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Technology Overview
The Canopy System & Dynamic Time Synchronized Spreading (DTSS)

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WHITE PAPER

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LIST OF ACRONYMS

AP	Access Point
BER	Bit Error Rate
C/I	Carrier to Interference
DSSS	Direct Sequence Spread Spectrum
DTSS	Dynamic Time-Synchronized Spreading
FHSS	Frequency Hopping Spread Spectrum
FSK	Frequency Shift Keying
GPS	Global Positioning System
MAC	Media Access Control
QOS	Quality of Service
RF	Radio Frequency
TDD	Time Division Duplexing
TFS	Transmit Frame Spreading

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INTRODUCTION

This document describes Dynamic Time-Synchronized Spreading (DTSS) Motorola's patented high-speed wireless communications technology used in the Canopy™ wireless broadband access products. DTSS technology makes the Canopy system one of the most reliable and scalable broadband wireless access solutions available in the world today. DTSS enables a low-cost wireless broadband solution that is also *fast, reliable and scalable*.

THE CANOPY DTSS SYSTEM

DTSS combines the best elements of the latest Radio Frequency (RF) modulation, synchronization and interference handling techniques available and packages them into an incredibly small, low-cost radio system. The result is a fast, reliable, scalable and cost-effective solution that boasts performance characteristics that rival all other wireless broadband systems.

DTSS MODULATION

The RF modulation element of DTSS consists of a wideband high-speed Frequency Shift Keying (FSK) modulated signal. FSK is a modulation technique for transmitting data in digital format over an analog carrier. FSK involves shifting the frequency level of the carrier. The wideband aspect of the modulation results in higher processing gain — *or lower power density* — than comparable Frequency Hopping Spread Spectrum (FHSS) or Direct Sequence Spread Spectrum (DSSS) systems. This means that the modulated DTSS signal is less likely to cause harmful interference to other systems sharing the same spectrum.

By the same token, DTSS makes the radio system less susceptible to harmful interference from other systems in the same spectrum. This is reflected by the low Carrier to Interference ratio (C/I) required by the Canopy system. The Canopy system's 2 to 3 dB C/I indicates that the DTSS signal needs to be only twice as strong as any interfering signal to operate properly. Other systems require C/I of 10 dB and above, meaning that their signals need to be ten times stronger — *or more* — than the surrounding interference to operate properly. The bottom line is that DTSS makes the Canopy radio platform one of the most reliable systems available today.

The high-speed aspect of DTSS modulation delivers user speeds upwards of 6 Mbps for truly *fast* broadband service. In contrast, residential cable Internet and DSL services typically top out between 256 Kbps to 1.5 Mbps.

TRANSMIT FRAME SPREADING

Another key element of DTSS is Transmit Frame Spreading (TFS). With TFS, the central transmitter — *or Access Point (AP)* — transmits beacon signals on pseudo-random frames. This enables multiple APs to address multiple receivers in the same geographic area without interfering with each other. Not only does TFS make a Canopy system more reliable but also more scalable. As the number of subscribers grows in a given geographical area, additional Canopy APs can be easily added to handle the increased

subscriber load. In addition, multiple independent Canopy systems can operate in the same frequency spectrum and in the same geographic area. This is a critical capability required to effectively operate in the unlicensed frequency bands.

GPS SYNCHRONIZATION

DTSS uses synchronization via the Global Positioning System (GPS) to tightly control and coordinate transmit and receive times for all of the components in the Canopy network. GPS is the satellite system deployed by the U.S. military to accurately position and locate objects anywhere on Earth. A side benefit of GPS is that it also provides a highly accurate timing signal.

DTSS uses this GPS timing signal to schedule communications and, more importantly, to accurately determine when transmitters should transmit and receivers should receive. This latter concept is absolutely critical in Time Division Duplexing (TDD) deployments, where the outbound and inbound transmissions occur over the same frequency, but in alternating fashion. This accurate timing makes sure that no transmitter is transmitting when it should be receiving, and vice versa, eliminating what is known as self-interference.

The absence of self-interference on the Canopy system also means that the APs will not interfere with each other even when placed within close proximity to each other such as in a dense urban environment. On the other hand, TDD systems without synchronization may work well in isolation but as the number of subscribers increases self-interference prevents those systems from adding APs to handle the additional load. In the end, GPS synchronization delivers a more *reliable* and *scalable* system.

DTSS MEDIA ACCESS CONTROL

Another key element of DTSS is its Media Access Control (MAC) layer, the method used to assign the available radio resources to transmitters and receivers. DTSS has a central controller — *the AP* — coordinating when each subscriber can send information. The AP acts like a teacher and requires subscribers *to raise their hand* and get permission before being allowed to talk.

Other wireless systems, such as 802.11 based WiFi systems, use a contention or collision-based mechanism. In this scheme subscribers are allowed to talk any time they want. However, if more than one subscriber talks at the same time the message is discarded and each subscriber waits and tries again later. This mechanism is sufficient in an indoor environment where a relatively small number of subscribers are using a network. In an outdoor environment, however, the system's performance quickly degrades as more subscribers are attempting to communicate at the same time.. The DTSS MAC layer makes the Canopy system more *reliable* and *scalable*.

SHORT PACKETS

The Canopy DTSS system breaks down incoming data into small fixed-length packets before transmission. This means that any transmission errors are corrected quickly by retransmitting only the affected short packets. In contrast, systems with long packets must wait until the entire packet is received before discovering that the packet contains errors.

When this occurs, the entire long packet must be retransmitted. The requirement to retransmit the entire long packet often results in significant degradation to the system's overall performance.

Short packets enable the Canopy system to operate at much lower fade margins for the same Bit-Error Rate (BER) than comparable systems. Short packets are also critical to the Canopy system's ability to deliver voice Quality of Service (QOS) on all subscriber modules throughout the network. In the end, short packets make the Canopy system *faster* and more *reliable*.

ANTENNA TECHNOLOGY

DTSS incorporates several patented antenna techniques that add speed, reliability and scalability to the Canopy wireless broadband system. These include directional antennas for reduced fading, spatial equalization and best in class frequency re-use.

CONCLUSION

The key design goal in Motorola's DTSS system was simplicity and economy. Through Motorola's innovation, these design goals have brought forth an extremely *fast*, *reliable* and *scalable* radio system: The Canopy Wireless Broadband Access system.

ADDITIONAL INFORMATION

For additional information on the unique way the Canopy system delivers the most scalable and reliable performance in the unlicensed frequency band, see "*Controlling Interference: The Motorola Canopy Approach* and *Performance in Broadband Wireless Access Systems"* available for download in the Canopy Library at www.motorola.com/canopy

For additional information on the Canopy systems QOS capabilities and what it means to system performance, see *"Performance in Broadband Wireless Access Systems"* available for download in the Canopy Library at www.motorola.com/canopy

For information on what makes the Canopy System the most secure broadband wireless solution on the market, see *"Security and the Motorola Canopy Wireless Platform"* and *"Advanced Encryption Security Overview"* both available for download in the Canopy Library at www.motorola.com/canopy