UNIVERSITY OF SCIENCE AND TECHNOLOGY OF HANOI

Network Simulation

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Lecture 3: Network models in NS-3

- Models and Attributes
- NS-3 models vs. modules
- Models in Wifi modules
- How to use ns-3 models in simulation
- Practical time

Models

- A model: an abstraction of reality
- Not everything is modeled
  - Range of accuracy
  - Domain of applicability

Attributes

- Parameters are used in a model
  - Examples: Mtu of CsmaNetDevice class in model CSMA
- Change attributes will change model behavior

Model vs. Module

- Distinguish:
  - ns-3 models: abstract of representations of real-world objects, protocols, devices, etc.
  - Ns-3 modules:
    - Separate software libraries
    - Consist of more than one model
- Documentation:
  - Ns-3 Doxygen (online/offline): https://www.nsnam.org/doxygen/
  - Ns-3 project wiki: https://www.nsnam.org/wiki/Main_Page

NS-3 Modules

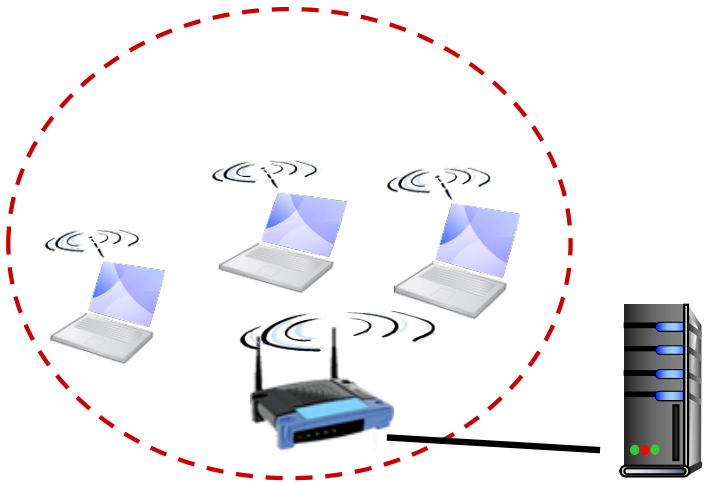
```
'build' finished successfully (0.503s)

Modules built:
antenna                  aodv                     applications
bridge                   buildings                config-store
core                     csma                     csma-layout
dsdv                     dsr                      energy
flow-monitor             internet                 internet-apps
lr-wpan                  lte                      mesh
mobility                 netanim                  network
nix-vector-routing       olsr                     point-to-point
point-to-point-layout    propagation              sixlowpan
spectrum                 stats                    tap-bridge
test (no Python)         topology-read            traffic-control
uan                      virtual-net-device       wave
wifi                     wimax

Modules not built (see ns-3 tutorial for explanation):
brite                    click                    mpi
openflow                 visualizer
```

Example of models for Wifi networks

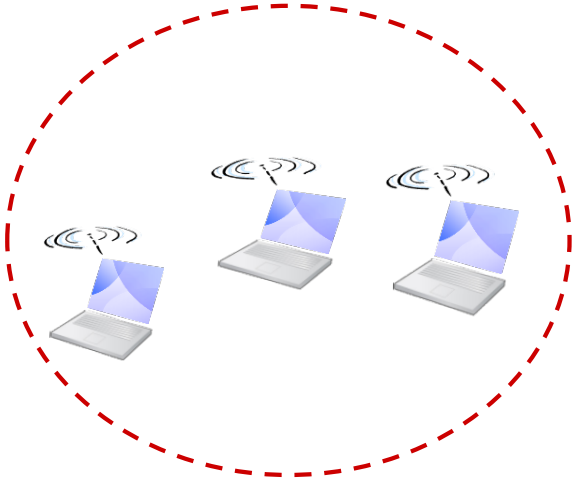
- Wifi module:
  - 802.11 models:

Models	Real aspects of 802.11
MAC high models	802.11 DCF
MAC low models	MSDU aggregation and MPDU aggregation
PHY layer models	Propagation loss and delay
	Packet error models and frame detection model
	Rate control algorithms
	…

Scenarios:



Infrastructure mode



Adhoc mode

Wifi Access Networks

PCF:

