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NLETS NETWORK COST REDUCTIONS

3 October 1974

B. Goldstein

Introduction:

The goal of this study was to investigate techniques for cost savings for the present NLETS Network configuration. The use of line multiplexing was the primary item considered. Purchase of modems, although a potential saving, does not compare with possible savings through line multiplexing. Multidropping is another technique for large cost savings but its use is not desired by NLETS.

Methods of Analysis

Both Frequency Division Multiplexing (FDM) and Time Division Multiplexing (TDM) techniques are used. Cases 1 through 6 employ the former method, while Cases 7 through 12 employ the latter and Case 13 illustrates TDM use with asynchronous terminals only. A summary of costs is given in Table 1. Also reference maps are included that permit the reader to identify the states involved in each candidate case. Popular manufacturers were used for typical costs. Unit list prices were used although quantity discounts and special governmental discounts through GSA would improve savings. Detailed costs of the candidate cases are included in Appendix A. Each case is described by first showing its multiplexed configuration and costs, next showing its non-multiplexed configuration (i.e. the present NLETS configuration) and costs and finally showing the difference between the present and proposed configuration costs, which in all cases selected results in dollar savings. Providing private line or dial backup capability to the multiplexed configuration would reduce the savings by the amounts indicated. Details given with each case allow the reader to extrapolate the technique to other cases. Costs for dial backup configurations are given in Appendix B. Both manual and automatic dial backup methods are discussed. Dial backup offers a low cost alternative to cover private line or equipment failures in multiplexed networks.

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Conclusions and Comments

1. General

Potential for dollar savings lies primarily in reducing network line mileage costs. All multiplexing techniques applied in the Eastern U.S. afford dramatic savings while multiplexing closer to Phoenix rapidly reaches a point of diminishing returns. Some additional savings could be made by buying rather than leasing modems. However by comparison the proportion of savings is small because line costs constitute close to 60% of NLETS actual costs while modems account for only 6% of the total.

2. FDM - asynchronous only - Cases 1 through 6

Because NLETS asynchronous terminals will eventually upgrade to become synchronous terminals they will each drop off of the FDM channel, reducing its efficiency. Consequently investment in FDM equipment is not recommended.

3. TDM - asynchronous only - Case 13

The same comment as made above would hold true if the TDM equipment were capable only of handling asynchronous inputs. However the TDM multiplex equipment used in Case 13 is capable of handling up to 3 - 2400 b/s synchronous lines plus a number of asynchronous inputs. The modem shown would then require upgrading to match the new transmission rate over the same voice grade line.

4. TDM - synchronous only - Cases 7 through 9

This appears to be a reasonably cost effective way of multiplexing a small number (4) of 2400 b/s users. Leasing arrangements favorable to NLETS (1 month termination notice) by using 209A's are attractive and private firms are now in the process of revamping their lease/purchase prices to meet this competition.

5. TDM - synchronous and asynchronous - Cases 10 through 12

These are easily reconfigured if terminals change from 150 b/s to 2400 bps or 2400 to 4800, etc.

Savings are signifigant when large numbers of geographically close terminals are served.

Purchase of multiplexer with lease of Bell 209 modems is an attractive option.

Bell may provide leased service using Timeplex equipment in the near future.

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ACQUISITIONS

Table 1
CANDIDATE CASES SUMMARY
Partial Mux Configurations of NLETS

Col 1 Case #	2 Type Mult	3 Mult Mfgr.	4 Multiplex Hi 2400b/s	5 Multiplex Lo 150b/s	6 W/Mult $Lease+ $Purch.	7 Without Multiplex	8 Savings (Lease)	Remarks
1	FDM	AT&T		Same as Case 4	$ 2412./mo.	$ 4200./mo.	$1788./mo.	Formerly called Datrex This Mux Service is being withdrawn on March 21, 1975!!! Reduce savings by $1307/mo. for backup backbone (5302) line inc. Service Termina No dial backup offered. Also reduce savings by $60.00/channel spare (2 spare channels max).
2	FDM	AT&T		Same as Case 5	$ 1683./mo.	$ 3186./mo.	$1503./mo.	Same as above except backbone line redundancy cost $917./mo.
3	FDM	AT&T		Same as Case 6	$ 1292./mo.	$ 2383./mo.	$1091./mo.	Same as above except backbone line redundancy cost $613./mo.
4	FDM	GTE 25C's		R.I. Maine N.H. Vt. Del. D.C.	$ 2182./mo. $ 5610. P	$ 4200./mo.	$2018./mo.	a) See Note 1 b) Includes 2 spare channels @ $280. ea. (purchase price) and leased dial back-up @ $40./mo.
5	FDM	GTE 25C's		Ky W. Va. Mich. Ala. Miss. S. Car.	$ 1971./mo. $ 5610. P	$ 3187./mo.	$1216./mo.	Same remarks as above
6	FDM	GTE 25C's		S. Dak. Mont. N. Dak. Minn. Iowa Neb.	$ 1679./mo. $ 5610./mo.	$ 2383./mo.	$ 704./mo.	

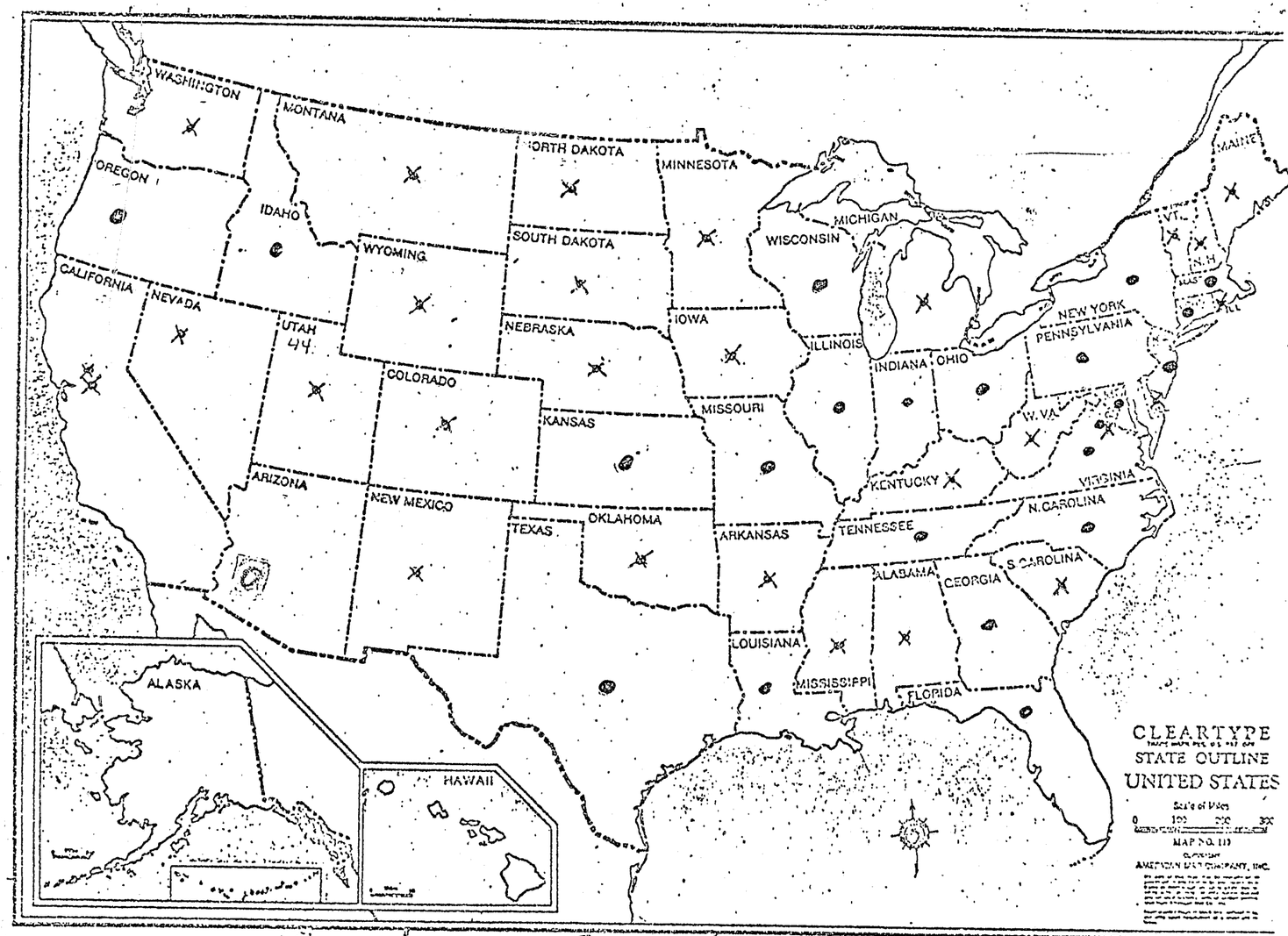
Col 1 Case #	2 Type Mult	3 Mult Mfgr.	4 Multiplex Hi 2400b/s	5 Lo 150b/s	6 W/Mult $Lease+ $Purch.	7 Without Multiplex	8 Savings (Lease)	Remarks
7	TDM	Bell 209A	Conn Mass N.J. N.Y.		$ 2505./mo.	$ 5485./mo.	$2980./mo.	a) All equipment leased from Bell. 209's to be run at 9.6K b/s in the Quad Mux Mode (4-2400 b/s channels) b) No Dial backup possible with this configuration c) See Note 2; $1759./mo.
8	TDM	Bell 209A's	D.C. Va. Pa. Md. Conn. Mass. N.J. N.Y.		$ 5339./mo.	$10521./mo.	$5182./mo.	This case includes same states as Case 7 but Multiplex is done in Wash. D.C. instead of Conn. Same remarks as Case 7 Note 2: $1635./mo.
9	TDM	Codex 9600's	same as Case 8 above		$ 5731./mo.	$10521./mo.	$4790./mo.	Codex equipment may be purchased for $44,100., reducing lease by $1290./mo. Note 2: $1715./mo. Codex 9600's to be run at 9600 b/s in a 4 channel multiplexed mode (4 - 2400 b/s channels) like 209's above. No maintenance provided.
10	TDM	Timeplex T-96; Codex 9600	Mass N.Y. Conn.	Me. N.H. Vt. R.I.	$ 2710./mo. $30540. P	$ 6543./mo.	$3833./mo.	Mux equipment located in Mass., but only a Hi speed (2400 b/s) channel is dropped here. Note 1. Note 2; $1885./mo. Note 3; $(A) 260 and $(S) 500
11	TDM	Timeplex T-96; Codex 9600's	D.C. Va. Md. Pa. N.J. N. Car.	D.C. Del. W. Va.	$ 3953./mo. $51280. P	$ 9450./mo.	$5497./mo.	Note 1 Note 2; $1715./mo. (or $19.5K buy + $1185. Note 3; $(A) 260 and $(S) 500.

Col 1	2	3	4	5	6	7	8	
Case #	Type Mult	Mult Mfgr.	Multiplex Hi 2400b/s	Multiplex Lo 150b/s	W/Mult $Lease+ $Purch.	Without Multiplex	Savings (Lease)	Remarks
12	TDM	Timeplex T-96; Codex 9600's	D.C. Same as Case 11 above plus states of Case 10	D.C. Same as Case 11 above plus states of Case 10	$ 7145./mo. $73320. P	$15993./mo.	$8848./mo.	Note 1 Note 2; $1715./mo. lease (or $19.5K buy + $1185./mo.) Note 3; $(A) 260 and $(S) 500.
13	TDM	Timeplex T-16		Same as Case 4	$ 2220./mo. $ 4800. P	$ 4200./mo.	$1980./mo.	Note 1 Note 2; $1335./mo.

Note 1: Equipment purchase (Col. 6) required to effect savings indicated in Column 8.

Note 2: Reduce savings by amount indicated for private line backup capability, including modems, service terminal charges and line conditioning where applicable (or modems purchase price plus lease of line, service terminal and conditioning)

Note 3: Reduce savings by amount indicated for cards needed to provide each additional async. channel $(A) 260. and a sync. channel $(S) 500.



