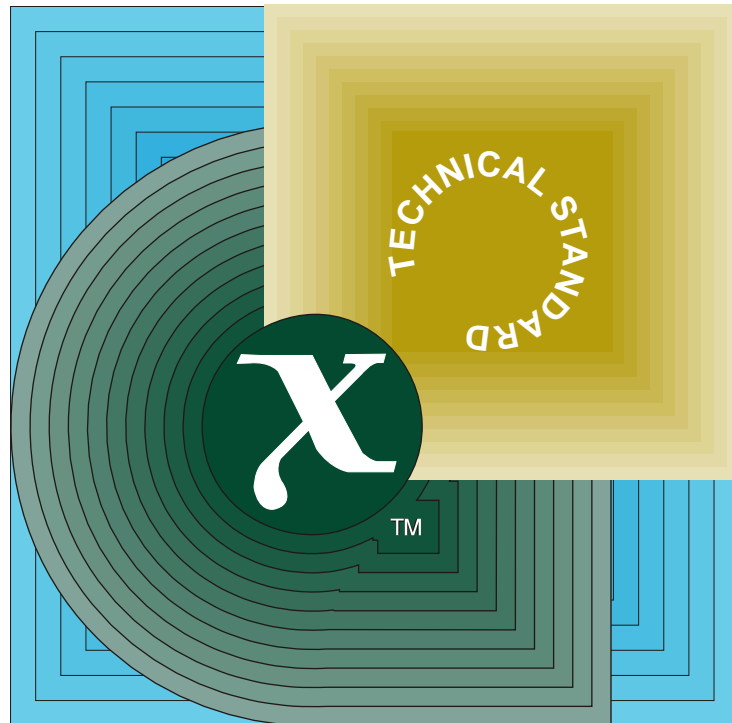


Technical Standard

Systems Management: Application Response Measurement (ARM) API



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/ Open Group Technical Standard

Systems Management: Application Response Measurement (ARM) API

The Open Group



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Open Group Technical Standard

Systems Management: Application Response Measurement (ARM) API

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Any comments relating to the material contained in this document may be submitted to:

The Open Group
Apex Plaza
Forbury Road
Reading
Berkshire, RG1 1AX
United Kingdom

or by Electronic Mail to:

OGSpecs@opengroup.org

Contents

Chapter 1	Introduction.....	1
1.1	Scope and Purpose.....	1
1.2	Measuring Service Levels.....	2
1.3	ARMing Your Applications	3
1.4	ARM Version 1.0 and Version 2.0	4
Chapter 2	Instrumenting an Application.....	5
2.1	Basic Tasks.....	5
2.2	What to Instrument	6
Chapter 3	ARM API Function Calls.....	7
3.1	Overview	7
3.2	Valid Call Sequences	8
3.3	ARM API Function Call Parameters	9
3.4	Definition of Data Type Terminology.....	10
3.4.1	Standard API Calls	10
3.4.2	More Advanced Functions.....	10
3.5	Function Call Reference Pages	10
	<i>arm_end()</i>	11
	<i>arm_getid()</i>	12
	<i>arm_init()</i>	14
	<i>arm_start()</i>	16
	<i>arm_stop()</i>	17
	<i>arm_update()</i>	19
Chapter 4	Advanced Topics	21
4.1	Additional Data Passed in ARM Function Calls	21
4.1.1	Transaction Correlation.....	21
4.1.2	Application-Defined Metrics.....	23
4.1.3	Choosing a Data Type.....	24
4.1.4	Format of Data Buffer in <i>arm_getid</i>	26
4.1.5	Data Type Definitions	27
4.1.6	Format of Data Buffer in <i>arm_start/arm_update/arm_stop</i>	28
4.2	Three Ways to Instrument within a Transaction Instance	32
4.3	Internationalization.....	33
Appendix A	<arm.h> Header File.....	35
Appendix B	Measurement Agent Information	41
B.1	Agents and Correlators.....	41
B.2	Format of the Correlator.....	42

Appendix C	The ARM Software Developers Kit (SDK)	47
C.1	Content.....	47
C.2	The ARM Shared Library.....	47
C.3	Logging Agent.....	48
Appendix D	Adding ARM Function Calls to an Application	49
Appendix E	Testing Your Instrumentation	51
E.1	Procedure.....	51
E.2	Logging Agent Sample Output.....	52
Appendix F	Examples	53
F.1	C/C++ (all platforms) Sample 1.....	53
F.2	C/C++ (all platforms) Sample 2.....	57
	Glossary	63
	Index	65
 List of Figures		
1-1	ARM in the Enterprise	3
3-1	Valid Call Sequences for ARM API Functions.....	8
4-1	Transaction Response Time Correlation.....	22

Preface

The Open Group

The Open Group is the leading vendor-neutral, international consortium for buyers and suppliers of technology. Its mission is to cause the development of a viable global information infrastructure that is ubiquitous, trusted, reliable, and as easy-to-use as the telephone. The essential functionality embedded in this infrastructure is what we term the *IT DialTone*. The Open Group creates an environment where all elements involved in technology development can cooperate to deliver less costly and more flexible IT solutions.

Formed in 1996 by the merger of the X/Open Company Ltd. (founded in 1984) and the Open Software Foundation (founded in 1988), The Open Group is supported by most of the world's largest user organizations, information systems vendors, and software suppliers. By combining the strengths of open systems specifications and a proven branding scheme with collaborative technology development and advanced research, The Open Group is well positioned to meet its new mission, as well as to assist user organizations, vendors, and suppliers in the development and implementation of products supporting the adoption and proliferation of systems which conform to standard specifications.

With more than 200 member companies, The Open Group helps the IT industry to advance technologically while managing the change caused by innovation. It does this by:

- Consolidating, prioritizing, and communicating customer requirements to vendors
- Conducting research and development with industry, academia, and government agencies to deliver innovation and economy through projects associated with its Research Institute
- Managing cost-effective development efforts that accelerate consistent multi-vendor deployment of technology in response to customer requirements
- Adopting, integrating, and publishing industry standard specifications that provide an essential set of blueprints for building open information systems and integrating new technology as it becomes available
- Licensing and promoting the Open Brand, represented by the "X" Device, that designates vendor products which conform to Open Group Product Standards
- Promoting the benefits of the IT DialTone to customers, vendors, and the public

The Open Group operates in all phases of the open systems technology lifecycle including innovation, market adoption, product development, and proliferation. Presently, it focuses on seven strategic areas: open systems application platform development, architecture, distributed systems management, interoperability, distributed computing environment, security, and the information superhighway. The Open Group is also responsible for the management of the UNIX trademark on behalf of the industry.

Development of Product Standards

This process includes the identification of requirements for open systems and, now, the IT DialTone, development of Technical Standards (formerly CAE and Preliminary Specifications) through an industry consensus review and adoption procedure (in parallel with formal standards work), and the development of tests and conformance criteria.

This leads to the preparation of a Product Standard which is the name used for the documentation that records the conformance requirements (and other information) to which a vendor may register a product.

The “X” Device is used by vendors to demonstrate that their products conform to the relevant Product Standard. By use of the Open Brand they guarantee, through the Open Brand Trade Mark License Agreement (TMLA), to maintain their products in conformance with the Product Standard so that the product works, will continue to work, and that any problems will be fixed by the vendor.

Open Group Publications

The Open Group publishes a wide range of technical documentation, the main part of which is focused on development of Technical Standards and product documentation, but which also includes Guides, Snapshots, Technical Studies, Branding and Testing documentation, industry surveys, and business titles.

There are several types of specification:

- *Technical Standards* (formerly *CAE Specifications*)

The Open Group Technical Standards form the basis for our Product Standards. These Standards are intended to be used widely within the industry for product development and procurement purposes.

Anyone developing products that implement a Technical Standard can enjoy the benefits of a single, widely supported industry standard. Where appropriate, they can demonstrate product compliance through the Open Brand. Technical Standards are published as soon as they are developed, so enabling vendors to proceed with development of conformant products without delay.

- *CAE Specifications*

CAE Specifications and Developers' Specifications published prior to January 1998 have the same status as Technical Standards (see above).

- *Preliminary Specifications*

Preliminary Specifications have usually addressed an emerging area of technology and consequently are not yet supported by multiple sources of stable conformant implementations. They are published for the purpose of validation through implementation of products. A Preliminary Specification is as stable as can be achieved, through applying The Open Group's rigorous development and review procedures.

Preliminary Specifications are analogous to the *trial-use* standards issued by formal standards organizations, and developers are encouraged to develop products on the basis of them. However, experience through implementation work may result in significant (possibly upwardly incompatible) changes before its progression to becoming a Technical Standard. While the intent is to progress Preliminary Specifications to corresponding Technical Standards, the ability to do so depends on consensus among Open Group members.

- *Consortium and Technology Specifications*

The Open Group publishes specifications on behalf of industry consortia. For example, it publishes the NMF SPIRIT procurement specifications on behalf of the Network Management Forum. It also publishes Technology Specifications relating to OSF/1, DCE, OSF/Motif, and CDE.

Technology Specifications (formerly AES Specifications) are often candidates for consensus review, and may be adopted as Technical Standards, in which case the relevant Technology Specification is superseded by a Technical Standard.

In addition, The Open Group publishes:

- *Product Documentation*

This includes product documentation—programmer's guides, user manuals, and so on—relating to the Pre-structured Technology Projects (PSTs), such as DCE and CDE. It also includes the Single UNIX Documentation, designed for use as common product documentation for the whole industry.

- *Guides*

These provide information that is useful in the evaluation, procurement, development, or management of open systems, particularly those that relate to the Technical Standards or Preliminary Specifications. The Open Group Guides are advisory, not normative, and should not be referenced for purposes of specifying or claiming conformance to a Product Standard.

- *Technical Studies*

Technical Studies present results of analyses performed on subjects of interest in areas relevant to The Open Group's Technical Program. They are intended to communicate the findings to the outside world so as to stimulate discussion and activity in other bodies and the industry in general.

Versions and Issues of Specifications

As with all *live* documents, Technical Standards and Specifications require revision to align with new developments and associated international standards. To distinguish between revised specifications which are fully backwards compatible and those which are not:

- A new *Version* indicates there is no change to the definitive information contained in the previous publication of that title, but additions/extensions are included. As such, it *replaces* the previous publication.
- A new *Issue* indicates there is substantive change to the definitive information contained in the previous publication of that title, and there may also be additions/extensions. As such, both previous and new documents are maintained as current publications.

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Readers should note that Corrigenda may apply to any publication. Corrigenda information is published on the World-Wide Web at <http://www.opengroup.org/corrigenda>.

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This Document

This document is an Open Group Technical Standard. It defines the Application Response Measurement (ARM) API function calls which can be used to instrument an application or other software for transaction monitoring. The ARM API provides a way to monitor business transactions, by embedding simple calls in the software which can be captured by an agent supporting the ARM API. The calls are used to capture data that allows software to be monitored for availability, service levels, and capacity.

The API can be used by programmers who want to collect performance information by instrumenting the business logic of their applications or on other software in their domain. This approach may be used by customers who have access to the source code of the business logic on their systems in such a way that instrumentation is possible or by the use of non-invasive techniques that may supply some of the data without instrumentation. Neither the collection or presentation mechanism of the ARM data returned from the API is covered in this standard.

Collection of ARM related data from the software components which surround the business logic is often very desirable, and may in many cases be possible by using ARM 2.0, but more work is needed in this area to encourage the software components to use the ARM API. This will take the form of the expansion of future versions of the ARM API, or definition of other mechanisms which can support these very diverse software environments.

It should further be noted that the applications (and other components) must normally be running within the reach of the enterprise management domain in order to allow for collection and presentation of performance data from agents, through some vendor specific mechanisms.

This Technical Standard is the formally adopted Open Group publication of the ARM API version 2.0 specification.

History

The Application Response Measurement (ARM) working group of the Computer Measurement Group (CMG) published its ARM version 1.0 API specification in June 1996. It then issued its ARM version 2.0 API specification in November 1997. Then, in March 1998, it submitted the ARM version 2 API to The Open Group, which approved it for publication as an Open Group Technical Standard.

Typographical Conventions

The following typographical conventions are used throughout this document:

- **Bold** font is used in text for options to commands, filenames, keywords, type names, data structures and their members.
- *Italic* strings are used for emphasis or to identify the first instance of a word requiring definition. Italics in text also denote:
 - Command operands, command option-arguments, or variable names; for example, substitutable argument prototypes
 - Environment variables, which are also shown in capitals
 - Utility names
 - External variables, such as *errno*
 - Functions; these are shown as follows: *name()*. Names without parentheses are C external variables, C function family names, utility names, command operands, or command option-arguments.

Preface

- Normal font is used for the names of constants and literals.
- The notation `<file.h>` indicates a header.
- Names surrounded by braces, for example, `{ARG_MAX}`, represent symbolic limits or configuration values which may be declared in appropriate headers by means of the C `#define` construct.
- The notation `[ABCD]` is used to identify a return value `ABCD`, including if this is an error value.
- Syntax, code examples and user input in interactive examples are shown in fixed width font. Brackets shown in this font, `[]`, are part of the syntax and do not indicate optional items.

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Acknowledgements

This Technical Standard is the formally adopted Open Group publication of the ARM API version 2.0 specification.

The Open Group acknowledges the work of the ARM Working Group, under the sponsorship of the Computer Measurement Group (CMG), in developing the ARM version 2.0 API specification, which provides the technical source material for this Open Group Technical Standard. The following CMG ARM Working Group member companies assisted in the development of the ARM version 2.0 API:

System Management Vendors	Database and Tools Vendors	Application Vendors	End Users
BGS www.bgs.com	Oracle www.oracle.com	SAS www.sas.com	Boeing www.boeing.com
BMC www.bmc.com	Unify www.unify.com	SES www.ses.com	Citicorp www.citicorp.com
Candle www.candle.com			Wells Fargo www.wellsfargo.com
Compuware www.compuware.com			
Hewlett-Packard www.hp.com			
Landmark www.landmark.com			
Sun www.sun.com			
Tivoli/IBM www.tivoli.com			

Referenced Documents

Further information on performance measurement agents that use the data generated by the ARM API function calls, and additional information on ARM, such as White Papers and slides, is available via the World Wide Web. The pointer to this information can be found from the on-line version of this publication, which is available at:

`http://www.opengroup.org/publications/catalog/c807.htm`

On completion of the request to enter your identity, the table at the start of this on-line document shows the URL where further information may be found.

