

# Использование протокола STP. Агрегирование каналов

Лабораторная работа № 9

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Изучение возможностей протокола STP и его модификаций по обеспечению отказоустойчивости сети, агрегированию интерфейсов и перераспределению нагрузки между ними.

## Выполнение лабораторной работы

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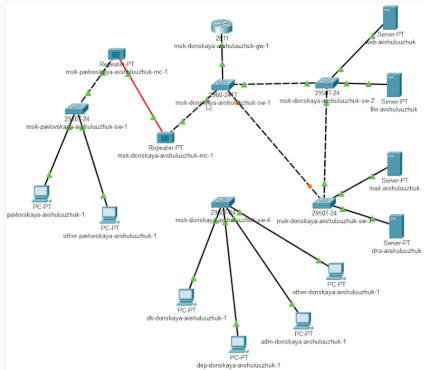


Рис. 1: изменение сети между коммутаторами

```
msk-donskaya-avshuluuzhuk-sw-3>en
Password:
msk-donskaya-avshuluuzhuk-sw-3#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
msk-donskaya-avshuluuzhuk-sw-3(config)#int g0/2
msk-donskaya-avshuluuzhuk-sw-3(config-if)#switchport mode trunk
msk-donskaya-avshuluuzhuk-sw-3(config-if)#^Z
msk-donskaya-avshuluuzhuk-sw-3#
%SYS-5-CONFIG_I: Configured from console by console
wr m
Building configuration...
[OK]
msk-donskaya-avshuluuzhuk-sw-3#
```

Рис. 2: настройка порта транковым

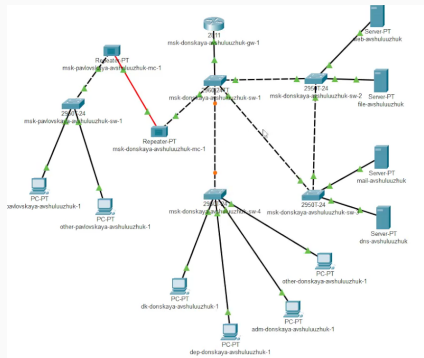


Рис. 3: добавление соединения между коммутаторами

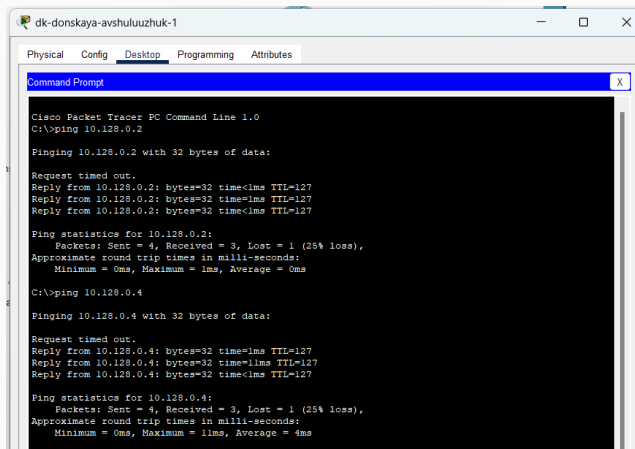
```
msk-donskaya-avshuluuzhuk-sw-1>en
Password:
msk-donskaya-avshuluuzhuk-sw-1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
msk-donskaya-avshuluuzhuk-sw-1(config)#int f0/23
msk-donskaya-avshuluuzhuk-sw-1(config-if)#switchport mode trunk

msk-donskaya-avshuluuzhuk-sw-1(config-if)#
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/23, changed state to down

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/23, changed state to up
^Z
msk-donskaya-avshuluuzhuk-sw-1#
%SYS-5-CONFIG_I: Configured from console by console
wr
%CDP-4-NATIVE_VLAN_MISMATCH: Native VLAN mismatch discovered on FastEthernet0/23 (1), with msk-
donskaya-avshuluuzhuk-sw-4 FastEthernet0/23 (104).
m
Building configuration...
[OK]
msk-donskaya-avshuluuzhuk-sw-1#wr m
Building configuration...
[OK]
```

