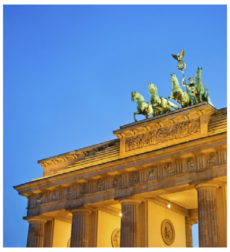
EANTC Independent Test Report

Huawei 50GE Flex Ethernet Card

October 2017

About EANTC



EANTC (European Advanced Networking Test Center) is internationally recognized as one of the world's leading independent test centers for telecommunication technologies.

Based in Berlin, the company offers vendor-neutral consultancy and realistic, reproducible high-quality testing services since 1991. Customers include leading network equipment manufacturers, tier 1 service providers, large enterprises and governments worldwide. EANTC's Proof of Concept, acceptance tests and network audits cover established and next-generation fixed and mobile network technologies.

Table of Contents

Introduction

Huawei Technologies commissioned EANTC to verify the functionality of its new Flex Ethernet (FlexE) network card, the ANK1EV2, to be integrated in Huawei's ATN series of multiservice access routers. EANTC conducted realistic tests to verify the vendor claims at Huawei's premises in Shenzhen, China, in September 2017.

Test Highlights

- ➔ In-service FlexE slicing
- ➔ Hitless bandwidth resizing
- ➔ 35.89 milliseconds failover time with MPLS-FRR for L2VPN service
- ➔ Proven congestion isolation between FlexE slices
- ➔ Seamless flow distribution across physical links using FlexE's bonding capabilities

We focused on testing new capabilities of the FlexE technology; network slicing and its benefits as a congestion isolation mechanism, and FlexE bonding of Ethernet links.

HUAWEI 50GE Flex Ethernet Card

☑ **FlexE Router Card**

Support for 2 x 50G FlexE interfaces or 1 x 100G FlexE interface

☑ **5G Ready**

The card is supported in ATN access series multiservice routers and it is targeted at 5G deployments

Test Period: September 2017
Product version V300R003C00

Tested by EANTC 2017

During our test, we verified the usability of this card in future 5th Generation mobile network (5G) deployments, as well as some relevant functionalities for Data Center (DC) networks. Our tests were performed on the recently released ATN 980B multiservice router and included scenarios where FlexE can be used.

Executive Summary

Huawei's FlexE network card showed great flexibility for Ethernet based Wide Area Network (WAN) deployments, in particular to be used as the core technology in X-Haul, a unified backhaul and fronthaul, for mobile transport networks.

It combined fast failover and restoration during a link failure event, and in-service slicing and bandwidth resizing.

Flex Ethernet

Flex Ethernet (FlexE) is a fairly new standard originally defined by the Optical Internetworking Forum (OIF), and it is now in the process of standardization in the Broadband Forum (BBF), the Internet Engineering Task Force (IETF) and the International Telecommunication Union (ITU-T).

FlexE is a variable rate interface for the Media Access Control (MAC) layer, commonly referred as Layer-2, that runs on top of one or more Ethernet physical links.

FlexE supports three operational modes: Channelization or Slicing, Bonding, and Sub-rating. These modes are possible thanks to the introduction of a time-division multiplexing calendar.

FlexE in 5th Generation Networks

ITU has defined three major use cases for 5G bearer networks; Enhanced Mobile Broadband (eMBB), Massive Machine Type Communication (mMTC), and Ultra-Reliable and Low-Latency Communication (uRLLC). These scenarios have diverse requirements for the bearer network. eMBB for instance requires high network bandwidth while uRLLC requires low latency and low jitter, and mMTC requires massive user scale.

In order to meet these strict bearing requirements, FlexE network slicing provides a mechanism to isolate service types with a granularity of 5 Gbit/s channels.

Hardware and Software

ATN 980B Chassis		
Component	**Description**	**Software**
ANJ2CXP	Route Processor	Version 8.160 V300R003C00
ANK1EV2	FlexE Line-card 2 x 50GE	
ANK1EX2S	Ethernet Line-card, 2 x 10GE	
QSFP28 - 50G	53.25G-10km-QSFP28	
QSFP28 - 100G	100G-10km-QSFP28	
CFP2 - 100G	Spirent 100GBASE LR (tester)	
10G SFP+	10GBASE LR	

Test Setup

Huawei's ANK1EV2 provides FlexE functionality on two QSFP28 ports that can be used as 2 x 50GE when using 50GBASE QSFP28, or 1 x 100GE when using 100GBASE QSFP28. In the latter case, the second port is automatically disabled.

