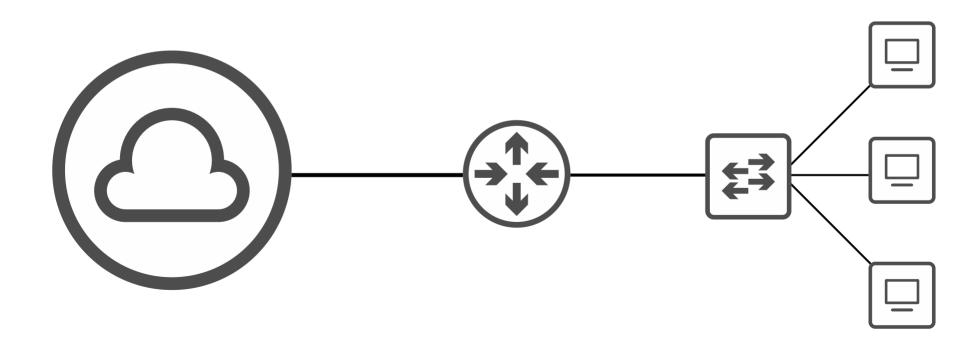




IPv4 Header

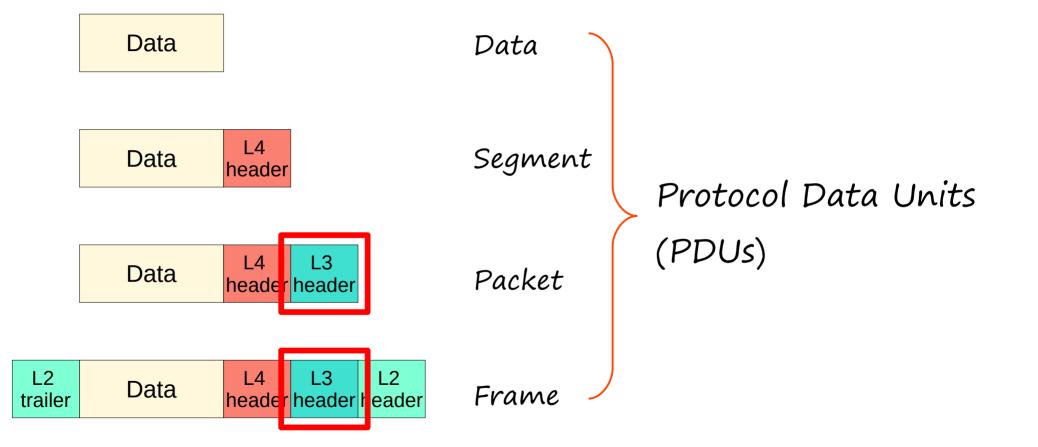




- IPv4 packet structure
- Fields of the IPv4 header



OSI Model – PDUs





IPv4 Header

Offsets	Octet				(0								1							:	2								3			
Octet	Bit	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	2 23	24	2	5 26	27	28	29	30	31
0	0		Vers	sion			IF	łL				DS	CP			EC	N								Total	Len	gth						
4	32							lc	lenti	ficati	ion								Flage	5						Frag	mer	t Off	set				
8	64			Т	ime ⁻	To Li	ve						Prot	tocol										He	ader	Che	cksu	m					
12	96															Sou	ce II	PA	ddres	ss													
16	128														C	Destin	ation	۱P	Addr	ess													
20	160																																
24	192															Onti		(if IL		5)													
28	224															Opti) sins (1L - 1	5)													
32	256																																



IPv4 Header – Version field

Offsets	Octet				0)								1								2								3			
Octet	Bit	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
0	0		Vers	ion			IF	HL				DS	SCP			E	CN							Т	otal	Leng	gth						
4	32							ld	lenti	ficati	ion								Flag	s					F	ragi	ment	Offs	et				
8	64			Tim	ie T	īo Liv	ve						Pro	toco										Hea	der (Chec	ksun	n					
12	96															So	urce	IP A	ddre	ss													
16	128														C	Desti	natio	n IP	P Add	ress													
20	160																																
24	192															0-		/:4 11		5)													
28	224															Op	lions	(ir ii	HL >	5)													
32	256																																

Length: 4 bits

- Identifies the version of IP used.
- IPv4 = 4(0100)
- IPv6 = 6(0110)



IPv4 Header – Internet Header Length (IHL)

Offsets	Octet					0									1								2									:	3			
Octet	Bit	0	1	2	3		4 :	5	6	7	8	9	10	11	1 12	13	14	15	10	6 17	18	1	9 20	0	21	22	23	2	24 2	5	26	27	28	29	30	31
0	0		Ver	sion	ĺ	L		IH	L				DS	SCF	>		E	CN								Т	otal	Le	ngth							
4	32								lde	əntif	ficati	on								Flag	s						F	Fra	agmer	nt C	Offse	et				
8	64			Т	ïme	То	Live							Pr	otoco	bl									H	lead	der (Ch	ecksu	m						
12	96																S	ource	IP/	Addre	SS															
16	128																Des	tinatio	on II	P Add	ress															
20	160																																			
24	192																~				-															
28	224																0	Juons	i (IT	IHL >	5)															
32	256																																			

