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Introduction

Dial-up access is one of the two primary ways users can access remote systems from micros or terminals. The "black boxes" providing this function are usually referred to as terminal servers, though the terms access servers, dial-up servers, modem pools, and modem groups are also often used. Here, initial research on the demands on a terminal server in a university is presented.

The Northeast Regional Data Center (NERDC), a computer utility at the University of Florida, currently operates two terminal server groups. One is designed primarily for students. It is known as the UF Personal Terminal Server (PTS). The second is known as the NERDC Terminal Server, or NTS. It can be used by any individual or organization having a formal affiliation with the State University System of Florida or the University of Florida. Only the NTS is considered in here. A user can connect graphically or in character mode. The graphics mode is provided by Point to Point Protocol (PPP) or Serial Line Internet Protocol (SLIP). The character mode permits the use of terminal emulators such as Kermit. Details can be found at http://nervm.nerdc.ufl.edu/cgi.bin/catosdoc.html

?D00065 on the Web. An access path exists when the user's session is connected through the NTS to an ethernet hub.

Access is controlled via userID's and passwords and an account not locked due to a negative balance. When connected in PPP/SLIP mode, users are charged $.01 per minute for local calls or $.20/minute for calls to an 800 number. Sessions in character mode are charged for specific service resources, e.g., CPU time, disk I/O, etc. When a session ends, data on it is passed from the individual server over an ethernet connection to another processor where charge records are created. This charge record is used to update the user's account balance. The major components of the NTS are in Figure 1; in each component box is an estimate of the percent of the location of failures given by the engineer in charge in the NTS and PTS. (Fig. 1)

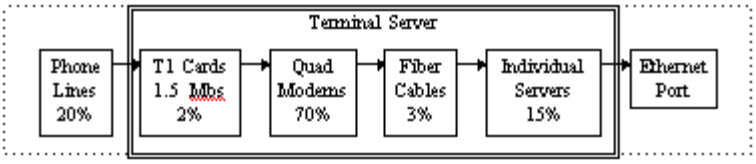
Aggregate Demands & Capacity

The NTS has experienced a very large growth in demand. From April '95 through March '96 total sessions increased 4.05 times to 105,492 (13.5%/month), total connect time increased 2.64 times to 2.76 million minutes (9.2%/month) , and unique userID's increased 2.34 times to 2,855 (8.1%/month). Capacity during this time period increased from 86 lines in April '95 to 200 lines in March '96. Details are shown in http://nervm.nerdc.ufl.edu/~dicke/

ts/tsuse.html#sumdata.

The data center considered a number of policy alternatives for the NTS service. The following was adopted for study of NTS demands and its costs: the terminal server should not have all lines busy for one contiguous minute or more. Dialing scripts with a 25 - 30 second cycle with 3 tries are recommended to users.

Figure 1: NERDC Terminal Servers



Under normal conditions, then, all users can always get a connection. This policy provided one of the focuses for this initial study on the components of demand growth. They are userID growth, sessions per userID, and the length of sessions. This initial work also includes source of funding.

The tentative results show here cover various periods ending either March '96 or April '96. An upgrade of the processor creating charge records result in the loss of all charge records for 6 days in April '96. The presentation at the AIS meetings in Phoenix will include data through June '96 or July '96 if possible.

UserID Growth

There appears to be large volatility in the use of the NTS by userID. Here the current academic year is included covering August '95 through March '95. The average month included 2,257 unique userID's. The average reflects 438.1 new userID's that were not used in the prior month, +19.4%. The average also reflects 276.4 userID's that were used in the prior month but not in the current month, -12.2%. Hence, the average monthly change was a net increase of 161.7 userID's, +7.2%. This analysis of participation will be expanded to cover all months sequentially.

Average session times are similar on this dimension with new users averaging 24.5 minutes the current month, those idle the current month averaged 24.2 minutes their prior month, while the average use of all was 26.5 minutes. The number of sessions shows major differences. New users averaged 14.5 sessions/month, those idle averaged only 7.5 sessions the prior month, while all users averaged 31.7 sessions/month. Details can be seen in http://nervm.nerdc.ufl. edu/~dicke/ts/tsuse.html#userid.