1.1 Scope and Purpose

The applications that are used to run businesses have changed dramatically over the past few years. In the early 1980s, large applications generally executed on large computers, and were accessed from "dumb" terminals. Non-networked applications executing on personal computers were just beginning to be widely used. Since then, these two application models have moved steadily towards each other, fusing together to form distributed (networked) applications.

The most common programming model for distributed applications is the client/server model. In a client/server application, the application is split into two or more parts. One part is the user or "client" part, and this part generally executes on a personal computer or workstation. The "server" parts execute on computers that provide functions for the client part, that is, they serve the client application. The client and server can run on the same system, but generally they are on different systems. The client part of an application may invoke one or more functions on one or more servers, and it may do a significant amount of processing itself combining, manipulating, or analyzing the data provided by the servers.

An example of a client/server application might be processing a sales order by retrieving inventory information from one database, sales information from another database, and pricing information from a third. The client part of the application determines if there is sufficient inventory to accept the order, calculates the price based on current market conditions, factors in price discounts for this particular customer, and then invokes more server functions to complete processing of the order.

By contrast, host-centric applications contain all the application logic in one computer system, and users connect through "dumb" terminals to use the application. Examples of the protocols used by these applications are 3270, Telnet, and X-Windows. The response time as seen by a user for a transaction can generally be broken down into two components: the time to process the transaction on the host, and the time for the input message and the output response. Processing time at the terminal is usually trivial.

1.2 Measuring Service Levels

A monitoring product running at the host is able to measure the service levels of host-centric applications. The monitor observes the input request message that starts the transaction, and then observes the outbound response back to the terminal. The difference between the two times is the amount of time to process the transaction on the host. The monitor generally also measures the time for the outbound response to be sent to the terminal and an acknowledgment to be received, using this as an approximation of the transit time. The combination of the host and transit times is an approximation of the service level seen by the user.

Monitoring the performance and the availability of distributed applications has not proved to be easy to do. Some of the fundamental assumptions that the host-centric methods depend on do not hold true. Some examples showing why this is so are:

- The user is typically running an application on a multitasking PC or workstation. When the user presses a key or the mouse button, the specified transaction starts, but the user may be able to continue doing other operations. Put another way, there is no reliable way to correlate keyboard or mouse input operations with business transactions.
- One user transaction (which would be classified as a business transaction) may spawn several other component transactions, some of which may execute locally and some remotely. Any measurement agents that exist only in the network layer or in a host (server) will not see the entire picture.
- The data may be sent through the network using various protocols, not just one, making the task of packet decoding and correlation much more difficult.
- Client/server applications can be complex, taking different execution paths and spawning different component transactions, depending on the results of previous component transactions. Every permutation could take a different form when it goes across the communication link, making it that much harder to reliably correlate network or host (server) observations with what the user sees.

In spite of these difficulties, the need to monitor distributed applications has never been greater. They are increasingly being used in mission-critical roles. An approach that solves the problems listed above is to let the application itself participate in the process. A developer knows unambiguously when transactions begin and end, both those that are visible to the user, and the component transactions that invoke transactions on remote servers.

1.3 ARMING Your Applications

With the Application Response Measurement (ARM) API, sections of an application can be marked to define business transactions. By invoking ARM API function calls at the beginning and end of each transaction, the application can be monitored by any of the measurement agents that use data generated by the ARM API. Programs executing on client or server systems can be instrumented.

By instrumenting an application to call the ARM API, that application can be managed by any of the measurement agents that implement ARM. The advantage of this approach is that the user of the application can choose the measurement agent that best meets their needs, without needing to change the application.

Using ARM, system administrators will be able to answer key questions such as:

- Is the application working correctly (available)?
- How is the application performing? What is the response time? What is the workload throughput? You will be measuring the actual service levels experienced by your users.
- Why is an application not available or performing poorly? What operation was the application performing when the problem occurred? If a remote server/application was being invoked when the problem occurred, which one?
- Who is using the application, how much are they using it, and what kind of operations are being performed? Which servers are providing the services? This information is useful for capacity planning and for charge-back accounting.

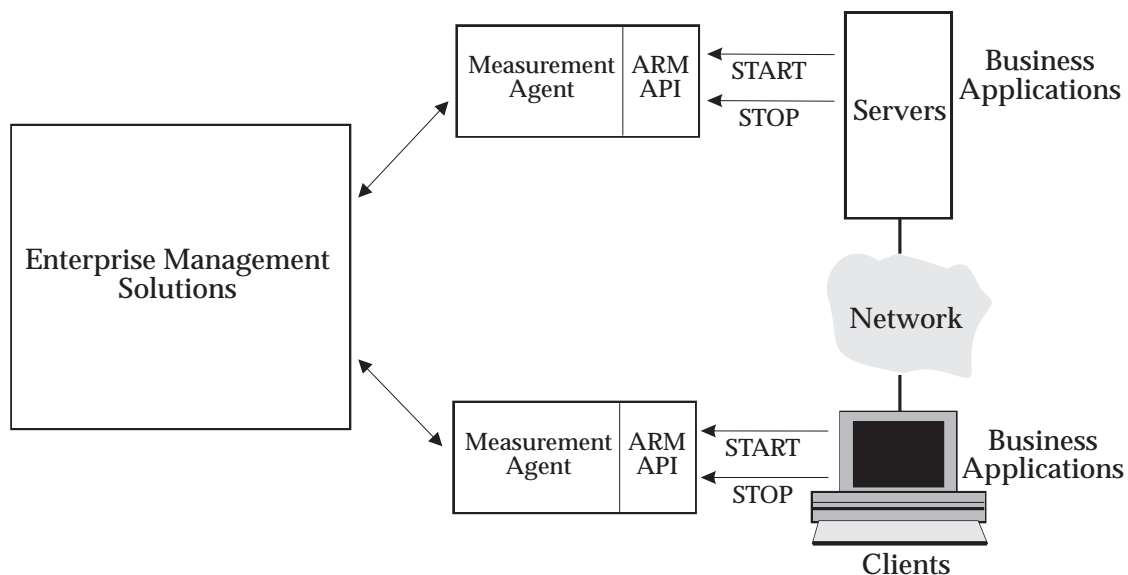


Figure 1-1 ARM in the Enterprise

This diagram shows how enterprise management applications, measurement agents that implement the ARM API, and business applications that call the ARM API, work together to provide a robust way to monitor application response.

1.4 ARM Version 1.0 and Version 2.0

The ARM version 1.0 API was not adopted or published by The Open Group. Nevertheless, since the ARM version 1.0 API has been released by the ARM working group of the CMG, it is appropriate to position this ARM version 2.0 API in the context of its predecessor.

Several additional features in ARM version 2.0 API improve the ways applications can be managed, compared to ARM version 1.0 API:

- You can indicate that a transaction is a component of another transaction. Also, you can do transaction correlation within one system or across multiple systems. This permits a better understanding of the overall transaction, how much time each part of the transaction is taking, and where problems are occurring.
- You can provide additional information about the transaction, such as the number of bytes or records being processed, or about the state of the application at the moment that the transaction is being processed, such as the length of a work queue. This information (called application-defined metrics) is useful to better understand response times, and how the application can be tuned to perform better.
- You can use the new logging agent to do simple verification of your instrumentation. It allows you to determine if the correct parameters are being passed on each call, but it does not function as a measurement agent.

ARM version 2.0 API is backward compatible with ARM version 1.0. Applications instrumented to the ARM 1.0 API will continue to function correctly with agents that implement the additional features of the ARM 2.0 API. Applications instrumented with ARM 2.0 will function correctly with agents that implement the features of ARM 1.0.

Instrumenting an Application

2.1 Basic Tasks

There are three basic tasks involved in instrumenting an application with the ARM API.

1. Define the key business transactions. This is the most important step. Each application developer needs to define who needs what kind of data, and what the data will be used for. It is common and useful for this process to be a joint collaboration between the users and developers of an application, and system and network administrators. There are two kinds of transactions that will generally provide the greatest benefit if they are instrumented. The following procedure is suggested:
 - Start with transactions that are visible to users or that represent major business operations. These are the building blocks for service level agreements, for workload monitoring, and for early problem detection.
 - Next, focus on transactions that are dependent on external services, such as a database operation, a Remote Procedure Call (RPC), or a remote queue operation. These generally are components of a user/business transaction. Knowing how these types of transactions are performing can be invaluable when analyzing problems, tuning applications, and reconfiguring systems and networks.
2. Modify the application to include calls to the ARM API¹. The key activity here is to decide where to place calls to the ARM API, by carefully defining the start and end of key business transactions.
3. Install an ARM-compliant agent and associated management applications². The distributed applications can then be monitored.

1. The NULL libraries and logging agent which are available in the ARM SDK (see Appendix C on page 47) can be used for initial testing.

2. If the NULL libraries or logging agent of the ARM SDK were used for testing, then they would be replaced by these ARM-compliant agent and associated management applications.

2.2 What to Instrument

The Application Response Measurement API is designed to instrument a unit of work, such as a business transaction, that is sensitive to performance time. These transactions should be something that needs to be measured, monitored, and for which corrective action can be taken if the performance is determined to be too slow.

This API is not designed to be a programmer profiling tool. The measurement agents using data generated by this API are designed to give application/system managers data to understand how their environment is performing, and whether all services are available.

For information on measurement agents that do transaction monitoring, refer to the CMG web site at <http://www.cmg.org/regions/cmgarmsw/>. Links may be found on this site to commercially available measurement agent solutions.

Some questions you may want to ask yourself when instrumenting a transaction are:

- What unit of work does this transaction define?
- Are the transaction counts and/or response times important?
- Who will use this information?
- If performance of this transaction is too slow, is there some corrective action that can take place (for example, offload work from the machine, add memory, relocate remote files, etc.)?

ARM API Function Calls

3.1 Overview

The ARM API is made up of a set of function calls that will normally be contained in a shared library. All the performance measurement agents that support the ARM API then provide their own implementation of the shared library.

When the ARM API function calls are included in an application, the performance of that application can be monitored by the agents that implement the shared library. The advantage of this approach is that it allows the user to select a measurement agent that best meets their needs without requiring any change to the application.

The set of ARM function calls is summarized below, in the logical order in which they may expect to be used:

- arm_init()* During the initialization of your application, call *arm_init()* which names your application and optionally the users, and initializes the ARM environment for your application. A unique identifier is returned that must be passed to *arm_getid()*.
- arm_getid()* Use *arm_getid()* to name each transaction class you use in your application. This is often done during the initialization of your application. A transaction class is a description of a unit of work, such as *Check Account Balance*. In each program, each transaction class may be executed once or many times. Call *arm_getid()* returns a unique identifier that must be passed to *arm_start()*.
- arm_start()* Each time a transaction class is executed, this is a transaction instance. Call *arm_start()* signals the start of execution of a transaction instance and returns a unique handle to be passed to *arm_update()* and *arm_stop()*.
- arm_update()* This is an optional function call that can be made any number of times after *arm_start()* and before *arm_stop()*. Call *arm_update()* gives information about the transaction instance, such as a *heartbeat* after a group of records has been processed.
- arm_stop()* Call *arm_stop()* signals the end of the transaction instance.
- arm_end()* At termination of the application, call *arm_end()* cleans up the ARM environment for your application. There should be no problem if this call is not made, but if it is not used then memory may be wasted because it is allocated by the agent even though it is no longer needed.

The workhorse functions are *arm_start()* and *arm_stop()*, which are called at the beginning and end of each executing transaction. There are two administrative calls used to define the application and transactions: *arm_init()* and *arm_getid()*. Call *arm_update()* is an optional call that can be used with long running transactions to provide an *I'm alive* heartbeat and a progress indicator. Call *arm_end()* is used when an application is shutting down, which allows an agent to release any storage used for monitoring this application.

3.2 Valid Call Sequences

The following diagram illustrates the valid call sequences for the ARM API. The dotted box encloses the call sequences valid for a specific transaction defined by a call to *arm_getid()*. This set of calls may be replicated for each defined transaction.

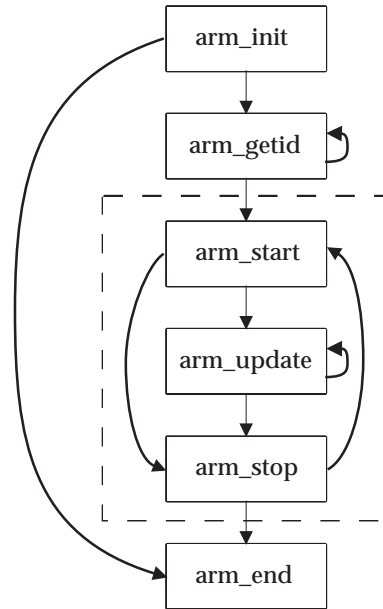


Figure 3-1 Valid Call Sequences for ARM API Functions

The following gives an example in an imaginary language showing the API calls:

```

arm_init ("Application Name", "User Name")
arm_getid ("Transaction A")
arm_getid ("Transaction B")
arm_getid ("Transaction C")

loop until program ends
  arm_start (A)

  arm_start (B)
  do some work
  arm_stop (B, status)

  arm_start (C)
  loop until transaction ends
  do some work
  arm_update (C)
  end loop
  arm_stop (C, status)

  arm_stop (A, status)
end loop
arm_end
  
```

3.3 ARM API Function Call Parameters

The following table shows which parameters are used in each of the ARM API function calls and what is passed on from one function call to another.

	<i>arm_init()</i>	<i>arm_getid()</i>	<i>arm_start()</i>	<i>arm_update()</i>	<i>arm_stop()</i>	<i>arm_end()</i>
<i>appl_name</i>	x					
<i>appl_user_id</i> (optional) (<i>user_name</i>)	x					
<i>tran_name</i>		x				
<i>tran_detail</i> (optional)		x				
<i>tran_status</i>					x	
<i>data</i> and <i>data_size</i> (optional)		x	x	x	x	
Return Codes: <i>appl_id</i> (appl/user) <i>tran_id</i> <i>start_handle</i> (transaction)						

indicates the code is returned from one call and passed to another

3.4 Definition of Data Type Terminology

The API calls use the terminology described in this section, to define each of the parameters.

3.4.1 Standard API Calls

The standard API calls use the following terminology to define each of the parameters:

`int32` A signed 32-bit integer.

`char*` A 32-bit or 64-bit pointer to a character string or data structure depending upon the operating system and/or the application mode of operation. Strings must be NULL terminated unless specified otherwise. Strings are expected to be displayed, put in reports, and so on, so appropriate characters should be chosen.

3.4.2 More Advanced Functions

The more advanced functions in the API use the following terminology to define each of the parameters:

`int64` A signed 64-bit integer.

`unsigned32` An unsigned 32-bit integer.

