802.15.4 and ZigBee Routing Simulation

at Samsung/CUNY

Contents

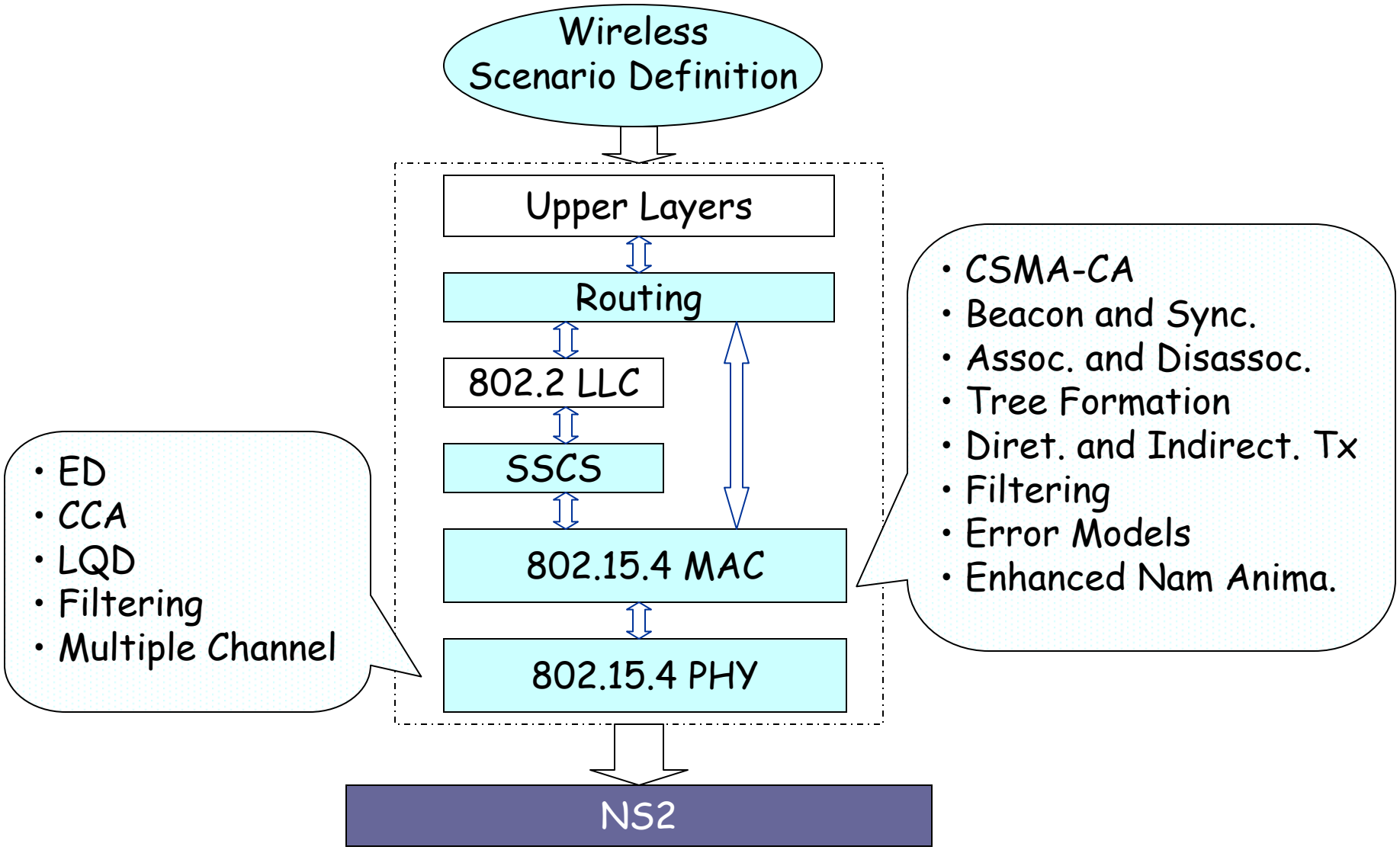
LRWPAN - Introduction

- Basic
  - Version: P802.15.4/D18
  - Simulation Platform: NS 2.26 or above
- Code Size
  - C++ Source Codes: 12k lines
  - Tcl Scripts: 500 lines
- Functionality
  - Pure CSMA-CA and Slotted CSMA-CA
  - Legacy application support (802.11b compatible)
  - Star and Peer-to-Peer topologies
  - Beacon enabled and non-beacon enabled modes
  - Beacon tracking and synchronization

