### Performance evaluation and enhancement of WLAN (CMPT885 / ENSC835)

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#### Introduction to WLAN

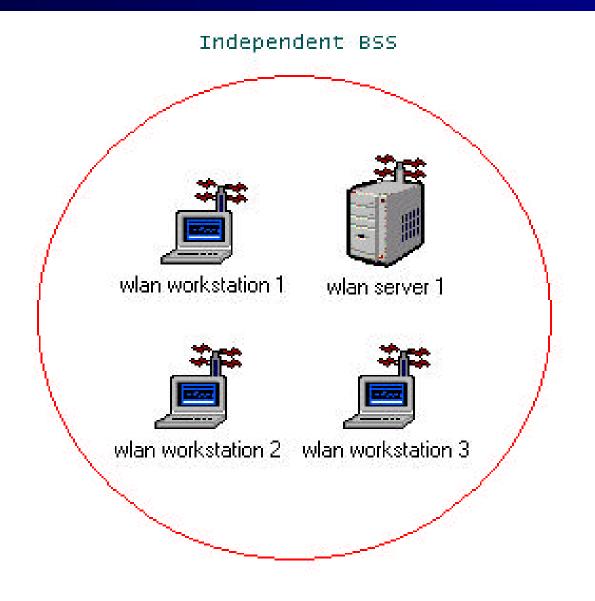
#### IEEE 802.11

- Defines both PHY layer and MAC layer
- Data rate: 1M, 2M, 5.5M, 11M
- Access model: DCF and PCF(optional)
- Adopts CSMA/CA as DCF
- Adopts RTS/CTS as PCF

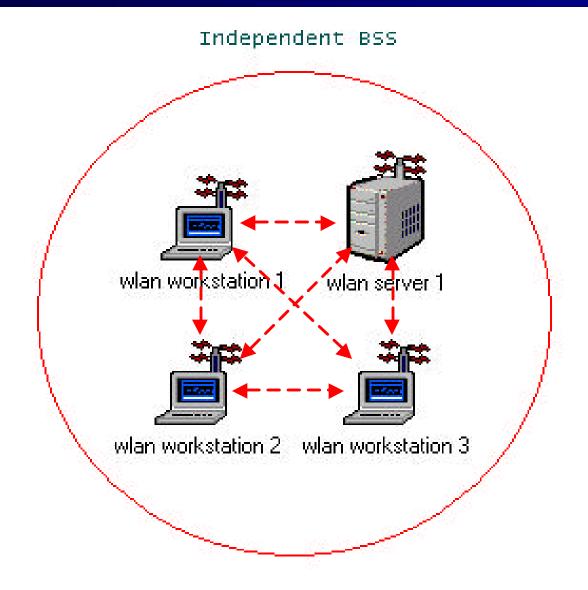
#### Some Problems of WLAN

- Media is error prone
- Carrier sensing is difficult
- Hidden terminal problem

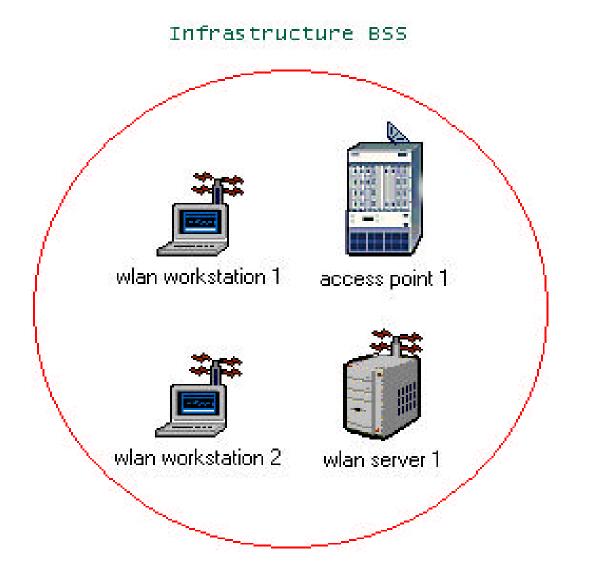
#### Introduction to WLAN - WLAN Components: Independent BSS



