

Simulation Blocks for TOSSIM- T2

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Outline

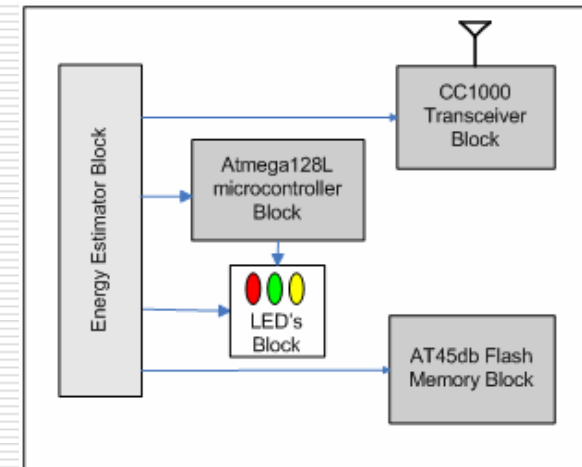
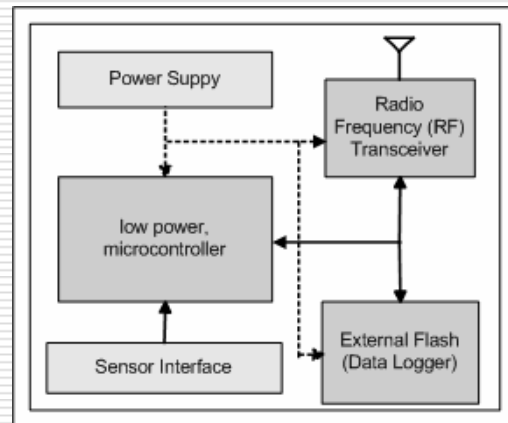
- Motivation
 - Simulation Models
 - Radio, Noise
 - Energy estimation Blocks
 - Radio, MCU, Flash and LED
 - Case Study
 - Summary and Conclusions
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Motivation

- Provide support for MICA2 under TinyOS-2 (T2) released in Nov 2006
 - Energy estimation for MICA2 in T2
 - How long does the battery last?
 - Is algorithm 'a' energy efficient compared to algorithm 'b'?
 - Improving wireless simulation
 - Realistic packet delivery model
 - Verify simulation-analysis results experimentally
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Simulation Blocks

- H/W and S/W simulation elements
 - - MCU, Radio, Flash, LED, & Environment noise model, Packet delivery model
- Introduced an energy estimator block



Radio Modeling - I

- ❑ Byte level radio model for CC1000
 - ❑ Several internal hardware registers were created for storing configuration
 - Transmission power, Radio data rate, Frequency of operation, receiver sensitivity
 - ❑ SPI Communication between MCU and Radio was established
 - SPI interrupts upon reception and transmission were handled
 - ❑ SPI event loop is handled – virtual channel access node is introduced
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Radio Modeling - II

- Byte Level SPI Simulation to solve packet corruption due to SPI event sync mismatch
 - Simulating capture and release of the SPI events for Packet transmission and reception

