Gentle RED, Nonlinear RED and Self Configuring RED Queue Disciplines

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Recap of RED algorithm

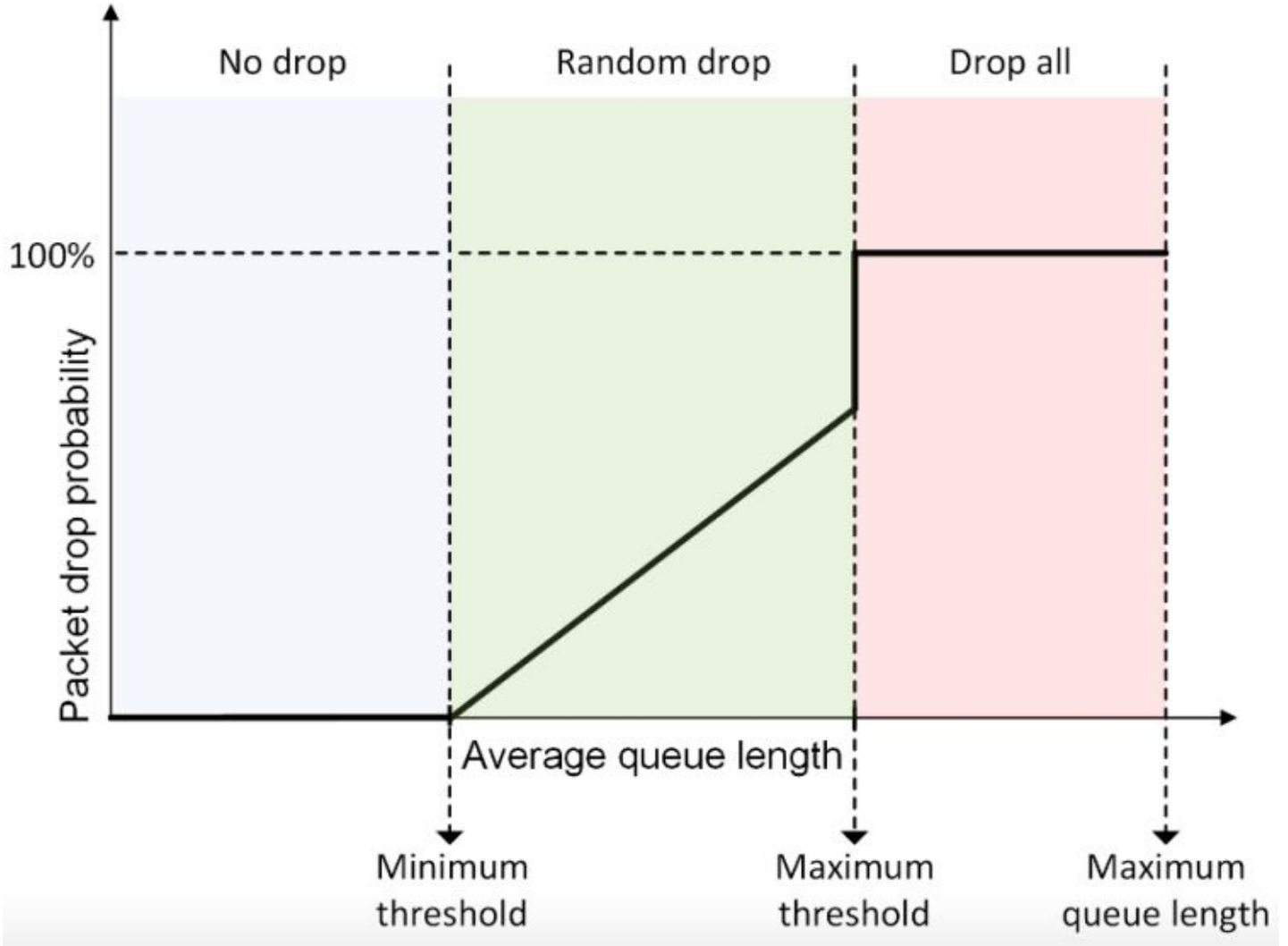
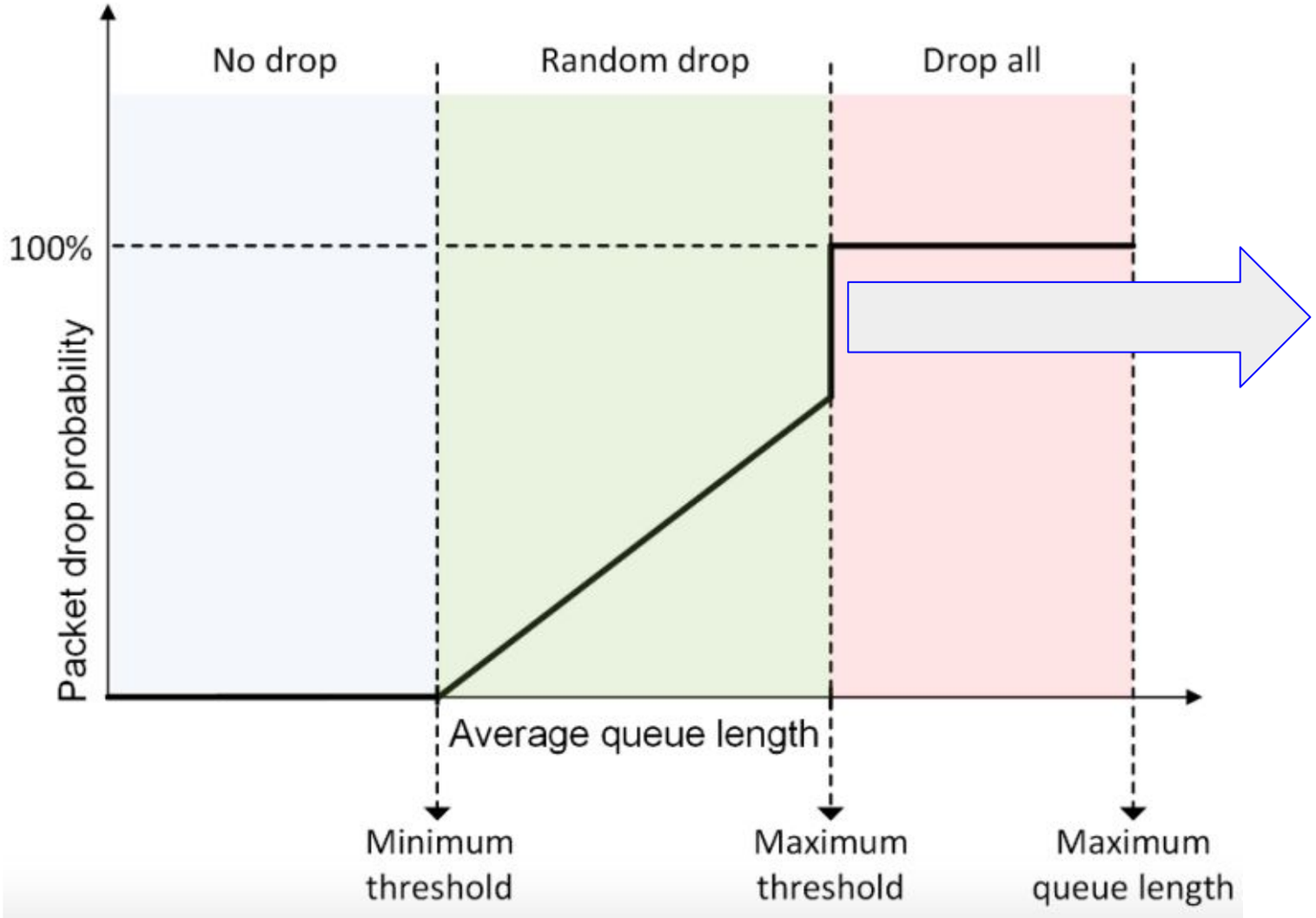


