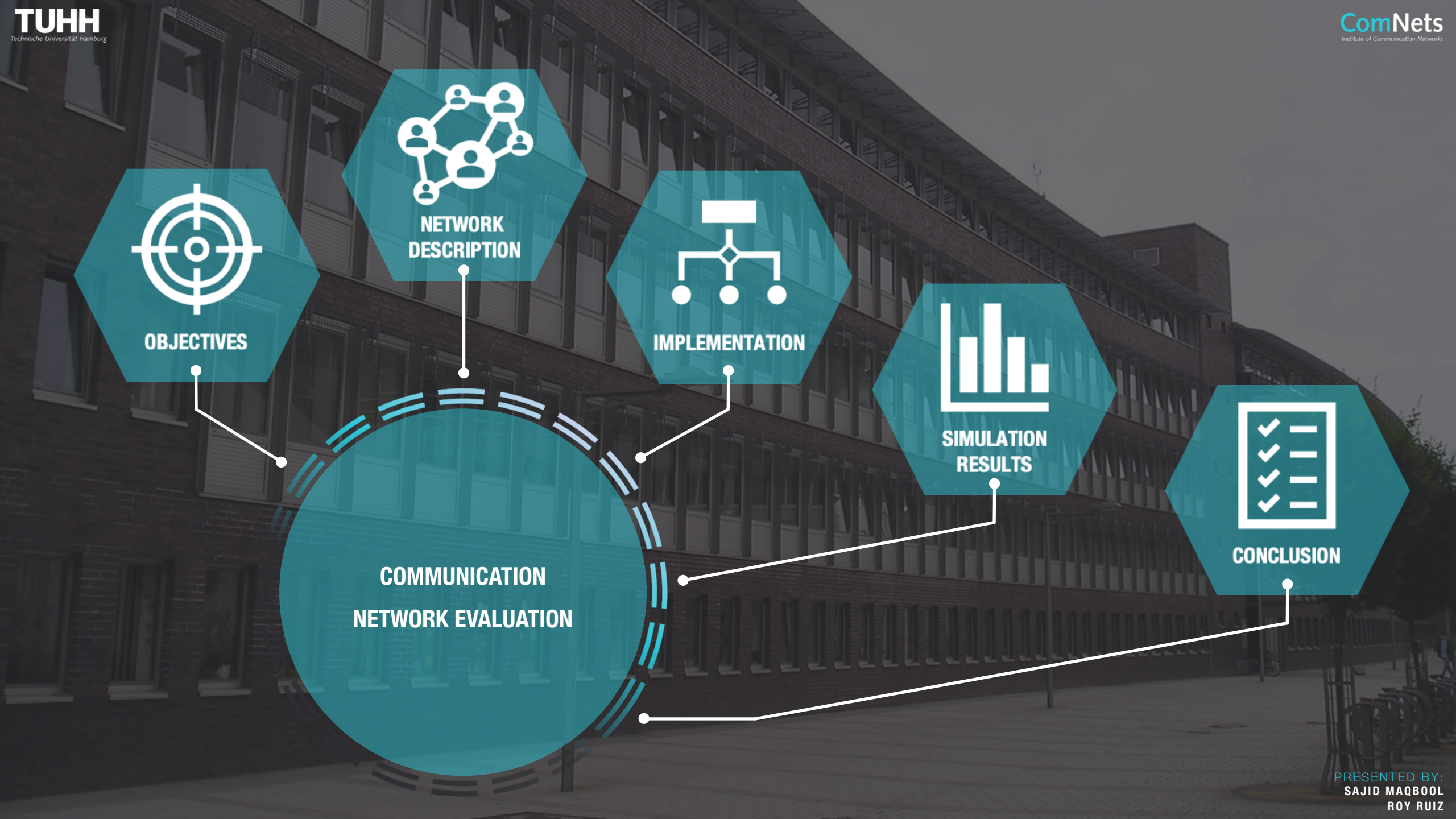
TUHH
Technische Universität Hamburg

ComNets
Institute of Communication Networks



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SAJID MAQBOOL
ROY RUIZ

PROBLEM STATEMENT

- CONSULT OPERATOR RUNNING A SMALL INTERNET PROTOCOL NETWORK
  - USES INTEGRATED SERVICES DIGITAL NETWORK (**ISDN**)