 - Medium state (free/busy) polling to solve ack wait problem
 - The ack packet issued by a receiver collides with the preamble of another source
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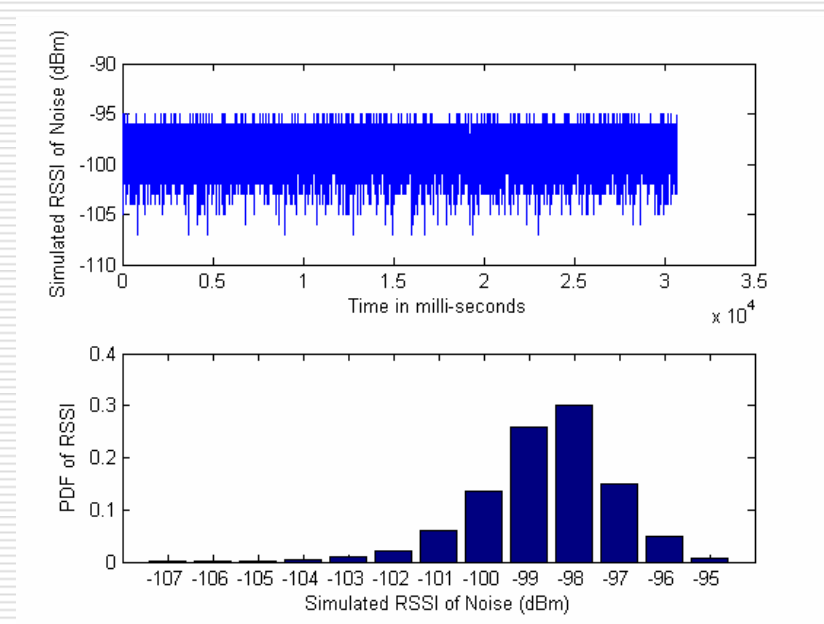
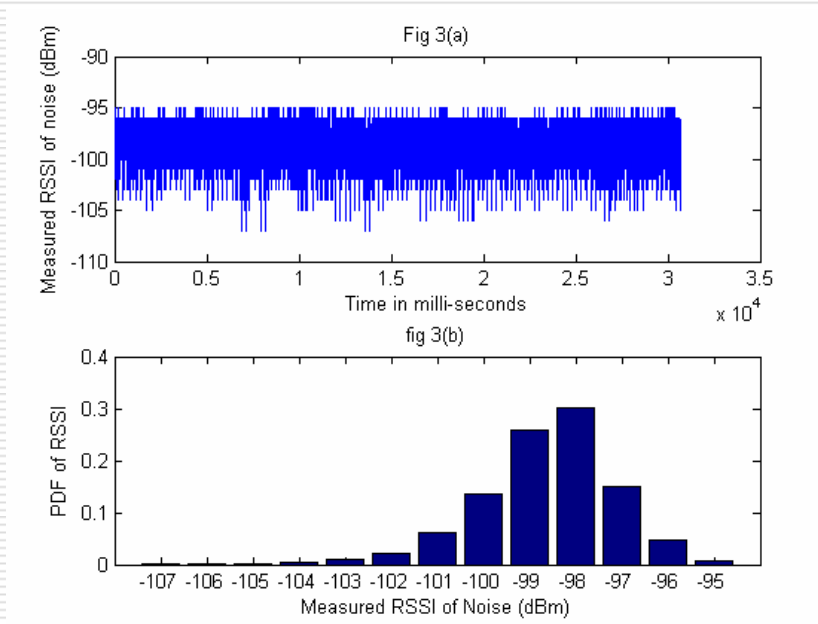
Noise modeling - Goal

- Connectivity is more complex than simple RF propagation models
 - Low power wireless networks have complex, rare and difficult behavior
 - Accurately simulate wireless packet delivery between 2 nodes
 - Early studies used unit disc model. Nodes within 'r' successfully receive packets (TOSSIM 1.x uses this!)
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Noise modeling

