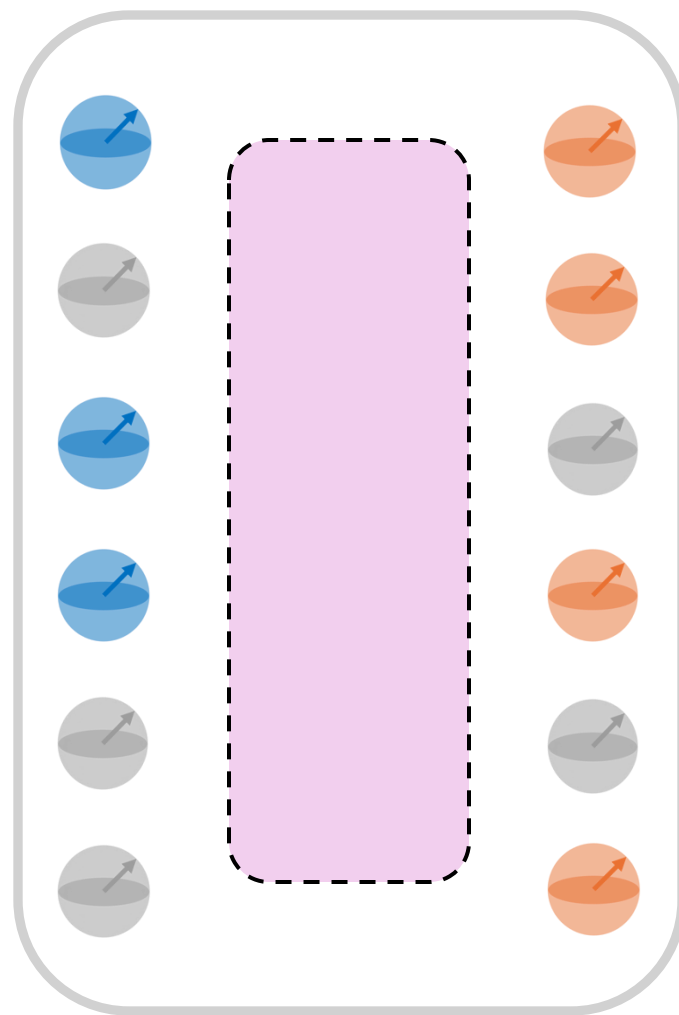





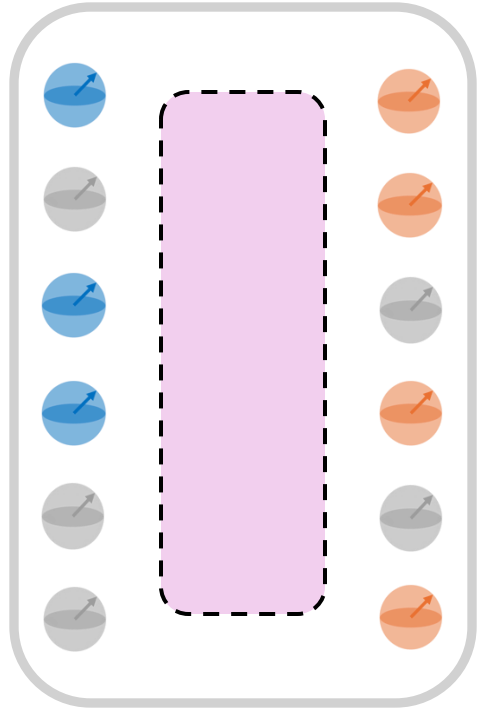
# Comparing One- and Two-way Quantum Repeater Architectures

Prateek Mantri, Kenneth Goodenough, and Don Towsley

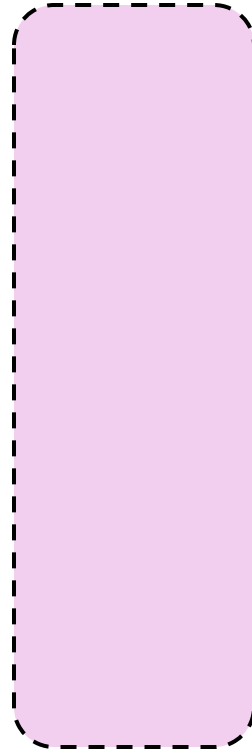


Repeater

-  Un-initialized qubit
-  Initialized Left qubit
-  Initialized Right qubit



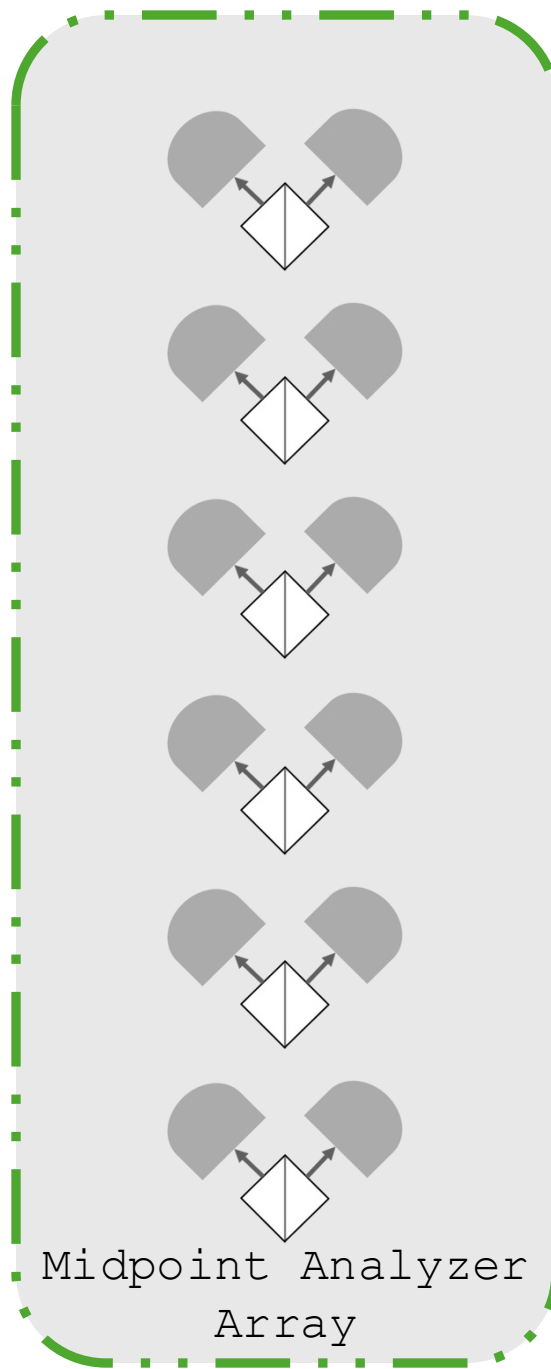
Repeater

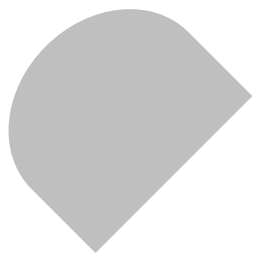


Switching  
Fabric

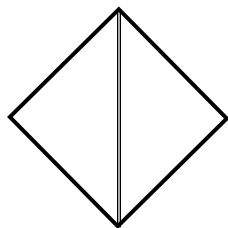
Ability to perform:

1. Two qubit gates between any two qubits
2. Measurement operations
3. Single qubit rotations

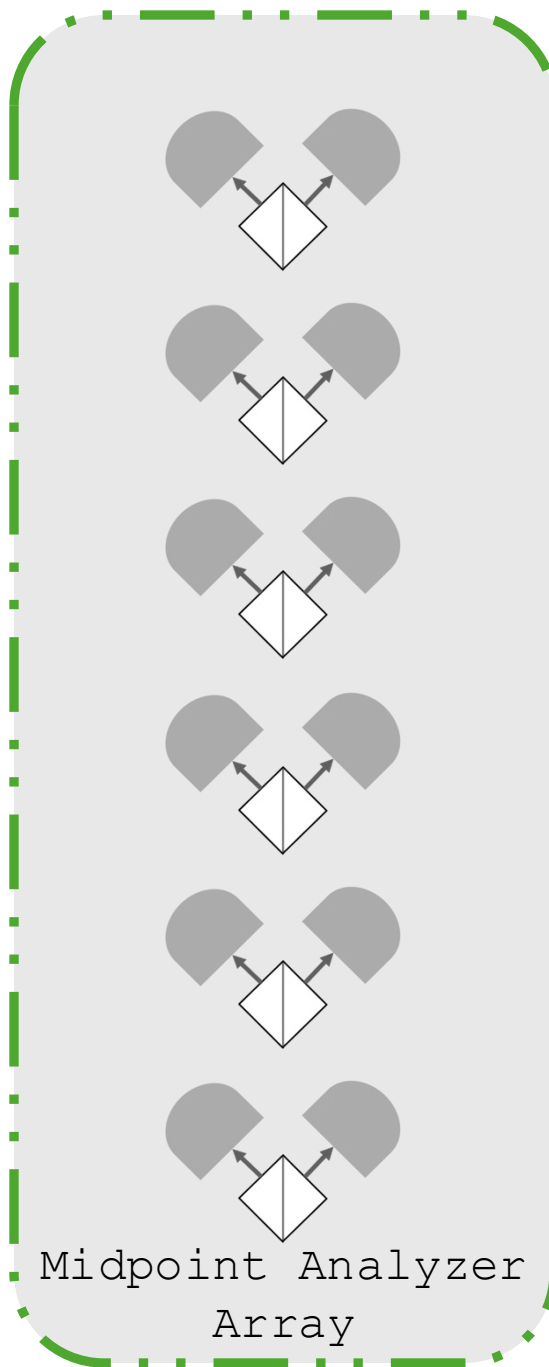




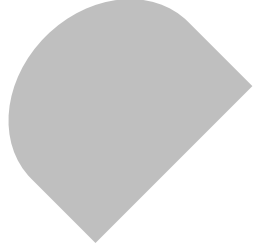
Photon  
detector



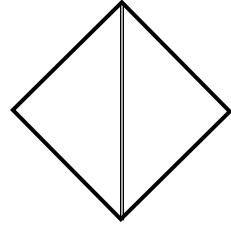
Beam  
splitter



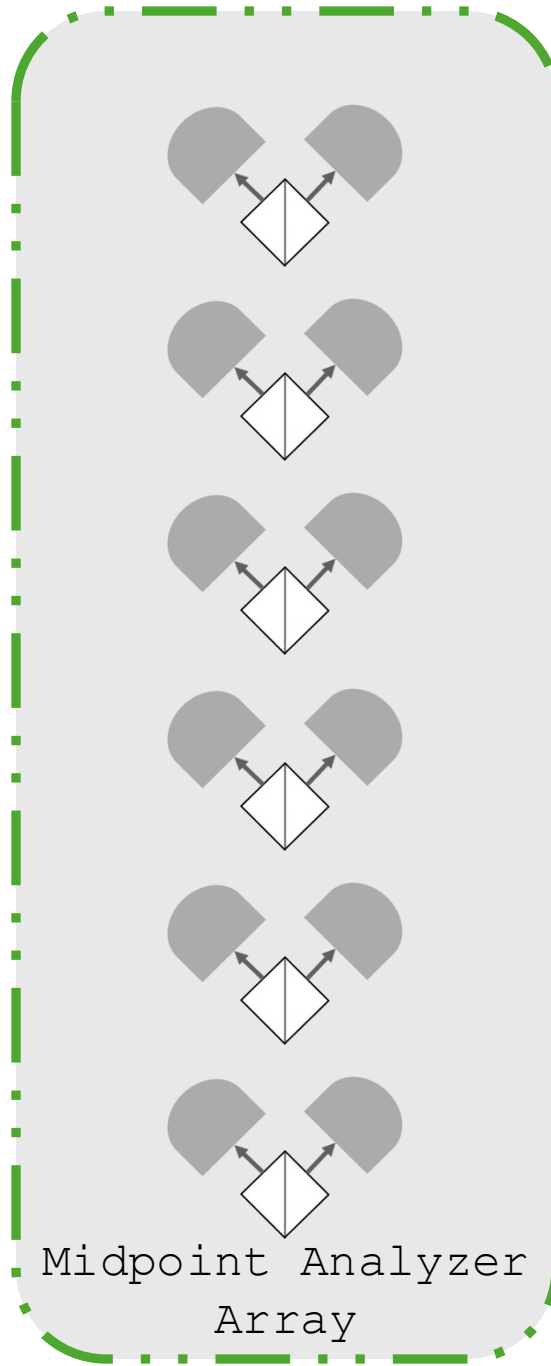
Midpoint Analyzer  
Array



Photon  
detector

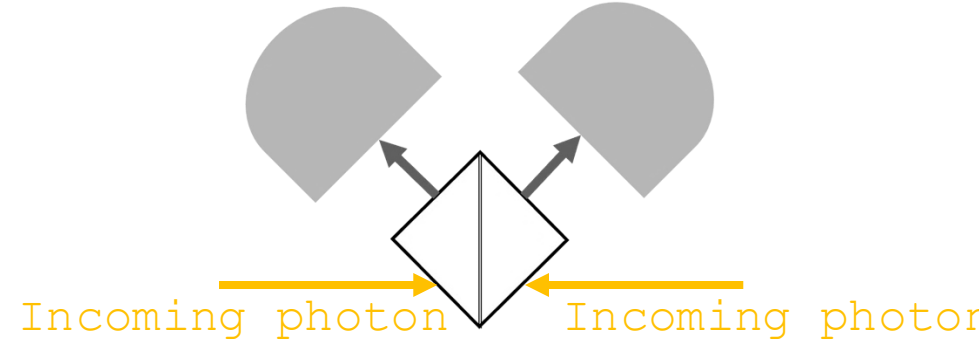


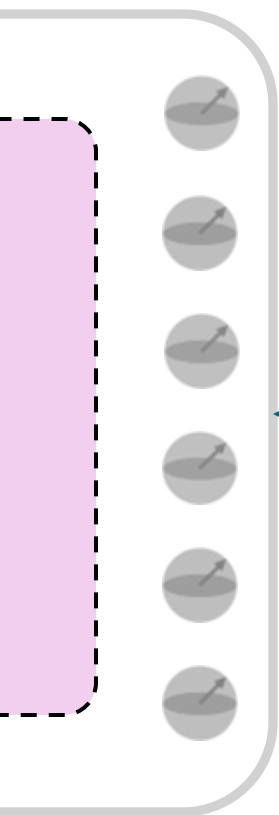
Beam  
splitter



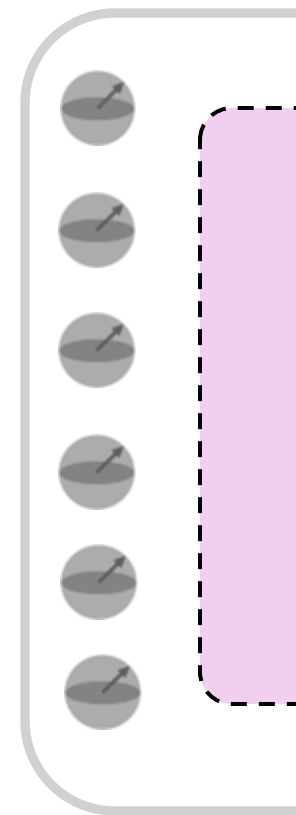
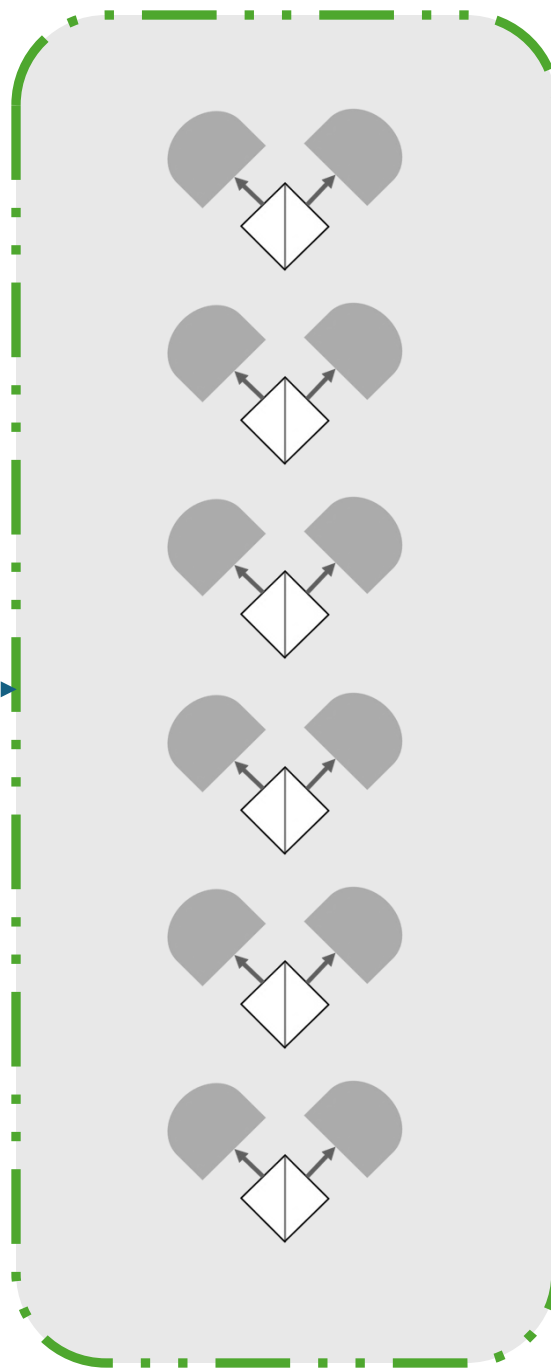
Midpoint Analyzer  
Array


Probability of  
success =  $\frac{1}{2}$



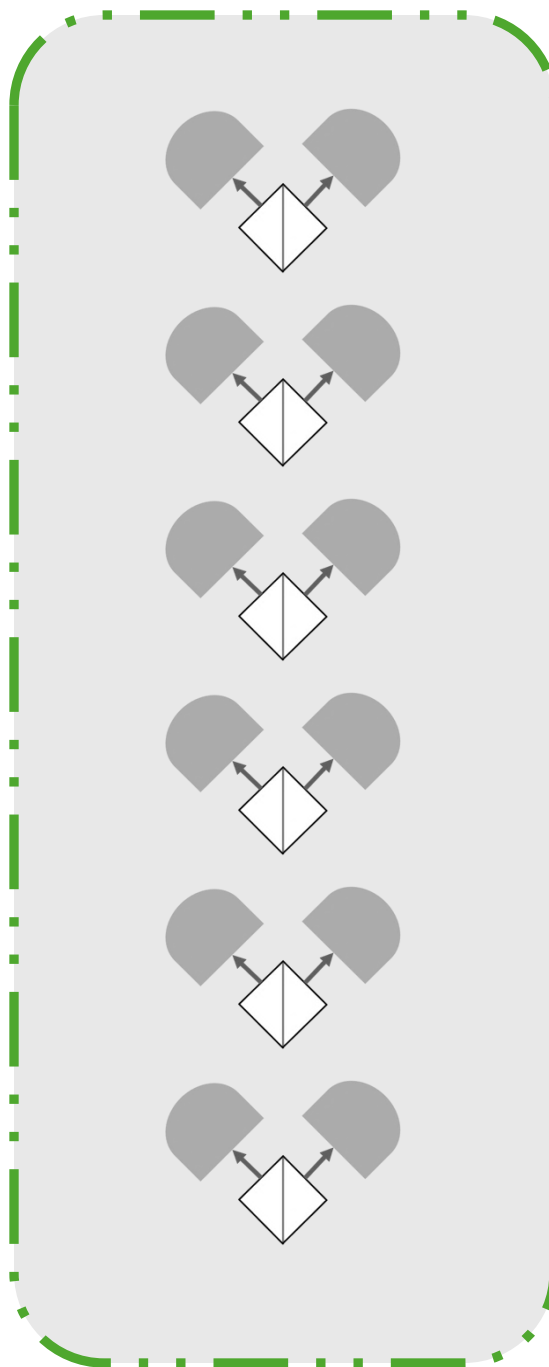
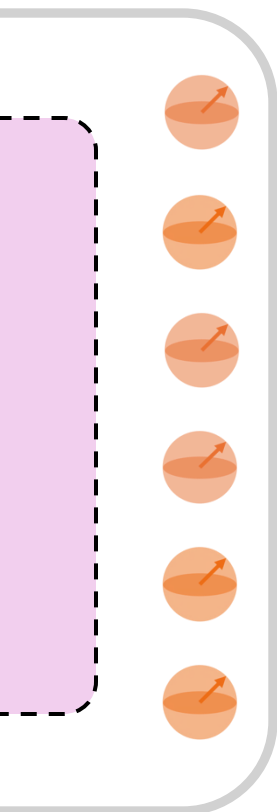


