

EEC 687/787 Mobile Computing (Spring, 2008)

Ns-2 Laboratory #5

Chansu Yu

Cleveland State University

Multirate Control

- ❑ Multirate support
 - 802.11 supports 1 and 2 Mbps
 - 802.11b supports 1, 2, 5.5 and 11 Mbps
 - 802.11a supports 6, 9, 12, 18, 24, 36, 48 and 54 Mbps
- ❑ Advantages of high-rate communication
 - Faster delivery (less delay)
 - More throughput
 - Less energy
 - Issues ???

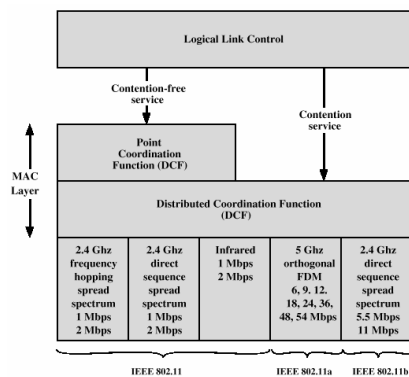


Figure 14.5 IEEE 802.11 Protocol Architecture

Multirate Control

- ❑ Signal-to-Interference Noise Ratio (SINR) required for successful reception at the receiver depends on the transmission rate being used.
- ❑ The ideal capacity of a channel with bandwidth B is given by Shannon's Equation: $W = B \log(1 + \text{SINR})$, yielding $\text{SINR}(\text{reqd}) \geq (2^{(W/B)} - 1)$.
- ❑ Recall that carrier-sense range (CSRange) is the distance from the transmitter upto which nodes assess the channel as busy, and thus CSThresh and CSRange possess an inverse relationship with each other.

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c.yu91@csuohio.edu

Multirate Control

- ❑ A small CSThresh implies that even nodes quite far away from a transmitting node shall detect the channel as busy, and defer.
- ❑ A larger CSRange implies more space is "reserved" by a transmission as a "guard zone" to avoid interference/collisions.
- ❑ On the contrary, a large CSThresh implies that only nodes very close to a transmitter shall assess the channel as busy.
- ❑ A smaller CSRange implies there can be more concurrent transmissions, but chances of collision are higher.

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c.yu91@csuohio.edu

Multirate Control

Data rate (Mbps)	Receive threshold (dBm)	Communication distance (m)	Capture threshold (dB)	Capture distance (m)	Carrier sense distance (m)
6	-82	238	6.02	337	575
9	-81	224	7.78	351	576
12	-79	200	9.03	336	536
18	-77	178	10.79	331	509
24	-74	150	17.04	400	550
36	-70	119	18.80	351	470
48	-66	95	24.05	389	484
54	-65	89	24.56	366	455

* *Transmit power: 6 dBm*

* *For a successful communication, when a node transmits a packet, other nodes should not send theirs. This can lead to capture distance.*

* *CSThresh = -91 dBm*

c.yu91@csuohio.edu

Lab Exercise #5 (in class)

- ❑ This exercise is aimed at exploring how rate control and adaptation of carrier sense threshold can affect spatial reuse (and hence aggregate throughput) in a multi-hop network.
- ❑ Download rate.tcl
 - A simulation topology of 100 nodes arranged in a 10x10 grid with a grid-spacing of 150m.
 - 25 CBR conversations between randomly chosen source-destination pairs are set up.
- ❑ The script takes as arguments the TX-Rate (in bps), the RxThresh (in Watts), CPTHresh (ratio; no units), and the CSThresh (-91 dBm). (see the table)
 - Usage: ns multi-hop.tcl -rate {rate (Mbps)} -rxthresh {rcv_threshold} -cpthresh {capture-threshold} -csthresh {carrier-sense threshold (W)}

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Lab Exercise #5 (in class)

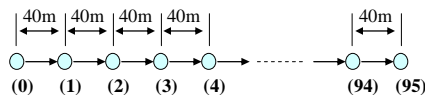
- Run the simulations for all combinations of TX-rate and RXThresh. Obtain the aggregate CBR throughput for each run.
- Draw a chart drawing throughput versus TX-rate for each value of RXThresh
- Discussion: What trends may be observed? For this simulation topology, what combination seems to yield the best performance?

