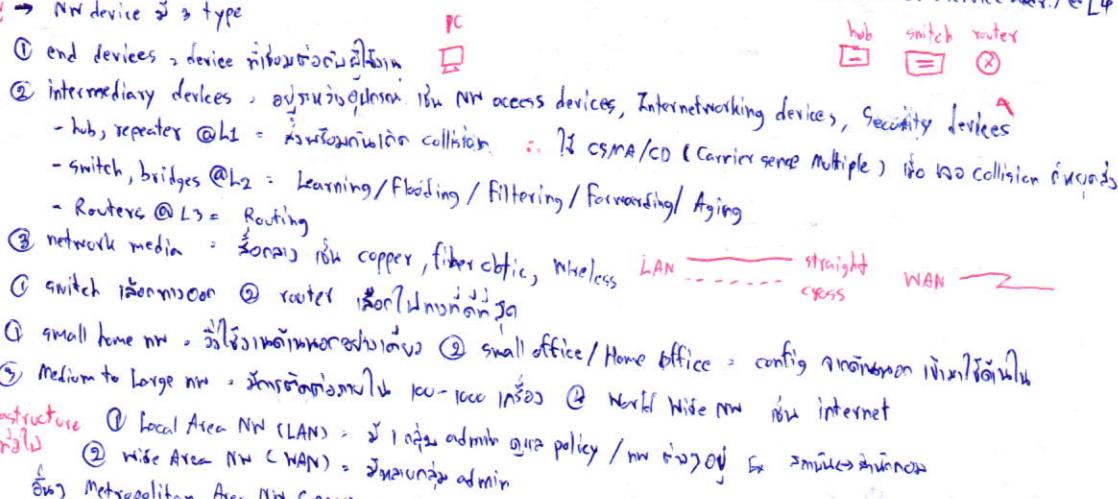
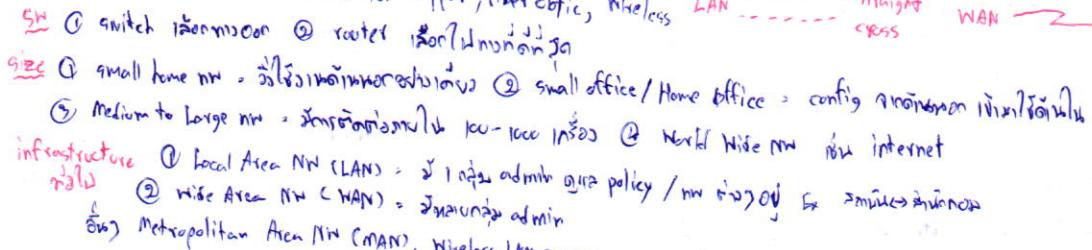


## Chapter 1 Network Overview

- Network diagrams = Diagramm der Netzwerkkomponenten, 2 type
    - ① physical layer / interface (H.W. komponenten) @ Layer 1
    - ② logical layer (Protokoll)
  - Network protocol = TCP/UDP, FTP, SMTP, ICMP, ARP, POP3, IMAP
    - Internet control message protocol = ping (Layer 1)
    - File transfer protocol = Smb file sharing client für server
    - Address Resolution Protocol = Map MAC IP Addr. zu MAC Addr. (Layer 2)
      - \* NW Addr. (① IP Addr. (Logical addr.) @ Layer 3 ② MAC addr (Physical addr.) @ Layer 2 (Protocol or media)) ③ Port number (Service addr.) @ Layer 4
  - Components of Network H.W. → NW device in 3 type

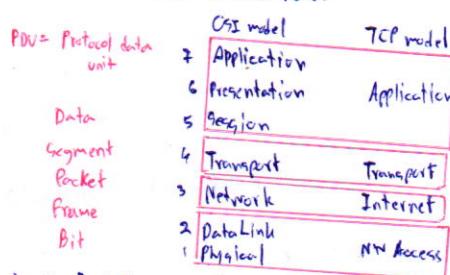


- ## - Types of Networks



- Reliable Network ① fault tolerance = resistencia a fallos ② scalability = escalabilidad ③ security = seguridad ④ Quality of Service (QoS) = calidad de servicio / calidad de servicio al usuario
  - Layer with TCP/IP ⑤ OSI model

- Layer with TCP/IP & OSI model



- Type of Connection in a LAN
    - Point to Point (UTP cat5) : ① BW = 10 Mbps ② cm 100m (connection hub, repeater, switch)
      - WAN connection = 10BaseT with router
        - DCE(female) : serial, command clock rate 5600c
        - DTE (male)
      - serial console (Rollover cable)  $\Rightarrow$  Router, ..., pc
        - $\Rightarrow$  RJ-45 -to- DB-9 Adopters labeled TERNIN
        - $\Rightarrow$  manage command via

## Chapter 2 Basic Router Configuration

- Port Abbrevs @ 14 :  $\{ \text{IANA} \}$  Internet Assigned Number Authority : IANA)
    - o - 1023 : requesting entities "Well Known port"
    - 1024- 49151 : registered port = destination port
    - 49152- 65535 : dynamic or private port "Randomly generates source port"
  - Logical Addresses : IP address (IPv4) @ 14

6x : 20 : FTP (data), 21 : FTP (control), 25 : SMTP (simple mail transfer)  
53 : DNS (domain name servers) [TCP/UDP], 80 : WWW HTTP  
81 : HOST Name server

- 5 classes : A, B, C, D, E  $\rightarrow$  Reserve (90%)       $\text{H}_2\text{O} \rightarrow \text{J}_2\text{O}$

- $\text{Mbps} \text{ per node or com} = \frac{\text{Mbps}}{\text{no. of nodes}}$

- |                           |                      |                            |           |
|---------------------------|----------------------|----------------------------|-----------|
| $192.168.1 / 24$          | prefix range         | logical name (domain name) | ip unique |
| 255.255.255.0             | subnet mask          | Class A                    | 1-127     |
| 192.168.1.255             | broadcast ip address | Class B                    | 128-191   |
| 255.255.255.255           | localhost IP         | Class C                    | 192-223   |
| ↳ routers & switches IP's |                      | Class D                    | 224-239   |
|                           |                      | Class E                    | multiple  |

- Private addressing > ip can reuse
    - > do not care about internet transmission

AFC 1918 Internal Addr. Range

Range A	10.0.0.0 - 10.255.255.255	CIDR Prefix
Range B	192.16.0.0 - 192.16.255.255	10.0.0.0 /8
Range C	192.168.0.0 - 192.168.255.255	192.16.0.0 /12

- Physical Address : MAC Address

- Ethernet : 48 bit MAC =  $12 \text{ bits MAC}_6 \rightarrow \text{MAC}_6 \text{ MAC}_6 \text{ MAC}_6$
  - ~~Protocol~~ for IEEE  $\rightarrow$  ~~Protocol~~  $\rightarrow$  ~~Protocol~~

- **Message Delivery**

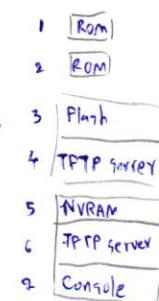
- Unicast = សំណើរបស់អ្នកប្រើបានទៅតាមលេខគម្ពុជា
  - Broadcast = សំណើរបស់អ្នកប្រើបានទៅអំពីចំណែកអាជីវកម្ម
  - Multicast = សំណើរបស់អ្នកប្រើបានទៅអំពីចំណែកអាជីវកម្មដែលមានសំវារណ៍ទូទៅ
  - SIGC, TOS C, ...  
→ និងអនុវត្តន៍ជាបញ្ហាសំណើរបស់អ្នកប្រើបានទៅអំពីទូទៅ

- Cisco IOS (Internetwork Operating System)
    - function ① Addressing ② Interface ③ Routing ④ Managing Resource ⑤ Security ⑥ QoS
    - Router & switch But sequence

- ① POST (Power On Self Test) → check hardware  
② Run boot loader SW <sup>mini-Zes</sup>

- ⑨ Boot loader does low-level CPU initialization  
⑩ Initialize the flash file system

