Telecom Network Systems

SRT

3/7/2015 second call exam

1) See lecture notes ch.3 p.6

2) a $H = -\sum p \log(p) = -\frac{1}{21}\log(\frac{1}{21}) - \frac{2}{21}\log(\frac{2}{21}) +$

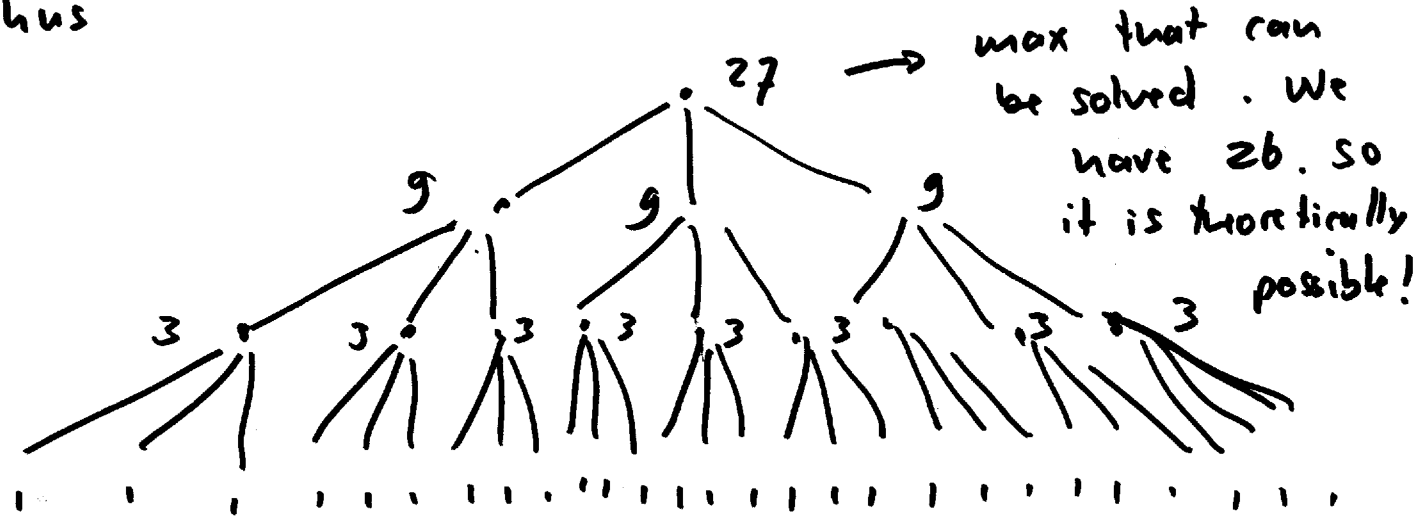
$- \frac{3}{21}\log(\frac{3}{21}) - \frac{4}{21}\log(\frac{4}{21}) - \frac{5}{21}\log(\frac{5}{21}) - \frac{6}{21}\log(\frac{6}{21})$

