Active Signaling for 802.11 Networks in the ns-3 Simulator

Hana Baccouch, Cedric Adjih, Paul Muhlethaler

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General context

MobSim project

- Goal : To develop an integrated simulation platform for mobile wireless networks
- Three Inria teams are involved in this project : Hipercom from Paris, Planete from Sophia-Antipolis and SOCRATE based at Lyon.
- Our main activities :
  - Implementing and evaluating routing protocols for mobile networks in the ns-3 simulator
  - Implementation of “Active signaling ” medium access mechanism for 802.11 networks and evaluate its performances
  - Amelioration of existing physical layer implementations in ns-3 simulator

Motivations and goal

Ey-Wifi : implementation of EY-NPMA in the ns-3 simulator for 802.11 networks

- EY-NPMA : a deterministic priority channel access scheme for QoS support
- Few suitable simulation environments for EY-NPMA protocol
- ns-3 is a recently released simulator intended to replace ns-2
- The existing library of modules (routing protocols, mobility models, physical layer) make ns-3 well suited for simulating wireless networks

Outline

1. ns-3 simulator
2. EY-NPMA medium access protocol
3. IEEE 802.11 for ns-3
4. EY-Wifi for ns-3
5. Conclusion

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1 ns-3 simulator

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Overview of ns-3

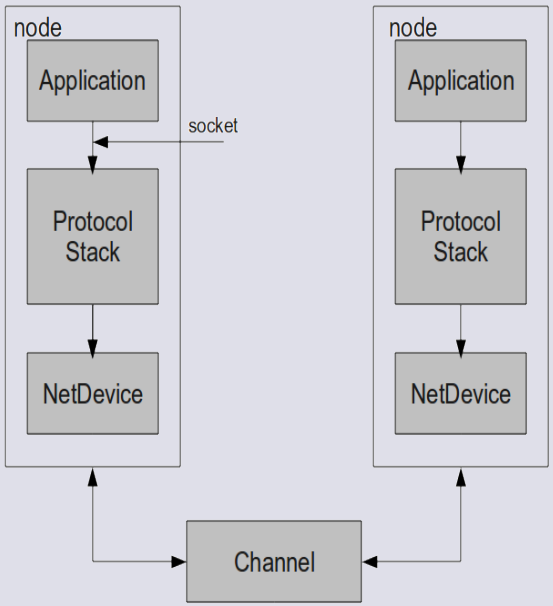
- Network simulator open source, distributed under GNU GPLv2 license
  - Based on YANS (Yet Another Simulator), which was developed par Mathieu Lacage (Inria - Sophia Antipolis)
- Written in C++
- Bindings in Python
- Build system : waf
- Simulation scripts can be written in C++ or Python

Overview of ns-3

Architecture

Key Objects :

- Node : a network element, to which Application and NetDevices can be added
- Application : a packet generator and consumer which can run on a Node and talk to a set of network stacks
- NetDevice : a network card which can be plugged in an IO interface of a Node
- Channel : a physical connector between a set of NetDevice objects



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Hiperlan (High Performance Local Area Network Type 1)

- A standard for WLANs, defined by ETSI (European Telecommunications Standards Institute)
- Hipercom members $\subset$ European project LAURA
- EY-NPMA is the medium access mechanism used by Hiperlan 1 : ”Active signaling”
  - Burst transmission to notify contending nodes of its presence.