$\frac{L_0}{2}$   
 $\frac{1}{2}$  of Inter-repeater  
distance  $L_0$

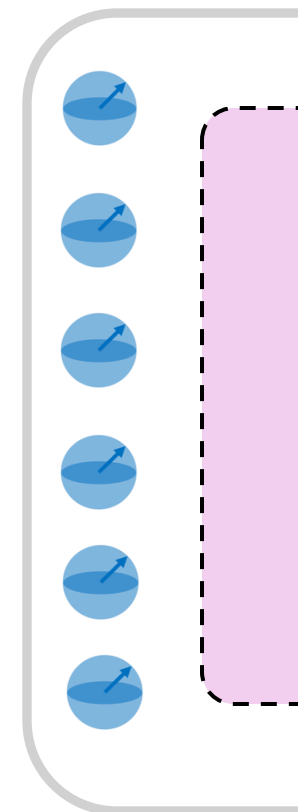





 Un-initialised qubit

Coupling  
efficiency

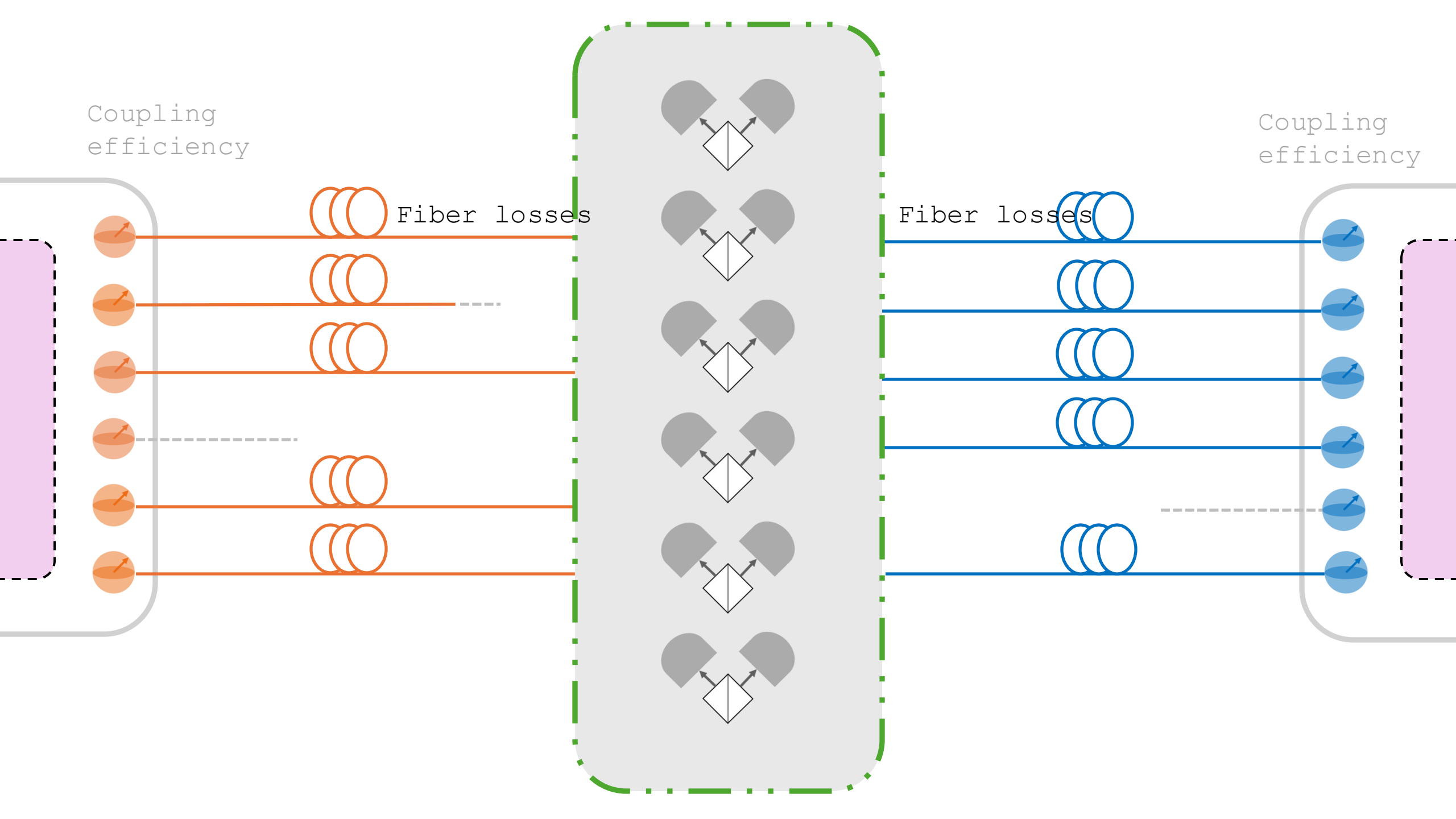


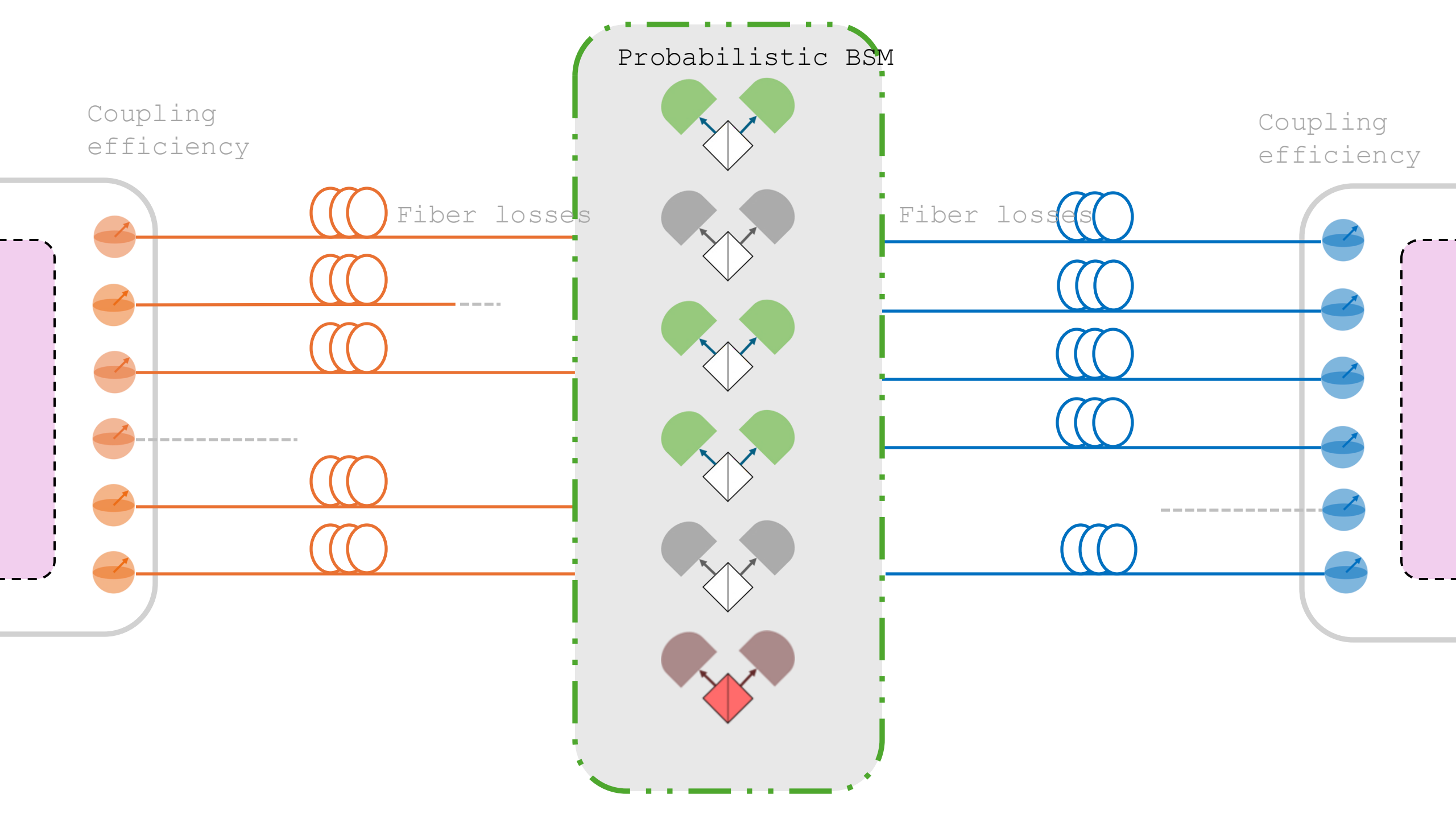
Coupling  
efficiency

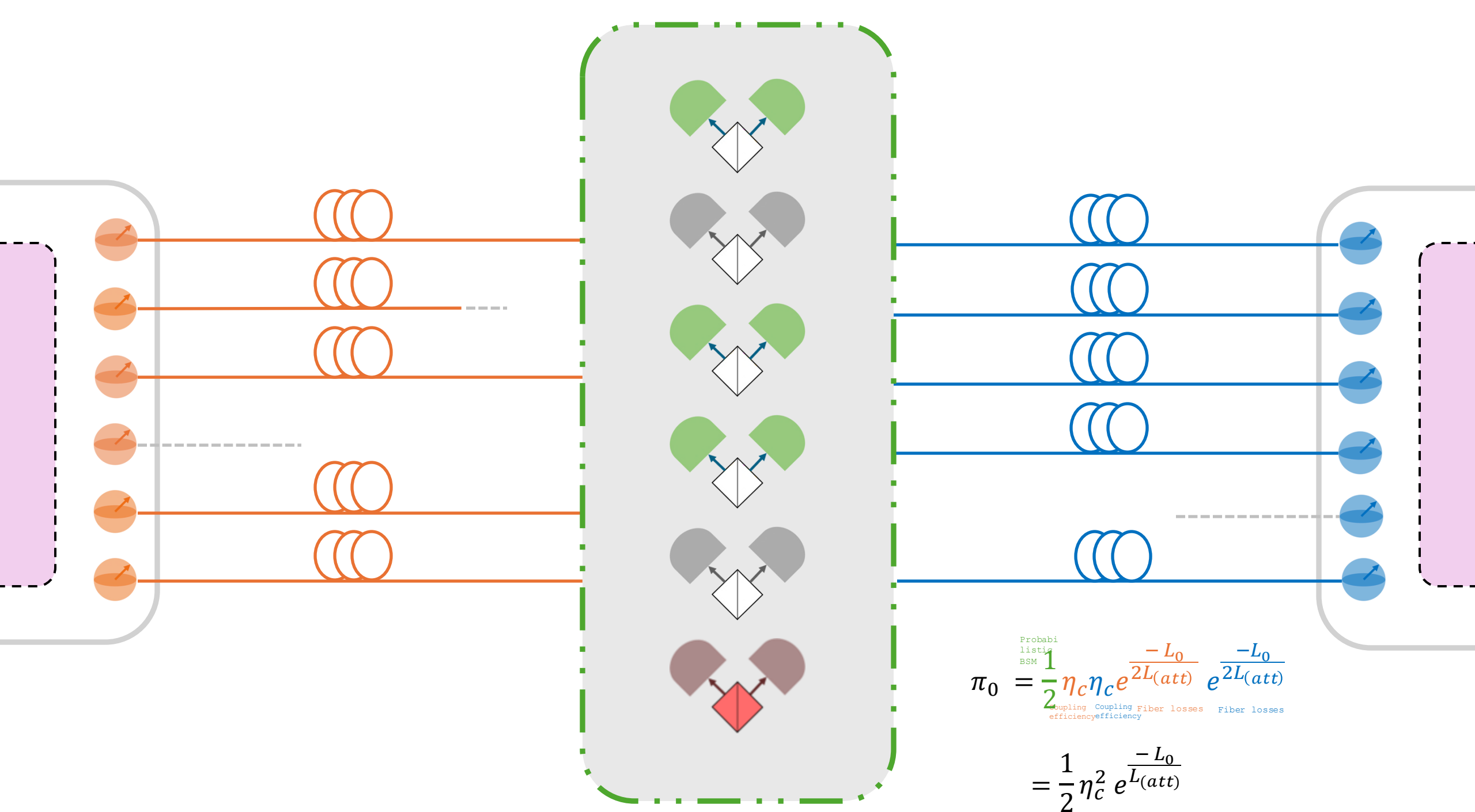


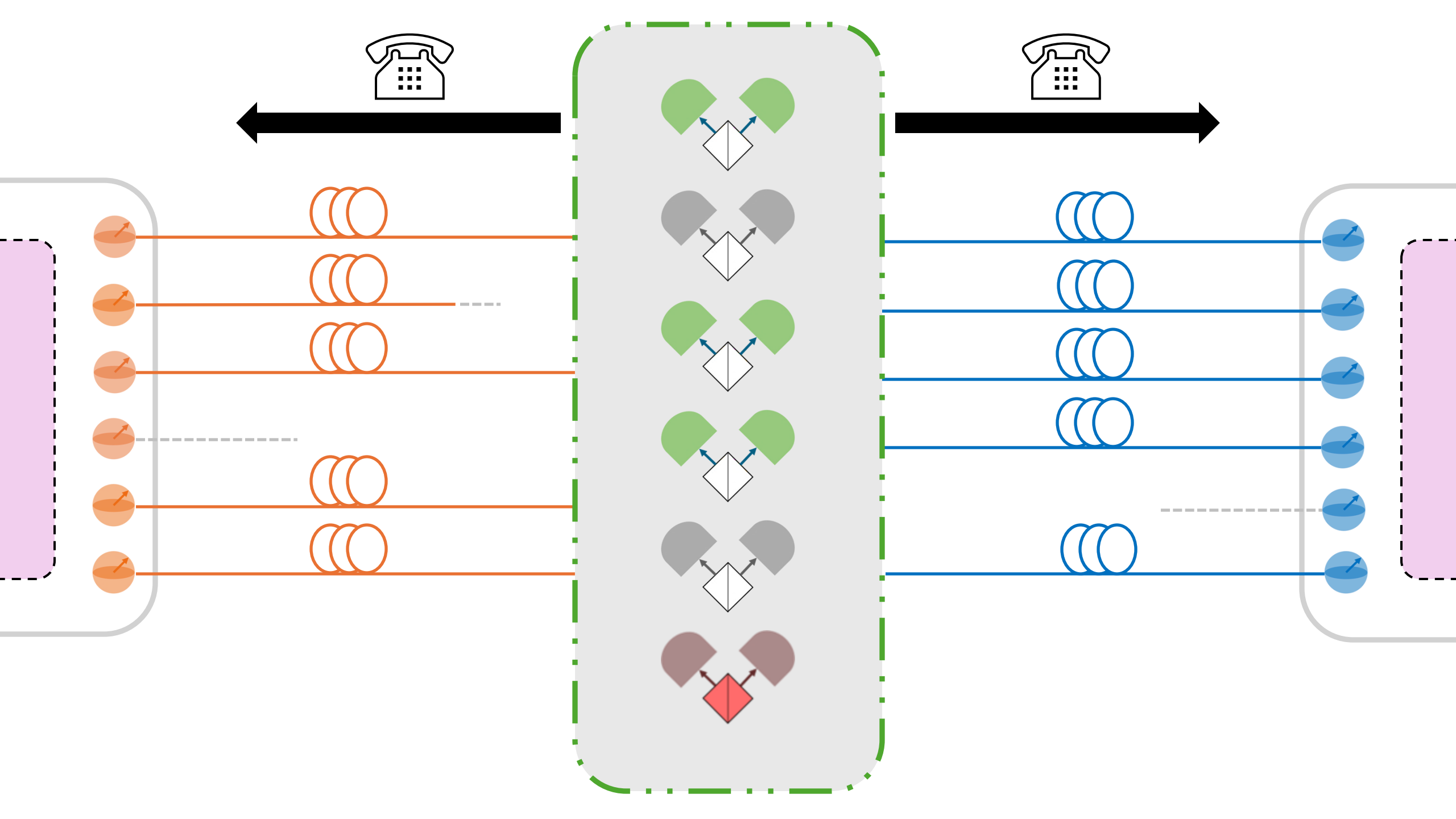
-  Un-initialized qubit
-  Initialized Left qubit
-  Initialized Right qubit

