

On-Board Land Vehicle Mayday Reporting Interface

Foreword—This SAE Standard describes the interface between an on-board automatic Mayday detection and reporting system (or systems) and the response center (or centers) which handles the receipt of such calls. This document covers the physical and application layers of the interface, emphasizing the required data (“message set”) to be exchanged between the vehicle and the service provider. This document defines minimum message content, message formats, and interaction protocols which any ITS mayday system should contain and adhere to in order to insure inter-operability with State, Federal, and Private service providers. The purpose of this document is to facilitate the deployment of such vehicle devices and define a common messaging methodology of how they will interface to both private service providers and government agencies such as the National 911 network over a variety of telecommunications links extending from the vehicle. See Figure 1.

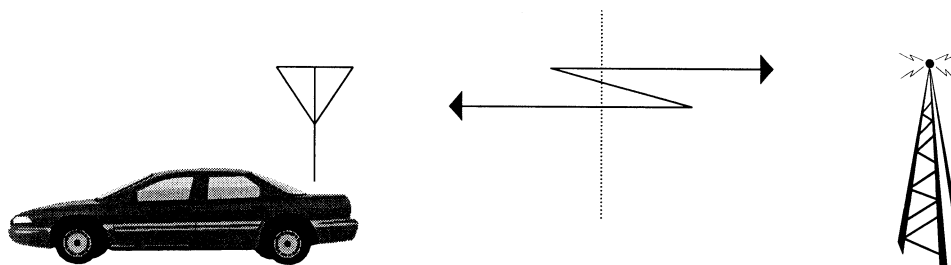


FIGURE 1—OVERALL OPERATIONAL CONCEPT

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- 1. Scope**—This SAE Standard describes the interface between an on-vehicle Mayday detection, reporting system and the off-vehicle response center that will manage the response to the vehicle's call for assistance. The automatic detection and reporting by either the intelligent vehicle itself or by the intelligent roadway of a vehicle that is disabled or involved in an accident, [referred to as Automatic Mayday], is one of the key services identified by the ITS America program plan road map. This effort has been identified, as STD SAE J2313 in recent DOT-FHWA efforts to advance needed National standards.

This document primarily addresses the responsibilities of a vehicle in detecting and reporting such an event. Equipment suites on each vehicle will vary widely, as will the communications channel employed to report the incident. This document proscribes a basic methodology to uniformly incorporate whatever level of data reporting the vehicle supports (containing information about both the vehicle condition and any occupant data), and transmits this data to the response management agency in a Nationally standardized format, regardless of the transmission media used to effect the communications.

This document has been developed by the SAE ITS In-Vehicle Systems Interfaces Committee (IVSIC) in conjunction with its members, private industry, and various public safety and response agencies at both the State and Federal level. The messages developed here will form a portion of the ITS message list which is being compiled by the SAE ITS ATIS under the SAE J2354 effort and which will be used as the US submission to the ISO TC-204 effort to develop worldwide standards in this area.

2. References

2.1 Applicable Publications—The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest version of SAE publications shall apply.

2.1.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001

SAE J1761—Information Report on ITS Terms and Definitions
SAE J2354—Message Sets for Advanced Traveler Information Systems (ATIS)
SAE J2355—ITS Data Bus Architecture Reference Model Inf. Report
SAE J2366—ITS Data Bus Protocol Standard
SAE J2367—ITS Data Bus Gateway Reference Design Recommended Practice
SAE J2374—National Location Referencing Message Standard
SAE J2369—Standards for ATIS Message Sets Delivered Over Highspeed FM Subcarriers

2.1.2 ISO PUBLICATIONS—Available from ANSI, 11 West 42nd Street, New York, NY 10036-8002.

ISO 3779—Road vehicles—Vehicle identification number (VIN)—Content and structure
ISO/IEC 8824-1:1998—Information Technology—Abstract Syntax Notation One (ASN.1): Specification of Basic Notation
ISO 8859-1—Information processing—8-bit single-byte coded graphic character sets—Part 1: latin alphabet No. 1.
This is the default character set. ISO 8859-1 is also known as the Latin 1 or ANSI character set. It is compatible with the ANSI characters used by the Windows NT and Windows operating systems.

2.2 Related Publications—The following publications are provided for information purposes only and are not a required part of this document.

2.2.1 OTHER PUBLICATIONS

U.S. Department of Transportation Research and Special Programs Administration - North America
Emergency Response Guidebook
NENA Master Glossary of 9-1-1 Terminology, NENA Document 01-002 dated May 28th 1997 from the
National Emergency Number Association (NENA) Technical Committee and PSAP Operational
Standards Committee. Available from NENA at NENA 47849 Papermill Road, Coshocton, OH 43812
(740) 622-8911 - Fax (740) 622-2090

3. Definitions—The following definitions are taken in part from SAE J1761, which defines terms used in the ITS community. The reader is cautioned to refer to SAE J1761 as the definitive source for defining these terms. Additional terms native to the wireline 911 industry have been added for cross-discipline education. It should also be noted that while these terms generally follow those used in the 911 Emergency response industry, exact definitions do vary.

3.1 911—The National Emergency Number used in the US. Dialing 911 on any phone (mobile or wireline) is expected to connect the caller to an emergency response center where the situation can be assessed and the proper response agency (police, fire, etc.) can be dispatched. ITS has a “mayday” service which is expected to provide some of the same function from calls automatically generated by vehicles detecting that they have been involved in a major accident. See also: Mayday, Automatic Incident Detection. Pronounced “nine-one-one,” not nine-eleven. It should be noted that other countries use other number sequences.

3.2 ALI Dip—The process of using the ANI to parse a database to retrieve the address associated with that number so that response personnel can be directed to it. See ANI, ALI.