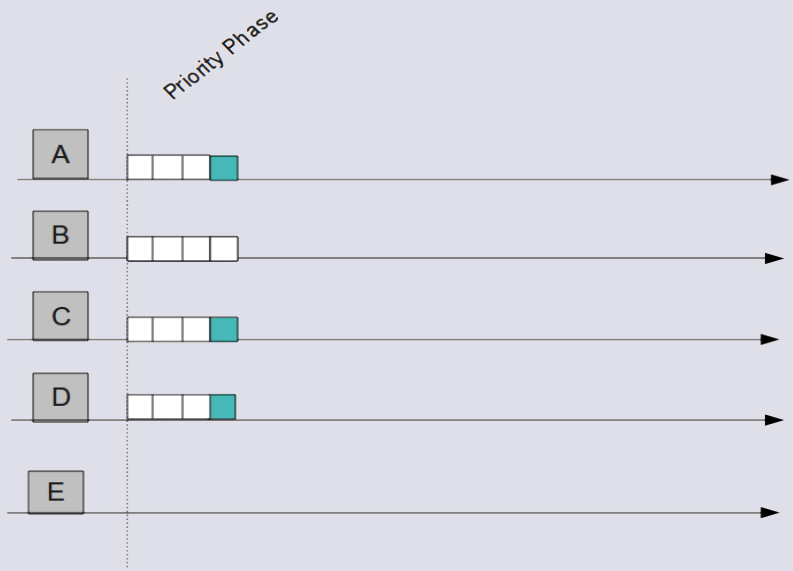
Advantages

- Low collision rates
- Support for Quality of Service (QoS)
- More deterministic

EY-NPMA (Elimination Yield-Non Preemptive Multiple Access)

Priority phase

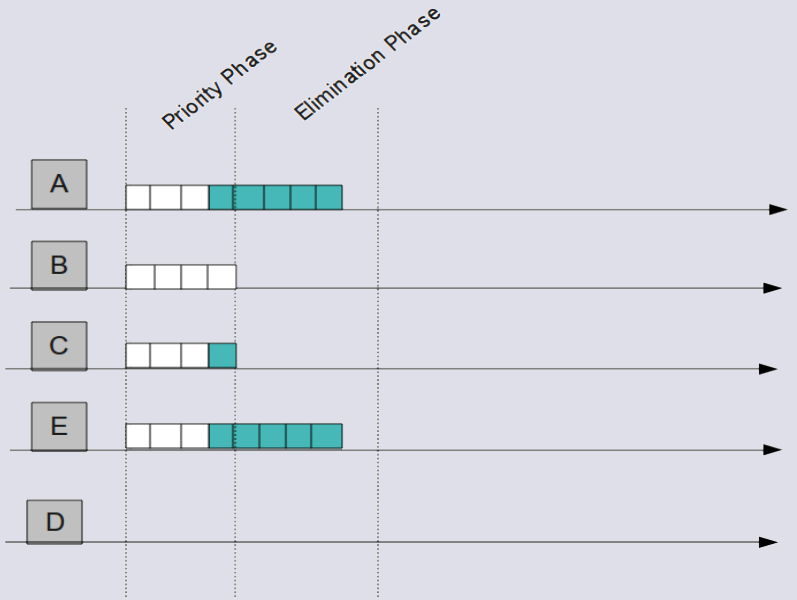
- Each node listens to the channel during idle slots according to the priority (five priorities from 0 to 4).
- If it detects a signal during this period, it defers until the next cycle.
- If the channel remains idle, it sends an assertion slot and enter the elimination phase.



EY-NPMA (Elimination Yield-Non Preemptive Multiple Access)

Elimination phase

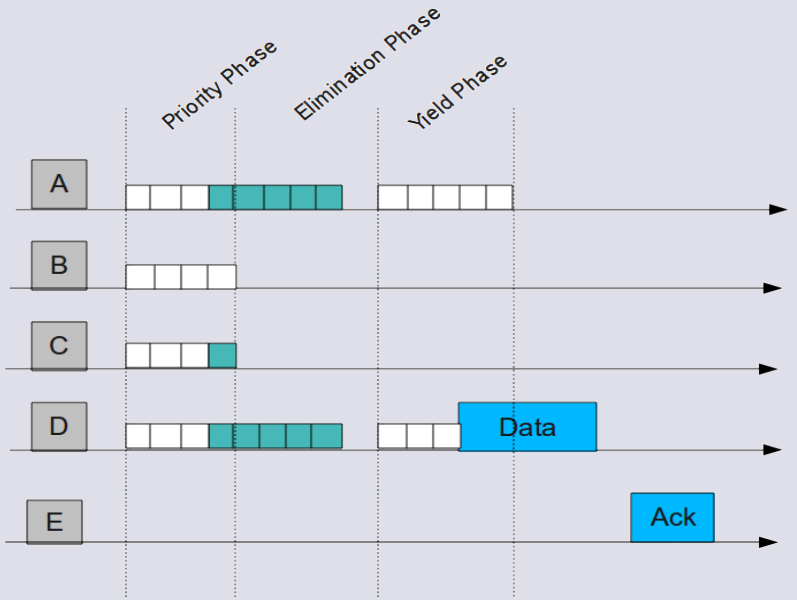
- Nodes send an elimination burst of a random length (between 0 and 12).
- After transmitting the burst, the node senses the channel.
- If the channel remains idle, node goes to next phase. Else, it quits contention.



