LIGO Data Analysis System Software Design

James Kent Blackburn
California Institute of Technology

LSC Meeting

Hanford, WA

March 12, 1998

OUTLINE

- **Data Formats**
- **Software Standards**
- **Version Control**
- **Software Architecture**

LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

LIGO-G980049-12-M

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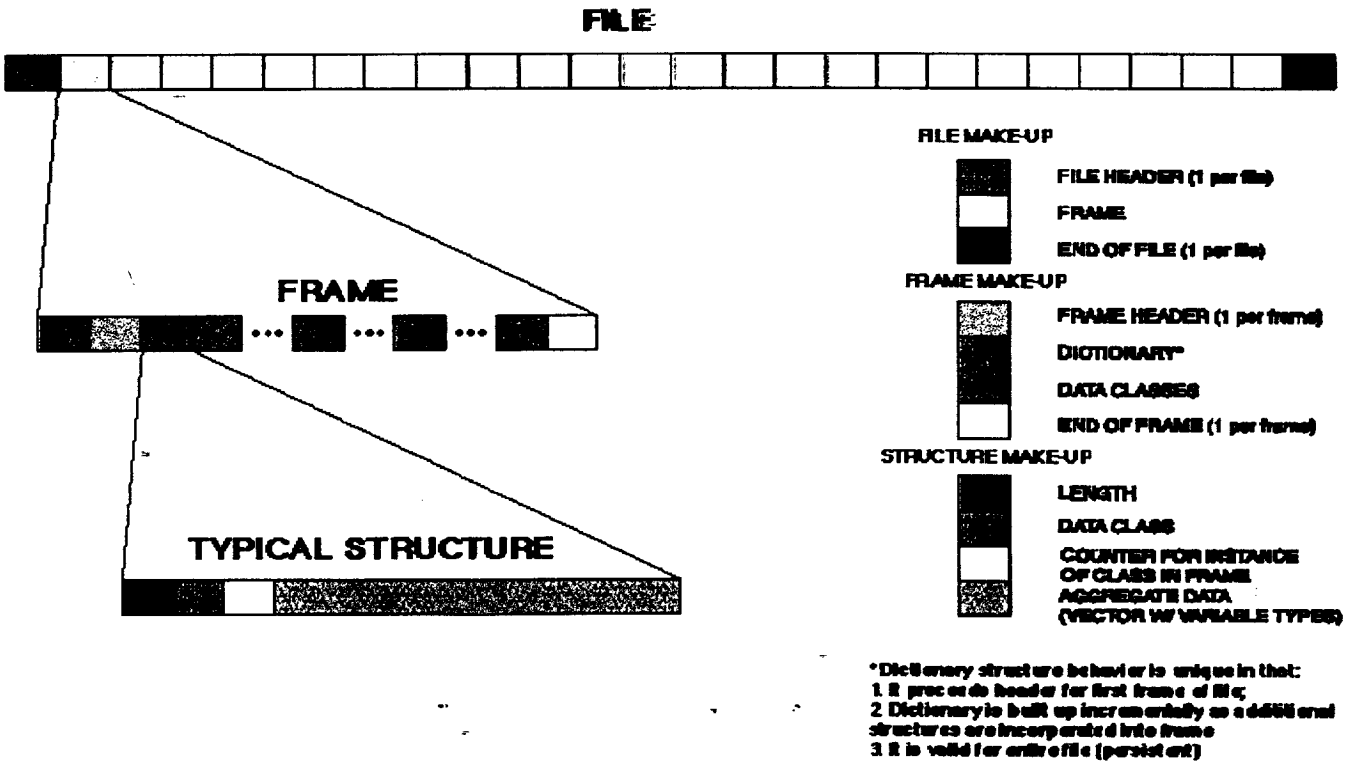
DATA FORMAT STANDARDS

FRAMES:

- Developed by VIRGO (Beniot Mours)
- Standardization defined by LIGO and VIRGO*(LIGO-T970130-B)*
- Accepted by GEO600 and TAMA
- Primarily developed for data acquisition and data archival
- Frame data attributes grow out of C language structures
- Frame I/O library (in C) and documentation available from Web see *(http://lapphp.in2p3.fr/virgo/FrameL)*
- MATLAB I/O interface to Frames also available
- C++ version of library and API under development at LIGO & VIRGO



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DATA FORMAT STANDARDS

Light-Weight Format:

