

Wenn was schiefgeht: Internet Control Message Protocol (ICMP)

Benjamin Wolff

Internet Protokolle WS 2014/15

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Wozu ICMP?

Wenn was
schiefgeht: ICMP

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Einleitung

Nachrichtenaufbau

Query Messages

Echo Request/Reply

Timestamp

ICMP Router Discovery
Protocol (IRDP)

Error Messages

Destination Unreachable

Time Exceeded

Redirect

Parameter Problem

Das Internetprotokoll (IP) ...

- ▶ ermöglicht den Transport von IP-Datagrammen von Host zu Host
- ▶ transportiert die Pakete von "Hop-zu-Hop" nach dem Prinzip "best-effort-delivery"
- ▶ ist verbindungslos und nicht zuverlässig

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Parameter Problem

Was IP nicht bieten kann:

- ▶ Gewährleistung oder Bestätigung, ob IP-Datagramme ankommen
- ▶ Kontroll- und Diagnoseinformationen

ICMP - Internet Control Message Protocol

- ▶ Mechanismus für Fehler- und Informationsmeldungen
- ▶ Ermöglicht den Austausch über den Zustand des Netze
- ▶ Fester Bestandteil jeder IP-Implementierung
- ▶ Benutzt zum Transport das IP-Protokoll (ICMP-Daten werden in IP gekapselt)
- ▶ Benutzt also IP wie ein Upper-Layer-Protokoll (ULP)
- ▶ ICMPv4 != ICMPv6

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Parameter Problem

- ▶ ICMPv4
 - ▶ [RFC792]: offizielle Basisspezifikation (1981)
 - ▶ [RFC1122][RFC1812]:
Verfeinerungen und Präzisierungen
- ▶ ICMPv6
 - ▶ [RFC4443]offizielle Basisspezifikation (2006)

Osi-Modell: Welche Schicht?

Wenn was
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Parameter Problem

	Number	Name
Hosts	7	Application
	6	Presentation
	5	Session
	4	Transport
All Networked Devices	3	Network or Internetwork
	2	Link
	1	Physical

Osi-Modell: Welche Schicht?

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Nachrichtenaufbau

Query Messages

Echo Request/Reply

Timestamp

ICMP Router Discovery
Protocol (IRDP)

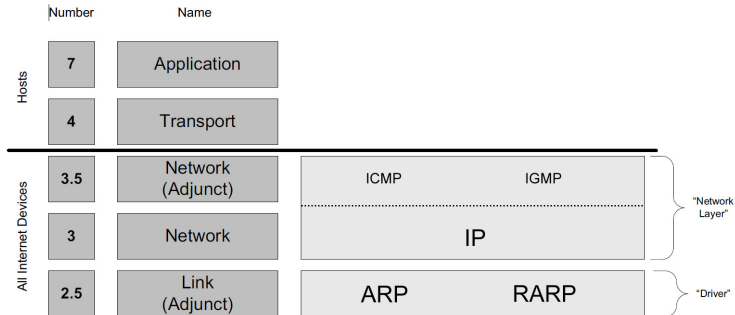
Error Messages

Destination Unreachable

Time Exceeded

Redirect

Parameter Problem



Kapselung in IP-Paketen

Wenn was
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Nachrichtenaufbau

Query Messages

Echo Request/Reply

Timestamp

ICMP Router Discovery
Protocol (IRDP)

Error Messages

Destination Unreachable

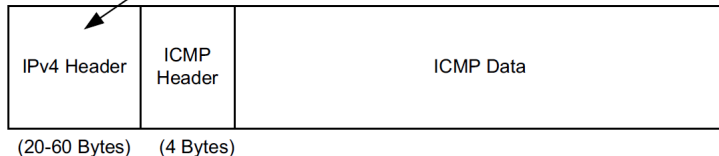
Time Exceeded

Redirect

Parameter Problem

- ▶ ICMP verwendet IP wie ein Protokoll einer höheren Schicht
- ▶ ICMP benutzt keine höheren Protokolle (wie z.B. UDP oder TCP)
- ▶ Keine Ports!

