

Network Working Group
Request for Comments: 2287
Category: Standards Track

C. Krupczak
Empire Technologies, Inc.
J. Saperia
BGS Systems Inc.
February 1998

Definitions of System-Level Managed Objects for Applications

Status of this Memo

This document specifies an Internet standards track protocol for the Internet community, and requests discussion and suggestions for improvements. Please refer to the current edition of the "Internet Official Protocol Standards" (STD 1) for the standardization state and status of this protocol. Distribution of this memo is unlimited.

Copyright Notice

Copyright (C) The Internet Society (1998). All Rights Reserved.

Table of Contents

| | |
|---|----|
| 1 Abstract | 2 |
| 2 The SNMPv2 Network Management Framework | 2 |
| 2.1 Object Definitions | 2 |
| 3 Overview | 3 |
| 4 Architecture for Application Management | 3 |
| 5 The Structure of the MIB | 4 |
| 5.1 System Application Installed Group | 5 |
| 5.2 System Application Run Group | 5 |
| 5.2.1 sysApplRunTable and sysApplPastRunTable | 5 |
| 5.2.2 sysApplElmtRunTable and sysApplElmtPastRunTable | 6 |
| 5.3 System Application Map Group | 7 |
| 6 Definitions | 7 |
| 7 Implementation Issues | 40 |
| 7.1 Implementation with Polling Agents | 40 |
| 7.2 sysApplElmtPastRunTable Entry Collisions | 40 |
| 8 Security Considerations | 41 |
| 9 Acknowledgements | 42 |
| 10 Author's Address | 42 |
| 11 References | 42 |
| 12 Full Copyright Statement | 44 |

1. Abstract

This memo defines a portion of the Management Information Base (MIB) for use with network management protocols in the Internet community. In particular, it describes a basic set of managed objects for fault, configuration and performance management of applications from a systems perspective. More specifically, the managed objects are restricted to information that can be determined from the system itself and which does not require special instrumentation within the applications to make the information available.

This memo does not specify a standard for the Internet community.

2. The SNMPv2 Network Management Framework

The SNMPv2 Network Management Framework consists of the following major components:

- o RFC 1902 Structure of Management Information for Version 2 of the Simple Network Management Protocol (SNMPv2) [2]
- o RFC 1903 Textual Conventions for Version 2 of the Simple Network Management Protocol (SNMPv2) [3]
- o RFC 1904 Conformance Statements for Version 2 of the Simple Network Management Protocol (SNMPv2) [4]
- o RFC 1905 Protocol Operations for Version 2 of the Simple Network Management Protocol (SNMPv2) [5]
- o RFC 1906 Transport Mappings for Version 2 of the Simple Network Management Protocol (SNMPv2) [6]
- o RFC 1907 Management Information Base for Version 2 of the Simple Network Management Protocol (SNMPv2) [7]
- o RFC 1908 Coexistence between Version 1 and Version 2 of the Internet-standard Network Management Framework [8]

The Framework permits new objects to be defined for the purpose of experimentation and evaluation.

2.1. Object Definitions

Managed objects are accessed via a virtual information store, termed the Management Information Base or MIB. Objects in the MIB are defined using the subset of Abstract Syntax Notation One (ASN.1) [1], defined in the Structure of Management Information (SMI) (See RFC

1902 [2])). In particular, each object type is named by an OBJECT IDENTIFIER, an administratively assigned name. The object type together with an object instance serves to uniquely identify a specific instantiation of the object. For human convenience, we often use a textual string, termed the object descriptor, to refer to the object type.

3. Overview

The primary purpose of computing technologies is the execution of application software. These applications, typically specialized collections of executables, files, and interprocess communications, exist to solve business, scientific or other "problems". The configuration, fault detection, performance monitoring and control of application software across its life on a host computer is of great economic importance. For the purposes of our work, we define applications as one or more units of executable code and other resources, installed on a single host system that a manager may think of as a single object for management purposes.

The information described by the objects in the System Application MIB support configuration, fault, and performance management; they represent some of the basic attributes of application software from a systems (non-application specific) perspective. The information allows for the description of applications as collections of executables and files installed and executing on a host computer.

This memo is concerned primarily with, and defines a model for, application information resident on a host computer which can be determined from the system itself, and not from the individual applications. This system-level view of applications is designed to provide information about software applications installed and running on the host system without requiring modifications and code additions to the applications themselves. This approach was taken to insure ease and speed of implementation, while allowing room for future growth.

4. Architecture for Application Management

In the area of application management it is fully acknowledged and even expected that additional MIB modules will be defined over time to provide an even greater level of detail regarding applications. This MIB module presents the most general case: a set of management objects for providing generic information about applications and whose object values can be determined from the computer system itself without requiring instrumentation within the application.

A finer-grained level of detail is planned for the future "appl MIB" which will be a common set of management objects relating to generic applications, but which require some type of instrumentation in the application in order to be determined. Since the applmib MIB module will provide a finer level of detail, any connection to the sysAppl MIB should be made by having references from the more detailed appl MIB back to the more generic sysAppl MIB. Likewise, as application-specific MIB modules such as the WWW MIB, etc., are developed over time, these more specific MIBs should reference back to the more generic MIBs.

While this MIB module does not attempt to provide every detailed piece of information for managing applications, it does provide a basic systems-level view of the applications and their components on a single host system.

5. The Structure of the MIB

The System Application MIB structure models application packages as a whole, and also models the individual elements (files and executables) which collectively form an application. The MIB is structured to model information regarding installed application packages and the elements which make up each application package. The MIB also models activity information on applications (and in turn, their components) that are running or have previously run on the host system. In modeling applications and their elements, this MIB module provides the necessary link for associating executing processes with the applications of which they are a part.

The objects are arranged into the following groups:

- System Application Installed Group
 - sysApplInstallPkgTable
 - sysApplInstallElmtTable
- System Application Run Group
 - sysApplRunTable
 - sysApplPastRunTable
 - sysApplElmtRunTable
 - sysApplElmtPastRunTable
 - (scalars for restricting table sizes)
- System Application Map Group
 - sysApplMapTable

As can be seen by the arrangement above, for each category, the MIB first treats an application package as a whole, and then breaks down the package to provide information about each of the elements (executable and non-executable files) of the package.

5.1. System Application Installed Group

The System Application Installed group consists of two tables. Through these two tables, administrators will be able to determine which applications have been installed on a system and what their constituent components are. The first table, the `sysApplInstallPkgTable`, lists the application packages installed on a particular host. The second, the `sysApplInstallElmtTable`, provides information regarding the executables and non-executable files, or elements, which collectively compose an application.

NOTE: This MIB is intended to work with applications that have been installed on a particular host, where "installed" means that the existence of the application and the association between an application and its component files can be discovered without requiring additional instrumentation of the application itself. This may require that certain conventions be used, such as using a central software installation mechanism or registry, when installing application packages. For example, many UNIX systems utilize a "pkgadd" utility to track installed application packages, while many PC systems utilize a global registry.

5.2. System Application Run Group

This group models activity information for applications that have been invoked and are either currently running, or have previously run, on the host system. Likewise, the individual elements of an invoked application are also modeled to show currently running processes, and processes that have run in the past. This information is modeled using two pairs of tables: a pair of tables for currently running applications and past run applications, and a pair of tables for the currently running elements and the past run elements. Seven scalars are also defined to control the size of the past run tables.

5.2.1. `sysApplRunTable` and `sysApplPastRunTable`

The `sysApplRunTable` and the `sysApplPastRunTable` make up the first pair of tables. The `sysApplRunTable` contains the application instances which are currently running on the host. Each time an application is invoked, a new entry is created in the `sysApplRunTable` to provide information about that particular invocation of the application. An entry will remain in this table until the

application instance terminates, at which time the entry will be deleted from the sysApplRunTable and placed in the sysApplPastRunTable.

The sysApplPastRunTable maintains a history of instances of applications which have previously executed on the host. Entries to this table are made when an invoked application from the sysApplRunTable terminates; the table entry which represents the application instance is removed from the SysApplRunTable and a corresponding entry is added to the sysApplPastRunTable.

Because the sysApplPastRunTable will continuously grow as applications are executed and terminate, two scalars are defined to control the aging-out of table entries. The value of sysApplPastRunMaxRows specifies the maximum number of entries the table may contain, while the sysApplPastRunTblTimeLimit specifies the maximum age of the table entries. Oldest entries are removed first.

It is important to note that the sysApplRunTable and sysApplPastRunTable contain entries for each INVOCATION of an application. A single application package might be invoked multiple times; each invocation is properly recorded by a separate entry in the sysApplRunTable.