Рис. 4: активирование порта в транковом режиме

# Выполнение лабораторной работы



The screenshot shows a Cisco Packet Tracer PC Command Line window for a device named 'dk-donskaya-avshuluuzhuk-1'. The window has tabs for 'Physical', 'Config', 'Desktop', 'Programming', and 'Attributes', with 'Desktop' selected. The Command Prompt displays the following text:

```
Cisco Packet Tracer PC Command Line 1.0
C:\>ping 10.128.0.2

Pinging 10.128.0.2 with 32 bytes of data:

Request timed out.
Reply from 10.128.0.2: bytes=32 time<1ms TTL=127
Reply from 10.128.0.2: bytes=32 time=1ms TTL=127
Reply from 10.128.0.2: bytes=32 time<1ms TTL=127

Ping statistics for 10.128.0.2:
    Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 1ms, Average = 0ms

C:\>ping 10.128.0.4

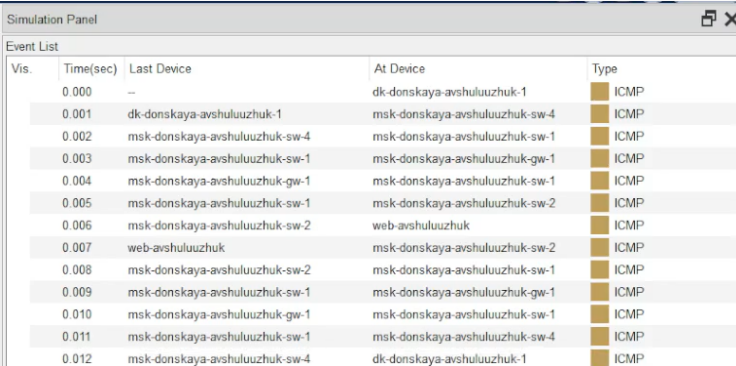
Pinging 10.128.0.4 with 32 bytes of data:

Request timed out.
Reply from 10.128.0.4: bytes=32 time=1ms TTL=127
Reply from 10.128.0.4: bytes=32 time=11ms TTL=127
Reply from 10.128.0.4: bytes=32 time<1ms TTL=127

Ping statistics for 10.128.0.4:
    Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 11ms, Average = 4ms
```

Рис. 5: пингование серверов mail и web





The screenshot shows a window titled "Simulation Panel" with a close button in the top right corner. Below the title bar is a section labeled "Event List" containing a table with the following data:

Vis.	Time(sec)	Last Device	At Device	Type
	0.000	--	dk-donskaya-avshuluuzhuk-1	ICMP
	0.001	dk-donskaya-avshuluuzhuk-1	msk-donskaya-avshuluuzhuk-sw-4	ICMP
	0.002	msk-donskaya-avshuluuzhuk-sw-4	msk-donskaya-avshuluuzhuk-sw-1	ICMP
	0.003	msk-donskaya-avshuluuzhuk-sw-1	msk-donskaya-avshuluuzhuk-gw-1	ICMP
	0.004	msk-donskaya-avshuluuzhuk-gw-1	msk-donskaya-avshuluuzhuk-sw-1	ICMP
	0.005	msk-donskaya-avshuluuzhuk-sw-1	msk-donskaya-avshuluuzhuk-sw-2	ICMP
	0.006	msk-donskaya-avshuluuzhuk-sw-2	web-avshuluuzhuk	ICMP
	0.007	web-avshuluuzhuk	msk-donskaya-avshuluuzhuk-sw-2	ICMP
	0.008	msk-donskaya-avshuluuzhuk-sw-2	msk-donskaya-avshuluuzhuk-sw-1	ICMP
	0.009	msk-donskaya-avshuluuzhuk-sw-1	msk-donskaya-avshuluuzhuk-gw-1	ICMP
	0.010	msk-donskaya-avshuluuzhuk-gw-1	msk-donskaya-avshuluuzhuk-sw-1	ICMP
	0.011	msk-donskaya-avshuluuzhuk-sw-1	msk-donskaya-avshuluuzhuk-sw-4	ICMP
	0.012	msk-donskaya-avshuluuzhuk-sw-4	dk-donskaya-avshuluuzhuk-1	ICMP

