M E M O R A N D U M

DATE: October 28, 2002
TO: Management
FROM: Brandon Miller, John Thompson, Brett Walke
RE: OUR RECCOMENDATIONS FOR OUR CLIENTS' NETWORKING NEEDS

Per your request, we have reviewed the three projects you currently are working on and we have made the requested analysis and recommendations for the following projects:

1. Eureka! And Their 4 Alternatives including our recommendation
2. Internal Connectivity Plan for MJ Manufacturing
3. GJ Enterprises Low Cost Internal Network and Internet Connectivity

Please take a look at the following reports which are formatted with the executive summary of each case, followed by the supporting information. Please contact us if you need more information or have any questions.

1) Eureka! and Their 4 Alternatives

Using the given information, we calculate that Eureka will have 20 staff working at any given time (60 employees over 3 shifts = 20 per shift). Being a concierge service, each employee will need to be able to both be on the phone as well as the Internet looking up information simultaneously. Additionally, their internet connection needs to be as fast as possible so that their clients' need not wait long for the information they need. We recommend that Eureka! implement the T1 service. This option will allow them the fast connection they need while still having a low variable cost. A table of the costs associated with each option is below and the pro / con analysis of each option follows:

	Variable Costs		*Fixed Costs*		*Total Costs*	
	Voice Lines	**Data Lines**	**Hardware**	**Wiring**	**Total Annual Variable**	**Total Fixed**
Option A	$800/month	$800/month* ISP: $400 /mo	$800 for 20 Modems	NA	$24,000	$800
Option B	$1200/mo	Included in Voice	$4000 for 20 DSL Modems, $700 for 20 NICs	Negligible – Patch Cords only	$14,400	$4700
Option C	$800/mo	$300/mo	Router $750 Switch $500 NICs $700	$2000	$13,200	$3950
Option D	$1200/mo	Included in Voice	$1000 for 20 Modems	NA	$14,400	$1000

*Need 2 lines (one for voice and one for data) since employees need to be on the phone while looking up information on the Internet.

Option Descriptions:

a. Use traditional analog services, with standard voice lines, and use modems to dial into its ISP ($40 per month for each voice line plus $20 per month for each Internet access line)?

b. Use standard voice lines but use DSL for its data ($60 per month per line for both services)?

c. Separate its voice and data needs using standard analog services for voice but finding some advanced digital transmission service for data ($40 per month for each voice line and $300 per month for a T1 circuit for data.

d. Provide for digital service for both voice and data ($60 per month for an all digital circuit that provides two PCM phone lines that can be used for two voice calls and one data call at 64 Kbps, or one data call at 128 Kbps)?

Option Pros/Cons & Costs:

a) Pros: Inexpensive wiring and hardware, minimal need for new hardware

Cons: Slow network speeds (maximum rate with V.92 is receiving at up to 56 kbps and sending at up to 33.6 kbps), need two phone lines if want to be on web and phone at same time, no static IPs, which can hinder static communication needs.

Cost: Voice Lines (20 lines @ $40/mo), Voice / Data Lines (20 @ $40/mo), ISP fee (20 @ $20/mo), Hardware (20 modems @ $40)

b) Pros: much faster than modem connections (receiving at 256 kbps – 1.5 Mbps and sending at 64 – 256 kbps) and ½ as many lines needed, it is a dedicated internet connection
Cons: if the ISP isn't running a DSL Modem promo, the modem fees could be astronomical at around $150 to $200 per modem for ADSL modems. If they want to ensure reliable fast service, they must be no more than 5 miles from the provider.

Cost: Voice Lines (20 lines @ 60/mo includes ISP fees), DSL modems (20 @ $200), NICs (20 @ $35).

c) Pros: Much faster than DSL (1.544 Mbps vs ~768 kbps), no individual system ISP fees, no individual system modem requirements, easier internal networking between local systems.
Cons: Must run internal cabling (cat5e), could be slower than HDSL if all users were utilizing their full capacity (it is shared.)