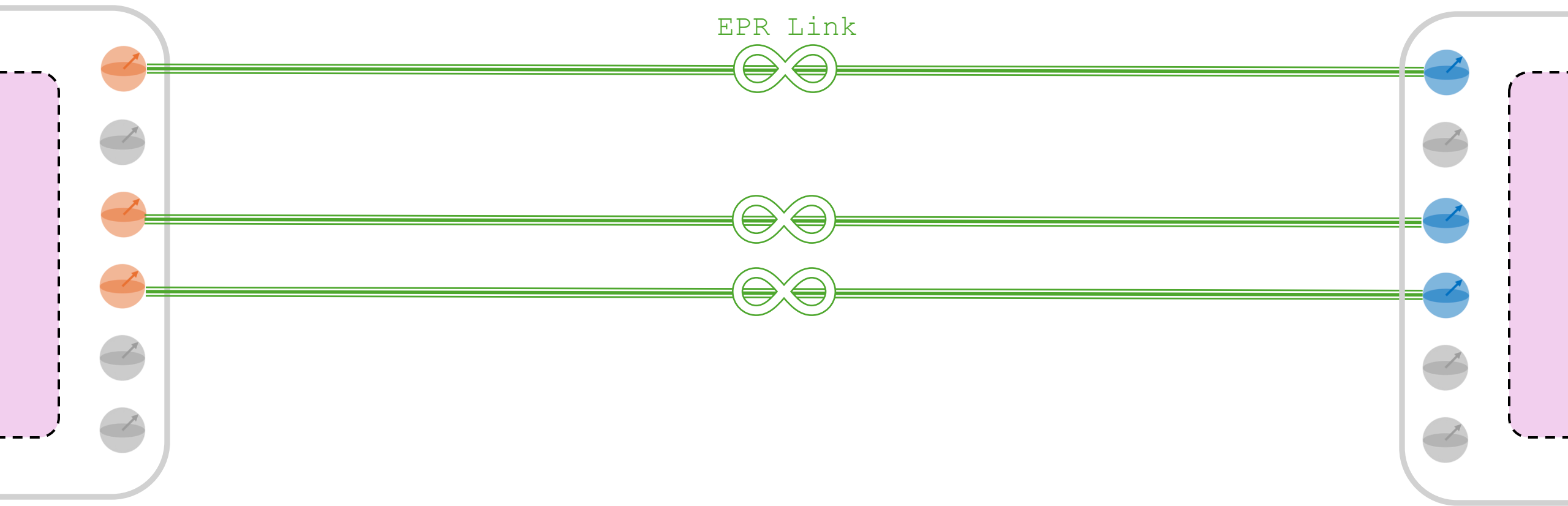


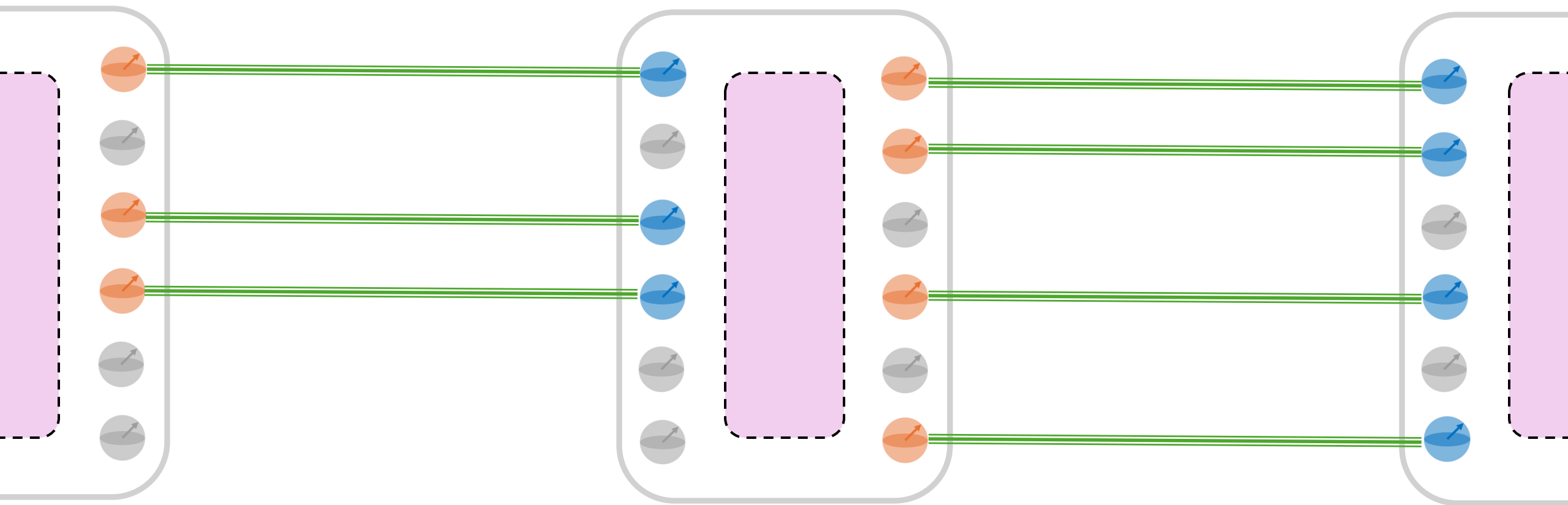


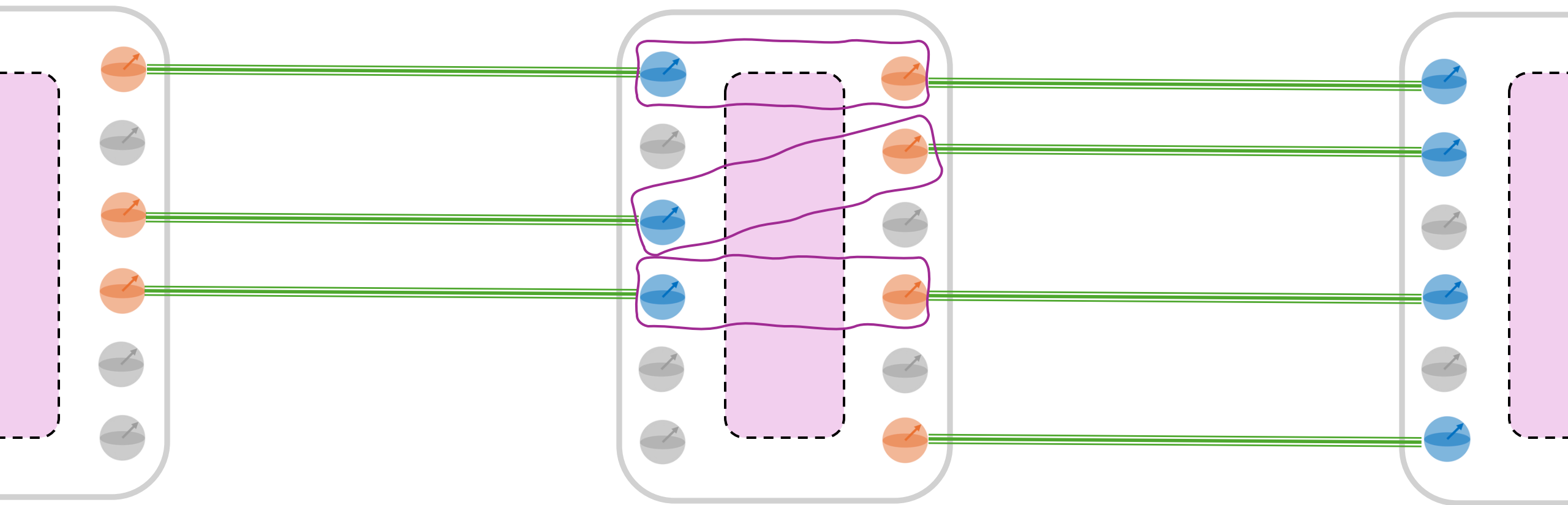





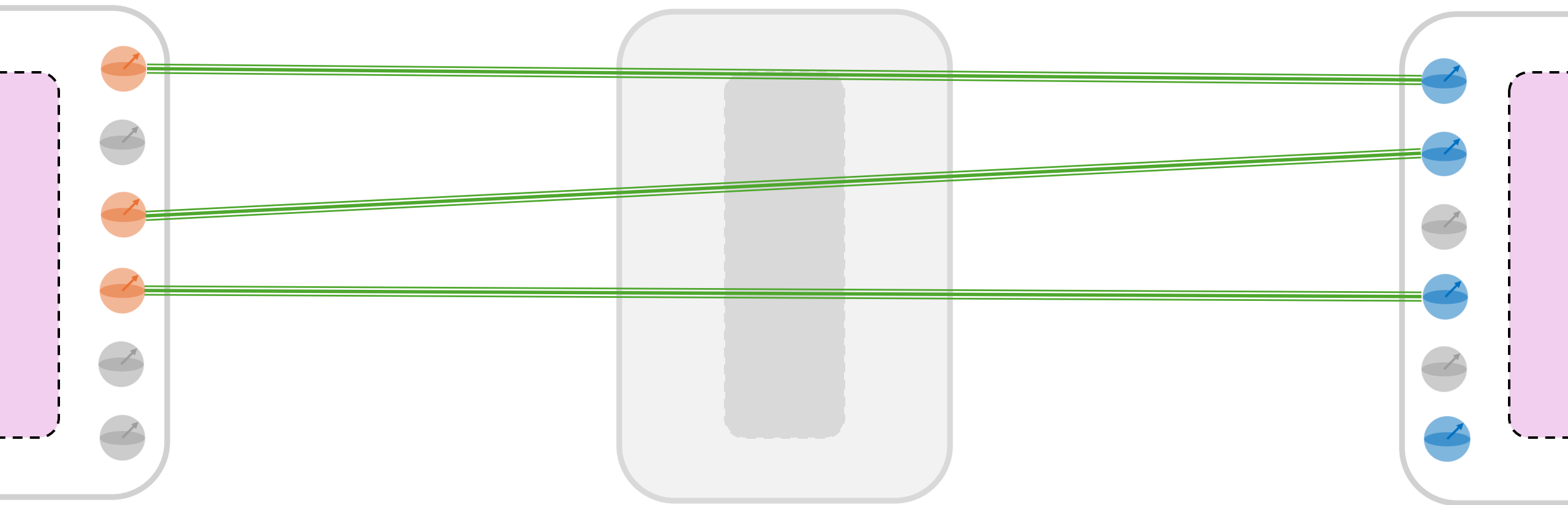




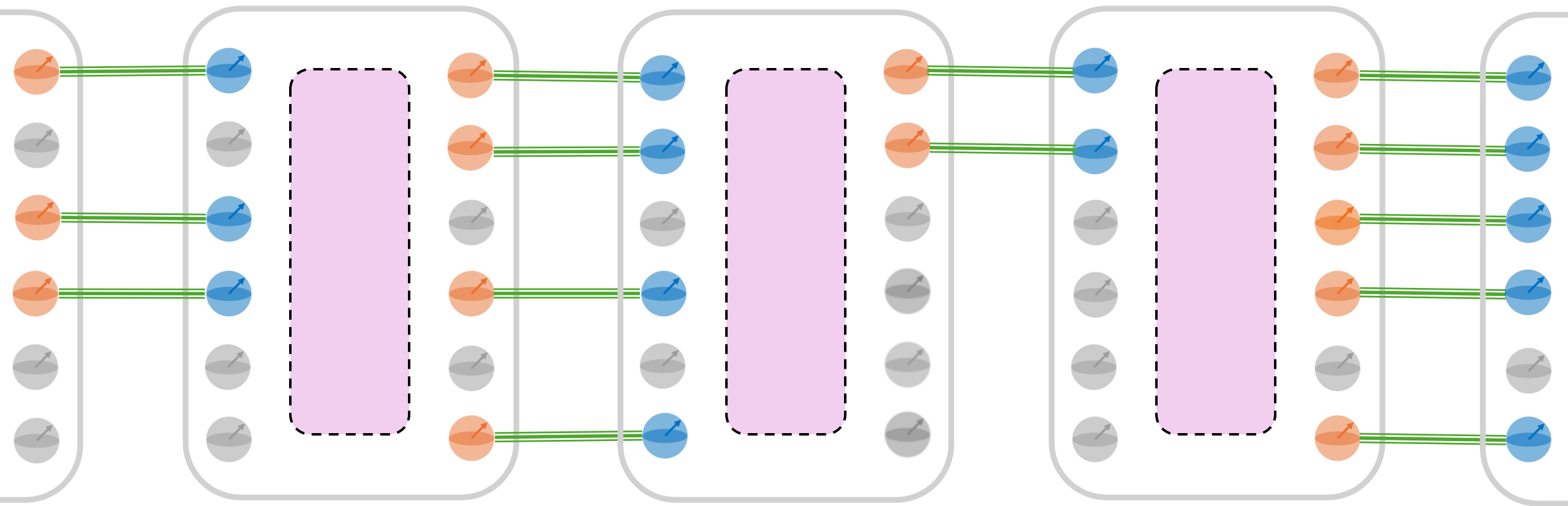


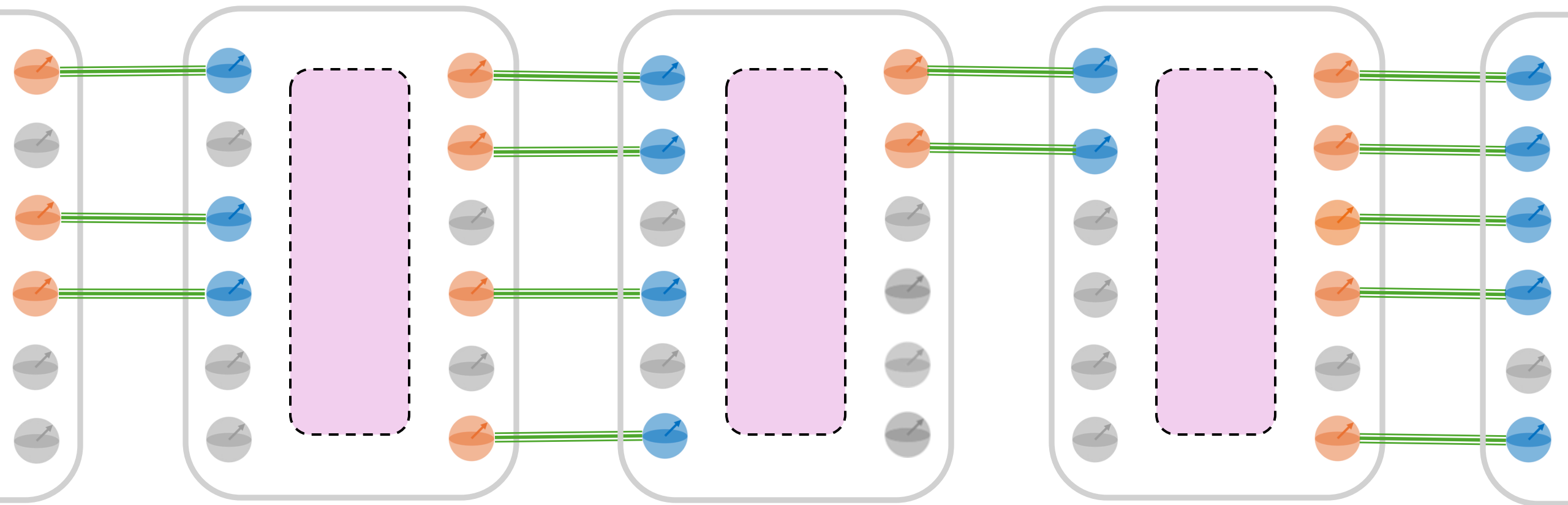


 Swap operation  
(Deterministic in  
our case, hence no  
CC wait)

