How to teach computer networks using simulation software

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The abbreviation ICT (Information and Communication Technology) is very often used as a synonym for term IC (Information Technology). However, its meaning is much wider, because it does not describe only information technologies, but also characterizes relations between them and telecommunication technologies. The main idea of ICT is the unified communication, which means the integration of many different services such as transmission of computer data, voice and video through the one unified network (Dye, 2007). A modern implementation of these assumptions is a very complicated task and requires well-educated specialists. On the other hand the increasing number of computer networks and their growth have created a shortage of people which are able to design, construct and administrate such telecommunication infrastructures. Therefore computer networks are one of the most interesting subject to study for people who would like to improve their technical skills and broaden career prospects.

The increasing complexity of modern telecommunication systems causes difficulties in both teaching and learning computer networks. Students have to learn theories and specifications of different technologies but also need to practise configurations of specialized routers, switches and wireless access point which are not common devices. Usually such equipment is accessible only during classes and laboratory activities, thus students can use it in limited period of time. Network simulation software can resolve this problem.

Nowadays, there are many different network simulation programs such as CNET (CNET), INET Framework (INET) with OMNeT++ library (OMNeT++) or GNS3 (GNS3) which can be useful for learning computer networks. However, one of the most universal one is Cisco Packet Tracer, which is an advanced tool for simulation and visualization of different aspects of computer networks. This software is widely used by the students participating in

CCNA (Cisco Certified Network Associate) courses offered by Cisco Networking Academy. It allows students to create different types of virtual networks from a small isolated environment consists of a few computers and hubs (Figure 1), to complex unified computer networks with many routers and switches (Figure 2).

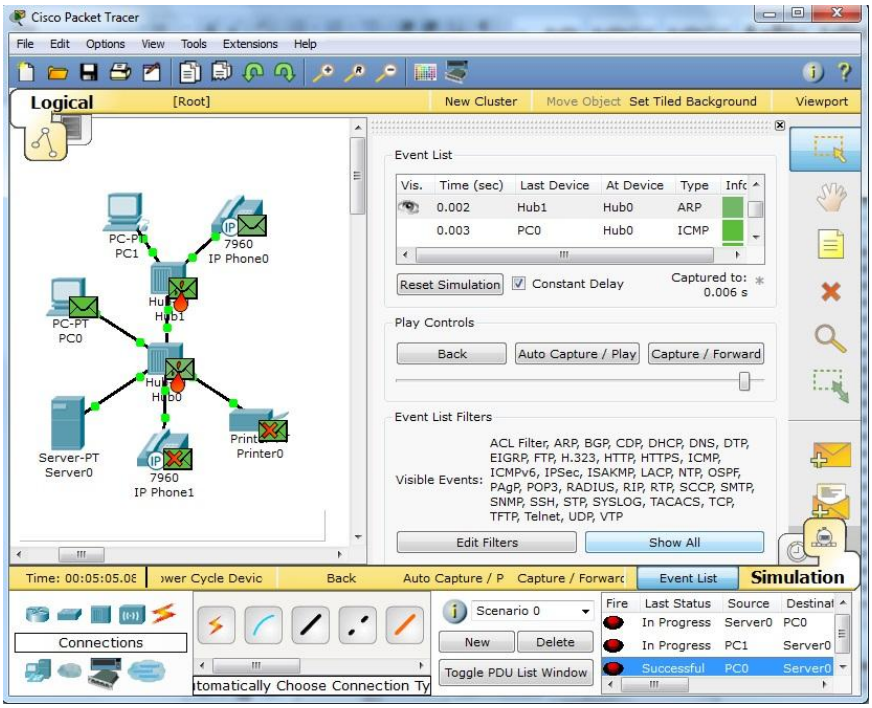

Figure 1: Cisco Packet Tracer, simulation of a small isolated network.

