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Internet Protocols

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PART 1

Internet Protocol Version 6 (IPv6)

Internet Protocol Version 6 or IPV6 is the next version and the latest one that is solving the big problem that IPV4 has with the lack of IP addresses in global aspect. That problem appeared, because with the modern technology more and more devices have their own IP address in way to connect to the Internet. Today the old version Internet Protocol or IPV4 is almost exhausted.

Internet Protocol Version 6 (IPV6) is set of numbers and letters. Unlike IPV4, which is 32 bit set of numbers grouped in four groups with four numbers between 0 and 9 each, IPV6 is 128 bit long grouped in eight groups with four hexadecimal numbers from 0 to 9 and letters between A to F.

“Typical IPV6 address looks like that:

2001:0db8:0000:0000:25fd:23b1:0870:3589

The short variant of that IPV6 address if any of the groups begins with zero could looks like:

2001:db8:0:0:25fd:23b1:870:3589

or even shorter

2001:db8::25fd:23b1:870:3589

Following these rules localhost 0:0:0:0:0:0:0:1 could be represent like that ::1”

(SuperHosting [2] 2019)

Advantages

1. Probably one of the most important advantage of IPV6 over IPV4 it is support far more IP addresses. IPV4 has 2^{32} or 4 294 967 296 IP addresses which today is almost exhausted, on the other side IPV6 has 2^{128} or 340 282 366 920 938 463 463 374 607 768 211 456 which is approximately 340 undecillion addresses.
2. “More Efficient Routing – IPv6 reduces the size of routing tables and makes routing more efficient and hierarchical. IPv6 allows ISPs to aggregate the prefixes of their customers' networks into a single prefix and announce this one prefix to the IPv6 Internet. In addition, in IPv6 networks, fragmentation is handled by the source device, rather than the router,

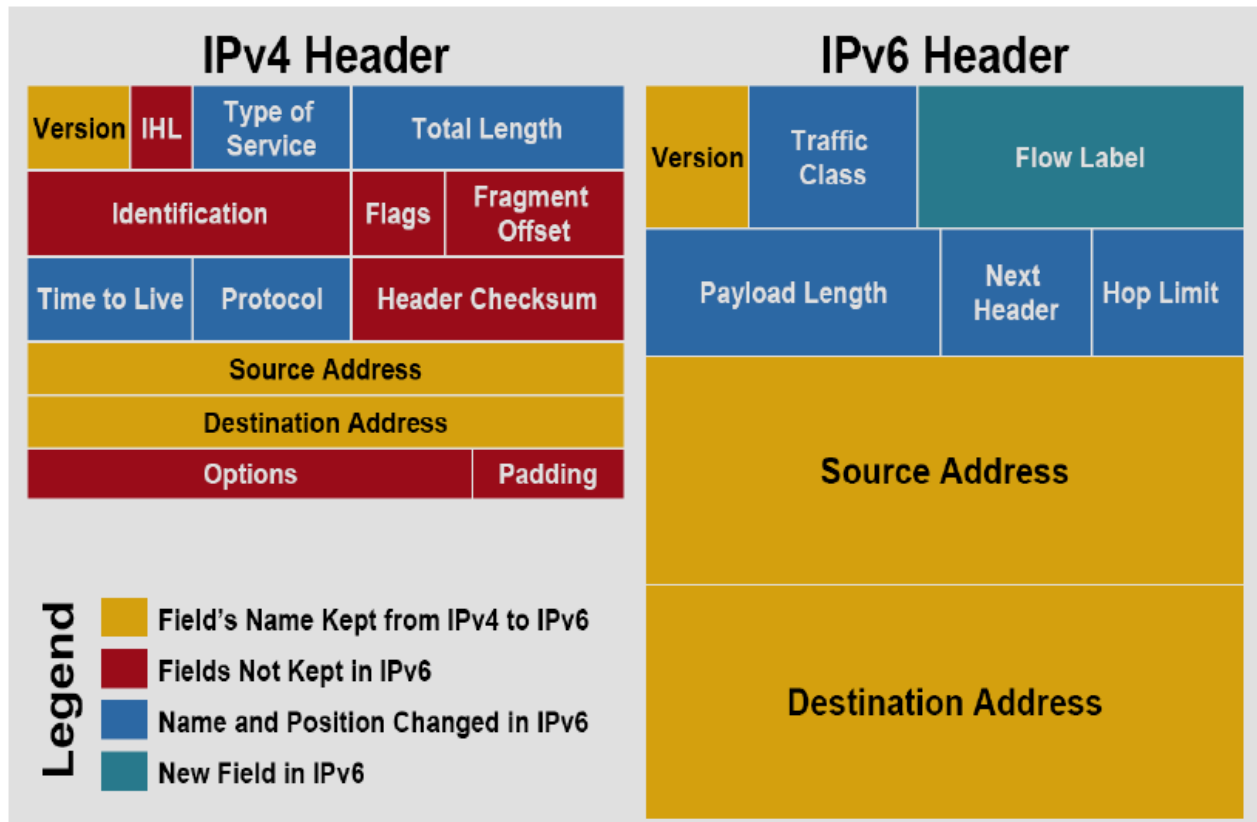
using a protocol for discovery of the path's maximum transmission unit (MTU).” (NetworkComputing [3] 2019)

