CHAPTER 11

DIRECT DISTANCE DIALING

11.1 INTRODUCTION

Direct Distance Dialing (DDD) is a term used to designate calls dialed by customers to points outside their local or extended service area. When such calls are dialed by operators, the phrase "Operator Distance Dialing" is used. Distance Dialing (nationwide dialing) has been accepted as an ultimate objective of the telephone industry, since it will usually provide the fastest, most accurate, and most dependable telephone service and at the same time give over-all operating economies. The direct distance dialing plan might more appropriately be referred to as "continentwide" rather than "Nationwide" since it provides for the handling of long distance traffic both within and between the United States and Canada and to Alaska and Hawaii.

Successful operation of the DDD program depends primarily on three factors:

1. A standard nationwide numbering plan.
2. A fundamental plan for automatic toll switching.
3. A method of charging the customer.

The first two requirements will be considered further in this chapter. The third requirement is met by automatic message accounting systems which are covered in Chapter 14.

11.2 THE NATIONAL NUMBERING PLAN

A primary requisite for distance dialing is that each customer be assigned a distinctive telephone number that does not conflict with the number of any other customer in the United States and Canada. It is essential that these numbers be similar in form, convenient to use, and compatible with local and extended area dialing arrangements. This is accomplished by giving each local central office a unique designation which is, nevertheless, similar in form to that of all other offices connected to the nationwide network. With such an arrangement, operators or customers,

wherever located, can use that designation as a "destination code" to reach the required office through the dial switching network. All offices, in effect, become a part of one huge multioffice city with each office having its own distinctive identity for routing purposes. The designations selected, readily understandable and convenient to use, have reduced the number of misdialed calls to a minimum. The result has been a savings in circuits and switching equipment, as well as improved customer relations. On each misdialed call the subscriber must call an operator to avoid being charged for the call.

The numbering plan adopted in 1947 required a maximum of 10 digits and was expected to last beyond the year 2000. The first 3 digits are the "area code" and the next 3 are the "office code." Together, they comprise the required unique designation for each central office. The remaining 4 digits constitute the "station number" of the telephone served from the particular office. The 3-digit office code plus the 4-digit station number make up the 2-letter 5-numeral (2-5) customer's number listed in the telephone directory.

TABLE 11-1 INITIAL NUMBERING PLAN

Listed Directory Number		
Area Code	Office Code	Station Number
X X' X"	L L N	N N N N

Notes:

Where L = Any letter except Q or Z
N = Any numeral from 0 to 9
X = Any numeral from 2 to 9
X' = 0 (zero) or 1
X" = Any numeral from 0 to 9 when X' = 0
Any numeral from 0 to 9 except 1 when X' = 1

The United States and Canada have been divided geographically into numbering plan areas, each of which is assigned a distinctive 3-digit designation called the area code. Calls between numbering plan areas (foreign area

calls) in general, require dialing the code of the area in which the called station is located as well as the called customer's listed telephone number. Home area calls, which originate and terminate within the same area, require dialing only the called customer's listed number, which consists of the office code and the station number. In this geographical division of numbering plan areas, borderlines between states and between Canadian Provinces have generally been used as area boundaries. Since, as will be shown later, only about 540 central offices can be served in a numbering plan area, it was necessary to divide the more populous states and provinces into two or more areas.

In fixing the intrastate numbering plan boundaries of subdivided states, effort was made to avoid cutting across heavy toll traffic routes to have as much of the toll traffic as possible terminate in the originating area. Also, wherever possible, the boundaries have been set to avoid having central offices in one area be tributary to toll offices in an adjacent area. With the numbering plan areas arranged this way, much intrastate dialing can be kept on a 7-digit basis.

As shown in Table 11-1, the numbering plan "Area Code" consists of three digits. If the middle digit is either a "1" or a "0", the switching equipment will be able to distinguish the area codes from the central office codes, for the latter will always have a letter (corresponding to a numerical digit from 2 through 9) in the middle position. Accordingly, the area codes consist of three digits with either a "1" or "0" in the middle position; e.g., 516, 201, 607, etc.

There are 80 possible combinations with "0" in the middle (called X0X codes), digits "2" to "9" in the first position, and all digits "0" to "9" in the third position. It is not practical to use either "1" or "0" for the initial digit of the area code since many customers dial "0" to reach the operator, and an initial "1" is either used for service or toll codes, or the local dial equipment is arranged to ignore it since it may be a preliminary pulse. Only 72 usable "X1X" combinations are available for area codes since "1" may not be used in the third position because such codes as 211, 411, etc., are used in many places for service codes. There are, then, 152 possible area code combinations of which more than 132 have been assigned. Because of the limited supply, assignment of

area codes must be made on the basis of actual needs Tables 11-2 and 11-3 show the present and proposed numbering plan areas. Assignments are made from the X0X or X1X series without regard to whether the areas are entire states or subdivisions of states, although at one time it was thought that such a distinction might be made.

Any one Numbering Plan Area is limited to about 540 central office codes. The 2-5 Numbering System will theoretically furnish 640 office code combinations. (Eight dial pulls for the first digit times eight dial pulls for the second digit times ten for the third digit; only eight holes on the dial have letters.) In practice, however, there are only about 60 usable letter combinations for the first two digits instead of 64. This is because of the difficulty in finding names to fit the dial pulls 5-5, 5-7, 9-5, 9-7 (5 corresponds to JKL, 7 to PRS, and 9 to WXY). Also, since there is considerable confusion between the letter "0" and the numeral zero, the latter is usually avoided in the central office designation. This leaves us with 60 usuable letter combinations multiplied by nine numerals for a total of 540 codes.

The use of all-numerical central office codes, when preceded by "1" prefix dialing arrangements, increases the number of codes from a theoretical maximum of 640 of the 2L-5N type (about 540 generally usable) to 792.(8 x 10 x 10 minus 8 (N11 service codes) = 792.) The 55, 57, 95 and 97 series, for which no suitable names are available, can be assigned on an all-numeral basis. However, ten of these codes (950-954 and 975-979) are reserved for possible future use for new services. It is planned to change to another series of codes in the future. The 55 office code is reserved for use as the code for a universal distant information number. Also, 844 is reserved for time service, and 936 for weather service.

With the above Name-Numeral Plan (2L, 5N), a shortage of numbers arose. Eighty-six of the 152 area codes were assigned when operator nationwide dialing was started in 1947. The remaining 66 area codes were expected to care for many years of growth. However, there has been a telephone explosion in the United States. In the decade 1950 to 1960, while the United States population grew from about 150 million to 180 million people, telephones grew from about 41 million to over 75 million. The rise in population of 30 million people required the addition of 34 million telephones.

