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Table of Contents

List of Tables

1 Acronyms and abbreviations

Abbreviation / Acronym:	***Description:***
AT	Acceptance Test
ECU	Electronic Control Unit
IUT	Implementation Under Test
LT	Lower Tester
PDU	Protocol Data Unit
SP	Service Primitive
TS	Test System
UDP	User Datagram Protocol (according to IETF RFC 768)
UT	Upper Tester
IPv4	Internet Protocol version 4
ICMP	Internet Control Message Protocol
TTL	Time To Live
TOS	Type Of Service
MTU	Maximum Transmission Unit
EMTU_S	Effective MTU for sending – This is the maximum IP datagram size that may be sent,
<LTIface-m>	m-th Interface of LT
<IUTIface-n>	n-th Interface of IUT
<IUTIface-n-IP>	IP address of n-th Interface of IUT
<LTIface-m-IP>	IP address of m-th Interface of LT

2 Related Documentation

2.1 Input documents

[1] AUTOSAR Specification of TCP/IP Stack
AUTOSAR_SWS_TcpIp.pdf

[2] AUTOSAR System Template
AUTOSAR_TPS_SystemTemplate.pdf

[3] AUTOSAR SRS Ethernet
AUTOSAR_SRS_Ethernet.pdf

[4] AUTOSAR General Specification for Basic Software Modules
AUTOSAR_SWS_BSWGeneral.pdf

[5] Specification of ECU Configuration
AUTOSAR_TPS_ECUConfiguration.pdf

[6] Requirements on Acceptance Tests
AUTOSAR_ATR_Requirements_Eth.doc

2.2 Related standards and norms

[7] IETF RFC 791
http://tools.ietf.org/html/rfc791

[8] IETF RFC 1122
http://tools.ietf.org/html/rfc1122

2.3 Testability protocol document

[9] Testability Protocol and Service Primitives
AUTOSAR_PRS_TestabilityProtocolAndServicePrimitives.pdf

3 RS_BRF_01784 - AUTOSAR communication shall support the IP protocol stack

3.1 General Test Objective and Approach

This document intends to provide a test-specification for various features of IPv4 Protocol as mentioned in RS_BRF_01784.
It uses the IPv4 message headers and operations as described in Trace to SWS Item. It also uses various parts of RFC 791 and RFC 1122 as reference.

This test-chapter aims to test following requirements which are mentioned in the "AUTOSAR SWS Specification of TCP/IP Stack" for an IPv4 stack:

a) [SWS_TCPIP_00053]: The TcpIp shall implement the Internet Protocol as defined in IETF RFC 791 (Internet Protocol of version 4).

b) [SWS_TCPIP_00102]: The TcpIp shall fulfill the Internet Protocol related requirements specified by IETF RFC 1122, section 3.2.1.1 (Version number), 3.2.1.2 (Checksum), 3.2.1.3 (Addressing), 3.2.1.7 (TTL), and 3.3.2 (Reassembly).

Following test sub-sections have been derived to test the above mentioned requirements:

- IPv4 header field verifications.
- IPv4 header checksum operations.
- IPv4 packet fragmentation and reassembly.

This specification gives the description of required test environments and detailed test cases for executing tests.

Please refer to the "Traceability Matrix" (Appendix-A) mentioned at the end of this document, which gives a consolidated correlation between the AUTOSAR requirement, IETF RFC sections and the test cases mentioned in this document.

3.1.1 Test System

3.1.1.1 Overview on Architecture

The basic test system architecture is depicted in the following figure:

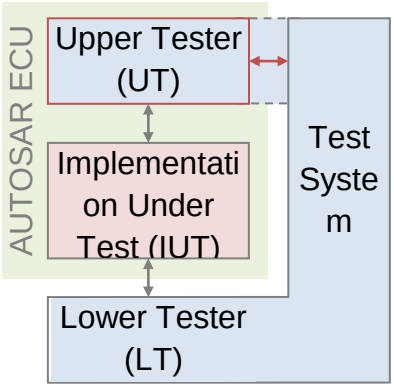

Figure 1: Basic test system architecture

Test System

- controls the Upper Tester and the Lower Tester
- evaluates the test results

The Upper Tester (UT)

- is part of the Test System
- sends / receives Testability SPs and propagates the needed actions to the IUT
- receives return values from the IUT
- communicates return values with the Lower tester to achieve test execution coordination with the Lower tester interface

The Lower Tester (LT)

- is part of the Test System
- records any Ethernet encapsulated packets during the test execution
- sends Ethernet PDUs to the IUT
- coordinates and synchronizes with the Upper Tester

3.1.1.2 Specific Requirements

The Testability Protocol and Service Primitives [9] shall be implemented as a part of the UT
in order to propagate the needed Service Primitives and actions to the IUT.

3.1.1.3 Test Coordination Requirements

As observation of the IUT is done by the test cases at both the Lower Tester and the Upper Tester, a test coordination procedure for collecting the local test verdicts (at LT and UT) at one central place is required. It is up to the test system designer / implementer to define that “central place” and to design and implement the test coordination functionality.

3.1.2 IPv4 Test Configuration

This section describes sets of requirements on configuration. These sets are later referenced by test cases. No configuration files are provided. They need to be developed when the test suite is implemented. The configuration can be divided into two separate parts.

The '**IPv4 Tester Configuration**' describes variables used to parameterize the Tester.
The '**IPv4 IUT Configuration**' describes the necessary settings of the IUT in order to allow a test case to perform. Now onwards this section will be referred as "IPv4 Test Configuration-1".

3.1.2.1 IPv4 Tester Configuration

This configuration is changeable during runtime and contains parameters that are referenced by test cases and can be adjusted by a test case itself. In case the test configuration parameter is only referenced the following default parameters will apply.