Рис. 6: режим симуляции

```
msk-donskaya-avshuluuzhuk-sw-2>en
Password:
msk-donskaya-avshuluuzhuk-sw-2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
msk-donskaya-avshuluuzhuk-sw-2(config)#^Z
msk-donskaya-avshuluuzhuk-sw-2#show spanning-tree vlan 3
VLAN0003
  Spanning tree enabled protocol ieee
  Root ID    Priority    32771
             Address     0001.96A6.8B25
             Cost        23
             Port        25 (GigabitEthernet0/1)
             Hello Time  2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID  Priority    32771 (priority 32768 sys-id-ext 3)
             Address     000C.8541.A473
             Hello Time  2 sec  Max Age 20 sec  Forward Delay 15 sec
             Aging Time  20

Interface                Role Sts Cost      Prio.Nbr Type
-----
Fa0/2                    Desg FWD 19        128.2    P2p
Fa0/1                    Desg FWD 19        128.1    P2p
Gi0/2                    Altn BLK 4         128.26   P2p
Gi0/1                    Root FWD 4         128.25   P2p

msk-donskaya-avshuluuzhuk-sw-2#
```

Рис. 7: просмотр состояния протокола STP для vlan 3 на коммутаторе msk-donskaya-sw-2

```
msk-donskaya-avshuluuzhuk-sw-1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
msk-donskaya-avshuluuzhuk-sw-1(config)#spanning-tree vlan 3 root primary
msk-donskaya-avshuluuzhuk-sw-1(config)#spanning-tree vlan 3
msk-donskaya-avshuluuzhuk-sw-1(config)#2
msk-donskaya-avshuluuzhuk-sw-1#spanning-tree vlan 3
^
% Invalid input detected at '^' marker.

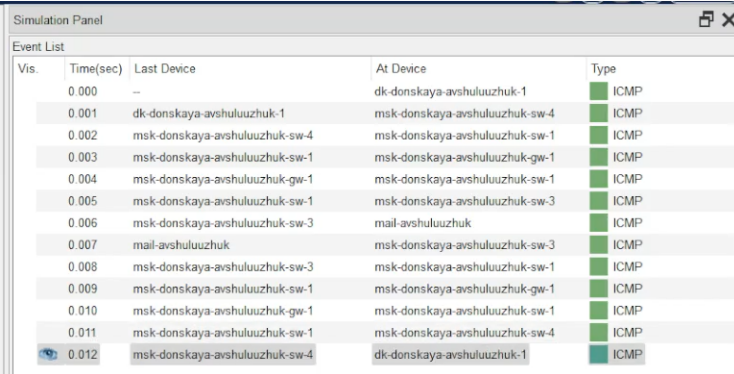
msk-donskaya-avshuluuzhuk-sw-1#show spanning-tree vlan 3
VLAN0003
  Spanning tree enabled protocol ieee
  Root ID    Priority    24579
             Address    00E0.B058.B7EB
             This bridge is the root
             Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

  Bridge ID  Priority    24579 (priority 24576 sys-id-ext 3)
             Address    00E0.B058.B7EB
             Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
             Aging Time 20

Interface Role Sts Cost Prio.Mbr Type
-----
Fa0/1 Desg FWD 19 128.1 Shr
Gi0/1 Desg FWD 4 128.25 P2p
Gi0/2 Desg FWD 4 128.26 P2p
Fa0/24 Desg FWD 19 128.24 P2p
Fa0/23 Desg FWD 19 128.23 P2p

msk-donskaya-avshuluuzhuk-sw-1#wr m
Building configuration...
[OK]
msk-donskaya-avshuluuzhuk-sw-1#
```

