

# Wireless Network Simulation With *NS-2*

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Richard Griswold  
School of Electrical Engineering and Computer  
Science  
Washington State University  
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# Overview

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- What Is NS-2?
- Example Wireless Network Simulation
- Reading Trace Files
- Analyzing Data
- Additional Resources

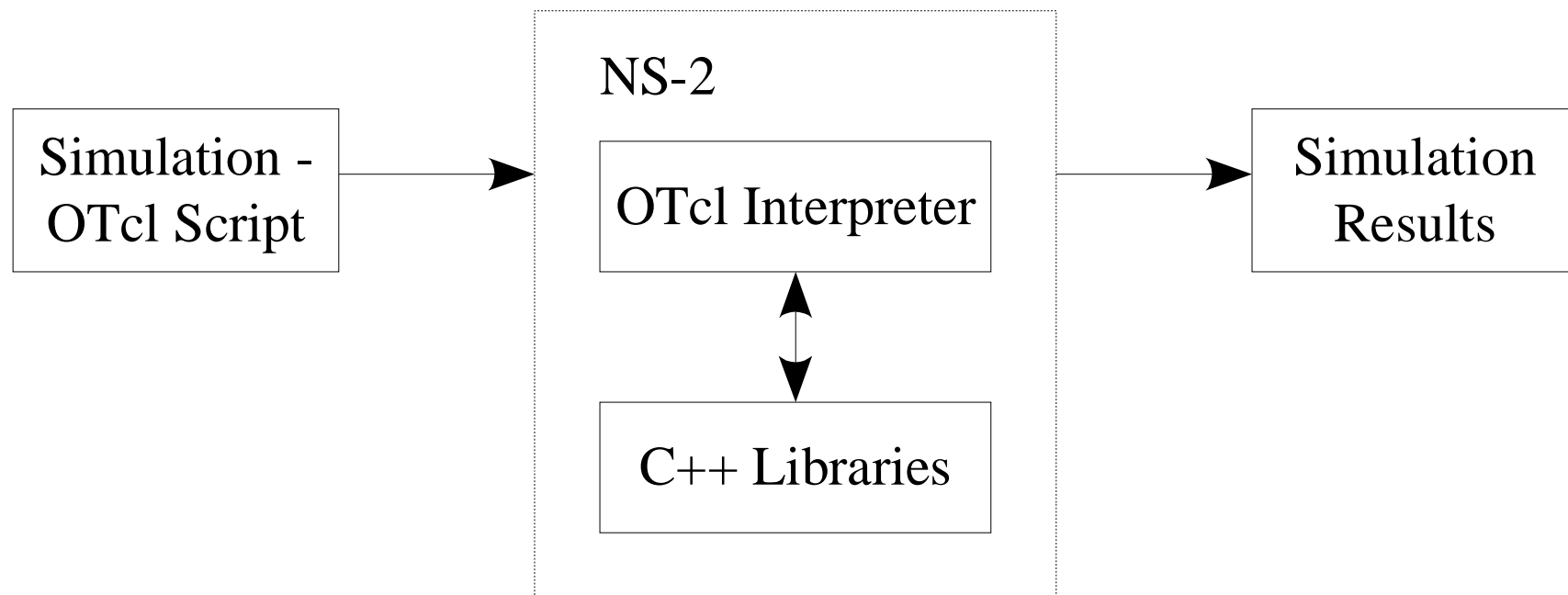
# What is NS-2?

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- Discrete event simulator for networks
- From University of Southern California Information Sciences Institute
- Supports wired and wireless networks, TCP, UDP, various routing and multicast protocols, etc
- Written in C++ and Object-Oriented Tcl (OTcl)
- Several ways to process output
  - NAM (Network ANimator), xgraph, gnuplot, custom scripts.

