STATE OFFICE OF EDUCATION

NETWORK DESIGN PROPOSAL

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FEASIBILITY STUDY

Situation in which the Project Exists: This proposal is for a data communication network to serve the Maryland public education system. The Maryland legislature recently approved funding sufficient to pay for the development of this proposal. Pending proposal acceptance by the Maryland State Public Education Office of Technology (a department within the state Office of Education), funding will be sought to implement the proposal.

Network Scope: The proposed network is designed to serve the state Office of Education and two of its school district offices. The state office, located in Kenzington, contains five departments to be served by this network. Each district office contains four departments to be served. The North School District is located in Ricksville, 25 miles from the state office. The South School District is located in Albanton, about 40 miles from the state office. Note that this network does not serve instructional needs of students; other resources have been allocated for that purpose. This network is for administrative purposes and is specifically designed to be independent of student computing facilities.

Objectives of the Network. The network is designed to achieve several specific business/operational objectives:

1. *Secure Service*: The main objective of this network is to provide secure administrative computing service to the State Office and two districts. It is designed to be functionally and physically isolated from access by people not employed by the Maryland public education system so as to minimize the risk of unauthorized use.
2. *Integration and Update*: Presently there are many LANs in the Maryland public education system, but much of the equipment is out of date, many of the LANs are incompatible with each other, and not connected in a system-wide network. This proposal describes a WAN that integrates and updates these LANs to support productive collaboration across the system.
3. *Versatile Information Processing*: The network will enable users to retrieve, process, and store ASCII and non-ASCII text, still graphics, audio, and video from any connected computer.
4. *Collaboration*: The network will combine the power and capabilities of diverse equipment across the

state to provide a collaborative medium that helps users combine their skills regardless of their physical location. A network for this educational community will enable people to share information and ideas easily so they can work more efficiently and productively.
5. *Scalability*: The design is scaleable so that more district offices can be added as funding becomes available without having to redo the installed network.

Intended Users. The primary users of the network at the state level will be the three administrators, three secretaries, ten members of the Curriculum Department, eight members of the Human Resource Department, six members of the Finance/Accounting Department, and three members of the Computer Services Department. At the district level the primary users will be four administrators, four secretaries, four members of the Computer Services Department, sixteen members of the Human Resource Department, and two members of the Finance/Accounting Department. Parents, pre-service teachers, teachers, and the public are secondary users of the network in that they will receive information produced on the network, but they will not directly use the network.

Design Assumptions. This design assumes the following:
1. The State Education Network has a firewall that protects all information coming and going from the network.
2. Internet service is provided by the State Education Network, which is subsidized by the state government.

NETWORK NEEDS ANALYSIS

Data Types. The types of data served by the network will be reports, bulletins, accounting information, personnel profiles, and web pages. The majority of the data will be text (ASCII and non-ASCII), but there will be some still graphics and possibly a small amount of voice and video (primarily for PC-based teleconferencing).

Data Sources. Data will be created and used at all end stations on the network. The data will be produced by software applications in Windows 2000, primarily Dream Weaver and Office 2000 Professional (Word, Excel, Access, PowerPoint, and Outlook). Other data sources to be supported on at least a limited basis will Windows 2000 Accessories (Paint, Notepad, etc.), NetMeeting, Media Player, and PhotoShop. Note that the network will be not be accessible from outside…

Numbers of Users and Priority Levels. At the state level, the users will be administrators, secretaries, and members of four departments. At the district levels, the users will be administrators, secretaries, and members of three departments. The maximum estimated number of users on the network at any given time is 100: 33 regular users in the State Office, 30 regular users in the North District Office, 30 regular users in the South District Office, and seven otherwise unanticipated users.

Three priority levels will be supported: management (top priority), user (medium priority), and background (low priority). Note that these designations do not correspond to administrative levels in the Maryland public education system; rather, they are network service levels. Network management processes will receive top-priority service; most network processes will receive medium-priority service; a few processes (e.g., e-mail transfers, backup, etc.) will be given low-priority service. It should be noted that network management will usually consume a small amount of the available bandwidth; this means that management and user processes will usually enjoy identical support. Background processes will also

usually receive more than adequate service, but they will be delayed as needed to maintain support for management and user services.

Transmission Speed Requirements. The network is to be transparent to the users. Thus, remotely executed applications, file transfers, and so forth should ideally appear to operate as quickly as processes executed within an end-station. Interviews with users to ascertain their needs and expectations indicate that an average throughput of 20 mbps per user within each LAN and 10 mbps per user between LANs will more than support the needed performance in most cases (teleconferencing being the possible exception).

Load Variation Estimates. Interviews with users and observation of LAN use at the three locations yielded data on hourly average and peak loads from January to March, 2001. The data are tabulated in the appendix. The data indicate that the highest average traffic volume will occur from 8:00 a.m. to 6:00 p.m., Monday through Friday. The peak network traffic volume is expected at two times during the day: 8:00 a.m. to 12:00 noon and 3:00 p.m. to 5:00 p.m. At night and on weekends the network traffic is minimal except for the daily backups of the PCs to the LAN servers in the districts and several batch data transfers anticipated from the districts to the State Office. The data indicate the following network design parameters:

- The average required throughput on any LAN during work hours (7:00 a.m. to 6:00 p.m.) will be only about 0.2 mbps.
- The average required throughput on the WAN during work hours (7:00 a.m. to 6:00 p.m.) will be only 0.04 mbps.
- The peak expected traffic load on any LAN will be about 10.4 mbps.
- The peak expected traffic load on the WAN will be about 6.4 mbps.

