Printer Management Interface Working Group

Printer Management Model

Version 0.1

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Introduction

The management of producing a printed document, in any computer environment, is a complex subject. Basically, the task can be divided into two overlapping pieces, the management of printing and of the printer. Management of printing is the taking of the user input and requirements to produce a printed document. This involves tasks such as location of an appropriate printing device, retrieving the input from the user, scheduling the print job, routing the job to the correct printer, determining when the job is complete and notification and deliver back to the user.

A printer is the physical device that takes media from the input, produces marks on that media according to some page description or page control language. Printers are complex devices that consume supplies, produce waste and have mechanical problems. In the management of the physical printing device the description, status and alert information concerning the printer and its various components has to be made available to the management agent so that it can be reported to the end user, key operators for the replenishment of supplies or the repair or maintenance of the device. The information needed in the management of the physical printer and the management of a printing job highly overlap and many of the tasks in each management area require the same or similar information .

Information about printers is classified into three basic categories, descriptions, status and alerts. Descriptions convey information about the configuration and capabilities of the printer and its various components. This information is largely static information an does not generally change dynamically during the operation of the system but may change as the printer is repaired, re configured or upgraded.

Status is the information regarding the current operating state of the printer and its various components. The management agent need to determine if the various components are ready to printer, broken or have some alert condition that prevents printing or will prevent printing in the future.

Alerts in printers are changes in status of various components that affect the printers ability to print. Alerts usually occur asynchronous to the operation of the computer system the printer is attached to. When alerts happen there occurrence needs to be conveyed to some management agent with in the system. Alerts can be classified into two basic categories, critical and non-critical. A critical alert is one that stops the printer from printing immediately and printing can not continue until the critical alert condition is eliminated. Paper out, toner empty and output bin full are examples of critical alerts. Non-critical alerts are those items that do not stop printing but may at some future time. Examples of non-critical alerts are input media low, toner low and output bin nearly full.

Description, status and alert information about printer can be thought of as a data base describing the printer. The management entity for a printer will want to view the printer data base information differently depending on how and for what purposes the information is needed. The printer data base can be viewed in basically two different ways. The first view is that of a collection of components where inquires are made as to the configuration, capabilities and status of each of the individual components that make up the total printing device. This is basically an informational view of the printer. The second way to view the printer data base is the problem management view of the printer, what things are keeping or will keep the printer from operation. This second view is for the determination and problem resolution task in the management of a printer.

In order to accomplishment the management of printer and printing, a model of the printing device is needed to visualize how to inquire and relate information and status to various components that make up the printer as a whole. A printer can be described as consisting of 13 types of components. It is important to note that the components of a printer do not necessarily relate directly to any physically identifiable mechanism. Components can also be a set of definable logical processes, such as page description languages or commands to set various operating modes of the printer.

Figure 1 shows a block diagram of the printer an it's basic 13 components.

Figure 1

Printer Component Block Diagram

```
   +------+                  +-----------+                +--------+     +---------+
   |      |                  |           |                |        |     |         |
+-------+ |               +------------+ |              +--------+ |  +----------+ |
| Input |-+  +--------+   |   Marker   |-+  +--------+  | Output |-+  | Finisher |-+
|       |===>|        |==>|            |===>|        |=>|        |<==>|          |
+-------+    +--+  +--+   +------------+    +--+  +--+  +--------+    +----------+
                |  |                           |  |
                |  |         +-----------+     |  |
                |  |         |           |     |  |
                |  |      +------------+ |     |  |
                |  +--+   | Media Path |-+  +--+  |
                |     |<=>|  Devices   |<==>|     |
                |  +--+   +------------+    +--+  |
                |  |                           |  |
                |  +---------------------------+  |
                |          Media Path             |
                +---------------------------------+

                +---------------------------------+
                |         System Controller       |
                |                                 |
                +---------------------------------+

                    +---------+       +-----------+
                    |         |       |           |
                +-----------+ |   +-------------+ |
                | Interface |-+   | Interpreter |-+
                |           |     |             |
                +-----------+     +-------------+

                +-----------+     +-------------+
                | Operator  |     |   Printer   |
                |  Console  |     |   Control   |
                +-----------+     +-------------+

                    +---------+       +-----------+
                    |         |       |           |
                +-----------+ |   +-------------+ |
                | Critical  |-+   | Non Critical-+
                |  Alerts   |     |   Alerts    |
                +-----------+     +-------------+
```