# NS-2 Overview

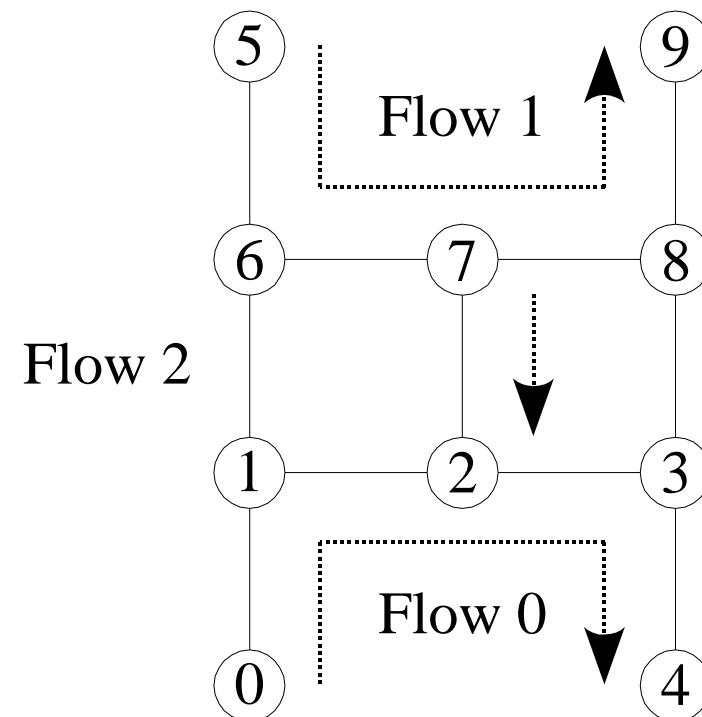
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# Example Wireless Network Simulation

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- 10 node network
- Three CBR data flows
  - Constant Bit Rate
  - Run over UDP



# Example Wireless Network Simulation (cont.)

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```
source utils.tcl
```

```
# Simulation options
```

```
set opt(chan)           Channel/WirelessChannel    ;# Channel type
set opt(prop)           Propagation/TwoRayGround   ;# Radio propagation
set opt(netif)          Phy/WirelessPhy           ;# Network interface type
set opt(mac)            Mac/802_11                ;# MAC type
set opt(ifq)            Queue/DropTail/PriQueue    ;# Interface queue type
set opt(ll)             LL                        ;# Link layer type
set opt(ant)            Antenna/OmniAntenna        ;# Antenna type
set opt(x)              1000                      ;# X dimension of the topography
set opt(y)              1000                      ;# Y dimension of the topography
set opt(ifqlen)         50                       ;# Max packets in ifq
set opt(seed)           0.0                      ;# Random number generator seed
set opt(rp)             DSR                      ;# Ad-hoc routing protocol
set opt(nn)             10                       ;# Number of mobile nodes
set opt(sc)             ""                       ;# Scenario (node movement) file
set opt(cp)             ""                       ;# Connection pattern file
set opt(stop)           10.0                     ;# Simulation time
set RouterTrace         ON                       ;# Trace router events
check_opt               ;# Check options
```

# Example Wireless Network Simulation (cont.)

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```
# Create simulator, channel, propagation, and topography objects
set ns_ [ new Simulator ]
set chan [ new $opt(chan) ]
set prop [ new $opt(prop) ]
set topo [ new Topography ]
set ns $ns_

# Open trace file
$ns_ use-newtrace
set tracefd [ open mytrace.tr w ]
$ns_ trace-all $tracefd

# Create a topology object to track movements of mobile nodes
$topo load_flatgrid $opt(x) $opt(y)
$prop topography $topo

# Create a GOD (General Operations Director) to store network state
set god_ [ create-god $opt(nn) ]

# Create nodes
for { set i 0 } { $i < $opt(nn) } { incr i } { dsr-create-mobile-node $i }
```

# Example Wireless Network Simulation (cont.)

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```
# Set node positions and distances
set pos "250.0 0.0 250.0 250.0 500.0 250.0 750.0 250.0 \
        750.0 0.0 250.0 750.0 250.0 500.0 500.0 500.0 \
        750.0 500.0 750.0 750.0"
set dist "0 1 2 3 4 3 2 3 4 5 \
          1 0 1 2 3 2 1 2 3 4 \
          2 1 0 1 2 3 2 1 2 3 \
          3 2 1 0 1 4 3 2 1 2 \
          4 3 2 1 0 5 4 3 2 3 \
          3 2 3 4 5 0 1 2 3 4 \
          2 1 2 3 4 1 0 1 2 3 \
          3 2 1 2 3 2 1 0 1 2 \
          4 3 2 1 2 3 2 1 0 1 \
          5 4 3 2 3 4 3 2 1 0"
set_pos; set_dist; $god_ dump

