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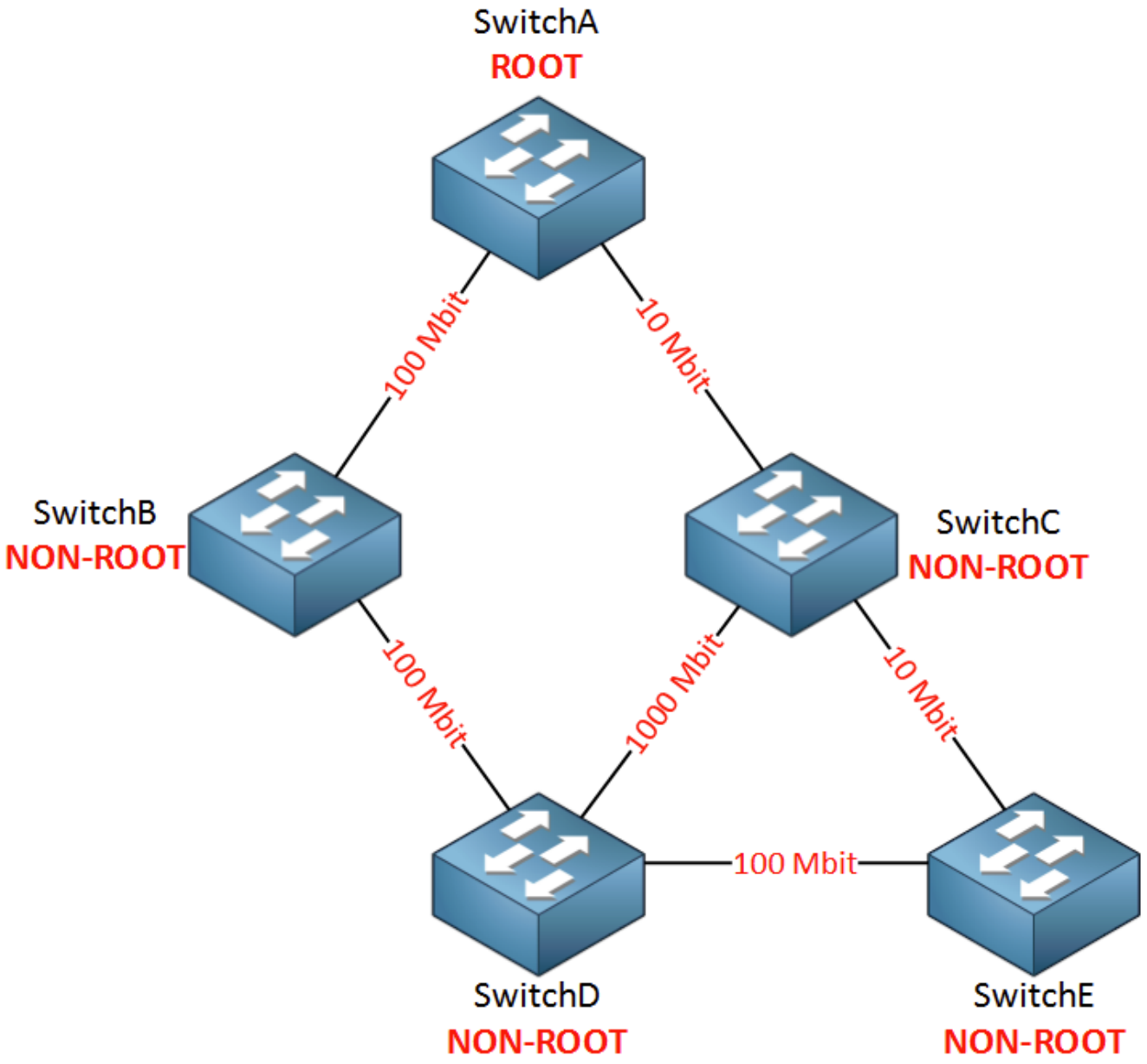
CCIE Routing & Switching

Spanning-Tree Cost Calculation

Non-root bridges need to find the **shortest path to the root bridge.** What will happen if we have a mix of different interface types like Ethernet, FastEthernet and Gigabit? Let's find out!