Printer Components

Inputs

Inputs are mechanisms that feed media to be marked on into the printer. A printer contains one or more input components. Associated with each component is the media that is to be marked on. There is a large set of possible media that can be associated with an input. This printer model provides information that is currently associated with a given input. The management of all possible media sources for a given input to a printer is a "Printing System" problem and is not included in the model.

Outputs

Outputs are mechanisms that received media that has been marked on. A printer contains one or more output mechanisms. An output component can logically have one or more finishing components associated with it. The exact interaction and sequencing between an output device and its associated finisher is very complex and depends on the type of finishing process and the exact implementation of the printer system. This standard allows for the logical association of a finishing process with an output device but does not put any restrictions on the exact sequence or interaction with the associated output device. The output and finisher devices may or may not be separate identifiable physical mechanisms depending on the exact implementation of a printer. In addition, a single output device may be associated with multiple finishing components and a single finishing component may be associated with multiple output devices.

Finishers

A finisher is a device that performs some operation on the media other than marking. Some examples of finishing processes are stapling, punching binding, inserting or folding. Finishing processes may have supplies associated with the process. Stapling, binding and punching are examples of processes that have supplies. A printer may have more than one finishing device and each finishing device may be associated with one or more output devices.

Markers

A marker is the mechanisms that produces marks on the print media and its associated supplies. A printer contains one or more marking mechanisms. An example of multiple marking devices is a printer that has the capability to produce spot colors in addition to the main marking device. In addition, each marking device can have its own set of characteristics associated with it such marking technology and resolution.

In this model the marker component is viewed as very generalized and encompasses all aspects of a marking process. For example, in a xerographic process, the marking process as well as the fusing process would be included in the generalized concept of the marker. With the generalized concept of a marking process, the concept of multiple marking supplies associated with a single marking component results. For example, in the xerographic process, there is not only a supply of toner, but there can also be other supplies such as a fuser supply that can be consumed and replaced separately. In addition there can be multiple supplies of toner for a single marker device, as in a color process.

Media Path

The media path is the mechanism in the printer that moves the media through the printer and connects all other media related components, inputs, outputs, duplexer, markers and finishers. In general the design of the media path determines maximum speed of the printer as well as the maximum medial size that the printer can handle. Media paths are complex mechanisms and can contain many different identifiable mechanisms such as media movement devices and interlocks. The model makes the assumption that there is only one media path that connects all components.

Media Path Devices

Media Path Devices are components that are in the media path where operations are performed on the media. A printer may have more than one media path device. A duplexer is an example of a media path device. The duplexer component of a printer is a mechanism that turns the media over so that marks can be made on both sides. A printer may or may not contain a duplexer component. The exact operation of a printer is dependent on the exact implantation. Duplexers can take different approaches, some turn each piece of media over and print the front and then the back sequentially. The number of pieces of media in the duplexer path before the other side is marked can also vary. Another approach to duplexing is to stack the media in an internal tray. First all pages are printed on the front and stacked, then the pages are feed from the internal tray and marked on the back side.

System Controller

This component is the entity that is responsible for the overall control and coordination of the printing system. Generally, this component is implemented as a computer or processor based system. The controller can range from simple single processor systems to multiprocessor systems. In addition, controllers can have a full range of resources such as hard disks. The printer is modeled to have one system controller even though it may have more than one processor and multiple other resources associated with it.