Of course, to avoid user complaints, the network is designed for the peak traffic loads, not the average throughput.

Storage Requirements. Storage requirements need to be large enough to store all student, teacher, and state data (note: student data are data about students, not data generated by students). Interviews and observations of users' present and anticipated storage requirements indicate that each user will need an average of 100 MB of server space (in addition to secondary storage on local PCs); the maximum estimated server-side storage requirement per user is about 1 GB. Additionally, the network operating system will occupy about 500 MB on each LAN server. Taking price-performance issues into account, each PC will have a minimum storage capacity of 10 GB, each LAN server will have a minimum storage capacity of 20 GB. A main data server in the State Office will have a 36 GB capacity.

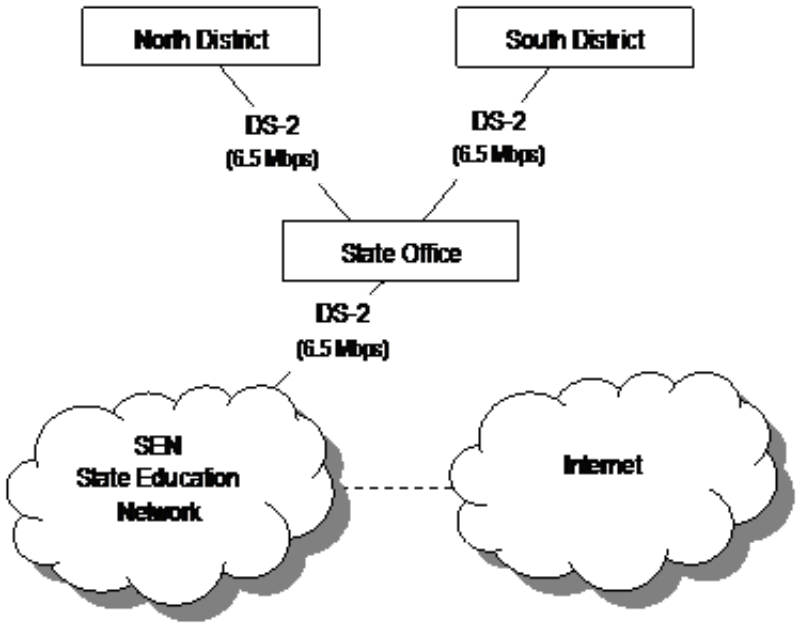
Reliability Requirements. In keeping with user expectations and industry standards, both the LANs and the WAN are expected to operate at 99.9% uptime and an undiscovered error rate of .001%.

Security Requirements. A firewall will be used so unauthorized users will be restricted. Part of the security will be Users accounts and passwords that will give limited access. There will be different access capabilities for network managers and users.

Existing Network. There is no existing network.