EY-NPMA (Elimination Yield-Non Preemptive Multiple Access)

Yield phase

- Nodes listen to channel during the yield period (between 0 and 9 slots)
- Node having smallest yield period is the winner, it starts transmission
- Others nodes detect its transmission, and quit the contention
- This phase is equivalent to Backoff algorithm



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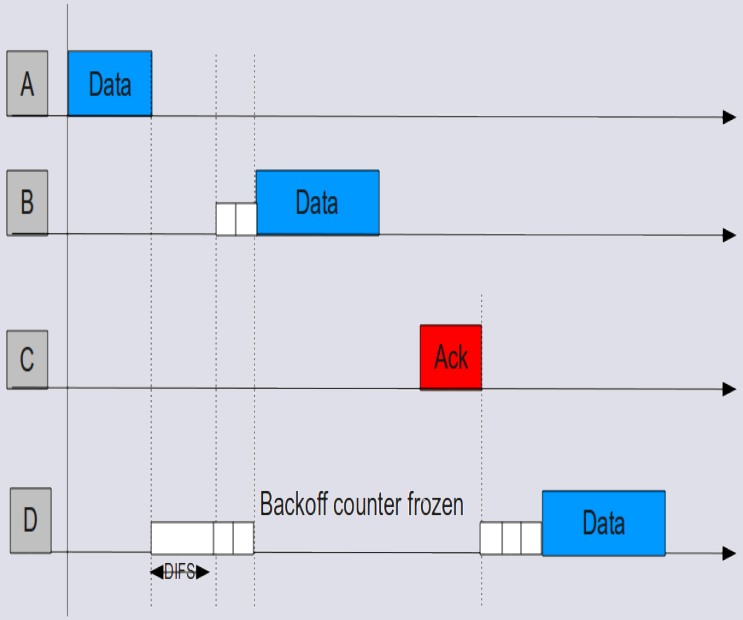
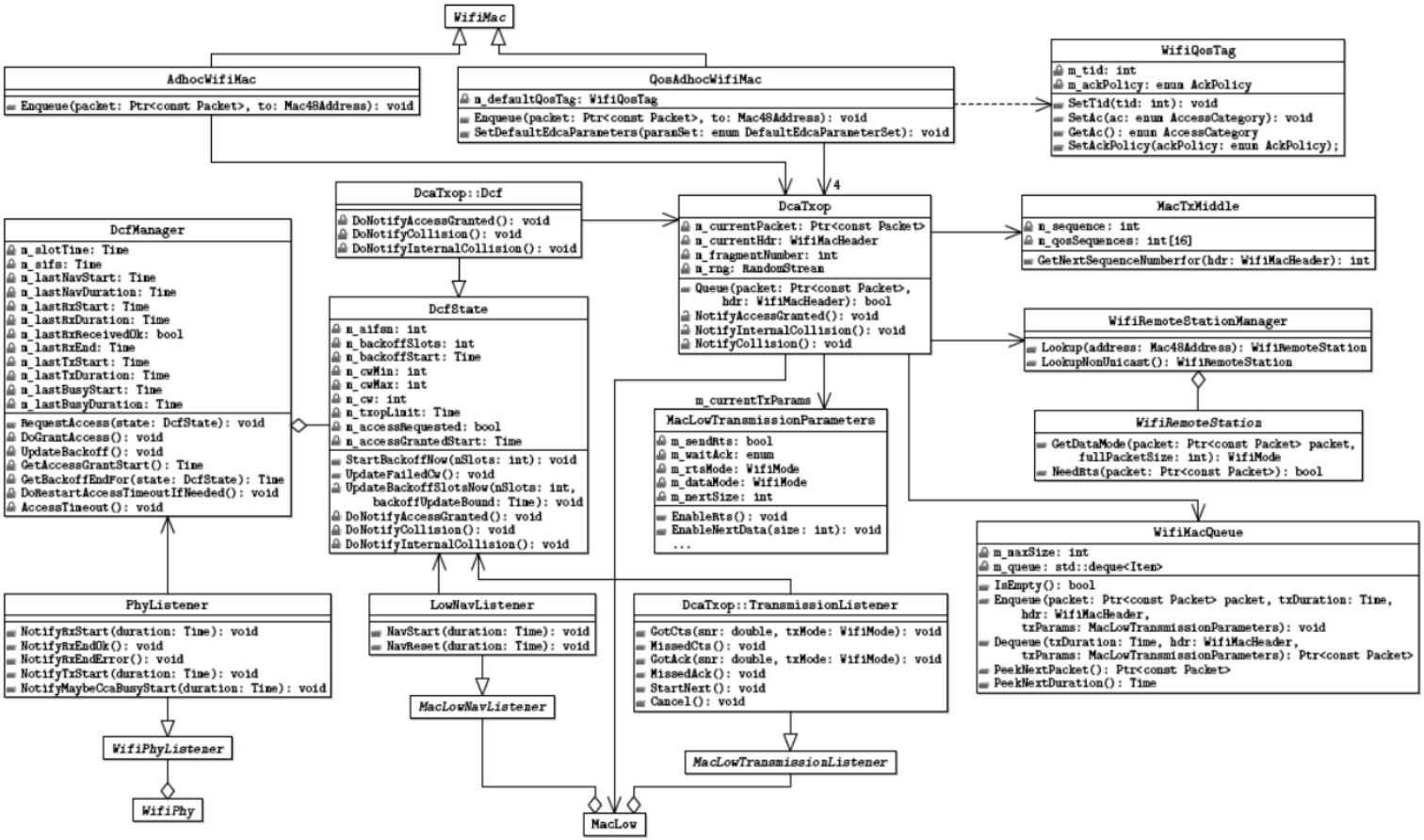
DCF access mechanism