`unsigned64` An unsigned 64-bit integer.

`bit8` A byte containing 8 single-bit flags. In this document, when a `bit8` is represented as eight flags using the notation `abcdefgh`, `a` is the most significant bit, and `h` is the least significant bit.

`unsigned16` An unsigned 16-bit integer.

`unsigned8` An unsigned 8-bit integer.

These formats are in the native format of the hardware platform. This accommodates the difference between *Big-Endian* and *Little-Endian* systems, that is, the difference between hardware architectures in which the most significant bit position is on the left as opposed to the right.

3.5 Function Call Reference Pages

The ARM 2.0 function calls are defined in alphabetical order in the remainder of this Chapter:

- `arm_end()`
- `arm_getid()`
- `arm_init()`
- `arm_start()`
- `arm_stop()`
- `arm_update()`

NAME

arm_end — finish ARM activity.

SYNOPSIS

```
error_status=arm_end(appl_id,flags,data,data_size)
```

DESCRIPTION

Function *arm_end()* is used to close initiating new ARM API activity. It is typically called when an application/user instance is terminating. Each *arm_end()* is paired with one *arm_init()* to mark the end of an application.

An *arm_end()* is a signal from the application that it does not intend to issue any more *arm_getid()* calls using this *appl_id*, or any *arm_start()* calls using any TRAN_ID defined using this *appl_id*. After *arm_end()*, the measurement agent may ignore any *arm_getid()* or *arm_start()* calls. It is acceptable to call *arm_update()* or *arm_stop()* for any incomplete transaction instances started with *arm_start()*.

PARAMETERS

appl_id (int32)

A unique reference to an application/user identifier returned from the *arm_init()* call. If *appl_id* is less than zero, this *arm_end()* call will be treated as a NULL operation, and a negative *error_status* returned.

flags (int32)=0

Reserved for future use. It must be set to zero.

data (char*)=0

Reserved for future use. A NULL pointer (0) must be used.

data_size (int32)=0

Reserved for future use. It must be set to zero.

RETURN CODE

ERROR_STATUS

Contains a zero if successful and a negative value if an error occurred.

ERRORS

If the value returned in ERROR_STATUS is less than zero, an error occurred in communicating with the measurement agent. The most likely cause is passing an invalid value for *appl_id*. The error should be logged so that corrective action can be taken.

EXAMPLE

```
status = arm_end (my_appl_id, /* transaction handle */
                 0,0,0);      /* reserved for future use */
```

NAME

arm_getid — assign a unique identifier to a transaction class.

SYNOPSIS

```
tran_id=arm_getid(appl_id,tran_name,tran_detail,flags,data,data_size)
```

DESCRIPTION

The *arm_getid()* function call is used to assign a unique identifier to a transaction class, and optionally to describe the format of additional data passed on *arm_start()*, *arm_update()*, and *arm_stop()* calls. This is often done during the initialization of your application. The identifier returned by *arm_init()* is passed as a parameter in *arm_start()* calls to identify which class of transaction is starting.

A transaction class is a description of a unit of work, such as *Check Account Balance*. Any number of transaction classes can be defined within each application. The transaction class name should help a person understand what function the transaction performs. The call to *arm_getid()* need be made only once for each transaction class each time the application is started. A call to *arm_getid()* can be made with the same information as a previous call, in which case the transaction identifier (*tran_id*) that is returned will be the same as the previous calls. Four types of information are tested to see if the information is the same. If any of these are different, a different *tran_id* will be returned:

- The application identifier (*appl_id*).
- The transaction name (*tran_name*).
- The data pointer (*data*) was NULL on previous calls and is not NULL, or it was not NULL on previous calls and now it is NULL.
- If the data pointer (*data*) is not NULL on previous calls and this call, and the contents and size (*data_size*) of the buffer pointed to by the data parameter differ.

Any number of transaction classes can be defined within each application. In each application, each transaction class may be executed any number of times. Each time a transaction class is executed — via *arm_start()*— it is called a transaction instance. There can be any number of instances of each transaction class executing simultaneously.

PARAMETERS

appl_id (int32)

The unique reference to an application/user identifier returned from the *arm_init()* call. If the *appl_id* is less than zero, this *arm_getid()* call will be treated as a NULL operation, and a negative *tran_id* returned.

tran_name (char*)

The unique name of the transaction class. It is defined for each transaction class by the application developer. It must be unique within the application (for each *arm_init()* call). The maximum length is 128 bytes, including the NULL string terminator.

tran_detail (char*)

Transaction detail allows a developer to provide additional information about a transaction class. It is a free-form text area that is set once for each *appl_id/tran_name* pair. If the contents of the field change on later calls using the same *appl_id/tran_name* pair, the new contents are ignored. The maximum length is 128 bytes including the NULL string terminator. If no *tran_detail* is associated with this transaction, the NULL value (0) must be specified.

flags (int32)=0

Reserved for future use. It must be set to zero.

data (char*)

A pointer to a buffer that describes the format of additional data that can be passed on *arm_start()*, *arm_update()*, and *arm_stop()* calls. If no additional data is passed on these calls, this parameter must be set to zero (0). See Section 4.1.4 on page 26 for the format of the data buffer in *arm_getid()*.

data_size (int32)

The length in bytes of the buffer pointed to by *data*. If data is set to zero (0), *data_size* must also be set to zero.

RETURN CODES

tran_id (int32)

The unique identifier assigned for this transaction class. This id needs to be passed on *arm_start()* calls.

ERRORS

If the value returned in *tran_id* is less than zero, an error occurred in communicating with the measurement agent. The most likely cause is passing an invalid value for *appl_id*. The value returned on an error can be passed to *arm_start()*, which will cause *arm_start()* to function as a NULL operation. The error should be logged so corrective action can be taken.

EXAMPLE

```
my_tran_id = arm_getid (my_appl_id, /* application name */
                       "Part Number Query", /* transaction name */
                       "Call to Server XYZ", /* transaction details */
                       0, /* reserved for future use */
                       my_buffer_ptr, /* metrics data/metrics meta-data */
                       my_buffer_length); /* length of data buffer */
```

NAME

`arm_init` — define the application or a unique instance of the application and user.

SYNOPSIS

```
appl_id=arm_init(appl_name,appl_user_id,flags,data,data_size)
```

DESCRIPTION

Use `arm_init()` to define the application or a unique instance of the application and user. Function `arm_init()` must be called before any other ARM API calls. It is often called when an application initializes. The return code is an application/user identifier that is input as a parameter on `arm_getid()`, to associate transactions with the application.

Each application needs to be identified by a unique name. It is the developer's responsibility to choose a name that is meaningful but which is not duplicated by other developers. Suggestions for names would be the product name and version number, or a project name.

There can be any number of application instances executing simultaneously that use the same application name, or the same application and user names. A measurement agent may assign a unique application identifier to each application instance, or it may assign an identifier that is shared across identically named instances.

PARAMETERS

appl_name (char*)

The name used to identify the application. The maximum length is 128 bytes including the NULL string terminator.

appl_user_id (char*)

The name of the application user. On UNIX and Windows NT, this value can be set to "*" to indicate the login user ID of the person running the application. The maximum length is 128 bytes including the NULL string terminator. If no value is preferred for this parameter, it should be specified as NULL value (0).

flags (int32)=0

Reserved for future use. It must be set to zero.

data (char*)=0

Reserved for future use. A NULL value (0) must be used.

data_size (int32)=0

Reserved for future use. It must be set to zero.

RETURN CODE

appl_id (int32)

A unique value to reference an application/user identifier. This id must be passed to the `arm_getid` call.

ERRORS

If the value returned in *appl_id* is less than zero, an error occurred in communicating with the measurement agent. The value returned on an error can be passed to `arm_getid()`, which will cause `arm_getid()` to function as a NULL operation. The error should be logged so corrective action can be taken.

EXAMPLE

```
my_appl_id = arm_init ("Parts Inventory Manager 1.1", /* appl name */
                      "**",                          /* user id   */
                      0, 0, 0);                      /* reserved for future use */
```

NAME

arm_start — mark the beginning of execution of a transaction.

SYNOPSIS

```
start_handle=arm_start(tran_id,flags,data,data_size)
```

DESCRIPTION

Function *arm_start()* is used to mark the beginning of execution of a transaction. Each time a transaction executes, it is called a transaction instance. Function *arm_start()* must be called in an application at the beginning of each transaction instance required to be monitored.

Additional information about the transaction can be provided in the optional data buffer. If no additional information is provided, a NULL pointer must be passed. This information can be provided on any or all of the *arm_start()*, *arm_update()*, and *arm_stop()* calls, except for correlation information, which is passed only on *arm_start()*. See Chapter 4 for details on how to pass this information.

PARAMETERS

tran_id (int32)

The unique identifier assigned to the transaction class. This is the id generated by *arm_getid()*. If the *tran_id* is less than zero, this *arm_start()* call will be treated as a NULL operation, and a negative *start_handle* returned.

flags (int32)=0

Reserved for future use. It must be set to zero.

data (char*)

A pointer to a buffer with additional data that can optionally be passed. If no additional data is passed, this parameter must be set to zero (0). See Section 4.1.6 on page 28 for the description of the format of the data buffer in *arm_start()*, *arm_update()*, and *arm_stop()* function calls.

data_size (int32)

The length in bytes of the buffer pointed to by the *data* parameter. If *data* is set to zero (0), *data_size* must also be set to zero.

RETURN CODES

start_handle (int32)

The unique transaction handle assigned to this instance of a transaction. This handle must be passed on *arm_stop* and any *arm_update* calls.

ERRORS

If the value returned in *start_handle* is less than zero, an error occurred in communicating with the measurement agent. The most likely cause is passing an invalid value for *tran_id*. The value returned on an error can be passed to *arm_update()* and *arm_stop()* calls, which will cause these calls to function as NULL operations. The error should be logged so corrective action can be taken.

EXAMPLE

```
my_handle = arm_start (my_tran_id, /* transaction handle */
                      0,          /* reserved for future use */
                      my_buffer_ptr, /* metrics data/correlator */
                      my_buffer_length); /*length of data buffer */
```

NAME

arm_stop — mark the end of a transaction instance that was started with *arm_start()*.

SYNOPSIS

```
error_status=arm_stop(start_handle, tran_status, flags, data, data_size)
```

DESCRIPTION

Function *arm_stop()* is used to mark the end of a transaction instance that was started with *arm_start()*. It should be called from your application program just after each transaction instance ends.

In addition to signaling the end of the transaction instance, which allows a measurement agent to calculate the elapsed time since the *arm_start()*, additional information about the transaction can be provided in the optional data buffer. This information can be provided on any or all of the *arm_start()*, *arm_update()*, and *arm_stop()* calls.

PARAMETERS

start_handle (int32)

The unique handle from the *arm_start()* call that marked the start of this transaction instance. *start_handle* must be passed in each *arm_stop()* call. Many transaction instances may be executing at the same time from this and other applications, so this handle is essential for the measurement agent to use to identify which transaction instance is stopping. If *start_handle* is less than zero, this *arm_stop()* call will be treated as a NULL operation, and a negative ERROR_STATUS returned.

tran_status (int32)

The completion code of the transaction, as determined by the application.

- 0 Transaction successful (defined as ARM_GOOD in <arm.h>). Use this value when the operation completed normally and as expected.
- 1 Transaction aborted (defined as ARM_ABORT in <arm.h>). Use this value when there was a fundamental failure in the system. For example, a timeout from a communications protocol stack, or an error when doing a database operation.
- 2 Transaction failed (defined as ARM_FAILED in <arm.h>). Use this value in applications where the transaction worked properly, but no result was generated. For example, when making an airline reservation, a server indicates no seats are available on the requested flight. Since no reservation was made, the transaction was not successful; however, since the reservation system is operating correctly, it is not an aborted transaction either. In this case, it might be desirable to record the transaction as a failed transaction.

flags (int32)=0

Reserved for future use. It must be set to zero.

data (char*)

A pointer to a buffer with additional data that can optionally be passed. If no additional data is passed, this parameter should be set to zero (0). The format is identical to the *arm_start()* call, except the *Correlator* field is not used in the *arm_stop()* call. See Section 4.1.6 on page 28 for a description of the format of the data buffer in *arm_start()*, *arm_update()*, and *arm_stop()*.

data_size (int32)

The length in bytes of the buffer pointed to by the *data* parameter. If *data* is set to zero (0), *data_size* should also be set to zero.

RETURN CODE**ERROR_STATUS** (int32)

Contains a zero if successful, and a negative value if an error occurred.

ERRORS

If the value returned in **ERROR_STATUS** is less than zero, an error occurred in communicating with the measurement agent. The most likely cause is passing an invalid value for *start_handle*. The error should be logged so corrective action can be taken.

EXAMPLE

```
status = arm_stop (my_handle,      /* transaction handle      */
                  ARM_GOOD,       /* transaction status      */
                  0,              /* reserved for future use */
                  buffer_ptr,     /* data description        */
                  buffer_length); /* length of data description */
```


NAME

arm_update — show the progress of a long transaction, or provide extra information about a transaction, or provide a larger opaque application private buffer.

SYNOPSIS

```
error_status=arm_update(start_handle, flags, data, data_size)
```

DESCRIPTION

Function *arm_update()* is an optional call, used for the following purposes:

- To show the progress of a long transaction. Each insertion of *arm_update()* call into an application program after *arm_start()* and before *arm_stop()* generates a *heartbeat* indicating that the transaction instance is still running. This would typically be done after a fixed interval of time (such as every minute) or after a fixed amount of work is completed (such as 1000 records processed). There can be any number of *arm_update()* calls between an *arm_start/arm_stop* pair. This call is most useful for long-running transactions that take minutes or hours to complete. Another way to capture data about the steps within a long transaction is to use component transactions (see Section 4.2 on page 32, which describes three ways to instrument within a transaction instance).

Function *arm_update()* is also useful for updating any of the metric or string variables passed in the buffer pointed to by the data parameter (as defined in *arm_getid()*). This could be used to show not only that the transaction is progressing, but also how far it has progressed. For example, every time another 1000 records are processed, an *arm_update()* call could be made with an updated count in the buffer.