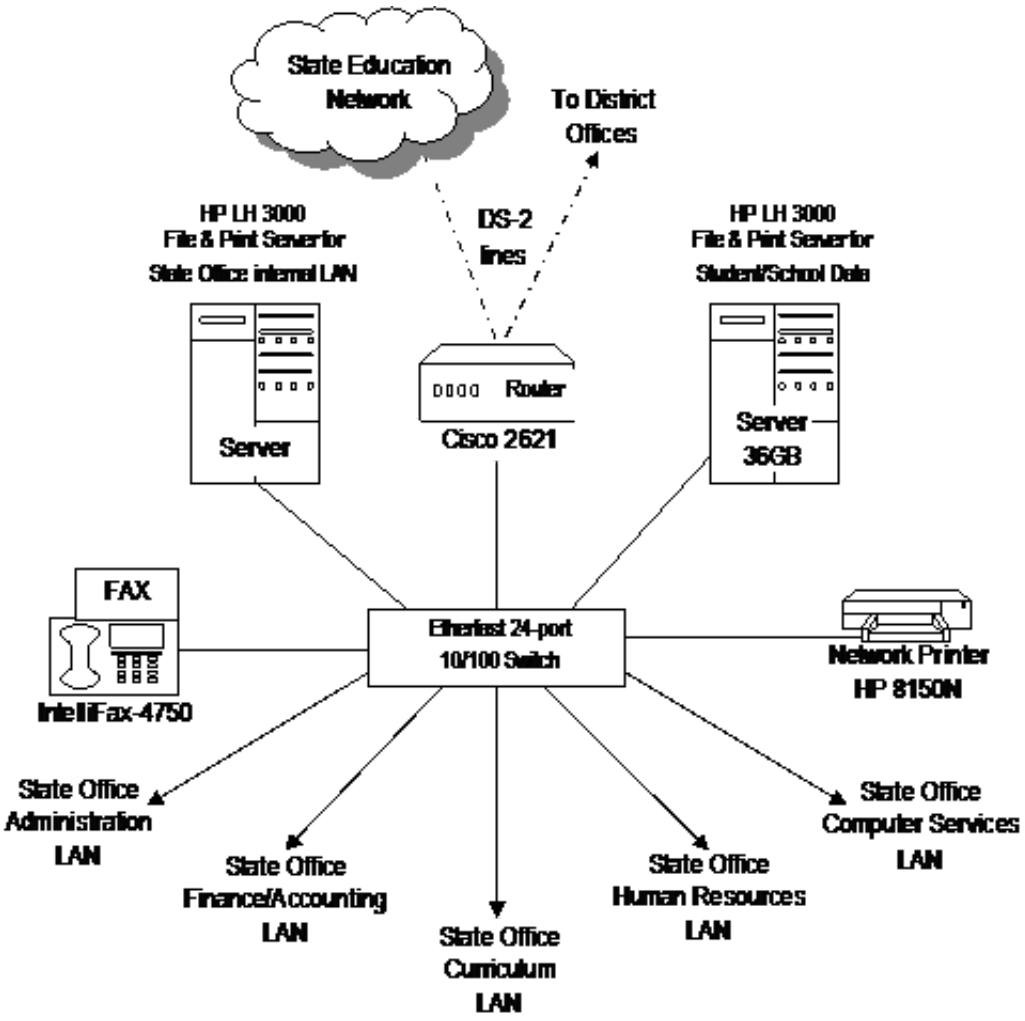
HIGH-LEVEL NETWORK DESIGN

Top-Level Network Diagram



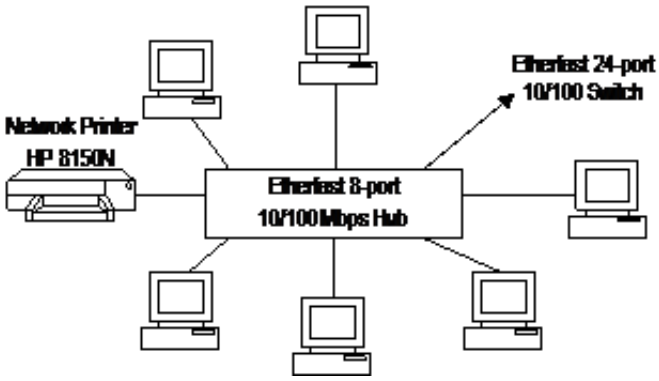
State Office Network Diagram

(LAN cabling is 100BaseT CAT5)

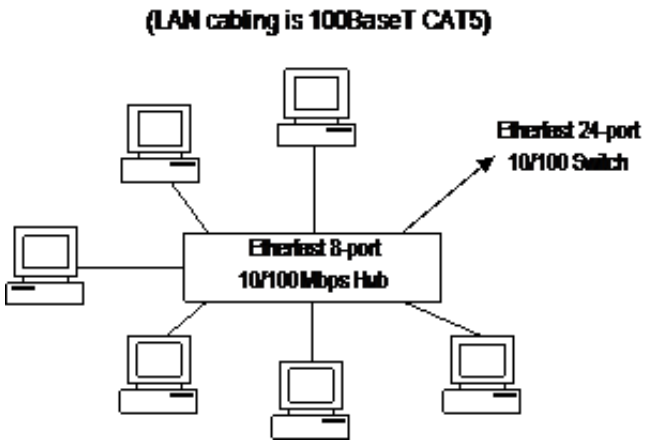


State Office Network Sub-Diagram
Administration LAN

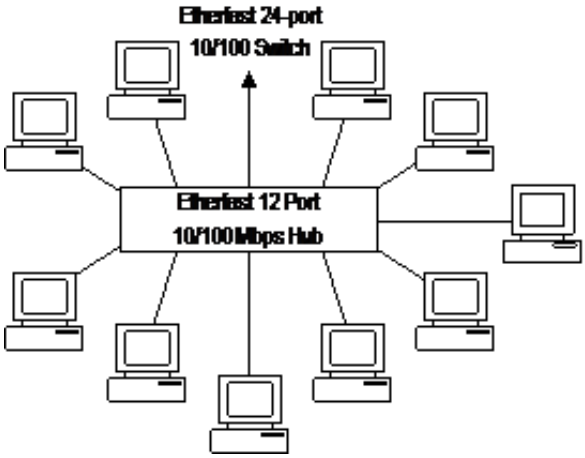
(LAN cabling is 100BaseT CAT5)



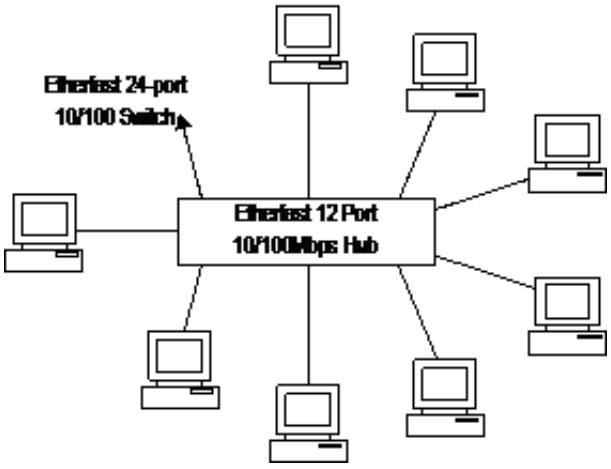
State Office Network Sub-Diagram
Finance/Accounting LAN