3. “More Efficient Packet Processing - IPv6's simplified packet header makes packet processing more efficient. Compared with IPv4, IPv6 contains no IP-level checksum, so the checksum does not need to be recalculated at every router hop. Getting rid of the IP-level checksum was possible because most link-layer technologies already contain checksum and error-control capabilities. In addition, most transport layers, which handle end-to-end connectivity, have a checksum that enables error detection.” (NetworkComputing [3] 2019)
4. “Directed Data Flows - IPv6 supports multicast rather than broadcast. Multicast allows bandwidth-intensive packet flows (like multimedia streams) to be sent to multiple destinations simultaneously, saving network bandwidth. Disinterested hosts no longer must process broadcast packets. In addition, the IPv6 header has a new field, named Flow Label, that can identify packets belonging to the same flow.” (NetworkComputing [3] 2019)
5. “Simplified Network Configuration - Address auto-configuration (address assignment) is built in to IPv6. A router will send the prefix of the local link in its router advertisements. A host can generate its own IP address by appending its link-layer (MAC) address, converted into Extended Universal Identifier (EUI) 64-bit format, to the 64 bits of the local link prefix.” (NetworkComputing [3] 2019)
6. “Security - IPsec, which provides confidentiality, authentication and data integrity, is baked into in IPv6. Because of their potential to carry malware, IPv4 ICMP packets are often blocked by corporate firewalls, but ICMPv6, the implementation of the Internet Control Message Protocol for IPv6, may be permitted because IPsec can be applied to the ICMPv6 packets.” (NetworkComputing [3] 2019)
7. Currently Internet rely on NAT (Network Address Translation). This technology allows behind one device with real IPV4 address to have many others different devices. With IPV6 that will be not necessary anymore, because IPV6 has 2^{128}

Disadvantages

1. IPV4 is still the most popular Internet Protocols which is worldwide used
2. IPV6 cannot communicate directly with IPV4 because it has different headers and it is needs special server in order to do that.
3. Difficult for the human to remember the long 128 bit IPV6 address (2001:0db8:bd23:0653:84ff:ff00:0042:8329).
4. Not all devices or IT infrastructure are prepared or upgraded for the new IPV6.

With IPV6 and his huge IP address range every device, which can communicate with the network, can has his own real IP address.



