# *TCP over Satellite – Effects of Advertised Receive Buffer Size, Timer Granularity, and Bit Error Rates*


Fraunhofer Institute for Open Communication Systems


# *TCP over Satellite – Effects of Advertised Receive Buffer Size, Timer Granularity, and Bit Error Rates*

## Dissemination of Project Results

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Fraunhofer Institute for
Open Communication Systems

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Berlin, Germany

June 19, 2002



# *Outline*

| | |
|---|---|
| Related Research | - SCPS/TP ---- TCP ---- ATM Sat Scope |
| Simulation Environment | - Used Toolsets<br>- Simulation Workflow<br>- Simulation Model Verification |
| Network Model | - Parameter<br>- Verification |
| TCP Evaluation | - Characteristics of TCP<br>- Simulation Model<br>- Simulation Parameter |
| Simulation Results | - Effects of Timer Granularity and Receive Buffer Size<br>- Effects of Bit Error Rates<br>- Overall Performance |

# *Related Research*

SCPS-TP

- Highly specialized
- Performance Issues

TCP

- Large BDP
- Downward compatible vs. experimental improvements
- Constant vs. variable delay

ATM-Sat Scope

- Standard IP suite
- Variable delay
- BERs

# *Where we are*

Related Research

| | |
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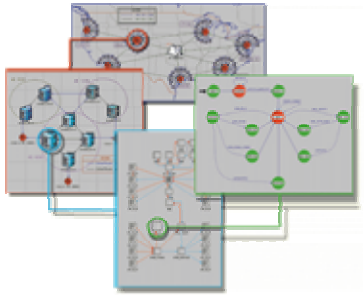
# *Simulation Environment*
## *Used Toolsets*

Satellite Toolkit STK

- Focus on satellite network aspects
- Commercial standard tool



OPNET Modeler Radio

- Focus on communication networks aspects
- Widely spread in commercial environments
- opnet vs. ns

# *Simulation Environment*
## *Simulation Workflow*

STK

Definition of satellite network- Orbit altitude
- Orbit type

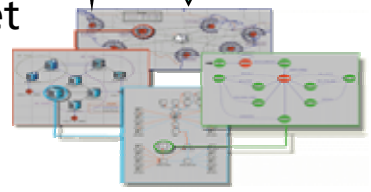
Satellite Path Description

AER Data → Parser Programs

p2p-link w/ variable delay

*.c and *.h Files for pipeline stages

Opnet



Definition of communication network aspects
- Bandwidth
- Bit Error Rates
- Internet Protocol Suite



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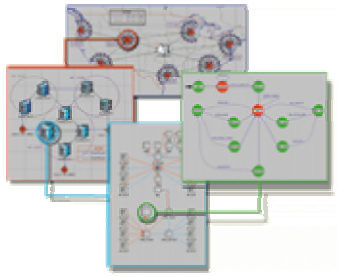
# *Simulation Environment*
# *Simulation Model Verification*



Simulation Models for
Research related Experiments

Simulation Models for
System Verification



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# *Network Model Parameter*
# *Slant Range*

