Automation of Discovering of an Enterprise Network's ICT-Infrastructure Link Layer Graph

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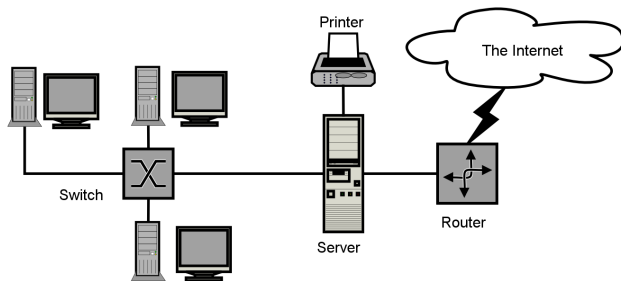Petrozavodsk State University

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Areas of graph usage

- Network modeling and analysis
- Load simulation
- Network management and optimization
- LAN designing
- Network documentation

Nest

Experimental platform for studying models and methods of ISP network management.

- IEEE 802 orientation
- Automatization of network graph discovery
- Graph visualization
- Data flows modeling
- Interface for work with graph structure
- Describing network with object model SON (Spatial-Organizational-Network)

Tasks

- Developing of data link layer graph discovering algorithm
- Finding a method of representation of VLAN on link layer graph
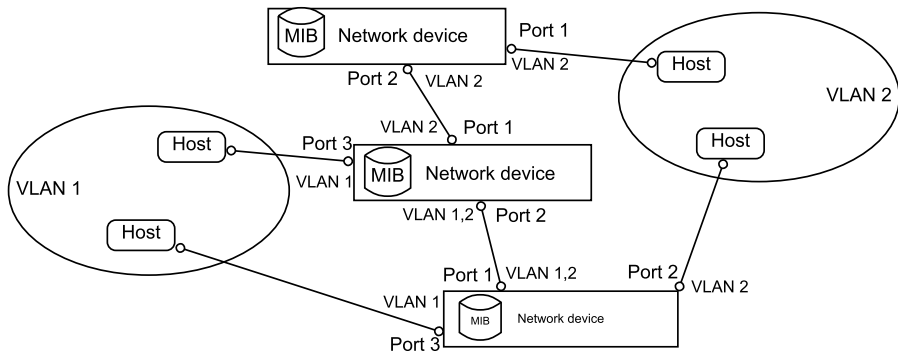- Implementation of developed algorithm within Nest

