**Fundamentals of Internet Protocol (IP) Addressing**

(Effective Date)

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| SECTION I. | ADMINISTRATIVE DATA | | | | | | | | | | | | | | | |
| All Courses Including This Lesson | Course Number | | Version | | Course Title | | | | | | | | | | | |
|  | | 1.0 | | Signal Support Systems Specialist (25U10) | | | | | | | | | | | |
| Task(s) Taught (\*) or Supported | Task Number Individual | | Task Title | | | | | | | | | | | | | |
| NONE | |  | | | | | | | | | | | | | |
| Knowledge | Knowledge Id | | Title | | | | | | | | Taught | | | Required | | |
|  | | Knowledge of network terminology. | | | | | | | | No | | | Yes | | |
|  | | Knowledge of classful networks. | | | | | | | | Yes | | | Yes | | |
|  | | Knowledge of classless networks. | | | | | | | | Yes | | | Yes | | |
| Skill | Skill Id | | Title | | | | | | | | Taught | | | Required | | |
|  | | Ability to convert a binary IP address into decimal. | | | | | | | | Yes | | | Yes | | |
|  | | Ability to determine IP addresses for network components on a classful network. | | | | | | | | Yes | | | Yes | | |
|  | | Ability to determine IP addresses for network components on a classless network. | | | | | | | | Yes | | | Yes | | |
| Administrative / Academic Hours | The administrative/academic hours required to teach this lesson are as follows: | | | | | | | | | | | | | | | |
| Academic | | | Resident Hours | | Methods | | | | | | | | | | |
| Yes | | | 2 hrs 10 mins | | Discussion (Large or Small Group) | | | | | | | | | | |
| Yes | | | 00 hrs 00 mins | |  | | | | | | | | | | |
| Yes | | | 00 hrs 00 mins | |  | | | | | | | | | | |
| Total Hours: | | | 5 hrs 00 mins | |  | | | | | | | | | | |
| Test Lesson Number | Hours | | | Lesson Number | | | | | | | | | | | | |
| NONE | | |  | | | | | | | | | | | | |
| Prerequisite Lesson(s) | Lesson Number | | | Lesson Title | | | | | | | | | | | | |
|  | | | LandWarNet School Orientation | | | | | | | | | | | | |
|  | | | WIN-T System Overview | | | | | | | | | | | | |
|  | | | Introduction to Networking | | | | | | | | | | | | |
| Clearance Access | Security Level: This course/lesson will present information that has a Security Classification of U - Unclassified. | | | | | | | | | | | | | | | |
| Foreign Disclosure Restrictions | FD7. This product/publication has been reviewed by the product developers in coordination with the USACYBERCOE&FG foreign disclosure authority. This product is NOT releasable to students from foreign countries. | | | | | | | | | | | | | | | |
| References | Number | Title | | | | | | | | | | | Date | | | |
| 13788 | IP Addressing and Subnetting for New Users, Cisco Corporation | | | | | | | | | | | 09/26/05 | | | |
| Student Study Assignments | NONE | | | | | | | | | | | | | | | |
| Instructor Requirements | Two instructor/facilitators for every 16 students.  Instructors/Facilitators presenting this training will be certified in accordance with TRADOC Regulation 350-70-3 and Army Regulation 614-200. | | | | | | | | | | | | | | | |
| Additional Support Personnel Requirements | NONE | | | | | | | | | | | | | | | |
| Equipment Required for Instruction | ID - Name | | | | | | Stu Ratio | | Inst Ratio | Spt | | Qty | | | | Exp |
| 6130-00-059-3404 – Power Supply | | | | | | 0:0 | | 0:0 | No | | 18 | | | | No |
| 7195-01-184-5595 – Workstation, On Line | | | | | | 0:0 | | 0:0 | No | | 18 | | | | No |
| 7010-01-226-2157 – Monitor, Computer Display | | | | | | 0:0 | | 0:0 | No | | 18 | | | | No |
| 7025-01-240-4345 – Chair, Desk, Lounge with Arms | | | | | | 0:0 | | 0:0 | No | | 18 | | | | No |
| 5820-00-512-9091 – Monitor-Receiver, Television | | | | | | 0:0 | | 0:0 | No | | 1 | | | | No |
| 7510-01-316-6213 – Whiteboard with markers and an eraser | | | | | | 0:0 | | 0:0 | No | | 1 | | | | No |
| 7025-01-240-4345 – Printer, Automatic Data Processing | | | | | | 0:0 | | 0:0 | No | | 1 | | | | No |
| 7125-00-269-8534 – Cabinet, Storage | | | | | | 0:0 | | 0:0 | No | | 1 | | | | No |
| Materials Required | Instructor Materials:  * Access to the instructional materials through the [GDPOINTS](http://jnndev.jnn.local:8080/web/lwns-home/home) online Content Management System (CMS) on the General Dynamics LandWarNet School (LWNS) training network. * Class Roster * Training Schedule * Risk Assessment  Student Materials:  * Access to the instructional materials through [GDPOINTS](http://jnndev.jnn.local:8080/web/lwns-home/home). Students may use a mobile device to access the instructional materials. | | | | | | | | | | | | | | | |
| Classroom, Training Area, and Range Requirements | ID – Name | | | | | | Qty | Student Ratio | | | Setup Mins | | | | Cleanup Mins | |
| 17136 Automation-Aided Instructional Building | | | | | | 1 | 1:16 | | | 5 min | | | | 10 min | |
| Instructional Guidance | Lesson Preparation: Before presenting this lesson, the facilitator must thoroughly prepare by studying this lesson plan and all identified reference material. The facilitator should also ensure the classrooms are scheduled and prepared, all students materials are on hand in the quantities needed, and the equipment is in working condition. Additionally, the facilitator must ensure usernames and passwords have been established for each student and sufficient data is available in the training network for practical exercise and demonstration purposes, when appropriate. Lesson Outcome Statement: At the completion of this lesson, students will be able to manually determine the IP addresses for network components in order to operate and maintain the WIN-T system in support of Army tactical units. Students will also learn to use the IP subnetting calculator to determine IP addresses for network components. Learning Objectives: During this lesson, the learning steps and activities defined below will be conducted in an effort to achieve each of the learning objectives.  TLO: Determine the IP addresses for network components.   1. Convert a binary IP address to decimal.    