- 3.3 American Association of State Highway and Transportation Officials (AASHTO)**—A consortia of State DOT and related stakeholders.
- 3.4 Association of Public Communications and Safety Officers (APCO)**—A professional organization of Public Safety (Police, Fire, etc.) dispatchers and communications network officers. See also: NENA.
- 3.5 Automatic Location Identification (ALI)**—A NENA term for the automated process of matching a phone number to an address used in the current wireline 911 systems, which have enhanced 911 services. The determination and display of a caller's location (coded by his wireline phone address of record) is used by a PSAP in responding to 911 calls. A major issue facing the deployment of its "mayday" services is that wireless callers (as vehicles are expected to be) do not automatically present an address in the systems deployed today. Today, this problem is found with cellular phones and with large corporate PBX's, neither of which, provide an easy means of determining a callers location.
- 3.6 Automatic Number Identification (ANI)**—The determination and display of the caller's phone number, which is used by a PSAP in responding to 911 calls. ANI data is then used to perform an "ALI dip" to display the address of record for that number to the dispatcher.
- 3.7 Automatic Vehicle Classification (AVC)**—A term used by the CVO community to imply automatic detection and the classification (size, weight, restrictions, goods carried, HAZMAT, etc.) of the subject vehicle. See also: weight in motion, toll tags, electric tariffs.
- 3.8 Automatic Vehicle Identification (AVI)**—An automated means of determining the identity (typically some sort of assigned serial number) of a vehicle. This information is then typically used in toll tag and tariff applications, however, AVI technology has also been widely applied to commercial container shipping and tracking. See also: Toll Tags, Smart Cards.
- 3.9 Automatic Vehicle Location (AVL)**—An automated means to determine and report the location of a vehicle without operator (typically driver) intervention. Technical approaches vary with the positioning technology used (GPS, Triangulation, Network systems) but typically involve the relaying of the position to a central command facility on an as-needed or periodic basis. Commonly used in CVO and transit/dispatch applications. AVL is not normally used in autonomous navigation systems.
- 3.10 Automatic Vehicle Location System (AVLS)**—See AVL, a system involving the use of AVL. The term "system" is often appended to "AVL" in those approaches where the position determination occurs at a central site or involves the use of a fixed infrastructure as part of the determination process (information regarding the vehicle position is then forwarded to the dispatch point where it is used). Systems which use time and/or angle of arrival of a vehicle originated signal would be examples of this.
- 3.11 Basic 911**—A NENA term to refer to (generally outdated) wireline systems where the dispatcher was not provided any information other than the voice of the caller, generally replaced by E911 in most of the country.
- 3.12 Call Taker**—The human person and his/her support equipment upon which information about the call or data from the PSN or the Vehicle is displayed. This is the actual human being who deals with the Vehicle in duress. In an actual 911 environment, there may be a related position of Call Dispatcher whose responsibility is to dispatch resources for the call. In smaller facilities, this is often the same person.
- 3.13 CLASS 1 TO CLASS 8**—A method used in the US to classify heavy trucks for purposes of registration, tariffs, and driver licenses. Class 1~3 refers to smaller trucks, say a "3 ton van" while a Class 8 truck is a large over-the-road CVO vehicle.
- 3.14 Data Element (DE)**—The basic building block used in all ITS standards, defined in this document as the building blocks used in message type and element of the frame.

- 3.15 Dedicated Short Range Communications (DSRC)**—The preferred term for vehicle to roadside communications such as that used in toll tags.
- 3.16 Dual Tone Multi-Frequency (DTMF) Tones**—A signaling process used in the telephone system, the tones heard when dialing.
- 3.17 E911**—Enhanced 911, a term for 911 systems which have the additional feature of matching the users (wireline) phone number to a database of known locations, and hence the callers presumed address. See also: ANI, ALI.
- 3.18 Electronic Serial Number (ESN)**—One of the identifying serial numbers in a cellular phone handset used to identify it. The ESN has a section reserved for the manufactures, for the model type, and for the serial number of that specific unit.
- 3.19 Emergency Management System (EMS)**—An ITS term for coordination of mayday responses. This is also the name of a subcommittee within ITS whose charter is to be a resource for State level EMS developers.
- 3.20 Emergency Medical Service (EMS)**—The direction of, and the rendering of aid to, person needing it. In the context of ITS, EMS represents the ambulance and medical technical personnel who must arrive on-site (over-the-roadway network) to render aid in a timely fashion. The EMS community places unique needs on both the TMC (to coordinate passage in the road network) and in the on-board vehicle equipment.
- 3.21 Emergency Service Numbers (ESN)**—The directory of which/what public safety group handles a given location, used by a PSAP to direct calls to the proper reposos group.
- 3.22 Emergency Service Zone (ESZ)**—A NENA term for the area in which a given single PSAP coordinates all wireline calls or for the coverage area of the response agency.
- 3.23 HAZardous MATerial (HAZMAT)**—Industry acronym for vehicles carrying such material, as well as various regulations concerning the portage and conveyance of same (routing restrictions, etc.). Outside of ITS, the term is also used to denote issues of fuel tank storage, etc.
- 3.24 Independent/Information Service Provider (ISP)**—An ITS term for private service bureaus of various types. In Mayday, the ISP is another term for the Private PSAP, the private agency which accepts and processes various types of calls from the vehicle. In this document, the terms ISP, PSAP, and PPSAP can in general be replaced with the generic term Call Taker.
- 3.25 INFORMATIVE**—Sections marked this way are NOT mandatory for compliance with this specification. Typically they are either informative or represent options which individual implementers may or may not choice to implement.
- 3.26 Location Referencing Message Set (LRMS)**—A body of ongoing research conducted by Oak Ridge National Labs (ORNL) to determine methods for the common interchange of spatial data across different map databases for reasons of interoperability.
- 3.27 M911**—Slang term for the subject of “Mobile 911.” See Mobile 911.
- 3.28 Master Street Address Guide (MSAG)**—A NENA term for the database used in 911 systems which contains data on selective (call) routing, emergency number directories (ESNs), and complete address ranges for the covered area.

