

INTRODUCTION TO RURAL TELEPHONE SYSTEM DESIGNS

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1. GENERAL

1.1 This section is intended to precede and introduce the design sections in the REA Telecommunications Manual which provides REA borrowers, consulting engineers, and other interested parties with introductory information for use in the design and construction of REA borrowers' telephone systems.

1.2 This issue replaces TE&CM Section 201, Issue No. 4, June 1974. The purpose of reissuing the section is to state general considerations to be kept in mind in the design of a rural telephone system.

1.3 The goal in the design of a telephone system is to provide adequate telephone service in the area to be served at a reasonable cost. This section discusses some general means and procedures recommended for attaining this goal. Most of the guidelines apply to the preparation of the Supplemental Loan Proposal or the Area Coverage Design described in REA TE&CM 205, "Presentation of an Area Coverage Design".

1.4 Detailed information on various subjects may be found in the many sections of the Telecommunications Engineering and Construction Manual. Please refer to the index, TE&CM Section 102, for guidance.

2. MAJOR ELEMENTS OF A TELEPHONE SYSTEM

2.1 A telephone system's plant is typically made up of the following:

2.1.1 Customer Premises Equipment (CPE). This is also known as "terminal or station equipment". It includes telephones, data sets, answering machines, automatic dialers, etc. Beginning in 1983, most of this equipment has been declassified by FCC ruling and decreed to be unregulated. The subscriber (or customer) is allowed and expected to obtain CPE from various suppliers besides the telephone company.

2.1.2 Access to the Communications Network. The physical (paired wire cable, poles, cross connect housings, etc.) electronic (remote switches, repeaters, carrier, etc.) or optical (lightwave cables and terminals, etc.) circuits and the associated hardware connecting the subscribers or station equipment with a central office are called outside plant.

2.1.3 Central Office Switching Equipment (COE). This includes local, remote and long distance switchgear. Electromechanical dial switches are being replaced by stored program controlled special purpose electronic digital computers capable of circuit switching with great speed, ample capacity, and versatility. Operators are seldom required. Most rural telephone offices are operated on an unattended basis. Operator services for directory assistance, calling card, collect calling, etc., are almost always provided on a centralized basis where the personnel serve a large number of the unattended offices. It has been advantageous for smaller rural systems to lease operator services from their connecting company. Each case should be studied for the most economical solution.

2.1.3.1 Automatic Timing and Ticketing (ATT). Some offices have equipment for timing and ticketing toll calls. A number of the unattended offices are often served by a particular ATT or AMA installation. AMA designates automatic message accounting; CAMA - centralized automatic message accounting serving multiple offices; and LAMA - local automatic message accounting for one office. When local calls are also timed, it is called "local measured service (LMS)".

2.1.4 Trunks to other offices. These include such facilities as Extended Area Service (EAS) trunks to associated offices and toll trunks to a toll center where connection is made with the national toll network. Special service trunks, interconnecting trunks with Inter-LATA⁽¹⁾ Carriers (IC's), foreign exchange, and private lines are also in this category. Foreign exchange lines establish a telephone number in a service area other than the area designated by the subscriber location. As with subscriber circuits, trunks may utilize physical, electronic, or optical equipment.

2.1.5 Electronic Transmission Equipment. Electronic transmission equipment is used extensively due to its versatility and flexibility and to control the cost of various types of circuits. Included in the electronic category are such items as: subscriber and trunk carrier, voice frequency and carrier repeaters, microwave and mobile radio equipment.

2.1.6 Buildings. These house central office equipment, repeater huts, remote switch shelters, headquarters and commercial offices, and toll operating rooms. Garages or warehouses are also included in this category.

2.1.7 Operating Equipment. Furniture, computers and office machines, records, tools, test and work equipment, and vehicles are included in this category.

