COBRA

TOKEN RING

LAN BRIDGE

SUMMARY PRODUCT IMPLEMENTATION PLAN

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0.0 COBRA - EXECUTIVE SUMMARY

0.1 MARKET DESCRIPTION AND OPPORTUNITY

As LANs rapidly become the dominant source of bits in the 1990s, Codex needs to have a product line that interfaces these LANs into its other wide area network products. The current EtherSpan product provides the first product in a family of LAN interconnect products which interfaces Ethernet/IEEE 802.3 LANs into a variety of wide area network technologies marketed by Codex. Cobra will provide a parallel solution that interfaces into 4 and 16 Mbps token ring LANs, the other dominant LAN technology. With the combination of the EtherSpan and Cobra product lines, the two most dominant LAN types will be addressed.

Many of the major "themes" supported by Cobra are the same as for EtherSpan, i.e.:

1. "Scalability" so that customers only pay for what they need
2. Migration, so that customers can migrate their network without pain as their needs grow
3. Optimal usage of WAN facilities to save users money
4. Ease of use ("Plug and play" to the greatest extent possible)
5. Integrated network management

However, besides the above themes, there are two particular major themes to be played in the token ring environment that give Codex a competitive edge versus other competitors. These are:

* Very high compatibility with the IBM environment which is where token ring dominates
* Optimal usage of WAN facilities to save users money (#3 above)

The first point gives Cobra a competitive advantage over non-IBM suppliers, who have a low level of IBM compatibility. The second point gives Cobra a significant competitive advantage over IBM, whose product does not provide innovative WAN solutions as well as many of the non-IBM suppliers that also do not have innovative WAN solutions.

Competitors products are seriously lacking in capability resulting in a huge opportunity for Codex. The current market leader, IBM, can only support one WAN port. Proteon, the second largest token ring remote interconnect vendor, has a severe source routing limitation and offers little support of the IBM environment where most of the market is. Other competitors are small companies with relatively weak products and the wrong sales channels to reach the largest part of the market. Additionally, it is a rapidly growing young market with growth of over 100% per year during the time period 1992-1995.

The sales goal is to reach $50.1 million in sales representing 12% market share by 1995, which results in over a 100% compounded sales growth for Codex from 1992-1995.

0.2 PRODUCT DESCRIPTION

The Cobra product has been planned to directly compete against the IBM remote bridge product. It is differentiated by superior WAN capabilities and packaging, and by offering two price/performance levels. It will be highly comptabile with the competing IBM products, and over time, will offer increasing levels of support for IBM network management products.

The Cobra product family is based on Modulus 9/21 packaging. A Base Cobra consists of a Main Bridge Assembly, a 4 Megabit Token Ring Lan Assembly, and a backplane which can accomodate a WAN option card. A single WAN port, capable of operating at up to 128Kbps, is included in the Base unit. The initial WAN option card is a Multiport WAN Assembly, offering 4 expansion ports, with an aggregate rate of up to 512Kbps.

Subsequent developments, which are described and estimated in this SPIP, will produce another type of WAN option card, supporting T1/E1 Muxport links. In addition, a 16Mbps Token Ring Lan Assembly and a High Performance Main Bridge Assembly will be developed. All three of these future products are plug-compatible with the initial card set, and a customer can be upgraded in the field.

Cobra first ships as a source routing bridge that is compatible with IBM bridges. Future plans include adding support for the pending SRT bridging standard and router-like features. An evolving set of capabilities that integrate Cobra with IBM network management capabilities is part of the development plan.

In the future, an EtherNet LAN Assembly and attendant software will be developed, which will provide a product which replaces the current EtherSpan (6310).

As an additional capability, the LAN boards that are developed for the Cobra program are designed to be compatible with the Data Networking group's new Jaguar Plus cpu cards.

0.3 PRODUCT COST AND GROSS MARGIN BREAKDOWN

The gross margins for the Cobra product line, based on the current cost estimates and revenue plans are:

	1992	1993	1994	1995
	Standard	Margin	Percentage	
Base (Low Perf)	55%	54%	49%	44%
Multiport WAN	81%	80%	79%	76%
T1/E1 Muxport	87%	87%	85%	84%
Frame Rel. SW	98%	98%	98%	98%
Base (High Perf)	- -	63%	60%	56%
Aggregate	67%	69%	67%	64%

A summary of product cost is given below. Note that the costs for the Modulus 9/21 components is the 1991 standard cost. Although it is anticipated that the 1992 cost will be lower, there are no official estimates available at this time.

	BASE Unit 4 M Token Ring	BASE Unit 4/16 Token Ring High Perf.	Multiport WAN Option Card	T1/E1 WAN Option Card
Card Type				
Main Bridge PWB 68000	$482.93			
Main Bridge PWB High Perf		$579.27		
Token Ring I/O 4 Mbps	$317.10			
Token Ring I/O 4/16 Mbps		$360.00		
WAN I/O AUX (68302)			$321.37	
WAN I/O T1 (68302)				$387.54
Backplane five Slot	$110.54	$110.54		
Elect Cost Subtotal	$910.57	$1,049.81	$321.37	$387.54
Materials Overhead 9.5%	$86.50	$99.73	$30.53	$36.82
Labor Overhead 17%	$154.80	$178.47	$54.63	$65.88
Fully Burdened Elec Cost	$1,151.87	$1,328.01	$406.54	$490.24
Packaging Cost (1991)	$488.00	$488.00		
Fit Cost ($84)	$84.00	$84.00		
Misc panel Fillers (1992)	$18.00	$18.00		
VRTX & IFX	$30.00	$30.00		
Total Unit Cost	$1,771.87	$1,948.01	$406.54	$490.24
DIM Transition cables	$45.00	$45.00	$180.00	$135.00
Shipping container	$32.00	$32.00		
Total System Cost	$1,848.87	$2,025.01	$586.54	$625.24

0.4 PROJECT COST BREAKDOWN

The planned non-recurring costs to develop the Cobra product line are:

Phase 0 and 1	$551K
Phase 2	3802K
Phase 3	394K
T1/E1 Muxport	423K
16M LAN	451K
High Perf. Version	569K
Total	$6190K

0.5 SCHEDULE SUMMARY

The Cobra development schedule leads to an unrestricted first customer shipment in March, 1992. The key development milestones are listed below:

Phase 2 Approval-- December, 1990

Hardware design and simulation-- November,1990 through April 1991

System analysis-- November, 1990-- January, 1991

Software design-- February through June, 1991

1st pass hardware debugged-- August, 1991

HW/SW integration begins-- August, 1991

System integration-- August through November, 1991

2nd pass hardware debugged-- November, 1991

System level testing-- December, 1991

Alpha testing-- Jan through March, 1992

Class 2 hw release-- Jan, 1992

Pilot production-- Feb, 1992

Beta testing-- March, 1992

FCS-- March, 1992

0.6 DEVELOPMENT RISKS AND DEPENDENCIES

The Cobra program is dependent on continued progress in reducing the cost of the Modulus 9/21 nest in order to continue to reduce product costs as required in an evolving, competitive market.

The development schedule for Cobra is heavily dependent on adding 7 additional software engineers to the group. The timing of these planned additions has been constrained by budget limitations.

0.7 QUALITY ISSUES

The Cobra program is depending on ongoing improvement in the reliability of the Modulus 9/21 nest in order to meet its reliability goal.

The current estimates indicate that Cobra will have a hardware sigma of 5.13, versus the goal of 6 sigma for products shipping in 1992. Unfortunately, there are no process ppm failure rates available that predict where we will be in 1992 with the SMT process. Therefore, the estimate was done with current process capability data. The estimate shows that the sigma is dominated by process capabilities, and that the Cobra boards have a hardware sigma level that is virtually identical to comparable SMT Modulus boards. Cobra is dependent on efforts throughout the corporation to help attain the goal of 6 sigma.

0.8 DECISION REQUIRED

Proceed with development phase 2, as described in this plan.

COBRA PROJECT OBJECTIVES SUMMARY

Goals	Phase 0 Review 8/15/89	Phase 1 Review 12/13/90	Phase 2 Review
Quality	Hardware: Software: Reliability:	Hardware: Goal: 6 Est.: 5.13 Software: 5.7 Reliability: 75,000 hrs.	Hardware: Software: Reliability:
Time to Market (FCS)	Entitlement: FCS: September '90	Entitlement: 104 weeks Planned: 102 * weeks based on FCS of 3/30/92 * Does not include a 6 mo. resource wht space	Entitlement: weeks Actual: weeks based on FCS of

Goals		Phase 0 Review					Phase 1 Review					Phase 2 Review				
Unit Forecast		1990	1991	1992	1993	Total	1992	1993	1994	1995	Total	1992	1993	1994	1995	Total
Domestic		117	454	1506	3515	5592	620	1574	2742	5343	10,279					
International		29	194	811	2343	3377	150	472	1133	2500	4255					
Total		146	648	2317	5858	8969	770	2046	3875	7843	14,534					
Unit A.S.P.	Dom	12K	10.8K	9.7K	8.7K	9.2K	6.8K	7.4K	6.8K	6.3K	6.6K					
	Int'l	12K	10.8K	9.7K	8.7K	9.1K	7.3K	7.7K	7.3K	6.6K	6.9K					
Revenue [ISV]	Dom	1404	4903	14,608	30,581	51,496	4214	11,574	18,722	33,540	68,050					
	Int'l	348	2095	7867	20,384	30,694	1099	3635	8257	16,540	29,531					
Total Revenue		1752	6998	22,475	50,965	82,190	5313	15,209	26,979	50,080	97,581					
Product Cost (Unit)		4K	3.8K	2.2K	2.1K	2.3K	2.3K	2.3K	2.3K	2.3K	2.3K					
Std. Margin % of Rev.		67%	65%	77%	76%	75%	67%	69%	67%	64%	66%					

NRE	Phase 1	Phase 2	Phase 3	Total	89-92	1993	1994	1995	Total	89-92	1993	1994	1995	Total
Labor	$370K				2087									
Material & ODC Overhead	N/A				4104									
Total NRE	$525K				6191									
Capital	$200K				711									

Function & Performance	Phase 0	Any changes since Ph 0?			Any changes since Ph 1?		
	See Business Plan Pages 6,8,31 for a preliminary assessment	No	Yes-Minor	Yes-Major	No	Yes-Minor	Yes-Major
				X			
		See attachment for a description of change:			See attachment for a description of change:		

Changes in Objectives Since Phase 0

There have been many changes since the Phase 0 review was held. The most important ones are:

1. Refined view of competition for token ring remote bridges
2. Switch to a modular product family, spanning range of performance and WAN capabilities
3. Switch to Modulus 9/21 packaging
4. Delay in completing Phase 1 due to delay in completing EtherSpan
5. Change in FCS target from Q4, 1990 to Q1, 1992

An unsuccessful phase 1 review was held in March, 1990. There have been changes since that phase review:

1. Refined view of competitive products
2. Switch to a modular product family, spanning range of performance and WAN capabilities
3. Switch to Modulus 9/21 packaging
4. Add IBM management functions to product
5. Add WAN and LAN link diagnostic functions to product
6. Lower the estimated product cost from $2300 to $1850
7. Change in FCS target from Q1, 1991 to Q1, 1992
8. Change in engineering management

1.0 MARKET REQUIREMENTS AND PLANS

1.1 MARKET DEFINITION: THE MARKET FOR LAN INTERCONNECT PRODUCTS

1.2 COMPETITORS

1.3 THE BRIDGING VERSUS ROUTING ISSUE

1.4 PRODUCTS AND PRICING STRATEGY

1.5 RISKS AND ASSUMPTIONS

1.0 MARKET REQUIREMENTS AND PLANS

1.1 MARKET DEFINITION: THE MARKET FOR LAN INTERCONNECT PRODUCTS

LANs are rapidly becoming the predominate source of bits that get transmitted over wide area data networks. By 1994, about 80% of the PCs in a corporate environment will be connected in a network, most of them in LANs and many interconnected with host computers on the LAN. Additionally, many PC LANs are replacing the functions previously taken by mainframes and minicomputers at a fraction of the cost. Dataquest predicts that the growth of PC connections will have over a 100% CAGR from 1988 to 1991.

This growth in LANs has recently fueled a corresponding growth in remote LAN internetworking. Combined with the current EtherSpan Ethernet intelligent bridge, Cobra will allow Codex to cover remote interconnect to the two most popular LANs, Ethernet and token ring.

The market for remote bridges and routers is one of the fastest growing in the data communications industry. It is projected to grow from $286M in 1990 to $1160M in 1995, a CAGR of 25%. Token ring LANs are today growing faster from a smaller base than Ethernet.

The token ring remote interconnect market is less mature than the Ethernet segment and it is also projected to grow faster from a smaller base. Products serving the token ring bridge/router market only began appearing in 1989.

1.1.1 TARGET MARKET

The initial target customer is the MIS manager of medium to large companies which have a heavy IBM data processing environment. Today's wide area data communications in this environment is largely covered by cluster controllers and traditional wide area communications, i.e. synchronous modems and DSU/CSUs often in multidrop configurations running at relatively low speeds.

This environment is rapidly changing. Cluster controllers are being displaced by token ring LANs in many instances as IBM hosts gain LAN interfaces and 3270 terminals are displaced by PCs running on LANs. The wide area network interface comes off of a token ring bridge in this new environment rather than from a cluster controller or host front end.

This target IBM environment is one which has been a traditional market that Codex has served over the years. It matches well with many of Codex's large direct accounts.

This match also represents the largest portion of the market. Approximately 77% of the token ring LAN nodes installed today are supplied by IBM (Source:

Dataquest). A smaller percentage (approximately 40%) of these token ring LANs are actually running IBM protocols with most of the remaining running Novell's Netware. The Codex sales force, however, will overwhelmingly come into contact with IBM environments, with Netware a distant second.

Our market research and concept testing indicates that source routing (the IBM standard for token ring bridging) will increasingly dominate in token ring remote LAN interconnect applications. All of the IBM environments and and a substantial proportion of other network operating system environments in the future will support source routing. Additionally, it is planned that future software enhancements will allow the Cobra product to effectively bridge/route both source routing and non-source routing based token ring LANs so as to open the total token ring market to Cobra.

A recent activity in the IEEE 802 committee has been the promotion of "SRT" as a bridging mechanism between token ring LANs. SRT supports both source routing and transparent bridging in one mechanism and is likely to be passed by the IEEE 802 committee. However, it remains to be seen what the actual usage of SRT is in the marketplace given that IBM was forced into this position by the advocates (from the Ethernet world) of transparent bridging. If IBM does not support SRT in their products, the liklihood is that it will not be much of a marketplace factor. The Cobra token ring design will have the hardware in place to support SRT but will only support source routing at first customer ship.

The installed base of token ring LANs is overwhelmingly at 4 Mbps. The growth of 16 Mbps token ring has been slowed in 1990 due to controversy over the jitter specification. In fact, a study question has been brought to the IEEE 802 committee on this question as there are some vendors stating the specification is flawed.

The Cobra product will address the 4 Mbps token ring market first at FCS with a 4/16 Mbps token ring board planned for a future release.

The options and capability planned for EtherSpan are also being planned for Cobra but in a more migratable, "scalable" fashion. Frame relay will be available at FCS. The T1 "muxport" will be available in a second release. Extensive span diagnostics for enhanced "plug and play" capability are also planned.

1.1.2 MARKET PROJECTIONS

Market studies do not break out Ethernet versus token ring remote interconnect products. The latest worldwide numbers for the total available market for bridges and routers is shown in Table 1 below:

Category	1990	1991	1992	1993	1994	1995	CAGR
Revenue ($M)	286	452	602	794	953	1160	25%
ASP ($K)	8.0	7.0	6.5	6.0	5.9	5.8	-7.7%
Units	35750	64571	92615	132333	161525	200000	35.7%

Table 1
Remote Bridge and Router TAM
(Source: Codex)

The equivalent numbers for token ring only may be derived in 1990 by the following methodology: The installed base of Ethernet interface cards exceeds token ring by about 2:1. Additionally, the average number of nodes on a token ring LAN is 2.5 times that of the average Ethernet LAN, resulting in a token ring LAN installed base that is 1/5 the size of the Ethernet installed base. Adding a small factor for the immaturity of the token ring market, we come up with a market size for token ring remote interconnect that is 15% of the total in 1990. From this, and knowing the growth of token ring LANs, an estimate in the out years can be made. This result is shown in Table 2 along with the percentage market share for token ring. It is also assumed that LAN based protocol routers will only have a small role in the token ring market place.

Category	1990	1991	1992	1993	1994	1995	CAGR
Revenue ($M)	42.9	90.4	150.5	238.2	333.6	464.0	57.9%
% Total (Rev.)	15	20	25	30	35	40	
ASP ($K)	8.5	8.0	7.0	6.5	6.2	6.0	-7.8%
Units	5047	11300	21500	36646	53806	82333	72.6%

Table 2
Token Ring Remote Bridge and Router TAM

The served available market for the Cobra product is initially that portion that supports the IBM backed source routing protocol until Cobra has the capability of supporting non-source routed LAN software. By 1993, the Cobra platform product line will be enhanced to support both source and non-source routing based LAN systems simultaneously. This will serve to increase Cobra's market penetration in non-IBM environments.

Table 3 shows the served available market that Cobra addresses. This initially is the subset known and/or assumed to support source routing.

Codex has the opportunity to be a dominate player in this market. It is a market in its infancy and is a perfect match with Codex's customer base and sales channels. We are conservatively targeting a 12% market share for Codex by 1995 as shown in Table 3.

Category	1990	1991	1992	1993	1994	1995	CAGR
Revenue ($M)	17.2	40.7	75.3	190.6	300.2	417.6	87.7%
SAM/TAM (%)	40	45	50	80	90	90	
Units	2019	5085	10750	29317	48425	74100	104.4%
Codex Rev. ($M)	0	0	5.3	15.2	27.0	50.1	103.7%
Mkt. sh. (% SAM)	0	0	7.0	8.0	9.0	12.0	

Table 3
Token Ring Remote Bridge and Router SAM

1.2 COMPETITORS

As mentioned previously, the remote LAN internetworking market for connecting together token ring LANs over wide area networks is in its infancy. Virtually all of the shipments made in 1989 were from IBM in the bridge category and from Proteon in the router category. The IBM dominance has continued into 1990 although a number of smaller suppliers have managed to gain some level of acceptance.

IBM

Our concept testing for Cobra indicated displeasure from many possible buyers with the IBM product. Many said they bought the IBM product simply because there were no viable alternatives.

IBM is historically weak in providing optimized WAN solutions for its customers. For example, it only supports one WAN port in their bridge. The Cobra strategy against IBM is to provide a very high set of functionality vis a vis the IBM environment while at the same time provide significant WAN support, e.g. frame relay, T1 muxport, suppression of source routing overhead traffic, as well as support of non-IBM environments for mixed applications.

IBM will nevertheless remain a formidable competitor.

PROTEON

Proteon is specializing in token ring routers. After IBM, Proteon is probably the second largest supplier of token ring LAN adapter boards and has been in the token ring business from the beginning. Proteon also has proprietary token ring products, most significantly an 80 Mbps backbone token ring product. Most of their token ring router sales are taking place into their significant installed base of token ring LANs and that they are not much of a presence in IBM environments. Not one of the concept test potential customers had Proteon equipment nor were they considering them.

Proteon provides combination products that source route the source routing frames, and routes other higher layer protocols such as TCP/IP, DECNET and IPX. Their source routing implementation is also not very competitive, as it only supports 1:1 source routing rather than 1:N due to a limitation in their hardware architecture. This means that the Proteon unit only supports one WAN port from one LAN port.

Additionally, Proteon provides virtually no support of the IBM environment besides being able to do source routing. For example, it does not support NETVIEW alerts, Ring Error Monitor, or LAN Network Manager.

OTHERS

Although only IBM and Proteon had significant shipments of remote bridge/router products in 1989, there are many others scrambling to come out with products. Virtually every Ethernet bridge/router supplier has either announced token ring support or is known to be working on products supporting token ring. Most of these new suppliers are relatively small companies and suffer or will suffer from not having the sales channels into IBM oriented accounts where most of the business for this type of product lies.

Today, there is a group of companies with token ring bridging products that are not very large factors in the marketplace. Some of these are:

* Microcom
* Halley Systems
* Andrew
* Vitalink

All of these competitors have sales channel problems in selling these products effectively. For example, these competitors sell primarily through indirect channels where token ring LANs are not a significant factor. These products also have only minimal support of the IBM environment. Cobra competes with these products by having a combination of a high level of IBM compatibility combined with optimal WAN usage capability as well as the fact that Codex is of a company size to be a viable IBM alternative.

1.2.1 COMPETITOR PRICING

The pricing of some competitors' products is shown in Table 4 and compared to Codex with Cobra (see section 1.4 for proposed Cobra pricing). These are for one WAN port unless otherwise stated.

Vendor	List Price	Comment
Codex	$5495 (low end)	Supports 4 Mbps, 128K WAN
	$7495 (high end)	Supports 4/16 Mbps TR
IBM	$7500	Supports 4/16 Mbps TR
Proteon	$8990	Supports 4/16 Mbps TR
Microcom	$5999	Recent price reduction
Halley Systems	$8295	Includes data compression
Vitalink (530)	$12750	Does not support source routing, 4 WAN ports
(550)	$17250	Same comment as 530 except high performance

Table 4
Base Unit List Prices

Additional WAN ports are also a pricing factor. This same list of competitors is shown in Table 5 with the cost per additional WAN port.

Vendor	List Price/WAN Port	Comment
Codex	$999	4 port V.35 card
	$250	Muxport + 2 V.35 ports
IBM	-------	Only supports 1 WAN port
Proteon	$1435	2 port card
Microcom	$1899	Includes 2:1 compression
Halley Systems	$1700	
Vitalink	$625	550 only, 4 port card

Table 5
Additonal WAN Port List Prices

As can be seen from the Table 5, Cobra is very price competitve in its ability to add WAN ports very inexpensively. This table also shows the advantage of the "muxport".

1.3 THE BRIDGING VERSUS ROUTING ISSUE

Routers have become a major force in providing LAN interconnect over wide area networks in Ethernet environments. This grew out of TCP/IP environments, which are primarily in UNIX and workstation based Ethernet LANs. These application environments are heavily engineering oriented and it is not unusual to have large amounts of data traffic.

The token ring application environment is totally different. Token ring applications are typically in IBM environments or used for general purpose non-engineering applications. These applications are usually more interactively based with smaller traffic requirements. However, the average number of nodes is larger on token ring than on Ethernet.

The combination of lower traffic requirements, the predominate IBM environment, and the fact that source routing, the standard for token ring bridging, is in fact a low end router, leads to the conclusion that LAN protocol based routers will be a minor market factor in the token ring environment. Yet there is still a need in very large networks for router like features.

The question then is: What is the future vision for the Cobra family of token ring LAN interconnect products? The answer lies in addressing some of the reasons found by our market research about what led customers to buy routers rather than bridges in the Ethernet environment.

It was found that users do not buy routers for their routing capabilites; rather they bought routers for other benefits they provide. These benefits are basically two:

1. Elimination of "broadcast storms", which are large amounts of overhead traffic that can flood the wide area links.
2. Segmentation of large networks into multiple sub-networks. This provides two principal benefits; more manageble networks that can be managed on a sub-network basis and a higher level of access security where an unauthorized

access will not gain access to the global network but simply the smaller sub-segment.

Routers also have a major disadvantage to the user which may outweigh their advantages. This disadvantage is that they can be a configuration problem to the network manager. Changes in the network architecture usually require manual configuration changes to the routers in the network, a major task especially in networks where changes happen often. In fact, there is anecdotal evidence which suggests that many users who have purchased routers actually do not use the router function but rather use them as bridges because of the configuration complexities.

Additionally, the protocol sensitivity of routers has led to multiprotocol versions which adds a whole new dimension of complexity to these products. Additionally, today there is no such thing as an "SNA router", so that SNA traffic must be bridged in the heavily SNA oriented IBM environment. There is work being done by IBM on a version of SNA called Advanced Peer to Peer Communications (APPC) which may have a routing capability in future, which would mean that an SNA router may then be possible to implement. This is a development to watch very closely.

Although this router information was derived from market research applicable to Ethernet LANs, much of it also applies to token ring LANs. Source routing can also create "broadcast storms" and the segmentation issue is still present. *Thus, the future direction is to add router like capabilities to Cobra without the corresponding negatives associated with LAN protocol routers.*

1.4 PRODUCTS AND PRICING STRATEGY

Cobra is planned to provide a spectrum of products all housed in Modulus II nests. Scalability and migration are the overall themes to allow users to pay for only what they need while at the same time allowing for easy migration to allow users to easily and cost effectively upgrade their network without having to replace their LAN internetworking device.

The basic low end unit ("Base" unit) consists of the "low end" CPU board, which includes the floppy drive, and the LAN board, 4 Mbps token ring being the first available. The CPU board includes a V.35 port which can operate up to 128 Kbps.

To the basic unit can be added different WAN boards. The first available is the multiple V.35 port (Multiport WAN) board, which supports four ports. This board combined with the low end CPU board supports an aggregate data rate of 512 Kbps. A second release of this board will add data compression using the VLSI chip being developed in CAPE. A second release also provides a WAN board with a T1/E1 DSO formatted "muxport" along with two V.35 interface ports.

A follow on development is a high end CPU board which can give approximately four times the throughput and which is compatible with any of the LAN or WAN boards and which runs software compatible with the Base unit. This board combined with the 4/16 Mbps LAN board consists of the "High Performance" Base unit.

There are a number of software options available with the different hardware option modules which all together forms a product family.

The product matrix and the proposed list prices for these products are given in Table 6.