Length: 4 bits

- The final field of the IPv4 header (Options) is variable in length, so this field is necessary to indicate the total length of the header.
- Identifies the length of the header in 4-byte increments
- Value of $5 = 5 \times 4$ -bytes = 20 bytes



IPv4 Header – Internet Header Length (IHL)

Offsets	Octet					0									1								2									3	3			
Octet	Bit	0	1	2	3	Ŀ	4 5	;	6	7	8	9	10	11	12	13	1	4 15	1	16 1	1	8	19 2	0	21	22	23	2	24 25	2	26	27	28	29	30	31
0	0		Ver	sion		L		IHI	_				DS	SCF	•			ECN								Т	otal	Le	ngth							
4	32								lde	əntif	ficati	on								Fla	gs						F	Fra	agmen	t O	ffsel	t				
8	64			Т	ime	То	Live							Pr	otoco	bl										Hea	der (Ch	ecksu	m						
12	96																S	ource	IP	Addr	ess															
16	128																Des	tinatio	on I	IP Ad	dres	s														
20	160																																			
24	192																~		/:6		(F)															
28	224																0	puons	5 (IT	fIHL:	• 5)															
32	256																																			

Length: 4 bits

- Minimum value is 5 (= 20 bytes)
- Maximum value is 15 (15 x 4-bytes = 60 bytes)

- MINIMUM IPv4 HEADER LENGTH = 20 BYTES
- MAXIMUM IPv4 HEADER LENGTH = 60 BYTES



IPv4 Header – DSCP field

Offsets	Octet					D								1								2								;	3			
Octet	Bit	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	2	1 2	2	23	24	25	26	27	28	29	30	31
0	0		Vers	sion			- II	HL				DS	SCP			E	CN								Tot	al L	ength							
4	32							l	denti	ficati	on								Flag	s						F	ragme	nt	Offse	ət				
8	64			Ti	me ⁻	Γο L	.ive						Pro	tocol										He	ade	er C	hecks	um						
12	96															So	urce	IP A	ddre	ss														
16	128														C	Desti	natio	n IP	Add	ress														
20	160																																	
24	192															0-1		/:4 11	+L >	E)														
28	224															Op	lons	(11.11	1L /	5)														
32	256																																	

'Differentiated Services Code Point' Length: 6 bits

- Used for QoS (Quality of Service)
- Used to prioritize delay-sensitive data (streaming voice, video, etc.)



IPv4 Header – ECN field

Offsets	Octet					0								1								2									3			
Octet	Bit	0	1	2	3	4	4 5	6	7	8	9	10	11	1 12	13	3 .	14 15	16	17	18	19	20) 2	21 2	2	23	24	25	26	27	28	29	30	31
0	0		Ver	sion				IHL				D	SCP	>		L	ECN								То	tal L	.engt	n						
4	32								lden	tifica	tion								Flag	s						F	ragm	ent	Offs	et				
8	64		Time To Live Protocol Header Checksum Source IP Address Destination IP Address																															
12	96																																	
16	128		Source IP Address																															
20	160																																	
24	192																Ontinen	/14-11		E)														
28	224															(Options	(ir if	11 2	5)														
32	256																																	

'Explicit Congestion Notification' Length: 2 bits

- Provides end-to-end (between two endpoints) notification of network congestion without dropping packets.
- Optional feature that requires both endpoints, as well as the underlying network infrastructure, to support it.



IPv4 Header – Total Length field

Offsets	Octet					0									1									2									:	3			
Octet	Bit	0	1	2	3		4	5	6	7	8	9	10	1	1 1	2	13	14	15	16	17	18	19	9 20)	21	22	23	2	4 25	5 2	26	27	28	29	30	31
0	0		Ver	sior	ı.			IH	L				DS	SCF	P			EC	N								Т	otal	Ler	ngth							
4	32								ld	enti	ficati	on									Flag	s						F	=rag	gmen	t O	ffse	t				
8	64			٦	ïme	То	Live							Pi	roto	col										H	lead	der (Che	ecksu	m						
12	96																	Sou	се	IP A	ddre	ss															
16	128																D	estin	atio	n IP	Add	ress															
20	160																																				
24	192																	0-1		/14-11		5)															
28	224																	Opti	лS	(ir if	76 2	5)															
32	256																																				

Length: 16 bits

- Indicates the total length of the packet (L3 header + L4 segment)
- Measured in bytes (not 4-byte increments like IHL)
- Minimum value of 20 (=IPv4 header with no encapsulated data)
- Maximum value of 65,535 (maximum 16-bit value)



