

TRUNKING DATA
DATA QUALITY
NETWORK SWITCHING ENGINEERING-TRUNKING DATA
NETWORK SERVICES METHODS

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B. Faulty Measuring Equipment	4	1.01 This section is issued to provide information concerning data quality as it applies to trunking data. It discusses sampling concepts as they relate to trunk group data and traffic item data. It reviews the relationship of trunk group data and point-to-point data. Various types of data errors are reviewed from a cause-effect standpoint. It discusses data validation and administrative considerations, as pertains to data quality.	
C. Wiring and Translation Errors	4	1.02 Whenever this section is reissued, the reason(s) for reissue will be given in this paragraph.	
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Trunk engineering, in this context, includes all of the numerous facets of trunk provisioning, including, but not limited to:

- (a) **Planning:** Trunking data is necessary to the network planning engineer who must study many network configurations over variable time spans to plan for new end offices, tandem replacements, and rehomes.
- (b) **Network Design Engineering:** A trunk forecast based on accurate trunking data is a primary input to the network designer whose responsibility is to order switching system and/or cable facilities for growth jobs in existing offices and new or replacement offices.
- (c) **Forecasting:** An accurate trunk forecast can occur only when accurate trunking data have been used for a base. Capital dollar expenditures are dependent to a large degree on future trunk requirements.
- (d) **Servicing:** Trunk servicers base their decisions to add or remove trunks or trunk groups for the next busy season on the trunk forecast modified by current trunking data. This creates an interdependency between trunk forecasting and servicing that can be affected by inaccurate trunking data. Sound servicing decisions can only be made when the decisions are based on reliable trunking data.
- (e) **Management:** Day-to-day network administration requires reliable trunking data for network surveillance purposes. Crucial decisions, responding to network overload conditions and based on trunking data, are made immediately by network managers.

2.02 Trunking data are used for many purposes other than those stated above, including several nontrunking purposes. Fulfilling the intent of the Bell System to provide the best possible service at the lowest possible cost is dependent on the continual provision of high quality data provided in sufficient quantities. The proper balance between service and utilization can be maintained only when ample amounts of reliable data are available.

3. POINT-TO-POINT VERSUS TRUNK GROUP DATA

3.01 Engineering of a message network can be accomplished only when adequate amounts of

high quality trunk group data and point-to-point data are available.

3.02 Trunk group data are a direct measurement taken on a specific trunk group. The measurement is indicative of the load offered to or carried on the trunk group, or it expresses the congestion experienced on the trunk group. Section 780-401-210, Trunk Group Data Sources and Measurements, defines trunk group data measurements. These measurements include:

- Usage (U)
- Peg count (PC)
- Overflow (O)
- All trunks busy (ATB)
- Last trunk busy (LTB)
- Last trunk usage (LTU)
- Peak load.

3.03 Point-to-point data are an expression of the load for a particular traffic item. Section 780-401-300 defines the various types of point-to-point data. Common point-to-point data measurements include:

- The number of messages
- Message time in hundred call seconds (CCS)
- Traffic item attempts.

3.04 Point-to-point data, while expressing the load for a particular traffic item, provide no indication of the load on the trunk group over which the traffic item is carried unless the trunk group carries only that traffic item.

3.05 Trunk group data state the load or congestion for a trunk group but provide no indication of the load for a traffic item carried on a trunk group over which multiple traffic items are carried.

3.06 Trunking data, whether point-to-point or trunk group, are subject to numerous sources of inaccuracies en route to the various trunk engineering processes.

3.07 A balanced cost/service relationship in the trunking arena can only be effectively pro-

vided when all influences affecting trunking data accuracy have been identified and a continual accuracy monitoring-correcting program established.

3.08 Table A provides a listing of the major causes of trunking data distortion and associates them with trunk group and/or point-to-point data. Part 4 discusses in detail these causes of trunking data distortion.

