

EARN Document

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EUROPEAN ACADEMIC AND RESEARCH NETWORK

INTERNATIONAL LINKS STUDY

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Table of contents

1. Management Summary.	Page 1
2. EARN network traffic.	Page 2
3. Methodology used for line load calculation.	Page 8
4. Line load results and analysis.	Page 8
5. Earn network suggested changes.	Page 9

1. MANAGEMENT SUMMARY

The purpose of this document is to analyse the present EARN network from both economical and technical viewpoints. From the technical standpoint the goal is to cope with the anticipated traffic growth of the coming years by adjusting the network meshing to the traffic flows and by using the services best suited to traffic volumes. Special attention is paid to the network ability to provide a minimal service in case of a catastrophic failure occurrence at a node. From the economical standpoint the approach is to take advantage of international services and line speeds provided by the PTTs. The proposed solution is to implement a hierarchical network using private leased lines with three levels:

1. A high traffic transit network with alternate routing capability.
2. Regional nodes handling the traffic of neighbouring countries and acting as gateways to the high traffic network
3. Individual country nodes acting as gateways to the regional nodes for the national traffic

The high traffic transit network should use the 64 kbps full duplex service currently available from the European PTTs (Arteres Numeriques terrestres by France Telecom) As the network is exclusively used for batch traffic, the various nodes use "store and forward" protocols.

Eligible nodes to be added to the high traffic transit network are:

- London
- Geneva
- Bonn

The other nodes can be either directly linked to this high traffic network or, to reduce the line charges, connected to another node acting like a regional node.

With the increasing importance of intercontinental traffic it is suggested to have an alternate route to the USA. This alternate route should use a transatlantic service different from the one presently used (i.e. TAT-8 cable service instead of satellite service). The advantage of doing so is an increase of the network security since the probability to have both the satellite service and the cable service failing at the same time is far lower than an interruption of either one of the two services. The tariffs for satellite and cable are

almost equal now and the trend is that the cable will become cheaper than the satellite in the next few years. Next autumn a new transatlantic cable called PTAT will be brought into service, and tariffs for this service are expected to be lower than the current ones.

2. EARN NETWORK TRAFFIC (Feb 1989)

Country name	Code
Argentina	AR
Austria	AT
Belgium	BE
Brazil	BR
Canada	CA
Chile	CL
Denmark	DK
Egypt	EG
Finland	FI
France	FR
Germany	DE
Great_Britain	GB
Greece	GR
Iceland	IS
Ireland	IE
Israel	IL
Italy	IT
Ivory_Coast	CI
Japan	JP
Korea	KR
Kuweit	KW
Luxembourg	LU
Mexico	MX
Netherlands	NL
Norway	NO
Portugal	PT
Saudi-Arabia	SA
Singapore	SG
Spain	ES
Sweden	SE
Switzerland	CH
Taiwan	TW
Turkey	TR
USA	US
Yugoslavia	YU

EARN NETWORK TRAFFIC (Feb 1989)

Contact: Miss Dominique DUMAS (MOP) 67.14.14.14
 June 28th 1989
 EARN traffic figures
 Feb 89

Unit: Total send + receive traffic expressed in records (80 char.)

From /To	AR	AT	BE	BR	CA
AR	0	0	0	0	0
AT	0	0	201449	9	139848
BE	0	201449	0	363	218826
BR	0	9	0	0	0
CA	0	139848	0	0	0
CH	0	1831532	0	0	0
CI	0	0	0	0	0
CL	0	319	0	0	0
DE	299	3175721	826068	16225	882493
DK	0	138069	58462	364	38326
EB	0	0	0	0	0
EG	0	0	0	0	0
ES	250	67514	155686	446	29229
FI	0	202829	0	0	0
FR	0	96931	0	0	0
GB	88	452142	439963	22225	1008210
GR	0	29104	16316	0	103340
IE	0	161808	102898	171	99113
IL	0	508636	88793	936	276027
IS	0	0	0	0	0
IT	173	427364	241654	22478	301541
JP	0	3410	0	0	0
KR	0	97	0	0	0
LU	0	0	0	0	0
MX	0	655	0	0	0
NL	90	1433948	233861	2836	313469
NO	0	92628	5885	215	36243
PT	0	712	23232	30	21207
SA	0	0	0	0	0
SE	0	65719	3973	3353	45362
SG	0	38754	0	0	0
TR	0	272157	127631	0	58809
TW	0	116	0	0	0
US	0	1251916	0	0	18318
YU	0	39975	0	0	12

