Automation of Sub-Netting Problems Using Mathematical Modeling and Simulation

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ABSTRACT: *This paper aims to develop and implement an application to calculate the subnetting and how to find the optimized IP depended on hosts number. Many organizations need for speed and accuracy of accomplishment to divide networks into sub-networks, due to the need to divide the networks complicated steps and accuracy, the need for an automated system is advised to simplify and speed up the process is very important. When company purchase web hosting from internet service provider that mean purchase several static IP Addresses and all that IPs needs to store in database, as a result of the distribution of these IPs for different companies it make conflict and waste the time to search for booked IPs. Therefore, an automated system for store the information about the assigned IP in database can solve this problem. The main objective of this paper is to discuss the complexity of calculating subnetting from user perspectives and to create an automated system to generate the subnetting process and store booked IPs. A mathematical model has been developed for the above said process.*

KEYWORDS: Subnetting, IPv4, Network, subnet mask, Class-based network Address, broadcast, ISP, automated system.

I.   INTRODUCTION:

This paper examine the network subnetting how it is difficultly to divides a largenetwork into smaller networks that meant to produce IPs from giving internet address (IP) that provide from Internet Service Provider (ISP) and separate into subnetworks. The phase teaching model subnetting IPv4 (PTMS-IP4) is an automated system which calculates the subnet of a network. It demonstrates step by step all the stages involved in subnetting. The PTMS-IP4 procedural model, implements the three phases that help the network or internet engineering people to grasp all the steps involved in subnetting. The system first computes the subnet mask into binary[11]. A prior art approach to LAN redundancy has been to provide two or more LANs, each having a LAN controller coupled to data communication devices. Some software is required in the data communication devices to switch between the LAN controllers when a failure occurs in some segments of the network. This approach has been proven to be very costly and difficult—especially when using off-the-shelf (rare and costly) data communication devices having built-in LAN controller drivers [12]. The working on assignment of IP addresses is important, as each device or user connected with a given subnet will be assigned an IP address using the same network prefix, but every subnetwork will have a different network prefix. In the following figure 1 illustrate how each subnet has a different network prefix: When dividing the network into subnets, it give us several practical advantages like Security, Limitations, Economic, Speed Network Transfers and Broadcast boundaries and Isolate performance issues.
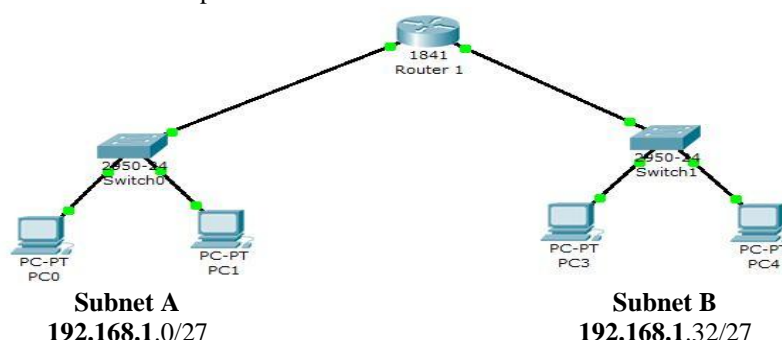

Subnet A   **Subnet B**
192.168.1.0/27   **192.168.1**.32/27

Figure 1: Each subnet has a different network prefix

Subnetting procedure: The obtained binary is typically used on the formula 2<SUP align=right>n</SUP> – 2 to calculate both the number of subnets and hosts in a subnet. From the binary mask the ones (1s) are used to determine the number of subnets, whereas the zeros (0s) calculate the number of hosts. Thereafter the PTMS-IP4 calculates the subnet permutations that display the hosts in each subnet. Not only is the system useful as a teaching model, it could also help the network or internet engineers to easily subnet complex networks[11]. We need three steps to subnetting, the first step is determine the number of host bits to be used for the subnetting. The number of host bits being used for subnetting determines the possible number of subnets and hosts per subnet. At the network layer, Internet topology consists of a set of routers connected via point-to-point or multi-access links or subnets. Most of the existing efforts on capturing a network layer map of the Internet focus on router level maps[17]

For example, the next table show the subnetting of a class C network ID. Based on a required number of subnets, and a maximum number of hosts per subnet. Second step is specify the new subnetted network IDs, based on the number of host bits (that clarify in step 1) you use for your subnetting, you must list the new subnetted network IDs. Third step is specify the IP addresses for each new subnetted network ID, specify the IP addresses for each subnetted network ID by defining the range of IP addresses (the first and the last) for each subnetted network ID.

