On The Joint Use of TCP and Network Coding

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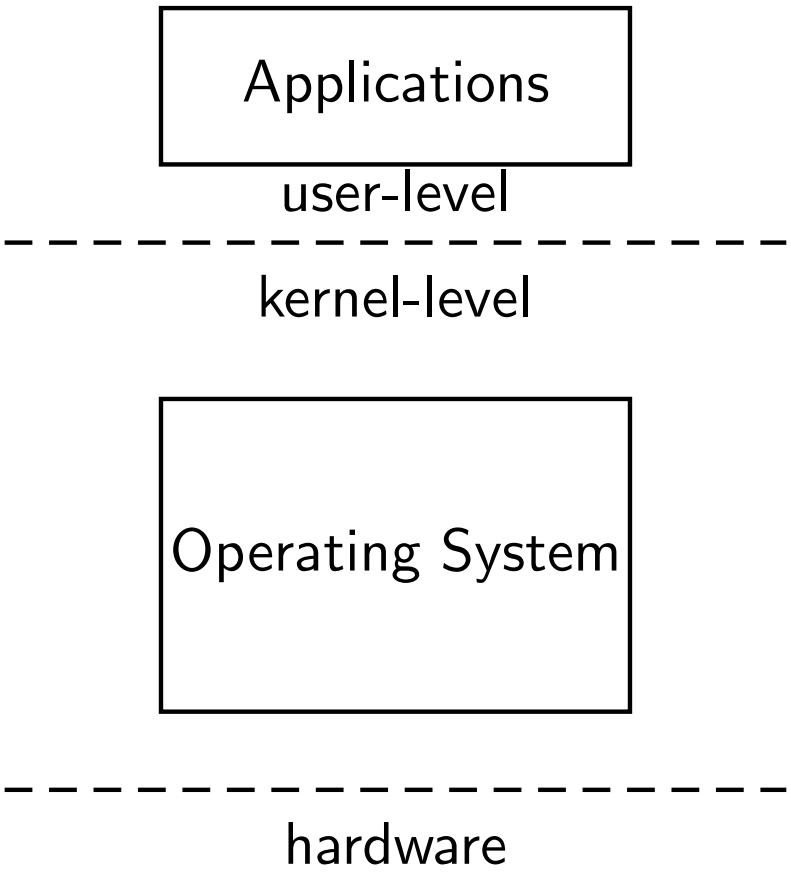
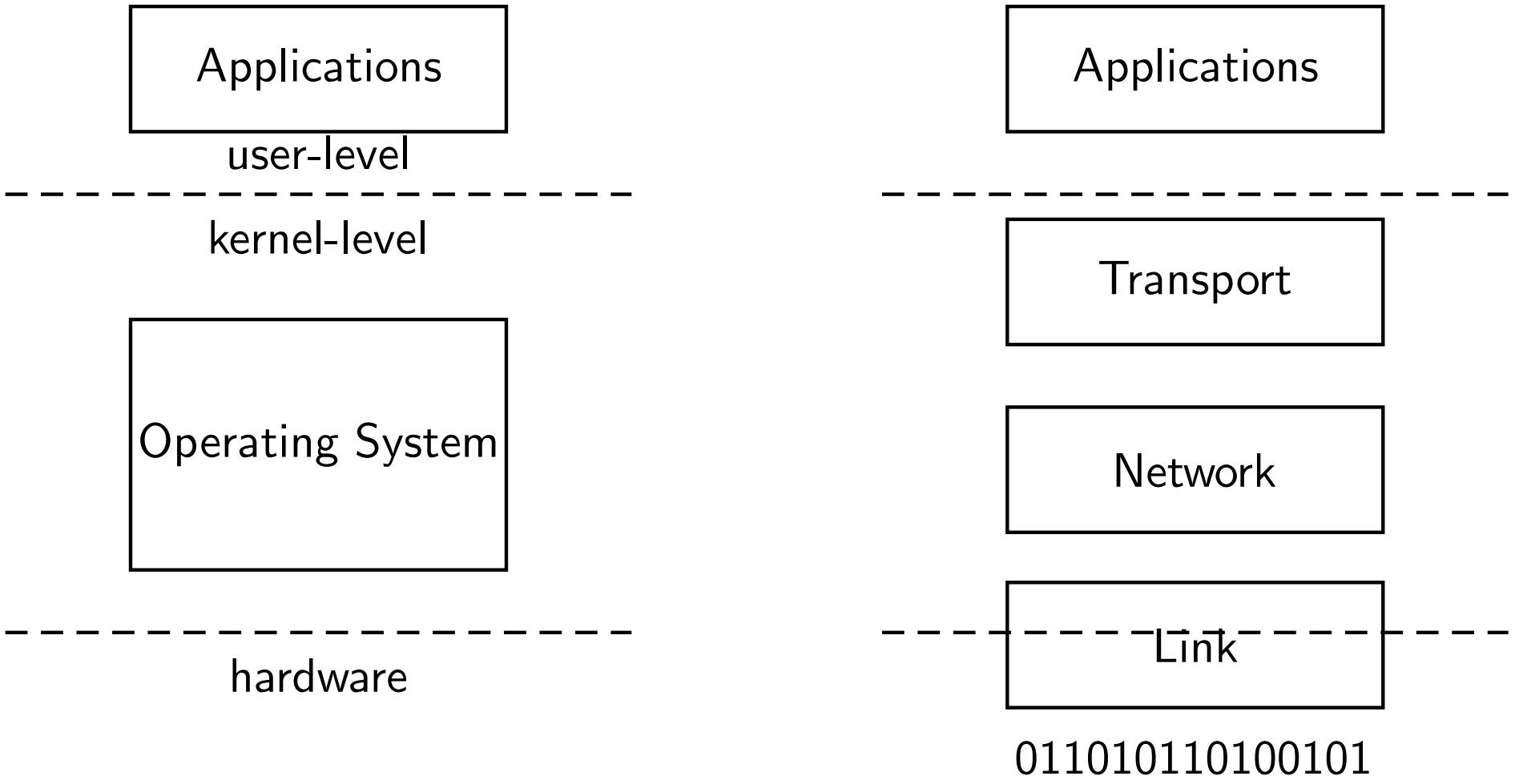
Some parts presented in these slides have been patented