TABLE 11-2

NUMBERING PLAN AREAS AND CODES-BY AREA CODE NUMBER

Area Code	Location
201	New Jersey
202	District of Columbia
203	Connecticut
204	Manitoba
205	Alabama
206	Washington
207	Maine
208	Idaho
209	California
212	New York
213	California
214	Texas
215	Pennsylvania
216	Ohio
217	Illinois
218	Minnesota
219	Indiana
301	Maryland
302	Delaware
303	Colorado
304	West Virginia
305	Florida
306	Saskatchewan
307	Wyoming
308	Nebraska
309	Illinois
312	Illinois
313	Michigan
314	Missouri
315	New York
316	Kansas
317	Indiana
318	Louisiana
319	Iowa
401	Rhode Island
402	Nebraska
403	Alberta
404	Georgia
405	Oklahoma
406	Montana
407	Unassigned
408	California
409	Unassigned
412	Pennsylvania
413	Massachusetts
414	Wisconsin
415	California
416	Ontario
417	Missouri
418	Quebec
419	Ohio
501	Arkansas
502	Kentucky
503	Oregon
504	Louisiana
505	New Mexico
506	New Brunswick
507	Minnesota
508	Unassigned
509	Washington
510	4-Row TWX (U.S.)
512	Texas
513	Ohio
514	Quebec
515	Iowa
516	New York
517	Michigan
518	New York
519	Ontario
601	Mississippi
602	Arizona
603	New Hampshire
604	British Columbia
605	South Dakota
606	Kentucky
607	New York
608	Wisconsin
609	New Jersey
610	4-Row TWX (Canada)
612	Minnesota
613	Ontario
614	Ohio
615	Tennessee
616	Michigan
617	Massachusetts
618	Illinois
619	Unassigned
701	North Dakota
702	Nevada
703	Virginia
704	North Carolina
705	Ontario
706	Unassigned
707	California
708	Unassigned
709	Newfoundland
710	4-Row TWX (U.S.)
712	Iowa
713	Texas
714	California
715	Wisconsin
716	New York
717	Pennsylvania
718	Unassigned
719	Unassigned
800	Inward WATS
801	Utah
802	Vermont
803	South Carolina
804	Unassigned
805	California
806	Texas
807	Ontario
*808	Hawaii
*809	Bermuda and Caribbean Islands
810	4-Row TWX (U.S.)
812	Indiana
813	Florida
814	Pennsylvania
815	Illinois
816	Missouri
817	Texas
819	Quebec
901	Tennessee
902	Nova Scotia and Prince Edward Island
903	Northwest Mexico
904	Florida
905	Unassigned
906	Michigan
*907	Alaska
908	Unassigned
909	Unassigned
910	4-Row TWX (U.S.)
912	Georgia
913	Kansas
914	New York
915	Texas
916	California
917	Unassigned
918	Oklahoma
919	North Carolina

*Not reachable by customers - operator dialing only.

TABLE 11-3

NUMBERING PLAN AREAS AND CODES-BY GEOGRAPHICAL LOCATION

Numbering Plan Area	Area Code
Alabama	205
Alaska	907
Arizona	602
Arkansas	501
California	209
California	213
California	408
California	415
California	707
California	714
California	805
California	916
Colorado	303
Connecticut	203
Delaware	302
District of Columbia	202
Florida	305
Florida	813
Florida	904
Georgia	404
Georgia	912
Hawaii	808
Idaho	208
Illinois	217
Illinois	309
Illinois	312
Illinois	618
Illinois	815
Indiana	219
Indiana	317
Indiana	812
Inward WATS	800
Iowa	319
Iowa	515
Iowa	712
Kansas	316
Kansas	913
Kentucky	502
Kentucky	606
Louisiana	318
Louisiana	504
Maine	207
Maryland	301
Massachusetts	413
Massachusetts	617
Michigan	313
Michigan	517
Michigan	616
Michigan	906
Minnesota	218
Minnesota	507
Minnesota	612
Mississippi	601
Missouri	314
Missouri	417
Missouri	816
Montana	406
Nebraska	308
Nebraska	402
Nevada	702
New Hampshire	603
New Jersey	201
New Jersey	609
New Mexico	505
New York	212
New York	315
New York	516
New York	518
New York	607
New York	716
New York	914
North Carolina	704
North Carolina	919
North Dakota	701
Ohio	216
Ohio	419
Ohio	513
Ohio	614
Oklahoma	405
Oklahoma	918
Oregon	503
Pennsylvania	215
Pennsylvania	412
Pennsylvania	717
Pennsylvania	814
Rhode Island	401
South Carolina	803
South Dakota	605
Tennessee	615
Tennessee	901
Texas	214
Texas	512
Texas	713
Texas	806
Texas	817
Texas	915
Utah	801
Vermont	802
Virginia	703
Washington	206
Washington	509
West Virginia	304
Wisconsin	414
Wisconsin	608
Wisconsin	715
Wyoming	307
Canada	
Ontario	416
Ontario	519
Ontario	613
Ontario	705
Ontario	807
Quebec	418
Quebec	514
Quebec	819
British Columbia	604
Alberta	403
Saskatchewan	306
Manitoba	204
Nova Scotia	902
New Brunswick	506
Newfoundland	709
Bermuda and Caribbean	809
Mexico	
Northwest Mexico	903

Forecasts for 1985 to 1990 predict an equal number of people and phones - 280 million; and by the year 2000, approximately 340 million people may require 600 million phones.

This problem is brought about by new services that require telephone numbers: BELLBOY^{R} signaling service, air-ground service, mobile telephone service, military systems and many others.

Centrex, which requires every PBX extension to have a 7-digit number per extension rather than one per PBX trunk, has added many new numbers.

Another new service that requires telephone numbers is data switching over the telephone network. Each data station will require one or two numbers, so additional numbers, office codes and area codes will be needed because of this service.

Overseas Gateway Operator Dialing, which began in March, 1963 with the United Kingdom and the Federal Republic of Germany, is now in operation with twelve points as follows:

New York Gateway	Oakland Gateway	White Plains Gateway
Belgium	Australia	United Kingdom
Denmark	Japan	
France		
Germany		
Italy		
New Zealand		
Netherlands		
Sweden		
Switzerland		

The initial nationwide numbering plan was expected to last beyond the year 2000, but now it appears that will be outgrown by about 1975. The telephone industry in the

United States and Canada has, therefore, adopted a new plan with several times the code capacity of the present one which should last well into the next century.

11.3 THE NEW NUMBERING PLAN

Under the initial plan, procedures varied with different types of offices, however, the new plan, shown in Table 11-4 provides uniform dialing procedures for all types of central offices. The following are also provided:

1. A prefix for customer dialed person to person collect, credit card, and other calls requiring operator assistance. The assigned prefix is "0" (zero).

2. A simplified toll office access code for DDD (Direct Distance Dialed) calls in Step-by-Step central offices. With the present plan, a Step-by-Step central office customer making a DDD call uses a 3-digit access code such as "112" to reach the toll office. The access code may be followed by as many as ten digits giving a maximum of thirteen digits. With the new plan, the recommended DDD access code is the single digit "1" and the maximum number of digits is therefore eleven.

3. A prefix to prevent local intended calls from reaching toll points in error in cities using common control type switching systems which store and process the dialed digits like No.1 and No. 5 Crossbar. The new plan uses a prefix, "0" or "1" on all toll calls. Hence, a wrong office code digit on a 7-digit local call (no prefix being dialed) cannot convert a local intended call into a toll call.