1. Describe the characteristics of an IP v4 address.    2. Determine the decimal value of binary numbers. 2. Determine the IP addresses for network components on a classful network.    1. Define classful networks.    2. Determine the Network Mask, Network ID, and Host ID for a Network Component on a Classful Network. 3. Determine the IP addresses for network components on a classless network.    1. Describe classless networks.    2. Convert an IP address into Classless Inter-domain Routing (CIDR).    3. Determine the number of subnets.    4. Determine the number of usable host IDs.    5. Determine the range of usable IP addresses in a subnet.  Lesson Guidance: During the classroom portion of the lesson, students will learn about classful and classless networks and how to manually determine IP addresses for network components by participating in group discussions and practice scenarios. Students will also learn to use the IP subnetting calculator to determine the IP addresses for network components. Lesson Learning Strategy: This lesson incorporates experiential learning model (ELM) into the Five Learning Components learning strategy by Dick, Carey, & Carey (2009). Based on information processing theories and models of human learning, this learning strategy organized Gagne’s nine events of instruction into five major learning components.  The strategy encourages students to do the following during the learning process:   * Motivate, Inform, and Recall prior to beginning of formal instruction, addressing three factors: motivating learners, informing learners of the objectives, and stimulating recall of pre-requisite skills. (ELM: Concrete Experience - Learners recall a previous experience.) * Content Presentation and Learning Guidance explains what the unit is about by presenting information, concepts, rules, and principles to be learned in either deductive or inductive manner. Learning guidance is integrated with content presentation using cues, outlines, diagrams, models, still and motion graphics, highlights, flowcharts, examples, etc. (ELM: Process – Learners make sense of the presented information.) * Learner Participation with feedback enhances learning by giving learners an opportunity to practice what they learned using practical exercises, scenarios, and embedded tests. (ELM: Publish – Learners participate in the instruction.) * Assessment including entry skills tests, pretests, practice tests, and post-test presented to learners at appropriate moments before, during, or after the lesson. (ELM: Develop Value – Learners reflect on the provided feedback.) * Follow-Through Activities including memory aids or job aids, parallel problem scenarios, and learner plans that help learners memorize skills and facilitate the transfer of learning to new contexts. (ELM: Apply – Learners use gained information to answer questions or perform a task).  21st Century Competencies: The facilitator should encourage students to participate and contribute productively during the instruction in order to observe the following 21st Century Soldier competencies.  Lifelong Learner   * Students should continually assess themselves to identify what they need to learn. * Students should attempt to acquire and update their knowledge and skills.   Critical Thinking and Problem Solving   * Students should analyze and evaluate thinking, with a view to improving it. * Students should use experiences, training, education, questioning, creative thinking, and collaboration to identify solutions for complex problems.   If the competencies are not observed for each student, the facilitator should discuss the specified behavior with the student and encourage additional participation in an effort to observe the competency. | | | | | | | | | | | | | | | |
| Proponent Lesson Plan Approvals |  | | | | | | | | | | | | | | | |
| SECTION II. | INTRODUCTION | | | | | | | | | | | | | | | |
|  | Method of Instruction: Discussion (Large or Small Group)  Instr Type (I:S Ratio/Qty): Contract Instructor (1:16/0)  Time of Instruction: 10 mins  Instructional Strategy: Large Group Instruction | | | | | | | | | | | | | | | |
| Motivator | **NOTE**:   * Login to POINTS and display the graphics relevant to this lesson. Ask the students to refer to POINTS as needed throughout the instruction for graphics and links to reference material. * Present the student motivator, learning objectives, safety requirements, and the instructional lead-in for this lesson. * Describe how the students should demonstrate the accomplishment of the TLO. Refer the student to the Individual Student Assessment Plan (ISAP), if necessary.   As a Signal Corps Soldier, students must be familiar with the instructional materials presented during this lesson in order to perform their job. If they should fail to perform their job correctly, they could damage equipment or enable situations that may cause severe injury to themselves or others. | | | | | | | | | | | | | | | |
| Terminal Learning Objective | **NOTE**: Inform the students of the terminal learning objective requirements.  At the completion of this lesson, students will: | | | | | | | | | | | | | | | |
| Action: | | | Determine the IP addresses for network components. | | | | | | | | | | | | |
| Conditions: | | | Provided a classroom environment, a facilitator and multiple students, and a computer or mobile device with access to the General Dynamics LWNS training network. | | | | | | | | | | | | |
| Standards: | | | Students will demonstrate their ability to determine IP addresses for network components by \_\_\_\_\_\_\_\_\_\_\_\_\_\_. | | | | | | | | | | | | |
| Safety Requirements | There are no special safety considerations for this lesson. The facilitator should use the facility standard operating procedures to provide a safety brief for this lesson. Students will react to any emergency situation in accordance with the facility standard operating procedures. | | | | | | | | | | | | | | | |
