Rohde & Schwarz
R&S® SITLine ATM Crypto Device
Performance & Interoperability Tests

Introduction

Rohde & Schwarz SIT commissioned the European Advanced Networking Test Center (EANTC) to verify the performance and interoperability of the new SITLine ATM Crypto Device. The tests were conducted at the EANTC test lab in Berlin in April and July 2006. EANTC test engineers performed the required tests to verify the expected interoperability and performance.

EANTC tested data plane and signaling performance as well as Traffic Management and ATM interoperability with various ATM switches from different manufacturers. The results confirmed a sophisticated crypto device which is able to encrypt ATM channels without slowing down the network performance. All test results provided a very positive confirmation of the performance of the R&S SITLine ATM Crypto Device.

Rohde & Schwarz SIT
R&S® SITLine ATM155

- ☒ ATM Performance
  Traffic Classes (UBR, CBR, VBR)
- ☒ Signaling Performance
  UNI 3.1/4.0
- ☒ ATM Interoperability

Test Period: April & July 2006

http://www.eantc.com

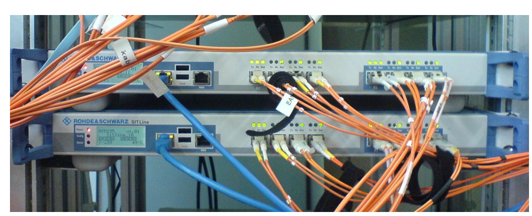
Tested by EANTC 2006

Test Highlights

- ➜ **Interoperability tested to Cisco Catalyst, Marconi TNX and Marconi ForeRunner switches**
- ➜ **4,000 PVCs were established with cell forwarding near maximum line rate of STM-1**
- ➜ **Low latency introduced by SITLine ATM Crypto Devices**
- ➜ **Additional added OAM cells did not lead to channel interruption**
- ➜ **Cell loss could be avoided with appropriate CDVT setting**
- ➜ **Incoming call setup rate of 15 calls per second was verified**

Tested Devices & Test Equipment

The R&S SITLine encrypts diverse transmission traffic including speech, audio and data, as well as video in broadcast and studio quality. The device cycle time is negligible (only a few seconds) and the additional overhead for the crypto function is extremely low. This results in simultaneous, realtime encryption for the different services with unimpaired transmission quality and protection at an individual ATM channel level.



The testing environment included the EANTC ATM signaling performance analyzer and the Navtel Interwatch 95000 Analyzer. All data plane tests were executed using Navtel's Interwatch 95000.
For the signaling performance tests, we used the EANTC signaling performance analyzer. It has been developed by EANTC and implements a light-weight ATM Forum UNI 3.0/3.1/4.0 signaling stack which has been optimized for performance tests.

Data Plane Performance

Test Highlights

- ➜ 4,000 PVCs successfully established
- ➜ 99.9999% utilization without cell loss
- ➜ Very low cell transfer delay caused by the R&S® SITLine ATM Crypto Device

The goal of the test was to measure Cell Loss, Cell Loss Ratio (CLR) and Cell Transfer Delay (CTD) caused by the R&S SITLine in four test scenarios:

1. Establishment of 4,000 PVCs over all four ports, two ports with encryption and 2 without encryption
2. Establishment of 4,000 PVCs over all four ports, encryption was enabled on all four ports
3. Establishment of 4,000 PVCs over one port without encryption
4. Establishment of 2,000 PVCs over one port with encryption enabled