TABLE 11-4 NEW NUMBERING PLAN

	INITIAL STAGE	ULTIMATE STAGE
HOME AREA DDD	(1) + NNX + XXXX	1 + NXX + XXXX
HOME AREA SPECIAL TOLL	0 + NNX + XXXX	0 + NXX + XXXX
FOREIGN AREA DDD	(1) + NO/1X + NNX + XXXX	1 + NXX + NXX + XXXX
FOREIGN AREA SPECIAL TOLL	0 + NO/1X + NNX + XXXX	0 + NXX + NXX + XXXX

TABLE 11-5 CAPACITY OF NEW NUMBERING PLAN

INITIAL:		
AREA CODES	N 0/1X	152
OFFICE CODES	NNX (NAMES AND NUMBERS)	540
	NNX (ALL NUMBER CALLING)	640
ULTIMATE:		
AREA CODES	NXX	800
OFFICE CODES	NXX (Less Service Codes)	792

Notes:

N = ANY NUMERAL 2 to 9
X = ANY NUMERAL 0 to 9
(1) INDICATES THAT THE PREFIX MAY BE USED IN COMMON CONTROL AREAS BUT MUST BE USED IN SXS AREAS.

A. Requirements

The new plan was designed to meet the following requirements:

1. Capacity. Additional capacity is a basic requirement. It could be extended for a few years beyond the expected exhaust date with modest changes in the present plan but underestimations have led to

difficulties in the past. It is more sensible to set up a large capacity plan that will last well into the next century. The 800 area codes provided by the new plan are considered adequate for North America. It leaves the door open for arrangements such as doubled prefix digits which will allow the plan to grow into the ultimate desirability, a world wide plan.

2. Programmable. A plan that would require a simultaneous nationwide switch from the existing to the new would be completely impractical. Apart from the large costs of such a cutover, the co-ordination of work in thousands of central offices could not conceivably be handled without major difficulties and service interruptions. The plan adopted can be implemented in easy stages.

3. No Modification of Customers' Equipment. The chief objection to modifying equipment, such as telephones on customers' premises, is cost. One which has been discussed is the use of specially designated buttons on dials and on keysets proposed to replace dials, which customers would push instead of dialing prefix digits such as "0" or "1". Other changes have also been suggested, but costs have prevented adoption of any of these ideas as a requirement of the new plan.

4. Customer Acceptance. It was felt that a plan that was essentially an extension of the present plan would be more readily accepted by users than a radically new plan. Such a plan would also be more desirable from a customer education standpoint.

All existing telephone switching systems, both local and toll, with the possible exception of step-by-step inter-toll equipment, will need to be modified.

B. Modifications

All common control local systems must be modified to enable them to do the following:

1. To register the prefix "1" or "0" and to signal the translating equipment which prefix has been received. The prefix will not be sent to the toll office.

2. To check after an initial "0" to see whether more digits are forthcoming. If only "0" is received, the call will be routed to an operator.

3. To route calls selectively on the basis of the prefix and the code which follows.

4. To provide translation capacity for up to 800 area codes and 792 office codes.

5. To determine whether a code is an area code or an office code (according to the number of digits dialed).

6. To block toll calls which are received without a prefix.

The step-by-step local system will require special trunks from the "1" and "0" levels. The "1" level trunk will immediately seize a trunk to the toll office and a sender or register at that office. If the second digit is 2 to 9, it and succeeding digits will be repeated to the toll office equipment and stored there. However, if the second digit is a "1," it will be absorbed, the toll office trunk will be immediately released and the auxiliary selector will accept the third digit and route to a service trunk. This problem will be eliminated when 11X service codes are replaced.

The "0" level trunk will be arranged to distinguish between prefix "0" toll calls such as person to person and collect, and "zero" operator calls by waiting three or four seconds to see if any more digits are to be dialed.

11.4 SWITCHING PLAN

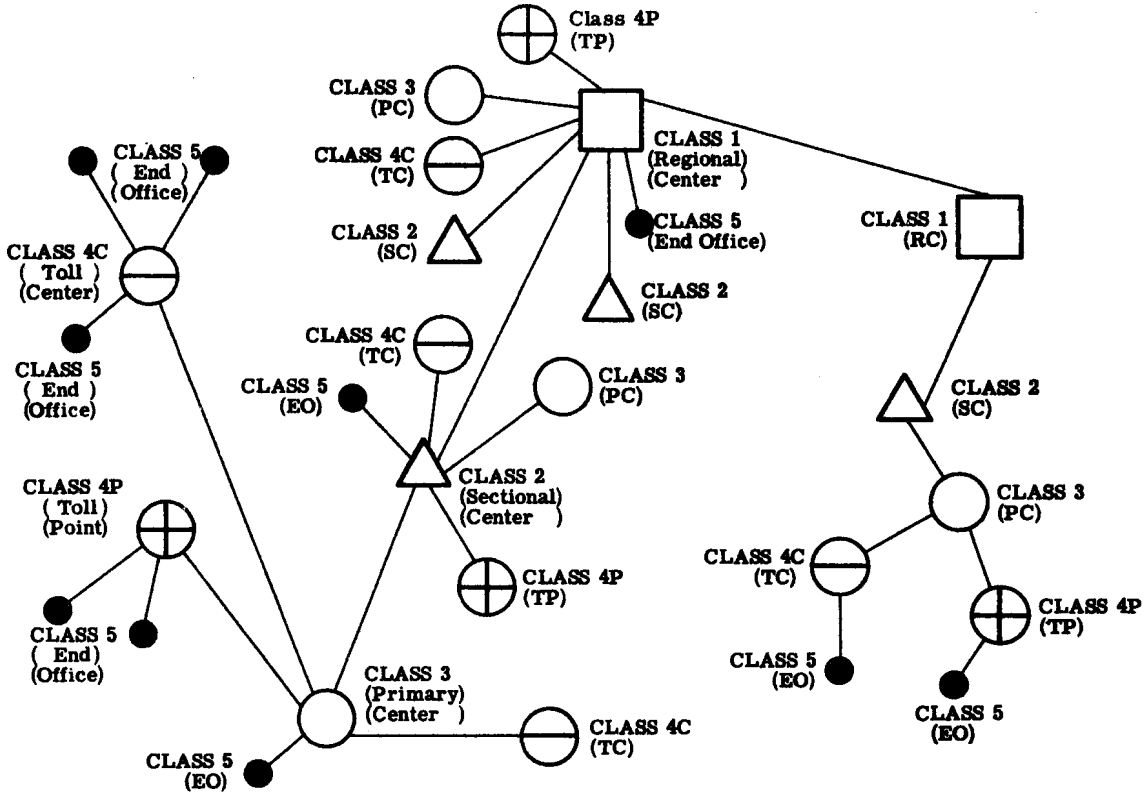
Large volumes of traffic between any two points are generally routed most economically over direct trunks. When the volume of traffic between two offices is small, however, the use of direct trunks is usually not economical. In these cases the traffic is handled by connecting together, by means of switching equipment at intermediate offices, two or more trunks to build up the required connection. The places where interconnections are made are generally known as "switching centers" and the process is referred to as a "switch." "Built-up" connections may involve several switching centers if the originating and terminating locations are a great distance apart. It is important that telephone plant be designed to provide adequate transmission

and service for this multiswitch traffic as well as the large volumes of traffic handled by the less complex direct and single switch connections.

The conditions under which toll traffic will be automatically switched on a nationwide scale are quite similar to those found in large cities with large volumes of traffic between many separate switching centers. Therefore, experience gained in these places was applied to the nationwide dialing job.

The needs of multioffice exchange areas are met by switching and trunking plans that employ a new principle, "automatic alternate routing," to provide rapid and accurate connections with few occasions for repeated attempts. With this principle, a call which encounters an "all trunks busy signal" on the first route tested is automatically and rapidly "route advanced" and offered to one or more alternate routes, in sequence.