| Risk Assessment Level | Low - Refer to DA Form 7566  Assessment: Refer to DA Form 7566  Controls: Refer to DA Form 7566  Leader Actions: Refer to DA Form 7566 | | | | | | | | | | | | | | | |
| Environmental Considerations | The facilitator will conduct a Risk Assessment to include Environmental Considerations in accordance with [FM3-34.5](http://192.168.252.60/Curriculum-Development/Curriculum/ReferenceMaterial/FieldManuals/FM0071.pdf), Environmental Considerations {MCRP 4-11B}, and ensure students are briefed on hazards and control measures.  It is the responsibility of all Soldier, DA civilians, and contractors to protect the environment from damage. Handle, use, store, and dispose of hazardous materials and hazardous waste (e.g., chemicals, cleaning solvents, contaminated materials, etc.) in accordance with the Material Safety Data Sheets (MSDS), unit SOP requirements, and all federal, state, local, and Army regulations. | | | | | | | | | | | | | | | |
| Instructional Lead-In | Learning Strategy: Motivate, Inform, and Recall  Imagine that your Commanding Officer has asked you to figure out a range of Internet Protocol (IP) addresses for a sub-network. Can you do it? Welcome to the Introduction to Internet Protocol version 4 (IPv4) lesson, where you will learn how to accomplish this task without having any previous experience with IPs.  During this lesson you will learn about the basics of IPv4, including IPv4 terminology and IPv4 addresses. You will then learn about classful and classless networks and how network and subnetwork masks work. You will also learn how IPv4 addresses are used in these types of networks. Finally, you will have an opportunity to apply your knowledge by assigning IPv4 addresses to network components on both classless and classful networks.  Once this lesson is complete, you will take a test which measures whether the desired learning has occurred and if you can perform tasks to standard. The test will inform you of your results, and recommend remediation if necessary.  Even though you will use this courseware to learn about these topics for the first time, you can also review it at any time to refresh your memory. | | | | | | | | | | | | | | | |
| SECTION III. | PRESENTATION | | | | | | | | | | | | | | | |
| ELO A. | ENABLING LEARNING OBJECTIVE | | | | | | | | | | | | | | | |
|  | Action: | | Convert binary IP addresses to decimal. | | | | | | | | | | | | | |
| Conditions: | | Provided a classroom environment, a facilitator and multiple students, and a computer or mobile device with access to the General Dynamics LWNS training network. | | | | | | | | | | | | | |
| Standards: | | Students will demonstrate their ability to convert binary IP addresses to decimal by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. | | | | | | | | | | | | | |
| NOTE: | Inform the students of the enabling learning objective requirements. | | | | | | | | | | | | | | | |
| ELO A – LSA 1. | Describe the characteristics of an IP v4 address. | | | | | | | | | | | | | | | |
|  | Method of Instruction: Discussion (Large or Small Group)  Instr Type (I:S Ratio/Qty): Contract Instructor (1:16/0)  Time of Instruction: 5 mins  Instructional Strategy: Large Group Instruction  Media Type: Computer Assisted Instruction  Other Media: None  Security Classification: Unclassified | | | | | | | | | | | | | | | |
| NOTE: | Learning Strategy: Content Presentation and Learning Guidance.   * Facilitate a discussion of the following instructional content. | | | | | | | | | | | | | | | |
|  | Internet Protocol Version 4Internet Protocol (IP) is a set of rules for communicating on a network. IPv4, the fourth set of these rules, is the one used by the United States Army. While the latest internet protocol version is six (IPv6), it is currently not widely adopted.IPv4 dictates how information is passed from one network component to another. One IPv4 rule is that all devices require a globally unique IP address.IP Addresses An IP address is a unique numeric value given to each device on a network. This number represents the location of a device on the internet. IP packets (data that is moved along the network) have IP addresses within them so routers know where to send the packet.  The IP address can be written in binary or decimal. Learning to write them in binary computer language is necessary because you will be switching between binary and decimal in order to complete the sub netting process. If the IP address is written in binary computer language, there are always 32 characters or bits, with each bit representing either a zero (0) or a one (1).  When written in binary, the 32 bits are grouped into 8 bit segments, known as octets or bytes. These octets are separated by a period. From left to right, the octets are titled first, second, third, and fourth octet.   * An example IPv4 address in binary is: **11000011.11100001.00001010.11100111**. | | | | | | | | | | | | | | | |
| Check on Learning | Learning Strategy: Assessment  Conduct a quick review to determine if the students have learned the presented material. Ask open ended questions and solicit student answers and explanations. Encourage students to provide feedback to each other. The following question may be used to assess student knowledge.  **Question**: What are the characteristics of an IP v4 address?   * **Answer**: A globally unique number assigned to network components to identify them on the network. | | | | | | | | | | | | | | | |
| Review Summary | If necessary, provide a short summary of the topic. | | | | | | | | | | | | | | | |
| ELO A – LSA 2. | Determine the decimal value of binary numbers. | | | | | | | | | | | | | | | |
|  | Method of Instruction: Drill and Practice  Instr Type (I:S Ratio/Qty): Contract Instructor (1:16/0)  Time of Instruction: 50 mins  Instructional Strategy: Large Group Instruction  Media Type: Computer Assisted Instruction  Other Media: None  Security Classification: Unclassified | | | | | | | | | | | | | | | |