On this network card, all ports support either working as standard Ethernet ports or as FlexE ports. The transceivers used in both cases are the same, a configuration change is only required to change the operational mode.

For our tests, Huawei provided the following card configuration:

- **ANK1EV2 - 2 x 50G FlexE**
  We used this configuration for Flex Ethernet ports, using 50GBASE transceivers (53.25G-10km-QSFP28).
- **ANK1EV2 - 1 x 100GE**
  We used this configuration for 100GE interconnection between the Devices Under Test (DUTs) and the tester - Spirent N11U. The transceiver in use was 100GBASE QSFP28 (100G-10km-QSFP28).
- **ANK1EX2S - 2 x 10GE**
  We used this configuration for 10GE interconnection with the tester only in the "Congestion Isolation" test case. The SFP in use was "10G BASE LR".

Unless otherwise specified, we used the same frame distribution for all test cases. A mix of IPv4 and IPv6 traffic with a 1:1 ratio for a total of 1,000 flows of bidirectional traffic. The packet size was fixed to 128 Bytes.

In our test, we used the main topology shown in Figure 1.

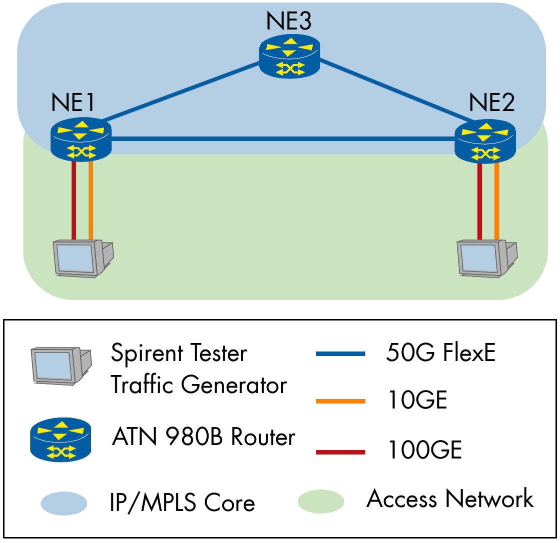


Figure 1: Physical Test Setup

For the MPLS network, we used Intermediate-System to Intermediate-System (IS-IS) as Interior Gateway Protocol (IGP) to propagate topology and reachability information within the IP/MPLS core. Huawei engineers configured Resource Reservation Protocol with Traffic Engineering (RSVP-TE) for Label Switched Path (LSP) creation and for MPLS Fast Reroute (FRR) traffic restoration. For Layer-2 service signaling, we used Label Distribution protocol (LDP).

Slicing Deployment

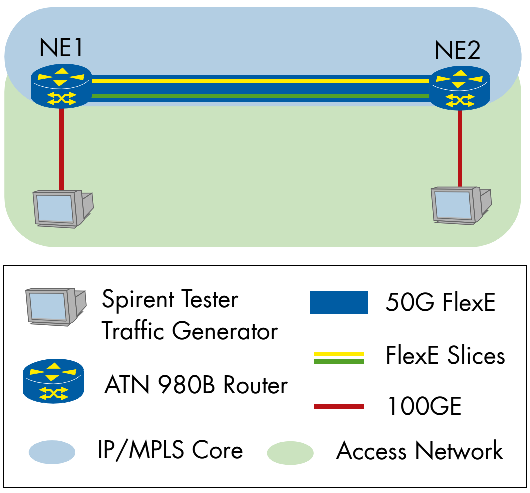


Figure 2: FlexE Slicing

After deploying and configuring the test topology as depicted in Figure 2, we reviewed and tested the process of FlexE slicing on a 50G physical link.

The slicing process consisted of defining new FlexE Client Identifiers for a given FlexE group. Since these parameters are signaled over the physical link, we tested how this procedure actually works on Huawei's network card.

Slice Oversubscription

In our first test we configured a 15 Gbit/s FlexE slice and we used it to forward a mix of IPv4 and IPv6 traffic, with a rate of 20 Gbit/s and using packet size of 128 Bytes. Our intention was to validate that the slice was in place and limiting the traffic to actual slice bandwidth.