Product		**List Price**	
	HW	**SW**	**Total System**
Base product with (4 Mbps LAN board)	$4995	$500	$5495
4 port V.35/X21 (Multiport WAN)option	$3995	*	$9490
T1 + 2 V.35 port (Muxport) option***	$6500	*	$11995
Frame Relay SW		$1995	Add to above
High Perf. Base unit with (4/16 Mbps LAN bd.)***	$6995	$500	$7495**

Table 6
Proposed Pricing Plan

Note: * Base software supports all WAN port cards.
** Option WAN boards supported by both CPU cards.
*** Not availabe at FCS

1.4.1 FUTURE LAN SUPPORT

It is intended that Cobra will serve as the hardware platform for the future. As such, there are plans to develop an Ethernet LAN card and the software to go with it. When this becomes available, it will end up displacing the current EtherSpan product.

1.4.2 INTEGRATION WITH OTHER PRODUCT LINES

The LAN card (first for 4 Mbps token ring, later 4/16 Mbps token ring and Ethernet) is designed such that it can mechanically and electrically interface to future Jaguar CPU cards. This will give Jaguar the ability to interface into LANs with a bridged port that is built into their product.

Additionally, the 9 slot Modulus II nest can house two 3500 DSU/CSUs in addition to EtherSpan. As other products become available in Modulus II form factors, they will also potentially be able to coexist in the same nest with Cobra. This ability will also be expanded once the 21 slot Modulus nest becomes available.

1.4.3 PROJECTED FACTORY COSTS

Projected factory cost in 1992 is $1850 for the low cost CPU and 4 Mbps LAN board (Base unit), $2025 for the high performance CPU and 4/16 Mbps LAN board (High Performance Base unit), $585 for the four port (Multiport) WAN option, and $625 for the T1 "muxport" + 2 V.35 port WAN board option. The frame relay software option is assumed to have a factory cost of $25 (the cost of a floppy, documentation, and packaging).

1.5 RISKS AND ASSUMPTIONS

Assumptions:

* Source routing dominates the token ring LAN interconnect market
* High support for IBM network management is important
* 9800 support will be forthcoming in a timely manner
* Growth projected depends on steady introduction of new features/capabilities

Risks:

* Slippage in schedule would impact our ability to be a market leader.
* Slippage in 9800 support will hurt our ability to sell into the Codex customer base.
* Non-IBM environments come to dominate in token ring LANs.
* IBM comes out with a hot product

2.0 PRODUCT DEFINITION AND PRODUCT DESIGN OVERVIEW

2.1 OVERVIEW

2.2 FUNCTIONAL CHARACTERISTICS

2.3 COMPATIBILITY

2.4 DESIGN ELEMENTS SHARED WITH OTHER CODEX PRODUCTS

2.5 INTENDED RELEASES

2.6 OTHER MAJOR FUNCTIONS CONSIDERED BUT NOT INCLUDED

2.7 POSSIBLE FOLLOW-ON DEVELOPMENTS

2.8 ANTICIPATED SPECIALS

2.0 COBRA PRODUCT DEFINITION AND PRODUCT DESIGN OVERVIEW

2.1 Overview

The overriding goal of the Cobra program is to enter the emerging market for Token Ring interconnectivity as early as possible with a competitive product. As described in the market requirements section, the primary competition being targeted is the IBM Remote Token Ring Bridge.

The Cobra Token Ring Remote Bridge has been defined to match the requirements for a product to be sold primarily into IBM environments. As such, emphasis has been placed on being compatible with the IBM bridges and with providing features to help the Cobra integrate within the IBM communications environment. Initially, Cobra will be differentiated from IBM's bridges primarily via richer WAN capabilities, superior packaging, and lower price. Subsequent releases will add functionality that will give us feature-for-feature parity with the IBM products as well as proprietary schemes to overcome key limitations of the IBM bridges.

Following on the key marketing strategy of offering scalability/migration to our customers (buy only the performance or capabilities that you need, with easy upgrades as your network evolves), Cobra has adopted a modular design. A variety of WAN configurations can be obtained by selecting from a family of WAN interface cards. Two price/performance levels of the Main Bridge printed circuit board allow flexibility in configuring a solution to match the traffic. The Modulus 9/21 packaging allows for simple field upgrades to the configuration.

The Cobra development program actually creates an entire family of second generation bridges for Codex, spanning a range of price/performance, and ultimately covering both Token Ring and Ethernet environments.

Finally, a spin out of the development program is the provision of a family of LAN daughter boards that will be used in both Cobra bridge products and in future Jaguar versions, to provide integrated network connections.

2.2 Functional Characteristics

2.2.1 LAN Support

Cobra includes one LAN port, which is fully compatible with the IEEE 802.5 and IBM Token Ring Standards. The port operates at a ring speed of 4 megabits per second.

As a fully compliant station on the token ring, Cobra supports the extensive error detection, error recovery, and maintenance features defined by the 802.5 standard.

2.2.2 WAN Support

The base Cobra includes a single synchronous data port that supports speeds from 9.6 Kbps to 128Kbps. The port can be configured via a DIM module to meet a variety of interface specifications. It is intended to connect to a DSU/CSU or T1 Multiplexor in order to provide a communications link to another Cobra.

A Multiport WAN Option card can be added to the base Cobra. This card offers an additional four synchronous data ports that can support aggregate speeds up to 512Kbps. One of the four ports can be clocked at up to 512Kbps, while the other three ports each have a 256Kbps maximum rate. Each port can be configured via a DIM module to meet a variety of interface specifications.

A software option is offered that provides Frame Relay Feeder Support on any one of the synchronous WAN ports. This allows a single Cobra port to exchange information with up to 32 other Cobra bridges through a Frame Relay network.

Additional WAN hardware and software capabilities are planned to be added in the future.

2.2.3 Bridging capabilities

Cobra implements the Source Routing Bridging Protocol, as specified in IEEE 802.5 and IBM documents. This protocol entails having stations involved in end-to-end communications with each other explore and then select a route through the bridged network at the start of every communications session. Source routing bridges (such as Cobra) participate in the route exploration process. Once the end stations have selected a route, subsequent traffic is placing on the network with a specified route indication, which is used by the bridges to forward the traffic.

User configurable traffic filters are provided to allow a user to selectively block traffic in the bridged network, to manage the available WAN bandwidth an to implement some degree of network security and isolation.

2.2.4 Performance

The base Cobra, with its integral WAN port, has a traffic forwarding capacity of 230 frames per second/128Kbps in each direction (LAN to WAN and WAN to LAN). Table 1 illustrates what this forwarding performance means for various size frames.

Performance of Base Cobra at Various Frame Lengths

(port max speed is 128Kbps)

Frame length	Frames/sec	Bits/sec
64	230	118000
100	160	128000
150	107	128000
200	80	128000
250	64	128000
500	32	128000
1000	16	128000
1500	11	128000

When the Multiple V.35 WAN Option card is added, the traffic forwarding capacity increases to 375 frames per second/512Kbps in each direction. Table 2 illustrates what this forwarding performance means for various size frames.

Performance of WAN Option Cobra at Various Frame Lengths

(port max speed is 512Kbps)

Frame length	Frames/sec	Bits/sec
64	375	192000
100	375	300000
150	375	450000
200	320	512000
250	256	512000
500	128	512000
1000	64	512000
1500	43	512000

2.2.5 Bridge Management

Cobra provides a CTP (Control Terminal Port) that allows a user with a VT100-compatible terminal to configure and monitor the unit. The man-machine interface has the same style as used in the EtherSpan (6310) product.

An integral floppy disk drive is used to load diagnostics and operating software. Bridge configuration data and an event log can also be saved and loaded from this device.

As with EtherSpan, the CTP allows a user to configure each port, the forwarding behavior and filters. In addition, events and alarms are generated by the bridge and are displayed and logged on disk. Statistics concerning normal and abnormal operations are accumulated and can be viewed.

A VT (Virtual Terminal) capability allows a user to connect his CTP terminal to any Cobra in the extended network. Events from any Cobra in the extended network can be sent to any other Cobra to be logged on its disk. These features facilitate centralized management and troubleshooting.

Cobra offers specific improvements over EtherSpan in the areas of statistics gathered, and the robustness of the VT and Remote Event Reporting features. In addition, it includes a new feature that allows the configuration of a bridge to be loaded or saved from the disk of another Cobra on the network. This enhances the ability to centrally manage the network.

2.2.6 Management via 9800

The Cobra will be supported by an OI running on the 9800 at FCS. This will allow a user to configure and manage any Cobra in the extended network from a CTP emulation window on the 9800 console. The OI also allows Cobra events and alarms to be logged and displayed.

The Cobra software utilizes a "back end agent" that operates on "CMMS" messages, as used by the 9800. This means that the amount of software that will need to be changed or added in the Cobra to support full 9800 integration is minimized.

2.2.7 Integration with Relevant IBM Products

Since the primary market target for the Cobra bridge is IBM computing environments, it is important that our product interoperate with the key pieces of the evolving IBM distributed architecture.

2.2.7.1 IBM Network applications

Cobra will provide an extended bridged network to all network applications that utilize a protocol stack that supports source routing. In today's IBM distributed environment, this means Netbios and PC/3270 Gateways.

2.2.7.2 IBM local bridges

Cobra can interoperate on a network with IBM local bridges. A route through the network can include hops across both IBM local bridges and Cobra bridges, in any sequence. The presence of the mixed types of bridges is transparent to network applications, except for the LAN Network Manager, as described below.

2.2.7.3 IBM remote bridges

Cobra can interoperate on a network with IBM remote bridges. A route through the network can include hops across both IBM local bridges and Cobra bridges, in any sequence. The presence of the mixed types of bridges is transparent to network applications, except for the LAN Network Manager, as described below.

2.2.7.4 IBM LAN Network Manager

The LAN Network Manager (renamed from LAN Manager to avoid confusion with the Microsoft LAN Manager network operating system) is a tool for managing token ring networks. It includes features for configuring aspects of the token ring protocol in stations on the ring, for detecting ring malfunctions, for troubleshooting, and for automated fault recovery on the ring. As a station on the token ring, Cobra can be managed by the LAN Network Manager.

In an extended bridged network, the LAN Network Manager relies on "management servers", which reside in IBM local and remote bridges, to extend its capabilities to stations that are not on the same physical ring as the LAN Network Manager. In addition, one of these servers allows the LAN Network Manager to manage token ring bridges. At FCS, Cobra will not include these servers, and consequently, a network including Cobra will not provide the full capabilities of the LAN Network Manager. However, a future release of Cobra software is planned to add support for these servers, and the software and hardware architecture at FCS are specifically designed to accomodate these capabilities.

2.2.7.5 IBM Netview

Cobra can send an alert covering a variety of bridge conditions to the IBM Netview program for logging and display. The mechanism used to transport the alerts is the so-called "alert transport service" incluoed in the IBM LAN Network Manager. Any Cobra in the extended network can send its alert to the LAN Network Manager, which locally displays and logs the event, and forwards it directly to the Netview system, without having to travel through a PC/Netview service point. This feature is planned for FCS with Release 1.0.

2.2.8 Packaging

Cobra is a Modulus 9/21 product. It consists of a unique backplane (occupying 5 slots of space in a nest), and several types of Modulus 9/21 printed circuit boards. A fully populated Cobra backplane contains two main printed circuit boards and one daughter board. Surface mount technology is used in the production of all the boards. Those boards are:

Main Bridge Assembly (contains main bridge circuitry, integral WAN port, CTP port, and floppy disk drive)

4 Megabit/sec Token Ring LAN daughter board (contains token ring interface plus circuitry to accelerate bridging algorithms. The daughter board connects to the Main Bridge Assembly.)

Optional Multiplort WAN expander card (contains additional four WAN ports)

Cable connections for LAN, WAN and CTP ports are made to connectors mounted on the backplane, and accessed from the rear of the nest.

The design of the Cobra hardware follows all Modulus 9/21 guidelines except one. Electrical design constraints force the connector for the LAN cable to be mounted directly on the LAN daughter board, as opposed to on the backplane. The consequence of this is that the LAN daughter board/ Main Bridge Assembly combination will be secured to the nest via two captive quick release fasteners accessed from the rear of the nest. This means that although the assembly can be installed and removed from the front of the nest the LAN cable and the two fasteners must be removed before the cards can be unplagged. A special warning legend will be present on the front panel of the Main Bridge Assembly to remind users to remove the LAN cable and retaining screws before attempting to remove the assembly. Alternative design approaches that supported the full front pluggability of Modulus 9/21 were rejected, as none could be found that did not pose serious disadvantages to the development cost, schedule and the product cost.

At FCS, Cobra will be supplied in a 9-slot nest, and will be tested for interoperability with two 3500 DSU/CSU units occupying the same nest. Additional configurations will be tested after FCS.

The Cobra backplane design and pinout allows the option of producing an additional backplane type in the future that would support two WAN option cards without any change to existing cards. This would provide configurations with greater flexibility and quantity of WAN ports.

2.2.9 Serviceability

The Cobra hardware diagnostics isolate failures to individual circuit boards, each of which is treated as a field replaceable unit. The failed board is identified via front panel LED indications and messages on the CTP.

The bulk of the hardware diagnostics for Cobra are loaded from disk after initial ROM-based tests are run. This allows for ongoing upgrading of the diagnostics to improve the fault detection and isolation capabilities without any prom upgrade activities.

Statistics and events produced by Cobra during bridging operations provide indications of network problems.

Cobra includes specific diagnostic tests that can be used to identify faulty WAN links and identify the faulty link element (Cobra port, cable, DSU/CSU, link).

In addition, Cobra includes specific diagnostic tests that can be used to verify connectivity between Cobra and a token ring end station in the extended network.

The various WAN and LAN options to be made available for Cobra are designed to be field installable by either customer or Codex personnel.

2.3 Compatibility

2.3.1 With Codex Products

Cobra follows the design specifications for Modulus 9/21 products, and can share a nest with other Codex products. Four slots are availabe in a 9 slot Modulus 9/21 nest when a Cobra is installed. This will allow a Cobra and two 3500 DSU/CSUs to be installed in a single 9 slot nest.

Cobra will operate with a variety of Codex transmission and networking products that provide WAN links: 3500, 6250, 6290, and Batman.

Cobra cannot interconnect with EtherSpan. However, the two types of bridges can coexist on the same WAN backbone as long as they occupy separate subnetworks, with separate transmission links. The CTP interface presented by Cobra is compatible with that employed on EtherSpan.

2.3.2 With Industry Standards

Cobra is compatible with IEEE 802.5 and IBM Token Ring standards. Where there are conflicts between the two sets of standards, Cobra will conform to the IBM standards.

In addition, Cobra conforms to RS-232 and VT-100 standards on its CTP port, and to V.35, V.36, RS-232, and V.11 (permanent circuit) standards on its WAN ports.

Cobra will comply will the following standards for product safety:
UL478
UL1950
CSA C22.2 No. 220-M1986
EN 60 950
IEC 950
IEC 380
VDE 0806/08.81

Cobra will comply with the following standards for electromagnetic compatibility:
FCC Part 15J, Class A
DOC SOR/88-475, Class A
C.I.S.P.R. Publication 22, Class A

Cobra will comply with the following telecommunications regulations:
FCC Part 68
DOC CS-03

2.3.3 With Competitors' Products

Cobra is compatible with any token ring local or remote bridge that supports source routing as per the previously mentioned standards. The product will be tested for interoperability with IBM bridges.

2.4 Design elements shared with other Codex products

The Cobra design shares certain elements with other Codex products. It uses the following shared elements: Modulus 9/21 nest and power supply family, Maverick DIMs for WAN port personality, and 9800 OI for network management. In addition, the WAN option card is designed to accept the CAPE data compression ASIC in a future release. A future release of software will incorporate the full NOS stack to support 9800 integration, and an LLC type 2 layer, to support communications with the IBM Lan Network Manager.

In addition, the Cobra program will provide certain elements to be used in future Data Networking products. These are the LAN daughter board assemblies, which are intended to be used with the Jaguar + family of cpus to provide integrated LAN feeder capabilities for the X.25 switches.

2.5 Intended Releases

The releases described in this section are viewed as integral parts of the Cobra Token Ring bridge being proposed at this Phase 1 review. The costs for these releases is included in this SPIP. The Phase 2 review will be held prior to FCS of Release 1. The costs for completing the Release 1.1 are included in the Phase 3 estimates. The costs for the other releases are included as separate estimates in Section 6 of this SPIP.

The sections on "Other Major Functions Considered" and "Possible Follow-On Developments" describe additional enhancements to the product line that are being considered, but are not covered in this phase review.

2.5.1 Release 1- FCS of Base Product

The first release consists of the 4Mbps Token Ring Source Routing bridge, with frame relay support and the integral synchronous WAN port. The unrestricted FCS is planned for March, 1992, with customer testing starting in January, 1992, and class 2 release of hardware in January of 1992, and a pilot build in February, 1992.

2.5.2 Release 1.1- Multiport WAN Option

The unrestricted FCS of the optional 4 port WAN expander is planned for April, 1992. This release will also include interoperability testing with IBM bridges.

2.5.3 Release 2- T1/E1 Muxport

A second type of WAN option card is planned for future release. It will contain a T1/E1 Muxport and possibly 2 V.35 ports as well. In addition to the Muxport capabilities offered in the current EtherSpan, this card will also offer frame relay feeder support. It will be developed after the initial set of cards, and is targeted for FCS in July, 1992. Ideally, this capability would be available at the same time as Release 1.1. This could not be achieved with the resources availabe for Cobra development.

2.5.4 Release 3- 16Mbps Token Ring

A second flavor of LAN daughter board, supporting both 4 and 16 Mbps token rings (software selectable speeds) is planned for future release. It is targeted for FCS in October, 1992.

This capability has been consciously removed from Release 1 due to a variety of risks associated with 16 Mbps token ring. The principal risks are: interoperability problems on 16Mbps rings, instability in the 802.5 standard for 16Mbps, increased design risk for 16Mbps LAN board versus 4Mbps version, and increased supplier risk for key components (from Motorola and others) required for the 16Mbps version.

2.5.5 Release 4- High Performance Bridge

The Cobra products described for the release listed above offer 128Kbps to 512Kbps forwarding rates, depending on configuration. Market opportunities exist for higher forwarding rates-- either on higher speed V.35 ports, or via the planned T1/E1 option card. Our plan is to address those market opportunites via a higher performance version of the Main Bridge assembly. The higher performance unit is fully compatible with the LAN and WAN option cards, and can be installed as a field upgrade. It is intended to support configurations that offer up to 2Mbps forwarding rates, to fully exploit an E1 link.

The decision to offer two performance levels of bridge allows us to offer a competively priced entry unit which meets a large segment of the market. We cannot develop both flavors simultaneously with the available resources, and have chosen to start with the lower performance unit, which matches how customer needs evolve. The development of the higher performance bridge will be primarily a hardware project, as a consequence of the architecture adopted for the Cobra software. The FCS for this option is targeted for October, 1992.

2.6 Other Major Functions Considered But Not Included

A variety of additional capabilities have been identified which would be attractive to include in Cobra. These have not been included in the plans for the specific releases mentioned above due to a variety of schedule, cost, and risk considerations. The costs and schedules for these capabilities are not covered in this SPIP. It is our intention to develop and release these capabilities as important additions to the product line. Plans to develop these items will be presented to the PAC committee as they are available.

2.6.1 IBM Management Servers

As mentioned in the section on Integration with Relevant IBM Products, it is highly desirable to include "IBM management servers" in the Cobra in order to preserve the full capabilities of the IBM LAN Network Manager in an extended network. The Cobra hardware at FCS will be capable of supporting these servers. It is our intention to plan, get approval, and commence development of these servers as soon as the software for the Cobra Release 1 is fully staffed.

2.6.2 Integrated 9800 support

As mentioned in the section on "Management via 9800" the software design includes the major features necessary to provide fully integrated 9800 support. Plans for developing the fully integrated support will be developed in conjunction with the Network Management Group.

2.6.3 Fancier Netview support

Release 1 of Cobra provides the ability to generate a summary bridge alert to Netview via a well-integrated mechanism. This will allow us to make the basic marketing claim that we "support Netview." Additional bells and whistles such as multiple types of alerts and user configurability of the alert generation process were considered, but judged to be not worth delaying the FCS date for Release 1. Furthermore, we would prefer to get actual customer feedback on the basic Netview alert feature before we go about enhancing it.

2.6.4 Data Compression

The hardware design of the Release 1.1 Multiport WAN option card and the Release 2 T1/E1 card support addition of the CAPE data compression chip. Development and release of these optional versions of the card was judged to be not worth delaying the FCS date for release 1.1.

2.6.5 SRT Routing

The IEEE is expected to adopt a new bridging standard, called SRT (source routing transparent) as an addendum to the 802.1d standard. The Cobra hardware is capable of providing this capability if appropriate software is developed. The capability has been consciously eliminated from the planned Cobra releases for several reasons: it takes additional time to develop versus pure source routing, IBM bridges do not implement the SRT technique, and IBM support for the SRT technique is uncertain and they may go in a different direction. We have decided to get to market with a competitive source routing bridge and watch industry developments carefully. Rather than delay FCS in order to offer this capability, we plan to follow IBM's lead. If they take a different tack, we would rather expend development resources developing the new IBM scheme.

2.6.6 Route exploration spoofing/broadcast storm minimization features

An acknowledged weakness of both source routing and transparent bridging is the tendency to flood the network with "overhead" traffic during route exploration or learning. Bridges that incorporate features to lessen these adverse effects would counter a significant advantage claimed by routers. The capability has been consciously eliminated from the planned Cobra releases for several reasons: it takes additional time to develop, any scheme we develop at this time would be proprietary, and IBM bridges do not offer this capability. We fully intend to offer some sort of capability in this area in future releases.

2.6.7 More elaborate filters

Cobra is planned to provide a basic set of filter capabilities that operate on MAC addresses. Additional types of filters can be designed, to operate on fields in higher layer protocols (such as network addresses), or to provide general-purpose flexibly defined filters. We have chosen to wait for customer feedback after Cobra FCS, rather than include these capabilities in the first release.

2.6.8 More extensive network troubleshooting tools

Cobra includes features for troubleshooting problems on token ring LANs. A longer list of such features could be offered which would offer capabilities available in LAN analyzers, the IBM LAN Network Manager, the IBM Token Ring Network Trace and Analysis program, and various utilities included with protocol stacks. These features would allow Cobra to serve as a single stop integrated network troubleshooting station. We have decided not to include these features for the following reasons: they would add time and expense to the Cobra schedule, they would duplicate capabilities available today in other products, and our experience with EtherSpan to date has been very few problems encountered during installation as a result of interactions between the bridge and the LAN or end stations.

2.6.9 WAN support

This feature was not included in the plans for Release 1 because it would delay the schedule. Ultimate plans for offering X.25 WAN support within Cobra will depend on the plans for integrating a LAN bridge feeder into future Jaguar X.25 switches and on the market acceptance of frame relay as an alternative.

2.6.10 WAN Link backup/restoral

The source routing protocol places the responsibility of detecting a failure in the route through the network on the end stations. They can then explore for an alternate route and continue communicating. It would be desirable for the bridges to offer a feature that automatically switched over to an alternate WAN link in the event of a failure on a WAN link being used between two bridges.

This would be transparent to the end stations, and would avoid the overhead of additional route exploration.

This feature was was not included in the plans for Release1.1 because it would delay the schedule. It will be developed and will be offered on one of the subsequent releases in 1992.

2.6.11 Remote program distribution

It would facilitate the central management of a network if software upgrades could be installed on unattended remote Cobras from a central Cobra. The provision of this feature would require a higher capacity storage device (either a hard disk, a non-standard floppy or a RAM disk) than the standard floppy drive included in Cobra. Such a device would add significant cost to the Cobra product, and hence has been rejected from the current plans. The backplane pinout assignments have been selected so that a future version of Main Bridge pcb could be developed that communicates with a future hard disk card. In such a case, the WAN option cards and LAN daughter cards would not need to be redesigned.

2.7 Possible Follow-on Developments

The following major features are possible evolutions of the Cobra product line.

2.7.1 Ethernet Version of Cobra

The Cobra architecture allows an Ethernet remote bridge to be developed by creating an Ethernet version of the LAN daughter board and modifying some of the Cobra software. The Main Bridge pcb and all WAN pcbs, as well as the backplane, would be unchanged.

When such a product is released, it will replace the EtherSpan bridge. At this time, the schedule and priority for this development versus planned enhancements to the Token Ring Cobra products has not been established.

2.7.2 Additional WAN capabilities

Another version of the Cobra backplane could be developed to allow a single bridge to support two WAN option cards, giving up to 9 synchronous "V.35" ports, or 5 "V.35" ports and a T1/E1 Muxport. In addition, a future synchronous WAN card could be developed that supports link speeds greater than 512Kbps.

2.7.3 SRT Bridging

As mentioned previously, SRT Bridging is likely to be adopted as an IEEE 802 standard. If sufficient market demand is perceived, we would create a future release of Cobra software to support this capability.

2.7.4 Routing

Software to route various protocols that do not support source routing could be developed. This could turn Cobra into a bridge/router. Of particular interest is the evolution of routing extensions to the SNA architecture, called Advanced Peer-to-Peer Communications (APPC) by IBM. The specifications for this are neither finalized or published yet.

2.7.5 Router-like features

Another path would be to add features to a source routing Cobra bridge that incorporate key advantages perceived to come with routers. These features include streamlining of the route discovery process (IBM is reported to be working on enhancements to the source routing protocol to achieve this) and access security provisions. Such a product would offer the key advantages of routers with the simplicity and lower price of a bridge.

2.8 Anticipated Specials

No special versions of Cobra are anticipated.

