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A new approach to simulating PHY, MAC and Routing

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Channel and PHY issues in network simulation

- Accurate channel and PHY modeling
- Easy prototyping of new wireless technologies
- Spectrum usage modeling
- Inter-technology interference

Accurate Channel and PHY modeling

- Long tradition of simplistic PHY models (e.g. disc propagation model in ns2)
- Dedicated PHY simulators use high-detail
  - e.g., bit level simulations, channel coding, synchronization, equalization...
- Need to simulate a complete system (not only PHY layer)
  ⇒ huge computational load
- A reasonable tradeoff needed
- Tunable level of detail is desirable
  -

Modularity & reusability

- Traditionally, for each wireless technology specific channel, PHY & MAC code is developed
- What if...
  - I want to use a different PHY for my MAC?
  - Or a different MAC for my PHY?
  - Or a more detailed channel model?
- Identify reusable components
- Compatibility between modules

Spectrum usage

- Traditionally, spectrum usage not modeled
- New scenarios:
  - Multi-channel ad-hoc/mesh networks
  - Underwater Acoustic Communications
  - Cognitive Radio /Dynamic Spectrum Access
- Need to model how transmissions make use of the spectrum

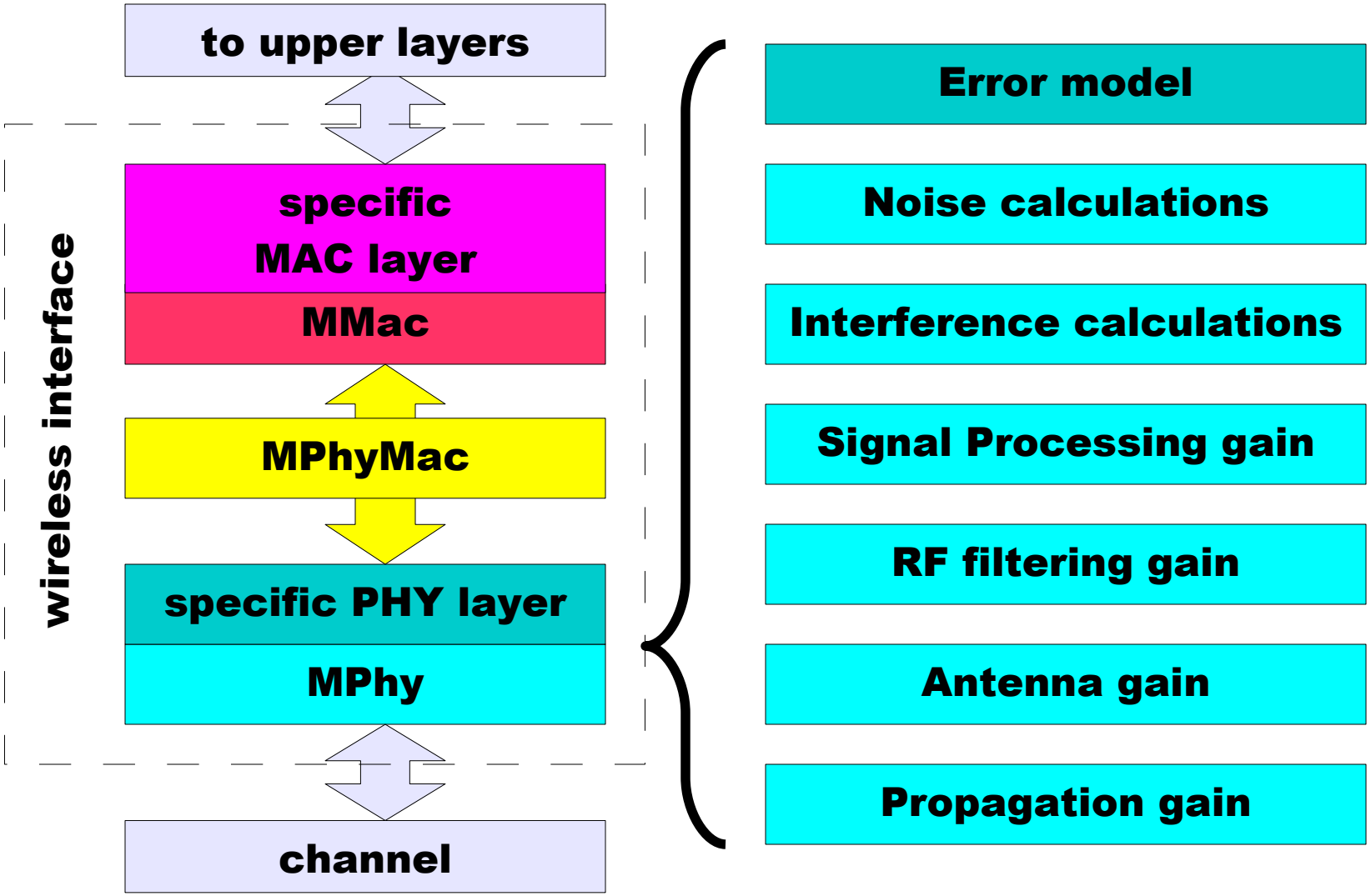
Inter-technology interference

- e.g., Wifi + bluetooth + WiMax @ 2.4Ghz
- Need modeling of spectrum usage
- Need compatible representation of transmission attributes
- Technology-specific solution to spectrum modeling will not work

Our solution: MPhy

- PHY layer framework for NS-Miracle
- Formal definition of transmission
- Support for channel modeling
- Support for development of PHY modules
- Well-defined PHY-MAC interface

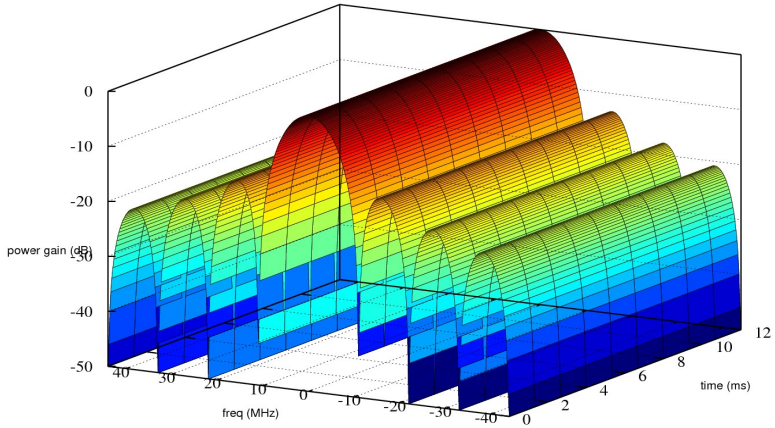
MPhy/MMac architecture



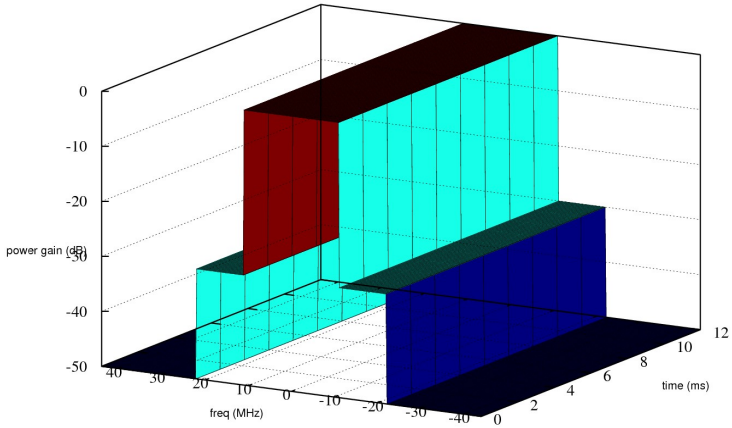
Transmissions in MPhy

- an event extending over a time interval
- constant TX power
- propagation and RX process modeled by gains applied to TX power
- each transmission has a spectrum occupancy

Transmissions in MPhy (2)