TOTAL 900 10633362 2525871 69651 3590373

EARN NETWORK TRAFFIC (Feb 1989)

From /To	CH	CI	CL	DE	DK	EB
AR	0	0	0	299	0	0
AT	1831532	0	319	3175721	138051	0
BE	671378	0	485	826068	56357	0
BR	0	0	0	16225	0	0
CA	0	0	0	882493	0	0
CH	0	0	0	5996407	0	0
CI	0	0	0	321	0	0
CL	0	0	0	6000	0	0
DE	5996407	321	6000	0	741954	0
DK	720065	0	0	741954	0	0
EB	0	0	0	0	0	0
EG	0	0	0	0	0	0
ES	729612	1410	1674	634283	17431	0
FI	0	0	0	721169	0	0
FR	1429	0	0	1628272	0	0
GB	1285488	91	4389	2013193	217487	0
GR	134428	0	0	58337	5388	0
IE	369329	1138	4156	631522	42217	0
IL	1231649	0	1090	1860405	132075	0
IS	0	0	0	230	0	0
IT	4244036	0	437	2436908	141512	0
JP	0	0	0	130323	0	0
KR	0	0	0	32868	0	0
LU	0	0	0	1565	0	0
MX	0	0	0	149789	0	0
NL	2211090	1520	1711	3608011	240626	0
NO	1134795	0	20	192724	148432	0
PT	26399	0	0	218600	1384	1413208
SA	0	0	0	0	0	0
SE	799493	32	60	257018	80269	0
SG	0	0	0	55574	0	0
TR	117769	0	75	1424720	92947	0
TW	0	0	0	38950	0	0
US	0	0	0	15875655	0	0
YU	38	0	0	2	0	0
TOTAL	21504937	4512	20416	43615606	2056130	1413208

EARN NETWORK TRAFFIC (Feb 1989)

From /To	EG	ES	FI	FR	GB	GR
AR	0	0	0	0	0	0
AT	0	67514	202829	96931	452142	29104
BE	0	153272	218547	888895	420229	10239
BR	0	0	0	0	0	0
CA	0	0	0	0	0	0
CH	0	0	0	1429	50397	0
CI	0	0	0	0	0	0
CL	0	0	0	0	0	0
DE	0	634283	721169	1628272	2004559	55375
DK	0	19796	684806	37955	206575	5727
EB	0	0	0	0	0	0
EG	0	0	0	0	0	0
ES	0	0	66252	1079525	154210	64119
FI	0	0	0	0	0	0
FR	0	0	0	0	709	0
GB	0	159514	296956	840636	0	76250
GR	0	74708	19672	987236	101891	0
IE	0	103524	154302	267306	2113287	9989
IL	0	185385	34300	826543	311482	44109
IS	0	0	0	0	0	0
IT	0	230946	196809	1119631	891453	67448
JP	0	0	0	0	0	0
KR	0	0	0	0	0	0
LU	0	0	0	0	0	0
MX	0	0	0	0	0	0
NL	0	180980	164197	1454631	378313	36190
NO	0	806	1021024	40782	46346	1066
PT	0	533	1029	140657	50677	73
SA	0	0	0	0	0	0
SE	0	4232	613952	65754	78392	10778
SG	0	0	0	0	0	0
TR	0	228795	115854	517291	169881	78847
TW	0	0	0	0	0	0
US	0	0	0	1873	0	0
YU	0	0	38	6	0	0
TOTAL	0	2044288	4511736	9995353	7430543	489314