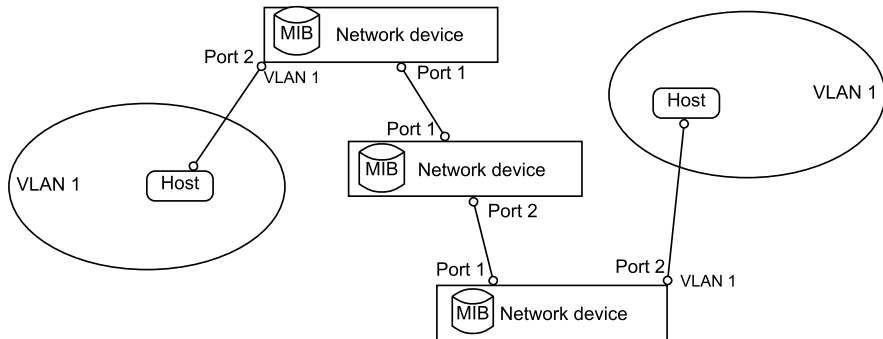# Network concept

MIB — Management Information Base.
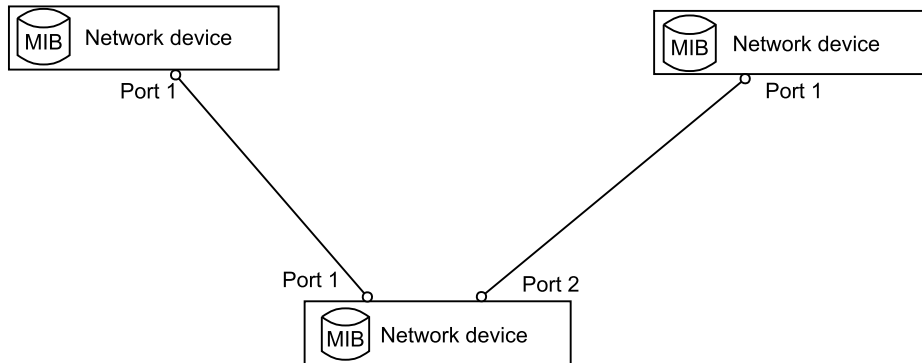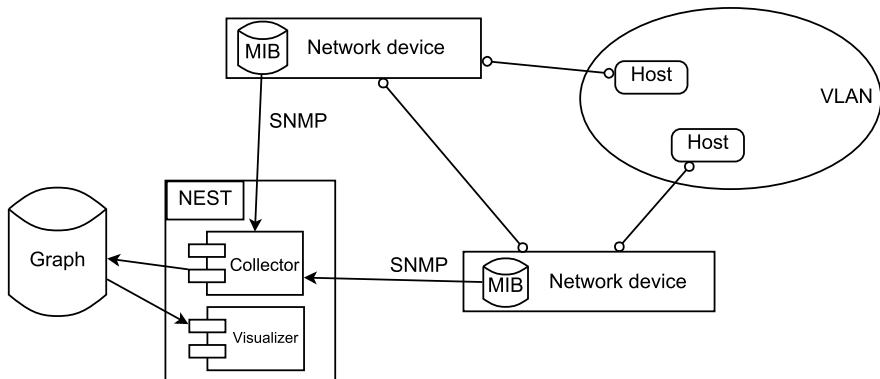
Network concept

MIB — Management Information Base

Network concept

MIB — Management Information Base

Graph building concept

SNMP - Simple Network Management Protocol

Problem statement

Problem of link layer graph building

- Heterogeneity of network devices
- Lack of common standards
- Possible inaccessibility of devices

Preferred data configuration

- Pairs of device identifiers
- Addresses, names, numbers of interfaces
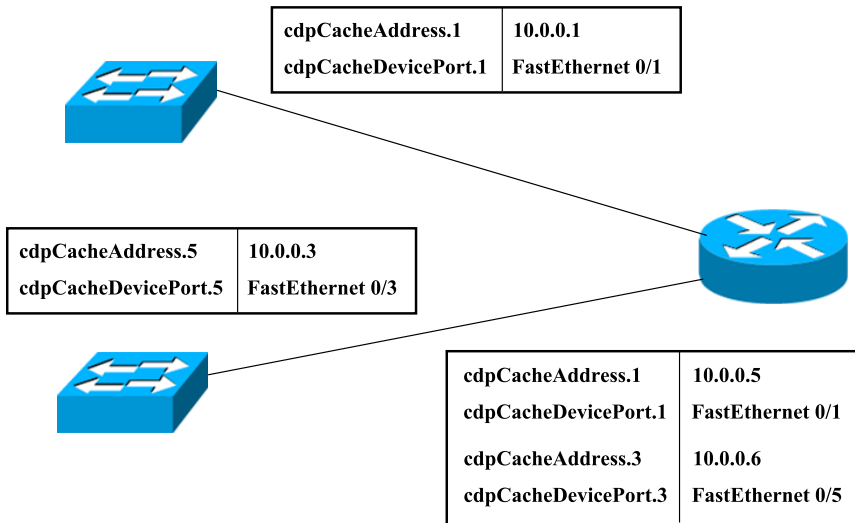
Information about VLAN configuration

Demands

- Numbers, addresses or names of interfaces
- VLAN numbers assigned to interfaces