| NOTE: | Learning Strategy: Content Presentation and Learning Guidance.   * Facilitate a discussion of the following instructional content. | | | | | | | | | | | | | | | |
|  | We use the decimal numbering system every day, so it makes sense to learn how to convert these binary octets into a decimal value like 192.168.0.1. This decimal representation is how most people understand and work with IP addresses.  (REMOVE THE EQUATION SECTION OF THIS TABLE – TOTALLY UNESSARY AND WILL CONFUSE PEOPLE)  Each position in an octet has a corresponding decimal value, which increases from right to left. The rightmost bit has a decimal value of 1; the bit to the immediate left of it has a value of 2, then 4, then 8 and keeps doubling in value until you reach 128.  See the table for a breakdown of each position's value.   |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **Position in Octet** | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | |  |  |  |  |  |  |  |  |  | | **Decimal Value by Position** | 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |   Here is where why you started with binary. Only the binary ones (1) are converted to decimal, while to binary zeros (0) are ignored. Simply add the corresponding decimal values of the binary ones (1) to determine the octet’s decimal value.  For example, consider the first octet of example IP address from earlier, 11000011.11100001.00001010.11100111.   |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **Decimal Value by Position** | 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 | | **Example Octet** | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | | **Decimal Value of Example** | 128 + 64 + 2 + 1 = 195 | | | | | | | |   IP address conversions always begin with the first octet, which is what we have done here. In this table, every bit that has a value of one (1) is highlighted. The corresponding decimal value of the turned on positions is also highlighted.  To determine the decimal value of this octet, add the decimal values for each position with a one (1). In this case, the values are 128, 64, 2, and 1. Adding these values equals 195. | | | | | | | | | | | | | | | |
| Check on Learning | Learning Strategy: Learner Participation and Assessment   * Allow the students time to practice converting sample IP addresses to decimal. * Observe active participation to determine if the students have learned the presented material. | | | | | | | | | | | | | | | |
| Review Summary | If necessary, provide a short summary of the topic. | | | | | | | | | | | | | | | |
| ELO A – Check on Learning | Learning Strategy: Assessment  Conduct a quick review to determine if the students have learned the presented material. Ask open ended questions and solicit student answers and explanations. Encourage students to provide feedback to each other. The following question may be used to assess student knowledge.  **Question**: Calculate the decimal value of the binary IP address: 11000011.11100001.00001010.111.00111.   * **Answer**: 195.225.10.231 | | | | | | | | | | | | | | | |
| ELO A – Review Summary | If necessary, provide a short summary of the learning objective. This skill is absolutely necessary to subnet IP address in either IPv4 or IPv6. | | | | | | | | | | | | | | | |
| ELO B. | **ENABLING LEARNING OBJECTIVE** | | | | | | | | | | | | | | | |
|  | Action: | | Determine IP addresses for network components on a classful network. | | | | | | | | | | | | | |
| Conditions: | | Provided a classroom environment, a facilitator and multiple students, and a computer or mobile device with access to the General Dynamics LWNS training network. | | | | | | | | | | | | | |
| Standards: | | Students will achieve a score of no less than 80 percent correct on the lesson test. | | | | | | | | | | | | | |
| NOTE: | Inform the students of the enabling learning objective requirements. | | | | | | | | | | | | | | | |
| ELO B – LSA 1. | Describe Classful Networks | | | | | | | | | | | | | | | |
|  | Method of Instruction: Discussion (Large or Small Group)  Instr Type (I:S Ratio/Qty): Contract Instructor (1:16/0)  Time of Instruction: 10 mins  Instructional Strategy: Large Group Instruction  Media Type: Computer Assisted Instruction  Other Media: None  Security Classification: Unclassified | | | | | | | | | | | | | | | |
| NOTE: | Learning Strategy: Content Presentation and Learning Guidance.   * Facilitate a discussion of the following instructional content. | | | | | | | | | | | | | | | |
|  | A classful network is a network addressing architecture that was created in 1981. Classfull networks were made long before sub netting was created. Once we break up one of these Classfull networks with sub netting, the new sub-netted network becomes a Classless network.. In classful networks, IP addresses were categorized into five classes, classes A, B, C, D, and E. Classes A, B, and C were widely used, while the use of classes D and E was reserved. All classes were assigned a range of unique IP addresses. The table shows how IP addresses were allocated for Classes A, B, and C.   |  |  |  | | --- | --- | --- | | **Class** | **Start IP Address** | **End IP Address** | | A | 1.0.0.0 | 127.255.255.255 | | B | 128.0.0.0 | 191.255.255.255 | | C | 192.0.0.0 | 223.255.255.255 |   These A, B, and C Classful networks where divided that so each class is known to handle a set amount of networks and hosts per network.  Only the first octet of any IPv4 address designates what class the IPv4 resides in. For example, IP address 10.0.1.1 would be a class A address, while 193.8.3.2 would be a class C address.  Here is a chart of how these classfull networks line up with the amount of networks and hosts per network they support:  Class A = Can create 126 networks with over 16 million users in each  Class B = Can create 16,384 networks with over 65,000 users in each  Class C = Can create over 2 million networks with only 254 users in each network.  Based on this chart, you may understand why large companies like AT&T bought the rights to use Class A IPv4 networks and you are assigned a little Class C IPv4 network from your local Internet Service Provider.  Knowing the class of the Ipv4 address you are sub netting starts the entire sub netting process. This is foundational knowledge for all IT network personnel. | | | | | | | | | | | | | | | |