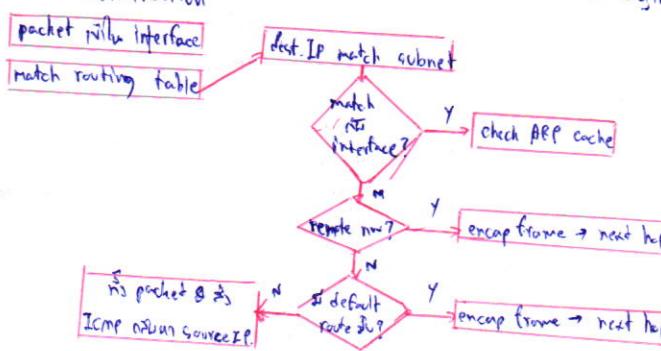
- ⑧ → initialize the flash file system  
ver ⑧ → locate & load a default ICS in romfs & APM



- Accessing a Cisco IOS Device
    - ① Console port ② Telnet ③ Secure Shell (SSH) ④ Aux Port
    - ↳ Terminal Emulation Program : PuTTY, TeraTerm, SecureCRT, HyperTerminal, OS X Terminal
  - Navigating the IOS & 2 mode : ① user "#>" ② privileged (enable) "#>"
  - The Command Structure
    - ① Context Sensitive Help : "?"
    - ② Command Syntax Check : enter `master` before `enable`
    - ③ Hot keys and Shortcuts
    - ④ IOS examination Commands → show...
  - Getting Basic
    - ① Cisco hostname ② IP address ③ Cisco interface addressing ④ Cisco config + criteria ⑤ save config
    - router (config) # hostname name
      - ↳ Banner msg. Router(config) # banner motd# text#
      - ↳ Securing Device Access : Enable password / secret, console pass, VTY pass, Encrypting pass display
    - ⑥ Addressing Devices
      - ① For interface to config
        - Physical interface / Loopback interface
        - Router (config) # interface type port
          - ↳ interface type port
          - ↳ type slot/port
          - ↳ switch virtual interface (SVI)
            - Switch (config) # interface vlan number
      - ② set ip address.
        - router (config-if) # ip address ip-address subnet mask
          - ↳ no shutdown

