



Competence Center for  
Advanced Network Technologies and Systems



# TCP/IP Over LEO Satellites

## Related Activities within the ATM-Sat Project

Presentation to Industry Representatives and  
Interested Scientists

<http://www.fokus.gmd.de>  
<http://www.fokus.gmd.de/cats>

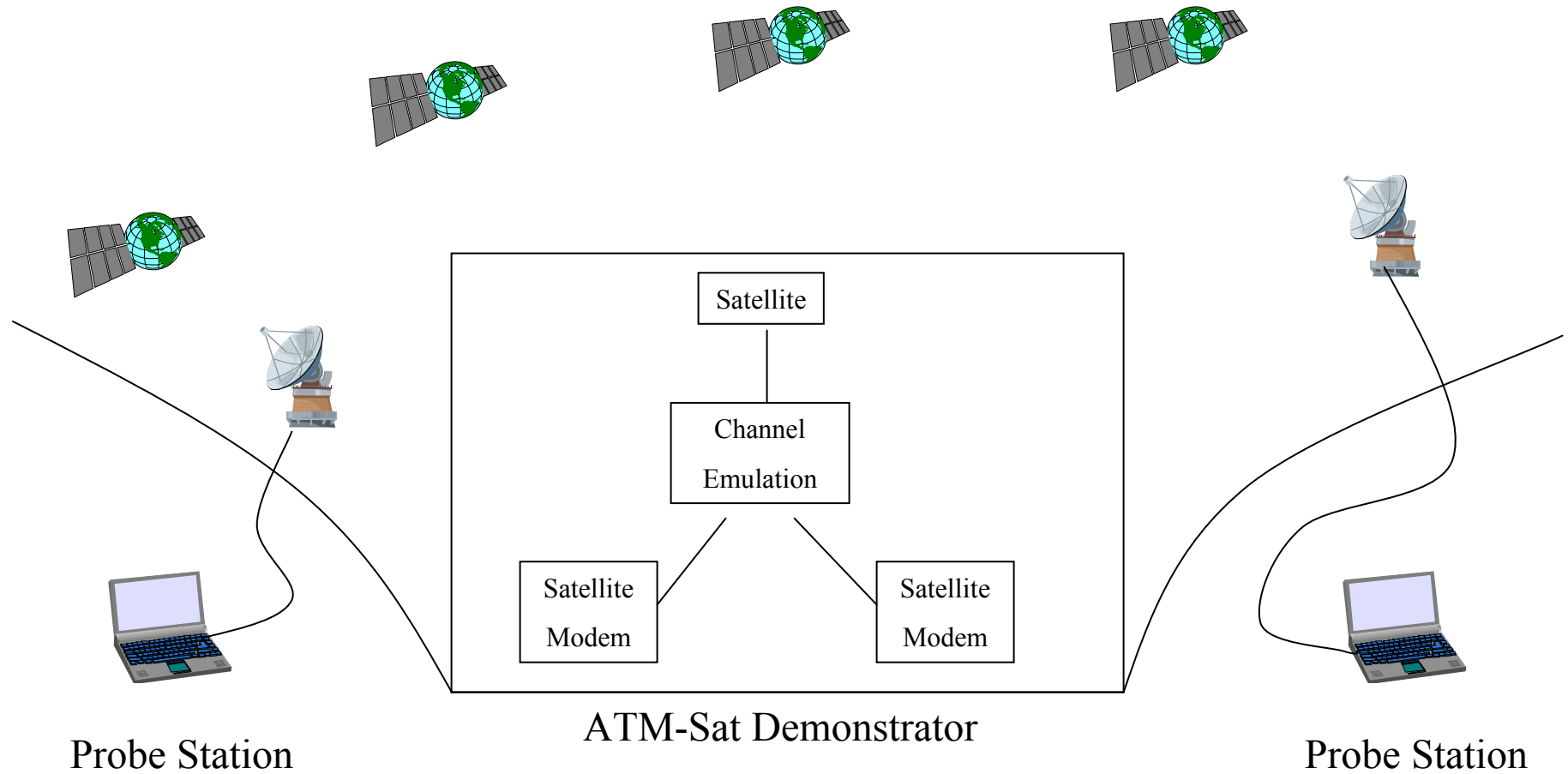


# Contents



- Test- & Measurement Suite
- Simulation Environment
- First Simulation Results

# Global Set-Up



ATM-Sat Demonstrator Hardware

# Probe Station



- Consists of:
  - Workstation or PC running standard operation system
    - FreeBSD
    - Windows
    - further OS possible
  - Protocol & performance testing tools (RFC 2398)
- Used as:
  - TCP analyzer
  - User application platform

