PATAPSCO Communications

PacketBand TDM over IP range providing high-quality clock-locked virtual leased T1/E1 circuits over Ethernet/IP/MPLS networks

The clock recovery capabilities of PacketBand ensure service for all voice/data applications including synchronous traffic.

This document covers the major technical specifications and should be read with other Application and Overview documents available from www.patapsco.co.uk or on request.

PacketBand-TDM is available to support different numbers of circuits. Although this document focuses on the 4 port units, the information is relevant for single port devices.

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Contents

1. Connectivity Overview

The PacketBand ranges are designed to supply clock-locked clear-channel circuits across Ethernet/IP/MPLS networks.
Because of the requirements of synchronous clocked non-packet data, the Packet Delay Variation (PDV) or "jitter" across the network is important (see below), and this means the PacketBand will normally be connected across/through a Private or Managed Network not the internet.
However, some internet services and routes also benefit from low PDVs and in these instances PacketBand may be used.

2. Physical Specifications

E1 and T1 ports are user software-selectable.

2.1 E1 TDM

RJ45 Connector
Presents as DCE
1 to 4 ports
120 Ohm balanced
75 Ohm unbalanced via balun
G. 703 2.048Mbps
G.704 structured full or fractional (31x64 / nx64)
ITU G.706
Software selectable CRC4 or non-CRC4 framing (Multiframe or Doubleframe)
Line coding HDB3

2.2 T1 TDM

RJ45 Connector
Presents as DCE
Cross-cable for DTE
1 to 4 ports
100 Ohm balanced (T1)
1.544Mbps
T1 Structured full or fractional
T1 clear unstructured
G.704
ESF or D4 Framing software selectable
B8ZS or AMI Line Code selectable

2.3 Ethernet Interfaces

Standard RJ45 connectors
4 ports with integrated Ethernet switch
One Ethernet/IP to the network and 3 local Ethernet ports.
10/100baseT
Full duplex
Auto-negotiation

2.4 Local Management Port

Local RJ12
Asynchronous

2.5 Alarm Relay

Dry contact Alarm Relay
Two pins within Management RJ12 connector

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3. Protocols Supported

PacketBand allows various protocol options to be configured by the user. The protocol can be selected to match the packet network characteristics. PacketBands can be used over Ethernet networks, Metro Ethernet networks, MPLS networks, or Internet Protocol (IP) networks. PacketBand complies with relevant published or emerging packet network standards.

LAN/WAN Protocols	User selectable TDM protocols
Ethernet 802.3	Y.1413 (TDM over MPLS)
Ethernet VLAN IEEE 802.1Q	UDP / RTP
IPv4	PWE3 CESoPSN (draft)
ARP	Metro Ethernet (MEF CES Requirements)
TCP (For remote management)	
IPv6 (Q3 05)	
ICMP (ping)	

4. Clocking

Clocking and clock-recovery is a critical area for this type of technology and one in which the PacketBand has particular strengths. The method of clock recovery (patent pending) uses timestamp values in packet headers (where available) or an averaging of the packet arrival rate to recover the clock to a high degree of accuracy. Graphs and further information of performance against specifications are available on request.

4.1 Clocking

4.1 Clock Sources

PacketBand has user configurable clock sources, able to select its clock from a number of interfaces (see below). These sources can be configured to be used in a hierarchic manner and switch-over to secondary clocks is normally error-free.

All attached ports will be clocked using the signal derived from the selected clock source.

- **TDM ports.** Any E1/T1 interface where the connected device provides clock.
- **"Adaptive"** via **Logical Links** (see Section 5 below). Clock will be derived from the encoded data arriving from another PacketBand via the Ethernet/IP Logical Link selected. The method of clock recovery method is patented and uses the timestamp in the packet header within the RTP packet header and the result is a very accurate clock (also covered below).
- **Internal.** PacketBand will source its clock from internal circuitry. This Internal Clock (25ppm) will be used to clock all attached interfaces. This option is normally used as a clock of "last resort" and to "boot" the unit and interfaces from a cold start.

4.2 Clock Stability

Clock frequency stability performance easily exceeds AT&T TR-62411, T1.403, G.824 and G.823 and is an important strength of PacketBand.

