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ITU-T

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SERIES E: OVERALL NETWORK OPERATION, TELEPHONE SERVICE, SERVICE OPERATION AND HUMAN FACTORS

Quality of service, network management and traffic engineering – Network management – Checking the quality of the international telephone service

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Comparative metrics for network performance management

ITU-T Recommendation E.437

(Previously CCITT Recommendation)

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ITU-T RECOMMENDATION E.437

COMPARATIVE METRICS FOR NETWORK PERFORMANCE MANAGEMENT

Summary

This Recommendation defines the metrics which can be employed as comparative measures in comparing the performance of different routes to common destinations as well as in assessing the effectiveness of services being offered on direct or alternative routings.

Source

ITU-T Recommendation E.437 was prepared by ITU-T Study Group 2 (1997-2000) and was approved under the WTSC Resolution No. 1 procedure on the 10th of May 1999.

FOREWORD

ITU (International Telecommunication Union) is the United Nations Specialized Agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of the ITU. The ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Conference (WTSC), which meets every four years, establishes the topics for study by the ITU-T Study Groups which, in their turn, produce Recommendations on these topics.

The approval of Recommendations by the Members of the ITU-T is covered by the procedure laid down in WTSC Resolution No. 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation the term *recognized operating agency (ROA)* includes any individual, company, corporation or governmental organization that operates a public correspondence service. The terms *Administration, ROA* and *public correspondence* are defined in the *Constitution of the ITU (Geneva, 1992)*.

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As of the date of approval of this Recommendation, the ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

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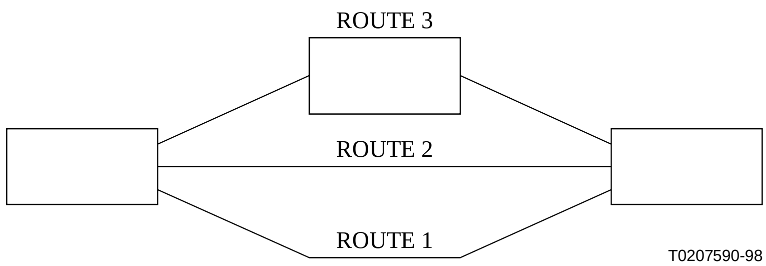
COMPARATIVE METRICS FOR NETWORK PERFORMANCE MANAGEMENT

(Geneva, 1999)

1 Introduction

Modern international networks have evolved from point-to-point networks with single routes interconnecting ROAs of different countries to more complex networks with multiple routes between countries. The number of interconnections between countries has increased due to growth in the number of ROAs, the ability to transit calls through intermediate countries, and an increase in the flexibility in routing mechanisms supported by modern switching equipment. This is illustrated by the following figure where we see three routes between two countries. In this example, two routes are direct routes, which may use the same or different technology, and the third is a non-direct or transit route.



Where there are multiple routes to a country, the performance of each of the routes contributes to the quality of service as observed by users, and the performance of each route must be managed. Performance management on such complex networks can be a difficult and expensive task that can be simplified by managing performance on a comparative rather than absolute basis. When managing performance on a comparative basis, an ROA would select one route to a destination as a reference route and establish performance objectives for other routes to that destination based on the performance of the reference route.

Most metrics currently in use can be used in either an absolute or comparative manner. For example, it is not unusual for ROAs to measure post dial delay (PDD) and compare the results against some absolute performance target. It is also possible to measure PDD on multiple routes and use the result in a comparative manner. Other widely used metrics such as answer seizure ratio, facsimile call cutoff ratio, etc. can also be used in both ways. Network effectiveness ratio (NER) is typically used in an absolute manner. NER could also be used in a comparative manner provided that there is sufficient visibility into the designs of the networks involved. This may be especially difficult when multiple networks are used to deliver calls to the destination point.

The metrics defined in this Recommendation are defined as comparative measures. Because these measures are heavily influenced by customer behaviour, they should not be used as absolute measures unless there is a significant quantitative understanding of customer behaviour including long-term trends and seasonal changes.

