Broadband Year 1999

Integration and Evaluation of Internet Protocols into ATM Networks

MPOA and LANE Performance Tests

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- Summary

Today`s problems

- Information flood by new media
- Rapid development of new technologies
- Proprietary systems of the manufactures avoid standards
- Faster development of the global market
- Missing Know-how by the fast development
- Faster information flood by actual Data within and without a company
- Single companies are not able to handle the global market

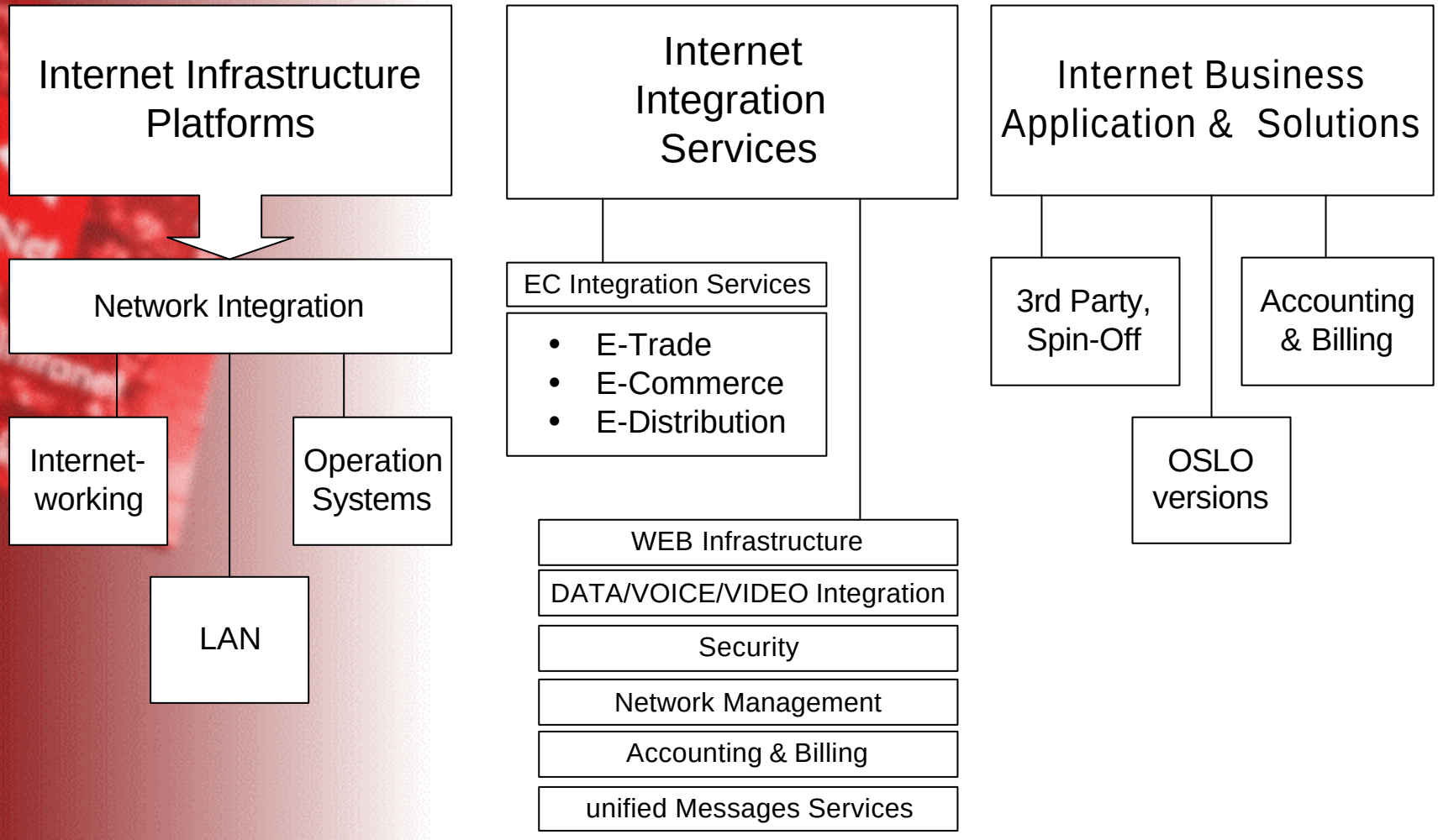
Solutions

- Filtration and conditioning of information
- Assessment and evaluation of new technologies
- Evaluation and detection of new products and market trends
- Build up of missing Know-how
- Information platform
- Co-operation and partnership

CC-FK visions

- Help companies to handle the change from the industrial society to the information society
- The companies is able to recognise visions, trends, and forecasts as soon as possible
- Decisions of the market can be evaluated and influenced
- Other Competence Center and customers get continuously information

Business Profile OptiNet



Goals of the measurements

- Get to know of the available products in the area of LAN and WAN
- Co-operations with the manufactures
- Test of the product and technology features
- Collect of experience with the handling of different switches, technologies, and adaptation methods
- Assessment of the tests for own customer projects
- Publication of the results in different publishing houses.
- Summarised the results in one report for customers and interest people.

