# NETMET 02/14
# traceroute

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academic year 2020-2021

# Outline

Basics

- Limits
- Load balancing
- The tool

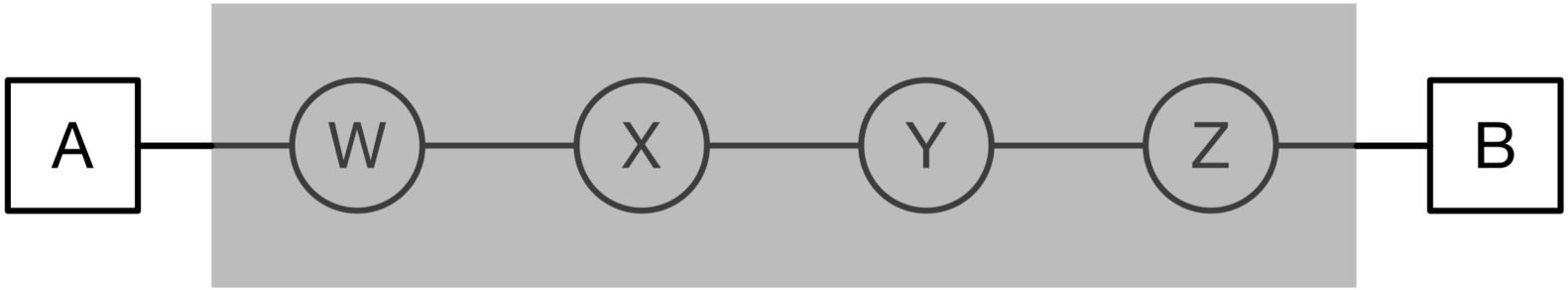
Zoom poll: What is your experience with traceroute?
Google docs poll: What does traceroute measure?
Google docs poll: What does traceroute fail to measure?
Google docs poll: Who created traceroute and in what year?


A

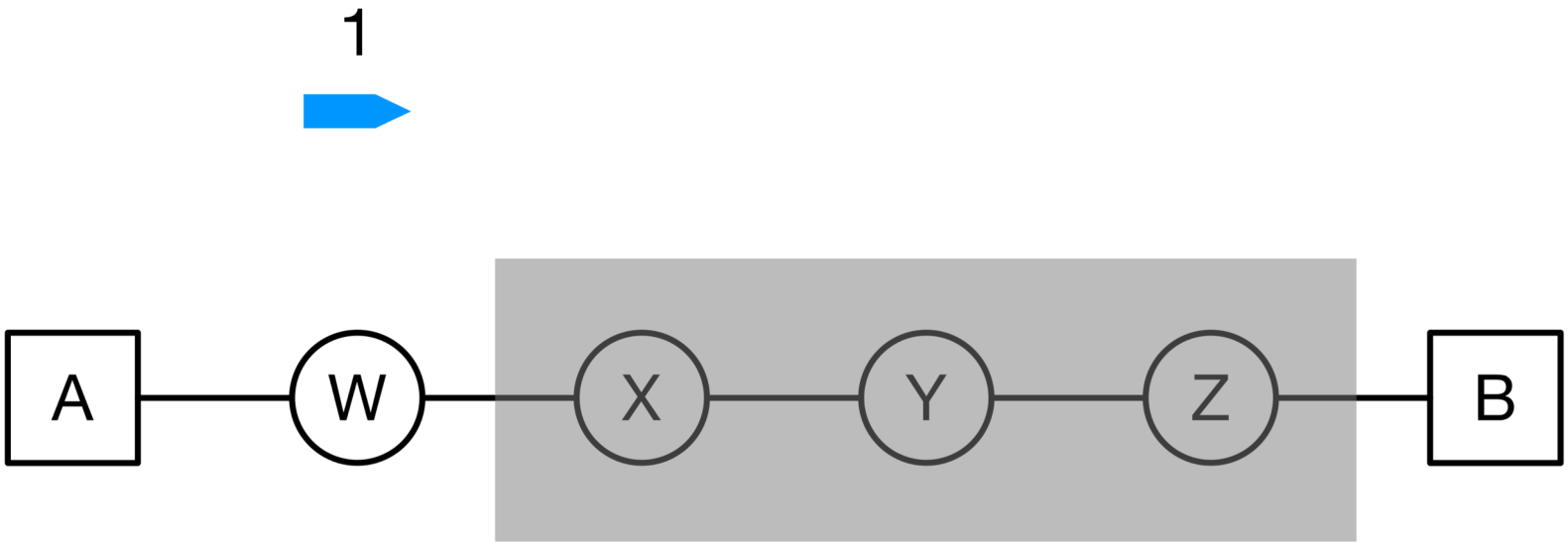

A


B

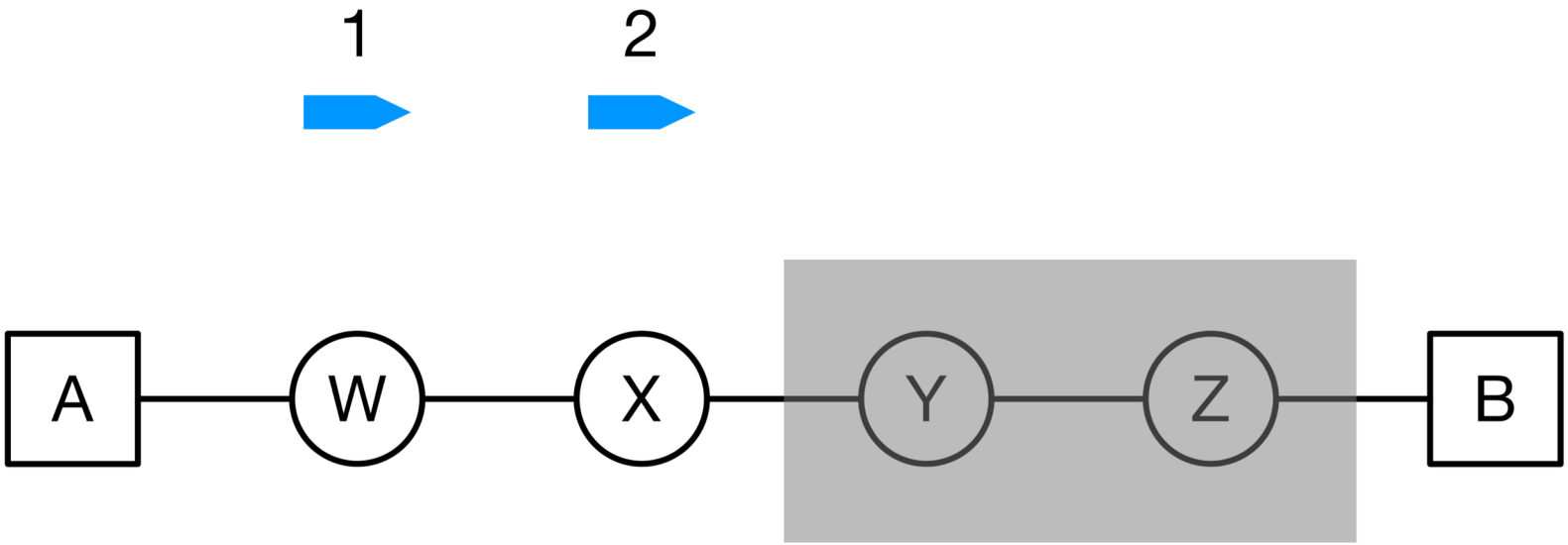

A
B




Google Doc poll: Which IP header field is key to how traceroute works?




Google Doc poll: What transport layer is used for the probe packets?
Google Doc poll: What type of message does router W send back to traceroute?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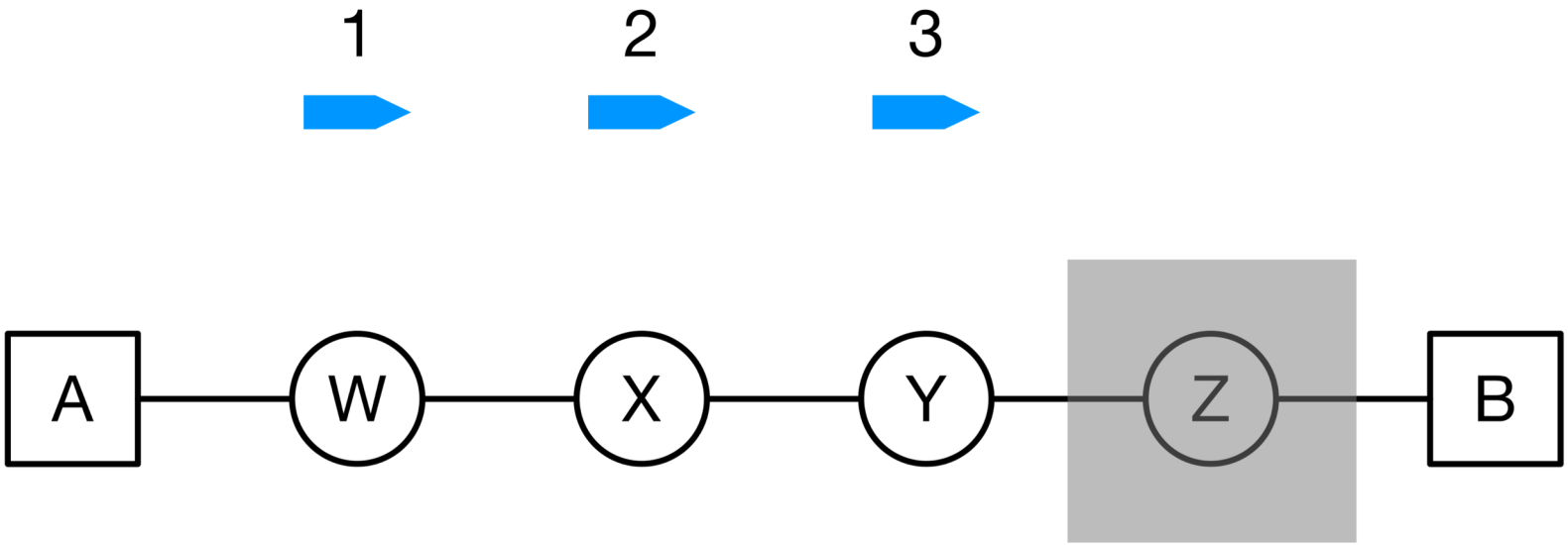
2
A
W
X
Y
Z
B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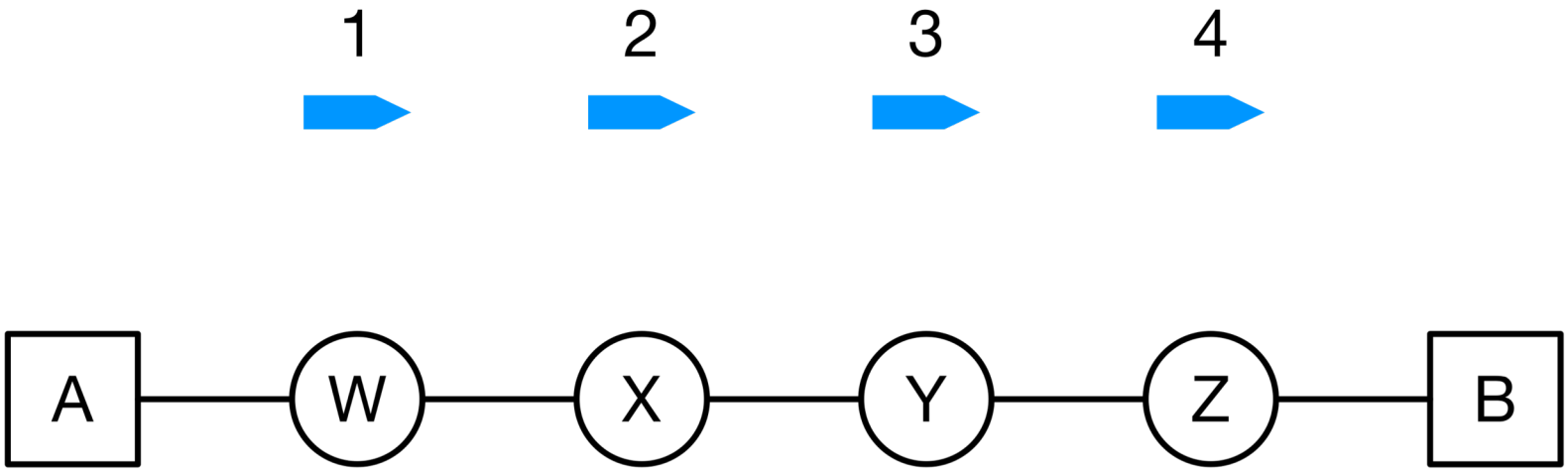
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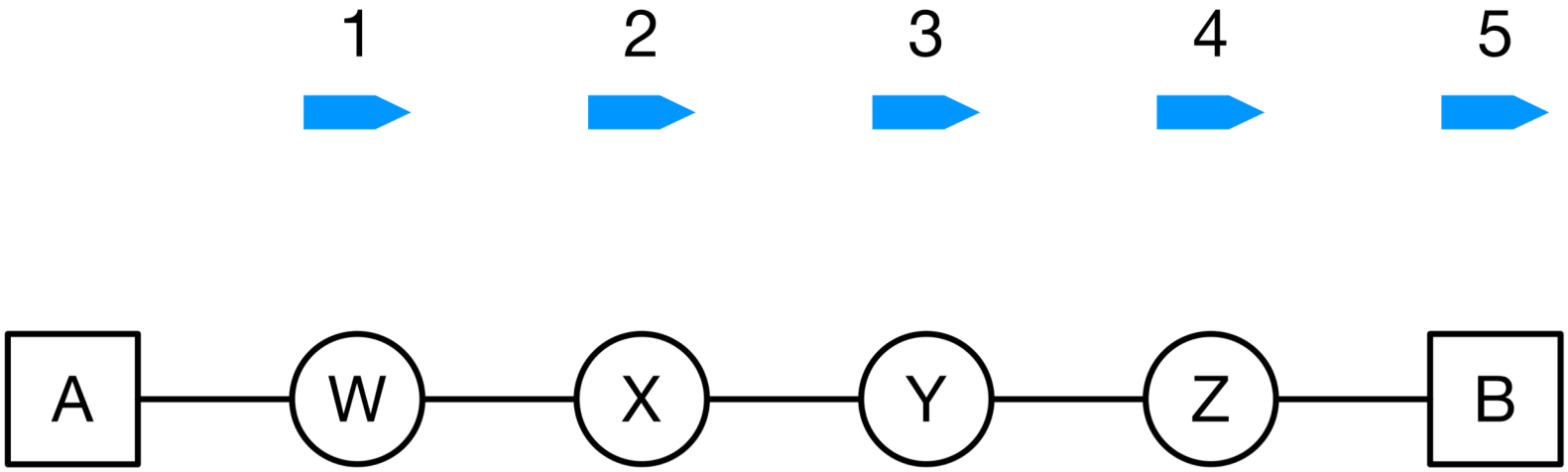
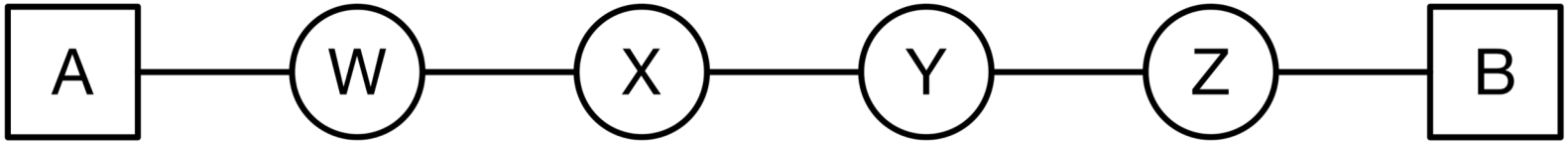
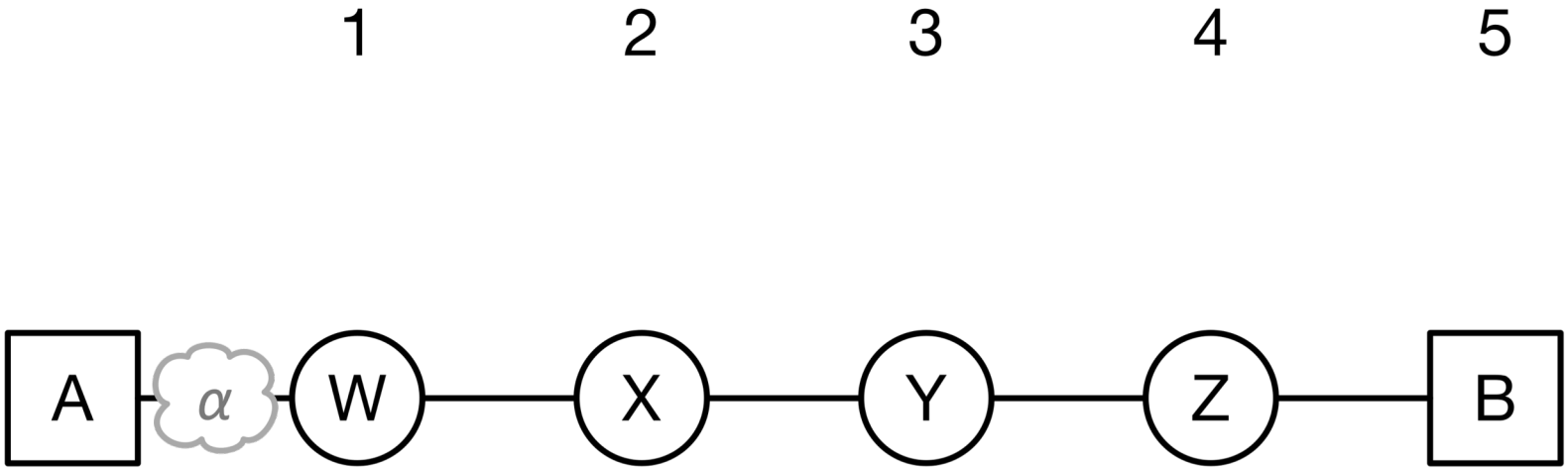



Google Doc poll: What type of message does destination D send back to traceroute?

1 2 3 4 5




Google Doc poll: Is this the full picture obtained by traceroute?
Google Doc poll: What is shown in this picture that is not in fact revealed by traceroute?
Google Doc poll: What is missing from this picture that is in fact revealed by traceroute?


1
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A
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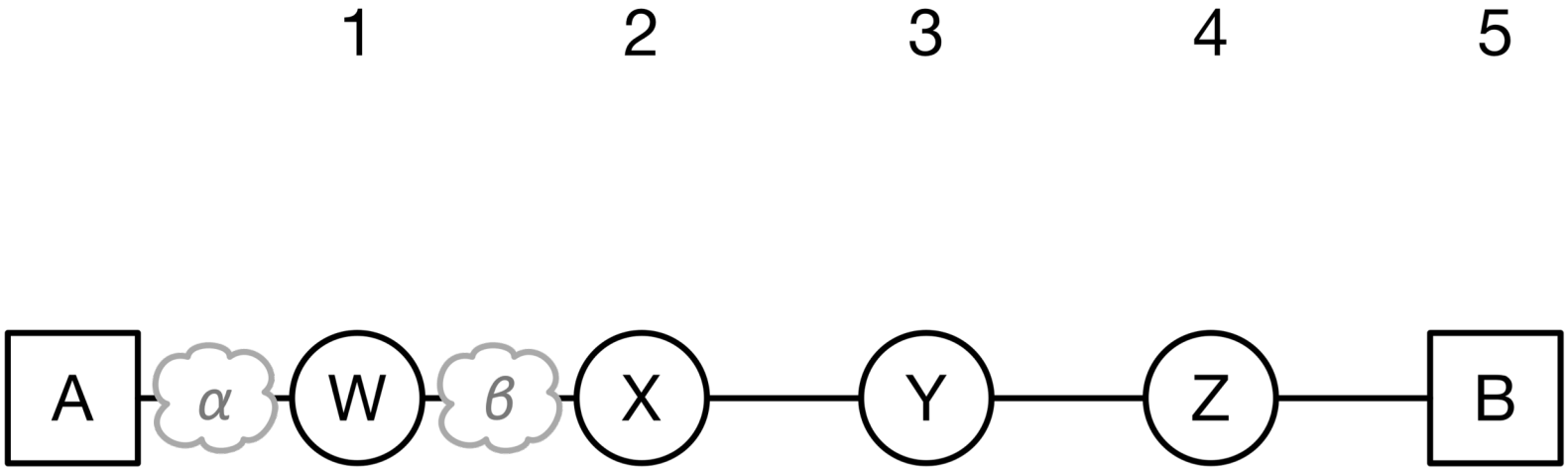
W
X
Y
Z
B


1
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A
α
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β
X
Y
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1 2 3 4 5

1 2 3 4 5

1 2 3 4 5

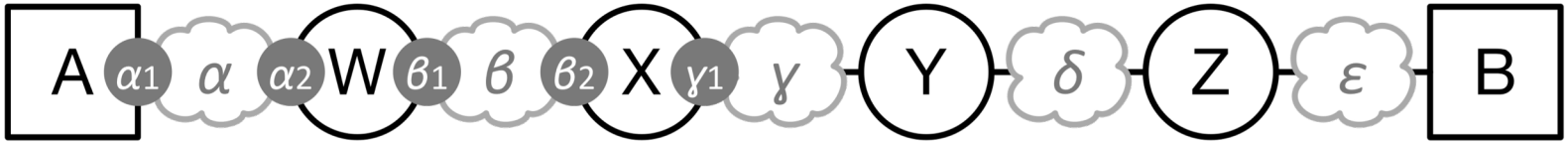
1 2 3 4 5

1 2 3 4 5

1 2 3 4 5

1 2 3 4 5

1 2 3 4 5



1 2 3 4 5

1 2 3 4 5

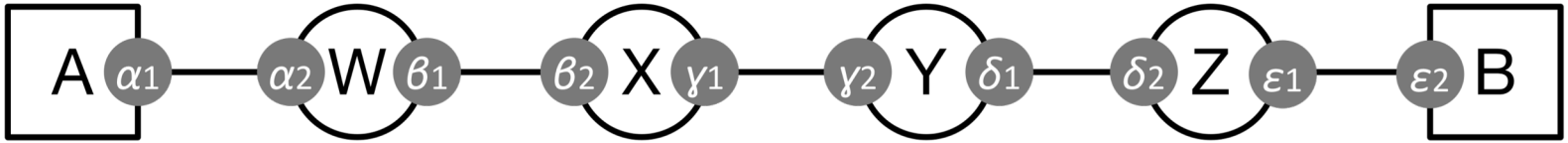
1 2 3 4 5

1 2 3 4 5

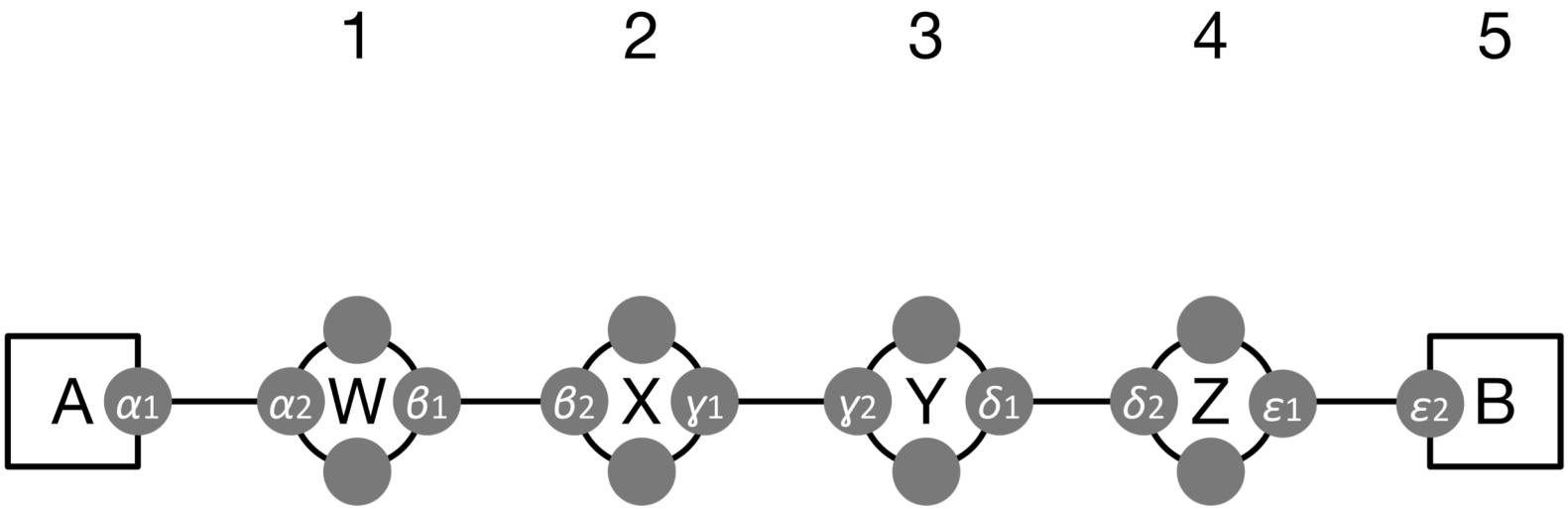
1 2 3 4 5


Zoom poll: Are the two interfaces of router W in the same network?

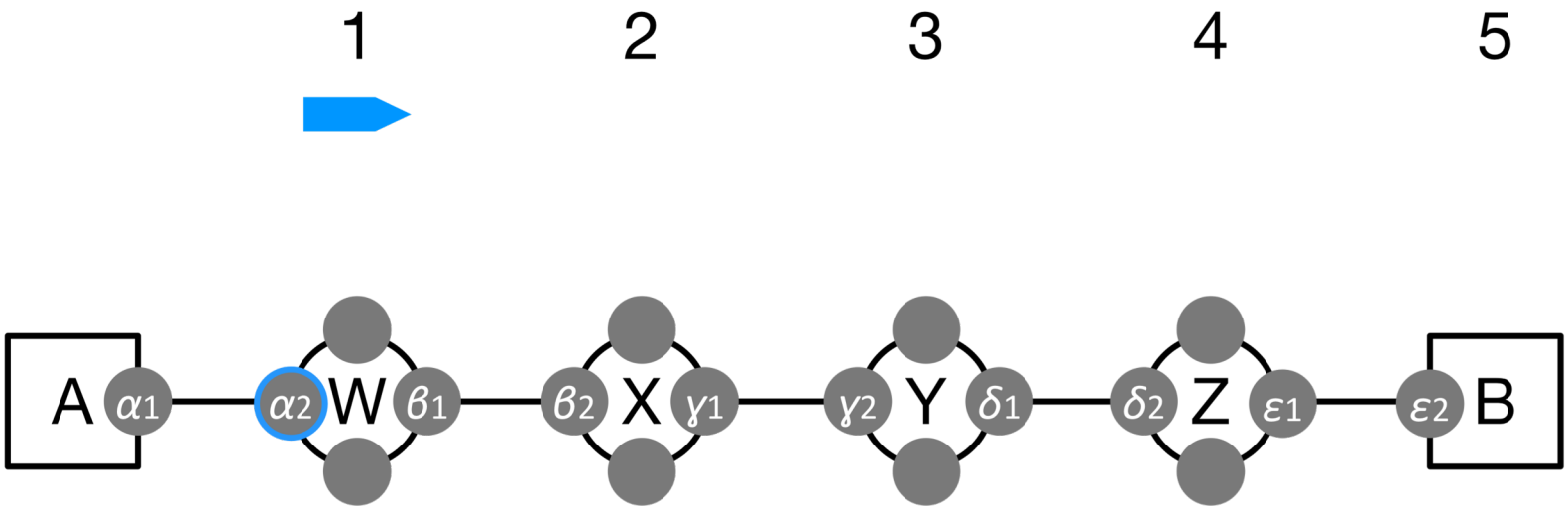
1 2 3 4 5




Google Doc poll: What is still missing from this picture at the IP level?




Google Doc poll: Which interface will respond to a probe with TTL 1?


1
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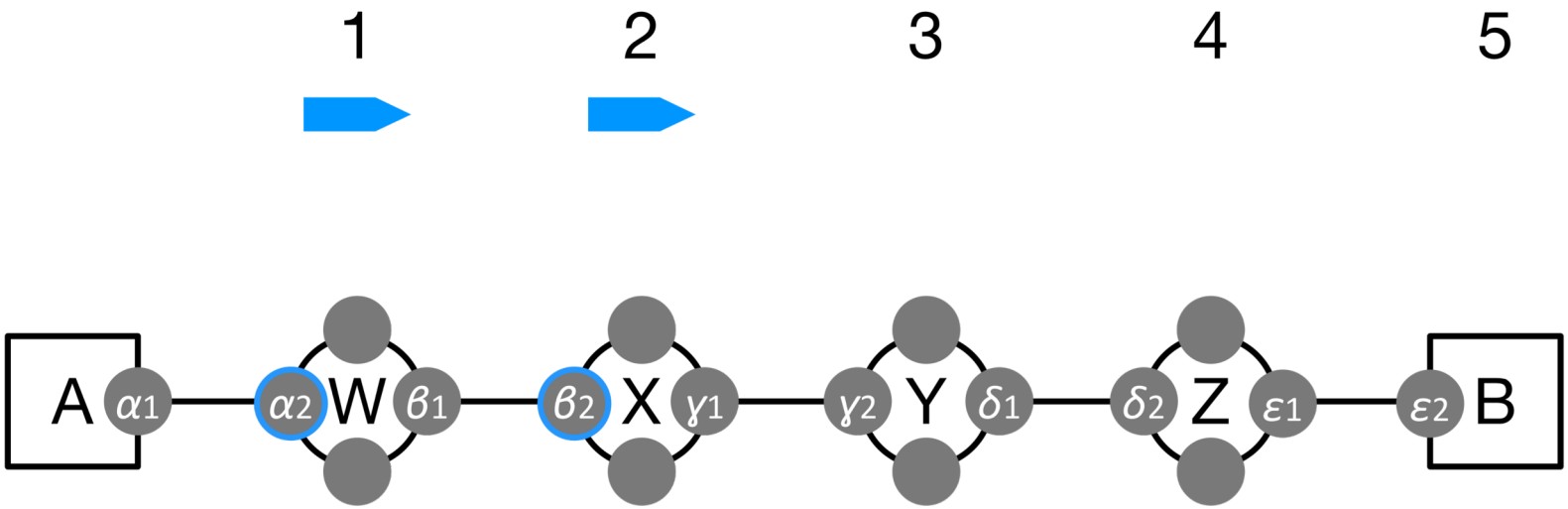
5
A
α1
α2
W
β1
β2
X
γ1
γ2
Y
δ1
δ2
Z
ε1
ε2
B


1
2
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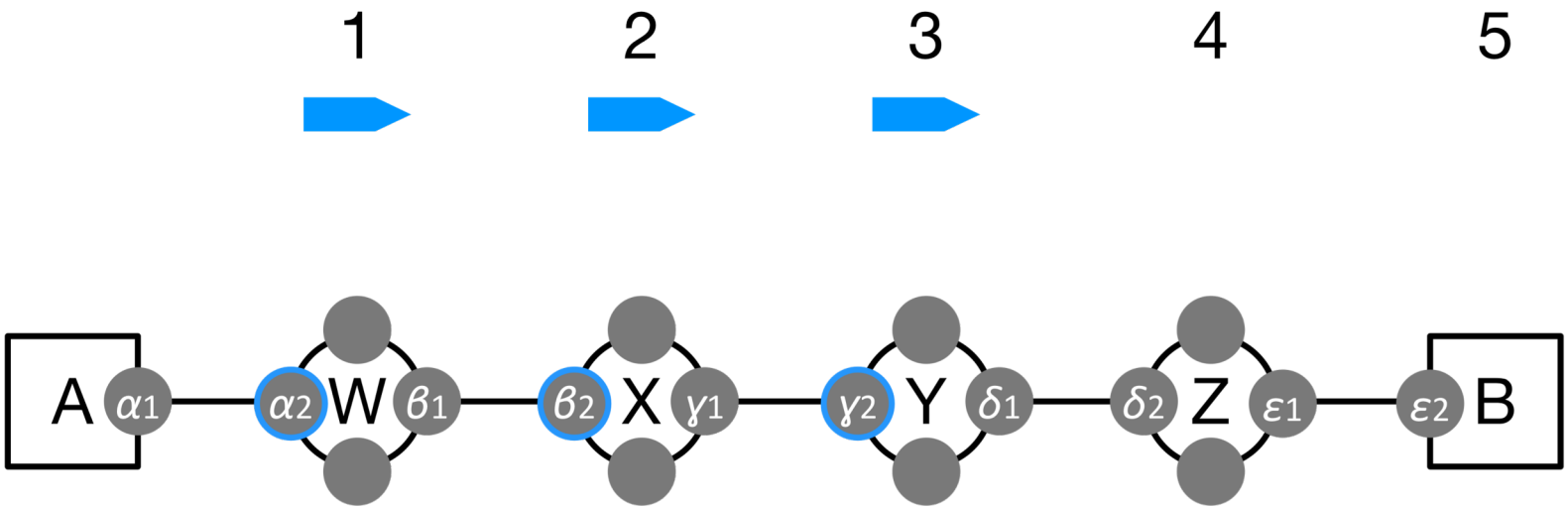
5
A
α1
α2
W
β1
β2
X
γ1
γ2
Y
δ1
δ2
Z
ε1
ε2
B


1
2
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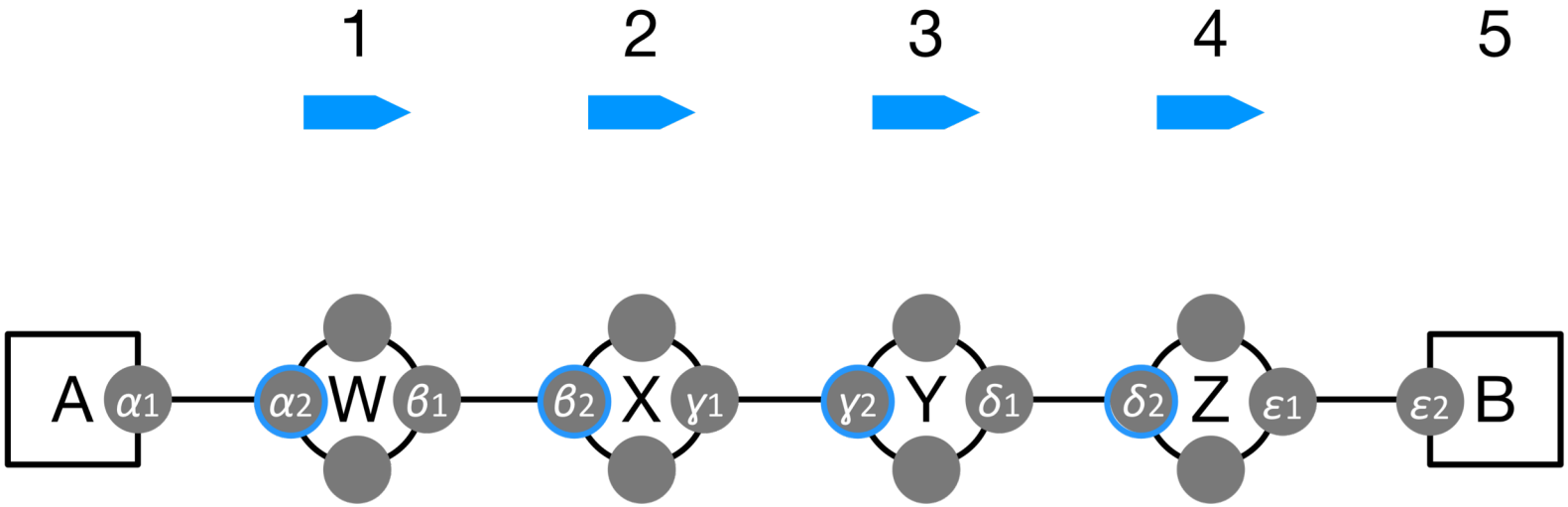
X
γ1
γ2
Y
δ1
δ2
Z
ε1
ε2
B


1
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A
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β1
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γ1
γ2
Y
δ1
δ2
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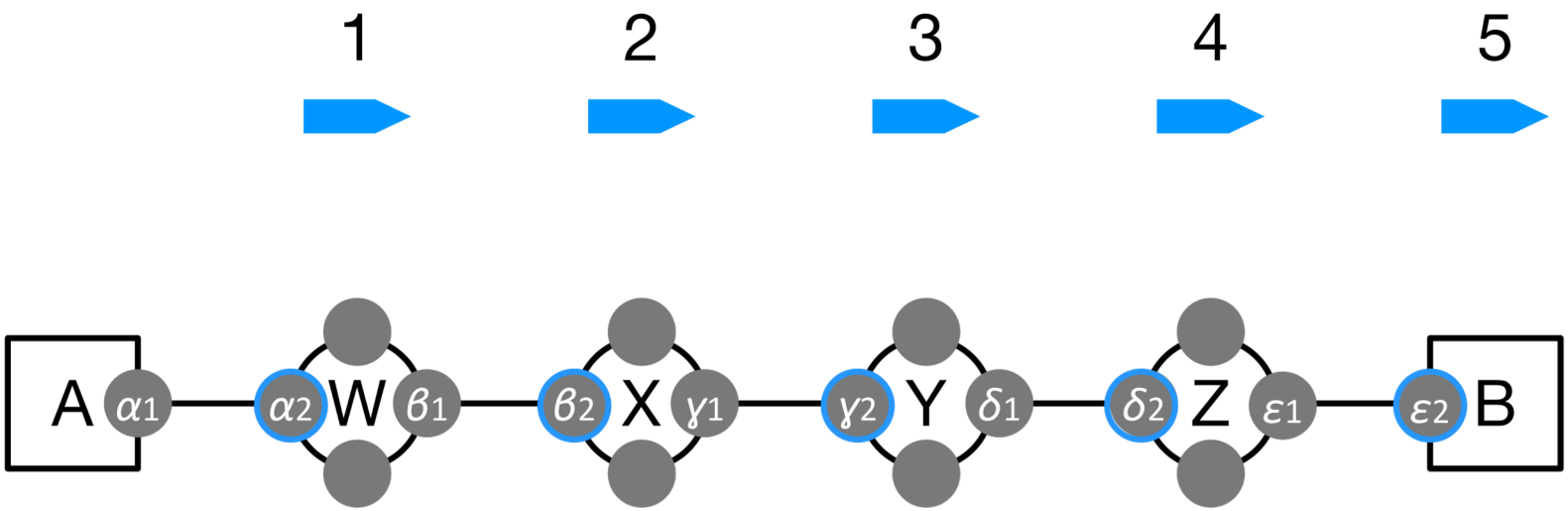
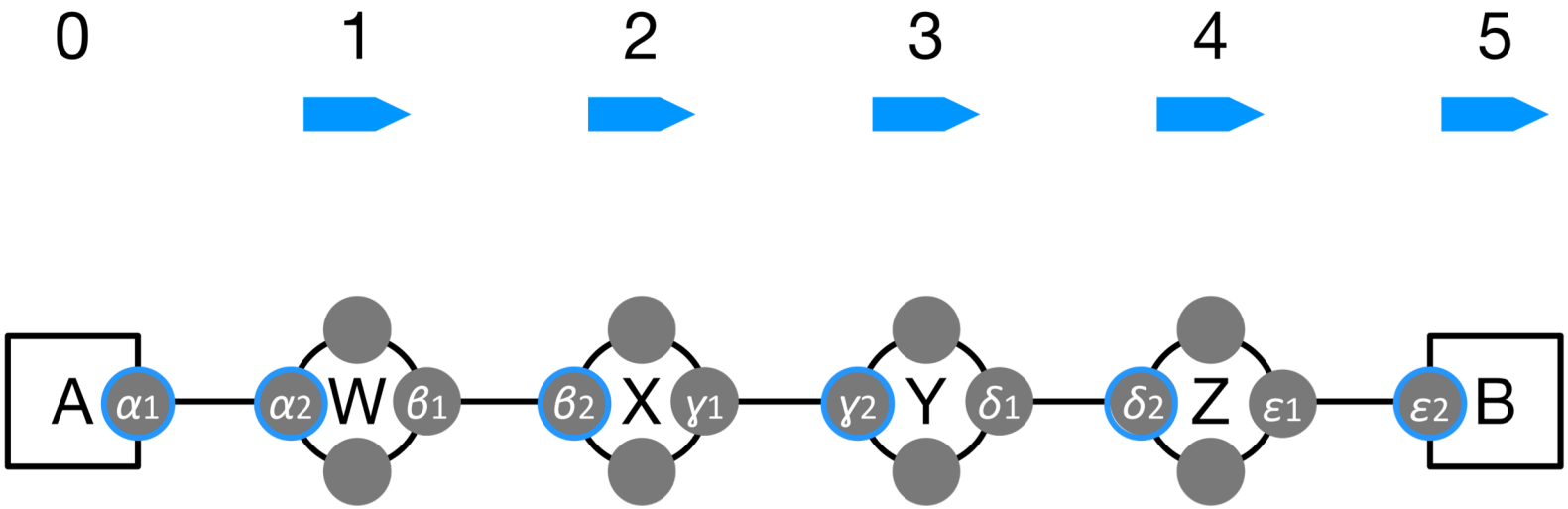
ε1
ε2
B




Google Doc poll: How does traceroute learn about the other interfaces of routers W, X, Y, and Z?
Google Doc poll: Is there any other interface that is known about that is not circled in blue in this picture?