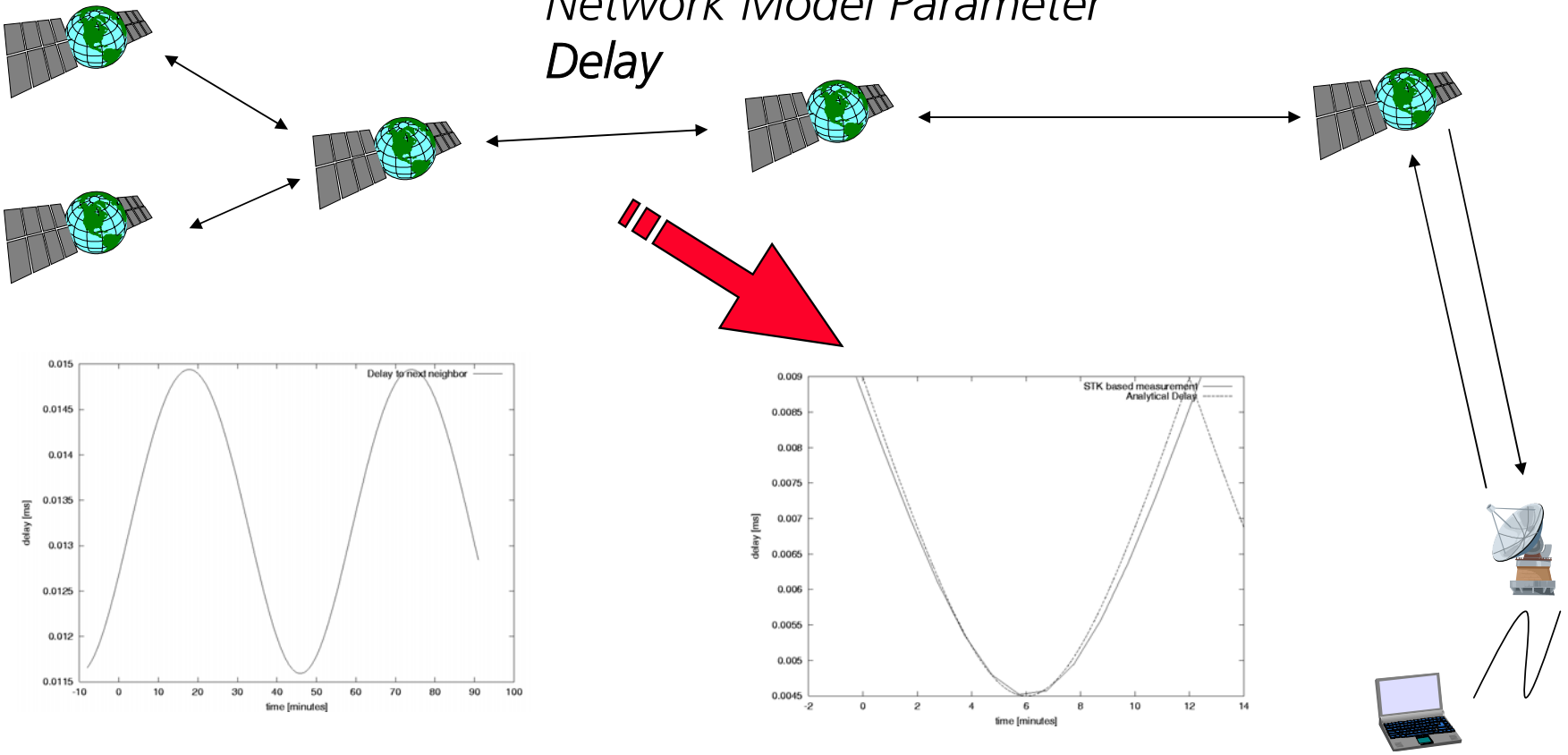
Slant Range

- Analytical model
- Function of orbit altitude
- Visibility constrains

Analytical
vs. Simulated Distance

- STK based simulation compared to theroy
- Derivation less than 2%

# Network Model Parameter
## Delay