Sources

- Q-BRIDGE-MIB : dot1qPortVlanTable
- CISCO-VTP-MIB : vlanTrunkPortTable
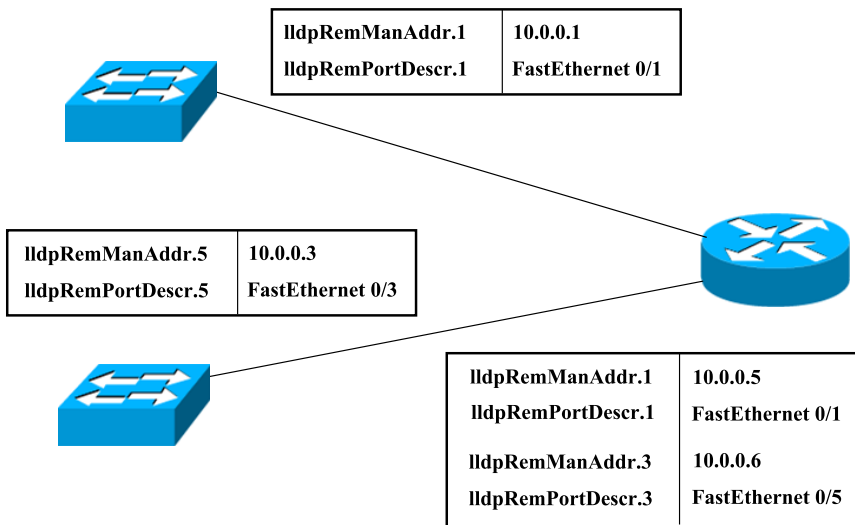- IF-MIB : ifStackTable

CDP

Cisco Discovery Protocol, CISCO-CDP-MIB

| cdpCacheAddress.1 | 10.0.0.1 |
| cdpCacheDevicePort.1 | FastEthernet 0/1 |

| cdpCacheAddress.5 | 10.0.0.3 |
| cdpCacheDevicePort.5 | FastEthernet 0/3 |

cdpCacheAddress.1	10.0.0.5
cdpCacheDevicePort.1	FastEthernet 0/1
cdpCacheAddress.3	10.0.0.6
cdpCacheDevicePort.3	FastEthernet 0/5

LLDP

Link Layer Discovery Protocol, IEEE 802.1AB, LLDP-MIB

| lldpRemManAddr.1 | 10.0.0.1 |
| lldpRemPortDescr.1 | FastEthernet 0/1 |

| lldpRemManAddr.5 | 10.0.0.3 |
| lldpRemPortDescr.5 | FastEthernet 0/3 |

lldpRemManAddr.1	10.0.0.5
lldpRemPortDescr.1	FastEthernet 0/1
lldpRemManAddr.3	10.0.0.6
lldpRemPortDescr.3	FastEthernet 0/5

STP

Spanning Tree Protocol, IEEE 802.1D, BRIDGE-MIB

| dot1dStpPortDesignatedBridge.1 | 00:A8:EF:99:01:01 |
| dot1dStpPortDesignatedPort.1 | 1 |

| dot1dStpPortDesignatedBridge.5 | 00:A8:EF:99:01:01 |
| dot1dStpPortDesignatedPort.5 | 3 |

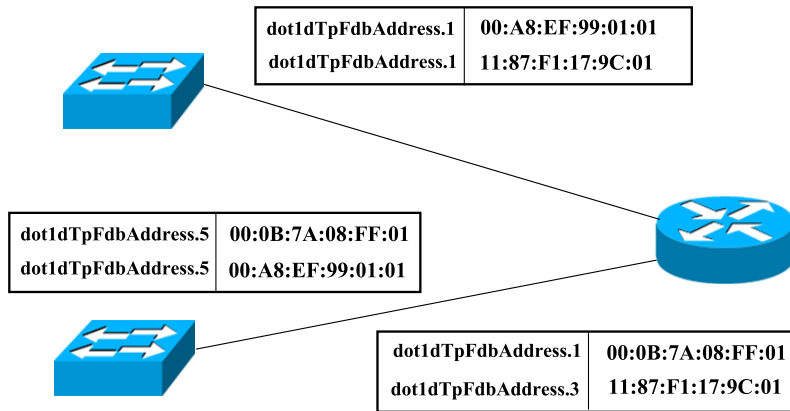| dot1dStpPortDesignatedBridge.1 | 00:0B:7A:08:FF:01 |
dot1dStpPortDesignatedPort.1	1
dot1dStpPortDesignatedBridge.3	11:87:F1:17:9C:01
dot1dStpPortDesignatedPort.3	5
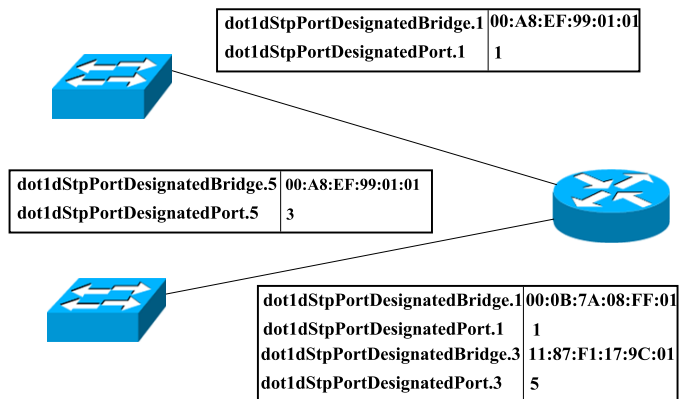
Myung-Hee Son, Bheom-Soon Joo, Byung-Chul Kim, and Jae-Yong Lee.