0
1
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A
α1
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γ1
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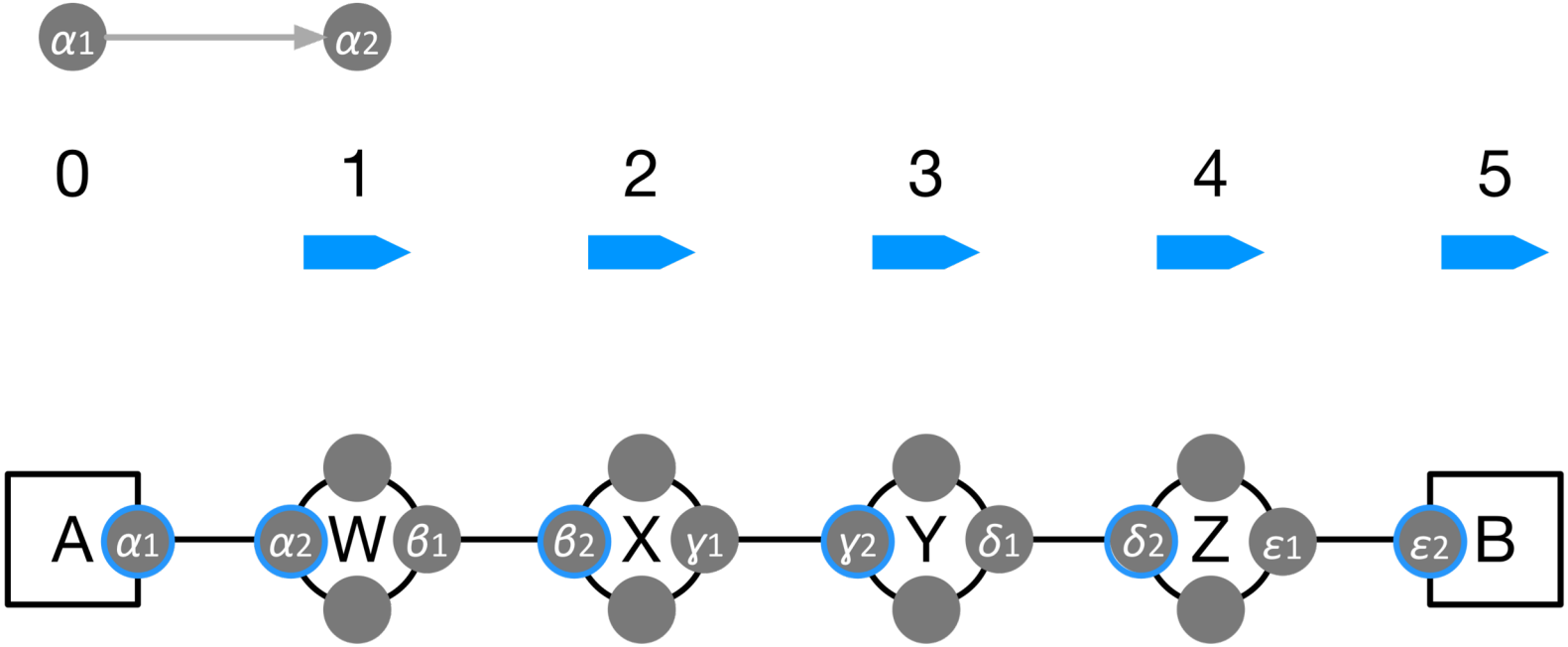
ε1
ε2
B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α2
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1
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4
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α2
W
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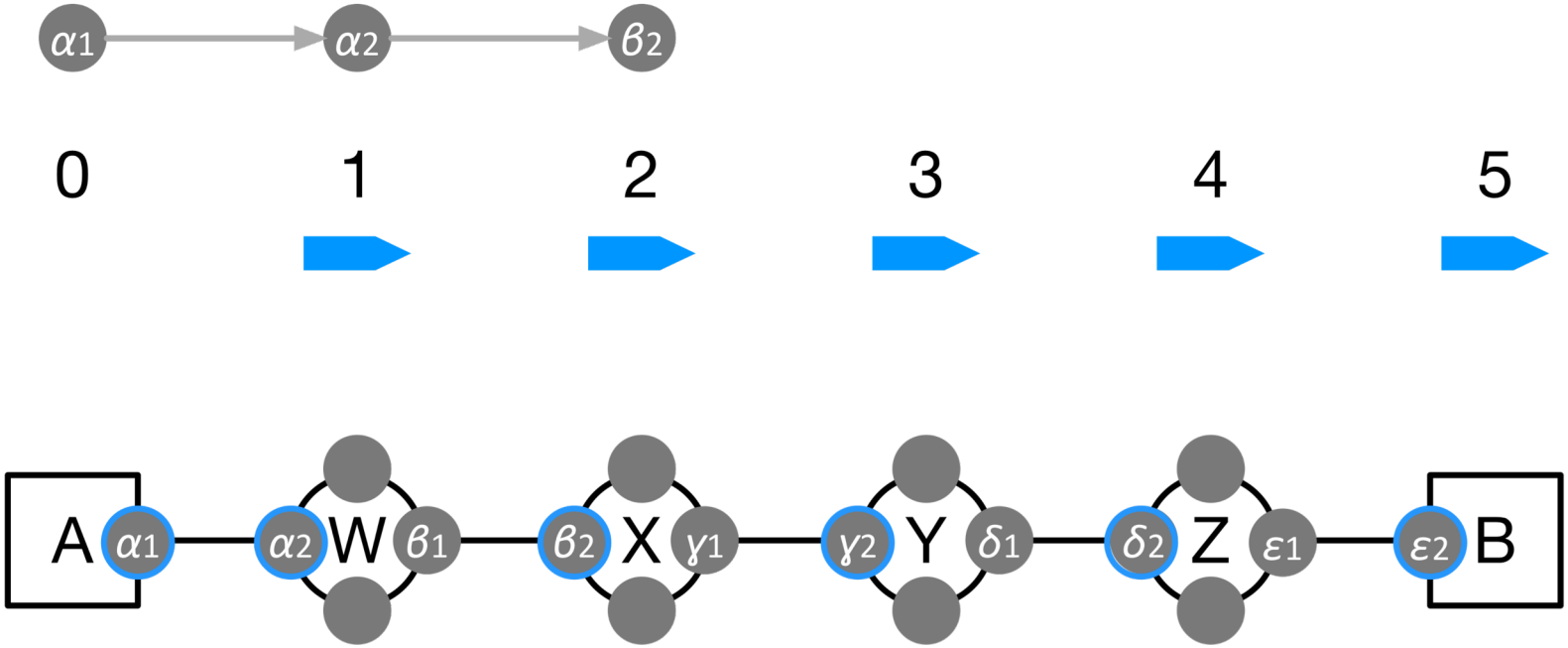
Y
δ1
δ2
Z
ε1
ε2
B


α1
α2
β2
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δ1
δ2
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ε1
ε2
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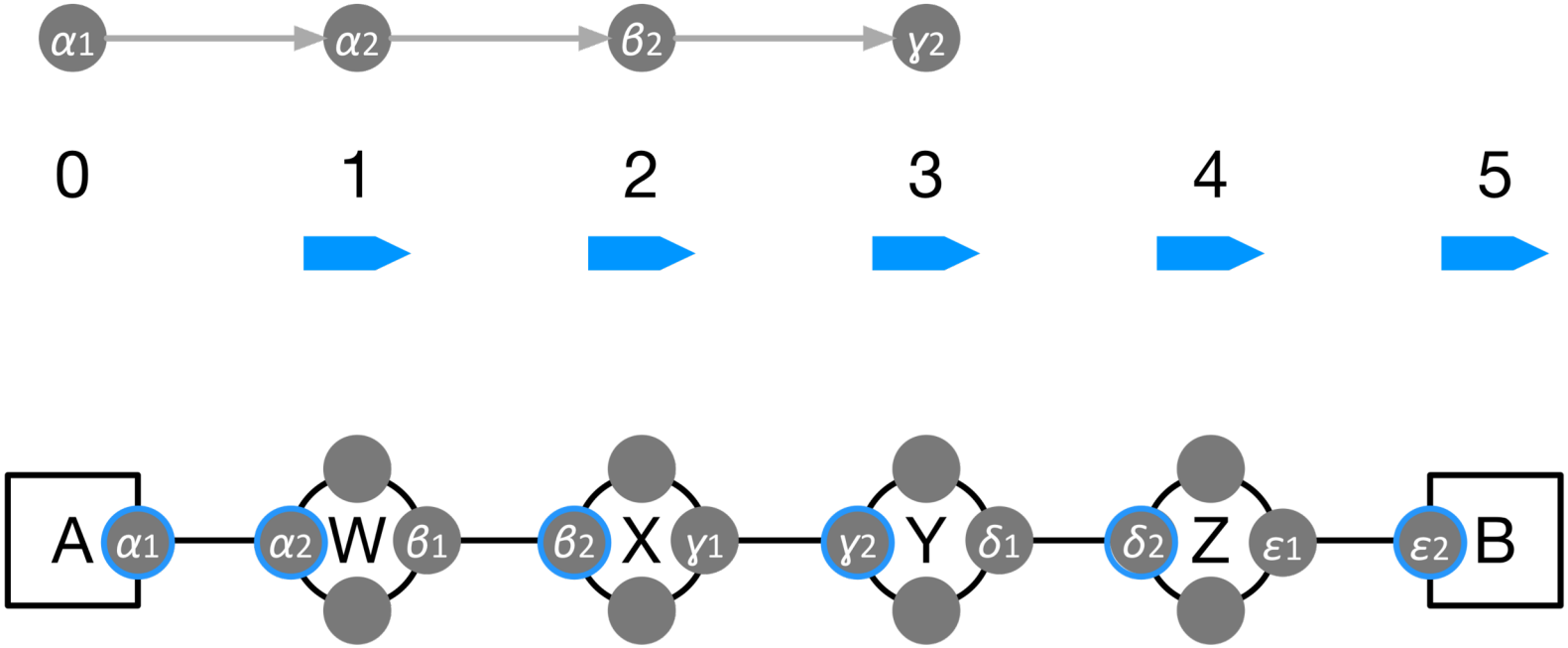
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α2
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γ2
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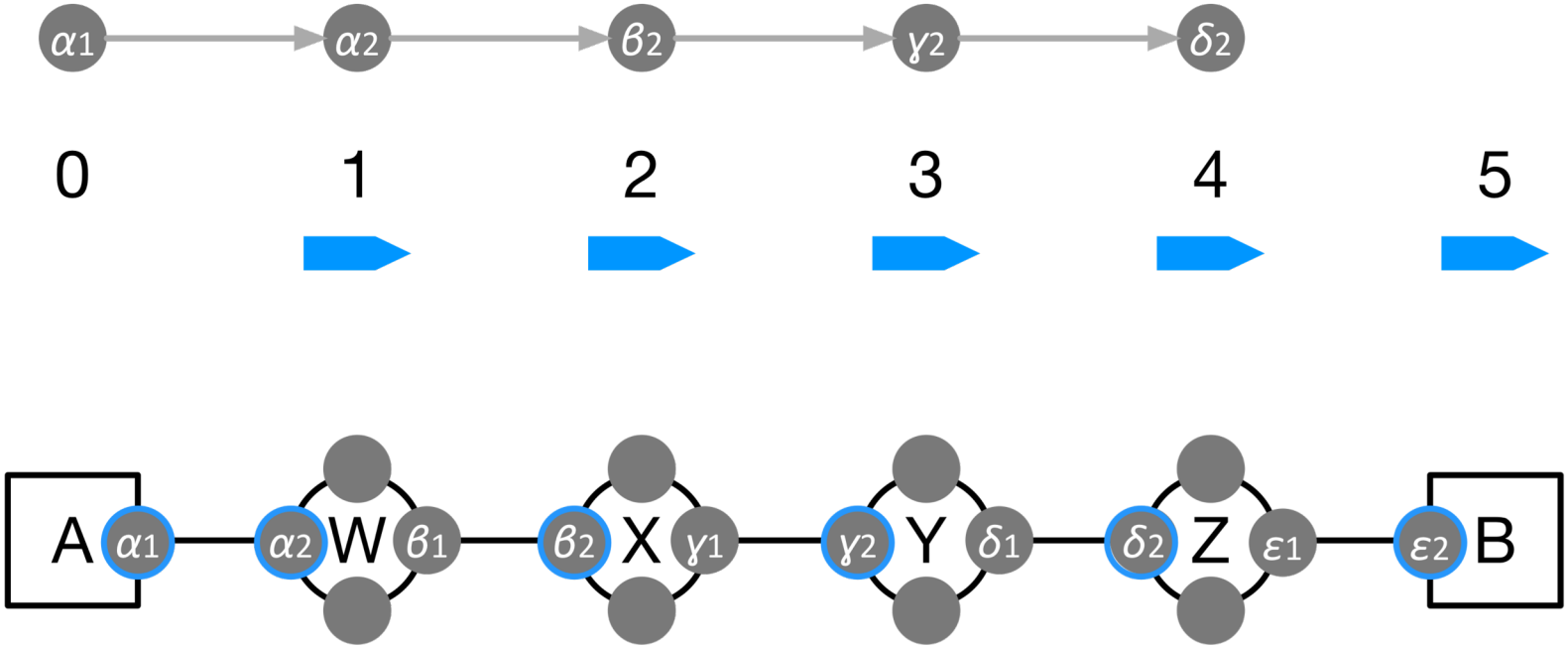
Y
δ1
δ2
Z
ε1
ε2
B


α1
α2
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γ2
δ2
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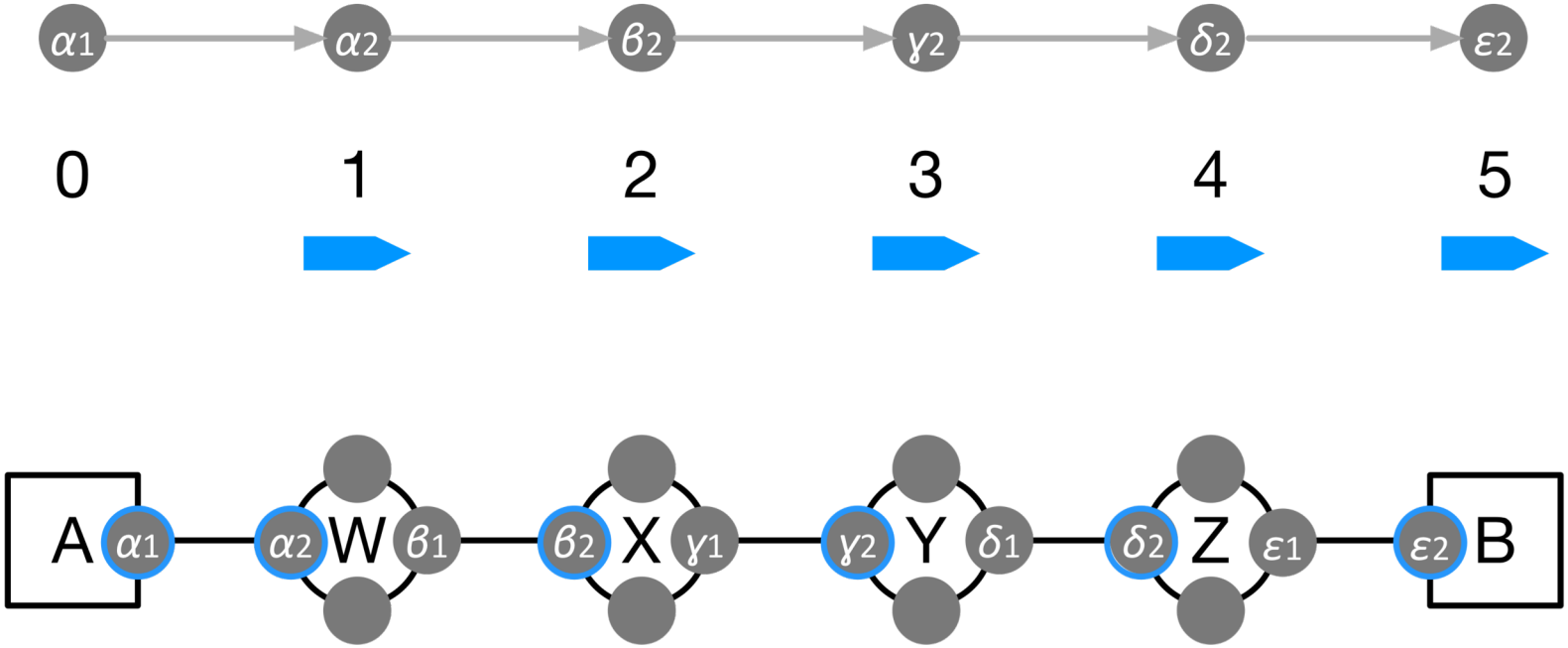
ε2
B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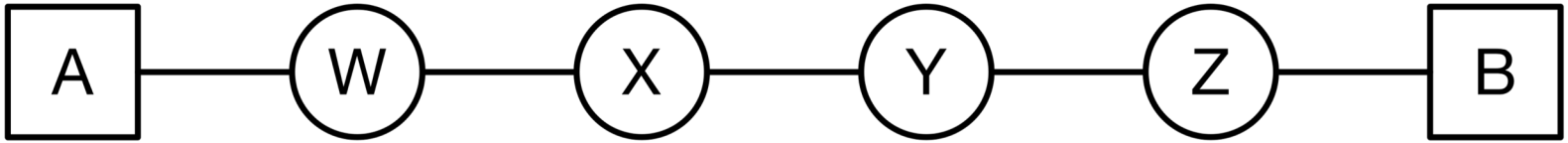
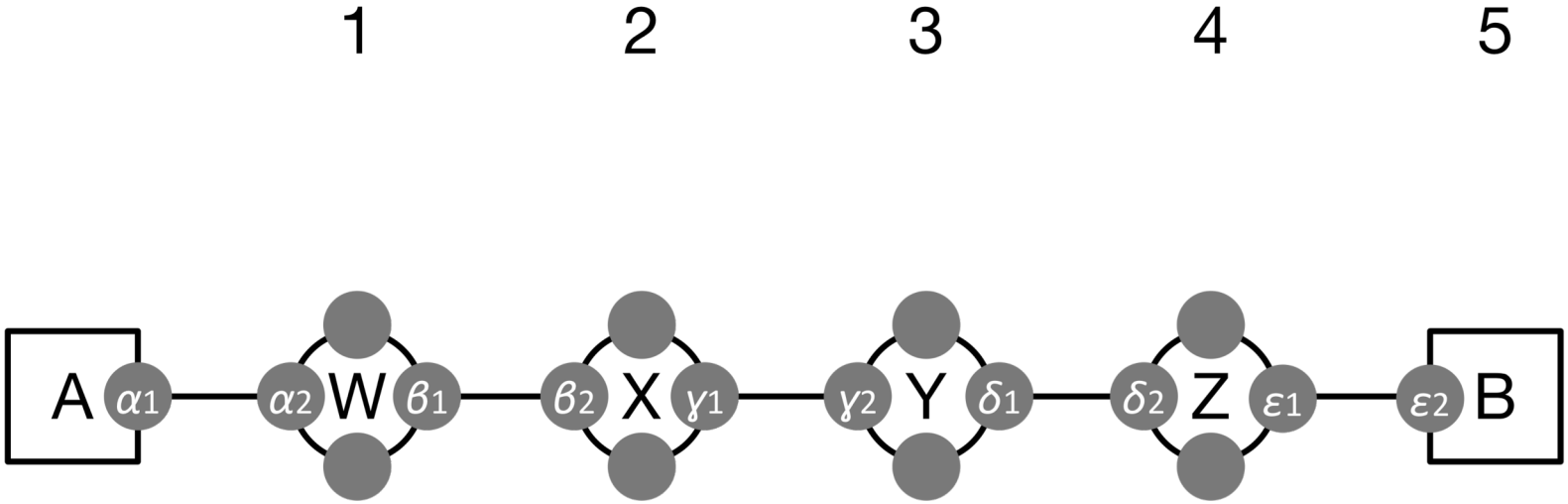
B


Google Doc poll: How might you guess the picture at the bottom from the picture at the top?

# Outline

- Basics
- Limits
- Load balancing
- The tool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δ2
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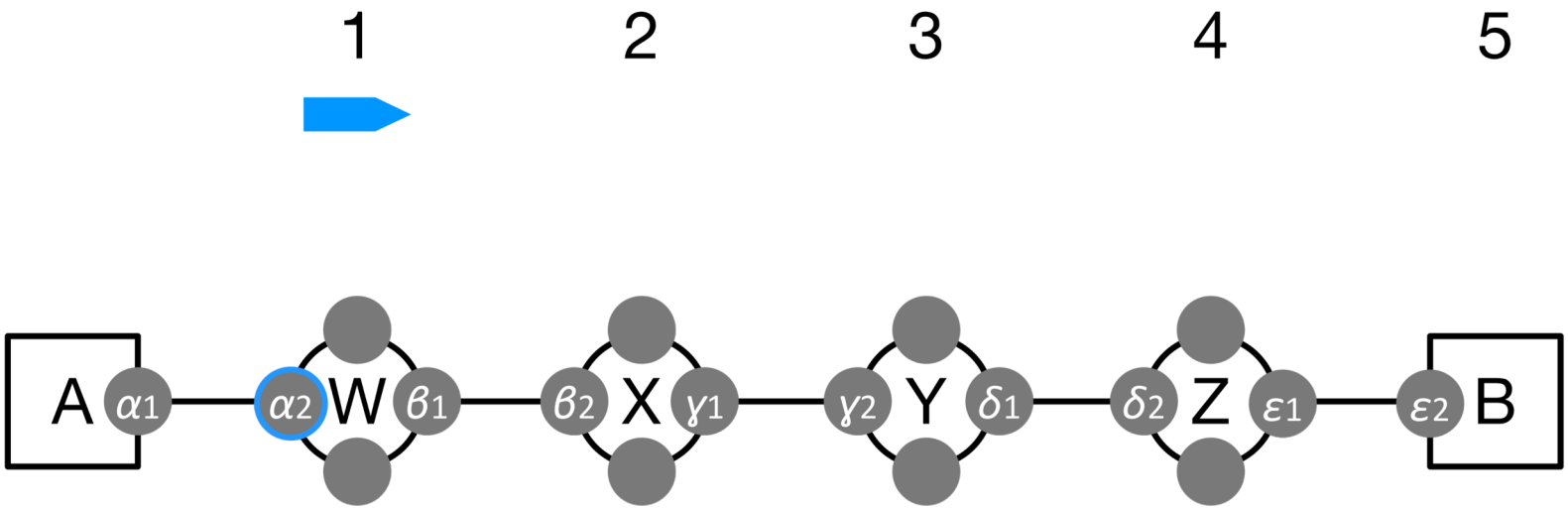
ε2
B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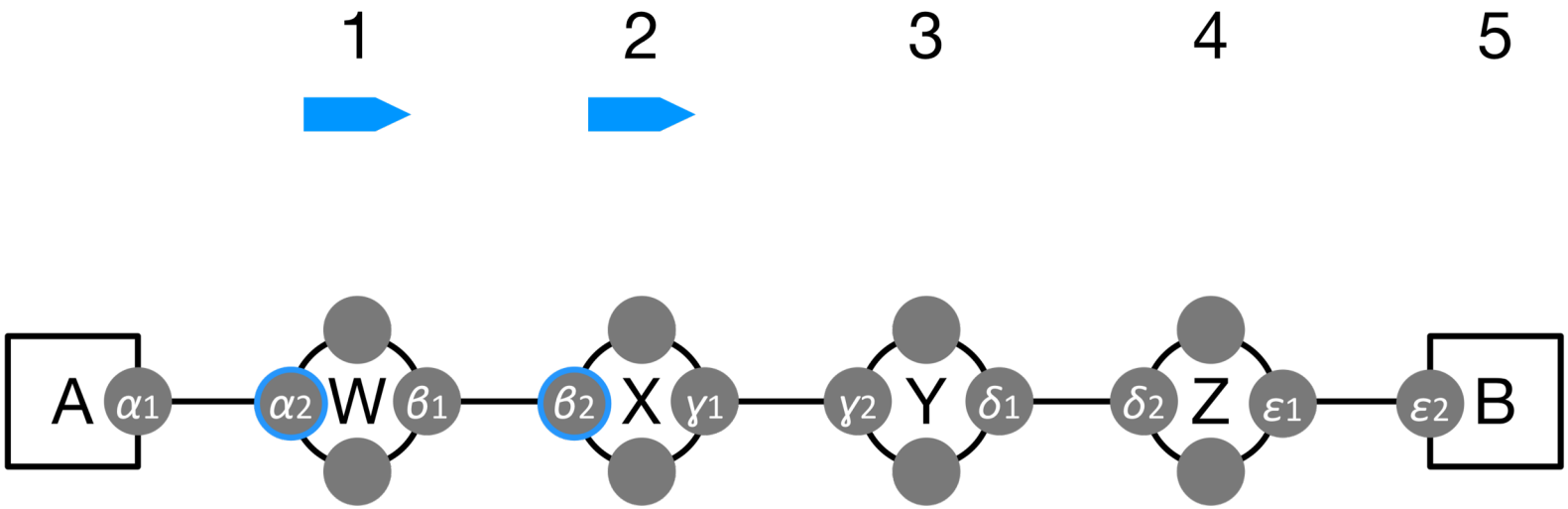
ε2
B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γ2
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δ2
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ε1
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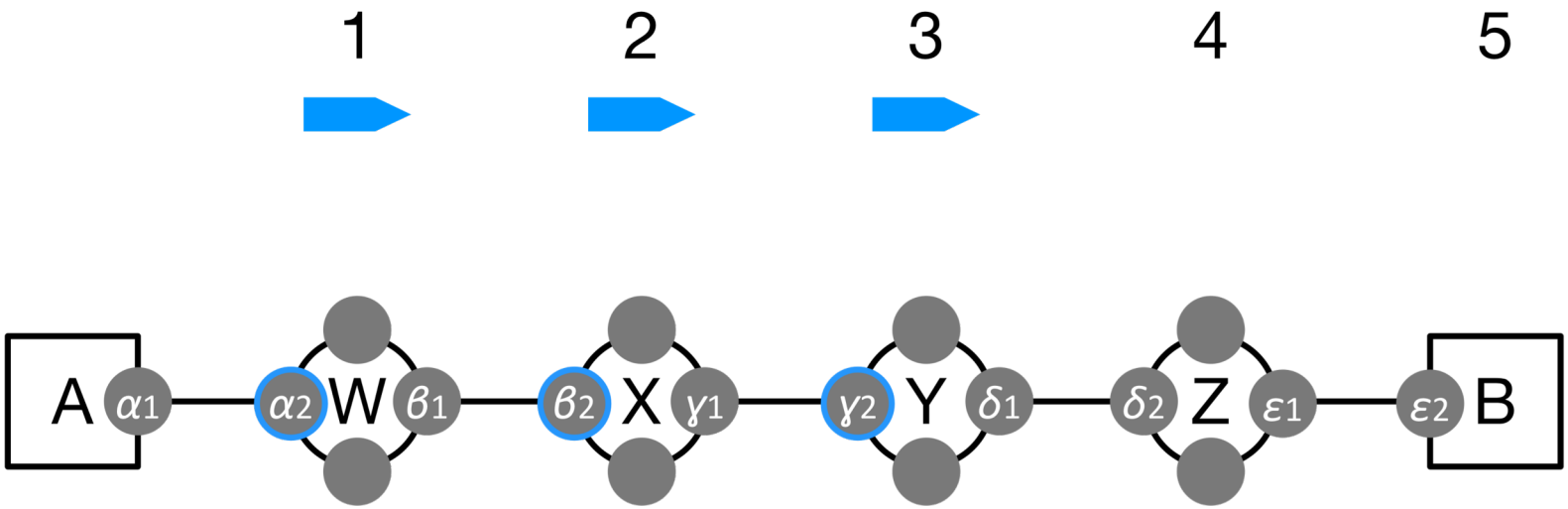
B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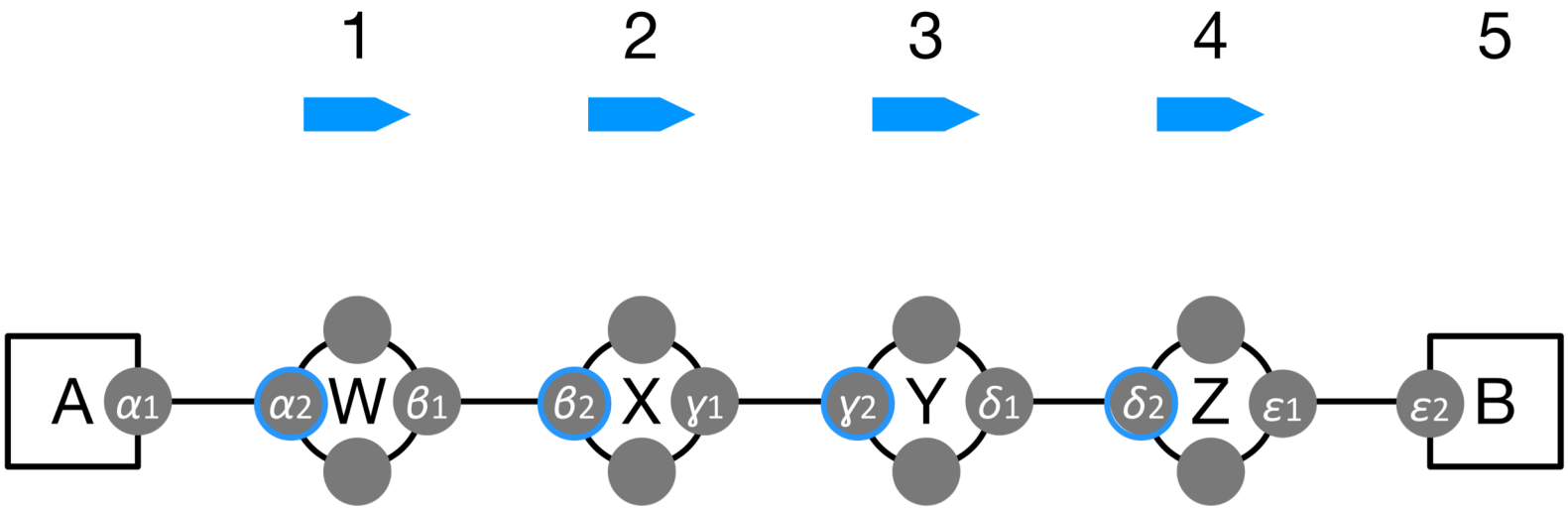
B


1
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ε2
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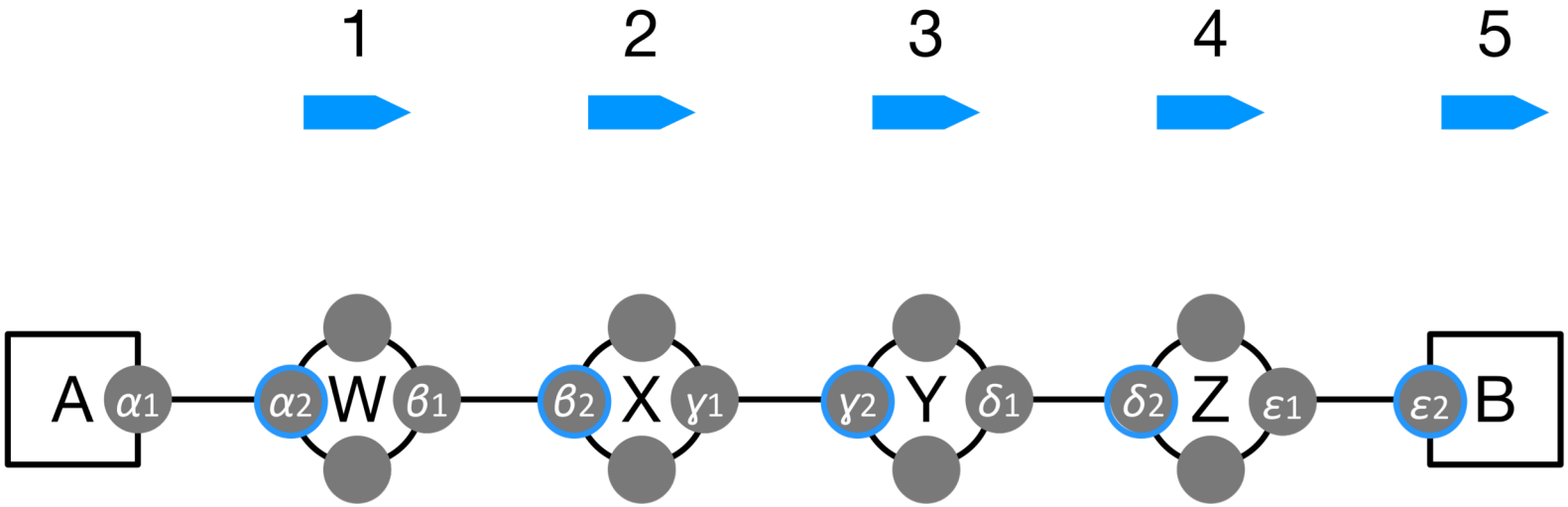
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ε2
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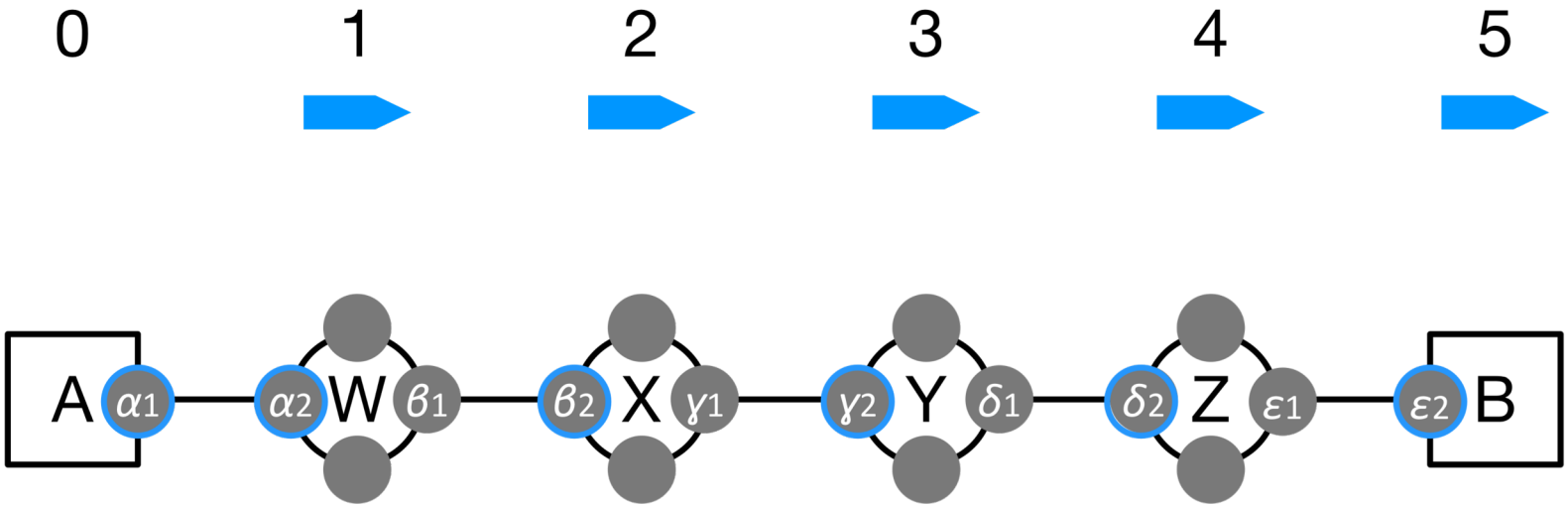
0
1
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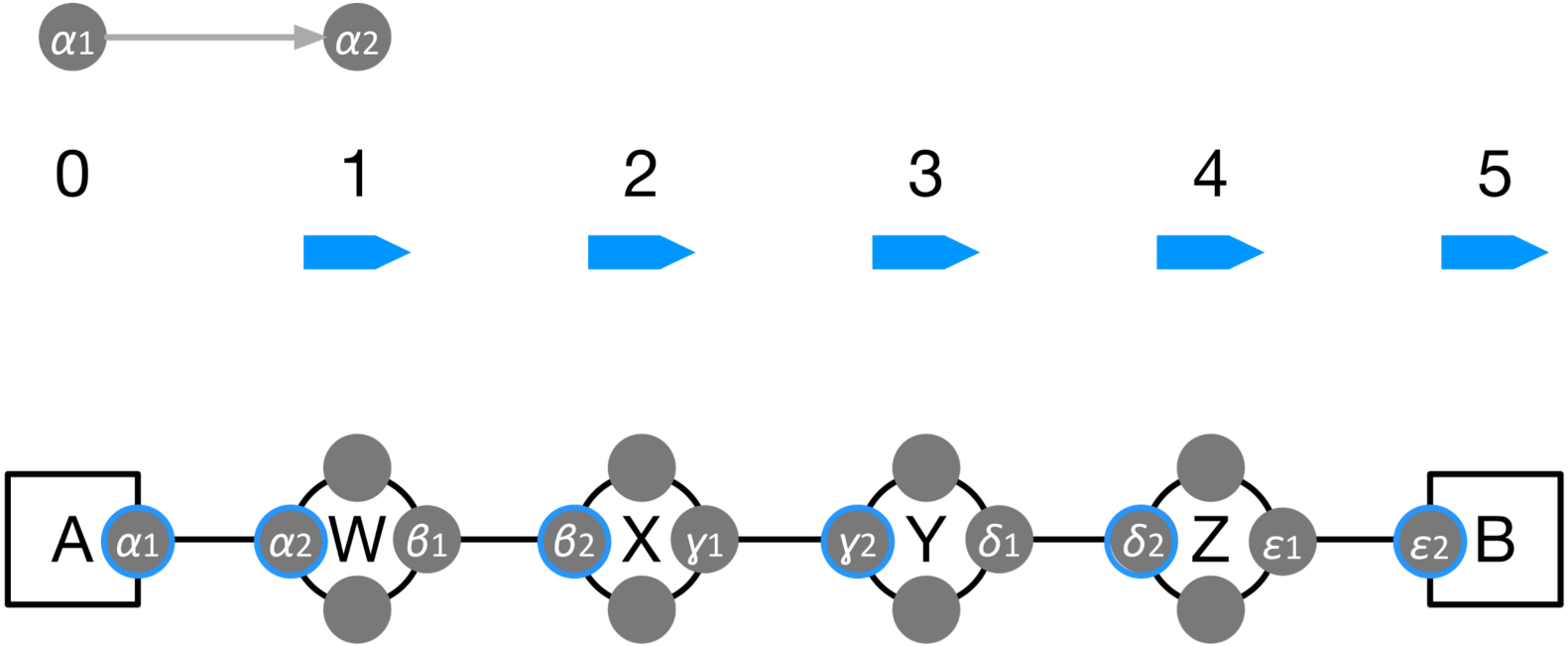
ε2
B


α1
α2
0
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4
5
A
α1
α2
W
β1
β2
X
γ1
γ2
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δ1
δ2
Z
ε1
ε2
B


α1
α2
β2


0
1
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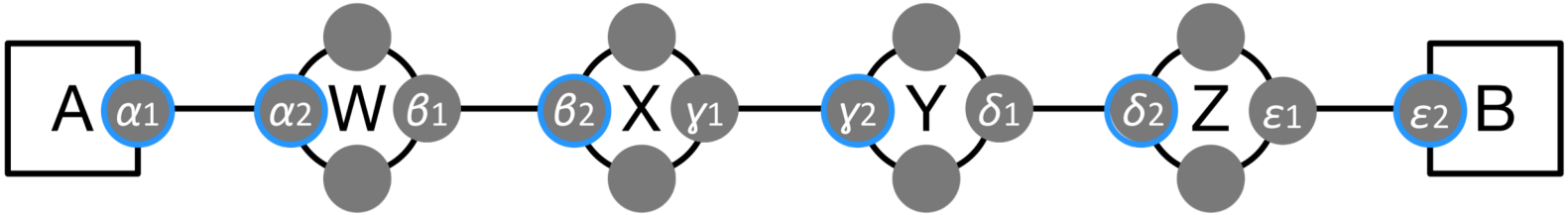
A
α1
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β1
β2
X
γ1
γ2
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δ1
δ2
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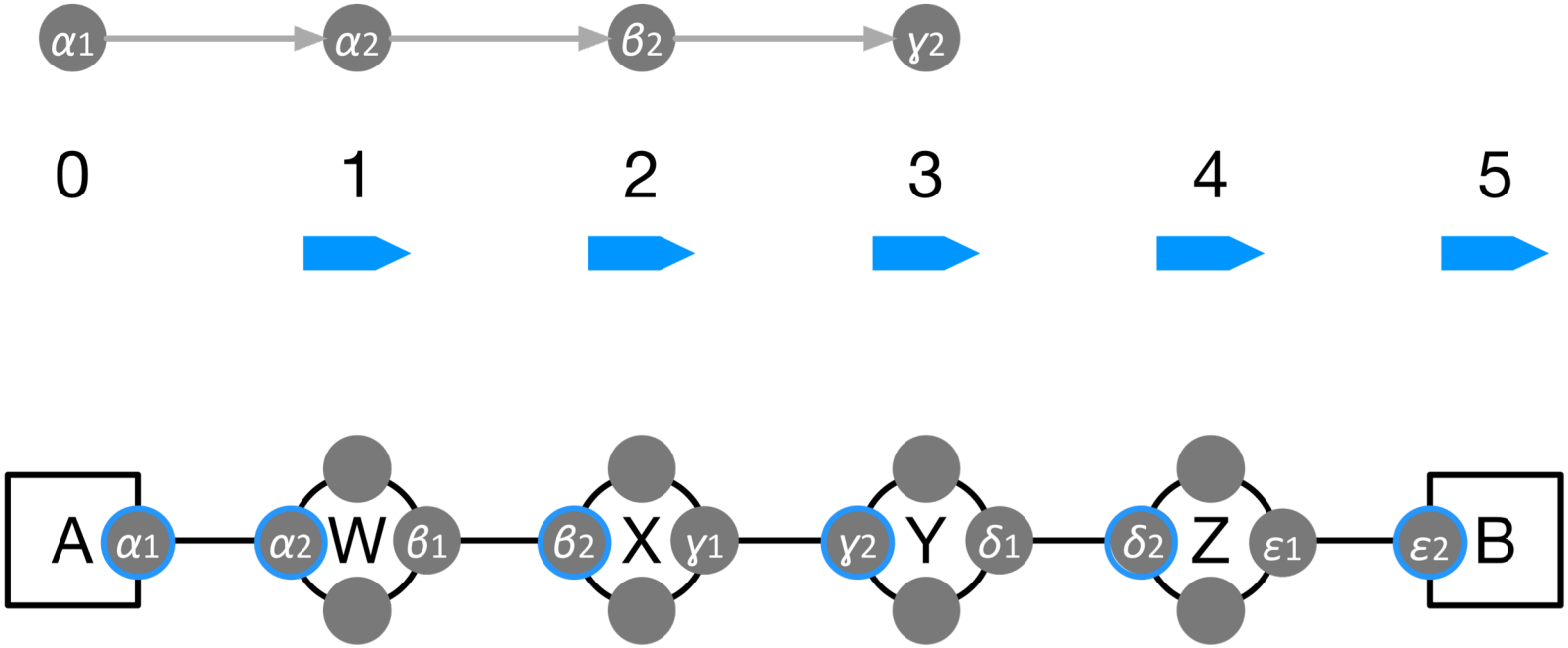
ε1
ε2
B


α1
α2
β2
γ2
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γ2
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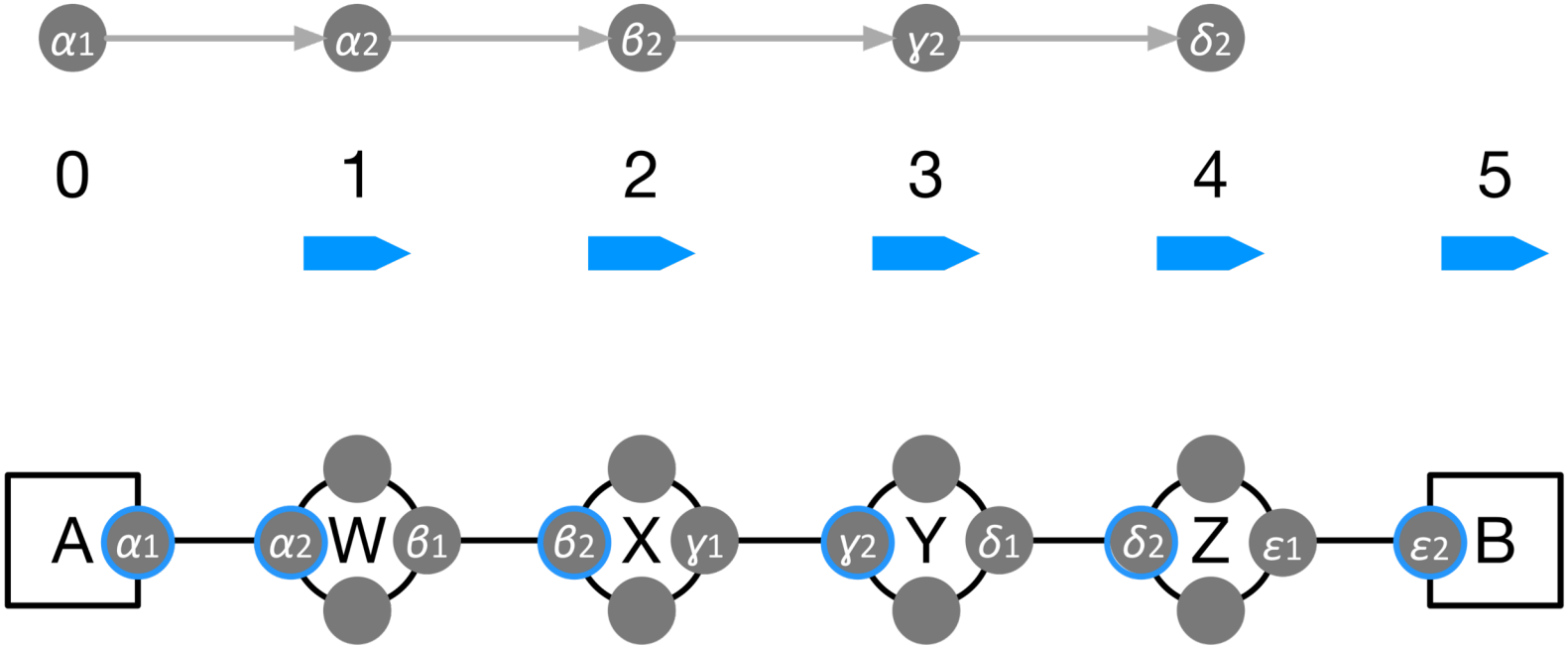
ε2
B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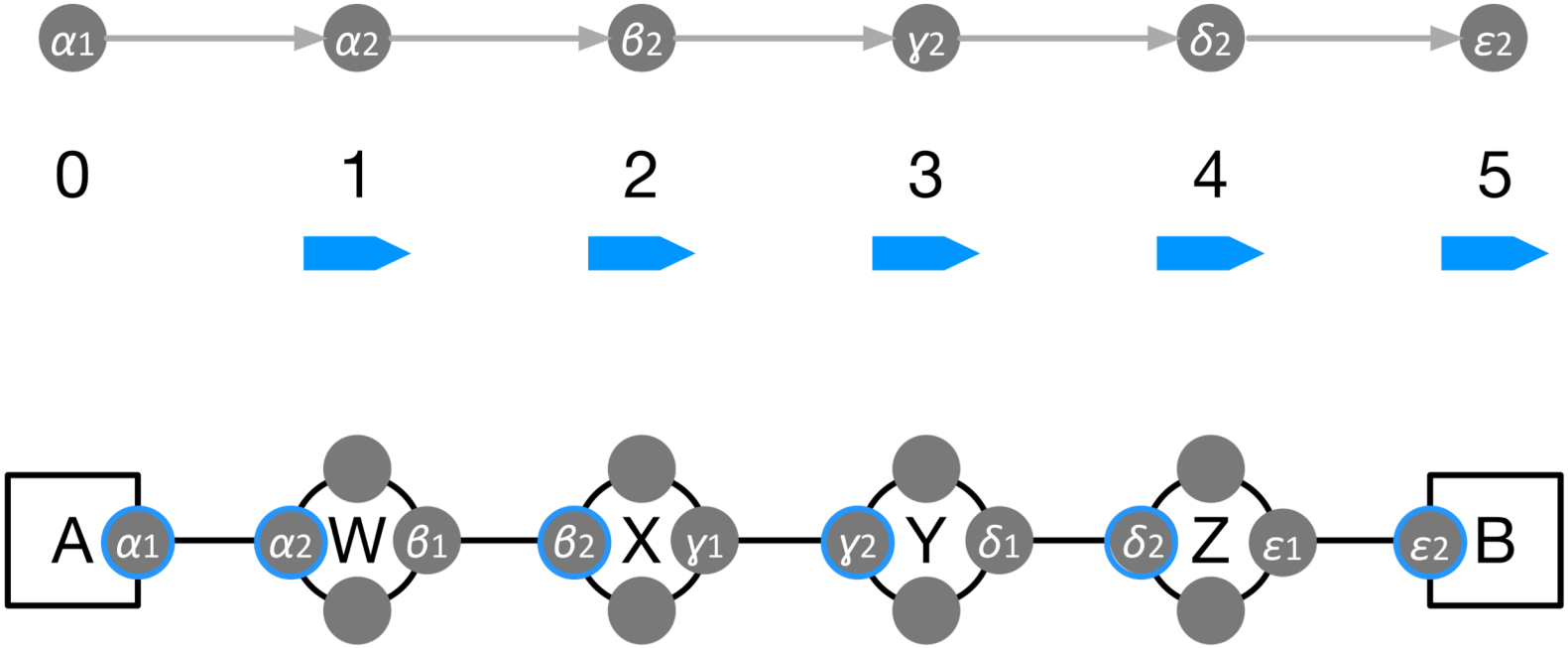
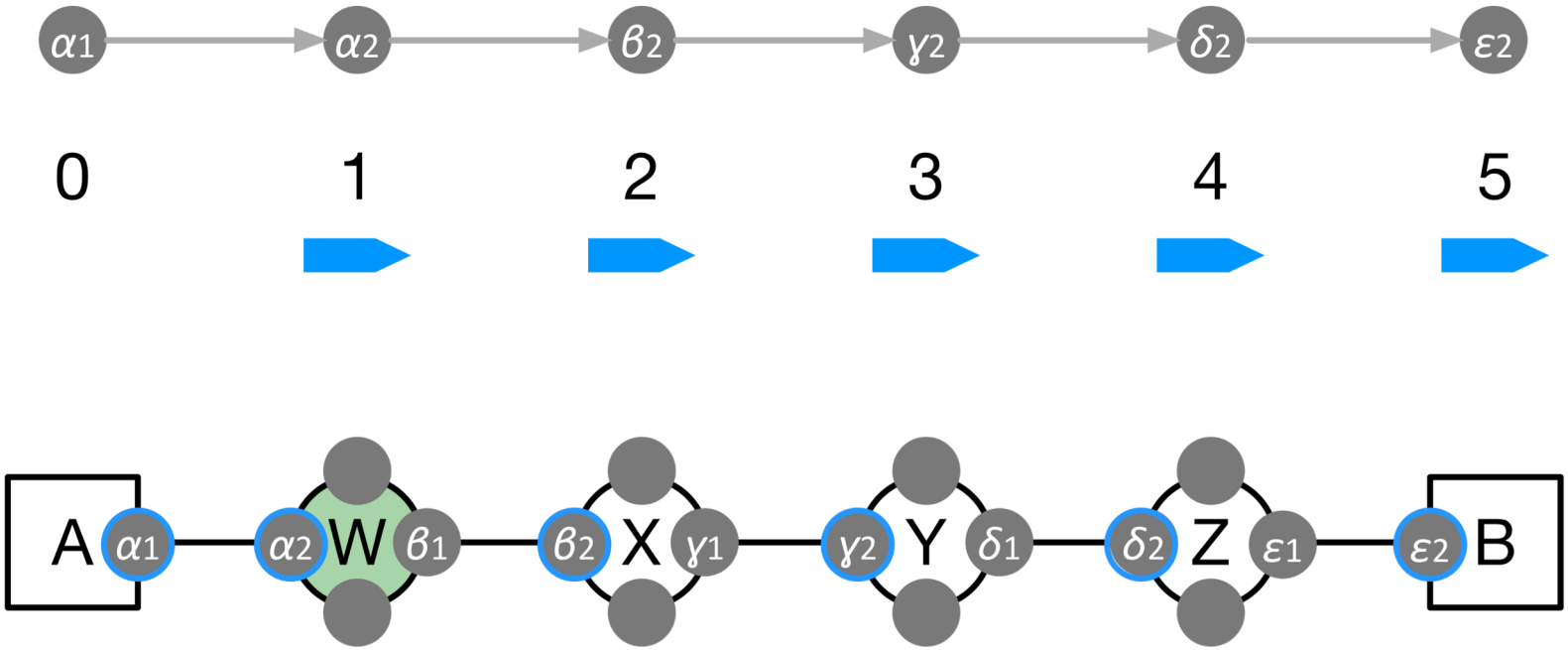
B




Google Doc poll: Which routers and hosts has traceroute learned something about?