- To provide extra information about a transaction. Each time you want to provide special information about a transaction instance, insert an *arm_update()* call into an application program after *arm_start()* and before *arm_stop()*. If there is no additional information to be provided, pass a NULL pointer. There are several types of additional information that may be useful, including about the size of the transaction (such as the number of bytes in a print job), about the state of the application (such as the number of threads that are running), and diagnostic information. This type of information can be provided via application-defined metrics on any or all of the *arm_start()*, *arm_update()*, and *arm_stop()* calls. See Section 4.1.6 on page 28 for description of the detailed buffer format.
- To provide a larger opaque application private buffer. Information that does not conform well to application-defined metrics (for example long diagnostic messages) may be provided via an opaque buffer containing up to 1020 bytes of data (Format 2). Except for the 4-byte Format field, the content of the buffer is entirely defined by the application developer. Because the contents of the buffer containing the information is known only to the application developer, measurement agents cannot do much with the data in this field. A typical measurement agent might provide an option to write the buffer with the information to a log file, but this is the most that can be expected.

Measurement agents are not required to do anything with the information in this call.

PARAMETERS

start_handle (int32)

The unique handle from the *arm_start()* call that marked the start of this transaction instance. The *start_handle* must be passed in each *arm_update()* call. Many transaction instances may be executing at the same time from this and other applications, so this handle is essential to identify which transaction instance is being updated. If *start_handle* is less than zero, this *arm_update()* call will be treated as a NULL operation, and a negative `ERROR_STATUS` returned.

flags (int32)=0

Reserved for future use. It must be set to zero.

data (char*)

A pointer to a buffer with additional data that can optionally be passed. If no additional data is passed, this parameter should be set to zero (0).

There are two possible buffer formats:

- 1 If the Format field contains the value 1, then application-defined metrics as defined in *arm_getid()* can be passed. The correlator field is not used in the *arm_update()* call.
- 2 If the Format field contains the value 2, then a status message up to 1020 bytes in length may be passed in.

See Section 4.1.6 on page 28 for description of the format of the data buffer in *arm_start()*, *arm_update()*, and *arm_stop()*.

data_size (int32)

The length in bytes of the buffer pointed to by *data*. If *data* is set to zero (0), *data_size* should also be set to zero.

RETURN CODE

ERROR_STATUS (int32)

Contains a zero if successful and a negative value if an error occurred.

ERRORS

If the value returned in ERROR_STATUS is less than zero, an error occurred in communicating with the measurement agent. The most likely cause is passing an invalid value for *start_handle*. The error should be logged so corrective action can be taken.

EXAMPLE

```
status = arm_update (my_handle,          /* transaction handle          */
                    0,                  /* reserved for future use     */
                    my_buffer_ptr,      /* data description            */
                    my_buffer_length); /* length of data description */
```

The following topics provide information on more advanced implementations using the ARM 2.0 API.

4.1 Additional Data Passed in ARM Function Calls

The following two types of additional data can now be provided via the ARM 2.0 API:

- Transaction correlation data

You can indicate that a transaction is a component of another transaction. You can do transaction correlation within one system or across multiple systems. This permits a better understanding of the overall transaction, how much time each part of the transaction is taking, and where problems are occurring.

- Application-defined metrics

Application-defined metrics provide additional information about the transaction, such as the number of bytes or records being processed, or about the state of the application at the moment that the transaction is being processed, such as the length of a work queue. This information is useful to better understand response times, and how the application can be tuned to perform better.

4.1.1 Transaction Correlation

Many client/server transactions consist of one transaction visible to the user, and any number of nested component transactions that are invoked by the one visible transaction. These component transactions are the children of the parent transaction (or the child of another child component transaction). It's very useful to know how much each component transaction contributes to the total response time of the visible transaction. Similarly, a failure in one of the component transactions will often lead to a failure in the visible transaction, and this information is also very useful.

There are two facilities that the application developer can use to provide this information to measurement agents that implement the ARM 2.0 API:

- On the same *arm_start()*, the application can request that the measurement agent assign and return a correlator for this instance of the transaction (that is, a parent correlator). Note that the agent has the option of not providing the correlator, because it may not support the capability (ARM Version 1.0 agents do not support correlators), or because it is operating under a policy to suppress generating them.

- When indicating the start of a child transaction with an *arm_start()*, the application can provide a correlator provided from a parent transaction. This allows the measurement agent to know the parent/child relationship.

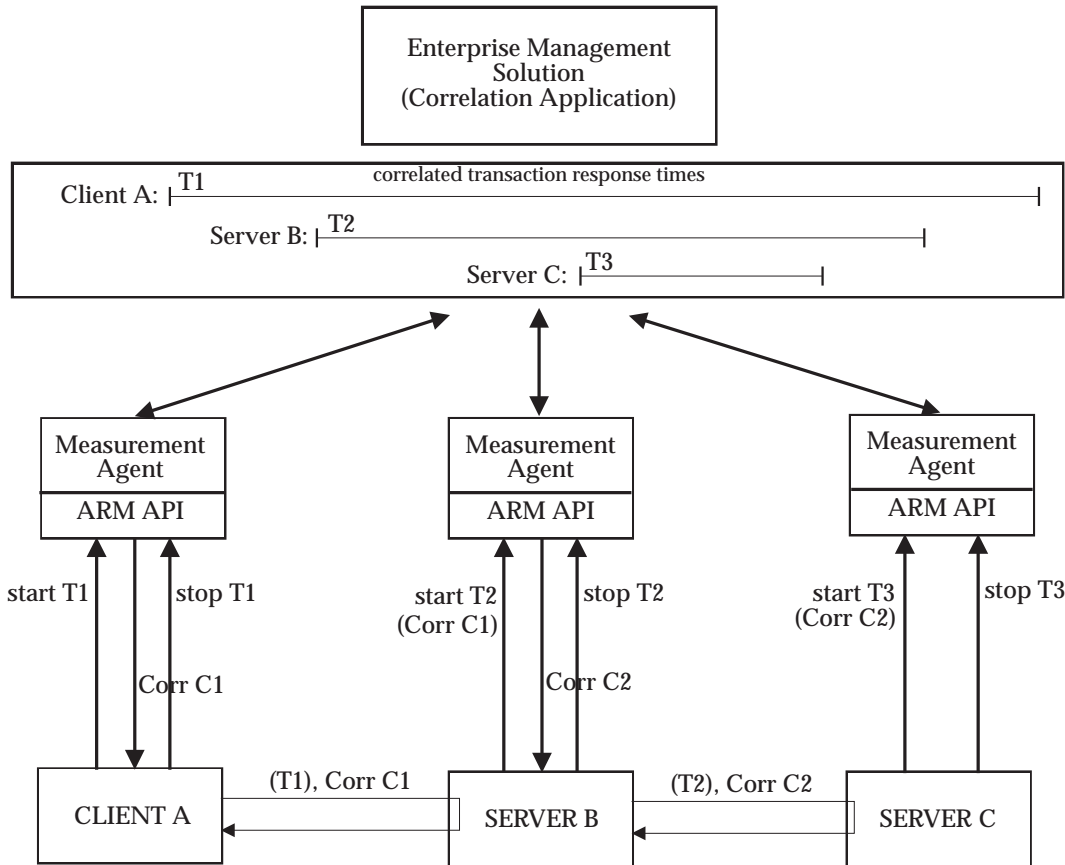


Figure 4-1 Transaction Response Time Correlation

The figure shows the concept for a simple model. The principle can be extended to a model of arbitrary complexity.

- Client A starts transaction T1, requesting a correlator via, and is assigned C1.
- Client A sends a request (T1) to Server B, and includes C1 in the request.
- Server B starts transaction T2, passing C1 as the parent. At the same time it requests a correlator and is assigned C2.
- Server B sends a request (T2) to Server C, and includes C2 in the request.
- Server C starts transaction T3, passing C2 as the parent.
- T3 stops, T2 stops, and T1 stops.

If the correlation application collects all the data about these transactions, it can put together the total picture, knowing that T1 is the parent of T2 (via C1), and T2 is the parent of T3 (via C2). The parent/child relationship could be from a client to a server, or within one program.

An application using the ARM API need not be concerned with the format of the correlators. Measurement agents generate correlators.

Changes Needed for Transaction Correlation

Each application responsible for a component of the overall transaction (client and server) will require some modifications. Applications have three responsibilities:

- Request correlators for transactions with one or more child transactions (via *arm_start()*) by getting the appropriate flag.
- Send the assigned correlators to the child transaction(s) along with the data needed to invoke the child transaction(s) itself. This is done by first checking that the agent assigned a correlator, and then sending the number of bytes in the correlator. The length is stored by the agent in the Correlator Length field.
- Pass correlators received from parent transactions to the measurement agents (via *arm_start()*) by storing the correlator in the optional buffer and setting the appropriate flag.

To enable a correlation application to analyze the correlators coming from different systems, measurement agents follow conventions when creating correlators. Included within the correlator is information identifying the system, the transaction class (from *arm_getid()*), the transaction instance (from *arm_start()*), and some flags. The format is flexible and extendible so more conventions can be added as the need arises. See Appendix B on Measurement Agent Information, for information on the correlator format.

Correlators are passed in the *arm_start()* calls by utilizing the data buffer. This same data buffer is used to pass application-defined metrics, as described in Section 4.1.6 on page 28, which describes format of the data buffer in *arm_start()*, *arm_update()*, and *arm_stop()*. Correlators are ignored in *arm_update()* and *arm_stop()* calls.

If a correlator is being requested, the data buffer should be 256 bytes, to allow for a variable size correlator. If a correlator is being passed to the measurement agent, and none is requested, the length may be truncated based on the correlator length.

If you only wanted to do transaction correlation in your application and not provide application-defined metrics, you can zero out the metrics (set the Flags Second Byte to zero and fill with zeros 80 bytes for the metrics descriptions).

Note: Other than the length, the correlator format need not be understood by the application developer, as it is opaque.

4.1.2 Application-Defined Metrics

Application-defined metrics can tell you more about the transaction or about the state of the application at the moment that the transaction is being processed. Three likely uses are envisioned as described below:

1. Specify characteristics of the transaction that will affect the response time, or that are useful for workload planning. Examples are the number of bytes in a file transfer or print job, or the number of records being processed. A file transfer of 100 megabytes would certainly be expected to take longer than a transfer of 100 kilobytes.
2. Specify information about the current state of the application. Examples would be the length of a workload queue, the amount of memory allocated, or the number of threads being used. This information is useful for adjusting workloads by shifting work between systems, or tuning the application. If a comparison of response times versus threads shows that congestion builds and response times increase dramatically if, for example, eight threads are used instead of twelve, the application can be recompiled or instructed to use more threads, which may result in a dramatic improvement in performance.

3. Specify information that can be used in diagnosing problems. Examples are error codes returned from services invoked by the application, or information about the transaction itself such as the part number being processed.

In setting up application-defined metrics, *arm_getid()* is used to define the context (or *meta-data*) for a buffer of values that can be passed at *arm_start()*, *arm_update()* or *arm_stop()*. Actual values are passed in *arm_start()*, *arm_update()* and *arm_stop()*. The length of the buffer is specified in the *data_size* parameter.

4.1.3 Choosing a Data Type

The additional data provided in the data buffer uses metric and/or string fields. (See later sections of this Chapter for information on the format of the data buffer.)

Four general data types can be specified for each field:

- Counter
- Gauge
- Numeric id
- String

This section provides some suggestions about which data type to use.

Counter

A counter should be used when it makes sense to sum up the values over an interval. Examples are bytes printed and records written. The values can also be averaged, maximums and minimums (per transaction) can be calculated, and other kinds of statistical calculations can be performed.

If a counter is used, its initial value must be set in the *arm_start()* call. The difference between the value in the *arm_start()* and the *arm_stop()* (or the value in the last *arm_update()* call if no metric value is passed in *arm_stop()*), equals the amount attributed to this transaction. Similarly, the difference between successive *arm_update()* calls, or from the *arm_start()* to the first *arm_update()* call, or from the last *arm_update()* to the *arm_stop()* call, equals the value for the time period between the calls.

Here are three examples of how a counter would probably be used:

- The counter is set to zero at *arm_start()* and to some value at *arm_stop()* (or the last *arm_update* call). In this case, the application probably measured the value for this transaction and provided that value in the *arm_stop()* call. The application always sets the value to zero in the *arm_start()* call, so the value at *arm_stop()* reflects both the difference from the *arm_start()* value and the absolute value.
- The counter is *x1* at *arm_start()*, *x2* at its *arm_stop*, *x2* at the next *arm_start()*, and *x3* at its *arm_stop()*. In this case, the application is probably keeping a rolling counter. Perhaps this is a server application that counts the total workload. The application simply takes a snapshot of the counter at the start of a transaction and another snapshot at the end of the transaction. The agent determines the difference attributed to this transaction.
- The counter is *x1* at *arm_start()*, *x2* at *arm_stop()*, *x3* (not equal to *x2*) at the next *arm_start()*, and *x4* at *arm_stop()*. In this case, the application is probably keeping a rolling counter as in the previous example. But in this case the measurement represents a value affected by other users or transaction classes, so the value often changes from one *arm_stop()* to the next *arm_start()* for the same transaction class.

Gauge

A gauge should be used instead of a counter when it is not meaningful to sum up the values over an interval. An example is the amount of memory used. If you were measuring the amount of memory used over 20 transactions in an interval and the average usage for each of these transactions was 15 MB, it does not make sense to say that $20 \times 15 = 300$ MB of memory used over the interval. It would make sense to say that the average was 15 MB, that the median was 12 MB, and that the standard deviation was 8 MB. These are the kinds of operations that an agent will typically apply to gauges. The values can also be averaged, maximums and minimums per transaction calculated, and other kinds of statistical calculations performed.

Gauges can be provided on *arm_start()*, *arm_update()*, and *arm_stop()* calls. This creates the potential for different interpretations. If several values are provided for a transaction (one on an *arm_start()*, one on each *arm_update()*, and one on an *arm_stop()*), which one(s) should be used? In order to have consistent interpretation, the following conventions apply. Measurement agents are free to process the data in any way within these guidelines.

- The maximum value for a transaction will be the largest valid value passed at any time during the transaction.
- The minimum value for a transaction will be the smallest valid value passed at any time during the transaction.
- The mean value for a transaction will be the mean of all valid values passed at any time during the transaction. All values will be weighted equally.
- The median value for a transaction will be the median of all valid values passed at any time during the transaction. All values will be weighted equally.
- The last value for a transaction will be the last valid value passed at any time during the transaction.

Numeric ID

A numeric id is simply a numeric value that is used as an identifier, and not as a measurement value. Examples are message numbers and error codes. It is not meaningful to sum, average, or manipulate these values in any arithmetic way. By using numeric id instead of a gauge or counter, the application indicates this to the measurement agent. An agent could create statistical summaries based on these values, such as generating a frequency histogram by error code, but this is done by counting the numbers, not by summing them or performing any other arithmetic operation.