Рис. 8: настройка коммутатора msk-donskaya-sw-1 корневым



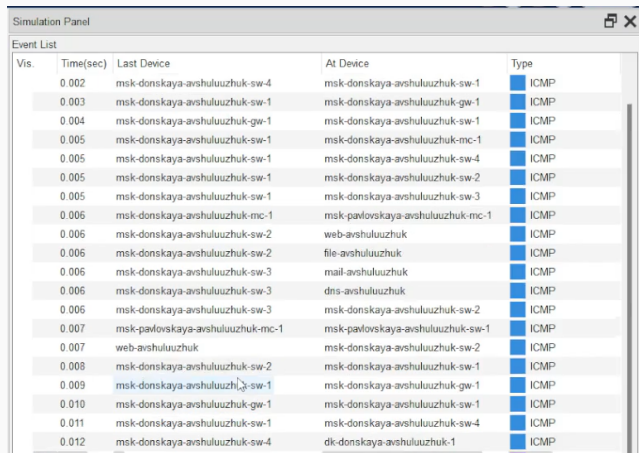
Simulation Panel

Event List

Vis.	Time(sec)	Last Device	At Device	Type
	0.000	--	dk-donskaya-avshuluuzhuk-1	ICMP
	0.001	dk-donskaya-avshuluuzhuk-1	msk-donskaya-avshuluuzhuk-sw-4	ICMP
	0.002	msk-donskaya-avshuluuzhuk-sw-4	msk-donskaya-avshuluuzhuk-sw-1	ICMP
	0.003	msk-donskaya-avshuluuzhuk-sw-1	msk-donskaya-avshuluuzhuk-gw-1	ICMP
	0.004	msk-donskaya-avshuluuzhuk-gw-1	msk-donskaya-avshuluuzhuk-sw-1	ICMP
	0.005	msk-donskaya-avshuluuzhuk-sw-1	msk-donskaya-avshuluuzhuk-sw-3	ICMP
	0.006	msk-donskaya-avshuluuzhuk-sw-3	mail-avshuluuzhuk	ICMP
	0.007	mail-avshuluuzhuk	msk-donskaya-avshuluuzhuk-sw-3	ICMP
	0.008	msk-donskaya-avshuluuzhuk-sw-3	msk-donskaya-avshuluuzhuk-sw-1	ICMP
	0.009	msk-donskaya-avshuluuzhuk-sw-1	msk-donskaya-avshuluuzhuk-gw-1	ICMP
	0.010	msk-donskaya-avshuluuzhuk-gw-1	msk-donskaya-avshuluuzhuk-sw-1	ICMP
	0.011	msk-donskaya-avshuluuzhuk-sw-1	msk-donskaya-avshuluuzhuk-sw-4	ICMP
	0.012	msk-donskaya-avshuluuzhuk-sw-4	dk-donskaya-avshuluuzhuk-1	ICMP

Рис. 9: режим симуляции

## Выполнение лабораторной работы



The screenshot shows a 'Simulation Panel' window with an 'Event List' table. The table has five columns: 'Vis.', 'Time(sec)', 'Last Device', 'At Device', and 'Type'. It displays a series of ICMP events occurring between various network devices over a 0.012-second period. The devices involved include msk-donskaya-avshuluuzhuk-sw-1, sw-2, sw-3, sw-4, gw-1, gw-2, gw-3, mc-1, mc-2, mc-3, and web-avshuluuzhuk. Each event is represented by a blue square icon in the 'Type' column.

Vis.	Time(sec)	Last Device	At Device	Type
	0.002	msk-donskaya-avshuluuzhuk-sw-4	msk-donskaya-avshuluuzhuk-sw-1	ICMP
	0.003	msk-donskaya-avshuluuzhuk-sw-1	msk-donskaya-avshuluuzhuk-gw-1	ICMP
	0.004	msk-donskaya-avshuluuzhuk-gw-1	msk-donskaya-avshuluuzhuk-sw-1	ICMP
	0.005	msk-donskaya-avshuluuzhuk-sw-1	msk-donskaya-avshuluuzhuk-mc-1	ICMP
	0.005	msk-donskaya-avshuluuzhuk-sw-1	msk-donskaya-avshuluuzhuk-sw-4	ICMP
	0.005	msk-donskaya-avshuluuzhuk-sw-1	msk-donskaya-avshuluuzhuk-sw-2	ICMP
	0.005	msk-donskaya-avshuluuzhuk-sw-1	msk-donskaya-avshuluuzhuk-sw-3	ICMP
	0.006	msk-donskaya-avshuluuzhuk-mc-1	msk-pavlovskaya-avshuluuzhuk-mc-1	ICMP
	0.006	msk-donskaya-avshuluuzhuk-sw-2	web-avshuluuzhuk	ICMP
	0.006	msk-donskaya-avshuluuzhuk-sw-2	file-avshuluuzhuk	ICMP
	0.006	msk-donskaya-avshuluuzhuk-sw-3	mail-avshuluuzhuk	ICMP
	0.006	msk-donskaya-avshuluuzhuk-sw-3	dns-avshuluuzhuk	ICMP
	0.006	msk-donskaya-avshuluuzhuk-sw-3	msk-donskaya-avshuluuzhuk-sw-2	ICMP
	0.007	msk-pavlovskaya-avshuluuzhuk-mc-1	msk-pavlovskaya-avshuluuzhuk-sw-1	ICMP
	0.007	web-avshuluuzhuk	msk-donskaya-avshuluuzhuk-sw-2	ICMP
	0.008	msk-donskaya-avshuluuzhuk-sw-2	msk-donskaya-avshuluuzhuk-sw-1	ICMP
	0.009	msk-donskaya-avshuluuzhuk-sw-1	msk-donskaya-avshuluuzhuk-gw-1	ICMP
	0.010	msk-donskaya-avshuluuzhuk-gw-1	msk-donskaya-avshuluuzhuk-sw-1	ICMP
	0.011	msk-donskaya-avshuluuzhuk-sw-1	msk-donskaya-avshuluuzhuk-sw-4	ICMP
	0.012	msk-donskaya-avshuluuzhuk-sw-4	dk-donskaya-avshuluuzhuk-1	ICMP