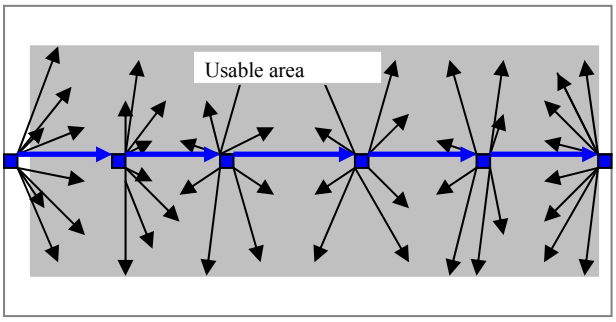
Cost: Voice Lines (20 Lines @ $40/mo), T1 line (1 line @ $300), Router (~$750 from pcstop.com), 20 Port 100MB Switch ($500), Wiring ($100 / jack), NICs (20 @ $35)

d) Pros: An additional telephone "line" for voice, fax, or data use; Employees could have option for 2 calls at once, but no data connection or just a faster data connection
Cons: Slow network speeds, expensive for the slow connection

Cost: Digital Circuit (20 @ $60/mo), Hardware (20 modems @ $50)

2) Internal Connectivity Plan for MJ Manufacturing

In reviewing MJ's situation, we noted several issues that need further exploration. First, we need to know the height of the ceiling runs off the floor since that will change the reach from the central wiring that runs through the middle of the ceiling in our model. Second, we would need to know the floor plan of the 50 pieces of equipment. This could change the plan considering that we had to make an assumption that the usable area of the floor would not include the outside walls. Given the assumptions we made, the *best way* to network MJ's plant would to be to lay cable runs in the floor by cutting into the cement and laying conduit; however, the client is reluctant to run the wiring on the floor and believes that the cable must be run in the ceiling. Thus, we believe the best option would be to install a switched UTP 100Base-TX network which is diagramed below. Our reasoning for this option relates mainly to cost.



Switched UTP diagram

Cost:
The cost of using a switched 100Base-TX network is minimal compared to the other options, the only other feasible one being fiber. Fiber would be run from one switch located on the left wall with runs up the center of the ceiling then out to each workstation. Specs and pricing in the following chart are from BlackBox Network Services.

Medium	Run Lengths	Total Wiring (ft)	Cost / ft	Connectivity Equip	Total Cost
Category 5e	(25) 300' (24) 150'	3,925	$.24	(6) 3Com switches @ $150 each	**$1,842 + labor**
OFNR/FT4	(4) 200 (4) 350 (4) 500 (4) 650 …	59,000	$.80	(1) switch @ $53,200	**$100,400 + labor**

Speed:
The speed requirements specified by the project coordinator are that the equipment must be able to send data at 2 Mbps every 2 or 3 seconds without interruption. The speed of our suggested network is 100 Mbps, which is more

than 40 times the required speed. This will allow for future expandability as technology needs change.

Distance:
The distance requirements in this situation call for runs up to 600 meters in length for the main run of cable for the network. UTP can be run up to 100 meters. To provide coverage to the entire usable area of the building, we have divided the building into a grid with one switch covering each grid area. (see figure). We find that in many plants, they tend to utilize the central most part of their floor space to provide efficiency in an assembly line or work cell floor model. As you can see by looking at the figure, this model allows for this area to be able to be served by our network layout.

Expandability:
We foresee two categories of expandability: speed and number of connections. By dividing the amount of equipment connected to the network by our 6 grid areas, we come up with approximately 8-9 pieces of equipment per switch. Allowing for an increase of 24 pieces of equipment in this plant, we are providing the necessary capacity by installing (6) 12 port 100 Mb switches. Additionally, the network architecture will allow for future changes in technology that may call for speeds up to gigabit.