## Chapter 3 Static Routing & Dynamic Routing protocols

- Function of Router  $\rightarrow$  Characteristic = ① Topology ② speed ③ cost, ④ Security ⑤ Availability ⑥ Scalability ⑦ Reliability
    - Packet Forwarding Methods ① Process switching: packet nötigstes Router  $\rightarrow$  process @ CPU  $\rightarrow$  own interface zuw?
    - ② Fast switching: direkt zu nächstem forward 7.1.5.2 ③ Cisco Express Forwarding (CEF)  $\rightarrow$  forward packet 7.1.5.2
  - Connect Devices
    - Default Gateway  $\rightarrow$  ip nötigstes ① first usable host (1) ② last usable host (254) ip
      - $\rightarrow$  mac address 7.1.5.2 nw zu
    - Enable IP on a Host: ① Statically Assigned IP addr.
      - ② Dynamically
  - Switching Packet between NW
    - Router:  $\rightarrow$  dest.ip @ 1.2.3.4.5.6.7.8.9.10.11.12.13.14.15.16.17.18.19.20.21.22.23.24.25.26.27.28.29.20.30.31.32.33.34.35.36.37.38.39.30.40.41.42.43.44.45.46.47.48.49.40.50.51.52.53.54.55.56.57.58.59.50.60.61.62.63.64.65.66.67.68.69.60.70.71.72.73.74.75.76.77.78.79.70.80.81.82.83.84.85.86.87.88.89.80.90.91.92.93.94.95.96.97.98.99.90.100.101.102.103.104.105.106.107.108.109.100.110.111.112.113.114.115.116.117.118.119.110.120.121.122.123.124.125.126.127.128.129.120.130.131.132.133.134.135.136.137.138.139.130.140.141.142.143.144.145.146.147.148.149.140.150.151.152.153.154.155.156.157.158.159.150.160.161.162.163.164.165.166.167.168.169.160.170.171.172.173.174.175.176.177.178.179.170.180.181.182.183.184.185.186.187.188.189.180.190.191.192.193.194.195.196.197.198.199.190.200.201.202.203.204.205.206.207.208.209.200.210.211.212.213.214.215.216.217.218.219.210.220.221.222.223.224.225.226.227.228.229.220.230.231.232.233.234.235.236.237.238.239.230.240.241.242.243.244.245.246.247.248.249.240.250.251.252.253.254.255.256.257.258.259.250.260.261.262.263.264.265.266.267.268.269.260.270.271.272.273.274.275.276.277.278.279.270.280.281.282.283.284.285.286.287.288.289.280.290.291.292.293.294.295.296.297.298.299.290.300.301.302.303.304.305.306.307.308.309.300.310.311.312.313.314.315.316.317.318.319.310.320.321.322.323.324.325.326.327.328.329.320.330.331.332.333.334.335.336.337.338.339.330.340.341.342.343.344.345.346.347.348.349.340.350.351.352.353.354.355.356.357.358.359.350.360.361.362.363.364.365.366.367.368.369.360.370.371.372.373.374.375.376.377.378.379.370.380.381.382.383.384.385.386.387.388.389.380.390.391.392.393.394.395.396.397.398.399.390.400.401.402.403.404.405.406.407.408.409.400.410.411.412.413.414.415.416.417.418.419.410.420.421.422.423.424.425.426.427.428.429.420.430.431.432.433.434.435.436.437.438.439.430.440.441.442.443.444.445.446.447.448.449.440.450.451.452.453.454.455.456.457.458.459.450.460.461.462.463.464.465.466.467.468.469.460.470.471.472.473.474.475.476.477.478.479.470.480.481.482.483.484.485.486.487.488.489.480.490.491.492.493.494.495.496.497.498.499.490.500.501.502.503.504.505.506.507.508.509.500.510.511.512.513.514.515.516.517.518.519.510.520.521.522.523.524.525.526.527.528.529.520.530.531.532.533.534.535.536.537.538.539.530.540.541.542.543.544.545.546.547.548.549.540.550.551.552.553.554.555.556.557.558.559.550.560.561.562.563.564.565.566.567.568.569.560.570.571.572.573.574.575.576.577.578.579.570.580.581.582.583.584.585.586.587.588.589.580.590.591.592.593.594.595.596.597.598.599.590.600.601.602.603.604.605.606.607.608.609.600.610.611.612.613.614.615.616.617.618.619.610.620.621.622.623.624.625.626.627.628.629.620.630.631.632.633.634.635.636.637.638.639.630.640.641.642.643.644.645.646.647.648.649.640.650.651.652.653.654.655.656.657.658.659.650.660.661.662.663.664.665.666.667.668.669.660.670.671.672.673.674.675.676.677.678.679.670.680.681.682.683.684.685.686.687.688.689.680.690.691.692.693.694.695.696.697.698.699.690.700.701.702.703.704.705.706.707.708.709.700.710.711.712.713.714.715.716.717.718.719.710.720.721.722.723.724.725.726.727.728.729.720.730.731.732.733.734.735.736.737.738.739.730.740.741.742.743.744.745.746.747.748.749.740.750.751.752.753.754.755.756.757.758.759.750.760.761.762.763.764.765.766.767.768.769.760.770.771.772.773.774.775.776.777.778.779.770.780.781.782.783.784.785.786.787.788.789.780.790.791.792.793.794.795.796.797.798.799.790.800.801.802.803.804.805.806.807.808.809.800.810.811.812.813.814.815.816.817.818.819.810.820.821.822.823.824.825.826.827.828.829.820.830.831.832.833.834.835.836.837.838.839.830.840.841.842.843.844.845.846.847.848.849.840.850.851.852.853.854.855.856.857.858.859.850.860.861.862.863.864.865.866.867.868.869.860.870.871.872.873.874.875.876.877.878.879.870.880.881.882.883.884.885.886.887.888.889.880.890.891.892.893.894.895.896.897.898.899.890.900.901.902.903.904.905.906.907.908.909.900.910.911.912.913.914.915.916.917.918.919.910.920.921.922.923.924.925.926.927.928.929.920.930.931.932.933.934.935.936.937.938.939.930.940.941.942.943.944.945.946.947.948.949.940.950.951.952.953.954.955.956.957.958.959.950.960.961.962.963.964.965.966.967.968.969.960.970.971.972.973.974.975.976.977.978.979.970.980.981.982.983.984.985.986.987.988.989.980.990.991.992.993.994.995.996.997.998.999.990.1000.1001.1002.1003.1004.1005.1006.1007.1008.1009.1000.1010.1011.1012.1013.1014.1015.1016.1017.1018.1019.1010.1020.1021.1022.1023.1024.1025.1026.1027.1028.1029.1020.1030.1031.1032.1033.1034.1035.1036.1037.1038.1039.1030.1040.1041.1042.1043.1044.1045.1046.1047.1048.1049.1040.1050.1051.1052.1053.1054.1055.1056.1057.1058.1059.1050.1060.1061.1062.1063.1064.1065.1066.1067.1068.1069.1060.1070.1071.1072.1073.1074.1075.1076.1077.1078.1079.1070.1080.1081.1082.1083.1084.1085.1086.1087.1088.1089.1080.1090.1091.1092.1093.1094.1095.1096.1097.1098.1099.1090.1100.1101.1102.1103.1104.1105.1106.1107.1108.1109.1100.1110.1111.1112.1113.1114.1115.1116.1117.1118.1119.1110.1120.1121.1122.1123.1124.1125.1126.1127.1128.1129.1120.1130.1131.1132.1133.1134.1135.1136.1137.1138.1139.1130.1140.1141.1142.1143.1144.1145.1146.1147.1148.1149.1140.1150.1151.1152.1153.1154.1155.1156.1157.1158.1159.1150.1160.1161.1162.1163.1164.1165.1166.1167.1168.1169.1160.1170.1171.1172.1173.1174.1175.1176.1177.1178.1179.1170.1180.1181.1182.1183.1184.1185.1186.1187.1188.1189.1180.1190.1191.1192.1193.1194.1195.1196.1197.1198.1199.1190.1200.1201.1202.1203.1204.1205.1206.1207.1208.1209.1200.1210.1211.1212.1213.1214.1215.1216.1217.1218.1219.1210.1220.1221.1222.1223.1224.1225.1226.1227.1228.1229.1220.1230.1231.1232.1233.1234.1235.1236.1237.1238.1239.1230.1240.1241.1242.1243.1244.1245.1246.1247.1248.1249.1240.1250.1251.1252.1253.1254.1255.1256.1257.1258.1259.1250.1260.1261.1262.1263.1264.1265.1266.1267.1268.1269.1260.1270.1271.1272.1273.1274.1275.1276.1277.1278.1279.1270.1280.1281.1282.1283.1284.1285.1286.1287.1288.1289.1280.1290.1291.1292.1293.1294.1295.1296.1297.1298.1299.1290.1300.1301.1302.1303.1304.1305.1306.1307.1308.1309.1300.1310.1311.1312.1313.1314.1315.1316.1317.1318.1319.1310.1320.1321.1322.1323.1324.1325.1326.1327.1328.1329.1320.1330.1331.1332.1333.1334.1335.1336.1337.1338.1339.1330.1340.1341.1342.1343.1344.1345.1346.1347.1348.1349.1340.1350.1351.1352.1353.1354.1355.1356.1357.1358.1359.1350.1360.1361.1362.1363.1364.1365.1366.1367.1368.1369.1360.1370.1371.1372.1373.1374.1375.1376.1377.1378.1379.1370.1380.1381.1382.1383.1384.1385.1386.1387.1388.1389.1380.1390.1391.1392.1393.1394.1395.1396.1397.1398.1399.1390.1400.1401.1402.1403.1404.1405.1406.1407.1408.1409.1400.1410.1411.1412.1413.1414.1415.1416.1417.1418.1419.1410.1420.1421.1422.1423.1424.1425.1426.1427.1428.1429.1420.1430.1431.1432.1433.1434.1435.1436.1437.1438.1439.1430.1440.1441.1442.1443.1444.1445.1446.1447.1448.1449.1440.1450.1451.1452.1453.1454.1455.1456.1457.1458.1459.1450.1460.1461.1462.1463.1464.1465.1466.1467.1468.1469.1460.1470.1471.1472.1473.1474.1475.1476.1477.1478.1479.1470.1480.1481.1482.1483.1484.1485.1486.1487.1488.1489.1480.1490.1491.1492.1493.1494.1495.1496.1497.1498.1499.1490.1500.1501.1502.1503.1504.1505.1506.1507.1508.1509.1500.1510.1511.1512.1513.1514.1515.1516.1517.1518.1519.1510.1520.1521.1522.1523.1524.1525.1526.1527.1528.1529.1520.1530.1531.1532.1533.1534.1535.1536.1537.1538.1539.1530.1540.1541.1542.1543.1544.1545.1546.1547.1548.1549.1540.1550.1551.1552.1553.1554.1555.1556.1557.1558.1559.1550.1560.1561.1562.1563.1564.1565.1566.1567.1568.1569.1560.1570.1571.1572.1573.1574.1575.1576.1577.1578.1579.1570.1580.1581.1582.1583.1584.1585.1586.1587.1588.1589.1580.1590.1591.1592.1593.1594.1595.1596.1597.1598.1599.1590.1600.1601.1602.1603.1604.1605.1606.1607.1608.1609.1600.1610.1611.1612.1613.1614.1615.1616.1617.1618.1619.1610.1620.1621.1622.1623.1624.1625.1626.1627.1628.1629.1620.1630.1631.1632.1633.1634.1635.1636.1637.1638.1639.1630.1640.1641.1642.1643.1644.1645.1646.1647.1648.1649.1640.1650.1651.1652.1653.1654.1655.1656.1657.1658.1659.1650.1660.1661.1662.1663.1664.1665.1666.1667.1668.1669.1660.1670.1671.1672.1673.1674.1675.1676.1677.1678.1679.1670.1680.1681.1682.1683.1684.1685.1686.1687.1688.1689.1680.1690.1691.1692.1693.1694.1695.1696.1697.1698.1699.1690.1700.1701.1702.1703.1704.1705.1706.1707.1708.1709.1700.1710.1711.1712.1713.1714.1715.1716.1717.1718.1719.1710.1720.1721.1722.1723.1724.1725.1726.1727.1728.1729.1720.1730.1731.1732.1733.1734.1735.1736.1737.1738.1739.1730.1740.1741.1742.1743.1744.1745.1746.1747.1748.1749.1740.1750.1751.1752.1753.1754.1755.1756.1757.1758.1759.1750.1760.1761.1762.1763.1764.1765.1766.1767.1768.1769.1760.1770.1771.1772.1773.1774.1775.1776.1777.1778.1779.1770.1780.1781.1782.1783.1784.1785.1786.1787.1788.1789.1780.1790.1791.1792.1793.1794.1795.1796.1797.1798.1799.1790.1800.1801.1802.1803.1804.1805.1806.1807.1808.1809.1800.1810.1811.1812.1813.1814.1815.1816.1817.1818.1819.1810.1820.1821.1822.1823.1824.1825.1826.1827.1828.1829.1820.1830.1831.1832.1833.1834.1835.1836.1837.1838.1839.1830.1840.1841.1842.1843.1844.1845.1846.1847.1848.1849.1840.1850.1851.1852.1853.1854.1855.1856.1857.1858.1859.1850.1860.1861.1862.1863.1864.1865.1866.1867.1868.1869.1860.1870.1871.1872.1873.1874.1875.1876.1877.1878.1879.1870.1880.1881.1882.1883.1884.1885.1886.1887.1888.1889.1880.1890.1891.1892.1893.1894.1895.1896.1897.1898.1899.1890.1900.1901.1902.1903.1904.1905.1906.1907.1908.1909.1900.1910.1911.1912.1913.1914.1915.1916.1917.1918.1919.1910.1920.1921.1922.1923.1924.1925.1926.1927.1928.1929.1920.1930.1931.1932.1933.1934.1935.1936.1937.1938.1939.1930.1940.1941.1942.1943.1944.1945.1946.1947.1948.1949.1940.1950.1951.1952.1953.1954.1955.1956.1957.1958.1959.1950.1960.1961.1962.1963.1964.1965.1966.1967.1968.1969.1960.1970.1971.1972.1973.1974.1975.1976.1977.1978.1979.1970.1980.1981.1982.1983.1984.1985.1986.1987.1988.1989.1980.1990.1991.1992.1993.1994.1995.1996.1997.1998.1999.1990.2000.2001.2002.2003.2004.2005.2006.2007.2008.2009.2000.2010.2011.2012.2013.2014.2015.2016.2017.2018.2019.2010.2020.2021.2022.2023.2024.2025.2026.2027.2028.2029.2020.2030.2031.2032.2033.2034.2035.2036.2037.2038.2039.2030.2040.204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- ## - The Routing Table

