IEEE STANDARDS FOR LOCAL & METROPOLITAN AREA NETWORKS

Supplement to Integrated Services (IS) LAN Interface at the Medium Access Control (MAC) and Physical (PHY) Layers

Remote Terminal Line Power for IEEE 802.9 Integrated Services Terminal Equipment

Prepared by the IEEE 802.9f Editor

Significant Changes

- Added relationship to ITU-T I.430
- Added to the critical functionality section those elements requested by Wayne Zakowski.
- Added some clarification to the use of the asymmetrical modes of the ISLAN remote powering.

Things to do:

-

NOTE : This is an internal working document of the IEEE 802.9 Working Group on Integrated Services LANs. As such, it is not a standard and may be changed as a result of further work by IEEE 802.9.

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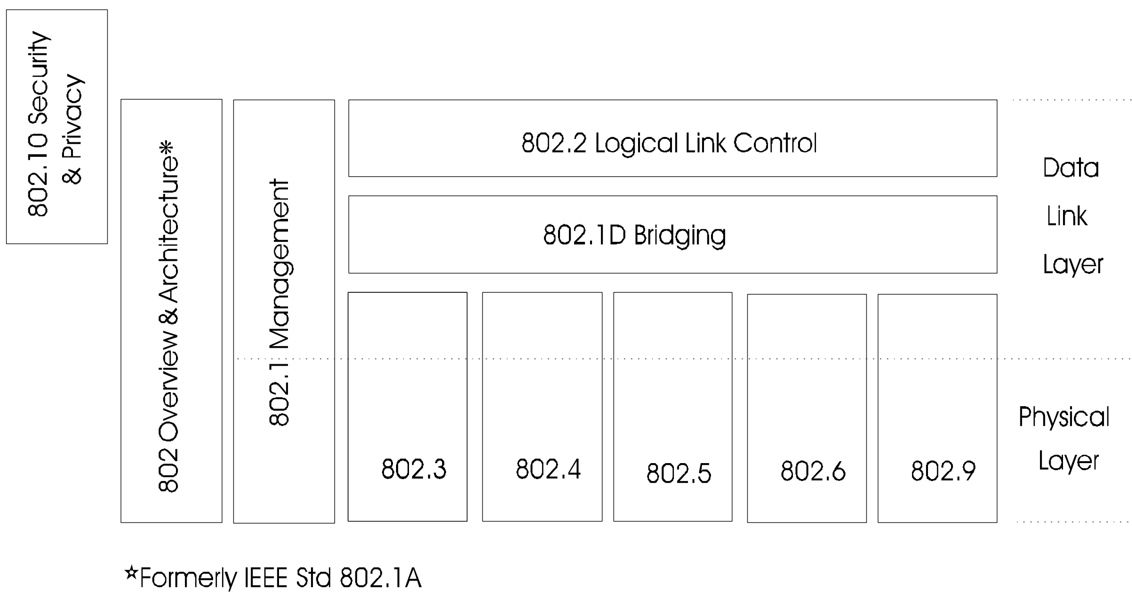
Foreword

(This Foreword is not part of the Proposed Standard P802.9f, Integrated Services (IS) LAN : Remote Terminal Line Power for IEEE 802.9 Integrated Services Terminal Equipment).

This standard is part of a family of standards for Local and Metropolitan Area Networks. The relationship between this standard and other members of the family is shown below. (The numbers in the figure refer to IEEE standard numbers.)



This family of standards deals with the physical and data link layers as defined by the ISO Open Systems Interconnection Basic Reference Model (ISO 7498:1984). The access standards define several types of medium access technologies and associated physical media, each appropriate for particular applications or system objectives. Other types are under investigation.

The standards defining these technologies are as follows :

- IEEE Std 802 : Overview and Architecture. This standard provides an overview to the family of IEEE 802 Standards. This document forms part of the 802.1 scope of work.
- IEEE Std 802.1D : MAC Bridging. Specifies an architecture and protocol for the interconnection of IEEE 802 LANs below the MAC service boundary.
- IEEE Std 802.1E : System Load Protocol. Specifies a set of services and protocol for those aspects of management concerned with the loading of systems on IEEE 802 LANs.
- ISO 8802-2 [ANSI/IEEE Std. 802.2] : Logical Link Control.
- ISO/IEC 8802-3 [ANSI/IEEE Std 802.3] : CSMA/CD Access Method and Physical Layer Specifications.

- ISO/IEC 8802-4 [ANSI/IEEE Std 802.4] : Token Bus Access Method and Physical Layer Specifications.

- IEEE Std 802.5 : Token Ring Access Method and Physical Layer Specifications.

- IEEE Std 802.6 : Metropolitan Area Network Access Method and Physical Layer Specifications.

- IEEE Std 802.9 : Integrated Services (IS) LAN Interface at the MAC and Physical Layers.

- IEEE Std 802.10 : Interoperable LAN/MAN Security (SILS) - Secure Data Exchange (SDE) [Currently contains Secure Data Exchange (Clause 2)].

In addition to the family of standards the following is a recommended practice for a common technology :

- IEEE Std 802.7 : IEEE Recommended Practice for Broadband Local Area Networks.

The reader of this document is urged to become familiar with the complete family of standards.

Contents

Figures

Tables

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Revisions to IEEE 802.9-1994

The contents of this document will be incorporated into IEEE Std 802.9 in a future edition. The clauses of this document are ordered to parallel the order of clauses in the base standard. This supplement is intended to be used in conjunction with IEEE Std 802.9-1994. Editing instructions necessary to incorporate this supplement into IEEE Std 802.9 are provided in ***bold italics****.*

1. Overview

Add the following as Subclause 1.1.2 of IEEE 802.9.