LAN Emulation (LANE)

- Migration of legacy LANs to ATM: Ethernet switch (layer 2) and router (layer 3) coupling
- Universal implementation (MAC layer is emulated): arbitrary LAN protocols
- Using of the application layer without ATM configuration
- Support of PVC/SVC connections
- AAL-5 packet encapsulation
- IP multicasting
- D-MTU: 1500 byte

Disadvantages of this approaches

- No QoS support
- High functionality of LANE (complex: IP-MAC-ATM)
- Router bottleneck between LIS or ELAN
- Legacy LAN bottleneck (old drivers, infrastructure)
- BUS limited the LANE performance
- Only IP support and high configuration effort in CLIP (RFC-1577)
- No redundancy and recovery mechanisms in LANE 1.0
- Bad scalability and bigger overhead of LANE

Multiprotocol-over-ATM (MPOA)

- Emulates a fully routed layer 3 protocol over ATM
- Distribute the routing functions between route servers
- Separate routing from switching functions
- Leverage performance and QoS capabilities of ATM network
- Direct connections between ELANs rather than passing through traditional routers via VCCs
- Interworking with unified routers
- Enables subnet members to be distributed across the network

Disadvantages of MPOA

- Today MPOA based only of IP
- The original approach was not realised regarding MARS, RSVP, and CLIP
- The manufactories have to late MPOA implementations for their ATM components (see Cisco, Fore, Cabletron, Nortel Networks, Olicom etc.)
- Secure mechanisms are missing (only proprietary solutions are available)
- MPOA has to compare itself with Layer-3-Switching in Gigabit-Ethernet networks

TCP/IP protocols

- IP protocols is today the most important protocol from the user point of view
- It is developed to achieve interoperability in heterogeneous networks
- Independent from the network layer
- Only best effort is currently available
- TCP/IP protocols were not designed for high speed networks
- Several extensions are available for TCP
- You have to tune your network for IP!