Table1: Subnetting Class C network ID:

Required Number of Subnets	Number of Subnet Bits	Subnet Mask	Number of Hosts per Subnet	Total of Hosts
1-2	1	255.255.255.128 or /25	126	252
3-4	2	255.255.255.192 or /26	62	248
5-8	3	255.255.255.224 or /27	30	240
9-16	4	255.255.255.240 or /28	14	224
17-32	5	255.255.255.248 or /29	6	192
33-64	6	255.255.255.252or /30	2	128

Class-based network Address (IPv4): The network world findfive address classes of different sizes. Microsoft TCP/IP supports class A, B, and C addresses assigned to hosts. The class of address defines which bits are uses for the network ID and which bits are uses for the host ID. It also determine the possible number of networks and the number of hosts per network. The two hypotheses following Kolb's cycle were supported, and the one based on advance organizers was not supported. The results indicate that solving network subnetting problems starts concrete, becomes more abstract, and ends concrete[13].Class A addresses are use with networks that have very large number of hosts,the default subnet mask for class A is (255.0.0.0). Class B addresses are use with medium-sized networks, the default subnet mask for class A is (255.255.0.0). Class C addresses are use with small networks, the default subnet mask for class C is (255.255.255.0).

The Next table summarizes of address classes A, B, and C that can be used for host IP addresses:

Table 2: Summarizes of address classes A, B, and C

Class	Range	Available Networks	Hosts per Network	default subnet mask
A	1–126	126	16,777,214	255.0.0.0
B	128–191	16,384	65,534	255.255.0.0
C	192–223	2,097,152	254	255.255.255.0

To illustrate the capacity difference between the classes, I organize the following table using following equations:
A(Hosts) = B(Hosts) * 256
B(Hosts) = C(Hosts) * 256
C(Hosts) = B(Hosts) / 256
Where A,B and C are classes

As a result of these differences note the subnet mask does not mean stability in the number of users, but the number varies depending on the type class with the use of the same subnet mask. In table 3 show the capacity difference between Classes and in charts (1 and 2) choose two subnet mask as example to illustrate the capacity difference too.

Table 3: Capacity Difference between Classes (A, B, C)

Class	Subnet Mask	Required Number of	Total of Hosts
A	255.255.128.0 or /17	512	16776192
B		2	65532
A	255.255.192.0 or /18	1,024	16775168
B		4	65528
A	255.255.224.0 or /19	2,048	16773120
B		8	65520
A	255.255.240.0 or /20	4,096	16769024
B		16	65504
A	255.255.248.0 or /21	8,192	16760832
B		32	65472
A	255.255.252.0 or /22	16,384	16744448
B		64	65408
A	255.255.254.0 or /23	32,768	16711680

|			
B		128	65280
A	255.255.255.0 or /24	65,536	16646144
B		256	65024
A	255.255.255.128 or /25	131,072	16515072
B		512	64512
C		2	252
A	255.255.255.192 or /26	262,144	16252928
B		1,024	63488
C		4	248
A	255.255.255.224 or /27	524,288	15728640
B		2,048	61440
C		8	240
A	255.255.255.240 or /28	1,048,576	14680064
B		4,096	57344
C		16	224
A	255.255.255.248 or /29	2,097,152	12582912
B		8,192	49152
C		32	192
A	255.255.255.252 or /30	4,194,304	8388608
B		16,384	32768
C		64	128
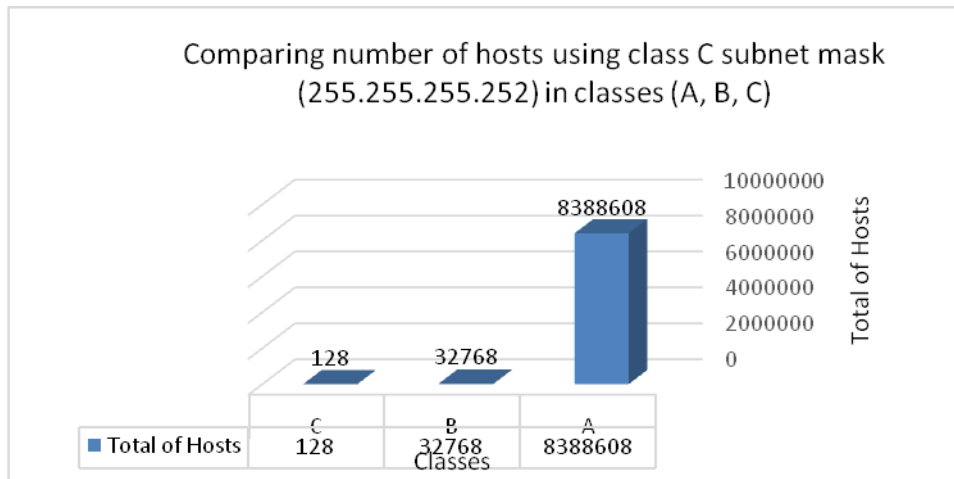
Chart 1: Comparing number of hosts using class C subnet mask (255.255.255.252) in classes (A, B, C)