1) 10.1.0.24 10.2.2.102 via 209.14.20.22, cost 1, serial 0/0/0  
Tosnaro.25 directly connected, Bz Prof, D=IGRP, S=static  
destination not via  
administrative distance of the route source  
metric to reach the remote netw. counts  
next hop ip addr. 209.14.20.22 not in use  
time  
outgoing interface control link

Config : Next-hop option

Router(config)# interface G0/0  
-----if# ip address 192.168.1.125 255.255.255.0

```
Ruter1(config) # ip route 128.1.1.0
```

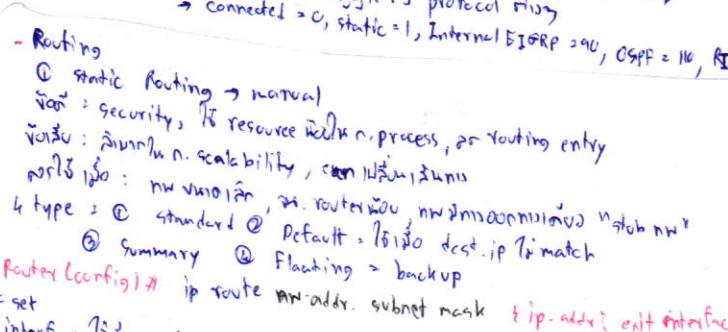
get default static route

• Router static route

- ② Dynamic Routing Protocol  $\rightarrow$  ADT

- ## Q.1 EGPC Exterior Gateway Routing Protocol :: BGP

- ## ② IGPC Interior



- Classful Addressing  $\rightarrow$  update only class
  - Classless Inter-Domain Routing
    - summarization និងគ្រប់គ្រង ① សម្រាប់គ្រប់គ្រង
  - Set Subclasses ip នៃការ ពិនិត្យ នៃ IP  $\rightarrow$  សម្រាប់
    - ② Group bit នូវអាជីវកម្ម
  - VLSM
    - Fixed Length Subnet Masking ពីរណ៍ ① prefix length - prefix len = no. bit នូវកម្លា
    - ② លើកកម្លា នូវការពិនិត្យ នៃ IP នូវ

Chapter 4 Distance Vector Routing Protocol RIP ver 1

## - Dynamic Routing Protocol

- $f(x) = \text{distance} + \text{hop}$  : units router, own routing table contains topology information (distance). in best path
- purpose : find remote nw (neighbor), exchange routing info, learn best path to dest. nw, update in new best path info
- component :
  - Algorithm : finds routing info has best path
  - Routing Protocol msg. : informs neighbor nw. includes routing info (best path)

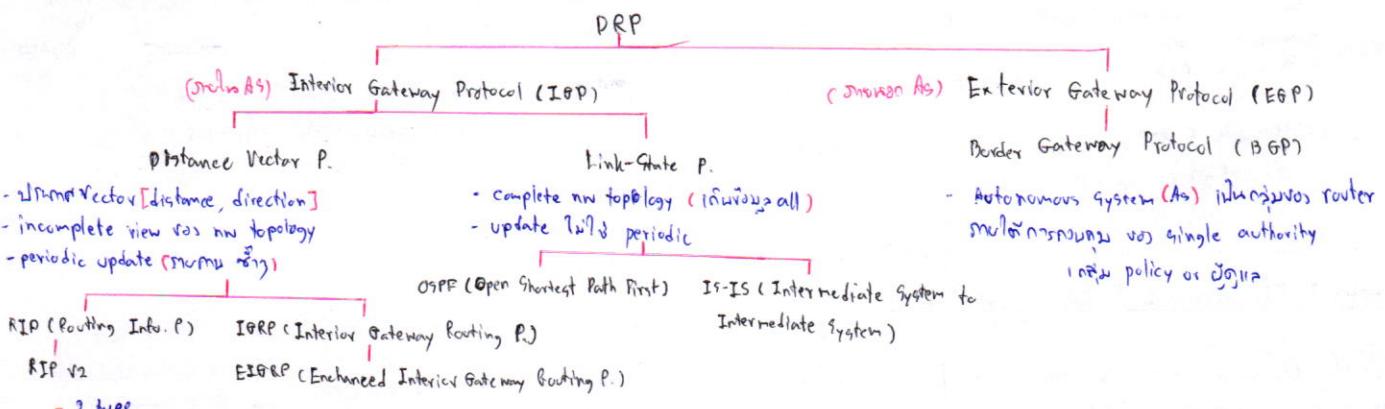
## Dynamic routing

## VS

## Static routing

networks config	<del>use nw (same link)</del>	<del>use nw (from command by router)</del>
Required config, admin	Advance (bec. config basic → config + update own topology info auto)	Simple (from command by router)
Topology change	simple but complex (router update directly from neighbors)	admin config (from command)
Scalability	modest	simple topology
Security	modest	modest
Resource usage	CPU, mem (info routing info), link, bandwidth	Route → dest. modicum
Predictability	Route & current topology	modicum

## - Classifying Routing Protocol



- ① Classful routing P. → update w/o class info subnet mask in routing update
  - ② Classless routing P. → w/o subnet mask in routing update
    - Convergence : gradually routing table reach router synchronization (consistent)
    - ↳ 2 type : slower > RIP than IGRP, faster (w/o update into inconsistent state) = EIGRP vs. OSPF
  - Routing Protocol Metric
    - Metric : number of hop to final dest. nw to find best path (w/o Hop Count, BW, Cost, Delay, Load, Reliability)
    - Load balancing : nw address > 1 metric (link) → 1 hop to 2 different routers (multiple paths)
  - Administrative Distance of a Router (AD)
    - 1 to 255 : indicates dependencies w/o particular (medium) route
- | Route Source | Connected | Static | Internal | EIGRP | OSPF | RIP | BIGRP | summary route | External | IGRP | IS-IS | External | Internal |
|--------------|-----------|--------|----------|-------|------|-----|-------|---------------|----------|------|-------|----------|----------|
| AD           | 0         | 1      | 00       | 110   | 120  | 5   | 20    | 100           | 115      | 170  | 200   | 200      | 200      |

## - Distance Vector Routing Protocol Ex. RIP, IGRP, EIGRP

- Distance Vector Technology mostly 2<sup>nd</sup> hop router
  - ① Vector or direction, minimum configuration
  - ② Distance to final dest. (cost)
- process: w/o periodic (continuous) update, neighbor (self-loop), broadcast (255.255.255.255) update, 1st routing table w/o info (no update)
- process: w/o Routing Protocol : 10.0.0.1 check 10.0.0.2 ① Time to convergence (minimum steady state w/o routing table) ② Scalability ③ Resource usage ④ Implementation & Maintenance

## - NW Discovery (initial) (in basic config dian)

- ① Cold start : Router Initial Start up

- ② Initial Exchange of Routing Info. → 10.0.0.1

- ③ Exchange of Routing Info → update (w/o hop count, routing info.)

## - Routing Table Maintenance

- Periodic update : RIP update timer (default 90s), Invalid timer (info is lost) (default 180s), Hold down timer (if down → hold 2x half up max) (default 180s), Flush (if) timer (default 240s)

- Boundary (external) Update : EIGRP → update neighbor

- Triggered Update → update (w/o periodic time)

- Random Filter → filter nw info multiple access router network (boundaries) → filter update random (random filter)

Network	Interface	Hop
10.2.0.0	Serial0/0	0
10.3.0.0	Serial0/0	0
10.1.0.0	Serial0/0	1
10.4.0.0	Serial0/0	1

10.2.0.0, 1	←	10.3.0.0, 1
10.1.0.0, 2	→	10.4.0.0, 2

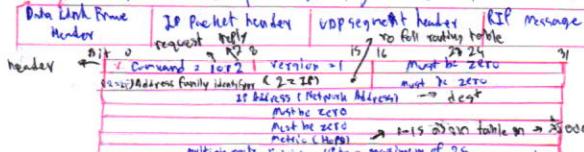


-	Router Statistics DIR.	① Routing loops from interface that down to neighbor advertisement (to update to hop limit +∞)
Speed convergence	slow	RIPv1 RIPv2 EIGRP
Scalability "size nw"	small	slow small fast
Use of VLSM	x	✓ x ✓
Resource usage	low	low medium
Implementation & maintenance	simple	simple complex