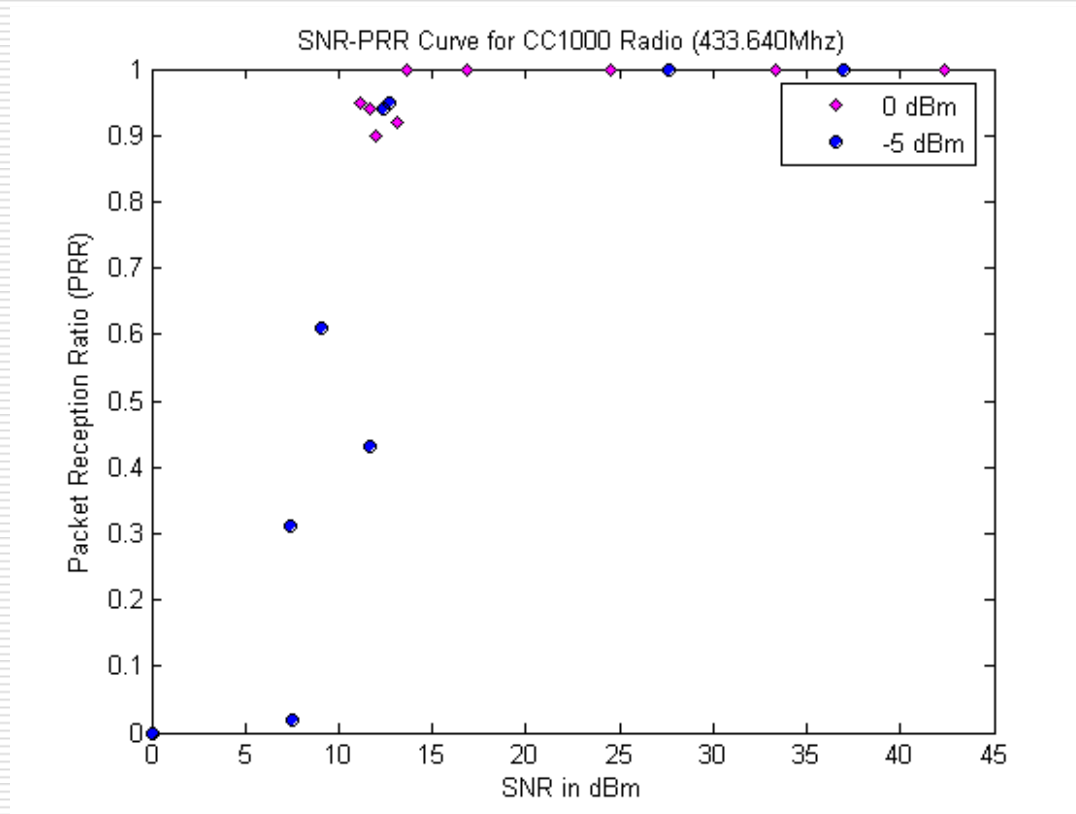
- Environment noise model is developed
 - Interfering sources not considered
 - Characterized being brief, strong, and short-lived
 - Used Naïve sampling and Closest-fit pattern matching techniques
 - Measure the RF energy at 1 KHz by reading ADC0 pin of MCU
 - Noise ranges from -95dBm to -105 dBm
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Noise model for CC1000 Radio



SNR – PRR curve

- link connectivity between node pairs



MCU Component

- ❑ Limited to energy consumption in several states of the MCU
 - Poll 3 bits of the MCUCR hardware register
 - Log data to energy estimator block
 - ❑ Data sheet provides information about power states
 - Idle 3.3mA
 - ADC Noise Reduction 1.0mA
 - Power Down 0.116mA
 - Power Save 0.124mA
 - Power Standby 0.237mA
 - Extended Standby 0.243mA
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Radio component

- Current consumption depends on transmit power level.
 - 0dBm – 10.4mA, 5dBm – 14.8mA, ..
 - Receive current is fixed – 7.4mA
 - Track and estimate the energy in several radio states
 - Power Down, Receive, Transmit
 - Estimate energy by radio electronics
 - Oscillator, Bias, Synthesizer
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Flash and LED