We observed roughly 34.69% packet loss for IPv4 traffic and a 34.72% for IPv6 traffic as expected considering the FlexE, Ethernet and MPLS header overhead, and the packet size.

Multi-Service Slice deployment

Following next, we configured a second slice of 30 Gbit/s bandwidth and we tested both services by sending a mix of IPv4 and IPv6 traffic with a rate of 10 Gbit/s and 20 Gbit/s for the first and second service respectively.

No traffic loss was observed.

In-Service FlexE Slicing

On the third test, we configured a third FlexE slice of 5 Gbit/s bandwidth while sending the same traffic pattern as in the previous test. The goal of this test was to validate that the new slice configuration did not impact existing services.

No traffic loss was observed.

Service Validation

As the last test of the service, while sending traffic as in the previous step, we generated an additional 3 Gbit/s traffic for the third slice.

We then verified that all slices were in service and were forwarding frames without any loss.

BW Resizing for FlexE interfaces

In this test scenario, we verified the capabilities of the network card to resize FlexE slices without impacting the overlay service.

Initially we configured two FlexE slices of 10 Gbit/s and 5 Gbit/s for service 1 and 2 respectively. Subsequently, we started forwarding traffic at a rate of 14 Gbit/s for service 1, and 3 Gbit/s for service 2. The results met our expectation of seeing packet loss on the first service and no loss on the second service.

Secondly, we established a baseline rate of 6 Gbit/s and 3 Gbit/s for service 1 and 2 respectively and verified there was no packet loss.

Bandwidth Increase

While the baseline traffic was being forwarded through the FlexE interfaces, we increased the bandwidth of service 1 to 20 Gbit/s and we observed no loss on any of the two services.

We continued to verify that the 20 Gbit/s was actually commissioned on the devices by increasing the forwarding rate for service 1 from 6 Gbit/s to 14 Gbit/s.

Again, we observed no traffic loss during the slice bandwidth increase.

Bandwidth Decrease

We followed a similar procedure to verify the bandwidth decrease behavior.

Using the previously configured FlexE slices of 20 Gbit/s and 5 Gbit/s, we forwarded 15 Gbit/s and 3 Gbit/s on the first and second service respectively.

We finalized the test and we did not detect any traffic loss.

Afterwards, we started forwarding traffic at the same specified rate and we decreased the bandwidth of slice 1, from 20 Gbit/s to10 Gbit/s.

We observed packet loss on the first service as expected, due to the 150% oversubscription scenario, and we did not observe traffic loss on service 2.

Based on the results of this set of bandwidth resizing tests, we can conclude that modifying the bandwidth does not cause a traffic impact, unless of course the forwarding rate is higher than the actual provisioned bandwidth.

Congestion Isolation

For this test, we verified the ability of Huawei's FlexE implementation to isolate traffic loads when placed in different FlexE slices.

As shown in Figure 3, we added a new 10GE link between each DUT and the tester for the first service under test. The purpose of this link was to eliminate any spurious results produced by sharing the same tester port.

We mapped the new links to the first FlexE slice of 10 Gbit/s of bandwidth.

For this test, we generated an Internet mix (IMIX)[1] of IPv4 and IPv6 traffic with a 1:1 ratio for a total of 1,000 flows. In our first test, we forwarded 6 Gbit/s of a mix of IPv4 and IPv6 traffic.

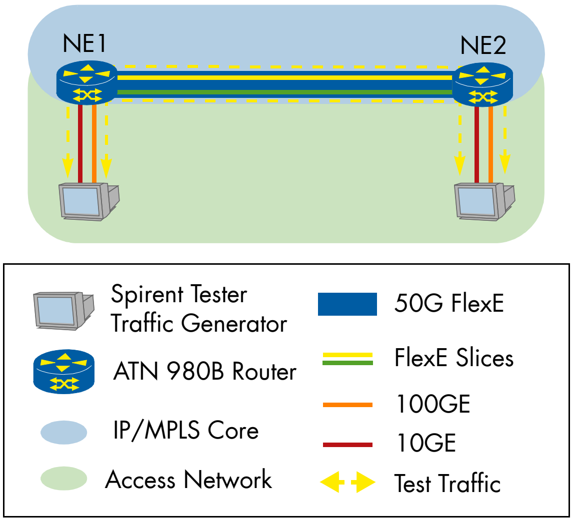


Figure 3: Congestion Isolation

As a baseline reference test, we verified that the test traffic was correctly forwarded and experienced zero packet loss. As part of the same baseline procedure, we also recorded the average packet delay for both IPv4 and IPv6.