4. TRUNKING DATA DISTORTION

4.01 Inaccuracies in the recording, accumulating, processing, and validating of trunking data impact, in varying degrees, the quality of the data. Trunking data that have been impacted by one or more significant sources of distortion are considered suspect as to their validity.

TABLE A
TRUNKING DATA DISTORTION

CAUSES OF DATA DISTORTION	AFFECTS		SOURCE OR TYPE
	POINT TO POINT	TRUNK GROUP	
Sampling Error	x	x	Size and/or Frequency of Sample
Faulty Measuring Equipment	x	x	Measuring Equipment in Use
Wiring/Translation Error	x	x	Connections to Measuring Equipment
Busy Hour/Busy Season Identification Error	x	x	Servicers Selection of Busy Hour/Busy Season
DCD Assignment Errors		x	Discrepancies in Dial Administration Record
Routing Discrepancies	x	x	Routing Records Differ From Physical Routing Arrangements
Record Keeping Error	x	x	Trunking Data Record Discrepancies
Processing Error	x	x	Mechanized or Manual Manipulation of Data
Conversion Error	x		Selection of Nonconversation Times not Representative of What is Actual
Excessive Maintenance		x	Network Maintenance
Validation Processing Error	x	x	Servicing - Forecasting
Rerouted Traffic		x	Network Management
Disassembly-Assembly Process Error	x	x	Manual or Mechanized Trunk Forecasting
Unexpected, External Events	x	x	Outside Influences, eg, Severe Weather, Fires, etc

A. Sampling Error

4.02 Trunk group usage is the result of a periodic "look" or scan of each trunk in a group. Scans are made at regular intervals, usually 100 or 200 seconds. A trunk found busy is assumed to have been busy for the entire interval. In reality, it could have been idle for the entire interval and become busy just as it was scanned. Conversely, a trunk that is found idle is assumed to have been idle during the entire interval. Again, this may or may not be true. Error from this source is usually not significant as the busy/idle conditions tend to offset each other.

4.03 On rare occasions, particularly when extremely short holding times characterize a trunk group, eg, a trunk group providing time-of-day service, it may be desirable to arrange for fast scan, ie, 10-second intervals. The 10-second busy/idle assumption, as opposed to 100 or 200 seconds, will assure more accurate usage for this type of trunk group.

4.04 Error associated with sampling is the most significant factor in the accuracy of Centralized Message Data System-Trunk Engineering (CMDS-TE) data. Sampling error is directly related to the size of the sample:

- As the sample size increases, accuracy improves
- As the sample size decreases, accuracy diminishes.

4.05 The accuracy of sampled data is affected more by the size of the sample in numbers, rather than the size of the sample as a percentage of the universe. Therefore, individual traffic items with a small sample size are highly susceptible to sampling error.

4.06 The 5 percent sample, taken at random from all toll messages processed each day by a Revenue Accounting Office (RAO), does not result in an exact 5 percent sample for each traffic item. It is known that a 5 percent sample of the universe is obtained, but the actual sampling rate of each traffic item, which is part of that universe, is not known.

4.07 The variance from the 5 percent sample is greater for smaller traffic item samples. As the size of the traffic item sample increases, the vari-

ance from the overall 5 percent sample decreases. For example, if CMDS-TE recorded 20 messages for a traffic item in the busy hour over a 20-day study period, the expected 5 percent sample rate would result in 1 message a day or 20 messages total. However, the true sampling rate, stated as a confidence level, is:

With 98 percent assurance, for 20 CMDS-TE reported messages, the sampling rate will average from 2.5 to 7.8 percent, and messages will average from 10 to 31. This equates to as much as a 50 percent variance.

4.08 Table B provides low and high sampling rates, the low and high message range, and the variance for different amounts of CMDS-TE reported messages. It clearly illustrates that variance decreases appreciably as the sample size increases.