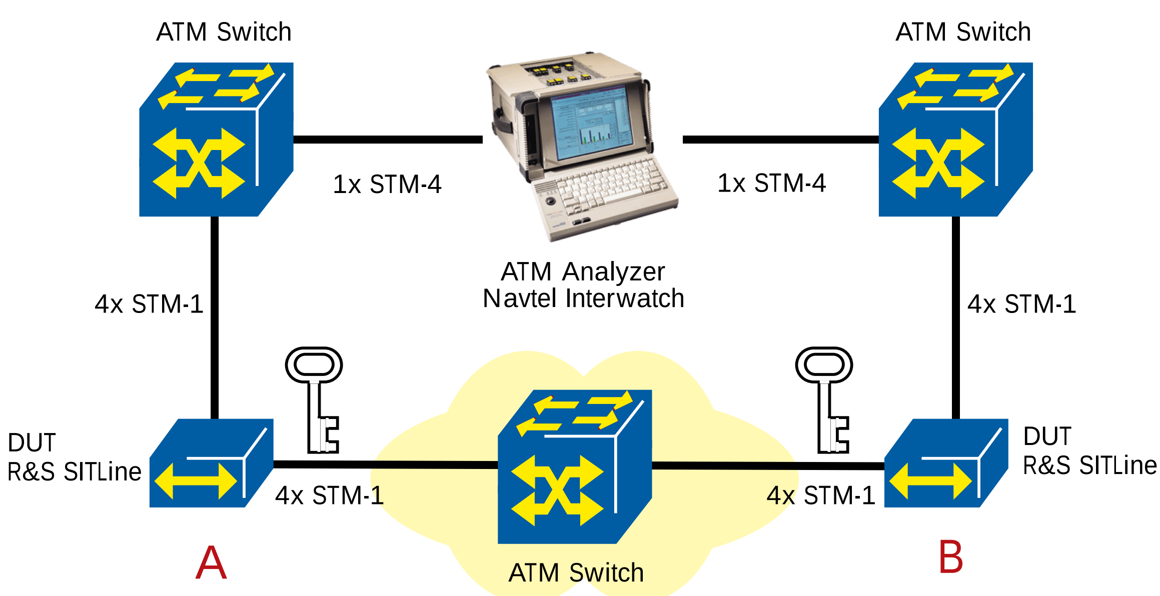
The picture below shows the test setup. We build a small network of three ATM switches, two R&S SITLine ATM Crypto Devices and the analyzer. The Interwatch 95000 analyzer ports and one R&S SITLine were each connected to one ATM switch.

We transmitted with a line utilization of 99.9999% (352,720 cells/second). The R&S SITLine needs two empty cells per minute per PVC to insert its OAM cells into this channel. Therefore, we didn't send at maximum ATM cell rate. These OAM cells are necessary to establish the secured channels and to keep the connection.

No cell loss could be observed. In the first three scenarios, we proved that the R&S SITLine is able to establish 4,000 PVC connections and forward ATM cells over these connections near the maximum possible ATM cell rate for SMT-1 links.

The table below shows the delay introduced by one R&S SITLine. The observed deviation of CTD values is introduced by the switches. We verified this with several reference measurements in which the R&S SITLines were not included.

Sce-nario	Direc-tion	Used Ports	Encrypted Ports	Average CTD [us]
1	A -> B	4	2	20.2
	B -> A			20.2
2	A -> B		4	20.6
	B -> A			21.1
3	A -> B	1	0	27.6
	B -> A			23.4
4	A -> B		1	19.5
	B -> A			16.3

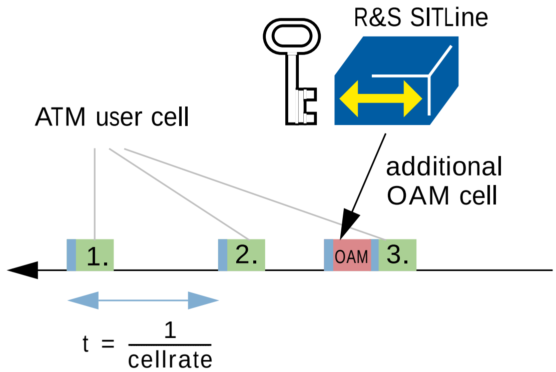


Traffic Management

Test Highlights

- ➜ Additionally inserted OAM cells did not lead to channel interruption
- ➜ Cell loss could be avoided by setting the appropriate CDVT values

The R&S SITLine inserts two OAM cells per minute into each PVC. In cases where the VC stream uses its maximum allowed cell rate, these additional cells can lead to some cell discard. These cells are inserted directly before the next user cell to prevent the switch from deleting the inserted OAM cells. The cell delay variation increases by at least the time one cell needs to be transmitted (2.8 microseconds).



Test Methodology

With using two test scenarios we validated the efficiency of the described mechanism above.

In the first scenario we tested whether the additional OAM cells lead to cell discard for CBR and VBR streams on a Marconi ForeRunner LE155 switch.

In an additional test, we configured four different CDVT values on the switch in steps to observe the cell loss behavior when the traffic contract for the tester and the switch were configured to the same value.

EANTC Test Analysis

Our Traffic Management tests showed that the additional OAM cells did not lead to crypto channel interruption. We observed some minor cell loss, but this cell loss was an expected behavior. We transmitted at exactly the same cell rate as the maximum cell rate (MCR) configured on the ATM switch. Because the R&S SITLine inserts additional cells, the switch will discard some cells. The mechanism used by the R&S SITLine, which inserts the additional OAM cell directly in front of the next user cell, prevented the switch from deleting these OAM cells. This is important to keep the crypto channel up and running.