2.2 Each element in a telephone system must be designed to work with all other elements so that any telephone user can be connected with any other telephone

¹ Local Access and Transport Area designated to define range of post divestiture exchange service by Bell Operating Companies.

in the same exchange, in any directly connected exchange, or in any exchange connected to the national telephone network.

3. AREA COVERAGE

3.1 The telephone system should be designed to provide all applicants in the franchised area of the telephone company with modern service. No mileage or zone charge should be imposed for the lowest grade of service furnished in any central office area.

4. ADEQUATE SERVICE

4.1 Definition. Adequate service means that the services provided will meet the expectations and the needs of most users.

4.2 The system should be designed to make available "adequate" service to the widest practicable number of users in the borrower's telephone service area. Service features include a sufficient number of conversation paths (intra and inter office trunks), clarity of transmission, low noise, dependable signaling, safety of equipment, reliability of service, four or less subscribers on a line, direct distance toll dialing (via multiple common carriers), local dialing, custom calling, automatic number identification, and other characteristics of modern telephone system operation. Equipment should be provided accordingly.

4.2.1 Consideration should be given to the recommendations in the various sections of the Telecommunications Engineering and Construction and Telecommunications Operations Manuals and the requirements of REA specifications. The use of materials on REA's List of Acceptable Materials and trained craftsmen performing preventive maintenance are necessary to assure achieving satisfactory and reliable telephone service.

4.3 Adequate service includes the offering of different classes of service to meet the requirements of individual users. The design, therefore, should include provision for classes of service offered in a modern telephone system to the extent of the demand for each class in individual exchanges. In the 1980's this will likely include a variety of data services, custom calling features, paging, key systems, local answering services, mobile and cellular radio -- to name some types of services that seem more popular.

4.4 Provision should be made in new switching equipment for local governments to handle 911 emergency service. There must be arrangements for handling information, repair service, assistance, calling card and operator handled toll calls.

4.5 One-party service is the accepted objective for rural service. Some rural telephone systems still have a significant number of four-party subscribers. These should be upgraded whenever feasible. No more than four parties on a line should be permitted for systems that must defer upgrading to all one-party due to costs.

4.6 Each exchange must interface with all features of the U. S. nationwide "Network" direct distance dialing plan. Among the requirements are a seven-digit

telephone numbering "address", plus a designated three-digit area code, four-digit inter-LATA carrier access code, adequate direct low loss trunks to a toll center or LATA point of presence, compatible subscriber signalling and automatic dialing capability, intercepting, and automatic number identification (ANI) arrangement.

5. COSTS

5.1 To serve the "greatest practicable number of rural users", especially in sparsely settled areas, the minimization of the plant investment to provide telephone service (access to the network) must be of prime consideration. Today's rural service is expected to be comparable to and compatible with urban service. The design of the rural system is based on the area coverage survey which locates and tabulates existing and potential subscribers, either by a field survey or by projection of a historical tabulation. Long range growth of the proposed system must be considered by means such as five-year forecasts. The area coverage design should consider meeting subscriber needs using current state of the art technology. The design must be adequate to serve all potential subscribers in a five-year period; it should be flexible enough to be able to be economically expanded beyond the five-year period where future growth patterns are known. All costs for the five-year period should be shown in the design regardless of the planned source of funding. New plant and equipment will be proposed taking into account the initial investments, annual operating expenses, (maintenance and depreciation, taxes, etc.), feasibility of expansion, flexibility and other factors that will contribute to the rates that must be charged.

5.1.1 Although physical (cable and wire) subscriber circuits work satisfactorily, carrier and remote electronic switching systems can provide more flexibility since the units are easier to move or expand when estimated growth is not realized or is exceeded. Each plant component adding to system cost should be evaluated from the point of view of system needs and subscriber desires. Anticipated revenues should offset annual cost estimates.