Next, we configured a second service of 20 Gbit/s bandwidth on a different FlexE slice, and using the 100GE tester ports.

Secondly, we generated the initial traffic load for service 1, 6 Gbit/s of traffic, and 35 Gbit/s for service 2, effectively saturating the latter.

As expected, service 2 showed packet loss due to the oversubscription conditions.

1. IMIX consisted of 1x 128-bytes packet, 1x 256-bytes packet, 1x 512-bytes packet, 1x 1200-bytes packet

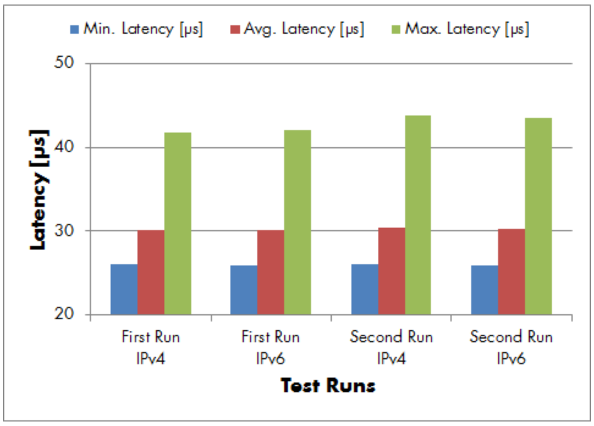


Figure 4: Latency Variation

We also measured the average latency of service 1 traffic and observed a negligible increase compared to the baseline value.

We were impressed by the FlexE capabilities to isolate different traffic loads and we see it as a real asset for 5G network deployments.

FlexE Bonding

Besides the previously tested slicing capabilities, FlexE supports bonding multiple physical links into a single logical one. By configuring the same FlexE Group Identifier on different FlexE interfaces, we effectively created a FlexE bonding.

In the following tests we used 2 x 50G FlexE ports to create a 100G FlexE bundle. For this test case, it was mandatory to perform bonding of FlexE ports within the same network card. Configuring bonding across different network cards is currently not supported.

The physical topology is depicted in Figure 5.

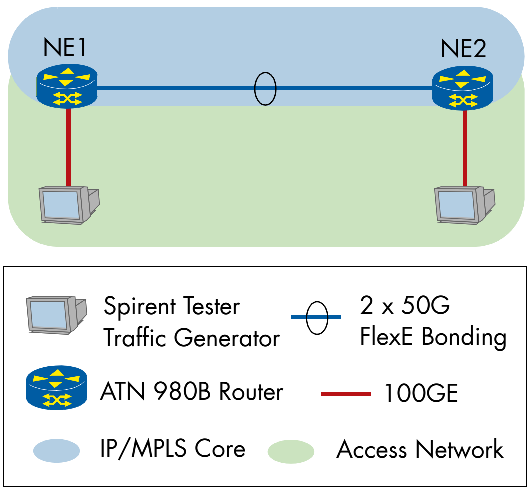


Figure 5: FlexE Bonding Physical

After bonding the two physical links we created a FlexE slice of 75 Gbit/s bandwidth for service 1 and a FlexE slice of 25 Gbit/s bandwidth for service 2, as shown in the logical topology in Figure 6.

We ran the same test with two different traffic patterns, first a single IPv4 flow and second a mix of IPv4 and IPv6 traffic. In both cases the packet size was 1024 Bytes.

