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1 Introduction

This document describes the eXtended Request Daemon (xrd) configuration directives protocols that can be used with xrd: cmsd, HTTP, and xrootd. It also includes the directives for the xrootd daemon that can run xroot and HTTP protocols. The cmsd-specific directives are described in a separate reference manual.

The xrd is a framework that can dynamically support multiple TCP/IP application service layer protocols. It is designed to provide a high performance environment for application services. The xrd is a generalized framework and it makes its primary decision on which protocol to support based on the name given to the executable. Currently, the following executable names are fully supported:

- cmsd daemon for the cms server clustering protocol, and
- xrootd daemon for xroot and other related protocols.

Configuration directives come from a configuration file. Directives are prefixed by the component acronym they apply to, as shown in the following table. This makes creating a single configuration file for all services possible.

<table>
<thead>
<tr>
<th>Component</th>
<th>Purpose</th>
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<td>acc</td>
<td>Access control (i.e., authorization)</td>
</tr>
<tr>
<td>cms</td>
<td>Cluster Management Services</td>
</tr>
<tr>
<td>frm</td>
<td>File Residency Manager</td>
</tr>
<tr>
<td>ofs</td>
<td>Open File System</td>
</tr>
<tr>
<td>oss</td>
<td>Open Storage System (i.e., file system implementation)</td>
</tr>
<tr>
<td>pfc</td>
<td>Proxy File Cache</td>
</tr>
<tr>
<td>pss</td>
<td>Proxy Storage Service</td>
</tr>
<tr>
<td>sec</td>
<td>Security authentication</td>
</tr>
<tr>
<td>xrd</td>
<td>Extended Request Daemon</td>
</tr>
<tr>
<td>xrootd</td>
<td>The xroot protocol implementation.</td>
</tr>
<tr>
<td>http</td>
<td>The HTTP protocol implementation.</td>
</tr>
<tr>
<td>all</td>
<td>Applies the directive to all of the above components.</td>
</tr>
</tbody>
</table>

Records that do not start with a recognized identifier are ignored. This includes blank record and comment lines (i.e., lines starting with a pound sign, #). This guide documents the all, http, xrd, and xrootd configuration directives (i.e., the un-shaded rows). Other directives are documented in supplemental references specific to the component they deal with.
The location of the configuration file is specified on the `xrootd` command line. Refer to the reference manuals for other components on how they locate their respective configuration files.

Refer to the manual “Configuration File Syntax” on how to specify and use conditional directives and set variables. These features are indispensable for complex configuration files usually encountered in large installations.

### 1.1 Security Considerations

The `xrd` framework relies on the loaded protocol(s) for strong authentication (e.g., Kerberos, GSI, etc.). Therefore, security is a protocol issue. The `xroot` protocol provide strong authentication should you choose to use it. Refer to each protocol on how to configure strong authentication.

The `xrd` framework does provide host-based authentication. While this type of authentication can be subverted in a number of ways, it still is a practical mechanism for installations that do not need strong authentication. The `allow` directive can be used to restrict the range of hosts that can connect to the daemon. This security can be used together with any protocol-provided security.

Because the `xrd` framework does not intrinsically provide strong authentication; you should not run `xrootd` as super-user (i.e., Unix root). Any attempt to do so without indicating that you really want to run super-user (see the `-R` command line option) will cause the program to exit.
1.2 Starting the xrootd Daemon

Use the following command to start the xrd-based xrootd daemon:

```
xrootd [ options ] [ path [ path [ . . . ] ] [piargs]
```

**options:**
- `-c cfn` [`l largs`]
- `[-k {num | sz{k|m|g} | sig}]` [esoteric]

**esoteric:**
- `[-a | -A] apath` [`-b` `[-d]` `-h` `[-I {v4 | v6}]`
- `[-n name] [-R user] [-s pfns] [-S site]`
- `[-w | -W] hpath` [-z] [devopts]

**devopts:**
- `[-L protlib] [-p {port | any}] [-P protocol]
```

**largs:**
- `[@lib[,{bsz=0}]][,{cse=0|1|2}],[{,logfn=fn}]

**sig:**
- `fifo` `hup` `rtmin` `rtmin+1` `rtmin+2` `ttou` `winch` `xfsz`

**piargs:**
- `+-[tag] [args] [piargs]

**Parameters**

*path*  
An absolute file system path prefix. All requests will be restricted to files with this prefix. You may specify any number of path prefixes. If no path is specified, operations will be restricted to paths starting with `/tmp`.

**Options**

* -c *fn*  
The name of the configuration file. If one is not specified, no configuration file is processed.
Specified how messages are to be handled. Options are:

- **fn**  
  Directs messages and any trace output to the indicated file, `fn`, possibly qualified by the instance name (see the fencing section). If `fn` is a dash (-), output is sent to standard error; the default.

- **=fn**  
  Same as `fn` but the `fn` is not qualified by the instance name, if any. This allows log files to be handled in an arbitrary manual way. For more information see the section on fencing.

- **@lib**  
  Directs messages to a plug-in that is defined in the shared library specified by `lib` (see the section on log file plug-ins). Additional comma-separated parameters may follow `lib`, as follows:

  - **bsz=sz**  
    Specifies the size of the speed matching buffer. The default is 64K. Messages are placed in the buffer and then forwarded to the plug-in as time permits. A value of 0 disables speed matching and messages are handed off to the plug-in as they occur. See the section on log file plug-ins for more information. A positive value less than 8K is forced to be 8K. The maximum allowed in one megabyte. The `sz` may be suffixed by `k` or `m` to indicate kilobytes or megabyte, respectively.

  - **cse={0|1|2}**  
    Specifies how standard error output should be handled:
    
    - **0**  
      Does not capture standard error output. All such output is sent to the logfn destination, if specified, or is otherwise lost. This is the default.
    
    - **1**  
      Captures standard error but only forwards it to the logging plug-in if it starts with a standard time stamp. This option may cause an infinite loop. Refer to the logging plug-in section for more information.
    
    - **2**  
      Captures standard error output and forwards it to the logging plug-in without inspection. Refer to the logging plug-in section for more information.

  - **logfn=|=fn**  
    Specifies that messages are also to be routed to a local log file. The parameter is identical to that described above. To use standard error, specify a dash (-) for `fn`.

To use standard error, specify a dash (-) for `fn`.
-k num | sz[k|m|g] | sig
Keep no more than num old log files. If sz is specified, the number of log files kept (excluding the current log file) is trimmed to not exceed sz bytes. The sz must be suffixed by k, m, or g to indicate kilobytes, megabyte, or gigabytes, respectively. If a sig value is specified (i.e. hup etc), then an external program is expected to handle log file rotation (e.g. logrotate). Except for fifo, the argument specifies signal that causes the daemon to close and re-open the log file to allow rotation to occur. When fifo is specified, the daemon waits for data to appear on a fifo whose path is identical to the log file path but whose name is prefixed by a dot. Refer to the notes for manual rotation caveats.

Esoteric Options
{-a | -A} apath
Specifies the default administrative path and can be overridden by the adminpath directive in the configuration file. When -A is specified group write access is allowed (see the adminpath directive option for details).

-b Runs the program in the background. You should also specify -l.

-d Turns on debugging. Warning! This severely impacts performance.

-h Displays help information.

-I {v4 | v6}
Restricts the server’s internet address protocol. When v4 is specified, only hosts with IPV4 addresses can connect or be connected to. When v6 is specified, the default, hosts using IPV6 or IPV4 addresses can connect or be connected to. This option is only useful for systems that have misbehaving IPV6 network stacks. The default is established by the network interface configuration on the machine at the time the program starts.

-n name
Assigns name to the xrootd instance. By default, the xrootd instance is unnamed. See the notes on how to use this option.

-R user
The user name or numeric uid of the user whose effective identity is to be assumed. See the usage notes for more information. The specified user may not have super-user privileges. This option may not be specified unless the program is running as super-user.
-s pfni Specifies the name of the file that is to hold the process id upon start-up.

-S site Specifies a 1- to 15-character site name that is to be included in monitoring records. The name may only contain letters, digits and the symbols “_-:.”; any other characters are converted to a period.

[-w | -W] hpath
Specifies the default home path; i.e. the current working directory during execution. If it is not specified on the command line, it can be specified by the homepath directive in the configuration file. When -W is specified group read access is allowed (see the homepath directive group option for details). The hpath is extended by any specified instance name (i.e. -n option). The path is created should it not exist.

-z provides microsecond resolution for log file message timestamps.

+- provides a mechanism to pass command line arguments to plug-ins. See the section “Passing Plug-In Command Line Arguments” for more information.

Developer Options
-L protlib
Specifies the shared library that holds the implementation of the default protocol specified by the -P option.

-p port
The TCP port, or service name associated with a port, that xrootd is use for new connections. The default is “xrootd” or port 1094, if the TCP service xrootd cannot be found /etc/services.

-p any
Uses any available port.

-P protocol
The name of the default protocol. Use this option when the name of the executable differs from the name of the default protocol. You may need to specify the -L option as well. See the notes for more information.
 Defaults Arguments
  -l  -I v6 -p xrootd -P executable_name /tmp

 General Notes
  1) For security purposes, only files in /tmp are allowed to be accessed unless you specify otherwise. You may specify other paths either on the command line or using the xrootd export configuration directive.
  2) Do not prefix any export path with the oss localroot directive path, if any.
  3) If a log file is specified without a signal -k option, the file is closed at midnight, renamed to have a date suffix (i.e., fn.yyyyymmdd) and possible sequence number (i.e. fn.yyyyymmdd.n), and a new log file is opened. When a signal value is specified, log files are not automatically renamed at midnight. Instead an external program must be used to properly rotate log files. Make sure to choose a signal that is not in use by any plug-in. If unsure, choose one of the obscure signal names and monitor for any odd behavior. Otherwise, use the fifo option. Be aware that on some non-Linux platforms the fifo file descriptor may leak.
  4) When fifo is specified the fifo file name must not exists or exist as a fifo file. A simple “echo x >> /path/ln” causes the logfile to close and reopen.
  5) The sig names should not be prefixed by “sig” or “SIG”.

 Notes on Esoteric Options
  1) The default port service name, default protocol, and pidfile name is normally determined by the prefix-name of the executable. The prefix-name is defined to be all of the characters in the base filename (i.e., the directory path removed) up to but not including the first dot in the name, if any. If the name starts with a dot, the prefix-name is the complete base filename.
  2) The way the prefix-name is derived allows you to maintain several versions of a particular xrd executable (e.g., xrootd and xrootd.debug) without changing the intrinsic way default names (e.g, protocol) are determined.
  3) The built-in protocol name for cmsd is cms and for xrootd is xroot.
  4) The –n option allows you to run multiple instances of the xrootd on the same machine. See the next section on instances and fencing.
  5) The –b option forces the program into the background. If –I is not specified; all output messages are discarded.
  6) When –b is specified, the program fails if it cannot write the pid file.
7) The -R option allows the program to run under the super user’s account. This is allowed because the effective user is set to specified user and the effective group to user’s primary group. Thus, the program is not effectively running as super-user. However, the real and saved user ids may still be “root”, depending on how the program was started.

8) The -R option provides a minimal increase in security since it is possible for a loaded protocol to switch back to super user mode. You should not use the -R option unless absolutely necessary.

9) **Warning**: Command line options, except for -a and -s, over-ride corresponding configuration file directives. For -s the **pid** file is written to the desired location in addition to the location specified by the **pidpath** directive.

**Notes on Developer Options**

1) You must use the -P option to set the default protocol name as well as other related naming aspects (e.g., port service name) when the name of the executable does not correspond to the name of the default protocol.

2) Use **-p any** for protocols that manage their own port numbers. This is the case for redirection target **xrootd/cmsd** combinations. Only the initial point of contact needs a well-known port number. All other connections between clients and servers are routed using whatever port numbers are currently in effect. This allows you to keep a simple configuration file for servers and to run more than one server on the same machine without worrying about conflicting port numbers.

**Example**

```
xrootd -c /opt/xrootd/xrootd.cf
```
1.2.1 Multiple Instances and Automatic Fencing

You can run multiple instances of xrootd on the same physical machine. This is useful when you want to overlay more than one cluster on top of a file system (e.g. production and test). In order to prevent instances from interfering with each other, you must provide each xrootd that is running on the same hardware a unique instance name. One of the daemons need not have an instance name as it assumes the name “anon” (i.e. anonymous).

Once an instance name is assigned to a daemon using the –n option, the system automatically fences in the daemon so that it does not interfere with any other xrootd processes running with it. Automatic fencing consists of these actions:

- The instance name is suffixed to the adminpath to create a unique location for temporary server files. For instance, if –n is not specified, xrootd creates /tmp/.xrootd/admin as the path for the administrative interface. If “-n test” is specified, xrootd creates /tmp/test/.xrootd/admin instead. Even the path specified with the adminpath configuration directive is modified.
- The instance name is used to create a new directory in the current working directory. The current working directory is changed to this newly created path. So, if “/home/xrootd” is the current working directory and “-n test” is specified; the current working directory becomes “/home/xrootd/test”. This allows core files to be segregated by instance name.
- The instance name is automatically inserted into the log file path specified via the -l command line directive to create a unique location for server log files. For instance, if “-l /var/adm/xrootd/xrd.log” is specified along with “-n test”, xrootd modifies the –l argument to be /var/adm/xrootd/test/xrd.log.

Automatic fencing of log files may, for some installations, run counter to the way log files are commonly handled. You can disable fencing of log files by prefixing the log file path by an equals sign. However, you are then responsible to make sure that each instance uses a different log file path or name.

Much of this functionality has been subsumed into containerized frameworks. However, the functionality described here is still supported in the cases where containerization either does not provide the desired performance or is inconvenient thus making host-based applications becomes an imperative.
1.2.2 Passing Plug-In Command Line Arguments

You can pass command line arguments to various plug-ins that support the feature using the \texttt{+} option. The option must be specified after all \texttt{XRootD} options and parameters as plug-in arguments are stripped from the command line. For example,

\begin{verbatim}
xrootd [ options ] [ path [ path [. . . ] ] +mypi arg1 arg2 +urpi arg3
\end{verbatim}

places a pointer to the vector containing “argv[0] arg1 arg2 0” into the internal environment passed to the plug-in using the variable “mypi.argv\***” and the count in “mypi.argc” (i.e. 3). Similarly, “argv[0] arg3 0” are pointed to by “urpi.argv\***” with the count in “urpi.argc” (i.e. 2). If no tag is specified, the leading prefix is missing (i.e. the variables are “.argv***” and “.argc”). Note that argv[0] is the actual value of argv[0] (i.e. the executable name) passed to \texttt{XRootD}.

It is up to the plug-in to extract the appropriate arguments using a documented tag. Tag values that start with “\texttt{xrd}” should not be used as these are reserved for plug-ins normally distributed with the \texttt{XRootD} package.
1.2.3 Log File Plug-Ins

XRootD allows you to specify a plug-in to handle messages that would otherwise be sent to a regular file or standard error. You do this using the ‘@’ qualifier with the –l option. Logging messages is a critical function in the server and any delay will severely impact server performance. The default logging path is very efficient and any plug-in placed in the path should be just as efficient. To help, a speed matching buffer is used to minimize plug-in vagaries. However, if you choose to not use a speed matching buffer (i.e. a bsz of zero for synchronous operation) then the plug-in becomes the choke point in server performance.

You may also choose to capture standard error output using the cse parameter. However, this option will result in an infinite loop if your logging plug-in writes to standard error for any reason. This may be mitigated by specifying cse=1 which only sends standard error output to the plug-in if it starts with a timestamp of the form “ymmd d hh:mm:ss”. All debugging output starts with such a timestamp.

The details on how you write a log file plug-in is detailed in the XrdSysLogPI.hh header file. It is important to realize that if you use the XrdSysLogger object to route a message from your plug-in, an infinite loop will result. Additionally, one log file plug-in is used for all XrdSysLogger instances.
### 1.2.4 Files created by xrootd

The following directories and files are created by xrootd:

<table>
<thead>
<tr>
<th>Default File</th>
<th>Changed by</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>&lt;stderr&gt;</code></td>
<td><code>-l and -n command line options</code></td>
<td>Informational and error messages</td>
</tr>
<tr>
<td><code>/tmp/[/name/].xrootd/</code></td>
<td><code>-n command line option and the </code>adminpath` directive</td>
<td>Directory for various server-related files.</td>
</tr>
<tr>
<td><code>&lt;cwd&gt;/[/name/].core[.pid]</code></td>
<td><code>-n command line options</code></td>
<td>Core file</td>
</tr>
<tr>
<td><code>/tmp/[name/exec.pid</code></td>
<td><code>pidpath</code> and <code>–n</code> option</td>
<td>Holds the process id</td>
</tr>
<tr>
<td><code>/tmp/exec.[name].env</code></td>
<td><code>adminpath</code> and <code>–n</code> option</td>
<td>Holds environmental information (see next section).</td>
</tr>
</tbody>
</table>

#### 1.2.4.1 Environmental Information File

The daemon writes environmental information in the directory specified by `adminpath` directive, or its default. This information can be used to automatically collect all relevant information about a daemon to facilitate automatic problem resolution.

The environmental file is named “`exec.[name].env`” where `exec` is the executable’s name and `name` is the instance name (i.e. `–n` option) and `anon` if no instance name was specified. The format of the information is shown below. When parsing this information, you should not depend on the order shown below.