4.09 The same sampling rate variances apply to CMDS-TE recorded conversation CCS. However, conversation CCS are also affected by message length variabilities. The chance sampling of one or more unusually long messages, in an hour when usage is ordinarily low, can overstate the conversation CCS for that hour. And conversely, the chance sampling of unusually short messages, in an hour when usage is ordinarily high, can understate the conversation CCS for that hour. Again, as the number of messages for a traffic item increases, the average message length variability decreases.

4.10 The message length variability in conjunction with sampling rate variation makes determination of a traffic item's busy hour, by examination of conversation CCS values, unreliable, particularly for the smaller size traffic items. One extremely long message originated during the 10:00 pm hour may not be representative of the hour.

B. Faulty Measuring Equipment

4.11 It takes several pieces of equipment, depending on the type of measurement equipment in use and types of measurements desired, to obtain trunking data. Any measuring equipment that is operationally faulty can significantly distort the data or cause the loss of the data completely. Continual monitoring and analyzing of trunking data and the questioning of missing data will assure early referral of faulty measurement equipment.

C. Wiring and Translation Errors

4.12 A wiring or translation error is the result of connecting the wrong trunk or group of trunks

TABLE B
SAMPLING RATE AND MESSAGE VARIATIONS
OF CMDS-TE REPORTED MESSAGES
WITH 98 PERCENT ASSURANCE

5 PERCENT CMDS-TE REPORTED MESSAGES	SAMPLING RATE RANGE		SAMPLED MESSAGES RANGE		PERCENT VARIATION
	LOW	HIGH	LOW	HIGH	
20	2.5	7.8	10	31	50
50	3.3	6.7	33	67	34
80	3.6	6.4	58	102	28
110	3.8	6.1	84	133	24
140	4.0	6.0	112	168	20
170	4.1	5.9	140	202	18
200	4.2	5.8	169	232	15

to the wrong register or data collection device (DCD). It may also be the result of only a portion of the trunks in a trunk group being wired to the register or DCD. Errors of this type are usually recognizable by analyzation of the detector test. Section 780-401-210 provides detailed information on the detector test. However, if the wrong trunks connected are the same in quantity as the correct group of trunks, the detector test will not be of value. In either case, a review of traffic usage recorder (TUR) assignments or electronic switching system (ESS) translation table listings may be helpful in detecting wiring or translation errors. Section 780-401-210 provides more detailed information on the TUR.

D. Busy Hour-Busy Season Identification Error

4.13 Every in-service trunk group and traffic item has a particular hour of the day and season of the year, usually predictable, when it experiences the greatest usage. Understated trunking data may be the result of the inaccurate identification of a busy hour and/or a busy season. It is also possible for the accurately identified busy hour or busy season of a trunk group or traffic item to change.

4.14 Each year AT&T publishes a letter identifying system standard study periods for the collection of CMDS-TE and trunk group data. Each schedule, CMDS-TE data and trunk group data, is a minimum collection schedule. The schedule includes

three 20-day average business day (ABD) study periods that are the same for both CMDS-TE and trunk group data collection. While these preassigned study periods will not necessarily include the busy season for 100 percent of the trunk groups and traffic items, they do include the normal busy seasons and will usually encompass the busy season for most trunk groups and traffic items. Trunk servicers and forecasters should be alert for changes in the identified busy hour or busy season of trunk groups and traffic items. Section 780-401-120 provides more information about trunking data scheduling and the annual AT&T letter.

E. Data Collection Device Assignment Errors

4.15 Errors of this sort are very similar to wiring and translation errors, in that the assignment of the DCD does not agree with the actual physical wiring or translations entered for the trunk group being measured. Analyzation of DCD assignment errors are the same as for wiring/translation errors. See paragraph 4.12.

F. Routing Discrepancies

4.16 Errors from this source are a result of routing records that do not agree with the actual routing of a traffic item. This error may involve only an overflow load (see Fig. 1) or the entire carried load (see Fig. 2).