X Low speed.
O High Speed

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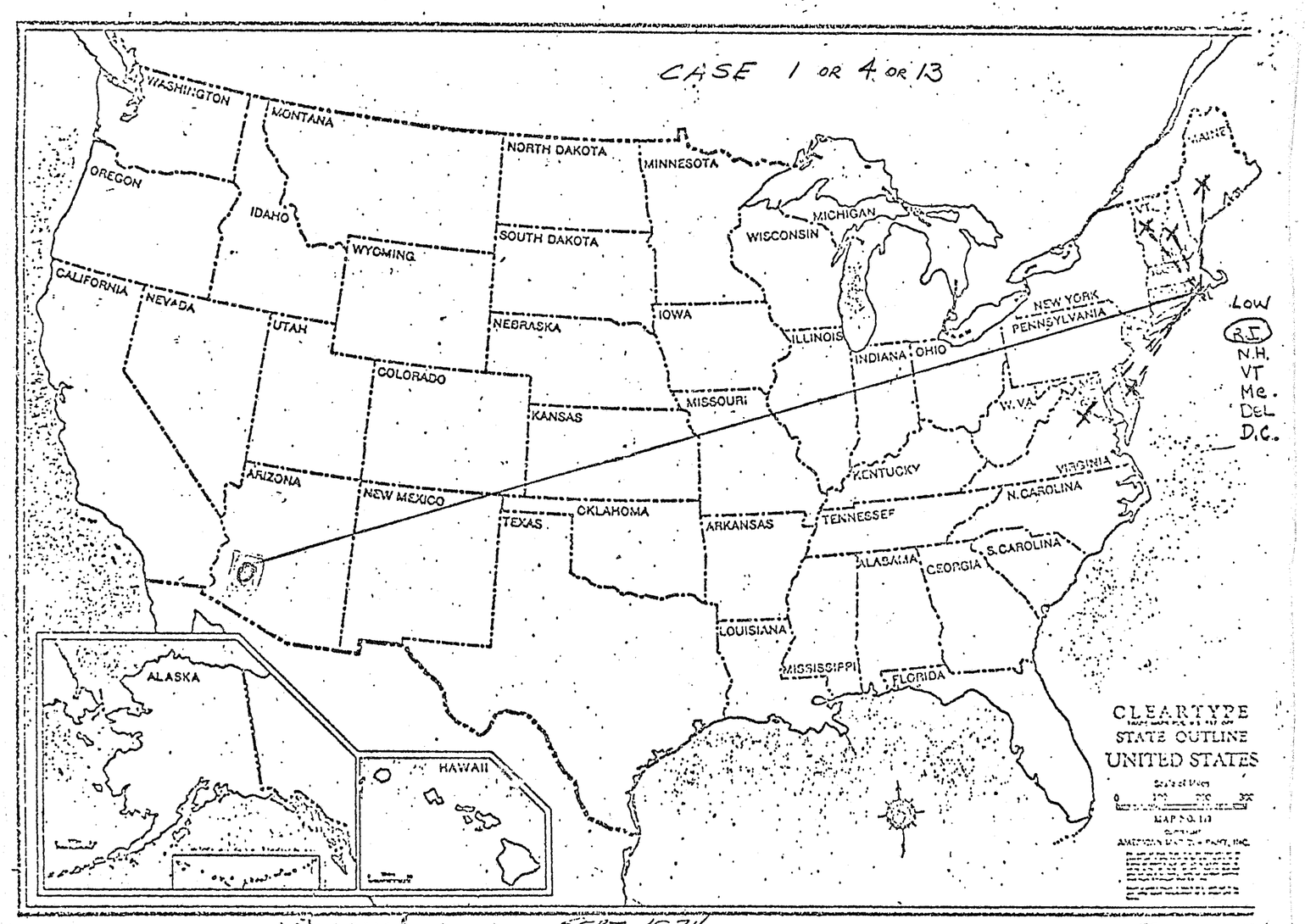
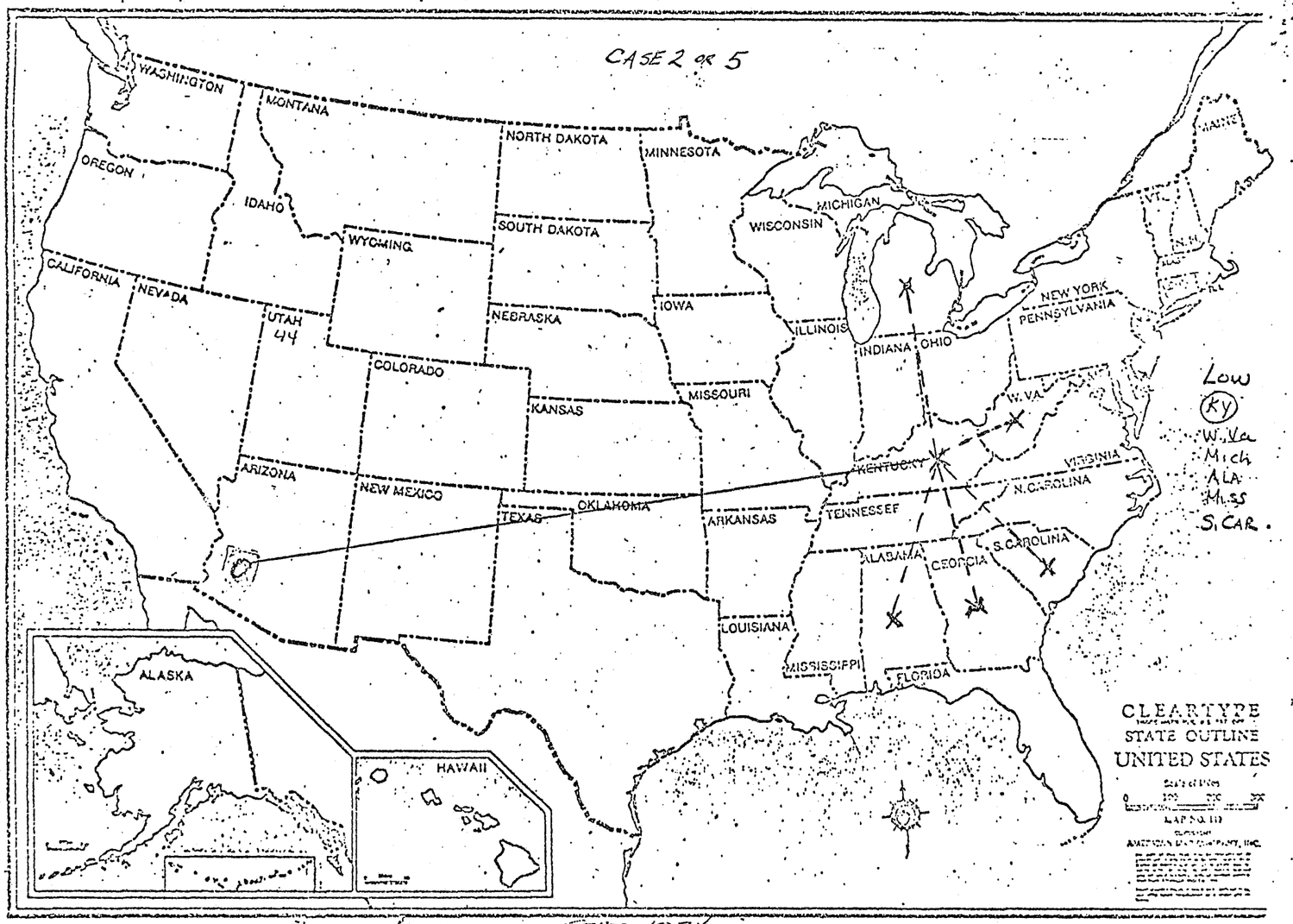
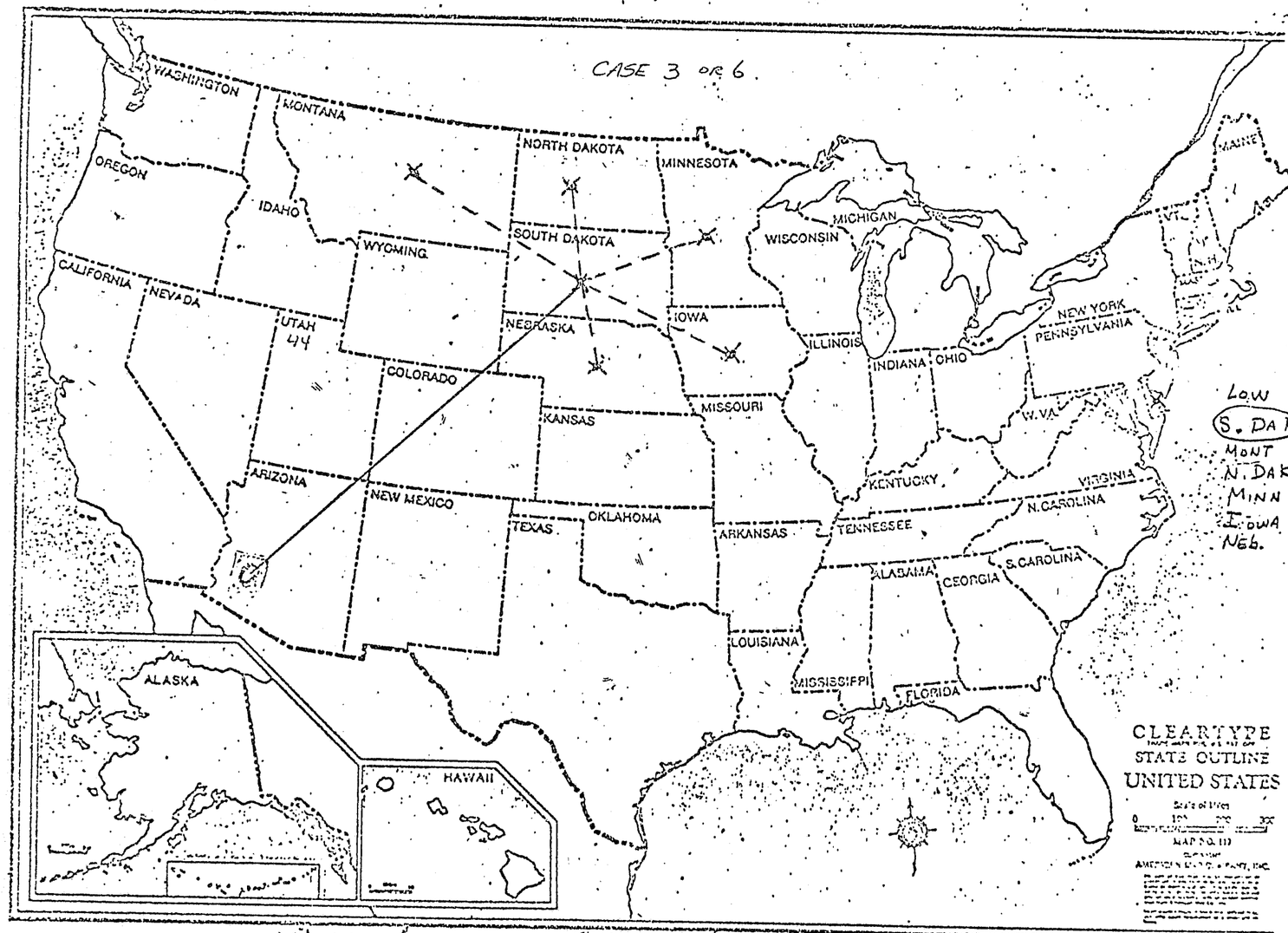

CASE 1 OR 4 OR 13
WASHINGTON
MONTANA
NORTH DAKOTA
MINNESOTA
OREGON
IDAHO
WYOMING
SOUTH DAKOTA
WISCONSIN
MICHIGAN
CALIFORNIA
NEVADA
UTAH
NEBRASKA
IOWA
ILLINOIS
INDIANA
OHIO
NEW YORK
PENNSYLVANIA
COLORADO
KANSAS
MISSOURI
W. VA
KENTUCKY
VIRGINIA
ARIZONA
NEW MEXICO
OKLAHOMA
TEXAS
ARKANSAS
TENNESSEE
N.CAROLINA
S.CAROLINA
ALABAMA
GEORGIA
LOUISIANA
MISSISSIPPI
FLORIDA
ALASKA
HAWAII
MAINE
VT.
Low
R.I.
N.H.
VT
Me.
Del
D.C.
CLEARTYPE
STATE OUTLINE
UNITED STATES
X Low speed.
O High Speed
SEPT 1974
NLETS TERMINALS
5302 GRADE LIN
5106 GRADE LIN



