

STP, PVST+, RSTP

Sadržaj

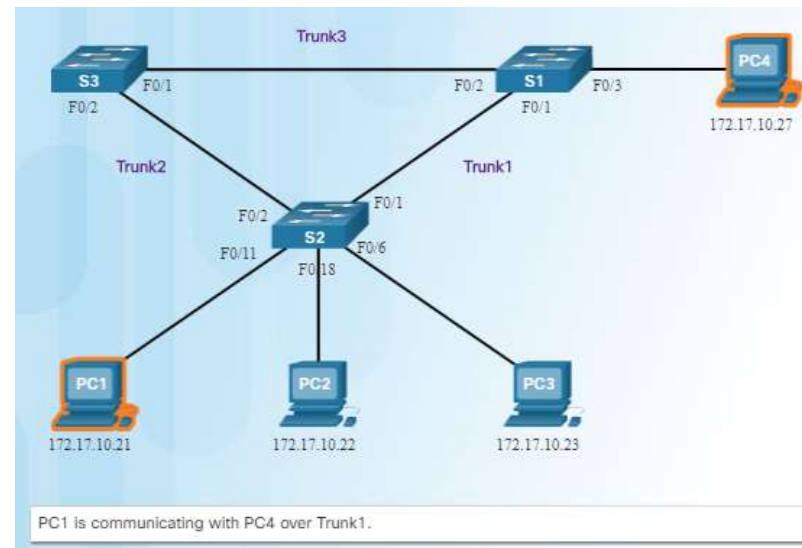
- * STP
- * Varijante STP protokola
- * Konfiguracija STP protokola

STP

Spanning Tree

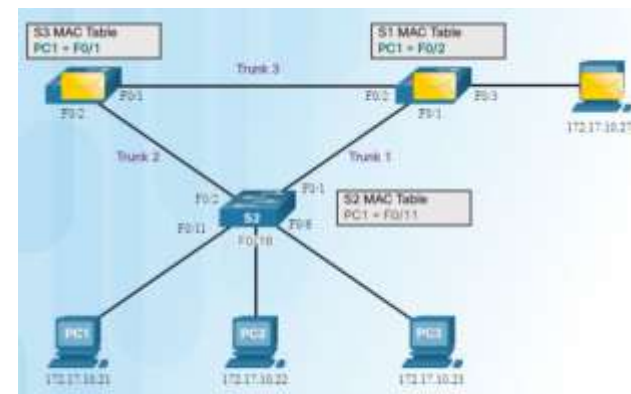
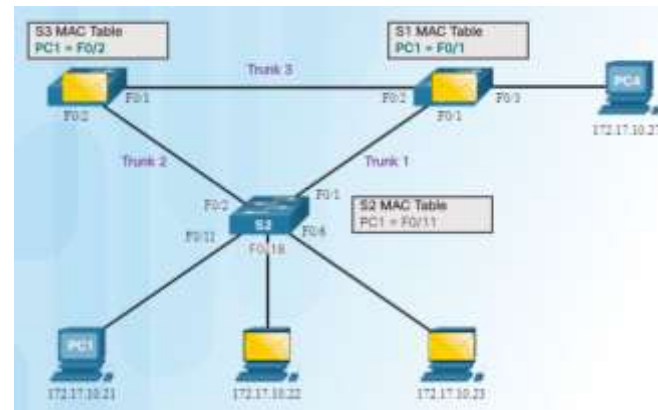
Redundansa na OSI slojevima 1 i 2

- Lokalne mreže sa svičevima obično (mogu da) imaju redundantne putanje.
 - Redundantni putevi eliminišu jedinstvene tačke otkaza u cilju poboljšanja pouzdanosti i dostupnosti.
 - Redundantne putanje mogu da kreiraju fizičke i logičke petlje na 2. sloju OSI modela.
- Spanning Tree Protocol (STP) je Layer 2 protokol koji rešava probleme koji postoje kod redundanse na L2.
- Problemi redundanse na L2:
 - Nestabilnost MAC tabela.
 - Brotkast oluje.
 - Višestruka dostava istog frejma.



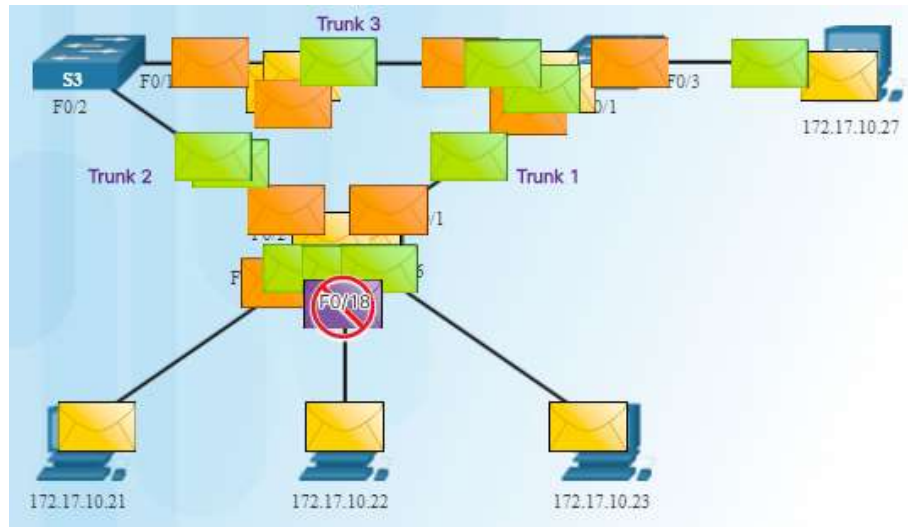
Problemi sa redundansom: Nestabilnost MAC Tabele

- Ethernet frejmovi nemaju TTL polje kao paketi IP protokola na Layer-u 3. Ovo znači da Ethernet nema mehanizam da odbaci frejmove koji kruže beskonačno. Ovo može rezultovati nestabilnom MAC tabelom.
1. PC1 šalje brotkast ka S2.
 2. S2 apdejtuje svoju MAC tabelu adresom PC1 na portu 11.
 3. S2 forvarduje frejm na sve portove sem na port sa koga je frejm došao. S1 i S3 dobijaju frejm preko tranka i apdejtuju svoje MAC tabele tako je PC1 dostupan preko odgovarajućih trank portova.
 4. S1 i S3 šalju frejm na sve portove, sem na one sa kojih je frejm došao
 5. Kada S1 šalje frejm preko porta 2 (Trunk 3), S3 apdejtuje svoju MAC tablu tako da smatra da je PC1 sada promenio opziciju i da je dostupan na portu 1.
- Host koji je „uhvaćen“ u petlju nije dostupan drugim hostovima.
 - Zbog konstantne promene informacija u MAC tabelama, S3 i S1 ne znaju gde da prosleđuju frejmove.



Problemi sa redundansom: Brotkast oluje

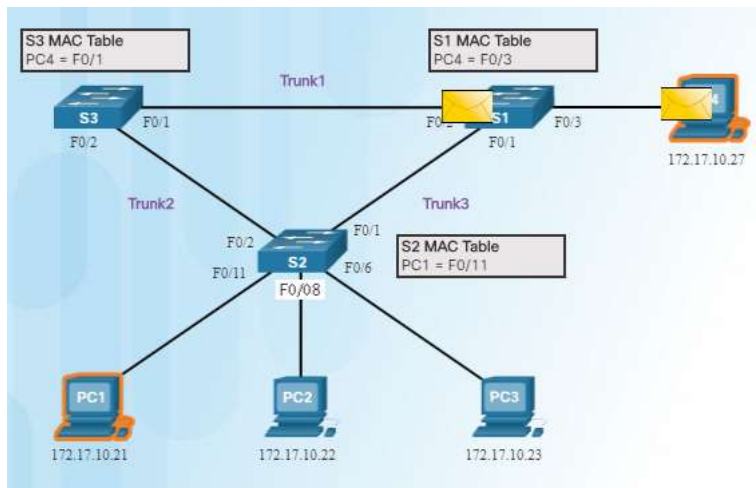
- Brotkast oluja – previše brotkast paketa uhvaćenih u L2 petlji koji zauzimaju većinu ako ne ceo propusni opseg mreže, pa je mreža nedostupna za regularan saobraćaj.
 - Prouzrokuje DoS
 - Može se javiti za veoma kratko vreme ...



Problemi sa redundansom: Brotkast oluje

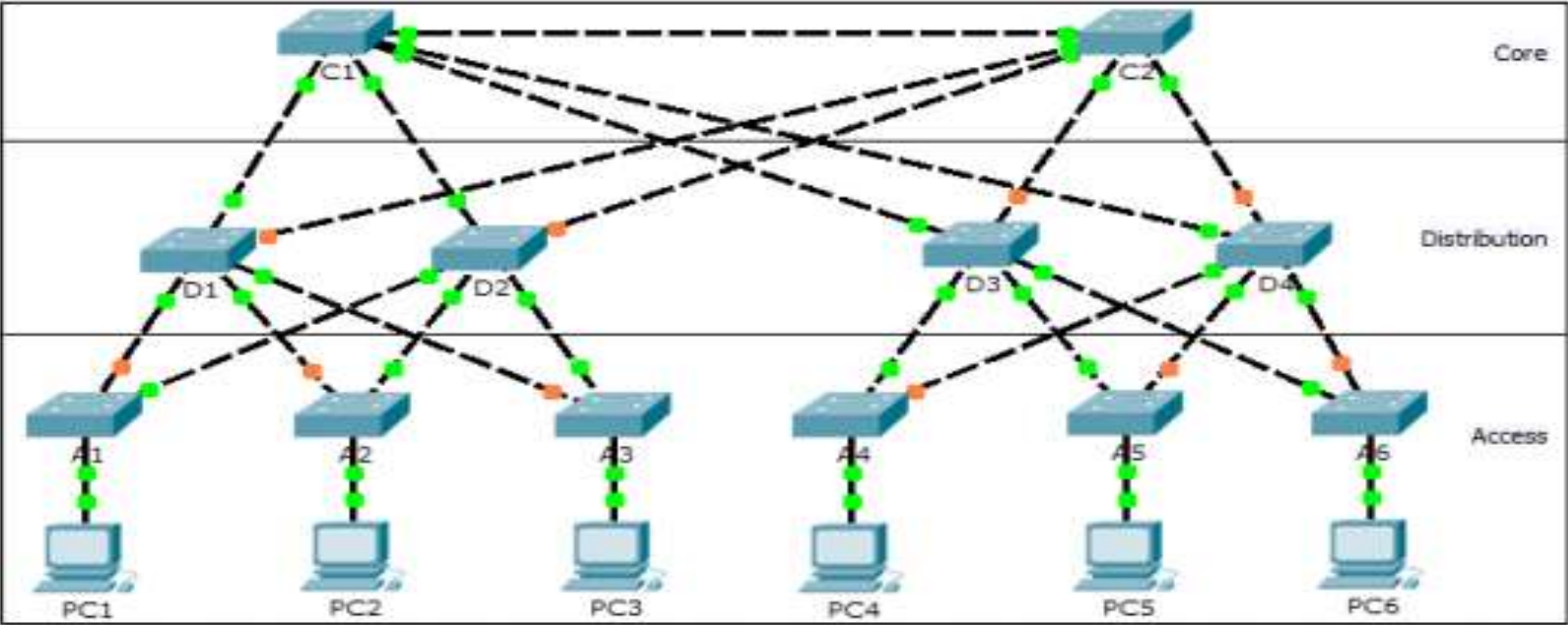
- Linearna brotkast oluja
- Eksponencijalna brotkast oluja

Problemi sa redundansom: Duplikati unikast frejmova



- An unknown unicast frame is when the switch does not have the destination MAC address in its MAC address table and has to broadcast the frame out all ports except the port the frame was received on (the ingress port).
- Unknown unicast frames sent onto a looped network can result in duplicate frames arriving at the destination device.
 1. PC1 sends a frame destined for PC4.
 2. S2 does not have PC4's MAC address in the MAC address table so it forwards the frame out all ports including the trunks that lead to S1 and S3. S1 sends the frame to PC4. S3 also sends a copy of the frame over to S1 which delivers the same frame again to PC4.