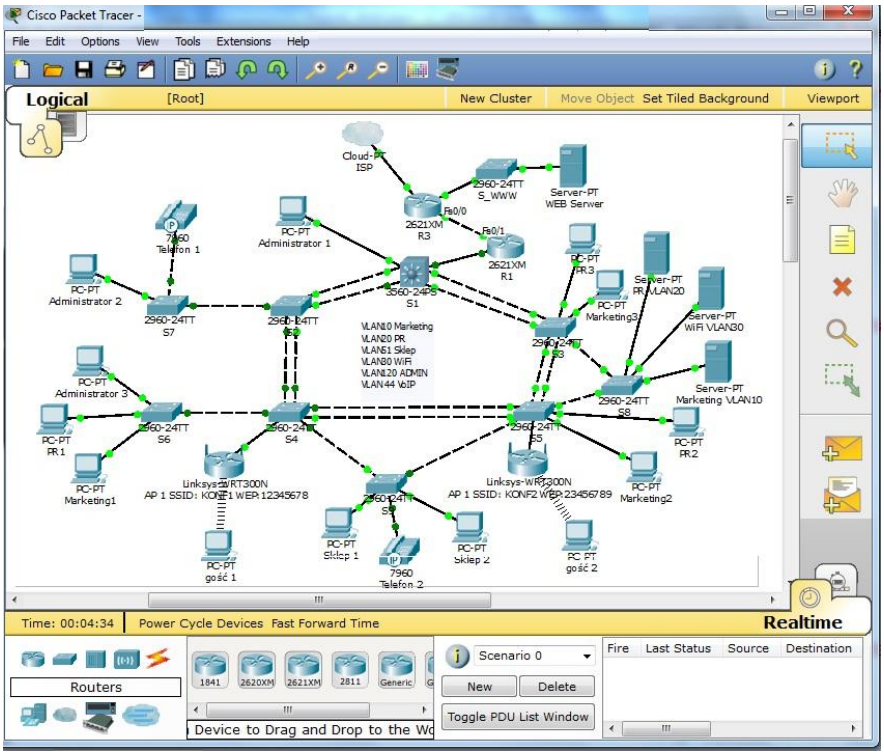

Figure 2: E-laboratory in Cisco Packet Tracer, simulation of an unified computer network.

During e-laboratories students configure network devices, test their capabilities and try to find and resolve all existing problems. Cisco Packet Tracer provides for all simulated devices both the graphical user interface (GUI) (Figure 3) and the command line interface (CLI), typically used by more advanced users (Figure 4).

