TeleBench™ Version 1.1 Benchmark Name: Bit Allocation

Highlights

- **Benchmarks part of a DSL modem that uses discrete multi-tone (DMT) technology**
- **16 bit fixed point (integer) code**
- **Multiple (3) data sets**
- **Largely Integer Math with memory accesses, fits inside small L1 caches but based on a real algorithm in a real application**

Application

This benchmark performs a Bit Allocation algorithm for digital subscriber loop (DSL) modems that use discrete multi-tone (DMT) technology. The benchmark provides an indication of the potential performance of a microprocessor in a DMT based DSL modem system.

DMT modulation partitions a channel into a large number of independent subchannels (carriers), each characterized by a signal to noise ratio (SNR). A bit allocation algorithm is thus required to allocate a number of bits to these carriers according to the measured SNR of each carrier.

Benchmark Description

The benchmark initializes the number of carriers, which come from different data sets (256, 100 and 20). The SNR profile in dB for the carriers is contained in a 16-bit input array (CarrierSNRdB). The range of Carriers' SNR in dB, [-64.0, 63.998] (float), is represented by the range [-32768, 32767] in fixed-point format. The total number of bits (BitsPerDMTSymbol) is allocated to the carriers by using a "water level" algorithm: each carrier is compared with a "water level". Carriers whose SNR is below the water level have no bits allocated to them. Carriers with an SNR above the water level have bits allocated to them in proportion to the difference between the water level and that carrier's SNR. The maximum number of bits which can be allocated to a carrier is defined as MAX_BITS_PER_CARRIER. If the difference between a carrier's SNR and the current water level is larger than or equal to 32767, MAX_BITS_PER_CARRIER bits will be allocated to the carrier. Upon the start of the benchmark, the maximum SNR of the carriers is saved as the initial water level.

The exact number of bits allocated to a carrier for a given delta from the water level is given by the allocation map array. This array is a pre-computed look-up table whose values range from 0 to MAX_BITS_PER_CARRIER.

The total bit allocation is clamped to the "Bits Per DMT Symbol", BPDS. This means that some carriers near the end of the allocation will have fewer or no bits allocated to them than the above calculation would assign. This is handled as follows to insure convergence: if the sum of the bits to be allocated to a carrier (CarrierBits) and the bits that have been allocated before to the carrier (TotalBits) are larger than the total bit allocation (BitsPerDMTSymbol), then the "CarrierBits" will be set to the difference between the "BitsPerDMTSymbol" and "TotalBits".

If, for a given water level, fewer than BPDS bits are allocated, the water level will be lowered. The amount that the water level is lowered is proportional to the number of remaining bits, and inversely proportional to the number of carriers. The allocation is then performed again from the beginning with the new water level.

A single iteration of the benchmark is complete when all BPDS bits are allocated for a given water level. Upon exit, allocation results are returned in the 16-bit output array: CarrierBitAllocation and the final water level in dB are stored at “WaterLeveldB_out”.

Analysis of Computing

The Bit Allocation benchmark performs integer math on 16 bit signed quantities (e.g., the DeltadB and TotalBits calculation) as well as shift and logical compare operations (Water level

Resources	comparison, etc.). These operations and accessing the data from memory are primarily what is tested by this benchmark. The buffer sizes in memory are relative small, which tend to take up residence in cache; therefore, this benchmark has a high cache hit rate for microprocessors with 16KB of Data Cache. The code size is small and easily fits in a small L1 Instruction Cache.
Special Notes	1. Each of the three packet sizes must be run to obtain an EEMBC Telemark™ score.