When using **"Adaptive"** clock recovery the derived remote clock is typically within the following tolerances of the master clock for the following types of networks:

- Dedicated 0.048ppm
- Metropolitan 0.054ppm
- Continental 0.083ppm

Performance cannot be guaranteed over an arbitrary network.

4.3 Clock Lock Times

Start-up time from "cold" to a fully-locked clock on a Metropolitan Network is around 100 seconds. Data can be transferred before this time whilst the clock is completing its synchronisation. See also "Hold-Over" below.

4.4 Clock Hold-Over

Problems in the packet network, for example a sudden increase in PDV or an interruption in delivery, could cause a large perturbation in the recovered clock. To avoid this the system enters a hold-over state maintaining the recovered clock at the value before the problem occurred.

The phase error during hold-over depends on the length of interruption although the on-board Phase Locked loops (PLLs) are very accurate. For example the clock recovery accuracy on a Metropolitan network is 0.054ppm and with an interruption of 20 seconds a Time Interval Error (TIE) of only 1.08µs will be generated.

5. Logical Links (or SVCs)

"Logical Link" is the term used to define the logical data connection across the packet network from one PacketBand to another. Each Logical Link can be constructed from a single or many timeslots.

PacketBand can support up to a maximum of 64 Logical Links across any combination of TDMs. A user port can comprise of up to 31 logical links in the case of E1 channelised (31 separate 64kbps links to 31 different destinations) or 30 in an E1 PRI. An unstructured E1/T1 is a single Logical Link.

Destination addresses can be set for each individual Logical Link.

VLAN tagging can be set for each individual Logical Link.

QoS type can be selected for each individual Logical Link.

6. Grooming

PacketBand-TDM is capable of "Grooming" several remote fractional T1/E1 circuits into a single T1/E1. For example, three remote 512kbps (8 timeslots) links at three different remote sites could be presented as three 512kbps logical channels in a single channelised T1/E1 at the central site.

7. Cross-Connectivity

Local TDM devices can cross-connect via PacketBand.

8. Quality of Service

For IP networks, the QoS for each Logical Link can be user configured.
There are two main options; Type of Service (TOS) and Differentiated Services (Diff serv).

8.1 ToS

Four options can be set independently to:

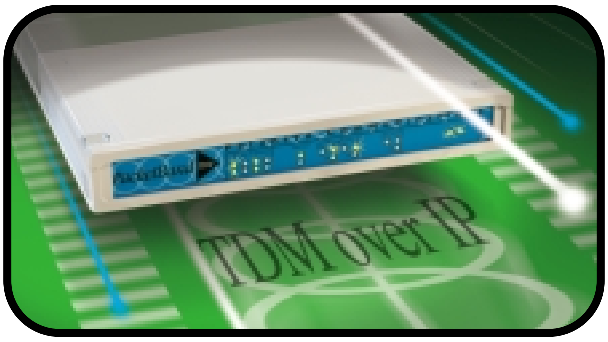
- Minimize delay
- Maximize throughput
- Maximize reliability
- Minimize monetary cost

Precedence options can also be set:

- Network Control
- Inter-network Control
- CRITIC/ECP
- Flash Override
- Flash
- Immediate
- Priority
- Routine

8.2 Diff Serv

The Diff Serv bits can be set in the range 0-3F. The value will be supplied by your network provider and will guarantee a level of service. Typically, the higher the value the better the service and the more the service will cost.



9. Network Issues

9.1. PDV (Jitter)

PacketBand can handle up to 1second (+/- 500msecs) of Packet Delay Variation (PDV) or network jitter depending upon a number of criteria, although a more realistic and practical figure would be 160msecs. This is normally far in excess of jitter experienced on Private or Managed Networks.

The depth of the jitter buffer is user-configurable on a per Logical Link basis. The jitter buffer should be optimised for the network in use, as configuring extra buffer can add to the end-to-end latency.

