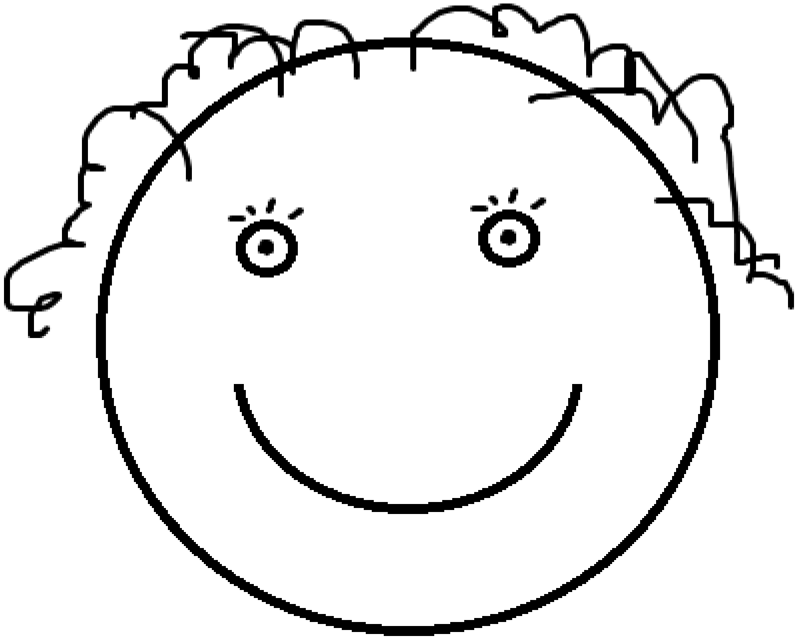
Low Resolution Radio Model for ns-3

Kirill Andreev, Pavel Boyko, Denis Fakhriev

{andreev, boyko, fakhriev}@telum.ru

High Resolution vs. Low Resolution



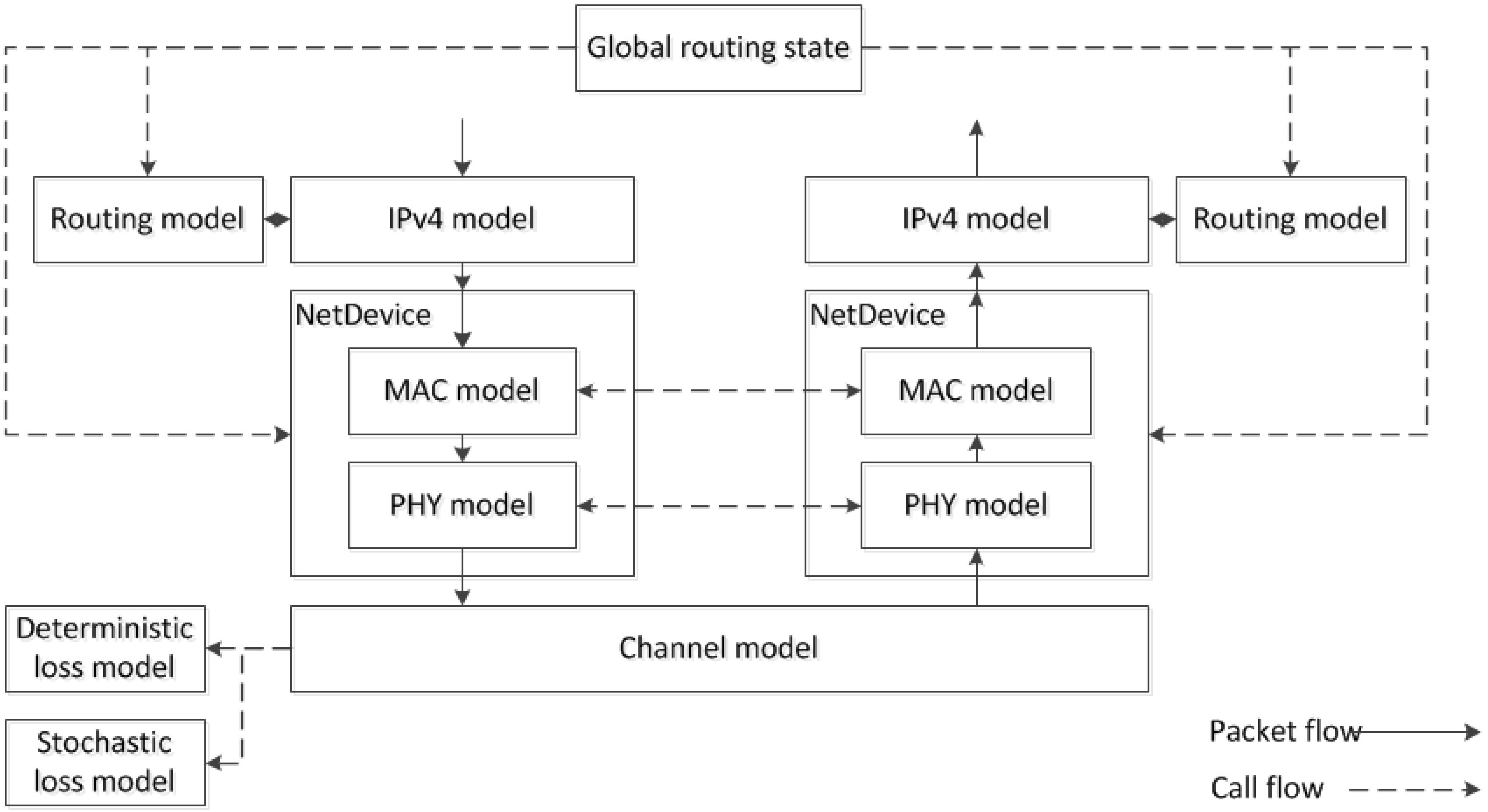
Low Resolution Radio (LRR) Model

- `NetDevice` and the corresponding `Channel` which can be used to model any time division packet radio technology
- Bonus: `Ipv4RoutingProtocol` which can be used to model any link state MANET routing (works only on top of the LRR devices)

Motivation

1. Details are unknown, yet
2. Details are unavailable
3. Need an “ideal” reference
4. Need to understand the assumptions (verify, validate and extend the model)
5. Need to understand the behavior
6. Simulation runtime & memory footprint

Model Overview



TELUM

Channel Assumptions & Model

Assumptions:

1. Channel gain is a function of the TX and RX positions, frequency and time.
2. Channel gain doesn't depend on frequency in the system spectrum band ("flat" channel)
3. Devices have identical isotropic antennas

Model:

$$G_{ch}(x, y, f, t) = \underbrace{G_D(x, y, f_C)}_{\text{deterministic}} + \underbrace{G_S(x, y, t)}_{\text{stochastic}}$$

