Centauri Application Note 20

Data Prioritization / Type of Service

1 Problems with data transmission for real-time applications

The transmission of data from one point within a network to another needs a certain time. First there is a time span which can be influenced and very well evaluated by the choice of codecs (coding algorithms) and network components. This part is determined by the time, the coding algorithms at both points require, the throughput time of the hardware of the participating knots and endpoints and the physical transfer rate of the different media for certain distances. Additionally there will arise delays depending on, for example, full queues because of overload or the possible choice of alternate routes to the arrival point. Both the latter situations can also be reasons for two other transmission errors. In case of the so called 'Jitter' the packets that are sent into the net in constant intervals arrive asynchronously at the receiver. If a packet is too fast, it can happen that it won't be decoded accurately or even will be discarded because the antecedent packet is not yet processed. Is it, in contrast, too late, there may occur vacancies within the data. Jitter can be avoided by establishing a Jitter-buffer which accepts the packets from the net and passes them on to the decoder delayed but in consistent intervals. Of course this will increase the delay. If the packets arrive at the receiver in a different order as intended by the sender, this is defined as a 'sequence-error'. The common reason for this situation is the rerouting of some packets, belonging to a transmission, because of an overload, so that these packets will reach the receiver via another, maybe more slowly route. The success of compensating these sequence-errors depends primarily on the used codecs. The same applies to the case of packets that get lost during a transmission (packet-loss). The reason for that can be a queue on the route which cannot be processed fast enough, so that packets have to be discarded or packets with such a high delay that makes it impossible for the receiver to recognize them as belonging to a specific transmission.

The most common network architecture in companies is Ethernet. It offers a cost-efficient, persistent solution from the backbone area to the workstations. Indeed Ethernet doesn't offer the same security within layer 2 and 3 as ATM does. In fact the ethernet-protocol is more facile and works with short overhead, but the transmissions work without establishing a connection before or negotiating the quality of the transmission route from endpoint to endpoint. For all applications it only provides a best-effort-treatment — as good as possible — , no matter what the users requirements are in fact. The protection of a connection, if there is one, only takes place within the higher levels, like the TCP.
Within ethernet-networks and with using the TCP/IP- thus within the Internet, Intranet or Extranet — there are no guaranteed qualities of connections. For that the implementation of Quality-of-Service or QoS, like it's known with ATM, is not possible. Nevertheless the developer of ethernet-products try to get different service classes, so called Class-of-Service or CoS, also within IP-nets. At this time there are existing two different ways of realizing service qualities, first via the reservation of network resourses, the Resource-Reservation, or second via preferred handling of certain packets during their transmission, the Prioritization.

2 Parameters

As described within the chapter above, there exist some important parameters to assure the quality of data transmission.

- **Line reliability**
  - datagram dropping by switches and routers
  - TCP retransmit capability
- **Datagramm latency**
  - depends on the type and number of network hops of a route
  - depends on the slowest linetype of a route
  - line distances are in most cases irrelevant
- **Datagram jitter**
  - differing routes from source to destination
  - high network load in certain segments of the route
  - heterogeneous usage in prioritized network segments
- **Route bandwith**
  - is determined by the slowest segment of a route

Note that a high priority concerning one parameter often causes a low priority concerning another. Consequently the datagram prioritization has to provide the possibility to differ depending on which parameter is decisive for the specific transmission.

3 Prioritization

Prioritization is possible on layer 2 and layer 3 of the network.

3.1 OSI level 2 prioritization (datalink layer, IEEE protocol types)

Within IEEE 802.3 there is no space for a prioritization flag.

Destination MAC address	6 Byte
Source MAC address	6 Byte
Ethernet Type or Length	2 Byte

Within IEEE 802.1p/Q there exists an additional datalink layer extend.

Destination MAC address	**6 Byte**	
Source MAC address	**6 Byte**	
Tag Control Info (TCI)	**2 Byte**	**= 8100**
Priority	**3 Bit (0-7)**	
Canonical Indicator	**1 Bit = 0**	
VLan Indicator	**12 Bit**	
Ethernet Type or Length	**2 Byte**	

If the value for TCI is defined with 8100 (hex=1FA4), the header must have an additional space of 4 Byte.