String

A measurement agent should process a string in the same way as a numeric id. As with numeric ids, it is not meaningful to do arithmetic operations on a string value.

4.1.4 Format of Data Buffer in arm_getid

Format	Size	101 (int32) (identifies "meta-data" format)
Flags: The flags indicate which Metric and String descriptions are included in the buffer.	4 bytes	<p>First Byte (bit8) = 0</p> <p>Second Byte (bit8) abcdefg0, where a through g each denote the value of a bit flag: a = 1 if there is a description for Metric #1, otherwise a = 0 b = 1 if there is a description for Metric #2, otherwise b = 0 c = 1 if there is a description for Metric #3, otherwise c = 0 d = 1 if there is a description for Metric #4, otherwise d = 0 e = 1 if there is a description for Metric #5, otherwise e = 0 f = 1 if there is a description for Metric #6, otherwise f = 0 g = 1 if there is a description for String #1, otherwise g = 0</p> <p>Third Byte (bit8) = 0</p> <p>Fourth Byte (bit8) = 0</p>
Metric #1 desc.	48 bytes	<p>The first 4 bytes (int32) define the type of data that will be passed in the 8 byte field. See the description below this table for an explanation of the different data types.</p> <ul style="list-style-type: none"> 1 = ARM_Counter32 2 = ARM_Counter64 3 = ARM_CntrDivr32 4 = ARM_Gauge32 5 = ARM_Gauge64 6 = ARM_GaugeDivr32 7 = ARM_NumericID32 8 = ARM_NumericID64 9 = ARM_String8 <p>The last 44 bytes (char*) are the name of the metric. This is a NULL terminated character string. A possible use of this name is to display it along with the current value, either on a user interface or in a report.</p>
Metric #2 desc.	48 bytes	Same as Metric description #1.
Metric #3 desc.	48 bytes	Same as Metric description #1.
Metric #4 desc.	48 bytes	Same as Metric description #1.
Metric #5 desc.	48 bytes	Same as Metric description #1.
Metric #6 desc.	48 bytes	Same as Metric description #1.
String #1 desc.	48 bytes	<p>The first 4 bytes (int32) define the type of data that will be in the field. Only one data type is valid in this field.</p> <ul style="list-style-type: none"> 10 = ARM_String32 <p>The last 44 bytes (char*) are the name of the String #1 field. It is a NULL terminated character string. A possible use of this name is to display it along with the current value, either on a user interface or in a report.</p>

4.1.5 Data Type Definitions

ARM_Counter32

An unsigned32 value that increases up to the maximum value that the counter can hold, at which point it resets to zero and continues counting up from zero. Except for the reset back to zero, the value can never decrease. The counter is in the first four bytes, and the second four bytes are unused.

ARM_Counter64

An unsigned64 counter (see ARM_Counter32, except it is 64 bits long).

ARM_CntrDivr32

A combination of two unsigned32 integers, with ARM_Counter32 in the first four bytes, and an unsigned32 divisor in the second four bytes. The total value is ARM_CntrDivr32. The purpose of this format is to be able to represent decimal values without using floating point formats.

ARM_Gauge32

An int32 (signed) value that can increase or decrease. The gauge is in the first four bytes, and the second four bytes are unused.

ARM_Gauge64

An int64 (signed) gauge (see ARM_Gauge32, except it is 64 bits long).

ARM_GaugeDivr32

A combination of two integers, one an int32 (signed) and one an unsigned32. ARM_Gauge32 is in the first four bytes, and an unsigned32 divisor in the second four bytes. The total value is ARM_GaugeDivr32. The purpose of this format is to be able to represent decimal values without using floating point formats.

ARM_NumericID32

An unsigned32 value that should not be used in arithmetic operations because it is used as an identifier, not as a measurement. For example, a message number or error code. The numeric id is in the first four bytes, and the second four bytes are unused.

ARM_NumericID64

An unsigned64 value that should not be used in arithmetic operations because it is used as an identifier, not as a measurement. An example is a message number or error code.

ARM_String8

An 8 byte string that is *not* NULL terminated. If the string is less than eight bytes long, it must be padded with blanks. The character set is ASCII or EBCDIC, depending on whatever is standard for that platform. Unlike the NULL terminated character strings passed in various places in the API, these strings cannot be reliably converted to other code pages, so it is suggested you use only the common characters in the first 128 characters of the Latin code pages. See Section 4.3 on page 33 for more information on internationalization.

ARM_String32

A 32 byte string that is *not* NULL terminated. If the string is less than 32 bytes long, it must be padded with blanks. The character set is ASCII or EBCDIC, depending on whatever is standard on that platform. Unlike the NULL terminated character strings passed in various places in the API, these strings cannot be reliably converted to other code pages, so it is suggested you use only the common characters in the first 128 characters of the Latin code pages. See the "Internationalization" section on page 56 for more information.

4.1.6 Format of Data Buffer in `arm_start/arm_update/arm_stop`

Format 1

Format	Size	1 (int32) (2 is special, for <code>arm_update()</code>)
Flags: The flags indicate which fields are included in the buffer.	4 bytes	<p>First Byte (bit8): Only valid for <code>arm_start()</code>. Ignored on <code>arm_update()</code> and <code>arm_stop()</code>.</p> <p>abcd0000, where a,b,c,d each denote the value of a bit flag. a,b,d are set by the application. c is set by the measurement agent.</p> <p>a = 1 if the application is passing the correlator from a parent transaction in the Correlator field; otherwise a = 0.</p> <p>b = 1 if the application is requesting that the agent generate a correlator for the transaction (the one indicated by this <code>arm_start()</code>), otherwise b = 0. If a correlator is being requested, the data buffer should be 256 bytes, to allow for a variable size correlator.</p> <p>c = 1 if the agent is returning a correlator in the Correlator field. When set, the value in the Correlator field overlays any previous value. This flag will only be set when three conditions are met, otherwise c=0:</p> <ol style="list-style-type: none"> 1. The application has set bit b = 1. 2. The agent supports this function (agents that only support version 1.0 of the ARM API do not). 3. The agent is running in a mode where the generation of correlators is enabled (that is, there might be an installation policy to disable the generation of correlators, either temporarily or permanently). <p>If this bit is <i>not</i> set to 1, there is no correlator, and therefore the application should not forward the contents of the Correlator field.</p> <p>d = 1 if the application is requesting that the agent trace this transaction. This might be done when a dummy test transaction is being executed, or when an error has occurred. Each agent can choose how and if it should honor the request, and administrators who configure the agent may establish the policy.</p> <p>Second Byte (bit8)</p> <p>abcdefg0, where a through g each denote the value of a bit flag:</p> <p>a = 1 if a value is passed in Metric #1, otherwise a = 0 b = 1 if a value is passed in Metric #2, otherwise b = 0 c = 1 if a value is passed in Metric #3, otherwise c = 0</p>

Format	Size	1 (int32) (2 is special, for <i>arm_update()</i>)
		<p>d = 1 if a value is passed in Metric #4, otherwise d = 0 e = 1 if a value is passed in Metric #5, otherwise e = 0 f = 1 if a value is passed in Metric #6, otherwise f = 0 g = 1 if a value is passed in String #1, otherwise g = 0</p> <p>It is perfectly permissible for an application to pass none or some of the metrics on each call, and to change which metrics are passed from call to call. This holds true for <i>arm_start()</i>, <i>arm_update()</i>, and <i>arm_stop()</i> calls. The one requirement that must be adhered to is that the meaning and position of the field must have been defined with the <i>arm_getid()</i> call (see Section 4.1.4 on page 26 for the format of data buffer in <i>arm_getid()</i>).</p> <p>Third Byte (bit8) = 0 Fourth Byte (bit8) = 0</p>
Metric #1	8 bytes	<p>The metric fields are used by the application to pass useful information about the transaction or the state of the application to the measurement agent. The field contains one or two integers, or a string variable. The use of the field and the format of the field are determined by the buffer passed on the <i>arm_getid()</i> call (see Section 4.1.4 on page 26 for the format of data buffer in <i>arm_getid()</i>).</p> <p>See Section 4.1.3 on page 24 for more information on choosing a data type, and Section 4.1.5 on page 27 for data type definitions.</p>
Metric #2	8 bytes	Same as Metric #1.
Metric #3	8 bytes	Same as Metric #1.
Metric #4	8 bytes	Same as Metric #1.
Metric #5	8 bytes	Same as Metric #1.
Metric #6	8 bytes	Same as Metric #1.
String #1	32 bytes	A string variable of up to 32 characters. The string is not NULL terminated, and is padded with blanks if it is less than 32 characters. Any information can be included in the string. Examples would be a part number being processed, or an error code.
Correlator		<p>The field has two different uses depending on whether it is passed on the call from the application to the measurement agent, or if it is passed in the return from the agent:</p> <ol style="list-style-type: none"> 1. The application can pass in the correlator from a parent transaction to the agent. This allows the agent to correlate the parent transaction to the component transaction being started with this <i>arm_start()</i> call. 2. The agent can return a correlator for the transaction

Format	Size	1 (int32) (2 is special, for <i>arm_update()</i>)
	<p data-bbox="516 688 607 751">Length 2 bytes</p> <p data-bbox="516 1045 654 1108">Data 0-166 bytes</p>	<p data-bbox="756 212 1373 369">being started by this <i>arm_start()</i> call. The application could then pass this correlator to applications that it invokes, and they in turn could pass it as the parent correlator in <i>arm_start()</i> calls that they make.</p> <p data-bbox="688 390 1373 579">If the correlator returned bit is set (Flags First Byte c=1), the application can either pass the entire 168 byte correlator. Or if you want to optimize, the application can choose to read the correlator length field and only pass the number of bytes containing data, starting with the 2 bytes of the correlator length.</p> <p data-bbox="688 600 1373 684">See Section 4.1.1 on page 21 for more information on correlating transactions. Also, see Appendix B for more information on the content of the correlator.</p> <p data-bbox="688 695 1373 810">The Correlator length field (unsigned 16) specifies the length of a correlator (including this field) generated by a measurement agent (when bit c is set in the first Flags byte).</p> <p data-bbox="688 831 1373 957">If this value is zero, it means that the agent is not returning a correlator, and therefore there is no reason to pass this correlator on to other parts of the application (or servers that it calls).</p> <p data-bbox="688 978 1373 1041">This field is considered a part of the correlator and must be included in the forwarded correlator data.</p> <p data-bbox="688 1052 1373 1167">The Correlator data field is used to show the parent/child relationship between transactions. (Note: the application instrumenter has no need to understand the correlator format, as it is <i>opaque</i>).</p>

Format 2

In the `arm_update()` calls with a Format field containing the value 2, the buffer may have the following format:

Format	Size	2 (int32)
Data	1020 bytes (maximum)	<p>Contains the data. The length of the buffer is determined by the <code>data_size</code> parameter. The format of the data is not defined, but it is suggested that the data be formatted as plain-text characters so it can be understood without requiring a special formatting program. The agent cannot summarize the data over an interval, it must be treated as trace data. One suggestion is to format all information as plain-text characters so it can be read by a person without a special formatting program.</p> <p>Note that because the data in an opaque buffer cannot be summarized, and processing by the agent may consist of logging the data to a trace file, many calls at a high frequency could result in a loss of data or a slowing down of the system, most likely due to an excessive amount of file I/O. Therefore it is recommended that the call be used only in special situations. NULL termination is not required.</p>

4.2 Three Ways to Instrument within a Transaction Instance

There are three methodologies for instrumenting within a transaction instance. The first two are useful when the transaction is within one application. The last one is useful when the transaction is distributed across applications or systems.

1. Instrument a transaction using *arm_update()* as a *heartbeat*, when it is an operation that takes a long time to complete (several minutes or hours) and you want to show the overall progress of the transaction in numeric form.

If these transactions have different steps associated with processing each record, you may want to instrument these steps with component transactions (as described below), or use repeated calls to *arm_update()* to show the overall progress of the transaction. For example, the transaction may process a million records. A call to *arm_update()* could be made for every 1000 records or every minute of processing. This could show the progress of the transaction based on the number of times *arm_update()* was called or with one or more application-defined metrics.

2. Instrument a transaction using component transactions when it is a long transaction that has many steps. A transaction can be defined for the overall transaction and then nested transactions can be defined for each of the steps. A step might represent a single discrete operation, or it could represent a large number of operations, such as copying 1000 files. This allows for the monitoring of each of the steps as well as the overall transaction.

For example, step 1 takes about 20 minutes, step 2 takes about 40 minutes, and step 3 takes about 10 minutes. Each step can have a defined transaction as well as the overall transaction. So you would define 3 component transactions monitoring each step, plus one transaction that monitors the overall transaction.

3. Instrument using transaction correlation when the transaction has components that span several applications or systems. This approach is more complex than the previous two as it requires changes to all the applications involved in processing components of the transaction, but it is the most accurate way to track transaction response time spanning systems.

4.3 Internationalization

The ARM API is designed to enable applications to use native code pages and languages, and for measurement agents to be able to support many different languages. Users of agents should contact the providers to see if the agent supports the needed code pages and languages.

The ARM API supports any code page as long as no characters are encoded with binary zero bytes (octets). This is because most strings are passed as NULL terminated strings, and the NULL terminator character is a binary zero byte. If a binary zero byte is encountered before the end of the string, the agent would interpret the zero byte as the NULL terminator and truncate the string. Most code pages meet this requirement.

These are code pages that contain binary zero bytes, but there are alternate ways to encode the characters. A well-known example is the Unicode standard. In its native format using 16 bit characters (UTF-2), there are binary zero bytes. However, the UTF-8 encoding of the same Unicode characters does not contain binary zero bytes, and this format is entirely compatible with the ARM API.

Agents that support native languages will often use the following technique. When the application links to the agent it links to a part of the agent that executes in the same process space as the application. Typically this small part of the agent communicates with the main part of the agent across an inter-process communications (IPC) channel. The small part of the agent that executes in the same process as the application can issue an operating system call to find out what code page and language the process is using. It can then pass this information to the main part of the agent, and the main part of the agent can convert from the native code page as necessary.

There are the following three restrictions on the use of native languages.