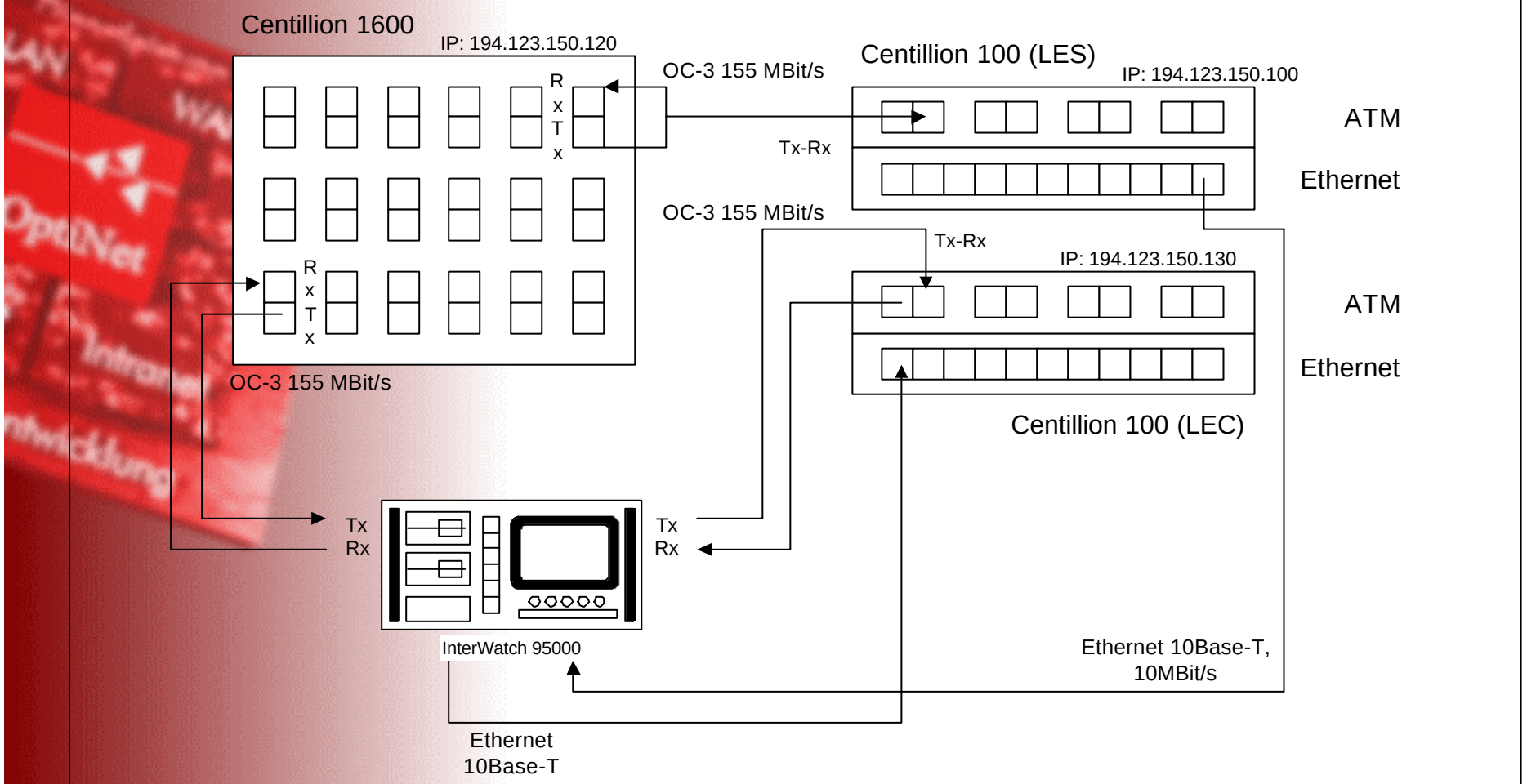
TCP/IP-over-ATM bottlenecks

- Send and receive socket buffer size
- Network: Maximum Transport Unit (MTU)
- Protocol: Maximum Segment Size (MSS)
- Transmitter: use of Nagle's algorithm
- Round Trip Time (RTT)
- Receiver: delayed acknowledgement mechanisms
- Transmitter: Silly Window Syndrome (SWS)
- Copy strategy at the socket interface
- Network congestion and lost notice

Test equipment

- ATM-Switch Centillion 100 (Bay/Nortel)
- ATM-Switch Centillion 1600 (Bay/Nortel)
- ATM-Switch CS3000 (Newbridge Networks)
- VIVID Route Server (Newbridge Networks) with Routing Protocols RIP, OSPF, NHRP and support of IP, IPX, etc.
- VIVID Orange Ridge (Newbridge Networks)
- ATM adapter boards from ForeRunnerLE series with throughput of 155 Mbps
- Olicom ATM Switch OC-9100