### - RIP version 1 AD = 120

- propagation : classful, DV = metric = hop count • hopcount > 15 unreachable • update board cost no route

encapsulated (VTP) / IP segment src source & dest port = 520 - msg type



- Basic RIP v1, Config ① in basic config ② as router rip + info nw

- Verification (config) & troubleshooting (terminal) show running-config or ip route or ip protocol & debug ip-rip

- passive interface command (not update interface) & (config-router) # passive-interface interface type (Fa0/0, S0/0) interface number (0/0, 0/0/0)

- Automatic Summarization : RIP auto summarizes classful nw → 16bit size routing table

↳ Router : no 9-size routing table → single router association multiple route 16bit in routing table

→ Router : support discontiguous nw (major nw boundary not boundary) → 0.0.0.0 load balancing for

boundary routers : summarizes RIP subnet sum 1 major nw boundary

→ Processing RIP update : get info & don't update if its interface in classful boundary → y : update subnet nr 16 or 172.16.0.0

- default route & RIP v1, in 16bit size routing table (bec b/c max protocol) → 0.0.0.0 default route  
R(config) # ip route 0.0.0.0 0.0.0.0 s0/0/1

→ Default info originate command → info update 16bit ip address : static vs dynamic  
router (S0/0/1) 2 protocol R(config-router) # default-information originate

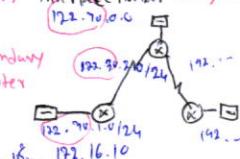
→ 16bit interface config (16bit size)

③ Response → add info via routing table

→ ip address 11.0.0.1 class A, B, C

R1(config) # router rip

R1(config-router) # network 11.0.0.0 0.0.0.255



### Chapter 5 RIP version 2 & Access Control Lists

RIP v1	vs	RIP v2
classful (fixed subnet mask, no support CIDR) not support discontiguous subnet not support VLSM b/c. fixed subnet mask routing update ⇒ board cast		classless (update subnet mask, support Variable Length Subnet Masking (VLSM), support Route summarization update next hop address) no authentication routing (support discontiguous subnet) Routing update ⇒ multi cast

IS

IS filter via routing loop

IS split horizon or split horizon with poison reverse

IS triggered update

max hop count = 15

- Joining to RIP v2,

- virtual interface { - loopback interface → ping → ip virtual interface → reply →  
multicast routing { - null interface → 1500ms channel interval → 1500 null interface + packet discard (0) → timer at 15 update interval → static route  
- static route & null interface → null interface 0.0.0.0/0 via static route  
R(config) # ip route summary static-route subnet-mask Null0  
(no for nw) → via static supernet route

- Route redistribution (Routers) → send ip rip 3 in static configuration (use rip as static protocol) R(config-router) # redistribute static

- Verify & Test connectivity : show ip interface brief, ping (src: !-ip, v: unreachable, t: time out), trace route

- RIPv1: classful, fixed subnet mask, summarize nw in major nw boundaries, in nw 0.0.0.0/24 contiguous & RIPv1 config convergence 8-10s

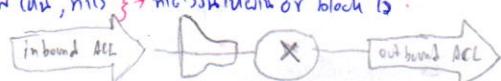
- 0.0.0.0 routing table debug ip rip (content of routing update), in 16bit RIP v1 → 253 subnet mask as in nw address

for Staples

## - RIP v2

- Config → Enabling & Verify (configuration) RIP v2
- Config RIP → RIPv2 → ผู้ตั้งค่า RIP v2, ไม่ระบุ V1, V2 ให้เป็น V1, V2
- Auto-Summary & RIP v2 → auto sum route ที่ major nw boundaries
- disabling Auto-Summary : no auto-summary b.c. ไม่รู้ nw topology จึงทำให้ discontinuous
- VLSM & CIDR → verify info ที่ config ให้ RIP v2 debug ip rip
  - VLSM → เรียกเก็บ nw address & subnet mask
  - CIDR → Is supernetting (= bunch of contiguous classful nw ที่มี address just one single nw)
  - verify show ip route, debug ip rip
- Access Control List → ผู้ตั้งค่า ACL → assign → check source → dest คืออะไร?
  - กรณี conversation [ กรณี FTP connection? ]
  - Packet Filtering ① dest, source ที่ Layer 2 ② protocol ที่ ③ ที่ nw ที่มา, ที่ไป { message filtering or block ? }
  - Operation → รีบวน sequence statement
    - last statement ที่ implicit deny → block → discard

RIP v2	23	1516	24	32
command = 1 or 2   version = 2	Must be zero			
Address family identifier (22 IP)	Route Tag			
IP Address Network Address	Subnet Mask			
Subnet Mask	Next Hop			
Next Hop	Metric (hops)			
	Multiple Route Entries, up to a maximum of 25			



## Extend IP ACLs

- check source & destination address
- who permits or denies specific (Layer 3) protocol
- access-list 10 permit top 192.168.70.0 0.0.0.255 any eq 80
- number ACL : 100 - 199 & 2000 - 2699

for Staples

- Guideline for (๒๖) → One ACL / Protocol = ระบุ traffic flow ที่ interface, ACL ที่ define นั้น protocol enable on interface
- ACL creation → One ACL / direction = ระบุ traffic flow ที่ interface, ไม่ระบุ protocol บน interface, ให้ ACL ดูใน in & out bound traffic

→ one ACL / interface = ACL ที่จะดู traffic ที่ interface, ให้ ACL ดู in & out bound traffic

→ Where → Extended ACL ที่ close source, Standard ACL ที่ 1. ที่ destination

- Config ACLs → standard Router(config)# access-list access-list-number
  - number
  - Protocol not to match not (permit, deny, remark)
  - in Interface
  - to match not (permit, deny, remark)

Router(config)# access-list access-list-number  
0-99, 1300-1999

deny | permit | remark comment

access-list num # permission

source [source-wildcard] [log]

Router(config-if)# ip access-group

{ access-list-number | access-list-name }

in | out

๓. remove all : no-access-list

๔. no user# → ลบ user # ที่มี

๕. remove all : no-ip access-group

๖. ลบ user # ที่มี

✓ ลบ user #

- verify : show ip interface, show access-list

- securing VTY port → configuration ที่ permit 192.168.1.1 ที่ต้องการ

→ extended : filter source/dest address, protocol, port number

access-list access-list-number { deny | permit | remark }

ip, tcp, udp protocol source [source wildcard] [operator operand]

[port port-number or name] destination [destination wildcard]

[operator operand] [port port-number or name] [established]

- รูปแบบ 1 ถูก standard

- รูปแบบ 2 ระบุ number ของ name

- debug-output: debug ip packet ACL number

## Chapter 6 OSPF &amp; DHCP

§ info all

(for digistray)

- Link-state Routing Protocol : โปรโตคอลที่สร้าง complete map ของ nw topology ขึ้นมา → shortest-path first (SPF)

→ ข้อดี : ① Large nw ② fast convergence ③ admin ไม่ต้อง管

→ ข้อเสีย ① learn info via link ② say hello neighbor ③ 10x info มาก Link-state Packet (LSP) ④ router flood LSP to all neighbor

→ ข้อดี : db ของ router ให้ LSP ที่รู้เรื่องใน db (binary tree) + Adding OSPF → routing table

→ ข้อดี : ① สร้าง topology map ของ unshortest path ② fast convergence รองรับ load balancing ③ LSP ของ OSPF ที่มี relation topology

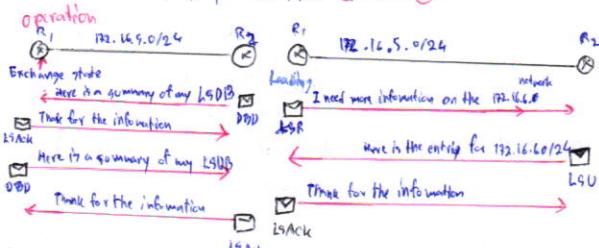
→ division shortest path ④ hierarchical design (nw hier) → แบ่ง resource dec. ตามอยู่ใน area