IPv4 Protocol field = 1



Kapselung in IP-Paketen

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Nachrichtenaufbau

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Timestamp

ICMP Router Discovery
Protocol (IRDP)

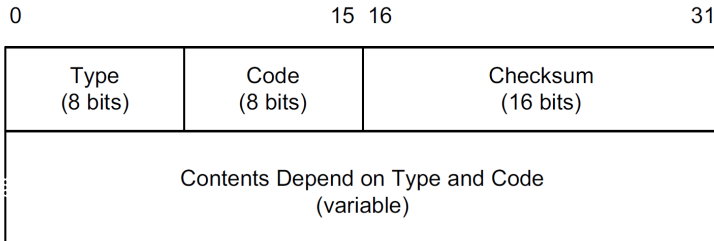
Error Messages

Destination Unreachable

Time Exceeded

Redirect

Parameter Problem



ICMP, Typen

Wenn was
schiefgeht: ICMP

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Nachrichtenaufbau

Query Messages

Echo Request/Reply

Timestamp

ICMP Router Discovery
Protocol (IRDP)

Error Messages

Destination Unreachable

Time Exceeded

Redirect

Parameter Problem

Type	Name	Reference
0	Echo Reply	[RFC792]
3	Destination Unreachable	[RFC792]
4	Source Quench	[RFC792]
5	Redirect	[RFC792]
8	Echo Request	[RFC792]
11	Time Exceeded	[RFC792]
12	Parameter Problem	[RFC792]
13	Timestamp	[RFC792]
14	Timestamp Reply	[RFC792]
15	Information Request	[RFC792]
16	Information Reply	[RFC792]

ICMP, Erweiterungen

Wenn was
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Type	Name	Reference
0	Echo Reply	[RFC792]
3	Destination Unreachable	[RFC792]
4	Source Quench	[RFC792]
5	Redirect	[RFC792]
8	Echo Request	[RFC792]
9	Router Advertisement	[RFC1256]
10	Router Solicitation	[RFC1256]
11	Time Exceeded	[RFC792]
12	Parameter Problem	[RFC792]
13	Timestamp	[RFC792]
14	Timestamp Reply	[RFC792]
15	Information Request	[RFC792]
16	Information Reply	[RFC792]
17	Address Mask Request	[RFC950]
18	Address Mask Reply	[RFC950]
30	Traceroute	[RFC1393]
31	Datagram Conversion Error	[RFC1475]
37	Domain Name Request	[RFC1788]
38	Domain Name Reply	[RFC1788]

Einleitung

Nachrichtenaufbau

Query Messages

Echo Request/Reply

Timestamp

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Parameter Problem

ICMP, Veraltete Typen

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Echo Request/Reply

Timestamp

ICMP Router Discovery
Protocol (IRDP)

Error Messages

Destination Unreachable

Time Exceeded

Redirect

Parameter Problem

Type	Name	Reference
0	Echo Reply	[RFC792]
3	Destination Unreachable	[RFC792]
4	Source Quench	[RFC792] [RFC6633]
5	Redirect	[RFC792]
8	Echo Request	[RFC792]
9	Router Advertisement	[RFC1256]
10	Router Solicitation	[RFC1256]
11	Time Exceeded	[RFC792]
12	Parameter Problem	[RFC792]
13	Timestamp	[RFC792]
14	Timestamp Reply	[RFC792]
15	Information Request	[RFC792] [RFC6918]
16	Information Reply	[RFC792] [RFC6918]
17	Address Mask Request	[RFC950] [RFC6918]
18	Address Mask Reply	[RFC950] [RFC6918]
30	Traceroute	[RFC1393] [RFC6918]
31	Datagram Conversion Error	[RFC1475] [RFC6918]
37	Domain Name Request	[RFC1788] [RFC6918]
38	Domain Name Reply	[RFC1788] [RFC6918]

ICMP, Relevante Typen

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Timestamp

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Destination Unreachable

Time Exceeded

Redirect

Parameter Problem

Type	Name	Reference
0	Echo Reply	[RFC792]
3	Destination Unreachable	[RFC792]
5	Redirect	[RFC792]
8	Echo Request	[RFC792]
9	Router Advertisement	[RFC1256]
10	Router Solicitation	[RFC1256]
11	Time Exceeded	[RFC792]
12	Parameter Problem	[RFC792]
13	Timestamp	[RFC792]
14	Timestamp Reply	[RFC792]

Error vs Query Message

Wenn was
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Einleitung

Nachrichtenaufbau

Query Messages

Echo Request/Reply

Timestamp

ICMP Router Discovery
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Error Messages

Destination Unreachable

Time Exceeded

Redirect

Parameter Problem

- ▶ Es werden grundsätzlich zwei Nachrichtentypen unterschieden: **Query und Error Messages**
- ▶ **Query Messages** werden direkt via ICMP beantwortet (Request und Reply Messages)
- ▶ **Error Messages** werden speziell behandelt: Nachricht wird an Verursacher (Protokoll oder Anwendung) der höheren Schicht weitergeleitet

Error Message - Paketaufbau

Wenn was
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Nachrichtenaufbau

Query Messages

Echo Request/Reply

Timestamp

ICMP Router Discovery
Protocol (IRDP)

Error Messages

Destination Unreachable

Time Exceeded

Redirect

Parameter Problem

Type (8 bits)	Code (8 bits)	Checksum (16 bits)
Contents Depend on Type and Code (variable)		
Internet Header + 64 bits of Original Data Datagram		

Error Message - Regeln

Wenn was
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Einleitung

Nachrichtenaufbau

Query Messages

Echo Request/Reply

Timestamp

ICMP Router Discovery
Protocol (IRDP)

Error Messages

Destination Unreachable

Time Exceeded

Redirect

Parameter Problem

ICMP Fehlernachrichten werden nicht generiert...