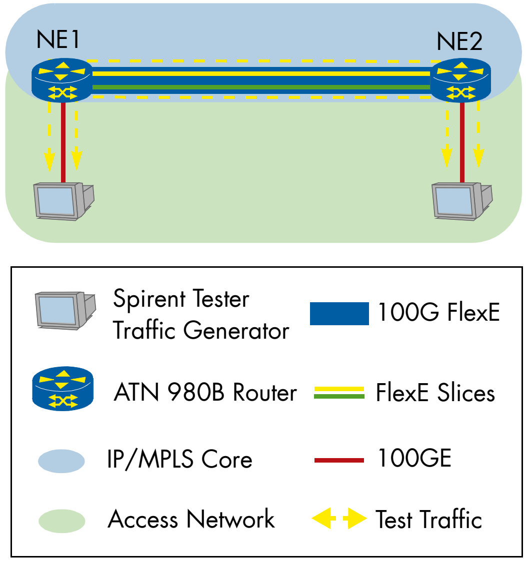


Figure 6: FlexE Bonding Logical

Single IPv4 Flow

Our intention while testing with a single flow was to demonstrate the capabilities of this technology to load-balance traffic across different physical links. This is normally not possible with existing Link Aggregation Groups (LAG) which normally rely on flow-based packet load-balancing, wherein a single flow will be pinned to a single physical link.

We generated 70 Gbit/s of traffic for service 1, and 10 Gbit/s of traffic for service 2. In both cases, a single IPv4 flow was used.

We observed even packet distribution across links and no packet loss or reordering.

Multiple IPv4/IPv6 Flows

Additionally, we performed a similar test with 1,000 flows with 50% IPv4 and 50% IPv6, for both services. The DUTs configuration was not changed for this test.

The results were the same. We did not detect any packet loss or frame reordering.

Resiliency

In our last set of tests, we tested the failover and restoration time during a link failure triggered by a Loss Of Signal (LoS).

As shown in Figure 7, we configured a constrained Label Switched Path (LSP) from NE1 to NE2, going through NE3 as primary path. We also configured another constrained LSP from NE1 to NE2 as backup path.

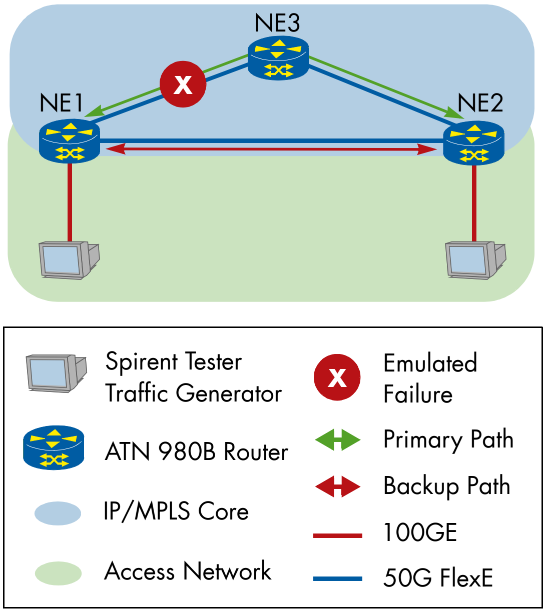


Figure 7: Resiliency Test Topology

Bidirectional Forwarding Detection (BFD) was configured on NE1 and NE2 for LSP health detection.

We configured two FlexE slices. A 10 Gbit/s bandwidth slice for service 1, and a 20 Gbit/s bandwidth slice for service 2.

We injected baseline traffic of around 1 Gbit/s of a mixture of IPv4 and IPv6 traffic on each service, for a total of 2 Gbit/s traffic on each FlexE link. The frame rate was fixed at exactly 422,297 Frames Per Second (FPS) per IP protocol, and per service. Afterwards, we introduced an emulated failure between NE1 and NE3 by disconnecting the fiber.

We measured the frames lost during the failover, and based on that we calculated the out of service time as follows:

- Failover time, service 1: 33.33 milliseconds
- Failover time, service 2: 35.89 milliseconds

Following the failover, we proceeded to reconnect the fiber and after a few seconds we saw the primary path active again and forwarding traffic.

Restoration time gave us the following results:

- Recovery time, service 1: 0 milliseconds
- Recovery time, service 2: 0 milliseconds

No packet loss was seen during restoration. We only detected one reordered frame, in direction NE1 to NE2, on service 2.

EANTC AG
Salzufer 14, 10587 Berlin, Germany
info@eantc.com, http://www.eantc.com/
[v1.4 20180220]