KN GU

T1.)

a.) Tanenbaum, 5.2.6 (p 366 ff)

- regionalization -> split routers into regions
- router has detailed knowledge about routers in own region
- regions may be aggregated

b.)

Tanenbaum, 5.4 (p 454 ff)

- 1 level (autonomous system ~~....~~ (AS))

  AS 680 (RWTH)

  ↳ AS 1275 (DFN)

- sublevels may exist

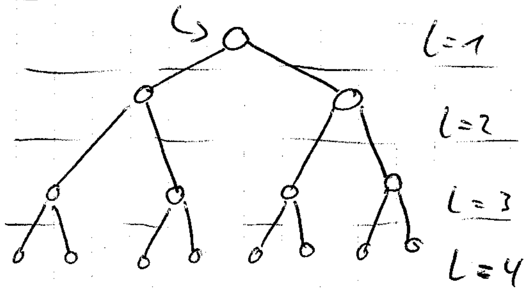
  CGK-...

- relationships differ: peer, transit, multi-homed

c.) Aggregation -> lower complexity -> smaller routing tables

Information hiding -> suboptimal routing

T2.) cluster head



observation

(a.) Node at level L is (L-1) hops ~~away~~ from CH

(b.) Adding a new level approximately doubles the number of nodes in tree.

(c.) Depth of tree $L \approx \log_2(N)$

$$\bar{l} = 0{,}5 \cdot 3 + 0{,}25 \cdot 2 + 0{,}125 \cdot 1$$
$$= \sum_{i=1}^{L} (L-i) \cdot (0{,}5)^i$$

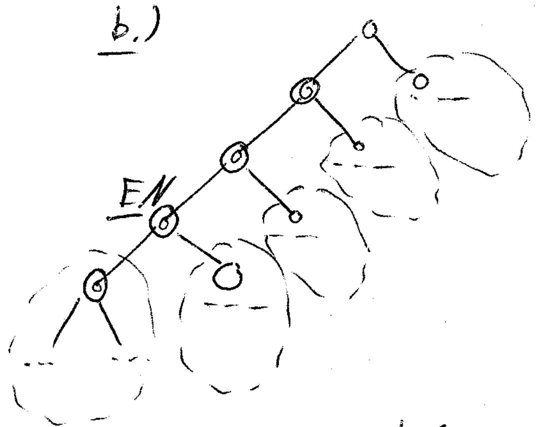
$\underline{L >> 10}$

$$\bar{l} = \sum_{i=1}^{\infty} (L-i)(0{,}5)^i$$
$$= \sum_{i=1}^{\infty} L \cdot (0{,}5)^i - \sum_{i=1}^{\infty} i \cdot (0{,}5)^i$$
$$= L \cdot \sum_{i=1}^{\infty} (0{,}5)^i - \sum_{i=1}^{\infty} i \cdot (0{,}5)^i$$
$$= L \cdot \sum_{i=0}^{\infty} (0{,}5)^i - L - \sum_{i=1}^{\infty} i \cdot (0{,}5)^i$$
$$= L - \frac{0{,}5}{(1-0{,}5)^2} = \underline{\underline{L-2}}$$

$$\sum_{i=0}^{\infty} (x)^i = \frac{1}{1-x}$$
$x < 1$

$$\sum_{i=1}^{\infty} i \cdot x^i = \frac{x}{(1-x)^2}$$
$x < 1$

b.)



Observation for example node (EN)

(a.) Tree can be split into subtrees, each several hops away

(b.) Left subtree has depth $L-l$

(c.) Size of subtree $\sim 2^{depth-1}$

$$\bar{l} = \sum_{i=0}^{L-1} \Big(\underbrace{((L-l+1)-2)}_{\text{u-tree depth}} + \underbrace{(i+1)}_{\text{path to subtree}} \Big) \cdot \underbrace{\frac{2^{L-l+i+1}}{2^{L+1}}}_{\text{fraction of nodes in subtree}}$$
$$+ \underbrace{\left((L-l)-2\right) \frac{2^{L-l+1}}{2^{L+1}}}_{\text{left-hand-side subtree}}$$

c.) $\bar{l}_{M \to CH} > \bar{l}_{M \to M}$

$N = M \cdot N_c$

d.) ~~Aggregation~~ Assumption

a.) $D_{MM} = \log_2(N_c) - 2{,}5$ direct conn

b.) $2 \cdot l_{M \to CH} + l_{CH \to CH}$

c.) All destinations are equally likely to occure

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(I) $$\bar{t} = \frac{N_c}{N} \cdot D_{M\,M}(N_c) + \left(1 - \frac{N_c}{N}\right)\left(2 \cdot \bar{t}_{M \to CH} + \bar{t}_{CH \to CH}\right)$$

$$\frac{d}{dN_c} \cdot \bar{t} \overset{!}{=} 0$$