NC layer placement



NC layer placement



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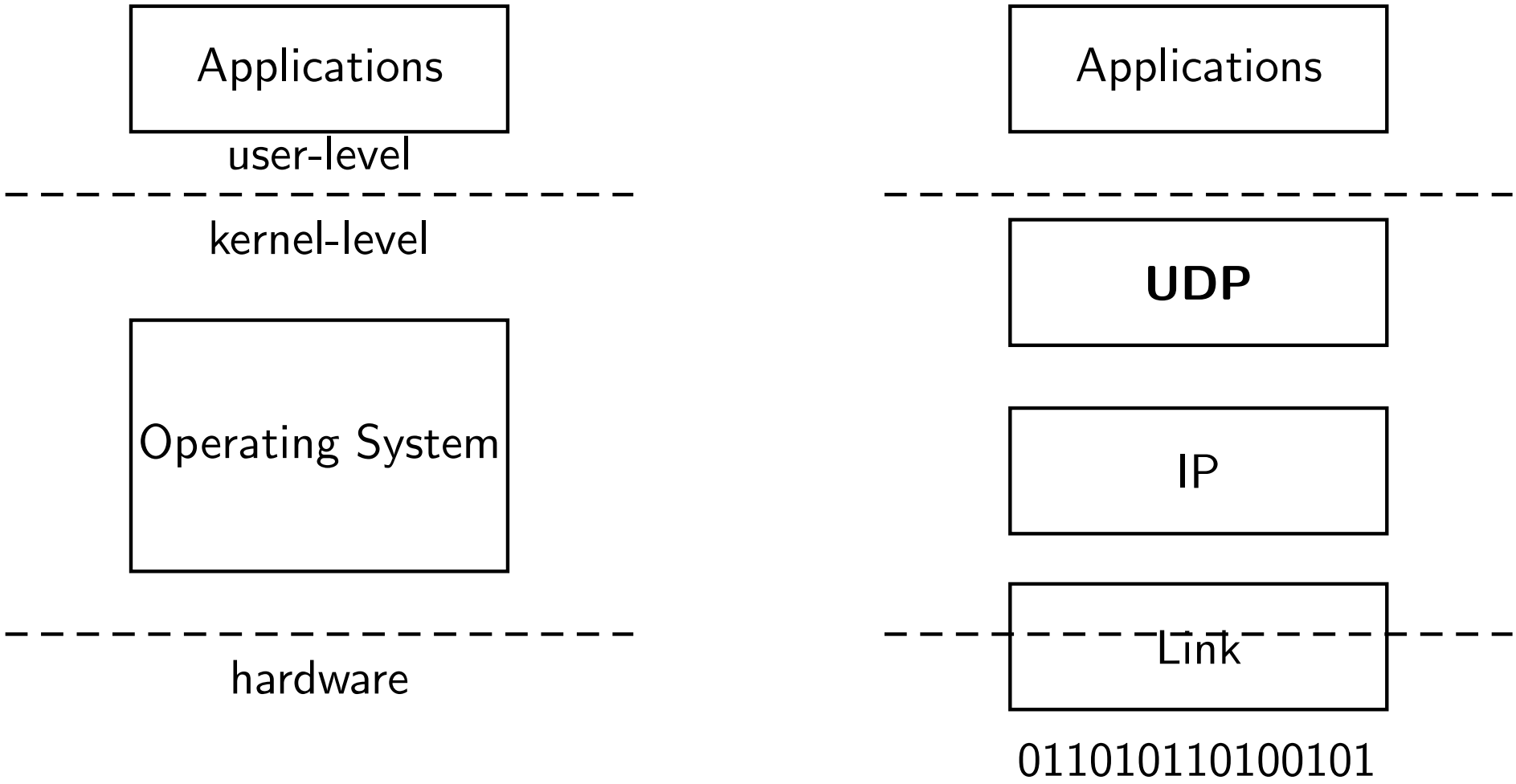
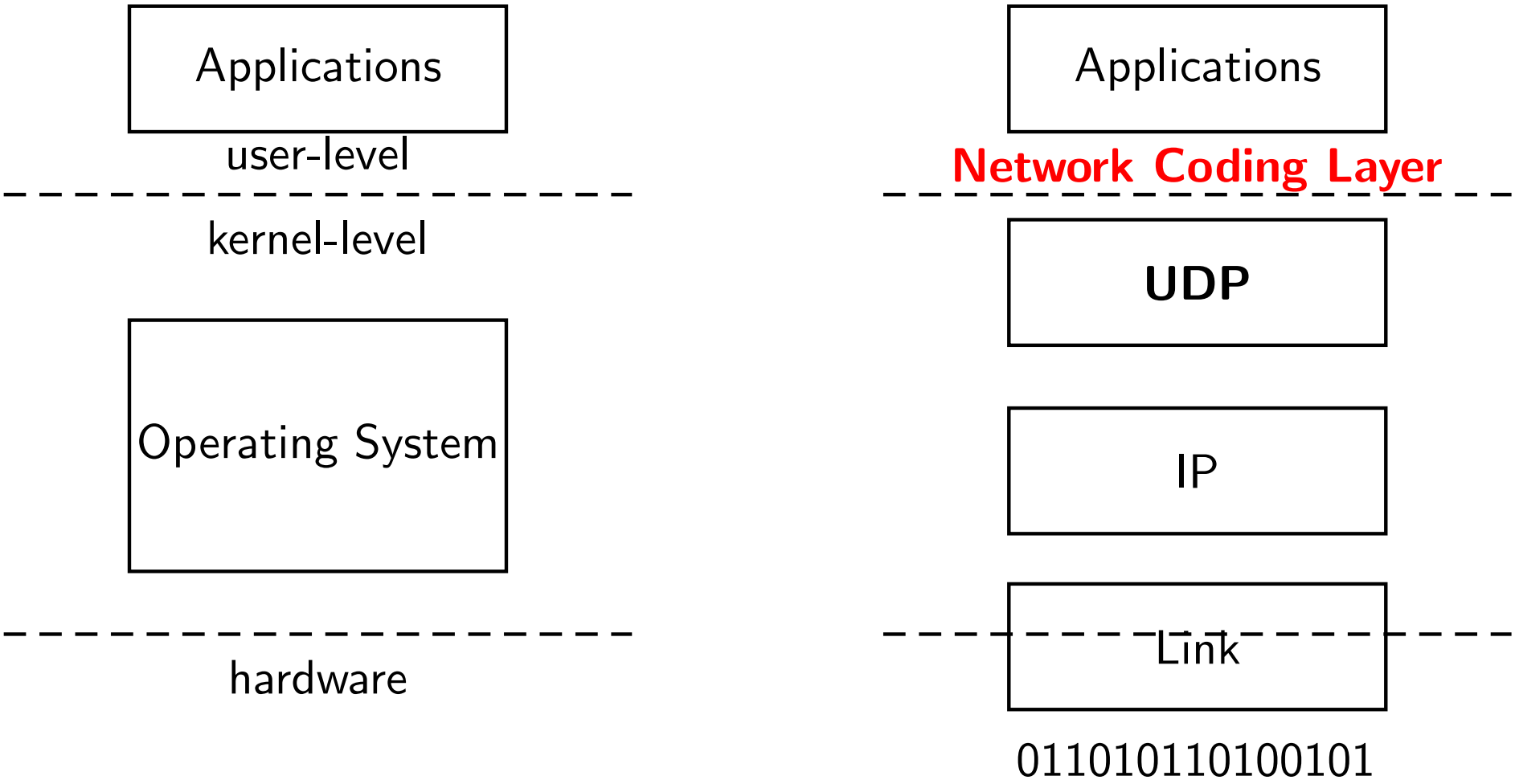


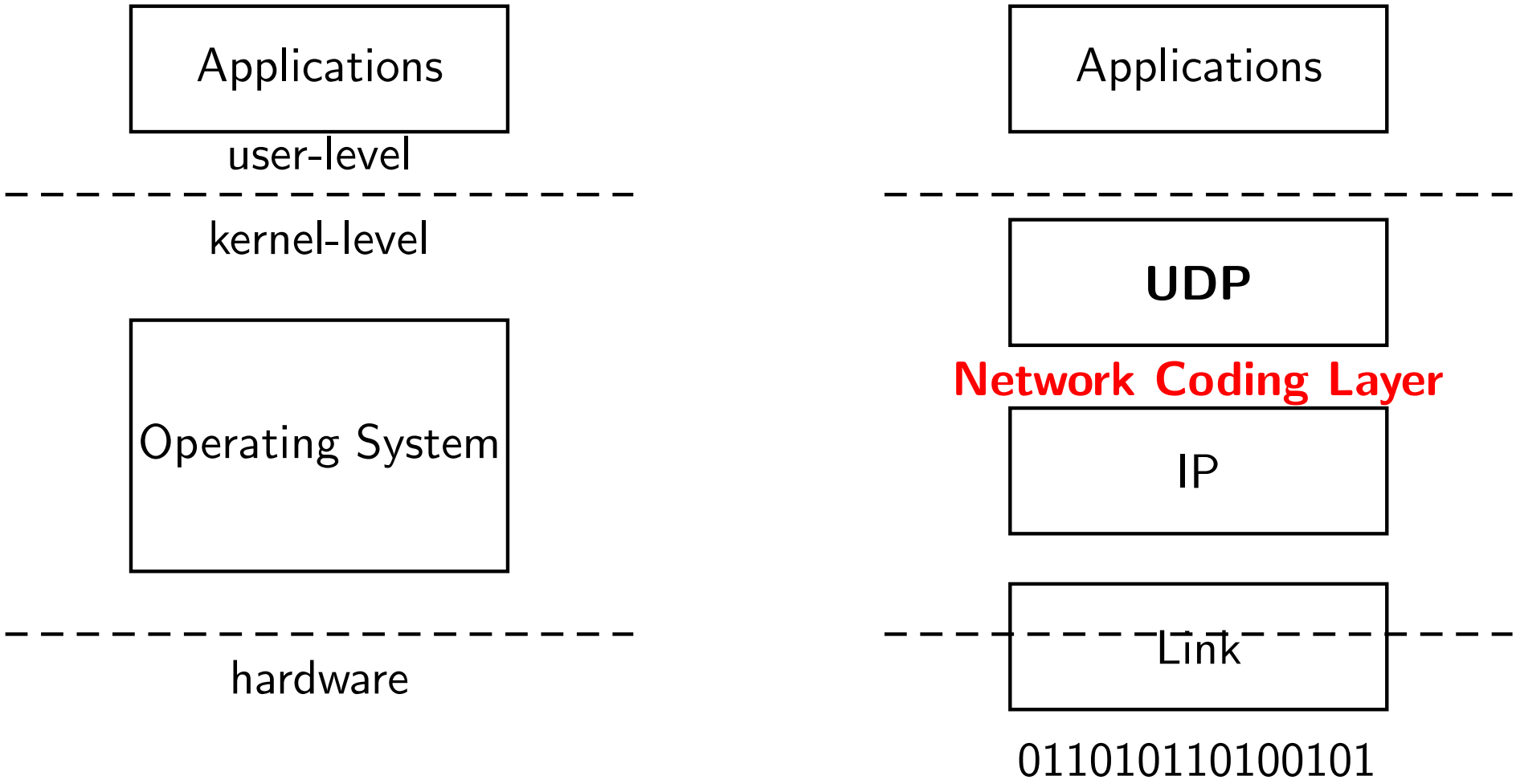
Considering UDP...

