Computational Cost Analysis of Block Processing

Let:

- n : Number of state operations per block (each block h consumes a constant amount of gas) so n is constant.
- L_h : Average number of nodes accessed per state operation (intermediate + leaf node).

Per operation:

- Reading time : $T_r = L_r.R \rightarrow T_h operation = L_h(R + N)$
- Writing time : $T_w = L_h.W \rightarrow T_h = n.T_h operation = n.L_h(R + W)$

More data means mode nodes accessed per operations with lead to: $L_h \approx k.\log_{16}(D_h)$ (assuming MPT is balanced)

k: Constant that depends on trie implementation and keys distribution

Which lead to:

$$\boxed{T_h = n.k.\log_{16}(D_h).(R + W)}$$

- The processing time for the block h: $T_h = n.k.\log_{16}(D_h) + (R + W)$
- The processing time for the previous block

$$\begin{gathered} h\text{: } T_h = n.k.\log_{16}(D_h).(R + W) \\ \Rightarrow \frac{T_h}{T_h - 1} = \frac{n.k.\log_{16}(D_h).(R + W)}{n.k.\log_{16}(D_h - 1).(R + W)} \\ \Rightarrow \frac{T_h}{T_h - 1} = \frac{\log_{16}(D_h)}{\log_{16}(D_h - 1)} \\ \Rightarrow T_h = \frac{\log_{16}(D_h)}{\log_{16}(D_h - 1)}.T_h - 1 \end{gathered}$$