# TCP Analyzer



- Fundamental Performance Evaluation
  - Pre-defined set of experiments
  - Automatic execution
  - Base for comparing TCP flavors
- Configuration:
  - Operation System: FreeBSD 4.1
  - Testing Tools: DBS, netperf, ...

# User Application Platform



- Subjective QoS
  - Set of “daily life” applications
  - User interaction
  - Supplementary performance evaluation
- Configuration:
  - Operation System: Windows, Unix, ...
  - Applications: Web-Browsing, NFS, etc.
  - Supplementary Tools: tcptrace, tcpdump, ...

# Where We Are ...



- Test- & Measurement Suite
- **Simulation Environment**
- First Simulation Results

# Simulation Environment



- General Aspects
- System Parameter



# General Aspects



- Independence of demonstrator hardware
- Analyzation of “large” networks
- Adaptation to emerging project constrains
- Simulation tool: OPNET modeler / radio

# System Parameter



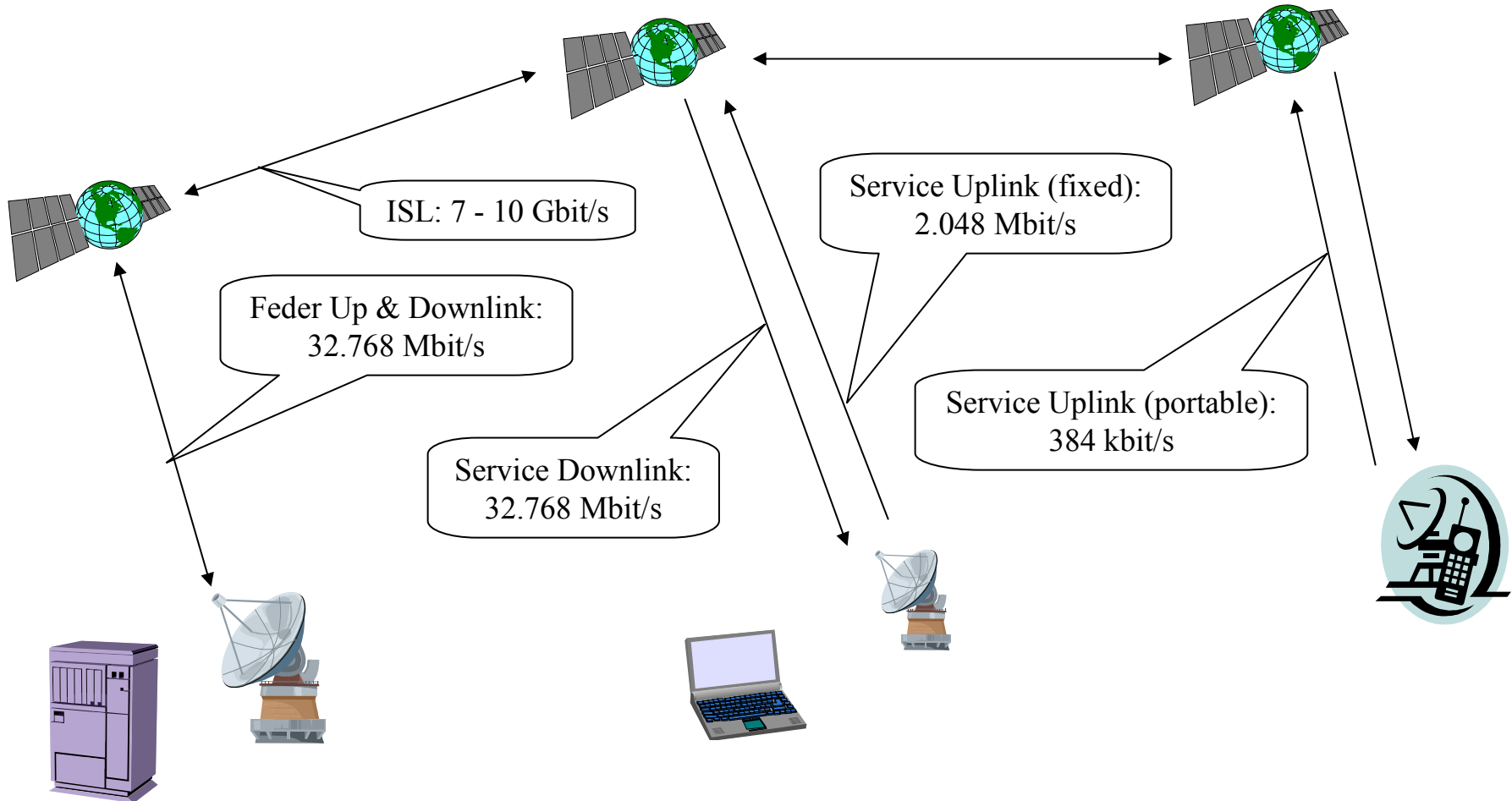
- Satellite Orbit
- Bit Rates
- Bit Error Rate
- Up- & Down-Link Delay
- Intra-Satellite Delay
- End-to-End Delay