Interpreters

The interpreter component is the entity that is responsible for the generation or computation of the image that is to be marked on the media. The interpreter is generally implemented with software running on the System Controller component. While interpreters are generally implemented within the System Controller, each interpreter can be thought of logically, as a separate manageable resource. A printer may have one or more interpreters.

Interfaces

The interface is the communications device or devices that are responsible for receiving print and control data and commands from an attached computer system. A printer has one or more interface components. The various interfaces may be operating singularly or simultaneously depending on the implantation and operation of the printer. While interfaces are generally implemented within the System Controller, each interface can be thought of logically, as an identifiable manageable resource.

Operator Console

The operator console device is the local user interface to the printer. The control console can be as simple as a few indicators and switches or as complicated as full screen displays and keyboards. There is one control console for the overall operation of the printer.

Printer Control

This device is a single logical entity that is responsible for the overall control and status of the printer. The printer control component is usually implemented within the system controller. The printer control component provide overall status and information concerning the printer as a whole.

Critical Alerts

This is a logical table that lists all the critical alerts currently active in the printer. A critical alert is one that stops the printer from printing immediately and printing can not continue until the critical alert condition is eliminated. The table contains information on the severity, component, detail location within the component, alert code and description of each critical alert that is currently active within the printer.

Non Critical Alerts

This is a logical table that lists all the non critical alerts currently active in the printer. Non-critical alerts are those items that do not stop printing but may at some future time. The table contains information on the severity, component, detail location within the component, alert code and description of each non critical alert that is currently active within the printer.

Status and Alerts

Each component that is contained in the printer has an associated status object. Each component status is a bit encoded octet that summarized the overall status of the that particular component. The format of the status octet is as follows;

Bit	Meaning
0	**Non Critical Alert Active** A value of 1 indicates that there are one or more entries in the Printer Non Critical Alert Table for this device.
1	**Critical Alert Active** A Value of 1 indicates that there are one or more entries in the Printer Critical Alerts Table for this device.
2	**On Request** A value of 1 indicates that the device is not currently available to service requests, but could be made available (brought to the ready state) with some human interaction.
3	**Unavailable** A value of 1 indicates that the device is unavailable for use (this is the same as "broken" in some terminology's). The printer may still be able to print if this device is not required in that process.
4	**Busy / Temporarily Unavailable** A value of 1 indicates that the device is operational but currently occupied with a request for activity. The device will become available without the need of human interaction
5	not used
6	not used
7	not used

If the value of the status octet is 1 or less, the component is available for use and there are no conditions, immediately, that will keep the printer from printing because this component.

When bit 0, Non Critical Alert Active, is set, the management agent must parse the Non Critical Alert table for entries that are associated with this particular device.

When bit 1, Critical Alert Active, is set, the management agent must parse the Critical Alert table for entries that are associated with this particular device.

Overall Printer Status

The overall status of the printer can be determined by reading the status object in the printer control group. This object has the same format as the component status object with the following meanings. A management agent reads the value of this object to determine the overall status of the printer.

Alert Tables

Bit	Meaning
0	**Non Critical Alert Active** A value of 1 indicates that there are one or more entries in the Printer Non Critical Alert Table. This is the logical or of all of the Non Critical Alert Active bits from all Component status octets.
1	**Critical Alert Active** A Value of 1 indicates that there are one or more entries in the Printer Critical Alerts Table. This the logical or of all of the Critical Alert Active bits from all Component Status octets.
2	**On Request** A value of 1 indicates that the Printer is not currently available to service requests, but could be made available (brought to the ready state) with some human interaction.
3	**Unavailable** A value of 1 indicates that the device is unavailable for use (this is the same as "broken" in some terminology's)
4	**Busy / Temporarily Unavailable** A value of 1 indicates that the device is operational but currently occupied with a request for activity. The device will become available without the need of human interaction.
5	Line Status Bit 0
6	Line Status Bit 1 Bit 5 and 6 form a 2 bit binary value with the values having the following meaning