→ ข้อเสีย : ① menunisi ใน link-state isoc ② ใช้ CPU หนาแน่น ③ ข้อมูล LSP มาก 98% BW bandwidth

for Staples



- OSPF AD = 110
  - 3 table: ① Neighbor Show ip ospf neighbor ② Topology (map) Show ip ospf database ③ Routing (shortest path)
  - message → Encapsulating: MAC Dest = Multi-Cast: 01-00-5E-00-00-05 or 01-00-5E-00-00-06, protocol field = 89
    - type OSPF Packet:
      - : 01 Hello → npn los (default: multiaccess & point-to-point nw) npn los (default: rev broadcast multiaccess [NMAN])
      - : 02 DB Description (DBD) → synchronization db info.
      - : 03 Link-State Request (LGR) → request link-state
      - : 04 Link-State Update (LSU) → send update link-state
      - : 05 Link-State Acknowledgment (LSAck) → received?/nau
  - operation: ~~transitions~~ ① Down state (initial) → ② Init state (sends hello) → ③ Two-way state (receives hello) → Exchange state → Loading state → Full state (receives routes update via osa) (initial)
  - Config Single-Area OSPF v2 router ospf process-id → 1-65,535, also locally significant
    - R (config-router) # router-id 1.1.1.1 → easiest way to loopback, active interface ip 2.2.2.2 in net ① 2.2.2.2 ②
    - router ospf process-id
    - network network-address wildcard-mask area area-id
  - OSPF cost → ⑤ BW default [default reference BW = 10<sup>6</sup>]
    - Cost =  $\frac{10^6}{\text{bw bps}}$
    - Interface BW bps
      - 10 Gb Ethernet =  $100 \times 10^6 \rightarrow \text{cost} = 1$
      - Gb " =  $10 \times 10^6 \rightarrow \text{cost} = 1$
      - Fast " =  $10^6 \rightarrow \text{cost} = 1$
      - Serial " =  $1.544 \times 10^6 \rightarrow \text{cost} = 64$
  - calculate cost
    - default ref BW
    - auto-cost reference-bandwidth bandwidth\_mbps
      - Fast Ethernet " " 100 (mb/s)
      - Gigabit Ethernet " " 1000 (mb/s)
      - 10 Gigabit Ethernet " " 10000 (mb/s)
  - default BW R(config-if) # bandwidth 64 (EIGRP & OSPF manip)!
  - default cost R(config-if) # ip ospf cost 15625



- verify OSPF show ip ospf neighbor, show ip protocol, show ip ospf interface brief, show ip ospf
  - more config
    - Redistributing an OSPF Default Route  
R(config)# ip route 0.0.0.0 0.0.0.0 loopback N  
R(config)# router ospf process-id  
R(config-router)# default-information

- DSCP (Dynamic Host Configuration Protocol) → originated from IGP → default route update PDU in OSPF

- method ① Manual Allocation : admin assign ips
  - ② Automatic Allocation : DHCPv4 auto assign address from pool & tell lease time
  - ③ Dynamic Allocation : (auto assign ip w/ lease time)

- Config R1(config)# ip dhcp excluded-address 192.168.1.100 lease time → 0 billion lease time and re-ip Quiz

ii ip dhcp exclude - address 192.168.10.9  
ii ip dhcp pool LAN-POL-1 ~~is pool~~

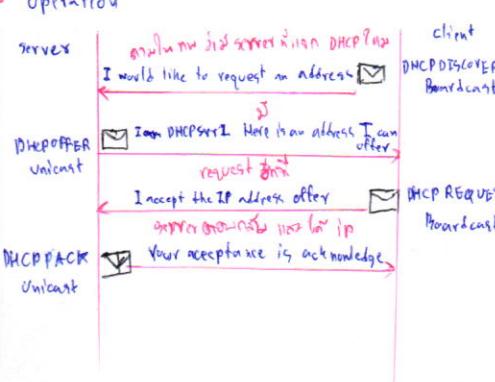
show running-config section|delp  
show ip dhcp binding  
show ip dhcp server statistics

- Config DHCP client (use ipif0 client) - if) \* ip address dhcp

- ជា ip រាយក្រឱ្យ → cmd → ip config /release  
 → ip - config /renew , ip config /all  
 → សំណងចិត្ត (នូវការ set ip)

- Config DHCP client (no ip/fü client) - if # ip address dhcp
  - connection " " no shutdown

- To disable dhcp no service dhcp



## Chapter 7 Basic Switch Address Resolution Protocol

- LAN Design → Borderless network design :  $\text{Single} \rightarrow \text{- Hierarchical, - Modularity, - Resiliency, - Flexibility}$
  - 2 elements: ① 3-Tier LAN design shows 1) core 2) Distribution 3) Access ② 2-Tier LAN design shows 1) Collapsed Core/Distribution 2) Access
  - Network layers
    - Core** → optimization strategy → reflect speed ↑ from switch to switch } Layer 3 support, [Fibre / 10Gb Ethernet]
    - Distribution** → routers, switches [1, 2], security policy, Access Ctrl } Redundant components →  $\frac{\text{Switch}}{\text{PoE}}$
    - Access** → end device, port security, VLAN, [PoE / Gig Ethernet] } Power over Ethernet  $\frac{\text{Switch}}{\text{PoE}}$  or  $\frac{\text{Hub}}{\text{PoE}}$
  - LAN & WAN: LAN = BW & broadcast domain, WAN = routing, switching
    - 1 LAN, 1 power line
  - FDDI & ATM Server ① Enterprise SC (switching center) → connects @ MDF (Main Distribution Facility: core) → multi-directional ring network
    - 2 Workshops S. learning → connects @ IDF Intermediate Distribution → broadcast cross line access
  - Collision detection issue (skewness between switches)
  - Segmentation issue (switches) →  $\frac{\text{VCC (Vertical cross-connect)}}{\text{HCC (Horizontal connection)}}$ : optical fibre:  $\rightarrow \text{MDF} \leftrightarrow \text{IDP}$
  - Broadcast domain issue →  $\frac{\text{Broadcast domain}}{\text{MAC Addr.}}$ : Broadcast now mechanism
    - Broadcast domain split single collision domain → smaller collision domain  $\Rightarrow$  collision on LAN segment:  $\frac{\text{L2}}{\text{L3}}$  device  $\Rightarrow$  hub/bridges, switches
    - Broadcast domain splitting port (L3)  $\Rightarrow$  MAC filter/segment broadcast  $\Rightarrow$  unicast delivery
  - SAN Environment

6 pages

- SW operation
    - ① Learning: If frame is SW to SW → MAC Addr. stored in port list + reset aging
    - ② Aging: Expires MAC Addr. → removes →  $\rightarrow$
    - ③ Flooding: If frame dest. part not SW (so frame will 1). Broadcast, 2). Multicast, 3). unknown unicast  $\rightarrow$  min dest (W/o) in table
    - ④ Forwarding: SW dest (mindest table)
    - ⑤ Filtering: SW dest min port min dest (source & dest in same interface)  $\rightarrow$  min filter  $\rightarrow$
  - SW methods
    - ① Store & Forward: SW  $\rightarrow$  check CRC & error  $\rightarrow$  if yes  $\rightarrow$  2nd  $\rightarrow$  3rd, auto buffer
    - ② Cut-through: SW  $\rightarrow$  check source address (dest, source address is bytelen) [10 ms], No FCS & auto buffer
      - $\hookrightarrow$  2 mode ① fast-forward ~ 12 byte ② Fragment-free ~ 64 byte:  $\because 64 = 10 \times 8 \rightarrow 10 \times 2$
  - SW domains
    - ① Collision Domains  $\rightarrow$  domain  $\rightarrow$  collision probability  $\rightarrow$  "QoS @ SW interface"
    - ② Broadcast Domains  $\rightarrow$  ...