1.1.2 Overview of Remote Terminal Line Powering

****NOTE—All underlined text should be deleted when this document is merged with IEEE Std 802.9 if IEEE 802.9a-1995 has also been included into IEEE 802.9. This supplement should not be merged without IEE 802.9a-1995.***

ISLAN (IEEE Std 802.9-1995) provides for the integration of voice, data, and video services to the desktop. A desired step in the evolution of this integration is improved availability. In the case of voice services, i.e. telephony, users have come to expect service under all conditions including loss of power. An ISLAN compatible ISTE should be able to provide basic voice service regardless of the state of the personal computer, building power, weather, time of day, etc. Achieving this level of service has several implications. 1). The network should be very reliable and have power backup. 2) The desktop instrument should have power available to operate (at least for basic voice services) under all conditions. IEEE 802.9f addresses the second item, provision for supplying power to an end instrument from the ISLAN network. It should be noted however that this is an optional implementation specification. It is NOT required that an ISTE accept remote terminal line powering in order to be conformant to IEEE Std 802.9. Neither is it mandatory for access units to provide remote terminal line powering. This standard is provided so as to standardize the characteristics by which such remote terminal line powering is provided so as to aid interoperability.

1.1.2.1 Scope

IEEE draft standard 802.9f specifies the details of providing power from an ISLAN Access Unit (AU) to an ISLAN compliant ISTE via one of two methods; 1) PS1 powering over the signal pairs, or 2) power over additional cabling (PS2 powering). Both methods are specified in IEEE 802.9f. The following diagram, Figure 1-1 illustrates the scope of IEEE 802.9f.

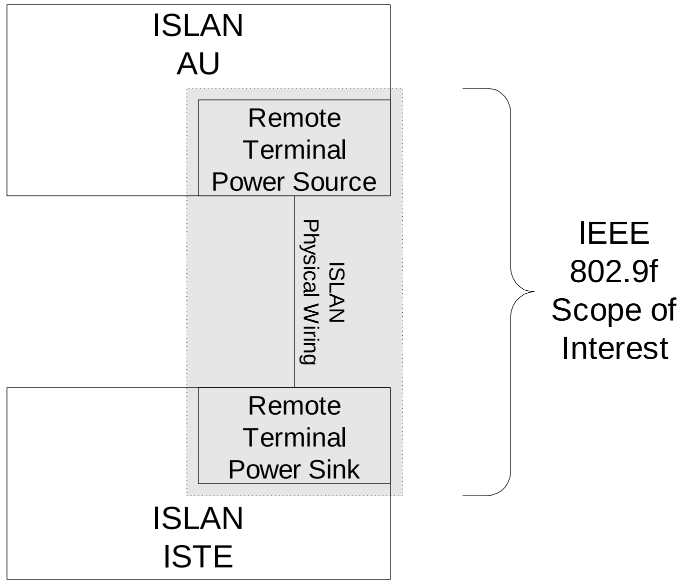

Figure 1-1 IEEE 802.9f Scope of Interest

1.1.2.2 Purpose

The purpose of this standard is to provide a set of methodologies which will allow a remote terminal to be powered from a central source. There are multiple ways of providing reliable power to an ISTE. The primary means are :

1. A local power supply with provision for power backup such as a mini-UPS.
2. Power Source 1 or PS1 allows power to be sourced to the desktop instrument from a centralized source across the same wiring used for data transfer.
3. Power Source 2 or PS2 powering allows power to be sourced from a centralized source across an additional pair of wires.

This standard shall specify only methods two and three.

The first possibility (local power with backup) is still relatively expensive particularly as the size of installations become larger. Local powering may make sense for cases where power backup is already in place such as servers. Any further discussion of local powering is considered beyond the scope of IEEE 802.9f.

PS1 powering has the following properties:

- Usage of existing ISLAN cabling (power is provided over the signal pairs) is possible.
- Modifications to existing ISLAN networks are relatively minor--mainly involving a change to the filter module.
- Existing non-powered 10Base-T devices and ISLAN ISTEs will be unaffected when connected to an AU capable of providing power.
- Total power is limited to basic voice service due to restrictions imposed by consideration of signal interference and DC components of the signal

PS2 powering has the following properties:

- There is a minor effect on signal pairs.
- There fewer limitations on powering.
- There is a requirement for an additional wire pair.

By specifying the requirements and procedures for these two powering methodologies, interoperability will be realized between powered AUs and powered/unpowered ISTEs. Furthermore, an ISLAN network will be capable of providing the same level of service currently associated with ISDN Basic Rate (BRI) devices regarding telephony as well as the additional transport of high-speed digital video and data. This level of service implies that the voice telephony capability (e.g. placing an emergency phone call) is available regardless of the state of the local PC. If this capability is provided, then, the ISLAN system could provide a total communications solution for the end user. ISLAN would then represent a truly "integrated service".

1.2 Notations

No Additions

1.3 Service Model

No Additions

1.4 Document Organization

This standard is organized into the following clauses:

Clause 1.1.2	Overview
Clause 2	References
Clause 3	Definitions
Clause 4	Abbreviations
Clause 14	Remote Terminal Line Power
Clause 14.1	PS1 Powering Method
Clause 14.2	PS2 Powering Method
Annex N	Remote Terminal Line Power Background
Annex O	Remote Terminal Line Power Critical Functions

2. References

Add to References

ITU-T Recommendation I.430 :1988, *Basic Rate - Layer 1 Specification.*

3. Definitions

3.1 Terms

Add to definitions.

Term	**Definition**
AU initiated restricted mode	A restricted power feeding mode initiated as a result of events at the AU
ISTE initiated restricted mode	A restricted power feeding mode initiated as a result of events at the ISTE.
ISTE type one	An ISTE whose normal powering source is locally provided.
ISTE type two	An ISTE whose normal powering source is remote power feeding from the AU to which it is attached.
ISTE type three	An ISTE whose normal powering source is locally provided but which can operate in a reduced capability mode from power provided through remote power feeding from the AU to which it is attached.
Normal power feeding mode	This power feeding mode is in operation when the ISTE is receiving its normal powering.
Phantom Power	A method of providing power to a remote entity by using the information carrying pairs of a communications cable to also carry DC power.
Power feeding	The process of providing power to an end device from a centralized source such as an AU. The power may be provided as “Phantom Power” or as “Third Pair Power”.
Power Source 1	A method for providing line power between an AU and an ISTE that utilizes the signal pair wires for power distribution. Also known as PS1.
Power Source 2	A method for providing line power between an AU and an ISTE that utilizes an additional wire pair for power distribution. Also known as PS2.
Restricted power feeding mode	This power feeding mode is in operation during exception conditions.
Third Pair Powering	A method of providing power to a remote entity by using an additional pair of wires in a communications cable to carry DC power.

