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TWO CISCO METHODS FOR OFFERED TRAFFIC EVALUATION – ANALYSIS AND NUMERICAL COMPARISON

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Abstract:

The aim of the research is comparison between two actual Cisco methods, for offered traffic evaluation. A numerical comparison is made, based on an overall network traffic model, with detailed users' behavior consideration. The received results show considerable difference between the two methods. They are applicable in dimensioning and redimensioning process of every telecommunication network, working in (virtual) circuit switching mode.

Keywords*: Offered Traffic, Virtual Circuits Switching.*

1. Introduction

In Teletraffic engineering, especially network dimensioning/ redimensioning in telecommunication system, different offered traffic definitions and calculation methods are used. Cisco offers offered traffic definitions and methods also. They are derived under different assumptions and are based on different structures and are corresponding with ITU offered traffic definitions. [1], [2]

The aim of this paper is to present two methods for offered traffic calculation, recommended and used by Cisco and to compare them

numerically. Task of the study is to derive analytical mathematical formulas based on the different reconstructions of Cisco conceptual models. A numerical comparison method used is based on an overall network traffic model, with detailed users' behavior consideration. [8], [9], [10], [11] The obtained numerical simulation results after the work of operating communication network from the application of two methods of offered traffic evaluation are compared.
Conceptual Cisco Models considered are concerning a communication system for transmission of voice data.

2. CISCO Conceptual Model Reconstruction

Various traffic analysis concepts and features that are applicable to Voice over IP (VoIP) in [4], [6] and [7] are considered.

CISCO recommended the following formula to calculate offered load from carried load:

$$\text{Offered load} = \frac{\text{carried load}}{\text{1.0 - blocking factor}}$$

It is denoted [4] that this formula does not take into account repeated calling rate in case when a caller is blocked. In Cisco conceptual model [4] the following formula to take the retry rate into account:

$$\text{Offered load} = \text{carried load} \,.\, \text{OAF}$$

$$\text{OAF} = \frac{\text{1.0 - R} \,.\, \text{blocking factor}}{\text{1.0 - blocking factor}},$$

where R is a probability of retry calls and OAF is Offered Load Adjustment Factors. For example, R = 0.6 for a 60 percent retry rate is recommended.

In [6] and [7] Extended Erlang B traffic model is indicated as an accurate method for determining the number of external voice lines (PSTN and WAN) required for an office dimensioning. There are several variants of the Erlang model, depending on the intended telephone use in the branch office. The Extended Erlang B traffic model takes into account the additional traffic load caused by blocked callers that immediately try to call again if their calls are blocked.

Parameters used and them notations in the paper

Letter *P* represents a probability for directing the calls of the external flow to the device considered, *F* is calling rate (frequency) of the flow [calls/s], *Y* denotes intensity of the device traffic [Erl], *N* is a number of service places (lines, servers) in the virtual device (capacity of the device).

For characterizing the intensity of the flow, we introduce the following notations: *inc.F* for incoming flow, *dem.F*, *rep.F*, *ofr.F*, *blc.F*, *crr.F* and *trm.F* for demand, repeated, offered, blocked, carried and terminated (abandoned calls) flows respectively. [8] When the calling rate is connected with switching stage then in the notations a subscript "s" is used. The same characterization is used for traffic intensity (*Y*). The probability of blocking switching *Pbs* due to lack of resources and the probability of blocking ringing *Pbr* when B-terminal is "busy" are used.

Conceptual Cisco Model Reconstruction

In [4] has not graphically shown conceptual model. Based on the statement in the papers [5], [6], [7] and lack of conceptual model, we made Cisco 1 and 2 conceptual model reconstructions (*Fig.1.* and *Fig.2.*)

Cisco 1 (First Cisco Method)

The following important virtual devices on *Fig.1* are shown and considered: flow intensity (calling rate) of offered ($ofr.Fs$), blocked ($blc.Fs$), carried ($crr.Fs$), and abandoned ($trm.Fs$), respectively.

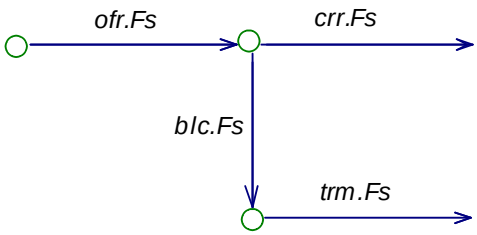

Fig. 1*. Cisco 1 Conceptual Model Reconstruction.*

Cisco 1 researches this case when the blocking attempts are not reduced in repeated bids and then they leave the system directly. The offered traffic calling rate ($ofr.Fs$) with probability Pbs will be reduced in blocking flow ($blc.Fs$) and with probability $1-Pbs$ will continue as carried calling rate ($crr.Fs$).