Physical Environment & Security:
The physical environment calls for durable cable that is flexible. Additionally, the structure and prominent materials in the building make some types of networking implausible. For example, large pieces of heavy equipment would make it possible for shadow zones to interrupt wireless transmissions and the amount of EMI disturbance needs to be measured to ensure that the UTP is run in the proper locations in the ceiling. Shielded cable is not necessary according to the experts at BlackBox Corp, because the twists in the cable will cancel out the noise caused by interference in the industrial environment. If MJ is very concerned about interference, then we should go ahead and use shielded cat 5e with the switches grounded. Due to the stability of today's switches, we are not concerned about one failing and having down time due to inaccessibility to the suspended switch. Since the requirements do not specify that the network needs to be anything more than an internal network, there is no issue of general outside security vulnerabilities. Physical security is not an issue unless the building is not locked and guarded, which is a problem with any structure.

Additional Consideration:
A 10Base5 Ethernet network with coaxial cable may also be another option. It is capable of delivering speeds of 10 Mbps and can run up to 500 meters. However, this network would require a complex line bus topology that would probably not be effective for this environment with runs from the ceiling. If speed needs increase, this would also not be an effective network since its max speed is

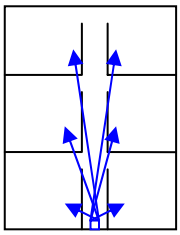
constrained to 10 Mbps. A couple positives for using coaxial cable is that it is more rugged than UTP and can be ran longer distances.

3) GJ Enterprises Low Cost Internal Network

GJ's need for a low cost network is important, but should not be overshadowed by the fact that we understand that their future needs are likely to change. Because of this, the marginal cost from the lowest cost alternative of using a hub to that of using a switch should be taken into consideration. If MJ installs DSL internet, a switch, and runs category 5e wiring to each desktop, they will have a network that will take care of their needs both now and for much of the future. We are assuming that small office means that the building is less than 1000 square feet and that the work areas are set up as cubicles.

Option 1: Small Office Switched Network (Recommended)

Overview:
We recommend the installation of a small office switched 100Base-TX Ethernet network using category 5e UTP wiring with Internet access for business email and research purposes. We are recommending a wired network over a wireless (described below) because the wired network will allow for a faster speed between computers, will not be inhibited by the brick walls, and is less susceptible to security and interference problems.



Details:
They will need to run category 5e UTP cable along floorboards and wall corners to each system from a 8-port switch connected to a DSL modem. Installation needs include wiring, DSL line, DSL modem, and all the computers will need NICs.

Cost:
Assuming that small office means that the square footage is less than 1,000 feet and that the work areas are cubicles distributed around the perimeter of the office, we estimate the **total fixed cost to be $827**. The calculations (from BlackBox Corp.) we used are below:

Cat 5e Wiring: 240' @ $.24 per foot = $57
Cable ends and jacks: $40
Labor: 8 hrs @ $40 an hour
8 port Switch: $120
NICs 6 @ $35: $210

DSL Router: $80
Total Fixed Cost: $827
Variable Cost of DSL Service per month: ~$50

Pros:
Each connection to the computer is unshared; probably faster than wireless (up to 100 Mbps compared to 11 Mbps for 802.11b); switch allows for expandability; more reliable than wireless

Cons:
More expensive than wireless; must run wiring

Option 2: Small Office Wireless Network

Overview:
Another option would be the installation of a wireless access point and an upgrade of existing network cards with outside internet access via DSL.

Details:
Installation is simple, just plug in the WAP to the router and install the new NICs in the six computers.

Cost:
DSL Router: $80
Linksys WAP from Buy.com (802.11b): $104
6 Linksys PCI NICs @ $70: $420
Labor: 3 hrs @ $40 an hour
Total cost would be $724
Variable Cost of DSL Service per month: ~$50

Pros:
No wiring needed; cheaper than switched network; more expandable with up to 20 users per access point

Cons:
Access point speed is shared among the 6 users; slower max speed at 11 Mbps; may have shadow zones depending on if the walls are brick or not (not everyone may be able to get access from just one access point in the building); higher susceptibility to security problems; may have interference from any other devices on the 2.4 GHz frequency (cordless phones)