

## IPTube Protector OPTION -PRO

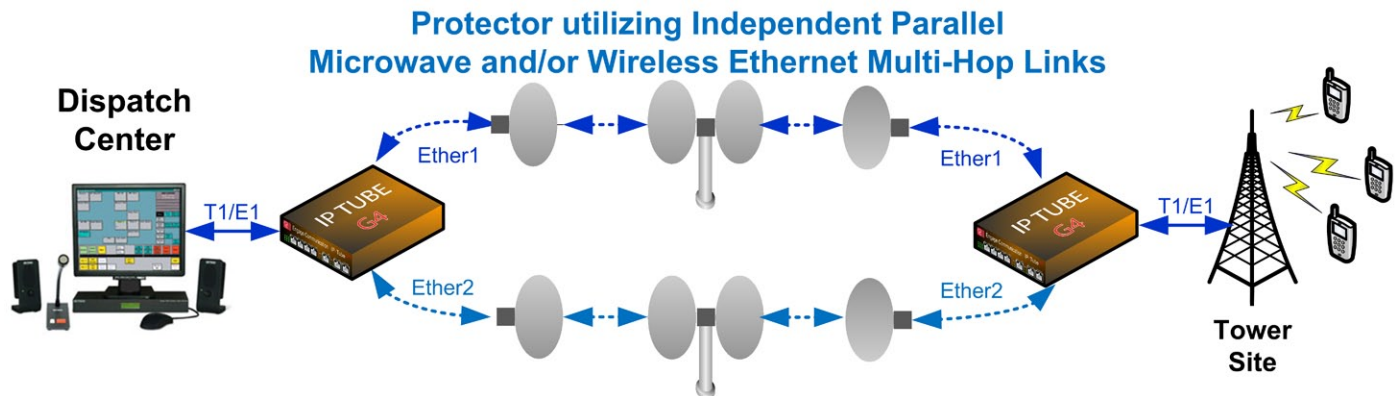
The Protector option provides for automatic protection of a T1/E1 circuit over independent IP packet routes. The IPTube converts T1/E1 circuits into sequential IP packets. The IPTube Protector when activated, which can be configured to **Always-On** or **On-Demand** with switch over criteria, sends sequentially duplicate IPTube packets onto a second Ethernet LAN interface.

The need to Protect Critical Communications is in high demand for the following applications:

- Public Safety Network Redundancy for: Police, Fire and Medical
- Auto Recovery for Military Communication
- Delivering on Service Level Agreements
- Resilient Cellular Backhaul

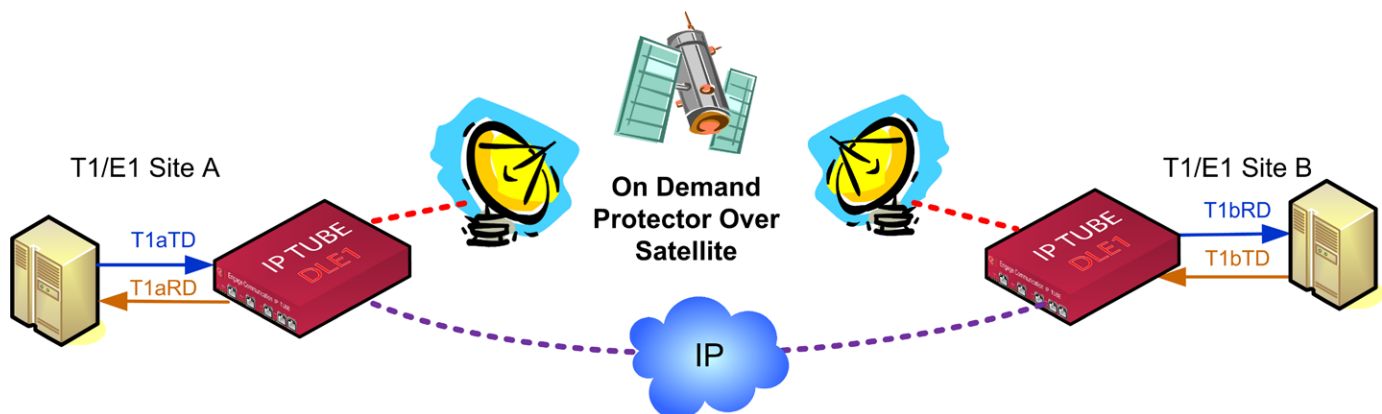
### Always-On

The Protector in **Always-On** mode sends the converted T1/E1 circuit's packet sequence simultaneously onto the IP-Tube LAN1 and LAN2 interfaces. A packet sequence disruption, as long as it does not occur to the same sequence number and the Tube buffering is set to accommodate the LAN1 to LAN2 packet latency skew, will not cause a T1/E1 circuit interruption. The conversion of the TDM over IP packets back into T1/E1 circuit frames takes the next sequence number from LAN with the quickest arrival.