- The strings can contain no binary zero bytes except for the NULL terminator character (as was mentioned above).
- All the strings should be encoded using the same code page and language information as the process that executes the *arm_init()* call. This also implies that the code page and language information should not change after the *arm_init()* call.
- This technique does not apply to any string data passed within the optional buffers on *arm_start()*, *arm_update()*, and *arm_stop()*. This is because these strings are not null terminated (note that it *does* apply to the metric descriptions passed within the optional buffer on *arm_getid()*). Further, these strings are often about things that are external to the program, such as a part number or an error code, so the requirement to use the same code page and language information as the process is unacceptable. The application developer is strongly recommended to restrict these strings to the first 128 bytes of the standard Latin code pages for ASCII and EBCDIC (depending on the platform). ,iX EBCDIC

<arm.h> Header File

A C language header file, <arm.h>, is supplied for applications written in either C or C++. If you are using a language other than C or C++, the data structures and external references need to be translated to the language you are using. Note that not all hardware systems or compilers provide native support for 64-bit integers, nor is there yet a standard type declaration for them. For these reasons the distributed version of the <arm.h> header file does not assume native support for 64 bit integers. However, the symbol "INT64" can be defined near the front of the file to customize the header for compilers and systems with 64 bit integer support.

```

#ifndef ARM_H_INCLUDED
#define ARM_H_INCLUDED

/*****
/* arm.h - ARM API Definitions
*****/

#include <sys/types.h>          /* C types definitions */

/* Type definitions for various field sizes */
/* 64-bit integer compiler support: */
/* If a type declaration supporting 64 bit integer arithmetic */
/* is defined for the target platform and compiler, the */
/* "INT64" #define should be set to that type declaration. */
/* E.g., */
/*     #define INT64 long long */
/* If 64 bit arithmetic is not supported on the target */
/* platform or compiler, remove (or comment out) the "INT64" */
/* #define and structures of two 32 bit values will be */
/* defined for the 64 bit fields. */

/**** #define INT64 long long ****/

typedef unsigned char bit8 ;
typedef short int16 ;
typedef long int32 ;
typedef unsigned char unsigned8 ;
typedef unsigned short unsigned16 ;
typedef unsigned long unsigned32 ;

#ifdef INT64
typedef INT64 int64 ;
typedef unsigned INT64 unsigned64 ;
#else
typedef struct int64 {
    int32    upper;
    int32    lower;
} int64 ;

typedef struct unsigned64 {
    unsigned32    upper;
    unsigned32    lower;}
unsigned64 ;
#endif

```

```
/** Symbol definitions */

/* Enumeration of transaction status completion codes */
enum arm_tran_status_e { ARM_GOOD = 0, ARM_ABORT, ARM_FAILED };

/* Enumeration of user data formats */
enum arm_userdata_e { ARM_Format1 = 1, ARM_Format2,
                    ARM_Format101 = 101 };

/* Enumeration of metric types */

typedef enum arm_metric_type_e {
    ARM_Counter32 = 1, ARM_Counter64, ARM_CntrDivr32,
    ARM_Gauge32, ARM_Gauge64, ARM_GaugeDivr32, ARM_NumericID32,
    ARM_NumericID64, ARM_String8, ARM_String32,
    ARM_MetricTypeLast
} arm_metric_type_e;

/** Data definitions */

/* User metric structures */

typedef struct arm_cntrdivr32_t { /* Counter32 + Divisor32 */
    unsigned32 count;
    unsigned32 divisor;
} arm_cntrdivr32_t;

typedef struct arm_gaugedivr32_t { /* Gauge32 + Divisor32 */
    int32 gauge;
    unsigned32 divisor;
} arm_gaugedivr32_t;

/* Union of user ARM_Format1 metric types */

typedef union arm_user_metric1_u {
    unsigned32 counter32; /* Counter32 */
    unsigned64 counter64; /* Counter64 */
    arm_cntrdivr32_t cntrdivr32; /* Counter32 + Divisor32 */
    int32 gauge32; /* Gauge32 */
    int64 gauge64; /* Gauge64 */
    arm_gaugedivr32_t gaugedivr32; /* Gauge32 + Divisor32 */
    unsigned32 numericid32; /* NumericID32 */
    unsigned64 numericid64; /* NumericID64 */
    char string8[8]; /* String8 */
} arm_user_metric1_u;

/* Application view of correlator */

typedef struct arm_app_correlator_t {
    int16 length; /* Length of the correlator */
    char agent_data[166]; /* Agent-specific data fields */
} arm_app_correlator_t;

/* User metrics ARM_Format1 structure definition */

typedef struct arm_user_data1_t {
    int32 format; /* Version/format id (userdata_e) */
```

<arm.h> Header File

```
    bit8          flags[4];      /* Flags for metrics' presence */
    arm_user_metric1_u metric[6]; /* User metrics */
    char          string32[32];   /* 32 byte non-terminated */
                                /* string */
    arm_app_correlator_t correlator; /* Correlator */
} arm_user_data1_t;

/* User metrics ARM_Format2 structure definition */

typedef struct arm_user_data2_t {
    int32         format;        /* Version/format id (userdata_e) */
    char          string1020[1020]; /* 1020 byte opaque blob */
} arm_user_data2_t;

/* User metric meta-data for ARM_Format101 structure */

typedef struct arm_user_meta101_t {
    int32         type;          /* Type of metric (arm_user_metric_e) */
    char          name[44];      /* NULL-terminated string <= 44 char */
} arm_user_meta101_t;

/* User meta-data ARM_Format101 structure definition */

typedef struct arm_user_data101_t {
    int32         format;        /* Version/format id (userdata_e) */
    bit8         flags[4];      /* Flags for which fields are present */
    arm_user_meta101_t meta[7]; /* User metrics meta-data */
} arm_user_data101_t;

/* Flag bit definitions (within bit8 fields) */

/* flags[0] in arm_user_data1_t passed in arm_start */

#define ARM_CorrPar_f 0x80 /* Correlator from parent */
#define ARM_CorrReq_f 0x40 /* Request correlator generation */
#define ARM_CorrGen_f 0x20 /* New correlator generated in data */
#define ARM_TraceReq_f 0x10 /* User trace request */

/* flags[1] in arm_user_data101_t passed in arm_get_id and
/* flags[1] in arm_user_data1_t passed in arm_start, arm_update
/* and arm_end */

#define ARM_Metric1_f 0x80 /* Metric 1 present */
#define ARM_Metric2_f 0x40 /* Metric 2 present */
#define ARM_Metric3_f 0x20 /* Metric 3 present */
#define ARM_Metric4_f 0x10 /* Metric 4 present */
#define ARM_Metric5_f 0x08 /* Metric 5 present */
#define ARM_Metric6_f 0x04 /* Metric 6 present */
#define ARM_AllMetrics_f 0xfc /* Metrics 1-6 present */
#define ARM_String1_f 0x02 /* String 1 present */

#if defined _WIN32
    #include <windows.h>
    #define ARM_API WINAPI
#elif defined __OS2__
    #define ARM_API _Pascal
#elif defined _OS216
    #define arm_data_t char _far
    #define arm_ptr_t char _far
```

```
#define ARM_API _far _pascal
#elif defined _WIN16 || _WINDOWS
#include <windows.h>
typedef BOOL (FAR PASCAL _export * FPSTRCB) (LPSTR, LPVOID);
#define arm_data_t char FAR
#define arm_ptr_t char FAR
#define ARM_API WINAPI
#else /* unix */
#define ARM_API
#endif

#ifdef __cplusplus
extern "C" {
#endif /* __cplusplus */

#ifdef _PROTOTYPES

/** Function prototypes */

extern int32 ARM_API arm_init(
    char* appl_name, /* application name */
    char* appl_user_id, /* Name of the application user */
    int32 flags, /* Reserved = 0 */
    char* data, /* Reserved = NULL */
    int32 data_size); /* Reserved = 0 */

extern int32 ARM_API arm_getid(
    int32 appl_id, /* application handle */
    char* tran_name, /* transaction name */
    char* tran_detail, /* transaction additional info */
    int32 flags, /* Reserved = 0 */
    char* data, /* format definition of user metrics */
    int32 data_size); /* length of data buffer */

extern int32 ARM_API arm_start(
    int32 tran_id, /* transaction name identifier */
    int32 flags, /* Reserved = 0 */
    char* data, /* user metrics data */
    int32 data_size); /* length of data buffer */

extern int32 ARM_API arm_update(
    int32 start_handle, /* unique transaction handle */
    int32 flags, /* Reserved = 0 */
    char* data, /* user metrics data */
    int32 data_size); /* length of data buffer */

extern int32 ARM_API arm_stop(
    int32 start_handle, /* unique transaction handle */
    int32 tran_status, /* Good=0, Abort=1, Failed=2 */
    int32 flags, /* Reserved = 0 */
    char* data, /* user metrics data */
    int32 data_size); /* length of data buffer */

extern int32 ARM_API arm_end(
    int32 appl_id, /* application id */
    int32 flags, /* Reserved = 0 */
    char* data, /* Reserved = NULL */
    int32 data_size); /* Reserved = 0 */


```

<arm.h> Header File

```
#else          /* _PROTOTYPES */

extern int32 ARM_API arm_init();
extern int32 ARM_API arm_getid();
extern int32 ARM_API arm_start();
extern int32 ARM_API arm_update();
extern int32 ARM_API arm_stop();
extern int32 ARM_API arm_end();

#endif        /* _PROTOTYPES */

#ifdef __cplusplus
}
#endif /* __cplusplus */

/* Type definitions for compatibility with version 1.0 of */
/* the ARM API */

typedef      int32 arm_appl_id_t;

typedef      int32 arm_tran_id_t;

typedef      int32 arm_start_handle_t;

typedef      unsigned32 arm_flag_t;

typedef      char arm_data_t;

typedef      int32 arm_data_sz_t;

typedef      char arm_ptr_t;

typedef      int32 arm_ret_stat_t;

typedef      int32 arm_status_t;

#endif /* ARM_H_INCLUDED */
```


Measurement Agent Information

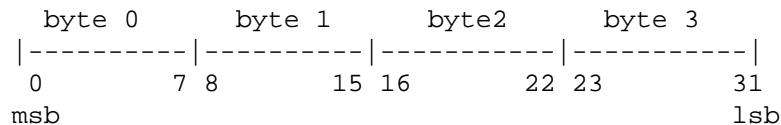
This appendix contains information provided for measurement agent implementers as opposed to ARM application instrumenters. For instrumenters it is provided as reference only, the correlator is *opaque* from an application instrumenter's perspective.

B.1 Agents and Correlators

The agents provide the correlators, and within the correlator they provide information to uniquely identify agents. To enable an enterprise management solution (correlation application) to analyze the correlators coming from different systems in a heterogeneous environment, agents need to follow some conventions when creating correlators.

The following section documents a set of semantics for measurement agents to use in formatting the correlator and agent identifiers. The correlator passed on *arm_start()* calls is sent across systems, so it is always in network byte order. Network byte order is a standard described as follows: is always in network byte order. Network byte order is a standard

Buffer word/byte/bit Format



B.2 Format of the Correlator

Correlators provided by agents and passed on the *arm_start()* calls have the following format:

2 bytes	<p>Length of the Correlator (unsigned16)</p> <p>If this value is zero, it means that the measurement agent is not returning a correlator, and therefore there is no reason to pass this correlator on to other parts of the application (or servers that it calls).</p> <p>A zero length provides another safeguard for agents. If an application passes a null correlator anyway, when any agent receives this correlator as the parent correlator for another transaction, the agent can see that the data in the correlator is invalid and ignore it, regardless of whether the <i>parent correlator</i> bit (Flags First Byte a) is set in the <i>arm_start()</i> buffer.</p>
1 byte	<p>Correlator format (unsigned8)=1</p> <p>Only one format is defined at this point, but others could be added in the future.</p>
1 byte	<p>Flags</p> <p>First Byte (bit8)</p> <p>ab000000, where a and b are bit flags.</p> <p>a=1 if a trace of this transaction and any nested component transactions is requested by the agent.</p> <p>b=1 if a trace of this transaction and any nested component transactions is requested by the application. The application requests this by setting the "d" bit (in abcdefgh notation) in the first flag byte in the buffer passed on <i>arm_start()</i>. The agent will decide whether to set this bit, based on its capabilities and how it is configured.</p> <p>The <i>trace this correlator</i> flag is a way to cause agents to trace and/or monitor a transaction and all component transactions associated with the transaction without having to trace or monitor all transactions on a system, or without requiring a complicated infrastructure to control tracing and monitoring. (Note that this does not preclude other ways to control agents, nor is this intended to be a final and comprehensive solution. It is intended that this will be used in addition to other approaches).</p> <p>When an agent builds a correlator, it is free to turn on these flags. The agent might do this if an application has been experiencing unsatisfactory response times. Any agents that receive this correlator as the parent correlator for a component transaction will also see the flag, and they in turn could turn on the flag in any correlators they generate. This process could repeat, resulting in the passing of the trace flag through all the transactions of interest. All the agents might be configured to trace only the few transactions with this flag on, and this would both capture the information needed to diagnose the transaction problem, and avoid overloading the agents and their systems with attempts to trace all transactions.</p>

	<p>The reason there are separate flags for traces requested by an agent and an application is to provide additional flexibility in how policies for monitoring and tracing are implemented. It might be common for an installation to trace transactions only when requested by agents (based on how the administrator has configured the agents), because then the administrator would control all tracing. On the other hand, permitting the application to highlight when a transaction is special has advantages.</p>
2 bytes	<p>Format of the Address field (unsigned16)</p> <p>The following formats are defined:</p> <ul style="list-style-type: none"> 0 = reserved 1 = IPv4 2 = IPV4+port number 3 = IPv6 4 = IPv6+port number 5 = SNA 6 = X.25 7:32767 = reserved <p>This list will be expanded as new requirements arise. The intent is to provide a value for any common addressing format as soon as the need is identified.</p> <p>32768-65535 = undefined and available for agent implementers to use. There are no semantics associated with the address format. It will be an unusual situation where a new format is needed, but this provides a solution if this is needed. The preferred approach is to get a new format defined that is in the 0-32767 range. There is a risk that two different agent developers will choose the same id, but this risk is small.</p>
2 bytes	<p>Vendor ID (unsigned16)</p> <p>The vendor ID is a way to identify who built the agent. Combining this information with the Agent Version field will provide a way for a management application to know what kind of agent generated a correlator. A management application may contain specialized functions or logic that only works with the agents from a particular vendor and/or supporting particular functions or interfaces. By putting these two fields in the correlator, a management application has a way to know whether the agent that generated the correlator has some of these specialized capabilities.</p> <p>For example:</p> <p>The management application wants to contact the agent to know the name of the application, user, and transaction class running this transaction instance. Although the address of the agent is known from the Address field, the protocol that one uses to interface to the agent could be anything. The management application may know how to access several different agents, and could use these values to determine if the correlator came from an agent that it knows how to access. Alternatively, an agent has a special capability. For example, maybe version 3.3 of a vendor's agent analyzes data in a particular way, but previous versions do not. The management application could use this field to see what are the agent's capabilities.</p>