Physical Topology Discovery for Metro Ethernet Networks

AFT

Address Forwarding Tables, BRIDGE-MIB (dot1dTpFdpTable)

| dot1dTpFdbAddress.1 | 00:A8:EF:99:01:01 |
| dot1dTpFdbAddress.1 | 11:87:F1:17:9C:01 |

| dot1dTpFdbAddress.5 | 00:0B:7A:08:FF:01 |
| dot1dTpFdbAddress.5 | 00:A8:EF:99:01:01 |

| dot1dTpFdbAddress.1 | 00:0B:7A:08:FF:01 |
| dot1dTpFdbAddress.3 | 11:87:F1:17:9C:01 |

📄 Hassan Gobjuka and Yuri J. Breitbart.
Ethernet Topology Discovery for Networks With Incomplete
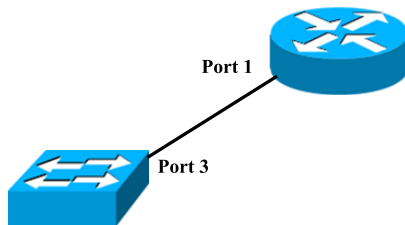Information.

Algorithm of link layer graph building

Main idea: sequential use of different data sources

- Probe the specified network node
- Retrieve data using SNMP
- Create objects representing device on graph

Algorithm of link layer graph building

- Determine physical addresses of neighbours using STP data
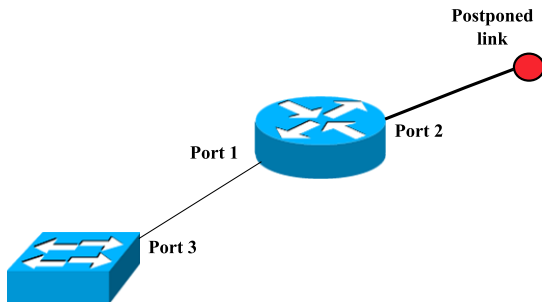- Find corresponding network addresses

- If an IP address of a certain device is not detected then this device is deferred to post-processing

Algorithm of link layer graph building

- Determine physical addresses of neighbours using STP data
- Find corresponding network addresses

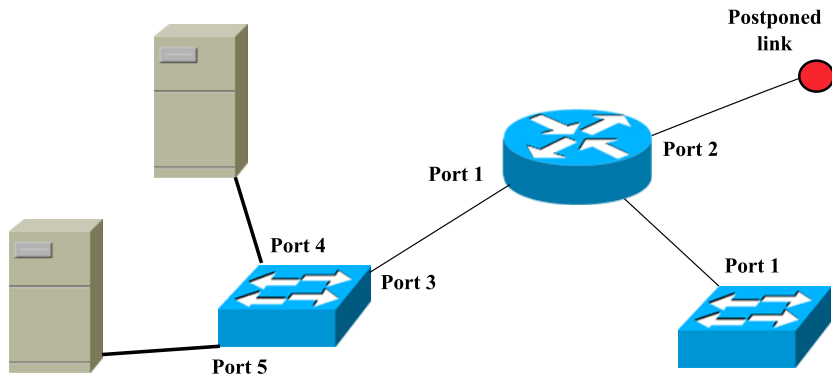- If an IP address of a certain device is not detected then this device is deferred to post-processing