(Figure 1 [4], IPV4 vs IPV6, 2020)

Benefits of using IPV4 and IPV6 together

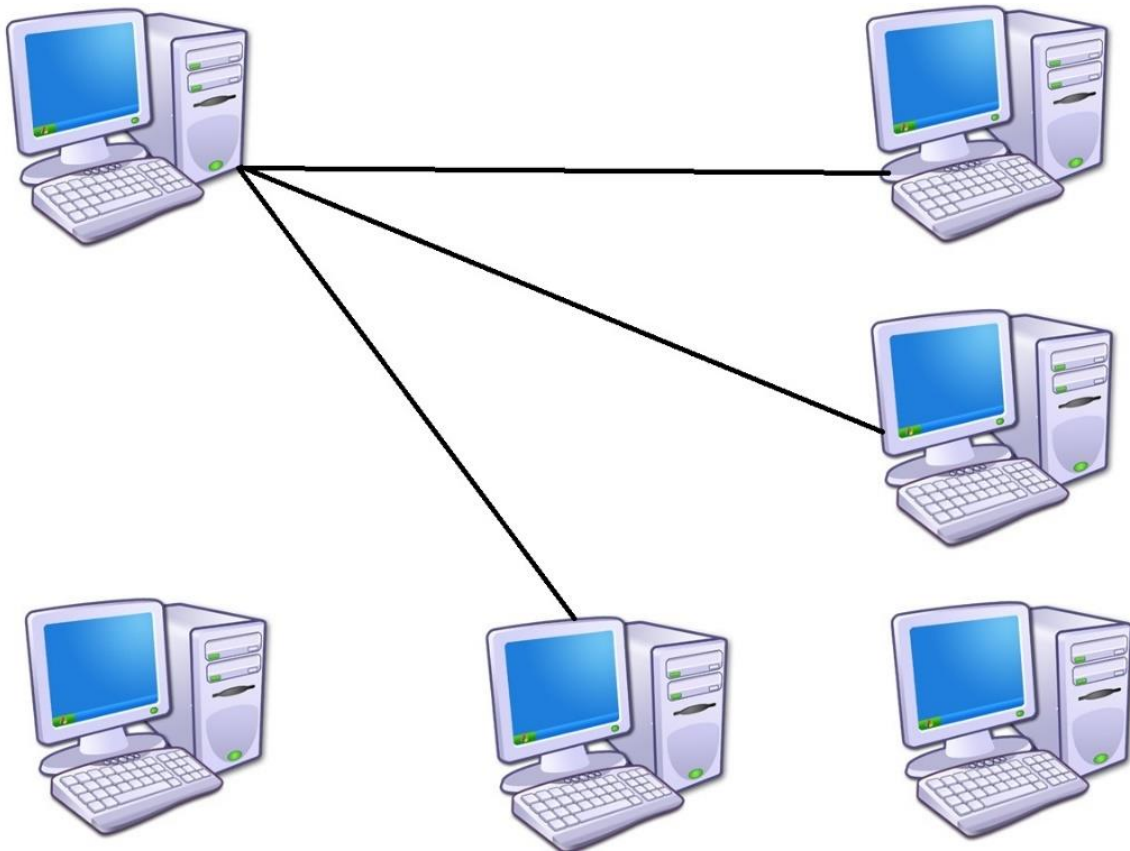
Worldwide many companies, organizations, end users are still using IPV4 on their devices such as computers, routers and many others devices that can access the network.

1. Supported dual IP network for IPV4 and IPV6
2. Tunneling

Different types of IPV6 Addresses

1. **Multicast** address can be used to deliver packages to a particular group of devices. Any packet sent to a multicast address, will be delivered simultaneously (one to many) to every host that has joined that particular group. IPV6 Multicast group can be identified by IPV6 Multicast Addresses. "In Multicast, the sender send only one copy of packets (data) over the network and it is delivered to all devices that are part of the particular Multicast Group (Not to all devices like IPV4 Broadcast)" (*OmniSecu [1] 2019*)

"Inside a corporate network, Multicast can deliver live video to multiple nodes without having to have massive bandwidth on the part of the server delivering the video feed. This way you can have a video server feeding a 720p stream on only a 100Mb connection, and yet still serve that feed to 3000 clients." (ServerFault [5], 2020)