- Energy consumed in several states:
 - Standby, Active Read, Program and Erase
 - Log energy information for read/write
 - Pin state monitor is implemented for LED
 - Keep track of low – high and high – low transitions
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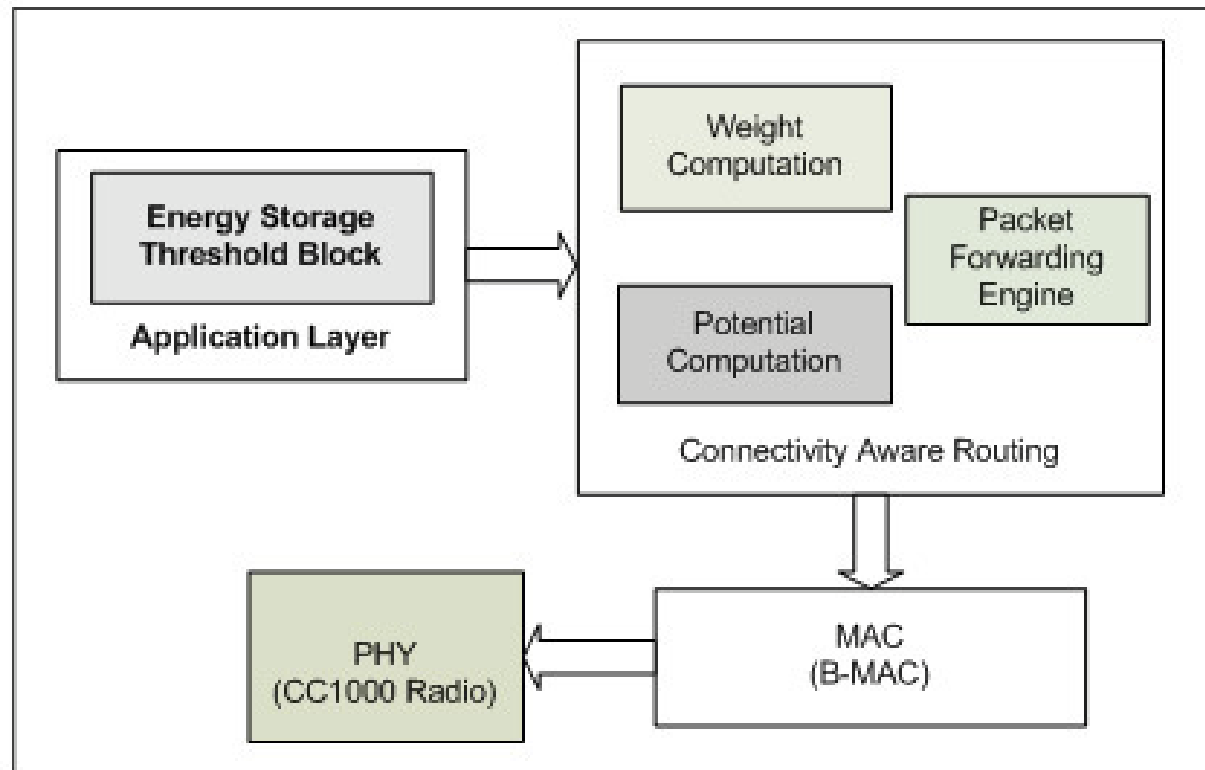
Case Study - Efficacy test!

- ❑ Implemented a routing algorithm
 - ❑ Compare theoretical and simulation lifetime
 - ❑ MICA2 mote implementation using 10 motes
 - ❑ Two scenarios are implemented to support the paper's analysis
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Connectivity aware routing