- 3.29 Mayday Device**—The equipment suite which provides the command and control of the called PSAP (on whatever communications media it uses), exchanging the message set (outlined in this document), and interacting with the driver and vehicle to various degrees. The scope of such equipment can vary significantly. It may have anywhere from total to no access concerning the vehicle safety systems. It may be aware of its geographic location, it may require external processing to determine this, it may have no idea at all regarding its geographical location. It may have an extensive or non-existent user interface. It may be a simple aftermarket cellular phone type device or an OEM installation. About the only thing which can be assured regarding this equipment is that it will communicate over some wireless means using the basic message formats defined in this document, and hence can be assured that public PSAPs can interact with it.
- 3.30 Mayday Processing Center**—A term used by some private service providers to refer to their own “PSAP” which often intercepts Mayday calls and processes them. Typically they will handle non-Mayday incidents (a roadside breakdown for example) while passing on “real” Mayday calls to the local government agency which can handle them. Referred to in this document as Private PSAPs, such service providers are both a necessary and a source of controversy within the 911 community. While the value they bring in filtering out some calls is a positive, the delay inherent with them could be problematic. Existing wireline 911 providers view such private PSAPs as being similar to a home alarm response agency, a fairly negative and at times hostile perspective.
- 3.31 MayDay**—In this document, the term is used in lower case to increase readability. Originally from the World War I French phrase “M’aidez” lit. “help me”. The term is used by the ITS community to mean a variety of users and automatically initiated requests for assistance to the vehicle or the traveler. It is generally not used by the 911 community.
- 3.32 Message Frame**—The package, which contains the message types, used in the protocol of the document. Each message frame contains one or more message types, which in turn contain the actual useful data.
- 3.33 Message Type**—The basic unit of data used in the document. Each message type contains an identifying code, a word count, and the data itself. Each of these is defined by the DEs, which are used to make it up.
- 3.34 Mobile – 911**—Calls to the 911 system placed by a mobile cellular phone. Calls of this type present the additional problem of not knowing the callers location. It is generally believed that future phone systems will be able to report their position. The FCC has currently proposed a set of regulations, which would require new phones to have this ability.
- 3.35 NASTD**—National Association of State Telecomm Directors.
- 3.36 National Emergency Number Association (NENA)**—The not-for-profit professional association concerned with operating the US 911 system.
- 3.37 NCCEM**—National Coordination Council of Emergency Management.
- 3.38 NORMATIVE**—Sections marked this way are mandatory for compliance with this specification.
- 3.39 Primary Safety Answering Point (PSAP)**—A slightly incorrect term which is gaining acceptance. Given the multi-jurisdictional nature of many mayday incidents, many calls are routed to Secondary PSAPs for handling, this has given rise to the P being redefined as primary.
- 3.40 Public Safety Answering Point (PSAP)**—A term used by the emergency number community to refer to the actual place where emergency (911) calls are routed to be handled by a dispatcher. Typically the PSAP dispatcher is in direct contact with local fire, police, ambulance, etc., and acts as the central management agent coordinating between those groups. It is expected that “Mayday” services, both user initiated and automatically detected by the vehicle, will be routed to a PSAP for further processing. See also: NENA, APCO, 911.

- 3.41 Rescue Service**—A (typically private) firm providing roadside assistance to motorist with stranded vehicles. There are a number of private firms, which provide this service in the US under the name or identify of a sponsoring agency, such as the local cellular carrier. In it increasing common in metro areas that these services are provided by the local authorities as well.
- 3.42 Safety Restraint System, Safety Response System (SRS)**—The automotive term most frequently used to refer to the entire system including airbags. An SRS system often includes many safety devices such as seat belt restraints and fuel shutoffs as well as multiple airbags. In this document, we have grouped SRS technologies by occupant position served.
- 3.43 Service Provider**—An ITS term for any entity which provides some service. In the context of MAYDAY, this refers to the private PSAPs who expect to handle non-MAYDAY messages and hence add value to the equipment installed in the vehicle. Example of such uses include car theft recovery, roadside assistance, specialized medical services, and general vehicle maintenance & servicing operations provided by the dealer and/or the manufacturer of the vehicle. The use of shared equipment for both MAYDAY and to service these other non-life threatening needs, is a key expectation of ITS proponents.
- 3.44 Universal Modeling Language (UML)**—A recently adopted industry standard which unified the several popular object orientated modeling methodologies. Used in this document to convey the relationship between message frames (in interaction diagrams) and in the state of the protocol (in state diagrams).
- 3.45 Vehicle Identification Number (VIN)**—The VIN identifies a specific make and model of car. It contains data regarding the car maker as well as the 'serial number' of the individual car in much the same way a cellular phone ESN is coded.
- 3.46 Wireless 911**—Another term for Mobile 911. See Mobile 911.
- 4. Overview of Message Set Standard—INFORMATIVE**—The use of location technology combined with wireless phone communications has produced an early ITS success story in the form of the popular "Mayday phone system" used by ever increasing numbers of consumers to summon help, request assistance, or receive convenience information upon request from a support organization. A primary selling feature of many of these products is the ability to use the device to summon aid during an emergency. At this time, all such devices use proprietary interfaces and go to national private service firms before having the critical data relayed to the local public 911 infrastructure – typically by human operators repeating information verbally to one another. This document was developed to provide a common message set between privately developed vehicle-based equipment¹ and publicly available call taker/dispatch equipment, to affect a more rapid response, reduce the chances of error, and to foster a wider deployment of such devices on a National and interoperable scale.

In establishing this document, much committee discourse has revolved around the proper level of complexity, which the message content should contain. A typical example of this would be a debate about the usefulness of sending to the PSAP information that the vehicle has detected three occupants. The initial reaction of 911 practitioners is that this is not useful information to the call taker. When is it pointed out that such information can be used to detect that one of the occupants has subsequently left the vehicle and is wandering about the incident site, then the value becomes more obvious. In related areas, crash information can be used to determine the degree of injury severity and therefore, what level of response is best. The problem with too great a number of such data elements, is that end user equipment will vary in feature sets and that receiving equipment (especially that operated with public funds) can not be expected to be able to handle every variety of equipment. Further, private firms, which feel they have a superior set of sensors, do not always wish to see them standardized.

1. This document is recommended for non-vehicle portable devices as well.

From this discussion, the following compromise position was determined as in the best interest of all parties. A message format with a set of basic required data elements has been developed which all parties are expected to implement. From this level of service, more advanced features could be implemented at either end but would not be required. A feature word, which outlines the abilities of each party, was made a part of the message structures. In this way, each device (the vehicle and the dispatching end) would be assured of a minimum set of interoperable messages. For those supporting it, further features with additional beneficial data could also be exchanged. In addition to this model, data fields of unspecified elements were also reserved so that private systems could be operated fully within the specification as needed.² A further benefit of this approach was that it allows a systematic evolution of the messages as technology matures. For example, crash severity or the needs of Hazmat tracking for commercial vehicles can be incorporated without any loss the functionality for prior systems already in the field.