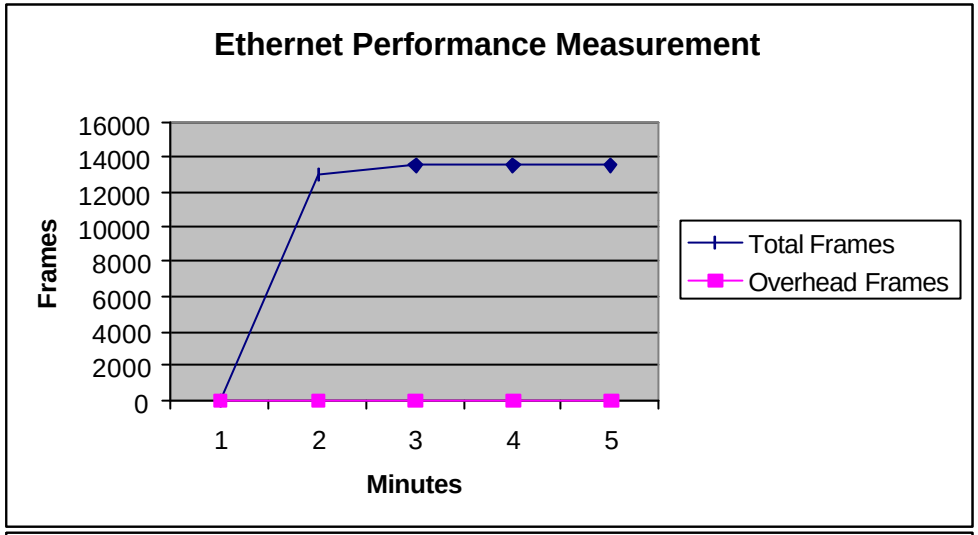
LANE test scenario

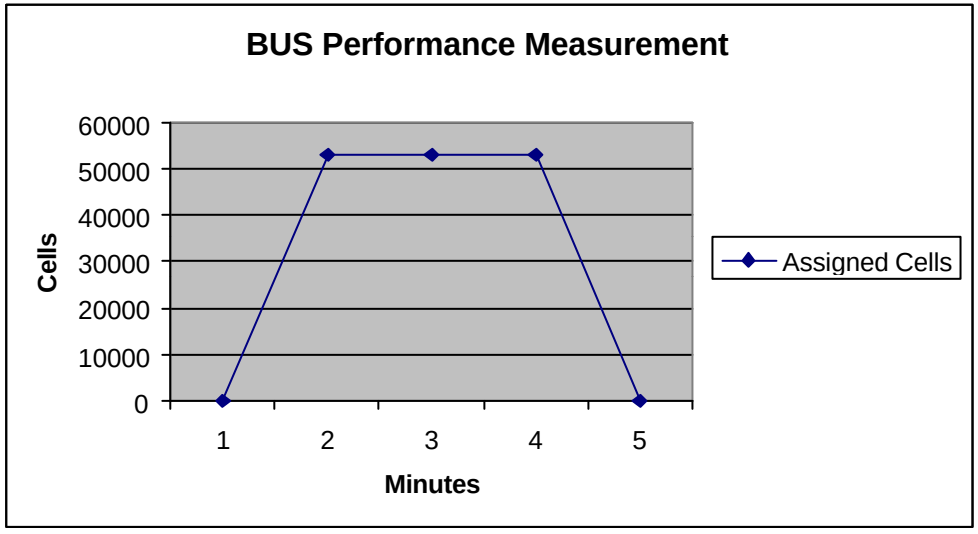


LANE test scenario

- LANE was tested without any router as there has been just one ELAN used, because of optimal traffic measurement
- Spanning Tree and dynamical routing were not tested and turned off
- LANE were tested by a pure Bay/Nortel Networks scenario
- Two edge devices and one core ATM switch have been used
- Unknown addresses have been used for the measurement to get real results

LANE test results

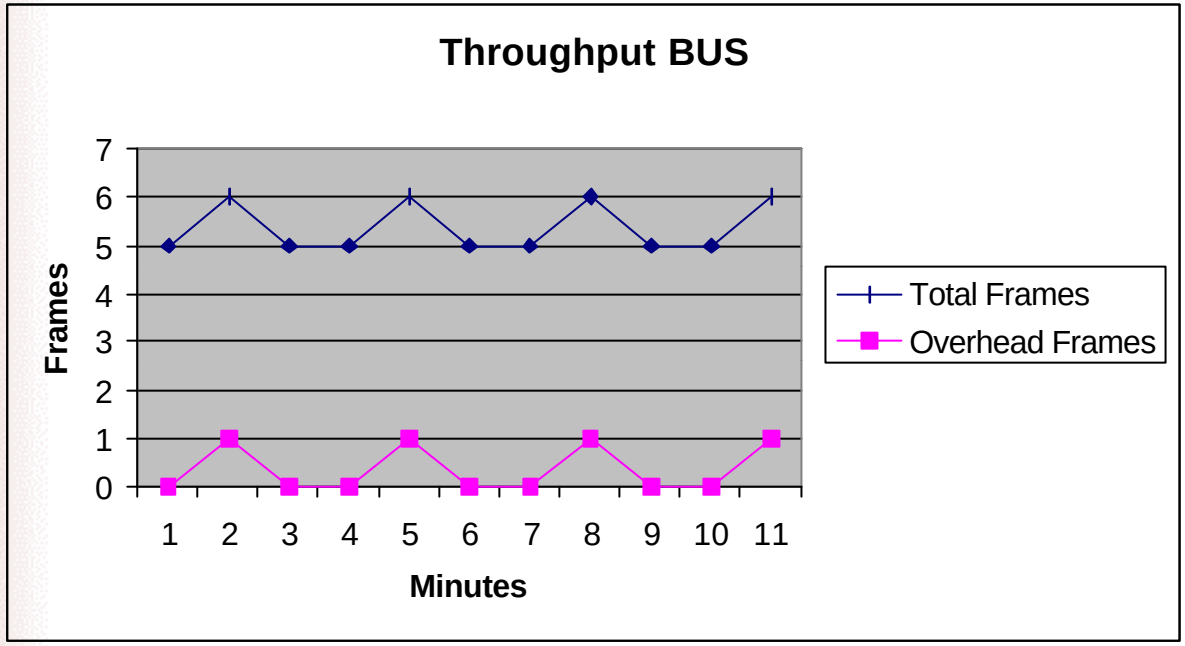




LANE test results

- Ethernet-to-Ethernet performance:
  - Exploitation of 100%
  - Throughput climbs up to 13.500 frames/s
  - Effective exploitation of 99,4%
  - Collisions: 27
- BUS performance:
  - Maximum throughput is approx. 53.000 cells per second
  - That represent a data rate of 22,4 Mbps
  - Full duplex has been configured
  - This result has got independence from the data rate and can be hold only few minutes (because of use of unknown frames)