- Choose a routing strategy such that network partitioning gets extended
 - One-by-One, Common-last approach
 - Utilizes common relays between networks at the end
 - Analytical results show network partitioning time is greater than common-first approach
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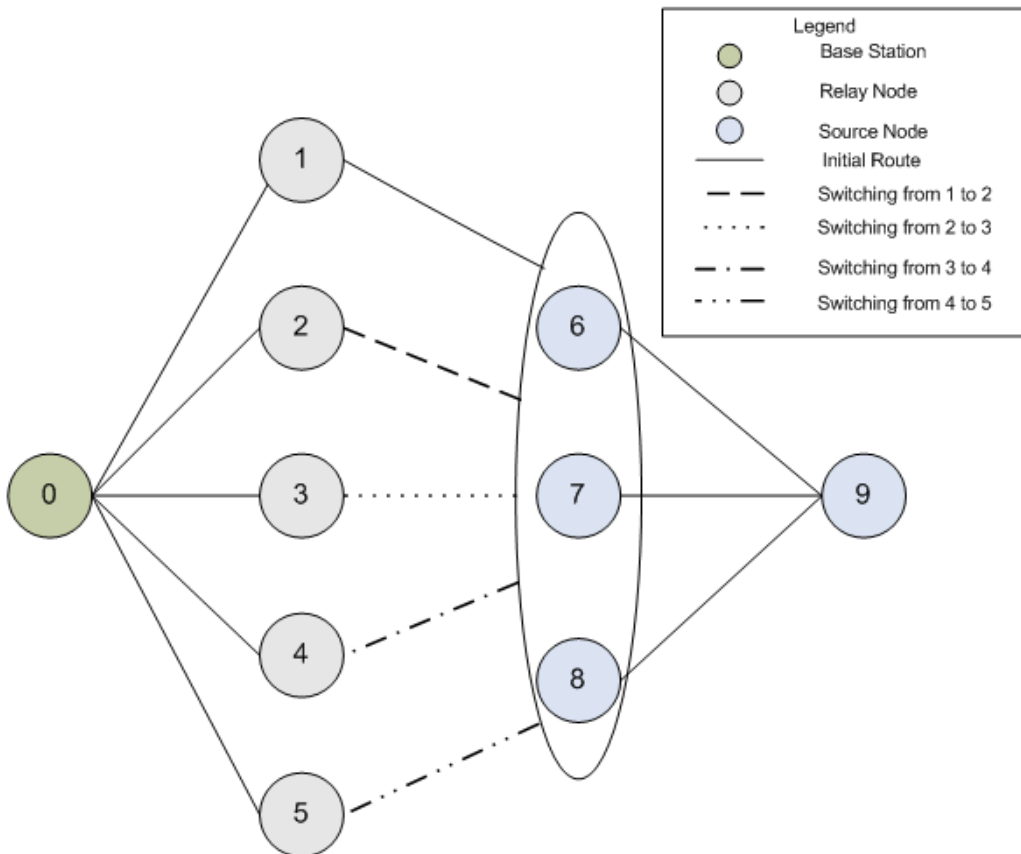
Connectivity aware routing



Routing Implementation

- Weight and Potential computation and communication
 - Routing beacons carry route topology information
 - Contain the weight, potential, number of neighbors, distance, and number of non relay neighbors.
 - Another type of route packet contains the number of sink nodes
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Network Topology - I