Redundantni dizajn hierarhijskog modela

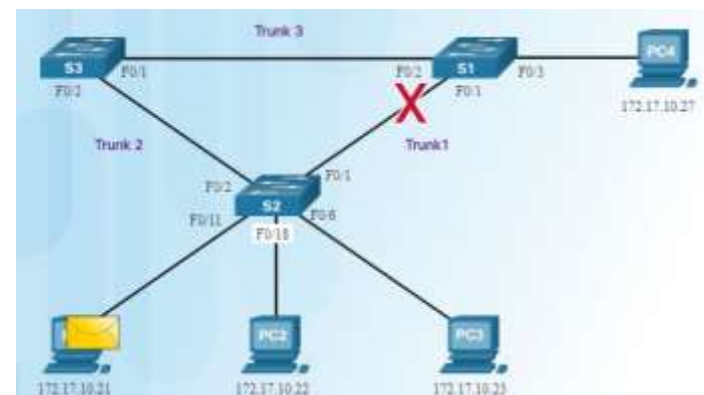
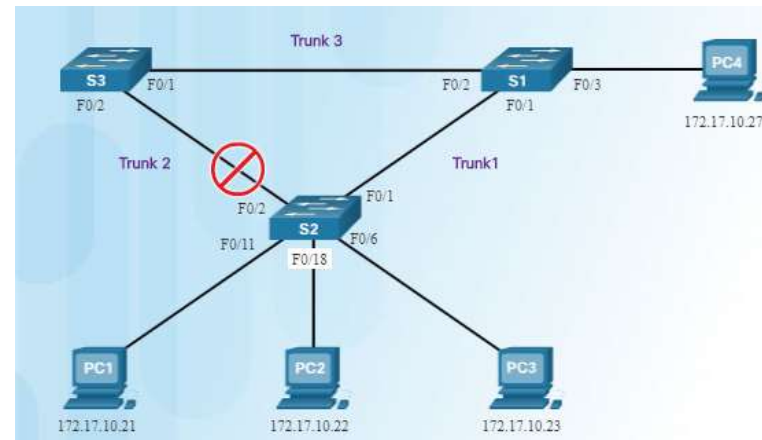


Redundansa na L3

- Da li postoje problemi sa redundansom na L3? Obrazložiti.

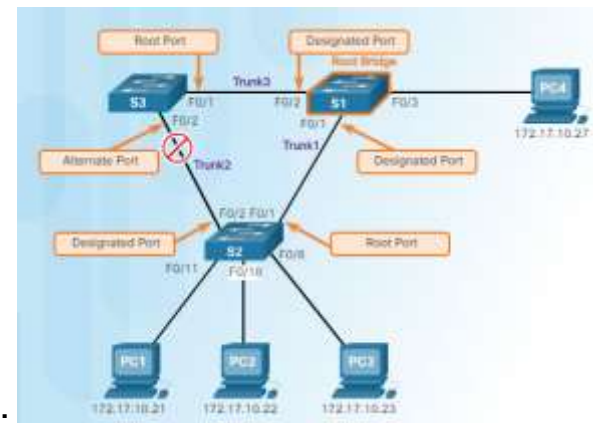
Spanning Tree algoritam: Uvod

- Spanning Tree Protocol (STP) kreira (samo) jedan logički put kroz mrežu sa svičevima.
 - Blokira redundantne puteve koji mogu prouzrokovati petlje.
 - STP šalje Bridge Protocol Data Units (BPDU) pakete između L2 uređaja kako bi uređaji uspostavili samo jedan logički put.
- Port na S2 je blokiran u normalnom režimu rada tako da postoji samo jedan put.
- Ako (kada) trunk 1 „padne“, blokirani port na S2 se odblokira kako bi saobraćaj mogao da teče između S2 i S3.



Spanning Tree algoritam: Uloge portova

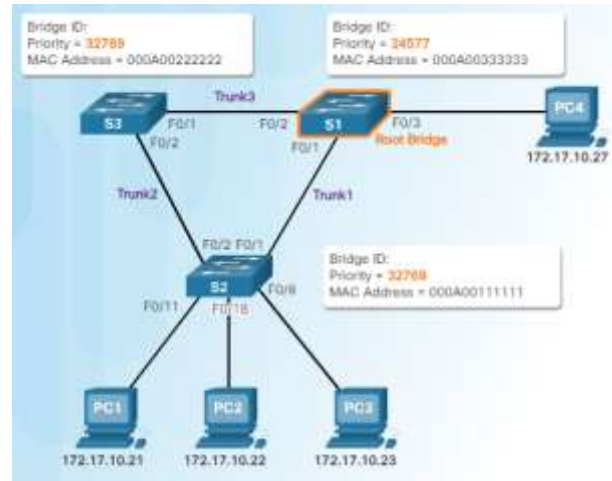
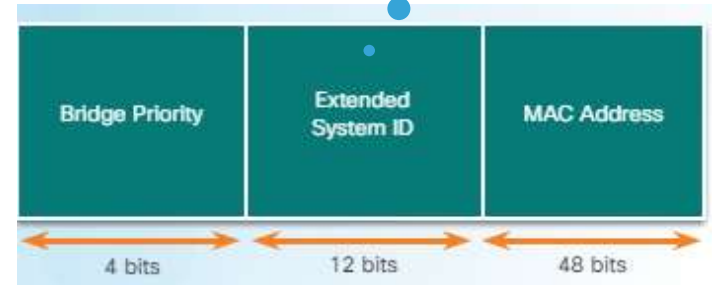
- Root bridge – jedan L2 uređaj na mreži.
- Root port – jedan port na sviču koji ima najmanju cenu do root bridža.
- Designated port – izabrani port na svakom segmentu (linku), na osnovu cene do root bridža za svaku stranu linka.
- Alternate port – (jedino kod RSTP protokol) backup port za designated port kada druga strana nije root port.
- Backup port – (jedino kod RSTP protokola) backup port za root port.



Spanning Tree algoritam: Root Bridge

Supports per-VLAN STP operations

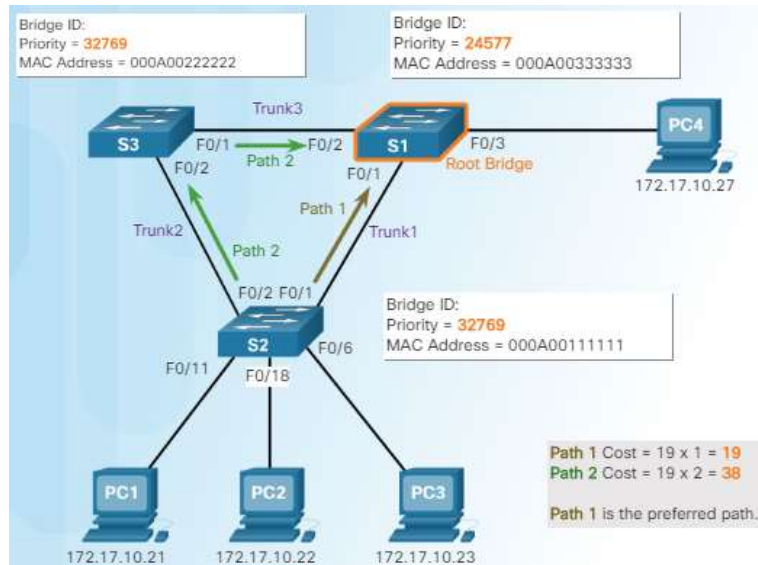
- Najmanji bridge ID (BID) postaje root bridge
 - BID ima dva polja: prioritet bridža i MAC adresu
 - Prioritet je podrazumevano 32,768 (može se promeniti)
 - Najmanja MAC adresa (ako prioriteti nisu promenjeni) postaje root bridge.



Spanning Tree algoritam: Root Path Cost

Link Speed	Cost (Revised IEEE Specification)	Cost (Previous IEEE Specification)
10 Gb/s	2	1
1 Gb/s	4	1
100 Mb/s	19	10
10 Mb/s	100	100

- Root path cost se koristi kako bi se odredile uloge portova i da li se saobraćaj blokira.
- Može se modifikovati naredbom **spanning-tree cost**.



```
S2# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
S2(config)# interface f0/1
S2(config-if)# spanning-tree cost 25
```

```
S2(config)# interface f0/1
S2(config-if)# no spanning-tree cost
```

```
S2# show spanning-tree

VLAN001
Spanning tree enabled protocol ieee
Root ID: Priority 24577
Address 000A.0033.3333
Cost 19
Port 1
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

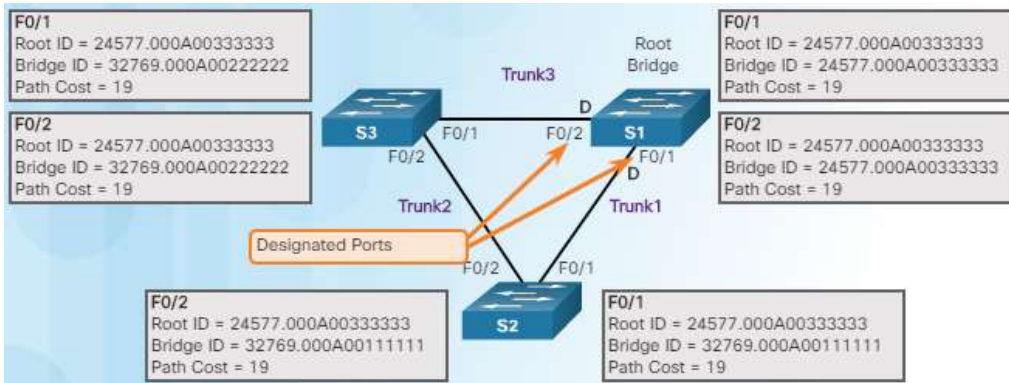
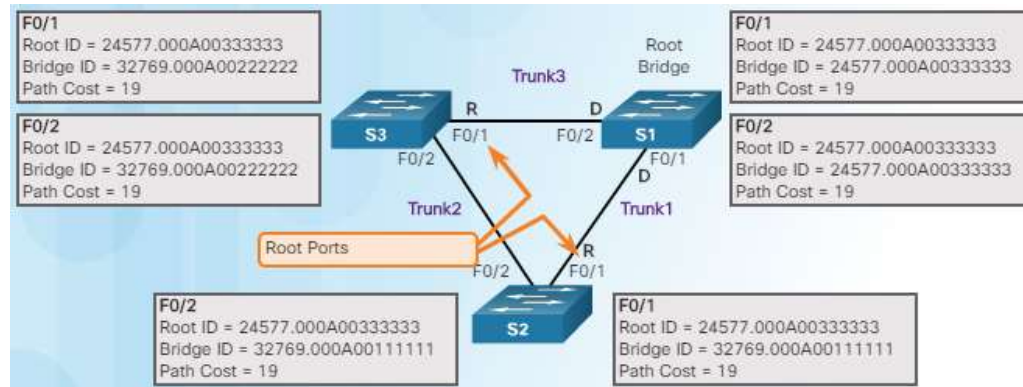
Bridge ID Priority 32769 (priority 32768 sys-id-ext 1)
Address 000A.0011.1111
Hello time 2 sec Max Age 20 sec Forward Delay 15 sec
Aging Time 300

Interface Role Sts Cost Prio.Nbr Type
-----
F0/1 Root FWD 19 128.1 Edge P2p
F0/2 Desg FWD 19 128.2 Edge P2p
```