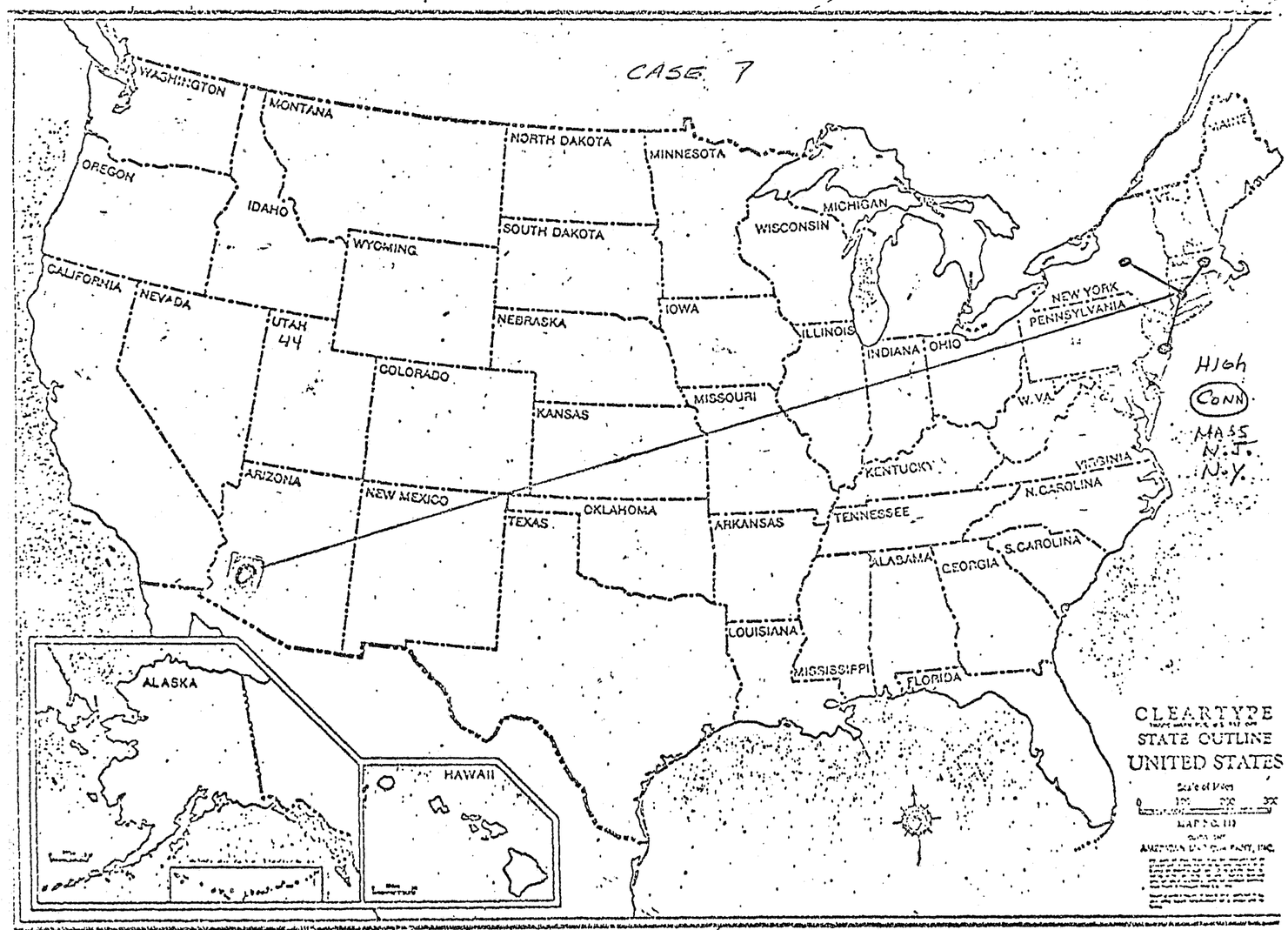
X Low speed.
O High Speed

SEPT 1974
NLETS TERMINALS



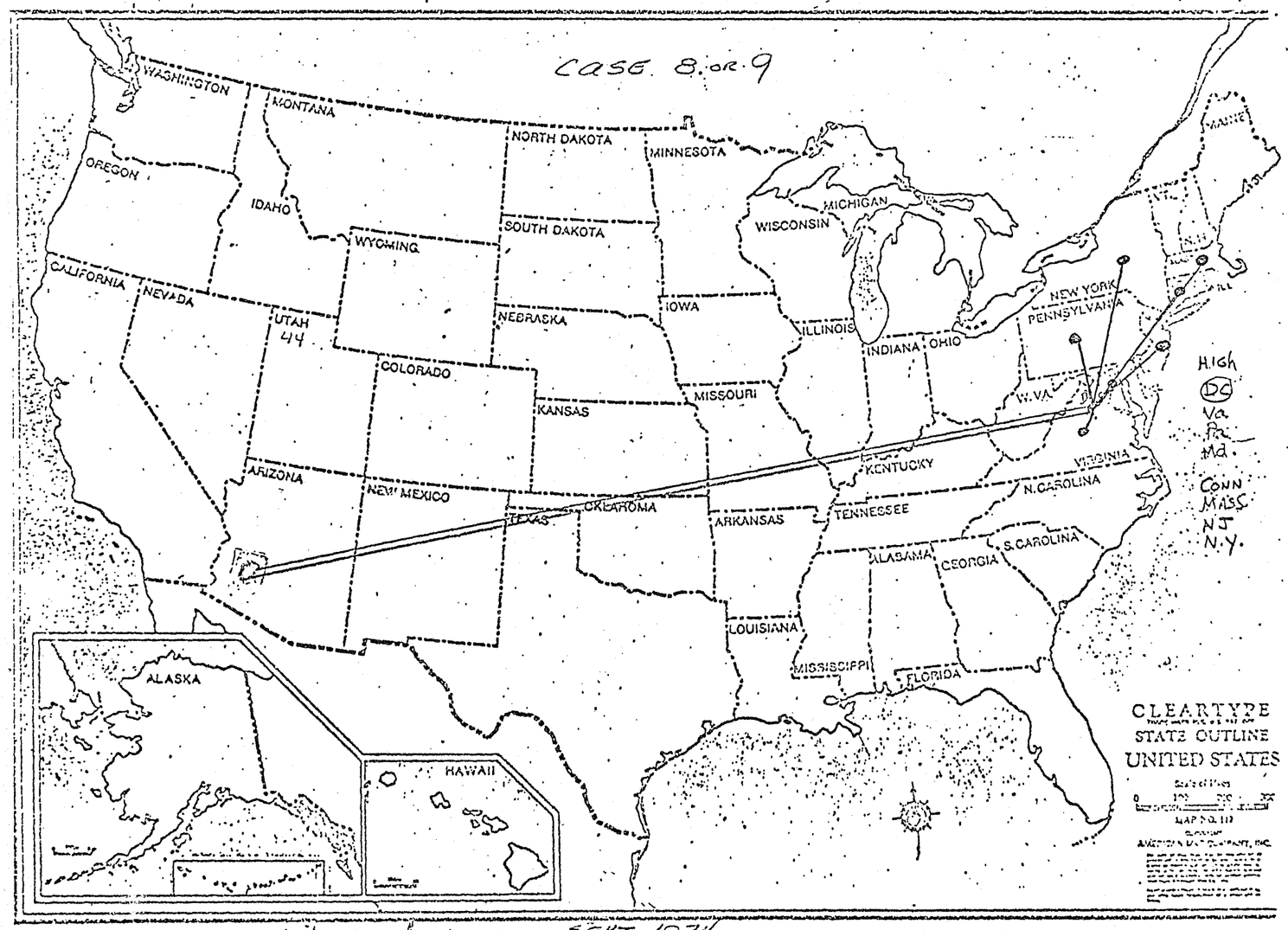
X Low speed.
O High Speed

SEPT 1974
NLETS TERMINALS



X Low speed.
O High Speed

SEPT 1974
NLETS TERMINALS



X Low speed.
O High Speed

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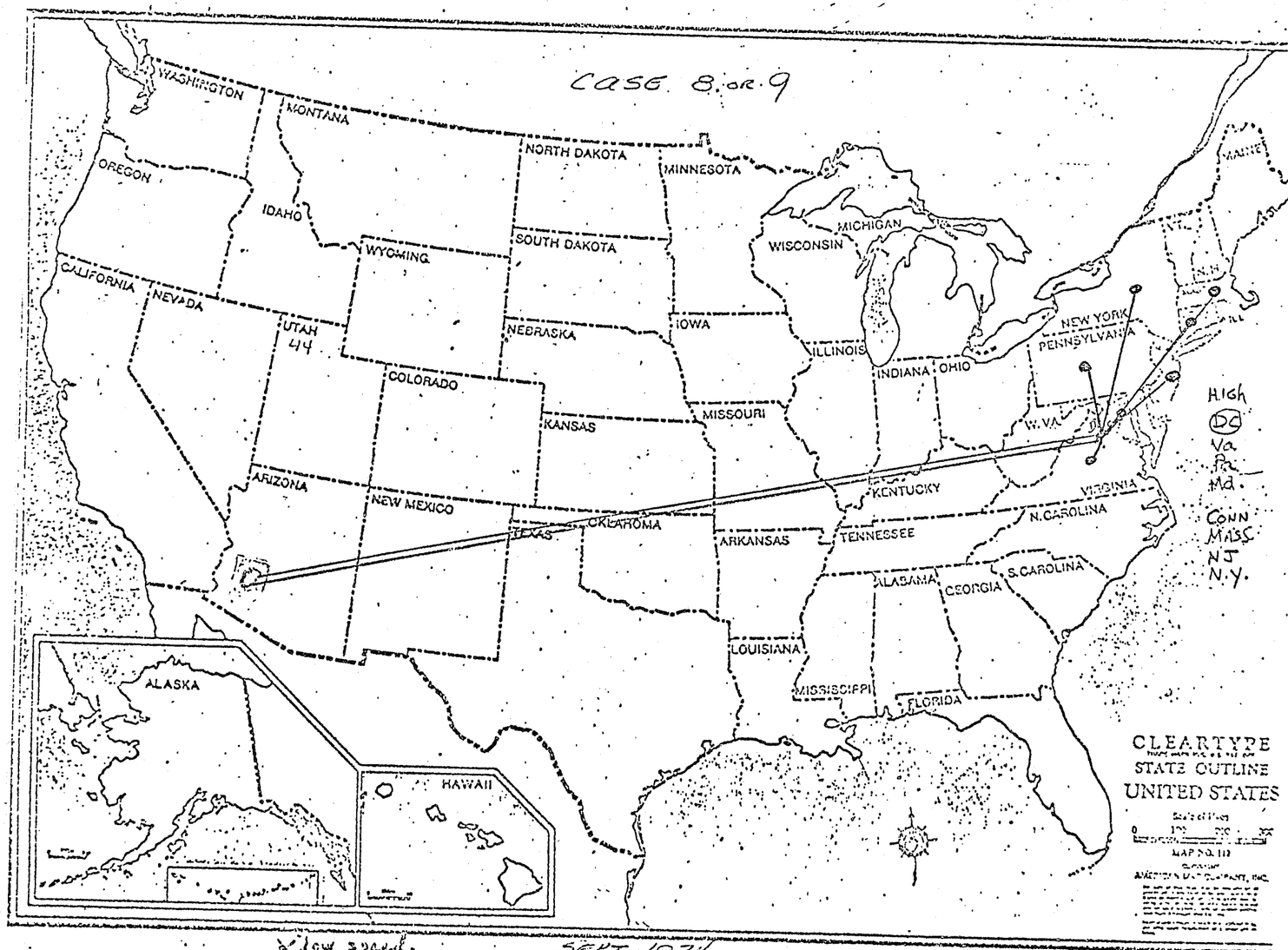
NLETS TERMINALS



X low speed.
O High Speed

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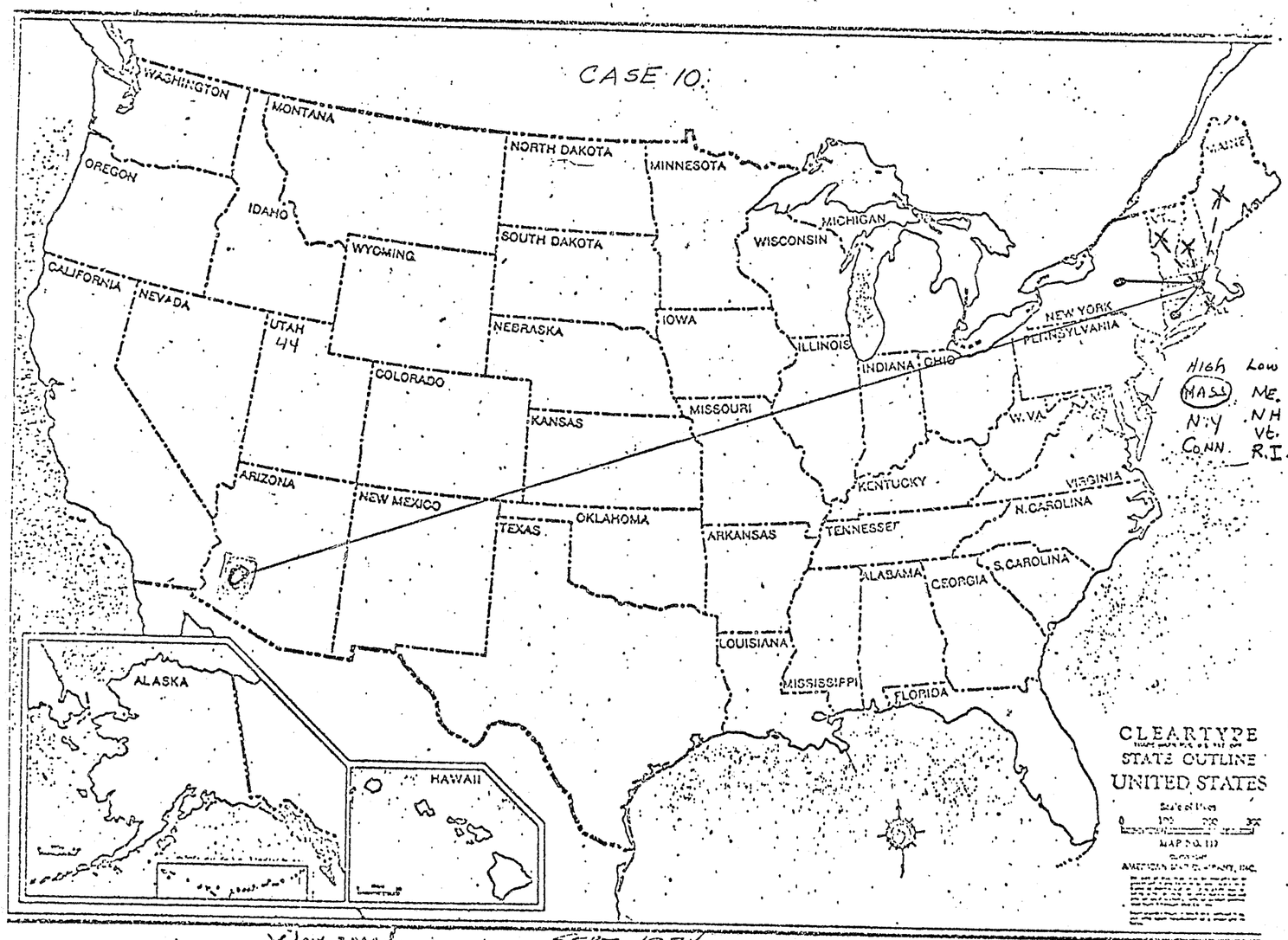

X Low speed.
O High Speed

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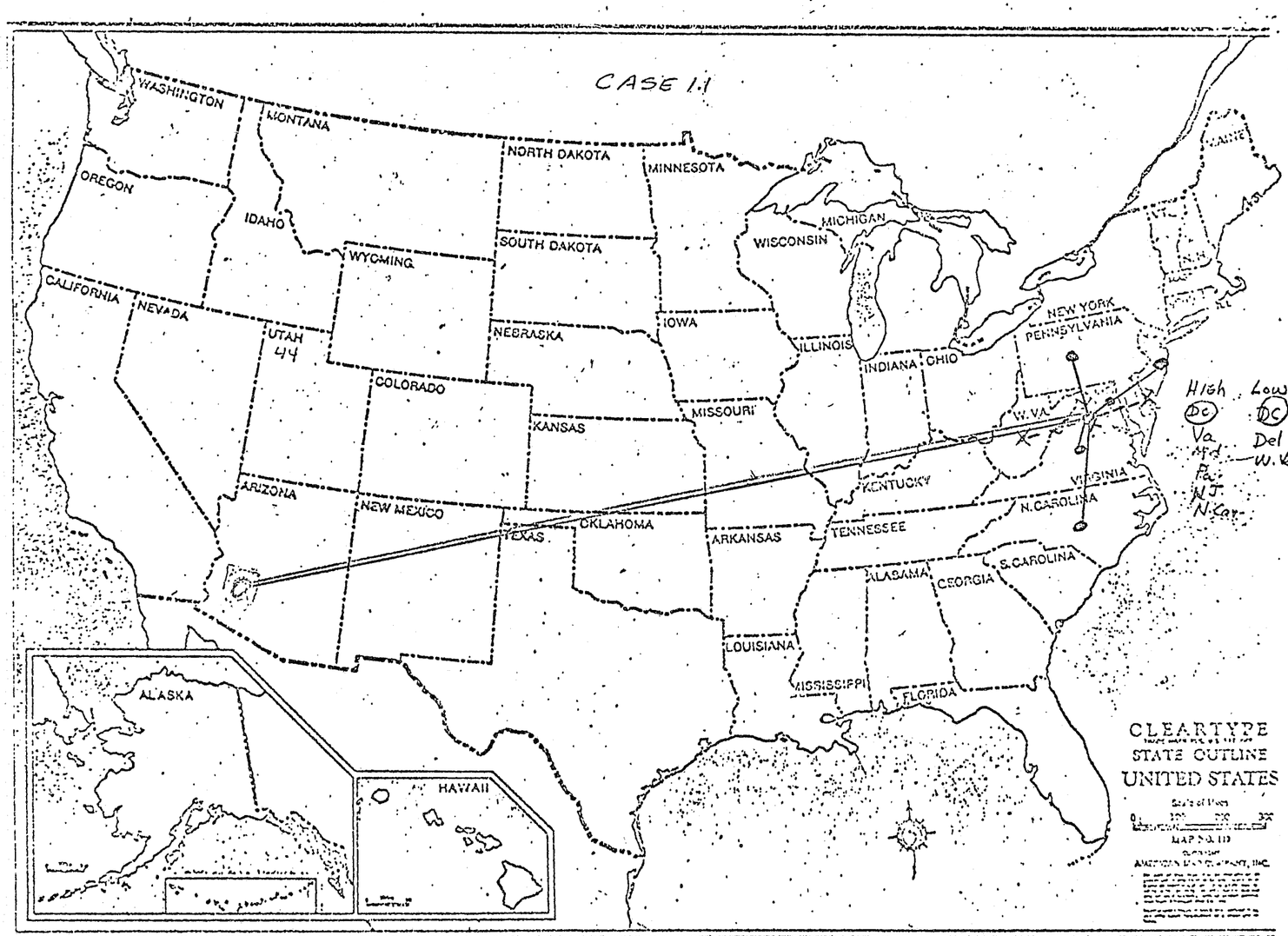
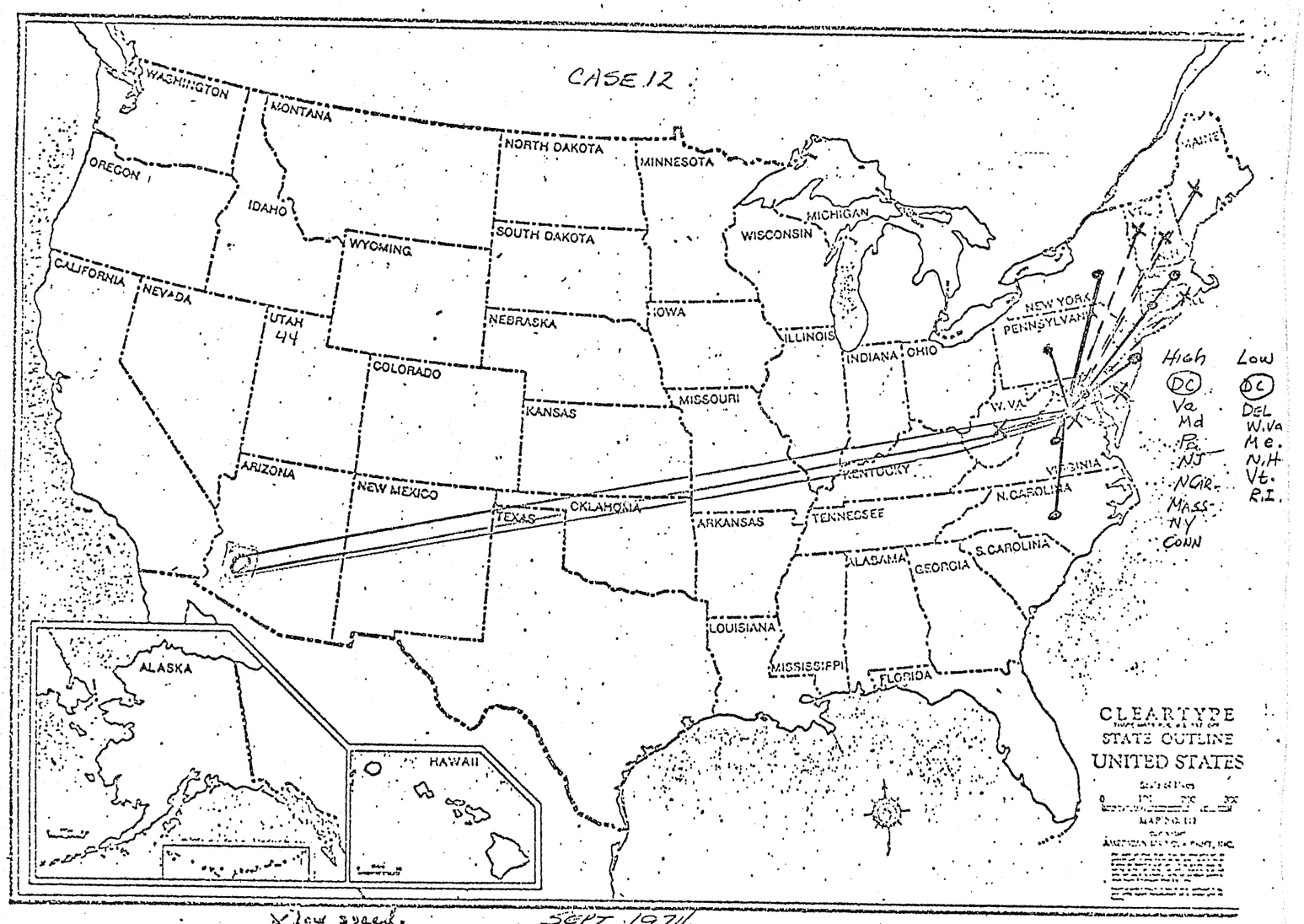
NLETS TERMINALS