3.0 HARDWARE DESIGN

3.1 HARDWARE OVERVIEW

3.2 SUMMARY OF DESIGN APPROACH

3.3 SOURCES OF MAJOR PARTS

3.4 COMPATIBILITY

3.5 ELECTRICAL QUALITY/RELIABILITY GOALS

3.6 REGULATORY/INTERNATIONAL GOALS

3.7 PATENTS

3.8 COST REDUCTION MEASURES

3.9 RELEASE 2 PLANNED HARDWARE ACTIVITY

3.0 HARDWARE DESIGN

3.1. HARDWARE OVERVIEW

This sections summarizes the Cobra hardware effort. The primary emphasis of this section is release 1 of the product.

Cobra will utilize the 9 slot Modulus 9/21 enclosure and power supply. It will require five backplane slots. Of the five slots, two will have physical connections to the backplane both using a standard 240 position edge card connector. With the use of only five slots, Cobra will be capable of coexisting with a variety of two slot products including a modulus version of the 3500 currently under development at Codex.

The first slot supports the main Bridge PWB. This PWB will contain the packet forwarding MPU engine of the product, LAN Interface daughtercard, Management MPU, integral data port, CTP port for device control, floppy disk drive (1.44 Mbyte formatted) for device storage, and an interface to the Cobra backplane.

Due to electrical requirements of the various LAN interfaces, Cobra will have a cutout in its backplane providing direct rear cable access to an I/O connector mounted on the LAN Interface PWB. The bus interface between the LAN Interface and main Bridge PWB has been specified to allow for this daughtercard's use with the new Jaguar CPU+ card currently under development by the data networking group.

The second slot will support a single WAN I/O option PWB. The first WAN I/O option card will be the multiport WAN card. The DIM interface modules and cables developed by the maverick group will be used to provide the proper electrical interfaces.

Below you will find brief descriptions of the above mentioned PWB assemblies.

3.1.1. MAIN BRIDGE PWB DEFINITION

Fig #3.1 shows a block diagram of the Main Bridge PWB. The following are descriptions of the main sections of this PWB.

3.1.1.1. FORWARDING MPU

The Forwarding MPU in Cobra provides two main functions. First as the name implies it is the main forwarding engine for Cobra. Secondly it is responsible for real time response and control of Cobra's LAN Interface daughtercard. The following is a list of the major blocks of this MPU.

- The MPU will be a 68HC000 operating @16.384 Mhz.
- 512Kbytes of local DRAM and 64k bytes PROM.
- Support timers and logic providing functions such as watchdog timeout etc.
- Buffers and logic to provide access to the LAN Interface daughtercard.

3.1.1.2. MANAGEMENT MPU

The Management MPU is responsible for the Bridge's CTP Interface, network management support, Protocol stack support, IBM management server support, floppy disk control, Integral data port, and diagnostic coordination. The following is a list of the major blocks of this MPU.

- The MPU will be a MC68302 operating @16.384 Mhz.
- 512Kbytes of local DRAM and 128k bytes PROM.
- A set of hardware programmable timers and I/O registers.
- LED Driver Interface
- Floppy Disk Interface connecting the main Bridge card to the Floppy Disk. The floppy disk controller will be resident on the main card, with cabling used for connection to the drive.
- Data port capable of external clocking up to 128Kbps, utilizing a single DIM module to provide a variety of electrical interfaces.
- Interrupt driven asychronous RS-232 CTP port, used to run product diagnostics and Control Terminal Port (CTP).

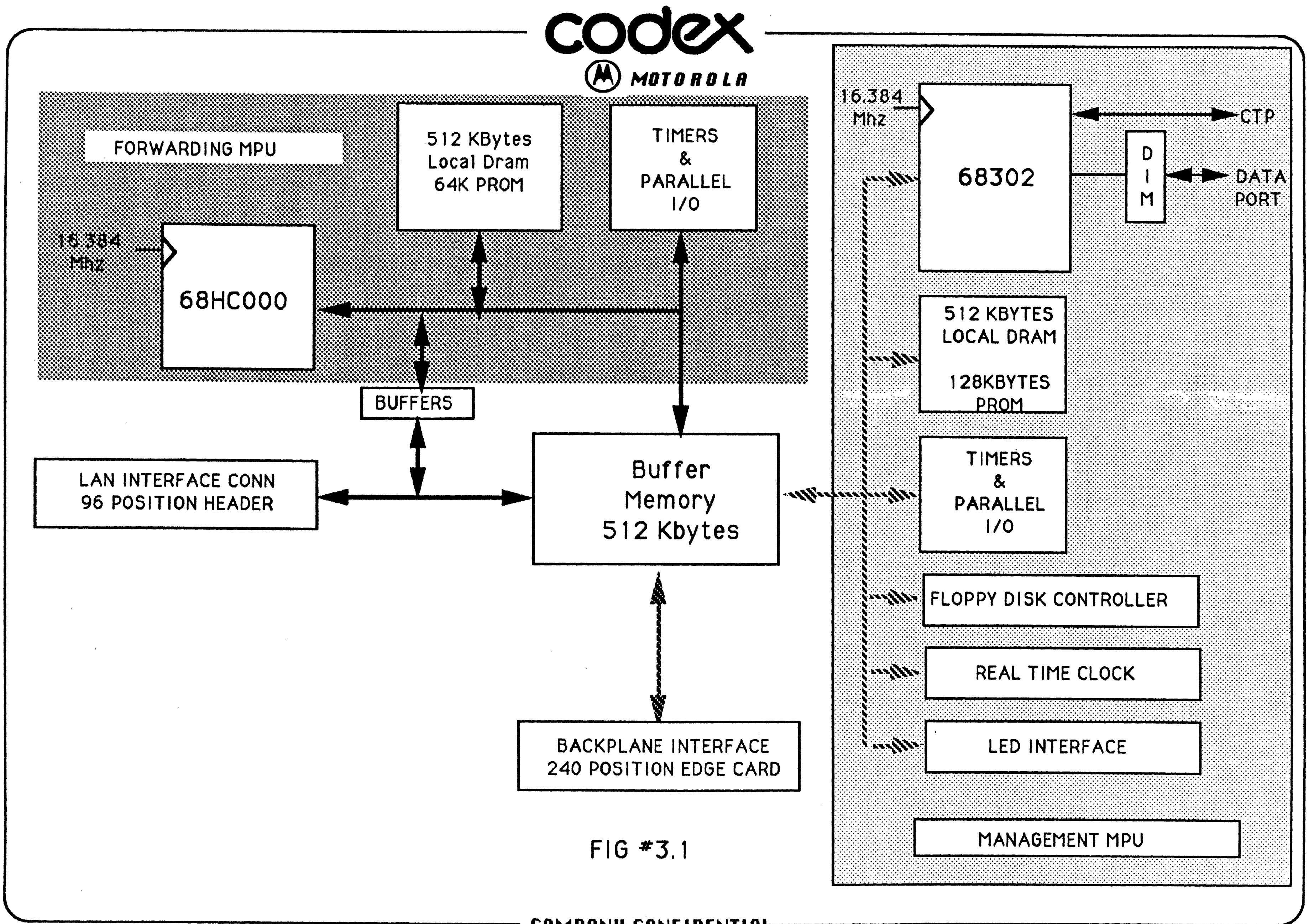


FIG #3.1

COMPANY CONFIDENTIAL

COBRA SPIP
RJC 12/4/90

3.1.1.3. SHARED MEMORY

This circuitry provides 512Kbytes of buffer memory. This memory is accessible by all MPU's in the system, and will be used for data transfer and for interprocessor communications.

3.1.2. 4 MBPS LAN INTERFACE INTERFACE PWB DEFINITION

Fig #3.2 presents a block diagram of the 4 Mbps LAN Interface PWB.

3.1.2.1. TOKEN RING INTERFACE

The 4 Mbps Token Ring Interface will use the Texas Instruments TMS380C16 Token Ring Controller. This device handles all the normal station MAC layer processing needed for token ring. The TMS380C16 requires local (adapter) high speed RAM memory for code and temporary data storage.

The Texas Instruments TMS38053 interface device will provide the electrical interface to the Token Ring.

Both of these T.I. components are capable of 16 Mbps Token Ring support.

3.1.2.2 HARDWARE ACCELERATOR CIRCUIT

The Hardware Accelerator circuit, will be based on the Motorola DSP56116 operating at 32 Mhz. Choosing this speed will allow Cobra to utilize a version of the DSP which is presently available. This circuit working together with the external copy feature of the TMS380C16, will provide local LAN traffic filtering support. In addition the circuit will provide real time table lookup support for the Main Bridge PWB's Forwarding MPU.

3.1.3. MULTIPORT WAN PWB DEFINITION

As shown in Fig #3.3, the Multiport WAN card will provide four additional HDLC connections for Cobra. It will be interfaced to the Main Bridge PWB via the Cobra backplane. All data transferred thru this card will be temporarily stored in the shared memory of the main Bridge PWB.

codex
MOTOROLA

LAN INTERFACE

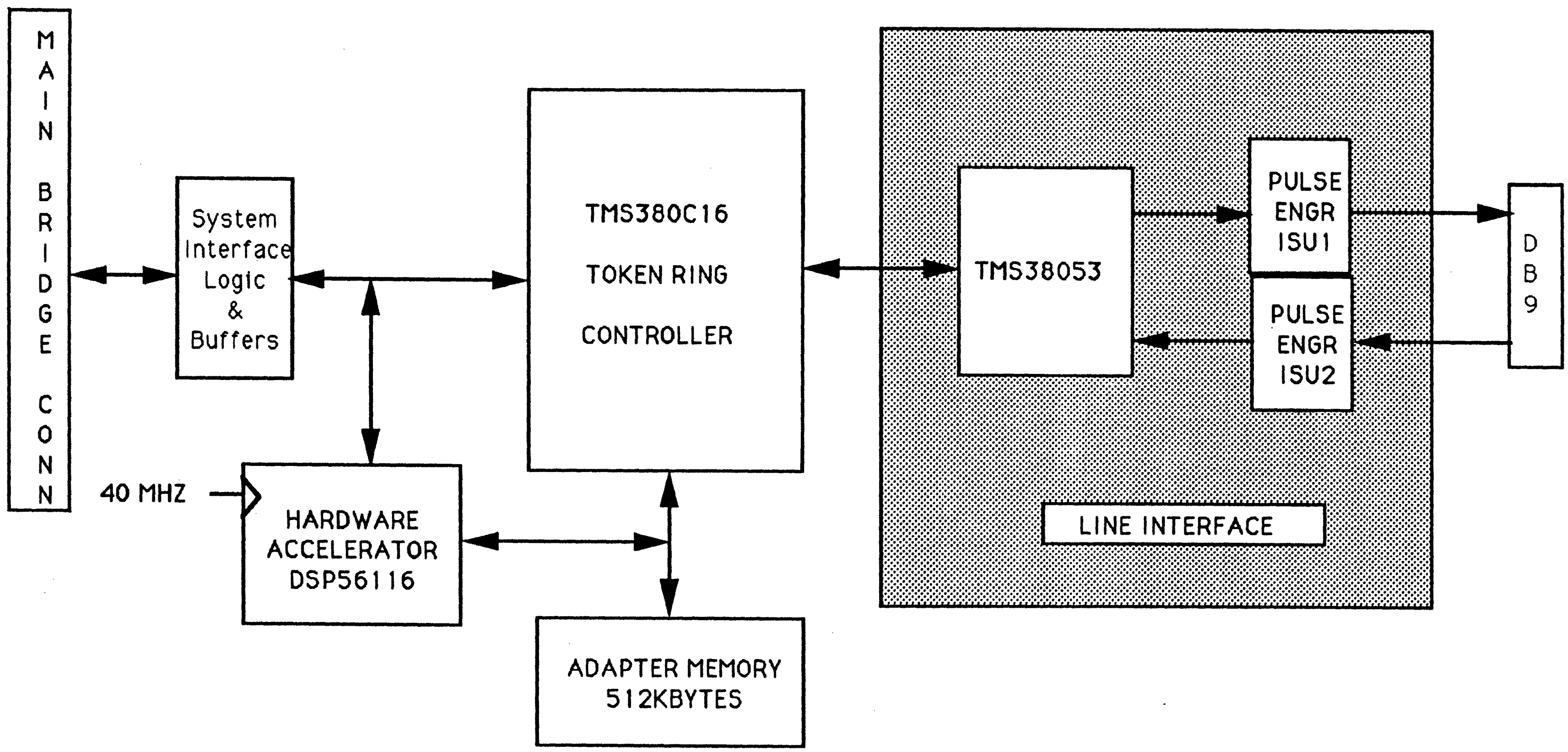


FIG #3.2

COMPANY CONFIDENTIAL

COBRA_SPIP
RJC 12/5/90

codex
MOTOROLA

MULTIPORT WAN

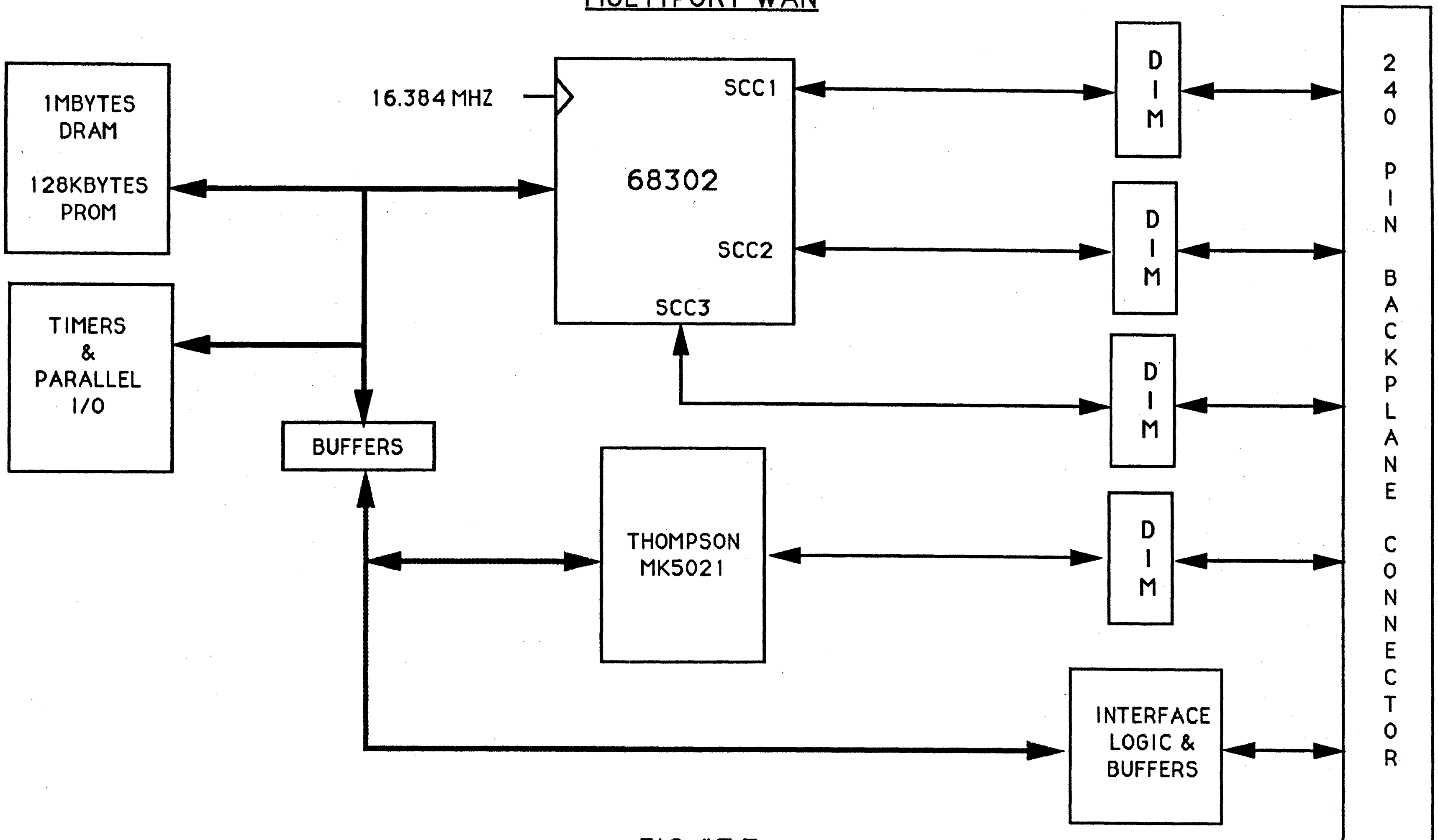


FIG #3.3

COMPANY CONFIDENTIAL

COBRA_SPIP
RJC 12/4/90

3.1.3.1. WAN MPU

The following are brief descriptions of each of the major blocks of the WAN MPU.

- The MPU will be a MC68302 operating @16.384 Mhz.
- 1Mbytes of local DRAM and 128k bytes PROM.
- A set of hardware programmable timers and I/O registers.
- LED Driver Interface.
- Buffers and logic to provide access to the Cobra Backplane and onboard data ports.

3.1.3.2. PORT INTERFACES

The multiport WAN card will provide four sychronous ports. All ports will capable of internal and external clocking. All ports will utilize DIM modules to provide their electrical interfaces. Do to the power requirements of the V.35 DIM module, this card will support a maximum of two V.35 DIM modules.

Three of the ports, supported by communications controllers internal to the 68302, will accept clocking up to 256Kbps. The fourth constructed using the Thompson MK5021 will be capable of clocking up to 512Kbps.

3.1.4. FIVE SLOT BACKPLANE PWB DEFINITION

As discussed above the Cobra five slot backplane will contain two 240 pin card edge card connectors. In addition to support the Main Bridge PWB, the backplane will have a single female DB25 connector for the CTP port, and female subminiature DB26 for the data port and DIM transition cable. As previously mentioned it is at this point in the backplane where the LAN Interface cutout will reside.

The selection of 240 backplane interface connections was made with an allowance for a future SCSI connection from the Main Bridge PWB to a winchester disk drive card. The feasibility of supporting a winchester drive's startup current with the Modulus 9/21 power supply will be resolved in the future.

To support the multiport WAN card, four female subminiature DB26 connectors will be mounted on the backplane. In addition a single female DB15, and two miniature BNC connectors have been added for support of a T1/E1 version of the WAN option card to be completed after first release of the product. See section 3.9.4 for more details on this option card.

Additional signals have been added to the backplane specification to support the future addition of a second WAN option card. See section 3.9.5 for more details on this backplane.

3.1.5. POWER SUPPLY

Cobra will utilize the standard Modulus 9/21 Power Supply Module. This module is rated for 185 Watts of total power, and provides +5 VDC and +/- 12 VDC to the product cards.

3.2. SUMMARY OF DESIGN APPROACH

3.2.1. ELECTRICAL DESIGN APPROACH

All Cobra PWB's will be schematic captured and simulated on Mentor Idea stations.

The bulk of the PLD design work will be accomplished using the Data I/O Abel-4 design package available on our Mentor stations. In addition we are working with component engineering to select suitable vendors and components in the programmable gate array marketplace for more complex logic synthesis.

The Mentor protoview package will be used to provide preliminary placement information for our CAD design group. In addition, a toolset available from Quad Design supported on our Mentor stations will be used to help improve critical component placement and trace routing.

All Cobra PWB layout will be performed on Mentor Board Station.

3.2.2. MECHANICAL INTERFACE/TRADE-OFFS

As is standard with products resident in the Modulus 9/21 enclosure, the majority of the Cobra interface connectors with reside directly on the Cobra backplane. The major mechanical interface trade-off however, concerned the connector mounted on the LAN Interface PWB. Several schemes to allow front plugability were entertained. These schemes were all found to add significant risk, schedule delay, and possible cost to the program.

3.2.3. SOFTWARE INTERFACE/TRADE-OFFS

Several MPU options including single processor designs were entertained during feasibility. It was found that the above mentioned architectures were desirable from a software partitioning and performance point of view.

In addition several flavors of the Hardware Accelerator were reviewed. The design we have chosen, based on the Motorola DSP, is felt to provide the greatest programming flexability while meeting the difficult real time requirements of the TMS380C16.

3.2.4. REDUNDANCY PLANS

The product is being designed to be a stand alone unit. It will not have hardware redundancy built in. It will be designed so that a second unit can act as a hot backup. In the event of the first unit failing the second can be activated by network management software.

3.3. SOURCES OF MAJOR PARTS

3.3.1. ESTIMATED PARTS COUNT

The Cobra base system has an estimated parts count of 310 electrical components (IC's, discretes, connectors, etc.). The addition of the multiport WAN card brings this total up to 525.

3.3.2. ESTIMATED NEW COMPONENT COUNT

Of the 525 electrical components approximately 25 are new components to Codex.

3.3.3. HIGH RISK COMPONENTS

The following is a list of the High risk components incorporated into Cobra design.

- The T.I. TMS380C16 and TMS38053 are the highest risk component since they are just released and performance, quality and reliability data is just becoming available.

- The Motorola DSP56116 is considered a high risk component since it is new and performance, quality and reliability data is just becoming available. We are seeking to limit this risk by using the 40 Mhz version of the part for first release.

- Two Pulse Engineering Isolation shaping units needed to support the T.I. TMS38053 are considered high risk, since Pulse is not a preferred supplier of Codex. At this time Pulse has not made these device specifications available to the general public. As these specifications become available we will actively seek an alternative source for these components.

3.4. COMPATIBILITY

3.4.1. CODEX PRODUCTS

3.4.1.1. BRIDGE PRODUCTS

The first version of this product will be a source routing token ring bridge. Since the Etherspan bridge is a transparent bridge with the Spanning Tree protocol, Cobra will be network incompatible with the Etherspan bridge unless special gateway software is developed. This means that packets coming from the Cobra cannot route through the Etherspan bridge and visa-versa.

3.4.1.2. T1 FAST PACKET PRODUCTS

At first release of the product, Cobra will communicate with products such as the 6290 using frame relay.

3.4.1.3. STATISTICAL MULTIPLEXERS PRODUCTS

On the 6742/45 the Cobra bridge would interface into the high speed HDLC (not muxport or extended muxport) terminal port or in the future a frame relay port. With HDLC a point-to-point logical connection can be made. With frame relay multiply logical connections can be made.

3.4.2. COMPETITORS' PRODUCTS

3.4.2.1. BRIDGE PRODUCTS

The source routing version of this bridge will be compatible with any device that corresponds to the source routing part or the IEEE 802.5 specification.

3.4.2.2. T1 FAST PACKET PRODUCTS

At first release of the product, Cobra will communicate with T1 fast packet products using frame relay.

3.4.2.3. STATISTICAL MULTIPLEXERS PRODUCTS

On any statistical multiplexer the Cobra bridge would only be able to interface into it by using a high speed HDLC terminal port or in the future a frame relay port. With HDLC only a point-to-point logical connection can be made. With frame relay multiply logical connections can be made.

3.4.3. PUBLIC NETWORKS, ETC.

The bridge will be compatible when connected to an appropriate CSU with Accunet 1.5 services.

3.5. ELECTRICAL QUALITY/RELIABILITY GOALS

3.5.1. DESIGN FEATURES INCORPORATED TO MEET GOALS

Surface mount components, and up front design for manufacturability will be the main factors leading to quality improvement. In addition the number of programmable devices will be kept as low as possible.

As volumes justify, we will seek to use standard ASIC technology to reduce component counts in our systems.

3.6. REGULATORY/INTERNATIONAL GOALS

3.6.1. DESIGN FEATURES INCORPORATED TO MEET REQUIREMENTS

A true V.35 and E1 interface are planned for Cobra. These interfaces were not supported in Etherspan.

3.7. PATENTS

No candidates for possible patent are seen at this point.

3.8. COST REDUCTION MEASURES

The costs of Cobra will be kept in-line, by choosing common components with other development efforts. In addition design for manufacturability and test, will also be built into the product.

3.9. RELEASE 2 PLANNED HARDWARE ACTIVITY

3.9.1 High Performance Main Bridge PWB.

This card will feature an upgraded forwarding engine over the base main Bridge PWB. In addition local processor and shared buffer memory will be increased to support increased performance capability.

3.9.2 4/16 MBPS TOKEN RING LAN INTERFACE PWB.

This card will be a high performance version of the 4 Mbps Token Ring interface card. At the present time we are considering the use of the Pulse Engineering Token Ring Line Interface module (TROLI) on this card.

3.9.3 ETHERNET INTERFACE PWB.

The Ethernet Interface PWB will replace the Token Ring Interface with a TBD ethernet interface. The FFHA circuitry utilized on the Token Ring Interface card, will be reused on this PWB.

3.9.4 T1/E1 WAN OPTION PWB.

The T1/E1 WAN Option PWB, will reuse the MPU circuitry used on the data port version WAN Option card. The high speed port logic will be replaced by the AT&T Spyder-T HDLC controller, and associated T1 circuitry as used in the Etherspan Product.

3.9.5 SEVEN SLOT BACKPLANE PWB.

This PWB will expand the five slot backplane to support an additional WAN Option card. All first release cards will be designed to support the possible future expansion to this two option card configuration.

4.0 SOFTWARE DESIGN

4.1 SCOPE

4.2 SYSTEM DEFINITION AND FUNCTIONAL ARCHITECTURE

4.3 PRELIMINARY RELEASE STRATEGY

4.4 USE/MODIFICATION OF EXISTING CODE

4.5 DEVELOPMENT VERIFICATION PROCESS

4.6 METRICS

4.7 LIST OF DELIVERABLES

4.8 INTERNATIONAL ISSUES

4.9 PATENTS AND COPYRIGHTS

4.10 RISKS AND CRITICAL DEPENDENCIES

4.0 SOFTWARE DESIGN

4.1 Scope

The primary scope of the software design is to development a high quality body of software to implement the capabilities identified in the product functional specification. However, because Cobra is intended to spawn a family of bridge products, there are several additional major goals placed on the software. We intend to create a software architecture that is ready to absorb network management functions without performance degradation of the main bridging functions. The management functions being targeted are integrated 9800 support and management servers for the IBM Lan Network Manager. Further, the software design is aimed at simplifying the development of the High Performance Bridge. The High Performance unit will differ from the base unit in that it substitutes a higher performance member of the 680X0 cpu family for the 68HC000. The software will undergo minor changes to account for instruction set differences and then be ready to be recompiled and run on the new hardware.