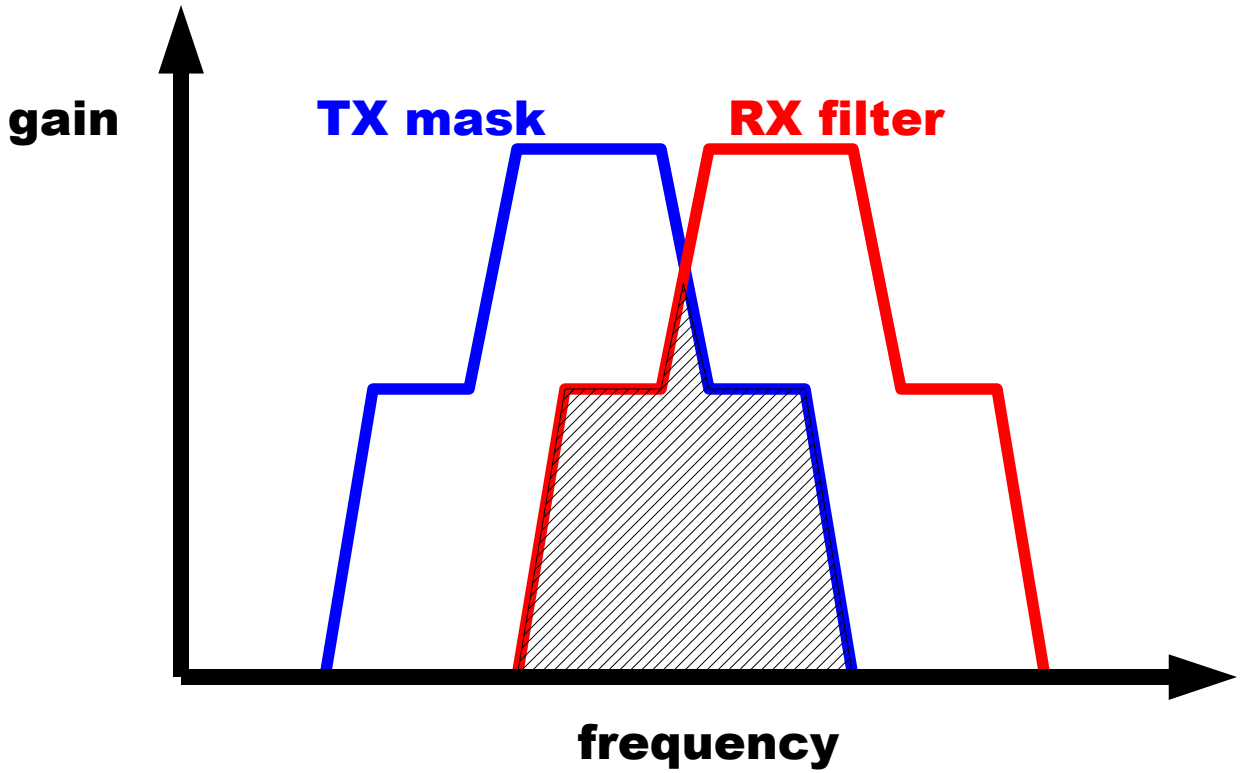


theory



implementation

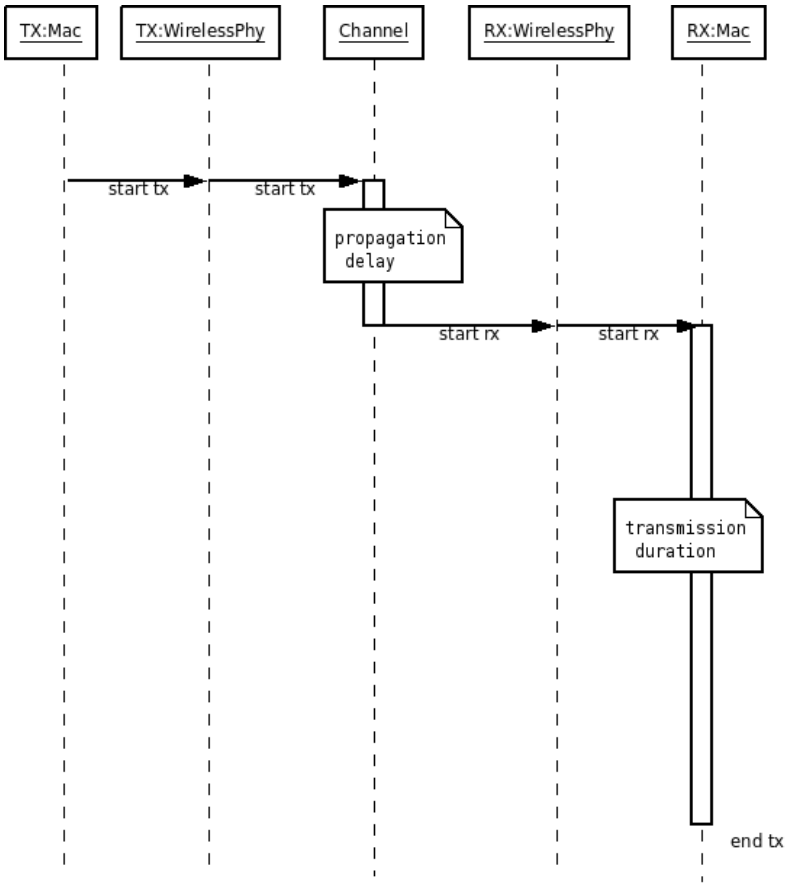
RF filtering