NC layer placement



NC layer can be placed everywhere with UDP

NC layer placement



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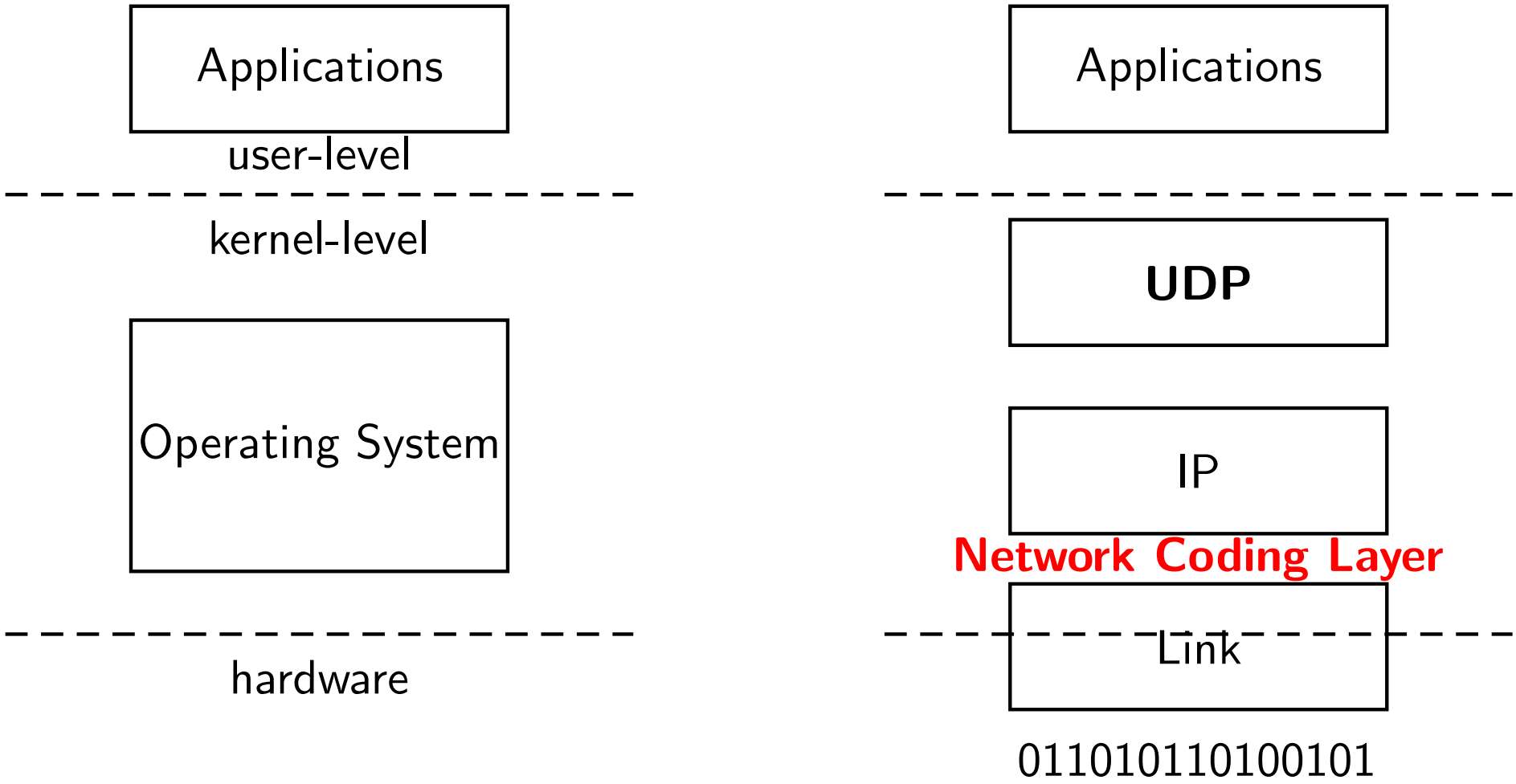

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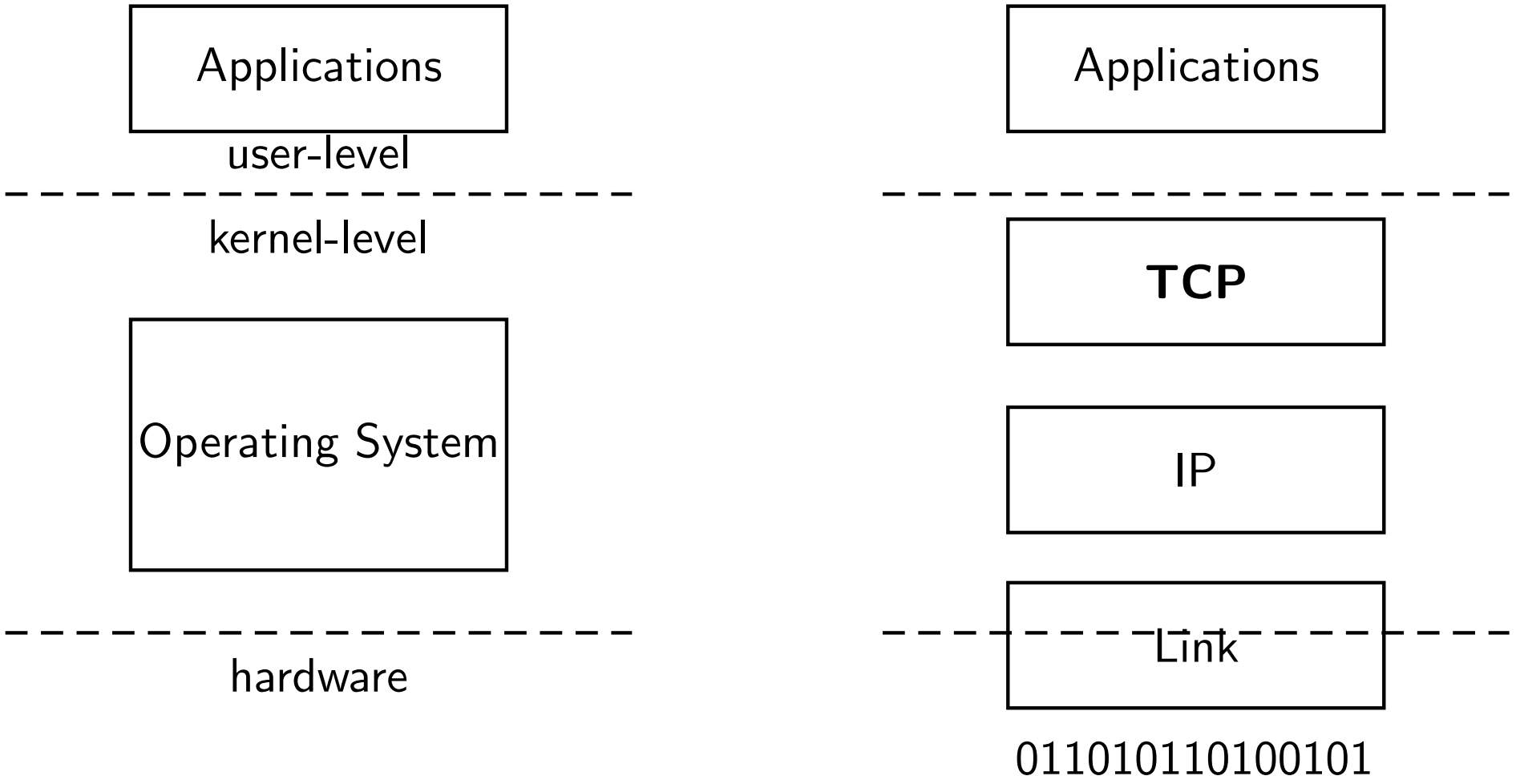
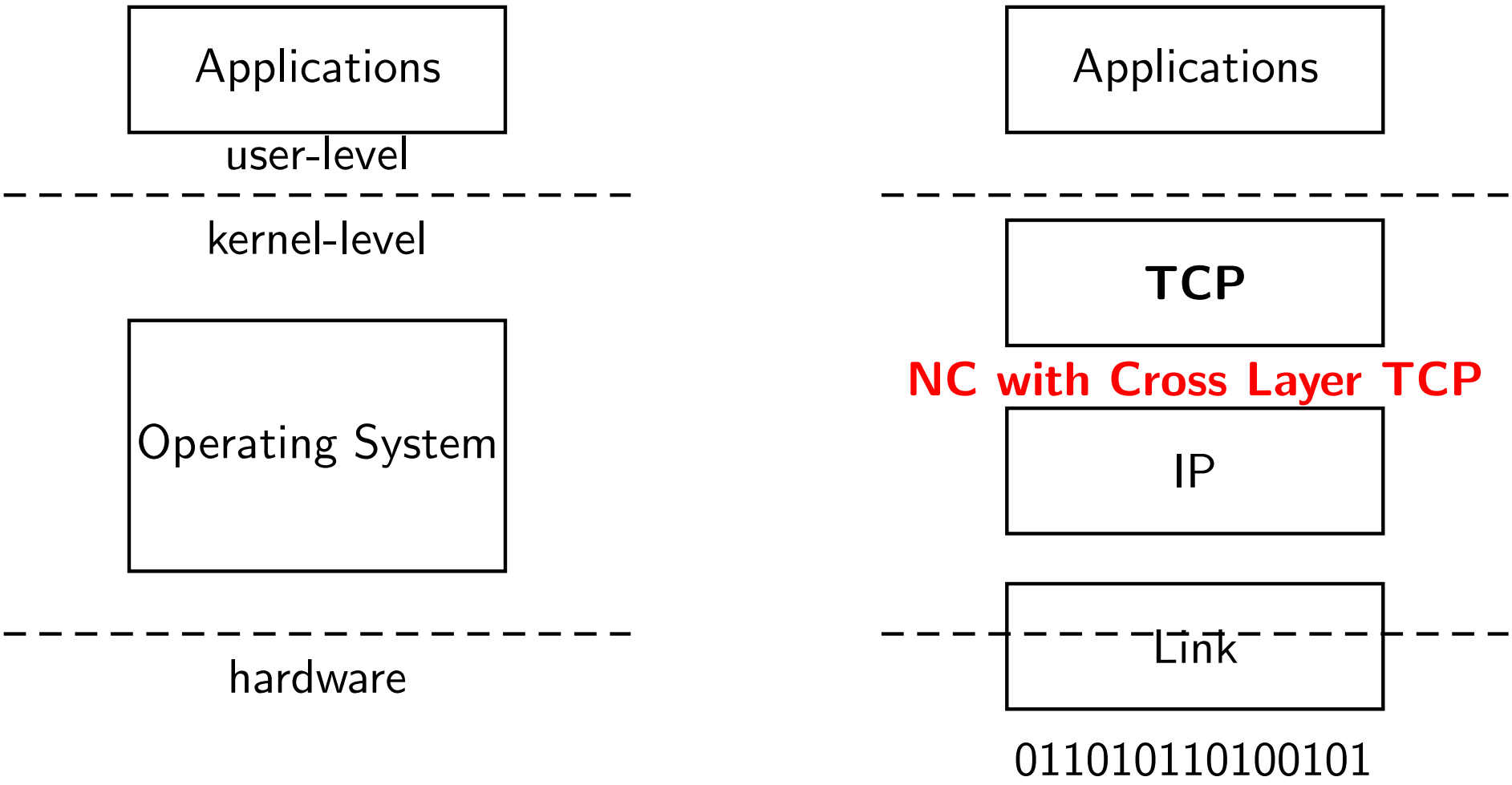
NC layer placement