Cisco 2 (Second Cisco Method) researches this case when the blocking attempts are reduced in repeated bids.

On *Fig.2* switching stage is shown. Both demand calling rate ($dem.Fs$) and the repeated calls ($rep.Fs$) as offered flow ($ofr.Fs$) are transformed.

The offered traffic calling rate ($ofr.Fs$) with probability Pbs will be reduced in blocking flow ($blc.Fs$) and with probability $1-Pbs$ will continue as carried calling rate ($crr.Fs$). Concerning the blocking attempts with probability *R* can transform into repeated calls and to extend the offered

traffic respectively or with probability $1-R$ abandon the communication system.

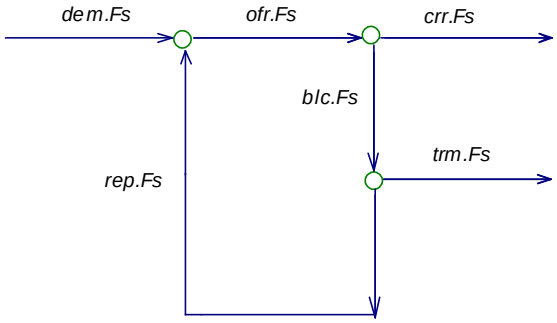

Fig. 2*. Cisco 2 Conceptual Model Reconstruction.*

3. Cisco Analytical Models

There are two Cisco Methods concerning traffic offered estimation and two different methods about finding necessary number of switching lines, respectively. The methods are based on the definitions and methods considered in ITU Recommendations (E.501 and E.600) and estimation of $eofr.Ys$ so called “equivalent” offered traffic intensity (as in ITU Recommendation E.501). [2], [1]

Finding $ofr.Ys$ on Basis of easy measurable Data

Easy measurable data in the network considered are carried traffic intensity, probability of blockage and some others.

Task Formulation: Based on measured carried traffic intensity $crr.Ys$ and blocking probability Pbs, find the expression of traffic offered intensity ($ofr.Ys$).

Known parameters’ values: $crr.Ys$, Pbs, Ts

First Method (Cisco 1)

Based on the Cisco 1 Conceptual Model Reconstruction (*Fig.1*) and dependencies between the parameters we receive the follow Cisco 1 Analytical Model:

$$ofr.Fs = crr.Fs + blc.Fs \tag{3.1}$$

$$blc.Fs = Pbs\ ofr.Fs \tag{3.2}$$

$$ofr.Ys = eofr.Ys = ofr.Fs\ Ts \tag{3.3}$$

$$(1-Pbs)\ ofr.Fs = crr.Fs \tag{3.4}$$

$$crr.Ys = crr.Fs\ Ts \tag{3.5}$$

Therefore from (3.1) and (3.2) follows

$$ofr.Fs = \frac{crr.Fs}{1-Pbs}.$$

From (3.3) and (3.5) follows

$$ofr.Ys = \frac{crr.Ys}{1-Pbs}$$

The result corresponds to formulae (5-1) and (5-2) about equivalent traffic offered estimation in [E.501, 1997] and (3.1) in [4].

Second Method (Cisco 2) is built basically based on E.600 definitions, the Cisco 2 Conceptual Model Reconstruction, the dependencies in the telecommunication system and the denotation used. Te follow analytical model is received:

$$dem.Fs + rep.Fs = ofr.Fs \tag{3.6}$$

$$ofr.Fs = crr.Fs + blc.Fs \tag{3.7}$$

$$trm.Fs + rep.Fs = blc.Fs \tag{3.8}$$

$$crr.Fs = (1-Pbs)\ ofr.Fs \tag{3.9}$$

$$ofr.Ys = eofr.Ys = dem.Fs\ Ts \tag{3.10}$$

$$blc.Fs = Pbs\ ofr.Fs \tag{3.11}$$

$$trm.Fs = (1-R)\ blc.Fs \tag{3.12}$$

$$rep.Fs = R\ \ blc.Fs \tag{3.13}$$

$$crr.Ys = crr.Fs\ Ts \tag{3.14}$$

If there is blockage (respectively retry rate) the second Cisco 2 Method (e.g. $rep.Fs \neq 0$) has follow analytical model corresponding to Cisco 2 conceptual model reconstruction (*Fig. 2*):
From (3.13) and (3.11) follows

$$rep.Fs = R\ Pbs\ \ ofr.Fs$$

From the expression above about $rep.Fs$ and (3.6) follows

$$dem.Fs = ofr.Fs - rep.Fs = (1 - R\ Pbs)\ ofr.Ys \tag{3.15}$$

Based on (3.9) and (3.15) follows

$$dem.Fs = (1-RPbs)\frac{crr.Fs}{1-Pbs} \tag{3.16}.$$

Applying (3.14) and (3.10) in (3.16) follows

$$ofr.Ys = \frac{1 - R\,Pbs}{1 - Pbs} crr.Ys \tag{3.17}$$

The result corresponds to formulae (4-1) about equivalent traffic offered estimation in [2] and (3.2) in [4]. Being R a percentage of retry probability retry rate R = 60 % is recommended. [4]