Image Credits: http://ce.sc.edu/cyberinfra/workshops/Material/NTP/Lab%2016.pdf

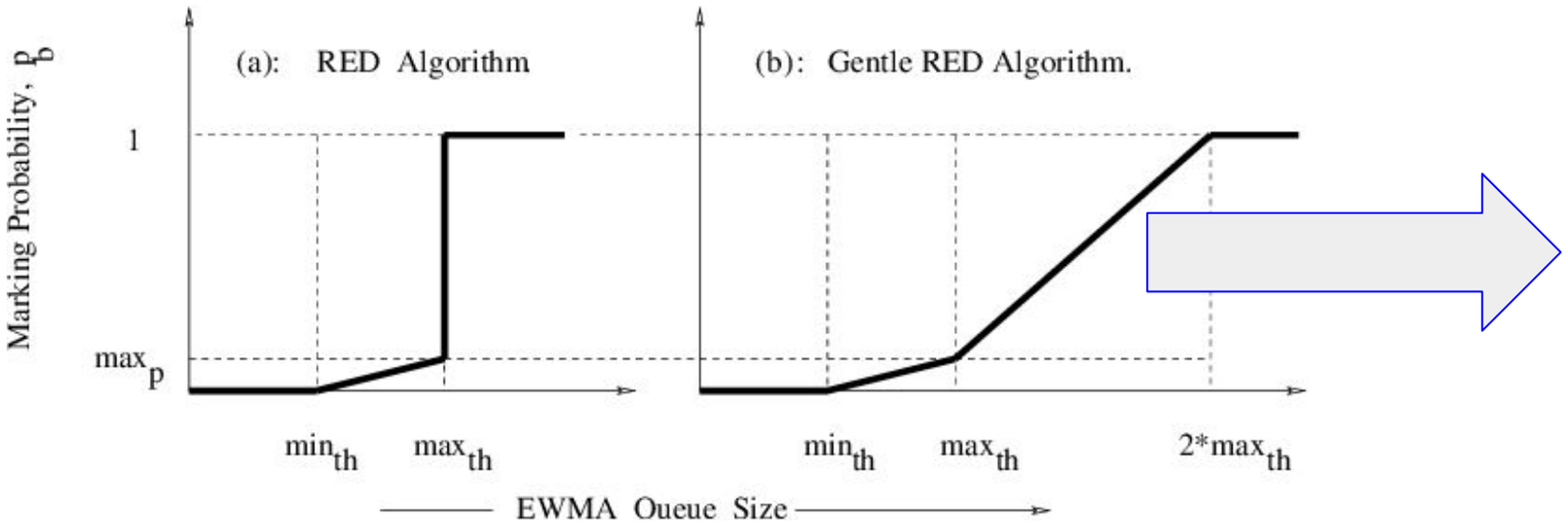
Motivation for Gentle RED



This behavior leads to aggressive packet drops i.e., when average queue length increases beyond the max_{th}, the drop probability sharply rises to 1.