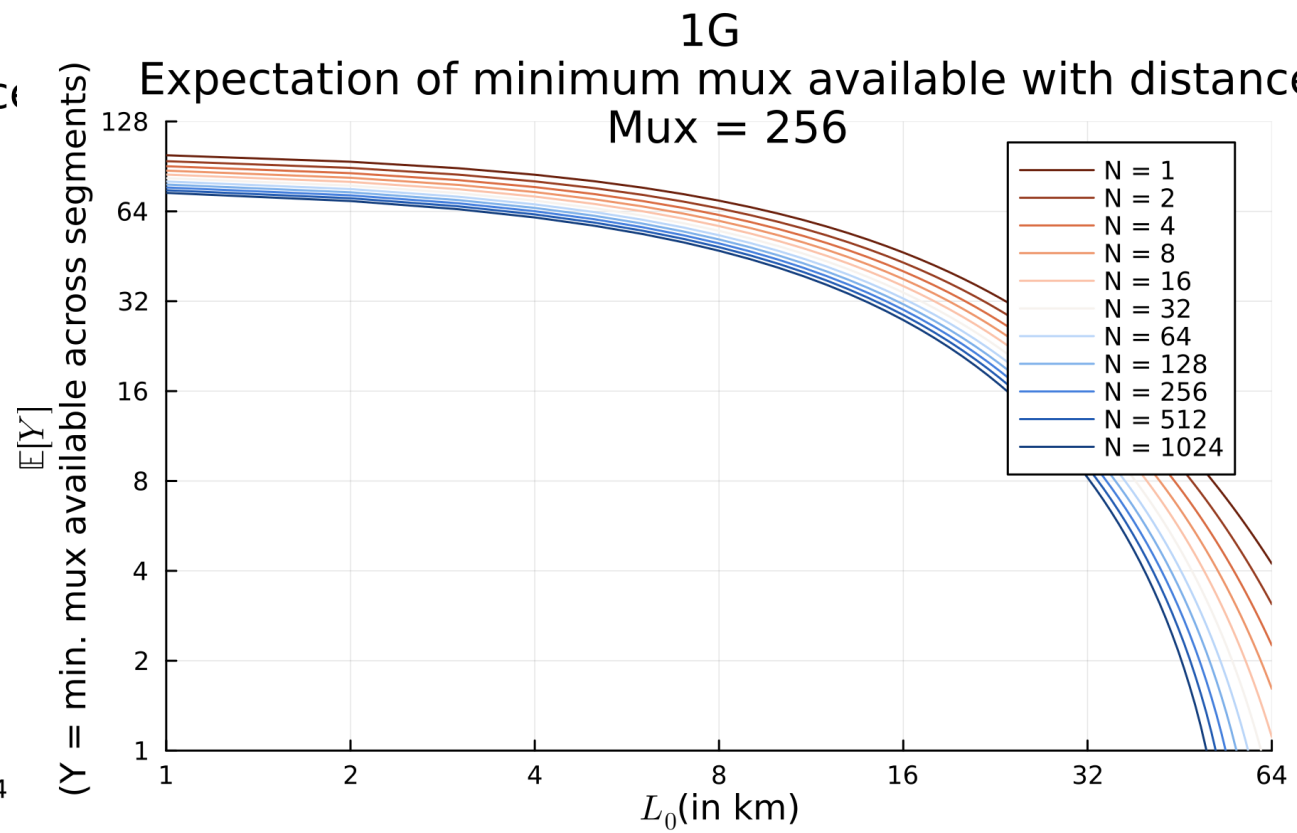
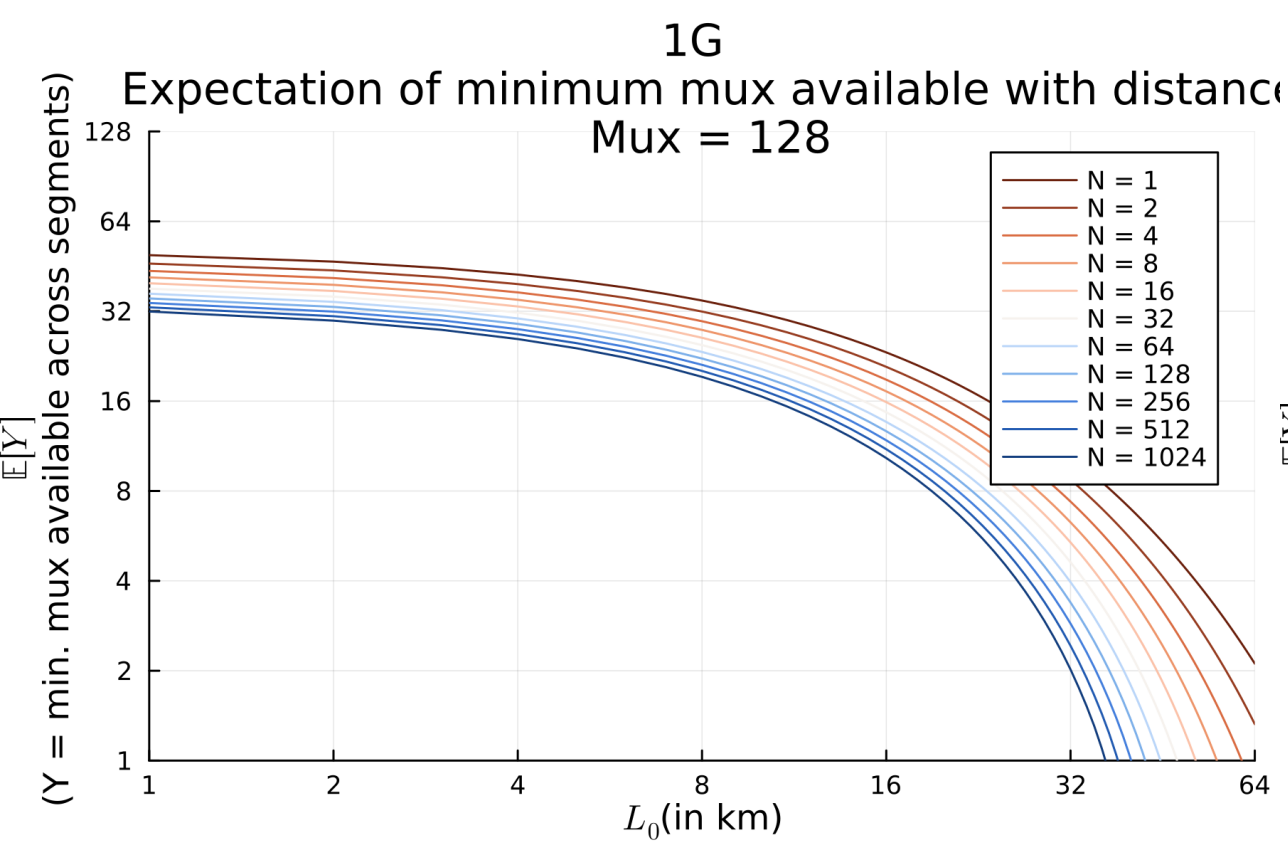
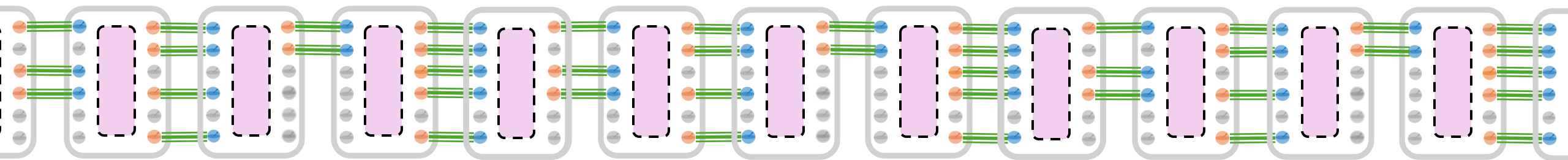