InfiniBand specifies a small number of management classes. It specifies a Subnet Management mechanism which monitors the state of the subnet and takes appropriate
steps to assimilate topology changes in a smooth fashion. It specifies an entity called Subnet Manager (SM) which is in charge of discovery, configuration and maintainence of the subnet[18].

II. PROPOSED MATHEMATICAL MODEL OF SUBNETTING

Class-based network Address subnetting: If we subnetting class-base subnet mask we ask questions to gather all the facts like the number of subnet bit that used in mask, the number of hosts bits per subnet, what are the subnet addresses?, what is broadcast address for each subnet address?, and the host range of each subnet.
The pre-splitting design and post-splitting designs are simpler and involve lower upgrading overhead, while the pre/post-splitting design gives smaller blocking probability and achieves better cost-effectiveness by suitably selecting the number of splitting modules of each type[15]. In addition, to solve each question it need little complex steps, take time, and may do not give precise steps. Therefore, finding automated systemwill make network Address subnetting easy and speedily.
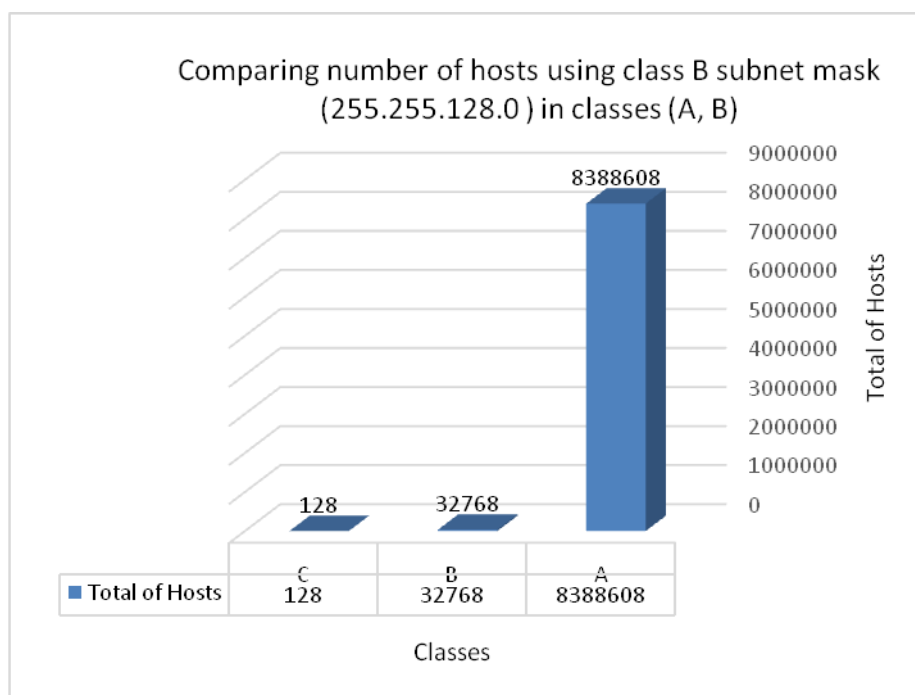

Chart 2: Comparing number of hosts using class B subnet mask (255.255.128.0) in classes (A, B)

Algorithm 1

To calculate broadcast address should looking in subnet mask in which class is it (A,B,C).