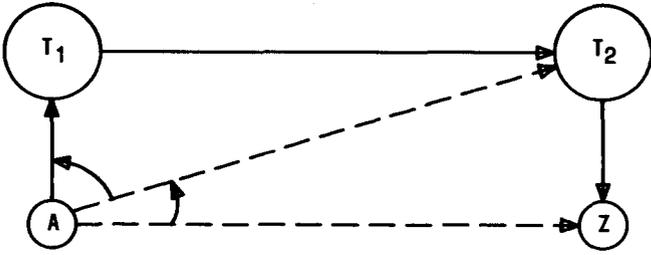


Fig. 1—Trunking Configuration 1

4.17 In Fig. 1, office A reaches office Z over a direct high-usage trunk group that overflows A to T₂. Routing records indicate that A to Z traffic overflows A to T₁.

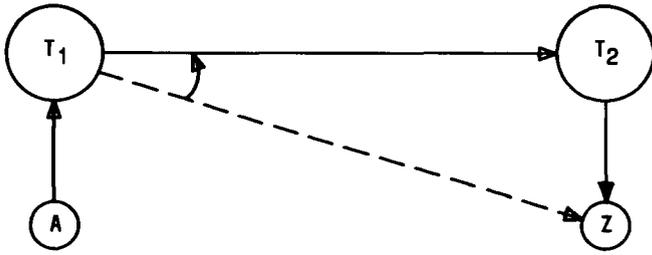


Fig. 2—Trunking Configuration 2

4.18 In Fig. 2, the A to Z traffic is completed A to T₁ to Z. Routing records indicate it completes A to T₁ to T₂ to Z.

4.19 In the case of Fig. 1, the network disassembly process will deduct the A to Z overflow from the A to T₁ load, resulting in an overstatement of the A to T₂ first routed traffic which should have been reduced and an understatement of the A to T₁ first routed traffic.

4.20 In the case presented in Fig. 2, should a direct A to Z route be planned, the trunk forecaster will erroneously deduct the base load, instead of overflow only, from the T₁ to T₂ and T₂ to Z groups, allowing for the predicted A to Z load completing direct. It could result in T₁ to Z being overtrunked, T₁ to T₂ and T₂ to Z being undertrunked.

G. Record Keeping Errors

4.21 Record keeping errors contribute significantly to unreliable data. Record keeping errors occur in numerous areas throughout the trunking data processing procedure. Some examples of these errors are demonstrated in wiring/translation errors, discussed in paragraph 4.12; DCD assignment errors, discussed in paragraph 4.15; and routing discrepancies, discussed in paragraphs 4.16 through 4.20.

4.22 It would be impossible to list all the areas where record keeping errors result in inaccurate trunking data. Some of the major areas, other than those stated above, include:

- (a) Inaccurate register reading and subtractions in a manual environment
- (b) Inaccurate recording of trunk group loads, eg, transposing digits or assigning a trunk group load to the wrong trunk group
- (c) Entering the wrong common language circuit identification (CLCI) in mechanized systems, eg, traffic class code
- (d) Entering other inaccurate information pertinent to a circuit group record, in mechanized systems, eg, alternate route identification, conversion codes, scheduler numbers, etc.

H. Processing Error

4.23 Error, attributable to processing, results when raw data is inaccurately adjusted to obtain trunk group loads. An example of this is:

- (a) Using holding times (HT) that are not representative to obtain a trunk group load, eg,

$$U = (PC - O)/100 \times HT$$

If usage is not available or is determined to be invalid for a study period, the formula above is often used to determine it. If the holding time is not representative, the usage derived will be overstated or understated. Holding times are also used in other formulas to replace missing data. The data derived from these formulas are only as valid as the validity of the holding time.

4.24 Another source of processing error is generated by a message timing adjustment made to

conversation minutes by the toll billing operations in each operating telephone company prior to sending the 5 percent sample to Kansas City. Each conversation interval is:

- (a) Rounded down to adjust for equipment operation time that may be included.
- (b) Then rounded up or down for customer billing:
 - (1) Customer dialed and operator serviced calls are rounded up to the next whole minute.
 - (2) Operator handled calls are:
 - Rounded down to the whole minute just passed when timing is less than 15 seconds past the whole minute
 - Rounded up to the next whole minute when timing is 15 seconds or more past the whole minute.