An optional automatic tuning of the jitter buffer by PacketBand will reduce any unneeded buffer if it is not being used, or increase the buffer if required. This is based on a hysteresis. Reducing and optimising the jitter buffer reduces the latency. PacketBand will automatically tune the buffer to match actual network conditions, optimising throughput and latency.

If the automatic tuning is not selected, the user can monitor the buffer utilisation via the statistics supplied. In the unlikely event of the buffer under- or over-flowing, a user-configurable data pattern will be transmitted to the DTE for the necessary number of packets.

9.2. Disordered Packets

PacketBand has an independent jitter buffer for each logical link. When a packet is received from the packet network, it will be inserted into the correct location in the jitter buffer (each packet carries a sequence number for this purpose). This allows out of order packets to be played out to the TDM interface in the correct order.

Packets which arrive too early or too late to be within the current range of the jitter buffer are discarded. Packets are played out to the TDM interface synchronously with the clock. Missing packets cause a (user configurable) under run value to be passed to the TDM channel(s).

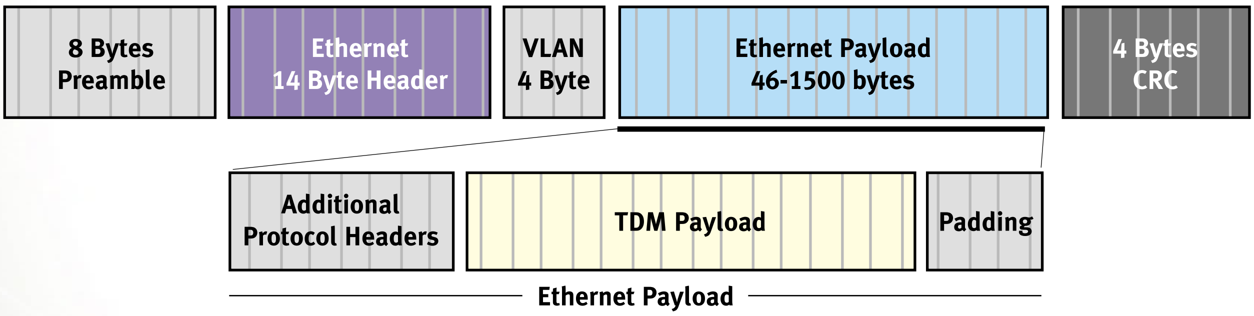
9.3 Loss of Packets

If the PacketBand stops receiving packets (for example through a network failure) it will continue to transmit the user-configure over-run data pattern to the DTE and incrementing the expected receive packet numbers. When communication is re-established the packets will be inserted into their correct position.

Should the packet number not match those expected (for example the network has had a failure), the receiving PacketBand will re-synchronise and re-centre the buffers and packet numbers.

10. Packetisation

An Ethernet packet is made up of a number of different elements shown below. Some are under control of the PacketBand, some can be user-configured and some are set within the standards.



10.1 Ethernet

26 Bytes including the Ethernet hardware bytes (8 bytes preamble and 4 bytes CRC)

10.2 VLAN

4 Bytes, Tagging and VLAN tagging is optional.

10.3 Ethernet Payload

The Ethernet payload consists of Additional Protocol headers, the data or TDM payload and Ethernet padding if required (not normally needed).

The Ethernet payload must be between 46 and 1500 bytes.

103.1. Additional Protocol headers.

Protocol	IP	UDP	RTP	MPLS	PW*	TS**	Total
Pseudo-wire over IP (CESoPSN)	•				•	•	26
Pseudo-wire over IP with UDP/RTP (CESoPSN)	•	•	•		•		44
Pseudo-wire over MPLS (Y.1413)				•	•		12
Pseudo-wire over Ethernet					•		4

Table shows the total bytes overhead per packet for each protocol.
* Pseudo-wire control word (4 bytes status and sequence numbering)
** Time Stamp (2 bytes)

10.3.2. TDM Payload

The TDM payload size will depend on the E1/T1 frames used to build an IP/Ethernet packet and the number of TDM channels assigned to the Logical Link.

The user can configure the number of frames per packet in the range of 1-128. Basing the payload on a number of frames as opposed to a fixed packet size adds flexibility. It means the packet size varies depending upon the number of TDM channels in use but the Latency remains almost constant.