User defined configuration parameters			
Input Parameter	Descriptions	Default values	Example of Variable names used during test
Ethernet Interface to be used by Tester	Name of the Ethernet interface on the host machine that tester will use.	Eth-0	<TesterIFace-n> [e.g. <TesterIFace-0>, <TesterIFace-1> etc]
Ethernet Interface to be used by IUT	Name of the Ethernet interface on the host machine that IUT will use.	As configured	<IUTIface-n> [e.g. <IUTIface-0>, <IUTIface-1> etc]
Lower Tester IP Address pool	This is the IP address pool to be used by LT. (Note – Lower Tester may need to simulate a series of IP addressed during a test, this pool will be used for that purpose).	As configured	<Host-n-IP> [e.g. <Host-1-IP>, <Host-2-IP> etc]
Lower Tester port pool	This is the port pool to be used by LT. (Note – Lower Tester may need to use multiple ports during a test, this pool will be used for that purpose).	20000	<unusedUDP-LT-Port-n>
IUT IP Address	This is the IP address of the Implementation Under Test's connection to that network.	As configured	<IUTIface-n-IPAddr> [e.g. <IUTIface-0-IPAddr> denotes the IP address of 0th interface of IUT]
IUT port number	This is the IUT port number to be used during the test.	20001	<unusedUDP-IUT-Port1>

Listen Time	This is the maximum time interval (in seconds) for which LT waits for a packet for cases when a certain event has been triggered on the IUT either by some protocol timer or using some external mechanism.	10 seconds	<ListenTime>
Tolerance Time	Time tolerance (in ms) to be used during various calculations for time sensitive tests.	500 ms	<ToleranceTime>
Sample IP data	Sample data used by TESTER.	<DATADATADATADATA….. up to n octets>	<Data-n>
Sample UDP data	Sample UDP data used by TESTER	<UDPDATAUDPDATAUDPDATA….. up to n octets>	<UDPData-n>
Sample ICMP data	Sample ICMP data used by TESTER	<ICMPDATAICMPDATAICMPDATA….. up to n octets>	<ICMPData-n>
Default IP TTL	Specifies the time to live value for outgoing frames.	64	<defaultIPTTL>
Invalid Checksum	Checksum other than actual checksum (actual checksum is the 16 bit one's complement of the one's complement sum of all 16 bit words in the header)	As calculated	<invalidChecksum>
Reassembly Timeout	This is the initial timeout in seconds for which Implementation Under Test waits for fragments for reassembly	15 seconds	<reassemblyTimeOut>
MTU	Maximum transmission unit (**MTU**). It is the size (in bytes or octets) of the largest protocol data unit that the Ethernet layer can pass onwards.	1500	<MTU>
EMTU_S	Effective MTU for sending. It denotes the maximum IP datagram size that may be sent, for a particular combination of IP source and destination addresses	<MTU>	<EMTU_S>
All System Multicast Addr	Refers to the multicast address of All Systems on a Subnet. It will be specific to a EthIfCtrl	As Configured	<allSystemMCastAddr>
Broadcast Address	Refers to the broadcast address corresponding to EthIfCtrl of an IUT interface. e.g <BroadCastAddr-0> signifies broad cast address corresponding to EthIfCtrl of <IUTIface-0>	As Configured	<BroadCastAddr-n>

Table 1 Input Parameters

3.1.2.2 IPv4 IUT Configuration

In order to make a test run possible, it is required to make a number of configurations at the IUT and the corresponding configuration parameters can be derived from the AUTOSAR System Template. ECUC Parameters can also be used if needed especially when no corresponding System Template Parameter is present.

3.1.2.2.1 Required system description

The purpose of the tests is to check the implementation of the SOP SW version as black box test. So only the final SOP System Description is required.

1. ApplicationEndpoint.TransportProtocolConfiguration.TcpUdpConfig.TcpTp.portNumber > <unusedUDP-IUT-Port1>
2. ApplicationEndpoint.TransportProtocolConfiguration.TcpUdpConfig.TcpTp.dynamicallyAssigned = FALSE
3. SystemTemplate::Fibex::Fibex4Ethernet::EthernetTopology::NetworkEndpointAddress.TcpIpLocalAddr = <IUTIface-0-IPAddr>
4. SystemTemplate::Fibex::Fibex4Ethernet::EthernetTopology::NetworkEndpointAddress. TcpIpAddressType = TCPIP_UNICAST

3.1.2.2.2 Required values for IPv4 stack configuration parameters

1. TcpIp.TcpIpGeneral.TcpIpIpV4Enabled = TRUE
2. TcpIp.TcpIpGeneral.TcpIpIcmpEnabled = TRUE
3. TcpIp.TcpIpGeneral.TcpIpUdpEnabled = TRUE
4. TcpIp.TcpIpGeneral.TcpIpBufferMemory > MIN_MEM_BUF
5. TcpIp.TcpIpConfig.TcpIpCtrl.TcpIpEthIfCtrlRef = <IUTIface-0>
6. TcpIp.TcpIpConfig.TcpIpCtrl.TcpIpLocalAddr = <IUTIface-0-IPAddr>
7. EthGeneral.EthCtrlOffloading.EthCtrlEnableOffloadChecksumUDP = FALSE
8. TcpIp.TcpIpConfig.TcpIpLocalAddr.TcpIpAddressType = TCPIP_UNICAST

3.1.2.2.3 Required Software Component Description Files

No specific configuration requirements for Software Components.

3.1.2.3 Mandatory vs. Customizable Parts

All the parameters mentioned at section 3.1.2.1 and section 3.1.2.2 are mandatory parameters to run any of the below mentioned test cases.
There could be a need for few more configuration items at ECU, however they are individual test case specific and defined at each test-case level.

3.2 Service Primitives

Depending on the necessity of a test case, the test system may use various service-primitives for the IUT to take certain actions.

For the complete working model of Service Primitives please refer to [9]

Name	Description
CREATE AND BIND	Triggers the IUT to create a socket and optionally binds this socket to a port and a local IP address.
SEND DATA	Triggers the IUT to send a specified data to a specified target.
CLOSE SOCKET	Triggers the IUT to close all the open sockets which were created during a particular test case.
CONFIGURE SOCKET	This SP is used to select and set certain parameters that can be configured on an UDP socket.