where $\int G_S(t)dt = 0$

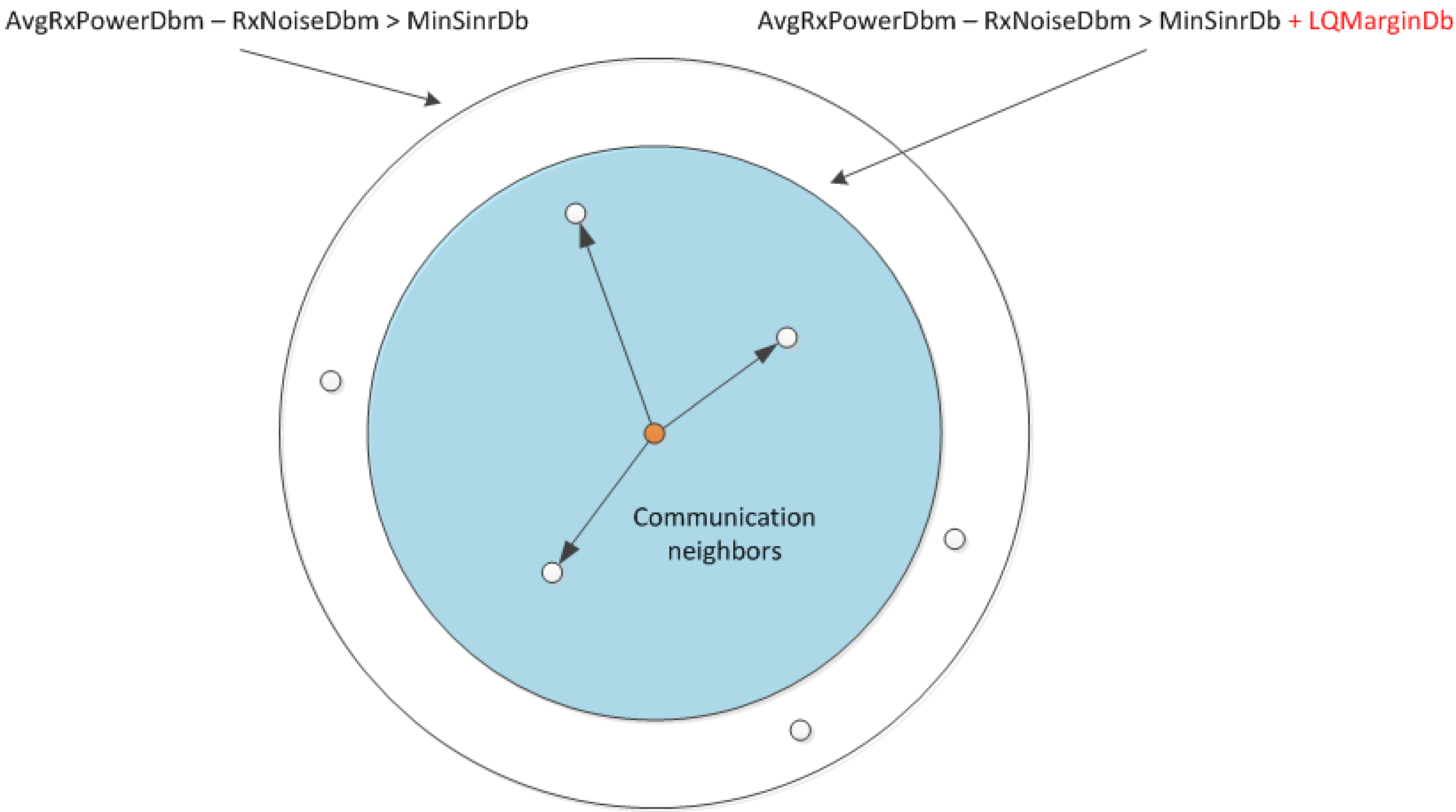
PHY Assumptions

1. RX noise = thermal noise + noise figure
2. Half duplex, states are {TX, RX, IDLE}
3. IDLE $\rightarrow$ RX transition is based on the energy detection threshold
4. Perfect RX synchronization is preserved until the end of a packet
5. Devices use fixed modulation and coding scheme
6. Devices have identical fixed TX power
7. Successful packet reception is based on the SINR threshold
8. There are several independent frequency channels