- OBJECTIVE
  - OFFER VOICE OVER IP (**VoIP**) SERVICE
  - UPGRADE ALL ISDN DIAL UP NODES TO DIGITAL SUBSCRIBER LINE (**DSL**)

- PERFORMANCE EVALUATION
  - AVERAGE BIT RATE
  - PACKET LOSS RATE

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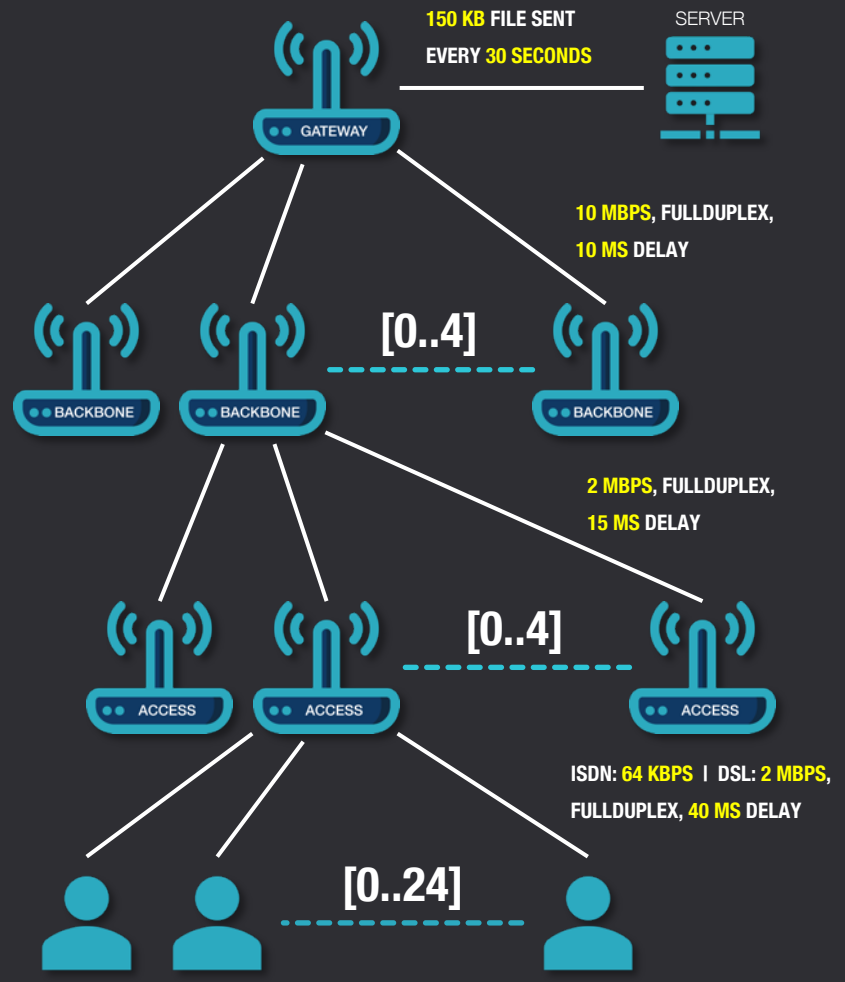
NETWORK DESCRIPTION

- CURRENT NETWORK TOPOLOGY

- ENVISIONED SERVICES
  - UPGRADE LINKS (**ISDN → DSL**)
  - ENABLE VOICE CALL (**VoIP**)
    - NO SERVICE DEGRADATION BELOW **1% PACKET LOSS RATE**