## -- Basic GW Concept & Configuration

- Basic SW Config
    - if Port Config
    - int f0/0 startup-config / s(config) / flash / version / ip f0/0 no address-table
    - SW boot sequence = some router routers
      - Router# s(config-if)# ip address IP subnet
      - Router# s(config-if) no shutdown
    - Preparing of Basic SW Management : Gw7/0/0 Loopback : interface SRI (SW Virtual Interface) → VLAN
      - Vlan intf → s(config-if) duplex full → s(config-if) speed 100 (full speed)
      - Auto-MDIX when sw port connection cross-over but mandatory Duplex
    - Config SW port → duplex communication ① Full ② Half (SW នៃពាណិជ្ជកម្មបានលើកឡើង)
  - SW Security : Security Remote Access → SSH (Secure Shell) TCP port 22, telnet : TCP port 23
    - Config : S-C(config)# ip domain-name &gt; # crypto key generate rsa → # username admin pass cisco → line vty 0 15 → change host name
    - line) # transport input ssh → - line) # login local [ Verify SSH : show ip ssh, show ssh ]
  - SW Port Security → Access Policy filter MAC Addr. 70:01:00:70:70:70
    - s(config) - if) # switchport mode access → # switchport port-security → 120sec 1 VLAN
    - Secure MAC Addr. → ① Static : S(config-if) # switchport port-security mac-address MAC-Addr
    - ② Dynamic : S(config-if) # switchport port-security mac-auth-fail enable

CNT INR an. MAC : # Switchport port-security mode

violation mode: C protect : security violation protect mode

② restrict :: security violation restrict mode > kill

③ shutdown :: security violation shutdown mode → fault

[Verify : show port-security int fa0/0 Show port-security]

Security Violation mode					
Violation mode	Firewall Traffic	Send system message	Displays Errors Message	Increases violation counter	Shut Down port
Protect	No	No	No	No	No
Restrict	No	Yes	No	Yes	No
Shutdown	No	No	No	Yes	Yes

Type : class C  
Subnet mask : 255.255.255.0  
Default gateway : 192.168.1.1  
MAC address : 00-0C-29-0A-0B-0C

114 : Classless [Page 1-2] :- Variable Length Subnet Masking (VLSM) : Using the Division  $\rightarrow$  Increasing  $\rightarrow$  128  
-fixed  $\rightarrow$  128 no. of bits

Chapter 8 LAN Redundancy & Spanning Tree Protocols (STP)

- Issue with Layer 1 Redundancy: ① MAC Addr. instability → MAC addr-table ~~is~~ ~~is~~ ~~is~~ ~~is~~ becomes unreliable  
② Broadcast storms → ~~ausbreitung~~ ③ Multiple frame transmission → start: unknown unicast → ~~in~~ ~~dest~~ ~~löschen~~ frame but source is 1 frame



- STP → port priority : min block port → block port → limitation traffic in information
- port 1 in Root Bridge has priority min [Rule: 1 1 RB / 1HW 2 1RP / 1RB 3 1DP / segment]
- in BPDU → 2 in path cost all 3 in Root port → path cost min elected Designated Port
- (Bridge = data unit) 4 from segment & path cost min → 5 BID (min) of designated port → elected block port
- ↳ 6 RB & source [802.1D]
- Config : 6.1 Spanning-tree VLAN 1 root primary 6.2 Spanning-tree VLAN 1 priority 24576 (16 bit)
- (if S1, S2 are RB) 6.3 Spanning-tree VLAN 1 root secondary [Verify: show spanning-tree]
- IEEE Extended System ID : 8. priority → Priority (per VLAN) + MAC Addr. 9. BID = 12 byte
- PVST + (Cisco-specific IEEE 802.1D STP) → more load balancing function port/vlan
- [Verify: show spanning-tree active]
- Rapid PVST+ → no Alternate port (2nd block port can be chosen, 2nd link)
- ↳ max 8 Edge Port @ port on host/router → 8F # spanning-tree port fast
- link type : port to point-to-point
- 8F # spanning-tree bpdu guard enable → port disabled bpdu (loop)
- Config : 6.1 Spanning-tree mode rapid-pvst → # int in p-to-p → # spanning-tree link-type point-to-point

- BPDU fields
- ① BPDU flag (Priority 16 bit)
  - ② BID (source MAC address)
  - ③ Path cost (source)
  - ④ Sender's BID (source)
  - ⑤ Sender's port (source)

Protocol	Standard	Resources Needed	Convergence	Tree Calculation
STP	802.1D	Low	Slow	All VLANs
PVST+	Cisco	High	Slow	Per VLAN
RSTP	802.1Q	Medium	Fast	All VLANs
Rapid PVST+	Cisco	Very High	Fast	Per VLAN
MSTP	802.1Q Cisco	Medium or High	Fast	Per Instance

## Chapter 9: VLANs & Inter-VLAN

- VLAN : part of network (switched network or broadcast domain) Layer 2 in SW transmission domain VLAN 100 ports
- VIO : - security, - cost, - broadcast domain, - VLAN ID, VLAN ID. [Verify: show vlan brief]
- in a Multi-SW Environment
- VLAN trunk : get it into switches in VLAN → can carry many VLANs > 1 VLAN
- ③ L config : in intf → 8F # switchport mode trunk [Verify: show int fa0/0 switchport]
  - Tagging Ethernet frames (IEEE 802.1Q) : Ethernet frame → Dest/MAC Src/MAC Tag Type/Length Data/FCS → Tag indicates VLAN when switch Trunk
  - Assignment : VLAN number → 1-1005 (no config @ vlan.dat in flash) → 808-4096 (no config @ running-config in VRAM)
    - ① 8.1.3 : 8.1(config)# vlan vlan-num & (vlan) # name to
    - ② 8.1.4 : 8.1(vlan database) → (vlan) # vlan num name to
- ② - assign port to VLAN : intf → 8F # switchport mode access → # switchport access vlan num (intf : int no VLAN + VLAN num)
  - Verify: show vlan interface & 80, show vlan summary, show int vlan num
  - (8.1.1.1 : no VLAN num)
- Inter-VLAN Routing → router set VLAN trunk "sub interface"
- Config :
  - ① get basic routing (get ip address, no shutdown)
  - ② R(config)# interface fa0/0.10 → VLAN → -subif# encapsulation dot1q 10 → # ip address ip subnet-mask

Native (base) VLAN  
Untagged & Untag → Local intf 7012  
(8.1.1.1)

## Chapter 10: VTP (VLAN Trunking Protocol) → manage VLAN & NAT (NW Addr. Translation)

- VTP [msg: ISL or IEEE 802.1Q] → manages SW VTP within organization domain
- operation : - auto update of VTP revision number 8 bit (0-4294927295) [8.1.1.1]
- ↳ mode : ① Server → can add, remove, rename VLAN within domain config ② Client → 8.1.2.2 VTP process, no VTP msg on my trunk ③ Transparent → can add, remove, rename VLAN within, transparent
- Config : 2.1.1.1 : 1) SW Cisco 2) J trunk (8.1.2.2) SW 3) to domain 4) 8.1 mode
  - ① in global configuration 8.1(config)# vtp version → # vtp domain & → # vtp password pass → # vtp mode server | mode client
  - ② in VLAN configuration 8.1(vlan) # vtp v2-mode [Verify: show vtp status / counters] → # vtp server/client/transparent
- Pruning → VLAN traffic filtering in interface based on config in interface (8.1.2.2) [remove VLANs]
  - 8.1.2.2 vtp pruning → in interface → 8.1(config-if)# switchport trunk pruning vlan remove vlan-num
- NAT → takes private IP → public IP/real IP
- terminology : 4 types : ① Inside Local Addr. (private IP) ② Outside Local Addr.
  - ③ Inside Global Addr. ④ Outside Global Addr. → same IP
- type : ① Static : 8.1.2.2 [map : 1 to 1] ② R(config)# ip nat inside static local-ip global-ip
- ② Dynamic : if pub vs Global/Real IP [map : many to 1] : real IP vs 8.1.2.2 { ③ # ip nat pool to start-ip end-ip [internal network] / prefix-length } ④ set ACL ⑤ ip not inside source list ACL-num pass to overload
- Config : 3.2.2 ① NAT ② INSIDE : R(config-if)# ip nat inside ③ OUTSIDE R(config-if) # ip not outside
- Config 8.1.2.2 PAT (Single Addr.) ④ R(config)# ip nat inside source list ACL-num interface fa0/0 overload PAT (many dynamic)
- Verify : show ip nat translations

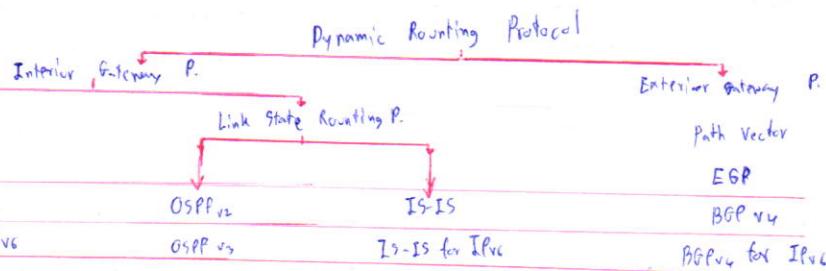
Feature	Server	Client	Transparent
Source VTP message	Yes	Yes	No
Listen to VTP message	Yes	Yes	No
Create VLANs	Yes	No	Yes
Remember VLANs	Yes	No	Yes*