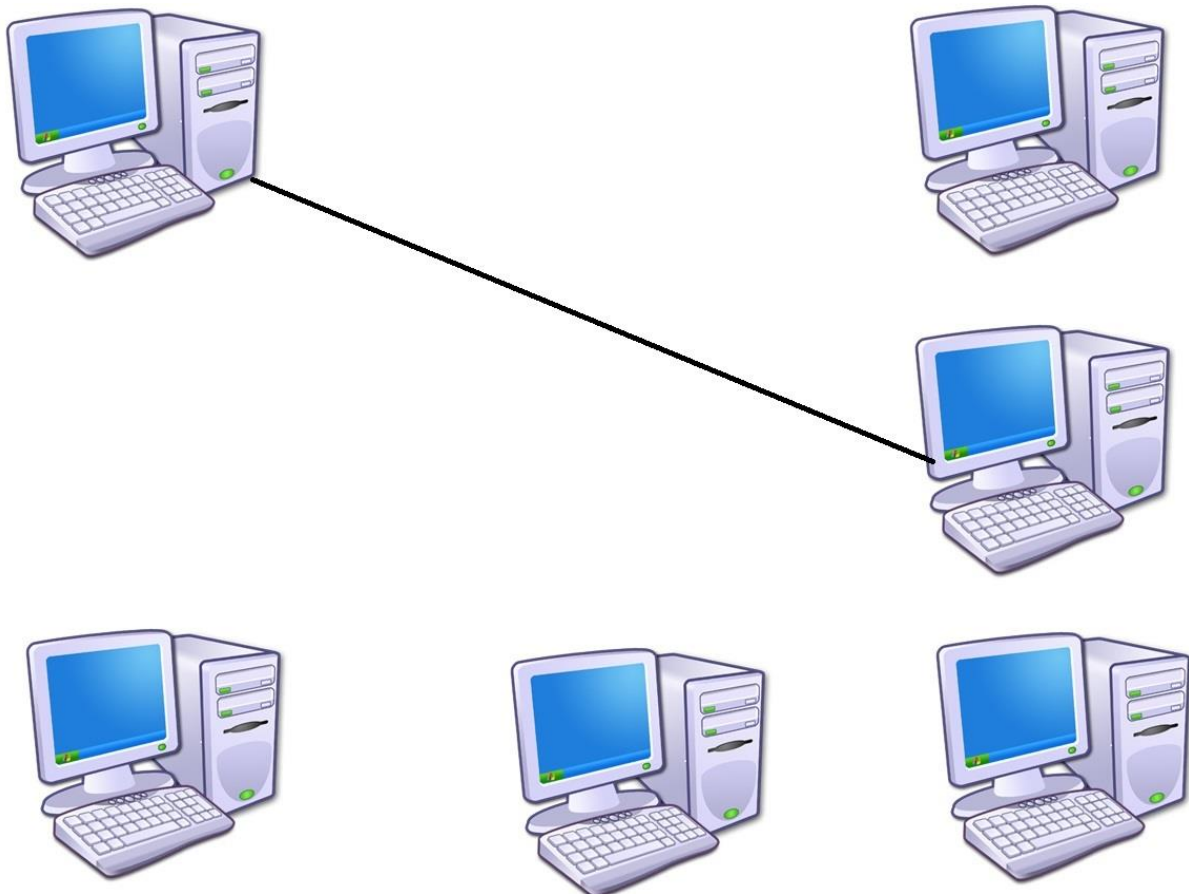


(Figure 2, IPV6 Multicast address)

2. **Unicast** is one to one type of communication. “Data is transferred from one computer to another across the network. Different data are generated for each Unicast connection. This type of communication is the option when clients need different data from network server.” (OmniSecu [1] 2019)