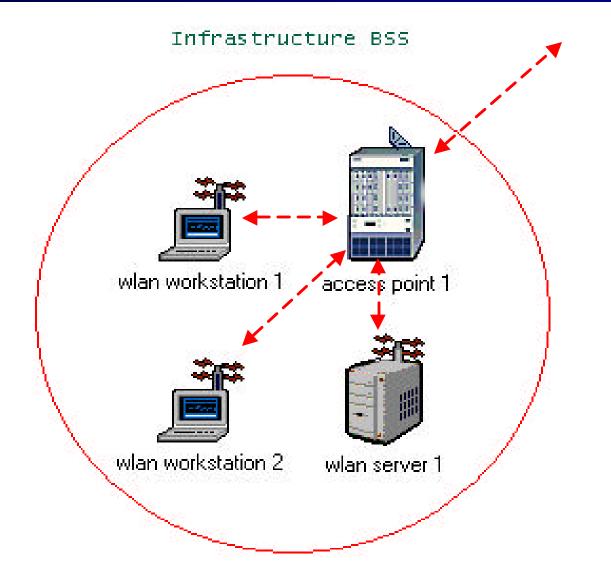
#### Introduction to WLAN - Independent BSS Data Link



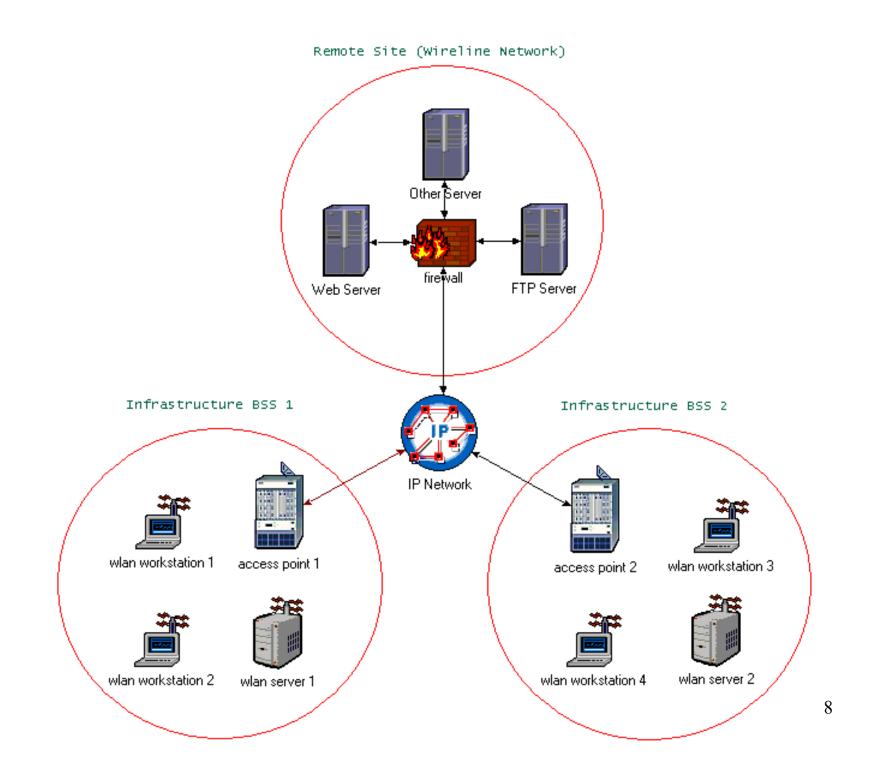
#### Introduction to WLAN - WLAN Components: Infrastructure BSS