| Check on Learning | Learning Strategy: Assessment  Conduct a quick review to determine if the students have learned the presented material. Ask open ended questions and solicit student answers and explanations. Encourage students to provide feedback to each other. The following question may be used to assess student knowledge.  **Question**: What is a classful network?   * **Answer**: A network addressing architecture that categorized ranges of IP address into 5 classes. | | | | | | | | | | | | | | | |
| Review Summary | If necessary, provide a short summary of the topic. | | | | | | | | | | | | | | | |
| ELO B – LSA 2. | Determine the Network Mask, Network ID, and Host ID for a Network Component on a Classful Network | | | | | | | | | | | | | | | |
|  | Method of Instruction: Discussion (Large or Small Group)  Instr Type (I:S Ratio/Qty): Contract Instructor (1:16/0)  Time of Instruction: 20 mins  Instructional Strategy: Large Group Instruction  Media Type: Computer Assisted Instruction  Other Media: None  Security Classification: Unclassified | | | | | | | | | | | | | | | |
| NOTE: | Learning Strategy: Content Presentation and Learning Guidance.   * Facilitate a discussion of the following instructional content. | | | | | | | | | | | | | | | |
|  | There is one more critical baseline piece of knowledge you need to understand sub netting: Subnet Masks. The subnet mask works closely with the Ipv4 address. It looks a lot like the Ipv4 address. Here is an example: 255.255.255.0. It has 4 octets and is 32 bits long just like the IPv4 address. The purpose of the subnet mask is to tell routers and IP hosts which part of an IP address is the network ID and which is the host ID. Without this information an IP address is useless to the devices that read it.  The network ID portion of the IPv4 address is designated by all binary 1s in the subnet mask. This network ID tells devices that a certain part of the IP address cannot be changed or subnetted. The network ID is like a zip code. Everyone in that network will have the same subnet mask and network ID.  The host ID of the ip address represents the IP host or user device – like your computer. If everyone in the same network has the same network ID, then this is the only way a host can be uniquely identified. The host part is like a social security number – there is only one like it in the universe. The host part of the IP address is identified by zeroes in the subnet mask.  A network mask can be written in binary or decimal, using the same format as an IP address. Converting the subnet mask to binary will help you calculate which part of the accompanying IPv4 address contains the Network ID and the Host ID.  Here is an example:  192.128.4.5 = IP assigned to your computer  255.255.255.0 = Subnet mask for the above IP.    If I wrote this same information in binary:  11000000.10000000.00000100.00000101 = IP assigned to your computer  11111111.11111111.11111111.00000000 = subnet mask for the above IP  The bits in first three octets of the subnet mask are 1s or turned on. This tells the routers that the first three octets of the IP address are the network ID or zip code. Routers route based on the network part of the address. The network ID is 192.128.4.  The last octet of the above subnet mask is all zeroes. This means that the last octet of the IP address is the host address. The Host ID is .5.  The tables below will demonstrate the default subnet masks for each classfull network.  **Class A**  Class A.png  The table above shows the default subnet mask , in binary, for a Class A network.  The decimal value in the first octet of the IP address is used to identify the network ID, while the values in the remaining octets are for the host IDs. When you add the decimal values for all positions that are turned on it shows that the subnet mask for Class A networks is 255.0.0.0.  **Class B**  Class B.png  The table above shows the default subnet mask , in binary, for a Class B network  When you add the decimal values for all positions that are turned on it shows that the network mask for Class B networks is 255.255.0.0.  **Class C**  Class C.png  The table above shows the default subnet mask , in binary, for a Class C network  When you add the decimal values for all positions that are turned on it shows that the network mask for Class C networks is 255.255.255.0.  Let us apply this new knowledge by classfull network, Remember that only the first octet of an IPv4 address designates the IPv4 address class. We need to know this in order to correctly determine how many hosts and networks we can make with the given IPv4 address. We would not want to try to make 300 subnet networks with a class A address –it can only make a maximum of 126. Return to the example IP address 195.225.10.231, which is a Class C network. Recall the network mask for Class C is 255.255.255.0. Writing the network mask in binary and stacking them, displays how the Network and Host IDs are allocated. If I wrote this same information in binary:  11000011.1110000100001010..11100111 = IP assigned to your computer  11111111.11111111.11111111.00000000 = subnet mask for the above IP To find the network ID, the bits in the IP address that line up with a one (1) bit in the network mask are used for the Network ID. The zeros (0) in the network mask line up with the Host I in the IPv4 address. In this example, the first three octets are the Network ID, resulting in a Network ID of 195.225.10.0, and the final octet identifies the Host ID of 0.0.0.231. | | | | | | | | | | | | | | | |
