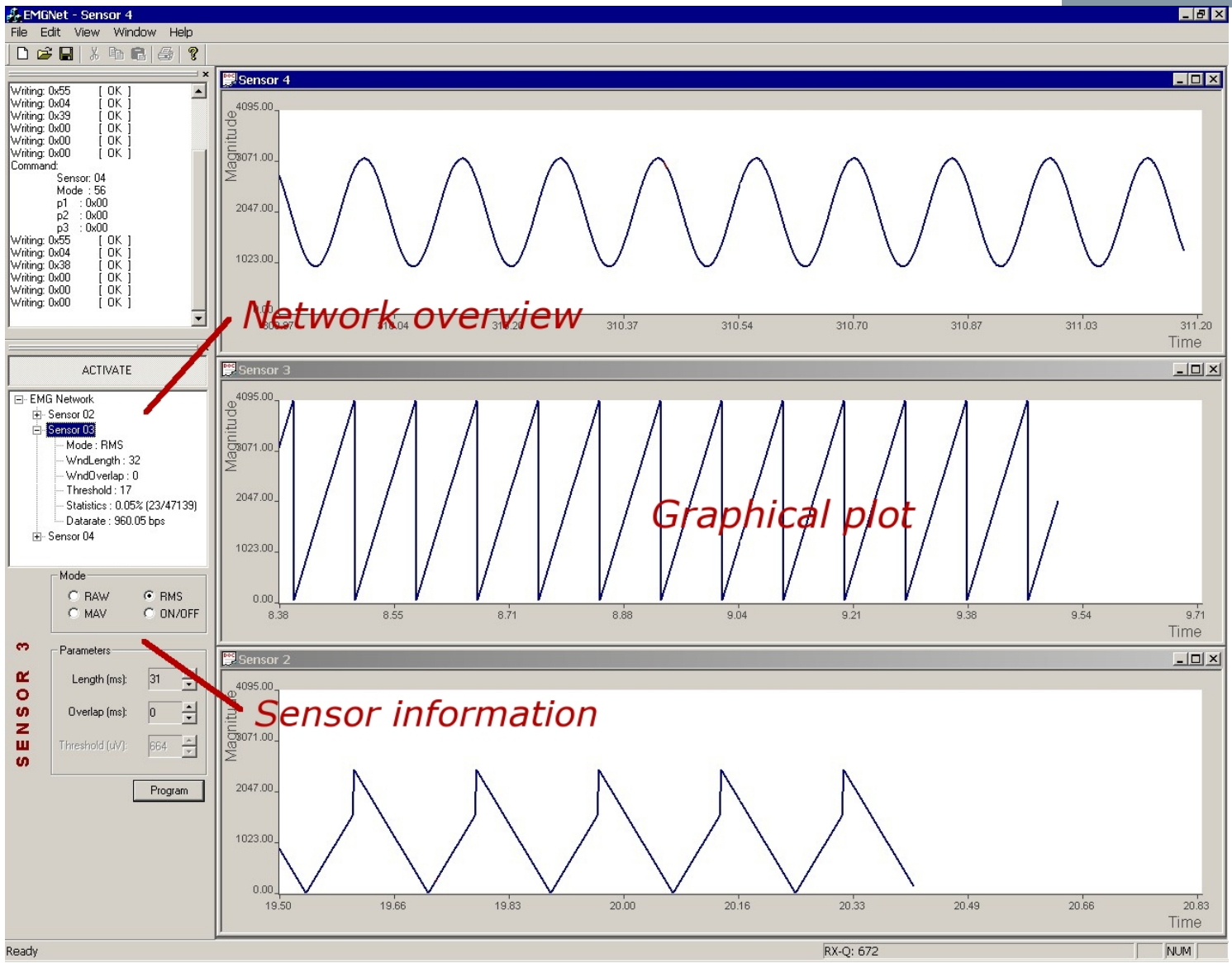
Base station specifications

- USB powered

- Low level MAC control
  - periodically sends beacons (UL)
  - network monitoring
- Host ↔ wireless network interface
  - sends configuration parameters
  - uploads sensor data

Host application screenshot



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