```
pid=pid&host=host&inst=inst &ver=ver&hpath=hpath &cfgfn=cfgfn&cwd=cwd&logfn=logfn
```

**Parameters**

- `cfgfn` The configuration file used.
- `cwd` The current working directory.
- `host` The host name.
- `hpath` The current working directory.
- `inst` The instance name.
- `logfn` The log file being used.
- `pid` The process id.
- `ver` The version string

These are the minimal elements. Additional elements may be added by specific protocols.
### 1.2.5 Exported Environment Variables

The following table shows the environment variable exported by `xrootd`. These may be used by external programs and plug-ins, as needed. They should never be modified.

<table>
<thead>
<tr>
<th><strong>XRD Variable</strong></th>
<th><strong>Contents</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>XRDADMINPATH</td>
<td>Is the directory for administrative files (i.e. all.adminpath)</td>
</tr>
<tr>
<td>XRDCONFIGFN</td>
<td>The effective administrative path used for server management files.</td>
</tr>
<tr>
<td>XRDDEBUG</td>
<td>Set to one when the <code>-d</code> command line option is specified.</td>
</tr>
<tr>
<td>XRDHOST</td>
<td>The current host’s DNS name.</td>
</tr>
<tr>
<td>XRDINSTANCE</td>
<td>Is the string of the form “execname instance@hostname”. Where execname is the executable’s name, instance is the name specified via <code>-n</code> or <code>anon</code> if no instance name was specified, and hostname is the current host’s DNS name.</td>
</tr>
<tr>
<td>XRDLOGDIR</td>
<td>Is the directory where log files are written.</td>
</tr>
<tr>
<td>XRDNAME</td>
<td>The name specified via <code>-n</code> or <code>anon</code> if no instance name was specified.</td>
</tr>
<tr>
<td>XRDPROG</td>
<td>The executable’s name.</td>
</tr>
<tr>
<td>XRDSITE</td>
<td>The site name specified either via the <code>-s</code> command line option or the all.sitename directive.</td>
</tr>
</tbody>
</table>

If the standard `cms` client plug-in is being used, the following additional environment variables are exported.

<table>
<thead>
<tr>
<th><strong>CMS Variable</strong></th>
<th><strong>Contents</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>XRDCMSMAN</td>
<td>The space separated list of managers for this host each in the form of “host:port”.</td>
</tr>
<tr>
<td>XRDCMSCLUSTERID</td>
<td>The globally unique cluster identification for this host.</td>
</tr>
</tbody>
</table>

If the standard `ofs` plug-in is being used, the following additional environment variables are exported.

<table>
<thead>
<tr>
<th><strong>OFS Variable</strong></th>
<th><strong>Contents</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>XRDROLE</td>
<td>The effective value specified on the all.role directive.</td>
</tr>
<tr>
<td>XRDTPC</td>
<td>Is set when TPC (Third Party Copy) has been configured and represents the version number of the protocol. If the first character is a plus sign, authentication is required.</td>
</tr>
</tbody>
</table>
If the standard **oss** plug-in is being used, the following additional environment variables are exported.

<table>
<thead>
<tr>
<th><strong>OSS Variable</strong></th>
<th><strong>Contents</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>XRDN2NLIB</td>
<td>The path and name of the name-to plug-in, if specified via the <strong>oss.namelib</strong> directive.</td>
</tr>
<tr>
<td>XRDRMTROOT</td>
<td>The local root path specified by the <strong>oss.remoteroot</strong> directive.</td>
</tr>
<tr>
<td>XRDLCRLROOT</td>
<td>The local root path specified by the <strong>oss.localroot</strong> directive.</td>
</tr>
<tr>
<td>XRDOSSQUOTAFILE</td>
<td>The name and location of the file handling disk space quotas.</td>
</tr>
<tr>
<td>XRDOSSUSAGEFILE</td>
<td>The name and location of the file handling disk space usage.</td>
</tr>
</tbody>
</table>

If the standard **xrootd** protocol plug-in is being used, the following additional environment variables are exported.

<table>
<thead>
<tr>
<th><strong>XROOTD Variable</strong></th>
<th><strong>Contents</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>XRDOFSLIB</td>
<td>The path and name of the OFS plug-in specified by the <strong>xrootd.fslib</strong> directive.</td>
</tr>
<tr>
<td>XRDMONRDR</td>
<td>If monitoring is enabled, how often server identification records are sent.</td>
</tr>
</tbody>
</table>
2 Framework Directives by Category

This section provides a guide to xrd directives by category that is helpful when you need to address a specific requirement.

2.1 Debugging

xrd.trace Specify which framework activities are to be traced.

2.2 Monitoring

xrd.report Specify which execution summary statistics are to be gathered and where they are to be sent.
all.sitename Specify the name of the site to be used for monitoring purposes.
xrd.tcpmonlib Specify the plug-in to be used to collect and report specialized TCP connection statistics.

2.3 Networking

xrd.network Specify network parameters such as DNS usage, interfaces, keep-alive characteristics, and routing.

2.4 Operational Environment

all.adminpath Specifies the location of runtime files used for administrative purposes.
xrd.homepath Specifies the location of the working directory during execution.
all.pidpath Specifies where the file containing the server’s process id should be created.

2.5 Protocol support

xrd.port Specifies the default port number for incoming requests.
xrd.protocol Load additional protocols such as HTTP.
2.6 Security and TLS

- **xrd.allow**: Restricts hosts that can connect to the server.
- **xrd.tls**: Specify the location of the server’s host certificate.
- **xrd.tlsca**: Specify the location of CA certificates and CRLs.
- **xrd.tlsciphers**: Specify allowable TLS ciphers.

2.7 Tuning

- **xrd.buffers**: Limit the amount of memory used for data buffers.
- **xrd.maxfd**: Limit the amount of memory used for file descriptors.
- **xrd.sched**: Specify execution parameters such as core file creation, default stack size, and threading.
- **xrd.timeout**: Specify various connection handling timeout parameters.
3 Common Framework Configuration Directives

3.1 adminpath

```
all.adminpath path [ group ]
```

**Function**
Specify the location of protocol-specific files for administrative purposes.

**Parameters**
- `path` The absolute path to a directory that is to hold protocol-specific files. The path should be no longer than 76 characters. See the notes for details.
- `group` Allows read/write group access to any named sockets created in the `path`. By default, only the owner can use such sockets.

**Default (see warning in the notes)**
```
/tmp
```

**Notes**
1) The `adminpath` directive allows you to specify the location of the local TCP sockets used for the command-line administrative functions along with special directories that are needed to handle protocol specific features.
2) Use the `-a` or `-A` command line option to set the defaults for the `adminpath` directive.
3) If `-n` is specified on the command line, a subdirectory corresponding to the instance name (i.e., `-n` argument) is created in `path`, if one does not exist. This becomes the new `path`. This allows fencing multiple daemons running on the same node.
4) **Warning:** if idle `/tmp` directories and socket files are automatically deleted by the system, you should specify a path other than `/tmp`. Be aware if neither `-a` command line option nor the `adminpath` directive is specified, the default becomes `/tmp`. External removal of files stored in the `adminpath` may lead to server failure.
5) When specifying an **adminpath**; be cognizant that the program may be containerized and the path may not be suitable for that environment. Confer with your system administrators on what the suitable path should be if the program will run in a container.

6) Local **TCP** socket names are limited to 108 characters. Up to 32 characters are needed to define actual socket files; leaving 76 characters that may be specified for the **path**.

7) The following steps are taken when creating a **Unix** named socket in path:
   - The subdirectory **.xrd** is created in **path** and
     - the **cmsd** daemon creates subdirectory **.olb** while
     - the **xrootd** daemon creates subdirectory **.xrootd** in **path**.
   - Mode bits for these directories are set to 0700 (rwx for owner). If the directories already exist, the mode settings are reset to correspond to the **adminpath** directive.
   - If **group** was specified, the mode setting is extended to 0770 (rwx for owner and group).
   - If the directories already exist, the mode settings are reset to correspond to the **adminpath** directive specification.
   - Server, manager, and supervisor **cmsd**’s create stream sockets named “**olbd.admin**”, “**olbd.nimda**”, and “**olbd.super**” in the **.olb** subdirectory, respectively. These sockets are used for administrative communication.
   - Server and manager **cmsd**’s respectively create datagram socket named “**olbd.notes**” and “**olbd.seton**” in the **.olb** subdirectory. These sockets are used for external notifications.
   - The **xrootd** daemon creates a **Unix** named socket with the name “**admin**” in the **.xrootd** subdirectory.

8) The **adminpath** value is passed to all protocols so that they can create their respective administrative files in **path**. However, for the **cmsd** only, you may specify an exception by using the **cms.adminpath** directive to create a completely different path for its files.

9) Refer to the **section “Administrative Interface”** for details on how to use the **Unix** named socket created by various protocols and daemons.

1)

**Example**

    all.adminpath /var/adm/xrd group
3.1.1 Administrative Interface

The `adminpath` directive is used to construct the path where local TCP sockets, called named sockets, are created. These sockets are used to communicate requests and receive responses via the administrative interface. Unix domain sockets function identically as INET domain sockets. The only differences are in how the socket is created and the domain in which it operates. Care should also be given as to who creates the socket. Following the next steps will allow the successful use of the administrative interface.

1. Wait until the server creates that the socket file (e.g., “/tmp/.xrootd/admin” or “/tmp/.olb/notes”). This can be done by polling for the socket using `stat()`.
2. Create a stream socket using `socket(PF_UNIX, SOCK_STREAM, 0)`
3. Properly fill out the `sockaddr_un` structure with the path name of the socket (e.g., “/tmp/.xrootd/admin”). This structure is normally defined in the `<sys/un.h>` include file.
4. Issue a `connect()` call to connect the newly created socket to the path.
5. Use `write()` to issue requests to the server and `read()` to read responses.

The administrative protocol used for the socket interface is defined elsewhere.
3.2 allow

```
xrd.allow { host | netgroup } name
```

**Function**
Restrict the hosts that can connect to **xrootd**.

**Parameters**

**host name**
The DNS host name allowed to connect to **xrootd**. Substitute for **name** a host name or IP address. A host name may contain a single asterisk anywhere in the name. This lets you allow a range of hosts should the names follow a regular pattern. IP addresses may be specified in IPV4 format (i.e. “a.b.c.d”) or in IPV6 format (i.e. “[x:x:x:x:x]”).

**netgroup name**
The NIS netgroup allowed to connect to **xrootd**. Substitute for **name** a valid NIS netgroup. Only hosts that are members of the specified netgroup are allowed to connect to **xrootd**.

**Defaults**
None. If **allow** is not specified, any host is allowed to connect.

**Notes**
1) You may specify any number of hosts and netgroups. Any host matching a specified name or is a member of a specified netgroup is allowed to connect to **xrootd**.
2) **Warning!** Using hostname based security relies on the security of the DNS server and the inability of other hosts spoofing and successfully using the “allowed” IP addresses. The two security assumptions have severe limitations.

**Example**
```
xrd.allow host objyana*.slac.stanford.edu
```
3.3 **homepath**

```
xrd.homepath path [ group ]
```

**Function**
Specify the location of the current working directory.

**Parameters**
- **path** The absolute path to a directory that is to be used as the working directory.
- **group** Allows read group access to path.

**Default**
Whatever is the directory on start-up.

**Notes**
1) Use the `-w` or `-W` command line option to set the home path. When the home path is set on the command line, it cannot be overridden with the `homepath` directive.
2) If `-n` is specified on the command line, a subdirectory corresponding to the instance name (i.e., `-n` argument) is created in `path`, if one does not exist. This becomes the new `path`. This allows fencing multiple daemons running on the same node.
3) When specifying a homepath, be cognizant that the program may be containerized and the path may not be suitable for that environment. Confer with your system administrators on what the suitable path should be if the program will run in a container.

**Example**
```
all.homepath /var/run/xrd group
```
3.4 **tls** *(required for TLS)*

```
xrd.tls cpath [ kpath ] [ options ]
options: [[no]detail] [hsto to{h|m|s}]
```

**Function**
Configure transport layer security (TLS).

**Parameters**
- `cpath` Specifies the absolute path to the x509 certificate file to use for TLS. The certificate must be in PEM format. The file may only be written by the owner of the file.
- `kpath` Specifies the absolute path to the certificate’s x509 private key file to use for TLS. The key must be in PEM format. The file may only be read and written by the owner of the file. If `kpath` is not specified then the certificate file must contain the key.
- `[no]detail` When `detail` is specified, detailed TLS trace back messages are printed along with explanatory messages. The `nodetail` option suppresses the TLS trace back messages. The default is `nodetail`. See the notes why this is so.
- `to` Specifies the maximum amount of time a TLS handshake is allowed to take before the connection is closed. The `to` value may be suffixed by `h` for hours, `m` for minutes, or `s` for seconds, respectively; otherwise, the `to` value defaults to seconds. There is no default time limit for the TLS handshake.

**Defaults**
TLS is not configured and cannot be used. See individual options for the defaults should you configure TLS.

**Notes**
1) Normally, a host certificate should be used because the client can use it to validate that it connected to the intended host.
2) If you specify the `tls` directive then you must specify the `tlsca` directive as well.

3) Most TLS trace back messages do not provide any more information than the companion explanatory messages and, as such, is only useful for debugging purposes. This is why `nodetail` is the default. However, if you enable TLS tracing using the `xrd.trace` directive, `detail` is enabled regardless of what is specified.

Example

```
xrd.tls /etc/security/xrootd/hostcert.pem
```
3.5 **tlsca** *(required for TLS)*

```
xrd.tlsca noverify | {certdir | certfile} path [options]
```

**options:**
```
[crlcheck {all | external | last}]
[log {failure | off}] [[no]proxies]
[refresh rint[h|m|s]] [verdepth vdn]
```

**Function**
Configure client certificate verification for transport layer security (TLS).

**Parameters**

**noverify**
Disables client certificate verification. All subsequent parameters, if any, are ignored.

**certdir path**
Specifies the absolute path of the directory containing trusted Certificate Authority certificates that can be used to verify client certificates. Each file in the directory may only contain a single certificate in **PEM** format. Naming conventions are those required by the version of **OpenSSL** being used. The directory may only be written to by the owner of the directory.

**certfile path**
Specifies the absolute path to the file containing one or more trusted Certificate Authority certificates that can be used to verify client certificates. The certificates in the specified file are used first before an attempt is made to find an appropriate certificate in **certdir**, if specified. The file must be in **PEM** format. The file may only be written to by the owner of the file.
crlcheck
Specifies the certificate revocation list (crl) is to be handled. Choose one of the following:
- all - apply crl checking to the complete certificate chain.
- external - crl application is handled by an external plug-in (the default).
- last - apply crl checking only to the last certificate in the chain.

log
Specifies logging requirements. Logging messages are written to the log file. Choose one of the following:
- failure - log failed verifications (the default).
- off - verification failures are not to be logged.

vdn
Specifies the verification depth. Should the client present a certificate chain, up to the last vdn certificates are verified. Specify a value between 1 and 256, inclusive. The default is 9.

rint
Specifies the refresh interval. Suffix the value with h for hours, m for minutes, or s for seconds (the default). The default is 8h (eight hours).

Defaults
xrd.tlsca crlcheck external log failure proxies refresh 8h verdepth 9

Notes
1) You may specify both a directory and a file. The certificates in the certfile will be searched before any certificates in certdir.
2) If all the loaded protocols use strong authentication (e.g. Kerberos, GSI, or SSS) client certificate verification is not necessary as the client will be verified using a strong authentication mechanism and the client’s certificate will only be used to establish a TLS connection.
3) Certain protocols require certificate verification (e.g. HTTPS). If you enable one of these protocols you should enable verification overall to avoid specifying protocol specific directives that duplicate ones that could be specified using the tlsca directive.
4) In the absence of strong authentication, you should always verify client certificates. Generally, you should always verify client certificates. This is why the directive requires that you make an explicit choice.
5) All of the certificates in the directory, as well as the file, must in a format that is recognized by the version of OpenSSL being used.
6) If you use a certdir be aware that OpenSSL requires that the c_rehash utility be run after the certificates in the directory are updated. This introduces a race condition between refreshes and updates to the directory and may produce verification failures should a refresh occur while the directory is being updated. You can avoid this problem by making sure that changes to the directory are visibly done in an atomic fashion.

Example

```
xrd.tlsca certfile /etc/security/xrootd/cacerts.pem
```
4 Esoteric Framework Configuration Directives

4.1 buffers

\[ \text{xrd.buffers memsz[k | m | g] [rint[m | s | h]]} \]

Function

Limits the amount of memory to be used to data buffers.

Parameters

\text{memsz}

The maximum number of bytes to be used for data buffers. The \text{memsz} can be suffixed by \text{k}, \text{m}, or \text{g} to indicate kilo-, mega-, or giga-bytes; respectively. The default is to use up to 12.5% (one-eighth) of the configured memory of the machine.

\text{rint}

The interval between buffer pool readjustments. Specify a number, optionally suffixed by \text{m} for minutes, \text{s} for seconds (the default), or \text{h} for hours. The default is every 20 minutes.

Defaults

\text{xrd.buffers memsz 20m}

Notes

1) The allotted memory for buffers is independent of any other memory allotment to the daemon.
2) Data buffers in the pool are periodically readjusted to reflect the actual working needs of the daemon. The \text{rint} interval controls how frequently this adjustment occurs. The default value is usually the best value.

Example

\text{xrd.buffers 512M}
4.2 maxfd

xrd.maxfd [strict] maxfd[k]

Function
Limit the amount of memory to be used for file descriptor handling.

Parameters
strict Applies the maxfd limit in all cases. When strict is not specified, maxfd is only used when the hard limit is unlimited, the default.

maxfd The maximum number of file descriptors allowed to be allocated. Specify a number between 1024 and 1024k, inclusive. The default is 256k.

Defaults
xrd.maxfd 256k

Notes
1) When strict is specified, the actual limit is determined by applying the formula
   \[ \min(\text{hard\_limit(\text{descriptors)}}, \text{maxfd}) \]

2) When strict is not specified, then maxfd is used only when the hard_limit(descriptors) is unlimited. This is necessary because an unlimited implies infinite but the server requires a fixed upper bound for control block allocation purposes.

3) With strict the hard limit can only set the lower bound. Without strict the hard limit controls the actual value unless it’s unlimited.

Example
xrd.maxfd strict 64k
4.3 network