4. Abbreviations

Add to abbreviations.

PS1: Power Source 1.
PS2: Power Source 2.
PCU: Power Consumption Unit.
NPCU: Normal Power Consumption Unit
RPCU: Restricted Power Consumption Unit

Add this as Clause 14 in its entirety as follows

14. Remote Terminal Line Power

Remote terminal line power is a set of methods for providing power to an ISTE device utilizing the AU-to-ISTE cabling. Although the remote terminal line power requirements hereafter defined are probably not sufficient to power a device such as a PC or workstation, they are sufficient to power a secondary device such as an audio instrument. ITU-T Recommendation I.430 is used as the reference model for this standard. In the 10BaseT mode of operation, remote powering shall not be supported. This insures that 10BaseT services are unaffected by this optional feature.

If remote terminal line powering is implemented, the following are mandatory requirements.

- Power sources at the AU must provide current limiting devices not to exceed 500mA**.**
- The rate of change of current drawn by an ISTE (for example, when connected) shall not exceed 5 milliamps per microsecond.
- ISTEs that provide power sinks shall provide galvanic isolation between power sources and the earth grounds of additional sources of power and/or equipment.

This last provision is intended to preclude earth loops or paths which could result in currents that would interfere with the satisfactory operation of the ISTE. It is independent of any requirement, for such isolation, related to safety which are already specified in IEEE 802.3. It shall not be interpreted to require isolation which conflicts with necessary provisions for safety.

Table 14-1 provides the connector assignments for the RJ-45 connectors used in several common LAN types. It is intended as information only and for comparison between the connector assignments.

Contact Assignments	**I.430 ISDN/BRI**	**IEEE 802.3I 10BASE-T**	**IEEE 802.3u 100BASE-T4**	**IEEE 802.5b Token Ring**	**IEEE 802.9 ISLAN**	**IEEE 802.12 100BASE-VG**
1	PS3(+)	TD+	TX_D1+	Unassigned	TD+	TPIO:0+
2	PS3(-)	TD-	TX_D1-	Unassigned	TD-	TPIO:0-
3	Transmit (+)	RD+	RX_D2+	Tx	RD+	TPIO:1+
4	Receive (+)	Not Used	BI_D3+	Rx	Not Used	TPIO:2+
5	Receive (-)	Not Used	BI_D3-	Rx	Not Used	TPIO:2-
6	Transmit (-)	RD-	RX_D2-	Tx	RD-	TPIO:1-
7	PS2 (-)	Not Used	BI_D4+	Unassigned	PS2 (-)	TPIO:3+
8	PS2 (+)	Not Used	BI_D4-	Unassigned	PS2 (+)	TPIO:3-

Table 14-1 RJ-45 Contact Assignments

Table 14-2 shall serve as the reference for polarity assignment at the ISTE RJ-45 connector.

Contact	MDI Signal	DC Polarity
1	Transmit Data +	+
2	Transmit Data -	+
3	Receive Data +	-
4	(Not used)	
5	(Not used)	
6	Receive Data -	-
7	Power Source 2	-
8	Power Source 2	+

Table 14-2 Power Sink Contact Assignments

There exists a relationship between ITU-T Recommendation I.430-1993 and IEEE 802.9f. This relationship is presented in the following paragraphs.

14.1 ITU-T Recommendation I.430-1993

ITU-T Recommendation I.430 Clause 9 defines a system of power feeding which is to be provided for powering ISDN terminal devices. It is designed to allow power to be provided from a point remote from the end device and yet allow for both normal conditions and exception conditions. Within the I.430 powering model, it is assumed that the power is supplied at the network side of the S/T reference points. In the case of central office connected ISDN terminals, this point is on the customer premise. In the case of typical PBX implementations, the S/T interface point is located at the PBX interface card or equivalent. It is implicit within the context of I.430 that the end device would need to be aware of the powering capabilities of its power source but that at no time would it be necessary for the powering point to be aware of the powering requirements of the end device.

I.430 defines three power sources designated PS1, PS2, and PS3. PS1 and PS2 power sources provide power from the NT (network termination) toward the TE (terminal adapter). PS1 and PS2 have the same meanings when used within the context of IEEE 802.9. PS3 is a provision which allows power to be feed from the TE to the NT but “is not subject to CCITT Recommendation”[1]. There is no equivalent powering source in IEEE 802.9.

I.430 introduces the concepts of normal mode power feeding and restricted mode power feeding. These two modes are network termination point centric. In the first mode, the network power source is capable of providing a full measure of power feeding. This power is defined in terms of power consumption units. A normal power consumption unit is 100 mW of power.

In the second mode, the network power source is no longer capable of supplying the full power feed. In this mode, indicated by a reversal of polarity of the power feed, designated terminals must reduce their power consumption and non-designated terminals must effectively “go to sleep”. The concept of designated and non-designated terminals comes from the “passive bus” configuration defined for ISDN. In the “passive bus” configuration, more than one end terminal is connected to the “T” reference point. Only one terminal may be selected as the “designated terminal” within a group of terminals on a “passive bus”. A restricted power consumption unit is equivalent to 95 mW. I.430 states that “The difference in units is required to allow adequate margins for power consumed be non-designated terminals in restricted mode”[2].