Table 2 Table of Service Primitives

3.3 Assumptions

At the beginning of each test it has to be ensured that the IUT is in the following conditions:

- All IUT interfaces that are connected to the Test System are enabled.
- All IUT interfaces that are NOT connected to The Test System are disabled
- There's no other unit in the test system that can inadvertently affect a test case.

3.4 Terminologies

This section defines the terminologies used in the test statements.
The following is a brief description of the special terminologies used in the test sections.

Sl. No.	Phrases	Illustrations
1	UT causes the IUT to <CREATE AND BIND> a UDP socket on port <unusedUDP-IUT-Port1> to unicast address <IUTIface-0-IPAddr> for EthIf controller <IUTIface-0>	A. UT issues service primitive <CREATE AND BIND> to create a UDP socket and optionally binds this socket to a port and a local IP address mentioned in the parameter.
2	Instruct IUT to send a UDP message with <UDPData-n> as data through <IUTIface-0>	UT issues service primitive <SEND DATA> to instruct IUT to send a UDP message through <IUTIface-0>, containing: - Source-port field set to <unusedUDP-IUT-Port1> - Source IP Address as defined in 'TcpIpLocalAddr' container. - Destination-port field set to <unusedUDP-LT-Port> - Destination IP Address set to <Host-1-IP> - Length field set to UDP header and data length - UDP data field set to <UDPData-n> - Checksum field set to 16-bit one's complement of the one's complement sum of the UDP header, UDP data and pseudo header.

Table 3 Table of Terminologies

3.5 Topology

3.5.1 IPv4-Topology-1

DESCRIPTION:

This topology simulates HOST to HOST communication scenario between the IUT and LT. In this topology both LT and IUT should be on the same network.

4 Test Cases

4.1 IPv4 Header Field verifications

4.1.1 [ATS_IPv4_00361] IP version field verification – invalid version

Test Objective	IP version field verification – invalid version		
ID	ATS_IPv4_00361	**AUTOSAR Releases**	4.2.1
Affected Modules	TcpIP, EthIf, Eth	**State**	reviewed
Trace to Requirement on Acceptance Test Document	ATR: ATR_ATR_00126		
Trace to SWS Item	TcpIp: SWS_TCPIP_00053 ATS_SID: ATS_SID_00001		
Requirements / Reference to Test Environment	IP-Topology-1		
Configuration Parameters	3.1.2 IPv4 Test Configuration (Table-1)		
Summary	LT Sends an ICMPv4 Echo Request to IUT having IP version field set to anything other than 4. Verify that IUT doesn't send back any ICMPv4 Echo Reply		
Needed Adaptation to other Releases	None		
Pre-conditions			
Main Test Execution			
Test Steps		**Pass Criteria**	
Step 1	**[LT]** LT sends an ICMPv4 Echo Request message to IUT containing: - IP Version field set to other than 4 or 6 - All other fields are set to their default values		
Step 2	**[LT]** Verify that IUT does not send ICMPv4 Echo Reply	The IUT discards ICMPv4 Echo Request and do not send ICMPv4 Echo Reply	
Post-conditions			

4.1.2 [ATS_IPv4_00362] IP version field verification

Test Objective	IP version field verification		
ID	ATS_IPv4_00362	**AUTOSAR Releases**	4.2.1
Affected Modules	TcpIP, EthIf, Eth	**State**	reviewed
Trace to Requirement on Acceptance Test Document	ATR: ATR_ATR_00126		
Trace to SWS Item	TcpIp: SWS_TCPIP_00053 ATS_SID: ATS_SID_00002		
Requirements / Reference to Test Environment	IP-Topology-1		
Configuration Parameters	3.1.2 IPv4 Test Configuration (Table-1)		
Summary	LT Sends an ICMPv4 Echo Request to IUT having IP version field set to 4. Verify that IUT send back corresponding ICMPv4 Echo Reply.		
Needed Adaptation to other Releases	None		
Pre-conditions			
Main Test Execution			
Test Steps		**Pass Criteria**	
Step 1	**[LT]** LT sends an ICMPV4 Echo Request message to IUT containing: - IP Version field set to 4 - All other fields are set to their default values		
Step 2	**[LT]** Verify that IUT sends ICMPV4 Echo Reply	IUT sends ICMPV4 Echo Reply	
Post-conditions			

4.1.3 [ATS_IPv4_00363] IP IHL field verification – checking minimum value

Test Objective	IP IHL field verification – checking minimum value		
ID	ATS_IPv4_00363	**AUTOSAR Releases**	4.2.1
Affected Modules	TcpIP, EthIf, Eth	**State**	reviewed
Trace to Requirement on Acceptance Test Document	ATR: ATR_ATR_00126		
Trace to SWS Item	TcpIp: SWS_TCPIP_00053 ATS_SID: ATS_SID_00003		
Requirements / Reference to Test Environment	IP-Topology-1		
Configuration Parameters	3.1.2 IPv4 Test Configuration (Table-1)		
Summary	LT Sends an ICMPv4 Echo Request to IUT containing no associated IP option field. Verify that IUT sends back corresponding ICMPv4 Echo Reply that doesn't contain any IP option field and the value of "Internet Header Length" (IHL) is set to 5. Also check that IUT discards the datagram if IHL is set to less than 5.		
Needed Adaptation to other Releases	None		
Pre-conditions			
Main Test Execution			
Test Steps			**Pass Criteria**
Step 1	**[LT]** LT sends an ICMPV4 Echo Request message to IUT containing: - No IP Option - All other fields are set to their default values		
Step 2	**[LT]** Verify that IUT sends ICMPV4 Echo Reply with no IP option and 'IHL' field set to 5		IUT sends ICMPV4 Echo Reply with no IP option and 'IHL' field set to 5
Step 3	**[LT]** LT sends an ICMPV4 Echo Request		

	message to IUT containing: - No IP Option - IHL field set to 3 - All other fields are set to their default values	
Step 4	[LT] Verify that IUT does not send ICMPV4 Echo Reply	IUT does not send ICMPV4 Echo Reply
Post-conditions		