Here's the topology I will use to explain the spanning-tree cost calculation:

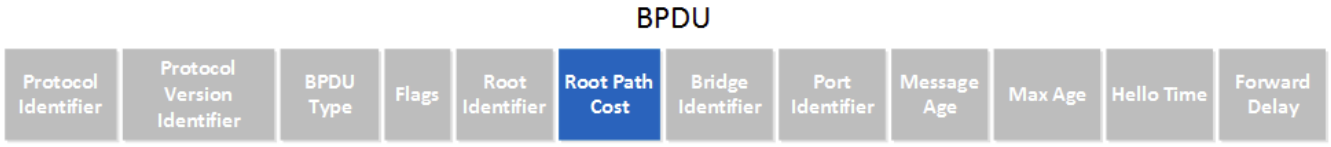


In the picture above we have a larger network with multiple switches. You can also see that there are different interface types, we have Ethernet (10 Mbit), FastEthernet (100Mbit) and Gigabit (1000Mbit). SwitchA on top is the root bridge so all other switches are non-root and need to find the shortest path to the root bridge.

Bandwidth	Cost
10 Mbit	100
100 Mbit	19
1000 Mbit	4

Spanning-tree uses **cost** to determine the shortest path to the root bridge. The slower the interface, the higher the cost is. The path with the lowest cost will be used to reach the root bridge.

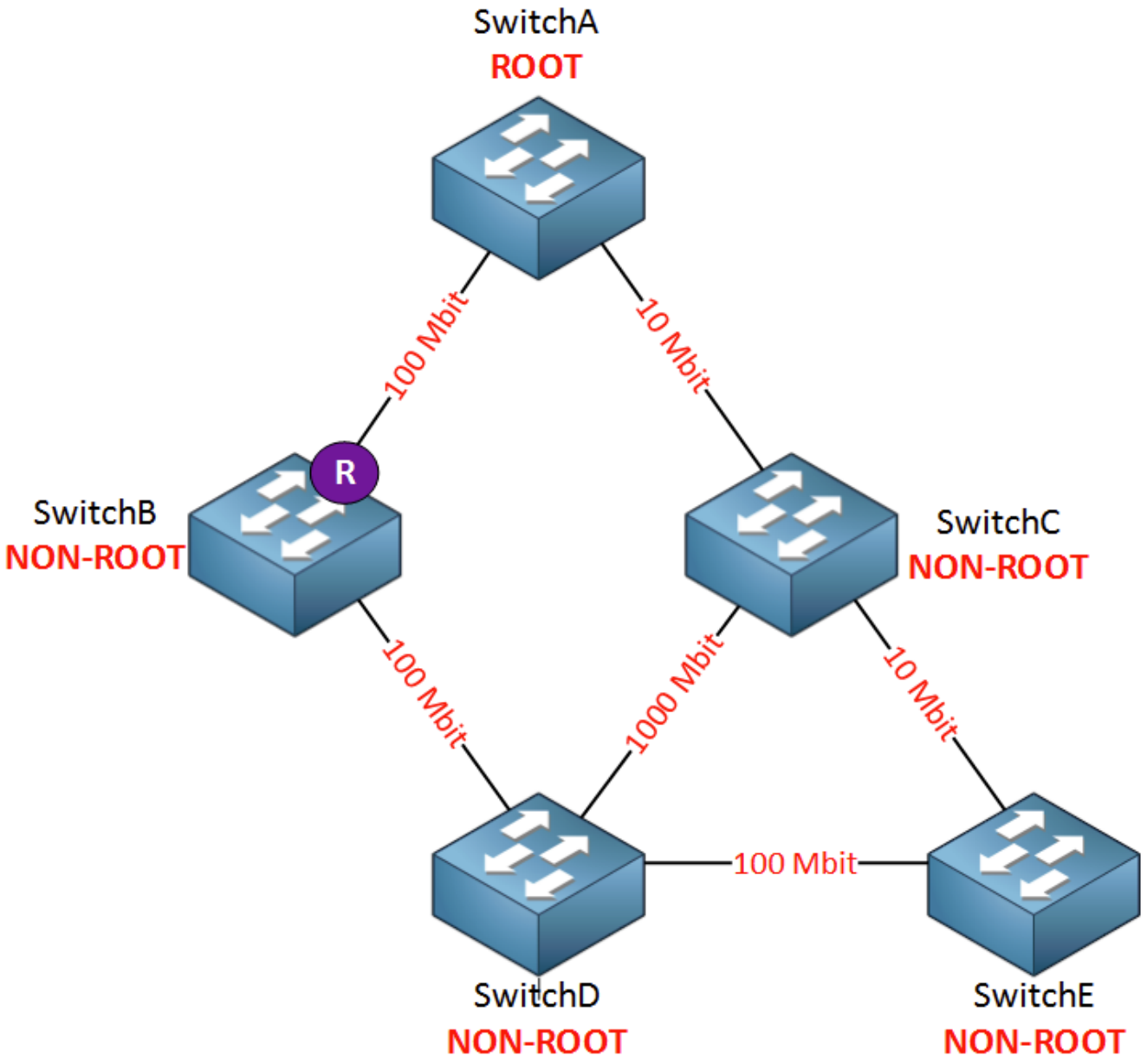
Here's where you can find the cost value:



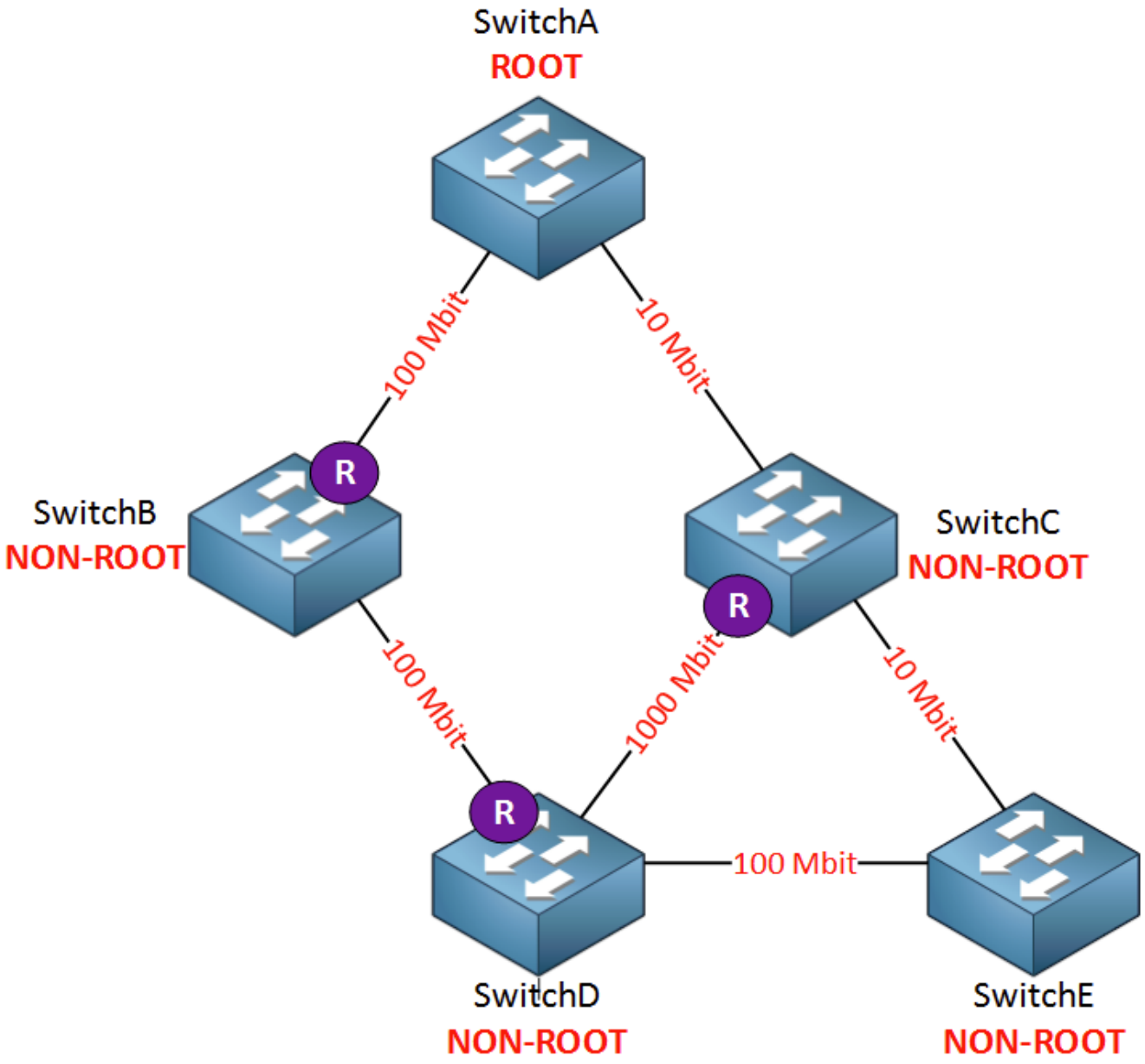
In the BPDU you can see a field called **root path cost**. This is where each switch will insert the **cost of its shortest path** to the root bridge. Once the switches found out which switch is declared as root bridge they will look for the shortest path to get there. **BPDUs will flow from the root bridge downwards to all switches**.