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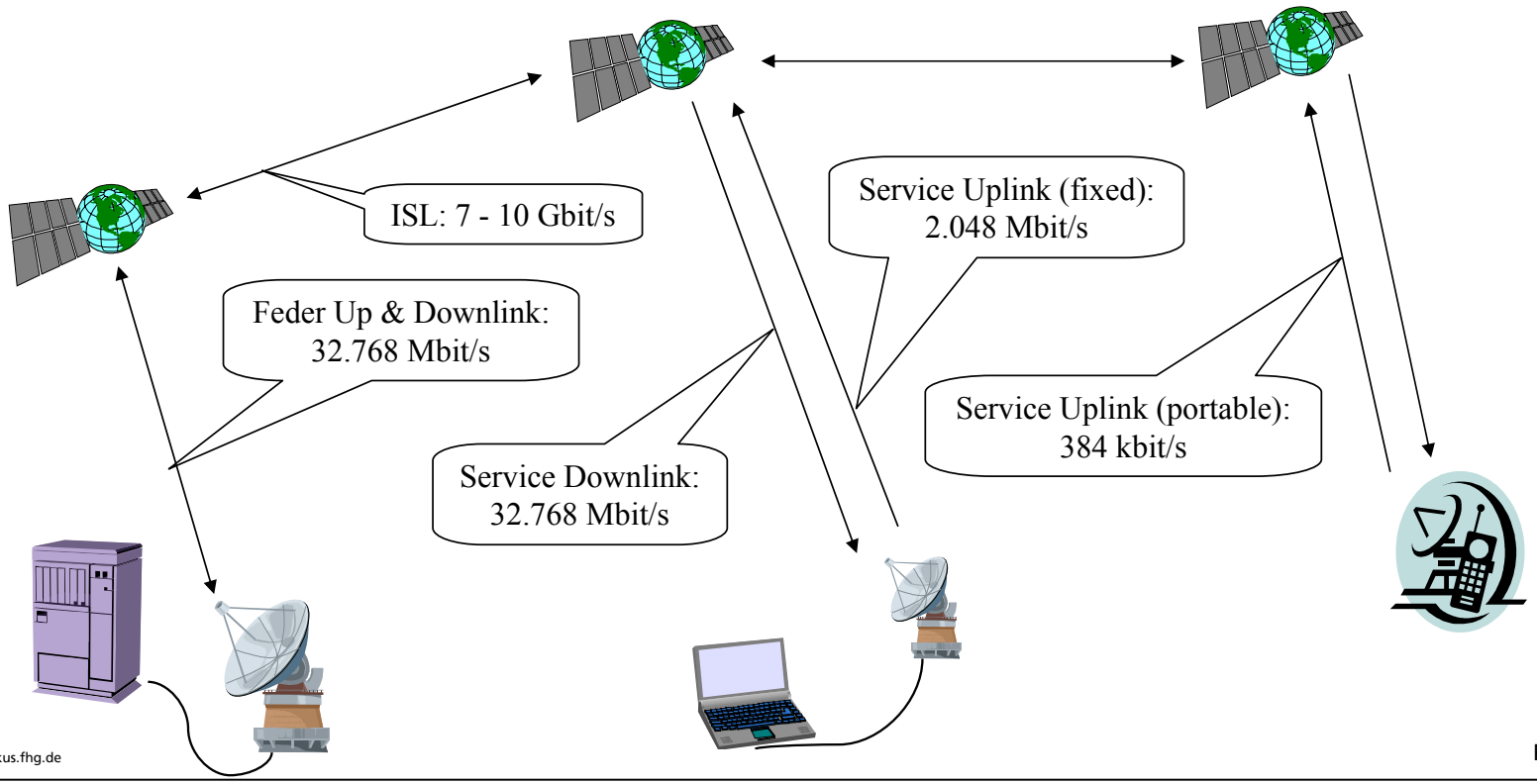
# Network Model Parameter
## Bandwidth

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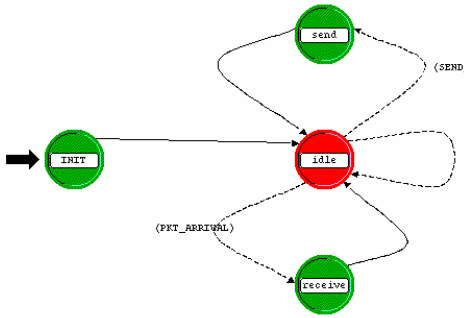
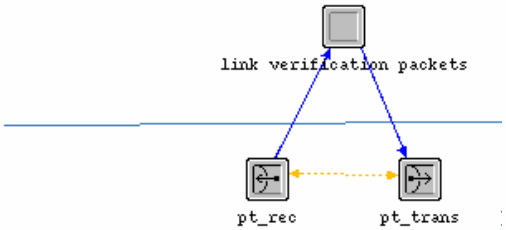
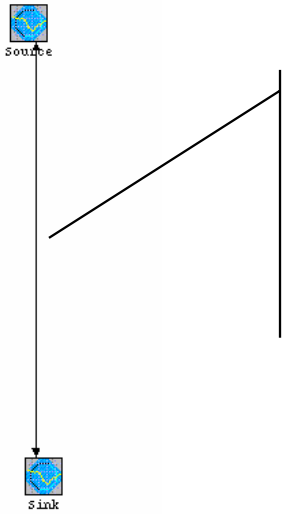
# *Network Model*
# *Verification Model*