The challenge then facing the committee became to develop a basic message set which meets the response needs of public safety in a uniform way while still encouraging the further development of message sets and data elements among private industry (and others). This document was developed to meet the needs of both local public safety response agencies and of private commercial equipment developers. Mandatory messages in this document are defined with the keyword NORMATIVE, while optional ones are defined with the keyword INFORMATIVE.

Historically, 911 telephone calls have originated from wireline telephones. In an enhanced 911 system (E911), additional information regarding the calling party is relayed with the call to the Public Safety Answering Point (PSAP) operator. In this document, the PSAP may also be an ISP or a privately operated PSAP. In any event, this person can be generically referred to as the call taker. In the case of traditional wireline 911 calls, the following events occur. Between rings of the incoming call, the central office switch provides ANI information to the call taker equipment, which uses it to obtain the ALI data from the MSAG using an ALI dip. This information includes the location (street address) of the caller (indexed by calling number into the message) contained in the MSAG database. It is displayed on a simple alphanumeric screen, most often without any geographic awareness or support or even the creature comforts of a modern windowing system. Additionally, a PSAP operator may be able to cross-reference this information to determine if previous calls have been made from that number or to find other information. The primary action of the call taker is to determine the callers situation then to dispatch³ the appropriate local resources (by contacting their respective dispatch point) to handle the call.

It is commonly understood that PSAPs do not want to receive information directly from fully automated systems. Historically, this was due to the high false alarm rate generated by residential burglar alarm systems. A highly reliable system will be required to prevent the same types of false alarm problems from occurring in a mobile environment. This is essential to improve confidence levels for automatic collision notification and other mobile MAYDAY systems among existing public safety response dispatchers.

4.1 System Architecture—Though it is out of the scope of this project and this document, it becomes necessary to make some assumptions as to how a complete MAYDAY system will operate. Some of the assumed system requirements, operational procedures, and architectures required for this MAYDAY message set to operate are as follows.

The basic system architecture that is assumed for this discussion is shown in Figure 2. Within the vehicle, it consists of an AMPS cellular phone, a GPS set, some sort of control unit, a user interface, and an interface to the vehicle.

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2. That is, when calling a public PSAP. Private message formats between a private PSAP and a vehicle, which are not the subject of this document, are also expected to co-exist. Nothing in this document prevents such private communication from occurring in whatever message set the vendor has implemented.
 3. We are presuming for this example that the call taker is also the dispatcher. In larger operations, the dispatching function is performed by another person. The point of this example is that the PSAP is concerned mostly with directing resources to the problem. It is less concerned with managing the incident scene or exchanging information while in route. Such considerations are more in the area of the responder agencies.

The non-vehicle portion of the model consists of the mobile telephone switching office (MTSO), the public telephone network, and any ISP/PSAP that may be accessed through a telephone line. This includes, but is not limited to a PSAP.

It is presently assumed that digital data sent between the vehicle and the MTSO is done "in-band" (i.e., the data is sent over the voice channel of the AMPS phone). This assumption is made because it does not require any changes to the cellular phone network. This obviously puts the burden of translating the digital data on the receiving ISP/PSAPs. Of course this message set will be designed to be independent of the transmission medium used. The document was developed with the mindset of using AMPS cellular but this message set will work equally well over CDPD, SMR etc.

As defined for the purposes of this document, one can assume that these systems are vehicle-based. It should be noted, however, that in the future there may be subset systems that use a Personal Information Assistant (PIA) or simply a GPS set merged into a cellular phone. These systems may still utilize this message set and may or may not have reduced accuracy or features.

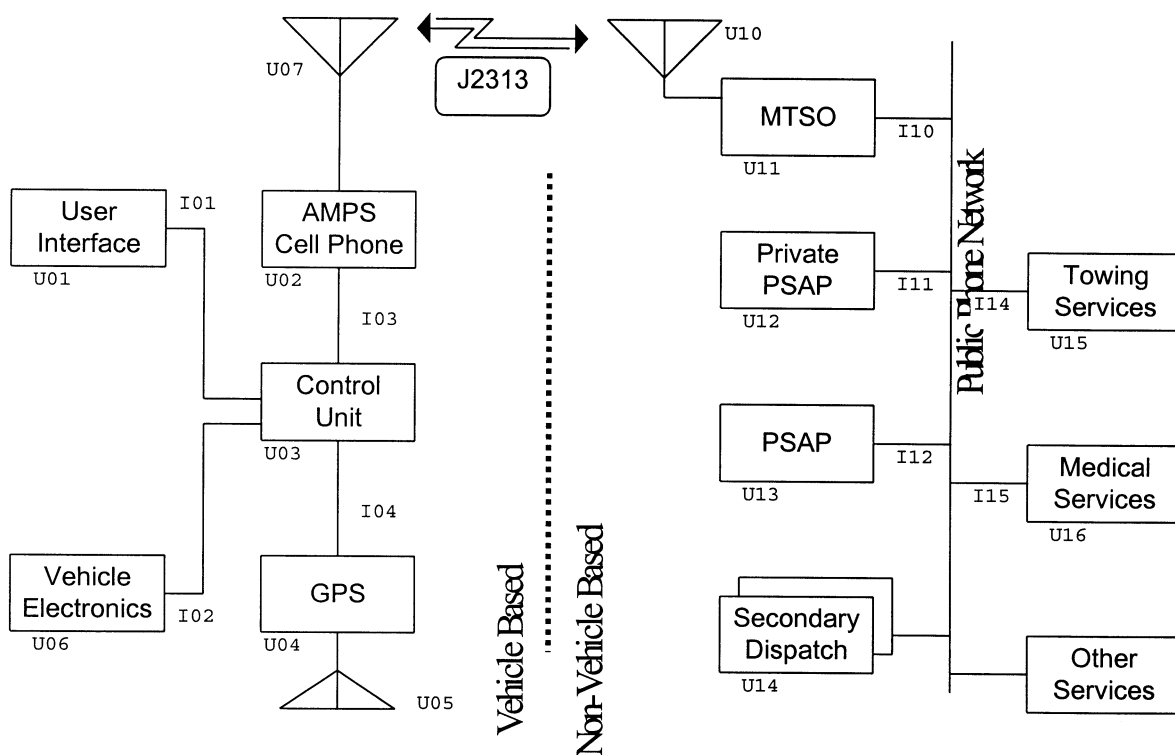


FIGURE 2—GENERIC MAYDAY SYSTEM DIAGRAM MODEL

4.2 Message Information Flow—In an effort to define the core messages within the MAYDAY message set, let's begin by investigating the current voice channel mobile 911 information flow. A typical (rather ideal) call to a mobile 911 operator might sound like this:

EXAMPLE—

Caller initiates call

911 Operator: "911, what is the nature of your call"
 Caller: "I've just been in an accident!"
 911 Operator: "Okay sir is anyone injured?"
 Caller: "Yes, I think I've ruptured my spleen!"
 911 Operator: "Okay, stay calm, where are you?"
 Caller: "I think I'm on the Eastbound 10 just past the Citrus exit"

In short, the information flow is as follows:

- a. Call taker sorts call to determine level of urgency, is call in fact an emergency?
If not, route call to lower priority operator or queue.
- b. If emergency, determine if lives are in danger.
- c. Determine the location of the incident. (Note that in the previous example the caller is particularly helpful in this regard, real life is typically more complex.)
- d. Gather additional supplemental information about the incident.
- e. Determine which response agencies cover the subject area and require their dispatch (in the case of mobile response problems such as mayday, a multi-jurisdictional matrix is involved with the additional uncertainty that the location may not be well known or the precise service areas of each agency involved.)

The automated nature of the MAYDAY system will improve the accuracy and efficiency of data from a potentially injured or at least flustered victim. Efficiency will be increased by reducing the amount of data exchanged between the ISP/PSAP call taker and the MAYDAY initiator by removing the need for "operator-side" queries. All message transactions between the ISP/PSAP and victim will follow the general procedure as follows:.

1. Traveler initiates MAYDAY call either manually or automatically
2. Data modems at the ISP/PSAP synchronize with the data modem in the caller's vehicle
3. Once the vehicle is placed in "send" mode, the core MAYDAY messages are streamed out
4. At the completion of this data package, an "end of message" flag is sent
5. If the data is received and understood by the ISP/PSAP, an ACK message is sent to the vehicle
6. The voice channel (if applicable) is then opened for the ISP/PSAP call taker
7. The voice channel may be periodically interrupted if the ISP/PSAP requests additional or supplemental data from the vehicle (this applies to AMPS phone technologies using a single cellular phone, other mediums may be able to transmit voice and data simultaneously)

4.3 Relationships with National Architecture flows—The functionality of Mayday in the ITS National Architecture is described as a set of two types of flows (see Figure 3): an emergency event notification, and an emergency acknowledgment. In this document, these two flows are extended and refined into the four "message frames" described in the subsequent sections. The message frame contains enough of the message "network" level of the protocol to allow necessary network information to be sent "in-band," this allows for greater portability of the message set to other networks. This is an area which is required for implementation but is not described in the functional processes of the National Architecture itself (or in many of the message catalog documents being built at this time.)

Within the message frame are nineteen messages which make up the message set of the specification. The mapping between the two flows in the National Architecture and the messages and messages frames is not precise. This document, representing a more detailed design process in this specific area, extends the conceptual schema of Mayday message to being bi-directional in nature and developing a framework for efficiently bundling the data over a media which is shared with a voice channel.

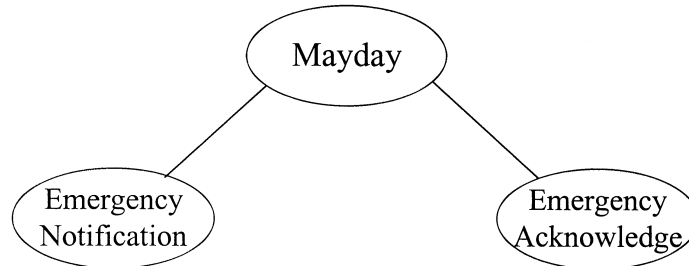


FIGURE 3—MAYDAY FUNCTIONAL FLOWS FROM THE NATIONAL ARCHITECTURE

In keeping with de facto practice in ITS standards of mapping each message set to and from the National Architecture flows, we can represent the full set of Mayday messages as shown in Figure 4. This figure can be considered similar to other ATIS message sets flows as represented in SAE J2354 Message Sets for Advanced Traveler Information Systems (ATIS). The message set defined in this document maps into Section 4.1.1 Emergency Notification of SAE J2354. The nineteen messages should all be considered “peers” to each other from the perspective of message sets, e.g., no order should be implied from the figure.

As specified in subsequent sections, each message can be made up of a variety of optional or mandatory data elements. Taken as a whole, these elements cover the functional requirements expressed by the National Architecture, as well as those expressed by NENA in its wireless 911 work and by private equipment vendors and stakeholders contacted by the committee in the course of developing this document.

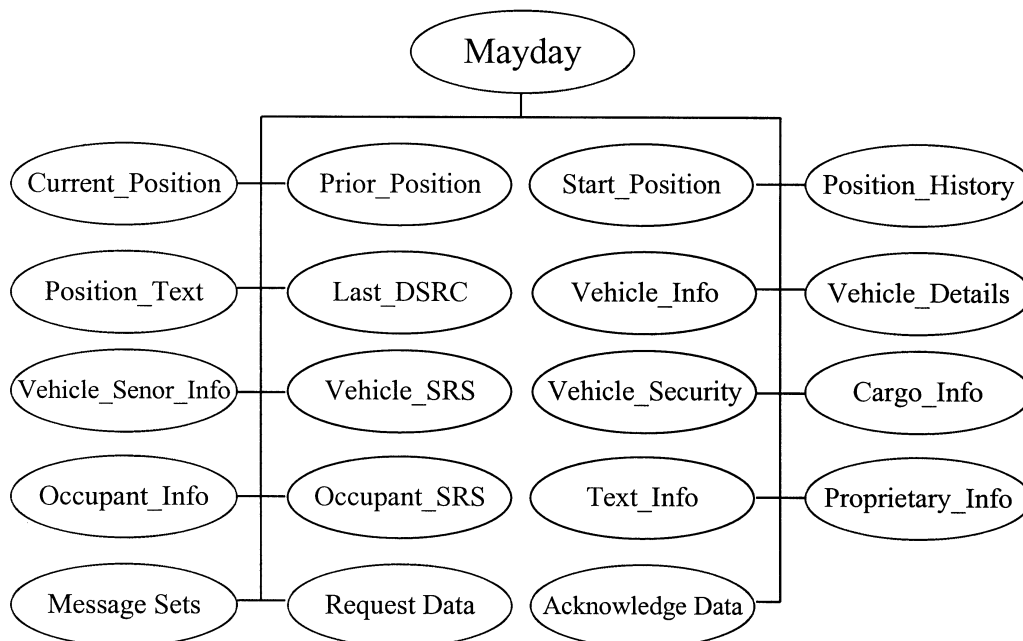


FIGURE 4—DETAILED MAYDAY MESSAGE FLOWS

4.4 Additional Requirements Imposed by Commercial, Hazmat, and Medical Needs—This document determines initial requirements for all Mayday systems regardless of the type of vehicle used. It is foreseen that a number of unique vehicle requirements will result in further profiling and applications of this document. In the ITS environment, vehicles are described as being one of four types: private, commercial, transit, and emergency response. Of these, the type “private” can be considered the base class object where the other types have additional (superset) requirements.

