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Roy Mayhall II's Progressive Bit Distribution (PBD) Summarized Mathematical Theory (Rev. 21, 05-10-2003)

The computation of the progressive bit distribution (PBD) of data sequence s, applying the averaged MDR and SUF data structures (the average of all obtained d_{cd} and v_{cv} values), represented by d and v respectively, understanding there to be more than 1 feasible element in the data sequence, is derived as follows:

$$P(s) = d - dv + \frac{v \cdot \ln\left(1 + d\left(e^{e} - 1\right)\right)}{e}$$

Prior to averaging the MDR and SUF data structures, for each cycle in the data sequence as it is computed, a significance value is obtained representing the length of the current cycle c divided by the default length of the cycle s (c / s). The number of cycles n is incremented by the significance value, and the current cycle value x (MDR or SUF) is multiplied by the significance value before being added onto the accumulated data structure z (MDR or SUF), as follows:

$$n = n + \frac{c}{s} \qquad\qquad z = z + \frac{xc}{s}$$

The maximum size of the MDR cycle s_d and the maximum size of the SUF cycle s_v are expressed in terms of the total number of feasible elements m within the data sequence, with l representing the total size of the data sequence, as follows:

$$s_d = m \qquad\qquad s_v = \left\{\left[l > 2m \therefore 2m\right] \quad \vee \quad \left[l \le 2m \therefore m\right]\right\}$$

In MDR calculation, given a cycle c_d of length s_d, and with x_n denoting the element occurrence rate for each element in the cycle, understanding x_n to be greater than zero, the mean distribution rate (MDR) of the data within this cycle can be expressed as

$$d_{c_d} = \frac{\left|\ln\left(\frac{x_1}{s_d}\right)\right| + \left|\ln\left(\frac{x_2}{s_d}\right)\right| + \left|\ln\left(\frac{x_3}{s_d}\right)\right| + \ldots + \left|\ln\left(\frac{x_n}{s_d}\right)\right|}{s_d \cdot \left|\ln\left(s_d\right)\right|}$$ (If d_{cd} is undefined [division by 0], it is defined as 1)

In SUF calculation, if the current cycle c_v is at least the second cycle in the data sequence (the first cycle's SUF is undefined or 0), then given two cycles (the previous and the current), of lengths s_{v1} and s_{v2} respectively, and with element occurrence rates a_1 and a_2 respectively, with m as the total number of feasible elements within both cycles, and deriving each x_n for each element a_n with each cycle size s_{vn} (where n denotes the subtype 1 or 2) as

$$x_n = \frac{ma_n}{s_{v_n}} + 1$$

then the spectral utilization factor (SUF) of the data within cycle c_v as compared to the previous cycle (c_v - 1) can be expressed as

$$v_{c_v} = \frac{y_1 + y_2 + y_3 + \ldots + y_n}{z_1 + z_2 + z_3 + \ldots + z_n}$$ (If v_{cv} is undefined [division by 0], it is defined as 0)

where each y value is computed as

$$y_n = \left|\ln\left(\frac{x_2}{x_1}\right)\right|$$

and each z value is computed as

$$z_n = \left\{\left[x_1 > x_2 \therefore \left|\ln\left(x_1\right)\right|\right] \quad \vee \quad \left[x_1 \le x_2 \therefore \left|\ln\left(x_2\right)\right|\right]\right\}$$

for as many elements as exist in the current cycle.