- ▶ auf eine Fehlernachricht (Endlosschleife)
- ▶ als Antwort auf Broadcasts oder Multicasts
- ▶ bei fragmentierten IP-Paketen, wenn es sich nicht um das erste Paket handelt

Echo Request, Echo Reply

Wenn was
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Einleitung

Nachrichtenaufbau

Query Messages

Echo Request/Reply

Timestamp

ICMP Router Discovery
Protocol (IRDP)

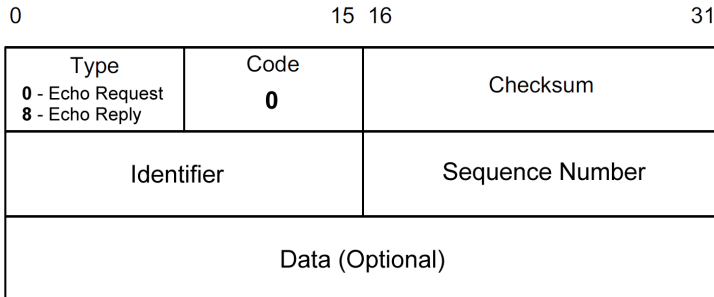
Error Messages

Destination Unreachable

Time Exceeded

Redirect

Parameter Problem



Beispiel: Ping

Wenn was
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Einleitung

Nachrichtenaufbau

Query Messages

Echo Request/Reply

Timestamp

ICMP Router Discovery
Protocol (IRDP)

Error Messages

Destination Unreachable

Time Exceeded

Redirect

Parameter Problem

```
bwolff@psychonaut:~$ ping 173.194.112.248
PING 173.194.112.248 (173.194.112.248) 56(84) bytes of data.
64 bytes from 173.194.112.248: icmp_seq=1 ttl=54 time=40.4 ms
64 bytes from 173.194.112.248: icmp_seq=2 ttl=54 time=42.9 ms
64 bytes from 173.194.112.248: icmp_seq=3 ttl=54 time=40.4 ms
64 bytes from 173.194.112.248: icmp_seq=4 ttl=54 time=40.2 ms
64 bytes from 173.194.112.248: icmp_seq=5 ttl=54 time=42.3 ms
64 bytes from 173.194.112.248: icmp_seq=6 ttl=54 time=42.5 ms
64 bytes from 173.194.112.248: icmp_seq=7 ttl=54 time=39.8 ms
64 bytes from 173.194.112.248: icmp_seq=8 ttl=54 time=41.4 ms
64 bytes from 173.194.112.248: icmp_seq=9 ttl=54 time=40.1 ms
64 bytes from 173.194.112.248: icmp_seq=10 ttl=54 time=42.2 ms
64 bytes from 173.194.112.248: icmp_seq=11 ttl=54 time=41.3 ms
64 bytes from 173.194.112.248: icmp_seq=12 ttl=54 time=40.0 ms
64 bytes from 173.194.112.248: icmp_seq=13 ttl=54 time=40.0 ms
64 bytes from 173.194.112.248: icmp_seq=14 ttl=54 time=51.9 ms
64 bytes from 173.194.112.248: icmp_seq=15 ttl=54 time=41.2 ms
64 bytes from 173.194.112.248: icmp_seq=16 ttl=54 time=40.0 ms
64 bytes from 173.194.112.248: icmp_seq=17 ttl=54 time=41.1 ms
^C
--- 173.194.112.248 ping statistics ---
17 packets transmitted, 17 received, 0% packet loss, time 16022ms
rtt min/avg/max/mdev = 39.865/41.674/51.909/2.734 ms
bwolff@psychonaut:~$
```

Timestamp

Wenn was
schiefgeht: ICMP

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0 15 16 31

Type 13 - Timestamp 14 - Timestamp Reply	Code 0	Checksum
Identifier		Sequence Number
Originate Timestamp		
Receive Timestamp		
Transmit Timestamp		

Einleitung

Nachrichtenaufbau

Query Messages

Echo Request/Reply

Timestamp

ICMP Router Discovery
Protocol (IRDP)