In the case of commercial vehicles, which may be employed in the transport of hazardous materials, additional message sets and operational restrictions will be developed in a subsequent standard.

In the case of medical information, which may be available from the vehicle and of use to response personal, additional message sets and operational restrictions will be developed in a subsequent standard.

In the case of response vehicles, which interact with the emergency management center (example: an ambulance), there will be a number of messages entering and leaving the vehicle which are NOT part of this Mayday document, but which are used in the command and control process of directing the vehicle to the site of an incident. This area of standardization is being considered by other standards developing organizations and does not overlap with this document. However, it should be pointed out that such specialty vehicles are also considered general purpose “private” vehicles in that they too may implement a Mayday system which would follow this document.

4.5 Use of Location Referencing Methods of ITS—This document adheres to the Location Referencing Message Specification (LRMS) as outlined in the guidelines of SAE J2374. All values of latitude, longitude, and height used in this document are simple 32-bit values as specified in various profiles of SAE J2374.

4.6 Structure of the Document—The next four sections of the document form the primary normative sections of the document. Taken as a whole, they define the Mayday message set from a bit level to a complete transaction exchange. The contents of each are briefly described in the paragraphs that follow.

Section 5 outlines the flow of control between the messages and the recovery process when a message is not correctly received. This forms the state diagrams of the protocol layer. It also introduces the concept of the message frame and presents some typical message interactions.

Section 6 describes in detail the four fundamental message frames, which transport the data elements themselves. The required order of elements in each frame is defined and legal rules for content are specified.

In Section 7, the message types themselves are described. Message types are made up of one or more data elements and contained in a three-part schema consisting of: a tag, a word count, and the payload data. Message types may be made up of one or more data elements (the bit level atomic definitions). A typical example would be `current_position` which is itself made up of data elements such as latitude, longitude, height, time, and technology fields. Each message type is provided with commentary as required to assist the implementers with proper use.

In Section 8, the atomic data elements are presented with a bit level definition and various enumerated values as needed. Each data element is provided with commentary as needed.

Section 9 discusses in a high level way, the use of the SAE - IDB Bus to implement a Mayday system. The IDB Bus is a standard being developed by a sister committee of the SAE for use in multi-function ITS products.

Section 10 discusses aspects of the document when implemented on cellular phone technology as well as other technologies.

Section 11 outlines the basic goals for testing of the message set - the subject of another SAE specification to be developed subsequent to this document.

5. **The Message Protocol—NORMATIVE**—This section describes the state diagrams and the flow of messages between the vehicle and the center. The concept of message frames is first explained in a general sense (see Section 6), then the state diagrams are presented. Message frames are defined in normative detail in the next section. Use is made of interaction diagrams commonly found in UML and other modeling formats.⁴ See Figure 5.

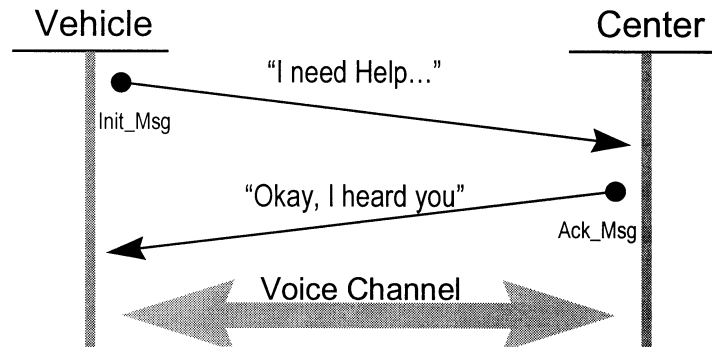


FIGURE 5—TYPICAL PROTOCOL EXCHANGE

Almost all successful message frame transactions occur in sets of two or three related messages. Typically, a Data_Msg (or an Init_Msg) from the vehicle is followed by an Ack_Msg from the center. This is considered a complete transaction (unless the message is corrupted in transmission in which case a retry may be requested). See Figure 6.

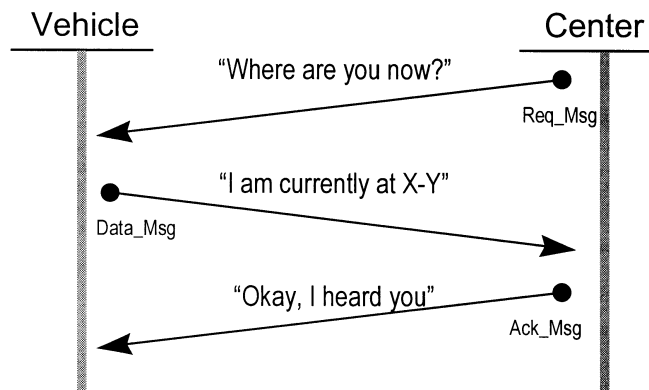


FIGURE 6—TYPICAL THREE FRAME PROTOCOL EXCHANGE

In essence, the communication flow is used as a calling vehicle using the Init_Msg message frame to send the most vital information as well as the abilities of the vehicle device to the center. The center then responds with an Ack_Msg which confirms the receipt of the message. It can then direct the vehicle as to what further action to take with a Req_Msg as needed.

The Ack_Msg may instruct the sender to simply go into voice mode (presuming that the vehicle has this ability.) It may also instruct the vehicle to cease sending certain types of information or that periodic update of some types of message data are welcome (as the example in Figure 7 for position).