4.1.4 [ATS_IPv4_00364] IP TOS field verification

Test Objective	IP TOS field verification		
ID	ATS_IPv4_00364	**AUTOSAR Releases**	4.2.1
Affected Modules	TcpIP, EthIf, Eth	**State**	reviewed
Trace to Requirement on Acceptance Test Document	ATR: ATR_ATR_00126		
Trace to SWS Item	TcpIp: SWS_TCPIP_00053 ATS_SID: ATS_SID_00004		
Requirements / Reference to Test Environment	3.2 Service Primitives (Table-2) IP-Topology-1		
Configuration Parameters	3.1.2 IPv4 Test Configuration (Table-1)		
Summary	UT instructs the IUT to create and bind an UDP socket to the unicast address <IUTIface-0-IPAddr> of <IUTIface-0>. UT instructs IUT send an UDP message. LT receives the UDP message from IUT and verify that the value of lower order 5 bits of the “Type of Service” (TOS) octet is set to zero.		
Needed Adaptation to other Releases	None		
Pre-conditions	Assign unicast address <IUTIface-0-IPAddr> for EthIf controller <IUTIface-0>		
Main Test Execution			

Test Steps		Pass Criteria
Step 1	UT causes the IUT to <CREATE AND BIND> a UDP socket on port <unusedUDP-IUT-Port1> to unicast address <IUTIface-0-IPAddr> for EthIf controller <IUTIface-0>	
Step 2	**[UT]** UT instructs the IUT to <SEND DATA> containing: - Destination-port is set to <UnusedUDP-LT-Port> - Destination IP address is set to <Host-1-IP>	
Step 3	**[LT]** Verify that IUT sends UDP message with lower order 5 bits of the 'TOS' octet is set to zero	IUT sends UDP Message where lower order 5 bits of 'TOS' octet is set to zero
Post-conditions	i) UT issues <CLOSE SOCKET> to IUT to close all UDP sockets created	

4.1.5 [ATS_IPv4_00365] IP Identification field verification – must be changed in each IP packet

Test Objective	IP Identification field verification – must be changed in each IP packet		
ID	ATS_IPv4_00365	**AUTOSAR Releases**	4.2.1
Affected Modules	TcpIP, EthIf, Eth	**State**	reviewed
Trace to Requirement on Acceptance Test Document	ATR: ATR_ATR_00126		
Trace to SWS Item	TcpIp: SWS_TCPIP_00053 ATS_SID: ATS_SID_00005		
Requirements / Reference to Test Environment	IP-Topology-1		
Configuration Parameters	3.1.2 IPv4 Test Configuration (Table-1)		
Summary	LT Sends three ICMPv4 Echo Requests to IUT. Verify that IUT sends back all the corresponding ICMPv4 Echo Reply messages and each of those ICMPv4 Echo Reply message contains different 'Identification' value.		

Needed Adaptation to other Releases	None	
Pre-conditions		
Main Test Execution		
Test Steps		**Pass Criteria**
Step 1	**[LT]** LT sends an ICMPV4 Echo Request message to IUT containing: - IP Identification field set to 1 - Echo request Payload field contains 100 bytes of data. - All other fields are set to their default values	
Step 2	**[LT]** LT receives the ICMP Echo reply from IUT and notes the IP Identification value.	
Step 3	**[LT]** LT sends an ICMPV4 Echo Request message to IUT containing: - IP Identification field set to 2 - Echo request Payload field contains 100 bytes of data. - All other fields are set to their default values	
Step 4	**[LT]** LT receives the ICMP Echo reply from IUT and verifies that the received IP Identification value doesn't matches with the earlier noted IP identification value of step-2	IUT sends ICMPV4 Echo Reply with a different IP Identification value.
Step 5	**[LT]** LT sends an ICMPV4 Echo Request message to IUT containing: - IP Identification field set to 1 - Echo request Payload field contains 100 bytes of data - All other fields are set to their default values	

Step 6	**[LT]** LT receives the ICMP Echo reply from IUT and verifies that the received IP Identification value doesn't matches with the earlier noted IP identification value of step-2 and step-4.	IUT sends ICMPV4 Echo Reply with a different IP Identification value.
Post-conditions		

4.1.6 [ATS_IPv4_00366] IP Flag field verification – Bit-0 is reserved

Test Objective	IP Flag field verification – Bit-0 is reserved		
ID	ATS_IPv4_00366	**AUTOSAR Releases**	4.2.1
Affected Modules	TcpIP, EthIf, Eth	**State**	reviewed
Trace to Requirement on Acceptance Test Document	ATR: ATR_ATR_00126		
Trace to SWS Item	TcpIp: SWS_TCPIP_00053 ATS_SID: ATS_SID_00006		
Requirements / Reference to Test Environment	IP-Topology-1		
Configuration Parameters	3.1.2 IPv4 Test Configuration (Table-1)		
Summary	LT sends ICMPv4 Echo Requests to IUT. IUT replies back with ICMPv4 Echo Reply. LT verifies that the Bit-0 of the 'IP Flags' is set to zero.		
Needed Adaptation to other Releases	None		
Pre-conditions			
Main Test Execution			
Test Steps			**Pass Criteria**
Step 1	**[LT]** LT sends an ICMPV4 Echo Request message to IUT containing: - All other fields are set to their default		

	values	
Step 2	**[LT]** Verify that IUT sends ICMPV4 Echo Reply and Bit-0 of the 'IP Flags' field is set to zero	IUT sends ICMPV4 Echo Reply and Bit-0 of the 'IP Flags' field is set to zero
Post-conditions		

4.1.7 [ATS_IPv4_00367] A TTL value less than 2 is valid and should not be discarded