Error Messages

Destination Unreachable

Time Exceeded

Redirect

Parameter Problem

ICMP Router Discovery

Wenn was
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Einleitung

Nachrichtenaufbau

Query Messages

Echo Request/Reply

Timestamp

ICMP Router Discovery
Protocol (IRDP)

Error Messages

Destination Unreachable

Time Exceeded

Redirect

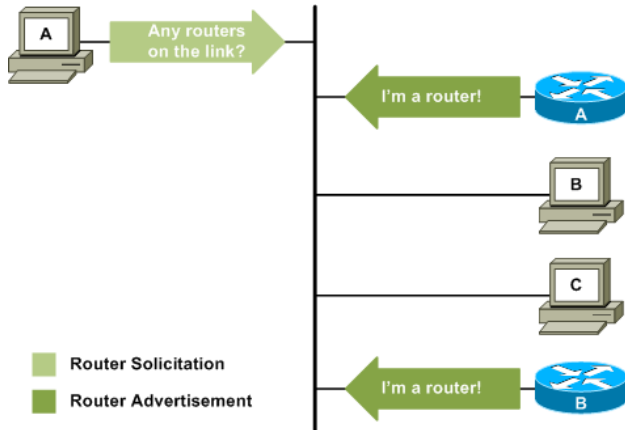
Parameter Problem

- ▶ Host benötigt die Adresse von mindestens einem Router um Datagramme außerhalb des Subnetzes zu versenden
- ▶ Entsprechende Konfigurationsdateien sind wartungsintensiv
- ▶ IRDP:
 - ▶ Alternativer Ansatz, basierend auf ICMP
 - ▶ Findet selbständig Router im Subnetz

ICMP Router Discovery

Wenn was
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Einleitung

Nachrichtenaufbau

Query Messages

Echo Request/Reply

Timestamp

ICMP Router Discovery
Protocol (IRDP)

Error Messages

Destination Unreachable

Time Exceeded

Redirect

Parameter Problem

Router Solicitation

Wenn was
schiefgeht: ICMP

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Einleitung

Nachrichtenaufbau

Query Messages

Echo Request/Reply

Timestamp

ICMP Router Discovery
Protocol (IRDP)

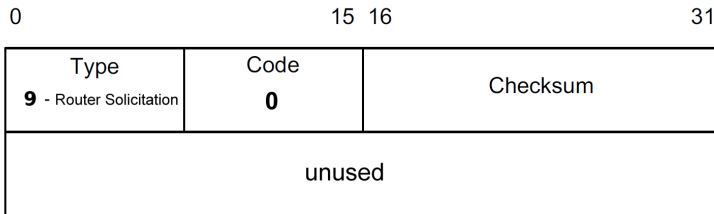
Error Messages

Destination Unreachable

Time Exceeded

Redirect

Parameter Problem



Router Advertisement

Wenn was
schiefgeht: ICMP

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0 15 16 31

Type 10 - Router Advertisement	Code 0	Checksum
Number Of Addresses	Address entry size (2)	Lifetime
router address [1]		
preference level [1]		
router address [2]		
preference level [2]		

Einleitung

Nachrichtenaufbau

Query Messages

Echo Request/Reply

Timestamp

ICMP Router Discovery
Protocol (IRDP)

Error Messages

Destination Unreachable

Time Exceeded

Redirect

Parameter Problem

Destination Unreachable

Wenn was
schiefgeht: ICMP

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Einleitung

Nachrichtenaufbau

Query Messages

Echo Request/Reply

Timestamp

ICMP Router Discovery
Protocol (IRDP)

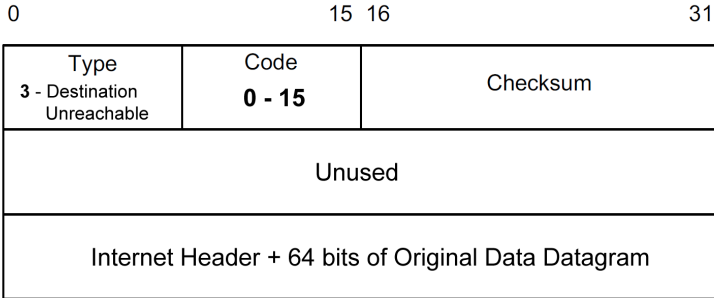
Error Messages

Destination Unreachable

Time Exceeded

Redirect

Parameter Problem



Destination Unreachable

Code	Name
0	Network unreachable
1	Host Unreachable
2	Protocol unreachable
3	Port unreachable
4	Packet too big
5	Source route failed
6	destination network unknown
7	destination host unknown
8	source host isolated
9	communication with destination network prohibited
10	communication with destination host prohibited
11	network unreachable for type of service
12	host unreachable for type of service
13	communication administratively prohibited
14	host precedence violation
15	precedence cutoff in effect