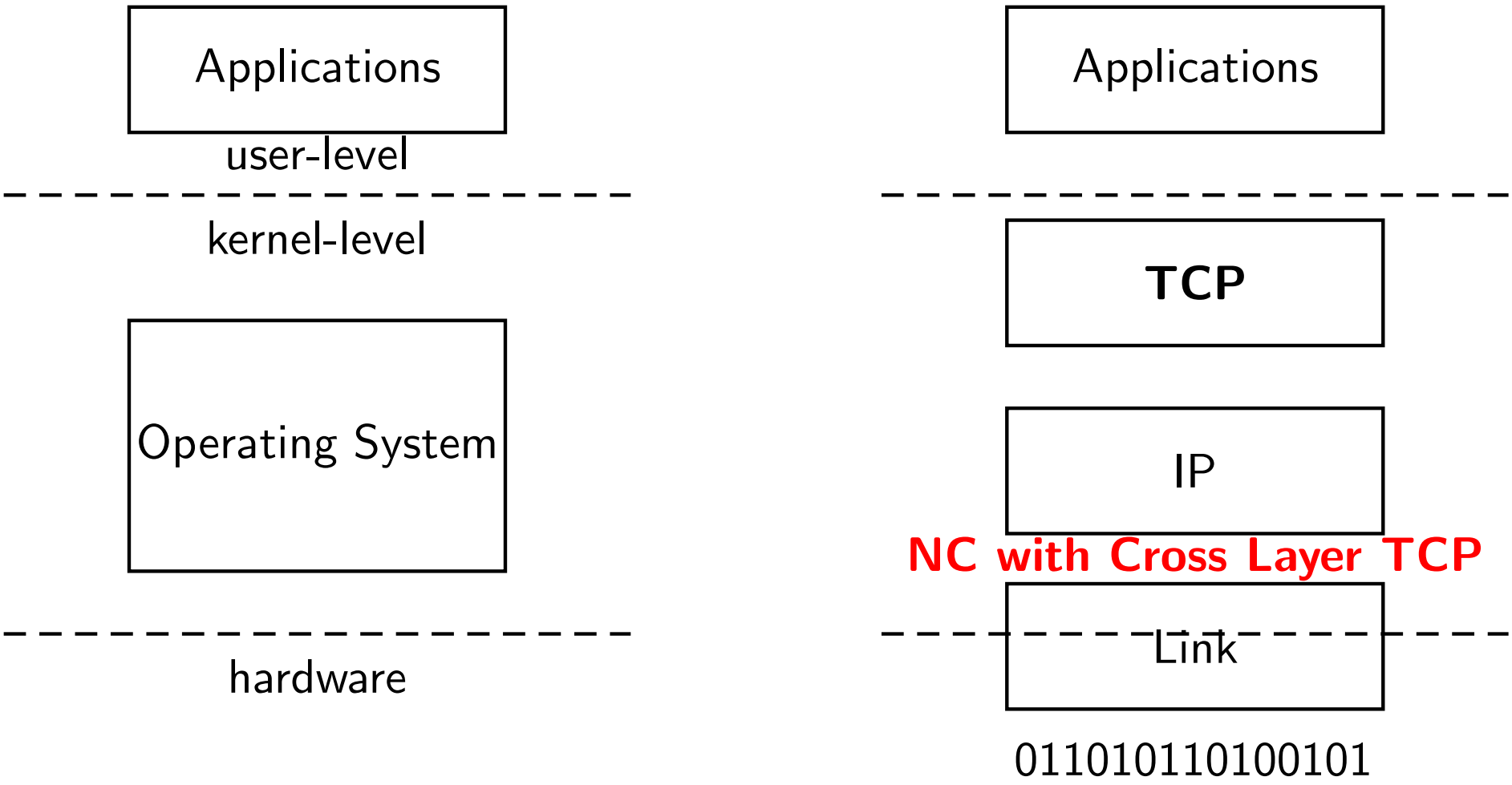
However with TCP...