Voltage differences exist between normal and restricted power feeding modes. In normal mode power feeding, an NT operating in PS1 mode is required to provide voltage of 34V to 42V (optionally up to 56.5 V if the NT is using a PBX style 48 V supply system) at the output of the NT when supplying up to the maximum available power[3]. In restricted mode operation, an NT operating as a PS1 must supply at the output of the NT voltage within the range 34V to 42V (optionally up to 56.6V) when supplying up to its rated maximum power which is not less than 420

[1] ITU-T Recommendation I.430-1993 Clause 9.1.2
[2] ITU-T Recommendation I.430-1993 Clause 9.3.1
[3] ITU-T Recommendation I.430-1993, Clause 9.2.2.1

mW[4]. NTs operating in PS2 mode must supply the same voltages as defined for the PS1 mode of operation. There is a set of similar requirements defined for the power and voltage levels at the TE which takes into account the line losses of the two powering models[5].

Galvanic isolation is defined as a minimum of 1 MΩ when measured at 500 VDC[6].

Finally, a description of characteristics relative to current availability and time frames during the transition from normal to restricted and restricted to normal modes of power feeding are presented in ITU-T Recommendation I.430-1993 Clause 9.7. The effects of current imbalance are presented in ITU-T Recommendation I.430-1993, Clause 9.8.

14.2 IEEE 802.9 Power Feeding Models

IEEE 802.9f defines in environment which differs somewhat from that presented and presumed in ITU-T Recommendation I.430. Within I.430, the requirements are assumed to flow from the network termination unit (NT) towards the terminating equipment (TE). The role of the I.430 NT is represented by the IEEE 802.9 AU in the current specification. The role of the I.430 TE is similarly represented by the IEEE 802.9 ISTE. Within the IEEE 802.9 network, powering and capabilities indications need to flow in both directions.

I.430 also introduces the concepts of a normal power feeding mode and a restricted power feeding mode. Within the context of I.430, normal power feeding mode means that the NT is capable of providing the maximum amount of power specified to all TE's attached to the NT. Restricted power feeding mode indicates that a limited amount of power is available to the NT. One TE is "designated" to allow it to consume a limited though relatively large amount of power from the TE. All other TE's attached to the NT are restricted to very low levels of power consumption. Because of the structure of an IEEE 802.9 network, there is no requirement to differentiate between "designated" and "non-designated" ISTEs since only one ISTE can be attached to a "port" of an AU. However, within the IEEE 802.9 environment, there is a need to allow for modifications of the power considerations due to events either at the AU or at the ISTE. These will be discussed below.

Power Source 1, also know as PS1 utilizes contacts 1,2,3,6. Power Source 2, also known as PS2, utilizes contacts 7 and 8. Typically, an ISLAN AU implementation will include at most one of these power feeding methods. However, for compatibility sake, an ISLAN ISTE should implement both power feeding methods with user selection between them. It should be noted that the PS1 method is the more desirable mode of implementation. If remote power feeding is used, subclauses 14.3 and 14.4 describe each of these methods in detail. Note that AU-to-AU interconnections shall not use remote power feeding.

14.2.1 PCU definitions

A normal power consumption unit (NPCU) shall be defined as 100 mW available at the ISTE. A restricted power consumption unit (RPCU) is defined as 95 mW available at the ISTE.

14.2.2 Types of ISTEs

For the purposes of this specification, there are three types of ISTEs which must be considered. Type one ISTEs receive their normal powering from a source which is local to the ISTE and are not capable of deriving power from a remote power feeding arrangement. However a type one ISTE is capable of operating in a reduced capabilities mode when the local power is not available and it is powered from the AU. Type two ISTEs derive all of their power from remote power feeding. A type two ISTE has no local power available. A type three ISTE derives all of

[4] ITU-T Recommendation I.430-1993, Clause 9.2.2.2
[5] ITU-T Recommendation I.430-1993, Clause 9.3
[6] ITU-T Recommendation I.430-1993, Clause 9.6

its power from local powering sources and is not capable of receiving any remote power feeding from the AU to which it is attached. A more detailed discussion of each of these types of ISTEs is contained below.

14.2.2.1 Type one ISTE

A type one ISTE derives all of its power from a local source. Unless special provisions are made to provide alternative powering locally, the loss of local power results in disabling the communications capability of the ISTE. A type three ISTE attached to an AU which is not capable of supporting remote power feeding should be considered to be a type one ISTE.

14.2.2.2 Type two ISTE

A type two ISTE derives all of its power from the AU to which it is attached. This type of ISTE has no local power source. An example of such a device is a standalone IEEE 802.9 attached phone. While this class of device is not the primary model used within IEEE 802.9 networks, it is definitely a viable device type.

14.2.2.3 Type three ISTE

A type three ISTE is somewhat of a hybrid device between a type one and a type two ISTE. During normal powering conditions, most if not all of the power required for operation of the ISTE is provided from a local source. However, during times when the local power source is not available, a limited audio communications capability is maintained by powering the required functionality from the associated AU by remote power feeding. This class of ISTE is typical of the normal PC based ISTE which is the sole communications device on a desktop. In the event that the local PC is unpowered, either because the PC itself has been powered down or because of a loss of local power, the user can still make and receive limited audio calls. This provides the user with the ability to report emergency conditions or to receive emergency instructions under power failure conditions.

14.2.3 IEEE 802.9 Normal and restricted power feeding modes

14.2.3.1 IEEE 802.9 Normal power feeding mode

This power feeding mode exists when the AU is capable of supplying the full measure of power consistent with the specifications detailed below to the attached ISTE. The ISTE may use this power to provide for some or all or none of the powering requirements of the attached ISTE. In this mode, all communications capability is available to the AU and the ISTE.

14.2.3.2 IEEE 802.9 Restricted power feeding modes

There exist two restricted power feeding mode models within the context of an IEEE 802.9 network. These models are 1) AU initiated restricted power feeding mode, and 2) ISTE initiated restricted power feeding mode. Each of these models are discussed below.

14.2.3.2.1 AU initiated restricted power feeding mode

This mode is activated as a result of events occurring at the AU. These events may include such things as switching to local emergency power or other restrictions on available power at the AU. Under this mode of operation, the power available to the ISTE from the AU is restricted to a lower level than normal. This mode is analogous to the restricted power feeding mode as defined in ITU-T I.430.