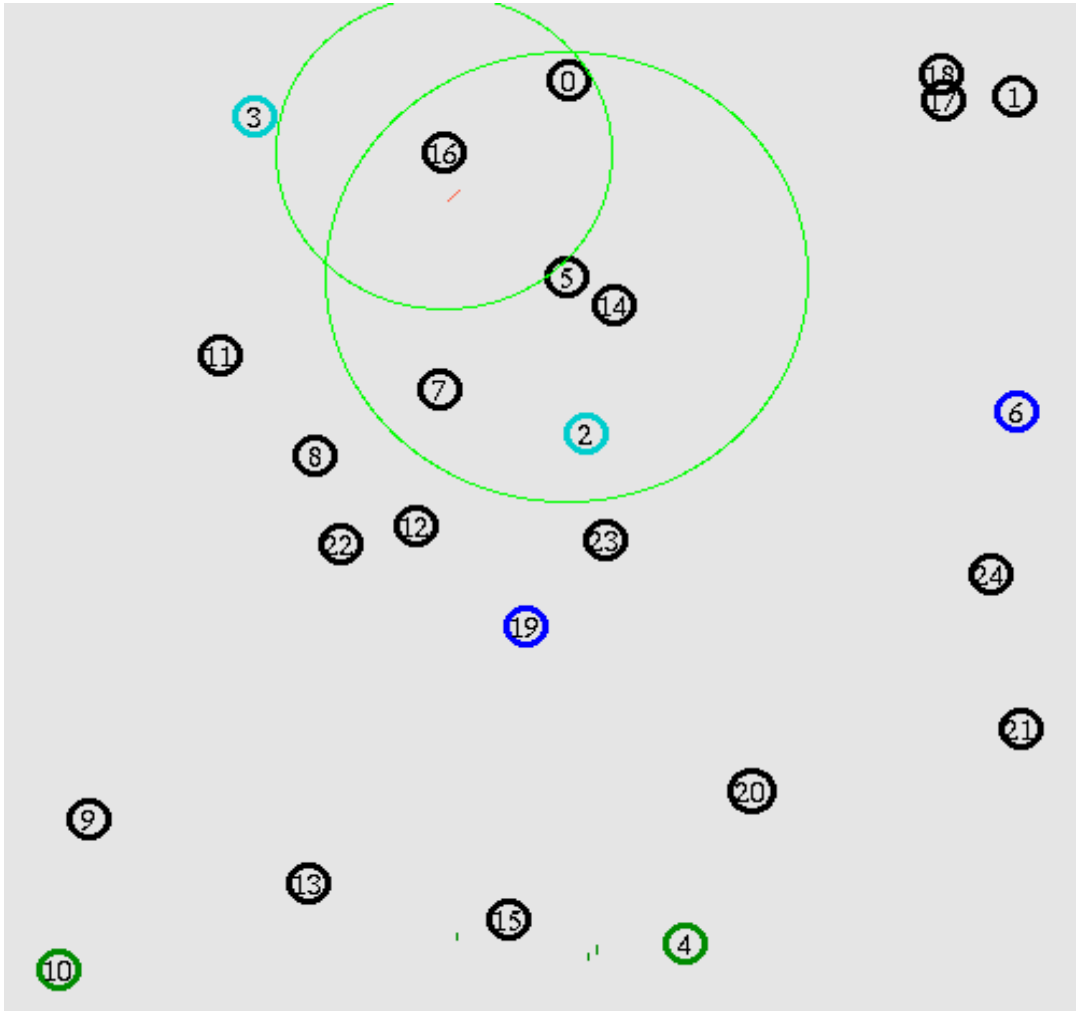
LRWPAN - Introduction (cont.)

- Functionality (cont.)
  - Association and Disassociation
  - Peer-to-Peer Tree and Cluster Tree Formation
  - Direct and Indirect (data polling and extraction) transmissions
  - Energy Detection (ED)
  - Clear Channel Assessment (CCA)
  - Link Quality Detection (LQD)
  - Multiple channel support
  - Channel Scan (ED/Active/Passive/Orphan)
  - Filtering (channel, beacon, duplication, interference, etc.)
  - Simulation Tracing
  - Deterministic Error Models (Node/Link)
  - Enhanced Nam Animation

LRWPAN - Function Modules



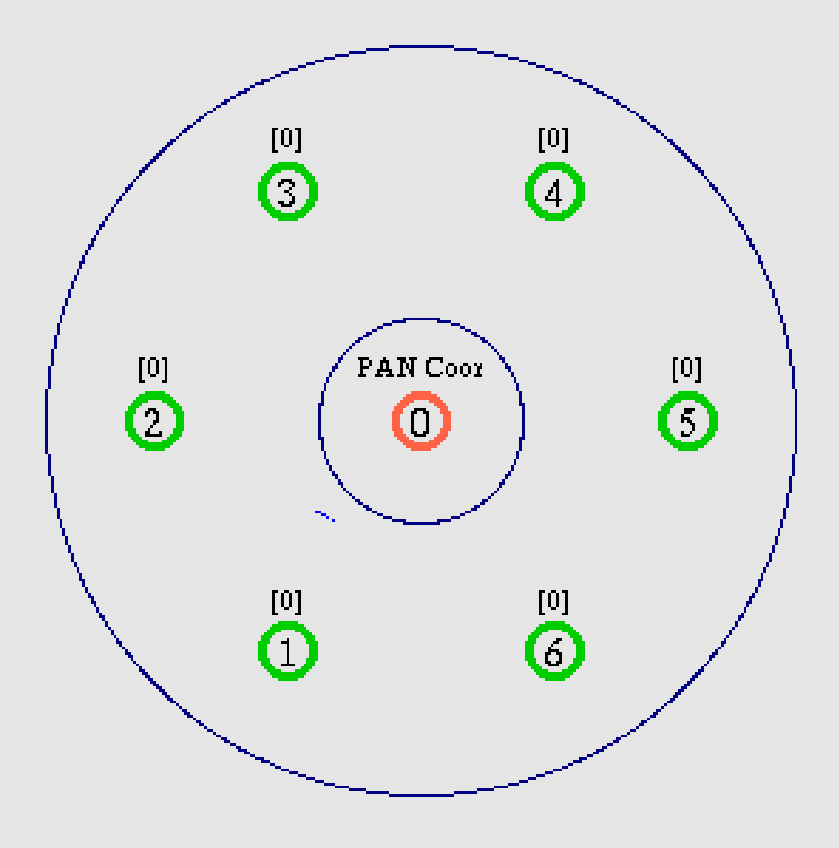
LRWPAN – Demo1: AODV over LRWPAN



Scenario Snapshot

- # of nodes: 25
- Area: 50 x 50 m^2
- Traffic Type:
  FTP/CBR/Poisson
- Traffic Flow:
  19 → 6
  10 → 4
  3 → 2
- Tx Range: 15m
- Duration: 900 sec