State Office Network Sub-Diagram
Curriculum LAN

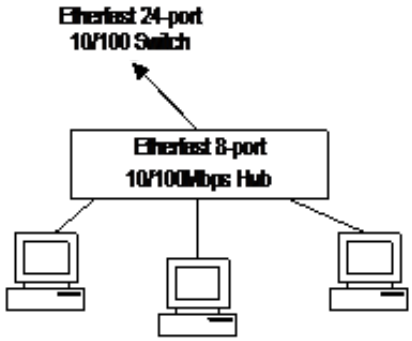


State Office Network Sub-Diagram
Human Resources LAN

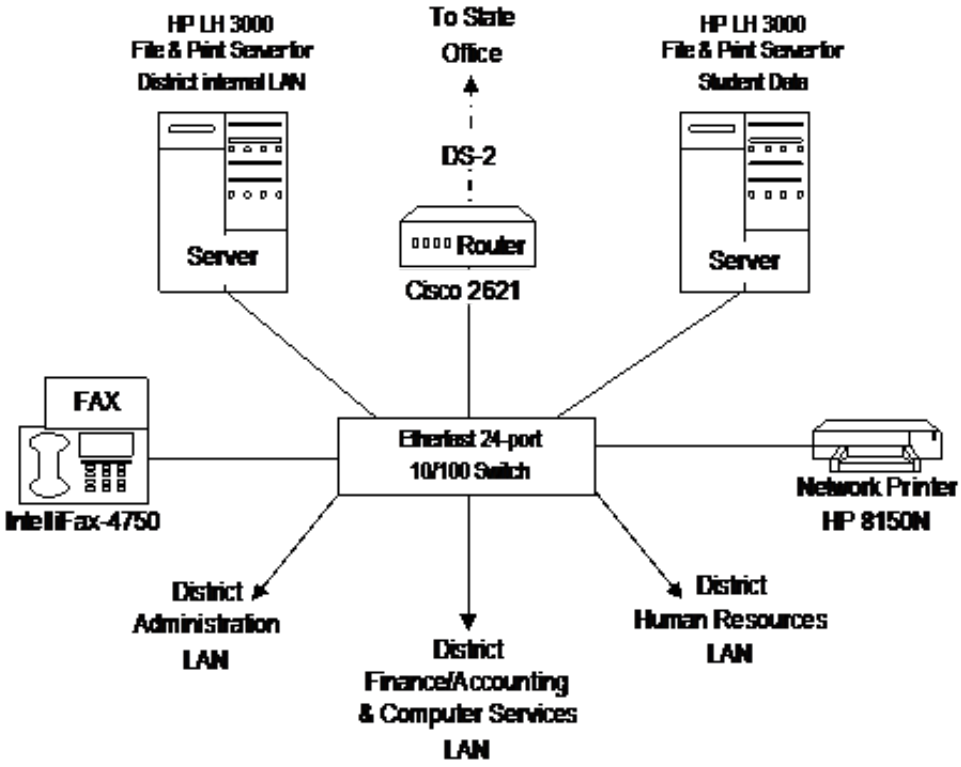


State Office Network Sub-Diagram
Computer Services LAN

(LAN cabling is 100BaseT CAT5)

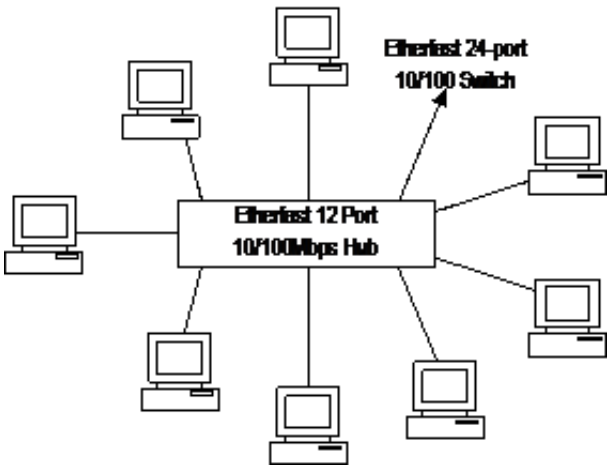


North District Network Diagram
(LAN cabling is 100BaseT CAT5)



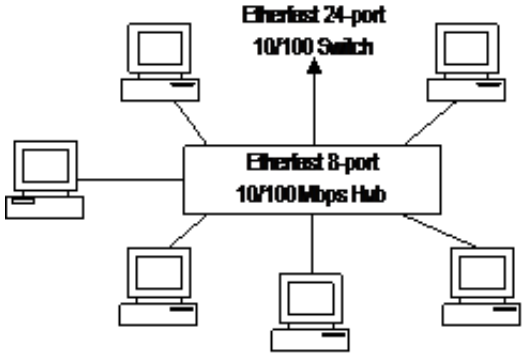
North District Network Sub-Diagram
Administration LAN

(LAN Cabling is 100BaseT CAT5)



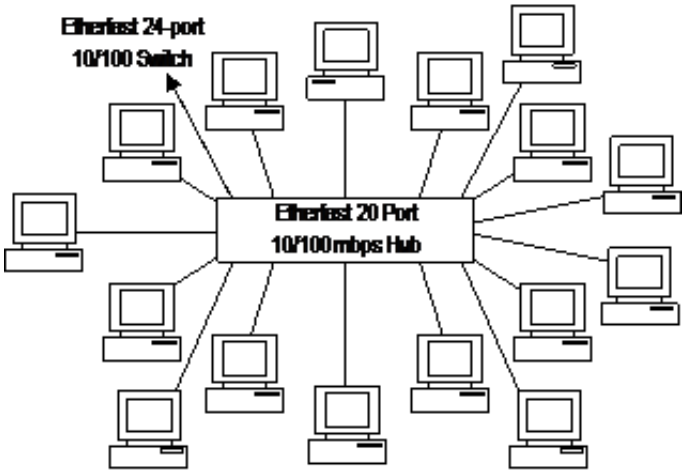
North District Network Sub-Diagram
Finance/Accounting & Computer Services LAN

(LAN Cabling is 100BaseT CAT5)

