

# Презентация по лабораторной работе №9

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

1. Сформировать резервное соединение между коммутаторами msk-donskayasw-1 и msk-donskaya-sw-3.
2. Настроить балансировку нагрузки между резервными соединениями.
3. Настроить режим Portfast на тех интерфейсах коммутаторов, к которым подключены серверы.
4. Изучить отказоустойчивость резервного соединения.
5. При выполнении работы необходимо учитывать соглашение об именовании.
6. Сформировать и настроить агрегированное соединение интерфейсов Fa0/20 – Fa0/23 между коммутаторами msk-donskaya-sw-1 и msk-donskaya-sw-4.
7. При выполнении работы необходимо учитывать соглашение об именовании.

# Выполнение лабораторной работы

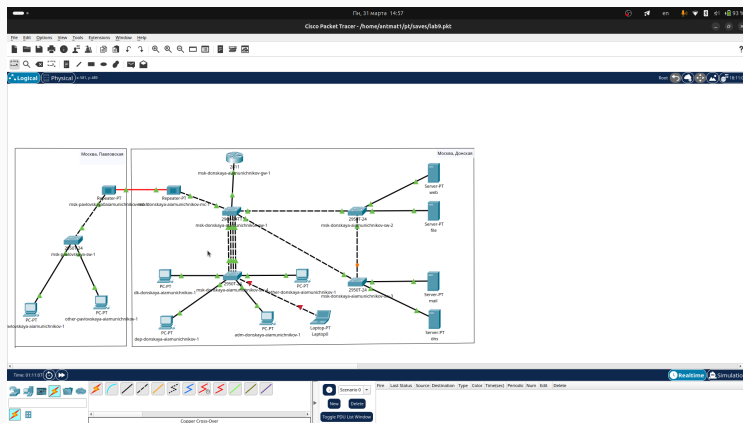


Рис. 1: Логическая схема локальной сети с резервным соединением

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

Рис. 2: Настройка trunk-порта на интерфейсе Gig0/2 коммутатора msk-donskaya-sw-3

```
C:\>ping www.donskaya.rudn.ru

Pinging 10.128.0.2 with 32 bytes of data:

Reply from 10.128.0.2: bytes=32 time=20ms TTL=127
Reply from 10.128.0.2: bytes=32 time=22ms 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 = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 22ms, Average = 10ms

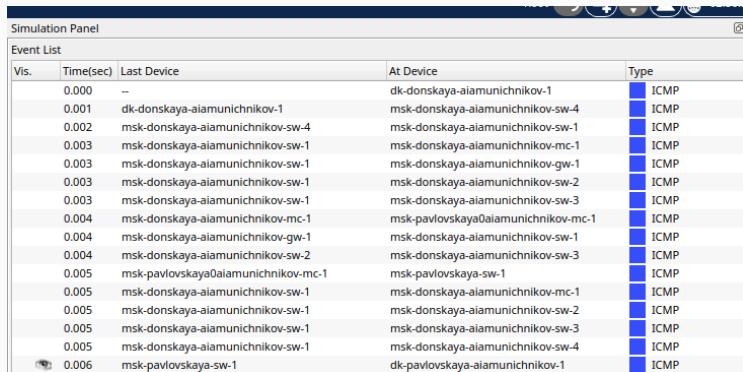
C:\>ping mail.donskaya.rudn.ru

Pinging 10.128.0.4 with 32 bytes of data:

Reply from 10.128.0.4: bytes=32 time=10ms 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

Ping statistics for 10.128.0.4:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 10ms, Average = 2ms
```