In order to implement this group, the agent must be able to recognize that an application has been invoked, and be able to determine when that invocation terminates. This poses a complex problem since a single application invocation may involve numerous processes, some of which may be required to remain running throughout the duration of the application, others which might come and go. The sysApplInstallElmtRole columnar object in the sysApplInstallElmtTable is meant to assist in this task by indicating which element is the application's primary executable, which elements must be running in order for the application to be running, which elements are dependent on required elements, etc. See the description of sysApplInstallElmtRole for more details.

5.2.2. sysApplElmtRunTable and sysApplElmtPastRunTable

While the sysApplRunTable and sysApplPastRunTable focus on applications as a whole, the sysApplElmtRunTable and sysApplElmtPastRunTable provide information regarding an application's executable elements, (processes), which are either currently executing or have executed in the past.

The sysApplElmtRunTable contains an entry for every process currently running on the host. An entry is created in this table for each process at the time it is started, and will remain in the table until

the process terminates. Note that in order to provide complete information on the load on the system, this table lists EVERY running process, not just those processes that are running as part of an identified application. However, when processes terminate, only information from entries corresponding to elements of an identified application are moved to the sysApplElmtPastRunTable.

The sysApplElmtPastRunTable maintains a history of processes which have previously executed on the host as part of an application. When a process from the sysApplElmtRunTable terminates, the entry's information is moved to this sysApplElmtPastRunTable provided that the process was part of an identified application. If the process cannot be associated with any 'parent' application, then it is simply removed from the sysApplElmtRunTable. This allows for processes like 'ps' or 'grep' to show up in the sysApplElmtRunTable, (where they are consuming resources and are thus "interesting"), but not in the sysApplElmtPastRunTable.

Because the sysApplElmtPastRunTable will continuously grow as processes are executed and terminate, two scalars are defined to control the aging-out of table entries. The value of sysApplElmtPastRunMaxRows specifies the maximum number of entries the table may contain, while the sysApplElmtPastRunTblTimeLimit specifies the maximum age of the table entries. Oldest entries are removed first.

5.3. System Application Map Group

The System Application Map group contains a single table, the sysApplMapTable, whose sole purpose is to provide a backwards mapping for determining the invoked application, installed element, and installed application package given a known process identification number.

6. Definitions

```
SYSAPPL-MIB DEFINITIONS ::= BEGIN
```

```
IMPORTS
```

```
    MODULE-IDENTITY, OBJECT-TYPE,  
    Unsigned32, TimeTicks, Counter32, Gauge32  
        FROM SNMPv2-SMI  
    DateAndTime, TEXTUAL-CONVENTION  
        FROM SNMPv2-TC  
    MODULE-COMPLIANCE, OBJECT-GROUP  
        FROM SNMPv2-CONF  
    mib-2 FROM SNMPv2-SMI;
```

`-- System Application MIB``sysApplMIB MODULE-IDENTITY``LAST-UPDATED "9710200000Z"``ORGANIZATION "IETF Applications MIB Working Group"``CONTACT-INFO``"Cheryl Krupczak (Editor, WG Advisor)``Postal: Empire Technologies, Inc.``541 Tenth Street NW``Suite 169``Atlanta, GA 30318``USA``Phone: (770) 384-0184``Email: cheryl@empiretech.com``Jon Saperia (WG Chair)``Postal: BGS Systems, Inc.``One First Avenue``Waltham, MA 02254-9111``USA``Phone: (617) 891-0000``Email: saperia@networks.bgs.com"``DESCRIPTION`

"The MIB module defines management objects that model applications as collections of executables and files installed and executing on a host system. The MIB presents a system-level view of applications; i.e., objects in this MIB are limited to those attributes that can typically be obtained from the system itself without adding special instrumentation to the applications."

`::= { mib-2 54 }`

| | |
|-----------------------------------|---|
| <code>sysApplOBJ</code> | <code>OBJECT IDENTIFIER ::= { sysApplMIB 1 }</code> |
| <code>sysApplInstalled</code> | <code>OBJECT IDENTIFIER ::= { sysApplOBJ 1 }</code> |
| <code>sysApplRun</code> | <code>OBJECT IDENTIFIER ::= { sysApplOBJ 2 }</code> |
| <code>sysApplMap</code> | <code>OBJECT IDENTIFIER ::= { sysApplOBJ 3 }</code> |
| <code>sysApplNotifications</code> | <code>OBJECT IDENTIFIER ::= { sysApplMIB 2 }</code> |
| <code>sysApplConformance</code> | <code>OBJECT IDENTIFIER ::= { sysApplMIB 3 }</code> |

`-- Textual Conventions``RunState ::= TEXTUAL-CONVENTION``STATUS current``DESCRIPTION`

"This TC describes the current execution state of a running application or process. The possible values are:


```

        running(1),
        runnable(2), - waiting for a resource (CPU, etc.)
        waiting(3),  - waiting for an event
        exiting(4),
        other(5)     - other invalid state"
SYNTAX      INTEGER {
        running (1),
        runnable (2), -- waiting for resource (CPU, etc.)
        waiting (3),  -- waiting for event
        exiting (4),
        other (5)     -- other invalid state
        }

```

LongUtf8String ::= TEXTUAL-CONVENTION

DISPLAY-HINT "1024a"

STATUS current

DESCRIPTION

"To facilitate internationalization, this TC represents information taken from the ISO/IEC IS 10646-1 character set, encoded as an octet string using the UTF-8 character encoding scheme described in RFC 2044 [10]. For strings in 7-bit US-ASCII, there is no impact since the UTF-8 representation is identical to the US-ASCII encoding."

SYNTAX OCTET STRING (SIZE (0..1024))

Utf8String ::= TEXTUAL-CONVENTION

DISPLAY-HINT "255a"

STATUS current

DESCRIPTION

"To facilitate internationalization, this TC represents information taken from the ISO/IEC IS 10646-1 character set, encoded as an octet string using the UTF-8 character encoding scheme described in RFC 2044 [10]. For strings in 7-bit US-ASCII, there is no impact since the UTF-8 representation is identical to the US-ASCII encoding."

SYNTAX OCTET STRING (SIZE (0..255))

```

-- sysApplInstalled Group
-- This group provides information about application packages
-- that have been installed on the host computer. The group
-- contains two tables. The first, the sysApplInstallPkgTable,
-- describes the application packages, the second, the
-- sysApplInstallElmtTable, describes the constituent elements
-- (files and executables) which compose an application package.

```

```
--
-- In order to appear in this group, an application and its
-- component files must be discoverable by the system itself,
-- possibly through some type of software installation mechanism
-- or registry.
```

```
-- sysApplInstallPkgTable
-- The system installed application packages table provides
-- information on the software packages installed on a system.
-- These packages may consist of many different files including
-- executable and non-executable files.
```

```
sysApplInstallPkgTable OBJECT-TYPE
```

```
SYNTAX          SEQUENCE OF SysApplInstallPkgEntry
```

```
MAX-ACCESS      not-accessible
```

```
STATUS          current
```

```
DESCRIPTION
```

```
    "The table listing the software application packages
    installed on a host computer. In order to appear in
    this table, it may be necessary for the application
    to be installed using some type of software
    installation mechanism or global registry so that its
    existence can be detected by the agent implementation."
```

```
 ::= { sysApplInstalled 1 }
```

```
sysApplInstallPkgEntry OBJECT-TYPE
```

```
SYNTAX          SysApplInstallPkgEntry
```

```
MAX-ACCESS      not-accessible
```

```
STATUS          current
```

```
DESCRIPTION
```

```
    "The logical row describing an installed application
    package."
```

```
INDEX          { sysApplInstallPkgIndex }
```

```
 ::= { sysApplInstallPkgTable 1 }
```

```
SysApplInstallPkgEntry ::= SEQUENCE {
```

```
    sysApplInstallPkgIndex          Unsigned32,
    sysApplInstallPkgManufacturer    Utf8String,
    sysApplInstallPkgProductName     Utf8String,
    sysApplInstallPkgVersion         Utf8String,
    sysApplInstallPkgSerialNumber    Utf8String,
    sysApplInstallPkgDate            DateAndTime,
    sysApplInstallPkgLocation        LongUtf8String
```

```
}
```

```
sysApplInstallPkgIndex OBJECT-TYPE
```

```
SYNTAX          Unsigned32 (1..'ffffffff'h)
```

MAX-ACCESS not-accessible
STATUS current
DESCRIPTION

"An integer used only for indexing purposes.
Generally monotonically increasing from 1 as new
applications are installed.

The value for each installed application must
remain constant at least from one re-initialization of
the network management entity which implements this
MIB module to the next re-initialization.

The specific value is meaningful only within a given SNMP
entity. A sysApplInstallPkgIndex value must not be re-used
until the next agent entity restart in the event the
installed application entry is deleted."

::= { sysApplInstallPkgEntry 1 }

sysApplInstallPkgManufacturer OBJECT-TYPE

SYNTAX Utf8String
MAX-ACCESS read-only
STATUS current
DESCRIPTION

"The Manufacturer of the software application package."