Session Variability

Low-level users differ dramatically from high-level NTS users. Table 1 shows 10 classes of users where classes are defined as hours per month. The average sessions/user and minutes/session are for the 8 months August '95 through March '96. The distributions for August '95 and March '96 are shown to illustrate the shift in usage patterns. Only PPP or SLIP sessions are included here, and sessions of the data center's employees are excluded. (Table 1)

A Class 1 user added 5.0 x 8.4 = 42 minutes, or .7 demand hours on average in a month. A Class 10 user added 92.6 hours, 132 times more demand than a Class 1 user. And, all Class 10 users added 16.4 times more demand than all Class 1 users given the percentages in the two classes August '95 through March '96! Similar relationships exist across almost all classes in Figure 2: the interaction of sessions per user and minutes per session was greater than the effect on demand of the percent of total users. This suggested the need to identify how new users would contribute to NTS demands via the sequential monthly analysis of userID's noted above.

There was a shift through time to more demand per user. Average hours per user increased 27 percent to 15.7 per month. The proportion of Class 1 and 2 users dropped from 51.2 percent to 36.9 percent over the 8 months while the proportion with 60 or more hours per month increased from 6.6 percent to 9.1 percent. This suggested the need to identify demand shifts through time by existing users.

Demand Variations by Funding

Initial analysis of NTS demands by users classified by their funding type suggests some systematic variations. Table 2 shows averages for users per month, number of sessions, and session length from August '95 through April '96. Included are 689,945 local sessions charged at $.01/minute. (Table 2)

Users of private funds and internal, i.e., from the UF, research funds had very similar use patterns. About one session per day and 26 minutes/session. The administration use session average corresponded to typical work days in a month and had the longest session average. These results suggest analysis of work patterns by days of weeks and hours of days is required to estimate the effects of additional administrative users on NTS demands.

Peak Load Analyses

Usage by hour and day of week in March '96 averaged 64.3 of the 200 local lines. In this measure, one 60-minute session was included as 1 used line while a 15 minute session was .25 of a used line. The lowest average hour was Tuesday 5 - 6 a.m. at 10.1 used lines. The busiest hour of a week day in March '96 was Tuesday 10 - 11 p.m. at 127.1 used lines. The 10 - 11 p.m. hour was busiest every day except Sunday which was busiest 11 p.m. to midnight. The busiest single hour in March '96 was 10 - 11 p.m. on Monday, the 18th, with 139.6 used lines.

Using similar measures, the busiest minutes in a time period can be found. The busiest minute in the prior three months (as of this writing) were as follows:

Feb 26 at 10:56pm: 145.4 Lines

Mar 18 at 10:38pm: 149.5 Lines

Apr 10 at 10:54pm: 151.2 Lines

However the true busiest minute in April could have occurred in the 6 days when all charge records were lost.

Further demand analyses of new vs. existing userID's, the shift through time to more longer sessions, and differences in funding will attempt to find whether systematic differences exist in or off peak periods. For example, if the administration funded uses tend to occur during 8 - 5 work days, a major increase in these users might not have any effect on the NTS peak load. Similarly, if research funded use is mostly at night -- because the individuals have network access from UF offices -- a modest increase in these users or their session patterns could significantly affect the NTS peak load.

Estimates of used lines per minute per day will be used to predict when existing capacity will not be adequate to meet the service level policy. Added to this demand side analysis will be a supply-side history of the number of individual lines not available for technical reasons. The current estimate is 3 "busied out" lines during the heavy-used evening hours. The demand and supply side estimates will be used to forecast when new capacity should be brought on line. This will permit purchase-install-test cycles for new NTS capacity consistent with the center's service level policy.

Table 1: NTS Users by Connect Hours Per Month

Class:	1	2	3	4	5	6	7	8	9	10	.
Hours:	0-2	2-5	5-10	10-17	17-20	20-25	25-33	33-60	60-90	90&UP	Means
Average:	5.0	14.9	25.5	38.5	48.8	52.3	62.3	70.6	80.6	107.9	31.5

Sess/User											
Min/Sess	8.4	13.5	17.1	20.3	22.4	25.6	27.8	30.9	36.1	51.5	26.3
Percent of Users:											Hours/ Month
Aug 95	33.7%	17.5%	16.0%	11.0%	3.4%	4.6%	4.6%	2.7%	3.6%	3.0%	12.4
Aug-Mar	25.8%	16.5%	17.0%	13.6%	5.0%	5.3%	5.9%	3.1%	4.5%	3.2%	13.8
Mar 96	21.4%	15.5%	16.7%	16.2%	5.5%	5.9%	5.9%	3.7%	5.0%	4.1%	15.7

Table 2: NTS Use by Funding Source

	Private	External	Internal	University	University
	Funds	Research	Research		Teaching
Administration Average:					
Users/Month	137.3	73.2	1,852.3	18.1	159.0
Sessions/User	30.4	24.8	33.0	20.3	21.7
Minutes/Sess.	26.3	32.6	25.9	29.7	40.1
Charges/Month	$8.00	$8.08	$8.54	$6.03	$8.70