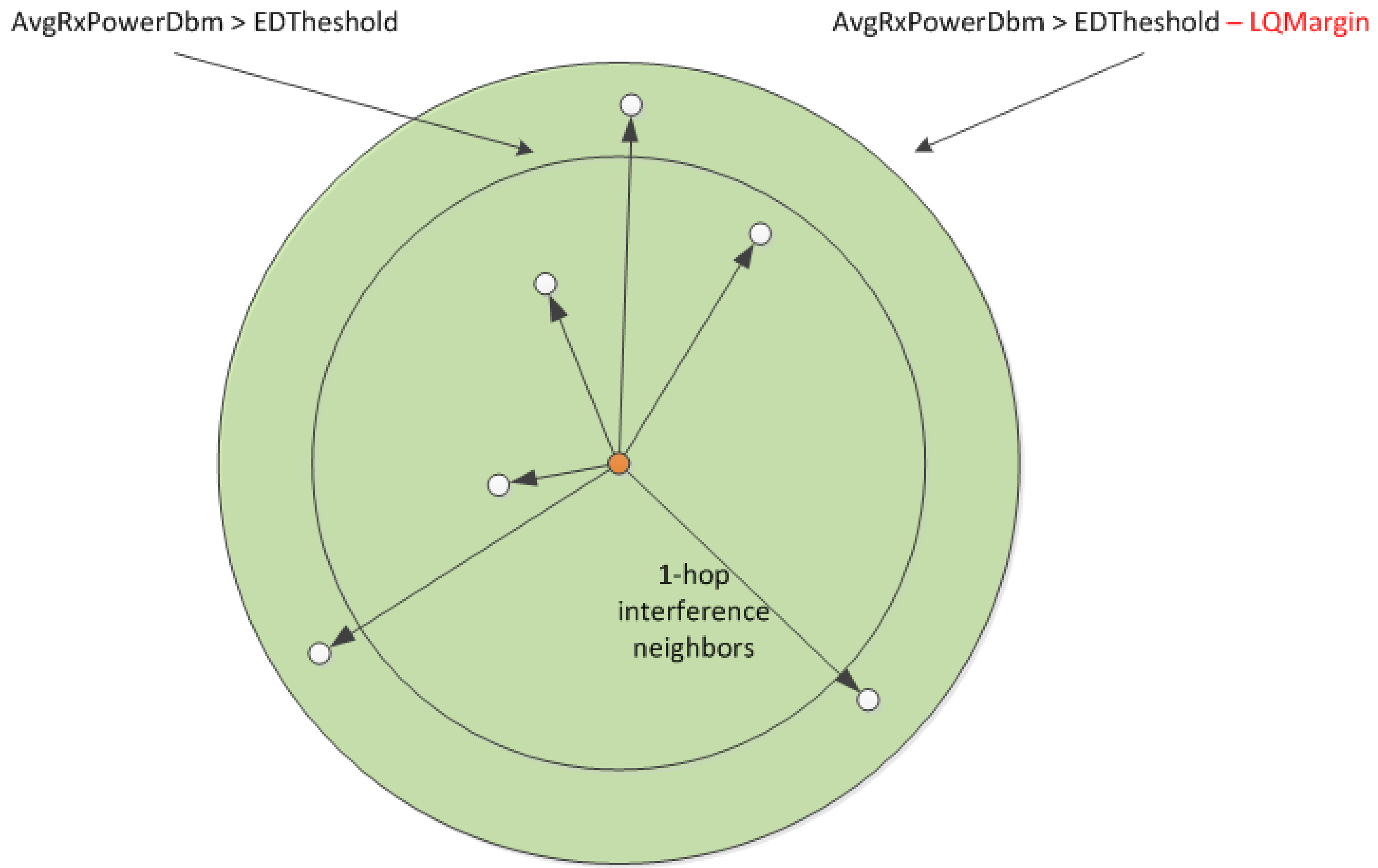
PHY Model Functions

- Send and receive packets – straightforward, `HalfDuplexIdealPhy` reused
- Periodically update:
  - the *communication neighbors* list for routing
  - the *interference neighbors* list for MAC