```
xrd.network [buffsz blen[k | m | g]] [cache sec]
    [[no]dnr] [[no]dyndns]
    [kaparms idle[,itvl[,cnt]]] [[no]keepalive]
    [routes {split|common|local} [use if1[,if2]]]
    [[no]rpipa] [tls]
```

Function
Specify network parameters.

Parameters

**buffsz blen**
The buffer size to be set for each connected socket. The *blen* can be suffixed by *k*, *m*, or *g* to indicate kilo-, mega-, or giga-bytes; respectively. The default is determined by the operating system.

**cache sec**
The maximum number of seconds that an address to hostname translation can be locally cached for future use. See the notes on its interaction with *dyndns*. The *sec* can be suffixed by *s*, *m*, *h* or *d* to indicate seconds, minutes, or hours, or days; respectively. The default is 3 hours.

**dnr**
Uses Domain Name Resolution to convert IP addresses to host name for connecting clients. Host names are displayed in various messages.

**nodnr**
Avoids using Domain Name Resolution to convert IP addresses to host name for connecting clients. Client IP addresses are displayed in various messages.
dyndns
The network uses a Dynamic DNS for name resolution. See the section on Dynamic DNS for information on when you should specify this option. See the notes on its interaction with cache.

nodyndns
The network uses a standard DNS whose name entries are stable. This is the default.

kaparms idle[,itvl[,cnt]]
Specifies TCP keepalive parameters. The kaparms option is only effective for Linux. Up to three parameters may be specified. Omitted parameters, as well as parameter values of zero, use the system default. The parameters are:
idle The time the connection needs to remain idle before TCP starts sending keepalive probes. The idle value may be optionally suffixed by m for minutes, s for seconds (the default), or h for hours.
itvl The time between individual keepalive probes. The itvl value may be optionally suffixed by m for minutes, s for seconds (the default), or h for hours.
cnt The maximum number of keepalive probes TCP should send before dropping the connection.

keepalive
Uses the operating system’s keep-alive mechanism to determine whether or not a client is still connected to the daemon. This is the default. See the usage notes for other ways of simulating keepalive.

nokeepalive
Does not use the operating system’s keep-alive mechanism to determine whether or not a client is still connected to the daemon.

routes
Specifies that a dual network exists and how public and private addresses are routed within a site. Select one of the below optionally followed by the use keyword and up to two interface names (i.e. if1 and optionally if2, immediately preceded by a comma; use ifconfig to display interfaces and their names):
split Two separate networks exist. Clients connecting with a private address can only be redirected to a server’s private address. Clients
connecting with a public address can only be redirected to a server’s public address. If clients can use both types of addresses, all servers must be dual homed with a public and private address. Typically, you must specify the interfaces you are using.

**common**
Two common networks exist. Clients connecting with a private address are preferentially redirected to a server’s private address but may be redirected to a server’s public address if need be. However, clients connecting with a public address can only be redirected to a server’s public address. All servers must have at least a public address. If the machine is dual-homed you must specify the interfaces you are using.

**local**
Two cross-routable networks exist. Clients connecting with a private address are preferentially redirected to a server’s private address but may be redirected to a server’s public address if need be. Clients connecting with a public address are preferentially redirected to a server’s public address but may be redirected to a server’s private address if need be. This is the default mode of operation in order to be compatible with previous releases. If the machine is dual-homed it is advisable to specify the interfaces you are using for predictable access. **Warning**, such a network configuration is not suitable for external access and a proxy server must be used for out of domain clients.

**rpipa**
Tries to resolve private IP addresses to host names. See the section on [resolving private IP address](#) for more information.

**norpipa**
Does not resolve private IP addresses to host names. This is the default.

**tls**
Indicates that the specifications apply to the Transport Layer Security port.

**Defaults**
```
xrd.network cache 3h dnr norpipa
```

**Notes**
1) For systems that support TCP buffer auto-tuning as a manual option, specify a `buffsz blen` of 0 to turn on auto-tuning.
2) Setting the buffer size to a large value may cause the operating system’s default value to be used. You should determine the maximum valid value for your system before specifying values greater than 64k.

3) Normally, the best performance is obtained by using TCP buffer auto-tuning.

4) Even if you specify nodnr, domain Resolution may be forced on if you specify an allow directive using a host name or host name fragment or authorize file access via host names, netgroups, or domain names. Resolution is still optimized by caching the results for future use.

5) The daemon’s internal timeout mechanism can be used to discover unconnected clients instead of TCP keepalive and may be more responsive. See the timeout directive. You should avoid using both mechanisms at the same time.

6) For aggressive keepalive processing you can use “kaparms 300,10,6”.

7) By default, public-private networking support is disabled. You must specify the routes option to enable it. If you do specify for one server you must specify for all nodes in your cluster (i.e. servers and redirectors). Failure to do so may result in unreachable nodes.

8) If the supplied information is inconsistent with the server network settings, warning messages are printed and the public-private network support may be turned off for that server. You should verify that your specification is consistent with the server’s networking configuration.

9) Interface names are arbitrary but usually are of the form enx, ethx, etc. One interface must be assigned a public address and the other the private address. This mechanism works best when all of the servers in a cluster use the same interface naming conventions; though the address assignments may differ. If this is not the case, you will need to use the if-else-fi configuration syntax to special case particular nodes.

10) Dual public/private network are fully supported in Linux, MacOS, and in Solaris 11.

11) IP address caching is generally incompatible with a dynamic DNS. When dyndns is specified but no cache option has been specified, the cache timeout is set to zero. This effectively turns off IP address caching.

Example

```
xrd.network nokeepalive nodnr
xrd.network tls buffsz 512k
```
4.3.1 Dual Public/Private Network Guidelines

Before you configure a dual public/private network, determine if such a network is actually necessary. Administering dual networks is difficult and problem resolution rather onerous. Typical reasons and alternatives to running a dual network are:

- Conserving IPV4 addressees: consider using IPV6, which does not suffer from this problem.
- Performance: if private addresses are routed along with public addresses over the same networking hardware then the switch becomes the bottleneck and performance improvements are moot.
- Security: if you desire to restrict certain kinds of access you may be able to achieve the same result using router and switch settings (e.g. file walls, routing restrictions, etc) thus avoiding a dual network.

If you still wish to run a dual network, you should use the following guidelines to avoid access surprises and mysterious performance issues.

- Never register private addresses in a publicly accessible DNS server. This exposes your private network configuration and is considered bad practice. Private addresses should only be registered in a private DNS or zone registered to prevent external leakage.
- Never register a server’s private and public address under a single host name unless both addresses have equal connectivity. While this practice works for simple applications, complex applications like XRootD and Proof attempt to use all addresses assigned to a particular host name. If connectivity is unequal, performance issues and connection failures are likely to occur.
- Never cluster servers with only a public address with servers that only have a private address if their name spaces overlap. While this may work for certain network routing topologies, it invariably introduces inconsistencies.
- Carefully review the routes option on the xrd.network directive to make sure your network routing topology and interfaces are correctly stated.
4.3.2 Resolving Private IP Addresses

By default, private IP addresses are not resolved to host names. This is commonly accepted practice to avoid DNS timeouts as private addresses are usually not registered in DNS. However, some installations may opt to register such addresses in either a private DNS or in a zoned public DNS. This actually may be necessary in cloud deployments where nodes within the cloud receive private addresses and a NAT box is installed to provide outside access. In such cases, there is usually a 1-to-1 mapping between a public address (e.g. IPv6) to a corresponding private address (e.g. IPv4). The public address is registered in a public DNS while the private address is registered in a private DNS within the cloud. Both addresses are registered with the same host name. However, to avoid leaking private addresses you must specify the xrd.network rpipa option so that only host names are returned and not actual addresses. This allows clients on the public network to accesses nodes in the private network using the NAT box. Nodes in the private network also receive host names but since these names are registered within the private network, proper address resolution occurs.

4.3.3 Dynamic DNS

The dyndns option specifies that a Dynamic DNS is being used for the network. This is typically the case for containerized cloud deployments (private or public) managed by an orchestration scheme (e.g. Kubernetes). In such schemes, when a container starts with an arbitrary local IP address, its host name and address are entered into a local DNS. When the container stops, the entry is removed. Even on a container restart, the entry may be removed between the time the container stops and the time it restarts with a new IP address. This becomes a problem for servers expecting to contact specific services when those services have not yet been started or are being restarted. In the XRootD framework, cluster management services that supervisor and data servers rely on expect those services to be permanently registered in DNS; albeit with arbitrary non-permanent IP addresses.

The dyndns option notifies all nodes in an XRootD cluster using the network that DNS entries may come and go and resolution of IP addresses needs to be done at the time of contact not during initialization. Failure to specify the dyndns option when a Dynamic DNS is actually being used inevitably leads to random failures.

Of course, you may be able to avoid using a Dynamic DNS if you opt for host networking, at least for management services. However, many times that is not an option and when allowed severely limits orchestration choices.
### 4.4 pidpath

#### Syntax

```
all.pidpath path
```

#### Function

Specify the location where the process id file (i.e. `pid` file) is to be written.

#### Parameters

`path`  The path to be used to create the file where the daemon’s process id is stored.

#### Defaults

The process id file is written into `/tmp`.

#### Notes

1) If `-n` is specified on the command line, a subdirectory corresponding to the instance name (i.e., `-n` argument) is created in `path`, if one does not exist. This becomes the new `path`. This allows fencing multiple daemons running on the same node.

2) The `-s` command line option may be used to specify the path and filename to be used for the `pid` file.

3) The name of the `pid` file corresponds to the executable name suffixed by `".pid"`.

#### Example

```
all.pidpath /var/run/scalla
```
4.5 port

```plaintext
xrd.port [tls] {pnum | any} [ if conds ]
```

**Function**
Designate the port number to use for incoming requests.

**Parameters**

- **tls** Sets the preferred TLS-only (Transport Layer Security) port number. Otherwise, the default port number is set. See the usage notes on how the default is determined and the caveats when using the `tls` option.

- **pnum** The TCP port number or the TCP service name associated with a port in `/etc/services` file that the daemon should use for incoming requests. See the usage notes on how the default is determined.

- **any** Specifies that any available TCP port number may be used for incoming requests. See the usage notes on how the default is determined.

- **conds** The conditions that must exist for this directive to apply. Refer to the description of the "if" directive on how to specify `conds`.

**Defaults**
See the usage notes.

**Notes**
1) The default port number is determined using the following rules:
   - The protocol specified port when the protocol is loaded.
   - The port specified on the protocol directive entry.
   - The port specified on the command line using `-p`.
   - Any available port number if `-p any` was specified on the command line.
   - The port associated with the service name that corresponds to the name of the program used to start the daemon (e.g., `xrootd`).
   - The port value of 1094.
2) The `tls` port number need only be specified if you wish to have a port that can *only* communicate using TLS at the outset. A client may discover this port using the `kXR_query` request with the `tlsport` as an argument. If not specified or used by a protocol, no TLS-only port is created.

3) Not all protocols support a TLS-only port. For instance, the `xroot` and `xroots` protocols negotiate TLS with the client and must first communicate without using TLS. So, TLS-only port cannot be used. The `http` protocol can use such a port but only for HTTPS connections. However, TLS-only port prevents it redirecting a TLS connection to a non-TLS connection.

4) When running clustered systems, you can keep a single configuration file that is applicable to all types of servers, as follows:
   - always specify “`xrd.port any`” in the configuration file, and
   - use the `if` modifier to identify the top-most servers (i.e., the initial point of contact also known as redirectors) and assign them fixed port numbers immediately following the “`xrd.port any`” directive.

4) Using the steps outlined above, the initial point of contact will have a well-known port number. While all other servers will choose random port numbers, the ports are communicated to the cluster manager which then automatically manages the port numbers while redirecting clients.

Example

```plaintext
xrd.port xrdnew
```
### 4.6 protocol

**xrd.protocol** \[**tls**\] \[**name[:port]**\] \{**+port** | **lib** | \*\} \[**parms**\]}

**Function**
Configure a protocol that `xrd` is to use for incoming requests.

**Parameters**
- **tls** Indicates that any connection to the port must communicate using TLS at the outset. Not all protocols support this option. See the notes for caveats.
- **name** The name of the protocol you wish to configure.
- **port** The port number the protocol is to use for incoming requests. Specify a number, the name of a TCP service, or the word any. If `port` is not specified, the preferred port is used (see the `xrd.port` directive).
- **+port** Adds the specified `port` to the list of port number that the protocol may receive connections. The protocol name must have been previously defined. You may not omit the `port` specification when using this parameter. If the port already is associated with the protocol, only the `tls` designation is updated.
- **lib** The path to the shared library that contains the code the implements the protocol. If `lib` is an asterisk, the protocol refers to the built-in or the command line assigned protocol. Any pre-existing protocol definition with the same name is completely replaced by this definition.
- **parms** Parameters to be passed to the protocol at load time.

**Defaults**
Not applicable.

**Notes**
1) The daemon expects that only one protocol is built-in. The name of this protocol must correspond to the name of the program implementing the daemon (e.g., `xrootd` implies `xroot` protocol). The built-in protocol may be overridden by the `-P` and `-L` command line options.
2) The built-in or assigned protocol is always loaded first followed by any additional protocols in the order they appear in the configuration file.

3) The `tls` option is meant to be used for protocols that require TLS but cannot configure it themselves. The `xroot` protocol is incompatible with this option as it negotiates the use of TLS using a non-TLS connection. The `http` protocol can work but only for HTTPS connections. However, enforcing TLS at the outset disables its ability to redirect a TLS connection to a non-TLS connection.

4) Most protocols can share the same port number because the framework picks the protocol that is compatible with the incoming data. For instance, the `xroot` and `http` protocols can both use the same port number. The framework automatically enables the `xroot` base port for `http` use. This makes it convenient in a clustered environment when an `http` connection is redirected to an `xroot` port number.

5) When the specified protocol name matches a previously declared protocol the `port`, `lib`, and `parms` specifications replace those in the previously specified directive. If the `port` is missing, the protocol uses its default port number. If the `parms` are missing then any existing `parms` are removed from the previous specification.

6) Additional protocols are dynamically loaded from the indicated `lib`.

7) A port of `any` assigns an arbitrary port number to the protocol.

8) Be aware that a protocol may choose its own port irrespective of what is actually specified. While current protocols respect the configured specification, future ones may not.

9) Only those protocols bound to a specific port are matched against incoming connections on that port. The daemon attempts to match each such protocol with an incoming connection on the associated port in the order that the protocols are specified. The built-in protocol is always tried first, if applicable.

10) Load-time parameters are specific to each protocol. Refer to the protocol requirements for details.

11) The `cms` and `xroot` protocols do not have any load-time parameters.

12) Up to eight different protocols may be specified. Each protocol may be assigned up to 8 different ports.

Example

- `xrd.protocol http:8000 libXrdHttp.so`
- `xrd.protocol http:8080 +port`
4.7 report

```
xrd.report dest1[,dest2] [every rsec] [-]option
```

```
option: all | buff | info | link | poll | process |
        prot[ocols] | sched | sgen | sync | syncwp

[-]option]
```

**Function**
Specify execution tracing options.

**Parameters**

*dest1* is a *host:port* or a UDP named local socket where reports are to be sent.
Reports are always sent as a single UDP message.

*dest2* is a secondary destination and must differ from *dest1*. The same report is delivered to *dest2* and *dest1*.

*rsec* determines how often reports are sent. Specify a number, optionally suffixed by *m* for minutes, *s* for seconds (the default), or *h* for hours. The default is every 10 minutes.

*option* Specifies the reporting level. One or more options may be specified. The specifications are cumulative and processed left to right. Each option may be optionally prefixed by a minus sign to turn off the setting. The following options produce reports on:

- **all** selects all possible reports
- **buff** I/O buffer activity
- **link** connection and socket I/O activity
- **poll** socket activity other than I/O
- **process** process resources
- **protocols** protocol specific information
- **sched** scheduling and thread activity
- **sgen** statistics generation
- **sync** synchronizes data for completeness (see the notes)
- **syncwp** synchronizes data only when practically possible
Defaults

Reporting is disabled.

Notes

1) Report messages are encoded in XML format. Refer to the xrootd protocol specification on the actual format and embedded information; as described under the response format for the kXR_QStats option of the kXR_query request.

2) By default, statistical values are obtained without data access synchronization. This may occasionally produce incomplete or inaccurate values. However, because information is collected asynchronously this has little impact on the server.

3) If absolute accuracy is required, you should specify the sync option. Be aware that reporting may require a significant amount of elapsed time while the server synchronizes its activities in order to produce accurate and consistent data.

4) If absolute accuracy is desired but not required, you should specify the syncwp option. The server synchronizes its activities only when possible. If the server is too active, an asynchronous report is done. The sgen report segment provides information on whether the report was synchronous or not and how much time it took to generate.

5) For scalability reasons, you should feed all UDP messages to one or more collectors whose sole function is to multiplex the UDP message streams into a single buffered serial stream. Generally, attempting to do more in a UDP message receiver substantially increases the chance for lost UDP messages.

6) A UDP message multiplexor and XML parser, mpxstats, is available as part of the reference XRootD distribution. Refer to the “Monitoring” reference for details.

Example

xrd.report myhost:1234 every 15m all -poll
4.8 sched

```
 xrd.sched parms

 parms: [avlt avlt] [core {asis | max | off}] [idle idle] [maxt maxt] [mint mint] [stksz size]
```

**Function**

Specify when threads are created, how many can be created, and when they should be destroyed.

**Parameters**

**avlt**

The number of threads that must always be available to service a request. These threads are never bound to any connection. Excess threads above this quantity will be allowed to bind with a socket until either the socket becomes idle or the number of available threads falls under avlt. The default is one half of the mint value.

**core** {asis | max | off}

Sets the limit for core file production. Choices are

- asis - leave the current setting alone.
- max - allow core files up the hard limit maximum (the default).
- off - turn off core file production.

**idle**

The interval between checks for underused threads. Underused threads in excess of the mint value are terminated. Specify a number, optionally suffixed by m for minutes, s for seconds (the default), or h for hours. The default is every 13 minutes (i.e., 13m). Specifying a value of zero prevents threads from being terminated even if they are idle.

**maxt**

The maximum number of threads that may be created to service requests. The number of threads will dynamically vary between mint and maxt.
mint \textit{mint}

The minimum number of threads that must exist to handle requests. Once this number has been created, it is never reduced.

stksz \textit{size}

The default thread stack size. Specify the number of bytes, optionally suffixed by \texttt{k} for kilobytes or \texttt{m} for megabytes. The default is controlled by the target operating system.

Defaults

\texttt{xrd.sched mint 8 maxt 2048 avlt 512 idle 780}

Notes

1) The \texttt{mint}-number of threads are eventually created.
2) The stack size is controlled by the target operating system used to create \texttt{xrootd}. For instance, in Solaris when sizeof(long) is 4 (indicating a 32-bit architecture), a 1M stack size is used. When sizeof(long) is 8 (indicating a 64-bit architecture or an LP64 data model) a 2M stack size is used. In Linux, the stack grows, as needed, to a maximum of 2M.
3) You should periodically review whether or not you have sufficient number of threads. The daemon prints a warning message the first time the \texttt{maxt} value is reached and more threads are needed.
4) If the daemon indicates that the thread limit was reached but less than \texttt{maxt} threads were created; then the target operating system maximum has been reached. This now becomes the new \texttt{maxt} value.
5) \textbf{Warning}, you should not change the thread parameters unless there is an overpowering reason to do so. The system is optimized for having many thread readily available. Constraining the number of threads may yield random failures that are hard to explain.

Example

\texttt{xrd.sched mint 10 maxt 100 avlt 20}
4.9 sitename

**Function**
Specify the site name to be included in monitoring records.

**Parameters**

- **sname**
The 1- to 63-character name of the site. The name may include letters, digits, and the symbols "_:.". Other symbols are converted to a period. If the name is longer than 63 characters it is truncated to 63 characters.

**Defaults**
None.

**Notes**
1) The -S command line option overrides the sitename directive.
2) The first sitename directive takes precedence over any subsequent sitename directives.

**Example**

all.sitename slac
4.10 tcpmonlib