Distributed coordination function (DCF)

- At the end of transmission, contending nodes must wait for a DIFS(DCF Interframe Space)
- Nodes waits for a Backoff before starting transmission.
- If the channel stills idle, the node sends its packet. Else, Backoff counter decrementing is stopped until channel becomes idle again.



Architecture of IEEE 802.11 module

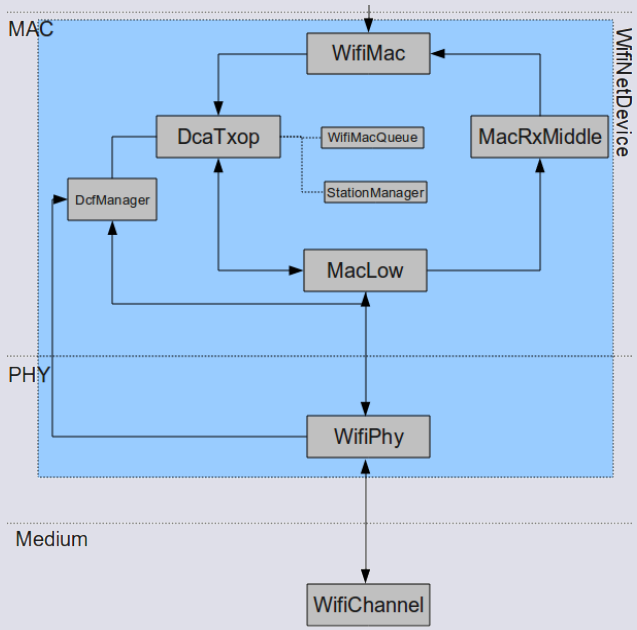


Ref : T. Bingmann. Accuracy Enhancements of the 802.11 Model and EDCA QoS Extensions in ns-3. PhD thesis, University of Karlsruhe.