$= 2.40$

b See lecture notes ch.1 p.7

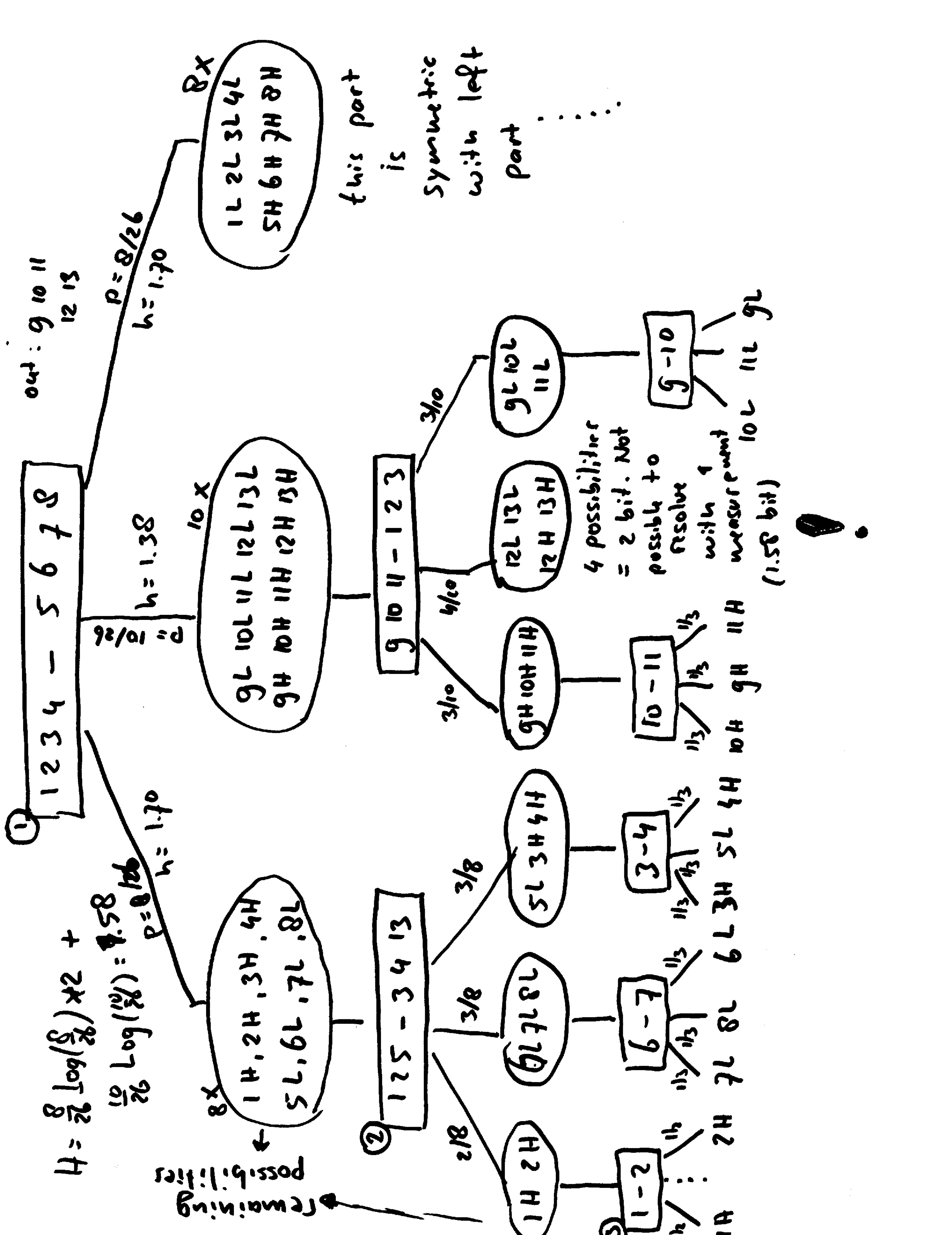
3) From question 2b we know that a balance with 3 possible outcomes can, at best, give $\sum_{i=1}^{3} p \log(1/p) = 1.58$ bits of information. In other words, reasoning backwards, it can determine, at best, decide between 3 equal possibilities at last measurement. Something like deciding between 1L, 5H and 12H (H means heavy, L means light):