IPv4 Header – Total Length field

Offsets	Octet					0									1									2									3				
Octet	Bit	0	1	2	3		4	5	6	7	8	9	10		11	12	13	14	4 15	16	6 17	18	3 1	19 2	0	21	22	23	24	25	2	6	27	28	29	30	31
0	0		Ver	rsio	n			IE	IL.				D	sc	CP			E	ECN	L							Т	otal	Leng	gth							
4	32								ł	dent	ificat	ion									Flag	js						F	rag	men	t Of	fse	t				
8	64				Time	То	b Liv	/e						F	Proto	ocol										ł	lead	ler (Cheo	cksui	m						
12	96																	S	ource	IP /	Addre	ss															
16	128																C	Des	stinatio	on II	P Ado	lress	\$														
20	160																																				
24	192																	~				-															
28	224																	0	ptions	5 (IT	IL 5	5)															
32	256																																				

Length: 16 bits

1 1 1 1 1 16384 8192 4096

= 65535



IPv4 Header – Identification field

Offsets	Octet					0									1									2									:	3			
Octet	Bit	0	1	2	3		4	5	6	7	8	9	10	1	1 1	2	13	14	15	10	6 17	18	•	19 2	0	21	22	23	1	24 2	5	26	27	28	29	30	31
0	0		Ve	rsio	n			Ш	IL				DS	SCI	P			E	N								Т	otal	Le	ength							
4	32								lo	lenti	ificat	ion									Flag	s						ł	Fra	agmer	nt (Offse	ət				
8	64				Time	e To	o Liv	е						Ρ	rotoc	ol										ł	lea	der (Ch	iecksi	ım						
12	96																	Sou	rce	IP /	Addre	ss															
16	128																D)esti	natio	n II	IP Add	ress	;														
20	160																																				
24	192																	~				-															
28	224																	Opi	ons	(11	i IHL >	5)															
32	256																																				

Length: 16 bits

- If a packet is fragmented due to being too large, this field is used to identify which packet the fragment belongs to.
- All fragments of the same packet will have their own IPv4 header with the same value in this field.
- Packets are fragmented if larger than the **MTU** (Maximum Transmission Unit)



IPv4 Header – Identification field

Offsets	Octet					0									1									2									3				
Octet	Bit	0	1	2	3		4	5	6	7	8	9	10	1	1 1:	2 1	13	14	15	16	6 1	7 18	B	19	20	21	22	23	2	24 25	2	6	27	28	29	30	31
0	0		Ve	rsio	า			Ш	IL .				DS	SCI	Р			Е	CN								Т	otal	Lei	ngth							
4	32								ld	enti	ficati	on									Fla	gs						F	Fra	igmen	Of	fse	t				
8	64				Time	То	Liv	е						Ρ	rotoc	ol											Hea	der (Che	ecksu	n						
12	96																	So	urce	IP /	Addr	ess															
16	128																D	est	natic	n I	P Ad	dres	s														
20	160																																				
24	192																	0-		/:e		- 5)															
28	224																	Op	uons	(IT	IHL :	- 5)															
32	256																																				

Length: 16 bits

- The MTU is usually 1500 bytes
- Remember the maximum size of an Ethernet frame?
- Fragments are reassembled by the receiving host



IPv4 Header – Flags field

Offsets	Octet					0								1									2									:	3			
Octet	Bit	0	1	2	3	4	5	6	7	8	9	10	1	11 1:	2 1	3	14	15	16	17	18	1	9 20)	21	22	23	2	24 2	5	26	27	28	29	30	31
0	0		Ver	sion			H	ΗL				D	sc	P			EC	N								Т	otal	Le	ngth							
4	32								den	tifica	tion									Flag	s						F	Fra	agmer	nt C	Offse	ət				
8	64			Т	ime	To L	ive						P	Protoc	ol										ł	lea	der (Ch	ecksu	ım						
12	96																Sou	rce	IP A	ddre	ss															
16	128															De	estin	atio	n IP	Add	ress															
20	160																																			
24	192																0.1				-															
28	224																Ορτι	UNS	(11.11)	HL >	5)															
32	256																																			

Length: 3 bits

- Used to control/identify fragments.
- Bit O: Reserved, always set to O
- Bit 1: Don't Fragment (DF bit), used to indicate a packet that should not be fragmented
- Bit 2: More Fragments (MF bit), set to 1 if there are more fragments in the packet, set to 0 for the last fragment

*Unfragmented packets will always have their MF bit set to 0



IPv4 Header – Fragment Offset field

Offsets	Octet					0									1								2										3			
Octet	Bit	0	1	2	3	4	4 5		6	7	8	9	10	11	1 12	13	14	15	16	6 17	18	•	19 2	ו	21	22	23		24 2	5	26	27	28	29	30	31
0	0		Ver	sion				IHI	L				DS	SCF	þ		E	CN				_				Т	otal	Le	ength							
4	32								ld	enti	ficati	on								Flag	s						1	Fra	agmei	nt (Offse	ət				
8	64			Т	ime	То	Live							Pr	otoco											Hea	der	Ch	necksi	ım						
12	96																Sc	urce	IP A	Addre	ss															
16	128																Dest	inatio	on IF	P Add	ress															
20	160																																			
24	192																0		/:# 1		5)															
28	224																Op	tions	(11.1	IHL >	5)															
32	256																																			

Length: 13 bits

- Used to indicate the position of the fragment within the original, unfragmented IP packet.
- Allows fragmented packets to be reassembled even if the fragments arrive out of order.