Modification of 802.11 module

802.11 sous ns-3

- DcfManager implements Dcf access mechanism (Backoff, Nav ..)
- DcaTxop handles channel access (Granted access, collision ..)
- DcaTxop uses MacLow to transmit packets
- DcfState keeps track (Backoff, CW ..) of the state needed for a Dcf function
  → Modify ONLY Mac layer classes



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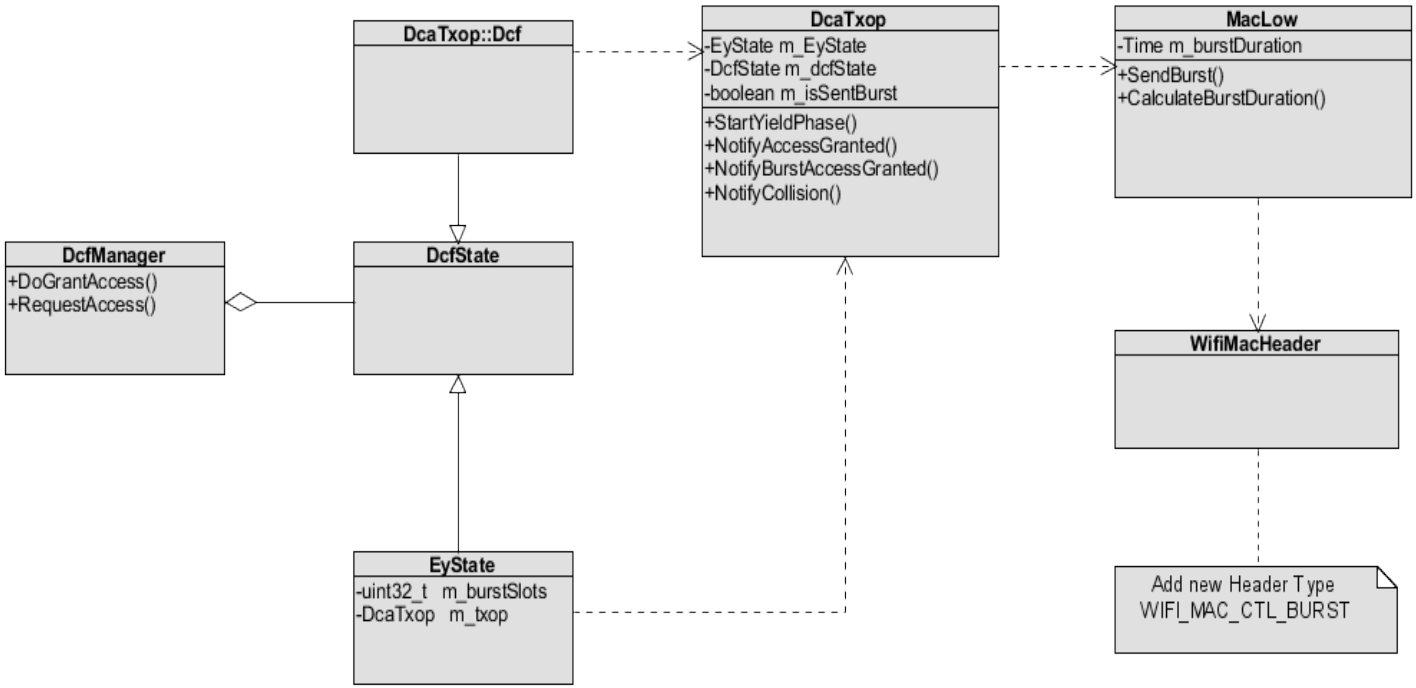
EY-Wifi modeling for ns-3

- Yield phase and data transmission phase in EY-NPMA are equivalent to Backoff countdown and grant access.
- Extra feature of EY-NPMA is Elimination phase.
- The idea is to :
  - Create a “new State” which handles the elimination phase : Ey-State (for Elimination-Yield State)
  - Aggregate two “States” for each packet
    - EyState to handle burst transmission
    - DcfState which handles data transmission