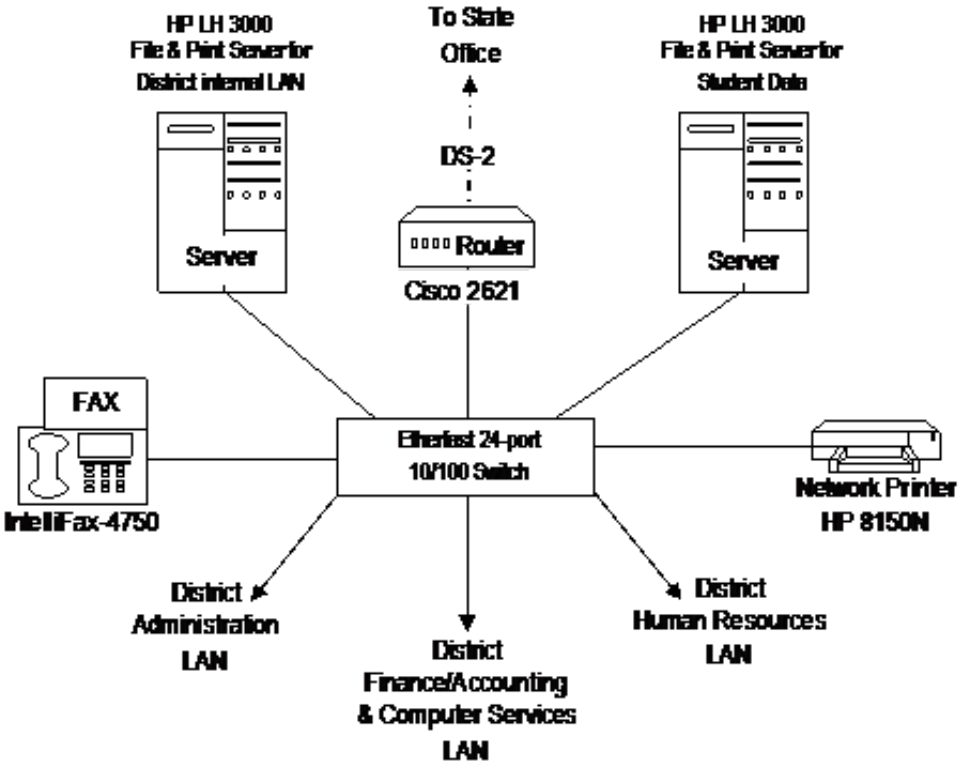


North District Network Sub-Diagram
Human Resources LAN

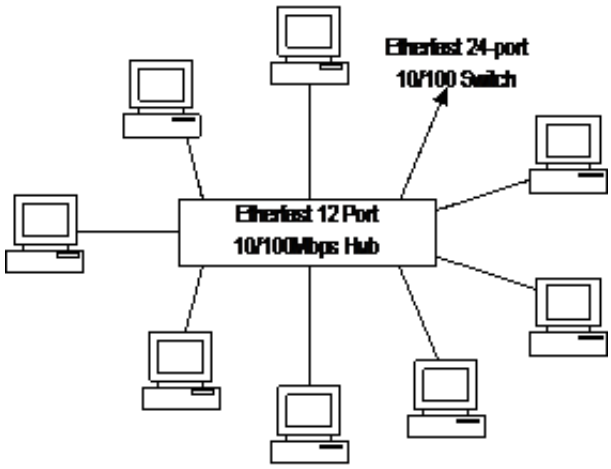
(LAN Cabling is 100baseT CAT5)



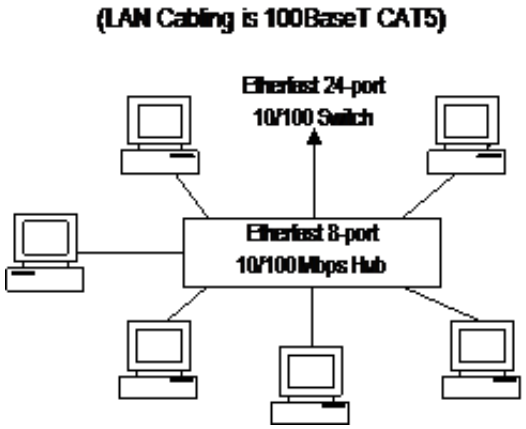
South District Network Diagram
(LAN cabling is 100BaseT CAT5)



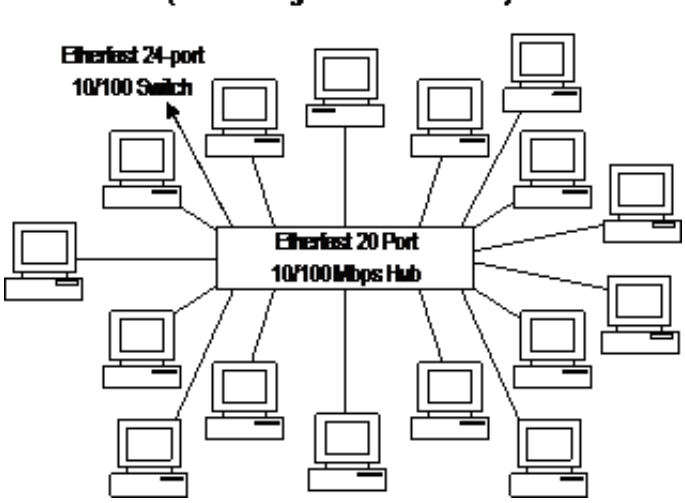
South District Network Sub-Diagram
Administration LAN
(LAN Cabling is 100baseT CAT5)