PTP-Duplex-Link:
- delay
- BW
- BER



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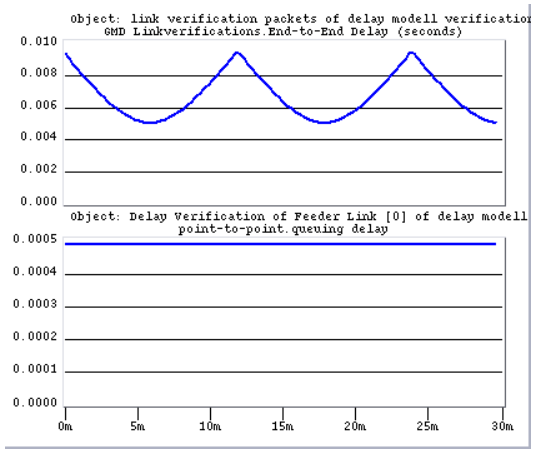
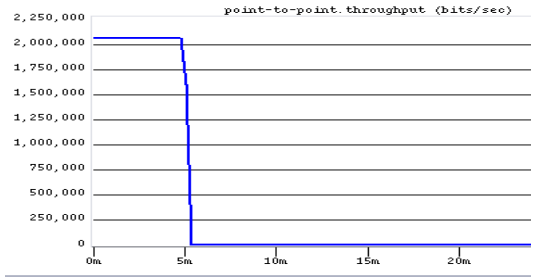
# *Network Model Verification*
## *Verification Measurements*




Delay

- Expected values
- Consider queuing delay




Bit rate

- Upper Limit

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TCP Evaluation
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# *TCP Evaluation*
## *Characteristics of TCP*

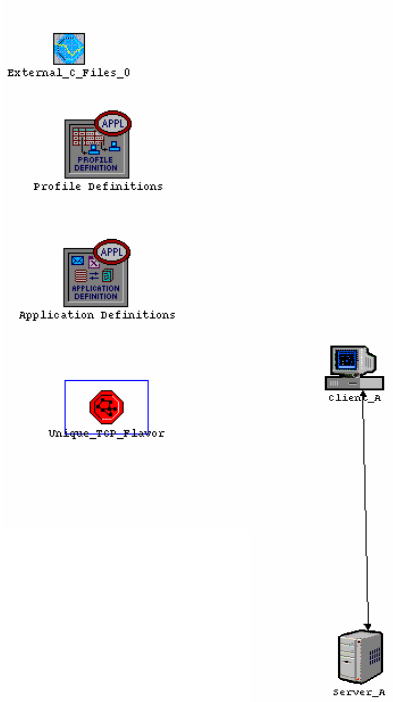
Retransmission Method

- ACK based
- Timeouts
- RTT Estimation

Throughput Limits

- Window Size
- Advertised Receive Buffer

# *TCP Evaluation*
# *Simulation Model*




Parameter Application

- File Size
- Put/Get Ratio
- Temporal behavior

Parameter Link

- Delay
- Bandwidth
- BER



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# *TCP Evaluation*
## *Simulation Parameter*

Given:

- TCP Flavor
- Buffer Size
- BER

More than 140 experiments

| Lower Bound Of RTT in ms | None | 100 | 200 | Default |
|---|---|---|---|---|
| Timer Granularity G | | | | |
| G=1 ms | | 2 | 7 | |
| G=50 ms | | 3 | 8 | |
| G=100 ms | | 4 | 9 | |
| G=250 ms | | 5 | 10 | |
| G=500 ms | | 6 | 11 | 12 |
| Minimal G to avoid false retransmissions (varying) | 1 | | | |