In the general toll switching plan, the central office, where customers' telephone lines are terminated, is called an End Office. For reference, it has been assigned the classification "5". Thus, the End Office is a Class 5 office. A Class 5 office may be physically located in the same building that houses an office of higher classification and in some cases the End Office and the toll office functions are performed by one machine. However, the offices are considered as separate entities, and customers' lines are terminated at the Class 5 office only. Figure 11-1 shows how a number of Class 5 offices is grouped on or homed at, a Toll Center or a Toll Point. A Toll Center, Class 4C, is defined as a toll switching location where operators are present to handle inward toll traffic in addition to other normal traffic operating functions. A Toll Point, Class 4P, is defined as a toll switching location where operators, if present, will not handle inward traffic. A Class 4P office may or may not have operators handling other traffic items such as outward, delayed outward, assistance, information, etc. Both the Class 4C and 4P offices have the same importance and rank in the toll switching plan as regards transmission considerations. Class 4 offices are grouped upon, and serve over final routes from, a higher rank toll switching location designated as a Primary Center or Class 3 office. Class 3 offices "home" at Sectional Centers, Class 2, and the latter have final routes to Class 1 offices known as Regional



Symbol	Class	Name	Abbreviation
□	1	Regional Center	RC
△	2	Sectional Center	SC
○	3	Primary Center	PC
⊖	4C	Toll Center	TC
⊕	4P	Toll Point	TP
●	5	End Office	EO
—	Final	Trunk Group	

Figure 11-1 General Toll Switching Plan (Basic Principle)

Centers. There are ten Regional Centers in the United States and two in Canada. Each of the Regional Centers (RC) serves a very large area known as a Region. The Regional Areas are listed in Tables 11-2 and 11-3. The Region is subdivided into small areas known as Sections, whose principal switching facility is the Sectional Center (SC). The Section is still a rather large area, and it, too, is further divided into smaller parts known as Primary Areas, each of which is served by a Primary Center (PC). The remaining toll offices that do not fall into the above categories are the Toll Centers (TC) and Toll Points (TP).

The general toll switching plan, as originally conceived, called for one of the regional centers to be designated "National Center" with final trunk groups to and from all regional centers. However, this "National Center" concept has now been abandoned. Instead, final trunk groups are provided between all regional centers in the United States. This does not affect the overall flexibility of the plan since it is possible to route inter-regional traffic via a third regional center on an emergency basis.

It is not necessary that Class 5, 4, or 3 offices home on the next higher ranking office; the complete intermediate final route chain is not necessary. For example, Class 5 offices may be served directly from any of the higher ranking through switching centers. One final circuit group will always be provided from each office to an office of a higher rank. That one higher ranking switching point to which an office is connected over a final group is called its "home" office; the dependent office is spoken of as "homing" on it. The network of final trunk groups will be engineered on a low delay basis so that, on the average, not more than three calls in each hundred that are offered to such a trunk group in the busy hour will find all circuits busy.

Since the general toll switching plan with DDD makes extensive use of alternate routing, the flow of traffic, in many ways, is different from what it was with

ring down operation. Figure 11-2 shows a comparison of intertoll trunk networks theoretically required with:

1. The limited switching under ring down operation, where engineering was on the basis of many inefficient direct groups, and

2. Operator and direct distance dialing utilizing common control equipment and full automatic alternate routing at the principal switching centers.

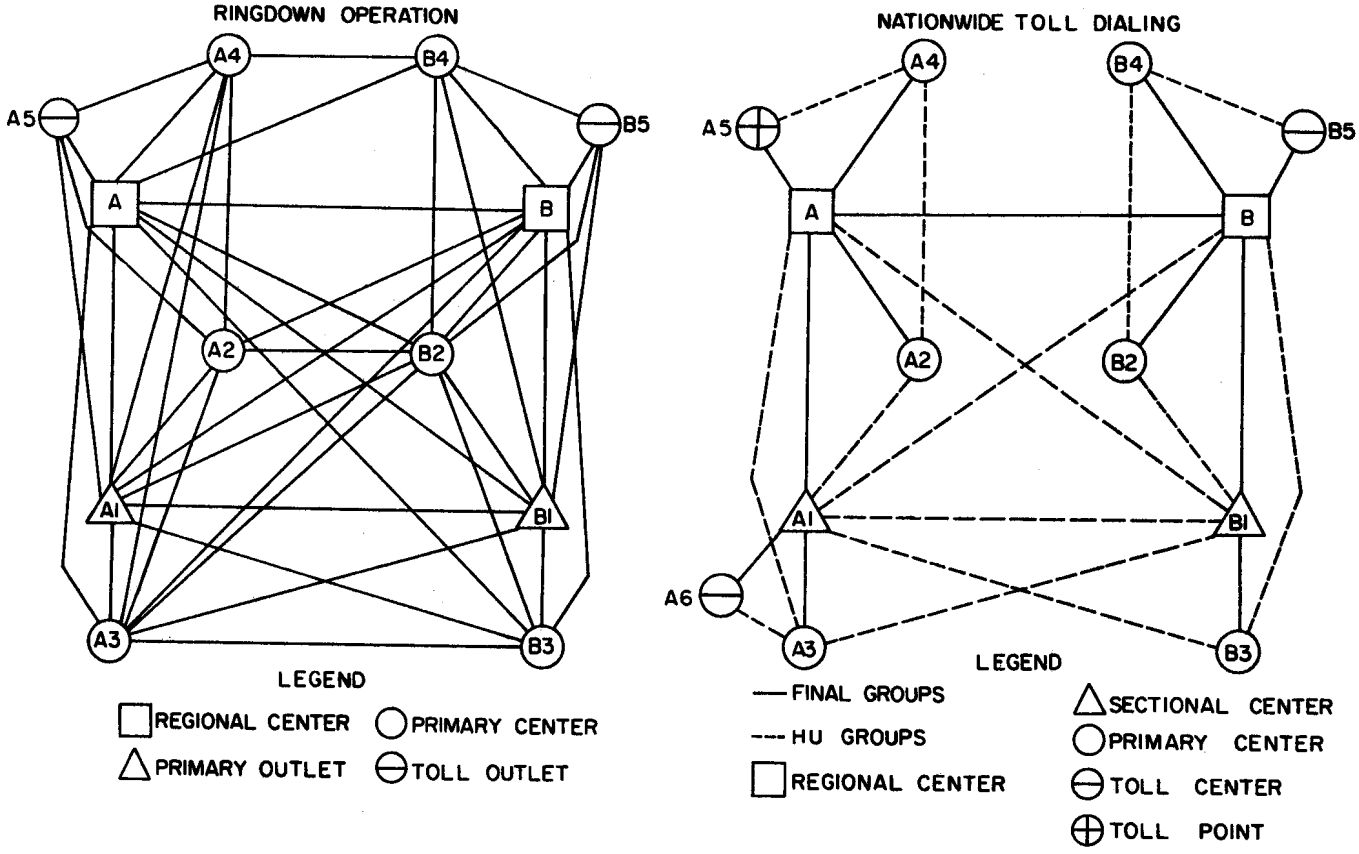


Figure 11-2 Theoretical Intertoll Trunk Network

Intertoll trunk groups, both high usage and final, are usually two-way because with the usual volumes of toll traffic, they are more economical than two groups of one-way trunks.