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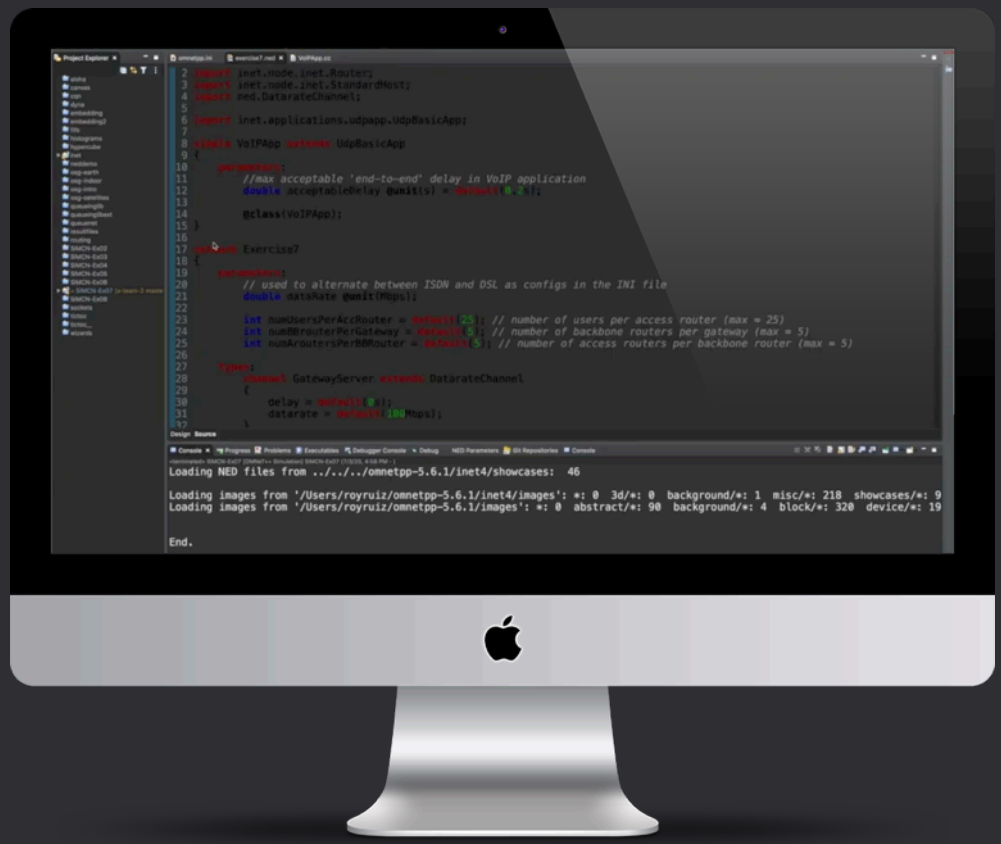
IMPLEMENTATION

- PARAMETER SELECTION
  - **TCP** SETTINGS
    - **TcpNewReno**
    - CONGESTION WINDOW
      - **mss = 1000**
      - **advertisedWindow = 100000**
      - **windowScalingSupport = true**
    - OUTPUT PORT BUFFER
      - MAXIMUM CAPACITY OF **40 IP PACKETS**
    - **startTime = uniform (1s, 30s)**
  - **VoIP** VIA **UDP** SETTINGS
    - PACKET RATE of **50 pps**
    - **acceptableDelay = 200 ms**
    - IMPLEMENT **VoIPApp** CLASS
      - USE **UdpBasicApp** MEMBER FUNCTIONS
      - CALCULATE **AVERAGE PACKET LOSS**
    - **startTime = exponential (0.001s)**



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IMPLEMENTATION

- MULTIPLE SCENARIOS TO EVALUATE PERFORMANCE
  - USED EDGE CASES (BEST & WORST)
  - STEADY-STATE ACHIEVED AFTER ~50 SECONDS
  - SIMULATED ACROSS 3, 10, 30 RUNS

VOICE CALL	YES **VoIP**		NO **VoIP**					
WEB SURFING	**DSL**	**ISDN**	**DSL**			**ISDN**		
Simulation Time (s)	**1K**	**1K**	**500**	**1K**	**2.5K**	**500**	**1K**	**2.5K**
VIA GATEWAY	✓	✓	✓			✓		
VIA BACKBONE	✓	✓	✓			✓		
VIA ACCESS	✓	✓	✓			✓		
ACC + BB (MIXED)	✓	✓	–			–		