# Satellite Orbit



- Observer - Satellite Distance
  - Analytical model
  - Function of orbit altitude
  - Visibility constrains
- Analytical vs. Simulated Distance

# Bit Rates



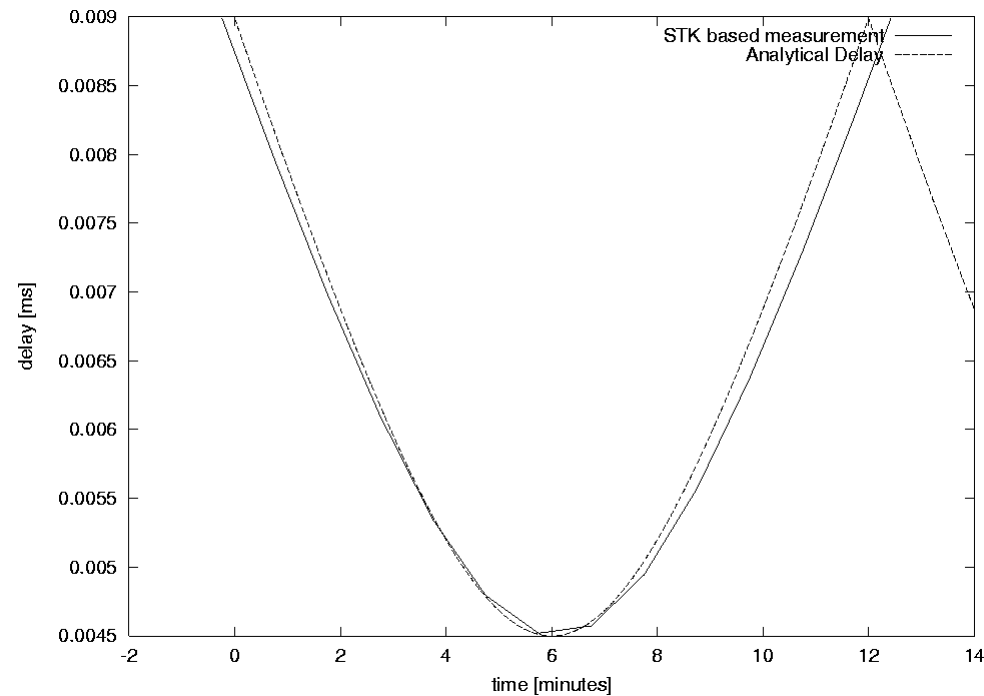
# Bit Error Rate



- BER at target system above MAC
- Up- & Down-Link
  - Good weather condition:  $2E-8$
  - Rain
    - causes link to collapse
    - last for approx. 10 minutes
- ISLs: tbd