| Check on Learning | Learning Strategy: Assessment.  Conduct a quick review to determine if the students have learned the presented material. Ask open ended questions and solicit student answers and explanations. Encourage students to provide feedback to each other. The following question may be used to assess student knowledge.  **Question**: A computer on a classful network has the IP Address of 128.11.240.123. What are the Network Mask, Network ID, and Host ID?   * **Answer**: Network Mask = 255.255.0.0; Network ID = 128.111.0.0; Host ID = 0.0.240.20 | | | | | | | | | | | | | | | |
| Review Summary | If necessary, provide a short summary of the topic. | | | | | | | | | | | | | | | |
| ELO C. | **ENABLING LEARNING OBJECTIVE** | | | | | | | | | | | | | | | |
|  | Action: | | Determine IP addresses for network components on a classless network. | | | | | | | | | | | | | |
| Conditions: | | Provided a classroom environment, a facilitator and multiple students, and a computer or mobile device with access to the General Dynamics LWNS training network. | | | | | | | | | | | | | |
| Standards: | | Students will achieve a score of no less than 80 percent correct on the lesson test. | | | | | | | | | | | | | |
| NOTE: | Inform the students of the enabling learning objective requirements. | | | | | | | | | | | | | | | |
| ELO C – LSA 1. | Describe Classless Networks | | | | | | | | | | | | | | | |
|  | Method of Instruction: Discussion (Large or Small Group)  Instr Type (I:S Ratio/Qty): Contract Instructor (1:16/0)  Time of Instruction: 10 mins  Instructional Strategy: Large Group Instruction  Media Type: Computer Assisted Instruction  Other Media: None  Security Classification: Unclassified | | | | | | | | | | | | | | | |
| NOTE: | Learning Strategy: Content Presentation and Learning Guidance.   * Facilitate a discussion of the following instructional content. | | | | | | | | | | | | | | | |
|  | While classful networks use one or more complete octets to assign the network ID, a classless network uses portions of an octet to create a sub-network (or subnet). We could call the default subnet mask of a classfull network a network mask, but network mask is not a common term and will cause confusion among IT professionals.For example, consider the IP address from earlier, 195.225.10.231. Now let’s give it a subnet mask of 255.255.255.194. Writing these values in binary and stacking them shows their relationship. (MAKE A NEW CHART AND DELETE THE “Decimal Value by Position” row. There is no need for it and it will confuse students. sub.png  Network ID - The Network ID portion of the IP address consists of octets that match the octets that are made up of all ones.  Subnet ID – The octet that contains the values of both ones and zeroes is where the Subnet ID is defined. This is also called the interesting octet. The portions of the interesting octet with the value of one are used for the Subnet ID.  Host ID - The portion of the subnet mask with the value of zero corresponds to the IP address’s Host ID. | | | | | | | | | | | | | | | |
| Check on Learning | Learning Strategy: Assessment.  Conduct a quick review to determine if the students have learned the presented material. Ask open ended questions and solicit student answers and explanations. Encourage students to provide feedback to each other. The following question may be used to assess student knowledge.  **Question**: What is a characteristic of a classless network?   * **Answer**: Classless network uses a portion of the interesting octet to create subnets. | | | | | | | | | | | | | | | |
| Review Summary | If necessary, provide a short summary of the topic. | | | | | | | | | | | | | | | |
| ELO C – LSA 2. | Convert an IP address into Classless Inter-domain Routing (CIDR) | | | | | | | | | | | | | | | |
|  | Method of Instruction: Discussion (Large or Small Group)  Instr Type (I:S Ratio/Qty): Contract Instructor (1:16/0)  Time of Instruction: 5 mins  Instructional Strategy: Large Group Instruction  Media Type: Computer Assisted Instruction  Other Media: None  Security Classification: Unclassified | | | | | | | | | | | | | | | |
| NOTE: | Learning Strategy: Content Presentation and Learning Guidance.   * Facilitate a discussion of the following instructional content. | | | | | | | | | | | | | | | |
|  | CIDR is a method to shorten the subnet mask.  Recall the example IP address of 195.225.10.231 and Subnet Mask of 255.255.255.194. The table shows the subnet mask converted to binary.  CIDR.png  To convert this to CIDR, write the Subnet Mask in binary and count the number of ones. In the example there are 26. To represent this as CIDR, simply write /26 at the end of the IP address, resulting in 195.225.10.231 /26.  In order to convert a subnet mask to CIDR fast, memorize the decimal conversion chart below,  Octet bit position to numerical value: (Adding them up as we go left to right in the octet)  bit 1 = 128  bit 2 = 192  bit 3 = 224  bit 4 = 240  bit 5 = 248  bit 6 = 252  bit 7 = 254  bit 8 = 255  If you learn to add the octet bits from left to right you will make a quick list of decimal values. Notice there are eight numbers in the list created from adding the bits from left to right in one octet.  Using the chart above, if given a subnet mask of 255.255.255.you can covert it quickly. The first three octets contain eight ones which equals 24. The last octet contains 2 subnet bits (ones). I calulcated 2 subnet bits because I used the chart above and I moved 2 bits to find 192. Therefore, the CIDR is 8+8+8+2 = 26. | | | | | | | | | | | | | | | |
| Check on Learning | Learning Strategy: Assessment.  Conduct a quick review to determine if the students have learned the presented material. Ask open ended questions and solicit student answers and explanations. Encourage students to provide feedback to each other. The following question may be used to assess student knowledge.  **Question**: You have an IP address of 123.122.25.0 and a subnet mask of 255.255.224.0. How would you write this IP address in CIDR ?   * **Answer**: 123.122.25.0 /19 | | | | | | | | | | | | | | | |
| Review Summary | If necessary, provide a short summary of the topic. | | | | | | | | | | | | | | | |