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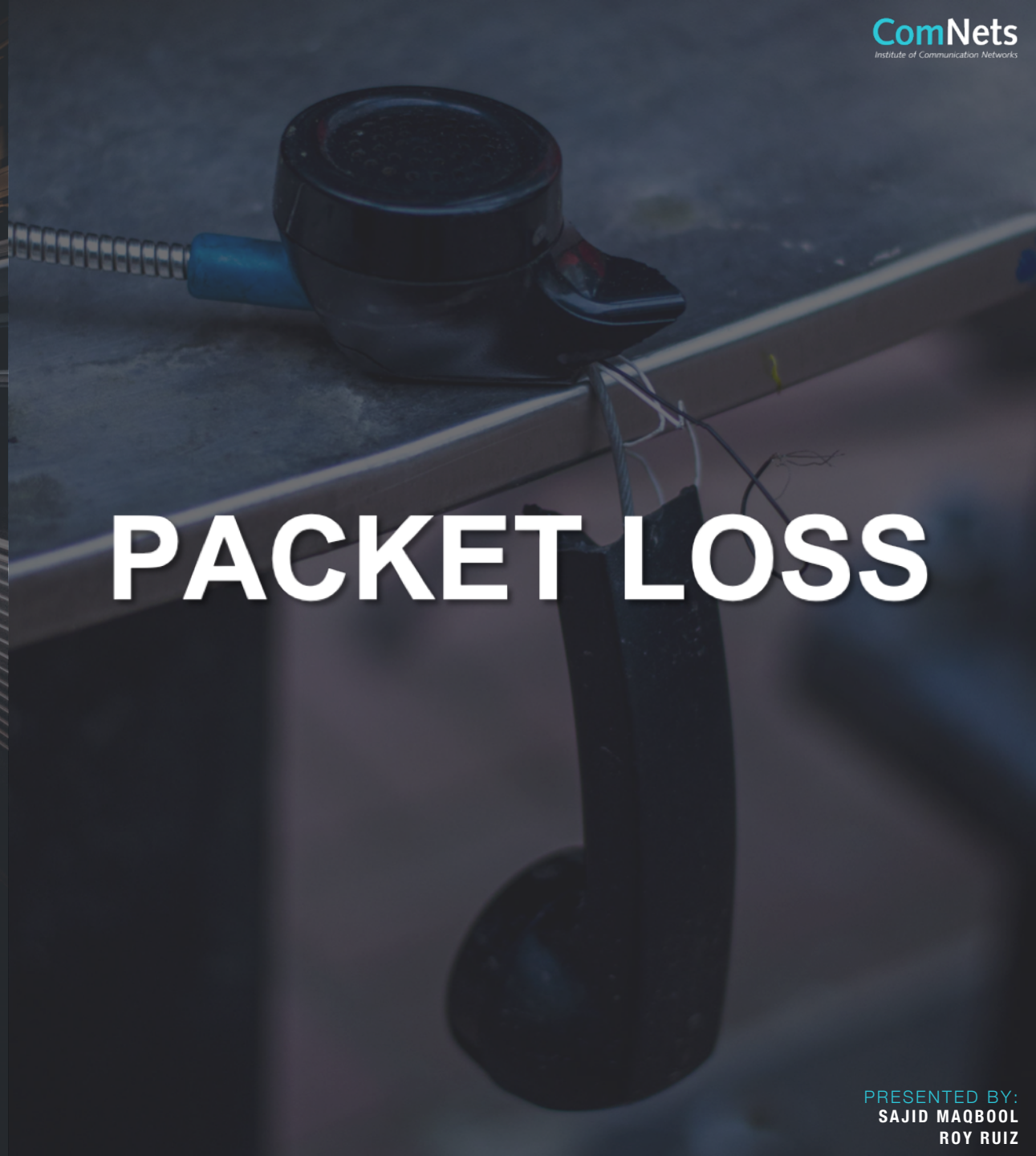
BIT RATE