11.5 CONTROL SWITCHING POINTS

Collectively, the Class 1, 2, and 3 offices (Regional Centers, Sectional Centers, and Primary Centers) constitute the control switching points (CSP's) for nationwide dialing. A control switching point is a key switching location in the nationwide automatic switching network which will have some or all of the following features:

1. Storying of digits received.
2. Variable spilling - deletion of certain digits which are not required for outpulsing and sending forward the required digits.
3. Prefixing of digits when required.
4. Code conversion.
5. Translation of 3 or 6 digits. (Also translation of 4 or 5 digits for TX codes.)
6. Automatic alternate routing.

In addition to these six items, which will be covered in more detail in this chapter, there are certain transmission characteristics which will be covered in a later chapter.

11.6 SWITCHING EQUIPMENT

Nationwide distance dialing places no restriction on the type of dial switching system provided at Class 5 offices. Class 4 offices may use any type of system except panel or No. 1 crossbar. Common control equipment such as registers, or senders, is not essential at these offices although it may be used in many instances to effect economies in switching traffic and to provide uniform dialing procedures. Outward direct distance dialing requires that the Class 5 (End) office be able to send the complete 7 or 10 digit called number to the toll switching system at which it homes. Common control switching equipment can be arranged to do this. If direct control equipment such as step-by-step without senders is used at the Class 5 office, it will be necessary to prefix a toll access code, such as 1 or 112, to direct the call to the toll office.

Class 1, 2, and most Class 3 offices employ common control switching facilities, and have the control point switching features outlined in the previous section. Some Class 3 offices which do not require all the CSP features, employ step-by-step intertoll equipment. The type of switching equipment used at each center is shown in Table 11-6.

TABLE 11-6 TYPE OF SWITCHING EQUIPMENT AT CENTERS

Center	Class	Type
Regional Center	1	4A or 4M toll crossbar, crossbar tandem.
Sectional Center	2	4A or 4M toll crossbar, crossbar tandem, or No. 5 crossbar.
Primary Center	3	4A or 4M toll crossbar, crossbar tandem, No. 5 crossbar, or intertoll step-by-step.
Toll Center or Toll Point	4	Crossbar tandem, No. 5 crossbar, or step-by-step.
End Office	5	Panel, No. 1 or No. 5 crossbar, or step-by-step.

11.7 STORING AND FORWARDING (VARIABLE SPILLING) OF DIGITS AS REQUIRED

One of the main functions performed by common control equipment at control switching points is to store all digits received and send forward as many as required to complete the call.

The called number recorded at a switching point is in the form of NNX-XXXX if the call is to be completed in the same numbering plan area. If the called destination is in another area, the present area code N0X or N1X precedes the 7 digit number. The area codes N0X or N1X and local office code NNX are the digits used for routing purposes and are sufficient to complete the call towards its destination when these codes are received. If the next switching point is not in the numbering area of the called telephone, the complete ten digit number is needed to advance the call toward its destination. If the next switching point is in the numbering plan area of the called telephone, the area code is not needed and seven digits will suffice for completing the call.

For example, suppose a call is originated by a customer in South Bend, Indiana, destined for customer NAtional 4-1234 in Washington, D.C. If it is assumed in Figure 11-3 that the route to Washington is via a switching

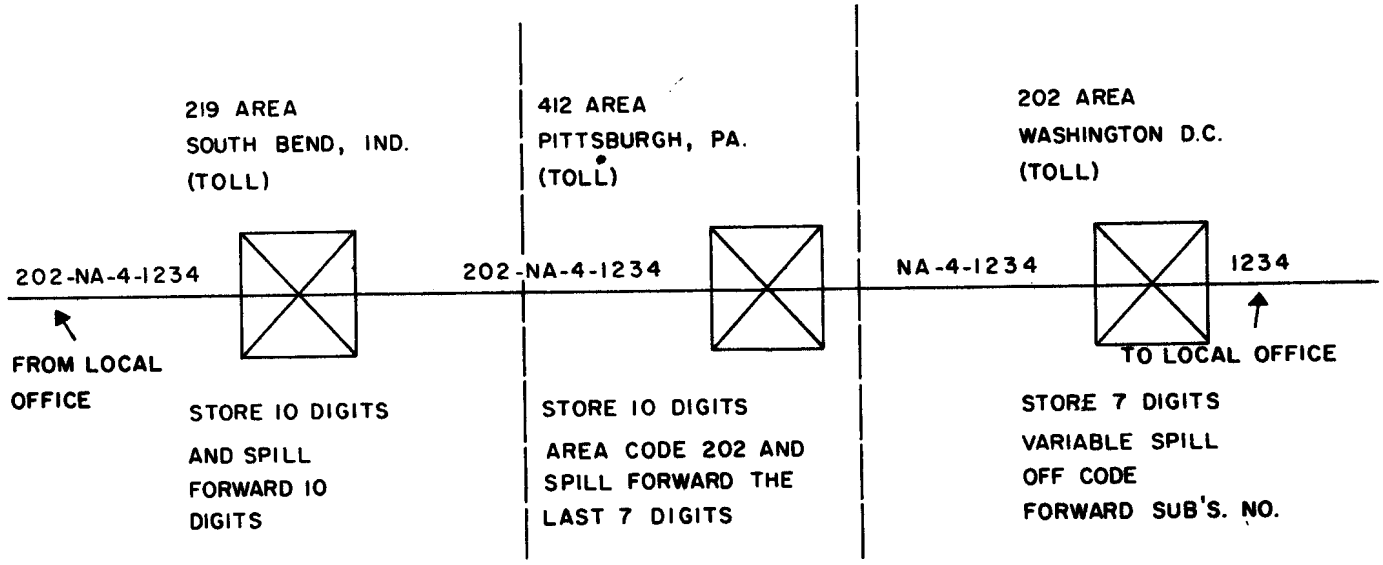


Figure 11-3 Storing and Variable Spilling (3 Digits)

