TDM over IP
Integra Series

Application Note

Abstract

Transmission of TDM[1]-based signals, such as E1/T1 over IP medium, is quite demanding in terms of synchronization accuracy and packet processing continuity. Necessary requirements can be fulfilled with the means of using QoS (Quality of Service) traffic prioritization based on the VLAN, port-based, DiffServ, or MPLS EXP separation. Integra series products are capable of providing the mentioned functionality as well as various supplemental techniques such as LLQ (Low Latency Queue) or WAN High Priority port, bandwidth limiting, and SyncE (Synchronous Ethernet). All of them should be used in conjunction to work efficiently.

Undesired packet loss and AIS[2] condition of E1/T1 channels can be eliminated after applying the recommended configuration described further in this document.

Different converter modules can be used for E1/T1 interface translation to Ethernet. An example is TPoP Smart SFP™, transparent PDH over Packet converter (P/N I0AE1E01).

The sequence of applying the respective configuration to an Integra series microwave link is provided below. We assume that SFP converter modules are used on LAN2 port at both sides of the link. The synchronization between both link end-points is established and there are no traffic interruptions due to RF impairments.

Configuration Example

The configuration process can be divided into three steps:

1. TDM and Ethernet traffic separation and prioritization.

2. Enabling Low Latency Queue or WAN High Priority port functionality and limiting Ethernet traffic rate.

3. Synchronous Ethernet (SyncE) configuration.

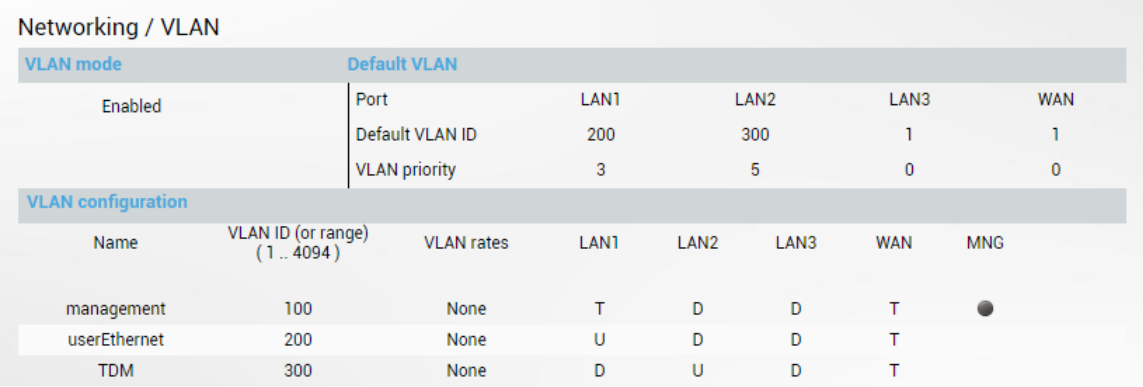
Each of the steps detailed below will describe this process applied to the Integra-G product:

1. The first step is to separate delay-sensitive TDM traffic from regular Ethernet traffic (including a management channel) and assign a different priority to each of these traffic types. This can be achieved with different queueing techniques. VLAN-based (Figure 1 and Figure 2) or port-based queueing (Figure 3) will be shown as an example. Other available methods supported by Integra series include DiffServ and MPLS EXP.

[1] Time Division Multiplexing
[2] Alarm Indication Signal

VLAN-based queueing requires setting up different VLANs for Ethernet traffic and TDM traffic and then assigning different priority levels to each of these VLANs. The example below shows 3 VLANs set up for different categories of traffic: VLAN 100 for management Ethernet traffic, VLAN 200 for user Ethernet traffic, and VLAN 300 for TDM traffic.

Integra management traffic is always assigned to the highest priority CoS (Class of Service) queue #7 (out of 8 queues in total: from 0 to 7). Therefore, it is only required to prioritize user Ethernet traffic and TDM traffic with VLAN priority level 3 and level 5 accordingly. This refers to the respective CoS priority queues #3 and #5 if we assume the default 802.1p mapping.