Test Objective	A TTL value less than 2 is valid and should not be discarded		
ID	ATS_IPv4_00367	**AUTOSAR Releases**	4.2.1
Affected Modules	TcpIP, EthIf, Eth	**State**	reviewed
Trace to Requirement on Acceptance Test Document	ATR: ATR_ATR_00126		
Trace to SWS Item	TcpIp: SWS_TCPIP_00102 ATS_SID: ATS_SID_00007		
Requirements / Reference to Test Environment	IP-Topology-1		
Configuration Parameters	3.1.2 IPv4 Test Configuration (Table-1)		
Summary	LT Sends an ICMPv4 Echo Request to IUT with TTL field set to one. Verify that IUT sends back the corresponding ICMPv4 Echo Reply. LT Sends an ICMPv4 Echo Request to IUT with TTL field set to zero. Verify that IUT sends back the corresponding ICMPv4 Echo Reply.		
Needed Adaptation to other Releases	None		
Pre-conditions			
Main Test Execution			
Test Steps			**Pass Criteria**
Step 1	**[LT]** LT sends an ICMPV4 Echo Request		

	message to IUT containing: - IP TTL field set to 1 - All other fields are set to their default values	
Step 2	**[LT]** Verify that IUT sends ICMPV4 Echo Reply	IUT sends ICMPV4 Echo Reply
Step 3	**[LT]** LT sends an ICMPV4 Echo Request message to IUT containing: - IP TTL field set to 0 - All other fields are set to their default values	
Step 4	**[LT]** Verify that IUT sends ICMPV4 Echo Reply	IUT sends ICMPV4 Echo Reply
Post-conditions		

4.1.8 [ATS_IPv4_00368] TTL set to zero must not send

Test Objective	TTL set to zero must not send		
ID	ATS_IPv4_00368	**AUTOSAR Releases**	4.2.1
Affected Modules	TcpIP, EthIf, Eth	**State**	reviewed
Trace to Requirement on Acceptance Test Document	ATR: ATR_ATR_00126		
Trace to SWS Item	TcpIp: SWS_TCPIP_00102 ATS_SID: ATS_SID_00008		
Requirements / Reference to Test Environment	3.2 Service Primitives (Table-2) IP-Topology-1		
Configuration Parameters	3.1.2 IPv4 Test Configuration (Table-1)		
Summary	UT instructs IUT send an UDP message to LT, containing TTL field set to zero Verify that LT does not receive any UDP message from IUT containing TTL field		

	set to zero	
Needed Adaptation to other Releases	None	
Pre-conditions	1) Assign unicast address <IUTIface-0-IPAddr> for EthIf controller <IUTIface-0> 2) UT causes the IUT to <CREATE AND BIND> a UDP socket on port <unusedUDP-IUT-Port1> to unicast address <IUTIface-0-IPAddr> for EthIf controller <IUTIface-0> 3) UT uses service primitive <CONFIGURE SOCKET> to set TTL of that UDP socket to zero.	
Main Test Execution		
Test Steps		**Pass Criteria**
Step 1	**[UT]** UT instructs the IUT to <SEND DATA> containing: • Destination-port is set to <UnusedUDP-LT-Port> • Destination IP address is set to <Host-1-IP> • UDP data set to <UDPData-16>	
Step 2	**[LT]** Doesn't receive any UDP datagram from IUT containing: • UDP data set to <UDPData-16> • IP TTL set to zero.	IUT does not send a UDP message where 'TTL' field is set to zero
Post-conditions	1) UT issues <CLOSE SOCKET> to IUT to close all UDP sockets created during this test. 2) Restore the default address assignment to <IUTIface-0>	

4.1.9 [ATS_IPv4_00369] IP Protocol field validation

Test Objective	IP Protocol field validation		
ID	ATS_IPv4_00369	**AUTOSAR Releases**	4.2.1
Affected Modules	TcpIP, EthIf, Eth	**State**	reviewed
Trace to Requirement on Acceptance	ATR: ATR_ATR_00126		

Test Document			
Trace to SWS Item	TcpIp: SWS_TCPIP_00102 ATS_SID: ATS_SID_00009		
Requirements / Reference to Test Environment	IP-Topology-1		
Configuration Parameters	3.1.2 IPv4 Test Configuration (Table-1)		
Summary	LT Sends an ICMPv4 Echo Request to IUT. IUT sends back the corresponding ICMPv4 Echo Reply. LT verifies that the 'Protocol' field of the IP header is set to 0x01 (corresponding to ICMP protocol).		
Needed Adaptation to other Releases	None		
Pre-conditions			
Main Test Execution			
Test Steps			**Pass Criteria**
Step 1	**[LT]** LT sends an ICMPV4 Echo Request message to IUT containing: - All fields are set to their default values		
Step 2	**[LT]** Verify that IUT sends ICMPV4 Echo Reply and 'Protocol' field set to 1		IUT sends ICMPV4 Echo Reply and 'Protocol' field set to 1
Post-conditions			

4.1.10 [ATS_IPv4_00370] IP Length field verification

Test Objective	IP Length field verification		
ID	ATS_IPv4_00370	**AUTOSAR Releases**	4.2.1
Affected Modules	TcpIP, EthIf, Eth	**State**	reviewed
Trace to Requirement on Acceptance Test	ATR: ATR_ATR_00126		

Document		
Trace to SWS Item	TcpIp: SWS_TCPIP_00053 ATS_SID: ATS_SID_00010	
Requirements / Reference to Test Environment	IP-Topology-1	
Configuration Parameters	3.1.2 IPv4 Test Configuration (Table-1)	
Summary	LT Sends an ICMPv4 Echo Request to IUT where total length field is set to 576 and IP payload contain 556 octets of data. Verify that IUT replies back with same amount of data octet.	
Needed Adaptation to other Releases	None	
Pre-conditions		
Main Test Execution		
Test Steps		**Pass Criteria**
Step 1	**[LT]** LT sends an ICMPv4 Echo Request message to IUT containing: - IP Total Length field set to 576 - IP Payload field contains, - 556 bytes of data - All other fields are set to their default values	
Step 2	**[LT]** Verify that IUT sends ICMPV4 Echo Reply and Identifier, Sequence Number and Data of ICMPV4 Echo Reply are same as those of ICMPV4 Echo Request sent	IUT sends ICMPv4 Echo Reply and Identifier, Sequence Number and Data of ICMPV4 Echo Reply are same as those of ICMPV4 Echo Request sent
Post-conditions		