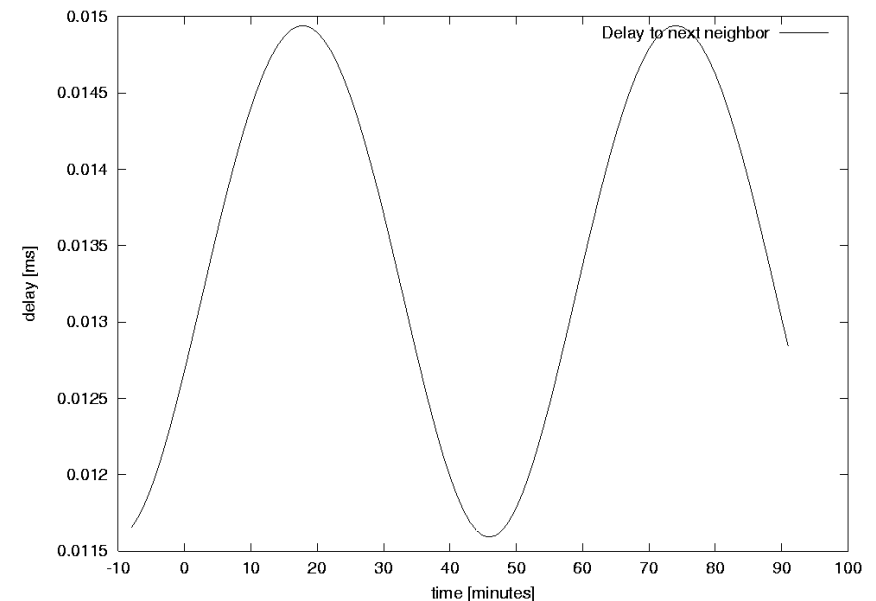
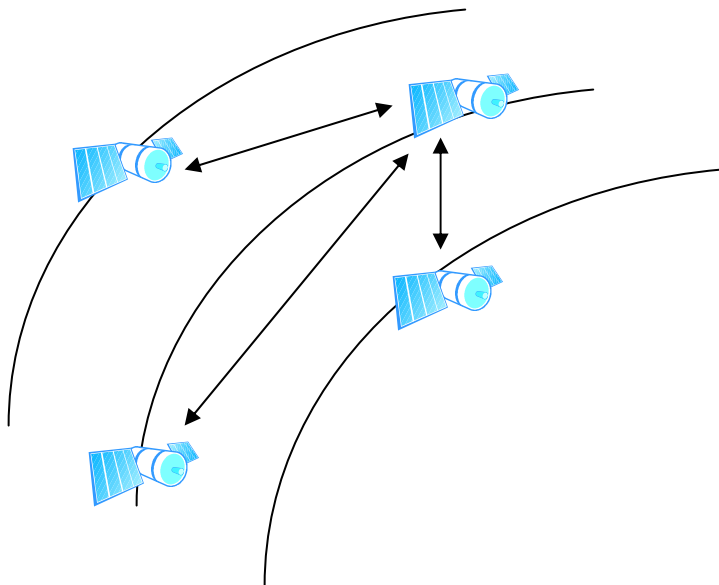
# Up- & Down-Link Delay

- Based upon analytically gained distance
- Comparison analytical vs. simulated delay



# Intra-Satellite Delay

- Final “routes in the sky” still open
- Assumed ISLs:
  - To forward and backward satellite
  - To left and right neighbor
- Simulation based delays



# End-to-End Delay



- Describes aspects of:
  - Cooperate networks
  - intercontinental connections
- Currently not considered
- Obtained through final simulations
- Reference measurements predict approx 150ms



# Where We Are ...



- Test- & Measurement Suite
- Simulation Environment
- **First Simulation Results**