EARN NETWORK TRAFFIC (Feb 1989)

From /To	IE	IL	IS	IT	JP	KR
AR	0	0	0	0	0	0
AT	161808	508636	0	343544	3410	97
BE	107008	78528	0	185516	19251	44545

BR	0	0	0	0	0	0
CA	0	0	0	90	0	0
CH	0	0	0	386	0	0
CI	0	0	0	0	0	0
CL	0	0	0	0	0	0
DE	617484	1860405	230	1851466	130323	32868
DK	42190	141686	39	140416	4841	53
EB	0	0	0	0	0	0
EG	0	0	0	0	0	0
ES	102364	183555	0	265648	30038	2616
FI	0	0	0	0	0	0
FR	0	5907	0	541	0	0
GB	2132148	303380	58	714659	72940	5586
GR	12414	60028	0	56088	0	219
IE	0	268345	0	210442	55812	4219
IL	261080	0	0	236828	41002	4238
IS	0	0	0	0	0	0
IT	159633	335370	64	0	14241	56
JP	0	0	0	0	0	0
KR	0	0	0	0	0	0
LU	0	0	0	0	0	0
MX	0	0	0	0	0	0
NL	1068235	441960	20	487257	4925	2118
NO	102125	31459	0	75080	238	70
PT	41483	7230	0	5007	365	0
SA	0	0	0	0	0	0
SE	89575	21169	0	97923	2362	0
SG	0	0	0	0	0	0
TR	54388	496293	0	300175	5058	347
TW	0	0	0	0	0	0
US	0	0	0	28301	0	0
YU	0	0	0	0	0	0
TOTAL	4951935	4743951	411	4999367	384806	97032

EARN NETWORK TRAFFIC (Feb 1989)

From /To	LU	MX	NL	NO	PT	SA
AR	0	0	0	0	0	0
AT	0	655	1433948	92615	426	0
BE	112816	9915	232752	9024	15832	0
BR	0	0	0	0	0	0
CA	0	0	1124	0	0	0
CH	0	0	18443	0	0	0
CI	0	0	0	0	0	0
CL	0	0	0	0	0	0
DE	1565	149789	3608011	192359	111990	0

DK	0	227	239797	154264	713	0
EB	0	0	0	0	0	0
EG	0	0	0	0	0	0
ES	1060	12897	173944	862	713300	0
FI	0	0	4044	0	0	0
FR	0	0	45628	43	0	0
GB	69	18052	405745	44103	39604	0
GR	0	378	47474	1040	101	0
IE	1129	4509	1066112	112740	23343	0
IL	0	4233	386672	24331	4924	0
IS	0	0	0	0	0	0
IT	33	12977	638101	98981	4249	0
JP	0	0	36	0	0	0
KR	0	0	0	0	0	0
LU	0	0	0	0	0	0
MX	0	0	2659	0	0	0
NL	0	5438	0	53865	20542	0
NO	0	328	60211	0	187	0
PT	0	400	41525	144	0	0
SA	0	0	0	0	0	0
SE	82970	630	75426	55077	666	0
SG	0	0	0	0	0	0
TR	0	1668	967035	91501	1956	0
TW	0	0	0	0	0	0
US	0	0	125763	0	0	0
YU	0	0	0	0	17	0
TOTAL	199642	222096	9574450	930949	937850	0

EARN NETWORK TRAFFIC (Feb 1989)

From /To	SE	SG	TR	TW	US	YU
AR	0	0	0	0	0	0
AT	65084	38754	272157	116	1251916	39975
BE	3885	39898	134178	3105	2880140	0
BR	0	0	0	0	0	0
CA	0	0	58809	0	18318	12
CH	0	0	117769	0	0	38
CI	0	0	0	0	0	0
CL	0	0	75	0	0	0
DE	257018	55574	1424720	38950	15875655	2
DK	88733	1262	107891	23	1118315	0
EB	0	0	0	0	0	0
EG	0	0	0	0	0	0
ES	4666	3606	261483	384	1831837	0
FI	0	0	115854	0	0	38
FR	0	0	517291	0	1873	6