> If you studied CCNA or CCNP ROUTE then this story about spanning-tree cost might sound familiar. OSPF (Open Shortest Path First) also uses cost to calculate the shortest path to its destination. Both spanning-tree and OSPF use cost to find the shortest path but there is one big difference. OSPF builds a topology database (LSDB) so all routers know exactly what the network looks like. Spanning-tree is "dumb"...switches have no idea what the topology looks like. BPDUs flow from the root bridge downwards to all switches, switches will make a decision based on the BPDUs that they receive!

Here's an example of the different spanning-tree costs for our topology:



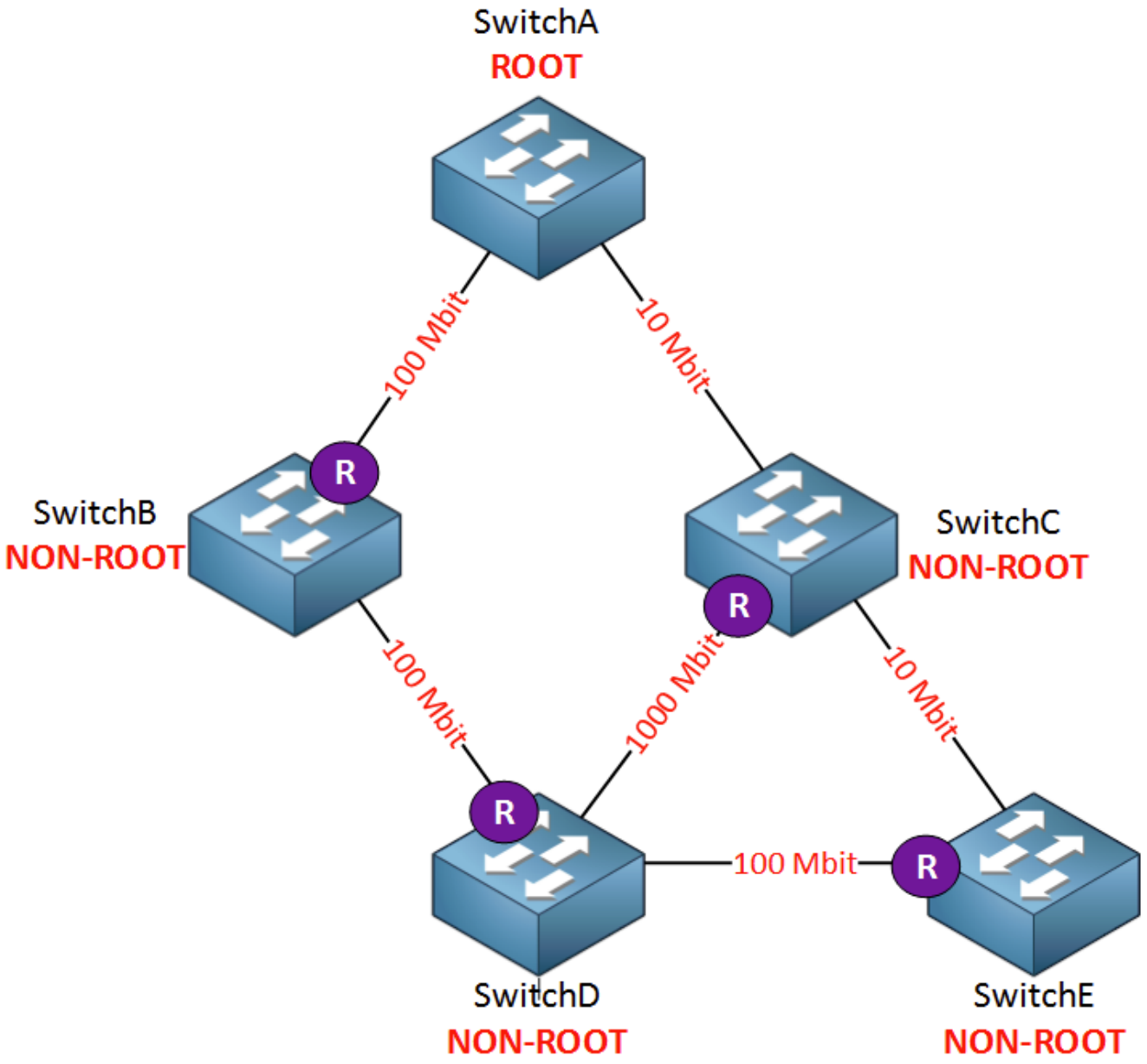
SwitchB will use the direct link to SwitchA as its root port since this is a 100 Mbit interface and has a cost of 19. It will forward BPDUs towards SwitchD; in the root path cost field of the BPDU you will find a cost of 19. SwitchC is also receiving BPDUs from SwitchA so it's possible that at this moment it selects its 10 Mbit interface as the root port. Let's continue...



This picture needs some more explanation so let me break it down:

- SwitchC will receive BPDUs on its 10 Mbit interface (cost 100) and on its 1000 Mbit interface (cost 4). It will use its 1000 Mbit interface as its root port.