4.25 After transmittal to Kansas City, the CMDS-TE process accumulates each message, makes a downward adjustment of billed minutes for each traffic item, and converts the conversation time to CCS. These adjustments result in conversation CCS which, on the average, represent the actual conversation times associated with all sampled messages for a traffic item.

4.26 Conversation intervals just past the whole minute normally compensate for the conversation intervals near the next whole minute. Therefore, it should not be necessary to make any compensatory adjustment. However, because average values are used, the upward/downward adjustment by the Bell Operating Companies (BOCs) and the downward adjustment by the CMDS-TE process may result in some bias from this source.

I. Conversion Error

4.27 Error associated with conversion is inherent in CMDS-TE conversation CCS if non-conversation seconds per message have been improperly identified. Section 780-401-320 discusses the makeup of nonconversation time and methods of selecting and confirming the applied values.

4.28 Service Evaluation System (SES) observations are normally the basis for determining

average nonconversation times per category (customer dialed, operator serviced, operator handled). Once established, these values remain somewhat constant; however, periodic studies should be taken to assure that the nonconversation values are as accurate as possible.

J. Excessive Maintenance

4.29 Maintenance usage, the measurement of trunk occupancy time expended for outages and repair, may or may not be included as part of the total trunk usage. Section 780-401-210 discusses maintenance usage and provides a chart by end office equipment type of maintenance usage inclusion.

4.30 Trunk outages are to be expected and maintenance time should normally be included in trunk group usage. However, maintenance that is excessive will inflate usage proportionately. The validation process should identify overstated trunk group usage caused by excessive maintenance. The characteristics and history of individual trunk groups should dictate what is considered excessive maintenance for the group. Once identified, no adjustments should be made to the data on those groups. Inflated maintenance makes the data invalid. It should be discarded.

K. Validation Processing Error

4.31 Discrepancies from this source are a result of erroneous influences between data registration and receipt that are not detected during the validation process. Most mechanized systems conduct some type of basic validation tests, eg, overflow that is greater than peg count or usage greater than the trunks in service times 36. However, ultimately, the user is responsible for the validation process.

4.32 The basic data validation checks include:

- (a) Overflow should not exceed peg count.
- (b) Usage should not exceed 36 CCS times the number of trunks in service.
- (c) If peg count is less than the number of trunks in service, overflow should be zero, assuming there are no trunks on make busy.

4.33 The most valuable validation tool is a trunk group history file including busy hour, busy

season, holding time, usage, peg count, overflow, trunks in service, trunks required, any data adjustments made, and the reason. A 3-year history for a trunk group is usually sufficient to detect invalid data.

4.34 Comparison of trunk group data with the component traffic item data from the CMDS-TE is often a useful validation tool. Section 780-401-320 discusses the limitations of comparing trunk group data with CMDS-TE data.

4.35 Another data validation tool that may be useful on a limited basis is comparing the data of two trunk groups having similar characteristics and influenced by the same community of interest. Caution must be observed in making such comparisons:

- (a) Both trunk groups should be of the same type
- (b) They should serve the same general business/residence split ratio
- (c) Compared data must be from the same study period and study hour
- (d) Both trunk groups should terminate at the same end office or tandem.

L. Rerouted Traffic Errors

4.36 Errors from this source result when traffic has been rerouted by Network Management. Alternate routing is automatic within tandem switching systems and causes no distortion of data in that the primary route, and first and second alternate routes are as anticipated. However, on occasion, Network Management personnel, because of a network emergency, overrides normal traffic routing and sends traffic via other paths. These overrides inflate data for some trunk groups while reducing the data for other trunk groups. It is important that close communication is maintained with Network Management personnel and a system established to receive notification of the overrides of normal traffic routing.