#### Introduction to WLAN - Infrastructure BSS Data Link



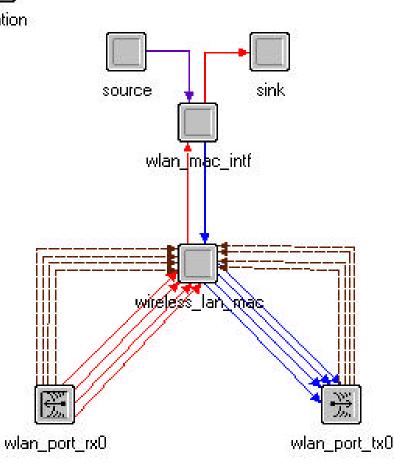
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# - OPNET Model: WLAN Station



wlan station



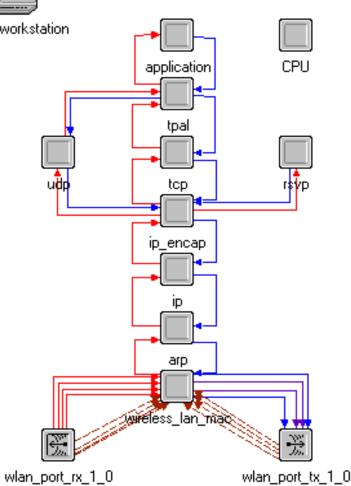
#### Introduction to WLAN - OPNET Model: WLAN Workstation/Server





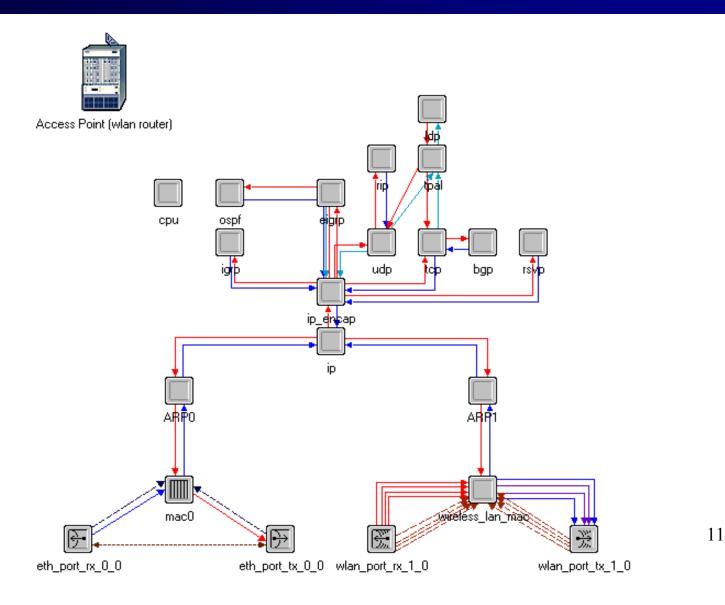
wlan server





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# - OPNET Model: WLAN Router



## Performance enhancementSurvey of Methods

- ✓ Physical layer characteristics (slot time, SIFS)
- ✓ Tune up the WLAN parameters (Fragmentation threshold, RTS threshold, …)
- ✓ Adaptive back-off protocol on MAC layer
- Proxy approach (snoop, SMART snoop protocol)
- o Reliable link-layer approach (AIRMAIL)
- o Split-connection approach (I-TCP, M-TCP)

## Implementation with OPNET

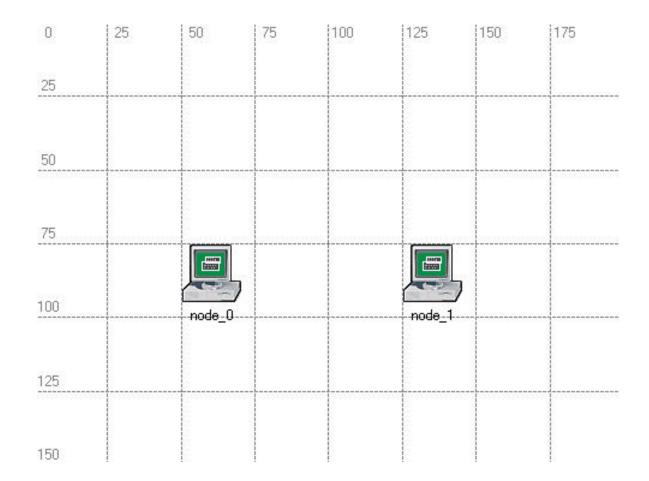
Part 1: PHY Characteristics

- Analyze the effect of PHY characteristics
- PHY characteristics provided by OPNET model: Frequency Hopping, Direct Sequence, Infra Red
- OPNET does not provide customized PHY characteristics
- Add Slot Time, Sifs Time, Minimum Contention Window, Maximum Contention Window parameters into the OPNET node model