- Candidates - SDF being developed by CACR (John Salmon)
  CDL/NetCDF developed by Unidata Program Center
- Primarily intended as an easy to use data format
- May also be used for communication of data between distributed processes

Other Data Formats:

- Meta Data - data about data; candidates include database solutions, distributed, accessible through web browsers
- Event Data - data about events (analysis/filter results) includes triggers, diagnostic filters, GW filters
- MPI Data - data communicated between MPI processes (MPI standard)

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SOFTWARE STANDARDS

Languages:

- ANSI C++ will be primary development language for compiled components to be maintained and supported by LIGO
- ANSI C will be used where wrappers are needed to bind C++ components with C, FORTRAN and TCL components
- TCL (Tool Control Language) will be used in the LDAS components responsible for controlling the LDAS software system
- TK will be used for the Graphical User Interface components
- Tclets (TCL/TK pluggins) will be used for web browser connectivity into the LDAS software system.
- A TBD database will be used to integrate metadata into the LDAS software system

Communications:

- TCL layer sockets will be used to communicate commands and messages between components (processes) of the LDAS
- C++ socket class library will be used to communicate data between components (processes) of the LDAS

Libraries:

- C++ Class Libraries, numerical libraries, I/O libraries will be dynamically linked and built as shared libraries on supporting platforms for efficient use of hardware resources

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VERSION CONTROL

Software Development:

- Development cycle will include CVS (Concurrent Version System) as the software management system
- LIGO will be responsible for the LDAS CVS software repository
- A secure CVS shell will allow remote check-ins and check-outs from the LIGO LDAS repository

Software Style:

- The LIGO systems integration team has written a recommended software style guide *(LIGO-T970211-00-E)*

Releases:

- Releases of the LDAS software system will be in the public domain and available via FTP and WWW
- User Interfaces to the LDAS (shells and GUIs) will be available via FTP and WWW
- New releases will be announced over the Web and in emails

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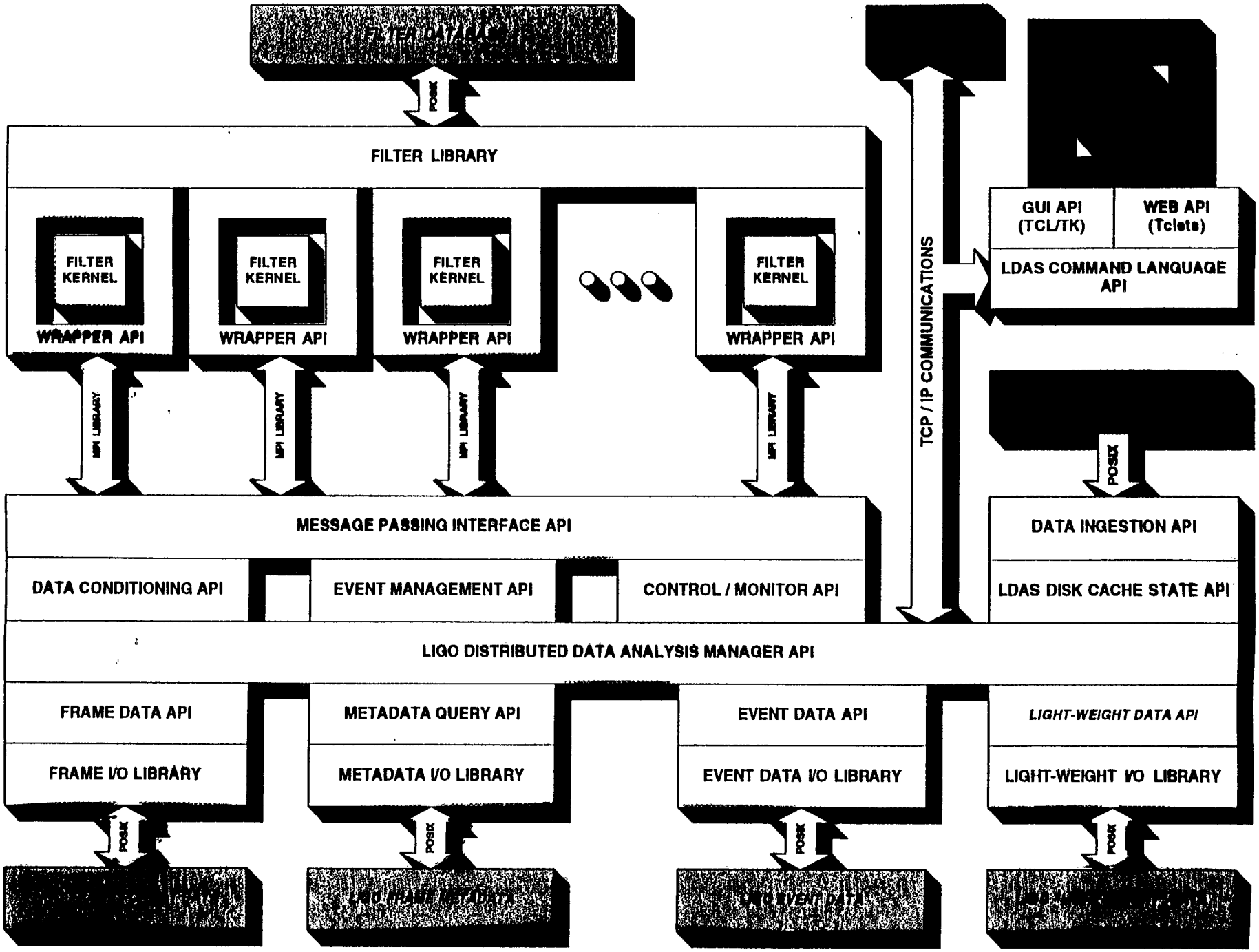
SOFTWARE ARCHITECTURE