Рис. 10: режим симуляции

```
msk-donskaya-avshuluuzhuk-sw-2#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
msk-donskaya-avshuluuzhuk-sw-2(config)#int f0/1
msk-donskaya-avshuluuzhuk-sw-2(config-if)#spanning-tree portfast
                                     ^
% Invalid input detected at '^' marker.

msk-donskaya-avshuluuzhuk-sw-2(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 FastEthernet0/1 but will only
have effect when the interface is in a non-trunking mode.
msk-donskaya-avshuluuzhuk-sw-2(config-if)#int f0/2
msk-donskaya-avshuluuzhuk-sw-2(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 FastEthernet0/2 but will only
have effect when the interface is in a non-trunking mode.
msk-donskaya-avshuluuzhuk-sw-2(config-if)#
```

Рис. 11: настройка режима Portfast

```
msh-donskaya-avshuluuzhuk-sw-3>en
Password:
msh-donskaya-avshuluuzhuk-sw-3#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
msh-donskaya-avshuluuzhuk-sw-3(config)#int f0/1
msh-donskaya-avshuluuzhuk-sw-3(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 FastEthernet0/1 but will only
have effect when the interface is in a non-trunking mode.
msh-donskaya-avshuluuzhuk-sw-3(config-if)#int f0/2
msh-donskaya-avshuluuzhuk-sw-3(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 FastEthernet0/2 but will only
have effect when the interface is in a non-trunking mode.
msh-donskaya-avshuluuzhuk-sw-3(config-if)#
```

Рис. 12: настройка режима Portfast

```
C:\>ping -n 1000 mail.donskaya.rudn.ru

Pinging 10.128.0.4 with 32 bytes of data:

Reply from 10.128.0.4: bytes=32 time=1ms TTL=127
Reply from 10.128.0.4: bytes=32 time=1ms TTL=127
Reply from 10.128.0.4: bytes=32 time<1ms TTL=127
Reply from 10.128.0.4: bytes=32 time<1ms TTL=127
Reply from 10.128.0.4: bytes=32 time<1ms TTL=127
Reply from 10.128.0.4: bytes=32 time=9ms TTL=127
Reply from 10.128.0.4: bytes=32 time<1ms TTL=127
```

Рис. 13: пингование сервера mail



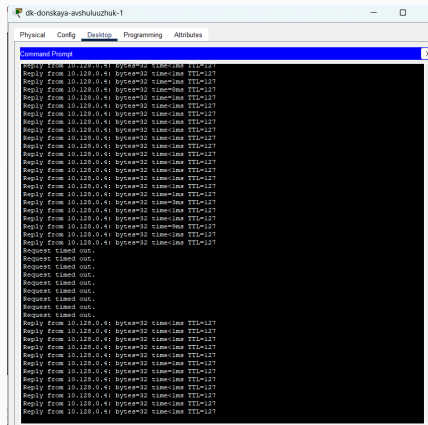
```
msk-donskaya-avshuluuzhuk-sw-3>en
Password:
msk-donskaya-avshuluuzhuk-sw-3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
msk-donskaya-avshuluuzhuk-sw-3(config)#int g0/2
msk-donskaya-avshuluuzhuk-sw-3(config-if)#shutdown

msk-donskaya-avshuluuzhuk-sw-3(config-if)#
%LINK-5-CHANGED: Interface GigabitEthernet0/2, changed state to administratively down

%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/2, changed state to down
```