## Implementation with OPNET Part 1: PHY - Settings

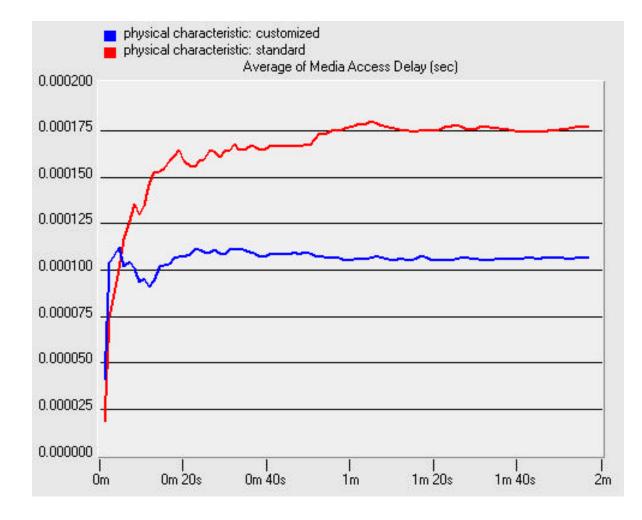
ttribute	Value	
ts Threshold (bytes)	None	
ragmentation Threshold (bytes)	None	Frequency Hopping
ata Rate (bps)	11 Mbps	Direct Sequence
hysical Characteristics	Customized	Infra Red
hort Retry Limit (slots)	7	Customized
ong Retry Limit (slots)	4	
ccess Point Functionality	Disabled	
hannel Settings	()	
uffer Size (bits)	256000	
lax Receive Lifetime (secs)	0.5	
arge Packet Processing	Drop	
SS Identifier	Not Used	
iot Time	2E-05	
ifs Time	1E-05	κ.
lin Contention Window	15	/
lex Contention Window	1023	

## Implementation with OPNET Part 1: PHY - Scenario

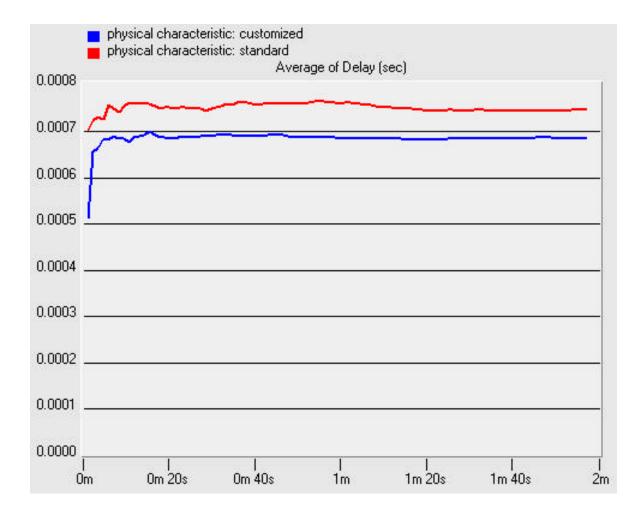


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### Implementation with OPNET Part 1: PHY – Results 1



### Implementation with OPNET Part 1: PHY – Results 2



#### Implementation with OPNET Part 2: WLAN Parameters

- Two important parameters: Fragmentation threshold, RTS/CTS threshold
- Proper fragmentation threshold can improve the wlan performance if the media error rate is high
- Too small fragmentation threshold will make the packet header occupy too much bandwidth
- RTS/CTS is used to deal with the hidden terminal problems

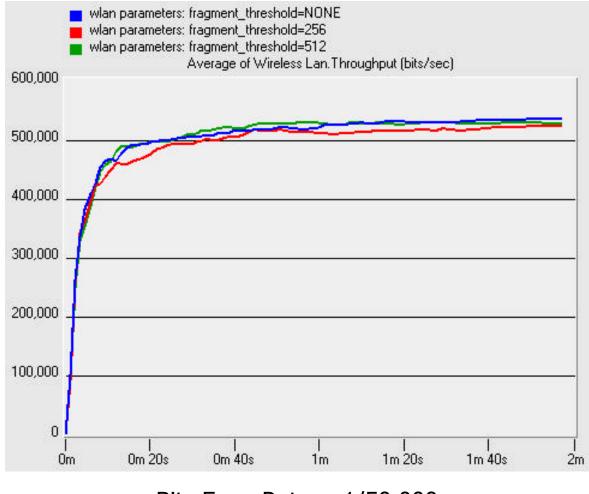
## Implementation with OPNET Part 2: WLAN Parameters – PEG

