Solutions to Packet Per Second Satellite Throughput Limitations

All IP routing devices have a limit that is often overlooked when planning a network. This is particularly true when designing a voice and data network using satellite modems with IP interfaces. All modems using IP are a form of router and all routers have a limit to the number of packets per second (PPS) that they can switch.

For many IP satellite modems the PPS throughput can be around 700 PPS. For a data only system this is rarely a problem. IP data only networks normally have large packets traversing them. If the packets are close to the MTU[i] size, even a 1Mbps link only supports 86 PPS. A fully utilized 1Mbps link with packets averaging 25% the size of the MTU still has a packet throughput well below the modem limit.

The PPS limit creates an often-unanticipated problem when compressed voice is brought on to the network. Compressed voice packets are small, very small when compared to the MTU size. Excluding the LAN header, a G.729A codec[ii] generates fifty, 60-byte packets per second for each voice call[iii]. With as few as ten voice calls, a satellite modem can approach its PPS limit. With fifteen calls many satellite modems will have exceeded the PPS limit, even though the bandwidth required to support these calls is less than 512Kbps.

The issue is further compounded by what happens to voice quality when the PPS limit is exceeded. In most cases the satellite modem discards the excess packets. Unlike data, because voice is a real-time application, voice packets cannot be usefully re-transmitted, so the packets are lost. This causes a severe degradation in voice quality. The voice calls become “choppy” as gaps are introduced into the audio stream. This is unacceptable to most users and gives rise to the belief that VoIP over satellite is a poor substitute for normal telephony. Similar effects may also be encountered if voice is not given prioritization on a mixed voice and data connection.

NSGDatacom provides a solution known as Frame Packing. Frame Packing addresses this problem by combining many small packets into larger ones. This allows multiple voice calls to be supported by each packet effectively reducing the number of packets per second being transmitted through the satellite modem.

The Frame Packing mechanism operates by maintaining separate queue buffers for each voice and data stream. When building outbound IP packets, each queue associated with a specific destination is examined for voice (or data) packets. If there is a packet in an appropriate outbound queue, unnecessary header information is stripped and the payload is placed into an outbound “Super Packet” for transmission. This will continue until either all the queues have been examined, or the MTU size has been reached.

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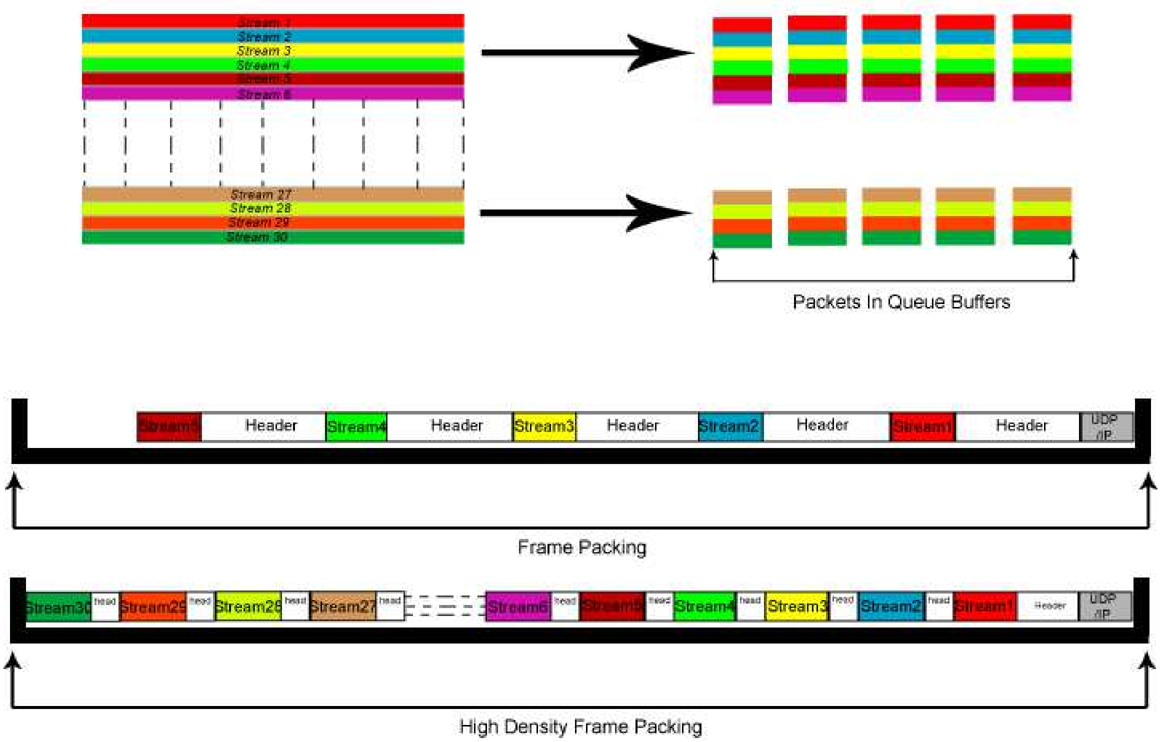
The diagram below illustrates this process.