Distributed Components:

- Software components will in integrated into a distributed system using MPI and sockets for inter-process communications
- A distributed software manager will act as the master, serving users and coordinating the connections between all system components
- User interfaces based on TCL/TK will act as clients, making requests for services from the LDAS system through the distributed software manager

API Components:

- The manager will see a standard interface(API) to all the software components


FILTER LIBRARY
FILTER KERNEL
WRAPPER API
FILTER KERNEL
WRAPPER API
FILTER KERNEL
WRAPPER API
FILTER KERNEL
WRAPPER API
MPI LIBRARY
MPI LIBRARY
MPI LIBRARY
MPI LIBRARY
MESSAGE PASSING INTERFACE API
DATA CONDITIONING API
EVENT MANAGEMENT API
CONTROL / MONITOR API
LIGO DISTRIBUTED DATA ANALYSIS MANAGER API
FRAME DATA API
METADATA QUERY API
EVENT DATA API
LIGHT-WEIGHT DATA API
FRAME I/O LIBRARY
METADATA I/O LIBRARY
EVENT DATA I/O LIBRARY
LIGHT-WEIGHT I/O LIBRARY
POSIX
POSIX
POSIX
POSIX
TCP / IP COMMUNICATIONS
GUI API (TCL/TK)
WEB API (Tclets)
LDAS COMMAND LANGUAGE API
POSIX
DATA INGESTION API
LDAS DISK CACHE STATE API