LRWPAN – Demo2: Beacon Enabled Star

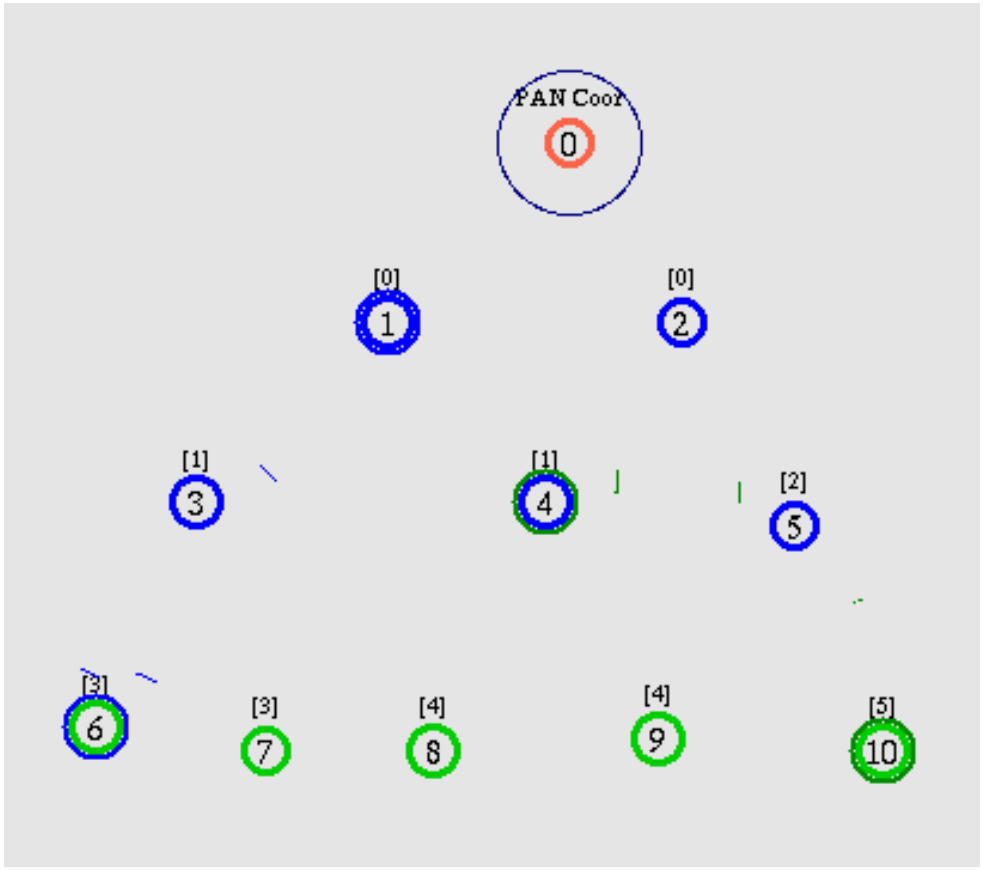


Scenario Snapshot

- # of nodes: 7
- Area: 50 x 50 m^2
- Neighbor distance: ~10 m
- Traffic: FTP/CBR/Poisson
- Tx Range: 15 m
- Duration: 900 sec
- Beacon mode: Enabled
  - -- Beacon Order: 3
  - -- Superframe Order: 3

PAN Coord Device

LRWPAN – Demo3: Beacon Enabled Tree



Scenario Snapshot

- # of nodes: 11
  - -- PAN Coord: 1
  - -- Coord: 5
  - -- Devices: 5
- Area: 50 x 50 m^2
- Neighbor distance: ~10 m
- Traffic: FTP/CBR/Poisson
- Tx Range: 15 m
- Duration: 900 sec
- Beacon mode: Enabled
  - -- Beacon Order: 3
  - -- Superframe Order: 3
- Data Tx: direct and indirect

PAN Coord. Coord. Device

LRWPAN – Commands Lookup Table

SSCS Interface

- $node sscs startPANCoord <txBeacon = 1> <beaconOrder = 3> <SuperframeOrder = 3>
  - This command can be used to start a new PAN, and the corresponding node will serve as the PAN coordinator.
  - If some parameters are omitted, the default values shown above will be assumed.
  - Examples:
    - $node_(0) sscs startPANCoord
    - $node_(0) sscs startPANCoord 1 2 2
- $node sscs startDevice <isFFD = 1> <assoPermit = 1> <txBeacon = 0> <beaconOrder = 3> <SuperframeOrder = 3>
  - This Command can be used to start a device or coordinator.
  - If some parameters are omitted, the default values shown above will be assumed.
  - Examples:
    - $node_(0) sscs startDevice 0 //device
    - $node_(0) sscs startDevice //coor., non-beacon
    - $node_(0) sscs startDevice 1 1 1 //coor., beacon enabled

LRWPAN – Commands Lookup Table (cont.)

SSCS Interface (Cont.)

- $node sscs startCTPANCoord <txBeacon = 1> <beaconOrder = 3> <SuperframeOrder = 3>
  - Similar to “startPANCoord”, except it is used to start a Cluster Tree based PAN.
- $node sscs startCTDevice <isFFD = 1> <assoPermit = 1> <txBeacon = 0> <beaconOrder = 3> <SuperframeOrder = 3>
  - Similar to “startDevice”, except it is used to start a Device in a Cluster Tree based PAN.
- $node sscs startBeacon <beaconOrder = 3> <SuperframeOrder = 3>
  - Start to transmit beacons if originally in non-beacon mode, or change the beacon order and superframe order if originally in beacon mode.
- $node sscs stopBeacon
  - Stop the transmission of beacons

LRWPAN – Commands Lookup Table (cont.)