Frame Packing



Operating results displayed in the bar chart below clearly illustrate how the benefits of Frame Packing can be very significant when compressed voice is introduced onto a satellite network.

The first two columns illustrate how the use of uncompressed PCM (G.711) voice, as deployed by a number of widely used VoIP services today, is barely affected by the modem PPS limitation on a 1Mbps satellite link. In this case the addition of Frame Packing allows the number of voice calls to be increased from 11 to 13, in both instances filling the link to capacity without hitting the modem packet throughput limitation. The useful (18%) advantage provided by Frame Packing in this example is due to efficiency gained from eliminating unnecessary packet overhead in the Super Packet. (Note that a 20ms sample rate is assumed here. If a 10ms sample rate is used, the number of calls supported without Frame Packing is only 5, increasing to 13 with Frame Packing).

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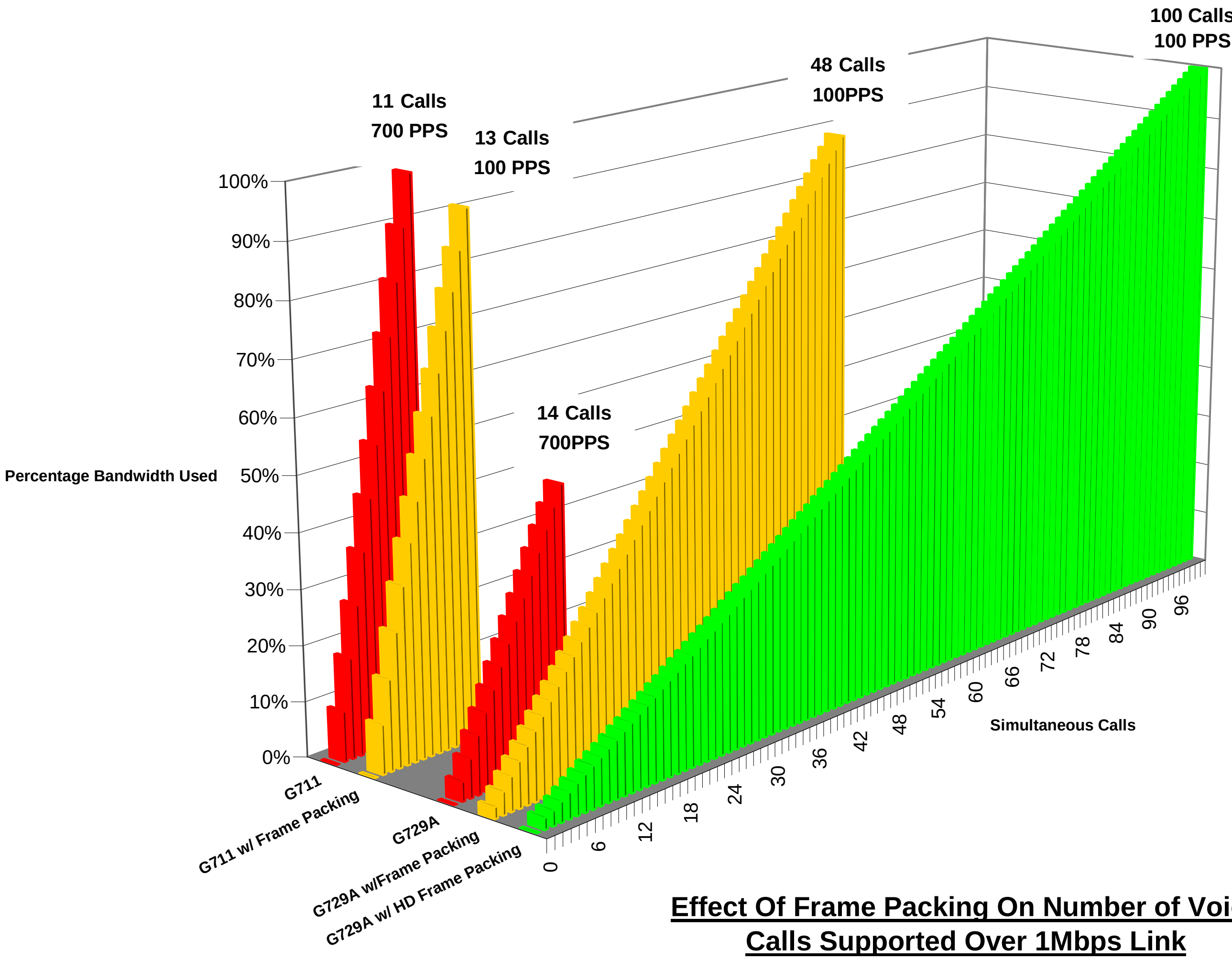