Finally, the software design is anticipating that we will want to enhance the bridge forwarding process in the future, to do things like suppress broadcast route discovery traffic and to offer network segmentation and security features. The design has been modularized and partitioned to hardware so that these changes can be made to forwarding without disrupting the rest of the software.

4.2 System Definition and Functional Architecture

4.2.1 Environment

The Cobra software execution environment has the following characteristics: Functions partitioned to execute on multiple cpu units--

68302 for management functions (ctp, protocol stack, management agents, diagnostic supervision)

68HC000 for bridge data passing functions (lan and wan drivers, forwarding, filtering)

DSP for forwarding accelerator (offloads key real time operations from 68HC000)

Shared memory for data buffers and interprocessor communications

Local memory for programs and data space for each cpu

Full mesh interprocessor communications via interupts and shared memory messages

VRTX/IFX real time OS and file system

Most code written in C, small sections optimized in assembler

4.2.2 Definition of major modules

LAN

This module acts as a full MAC station on the token ring, implementing all protocols for attachment to the ring, repeating frames on the ring, transmitting frames to the ring from other portions of the bridge, receiving frames from the ring and giving them to other portions of the bridge, detecting ring error conditions, responding to ring error conditions, reporting ring errors, and detaching from the ring. In this regard, it provides the same functions as would a token ring lan interface module in any computer attached to the ring.
In addition, this module also carries the responsibility for determining whether a frame on the ring should be passed to the forwarding module for further action.
This module accumulates statistics on the operation of the LAN link.

WAN

This module transmits and receives frames on the WAN links of the bridge. When the forwarding module decides to transmit a frame on a given WAN link, it passes that frame to the WAN module. The WAN module encapsulates the frame in another data link protocol (either HDLC or frame relay) and transmits it. When data is received on a WAN link, this module checks for various errors. Error free received frames are passed to the forwarding module, where the decision is made to either forward them out another port(s) of the bridge, or to pass them up to other modules within the bridge.
This module accumulates statistics on the operation of the WAN links.

Forwarding

As mentioned above, certain frames received on the LAN and WAN ports are passed on to this module. Here, the decision is made as to whether the frame is "user data" or "bridge management data."
If it is "user data", then forwarding determines whether it is data that already contains a completed route (the result of token ring end stations having completed the route discovery process). If so, forwarding uses the route information in the frame to determine which WAN or LAN link to pass the frame to, and does so. During this process, forwarding also checks the contents of the frame against various filter conditions that have been configured in the bridge. If the filter conditions indicate that the frame should not be forwarded, it is dropped.
Some "user data" consists of frames that are part of the route discovery process carried on by end stations on the token ring when they wish to establish a connection. When forwarding receives such frames, it adds information to the frame describing the fact that the frame has travelled through this bridge. It then passes the modified frame on for transmission to some or all of the links on the bridge, depending on the configuration details.

When "bridge management data" is received by forwarding, it is passed to the lower stack layers module. Likewise, bridge management data leaving this bridge will be passed from the lower stack layers to forwarding.
In addition, the forwarding module collects statistics about its operation.

Lower stack layers

This module consists of the LLC and upper portion of the MAC protocol layers, both part of the Data Link Layer in the OSI model. Frames are exchanged between the forwarding module and the "bottom" of this module. Some of these frames cause information to be exchanged between this module and either the higher stack layers or the station management module. In the first release of Cobra, a type 1 LLC layer will be included in this module, based on code developed by the NOS group. In future releases, a type 2 LLC layer will be added.

Station management

This module is responsible for operating the Cobra as an end station on the extended token ring network. This is necessary for implementing remote CTP functionality (VT) and for LAN diagnostic and troubleshooting features. A key responsibility of this module is to initiate a route discovery process through the network to establish communications to another station.
This module maintains statistics about its operation.

Higher stack layers

This module implements layers 3 through 7 of the OSI model. This provides a path between the bridge management module, the CTP module, and the CTP or bridge management module on a remote bridge (for VT and remote event reporting capability). In future releases, it also provides the path between the bridge management module and the 9800, and between the "management servers" in the bridge and the IBM LAN Network Manager.
In the first release of Cobra, this module will be a highly simplified protocol stack. It will include features for providing reliable operation of the VT and remote event reporting functions. In future releases, it will include the full protocol stack from the NOS group, including TP4 and the network layer.

Bridge management

This module implements a large portion of the bridge functionality. It responds to commands issued from the CTP or from a remote CTP and causes appropriate actions in the bridge. Such actions can be to change the value of various parameters in the bridge, to enable/disable capabilities, to log on to a remote bridge, to conduct various diagnostic tests, to view statistics or events, and to load or save information from the disk.
In addition, it is the recipient of event messages generated by all other modules. It handles the logging and display of those events, and causes other actions to occur in response to events.

This module is designed so that it may be controlled by commands issued from a 9800 system in the future. The key to this is to have it operate on CMMS messages that are structured to be compatible with 9800 specifications.

CTP

This module implements the CTP operator interface on a terminal connected to the CTP port. As such, it implements the command/menu structure of the bridge, accepts and validates input, and sends the input to the bridge management module as CMMS messages. It also controls the formatting and display of information on the CRT screen in response to keyboard input from the CTP and messages sent to it from the bridge management module. The software is based on a "Curses" terminal driver package which was first ported for use in EtherSpan.

System services

This module provides services that are used by other modules in the system. They include: interprocessor communications, synchronization of requests for shared resources, buffer management, timers, event formatting, CMMS message handling, and congestion control.

Operating system support

This module is responsible for scheduling tasks, implementing a priority mechanism, responding to interrupts, implementing a file system on the diskette, and providing access to hardware devices. It includes the VRTX real time operating system, the IFX file system, and additional code.

Initialization

This module is responsible for loading and running power up diagnostics, loading the bridge software and configuration, validating the software and configuration, initializing software modules, and activating the bridge.

4.2.3 Compatibility

With existing Codex products

Section 2 describes the products that can operate in conjunction with the Cobra. This section lists the other pieces of Codex software which are compatible with Cobra software.

9800 OI

9800 CMMS structure, for fully integrated management in future

EtherSpan CTP software

With other vendor's products

Cobra incorporates the following outside software:

VRTX/IFX (licensed from Ready Systems-- operating system used in Cobra)
TI380 MAC layer software (one time license from Texas Instruments)

In addition, it is compatible with the following outside software:

IBM LAN Network Manager (partial capability at FCS, full capability in later releases)

IBM Netbios for Token Ring

Novell Netware with source routing, for Token Ring

4.3 Preliminary release strategy

4.3.1 Timing of releases

Release 1.0-- unrestricted FCS 3/92

Release 1.1-- unrestricted FCS 4/92

Other releases planned for 1992 to support additional hw modules (T1/E1, 16 Mbps LAN, High Performance Bridge) and additional capabilities, as described in Section 2.

4.3.2 Level of functionality

Release 1.0-- Standard source routing bridge, full CTP management capabilities, single WAN port for either frame relay feeder or point to point HDLC

Release 1.1-- Adds support for Multiport WAN expander and compatibility testing with IBM bridges

4.3.3 Upgrade strategy

Upgrades will be available according to a variety of service offerings, as described in Section 7.

4.4 Use/modification of existing code

Cobra will use the following code from EtherSpan:

CTP (terminal driver, screen formatter, input parser)
CMMS message handler
Portions of Back End Agent
Portions of Initialization
T1 Driver (when released with T1/E1 card)
VRTX/IFX operating and file system

The other portions of the Cobra software are primarily new code due to the dramatically different nature of a token ring source routing bridge from a transparent learning Ethernet bridge. In addition, some portions of Etherspan software are being rewritten to address performance concerns.

A future release of Cobra will incorporate existing NOS stack code and LLC type 2 code from the network management group.

4.5 Development verification process

4.5.1 Methodology

The Codex software life cycle model will be followed. A structured analysis phase is in process, and will be followed by a structured design phase. As sections of the system are designed, they will be coded and unit tested. A phased integration of software modules with each other, and with hardware, will then be conducted. After the integration, a thorough system level test of the product will be conducted to verify that the system is fully operational and ready for alpha testing.

Two improvements to the software life cycle model will be used on this project which were not used in the development of EtherSpan software. They are "software prototyping" and "parallel integration team."
Certain portions of the software will be prototyped before undergoing final coding. The purpose of the prototype phase for those software elements will be to get an early verification of the design approach for that element, prior to the availability of companion software elements or real hardware. Such prototyping is an effective technique for eliminating design risk in an early phase, and in that sense serves the same purpose as traditional hardware breadboarding and prototyping. The candidates for this prototyping activity are:

Forwarding accelerator software (run on 56116 emulator\board without rest of bridge hw or sw to verify performance)

LAN module (run on purchased VME card containing TI 380 chip set, to verify performance and understanding of 380 and token ring operation

Forwarding module (run on purchased VME card containing 68020 and 380 chip set, to verify performance and understanding of forwarding algorithm)

Bridge management module (run on HPUX workstations, to isolate testing and debugging from availability of other sw and hw elements for integration)

The "parallel integration team" concept involves having a member of the sw group dedicated to planning the sequence and details of the software integration activities. In addition, this person will create any necessary "test bed" software so that integration can start with a portion of the system, before everything is ready. The primary benefits of this approach are:

Preparation for integration is done in parallel with coding and unit testing (allows serious integration to start sooner)

Integration testing is more thorough (because someone is working full time thinking about what tests should be done and preparing the necessary software to conduct the tests)

Integration schedule is more predictable (because a detailed plan has been prepared beforehand, with precisely measurable milestones that can be tracked)

Interfaces between modules get extra scrutiny (because someone separate from the development of the modules is paying serious attention to how they will integrate with each other)

A formal inspection process will be conducted for the product functional specification, design specifications, selected code, unit test plans, integration test plans, and alpha test plans.

4.5.2 Test, Debug, and Q/A Features

The Cobra software includes a system monitor function that is specifically designed to facilitate software debugging.

4.5.3 Language(s) and Platforms

The bulk of the software will be coded in C on HP/UX cross development systems for the 68302 and 68HC000 software. A very minor portion of the software will be coded in assembly language. The software for the 56116 will be coded in assembly language, using the development support tools available from Motorola.

4.5.4 Tools

Cadre Teamwork will be used to support structured analysis and design

Editors, compilers, cross compilers, assemblers, and linkers on HP/UX will be used for code development

Emulators, lan analyzers and logic analyzers will be used for debugging

Source code control tools on HP/UX will be used for software configuration management

Corporate CBS system will be used to track bugs

Microsoft Excel will be used to track inspection results

4.6 Metrics

SQA will participate in all inspections

Defects found per inspection will be categorized and tracked

CBS will be used to track bugs

SW quality will be computed according to corporate standards at beginning of beta testing and at FCS

Data will be collected during system testing, alpha testing, and beta testing regarding the rate of discovery of new bugs, to help predict readiness for release

4.7 List of Deliverables

Structured analysis spec and inspection results

Structured Design spec and inspection results

Unit test plans and inspection results

Unit test results

Integration test plans and inspection results

Integration test results

Full functional software for alpha testing

Beta software

FCS software

4.8 International Issues

No country specific software is required.

4.9 Patents and Copyrights

Procedure for securing copyright on all software will be followed. A review for potential patentability or patent infringement will be conducted when the software design phase has been completed.

4.10 Risks and Critical Dependencies

The development of the software is highly dependent on adding 7 additional software engineers to the group, as provided in the 1991 budget. In addition, the plan is dependent on limiting EtherSpan software enhancement work to 2 software engineers as of the end of March. The Cobra software schedule is extremely tight, and does not leave room for any significant change in manpower availability.

5.0 PACKAGING/MECHANICAL DESIGN

5.0 PACKAGING/MECHANICAL DESIGN

5.1 INTRODUCTION

The base Codex Cobra product will consist of a single Main Bridge circuit board assembly, based on the Modulus Enclosure System board outline, a LAN interface daughter board assembly, and a two board, five slot, backplane assembly. An optional Multi-Port WAN interface board can be installed into the second board slot provided in the backplane assembly to augment the base product functionality.

The primary enclosure system offered will be the Modulus 9 slot nest to provide both entry level standalone and rack mount capability. The 21 slot Modulus enclosure is available for applications requiring increased product capacity or to enhance mix and match capabilities with other Codex products. Current Codex customers could utilize their existing Modulus 9/21 enclosure if they have the available slot capacity.

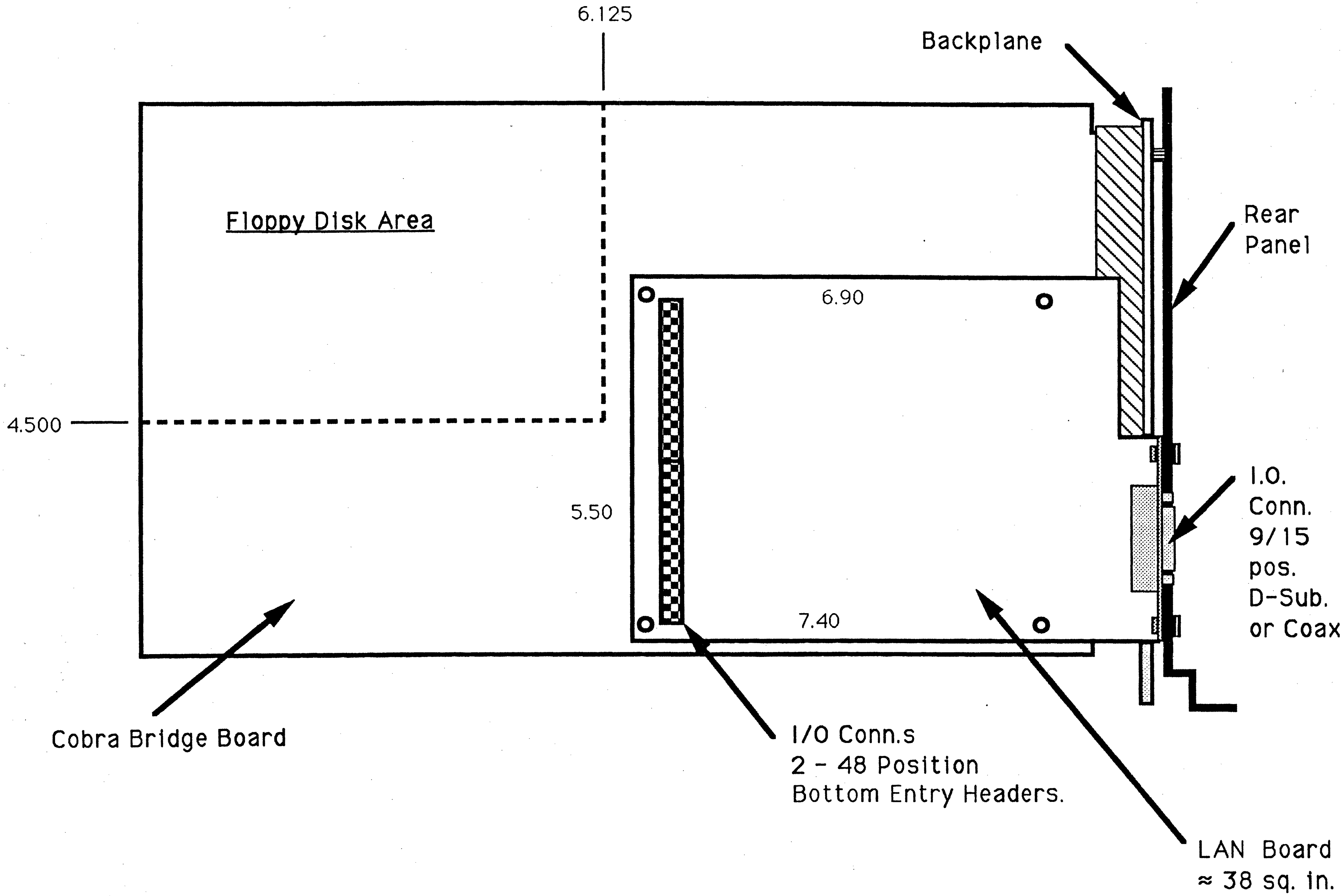
5.2 MECHANICAL ARCHITECTURE

The Cobra Bridge will be designed for installation into the Codex Modulus 9 and 21 slot enclosure system for both standalone and rack mount applications.
Cobra will consist of five major mechanical elements separate of the nest enclosure. They are:

1. Main Bridge PWA
2. LAN Daugther Board PWA
3. Backplane Assembly
4. Optional Multi-Port WAN PWA
5. Base WAN Port Transistion Cable

Main Bridge Board and Lan Daughter Board:

The Main Bridge board assembly will conform to the Modulus board outline but will not be compatable with the existing Modulus 8/18 Enclosure System. Power for the board will be bussed in through the 240 position cardedge connector; no power tang will be provided. All Cobra boards will be designed using surface mount components to improve board area utiliztion and enhance manufacturing process quality. Mounted to the Main Bridge board, via a support platform and accessible through the front panel, will be the floppy disk drive used for system software installation and recording of Bridge events and metrics. Also mounted to this board will be the LAN Interface board on which will reside a single LAN interface connector (see Fig. 1). This LAN connector must be accessable directly at the rear panel due to critical electrical characteristics of the LAN interface circuitry. As a result, a clearance slot will be provide in the backplane to allow passage of a section of the daughter board, with the LAN connector, through the backplane PWA directly to the metal rear panel. The connector will locate against, and attach to, the rear panel by means of a connector plate mounted to the LAN board. This attachment method was choosen since it provides a mechanically simple and solid assembly once fastened.



Cobra Bridge / LAN Daughter Board Proposal

Figure 1

Grounding and mechanical integrity of the Bridge / LAN board are enhanced while stresses imparted to the LAN connector and the daughter board mounting hardware are minimized. Once the LAN connector plate/board is secured to the rear panel with captive hardware the appropriate LAN cable can then be attached. This physical attachment scheme will require that the LAN cable be disconnected from the LAN connector prior to removal of the Main Bridge board/LAN daughter board assembly.

Various versions of the LAN board will be developed to support different LAN media types for the single LAN connector port. The LAN board/connector options supported with the initial product release and subsequent releases will include DB-9, DB-15 and coax.

The LAN Interface board itself will be attached to the Main Bridge board using a combination of board-lock and threaded standoffs. The planned electrical interconnection method between the two boards is to use two dual 48 position .025 square pin headers on the Bridge board along with two dual 48 position bottom entry recepticles on the LAN daughter board.

Backplane - Rear Panel Assembly:

The backplane assembly will consist of a four board, five slot wide PWA populated with two 240 postion cardedge connectors to accommadate the Main Bridge board and the optional Multi-Port WAN Interface board. The I/O side of the PWA will be populated with the base system WAN I/O port connector (Micro-26 D-Sub.), the CTP connector (15 pin D-Sub.) and the I/O connectors associated with the Multi-Port WAN option board; 4 Micro 26 D-Sub's, 1 DB-15 and 2 SMA Coax connectors (see Fig. 2). The Metal rear panel will attach to the PWA using threaded standoffs and will connect directly to the LAN I/O connector mounted to the LAN daughter board.

Optional Multi-Port WAN Board:

The optional Multi-Port WAN Interface Board would also conform to the Modulus board outline and would be installed into the designated backplane slot. I/O connectors associated with this option board are located on the backplane and correspond to the four interfaces which will be supported with the initial and subsequent WAN option board releases. Interfaces supported are to include V.35, V.36, RS-232 and X.21 configurable with the appropriate DIM module on the board.

PWA Front Panels:

The front panels for Cobra will consist of a metal 3-slot panel for the Main Bridge board and a metal 2-slot panel for the optional Multi-Port WAN board (see Fig.s 3 & 4). Base applications with no option board would use the standard Modulus filler panels to cover the 2-slot openning.

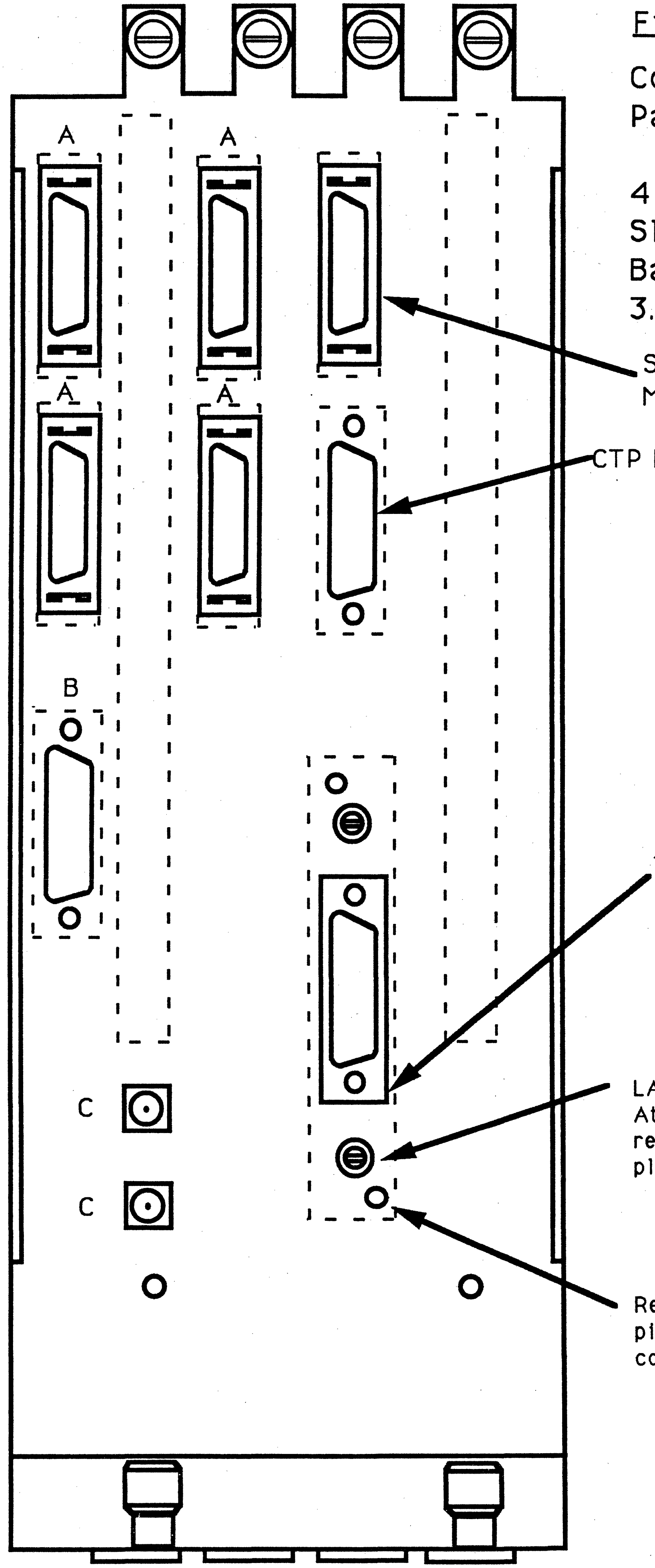


Figure 2

Cobra Rear Panel.