Рис. 14: разрыв соединения на интерфейсе

# Выполнение лабораторной работы



```
dk-donskaya-avshuluuzhuk-1
Physical Config Desktop Programming Attributes
Command Prompt
Reply from 10.128.0.4: bytes=32 time=1ms TTL=127
Reply from 10.128.0.4: bytes=32 time=1ms TTL=127
Reply from 10.128.0.4: bytes=32 time=1ms TTL=127
Reply from 10.128.0.4: bytes=32 time=1ms TTL=127
Reply from 10.128.0.4: bytes=32 time=1ms TTL=127
Reply from 10.128.0.4: bytes=32 time=1ms TTL=127
Reply from 10.128.0.4: bytes=32 time=1ms TTL=127
Reply from 10.128.0.4: bytes=32 time=1ms TTL=127
Reply from 10.128.0.4: bytes=32 time=1ms TTL=127
Reply from 10.128.0.4: bytes=32 time=1ms TTL=127
Reply from 10.128.0.4: bytes=32 time=1ms TTL=127
Reply from 10.128.0.4: bytes=32 time=1ms TTL=127
Reply from 10.128.0.4: bytes=32 time=1ms TTL=127
Reply from 10.128.0.4: bytes=32 time=1ms TTL=127
Reply from 10.128.0.4: bytes=32 time=1ms TTL=127
Reply from 10.128.0.4: bytes=32 time=1ms TTL=127
Reply from 10.128.0.4: bytes=32 time=1ms TTL=127
Reply from 10.128.0.4: bytes=32 time=1ms TTL=127
Request timed out.
Request timed out.
Request timed out.
Request timed out.
Request timed out.
Request timed out.
Request timed out.
Request timed out.
Reply from 10.128.0.4: bytes=32 time=1ms TTL=127
Reply from 10.128.0.4: bytes=32 time=1ms TTL=127
Reply from 10.128.0.4: bytes=32 time=1ms TTL=127
Reply from 10.128.0.4: bytes=32 time=1ms TTL=127
Reply from 10.128.0.4: bytes=32 time=1ms TTL=127
Reply from 10.128.0.4: bytes=32 time=1ms TTL=127
Reply from 10.128.0.4: bytes=32 time=1ms TTL=127
Reply from 10.128.0.4: bytes=32 time=1ms TTL=127
Reply from 10.128.0.4: bytes=32 time=1ms TTL=127
Reply from 10.128.0.4: bytes=32 time=1ms TTL=127
Reply from 10.128.0.4: bytes=32 time=1ms TTL=127
Reply from 10.128.0.4: bytes=32 time=1ms TTL=127
```

Рис. 15: отказоустойчивость протокола STP и время восстановления соединения при переключении на резервное соединение

```
msk-donskaya-avshuluuzhuk-sw-1>en
Password:
Password:
msk-donskaya-avshuluuzhuk-sw-1#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
msk-donskaya-avshuluuzhuk-sw-1(config)#spanning-tree mode rapid-pvst
msk-donskaya-avshuluuzhuk-sw-1(config)#^Z
msk-donskaya-avshuluuzhuk-sw-1#
%SYS-5-CONFIG_I: Configured from console by console
wr m
Building configuration...
[OK]
```