- SwitchC will forward BPDUs to SwitchD. The root path cost field will be 100.
- SwitchD receives a BPDU from SwitchB with a root path cost of 19.
- SwitchD receives a BPDU from SwitchC with a root path cost of 100.
- The path through SwitchB is shorter so this will become the root port for SwitchD.
- SwitchD will forward BPDUs towards SwitchC and SwitchE. In the root path cost field of the BPDU we will find a cost of 38 (its root path cost of 19 + its own interface cost of 19).
- SwitchC will forward BPDUs towards SwitchE and inserts a cost of 42 in the root path cost field (19 + 19 + 4).

The complete picture will look like this:



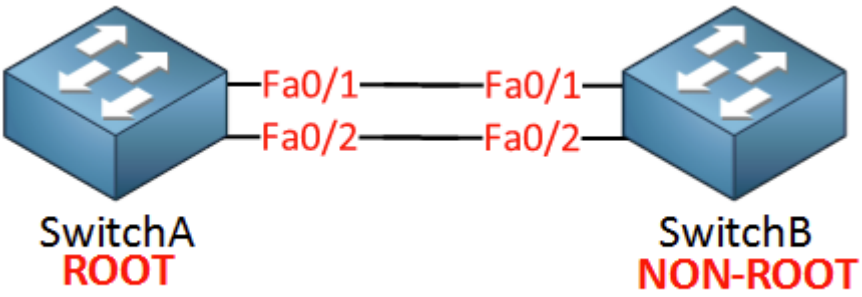
SwitchE receives BPDUs from SwitchC and SwitchD. In the BPDU we will look at the root path cost field and we'll see the following information:

- BPDU from SwitchC: cost 42
- BPDU from SwitchD: cost 38

SwitchE will add the cost of its own interface towards SwitchD so the total cost to reach the root bridge through SwitchD is 38 + 19 (cost of 100 Mbit interface) = 57. The total cost to reach the root bridge through SwitchC is 42 + 100 (10 Mbit interface) = 142. As result it will select the interface towards SwitchD as its root port.