Network performance and quality of service metrics for telephone service can be categorized as pertaining to connectivity (i.e. the ability to establish a connection) and call clarity. As shown in the following table, pertinent metrics can be measured either by intrusive means or by non-intrusive methods such as call detail records or special monitoring devices.

	Intrusive measures	**Non-intrusive measures**
Connection establishment	Call success ratio Post dialling delay	ASR, ABR, NER PGAD (new metric)
Call clarity	Loss, noise, etc.	Parameters defined in Recommendation P.561 ALOC (new metric)

This Recommendation introduces two new metrics: PGAD and ALOC. PGAD is useful as an alternative to PDD when comparing the performance of multiple routes to common destinations and in similar fashion ALOC is a useful indicator of relative call clarity as well as other quality of service factors.

2 References

The following Recommendations contain material that is either relevant to or provides background for this Recommendation:

– ITU-T Recommendation E.425 (1998), *Internal automatic observations*.

– CCITT Recommendation E.431 (1992), *Service quality assessment for connection set-up and release delays***.**

– ITU-T Recommendation E.450 (1998), *Facsimile quality of service on Public networks – General aspects*.

– ITU-T Recommendation P.561 (1996), *In-service non intrusive measurement device – Voice service measurements.*

3 Comparative metrics

3.1 Answer seizure ratio (ASR)

The ability to complete calls is perhaps the one of the most important measures of network performance, and ASR has long been used to indicate such. As defined in Recommendation E.425, ASR gives the relationship between the number of seizures that result in an answer signal and the total number of seizures. This is a direct measure of the effectiveness of the service being offered and is usually expressed as a percentage as follows:

$$ASR = \frac{\text{Seizures resulting in answer signal}}{\text{Total seizures}} \times 100$$

Typically, ASR data is gathered from switch call detail records (CDRs) and for international networks is based on the seizure of an international trunk. Many factors impact the ASR on a specific network. Network factors include signalling failures and network congestion beyond the international network. Customer behaviour also impacts ASR. Customer-related attributes such as frequency of subscriber busy, the penetration of automatic answering devices impacting the rate of ring-no-answer, and dialling behaviour impact ASR.

ASR is useful as a comparative metric. When examining the performance of multiple routes to common destinations, any difference in ASR should be attributed directly to the networks involved. Care must be taken to ensure that proper comparisons are conducted as described in clause 5 (Remarks).

3.2 Post gateway answer delay (PGAD)

The speed with which a network responds to a user who is requesting that a connection be established is an important quality factor that is readily discernible by customers. Recommendation E.431 (Service quality assessment for connection set-up and release delays) defines three relevant time intervals: start dial signal delay, post dialling delay and call clearing delay. Of these, post dialling delay (PDD) provides a view of the time it takes networks to establish connections after the customer has completed dialling the destination address. PDD is most often measured on an end-to-end basis, requiring test equipment be placed at call originating and terminating points. PDD may also be measured by the observation of appropriate signalling messages within networks. A metric that allows call set-up time on multiple routes to the same destination to be compared would provide a cost efficient method of assessing the quality on those routes. Post gateway answer delay (PGAD) is such a metric.

PGAD is defined for calls that are answered as follows:

- PGAD is the time interval between the seizure of the international circuit and the receipt of answer supervision.

Within this interval, the time between the seizure and the first network response is a function of the performance of the network, while the time between the network response and the answer is user driven. When looked at for a single route, PGAD would not be terribly useful. However, when comparing two routes with large and carefully selected data samples, there should be no significant difference in customer behaviour between the two routes and any significant difference in PGAD could be attributed to the networks involved. PGAD, and its relationship to PDD is illustrated in Figure 1.