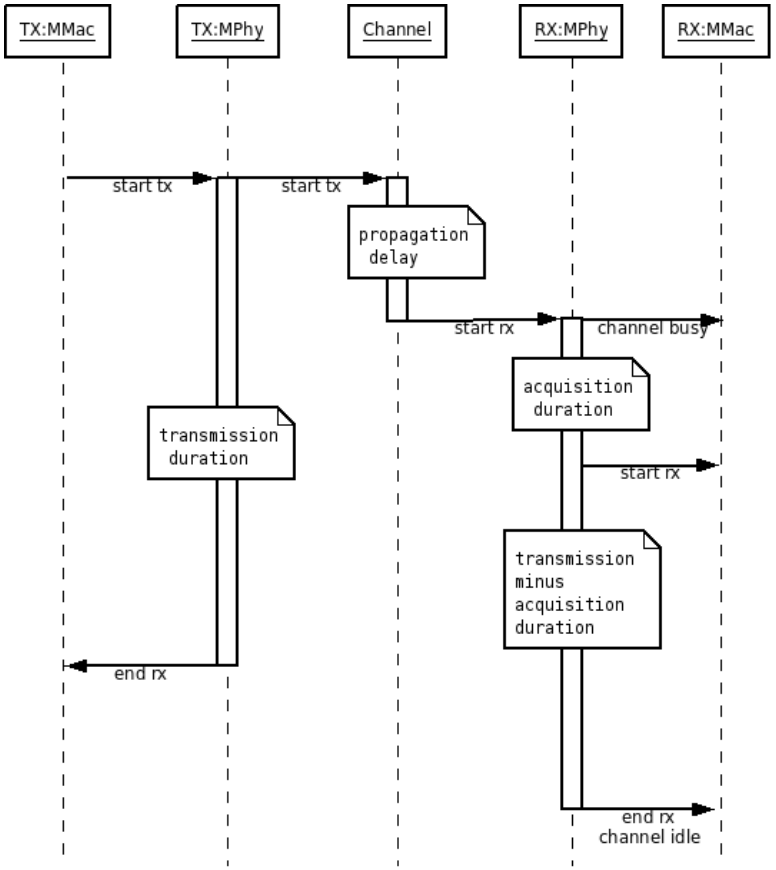
- RF filtering gain is fraction of RX filter overlapping with TX mask
- Applied to all signals (also interferers)