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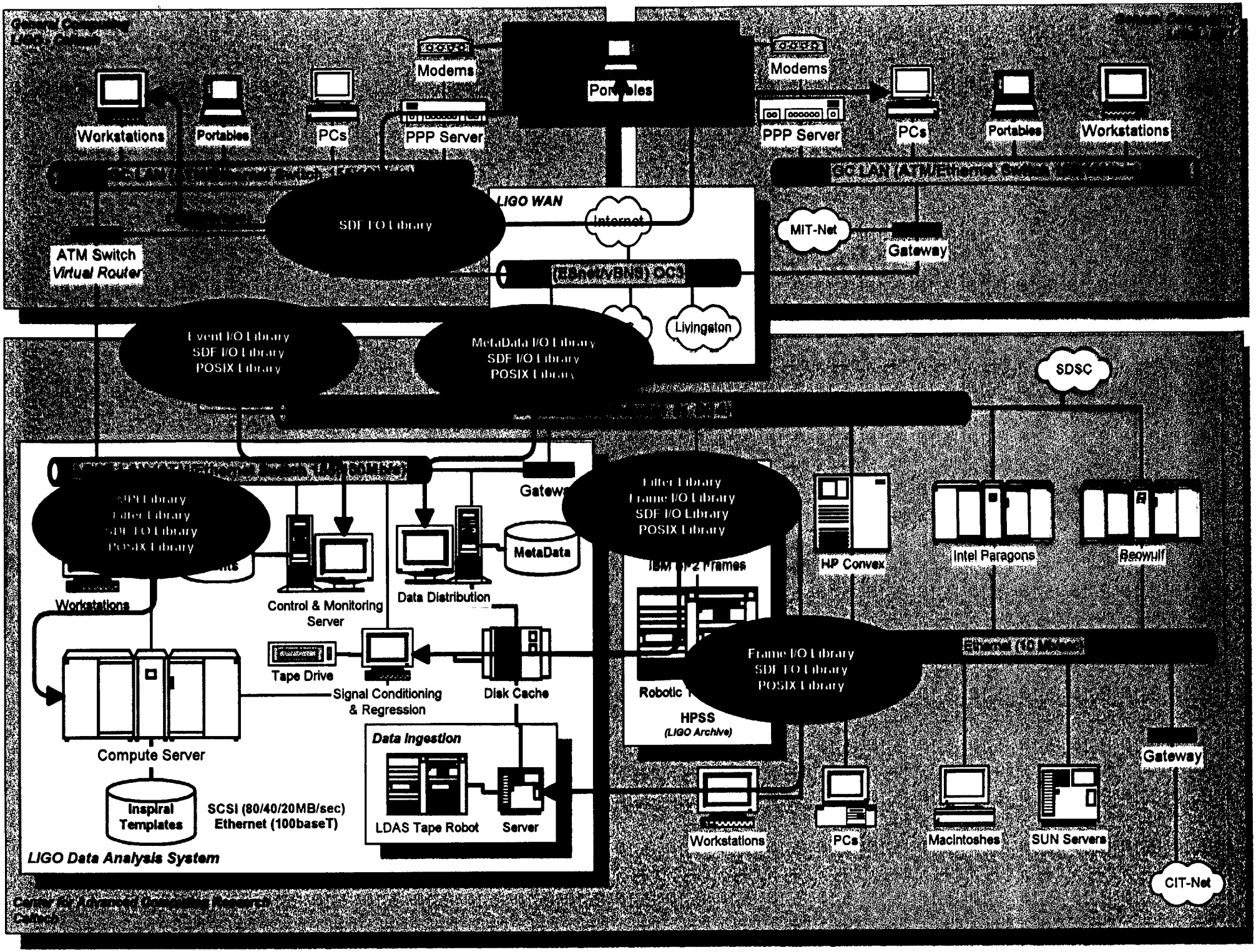