Nam Animation Interface

- Mac/802_15_4 wpanNam namStatus [on/off]
  - Turn on/off the Nam animation enhancement
  - Default: off
- Mac/802_15_4 wpanNam emHandling [on/off]
  - Turn on/off special handling for energy model
  - Default: on
- Mac/802_15_4 wpanNam PANCoorClr [clrName]
  - Set PAN coordinator color
  - Example:
    - Mac/802_15_4 wpanNam PANCoorClr tomato
- Mac/802_15_4 wpanNam CoorClr [clrName]
  - Set the coordinator color
  - Example:
    - Mac/802_15_4 wpanNam CoorClr blue
- Mac/802_15_4 wpanNam DevClr [clrName]
  - Set the device color
  - Example:
    - Mac/802_15_4 wpanNam DevClr green

LRWPAN – Commands Lookup Table (cont.)

Nam Animation Interface (cont.)

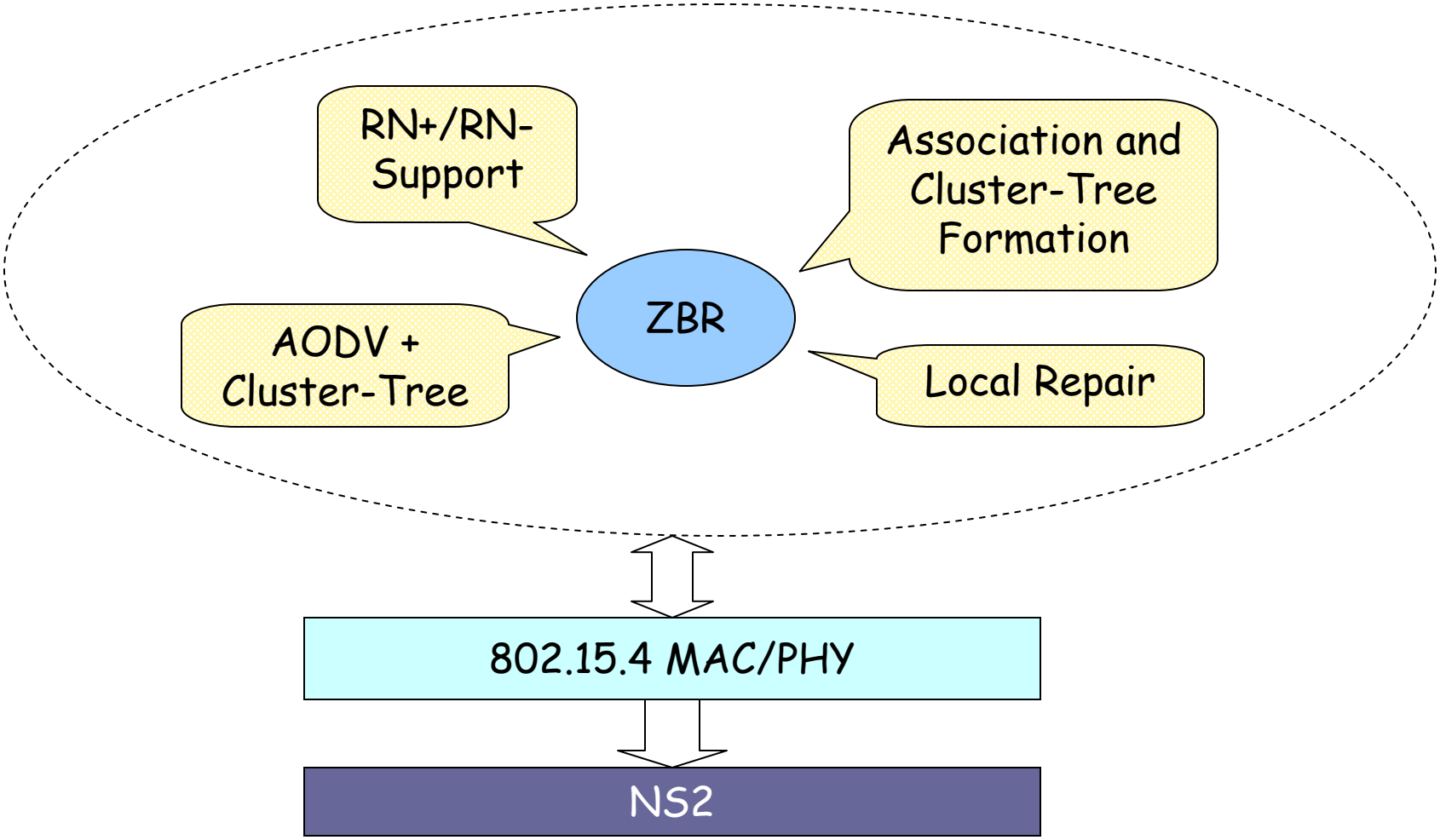
- Mac/802_15_4 wpanNam ColFlashClr [clrName]
  - Set collision flash color
- Mac/802_15_4 wpanNam NodeFailClr [clrName]
  - Set Node failure color
- Mac/802_15_4 wpanNam PlaybackRate [step]
  - Set Nam playback rate
  - Examples:
    - Mac/802_15_4 wpanNam PlaybackRate 2ms
    - Mac/802_15_4 wpanNam PlaybackRate 0.18ms
- Mac/802_15_4 wpanNam FlowClr [-p <packet_type_name>] [-s <src>] [-d <dst>] [-c <clrName>]
  - Set flow color; you can define what type of packets and what are the source and destination
  - Examples:
    - Mac/802_15_4 wpanNam FlowClr –p tcp –s 0 –d 3 –c green
    - Mac/802_15_4 wpanNam FlowClr –p exp –s 0 –d -1 –c blue
    - Mac/802_15_4 wpanNam FlowClr –p AODV –c red

LRWPAN – Commands Lookup Table (cont.)