	<p>In order to minimize the possibility of two vendors using the same vendor ID, the value should be taken from the list of enterprise identifiers from the Internet Assigned Numbers Authority (IANA). This list was created for vendors who have SNMP agents. Although the ARM API specification does not require or endorse SNMP, it's likely that most or all the organizations that will create an ARM agent will have at least one enterprise ID assigned. The list of enterprise IDs can be found at:</p> <p><code>ftp://ftp.isi.edu/in-notes/iana/assignments/enterprise-numbers</code></p> <p>For organizations that do not have an enterprise identifier assigned by the IANA, the values between 32768-65535 are free for agent developers to use. There are no semantics associated with these ids. It is expected that most or all agent developers will have a formally assigned vendor id, and it will be an unusual situation where another id is needed, but this provides a solution if this is needed. There is a risk that two different agent developers will choose the same id, but this risk is very small.</p>
2 bytes	<p>Agent Version (unsigned16)</p> <p>The Agent Version is used to distinguish between different versions of an agent, and will be most useful when the capabilities and/or interfaces of an agent change from one release to another. It will also be useful to distinguish between different agents from the same vendor. Each vendor is responsible for avoiding having multiple agents with different capabilities using the same Agent Version value. Refer to the explanation in the Vendor ID field above to understand how to use this field.</p>
2 bytes	<p>Agent Instance (unsigned16)</p> <p>Each agent assigns transaction ids and start handles. Typically there will be one agent on each system, and this one agent is responsible for making sure that there are no duplicate ids or handles. From one system to another, however, duplicate ids and handles will be common, that is, an id/handle combination assigned on system X will also be assigned on system Y.</p> <p>One of the main purposes of the Address, Vendor ID, and Agent Version fields is to tell a management application how to contact an agent in order to translate the transaction id and start handle into the names of the application, user, and transaction class, and the instance of the transaction. As long as there is only one set of ids and handles stored at that address, all the required information is there. However, if the address is not the address of an individual agent, but rather is the address of a directory that contains information about multiple agents, there is insufficient information, because the id/handle combinations can be duplicated.</p> <p>The purpose of the Agent Instance field is to provide a way to identify which agent generated a correlator, even if the correlation data from multiple agents is available at the address specified in the Address field.</p>
4 bytes	<p>Transaction instance (<i>start_handle</i> returned from an <i>arm_start()</i>)</p>

4 bytes	Transaction class ID (<i>tran_id</i> returned from an <i>arm_getid()</i>)
2 bytes	Length of the address field (unsigned16)
Maximum 146 bytes	<p>Address</p> <p>This field is the address of the agent. More precisely, it is the address that a management application can contact in order to have the Transaction class ID mapped to the names of an application, user, and transaction class, and to get information about the transaction instance, or aggregated data about the transaction class (or any other data).</p> <p>The maximum length of this field is determined by an overall limit of 168 bytes for the correlator. In the correlator format described here, the maximum address length is 146 bytes. In actual practice, it is expected to be no more than 20 bytes for most implementations. If new correlator formats are added in the future, the maximum size of this field could change. The maximum correlator size of 168 bytes will not change.</p> <p>Correlators are passed on <i>arm_start()</i> calls as part of the buffer pointed to by the data pointer. The maximum size of the buffer is 256 bytes, of which 88 bytes are used for other fields, leaving 168 bytes for the correlator. An application should allocate space for the full 256 bytes when making the <i>arm_start()</i> call, but can then use the Correlator Length field to determine how long the correlator really is, and only forward that much data to other cooperating applications.</p> <p>Following are the formats that have been defined so far. The data is stored in network standard byte order, in which integers are sent most significant byte first, unless otherwise indicated. This list is not intended to be exhaustive, and will be extended whenever a new agent implementation requires a new format.</p> <p>0 = reserved</p> <p>1 = IPv4 Bytes 0:3 4 byte IP address</p> <p>2 = IPV4+port number Bytes 0:3 - 4 byte IP address Bytes 4:5 - 2 byte IP port number</p> <p>3 = IPv6 Bytes 0:15 - 16 byte IP address</p> <p>4 = IPv6+port number Bytes 0:15 - 16 byte IP address Bytes 16:17 - 2 byte IP port number</p> <p>5 = SNA Bytes 0:7 - EBCDIC-encoded network ID Bytes 8:15 - EBCDIC-encoded network accessible unit (control point or LU)</p>

	<p>6 = X.25 Bytes 0:15 - The X.25 network address (also referred to as an X.121 address). This is up to 16 ASCII character digits ranging from 0-9. The length is known from the <i>Length of the address field</i>. An agent running over an X.25 link with the IP configured may choose to use this format or the IP format. This format must be used when IP is not configured above an X.25 link.</p> <p>7:32767 = reserved 32768-65535 = undefined and available for agent implementers to use.</p>
--	--

The ARM Software Developers Kit (SDK)

The ARM SDK has been developed by the ARM Working Group of the CMG. The following information is included in this document for the convenience of application developers. Further information on the ARM SDK can be found on the World Wide Web, by following the address pointer given in **Referenced Documents** on page xii.

C.1 Content

The ARM SDK contains everything you need to prepare your application for transaction monitoring. It comes with a default no-operation (NULL) shared library that contains all the function calls you will need and a header file. The NULL library allows developers to instrument and run their applications without having one of the measurement agents installed.

Additionally, the source used to create the NULL library is part of the SDK. This is provided so a shared library can be created for applications that exist on platforms not currently supported by the measurement technologies. The SDK contains NULL libraries compiled for UNIX systems (HP-UX, IBM AIX, NCR MP-RAS, and Sun Solaris) and PC based systems (OS/2, Windows NT, and Windows95). The kit installs the correct library for the system.

A C language header file is supplied for applications written in either C or C++.

The source code and header file for a logging agent is supplied for use in testing your instrumentation.

Sample programs for C/C++ are provided as examples of how to instrument applications. Examples for other programming languages from the ARM 1.0 SDK are also available on the CD-ROM and the referenced Web site.

C.2 The ARM Shared Library

The library specified here is a NULL shared library provided to resolve externals in the code. If you are working with a specific vendor's performance measurement agent you may want to use the `libarm` library supplied for that agent instead of the NULL library. The agent-specific library will return errors that may be helpful during development, whereas the NULL library will always return a non-error condition (0).

After installation, `libarm.*` shared libraries reside in the directory where the system libraries are installed. For example:

HP-UX 10.x	<code>/usr/lib/libarm.sl</code>
IBM AIX	<code>/usr/lib/libarm.a</code>
Sun Solaris	<code>/usr/lib/libarm.so</code>
NCR MP-RAS	<code>/usr/lib/libarm.so</code>
Windows NT	<code>\$windir\$\SYSTEM32\LIBARM32.DLL</code>
Windows95	<code>\$windir\$\SYSTEM32\LIBARM32.DLL</code>
OS/2 (32-bit)	<code>\$os2dir\$\DLL\LIBARM.DLL</code>

It is recommended that the library be used from the standard location, so that applications can locate the library in a standard location and be able to take advantage of a measurement agent once it is installed on the system.

C.3 Logging Agent

The source code for a logging agent, `logagent.c`, is included in the SDK, for use in testing your instrumentation.

Unlike the NULL libraries, it is only in source format, so it needs to be compiled before it can be used.

Adding ARM Function Calls to an Application

The following steps show how to add ARM API function calls to an application. Also shown is a very simple application that has been instrumented with the ARM Software Developer's Kit (SDK) `libarm` library of calls.

Each numbered step below (1-4) is highlighted in the source code for the sample application that follows:

1. Once the SDK is installed, include the header file `<arm.h>` (for C and C++) in your source code and modify the compile link to reference the library.
2. Identify the start and the end of the application, and place the calls to `arm_init()` and `arm_end()`. These calls are used for initialization and cleanup of the ARM environment for your application, and therefore should be called from the initialization and exit sections of your application.
3. Determine what transaction classes you want to instrument, and the names to use to uniquely identify each transaction class. Modify the code to call `arm_getid()` for each transaction class. The `arm_getid()` calls can also be made from the application initialization section.
4. Call `arm_start()` just prior to the start of execution of the transaction, and `arm_stop()` just after the transaction completes.

When distributing an application, a NULL shared library must be included in the installation package. This will ensure that the application will load and execute correctly, even if no measurement agent is installed.

Note: If the `libarm.*` file already exists on the system where the application is being installed, do not overwrite the library. The library that exists may be the NULL library or it could be one of the measurement agent's libraries.

```

/*****
/* sample.c
*****/

#include <stdio.h>
(1) #include "arm.h"
int32 appl_id = -1;           /* Unique id for the application */
int32 tran_id = -1;         /* Unique id for the transaction */
void init()
{
(2)     appl_id = arm_init("ARM sample program" /* application name */
                        "*", /* use default user */
                        0,0,0);

    if (appl_id < 0)
        printf("ARM sample program not registered.0);
(3) tran_id = arm_getid(appl_id, /* application id from arm_init */
                      "Sample_transaction", /* transaction name */
                      "First Transaction in Sample program",
                      0,0,0);

    if (tran_id < 0)
        printf("Sample_transaction is not registered.0);
}
                                           /* init */

```

```
void transaction()
{
    int32 tran_handle;
(4)   tran_handle = arm_start(tran_id, /* trans id from arm_getid */
                             0,0,0);
    /******
    /* Perform actual transaction processing here*/
    /******
    sleep(1);
(4)   arm_stop(tran_handle,      /* transaction handle from arm_start */
              ARM_GOOD,        /* successful completion define = 0 */
              0,0,0);
    return;
}                                           /* transaction */
main()
{
    int continue_processing = 1;
    init();
    while (continue_processing)
    {
        transaction();
    }
(2)   arm_end(appl_id,          /* application id from arm_init   */
              0,0,0);
    return(0);
}
```


Testing Your Instrumentation

E.1 Procedure

The following tasks are recommended for testing your instrumentation after you have included the ARM API calls in your program.

1. Link to the NULL library that is part of the ARM SDK. If the link fails, it means that you are not linking to the correct library, or you are using incorrect names or parameters in at least one of the ARM API calls.
2. Once you can link successfully, then run your application, including the calls to the API, and verify that your application performs correctly. No testing of the API calls is done except for the linking parameters, because the NULL library simply returns zero every time it is called. Running the application is useful to insure that you did not inadvertently alter the program in a way that affects its basic function.
3. Assuming you have a compiled logging agent source, link to the logging agent generated in the previous step. Run your application, including the calls to the ARM API and verify that your application performs correctly.
4. Manually review the log created by the logging agent to verify that the correct parameters are passed on each call. These parameters include transaction ids to connect start calls to the correct transaction class, start handles to connect stop calls to the correct start calls, and any of the optional parameters. Optional advanced parameters include correlators that indicate the parent/child relationship between transactions and components, and metrics about the transaction or application state.

Search the log for error messages (identified by **ERROR** in the text), and informative messages (identified by **INFO** in the text), after your application has run for a considerable period of time in a simulated production environment. Upon successful completion of this test, you should be confident that your ARM API calls are correct. A sample log is provided in Section E.2.

5. Link to a performance measurement product (if available) and run the application under typical usage scenarios. This will test the entire system of application plus management tools.

E.2 Logging Agent Sample Output

```
7:47:39.sss: arm_init: Application <Appl_0> User <User_0> = Appl_id <1>

17:47:39.sss: arm_getid: Application <Appl_0> User <User_0> Transaction <Tran_0>
Detail <This is transaction type 0>

17:47:39.sss: arm_getid: Application <Appl_0> User <User_0> Transaction <Tran_0>
= Tran_id <1>

17:47:39.sss: arm_getid: Application <Appl_0> User <User_0> Transaction <Tran_0>
Metric Field <1> Type <1> Name <This is a Counter32 user metric          >

17:47:39.sss: arm_start: Application <Appl_0> User <User_0> Transaction <Tran_0>
= Start_handle <1>

17:47:39.sss: arm_start: Application <Appl_0> User <User_0> Transaction <Tran_0>
Start_handle <1> Metric < This is a Counter32 user metric          > : <0>

17:47:40.sss: arm_update: Application <Appl_0> User <User_0> Transaction <Tran_0>
Start_handle <1> Metric < This is a Counter32 user metric          > : <2>

17:47:41.sss: arm_stop: Application <Appl_0> User <User_0> Transaction <Tran_0>
Start_handle <1> Status <0>

17:47:41.sss: arm_stop: Application <Appl_0> User <User_0> Transaction <Tran_0>
Start_handle <1> Metric < This is a Counter32 user metric          > : <4>

17:47:41.sss: arm_end: Application <Appl_0> User <User_0> appl_id <1>
```

Examples

F.1 C/C++ (all platforms) Sample 1

Sample 1 uses standard ARM API calls, not advanced functions.

```

/*****
/* sample1.c
/* This program provides examples of how to use the features
/* provided by version 1.0 and 2.0 of the ARM API.
*****/

#include <stdio.h>
#include "arm.h"

int32 appl_id = -1; /* Define an identifier for the application id */
int32 simple_tran_id = -1; /* Define a unique identifier for each */
int32 long_tran_id_1 = -1; /* TRANSACTION */
int32 long_tran_id_2 = -1;
int32 sub_tran_id_1 = -1;
int32 sub_tran_id_2 = -1;

/*****
/* init
*****/

void init()
{
    appl_id=arm_init("ARM sample program", /* application name */
                    "", /* use default user */
                    0,0,0);

    simple_tran_id = arm_getid(appl_id,
                               "Simple_transaction_1", /* transaction name */
                               "First Transaction in Sample program",
                               0,0,0);

    if (simple_tran_id < 0)
        printf("Simple_transaction_1 is not registered.0);

    long_tran_id_1 = arm_getid(appl_id,
                               "Long_transaction_1", /* transaction name */
                               "A long transaction using arm_update",
                               0,0,0);

    if (long_tran_id_1 < 0)
        printf("Long_transaction_1 is not registered.0);

    long_tran_id_2 = arm_getid(appl_id,
                               "Long_transaction_2", /* transaction name */
                               "A long transaction using sub transactions",
                               0,0,0);