| ELO C – LSA 3. | Determine the Number of Subnets | | | | | | | | | | | | | | | |
|  | Method of Instruction: Discussion (Large or Small Group)  Instr Type (I:S Ratio/Qty): Contract Instructor (1:16/0)  Time of Instruction: 10 mins  Instructional Strategy: Large Group Instruction  Media Type: Computer Assisted Instruction  Other Media: None  Security Classification: Unclassified | | | | | | | | | | | | | | | |
| NOTE: | Learning Strategy: Content Presentation and Learning Guidance.   * Facilitate a discussion of the following instructional content. | | | | | | | | | | | | | | | |
|  | The total number of subnets is dependent upon the number of bits that were allocated to the subnet.We can easily calculate how many subnets are created from the subnet bits by using the Powers of 2 chart below. Power of two: 2 4 8 16 32 64 128 256 512 1024  Bit position: 1 2 3 4 5 6 7 8 9 10  Note: 0s identify host bits, 1s identity network bits  Using the example subnet mask earlier of 195.225.10.231 /26 we can find the number of subnets. Here is the process:  1. Determine the IP address class so we can find the number of added subnet bits. Depending on the class, a person can add up to 22 subnet bits! In our example, the IP address begins with 195 meaning it is a class C IP address.  2. Determine the default subnet mask. By using the class chart in the earlier lessons we know that all class C subnet masks are 255.255.255.0 or /24.  3. Determine the number of subnet bits added to the subnet mask. The example subnet mask is /26. The default subnet mask is /24 meaning that 2 subnet bits were added.  4. Use the Powers of 2 chart above by finding the number of added subnet bits in the row titled “Bit postion” In this case, we have 2 subnet bits. Look at the number above the 2 and see the number 4. This combination of IP address and subnet mask creates 4 subnets!  This process can be done in seconds once you are familiar with it. Also understand that you have just taken an IP address, and by adding some bits in the subnet mask you were able to sub divide one network into 4 different networks. These subnets can be assigned to 4 different departments and they would not conflict with each other on the network. They could only communicate within their subnets unless a router connected them.  Now that we have four different sub divided networks, we need to how many hosts we can support in each network. We will learn that in the next LSA | | | | | | | | | | | | | | | |
| Check on Learning | Learning Strategy: Assessment.  Conduct a quick review to determine if the students have learned the presented material. Ask open ended questions and solicit student answers and explanations. Encourage students to provide feedback to each other. The following question may be used to assess student knowledge.  **Question**: Imagine you have an IP address of 128.111.1.0 / 20. Use the Powers of 2 chart and the process to calculate the number of subnets this IP and subnet mask will support.   * **Answer**: 16 subnets | | | | | | | | | | | | | | | |
| Review Summary | If necessary, encourage students to participate in the discussion. | | | | | | | | | | | | | | | |
| ELO C – LSA 4. | **Determine the Number of Usable Host IDs** | | | | | | | | | | | | | | | |
|  | Method of Instruction: Discussion (Large or Small Group)  Instr Type (I:S Ratio/Qty): Contract Instructor (1:16/0)  Time of Instruction: 10 mins  Instructional Strategy: Large Group Instruction  Media Type: Computer Assisted Instruction  Other Media: None  Security Classification: Unclassified | | | | | | | | | | | | | | | |
| NOTE: | Learning Strategy: Content Presentation and Learning Guidance.   * Facilitate a discussion of the following instructional content. | | | | | | | | | | | | | | | |
|  | The total number of hosts is dependent upon the number of bits that were allocated to host IDs. Remember the subnet bits in the interesting octet are 1s and represent the number of subnets. Now focus on the zeros left in the interesting octet. The amount of zeros will determine the number of hosts.  We can easily calculate the amount of hosts that each subnet can support by using the Powers of 2 chart below.  Power of two: 2 4 8 16 32 64 128 256 512 1024  Bit position: 1 2 3 4 5 6 7 8 9 10  Note: 0s identify host bits, 1s identity network bits  Here is the process:  1. Count the number of zeros in the subnet mask‘s interesting octet. In the example above, there are 6 zeros in the interesting octet.  2. Determine the number of hosts per subnet. Find the number 6 in the “Bit position” of the Powers of 2 chart. Next, locate the number above it in the “Powers of two” row. In this case, the number 64 is located.  3. Subtract 2 from your answer. We subtract the Network ID IP address and the Broadcast IP address from the useable host addresses. Simply subtract 2 from 64 and you have 62 useable IP addresses or 62 hosts for each of the 4 subnets.  The powers of 2 chart can be extended up to 24 bit positions. We have only offered 10 bit positions in this example. | | | | | | | | | | | | | | | |
| Check on Learning | Learning Strategy: Assessment  Conduct a quick review to determine if the students have learned the presented material. Ask open ended questions and solicit student answers and explanations. Encourage students to provide feedback to each other. The following question may be used to assess student knowledge.  **Question**: Imagine you have an IP address of 128.111.1.0 / 20. Use the Powers of 2 chart and the process to calculate the number of hosts this IP and subnet mask will support.   * **Answer**: 4094 hosts per subnet | | | | | | | | | | | | | | | |
| Review Summary | If necessary, encourage students to participate in the discussion. | | | | | | | | | | | | | | | |
| ELO C – LSA 5. | **Determine the Range of Usable IP Addresses in a Subnet** | | | | | | | | | | | | | | | |