Networking / VLAN

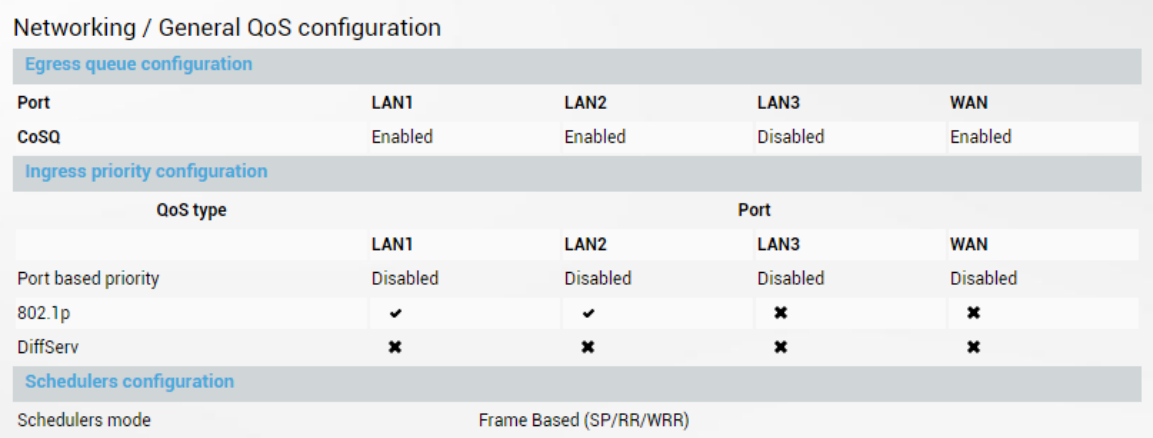
VLAN mode	Default VLAN				
Enabled	Port	LAN1	LAN2	LAN3	WAN
	Default VLAN ID	200	300	1	1
	VLAN priority	3	5	0	0

VLAN configuration

Name	VLAN ID (or range) (1 .. 4094)	VLAN rates	LAN1	LAN2	LAN3	WAN	MNG
management	100	None	T	D	D	T	●
userEthernet	200	None	U	D	D	T	
TDM	300	None	D	U	D	T	

Figure 1. Configuration example of VLAN-based queueing (1).

After the VLANs are configured, the appropriate ingress priority queueing has to be enabled in *Networking -> General QoS configuration*. As shown in Figure 2, the egress queue has to be enabled for all the involved Integra ports (LAN1, LAN2 and WAN) and the QoS type "*802.1p*" has to be enabled for LAN1 and LAN2 ports as a part of ingress priority configuration. Frame Based Scheduler mode can be selected.



Networking / General QoS configuration

Egress queue configuration

Port	LAN1	LAN2	LAN3	WAN
CoSQ	Enabled	Enabled	Disabled	Enabled

Ingress priority configuration

QoS type	Port			
	LAN1	LAN2	LAN3	WAN
Port based priority	Disabled	Disabled	Disabled	Disabled
802.1p	✔	✔	✖	✖
DiffServ	✖	✖	✖	✖

Schedulers configuration

Schedulers mode	Frame Based (SP/RR/WRR)

Figure 2. Configuration example of VLAN-based queueing (2).

Port-based prioritization is an alternative approach of separating TDM and Ethernet traffic. Figure 3 shows an example of the corresponding QoS configuration when the same scenario as in the previous example is used: LAN1 for management and user Ethernet traffic and LAN2 for TDM traffic. "*Port based priority*" QoS type is selected with the corresponding priority levels of 3 and 5 for LAN1 and LAN2 ports accordingly. Other parameters remain as in the previous example.

Networking / General QoS configuration

Egress queue configuration				
Port	**LAN1**	**LAN2**	**LAN3**	**WAN**
CoSQ	Enabled	Enabled	Disabled	Enabled
Ingress priority configuration				
QoS type	**Port**			
	LAN1	**LAN2**	**LAN3**	**WAN**
Port based priority	3	5	Disabled	Disabled
802.1p	✖	✖	✖	✖
DiffServ	✖	✖	✖	✖
Schedulers configuration				
Schedulers mode	Frame Based (SP/RR/WRR)			

Figure 3. Configuration example of port-based queueing.

