TCET 2102 – Lesson 5

The Medium

Outline

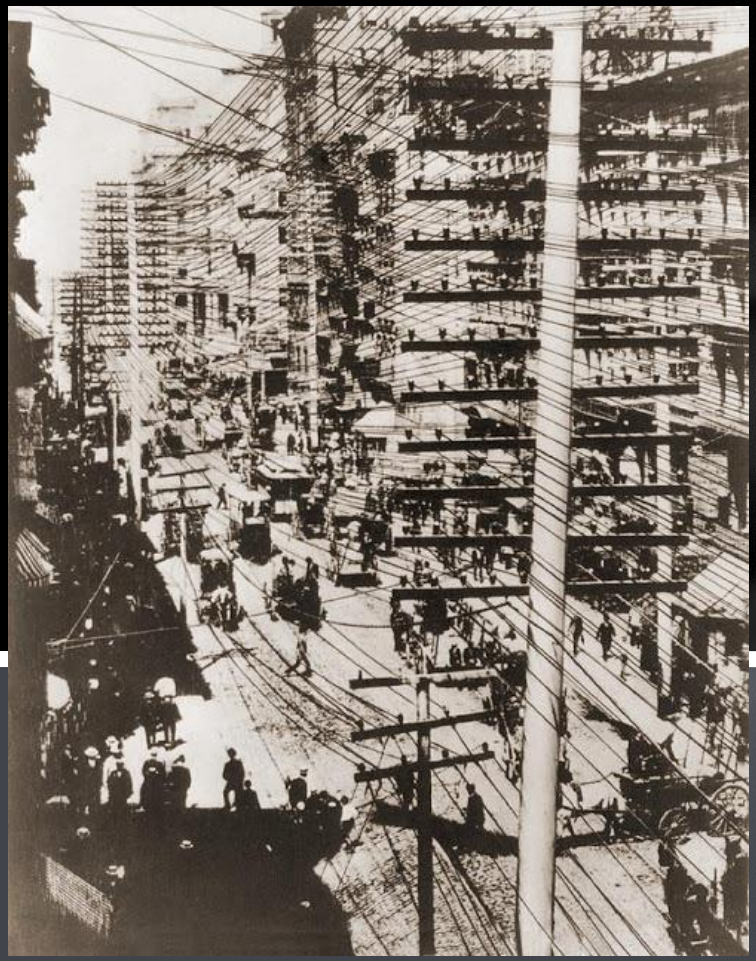
- Local Loop
- The Central Office
- The Medium – wires
  - Color Code
  - Resistance
    - AWG
    - Telephone
- Voice
- Reactance and Loading

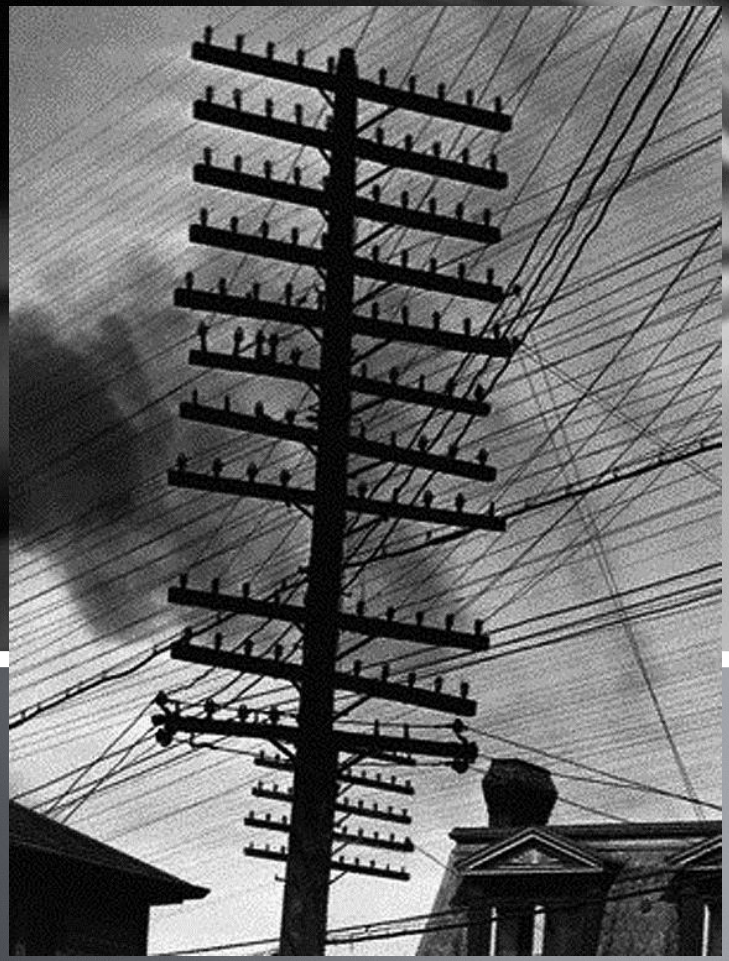
Local Loop

'The Last Mile'

Subscriber line carrier systems

- SLC-96
  - AC→ DC





Color Codes

Plastic Insulated Cable (PIC)

Colors: black, brown, red, orange, yellow, green, blue, violet, slate, white. (Sound familiar?)

