1. Diameter & Average Path Length:

① if distance unconsidered, D=6, implying that we have to switch at most 6 times to go there (node 9—Tuluksak, Alaska) from here (node 332--West Tinian, a western island near Philippines); APL=2.74.

② if distance considered, D=8661 miles (node 37, Eareckson Air Station at Alaska to node 330, Babelthuap/Koror at Palau in western Pacific; APL=2033 miles. Note that the east-west straight distance of the US is about 2500 miles.

Conclusion: Network is rather compact, but some nodes that belong to the **overseas territories** or **remoted states** (e.g. Alaska) may influence the density, because the degree of these nodes tend to be relatively small. Node 9 has degree 4, node 37 and 330 have degree 2 and node 332 has merely 1 degree.

2. Degree—Consider some big-degree nodes as well as small ones!!!!!!!

Biggest 20 are: [('118', 139), ('261', 118), ('255', 101), ('182', 94), ('152', 94), ('230', 87), ('166', 85), ('67', 78), ('112', 70),

('201', 68), ('147', 67), ('293', 62), ('162', 62), ('176', 61), ('258', 60), ('248', 59), ('144', 59), ('47', 57), ('299', 56), ('217', 56)]

(**don’t forget to draw a bar pic**)

118- Chicago O’hare Intl-伊利诺伊州-Illinois

261- Dallas/Fort Worth Intl-得克萨斯州-Texas

255- Hartsfield-Jackson Atlanta Intl-佐治亚州-Georgia

182- Lambert-St Louis Intl-密苏里州-Missouri

152- Pittsburgh Intl-宾夕法尼亚州-Pennsylvania

230-Charlotte/Douglas Intl-北卡罗来纳州-North Carolina

166- Stapleton Intl-科罗拉多州-Colorado

(Now **Abandoned** and moved to Denver because of natural disaster) Denver also in Colorado！

67- Minneapolis-St Paul Intl-明尼苏达州-Minnesota

112- Detroit Metropolitan Wayne County Airport-密歇根州-Michigan

201- San Francisco Intl-加利福尼亚州-California

147- Newark Intl-新泽西州-New Jersey

293- Houston Intercontinental-德克萨斯州-Texas

162- Philadelphia Intl-宾夕法尼亚州-Pennsylvania

176- Cincinnati/Northern Kentucky Intl-肯塔基州-Kentucky

258- Phoenix Sky Harbor Intl-亚利桑那州-Arizona

248- Los Angeles Intl-加利福尼亚州-California

144- Salt Lake City Intl-犹他州-Utah

47- Seattle-Tacoma Intl-华盛顿州-Washington

299- Orlando Intl-佛罗里达州-Florida

217- Nashville Intl-田纳西州-Tennessee

It includes Illinois, Texas, Georgia, Missouri, Pennsylvania, North Carolina, Colorado, Minnesota, Michigan, California, New Jersey, Kentucky, Arizona, Utah, Washington, Florida and Tennessee.

We can see that the number of the big and busy airports is rather uniformly distributed to SOME states. Texas, Pennsylvania and California have **two** such airports, indicating that they are better in development, which accords with the situation in the real world.

Then we calculate the number of big airports in the WEST/MID/EAST part of the US. It shows that:

WEST-6

MID-6

EAST-8

We can see that it is also uniformly distributed. So this may be a proof that the US had a balanced development from that time (1997).

Now let’s see those airports with degree merely 1.

**Alaska-6**

Small scale or for special use:

Washington-1

North Dakota-2

Minnesota-1

Michigan-1

New York State-1

Illinois-2

Pennsylvania-1

Nebraska-1

Ohio-2

New Jersey-1+

Colorado-3

**California-6**

Missouri-2

West Virginia-2

Virginia-1

Kentucky-1

North Carolina-2

Arizona-2

Kansas-1

**Texas-7**

Louisiana-2

Oregon-1

Florida-2

Oklahoma-1

Overseas Territories:

Puerto Rico-1

Pacific Ocean-2

**Total-3**

We can see that except Alaska, Texas and California, airports with extremely small degree (merely 1) are also uniformly distributed to every state. As for Alaska, it has 6 small airports, possibly due to its harsh weather and its undeveloped tourism at that time (1997). With the prosper of tourism, Alaska may have more airlines. As for Texas and California, they own two super-big airports and they also have many small airports, which locate mostly near their scenic spots. The above facts indicate that Texas and California are well-developed in air transportation.