|  | Method of Instruction: Discussion (Large or Small Group)  Instr Type (I:S Ratio/Qty): Contract Instructor (1:16/0)  Time of Instruction: 30 mins  Instructional Strategy: Large Group Instruction  Media Type: Computer Assisted Instruction  Other Media: None  Security Classification: Unclassified | | | | | | | | | | | | | | | |
| NOTE: | Learning Strategy: Content Presentation and Learning Guidance   * Facilitate a discussion of the following instructional content. | | | | | | | | | | | | | | | |
|  | There are 4 subnets and 62 usable Host IP addresses per subnet in the example network. Recall we began with an IP address of 195.225.10.231/26 .Now let’s figure out the range of usable IP addresses for each subnet. We must do this in order to know which IP addresses to assign to hosts in each subnet.  This is quickly determined by subtracting the decimal value of the subnet mask’s interesting octet from 256. In our example, the decimal value 192 represents the subnet mask’s interesting octet. We know that 192 – 256 is 64.  The decimal value of 64 becomes our Magic Number and is used to determine our IP address range per subnet. In this case will separate each subnet by 64 Ip addresses, ALWAYS begin with a zero in the interesting octet of the first subnet IP address as you list the subnets.  Subnet 1 Subnet 2 Subnet 3 Subnet 4  195.225.10.**0** 195. 225.10.**64** 195. 225.10.**128** 195. 225.10.**192**  195. 225.10.1 195. 225.10.65 195. 225.10.125 195. 225.10.193  All the way to All the way to All the way to All the way to  195. 225.10.**63** 195. 225.10.**127** 195. 225.10.**191** 195. 225.10.**255**  Notice that in the first subnet 195.225.10.0 is the Network ID and cannot be assigned to a host. Aslo, 195.225.10.63 is the broadcast IP address and cannot be assigned to a host. This leaves 62 useable IP addresses that can be assigned to hosts as we learned earlier. | | | | | | | | | | | | | | | |
| Check on Learning | Learning Strategy: Assessment  Conduct a quick review to determine if the students have learned the presented material. Ask open ended questions and solicit student answers and explanations. Encourage students to provide feedback to each other. The following question may be used to assess student knowledge.  **Question**: You have a network ID of 195.168.50.0 and Subnet Mask of 255.255.255.192. Determine the First, First Usable, Last Usable, and Last IP address for the third and fourth subnets.   * **Answers**:  |  |  |  |  | | --- | --- | --- | --- | | **First IP Address in Subnet** | **First Usable Host IP Address** | **Last Usable Host IP Address** | **Last IP Address in Subnet** | | 195.168.50.0  195.168.50.1  195.168.50.62 | 195.168.50.64  195.168.50.65  195.168.50.126 | 195.168.50.128  195.168.50.129  195.168.50.190 | 195.168.50.162  195.168.50.163  195.168.50.254 | | 195.168.50.63 | 195.168.50.127 | 195.168.50.191 | 195.168.50.255 | | | | | | | | | | | | | | | | |
| Review Summary | If necessary, provide a short summary of the topic. | | | | | | | | | | | | | | | |
| ELO C – Review Summary | If necessary, provide a short summary of the learning objective. | | | | | | | | | | | | | | | |
| SECTION IV. | SUMMARY | | | | | | | | | | | | | | | |
|  | Method of Instruction: Discussion (Large or Small Group)  Instr Type (I:S Ratio/Qty): Contract Instructor (1:16/0)  Time of Instruction: 5 mins  Instructional Strategy: Large Group Instruction | | | | | | | | | | | | | | | |
| Check on Learning | Ask students if they have any questions about the content presented during this lesson. Answer questions and clarify misunderstandings, as needed. | | | | | | | | | | | | | | | |
| Review Summary | Summarize the instructional material presented during the lesson. Review the following key points, and solicit and answer questions as required.   * Convert binary IP addresses to decimal. * Determine IP addresses for network components on a classful network. * Determine IP addresses for network components on a classless network. | | | | | | | | | | | | | | | |
| SECTION V. | STUDENT EVALUATION | | | | | | | | | | | | | | | |
| Testing Requirements | **Knowledge:**  The students are not assessed with a written test at the end of this lesson. Students are assessed on their ability to demonstrate knowledge of the presented material by participating in group discussions and answering review questions presented throughout the instruction. If a student is unable to accurately answer questions or provides incorrect information during a discussion, the facilitator should provide answers and clarify misunderstandings.  **Skills:**  Students are evaluated on their ability to perform the skills taught during this lesson by practicing the skills as demonstrated throughout the instruction and by completing a practical exercise. Information about the conduct of the practical exercise is presented in the Practical Exercise section of this lesson plan. If a student is unable to perform any of the practical exercise activities or performs an activity incorrectly, the facilitator should inform the student of the error and demonstrate how to perform the task correctly. | | | | | | | | | | | | | | | |
| Feedback Requirements | Feedback is essential to efficient and effective learning. The facilitator should continuously provide performance feedback to the students throughout the instruction and should also encourage students to provide constructive feedback to each other.  **Knowledge:**  If a student is unable to accurately answer questions, the facilitator should immediately provide answers and clarify misunderstandings. If a student does not participate in the group discussions, the facilitator should explain the expectations and encourage the student to participate.  **Skills:**  If a student is unable to perform any of the practical exercise activities or performs an activity incorrectly, the facilitator should inform the student of the error and demonstrate how to perform the task correctly. The facilitator should then re-evaluate the abilities of the student. | | | | | | | | | | | | | | | |