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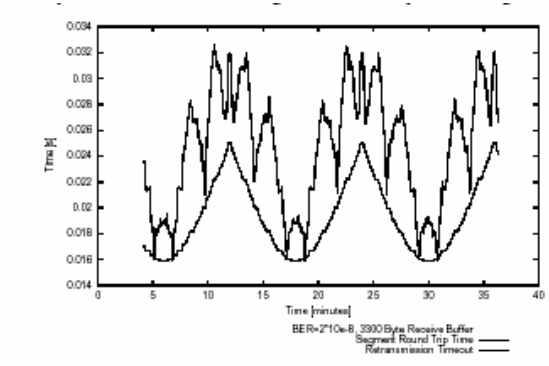
# *Simulation Results*
# *Effects of Buffer Size & Timer Granularity*

Advertised Receive Buffer
- Larger than BDP
- Less than BDP
- Equal to MSS

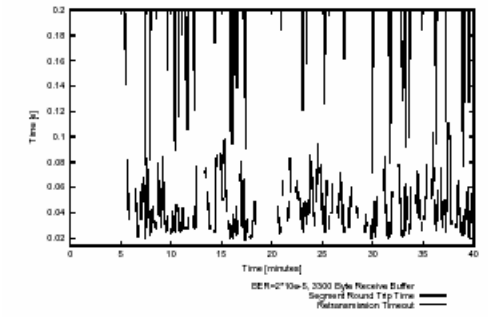
Timer Granularity
- May cause false retransmissions

| Advertised Receive Buffer | 64 kB<br>>> BDP | 6.6 kB<br>= BDP | 3.3 kB<br>1/2 BDP | 1.46 kB<br>MSS |
|---|---|---|---|---|
| Min. Timer Granularity (G) | 1 ms | 1 ms | 4 ms | 26 ms (250 ms) |

# *Simulation Results*
# *Effects of Bit Error Rates*




BER = 2*10e-8
- Overlapping with BER = 0
- No needless retransmissions




BER = 2 * 10e-5
- No resemblance with variable propagation delay
- Prevention of false retransmissions



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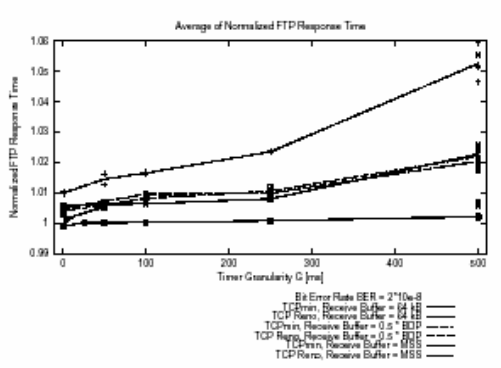
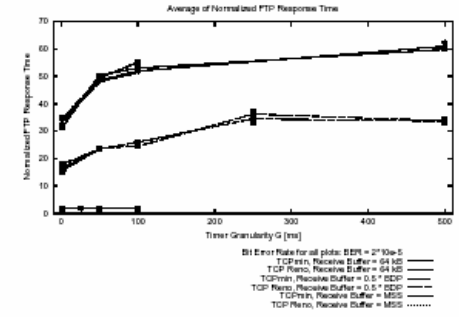
# *Simulation Results*
# *TCP Performance*




TCP flavor dominates




Influence of different timer granularities

Feasibility for real life environments



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# *Conclusion & Outlook*

| | |
|---|---|
| TCP | - Sophisticated protocol<br>- Minor influence of hand-tuned implementations |
| SCPS-TP | - No better performance for today's BER above FEC<br>- Acceptance by IETF for usage over Internet unsure |
| Simulation Environment | - Model exchange between industry and research vital<br>- Engineering approach necessary |