M. Network Disassembly-Assembly Processing Error

4.37 Error introduced through the network disassembly-assembly process is inherent in mech-

anized or manual forecasting systems using trunk group alternate routes (TGARs) in a multistage alternate routing network and defaulting to zero a first route load that is negative after the disassembly process. Because of the inherent measurement error introduced by using TGARs, a negative value, as apposed to a zero value, first route load may be more accurate.

4.38 Network disassembly takes measurements of offered loads (either trunk group or traffic item) and overflows and, beginning at the top of the network hierarchy, removes overflow (disassembles) until only first-route loads remain. Removing overflow loads requires a knowledge of the alternate route taken by blocked calls. The alternate route can be calculated using traffic item alternate route (TIAR) or, at the risk of possible error, using the trunk group alternate route. The Trunk Forecasting System uses trunk group alternate routes.

4.39 After first-route loads are calculated, they are then projected. Assembly, beginning at the base of the network hierarchy, takes the projected first-route loads, computes overflow, and adds it back onto the groups to yield their forecasted offered load for some future period(s).

4.40 Figure 3 illustrates a simplified multistage alternate route network.

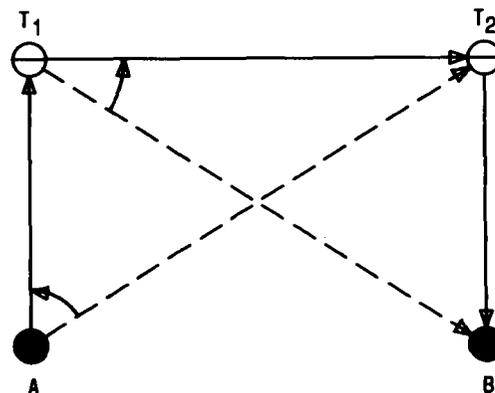


Fig. 3—Trunking Configuration 3

A call from A to B, blocked A to T_2 will alternate route A- T_1 -B (the TIAR). The TGAR is A- T_1 - T_2 -B. That is, the alternate route of the trunk group A to T_2 is A- T_1 - T_2 . Using TGARs in the assembly process could possibly overstate the T_1 - T_2 and T_2 -B trunk groups. Elimination of the first route load nonnegative constraint, coupled with accurate traffic descriptions (smooth versus random), could reduce the magnitude of error in the disassembly—assembly process.

N. Unexpected, External Events

4.41 The data validator must be alert to any outside events that influence data. Among these events are:

- Tornadoes/hurricanes
- Earthquakes
- Severe floods
- Local emergencies, eg, fires, riots.

4.42 Trunking data subjected to any major outside influence is usually distorted to the degree that the user should disregard it and delete it from the data base.

4.43 Data influenced by a severe storm is debatable as to its validity. If the area is subject to severe storms, eg, snow, and the storm is not much more severe than usual, the resultant trunking data should probably be considered valid. In each case,

local decisions must be made to use or disregard the data.

5. POINT-TO-POINT DATA VERSUS TRUNK GROUP DATA

5.01 Networks in today's mechanized systems are usually engineered with only one type of load data, either point-to-point or trunk group. If only one type of data can be the predominant source, a consideration is whether one or the other type is preferable. However, the crucial issue is not the type of data used but how to use both types effectively.

5.02 The choice of an engineering method for a trunk group is highly dependent upon the stability of the network, that is, the amount of load rerouted from the base year. Networks with a reroute fraction less than 25 percent by the third forecast year are considered stable. Moderately unstable networks reroute up to 45 percent of their traffic by the third forecast year. Rerouting over 45 percent is considered highly unstable.

5.03 Trunk groups in stable networks can usually be engineered using trunk group data. Point-to-point data is usually better for engineering new groups and reroutes. Point-to-point data, supplemented, for selected groups, by trunk group data, are usually better for engineering unstable networks. Sound engineering judgment must be exercised in determining which type of data should be used for each trunk group.