South District Network Sub-Diagram
Finance/Accounting & Computer Services LAN



South District Network Sub-Diagram
Human Resources LAN



DETAILED DESIGN DOCUMENTATION

Key for Lists = Product

- Cost
- Availability
- Performance
- Maintainability

HP File/Print Server LH 3000

- $4,089.00
- Available/In Stock
- P3 866MHz, 128 MB/4GB RAM, 256KB L2, 32X CD
- 3 Year Warranty and Maintained by Computer Services as needed

HP NetServer Hard Drive

- $379.95
- Available/In Stock
- 9.1 GB SCSI3 7200 RPM LVD, LC2000/LH3 Compatibility

- Maintained by Computer Services as needed

IntelliFax-4750 Commercial Laser Fax

- $499.95
- Available/In Stock
- 250-sheet Universal Paper Cassette, 4 MB, Dual Access Memory (upgradeable to 12 MB or 20 MB), Up to 50 page Auto Document Feeder, Stores up to 270 pages, 14.4 Kbps fax modem
- Maintained by Computer Services as needed

HP Laser Jet 8150N Series

- $2,469.95
- Available/In Stock
- 1200 dpi, 32 MB memory expandable to 192 MB, Network ready 10/100 Base-TX, 2 open EIO Slots, 3/100 (Number of trays/capacity)
- Maintained by Computer Services as needed

Windows 2000 Server

- $819.95
- Available/In Stock
- 5 Licenses included, Full Version
- Maintained by Computer Services as needed

Compaq DeskPro EN P3/600

- $999.00
- Available/In Stock
- 10 GB, 128 MB, 40X CD ROM, NIC DT Win 00; with Windows 2000 OS
- 3 Year Parts and Labor Warranty and Maintained by Computer Services as needed

CAT 5 Cable

- $145.99
- Available/In Stock
- 4 pair solid PVC; 1000 feet
- Maintained by Computer Services as needed

SmartPro 1400

- $454.99
- Available/In Stock
- 6 outlets +LAN
- Maintained by Computer Services as needed

EtherFast 8-Port 10/100 Desktop Hub

- $79.99
- Available/In Stock
- True 10/100 auto-sensing ports, Internal store-and-forward switching segment, built-in data collision and frame re-timing
- Manufacturer's 5 year limited warranty and Maintained by Computer Services as needed

EtherFast 12-Port 10/100 Desktop Hub

- $129.99
- Available/In Stock

- True 10/100 auto-sensing ports, Internal store-and-forward switching segment, built-in data collision and frame re-timing
- Manufacturer's 5 year limited warranty and Maintained by Computer Services as needed

EtherFast 20-Port 10/100 Desktop Hub

- $199.99
- Available/In Stock
- True 10/100 auto-sensing ports, Internal store-and-forward switching segment, built-in data collision and frame re-timing
- Manufacturer's 5 year limited warranty and Maintained by Computer Services as needed

EtherFast II 24-Port 10/100 Switch

- $449.99
- Available/In Stock
- True 10/100 auto-sensing ports, Internal store-and-forward intelligent switching segment, built-in data collision and frame re-timing
- Manufacturer's 5 year limited warranty and Maintained by Computer Services as needed

CISCO 2621 Ethernet Router 2 10/100

- $2,319.00
- Available/In Stock
- Provides remote access and WAN integrations, supports extranet VPN access and multiple modules, two 10/100 RJ45 ports, two WAN slots, one network module slot, one AIM slot
- Maintained by Computer Services as needed

Firewall I Internet Gateway V4.1 100 Nodes ONL

- $6,000.00
- Available/In Stock
- Full Version
- Maintained by Computer Services as needed

DS-2 Connection

- $650.00
- Available
- 1 month, exclusive rights
- Maintained by Quest Communications

COST-BENEFIT ANALYSIS

Cost Analysis			
Tangible Costs			
Product	**Price**	**Quantity**	**Total**
HP File/Print Server LH 3000	$4,089.00	6	$24,534.00
HP NetServer Hard Drive	$379.95	10	3,799.50
IntelliFax-4750 Commercial Laser Fax	$499.95	3	1,499.85
HP Laser Jet 8150N Series	$2,469.95	4	9,879.80
Windows 2000 Server	$819.95	6	4,919.70

Compaq DeskPro EN P3/600	$999.00	65	64,935.00
CAT 5 Cable (1,000 feet)	$145.99	4	583.96
SmartPro 1400	$454.99	6	2,729.94
EtherFast 8-Port 10/100 Desktop Hub	$79.99	5	399.95
EtherFast 12-Port 10/100 Desktop Hub	$129.99	4	519.96
EtherFast 20-Port 10/100 Desktop Hub	$199.99	2	399.98
EtherFast II 24-Port 10/100 Switch	$449.99	3	1,349.97
CISCO 2621 Ethernet Router 2 10/100 Ports 2 Slots	$2,319.00	3	6,957.00
RJ45 Plugs *Packs of 50	$49.99	8	399.92
Ultimate Tool Kit	$399.00	1	399.00
Firewall I Internet Gateway V4.1 100 Nodes ONL	$6,000.00	1	6,000.00
Labor (Maintaining the System) per hour	$75.00	300	22,500.00
DS-2 Connection (1 month, exclusive rights)	$650.00	36	23,400.00
Subtotal of Tangible Costs			**$175,207.53**
Intangible Costs			
Product	**Price**		
Network Down Time (Estimated at 9 hrs/yr)	$8,000.00	1	$8,000.00
Subtotal of Intangible Costs			**$8,000.00**
Total 3-year Cost Analysis			**$183,207.53**
Total Annualized Cost			**$61,069.18**