Effect Of Frame Packing On Number of Voice Calls Supported Over 1Mbps Link

The last three columns show a completely different story. In this case the high rate of small packets generated by standards-based G.729A VoIP quickly saturates the PPS capability of the satellite modem. Now a maximum of only 14 voice calls can be supported over the 1Mbps satellite link before the modem PPS capability is exceeded, leaving more than 50% of the link capacity unused and unavailable to the user. The next column illustrates that by using Frame Packing and standard RTP (Real Time Protocol) header compression, the number of voice calls is more than doubled and can fill the link to capacity without coming close to the PPS limit of the modem.

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The final column shows how High Density Frame Packing extends this advantage even further; allowing the number of standards based VoIP calls to be more than doubled again, without any increase in the number of packets being transmitted.

The chart clearly highlights a major benefit of High Density Frame Packing, which is minimizing the packet overhead on the satellite link. In standard VoIP packets the compressed voice payload is normally much smaller than the packet overhead itself, so that around two thirds of the link capacity, is lost to the headers[iv]. By packing just the payload of these small packets into a larger packet and regenerating the header information at both ends of the link, the loss due to headers is minimized and link efficiency is substantially increased. (Note that the advantage gained using RTP header compression[v] only is minimal by comparison).

The High Density Frame Packing solution of NSGDatacom's Nx2200 Series Products use patented techniques to combine multiple voice and data packet streams into fewer, larger packets optimized for the modem MTU. Tightly integrated voice gateway and Frame Packing functions enable enhanced capabilities that further extend the service capability of satellite modems with PPS limitations. These include:

1. Automatic priority of voice over other data traffic,
2. Allow unused portions of Super Packets to be used for other data.
3. Additional compression techniques to further increase voice capacity beyond the above examples.

Although not widely published, the PPS limit for a satellite modem has to be taken into consideration when designing high quality VoIP and mixed voice/data networks. Frame Packing solutions overcome packet throughput limitations and extend the capability of many low cost satellite modems, ensuring the highest quality service for the maximum number of calls.

When implemented with NSGDatacom's patented voice compression and High Density Frame Packing techniques, the Nx2200 series products provide the user with a unique cost effective implementation of voice and data over satellite.

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i MTU: Maximum Transmission Unit, the maximum packet size for the link. Commonly this is 1500 bytes.
ii This is a common codec used for SIP VoIP.
iii 20msec sample rate.
iv IP, UDP, RTPand LAN encapsulation adds 58 bytes to the 20 byte G.729A payload. VLAN adds a further 4 bytes of overhead
v As defined in RFC2508 the RTP header is compressed from 12 to 4 bytes.

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