X Low speed.
O High Speed

SEPT 1974
NLETS TERMINALS



X low speed.
O High Speed

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NLETS TERMINALS

Appendix A

Detailed Cost Breakdowns

Cases 1 through 13

Table A1-1

Numerical Designations for System Terminations

	STATE	CAPITAL	LATITUDE	LONGITUDE	POPULATION
1.	Alabama	Montgomery	32.37°	86.33°	3.510
2.	Alaska	Juneau	58.33°	134.33°	.325
3.	Arizona	Phoenix	33.50°	112.05°	1.945
4.	Arkansas	Little Rock	34.70°	92.28°	1.978
5.	California	Sacramento	38.53°	121.50°	20.468
6.	Colorado	Denver	39.75°	105.00°	2.357
7.	Connecticut	Hartford	41.75°	72.70°	3.082
8.	Delaware	Dover	39.17°	75.53°	.565
9.	Florida	Tallahassee	30.43°	84.32°	7.259
10.	Georgia	Atlanta	33.78°	84.37°	4.720
11.	Hawaii	Honolulu	21.32°	157.83°	.809
12.	Idaho	Boise	43.63°	116.20°	.756
13.	Illinois	Springfield	39.82°	89.65°	11.251
14.	Indiana	Indianapolis	39.75°	86.17°	5.291
15.	Iowa	Des Moines	41.58°	93.58°	2.883
16.	Kansas	Topeka	39.03°	95.68°	2.258
17.	Kentucky	Frankfort	38.18°	84.88°	3.299
18.	Louisiana	Baton Rouge	30.50°	91.17°	3.720
19.	Maine	Augusta	44.28°	69.83°	1.029
20.	Maryland	Annapolis	38.98°	76.50°	4.056
21.	Massachusetts	Boston	42.33°	71.08°	5.787
22.	Michigan	Lansing	42.74°	85.57°	9.082
23.	Minnesota	St. Paul	45.00°	93.17°	3.896
24.	Mississippi	Jackson	32.33°	90.18°	2.263
25.	Missouri	Jefferson City	38.55°	92.17°	4.753
26.	Montana	Helena	46.58°	112.00°	.719
27.	Nebraska	Lincoln	40.82°	96.68°	1.525
28.	Nevada	Carson City	39.17°	119.77°	.527
29.	New Hampshire	Concord	43.22°	71.57°	.771
30.	New Jersey	Trenton	40.25°	74.72°	7.367
31.	New Mexico	Santa Fe	35.68°	105.95°	1.065
32.	New York	Albany	42.67°	73.82°	18.366
33.	North Carolina	Raleigh	35.77°	78.65°	5.214
34.	North Dakota	Bismark	46.83°	100.80°	.632
35.	Ohio	Columbus	39.98°	83.05°	10.783
36.	Oklahoma	Oklahoma City	35.47°	97.55°	2.634
37.	Oregon	Salem	44.95°	123.02°	2.182
38.	Pennsylvania	Harrisburg	40.28°	76.90°	11.926
39.	Rhode Island	Providence	41.83°	71.42°	.968
40.	South Carolina	Columbia	34.00°	81.00°	2.665
41.	South Dakota	Pierre	44.38°	100.33°	.679
42.	Tennessee	Nashville	36.17°	86.83°	4.031
43.	Texas	Austin	30.30°	97.78°	11.649
44.	Utah	Salt Lake City	40.75°	111.92°	1.126
45.	Vermont	Montpilier	44.27°	72.57°	.462
46.	Virginia	Richmond	37.57°	77.45°	4.764
47.	Washington	Olympia	47.05°	122.88°	3.443
48.	West Virginia	Charleston	38.38°	81.67°	1.761
49.	Wisconsin	Madison	43.07°	89.37°	4.520
50.	Wyoming	Cheyenne	41.13°	104.83°	.345
51.	Washington D.C.	City	38.9 °	77 °	.757
52.	Washington D.C.	NCIC	38.9 °	77 °	-
					208.243

Table A1-2. Distance Matrix

STATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	0.	2847.	1490.	378.	2012.	1158.	990.	765.	179.	150.	4395.	1789.	547.	510.	751.
2	2847.	0.	2001.	2514.	1483.	1820.	2844.	2871.	3025.	2837.	2813.	1277.	2330.	2457.	2102.
3	1490.	2001.	0.	1132.	632.	582.	2207.	2056.	1634.	1587.	2906.	735.	1312.	1492.	1152.
4	378.	2514.	1132.	0.	1635.	781.	1165.	973.	549.	456.	4035.	1415.	382.	484.	480.
5	2012.	1483.	632.	1635.	0.	887.	2552.	2447.	2174.	2083.	2456.	447.	1699.	1883.	1485.
6	1158.	1620.	582.	781.	887.	0.	1686.	1565.	1330.	1211.	3337.	636.	814.	998.	611.
7	990.	2844.	2207.	1165.	2552.	1686.	0.	232.	1014.	841.	5007.	2187.	895.	718.	1075.
8	765.	2871.	2056.	973.	2447.	1565.	232.	0.	782.	616.	4902.	2109.	753.	569.	963.
9	179.	3025.	1634.	549.	2174.	1330.	1014.	782.	0.	231.	4536.	1964.	715.	652.	927.
10	150.	2837.	1587.	456.	2083.	1211.	841.	616.	231.	0.	4491.	1832.	509.	424.	737.
11	4395.	2813.	2906.	4035.	2456.	3337.	5007.	4902.	4536.	4491.	0.	2832.	4151.	4335.	3941.
12	1789.	1277.	735.	1415.	447.	636.	2187.	2109.	1964.	1832.	2832.	0.	1388.	1564.	1155.
13	547.	2330.	1312.	382.	1699.	814.	895.	753.	715.	509.	4151.	1388.	0.	185.	239.
14	510.	2457.	1492.	484.	1883.	998.	718.	569.	652.	424.	4335.	1564.	185.	0.	408.
15	751.	2102.	1152.	480.	1485.	611.	1075.	963.	927.	737.	3941.	1155.	239.	408.	0.
16	691.	2162.	981.	353.	1386.	500.	1220.	1078.	876.	725.	3831.	1108.	326.	510.	208.
17	415.	2584.	1550.	476.	1911.	1084.	690.	509.	536.	305.	4417.	1668.	203.	129.	517.
18	313.	2769.	1239.	297.	1804.	1001.	1286.	1068.	408.	458.	4133.	1641.	649.	698.	777.
19	1211.	2825.	2360.	1361.	2662.	1818.	227.	459.	1241.	1062.	5106.	2275.	1059.	893.	1211.
20	715.	2845.	2004.	920.	2399.	1511.	277.	54.	738.	566.	4853.	2065.	704.	519.	916.
21	1081.	2874.	2231.	1257.	2626.	1765.	92.	319.	1101.	932.	5078.	2254.	981.	805.	1154.
22	718.	2330.	1566.	662.	1892.	1028.	661.	578.	853.	622.	4347.	1535.	252.	209.	418.
23	946.	1948.	1280.	713.	1518.	703.	1049.	987.	1115.	965.	3964.	1139.	400.	509.	237.
24	225.	2711.	1269.	204.	1805.	912.	1159.	946.	370.	351.	4173.	1608.	518.	559.	666.
25	538.	2308.	1152.	266.	1578.	692.	1049.	895.	717.	545.	4021.	1294.	161.	332.	222.
26	1672.	1232.	904.	1314.	736.	589.	1955.	1898.	1850.	1692.	3091.	289.	1213.	1377.	974.
27	818.	2034.	984.	486.	1325.	444.	1243.	1122.	996.	832.	3779.	1015.	371.	558.	169.
28	1921.	1473.	581.	1543.	103.	708.	2450.	2345.	2085.	1989.	2558.	359.	1599.	1782.	1383.
29	1697.	2813.	2259.	1254.	2590.	1735.	117.	347.	1128.	949.	5040.	2212.	962.	792.	1125.
30	844.	2845.	2099.	1034.	2471.	1595.	148.	86.	867.	694.	4928.	2122.	789.	607.	987.
31	1144.	2028.	378.	774.	878.	286.	1829.	1678.	1301.	1230.	3262.	773.	934.	1114.	781.
32	986.	2759.	2153.	1134.	2484.	1624.	86.	258.	1025.	838.	4937.	2114.	844.	672.	1013.
33	498.	2934.	1836.	772.	2346.	1460.	523.	291.	494.	352.	4784.	2049.	662.	494.	898.
34	1257.	1553.	1093.	948.	1192.	533.	1425.	1374.	1434.	1245.	3611.	700.	739.	881.	509.
35	556.	2557.	1659.	624.	2043.	1161.	554.	404.	664.	434.	4498.	1714.	350.	166.	561.
36	677.	2257.	836.	303.	1334.	503.	1404.	1233.	841.	758.	3734.	1138.	526.	689.	473.
37	2139.	1041.	383.	1764.	450.	985.	2497.	2433.	2313.	2179.	2559.	349.	1727.	1899.	1491.
38	757.	2765.	1984.	925.	2359.	1481.	241.	106.	798.	609.	4815.	2013.	674.	492.	874.
39	1047.	2885.	2273.	1230.	2616.	1751.	66.	283.	1064.	898.	5070.	2248.	961.	784.	1140.
40	328.	2945.	1777.	645.	2259.	1380.	700.	468.	314.	194.	4678.	1991.	624.	489.	862.
41	1121.	1727.	978.	794.	1164.	399.	1400.	1322.	1299.	1123.	3611.	789.	631.	792.	392.
42	264.	2621.	1438.	323.	1900.	1018.	850.	651.	422.	216.	4328.	1630.	295.	250.	521.
43	690.	2589.	865.	442.	1461.	769.	1600.	1399.	802.	821.	3744.	1366.	802.	924.	814.
44	1526.	1561.	501.	1149.	532.	371.	2021.	1916.	1697.	1582.	2908.	296.	1172.	1355.	954.
45	1107.	2727.	2225.	1237.	2529.	1682.	174.	384.	1151.	960.	4975.	2145.	927.	754.	1076.
46	611.	2883.	1954.	850.	2374.	1488.	384.	152.	631.	468.	4823.	2056.	675.	494.	901.
47	2165.	912.	1034.	1796.	593.	1026.	2461.	2411.	2341.	2195.	2636.	401.	1725.	1891.	1487.
48	491.	2689.	1724.	641.	2138.	1251.	528.	335.	570.	352.	4501.	1823.	439.	259.	667.
49	757.	2177.	1390.	599.	1639.	840.	854.	768.	916.	696.	4154.	1343.	225.	283.	238.
50	1186.	1749.	659.	814.	901.	96.	1655.	1546.	1361.	1228.	3357.	605.	802.	984.	584.
51	670.	2813.	1950.	866.	2348.	1465.	320.	107.	701.	521.	4802.	2017.	652.	467.	867.
52	691.	2831.	1977.	892.	2375.	1491.	300.	81.	717.	541.	4828.	2042.	678.	493.	892.