```
xrd.tcpmonlib [++] path [parms]
```

Function
Specify the location of the TCP connection statistics monitoring plug-in.

Parameters
++ The specified plug-in should stack on top of the existing plug-in or default. A stacked plug-in cannot be overridden by a subsequent directive.

path The absolute path to the shared library that contains an implementation of the TCP connection statistics monitor.

parms Optional parameters to be passed to the plug-in object creation function.

Defaults
None.

Notes
1) The TCP connection monitor plug-in interface is defined in the XrdTcpMonPin.hh include file. Refer to this file on how to create a custom monitoring plug-in.
2) You must specify the tcpmon option in the xrootd.monitor directive in order to enable the TCP connection monitoring.
3) The plug-in is called just before the TCP socket to a client is closed.

Example
```
ofs.authlib /opt/xrootd/lib/libAuth.so
```
4.11 timeout

```
xrd.timeout parms

parms: [hail hlto[h | m | s]] [idle idto[h | m | s]]
[kill klto[h | m | s]] [read rdto[h | m | s]]
```

**Function**
Specify timeout parameters.

**Parameters**

*hail hlto*

The maximum number of seconds to wait for data to arrive after a connection is accepted. Specify a number optionally suffixed by h for hours, m for minutes, or s for seconds, the default.

*idle idto*

The number of seconds a connection may remain idle before it is closed. Specify a number optionally suffixed by h for hours, m for minutes, or s for seconds, the default. A value of 0 disables idle timeout processing.

*kill klto*

The number of seconds to wait for an “end session” request to complete. Specify a number optionally suffixed by h for hours, m for minutes, or s for seconds, the default.

*read rdto*

The number of seconds a read may wait for data before it is either terminated or rescheduled. Specify a number optionally suffixed by h for hours, m for minutes, or s for seconds, the default.

**Defaults**

```
xrd.timeout hail 30 idle 0 kill 3 read 5
```
Notes

1) The **idle** timeout prevents accumulation of dead connections which may happen when a client host machine crashes.

2) Currently, **idle** timeouts are disabled. You may enable them by specifying an *idto* value greater than zero.

3) Forced closure of connections is safe if the protocol supports dynamic reconnection, as the *xroot* protocol does.

4) The **read** timeout forces a link to be closed should the initial protocol identification data not arrive within the timeout interval. After which, connections that do not send all of their data in the indicated period are simply rescheduled to the background.

5) Avoid setting short idle timeouts (e.g. less than 2 minutes). The framework oversamples timeout conditions so that it can accurately meet the specified value. Shorter timeouts require a higher sampling rate which increases overhead.

Example

```
xrd.timeout idle 120m read 10
```
### 4.12 tlsciphers

<table>
<thead>
<tr>
<th>Function</th>
<th>Specify the allowed ciphers for transport layer security (TLS).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameters</td>
<td>ciphers</td>
</tr>
<tr>
<td></td>
<td>A list of colon separated ciphers that are allowed to be used.</td>
</tr>
<tr>
<td>Defaults</td>
<td>For OpenSSL versions greater than 1.0.2 the ciphers recommended by mozilla.org version 5.4 guidelines are used. These are strict ciphers. For older OpenSSL versions, generic ciphers are used for compatibility reasons.</td>
</tr>
<tr>
<td>Notes</td>
<td>1) The <strong>tls.ciphers</strong> directive is provided in cases where a default cipher has been shown to be insecure and should be removed. In this case, you need to specify all of the ciphers less the one you wish to eliminate.</td>
</tr>
<tr>
<td>Example</td>
<td>xrd.tlsciphers ALL:!LOW:!EXP:!MD5:!MD2</td>
</tr>
</tbody>
</table>
### 4.13 trace

**Syntax**

```
xrd.trace [ -]option
```

**Option**

```
option:   { all | conn | debug | mem | net | none | off |
          poll | protocol | sched | tls | tlsctx | tlsio |
          tlssok} [ [ -]option]
```

**Function**

Specify execution tracing options.

**Parameters**

*option* Specifies the tracing level. One or more options may be specified. The specifications are cumulative and processed left to right. Each option may be optionally prefixed by a minus sign to turn off the setting. Valid options are:

- **all** selects all possible trace levels
- **conn** traces connection activity
- **debug** traces internal activities for debugging purposes
- **mem** traces memory management functions
- **net** traces network management functions
- **none** traces nothing
- **off** a synonym for **NONE**
- **poll** traces I/O interrupt polling activities
- **protocol** traces protocol activity (see the notes)
- **sched** traces scheduling functions
- **tls** a synonym for the combination **tlsctx** and **tlssok**
- **tlsctx** traces TLS context activities
- **tlsio** traces TLS I/O activities
- **tlssok** traces TLS socket activities

**Defaults**

Tracing is disabled.
Notes

1) All tracing is forcibly enabled when the daemon is invoked with the \texttt{--d} option.
2) All previous trace settings are discarded when \texttt{none} or \texttt{off} is encountered.
3) The \texttt{protocol} trace option is passed along to the all loaded protocols that may or may not respect the option or may have their own options.

Example

\texttt{xrd.trace all \textendash debug}
5  xrootd Directives by Category

5.1  Data Access

\texttt{xrootd.all.export} \hspace{1cm} Specify the file system paths that may be accessed.
\texttt{xrootd.fslib} \hspace{1cm} Specify the file system plug-in to be used for data access.
\texttt{xrootd.redirect} \hspace{1cm} Specify client redirection by type of request, access path, and possible errors during access.

5.2  Data Integrity

\texttt{xrootd.chksum} \hspace{1cm} Enable file checksum calculation.

5.3  Debugging

\texttt{xrootd.diglib} \hspace{1cm} Enable interactive remote debugging.
\texttt{xrootd.trace} \hspace{1cm} Specify execution tracing options.

5.4  Monitoring

\texttt{xrootd.mongstream} \hspace{1cm} Specify custom g-stream parameters.
\texttt{xrootd.monitor} \hspace{1cm} Specify which statistics are to be collected and where they are to be sent.
\texttt{xrootd.pmark} \hspace{1cm} Specify packet marking firefly parameters.

5.5  Prepare Processing

\texttt{xrootd.prep} \hspace{1cm} Specify how prepare requests tracking should be handled.

5.6  Security

\texttt{xrootd.seclib} \hspace{1cm} Specify the location of the security interface layer.
\texttt{xrootd.log} \hspace{1cm} Specify which events are to be logged.
\texttt{xrootd.tls} \hspace{1cm} Specify TLS requirements by request category.

5.7  Tuning

\texttt{xrootd.async} \hspace{1cm} Specify asynchronous data processing features and limits.
\texttt{xrootd.bindif} \hspace{1cm} Specific alternate interfaces that should be used for data.
\texttt{xrootd.fsoverload} \hspace{1cm} Specify how file system overloads are to be handled.
**xrootd.tlsreuse**  
Specify TLS session cache characteristics.
6 Common xrootd Configuration Directives

6.1 export

```
all.export {path | *[]} [[no]lock] [oss_options]
```

**Function**

Specify a valid path prefix for file requests.

**Parameters**

- **path**
  - An absolute path prefix for valid file requests. Only files starting with this prefix are allowed in requests.

- *** allows arbitrary object identifiers (i.e. names that do not start with a slash)
  - The names are not inspected in any way and passed as is to the file system plug-in.

- ***? allows arbitrary object identifiers (i.e. names that do not start with a slash)
  - Inspected the names for CGI information and, if present, separate it from the object identifier (i.e. characters before the question mark) before passing the object name and CGI information to the file system plug-in.

- **lock uses standard xroot protection against multiple writers. This is the default.**

- **nolock**
  - Does not protect against multiple writers.

- **oss_options**
  - Optional oss options that affect how the path is processed by the storage system and cluster service. Refer to the “Open File System & Open Storage System Configuration Reference” and the “Clustering Configuration Reference”.

**Defaults**

- `xrootd.export /tmp lock`
Notes

1) For security purposes, only files in /tmp are allowed to be accessed unless you specify otherwise. You may specify valid paths either on the command line or using the export configuration directive.

2) Do not prefix path with the oss localroot directive path, if any.

3) By default, a file may be opened by a single writer with no readers or multiple readers without any writer. If an external locking mechanism is used or no locking mechanism is needed; specify the nolock option to disable the default.

4) The [no]lock option must appear before any oss options.

5) The underlying file system plug-in as well as the storage system plug-in must support object identifiers in order to use the * or *? export. The default file system plug-in will pass the object identifier to the storage system plug-in for the common set of file operations. However, the default storage system plug-in will not load if object identifiers are being exported.

6) Object identifiers exportation is meant to support object store plug-ins such as the Ceph block storage plug-in.

Example

xrootd.export /store
6.2 seclib

```
xrootd.seclib {default | path}
```

Function

Specify the location of the security interface layer.

Parameters

default

Uses the default security plug-in the security interface.

path

The absolute path to the shared library that contains an implementation of the Security (sec) interface that xrootd is to use for strong authentication (e.g., Kerberos, GSI, etc).

Defaults

Strong authentication is disabled unless seclib is specified.

Notes

1) The sec interface allows you to provide an arbitrary authentication implementation (e.g., Kerberos, GSI, etc).
2) A sec implementation requires that compatible interface libraries be used on the server and client sides of the connection.
3) Refer to XrdSecEntity.hh and XrdSecInterface.hh for guideline on how to write a sec interface.
4) It is up to the sfs implementation to use authentication information to restrict access to files.
5) The provided ofs implementation can use authentication information for access control purposes.
6) The default sfs implementation does not provide any access control.

Example

```
xrootd.seclib /opt/xrootd/lib/libosec.so
```
7 Esoteric xrootd Configuration Directives

7.1 async

```
xrootd.async parms

parms: [force] [limit aiorpc] [maxsegs smax]
  [maxstalls mstall] [maxtot slim]
  [minsize reqsz[k | m | g]] [minsfsz sfsz[k | m | g]]
  [nocache] [nosf] [off] [segsize segsz[k | m | g]]
  [syncw] [timeout tmo]
```

**Function**
Specify how asynchronous I/O is to be handled.

**Parameters**

- **force**
  Uses asynchronous I/O for all requests, even if the client did not ask for asynchronous handling.

- **limit clim**
  The maximum allowed number of outstanding asynchronous requests per client connection. Any additional requests past clim are synchronously handled. The default is eight (8).

- **maxsegs smax**
  The maximum number of simultaneous asynchronous operations that may any one request may have in progress. The default is eight (8).

- **maxstalls mstall**
  The maximum number of times a client may fail to deliver data at a sufficient rate to keep up with asynchronous I/O needs before future requests from the client are synchronously handled. Asynchronous handling is tried again after mstall number of synchronously handled requests. The default is four (4).
maxtot slim
The maximum number of simultaneous asynchronous operations the server may have in progress. The default is 4,096.

minsz reqsz
The minimum number of bytes required in a single client request for it to be eligible for async handling. I/O requests smaller than reqsz are always synchronously handled. The reqsz can be suffixed by k, m, or g to indicate kilo-, mega-, or giga-bytes; respectively. The default is 1.5 of the default segsz.

minsfz sfsz
The minimum number of bytes that must be read in a single client request for that request to be handled using sendfile(). I/O requests smaller than sfsz are always handled in the standard way. The sfsz can be suffixed by k, m, or g to indicate kilo-, mega-, or giga-bytes; respectively. The default is 8k for Linux, 1 otherwise.

cache.
Disables using asynchronous I/O for caching servers (e.g. Xcache).
	nosf
Disables using sendfile(), where available, for all read requests.
	off
Disables asynchronous I/O for all requests. This is the default for the built-in oss plug-in and cannot be changed.

segsz segsz
The segment size to use for quantizing I/O requests (i.e. requests are broken into segsz pieces). The segsz can be suffixed by k, m, or g to indicate kilo-, mega-, or giga-bytes; respectively. The default is 64k.

syncw
Uses synchronous I/O for all fsync requests. Otherwise, asynchronous I/O is used for fsync requests if the client requested asynchronous I/O or if the force has been specified.

timeout tmo
The maximum number of seconds an asynchronous operation may take before the request fails. Specify a value between 1 and 360. The default is 45.
Defaults

```
xrootd.async limit 8 maxsegs 8 maxstalls 4 maxtot 4096
    minsize 98304 minsfsz 8k segsz 64k timeout 45
```

Notes

1) Asynchronous requests allow the client to start a number of read operations at one time and wait for the request to complete in optimal order. When properly employed, asynchronous requests may substantially improve overall client processing speed.

2) Asynchronous processing represents a substantial resource commitment on part of the daemon. Each operation requires the dispatching of a separate thread. Rampant asynchronous processing may exhaust resource limits or allow a single client to more easily monopolize the server.

3) Asynchronous processing is effective when the disk transfer rate approaches the network transfer rate. Thus, asynchronous processing is enabled only when a sufficiently large amount of data is requested by the client at one time. Use the `minsize` parameter to control the point where asynchronous operation is effective.

4) The `segsz` parameter specifies the ideal I/O size for asynchronous operations in order to maintain continuous incoming/outgoing transfer overlap. Requests are broken into `segsz` units.

5) Conversion of asynchronous requests to synchronous requests is transparent to the client.

6) The `sendfile()` interface allows data to be transferred directly from the kernel’s file system memory cache to a client. Generally, this significantly reduces system overhead.

7) Use the `nosf` option in cases where you suspect that the `sendfile()` interface is causing data transfer problems.

8) Asynchronous I/O may cause incorrect cache hit/miss calculations because the I/O size is not the true request size.

9) The `pgread` and `pgwrite` requests use a fixed 64k `segsz` as this is optimal.

10) The default values allow for the best overall performance in most cases. Whenever changing these values you should measure the difference in performance as changes may actually produce worse performance.

Example

```
xrootd.async minsz 1M
```
7.2 bindif

**xrootd.bindif**  \textit{target}

:\textit{target}:  \textit{host[:port]|host[:port]|target}

:\textit{host}:  dnsname | [ipv6addr] | ipv4addr

**Function**

Specify the endpoints for future bound data paths.

**Parameters**

\textit{target}  The name or address of the \textit{host} and optional \textit{port} number where clients are to use when creating an additional data path. When the \textit{port} is omitted the default of first assigned port number is used (see the notes for additional caveats when specifying a port). Any number of targets may be specified. The \textit{target} consists of one or two \textit{host[:port]} specifications with the second separated by a percent sign (%). When a second \textit{host[:port]} is specified, then clients connecting using a private IP address are told to use the second \textit{host[:port]} while clients connecting with a public IP address are told to use to the first \textit{host[:port]}. If only one \textit{host[:port]} is specified, no distinction is made.

**Defaults**

By default, the session endpoint is used to create additional data paths.

**Notes**

1) When there is more than one target, the client round-robins the use of the end-points as additional data paths are created.

2) When specifying a non-default port make sure that the port is added to the list of ports the daemon should enable via the \texttt{xrd.protocol} directive using the +\textit{port} option.

3) When as actual host name is specified as a target, the host name must be registered in DNS unless dynamic DNS is enabled. See the \texttt{xrd.network} directive for more information and, specifically, the discussion on when dynamic DNS should be enabled.

**Example**

\texttt{xrootd.bindif foo.proxy.edu:1094}
7.3 chksum

```
xrootd.chksum [chkcgi] [max num] digest [path [args]]

digest: algorithm [digest]
```

**Function**
Specify how file check sums are computed.

**Parameters**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>chkcgi</td>
<td>Always checks the cgi information, if any, for the cks.type element that can be used to select a checksum algorithm. The cgi information is not checked if only one digest is specified for backward compatibility. It is always checked if more than one digest is specified, making chkcgi unnecessary. See the usage notes for more information.</td>
</tr>
<tr>
<td>num</td>
<td>Maximum number of checksum calculations that may run at the same time. Specifying 0 prevents real-time check summing. See the notes for more information.</td>
</tr>
<tr>
<td>algorithm</td>
<td>The name of the checksum digest (e.g., md5) used for the check summing. Specify one or more supported digests, each separated by a space. The first algorithm becomes the default algorithm. See the usage notes on how multiple digests are supported,</td>
</tr>
<tr>
<td>path</td>
<td>The absolute path of the program that computes the check sum. If path is not specified, checksums are internally performed.</td>
</tr>
<tr>
<td>args</td>
<td>Initial arguments to be passed to the program identified by path, if any.</td>
</tr>
</tbody>
</table>

**Defaults**
The default max is 4; otherwise. If path is not specified, checksums are internally performed. File check summing is not supported unless the directive is specified.
Notes

1) When a client issues an `xrootd` query checksum request, the following steps are performed:
   a. A checksum digest is selected as follows:
      i. If a single algorithm is specified and `chkcgi` was not specified, the digest in the configuration file is used.
      ii. If a single algorithm is specified and `chkgri` is specified, a `cgi` scan is made for `cks.type` and, if specified, its argument must match the single algorithm in the configuration file or an error results. In any case, the digest in the configuration file is used.
      iii. If more than one algorithm has been specified, a `cgi` scan is made for `cks.type` and, if specified, its argument must match one of the specified algorithms in the configuration file or an error results. If there is a match, the `cks.type` argument is used as the desired digest. If `cks.type` is not found, then the first algorithm specified in the configuration file is used.
   b. A check is made that the client has lookup privileges for the file and that a valid checksum has been recorded for the file. If both are true, that checksum is sent back to the client. If the client lacks lookup privileges, an access error is sent back to the client.
   c. Since a checksum needs to be computed the `max` value applies. If it is zero, the client is told that the checksum is not available.
   d. If the checksum is natively supported and no program path has been specified, a new checksum is locally computed and recorded for future queries. Otherwise, the program named in path is executed to compute a new checksum and it is not recorded for future queries. Of course, the program may record the checksum in some way for future queries.
   e. Either the previously recorded checksum or the computed checksum is provided to the client.

2) Native checksums are `adler32`, `crc32`, `crc32c`, and `md5`.

3) `XRootD` uses hardware assist features for `crc32c` should the platform support them (e.g. AMD and Intel).

4) Use the `ofs.ckslib` directive to add new digests or improve the performance of the native digests.

5) Since computation of multiple checksums is CPU and memory intensive choose the `max` with circumspection. You can control memory usage via the `ofs.cksrdsz` directive.

6) The `ofs` directives are documented on the OFS/OSS reference manual.
7) When the program identified by \texttt{path} is invoked, it is passed the path to
the file that is to be processed. The actual argument list varies depending
on whether or not a single algorithm has been specified, as follows:
a. When a single algorithm has been specified, the program is passed the
file path as the last argument and is the only argument if no \texttt{args} have
been specified.
b. When multiple algorithms have been specified, the program is passed
the file path as the last argument and the checksum algorithm name as
the second to the last argument. If no \texttt{args} have been specified, these
are the only two arguments that are passed.

8) The program must output on standard out a single checksum value;
normally ending with a new-line (\texttt{'\n'}) character and terminate with a
status code of zero. If the program terminates with a non-zero status code
or returns no output, the client’s request fails.

9) Upon success, the returned checksum value is passed back to the client,
prefixed by the digest token, \texttt{digest}.

10) \textbf{Warning:} If an external checksum program is specified (i.e. \texttt{path} is
specified), then neither the \texttt{oss.localroot} nor \texttt{oss.namelib} directives are
applied to the logical file name before passing the file name to the
specified program that computes the checksum. Hence, the program is
responsible for converting a logical file name to a physical file name.

11) When checksums are natively computed (i.e., \texttt{path} is not specified), then
the \texttt{oss.localroot} and \texttt{oss.namelib} directives are applied to the logical file
name. The checksum is computed against the resulting physical file name.

12) The \texttt{chkcgi} option is provided for backward compatibility. In previous
releases only one algorithm could be specified and \texttt{cgi} information was
immaterial. This processing mode remains the default when only a single
algorithm is specified. You may wish to verify that a client as not
requesting an unsupported digest in the case where some servers support
multiple checksums and others do not.

13) The administrator’s interface allows you to list and cancel checksum jobs.
This applies to external as well as internal computation of the checksum.

14) When max is zero, checksums on demand are prohibited. This requires
that checksums to be pre-computed. This can be done using the
\texttt{frm_admin chksum} command. See the File Residency Manager reference.

15) Using an external checksum calculation via the \texttt{path} option disables the
server’s ability to return checksums in a directory listing.

\textbf{Example}
\begin{verbatim}
xrootd.chksum max 2 crc32c
\end{verbatim}
7.4 diglib