4.1.11 [ATS_IPv4_00371] Broadcast address MUST NOT be used as Source address

Test Objective	Broadcast address MUST NOT be used as Source address

ID	ATS_IPv4_00371	**AUTOSAR Releases**	4.2.1
Affected Modules	TcpIP, EthIf, Eth	**State**	reviewed
Trace to Requirement on Acceptance Test Document	ATR: ATR_ATR_00126		
Trace to SWS Item	TcpIp: SWS_TCPIP_00053 ATS_SID: ATS_SID_00011		
Requirements / Reference to Test Environment	IP-Topology-1		
Configuration Parameters	3.1.2 IPv4 Test Configuration (Table-1)		
Summary	LT Sends an ICMPv4 Echo Request to IUT source IP address field set to IP Broadcast address. Verify that IUT doesn't reply back for this ICMPv4 Echo Request.		
Needed Adaptation to other Releases	None		
Pre-conditions			
Main Test Execution			
Test Steps		**Pass Criteria**	
Step 1	**[LT]** LT sends an ICMPV4 Echo Request message to IUT containing: - IP Source Address field set to a broadcast address <BroadCastAddr-0> - All other fields are set to their default values		
Step 2	**[LT]** Verify that IUT does not send ICMPV4 Echo Reply	IUT does not send ICMPV4 Echo Reply	
Post-conditions			

4.1.12 [ATS_IPv4_00372] Multicast address MUST NOT be used as Source address

Test Objective	Multicast address MUST NOT be used as Source address		
ID	ATS_IPv4_00372	**AUTOSAR Releases**	4.2.1
Affected Modules	TcpIP, EthIf, Eth	**State**	reviewed
Trace to Requirement on Acceptance Test Document	ATR: ATR_ATR_00126		
Trace to SWS Item	TcpIp: SWS_TCPIP_00053 ATS_SID: ATS_SID_00012		
Requirements / Reference to Test Environment	IP-Topology-1		
Configuration Parameters	3.1.2 IPv4 Test Configuration (Table-1)		
Summary	LT Sends an ICMPv4 Echo Request to IUT source IP address field set to IP multicast address. Verify that IUT doesn't replies back for this ICMPv4 Echo Request.		
Needed Adaptation to other Releases	None		
Pre-conditions			
Main Test Execution			
Test Steps		**Pass Criteria**	
Step 1	**[LT]** LT sends an ICMPV4 Echo Request message to IUT containing: - IP Source Address field set to a multicast address <allSystemMCastAddr> - All other fields are set to their default values		
Step 2	**[LT]** Verify that IUT does not send ICMPV4 Echo Reply	IUT does not send ICMPV4 Echo Reply	
Post-conditions			

4.2 IPv4 Header Checksum operations

4.2.1 [ATS_IPv4_00373] Internet datagram discarded if the header Checksum fails

Test Objective	Internet datagram discarded if the header Checksum fails		
ID	ATS_IPv4_00373	**AUTOSAR Releases**	4.2.1
Affected Modules	TcpIP, EthIf, Eth	**State**	reviewed
Trace to Requirement on Acceptance Test Document	ATR: ATR_ATR_00126		
Trace to SWS Item	TcpIp: SWS_TCPIP_00102 ATS_SID: ATS_SID_00013		
Requirements / Reference to Test Environment	IP-Topology-1		
Configuration Parameters	3.1.2 IPv4 Test Configuration (Table-1)		
Summary	LT Sends an ICMPv4 Echo Request to IUT with Checksum field set to an invalid value Verify that IUT does not send back the corresponding ICMPv4 Echo Reply.		
Needed Adaptation to other Releases	None		
Pre-conditions			
Main Test Execution			
Test Steps		**Pass Criteria**	
Step 1	**[LT]** LT sends an ICMPV4 Echo Request message to IUT containing: - IP Checksum field set to <invalidChecksum> - All other fields are set to their default values		
Step 2	[LT] Verify that IUT does not send ICMPV4 Echo	IUT does not send ICMPV4 Echo Reply	

	Reply	
Post-conditions		

4.2.2 [ATS_IPv4_00374] Checksum method Validations

Test Objective	Checksum method Validations		
ID	ATS_IPv4_00374	**AUTOSAR Releases**	4.2.1
Affected Modules	TcpIP, EthIf, Eth	**State**	reviewed
Trace to Requirement on Acceptance Test Document	ATR: ATR_ATR_00126		
Trace to SWS Item	TcpIp: SWS_TCPIP_00053 ATS_SID: ATS_SID_00014		
Requirements / Reference to Test Environment	IP-Topology-1		
Configuration Parameters	3.1.2 IPv4 Test Configuration (Table-1)		
Summary	LT Sends an ICMPv4 Echo Request to IUT with a predefined a data set. Verify that IUT replies back for this ICMPv4 Echo Request with correctly computed checksum- i.e. it is calculated as the 16 bit one's complement of the one's complement sum of all 16 bit words in the header.		
Needed Adaptation to other Releases	None		
Pre-conditions			
Main Test Execution			
Test Steps		**Pass Criteria**	
Step 1	**[LT]** LT sends an ICMPV4 Echo Request message to IUT containing: - IP Checksum field set to valid checksum - ICMP payload is set to <ICMPDATA-100> - All other fields are set to their default		

	values	
Step 2	**[LT]** Verify that IUT sends ICMPV4 Echo Reply containing: - IP Checksum field set to correct value. - ICMP payload is set to <ICMPDATA-100> - All other fields are set to their default values	IUT sends ICMPV4 Echo Reply with correctly computed checksum.
Post-conditions		

4.3 IPv4 Fragmentation and reassembly

4.3.1 [ATS_IPv4_00377] Verification of Reassembly timeout

Test Objective	Verification of Reassembly timeout		
ID	ATS_IPv4_00377	**AUTOSAR Releases**	4.2.1
Affected Modules	TcpIP, EthIf, Eth	**State**	reviewed
Trace to Requirement on Acceptance Test Document	ATR: ATR_ATR_00126		
Trace to SWS Item	TcpIp: SWS_TCPIP_00053 ATS_SID: ATS_SID_00017		
Requirements / Reference to Test Environment	IP-Topology-1		
Configuration Parameters	3.1.2 IPv4 Test Configuration (Table-1)		
Summary	LT sends an ICMPv4 Echo request message with fragment zero and MF bit set to 1. After that without sending any further message LT waits to expire the “Reassembly timeout” period. Then verify that IUT sends an “ICMPv4 Time Exceeded message” to LT.		