PHY-MAC interactions

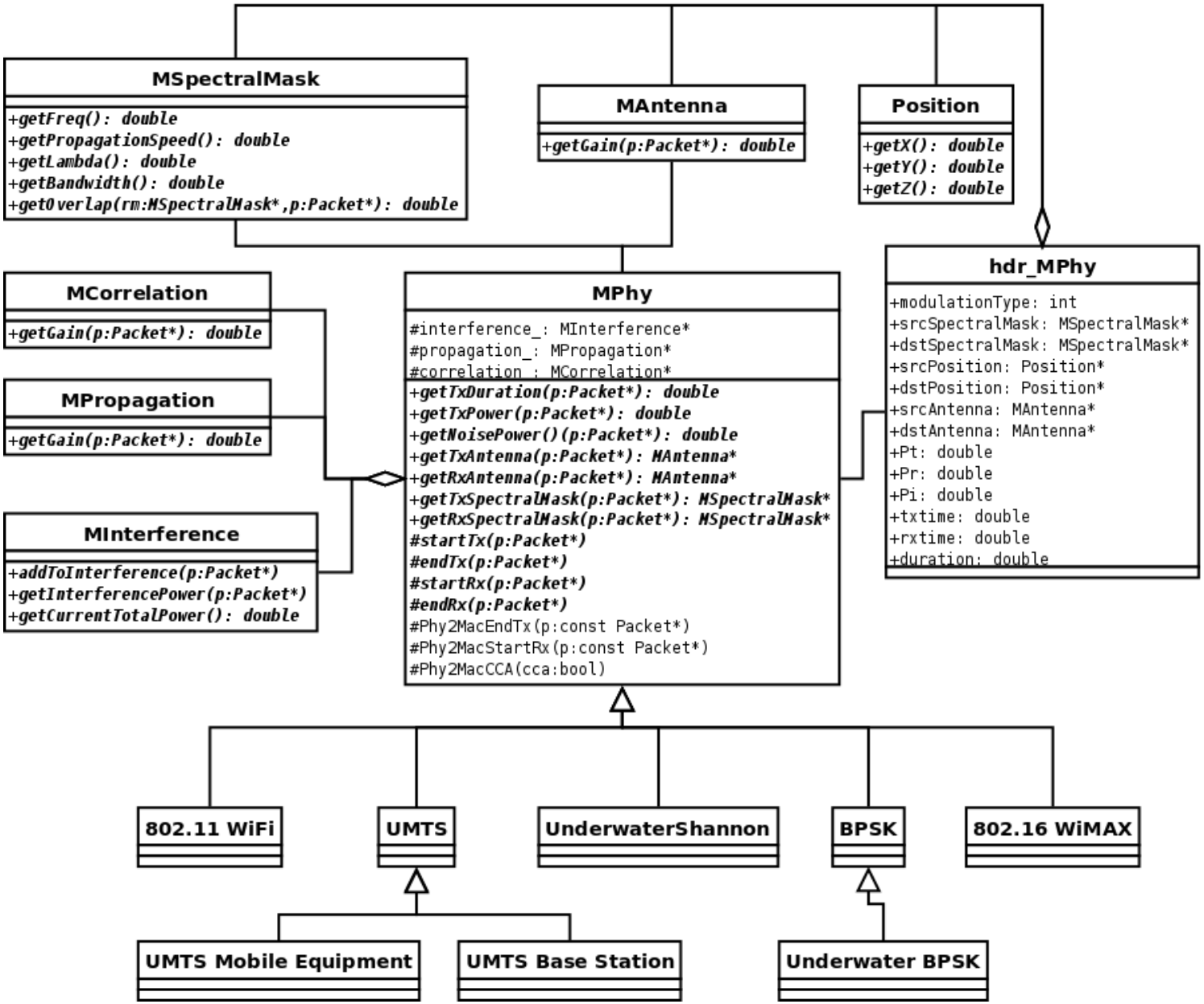
ns2 mobileNode



MPhyMac



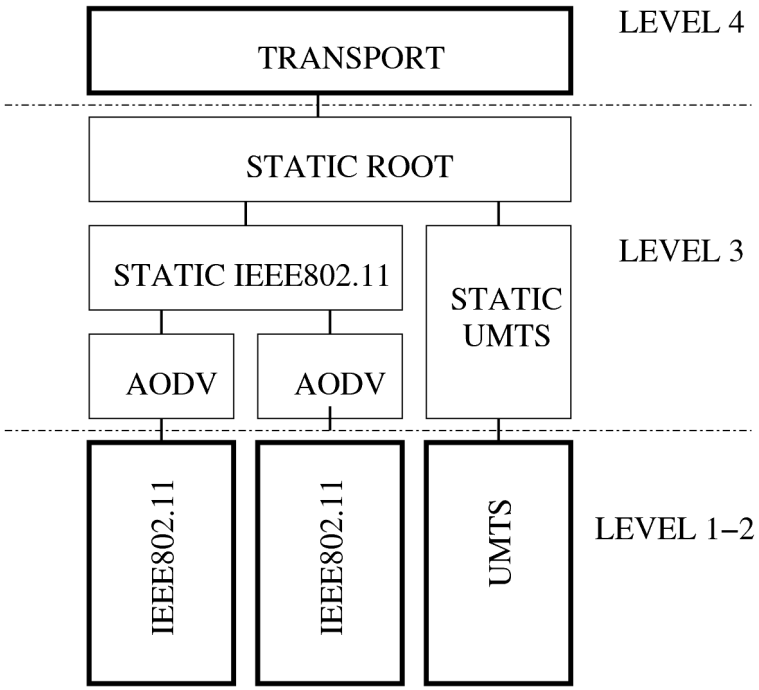
Mphy class hierarchy

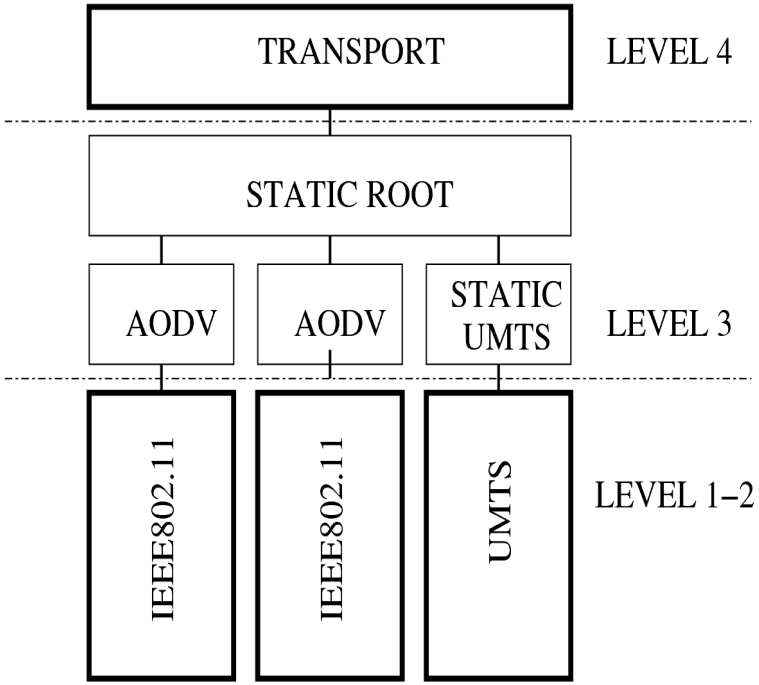


New routing challenges in network simulation

- Multi-interface nodes
- Interfaces might be equipped with different wireless technologies
- Heterogeneous networks
  - e.g., mixed ad-hoc / infrastructure network
- Different routing metrics
  - Hop count, bandwidth, delay...