STP princip rada

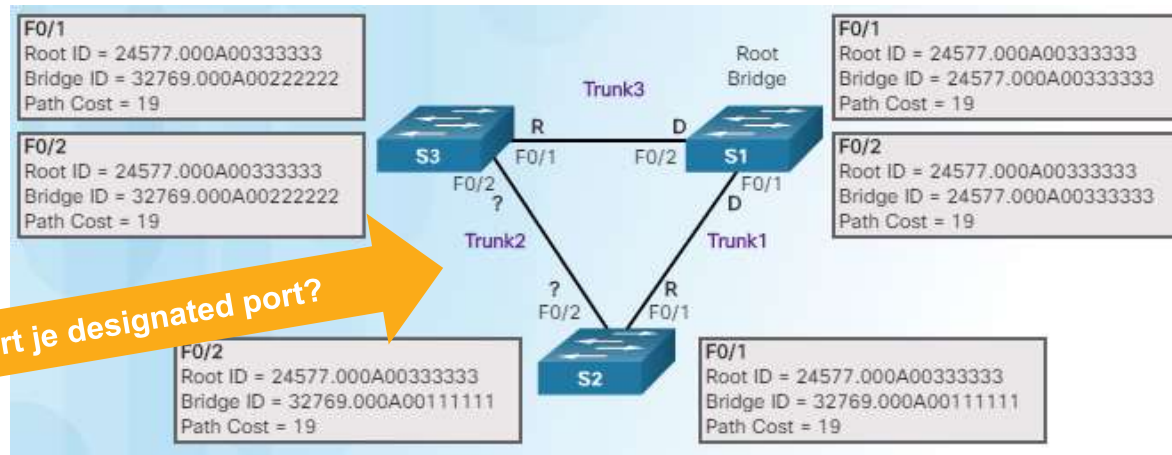
Određivanje tipova portova

- S1 je root bridge



STP princip rada

Određivanje tipova portova (nast.)



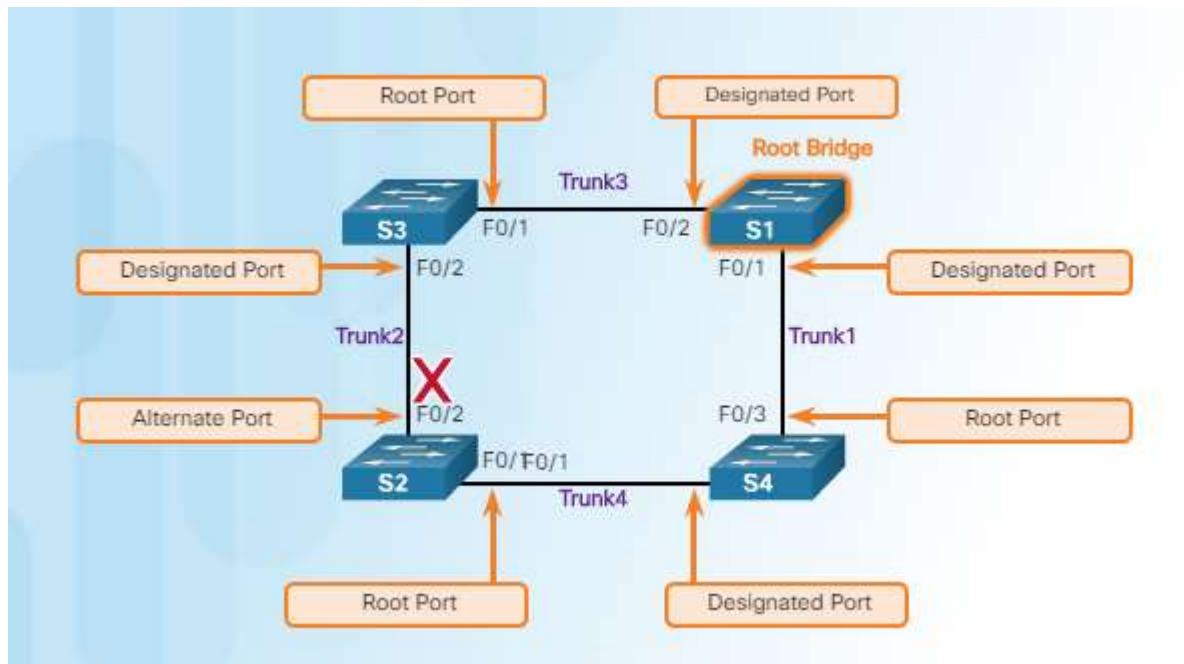
Koji svič (S3 ili S2) ima najmanji BID?

Koji port je designated port?

- Nakon što S3 and S2 razmene BPDU-ove, STP određuje da je port F0/2 na S2 designated port i da port F0/2 na S3 postaje alternate (non-designated) port, odnosno da prelazi u blocking state.

STP princip rada

Određivanje Designated i Alternate uloge portova



Status portova se bazira na ceni puta nazad do root bridža.
Ukoliko je cena ista, razmatra se prioritet porta!

802.1D BPDUs Frame format

Field Number	Bytes	Field
1-4	2	Protocol ID
	1	Version
	1	Message Type
	1	Flags
5-8	8	Root ID
	4	Root Path Cost
	8	Bridge ID
	2	Port ID
9-12	2	Message Age
	2	Max Age
	2	Hello Time
	2	Forward Delay

```

Frame 1 (60 bytes on wire, 60 bytes captured)
  IEEE 802.3 Ethernet
    Destination: Spanning-tree-(for-bridges)_00 (01:80:c2:00:00:00)
    Source: Cisco_9e:93:03 (00:19:aa:9e:93:03)
    Length: 38
    Trailer: 0000000000000000
  Logical-Link Control
    Spanning Tree Protocol
      Protocol Identifier: Spanning Tree Protocol (0x0000)
      Protocol version identifier: Spanning Tree (0)
      BPDUs Type: Configuration (0x00)
    BPDUs Flags: 0x01 (Topology Change)
      Root Identifier: 24577 / 00:19:aa:9e:93:00
      Root Path Cost: 0
      Bridge Identifier: 24577 / 00:19:aa:9e:93:00
      Port Identifier: 0x8003
      Message Age: 0
      Max Age: 20
      Hello Time: 2
      Forward Delay: 15

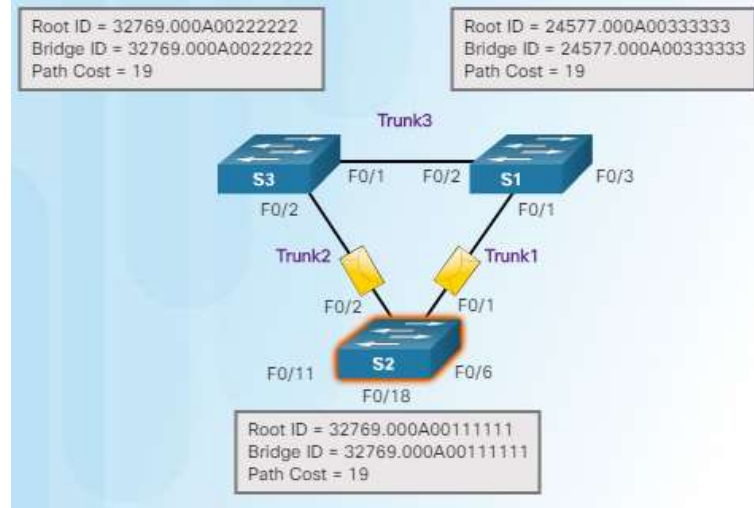
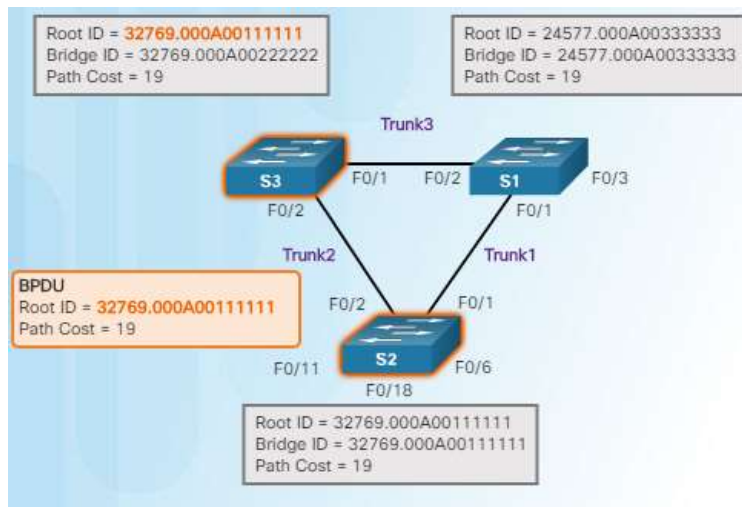
```

Field	Description
Protocol ID	Type of protocol being used; set to 0
Version	Protocol version; set to 0
Message type	Type of message; set to 0
Flags	Topology change (TC) bit signals a topology a change; topology change acknowledgment (TCA) bit used when a configuration message with the TC bit set has been received
Root ID	Root bridge information
Root path cost	Cost of the path from the switch sending the configuration message to the root bridge
Bridge ID	Includes priority, extended system ID, and MAC address ID of the bridge sending the message
Port ID	Port number from which the BPDU was sent
Message age	Amount of time since the root bridge sent the configuration message
Max age	When the current configuration message will be deleted
Hello time	Time between root bridge messages
Forward delay	Time the bridges should wait before going to a new state