::= { sysApplInstallPkgEntry 2 }

sysApplInstallPkgProductName OBJECT-TYPE

SYNTAX Utf8String
MAX-ACCESS read-only
STATUS current
DESCRIPTION

"The name assigned to the software application package
by the Manufacturer."

::= { sysApplInstallPkgEntry 3 }

sysApplInstallPkgVersion OBJECT-TYPE

SYNTAX Utf8String
MAX-ACCESS read-only
STATUS current
DESCRIPTION

"The version number assigned to the application package
by the manufacturer of the software."

::= { sysApplInstallPkgEntry 4 }

sysApplInstallPkgSerialNumber OBJECT-TYPE

SYNTAX Utf8String
MAX-ACCESS read-only
STATUS current

DESCRIPTION

"The serial number of the software assigned by the manufacturer."

::= { sysApplInstallPkgEntry 5 }

sysApplInstallPkgDate OBJECT-TYPE

SYNTAX DateAndTime

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The date and time this software application was installed on the host."

::= { sysApplInstallPkgEntry 6 }

sysApplInstallPkgLocation OBJECT-TYPE

SYNTAX LongUtf8String

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The complete path name where the application package is installed. For example, the value would be '/opt/MyapplDir' if the application package was installed in the /opt/MyapplDir directory."

::= { sysApplInstallPkgEntry 7 }

-- sysApplInstallElmtTable

-- The table describing the individual application package

-- elements (files and executables) installed on the host computer.

sysApplInstallElmtTable OBJECT-TYPE

SYNTAX SEQUENCE OF SysApplInstallElmtEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"This table details the individual application package elements (files and executables) which comprise the applications defined in the sysApplInstallPkg Table. Each entry in this table has an index to the sysApplInstallPkg table to identify the application package of which it is a part. As a result, there may be many entries in this table for each instance in the sysApplInstallPkg Table.

Table entries are indexed by sysApplInstallPkgIndex, sysApplInstallElmtIndex to facilitate retrieval of all elements associated with a particular installed application package."

```

 ::= { sysApplInstalled 2 }

sysApplInstallElmtEntry OBJECT-TYPE
    SYNTAX      SysApplInstallElmtEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
        "The logical row describing an element of an installed
        application.  The element may be an executable or
        non-executable file."
    INDEX       {sysApplInstallPkgIndex, sysApplInstallElmtIndex}
    ::= { sysApplInstallElmtTable 1 }

SysApplInstallElmtEntry ::= SEQUENCE {
    sysApplInstallElmtIndex      Unsigned32,
    sysApplInstallElmtName      Utf8String,
    sysApplInstallElmtType      INTEGER,
    sysApplInstallElmtDate      DateAndTime,
    sysApplInstallElmtPath      LongUtf8String,
    sysApplInstallElmtSizeHigh  Unsigned32,
    sysApplInstallElmtSizeLow   Unsigned32,
    sysApplInstallElmtRole      BITS,
    sysApplInstallElmtModifyDate DateAndTime,
    sysApplInstallElmtCurSizeHigh Unsigned32,
    sysApplInstallElmtCurSizeLow Unsigned32
}

sysApplInstallElmtIndex OBJECT-TYPE
    SYNTAX      Unsigned32 (1..'ffffffff'h)
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
        "An arbitrary integer used for indexing.  The value
        of this index is unique among all rows in this table
        that exist or have existed since the last agent restart."
    ::= { sysApplInstallElmtEntry 1 }

sysApplInstallElmtName OBJECT-TYPE
    SYNTAX      Utf8String
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The name of this element which is contained in the
        application."
    ::= { sysApplInstallElmtEntry 2 }

```

sysApplInstallElmtType OBJECT-TYPE

```
SYNTAX      INTEGER {
                unknown(1),
                nonexecutable(2),
                operatingSystem(3),  -- executable
                deviceDriver(4),    -- executable
                application(5)      -- executable
            }
```

```
MAX-ACCESS  read-only
```

```
STATUS      current
```

DESCRIPTION

"The type of element that is part of the installed application."

```
::= { sysApplInstallElmtEntry 3 }
```

sysApplInstallElmtDate OBJECT-TYPE

```
SYNTAX      DateAndTime
```

```
MAX-ACCESS  read-only
```

```
STATUS      current
```

DESCRIPTION

"The date and time that this component was installed on the system."

```
::= { sysApplInstallElmtEntry 4 }
```

sysApplInstallElmtPath OBJECT-TYPE

```
SYNTAX      LongUtf8String
```

```
MAX-ACCESS  read-only
```

```
STATUS      current
```

DESCRIPTION

"The full directory path where this element is installed. For example, the value would be '/opt/EMPuma/bin' for an element installed in the directory '/opt/EMPuma/bin'. Most application packages include information about the elements contained in the package. In addition, elements are typically installed in sub-directories under the package installation directory. In cases where the element path names are not included in the package information itself, the path can usually be determined by a simple search of the sub-directories. If the element is not installed in that location and there is no other information available to the agent implementation, then the path is unknown and null is returned."

```
::= { sysApplInstallElmtEntry 5 }
```

sysApplInstallElmtSizeHigh OBJECT-TYPE

```
SYNTAX      Unsigned32
```

```
MAX-ACCESS  read-only
```

```
STATUS      current
```

DESCRIPTION

"The installed file size in 2³² byte blocks. This is the size of the file on disk immediately after installation.

For example, for a file with a total size of 4,294,967,296 bytes, this variable would have a value of 1; for a file with a total size of 4,294,967,295 bytes this variable would be 0."

::= { sysApplInstallElmtEntry 6 }

sysApplInstallElmtSizeLow OBJECT-TYPE

SYNTAX Unsigned32

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The installed file size modulo 2³² bytes. This is the size of the file on disk immediately after installation.

For example, for a file with a total size of 4,294,967,296 bytes this variable would have a value of 0; for a file with a total size of 4,294,967,295 bytes this variable would be 4,294,967,295."

::= { sysApplInstallElmtEntry 7 }

sysApplInstallElmtRole OBJECT-TYPE

SYNTAX BITS {

executable(0),

-- An application may have one or
-- more executable elements. The rest of the
-- bits have no meaning if the element is not
-- executable.

exclusive(1),

-- Only one copy of an exclusive element may be
-- running per invocation of the running
-- application.

primary(2),

-- The primary executable. An application can
-- have one, and only one element that is designated
-- as the primary executable. The execution of
-- this element constitutes an invocation of
-- the application. This is used by the agent
-- implementation to determine the initiation of
-- an application. The primary executable must
-- remain running long enough for the agent
-- implementation to detect its presence.

required(3),

-- An application may have zero or more required
-- elements. All required elements must be running

```
-- in order for the application to be judged to be
-- running and healthy.
dependent(4),
-- An application may have zero or more
-- dependent elements. Dependent elements may
-- not be running unless required elements are.
unknown(5)
-- Default value for the case when an operator
-- has not yet assigned one of the other values.
-- When set, bits 1, 2, 3, and 4 have no meaning.
}
MAX-ACCESS read-write
STATUS current
DESCRIPTION
    "An operator assigned value used in the determination of
    application status. This value is used by the agent to
    determine both the mapping of started processes to the
    initiation of an application, as well as to allow for a
    determination of application health. The default value,
    unknown(5), is used when an operator has not yet assigned
    one of the other values. If unknown(5) is set, bits
    1 - 4 have no meaning. The possible values are:

    executable(0),
        An application may have one or
        more executable elements. The rest of the
        bits have no meaning if the element is not
        executable.
    exclusive(1),
        Only one copy of an exclusive element may be
        running per invocation of the running
        application.
    primary(2),
        The primary executable. An application can
        have one, and only one element that is designated
        as the primary executable. The execution of
        this element constitutes an invocation of
        the application. This is used by the agent
        implementation to determine the initiation of
        an application. The primary executable must
        remain running long enough for the agent
        implementation to detect its presence.
    required(3),
        An application may have zero or more required
        elements. All required elements must be running
        in order for the application to be judged to be
        running and healthy.
    dependent(4),
```


An application may have zero or more dependent elements. Dependent elements may not be running unless required elements are.

unknown(5)
 Default value for the case when an operator has not yet assigned one of the other values. When set, bits 1, 2, 3, and 4 have no meaning.