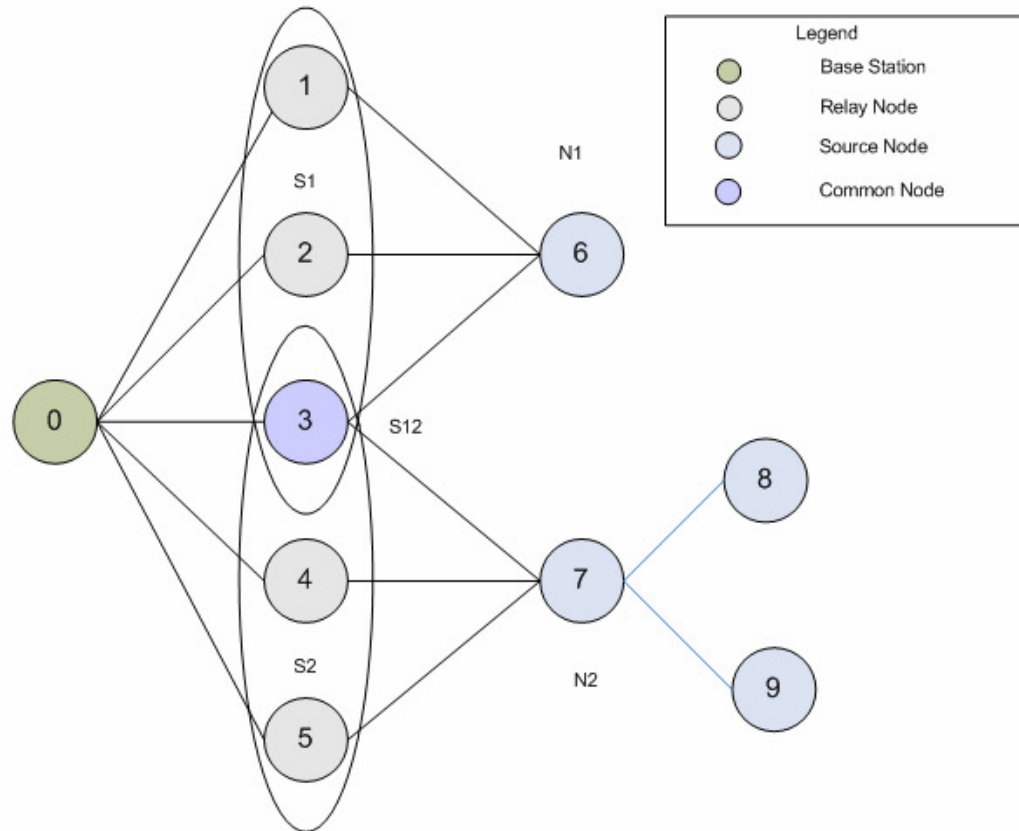
Weight computation

$$W^i = (\text{nu_non_relay_nbrs})^{-1}$$

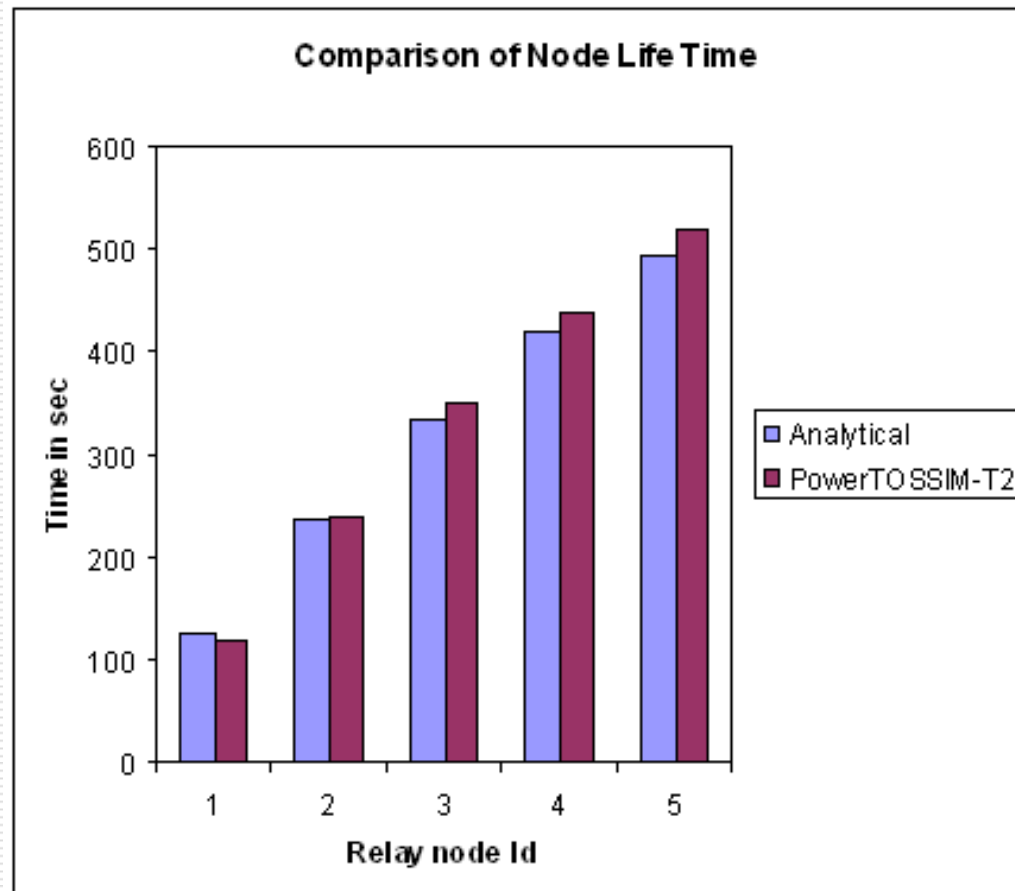
$$\text{Potential} = \phi_A = \max_{1 \leq i \leq L} \frac{W_{\min}^i}{d_i^k}$$

