Digital Trolleys (Instructor Version)

**Instructor Note**: Red font color or Gray highlights indicate text that appears in the instructor copy only.

1. Objective

Use CLI commands to verify operational status of a multiarea OSPF network.

OSPF is configured in this activity both as a single-area topology and as a multiarea topology to review **show** commands from the chapter curriculum.

1. Scenario

Your city has an aging digital trolley system based on a one-area design. All communications within this one area are taking longer to process as trolleys are being added to routes serving the population of your growing city. Trolley departures and arrivals are also taking a little longer, because each trolley must check large routing tables to determine where to pick up and deliver residents from their source and destination streets.

A concerned citizen has come up with the idea of dividing the city into different areas for a more efficient way to determine trolley routing information. It is thought that if the trolley maps are smaller, the system might be improved because of faster and smaller updates to the routing tables.

Your city board approves and implements the new area-based, digital trolley system. But to ensure the new area routes are more efficient, the city board needs data to show the results at the next open board meeting.

Complete the activity directions as stated below.

Save your work and explain the differences between the old, single area and new, multiarea system to another group or the entire class.

1. Required Resources
* Packet Tracer software
* Word processing software
1. Directions
	1. Map the single-area city trolley routing topology.
		1. Use Packet Tracer to map the old routing topology for the city. Cisco 1941 Integrated Services Routers (ISRs) are preferred.
		2. Create a core area and place one of the routers in the core area.
		3. Connect at least two routers to the core area router.
		4. Choose to connect two more routers to the routers from Step 1c or create loopback addresses for the LAN interfaces on the routers from Step 1c.
		5. Address the connected links or interfaces using IPv4 and VLSM.
		6. Configure OSPF on each router for area 0 only.
		7. Ping all routers to ensure full connectivity within the entire area.
	2. Map the multiarea city trolley routing topology.
		1. Use your cursor to highlight all devices from Step 1, and copy and paste them to another area of the Packet Tracer desktop.
		2. Assign at least three areas to your topology. One must be the backbone (or core area) and the other two areas will be joined to the backbone area using current routers, which will now become area border routers.
		3. Configure the appropriate routers to their new area assignments. Remove old area configuration commands and assign new area commands to the appropriate interfaces.
		4. Save each router’s changes as you make changes.
		5. When complete, you should have three areas represented on the topology and all routers should be able to ping each other throughout the network.
		6. Use the drawing tool and identify your areas by drawing circles or rectangles around the three areas.
		7. Save your work.
	3. Verify the network for city council members.
		1. Use at least three commands learned (or used in this chapter) to help the city council prove that the new area, digital trolley routing topology works.
		2. Save a copy of topology graphics and verification commands comparisons in table format to a word processing file.
		3. Share your work with another group or the class. You may also want to add this activity and its files to a portfolio for this course.
2. Instructor Resource Example

The information listed in this section is only one depiction of what students could see as a result of this activity. Other topology designs may vary per student groups.

Packet Tracer Single-area and Multiarea Topology Diagram Example



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| Single-Area OSPF City DesignR1# **show ip protocols**Routing Protocol is "ospf 1" Outgoing update filter list for all interfaces is not set  Incoming update filter list for all interfaces is not set  Router ID 1.1.1.1 Number of areas in this router is 1. 1 normal 0 stub 0 nssa Maximum path: 4 Routing for Networks: 192.168.4.0 0.0.0.3 area 0 192.168.20.4 0.0.0.3 area 0 192.168.10.4 0.0.0.3 area 0 Routing Information Sources:  Gateway Distance Last Update  1.1.1.1 110 00:03:33 2.2.2.2 110 00:02:58 3.3.3.3 110 00:02:58 4.4.4.4 110 00:02:58 5.5.5.5 110 00:02:58 6.6.6.6 110 00:03:03 7.7.7.7 110 00:02:58 Distance: (default is 110)R1# | Multiarea OSPF City DesignR1# **show ip protocols**Routing Protocol is "ospf 1" Outgoing update filter list for all interfaces is not set  Incoming update filter list for all interfaces is not set  Router ID 1.1.1.1 Number of areas in this router is 1. 1 normal 0 stub 0 nssa Maximum path: 4 Routing for Networks: 192.168.4.0 0.0.0.3 area 0 192.168.20.4 0.0.0.3 area 0 192.168.10.4 0.0.0.3 area 0 Routing Information Sources:  Gateway Distance Last Update  1.1.1.1 110 00:03:50 2.2.2.2 110 00:03:51 3.3.3.3 110 00:03:50 Distance: (default is 110)R1# |