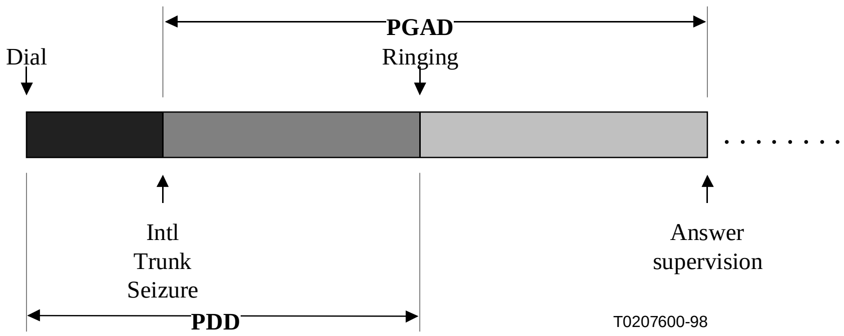


Figure 1/E.437

3.3 Average length of conversation (ALOC)

Another parameter that provides useful data on a comparative basis is average length of conversation (ALOC) for completed calls. When comparing routes to the same destination, where each route carries a portion of a common traffic stream, it should be expected that average conversation times on each route would be comparable. A statistically significant difference in ALOC between two routes could be considered as an indication of some irregularity warranting further investigation.

ALOC is measured for completed calls only. Preferably, ALOC should be measured from the time of answer-supervision to the time of call release. If measurement systems do not support this, ALOC may be measured from the time of trunk seizure. In this case, call set-up time is included in the measure and variations in the call set-up time could have an influence on ALOC. However, because call set-up time is typically small compared to conversation time, any error introduced should be small. Regardless of where the ALOC measurement interval begins, all routes being measured should be measured the same way.

Several factors could impact ALOC. A route that is subjected to an increased level in network-caused call cut-offs would have a lower ALOC than the reference route. The same would hold true if there was a greater frequency of facsimile transaction failures. The use of double-hop satellite or tandem compression equipment on a route may reduce voice transmission quality that could lead to a reduction in ALOC. Signalling-related problems and numbering plan changes could lead to short holding time calls that would impact ALOC. Additional factors other than those indicated here could result in a difference in ALOC between two routes.

Care must be taken to ensure that proper comparisons are conducted as described in clause 5 (Remarks).

4 Statistical comparisons

A typical application of PGAD and ALOC data would involve comparing the mean value for the metric obtained for one route against the mean value obtained for the baseline route. When doing such comparisons, it is important to employ some statistical mechanisms to determine if any observed difference is statistically significant. Factors affecting the significance between two sample means include the dispersion or distribution of the samples used to compute the mean along with the number of samples obtained.

The formula given below is an example of how statistical methods could be applied to PGAD data. In this example, we want to test if the PGAD on one route exceeds that of a baseline route by some factor. A one tailed test is performed to test this comparison to a 95% confidence level.

P_A = Mean PGAD for route under study (for one measurement interval)

P_B = Mean PGAD for baseline route (for one measurement interval)

σ_A = Standard deviation of PGAD for route under study

σ_B = Standard deviation of PGAD for baseline route

N_A = Number of calls on route under study

N_B = Number of calls on baseline route

If D exceeds some value (X), then it can be said that with 95% confidence, the PGAD on the route under study exceeds that of the baseline route by X seconds.

NOTE – If standard deviation is not available, then a value of one half the mean value may be used as a conservative estimate.

$$D = (P_A - P_B) - 1.645 \times \sqrt{\frac{(\sigma_A)^2}{N_A} + \frac{(\sigma_B)^2}{N_B}}$$

5 Remarks

Unless otherwise noted, the following remarks apply to all metrics used in a comparative manner.

1) When using any comparative measure, care must be taken so that the routes being compared carry identical mixtures of services and serve the same completing fields.

2) Comparative measures are useful when comparing multiple routes to the same destinations. Routing mechanisms such as code or carrier specific routing must be taken into account when comparing the performance of multiple routes.

3) Data for comparative measures may be obtainable from switch call detail records. This method of data collection as well as the collection of data from other suitable network monitoring sources is often very efficient, providing large samples at relatively low incremental cost.

4) Sample sizes must be sufficiently large to ensure statistical integrity of the data.

5) Statistical means to test the significance of any difference in any comparative measure between different routes must be used. The availability of the appropriate measures of central tendency and dispersion along with the corresponding standard error estimates is desirable.

6) When a significant difference in ALOC is identified, detailed analysis should be undertaken to determine the root cause so that corrective action can be taken.

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