PACKET LOSS

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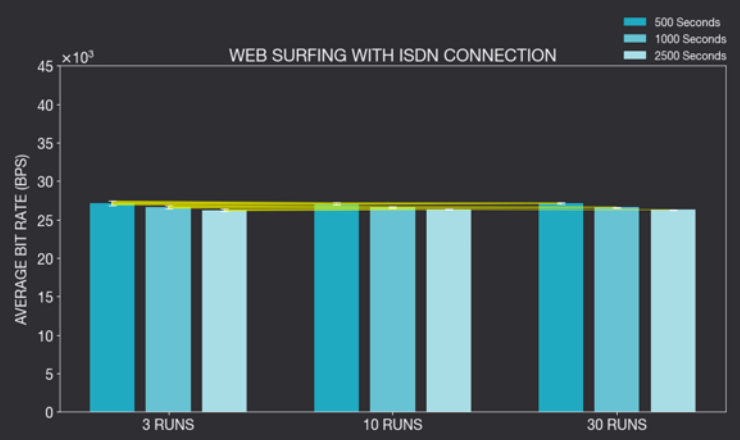
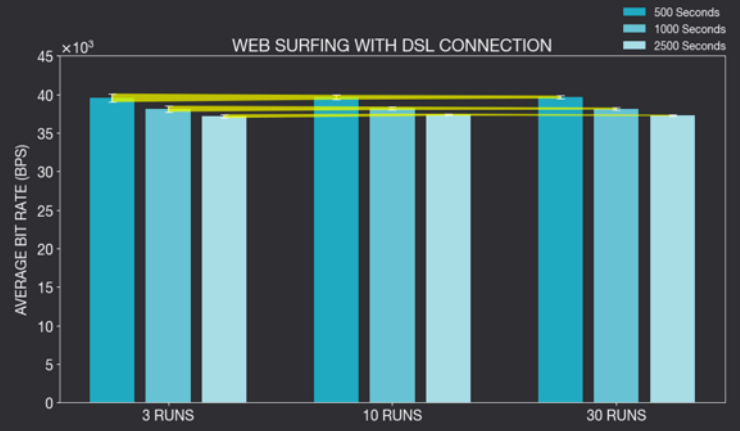
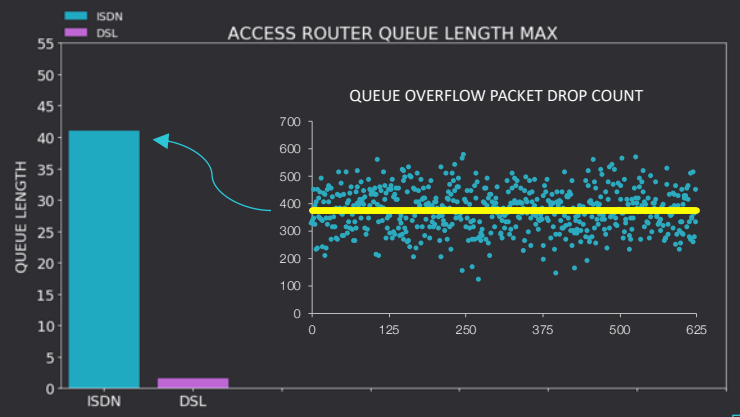
SIMULATION RESULTS

- AVERAGE BITRATE WHILE WEB SURFING PER USER
  - **ISDN: ~26.7 Kbps**
  - **DSL: ~38.4 Kbps**
- ELIMINATION OF TRANSIENT EFFECTS