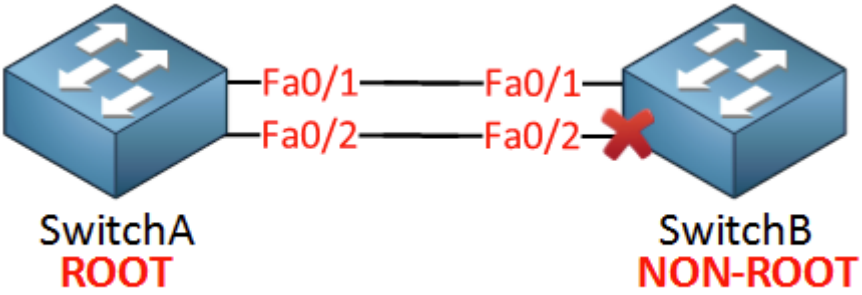
Are you following me so far? Keep in mind that switches only make decisions on the BPDUs that they receive! They have no idea what the topology looks like. The only thing they do know is on which interface they received the **best BPDU.** The best BPDU is the one with the shortest path to the root bridge!

What is the cost is equal?



Take a look at the picture above. SwitchA is the root bridge and SwitchB is non-root. We have two links between these switches so that we have redundancy. Redundancy means loops so spanning-tree is going to block one the interfaces on SwitchB.

SwitchB will receive BPDUs on both interfaces but the root path cost field will be the same! Which one are we going to block? Fa0/1 or fa0/2? When the cost is equal spanning-tree will look at the **port priority.** By default the port priority is the **same for all interfaces** which means that the **interface number will be the tie-breaker.**



The lowest interface number will be chosen so fa0/2 will be blocked here. Of course port priority is a value that we can change so we can choose which interface will be blocked, I'll show you later how to do this!

Whenever spanning-tree has to make a decision, this is the list that it will use. This is something to write down and remember:

1. **Lowest bridge ID**: the switch with the lowest bridge ID becomes the root bridge.
2. **Lowest path cost to root bridge**: when the switch receives multiple BPDUs it will select the interface that has the lowest cost to reach the root bridge as the root port.
3. **Lowest sender bridge ID**: when a switch is connected to two switches that it can use to reach the root bridge and the cost to reach the root bridge is the same, it will select the interface connecting to the switch with the lowest bridge ID as the root port.
4. **Lowest sender port ID**: when the switch has two interfaces connecting to the same switch, and the cost to reach the root bridge is the same it will use the interface with the lowest

number as the root port.

That's all for now, I hope this helps you to understand the spanning-tree cost calculation! If you enjoyed this tutorial, please use one of the social share buttons.

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This topic contains 13 replies, has 7 voices, and was last updated by Rene Molenaar 18 hours, 3 minutes ago.

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- July 16, 2014 at 22:55 #11712 Reply

Andy
4. Lowest sender port ID: when the switch has two interfaces connecting to the same switch, and the cost to reach the root bridge is the same it will use the interface _connected to the lowest upstream switch port_. Isnt it, Rene?

July 23, 2014 at 15:33 #11713 Reply

Marek

Andy if I understand your question correctly then I think no. The lowest switch port number is a local decision therefore it is not considering the port numbers of the upstream switch.
I also can be wrong... 🙂 Maybe someone will correct me.

Marek

May 8, 2015 at 13:10 #11714 Reply

francesco r
Participant
In the calculation , the switch , receive a bdpu with root path cost value (the link cost is given by costs Of the 2 port ,upstream and downstream)
The switch add at this path cost value , cost Of the port whrere receive the bpdu..... When sendig this bpdu out another port, the switch shoulds also add the cost Of the port which use to forward??