Algorithm of link layer graph building

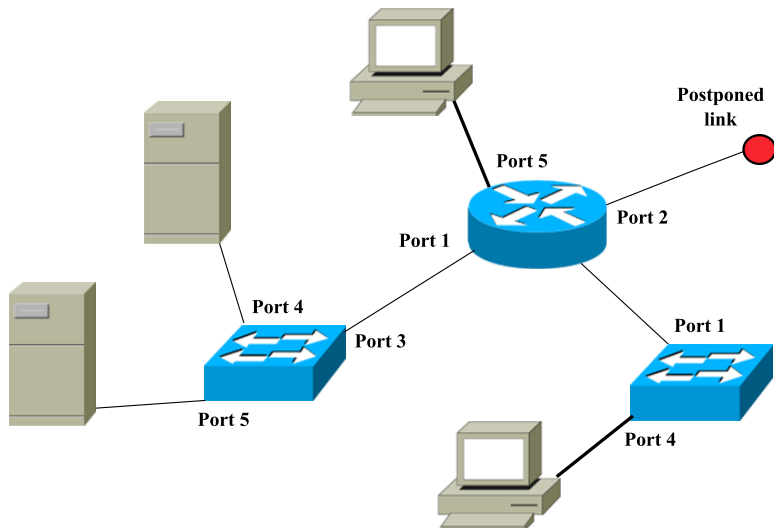- Determine remaining connections using CDP data
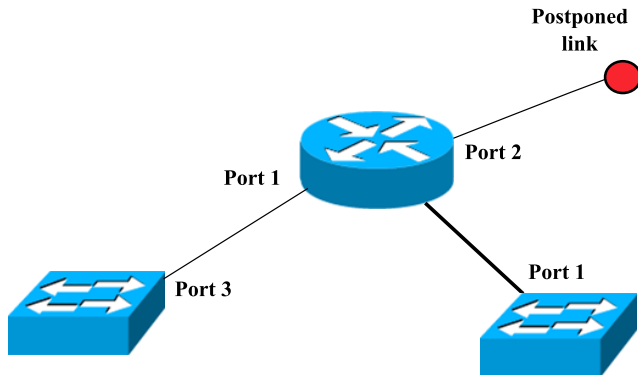
Algorithm of link layer graph building
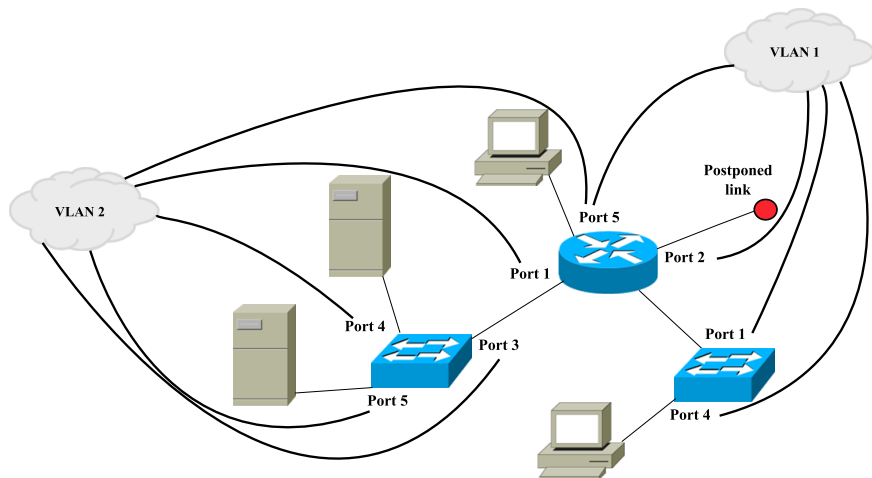
- Determine remaining connections using LLDP data