α1
α2
β2
γ2
δ2
ε2
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2
3
4
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β1
β2
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γ1
γ2
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δ2
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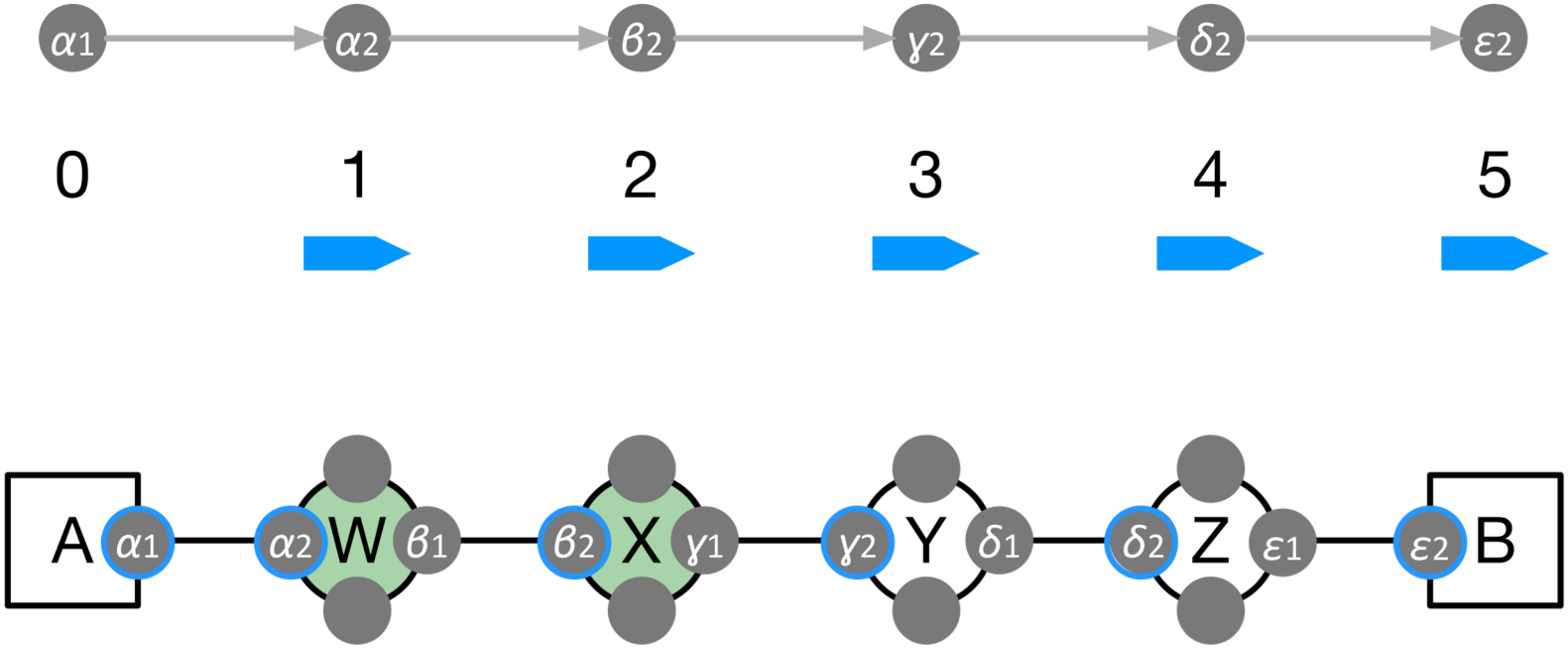
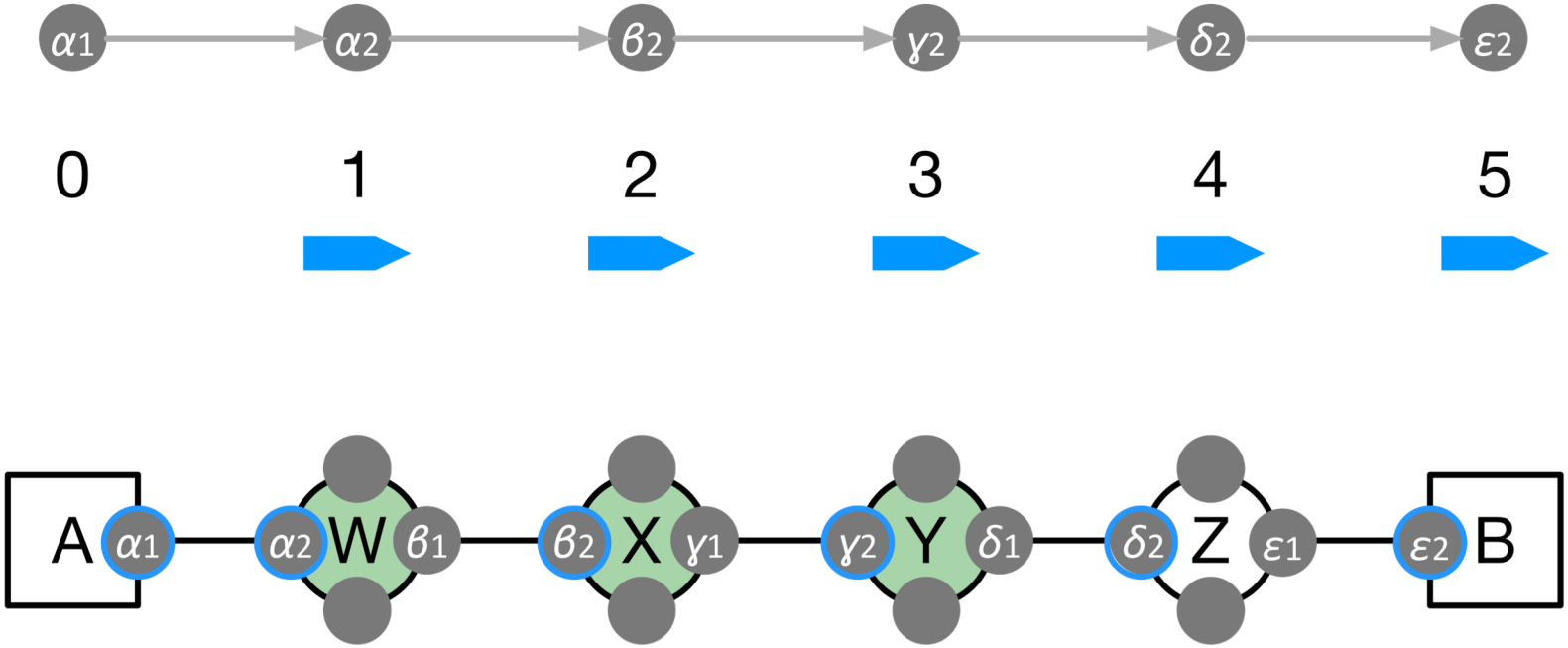
ε1
ε2
B


α1
α2
β2
γ2
δ2
ε2
0
1
2
3
4
5
A
α1
α2
W
β1
β2
X
γ1
γ2
Y
δ1
δ2
Z
ε1
ε2
B


α1
α2
β2
γ2
δ2
ε2
0
1
2
3
4
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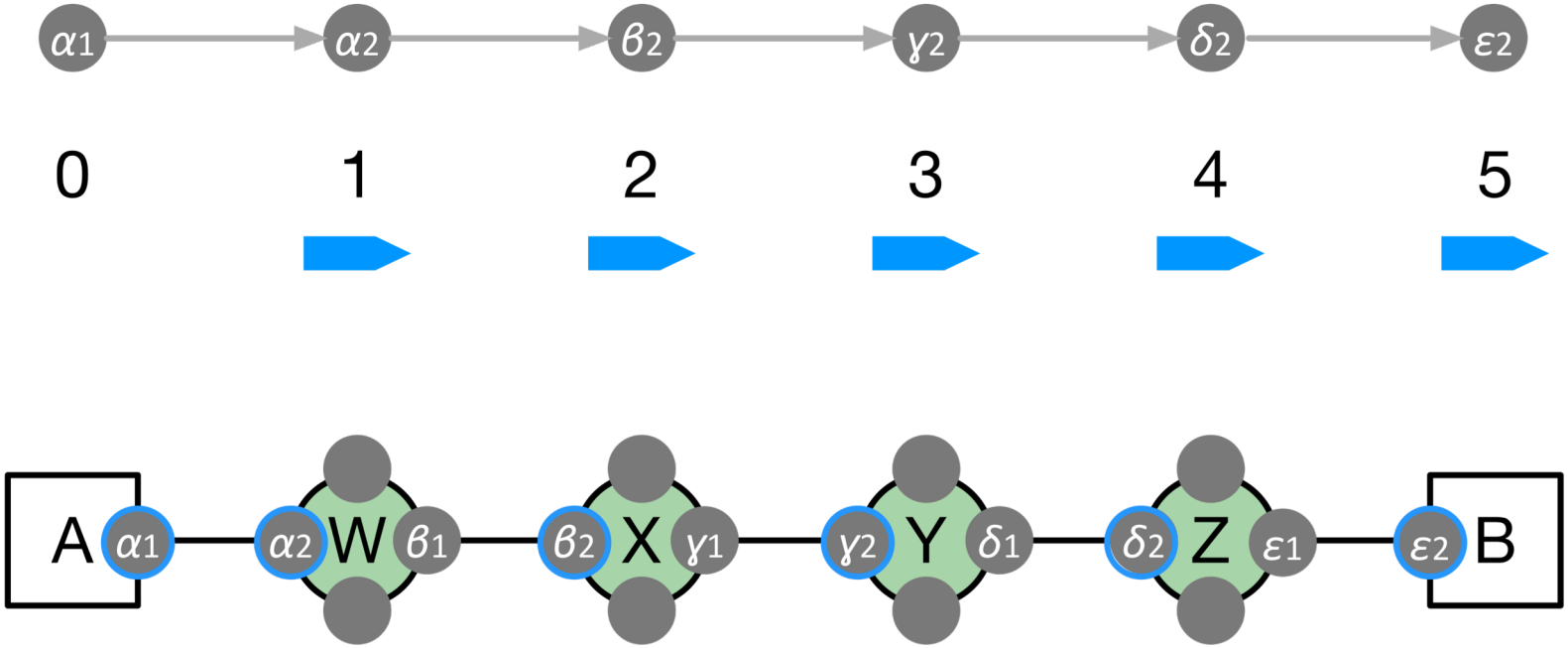
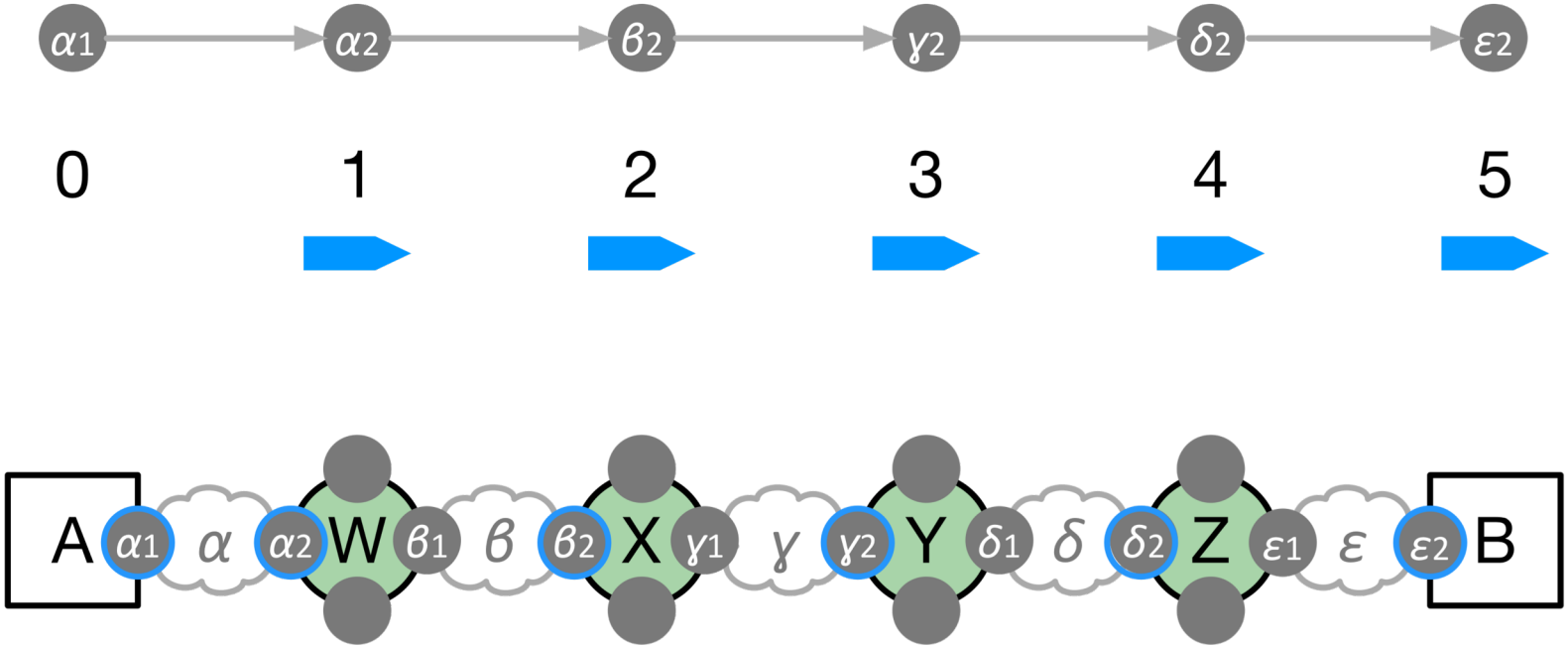
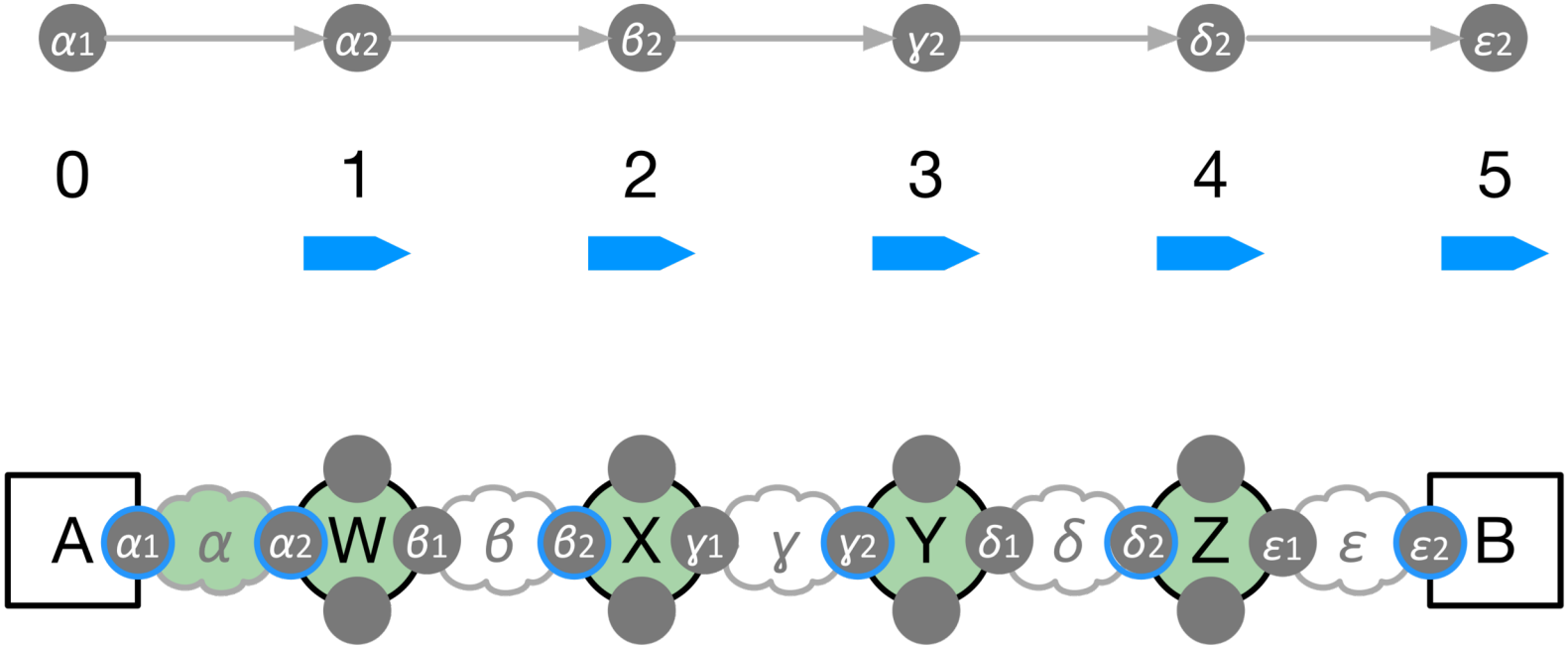
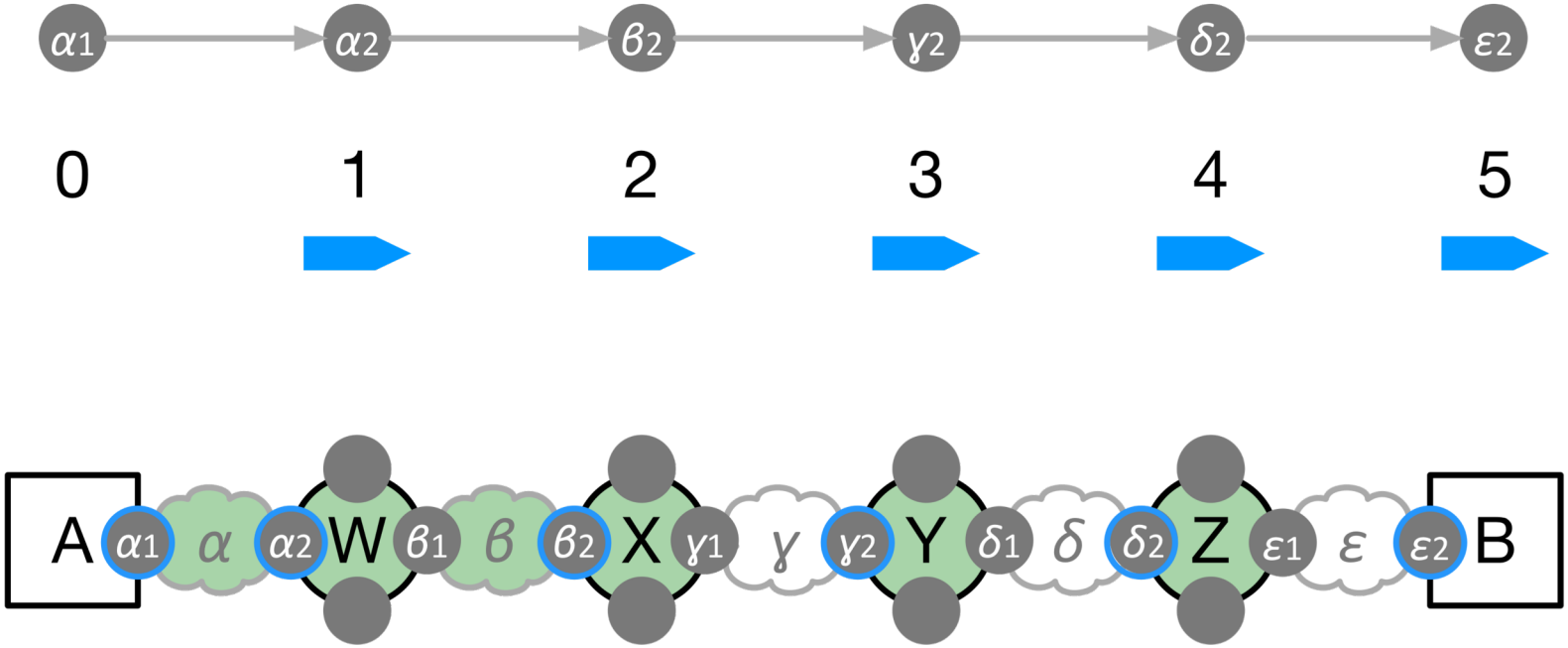
α1
α2
W
β1
β2
X
γ1
γ2
Y
δ1
δ2
Z
ε1
ε2
B

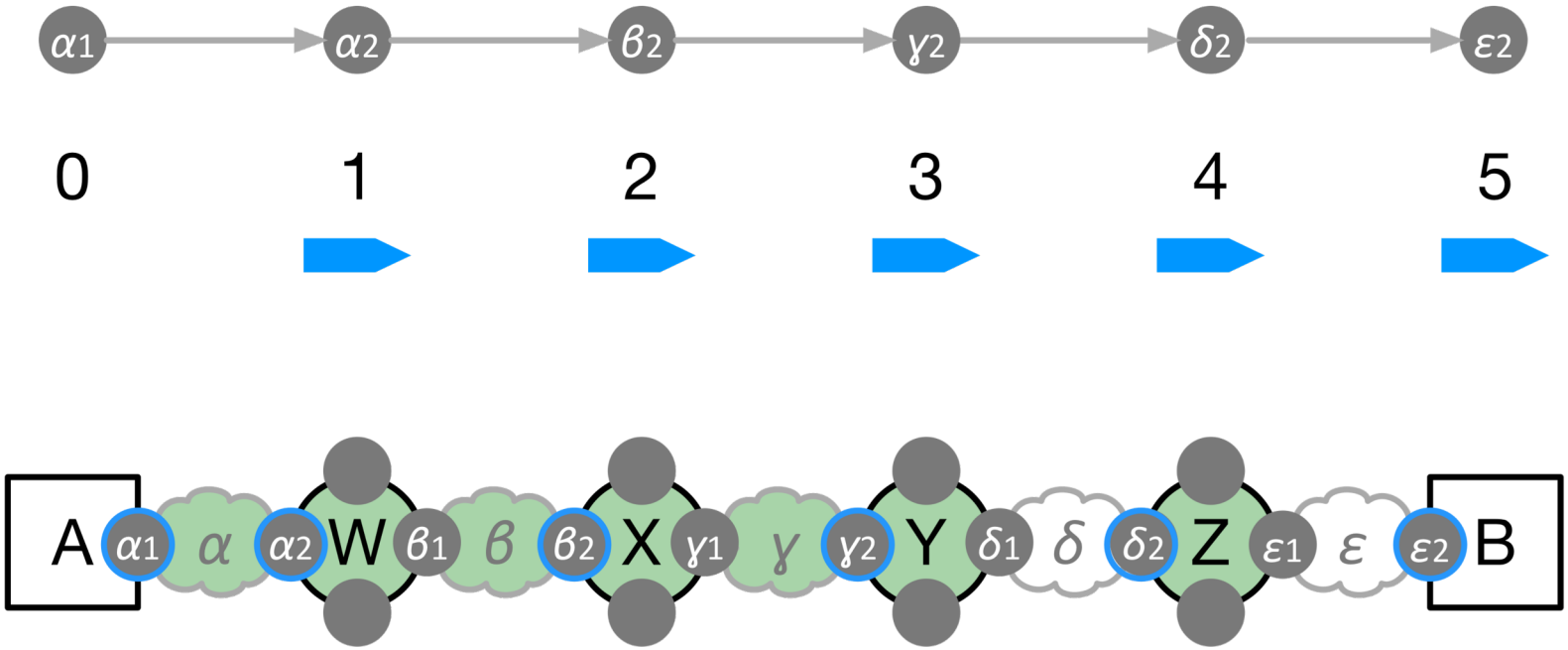

α1
α2
β2
γ2
δ2
ε2
0
1
2
3
4
5
A
α1
α2
W
β1
β2
X
γ1
γ2
Y
δ1
δ2
Z
ε1
ε2
B




Google Doc poll: Which networks has traceroute learned something about?


α1
α2
β2
γ2
δ2
ε2
0
1
2
3
4
5
A
α1
α
α2
W
β1
β
β2
X
γ1
γ
γ2
Y
δ1
δ
δ2
Z
ε1
ε
ε2
B


α1
α2
β2
γ2
δ2
ε2
0
1
2
3
4
5
A
α1
α
α2
W
β1
β
β2
X
γ1
γ
γ2
Y
δ1
δ
δ2
Z
ε1
ε
ε2
B


α1
α2
β2
γ2
δ2
ε2
0
1
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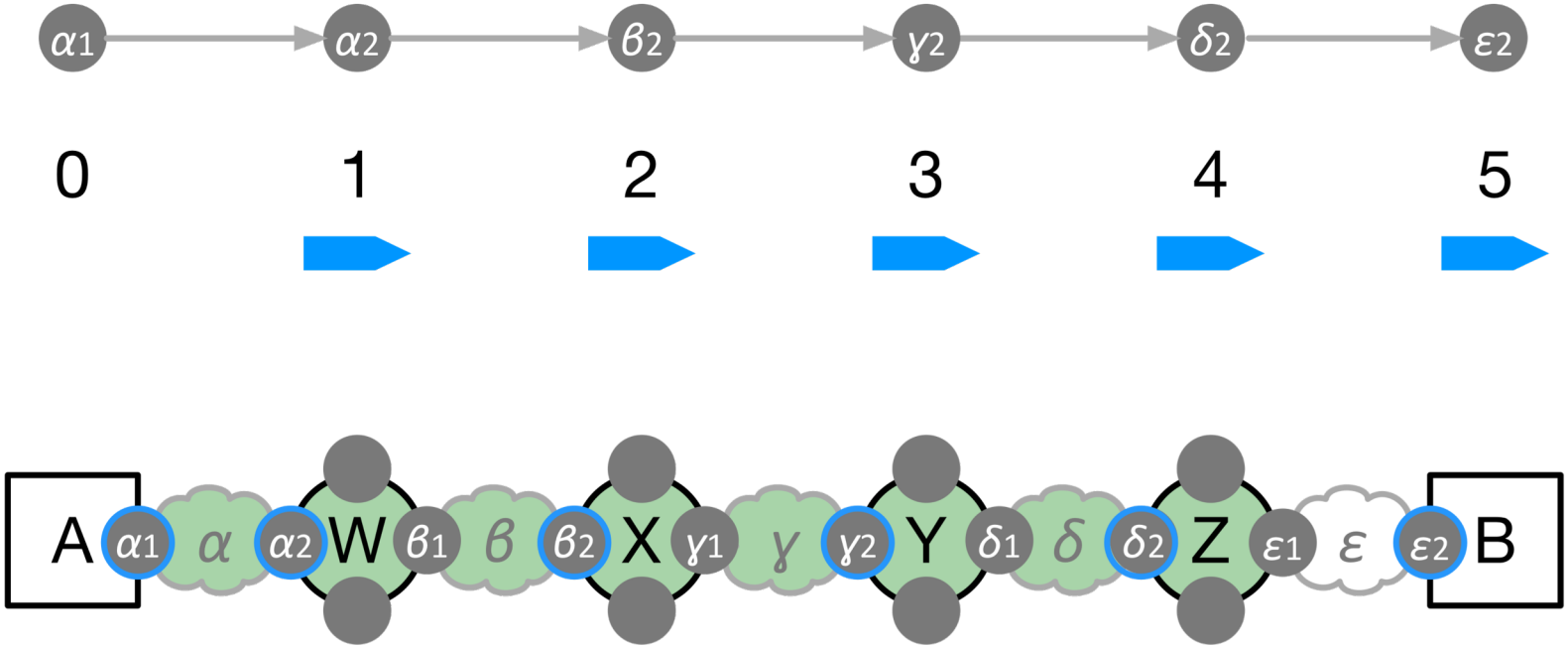
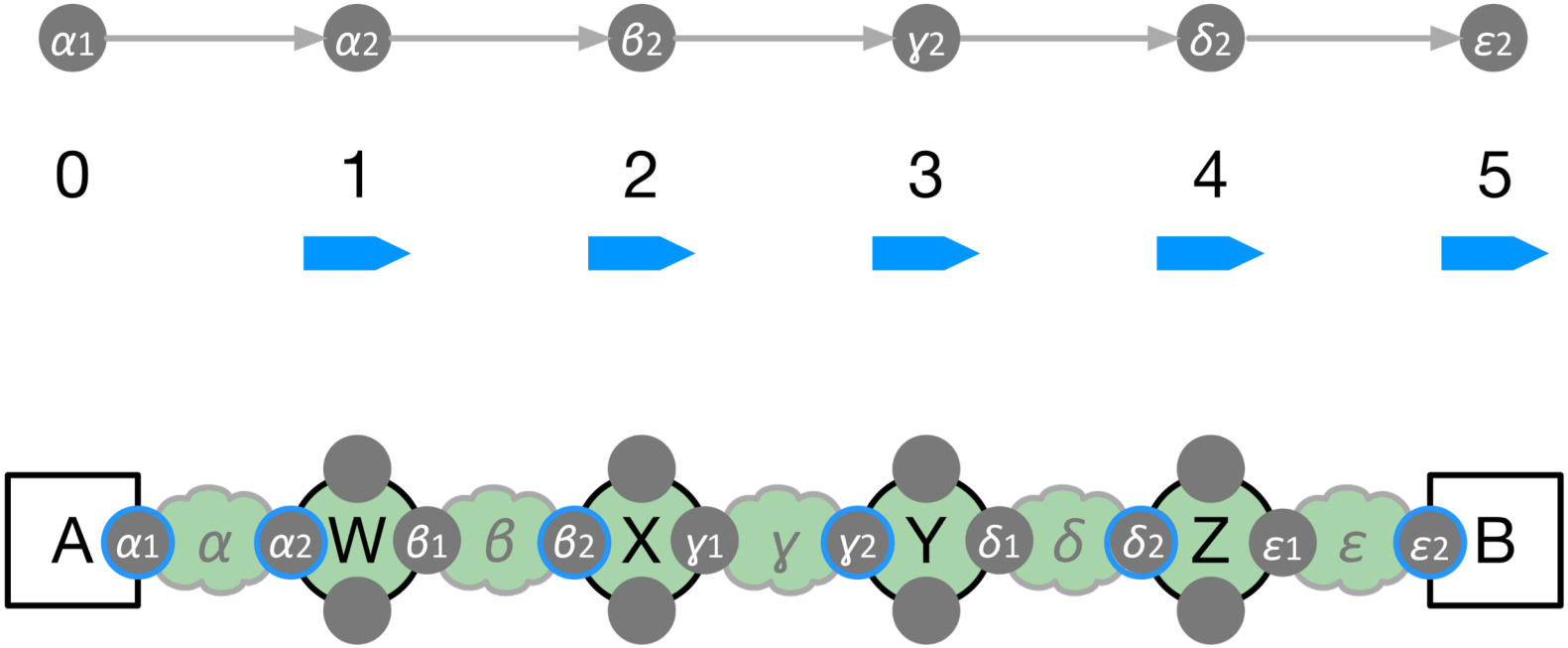
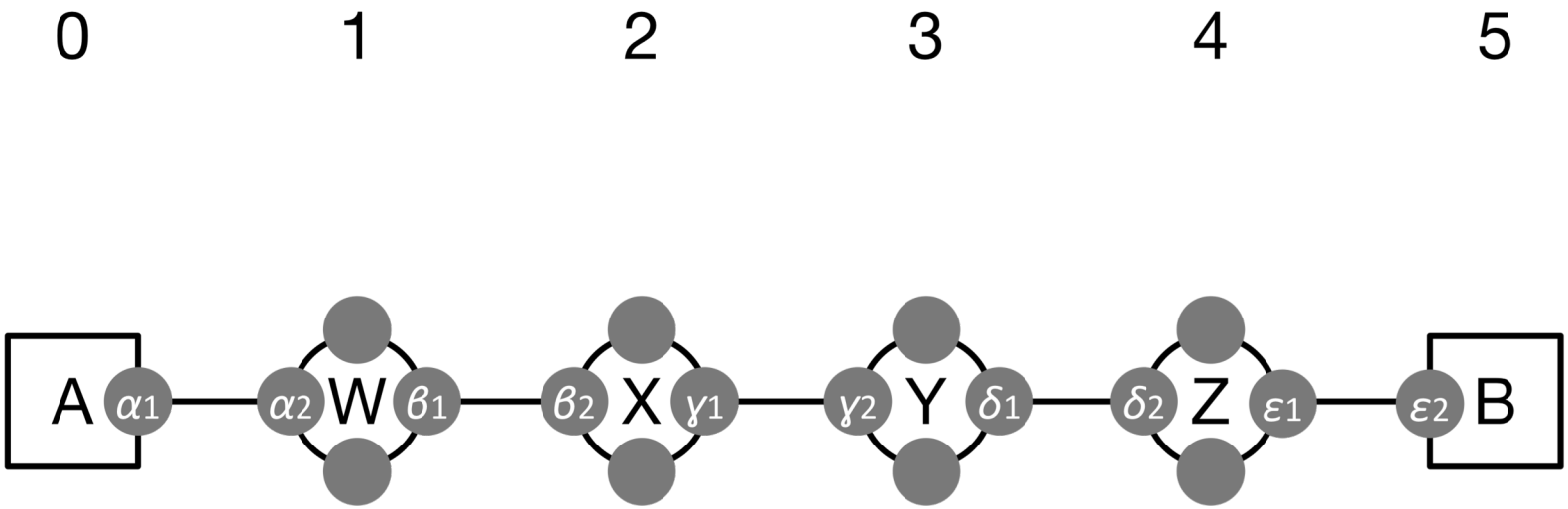
3
4
5
A
α1
α
α2
W
β1
β
β2
X
γ1
γ
γ2
Y
δ1
δ
δ2
Z
ε1
ε
ε2
B


α1
α2
β2
γ2
δ2
ε2
0
1
2
3
4
5
A
α1
α
α2
W
β1
β
β2
X
γ1
γ
γ2
Y
δ1
δ
δ2
Z
ε1
ε
ε2
B


α1
α2
β2
γ2
δ2
ε2
0
1
2
3
4
5
A
α1
α
α2
W
β1
β
β2
X
γ1
γ
γ2
Y
δ1
δ
δ2
Z
ε1
ε
ε2
B


0
1
2
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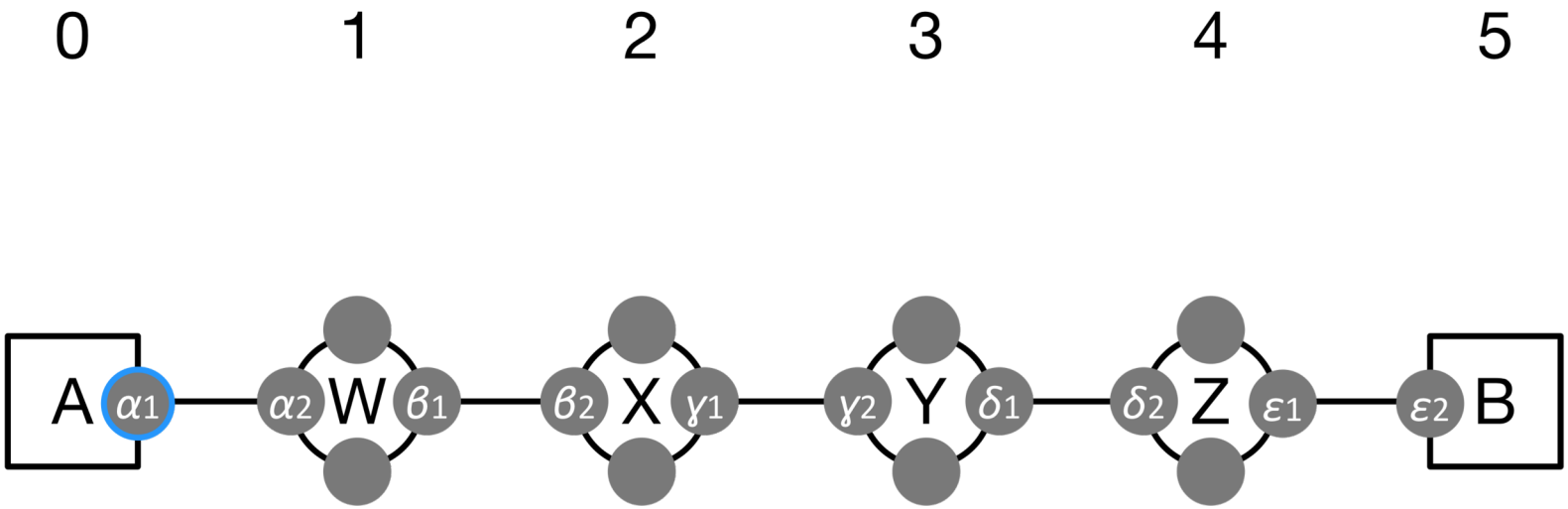
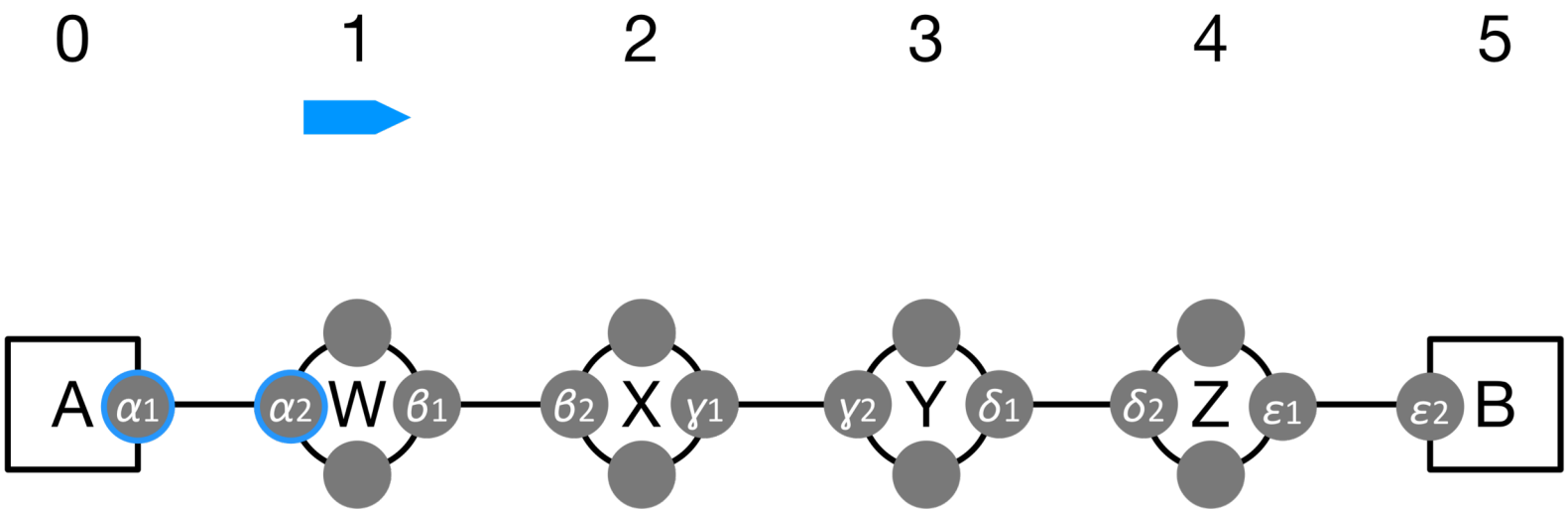
5
A
α1
α2
W
β1
β2
X
γ1
γ2
Y
δ1
δ2
Z
ε1
ε2
B


0
1
2
3
4
5
A
α1
α2
W
β1
β2
X
γ1
γ2
Y
δ1
δ2
Z
ε1
ε2
B


0
1
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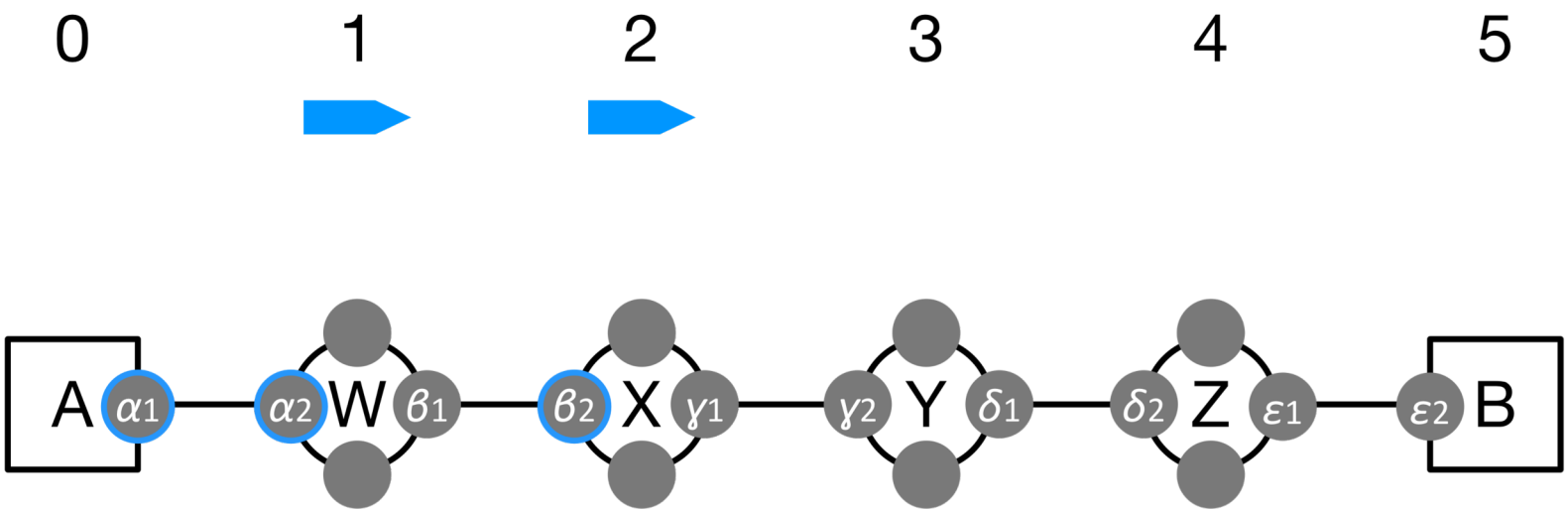
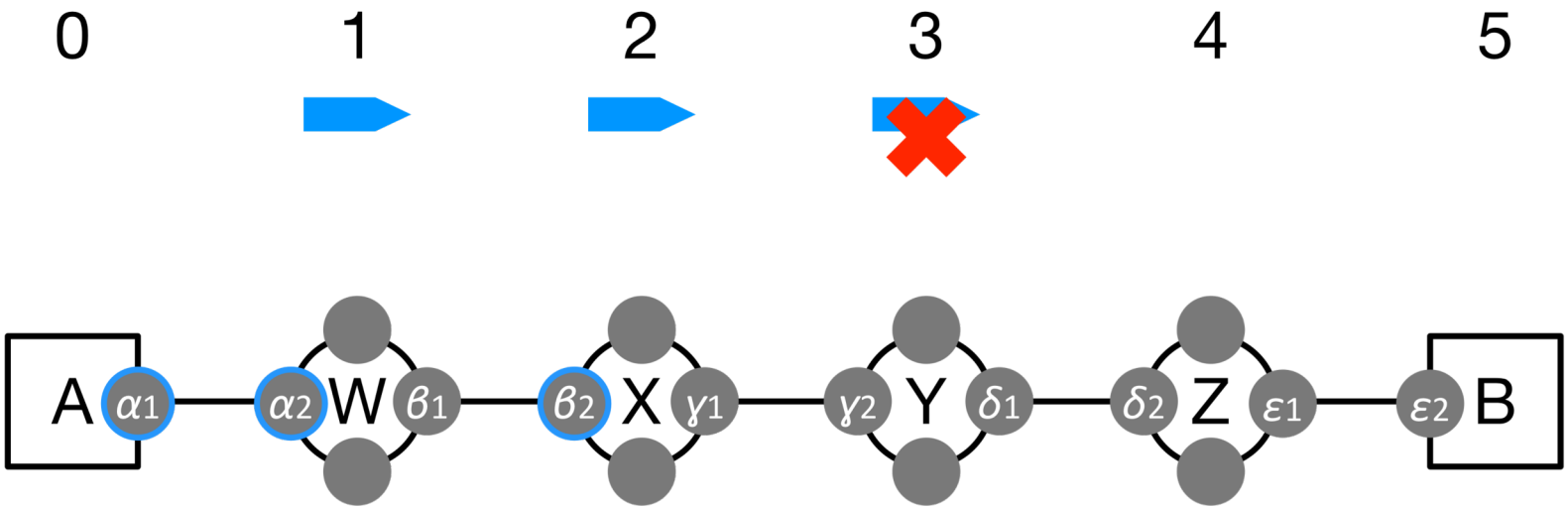
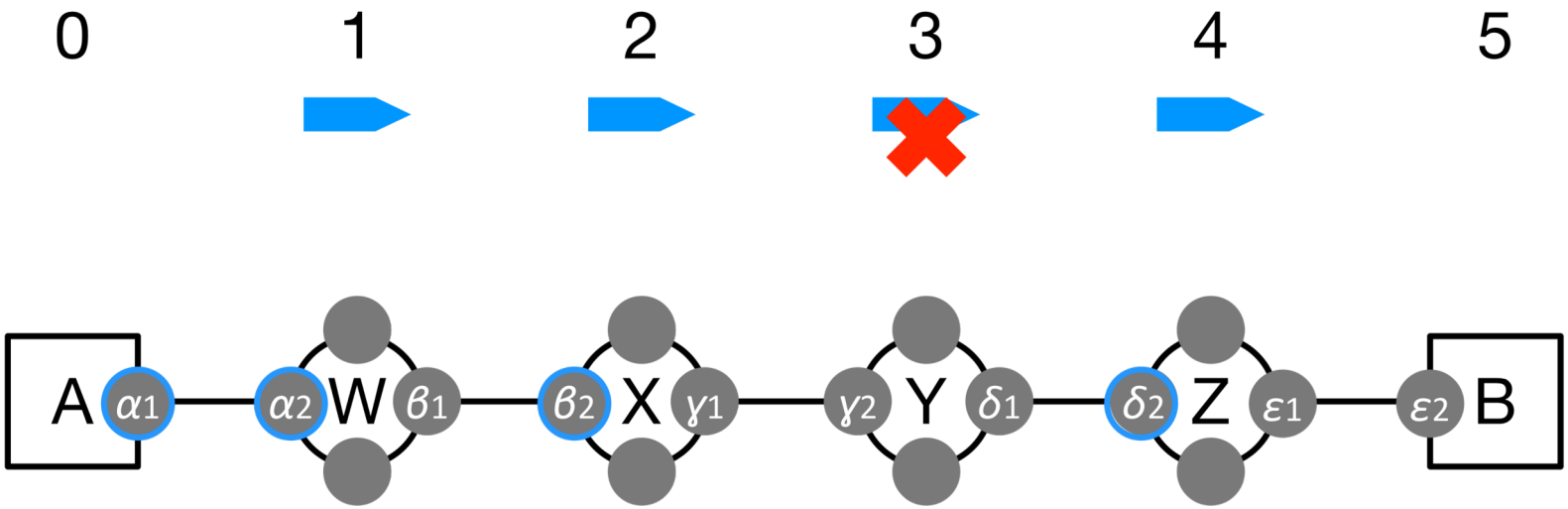
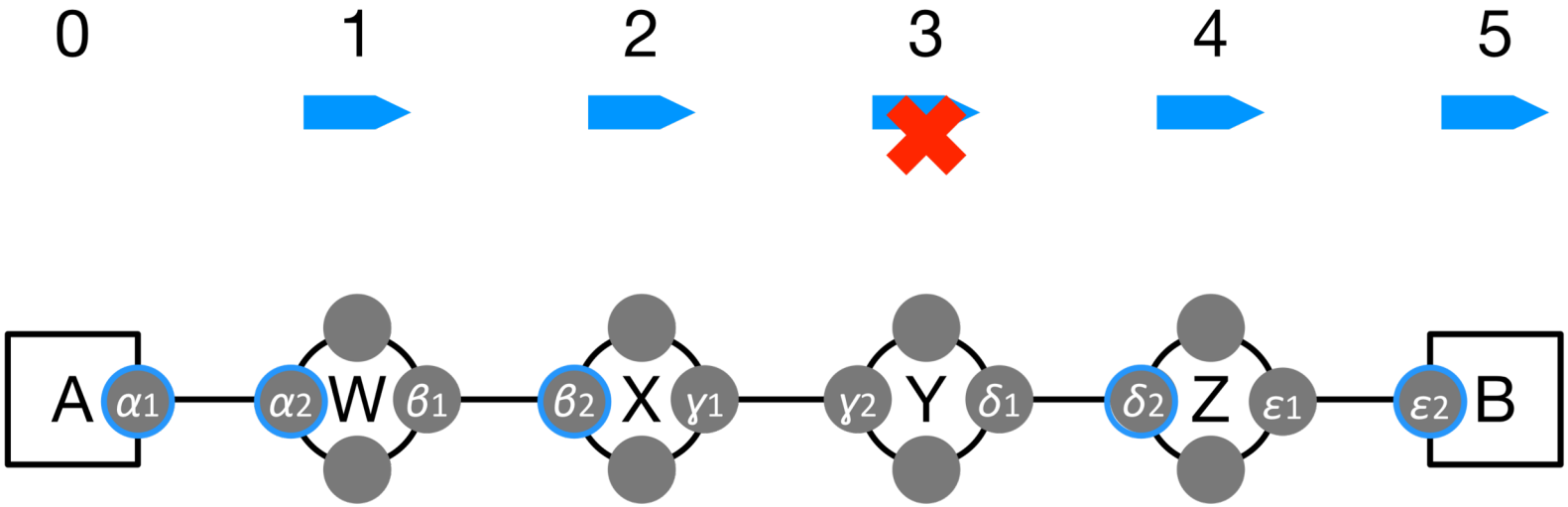
4
5
A
α1
α2
W
β1
β2
X
γ1
γ2
Y
δ1
δ2
Z
ε1
ε2
B