4 Board / 5 Slot Backplane. 3.72 " Wide

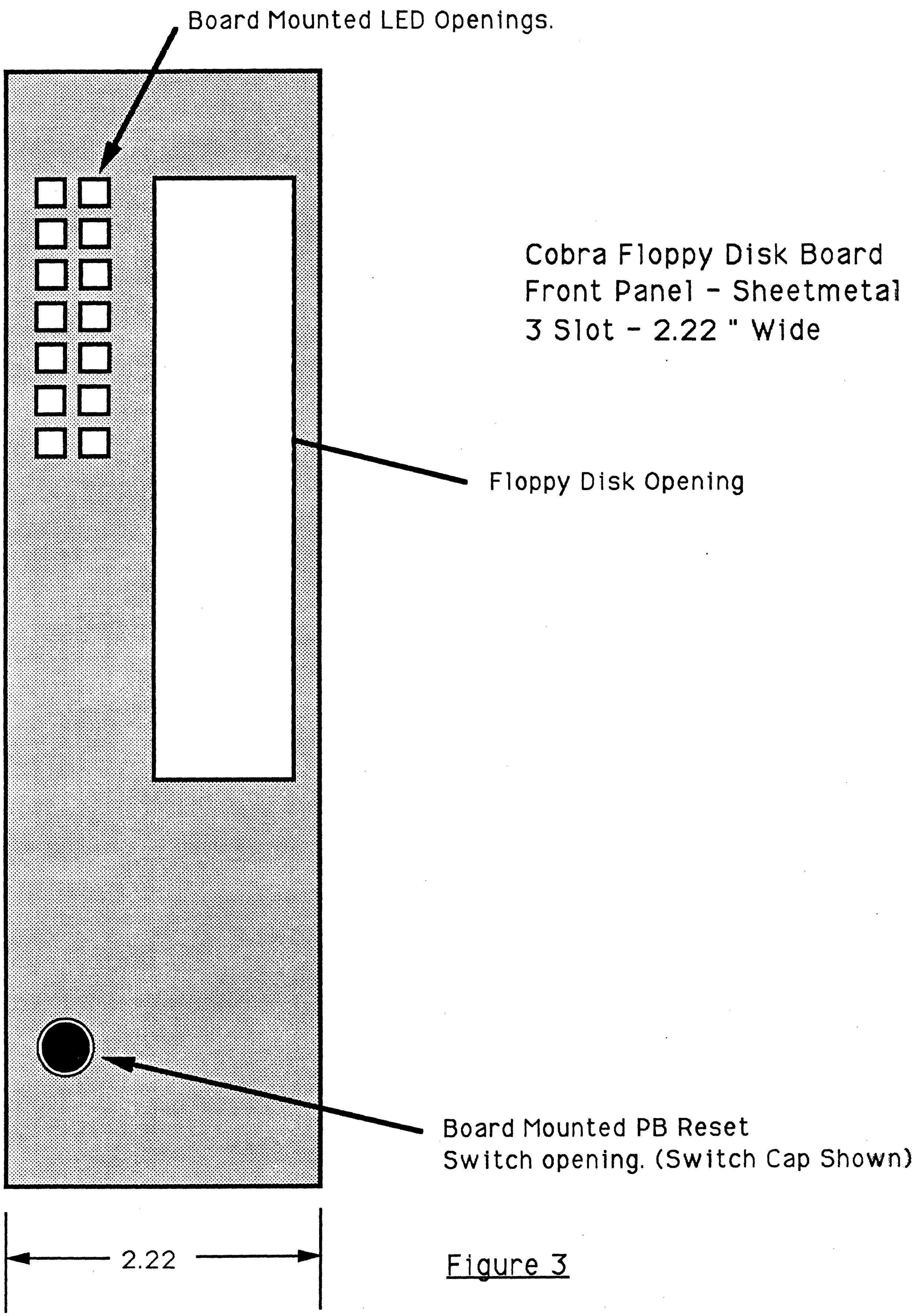
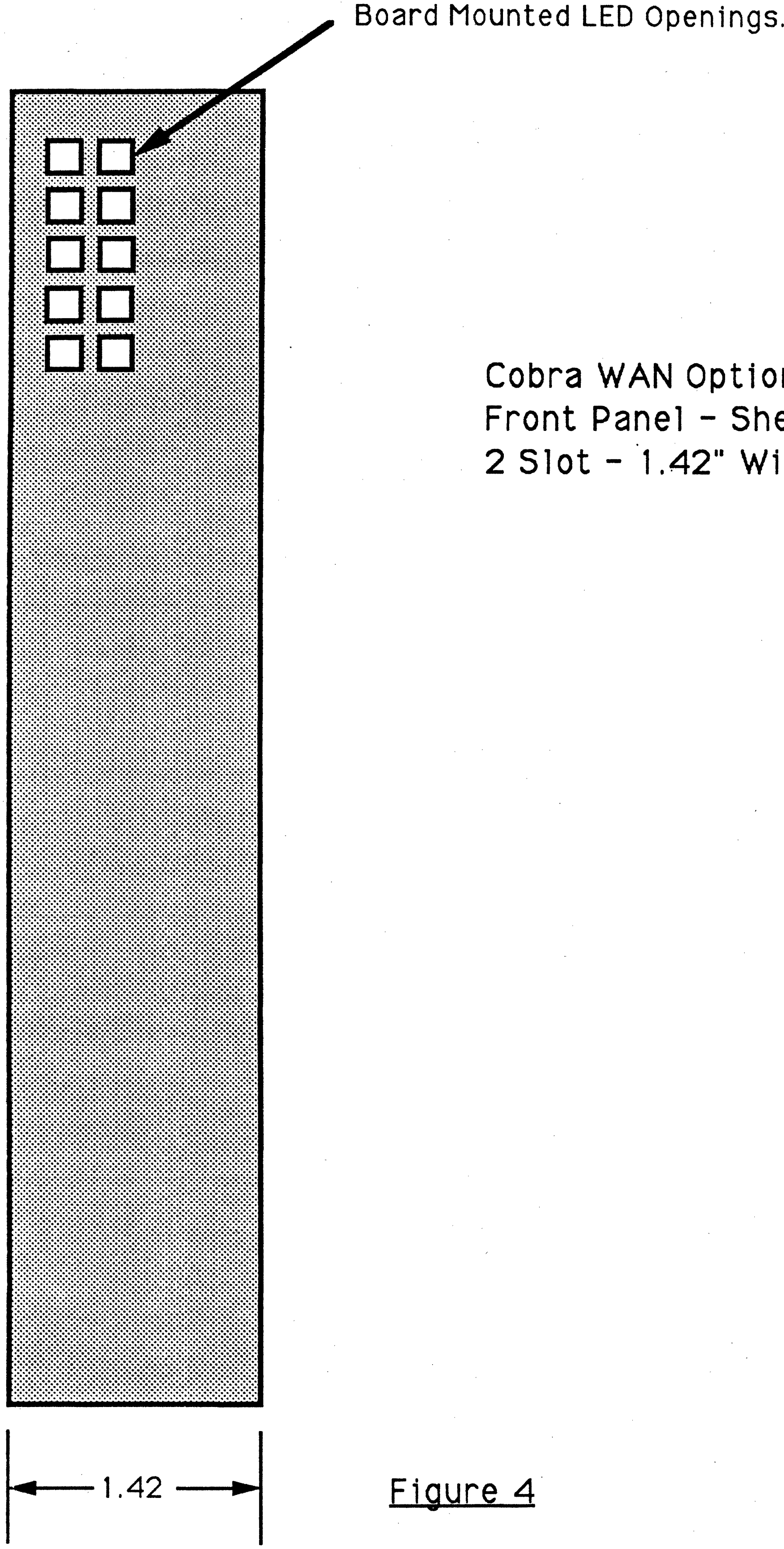

Board Mounted LED Openings.
Cobra Floppy Disk Board
Front Panel - Sheetmetal
3 Slot - 2.22 " Wide
Floppy Disk Opening
Board Mounted PB Reset
Switch opening. (Switch Cap Shown)
2.22

Figure 3



Cobra WAN Option Board
Front Panel - Sheetmetal
2 Slot - 1.42" Wide

Figure 4

WAN Port Transistion Cable:

The Transistion Cable developed for Maverick will be used with the single WAN port (Micro-26) available with the base Cobra product. The interface to this port is selected with the installation of a DIM module on the Main Bridge board.

The Transistion cable provides the correct media connection to the WAN port Micro-26 connector on the backplane. Port connectors on the backplane designated from the optional Multi-Port WAN board are specific to the interfaces available and will not require a transistion cable.

5.3 DESIGN APPROACH

New mechanical components (e.g. front panels, connector plates etc.), PWB outline drawings, cables and assembly drawings will be designed and documented on the Intergraph CAE/CAD System in order to maximize the utilization of design analysis capabilities.

5.4 SOURCES OF MAJOR PARTS AND TOOLING

The Cobra product will use the existing Modulus 9/21 Enclosure System. No major tooling expeditures for enclosure parts are anticipated. Due to the anticipated volumes for Cobra and concerns relating to RFI/ESD , front panels will be fabricated from sheetmetal.

Potential use of existing Maverick blanking dies for the sheetmetal front panels will be investigated since it would substancially improve Cobra part cost and would limit tooling expenses associated with producing Cobra parts. Inserting of existing dies or fabrication of new die sets to punch unique hole configurations would be required.

5.5 COMPATIBILITY

The Cobra PWA's and backplane/rear panel design will be fully compatable with the Modulus 9/21 Enclosure System. The Cobra board set and backplane design will not support installation into the existing Modulus 8/18 Enclosures.

5.6 REGULATORY AND CONFORMANCE REQUIREMENTS

The Product will be designed and tested to comply with the regulatory requirements as specified in SECTION 2 of this SUMMARY PIP. RFI suppression will be designed into the PWB via the use of multi-layers, chokes, and other standard design techniques. In the event that further suppression is required at the enclosure level several alternatives are available. Front panels will be fabricated of sheetmetal to provide maximum RFI containment and protection of exposed front panel componets (e.g. floppy disk, switches, LED's etc.) to ESD.

5.7 ENVIRONMENTAL REQUIREMENTS

Cobra, in its enclosure environment, will be designed to meet Class 2 operating conditions per Codex P&P 609 & Supplements with the exception of a restricted operating temperature range of 0 - 40 deg C .

5.8 DO DIFFERENTLIES

Packaging Design will approach the mechanical packaging as follows:

- Employ Modulus PWA form factor with an integrated daughter board and direct connector access to the rear panel.
- Utilize existing Maverick front panel sheetmetal tooling, where possible, to improve cost and quality of Cobra front panels.
- Standardize The LAN daughter board interconnection method and mounting hole pattern to satisfy Jaguar product requirements.

5.9 RISKS AND ASSUMPTIONS

- Due to the commonality of the enclosure parts and the backplane designs, the main packaging risk is board power density on the Main Bridge board.
  - Thermal densities will be simulated and evaluated as the design evolves and any issues will be brought to the attention of the core team.

- Circuit routing complexity on the backplane will be affected by the clearance area (hole) required for the LAN daughter board.

6.0 SALES PLAN AND PROFIT AND LOSS; PROJECT AND PRODUCT COSTS

6.0 SALES PLAN AND PROFIT AND LOSS

This section addresses the sales support and distribution channel plan for Cobra and its options, including those not available at first customer ship (FCS). Additionally, the revenues and costs are also displayed and discussed.

6.1 FORECAST AND ASSUMPTIONS

Cobra and its options is a product set for all three major sales channels, i.e. domestic direct, domestic indirect, and international. The product mix for these different channels is different, however, reflecting the different markets served. The table labled *Cobra Business Plan* displays the units and revenues per channel from 1992 to 1995.

These three sales channels are assumed to have different average sell prices that are determined as follows:

Domestic Direct: 25% off of U.S. List

Domestic Indirect: 40% off of U.S. List

International: List price = 1.15 times U.S. List Price
Subsidiary: ASP = 10% off international list price
Distributor: ASP = 45% off international subsidiary ASP
Business breakdown: 60% subsidiary, 40% distributor
Result: Assumed 15% off U.S. list price as overall international discount

The list prices given in Section 1 are assumed to decline by 7.8% per year after 1992. This decline is consistent with the market forecasted ASP decline given in Table 2, Section 1. A year by year description follows and is tabulated in the*Cobra Business Plan* given in this section.

1992

In 1992, most sales in all channels involve the Base unit and the multiport WAN option board. This is a reflection of the lack of availability of the high performance Base unit in 1992 and the fact that the T1 muxport WAN option is only available for about half the year. In this first year of shipment (1992), the highest percentage of sales comes through the direct domestic sales channel (about 69%) with about 20% of sales in international and the remainder in domestic indirect. This reflects the fact that there is a lag in popularity in token ring LANs in international markets and that indirect domestic sales are heavily departmentally based which are more Ethernet oriented.

1993

In 1993, a full hardware product mix is available. Tables 6.1 to 6.3 provide the product mix assumptions for the three sales channels. International shows the largest growth followd by domestic indirect. Domestic direct grows the least and is a declining proportion of sales but is still by far the bulk of the revenues. This is a reflection of the relative immaturity of the domestic indirect and international in this young market.

	Base Units (70%)	High Performance Units (30%)
Multiport WAN option	40%	45%
T1/FT1 "muxport" option	40%	50%
Frame Relay SW option	30%	35%

Table 6.1
Domestic Direct Product Mix

	Base Units (80%)	High Performance Units (20%)
Multiport WAN option	40%	45%
T1/FT1 "muxport" option	30%	50%
Frame Relay SW option	15%	20%

Table 6.2
Domestic Indirect Product Mix

	Base Units (70%)	High Performance Units (30%)
Multiport WAN option	55%	85%
T1/FT1 "muxport" option	10%	10%
Frame Relay SW option	25%	25%

Table 6.3
International Product Mix

1994

Tables 6.4 to 6.6 show the assumed product mix by channel for 1994. A higher percentage of sales comes from the high performance Base unit in this year as data traffic needs grow in the marketplace. The trend of an increasing percentage of sales in international continues.

	Base Units (40%)	High Performance Units (60%)
Multiport WAN option	40%	45%
T1/FT1 "muxport" option	30%	50%
Frame Relay SW option	20%	40%

Table 6.4
Domestic Direct Product Mix

	Base Units (75%)	High Performance Units (25%)
Multiport WAN option	40%	45%
T1/FT1 "muxport" option	30%	50%
Frame Relay SW option	15%	20%

Table 6.5
Domestic Indirect Product Mix

	Base Units (60%)	High Performance Units (40%)
Multiport WAN option	55%	85%
T1/FT1 "muxport" option	10%	10%
Frame Relay SW option	25%	25%

Table 6.6
International Product Mix

1995

In 1995, the trends of increasing sales of the high perfomance base unit and a higher percentage of sales through international and domestic indirect distribution channels continues. In the domestic direct channel, 30% are Base and 70% high performance Base. In the domestic indirect channel, 75% are Base and 25% high performance Base. In the international channel, 60% are Base and 40% are high performance Base. The option mix remains the same as in 1994.

6.2 FIRST CUSTOMER SHIP DATES

The schedule shows that the first availability of product is the Base unit in March, 1992 immediately followed by the multiport 4 port WAN option board in April, 1992. These are so close to each other that it is planned to announce them together and with a common availability. The optional frame relay software is available at this time.

Next in availability is the T1/FT1+ WAN port option. It becomes available in July, 1992. The high performance Base unit (and 4/16 Mbps LAN card) follow near the end of the year when an Ethernet LAN card also become available and phase out of EtherSpan can commence. (Note that no Ethernet versions are forecasted or costed in this plan).

There will also be a number of software releases scheduled, some of which will add significant functionality. These extra software releases are not forecasted at this time.

6.3 COST ASSUMPTIONS

Estimated product costs at FCS are $1850 for the Base unit, $585 for the multiport WAN option, $625 for the T1/FT1 muxport WAN option, $2025 for the high performance Base unit, and $25 for the frame relay software option. These costs are assumed to be declining 5% per year due to parts cost declines and manufacturing efficiencies.

6.4 PROMOTION AND PRODUCT LAUNCH

The Cobra product line and strategy is a winning one, but a major factor in gaining significant market share is effectively getting the message into the marketplace with an effective product launch and promotion. This involves getting the maximum from free publicity with a program of briefing the trade press and consultants just before announcement. This is similar to the program that got the significant publicity for EtherSpan at its introduction; however, the launch will not be initiated without assurance that the product will be delivered on time as opposed to the EtherSpan experience.

After the product is introduced, an effective advertising campaign needs to be put into place to keep the product in front of the public. Additionally, trade shows that are more LAN oriented and different than the set that Codex has traditionally attended need to be hit to gain Codex share of mind in this business. This will start to happen in 1991 with EtherSpan as a vehicle. For example, it is now planned that Codex will have a booth at NetWorld Boston in February, 1991.

Ongoing programs will also be used to gain as much free publicity as possible. Magazine articles and press quotes from personnel in the LAN Internetworking group on stories in the press will be used to keep the company name in front of the market as one of the companies in the forefront of this market.

Special programs will also be used to get the indirect domestic channel up as a viable distribution arm even though it contributes the least to revenue in the first year. Much of the experience gained from the 1990/91 launch of EtherSpan into domestic indirect channels will be valuable in performing an effective launch of Cobra into this channel.

6.4.1 INTERNATIONAL LAUNCH AND HOMOLOGATION PLAN

In 1991, it will be determined which countries internationally have the most potential for Cobra and plans will be established to penetrate initially the target countries with the international distribution group and the country subsidiary or distributor. A homologation priority will be set up to match. Although the market is less mature for token ring than domestically, Cobra will have significant international attractiveness at first customer shipment.

6.5 SALES/PRODUCT LITERATURE

Many of the same types of sales collateral implemented or planned for EtherSpan will be carried over to Cobra. Some examples are brochures, application stories, "All Abouts", and early customer stories. Many of the explanations of the WAN based "muxport" and frame relay that have previously been created will also be applicable for Cobra.

Additionally, the normal PIK will be provided at introduction for the product. Sales guides to assist sales people in selling the product will also be prepared.

6.6 SALES AND AE TRAINING

The training problem for the field is less severe for Cobra than with EtherSpan since EtherSpan will have been in the marketplace for about 1 1/2 years when Cobra hits. Thus, the field forces will now know some of the issues re LANs and bridging and routing over wide area networks. Nevertheless, the token ring environment is quite different than Ethernet and significant training will need to be performed that is specific to token ring and source routing environments.

These training programs will be heavily application oriented to help sales and AE personnel explain our advantages to their customers.

6.7 P & L STATEMENT

The attached schedules show the financial analysis of the Cobra project. Standard gross margins are in the 60-70% range during the period. The gross margins for 1993 increase even though the ASPs are declining faster than the costs due to the increase in sales of the high performance base unit and a higher percentage of options, both of which are very high margin.

The PBG margin in 1992, the first year of product shipment, indicates positive contibution margin.

Product Operations
COBRA BUSINESS PLAN
($'s In Thousands)
PHASE 1

ASSUMPTIONS Product	List Price	List Dom Dir	List Dom Ind	List Int'l	Standard Cost	Annual Price Erosion	Annual Cost Reduction
Discount		**25%**	**40%**	**15%**		**7.8%**	**5.0%**
Base (LP)	5.495	4.121	3.297	4.671	1.850		
Mutiport	3.995	2.996	2.397	3.396	0.585		
Muxport	6.500	4.875	3.900	5.525	0.625		
FR SW	1.995	1.496	1.197	1.696	0.025		
Base (HP)	7.495	5.621	4.497	6.371	2.025		

ISV REVENUES-DOM DIRECT

	"1992"		"1993"		"1994"		"1995"	
	Units	Rev	Units	Rev	Units	Rev	Units	Rev
Base (LP)	510	$2,102	910	$3,458	830	$2,887	1310	$4,136
Mutiport	306	$917	539	$1,489	809	$2,046	1572	$3,608
Muxport	102	$497	559	$2,513	872	$3,586	1703	$6,359
FR SW	102	$153	410	$565	664	$839	1310	$1,501
Base (HP)	0	$0	389	$2,018	1245	$5,907	2620	$11,281
Totals	1020	$3,669	2807	$10,042	4420	$15,264	8515	$26,886
% of Total Revenue		***69.1%***		***66.0%***		***56.6%***		***53.7%***

ISV REVENUES-DOM INDIRECT

	"1992"		"1993"		"1994"		"1995"	
	Units	Rev	Units	Rev	Units	Rev	Units	Rev
Base (LP)	110	$363	220	$669	500	$1,391	1060	$2,677
Mutiport	55	$132	113	$250	275	$556	584	$1,071
Muxport	11	$43	94	$336	233	$767	495	$1,478
FR SW	6	$7	44	$49	108	$109	230	$211
Base (HP)		$0	55	$228	167	$634	353	$1,217
Totals	182	545	526	$1,532	1283	$3,458	2722	$6,654
% of Total Revenue		***10.3%***		***10.1%***		***12.8%***		***13.3%***

ISV REVENUES-TOTAL DOMESTIC

	"1992"		"1993"		"1994"		"1995"	
	Units	Rev	Units	Rev	Units	Rev	Units	Rev
Base (LP)	620	$2,465	1130	$4,127	1330	$4,278	2370	$6,813
Mutiport	361	$1,049	652	$1,739	1084	$2,603	2156	$4,679
Muxport	113	$540	653	$2,849	1105	$4,353	2198	$7,837
FR SW	108	$160	454	$613	772	$948	1540	$1,712
Base (HP)	0	$0	444	$2,246	1412	$6,541	2973	$12,499
Totals	1202	$4,213	3333	$11,574	5703	$18,722	11237	$33,540
% of Total Revenue		***79.3%***		***76.1%***		***69.4%***		***67.0%***

ISV REVENUES-INTERNATIONAL

	"1992"		"1993"		"1994"		"1995"	
	Units	Rev	Units	Rev	Units	Rev	Units	Rev
Base (LP)	150	$701	330	$1,421	680	$2,681	1500	$5,367
Mutiport	90	$306	302	$945	759	$2,175	1675	$4,358
Muxport	8	$41	47	$242	113	$527	250	$1,058
FR SW	30	$51	125	$195	306	$438	675	$877
Base (HP)	0	$0	142	$832	453	$2,436	1000	$4,880
Totals	278	$1,099	946	$3,635	2311	$8,257	5101	$16,540
% of Total Revenue		***20.7%***		***23.9%***		***30.6%***		***33.0%***

ISV REVENUES-WORLDWIDE

	"1992"		"1993"		"1994"		"1995"		"Total"	
	Units	Rev	Units	Rev	Units	Rev	Units	Rev	Units	Rev
Base (LP)	770	$3,165	1460	$5,548	2010	$6,959	3870	$12,179	8110	$27,851
Mutiport	451	$1,354	954	$2,684	1843	$4,778	3831	$9,038	7079	$17,854
Muxport	121	$582	700	$3,091	1218	$4,880	2448	$8,895	4486	$17,448
FR SW	138	$211	578	$809	1078	$1,386	2216	$2,590	4010	$4,995
Base (HP)	0	$0	586	$3,078	1865	$8,977	3973	$17,379	6424	$29,433
Totals	1480	$5,312	4278	$15,209	8014	$26,979	16338	$50,080	30109	$97,581

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PHASE 1

FINANCIAL CONTRIBUTION

WORLDWIDE

		1990	*1991*	*1992*	*1993*	*1994*	*1995*	*TOTAL*
°UNITS		0	0	770	2046	3875	7843	14534
REVENUES @ ISV								
-Domestic		$0.0	$0.0	$4,214.0	$11,574.0	$18,722.0	$33,540.0	$68,050.0
-International		$0.0	$0.0	$1,099.0	$3,635.0	$8,257.0	$16,540.0	$29,531.0
°TOTAL REVENUES @ ISV		$0.0	$0.0	$5,313.0	$15,209.0	$26,979.0	$50,080.0	$97,581.0
COST OF SALES								
-Projected Std Costs		$0.0	$0.0	$1,767.2	$4,652.6	$8,893.1	$18,078.1	$33,391.0
°STANDARD MARGIN $		$0.0	$0.0	$3,545.9	$10,556.4	$18,085.9	$32,001.9	$64,190.0
	%	0.0%	0.0%	66.7%	69.4%	67.0%	63.9%	65.8%
OTHER COST OF SALES		$37.4	$526.9	$447.4	$760.5	$1,349.0	$2,504.0	$5,625.1
°PROJECTED GROSS MARGIN $		($37.4)	($526.9)	$3,098.5	$9,795.9	$16,736.9	$29,497.9	$58,565.0
	%	0.0%	0.0%	58.3%	64.4%	62.0%	58.9%	60.0%
DEVELOPMENT EXPENSES		$551.8	$3,039.6	$2,599.1	$0.0	$0.0	$0.0	$6,190.5
°PROJECTED PBG MARGIN $		($589.2)	($3,566.5)	$499.4	$9,795.9	$16,736.9	$29,497.9	$52,374.5
	%	0.0%	0.0%	9.4%	64.4%	62.0%	58.9%	53.7%

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REVENUES @ ISV

DOMESTIC

	1990	1991	1992	1993	1994	1995	TOTAL
UNITS							
-Purchase Direct			510	1299	2075	3930	7814
-Purchase Indirect			110	275	667	1413	2465
TOTAL	0	0	620	1574	2742	5343	10279
ASPs/I.S.V.s							
-Purchase Direct			$7.194	$7.731	$7.356	$6.841	
-Purchase Indirect			$4.955	$5.571	$5.184	$4.709	
OTHER REVENUES							
-$							$0.0
TOTAL REVENUES @ ISV							
-Purchase Direct	$0.0	$0.0	$3,669.0	$10,042.0	$15,264.0	$26,886.0	$55,861.0
-Purchase Indirect	$0.0	$0.0	$545.0	$1,532.0	$3,458.0	$6,654.0	$12,189.0
TOTAL	$0.0	$0.0	$4,214.0	$11,574.0	$18,722.0	$33,540.0	$68,050.0
-Other	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
TOTAL	$0.0	$0.0	$4,214.0	$11,574.0	$18,722.0	$33,540.0	$68,050.0

PHASE 1

REVENUES @ ISV

INTERNATIONAL

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	1990	1991	1992	1993	1994	1995	TOTAL
Units							
-International			150	472	1,133	2,500	4,255
							0
TOTAL	0	0	150	472	1,133	2,500	4,255
ASPs/I.S.V.s							
-International			$7.327	$7.701	$7.288	$6.616	
OTHER REVENUES							
-$							$0.0
TOTAL REVENUES @ ISV							
-International	$0.0	$0.0	$1,099.0	$3,635.0	$8,257.0	$16,540.0	$29,531.0
	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
TOTAL	$0.0	$0.0	$1,099.0	$3,635.0	$8,257.0	$16,540.0	$29,531.0
-Other	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
TOTAL	$0.0	$0.0	$1,099.0	$3,635.0	$8,257.0	$16,540.0	$29,531.0

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PHASE 1

MANUFACTURING COST OF SALES

	1990	1991	1992	1993	1994	1995	TOTAL
°Units	0	0	770	2046	3875	7843	14534
Projected Unit Cost			$2.295	$2.274	$2.295	$2.305	
°Projected Total Cost at Std.	$0.0	$0.0	$1,767.2	$4,652.6	$8,893.1	$18,078.1	$33,391.0
Other Cost of Sales							
-5% of ISV Revenue	$0.0	$0.0	$265.7	$760.5	$1,349.0	$2,504.0	$4,879.1
-NPI Dev Expenses	$18.9	$236.9	$83.1				$338.9
-Component Engineering	$18.5	$290.0	$98.6				$407.1
							$0.0
							$0.0
							$0.0
							$0.0
							$0.0
°TOTAL OTHER COS	$37.4	$526.9	$447.4	$760.5	$1,349.0	$2,504.0	$5,625.1