Miscellaneous Interface

- Mac/802_15_4 wpanCmd verbose [on/off]
  - Run simulation in verbose mode or non-verbose mode;
  - Default: off
- Mac/802_15_4 wpanCmd ack4data [on/off]
  - MAC level acknowledgement for upper layer packets
  - Default: on
- Mac/802_15_4 wpanCmd link-down <src> <dst>
  - Bring down the link
- Mac/802_15_4 wpanCmd link-up <src> <dst>
  - Bring up the broken link
- $node node-down <node_addr>
  - Bring down the node
- $node node-up <node_addr>
  - Bring up the failed node
- $node RNType [1/0]
  - Set RN type; 1 = RN+; 0 = RN-
  - Default: RN+

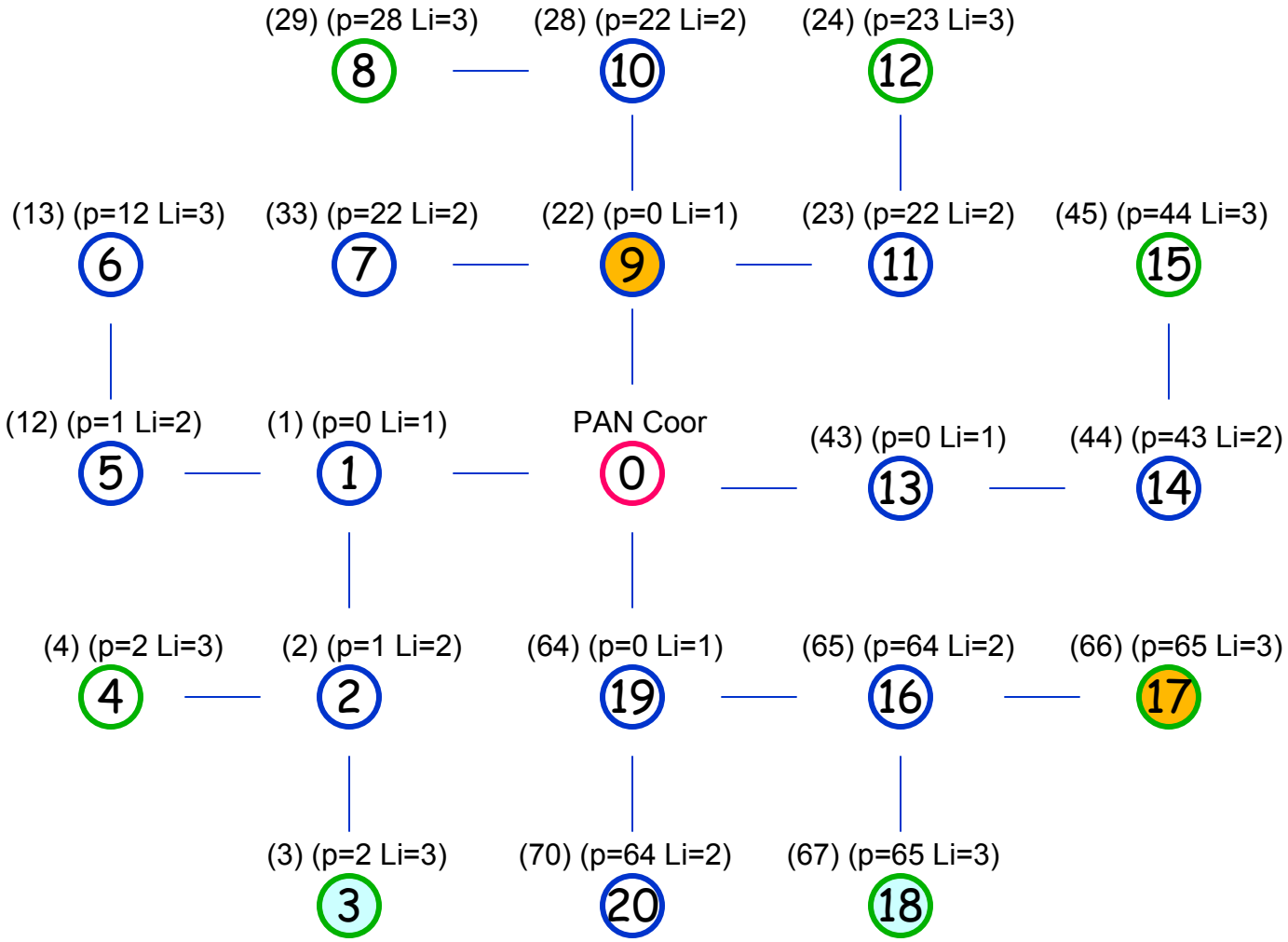
ZBR - Introduction



ZBR – Demo4: Setup

- # of nodes: 21
- Area: 50 x 50 m^2
- Traffic: CBR (5 pkts/sec) + Poisson (ave. 5 pkts/sec)
- Duration: 900 sec
- Neighbor Distance: 10 m
- Tx Range: 12 m
- Cluster-Tree Parameters
  - Cm: 4
  - Lm: 3
  - Block Size: 85
- Scenarios
  - All RN+
  - All RN-
  - 11 RN+ and 10 RN-

ZBR - Demo4: Setup (Cont.)