Some places still have paper.

- Site 1
- Site 2

Current requirements

27 mA to trip the 'Ring trip relay.'

How can we get that?

- Ring/tip = 500 Ω each
- Telephone = 400 Ω
- Relay = 350 Ω
- Supply voltage = 48 V

Total current = 27.428 mA

Necessary for the Strowger switch.

Transmitter Current

Improvements

- Better mic – Less resistance
- Higher voltage – 52 V, necessary to run electronic switching
- Ring trip relay current reduction – 20 mA

Consequences:

- Total line resistance may be increased.

Practical consequences:

- May service customers further away from central office.

Outside plant design

Revised resistance design (RRD)

- up to 18,000 ft. → 1300 Ω
- up to 24,000 ft → 1500 Ω

Modified long route design (MLRD)

- over 24,000 ft
- pump up the power → 78/104 V

Central office and serving areas

- Main distribution frame (MDF)
  - Central terminating point for twisted pair
  - Jumper wire for connecting line to phone.
- Wire is expensive
  - Cheaper to have many exchanges with smaller wire, than fewer exchanges and thicker wire.

Wire gauge

Metric

A.W.G.	Diameter	Area	Weight		Length		Resistance	
B. & S.	Mm.	Sq. Mm.	Kg. per M.	Kg. per Ohm	M. per Kg.	M. per Ohm	Ohms per Kg.	Ohms per M.
0000	11.7	107.2	.953	5940	1.05	6,230	.000168	.000161
000	10.4	85.0	.756	3730	1.32	4,940	.000268	.000202
00	9.27	67.4	.599	2350	1.67	3,920	.000426	.000255
0	8.25	53.5	.475	1480	2.10	3,110	.000677	.000322
1	7.35	42.4	.377	929	2.65	2,460	.00108	.000406
2	6.54	33.6	.299	584	3.35	1,950	.00171	.000512
3	5.83	26.7	.237	367	4.22	1,550	.00272	.000645
4	5.19	21.2	.188	231	5.32	1,230	.00433	.000814
5	4.62	16.8	.149	145	6.71	975	.00688	.00103
6	4.11	13.3	.118	91.4	8.46	773	.0109	.00129
7	3.67	10.6	.0938	57.5	10.7	613	.0174	.00163
8	3.26	8.37	.0744	36.2	13.5	486	.0277	.00206
9	2.91	6.63	.0590	22.7	17.0	386	.0440	.00259
10	2.59	5.26	.0468	14.3	21.4	306	.0699	.00327
11	2.31	4.17	.0371	8.99	27.0	242	.111	.00413
12	2.05	3.31	.0294	5.66	34.0	192	.177	.00520
13	1.83	2.62	.0234	3.56	42.9	153	.281	.00656
14	1.63	2.08	.0185	2.24	54.1	121	.447	.00827
15	1.45	1.65	.0147	1.41	68.2	95.9	.711	.0104
16	1.29	1.31	.0116	.885	86.0	76.0	1.13	.0132
17	1.15	1.04	.00922	.556	108	60 3	1.80	.0166
18	1.02	.823	.00732	.350	136	47.8	2.86	.0209
19	.912	.653	.00580	.220	172	37.9	4.54	.0264
20	.812	.518	.00460	.138	217	30.1	7.23	.0333
21	.723	.410	.00365	.0871	274	23.9	11.5	.0419
22	.644	.326	.00289	.0548	346	18.9	18.3	.0529
23	.573	.258	.00229	.0344	436	15 0	29.1	.0667
24	.511	.205	.00182	.0217	550	11.9	46.2	.0841
25	.455	.162	.00144	.0136	693	9.43	73.4	.106
26	.405	.129	.00114	.00856	874	7.48	117	.134
27	.361	.102	.000908	.00538	1,100	5.93	186	.169
28	.321	.081	.000720	.00339	1,390	4.70	295	.213
29	.286	.0642	.000571	.00213	1,750	3.73	470	.268
30	.255	.0510	.000453	.00134	2,210	2.96	747	.338
31	.227	.0404	.000359	.000842	2,790	2.35	1,190	.426
32	.202	.0320	.000285	.000530	3,510	1.86	1,890	.537
33	.180	.0254	.000226	.000333	4,430	1.48	3,000	.678
34	.160	.0201	.000179	.000210	5,590	1.17	4,770	.855
35	.143	.0160	.000142	.000132	7,040	.928	7,590	1.08
36	.127	.0127	.000113	.0000829	8,880	.736	12,100	1.36
37	.113	.0101	.0000893	.0000521	11,200	.584	19,200	1.71
38	.101	.00797	.0000708	.0000327	14,100	.463	30,600	2.16
39	.0897	.00632	.0000562	.0000206	17,800	.367	48,500	2 73
40	.0799	.00501	.0000445	.0000130	22,500	.291	77,100	3 44