Node Id	Weight	Potential
1	1/4	1/4
2	1/4	1/4
3	1/4	1/4
4	1/4	1/4
5	1/4	1/4
6	1/4	0.125
7	1/4	0.125
8	1/4	0.125
9	1/4	0.0833

Network Topology - II



Result for Topology - I

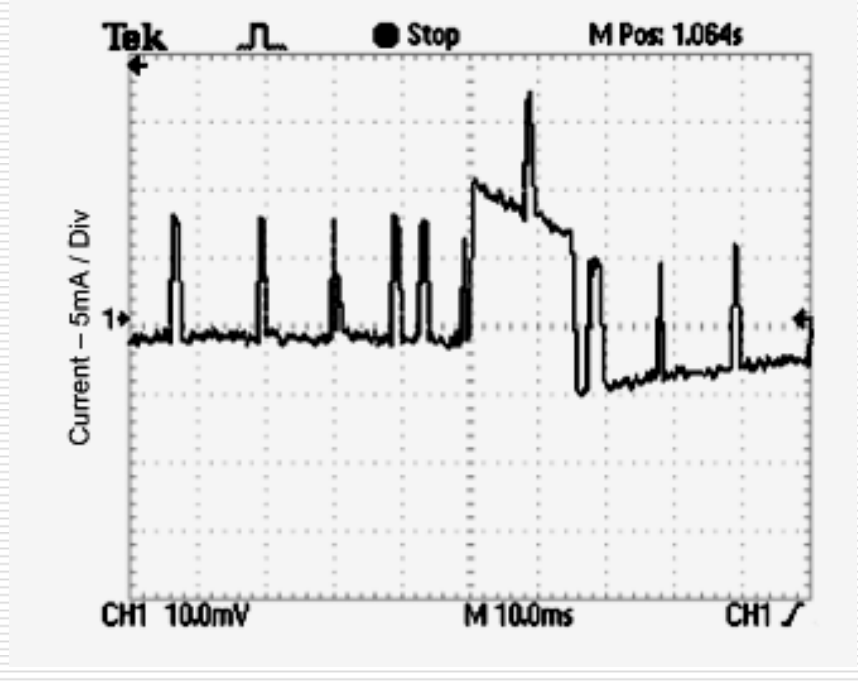
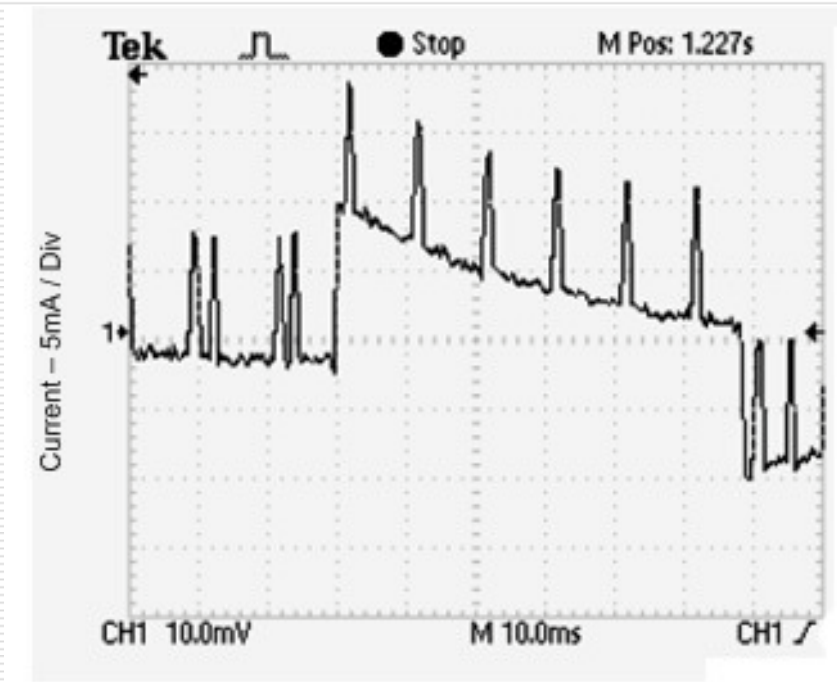