# First Simulation Results



- Link Model & Verification
- RTT Measurement of TCP

# Link Model Description

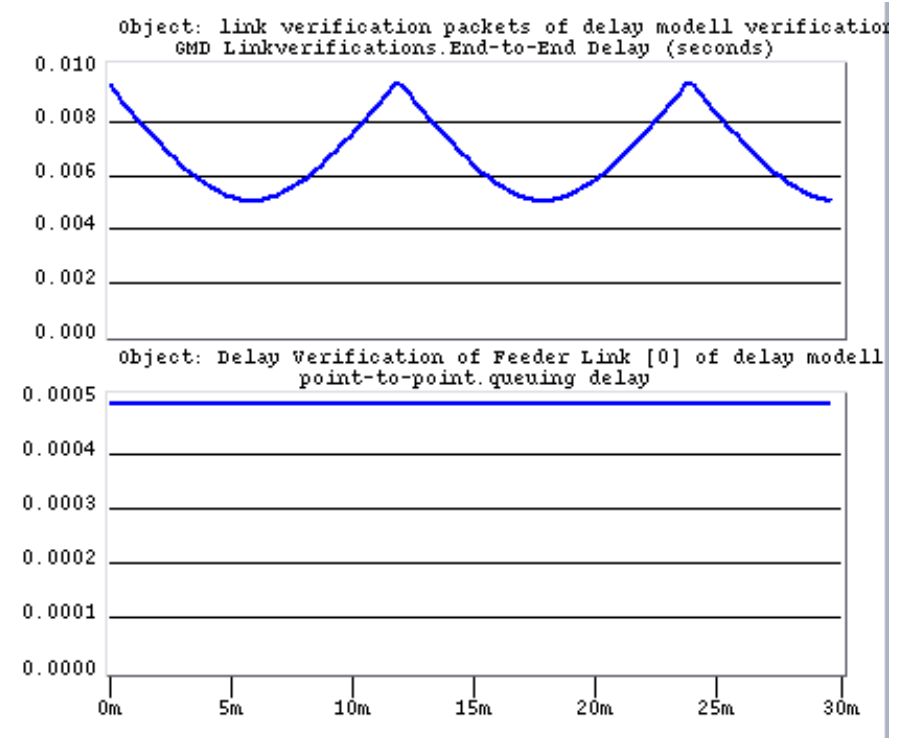
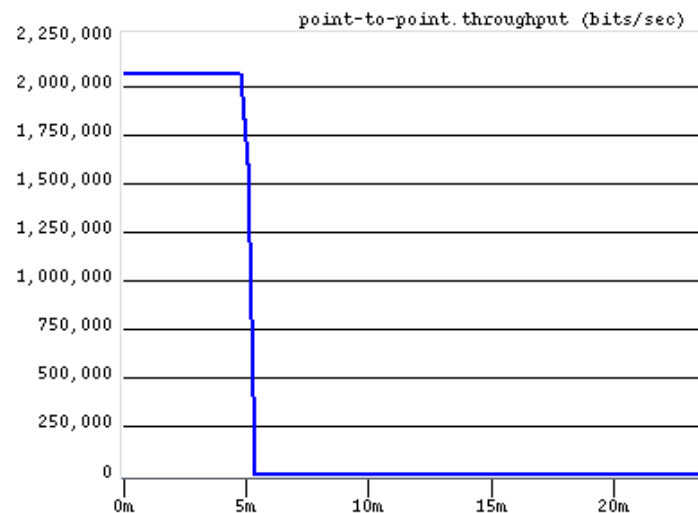


- Point-to-point, symmetrical, wired link
- Delay
  - function of time
  - deterministic, periodic
- Configurable Parameter:
  - BER
  - Bit rate

# Link Model Verification



- Delay:
  - Expected values
  - Consider queuing delay
- Bit rate
  - Upper Limit



# RTT Measurement of TCP



## ■ Impact of RTT-gain coefficient

- Acts as „smoothing“ factor

- Considered values

  - gain = 0.125

  - gain = 1

## ■ Results

- Derivation less than 1ms

- „Smoothed“ curved closer to real round-trip delay