STP princip rada

802.1D BPDUs propagacija

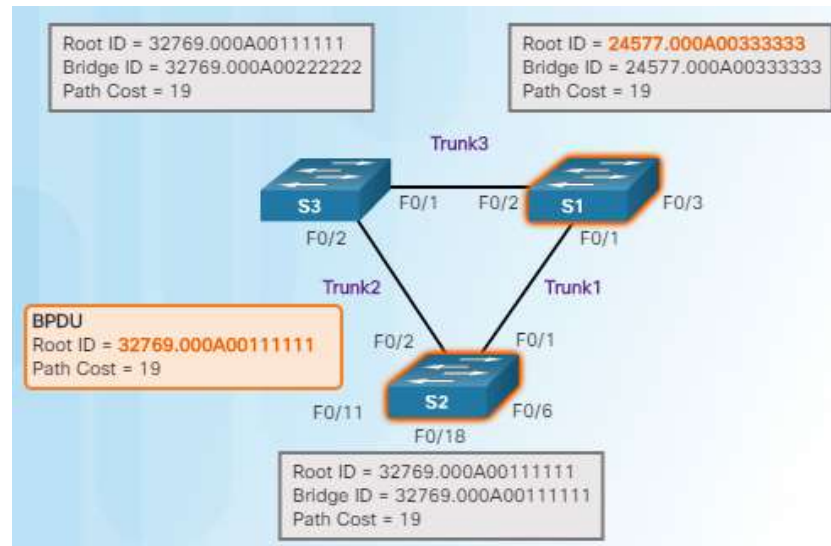
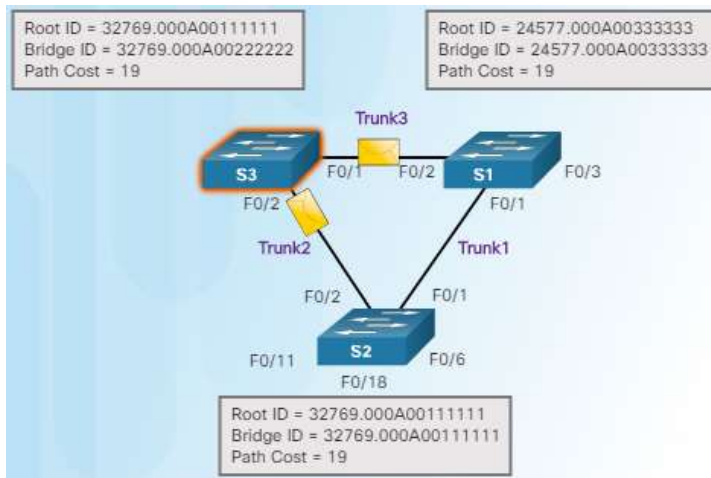
1. Kada se svič uključi, (svaki) svič pretpostavlja da je baš on root bridge dok BPDUs ne budu poslani i STP izračunavanja završena. Npr. S2 šalje BPDUs...
2. S3 upoređuje svoj root ID sa BPDUs dobijenom od S2. S2 ima manji BID pa S3 apdejtuje root ID.



STP princip rada

802.1D BPDUs propagacija (nast.)

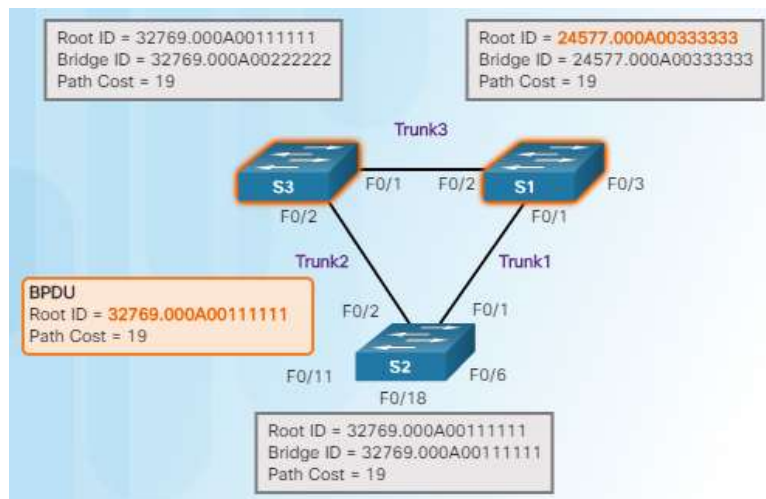
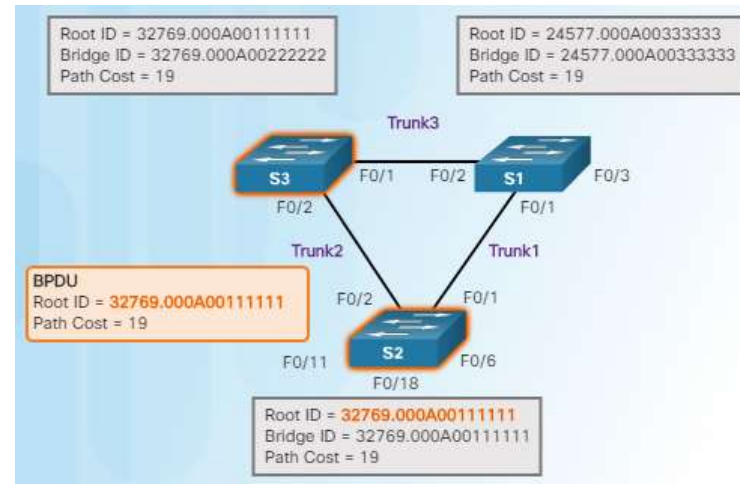
3. S1 dobija istu informaciju od S2 i zato što S1 ima manji BID on ignoriše informaciju od S2.
4. S3 šalje svoj BPDUs na sve portove sa naznakom da je S2 root bridge.



STP princip rada

802.1D BPDU propagacija (nast.)

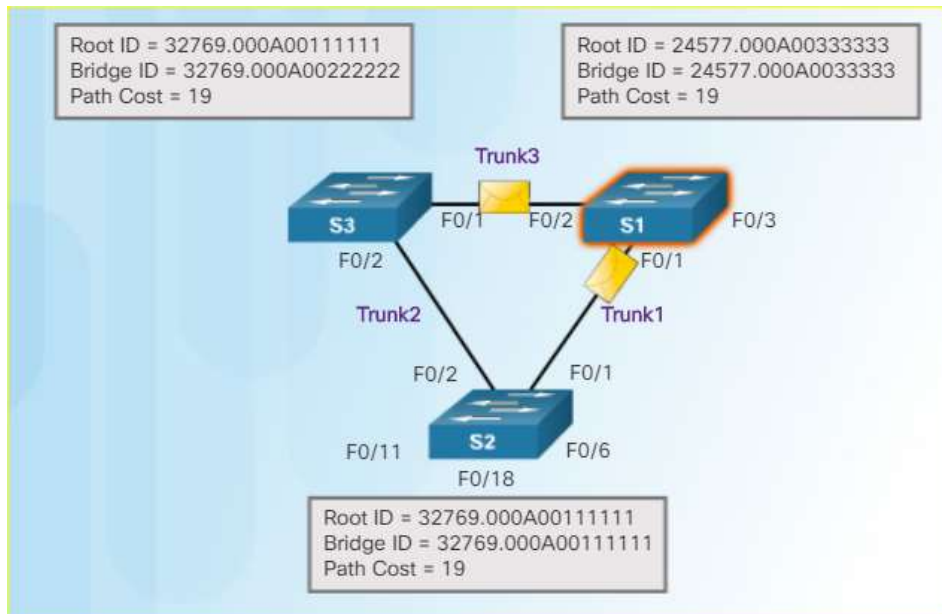
5. S2 upoređuje informacije dobijene od S3 pa S2 i dalje misli da je on root bridge.
6. S1 dobija iste informacije od S3 (da je S2 root bridge), pa pošto S1 ima manji BID, on ignoriše informacije iz BPDU.



STP princip rada

802.1D BPDU propagacija (nast.)

7. S1 šalje BPDU'-ove na sve svoje portove. BPDU sadrži informacije da je S1 root bridge.

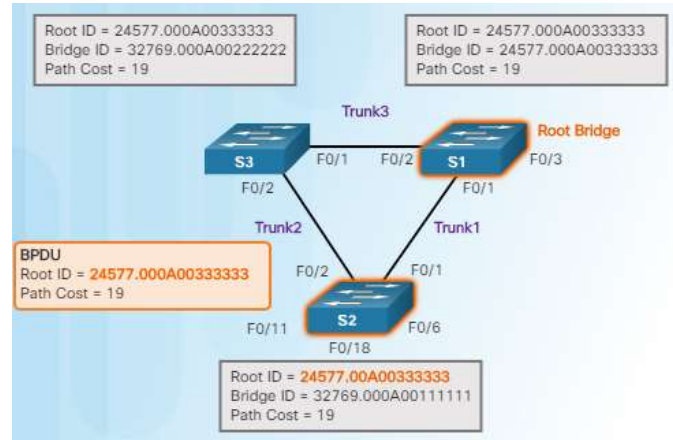
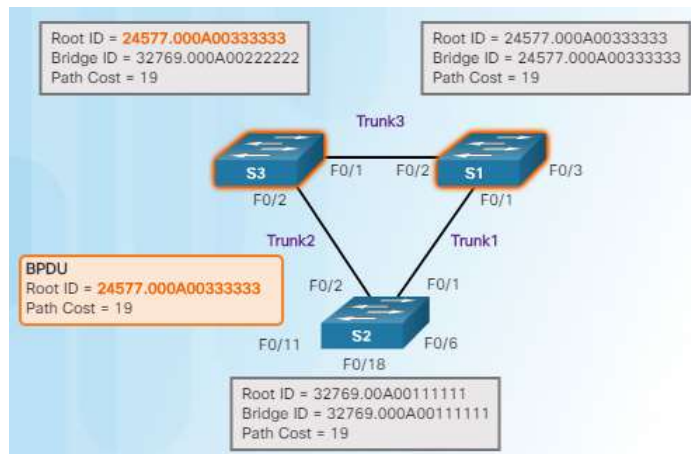


STP princip rada

802.1D BPDUs propagacija (nast.)

8. S3 upoređuje informacije od S1 i S3 i sada vidi da je BID dobijen od S1 manji od njegovog zapamćenog root bridge polja koje trenutno pokazuje da je S2 root bridge. S3 menja root ID na informaciju dobijenu od S1.
9. S2 upoređuje informacije od S1 pa S2 sada vidi da je BID kod S1 manji od njegovog BID-a. S2 sada apdejtuje svoju informaciju i sada zna da je S1 root bridge.

Nakon izbora root bridge-a uloge portova se mogu odrediti zato što se one određuju na osnovu ukupne cene puta do root bridge-a.