For that when we working in (class A) IP address, have tree cases:
1. If given subnet mask is in class A: the formula comes like this:

$X = (2^y / 256^{2)}$ + given subnet mask address - 1

Broadcast address = (First octet from given IP address**.X.**255**.**255)

The power (2) refer to the last two octets (because in this case each one of them will be 256)

The power(y) refer to Number of zeros in last three subnet mask octets

2. *If given subnet mask is in class B: the formula comes like this:*

$X = (2y / 2561)$ + given subnet mask address - 1

Broadcast address = (First octet from given IP address.

Second octet from   given IP address.X.255)

The power (1) refer to the last one octets (because in this case it will be 256)

The power(y) refer to Number of zeros in last two subnet mask octets

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Algorithm 1 (Continued)

3. *If given subnet mask is in class C: the formula comes like this:*

$X = (2y / 2560)$ + given subnet mask address - 1

Broadcast address = (First octet from given IP address.

Second octet from   given IP address. Third octet from given IP address. X)

The power (0) means no remaining octet in last has 256.

The power(y) refer to Number of zeros in last one subnet mask octets

By using normal way that most technical using to find broadcast address it take time and need analysis to reach to result. To arrive the solution soon, the proposed work has two algorithms for the above said problem. After subnetting class-based network address, we get like the following table:

Table 4: Subnetting result

The numbers in between the **subnet** and **broadcast** addresses	subnet	IP
	First Host	IP
	Last Host	IP
	broadcast addresses	IP

Algorithm 2

To calculate broadcast address should looking in subnet mask in which class is it (A,B,C).

1. If given subnet mask is in class A: the formula comes like this:

X = (third octet from given IP address) / subnet address)

X = round(X * subnet address, 0)

Broadcast address= $(2^y / 256^2)$ + X - 1

The power(y) refer to Number of zeros in last three subnet mask octets

2. *If given subnet mask is in class B: the formula comes like this:*

X = (third octet from given IP address) / subnet address)

*X=round(X * subnet address, 0)*

Broadcast address= (2y / 2561) + X - 1

The power(y) refer to Number of zeros in last two subnet mask octet

3. *If given subnet mask is in class C: the formula comes like this:*

X = (third octet from given IP address) / subnet address)