Image Credits: http://ce.sc.edu/cyberinfra/workshops/Material/NTP/Lab%2016.pdf

Working of Gentle RED



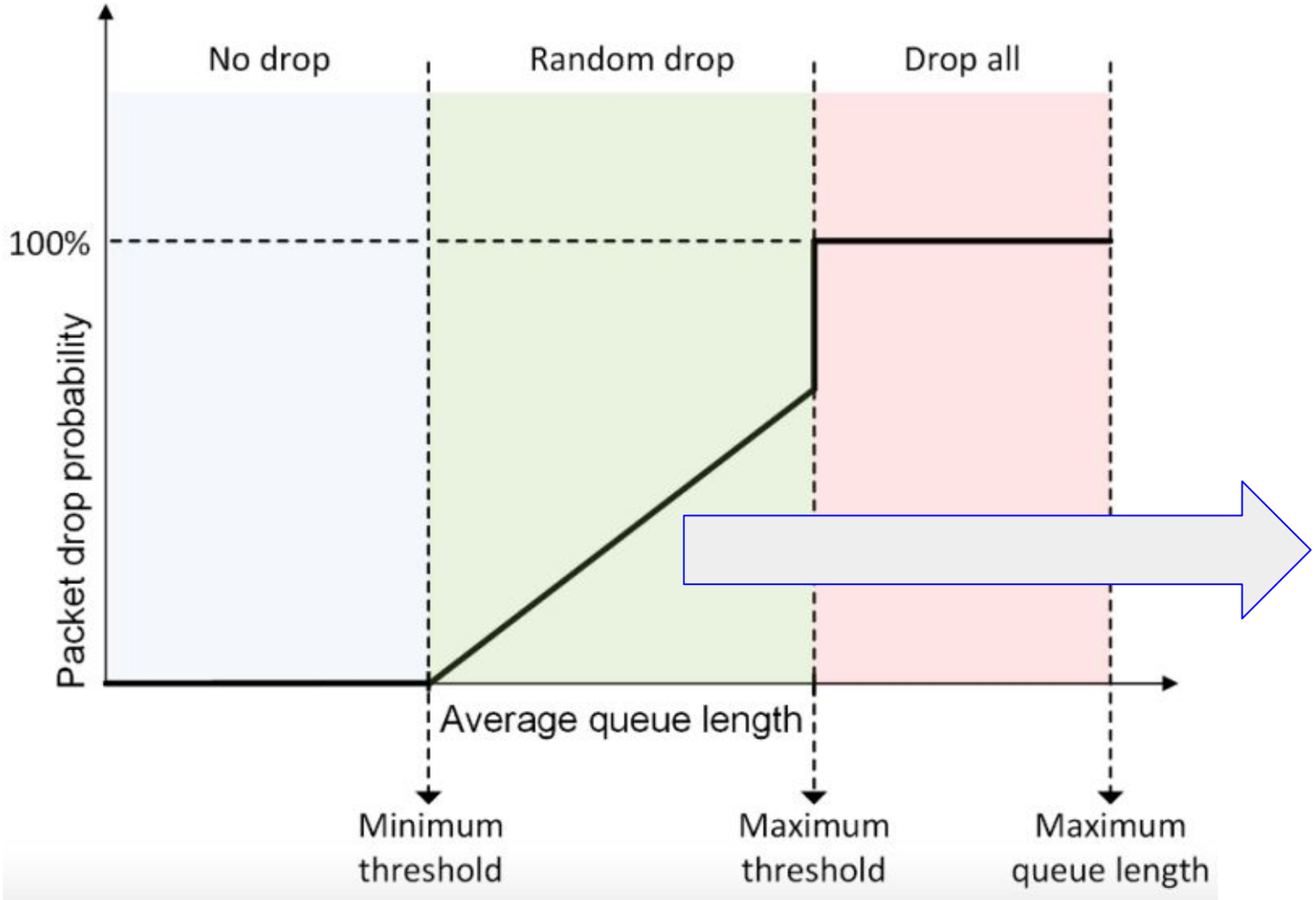
Gentle RED tries to flatten this curve with a slope similar to the original RED when average queue length is between max_{th} and twice of max_{th}.

Question: How is P_d and P_a calculated when max_{th} < newavg < 2 x max_{th}

Hint: See the paper mentioned below in 'Image Credits'

Image Credits: Aun Haider, Harsha Sirisena, and Krzysztof Pawlikowski. "Hybrid Random Early Detection Algorithm for Improving End-to-End Congestion Control in TCP/IP Networks." (2005).

Motivation: Nonlinear RED and Self Configuring RED



Instead of increasing the P_d linearly, it might be better if P_d is increased slowly when it is near to min_{th} and increased sharply when it is near to max_{th}.