English Units

American Wire Gage (B. & S.). English Units

Gage No.	Diameter in mils	Cross-section		Ohms per 1000 ft.		Ohms per mile	Pounds per 1,000 ft.
		Circular mils	Square inches	25° C. (=77° F.)	65° C. (=149° F.)	25° C. (=77° F.)	
0000	460.0	212,000.0	0.166	0.0500	0.0577	0.264	641.0
000	410.0	168,000.0	0.132	0.0630	0.0727	0.333	508.0
00	365.0	133,000.0	0.105	0.0795	0.0917	0.420	403.0
0	325.0	106,000.0	0.0829	0.100	0.116	0.528	319.0
1	289.0	83,700.0	0.0657	0.126	0.146	0.665	253.0
2	258.0	66,400.0	0.0521	0.159	0.184	0.839	201.0
3	229.0	52,600.0	0.0413	0.201	0.232	1.061	159.0
4	204.0	41,700.0	0.0328	0.253	0.292	1.335	126.0
5	182.0	33,100.0	0.0260	0.319	0.369	1.685	100.0
6	162.0	26,300.0	0.0206	0.403	0.465	2.13	79.5
7	144.0	20,800.0	0.0164	0.508	0.586	2.68	63.0
8	128.0	16,500.0	0.0130	0.641	0.739	3.38	50.0
9	114.0	13,100.0	0.0103	0.808	0.932	4.27	39.6
10	102.0	10,400.0	0.00815	1.02	1.18	5.38	31.4
11	91.0	8,230.0	0.00647	1.28	1.48	6.75	24.9
12	81.0	6,530.0	0.00513	1.62	1.87	8.55	19.8
13	72.0	5,180.0	0.00407	2.04	2.36	10.77	15.7
14	64.0	4,110.0	0.00323	2.58	2.97	13.62	12.4
15	57.0	3,260.0	0.00256	3.25	3.75	17.16	9.86
16	51.0	2,580.0	0.00203	4.09	4.73	21.6	7.82
17	45.0	2,050.0	0.00161	5.16	5.96	27.2	6.20
18	40.0	1,620.0	0.00128	6.51	7.51	34.4	4.92
19	36.0	1,290.0	0.00101	8.21	9.48	43.3	3.90
20	32.0	1,020.0	0.000802	10.4	11.9	54.9	3.09
21	28.5	810.0	0.000636	13.1	15.1	69.1	2.45
22	25.3	642.0	0.000505	16.5	19.0	87.1	1.94
23	22.6	509.0	0.000400	20.8	24.0	109.8	1.54
24	20.1	404.0	0.000317	26.2	30.2	138.3	1.22
25	17.9	320.0	0.000252	33.0	38.1	174.1	0.970
26	15.9	254.0	0.000200	41.6	48.0	220.0	0.769
27	14.2	202.0	0.000158	52.5	60.6	277.0	0.610
28	12.6	160.0	0.000126	66.2	76.4	350.0	0.484
29	11.3	127.0	0.0000995	83.4	96.3	440.0	0.384
30	10.0	101.0	0.0000789	105.0	121.0	554.0	0.304
31	8.9	79.7	0.0000626	133.0	153.0	702.0	0.241
32	8.0	63.2	0.0000496	167.0	193.0	882.0	0.191
33	7.1	50.1	0.0000394	211.0	243.0	1,114.0	0.152
34	6.3	39.8	0.0000312	266.0	307.0	1,404.0	0.120
35	5.6	31.5	0.0000248	335.0	387.0	1,769.0	0.0954
36	5.0	25.0	0.0000196	423.0	488.0	2,230.0	0.0757
37	4.5	19.8	0.0000156	533.0	616.0	2,810.0	0.0600
38	4.0	15.7	0.0000123	673.0	776.0	3,550.0	0.0476
39	3.5	12.5	0.0000098	848.0	979.0	4,480.0	0.0377
40	3.1	9.9	0.0000078	1,070.0	1,230.0	5,650.0	0.0299

Wires

Affects carrier service area (CSA)

What about the AC signal?

Reactance considerations

- ~ 0.083 μF/mile

What's the trick to counter reactance?

Loading!

- The addition of loading coils help counter the capacitive effect.