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Echo Request/Reply

Timestamp

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Destination Unreachable

Time Exceeded

Redirect

Parameter Problem

Host Unreachable

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Query Messages

Echo Request/Reply

Timestamp

ICMP Router Discovery
Protocol (IRDP)

Error Messages

Destination Unreachable

Time Exceeded

Redirect

Parameter Problem

- ▶ Wird von einem Router an die Quelle gesendet, wenn Paket nicht zugestellt oder weitergeleitet werden kann
- ▶ Mögliches Szenario:
 - ▶ IP-Datagramm wird zum Last-Hop-Router gesendet
 - ▶ Last-Hop Router sendet einen ARP-Request
 - ▶ Gewünschter Host existiert nicht, oder ist nicht im Netz verfügbar ist

Port Unreachable

Wenn was
schiefgeht: ICMP

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Einleitung

Nachrichtenaufbau

Query Messages

Echo Request/Reply

Timestamp

ICMP Router Discovery
Protocol (IRDP)

Error Messages

Destination Unreachable

Time Exceeded

Redirect

Parameter Problem

- ▶ Tritt meist im Zusammenhang mit UDP auf
- ▶ Empfänger erhält UDP-Datagramm
- ▶ Entsprechender Zielport ist nicht geöffnet
- ▶ Empfänger antwortet mit "Port Unreachable"

Beispiel: Port Unreachable

Wenn was
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Einleitung

Nachrichtenaufbau

Query Messages

Echo Request/Reply

Timestamp

ICMP Router Discovery
Protocol (IRDP)

Error Messages

Destination Unreachable

Time Exceeded

Redirect

Parameter Problem

- ▶ Sniffe ICMP und TFTP Datagramme

```
bwolff@psychonaut:~$ sudo tcpdump -s 1500 -i wlan2 -vv icmp or port tftp
```

- ▶ FTP-Zugriff mittels TFTP auf System, auf dem kein TFTP-Server läuft(z.B. <http://scanme.nmap.org/>)

```
bwolff@psychonaut:~$ tftp scanme.nmap.org
tftp> get /foo
Transfer timed out.

tftp>
```

Beispiel: Port Unreachable

Wenn was
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Einleitung

Nachrichtenaufbau

Query Messages

Echo Request/Reply

Timestamp

ICMP Router Discovery
Protocol (IRDP)

Error Messages

Destination Unreachable

Time Exceeded

Redirect

Parameter Problem

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	192.168.1.6	74.207.244.221	TFTP	58	Read Request, File: /foo, Transfer type: netascii
2	0.183965	74.207.244.221	192.168.1.6	ICMP	86	Destination unreachable (Port unreachable)
3	5.000086	192.168.1.6	74.207.244.221	TFTP	58	Read Request, File: /foo, Transfer type: netascii
4	5.181866	74.207.244.221	192.168.1.6	ICMP	86	Destination unreachable (Port unreachable)
5	10.000157	192.168.1.6	74.207.244.221	TFTP	58	Read Request, File: /foo, Transfer type: netascii
6	10.180871	74.207.244.221	192.168.1.6	ICMP	86	Destination unreachable (Port unreachable)
7	15.000231	192.168.1.6	74.207.244.221	TFTP	58	Read Request, File: /foo, Transfer type: netascii
8	15.183558	74.207.244.221	192.168.1.6	ICMP	86	Destination unreachable (Port unreachable)
9	20.000303	192.168.1.6	74.207.244.221	TFTP	58	Read Request, File: /foo, Transfer type: netascii
10	20.181357	74.207.244.221	192.168.1.6	ICMP	86	Destination unreachable (Port unreachable)

```
►Frame 1: 58 bytes on wire (464 bits), 58 bytes captured (464 bits)
►Ethernet II, Src: Tp-LinkT c1:91:ca (f8:1a:67:c1:91:ca), Dst: Arcadyan b2:81:1e (9c:80:df:b2:81:1e)
►Internet Protocol Version 4, Src: 192.168.1.6 (192.168.1.6), Dst: 74.207.244.221 (74.207.244.221)
▼User Datagram Protocol, Src Port: 48766 (48766), Dst Port: tftp (69)
  Source port: 48766 (48766)
  Destination port: tftp (69)
  Length: 24
  ►Checksum: 0x0d09 [validation disabled]
▼Trivial File Transfer Protocol
  [Source File: /foo]
  Opcode: Read Request (1)
  Source File: /foo
  Type: netascii
```