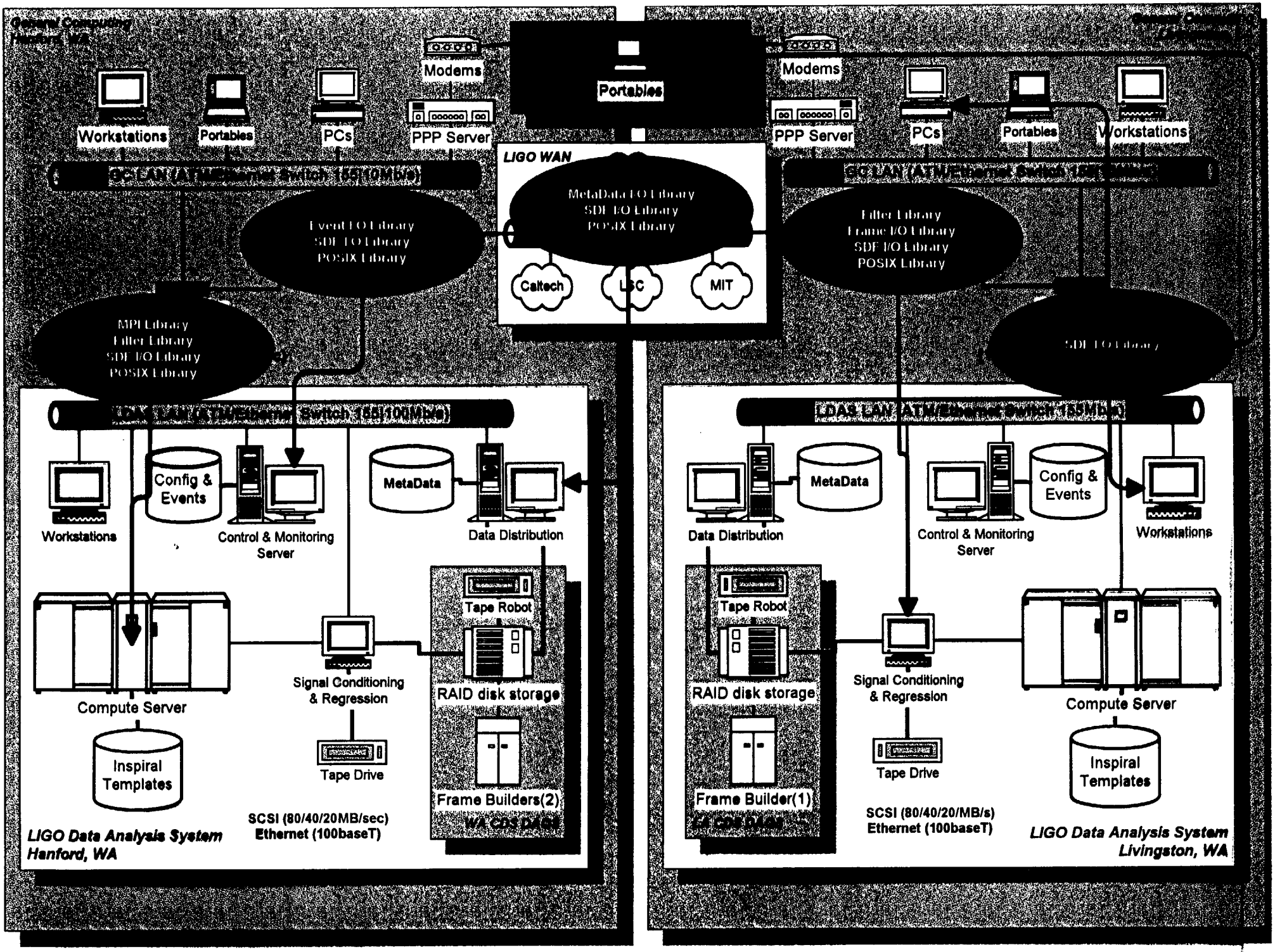
LIBRARIES LINKED ON LDAS HARDWARE