- EFFECT OF CONGESTION WINDOW
- OBSERVED QUEUE LENGTHS
- QUEUE OVERFLOW PACKET DROP COUNT







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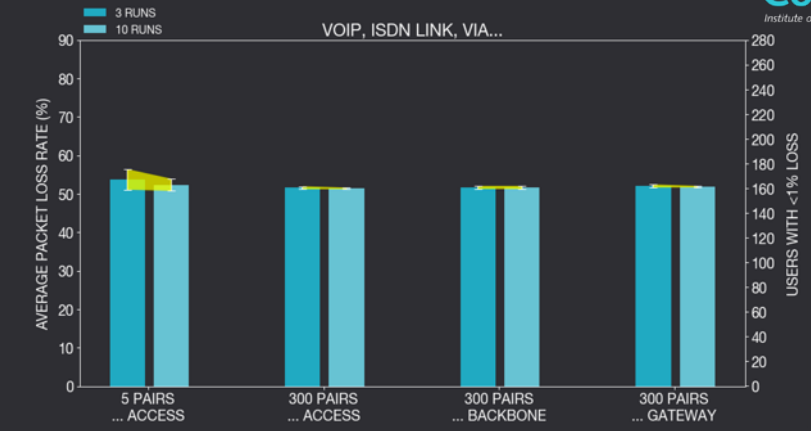
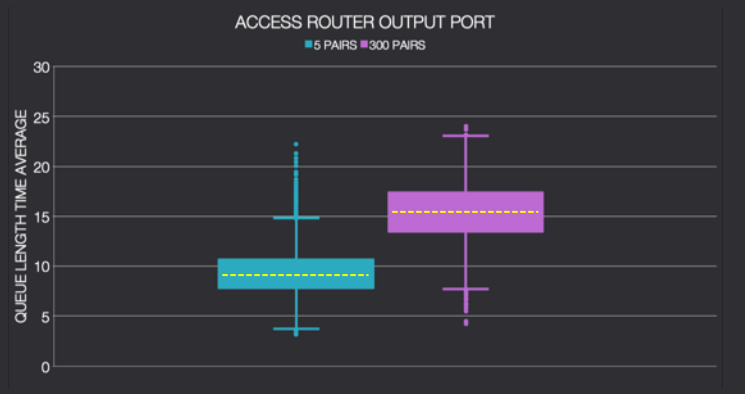
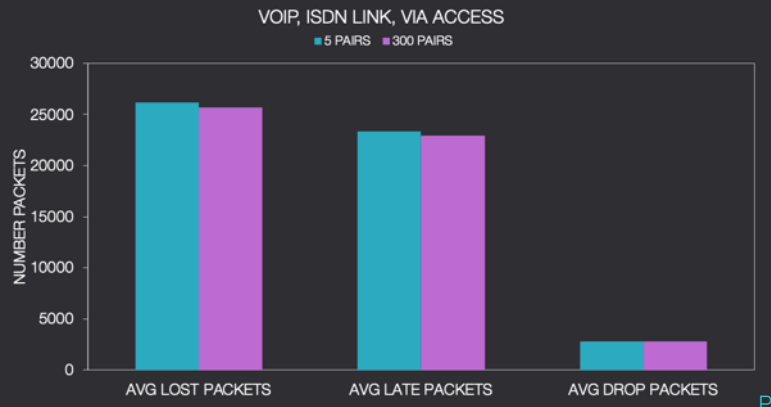
SIMULATION RESULTS

- WORST CASE PACKET LOSS RATE IN CURRENT NETWORK
  - **VoIP + ISDN: 51.8%**

- NO TREND OBSERVED
  - **queueLength timeAvg >> acceptableDelay**
  - **TOTAL LATE PACKETS >> TOTAL DROP PACKETS**