2. The next step can be divided into two sub-steps, both of them can be configured under *Networking -> CoSQ configuration -> WAN*:

   a. To enable the Low Latency Queue for the CoS queue #5 which has been selected for TDM traffic in the previous step. This will ensure delivering high priority delay-sensitive packets with reduced delay. The alternative functionality supported by Integra-X product is WAN High Priority port which is described separately below.

   b. To set the Bandwidth Limit for management and user Ethernet traffic. 1000kbps should be allocated for management traffic in any case. This will make sure that being intrinsically top-prioritized it does not interrupt TDM traffic. A limit for user Ethernet traffic has to be selected based on overall available channel bandwidth given that the recommended capacity allocated for a single E1 channel is 3Mbps. The following equation can be used for estimations:

$$Total\ BW = 1Mbps + Ethernet\ capacity + 3Mbps * Number\ of\ E1\ channels$$

An example of both sub-step's configuration is shown in Figure 4. 100000kbps capacity is allocated for user Ethernet traffic in this example. Strict Priority (SP) CoSQ mode is selected.

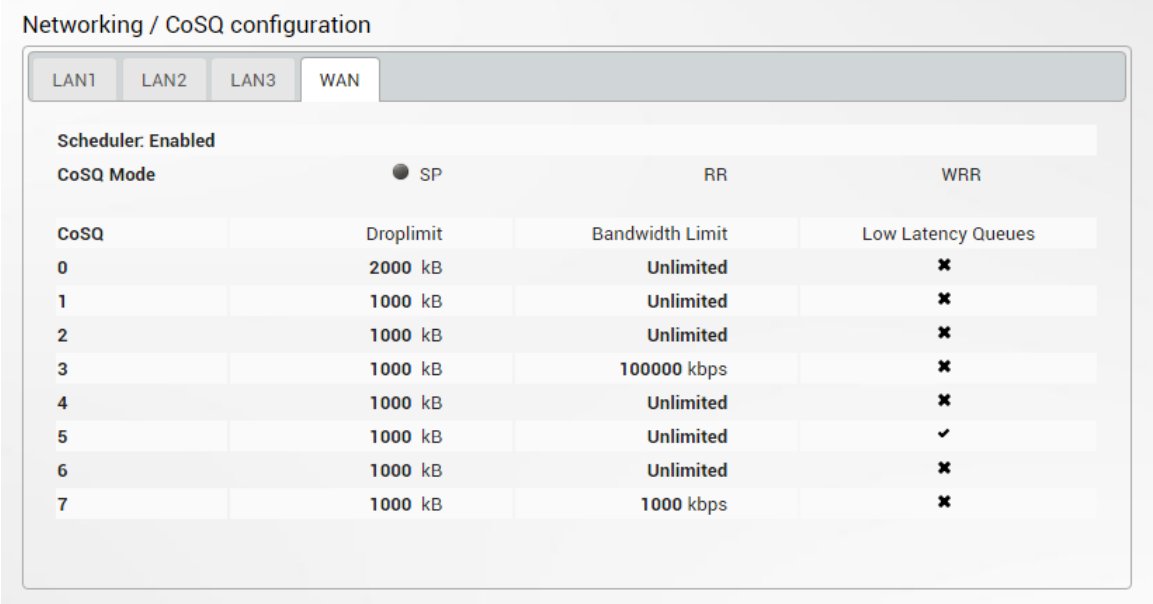


Figure 4. Configuration example of Bandwidth Limit and LLQ.

Alternatively, another fragmentation technique can be used instead of LLQ: **WAN High Priority port** functionality supported by Integra-X. It relies on VLAN separation of small size latency-sensitive frames and larger frames non-sensitive to latency; thus, VLAN-based queueing must be set up prior to splitting traffic between WAN HP (High Priority) and WAN LP (Low Priority) ports of Integra-X switch. An example of WAN High Priority port configuration is shown in Figure 5 for the VLANs from the first step. License capacity distribution has to be set up according to the throughput demand of each traffic type.