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c.yu91@csuohio.edu

Lab Exercise #5 (lab report)

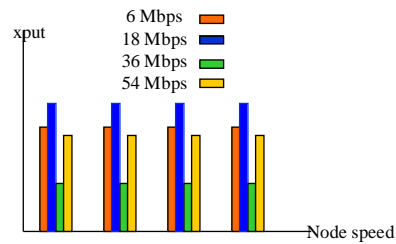
- Goal: Compare the performance with different data rate (6, 18, 36 and 54 Mbps) with different mobility.
- Setup: 96 nodes in a chain. Nodes are separated by 40m. Traffic is node 1 to node 0 (CBR, 1000 bytes, 200 packets/second). Node 0 moves to the other end of the network with 0, 1, 5, 10, 20 m/second. Use AODV. (Need to change NETWORK_DIAMETER to 150 in aodv.h.) Use RTS/CTS.
- Output: Compare throughput



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c.yu91@csuohio.edu

Multirate Control



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c.yu91@csuohio.edu

Multirate Control

- What does the data rate change affect?
 - Data rate (it will affect the packet time, etc.)
 - Receive threshold
 - Capture threshold
- How to make changes in ns-2?
 - Source file changes
 - Variable binding
 - Command method

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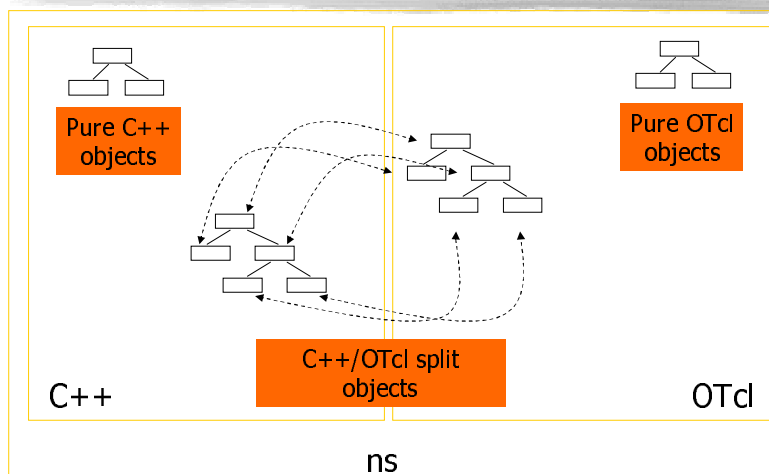
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Variable Binding

- ❑ Set/change a variable of C++ component from TCL run script
 - Advantage: No need to modify the source file (no need to compile & link)
- ❑ Special function “bind”
 - Interface: bind, bind_bw, bind_time, bind_bool
 - WirelessPhy::WirelessPhy() : Phy(), sleep_timer_(this), status_(IDLE) {


```
bind("CPTthresh_", &CPTthresh_);
bind("CSTthresh_", &CSTthresh_);
bind("RXThresh_", &RXThresh_);
bind("Pt_", &Pt_);
```
 - Default value is defined in \$ns/tcl/lib/ns-default.tcl
 - Mac/802_11 set dataRate_ 1.0e6
 - Mac/802_11 set PLCPDataRate_ 1.0e6
 - Phy/WirelessPhy set CPTthresh_ 10.0
 - Phy/WirelessPhy set RXThresh_ 3.652e-10
 - Phy/WirelessPhy set bandwidth_ 2e6
 - Phy/WirelessPhy set Pt_ 0.28183815