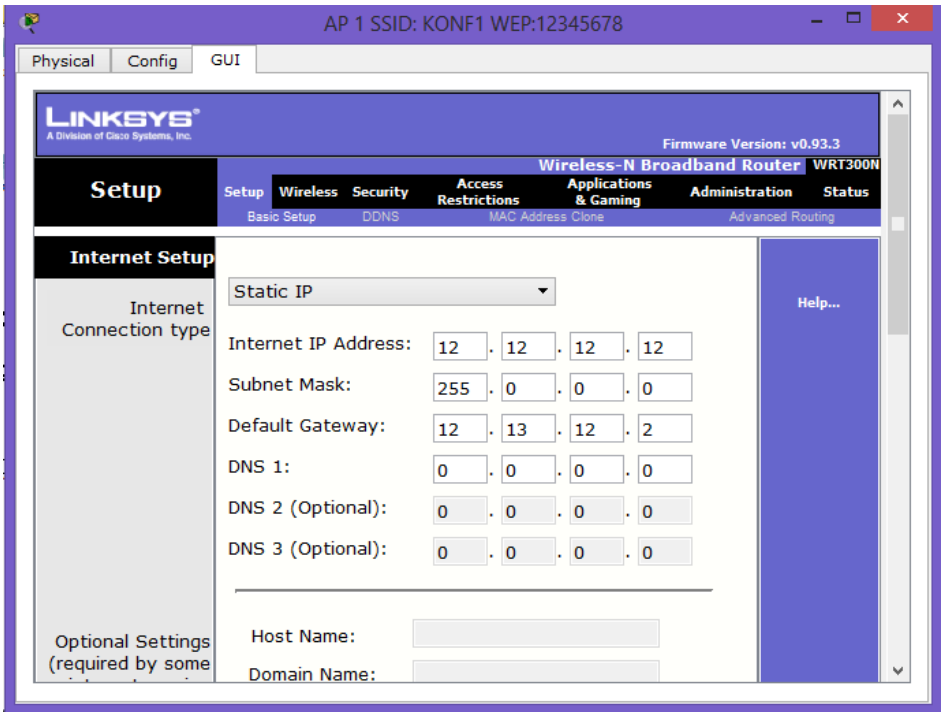

Figure 3: Graphical User Interface (GUI) of the Wireless-N Broadband Router WRT300N in Cisco Packet Tracer.

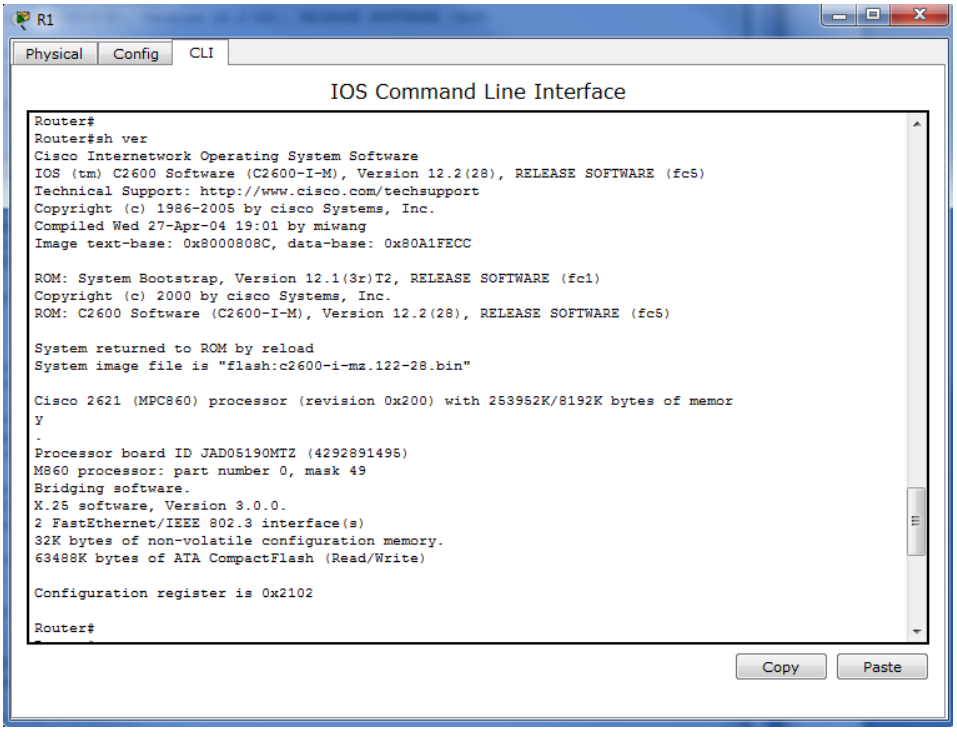

Figure 4: Command Line Interface of the 2620XM Router in Cisco Packet Tracer.

The network devices can be used in different network topologies and configured with various network protocols such as routing protocols (EIGRP, OSPF, RIP) (Figure 5), Vlan Trunking Protocol (VTP) (Figure 6) or Spanning-Tree Protocol (STP) which can be analysed in both Real-time and Simulation mode (Figure 7).

