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White Paper

TI G-plus (802.11g+) Performance-Enhancing Technology

Wireless LAN Business Unit
Texas Instruments

What is G-plus?

Today's data-centric wireless LAN (WLAN) spotlight is concentrated on pure speed, leading to an explosion of proprietary throughput technologies and an equally prolific set of "on-the-box" claims. With the emergence of new applications for WLANs, however, this focus is already widening to encompass better quality-of-service (QoS), broader coverage, higher interoperability and enhanced power consumption.

G-plus from Texas Instruments, part of TI's "Plus" family, is an evolving lineup of performance enhancements for 802.11g. G-plus is standard-friendly, composed of advanced features derived from draft IEEE 802.11 standards and proprietary features that co-exist with 802.11. TI drives many of the new WLAN standards in the IEEE, enabling TI to remain at the forefront of WLAN technologies and to continuously incorporate new features into G-plus.

G-plus is not limited to the speed dimension but comprises the full spectrum of features that WLAN users will demand today and tomorrow, such as TI's industry-leading Enhanced Low Power (ELP)™ technology.

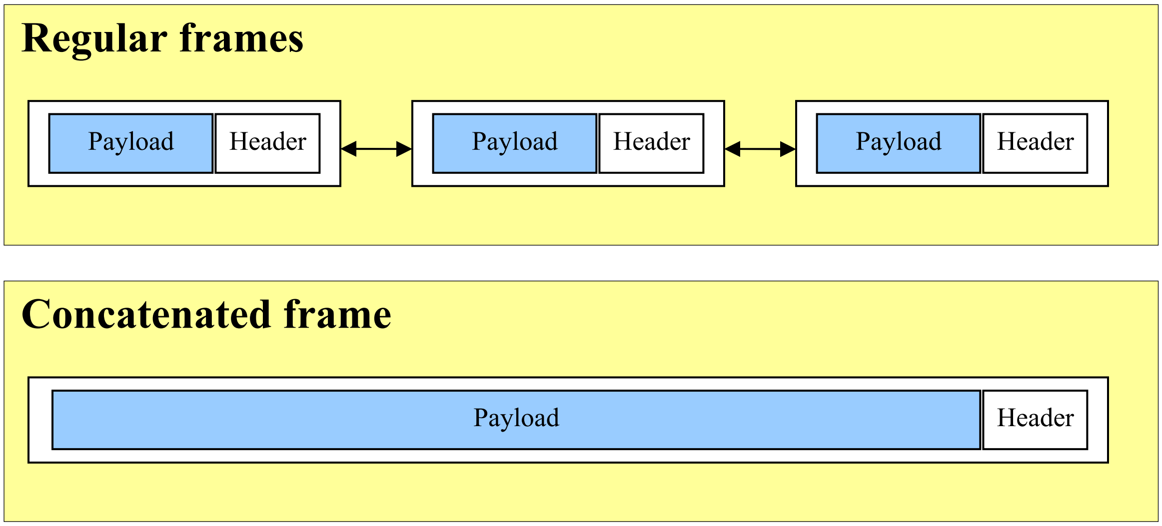
Regarding speed, G-plus increases effective throughput by reducing overhead and maximizing MAC-layer capacity, thereby improving the efficiency of the wireless network. Better network utilization enables a better experience for data users, and it also paves the way for QoS-dependent technologies such as video and voice-over-WLAN.

The 54-Mbps top physical layer rate for 802.11g is misleading. Standard 802.11g supplies only a fraction of this rate to the user, roughly 15 Mbps in 54-Mbps mode. Utilizing schemes such as frame concatenation and packet bursting, TI's 802.11g+ can supply ~35-Mbps effective throughput, more than twice the rate of standard 802.11g.

Frame Concatenation

Frame concatenation (also called packet aggregation and packet concatenation) combines multiple 802.11 frames together, increasing throughput by reducing protocol overhead.

More specifically, frame concatenation increases the size of the MAC Protocol Data Unit (MPDU) transmitted over the WLAN, enabling TI-based 802.11g+ products to send packets 4000 bytes long – almost three times longer packets than typical 802.11 packet lengths. TI's driver disables frame concatenation when data-rates go below 11 Mbps since longer packets at slower rates increase transmission times.



In addition, G-plus frame concatenation operates seamlessly with any 802.11b/b+ or 802.11g product from TI or any other vendor. Although the direct gains of frame concatenation are realized only with TI 802.11 at both ends of a WLAN connection, the benefits of improved network efficiency can be experienced by all users on the network because faster throughput reduces the time that the wireless channel is in use.

How Does Frame Concatenation Work?

The basic structure of a frame transmitted over a WLAN consists of a PLCP preamble (18 bytes), PLCP header (4 bytes) and MPDU. The MPDU contains 24 or 30 bytes of MAC header information preceding the data portion of the frame, followed by 4 bytes of FCS.