LANE test results

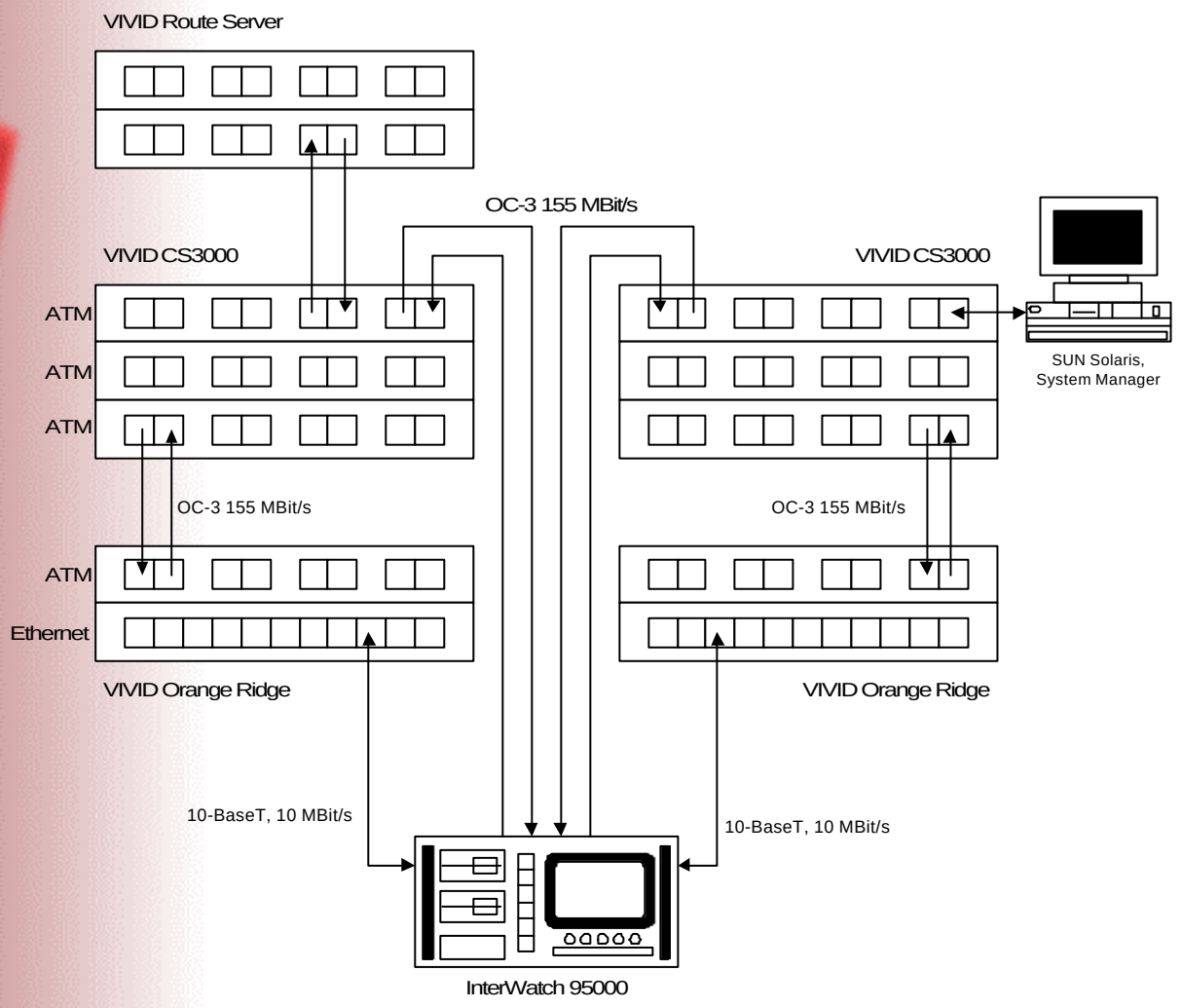


- Exploitation of 50% for longer operation
- Measure the unknown packets
- More real environment than the other case
- BUS sent only 5-6 frames with 0-1 frames overhead without breaking

LANE final test results

- An exploitation of 100% was adjusted
- Throughput of the Frames after a very short time climbs up to 13.500 frames/sec and remains at that level
- Effective exploitation of 99,4% (collisions and overhead)
- Maximum BUS throughput is approx. 53.000 cells per second
- This represents a data rate of 22,4 Mbps
- The BUS does not need to have a high performance and works with short bursts
- The unknown packets did not load the BUS