IPv4 Header – Time To Live field

Offsets	Octet					0									1									2	2									3			
Octet	Bit	0	1	2	3	4	5		6	7	8	9	10	1	1 12	1	13	14	15	1	6 1	7 1	18	19	20	21	22	23		24 2	5	26	27	28	29	30	31
0	0		Vers	sion	i			IHI	-				DS	SC	Р			E	CN									Total	Le	ength							
4	32								lde	ntif	icati	on									Fla	igs							Fra	agme	nt (Offse	et				
8	64			т	ïme	To L	.ive							Ρ	rotoc	ol											He	ader	Ch	necks	um						
12	96																	So	urce	IP /	Addr	ess															
16	128																D	est	inatic	on I	P Ad	dre	ss														
20	160																																				
24	192																	~																			
28	224																	Op	tions	(IT	IHL	> 5)															
32	256																																				

Length: 8 bits

Recommended default TTL is 64.

- A router will drop a packet with a TTL of O
- Used to prevent infinite loops
- Originally designed to indicate the packet's maximum lifetime in seconds
- In practice, indicates a 'hop count': each time the packet arrives at a router, the router decreases the TTL by 1.



IPv4 Header – Protocol field

Offsets	Octet				(D								1								2								3			
Octet	Bit	0	1	2	3	4	5	6	7	8	9	10	11	1 12	13	14	15	16	6 17	18	19	9 20	21	22	23	1	24 25	2	6 2	27 28	3 29	30	31
0	0		Vers	sion			IF	HL				DS	SCF	þ		E	CN							٦	Total	Le	ength						
4	32							þ	dent	ificat	ion								Flag	s						Fra	agmen	t Of	fset				
8	64			Ti	me T	Γο Li	ive						Pr	otoco	I.									Hea	der	Ch	iecksu	m					
12	96															So	urce	IP A	Addres	ss													
16	128														I	Desti	natio	n IF	P Add	ress													
20	160																																
24	192															0-		/:6 1		5)													
28	224															Op	uons	(11.1	IHL >	5)													
32	256																																

Length: 8 bits

- Indicates the protocol of the encapsulated L4PDU
- Value of 6: TCP
- Value of 17: UDP
- Value of 1: ICMP
- Value of 89: OSPF (dynamic routing protocol)
- https://en.wikipedia.org/wiki/List_of_IP_protocol_numbers



IPv4 Header – Header Checksum field

Offsets	Octet					0									1								2										3			
Octet	Bit	0	1	2	3		4 5		6	7	8	9	10	11	1 12	13	1	4 15	1	16 1	1	8	19 2	0	21	22	23	1	24 25	1	26	27	28	29	30	31
0	0		Ve	rsion				IH	L				DS	SCF	>			ECN								Т	otal	Le	ength							
4	32								ld	ənti	ficati	on								Fla	gs						ł	Fra	agmen	t O	ffse	t				
8	64			т	ime	То	Live							Pr	rotocc	I			Γ							Hea	der (Ch	necksu	m						
12	96																S	ource	IP	P Addr	ess															
16	128																Des	stinatio	on	IP Ad	dres	s														
20	160																																			
24	192																~				-															
28	224																0	ptions	s (II	fIHL:	• 5)															
32	256																																			

Length: 16 bits

- A calculated checksum used to check for errors in the IPv4 header.
- When a router receives a packet, it calculates the checksum of the header and compares it to the one in this field of the header.
- If they do not match, the router drops the packet.



IPv4 Header – Header Checksum field

Offsets	Octet					0									1								2									;	3			
Octet	Bit	0	1	2	3	4	4 5	6	5	7	8	9	10	11	1 12	1:	3 1	4 15	;	16 1	7 1	8	19	20	21	22	23	3	24 2	5	26	27	28	29	30	31
0	0		Ver	sion			I	HL					DS	SCF	2			ECN									Total	Le	ength							
4	32								lde	ntifi	catio	on								Fla	gs							Fra	agmer	nt C	Offse	t				
8	64			Ti	me ⁻	To I	Live							Pr	otoco	d			Γ							Hea	der	C٢	hecksu	m						
12	96																s	ource	IF	P Addr	ess															
16	128																De	stinati	on	IP Ad	dres	ss														
20	160																																			
24	192																																			
28	224																C	puon	s (I	if IHL	- 0)															
32	256																																			

Length: 16 bits

- Used to check for errors only in the IPv4 header.
- IP relies on the encapsulated protocol to detect errors in the encapsulated data.
- Both TCP and UDP have their own checksum fields to detect errors in the encapsulated data.