May 9, 2015 at 12:02 #11715 Reply

Rene Molenaar
Keymaster
Hi Francesco,

The switch will add the cost of its root port when it forwards the BPDU. It never adds the cost of the interface that is used to send the BPDU.

The total cost to get to the root will be the sum of all root ports.

Rene

May 14, 2015 at 12:25 #11716 Reply

francesco r
Participant
thanks so much—

March 12, 2016 at 00:59 #22671 Reply

Oscar S
Participant
If my topology is SW1 (root) ==> SW2 ==> SW3 The “root path cost” that received the SW3 is the cost that SW2 has to reach the root?
SW3 not add the cost of its interface?

March 13, 2016 at 16:13 #22690 Reply

Rene Molenaar
Keymaster
Hi Oscar,

The cost on SW3 will include the cost from SW2 and also the cost of the root port of SW3.

If you want to test this, connect three switches in a row and then use the **spanning-tree cost** command on the root ports of SW2 and SW3.

Rene

May 8, 2016 at 19:07 #23909 Reply

Mohammad Hasanuz Z
Participant
Hlw Rene,

When Root Bridge will send BPDU to downside, what will be the cost in path cost field ??

Expecting your so nice explanation as always 🙂

br//
zaman

May 8, 2016 at 22:22 #23911 Reply

Andrew P

Moderator
Mohammad,
When a switch (including the root) sends a BPDU, it does not add any additional cost to the BPDU. Instead, the receiver of the BPDU adds the cost of the link on its root port to the incoming BPDU.

In the case of a root bridge (since it is the root), the cost would be zero. When the root bridge sends the BPDU, it maintains zero as the cost.

May 26, 2016 at 12:55 #24508 Reply

Mohammad Hasanuz Z
Participant
Hlw Rene,

According to your Topology what is the port role between SWC to SWA and SWC to SWE link ??

I have one more question …

Suppose SW1—-SW2——SW3 connected serially .We have set SW1 priority 4096 and other SW priority default.First Elect Root bridge by exchanging BPDU to each other, right ?? So, How SW3 will receive superior BPDU of SW1.How SW2 inform SW3? SW3 will reform BPDU ??

br//
zaman

May 26, 2016 at 20:40 #24521 Reply

Andrew P
Moderator
Mohammad,
You got it right. So in you scenario

SW1–SW2–SW3

where all three switches start up at the same time, all three switches claim that they, themselves, are the root bridge. Once SW2 gets the BPDU from SW1 with a lower priority, SW2 agrees that SW1 is better, and so is the root. In the meantime, if SW3 sends SW2 a bpdu where SW3 is claiming to be the root, SW2 will just ignore that, because SW3 has a worse priority than SW1.

Now, once SW1 starts sending BPDUs (which is the job of the root bridge), SW2 will accept that via its root port (connection to SW1), and send out a copy of that BPDU on all of its ports (in this case the Designated Port to SW3). When SW3 sees that BPDU (the copy sent from SW2), it now knows that SW1 should be the root.

June 12, 2016 at 10:06 #24823 Reply

sze jie k
Participant
Hi Rene, Andrew,

Just curious on my spanning tree understand,

q1) For STP, can I say that -> for a connection between 2 switches, if both ends are “Designated port” , 1 end will have to be BLOCK.

q2) For the complete diagram above,
Switch C’s interface (10mbits connection) to Switch A will be block (assuming switch A has a lower MAC then C)
Switch E’s interface (10Mbits connection) to Switch C will be block (assuming switch C has a lower MAC then E)
right ?

Regards,
Alan

June 21, 2016 at 18:07 #25818 Reply

Rene Molenaar
Keymaster
Hi Alan,

If you only have two switches then you will have a root port on one end and a designated port on the other end. One switch will be the root bridge, that will be the designated port.

Only between non-root switches, one end will be the designated port and the other end the non-designated port.

You are correct about the blocked ports. SwitchA is the root btw so those interfaces are always designated ports.

Rene

- Author
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