3. our network VS random network/small-world/scale-free (if node number is the **same**)

|  |  |  |  |
| --- | --- | --- | --- |
|  | Average Degree | Clustering Coefficient | Average Path Length |
| Our Network | 12.81 | 0.625 | 2.738 |
| Random | P=0.3, then 99.60 | 0.300 | 1.263 |
| Small-World WS | K=3, then 6 | P=0.2, K=3, then 0.192 | 5.863 |
| Scale-Free BA | 11.78 | 0.070 | 2.530 |

4. assortativity is negative. Then we investigate whether those big nodes connect with big nodes. (suppose those whose degree >=20 are big nodes)

{'118': 56, '261': 54, '255': 53, '182': 52, '152': 47, '230': 45, '166': 45, '67': 52, '112': 50, '201': 41, '147': 45, '293': 43, '162': 43, '176': 45, '258': 40, '248': 43, '144': 30, '47': 35, '299': 45, '217': 41}

Compared with their total degree:

[('118', 139), ('261', 118), ('255', 101), ('182', 94), ('152', 94), ('230', 87), ('166', 85), ('67', 78), ('112', 70), ('201', 68), ('147', 67), ('293', 62), ('162', 62), ('176', 61), ('258', 60), ('248', 59), ('144', 59), ('47', 57), ('299', 56), ('217', 56)]

We can see that the probability that big airports connect with big airports Pbb is roughly the same as big airports connect with small airports Pbs. This may be the reason for the negative assortativity.

5. Top 20 node betweenness:

[(118, 0.20731993223098968), (8, 0.16948031947190978), (261, 0.15241740407914336), (201, 0.09384593454509225), (47, 0.09241355545314715), (182, 0.08104336166564649), (255, 0.07085473163772363), (152, 0.06916485349203222), (13, 0.06509811101956116), (67, 0.06479638197389133), (313, 0.06215761735790646), (230, 0.05421400126936584), (144, 0.048700235274616095), (166, 0.04537799052973221), (65, 0.04354882086075502), (248, 0.03496949563237522), (112, 0.0320952394739868), (258, 0.025578157331868207), (329, 0.01797125331868534), (293, 0.01685547257189301)]

These nodes’ degrees are:

[139, 29, 118, 68, 57, 94, 101, 94, 14, 78, 24, 87, 59, 85, 41, 59, 70, 60, **4**, 62]

We can see that those with big node-betweenness tend to have relatively big degree, except for node 329. 329 is **Guam Intl** (关岛国际机场), whose neighbors are 313 (Hawaii), 327 (Saipan 塞班岛), 328 (Rota 罗塔岛) and **330 (Palau, mentioned above)**. In conclusion, Guam Intl is crucial in connecting those airports in some (**scenic**) islands!!!

In addition, 313’s degree is 24, 327’s degree is 4, 328’s degree is 2, 330’s degree is 2. That means the Guam Intl is an important **BRIDGE**!

As for the edge-betweenness, [(248, 331), (313, 331), (327, 330), (329, 330), (313, 329), (327, 329), (328, 329), (327, 328), (313, 326), (147, 325), (150, 325), (221, 325), (273, 325), (299, 325), (311, 325), (321, 325), (322, 325), (147, 324), (150, 324), (311, 324)] are the edges that have the most edge-betweenness.

We discover that node 324, 325, 328, 329, 330, 331 have repeatedly occurred in the above result.

324 locates in Puerto Rico (overseas territory) with a degree 4;

325 locates in Virgin Islands (overseas territory) with a degree 8;

328 locates in Rota Islands (overseas territory) with a degree 2;

329 locates in Guam Islands (overseas) with a degree 4;

330 locates in Palau (overseas) with a degree 2;

331 locates in American Samoa (overseas) with a degree 2.

We notice that almost all of the possible airlines of the above nodes have a high edge-betweenness while these nodes have small degree. Also, those with high node-betweenness tend to **influence its related edge-betweenness**!!!

To sum up, **overseas territories have strong impact on both** node-betweenness and edge-betweenness!!!!!!!

6. coreness of the network is 26, with 35 nodes’ coreness equalizes it.

['67', '112', '118', '201', '248', '166', '94', '109', '131', '147', '150', '152', '172', '176', '177', '182', '219', '230', '232', '255', '258', '261', '293', '311', '146', '159', '162', '167', '174', '179', '217', '292', '299', '301', '310']

Among them, 18 are in the top-20-biggest-degree list. Clear evidence that a large coreness node is inclined to be a large degree node.

**144 and 47** are top20 biggest degree nodes, but not the biggest coreness nodes. Their coreness, respectively 22 and 24.