Table A1-2 cont'd

STATE	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1	697.	410.	313.	1211.	715.	1081.	718.	946.	225.	538.	1672.	818.	1921.	1097.	844.
2	2162.	2584.	2789.	2825.	2845.	2874.	2330.	1948.	2717.	2308.	1232.	2034.	1473.	2813.	2845.
3	987.	1550.	1239.	2360.	2004.	2291.	1566.	1280.	1269.	1162.	904.	984.	581.	2259.	2039.
4	353.	476.	297.	1361.	920.	1257.	662.	713.	204.	266.	1314.	486.	1543.	1254.	1034.
5	1386.	1971.	1834.	2662.	2399.	2626.	1892.	1518.	1805.	1578.	736.	1325.	103.	2590.	2471.
6	500.	1084.	1067.	1818.	1517.	1765.	1028.	703.	972.	692.	589.	444.	788.	1735.	1595.
7	1220.	690.	1236.	227.	277.	92.	661.	1049.	1159.	1049.	1955.	1243.	2453.	117.	148.
8	1078.	509.	1068.	459.	54.	319.	578.	987.	946.	895.	1898.	1122.	2345.	347.	86.
9	876.	536.	438.	1241.	738.	1101.	853.	1115.	370.	717.	1850.	996.	2085.	1128.	857.
10	725.	305.	458.	1062.	566.	932.	622.	905.	351.	545.	1692.	832.	1989.	949.	694.
11	3831.	4417.	4133.	5106.	4853.	5078.	4347.	3964.	4173.	4021.	3091.	3779.	2558.	5043.	4928.
12	1108.	1668.	1641.	2275.	2065.	2254.	1535.	1139.	1608.	1294.	289.	1015.	359.	2212.	2122.
13	326.	280.	649.	1059.	704.	981.	292.	400.	518.	161.	1213.	377.	1599.	952.	789.
14	510.	129.	698.	893.	519.	805.	209.	509.	559.	332.	1377.	558.	1782.	792.	607.
15	208.	517.	777.	1211.	916.	1154.	418.	237.	666.	222.	974.	169.	1383.	1125.	987.
16	0.	586.	642.	1376.	1028.	1304.	586.	432.	556.	192.	975.	135.	1288.	1283.	1116.
17	586.	0.	640.	886.	456.	781.	317.	636.	502.	396.	1491.	654.	1871.	778.	552.
18	642.	640.	0.	1501.	1016.	1378.	900.	1008.	139.	559.	1572.	777.	1720.	1389.	1142.
19	1376.	886.	1501.	0.	502.	149.	795.	1145.	1371.	1219.	2026.	1381.	2559.	114.	374.
20	1028.	456.	1016.	502.	0.	366.	540.	949.	893.	844.	1858.	1075.	2258.	389.	129.
21	1304.	781.	1378.	149.	366.	0.	737.	1116.	1252.	1136.	2016.	1322.	2523.	55.	237.
22	586.	317.	900.	795.	540.	737.	0.	409.	762.	451.	1319.	587.	1789.	708.	587.
23	432.	636.	1008.	1145.	949.	1116.	409.	0.	890.	449.	911.	339.	1415.	1075.	931.
24	556.	502.	139.	1371.	893.	1252.	762.	890.	0.	444.	1515.	688.	1716.	1260.	1018.
25	192.	396.	559.	1219.	844.	1136.	451.	449.	444.	0.	1147.	286.	1483.	1120.	937.
26	975.	1491.	1572.	2026.	1858.	2016.	1319.	911.	1515.	1147.	0.	860.	645.	1970.	1902.
27	135.	654.	777.	1381.	1075.	1322.	587.	339.	688.	286.	860.	0.	1224.	1294.	1151.
28	1288.	1871.	1720.	2559.	2298.	2523.	1789.	1415.	1716.	1480.	645.	1224.	0.	2487.	2369.
29	1283.	778.	1389.	114.	389.	66.	708.	1075.	1260.	1120.	1970.	1294.	2487.	0.	262.
30	1116.	562.	1142.	374.	129.	237.	587.	931.	1018.	937.	1902.	1151.	2369.	262.	0.
31	609.	1174.	926.	1384.	1627.	1913.	1191.	929.	931.	784.	816.	615.	795.	1892.	1721.
32	1166.	658.	1273.	229.	291.	142.	596.	975.	1143.	1001.	1878.	1182.	2381.	120.	174.
33	960.	382.	810.	750.	251.	608.	607.	993.	701.	768.	1870.	1036.	2248.	638.	376.
34	598.	1004.	1240.	1499.	1337.	1486.	797.	388.	1148.	720.	530.	463.	1091.	1440.	1375.
35	676.	158.	798.	739.	356.	643.	231.	621.	661.	497.	1516.	719.	1942.	633.	440.
36	267.	725.	504.	1581.	1180.	1493.	814.	691.	475.	365.	1072.	373.	1244.	1480.	1284.
37	1454.	2007.	1938.	2568.	2392.	2559.	1856.	1451.	1957.	1639.	542.	1357.	433.	2513.	2441.
38	1001.	451.	1048.	455.	92.	334.	479.	887.	919.	823.	1798.	1037.	2257.	342.	115.
39	1286.	755.	1346.	187.	332.	39.	725.	1110.	1221.	1115.	2014.	1338.	2513.	95.	234.
40	885.	361.	641.	927.	425.	787.	652.	997.	543.	696.	1834.	979.	2163.	814.	553.
41	440.	907.	1081.	1499.	1280.	1468.	747.	354.	996.	583.	585.	308.	1061.	1429.	1333.
42	523.	175.	465.	1054.	596.	942.	459.	694.	327.	336.	1481.	621.	1803.	944.	714.
43	615.	915.	334.	1801.	1345.	1692.	1092.	1046.	470.	653.	1358.	729.	1386.	1692.	1455.
44	868.	1447.	1358.	2134.	1870.	2094.	1360.	991.	1335.	1059.	403.	796.	430.	2059.	1940.
45	1242.	784.	1389.	136.	418.	154.	659.	1011.	1257.	1086.	1899.	1245.	2425.	88.	239.
46	992.	407.	923.	610.	110.	471.	558.	962.	806.	803.	1860.	1052.	2274.	498.	236.
47	1472.	2005.	2033.	2519.	2372.	2518.	1832.	1424.	1993.	1651.	515.	1365.	566.	2473.	2414.
48	756.	175.	787.	136.	282.	620.	364.	748.	636.	568.	1634.	816.	2038.	624.	393.
49	431.	412.	874.	978.	727.	928.	194.	231.	743.	345.	1131.	406.	1596.	895.	780.
50	505.	1078.	1058.	1777.	1499.	1731.	994.	646.	1011.	694.	519.	425.	799.	1698.	1571.
51	975.	402.	957.	543.	54.	412.	498.	907.	843.	790.	1813.	1024.	2247.	429.	175.
52	1002.	429.	990.	524.	27.	390.	520.	929.	867.	817.	1837.	1050.	2274.	411.	153.

Table A1-2 Cont'd

STATE	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
1	1144.	986.	498.	1257.	556.	677.	2139.	757.	1047.	328.	1121.	264.	690.	1526.	1137.
2	2028.	2159.	2934.	1593.	2557.	2297.	1041.	2765.	2886.	2945.	1727.	2621.	2589.	1561.	2727.
3	378.	2153.	1835.	1093.	1659.	836.	983.	1984.	2273.	1777.	978.	1438.	865.	501.	2225.
4	774.	1134.	772.	948.	624.	303.	1764.	925.	1230.	645.	794.	323.	442.	1149.	1237.
5	878.	2484.	2346.	1192.	2043.	1334.	450.	2359.	2616.	2259.	1164.	1900.	1461.	532.	2529.
6	286.	1624.	1460.	533.	1161.	503.	585.	1481.	1151.	1380.	399.	1038.	769.	371.	1682.
7	1829.	86.	523.	1425.	554.	1404.	2497.	241.	66.	700.	1400.	850.	1600.	2021.	174.
8	1678.	258.	291.	1374.	404.	1233.	2433.	106.	283.	468.	1322.	651.	1399.	1916.	364.
9	1301.	1025.	494.	1434.	664.	841.	2313.	798.	1064.	314.	1299.	422.	802.	1697.	1151.
10	1230.	838.	352.	1245.	434.	758.	2179.	609.	898.	194.	1123.	216.	821.	1582.	960.
11	3262.	4937.	4734.	3611.	4498.	3734.	2559.	4815.	5070.	4678.	3611.	4328.	3744.	2988.	4975.
12	713.	2114.	2049.	780.	1714.	1138.	349.	2013.	2248.	1991.	789.	1630.	1306.	296.	2145.
13	934.	848.	652.	739.	350.	526.	1721.	674.	961.	624.	631.	295.	802.	1172.	927.
14	1114.	672.	494.	881.	166.	689.	1899.	492.	784.	489.	792.	250.	924.	1355.	764.
15	781.	1013.	838.	509.	561.	473.	1491.	874.	1140.	862.	392.	521.	814.	954.	1076.
16	609.	1166.	960.	598.	676.	267.	1454.	1001.	1286.	885.	440.	523.	615.	868.	1242.
17	1174.	658.	382.	1004.	158.	725.	2307.	451.	755.	361.	907.	175.	915.	1447.	754.
18	926.	1213.	810.	1240.	798.	504.	1988.	1048.	1346.	641.	1081.	465.	394.	1358.	1389.
19	1984.	229.	750.	1499.	739.	1581.	2568.	455.	187.	927.	1499.	1054.	1831.	2134.	136.
20	1621.	251.	251.	1337.	356.	1180.	2392.	92.	332.	425.	1280.	598.	1345.	1870.	418.
21	1913.	142.	608.	1486.	643.	1493.	2559.	334.	39.	787.	1468.	942.	1692.	2094.	154.
22	1191.	596.	607.	797.	231.	814.	1056.	479.	725.	652.	747.	459.	1092.	1360.	659.
23	929.	975.	333.	388.	621.	697.	1451.	887.	1110.	997.	354.	694.	1046.	991.	1011.
24	931.	1143.	701.	1148.	661.	475.	1957.	919.	1221.	543.	996.	327.	470.	1335.	1257.
25	784.	1001.	758.	720.	497.	365.	1639.	823.	1115.	696.	583.	336.	653.	1059.	1036.
26	816.	1876.	1870.	530.	1516.	1072.	542.	1798.	2014.	1834.	585.	1481.	1358.	403.	1899.
27	615.	1182.	1036.	463.	719.	373.	1357.	1037.	1308.	979.	308.	621.	729.	796.	1245.
28	795.	2381.	2248.	1091.	1942.	1244.	433.	2257.	2513.	2163.	1061.	1803.	1386.	430.	2425.
29	1892.	120.	638.	1440.	633.	1480.	2513.	342.	96.	814.	1429.	944.	1692.	2059.	88.
30	1721.	174.	376.	1375.	440.	1284.	2441.	115.	204.	553.	1333.	714.	1465.	1940.	299.
31	0.	1775.	1526.	815.	1281.	472.	1100.	1606.	1895.	1416.	670.	1068.	601.	477.	1849.
32	1775.	0.	542.	1348.	513.	1361.	2420.	229.	136.	714.	1327.	825.	1573.	1953.	127.
33	1526.	542.	0.	1373.	377.	1060.	2388.	326.	571.	181.	1286.	458.	1168.	1823.	659.
34	815.	1348.	1373.	0.	1006.	803.	1073.	1273.	1483.	1361.	171.	1029.	1153.	695.	1370.
35	1281.	513.	377.	1006.	0.	850.	2045.	325.	620.	428.	933.	334.	1065.	1514.	613.
36	472.	1361.	1060.	803.	850.	0.	1486.	1171.	1470.	944.	633.	602.	357.	861.	1450.
37	1100.	2420.	2388.	1073.	2045.	1486.	0.	2335.	2556.	2335.	1112.	1975.	1700.	632.	2441.
38	1606.	229.	326.	1273.	325.	1171.	2335.	0.	305.	489.	1225.	609.	1359.	1827.	353.
39	1895.	136.	571.	1483.	620.	1470.	2556.	305.	0.	751.	1461.	913.	1664.	2084.	178.
40	1416.	714.	181.	1361.	428.	944.	2335.	489.	751.	0.	1254.	362.	1013.	1750.	840.
41	670.	1327.	1286.	171.	933.	633.	1112.	1225.	1461.	1254.	0.	908.	983.	640.	1355.
42	1068.	825.	458.	1029.	334.	602.	1975.	609.	913.	362.	908.	0.	751.	1389.	935.
43	601.	1573.	1168.	1153.	1065.	357.	1700.	1359.	1664.	1013.	983.	751.	0.	1071.	1677.
44	477.	1953.	1826.	695.	1514.	861.	632.	1827.	2084.	1750.	640.	1389.	1071.	0.	1999.
45	1849.	127.	659.	1370.	613.	1450.	2441.	353.	178.	840.	1365.	935.	1677.	1999.	0.
46	1580.	401.	141.	1348.	344.	1123.	2388.	190.	435.	317.	1277.	527.	1265.	1848.	528.
47	1173.	2382.	2385.	1038.	2031.	1529.	145.	2311.	2518.	2343.	1099.	1987.	1767.	697.	2395.
48	1348.	507.	245.	1130.	133.	899.	2157.	287.	591.	305.	1049.	322.	1073.	1611.	623.
49	1013.	787.	752.	616.	390.	683.	1665.	671.	917.	772.	554.	495.	996.	1167.	842.
50	381.	1589.	1450.	442.	1143.	555.	953.	1450.	1719.	1389.	320.	1028.	845.	371.	1642.
51	1573.	324.	225.	1294.	305.	1126.	2345.	101.	379.	390.	1233.	544.	1293.	1819.	450.
52	1600.	309.	234.	1317.	331.	1153.	2370.	95.	357.	405.	1258.	570.	1318.	1845.	436.

Table A1-2 Cont'd

STATE	46	47	48	49	50	51	52
1	618.	2165.	491.	757.	1386.	670.	691.
2	2883.	912.	2619.	2177.	1749.	2813.	2831.
3	1954.	1094.	1724.	1390.	659.	1950.	1977.
4	850.	1796.	641.	599.	814.	866.	892.
5	2374.	593.	2138.	1699.	901.	2348.	2375.
6	1488.	1026.	1251.	840.	96.	1465.	1491.
7	384.	2461.	528.	854.	1655.	320.	300.
8	152.	2411.	335.	768.	1546.	107.	81.
9	631.	2341.	570.	916.	1361.	701.	717.
10	468.	2195.	352.	696.	1228.	521.	541.
11	4823.	2636.	4587.	4154.	3357.	4802.	4828.
12	2056.	401.	1823.	1343.	605.	2017.	2042.
13	675.	1726.	439.	225.	802.	652.	678.
14	434.	1891.	259.	283.	984.	467.	493.
15	901.	1487.	667.	238.	584.	867.	892.
16	992.	1472.	756.	431.	505.	975.	1002.
17	407.	2005.	175.	412.	1078.	402.	429.
18	923.	2033.	757.	874.	1058.	967.	990.
19	610.	2519.	736.	978.	1777.	543.	524.
20	113.	2372.	232.	727.	1499.	54.	27.
21	471.	2518.	620.	928.	1731.	412.	390.
22	558.	1832.	354.	194.	934.	498.	520.
23	962.	1424.	748.	231.	646.	907.	929.
24	806.	1993.	636.	143.	1011.	843.	867.
25	803.	1651.	568.	345.	694.	790.	817.
26	1860.	515.	1634.	1131.	519.	1813.	1837.
27	1052.	1365.	816.	406.	425.	1024.	1050.
28	2274.	566.	2038.	1596.	799.	2247.	2274.
29	498.	2470.	624.	896.	1698.	429.	411.
30	236.	2414.	333.	780.	1571.	175.	153.
31	1580.	1173.	1348.	1019.	381.	1573.	1600.
32	401.	2382.	507.	787.	1589.	324.	309.
33	141.	2385.	245.	762.	1458.	225.	234.
34	1348.	1038.	1130.	616.	442.	1294.	1317.
35	344.	2031.	133.	390.	1143.	305.	331.
36	1123.	1529.	839.	683.	555.	1126.	1153.
37	2308.	145.	2157.	1665.	953.	2345.	2370.
38	193.	2311.	237.	671.	1456.	101.	95.
39	435.	2518.	591.	917.	1119.	379.	357.
40	317.	2343.	305.	772.	1389.	390.	405.
41	1277.	1095.	1049.	554.	320.	1233.	1258.
42	527.	1587.	322.	495.	1028.	544.	570.
43	1265.	1167.	1073.	996.	045.	1293.	1318.
44	1848.	697.	1611.	1167.	371.	1819.	1845.
45	528.	2395.	623.	842.	1642.	450.	436.
46	0.	2375.	237.	733.	1477.	92.	95.
47	2375.	0.	2149.	1645.	982.	2327.	2351.
48	237.	2149.	0.	517.	1241.	228.	255.
49	733.	1645.	517.	0.	803.	682.	706.
50	1477.	982.	1241.	803.	0.	1448.	1474.
51	92.	2327.	228.	682.	1448.	0.	27.
52	95.	2351.	255.	706.	1474.	27.	0.