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| Single-Area OSPF City DesignR1# **show ip ospf database** OSPF Router with ID (1.1.1.1) (Process ID 1) Router Link States (Area 0)Link ID ADV Router Age Seq# Checksum Link count1.1.1.1 1.1.1.1 728 0x80000005 0x001701 46.6.6.6 6.6.6.6 698 0x80000002 0x005ba8 13.3.3.3 3.3.3.3 693 0x80000007 0x00c181 47.7.7.7 7.7.7.7 693 0x80000002 0x0025d4 15.5.5.5 5.5.5.5 693 0x80000002 0x00917c 12.2.2.2 2.2.2.2 693 0x80000007 0x004e19 44.4.4.4 4.4.4.4 693 0x80000003 0x00c551 1 Net Link States (Area 0)Link ID ADV Router Age Seq# Checksum10.1.3.2 6.6.6.6 698 0x80000001 0x00a70b10.1.4.2 7.7.7.7 693 0x80000001 0x00a44210.1.2.2 5.5.5.5 693 0x80000001 0x00992010.1.1.2 4.4.4.4 693 0x80000001 0x002479R1# | Multiarea OSPF City DesignR1# **show ip ospf database** OSPF Router with ID (1.1.1.1) (Process ID 1) Router Link States (Area 0)Link ID ADV Router Age Seq# Checksum Link count2.2.2.2 2.2.2.2 716 0x80000003 0x0020a2 23.3.3.3 3.3.3.3 715 0x80000003 0x00297d 21.1.1.1 1.1.1.1 715 0x80000005 0x00d443 4 Summary Net Link States (Area 0)Link ID ADV Router Age Seq# Checksum10.1.3.0 3.3.3.3 681 0x80000001 0x0089ba10.1.4.0 3.3.3.3 681 0x80000002 0x007cc510.1.2.0 2.2.2.2 676 0x80000001 0x00b29610.1.1.0 2.2.2.2 676 0x80000002 0x00bb8dR1# |

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| Single-Area OSPF City Design R1# **show ip ospf 1** Routing Process "ospf 1" with ID 1.1.1.1 Supports only single TOS(TOS0) routes Supports opaque LSA SPF schedule delay 5 secs, Hold time between two SPFs 10 secs Minimum LSA interval 5 secs. Minimum LSA arrival 1 secs Number of external LSA 0. Checksum Sum 0x000000 Number of opaque AS LSA 0. Checksum Sum 0x000000 Number of DCbitless external and opaque AS LSA 0 Number of DoNotAge external and opaque AS LSA 0 Number of areas in this router is 1. 1 normal 0 stub 0 nssa External flood list length 0 Area BACKBONE(0) Number of interfaces in this area is 2 Area has no authentication SPF algorithm executed 3 times Area ranges are Number of LSA 11. Checksum Sum 0x0507ca Number of opaque link LSA 0. Checksum Sum 0x000000 Number of DCbitless LSA 0 Number of indication LSA 0 Number of DoNotAge LSA 0 Flood list length 0R1# | Multiarea OSPF City DesignR1# **show ip ospf 1** Routing Process "ospf 1" with ID 1.1.1.1 Supports only single TOS(TOS0) routes Supports opaque LSA SPF schedule delay 5 secs, Hold time between two SPFs 10 secs Minimum LSA interval 5 secs. Minimum LSA arrival 1 secs Number of external LSA 0. Checksum Sum 0x000000 Number of opaque AS LSA 0. Checksum Sum 0x000000 Number of DCbitless external and opaque AS LSA 0 Number of DoNotAge external and opaque AS LSA 0 Number of areas in this router is 1. 1 normal 0 stub 0 nssa External flood list length 0 Area BACKBONE(0) Number of interfaces in this area is 2 Area has no authentication SPF algorithm executed 3 times Area ranges are Number of LSA 7. Checksum Sum 0x039304 Number of opaque link LSA 0. Checksum Sum 0x000000 Number of DCbitless LSA 0 Number of indication LSA 0 Number of DoNotAge LSA 0 Flood list length 0R1# |

1. **Identify elements of the model that map to IT-related content:**
* Backbone router
* Border area router
* Core area
* OSPF verification commands
	1. show ip protocols
	2. show ip ospf database
	3. show ip ospf