The number of TDM channels per Logical Link in the range of 1-31 (or 32 in unstructured G.703).

10.3.3 Ethernet Padding

The minimum Packet size for Ethernet is 46 bytes, if the TDM payload is under this size, Padding will be added (not normally used in a PacketBand application).

11. Overheads

The total overhead as a percentage of the payload depends upon a number of factors:

a) The number of channels assigned to the logical link. There is a fixed overhead (due to packet headers) for each Logical Link, so maximising the number of channels per logical link minimises the overhead percentage.

b) The protocol selected. PacketBand supports a number of different packet network protocols. The user's choice for a particular network will be constrained by the network infrastructure. Each packet transmitted on each logical link consists of Ethernet packet headers and protocol packets headers as shown in Section 10.

Patapsco have available an Excel spreadsheet which identifies overhead percentages and latency under different settings. Please contact Patapsco or your distributor.

By way of an illustration, With a 20 Frames per packet giving a Packetisation delay of 2.5msecs the overhead for 8 timeslots (512k) is 25% and for 31 timeslots 6%. For the same speeds but with a Packetisation delay of 10msecs the overheads are 6% and 2% respectively.

12. Latency

The extra latency that PacketBand adds to the process through its own silicon and systems is very low, in the area of 0.5msecs end-to-end. The actual end-to-end latency consists of this small PacketBand element, the time taken to build the packet (which depends on the number of timeslots channels and the size of the packet), time to cross the network, the time to pass through the receive jitter buffer and again the small PacketBand processing delay.

PacketBand allows the jitter buffer size to be configured. The jitter buffer size is a trade-off between minimising latency and maximising the amount of packet delay variation that can be handled.

13. IP and MAC Address

PacketBand uses a single IP and MAC address.

PacketBand can be configured with a default gateway IP address to support IP connectivity beyond the LAN.

14. Call Signalling

TDM Logical Links do not require any call signalling. They are established via the DbManager by specifying the remote unit's packet addresses.

15. Scedules

Calls can be established permanently 24/7, or when required using a scheduling which "opens" and "closes" or "resizes" the link based on day and time.

16. Management

PacketBand can be Locally or Remotely configured using Patapsco's DbManager GUI software.

Connection can be via:

- PC serial port
- Wide area Packet Network
- Local LAN

The DbManager is a sophisticated but simple-to-use intuitive Graphical User Interface (GUI) which controls, configures and monitors individual Patapsco units and complete networks. PC-based it can also generate SNMP Traps and Alarms.

The DbManager supplied with PacketBand allows control and visibility of a single PacketBand at any one time via a single PC. Other cost-options support multiple real-time PC work-stations, multiple PacketBands and other features such as SNMP Traps & Alarms. Please ask for information.

PATAPSCO Communications

17. Statistics

A wide number of statistics are available and some are shown below:

For each logical link:

- Whether in use or not
- Destination address resolution status
- Number of channels in use
- Jitter buffer length
- Average, max and min jitter buffer loadings
- Average network PDV
- Number of discarded early and late packets
- Number of underruns

For each Ethernet port:

- Number of packets received
- Number of packets transmitted
- Number of receive/transmit failures

18. Power

Internal supply
Standard IEC connector
Auto sensing, 100-240 VAC 15W
Max consumption 0.13Amps RMS @223VAC

19. Dimensions & Environment

Metal chassis and front/rear panels
W 292mm
D 200mm
H 44mm (including detachable feet) or 1rack unit
Weight 1.07kg
Optional 19” rack mounting kit available.
Temperature 0-45°c
Humidity 10-90% non-condensing

20. Maintenance

There are no serviceable parts or maintenance required

21. Approvals/Standards

21.1 Telecoms

TB12/TBR13
TIA/E1A-IS/968
TNA117
AS-ACIF S006/S016

21.2 EMC

EN55022:1998
EN 55024: 1998
EN 61000-3-2/3: 1995
AS/NZS CISPR22:2000

21.3 Safety standards

EC EN60950-1:2002
ACA TS001:1997
ACS/NZS60950:2000
AS/NZS3260:1993

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