# Algorithm of link layer graph building

- Find attached hosts using AFT

Algorithm of link layer graph building

- Create objects for broadcast domains and add interfaces to them

Algorithm of link layer graph building

- Handle all postponed devices
- Create graph objects for all inaccessible devices
- Put together all broadcast domains that have at least one common interface
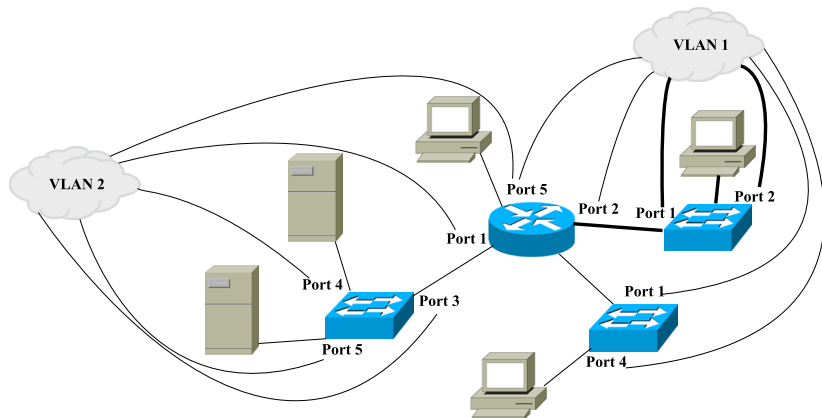
Disadvantages of testing in huge networks

- Difficulty of checking of the results correctness
- Increased duration of data retrieving and processing
- Lack of variety in data forms
- Absence of control over device configuration
- Network behavior is unpredictable
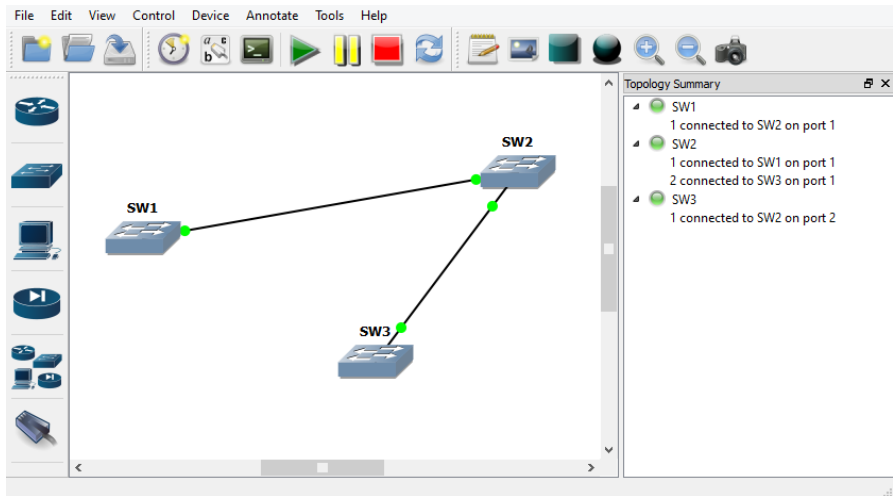
Advantages of program experimental environment

- Total control ever network configuration
- Diversity of configuration variants
- Relatively low cost
- Absence of external factors
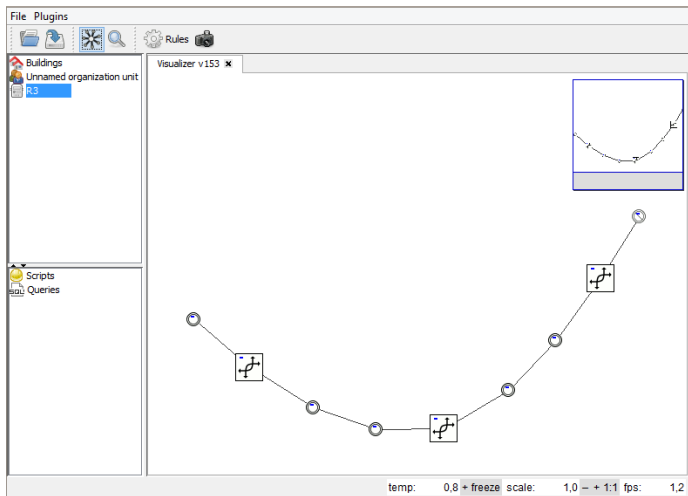- Reproducible results