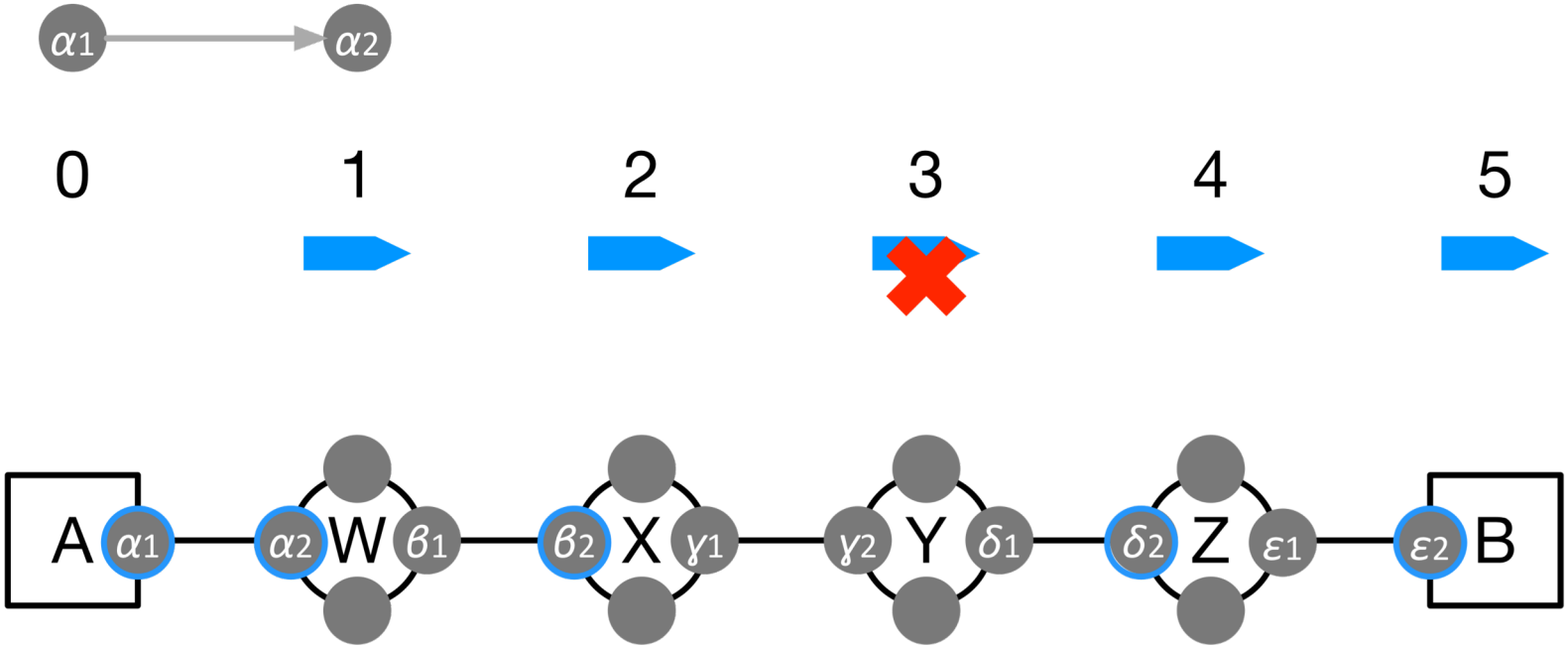

0
1
2
3
4
5
A
α1
α2
W
β1
β2
X
γ1
γ2
Y
δ1
δ2
Z
ε1
ε2
B

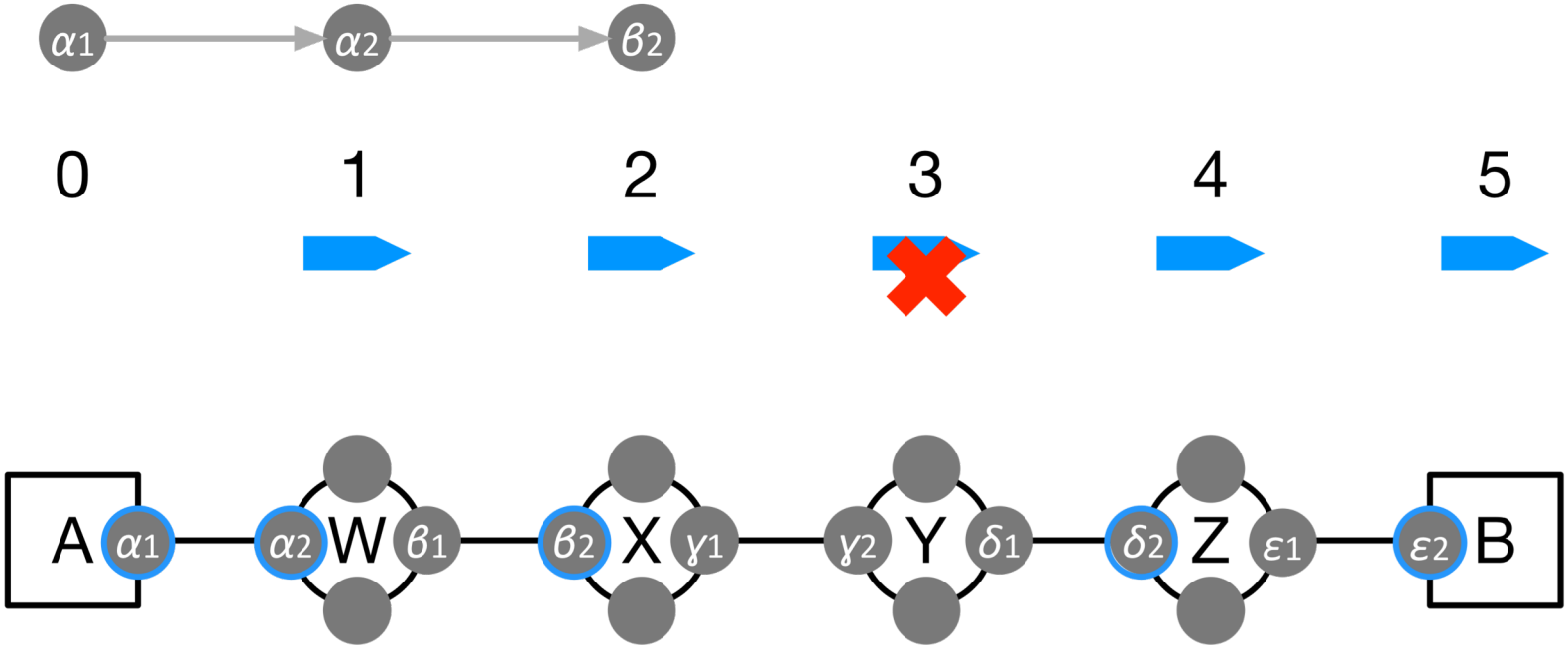

0
1
2
3
4
5
A
α1
α2
W
β1
β2
X
γ1
γ2
Y
δ1
δ2
Z
ε1
ε2
B

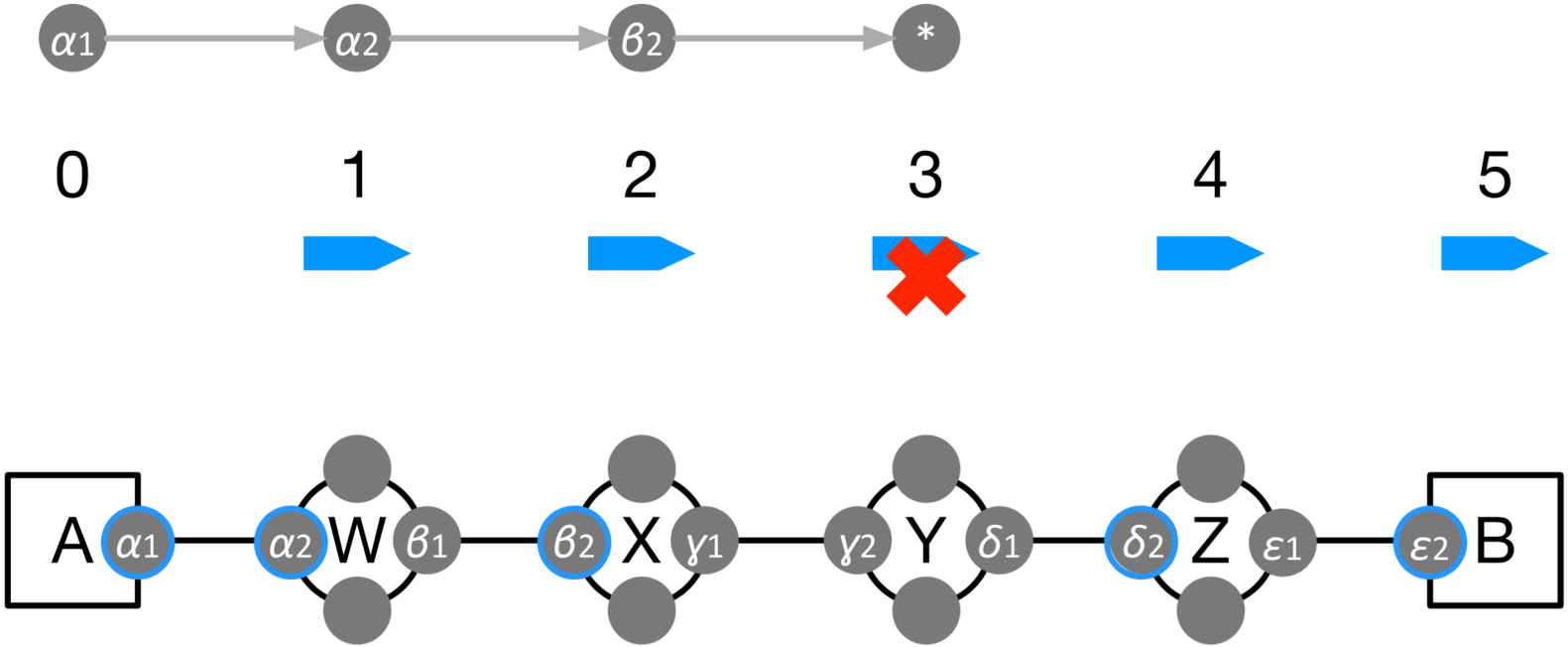

0
1
2
3
4
5
A
α1
α2
W
β1
β2
X
γ1
γ2
Y
δ1
δ2
Z
ε1
ε2
B

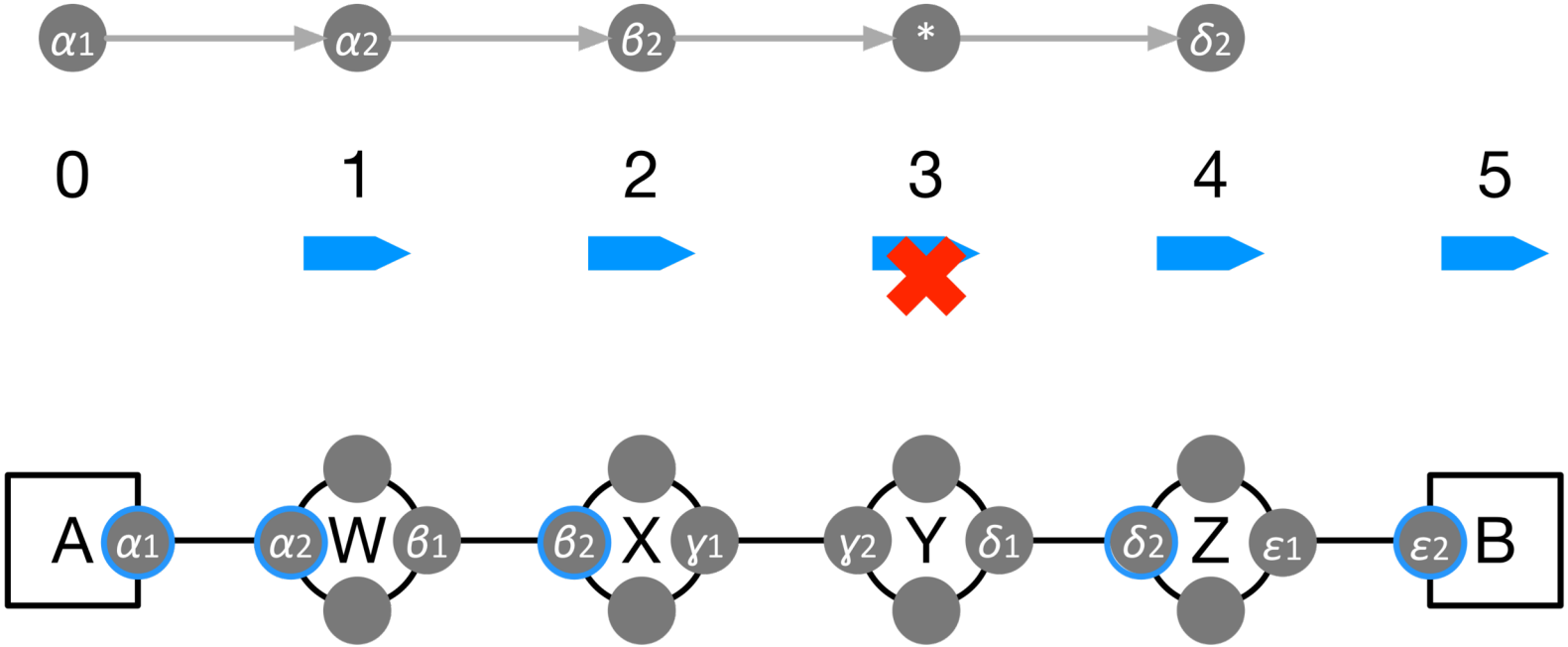


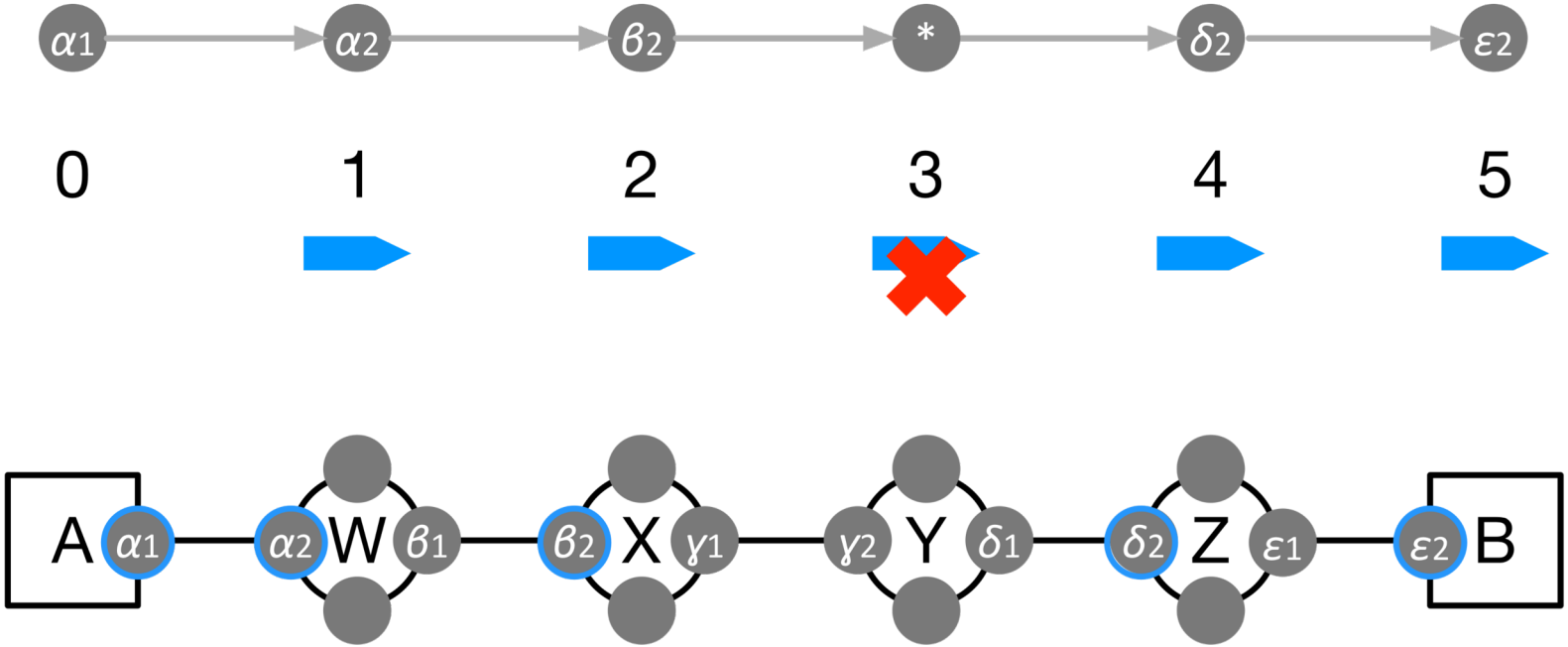

Google Doc poll: What will traceroute output for TTL 3 in this case?


α1
α2
0
1
2
3
4
5
A
α1
α2
W
β1
β2
X
γ1
γ2
Y
δ1
δ2
Z
ε1
ε2
B

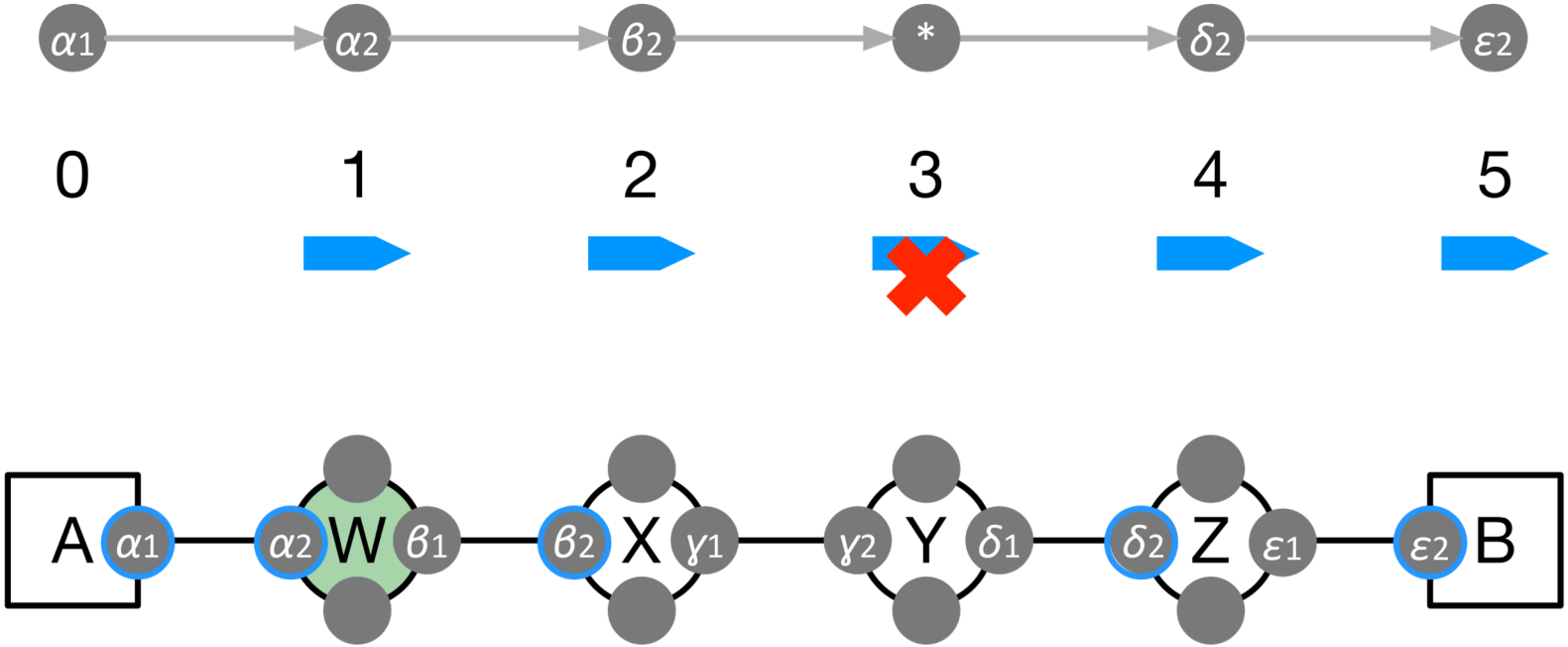

α1
α2
β2
0
1
2
3
4
5
A
α1
α2
W
β1
β2
X
γ1
γ2
Y
δ1
δ2
Z
ε1
ε2
B

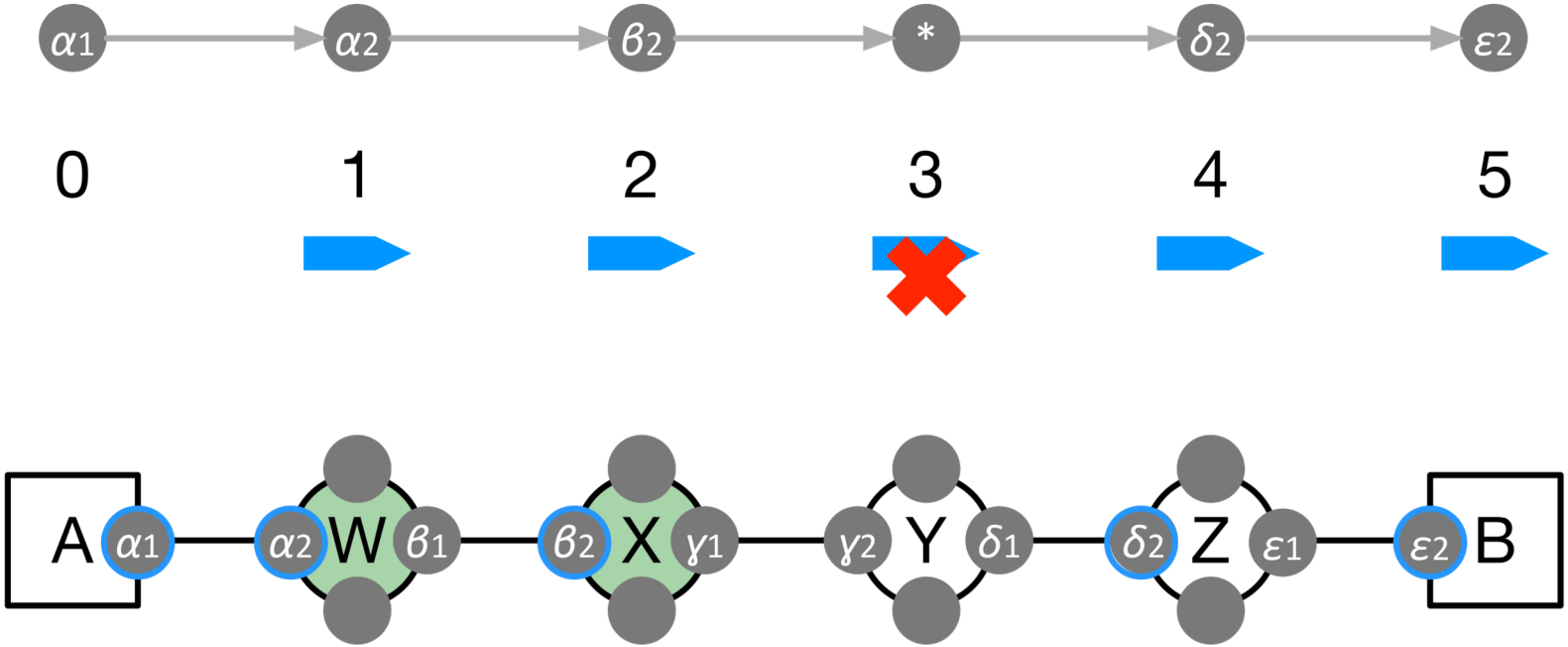

α1
α2
β2
*
0
1
2
3
4
5
A
α1
α2
W
β1
β2
X
γ1
γ2
Y
δ1
δ2
Z
ε1
ε2
B

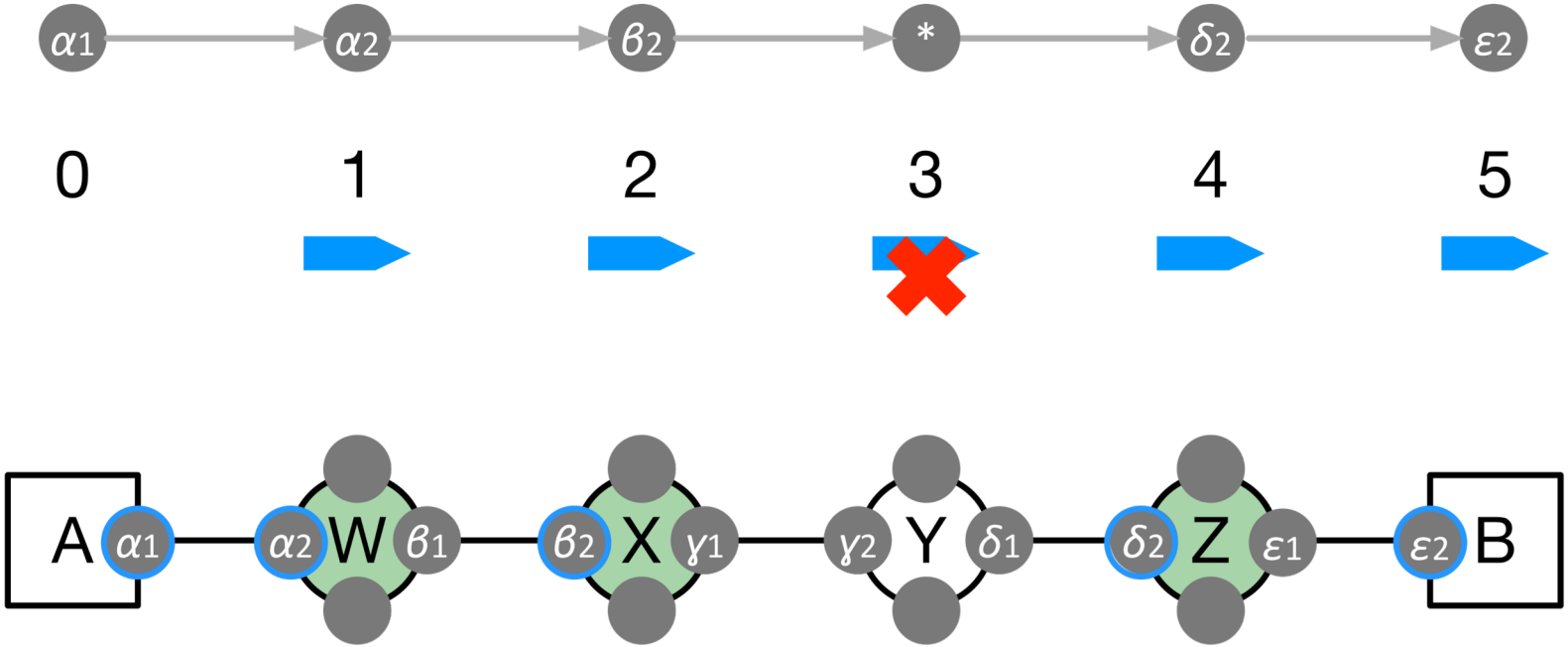

α1
α2
β2
*
δ2
0
1
2
3
4
5
A
α1
α2
W
β1
β2
X
γ1
γ2
Y
δ1
δ2
Z
ε1
ε2
B

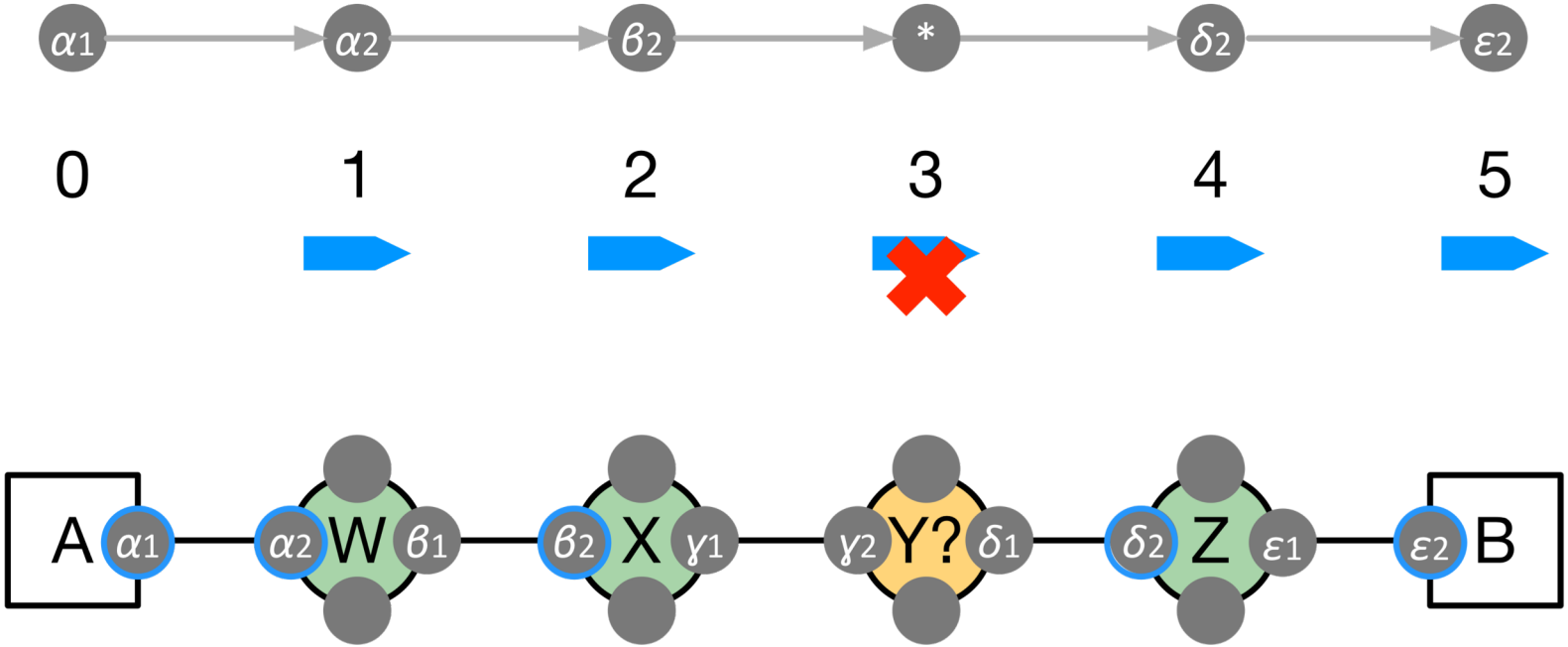


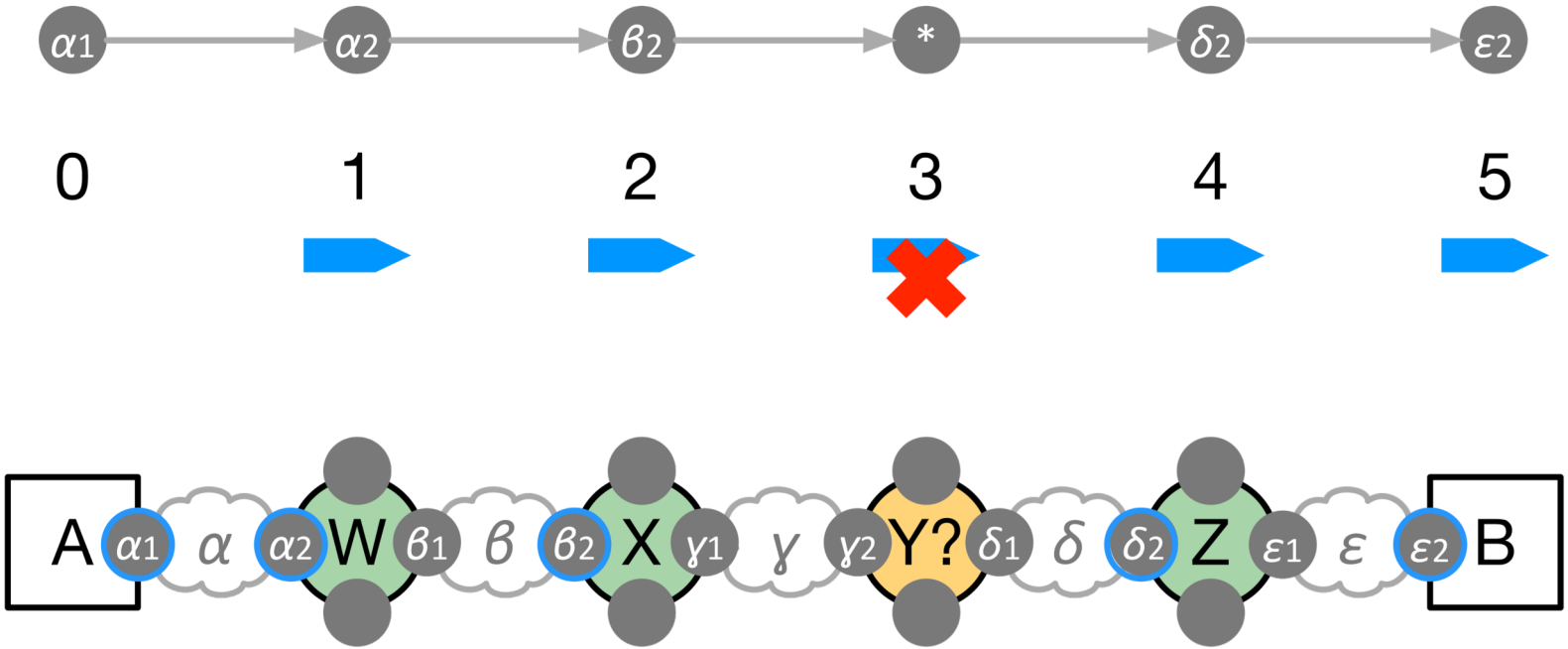

Google Doc poll: Which router has traceroute learned nothing about in this example?


α1
α2
β2
*
δ2
ε2
0
1
2
3
4
5
A
α1
α2
W
β1
β2
X
γ1
γ2
Y
δ1
δ2
Z
ε1
ε2
B

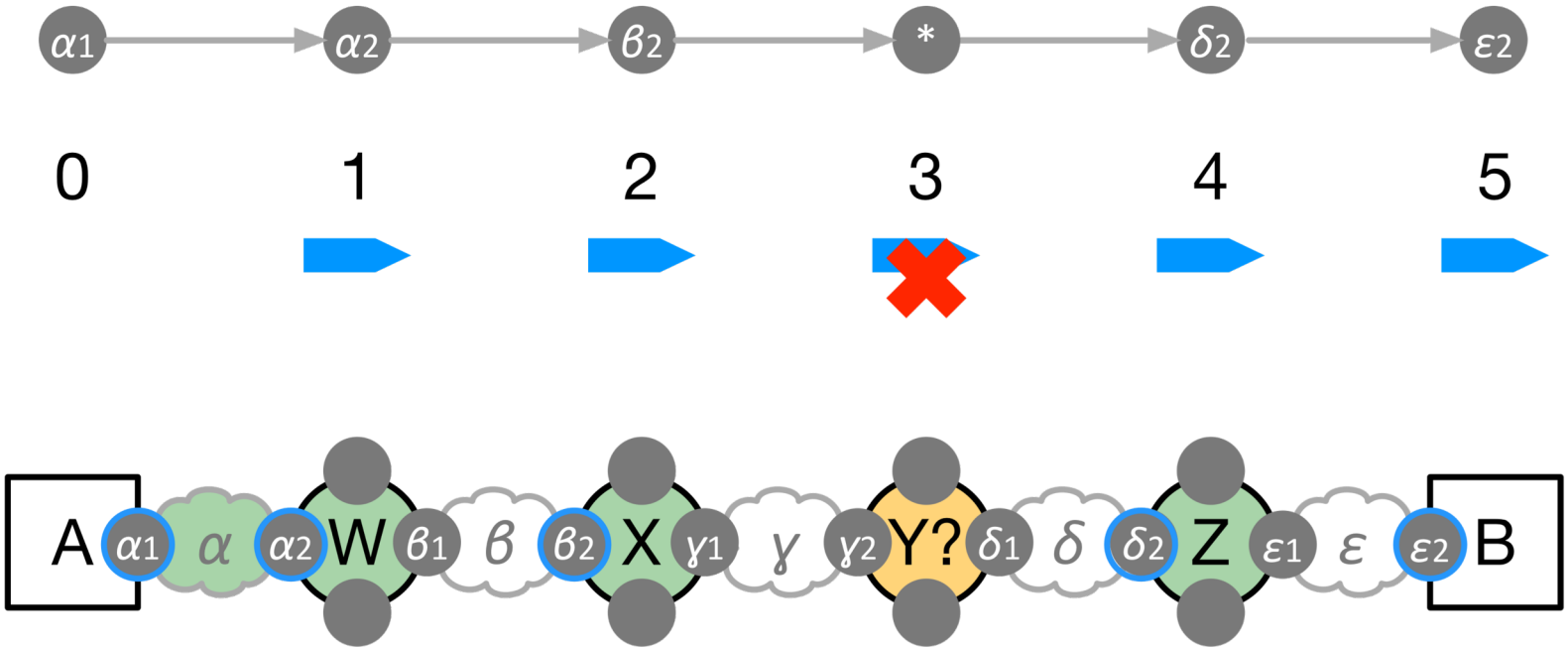

α1
α2
β2
*
δ2
ε2
0
1
2
3
4
5
A
α1
α2
W
β1
β2
X
γ1
γ2
Y
δ1
δ2
Z
ε1
ε2
B

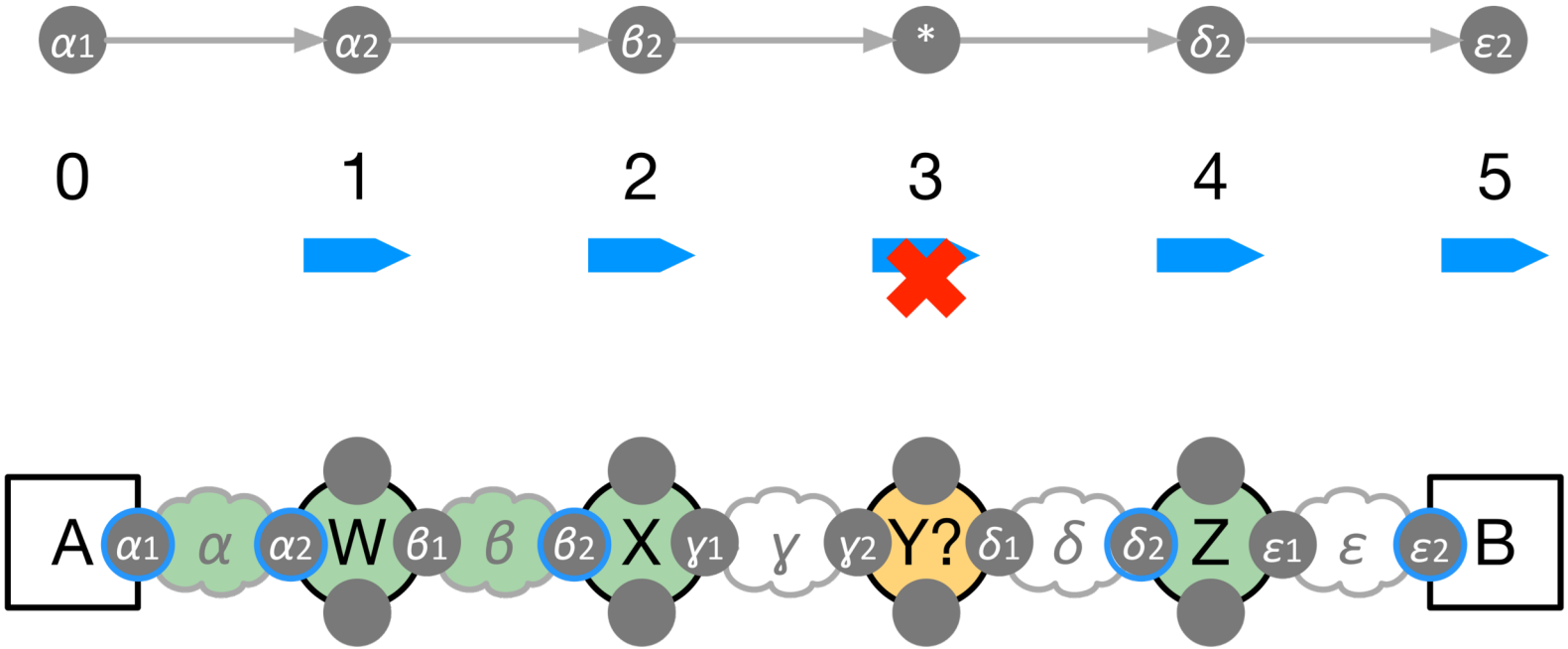

α1
α2
β2
*
δ2
ε2
0
1
2
3
4
5
A
α1
α2
W
β1
β2
X
γ1
γ2
Y
δ1
δ2
Z
ε1
ε2
B


α1
α2
β2
*
δ2
ε2
0
1
2
3
4
5
A
α1
α2
W
β1
β2
X
γ1
γ2
Y?
δ1
δ2
Z
ε1
ε2
B




Google Doc poll: Which network has traceroute learned nothing about in this example?