IPv4 Header – Source/Destination IP Address fields

Offsets	Octet					0								1								2								3			
Octet	Bit	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	6 17	18	1	19 20	21	22	23	2	24 25	26	3	27 2	3 29	30	31
0	0		Ver	sion			- II	HL				DS	SCP			E	CN								Total	Le	ngth						
4	32								dent	ificat	ion								Flag	s					F	Fra	agmen	Off	set				
8	64			Т	ime	To l	Live						Pro	otoco										Hea	der (Ch	ecksu	n					
12	96															So	urce	IP A	Addre	ss													
16	128														0	Dest	inatio	n IF	P Add	ress													
20	160																																
24	192															~				-													
28	224															Op	tions	(11.1	IHL >	5)													
32	256																																

Length: 32 bits (each)

- Source IP Address = IPv4 address of the sender of the packet.
- Destination IP Address = IPv4 address of the intended receiver of the packet.



IPv4 Header – Options fields

Offsets	Octet					0								1								2								3			
Octet	Bit	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	9 20	21	22	23	24	24 25	26	27	28	29	30	31
0	0		Ver	sion			H	HL				DS	CP			E	N							1	otal	Ler	ngth						
4	32							lo	lenti	ficati	on								Flag	s					F	=rag	gment	Offs	et				
8	64			Т	ime	To L	Live						Pro	otocol										Hea	der (Che	ecksur	n					
12	96															Sou	rce	IP Ad	ddres	ss													
16	128														C	Desti	natio	n IP	Addr	ress													
20	160																																
24	192															0-1		/:6.11		E)													
28	224															Opt	ons	(11.11	HL >	5)													
32	256																																

Length: 0 - 320 bits

- Rarely used.
- If the IHL field is greater than 5, it means that Options are present.

Field	Size (bits)	Description
Copied	1	Set to 1 if the options need to be copied into all fragments of a fragmented packet.
Option Class	2	A general options category. 0 is for "control" options, and 2 is for "debugging and measurement". 1 and 3 are reserved.
Option Number	5	Specifies an option.
Option Length	8	Indicates the size of the entire option (including this field). This field may not exist for simple options.
Option Data	Variable	Option-specific data. This field may not exist for simple options.



IPv4 Header

Offsets	Octet				(D								1							:	2								3				
Octet	Bit	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	2	2 23	3 24	4 2	25 2	26	27	28	29	30	31
0	0		Ver	sion			IF	łL				DS	CP			EC	N								Tota	Ler	ngth							-
4	32							ld	lenti	ficati	ion								Flage	S						Frag	gme	nt O	ffse	t				
8	64			Ti	me ⁻	To Li	ve						Prot	ocol										He	ader	Che	cks	um						
12	96															Sou	ce II	P Ac	ddres	s														
16	128														C	Destin	atior	ו IP	Addr	ess														
20	160																																	
24	192															Onti		(; f		5)														
28	224															Opti	ons (1L - 1	5)														
32	256																																	

[R1 Gi0/0 to R2 Gi0/0]

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Apply a display filter ... (Ctrl-/) Expression... No. Time Destination Protocol Length Info Source 1 0.000000 0c:99:2a:f2:55:00 0c:99:2a:f2:55:00 LOOP 60 Reply 2 1.390201 0c:99:2a:8a:bd:00 0c:99:2a:8a:bd:00 1 00P 60 Reply 3 10.100463 0c:99:2a:f2:55:00 LOOP 0c:99:2a:f2:55:00 60 Reply 4 11 454510 0c+99+2++8++hd+00 0c+99+22+82+bd+00 60 Ronly 5 12,265055 192.168.1.1 114 Echo (ping) request id=0x0001, seq=0/0, ttl=255 (reply in 6) 192,168,1,2 ICMP 197, 100, 1,7 97. 190. . . 114 ECNO (ping) reply 10=0x0001, seq=0/0, ttl=255 (request in 5) 0 1/./0/0/9 LOPE 7 12.271809 192,168,1,1 192.168.1.2 ICMP 114 Echo (ping) request id=0x0001, seq=1/256, ttl=255 (reply in 8) 8 12,273420 192.168.1.2 192.168.1.1 TCMP 114 Echo (ping) reply id=0x0001, seq=1/256, ttl=255 (request in 7) 9 12,276097 192.168.1.1 192.168.1.2 ICMP 114 Echo (ping) request id=0x0001, seq=2/512, ttl=255 (reply in 10) 10 12.277896 192.168.1.2 192.168.1.1 ICMP 114 Echo (ping) reply id=0x0001, seg=2/512, ttl=255 (request in 9) 11 12.280969 192.168.1.1 192.168.1.2 TCMP 114 Echo (ping) request id=0x0001, seq=3/768, ttl=255 (reply in 12) 12 12.282918 192.168.1.2 192.168.1.1 TCMP 114 Echo (ping) reply id=0x0001, sea=3/768, ttl=255 (request in 11) 13 12,287860 192.168.1.1 192.168.1.2 ICMP 114 Echo (ping) request id=0x0001, seq=4/1024, ttl=255 (reply in 14) ICMP 14 12,289538 192,168,1,2 192.168.1.1 114 Echo (ping) reply id=0x0001, seq=4/1024, ttl=255 (request in 13)