Case 1

Multiplexed with Bell Multi-Channel Station Equipment

NOTE: THIS SERVICE IS BEING CANCELLED AS OF MARCH 21, 1975! (formerly DATREX)

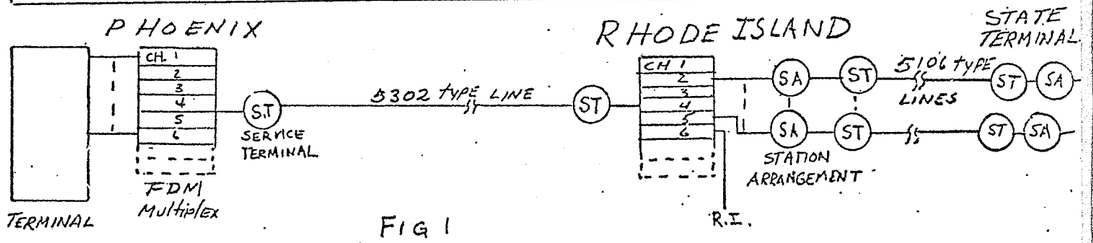


FIG 1

Phoenix	R.I.		Mileage to Phoenix	Miles to R.I.
3 →	39		2273	0
	19	Me.	2360	187
	29	N.H.	2269	96
	45	Vt.	2225	178
	8	DEL.	2056	283
	52	D.C.	1977	357
			13130	1101

Multiplex equipment:

6 channels; first 3 = $180. + 3 @ $30. ea →	$ 270.00
12 service terminals @ $40. →	480.00
10 Station Arrangements →	137.50
Line costs Backbone (5302 Type) 2273 mi. @ 54 →	1227.42
Other states to R.I. via 5106 type 1101 mi. @ 27 →	297.27
	$2412.19/month

Non-Multiplexed

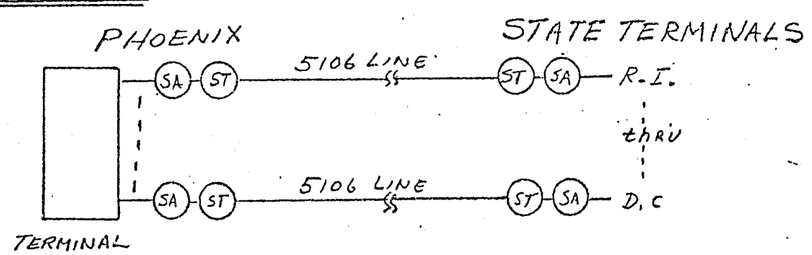


FIG 2

Station Arrangements:
12 @ $13.75 = $ 175.00

Service terminals:
12 @ $40.00 = 480.00

Mileage:
13,130 x 27¢/M./Mo. = 3545.10

$4200.10 total monthly cost with non-mux Case 1

Case 1 Difference

Non-multiplexed cost	$4,200.10
Multiplexed cost	2,412.19
	$1,787.91 savings

Reduce this figure as desired for following features:
1) per spare mux channel (2 ends) - $30.00
2) Backup backbone line & ST:
   type 5302; 2273 miles @ 54¢ = $1227.42
   service terminals; 2 @ $40. = 80.00
   $1307.42

NOTE: NO DIAL BACKUP CAPABILITY AVAILABLE FOR LINK FROM PHOENIX TO RHODE ISLAND.

Case 2

Multiplex

NOTE: THIS SERVICE TO BE CANCELLED 3-75!

Same as config. #1 except Phoenix to Ky, W.Va., Mich., Ala., Miss., & S. Carolina

Line costs Phoenix to Ky.:
1550 x 54¢ = $ 837.00
Others to Ky.:
1765 x 27¢ = 476.55
$1313.55 → Lease $1313.55

Mux 1st three channels $180. = $180.
+$30./channel x 3 channels = $90. = 90.
$270.

270.00
$1683.55/mo.

Non-Multiplex

12 Station Arrangements @ $13.75	$ 175.00
12 Serv. terminals @ $40.	480.00
6 Lines (5106 type) 9376 mi. @ 27¢	2531.62
	$3186.62/mo.

Case 2 Difference

Non-mux $3186.62
Mux 1683.55
$1503.07 Lease Savings/mo.

Reduce savings as desired for following features:
1) per SPARE mux channel (2 ends) - $30.00
2) Backup Line and service terminals - $917.00/mo.:
type 5302 line; 1550 mi. @ 54¢ = $837.00
service terminals; 2 @ $40. = 80.00
$917.00

NOTE: No dial backup capability available for link from Phoenix to Kentucky.

Case 3

Multiplex

NOTE: THIS SERVICE TO BE CANCELLED 3/75!

Configuration same as Case 1 except Phoenix to S. Dak., Mont., N. Dak., Minn., Iowa and Neb.

Line costs:
1-5302 Line Phoenix to S. Dak.
987mi. x 54¢/m = $ 532.98
5-5106 Lines Other State to S. Dak.
1810 x 27¢/m = 488.70
$1021.68 → Lease $1021.68

Mux equipment lease same as Case 2. → 270.00
$1291.68/mo.

Non-Multiplex

12 S.A.	$ 175.00
12 S.T.	480.00
6 Lines 6400 mi. @ 27¢	1728.00
	$2383.00

Case 3 Difference

Non-mux $2383.00
Mux 1291.68
$1091.32 savings

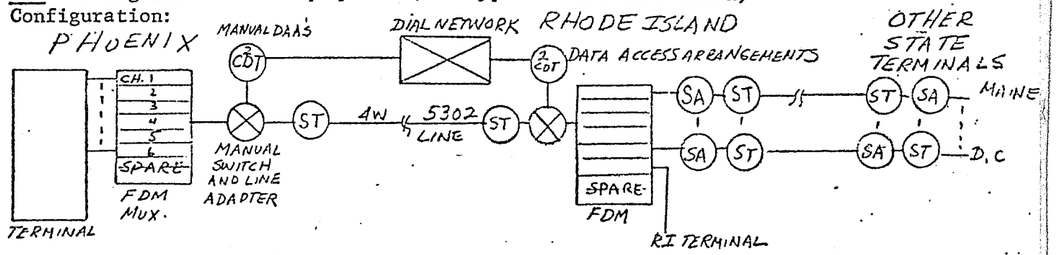
Reduce savings as desired for following features:
1) Per spare mux channel (2 ends) - $30.00
2) Backup Line and service terminals - $612.98/mo.
5302 type line; 987 mi. x 54¢ = $532.98
Service terminals; 2 @ $40.00 = 80.00
$612.98

NOTE: No dial backup capability available for link from Phoenix to South Dakota.

Case 4

Multiplexed

FDM - using Lenkurt 25c equipment (for typical cost derivation)
Configuration:



Lines - $/month

1 (GSA) 5302 Line Phoenix to R.I. = 2273 mi. x $.54/mi. = $1227.42
5 (GSA) 5106 Lines to Mux @ R.I. =
R.I. to Maine = 187 mi.
R.I. to N.H. = 96 mi.
R.I. to Vt. = 178 mi.
R.I. to Del. = 283 mi.
R.I. to Wash D.C.= 357 mi.
1101 mi. x $.27/mi./mo. = 297.27 — Lease/mo.
Cost total line = $1524.69 ——→ $1524.69

Other Telco Charges - $/month

10 Station Arrangements (tty modems for 5106 lines) @ $13.75 = $137.50
12 Service Terminal Charges @ $40.00 = 480.00
$617.50 ——→ 617.50

Dial Backup Costs
4 CDT Data Couplers @ $2.50 $10.00
4 Measured Business Lines @ $7.50 = $30.00
(inc. phones) $40.00 ——→ 40.00

Equipment

		Purchase Price	
	2 Line Adapter & Switch units @ $75.00 (ICC Model 21 B cost used for illustration)	= 150.	
GTE Lenkurt 25c	2 - 8 channel FDM capacity 25c data shelves w/P.S @$340.	= 680.	
	16 - transmitter cards (inc. 2 spares) @ $130.	=2080.	
	16 - receiver cards (inc. 2 spares) @ $150.	=2400.	
	2 - redundant power supplies @ $150.	= 300.	
		$5610. purch. price	$2182.19 Lease/mo.

Non-Multiplexed (Point to Point)

	Lease
Phoenix to 6 cities listed	
Station Arrangements 12 @ $13.75	$ 175.00
Serv. terminals 12 @ $40.00	480.00
Mileage 13,130 @ 27¢/mi./mo. (type 5106)	3545.10
	$4200.10/mo.

Case 4 Difference

FDM
Non-Multiplexed $4200.10 Lease cost
Multiplexed 2182.19 Lease cost
$2017.91 savings/month (not counting equipment purchased)

Multiplex equipment purchase price
(includes dial backup switching and 2 spare channels) $5610.00

Note: No toll charges for dial use estimated.
No racks and cable costs estimated.

Case 5

Multiplexed

FDM - Lenkurt 25c equipment
Configuration:
Phoenix to Kentucky, W. Virginia, Mich., Ala., Miss., S. Carolina
Same Figure as Case 4 except multiplexer at Kentucky and terminals at other states above.

Lines

1 GSA 5302 Line Phoenix to Ky. 1550 mi. @54¢/mi= $837.00
5 GSA 5106 Lines to Mux at Ky.

W. Va.	175 mi.	
Mich.	317 mi.	
Ala.	410 mi.	
Miss.	502 mi.	
S. Car.	361 mi.	
	1765 mi. @ 27¢	= 476.55

Lease/mo. $1313.55

Other TELCO

10 Station Arrangements (TTY Modems for 5106 lines) @$13.75 = $137.50
12 Service Terminals @$40.00 = 480.00

617.50

Dial Backup (not counting time use charges)
4 CDT Couplers @ $2.50 $10.00 (also called Manual Data Access Arrangement)
4 measured business lines @ $7.50 = 30.00

40.00

Equipment

		Purchase
2 Line Adapters (PL DDD switches) ICC Model 21B illustrative @ $75.00		$ 150.00
GTE Lenkurt 25c	2 - FDM data shelf assemblies @ $340.00 =	680.00
	16 transmitter cards (inc. 2 spares)	2080.00
	16 receiver cards (inc. 2 spares)	2400.00
	2 redundant power supplies @ $150.00	300.00
	Purchased Equipment Cost =	$5610.00

$1971.05 Leased/mo. costs

Non-Multiplexed (Point to Point)

Phoenix to 6 cities listed	Lease/mo.
12 Station Arrangements @ $13.75	$ 175.00
12 Service Terminals @ $40.00	480.00
Mileage, lines 9376mi.@ 27¢/mi/mo. (type 5106)	2531.62
Lease/mo. =	$3186.62

Case 5 Difference

Non-multiplexed	Leased costs/mo.	= $3186.62
Multiplexed	Leased costs/mo.	= 1971.05
		$1215.57 Leased savings/mo.

Multiplex Equipment (includes dial backup switches and 2 spare FDM channels)	Purchase Price
	$5610.00

Note: No toll charges for dial use estimated.
No racks and cable costs estimated.

Case 5

Multiplexed

FDM - Lenkurt 25c equipment
Configuration:
Phoenix to Kentucky, W. Virginia, Mich., Ala., Miss., S. Carolina
Same Figure as Case 4 except multiplexer at Kentucky and terminals at other states above.

Lines

1 GSA 5302 Line Phoenix to Ky. 1550 mi. @54¢/mi= $837.00
5 GSA 5106 Lines to Mux at Ky.

W. Va.	175 mi.
Mich.	317 mi.
Ala.	410 mi.
Miss.	502 mi.
S. Car.	361 mi.
1765 mi. @ 27¢	= 476.55

Lease/mo. $1313.55

Other TELCO

10 Station Arrangements (TTY Modems for 5106 lines) @$13.75 = $137.50
12 Service Terminals @$40.00 = 480.00

617.50

Dial Backup (not counting time use charges)
4 CDT Couplers @ $2.50 $10.00 (also called Manual Data Access Arrangement)
4 measured business lines @ $7.50 = 30.00

40.00

Equipment

		Purchase
2 Line Adapters (PL DDD switches) ICC Model 21B illustrative @ $75.00		$ 150.00
GTE Lenkurt 25c	2 - FDM data shelf assemblies @ $340.00 =	680.00
	16 transmitter cards (inc. 2 spares)	2080.00
	16 receiver cards (inc. 2 spares)	2400.00
	2 redundant power supplies @ $150.00	300.00
	Purchased Equipment Cost =	$5610.00

$1971.05 Leased/mo. costs

Non-Multiplexed (Point to Point)

Phoenix to 6 cities listed	Lease/mo.
12 Station Arrangements @ $13.75	$ 175.00
12 Service Terminals @ $40.00	480.00
Mileage, lines 9376mi.@ 27¢/mi/mo. (type 5106)	2531.62
Lease/mo. =	$3186.62

Case 6

FDM - Multiplexed
Phoenix to S. Dakota, Montana, N. Dakota, Minn., Iowa and Neb.

Configuration same as Case 4 except multiplexer at S. Dakota

	Mileage to Phoenix	Mileage to S. Dakota
S. Dakota	987	0
Montana	904	585
N. Dakota	1093	171
Minnesota	1280	354
Iowa	1152	392
Nebraska	984	308
	6400	1810

Lines

1 GSA 5302 Phoenix to S. Dakota
987 mi. x 54¢/mi./mo. = $532.98
5 GSA 5106 others to S. Dakota
1810 mi. @ 27¢ = 488.70

Lease Cost $1021.68

Other Telco Equipment
Same as Case 4 or 5 -
Station Arrangements, Service Terminals and Dial Backup

657.50

Equipment
Same as Case 4 or 5
Line Adapters, FDM Data Shelf Assemblies, transmitter and receiver cards and redundant power supplies
Purchase Cost = $5610.00

$1679.18 Lease/mo. cost

Non-Multiplexed Point to Point

Phoenix to 6 cities listed	Lease/mo.
12 Station Arrangements @ $13.75	$ 175.00
12 Service Terminals @ $40.00	480.00
Mileage type 5106 lines 6400 mi. @ 27¢/mi./mo.	1728.00
	$2383.00 Lease

Case 6 Difference

Non-Multiplexed	$2383.00	
Multiplexed	1679.18	
"	$ 703.82	Lease/month savings

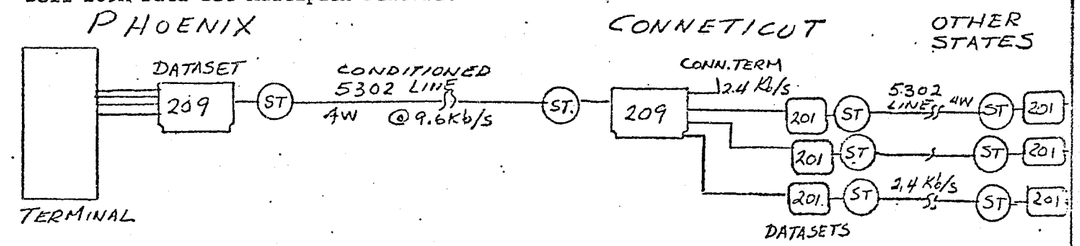
Multiplex Equipment (includes dial backup and 2 spares)	Purchase Price
	$5610.00

Note: No cables, racks or $ for Dial backup use

Case 7

Multiplexed

TDM Synchronous Multiplexing of 4-2400 bps channels on 1 V.G. Line by means of Bell 209A Data Set Multiplex Feature.



= Service Terminal
X = 2400 bps Datasets (201C type)
_____ voice grade (5302) lines

	Mileage to Phoenix	Mileage to Connecticut
Connecticut	2207	0
Massachusets	2291	92
New Jersey	2099	148
New York	2153	86
	8750	326

Lines

		Lease/mo.
1 GSA 5302 Phoenix to Conn. 2207 @ 54¢/mi.	= $1191.78	
3 GSA 5302 other states to Conn. 326 mi. @ 54¢/mi.	= 176.04	
	1367.82	
2-D± conditioning @ $13.50	= 27.00	$1394.82

Other Telco Equipment

2 - 209A Datasets @ $230.00	= $ 460.00	
6 - 201C Datasets @ 55.00	= 330.00	
8 - Service Terminals @ $40.00	= 320.00	
		1110.00
		$2504.82 Leased cost/mo.