12/6/90

Development Expenses

Proj Name Cobra Program Costs
Phase Phase 1

Lan	1990	1991	1992	1993	Total
Direct Man Years	4.3	14.5	11.3	0.0	30.2
Direct Labor	186.8	730.8	569.7	0.0	1,487.3
Overhead	268.1	1,352.0	1,053.9	0.0	2,674.0
Prototype (Lab,OH,Matl)		180.0	78.0		258.0
Direct Materials	5.0	32.0	34.0		71.0
Direct Travel	3.2	25.0			28.2
Other Direct	1.0		6.0		7.0
Total	**464.1**	**2,319.9**	**1,741.6**	**0.0**	**4,525.5**

Development Support	1990	1991	1992	1993	Total
Direct Man Years	0.4	3.7	4.3	0.0	8.4
Direct Labor	25.8	185.8	212.9	0.0	424.5
Overhead	52.5	358.6	411.0	0.0	822.1
Prototype (Lab,OH,Matl)					0.0
Direct Materials					0.0
Direct Travel					0.0
Other Direct					0.0
Total	**78.3**	**544.4**	**623.9**	**0.0**	**1,246.6**

Digital	1990	1991	1992	1993	Total
Direct Man Years	0.1	1.7	2.3	0.0	4.1
Direct Labor	4.0	73.6	97.6	0.0	175.1
Overhead	5.4	99.8	132.4	0.0	237.7
Prototype (Lab,OH,Matl)					0.0
Direct Materials					0.0
Direct Travel					0.0
Other Direct					0.0
Total	**9.4**	**173.4**	**230.0**	**0.0**	**412.8**

Total DEV Costs	1990	1991	1992	1993	Total
Direct Man Years	4.8	20.0	17.9	0.0	42.7
Direct Labor	216.6	990.2	880.2	0.0	2,087.0
Overhead	326.0	1,810.4	1,597.3	0.0	3,733.8
Prototype (Lab,OH,Matl)	0.0	180.0	78.0	0.0	258.0
Direct Materials	5.0	34.0	37.6	0.0	76.6
Direct Travel	3.2	25.0	0.0	0.0	28.2
Other Direct	1.0	0.0	6.0	0.0	7.0
Total	**551.8**	**3,039.6**	**2,599.1**	**0.0**	**6,190.6**

Note: Costs include Phase 1,2,3 and All Enhancements

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PHASE 1

CAPITAL EXPENDITURES

RESEARCH & DEVELOPMT	*1990*	*1991*	*1992*	*1993*	*1994*	*1995*	*TOTAL*
TEST EQUIPMENT (5 Years)							
Tek Logic Analyzer	$28,560						$28,560
Token Ring Cards	$3,750						$3,750
Token Ring Analyzer	$38,900						$38,900
Tek 2440 Scope	$10,532						$10,532
HP 68000 Emulator		$14,000					$14,000
HP 68302 Emulator		$30,000					$30,000
Physical Design Capital		$13,500					$13,500
5-68302 Emulators		$83,000					$83,000
3-68000 Emulators		$48,000					$48,000
3-Token Analyzers		$111,000					$111,000
SMT Device Programming Site		$3,000					$3,000
Sniffer Upgrade		$4,000					$4,000
							$0
							$0
							$0
DP EQUIPMENT (4 Years)							$0
HP Workstation Upgrades	$30,943						$30,943
Mentor Idea Station		$27,500					$27,500
9-X11 Terminals		$27,000					$27,000
							$0
							$0
°TOTAL	$112,685	$361,000	$0	$0	$0	$0	$473,685

Project:__Cobra________________ | PHASE 1

000's$ | CAPITAL EXPENDITURES

MANUFACTURING	1990	1991	1992	1993	1994	1995	TOTAL
TEST EQUIPMENT (5 Years)							
HP 3070 Fixtures-Board Test		$75,000					$75,000
HP 3070 Fixtures-Final Test		$62,000					$62,000
							$0
							$0
							$0
°TOTAL	$0	$137,000	$0	$0	$0	$0	$137,000
TOOLING							
SMT Material Handlers-Fuji-II		$40,000					$40,000
SMT Material Handlers-Zevatech		$40,000					$40,000
Robot Tooling, Various		$20,000					$20,000
-							$0
°TOTAL	$0	$100,000	$0	$0	$0	$0	$100,000
OTHER							
-							$0
-							$0
-							$0
-							$0
-							$0
-							$0
°TOTAL-OTHER	$0	$0	$0	$0	$0	$0	$0
°TOTAL-MFG	$0	$237,000	$0	$0	$0	$0	$237,000

12/6/90				
Prototypes for Cobra Program				
Phase 2 Needs			Unit Cost =	3500
		Qty	Cost	
Design eng				
	1st pass units	7	24500	
	2nd pass units	15	52500	
Diagnostics				
	1st pass units	1	3500	
	2nd pass units	1	3500	
Alpha Test				
	1st pass units	0	0	
	2nd pass units	4	14000	
QA/regulatory				
	1st pass units	2	7000	
	2nd pass units	13	45500	
Service				
	1st pass units	0	0	
	2nd pass units	2	7000	
Training				
	1st pass units	0	0	
	2nd pass units	2	7000	
Totals		47	164500	

COBRA SYSTEMS COST

	BASE Unit 4 M Token Ring 68000 based	BASE Unit 4/16 Token Ring 68030 Based	Multiport WAN Option Card	T1/E1 WAN Option Card
Card Type				
Main Bridge PWB 68000	$482.93			
Main Bridge PWB 68030		$579.27		
Token Ring I/O 4 Mbps	$317.10			
Token Ring I/O 4/16 Mbps		$360.00		
WAN I/O AUX (68302)			$321.37	
WAN I/O T1 (68302)				$387.54
Backplane five Slot	$110.54	$110.54		
Elect Cost Subtotal	$910.57	$1,049.81	$321.37	$387.54
Materials Overhead 9.5%	$86.50	$99.73	$30.53	$36.82
Labor Overhead 17%	$154.80	$178.47	$54.63	$65.88
Fully Burdened Elec Cost	$1,151.87	$1,328.01	$406.54	$490.24
Packaging Cost (1991)	$488.00	$488.00		
Fit Cost ($84)	$84.00	$84.00		
Misc panel Fillers (1992)	$18.00	$18.00		
VRTX & IFX	$30.00	$30.00		
Total Unit Cost	$1,771.87	$1,948.01	$406.54	$490.24
DIM Transition cables	$45.00	$45.00	$180.00	$135.00
Shipping container	$32.00	$32.00		
Total System Cost	$1,848.87	$2,025.01	$586.54	$625.24

PHASE 1 COBRA COST ESTIMATE

Estimate based on: ENGINEERING PARTS LIST

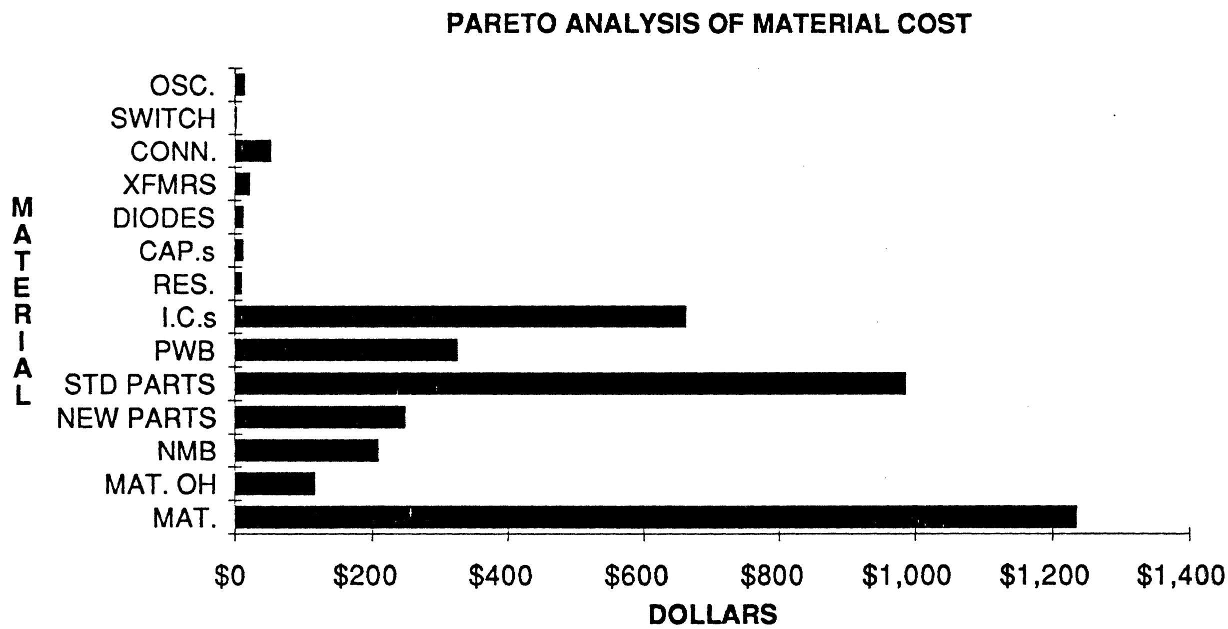
Estimate based on year 1volumes of : 1000 UNITS/YEAR

Configuration: Bridge and Multiport WAN PCBs

Major Cost Elements	Qty	Cost Info Source	Material Unit Cost	Material Extended Cost
• Token Ring Devices	2	Comp	Various	$ 58.30
• Memory Devices	36	Comp	Various	$120.13
• Gals/Pals	15	Comp	Various	$ 129.91
• PWBs	4	Purch	Various	$ 326.00
• Resistors - Resnets	194	Comp	Various	$ 9.57
• Capacitors	217	Comp	Various	$ 13.05
• Diodes/Rectifiers	26	Comp	Various	$ 13.05
• OSC, Crystals Misc	8	Comp	Various	$ 15.29
• Switches and relays	1	Comp	$ 1.50	$ 1.50
• Connectors	25	Comp	Various	$ 53.31
• IC's	141	Comp	Various	$ 354.54
• Hardware	12	Comp	Various	$ 36.11
• Transformers	3	Comp	Various	$ 22.38
• Floppy Material	4	Comp	Various	$ 81.70
Total Material Cost	688			$1234.84
Material overhead (burden rate 9.5%)				$ 117.31
Variable burden (rate 17%)				$ 209.92
TOTAL COST		The accuracy of this estimate is: ± 20%		$1562.07

CODEX/PACE
Product And Cycle Time Excellence

COBRA II COST GRAPH 12/6



7.0 CUSTOMER SERVICE PLAN

7.1 SERVICE STRATEGY

7.2 SERVICE PRODUCT MARKETING

7.3 SUPPORT PROCESS DESIGN OBJECTIVES

7.4 SERVICE PROCESS DELIVERY SPECIFICATIONS

7.5 RESOURCES REQUIREMENTS

7.6 ALPHA TEST GOALS

7.7 BETA TEST GOALS

7.8 SUNSET STRATEGY

7.9 FINANCIAL PERFORMANCE SUMMARY

7.10 RISKS / ISSUES

7.1 SERVICE STRATEGY

The Customer Service strategy for Cobra will focus on developing the necessary skills and tools required to support Cobra's target markets. The service strategy for Cobra and its implementation will also deliver the appropriate service offerings described below in an effective and efficient manner, thus ensuring customer satisfaction and service profitability as well as contributing to the overall success of Cobra.

7.1.1 SERVICE PRODUCT OBJECTIVES:

The Cobra product strategy will provide LAN to HOST connectivity. Market requirements will support the standalone and network segments. Delivering product services to support these market requirements will require the following objectives:

- Hardware support with a minimum of customer network downtime.
- Software support
- Alignment with product offerings of sister product T1-EtherSpan
- Provide service products in line with our existing T1 strategies. (i.e. 6290 product support strategies.)
- Provide service products in line with competition.

7.1.2 SERVICE PRODUCTS:

The following Codex Unbundled Maintenance Service Products for the Cobra product will meet the product market strategies and objectives

Installation Service: An Installation package which provides hardware, software and configuration services at customer install and startup.

Priority On-Site Service: Priority on site is offered on the Cobra product.

Factory Return and Repair Service: The Factory Return and Repair plan is designed for the Codex Customer who has an inventory of Codex parts and a complement of trained personnel.

Time and Material Service: A per-incident equivalent of On-Site Service with a minumum two hour labor charge plus travel.

Codex Software Services: A software subscription service designed to provide complete software support to Codex customers.

7.1.3 COMPETITIVE ANALYSIS:

	Warranty	Install	Maint.
IBM (Bridge Program)	90 FR	600	65/mo
Cross Com (TLAN)	90 FR	1000	70
Microcom (MLB/6500)	1 yr FR	700	65
Codex (Bridge)	2 yr FR	1050*	65
Proteon	90 FR	800	RFQ ($110/HR-T&M)

*Turn-key installation service includes Hardware installation and configuration.

7.1.4 FINANCIAL PERFORMANCE GOALS:

Lifecycle margins:

Installation:	20%
Hardware Contract:	40%
Software Contract:	70%

Financial Breakeven goals:

7.2 SERVICE PRODUCT MARKETING

The service offerings offered for the Cobra program will complement the services supported currently by the 6310 EtherSpan product line. Additional services and modifications are identified in support of the IBM Token Ring environmental and interface requirements.

7.2.1 SERVICE OFFERINGS:

7.2.1.1 INSTALLATION / CONFIGURATION SERVICES

The Cobra product can be installed by the customer or Codex. Installation documentation will be developed by tech pubs providing technical direction on the installation procedures. For Customers who have purchased an Installation Service remote telephone support will be provided by Codex through the CSC at a no charge rate. For Customers who have not purchased an Installation Service and on-site support is required, it will be provided at a Time & Materials rate.

Customers purchasing the installation/configuration service will be provided with an on-site service engineer (CSE) to install and benchmark, cut-over applications and will set filters for the Cobra product. Standard Codex product escalation and backup support flows will be used.

In addition to standard on-site installation, Codex will include the following at no charge:

1. * Technical support from the Customer Support Center (CSC).
2. Expedited replacement materials availability and shipment.
3. Standard escalation procedures will be followed.
4. Remote Dial-in Support using dial modem access (only provided if the customer purchases a remote access Cobra node for the network).
5. * Technical expertise dispatched by the CSC if necessary.

* Includes Token Ring and T1 Digital support as it relates to the Cobra product. This does not include support on a T1 problem or on Token Ring LAN media problems.

Chargeable services offered to the customer not covered under the installation/configuration pricing includes:

1. Engineering Services: This service is home office based and will be available to the Customer at an hourly rate. The customer will have the option to purchase on-site support to cover host or LAN related planning, reconfiguration and fine-tuning support prior to or at the time of the installation. This service represents the pre-installation planning phase of the installation process.

7.2.1.2 MAINTENANCE SERVICES

The following are Codex's Unbundled Maintenance Service Offerings for the Cobra product:

Priority On-Site Service : This is the highest level Service is offering for the Cobra product. Codex will strategically deploy spares to Codex field offices to support customer requirements with a four-hour average response time. Customers choosing this level of service do so to ensure that maximum uptime is maintained by having any failed module replaced immediately. Remote access is required to purchase this service.

Factory Return and Repair Service : The Factory Repair and Return Plan is designed for the Codex customer who has an inventory of Codex parts and a complement of trained personnel. Factory material and labor are included in the cost of factory repair; the customer is responsible for all associated shipping charges. Equipment sent in for this level of service will be repaired only. Updates to current revision are not included in this service.

Time and Materials Service : This is the per-incident equivalent of On-Site Service and the most costly in terms of cost and response time with a minimum two- hour labor charge plus travel. Customer support is provided on a best-effort basis only and helpline support is not provided. There are no response time guarantees, as customers with maintenance service contracts are handled on a priority basis. The materials charge is higher than Factory Repair, ana On-Site support is additive at standard T&M rates with a two-hour minimum.

Software Subscriptions : Software Subscription Services are a family of services that provide comprehensive software support for Codex software intensive products. Software Subscription features include:

- Software and documentation subscription.
- Software and documentation upgrades to current revisions.
- Toll free product helpline.
- Software newsletter.
- Software Advisory notice.
- Software product and defective media warranties.
- Software subscription service.

7.2.1.3 WARRANTY SERVICE

Codex's Standard Warranty for the Cobra is Two Years - Parts Repair.
Telephone support is included as part of Warranty.

7.3 SUPPORT PROCESS DESIGN OBJECTIVES

7.3.1 DELIVERY METHODOLOGY:

The support methodology for Cobra will leverage off current methodologies used to support 6310 EtherSpan products, with the exception of an added capability to provide remote support of 6320 units for customers who purchase the remote access Cobra product for their networks.

The realm of responsibility for the Codex CSE's shall be restricted to installation and maintenance fo the Cobra products. Codex CSE's will not be responsible for the configuration of the T1 lines, the Token Ring cable plant, or the connections into the Token Ring LAN. The customer must provide installed and operational T1 lines and also must provide a proven Token Ring connection access point which has already been installed on the Token Ring LAN.

7.3.2 SERVICIBILITY, RELIABILITY, MAINTAINABILITY

7.3.2.3 SERVICEABILITY DESIGN:

Technical Services will work with Engineering to further define the following requirements necessary to provide serviceability of the Cobra product. A Serviceability Requirements Statement (SRS) has been developed and will be required to be signed off by Product Ops. and Customer prior to the phase 1 review. Verification of all of the SRS items will occur during Alpha Test.

- Provide remote access and control capability for Service
- Define error and statistic reports
- Identify product resident diagnostic requirements.
- Identify and evaluate external diagnostic requirements.
- Ability to isolate T1 and Token Ring problems.
- Ability to analyze and repair Bridge/Router problems with minimal disruption to the network.
- Minimize the installation and configuration complexity of the options without requiring highly specialized skills required.
- Minimize the addition of adding new test tools in the Field by providing test capabilities in the product.
- Ability to maintain the network after the installation without highly specialized skills required.

7.3.3 DELIVERY ADMINISTRATION REQUIREMENTS:

7.3.3.1 SUPPORT TOOLS:

The Cobra product SRS defines that the product diagnostic and monitoring capabilities will provide the field personnel (CSE and APSE) with 90-95% support coverage on the Cobra product and its application environment. These capabilities will provide isolation testing and verification of the Cobra product from its connected environments (T1, V.35, and Token Ring LAN), and will also provide in-depth self-diagnostics to isolate faulty HW, SW, and configuration failures within the product itself. Higher level support tools required to support fault isolation and configuration problems of the Cobra product will utilize existing support tools. These tools are:

T1/Digital Support - 1500/5575A (Field Personel)
5500 (CSO Personnel)

V.35 Support - HP 4952A (Field and CSO Personnel

Token Ring LAN Support - Addition of Token Ring Medsia card to Sniffer

Detailed testing and verification practices and procedures for support of troubleshooting T1, V.35, and Token Ring LAN problems will be documented and supplied to support personnel via the Cobra User manual (Installation and Troubleshooting sections) and via Technical Reference documentation. The user manual will provide detailed information and flowcharts on the installation and troubleshooting of the Cobra product and isolation of the product versus application problems, but only limited to the capabilities of the product (no test equipment coverage detailed). Whereas, the Technical reference will provide brief, specific installation and maintenance information on the utilization of the test tools carried by service to provide support on this product and its environment. These installation and support tools and procedures will also be fully covered in the training class. LAN Analyzers (with Token Ring media support) will be used via remote analysis access control from the CSC. Only the CSC personnel will require in-depth support tools skills to support this product.

The only additional purchases to provide support on this product will be the addition of two Token Ring interface cards and software for the two existing LAN Analyzers (currently support the 6310 EtherSpan and 9800 LAN products). Incremental additions to the LAN Analyzer base will be provided as field requirements increase.

7.3.4 SKILL SET DEFINITION:

The audiences targeted to receive training on this product in the Customer Service organization is comprised of RTS, CSE, ATS, NTS, and Field Management personnel.

The following chart depicts the skill sets required to install and troubleshoot the Cobra Product/System:

Service Skill Prerequisites	Technical Audience			
	RTS	CSE	ATS	NTS
•Technology				
•Digital				
•T1 Fundamentals (excluding voice)	X	X	X	X
•Span Measurement/Interpretation Capability	X	X	X	X
•Test Equipment Usage				
- 1500/5575A	X	X	X	X
- 5500			X	X
- HP4952	X	X	X	X
•System Fundamentals				
•Feeder into Public Service	X	X	X	X
•Feeder into Private Backbone	X	X	X	X
•6290 installation/Conf. Capability	X	X	X	X
• 6290 to Cobra Frame Relay				X
• LAN				
•LAN Fundamentals	X	X	X	X
•Token Ring LAN fundamentals	X	X	X	X
• Token Ring LAN Install/Maint. Skills	X	X	X	X
• IBM Ntwk/Mgr. Applications	X	X	X	X
• IBM Token Ring/Appl. Fund.	X	X	X	X
• LAN Protocols and Applications				X
•Test Equipment Usage (Analyzers)				X
• OTHER				
• Netview Operation (LAN Mgr)				
• Installation				
•Perform physical installation	X	X	X	X
•Understand and configure Parameters	X	X	X	X
• Test Validation (T1, V.35, LAN)	X	X	X	X
• Maintenance				
•Understand Line/Device Alarm Parameters	X	X	X	X
•Understand Troubleshooting Techniques	X	X	X	X
• Remote Support/Access				X
• LAN Analyzer Operation				X
• LAN Protocol Troubleshooting				X

Service Field Managers who are tasked with selling Service Contracts will require product knowledge and technical/pricing installation and maintenance information. This will be accomplished via a joint Sales/Service Introduction Kit and the Service Implementation Plan.

7.3.5 OEM RELATIONSHIPS:

The Cobra product is manufactured and shipped from Codex Mansfield. There is no OEM relationships with this product.

7.3.6 UPGRADE POLICY :

SW Upgrades will be provided via floppy disk. No provision has been made in the Cobra product to perform SW downloads. Codex policy on upgrades will utilize the standard procedures and practices incorporated by Service.

7.4 SERVICE PROCESS DELIVERY SPECIFICATIONS:

7.4.1 REMOTE DIAGNOSTIC REQUIREMENTS:

The inclusion of one of more Cobra products with the remote access and control capability (separate product code orderable) will provide Service with an entry point into the customer's network. At the present time this product code will consist of a Cobra product integrated with a 2239 dial modem in the Modulus 9/21 nest enclosure (either 5 or 9 slot). The customer must provide a network diagram, dial telephone number(s), a dedicted dial line, and a contract at each location(s) as a backup if remote dial-in fails or if the remote CTP cannot gain access into the unit.

The internal product monitoring, diagnostic, and control capabilities will then be utilized via remote control from the CSO organization. If an on-site visit is required, CSO will be able to provide the CSE with an insight into the problem.

7.4.2 MATERIAL STRATEGY:

The Field Replaceable Unit (FRU) kit will be developed from two projects:

	Located
Modules 9/21	
Power Supply	District Office
Fan	District Office
Cobra	
Backplane	Home Office
Main Bridge Card	District Office
WAN port Card	District Office
LAN interface assy	District Office
Replacement DIMS	Home Office
Disk Drive	District Office

FRU locations will be adjusted based on MTBF and frequency of failure.

7.4.3 ON-SITE PROCEDURES - INSTALLATION

NOTE: The definition the the MTTI and MTTR is based on the following assumptions:

1. The WAN lines have been installed and have been verified for data passing integrity.
2. The IBM Token Ring LAN equipment has been installed and is working properly.
3. Installation planning data sheets and configuration worksheets are accurate and complete.
4. Codex will not supply or support tha Token Ring interface attachments.

Mean Time To Install (MTTI): The following are the MTTI Service Goals:

HW/SW:

Circuit Integrity Check
Unpack and inspect equipment
Install and Verify Cobra Hardware
Install, Boot and Verify Software
Verify LAN and remote 6320 attachment

Goal - 1.0 Hours

Configuration: Pre-Installation/PPK Part 2
Dev. Installation plan
Configuration input
Application Cut-Over

Goal - 4 Hours

The Cobra product can be Customer installable although Customer Service will provide an installation/configuration service which can be purchased by the customer. Purchased installation/configuration services will be performed by the Field Customer Service Engineers (CSE's) with support from the Home Office Remote Tech Support (RTS) personnel and, if needed, from Area Product Support Engineers (APSE's) and Home Office National Tech Support (NTS's) personnel. Additional pre-installation services can be purchased from Codex at a Time & Material rate.

7.4.4 RESTORAL PROCEDURES - REMEDIAL

Mean Time To Repair (MTTR): The MTTR goals include the diagnostic time, but do not include any travel time (average travel time is two hours). The MTTR is divided into hardware/software and configuration and application diagnostic process.

HW MTTR: Review CTP Reports & Statistics
Run Hardware diagnostics
Swap Hardware, run diagnostics

Goal - 30 min.

CON/APPL: Analyze CTP Reports & Statistics
Analyze Configuration
Analyze Application Requirements
Determine Software Deficiency
Perform, Test and Verify Fix

Goal - 1.2 Hours

Cobra maintenance will be performed as a **modular level exchange.** There are no periodic maintenance incidences required for this product. Card level repair will be performed by the CSE for those customers who maintain a maintenance contract service. For those customers who do not have maintenance contract services FR&R or T&M maintenance is available.

CSE's will receive first level support from RTS personnel within the Home Office technical group. On-site assistance of an Area PSE (APSE) may be required by the RTS. The determination to escalate a customer problem to National Technical Support (NTS) is the responsibility of the RTS.