NC layer placement



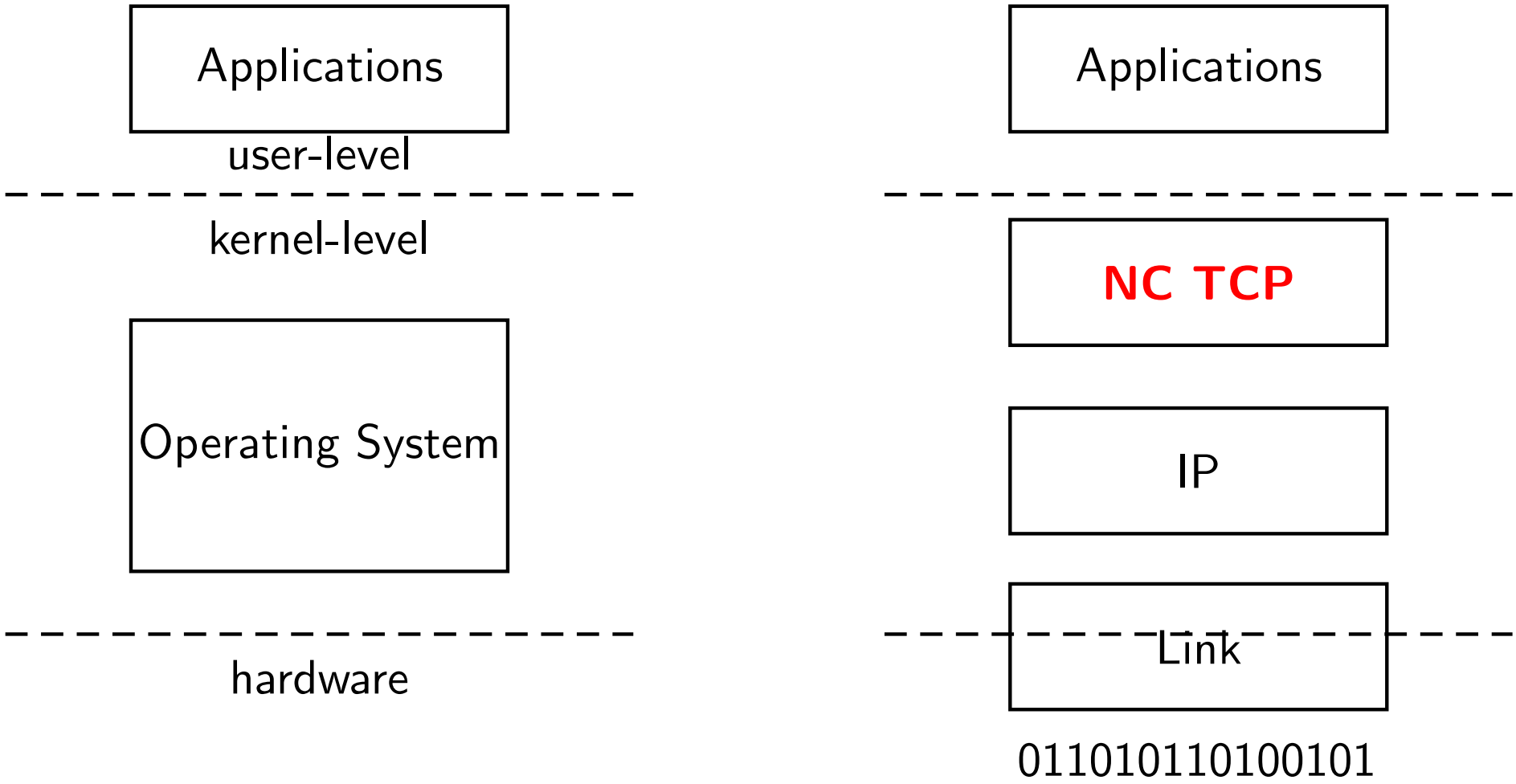
NC layer must be below the transport layer and must interact with TCP

NC layer placement



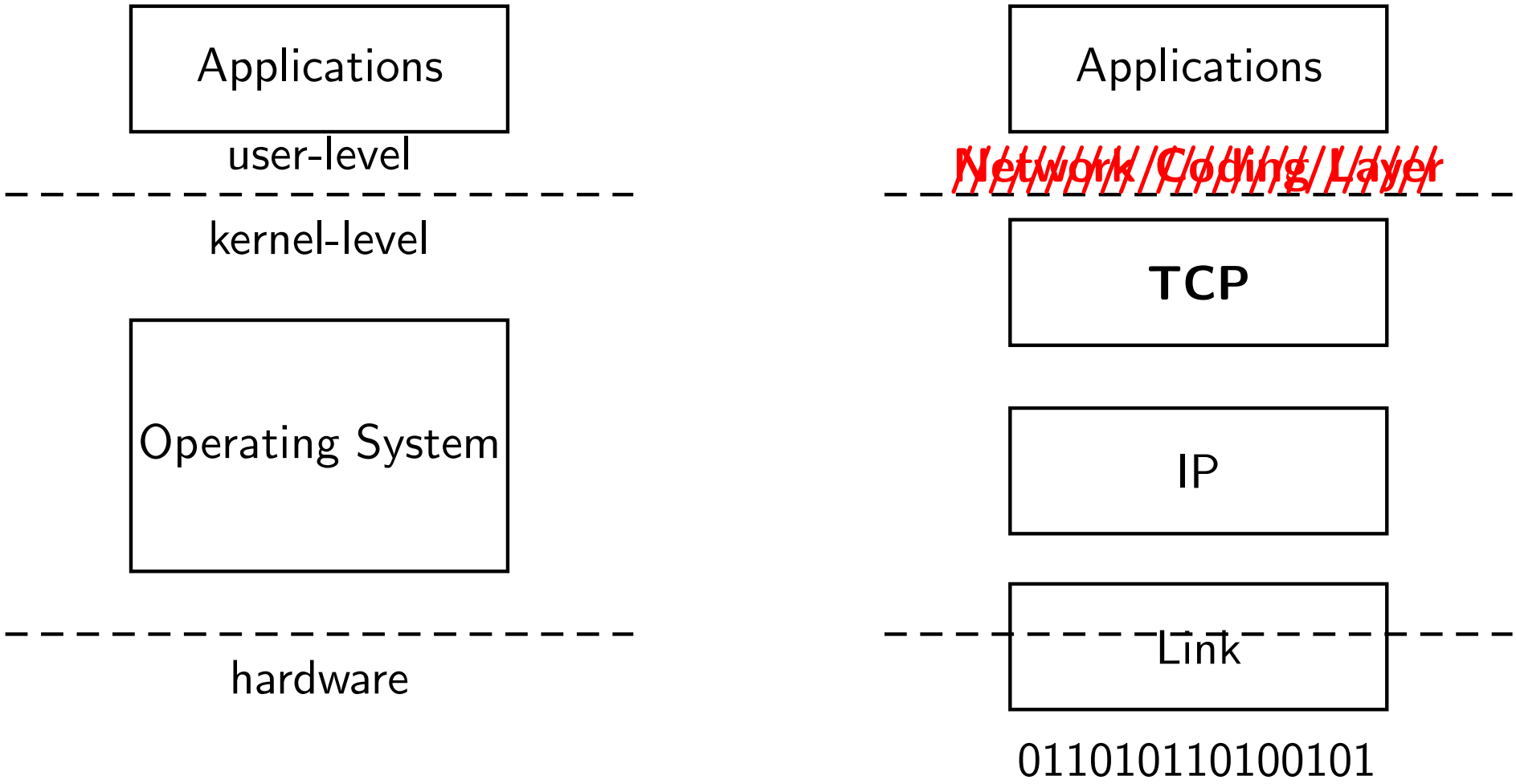
TCP uses losses as a congestion signal to compute its sending rate
Using a NC coding scheme below the TCP layer masks losses