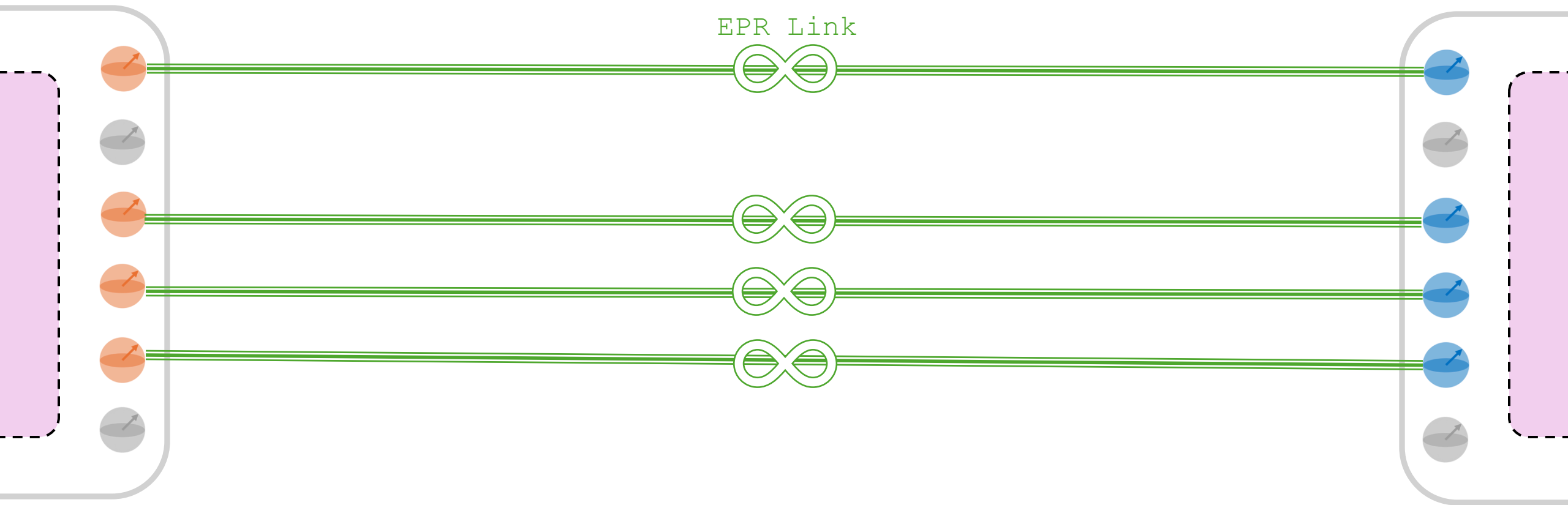


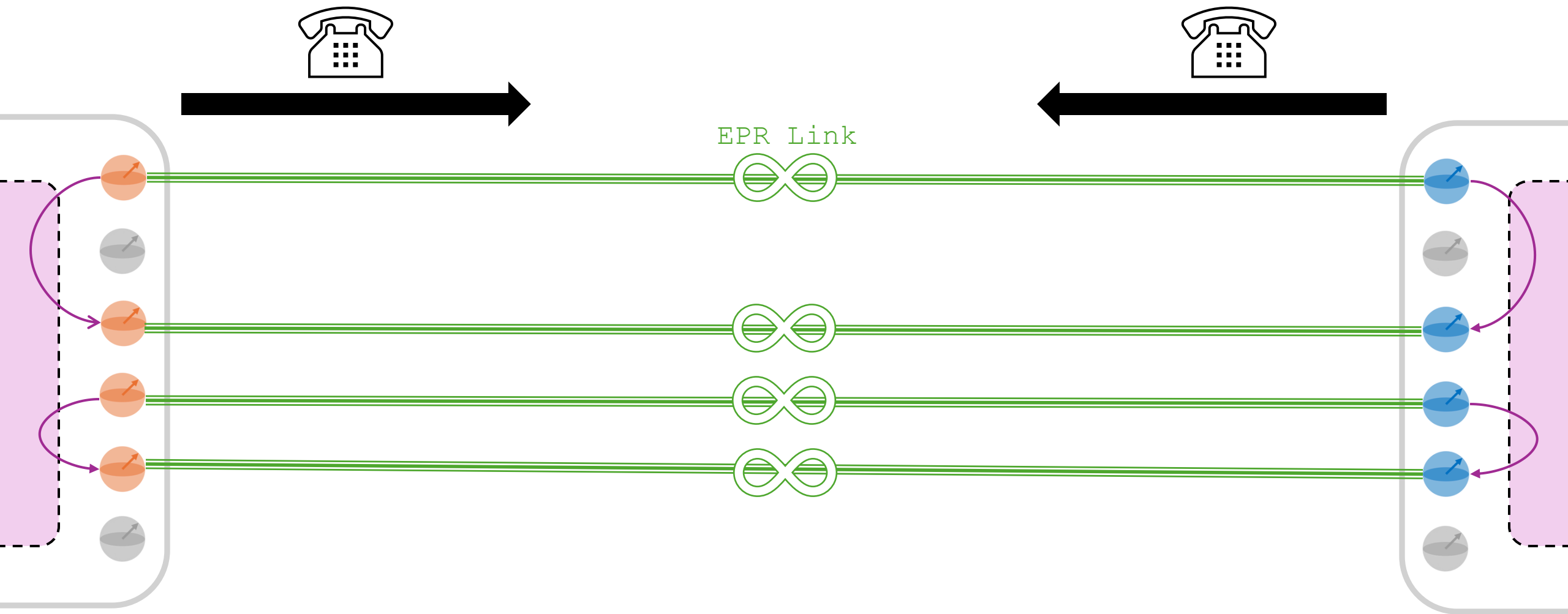




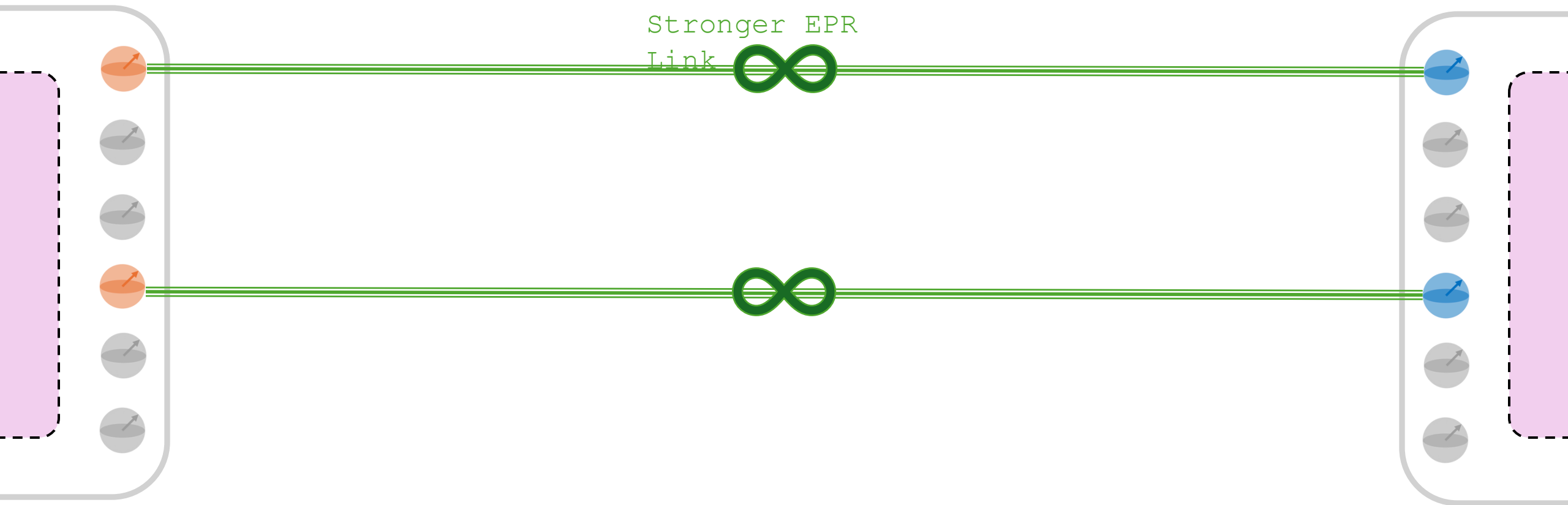
If swaps are perfect, and we don't perform distillation, how many bell pairs we can have end-to-end?

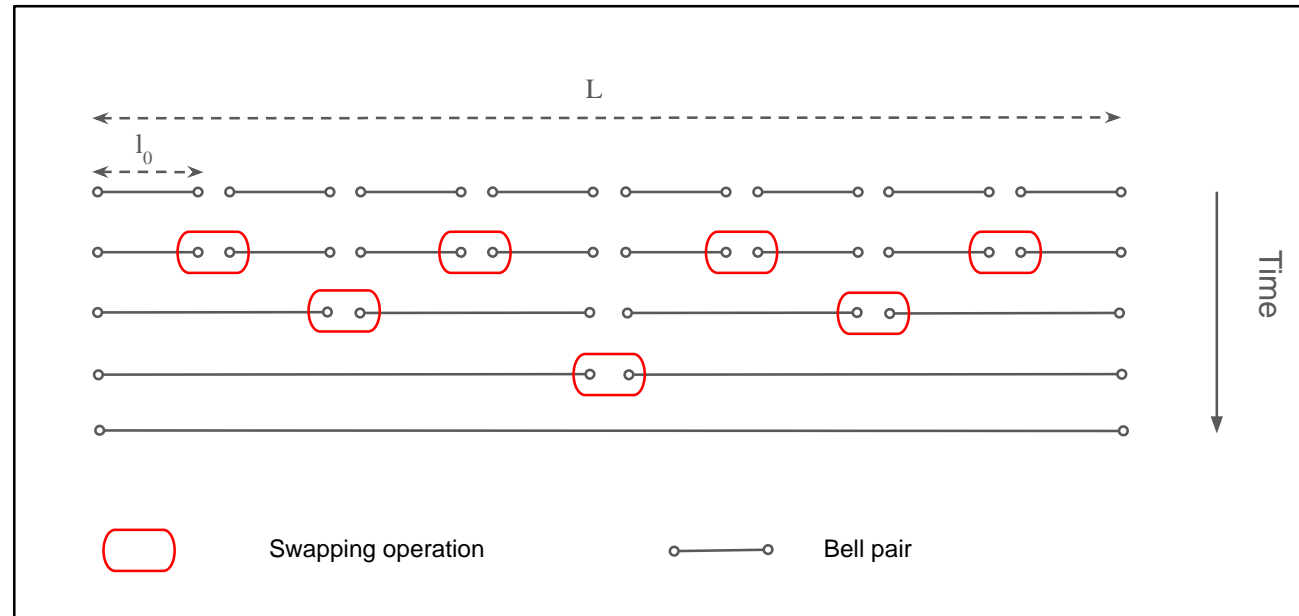






→ Circuit implementing  
distillation protocol with the  
direction signifying the  
sacrificial pair(s)

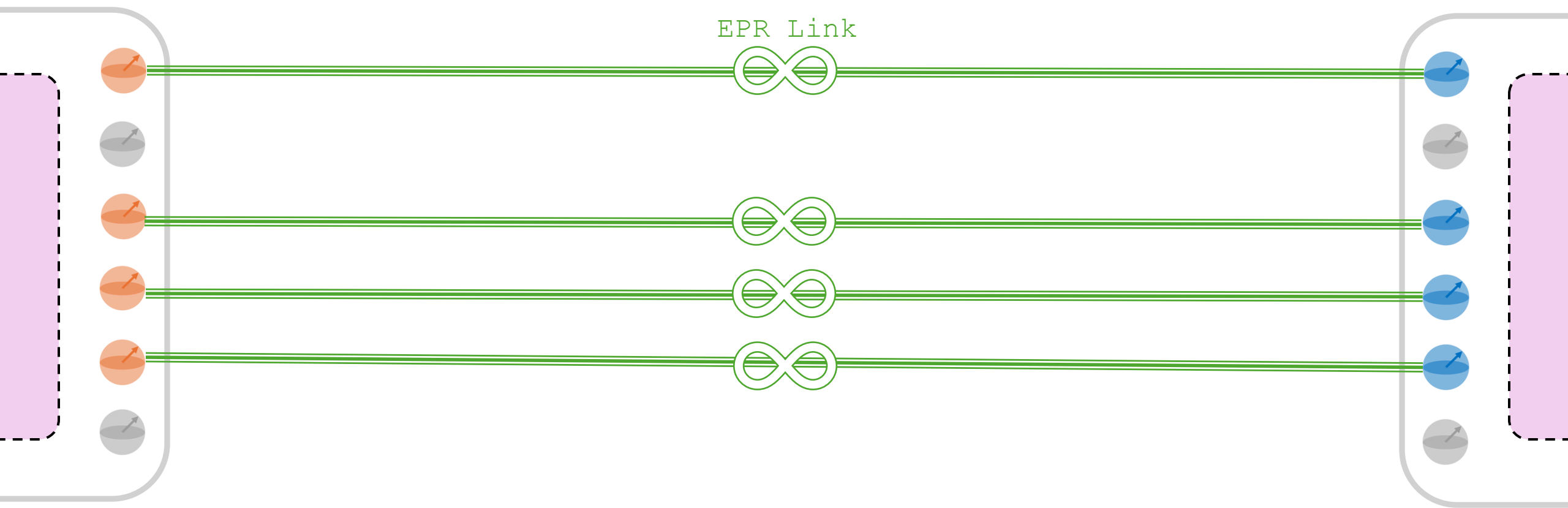




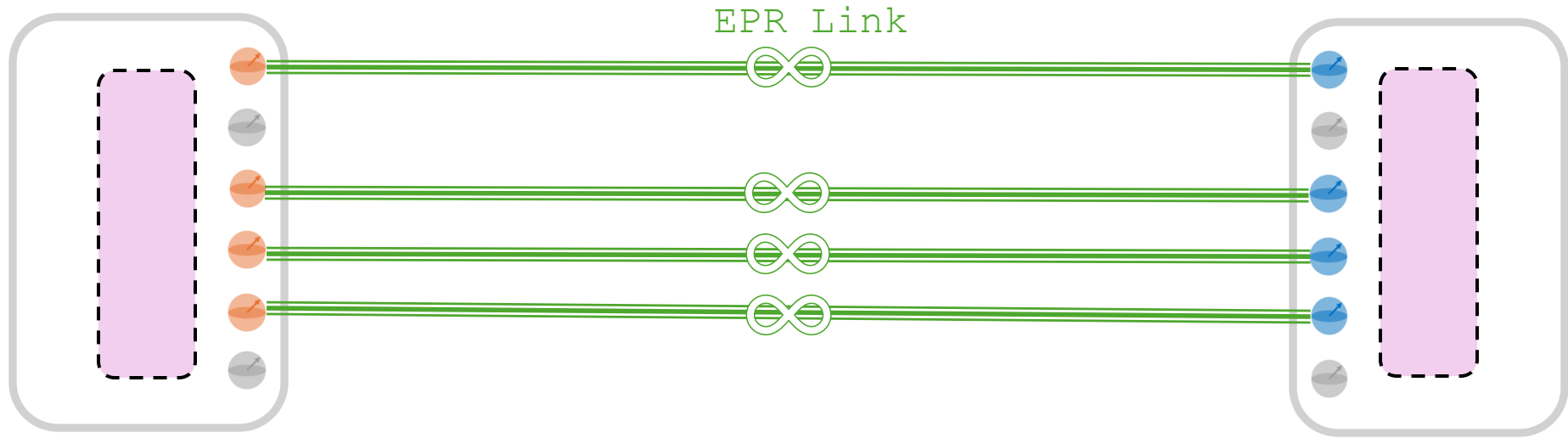
Nested swap/purification

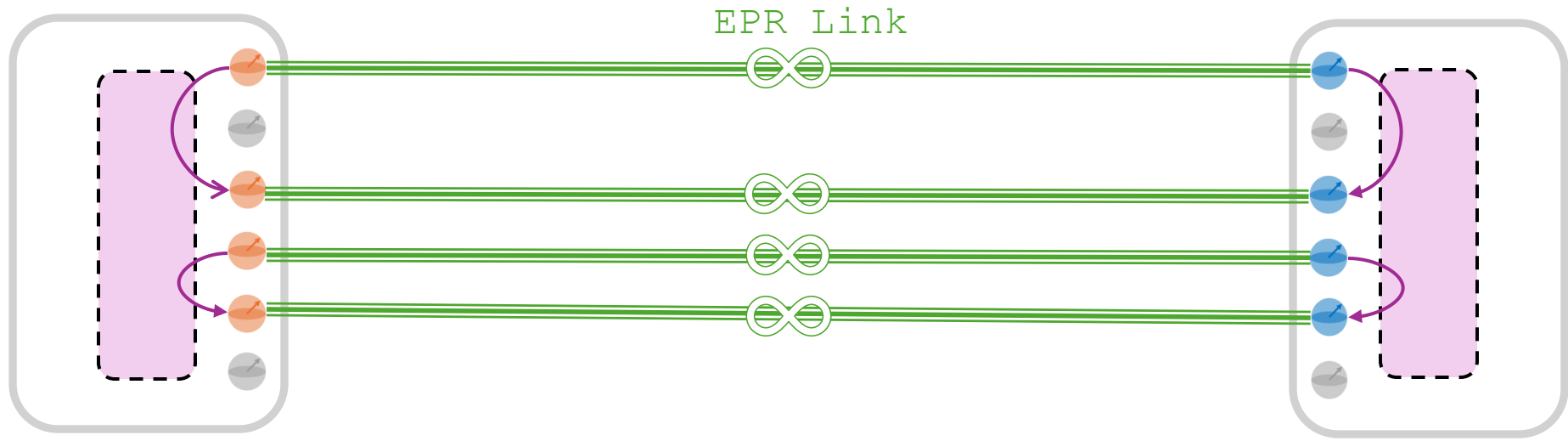
Each successive level  $i$  has the twice the link length than its predecessor  $i - 1$

Let's consider a linear network with  $N = 2^n$  links, and  $M = m2^{n+1}$  number of multiplexed channels at elementary link level