Рис. 3: Пингование сервера mail и web



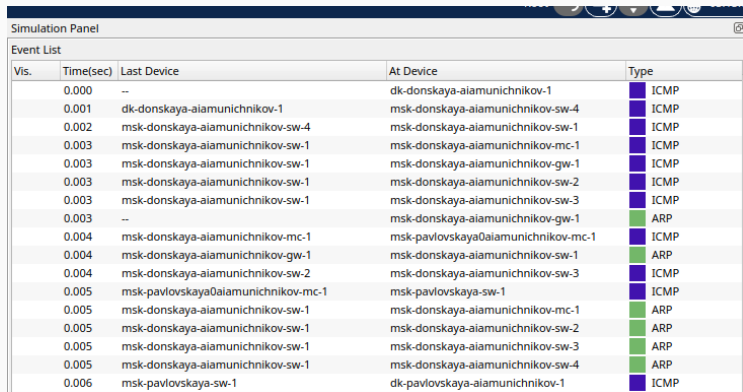
Simulation Panel

Event List

Vis.	Time(sec)	Last Device	At Device	Type
	0.000	--	dk-donskaya-aiamunichnikov-1	ICMP
	0.001	dk-donskaya-aiamunichnikov-1	msk-donskaya-aiamunichnikov-sw-4	ICMP
	0.002	msk-donskaya-aiamunichnikov-sw-4	msk-donskaya-aiamunichnikov-sw-1	ICMP
	0.003	msk-donskaya-aiamunichnikov-sw-1	msk-donskaya-aiamunichnikov-mc-1	ICMP
	0.003	msk-donskaya-aiamunichnikov-sw-1	msk-donskaya-aiamunichnikov-gw-1	ICMP
	0.003	msk-donskaya-aiamunichnikov-sw-1	msk-donskaya-aiamunichnikov-sw-2	ICMP
	0.003	msk-donskaya-aiamunichnikov-sw-1	msk-donskaya-aiamunichnikov-sw-3	ICMP
	0.004	msk-donskaya-aiamunichnikov-mc-1	msk-pavlovskaya0aiamunichnikov-mc-1	ICMP
	0.004	msk-donskaya-aiamunichnikov-gw-1	msk-donskaya-aiamunichnikov-sw-1	ICMP
	0.004	msk-donskaya-aiamunichnikov-sw-2	msk-donskaya-aiamunichnikov-sw-3	ICMP
	0.005	msk-pavlovskaya0aiamunichnikov-mc-1	msk-pavlovskaya-sw-1	ICMP
	0.005	msk-donskaya-aiamunichnikov-sw-1	msk-donskaya-aiamunichnikov-mc-1	ICMP
	0.005	msk-donskaya-aiamunichnikov-sw-1	msk-donskaya-aiamunichnikov-sw-2	ICMP
	0.005	msk-donskaya-aiamunichnikov-sw-1	msk-donskaya-aiamunichnikov-sw-3	ICMP
	0.005	msk-donskaya-aiamunichnikov-sw-1	msk-donskaya-aiamunichnikov-sw-4	ICMP
	0.006	msk-pavlovskaya-sw-1	dk-pavlovskaya-aiamunichnikov-1	ICMP

Рис. 4: Режим симуляции движения пакетов ICMP





The screenshot displays a 'Simulation Panel' window with a title bar containing standard OS icons. Below the title bar is the 'Event List' section, which contains a table with five columns: 'Vis.', 'Time(sec)', 'Last Device', 'At Device', and 'Type'. The table lists 20 events, showing the sequence of ICMP and ARP packets between various network devices. The 'Type' column uses color-coded squares: purple for ICMP and green for ARP.