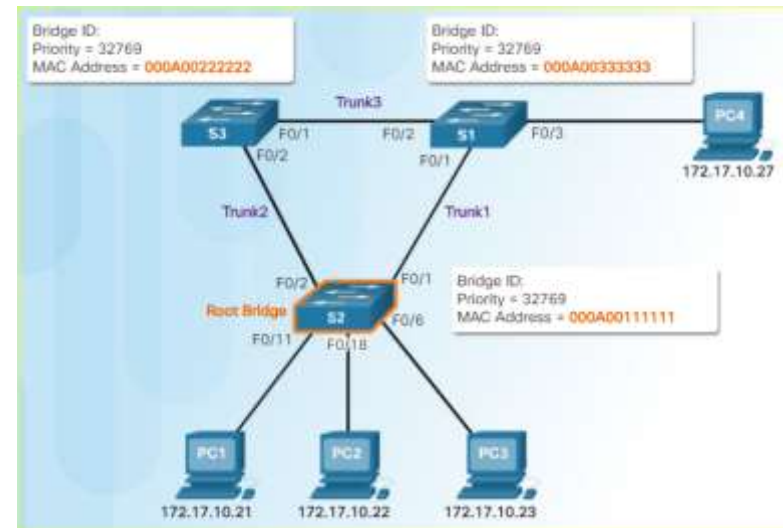
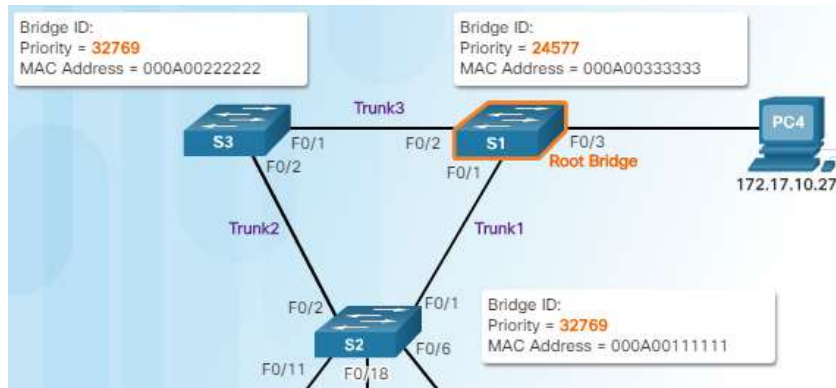
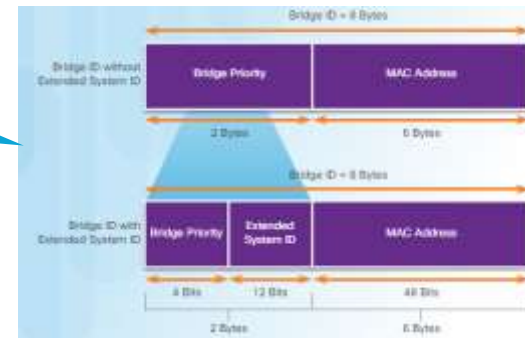


STP princip rada

Extended System ID

Najmanji BID
postaje root

- Ako su svi prioriteti postavljeni na podrazumevane vrednosti, najmanja MAC adresa određuje najmanji BID.
- Prioritet je moguće promeniti.



TIPOVI SPANNING TREE PROTOKOLA

Varijante Spanning Tree protokola

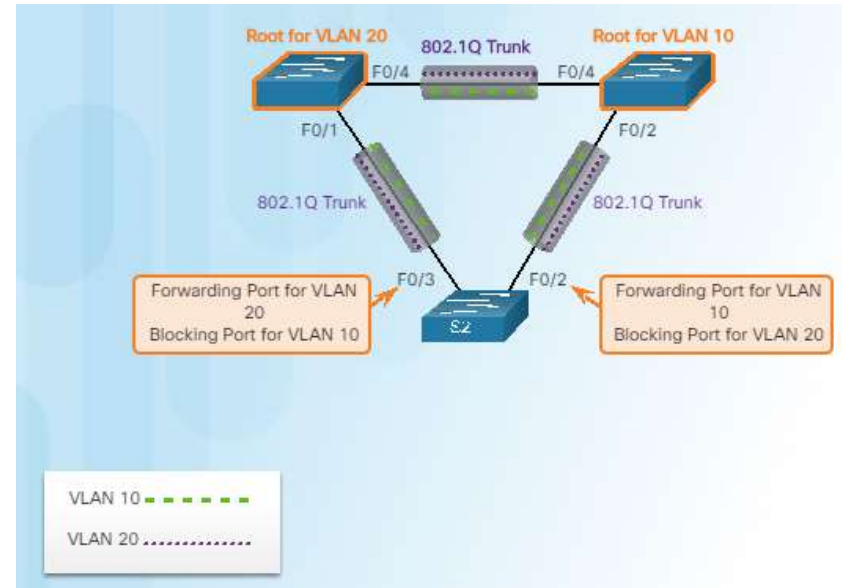
STP Type	Description
802.1D	1998 - Original STP standard
CST	One spanning-tree instance
PVST+	Cisco update to 802.1D; each VLAN has its own spanning-tree instance
802.1D	2004 – Updated bridging and STP standard
802.1w (RSTP)	Improves convergence by adding new roles to ports and enhancing BPDU exchange
Rapid PVST+	Cisco enhancement of RSTP using PVST+
802.1s (MSTP)	Multiple VLANs can have the same spanning-tree instance

Karakteristike Spanning Tree protokola

STP Type	Standard	Resources Needed	Convergence	Tree Calculation
STP	802.1D	Low	Slow	All VLANs
PVST+	Cisco	High	Slow	Per VLAN
RSTP	802.1w	Medium	Fast	All VLANs
Rapid PVST+	Cisco	Very high	Fast	Per VLAN
MSTP	802.1s	Medium or high	Fast	Per instance

PVST+ protokol

- Originalni 802.1D standard definiše zajedničko spanning tree stablo
 - Jedno stablo za celu mrežu (bez obzira koliko VLANova ima)
 - Nema deljenja i balansiranja opterećenja
 - Blokirani port blokira sve VLANove
 - Nije zahtevan po pitanju upotrebe CPU-a jer se izračunava stablo samo za jednu instancu
- PVST+ - svaki VLAN ima svoju spanning tree instancu
 - Jedan port može blokirati jedan VLAN i istovremeno forvardovati saobraćaj na drugom VLAN-u
 - Može balansirati opterećenje
 - Može biti zahtevan po pitanju CPU-a ako se koristi veli broj VLAN-ova



Varijante Spanning Tree protokola

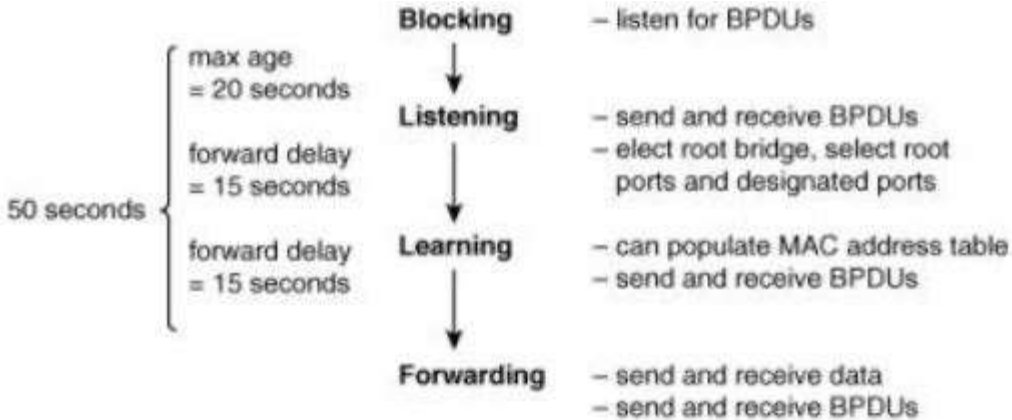
Stanja portova i rad PVST+ protokola

	Port State				
Operation allowed	Blocking	Listening	Learning	Forwarding	Disabled
Can receive/process BPDUs	Yes	Yes	Yes	Yes	No
Can forward data frames received on an interface	No	No	No	Yes	No
Can forward data frames switched from another interface	No	No	No	Yes	No
Can learn MAC addresses	No	No	Yes	Yes	No

Varinante Spanning Tree protokola

Stanja portova i rad PVST+ protokola

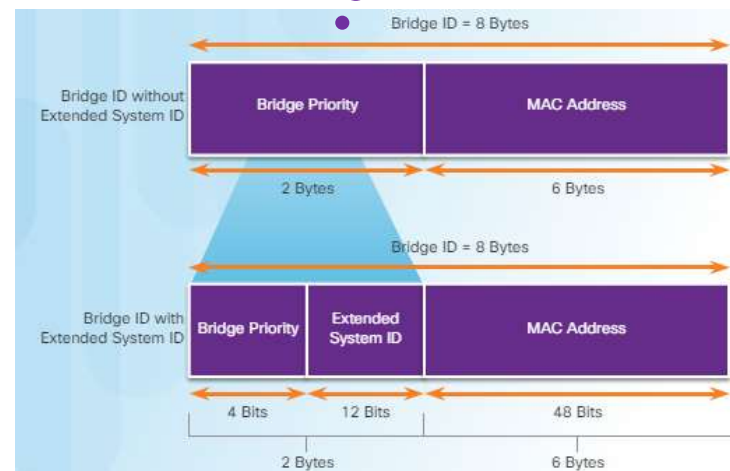
Timer	Default Value	Description
Hello	2 Seconds	How often will a BPDU be sent.
Max Age	20 Seconds (10 x Hello Time)	How long will a port remain in Blocking state after a topology change.
Forward Delay	15 Seconds	How long will a port remain in Listening/Learning states, before transitioning to Forwarding state. (15secs each by default, 30secs total)



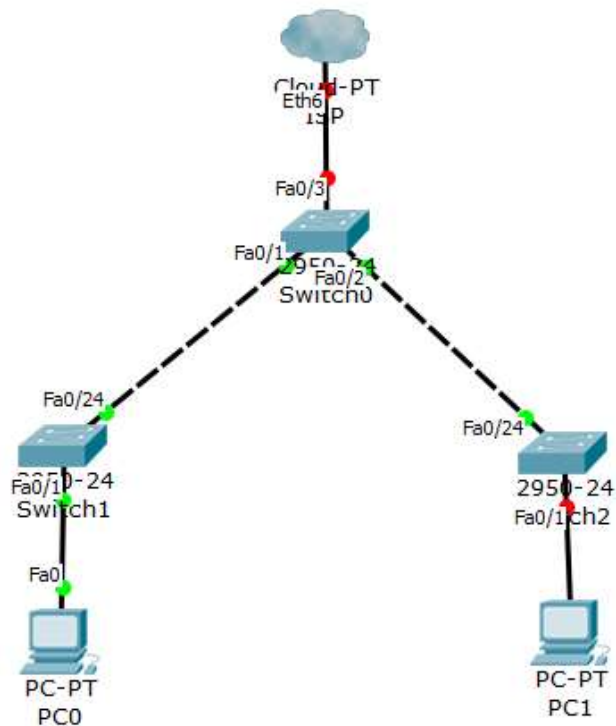
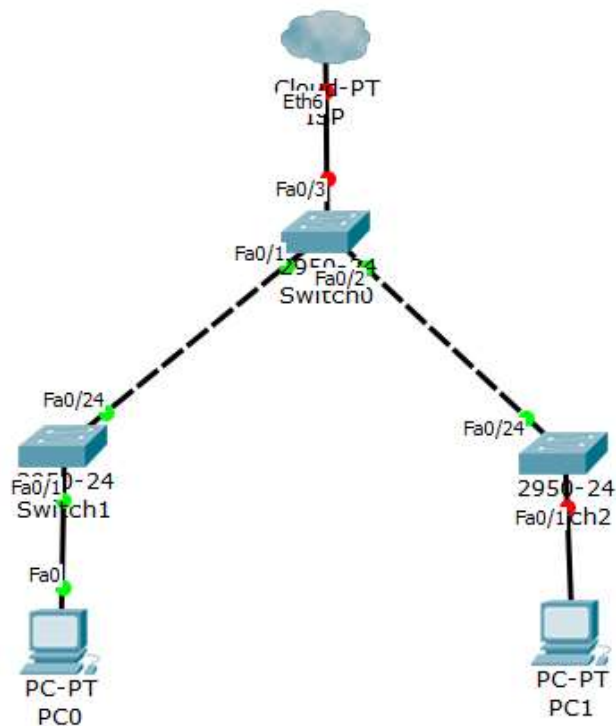
Extended System ID i PVST+