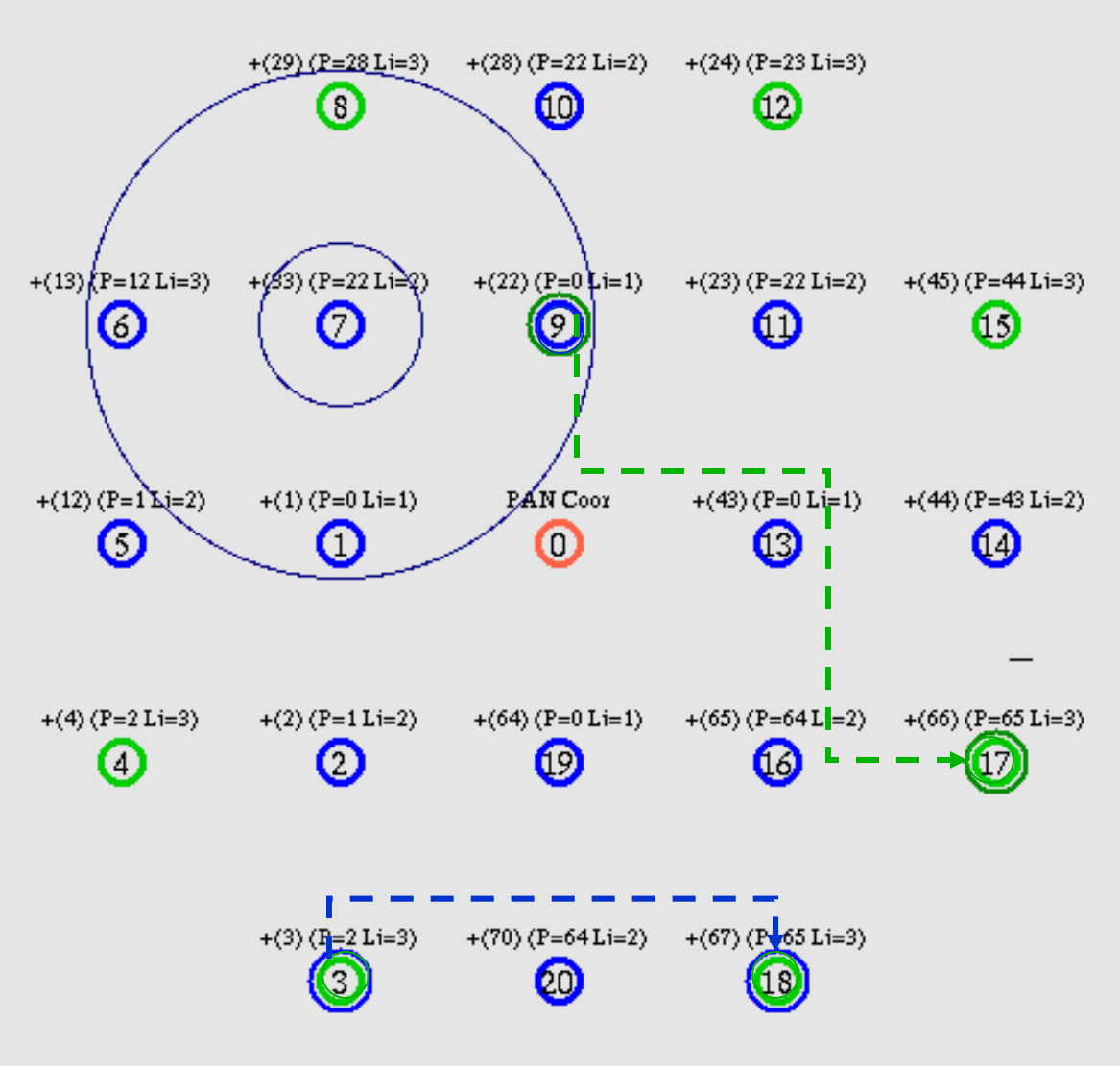


- PAN Coord.
- Coord.
- Device

Traffic

3 → 18: CBR
9 → 17: Poisson

ZBR – Demo4: All RN+



Scenario Snapshot

Traffic Flow:

3 → 18 CBR

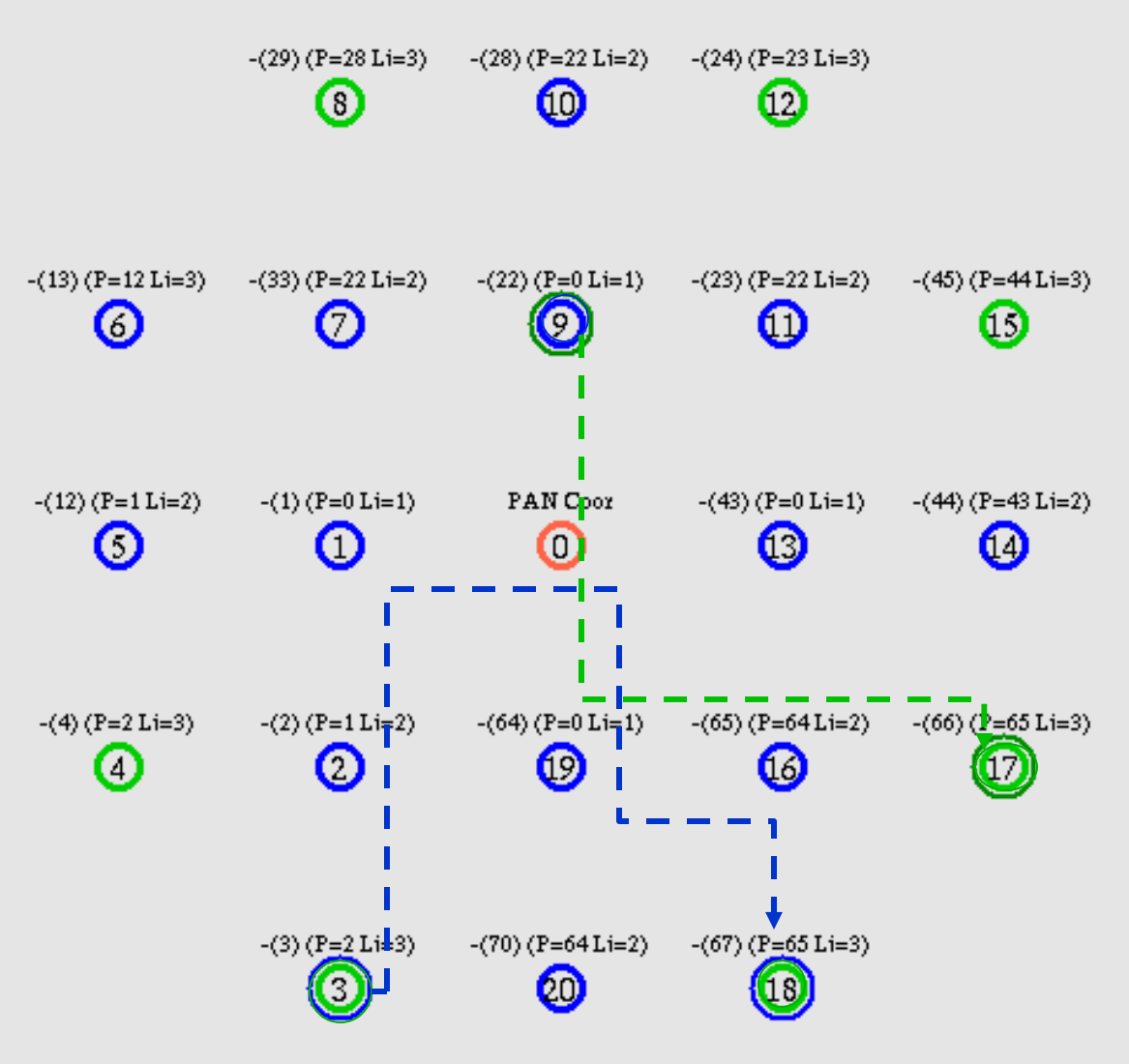
9 → 17 Poisson

Hop Count:

3 → 18: 2 hops

9 → 17: 4 hops

ZBR – Demo4: All RN-

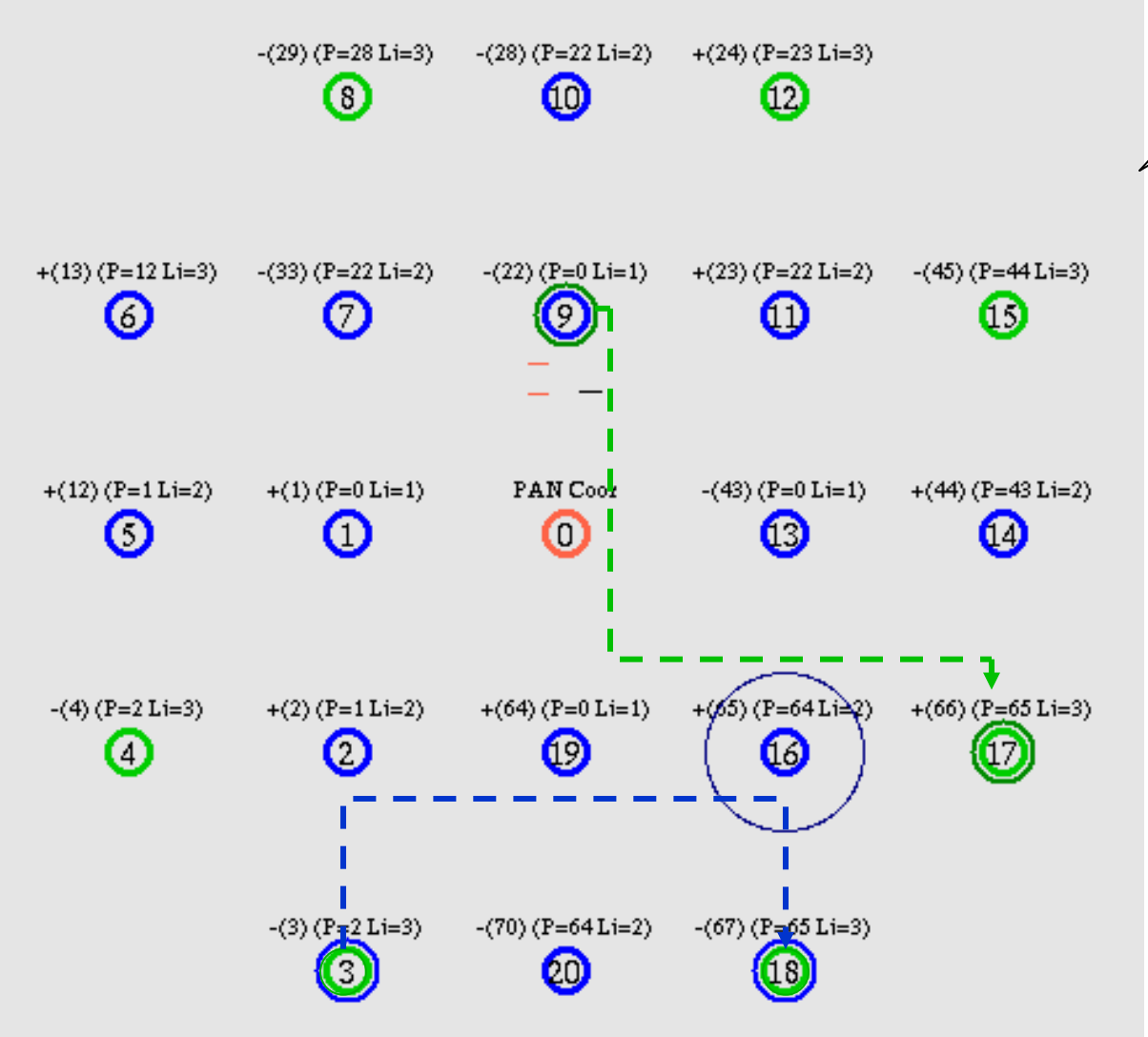


Scenario Snapshot

Traffic Flow:
3 → 18 CBR
9 → 17 Poisson

Hop Count:
3 → 18: 6 hops
9 → 17: 4 hops

ZBR – Demo4: 11 RN+ and 10 RN-



Scenario Snapshot

Traffic Flow:

3 → 18 CBR

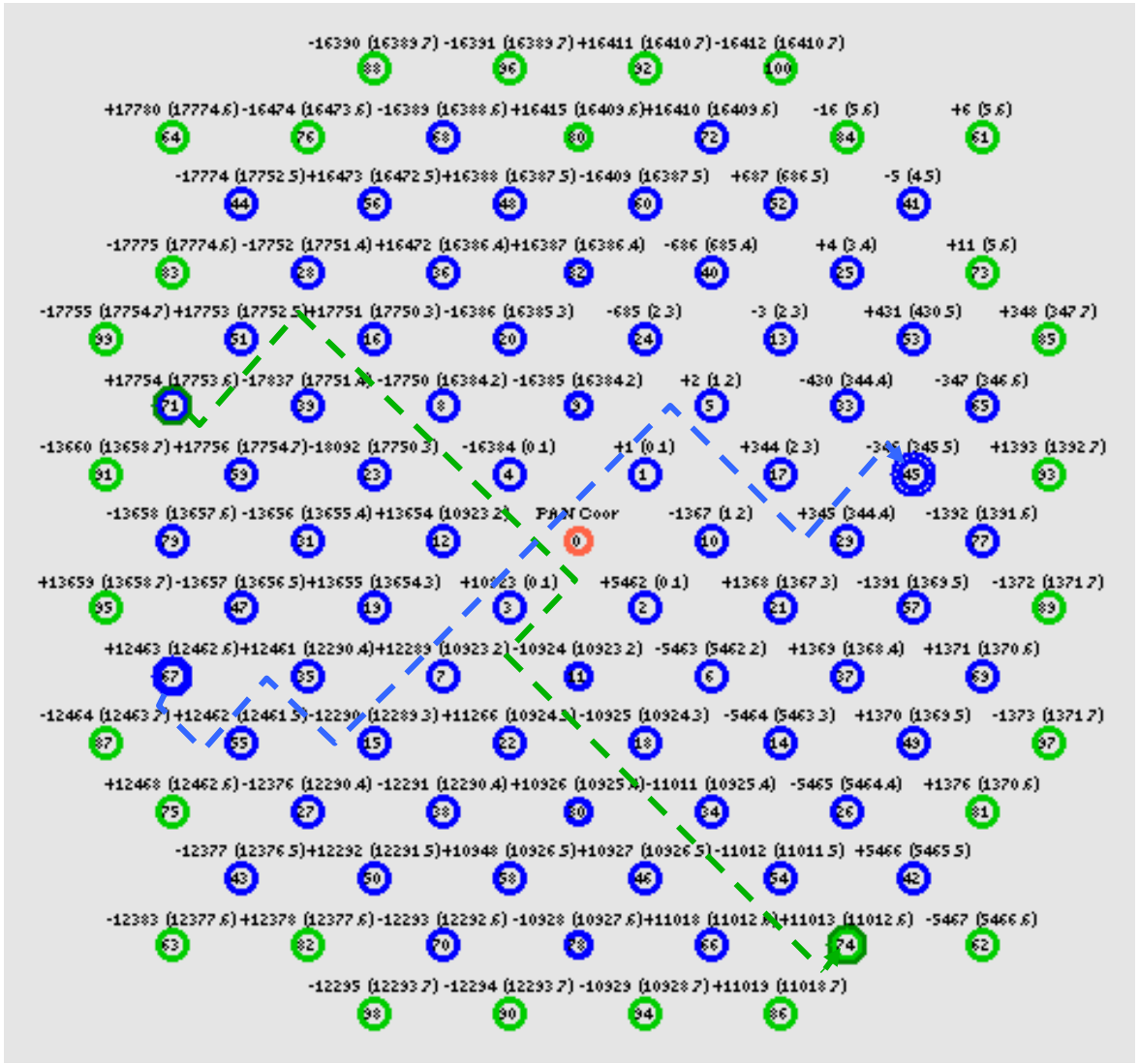
9 → 17 Poisson

Hop Count:

3 → 18: 4 hops

9 → 17: 4 hops

ZBR – Demo5: 49 RN+ and 52 RN-



Scenario Snapshot

- # of nodes: 101
- Area: 80 x 80 m^2
- Traffic Flow
  - 67→45: CBR
  - 71→74: Poisson
- Duration: 900 sec
- Nb. distance: ~7 m
- Tx Range: 9 m
- Cluster-Tree Para.
  - Cm: 4
  - Lm: 7

- PAN Coord.
- Coord.
- Device

ZBR – Commands Lookup Table

- Agent/ZBR Cm [Cm]
  - Set Cm or get Cm
- Agent/ZBR Lm [Lm]
  - Set Lm or get Lm
- Agent/ZBR BSize calc
  - Update the block size using Cm and Lm
  - Suitable for full block
- Agent/ZBR BSize [block_size]
  - Set block size or get block size
  - For non-full block, the block size cannot be calculated using Cm and Lm
- Agent/ZBR CSkip <Li>
  - Return CSkip for depth <Li>

Simulation Code Download

http://www-ee.ccny.cuny.edu/zheng/pub

(Contact: zheng@ee.ccny.cuny.edu)