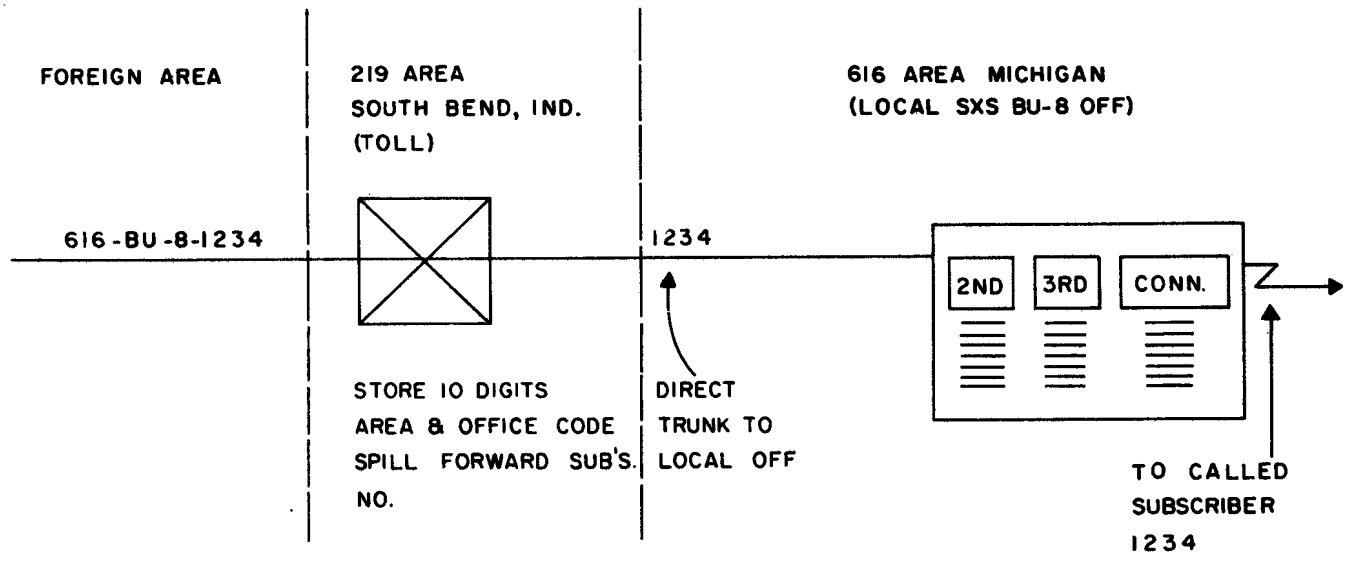


Figure 11-4 Storing and Variable Spilling (6 digits)

center in Pittsburgh, then the crossbar equipment at South Bend pulses forward to Pittsburgh 202-NA 4-1234, 202 being the area code for the District of Columbia. Pittsburgh in turn will delete the area code and send NA-4-1234 to the District of Columbia terminating area.

As another example, suppose the crossbar office at South Bend receives a call from some foreign area destined to a nearby step-by-step end office in Michigan. The crossbar equipment receives and stores a ten digit number comprising the area code and the seven digits for the office code and station number. Assuming that direct trunks to the step-by-step end office in Michigan are available, as shown in Figure 11-4, the area code and office code are deleted and the line number only is pulsed forward. To meet all conditions, the equipment is arranged to permit deletion of either the first three, four, five or six digits of a ten digit number.

11.8 PREFIXING OF DIGITS

In establishing calls, it may be necessary to route a call from one area to another and back to the original area for completion. Such a situation arises on a call from Amarillo to Lubbock, Texas, both in area 915, when the switching equipment finds all of the direct trunks from Amarillo to Lubbock busy, as illustrated in Figure 11-5. The call could be routed to Lubbock via Oklahoma City which is in area 405. A seven-digit number for example MA 2-1234, is received in the crossbar tandem office at Amarillo. Assuming that the call is to be switched out of the 915 area through the 405 area and back to the 915 area for completion, it is necessary for the crossbar tandem office in Amarillo to prefix 915 to the MA 2-1234 number so that the switching equipment in Oklahoma City will know that the call is for the 915 area and not for the 405 area.

Prefixing of digits, Figure 11-6, may also be required when calls are routed through step-by-step primary centers. For example, assume that the common control equipment at sectional center received the seven digit number MA 2-1234, for a call to a customer in the Madison office in the same area. The routing required to complete the call is through a step-by-step primary center to a No. 5 crossbar toll center and then to the Madison office. However, the step-by-step

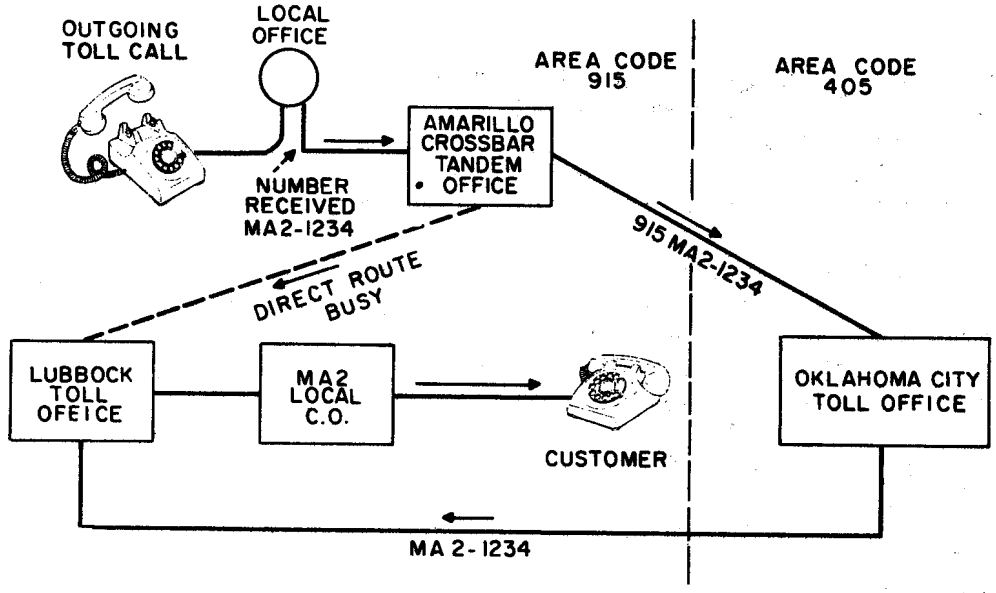


Figure 11-5 Prefixing of Digits

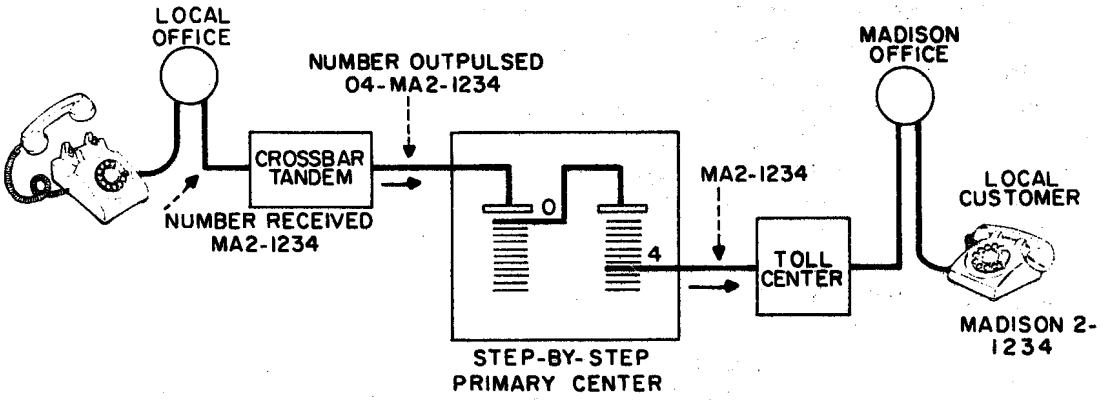


Figure 11-6 Prefixing

switches at the primary center "use up" digits for its switching of the call to the toll center. The common control equipment at the sectional center must therefore prefix digits to accomplish this switching in order to provide the full seven digit number to the toll center for completing the call.

11.9 AUTOMATIC ALTERNATE ROUTING

The nationwide trunking network is so designed that direct trunks, called "high usage" groups, are provided between individual switching offices of all classes where such trunks are warranted by the traffic load. These high usage groups are not engineered to handle all the traffic offered to them during the busy hour, since it is not practical or economical to provide facilities for the busiest five or ten minutes. Traffic offered to a high usage group, which finds all trunks busy, is automatically rerouted to alternate routes consisting of other high usage groups, and finally to a final trunk group for which no alternate route is provided. In intertoll operation there are calls for which no direct trunk groups exist. Such calls are handled over a preferred trunk group, but are automatically rerouted to other trunk groups if the preferred trunks are busy. The characteristic of the common control equipment at a control switching point to select one of several alternate routes automatically, when all choices in the first route are busy, contributes to the economy of the plant and provides additional protection against complete interruption of service when all circuits on a particular route are out of service.