sysApplInstallElmtRole is used by the agent implementation in determining the initiation of an application, the current state of a running application (see sysApplRunCurrentState), when an application invocation is no longer running, and the exit status of a terminated application invocation (see sysApplPastRunExitState)."

```
DEFVAL { { unknown } }
::= { sysApplInstallElmtEntry 8 }
```

sysApplInstallElmtModifyDate OBJECT-TYPE

SYNTAX DateAndTime

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The date and time that this element was last modified. Modification of the sysApplInstallElmtRole columnar object does NOT constitute a modification of the element itself and should not affect the value of this object."

```
::= { sysApplInstallElmtEntry 9 }
```

sysApplInstallElmtCurSizeHigh OBJECT-TYPE

SYNTAX Unsigned32

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The current file size in 2³² byte blocks. For example, for a file with a total size of 4,294,967,296 bytes, this variable would have a value of 1; for a file with a total size of 4,294,967,295 bytes this variable would be 0."

```
::= { sysApplInstallElmtEntry 10 }
```

sysApplInstallElmtCurSizeLow OBJECT-TYPE

SYNTAX Unsigned32

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The current file size modulo 2³² bytes. For example, for a file with a total size of 4,294,967,296

bytes this variable would have a value of 0; for a file with a total size of 4,294,967,295 bytes this variable would be 4,294,967,295."

```
::= { sysApplInstallElmtEntry 11 }
```

```
-- sysApplRun Group
```

```
-- This group models activity information for applications
-- that have been invoked and are either currently running,
-- or have previously run on the host system. Likewise,
-- the individual elements of an invoked application are
-- also modeled to show currently running processes, and
-- processes that have run in the past.
```

```
-- sysApplRunTable
```

```
-- The sysApplRunTable contains the application instances
-- which are currently running on the host. Since a single
-- application might be invoked multiple times, an entry is
-- added to this table for each INVOCATION of an application.
-- The table is indexed by sysApplInstallPkgIndex, sysApplRunIndex
-- to enable managers to easily locate all invocations of
-- a particular application package.
```

```
sysApplRunTable OBJECT-TYPE
```

```
SYNTAX SEQUENCE OF SysApplRunEntry
```

```
MAX-ACCESS not-accessible
```

```
STATUS current
```

```
DESCRIPTION
```

"The table describes the applications which are executing on the host. Each time an application is invoked, an entry is created in this table. When an application ends, the entry is removed from this table and a corresponding entry is created in the SysApplPastRunTable.

A new entry is created in this table whenever the agent implementation detects a new running process that is an installed application element whose sysApplInstallElmtRole designates it as being the application's primary executable (sysApplInstallElmtRole = primary(2)).

The table is indexed by sysApplInstallPkgIndex, sysApplRunIndex to enable managers to easily locate all invocations of a particular application package."

```
::= { sysApplRun 1 }
```

```
sysApplRunEntry OBJECT-TYPE
```

```
SYNTAX SysApplRunEntry
```

```

MAX-ACCESS    not-accessible
STATUS        current
DESCRIPTION
    "The logical row describing an application which is
    currently running on this host."
INDEX         { sysApplInstallPkgIndex, sysApplRunIndex }
::= { sysApplRunTable 1 }

```

```

SysApplRunEntry ::= SEQUENCE {
    sysApplRunIndex          Unsigned32,
    sysApplRunStarted        DateAndTime,
    sysApplRunCurrentState   RunState
}

```

```

sysApplRunIndex OBJECT-TYPE
    SYNTAX      Unsigned32 (1..'ffffffff'h)
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
        "Part of the index for this table. An arbitrary
        integer used only for indexing purposes. Generally
        monotonically increasing from 1 as new applications are
        started on the host, it uniquely identifies application
        invocations.

```

The numbering for this index increases by 1 for each INVOCATION of an application, regardless of which installed application package this entry represents a running instance of.

An example of the indexing for a couple of entries is shown below.

```

:
sysApplRunStarted.17.14
sysApplRunStarted.17.63
sysApplRunStarted.18.13
:

```

In this example, the agent has observed 12 application invocations when the application represented by entry 18 in the sysApplInstallPkgTable is invoked. The next invocation detected by the agent is an invocation of installed application package 17. Some time later, installed application 17 is invoked a second time.

NOTE: this index is not intended to reflect a real-time (wall clock time) ordering of application invocations;

it is merely intended to uniquely identify running instances of applications. Although the sysApplInstallPkgIndex is included in the INDEX clause for this table, it serves only to ease searching of this table by installed application and does not contribute to uniquely identifying table entries."

```
::= { sysApplRunEntry 1 }
```

sysApplRunStarted OBJECT-TYPE

SYNTAX DateAndTime

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The date and time that the application was started."

```
::= { sysApplRunEntry 2 }
```

sysApplRunCurrentState OBJECT-TYPE

SYNTAX RunState

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The current state of the running application instance. The possible values are running(1), runnable(2) but waiting for a resource such as CPU, waiting(3) for an event, exiting(4), or other(5). This value is based on an evaluation of the running elements of this application instance (see sysApplElmRunState) and their Roles as defined by sysApplInstallElmtRole. An agent implementation may detect that an application instance is in the process of exiting if one or more of its REQUIRED elements are no longer running. Most agent implementations will wait until a second internal poll has been completed to give the system time to start REQUIRED elements before marking the application instance as exiting."

```
::= { sysApplRunEntry 3 }
```

```
-- sysApplPastRunTable
```

```
-- The sysApplPastRunTable provides a history of applications
-- previously run on the host computer. Entries are removed from
-- the sysApplRunTable and corresponding entries are added to this
-- table when an application becomes inactive. Entries remain in
-- this table until they are aged out when either the table size
-- reaches a maximum as determined by the sysApplPastRunMaxRows,
-- or when an entry has aged to exceed a time limit as set be
-- sysApplPastRunTblTimeLimit.
```

```
--
```

```
-- When aging out entries, the oldest entry, as determined by
```

-- the value of sysApplPastRunTimeEnded, will be removed first.

sysApplPastRunTable OBJECT-TYPE

SYNTAX SEQUENCE OF SysApplPastRunEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"A history of the applications that have previously run on the host computer. An entry's information is moved to this table from the sysApplRunTable when the invoked application represented by the entry ceases to be running.

An agent implementation can determine that an application invocation is no longer running by evaluating the running elements of the application instance and their Roles as defined by sysApplInstallElmtRole. Obviously, if there are no running elements for the application instance, then the application invocation is no longer running. If any one of the REQUIRED elements is not running, the application instance may be in the process of exiting. Most agent implementations will wait until a second internal poll has been completed to give the system time to either restart partial failures or to give all elements time to exit. If, after the second poll, there are REQUIRED elements that are not running, then the application instance may be considered by the agent implementation to no longer be running.

Entries remain in the sysApplPastRunTable until they are aged out when either the table size reaches a maximum as determined by the sysApplPastRunMaxRows, or when an entry has aged to exceed a time limit as set by sysApplPastRunTblTimeLimit.

Entries in this table are indexed by sysApplInstallPkgIndex, sysApplPastRunIndex to facilitate retrieval of all past run invocations of a particular installed application."

::= { sysApplRun 2 }

sysApplPastRunEntry OBJECT-TYPE

SYNTAX SysApplPastRunEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"The logical row describing an invocation of an application which was previously run and has terminated. The entry is basically copied from the sysApplRunTable when the application instance terminates. Hence, the entry's

value for sysApplPastRunIndex is the same as its value was for sysApplRunIndex."

```

INDEX      { sysApplInstallPkgIndex, sysApplPastRunIndex }
 ::= { sysApplPastRunTable 1 }

SysApplPastRunEntry ::= SEQUENCE {
    sysApplPastRunIndex      Unsigned32,
    sysApplPastRunStarted    DateAndTime,
    sysApplPastRunExitState  INTEGER,
    sysApplPastRunTimeEnded  DateAndTime
}

sysApplPastRunIndex OBJECT-TYPE
    SYNTAX      Unsigned32 (1..'ffffffff'h)
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
        "Part of the index for this table. An integer
        matching the value of the removed sysApplRunIndex
        corresponding to this row."
    ::= { sysApplPastRunEntry 1 }

sysApplPastRunStarted OBJECT-TYPE
    SYNTAX      DateAndTime
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The date and time that the application was started."
    ::= { sysApplPastRunEntry 2 }

sysApplPastRunExitState OBJECT-TYPE
    SYNTAX      INTEGER {
        complete (1), -- normal exit at sysApplRunTimeEnded
        failed (2),  -- abnormal exit
        other (3)
    }
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The state of the application instance when it terminated.
        This value is based on an evaluation of the running elements
        of an application and their Roles as defined by
        sysApplInstallElmtRole. An application instance is said to
        have exited in a COMPLETE state and its entry is removed
        from the sysApplRunTable and added to the sysApplPastRunTable
        when the agent detects that ALL elements of an application
        invocation are no longer running. Most agent implementations
        will wait until a second internal poll has been completed to

```

give the system time to either restart partial failures or to give all elements time to exit. A failed state occurs if, after the second poll, any elements continue to run but one or more of the REQUIRED elements are no longer running. All other combinations MUST be defined as OTHER."

```
::= { sysApplPastRunEntry 3 }
```

sysApplPastRunTimeEnded OBJECT-TYPE

SYNTAX DateAndTime

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The DateAndTime the application instance was determined to be no longer running."

```
::= { sysApplPastRunEntry 4 }
```

```
-- sysApplElmtRunTable
```

```
-- The sysApplElmtRunTable contains an entry for each process that
-- is currently running on the host. An entry is created in
-- this table for each process at the time it is started, and will
-- remain in the table until the process terminates.
```

```
--
```

```
-- The table is indexed by sysApplElmtRunInstallPkg,
-- sysApplElmtRunInvocID, and sysApplElmtRunIndex to make it easy
-- to locate all running elements of a particular invoked application
-- which has been installed on the system.
```

sysApplElmtRunTable OBJECT-TYPE

SYNTAX SEQUENCE OF SysApplElmtRunEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"The table describes the processes which are currently executing on the host system. Each entry represents a running process and is associated with the invoked application of which that process is a part, if possible. This table contains an entry for every process currently running on the system, regardless of whether its 'parent' application can be determined. So, for example, processes like 'ps' and 'grep' will have entries though they are not associated with an installed application package.