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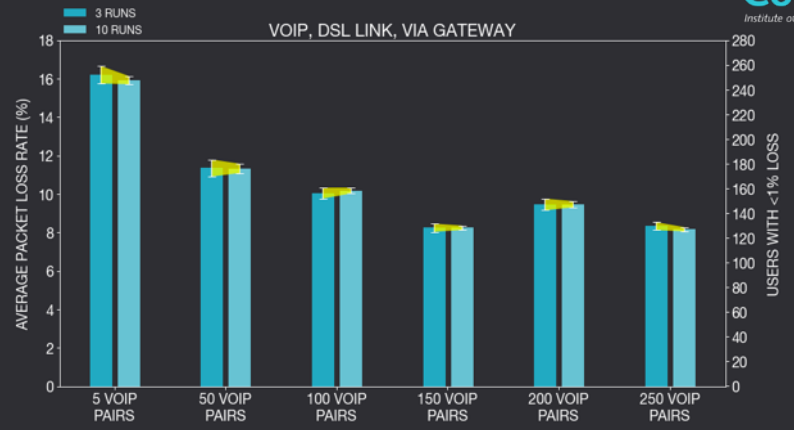
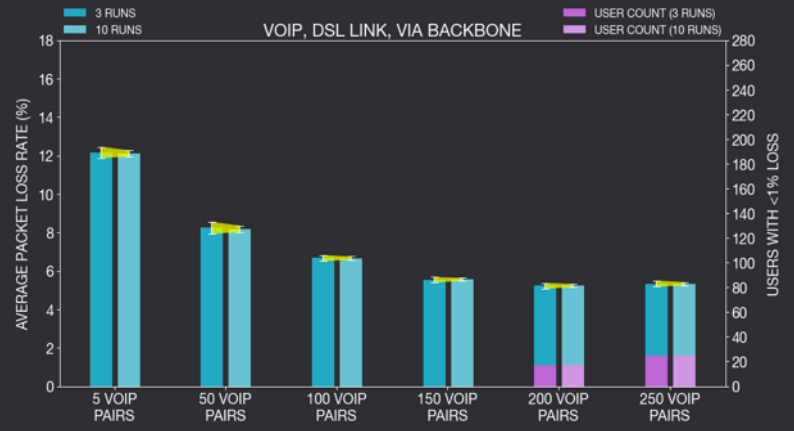
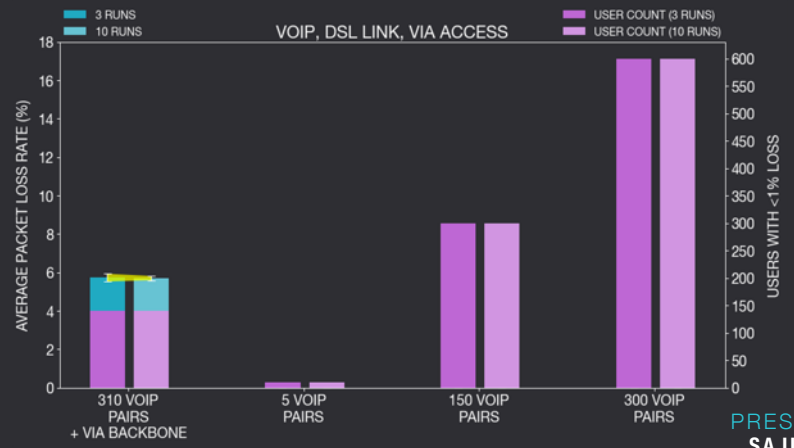
SIMULATION RESULTS

- WORST CASE PACKET LOSS RATE IN UPGRADED NETWORK
  - **VoIP + DSL: 15.9%**

- TREND OBSERVED
  - PACKET LOSS RATE DECREASED AS NUMBER OF **VoIP** PAIRS INCREASED
  - SOME USERS EXPERIENCED NO DEGRADATION (**<1% AVERAGE PACKET LOSS**)







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SIMULATION RESULTS

- VIA GATEWAY (WORST CASE)
  - DELAY EXPERIENCED

- MIXED SCENARIO (BEST CASE)
  - CONSIDERABLY LOW **AVERAGE PACKET LOSS RATE**
  - CONSIDERABLY HIGH NUMBER OF USERS EXPERIENCED NO DEGRADATION (**<1% AVERAGE PACKET LOSS**)

VOICE CALL / WEB SURFING	CASE	VoIP DSL	VoIP ISDN	CASE
VIA GATEWAY	BEST	8.2% [1.1,18.7]	51.8% [19.4, 80.2]	WORST
	WORST	15.9% [13.9,18.5]		
	USERS <1%	0		
VIA BACKBONE	BEST	5.3%* [0.6,15.8]	51.6% [26.7, 76.4]	MEDIOCRE
	WORST	12.1% [9.8,14.2]		
	USERS <1%	25		
VIA ACCESS	SPECIAL	0%	51.4% [21.0,79.6]	BEST
	USERS <1%	625		
VIA ACC + BB (MIXED)	BEST	5.7%** [0.0,14.8]	–	–
	USERS <1%	140		