GB	83625	55281	215367	8143	7255301	0
GR	4119	212	80297	3428	1258909	0
IE	101495	22468	59435	19622	1441895	0
IL	24841	43498	512117	14592	11048183	0
IS	0	0	0	0	0	0
IT	133532	6172	362463	13496	4644908	0
JP	0	0	5058	0	0	0
KR	0	0	347	0	0	0
LU	0	0	0	0	0	0
MX	0	0	1668	0	0	0
NL	78313	6305	1062708	1774	5635964	0
NO	69060	530	92080	0	1172027	0
PT	1271	162	3733	23	219874	34
SA	0	0	0	0	0	0
SE	0	756	31042	151	1386734	0
SG	0	0	22843	0	0	0
TR	31042	22843	0	1669	1052224	0
TW	0	0	1669	0	0	0
US	0	0	1052224	0	0	180
YU	0	0	0	0	180	0
TOTAL	946684	297321	6513278	105476	58094253	40285

3. METHODOLOGY USED FOR LINE LOAD CALCULATION.

For the analysis of the traffic figures, the spreadsheet application ESS (electronic Spread Sheet) from TRAX corporation is used.

The methodology is based on matrices multiplication. Two matrices are used, one is the traffic matrix (refer to section 2 above), the second one is the selection matrix. Both matrices have the same dimensions. The selection matrix contains only zeros or ones. If a specific element of the traffic matrix contributes to the traffic over the analysed link then a one is specified, otherwise a zero is specified.

It is necessary to define as many selection matrices as the quantity of links to be analysed.

Then, each element of the traffic matrix is multiplied by the correspond element of the selection matrix and all the resulting products are added, their total represents the traffic over the analysed link. One should bear in mind that in the case of the total traffic (send plus receive), the traffic matrix should be symmetrical and whether the selection is made per line or per column the result should be same. With the Feb. 1989 traffic figures, it was found that this is not the case and only the bigger result of the two methods is given in section 4.

4. LINE LOAD RESULTS AND ANALYSIS.

Due to time constraints, only the following links were analyzed

- Montpellier - USA
- Montpellier - Geneva
- Geneva - Stockholm
- London - Geneva
- Montpellier - Bonn

The results are:

Link	Line Speed in kbps	Traffic in records	Line load in %
Montpellier - USA	56	58.1 M	34.4
Montpellier - Geneva	64	41.8 M	24.3
Geneva - Stockholm	9.6	9.6 M	33.5
London - Geneva	9.6	20.9 M	64.6
Montpellier - Bonn	64	42.9 M	24.8

The link London - Geneva is almost saturated and an upgrade to 64 kbps should be envisaged.

All the 64 kbps (or 56 kbps) links are used up to respectively 25% and 35% and should be sufficient for the next years.

Although the calculation was not made it is obvious that a very high proportion of the traffic is going thru Montpellier. It is not a safe option to do so and it will be wise to reduce the amount of traffic going thru this node. This can be achieved by adding a line between the US and a European node with 64 kbps access. Then the choice for the European side is between Bonn, Geneva and London.

5. EARN NETWORK SUGGESTED CHANGES.

The suggested changes are:

1. Upgrade of the London - Geneva link to 64 kbps.
2. Add a link between the USA and one of the European nodes having a 64 kbps access. This node can be London or Geneva or Bonn. Bonn should not be excluded since the Bundespost has very recently removed the usage sensitive tariffing scheme for national leased services at 64 kbps and 2 Mbps. It is expected that a similar move will occur for international services.
3. Transfer some of the links ending in Montpellier to another node with 64 kbps access. This would reduce the dependency of the EARN network on the Montpellier node.