```
xrootd.diglib * authpath
```

**Function**
Enable remote debugging via the **digFS** read-only file system.

**Parameters**
* Loads the built-in version of **digFS**; the only the version currently supported.

authpath
The path to the authorization file that describes who is allowed to access **digFS** and what kind of information they may view.

**Defaults**
By default, **digFS** is disabled.

**Notes**
1) The **digFS** provides a virtual read-only file system view of key information about **xrootd** and **cmsd** that is valuable to remotely debug system problems.
2) Since **digFS** exposes system information an authorization file describing access permissions is required. See the next section.
3) When **diglib** is specified, the */=/* directory is automatically exported and available to authorized users. You must not list */=/* in the **all.export** list.
4) The */=/* path always refers to local storage regardless of server role and is never subject to redirection.
5) Only **close**, **dirlist**, **locate**, **open**, **read**, and **stat** requests can be vectored to **digFS**. Other requests referring to */=/* are disallowed.
6) The **digFS** accepts configuration directives starting with **dig**. Refer to subsequent sections for a description of these directives.

**Example**
```
xrootd.diglib * /etc/xrootd/digauth.cf
```
7.4.1 Authorizing digFS Access

The file describing digFS access permissions is composed of newline delimited records. Each record describes a single entity that is authorized to access certain information. The format of each record is

```
info allow aprot ident
```

```
info:  all | [-]conf | [-]core | [-]logs | [-]proc | [info]
aprot: gsi | host | krb5 | pwd | sss | unix
ident: g=group | h=host | n=name | o=org | r=role | [ident]
```

Parameters

**info** Authorizes the entity described in the record to access certain information. Use the word **all** to allow access to all information. If you specify **all**, you can remove specific information by specifying subsequent information keywords prefixed by a minus sign. Alternatively, list the **info** keywords to enable access to the associated information described below.

<table>
<thead>
<tr>
<th>Keyword</th>
<th>Information</th>
<th>Keyword</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>conf</td>
<td>configuration file</td>
<td>logs</td>
<td>log files</td>
</tr>
<tr>
<td>core</td>
<td>core files</td>
<td>proc</td>
<td>process information</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(Linux only)</td>
</tr>
</tbody>
</table>

**aprot** Specifies the authentication protocol that must be used in order to use digFS. Only one protocol per entity description may be specified. Since the information provided by digFS is sensitive in nature you should use the strongest authentication protocol consistent with site policies. The following table lists the default protocols\(^1\) from strongest to weakest. Additionally, the rightmost column lists the **ident** tags that can be successfully specified relative to that protocol since not every protocol identifies clients in the same way. See the XRootD security reference for more detailed information.

---

\(^1\) Authentication is plug-in based and any implemented authentication protocol may be specified as aprot.
Protocol | Description | Meaningful ident Codes
---|---|---
krb5 | Kerberos Version 5 | h n
 gsi | Grid Security Infrastructure (i.e. x.509) | g h n o r
 sss | Simple Shared Secret | g h n
 pwd | Password | g h n o r
 host | DNS resolved hostname | h
 unix | NFS V2-Style authentication | g h n

**ident**

Authorizes the aprot authenticated entity possessing the specified identity values access to info **digFS** information. Identity values are specified as key value pairs. The entity must match all the specified pairs in order to be granted access. An imbedded space in a value must be designated as a \s (i.e. two character sequence). Specifying an inappropriate key relative to an authentication protocol prohibits access. The following table describes the possible key value pairs.

<table>
<thead>
<tr>
<th>Key</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>g</td>
<td>Group name</td>
</tr>
<tr>
<td>h</td>
<td>Fully qualified hostname</td>
</tr>
<tr>
<td>n</td>
<td>Authentication-specific protocol client identity string (see notes)</td>
</tr>
<tr>
<td>o</td>
<td>Organization name</td>
</tr>
<tr>
<td>r</td>
<td>Role name</td>
</tr>
</tbody>
</table>

**Notes**

1) Valid entries in the authfile are used and syntactically incorrect entries are discarded. At least one valid entry must exist for **digFS** to be enabled.
2) If the modification time of the authfile changes outside of a 5 second window it is reprocessed. This allows you to modify the authfile on a running system. However, you must atomically update the file as follows:
   a. Create a copy of the file.
   b. Modify the copy as needed.
   c. Rename the copy to be the original name (i.e. use mv).

Distributing a modified copy of the file to other hosts should also use rename to install the new authfile.
3) Each authentication protocol has a specific way of identifying a client. For instance, x.509 (i.e. gsi) uses distinguished name (i.e. dn). Depending on the security configuration the protocol-specific name may be mapped to a Unix name. If so, you must use the mapped name not the original name.

4) If an entity is associated with more than one group name then the specified group (i.e. g=) must match one of the associated group names.

5) Starting in version 4.2 you are able to enable digFS but prevent its use by simply not creating an authorization file or commenting out all authorization entries. This allows you to enable its use in real-time without restarting XRootD by either creating an authorization file or adding authorization lines to an existing file.

6) Prior to 4.2 you must have a valid authorization file with at least one authorization entry. However, that entry may be unsatisfiable. This also allows you to selective enable or disable digFS without an XRootD restart.

Example

```sh
all -core allow krb5 h=test.org n=xtestor
cnf logs allow gsi g=atlas n=theuser
```
7.4.2 Optional digFS Directives
The digFS accepts the following directives in the configuration file.

7.4.2.1 addconf

```
    dig.addconf path [ fname ]
```

**Function**
Add a configuration file reference to the digFS namespace.

**Parameters**

- `path` The absolute path to a regular file that is to be added to “/=/conf/etc”. The name of the file will be the same as the last component of path unless `fname` is specified.

- `fname` The name that is to appear in “/=/conf/etc” but refers to path.

**Defaults**
None.

**Notes**
1) The `path` is only added if it is readable by the xrootd server.
2) This directive allows you to make other server related configuration files available via digFS.

**Example**

```
dig.addconf /etc/sysconfig/xrootd
```
7.4.2.2  log

<table>
<thead>
<tr>
<th>Function</th>
<th>Control the level of logging.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameters</td>
<td>parm The level of logging; specify one or more of:</td>
</tr>
<tr>
<td>parm</td>
<td>deny - log file access denials</td>
</tr>
<tr>
<td></td>
<td>grant - log file access approvals</td>
</tr>
<tr>
<td></td>
<td>none - turn off logging</td>
</tr>
<tr>
<td>Defaults</td>
<td>dig.log deny grant</td>
</tr>
<tr>
<td>Notes</td>
<td>1) To enable logging of denials and approvals you must specify both deny and grant parameters.</td>
</tr>
<tr>
<td>Example</td>
<td>dig.log deny</td>
</tr>
</tbody>
</table>
7.4.3 Using digFS

The digFS file system can be accessed using standard file system applications. All information is rooted in the /=/ directory and follows a standard layout. The following table describes directory tree.

<table>
<thead>
<tr>
<th>Directory</th>
<th>Subdirectory</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>/=/conf</td>
<td></td>
<td>Configuration files <strong>cmsd.cf</strong> and <strong>xrootd.cf</strong></td>
</tr>
<tr>
<td></td>
<td>/etc</td>
<td>Other site selected configuration files.</td>
</tr>
<tr>
<td>/=/core</td>
<td></td>
<td>Core files</td>
</tr>
<tr>
<td></td>
<td>/cmsd</td>
<td>Directory holding <strong>cmsd</strong> core files.</td>
</tr>
<tr>
<td></td>
<td>/xrootd</td>
<td>Directory holding <strong>xrootd</strong> core files.</td>
</tr>
<tr>
<td>/=/logs</td>
<td></td>
<td>Log files</td>
</tr>
<tr>
<td></td>
<td>/cmsd</td>
<td>Directory holding <strong>cmsd</strong> log files.</td>
</tr>
<tr>
<td></td>
<td>/xrootd</td>
<td>Directory holding <strong>xrootd</strong> log files.</td>
</tr>
<tr>
<td>/=/proc</td>
<td></td>
<td>/proc files (Linux only)</td>
</tr>
<tr>
<td></td>
<td>/cmsd</td>
<td>Directory holding the <strong>cmsd</strong> proc files.</td>
</tr>
<tr>
<td></td>
<td>/xrootd</td>
<td>Directory holding the <strong>xrootd</strong> proc files.</td>
</tr>
</tbody>
</table>

If the **cmsd** and the **xrootd** share the same configuration file the /=/conf/cmsd.cf and /=/conf/xrootd.cf will be identical. If they share the core file directory or the log file directory; the same files may appear in the **cmsd** and **xrootd** subdirectories. As other components are added to digFS, additional executable names may appear in each root subdirectory.

To find out your access rights, simply list the entries in the /=/ directory. Only the subdirectories for which you are authorized are displayed.
7.5 fslib

```
xrootd.fslib [++] [throttle | path]
```

**Function**
Specify the location of the file system interface layer.

**Parameters**
++ The specified plug-in should stack on top of the existing plug-in or default. Once specified, it cannot be replaced by a subsequent directive.

throttle
Loads `libXrdThrottle.so` to wrap the subsequent library specification.

path The path to the shared library that contains the file system plug-in.

path2 The path to the shared library that is to be used as the wrapper for the subsequent library specification.

default
Loads a built-in version of the file system implementation.

path1 The path to the shared library that contains an implementation of the Open File System (ofs) interface that `xrootd` is to use for file system specific operations (e.g., open, close, read, write, rename, etc).

**Defaults**
```
xrootd.fslib default
```

**Notes**
1) When you only specify the shared library filename, the library is located using the standard platform-dependent loader rules (e.g. well known places followed by the `LD_LIBRARY_PATH` envvar setting).
2) The sfs interface allows you to provide an arbitrary file system implementation. It is documented in XrdSfsInterface.hh. Refer to this include file for differences between version 1 and 2 instantiation.

3) The deprecated version of this directive should be avoided. The general version is a superset of the deprecated version. In the common case

   ofs.fslib throttle default

   can be simply replaced by

   ofs.fslib ++ throttle

   Should you mix both styles, the deprecated version is handled before the general version of the directive which may be confusing.

Example

   xrootd.fslib /opt/xrootd/lib/libofs.so
7.6 fs_overload

```
xrootd.fs_overload  [[no]bypass]  [redirect  target]
                [stall  sec]

target:  host:port[host:port]

host:  dnsname  |  [ipv6addr]  |  ipv4addr
```

**Function**
Specify how to handle file system overload.

**Parameters**

**[no]bypass**
Specifies whether or not clients should be redirected to the client-specified forwarding destination when the file system indicates it is overloaded. This option is only meaningful for servers configured as forwarding proxies and is ignored if that is not the case. It is only applicable when the client specifies a forwarding destination.

**redirect target**
The name or address of the `host` and `port` number where clients are to be redirected when the file system indicates that it is overloaded. The target consists of one or two `host:port` specifications with the second separated by a percent sign (%). When a second `host:port` is specified, then clients connecting using a private IP address are redirected to the second `host:port` while clients connecting with a public IP address are redirected to the first `host:port`. If only one `host:port` is specified, all clients are redirected to that host.

**stall sec**
Specifies how long the client should be stalled when a redirect target is not available and the file system indicates that it is overloaded. After the stall, clients will re-issue the request. A value of zero passes back an overload error to the client when the file system indicates an overload.

**Defaults**
```
xrootd.fs_overload nobypass stall 33
```
Notes

4) The \texttt{fsoverload} directive is most effective for disk caching proxy servers. Refer to the “Proxy Storage Services Configuration Reference” for additional information on how to effectively use this directive.

5) Currently, the \texttt{fsoverload} directive only applies to file open requests. All other requests encountering a file system overload event fail with an overload error.

6) The \texttt{bypass} directive only applies to release 4.0 or higher clients. Older clients that specify a forwarding path are subject to the \texttt{stall} option should a file system overload event occur.

Example
\begin{verbatim}
xrootd\texttt{.fsoverload bypass redirect foo.proxy.edu:1094}
\end{verbatim}
### 7.7 log

<table>
<thead>
<tr>
<th>xrootd.log</th>
<th>[-]levent [ [-]levent ] [· · ·]</th>
</tr>
</thead>
<tbody>
<tr>
<td>levent:</td>
<td>all</td>
</tr>
</tbody>
</table>

**Function**

Specify event logging options.

**Parameters**

- **levent**: Specifies the events to be logged level. One or more events may be specified. The specifications are cumulative and processed left to right. Each event may be optionally prefixed by a minus sign to turn off the setting. Valid events are:
  - **all**: logs all possible events, the default
  - **disc**: disconnect events
  - **login**: login events

**Defaults**

- **xrootd.log all**

**Notes**

1) Events messages are routed to the xrootd log file.

**Example**

- **xrootd.log all -login**
7.8 mongstream

\[
xrootd.mongstream \text{ events use parms}
\]

- **events**\[
  \{ \text{all} | \text{ccm} | \text{pfc} | \text{tcpmon} | \text{tpc} \} \ [\text{events}]
\]
- **parms**\[
  [\text{flush} \ \text{intvl} [\text{m} | \text{s} | \text{h}]] \ [\text{maxlen} \ \text{size} [\text{k}]]
\]
  \[
  \{\text{send} \ \text{fmt} \ [\text{noident}] \ \text{host:port}\}
  \]
- **fmt**\[
  \{ \text{cgi} | \text{json} \} \ [\text{hdr}] \ | \text{nohdr}
\]
- **hdr**\[
  \text{dflthdr} \ | \text{sitehdr} \ | \text{hosthdr} \ | \text{insthdr} \ | \text{fulhdr}
\]

**Function**

Specify g-stream monitoring parameters and, optionally, enable selected events.

**Parameters**

- **events** The events to which this directive applies. The permissible events are:

<table>
<thead>
<tr>
<th>Event</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>all</td>
<td>Selection applies to all of the events below.</td>
</tr>
<tr>
<td>ccm</td>
<td>cache context management information.</td>
</tr>
<tr>
<td>pfc</td>
<td>proxy file cache information (i.e. proxy disk caching).</td>
</tr>
<tr>
<td>tcpmon</td>
<td>TCP connection statistics at time of socket close.</td>
</tr>
<tr>
<td>tpc</td>
<td>Third party copy for http and xroot protocols.</td>
</tr>
</tbody>
</table>

- **flush intvl**

  The maximum time event data may be internally buffered before it is sent to the monitoring destination. Specify a number optionally suffixed by h for hours, m for minutes, or s for seconds, the default. The default comes from the xrootd.monitor directive.

- **maxlen size**

  the maximum size of the datagram. Specify no less than 1024 and no more than 64k. The size can be suffixed by k to indicate kilo-bytes. The default comes from the xrootd.monitor directive.
send fmt [noident] host:port
    specifies header formatting and the destination for the selected g-stream events. This overrides whatever is specified in the xrootd.monitor directive dest option. The fmt parameter specifies the header format, if any:
    cgi formats the header as a CGI query string
    json formats the header as a JSON object
    nohdr do not include any header for any message. See the notes for caveats.

When an actual format (i.e. not nohdr) is specified, you may specify the kind of header to be used:
    dfthdr uses a minimal header to identify the message and timing.
    sitehdr uses dfthdr but adds the site name, if any.
    hosthdr uses sitehdr but adds the host name.
    insthdr uses hosthdr but adds the port and instance name.
    fullhdr uses insthdr but adds the program name and version.

When the previous specification is followed by noident, the server does not send periodic identification messages. The noident option is the default when nohdr is specified since an identification record requires a header.

The final element is the endpoint specification. Specify the host and port where the selected g-stream messages are to be sent using UDP.

Defaults
    Defaults come from the xrootd.monitor directive. If a header format is specified, the default is dfthdr.

Notes
    1) The mongstream directive is meant to customize specific g-stream events. It also allows enabling these events without enabling common monitoring using the xrootd.monitor directive.
    2) If you do not specify the send parameter, then g-stream monitoring is controlled by the xrootd.monitor dest parameter. Otherwise, the send specification overrides the xrootd.monitor specification.
    3) You may still use common monitoring for g-streams via the xrootd.monitor directive yet select specific flush intervals and message sizes using the mongstream directive by simply not specifying the send parameter.
4) Specifying `nohdr` automatically disables identification messages as well as any map messages. The latter makes dictionary mapping inoperative. If a g-stream plug-in uses dictionary mapping, that mapping is never recorded.

5) Unless the monitoring collectors are able to handle multiple header formats, it is unwise to send different header formats to the same collector. This is not enforced.

6) The `mongstream` directive is cumulative with each subsequent directive replacing previously set values.

Example