Vis.	Time(sec)	Last Device	At Device	Type
	0.000	--	dk-donskaya-aiamunichnikov-1	ICMP
	0.001	dk-donskaya-aiamunichnikov-1	msk-donskaya-aiamunichnikov-sw-4	ICMP
	0.002	msk-donskaya-aiamunichnikov-sw-4	msk-donskaya-aiamunichnikov-sw-1	ICMP
	0.003	msk-donskaya-aiamunichnikov-sw-1	msk-donskaya-aiamunichnikov-mc-1	ICMP
	0.003	msk-donskaya-aiamunichnikov-sw-1	msk-donskaya-aiamunichnikov-gw-1	ICMP
	0.003	msk-donskaya-aiamunichnikov-sw-1	msk-donskaya-aiamunichnikov-sw-2	ICMP
	0.003	msk-donskaya-aiamunichnikov-sw-1	msk-donskaya-aiamunichnikov-sw-3	ICMP
	0.003	--	msk-donskaya-aiamunichnikov-gw-1	ARP
	0.004	msk-donskaya-aiamunichnikov-mc-1	msk-pavlovskaya0aiamunichnikov-mc-1	ICMP
	0.004	msk-donskaya-aiamunichnikov-gw-1	msk-donskaya-aiamunichnikov-sw-1	ARP
	0.004	msk-donskaya-aiamunichnikov-sw-2	msk-donskaya-aiamunichnikov-sw-3	ICMP
	0.005	msk-pavlovskaya0aiamunichnikov-mc-1	msk-pavlovskaya-sw-1	ICMP
	0.005	msk-donskaya-aiamunichnikov-sw-1	msk-donskaya-aiamunichnikov-mc-1	ARP
	0.005	msk-donskaya-aiamunichnikov-sw-1	msk-donskaya-aiamunichnikov-sw-2	ARP
	0.005	msk-donskaya-aiamunichnikov-sw-1	msk-donskaya-aiamunichnikov-sw-3	ARP
	0.005	msk-donskaya-aiamunichnikov-sw-1	msk-donskaya-aiamunichnikov-sw-4	ARP
	0.006	msk-pavlovskaya-sw-1	dk-pavlovskaya-aiamunichnikov-1	ICMP

Рис. 5: Режим симуляции движения пакетов ICMP

## Выполнение лабораторной работы

```
msk-donskaya-aiamunichnikov-sw-2#show spanning-tree vlan 3
VLAN0003
  Spanning tree enabled protocol rstp
  Root ID    Priority    32771
             Address     0001.6328.64D1
             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     0001.9695.BC58
             Hello Time  2 sec  Max Age 20 sec  Forward Delay 15 sec
             Aging Time  20

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

msk-donskaya-aiamunichnikov-sw-2#
```

Рис. 6: Просмотр состояния протокола STP для vlan 3

## Выполнение лабораторной работы

```
msk-donskaya-aiamunichnikov-sw-1(config)#spanning-tree vlan 3 root primary
msk-donskaya-aiamunichnikov-sw-1(config)#^Z
msk-donskaya-aiamunichnikov-sw-1#
%SYS-5-CONFIG_I: Configured from console by console

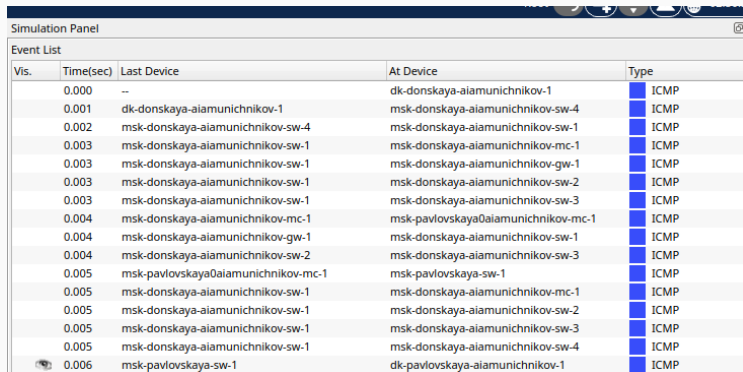
msk-donskaya-aiamunichnikov-sw-1#show spanning-tree vlan 3
VLAN0003
  Spanning tree enabled protocol rstp
  Root ID    Priority    24579
             Address     0030.F20A.4933
             This bridge is the root
             Hello Time  2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID  Priority    24579 (priority 24576 sys-id-ext 3)
             Address     0030.F20A.4933
             Hello Time  2 sec  Max Age 20 sec  Forward Delay 15 sec
             Aging Time  20

Interface                Role Sts Cost          Prio.Nbr Type
-----
Po1                      Desg FWD 8           128.27 Shr
Fa0/1                    Desg FWD 19          128.1  Shr
Gi0/2                    Desg FWD 4           128.26 P2p
Fa0/24                   Desg FWD 19          128.24 P2p
Gi0/1                    Desg FWD 4           128.25 P2p

msk-donskaya-aiamunichnikov-sw-1#
```