Figure 11-7 and the following discussion illustrate a particular routing pattern that might be involved in completing a call that appears at an end office served from toll center TC_1 destined for an end office served from toll center TC_2. In this example, TC_1 has trunks to PC_1 only, hence the call is routed to that primary center.

At PC_1 the call would be offered first to the high usage group to PC_2. At PC_2 the switching equipment would select an idle trunk in the final group to TC_2 and the call would be routed to the called customer in EO_2. If, however, all the trunks in the first high usage group (between PC_1 and PC_2) had been busy, the call would next be offered to the high usage group between PC_1 and SC_2 (if PC_1-SC_2-PC_2 is the most economical alternate route). At SC_2 the call would have a choice of two routings:

1. Via direct high usage trunks to TC_2, or if they were all busy,
2. Over the two final trunk groups SC_2-PC_2 and PC_2-TC_2.

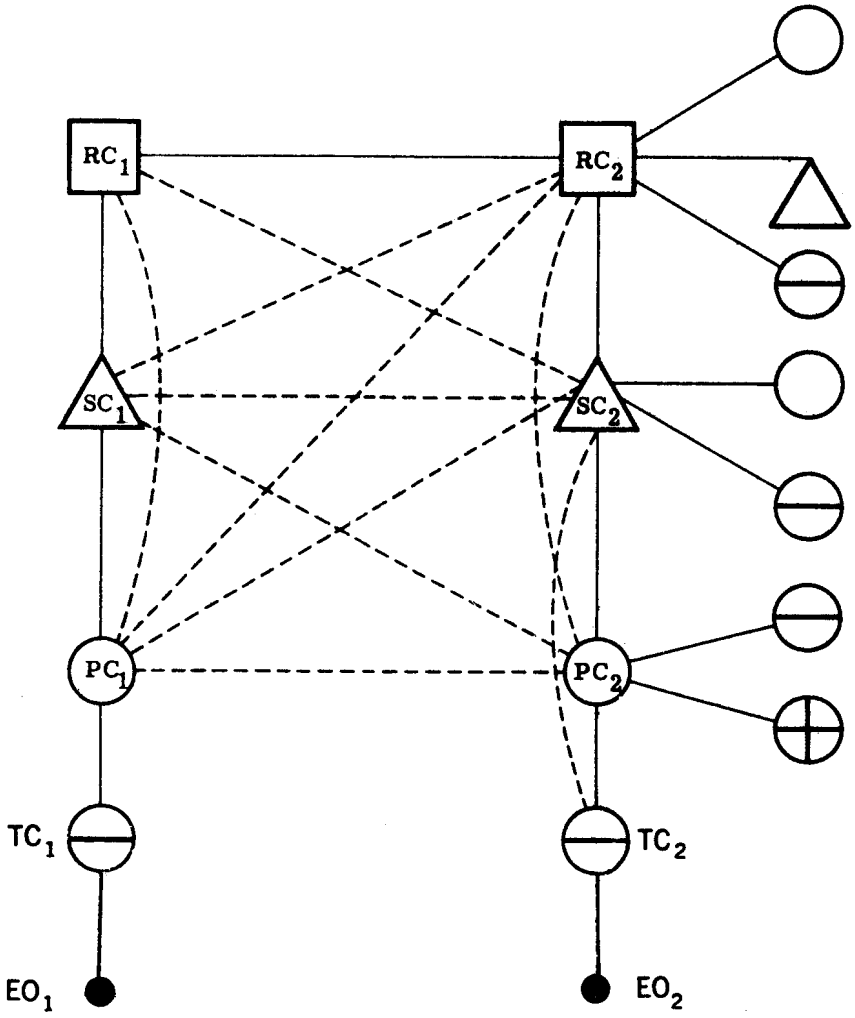
In the event all the trunks in the group between PC_1 and SC_2 are busy, the call should next be offered to the final group to SC_1. There are available at PC_1 other high usage groups to RC_2 and RC_1. These are intended for terminal and certain other traffic items that must be so routed. Traffic routed via PC_1 should not be offered directly to Regional Centers if there are other lower ranking switching centers in the final route path which have not yet been selected. It is desirable to restrict the switched lead to centers of lower rank even though the service advantages of other alternate route possibilities are not realized. At SC_1 the call would have a choice of four routings in the following sequence:

1. Via the SC_1-PC_2 high usage group,
2. Via the SC_1-SC_2 high usage group,
3. Via the SC_1-RC_2 high usage group, and lastly
4. Via the final group from SC_1 to RC_1.

The routing described above is for one set of assumed conditions and could vary in actual practice to the extent that economics and plant layout would offer different high usage trunk groups.

11.10 CODE CONVERSION

At the present time, some step-by-step primary centers reach other offices by using routing codes that differ from those assigned under the national numbering plan. This arrangement is used to obtain economies in switching equipment of the step-by-step plant and is acceptable with operator originated calls. However, with the introduction of customer direct distance dialing, it is essential that the codes used by customers be in accordance with the national numbering plan. The common control equipment at the control switching point must then automatically provide the routing codes needed by the intermediate step-by-step primary centers. This is accomplished by the code conversion feature of this equipment which substitutes the arbitrary digits required to reach the called office through the step-by-step systems. Figure 11-8 illustrates an application of this feature. It shows a



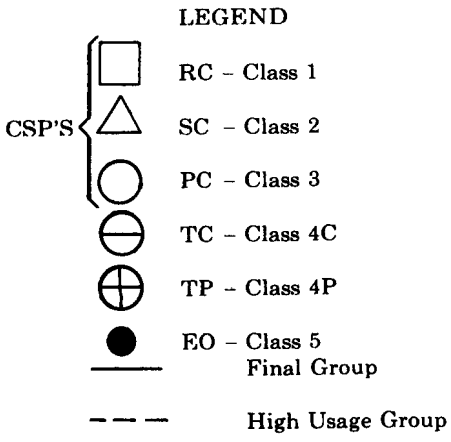


Figure 11-7 Routing Pattern

crossbar tandem office arranged for completing calls through a step-by-step toll center to a local central office, GArden 8, in an adjacent area. A call reaching the crossbar tandem office for a customer in this office arrives with the national number, 218-GA8-1234. To complete this call, the crossbar tandem equipment deletes the area code 218 and pulses forward the local office code and number. If the call is switched to an alternate route, via the step-by-step primary center, it will be necessary for the crossbar tandem equipment to delete the area code 218 and substitute the arbitrary digits 062 to direct the call through the switches at the primary center, since the toll center requires the full seven digit number for completing the call.

11.11 3 AND 6 DIGIT TRANSLATION

3 and 6 digit translation is mainly used when a foreign area can be reached directly or indirectly by more than one route.

Figure 11-9 shows both 3 and 6 digit translation on calls between subscriber "A" in the Oakland, California Area and subscribers "B" and "C" in the Ohio Area.

Upon receiving the details of the toll call from subscriber "A", the Oakland operator keys the area code, 216, followed by the appropriate national office code and numericals, to reach either subscriber "B" or "C".