14.2.3.2.2 ISTE initiated restricted power feeding mode

This mode is activated as a result of events occurring at the ISTE. These events may include such things as turning off of the local PC or unplanned loss of power. Under this mode of operation, the ISTE may draw from the AU, the measure of power available under the current power feeding that the AU is operating under. If the AU is in normal power feeding mode, the ISTE will have the full measure of NPCUs available to it. If the AU is in AU initiated restricted power feeding mode, the ISTE will be required to operate within the limits of available RPCUs.

While operating under the ISTE initiated restricted power feeding mode, the ISTE shall provide only those audio communications services consistent with Annex N of this specification. Other communications modes are not provided.

14.3 PS1 Powering Method

This section describes the PS1 method for remote terminal line power. PS1 utilizes the same wire pairs as the IEEE 802.9 signal pairs. Normal IEEE 802.3 and IEEE 802.9 operation shall not be effected by the PS1 method. Other IEEE 802.x PHYs that utilize the same RJ-45 connector as IEEE 802.3 and IEEE 802.9 (such as IEEE 802.5 over TP), shall likewise not be effected by the PS1 method. If implemented, PS1 shall provide adequate isolation and protection from shorts and transients so as to protect other AU ports and other functions within the ISTE or any associated equipment. Figure 14-1 below provides the reference configuration for PS1 powering.

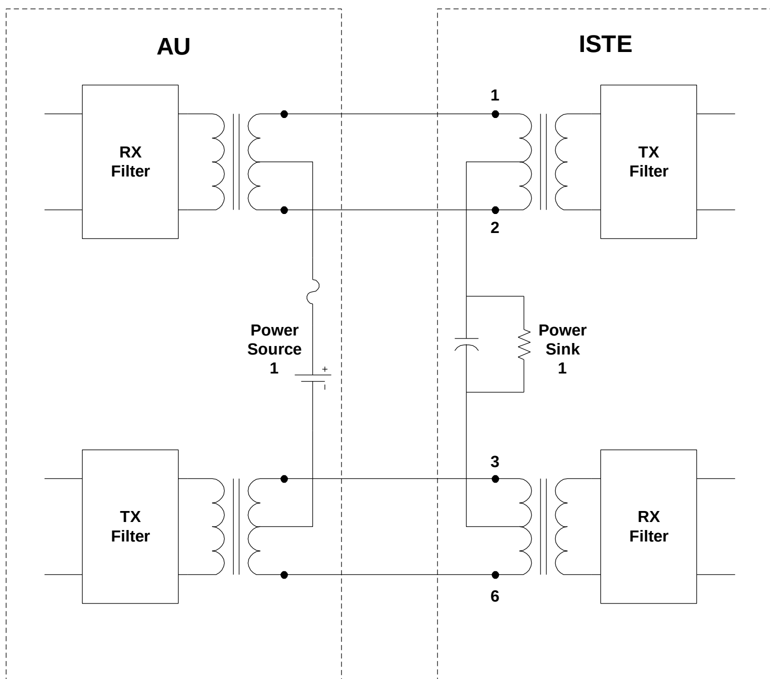

Figure 14-1 Power Source 1

14.3.1 Normal power feeding mode for the PS1 powering method

The PS1 source shall provide a nominal voltage of 48 volts DC (maximum voltage of 56.5 volts DC and a minimum of 42 volts DC) as measured across connections 1 (or 2) and 3 (or 6) of the ISLAN ISTE port. The maximum power available at the ISLAN ISTE shall be 50 NPCUs (5 watts).

14.3.2 AU initiated restricted power feeding mode for the PS1 powering method

The PS1 source shall provide a nominal voltage of 48 volts DC (maximum voltage of 56.5 volts DC and a minimum of 42 volts DC) as measured across connections 1 (or 2) and 3 (or 6) of the ISLAN ISTE port. The maximum power available at the ISLAN ISTE shall be 21 RPCUs (2 watts).

14.4 PS2 Powering Method

The implementation of an ISLAN AU may alternatively provide power to the remote terminal through the use of additional wires within the RJ-45 connector. If implemented, PS2 shall provide adequate isolation and protection from shorts and transients so as to protect other AU ports and other functions within the ISTE or any associated equipment. Figure 14-2 below provides the reference configuration for PS2 powering.

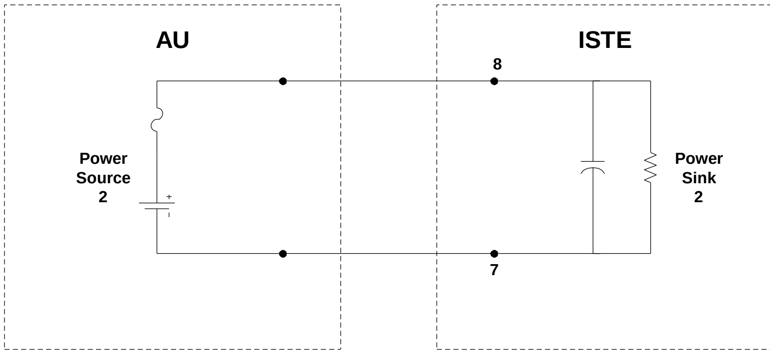

Figure 14-2 Power Source 2

14.4.1 Normal power feeding mode for the PS2 powering method

The PS2 source shall provide a nominal voltage of 48VDC (maximum voltage of 56.5 volts DC and a minimum of 42 volts DC) as measured across connections 7 and 8 of the ISLAN ISTE port. The maximum power available at the ISLAN ISTE shall be 80 NPCUs (8 watts).

14.4.2 AU initiated restricted power feeding mode for the PS2 powering method

The PS2 source shall provide a nominal voltage of 48VDC (maximum voltage of 56.5 volts DC and a minimum of 42 volts DC) as measured across connections 7 and 8 of the ISLAN ISTE port. The maximum power available at the ISLAN ISTE shall be 32 NPCUs (3.2 watts).

14.5 ISLAN ISTE power consumption

Editor’s Note: This is a new section and corresponds to ITU-T Recommendation I.430 Clause 9.5. Contributions for this section are required. It will be added as the subclause indicated.