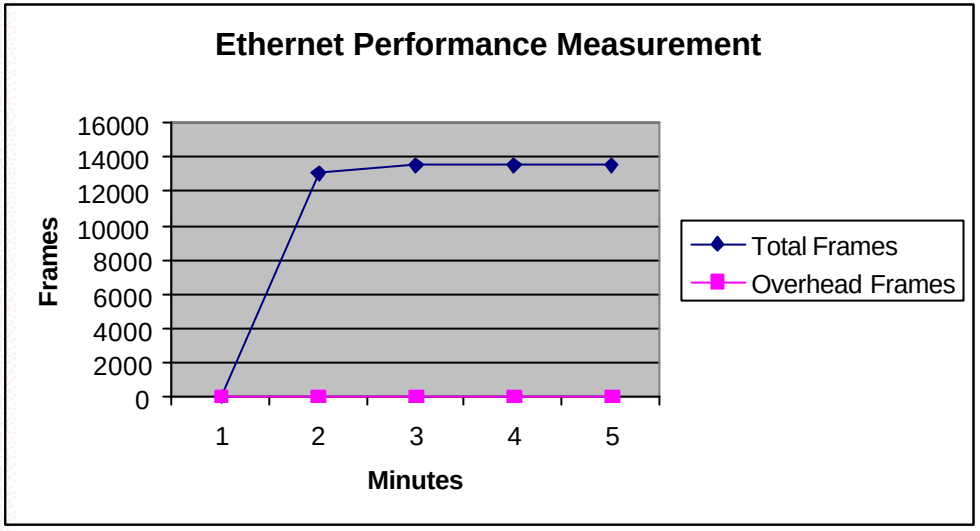
MPOA test scenario

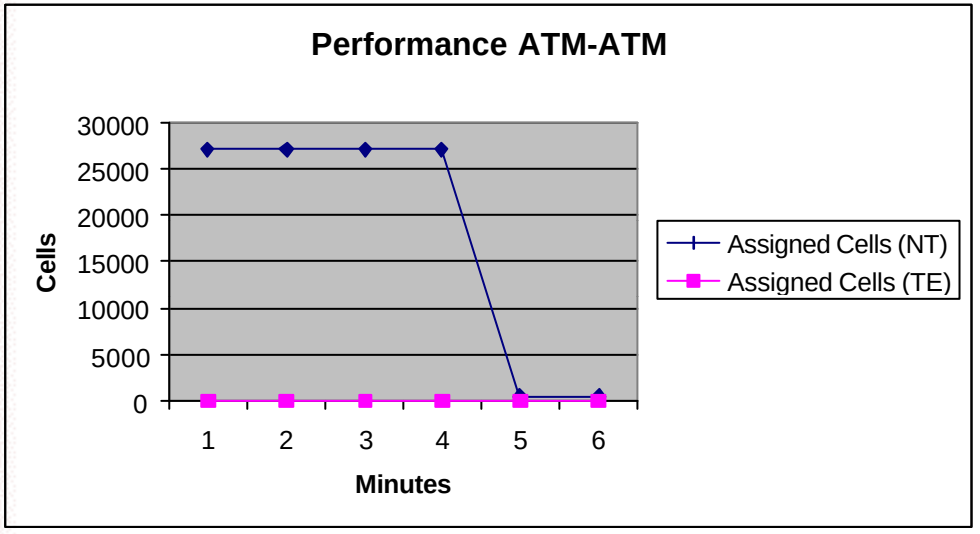


MPOA test scenario

- MPOA scenario was different to LANE, because Logical IP Subnets (LIS) were needed in order to use the forwarding and routing functionality of MPOA
- The VIVID components included LANEv1.0 and NHRP
- Two edge devices and core ATM switches
- P-NNI has been configured for automatically dynamical routing
- VIVID Route Server for establishing shortcuts if data flows appears