Because a running application may involve more than one executable, it is possible to have multiple entries in this table for each application. Entries are removed from this table when the process terminates.

The table is indexed by sysApplElmtRunInstallPkg, sysApplElmtRunInvocID, and sysApplElmtRunIndex to facilitate the retrieval of all running elements of a particular invoked application which has been installed on the system."

```
::= { sysApplRun 3 }
```

sysApplElmtRunEntry OBJECT-TYPE

SYNTAX SysApplElmtRunEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"The logical row describing a process currently running on this host. When possible, the entry is associated with the invoked application of which it is a part."

INDEX { sysApplElmtRunInstallPkg, sysApplElmtRunInvocID,
sysApplElmtRunIndex }

```
::= { sysApplElmtRunTable 1 }
```

SysApplElmtRunEntry ::= SEQUENCE {

| | |
|---------------------------|-----------------|
| sysApplElmtRunInstallPkg | Unsigned32, |
| sysApplElmtRunInvocID | Unsigned32, |
| sysApplElmtRunIndex | Unsigned32, |
| sysApplElmtRunInstallID | Unsigned32, |
| sysApplElmtRunTimeStarted | DateAndTime, |
| sysApplElmtRunState | RunState, |
| sysApplElmtRunName | LongUtf8String, |
| sysApplElmtRunParameters | Utf8String, |
| sysApplElmtRunCPU | TimeTicks, |
| sysApplElmtRunMemory | Gauge32, |
| sysApplElmtRunNumFiles | Gauge32, |
| sysApplElmtRunUser | Utf8String |

}

sysApplElmtRunInstallPkg OBJECT-TYPE

SYNTAX Unsigned32 (0..'ffffffff'h)

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"Part of the index for this table, this value identifies the installed software package for the application of which this process is a part. Provided that the process's 'parent' application can be determined, the value of this object is the same value as the sysApplInstallPkgIndex for the entry in the sysApplInstallPkgTable that corresponds to the installed application of which this process

is a part.

If, however, the 'parent' application cannot be determined, (for example the process is not part of a particular installed application), the value for this object is then '0', signifying that this process cannot be related back to an application, and in turn, an installed software package."

```
::= { sysAppElmtRunEntry 1 }
```

sysAppElmtRunInvocID OBJECT-TYPE

SYNTAX Unsigned32 (0..'ffffffff'h)

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"Part of the index for this table, this value identifies the invocation of an application of which this process is a part. Provided that the 'parent' application can be determined, the value of this object is the same value as the sysAppRunIndex for the corresponding application invocation in the sysAppRunTable.

If, however, the 'parent' application cannot be determined, the value for this object is then '0', signifying that this process cannot be related back to an invocation of an application in the sysAppRunTable."

```
::= { sysAppElmtRunEntry 2 }
```

sysAppElmtRunIndex OBJECT-TYPE

SYNTAX Unsigned32 (0..'ffffffff'h)

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"Part of the index for this table. A unique value for each process running on the host. Wherever possible, this should be the system's native, unique identification number."

```
::= { sysAppElmtRunEntry 3 }
```

sysAppElmtRunInstallID OBJECT-TYPE

SYNTAX Unsigned32 (0..'ffffffff'h)

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The index into the sysAppInstallElmtTable. The

value of this object is the same value as the sysApplInstallElmtIndex for the application element of which this entry represents a running instance. If this process cannot be associated with an installed executable, the value should be '0'."

```
::= { sysApplElmtRunEntry 4 }
```

sysApplElmtRunTimeStarted OBJECT-TYPE

SYNTAX DateAndTime

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The time the process was started."

```
::= { sysApplElmtRunEntry 5 }
```

sysApplElmtRunState OBJECT-TYPE

SYNTAX RunState

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The current state of the running process. The possible values are running(1), runnable(2) but waiting for a resource such as CPU, waiting(3) for an event, exiting(4), or other(5)."

```
::= { sysApplElmtRunEntry 6 }
```

sysApplElmtRunName OBJECT-TYPE

SYNTAX LongUtf8String

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The full path and filename of the process. For example, '/opt/MYYpkg/bin/myyproc' would be returned for process 'myyproc' whose execution path is '/opt/MYYpkg/bin/myyproc'."

```
::= { sysApplElmtRunEntry 7 }
```

sysApplElmtRunParameters OBJECT-TYPE

SYNTAX Utf8String

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The starting parameters for the process."

```
::= { sysApplElmtRunEntry 8 }
```

sysApplElmtRunCPU OBJECT-TYPE

SYNTAX TimeTicks

MAX-ACCESS read-only

```

STATUS      current
DESCRIPTION
    "The number of centi-seconds of the total system's
    CPU resources consumed by this process. Note that
    on a multi-processor system, this value may
    have been incremented by more than one centi-second
    in one centi-second of real (wall clock) time."
 ::= { sysAppElmtRunEntry 9 }

```

sysAppElmtRunMemory OBJECT-TYPE

```

SYNTAX      Gauge32
UNITS       "Kbytes"
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION
    "The total amount of real system memory measured in
    Kbytes currently allocated to this process."

 ::= { sysAppElmtRunEntry 10 }

```

sysAppElmtRunNumFiles OBJECT-TYPE

```

SYNTAX      Gauge32
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION
    "The number of regular files currently open by the
    process. Transport connections (sockets)
    should NOT be included in the calculation of
    this value, nor should operating system specific
    special file types."
 ::= { sysAppElmtRunEntry 11 }

```

sysAppElmtRunUser OBJECT-TYPE

```

SYNTAX      Utf8String
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION
    "The process owner's login name (e.g. root)."
 ::= { sysAppElmtRunEntry 12 }

```

-- sysAppElmtPastRunTable

```

-- The sysAppElmtPastRunTable maintains a history of
-- processes which have previously executed on
-- the host as part of an application. Upon termination
-- of a process, the entry representing the process is removed from
-- the sysAppElmtRunTable and a corresponding entry is created in
-- this table provided that the process was part of an
-- identifiable application. If the process could not be associated

```

```
-- with an invoked application, no corresponding entry is created.
-- Hence, whereas the sysApplElmtRunTable contains an entry for
-- every process currently executing on the system, the
-- sysApplElmtPastRunTable only contains entries for processes
-- that previously executed as part of an invoked application.
--
-- Entries remain in this table until they are aged out when
-- either the number of entries in the table reaches a
-- maximum as determined by sysApplElmtPastRunMaxRows, or
-- when an entry has aged to exceed a time limit as set by
-- sysApplElmtPastRunTblTimeLimit. When aging out entries,
-- the oldest entry, as determined by the value of
-- sysApplElmtPastRunTimeEnded, will be removed first.
--
-- The table is indexed by sysApplInstallPkgIndex (from the
-- sysApplInstallPkgTable), sysApplElmtPastRunInvocID, and
-- sysApplElmtPastRunIndex to make it easy to locate all
-- previously executed processes of a particular invoked application
-- that has been installed on the system.
```

sysApplElmtPastRunTable OBJECT-TYPE

```
SYNTAX          SEQUENCE OF SysApplElmtPastRunEntry
MAX-ACCESS      not-accessible
STATUS          current
DESCRIPTION
```

"The table describes the processes which have previously executed on the host system as part of an application. Each entry represents a process which has previously executed and is associated with the invoked application of which it was a part. Because an invoked application may involve more than one executable, it is possible to have multiple entries in this table for each application invocation. Entries are added to this table when the corresponding process in the sysApplElmtRun Table terminates.