14.6 Galvanic isolation

ISLAN ISTEs shall provide galvanic isolation between power sources PS1 or PS2 and the earths of additional sources of power and/or of other equipment. This galvanic isolation shall be a minimum of 1 Mohm when measured at 500 VDC between an interface conductor and any of the following points:

- AC mains earth
- all pins of any external interfaces
- any conductive surface

Equipment must also comply with the applicable IEC safety specifications. (This provision is intended to preclude earth loops or paths which could result in currents that would interfere with the satisfactory operation of the ISLAN ISTE. It is independent of any requirement for such isolation related to safety considerations.)

14.7 Limitations on power source and sink during transition conditions

Editor’s Note: This is a new section and corresponds to ITU-T Recommendation I.430 Clause 9.7. Contributions for this section are required. It will be added as the subclause indicated.

14.8 PS1 method direct current imbalance

Editor's Note: This is a new section and corresponds to ITU-T Recommendation I.430 Clause 9.8. Contributions for this section are required. It will be added as the subclause indicated.

14.9 Power feed mode status signalling

In order to coordinate the actions of both ends of the ISLAN link, it is necessary to provide a means of communicating the remote power feeding condition of each end. The mechanisms for this communications differ depending on the type of ISLAN link involved. Each type of communications is discussed below.

Assertion of a power feed mode in one direction on an ISLAN link is independent from the assertion of the power feed mode in the other direction. Thus, the AU can assert a restricted power feeding mode towards the ISLAN ISTE while the ISLAN ISTE indicates that it is in normal operating mode. It is not necessary for one end of the link to acknowledge a status change.

Determination of a status change requires that the transition from one state to another persist for a period of not less than 25 msec. before the new state becomes valid.

14.9.1 ISLAN4-T and ISLAN20-T status signalling

The bit which shall be used to indicate the power feeding mode status shall be the RES bit (bit 7) of the TDM_MTN field of the IEEE 802.9 TDM frame. A zero condition of this bit indicates that the originating interface is in the normal power feeding mode. A one condition indicates that the originating interface is operating in the restricted mode. The receiving interface shall remain in its current state until the transition of the status bit has remained stable for a period not to exceed 30 msec. Once the transition has stabilized for the required period, the new state may be reported to the appropriate management layer entity.

The AU shall assert the status bit to a one state when it is requiring all of the subordinate ISLAN ISTEs to enter the AU initiated restricted powering mode. The AU shall assert the status bit to a zero state when no longer requiring this power feeding restriction.

The ISLAN ISTE shall assert the status bit to a one state to inform the associated AU that it has entered the ISTE initiated restricted power feeding mode of operation. The ISTE shall assert the status bit to a zero state when no longer requiring this restricted power feeding mode of operation.

14.9.2 ISLAN16-T status signalling

The bit which shall be used to indicate the power feeding mode status shall be the BUPS bit of the ISLAN16-T M-channel. In all other ways, the operation of this status indication shall conform to the usage as defined in subclause 14.9.1.

14.9.3 Additional M-channel bits supported during restricted powering modes

The following table presents the M-channel bit definitions and their supporting requirements.

Bit Designation	Supported?	Discussion
*NFSA	No	The AU can be designated to provide the 8 KHz network timing under most circumstances.
*LMR(1:0)	Partial	"Activate/Deactivate Remote Loopbace" and "Activate Low-Power Request" are supported. All other values are for further study.
*FMG	No	AU shall act in the master mode
*BUPS	Yes	Indicates ISTE Initiated Restricted Powering Mode
*LMG	Yes	This is part of the loopback operations and should thus be supported
*LSS(1:0)	Yes	Mandatory under all powering conditions
*FMA	No	See FMG
*FED	Yes	Mandatory under all powering conditions
*DCRS	Yes	Always set to "1"
*LLB	Yes	Part of loopback operations

14.10 Reduced call signalling procedures for ISTE initiated restricted powering mode operation

Editor's Note: This is a new section. Contributions for this section are required.

Add this subclause as Annex N in IEEE Std 802.9

Annex N Remote terminal line powering background (Informative)

Annex N .1 Voltage Selection

The voltage level (-48VDC nominal) is the telephony voltage level that operates standard telephones. Power sources with either AC or DC power back up mechanism's and a wide range of power levels are available from multiple sources. In addition DC-DC convertors to convert 48VDC to logic voltage levels (i.e. 3 or 5 volts) are also readily available. Use of -48VDC (nominal) is below UL regulated levels and also reduces the current levels to minimize voltage drop on connectors and cabling and impact to isolation transformers.

Annex N .2 Connector Imbalance

Significant work on current imbalance in transformers has shown that certain data patterns induce a large base line wander. Base line wander induced a DC offset comparable to 6mA. The transformer specification that resulted is 350 μHy under all conditions of tolerance, temperature, and with 8mA of DC bias. The resistance imbalance in the cable is 5% maximum. Using a transformer that can tolerate 8mA offset, the maximum current that can be sourced is 320mA.

The nominal voltage and current values will produce a minimum power value to the ISTE of about 6.54 watts (assuming worst case; 26 AWG wire, 100m length, 5 intermediate connectors). The maximum amount of power which an ISLAN ISTE terminal device may draw is 5 watts in PS1 mode and 8 watts in PS2 mode.

Table Annex N -1 details the resistance of different cable sizes over minimum and maximum temperature ranges. These resistance values are used in calculations to resolve connector imbalance and voltage drops.

AWG	Min @ 0 °C	Max @ 0 °C	Nominal	Min @ 50 °C	Max @ 50 °C
26	12.18	12.79	13.47	14.70	15.43
24	7.65	8.03	8.42	9.14	9.60
22	4.81	5.05	5.31	5.79	6.08

Table Annex N -1 Cable Resistance in ohms at 100 Meters

In order to resolve connector imbalance a series of balancing resistors is required. Table Annex N -2 details the effects of connectors contributing to load imbalance. Connectors occur in several places; i.e. the hub, the patch panel, the wiring frame, the wall jack, the desktop, etc. For purposes of calculation, a typical maximum connectorization of 5 connectors is used.