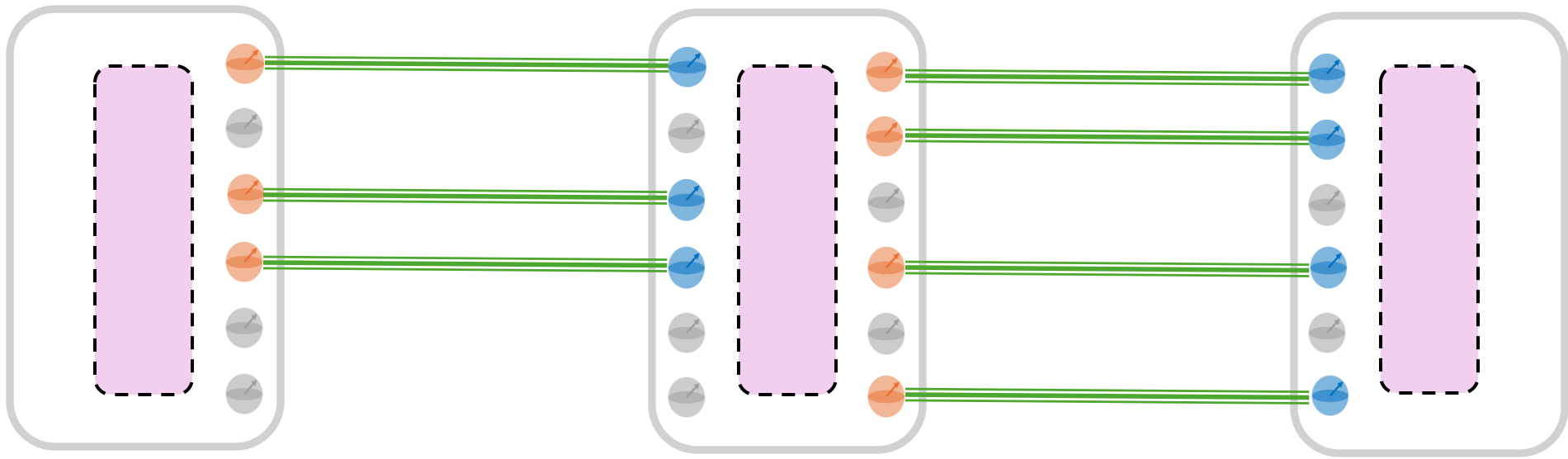


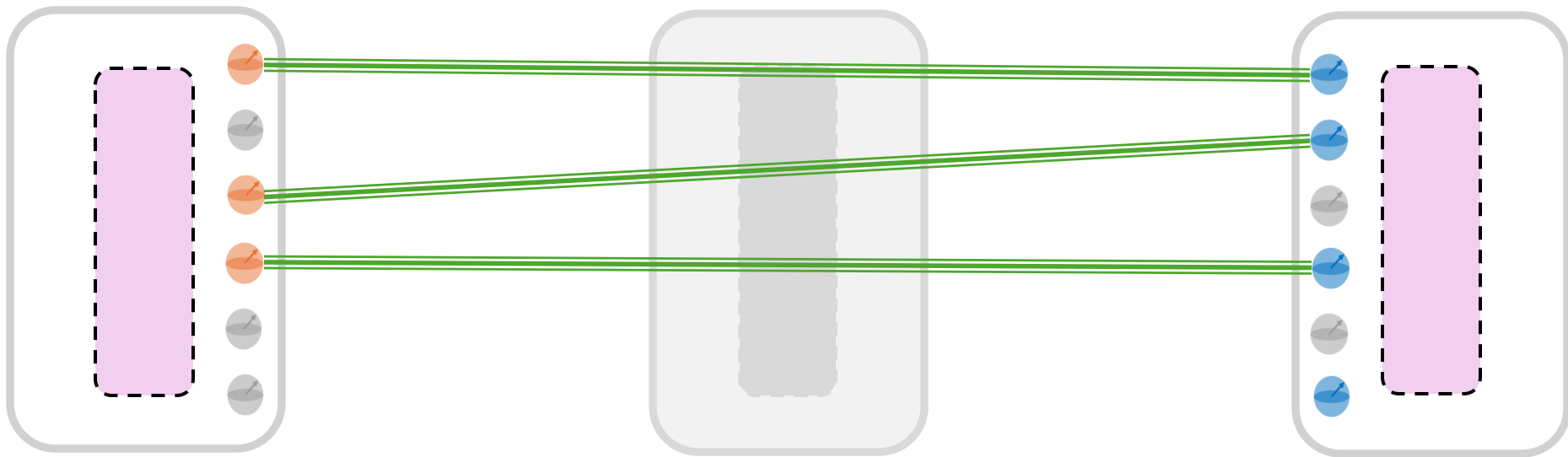


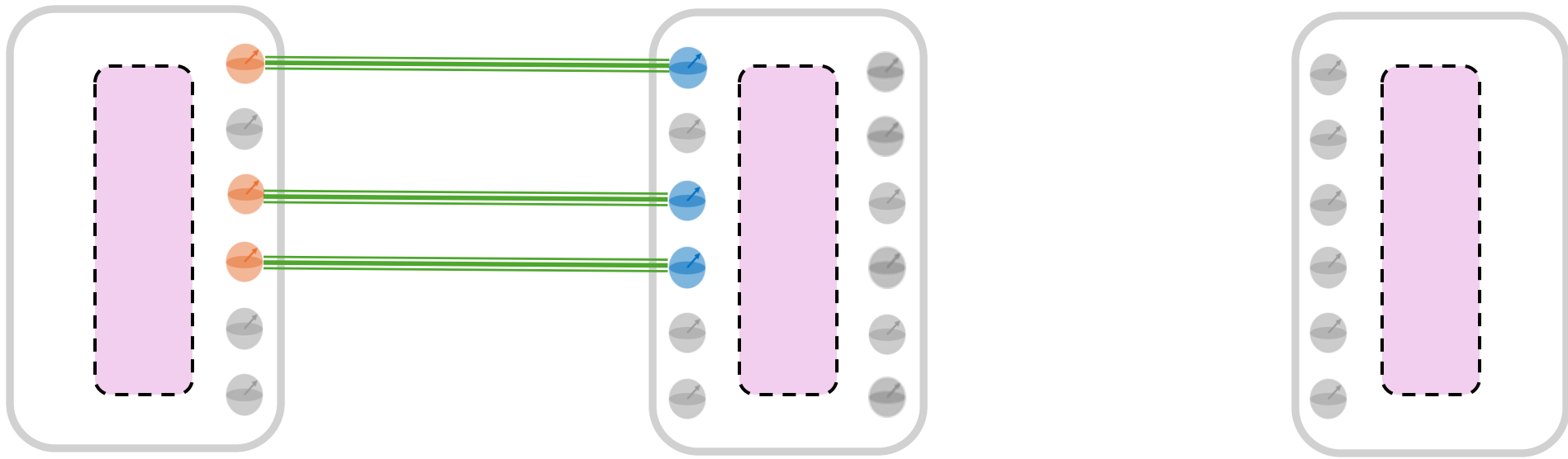
Distillation has success probability

Circuit implementing distillation  
protocol with the direction  
signifying the sacrificial  
pair(s)

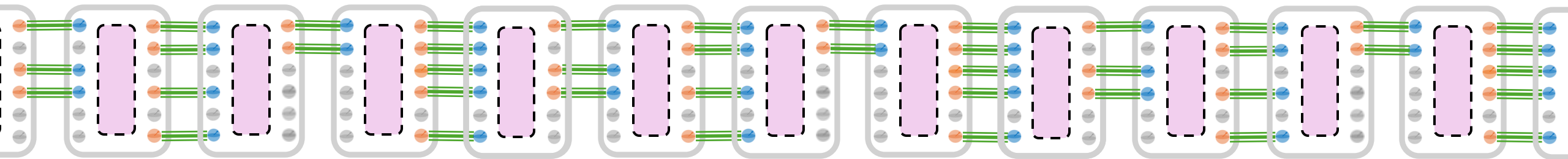




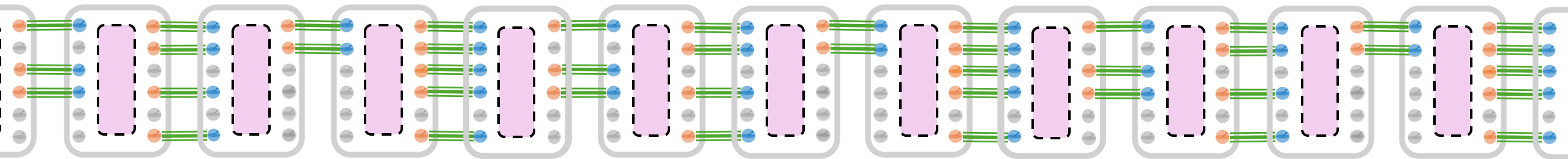




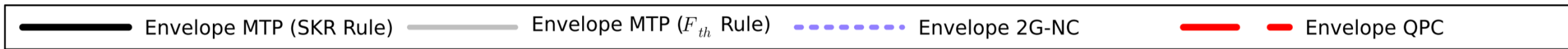
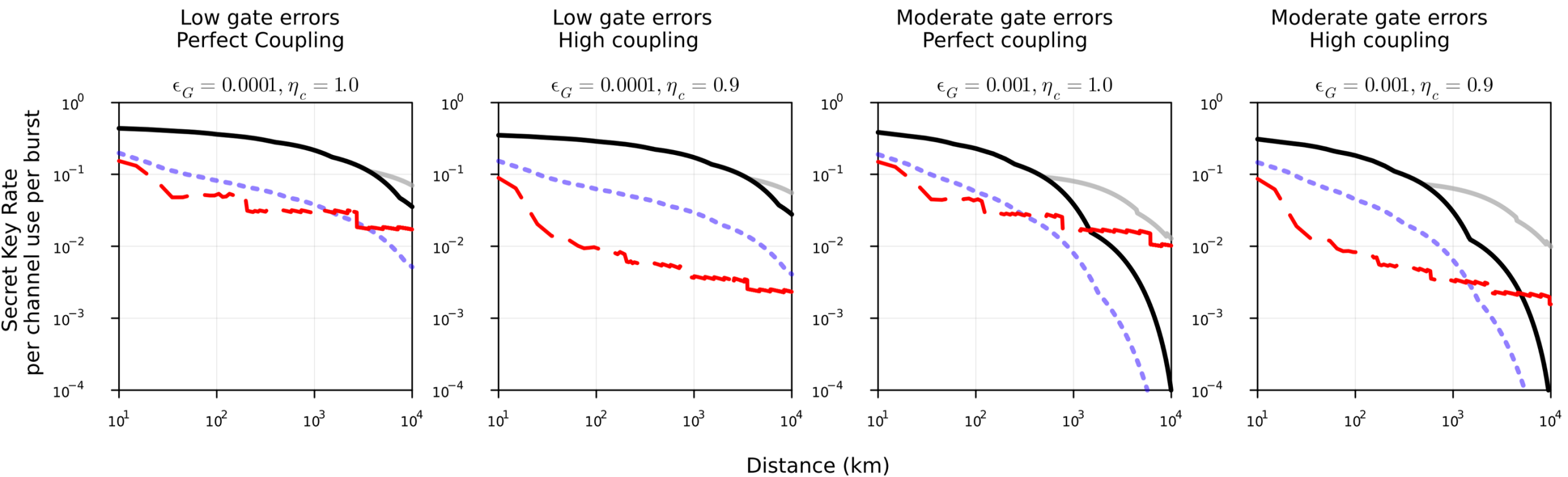
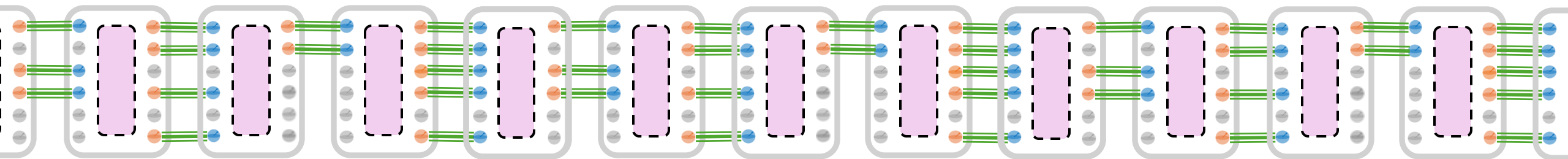
We reach level  $i$ , and we realize that the neighbor doesn't have enough links available - Reset!