### On Demand Protection

The Protector supports the use of an on demand backup over a second IP packet network connection. The reasons to use an on demand connection can be for cost or bandwidth reasons. For example the use of IP service over a Satellite connection is expensive and should be only activated when the primary connection has failed. An individual low latency Full E1 over IP connection, that is not optimized, requires 2.5 megabits per second. Putting this much bandwidth on an already busy network to support fault tolerance when the primary T1/E1 circuit over IP connection is fully functional can be a waste of bandwidth for most TDM Over IP applications.



### Switch Over Criteria

The IP•Tube Protector offers a fail over path to LAN2 if the LAN1 link quality reaches an unacceptable level. The link quality is determined by a set of configurable factors. When the link quality returns to an acceptable level, the IP•Tube data path returns to LAN1.

The Protector monitors incoming packets for link quality over a period of time. Incoming packets are monitored for percentage of expected packets actually received, the number of packets received out of sequence, the number of times the serial transmit buffer overflows, and the number of times the serial transmit buffer underruns. The threshold for each are independently configured. If any are exceeded during a PollingPeriod, the Protector fails over to LAN2.

When failed over to LAN2, the Protector continues to monitor LAN1. If over a period of time the quality of incoming packets meets all the configured thresholds, the IP•Tube switches back to LAN1. If the IP•Tube loses the link on the LAN1 port (i.e. the cable is pulled), the Protector immediately fails over to LAN2. While failed over to LAN2, the Protector monitors LAN1 and LAN2 for the configured thresholds. If over a Qualification period of time LAN1 has better link quality than LAN2, the Protector switches back to LAN1. This is done even if LAN1 has not met the threshold criteria. Thus the Protector always switches back to LAN1 if the LAN2 link quality is worse than LAN1.

When the Protector fails over to LAN2, it is only altering its receive path. It requests the remote IP•Tube Protector to begin transmitting on LAN2, but does not itself begin transmitting on LAN2. It would only do so if the remote IP•Tube had determined to fail over and requested the local IP•Tube to begin transmitting on LAN2. Thus the Protector on each IP•Tube operates in an independent, uni-directional mode. When its LAN receive link quality degrades, it asks to receive on a different path.

The state of the Protector can be determined by displaying the output of the Show Info command. The Protector Receive Port is the LAN on which the IP•Tube is receiving, a determination made by the local IP•Tube Protector. The Protector Transmit Port is the LAN on which the IP•Tube is transmitting, a determination made by the remote IP•Tube Protector.

When the Protector fails over to LAN2 there may be a small delay between the time it switches to receiving on LAN2 and the time the remote Protector actually begins transmitting on LAN2. This delay can cause a brief loss of service and can be eliminated by turning Tube Protector Hardswitch Off. In that case, the Protector always transmits on LAN2 making the data on the failover path constantly available to a remote Protector.

### Enhanced Mode Protector Option

Enhanced Mode, optional, is designed to accommodate the packet arrival delay that can occur between LAN1 and LAN2 packet networks. Buffering is added to the faster path so that packet loss on one link is replaced with a packet from the other link without a fault. Enhanced mode is specifically designed to work with the difference between Satellite and Terrestrial network delays. Interoperability requires receiving IPTube also be configured for Enhanced Mode since Enhanced Mode uses 16 bit sequence numbers. The Secondary Queue from LAN2 provides redundancy for LAN1 packet loss or outage. Buffers are synchronized with LAN1 buffer to hold up to 500 milliseconds of delay from LAN1.

### Considerations for Network Conditions

If there are asymmetrical conditions on a network, there may be instances where a local IP•Tube has failed over to LAN2, but the remote IP•Tube has not. If LAN1 and LAN2 have a difference in packet delay, there is a corresponding difference in packet sequence number between LAN1 and LAN2. If the difference in packet sequence number is sufficiently large, when switching to LAN1 or LAN2 there may be a very brief loss of data as the IP•Tube must synchronize to the packet sequence of the new data stream.