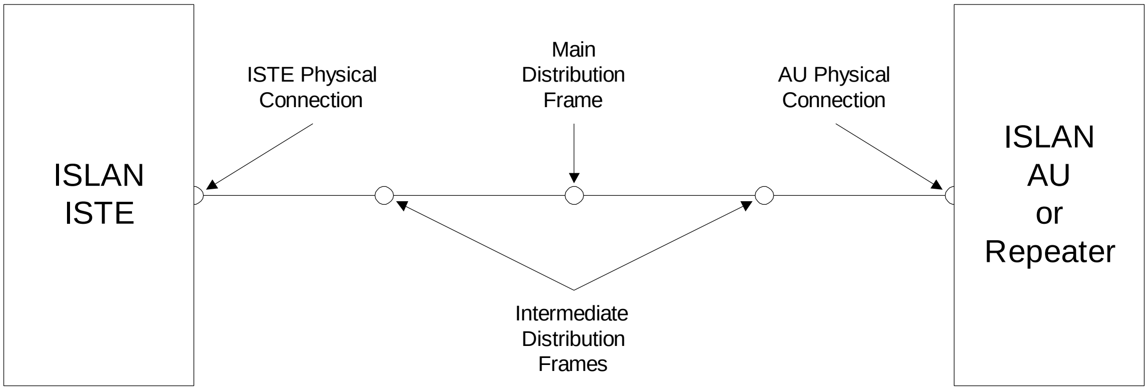

Figure Annex N -1 Typical Connectorization Example

Description	Symbol	Value
Output current	I^{out}	0.320 amp
Cable resistance (5m 22AWG	R^{c}	0.481 ohm
Balancing Resistor	R^{b}	4.000 ohm
Connector Resistance (5 @ .02Ω)	R^{conn}	0.100 ohm

Table Annex N -2 Connector Effects

For balance, the worst case requires the use of two 2 Ω resistors (4 ohms total).

The following diagram details the method for resolving connector imbalance using two resistors with a value of 2 ohms as noted earlier. Note that the balancing resistors are required at each end and at both the transmit and receive filters.

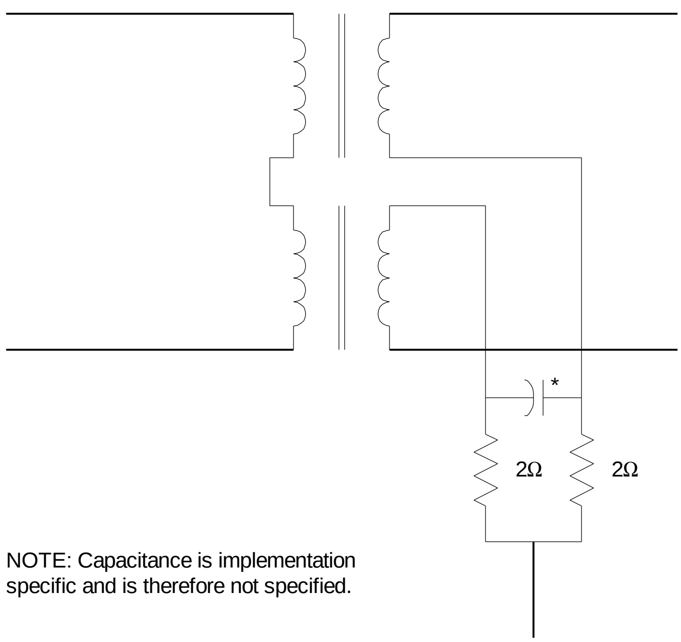

Figure Annex N -2 Isolation Transformer Detail

The usage of 2 ohm resistors to handle the worst case is based upon the following assumptions:

- Five connectors between AU and ISTE
- Zero ohms in one path and 0.1 ohm in the other (0.02 ohms/connector * 5 connectors)
- Five meter length of cable (longer cable reduces imbalance)
- 5% variation in cables
- Balancing resistors are 1% tolerance and are at extremes

The equations describing this interaction are $(I_{out}/2 + 0.004)(R_c/1.05 + R_b/1.01) = (I_{out}/2 - 0.004)(R_c \bullet 1.05 + R_b \bullet 1.01 + R_{conn})$. Where:

I_{out}	Current from AU
R_c	Cable Resistance
R_b	Balancing Resistance
R_{conn}	Connector Resistance

The addition of the capacitor in parallel with the resistors helps to minimize the signal loss induced by the connector imbalance resistors and should be selected to present a low impedance at the lowest signal frequency.

Under conditions wherein a high current power supply is used for supplying multiple ISTE's on different ports, current limiting on each port should be used to protect against shorting. Thermistors and positive temperature coefficient devices are examples of inexpensive current limiting devices which will recover when the short is removed. The balancing resistors will dissipate worst case power during over-current (short) fault conditions. Selection of the wattage rating of the balancing resistors should be coordinated with the current limiting value of the fault protection device. For example, if the maximum short circuit is 500 mA then a half watt resistor would be required ($P=I^2*R=.5^2*2=.5$ watts).

Annex N .3 Power distribution examples

The following represent information from the design of a typical implementation. The first case involves the use of PS1 powering. The second is PS2.

Annex N .3.1 Power distribution for a PS1 implementation

The goal is to provide the required amount of power (5 watts) to an ISLAN ISTE terminal device. The basic assumptions are as follows :

- 100 meters of 26 AWG twisted pair wiring.
- Balance resistor of 4 Ω.
- Protective device resistance of 20 Ω.
- Connector resistance of 0.2 Ω.

It is also assumed that the internal transformer resistance is negligible relative to the assumed resistance of the protective device. Given the above information, the following table describes the power requirements for the AU.