Bit 6	Bit 5	Meaning
0	0	On Line
0	1	Pending On Line
1	0	Pending Off Line
1	1	Off Line

Bit	Meaning
7	not used

Alert Tables

The printer maintains two tables that reflect all alert conditions with in the printer, the Critical Alert Table and the Non-Critical Alert Table. Every time an alert occurs in the printer, the printer makes one or more entries into the appropriate table. Every time a table changes the printer sends a trap or event notification to the host indicating that the table has changed. The alert tables are sparsely populated tables. This means the tables will only contain entries of the alerts that are currently active and the number of rows, or entries in the table will be dynamic.

The management agent is expected to read and parse the table to determine what conditions have changed in either or both of the tables. The printer determines if a trap or event notification is to be sent for each of the tables by the state of the prtControlCriticalAlertTrapEnable and prtControlNonCriticalAlertTrapEnable objects. If the objects have a value of zero, no trap or event notification is sent, the notification is sent when the corresponding object has a value of one. The printer determines if an event is to be classified as critical or Non Critical. More than one event can be added or removed from the event tables at a time depending on the implementation of the printer.

Alerts can be classified into two basic types, critical and non critical. Critical alerts are events that immediately stop the printer from completing the current print job. Non critical alerts are events that will affect the printer some time in the future but do not immediately affect the printers ability to compete the current print job. Whether a particular event is a critical or non critical alert is dependent on how a particular printer or printer operating mode deals with the event. An event that causes a critical alert in one printer may only be a non critical alert in another printer. An example of this would be that of an input tray running out of media. In a single input printer, running out of media would cause an critical alert event because it would stop printing immediately, In a printer with two input components, could switch from one input tray to another and continue to print, in this case the media out condition in one input tray would only be a non critical condition.

Events can also be assigned a class that relates to the type of information or the training required to handle a particular event. The printer will break events into three different classes. It is the responsibility of the management agent in the system to determine how a particular event is handled and how and who that event is routed. The following are the three classes of events that the printer will use to classify alerts.

Technical Events that typically require advanced training and technical knowledge of the printer and its components. An example of a technical person would be a manufacture's Field Service representative, or other person formally trained by the manufacturer or similar representative.

Operator Events that require an intermediate or moderate level of knowledge of the printer and its components. Typical examples of events that an operator can handle are filling of empty media trays, emptying full output trays and replacing toner cartridges.

Management Events that have to do with overall operation of and configuration of the printer. Examples of management events are configuration change of components.

The classification of the class of an event is done by the manufacturer of the printer. Any further event classification or event class changing is the responsibility of the management layer on the system the printer is in.

When an entry is made into an event table the following information is entered.

1. Index
2. Severity Level
3. Information Class
4. Component
5. Component ID
6. Component Location
7. Code
8. Description

The following is the detail description for each of the entries in the events tables.

Index

The index value is used to determine which alerts have been added or removed from the alert table. This is an incrementing integer starting from zero. When the printer adds an alert to the table, that alert is assigned the next higher integer value from the last item entered into the table. The management agent is expected to keep a local copy of the alert table. The agent will read the alert table when a trap or event notification occurs or at a periodic rate and then parse the table to determine if any new entries were added by comparing the last know index value with the current highest index value. The agent will then update its copy of the alert table. When the printer removes an alert from the table a trap or event notification will be sent to indicate the removal. The entry row will be removed from the table and the number of rows in the table will be reduced. The printer may add or delete any number of rows from the table at any time. The index value is initialized to zero each time the printer is powered on. The value is incremented each time an event is entered into the table. If the index value reaches its maximum value, the next item entered will cause the index value to roll over and start at zero again. The first event placed in the alert table after power up initialization of the printer will have an index value of 1.

Severity Level

This an enumeration value of the level of severity of the alert entry. The printer determines the severity level assigned to each entry into the table.