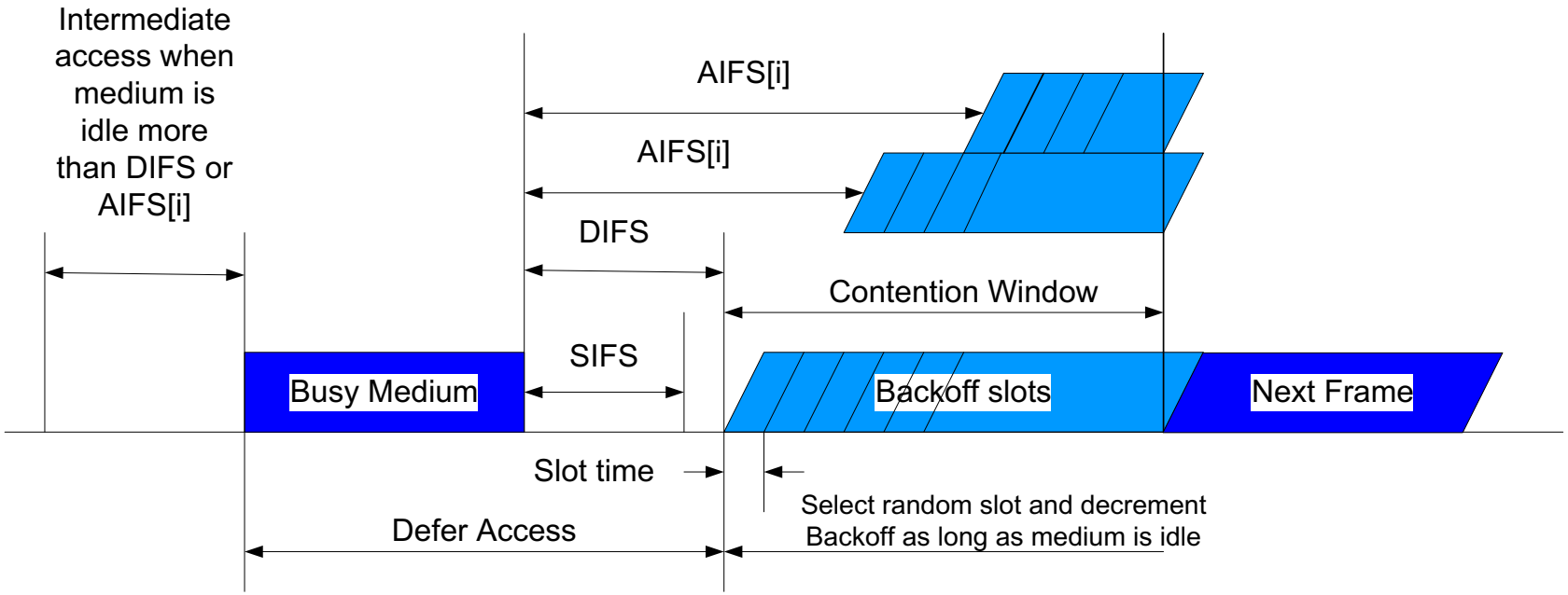
- Poll and Response

DCF

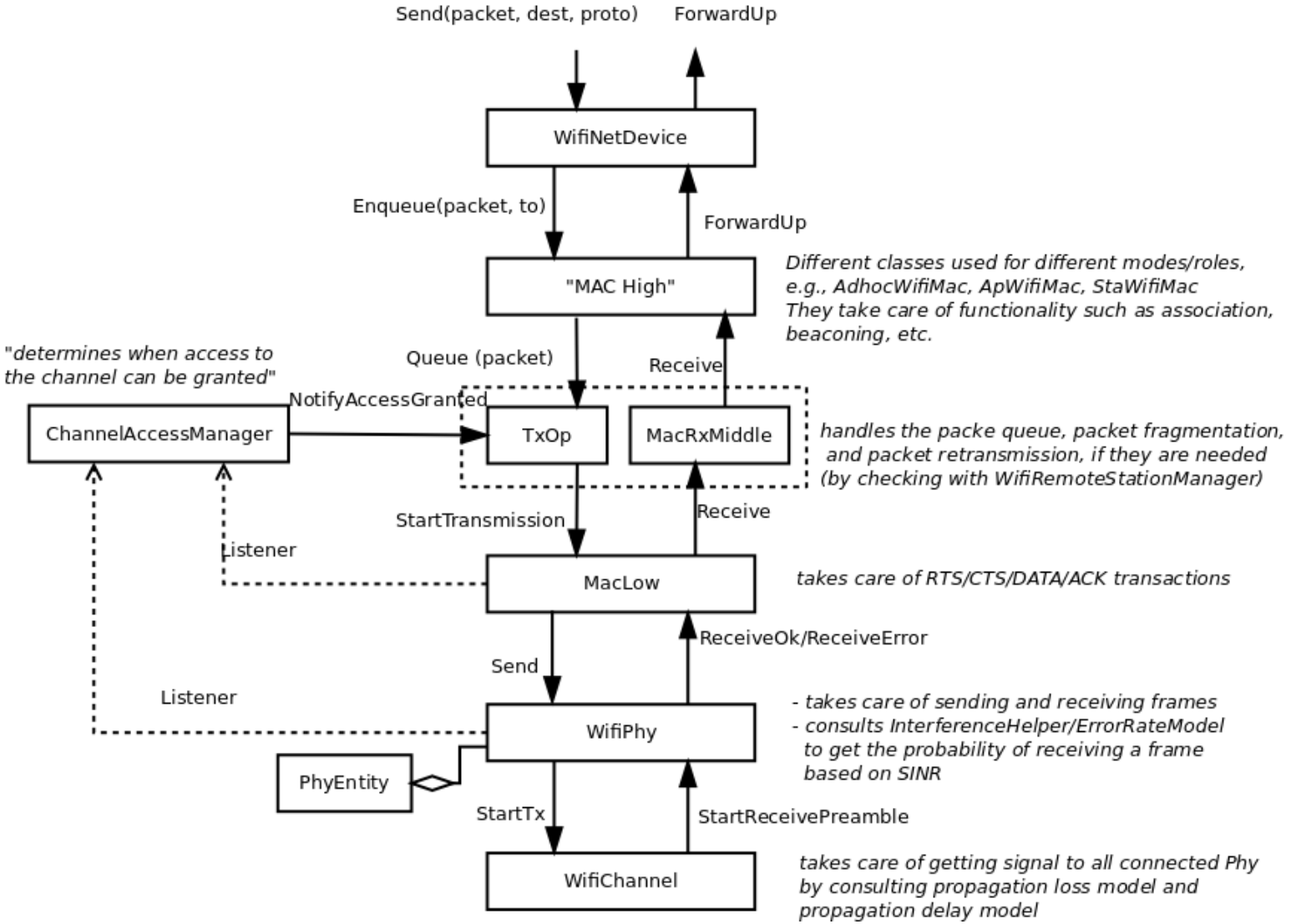
- CSMA/CA
  - Carrier sensing
  - Backoff procedure
  - RTS/CTS
- EDCA