	libmpi.a	libframe.a	libmeta.a	libevent.a	libsdf.a	libfilter.a	libposix.a
Computer Server	X				X	X	X
Control & Monitor Server				X	X		X
Data Distribution Server		X	X		X		X
User Interface					X		
Data Ingestion Server		X			X		X
Data Conditioning Server		X			X		X

LIBRARIES LINKED TO LDAS SOFTWARE

	libmpi.a	libframe.a	libmeta.a	libevent.a	libsdf.a	libfilter.a	libposix.a
Filter Wrapper Class	X				X	X	X
MPI API	X						X
Data Conditioning API					X		X
Event Management API					X		X
Control & Monitor API					X		X
Frame Data API		X			X		X
Meta-Data API			X		X		X
Event Data API				X	X		X
SDF API					X		X
Filter Kernel	Inherits				Inherits	Inherits	Inherits
GUI User Interfaces					TCL		
LDAS Command API					TCL		
Data Ingestion API		X			X		X
LDAS Disk Cache API					X		X
LDAS Manager API					X		X


Modems
Portables
Modems
Workstations
Portables
PCs
PPP Server
PPP Server
PCs
Portables
Workstations
LIGO WAN
Internet
SDE I/O Library
MIT-Net
Gateway
ATM Switch
Virtual Router
(Ethernet/BNS) OC3
Livingston
Event I/O Library
SDE I/O Library
POSIX Library
MetaData I/O Library
SDE I/O Library
POSIX Library
SDSC
Gateway
Filter Library
Frame I/O Library
SDE I/O Library
POSIX Library
HP Convex
Intel Paragons
Beowulf
Workstations
Control & Monitoring Server
Data Distribution
MetaData
Tape Drive
Signal Conditioning & Regression
Disk Cache
Frame I/O Library
SDE I/O Library
POSIX Library
HPSS
(LIGO Archive)
Compute Server
Data Ingestion
Inspiral Templates
SCSI (80/40/20MB/sec)
Ethernet (100baseT)
LDAS Tape Robot
Server
Workstations
PCs
Macintoshes
SUN Servers
Gateway
CIT-Net
LIGO Data Analysis System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PPP Server
LIGO WAN
MetaData I/O Library
SDF I/O Library
POSIX Library
Caltech
LSC
MIT
Event I/O Library
SDF I/O Library
POSIX Library
MPI Library
Filter Library
SDF I/O Library
POSIX Library
Switch (155/100Mb/s)
Workstations
Config & Events
Control & Monitoring Server
MetaData
Data Distribution
Compute Server
Inspiral Templates
Signal Conditioning & Regression
Tape Drive
Tape Robot
RAID disk storage
Frame Builders(2)
SCSI (80/40/20MB/sec)
Ethernet (100baseT)
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Modems
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Workstations
Filter Library
Frame I/O Library
SDF I/O Library
POSIX Library
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LDAS LAN ATM/Gb/s Switch 155Mb/s
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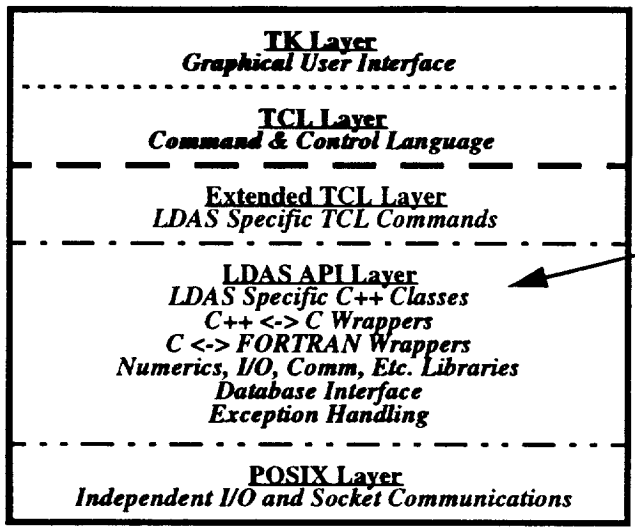
API COMPONENT LAYERS