NC layer placement



Or you must to implement a new NC transport layer

NC layer placement



Obviously no point to be above

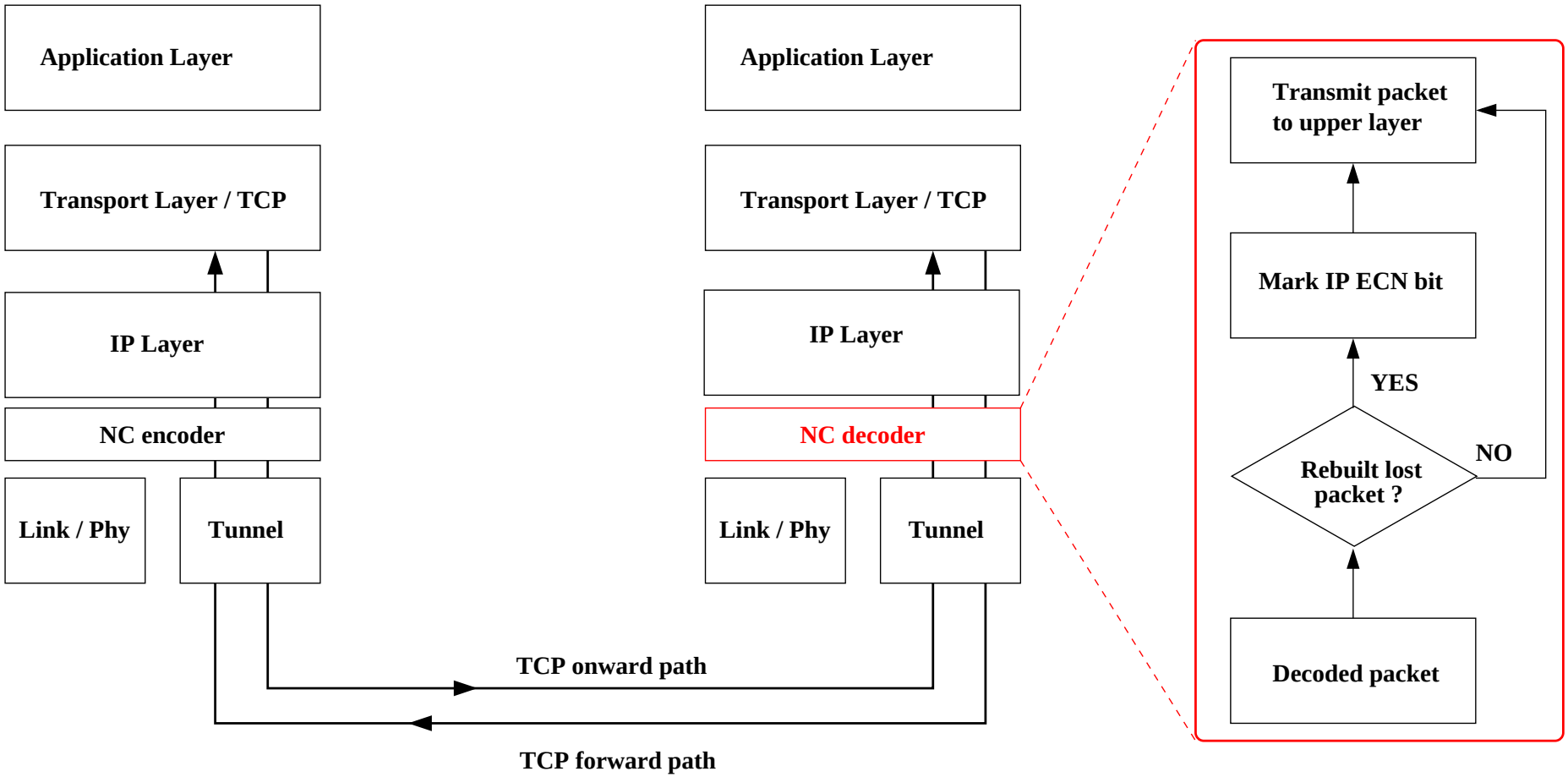
NC TCP stack

- One solution is to implement a new TCP stack $\Rightarrow$ a coded transport layer eg. CodedTCP
- Problems
  - Need to replace TCP and implement the transport layer stack, or need a proxy-like system
  - TCP must remain sender based $\Rightarrow$ need to change TCP negociation semantic with CodedTCP
  - You can't take benefit of various TCP flavours and TCP evolution

Proposed solution : TENTET

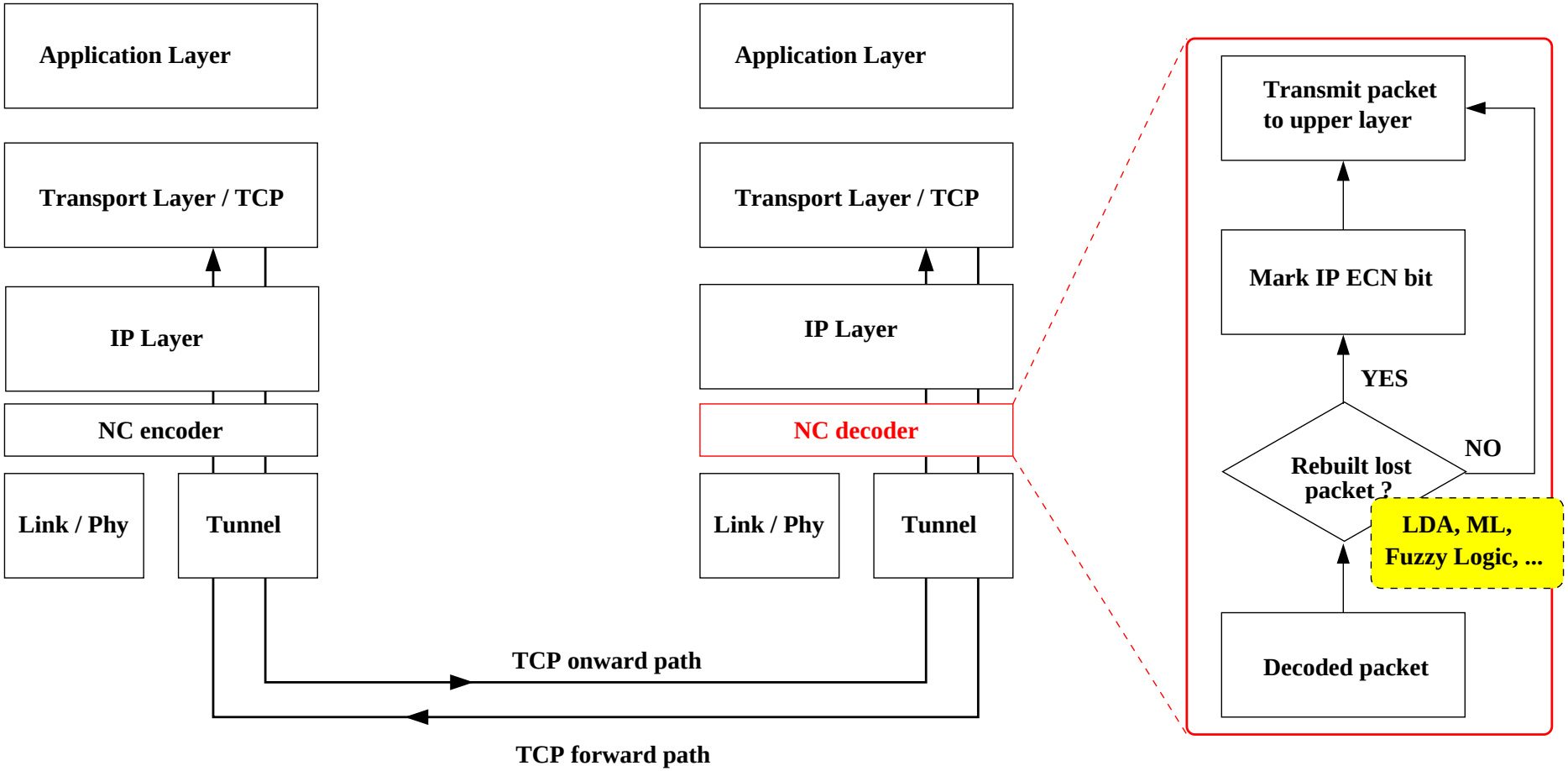
- The question is how to enable a cross-layer scheme between a NC and a TCP layer ?
- Idea is to use ECN as a cross-layering scheme between NC and TCP $\Rightarrow$ BTW this is ECN job
- Basically ECN is used to pilot/control TCP sending rate when NC is used
- ECN is broadly supported : Linux, *BSD, OSX, Windows
- All these OS follow RFC3168