*X=round(X * subnet address, 0)*

Broadcast address= (2y / 2560) + X - 1

The power(y) refer to Number of zeros in last one subnet mask octets

III. SIMULATION AND RESULTS

Reliance on programming in the C# language to develop Class-based Subnetting software, and it contain two main sections, one is ISP interface and other for customer interface. In the following, illustrate the software. Microsoft visual studio 2010 with c# will be the base to process the calculating subnetting and to create the user interface. ISP interface: The seller can ask organization customer about the number of hosts require. Then, by using this interface can find the optimizedIP for his request and before get the best IP must determine the way of calculating. In figure 3 appear two option, one is (AutoDeterminate IP class) and this shows the IP class with the appropriate number of hosts required, the second option in (Subnet Mask) and this gives each subnet contain required number of hosts without change the IP class. In the right side of window show reserved IPs database with customer name listed in table, this prevents conflicts of distribution of IPs to customers. In the figure 3 illustrate ISP interface map workflow processes
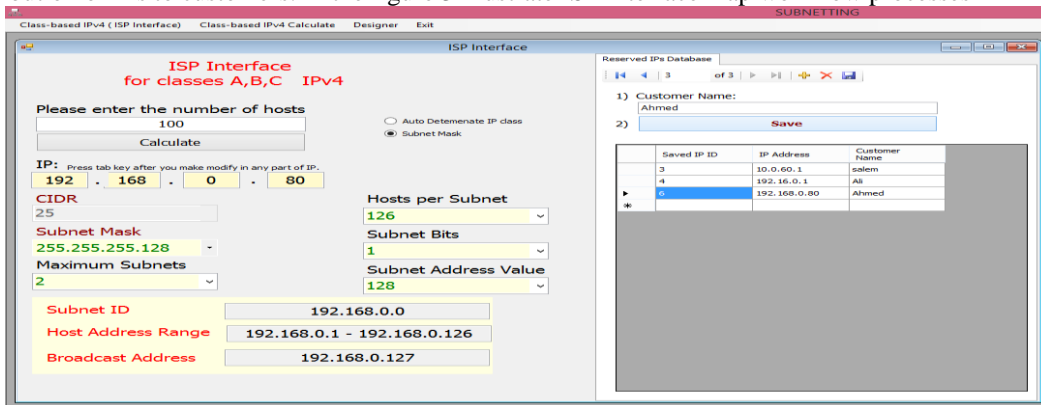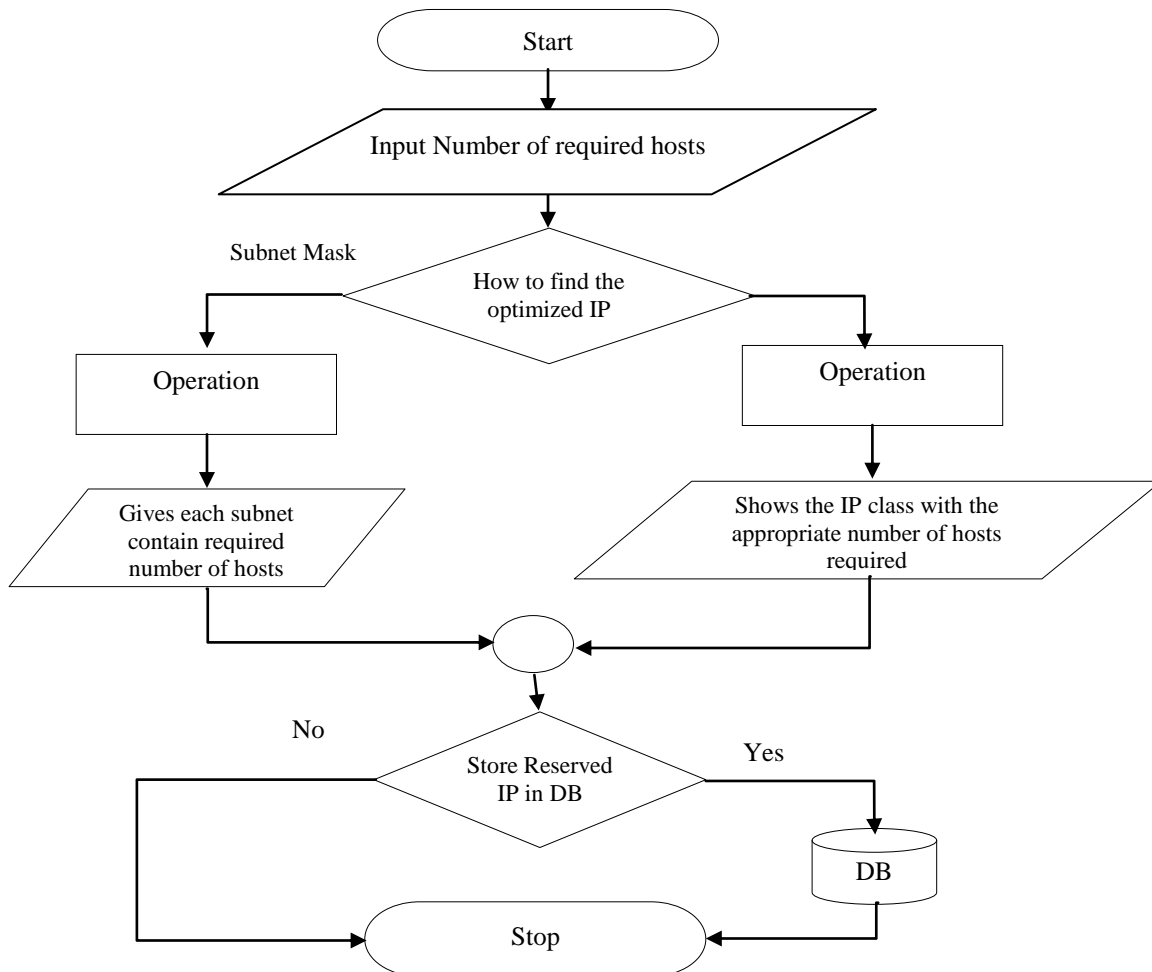

Figure 2: ISP interface

Figure 3: ISP interface map workflow processes

Customer interface: The successful inclusion of subnet relations among the routers will yield topology maps that are closest, at the network layer, to the sampled segments of the Internet. In our experiments, we present the utility of identifying subnets in a topology map. Besides, we show how identified subnets can be utilized to reduce the number of probes while resolving IP aliases[16]. This window is very helpful for users. Complexity and loss of time becomes nonexistent here. Customer can give IP from any classes A, B or C and get the precise result of subnet ID, host address range, broadcast address and other information as appear in Figure 4.In the figure 6 illustrate customer interface map workflow processes