```plaintext
xrootd.mongstream all use send json datacoll:1234
```
# 7.9 monitor

```
xrootd.monitor [...] [options] [dest dest [dest dest]]
```

**options:**  
`[all] [auth] [flush [io] intvl[m|s|h]]`

```
[fstat intvl[m|s|h] [lfn] [ops] [ssq] [xfr cnt]]
```

```
[ident {intvl[m|s|h] | off}] [fbuff size[k]]
```

```
[gbuff size[k]] [mbuff size[k]] [rbuff size[k]]
```

```
[rnums cnt] [window intvl[m|s|h]]
```

**dest:**  
`[events] host:port`

**events:**  
`{ccm | files | fstat | io | info | pfc | redir | tcpmon | tpc | user} [events]`

---

**Function**

Specify monitoring parameters and, optionally, enable it.

**Parameters**

... uses previously set values to allow a continuation. If the directive does not start with a triple dot, all previous values are reset to initial defaults.

all Automatically enables monitoring for all connections. If all is not specified, monitoring is only enabled upon client request for that specific client.

auth includes authentication information along with user information, when user is specified and authentication has been configured.

flush [io] intvl  
The maximum time event data may be internally buffered before it is sent to the monitoring destination. Specify a number optionally suffixed by h for hours, m for minutes, or s for seconds, the default. When io is specified, io event data is also subject to flushing. Otherwise, only non-io events are flushed. The default only applies to non-io events and is 10 minutes.
**fstat intvl [lfn] [ops] [ssq] [xfr cnt]**

Enables file activity monitoring using a special “f” stream. The `intvl` is the maximum time event data may be internally buffered before it is sent to the monitoring destination. Specify a number optionally suffixed by h for hours, m for minutes, or s for seconds. A value of zero disables the “f” stream. The `intvl` is also used as the basis for xfr event data. By default, only file open and close events are inserted into the stream. Additional information may be requested as follows:

- lfn includes the user’s dictionary identifier along with the logical file name being opened in the open event record.
- ops includes detailed operation count information along with minimum and maximum values in the close event record.
- ssq includes the sum of squares count for read and write sizes in the close event record. Specifying ssq automatically includes ops. This option impacts server performance. See the notes for more information.
- xfr cnt inserts the number of bytes read and written from each open file every `intvl*cnt` elapsed time. The `cnt` must be 1 or more.

**ident sec**

The number of seconds between each server identity transmissions (i.e., the ‘=’ map record). Specify a number optionally suffixed by h for hours, m for minutes, or s for seconds, the default. A value of zero transmits the identity only once at start-up time. Specifying off prevents identity records from being sent. The default is 1 hour (i.e. 3600 seconds).

**fbuff size**

The maximum size of the datagram for file and I/O events (i.e. the f–stream). Specify no less than 1024 and no more than 64k. The size can be suffixed by k to indicate kilo-bytes. The default size is 64k.

**gbuff size**

The maximum size of the datagram for plug-in generated events (i.e. the g-stream). Specify no less than 1024 and no more than 64k. The size can be suffixed by k to indicate kilo-bytes. The default size is 32k.

**mbuff size**

The maximum size of the datagram for all other events not covered by a specific xbuff parameter. Specify no less than 1024 and no more than 64k. The size can be suffixed by k to indicate kilo-bytes. The default size is 16k.
**rbuff** *size*

the maximum size of the datagram for redirection events (i.e. the r-stream). Specify no less than 2048 and no more than 64k. The *size* can be suffixed by *k* to indicate kilo-bytes. The default size is 32k.

**rnums** *cnt*

the number of redirection monitoring streams to start. Specify no less than 1 and no more than 8. The default size is 3.

**window** *intvl*

The monitoring window size. Data collected within the window is not differentiated by time. Thus, the window represents the undifferentiated sampling interval. Specify a number optionally suffixed by *h* for hours, *m* for minutes, or *s* for seconds, the default. The default is 60 seconds.

**dest** *events* *host:port*

The *events* that are to be sent to the endpoint identified by *host:port*. All monitoring messages are sent as datagrams (i.e., UDP protocol). The *dest* parameter, if specified, must be specified as the last parameter. Up two destinations are allowed. By default, only file event information is sent. The permissible events are:

<table>
<thead>
<tr>
<th>Event</th>
<th>Stream</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>ccm</td>
<td>g</td>
<td>cache context management information.</td>
</tr>
<tr>
<td>files</td>
<td>t</td>
<td>file-related request monitoring (i.e., open and close requests).</td>
</tr>
<tr>
<td>fstat</td>
<td>f</td>
<td>specified “f” stream information (i.e., open and close requests).</td>
</tr>
<tr>
<td>io</td>
<td>t</td>
<td>I/O request monitoring (read and write requests plus files).</td>
</tr>
<tr>
<td>iov</td>
<td>t</td>
<td>same as io above plus details on readv vector elements.</td>
</tr>
<tr>
<td>info</td>
<td>m</td>
<td>client specified monitoring data submitted using xrootd protocol and other miscellaneous information.</td>
</tr>
<tr>
<td>pfc</td>
<td>g</td>
<td>proxy file cache information (i.e. proxy disk caching).</td>
</tr>
<tr>
<td>redir</td>
<td>r</td>
<td>redirection events.</td>
</tr>
<tr>
<td>tcpmon</td>
<td>g</td>
<td>TCP connection statistics at time of socket close.</td>
</tr>
<tr>
<td>tpc</td>
<td>g</td>
<td>Third party copy for http and xroot protocols.</td>
</tr>
<tr>
<td>user</td>
<td>f</td>
<td>client login and disconnect events.</td>
</tr>
</tbody>
</table>
Esoteric xrootd Directives

Configuration

Defaults

```
flush 10m ident 1h fbuff 64k gbuff 32k mbuff 16k xbuff 32k \n  rnums 3 window 60
```

Notes

1) Use the `monitor` directive to enable statistical gathering and reporting of events, file information, and I/O requests.

2) The `monitor` directive not only sets general parameters but is also used to enable monitoring streams whose events are sent with a common XRootD binary header. The header facilitates the use of a central collection, reformatting, and redistribution service.

3) Specifying the `dest` parameter enables the selected events to be sent to the specified endpoint. If `dest` is not specified, common header event monitoring is not enabled. You may, however, selectively enable alternative g-stream event monitoring using the `mongstream` directive even when other event monitoring is disabled.

4) The `fstat ssq` option impacts performance since floating point operations must be carried out for each read and write request in order to accurately compute the sum of squares. The counts can be used to compute the standard deviation for read and write sizes. Do not specify this option unless there is a clear need for such information.

5) The `fstat ssq` counts are available on platforms that use IEEE 754 floating point format. The `fstat ssq` option is ignored on non-conforming platforms.

6) The `io` option reports individual seeks for each read and write request. While this data may be used to determine access patterns or used in I/O trace simulation studies, it reduces server performance by about 7% and generates a large amount of monitoring data. Normally, `fstat` provides sufficient information about client I/O efficiency at a much lower cost.

7) The `flush` parameter does not apply to monitor streams that include `io` event data unless `io` is specified. By default, monitor streams that include `io` event data are flushed only when the internal monitor buffer becomes full or when the user owning the stream being monitored disconnects.

8) You may specify two monitoring destinations. This allows you to isolate data high volume streams (i.e., `io` monitoring) and provide real-time display for low-volume streams (i.e., `info`, `files`, `fstat`, and `user`). Also refer to the `mongstream` directive that provides for additional routing options.
9) The **all** option forces monitor data to be collected for all connections. If **all** is not specified, each client must enable monitoring manually using the **xrootd set** request code (see the **xrootd** protocol specification). This allows selective monitoring and gives each client the opportunity to tag **io** monitor data with the relevant application name.

10) The **iov** option inserts a read entry for every element in a **readv** vector. This may explode the amount of monitoring information that is generated. By default, when only **io** is specified, a summary **readv** entry is placed in the monitoring stream.

11) Clients cannot enable monitoring that has not been enabled by the **monitor** directive.

12) Specifying a small datagram buffer size (e.g. less than 8k) increases the number of datagrams that need to be sent and, consequently, adds to server overhead. Large datagram buffer sizes reduce the number of datagrams as well as server overhead but increase memory utilization as each connection allocates a buffer.

13) Approximately 61 requests can fit into a 1K **mbuff**.

14) On average, 64 to 128 redirection events can fit into a 32K **rbuff**.

15) Increasing the number of redirection monitoring streams (**rnums**) reduces the bottlenecks in the monitoring path.

16) Specifying a small window increases the timing accuracy of any individual request entry at the expense of additional datagrams and significantly increased server overhead. Conversely, large window sizes reduce timing accuracy but also reduce server overhead.

17) The g-stream events: **ccm**, **pfc**, **tcpmon** and **tpc** are for events generated by specific plug-ins. The plug-ins are loaded by various directives. Specifying a g-stream whose associated plug-in has not been loaded is ignored. The g-stream events are:

<table>
<thead>
<tr>
<th>Event</th>
<th>Plug-in Directive</th>
<th>Type of information reported</th>
</tr>
</thead>
<tbody>
<tr>
<td>ccm</td>
<td>pss.ccmlib</td>
<td>Cache context management events.</td>
</tr>
<tr>
<td>pfc</td>
<td>pss.cachelib</td>
<td>Data caching events.</td>
</tr>
<tr>
<td>tcpmon</td>
<td>xrd.tcpmonlib</td>
<td>TCP connection statistics at disconnect.</td>
</tr>
<tr>
<td>tpc</td>
<td>http.exthandler ofs.tpc</td>
<td>Third party copy statistics.</td>
</tr>
</tbody>
</table>
18) Refer to the “XRootD Monitoring” reference for a detailed explanation on the datagram format used by the monitoring subsystem. It is especially important to understand the difference between files, fstat, and io monitoring as the information overlaps and there is rarely a need to specify all three.

Example

```
xrootd.monitor all fstat 5m dest fstat datacoll:5050
```
7.10 pmark

```
xrootd.pmark parms

parms: [[no]debug] [defsfile [[no]fail] dparms]

domain {any | local | remote}

[ffdest ffdest] [ffecho intvl[m|s|h]]

[map2act exp {default | {role|user} name} act]

[map2exp {default | {path path | vo vo}} exp]

[[no]trace] [use {[[no]firefly] [[no]scitag]}]

dparms: fpath | {curl | wget} [tmo[m|s|h]] url

ffdest: host[:hport]
```

**Function**

Specify packet marking parameters and, optionally, enable it. **Caution:** this directive is experimental and subject to change.

**Parameters**

* [no]debug
  
  controls detailed debugging messages and should normally not be specified. The **nodebug** option disables detailed log messages and is the default.

* defsfile [[no]fail] dparms
  
  specifies the location of the json definition file. This file maps experiment names to experiment IDs and activity names within each experiment to their respective activity IDs. It is required when either the **map2act** or **map2exp** parameters are specified. The **nofail** option ignores processing errors of the **defsfile** to prevent 3rd party suppliers from preventing a server from starting and is the default. When a processing error occurs, mapping is disabled which may also disable packet marking. The **nofail** option does not cover blatant configuration errors. The **defsfile** may be local or may exist at a remote location, as described below.
defsfie [[no]fail] fpath
the defsfie is local and fpath specifies it’s file system location as an
absolute path (i.e. starts with a slash).

defsfie [[no]fail] {curl | wget} [tmo[m|s|h]] url
the defsfie is remote and url specifies it’s remote location. The file is
downloaded using curl or wget (specify the program you wish to use). Since the remote server may be inaccessible when the file needs
to be accessed, specify for tmo the maximum amount of time in
which the download must complete. The tmo value may be
optionally suffixed by h for hours, m for minutes, or s for seconds,
the default. If unspecified, a 30 second limit applies.

domain {any | local | remote}
specifies which type of connections the pmark directives applies to, as
follows:
any include local and remote connections.
local include local connections only, remote connections are ignored.
remote include remote connections only, local connections are ignored; this
is the default.

ffdest host:hport
specifies an additional destinations for firefly UDP packets. Packets are sent
to host:hport in addition to the connecting client at port 10514. If a hport is not
specified, a value of 10514 is used.

ffecho intvl
specifies how often firefly UDP packets are to sent as long as the connection
is open. Specify for intvl a number optionally suffixed by h for hours, m for
minutes, or s for seconds, the default. Any value less than 30s is interpreted
as zero. The default is 0 and a firefly UDP packet, if enabled, is sent only at
the start of a connection and when the connection ends. Be aware that this
parameter is not yet implemented.
map2act \( exp \{\text{default} \mid \{\text{role} | \text{user}\}\} \) name\( act \)
specifies how activities are to be determined for an experiment. There may be as many such parameters as needed. For each parameter specify the name of the experiment for \( exp \) and the name of the activity for \( act \). The names must be defined in the \texttt{defsfile}. The two major variations are described below:

map2act \( exp \text{ default} \) \( act \)
defines the default activity for experiment \( exp \) when the actual activity cannot be determined. When the activity cannot be determined and no default exists, the activity is reported as undetermined.

map2act \( exp \{\text{role} \mid \text{user}\} \) name\( act \)
specifies that the experiment’s, \( exp \), activity is based on either the client’s role or the actual username. Specify for \( name \) either to role name or the user’s name, as appropriate. See the notes for a description of how this mapping actually occurs.

map2exp \{\text{default} \mid \{\text{path} path \mid \text{vo} vo\}\} \) \( exp \}
specifies how experiments are to be determined. There may be as many such parameters as needed. For each parameter specify the name of the experiment for \( exp \). The names must be defined in the \texttt{defsfile}. The two major variations are described below:

map2exp \text{ default} \) \( exp \)
defines the default experiment when the actual experiment cannot be determined. When the experiment cannot be determined and no default exists, the connection is not reported.

map2exp \{\text{path} path \mid \text{vo} vo\} \) \( exp \)
specifies that the experiment is based on either the path of the client’s first successful file open or the client’s virtual organization. For \texttt{path}, specify the logical path prefix, \( path \), that maps to the experiment, \( exp \). For \texttt{vo}, specify the virtual organization name, \( vo \). See the notes for a description of how this mapping actually occurs.

[no]trace
Controls execution tracing information and should normally not be specified. The \texttt{notrace} option disables execution tracing and is the default.
use [[[no]firefly]] [[[no]scitag]]

specifies additional processing options, as follows:

[no]firefly

Specifying nofirefly disables sending firefly UDP packets and essentially disables packet marking. Specifying firefly enables it and automatically sends packets to the connecting client at port 10514. An additional destination may be specified using the ffdest option. When neither is specified, firefly becomes the default if ffdest is specified and nofirefly otherwise.

[no]scitag

Specifying noscitag disables checking the cgi string for the token scitag.flow that normally identifies the experiment and activity. Specifying or defaulting to scitag enables cgi checking. If the token is found and the information is valid, it is used in the firefly UDP packet; thus avoiding any other mapping rules.

Defaults

nodebug nofail domain remote ffecho 0 notrace use scitag

Notes

1) The pmark directive is primarily meant for controlling firefly UDP packets to monitor data flows at the internet network level.
2) The pmark directives are cumulative with duplicate parameters replacing previously specified values.
3) When a client connects and issues the first successful open request and the experiment can be determined, a firefly UDP pack is sent to indicate the start of a data flow. No additional packets are sent and all subsequent traffic is assigned to the initial flow marker. When the client disconnects a firefly UDP packet is sent to indicate the end of the flow.
4) If the experiment cannot be determined on the first successful open, no firefly UDP packets are sent and the flow is not recorded.
5) The following features have not yet been implemented:
   a. Automatic defsfile refresh. The server needs to be restarted to pick up any defsfile changes.
   b. A defsfile fallback to using the previously downloaded version if the current download fails.
   c. Periodic retransmission of the firefly UDP packet. When the ffecho parameter, when specified, must be valid but otherwise ignored.
   d. Integration with gstream monitoring.
6) The following steps are taken to identify the experiment and activity:
   a. If scitag usage is allowed and a valid scitag is found, it is used to identify the experiment and activity.
   b. If path mapping is enabled, the logical file name in the open request is matched against the specified path prefixes in decreasing length order. When a match is found its target is used to identify the experiment.
   c. If vo mappings are enabled, the first vo present in the client’s vo list is matched against the specified vo mappings. When a match is found, its target is used to identify the experiment.
   d. If a default experiment has been defined, it is used. Otherwise, firefly flow identification for the connection is disabled.
   e. When user name activity mapping exist for the identified experiment, the client’s name is matched against the specified user mappings. When a match is found, its target is used to identify the experimental activity.
   f. If role mappings exist for the identified experiment, the first role present in the client’s role list is matched against the specified role mappings. When a match is found, its target is used to identify the experimental activity.
   g. If a default activity is defined for the identified experiment, it is used. Otherwise, that activity is reported as undetermined.

Example

xrootd.pmark defe$ip $cur https://api.scitags.org/api.json
xrootd.pmark $ffdest firefly.esnet.net:1234
xrootd.pmark map2exp path /data/atlas atlas
xrootd.pmark map2exp path /data/cms cms
xrootd.pmark map2exp default atlas
xrootd.pmark map2act atlas role prod production
xrootd.pmark map2act cms user fts rebalancing
xrootd.pmark map2act cms default dc
7.11 prep

```bash
xrootd.prep parms

parms: [ keep ksec ] [ scrub time ] [ logdir ldir ]
```

**Function**
Specify how prepare request tracking is done.

**Parameters**

- **keep ksec**
The time that prepare request tracking record are to be held. The time may be suffixed by s (the default), m, or h to indicate seconds, minutes, and hours, respectively. The default is 24 hours.

- **scrub time**
The time between scrubs of the tracking log directory. The time may be suffixed by s (the default), m, or h to indicate seconds, minutes, and hours, respectively. The default is 1 hour.

- **logdir ldir**
The absolute path of the directory that is to hold the preparation tracking records. A directory must be specified, otherwise preparation request tracking is disabled.

**Defaults**
None. Preparation request tracking is normally disabled. When a logdir directory is specified, the keep and scrub defaults of 24H and 1H apply, respectively.

**Notes**
7) This directive allows server to track prepare requests. When request tracking is enabled, each prepare is logged in the logdir directory. It then becomes possible to list the requests and cancel them, if need be.
8) Since there can be more than one redirecting xrootd server, prepare requests may be scattered across several servers. It is the client’s responsibility to collect information from each server in order to create a composite preparation request history.

9) Each server uniquely names the files in the logdir directory. When multiple xrootd redirecting servers exist, it is possible to collect full preparation history from any server, if the logdir directory is located in a shared file system (e.g., NFS).

10) When running multiple xrootd servers on the same machine, the instance name (-n command line option) is used to differentiate logdir directories among all instances by appending the instance name to the path.

Example

xrootd.prep keep 12H logdir /nfs/xrootd/preplog
7.12 redirect