Frame 5: 114 bytes on wire (912 bits), 114 bytes captured (912 bits) on interface 0

Ethernet II, Src: 0c:99:2a:f2:55:00 (0c:99:2a:f2:55:00), Dst: 0c:99:2a:8a:bd:00 (0c:99:2a:8a:bd:00)

Internet Protocol Version 4, Src: 192.168.1.1, Dst: 192.168.1.2

Internet Control Message Protocol

0000	0c 99 2a 8a bd	00 0c 99 2a f2 55	00 08 00 45 00	••••••••••••••••••••••••••••••••••••••
0010	00 64 00 05 00	00 ff 01 38 40 c0	a8 01 01 c0 a8	•d••••• 8@•••••
0020	01 02 08 00 80	7a 00 01 00 00 00	00 00 00 00 01	
0030	fd cd ab cd ab	cd ab cd ab cd ab	cd ab cd ab cd	
0040	ab cd ab cd ab	cd ab cd ab cd ab	cd ab cd ab cd	
0050	ab cd ab cd ab	cd ab cd ab cd ab	cd ab cd ab cd	
0060	ab cd ab cd ab	cd ab cd ab cd ab	cd ab cd ab cd	
0070	ab cd			

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[R1 Gi0/0 to R2 Gi0/0]

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Apply a display filter ··· <Ctrl-/ Expression... No. Time Destination Protocol Length Info Source 1 0.000000 0c:99:2a:f2:55:00 0c:99:2a:f2:55:00 LOOP 60 Reply 2 1,390201 0c:99:2a:8a:bd:00 0c:99:2a:8a:bd:00 LOOP 60 Reply 3 10.100463 0c:99:2a:f2:55:00 0c:99:2a:f2:55:00 1 00P 60 Reply LOOP 4 11.454510 0c:99:2a:8a:bd:00 0c:99:2a:8a:bd:00 60 Reply 5 12,265055 192.168.1.1 192.168.1.2 ICMP 114 Echo (ping) request id=0x0001, seq=0/0, ttl=255 (reply in 6) 6 12,267829 192.168.1.2 192.168.1.1 ICMP 114 Echo (ping) reply id=0x0001, seq=0/0, ttl=255 (request in 5) 114 Echo (ping) request id=0x0001, seg=1/256, ttl=255 (reply in 8) 7 12,271809 192.168.1.1 192,168,1,2 ICMP 8 12.273420 192.168.1.2 192.168.1.1 TCMP 114 Echo (ping) reply id=0x0001, seg=1/256, ttl=255 (request in 7) 9 12.276097 192.168.1.1 192.168.1.2 ICMP 114 Echo (ping) request id=0x0001, seq=2/512, ttl=255 (reply in 10) 10 12.277896 192.168.1.1 192.168.1.2 ICMP 114 Echo (ping) reply id=0x0001, seq=2/512, ttl=255 (request in 9) 11 12,280969 192.168.1.1 192.168.1.2 ICMP 114 Echo (ping) request id=0x0001, seq=3/768, ttl=255 (reply in 12) ICMP id=0x0001, seg=3/768, ttl=255 (request in 11) 12 12.282918 192,168,1,2 192,168,1,1 114 Echo (ping) reply 13 12.287860 192.168.1.1 192.168.1.2 ICMP 114 Echo (ping) request id=0x0001, seg=4/1024, ttl=255 (reply in 14) 14 12.289538 192.168.1.2 192.168.1.1 ICMP 114 Echo (ping) reply id=0x0001, seg=4/1024, ttl=255 (request in 13)

Ename 5: 114 bytes on wine (912 bits) 114 bytes cantured (912 bits) on intenface 0

Ethernet II, Src: 0c:99:2a:f2:55:00 (0c:99:2a:f2:55:00), Dst: 0c:99:2a:8a:bd:00 (0c:99:2a:8a:bd:00)

Internet Protocol Version 4, Src: 192.168.1.1, DSt: 192.168.1.2

Internet Control Message Protocol

	0c 99 2a 8a bd 00 0c 99 2a f2 55 00 08 00 <mark>45</mark> 00	
	00 64 00 05 00 00 ff 01 38 40 c0 a8 01 01 c0 a8	
0020	01 02 08 00 80 7a 00 01 00 00 00 00 00 00 00 01	·····Z·· ·····
	fd cd ab cd	
	abcdabcdabcdabcd abcdabcdabcdabcdabcd	
	abcdabcdabcdabcd abcdabcdabcdabcd	
0060	abcd abcd abcd abcd abcd abcd abcd abcd	
0070	ab cd	