In case, when there is no blockage (respectively no retry rate, e.g. Pbs=0 и R=0), then Cisco 1 Method regarding traffic offered estimation coincide with Cisco 2 Method and with the First ITU-Method [2] also. Then traffic offered will equal traffic carried measured according to Recommendation E.500. [3]

Consequence: On basis of easy measurable parameters $crr.Ys$ and $emp.Pbs$, the values of offered traffic intensity $ofr.Ys$ are

$$emp.ofr.Ys = \frac{emp.crr.Ys}{1 - emp.Pbs} \text{ based on Cisco 1 and} \tag{3.18}$$

$$emp.ofr.Ys = \frac{1 - R\,emp.Pbs}{1 - emp.Pbs} emp.crr.Ys \text{ based on Cisco 2 respectively.} \tag{3.19}$$

4. Numerical results

Numerical results are based on an overall network traffic model, worked in [8], [9], [10], [11], with detailed users' behavior consideration. Numerical values of the parameters, discussed in [9], are used. A computer program is made. The numerical results obtained from the application of two methods of offered traffic evaluation after simulation of the worked operating communication network, are compared.

On the graphics of the *Fig.3* is shown:

1) When system load is less than *Yab*/Nab* = 39,2 % then difference between offered traffic intensity $ofr.Ys / Nab$ through Cisco 1 and Cisco 2 evaluated is close to 0.
2) Maximal difference between is 32,35 % when system load is *Yab/Nab*=72,43 %.

5. Conclusions

Conceptual Model Reconstruction of Cisco 1 and Cisco 2 are made and their corresponding analytical models are worked out also.

Offered traffic intensity $ofr.Ys/Nab$ through Cisco 1 and Cisco 2 Methods in the whole theoretical interval are evaluated. The first method doesn't take into consideration the repeated calls influence but the second - take them into account.

The offered traffic intensity values evaluated through Cisco 1 and Cisco 2 Methods are not coinciding in the whole theoretical interval.

Difference between Cisco 1 and 2 offered traffic calculation is based on two different ITU offered traffic definitions (ITU E.600 and equivalent offered traffic definition in ITU E.501).[1], [2]

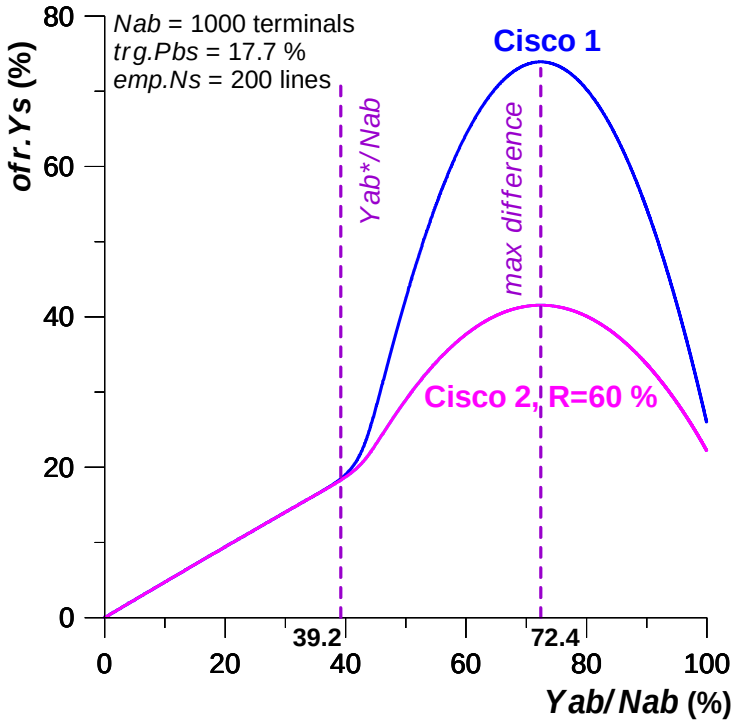

Fig.3. The offered traffic intensity $ofr.Ys/Nab$ through Cisco 1 and Cisco 2 methods considered evaluated, where Nab is number of all terminals in the system and Yab/Nab is system load regarding 1 terminal.

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