- Extended system ID obezbeđuje da svič ima jedinstveni BID za svaki VLAN.
- Broj VLAN-a se dodaje prioritetu.
 - Primer – VLAN 2 sa priritetom 32770 (podraumevana vrednost 32768 plus broj VLAN-a 2 jednako 32770)
 - Može se modifikovati prioritet bez uticaja na proces odlučivanja
- Razlozi za izbor određenog sviča za root bridge
 - Root svič se pozicionira tako da veći deo saobraćaja na mreži teče ka tom sviču
 - Root svič treba da ima bolji forwarding rate, brže portove, i sl. (bolji CPU, i sl)
 - Treba da je moguće lakše pristupiti ovom sviču

Podsetnik: BID je jedinstven

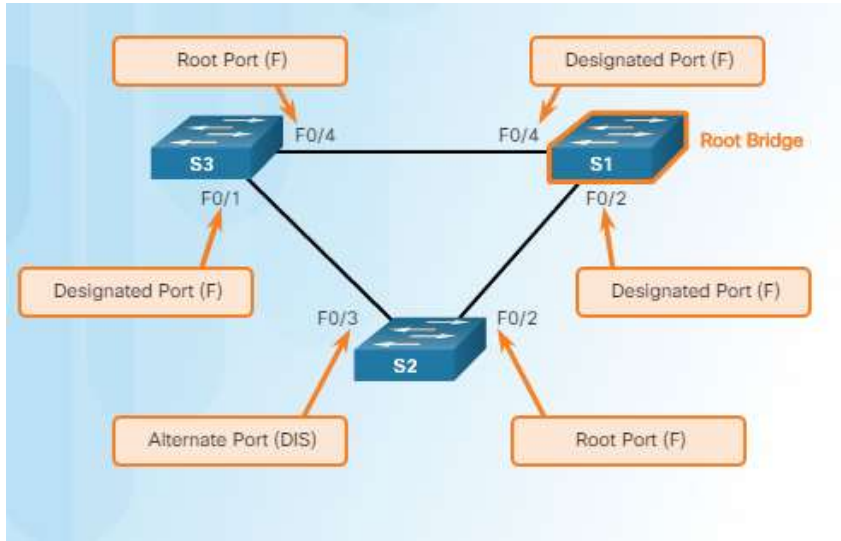


Primer (lošeg) izbora root bridža



Varijante Spanning Tree protokola

Rapid PVST+



- Rapid PVST+ ubrzava STP rekalkulacije tako da protokol konvergira brže
 - Cisco verzija RSTP
- Dva nova tipa portova
 - Alternate port (DIS)
 - Backup port
- Nezavisna instanca RSTP za svaki VLAN

Varijante Spanning Tree protokola

RSTP BPDUs

- RSTP koristi tip 2, verziju 2 BPDU-a
 - Originalna verzija je tipa 0, verzija 0
- Svič koji koristi RSTP može komunicirati sa svičem koji koristi originalni 802.1D
- BPDU-ovi se koriste kao keepalive mehanizam
 - 3 propuštena BPDU-a impliciraju da je konencija izgubljena

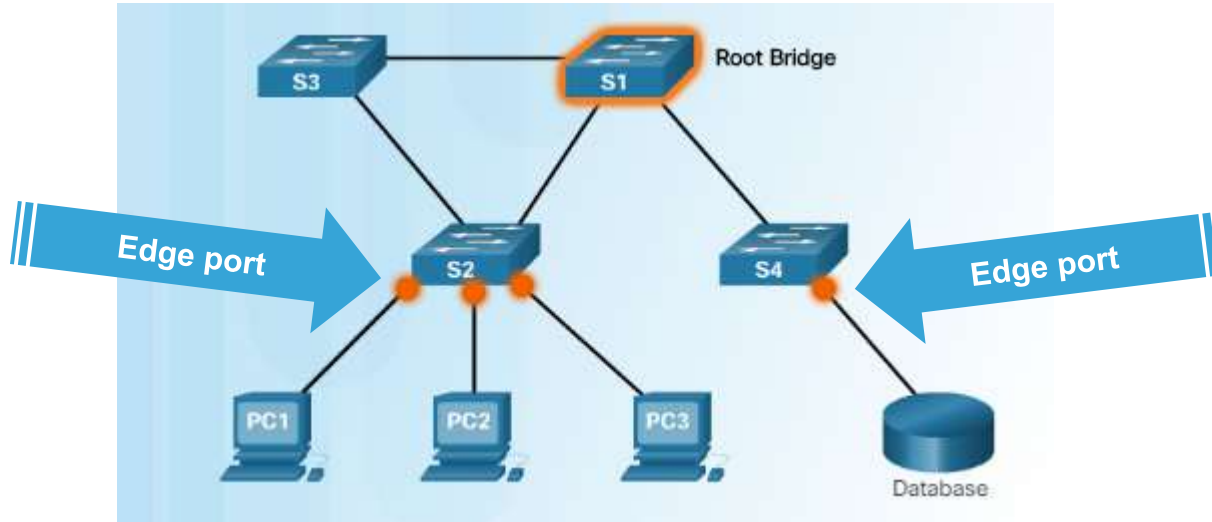
RSTP Version 2 BPDU	
Field	Byte Length
Protocol ID=0x0000	2
Protocol Version ID=0x02	1
BPDU Type=0X02	1
Flags	1
Root ID	8
Root Path Cost	4
Bridge ID	8
Port ID	2
Message Age	2
Max Age	2
Hello Time	2
Forward Delay	2

Flag Field	
Field Bit	Bit
Topology Change	0
Proposal	1
Port Role	2-3
Unknown Port	00
Alternate or Backup	01
Port	
Root Port	10
Designated Port	11
Learning	4
Forwarding	5
Agreement	6
Topology Change	7
Acknowledgment	

Varijante Spanning Tree protokola

Edge Ports

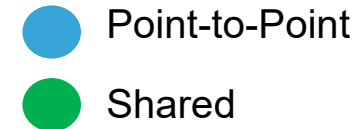
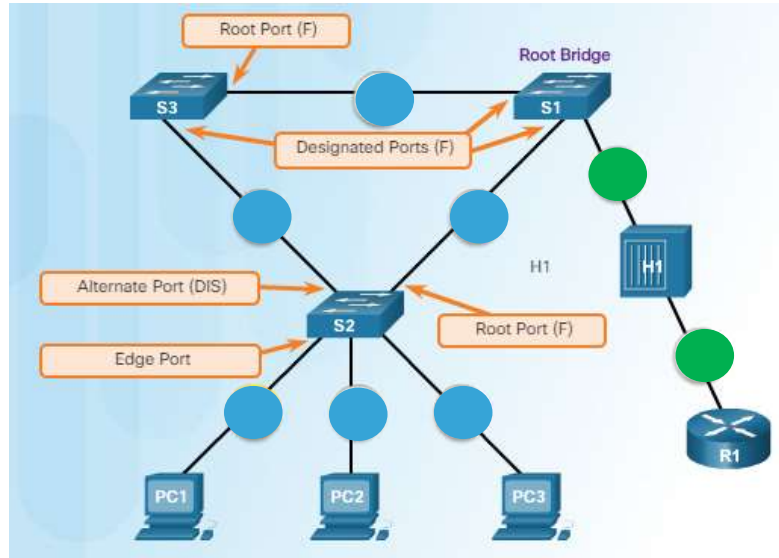
- Na Edge portove se povezuju isključivo krajnji uređaji – **NIKADA** drugi svič
- Odmah po uključivanju prelazi u forwarding state
- Sličan je princip rada kao Cisco PortFast
- Aktivira se naredbom **spanning-tree portfast**



Varijante Spanning Tree protokola

Link Types

- Point-to-Point – port u full-duplex modu koji povezuje dva uređaja: svič na svič, ili svič na krajnji uređaj
- Shared – port u half-duplex modu koji povezuje hub na svič



KONFIGURACIJA SPANNING TREE PROTOKOLA

PVST+ konfiguracija

Catalyst 2960 Default Configuration

Feature	Default Setting
Enable state	Enabled on VLAN 1
Spanning-tree mode	PVST+ (Rapid PVST+ and MSTP are disabled)
Switch priority	32768
Spanning-tree port priority (configurable on a per-interface basis)	128
Spanning-tree port cost (configurable on a per-interface basis)	1000 Mb/s: 4 100 Mb/s: 19 10 Mb/s: 100
Spanning-tree VLAN port priority (configurable on a per-VLAN basis)	128
Spanning-tree VLAN port cost (configurable on a per-VLAN basis)	1000 Mb/s: 4 100 Mb/s: 19 10 Mb/s: 100
Spanning-tree timers	Hello time: 2 seconds Forward-delay time: 15 seconds Maximum-aging time: 20 seconds Transmit hold count: 6 BPDUs

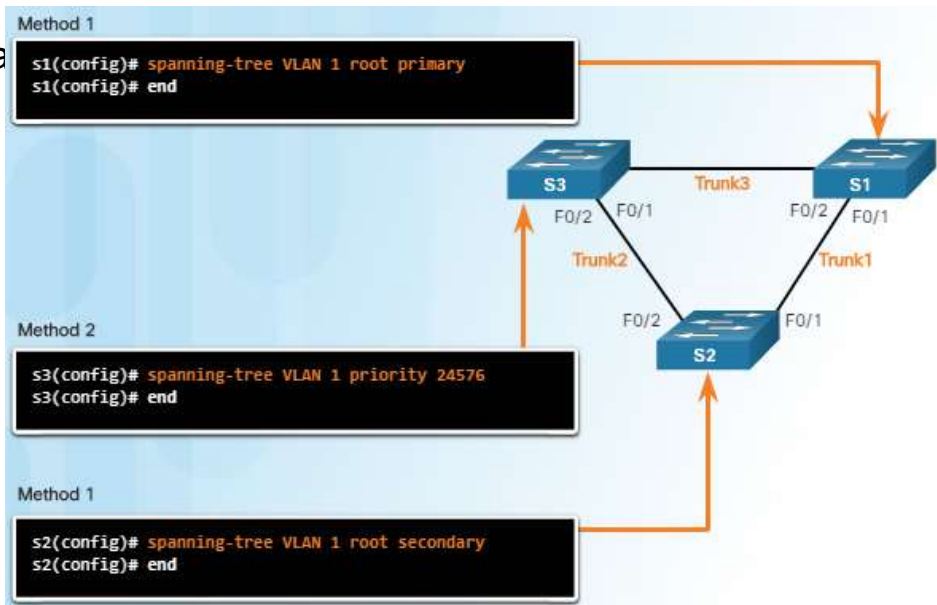
PVST+ konfiguracija

Konfiguracija i provera Bridge ID-ja

- Na dva načina se može uticati na izbor root bridža
 - **spanning-tree vlan x root primary** ili **secondary** naredba.
 - Promena prioriteta korišćenjem **spanning-tree vlan x priority x** naredbe.
- Provera bridge ID i root bridge izbora naredbom **show spanning-tree**.

```
S3# show spanning-tree
VLAN0001
  Spanning tree enabled protocol ieee
  Root ID    Priority    24577
             Address     00A.0033.3333
             This bridge is the root
             Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
  Bridge ID  Priority    24577 (priority 24576 sys-id-ext 1)
             Address     00A.0033.3333
             Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
             Aging Time 300

Interface Role Sts Cost Prio.Nbr Type
-----
Fa0/1 Desg FWD 4 128.1 p2p
Fa0/2 Desg FWD 4 128.2 p2p
```