Рис. 16: переключение коммутаторов на режим работы по протоколу Rapid PVST+

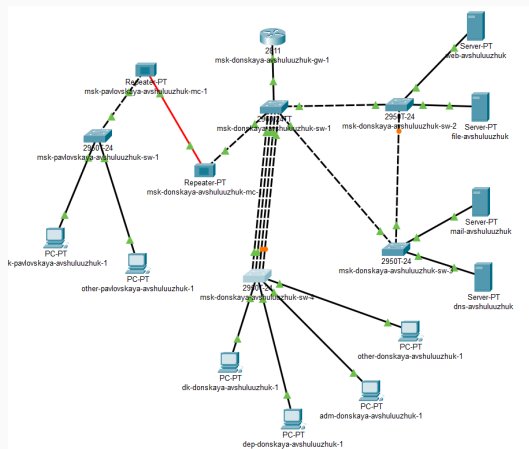
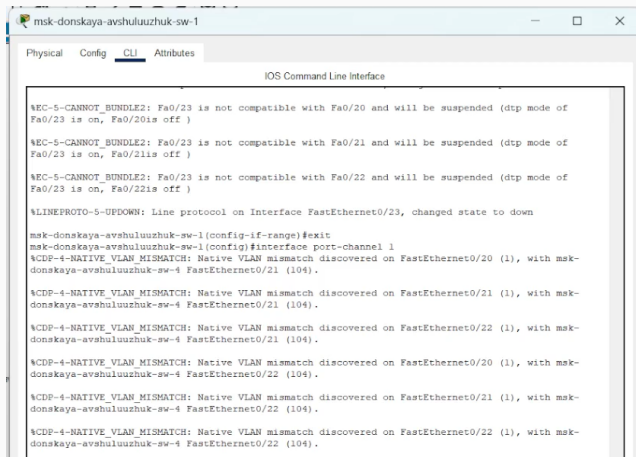


Рис. 17: формирование агрегированного соединения интерфейсов Fa0/20 – Fa0/23



The screenshot shows a terminal window titled "msk-donskaya-avshuluuzhuk-sw-1" with tabs for Physical, Config, CLI, and Attributes. The CLI tab is active, displaying the "IOS Command Line Interface". The terminal output shows several status messages and configuration commands:

```
%EC-5-CANNOT_BUNDLE2: Fa0/23 is not compatible with Fa0/20 and will be suspended (dtp mode of Fa0/23 is on, Fa0/20is off )
%EC-5-CANNOT_BUNDLE2: Fa0/23 is not compatible with Fa0/21 and will be suspended (dtp mode of Fa0/23 is on, Fa0/21is off )
%EC-5-CANNOT_BUNDLE2: Fa0/23 is not compatible with Fa0/22 and will be suspended (dtp mode of Fa0/23 is on, Fa0/22is off )
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/23, changed state to down
msk-donskaya-avshuluuzhuk-sw-1(config-if-range)#exit
msk-donskaya-avshuluuzhuk-sw-1(config)#interface port-channel 1
%CDP-4-NATIVE_VLAN_MISMATCH: Native VLAN mismatch discovered on FastEthernet0/20 (1), with msk-donskaya-avshuluuzhuk-sw-4 FastEthernet0/21 (104).
%CDP-4-NATIVE_VLAN_MISMATCH: Native VLAN mismatch discovered on FastEthernet0/21 (1), with msk-donskaya-avshuluuzhuk-sw-4 FastEthernet0/21 (104).
%CDP-4-NATIVE_VLAN_MISMATCH: Native VLAN mismatch discovered on FastEthernet0/21 (1), with msk-donskaya-avshuluuzhuk-sw-4 FastEthernet0/21 (104).
%CDP-4-NATIVE_VLAN_MISMATCH: Native VLAN mismatch discovered on FastEthernet0/20 (1), with msk-donskaya-avshuluuzhuk-sw-4 FastEthernet0/22 (104).
%CDP-4-NATIVE_VLAN_MISMATCH: Native VLAN mismatch discovered on FastEthernet0/21 (1), with msk-donskaya-avshuluuzhuk-sw-4 FastEthernet0/22 (104).
%CDP-4-NATIVE_VLAN_MISMATCH: Native VLAN mismatch discovered on FastEthernet0/22 (1), with msk-donskaya-avshuluuzhuk-sw-4 FastEthernet0/22 (104).
```

Рис. 18: настройка агрегирования каналов

## Выводы

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В результате выполнения лабораторной работы было произведено изучение возможностей протокола STP и его модификаций по обеспечению отказоустойчивости сети, агрегированию интерфейсов и перераспределению нагрузки между ними.