* BASED ON 250 **VoIP** PAIRS DATA
** BASED ON 310 **VoIP** PAIRS DATA

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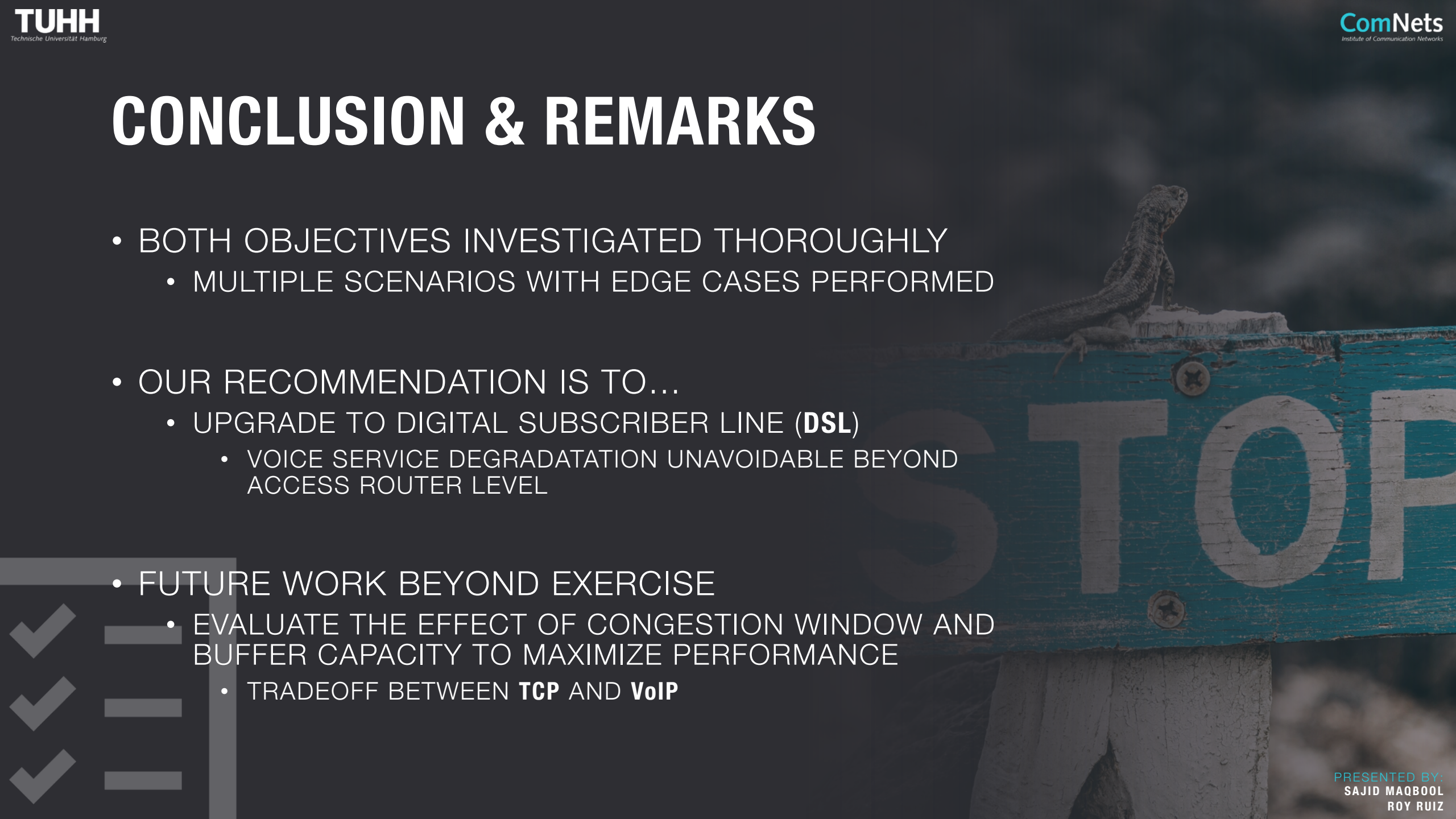
CONCLUSION & REMARKS

- BOTH OBJECTIVES INVESTIGATED THOROUGHLY
  - MULTIPLE SCENARIOS WITH EDGE CASES PERFORMED
- OUR RECOMMENDATION IS TO…
  - UPGRADE TO DIGITAL SUBSCRIBER LINE (**DSL**)
    - VOICE SERVICE DEGRADATATION UNAVOIDABLE BEYOND ACCESS ROUTER LEVEL
- FUTURE WORK BEYOND EXERCISE
  - EVALUATE THE EFFECT OF CONGESTION WINDOW AND BUFFER CAPACITY TO MAXIMIZE PERFORMANCE
    - TRADEOFF BETWEEN **TCP** AND **VoIP**



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