MPOA test results

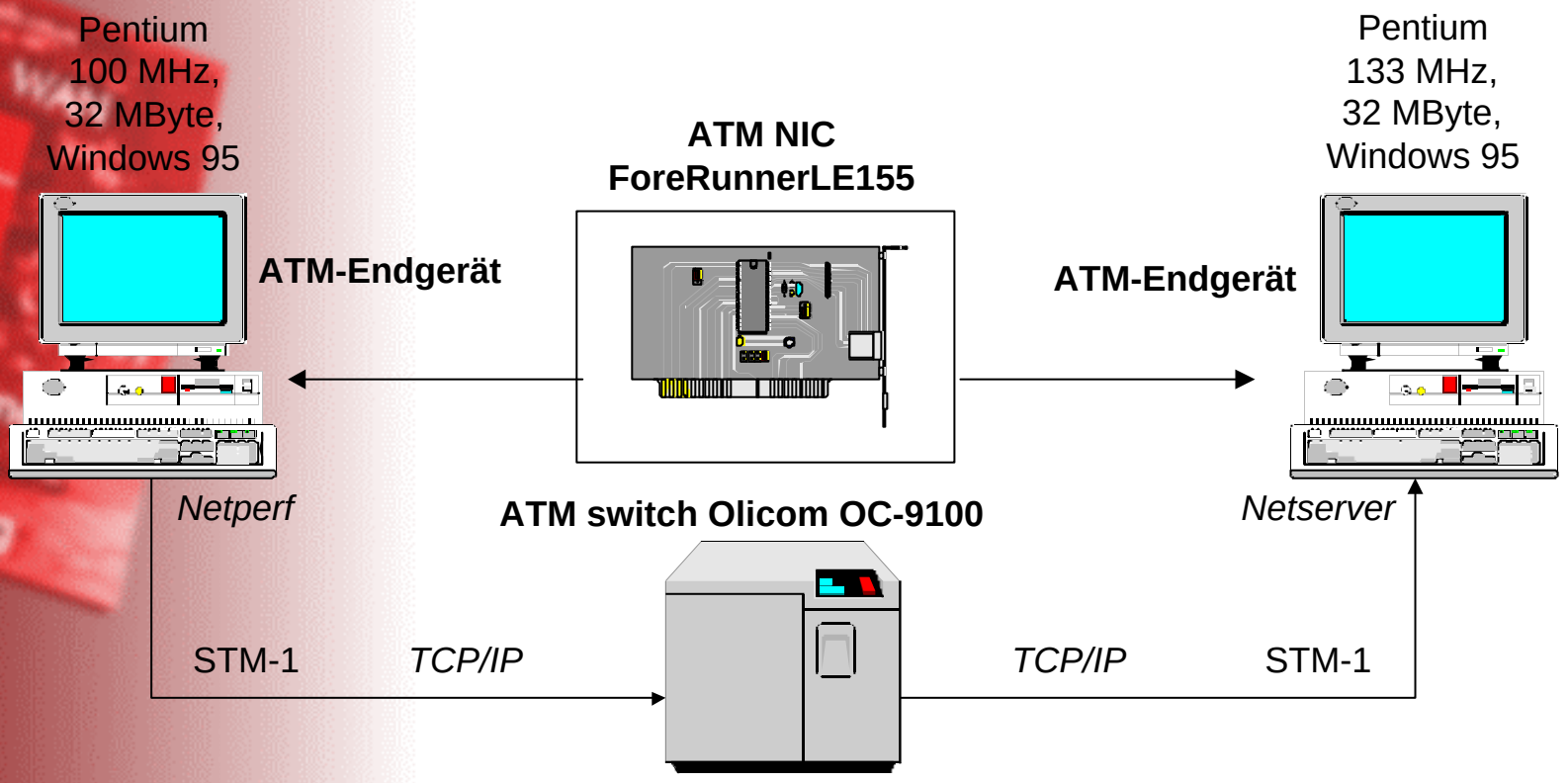




MPOA test results

- This test has been conducted with more than two subnets in order to force the router to route and to forward the packets
- The measurements showed the same result as the aforementioned with LANE
- Changes of the packet sizes from100 bytes to 1000 bytes and 64 kbytes did not influence the test results
- The exploitation was 99,4% with 1.100 collisions (more collisions)
- 27.000 cells/s (11,45 Mbps) as the maximum throughput was measured (unidirectional)

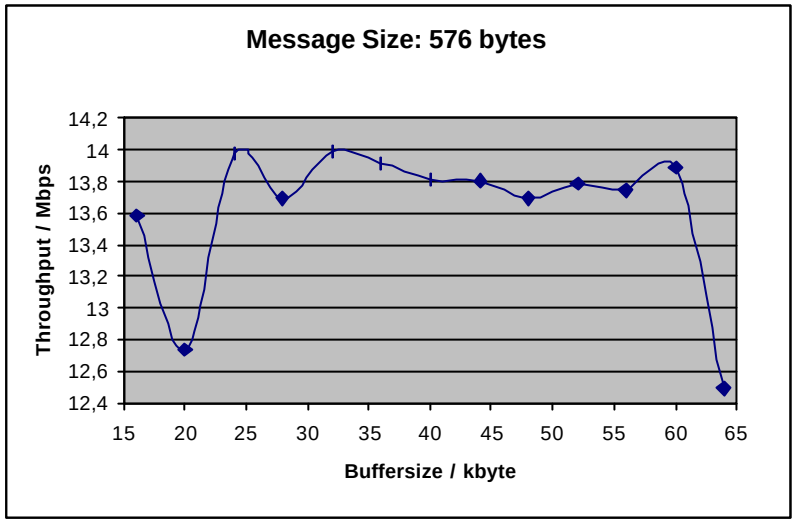
TCP/IP-over-ATM test scenario

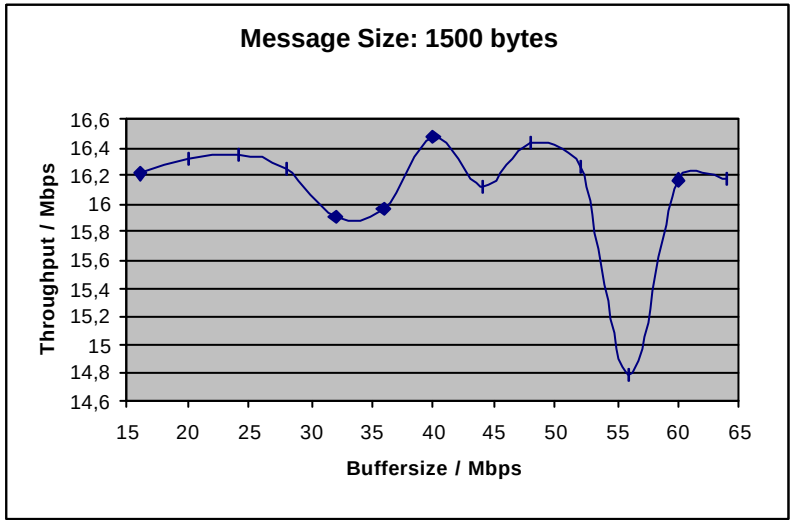


TCP/IP-over-ATM test scenario

- The buffer size varies from 15-64 kbytes
- The measurement used packet sizes of 576, 1500, 9180, and 65 kbyte
- Fragmentation of packets is needed
- ATM Network Interface Cards (NIC) from Fore Systems; ATM switch from Oliciom OC-9100
- Interfaces OC-3c (155 Mbps)
- AAL-5 for IP encapsulation via RFC-1483
- LANEv1.0 has been used without routing
- Netperf from Hewlett Packard as benchmark program for testing the network performance