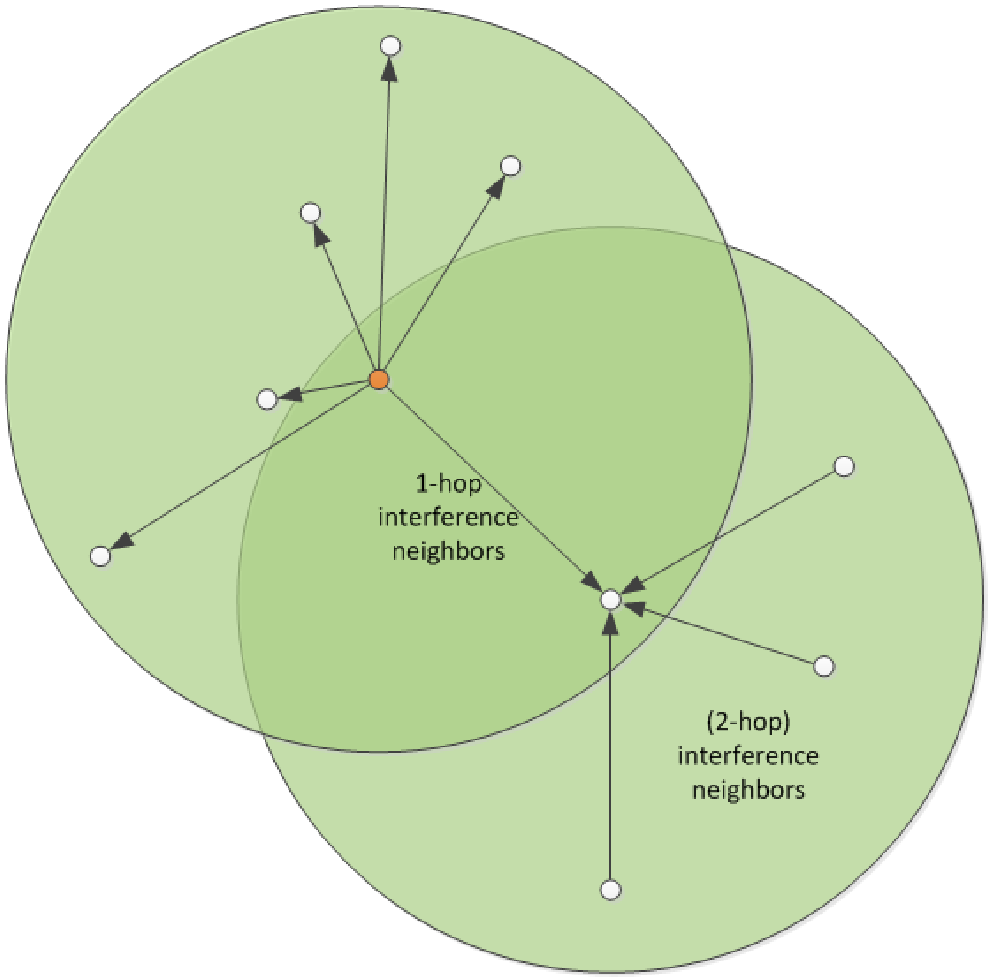
Communication neighbors can hear me



One hop interference neighbors can sync on me



Interference neighbors can interrupt me



TELUM

MAC Assumptions

1. TDMA
2. MAC level control traffic is not modeled
3. MAC completely avoids collisions
4. ARQ is not modeled
5. Link layer segmentation is not modeled
6. MAC header has known fixed size
7. MAC uses 48-bit address space
8. There is a known fixed time interval ("a guard") between two consecutive transmitted packets

TELUM

MAC Model

Schedule a packet after all scheduled packets of all interference neighbors (if any):

$TxStart(u) = \max_{v} TxEnd(v) + GuardInterval$ or now,

where $v \in InterferenceNeighbors(u)$;

