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ECE 478/578 Project #2

**2.1: AS Classification**

**Description**: A pie chart that shows the (%) distribution of ASes to the three classes (Transit/Access, Content, Enterprise).

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| --- | --- |
| **Graph 1: AS Class Distribution** | |
| Transit/Access | 42.17% |
| Enterprise | 53.29% |
| Content | 4.54% |

**Explanation:** This pie chart has a total number of ASes of over 50,000. It is shown in the graph that a majority of the ASes fall into the category of enterprise or transit/access class. Over 50% of the nodes are stub nodes which create traffic and pass this traffic to other node types.

**2.2: Topology Inference Through AS Links**

**Description:** A histogram of the AS node degree distribution.

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| --- | --- |
| **Graph 2: AS Node Degree Distribution** | |
| 1 | 20913 |
| 2 - 5 | 29450 |
| 6 - 100 | 7413 |
| 101 - 200 | 136 |
| 201 - 1000 | 812 |
| 1000+ | 89 |

**Explanation:** From the graph, it is clear that a majority of the ASes on the internet have a very small amount of connections to other nodes. They have in the range of at most 1 – 100 edges that will connect to other ASes. These ASes with very small degrees most likely see all of their traffic to ASes of larger degree. The small amount of ASes that have many connections are in the range of 100 – 1000+. The ASes with many connections in the 1000+ range are most likely highly ranked, tier 1 nodes that handle much of the traffic from the lower degree ASes and form the backbone of the internet.

**Description:** A histogram of the IP space assigned to each AS. IP space assigned to each AS has been normalized to the total IP space

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| --- | --- |
| **Graph 3: AS IP Space Distribution** | |
| 2^0-2^6 | 24 |
| 2^6-2^10 | 22127 |
| 2^10-2^14 | 29000 |
| 2^14-2^18 | 7007 |
| 2^18-2^22 | 982 |
| 2^22-2^26 | 154 |
| 2^26-2^32 | 7 |

**Explanation:** From looking at the graph, a majority of the ASes have an IP distribution in the range of 26 – 218. This means that the majority of ASes are from a number of unique IP address anywhere from 64 – 260,000. Using the high end of that range, this would be less than 0.01% of the total IP space. There are very few nodes that have an IP space in the range of 218-232. These would be the tier 1 nodes that were inferred in graph 2 that have a very high degree of connections. These tier 1 nodes will have the lower IP space nodes as customers give them portions of their IP space.

**Description:**  A pie chart that shows the (%) distribution of ASes to the three classes by the following classification

* Enterprise – Any AS with degree less of equal to two and no customers or peers
* Content – Any AS with no customers and at least one peer
* Transit – Any AS with at least one customer

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| --- | --- |
| **Graph 4: AS Special Class Distribution** | |
| Transit/Access | 22.10% |
| Enterprise | 75.84% |
| Content | 2.06% |

**Explanation:** When using the classifications to define the three classes and compare it to graph 1, the enterprise class comprises more than 75% of the nodes. About half of the transit/access nodes did not have any customers; and a majority of the enterprise nodes had a small degree. As for the content class, this had a similar overall percentage when compared to graph 1, but almost half of them did not have at least one peer. In this graph over 12,000 nodes did not fall into any of these categories compared to graph 1 where every node had a category.

**2.3: Inference of Tier 1 ASes**

**Description:** This shows the largest clique in the AS topology graph using a greedy heuristic algorithm. The table below is the inferred list tier 1 nodes that the algorithm found and the organization that owns them.

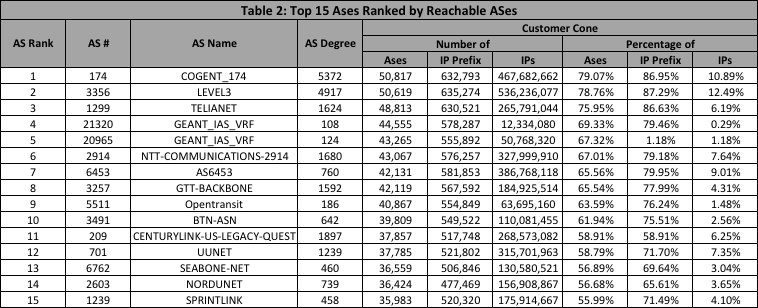
|  |  |  |
| --- | --- | --- |
| **Table 1.1: Inferred Tier 1 ASes** | | |
| **AS Number** | **Organization** | **Degree** |
| 6939 | HURRICANE | 6854 |
| 174 | COGENT-174 | 5372 |
| 3356 | LEVEL3 | 4917 |
| 24482 | SGGS-AS-AP | 2925 |
| 3549 | LVLT-3549 | 2690 |
| 36351 | SOFTLAYER | 2433 |
| 7018 | ATT-INTERNET4 | 2391 |
| 58511 | ANYCAST-GLOBAL-BACKBONE | 2322 |
|  |  |  |
| **Clique Size:** |  | **8** |

**Description:** When reading through the section 2.3 instruction, the project requirements said to infer the list of Tier 1 ASes by computing the largest clique in the complete graph topology. We used the algorithm given in the instructions, which finds a clique from the highest set of nodes and stops when it reaches the first node that is not in the clique. When we performed this algorithm, we got a clique of size 8, shown above, with each node having a very high degree. We then decided to run multiple iterations of the algorithm starting from the highest degree nodes. Every time we found a clique, we stored it and eliminated the highest degree node and ran the algorithm again. By doing this we were able to discover a much larger clique of size 106 with the first 10 nodes shown below.

|  |  |  |
| --- | --- | --- |
| **Table 1.2: Inferred Tier 1 Ases** | | |
| **AS Number** | **Organization** | **Degree** |
| 197898 | IDSI | 478 |
| 29009 | UKBROADBAND-AS | 478 |
| 41095 | IPTP | 478 |
| 200507 | VUETEL | 478 |
| 198313 | SystemHOST | 477 |
| 6643 | JIVECOMMUNICATIONS | 477 |
| 61081 | DEFAULTROUTE | 477 |
| 199659 | SURETEC | 477 |
| 43323 | PLAYOUT247 | 477 |
| 51918 | CERBERUSNETWORKS-AS | 477 |
|  |  |  |
|  | **Clique Size:** | **106** |

**2.4: Cones and AS Rank**

**Description:** This shows the top 15 ranked ASes by the customer cone in number of ASes that they can reach using p2c (provider to customer) links.



**Description:** This shows the top 15 ranked ASes by the customer cone in percentage of IP addresses they can reach using p2c links.