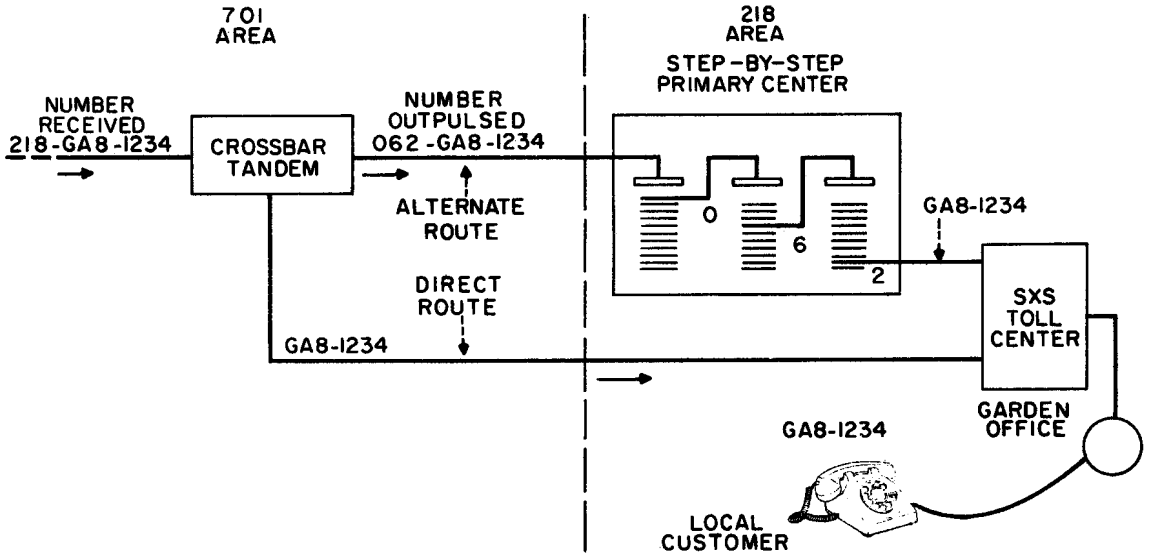


Figure 11-8 Code Conversion

On the call to subscriber "B" in Cleveland, Ohio, the Oakland operator keys 216-MA 2-1234. The Oakland toll office translates the first three digits to select a trunk to Chicago and spills forward 216-622-1234. The Chicago toll office has two trunk groups to the 216 Area (one to Cleveland and one to Canton), and must determine which one shall be used on this call. The Chicago toll center must translate the first six digits. The Area Code, 216, indicates that one of the trunk groups to the 216 Area must be selected. The national office code MA 2 (622) determines that this is the trunk group to Cleveland, since the MAin 2 office "homes" on Cleveland. In this way the Chicago toll center translates the combination of the area code and the NAtional office code to select the trunk group to the Cleveland Toll Center.

The Chicago toll center spills forward 622-1234, skipping the Area Code. This illustrates the variable spill feature. The Cleveland toll center receives 622-1234, selects a trunk to the MAin 2 office, and variable spills forward the digits -1234. The MAin 2 office receives the digits -1234 and connects subscriber "A" to subscriber "B".

On the call to subscriber "C" in an office that "homes" on the Canton toll office, the Oakland toll operator keys 216-623-1234. When the call arrives in Chicago the common control again translates the first six digits and this time selects a trunk to Canton, because the office with national office code MAin 3 (623) is served directly by Canton. The call is then terminated in the same manner as above.

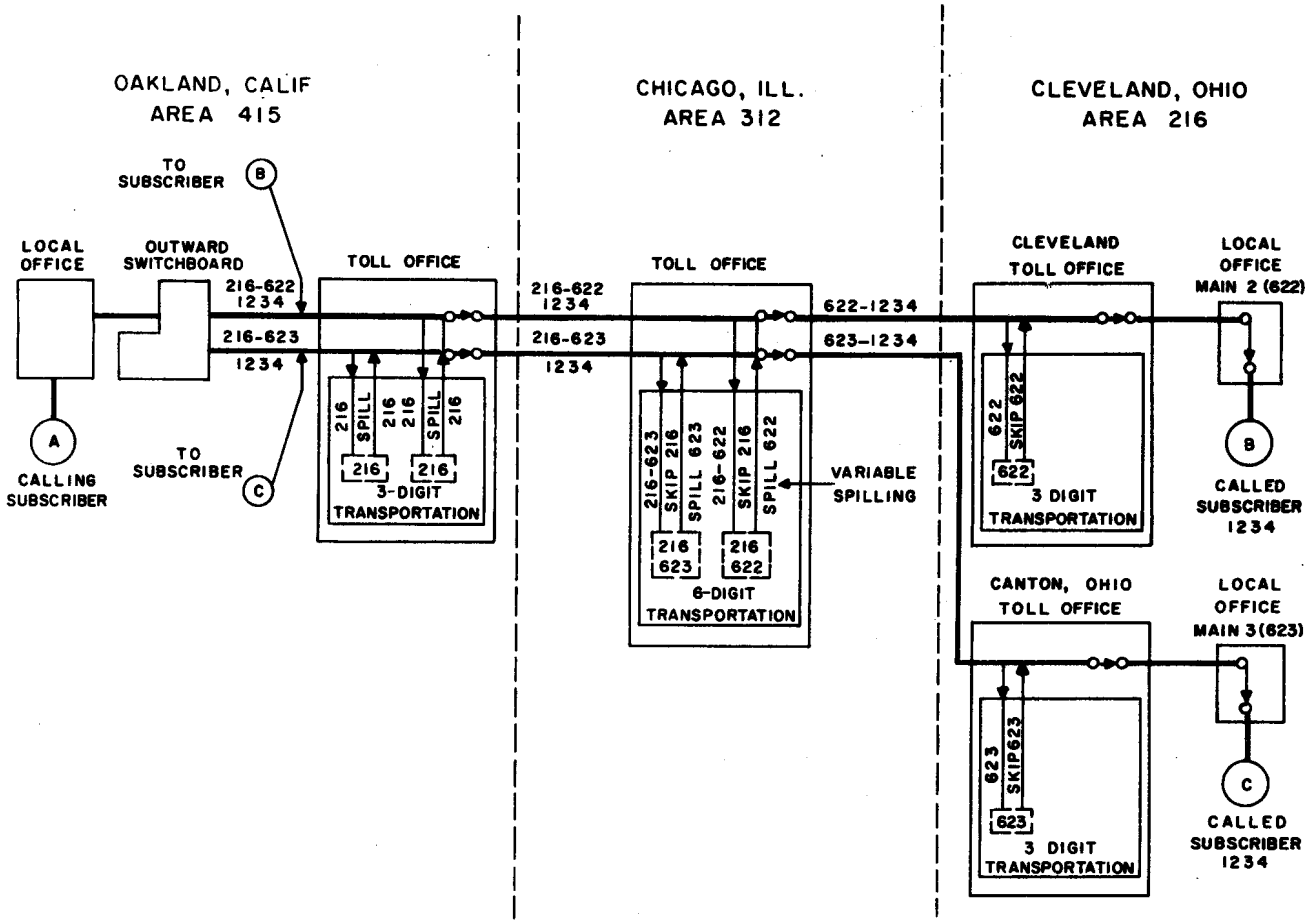


Figure 11-9 3 & 6 Digit Translation