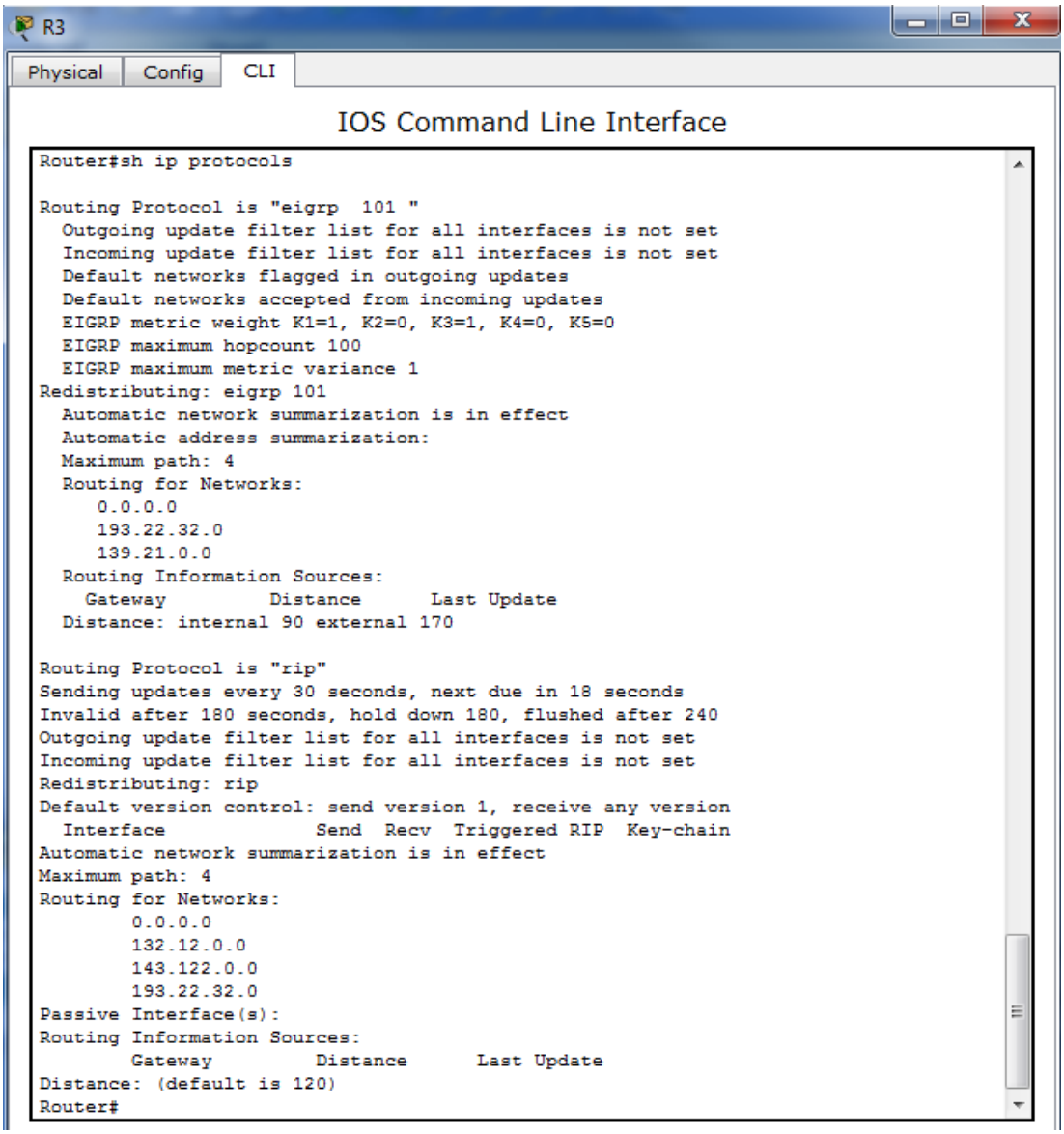

Figure 5: Verification of the configured ip routing protocols (RIP and EIGRP) on the router in Cisco Packet Tracer.