Figure 4: Customer interface

In figure 5 show the program code function that use for calculate broadcast address.

```
SubnetIDcal = (Convert.ToInt32(IpA4.Text) / Convert.ToInt32(SubnetAddress.Text));
SubnetIDcal = SubnetIDcal * Convert.ToInt32(SubnetAddress.Text);
BroadcastCal = ((Convert.ToInt32(HostsPerSubnet.Text) + 2)) + Convert.ToInt32(SubnetIDcal) - 1;
SubnetID.Text = IpA1.Text + "." + IpA2.Text + "." + IpA3.Text + "." + SubnetIDcal.ToString();
BroadcastAddress.Text = IpA1.Text + "." + IpA2.Text + "." + IpA3.Text + "." + BroadcastCal.ToString()
HostAddressRange.Text = (IpA1.Text + "." + IpA2.Text + "." + IpA3.Text + "." + (SubnetIDcal + 1).ToSt
```
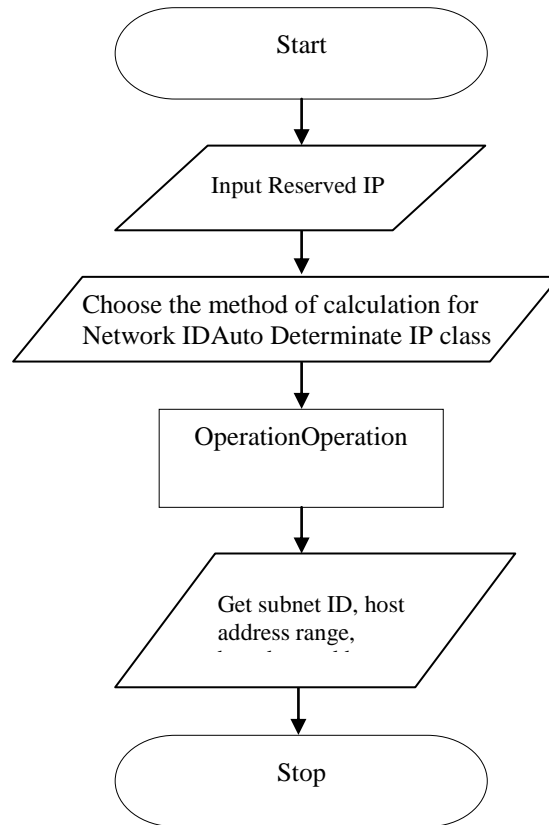
Figure 5: Function code

```
                              ┌────────────┐
                              │   Start    │
                              └────────────┘
                                    │
                                    ▼
                          ╱──────────────────╲
                          │  Input Reserved IP │
                          ╲──────────────────╱
                                    │
                                    ▼
                     ╱──────────────────────────────╲
                     │ Choose the method of calculation for │
                     │ Network IDAuto Determinate IP class  │
                     ╲──────────────────────────────╱
                                    │
                                    ▼
                          ┌──────────────────┐
                          │ OperationOperation │
                          └──────────────────┘
                                    │
                                    ▼
                          ╱──────────────────╲
                          │  Get subnet ID, host │
                          │  address range,      │
                          ╲──────────────────╱
                                    │
                                    ▼
                              ┌────────────┐
                              │    Stop    │
                              └────────────┘
```

Figure 6: Customer interface map workflow processes

IV.   CONCLUSION:

The ``Local-Area based Traffic splitter'' is based on subnetting techniques. It is basically used for calculating subnets for sub-dividing the LAN. Subnetting an IP Network can be done for a variety of reasons, including organization, use of different physical media (such as Ethernet, FDDI, WAN, etc.), preservation of address space, and security. The most common reason is to control network traffic[14]. There are various techniques for calculating subnets that are considered by this tool. This paper will explore the various features of this tool and will also check the effect of subnetting after implementing it on the LAN. These instructions give you basic guidelines for preparing camera-ready papers for conference proceedings[14]. Nowadays the speed and simplicity required in most organization such ISP to achieve its frequent business.Therefore, using subnettingautomated system very useful,and this software can use in studying fieldssuchcomputer science high college education, the student can use it to verifytheir answers resulted frommanualsubnetting calculating.When we return tothe manual methodin the calculation ofsubnetting, we can see the suffering anddifficultyuntil we getthe result, which may carryerrorsandloss of time too. Throughthis paper,researchers canrefer to itto take advantage, such as buildingequationsthat supportprogrammers in their software.

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