Beispiel: Port Unreachable

Wenn was
schiefgeht: ICMP

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No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	192.168.1.6	74.207.244.221	TFTP	58	Read Request, File: /foo, Transfer type: netascii
2	0.183965	74.207.244.221	192.168.1.6	ICMP	86	Destination unreachable (Port unreachable)
3	5.000086	192.168.1.6	74.207.244.221	TFTP	58	Read Request, File: /foo, Transfer type: netascii
4	5.181866	74.207.244.221	192.168.1.6	ICMP	86	Destination unreachable (Port unreachable)
5	10.000157	192.168.1.6	74.207.244.221	TFTP	58	Read Request, File: /foo, Transfer type: netascii
6	10.180871	74.207.244.221	192.168.1.6	ICMP	86	Destination unreachable (Port unreachable)
7	15.000231	192.168.1.6	74.207.244.221	TFTP	58	Read Request, File: /foo, Transfer type: netascii
8	15.183558	74.207.244.221	192.168.1.6	ICMP	86	Destination unreachable (Port unreachable)
9	20.000303	192.168.1.6	74.207.244.221	TFTP	58	Read Request, File: /foo, Transfer type: netascii
10	20.181357	74.207.244.221	192.168.1.6	ICMP	86	Destination unreachable (Port unreachable)

```
► Frame 2: 86 bytes on wire (688 bits), 86 bytes captured (688 bits) on interface 0
► Ethernet II, Src: Arcadyan_b2:81:1e (9c:80:df:b2:81:1e), Dst: Tp-LinkT_c1:91:ca (f8:1a:67:c1:91:ca)
► Internet Protocol Version 4, Src: 74.207.244.221 (74.207.244.221), Dst: 192.168.1.6 (192.168.1.6)
▼ Internet Control Message Protocol
  Type: 3 (Destination unreachable)
  Code: 3 (Port unreachable)
  Checksum: 0xfe81 [correct]
► Internet Protocol Version 4, Src: 192.168.1.6 (192.168.1.6), Dst: 74.207.244.221 (74.207.244.221)
▼ User Datagram Protocol, Src Port: 48766 (48766), Dst Port: tftp (69)
  Source port: 48766 (48766)
  Destination port: tftp (69)
  Length: 24
  ► Checksum: 0x0d09 [validation disabled]
▼ Trivial File Transfer Protocol
  [Source File: /foo]
  Opcode: Read Request (1)
  Source File: /foo
  Type: netascii
```

Einleitung

Nachrichtenaufbau

Query Messages

Echo Request/Reply

Timestamp

ICMP Router Discovery
Protocol (IRDP)

Error Messages

Destination Unreachable

Time Exceeded

Redirect

Parameter Problem

Packet Too Big

Wenn was
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Einleitung

Nachrichtenaufbau

Query Messages

Echo Request/Reply

Timestamp

ICMP Router Discovery
Protocol (IRDP)

Error Messages

Destination Unreachable

Time Exceeded

Redirect

Parameter Problem

- ▶ Im IP-Header wurde “Dont Fragment bit” gesetzt
- ▶ Datagramm überschreitet zulässige MTU
- ▶ Datagramm wird verworfen und ICMP-Message generiert
- ▶ Wird für Path MTU Discovery verwendet (maximale Paketgröße für einen bestimmten Pfad)

Time Exceeded

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Query Messages

Echo Request/Reply

Timestamp

ICMP Router Discovery
Protocol (IRDP)

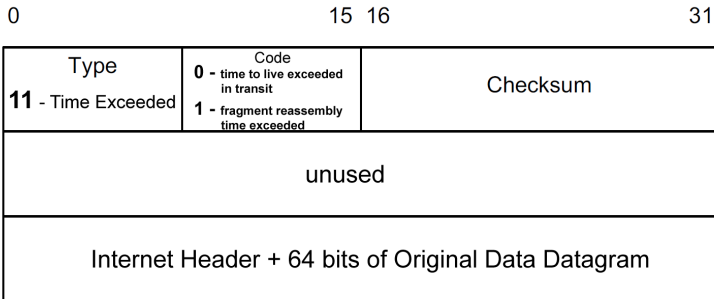
Error Messages

Destination Unreachable

Time Exceeded

Redirect

Parameter Problem



Redirect

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Nachrichtenaufbau

Query Messages

Echo Request/Reply

Timestamp

ICMP Router Discovery
Protocol (IRDP)

