Examples of 2–4 search trees

Each node has 1, 2, or 3 virtual addresses.
Non-leaf nodes have 2, 3 or 4 children.
All leaves have the same depth $H$.
Given $H$, what is the min. and max. number of virtual addresses (keys)?

$1 + 2 + 4 + \ldots + 2^H \leq \# \text{ of keys} \leq 3(1 + 4 + 16 + \ldots + 4^H)$

$2^{(H+1)} - 1 \leq \log(\# \text{ of keys}) \leq \approx H \log(2)$

$3*(1/3)(4^{(H+1)}-1) \leq \approx H \log(4)$

Suppose we have 1024 segments, $\log(1024) = 10$

$H \leq 10; \quad H \geq 10/2 = 5$ (since $\log(4) = 2$)

Conclude: When an illegal addr. page fault occurs, the kernel only looks at 5 to 10 nodes to figure out it was illegal.