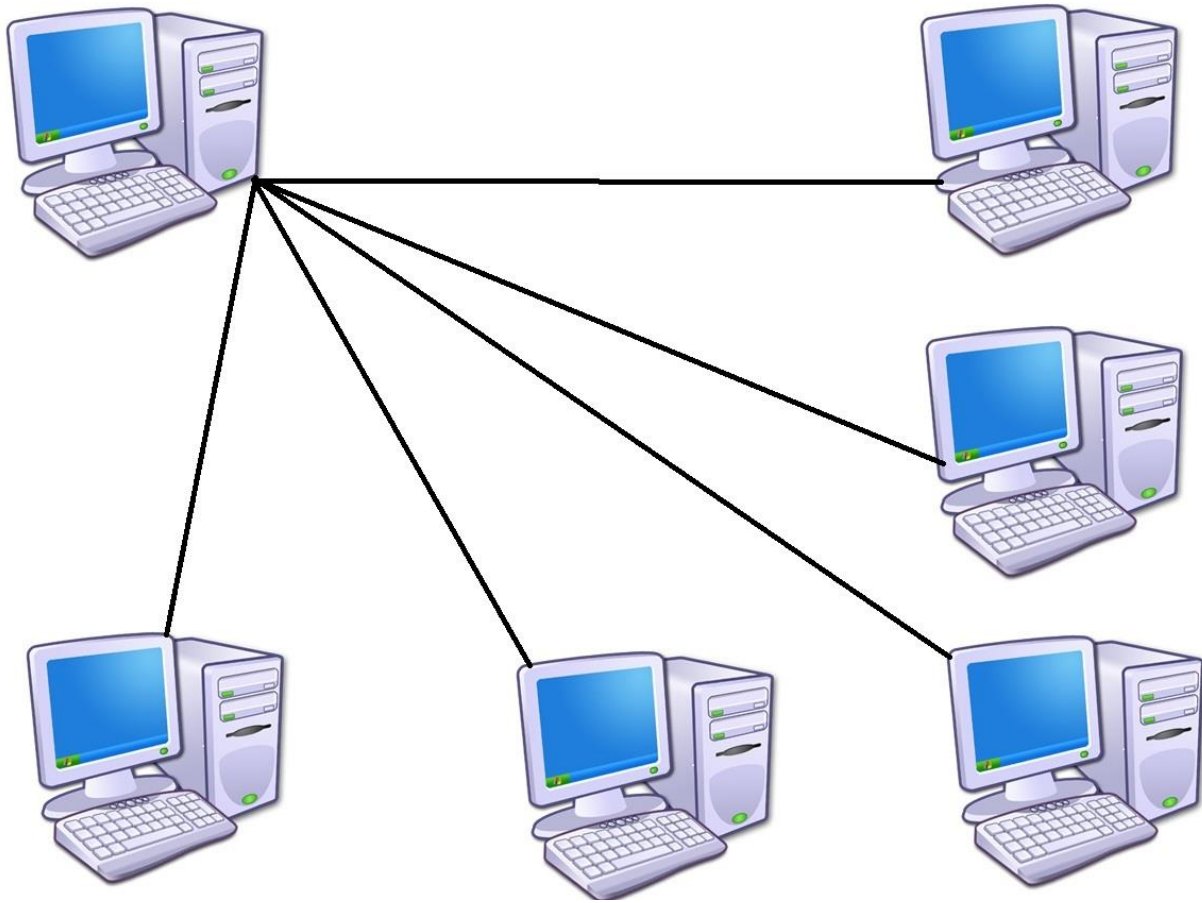
Example for IPv6 Unicast type of network communication:

- a) Browsing on internet, webserver is the sender and your computer is the receiver.
- b) Downloading a file from a FTP Server, FTP Server is the sender and your computer is the receiver.