Attribute	Value 🛆	Mode Disabled
Error Mode	Bit Error Mode	Bit Error Mode
Bit Error Rate (bits per error)	10,000	Packet Error Mode
Packet Error Rate (packets per e	rrot 0.0	
	1	
	L X	

## Implementation with OPNET Part 2: WLAN Parameters – Settings

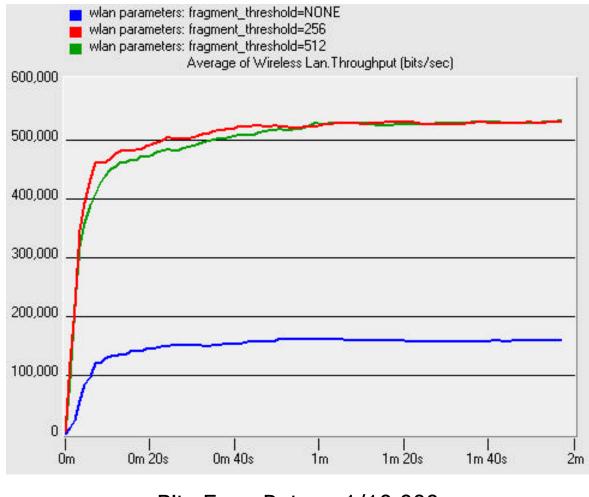
ON State Time (seconds)       constant (100)         OFF State Time (seconds)       constant (0)         Packet Generation Arguments       ()         Stop Time (seconds)       Never         Methods       Methods         Details       Promote         Cant       Cant         Interarrival Time (seconds)       exponential (0.01)	ON State Time (seconds) constant (100) OFF State Time (seconds) constant (0) Packet Generation Arguments () Stop Time (seconds) Never * (Packet Generation Arguments) Table Attribute Value	ON State Time (seconds)       constant (100)         OFF State Time (seconds)       constant (0)         Packet Generation Arguments       ()         Stop Time (seconds)       Never         Details       Promote         Cant       (Packet Generation Arguments) Table         Attribute       Value         Interarrival Time (seconds)       exponential (0.01)         Packet Size (bytes)       exponential (1024)	Attribute	Value	
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Packet Generation Arguments       ()         Stop Time (seconds)       Never         Image: Canal Details       Promote         Image: Details       Promote         Image: Canal Details       Canal Can	Packet Generation Arguments       ()         Stop Time (seconds)       Never	Packet Generation Arguments       ()         Stop Time (seconds)       Never         ▲ (Packet Generation Arguments) Table         ▲ (Packet Generation Arguments) Table         ▲ Attribute       Value         Interarrival Time (seconds)       exponential (0.01)         Packet Size (bytes)       exponential (1024)	ON State Time (seconds)	constant (100)	
Stop Time (seconds)       Never         Image: Stop Time (seconds)       Image: Stop Time (seconds)         Image: Stop Time (seconds)       Value         Image: Stop Time (seconds)       Image: Stop Time (seconds)         Image: Stop Time (seconds)       Image: Stop Time (seconds)	Stop Time (seconds)       Never	Stop Time (seconds)       Never         Mever       ★ (Packet Generation Arguments) Table         Details       Promote       Cant         Interarrival Time (seconds)       exponential (0.01)         Packet Size (bytes)       exponential (1024)	OFF State Time (seconds)	constant (0)	
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			Details Promote	Cant Interarrival Time (seconds)	exponential (0.01)
Packet Size (bytes) exponential (1024	Segmentation Size (bytes) No Segmentation	Segmentation Size (bytes) No Segmentation			
Segmentation Size (bytes) No Segmentation				Packet Size (bytes)	exponential (1024)