Information Class

The class is an enumeration that is determined and assigned by the printer manufacturer. The entry will be either Technical, Operator or Management. The definitions of the severity levels are aligned with the ISO / DPA definitions.

Component

The component is an enumeration that defines what component type, in the printer model, that the alert is relating to. Input, output, and markers are examples of printer model components.

Component Identification

The Identification is the integer designation, assigned by the printer, of the specific component type that the alert is related to. Combined with the component enumeration this defines exactly which printer component that the alert is related to. Input 3, Output 2 and Marker 1 are examples.

Component Location

The component location is an integer value that is defined by the printer to further refine the location of the alert within the designated component. The location is used in conjunction with the component enumeration and identification fields. An example is that there is an alert in Input # 2 at location number 7.

Code

The code is an enumerated value that describes the type of alert for this entry in the table. There are different codes for each component type. Jam, Media Low, Toner Out and Output Full are examples of different codes for various component types.

Description

The description is a string that provides a description of the Alert. The description is provided by the printer to further elaborate on the enumerated alert or provide a information in the case where the code is classified as "other" or "unknown". The printer is required to return a description string but the string may be a null string.

The following is a list of proposed Component Alert Codes.

PMI Enumerations - Alert Codes

Security Level Alert Code

1	Other
2	Unknown
3	Critical
4	Severly Critical
5	Mild
6	Severly Mild

Alert Class Code

1	Other
2	Unknown
3	Management
4	Technical
5	Operator

Alert Component Code

1	Other
2	Unknown
3	Input
4	Output
5	Finisher
6	Media Path
7	Media Path Device
8	Marker
9	System Controller
10	Interface
11	Interpreter
12	Operator Console

Input Alert Code

1	Other
2	Unknown
3	Cover Open
4	Cover Closed
5	Interlock Open
6	Interlock Closed
7	Configuration Change
8	Jam
9	Media Tray Missing
10	Media Size Change
11	Media Weight Change
12	Media Type Change
13	Media Color Change
14	Media Form Parts Change
15	Media Supply Low
16	Media Supply Empty

Output Alert Code

1	Other
2	Unknown
3	Cover Open
4	Cover Closed
5	Interlock Open
6	Interlock Closed
7	Configuration Change
8	Jam
9	Media Tray Missing
10	Media Tray Almost Full
11	Media Tray Full

Finisher Alert Code

1	Other
2	Unknown
3	Cover Open
4	Cover Closed
5	Interlock Open
6	Interlock Closed
7	Configuration Change
8	Jam
9	Media Tray Missing
10	Supply Empty
11	Supply Low
12	Receptical Almost Full
13	Receptical Full

Media Path Alert Code

1	Other
2	Unknown
3	Cover Open
4	Cover Closed
5	Interlock Open
6	Interlock Closed
7	Configuration Change
8	Jam

Media Path Device Alert Code

1	Other
2	Unknown
3	Cover Open
4	Cover Closed
5	Interlock Open
6	Interlock Closed
7	Configuration Change
8	Jam
9	Media Tray Missing
10	Media Tray Almost Full
11	Media Tray Full

Marker Alert Code

1	Other
2	Unknown
3	Cover Open
4	Cover Closed
5	Interlock Open
6	Interlock Closed
7	Configuration Change
8	Jam
9	Toner Empty
10	Ink Empty
11	Print Ribbon Empty
12	Toner Almost Empty
13	Ink Almost Empty
14	Print Ribbon Almost Empty
15	Waste Toner Receptical Almost Full
16	Waste Ink Receptical Almost Full
17	Waste Toner Receptical Full
18	Waste Ink Receptical Ful

Interpreter Alert Code

1	Other
2	Unknown
3	Configuration Change
4	Memory Increase
5	Memory Decrease
6	Cartridge Added
7	Cartridge Deleted
8	Resource Added
9	Resource Deleted

Interface Alert Code

1	Other
2	Unknown
3	Configuration Change