4. UML—Universal Modeling language. In these diagrams, each vertical line represents an entity (here the vehicle and the center). Time advances as one goes down the diagram. Messages flow between the two entities as shown by the arrows. The pseudo-context of the message is in quotes while the actual definition data or action is presented at each side.

Subsequent to this, the vehicle or the center may initiate a new message frame as conditions at either end change. For example, if the vehicle is moving, it will periodically send an update of its position to the center. The center will reply with an Ack_Msg to this. If the center does not wish to receive such a message, it will assert the Shut_Up flags as a part of the Ack_Msg.

If either side desires additional data (what data is available is revealed by examining the sender flag from the other side), then a Req_Msg is issued requesting that data. This would result in a Data_Msg followed by an Ack_Msg message. Should that status change at either end, a new Data_Msg is issued with the updated send status in it. Refer to the state diagram for a more complete description of this, including retry flow in the event of a garbled message.

If a vehicle is sent a Shut_Up command, it must refrain from transmitting any further message frames until requested to do so by a subsequent Req_Msg. There is one sole exception to this, in the case where the sender status definition (see 8.5) changes. This would occur in the rare case where an event changes from one type to another during the call exchange. An example of this would be a non-emergency stalled vehicle, which during the call sequence, is rear-ended and thereby becomes an accident type. (see Figure 8.)

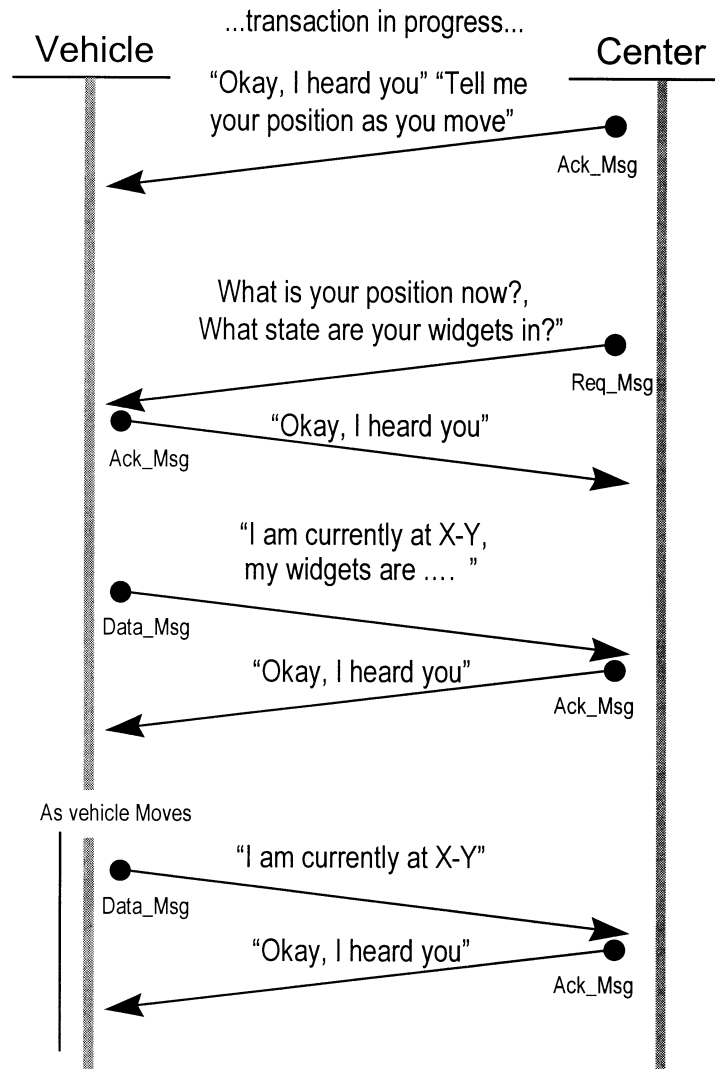


FIGURE 7—EXAMPLE OF EXTENDED PROTOCOL EXCHANGE

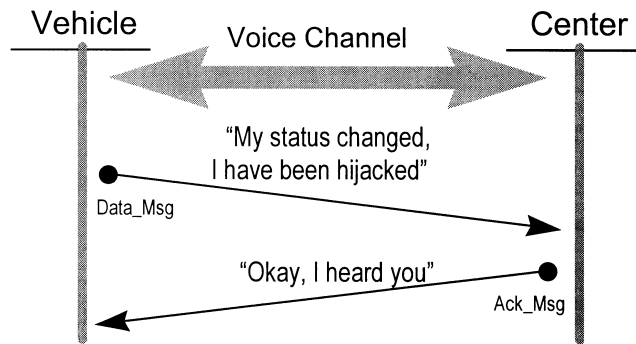


FIGURE 8—EXCHANGE INITIATED BY STATUS CHANGE

If a vehicle indicated (by way of prior message sender flags) that it can accept data from the center, the center may send to it various data items. Examples of this could be call numbers or information about the response plan. In this case, the vehicle device replies with the same Ack_Msg (including the right to assert "Shut_Up" message to the center as required). See Figure 9.

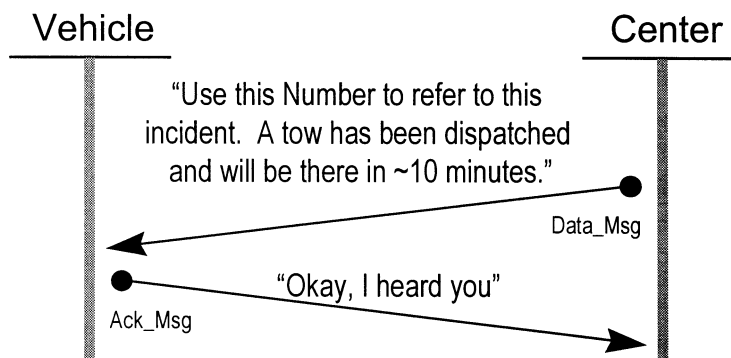


FIGURE 9—EXAMPLE OF DATA FROM THE DISPATCH CENTER

5.1 Message Protocol Flow—This section outlines the states of the receiving and transmitting devices as they exchange the message frames. By understanding the various state transition diagrams, the implementers can ensure that each device will always respond as expected in the cases when message frames collide or are otherwise garbled in transmission.

The following state diagram (Figure 10) describes the process for sending a data message. A device enters this state diagram to process Data_Msg, Req_Msg, and Ack_Msg message frames (message frames are defined in Section 6).