TCP/IP-over-ATM test results

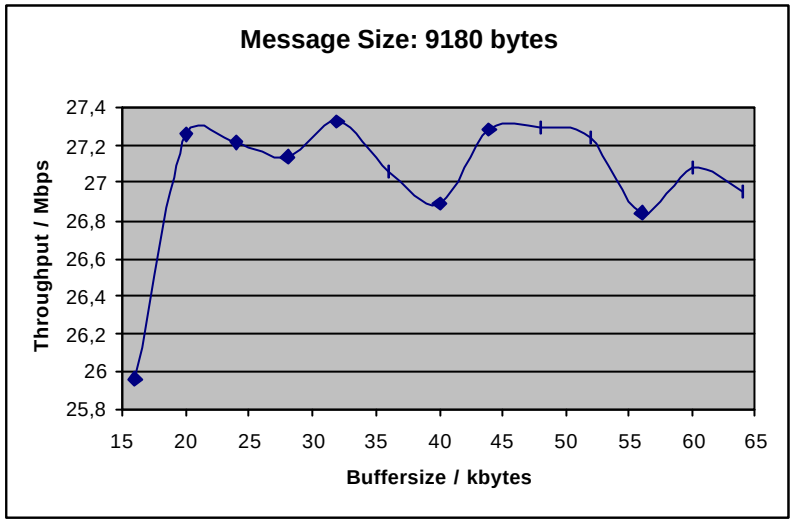


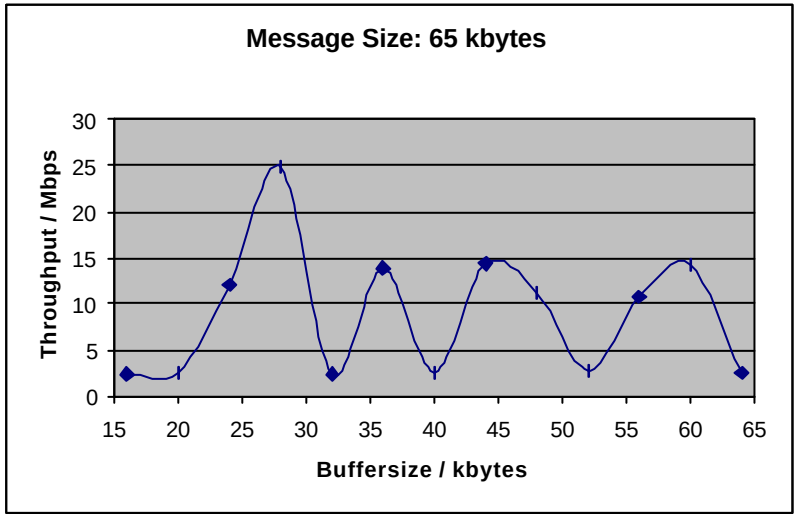


TCP/IP-over-ATM test results

- The measurement of TCP/IP-over-ATM was carried out by using various packet sizes in order to represent the effectiveness of IP-over-ATM
- Bad results with small buffer sizes on sender and receiver
- Small fluctuation of the throughput (between 1-2 Mbps)

TCP/IP-over-ATM test results





TCP/IP-over-ATM test results

- The throughput alone was not really interesting, the fluctuations and throughput breaks were more important
- If the fragmentation was increased the performance went down (see 65 kbyte)
- The best results were achieved at 40 and 65 kbytes buffers
- Big packets are not useful for data networks
- Operation systems are also responsible for the effectiveness

Summary

- LANE is a very stable standard and simply to configure
- LANE and MPOA have the same performance in one ELAN between LECs
- LANE supports only UBR; MPOA: QoS
- OptiNet tests now MPOA from different manufactures (Cisco, Cabletron, Bay/ Nortel; later: Fore Systems, Newbridge and Olicom)
- TCP has been extended and further developed for better and more efficient mechanisms in high-speed networks

Book recommendations

1. ATM in TCP/IP networks; Author: Kai-Oliver Detken; Publishing House: Hüthig, Heidelberg/Germany; Topics: ATM, Signalling, TCP/IP, CLIP, LANE, MPOA, NHRP, CSCW etc.
2. Local Area Networks; Author: Kai-Oliver Detken; Publishing House: Hüthig, Heidelberg/Germany; Topics: LAN technologies, Gigabit-Ethernet, ATM, Layer-3/4-Switching, Voice-over-IP/ATM, QoS, CoS etc.

Thank you for your attention

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