Traffic	Direction	Cells Received	Cells Lost	Cell Loss Ratio [%]
CBR	A -> B	179,997	1	0.000006
UBR		8,999,386	0	none
CBR	B-> A	179,991	7	0.000039
UBR		8,999,364	0	none

In our second test scenario we demonstrated the dependence of the configured Cell Delay Variation Tolerance (CDVT) on the amount of lost cells. The additional OAM cell leads to a cell delay variation of at least one ATM cell (2.8 microseconds) because it is inserted directly before the next user cell.

Our test showed, that it is important to set the appropriate CDVT values at the intermediate ATM switches if R&S SITLine ATM Crypto Devices are used in the network.

Because the CDVT on the intermediate switches was configured below two ATM cells (5 microseconds), we observed a cell loss rate of approximately 0.05 percent. We did not observe any cell loss with CDVT set to more than two ATM cells (6 microseconds) and higher.

Direction	CDVT [us]	Cells Received	Cells Lost	Cell Loss Ratio [%]
A -> B	5	178,990	1,008	0.005600
B-> A		179,110	888	0.004933
A -> B	6	179,998	0	none
B-> A		178,998	0	none

Interoperability

We built a small multivendor ATM network with two R&S SITLines, a Cisco Catalyst 8540, a Marconi TNX and a Marconi Forerunner LE155 to prove compatibility with various ATM switches.

We didn't observe any interoperability problems in all test scenarios between the R&S SITLines and the ATM switches. Our signaling test scenarios proved the correct interoperation between the R&S SITLines and the Cisco Catalyst 8540.

Signaling Performance

Test Highlights

➜ Call Set up rate of 15 calls/second

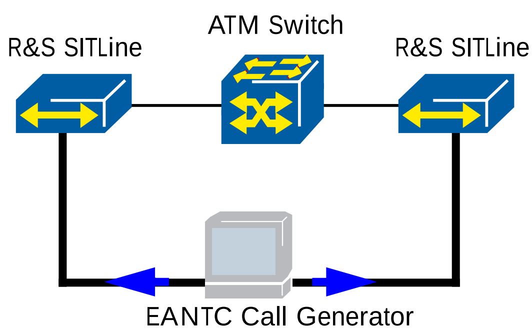
➜ Call capacity of 3998 SVCs validated

All signaling performance tests were performed for the UNI3.1 and UNI4.0 signaling versions.

They focused on robustness (long-term stability of the signaling implementation) and performance (short-term maximum speed). The call generator can quickly uncovers some problems that usually only occur in long-term operation by generating a large number of call setups in a short time.

We tested whether the R&S SITLine supports high signaling activity and a large number of active connections and how the device react to a signaling storm typically observed in ATM SVC networks after power failures or other major network topology changes.

Test Methodology



The following test cases evaluated these goals:

1. We measured maximum signaling performance of the device under test by initiating a large number of setup requests as fast as possible. The switch flow control limited the setup performance. We measured the average number of established connections per second and the peak call establishment latency.
2. We measured the maximum capacity of simultaneously established connections.

All tests were executed for point-to-point connections. The number of calls chosen for the emulation was derived from the scale of R&S SITLine device specification. All SVCs were established as encrypted SVCs.

EANTC Test Analysis

The Call Setup Rate test showed that the R&S SITLine is capable of handling incoming calls at a rate of 15 calls/s offered with burst size set to 3 for all connection types (UBR, CBR, VBR). Connections will only be established after a successful key agreement. The R&S SITLine needs 65 milliseconds for the key agreement which is processed sequentially.The theoretical maximum call establishment rate is, therefore, 16 calls per second.

Measured Value	UBR	CBR PCR=500	VBR SCR=500
Offered connection establishment rate [calls/s]	15	15	15
Number of successfully established connections	3997 of 3998	694 of 694	693 of 693
Connection establishment rate [calls/s]	15	15	15
Min. establishment latency [s]	0.14	0.19	0.20
Average establishment latency [s]	0.38	0.28	0.33
Max. establishment latency [s]	4.77	2.35	0.86

Delayed or lost signaling messages could be the reason for high maximum call establishment values. The call establishment latency depends on the signaled PCR values. The lower the PCR value, the higher the latency. A previous test showed that smaller PCR and SCR values result in lower call setup performance. The security data exchange lasts longer because of the lower bandwidth available.

The Call Capacity test was executed for UBR connections. 3998 connections were established successfully. The implementation showed stable behavior. Once this limit was exceeded by trying to establish further SVCs.

About EANTC

The European Advanced Networking Test Center (EANTC) offers vendor-neutral network test services for manufacturers, service providers and enterprise customers. Primary business areas include interoperability, conformance and performance testing for IP, MPLS, ATM, VoIP, Triple Play, and IP applications.

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