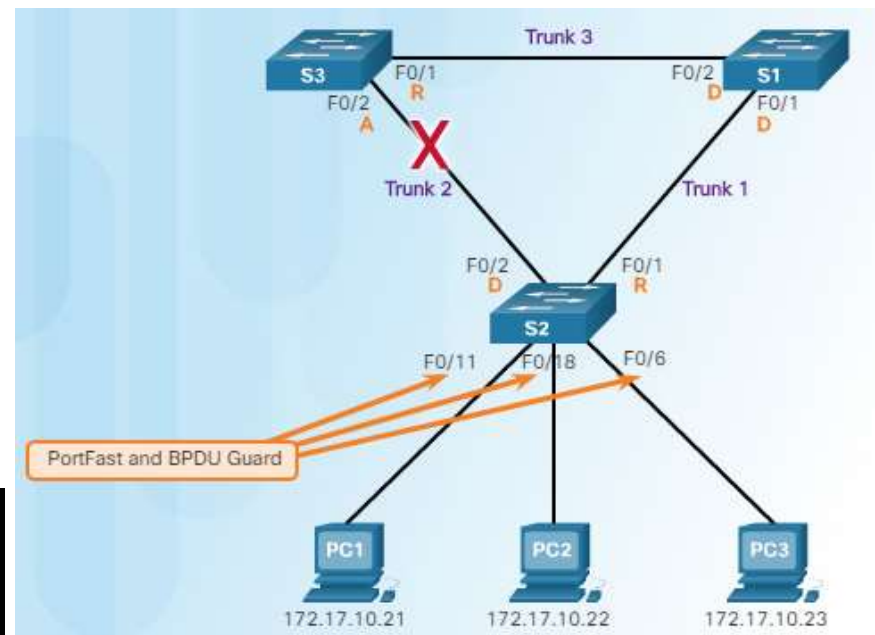


PortFast i BPDU Guard

- PortFast se koristi na portovima sa povezanim krajnjim uređajima.
 - Prebacuje port direktno u forwarding state
 - Npr. DHCP radi bez tajm-outa
- BPDU Guard isključuje port koji je konfigurisan kao PortFast ako na taj port dođe BPDU paket

```
S2(config)# interface FastEthernet 0/11
S2(config-if)# spanning-tree portfast
%Warning: portfast should only be enabled on ports connected to a single host.
Connecting hubs, concentrators, switches, bridges, etc... to this interface
when portfast is enabled, can cause temporary bridging loops.
Use with CAUTION

%Portfast has been configured on FastEthernet0/11 but will only
have effect when the interface is in a non-trunking mode.
S2(config-if)# spanning-tree bpduguard enable
```



```
S2# show running-config interface f0/11
Building configuration...

Current configuration : 90 bytes
!
interface FastEthernet0/11
 spanning-tree portfast
 spanning-tree bpduguard enable
```


PVST+ konfiguracija

PVST+ Load Balancing

```
S3(config)# spanning-tree vlan 20 root primary
S3(config)# spanning-tree vlan 10 root secondary
```

or

```
S3(config)# spanning-tree vlan 20 priority 4096
```

```
S1(config)# spanning-tree vlan 10 root primary
S1(config)# spanning-tree vlan 20 root secondary
```

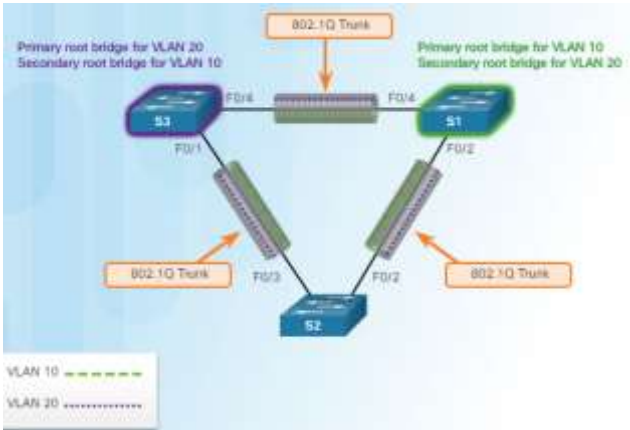
or

```
S1(config)# spanning-tree vlan 10 priority 4096
```

```
S1# show spanning-tree active
<output omitted>

VLAN0010
  Spanning tree enabled protocol ieee
  Root ID    Priority    4106
             Address     0019.aa9e.b000
             This bridge is the root
             Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
  Bridge ID  Priority    4106 (priority 4096 sys-id-ext 10)
             Address     0019.aa9e.b000
             Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
             Aging Time 300

Interface Role Sts Cost Prio.Nbr Type
-----
Fa0/2     Desg FWD 19   128.2 p2p
Fa0/4     Desg FWD 19   128.4 p2p
```



```
S1# show running-config
Building configuration...

Current configuration : 1595 bytes
!
version 12.2
<output omitted>
!
spanning-tree mode pvst
spanning-tree extend system-id
spanning-tree vlan 1 priority 24576
spanning-tree vlan 10 priority 4096
spanning-tree vlan 20 priority 28672
```

Rapid PVST+ konfiguracija

Izbor Spanning Tree moda

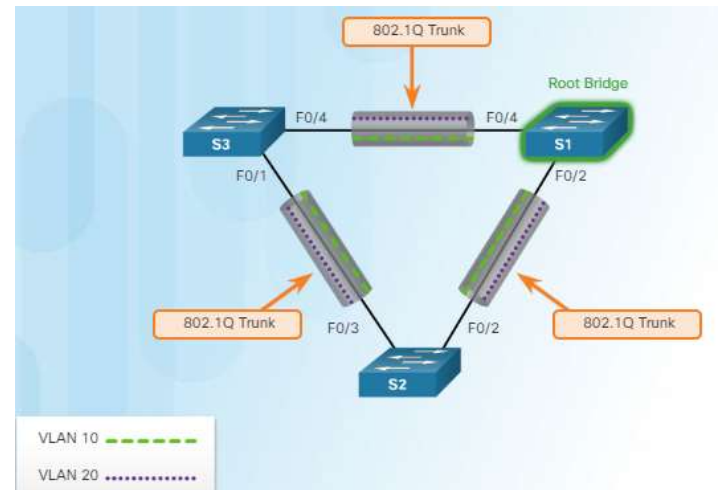
- Rapid PVST+ podržava RSTP na per-VLAN osnovi.
 - Na 2960 svičevima je podrazumevano uklj. PVST+.
 - **spanning-tree mode rapid-pvst** naredba aktivira Rapid PVST+ mod.
 - **spanning-tree link-type point-to-point** interfejs naredba govori da je link point-to-point (nema hub).
 - **clear spanning-tree detected-protocols** naredba privilegovanog moda resetuje STP proces.

```
S1# configure terminal
S1(config)# spanning-tree mode rapid-pvst
S1(config)# interface f0/2
S1(config-if)# spanning-tree link-type point-to-point
S1(config-if)# end
S1# clear spanning-tree detected-protocols
```

```
S1# show run

<output omitted>

spanning-tree mode rapid-pvst
spanning-tree extend system-id
spanning-tree vlan 1 priority 24576
spanning-tree vlan 10 priority 4096
spanning-tree vlan 20 priority 28672
```



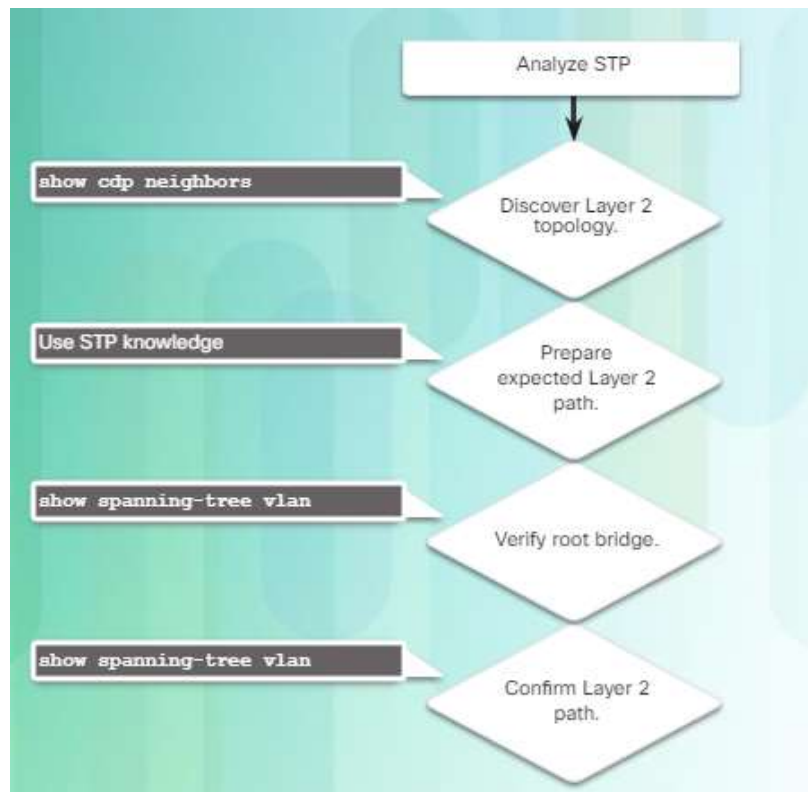
```
S1# show spanning-tree vlan 10
```

```
VLAN0010
  Spanning tree enabled protocol rstp
    Root ID    Priority    4106
              Address     0019.aa9e.b000
              This bridge is the root
              Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
    Bridge ID  Priority    4106 (priority 4096 sys-id-ext 10)
              Address     0019.aa9e.b000
              Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
              Aging Time 300

Interface      Role Sts Cost      Prio.Nbr Type
-----
Fa0/2          Desg LRN 19        128.2    P2p
Fa0/4          Desg LRN 19        128.4    P2p
```

STP konfiguracija: Potencijalni problemi

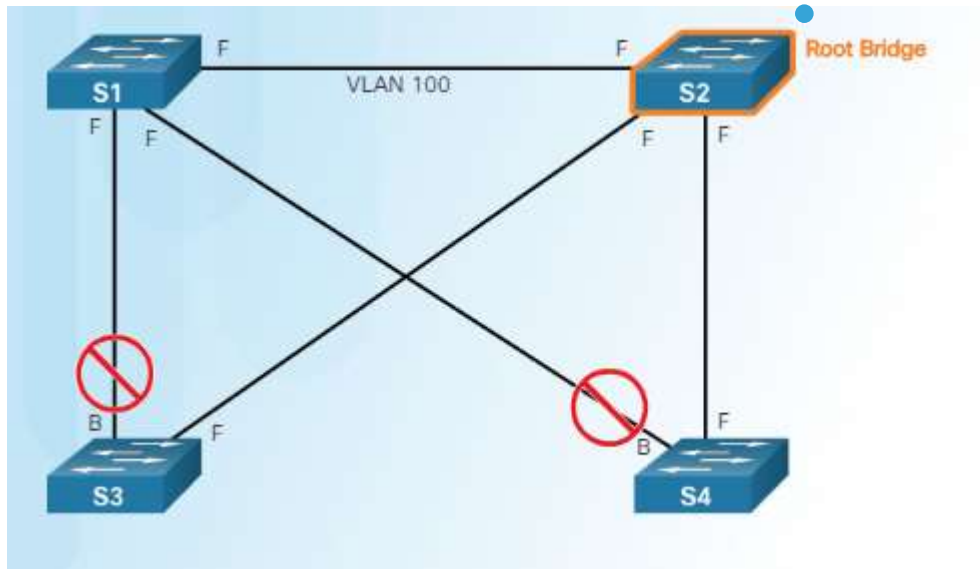
Analiza STP topologije



Očekivana topologija vs. Stvarna topologija

- Budite sigurni da se spanning-tree topology poklapa sa očekivanom

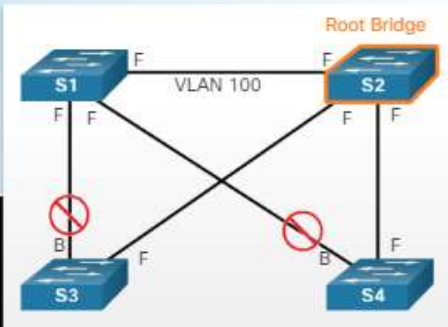
show naredbe za
proveru STP-a.
Obavezno proveriti load
balancing.