Рис. 7: Настройка коммутатора msk-donskaya-sw-1 корневым

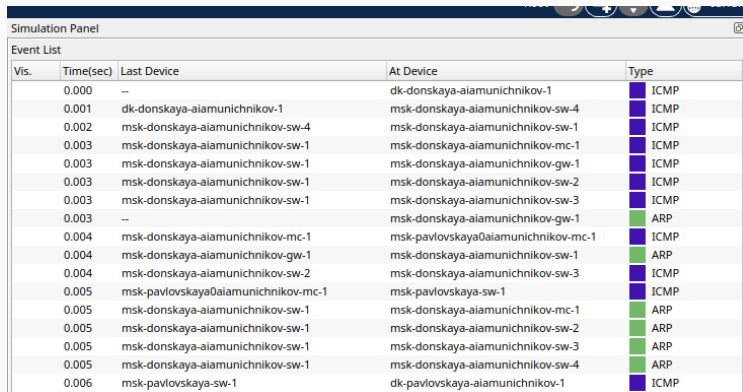


Simulation Panel

Event List

Vis.	Time(sec)	Last Device	At Device	Type
	0.000	--	dk-donskaya-aiamunichnikov-1	ICMP
	0.001	dk-donskaya-aiamunichnikov-1	msk-donskaya-aiamunichnikov-sw-4	ICMP
	0.002	msk-donskaya-aiamunichnikov-sw-4	msk-donskaya-aiamunichnikov-sw-1	ICMP
	0.003	msk-donskaya-aiamunichnikov-sw-1	msk-donskaya-aiamunichnikov-mc-1	ICMP
	0.003	msk-donskaya-aiamunichnikov-sw-1	msk-donskaya-aiamunichnikov-gw-1	ICMP
	0.003	msk-donskaya-aiamunichnikov-sw-1	msk-donskaya-aiamunichnikov-sw-2	ICMP
	0.003	msk-donskaya-aiamunichnikov-sw-1	msk-donskaya-aiamunichnikov-sw-3	ICMP
	0.004	msk-donskaya-aiamunichnikov-mc-1	msk-pavlovskaya0aiamunichnikov-mc-1	ICMP
	0.004	msk-donskaya-aiamunichnikov-gw-1	msk-donskaya-aiamunichnikov-sw-1	ICMP
	0.004	msk-donskaya-aiamunichnikov-sw-2	msk-donskaya-aiamunichnikov-sw-3	ICMP
	0.005	msk-pavlovskaya0aiamunichnikov-mc-1	msk-pavlovskaya-sw-1	ICMP
	0.005	msk-donskaya-aiamunichnikov-sw-1	msk-donskaya-aiamunichnikov-mc-1	ICMP
	0.005	msk-donskaya-aiamunichnikov-sw-1	msk-donskaya-aiamunichnikov-sw-2	ICMP
	0.005	msk-donskaya-aiamunichnikov-sw-1	msk-donskaya-aiamunichnikov-sw-3	ICMP
	0.005	msk-donskaya-aiamunichnikov-sw-1	msk-donskaya-aiamunichnikov-sw-4	ICMP
	0.006	msk-pavlovskaya-sw-1	dk-pavlovskaya-aiamunichnikov-1	ICMP

Рис. 8: Режим симуляции движения пакетов ICMP к серверу web



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 sequence of network events, including ICMP packets and ARP requests, with their respective timestamps and device identifiers.