Non-Multiplexed

	Lease Cost
8 - Service Terminals @ $40.00	$ 320.00
8 - 201C Datasets @ $55.00	440.00
Line Mileage - 8750 mi. @ 54¢ (5302 type)	4725.00
	$5485.00 Lease Cost

Case 7 Difference

Non Multiplexed	$5485.00
Multiplexed	2505.00
	$2980.00 Lease savings/mo.

Note: No purchased equipment with this case.
Cannot use Dial Backup with this configuration for backup of 9600 BPS line.
For Backup conditioned Private Line (inc. Service terminals) reduce savings above by $1298.78:

type 5302 Line; 2207 mi. @ 54¢	=	$1191.78
2 service terminals @ $40. ea.	=	80.00
2 DI conditiong @ $13.50	=	27.00
		$1298.78

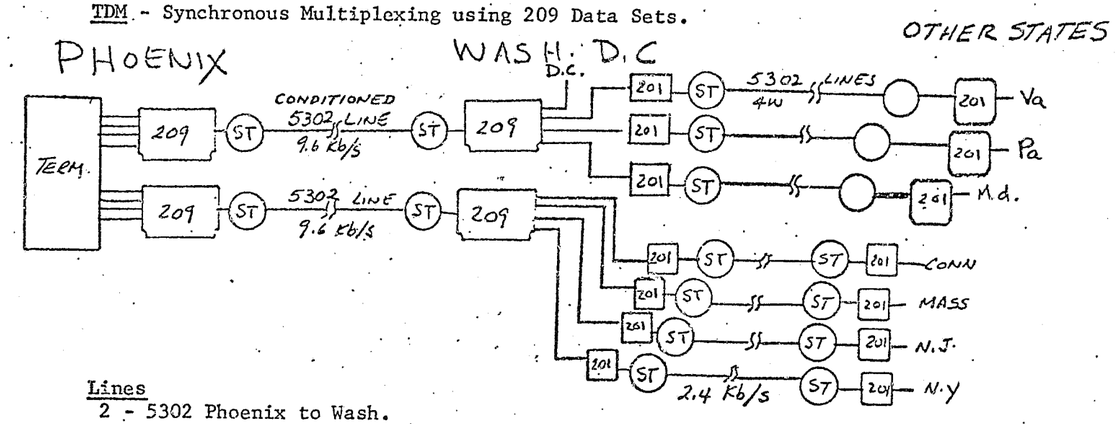
For Backup conditoned line including Service terminals and 209 modems, reduce savings by $1759.00/mo.
Manual Dial backup (full duplex) from Phoenix to end point at 2400 BPS including 201 C at Phoenix costs $59.00/mo. total. The 201 C & dial equipment at the Phoenix end may serve as a common dial channel to ALL states who backup their 201 C's:

4 Measured Business Lines (MB) @ $7.50	=	$30.00
2 D33 Arrangements @ $14.50	=	29.00
		$59.00

Case 8

Multiplexed

TDM - Synchronous Multiplexing using 209 Data Sets.



Lines

2 - 5302 Phoenix to Wash. 2 x 1977 mi. x 54¢/mi.	=	$2136.16	
7 - 5302 Other states to Wash. 1369 x 54¢/mi.	=	739.26	
		2875.42	
4 - DI Line conditioning @ $13.50	=	54.00	
		$2929.42 →	Lease/mo. $2929.42

Other Telco Charges

4 - 209's @ $230./mo.	=	$ 920.00	
14 - 201C's @ $55./mo.	=	770.00	
18 - Service Terminals @ $40.	=	720.00	
		$2410.00 →	$2410.00
			$5339.42 Lease/mo.

Non-Multiplexed (Point to Point)

16 Service Terminals @ $40.00	=	$ 640.00
16 201C Data Sets @ $55.00	=	880.00
Line Mileage (5302 type) 16,669 @ 54¢/mi.	=	9,001.00
		$10,521.00

Case 8 Difference

Non-multiplexed	$10,521.00
Multiplexed	5,339.00
	$ 5,182.00 Lease Savings/mo.

Note: For backup conditioned private line including S.T. charge, reduce savings by $1174.50:

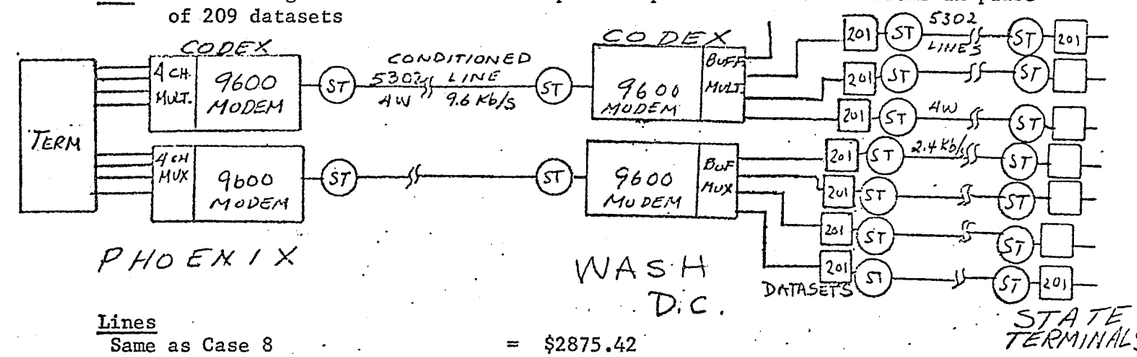
type 5302 line; 1977 mi. @ 54¢	=	$1067.58
2 service terminals @ $40.	=	80.00
2 DI line conditioning @ $13.50	=	27.00
		$1174.58

For above plus pair of spare datasets, reduce savings by $1635.00
For Manual Dial backup see Case 7 Note.

Case 9

Multiplexed

TDM - Same configuration as Case 8 except multiplexed Codex 9600 Modems in place of 209 datasets



Lines

			Lease Costs
Same as Case 8	=	$2875.42	
4 - C2 type conditioning @ $19.00	=	76.00	
		$2951.42	$2951.42

Other Telco Charges

14 - 201C Data Sets	=	$ 770.00	
18 - Service Terminals	=	720.00	
		$1490.00	1490.00

Codex Equipment

4 - Codex 9600 Modems @ $265.	=	$1060.00	
2 - Multiplexers @ $30.	=	60.00	
2 - Buff Multiplexers @ $85.	=	170.00	
		$1290.00	1290.00
			$5731.42 Leased
Purchase @ $9750. ea.	=	$39,000.	
@ 675.	=	1,350.	
@ 1875.	=	3,750.	
SEE NOTE BELOW		$44,100. Purchase Price of Codex Equipment	

Non-Multiplexed

Same as Case 8 = $10,521.00

Case 9 Difference

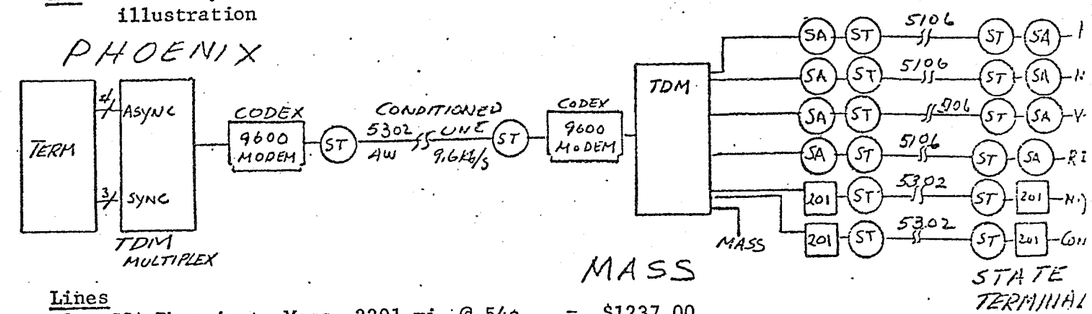
Non-Multiplexed	$10,521.00	
Multiplexed	5,731.00	
(includes lease of Codex equipment)	$ 4,790.00	Leased savings/mo.

Note: Codex equipment could be purchased for $44,100. (no maintenance included)
A backup conditioned private line including Service Terminals would reduce savings by $1175.00. See Case 8 for detailed breakdown.
For above plus spare modems, reduce savings by $1715.00
For Manual Dial Backup see Case 7 Note.

Case 10

Multiplexed

TDM - Mixed Asynchronous and Synchronous channels using Timeplex T-96 for illustration



Lines		
1 - GSA Phoenix to Mass. 2291 mi. @ 54¢	=	$1237.00
2 - GSA 5302 other to Mass. 234 mi. @ 54¢	=	126.00
4 - GSA 5106 other to Mass. 404 mi. @ 27¢	=	109.00
		$1472.00
2 - C2 Line conditioning		38.00
		$1510.00

Lease/mo. $1510.00

Other Telco Charges			
8 Station Arrangements @ $13.75 (for low speed asynch TTY channels)	=	$ 110.00	
14 Service Terminals @ $40.00	=	560.00	
4 - 201C datasets	=	530.00	
		$1200.00	1200.00

TDM Equipment		
Timeplex Corp. Equipment		Purchase
2 - Basic chassis @ $2500.00	=	$ 5,000.00
6 - Sync channel cards @ $250.00	=	1,500.00
8 - Async channel cards @ $130.00	=	1,040.00
1 - Redundant Logic and Power Supply	=	3,500.00
		$11,040.00
Codex Equipment		
2 - 9600 bps Modems @ $9750.00	=	19,500.00
		$30,540.00 Purchase Price

$2710.00 Lease/mo.

Non-Multiplexed

6 - 201 C datasets	=	$ 330.00
8 - Station Arrangements (TTY)	=	110.00
14 - Service terminals	=	560.00
4 - Async (5106) Lines 7227 mi. total x 27¢	=	1951.00
3 - Sync (5302) Lines 6651 @ 54¢	=	3592.00
		$6543.00

Case 10 Difference

Non-Multiplexed	$6543.00
Multiplexed	2710.00
	$3833.00 Leased savings/mo.

Note: TDM Multiplex Equipment Purchases required $30,540.00 (no racks, cables, spare cards or maintenance included)

For backup conditioned line including service terminals charge reduce savings by $1355.00:

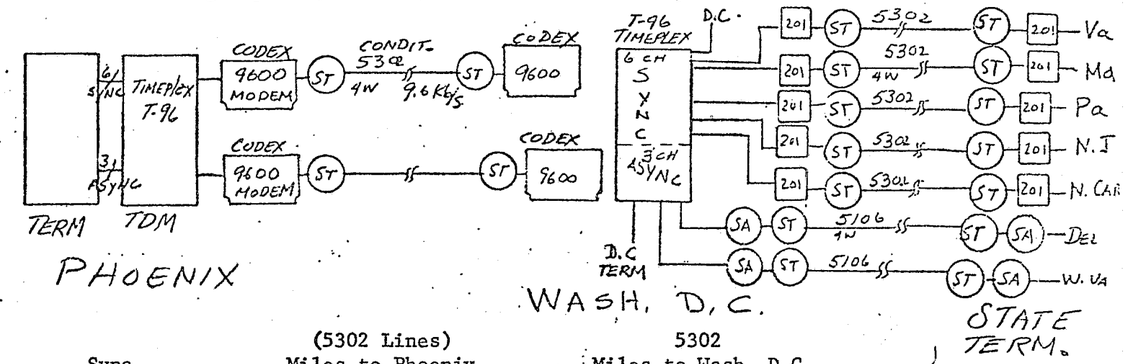
type 5302 Line; 2291 mi. @ 54¢/mi.	=	$1237.00
2 service terminals @ $40.00	=	80.00
2 - C2 line conditioning @ $19.00	=	38.00
		$1355.00

For above including spare modems reduce savings by $1885.00

Case 11

Multiplexed

TDM - Using Timeplex TDM and Codex Modem Multiplexers in Phoenix and Washington - 6 High speed (2400 b/s) channels and 3 low speed (150 b/s) channels



Sync	(5302 Lines) Miles to Phoenix	5302 Miles to Wash. D.C.
Washington	1977	0
Virginia	1954	95
Maryland	2004	27
Pennsylvania	1984	95
New Jersey	2099	153
N. Carolina	1896	234
	11,914 sync	604 sync

Async	(5106 Lines) Miles to Phoenix	Miles to Wash. D.C.
Washington	1977	0
Delaware	2056	81
W. Virginia	1724	255
	5757	336

Lines

			Lease
2 (5302) Phoenix to Wash. D.C. 1977 x 2 x 54¢ = 2 x 1067.58	=	$2135.16	
5 (5302) Other sync lines to D.C. 604 x 54¢	=	326.16	
2 (5106) other async lines to D.C. 336 x 27¢	=	90.72	
		2552.04	
4 - C2 Line Condit. @ $19.00	=	76.00	
		$2628.04 →	$2628.04

Other Telco Charges

18 Service Terminals @ $40.00	=	$ 720.00	
10 201C data sets @ $55.00	=	550.00	
4 Station Arrangements @ $13.75	=	55.00	
		$1325.00 →	1325.00

TDM Equipment

		Purchase Price	Lease cont.
2 Timeplex T-96 @ $2500.00	=	$ 5,000.00	
2 Redundant Logic and Power @ $1750.00	=	3,500.00	
12 Sync. Cards @ $250.00	=	3,000.00	
6 Async. Cards @ $130.00	=	780.00	
		12,280.00	
4 Codex 9600 Modems @ $9750.00	=	39,000.00	
Equipment Purchase Price	=	$51,280.00	$3953.04 Lease price

Non-Multiplexed

Lines

6 High Speed 11,914 x 54¢	=	$6433.96
3 Low Speed 5757 x 27¢	=	1554.39
		7988.35
6 Station Arrangements @ $13.75	=	82.50
18 Service Terminals @ $40.00	=	720.00
12 201C Modems @ $55.00	=	660.00
		$9450.85

Case 11 Difference

Non-Multiplexed	$9450.85
Multiplex	3953.04
	$5497.81 Lease/mo.

Note: Above savings requires purchase of TDM Equipment for $51,280.00
If spare backbone link between Phoenix and Washington is desired, reduce savings/mo. by $1185.58:

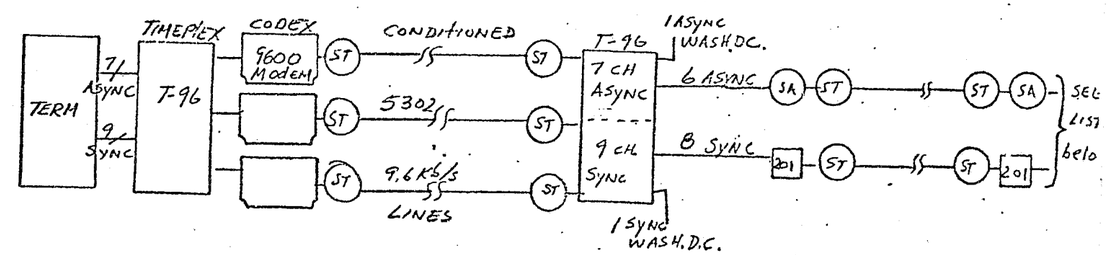
type 5302 line; 1977 mi. @ 54¢/mi.	=	$1067.58
2 service terminals @ $40.00	=	80.00
2 C2 conditioning @ $19.00	=	38.00
		$1185.58

For above including spare modems, reduce savings by $1715.00
For manual dial backup see Note, Case 7

Case 12

Multiplexed

TDM using Timeplex TDM and Codex Modems same as Case 11 plus Case 10 terminals.