```

```

if (long_tran_id_2 < 0)
    printf("Long_transaction_2 is not registered.0);

sub_tran_id_1 = arm_getid(appl_id,
    "Sub_tran1_of_long_tran_2", /* transaction name */
    "Subtransaction 1 of Long_trans2",
    0,0,0);

if (sub_tran_id_1 < 0)
    printf("Sub_tran_of_long_tran_2 is not registered.0);

sub_tran_id_2 = arm_getid(appl_id,
    "Sub_tran2_of_long_tran_2", /* transaction name */
    "Subtransaction 2 of Long_trans2",
    0,0,0);

if (sub_tran_id_2 < 0)
    printf("Sub_tran_of_long_tran_2 is not registered.0);

} /* init */

/*****
/* simple_trans1
*****/

void simple_trans1()
{
    int32 tran_handle;

    tran_handle = arm_start(simple_tran_id, /* transaction id */
        /* from arm_getid */
        0,0,0);

    /*****
    /* Perform actual transaction processing here */
    *****/

    arm_stop(tran_handle, /* transaction handle from arm_start */
        ARM_GOOD, /* successful completion define = 0 */
        0,0,0);
    return;
} /* simple_trans1 */

/*****
/* long_trans_using_update
/* arm_update can show the progress of an iterative process
*****/

void long_trans_using_update()
{
#define MAX_COUNT 1000000
#define UPDATE_COUNT 100000 /* call update every 100,000 iterations */

    int32 tran_handle;
    int i;
    tran_handle = arm_start(long_tran_id_1, /* trans id from arm_getid */
        0,0,0);

```

```

for (i=1;i<=MAX_COUNT;i++)
{
    /* your processing goes here */

    if (i%UPDATE_COUNT == 0)
        arm_update(tran_handle, /* update based on UPDATE_COUNT */
                  0,0,0);
}
arm_stop(tran_handle, /* transaction handle from arm_start */
         ARM_GOOD, /* successful completion define = 0 */
         0,0,0);
return;
} /* long_trans_using_update */

/*****
/* long_trans_using_sub_trans */
/* Sub-transactions can show the progress of the steps of a long */
/* transaction */
*****/

void long_trans_using_sub_trans()
{
    int32 tran_handle;
    int32 sub_tran_handle1;
    int32 sub_tran_handle2;

    /* record the overall transaction processing (optional) */

    tran_handle = arm_start(long_tran_id_2, /* trans id from*/
                           /* arm_getid */
                           0,0,0);

    /* start recording the first step of the long transaction */
    sub_tran_handle1 = arm_start(sub_tran_id_1,
                                0,0,0);

    /*****
    /* Process step 1 on this transaction */
    *****/

    /* record the completion of the first step */

    arm_stop(sub_tran_handle1, /* transaction handle from arm_start */
            ARM_GOOD, /* successful completion define = 0 */
            0,0,0);

    /* start recording the second step of the long transaction */
    sub_tran_handle2 = arm_start(sub_tran_id_2,
                                0,0,0);

    /*****
    /* Process step 2 on this transaction */
    *****/

    /* record the completion of the second step */

    arm_stop(sub_tran_handle2, /* transaction handle from arm_start */
            ARM_GOOD, /* successful completion define = 0 */
            0,0,0);
}

```

```
        0,0,0);

    /* record the completion of the overall transaction */
    arm_stop(tran_handle, /* transaction handle from arm_start */
            ARM_GOOD, /* successful completion define = 0 */
            0,0,0);
    return;
} /* long_trans_using_sub_trans */

/*****
/* main
*****/

main()
{

    int continue_processing = 1;

    init();

    while (continue_processing)
    {
        simple_trans1();
        long_trans_using_update();
        long_trans_using_sub_trans();

        continue_processing = 0;
    }

    arm_end(appl_id, /* application id from arm_init */
            0,0,0);

    return(0);
}
```

F.2 C/C++ (all platforms) Sample 2

Sample 2 uses the advanced functions of application-defined metrics and transaction correlation.

```

/*****
/* Sample2.c
/* This program provides examples of how to use two of the new
/* features provided by version 2.0 of the ARM API:
/* - user defined metrics and correlation. For simplicity,
/* this sample program does not perform any error checking.
/*****

#include <stdio.h>
#include "arm.h"

int32 client_appl_id = -1; /* application id */
int32 client_tran_id = -1; /* transaction id */

int32 metric_appl_id = -1; /* application id */
int32 metric_tran_id = -1; /* transaction id */

/*****
/* server_application
/* This routine is included here to simplify this example.
/* In a real life situation, this piece of code would likely be
/* running on a separate system.
/*****

void server_application(arm_app_correlator_t client_correlator)
{
    int32 server_appl_id = -1; /* unique application id */
    int32 server_tran_id = -1; /* unique transaction id */
    int32 server_tran_handle = -1; /* transaction instance */

    arm_user_data1_t *buf_ptr, buf = {
        1, /* header */
        {ARM_CorrPar_f, 0, 0, 0}, /* flags */
    };

    int32 buf_sz;

    int i, data_len;

    server_appl_id=arm_init("Server_Application", /* application name */
                           "", /* use default user */
                           0,0,0); /* reserved */

    server_tran_id = arm_getid(server_appl_id, /* appl_id from arm_init */
                              "Server_transaction", /* transaction name */
                              "First Transaction in Server program",
                              0, /* data buffer */
                              0,0); /* buffer pointer & size */

    /* Pass the parent correlator received from the client
    /* application to the ARM agent using the arm_start call. */

    buf_ptr = &buf;

```

```

buf_ptr->flags[0] = ARM_CorrPar_f;

buf_ptr->correlator.length = client_correlator.length;
data_len = (client_correlator.length
            - sizeof(client_correlator.length) );
for (i = 0; i < data_len; i++)
    buf_ptr->correlator.agent_data[i] = client_correlator.agent_data[i];

buf_sz = (sizeof(buf)-sizeof(client_correlator)
          + client_correlator.length);

server_tran_handle = arm_start(server_tran_id,      /* tran_id from */
                              /* arm_getid */
                              0,                  /* reserved */
                              (char *)buf_ptr,
                              buf_sz);

/*****
/* Perform actual transaction processing here */
*****/

arm_stop(server_tran_handle, /* transaction handle from arm_start */

         ARM_GOOD,          /* successful completion define = 0 */
         0,                 /* reserved for future use */
         0,0);             /* buffer pointer & buffer size */

arm_end(server_appl_id,     /* application id from arm_init */
        0,0,0);           /* reserved for future use */

return;

} /* server_application() */

/*****
/* client_transaction */
*****/

void client_transaction()
{
    int32 client_tran_handle = -1; /* transaction start handle */

    arm_user_data1_t *buf_ptr, buf = {
        1, /* Header */
    };

    int32 buf_sz;

    arm_app_correlator_t correlator = {
        0, /* correlator length */
        0, /* agent data */
    };

    int i, data_len;

    buf_ptr = &buf;
    buf_sz = sizeof(buf);

```



```

/* The client application requests a correlator from the ARM Agent */

buf_ptr->flags[0] = ARM_CorrReq_f;
client_tran_handle = arm_start(client_tran_id,      /* tran_id from */
                              /* arm_getid */
                              0,                  /* reserved for future use */
                              (char *)buf_ptr,    /* metrics buf ptr */
                              buf_sz);          /* user metric buffer size */

/* If the ARM Agent returns a correlator, determine the size of      */
/* the agent specific data in the correlator and pass the data,     */
/* along with the correlator length, to the server application.     */

if ((buf_ptr->flags[0] & ARM_CorrGen_f) == ARM_CorrGen_f) {
    correlator.length = buf_ptr->correlator.length;
    data_len = (correlator.length - sizeof(buf_ptr->correlator.length) );
    for (i = 0; i < data_len; i++)
        correlator.agent_data[i] = buf_ptr->correlator.agent_data[i];
}

server_application(correlator);

arm_stop(client_tran_handle, /* transaction handle from arm_start */
         ARM_GOOD,          /* successful completion define = 0 */
         0,                 /* reserved for future use */
         0,0);             /* buffer pointer & buffer size */

return;

} /* client_transaction() */

/*****
/* init_client_application */
*****/

void init_client_application()

{

    client_appl_id=arm_init("Client_Application", /* application name */
                          "**",                /* use default user */
                          0,0,0);             /* reserved for future use */

    client_tran_id = arm_getid(client_appl_id, /* appl_id from arm_init */
                              "Client_transaction", /* transaction name */
                              "First transaction in Client application",
                              0,                    /* reserved */
                              0,0);             /* buffer pointer & size */

    return;

} /* init_client_application */

/*****
/* metric_transaction */
*****/

void metric_transaction()

```

```

{
    int32 metric_tran_handle = -1; /* transaction start handle */

    arm_user_data1_t *buf_ptr, buf = {
        1, /* Header */
        {0, ARM_AllMetrics_f | ARM_String1_f, 0, 0}, /* Flags */
    };

    int32 buf_sz;

    buf_ptr = &buf;
    buf_sz = sizeof(buf);

    buf_ptr->metric[0].counter32 = 0x32;
    buf_ptr->metric[1].gauge32 = 0x32;
    buf_ptr->metric[2].counter64.upper = 0x01234567;
    buf_ptr->metric[2].counter64.lower = 0x76543210;
    strcpy(buf_ptr->metric[3].string8, "String 8");
    buf_ptr->metric[4].cntrdivr32.count = 0x32;
    buf_ptr->metric[4].cntrdivr32.divisor = 0x32;
    buf_ptr->metric[5].numericid64.upper = 0x01234567;
    buf_ptr->metric[5].numericid64.lower = 0x76543210;
    strcpy(buf_ptr->string32, "This is a 32 character string ");

    metric_tran_handle = arm_start(metric_tran_id, /* tran_id from */
                                   /* arm_getid */
                                   0, /* reserved */
                                   (char *)buf_ptr, /* metrics buf ptr */
                                   buf_sz); /* user metric buffer size */

    /******
    /* Perform some processing here */
    /******

    arm_update(metric_tran_handle, /* trans handle from arm_start */
               0, /* reserved for future use */
               (char *)buf_ptr, /* user metrics buffer pointer */
               buf_sz); /* user metric buffer size */

    /******
    /* Perform some more processing here */
    /******

    arm_stop(metric_tran_handle, /* transaction handle from arm_start */
             ARM_GOOD, /* successful completion define = 0 */
             0, /* reserved for future use */
             (char *)buf_ptr, /* user metrics buffer pointer */
             buf_sz); /* user metric buffer size */

    return;
} /* metric_transaction() */

/******
/* init_metric_application */
/******

void init_metric_application()
{

```

```

arm_user_data101_t *buf_ptr, buf = {
    101,
    {0, ARM_AllMetrics_f | ARM_String1_f, 0, 0},
    {{1, "Metric #1 - Type 1 is a COUNTER32      "},
     {4, "Metric #2 - Type 4 is a GAUGE32       "},
     {2, "Metric #3 - Type 2 is a COUNTER64     "},
     {9, "Metric #4 - Type 9 is a STRING8       "},
     {3, "Metric #5 - Type 3 is a COUNTER32/DIVISOR32"},
     {8, "Metric #6 - Type 8 is a NUMERICID64   "},
     {10, "The last field is always a STRING32  "}}
    };

int32 buf_sz;

buf_ptr = &buf;
buf_sz = sizeof(buf);

metric_appl_id=arm_init("Metric_Application", /* application name */
                       "", /* use default user */
                       0,0,0); /* reserved */

metric_tran_id = arm_getid(metric_appl_id, /* appl_id from arm_init */
                           "Metric_transaction", /* transaction name */
                           "First transaction in Metric application",
                           0, /* reserved */
                           (char *)buf_ptr, /* buffer */
                           buf_sz); /* buffer size */

return;

} /* init_metric_application */

/*****
/* Main */
*****/

main()
{
    int continue_processing = 1;

    init_client_application();

    init_metric_application();

    while (continue_processing)
    {
        client_transaction();
        metric_transaction();
        continue_processing = 0;
    }

    arm_end(client_appl_id, /* application id from arm_init */
            0,0,0); /* reserved for future use */

    arm_end(metric_appl_id, /* application id from arm_init */
            0,0,0); /* reserved for future use */
    return(0);
}

```


/ *Glossary*

ARM

Application Response Measurement

Information on this Group is available on the Web, at

<http://www.cmg.org/regions/cmgarwmw/>

ARM Working Group

The Application Response Measurement working group which developed the original specification on which this ARM Open Group Technical Standard is based. The ARM Working Group performed this development work under the sponsorship of the CMG.

CMG

Computer Measurement Group.

Information on this Group is available on the Web, at

<http://www.cmg.org/>

SDK

The ARM working group's Software Developer's Kit.

URL

Uniform Resource Locator — a World Wide Web address.

Index

<arm.h>	35	distributed applications	1
agent	41	distributed transactions	32
application-defined metrics	23	enterprise environment	3
ARM	63	function call parameters	9
ARM API function call parameters	9	function calls	7
ARM API function calls	7	gauge	25
ARM Software Developers Kit	47	header file	35, 47
ARM Working Group	63	heartbeat	32
arm_end()	7, 11	host-centric applications	1
arm_getid()	7, 12, 26	instrumenting	
arm_init()	7, 14	distributed transactions	32
arm_start()	7, 16, 28, 41	long transactions	32
arm_stop()	7, 17, 28	multi-step long transactions	32
arm_update()	7, 19, 28	instrumenting an application	3, 6, 49
ASCII	33	instrumenting methodologies	32
basic tasks	5	internationalization	33
business transaction	3	libarm	47
C language header	47	logging agent	48
C++ language header	47	Logging agent	52
call sequences	8	long transactions	32
child transaction	23	measurement agent	21, 33
child/parent transaction relationship	21	methodologies for instrumenting	32
client/server model	1	mission-critical roles	2
CMG	63	multi-step long transactions	32
code pages	33	multiple network protocols	2
component transaction	2	multitasking terminal	2
correlation	21-22	native languages	33
correlation application	22	network byte order	41
correlator	41	NULL shared library	47
format	42	NULL terminator	33
network byte order	41	numeric id	25
counter	24	parameters	9
data format		parent correlator	21
arm_getid	26	parent transaction	23
arm_start()	28	performance	23
arm_stop()	28	processing time	1
arm_update()	28	reducing threads	23
data type	24	remote server	2
counter	24	requirements for transaction correlation	23
gauge	25	response time	1
numeric id	25	response time correlation	22
string	25	SDK	47, 49, 63
data type definitions	27	C language header	47
data type terminology	10	C++ language header	47
definitions for data types	27	logging agent	48
diagnostic uses	24	NULL library	47

selecting a data type.....24
service level.....2
string.....25
testing an instrumentation51
transaction.....1
transaction correlation21, 23
transaction instance32
transaction response time correlation.....22
transit time2
tuning an application.....23
Unicode.....33
URL.....63
UTF-8.....33
valid call sequences.....8
Version 1.0/Version 2.04
workload planning.....23