Wifi Access Networks

- CSMA/CA in IEEE 802.11



Wifi Modules – WifiNetDevice Architecture



Wifi Modules

- WifiNetDevice:
  - NICs:
    - Network device to connect a computer to a network
    - Network device drivers (Net devices)
  - abstraction of NICs for Wifi:
    - Hardware + software
    - Installed in a Node
    - Multiple net devices in a node

Wifi Modules

- MAC high models
- MAC low models
- PHY layer models

WifiNetDevice

- Use case
- How to create?
  - Wifi Channel
  - Wifi Physical layer
  - Wifi MAC layer

```
NodeContainer wifiStaNode;
wifiStaNode.Create (10);   // Create 10 station node objec
NodeContainer wifiApNode;
wifiApNode.Create (1);   // Create 1 access point node obj

// Create a channel helper and phy helper, and then create
YansWifiChannelHelper channel = YansWifiChannelHelper::Def
YansWifiPhyHelper phy = YansWifiPhyHelper::Default ();
phy.SetChannel (channel.Create ());

// Create a WifiMacHelper, which is reused across STA and
WifiMacHelper mac;

// Create a WifiHelper, which will use the above helpers t
// and install Wifi devices.  Configure a Wifi standard to
// will align various parameters in the Phy and Mac to sta
WifiHelper wifi;
wifi.SetStandard (WIFI_STANDARD_80211n_5GHZ);
// Declare NetDeviceContainers to hold the container retur
NetDeviceContainer wifiStaDevices;
NetDeviceContainer wifiApDevice;

// Perform the installation
mac.SetType ("ns3::StaWifiMac");
wifiStaDevices = wifi.Install (phy, mac, wifiStaNodes);
mac.SetType ("ns3::ApWifiMac");
wifiApDevice = wifi.Install (phy, mac, wifiApNode);
```

MAC high models

- Access Point (AP): ns3::ApWifiMac
- Non-AP Station (STA): ns3::StaWifiMac
- Ad-hoc network STA: ns3::AdhocWifiMac

The MAC low layer models

- MacLow: takes care of RTS/CTS/DATA/ACK transactions and performs MPDU aggregation
- ChannelAccessManager: and DcfState: DCF and EDCAF functions
- Txop and QosTxop: handle packet queue, packet fragment and packet transmissions

PHY models

- Models of:
  - reception of packets
  - Energy consumption
- 2 physical layer modules:
  - YansWifiPhy and YansWifiChannel: IEEE 802.11 Physical layer
  - Spectrum Module: SpectrumWifiPhy and SpectrumWifiChannel

How to use Wifi modules to simulate Wifi networks?

- Consider a scenario of a Wifi network
- Set up a corresponding simulation
  - Channel
  - Physical layer
  - MAC layer
  - Higher layers in the stack (IP, Applications)
  - Topology

Practical time

1. Set up a simulation of a wifi network with given topology

Labwork 3

2. Set up a simulation to demonstrate:

- Hidden-terminal problem
- RTS/CTS exchanging scheme