Main principle below the IP layer



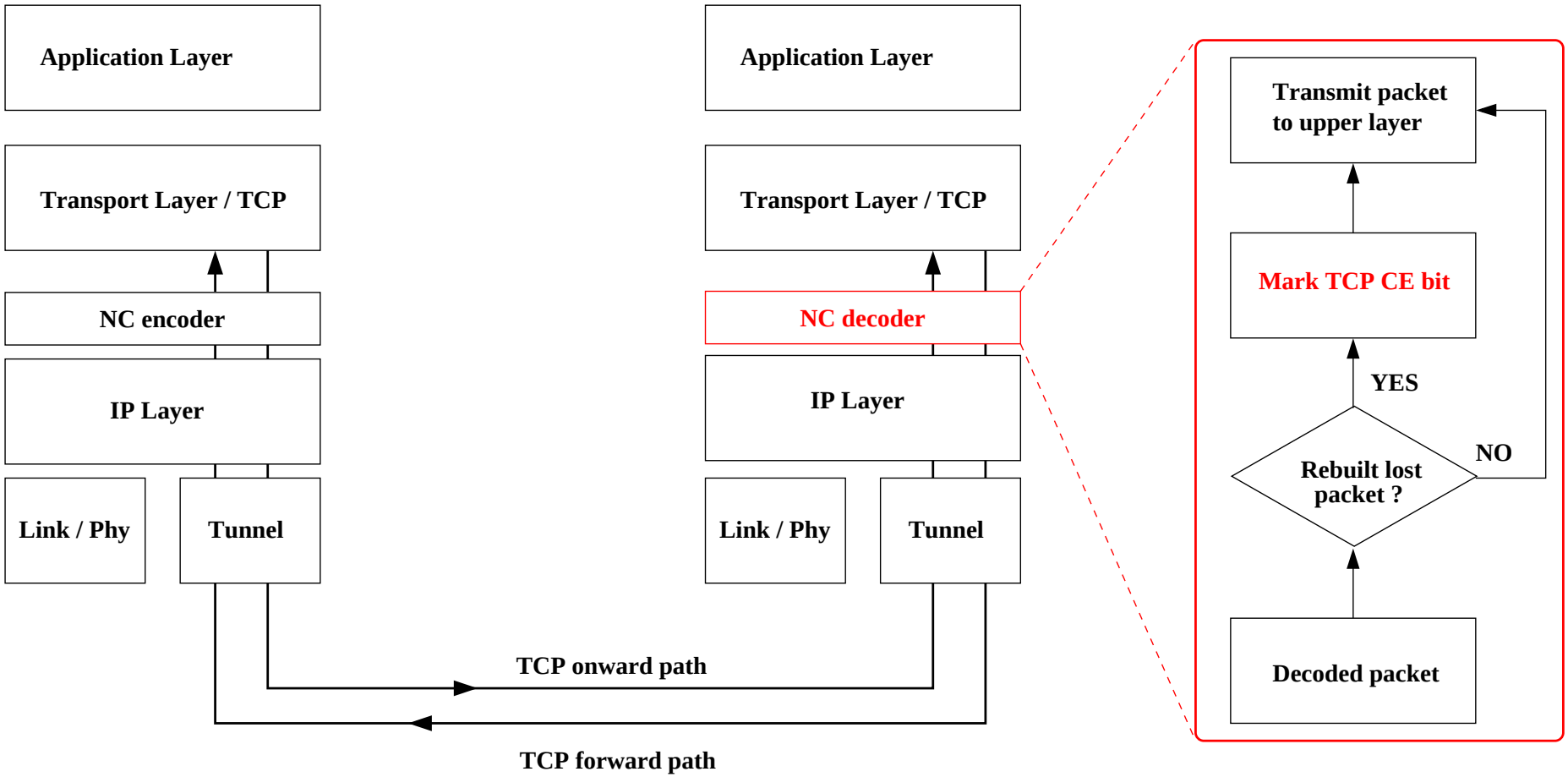
You wish to strictly behave as TCP

Main principle below the IP layer



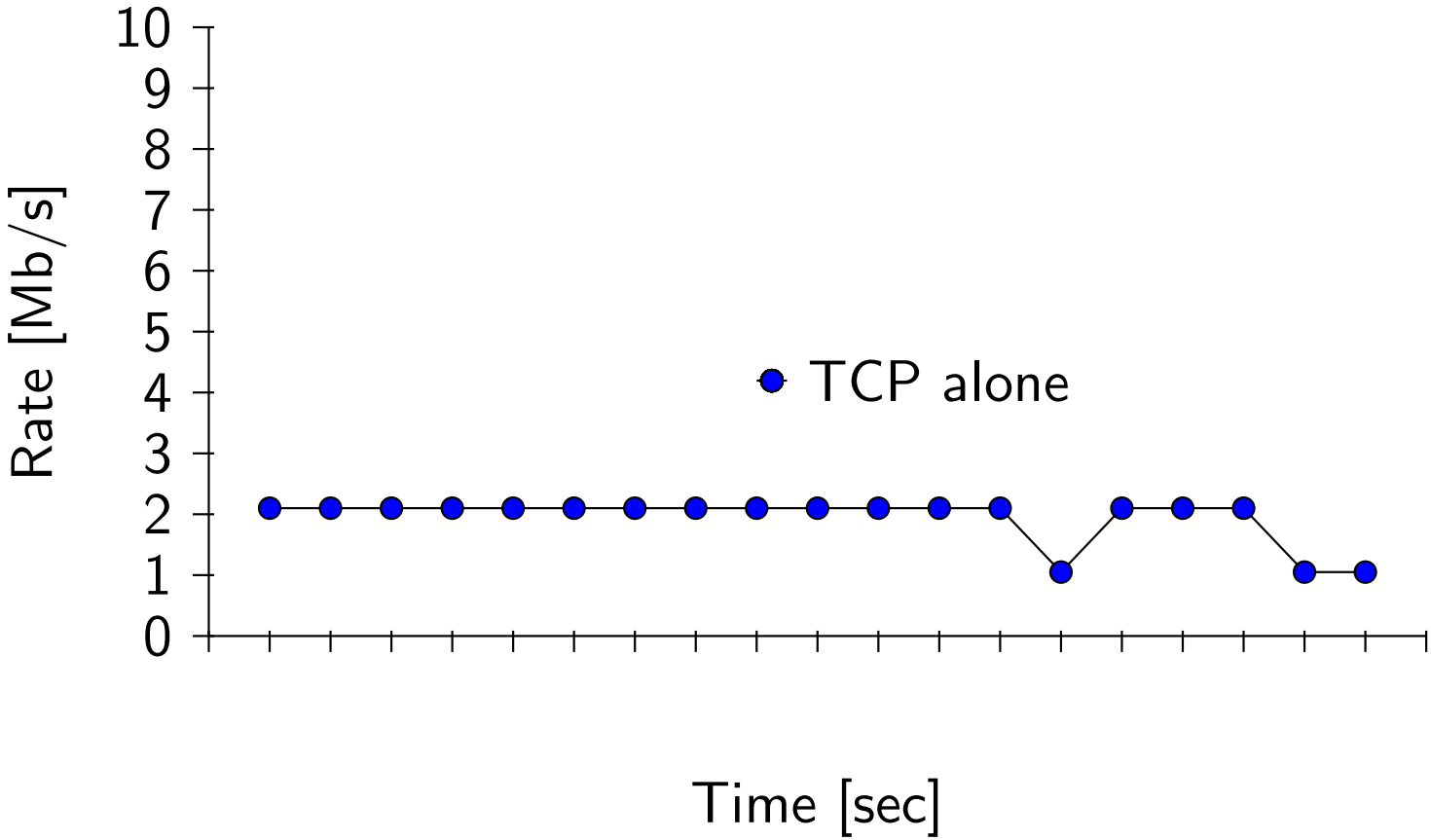
Don't want to be as bad as TCP in presence of random losses ?
You can monitor/pilot the signal with for instance a Loss Discrimination Algorithm, ...