STP konfiguracija: Potencijalni problemi

Provera STP statusa

- Koristiti **show spanning-tree** i **show spanning-tree vlan x** naredbe za proveru STP statusa.



```
S1# show spanning-tree vlan 100

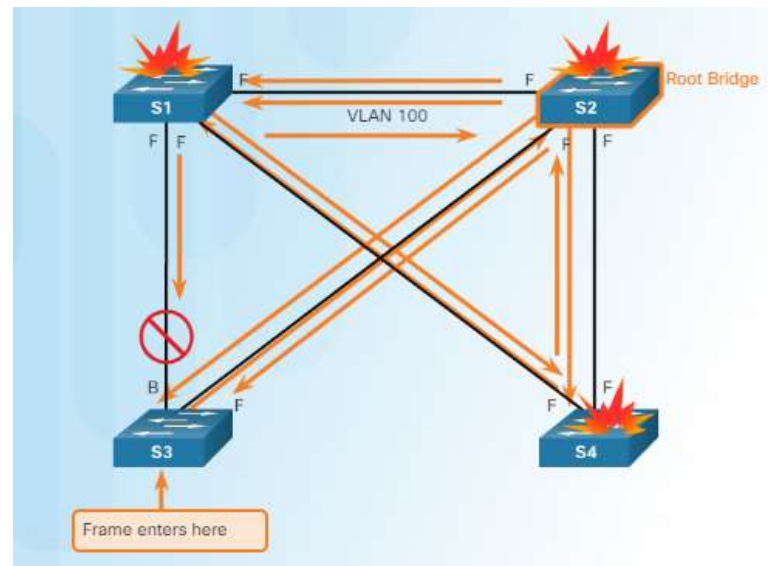
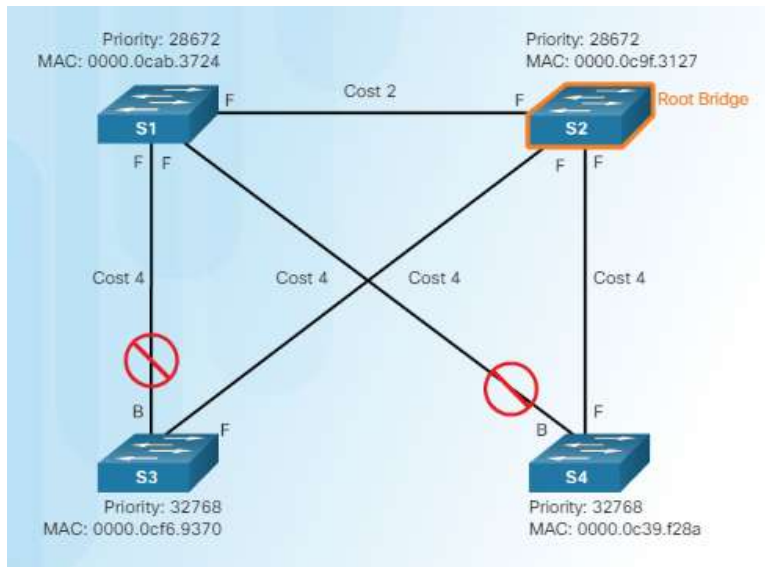
VLAN0100
Spanning tree enabled protocol rstp
Root ID    Priority    28772
           Address    0000.0c9f.3127
           Cost        2
           Port        88 (TenGigabit9/1)
           Hello Time  2 sec Max Age 20 sec Forward Delay 15 sec
Bridge ID   Priority    28772 (priority 28672 sys-id-ext 100)
           Address    0000.0cab.3724
           Hello Time  2 sec Max Age 20 sec Forward Delay 15 sec
           Aging Time  300

Interface   Role Sts Cost      Prio.Nbr Type
-----
Gi3/1       Desg FWD 4        128.72   P2p
Gi3/2       Desg FWD 4        128.80   P2p
Te9/1       Root FWD 2        128.88   P2p
```

10 gbps
Ethernet interface

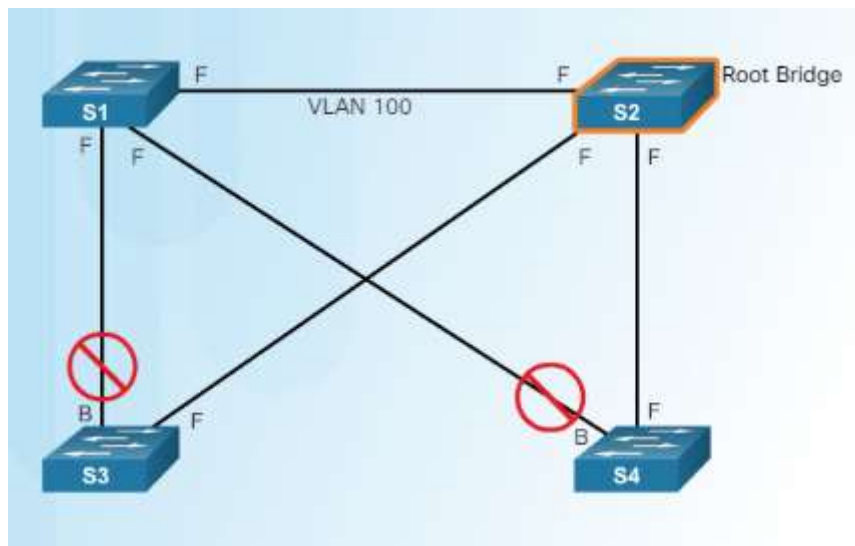
Posledice otkaza Spanning Tree protokola

- Nikada ne isključujte STP; ovo može prouzrokovati nestabilnost cele mreže– nema TTL mehanizma koji će sprečiti potencijalni problem.



Otklanjanje Spanning Tree problema

- „Ručno“ ukloniti redundantne linkove (fizički ukloniti kablove, ili, ako je moguće, pristupiti sviču i isključiti port kroz CLI).
- Ustanoviti i otkloniti uzrok spanning tree otkaza.
- U slučaju da se problem ne može identifikovati, ukloniti sve kablove i vraćati jedan po jedan.



„Switch Stacking“ i „Chassis Aggregation“

Switch Stacking koncept

- Moguće je povezati do devet 3750 svičeva
- Jedan svič (stack master) kontroliše rad steka
 - Ukoliko dođe do otkaza stek mastera bira se novi
- Ceo stek se „vidi“ kao jedan entitet
 - Stek ima jednu IP adresu i jedan CLI pre koga mu se pristupa
- Svaki svič ima jedinstveni stack member broj
 - Može se podesiti priority value koji određuje koji će svič biti izabran za master
 - Veći stack member priority broj znači veći prioritet
- Stack master ima saved i running konfiguracije za ceo stek.
 - Za ceo stek postoji samo jedna konfiguracija
- Portovi se identifikuju sa tri broja x/y/z

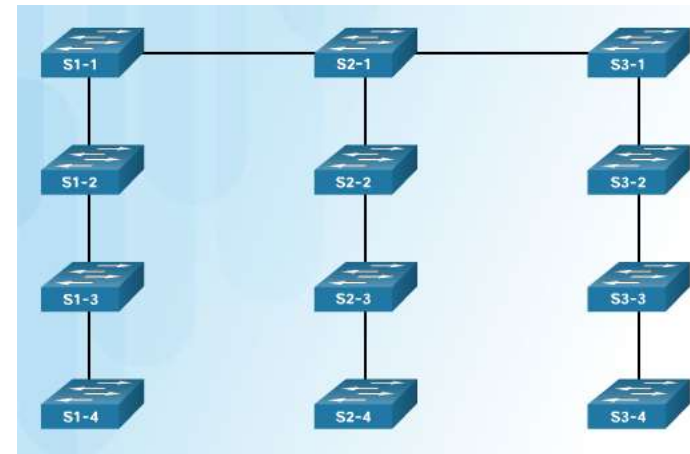


```
Switch# show running-config | begin interface
interface GigabitEthernet1/0/1
!
interface GigabitEthernet1/0/2
!
interface GigabitEthernet1/0/3
!
<output omitted>
!
interface GigabitEthernet1/0/52
!
interface GigabitEthernet2/0/1
!
interface GigabitEthernet2/0/2
!
<output omitted>
!
interface GigabitEthernet2/0/52
!
interface GigabitEthernet3/0/1
!
interface GigabitEthernet3/0/2
!
<output omitted>
!
interface GigabitEthernet3/0/52
```

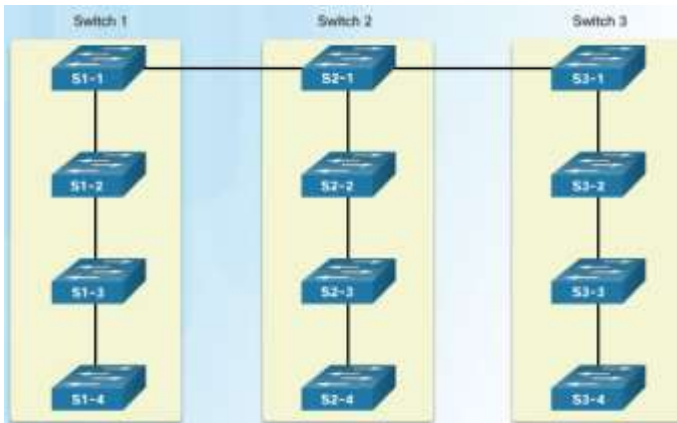

„Switch Stacking“ i „Chassis Aggregation“

Spanning Tree i Switch Stacks

- Svaki stek je javlja kao jedna spanning tree instanca
- Mogu da se dodaju svičevi bez uticaja na STP dijametar (maksimalni broj svičeva koji paket mora da prođe sa jednog na drugi kraj mreže)
- Preporučeni dijametar je 7 i on odgovara podrazumevanim vrednostima STP tajmera
 - Default STP timeri su: hello – 2 seconds, max age – 20 seconds, forward delay timer – 15 seconds



Dijametar je 9 od S1-4 do S3-4



Kada su svičevi u steku dijametar je sada 3