Entries remain in this table until they are aged out when either the number of entries in the table reaches a maximum as determined by sysApplElmtPastRunMaxRows, or when an entry has aged to exceed a time limit as set by sysApplElmtPastRunTblTimeLimit. When aging out entries, the oldest entry, as determined by the value of sysApplElmtPastRunTimeEnded, will be removed first.

The table is indexed by sysApplInstallPkgIndex (from the sysApplInstallPkgTable), sysApplElmtPastRunInvocID, and sysApplElmtPastRunIndex to make it easy to locate all

previously executed processes of a particular invoked application that has been installed on the system."
 ::= { sysApplRun 4 }

sysApplElmtPastRunEntry OBJECT-TYPE

SYNTAX SysApplElmtPastRunEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"The logical row describing a process which was previously executed on this host as part of an installed application. The entry is basically copied from the sysApplElmtRunTable when the process terminates. Hence, the entry's value for sysApplElmtPastRunIndex is the same as its value was for sysApplElmtRunIndex. Note carefully: only those processes which could be associated with an identified application are included in this table."

INDEX { sysApplInstallPkgIndex, sysApplElmtPastRunInvocID,
 sysApplElmtPastRunIndex }

::= { sysApplElmtPastRunTable 1 }

sysApplElmtPastRunEntry ::= SEQUENCE {

| | |
|-------------------------------|-----------------|
| sysApplElmtPastRunInvocID | Unsigned32, |
| sysApplElmtPastRunIndex | Unsigned32, |
| sysApplElmtPastRunInstallID | Unsigned32, |
| sysApplElmtPastRunTimeStarted | DateAndTime, |
| sysApplElmtPastRunTimeEnded | DateAndTime, |
| sysApplElmtPastRunName | LongUtf8String, |
| sysApplElmtPastRunParameters | Utf8String, |
| sysApplElmtPastRunCPU | TimeTicks, |
| sysApplElmtPastRunMemory | Unsigned32, |
| sysApplElmtPastRunNumFiles | Unsigned32, |
| sysApplElmtPastRunUser | Utf8String |

}

sysApplElmtPastRunInvocID OBJECT-TYPE

SYNTAX Unsigned32 (1..'ffffffff'h)

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"Part of the index for this table, this value identifies the invocation of an application of which the process represented by this entry was a part. The value of this object is the same value as the sysApplRunIndex for the corresponding application invocation in the sysApplRunTable. If the invoked application as a whole has terminated, it will be the

same as the sysApplPastRunIndex."
 ::= { sysApplElmtPastRunEntry 1 }

sysApplElmtPastRunIndex OBJECT-TYPE

SYNTAX Unsigned32 (0..'ffffffff'h)

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"Part of the index for this table. An integer assigned by the agent equal to the corresponding sysApplElmtRunIndex which was removed from the sysApplElmtRunTable and moved to this table when the element terminated.

Note: entries in this table are indexed by sysApplElmtPastRunInvocID, sysApplElmtPastRunIndex. The possibility exists, though unlikely, of a collision occurring by a new entry which was run by the same invoked application (InvocID), and was assigned the same process identification number (ElmtRunIndex) as an element which was previously run by the same invoked application.

Should this situation occur, the new entry replaces the old entry.

See Section: 'Implementation Issues - sysApplElmtPastRunTable Entry Collisions' for the conditions that would have to occur in order for a collision to occur."

::= { sysApplElmtPastRunEntry 2 }

sysApplElmtPastRunInstallID OBJECT-TYPE

SYNTAX Unsigned32 (1..'ffffffff'h)

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The index into the installed element table. The value of this object is the same value as the sysApplInstallElmtIndex for the application element of which this entry represents a previously executed process."

::= { sysApplElmtPastRunEntry 3 }

sysApplElmtPastRunTimeStarted OBJECT-TYPE

SYNTAX DateAndTime

MAX-ACCESS read-only

```

STATUS      current
DESCRIPTION
    "The time the process was started."
 ::= { sysAppElmtPastRunEntry 4 }

```

sysAppElmtPastRunTimeEnded OBJECT-TYPE

```

SYNTAX      DateAndTime
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION
    "The time the process ended."
 ::= { sysAppElmtPastRunEntry 5 }

```

sysAppElmtPastRunName OBJECT-TYPE

```

SYNTAX      LongUtf8String
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION
    "The full path and filename of the process.
     For example, '/opt/MYYpkg/bin/myyproc' would
     be returned for process 'myyproc' whose execution
     path was '/opt/MYYpkg/bin/myyproc'."
 ::= { sysAppElmtPastRunEntry 6 }

```

sysAppElmtPastRunParameters OBJECT-TYPE

```

SYNTAX      Utf8String
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION
    "The starting parameters for the process."
 ::= { sysAppElmtPastRunEntry 7 }

```

sysAppElmtPastRunCPU OBJECT-TYPE

```

SYNTAX      TimeTicks
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION
    "The last known number of centi-seconds of the total
     system's CPU resources consumed by this process.
     Note that on a multi-processor system, this value may
     increment by more than one centi-second in one
     centi-second of real (wall clock) time."
 ::= { sysAppElmtPastRunEntry 8 }

```

sysAppElmtPastRunMemory OBJECT-TYPE

```

SYNTAX      Unsigned32 (0..'ffffffff'h)
UNITS       "Kbytes"
MAX-ACCESS  read-only

```

```
STATUS          current
DESCRIPTION
    "The last known total amount of real system memory
    measured in Kbytes allocated to this process before it
    terminated."
::= { sysAppElmtPastRunEntry 9 }
```

```
sysAppElmtPastRunNumFiles OBJECT-TYPE
SYNTAX          Unsigned32 (0..'ffffffff'h)
MAX-ACCESS      read-only
STATUS          current
DESCRIPTION
    "The last known number of files open by the
    process before it terminated. Transport
    connections (sockets) should NOT be included in
    the calculation of this value."
::= { sysAppElmtPastRunEntry 10 }
```

```
sysAppElmtPastRunUser OBJECT-TYPE
SYNTAX          Utf8String
MAX-ACCESS      read-only
STATUS          current
DESCRIPTION
    "The process owner's login name (e.g. root)."
```

```
 ::= { sysAppElmtPastRunEntry 11 }
```

-- Additional Scalar objects to control table sizes

```
sysApplPastRunMaxRows OBJECT-TYPE
SYNTAX          Unsigned32 (0..'ffffffff'h)
MAX-ACCESS      read-write
STATUS          current
DESCRIPTION
    "The maximum number of entries allowed in the
    sysApplPastRunTable. Once the number of rows in
    the sysApplPastRunTable reaches this value, the
    management subsystem will remove the oldest entry
    in the table to make room for the new entry to be added.
    Entries will be removed on the basis of oldest
    sysApplPastRunTimeEnded value first.
```

This object may be used to control the amount of system resources that can be used for sysApplPastRunTable entries. A conforming implementation should attempt to support the default value, however, a lesser value may be necessary due to implementation-dependent issues and resource availability."


```

DEFVAL      { 500 }
 ::= { sysApplRun 5 }

```

sysApplPastRunTableRemItems OBJECT-TYPE

```

SYNTAX      Counter32
MAX-ACCESS  read-only
STATUS      current

```

DESCRIPTION

"A counter of the number of entries removed from the sysApplPastRunTable because of table size limitations as set in sysApplPastRunMaxRows. This counter is the number of entries the management subsystem has had to remove in order to make room for new entries (so as not to exceed the limit set by sysApplPastRunMaxRows) since the last initialization of the management subsystem."

```
 ::= { sysApplRun 6 }
```

sysApplPastRunTblTimeLimit OBJECT-TYPE

```

SYNTAX      Unsigned32 (0..'ffffffff'h)
UNITS       "seconds"
MAX-ACCESS  read-write
STATUS      current

```

DESCRIPTION

"The maximum time in seconds which an entry in the sysApplPastRunTable may exist before it is removed. Any entry that is older than this value will be removed (aged out) from the table."

Note that an entry may be aged out prior to reaching this time limit if it is the oldest entry in the table and must be removed to make space for a new entry so as to not exceed sysApplPastRunMaxRows."

```

DEFVAL      { 7200 }
 ::= { sysApplRun 7 }

```

sysApplElemPastRunMaxRows OBJECT-TYPE

```

SYNTAX      Unsigned32 (0..'ffffffff'h)
MAX-ACCESS  read-write
STATUS      current

```

DESCRIPTION

"The maximum number of entries allowed in the sysApplElmtPastRunTable. Once the number of rows in the sysApplElmtPastRunTable reaches this value, the management subsystem will remove the oldest entry to make room for the new entry to be added. Entries will be removed on the basis of oldest sysApplElmtPastRunTimeEnded value first."