Example architectures

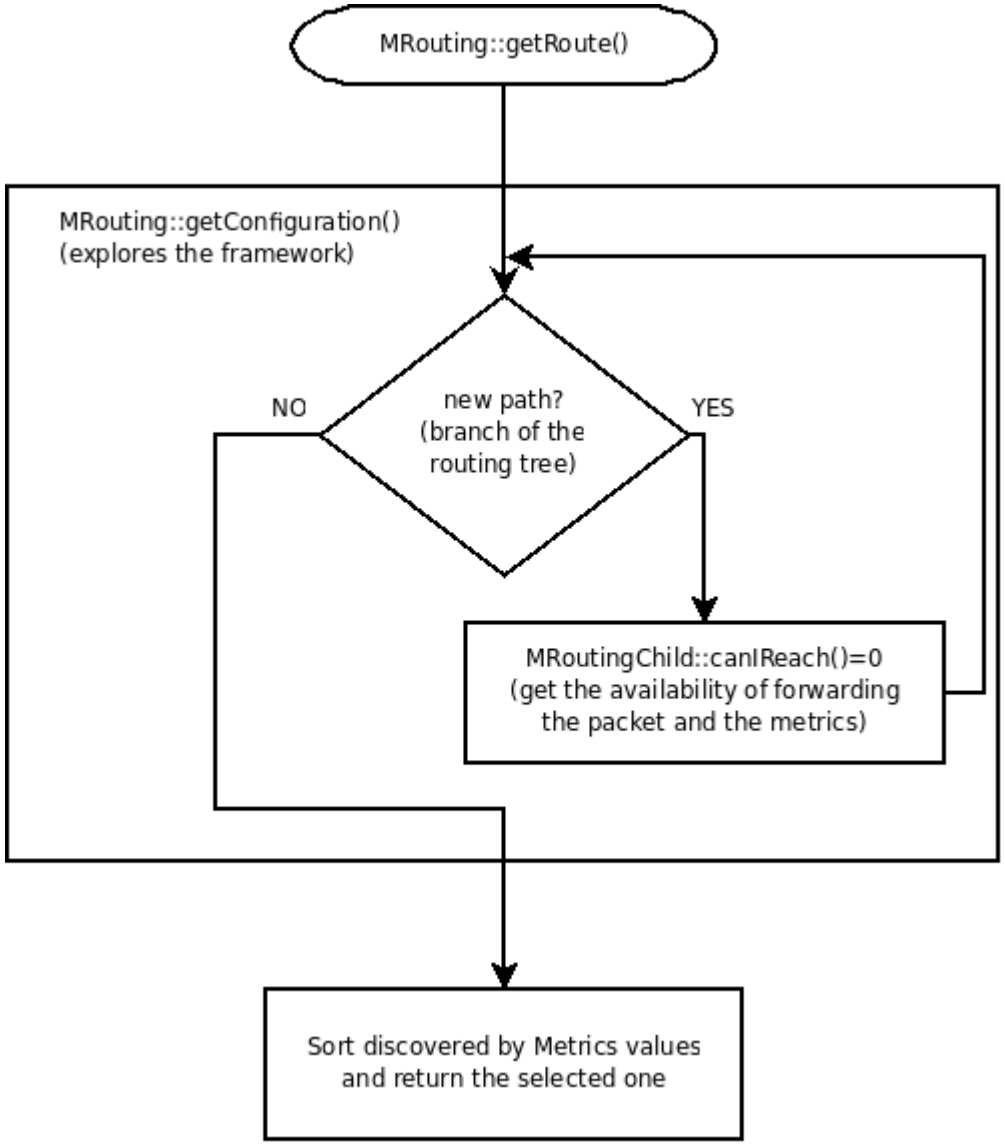




Our solution: MRouting

- Framework for the routing layer
- Several routing modules in a tree topology
- Support for routing module development
  - MrclRouting base class
- Support for modules integration and interaction
  - The tree topology is dynamically created in simulation script
  - All the interactions (e.g., to discover routes and forward packets) are internally managed
- Class hierarchy for routing metrics
  - Provides compatibility between routing modules using different metrics