Sync	5302 Line Miles to Phoenix	5302 Miles to Wash.
Washington	1977	0
Virginia	1954	95
Maryland	2004	27
Pennsylvania	1984	95
New Jersey	2099	153
N. Carolina	1896	234
New York	2153	309
Connecticut	2207	300
Massachusetts	2291	390
	18,565	1603

Async	5106 to Phoenix	5106 to Wash.
Washington	1977	0
Delaware	2056	81
W. Virginia	1724	255
Maine	2360	524
New Hampshire	2269	411
Vermont	2225	436
Rhode Island	2273	357
	12,984	2064

TDM for all states east of Ohio and north of N. Carolina

Lines

3 - (5302) Phoenix to Washington Lines 1977 x 3 x 54¢	=	$3202.74
8 - (5302) States to Washington 1603 mi. @ 54¢	=	865.62
6 - (5106) States to Washington 2064 mi. @ 27¢	=	557.28
		$4625.64
6 - C2 conditioning @ $19.00	=	114.00
		$4739.64 → Lease $4739.64

Other Telco Charges

			Lease cont.
34 Service Terminals @ $40.00	=	$1360.00	
12 Station Arrangements @ $13.75	=	165.00	
16 - 201C Data Sets @ $55.00	=	880.00	
		$2405.00 →	$2405.00

TDM Equipment

2 - Timeplex T - 96 Basic chassis @ $2500.00	=	$ 5,000.00	
2 - Redundant R.S. and Logic @ $1750.00	=	3,500.00	
14 - Async cards @ $130.00	=	1,820.00	
18 - Sync cards @$250.00	=	4,500.00	
		14,820.00	
6 - Codex 9600 Modems @ $9750.00	=	58,500.00	
TDM Equipment Purchase Price	=	$73,320.00	$7144.64 Lease cost/mo.

Non-Multiplexed Point to Point

Lines

7 Low Speed 150 b/s 5106 type lines - 12,984 @ 27¢	=	$ 3,505.68	
9 High Speed 2400 b/s 5302 type lines - 18,565 @ 54¢	=	10,025.10	
32 Service terminals @ $40.00		1,280.00	
14 Station Arrangements @ $13.75		192.00	
18 - 201C data sets @ $55.00		990.00	
		$15,993.28	Leased cost/mo.

Case 12 Difference

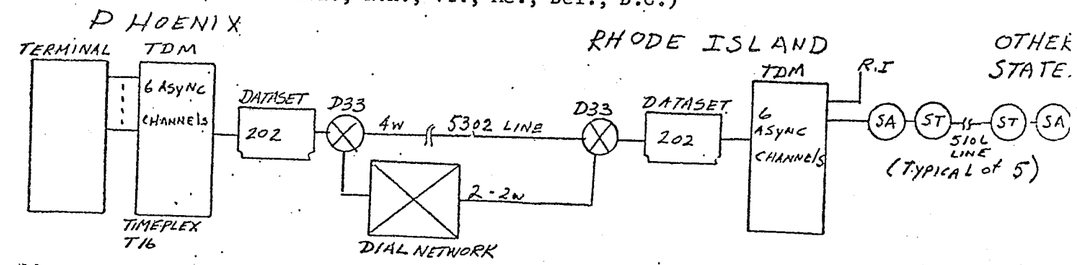
Non-Multiplexed	$15,993.28	
Multiplexed	7,144.64	
	$ 8,848.64	Leased savings/mo.

Note: TDM Equipment Required:
Purchase Price: $73,320.00 (no spare cards, racks or cables or maintenance included)
For spare backbone line between Phoenix and Washington reduce savings by $1185.00 as detailed in Case 11.
For above including spare modems reduce savings by $1715.00.
For manual dial backup, see Note Case 7.

Case 13

Multiplexed

TDM - 6 state configuration same as Case 4 (ie. 6 asynchronous 150 b/s states in northeast U.S. - R.I., N.H., Vt., Me., Del., D.C.)



Lines

1 GSA 5302 Phoenix to R.I.: 2273 mi @ 54¢	=	$1227.42	
5 GSA 5106 to R.I. from 6 states: 1101 mi @ 27¢	=	297.69	
		$1525.11	Lease/mo. $1525.11

Other Telco Costs

10 Station Arrangements @ $13.75	=	$137.50	
12 Service Terminals @ $40.00	=	480.00	
2-202 Datasets (1200 b/s) @ $14.00	=	28.00	
		$645.50	645.50
Manual Dial backup			
4 CDT Couplers @ $2.50	=	$10.00	
4 Measured business lines @ $7.50	=	40.00	
		$50.00	50.00

Equipment

		Purchase Price	
2 - T-16 Basic chassis (TDM) @ $1200.	=	$2400.	
14 - TAC cards @ $150. (includes 4 spare cards for 2 spare channels)	=	$2400.	
		$4800. Purch. Price	$2220.19 Lease/mo.

Non-Multiplexed

Same as Case 4

Case 13 Difference

Non-multiplexed	$4200.10	Lease/mo
Multiplexed	2220.19	Lease cost
	$1979.91	Savings

This Case requires equipment purchase cost of $4800.00. This includes 2 spare channels and dial backup in order to make equitable comparison with Case 4.

Note: Reduce savings as desired for backup private backbone bine, service terminals, and 1200 bps modems by $1335.42:

5302 Line: 2273 mi. @ 54¢/mi	=	$1227.42
2 Service terminals @ $40.00	=	80.00
2-202 Datasets @ $14.00	=	28.00
		$1335.42

Appendix B

Dial Backup Details

1.0 General

In cases where failure of private line (PL) connection(s) in a network would cause serious problems, the direct distance dial (DDD) network is sometimes used for backup. Its main advantage is low cost. While the DDD network is in backup mode the private line circuit would be repaired The main disadvantage of the DDD network is that satisfactory data transmission above 4800 b/s is generally not achieved.

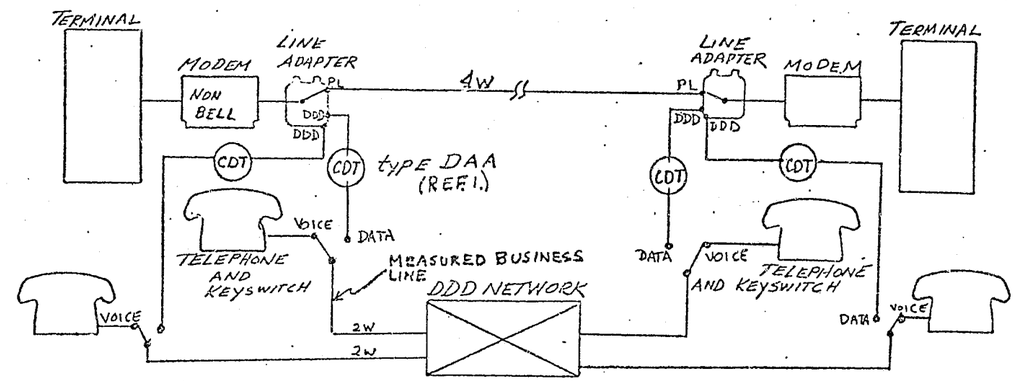
In the case of data transmission using non-Bell Telephone Company modems there is a legal requirement for protecting the DDD network. This is accomplished by connecting a Data Access Arrangement (DAA) unit between the modem and DDD connection. DAA's are not needed when the Telephone Company interfaces their own modems. Where non-Bell Modems are used, line adapters are also required. These can be built into the modem but are usually separate units. The line adapter function may be built into other interface equipment such as the Linebacker described in paragraph 2.2. The line adapter contains the PL/DDD connection switch as well as impedence and power matching circuitry.

2.0 Dial Backup Methods

To back up private line 4 wire duplex transmission, two 2 wire dialup links must be established.

2.1 Manual Method

The manual method is common. An operator will dial-up separate transmit and receive circuits. He will talk to the operator at the other end and coordinate to insure that their modems are switched from PL to DDD connection. They will then coordinate switching both telephones from the voice or talk mode to the data mode. Full duplex transmission may then proceed over the DDD network. When the private lines are repaired the operators at both ends must "hang up," go back to voice mode, and switch the line connection from DDD to PL for normal operation. Notice that while in the dial backup mode, the operators cannot call each other over the send or receive circuits, so that another means of communication or prearrangement for switching back to PL operation is needed.



4 wire operation requires 4 wire PL or 2 telephones with key switches at each end.

Figure 1a - Manual Method - Non- Bell

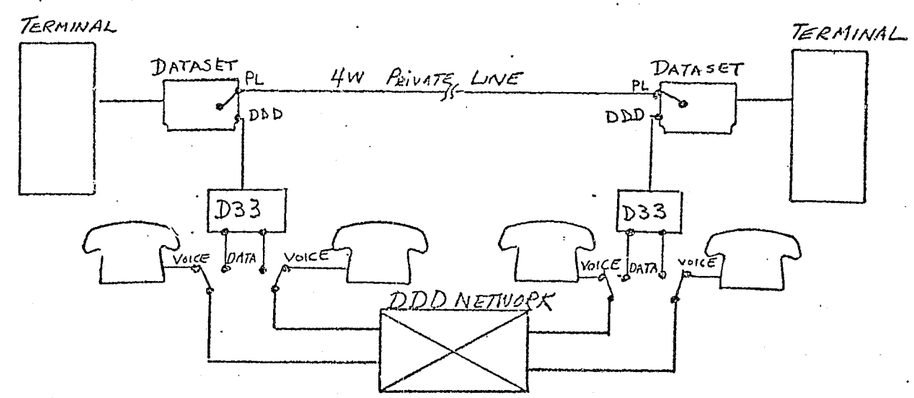


Fig. 1b - Manual Method - Bell

2.2 Automatic Method

It is also possible to accomplish the dial backup automatically. See Fig. 2. This can be done with commercially available (non-Bell) equipment like Timeplex Linebacker (Ref. 3) interfacing to the DDD network via two automatic (CBS type) DAA's (Ref. 2). Unattended operation is accomplished as follows: Linebacker A (Master) monitors the 4 wire private line performance by way of a tone loop. If the PL performance is unsatisfactory a complex bi-directional auto call-auto answer protocol with two different tones proceeds. If satisfactorily effected, both linebackers will switch the DDD connections to the modem in place of those of the PL. Dual tones and tone timing provide protection against wrong numbers. In addition the condition of the PL is continuously monitored and switchback is automatic.

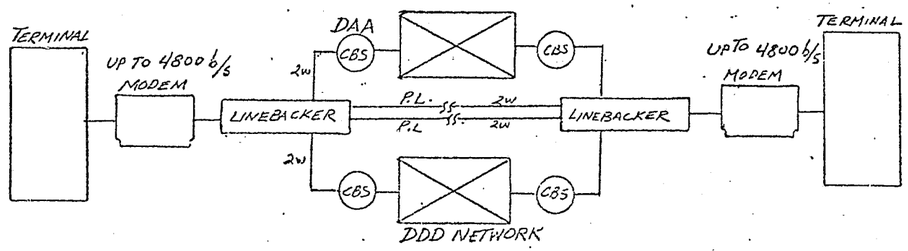


Fig. 2a - Automatic Dial Backup Up To 4.8 Kb/s

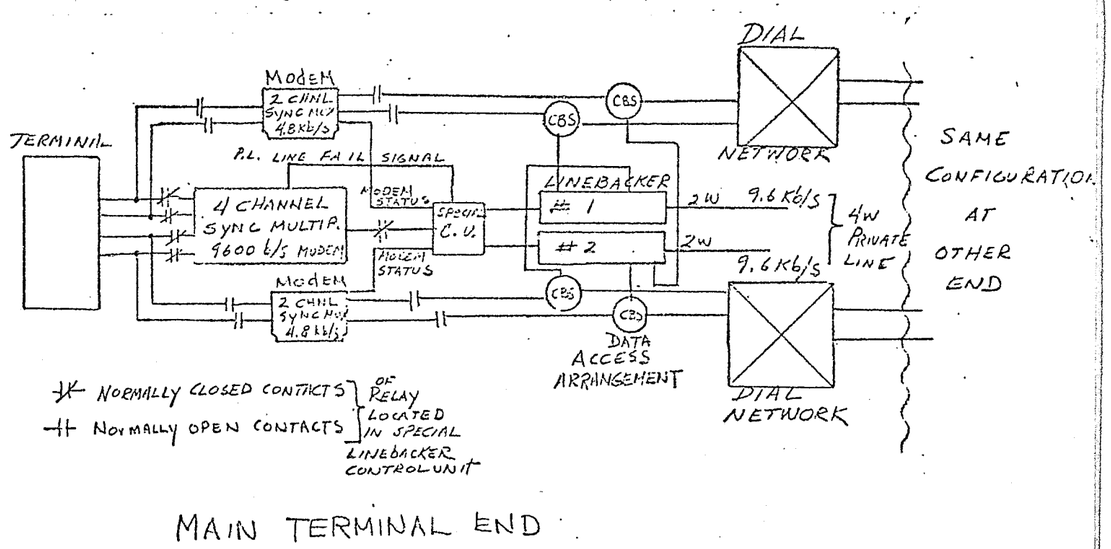


FIG 2b
AUTOMATIC DIAL BACKUP. UP TO 9.6Kb/s

3.0 Required Dial Backup Equipment Costs - 4 wire. (excluding toll charges)

Manual Method

		# Req'd.	Monthly Lease Each (Approx)	Purchase Price Each
Note 1	Manual DAA type CDT	4	$ 2.50	
	Line Adapters	2	$ 4.00	$75.00
Note 2:	D33 Access Arrangement	2	$14.50	
	Measured Business Lines	4	$ 7.50	

Automatic Method

Note 1	Automatic DAA type CBS	4	$ 4.50	
	Linebackers	2	$80.00	$900.00
	Measured Business Lines	4	$ 7.50	

Note 1: with non-Bell Modems
Note 2: with Bell Modems only

3.1 Summary of Costs

Dialup Configuration		Lease Cost Per End
1. Manual non-Bell modems 2 CDT DAA's @ $2.50 = $ 5.00 2 M.B. Lines @ $7.50 = 15.00 1 Line Adapter @ $4.00 = 4.00 $ 24.00		$ 24.00
2. Manual with Bell modems 1 - D33 @ $14.50 = $ 14.50 2 - MB Lines @ $7.50 = 15.00 $ 29.50		$ 29.50
3. Automatic - 4.8 Kb/s 2 CBS DAA's @ $4.50 = $ 9.00 1 Linebacker @ $80.00 = 80.00 2 MB Lines @ $14.50 = 29.00 $118.00		$118.00

4. Automatic up to 9.6 Kb/s		$558.00
4 CBS DAA's @ $4.50	= $ 18.00	
2 Linebackers @ $80.00	= 160.00	
1 Linebacker Control Unitest	= 20.00	
4 M.B. Lines @ $7.50	= 30.00	
2 4.8 Kb/s modems @ $120.	= 240.00	
1 2 Channel Modem Multiplex@ $30.00	= 30.00	
1 2 Channel Modem Buff Mult. @ $60.00	= 60.00	
	$558.00	

4.0 References

Ref. (1) Bell System Technical Reference - Pub. #41801
Data Access Arrangement CDT for Manual
Originating and Answering Terminals, May '71

Ref. (2) Bell System Technical Reference - Pub. #41802
Data Couplers CBS and CBT for Automatic
Terminals, Aug. '70

Ref. (3) The Timeplex Automatic Linebacker Brochure
Available from Timeplex
65 Oak Street
Norwood, N. J. 07648

END