LSC Designed Algorithms overload virtual functions found in LDAS C++ Classes

API's	*TK (GUI)*	*TCL (Control)*	*Extended TCL(LDAS)*	*LDAS Applications*
Message Passing Interface	OPTIONAL	YES	YES	YES
Data Conditioning	YES	YES	YES	YES
Event Manager	YES	YES	YES	YES
Control & Monitor	YES	YES	YES	YES
Frame Data	OPTIONAL	YES	YES	YES
Meta-Data	OPTIONAL	YES	YES	YES
Event Data	OPTIONAL	YES	YES	YES
Simple Data Format	OPTIONAL	YES	YES	YES
LDAS Command Language	GUI Front Ends	YES	OPTIONAL	YES
Data Ingestion	YES	YES	YES	YES
LDAS Disk Cache	YES	YES	YES	YES
LDAS Manager	YES	YES	NO	NO

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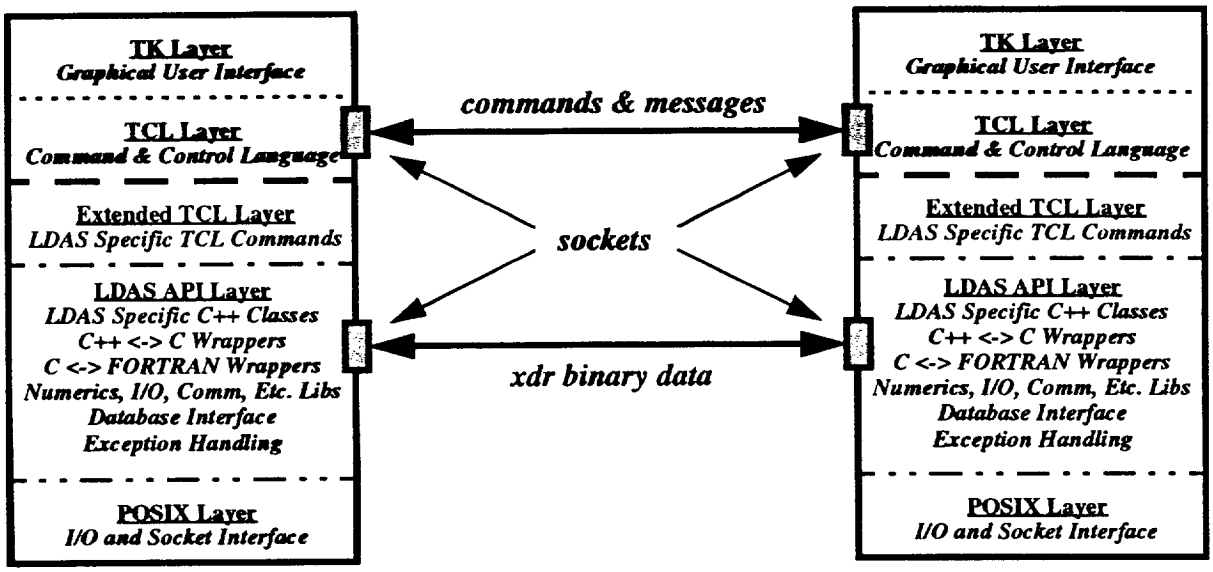
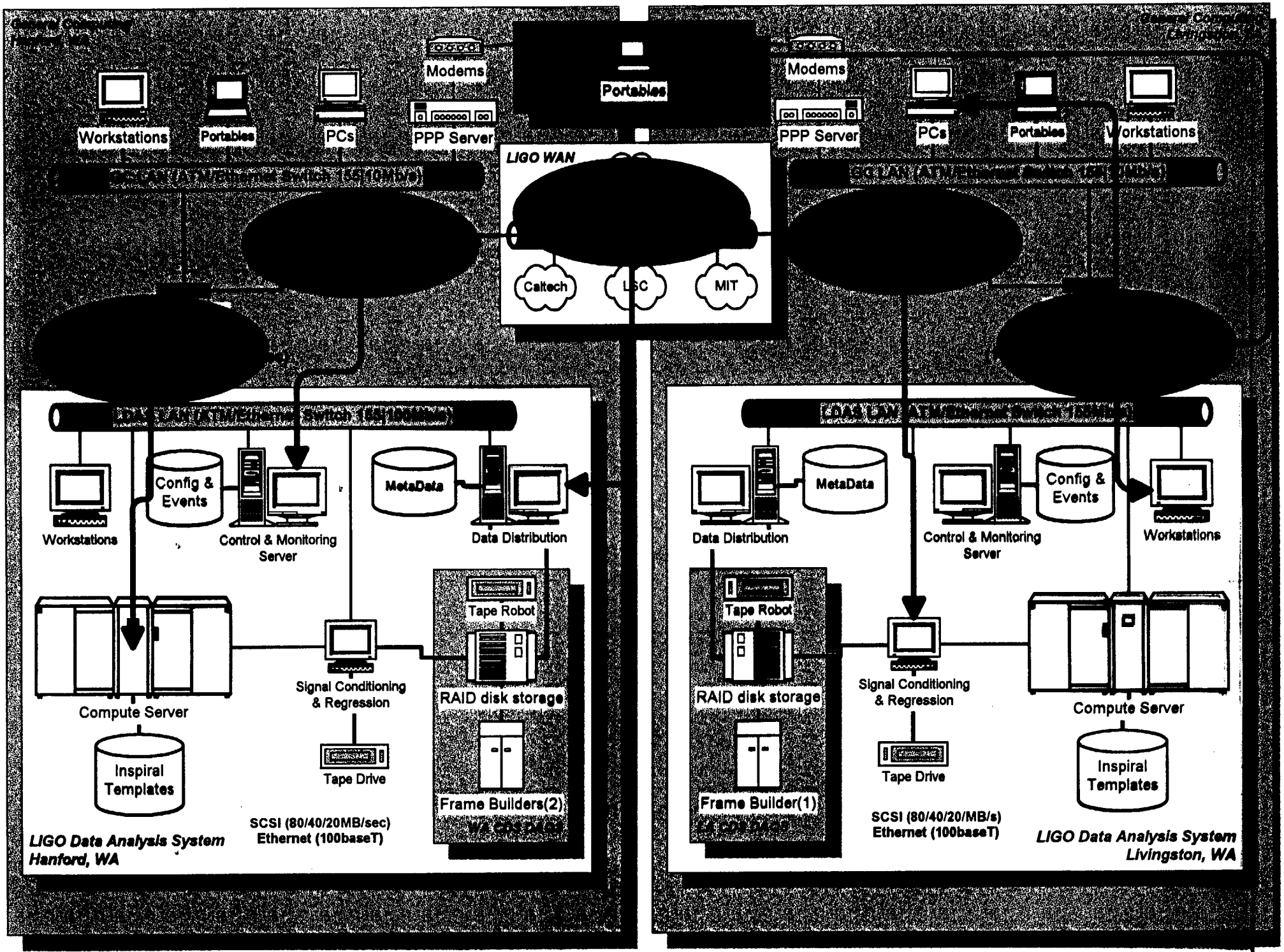
API COMPONENT COMMUNICATIONS