OTcl and C++



Parameters

```
# Tx = 6 dBm (3.981 mW or 3.981e-3)
Phy/WirelessPhy set Pt_ 3.981e-3
# CS = -91 dBm (7.943e-10 mW or 7.943e-13) => 399m
Phy/WirelessPhy set CStresh_ 7.943e-13

if { $spar0 == "06" } {
    # 6 mbps, -82 dBm (Rx), 6.02 dB (Cp) => 6.310e-12, 3.999
    => 238m
    Mac/802_11 set dataRate_ 6.0e6
    Phy/WirelessPhy set bandwidth_ 6e6
    Mac/802_11 set PLCPDataRate_ 6.0e6
    Phy/WirelessPhy set CPTresh_ 3.999
    Phy/WirelessPhy set RXThresh_ 6.310e-12
}

if { $spar0 == "18" } {
    # 18 mbps, -77 dBm (Rx), 10.79 dB (Cp) => 1.995e-11,
    11.995 => 178m
    Mac/802_11 set dataRate_ 18.0e6
    Phy/WirelessPhy set bandwidth_ 18e6
    Mac/802_11 set PLCPDataRate_ 18.0e6
    Phy/WirelessPhy set CPTresh_ 11.995
    Phy/WirelessPhy set RXThresh_ 1.995e-11
}

if { $spar0 == "36" } {
    # 36 mbps, -70 dBm (Rx), 18.80 dB (Cp) => 1.000e-10, 75.858 => 119m
    Mac/802_11 set dataRate_ 36.0e6
    Phy/WirelessPhy set bandwidth_ 36e6
    Mac/802_11 set PLCPDataRate_ 36.0e6
    Phy/WirelessPhy set CPTresh_ 75.858
    Phy/WirelessPhy set RXThresh_ 1.000e-10
}

if { $spar0 == "54" } {
    # 54 mbps, -65 dBm (Rx), 24.56 dB (Cp) => 3.162e-10, 285.759 => 89m
    Mac/802_11 set dataRate_ 54.0e6
    Phy/WirelessPhy set bandwidth_ 54e6
    Mac/802_11 set PLCPDataRate_ 54.0e6
    Phy/WirelessPhy set CPTresh_ 285.759
    Phy/WirelessPhy set RXThresh_ 3.162e-10
}
```

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c.yu91@csuohio.edu

Multirate Control

- Make your life a bit easier...
- Use a run batch file

```
TCL_FILE=carj.tcl
TRACE_FILE=out.tr
RES_AWK_FILE=delay.awk
RESULT_FILE=carj.out

for RATE in 06 18 36 54
do
    for SPEED in 0 1 5 10 20
    do
        OPTION="$RATE $LAYOUT $SPEED"
        echo $OPTION .....
        echo $OPTION ..... >> $RESULT_FILE
        ns $TCL_FILE $OPTION
        awk -f $RES_AWK_FILE $TRACE_FILE >> $RESULT_FILE
    done
done
```

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c.yu91@csuohio.edu

Multirate Control

- How to pass values to TCL script?

```

set val(x)      4000
set val(y)      200
set val(nn)     96
set val(stop)   170

if {$Sargc != 3} {
    puts "Usage ns carj.tcl
    DataRate(06/18/36/54) Layout(chain/para)
    Speed(0/1/5/10/20)"
    exit
}

set par0 [lindex $argv 0]
set par1 [lindex $argv 1]
set par2 [lindex $argv 2]

if {$par0 == "06"} {
    Mac/802_11 set dataRate_ 6.0e6
    Phy/WirelessPhy set bandwidth_ 6e6
    Mac/802_11 set PLCPDataRate_ 6.0e6
    Phy/WirelessPhy set CPTthresh_ ???
    Phy/WirelessPhy set RXThresh_ ???
}
.....

if {$par0 == "54"} {
    Mac/802_11 set dataRate_ 54.0e6
    Phy/WirelessPhy set bandwidth_ 54e6
    Mac/802_11 set PLCPDataRate_ 54.0e6
    Phy/WirelessPhy set CPTthresh_ ???
    Phy/WirelessPhy set RXThresh_ ???
}
.....
if {$par2 == "1"} {
    $ns_at 0.0 "$node_(0) setdest 3400.0 1.0
    1.0"
}
.....
if {$par2 == "20"} {
    $ns_at 0.000000000000 "$node_(0)
    setdest 3400.0 1.0 20.0"
}
}
.....

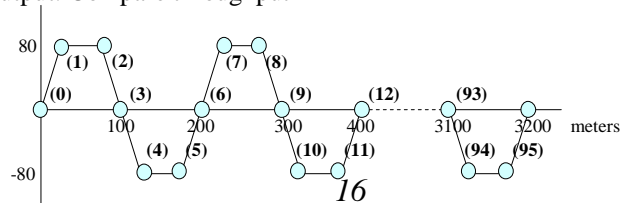
```

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c.yu91@csuohio.edu

Extra

- Goal: Compare the performance with different data rate (6, 18, 36 and 54 Mbps) with different mobility.
- Setup: 96 nodes in a quadrilateral topology. Traffic is node 1 to node 0 (CBR, 1000 bytes, 200 packets/second). Node 0 moves to the other end of the network with 0, 1, 5, 10, 20 m/second. Use AODV. (Need to change NETWORK_DIAMETER to 150 in aodv.h.) Use RTS/CTS.
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