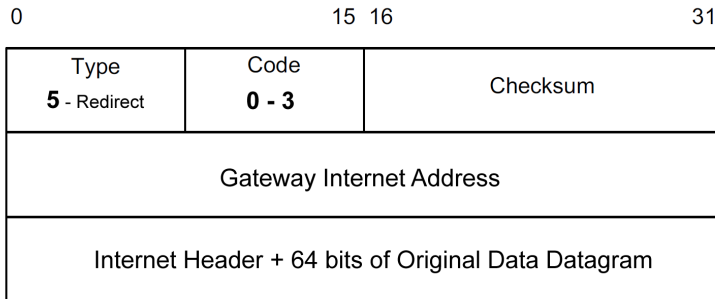
Error Messages

Destination Unreachable

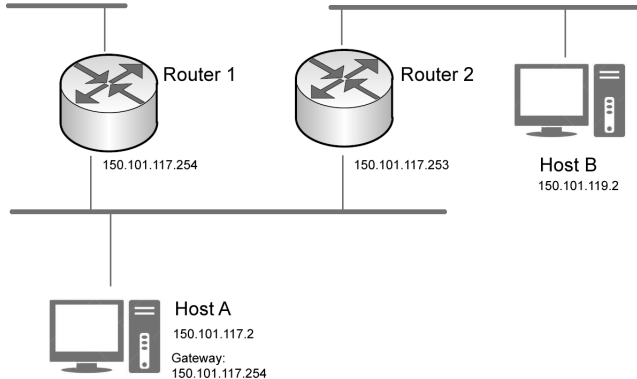
Time Exceeded

Redirect

Parameter Problem



Redirect



Wenn was
schiefgeht: ICMP

Benjamin Wolff

Einleitung

Nachrichtenaufbau

Query Messages

Echo Request/Reply

Timestamp

ICMP Router Discovery
Protocol (IRDP)

Error Messages

Destination Unreachable

Time Exceeded

Redirect

Parameter Problem

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Query Messages

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Timestamp

ICMP Router Discovery
Protocol (IRDP)

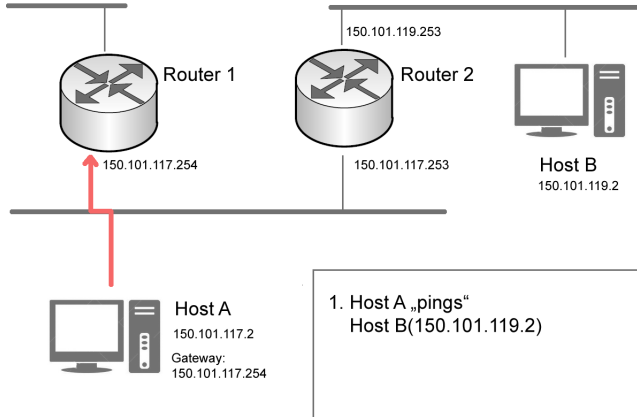
Error Messages

Destination Unreachable

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Redirect

Parameter Problem



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Nachrichtenaufbau

Query Messages

Echo Request/Reply

Timestamp

ICMP Router Discovery
Protocol (IRDP)

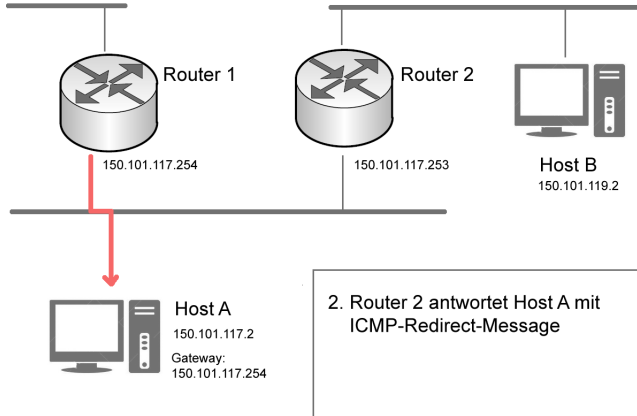
Error Messages

Destination Unreachable

Time Exceeded

Redirect

Parameter Problem



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Nachrichtenaufbau

Query Messages

Echo Request/Reply

Timestamp

ICMP Router Discovery
Protocol (IRDP)

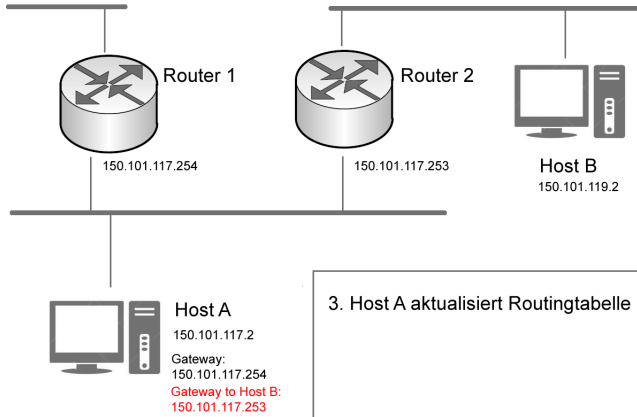
Error Messages

Destination Unreachable

Time Exceeded

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Parameter Problem



Redirect

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Nachrichtenaufbau

Query Messages

Echo Request/Reply

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ICMP Router Discovery
Protocol (IRDP)