Needed Adaptation to other Releases	None	
Pre-conditions	configure Reassembly Time out period to <reassemblyTimeOut>	
Main Test Execution		
Test Steps		**Pass Criteria**
Step 1	**[LT]** LT sends an ICMPV4 Echo Request message to IUT containing: - IP fragment offset field set to zero - IP MF flag field set to 1 - first half of the constructed ICMPV4 packet - All other fields are set to their default values	
Step 2	**[LT]** LT Wait till upto <reassemblyTimeOut> period	
Step 3	**[LT]** Verify that IUT sends ICMPv4 Time Exceeded message, containing: • ICMPv4 TYPE field is set to 11 and ICMPv4 Code field is set to 1	IUT sends ICMPv4 Time Exceeded message, containing: • ICMPv4 TYPE field is set to 11 and ICMPv4 Code field is set to 1
Post-conditions		

4.3.2 [ATS_IPv4_00388] IUT does not reassemble fragments of an IPv4 packet if no first fragment is sent

Test Objective	IUT does not reassemble fragments of an IPv4 packet if no first fragment is sent		
ID	ATS_IPv4_00388	**AUTOSAR Releases**	4.2.1
Affected Modules	TcpIP, EthIf, Eth	**State**	reviewed
Trace to Requirement on Acceptance Test Document	ATR: ATR_ATR_00126		
Trace to SWS	TcpIp: SWS_TCPIP_00053		

Item	ATS_SID: ATS_SID_00028	
Requirements / Reference to Test Environment	IP-Topology-1	
Configuration Parameters	3.1.2 IPv4 Test Configuration (Table-1)	
Summary	Tester sends an ICMPv4 echo request to IUT divided into two fragments. But none of those fragments indicate the first fragment (i.e. none of them have 'IP fragment offset' field set to zero). Verify that IUT does not reassemble and accept the IP packets and does not sends ICMPv4 Echo Reply	
Needed Adaptation to other Releases	None	
Pre-conditions		
Main Test Execution		
Test Steps		**Pass Criteria**
Step 1	**[LT]** LT constructs an ICMPv4 Echo Request LT sends an IP packet to IUT containing: - IP fragment offset field set to non-zero - IP MF flag field set to 1 - first half of the constructed ICMPV4 packet - All other fields are set to their default values	
Step 2	**[LT]** LT sends 2 IP packet to IUT containing: - IP fragment offset field set to data size sent in the first IP packet in unit of 8-octets - IP MF flag field set to zero - Second half of the constructed ICMPV4 packet - All other fields are set to their default values	
Step 3	**[LT]** Verify that IUT does not sends ICMPv4 Echo Reply	Verify that IUT does not reassemble and accept the IP packets and does not sends ICMPv4 Echo Reply

Post-conditions	

4.3.3 [ATS_IPv4_00389] IUT does not reassemble fragments of an IPv4 packet if some IPv4 fragments are missing

Test Objective	IUT does not reassemble fragments of an IPv4 packet if some IPv4 fragments are missing		
ID	ATS_IPv4_00389	**AUTOSAR Releases**	4.2.1
Affected Modules	TcpIP, EthIf, Eth	**State**	reviewed
Trace to Requirement on Acceptance Test Document	ATR: ATR_ATR_00126		
Trace to SWS Item	TcpIp: SWS_TCPIP_00053 ATS_SID: ATS_SID_00029		
Requirements / Reference to Test Environment	IP-Topology-1		
Configuration Parameters	3.1.2 IPv4 Test Configuration (Table-1)		
Summary	Tester sends an ICMPv4 echo request to IUT divided into three fragments. But the fragment offset field indicates a mismatch and implies a missing fragment. Verify that IUT does not reassemble and accept the IP packets and does not sends ICMPv4 Echo Reply		
Needed Adaptation to other Releases	None		
Pre-conditions			
Main Test Execution			
Test Steps		**Pass Criteria**	
Step 1	**[LT]** LT constructs an ICMPv4 Echo Request LT sends an IP packet to IUT containing: - IP fragment offset field set to zero - IP MF flag field set to 1 - first part of the constructed ICMPV4 packet - All other fields are set to their default		

	values	
Step 2	**[LT]** LT sends an IP packet to IUT containing: - IP fragment offset field set to data size sent in the first IP packet in unit of 8-octets - IP MF flag field set to 1 - Second part of the constructed ICMPV4 packet - All other fields are set to their default values	
Step 3	**[LT]** LT sends an IP packet to IUT containing: - IP fragment offset field set to (total data size sent in the first and second IP packet in unit of 8-octets + 8) - IP MF flag field set to zero - Last part of the constructed ICMPV4 packet - All other fields are set to their default values	
Step 4	**[LT]** Verify that IUT does not send ICMPv4 Echo Reply	Verify that IUT does not reassemble and accept the Ipv4 packets and does not send ICMPv4 Echo Reply
Post-conditions		

5 Appendix – A :: Traceability Matrix

The AUTOSAR SWS for TCP/IP contain requirements which are not granular enough for testing: a requirement references an IETF RFC (or sections of IETF RFCs) where multiple test cases need to be derived

In other ATS documents, the test cases reference (“Trace to SWS Item”) specification items from AUTOSAR SWS documents, but for the Ethernet related test case this would lead to many test cases referencing the same AUTOSAR specification item.

For this purpose, this ATS document proposes an identification of specification statement from the IETF RFCs so that they can be referenced in the test cases.