*- [R1 Gi0/0 to R2 Gi0/0]

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 Image: Statistic statistic

Appl	y a display filter … <otr< th=""><th></th><th></th><th></th><th></th><th>Expression**</th></otr<>					Expression**
No.	Time	Source	Destination	Protocol	Length Info	
	1 0.000000	0c:99:2a:f2:55:00	0c:99:2a:f2:55:00	LOOP	60 Reply	
	2 1.390201	0c:99:2a:8a:bd:00	0c:99:2a:8a:bd:00	LOOP	60 Reply	
	3 10.100463	0c:99:2a:f2:55:00	0c:99:2a:f2:55:00	LOOP	60 Reply	
	4 11.454510	0c:99:2a:8a:bd:00	0c:99:2a:8a:bd:00	LOOP	60 Reply	
_►	5 12.265055	192.168.1.1	192.168.1.2	ICMP	114 Echo (ping) request	id=0x0001, seq=0/0, ttl=255 (reply in 6)
+	6 12.267829	192.168.1.2	192.168.1.1	ICMP	114 Echo (ping) reply	id=0x0001, seq=0/0, ttl=255 (request in 5)
	7 12.271809	192.168.1.1	192.168.1.2	ICMP	114 Echo (ping) request	id=0x0001, seq=1/256, ttl=255 (reply in 8)
	8 12.273420	192.168.1.2	192.168.1.1	ICMP	114 Echo (ping) reply	id=0x0001, seq=1/256, ttl=255 (request in 7)
	9 12.276097	192.168.1.1	192.168.1.2	ICMP	114 Echo (ping) request	id=0x0001, seq=2/512, ttl=255 (reply in 10)
	10 12.277896	192.168.1.2	192.168.1.1	ICMP	114 Echo (ping) reply	id=0x0001, seq=2/512, ttl=255 (request in 9)
	11 12.280969	192.168.1.1	192.168.1.2	ICMP	114 Echo (ping) request	id=0x0001, seq=3/768, ttl=255 (reply in 12)
	12 12.282918	192.168.1.2	192.168.1.1	ICMP	114 Echo (ping) reply	id=0x0001, seq=3/768, ttl=255 (request in 11)
	13 12.287860	192.168.1.1	192.168.1.2	ICMP	114 Echo (ping) request	id=0x0001, seq=4/1024, ttl=255 (reply in 14)
L	14 12.289538	192.168.1.2	192.168.1.1	ICMP	114 Echo (ping) reply	id=0x0001, seq=4/1024, ttl=255 (request in 13)
> Fra	me 5: 114 bytes	on wire (912 bits), 1	114 bytes captured (9	12 bits)	on interface 0	
					a:8a:bd:00 (0c:99:2a:8a:bd:0	99)
		/ersion 4, Src: 192.16				~,
	ernet control me		,			
		0				
		00 0c 99 2a f2 55 00		··· *·U··		
		00 ff 01 38 40 c0 a8		••• 8@•••		
0020		7a 00 01 00 00 00 00		z		
		cd ab cd ab cd ab cd				
0040		cd ab cd ab cd ab cd cd ab cd ab cd ab cd				
		cd ab cd ab cd ab cd				
	ab cd ab cd ab					
207.5						

🚄 *- [R1 Gi0/0 to R2 Gi0/0]

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 Internet Protocol Version 4, Src: 192.168.1.1, Dst: 192.168.1.2
0100 = Version: 4
<pre> 0101 = Header Length: 20 bytes (5)</pre>
 Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
0000 00 = Differentiated Services Codepoint: Default (0)
00 = Explicit Congestion Notification: Not ECN-Capable Transport (0)
Total Length: 100
Identification: 0x0005 (5)
Flags: 0x0000
0 = Reserved bit: Not set
.0 = Don't fragment: Not set
0 = More fragments: Not set
0 0000 0000 0000 = Fragment offset: 0
Time to live: 255
Protocol: ICMP (1)
Header checksum: 0x3840 [validation disabled]
[Header checksum status: Unverified]
Source: 192.168.1.1
Destination: 192.168.1.2



R1#ping 192.168.1.2 size 10000

7 17.411175	192.168.1.1	192.168.1.2	IPv4	1514	Fragmented IP protocol (proto=ICMP 1, off=0, ID=0001) [Reassembled in #13]
8 17.412827	192.168.1.1	192.168.1.2	IPv4	1514	Fragmented IP protocol (proto=ICMP 1, off=1480, ID=0001) [Reassembled in #13]
9 17.414347	192.168.1.1	192.168.1.2	IPv4	1514	Fragmented IP protocol (proto=ICMP 1, off=2960, ID=00 <mark>0</mark> 1) [Reassembled in #13]
10 17.415913	192.168.1.1	192.168.1.2	IPv4	1514	Fragmented IP protocol (proto=ICMP 1, off=4440, ID=00 <mark>0</mark> 1) [Reassembled in #13]
11 17.417560	192.168.1.1	192.168.1.2	IPv4	1514	Fragmented IP protocol (proto=ICMP 1, off=5920, ID=00 <mark>0</mark> 1) [Reassembled in #13]
12 17.419203	192.168.1.1	192.168.1.2	IPv4	1514	Fragmented IP protocol (proto=ICMP 1, off=7400, ID=00 <mark>0</mark> 1) [Reassembled in #13]
13 17.420793	192.168.1.1	192.168.1.2	ICMP	1134	Echo (ping) request id=0x0000, seq=1/256, ttl=255 (reply in 20)