Benefit Analysis		
Product	**Price**	
Increased Productivity	$25,000.00 yr	
Decreased Anxiety (from increased reliability)	$4,000.00 yr	
Less Training Time	$6,000.00 yr	
Increased Connectivity between State and District Offices	$10,000.00 yr	
Ease of Record Keeping (i.e., fewer lost files and faster availability)	$25,000.00 yr	
Increased Security	$30,000.00 yr	
Total		**$100,000.00/year**

Intangible Benefits		
Product	**Price**	
Increased Community Support	$30,000.00 yr	
Increased Staff Morale	$15,000.00 yr	
Better Informed Public	$20,000.00 yr	
Total		**$65,000.00/year**
Total Benefit Analysis = $165,000.00/year		

Cost-Benefit Ratio		
Total Cost	**Total Benefit**	**Ratio**
$61,069.18/year	$165,000/year	0.37

* Annual benefit exceeds annualized cost.

* The project is expected to pay for itself in about 14 months.

* The time to functional obsolescence of the equipment is estimated at about 36 months.

* **It is therefore recommended that the project be implemented.**

APPENDIX

Average Network Usage for January to March 2000

Time	Loc	Average Coincident LAN Accesses	Average MB per Access	Total LAN Data Transfer	Average Coincident WAN Accesses (Est)	Average MB per WAN Access (Est)	Total WAN Data Transfer (Est)
0100	State	0.2	0.3	0.1	0.0	0.0	0.0
	North	0.5	0.2	0.1	0.1	0.1	0.0
	South	0.4	0.4	0.2	0.2	0.2	0.0
0200	State	1.1	7654.2	8419.6	0.2	3827.1	814.3
	North	0.3	0.4	0.1	0.2	0.2	0.0
	South	0.2	0.2	0.0	0.0	0.1	0.0
0300	State	0.2	0.2	0.0	0.1	0.1	0.0
	North	1.0	4487.0	4487.0	0.5	2243.5	1126.6
	South	0.1	0.3	0.0	0.1	0.2	0.0
0400	State	0.4	0.6	0.2	0.4	0.3	0.1
	North	0.3	0.3	0.1	0.1	0.2	0.0
	South	1.2	6529.7	7835.6	1.1	3264.9	3602.5
0500	State	0.3	0.1	0.0	0.2	0.1	0.0
	North	0.3	0.1	0.0	0.2	0.1	0.0
	South	0.4	0.2	0.1	0.0	0.1	0.0
0600	State	0.5	0.5	0.3	0.1	0.3	0.0
	North	0.4	0.3	0.1	0.4	0.2	0.1
	South	0.2	0.2	0.0	0.1	0.1	0.0
0700	State	0.5	0.5	0.3	0.2	0.3	0.0
	North	1.8	0.6	1.1	0.1	0.3	0.0
	South	2.5	0.7	1.8	0.9	0.4	0.3
0800	State	27.6	3.1	85.6	23.5	1.6	36.4
	North	25.5	5.1	130.1	2.5	2.6	6.3
	South	26.8	3.9	104.5	14.9	2.0	29.0
0900	State	30.1	2.1	63.2	3.4	1.1	3.6

Maximum Network Usage for January to March 2000

Time	Loc	Maximum Coincident LAN Accesses	Max MB per Access	Max LAN Data Rate	Maximum Coincident WAN Accesses (Est)	Maximum MB per WAN Access (Est)	Max WAN Data Rate (Est)
0100	State	2	0.2	0.5	0.0	0.0	0.0
	North	2	0.2	0.3	1.0	0.1	0.1
	South	2	0.3	0.6	1.0	0.2	0.2
0200	State	3	5740.7	222.0	1.0	2870.3	272.2
	North	2	0.3	0.6	2.0	0.2	0.3
	South	2	0.2	0.3	0.0	0.1	0.0
0300	State	2	0.2	0.3	1.0	0.1	0.1
	North	2	3365.3	730.5	2.0	1682.6	35.3
	South	1	0.2	0.2	2.0	0.1	0.2
0400	State	2	0.5	0.9	2.0	0.2	0.5
	North	3	0.2	0.7	2.0	0.1	0.2
	South	3	4897.3	4691.8	2.0	2448.6	442.3
0500	State	2	0.1	0.2	1.0	0.0	0.0
	North	2	0.1	0.2	2.0	0.0	0.1
	South	3	0.2	0.5	0.0	0.1	0.0
0600	State	3	0.4	1.1	1.0	0.2	0.2
	North	4	0.2	0.9	2.0	0.1	0.2
	South	3	0.2	0.5	2.0	0.1	0.2
0700	State	1	0.4	0.4	2.0	0.2	0.4
	North	3	0.5	1.4	2.0	0.2	0.5
	South	4	0.5	2.1	3.0	0.3	0.8
0800	State	33	2.3	76.7	12.0	1.2	14.0
	North	30	3.8	114.8	4.0	1.9	7.7
	South	30	2.9	87.8	16.0	1.5	23.4
0900	State	33	1.6	52.0	6.0	0.8	4.7