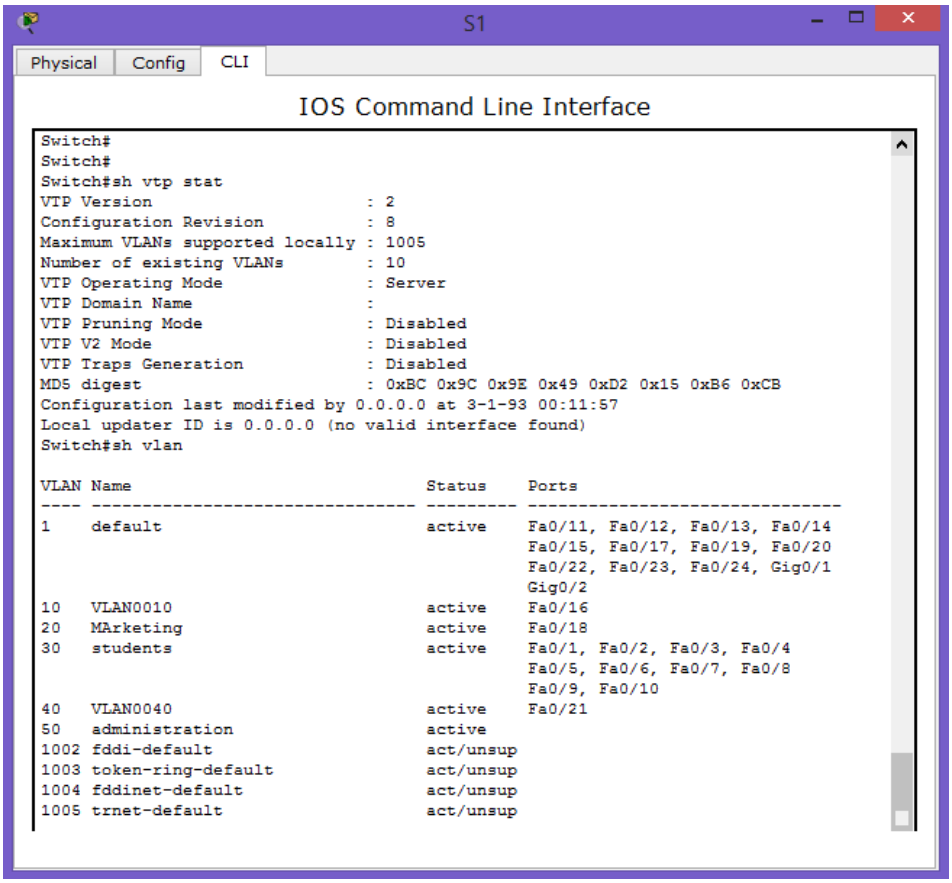

Figure 6: Verification of the VTP and VLAN's configured on the switch in Cisco Packet Tracer.