7.4.5 FACTORY REPAIR PROCEDURES:

Field returns will be repaired, upgraded and tested per ECO processes as required. Standard ERR repair procedures will be followed. Test and repair procedures, equipment, and utilization of equipment will be the responsibility of Manufacturing. Testing capabilities will be the same as new product.

7.4.6 TRAINING / DOCUMENTATION REQUIREMENTS:

7.4.6.1 TRAINING

The method of training delivery for Cobra will differ based on the intended audience and their skill set requirements and are as follows:

Customer Service Engineers (CSE): The CSEs will be trained on the Cobra product via a self-study training package. Token Ring technology training will be developed and added to the existing 6310 training program.

Area Product Support Engineers, Remote Technical Support and National Technical support (APSE, RTS, NTS) will be Mansfield based classroom training. Token Ring technology training will be developed and added to the existing 6310 class room training.

The need for Customer Training requires further investigation. Preliminary findings show a small requirement for this service.

7.4.6.2 DOCUMENTATION

CUSTOMER
A User's Manual will be provided for this product covering the following areas: Product Overview, Configuration and Operation, Installation and Maintenance procedures. The Beta Test documentation will be a preliminary User's Manual.

SERVICE
A Technical Reference should be developed and should focus on the service and support of this product. The audience of the document is the post-sales support functions. The technical content should include the following:

- Fault Isolation (WAN side)
- Fault Isolation (LAN side)
- Common problem/application scenarios

Preliminary documentation should be available at Beta Test with final documentation available for FCS.

7.5 RESOURCE REQUIREMENTS

7.5.1 MATERIALS:

This product will be supported as a "level -one" (on-site modular exchange product). The following depicts the logistic sparing requirements through the five-year forecast:

	1992	1993	1994	1995	TOTAL
Unit Forecast	620	1,574	2,742	5,343	10,279
Spare Forecast	65	60	35	0	0 - 3%

Kit material will be ordered through the manufacturing planning cycle and produced from manufacturing build cycles. Average lead time will be 4 weeks.

7.5.2 FACTORY REPAIR REQUIREMENTS:

All defective field modules will be returned to Mansfield (Logistics Receiving) for processing into repair cycle. Field modules will be returned with failure information tags (Equipment Repair Tags) properly completed. Equipment Repair tags will aid in identifying field failures in ERR. ERR will provide corrective action taken and ECO's required on the equipment returned. QA will be supplied copies of the Equipment Repair tags to monitor failure trends.

7.5.3 RESOURCE COST ASSUMPTIONS:

7.6.0 ALPHA TEST GOALS:

Customer Service (Technical Services) expects to support Alpha Test. Alpha Test will be used to gain hands-on product knowledge and as an aid in developing support tools. Some of the goals of a successful Alpha Test for Service are:

- Verification of the SRS requirements as per Phase 1 spec
- Develop product operational skills and understanding
- Develop a detailed understanding of all product features
- Establish installation procedures.
- Establish troubleshooting/fault isolation procedures
- Establish upgrade procedures
- Ensure compliance to serviceability requirements.
- Review, prioritize, and signoff of all bugs found.

Also, Customer Service needs to review the Alpha Test Plan in order to plan involvement and ensure that Service can accomplish its goals in the most effective and efficient manner. The knowledge and procedures gained as a result of Alpha Test involvement will be used to update product documentation and will be included with any training.

7.7 BETA TEST GOALS

Participation in Beta Test will be designed to measure and evaluate Customer Service readiness. Beta Test goals may include, but are not limited to, the following:

- Test order placement procedures, i.e., verify all the correct parts are delivered when an order is placed.
- Test installation procedures and tools.
- Test fault isolation procedures, i.e., verify diagnostic procedures.
- Ensure effective call handling, technical support and escalation policy.
- Verify that the sparing methodology can be supported.
- Evaluate documentation completeness and accuracy.
- Verify product stability in a customer environment.

7.8 SUNSET STRATEGY:

As future ethernet features become available with the Cobra platform a sunset strategy will need to be developed for the existing 6310 EtherSpan.

7.9 FINANCIALS SUMMARY

FCS	1992	1993	1994	1995	Total
Units Sold	620	1574	2742	5343	10,279
Revenue $K	142	1121	2234	4278	
Exp $K*	339	744	1217	2036	
GM $K	(198)	377	1016	2242	
GM%	-139%	34%	45%	52%	

7.10 RISKS / ISSUES

1. Token Ring will be a new technology for Codex. Training, documentation, and hands-on with the product are essential to meet service target MTTI/MTTR and quality goals.

2. Availability of the two LAN analyzers (currently shared between 6310, 9800 LAN support) at Cobra FCS.

3. The responsibility of the customer to ensure circuit integrity is a risk with respect to Mean Time to Repair and Install. If customer circuit lines are not fully operational within specification, the MTTI/MTTR goals will not be met.

4. The responsibility of the customer to ensure LAN integrity is a risk with respect to Mean Time to Repair and Install. If customer's LAN(s) are not fully operational, the MTTI/MTTR goals will not be met.

5. PPK1 to identify customer dial access requirement when remote support is purchased.

8.0 MANUFACTURING PLAN

8.1 MANUFACTURING STRATEGY

8.2 MATERIAL PLAN

8.3 MANUFACTURING PROCESS DESCRIPTION

8.4 CAPACITY VS. BUILD PLANS

8.5 MANUFACTURING TRAINING

8.6 PROTOTYPE, AND PILOT BUILD PLANS

8.7 MANUFACTURING COSTS

8.9 DO DIFFERENTLIES

8.9 ASSUMPTIONS, RISKS, AND ISSUES

8.0 MANUFACTURING STATEGY

8.1 BASIC PHILOSOPHY

Printed wiring assembly at Codex is moving heavily toward SMT (Surface Mount Technology) for new products. The reasons are fewer defects (due to a more automated assembly), shorter production cycle times, and shorter process development cycle times. In addition the VLSI portion of new designs continues to rise, with higher pin counts per device. Many of these devices are available predominantly (or only) in SMT packages (which is the case with this product). For all these reasons SMT is the technology of choice for this product.

At the volumes forecasted for the first year of product life batch assembly on the Modulus 9/21 line with other resident products will be used. The phase one plan calls for volumes over 3.8K per year in year 3 of the product life. This plan will not address those volumes. It will require revision by production engineering in 1993 to meet those volumes in 1994.

The Cobra manufacturing plan will be centered on the Codex SMT facility in M7. This facility has been designed to produce high quality surface mount technology PWAs with very short cycle times while providing state-of-the-art SPC data collection and variables trending in a transaction-oriented integrated environment.

The SMT process to be used in building the Cobra is a low risk part of the program. SMT is a mature and well understood process within Motorola, although relatively new to Codex. Codex has had SMT equipment for 3-4 years and has gained significant knowledge of the techniques used by Motorola. This allowed Codex to implement and perfect mixed technology (SMT/THT) very rapidly. The ability to have excellent yields in mixed technology is crucial to the Cobra program which uses a variety of SMT and THT components on it's PWAs.

The Cobra product must be designed to be compatible to all aspects of the process so that the full potential of the facility can be realized. This introduces a few new design factors to the design engineer which will require a close working relationship with the process engineers. These factors include:

- DFM - Design for Manufacturability
  - Process compatible components selection
  - Process compatible PCB layout
  - Group Technology (Lowest Cost usage of equipment)
  - Minimum Parts Count for Minimum Cost

- DFT - Design for Testability
  - Schematic Capture using Hierarchal Design Techniques
  - Design/Test Engineering definition of Variables Tests
  - Test Point definition at schematic for VIA Components

- SIMULATION - Design for automatic ATE programming
  - QuickSim or Verilog Files for TSSI TDS ATE program production
  - Process Monitoring of production units on the hp® 3070 in-circuit tester.

8.1.1 MANUFACTURING GOALS

Each new manufacturing process must be designed and evaluated against long term manufacturing goals for cost, quality, and cycle time.

8.2 MATERIAL PLAN

8.2.1 PROCUREMENT STRATEGY

All materials for procurement on prototype, pilot (FCS), and production requirements will be placed with the existing supplier base in accordance with Codex Corporation policies covering these materials. Long leadtime, high risk, critical and single sourced components will be addressed for availability and advanced ordering. Only with appropriate approval will material be procured for pilot and production builds.

8.2.2 HIGH RISK COMPONENTS FOR MANUFACTURING

Single sourced or items that represent a higher risk to the program goals of quality, availabilty, and cost are:

- TMS380C16 TOKEN RING CONTROLLER
- TMS38053 TOKEN RING LINE INTERFACE
- MC56116 DSP 40MHZ
- PE65621 ISOLATION SHAPING UNIT
- PE65611 ISOLATION SHAPING UNIT

8.2.3 VENDOR CERTIFICATION AND PARTNERSHIP

Supplier certification, partnership programs, and Corporate Purchasing (Contracts) agreements presently in place will be adhered to. New components will be acquired from the present supplier base having previous Supplier Partnership Agreements with Codex whenever possible.

8.3 MANUFACTURING PROCESS DESCRIPTION

8.3.1 PROCESS FLOW CHART

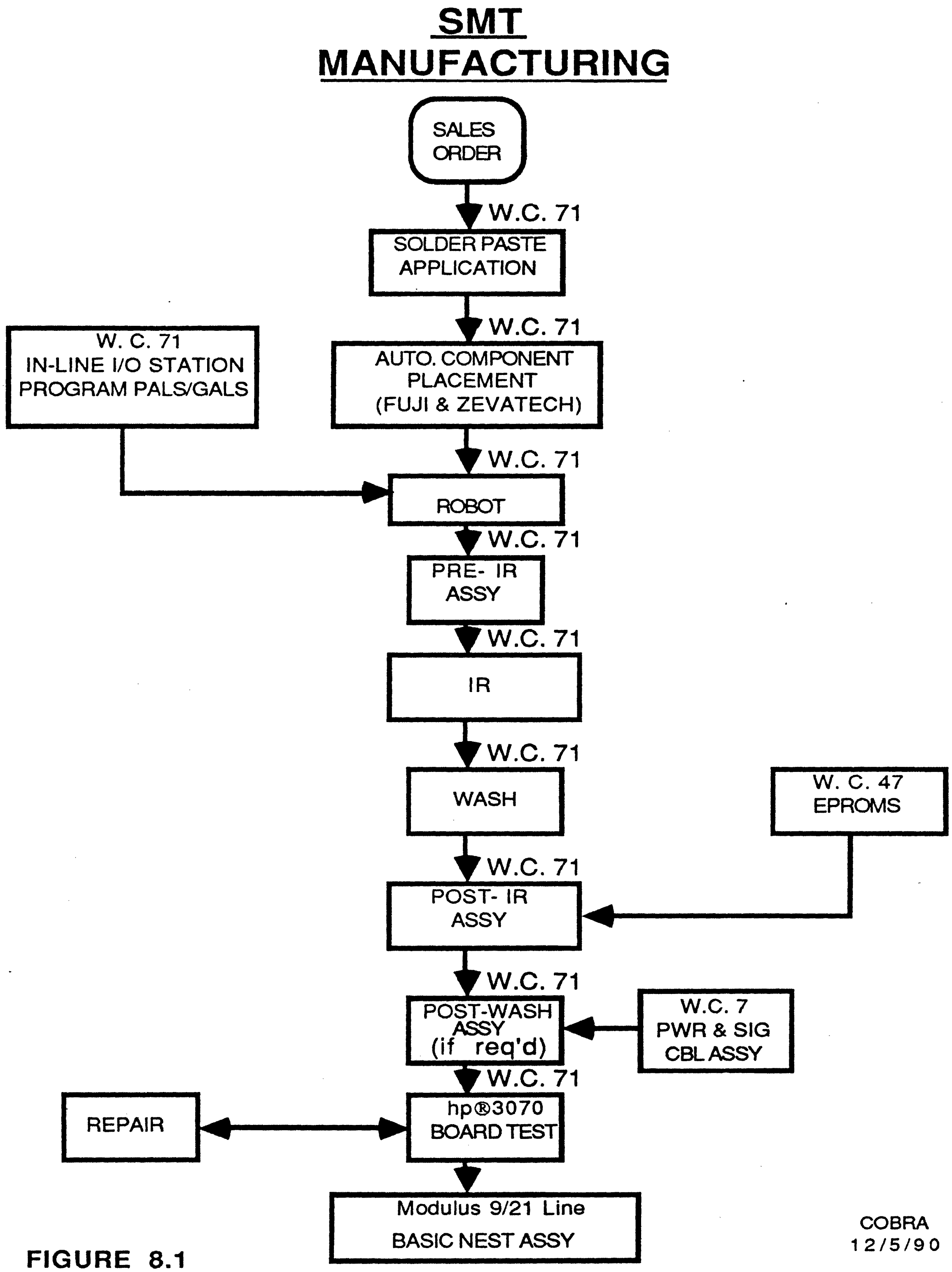


FIGURE 8.1

FIT LINE MANUFACTURING

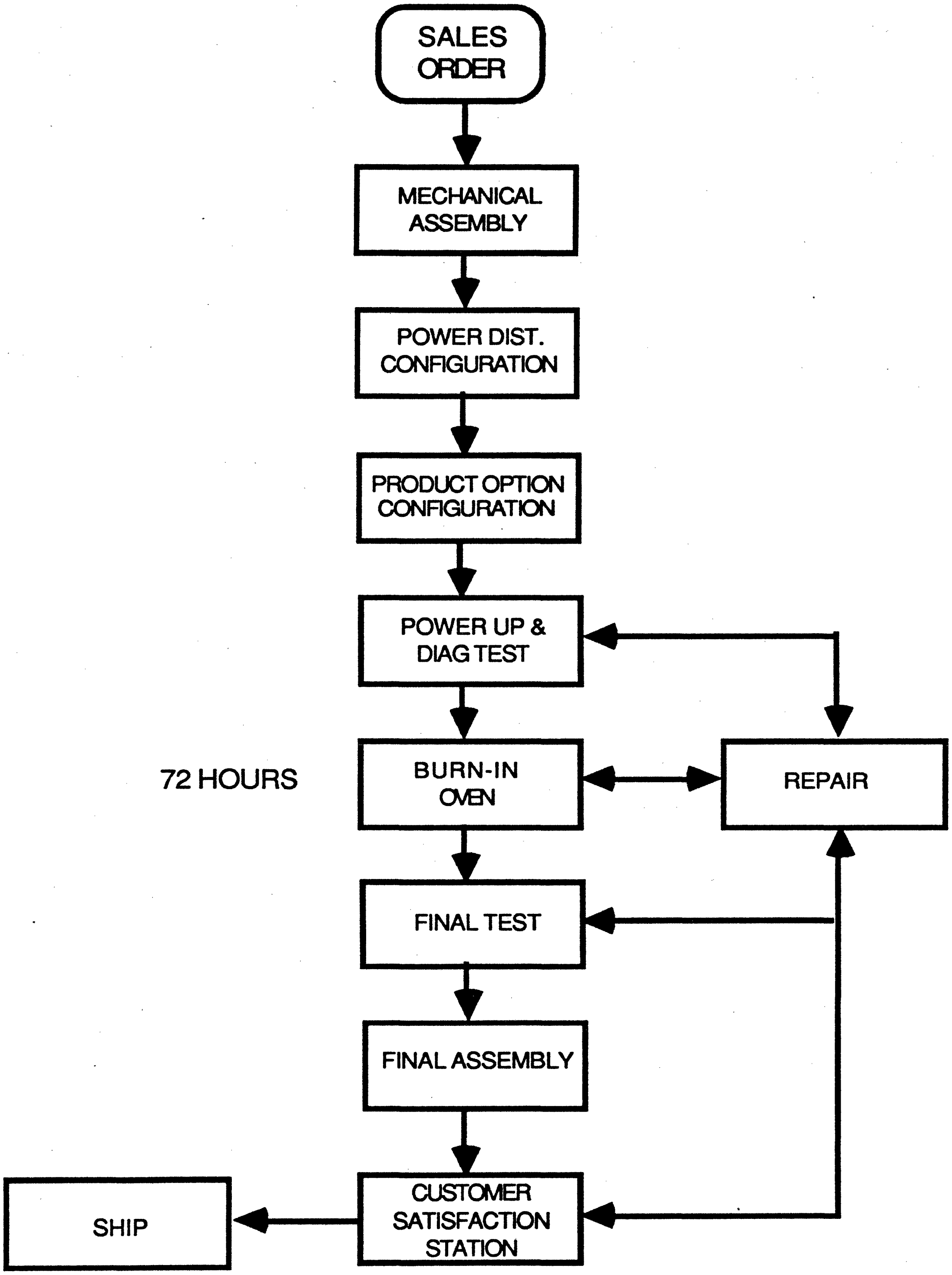


FIGURE 8.2

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8.3.2 BUILD PLAN PROCESS SUMMARY

The Bridge PWA, Lan Interface PWA, and Multiport Aux PWA will utilize the process capabilities of the SMT production line as outlined in the Process Flow Chart (Figure 8.1). The Texas Instrument Token Ring device set requires " fine pitch" SMT technology which is currently available in M7 (SMT manufacturing facility). However, the alternate plan will be to socket this particular device for the low volume prototype builds.

All SMT PWAs required would be supplied by M7 and would be transported in totes to the M1 Modulus 9/21 FIT Line (Refer to Figure 2). Likewise the five slot backplane PWA will be assembled by the M1 Flex PWA Line and supplied to the Modulus 9/21 FIT Line.

The present strategy is to utilize the Modulus 9/21 nest package. There would be three SMT printed wiring boards created for release one. The Bridge PWA would be the main board that would support most of the functionality of the product. Piggy-backed to the bridge board would be a 3 1/2" floppy drive with cable connect down to the bridge board, and a Lan Interface PWA (approx 38 sq. in.) which would connect through a bottom entry connector. Along with the plug-in Bridge PWA would be an optional Multiport Wan PWA, both cards would plug into 240 pin connectors mounted on the backplane. All circuitry to operate the floppy drive would be resident on the Bridge PWA. Only the floppy drive itself would be mounted above the Bridge PWA to align it with the front rail cut-out. There will also be a five slot backplane PWA which will have all the I/O interfacing connectors presented, plus the two 240 pin connectors for plugging in the Bridge PWA and the Multiport Wan PWA. The Bridge PWA would take-up 3 slots and the optional Multiport Wan PWA will take-up 2 slots of the 9 slot Modulus nest.

8.3.3 TEST PROCESS SUMMARY

The test process for Token Ring technology is a new area for Codex and, therefore is considered a higher risk. The intent is to focus the test process around a "designed-in" diagnostic test capability (power-on, off-line, and burn-in) within the product itself with high coverage thereby minimizing the time spent on the hp® 3070 and other test equipment.

The diagnostics will partially be burnt into ROM on the Bridge PWA with the remainder residing on the system software disk. The power-on diagnostics will test logic to the extent where additional diagnostics can be downloaded. The off-line and burn-in diagnostics will build on the coverage of the power-on diagnostics and will provide more detailed coverage of the token ring, floppy, and front rail interface.

In-circuit test is planned for the Bridge PWA, Lan Interface PWA, and Multiport Wan PWA using the hp® 3070 at a level 3 , which would be equal to or better than board test done on a Fairchild 303. The diagnostics would cover any items not testable with the hp® 3070. Fault data from the diagnostics will be fed back to improve the coverage at the hp® 3070 as necessary.

Final test will be accomplished by expanding on the Maverick test station already resident on the Modulus 9/21 FIT Line. IBM Token Ring cards will be added to the existing hp® Vectra (IBM 386 equiv.) to allow checking connectivity of the Lan Interface.

The test programs will insure that the defined manufacturing process remains in control and detects and identifies any potential performance deficiencies introduced during manufacturing. No non-value added testing will be introduced into the test process. This test philosophy may vary slightly due to the concept of trying to share common test equipment and develop similar test stations.

8.3.4 QUALITY/YIELD GOALS & APPROACHES

The startup defect rate for the Cobra product will have to be 6.0 Sigma determined by the product shipping in quarter one of 1992. A large improvement in defect rate over the Etherspan product will be realized from using surface mount technology. Two areas that will require the most attention for quality will be:

- Paste and solder reflow (SMT).
- Properly placing component reels and tubes on the pick and place machines (SMT).

8.3.4.1 CALCULATED SIGMA

	DESIGN ESTIMATE			
ITEM DESCRIPTION	DEFECTS/ UNIT	PPM/ OPP.	SIGMA (REF.)	FPY
PWA, BRIDGE - 68000	0.4903	147	5.11	61.24%
PWA, LAN INTERFACE - 4MBPS	0.2248	139	5.12	79.87%
PWA, MULTIPORT WAN	0.2778	131	5.13	75.74%
PWA, FIVE SLOT BACKPLANE	0.0674	101	5.20	93.49%
UNIT ASSEMBLY, MODULUS 9	0.0042	58	5.37	99.58%
PWA, AC/DC DISTRIBUTION	0.0398	113	5.17	96.10%
POWER MODULE ASSEMBLY	0.0005	104	5.19	99.95%
TOTALS	**1.1048**	**135**	**5.13**	**33.13%**

8.3.5 SOFTWARE DUPLICATION PROCESS SUMMARY

The software production work center 47 will duplicate the 3 1/2" floppy disks for system software and the EPROMS (M1). The in-line I/O station at work center 71 will program the PAL's and GAL's (M7). However, because of the large amount of programmed PAL's/GAL's the majority will have to be pre-programmed in W.C. 47 or W. C 71, rather than, bog down the robot station.

8.4 CAPACITY VS. BUILD PLAN

8.4.1 BUILD LOCATION

The build location of the Bridge PWA, Lan Interface PWA, and Multiport Wan PWA will be the SMT production line (work center 71). Work center 1 the Flex PWA Line will build the five slot backplane. The mechanical sub-assemblies and the basic nest assembly are currently being built on the Modulus 9/21 FIT Line, and floppy disk signal & power cables are built in work center 7.

8.4.2 SHARED EQUIPMENT CAPACITY

* Screen Printer

* Fuji

* Zevatech

* Robot

* Convection/IR Oven

* hp® 3070

8.4.3 LABOR CAPACITY

The volume forecasts of the Cobra product are similiar to that of EtherSpan and are considered low volume which is typical of the networking products. Build plans can be handled within a one shift operation.

Build Plans Vs. Capacity

1992

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
0	0	50	65	75	80	80	80	80	80	90	90	770

1993	1994	1995	Total
2,046	3,875	7,843	14,534

8.5 MANUFACTURING TRAINING

The Corporate training department will be evaluating the skills presently employed on an individual basis during the 1991 timeframe. The Corporate training department will conduct technical training sessions with design engineers participating for 1 - 2 test technicians. These sessions will include a systems overview, block diagrams, schematics and troubleshooting techniques using diagnostics. Training is required for the unique features of the token ring functionality. They will be videotaped for subsequent use. The training will be aimed at the manufacturing technician level but could be used across all organizations on an as needed basis. Outside training courses offered by TI on token ring technology may also be utilized.

8.6 PROTOTYPE, AND PILOT (FCS) BUILD PLANS

8.6.1 PROTOTYPE BUILD

The initial program schedule allows for two prototype passes. Prototype #1 will consist of a small quantity (approx. 12 units) and will be built in the begining of Q3/1991 timeframe. Preliminary manufacturing process support items will be available where possible and some low level (TBD) of test capability is expected to be available.

The intent is to have the actual production work center (W/C 71) at M7 perform as much of the assembly as possible with the prototype department performing any required cuts and jumpers.

Prototype #2 will consist of a larger quantity (approx. 37 units) and will be built in the late Q4/1991 timeframe. All manufacturing process support items will be updated and available for this build. The production work center (W/C 71) at M7 will perform all of the work and a high percent of test coverage will be available.

These units will represent the product's final form, fit, and function and we expect that they can be converted into revenue product, if needed, for early internal customer requirements, i.e. trade shows, regional sales demos, etc.

8.6.2 PILOT BUILD (FCS)

Approximately 50 units will be built in the late Q1/1992, timeframe to support initial sales order demands. All assembly and test process support items will be available for this build. All documentation will be loaded, routings, standards, drop zones, and locations on AMAPS.

The product code structure for the Cobra product will be basically the same as the EtherSpan product. This would include a hardware product code calling for a basic unit assembly in which it's components are the various mechanical sub-assemblies, PWA's, cables,and shipping container. The software would be a separate product codes, including user manual (kit). Unique to Cobra would be an option product code calling for a Multiport Wan PWA.

8.7 MANUFACTURING COSTS

8.7.1 CAPITAL EQUIPMENT REQUIRED:

ITEM	EST. COST	NOTES/ STATUS
SMT Material Handlers		
Component Carriers (Fuji-II)	$ 40,000.	# of new SMD parts Need CAR

Component Carriers (Zevatech)	$ 40,000.	# of new SMD parts Need CAR
Robot Tooling, Various	$ 20,000.	EST. Need CAR
hp® 3070 Development	$ 75,000.	EST. Need CAR
Total	$175,000.	Maximum

8.7.2 NON RECURRING EXPENSES:

ITEM	EST. COST	NOTES/ STATUS
Prototype #1 Build	$ 43,200.	EST. Need PCA
Prototype #2 Build	$ 133,200.	EST. Need PCA
Test Development	$ 62,000.	EST. Need PCA
Total	$182,600.	EST.