Thus

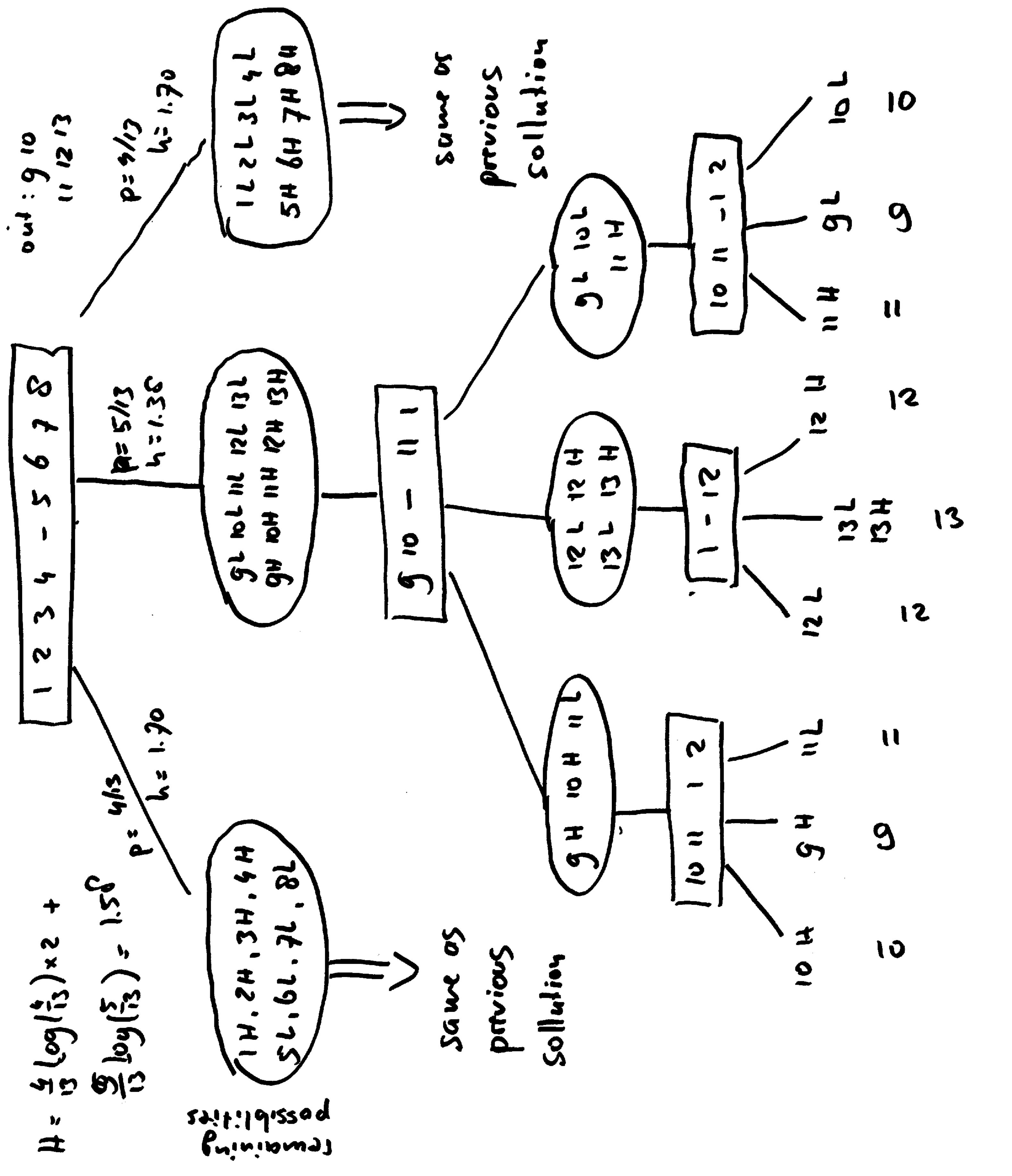


26 is close to limit. We have to find a "9-8-9" sol.

9·8·9 solutions = leave 4 coins out. This is not possible! Best we can do:



If we do not need to know if the false coin is too light or too heavy, there are only 13 possiblities and it is possible to determine it. Here is a sollution:



4) $b_0 b_1 b_2 P$

4 bits

0 errors : $(1-f)^4$

1 error : $(1-f)^3 \cdot f \cdot \binom{4}{1} \sim 4f$ — detected

2 errors : $(1-f)^2 \cdot f^2 \binom{4}{2} \sim 6f^2$ — not detected

3 errors : $(1-f) \cdot f^3 \binom{4}{3} \sim 4f^3$ — detected

4 errors : f^4 — not detected

BER : passing 3 bits of info with error $\sim 6f^2 = 0.0006 = 6 \cdot 10^{-4}$

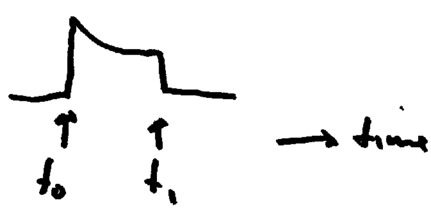
per bit $= 6 \cdot 10^{-4} / 3 = 2 \cdot 10^{-4}$

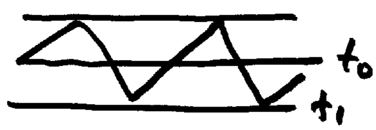
5) See lecture notes ch. 2 p. 4-5. To avoid drift wander and to remove low frequency signal

6) a. See exercise of modal dispersion

$\alpha_c = \sin^{-1}\left(\frac{1}{n}\right) = 43.98^\circ$

b.





$$t_0 = \frac{Ln}{c} = \frac{10\ \text{km} \cdot 1.44}{3 \cdot 10^8\ \text{m/s}} = 48.0\ \mu s$$

$$t_1 = \frac{Ln}{c \sin(\alpha_c)} = \frac{Ln^2}{c} = \frac{10\ \text{km}\ (1.44)^2}{3 \cdot 10^8\ \text{m/s}} = 69.2\ \mu s$$

$$\text{b.r.} = \frac{1}{\Delta t} = \frac{1}{t_1 - t_0} = \frac{1}{21.2\ \mu s} = 47.2\ \text{kb/s}$$

7) DCF77 is the frequency standard sent from Mainflingen working at 77.5 kHz. later versions / adoptations used this signal to pass information about the time.