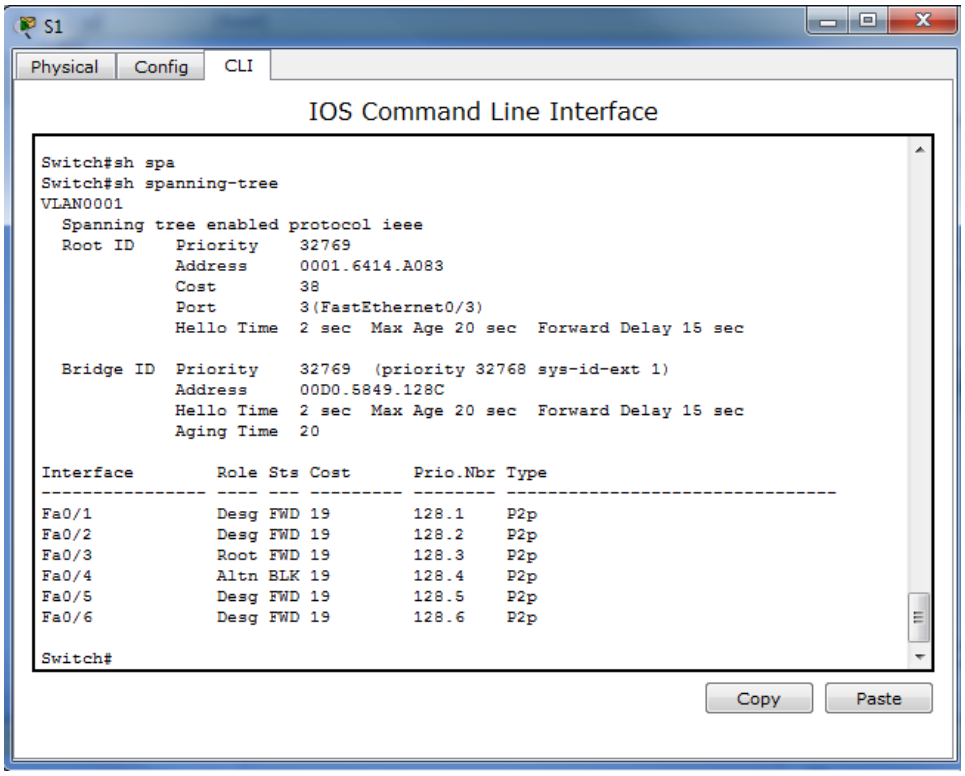

Figure 7: Verification of the Spanning-Tree Protocol configured on the switch in Cisco Packet Tracer.

Moreover, the universality of this tool enables every teacher to prepare own virtual laboratories with different scenarios, which can also automatically evaluate student's practical skills and knowledge (Figure 8). All these Cisco Packet Tracer capabilities make this simulation software very useful tool for both students and teachers.

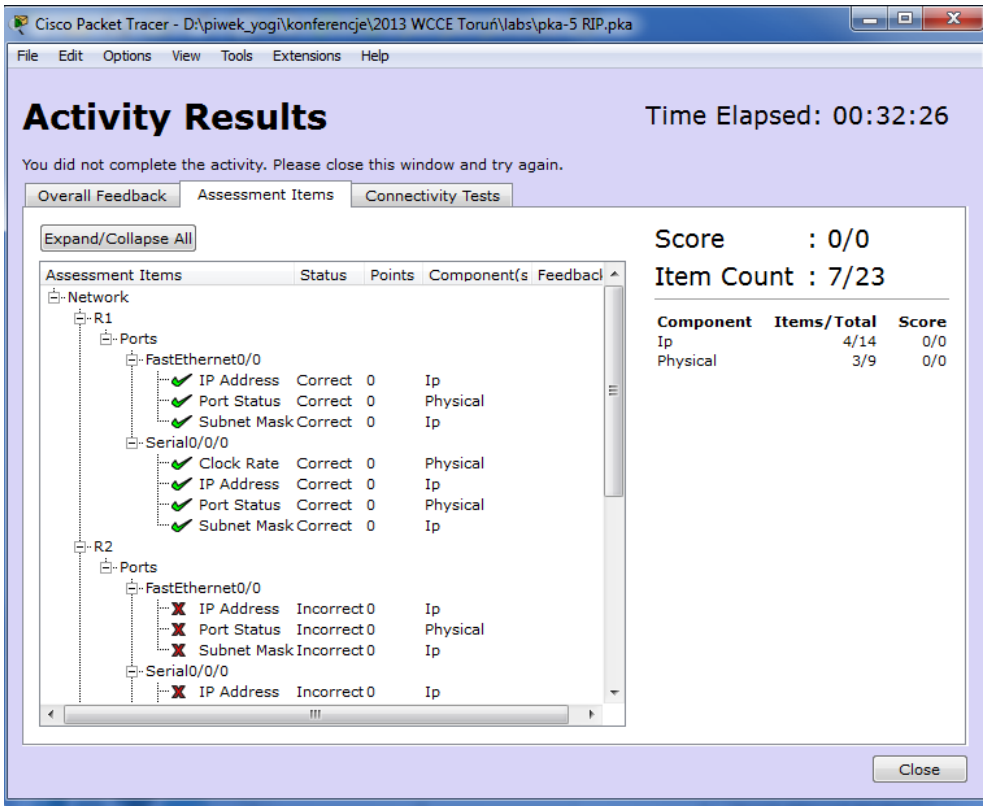

Figure 8: Student result of virtual laboratory activity in Cisco Packet Tracer.

REFERENCES

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CNET Network Simulator, http://www.csse.uwa.edu.au/cnet3/

INET Framework project, http://inet.omnetpp.org/

OMNeT++ project, http://www.omnetpp.org/

GNS3 graphical network simulator, http://www.gns3.net/