α1
α2
β2
*
δ2
ε2
0
1
2
3
4
5
A
α1
α
α2
W
β1
β
β2
X
γ1
γ
γ2
Y?
δ1
δ
δ2
Z
ε1
ε
ε2
B


α1
α2
β2
*
δ2
ε2
0
1
2
3
4
5
A
α1
α
α2
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β1
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β2
X
γ1
γ
γ2
Y?
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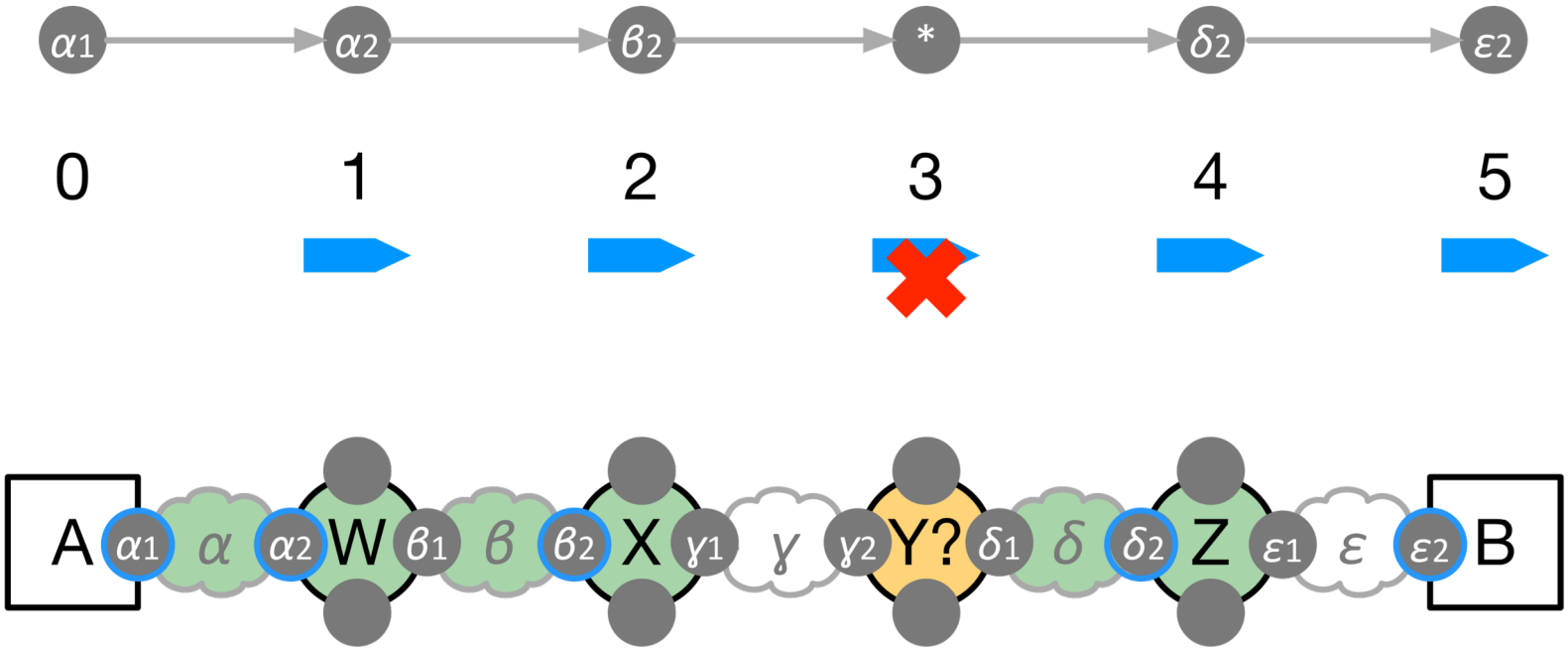
δ
δ2
Z
ε1
ε
ε2
B


α1
α2
β2
*
δ2
ε2
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A
α1
α
α2
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β1
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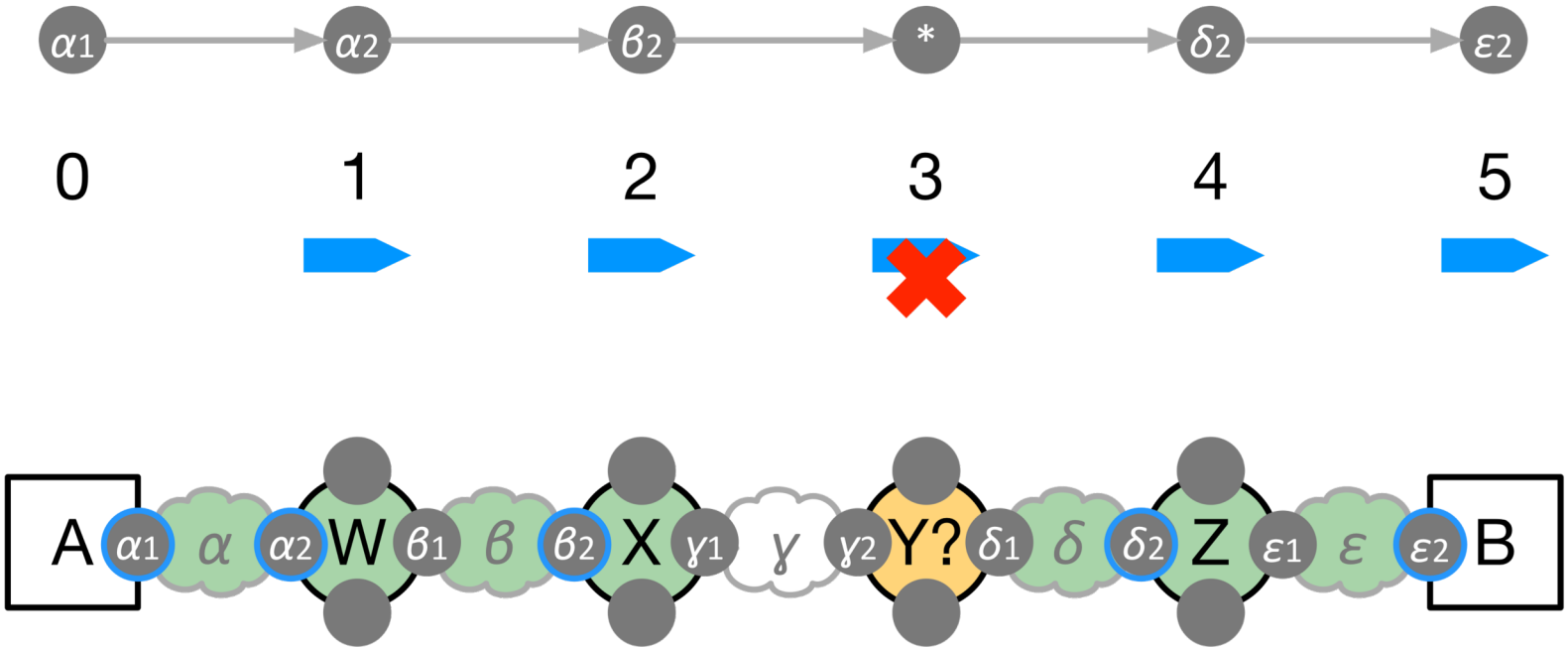
β2
X
γ1
γ
γ2
Y?
δ1
δ
δ2
Z
ε1
ε
ε2
B


α1
α2
β2
*
δ2
ε2
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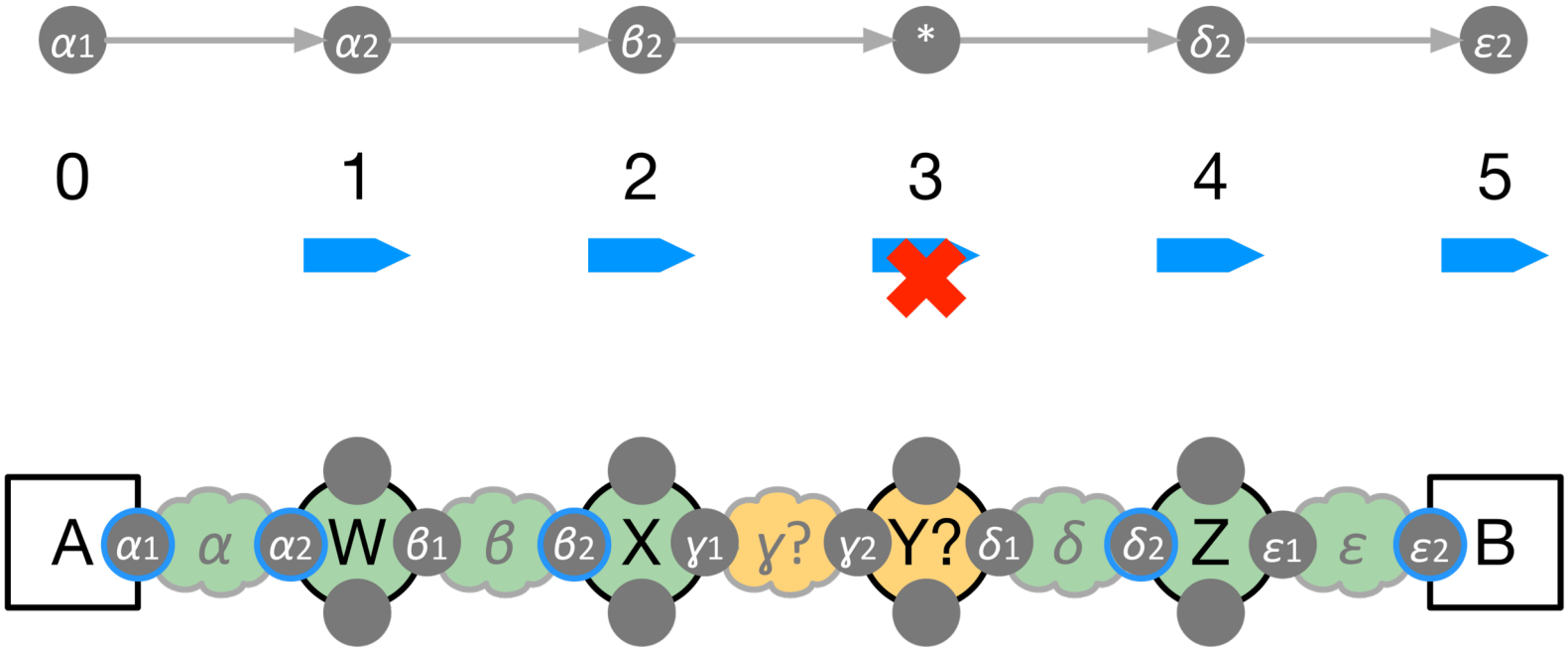
A
α1
α
α2
W
β1
β
β2
X
γ1
γ
γ2
Y?
δ1
δ
δ2
Z
ε1
ε
ε2
B


α1
α2
β2
*
δ2
ε2
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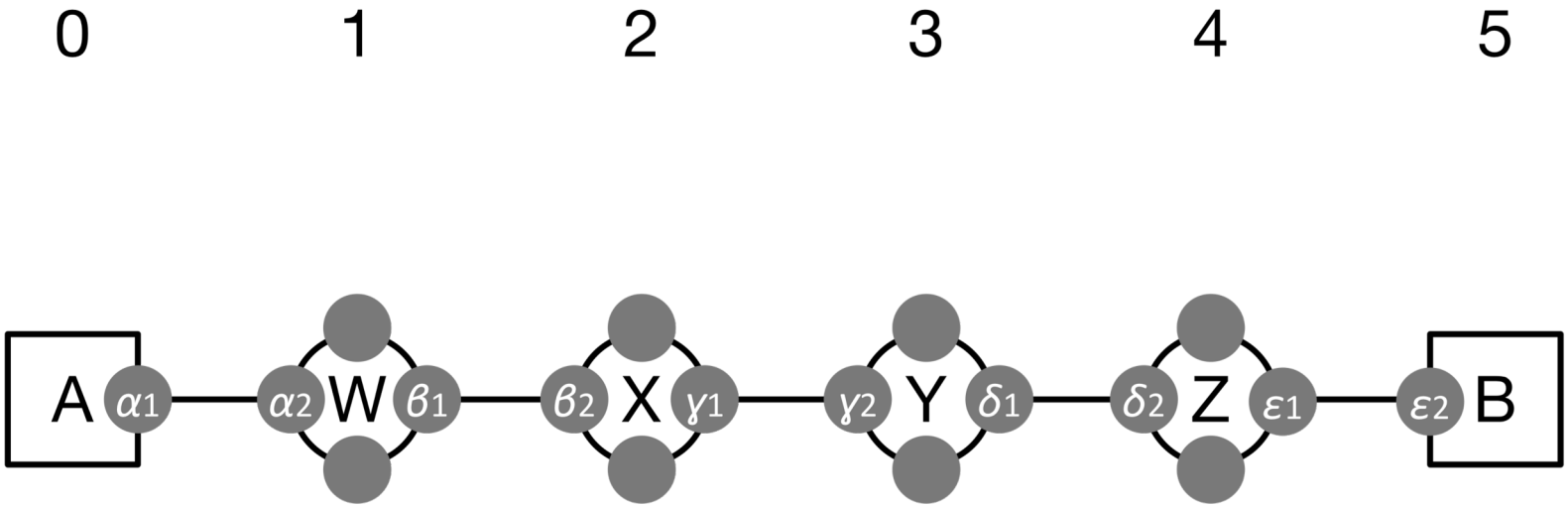
5
A
α1
α
α2
W
β1
β
β2
X
γ1
γ?
γ2
Y?
δ1
δ
δ2
Z
ε1
ε
ε2
B


0
1
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4
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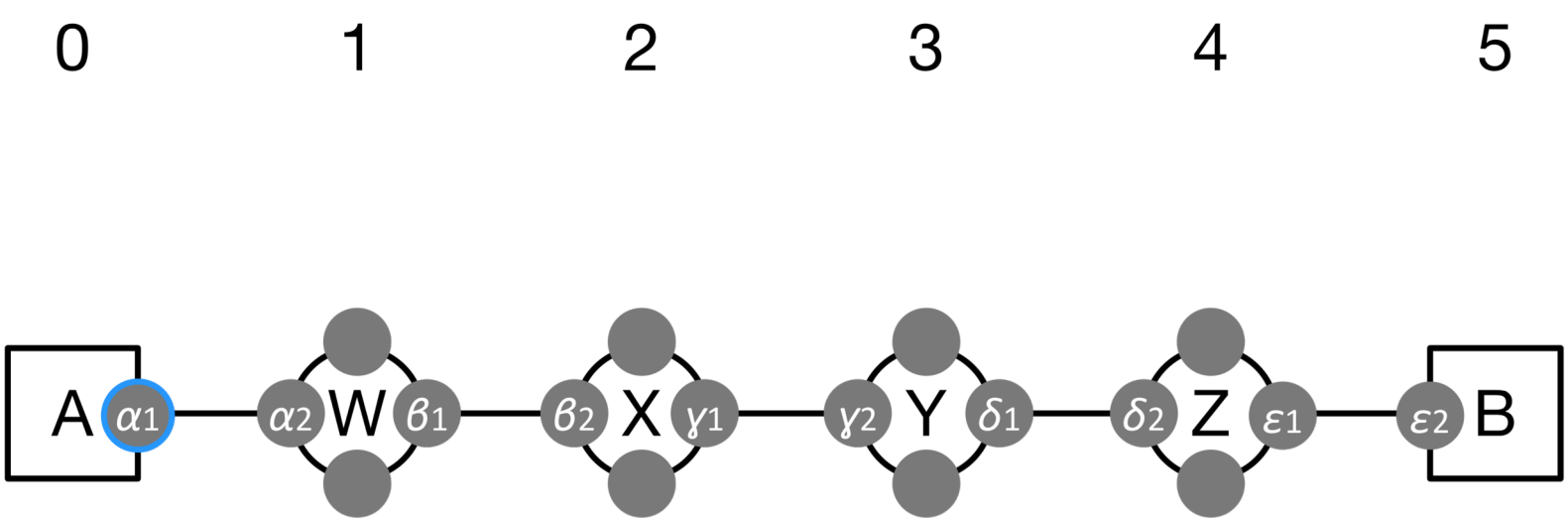
A
α1
α2
W
β1
β2
X
γ1
γ2
Y
δ1
δ2
Z
ε1
ε2
B


0
1
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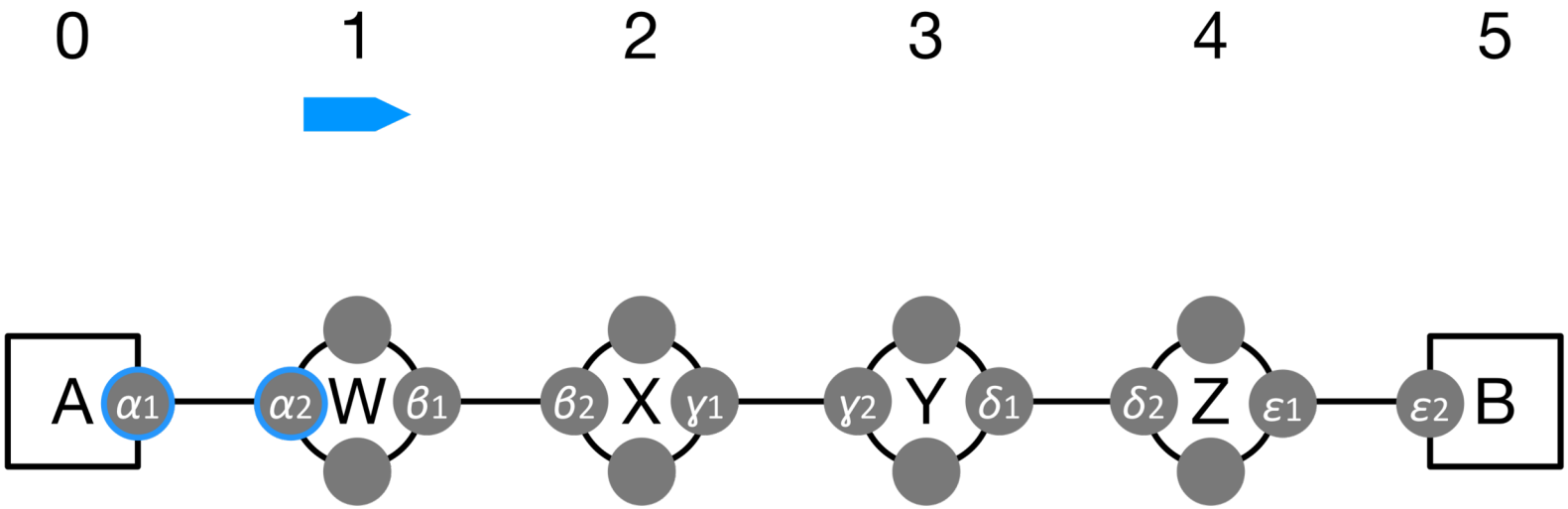
4
5
A
α1
α2
W
β1
β2
X
γ1
γ2
Y
δ1
δ2
Z
ε1
ε2
B


0
1
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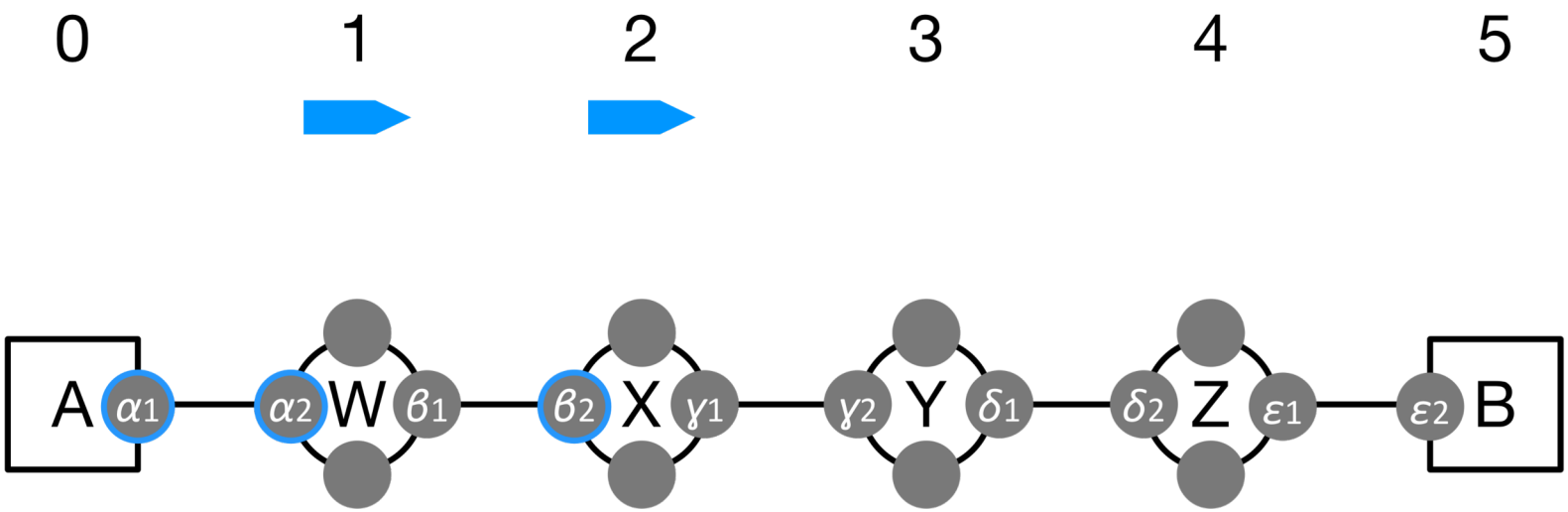
4
5
A
α1
α2
W
β1
β2
X
γ1
γ2
Y
δ1
δ2
Z
ε1
ε2
B


0
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4
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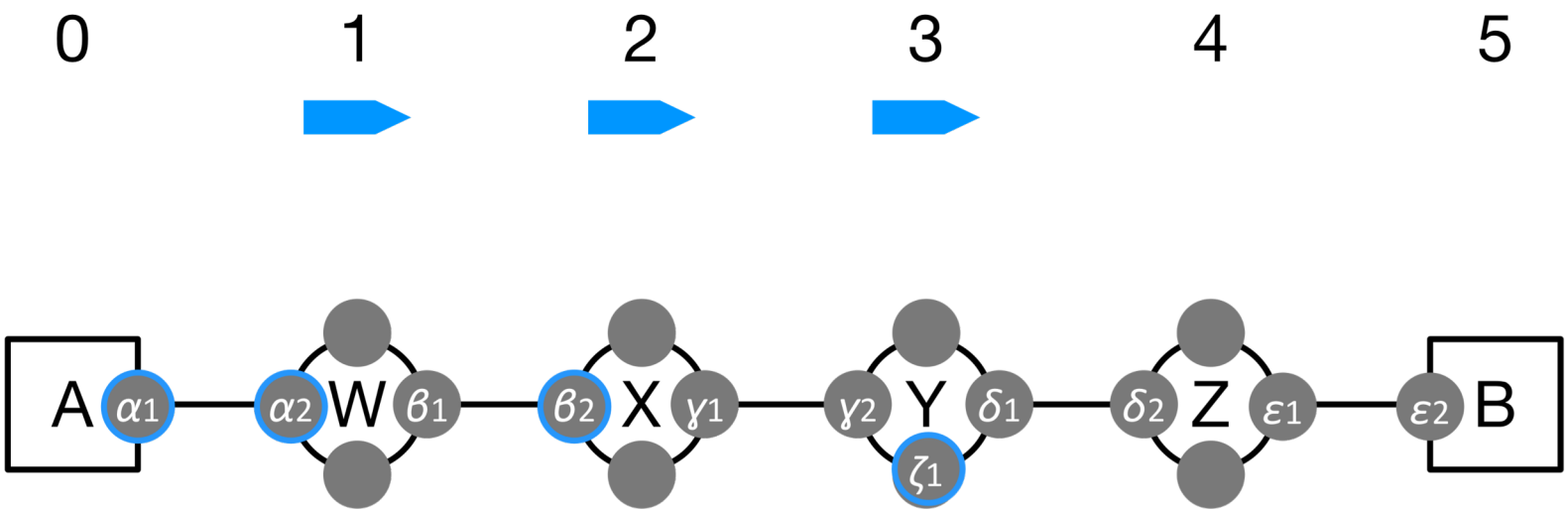
A
α1
α2
W
β1
β2
X
γ1
γ2
Y
δ1
δ2
Z
ε1
ε2
B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β1
β2
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ζ1
δ2
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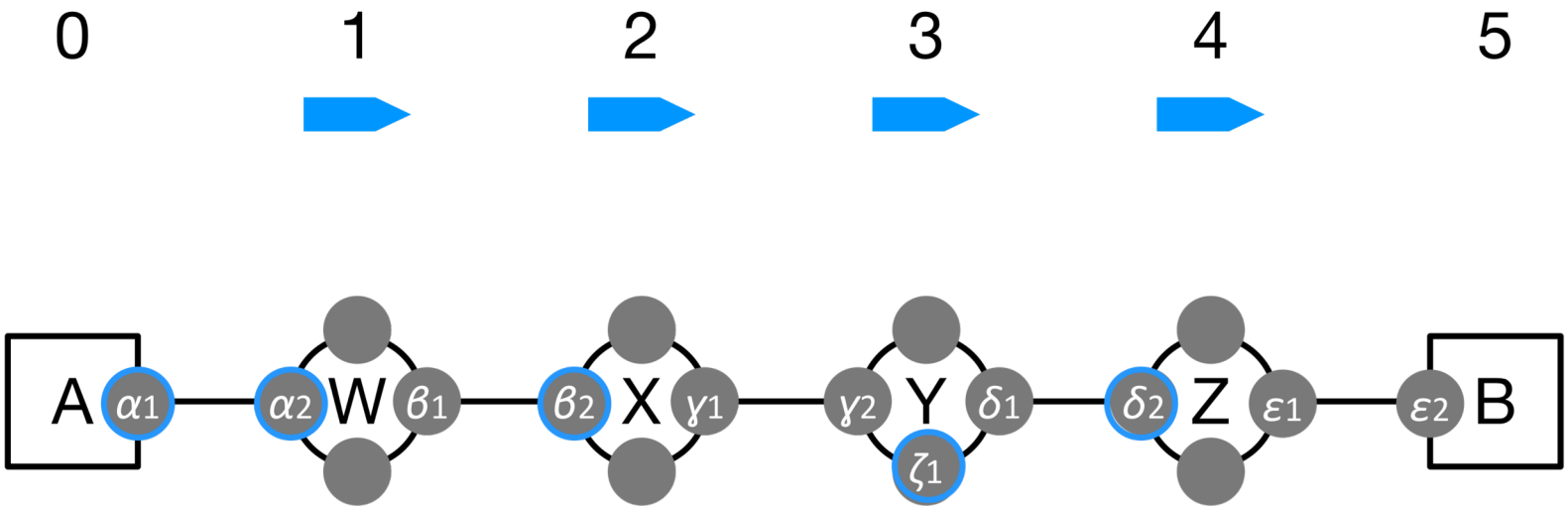
ε1
ε2
B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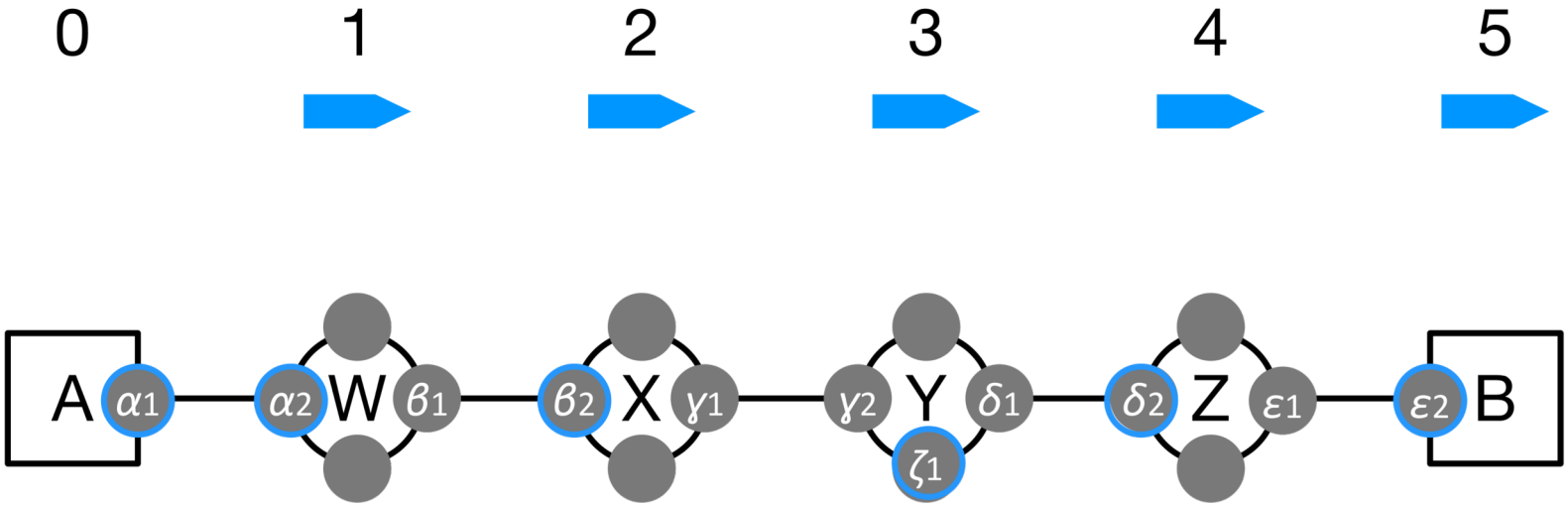
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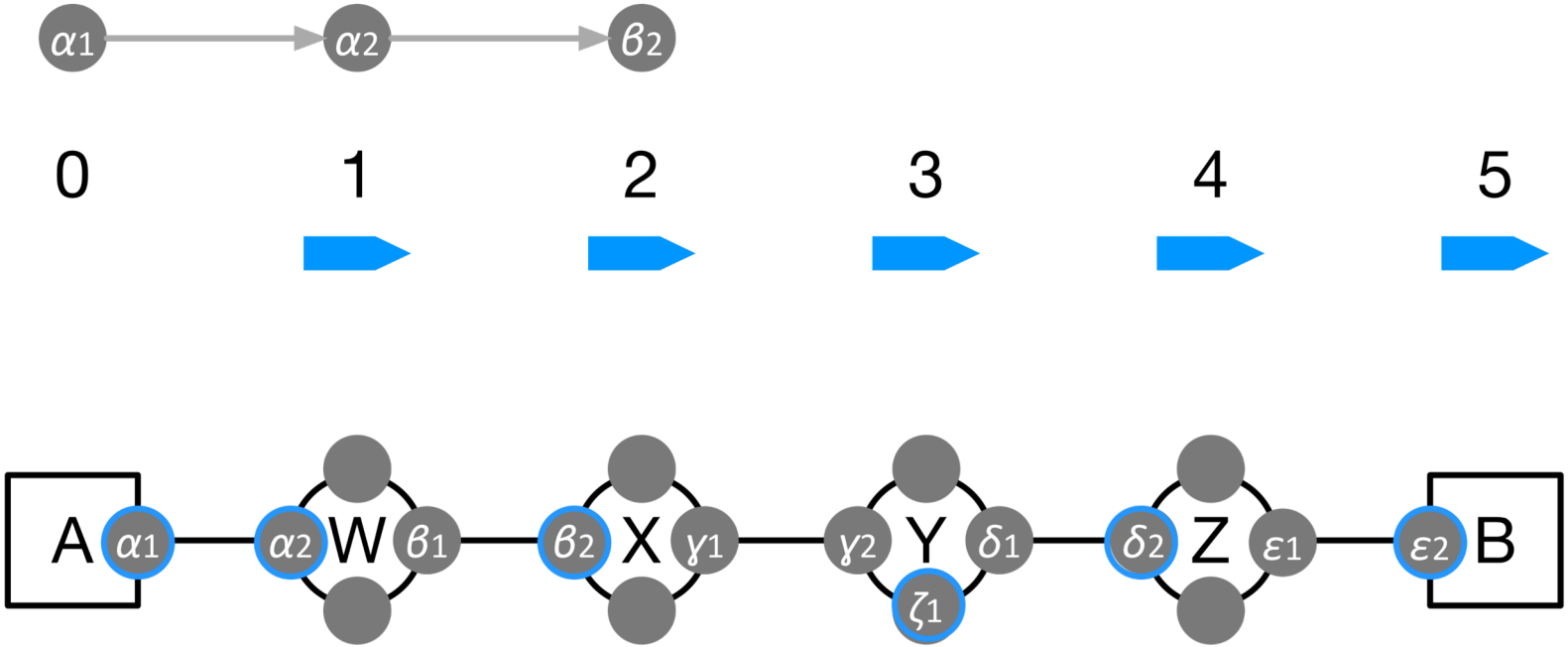
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ζ1
δ2
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ε1
ε2
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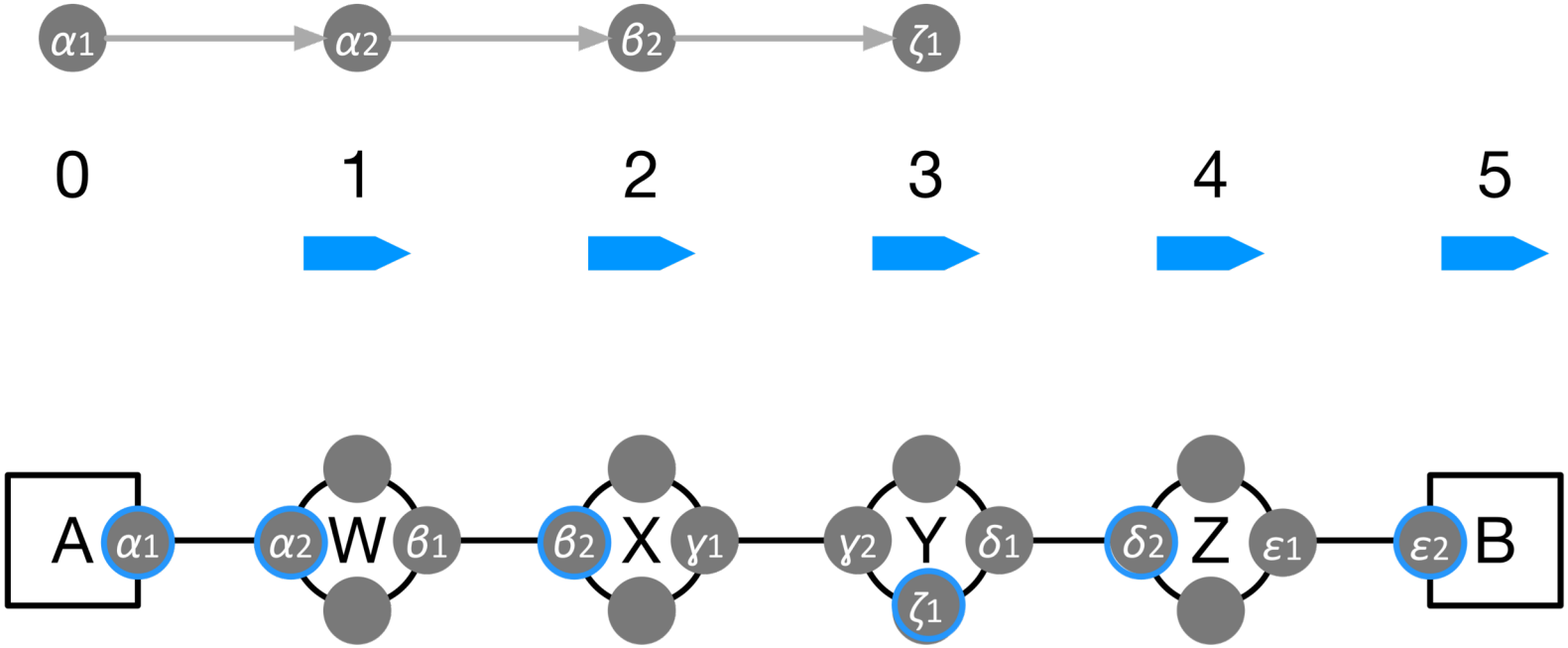
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ε2
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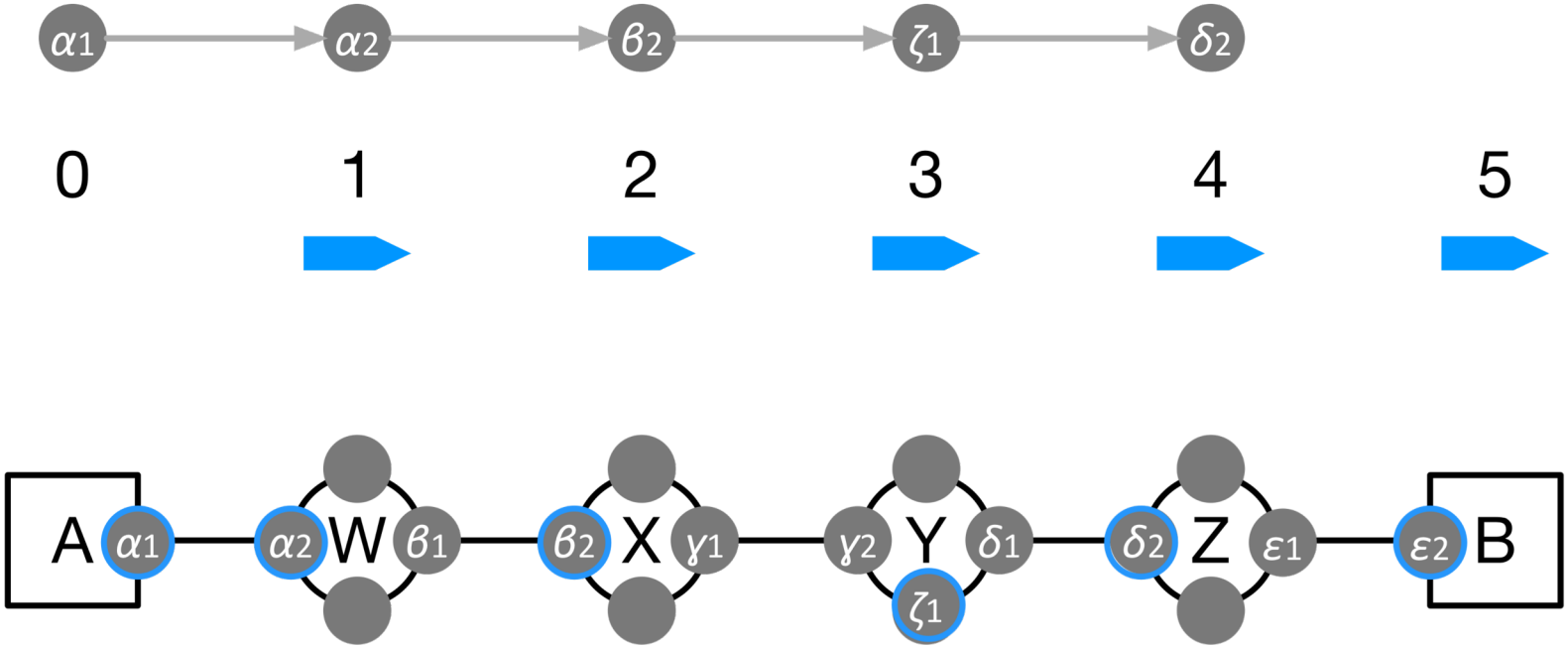
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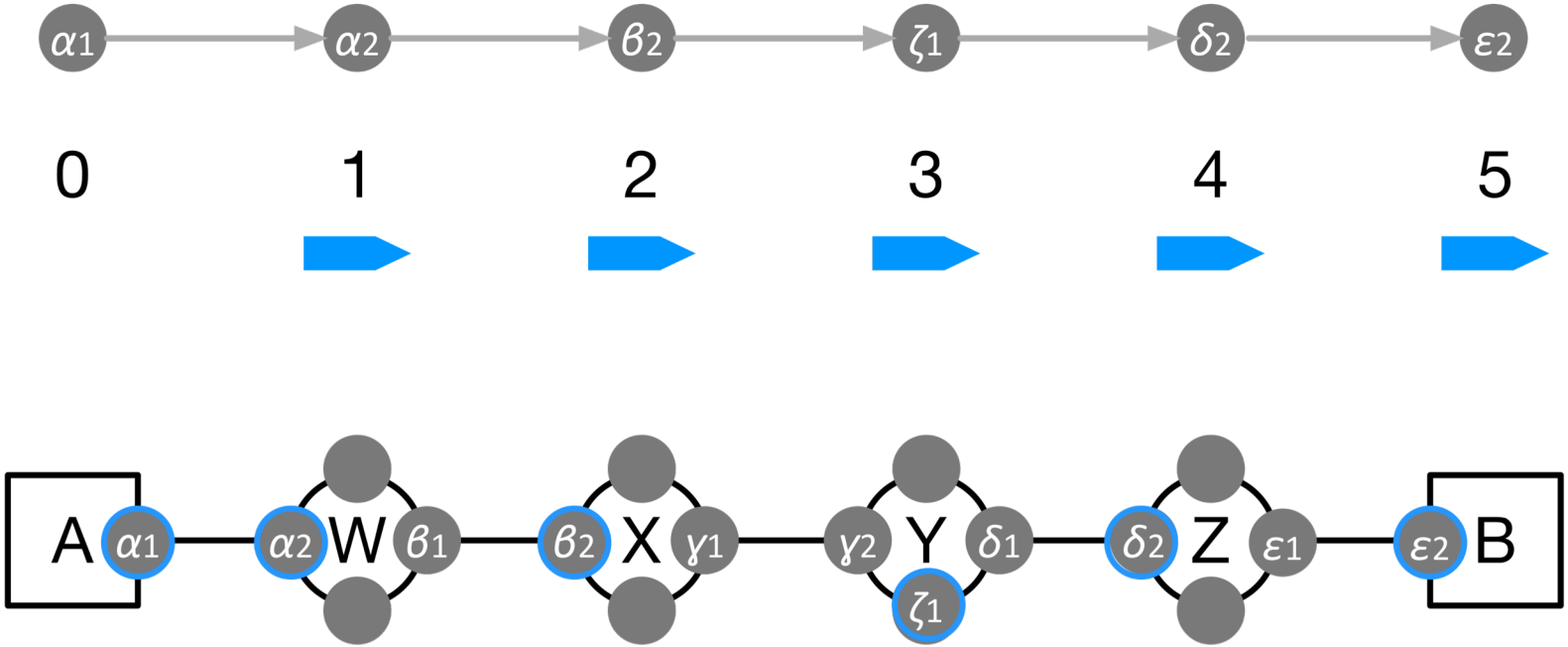
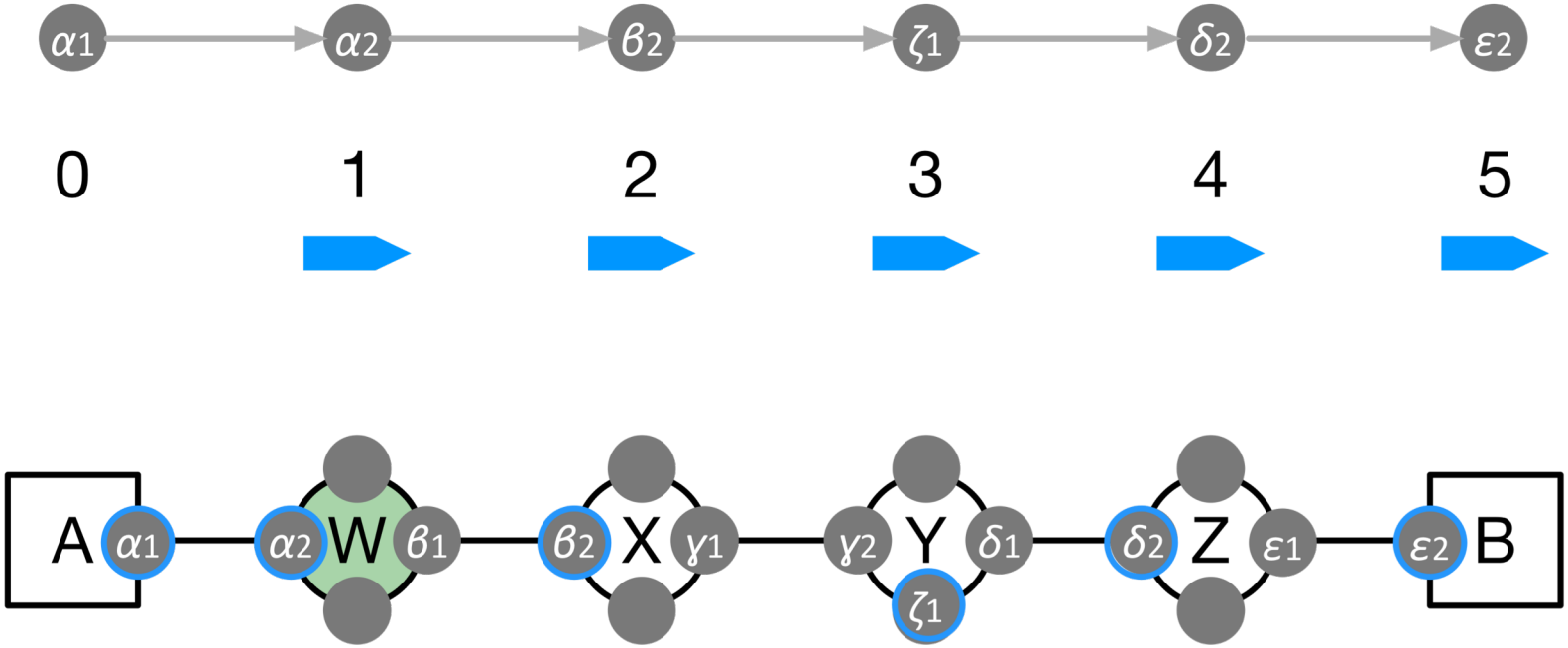