This object may be used to control the amount of system resources that can be used for sysAppElemPastRunTable entries. A conforming implementation should attempt to support the default value, however, a lesser value may be necessary due to implementation-dependent issues and resource availability."

```
DEFVAL      { 500 }
::= { sysApplRun 8 }
```

sysAppElemPastRunTableRemItems OBJECT-TYPE

```
SYNTAX      Counter32
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION
```

"A counter of the number of entries removed from the sysAppElemPastRunTable because of table size limitations as set in sysAppElemPastRunMaxRows. This counter is the number of entries the management subsystem has had to remove in order to make room for new entries (so as not to exceed the limit set by sysAppElemPastRunMaxRows) since the last initialization of the management subsystem."

```
::= { sysApplRun 9 }
```

sysAppElemPastRunTblTimeLimit OBJECT-TYPE

```
SYNTAX      Unsigned32 (0..'ffffffff'h)
UNITS       "seconds"
MAX-ACCESS  read-write
STATUS      current
DESCRIPTION
```

"The maximum time in seconds which an entry in the sysAppElemPastRunTable may exist before it is removed. Any entry that is older than this value will be removed (aged out) from the table.

Note that an entry may be aged out prior to reaching this time limit if it is the oldest entry in the table and must be removed to make space for a new entry so as to not exceed sysAppElemPastRunMaxRows."

```
DEFVAL      { 7200 }
::= { sysApplRun 10 }
```

sysApplAgentPollInterval OBJECT-TYPE

```
SYNTAX      Unsigned32 (0..'ffffffff'h)
UNITS       "seconds"
MAX-ACCESS  read-write
STATUS      current
DESCRIPTION
```

"The minimum interval in seconds that the management

subsystem implementing this MIB will poll the status of the managed resources. Because of the non-trivial effort involved in polling the managed resources, and because the method for obtaining the status of the managed resources is implementation-dependent, a conformant implementation may chose a lower bound greater than 0.

A value of 0 indicates that there is no delay in the passing of information from the managed resources to the agent."

```
DEFVAL      { 60 }  
::= { sysApplRun 11 }
```

```
-- sysApplMap Group  
-- This group contains a table, the sysApplMapTable,  
-- whose sole purpose is to provide a 'backwards'  
-- mapping so that, given a known sysApplElmtRunIndex  
-- (process identification number), the corresponding invoked  
-- application (sysApplRunIndex), installed element  
-- (sysApplInstallElmtIndex), and installed application  
-- package (sysApplInstallPkgIndex) can be quickly determined.  
--  
-- The table will contain one entry for each process  
-- currently running on the system.  
--  
-- A backwards mapping is extremely useful since the tables  
-- in this MIB module are typically indexed with the  
-- installed application package (sysApplInstallPkgIndex)  
-- as the primary key, and on down as required by the  
-- specific table, with the process ID number (sysApplElmtRunIndex)  
-- being the least significant key.  
--  
-- It is expected that management applications will use  
-- this mapping table by doing a 'GetNext' operation with  
-- the known process ID number (sysApplElmtRunIndex) as the partial  
-- instance identifier. Assuming that there is an entry for  
-- the process, the result should return a single columnar value,  
-- the sysApplMapInstallPkgIndex, with the sysApplElmtRunIndex,  
-- sysApplRunIndex, and sysApplInstallElmtIndex contained in the  
-- instance identifier for the returned MIB object value.  
--  
-- NOTE: if the process can not be associated back to an  
-- invoked application installed on the system, then the  
-- value returned for the columnar value sysApplMapInstallPkgIndex  
-- will be '0' and the instance portion of the object-identifier  
-- will be the process ID number (sysApplElmtRunIndex) followed
```

-- by 0.0.

sysApplMapTable OBJECT-TYPE

SYNTAX SEQUENCE OF SysApplMapEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"The sole purpose of this table is to provide a 'backwards' mapping so that, given a known sysApplElmtRunIndex (process identification number), the corresponding invoked application (sysApplRunIndex), installed element (sysApplInstallElmtIndex), and installed application package (sysApplInstallPkgIndex) can be quickly determined.

This table will contain one entry for each process that is currently executing on the system.

It is expected that management applications will use this mapping table by doing a 'GetNext' operation with the known process ID number (sysApplElmtRunIndex) as the partial instance identifier. Assuming that there is an entry for the process, the result should return a single columnar value, the sysApplMapInstallPkgIndex, with the sysApplElmtRunIndex, sysApplRunIndex, and sysApplInstallElmtIndex contained in the instance identifier for the returned MIB object value.

NOTE: if the process can not be associated back to an invoked application installed on the system, then the value returned for the columnar value sysApplMapInstallPkgIndex will be '0' and the instance portion of the object-identifier will be the process ID number (sysApplElmtRunIndex) followed by 0.0."

::= { sysApplMap 1 }

sysApplMapEntry OBJECT-TYPE

SYNTAX SysApplMapEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"A logical row representing a process currently running on the system. This entry provides the index mapping from process identifier, back to the invoked application, installed element, and finally, the installed application package. The entry includes only one accessible columnar object, the sysApplMapInstallPkgIndex, but the invoked application and installed element can be

determined from the instance identifier since they form part of the index clause."

```

INDEX { sysApplElmtRunIndex, sysApplElmtRunInvocID,
        sysApplMapInstallElmtIndex }
 ::= { sysApplMapTable 1 }

SysApplMapEntry ::= SEQUENCE {
    sysApplMapInstallElmtIndex      Unsigned32,
    sysApplMapInstallPkgIndex       Unsigned32
}

sysApplMapInstallElmtIndex OBJECT-TYPE
    SYNTAX      Unsigned32 (0..'ffffffff'h)
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
        "The index into the sysApplInstallElmtTable. The
        value of this object is the same value as the
        sysApplInstallElmtIndex for the application element
        of which this entry represents a running instance.
        If this process cannot be associated to an installed
        executable, the value should be '0'."
    ::= { sysApplMapEntry 1 }

sysApplMapInstallPkgIndex OBJECT-TYPE
    SYNTAX      Unsigned32 (0..'ffffffff'h)
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The value of this object identifies the installed
        software package for the application of which this
        process is a part. Provided that the process's 'parent'
        application can be determined, the value of this object
        is the same value as the sysApplInstallPkgIndex for the
        entry in the sysApplInstallPkgTable that corresponds
        to the installed application of which this process
        is a part.

        If, however, the 'parent' application cannot be
        determined, (for example the process is not part
        of a particular installed application), the value
        for this object is then '0', signifying that this
        process cannot be related back to an application,
        and in turn, an installed software package."
    ::= { sysApplMapEntry 2 }

```

-- Conformance Macros

```

sysApplMIBCompliances OBJECT IDENTIFIER ::= { sysApplConformance 1 }
sysApplMIBGroups       OBJECT IDENTIFIER ::= { sysApplConformance 2 }

```

```

sysApplMIBCompliance MODULE-COMPLIANCE

```

```

    STATUS current

```

```

    DESCRIPTION

```

```

        "Describes the requirements for conformance to
        the System Application MIB"

```

```

    MODULE -- this module

```

```

        MANDATORY-GROUPS { sysApplInstalledGroup,
                            sysApplRunGroup, sysApplMapGroup }

```

```

    ::= { sysApplMIBCompliances 1 }

```

```

sysApplInstalledGroup OBJECT-GROUP

```

```

    OBJECTS { sysApplInstallPkgManufacturer,
              sysApplInstallPkgProductName,
              sysApplInstallPkgVersion,
              sysApplInstallPkgSerialNumber,
              sysApplInstallPkgDate,
              sysApplInstallPkgLocation,
              sysApplInstallElmtName,
              sysApplInstallElmtType,
              sysApplInstallElmtDate,
              sysApplInstallElmtPath,
              sysApplInstallElmtSizeHigh,
              sysApplInstallElmtSizeLow,
              sysApplInstallElmtRole,
              sysApplInstallElmtModifyDate,
              sysApplInstallElmtCurSizeHigh,
              sysApplInstallElmtCurSizeLow }

```

```

    STATUS current

```

```

    DESCRIPTION

```

```

        "The system application installed group contains
        information about applications and their constituent
        components which have been installed on the host system."