Internet Protocol Version 4, Src: 192.168.1.1, Dst: 192.168.1.2	Internet Protocol Version 4, Src: 192.168.1.1, Dst: 192.168.1.2
0100 = Version: 4	0100 = Version: 4
0101 = Header Length: 20 bytes (5)	0101 = Header Length: 20 bytes (5)
✓ Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)	✓ Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
0000 00 = Differentiated Services Codepoint: Default (0)	0000 00 = Differentiated Services Codepoint: Default (0)
Total Length: 1500	Total Length: 1500
Identification: 0x0001 (1)	Identification: 0x0001 (1)
✓ Flags: 0x2000, More fragments	✓ Flags: 0x20b9, More fragments
0 = Reserved bit: Not set	0 = Reserved bit: Not set
.0 = Don't fragment: Not set	.0 = Don't fragment: Not set
1 = More fragments: Set	1 = More fragments: Set
0 0000 0000 = Fragment offset: 0	0 0000 1011 1001 = Fragment offset: 185
Time to live: 255	Time to live: 255
Protocol: ICMP (1)	Protocol: ICMP (1)
Header checksum: 0x12cc [validation disabled]	Header checksum: 0x1213 [validation disabled]
[Header checksum status: Unverified]	[Header checksum status: Unverified]
Source: 192.168.1.1	Source: 192.168.1.1
Destination: 192.168.1.2	Destination: 192.168.1.2
Reassembled IPv4 in frame: 13	
	<u>Reassembled IPv4 in frame: 13</u>



R1#ping 192.168.1.2 df-bit

✓ Flags: 0x4000, Don't fragment

0... = Reserved bit: Not set
.1.. = Don't fragment: Set
...0 = More fragments: Not set
...0 0000 0000 0000 = Fragment offset: 0

```
R1#ping 192.168.1.2 size 10000 df-bit
Type escape sequence to abort.
Sending 5, 10000-byte ICMP Echos to 192.168.1.2, timeout is 2 seconds:
Packet sent with the DF bit set
```

Success rate is 0 percent (0/5)



- IPv4 packet structure
- Fields of the IPv4 header



QUIZ



Quiz Question 1

What is the fixed binary value of the first field of an IPv4 header?

a) 0010
b) 0110
c) 0001
d) 0100

Offsets	Octet				0	0				1									2									3							
Octet	Octet Bit			2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	1	7 18	: 1	19 2	0 2	1	22 2	23	24	25	26	27	28	29	30	3	
0	0	Version IHL									DSCP ECN									Total Length															
4	32		Identification Flags Fragment Offset																																
8	64	Time To Live Protocol Header Checksum																																	
12	96		Source IP Address																																
16	128		Destination IP Address																																
20	160																																		
24	192																	(: 6 11																	
28	224															Optio	ons		HL ?	> 5)															
32	256																																		



Quiz Question 2

Which field will cause the packet to be dropped if it has a value of O?

- a) TTL
 b) DSCP
 b) DSCP
 c) TTL stands for Time To Live. It is reduced by 1 at each router the packet passes through. If it reaches 0, the packet is dropped.
- c) IHL
- d) ECN



How are errors in an IPv4 packet's encapsulated data detected?

- a) The IPv4 Header Checksum field checks for errors.
- b) The encapsulated protocol (TCP, UDP) checks for errors.
- c) Errors in the encapsulated data cannot be detected.

The IPv4 **Header Checksum** field only checks for errors in the IPv4 header itself. However, Layer 4 protocols like TCP or UDP can use their checksum to check for errors in the encapsulated data.



Quiz Question 4

Which field of an IPv4 header is variable in length?

- a) Options
- b) Header Checksum
- c) Total Length

d) IHL

The **Options** field can vary in length from 0 bits to 320 bits. The other fields are fixed-length. Although the **Total Length** and **IHL** fields are used to represent the variable length of the IPv4 header and packet, the fields themselves are fixed in length.



Quiz Question 5

Which bit will be set to 1 on all IPv4 packet fragments except the last fragment?

- a) Fragment Offset bit
- b) More Fragments bit
- c) Don't Fragment bit
- d) Packet Fragment bit

The **More Fragments** bit, part of the **Flags** field of the IPv4 header, is used to indicate that the current fragment is not the last fragment of a fragmented packet. It is set to 1 on all fragments except the last, which will set it to 0.