The total overhead of bytes that must be transmitted per MPDU is composed of PLCP preamble, PLCP header, MAC header and FCS and is equal to 50 (or 56) bytes of overhead per transmitted frame. For minimum-sized data frames (e.g. the 64-byte minimum used in 802.3 Ethernet frames), this means nearly half the transmitted bytes on the air are overhead. Furthermore, after each MPDU is transmitted, an additional delay occurs due to 802.11 MAC protocol definitions.

The frame concatenation feature of G-plus:

- significantly increases data throughput
- maintains the order of data sent
- allows dynamic decisions to be made as to whether or not frame concatenation should be applied to outgoing frames

The ability to dynamically decide if frame concatenation is necessary allows for the immediate transmission of a frame if that frame is the only one queued for a specific destination. At the same time, frame concatenation guarantees the coexistence of concatenated traffic with non-concatenated traffic for legacy equipment that does not support G-plus frame concatenation.

The basic principle of the frame concatenation algorithm is to send multiple MSDUs destined for the same destination address (DA) in a single MPDU. Frame concatenation is applied only to unicast data frames. Management, control and multicast frames are excluded from the frame concatenation algorithm and transmitted as individual frames.

The current G-plus implementation supports a maximum concatenated MPDU size of 4K bytes. In order to optimize the number of MSDUs that can be packaged in a concatenated MPDU, the MTU reported by the driver to the operating system is 1300 bytes.

Aggressive Network Access

Aggressive network access is an important complement to frame concatenation, in that it increases the probability a G-plus frame gains access to the WLAN by reducing the size of the 802.11 contention window to the size recommended for 802.11g. In addition, aggressive network access manages the host waiting queue on the AP.

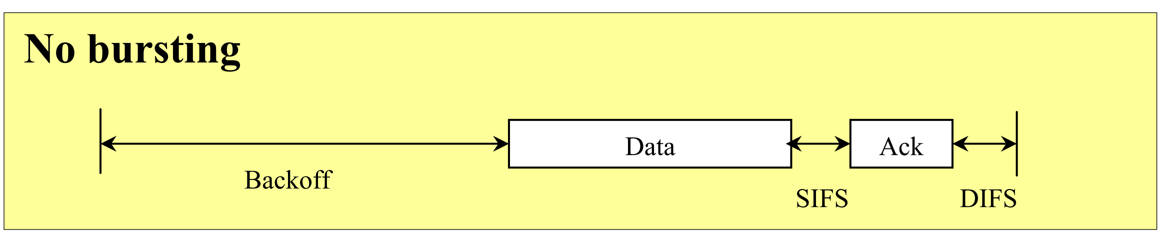
Packet Bursting

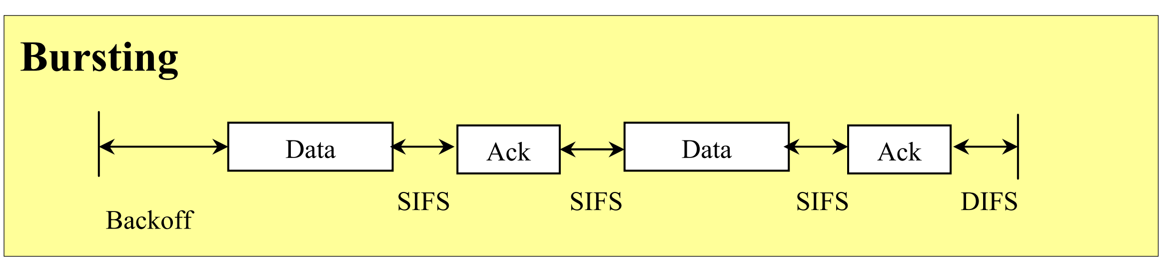
Packet bursting increases throughput (when communicating with 802.11a, 802.11b and 802.11g-compliant devices) by reducing the overhead associated with the wireless transmission. Packet bursting is a transmission technique and an early implementation of 802.11e/WME TxOp continuation.

How Does Packet Bursting Work?

In a burst transmission, the interframe spacing is reduced, and a new data frame is sent after a Priority Interframe Spacing (PIFS) period. In a standard transmission, frames are separated in time by a Distributed Interframe Space (DIFS) period and then a random back-off period. After a successful data transmission, this process repeats.

Packet bursting protects the entire burst with a single CTS protection frame in a 2.4-GHz mixed network. The overhead of contending for the medium and the interframe spacing is reduced. Burstiness is assured since the interframe spacing is such that no other device can interfere during a burst transmission.





Packet Binary Convolutional Code™

G-plus includes TI's Packet Binary Convolutional Code (PBCC)™ technology for backward compatibility with legacy 802.11b+ products.

Conclusion: The Future of G-plus

In the future, many of the existing G-plus enhancements will be rolled into official standards such as 802.11e. In the meantime, Texas Instruments will continue to advance standard-friendly G-plus technology with range enhancements and further improvements in throughput, coverage, quality-of-service and power consumption.

For more information, visit the Texas Instruments Web site:
www.ti.com/wlan