$TxEnd(u) = TxStart(u) + size/bitrate$

Routing Assumptions

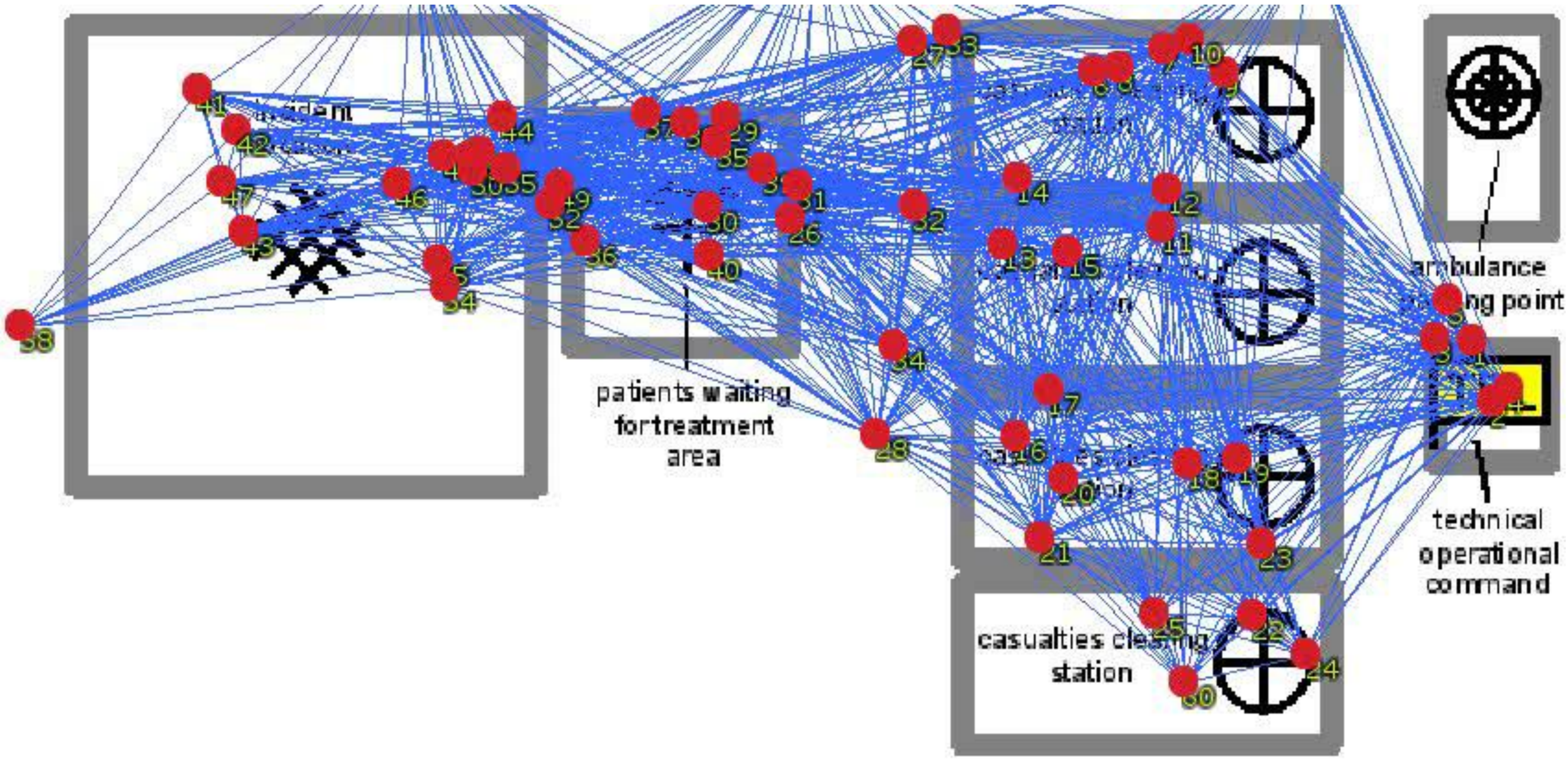
1. IPv4
2. Unicast and multicast destinations
3. Proactive link state routing
4. All nodes have the same network topology representation
5. Routing control traffic is not modeled
6. Hop count metric
7. Unicast and multicast destinations

Routing Model

Periodically:

1. Update global topology graph using communication neighbors lists from all LRR devices. If topology haven't changed skip steps 2 and 3.
2. Solve all-to-all shortest path (Floyd-Warshall) and populate unicast routing tables.
3. For every known node of every known multicast group build an SP tree and populate multicast routing tables.