Main principle above the IP layer



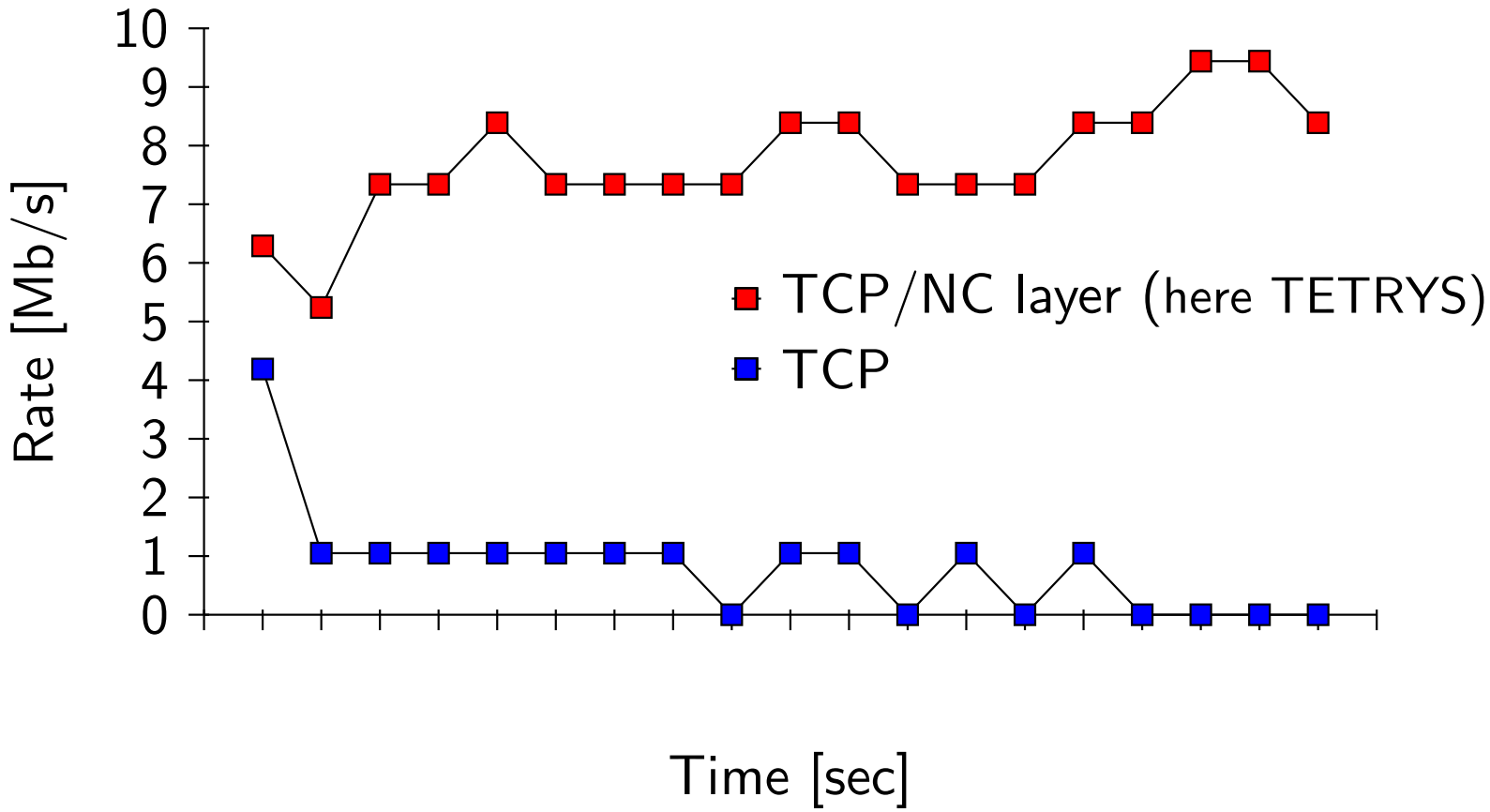
Same principle but above IP layer

Illustration



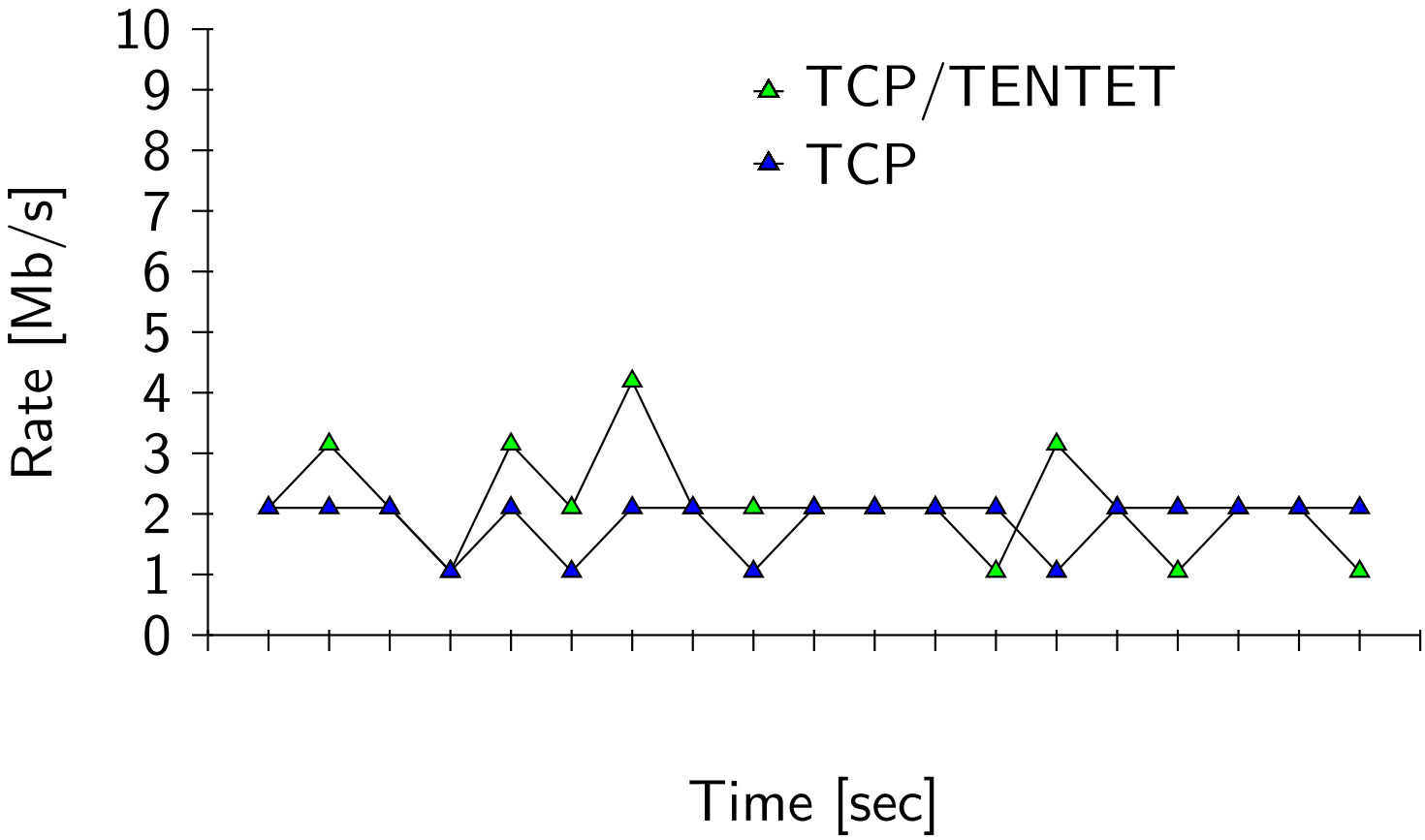
IPERF experiment with link capacity 10Mb/s, RTT 40ms and $\approx 2\%$ uniform random losses
Estimation based on Mathis et al. formula $\frac{MSS}{RTT*\sqrt{p}}$ gives 2.06 Mbit/s

Illustration



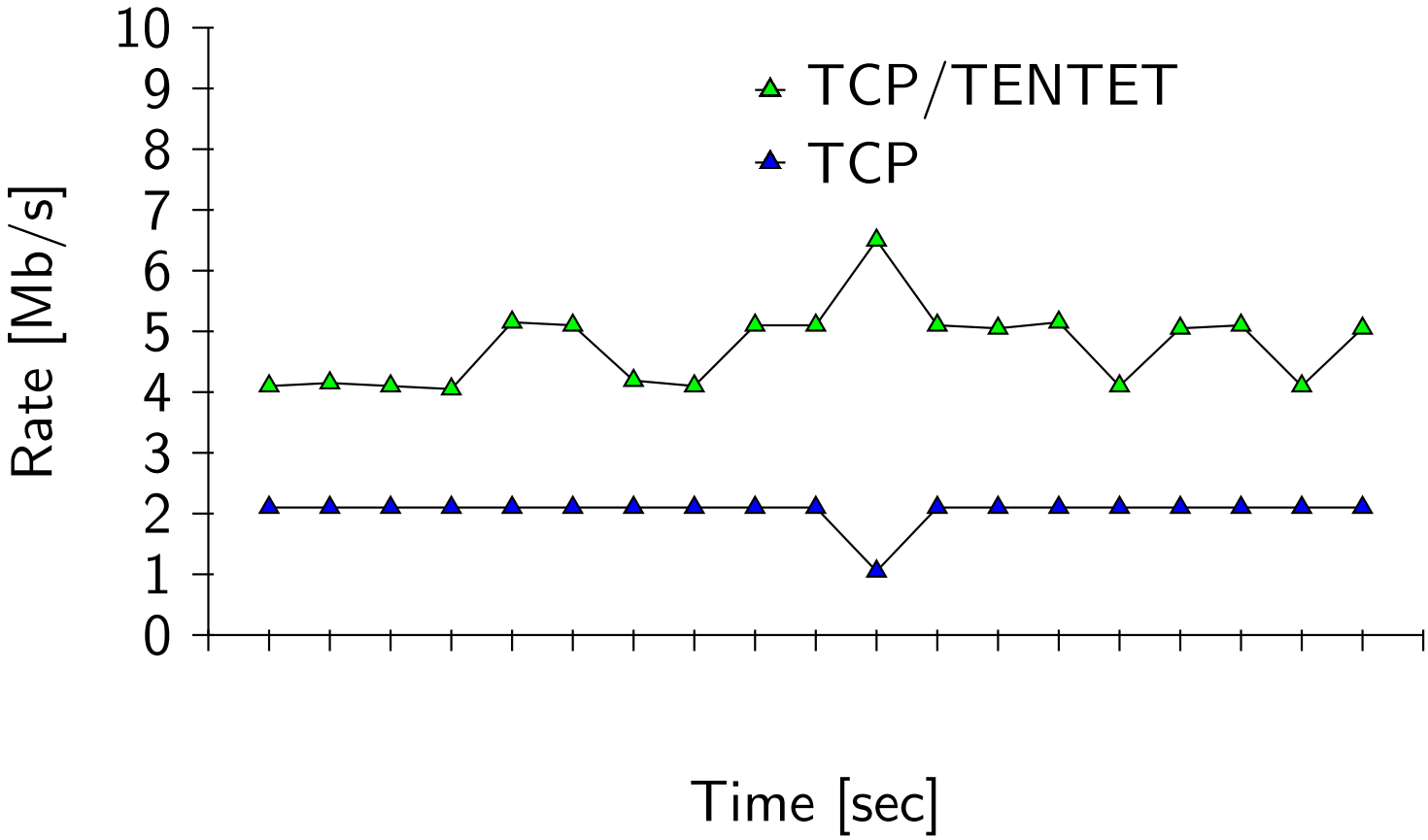
NC layer (TETRYS) below TCP all losses are masked

Illustration



NC layer with ECN crosslayer (TENTET) below TCP all losses are masked but signaled to TCP with ECN

Illustration



You might also choose when to signal

Conclusion

- Using ECN with a receiver NC layer allows to simply interact with TCP
- No modification of existing TCP stacks
- Compliant with all TCP version that follows RFC3168