Google Doc poll: Which router has traceroute learned nothing about in this example?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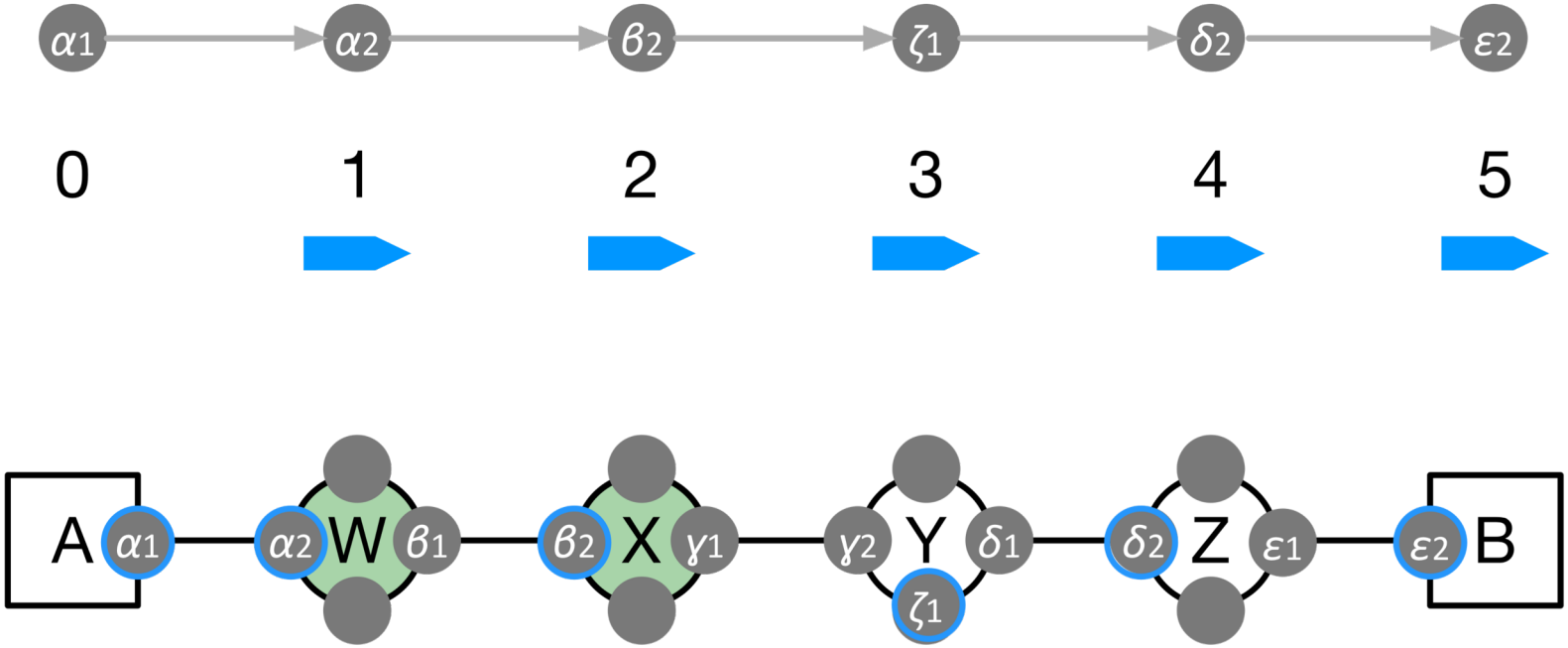
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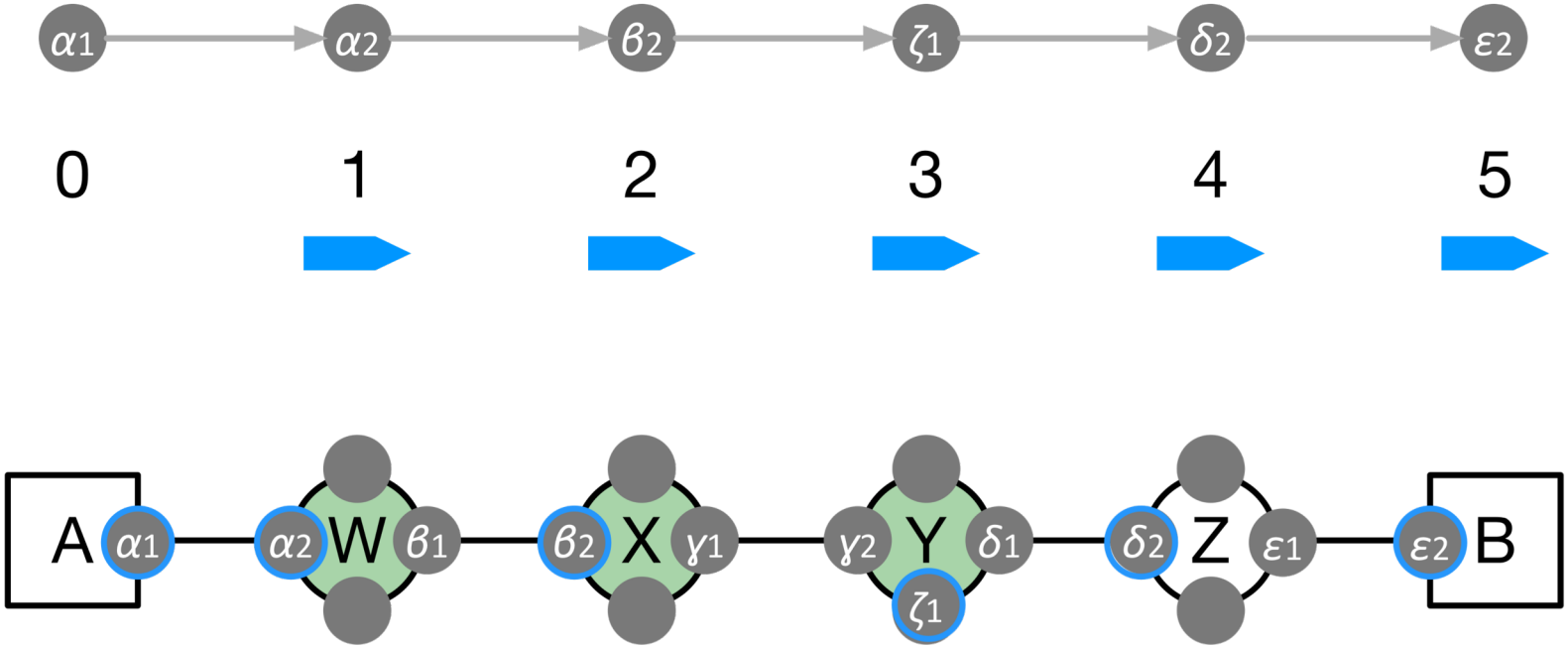
α1
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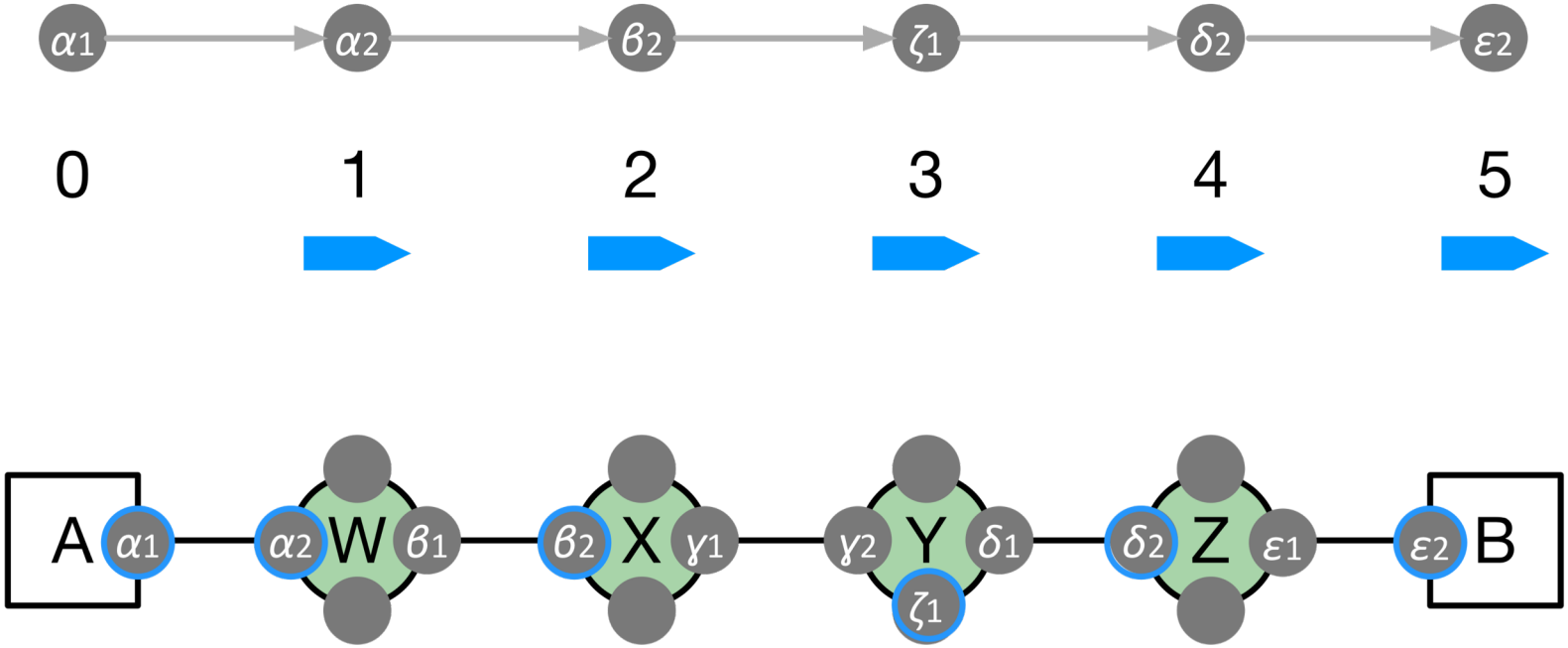
α1
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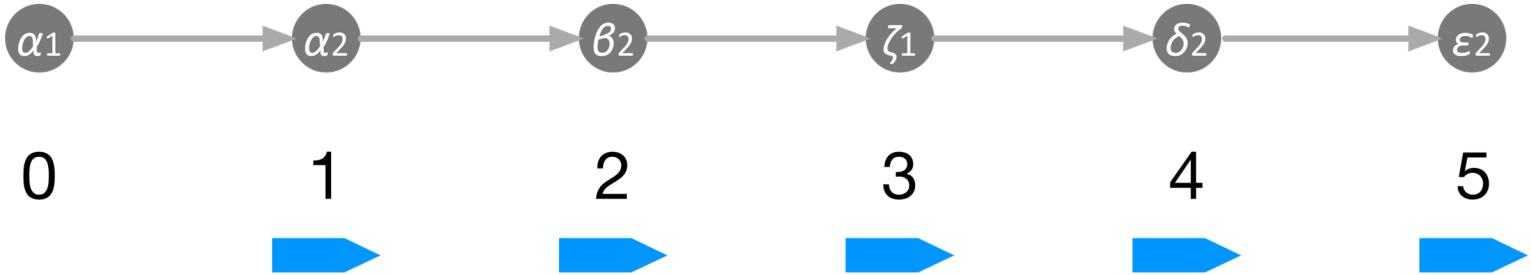
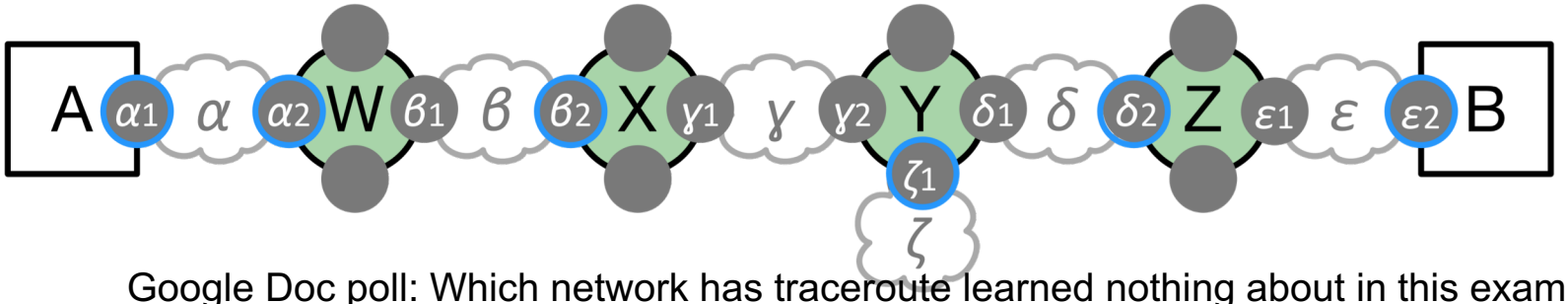
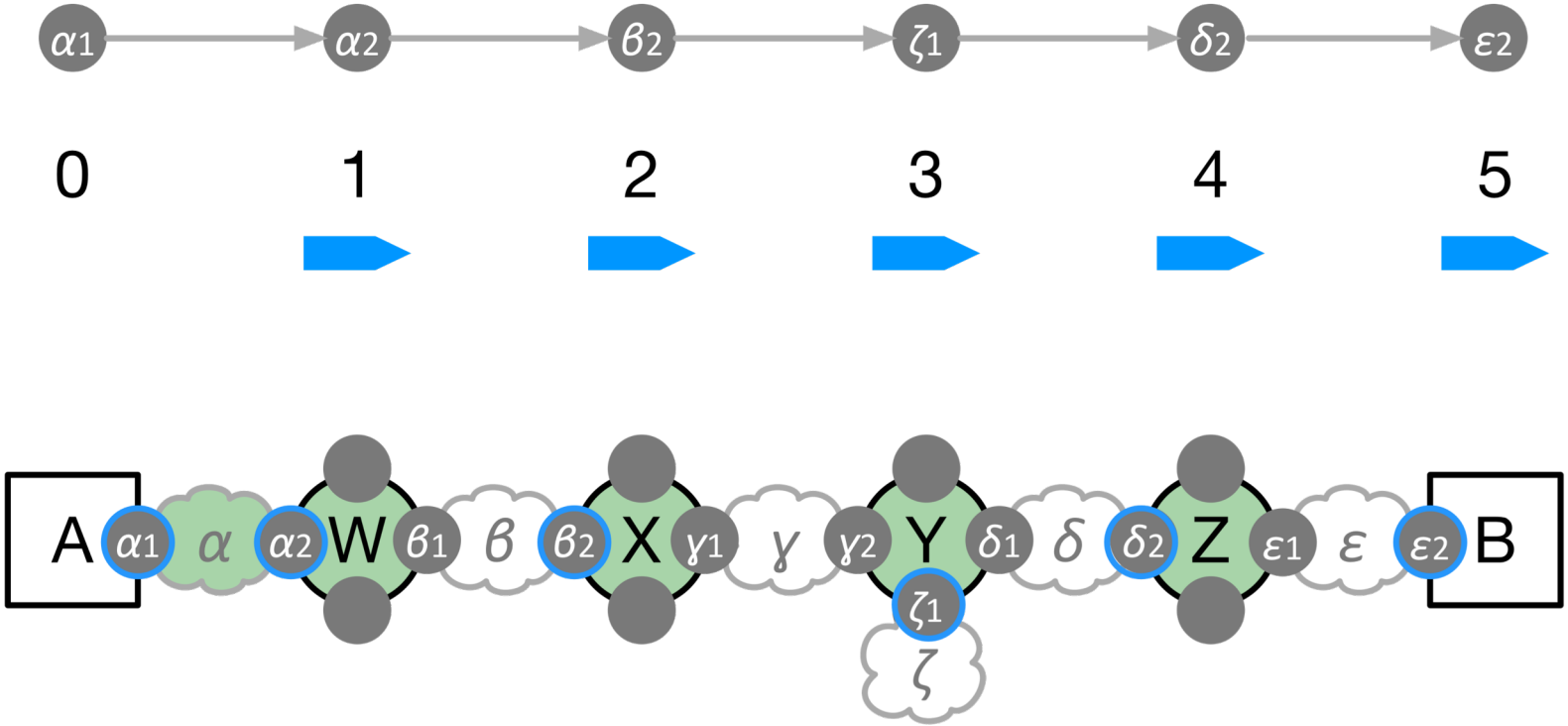



Google Doc poll: Which network has traceroute learned nothing about in this example?
Google Doc poll: Which network does traceroute learn about in this example, but in a misleading way?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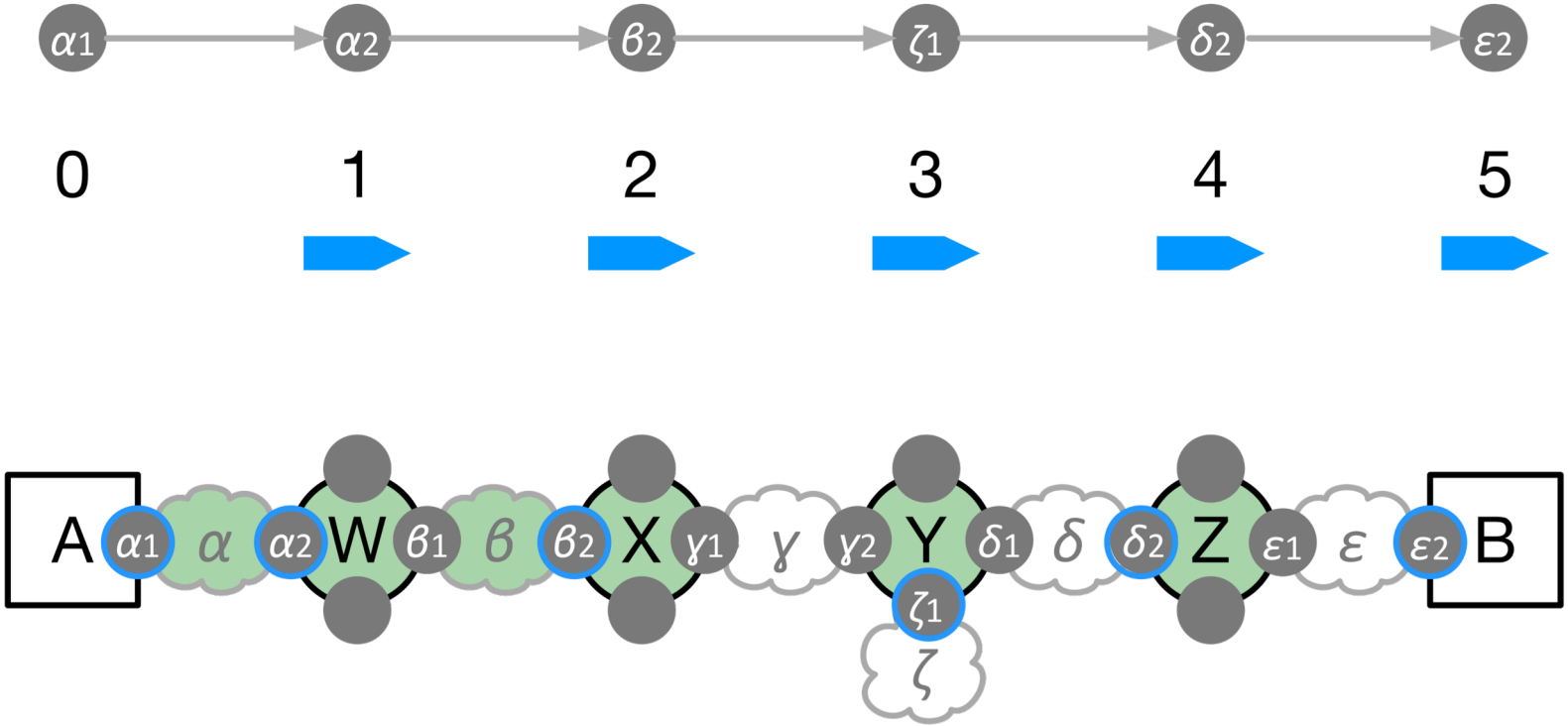
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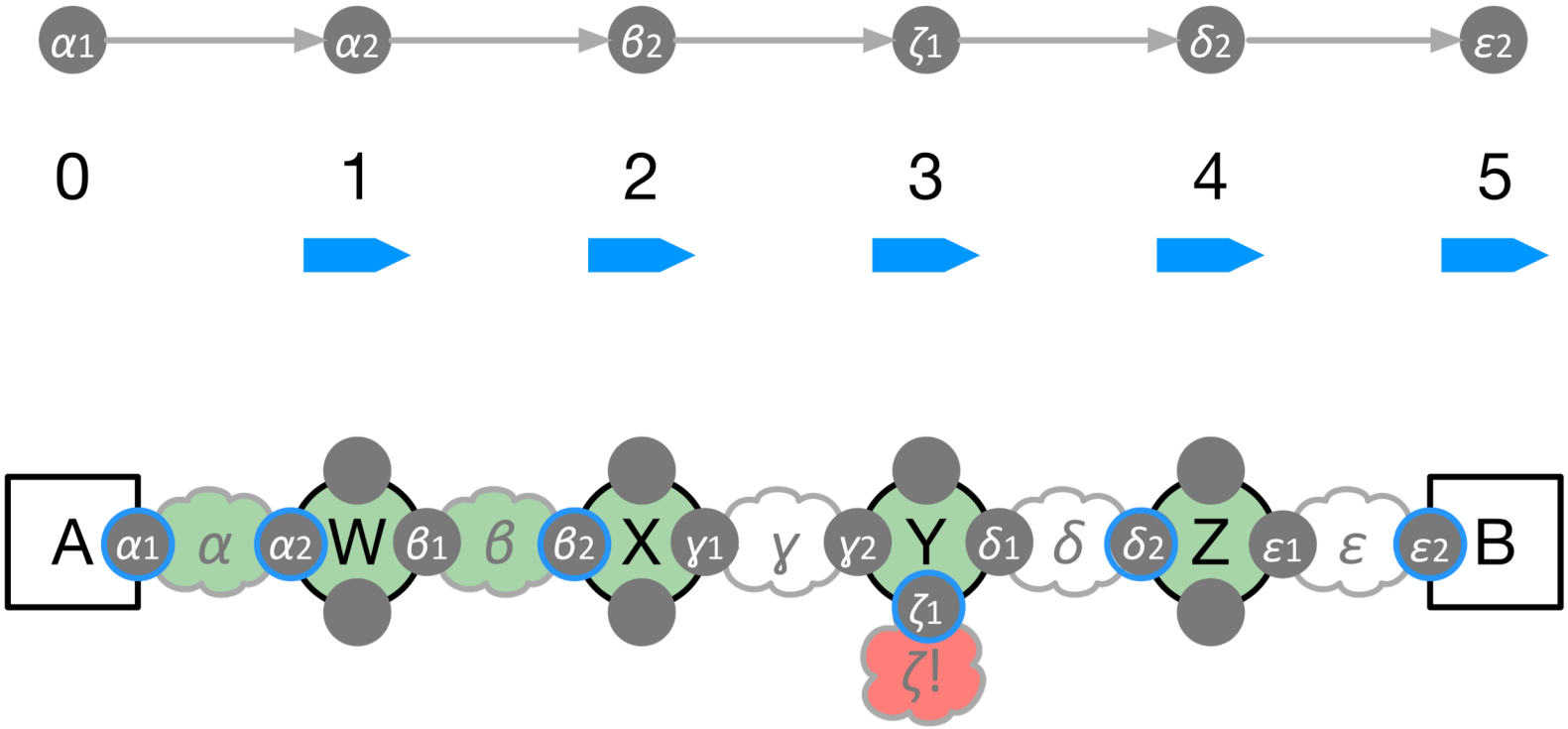
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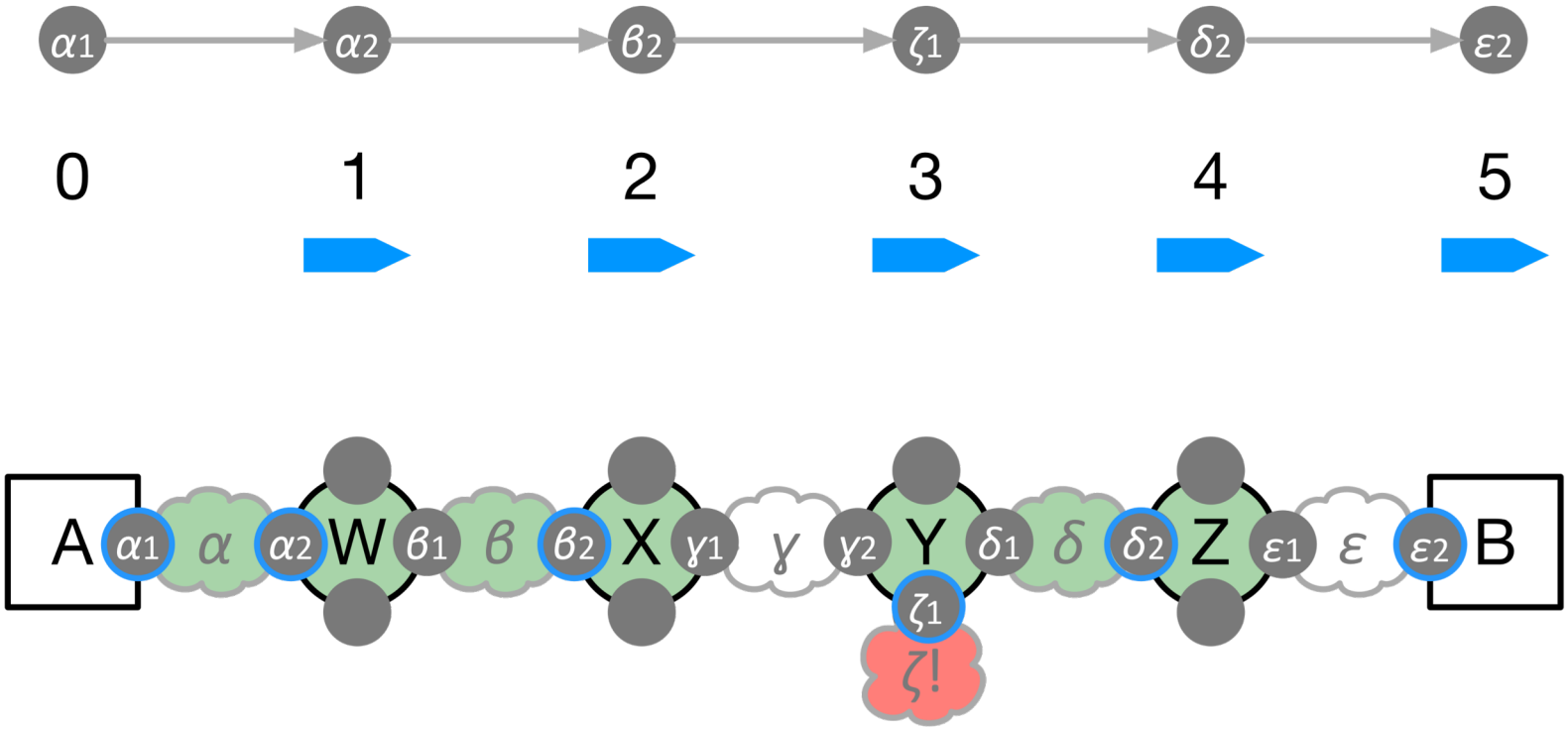
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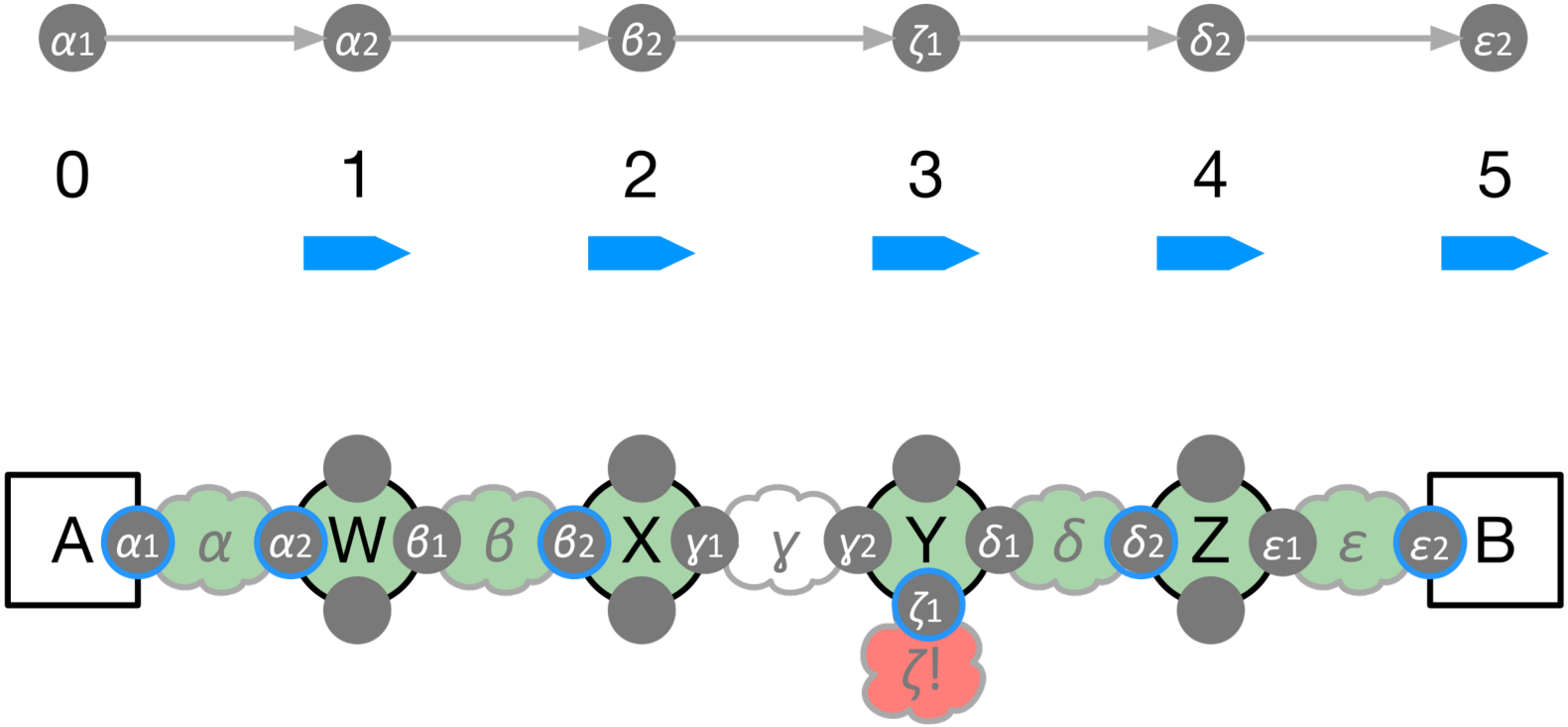
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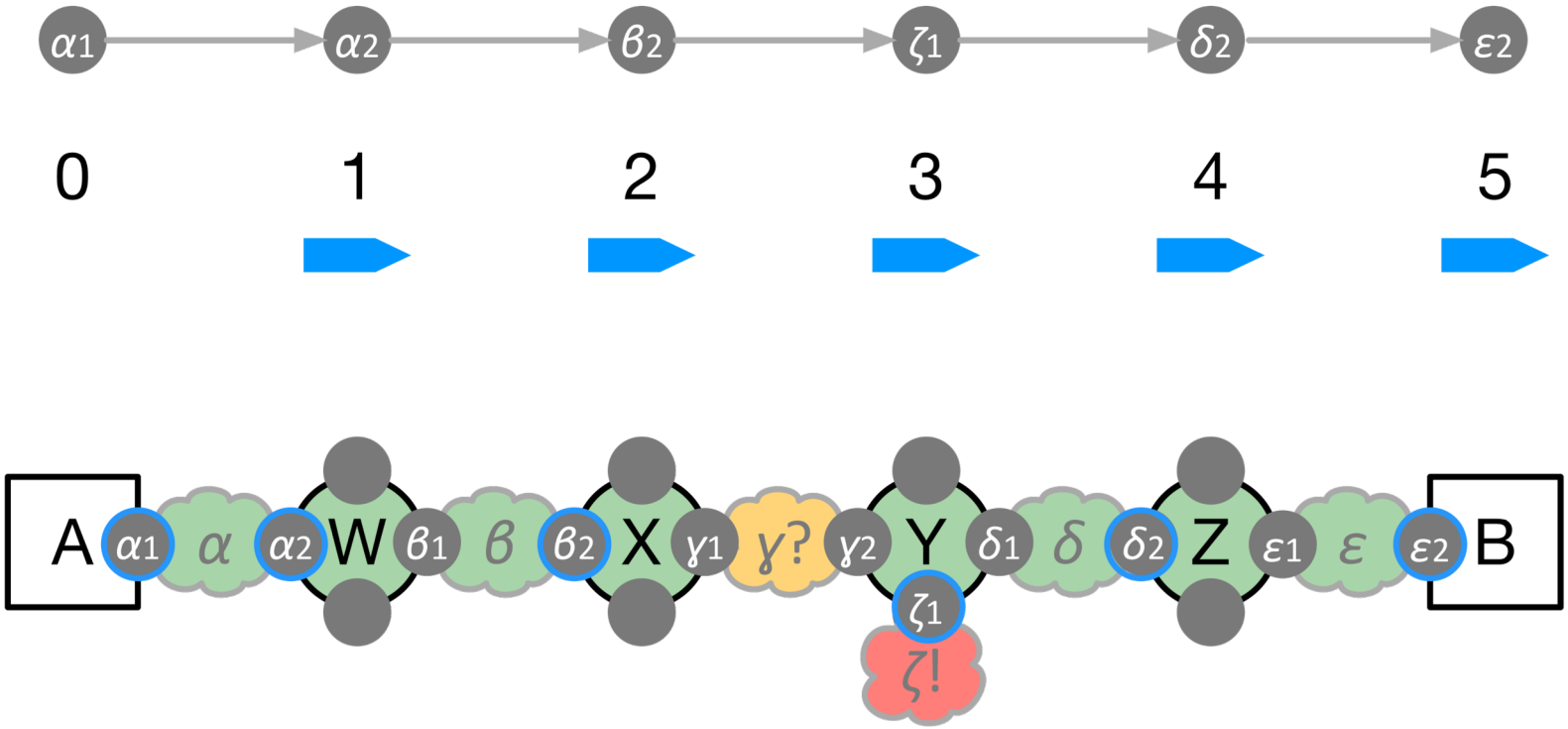
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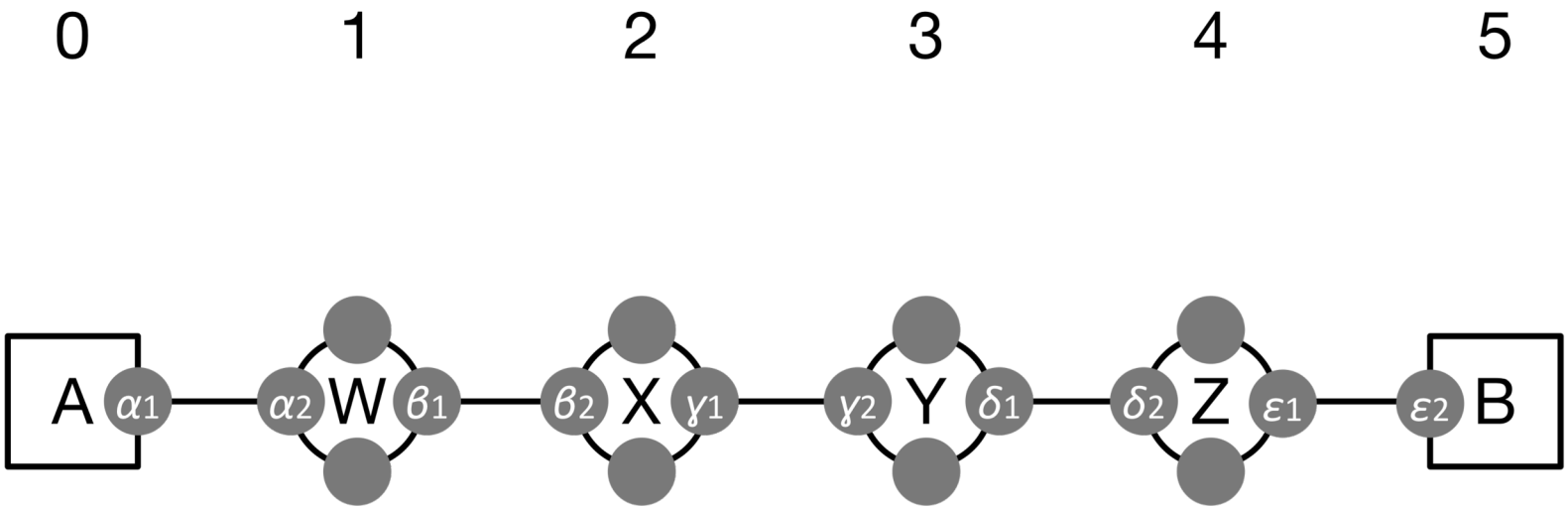
ζ1
ζ!

# Traceroute - limits

- Two scenarios
  - "Star"
  - Reply from non-ingress interface
- Limitations
  - Missing information
  - Misleading information