### Implementation with OPNET Part 2: WLAN Parameters – Results 1



Bits Error Rate = 1/50,000

## Implementation with OPNET Part 2: WLAN Parameters – Results 2

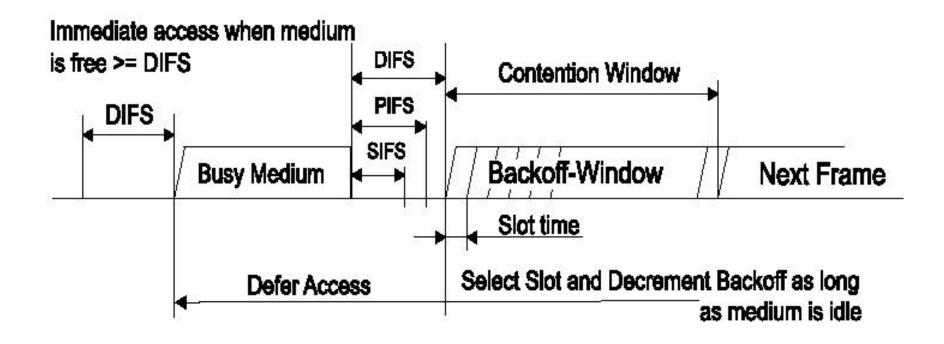


Bits Error Rate = 1/10,000

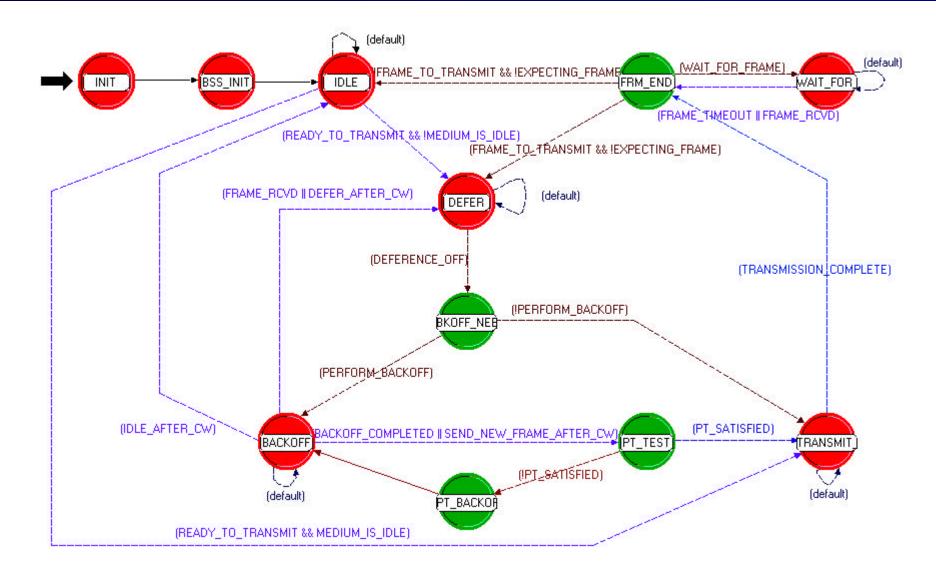
#### Implementation with OPNET Part 3: Adaptive Backoff

- Named Distributed Contention Control (DCC)
- Can be executed on the top of pre-existent access scheduling protocol (DCF)
- For the adaptive reduction of contention in WLAN networks
- Estimate the channel's congestion level from the slots utilization rate
- High congestion level → Trigger the virtual congestion procedure → Do the Backoff without the cost of a collision