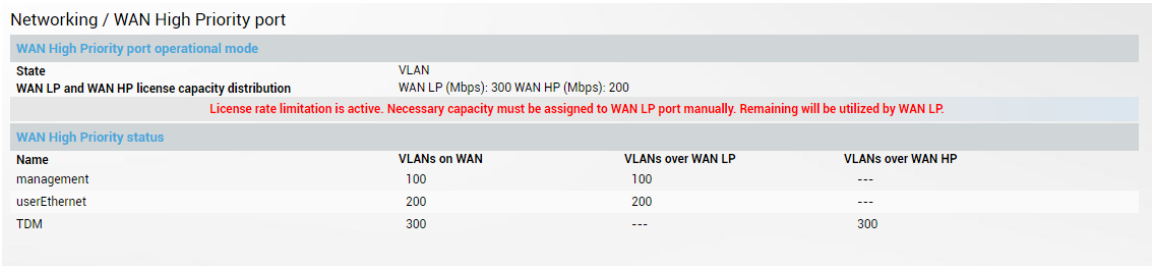


Figure 5. Configuration example of WAN High Priority port.

3. **Synchronous Ethernet (SyncE)** feature helps with maintaining a clock reference essential for TDM-over-IP traffic. TDM traffic is known to be sensitive to such network parameters as transmission delay and transmission delay variation (or jitter). SyncE functionality available in Integra-G equipment minimizes adverse effects caused by the synchronization absence in the Ethernet medium. Please note that an external clock reference is required for SyncE implementation.

SyncE configuration example is shown below given that LAN2 port with TDM-to-IP converter is used as a clock reference source at the local side of the link (a). The remote Integra-G (b) takes its clock reference from the opposite side through the WAN port.

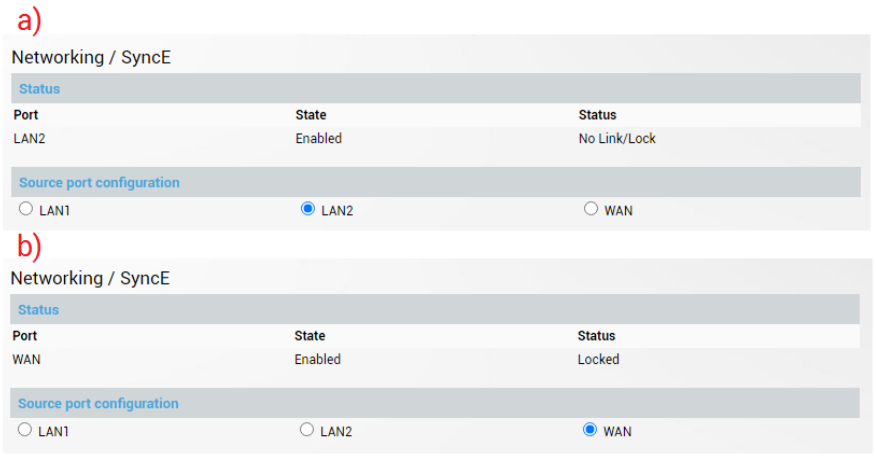


Figure 6. SyncE configuration example for local (a) and remote (b) Integra-G.

Available Functionality Summary

The features described in this document are not fully supported by all Integra series products. This defines how a particular product should be configured to efficiently transport TDM over IP with available queueing and prioritization techniques. The table below summarizes all previously mentioned features available for each Integra model.

Feature	Available in
Queueing:	
VLAN-based	Integra-G, -X, -E
Port-based	Integra-G, -X, -E
DiffServ	Integra-G, -X, -E
MPLS EXP	Integra-G, -X, -E
Low Latency Queue	Integra-G
WAN High Priority port	Integra-X
Bandwidth Limit	Integra-G, -X, -E
Synchronous Ethernet	Integra-G, -X, -E