\* Locally significant only

VTP Interned addr. are defined in RFC 1918: ✓

Class	RFC 1918 Internal Address Range	CDR Prefix
A	10.0.0.0 - 10.255.255.255	10.0.0.0/8
B	172.16.0.0 - 172.31.255.255	172.16.0.0/12
C	192.168.0.0 - 192.168.255.255	192.168.0.0/16

## Chapter 11 EIGRP IPv6 &amp; Routing

**EIGRP (Enhanced IGRP)**

- Characteristics

- Basic features - Cisco - proprietary (ที่มีเฉพาะคisco) ได้รับการพัฒนาในปี 1992.
- ④ คือ classless version of IGRP ④ ไม่ต้องการที่จะต้องมี route protocol, รองรับที่ต้องการ cisco router ที่มีอยู่
- ✓ Dual (Diffusing Update Algorithm) = ผู้ให้บริการloop-free & back up path ให้กับทุกๆ ของ routing domain  $\rightarrow$  in best path
  - $\rightarrow$  ทำให้ routing ทำงาน very fast convergent (converge time < OSPF) สร้าง back up path ที่มีประสิทธิภาพ
  - $\rightarrow$  if link down ผู้ให้บริการ path ที่ back up ทันที
- ✓ Establishing Neighbor = ผู้ให้บริการที่ต้องการ run directly connected EIGRP router

**Adjacencies**

✓ Reliable Transport Protocol was Cisco

EIGRP can update

**Partial and Bounded**

OSPF, RIPv2

**Equal and Unequal Cost**

Load Balancing  $\rightarrow$  on cost of both in link load balance

▷ IP protocol-dependent modules (PPMs) ไม่ว่าจะเป็น protocol ที่ต้องการใน IPv4, IPv6, legacy protocol IPX และ AppleTalk  
▷ PPMs คืออะไร :

- maintain EIGRP neighbor and topology table (Neighbor Table  $\xrightarrow{\text{partial}}$  คือ Topology Table  $\xrightarrow{\text{partial}}$  คือ routing table สำหรับ routing)
- คำนวณ metric ที่ DUAL - คำนวณ DUAL สำหรับ routing table
- implement filtering and access lists - สำหรับ redistribution with other routing protocol

▷ RTP is EIGRP Transport layer protocol สำหรับ delivery & reception ของ EIGRP packets

$\rightarrow$  บนชั้น application layer ที่ maintain ทางไป, ทางมาของ EIGRP

▷ ตัวต่อไปของ EIGRP packets คือ OSPF (msg = OSPF)

- Reliable packet require explicit (ต้องรู้) ack วน dest - Update, Query, Reply
- Unreliable packet do not require ack วน dest - Hello, Ack

▷ สำหรับ authentication (จะ encrypt routing update) ไม่แนะนำ (ไม่แนะนำ) (auther คือ RIPv2, OSPF)  
(protocol อยู่ใน transport layer)

- Packet Type routing update or queries EIGRP multicast IPv4 : 224.0.0.10, IPv6 FF02::A สำหรับ EIGRP multicast 224.0.0.9  
① Hello  $\rightarrow$  แสดง adjacencies ระหว่าง routers 2 ตัวที่เป็น neighbor 互相 respond, แต่ unreliable  
② Update  $\rightarrow$  update info ของ dest, update info ของ routing ที่มี neighbor router  
③ Acknowledgement  $\rightarrow$  ตอบกลับ ของ update ของ ACK  
④ Query  $\rightarrow$  request info ของ routing วน neighbor router  
⑤ Reply  $\rightarrow$  วิธีการ query คือ reply

**Implement EIGRP for IPv4**

▷ Autonomous System (AS) is a collection of routers controlled by single authority (โดย AS RFC 1940)

$\hookrightarrow$  AS number  $\rightarrow$  ที่ exchange routes between AS

$\rightarrow$  managed by IANA & assigned by RIRs to ISPs, Internet Backbone providers, and institution สถาบันที่ต้องการ  
 $\rightarrow$  16 bit : 0-65535 ~~since 2007~~, 32 bit : over 4 million  $\rightarrow$  verify show ip eigrp neighbors, (ซึ่งมี)

▷ Configure : `R(config)# router eigrp AS-ID` ( $\equiv$  router-id @ OSPF)

show ip protocols `R(config-router)# eigrp router-id`  $\rightarrow$  กำหนด router-id ของ interface

`R(config-router)# network nn-number [ wildcard-mask ]`  $\rightarrow$  IP address ที่ต้องการที่จะเปิดใช้งาน EIGRP

`R(config-router)# passive-interface type number [ default ]` : กำหนด update ที่ไม่ต้องการที่จะเปิดใช้งาน LAN, Ethernet, FastEthernet



## > Operation

- Initial Route Discovery (1) R1 say Hello to neighbor routers (2) R2 answer Hello or update neighbor (3) R1 download & update info

(4) R1 DUAL running best route and update routing table

- Metrics : BW [Element], Delay [Element], Reliability [Element], Load [Element] , opt values show interface

Default Composite formula : 
$$\text{metric} = k_1 * \text{bw} + k_2 * \text{delay} + k_3 * \text{load}$$

$$= \left[ \frac{10,000,000}{\text{bw}} \right] + \left( \frac{\text{sum of delay}}{\text{delay}} \right) * 256$$

$$\text{complete} = \left[ k_1 * \text{bw} + \frac{k_2 * \text{delay}}{\text{load}} + k_3 * \text{delay} \right] * \left[ \frac{\text{ks}}{\text{reliability} + \text{ks}} \right]$$

- R (config-router) # metric weights tos  $k_1, k_2, k_3, k_4$  - set bw for intf → R(config-if) # bandwidth kilobits - bw = value

- DUAL and the Topology Table (16 FSM (Finite state machine) transitions) show ip eigrp topology (all-link), show ip route

+ Successor (S) [router will dest  $\neq$  self] = neighbor if (FDR<FD) → FS

+ Feasible Successor (FS) [ $\neq$  S & feasible condition] = Backup path (transitions)

+ Reported Distance (RD) [distance to neighbor change report distance diff] = "advertised distance" increase → dest cost increases 2 more hop

+ Feasible Distance (FD) [distance  $\neq$  (Unk S)] = min distance to neighbor with dest min FDR lowest → dest

## IPv6

### - IPv4 Issue

▷ Need for IPv6 → no more IP assignments (private IP, NAT), No ToT (to

▷ inconsistency (coexistence)

- Migration IPv4 - IPv6 Techniques :
  - ① Dual stack : run both if available (new user)
  - ② Tunneling (encapsulate v6 but core v4 support) : new hardware required v6 support
  - ③ Translation : (new NAT) → IPv6 ↔ IPv4

- IPv6 Addressing : 128 bit NDI & 20 [128 / 2 byte = 16 bit] → represent base 16 now 4 bit

- 8 octets binary address IPv6

- Rule 1 - omit leading 0s = 8 binary partition "0" → 0000, 00xx, 0xxx
- Rule 2 - omit All 0 segment = 1111 segment not "0" → 1111 1111 1111 1111

- Type of IPv6 Address

- IPv6 Addr. Type
  - ① unicast : - Global Unicast - Link-local - Unique Local
  - ② Multi cast
  - ③ Anycast : is 2 devices
- shift mask : 1011 or 2000::/3 → no shutdown
- 1111 1111 1111 1111 : link-local (local)

▷ IPv6 prefix Length > 0-128, most LANs is /64 bcc. LAN length 64 bit

### - IPv6 Routing

- config static route

next hop addr exit interface

R(config)# ipv6 route ipv6-prefix/prefix-length {ip vs -addr | exit intf} → result

\* Behavior config Router routing ipv6 ipv6 unicast routing

④ verify : show ipv6 route static, show ip route ipv6, show running-config | section ipv6 route

▷ Default Static IPv6 Route

R(config)# ipv6 route ::/0 {ip vs -addr | exit-intf}

▷ Verify : show ipv6 route static

- Config EIGRP for IPv6

R(config)# ipv6 unicast-routing

R(config)# ipv6 router eigrp AS-#

R(config-router)# eigrp Router ID 2.0.0.0 → global IPv4

R(config-router)# no shutdown

▷ network command : intf → ipv6 eigrp AS-#

but passive-interface (global config function)

▷ Verify : show ipv6 eigrp neighbors, show ipv6 protocol, show ipv6 route