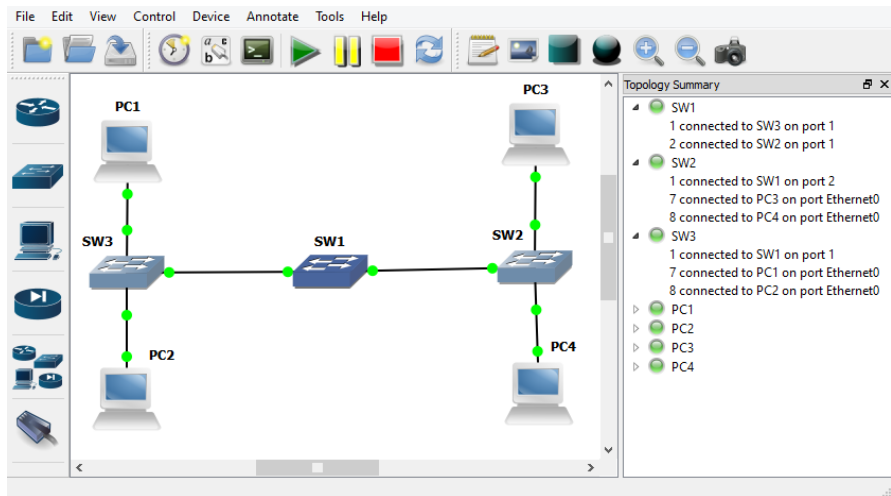## Program tools

- Cisco Packet Tracer
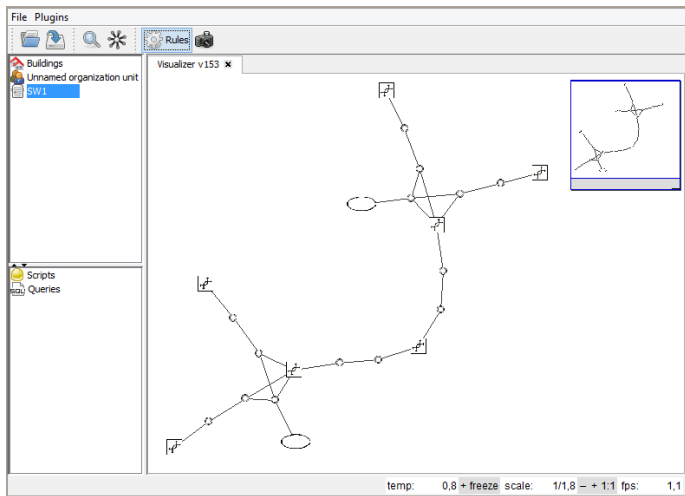- NetSim
- GNS3

LLDP lab

LLDP lab

VLAN lab

VLAN lab

Testing results

Network	Devices	Collecting time, sec.	Building time, sec.	Nodes
PetrSU	9	119	61	1318
GNS3 LLDP	3	5.9	0.9	3
GNS3 VLAN	3	7.1	1.25	7

We can be sure that device is inaccesible with SNMP only after timeout

Results

- Complex algorithm of link layer graph discovering (including VLANs) was developed
- 3 new classes were added to SON
- 12 new classes were coded in Nest, 15 were changed
- Added a total of 1254 of new lines of code, including 245 lines of comments
- Testing of an algorithm was done in PeterSU's network and in virtual laboratories built with GNS3
- The algorithms demonstrated acceptable levels of accuracy and speed of building

Future plans

- Search for additional data sources
- Support of data sources about wireless devices

Thank you for your attention!

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