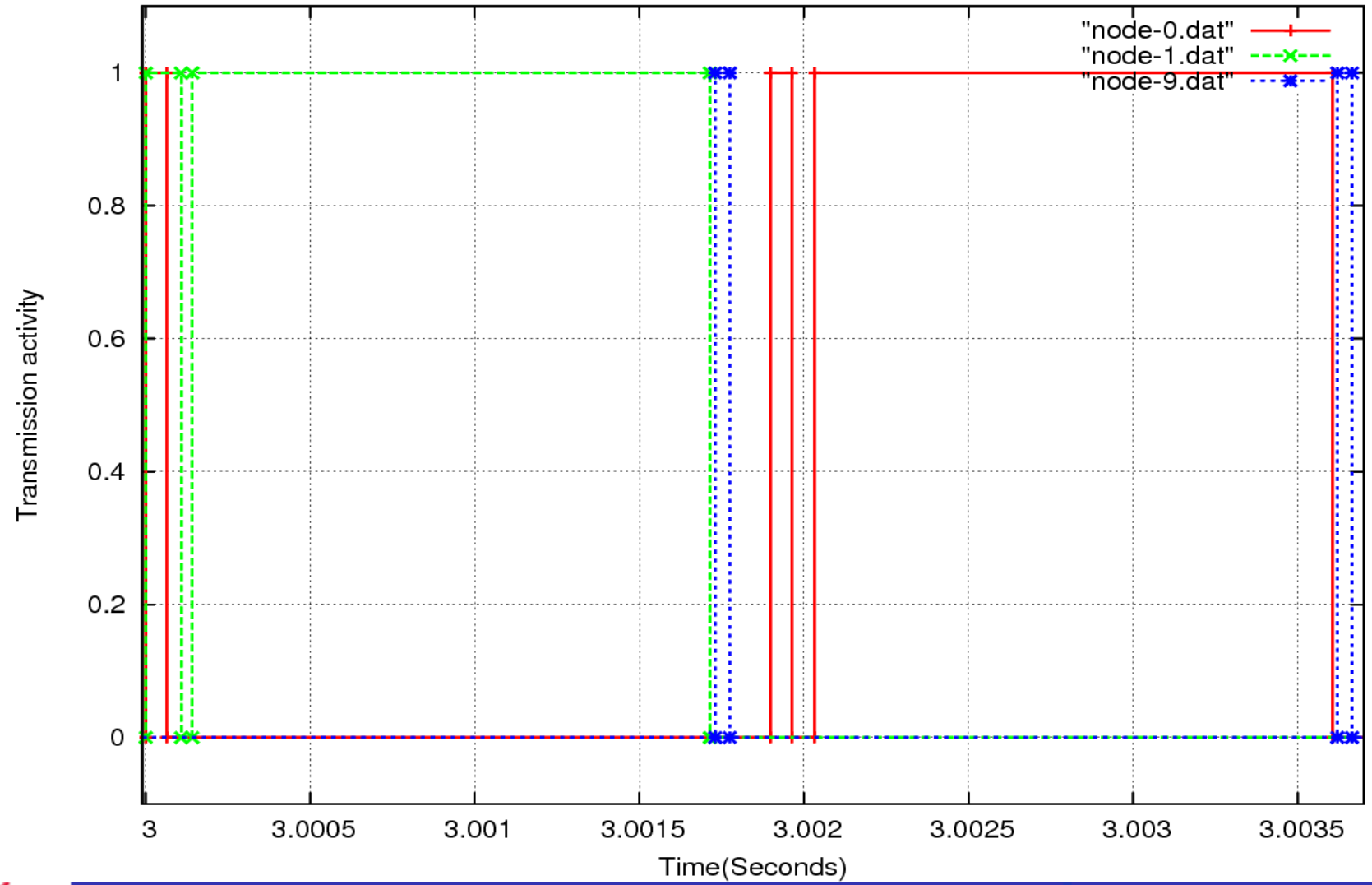
UML Diagram of EY-NPMA related classes



Scenario example

- EY-NPMA was implemented as MAC protocol in ns-3.
- 10 nodes distant of 5 meter.
- Nodes 0 and 1 send UDP packet to node 9 with an interval of 1 Second.
- Physical Layer at 6Mbps.
- Packet size is 1096 bytes.

Illustration



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EY-Wifi : an EY-NPMA module for ns-3 simulator

- Implements different phases of EY-NPMA protocol
- Enables tracing, emulation and implementation of new scenarios

Future works :

- Scientific tests to evaluate this approach
- Performance study of EY-NPMA

Questions ?