8.7.3 RECURRING PRODUCT COSTS:

COBRA PRODUCT

ITEM DESCRIPTION	COST (QTY. 1000)
Base Unit (68000):	
PWAs	
Material	$ 910.57
Mat. Overhead	$ 86.50
Non Mat. Burden	$ 238.80
PWA Total	$ 1,235.87
Modulus 9 Nest	$ 488.00
Misc. Sheet Metal	$ 18.00
Vertex/IFX S/W	$ 30.00
DIM Cables	$ 45.00
Shipping Package	$ 32.00
Product Total	**$1,848.87**

Multiport Wan PWA (Optional):

PWA

Material	$ 321.37
Mat. Overhead	$ 30.53
Non Mat. Burden	$ 54.63
PWA Total	$ 406.54
DIM Cables	$ 180.00
Product Total	**$ 586.54**

Costs for the Cobra product were derived by using a building block approach. Utilizing costed functional modules taken from the EtherSpan and adding in the costs of additional functionality required to design the product. This cost model is an engineering approximated cost which could be ± 20 %.

8.7.4 PERSONNEL REQUIREMENTS:

RESOURCE	% TIME
Additional Resources Req'd:	
Test Engineer - In-Circuit	40%
Test Technician - Diagnostics	100%
Test Engineer - Final Qual. Test	70%
Mfg. Engineer	35%
Material Planner	25%
Program Manager	50%

8.8 DO DIFFERENTLIES

This Cobra product will be the first product from the Lan Internetworking Group that will use SM Technology to manufacturer three PWAs. Present manufacturing processes, test procedures, and dedicated capital equipment available in both M1 & M7 will be used in manufacturing the product. The Cobra program will utilize the following Do-Differentlies as the product is introduced:

- Utilizing SMT "fine pitch" technology
- Seamless Data Download to Process Equipment
- In-Line Device Programming (limited scale)
- On-Line Inventory Stocking
- Semi-Automatic ATE Programming
- In-circuit Test and Process Monitoring

8.9 ASSUMPTIONS, RISKS, AND ISSUES

Assumptions:

- Assumes there will only be two turns of artworks
- Assumes Pace Engineers will be involved in component placement for DFM/DFA/DFT

Risk:

- Requirement to use "fine pitch" SMT devices, which is not a mature process in M7.
- Test philosphy (Token Ring)
- There are five (5) high risk components in the Cobra product.

Issues:

9.0 COBRA PRODUCT EVALUATION

9.1 OVERVIEW OF COBRA PRODUCT EVALUATING TESTING

9.2 TEST DESCRIPTIONS

9.3 RELEASE CRITERIA

9.0 COBRA PRODUCT EVALUATION

9.1 OVERVIEW OF COBRA PRODUCT EVALUATING TESTING

The Cobra project will use various forms of testing to identify design problems that have not been uncovered by other techniques earlier in the cycle. The purpose of the testing is to demonstrate that the design is capable of meeting the functional specification and is suitable for use in the intended applications.

Prior to any testing, the hardware designs will have been carried out with 6 sigma timing specifications, and the designs and simulations will be technically reviewed. Also prior to any testing, the software designs will be formally inspected for compliance with the product functional specification, and for technical correctness. In addition, sections of the software will have been prototyped to identify additional design problems prior to testing of the production design. These techniques will be the first layer of defense against design errors.

Once the design progresses to the test phase, various test phases will be conducted, focussing on the hardware, the software, the diagnostics, and the entire system.

The hardware tests are design margin tests, regulatory compliance tests, and reliability tests.

The software tests are unit tests and integration tests.

The diagnostic test is fault insertion.

The system level tests are system operation test, performance test, alpha test, and beta test.

In addition, results of subsystem and system level tests in the prototype and pilot manufacturing run will be carefully monitored by the core team to identify and correct any design problems that show up.

All product qualification tests will have a written plan, stating the types of defects the test is attempting to capture, the detailed test conditions, the information to be collected for each test, the criteria for successful completion of the test, and the schedule for carrying out the tests. These test plans will be formally inspected to insure that the tests are thorough enough to achieve their objectives. A written report of the test results will be prepared at the end of each test program. A project file containing all test reports and results will be maintained.

9.2 TEST DESCRIPTIONS

DESIGN MARGIN TESTS
These tests will demonstrate that the hardware is capable of proper operation under variations in component parameters and operating conditions. Power supply voltages, clock rates, and environmental conditions will be varied while the hardware is running diagnostic test software. In addition, electrostatic discharge testing and shipping conditions testing will be conducted, as per Codex standards.

REGULATORY COMPLIANCE TESTS
These tests will demonstrate that the hardware meets the regulatory requirements for safety, EMI, and telecommunications equipment set forth in Section 2 of this SPIP.

RELIABILITY TESTS
Accelerated life tests will be conducted on a sample of 10 prototype units to establish a measured value for MTBF.

FAULT INSERTION TESTS
This test verifies that the hardware diagnostics are capable of meeting their fault detection and isolation goals. The purpose is to indicate that the diagnostics can be used by customer or service personnel to identify a problem and repair it by replacing a FRU, and to also show that the diagnostics can be used by factory technicians to troubleshoot faulty components on printed circuit boards.

SOFTWARE UNIT TESTS
These tests are run on individual software modules after they have been coded. The modules are run outside of the normal system context, with any necessary external conditions being simulated by test software, software debuggers, or in-circuit emulation tools. The unit tests may or may not be run on the product hardware, depending on the module. They are intended to demonstrate that the individual software modules correctly implement their design specification and are ready for system integration.

SYSTEM INTEGRATION TESTS
These tests are run on successive "builds" of the entire system software, which successively add additional software modules. The tests verify that the modules are able to operate in the context and environment of the real system and that the modules operate with each other as designed. A failure in these tests indicates either an error in the software design specifications, or an error in the software module coding that was not detected by the unit tests. The integration tests are intended to demonstrate that the software modules can be combined to comprise the entire system, and that the system is ready for operational testing.

SYSTEM OPERATION TESTS
These tests are run on the system after the integration tests have been completed. The product is exhaustively tested as a "black box" against the functional specification. The purpose of this test is to verify that the complete functional specification has been implemented. This test is more thorough than the integration test, and is intended to

identify any remaining problems that would keep the product from being useable in the intended application. After this test, the product is ready for alpha testing and for evaluation by early customers.

SYSTEM PERFORMANCE TESTS
These tests are performed after the system operation tests indicate that the implementation is complete. They are intended to quantify key system performance behavior under a variety of operating conditions. The purpose of these tests is to provide detailed data to support marketing efforts.

ALPHA TESTS
These tests are conducted by Sustaining Engineering, as an independent validation of system operation. They are intended to act as a safety net, to double check the conclusions of the system operation tests. The alpha test plan is developed independently from the system operation test plan, to insure an independent view. Cobra has scheduled two passes of alpha testing. At the end of the first pass, the outstanding problems in the system will be very well characterized. This will trigger a "software repair" cycle which will close the most important open bugs. After the software repair, the system will be ready for beta testing by non-Codex users. In addition, the repaired version of the system will go through a second pass of the alpha test, to confirm that the repair cycle effectively closed the selected bugs.

BETA TESTS
The beta tests are designed to further verify the product design and its suitability for the intended applications, as well as to verify that the manufacturing and service organizations are prepared to support the product. Beta sites will also be used to test important network and applications configurations that cannot be created in our test lab. Pilot production hardware will be installed at customer sites. The software will have undergone one pass of alpha testing, with repair of selected bugs after that pass. Approximately one month has been scheduled for beta testing, to allow sufficient time for customers to gain adequate experience with the product.

9.3 RELEASE CRITERIA

The plan is to announce the Cobra product and release it for bookings when the first pass alpha test has been successfully completed.

The phase 2 review and unrestricted production release will be held after the second pass alpha test and the beta test have been successfully completed.

10.0 COBRA QUALITY PLAN

10.1 QUALITY/RELIABILITY GOALS AND OBJECTIVES

10.2 PRELIMINARY ASSESSMENT

10.3 STRATEGY

10.4 IMPLEMENTATION PLAN

10.5 RISKS/ISSUES

10.0 COBRA - QUALITY PLAN

10.1 QUALITY/RELIABILITY GOALS AND OBJECTIVES

The hardware quality goals for this product are aligned with Corporate Quality Goals to achieve 6 sigma. Software quality goals are based upon Codex's software quality roadmap. The numeric quality goals stated in this SPIP indicate the expected quality level for March 1992 (planned FCS).

10.1.1 Reliability (MTBF) Goals

The Base Cobra will consist of a main bridge printed wiring board, a LAN interface daughterboard, and a 5-slot backplane housed in a 9-slot Modulus 9/21 nest assembly. The backplane supports optional WAN interface printed wiring boards. The following Mean Time Between Failure (MTBF) goals have been established. These goals are based upon market requirements with consideration given to product complexity.

Base Cobra MTBF:	75,000 hours
Base Cobra w/WAN Options MTBF:	70,000 hours

The reliability model for Cobra is a simple serial model with no redundancy.

10.1.2 Maintainability (MTTR) Goal

The average time required to diagnose and replace a Cobra Field Replaceable Unit (FRU) will be less than 2.0 hours. This is known as the mean time to repair (MTTR). It includes fault recognition, diagnoses, repair or replace and checkout times as performed by the service personnel, (Customer or Codex), but does not include either logistics or travel time. It is recommended that customers with critical needs or a large number of units carry spare a unit since any repairs of the unit will probably be carried out at the factory level.

10.1.3 Factory Defects per Unit

Factory Defects per Unit (FDU) for Codex developed and manufactured hardware assemblies, is based on the current Sigma goal (related to calender time) and number of defect opportunities in the assembly. For FCS in March 1992, the quality goal is 6.0 sigma (3.43 PPM defects/opportunity). Variable data measurements will be used wherever practical to enhance the sensitivity of this control activity.

10.1.4 Cost of Poor Quality

The cost of poor quality goal is 2.0 % of product revenue. Cost of poor quality includes factory and warranty costs as well as appraisal and prevention costs.

10.1.5 Defective on Arrival Rate

The Defective on Arrival (DOA) goal is 3.43 PPM in March 1992.

10.1.6 Software Quality

In conformance with Codex software quality objectives, the software quality goal for Cobra is 0.012 defects/KLOC or 5.7 Sigma, based on a 3/92 FCS. The metric (Motorola Software Metrics 5/89) will be measured in defects per thousand lines of code (KLOC) normalized to assembler, where defects include all open priority 1, 2, and 3 bugs.

10.1.7 Regulatory Approvals

Regulatory requirements for this product are addressed in Section 2.

10.2 PRELIMINARY ASSESSMENT

10.2.1 Reliability Availability Maintainability (RAM)

The most stringent requirement is the mean time between failures requiring field service maintenance. With the kind of program being implemented for Cobra, the specified MTBF goals should be achieved. The MTTR goal should be reached with a modular design with high quality fault recognition and isolation diagnostics.

10.2.2 Quality

The quality goals imposed on Cobra by the six sigma program are challenging. The use of integrated design, layout and process planning techniques together with surface mount technology offers higher potential quality than traditional through-hole construction. As the design evolves and more concrete information becomes available, process modeling techniques using FDU estimation, capability studies on critical characteristics, and designed experiments will be used to identify low potential quality areas and help select and evaluate potential improvements. The quality modeling and improvement program will be linked to the product and process development schedule.

10.2.3 Software

The Checkpoint Software Reliability Model will be used to help estimate the reliability of the software. This estimate considers project size, development methods, defect removal methods, coverage and completeness of testing, inspections, etc. The estimated defect potential, delivered defects and defect removal efficiency will be used as a model to realistically align the estimate with the sigma goal.

The software designers will identify the components of the Cobra software system with respect to their source (new or modified existing), level of previous inspection, testing, and associated risk. This preliminary assessment will be the basis for inspection and test planning.

10.3 STRATEGY

10.3.1 RAM/QA Strategy

In the early stages of the program analytical tasks will predominate the activities. The output of these activities will be recommendations based on paper analysis to improve the design and manufacturing process for the product. As actual hardware and software become available the focus of our activities will shift to a test analyze and fix process while we accumulate a product performance file of historical data.

10.3.2 Software Strategy

The software development process should follow the Codex Software Product Life Cycle Methodology (Release 1.0). These development and review guidelines define the standard for software deliverable documents and the methodologies required to achieve the quality goal.

The Cobra software quality program will include as a minimum inspections of newly developed code and documentation, successful Alpha and Beta tests, and two risk assessments, one prior to Beta test and the other prior to the final software freeze being signed, and FCS. All bugs will be formally tracked via the Codex Bug System (CBS) throughout the development process.

10.4 IMPLEMENTATION PLAN

This section provides a summary of the tasks which the Quality and Reliability Engineering Group and the Software Quality Assurance Group will conduct for this program. Additional detailed plans will be prepared separately for the regulation and control of these activities as required.

10.4.1 Reliability Design

Reliability Program Plan. A detailed reliability program plan will be prepared which describes the specific task to be performed with a schedule for their completion. This document provides for the control of Quality and Reliability Engineering Activities on this program.

10.4.1.1 Reliability Block Diagram, Allocation and Assessment

This model and feasibility study will be prepared to examine the potential of the proposed design of meeting the goals and apportion failure rates to the major subassemblies.

10.4.1.2 Failure Modes, Effects and Criticality Analysis (FMECA)

When schematics and detailed design information becomes available, a FMECA will be conducted at the FRU level. Design Engineering will perform this analysis with guidance and support from Quality and Reliability Engineering. This task will identify potential functional failure modes, determine their effects and assess their criticality in terms of overall failure of the Cobra system. The purpose of this task is to highlight possible design weaknesses and increase fault tolerance of the design.

10.4.1.3 Part Derating and Stress Analysis

Conservative application of parts through derating, significantly contributes to higher product reliability. Codex's Electrical Parts Derating Guide provides appropriate stress derating factors for the different classes of electrical piece parts. Designers will provide evidence of proper electrical parts derating, through stress analysis, to Development Support QA.

10.4.1.4 Reliability Prediction

Two reliability predictions will be prepared to assess the status of the design relative to meeting the MTBF goals. The first prediction, already completed, is a part count reliability prediction. This prediction yielded a predicted MTBF of approximately 50,000 hours for the base system. The predicted MTBF of the base system cardset, excluding the Modulus 9/21 nest assembly, is approximately 78,000 hours. Areas for reliability improvement have already been identified; it is judged that the base system MTBF goal of 75,000 is achievable. As more detailed design information becomes available and the part stress analysis has been completed, a detailed part stress reliability prediction will be performed. The part stress reliability prediction provides a greater level of insight into the reliability of the design and can highlight additional areas of opportunity for improvement.

10.4.2 Hardware Quality

10.4.2.1 Critical Characteristics

The major critical characteristics associated with this product will be identified by Design Engineering and will serve as primary indicators of overall product quality.

10.4.2.2 Quality Assessment

The designers will perform critical parameter measurements for the major critical characteristics of this product. Acceptable levels for these parameters will be established and serve as the basis for unit level evaluation by the HP 3070 during normal production. Variables measurement will be used to the maximum extent possible.

10.4.3 Product Qualification Testing

10.4.3.1 Qualification Testing

Product qualification testing will be performed in accordance with Codex Policy and Procedure (P&P) No. 609 and associated P&P 693 Supplements. A detailed test plan will be prepared prior to the start of testing. This testing consists of Environmental & Mechanical, Reliability, and ESD susceptibility testing. Reliability testing, which will be performed by QA/Reliability and supported by Development, will be aimed at maturing the reliability of the design by testing in a stress oriented environment. During this test the primary emphasis will be in precipitating, identifying and correcting any design weaknesses or defects.

10.4.3.2 Failure Reporting, & Analysis & Corrective Action (FRACA)

FRACA will be driven by QA/Reliability and implemented for Cobra throughout all phases of product qualification testing. The intent of this task is to document, track, and correct potential reliability problems found during test. The core team will be used as the primary forum to initiate analysis of anomalies, track progress and drive appropriate corrective action. Separate Review Action Team (RAT) meetings will be held if necessary to ensure satisfactory closure of anomalies.

10.4.4 Software Quality

Software Quality will be the prime point of contact for all issues related to software quality. The involvement of the Software Quality organization will directly parallel the software development schedule. Software quality will be involved, monitoring inspection and testing activities, compiling error/defect data reported by the development organization, and report software status to Motorola on a monthly basis. Software Quality will schedule and chair Risk Assessments prior to Beta and FCS.

10.4.4.1 Inspections

Each deliverable in the software process will be subject to an inspection. This includes specifications, design, code, test plans, and documentation.

10.4.4.2 Metrics

During development and after release, data should be collected for useful analysis of product and process quality.

The current Corporate Metrics Program requires that for each month the Total Open Defects/KLOC metric be collected and reported to Motorola for inclusion in Corporate Software Quality Reports.

Additional metrics will be required in 1991. A guideline for the current and any additional metrics are outlined in the Minimal Set of Software Metrics prepared by the Software Engineering Technology (SET) Steering Committee

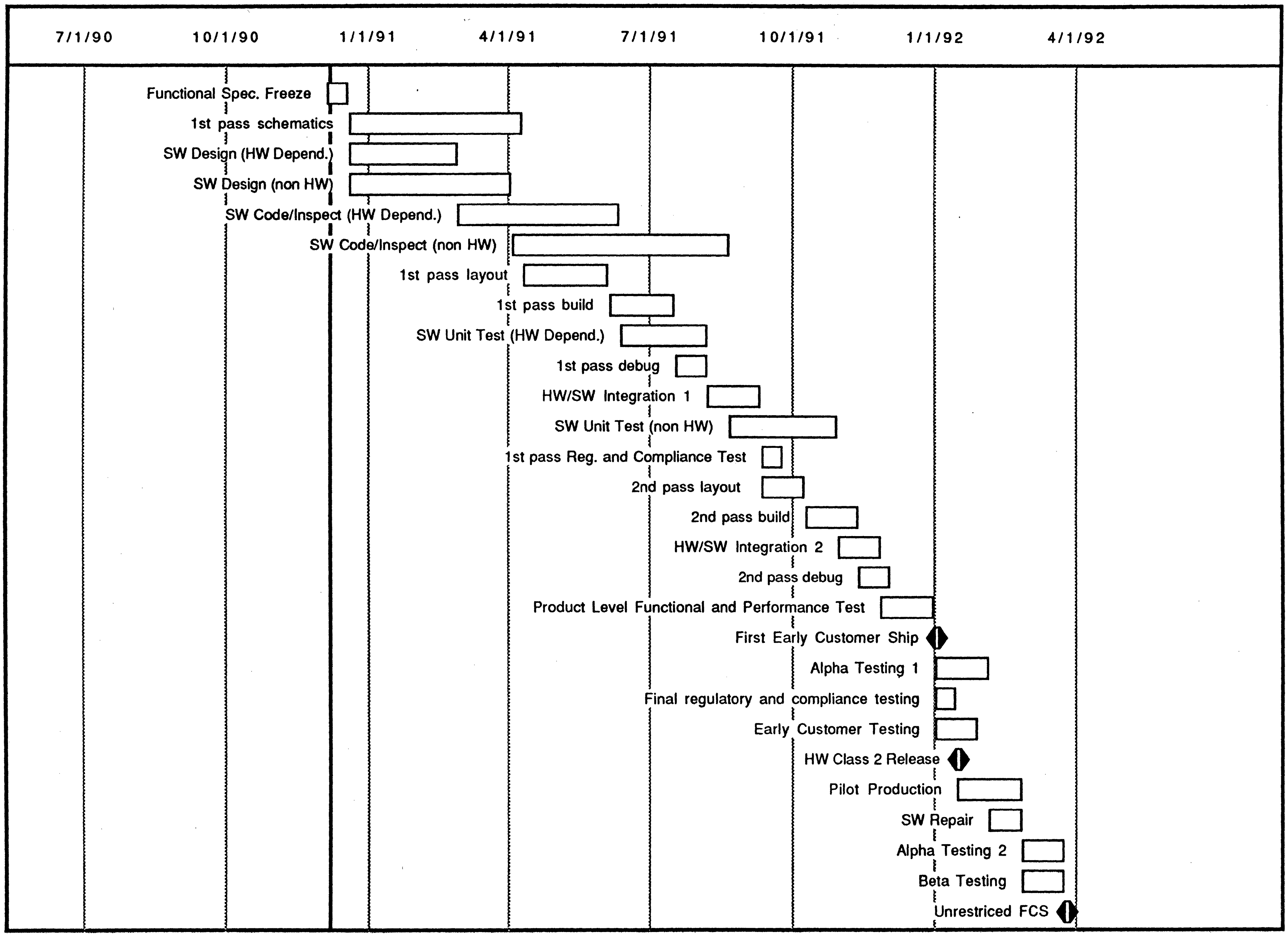
10.5 RISKS/ISSUES

The technology risk and issues for the Cobra program are considered acceptable. The rapid pace of the program will be a challenge to keep up with the design activity and deliver Quality and Reliability feedback synchronized with the design so that results can be used in improving the design where needed. An efficient interface with the design development personnel must be maintained in order to achieve the potential of the program described.

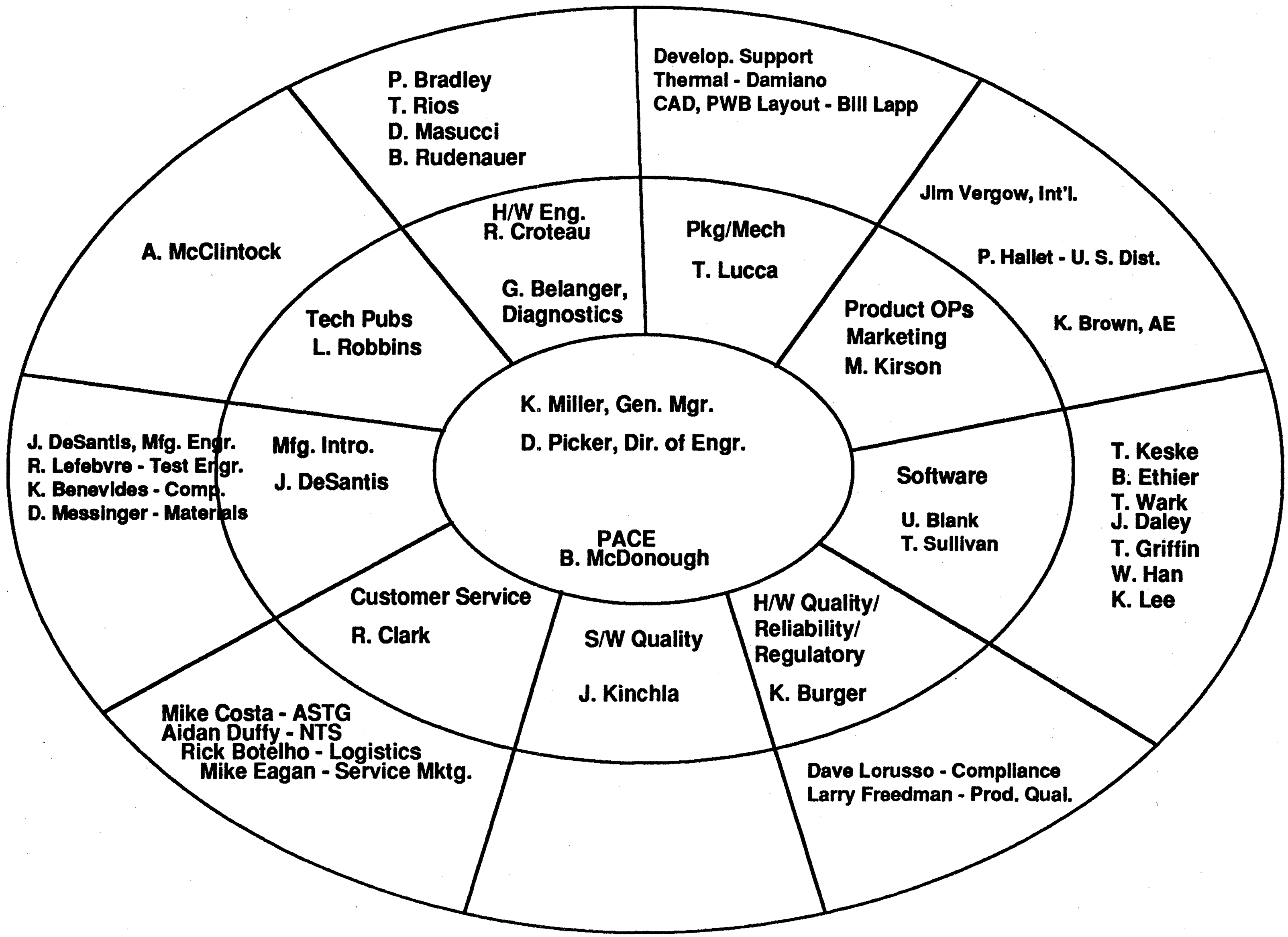
10.5.1 Hardware Risks/Issues

The major potential impact to hardware quality and reliability are the high risk components as listed in Section 3; specifically, the TI Token Ring chipset, the Motorola DSP56116, and Pulse Engineering Isolation Shaping Units. Also, the Modulus 9/21 nest assembly is a major contributor to Cobra system failure rate. The Cobra team has no direct design control over this assembly.

11.0 PROJECT ORGANIZATION AND SCHEDULE


7/1/90
10/1/90
1/1/91
4/1/91
7/1/91
10/1/91
1/1/92
4/1/92
Functional Spec. Freeze
1st pass schematics
SW Design (HW Depend.)
SW Design (non HW)
SW Code/Inspect (HW Depend.)
SW Code/Inspect (non HW)
1st pass layout
1st pass build
SW Unit Test (HW Depend.)
1st pass debug
HW/SW Integration 1
SW Unit Test (non HW)
1st pass Reg. and Compliance Test
2nd pass layout
2nd pass build
HW/SW Integration 2
2nd pass debug
Product Level Functional and Performance Test
First Early Customer Ship
Alpha Testing 1
Final regulatory and compliance testing
Early Customer Testing
HW Class 2 Release
Pilot Production
SW Repair
Alpha Testing 2
Beta Testing
Unrestriced FCS

6320 COBRA TEAM



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