# Outline

- Basics
- Limits
- Load balancing
- The tool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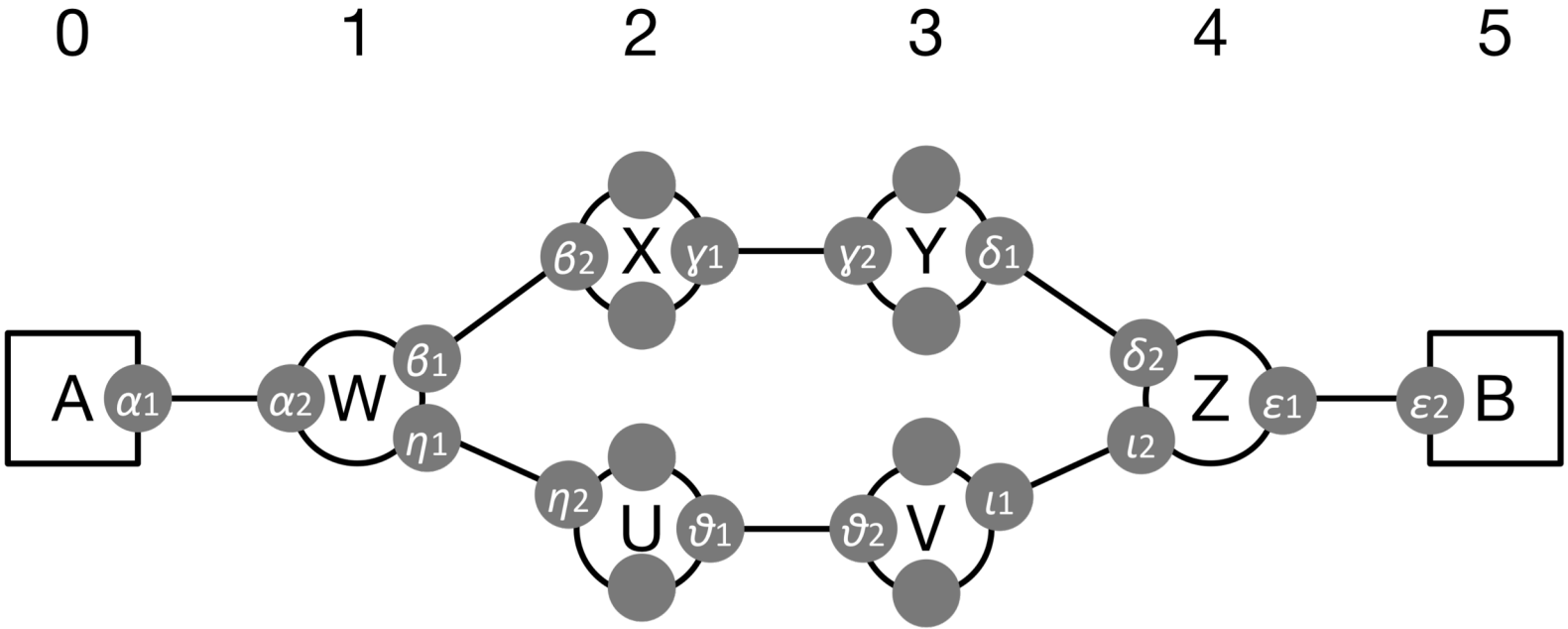
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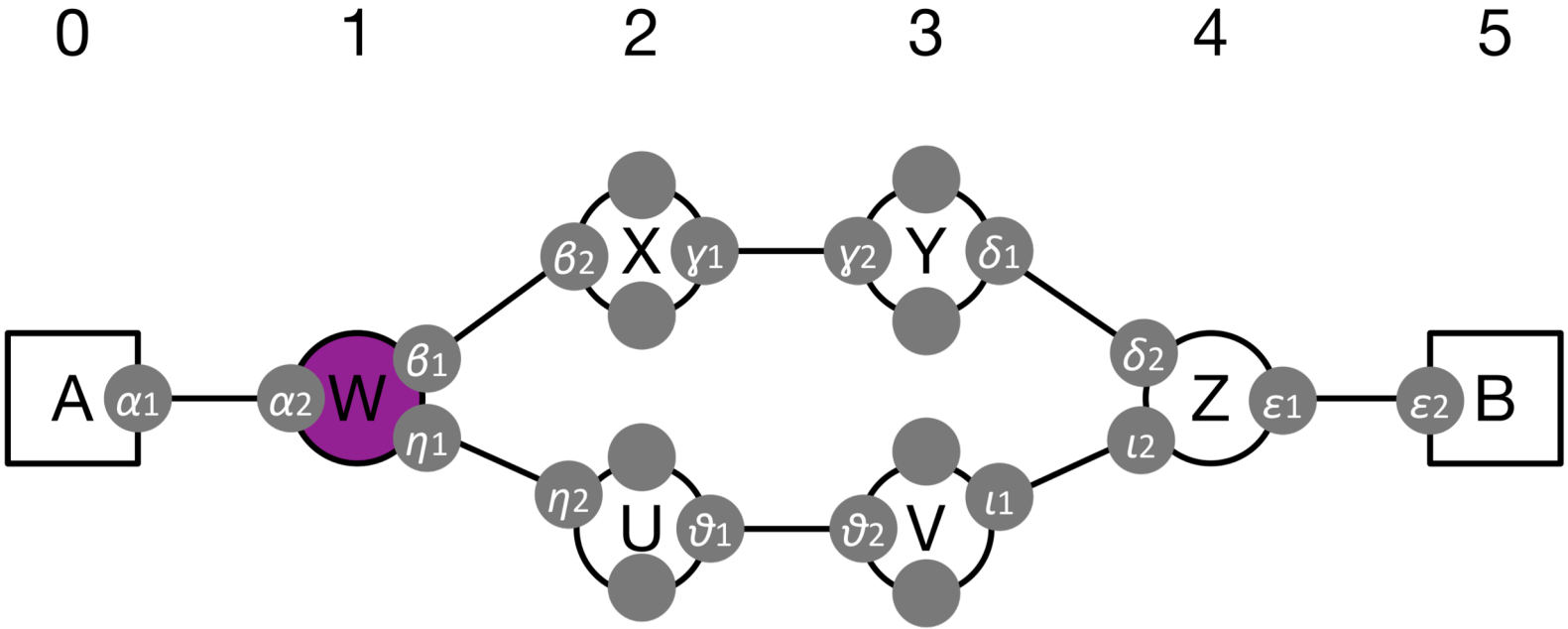
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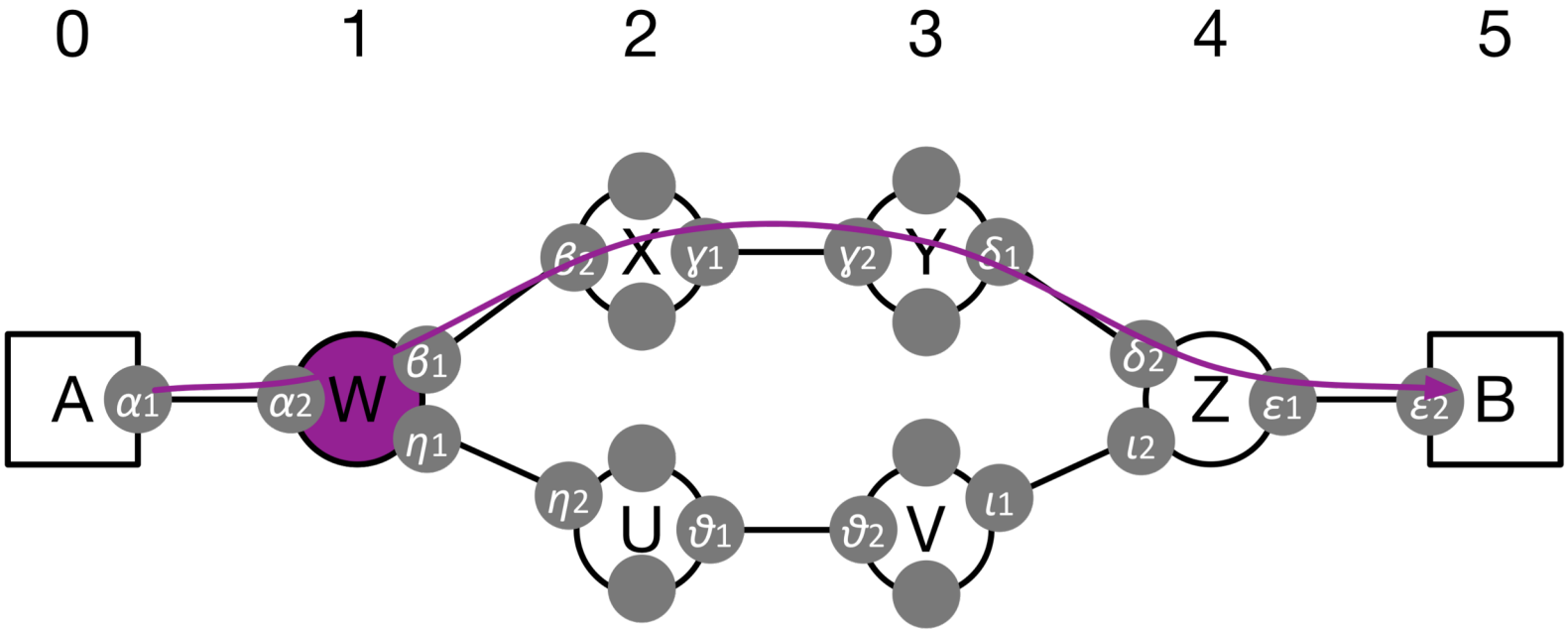
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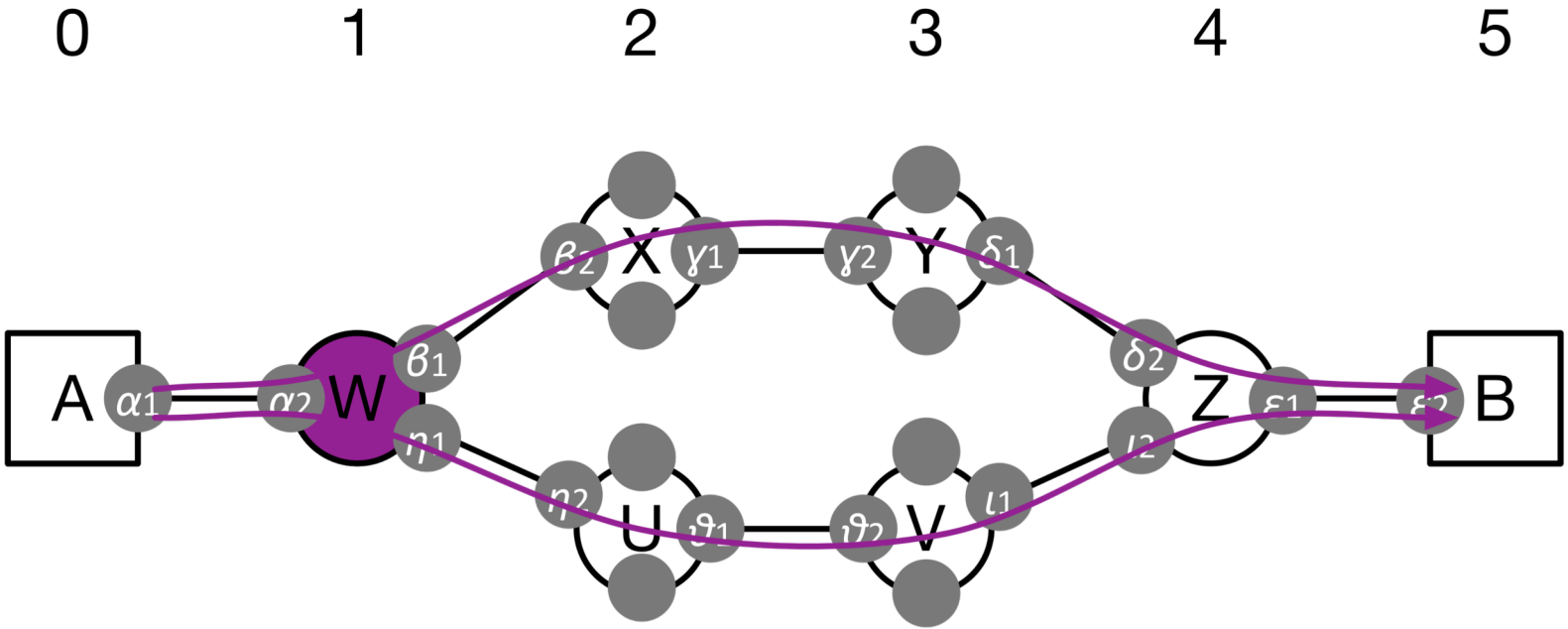
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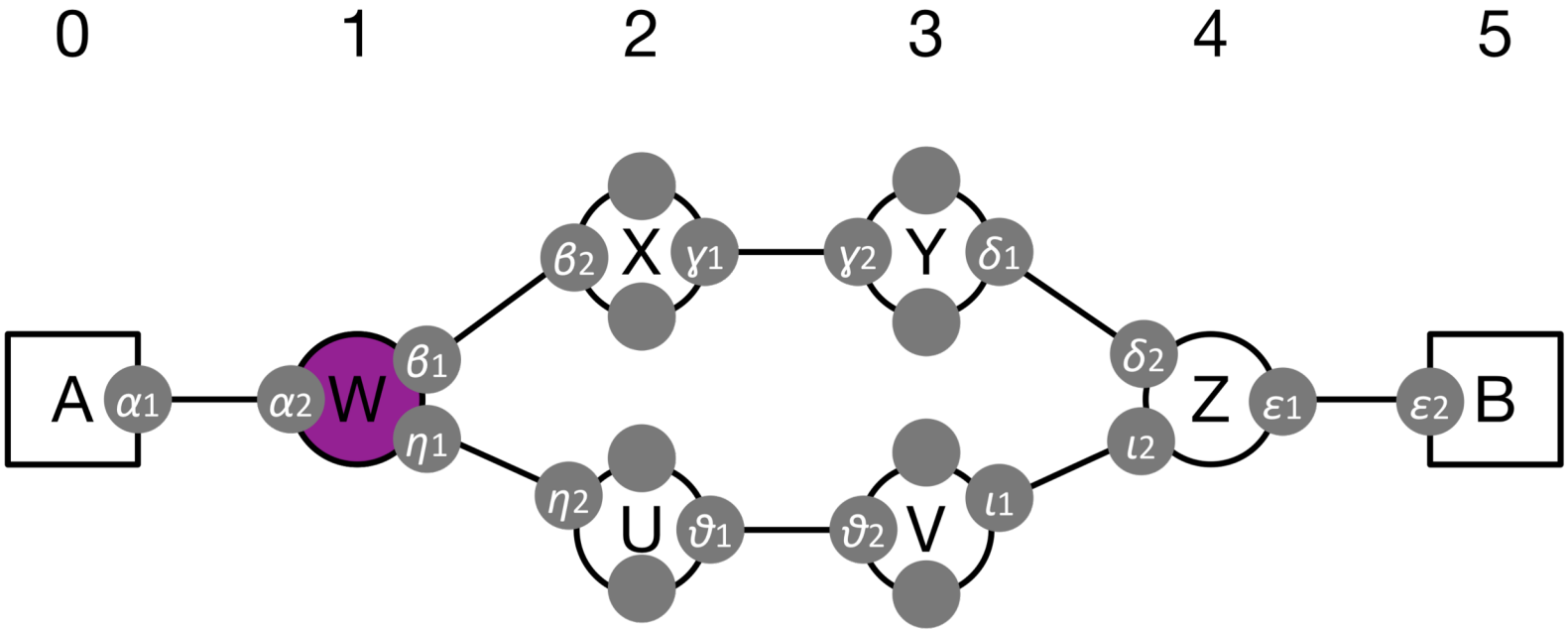
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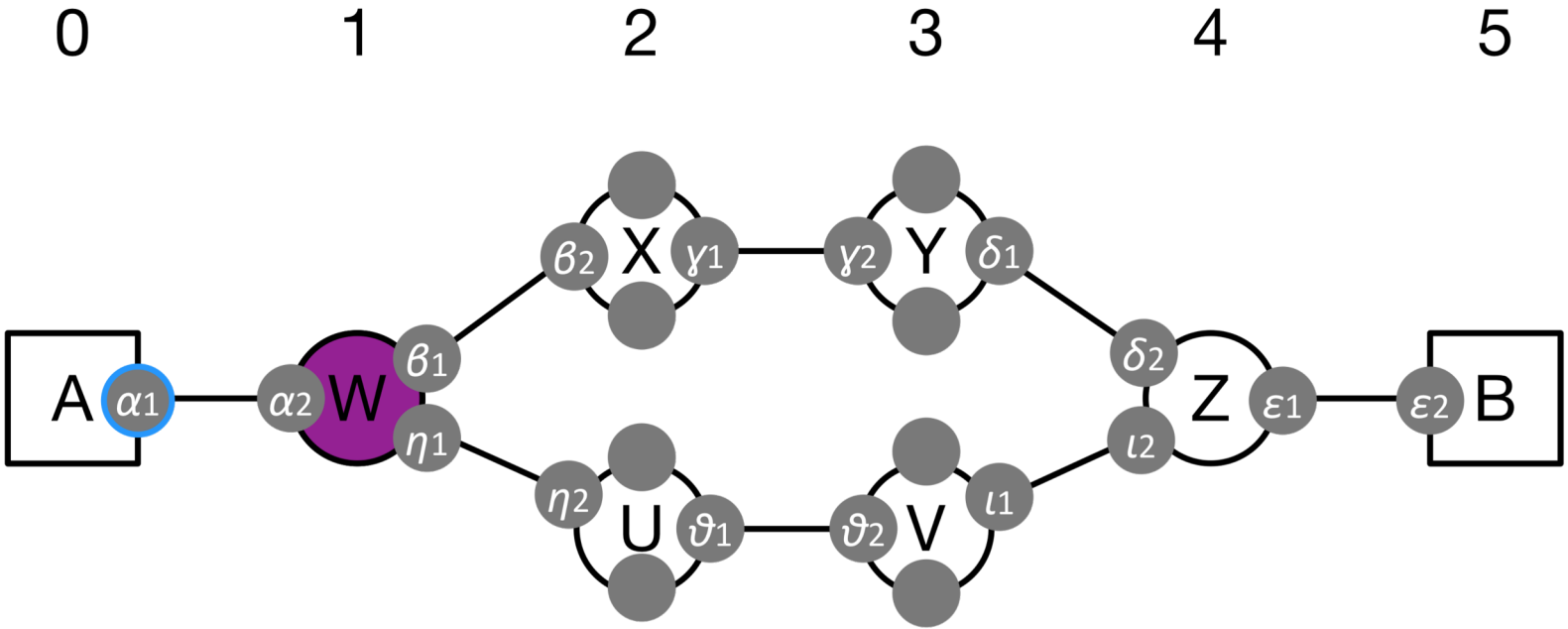
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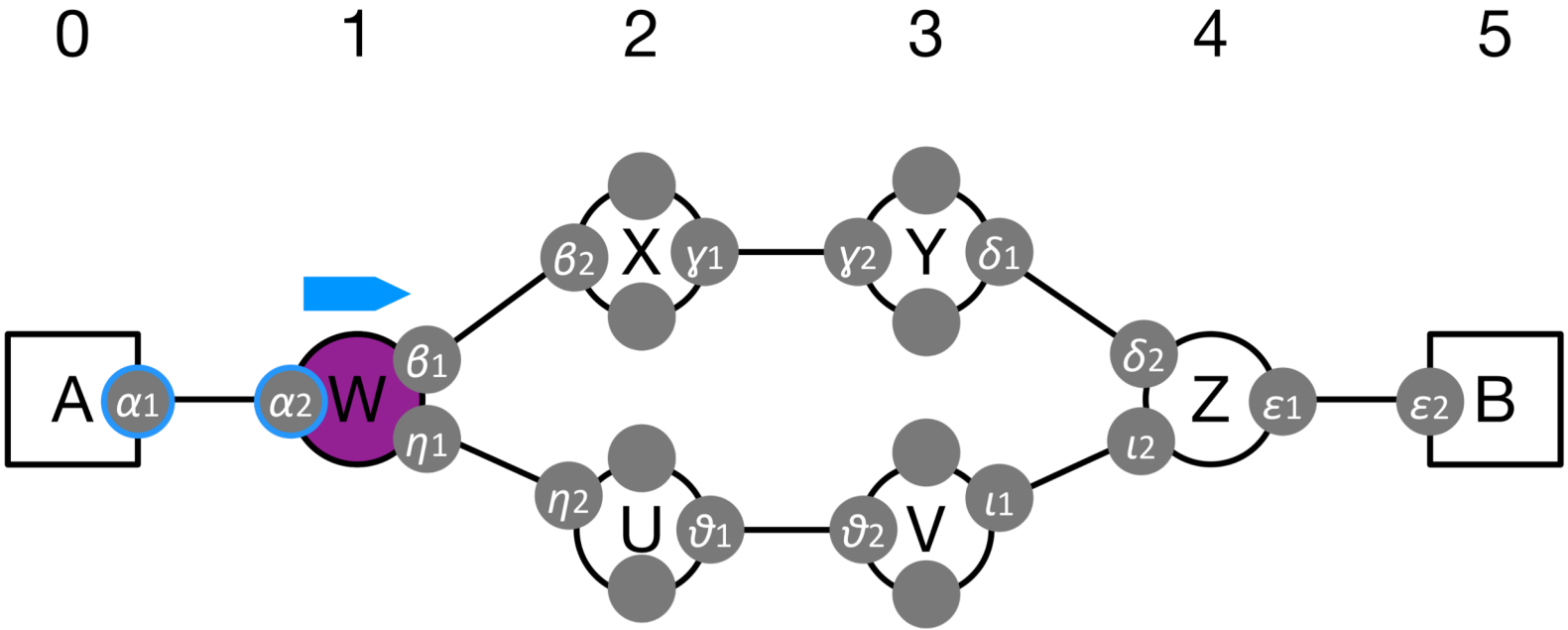
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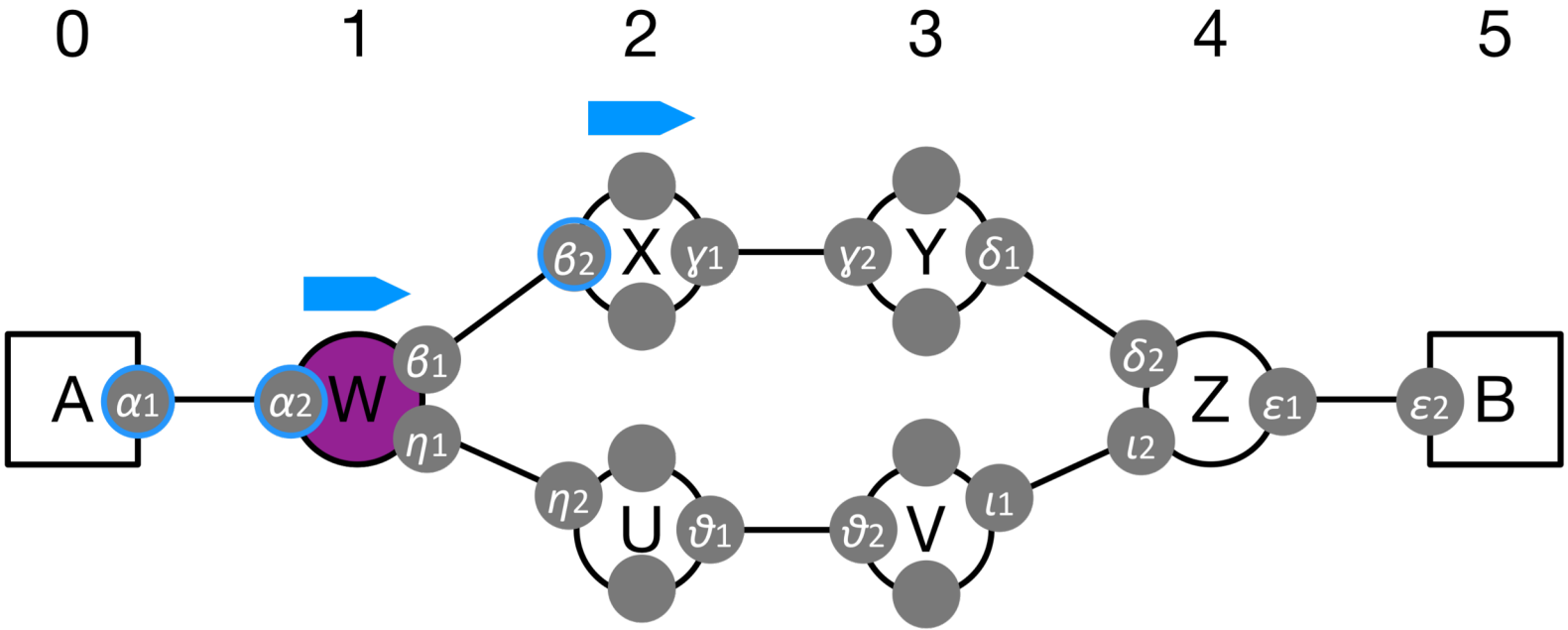
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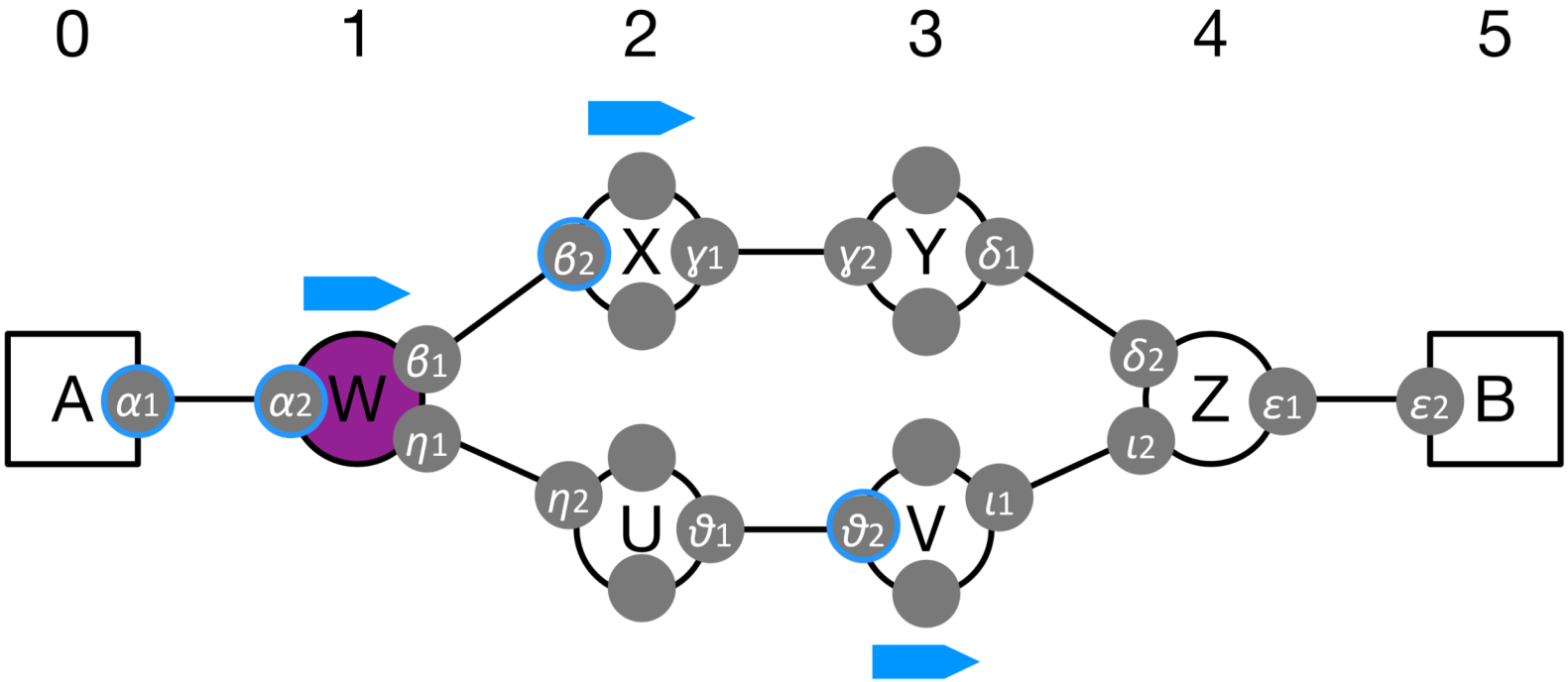
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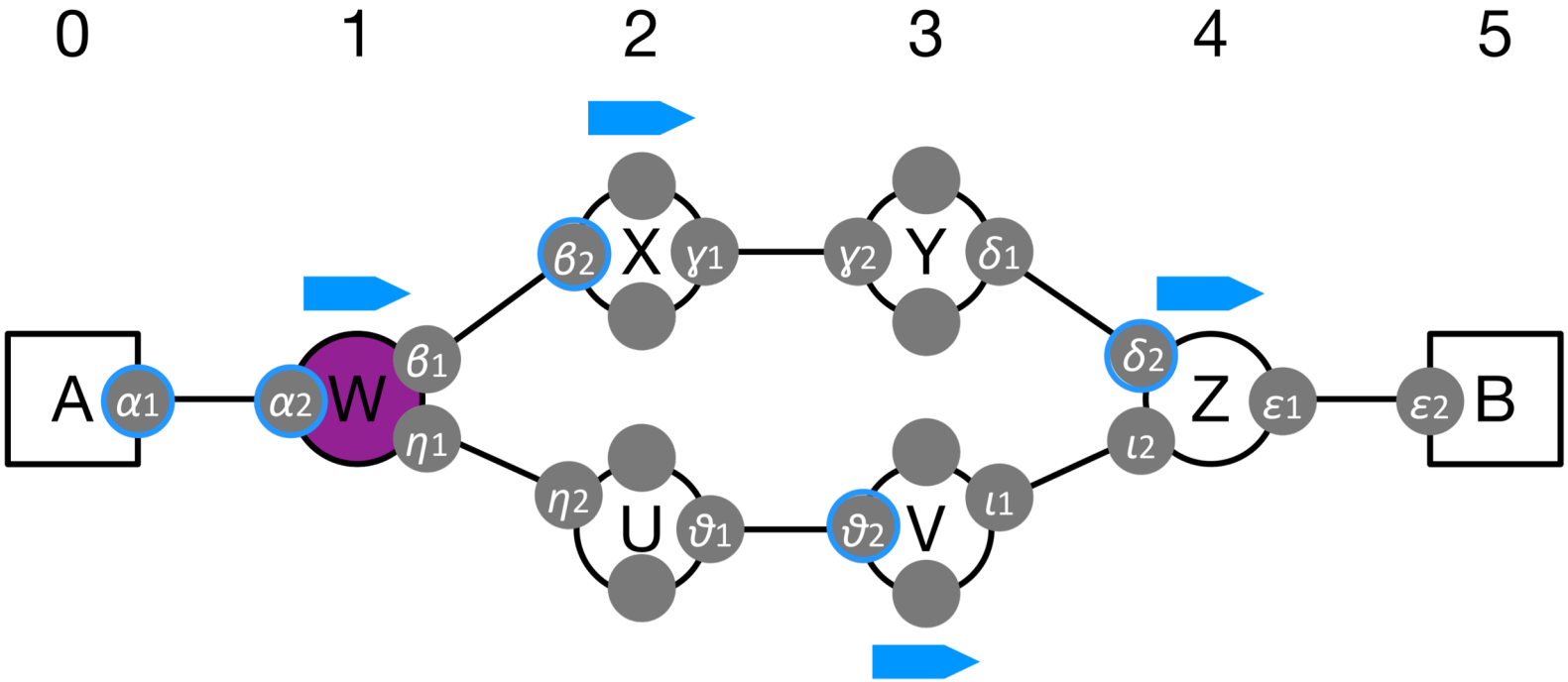
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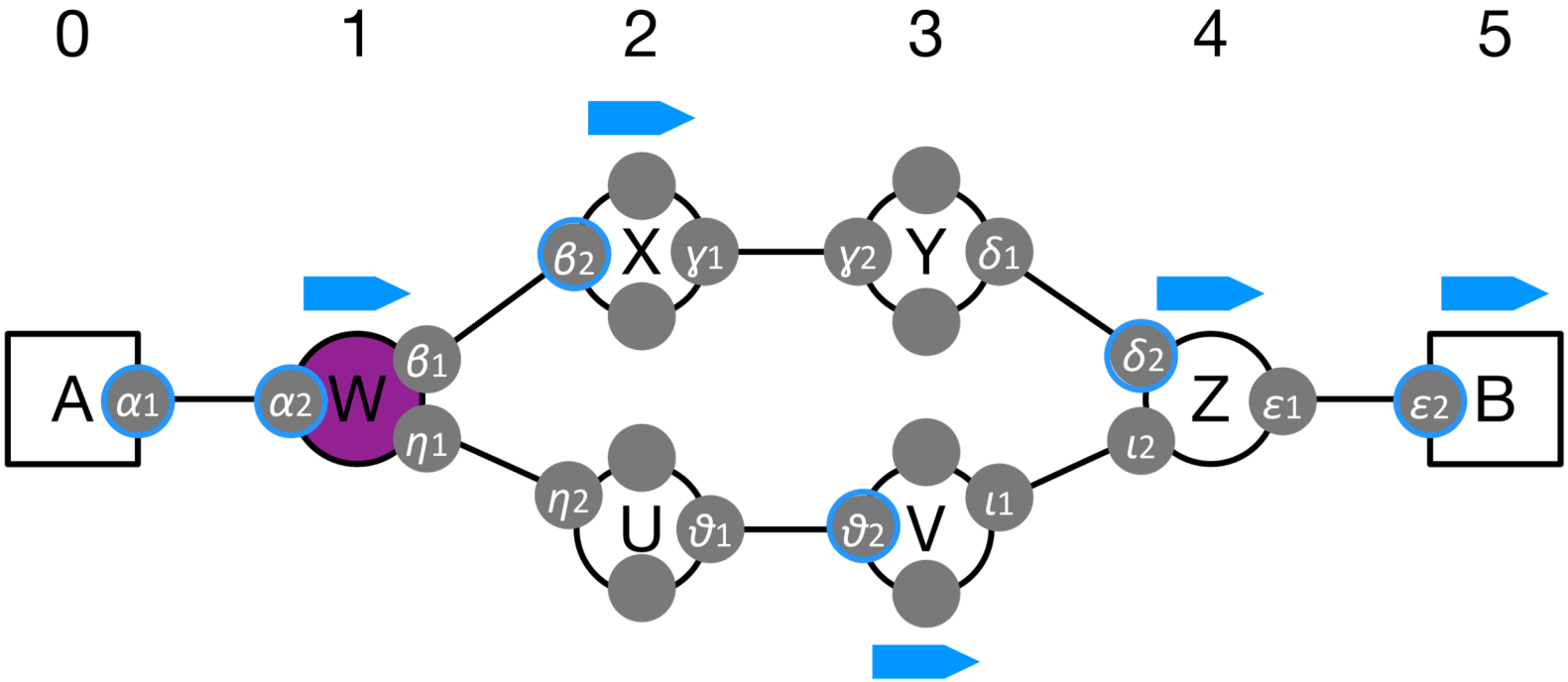
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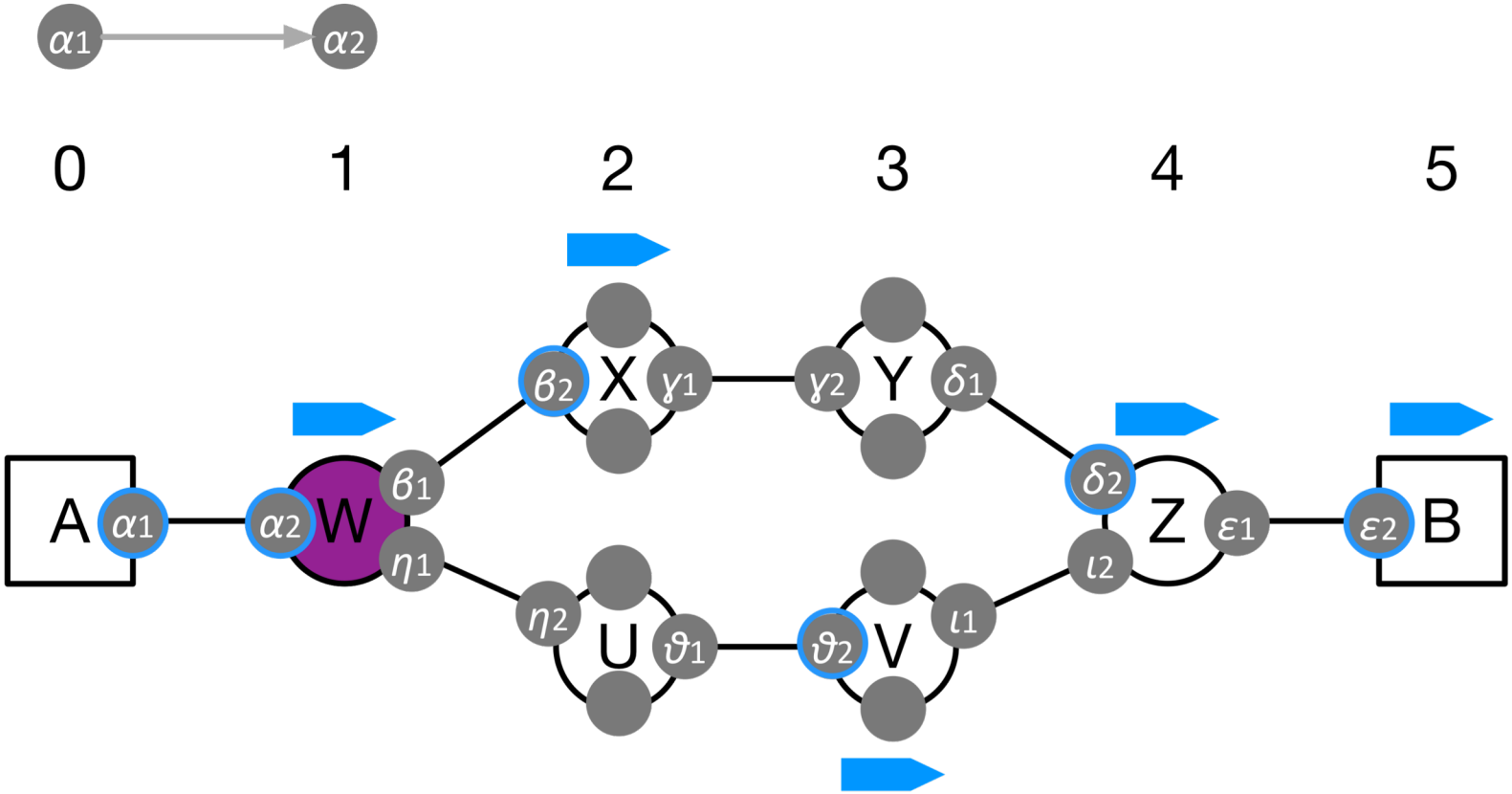
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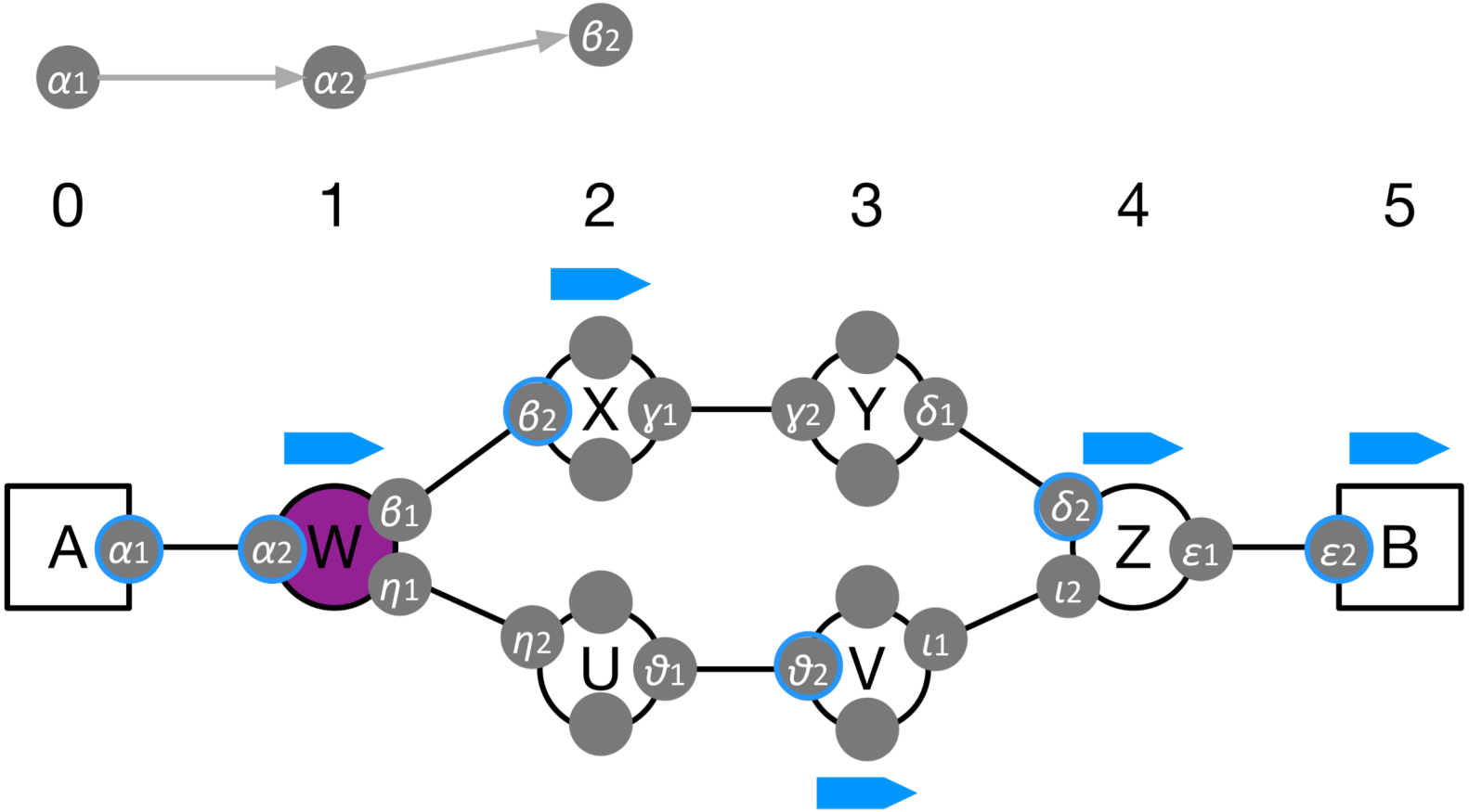
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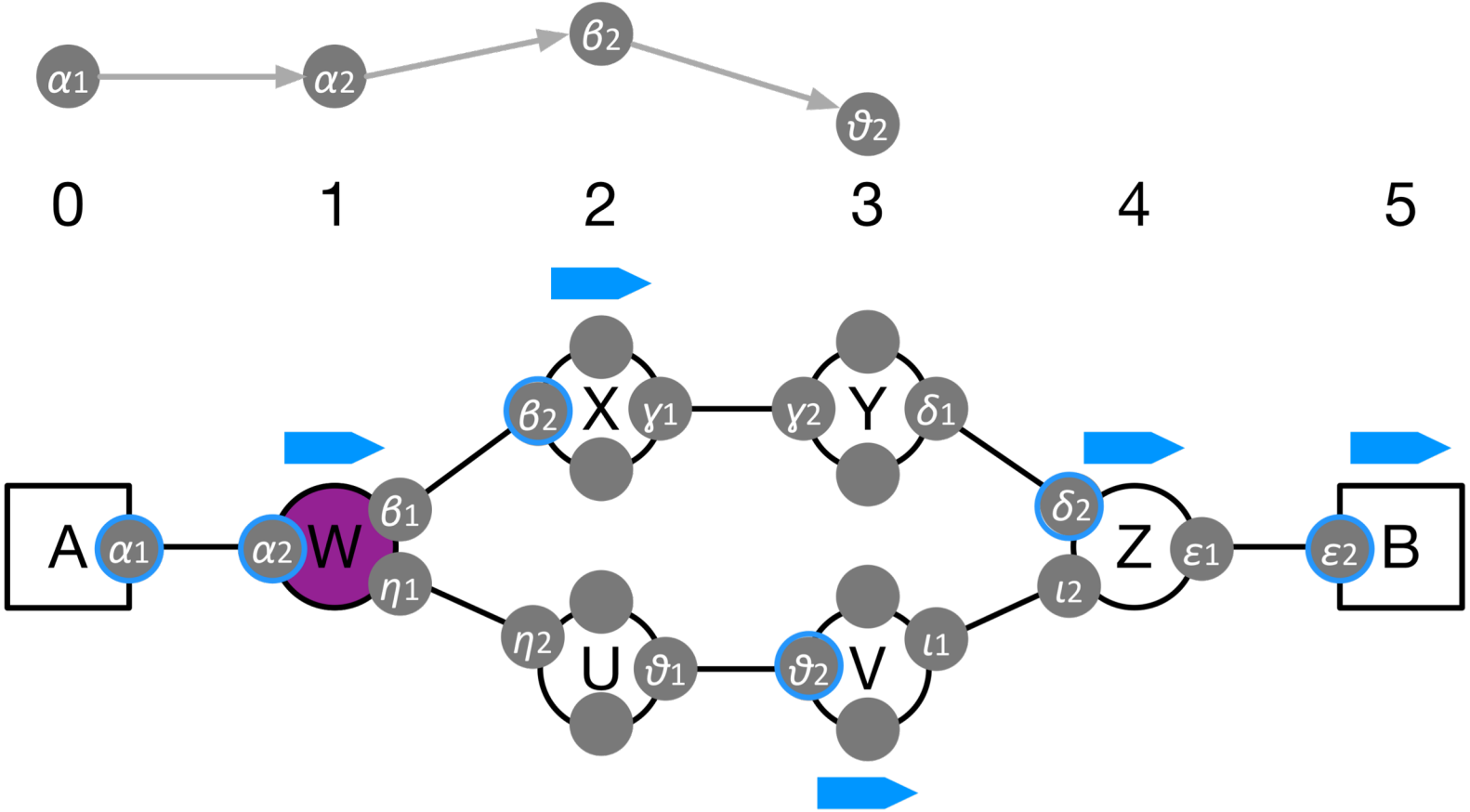
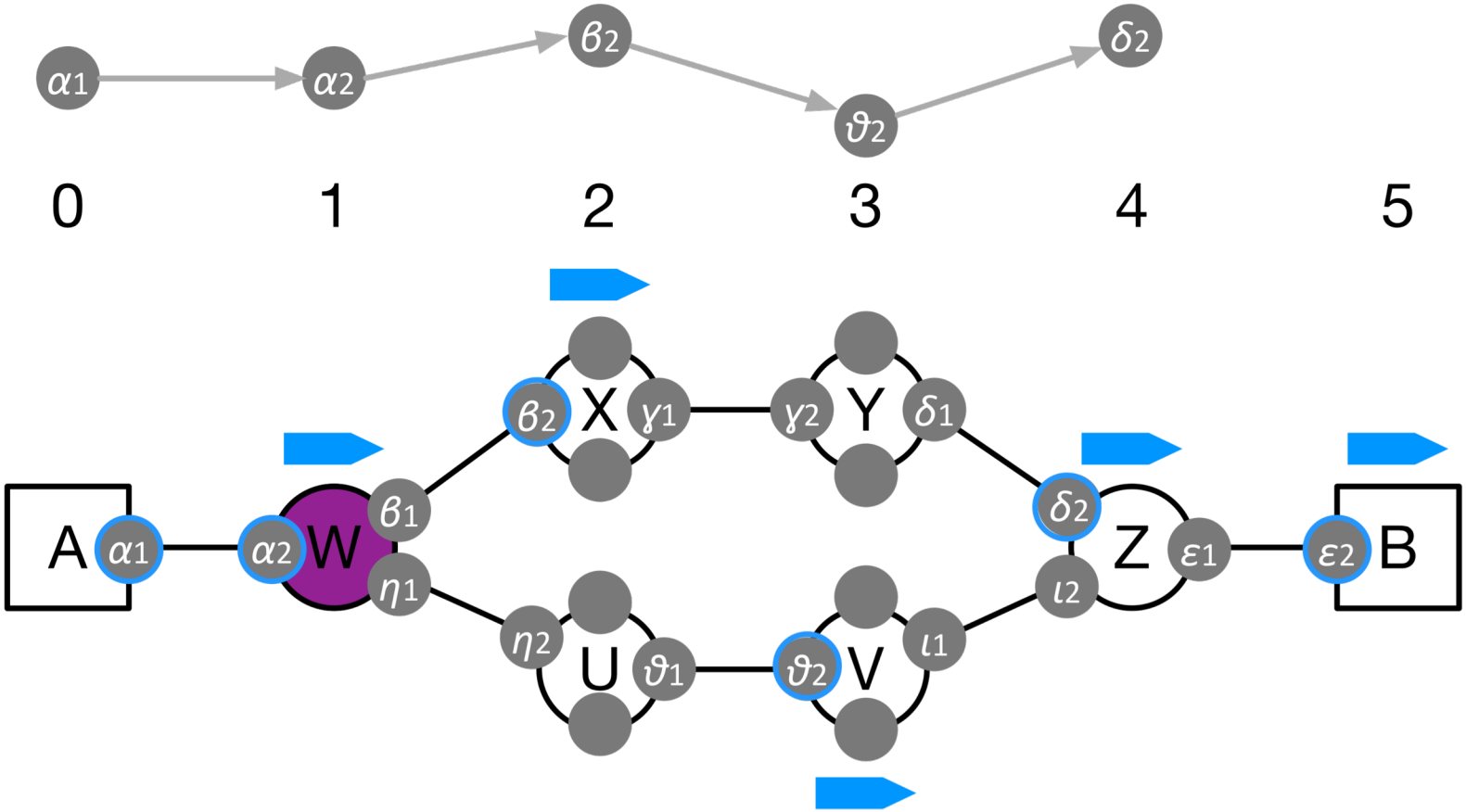
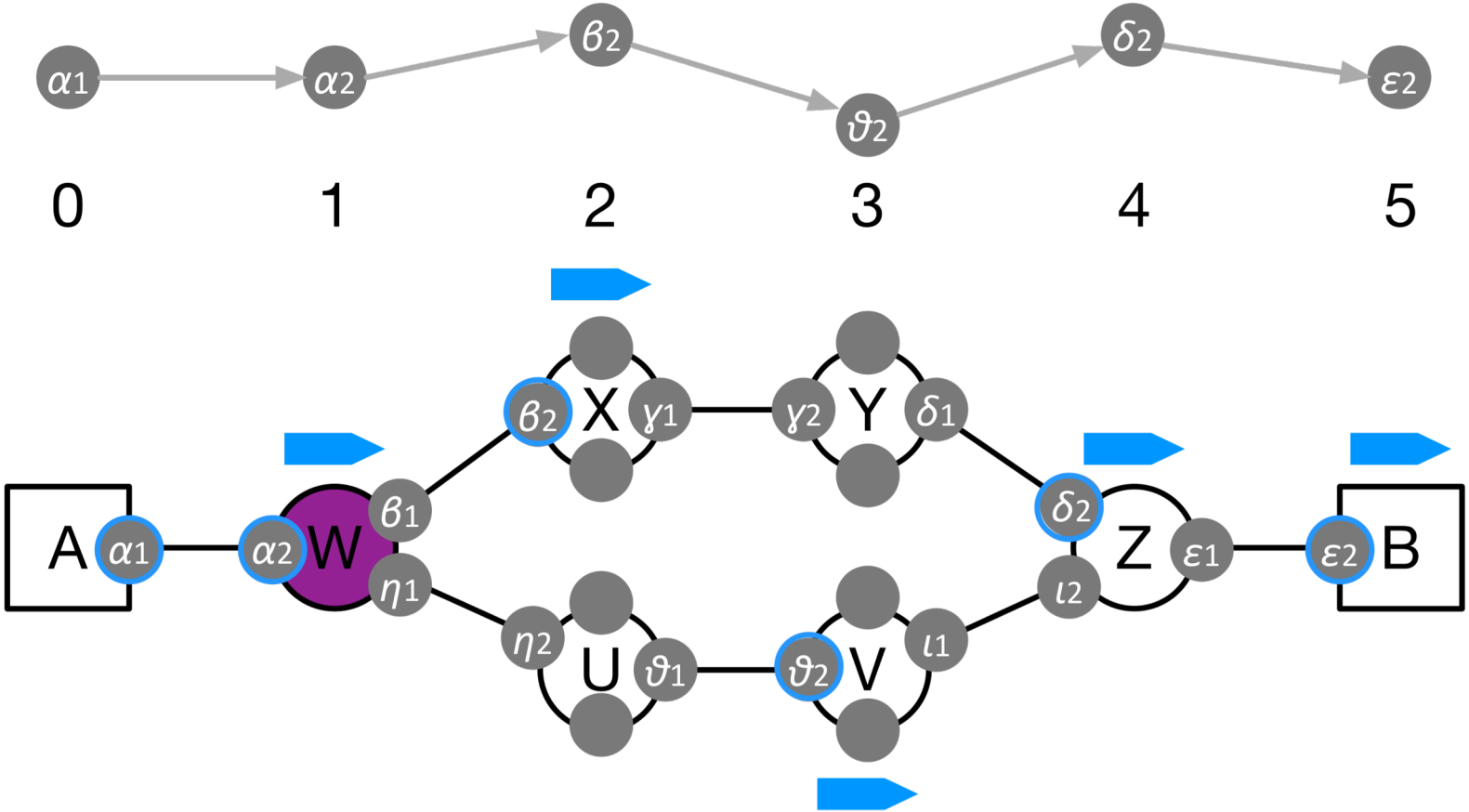
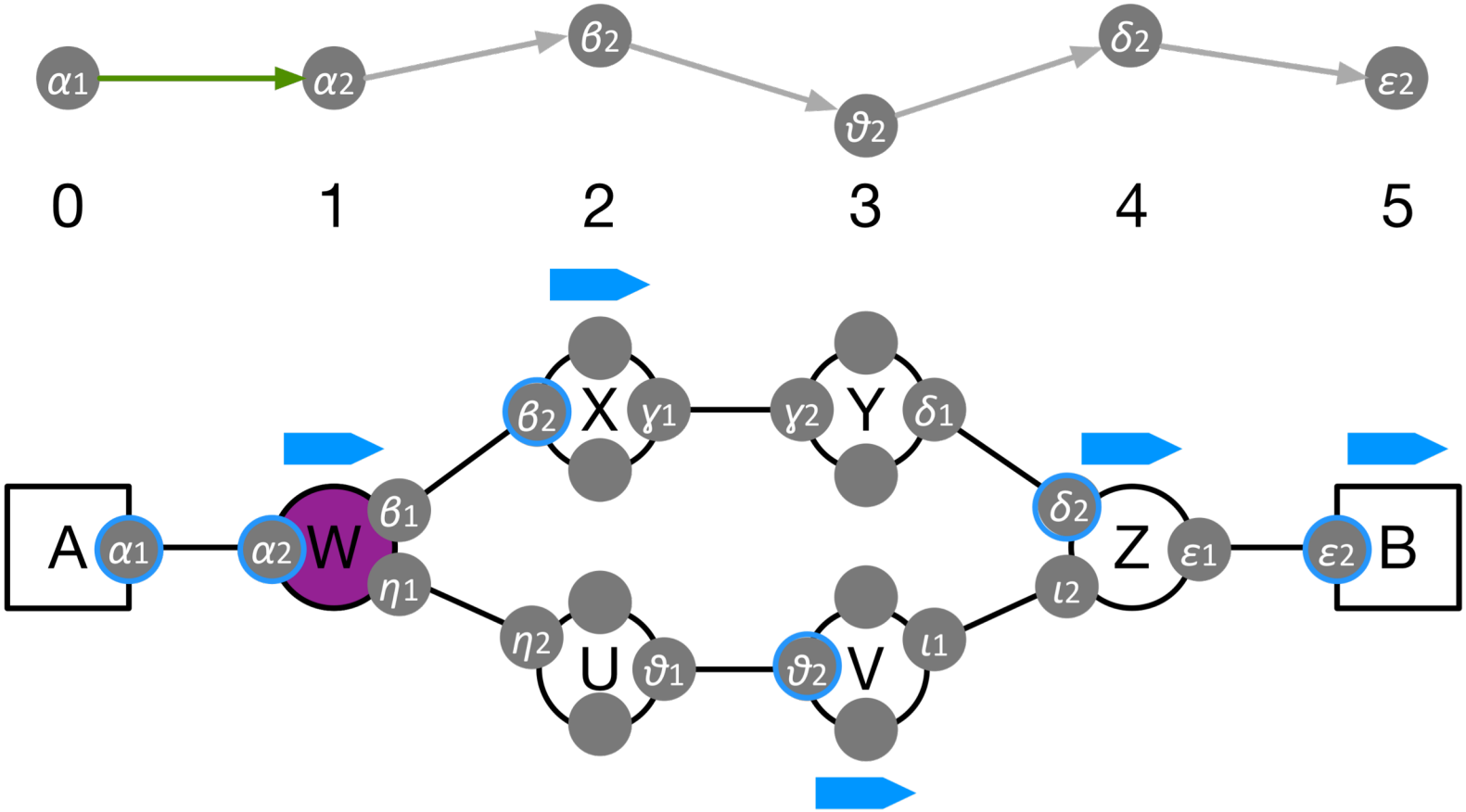
5
A
α1
α2
W
β1
η1
β2
X
γ1
γ2
Y
δ1
δ2
Z
ε1
ε2
B
η2
U
ϑ1
ϑ2
V
ι1
ι2

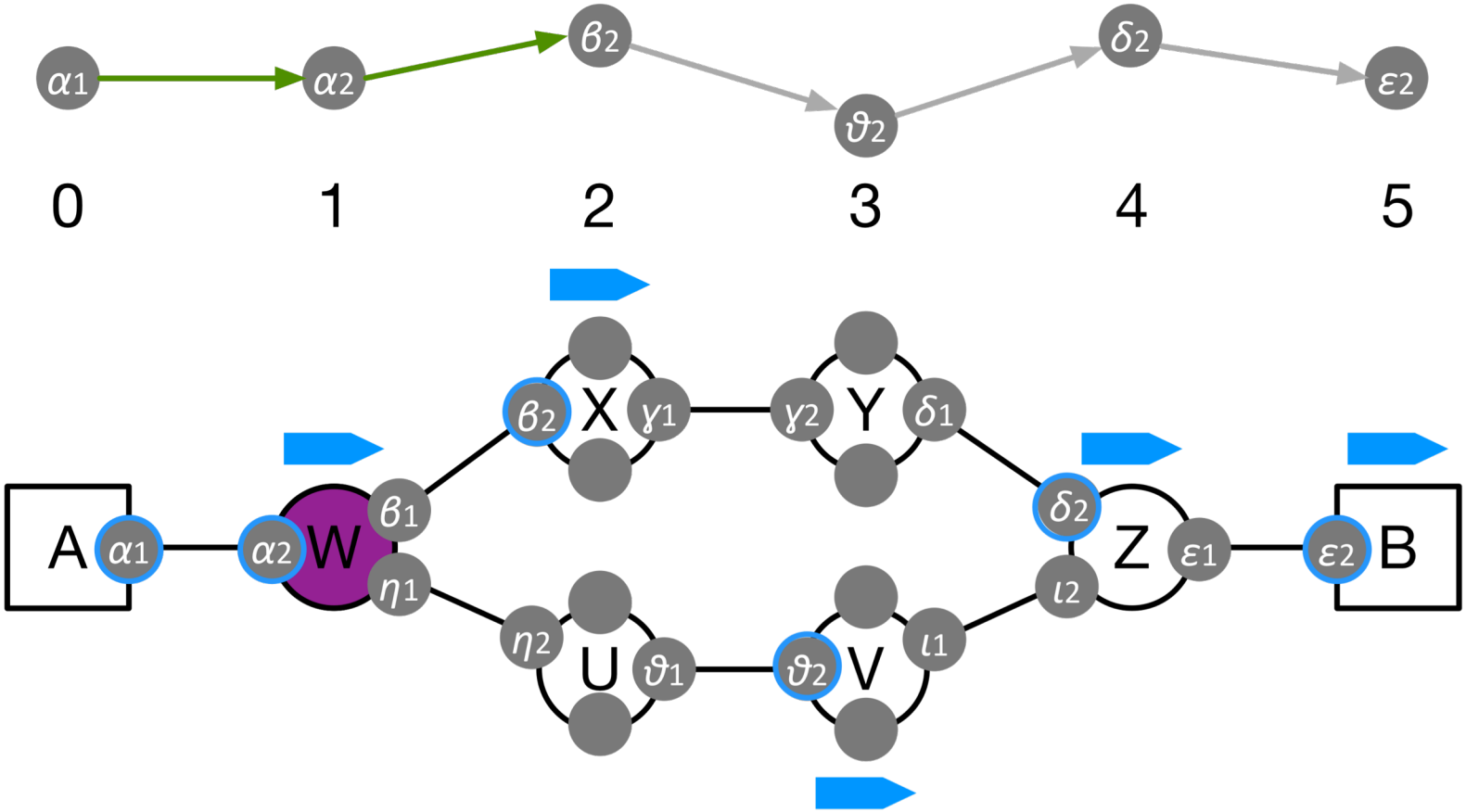

α1
α2
β2
ϑ2
0
1
2
3
4
5
A
α1
α2
W
β1
η1
β2
X
γ1
γ2
Y
δ1
δ2
Z
ε1
ε2
B
η2
U
ϑ1
ϑ2
V
ι1
ι2