```
 xrootd.redirect target {client domlist | byfunc}

 domlist:   {local | private | .domain} [domlist]

 byfunc:   {[-]foper | [?] path [path [...]]}

 foper:    {all | chmod | chksum | dirlist | locate | mkdir

             | mv | prepare | prepstage | rm | rmdir | stat

             | trunc} {[-]foper]

 target:   host:port[&host:port]

 host:      dnsname | [ipv6addr] | ipv4addr
```

**Function**

Specify request forwarding.

**Parameters**

*target* The name or address of the *host* and *port* number where clients are to be redirected based on the subsequent parameters. The target consists of one or two *host:port* specifications with the second separated by a percent sign (%). When a second *host:port* is specified, then clients connecting using a private IP address are redirected to the second *host:port* while clients connecting with a public IP address are redirected to the first *host:port*. If only one *host:port* is specified, all clients are redirected to that host.

*domlist*

Specifies which clients, by domain, should be redirected. The redirection occurs after login but before any significant client activity. Only one *client* redirection may be defined. Specify one or more of the following:

*local* clients whose IP address is in the server’s DNS domain.

*private* clients using a private IP address.

*domain* clients whose IP address is in the DNS *domain* (e.g. “.oscer.ou.edu” note the leading period).
foper  Specifies which metadata operations are to be immediately redirected. One or more operations may be specified. The specifications are cumulative and processed left to right. Each operation may be optionally prefixed by a minus sign to turn off the setting. Valid operations are:

- all: redirect all possible operations
- chmod: redirect change mode requests
- cksum: redirect checksum requests
- dirlist: redirect directory content listing requests
- locate: redirect path location requests
- mkdir: redirect create directory requests
- mv: redirect rename requests
- prepare: redirect prepare requests that do not need file staging
- prepstage: redirect prepare requests that may need file staging
- rm: redirect file removal requests
- rmdir: redirect directory removal requests
- stat: redirect file attribute requests
- trunc: redirect file truncate requests using a path

path  Specifies that when a file open request occurs on the specified path prefix, the client should be redirected to the specified host and port. One or more paths may be specified. However, no more than four different host-port combinations may be specified.

?path  Specifies that any client operation on the specified path prefix that ends with a “not found” error (i.e., EONOENT) and has not been specifically covered by another redirect directive, the client should be redirected to the specified host and port. All subsequently specified paths, if any, on the line fall under the “not found” provision.

Defaults

xrootd.redirect -all

Notes

1) Request redirection is typically applicable to the cluster manager. Refer to the role directive in the “Clustering Configuration Reference” for additional information, especially on inter-related directives.

2) Client IP address based redirection is primarily meant to protect proxy servers from clients within a domain who mistakenly use the proxy server when they could have directly connected to services fronted by the proxy server.
3) Normally, meta-data requests are performed on the local host. However, certain clustered environments may be controlled by a central manager that records the exact state of every file. In such environments, the central manager may perform meta-data requests. When the `redirect` directive is not specified, the client is directed to perform the operation on a single host, normally the one that has the file. When the request is redirected, the target host is responsible for performing the operation.

4) The redirect path prefixes are always matched from most- to least-specific prefix (i.e., longest to shortest).

Example

```
xrootd.redirect all -prepare
```
7.13 tls

\[\text{xrootd.tls [capable] req} \]

\[\begin{align*}
\text{req: } & [-]\text{all} | [-]\text{data} | [-]\text{login} | \text{none} | \text{off} | \\
& [-]\text{session} | [-]\text{tpc} | \text{req} \\
\end{align*}\]

Function
Specify transport layer security (TLS) requirement.

Parameters
capable
 appliest requirements only to TLS capable clients. The default is to apply TLS requirements to all clients irrespective of their ability to use TLS.

req specifies the general requests for which TLS must be used. Clients who attempt these requests without using a TLS connection are rejected with a "TLS Required" error message. Valid req are:

\begin{itemize}
\item \text{all} requires TLS for all requests
\item \text{data} requires that all file data or metadata be transmitted using TLS
\item \text{login} requires TLS for login requests and all subsequent requests
\item \text{none} turns off all requirements (off is a synonym)
\item \text{session} requires TLS for all requests after the login and authentication
\item \text{tpc} requires TLS for third party copy requests
\end{itemize}

Defaults
\text{xrd.tls none}

Notes
1) The \text{capable} parameter is meant to provide a migration path for pre-Release 5 clients (i.e. those that do not support TLS). Requiring TLS for all clients essentially disallows older clients from using \text{XRootD}.
2) The \text{tls} directive is cumulative and allows different settings for TLS-capable clients and those that do not support TLS. See the examples on how to accomplish this.
3) Specifying a minus sign in front of any indicated requirement removes that requirement from the current set of requirements.
4) The **session** requirement is a subset of the **login** requirement. If both are specified, **login** prevails.

5) The **data** requirement applies to the session connection as well as any additional connections bound to the session. If **data** is specified without specifying **login** or **session**, **session** is automatically added to the requirements.

6) At least one requirement must be specified, even if it’s **none** or **off**.

7) When **none** or **off** is encountered, all applicable requirements are discarded.

8) The requirements only apply to the **XRootD** protocol. They do not apply to any other protocols running in parallel with **XRootD**.

9) The **tls** directive fails if **TLS** has not been configured using the **xrd.tls** directive.

**Example**

```
xrootd.tls tpc
```

The above requires that any third party copy request use a **TLS** connection. This also prohibits older client (i.e. those incapable of **TLS**) from requesting a third party copy. Adding the following directive

```
xrootd.tls capable session
```

also requires that **TLS** capable clients must use a **TLS** connection after the login and authentication phases. Note that while **session** also covers third party copy requests, the preceding directive requires that all **TPC** requests use **TLS**. Hence, non-capable clients can do anything they are allowed to do but cannot request a third-party copy.
7.14 trace

```
xrootd.trace [-]option [ [-]option ] [• • •]
```

**Function**
Specify execution tracing options.

**Parameters**

`option` The tracing level. One or more options may be specified. The specifications are cumulative and processed left to right. Each option, other than `off`, may be optionally prefixed by a minus sign to turn off the setting. Valid options are:

- `all` selects all possible trace levels*
- `auth` traces the result of client authentication
- `debug` traces internal activities for debugging purposes*
- `emsg` traces errors sent back to the client
- `fs` traces file system requests other than I/O requests
- `fsaio` traces file system asynchronous I/O requests*
- `fsio` traces file system synchronous I/O requests*
- `login` traces login and authentication steps
- `mem` traces memory management functions*
- `off` traces nothing
- `pgcserr` traces checksum errors encountered by `pgwrite`
- `redirect` traces client redirections to other servers
- `request` traces client request information
- `response` traces request response information
- `stall` traces client deferrals due to resource limitations

*These selections severely reduce server performance

**Defaults**

```
xrootd.trace off
```
Notes

1) **Warning**: enabling tracing may reduce server performance by 50%!
2) All tracing is enabled when the daemon is invoked with the `-d` option.
3) All previous trace settings are discarded when `off` is encountered.

Example

`xrootd.trace all -debug`
8 Enabling HTTP Access

**XRootD** supports **HTTP** access via a protocol plug-in. The **HTTP** protocol can run alongside of standard **XRootD** protocol without any interference; providing an additional access mode. To Enable **HTTP** access, add the following configuration parameter to the configuration file.

```
if exec xrootd
  xrd.protocol http[:port] path/libXrdHttp.so [cfgfile]
fi
```

**Parameters**

- **port**  The port number http is to use for incoming requests. Specify a number, the name of a **TCP** service, or the word **any**. If you do not specify port number, port 1094 is used. This is also the default port for **XRootD** protocol.

- **path**  The path to the shared library **libXrdHttp.so** that contains the code the implements the **HTTP** protocol.

- **cfgfile**  is the path to an external configuration file specific to **HTTP**. If not specified, the configuration file at daemon start-up is used.

**Defaults**

Not applicable.

**Notes**

1) You should surround the **xrd.protocol** directive with the shown **if-fi** if you are using a common configuration file for **xrootd** and **cmsd** daemons. Failure to do so will prevent the **cmsd** from starting.

2) All **HTTP** requests are bound by any “**xrd.**” and “**xrootd.**” Directives that exist in the start-up configuration file. Hence, **HTTP** access cannot exceed any restriction imposed by those directives.

3) Monitoring of **HTTP** requests is handled as if they are **XRootD** requests. Consequently, the monitoring stream includes all **HTTP** requests as well. However, monitoring information is tagged with the fact that the information was generated by the **HTTP** protocol.
4) While the default port number is the same as for XRootD; the framework directs each request to appropriate protocol and these requests are never intermixed. To avoid any confusion you may wish to use a more standard HTTP port number such as 8080. This is especially true if connection are made using HTTPS.

5) Additional configuration file directives specific to HTTP are always prefixed with “http.” and the following sections describe these directives.

6) HTTP support also includes WebDav support enabling a wider range of access abilities beyond simple get and post capabilities.

7) When HTTP is used in a clustered XRootD deployment, all servers in that deployment must have HTTP enabled. Failure to do so typically results in access failure when a client is redirected to a server that holds the desired file but for which HTTP was not enabled.

8) Not all HTTP clients support all HTTP features. While the plug-in does not violate the HTTP or WebDav standards, it does implement a wide range of allowable features (e.g. redirection on POST requests) that may not be supported by the HTTP client being used.
8.1 Enabling HTTPS

When a server is configured to use HTTPS, each server processes the client’s credentials from the connection. This allows the client to be authenticated and makes authorization possible. On the other hand, HTTPS is very resource demanding because it encrypts and decrypts all of the TCP traffic. Additionally, the process of establishing an encrypted connection requires several network interchanges that increase connection latency which can be substantial on a wide area network.

While HTTP is much faster it is impossible to authenticate the client using HTTP. However, the HTTP plug-in allows a client to initially connect with HTTPS, extract the authentication information, encode that information in a low-overhead encrypted security token and redirect the connection to use HTTP. This is known as HTTPS to HTTP conversion and is much less resource intensive. When a server is configured to do HTTPS to HTTP conversion, it always expects a security token to be present when a client connects via HTTP. If the token is missing or cannot be decrypted the connection is rejected. This mechanism provides a relatively secure authentication but at the expense of privacy as no traffic is encrypted past the authentication stage.

HTTPS to HTTP conversion is especially attractive in clustered environments where a client typically makes contact with a particular node (i.e. redirector) that then redirects the client to a particular server that holds the requested file. Using HTTPS everywhere incurs identical overhead at each contact point. This can be eliminated by using HTTPS at the initial contact point and converting HTTPS to HTTP for subsequent connections. This incurs the overhead just once.

When enabling HTTPS you should consider the following points:

- If only HTTPS is configured, then the server only accepts HTTPS connections (see the xrd.tls and xrd.tlsca directives).
- If HTTPS to HTTP conversion is configured a server accepts an HTTPS connection or an HTTP connection that provides a valid security token (see the secretkey directive)
- If self-conversion of HTTPS to HTTP is configured, the server unconditionally redirects any HTTPS incoming connections to itself; using HTTP and a security token (see the selfhttps2http directive). This allows greater performance for subsequent requests.
When using **HTTP** in an XRootD cluster, additional considerations apply on how the cluster redirector interacts with data servers in that cluster. The following table provides reasonable possibilities, depending on the degree of security that is desired.

<table>
<thead>
<tr>
<th>Redirector Accepts</th>
<th>Server Accepts</th>
<th>Configuration</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>HTTP</td>
<td>HTTP</td>
<td>The is the default</td>
<td>No security.</td>
</tr>
<tr>
<td>HTTPS</td>
<td>HTTP with security token</td>
<td>Specify <code>xrd.tls</code>, <code>xrd.tlsca</code> and <code>http.secretkey</code> directives.</td>
<td>Central authentication, fast unencrypted data access but higher CPU load in the redirector</td>
</tr>
<tr>
<td>HTTP</td>
<td>HTTPS</td>
<td>Specify <code>xrd.tls</code> and <code>xrd.tlsca</code> directives only in data servers. Specify <code>http.desthttps</code> in redirectors.</td>
<td>Fast redirection, distributed authentication, slow encrypted data access</td>
</tr>
<tr>
<td>HTTP</td>
<td>HTTPS with self redirection using HTTP with security token</td>
<td>Specify <code>xrd.tls</code>, <code>xrd.tlsca</code>, <code>http.selfhttps2http</code> and <code>http.secretkey</code> directives only in data servers. Specify <code>http.desthttps</code> in redirectors.</td>
<td>Fast redirection, distributed authentication, fast unencrypted data access</td>
</tr>
<tr>
<td>HTTPS</td>
<td>HTTPS</td>
<td>Specify <code>xrd.tls</code> and <code>xrd.tlsca</code> directives in servers and redirectors.</td>
<td>Fully authenticated but authentication occurs twice, slow encrypted data access, resource consumption can be high</td>
</tr>
</tbody>
</table>
8.1.1 Backward Compatibility and Overrides

Exceptions are handled by the `http.htpsmode` directive. See this directive on how to control backward compatibility warning messages.

8.2 Directives to Enhance HTTPS Access

By default, HTTPS access is not enabled. You must specify certain critical xrd information in order for HTTPS to be enabled (i.e. `xrd.tls` and `xrd.tlsca`).

The xrd framework provides TLS services to all protocols and HTTPS relies on these services. The `xrd.tls` and `xrd.tlsca` directives should be used to configure TLS for HTTPS. Previous releases relied on http specific directives to do this (i.e. `http.cadir`, `http.cafile`, `http.cert` and `http.key`). These are still accepted and still allow HTTPS to be configured. However, when specified a warning message is issued to remind you to use the xrd framework directives instead. It is best to configure TLS for all protocols using a common set of directives to avoid inconsistency. Therefore, the http-specific TLS directives have been deprecated.

However, there are other directives that are specifically oriented to improving the handling of HTTPS. These are described in the following sections.
8.2.1 desthttps

```
http.desthttps { no | yes }
```

Function
Specify whether or not HTTPS is to be used for redirections.

Parameters
no A redirector will always redirect a client using http. The word false and the number 0 are synonyms.

yes A redirector will always redirect a client using https. The word true and the number 1 are synonyms.

Defaults
http.desthttps no

Notes
1) While this directive applies normally applies to redirectors it is used by any node, redirector or data server that redirects a client.

Example
```
http.desthttps yes
```
8.2.2  gridmap

```
http.gridmap [ required ] [ compatNameGeneration ] path
```

**Function**
Specify the file containing the "grid map file" that the server must use.

**Parameters**

- **required**
  when specified treats any gridmap errors as fatal errors.

- **compatNameGeneration**
  when no mapping exists the entity name format adheres to the format used by GSI authentication (i.e. unqualified DN hash).

- **path**
  The path to the file.

**Defaults**
None.

**Notes**
1) This file is loaded at startup and used to translate the requestor’s x509 DN into a short user name for internal authorization usage.
2) Unlike other directives, the optional option must be specified in the order pictured above.
3) This directive requires that HTTPS be enabled with certificate verification.

**Example**
```
http.gridmap /etc/grid-security/mapfile
```
8.2.3 httpsmode

```
http.httpsmode { auto | disable | manual }
```

**Function**
Specify how to handle enabling HTTPS protocol.

**Parameters**
- **auto**: automatically enables the use of HTTPS if the underlying xrd framework was configured to allow TLS (i.e. the xrd.tls and xrd.tlsca directives). This is the default.

- **disable**: disables the use of HTTPS regardless of any other directives.

- **manual**: enables the use of HTTPS but requires that the appropriate http directives are used to specify required HTTPS parameters (i.e. http.cadir, http.cafile, http.cert and http.key).

**Defaults**
```
http.httpsmode auto
```

**Notes**
1) When auto is in effect, you may still override xrd directives that are used for HTTPS. However, each override produces a warning message. To suppress the warnings specify manual and provide all the required http directives to configure HTTPS.

**Example**
```
http.httpsmode manual
```
8.2.4 secretkey

```
http.secretkey {path | token}
```

**Function**
Specify the key to be used to encrypt and decrypt redirection tokens.

**Parameters**

`path` The absolute path to the file containing a random string of alpha-numeric characters and symbols that are to be used to encrypt and decrypt redirection tokens.

`token` A random string of alpha-numeric characters and symbols that are to be used to encrypt and decrypt redirection tokens. The token may not start with a slash. **Warning!** Specifying the key in the configuration file exposes the key to theft whenever the configuration file is displayed!

**Defaults**
None.

**Notes**
1) The same key must be used by all nodes within a cluster.
2) Specifying a secret key automatically enables HTTPS to HTTP conversion.

**Example**
```
http.secretkey /admin/thekey
```
Function
Specify whether or not a server may redirect an HTTPS connection to itself using HTTP plus a security token.

Parameters
no A server should continue to use HTTPS for all communications. The word false and the number 0 are synonyms.

yes A server should convert an HTTPS session to an HTTP session by redirecting the client to itself using HTTP plus a security token. The word true and the number 1 are synonyms. You must also specify the secretkey directive.

Defaults
http.selfhttps2http no

Notes
1) This option is meant to control the level of data privacy that is desired. Normally, HTTPS connections are converted to HTTP connections after authentication information is extracted from the HTTP stream. This greatly reduces overhead as no data past the authentication stage has to be encrypted.

2) When an HTTPS connection is converted to an HTTP connection, the redirection includes a security token encrypted with the key specified by with the secretkey directive. The HTTP connection is only accepted if the token can be decrypted using the same key.

Example
http.selfhttps2http yes
8.2.6 secxtractor

```
http.secxtractor path [parms]
```

**Function**
Specify the location of the specialized authentication information extractor plug-in.

**Parameters**

- **path**: The path to the shared library containing the plug-in.

- **parms**: The parameters to the shared library containing the plug-in.

**Defaults**
None.

**Notes**

1) A Security eXtractor plug-in is a component that can be loaded at initialization time in order to provide specialized processing to the certificate passed by the client. Normally, all authentication information comes from the standard part of the client certificate and any extensions are ignored. A Security eXtractor can be used to extract other information from the certificate or any of its extensions. This information is then passed along and may be used for other authorization functions within XRootD.

2) The typical case for which a security extractor library is needed is to extract the extended VO information from a Grid client’s certificate.

3) A general purpose VO Security eXtractor plug-in is available with the gsi package that can be used with HTTPS. See the explanation of the VOMS plug-in in the security reference.

4) The secxtractor plug-in requires that HTTPS be enabled with certificate verification (i.e. xrd.tlsca or http.cadir or http.cafile be specified).

**Example**