Results – Topology -II

Scenario	Network Life time
Common- First	600 secs
Common-last	660 secs

Measurements

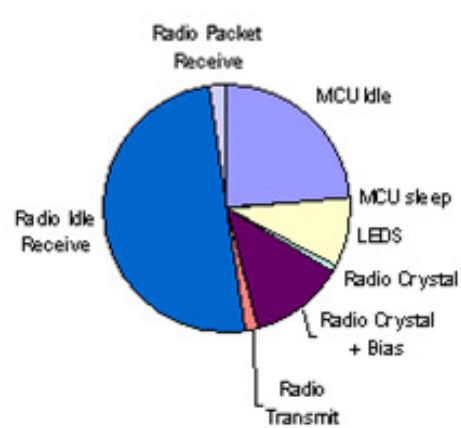
- Snapshot of data and routing packet transmission



Energy Results for node 1 (Joules)

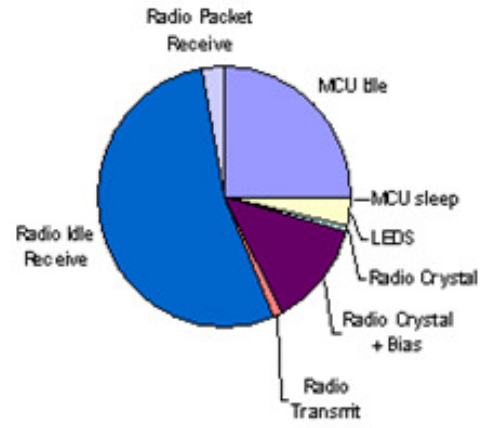
	TOSSIM-T2	Analysis	Measurements
MCU Total	0.89	-	-
Radio Total	2.56	-	2.14
Transmission	0.11	0.08	0.07
Reception (Rx)	0.09	0.06	0.08
Rx_Idle	1.85	-	1.97
Rx_Total	1.95	-	2.05
Lifetime(secs)	60.8	60	63

Expended Energy Distribution



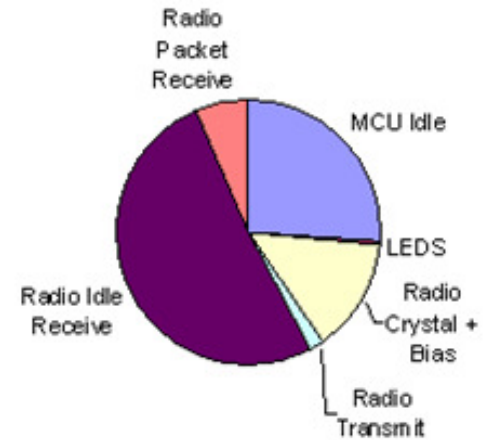
Scenario 1 : Energy Spent by Node 1

(a)



Scenario 2, Case 1: Energy Spent by Node 3

(b)



Scenario 2, Case 2: Energy Spent by Node 3

(c)

Summary and Conclusions

- ❑ Several hardware and software blocks are Implemented for MICA2
 - ❑ Using these blocks energy consumption cab be quite accurate
 - ❑ Available under GPL.
 - <http://tinynos.cvs.sourceforge.net/tinynos/tinynos-2.x-contrib/>
 - ❑ cedt folder
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