1040. Technical Note

"COMPOSITE THEORETICAL PERFORMANCE" (CTP)

Abbreviations used in this Technical Note

CE	"computing element" (typically an arithmetic logical unit)
FP	floating point
XP	fixed point t execution time
XOR	exclusive OR
CPU	central processing unit
TP	theoretical performance (of a single CE)
CTP	"composite theoretical performance" (multiple CEs)
R	effective calculating rate

Execution time 't' is expressed in microseconds, and CTP is expressed in Mtops (millions of theoretical operations per second).

CTP is a measure of computational performance given in millions of theoretical operations per second (Mtops). In calculating the "Composite Theoretical Performance" (CTP) of a configuration of Computing Elements (CEs) the following three steps are required:

1. Calculate the effective calculating rate R for each CE;
2. Apply the word length adjustment to this rate, resulting in a Theoretical Performance (TP) for each CE. Select the maximum resulting value of TP;
3. If there is more than one "computing element", combine the TPs resulting in a "Composite Theoretical Performance" for the configuration.

NOTE:
This aggregation should not be applied to computers connected through a decontrolled "local area network".

The following table shows the method of calculating the Effective Calculating Rate R for each Computing Element:

For Computing Elements (CEs) Implementing:	Effective calculating Rate, R
XP only (R_{xp})	$\frac{1}{3 * (t_{xp\ add})}$ if no add is implemented use: $\frac{1}{(t_{xp\ mult})}$ If neither add nor multiply is implemented use the fastest available arithmetic operation as follows: $\frac{1}{3 * t_{xp}}$ See Notes X & Z
FP only (R_{fp})	$\text{Max}\ \frac{1}{t_{fp\ add}}, \frac{1}{t_{fp\ mult}}$ See Notes X & Y
Both FP and XP (R)	Calculate both R_{xp}, R_{fp}
For simple logic processors not implementing any of the specified arithmetic operations.	$\frac{1}{3 * t_{log}}$ Where t_{log} is the execution time of the XOR, or for logic hardware not implementing the XOR, the fastest simple logic operation. See Notes X & Z
For special logic processors not using any of the specified arithmetic or logic operations.	R = R' * WL/64 where R' is the number of results per second, WL is the number of bits upon which the logic operation occurs, and 64 is a factor to normalize to a 64 bit operation.

Note X: For CEs which perform multiple arithmetic operations of a specific type in a single cycle (e.g., two additions per cycle), the execution time t is given by:

$$t = \frac{\textit{cycle time}}{\textit{the number of arithmetic operations per machine cycle}}$$

CEs which perform different types of arithmetic operations in a single machine cycle are to be treated as multiple separate CEs performing simultaneously (e.g., a CE performing an addition and a multiplication in one cycle is to be treated as two CEs, the first performing an addition in one cycle and the second performing a multiplication in one cycle).

If a single CE has both scalar function and vector function, use larger value.

Note Y: If no FP add or FP multiply are implemented, but the CE performs FP divide: $R_{fp} = \frac{1}{t_{fp\ divide;}}$

If the divide is not implemented, the fp reciprocal should be used.

If none of the specified instructions is implemented, the effective FP rate is 0.

Note Z: In simple logic operations, a single instruction performs a single logic manipulation of no more than two operands of given lengths.

In complex logic operations, a single instruction performs multiple logic manipulations to produce one or more results from two or more operands.

Rates should be calculated for all supported operand lengths, using the fastest executing instruction for each operand length based on:

1. Register-to-register. Exclude extraordinarily short execution times generated for operations on a predetermined operand or operands (for example, multiplication by 0 or 1). If no register-register operations are implemented, continue with (2).
2. The faster of register-to-memory or memory-to-register operations; if these also do not exist, then continue with (3).
3. Memory-to-memory.

In each case above, use the shortest execution time certified by the manufacturer.

TP for each supported operand length WL

Adjust the effective rate R (or R') by the word length adjustment L as follows:

$$TP = R * L,$$

where $L = (1/3 + WL/96)$

Note: The word length WL used in these calculations is the operand length in bits. (If an operation uses operands of different lengths, select the largest word length.)

This adjustment is not applied to specialized logic processors which do not use XOR instructions. In this case TP = R.

SELECT THE MAXIMUM RESULTING VALUE OF TP FOR:
Each XP-only CE (R_{xp});
Each FP-only CE (R_{fp});
Each combined FP and XP CE (R);
Each simple logic processor not implementing any of the specified arithmetic operations; *and*
Each special logic processor not using any of the specified arithmetic or logic operations.