3.2 OSI level 3 prioritization (network layer, Internet Protocol)

The IP Header is already prepared for it

Bits

1	4	8	12	16	20	24	28	32
Version	**Length**	**Type of Service (ToS) Priority |D|T|R|C|**		**Total Length**				
Identification Unique ID, to rejoin fragments				**Flags |N|M|**	**Fragment Offset In bytes/8**			
Time To Live (TTL)		**Protocol**		**Header Checksum**				
Source Address								
Destination Address								

IP (RFC 791) uses some type of service bits to set the degree of priority as well as other information for the routers.

D **low delay**
T **high throughput**
R **high reliability**
C **low cost**

IP is able to fragment the packets for to get them through nets with little MTU(maximum transfer units)-values. They have to be recombined after transmission:

N **don't fragments**
M **more to come**

If N is set for a packet which is too big for a net, it will be discarded. The fragments will be identified by their ID and recombined by the offset until M is no longer set.

3.3 Type of Service parameter

The 8 Bits reserved for priority are separated as follows:

Bits*	Type	Description
5-7	Priority	eight levels
		level 0 = normal
		level 7 = highest priority
1-4	Type of Service Flag	Delay, Reliability,
		Bandwidth, Economics
0	Reserved for future use	

* The bits are counted from right to left, according to the Centauri Communication Reference Manual

Within the following table the Type-of-Service-Flag (Bit 1-4) is described in particular.

TYPE OF SERVICE	BIT FLAGS	VALUE	NOTES
Low Delay (D)	1000	8	Telnet keystrokes, FTP commands and other urgent data
High Throughput (T)	0100	4	FTP downloads, backups and other bandwidth-sensitive applications
High Reliability (R)	0010	2	File-sharing database updates and any UDP-based transactions
Low Cost (C)	0001	1	NNTP newsfeeds and other nonessential traffic
Normal	0000	0	Normal traffic
Maximum QoS	1111	15	

4 Type of Service with the Centauri

The Centauri provides two commands for setting the priority of IP-datagrams, one for TCP and another for UDP.

4.1 IP Type of Service for TCP

This corresponds to chapter 3.8.21 of the Centauri Communication Reference Manual.

Command to set the type of service for a TCP-packet. This value is only valid for IP audio datagrams. Subaddressing possible, see chapter 3.4.

Syntax:

`ip_tostcp <param1>`

Parameter:

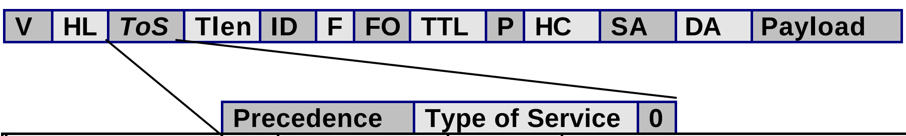
Param1: **`[param as int value, ?]`**

Response:

- set type of service for TCP
  `ip_tostcp [int value for ToS]: ok [CR][LF][IP address]>`
- request type of service for TCP
  `ip_tostcp?: [int value for ToS][CR][LF][IP address]>`
- error
  `ip_tostcp [int value for ToS]: error [err no][CR][LF][IP address]>`

<param as int value>: Bit 76543210
Precedence (Bit 5-7)
Low latency (Bit 4)
High throughput (Bit 3)
High reliability (Bit 2)
Low cost (Bit 1)
reserved (Bit 0)
param = 0: Normal traffic

IP-Packet Format:



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Normal	0000	0	Normal traffic

4.2 IP Type of Service for UDP

This corresponds to chapter 3.8.22 of the Centauri Communication Reference Manual.

Command to set the type of service for a UDP-packet. This value is only valid for IP audio datagrams. Subaddressing possible, see chapter 3.4.

Syntax:

`ip_tosudp <param1>`

Parameter:

Param1: **`[param as int value, ?]`**

Response:

- set type of service for UDP
  `ip_tosudp [int value for ToS]: ok [CR][LF][IP address]>`

- request type of service for UDP
  `ip_tosudp ?: [int value for ToS][CR][LF][IP address]>`

- error
  `ip_tosudp [int value for ToS]: error [err no][CR][LF][IP address]>`

For parameter description see chapter 3.8.21, IP Type of Service for TCP.