Five attempts shall be made to send the message frame on a failed attempt before ending. The time to transition between states and the time to wait in states for the reception of messages is specified in 5.2.

The following state diagram (Figure 11) describes the process for receiving a data message. A device enters this state diagram to process Data_Msg, Req_Msg, and Ack_Msg message frames (message frames are defined in Section 6).

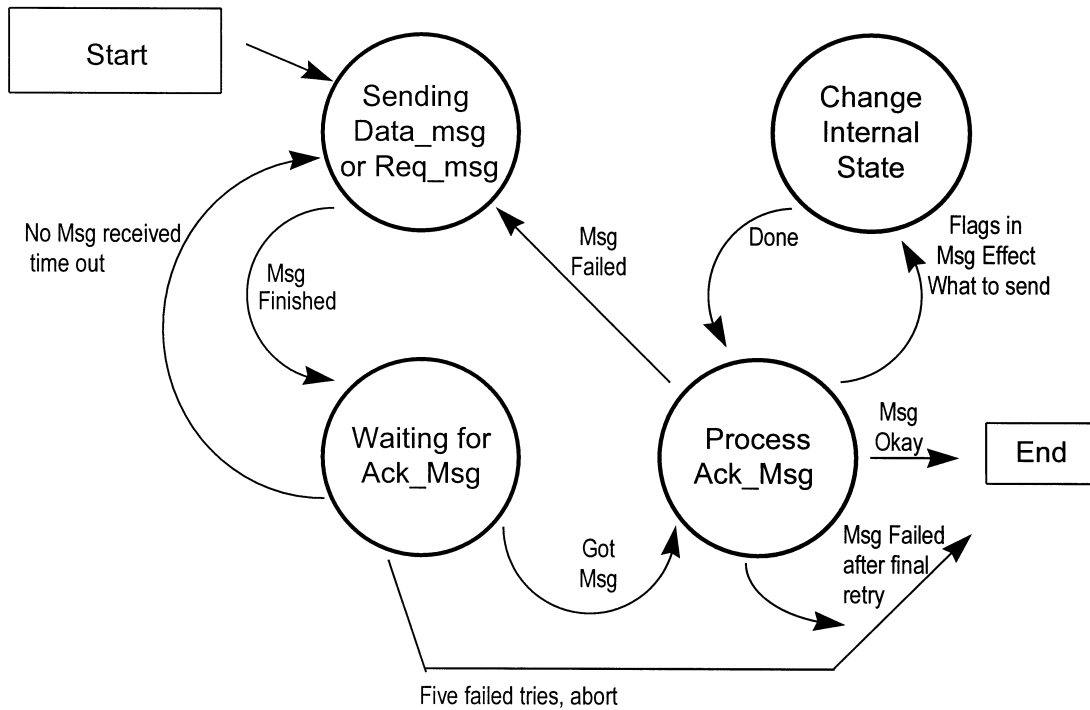


FIGURE 10—GENERAL SENDING MESSAGE STATE FLOW

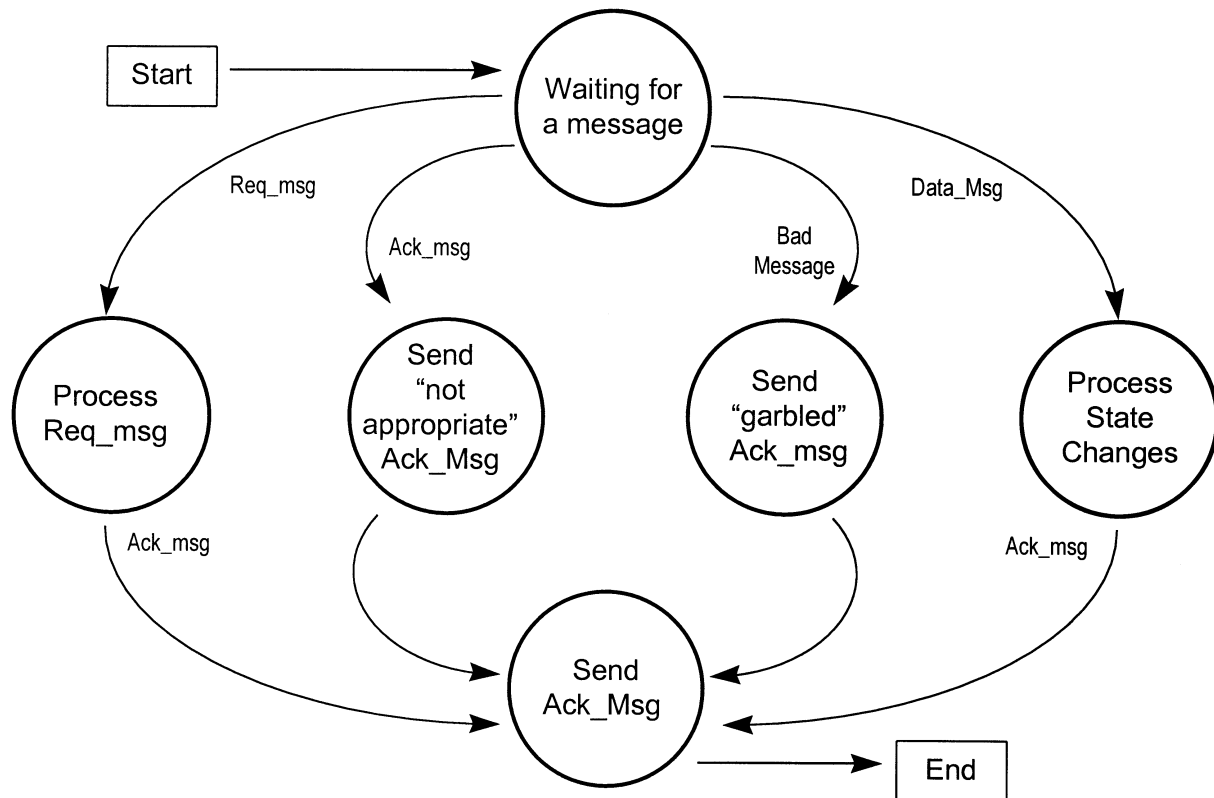


FIGURE 11—GENERAL [WAITING FOR &] RECEIVING MESSAGE STATE FLOW