Below table is organized with the following columns

1. Statement ID
    - Is a unique identifier.
    - For example: ATS_SID_00000, ATS_SID_00001
2. Related AUTOSAR specification item
    - Single AUTOSAR SWS requirement which requires the statement
3. Reference in IETF RFC
    - provides the location of the statement
    - It is constructed with a comma separated list of:
        - IETF RFC number,
        - Page number,
        - section number (if exists)
        - section name,
    - For example: RFC 1122, Page 77, Section 4.1.3.1, 'Ports'.
4. Content
    - The statement copy pasted from corresponding IETF RFC or from AUTOSAR SWS document.
5. Classifier
    - It is used to signify the requirement category in the specification. There are five different types of classifiers:
        - MUST: This classifier means that the relevant statement is an absolute requirement of the specification. Usually corresponding statements consists words like “must”, “shall”, “required”.
        - MUST NOT: This classifier means that the relevant statement is an absolute prohibition of the specification. Usually corresponding statements consists words like “must not”, “shall not”.
        - SHOULD: This classifier means that for the relevant statement there may exist valid reasons in particular circumstances to ignore a particular item, but the full implications must be understood and carefully weighed before choosing a different course. Usually corresponding statements consists words like “should”, “would”, “recommended”, “suggested”.
        - SHOULD NOT: This classifier means that for the relevant statement there may exist valid reasons in particular circumstances when the particular behavior is acceptable or even useful, but the full implications must be understood and carefully weighed before choosing a different course. Usually corresponding statements consists words like “should not”, “not recommended”.

- MAY: This classifier signifies that an item is truly optional. One vendor may choose to include the item because a particular marketplace requires it or because the vendor feels that it enhances the product while another vendor may omit the same item. An implementation which does not include a particular option MUST be prepared to interoperate with another implementation which does include the option, though perhaps with reduced functionality. In the same vein an implementation which does include a particular option MUST be prepared to interoperate with another implementation which does not include the option (except, of course, for the feature the option provides.). Usually corresponding statements consists words like “may”, “optional”.

Sl. No.	Statement ID	AUTOSAR SWS #	Reference in IETF RFC	Content	Classifier
1	ATS_SID_00001	SWS_TCPIP_00053	RFC 791, section3.1, ‘Internet Header Format (Version)’, page 11	A datagram whose IP version number is not 4 MUST be silently discarded	MUST
2	ATS_SID_00002	SWS_TCPIP_00053	RFC 791, section3.1, ‘Internet Header Format (Version)’, page 11	IUT sends ICMPv4 Echo Reply if the IP version number of the received ICMPv4 Echo Request is set to 4.	MUST
3	ATS_SID_00003	SWS_TCPIP_00053	RFC 791, section3.1, ‘Internet Header Format (IHL)’, page 11	IHL: 4 bits Internet Header Length is the length of the internet header in 32 bit words, and thus points to the beginning of the data. Note that the minimum value for a correct header is 5	MUST
4	ATS_SID_00004	SWS_TCPIP_00053	RFC 1122, section3.2.1.6, ‘Type-of-Service‘, page 33	TOS: 5 bits The IP layer MUST provide a means for the transport layer to set the TOS field of every datagram that is sent; the default is all zero bits. The IP layer SHOULD pass received TOS values up to the transport layer.	SHOULD
5	ATS_SID_00005	SWS_TCPIP_00053	RFC 791, section3.1, ‘Internet Header Format (Identification)’, page 13	Identification: 16 bits An identifying value assigned by the sender to aid in assembling the fragments of a datagram	MAY
6	ATS_SID_00006	SWS_TCPIP_00053	RFC 791, section3.1, ‘Internet Header Format (Flags)’, page 13	Flags: 3 bits Various Control Flags. Bit 0: reserved, must be zero	MUST
7	ATS_SID_00007	SWS_TCPIP_00102	RFC 1122, section 3.2.1.7, ‘Time-to-Live’, Page 34	A host MUST NOT discard a datagram just because it was received with TTL less than 2.	MUST NOT
8	ATS_SID_00008	SWS_TCPIP_00102	RFC 1122, section 3.2.1.7, ‘Time-to-Live’, Page 34	A host MUST NOT send a datagram with a Time-to-Live (TTL) value of zero	MUST NOT
9	ATS_SID_00009	SWS_TCPIP_00102	RFC 791, section3.1, ‘Internet Header Format (Protocol)’, page 14	Protocol: 8 bits This field indicates the next level protocol used in the data portion of the internet datagram	SHOULD
10	ATS_SID_00010	SWS_TCPIP_00053	RFC 791, section3.1, ‘Internet Header Format (Length)’, page 13	All hosts must be prepared to accept datagrams of up to 576 octets.	MUST
11	ATS_SID_00011	SWS_TCPIP_00053	RFC 791, section3.2, ‘Discussion (Addressing)’, page 24	IUT must not reply to ICMPv4 Echo Request where IP source address is set to Broadcast address.	MUST
12	ATS_SID_00012	SWS_TCPIP_00053	RFC 791, section3.2, ‘Discussion (Addressing)’, page 24	A host MUST NOT reply to ICMPv4 Echo Request where IP source address is set to multicast address.	MUST NOT
13	ATS_SID_00013	SWS_TCPIP_00102	RFC 1122, section 3.2.1.2, ‘Checksum’, Page 29	If the header checksum fails, the internet datagram is discarded at once by the entity which detects the error	MUST

14	ATS_SID_00014	SWS_TCPIP_00053	RFC 791, section3.1, 'Internet Header Format (Checksum)', page 14	The checksum field is the 16 bit one's complement of the one's complement sum of all 16 bit words in the header.	SHOULD
17	ATS_SID_00017	SWS_TCPIP_00053	RFC 1122, section3.3.2, 'Reassembly', page 57	There MUST be a reassembly timeout. The reassembly timeout value SHOULD be a fixed value, not set from the remaining TTL. It is recommended that the value lie between 60 seconds and 120 seconds. If this timeout expires, the partially-reassembled datagram MUST be discarded and an ICMP Time Exceeded message sent to the source host (if fragment zero has been received).	MUST
29	ATS_SID_00029	SWS_TCPIP_00053	RFC 791, section 3.2 'Discussion (Fragmentation and Reassembly)', page 24	Verify that the IUT does not reassemble fragments of an IPv4 packet if some IPv4 fragments are missing	SHOULD

Table 4 Traceability matrix.