5.2 In determining the best configuration and number of central offices required to serve an area, cost savings and revenue changes for eliminating or reducing the number of existing switches should be compared with additional cost of outside plant facilities, remote switches, subscriber carrier equipment, differences in EAS and toll trunking arrangements, and variations in system operation and maintenance expense. Considerations will also be involved such as the scope of LATA's (Local Access and Transport Areas), revised toll arrangements, and direct access rate structures.

5.2.1 One or two sophisticated switchboards can sometimes provide and control the expanding range of telecommunications services more economically than numerous small offices. Many of yesterday's small offices are becoming locations for remote switching apparatus and/or carrier equipment for subscriber lines controlled by and linked with "host" electronic digital switches.

5.2.2 It may be expected, however, with the expanding capability of digital switches to function on a "distributed" basis that all subscriber services can be offered even from small offices of 500 lines or less. New small digital "full service" switches are becoming readily available at an opportune time to replace earlier types. There is, of course, considerable fixed cost for replacing any dial central office.

5.3 Historically, the most economical location of a local central office has been at the wire center of the area served. However, a new central office with considerable electronic equipment substituting for cable pairs may be located at some distance from the wire center with little or no increase in the cost of outside plant. This permits selection of a site which is most favorable with regard to accessibility, nearness to power supply, cost of land, terrain conditions, and other desirable features.

5.4 Where a central office building contains a commercial office or a toll operating room, it should include accessibility to the public and to employees. This does not mean, however, that the telephone office has to be in the best business section of the town. Most telephone offices of this type are located so as to be convenient to find and visit, where parking space is available, and where land is already owned or can be obtained at reasonable cost to permit the providing of adequate space, both initially and for growth.

6. REVENUES

6.1 Telephone systems' revenue requirements have been largely met by income for system access (including a prescribed limited or unlimited local calling allotment) on a monthly basis, plus toll revenues usually generated on a message time and usage schedule.

6.1.1 Toll revenues have been divided since 1917 between the Bell System and the independent telephone companies through a process called "toll separations" adhering to complex formulas and rules. Much of the telephone plant is used jointly--for toll or local calling or for special services. Therefore, part of the toll funds have been apportioned to offset expenses of the local switching and distribution plant used to connect the individual subscribers to the toll lines.

6.1.2 Intercity competition by other common carriers (OCC's) who provide long distance communication, has created a need for new pricing procedures. Toll settlements are to be discontinued. Access charges will be established for various telephone network connections. Local service charges are expected to increase.

6.1.3 A permanent Universal Fund to be administered by an Exchange Carrier Association (composed of telephone companies involved in furnishing of exchange services) and funded by a surcharge on all toll calls is planned. This fund will be disbursed on a sliding scale to partially compensate those companies for whom the cost of facilities is higher than a specified percentage of the national average.

6.1.4 Subscribers desire "Extended Area Service" or EAS (erroneously called free service) rather than message toll charges to nearby areas to which they have a high community of interest. The cost of such service is included in the monthly rates for local service. Optional charges may be imposed to only those subscribers using the extended service. Some local services may be measured by time or mileage units to achieve the flexibility of "user sensitive" pricing; EAS may be subject to similar measurements.

7. NEW TECHNOLOGY

7.1 Rural systems have progressed from manual switching, open wire lines, multiparty service--to unattended dial offices with buried cables--to stored program control and digital switching steadily replacing electro-mechanical equipment. Fiber optics are now competitive with electronic and metallic circuit derivatives in some applications. Satellites are also becoming useful for communication purposes such as alternate trunking or to serve isolated communities.

7.2 Digital telephone enables subscriber lines to transmit both voice communication and digital information from any one subscriber to another or from central computers to the users. Distribution of volumes of data to and from individuals may require a wideband transmission facility such as optical cable. Many new services are expected to become available for residential subscribers such as data for home computing, electronic mail, alarms, and monitoring services.

7.3 Changes in technology and engineering must be coupled with jurisdictional restructuring and realignment of the industry. The continuing goal is to provide adequate and useful communication services to rural users while controlling costs and maintaining affordable rates.