```
http.secxtractor /usr/lib64/libXrdSecgsiVOMS.so
```
8.2.7 tlsreuse

```
http.tlsreuse off | on
```

**Function**
Specify transport layer security (TLS) session reuse characteristics.

**Parameters**

- **off**
  - disables the TLS session cache and may substantially increase latency for reconnecting clients. This is the default.

- **on**
  - enables the TLS session cache.

**Defaults**

```
http.tlsreuse off
```

**Notes**

1) The https protocol cannot successfully use the TLS session cache when it needs to handle TLS peer certificates. This is why the default is off.
2) The cache is flushed every 255 connection which is not ideal but the mechanism OpenSSL uses.
8.2.8 Deprecated HTTPS Directives

8.2.8.1 cadir

\texttt{http.cadir path}

\textbf{Function}
Specify the directory containing the CA certificates (see the \texttt{cafile} directive as an alternative).

\textbf{Parameters}

\textit{path} \hspace{1cm} The path to the directory.

\textbf{Defaults}
None.

\textbf{Notes}

1) Replace this directive with \texttt{xrd.tlsca} to configure all protocols to use the same certificate directory.
2) All of the certificates in the directory must be in a format that is recognized by the version of OpenSSL is being used.
3) If the certificate information is contained in a single file, you should either use the \texttt{xrd.tlsca certfile} (preferable) or the \texttt{http.cafile} directive.

\textbf{Example}

\texttt{http.cadir /etc/grid-security/certificates}
8.2.8.2  cafile

```
http.cafile path
```

**Function**
Specify the file containing the CA certificates.

**Parameters**

- **path**  The path to the file.

**Defaults**
None.

**Notes**

1) Replace this directive with `xrd.tlsca certfile` to configure all protocols to use the same certificate file.
2) All of the certificates in the file must in a format that is recognized by the version of OpenSSL is being used.
3) If certificates are contained in multiple files you should use the `xrd.tlsca certdir (preferable)` or the `http.cadir` directive.

**Example**
```
http.cafile /etc/myCA.pem
```
8.2.8.3  cert

```
  http.cert path
```

**Function**
Specify the file containing the x.509 certificate that the server must use.

**Parameters**

- `path`  The path to the file.

**Defaults**
None.

**Notes**
1) Replace this directive with `xrd.tls` to configure all protocols to use the same certificate.
2) The certificate must be in PEM format.
3) See the related `http.key` directive to specify the location of the private key.

**Example**
```
  http.cert /etc/grid-security/hostcert.pem
```
8.2.8.4 cipherfilter

| http.cipherfilter | ciphers |

**Function**

Specify the allowed ciphers for transport layer security (TLS).

**Parameters**

ciphers

A list of colon separated ciphers that are allowed to be used.

**Defaults**

For OpenSSL versions greater than 1.0.2 the ciphers recommended by mozilla.org version 5.4 guidelines are used. These are strict ciphers. For older OpenSSL versions, generic ciphers are used for compatibility reasons.

**Notes**

1) Replace this directive with xrd.tlsCipher to configure all protocols to use the same ciphers.

2) The http.cipherfilter directive is provided in cases where a default cipher has been shown to be insecure and should be removed. In this case, you need to specify all of the ciphers less the one you wish to eliminate.

**Example**

```
http.cipherfilter ALL:!LOW:!EXP:!MD5:!MD2
```
8.2.8.5  **key**

```
http.key  path
```

**Function**
Specify the file containing the x.509 private key that the server must use.

**Parameters**

- `path`  The path to the file.

**Defaults**
None.

**Notes**

1) Replace this directive with `xrd.tls` to configure all protocols to use the same certificate key.
2) The key must be in **PEM** format.
3) See the related `http.cert` directive to specify the location of the server’s certificate.
4) Specifying a key without specifying a certificate location is inconsistent and causes the key specification to be ignored along with a warning message.

**Example**
```
http.key /etc/grid-security/hostkey.pem
```
8.3 Common Directives

8.3.1 embeddedstatic

```
http.embeddedstatic {no | yes}
```

Function
Specify where CSS template and logo is to come from for formatted listings.

Parameters
- **no** The CSS template and logo information must be over-ridden by another file containing such information. The word `false` and the number `0` are synonyms.
- **yes** An internal memory-based CSS template and logo should be used. The word `true` and the number `1` are synonyms.

Defaults
```
http.embeddedstatic yes
```

Notes
1) Using the default memory-based CSS template and logo provide much better performance and makes the setup much simpler.
2) If you need to use a custom style sheet, significant performance gains can be achieved by preloading the style sheet file using the `staticpreload` directive.

Example
```
http.embeddedstatic yes
```
8.3.2 exthandler

```
http.exthandler name path [token]
```

**Function**
Specify the location of the external handler plug-in.

**Parameters**
- **name**  
  A 1- to-16 character unique name identifying the handler.

- **path**  
  The absolute path to the shared library that contains an implementation of the handler.

- **token**  
  An optional parameter to be passed to the plug-in object creation function. Typically, this is the name of a configuration file.

**Defaults**
None.

**Notes**
1) Each exthandler is invoked for every HTTP request to allow special handling for certain requests.
2) No more than 4 handlers may be loaded.

**Example**
```
http.exthandler mhandler17 /opt/http/lib/libExtHndlr.so
```
8.3.3 header2cgi

```
http.header2cgi  hdrkey  cgikey
```

**Function**
Specify which headers are to be promoted tocgiinformation and appended to the incoming url.

**Parameters**
- **hdrkey** the header key that is to be promoted to cgi information.
- **cgikey** the cgi key name that the promoted header should have.

**Defaults**
None.

**Notes**
1) Normally, header information is internally processed and not made available to other plug-ins. The header2cgi directive allows you to pass on header information to external plug-ins via the incoming url by promoting the header payload to a cgi element.
2) Assuming xyzzy is the payload of header with a key of auth, the example shown below would promote the header by appending “authz=xyzzy” to the incoming url as cgi information before it is passed to other system components. This essentially makes the header visible outside of the http plug-in.
3) The header2cgi directive is meant to be used for non-http plug-ins that wish to consider specific information sent via the http protocol.

**Example**
```
http.header2cgi auth authz
```
8.3.4 listingdeny

| http.listingdeny {no | yes} |

**Function**
Specify whether or not directory listings are allowed.

**Parameters**
- **no** Directory listings are not allowed. The word `false` and the number `0` are synonyms.
- **yes** Directory listings are allowed. The word `true` and the number `1` are synonyms.

**Defaults**
http.listingdeny no

**Notes**
1) In a clustered environment a listing of a directory via HTTP only lists the directory of some arbitrary server in the cluster. Since files are scattered across all of the servers in the cluster; this likely produces an incomplete listing. You may wish to deny directory listings to avoid confusion.
2) Alternatively, you can redirect directory listings to a special node that can produce a composite listing using all nodes in the cluster via the listingredir directive.
3) Note that the XRootD based `xrdfs` command automatically produces a composite listing.

**Example**
http.listingdeny yes
8.3.5 listingredir

```
http.listingredir desturl
```

**Function**
Specify the node to which to redirect clients requesting a directory listing.

**Parameters**

*desturl* The redirection URL to use when a directory listing is requested.

**Defaults**
None.

**Notes**
None.

**Example**
```
http.listingredir http://hostwhichprovideslistings:80/
```
8.3.6 staticpreload

Function
Preload a static resource file into memory.

Parameters
url The URL naming a static resource (e.g. style sheet or icon).

path The path to the local file containing the resource.

Defaults
None.

Notes
1) Static resources named in a URL must start with “/static” in order to be recognized.
2) The contents of the static resource contained in path may not exceed 64K. If it does, it is truncated to 64K.
3) Typical static resources are URL resources ending with “.css” and “.ico”.
4) This directive is ineffective if the staticredir directive is specified.

Example
http.staticpreload http://static/mcss.css /etc/mycss
8.3.7  staticredir

http.staticredir newurl

Function
Preload a static resource file into memory.

Parameters
newurl The URL the client is to be redirected to when requesting a non-local or unsupported static resource.

Defaults
None.

Notes
1) The staticredir directive is only effective when a) embeddedstatic processing is disabled, or b) the resource is neither a content style sheet nor an icon.

Example
http.staticredir http://althost/
8.3.8 trace

```
http.trace [-]option [ [-]option ] [· · ·]
```

option: all | debug | none | off | request | response

**Function**
Specify execution tracing options.

**Parameters**

`option` The tracing level. One or more options may be specified. The specifications are cumulative and processed left to right. Each option may be optionally prefixed by a minus sign to turn off the setting. Valid options are:

- **all**: selects all possible trace levels
- **debug**: traces internal activities for debugging purposes
- **none**: traces nothing
- **off**: a synonym for **none**
- **request**: traces client request information
- **response**: traces request response information

**Defaults**
Tracing is disabled.

**Notes**

1) All tracing is enabled when the daemon is invoked with the `-d` option.
2) All previous trace settings are discarded when **none** or **off** is encountered.
3) Tracing seriously degrades server performance. Use this directive only for debugging purposes.

**Example**

```
http.trace all -debug
```
9 Document Change History

14 March 2005
- Remove documentation on local redirection mode.
- Remove documentation of `-s` command line option.
- Add `-t` option to the `StartXRD` documentation.
- Significantly change the `port` directive, adding "port any" and "if".
- Discuss using "port any" mode.

26 April 2005
- Further clarified the `xrootd monitor flush` parameter.

1 June 2005
- Added description of conditional directives (if-fi).
- Added description of the `-n` command line option.
- Fully explain which run-time files are created.
- Deprecate `–r, –t, and –y` command line options.
- Deprecate the `XRDMODE` variable and remove the description of the `XRDTYPE` variable in the `StartXRD.cf` script.
- Remove extraneous options from the `StartXRD` script.

1 Aug 2005
- Document administrative interface portal socket.
- Add file size to open monitor record.

16 Aug 2005
- Add authentication mapping (a-record) to monitoring data.

6 Jan 2006
- Document the `-b` and `-R` command line options.
- Document how to independently bind different port numbers to available protocols.

25 Jan 2006
- Add max option to `chksum` directive.

22 March 2006
- Add `exec` condition to `if/else/fi`.
28 February 2007
- Cleaned up documentation relative to role directive and all prefix modifier.
- Documented the xrootd.redirect directive.
- Removed the xrd.connections directive.
- Placed most xrd directives in esoteric status.

28 March 2007
- Move conditional directives to a separate manual.
- Indicate the adminpath now is configured via the all prefix.
- Documented the xrd wan network and protocol directive option.
- Indicate that the xrootd export directive is configured via the all prefix and accepts oss options.

01 October 2007
- Document the locate option of the redirect directive.

01 January 2008
- Remove references to olbd.

01 February 2008
- General clean-up.

11 April 2008
- Document staging (‘s’) monitor record.

29 May 2008
- Document the xrootd async nosf option.

21 July 2008
- Document the xrd network [no]dnr option.
- Document the xrd async minsfsz option.

6 March 2009
- Document the xrootd monitor stage option.

22 June 2009
- Document the xrd.report directive.
7 July 2009
• Document the **mpxstats** command for monitoring.
• Document the summary variables.

17 March 2010
• Document the **timeout hail** and **kill** options.
• Document the pid file creation and the **pidpath** directive.

8 March 2011
• Document the **–s** command line option.
• Minor editorial changes.

24 May 2011
• Document the **auth** option in the **xrootd.monitor** directive.

31 May 2011
• Change the **xrootd.chksum** directive to support native checksums.
  Additional wording added explaining native checksums.

29 June 2011
• Document the **rbuff** and **redir** options on the **xrootd.monitor** directive to support redirection monitoring.

27 September 2011
• Document the **io flush** option on the **xrootd.monitor** directive.

---------- Release 3.1.0

10 October 2011
• Document the **iov, migr, and purge** options on the **xrootd.monitor** directive.

2 November 2011
• Update documentation on the **xrootd.redirect** directive. It now accepts additional file operations (**chksum** and **trunc**), **open** targets (previously undocumented feature), and **ENOENT** targets.
3 December 2011
- Remove the migr, purge and stage options from the xrootd.monitor directive. These have been moved to the frm.all.monitor directive.
- Document the new ident option on the xrootd.monitor directive.

12 December 2011
- Document the rnums option for the xrootd.monitor directive.

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Release 3.2.0
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Release 3.2.1
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Release 3.2.2
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Release 3.2.3
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Release 3.2.4

21 September 2012
- Document the fstat option for the xrootd.monitor directive.
- Remove the rootd configuration section.

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Release 3.2.5
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22 October 2012
- Document the –S command line option and the all.sitename directive for specifying a monitoring site name.

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Release 3.2.6
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Release 3.2.7

15 December 2012
- Change the fstat sdv option to fstat ssq in the xrootd.monitor directive.

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Release 3.3.0
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Release 3.3.1
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Release 3.3.2
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Release 3.3.3
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Release 3.3.4
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Release 3.3.5
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Release 3.3.6
11 February 2013
- Enhance the \texttt{fslib} directive to allow one to easily wrap one library with another.

23 February 2013 (IPV6 Introduction)
- Document the \texttt{–I} command line option.
- Document the \texttt{cache} option in the \texttt{xrd.network} directive.

12 August 2013
- Document the extended \texttt{–k}, \texttt{–l} and \texttt{–z} command line options.
- Document exported environment variables.
- Document the environment information file contents.
- General clean-up and better explanations.

2 December 2013
- Document the \texttt{xrootd.diglib} directive.

8 January 2014
- Document the \texttt{routes} option on the \texttt{xrd.network} directive.
- Document enhanced \texttt{xrootd.redirect} directive that can distinguish between public and private IP addresses.

18 February 2014
- Restrict the \texttt{routes} option on the \texttt{xrd.network} directive to prohibit auto-discovery of interface addresses as this may lead to choosing the wrong addresses.

27 March 2014
- Document how to enable \texttt{HTTP} and \texttt{HTTPS} protocols.
- Redesign the \texttt{routes} option on the \texttt{xrd.network} directive to cover the most common case.

6 August 2014
- Document the core option in the \texttt{xrd.sched} directive.
- Document how to export object identifier names via the \texttt{all.export} directive.
8 September 2014
- Document that TCP keepalive is now the default setting.
- Add a nokeepalive option and a kaparms option to the xrd.network directive.
- Indicate the use option in xrd.network accepts one or two interface names.
- Minor corrections to HTTP section.

27 September 2014
- Document multiple checksum support via the xrootd.chksum directive.
- Document the default option on the xrootd.seclib directive.
- Document the –L command line option.

26 November 2014
- Document the version option in the xrootd.fslib directive.

10 February 2015
- Document how to pass command line arguments to plug-ins.
- Document how to enable digFS but prevent its use until needed.

25 November 2015
- Explain the side-effects of the –s command line option on the placement of the environmental file.

15 April 2016
- Document log file plug-ins.

20 June 2016
- Document the cse parameter for logging plug-ins.
- Document the xrd.network [no]pipa option.

10 March 2017
- Correct http.mapfile directive (it’s really gridmap).

20 May 2017
- Document the xrootd.fsoverload directive.
27 October 2017
- Document the http.header2cgi directive.

19 December 2018
- Document the xrd.tls and the xrootd.tls directives.

31 May 2019
- Document the xrd.tlsca directive.

21 June 2019
- Document the dyndns option in the xrd.network directive.
- Remove all references to the wan option. It is no longer supported.
- Documented the xrd tls network, port, and protocol directive option.
- Correct spelling of xrootd.async segsize option (was segsz).

18 October 2019
- Document the preferred version of the xrootd.fslib directive.

21 December 2019
- Document the interaction between the dyndns and cache option of the xrd.network directive.

31 March 2020
- Document the xrd.tlsciphers directive.

11 April 2020
- General cleanup with better descriptions.
- Document the ccm, pfc, and tcpmon options of the xrootd.monitor directive.
- Document the xrd.tcpmonlib directive.
- Document the http.cipherfilter and http.exthandler directives.

14 April 2020
- Document the -a and -A command line options.
- Document the xrd.homepath and xrd.tcpmonlib directives.
24 April 2020
- Document the `xrd.trace` directive’s `tls`, `tlsectx`, `tlsio`, and `tlssok` options.
- Document the `xrd.tlsca refresh` option.
- Document the `detail` and `cache` options of the `xrd.tls` directive.
- Document the `http.httpsmode` directive.

28 April 2020
- Remove the `xrd.tls` directive’s `cache` option.
- Document the `xrd.tlsca` directive’s `crlcheck` and `[no]proxies` options.
- Document changes in the `http.httpsmode` directive where `enable` has changed to `manual`.
- Re-factor the `http` protocol section and describe the deprecated directives.
- Document how the TLS session cache has, by default, turned off.
- Document the `xrootd.tlsreuse` directive.

5 May 2020
- Add directives by category for `xrd` and `xrootd` section.
- Cleanup `HTTP` section.

23 July 2020
- Remove documentation of the `xrootd.tlsreuse` directive.
- Add documentation for the `http.tlsreuse` directive.

20 August 2020
- Document the `xrootd.monitor` directive triple dot, `fbuff` and `gbuff` parameters.
- Document that the `xrootd.monitor` directive `dest` parameter is now optional.
- Add documentation for the `xrootd.mongstream` directive.

29 December 2020
- Document the `+port` option of the `xrd.protocol` directive.

6 January 2021
- Add admonition that using an external checksum agent via the `xrootd.chksum` directive disables returning checksums in a directory listing.
16 March 2021
- Document the `pgcerrs`, `pgread`, and `pgwrite` options of the `xrootd.trace` directive.

13 June 2021
- Document the `auth`, `fsaio` and `fsio` options of the `xrootd.trace` directive.
- Remove the `pgread`, and `pgwrite` options of the `xrootd.trace` directive.
- Correct `minsz` (should be `minsize`) option of the `xrootd.trace` directive.

30 July 2021
- Document that `crc32c`, is a natively supported checksum.

2 August 2021
- Document the `xrootd.bindif` directive.

22 November 2021
- Document the `xrootd.pmark` directive.
- Document the `xrootd.redirect` directive's `client` option.

9 December 2021
- Document the `nocache` option of the `xrootd.async` directive.

10 March 2022
- Document the `required` and `compatNameGeneration` option of the `http.gridmap` directive.

20 March 2022
- Document the `tpc` monitoring option on the `xrootd.mongstream` and `xrootd.monitor` directives.

22 May 2023
- Document the `xrd.maxfd` directive.

15 August 2023
- Correct defaults for the `xrootd.pmark` directive. Enabling `firefly` packets always sends packets to the connecting client using port 10514.