Case Study: Video Over MANET



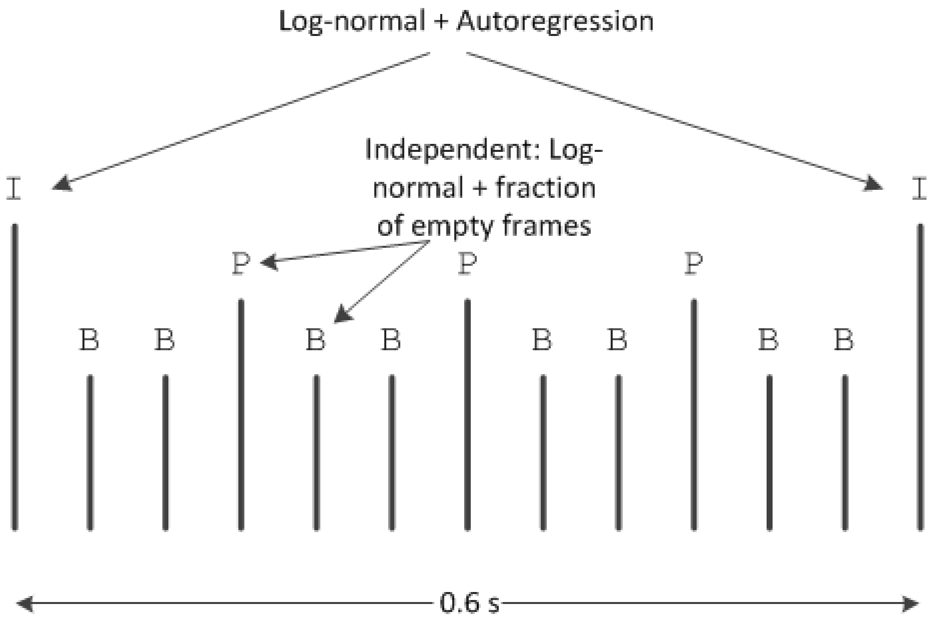
Nils Aschenbruck et. al. Modeling mobility in disaster area scenarios

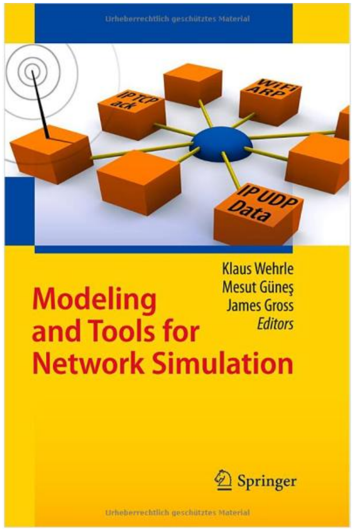
100m

Video Stream Model

- Autoregressive model of a particular real MPEG4 177x144@20Hz video stream
- Stream structure:

Reference





Simulation Results

Device	Routing	Average PDR	Average delay	Runtime	Memory
LRR	LRR	97.9%	7.7 ms	348 s	6.4 MB
LRR	OLSR	97.3%	72 ms	3314 s	23 MB
Wi-Fi	OLSR	64.8%	209 ms	1572 s	23 MB

Summary

- We designed, implemented and verified the low resolution radio model which can be used to model any TDM packet radio technology in ns-3 (but don't forget to validate the model for a particular application)
- The source code is available, the model is simple to use, understand and extend
- Bonus: MANET routing model and the case study example with the video stream application model

Check the code here

http://codereview.appspot.com/5466046