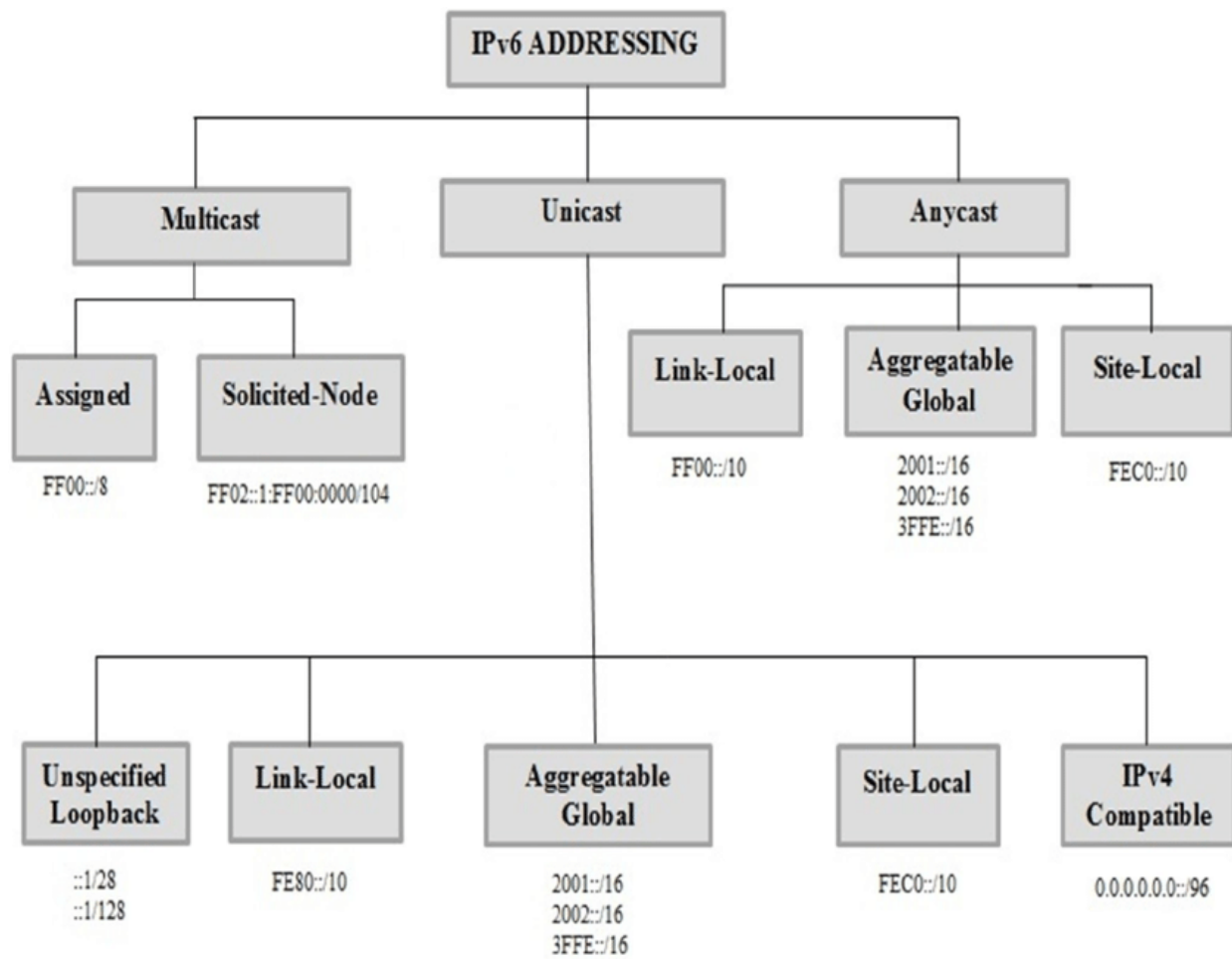


(Figure 3, IPV6 Unicast address)

3. “**Anycast** is a type of IPv6 network communication in which IPv6 datagrams from a source are routed to the nearest device (in terms of routing distance) from group servers which provide the same service. Every nodes, which provide the same service, are configured with same Anycast destination address. ” (OmniSecu [1] 2019)



(Figure 4, IPV6 Anycast address)



(Figure 5, IPV6 Different Address types [6], 2019)

PART 2

IP Addressing scheme

As an IT administrators to support more than 2000 end user devices and most likely future grow on the network, we have to use class B network to fully satisfy our need.