# Setup CBR/UDP connections
set i 0
setup_udp_conn $i 0 4 0.0 $opt(stop) 5.0; incr i
setup_udp_conn $i 5 9 2.0 $opt(stop) 5.0; incr i
setup_udp_conn $i 7 2 4.0 $opt(stop) 5.0; incr i
```



# Example Wireless Network Simulation (cont.)

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```
# Source connection pattern and node movement scripts
cp_sc

# Reset nodes and stop simulation
for { set i 0 } { $i < $opt(nn) } { incr i } {
    $ns_ at $opt(stop) "$node_($i) reset";
}
$ns_ at [ expr $opt(stop) + 0.0001 ] "puts $tracefd \"NS Exiting...\\""
$ns_ at [ expr $opt(stop) + 0.0002 ] "$ns_ flush-trace; close $tracefd"
$ns_ at [ expr $opt(stop) + 0.0003 ] "puts \"NS Exiting...\"; $ns_ halt"

# Add informative headers for the CMUTrace file
puts $tracefd "M 0.0 nn $opt(nn) x $opt(x) y $opt(y) rp $opt(rp)"
puts $tracefd "M 0.0 sc $opt(sc) cp $opt(cp) seed $opt(seed)"
puts $tracefd "M 0.0 prop $opt(prop) ant $opt(ant)"

# Start the simulation
puts "Starting simulation..."
$ns_ run
```

# Reading Trace Files

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- NS-2 trace files have many formats
  - Wired trace format
  - Old wireless trace format
  - New wireless trace format
  - Ad-hoc routing protocol trace formats
  - Network Animator trace format
- May be replaced with unified format in the future

# Example New Wireless Trace

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```
f -t 33.195597851 -Hs 8 -Hd 9 -Ni 8 -Nx 750.00 -Ny 500.00 -Nz 0.00 -Ne  
-1.000000 -Nl RTR -Nw --- -Ma 13a -Md 8 -Ms 7 -Mt 800 -Is 5.0 -Id 9.0 -It cbr  
-Il 552 -If 1 -Ii 27 -Iv 29 -Pn cbr -Pi 6 -Pf 3 -Po 4
```

f	Forward	-Is -Id	IP Source/Destination
-t	Time	-It	Packet Type
-Hs -Hd	Hop Source/Destination	-Il	Packet Length
-Ni	Node ID	-If	Flow ID
-Nx -Ny -Nz	Node X/Y/Z	-Ii	Packet ID
-Ne	Node Energy	-Iv	Time-to-Live
-Nl	Network Level	-Pn	Packet Specific Trace Start
-Nw	Drop Reason	-Pi	Sequence Number
-Ma	Duration	-Pf	Forward Count
-Ms -Md	MAC Source/Destination	-Po	Optimal Number of Forwards
-Mt	MAC Type		

# Analyzing Data

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- Counting Packets
  - Sent: Count send events at agent (AGT) level
  - Received: Count receive events at agent level
  - Dropped: Count drop events
- Finding Route
  - Dump all events for a specific packet unique ID
  - IP source/destination fields give initial/final node
  - Hop source/destination fields give intermediate nodes

# Packet Route Example

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- The route for packet 27 is 5,6,7,8,9

```
s -t 33.177618351 -Hs 5 -Hd -2 -Ni 5 -Nl AGT -Is 5.0 -Id 9.0 -Ii 27
r -t 33.177618351 -Hs 5 -Hd -2 -Ni 5 -Nl RTR -Is 5.0 -Id 9.0 -Ii 27
s -t 33.177618351 -Hs 5 -Hd 6 -Ni 5 -Nl RTR -Is 5.0 -Id 9.0 -Ii 27
r -t 33.183228851 -Hs 6 -Hd 6 -Ni 6 -Nl RTR -Is 5.0 -Id 9.0 -Ii 27
f -t 33.183228851 -Hs 6 -Hd 7 -Ni 6 -Nl RTR -Is 5.0 -Id 9.0 -Ii 27
r -t 33.189563351 -Hs 7 -Hd 7 -Ni 7 -Nl RTR -Is 5.0 -Id 9.0 -Ii 27
f -t 33.189563351 -Hs 7 -Hd 8 -Ni 7 -Nl RTR -Is 5.0 -Id 9.0 -Ii 27
r -t 33.195597851 -Hs 8 -Hd 8 -Ni 8 -Nl RTR -Is 5.0 -Id 9.0 -Ii 27
f -t 33.195597851 -Hs 8 -Hd 9 -Ni 8 -Nl RTR -Is 5.0 -Id 9.0 -Ii 27
r -t 33.201652351 -Hs 9 -Hd 9 -Ni 9 -Nl RTR -Is 5.0 -Id 9.0 -Ii 27
r -t 33.201652351 -Hs 9 -Hd 9 -Ni 9 -Nl AGT -Is 5.0 -Id 9.0 -Ii 27
```

# Additional Resources

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- Links to additional information at <http://www.eecs.wsu.edu/~rgriswol/NS2/>
  - Tutorials
  - Patches
  - Utilities
  - Presentations
  - Trace Formats
  - Documentation