North	31.1	0.9	28.0	25.0	0.5	11.2
South	28.4	1.2	34.1	20.7	0.6	12.4
1000 State	29.4	12.1	355.7	29.4	6.1	177.8
North	26.2	1.1	28.8	16.7	0.6	9.2
South	26.5	3.2	84.8	20.4	1.6	32.6
1100 State	19.8	5.7	112.9	10.2	2.9	28.9
North	20.3	1.3	26.4	10.8	0.7	7.0
South	18.7	0.7	13.1	14.0	0.4	4.9
1200 State	10.4	1.8	18.7	9.1	0.9	8.2
North	14.6	0.8	11.7	13.1	0.4	5.2
South	12.2	0.6	7.3	7.9	0.3	2.4
1300 State	13.5	1.4	18.9	1.9	0.7	1.4
North	16.7	0.5	8.4	0.2	0.3	0.1
South	17.5	0.5	8.8	12.1	0.3	3.0
1400 State	17.6	1.2	21.1	2.9	0.6	1.7
North	15.3	2.3	35.2	4.0	1.2	4.6
South	15.4	1.3	20.0	3.7	0.7	2.4
1500 State	16.0	41.0	656.0	5.7	20.5	116.3
North	12.7	11.3	143.5	4.6	5.7	26.2
South	14.6	9.4	137.2	5.4	4.7	25.3
1600 State	21.1	33.1	698.4	5.2	16.6	86.3
North	16.8	1.4	23.5	5.1	0.7	3.6
South	14.9	4.3	64.1	8.5	2.2	18.3
1700 State	7.1	6.2	44.0	5.7	3.1	17.6
North	8.6	5.2	44.7	4.0	2.6	10.4
South	5.6	4.0	22.4	2.0	2.0	4.0
1800 State	3.3	3.2	10.6	3.3	1.6	5.2
North	3.6	1.0	3.6	0.4	0.5	0.2
South	2.7	0.9	2.4	0.7	0.5	0.3
1900 State	5.6	0.5	2.8	4.8	0.3	1.2
North	5.1	0.5	2.6	4.0	0.3	1.0
South	3.3	0.3	1.0	3.1	0.2	0.5
2000 State	3.2	0.4	1.3	1.7	0.2	0.3
North	2.6	0.3	0.8	1.2	0.2	0.2
South	1.8	0.5	0.9	0.6	0.3	0.2
2100 State	2.1	0.2	0.4	1.0	0.1	0.1
North	0.9	0.2	0.2	0.8	0.1	0.1
South	0.7	0.3	0.2	0.4	0.2	0.1
2200 State	1.0	0.4	0.4	0.3	0.2	0.1
North	0.9	0.5	0.5	0.7	0.3	0.2
South	0.6	0.2	0.1	0.0	0.0	0.0
2300 State	0.7	0.3	0.2	0.7	0.2	0.1
North	0.5	0.6	0.3	0.4	0.3	0.1
South	0.2	0.4	0.1	0.0	0.0	0.0

North	30	0.7	20.3	31.0	0.3	10.5
South	30	0.9	27.0	30.0	0.5	13.5
1000 State	33	9.1	299.5	31.0	4.5	140.7
North	30	0.8	24.8	20.0	0.4	8.3
South	30	2.4	72.0	25.0	1.2	30.0
1100 State	33	4.3	141.1	16.0	2.1	34.2
North	30	1.0	29.3	17.0	0.5	8.3
South	30	0.5	15.8	15.0	0.3	3.9
1200 State	29	1.4	39.2	13.0	0.7	8.8
North	29	0.6	17.4	16.0	0.3	4.8
South	28	0.5	12.6	15.0	0.2	3.4
1300 State	33	1.1	34.7	4.0	0.5	2.1
North	30	0.4	11.3	2.0	0.2	0.4
South	30	0.4	11.3	17.0	0.2	3.2
1400 State	33	0.9	29.7	5.0	0.5	2.3
North	30	1.7	51.8	6.0	0.9	5.2
South	30	1.0	29.3	6.0	0.5	2.9
1500 State	33	30.8	1014.8	7.0	15.4	107.6
North	30	8.5	254.3	8.0	4.2	33.9
South	30	7.1	211.5	7.0	3.5	24.7
1600 State	33	24.8	819.2	7.0	12.4	86.9
North	30	1.1	31.5	6.0	0.5	3.2
South	30	3.2	96.8	12.0	1.6	19.4
1700 State	27	4.7	125.6	9.0	2.3	20.9
North	27	3.9	105.3	7.0	2.0	13.7
South	26	3.0	78.0	8.0	1.5	12.0
1800 State	25	2.4	60.0	6.0	1.2	7.2
North	27	0.8	20.3	5.0	0.4	1.9
South	28	0.7	18.9	3.0	0.3	1.0
1900 State	22	0.4	8.3	9.0	0.2	1.7
North	16	0.4	6.0	7.0	0.2	1.3
South	18	0.2	4.1	5.0	0.1	0.6
2000 State	28	0.3	8.4	4.0	0.2	0.6
North	21	0.2	4.7	3.0	0.1	0.3
South	23	0.4	8.6	2.0	0.2	0.4
2100 State	15	0.2	2.3	3.0	0.1	0.2
North	11	0.2	1.7	2.0	0.1	0.2
South	12	0.2	2.7	4.0	0.1	0.5
2200 State	9	0.3	2.7	5.0	0.2	0.8
North	3	0.4	1.1	5.0	0.2	0.9
South	6	0.2	0.9	0.0	0.0	0.0
2300 State	7	0.2	1.6	2.0	0.1	0.2
North	6	0.5	2.7	1.0	0.2	0.2
South	5	0.3	1.5	0.0	0.0	0.0