```

```

    ::= { sysApplMIBGroups 1 }

```

```

sysApplRunGroup OBJECT-GROUP

```

```

    OBJECTS { sysApplRunStarted,
              sysApplRunCurrentState,
              sysApplPastRunStarted,
              sysApplPastRunExitState,
              sysApplPastRunTimeEnded,
              sysApplElmtRunInstallID,
              sysApplElmtRunTimeStarted,
              sysApplElmtRunState,
              sysApplElmtRunName,
              sysApplElmtRunParameters,

```

```

        sysApplElmtRunCPU,
        sysApplElmtRunMemory,
        sysApplElmtRunNumFiles,
        sysApplElmtRunUser,
        sysApplElmtPastRunInstallID,
        sysApplElmtPastRunTimeStarted,
        sysApplElmtPastRunTimeEnded,
        sysApplElmtPastRunName,
        sysApplElmtPastRunParameters,
        sysApplElmtPastRunCPU,
        sysApplElmtPastRunMemory,
        sysApplElmtPastRunNumFiles,
        sysApplElmtPastRunUser,
        sysApplPastRunMaxRows,
        sysApplPastRunTableRemItems,
        sysApplPastRunTblTimeLimit,
        sysApplElemPastRunMaxRows,
        sysApplElemPastRunTableRemItems,
        sysApplElemPastRunTblTimeLimit,
        sysApplAgentPollInterval }
STATUS    current
DESCRIPTION
    "The system application run group contains information
    about applications and associated elements which have
    run or are currently running on the host system."
 ::= { sysApplMIBGroups 2 }

sysApplMapGroup OBJECT-GROUP
OBJECTS { sysApplMapInstallPkgIndex }
STATUS    current
DESCRIPTION
    "The Map Group contains a single table, sysApplMapTable,
    that provides a backwards mapping for determining the
    invoked application, installed element, and installed
    application package given a known process identification
    number."
 ::= { sysApplMIBGroups 3 }

END

```

7. Implementation Issues

This section discusses implementation issues that are important for both an agent developer, and a management application developer or user to understand with regards to this MIB module. Although this section does not attempt to prescribe a particular implementation strategy, it does attempt to recognize some of the real world limitations that could effect an implementation of this MIB module.

7.1. Implementation with Polling Agents

Implementations of the System Application MIB on popular operating systems might require some considerable processing power to obtain status information from the managed resources. It might also be difficult to determine when an application or a process starts or finishes. Implementors of this MIB might therefore choose an implementation approach where the agent polls the managed resources at regular intervals. The information retrieved by every poll is used to update a cached version of this MIB maintained inside of the agent. SNMP request are processed based on the information found in this MIB cache.

A scalar `sysApplAgentPollInterval` is defined to give the manager control over the polling frequency. There is a trade-off between the amount of resources consumed during every poll to update the MIB cache, and the accuracy of the information provided by the System Application MIB agent. A default value of 60 seconds is defined to keep the processing overhead low, while providing usable information for long-lived processes. A manager is expected to adjust this value if more accurate information about short-lived applications or processes is needed, or if the amount of resources consumed by the agent is too high.

7.2. `sysApplElmtPastRunTable` Entry Collisions

The `sysApplElmtPastRunTable` maintains a history of processes which have previously executed on the host as part of an application. Information is moved from the `sysApplElmtRunTable` to this `PastRun` table when the process represented by the entry terminates.

The `sysApplElmtPastRunTable` is indexed by the tuple, (`sysApplElmtPastRunInvocID`, `sysApplElmtPastRunIndex`), where the first part identifies the application invocation of which the process was a part, and the second part identifies the process itself.

Recall that the `sysApplElmtRunIndex` represents the system's unique identification number assigned to a running process and that this value is mapped to `sysApplElmtPastRunIndex` when the process

terminates and the entry's information is moved from the sysApplElmtRunTable to the sysApplElmtPastRunTable. Many systems re-use process ID numbers which are no longer assigned to running processes; typically, the process numbers wrap and the next available process number is used.

It is therefore possible for two entries in the sysApplElmtPastRun Table to have the same value for sysApplElmtPastRunIndex. For this reason, entries in the ElmtPastRun table are indexed by the tuple sysApplElmtPastRunInvocID, sysApplElmtPastRunIndex to reduce the chance of a collision by two past run elements with the same sysApplElmtPastRunIndex.

However, it is still possible, though unlikely, for a collision to occur if the following happens:

- 1) the invoked application (identified by InvocID), has an element which runs, terminates, and is moved into the sysApplElmtPastRun table (index: InvocID, RunIndex)
- 2) the numbers used for the system's process identification numbering wrap
- 3) that same invoked application (same InvocID), has another element process run, AND that process is assigned the same identification number as one of the processes previously run by that invoked application (same RunIndex), and finally,
- 4) that element process terminates and is moved to the sysApplElmtPastRun table prior to the old, duplicate (InvocID, RunIndex) entry being aged out of the table by settings defined for sysApplElmtPastRunMaxRows and sysApplElmtPastRunTblTimeLimit.

In the event that a collision occurs, the new entry will replace the old entry.

8. Security Considerations

In order to implement this MIB, an agent must make certain management information available about various logical and physical entities within a managed system which may be considered sensitive in some network environments.

Therefore, a network administrator may wish to employ instance-level access control, and configure the access mechanism (i.e., community strings in SNMPv1 and SNMPv2C), such that certain instances within this MIB are excluded from particular MIB views.

9. Acknowledgements

This document was produced by the Application MIB working group. Special acknowledgement is made to:

Rick Sturm
Enterprise Management Professional Services, Inc.
sturm@emi-summit.com
For hosting the working group mailing list, and for his participation in the development of the initial draft.

Jon Weinstock
General Instrument Corporation
jweinstock@gic.gi.com
For his participation in the development of the initial drafts and for serving as editor for drafts 1 and 2.

The editor would like to extend special thanks to the following working group members for their contributions to this effort.

Harald Alvestrand, George Best, Ian Hanson, Harrie Hazewinkel, Carl Kalbfleisch, Bobby Krupczak, Randy Presuhn, Jon Saperia, Juergen Schoenwaelder

11. Author's Address

Cheryl Krupczak
Empire Technologies, Inc.
541 Tenth Street, NW Suite 169
Atlanta, GA 30318

Phone: 770.384.0184
EMail: cheryl@empiretech.com

Jonathan Saperia
BGS Systems Inc.
saperia@networks.bgs.com

12. References

- [1] Information processing systems - Open Systems Interconnection - Specification of Abstract Syntax Notation One (ASN.1), International Organization for Standardization. International Standard 8824, (December, 1987).

- [2] SNMPv2 Working Group, Case, J., McCloghrie, K., Rose, M., and S. Waldbusser, "Structure of Management Information for Version 2 of the Simple Network Management Protocol (SNMPv2)", RFC 1902, January 1996.
- [3] SNMPv2 Working Group, Case, J., McCloghrie, K., Rose, M., and S. Waldbusser, "Textual Conventions for Version 2 of the Simple Network Management Protocol (SNMPv2)", RFC 1903, January 1996.
- [4] SNMPv2 Working Group, Case, J., McCloghrie, K., Rose, M., and S. Waldbusser, "Conformance Statements for Version 2 of the Simple Network Management Protocol (SNMPv2)", RFC 1904, January 1996.
- [5] SNMPv2 Working Group, Case, J., McCloghrie, K., Rose, M., and S. Waldbusser, "Protocol Operations for Version 2 of the Simple Network Management Protocol (SNMPv2)", RFC 1905, January 1996.
- [6] SNMPv2 Working Group, Case, J., McCloghrie, K., Rose, M., and S. Waldbusser, "Transport Mappings for SNMPv2", RFC 1906, January 1996.
- [7] SNMPv2 Working Group, Case, J., McCloghrie, K., Rose, M., and S. Waldbusser, "Management Information Base for Version 2 of the Simple Network Management Protocol (SNMPv2)", RFC 1907, January 1996.
- [8] SNMPv2 Working Group, Case, J., McCloghrie, K., Rose, M., and S. Waldbusser, "Coexistence between Version 1 and Version 2 of the Internet-standard Network Management Framework", RFC 1908, January 1996.
- [9] Grillo, P., and S. Waldbusser, "Host Resources MIB", RFC 1514, September 1993.
- [10] Yergeau, F., "UTF-8, a transformation format of Unicode and ISO 10646", RFC 2044, October 1996.
- [11] Krupczak, C., and S. Waldbusser, "Applicability of Host Resources MIB to Application Management", Application MIB working group report, October 1995.

12. Full Copyright Statement

Copyright (C) The Internet Society (1998). All Rights Reserved.

This document and translations of it may be copied and furnished to others, and derivative works that comment on or otherwise explain it or assist in its implementation may be prepared, copied, published and distributed, in whole or in part, without restriction of any kind, provided that the above copyright notice and this paragraph are included on all such copies and derivative works. However, this document itself may not be modified in any way, such as by removing the copyright notice or references to the Internet Society or other Internet organizations, except as needed for the purpose of developing Internet standards in which case the procedures for copyrights defined in the Internet Standards process must be followed, or as required to translate it into languages other than English.

The limited permissions granted above are perpetual and will not be revoked by the Internet Society or its successors or assigns.

This document and the information contained herein is provided on an "AS IS" basis and THE INTERNET SOCIETY AND THE INTERNET ENGINEERING TASK FORCE DISCLAIMS ALL WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY WARRANTY THAT THE USE OF THE INFORMATION HEREIN WILL NOT INFRINGE ANY RIGHTS OR ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