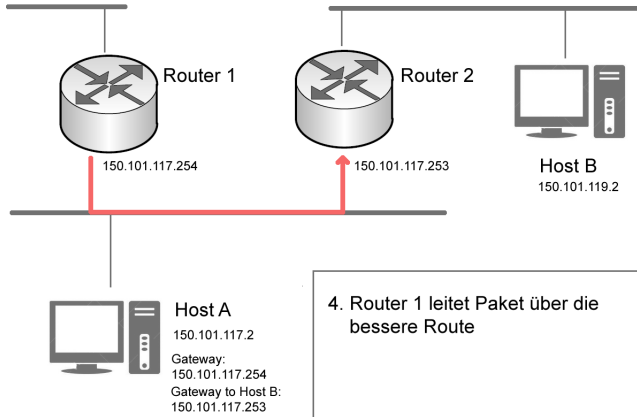
Error Messages

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Nachrichtenaufbau

Query Messages

Echo Request/Reply

Timestamp

ICMP Router Discovery
Protocol (IRDP)

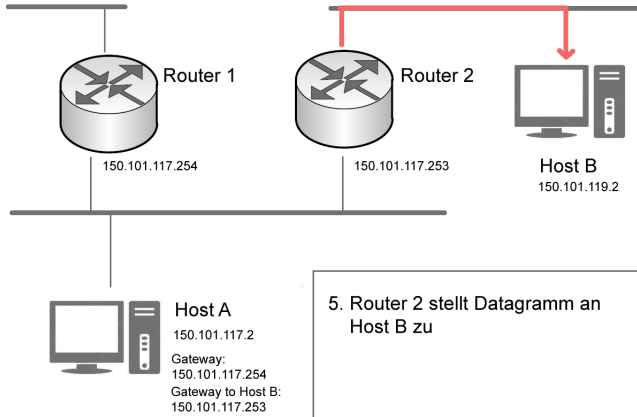
Error Messages

Destination Unreachable

Time Exceeded

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Parameter Problem



Redirect

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Einleitung

Nachrichtenaufbau

Query Messages

Echo Request/Reply

Timestamp

ICMP Router Discovery
Protocol (IRDP)

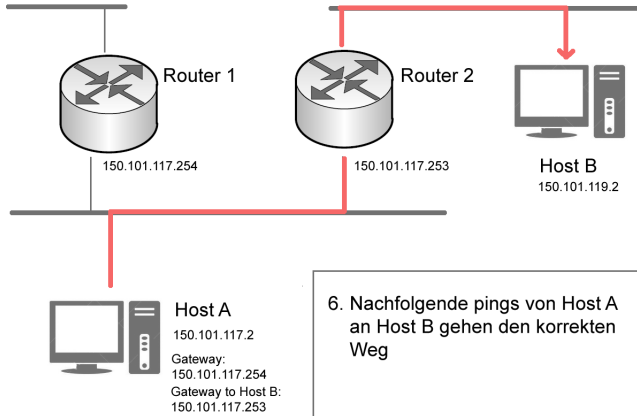
Error Messages

Destination Unreachable

Time Exceeded

Redirect

Parameter Problem



Parameter Problem

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Einleitung

Nachrichtenaufbau

Query Messages

Echo Request/Reply

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ICMP Router Discovery
Protocol (IRDP)

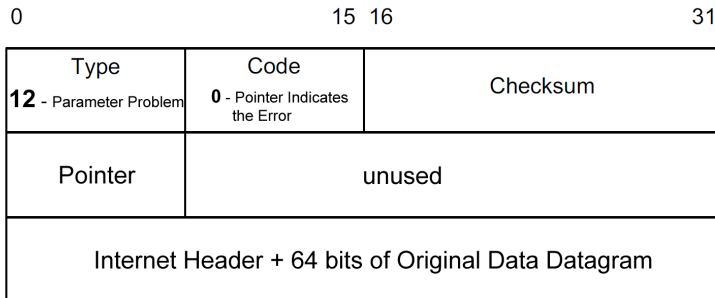
Error Messages

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Time Exceeded

Redirect

Parameter Problem



Wenn was
schiefgeht: ICMP

Benjamin Wolff

ICMP Router Discovery Protocol (IRDP)

Time Exceeded

Redirect

Parameter Problem

Byte	0							1							2							3											
	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	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	Options (Could be non-existent or longer than 4 bytes)																															

Wenn was schiefgeht: Internet Control Message Protocol (ICMP)

Benjamin Wolff

Internet Protokolle WS 2014/15

18.11.2014