### Implementation with OPNET Part 3: Adaptive Backoff

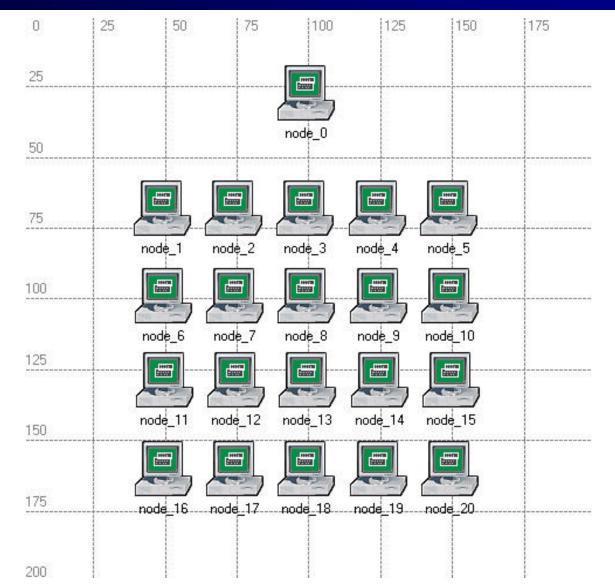


### Implementation with OPNET Part 3: Adaptive Backoff – Modified Model



## Implementation with OPNET

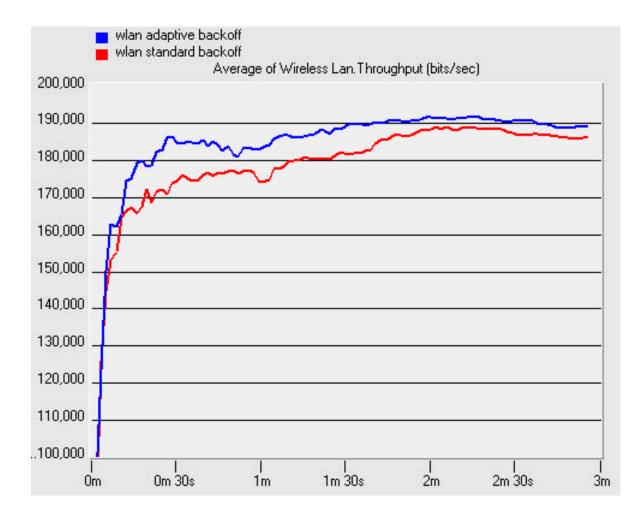
#### Part 3: Adaptive Backoff - Scenario



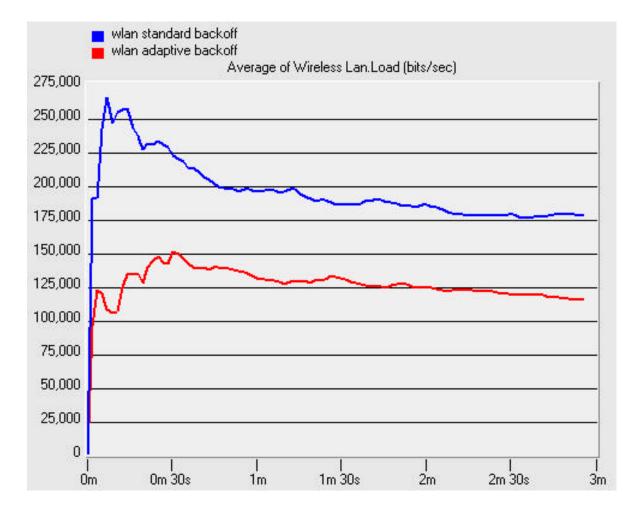
## Implementation with OPNET Part 3: Adaptive Backoff - Settings

tribute		Value	
name		node_0	
model		song_wlan_station_adv	Standard
Backoff Mode		Adaptive	
Destination Address		Random	Тисратс
Media Error Rate		Default	
Traffic Generation Pa	rameters	()	
Wireless LAN MAC Add	dress	Auto Assigned	
Wireless LAN Paramet	ore	1.3	
WITCHESS LAN Faranter	.615	()	
WITCHESS LAIN Farallien	JET 3	()	

## Implementation with OPNET Part 3: Adaptive Backoff – Results 1



## Implementation with OPNET Part 3: Adaptive Backoff – Results 2



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Implementation with OPNET Part 4: SMART Snoop

- TCP-aware link-layer scheme
- Makes the lossy link appear as a higher quality link with a reduced effective bandwidth
- Based on the Snoop protocol
- Use SMART strategy(Simple Method to Aid Retransmissions, it combines the best feature of Go-Back-N and Selective-Ack)



#### References - Page I

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## Thanks! (April 2, 2002)