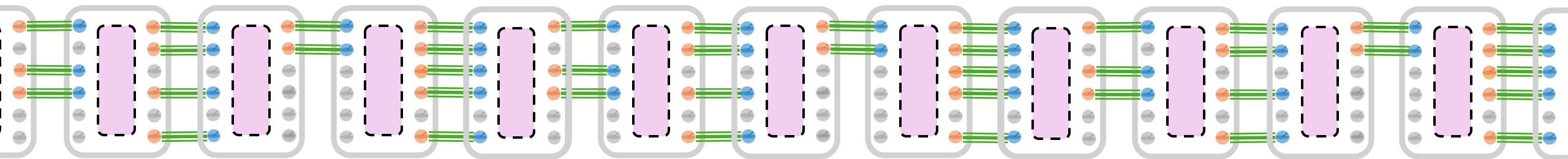
Updated equations to incorporate reset



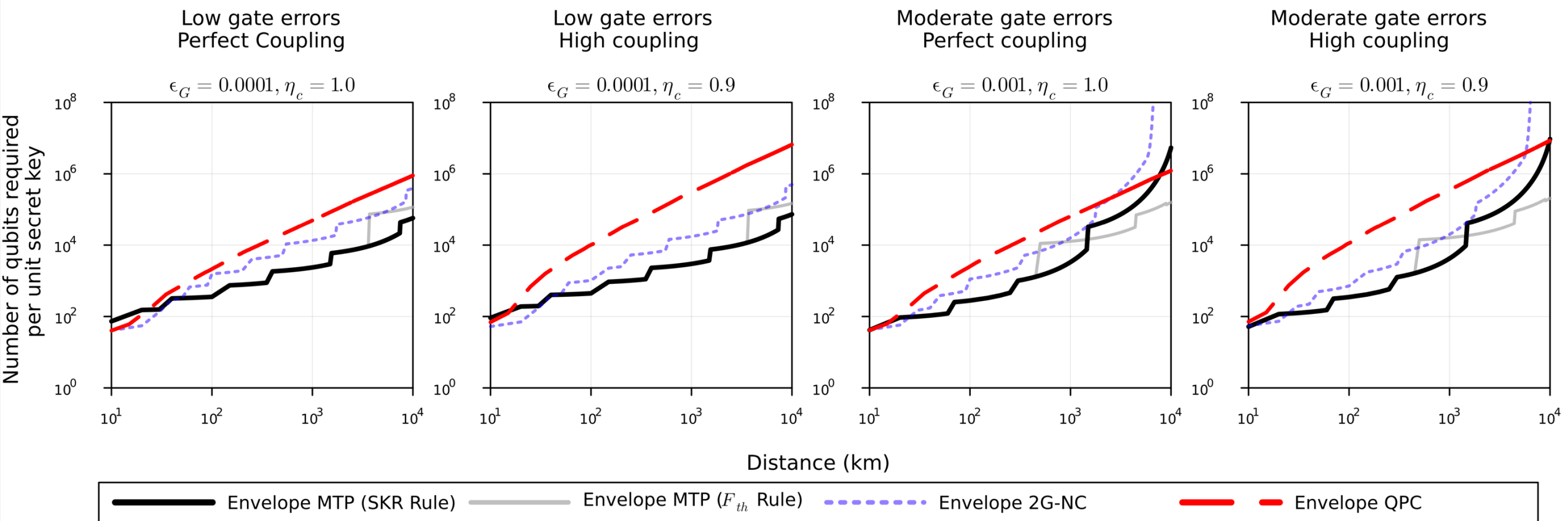
Updated equations to incorporate reset

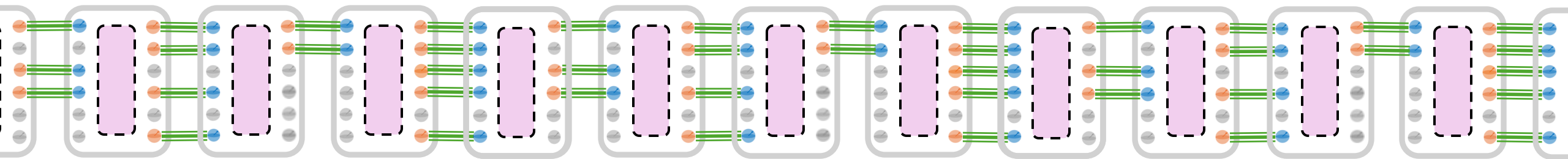




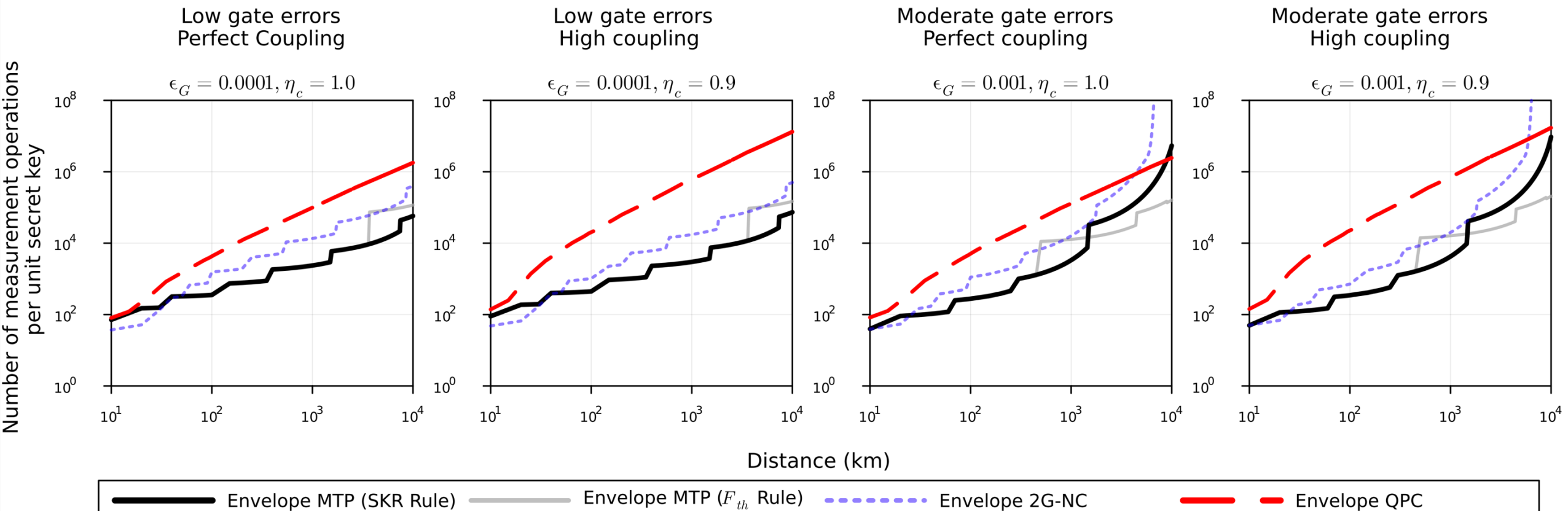


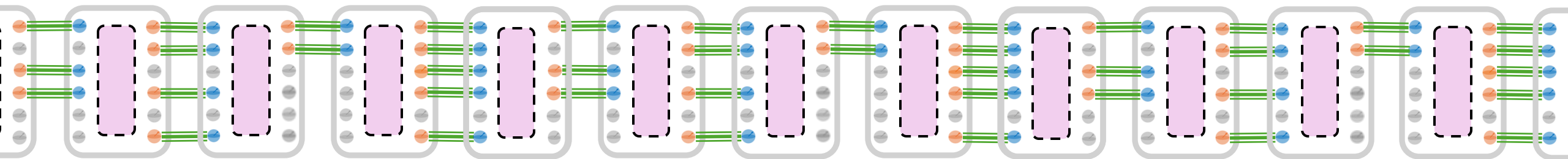
## Costs



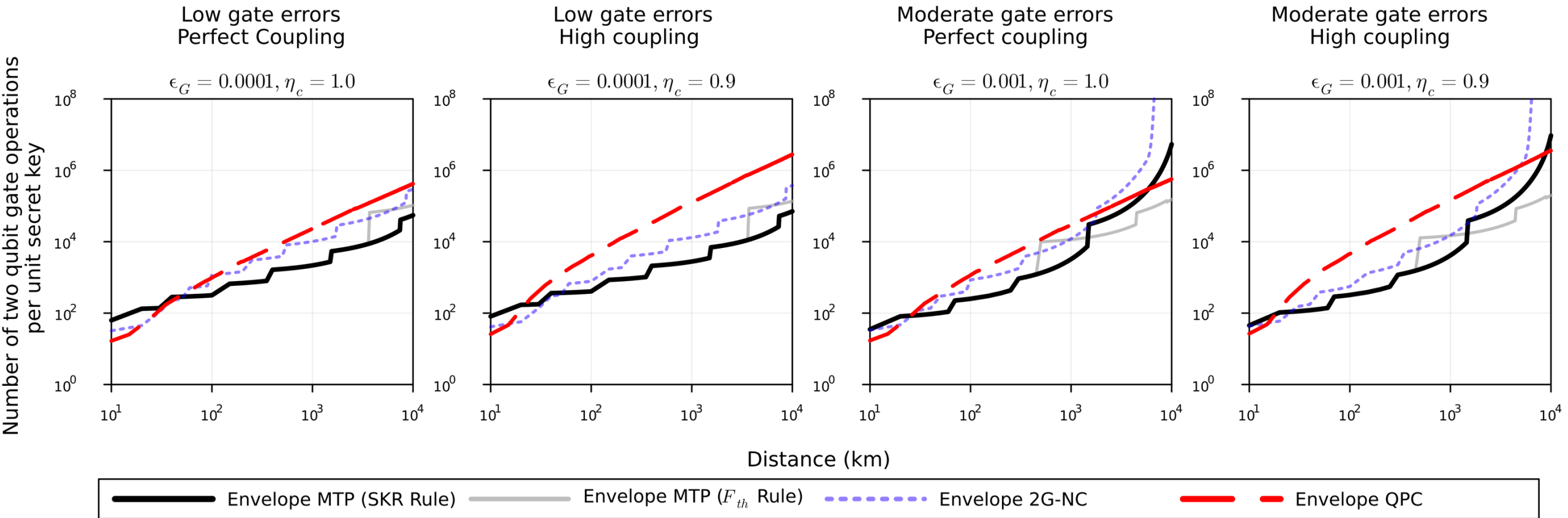


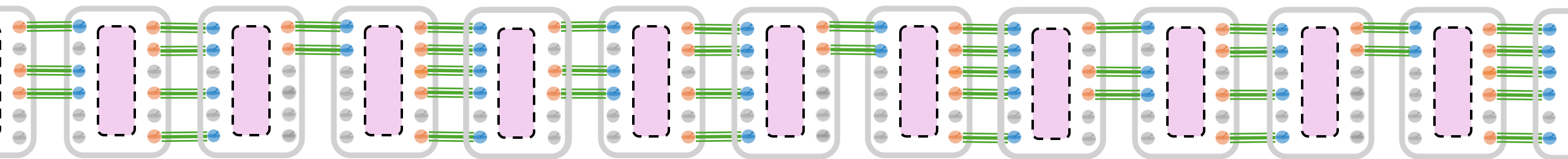
## Costs



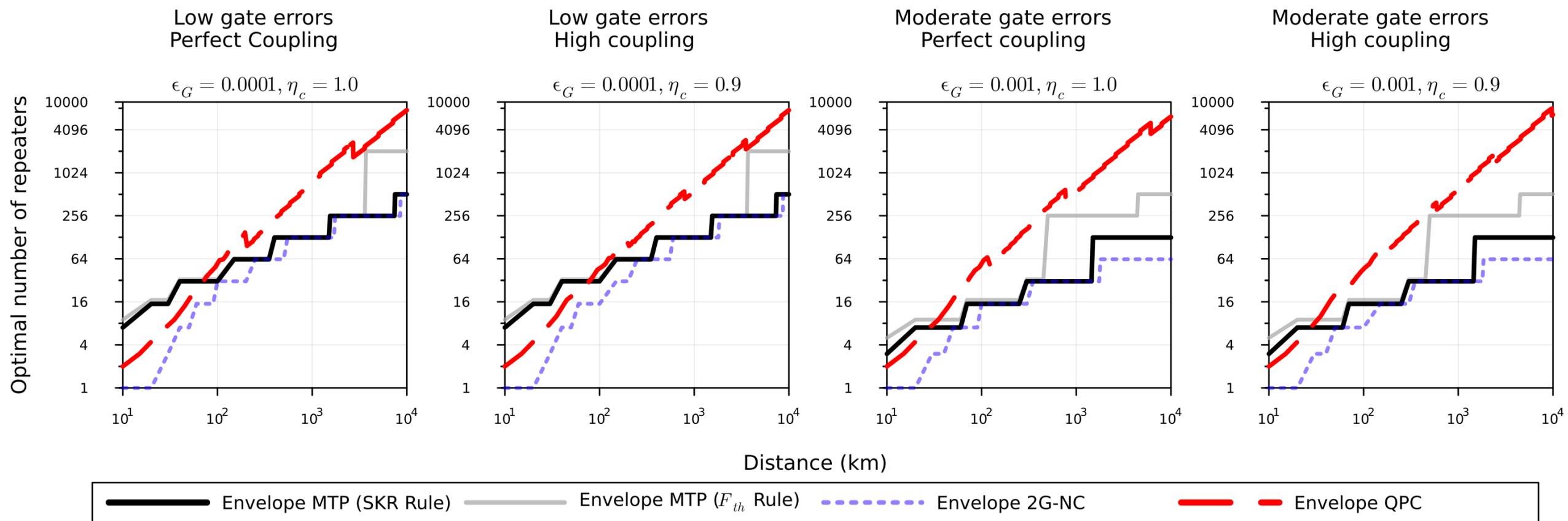


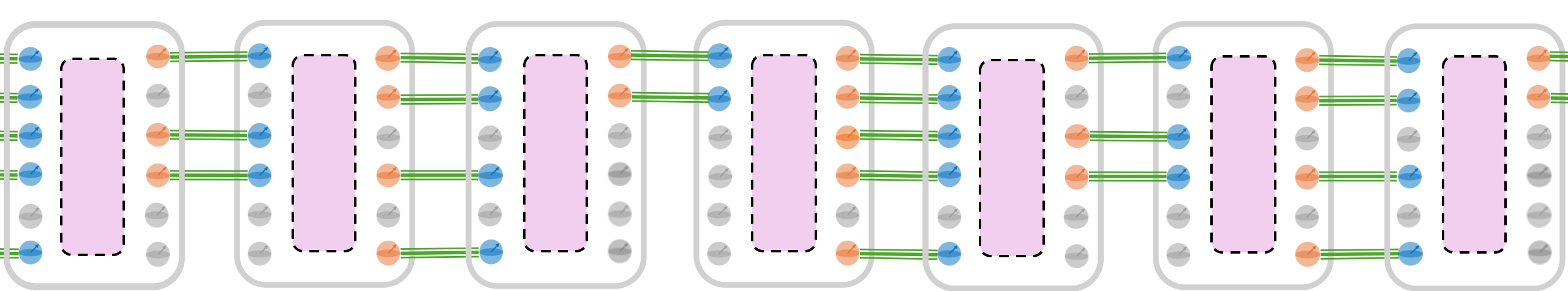
## Costs





## Costs





Thank  
you!