Vis.	Time(sec)	Last Device	At Device	Type
	0.000	--	dk-donskaya-aiamunichnikov-1	ICMP
	0.001	dk-donskaya-aiamunichnikov-1	msk-donskaya-aiamunichnikov-sw-4	ICMP
	0.002	msk-donskaya-aiamunichnikov-sw-4	msk-donskaya-aiamunichnikov-sw-1	ICMP
	0.003	msk-donskaya-aiamunichnikov-sw-1	msk-donskaya-aiamunichnikov-mc-1	ICMP
	0.003	msk-donskaya-aiamunichnikov-sw-1	msk-donskaya-aiamunichnikov-gw-1	ICMP
	0.003	msk-donskaya-aiamunichnikov-sw-1	msk-donskaya-aiamunichnikov-sw-2	ICMP
	0.003	msk-donskaya-aiamunichnikov-sw-1	msk-donskaya-aiamunichnikov-sw-3	ICMP
	0.003	--	msk-donskaya-aiamunichnikov-gw-1	ARP
	0.004	msk-donskaya-aiamunichnikov-mc-1	msk-pavlovskaya0aiamunichnikov-mc-1	ICMP
	0.004	msk-donskaya-aiamunichnikov-gw-1	msk-donskaya-aiamunichnikov-sw-1	ARP
	0.004	msk-donskaya-aiamunichnikov-sw-2	msk-donskaya-aiamunichnikov-sw-3	ICMP
	0.005	msk-pavlovskaya0aiamunichnikov-mc-1	msk-pavlovskaya-sw-1	ICMP
	0.005	msk-donskaya-aiamunichnikov-sw-1	msk-donskaya-aiamunichnikov-mc-1	ARP
	0.005	msk-donskaya-aiamunichnikov-sw-1	msk-donskaya-aiamunichnikov-sw-2	ARP
	0.005	msk-donskaya-aiamunichnikov-sw-1	msk-donskaya-aiamunichnikov-sw-3	ARP
	0.005	msk-donskaya-aiamunichnikov-sw-1	msk-donskaya-aiamunichnikov-sw-4	ARP
	0.006	msk-pavlovskaya-sw-1	dk-pavlovskaya-aiamunichnikov-1	ICMP

Рис. 9: Режим симуляции движения пакетов ICMP к серверу mail

## Выполнение лабораторной работы

```
Gi0/2          Desg FWD 4      128.26  P2p
Fa0/1          Desg FWD 19     128.1   P2p
Fa0/2          Desg FWD 19     128.2   P2p

msk-donskaya-aiamunichnikov-sw-2#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
msk-donskaya-aiamunichnikov-sw-2(config)#int f0/1
msk-donskaya-aiamunichnikov-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-aiamunichnikov-sw-2(config-if)#int f0/2
msk-donskaya-aiamunichnikov-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-aiamunichnikov-sw-2(config-if)#
```

Copy

Paste

Рис. 10: 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=15ms 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
```

Рис. 11: Пингование mail.donskaya.rudn.ru

```
msk-donskaya-aiamunichnikov-sw-3(config)#int g0/2
msk-donskaya-aiamunichnikov-sw-3(config-if)#shutdown

msk-donskaya-aiamunichnikov-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. 12: Разрыв соединения



```
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.
Reply from 10.128.0.4: bytes=32 time=10ms 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. 13: Время восстановления соединения

```
msk-donskaya-aiaamunichnikov-sw-1#en
msk-donskaya-aiaamunichnikov-sw-1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
msk-donskaya-aiaamunichnikov-sw-1(config)#spanning-tree mode rapid-pvst
msk-donskaya-aiaamunichnikov-sw-1(config)#
```

Рис. 14: Режим работы по протоколу Rapid PVST+

```
Pinging 10.128.0.4 with 32 bytes of data:  
  
Reply from 10.128.0.4: bytes=32 time=30ms TTL=127  
Reply from 10.128.0.4: bytes=32 time<1ms TTL=127  
Reply from 10.128.0.4: bytes=32 time=10ms 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=10ms TTL=127  
Reply from 10.128.0.4: bytes=32 time=10ms 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: Пингование mail.donskaya.rudn.ru