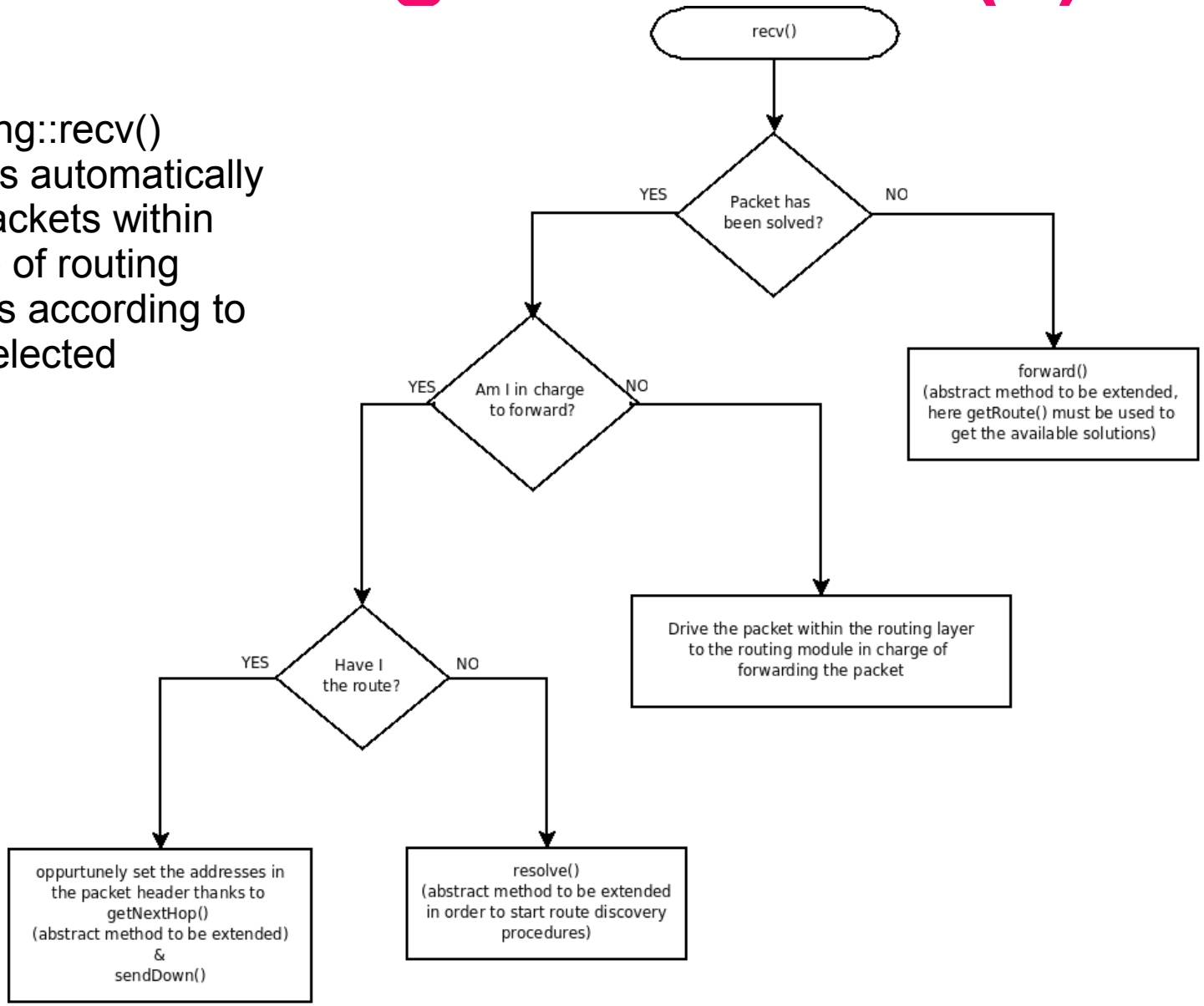
MRouting flow chart



Internal engine to manage packet route resolution considering all the modules (and their metrics) within the routing layer

MRouting flow chart (2)

MRouting::recv() methods automatically drive packets within the tree of routing modules according to route selected



MAODV

- Porting of the ns2 AODV module to the to MRouting framework
- Backward compatible
- Fully exploitation of MRouting
  - Route Discovery are replied according to the global capabilities of the routing layer
  - Packets may be forwarded to other interfaces
  - Can interoperate with other types of routing (e.g., static routing)