API	FW	MPI	DC	EM	CM	FD	MD	ED	SDF	FK	COM	DI	DC	MAN
FW		mpi								inherit				
MPI	mpi	mpi	socket	socket	socket					inherit				
DC		socket			socket	socket	socket		socket					socket
EM		socket		socket	socket			socket	socket					socket
CM		socket	socket	socket		socket	socket	socket	socket					socket
FD			socket		socket				socket				socket	socket
MD			socket		socket		socket	socket	socket				socket	socket
ED				socket	socket		socket	socket	socket					socket
SDF			socket	socket	socket	socket	socket	socket					socket	socket
FK	inherit	inherit												
COM														socket
DI													socket	
DC						socket	socket		socket			socket		socket
MAN			socket	socket	socket	socket	socket	socket	socket		socket		socket	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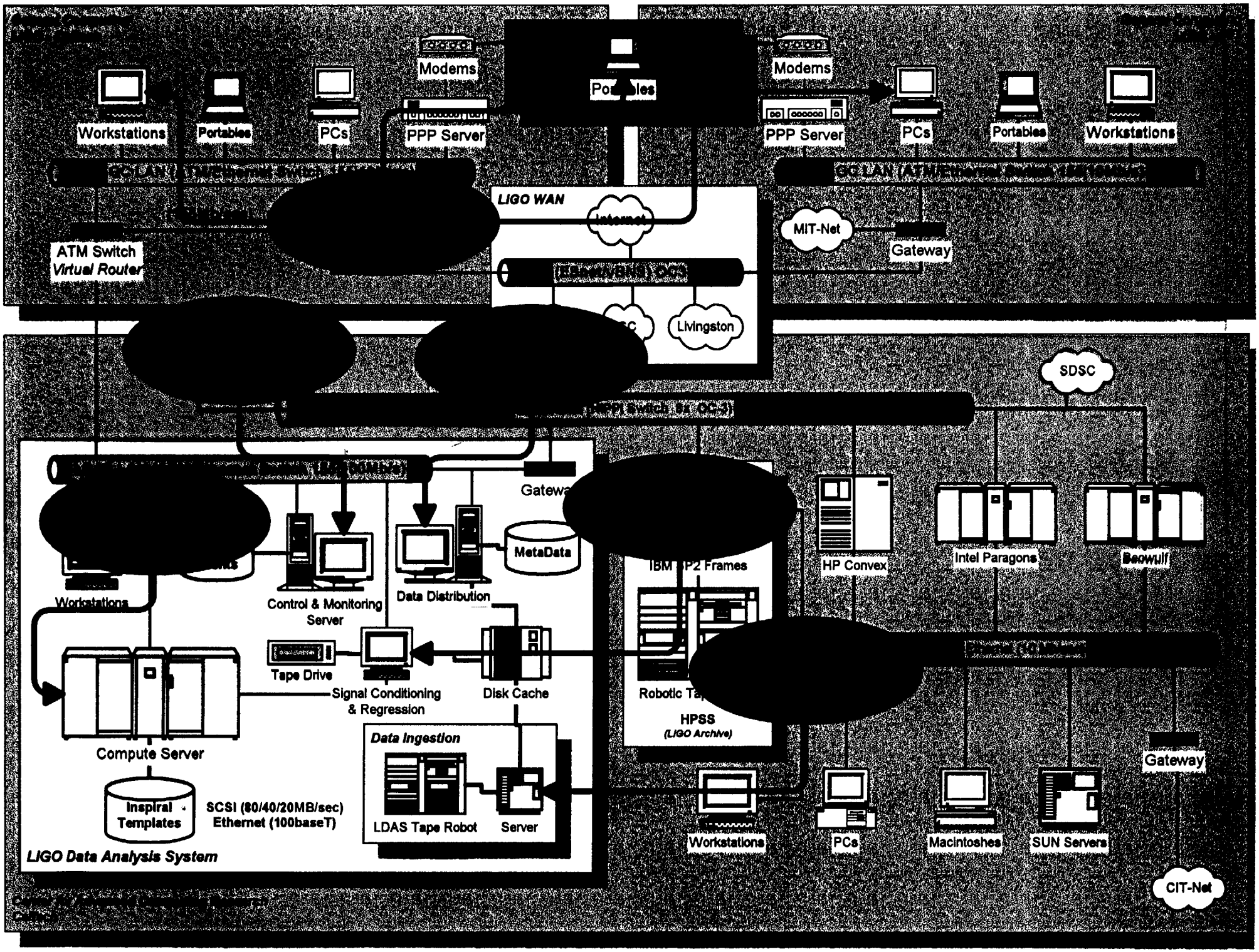
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Note 1, Linda Turner, 04/20/98 04:06:58 PM
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