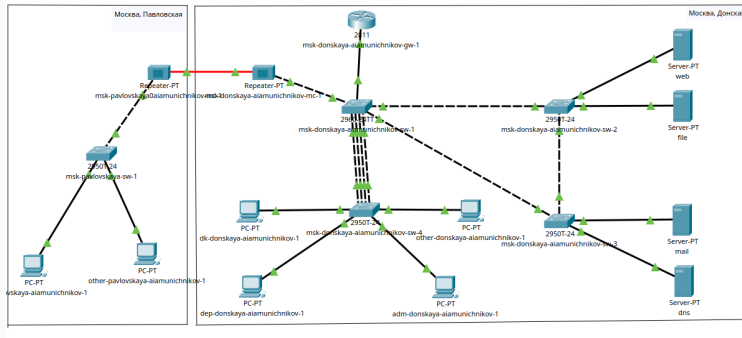
```
msk-donskaya-aiamunichnikov-sw-3(config-if)#shutdown  
  
msk-donskaya-aiamunichnikov-sw-3(config-if)#  
%LINK-5-CHANGED: Interface GigabitEthernet0/2, changed state to administratively down  
  
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/2, changed state to down  
  
msk-donskaya-aiamunichnikov-sw-3(config-if)#no shutdown  
  
msk-donskaya-aiamunichnikov-sw-3(config-if)#  
%LINK-5-CHANGED: Interface GigabitEthernet0/2, changed state to up  
  
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/2, changed state to up
```

Рис. 16: Разрыв соединения

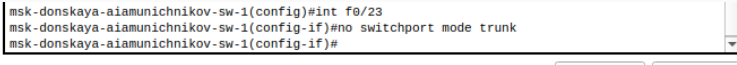
```
Reply from 10.128.0.4: bytes=32 time=1ms TTL=127
Reply from 10.128.0.4: bytes=32 time=1ms TTL=127
Reply from 10.128.0.4: bytes=32 time<1ms TTL=127
Reply from 10.128.0.4: bytes=32 time<1ms TTL=127
Reply from 10.128.0.4: bytes=32 time=10ms TTL=127
Reply from 10.128.0.4: bytes=32 time=10ms TTL=127
Reply from 10.128.0.4: bytes=32 time=10ms TTL=127
Reply from 10.128.0.4: bytes=32 time<1ms TTL=127
Request timed out.
Reply from 10.128.0.4: bytes=32 time=11ms TTL=127
Reply from 10.128.0.4: bytes=32 time<1ms TTL=127
Reply from 10.128.0.4: bytes=32 time=23ms TTL=127
Reply from 10.128.0.4: bytes=32 time=10ms 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. 17: Время восстановления соединения

## Выполнение лабораторной работы



**Рис. 18:** Логическая схема локальной сети с агрегированным соединением



```
msk-donskaya-aiamunichnikov-sw-1(config)#int f0/23
msk-donskaya-aiamunichnikov-sw-1(config-if)#no switchport mode trunk
msk-donskaya-aiamunichnikov-sw-1(config-if)#
```

The image shows a terminal window with a light gray background. It contains three lines of text representing network configuration commands. The first line is 'msk-donskaya-aiamunichnikov-sw-1(config)#int f0/23', the second is 'msk-donskaya-aiamunichnikov-sw-1(config-if)#no switchport mode trunk', and the third is 'msk-donskaya-aiamunichnikov-sw-1(config-if)#'. The terminal has a vertical scrollbar on the right side.

Рис. 19: Настройка агрегирования каналов на msk-donskaya-dmbelicheva-sw-1

[illegible]

**Рис. 20:** Настройка агрегирования каналов на msk-donskaya-dmbelicheva-sw-1



В результате выполнения лабораторной работы я изучил возможности протокола STP и его модификаций по обеспечению отказоустойчивости сети, агрегированию интерфейсов и перераспределению нагрузки между ними.