Room	PCs, Printers and IP Phones	Net Address	Subnet Mask	First IP Address	Last IP Address	Broadcast IP Address	Supported Hosts
School of Applied Computing		164.34.0.0/21	255.255.248.0				
Open Access Lab	245	164.34.0.0/23	255.255.255.0	164.34.0.1	164.34.1.254	164.34.1.255	254
Lab 308	140	164.34.2.0/24	255.255.255.0	164.34.2.1	164.34.2.254	164.34.2.255	254
Lab 301	60	164.34.3.0/24	255.255.255.0	164.34.3.1	164.34.3.254	164.34.3.255	254
Lab 309	50	164.34.4.0/26	255.255.255.192	164.34.4.1	164.34.4.62	164.34.4.63	62
Lab 304	45	164.34.4.64/26	255.255.255.192	164.34.4.65	164.34.4.126	164.34.4.127	62
Lab 306	40	164.34.4.128/26	255.255.255.192	164.34.4.129	164.34.4.190	164.34.4.191	62
Lab 303	36	164.34.4.192/26	255.255.255.192	164.34.4.193	164.34.4.254	164.34.4.255	62
Lab 302	30	164.34.5.0/26	255.255.255.192	164.34.5.1	164.34.5.62	164.34.5.63	62
A test Centre	20	164.34.5.64/27	255.255.255.224	164.34.5.65	164.34.5.94	164.34.5.95	30
Staff Room	20	164.34.5.96/27	255.255.255.224	164.34.5.97	164.34.5.126	164.34.5.127	30
Lab 310	18	164.34.5.128/27	255.255.255.224	164.34.5.129	164.34.5.158	164.23.5.159	30
School of Automotive Engineering		164.35.0.0/23	255.255.254.0				
Lab 301	50	164.35.0.0/26	255.255.255.192	164.35.0.1	164.35.0.62	164.35.0.63	62
Lab 206	48	164.35.0.64/26	255.255.255.192	164.35.0.65	164.35.0.126	164.35.0.127	62
Lab 205	40	164.35.0.128/26	255.255.255.192	164.35.0.129	164.35.0.190	164.35.0.191	62
Lab 101	40	164.35.0.192/26	255.255.255.192	164.35.0.193	164.35.0.254	164.35.0.255	62
Lab 103	35	164.35.1.0/26	255.255.255.192	164.35.1.1	164.35.1.62	164.35.1.63	62
Lab 102	25	164.35.1.64/26	255.255.255.192	164.35.1.65	164.35.1.126	164.35.1.127	62
Staff Room	25	164.35.1.128/27	255.255.255.224	164.35.1.129	165.35.1.158	164.35.1.159	30
CAD Lab	20	164.35.1.160/27	255.255.255.224	164.35.1.161	164.35.1.190	164.35.1.191	30
School of Engineering		164.36.0.0/22	255.255.252.0				
Lab 202	80	164.36.0.0/25	255.255.255.128	164.36.0.1	164.36.0.126	164.36.0.127	126
Lab 409	80	164.36.0.128/25	255.255.255.128	164.36.0.129	164.36.0.254	164.36.0.255	126
Lab 203	65	164.36.1.0/25	255.255.255.128	164.36.1.1	164.36.1.126	164.36.1.127	126
Lab 404	45	164.36.1.128/25	255.255.255.128	164.36.1.129	164.36.1.254	164.36.1.255	126
Lab 410	45	164.36.2.0/26	255.255.255.192	164.36.2.1	164.36.2.62	164.36.1.63	62
Lab 205	25	164.36.2.64/26	255.255.255.192	164.36.2.65	164.36.2.126	164.36.2.127	62
Lab 201	20	164.36.2.128/26	255.255.255.192	164.36.2.129	164.36.2.190	164.36.2.191	62
Lab 408	18	164.36.2.192/26	255.255.255.192	164.36.2.193	164.36.2.254	164.36.2.255	62
Staff Room	18	164.35.3.0/27	255.255.255.224	164.36.3.1	164.36.3.30	164.36.3.31	30

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[5] ServerFault.com, What is the difference between unicast, anycast, broadcast and multicast traffic?, accessed on 04-Jan-2020, available online at: <https://serverfault.com/questions/279482/what-is-the-difference-between-unicast-anycast-broadcast-and-multicast-traffic>

[6] ResearchGate.net, IPv6 Address types, accessed on 04-Jan-2020, available online at: https://www.researchgate.net/figure/2-1-IPv6-Address-types-1_fig3_260622269