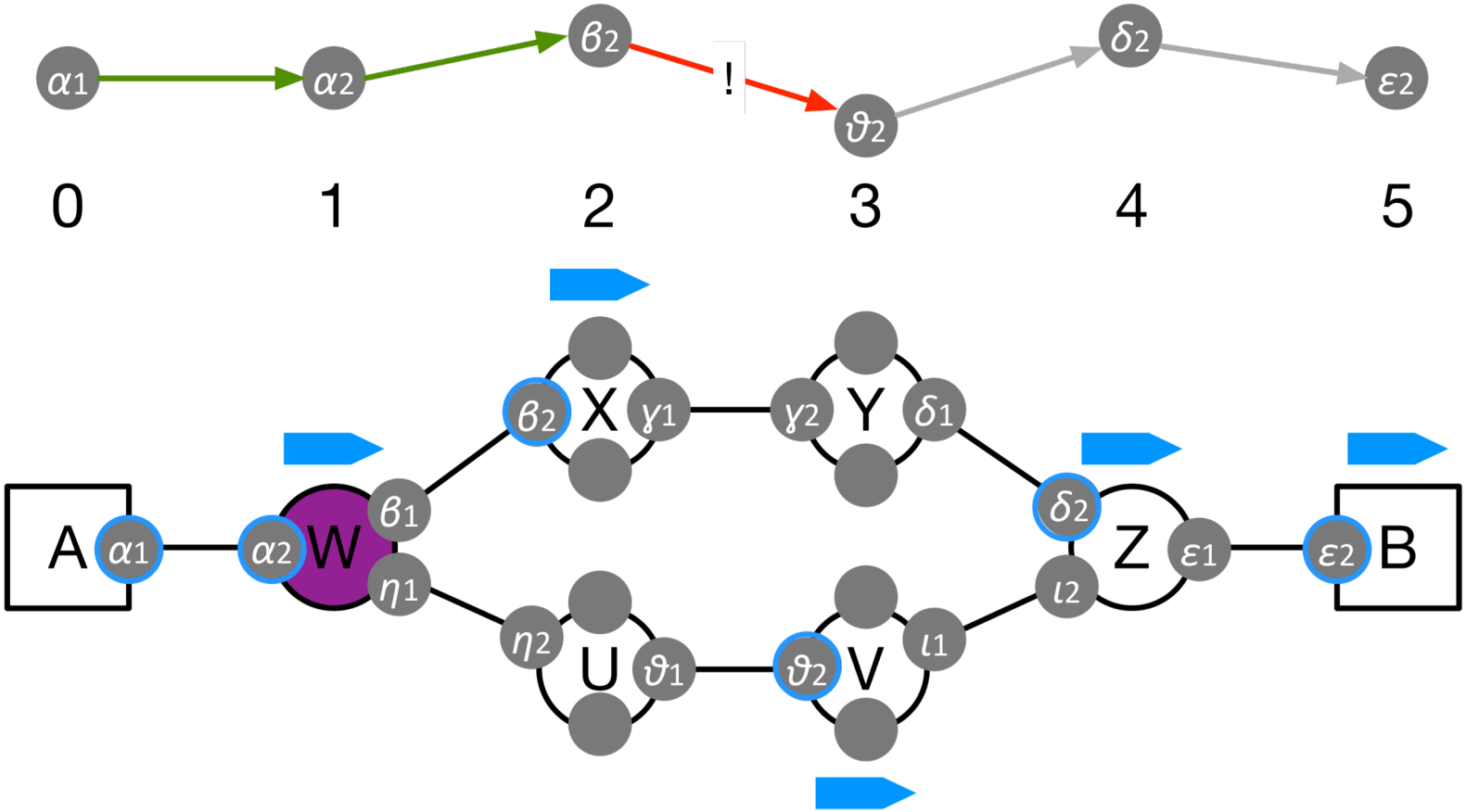

α1
α2
β2
ϑ2
δ2
0
1
2
3
4
5
A
α1
α2
W
β1
η1
β2
X
γ1
γ2
Y
δ1
η2
U
ϑ1
ϑ2
V
ι1
δ2
ι2
Z
ε1
ε2
B

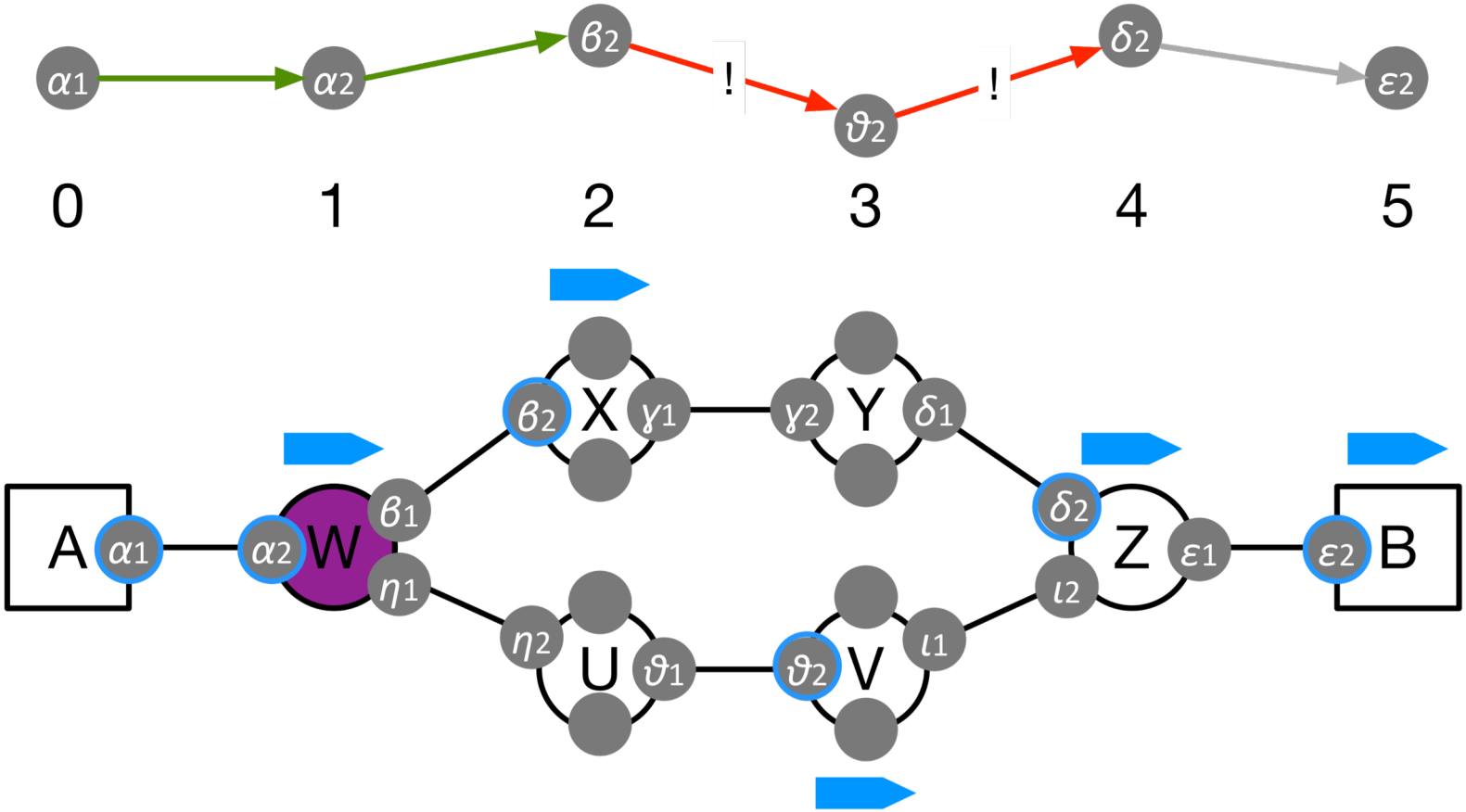


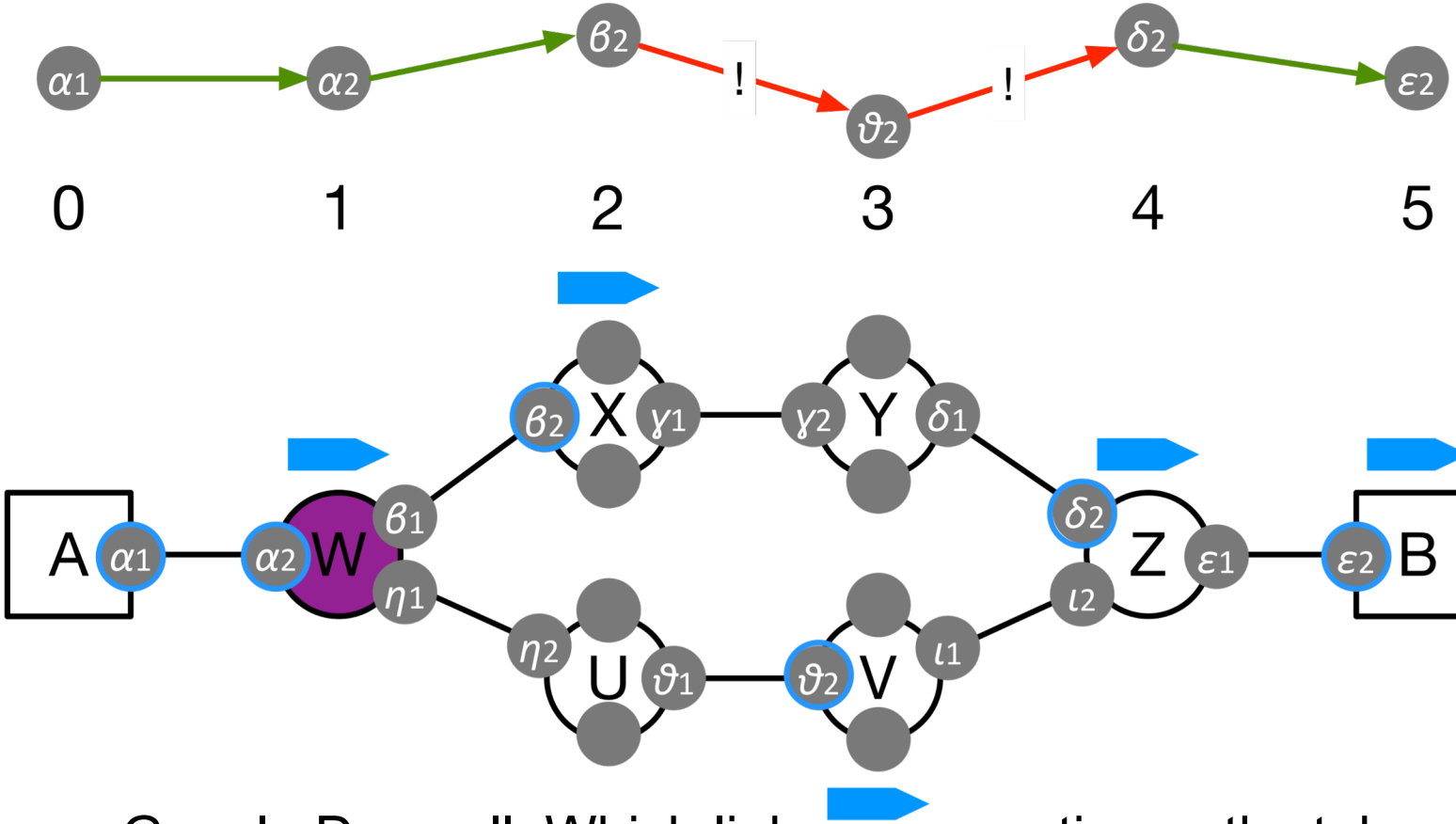

Google Doc poll: Which links in the picture above do not represent the paths taken by packets in the network?


α1
α2
β2
ϑ2
δ2
ε2
0
1
2
3
4
5
A
α1
α2
W
β1
η1
β2
X
γ1
γ2
Y
δ1
η2
U
ϑ1
ϑ2
V
ι1
δ2
ι2
Z
ε1
ε2
B

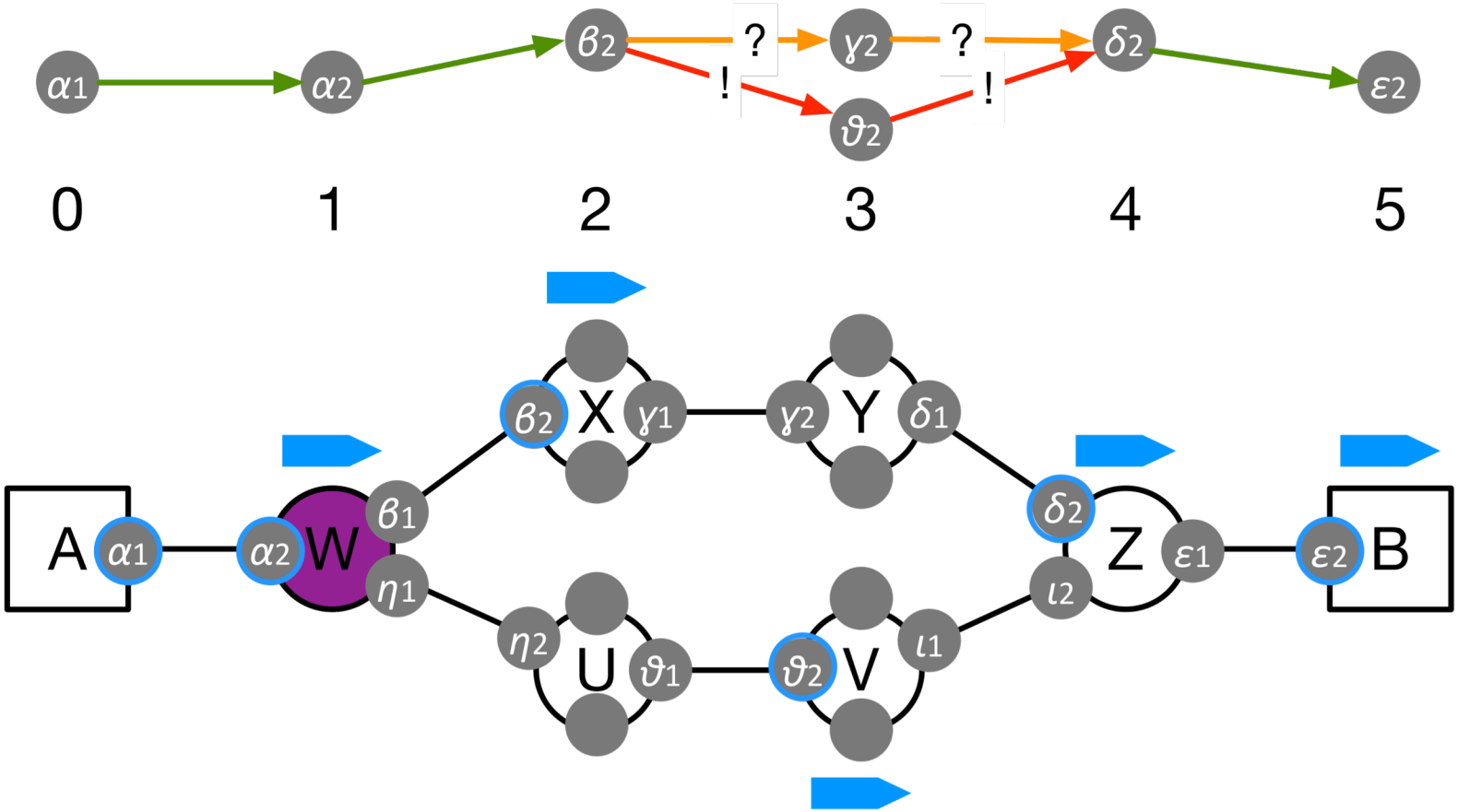

α1
α2
β2
ϑ2
δ2
ε2
0
1
2
3
4
5
A
α1
α2
W
β1
η1
β2
X
γ1
γ2
Y
δ1
η2
U
ϑ1
ϑ2
V
ι1
δ2
ι2
Z
ε1
ε2
B

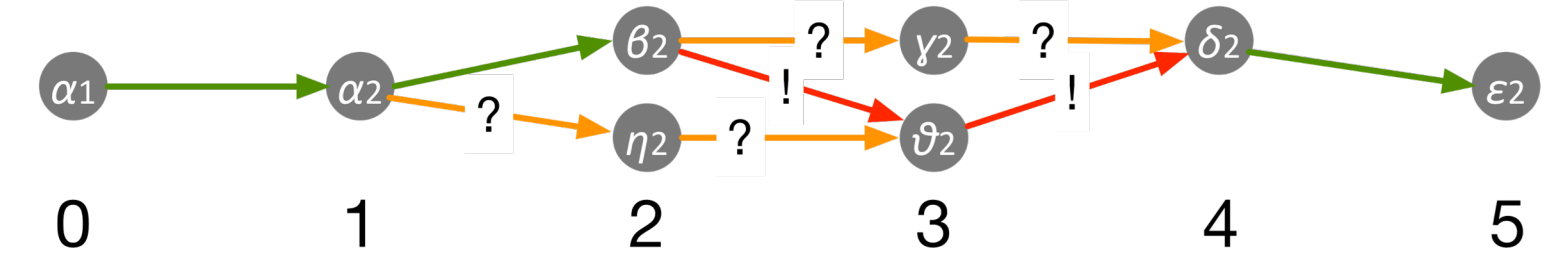

α1
α2
β2
!
ϑ2
δ2
ε2
0
1
2
3
4
5
A
α1
α2
W
β1
η1
β2
X
γ1
γ2
Y
δ1
η2
U
ϑ1
ϑ2
V
ι1
δ2
ι2
Z
ε1
ε2
B

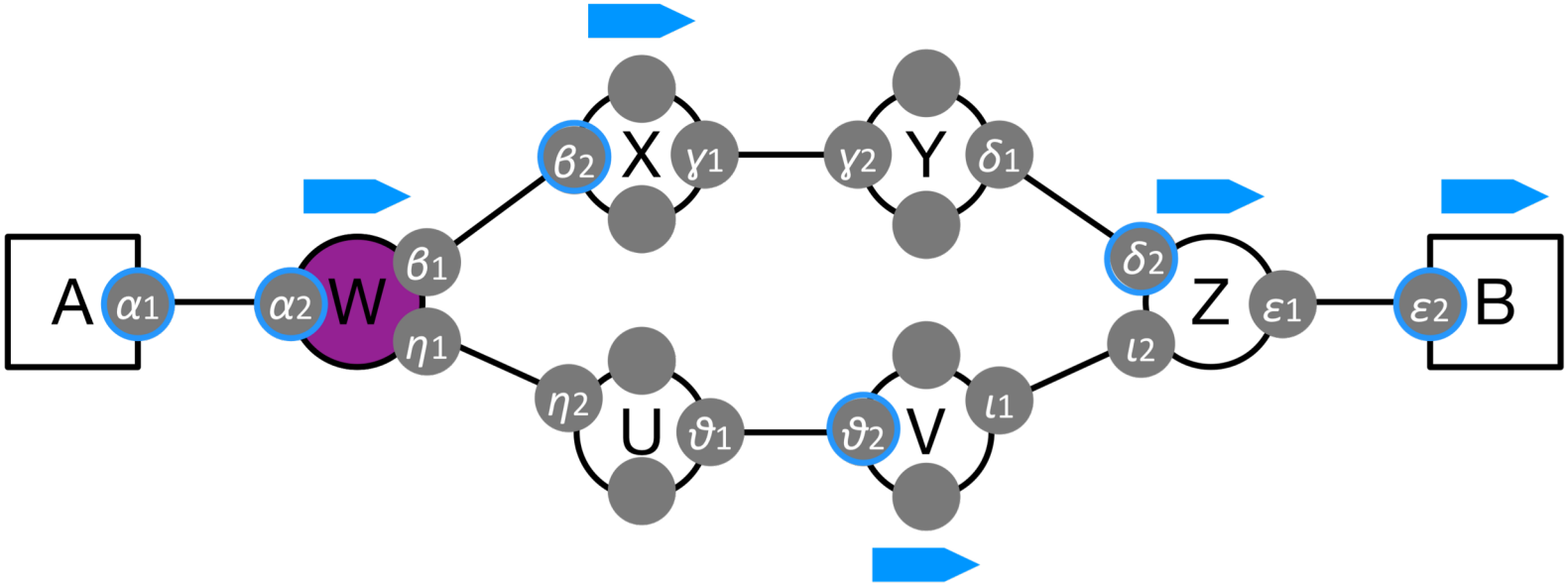

α1
α2
β2
!
ϑ2
!
δ2
ε2
0
1
2
3
4
5
A
α1
α2
W
β1
η1
β2
X
γ1
γ2
Y
δ1
η2
U
ϑ1
ϑ2
V
ι1
δ2
ι2
Z
ε1
ε2
B

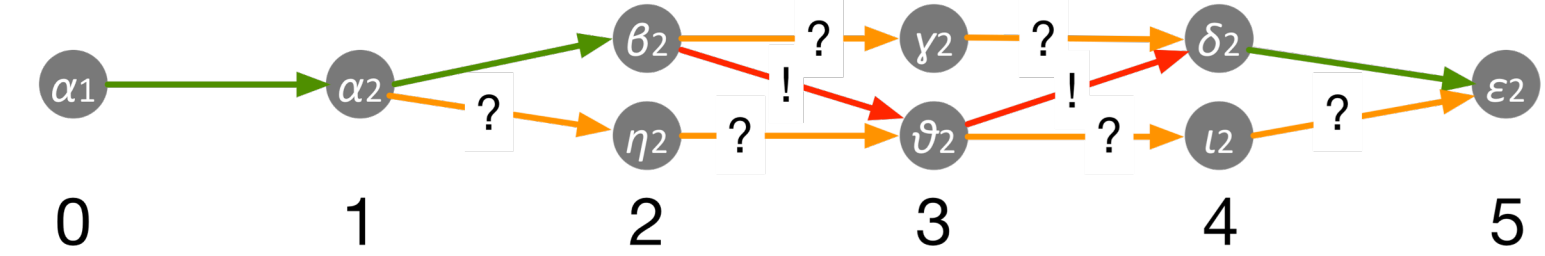


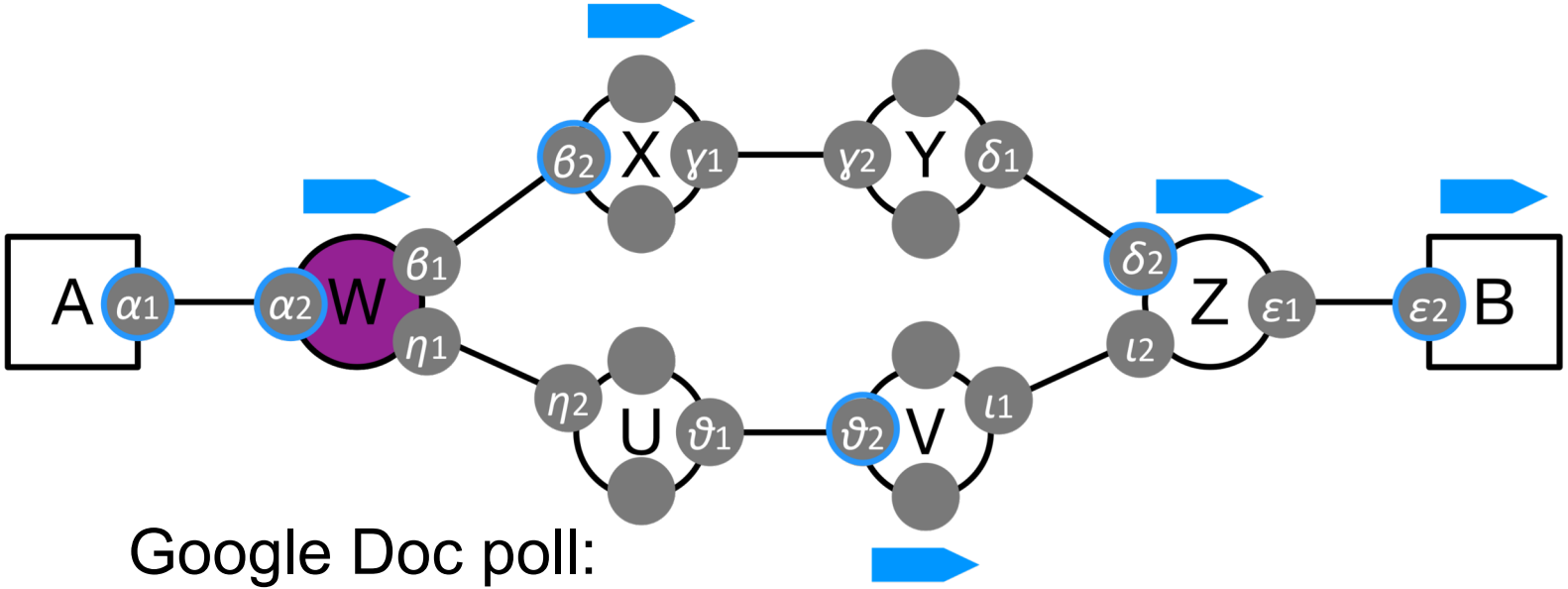

Google Doc poll: Which links representing paths taken buy packets should appear in the picture above, but do not appear?


α1
α2
β2
?
γ2
?
δ2
ε2
!
!
ϑ2
0
1
2
3
4
5
A
α1
α2
W
β1
η1
β2
X
γ1
γ2
Y
δ1
δ2
Z
ε1
ε2
B
ι2
η2
U
ϑ1
ϑ2
V
ι1


α1
α2
β2
η2
γ2
ϑ2
δ2
ε2
?
?
?
?
!
!
0
1
2
3
4
5

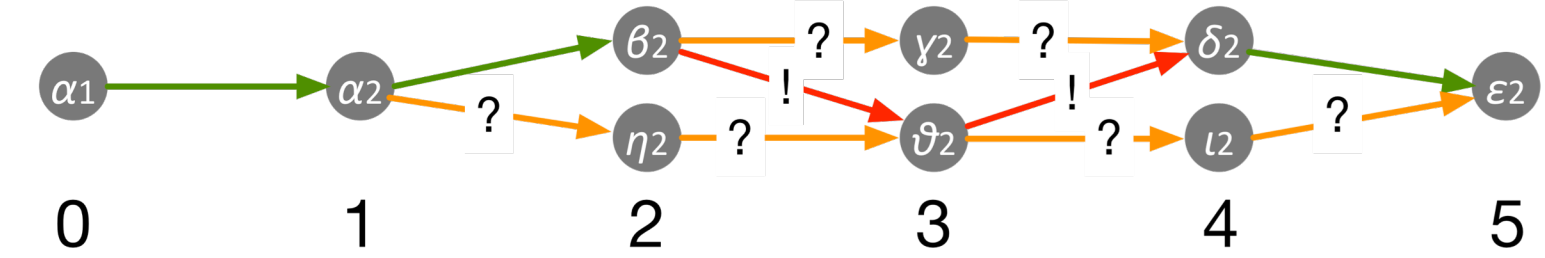

A
α1
α2
W
β1
η1
β2
X
γ1
η2
U
ϑ1
γ2
Y
δ1
ϑ2
V
ι1
δ2
ι2
Z
ε1
ε2
B

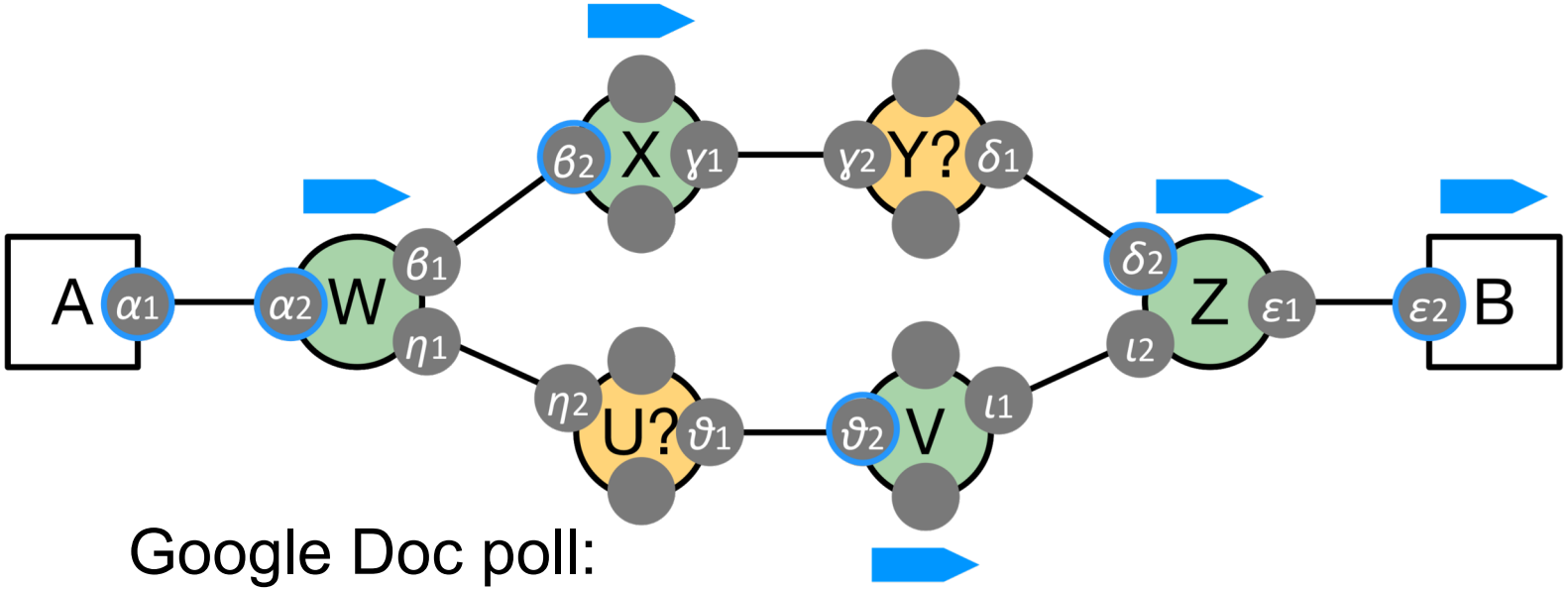



## Google Doc poll:

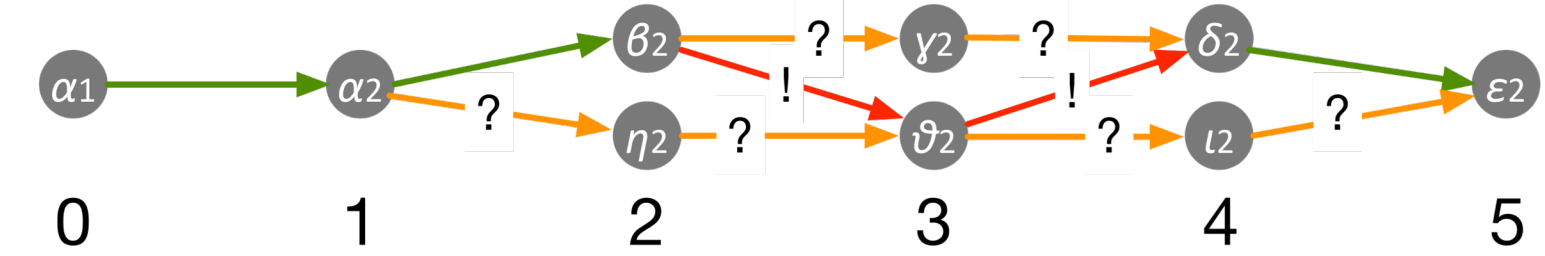
About which routers does traceroute learn absolutely nothing in this example?

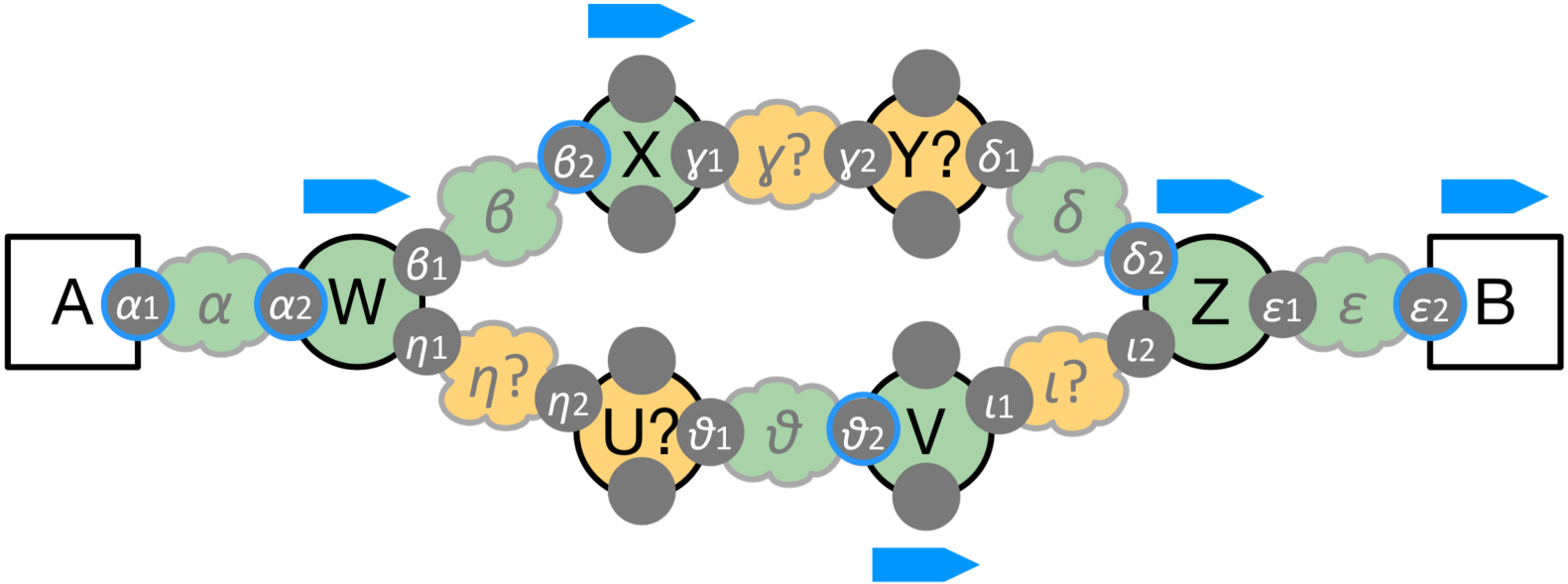



## Google Doc poll:

About which networks does traceroute learn absolutely nothing in this example?


α1
α2
β2
η2
γ2
ϑ2
δ2
ι2
ε2
?
!
0
1
2
3
4
5


A
α1
α
α2
W
β1
η1
β
η?
η2
β2
X
γ1
γ?
γ2
Y?
δ1
U?
ϑ1
ϑ
ϑ2
V
ι1
ι?
δ
δ2
ι2
Z
ε1
ε
ε2
B

# Traceroute - load balancing

- Per-flow load balancing
  - Problem: Traceroute changes the flow identifier with each probe
  - Solution: Paris Traceroute
- Per-packet load balancing
  - Nothing to be done
  - Fortunately, less frequently encountered

# Outline

- Basics
- Limits
- Load balancing
- The tool

```
$ traceroute www.example.com
traceroute to www.example.com (93.184.216.34), 64 hops max, 52 byte packets
 1  livebox (192.168.1.1)  3.079 ms  5.188 ms  1.411 ms
 2  80.10.237.102 (80.10.237.102)  3.999 ms  137.773 ms  6.387 ms
 3  ncidf104.paris.ft.net (193.253.80.126)  3.849 ms  4.992 ms  3.695 ms
 4  niaub102.lyon.ft.net (193.252.159.46)  13.845 ms  15.477 ms  16.557 ms
 5  193.252.137.70 (193.252.137.70)  15.627 ms  18.621 ms  14.790 ms
 6  tengige0-29.ot.net (193.251.240.179)  20.478 ms  16.633 ms  23.926 ms
 7  telia.gw.ot.net (193.251.248.70)  14.067 ms  34.980 ms  19.455 ms
 8  93.184.216.34 (93.184.216.34) 20.619 ms  16.659 ms  15.259 ms
$
```

```
$ traceroute www.example.com
traceroute to www.example.com (93.184.216.34), 64 hops max, 52 byte packets
 1  livebox (192.168.1.1)  3.079 ms  5.188 ms  1.411 ms
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 4  niaub102.lyon.ft.net (193.252.159.46)  13.845 ms  15.477 ms  16.557 ms
 5  193.252.137.70 (193.252.137.70)  15.627 ms  18.621 ms  14.790 ms
 6  tengige0-29.ot.net (193.251.240.179)  20.478 ms  16.633 ms  23.926 ms
 7  telia.gw.ot.net (193.251.248.70)  14.067 ms  34.980 ms  19.455 ms
 8  93.184.216.34 (93.184.216.34) 20.619 ms  16.659 ms  15.259 ms
$
```

Zoom poll: Is the destination reached by this traceroute?

Zoom poll: How many hops away is the destination?

```
$ traceroute www.example.com
traceroute to www.example.com (93.184.216.34), 64 hops max, 52 byte packets
 1  livebox (192.168.1.1)  3.079 ms  5.188 ms  1.411 ms
 2  80.10.237.102 (80.10.237.102)  3.999 ms  137.773 ms  6.387 ms
 3  ncidf104.paris.ft.net (193.253.80.126)  3.849 ms  4.992 ms  3.695 ms
 4  niaub102.lyon.ft.net (193.252.159.46)  13.845 ms  15.477 ms  16.557 ms
 5  193.252.137.70 (193.252.137.70)  15.627 ms  18.621 ms  14.790 ms
 6  tengige0-29.ot.net (193.251.240.179)  20.478 ms  16.633 ms  23.926 ms
 7  telia.gw.ot.net (193.251.248.70)  14.067 ms  34.980 ms  19.455 ms
 8  93.184.216.34 (93.184.216.34) 20.619 ms  16.659 ms  15.259 ms
$
```

```
$ traceroute www.example.com
traceroute to www.example.com (93.184.216.34), 64 hops max, 52 byte packets
 1  livebox (192.168.1.1)  3.079 ms  5.188 ms  1.411 ms
 2  80.10.237.102 (80.10.237.102)  3.999 ms  137.773 ms  6.387 ms
 3  ncidf104.paris.ft.net (193.253.80.126)  3.849 ms  4.992 ms  3.695 ms
 4  niaub102.lyon.ft.net (193.252.159.46)  13.845 ms  15.477 ms  16.557 ms
 5  193.252.137.70 (193.252.137.70)  15.627 ms  18.621 ms  14.790 ms
 6  tengige0-29.ot.net (193.251.240.179)  20.478 ms  16.633 ms  23.926 ms
 7  telia.gw.ot.net (193.251.248.70)  14.067 ms  34.980 ms  19.455 ms
 8  93.184.216.34 (93.184.216.34) 20.619 ms  16.659 ms  15.259 ms
$
```

```
$ traceroute www.example.com
traceroute to www.example.com (93.184.216.34), 64 hops max, 52 byte packets
 1  livebox (192.168.1.1)  3.079 ms  5.188 ms  1.411 ms
 2  80.10.237.102 (80.10.237.102)  3.999 ms  137.773 ms  6.387 ms
 3  ncidf104.paris.ft.net (193.253.80.126)  3.849 ms  4.992 ms  3.695 ms
 4  niaub102.lyon.ft.net (193.252.159.46)  13.845 ms  15.477 ms  16.557 ms
 5  193.252.137.70 (193.252.137.70)  15.627 ms  18.621 ms  14.790 ms
 6  tengige0-29.ot.net (193.251.240.179)  20.478 ms  16.633 ms  23.926 ms
 7  telia.gw.ot.net (193.251.248.70)  14.067 ms  34.980 ms  19.455 ms
 8  93.184.216.34 (93.184.216.34) 20.619 ms  16.659 ms  15.259 ms
$
```

Zoom poll: How many probe packets are sent to each hop?

```
$ traceroute www.example.com
traceroute to www.example.com (93.184.216.34), 64 hops max, 52 byte packets
 1  livebox (192.168.1.1)  3.079 ms  5.188 ms  1.411 ms
 2  80.10.237.102 (80.10.237.102)  3.999 ms  137.773 ms  6.387 ms
 3  ncidf104.paris.ft.net (193.253.80.126)  3.849 ms  4.992 ms  3.695 ms
 4  niaub102.lyon.ft.net (193.252.159.46)  13.845 ms  15.477 ms  16.557 ms
 5  193.252.137.70 (193.252.137.70)  15.627 ms  18.621 ms  14.790 ms
 6  tengige0-29.ot.net (193.251.240.179)  20.478 ms  16.633 ms  23.926 ms
 7  telia.gw.ot.net (193.251.248.70)  14.067 ms  34.980 ms  19.455 ms
 8  93.184.216.34 (93.184.216.34) 20.619 ms  16.659 ms  15.259 ms
$
```

Google Doc poll: Which cities does the traceroute pass through?

```
$ traceroute www.example.com
traceroute to www.example.com (93.184.216.34), 64 hops max, 52 byte packets
 1  livebox (192.168.1.1)  3.079 ms  5.188 ms  1.411 ms
 2  80.10.237.102 (80.10.237.102)  3.999 ms  137.773 ms  6.387 ms
 3  ncidf104.paris.ft.net (193.253.80.126)  3.849 ms  4.992 ms  3.695 ms
 4  niaub102.lyon.ft.net (193.252.159.46)  13.845 ms  15.477 ms  16.557 ms
 5  193.252.137.70 (193.252.137.70)  15.627 ms  18.621 ms  14.790 ms
 6  tengige0-29.ot.net (193.251.240.179)  20.478 ms  16.633 ms  23.926 ms
 7  telia.gw.ot.net (193.251.248.70)  14.067 ms  34.980 ms  19.455 ms
 8  93.184.216.34 (93.184.216.34) 20.619 ms  16.659 ms  15.259 ms
$
```

```
$ traceroute www.example.com
traceroute to www.example.com (93.184.216.34), 64 hops max, 52 byte packets
 1  livebox (192.168.1.1)  3.079 ms  5.188 ms  1.411 ms
 2  80.10.237.102 (80.10.237.102)  3.999 ms  137.773 ms  6.387 ms
 3  ncidf104.paris.ft.net (193.253.80.126)  3.849 ms  4.992 ms  3.695 ms
 4  niaub102.lyon.ft.net (193.252.159.46)  13.845 ms  15.477 ms  16.557 ms
 5  193.252.137.70 (193.252.137.70)  15.627 ms  18.621 ms  14.790 ms
 6  tengige0-29.ot.net (193.251.240.179)  20.478 ms  16.633 ms  23.926 ms
 7  telia.gw.ot.net (193.251.248.70)  14.067 ms  34.980 ms  19.455 ms
 8  93.184.216.34 (93.184.216.34) 20.619 ms  16.659 ms  15.259 ms
$
```

Google Doc poll: Why do we not see the name that corresponds to this IP address?

```
$ traceroute www.example.com
traceroute to www.example.com (93.184.216.34), 64 hops max, 52 byte packets
 1  livebox (192.168.1.1)  3.079 ms  5.188 ms  1.411 ms
 2  80.10.237.102 (80.10.237.102)  3.999 ms  137.773 ms  6.387 ms
 3  ncidf104.paris.ft.net (193.253.80.126)  3.849 ms  4.992 ms  3.695 ms
 4  niaub102.lyon.ft.net (193.252.159.46)  13.845 ms  15.477 ms  16.557 ms
 5  193.252.137.70 (193.252.137.70)  15.627 ms  18.621 ms  14.790 ms
 6  tengige0-29.ot.net (193.251.240.179)  20.478 ms  16.633 ms  23.926 ms
 7  telia.gw.ot.net (193.251.248.70)  14.067 ms  34.980 ms  19.455 ms
 8  93.184.216.34 (93.184.216.34) 20.619 ms  16.659 ms  15.259 ms
$
```

```
$ traceroute www.example.com
traceroute to www.example.com (93.184.216.34), 64 hops max, 52 byte packets
 1  livebox (192.168.1.1)  3.079 ms  5.188 ms  1.411 ms
 2  80.10.237.102 (80.10.237.102)  3.999 ms  137.773 ms  6.387 ms
 3  ncidf104.paris.ft.net (193.253.80.126)  3.849 ms  4.992 ms  3.695 ms
 4  niaub102.lyon.ft.net (193.252.159.46)  13.845 ms  15.477 ms  16.557 ms
 5  193.252.137.70 (193.252.137.70)  15.627 ms  18.621 ms  14.790 ms
 6  tengige0-29.ot.net (193.251.240.179)  20.478 ms  16.633 ms  23.926 ms
 7  telia.gw.ot.net (193.251.248.70)  14.067 ms  34.980 ms  19.455 ms
 8  93.184.216.34 (93.184.216.34) 20.619 ms  16.659 ms  15.259 ms
$
```

Google Doc poll: How far away is the destination from the source?

```
 7  telia.gw.ot.net (193.251.248.70)  17.657 ms  21.913 ms  16.441 ms
 8  * * *
 9  * * *
10  dk-ore.nordu.net (109.105.97.136)  126.153 ms  164.046 ms  168.931 ms
```

Google Doc poll: What explains the stars in this excerpt from a traceroute?

```
 7  telia.gw.ot.net (193.251.248.70)  17.657 ms  21.913 ms  16.441 ms
 8  * * *
 9  * * *
10  dk-ore.nordu.net (109.105.97.136)  126.153 ms  164.046 ms  168.931 ms
```

```
7  telia.gw.ot.net (193.251.248.70)  17.657 ms  21.913 ms  16.441 ms
8  ldn-bb3-link.telia.net (80.91.248.217)  27.737 ms
   ldn-bb2-link.telia.net (80.91.246.114)  18.095 ms
   ldn-bb2-link.telia.net (80.91.249.181)  25.971 ms
9  ash-bb4-link.telia.net (62.115.141.92)  98.975 ms
   ash-bb4-link.telia.net (62.115.116.66)  86.646 ms
   nyk-bb1-link.telia.net (62.115.135.96)  83.222 ms
```

```
7  telia.gw.ot.net (193.251.248.70)  17.657 ms  21.913 ms  16.441 ms
8  ldn-bb3-link.telia.net (80.91.248.217)  27.737 ms
   ldn-bb2-link.telia.net (80.91.246.114)  18.095 ms
   ldn-bb2-link.telia.net (80.91.249.181)  25.971 ms
9  ash-bb4-link.telia.net (62.115.141.92)  98.975 ms
   ash-bb4-link.telia.net (62.115.116.66)  86.646 ms
   nyk-bb1-link.telia.net (62.115.135.96)  83.222 ms
```

Google Doc poll: What explains the multiple answers at a given hop in this traceroute?

# Traceroutes

IPv4 route lengths

- Mean: 15-16 hops
- Roughly normal distribution of hop lengths
- Few routes shorter than 6 hops
- Few routes longer than 25 hops
- Routes longer than 30 hops extremely rare

Source: presenter's own work with Leguay, Latapy, Salamatian (2005)

# Outline

- Basics
- Limits
- Load balancing
- The tool