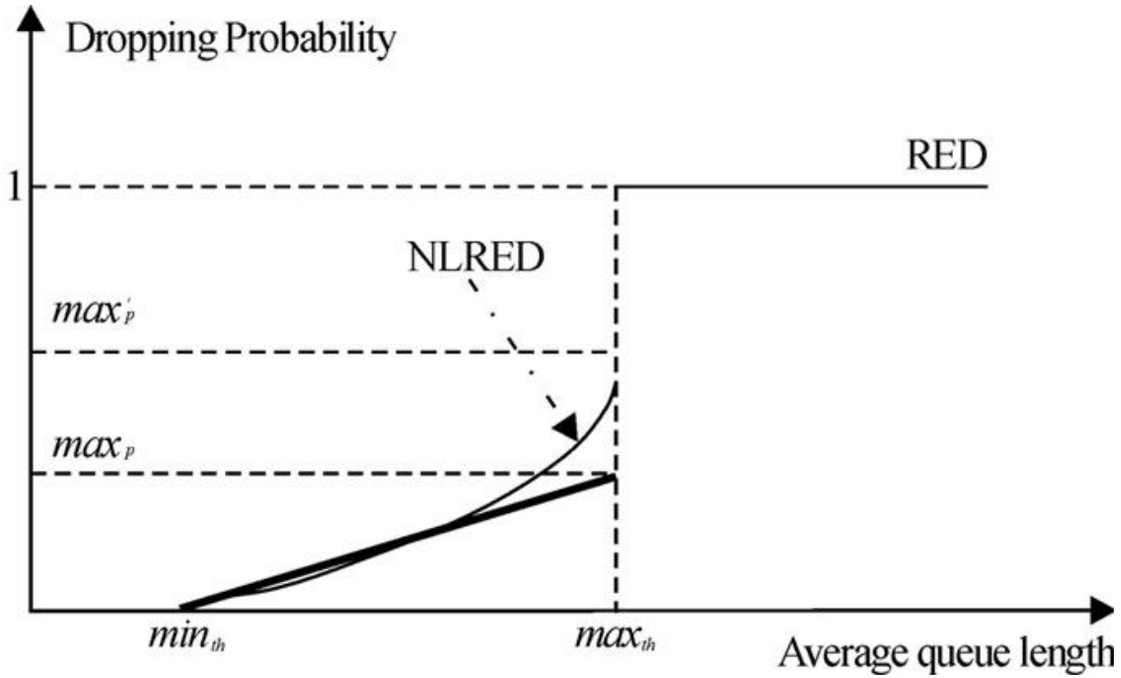
Image Credits: http://ce.sc.edu/cyberinfra/workshops/Material/NTP/Lab%2016.pdf

Working of Nonlinear RED

$$p'_{\mathrm{d}} = \begin{cases} 0 & \mathrm{avg} \leqslant \mathrm{min_{th}}, \\ \left(\frac{\mathrm{avg} - \mathrm{min_{th}}}{\mathrm{max_{th}} - \mathrm{min_{th}}} \right)^2 \mathrm{max}'_p & \mathrm{min_{th}} < \mathrm{avg} \leqslant \mathrm{max_{th}}, \\ 1 & \mathrm{max_{th}} < \mathrm{avg}. \end{cases}$$

where,

$max'_p = 1.5 \times max_p$



Equation Credits: Kaiyu Zhou, Kwan L. Yeung, and Victor OK Li. "Nonlinear RED: A simple yet efficient active queue management scheme." Computer Networks 50, no. 18 (2006): 3784-3794.

Image Credits: Hui Wang, Xiao-Hui Lin, Kai-Yu Zhou, Nin XIE, and Hui LI. "On the scalable fairness and efficient active queue management of RED." *Int'l J. of Communications, Network and System Sciences* 2009 (2009).

Working of Self Configuring RED

It adapts max_p as shown in the pseudocode below:

On every update of 'newavg':

if (min_{th} < newavg < max_{th})

    status = between;

else if (newavg < min_{th} && status != below)

    status = below;

    $max_p = max_p \div \alpha$ // default value is 3

else if (newavg > max_{th} && status != above)

    status = above;

    $max_p = max_p \times \beta$ // default value is 2

Question: Is there an upper and lower limit for maxp in this algorithm?

Important Note!

- This algorithm is named as 'Adaptive RED' in the original paper published by Feng in 1999.
- Sally Floyd proposed another algorithm in 2001 which is also named as 'Adaptive RED'.
- Eventually, the research community went on to use the term 'Adaptive RED' for Floyd's algorithm.
- Feng's algorithm is popularly known as 'Self Configuring RED' or 'Feng Adaptive RED'. The latter is used in ns-3.

Recommended Reading

Gentle RED:
Link: https://ir.canterbury.ac.nz/bitstream/handle/10092/14719/tr_0502.pdf?sequence=1&isAllowed=y

Nonlinear RED
Link: https://www.sciencedirect.com/science/article/abs/pii/S1389128606000879?via%3Dihub

Self Configuring RED:
Link: https://ieeexplore.ieee.org/abstract/document/752150/