Voltage @ AU	Worst Case Voltage Drop	Watts available @ ISLAN ISTE	Current Sourced @ AU	Watts Sourced @ AU
42.00 VDC	5.43 V	5.01 W	137 mA	5.75 W
48.00 VDC	4.56 V	5.00 W	115 mA	5.52 W
56.50 VDC	3.77 V	5.01 W	95 mA	5.37 W

Figure Annex N -3 PS1 Power Distribution Example

Annex N .3.2 Power distribution for a PS2 implementation

The goal is to provide the required amount of power (8 watts) to an ISLAN ISTE terminal device. The basic assumptions are as follows :

- 100 meters of 26 AWG twisted pair wiring.
- Protective device resistance of 20 Ω.
- Connector resistance of 0.2 Ω.

It is also assumed that the internal transformer resistance is negligible relative to the assumed resistance of the protective device. Given the above information, the following table describes the power requirements for the AU.

Voltage @ AU	Worst Case Voltage Drop	Watts available @ ISLAN ISTE	Current Sourced @ AU	Watts Sourced @ AU
42.00 VDC	15.32 V	8.00 W	300 mA	12.60 W
48.00 VDC	11.08 V	8.01 W	217 mA	10.42 W
56.50 VDC	8.53 V	8.01 W	167 mA	9.44 W

Figure Annex N -4 PS2 Power Distribution Example

Please note that the difference in the worst case voltage drop is that PS2 powering uses a single pair of wires to deliver power. PS1 powering uses two pairs for the delivery of power.

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Add this subclause as Annex O in IEEE Std 802.9

Annex O Critical functionality for remote terminal line powering (Normative)

The primary reason for providing remote terminal line powering within a system is to provide the terminal user with functionality even when the local power is not present. This lack of local power may result from something as simple as powering down the local personal computer which is the primary terminal to more complex reasons such as a fire emergency. The actual design of the remote terminal is left to the implementers; however, the following is provided as suggestions to indicate the intent of the creators of the remote terminal line powering specification. The shaded area of below illustrates the area of interest for this standard.

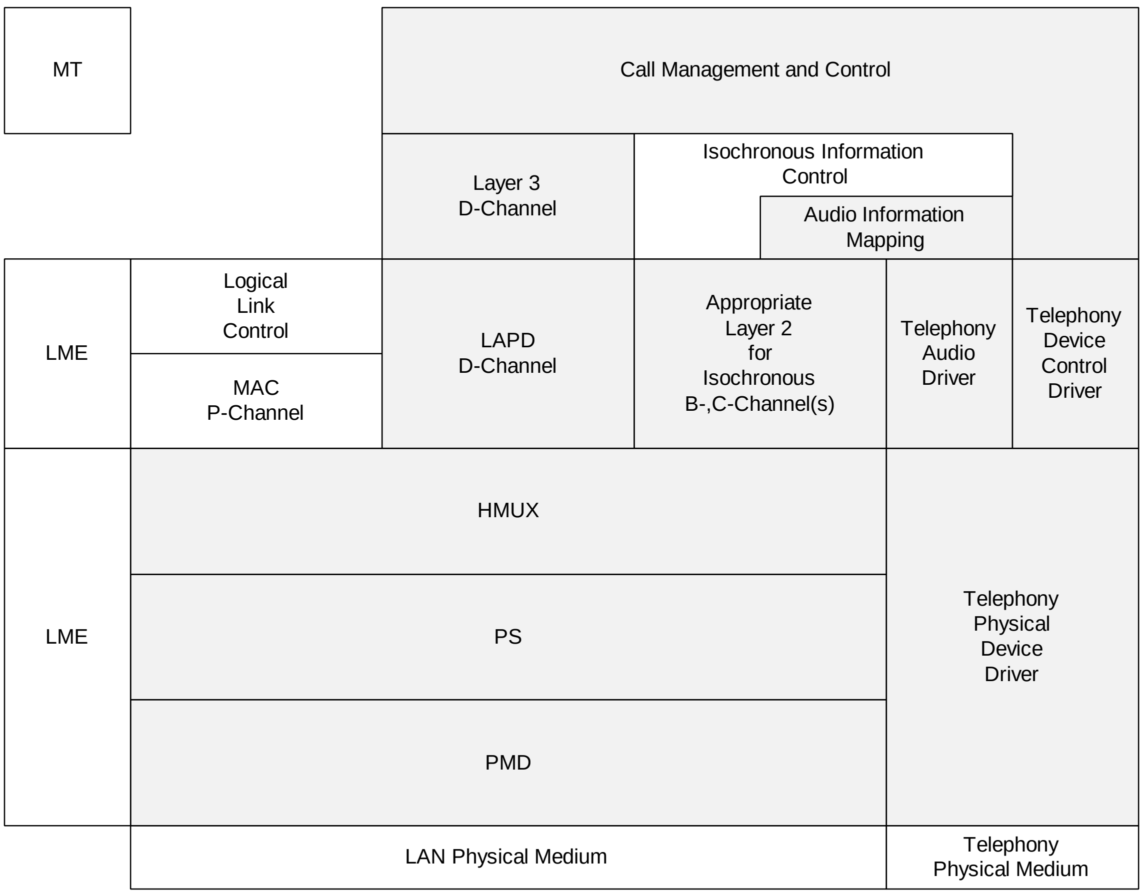

Figure O-1 Scope of Interest

There are two classes of functionality which are germane to this discussion. The first is emergency functionality and the second is routine functionality. Each of these classes are detailed below.

Annex O .1 Emergency Functionality

This class of functionality applies during those times when local power is unavailable because of some catastrophic event. Under these conditions, it is crucial that the user be able to establish at least minimal communications with external authorities in order to report the emergency condition and receive instructions relating to the resolution of the emergency. At a minimum, the remote terminal should be able to originate an outgoing call and to receive an incoming call. This minimum functionality requires that the remote terminal maintain the powering of:

1. a user interface device
2. a user interface control function
3. an ISLAN16-T physical layer interface
4. a protocol control function
5. a user information stream mapping function

Each of these are discussed below.

Annex O .1.1 User interface device

The user interface device is a device which at a minimum provides the user with the ability to communicate verbally. This device should also include a mechanism for alerting the user for an incoming call and optionally provide a mechanism for addressing the outgoing call and. A typical user interface device would be an analog phone with a DTMF dialing pad and a ringer. There are many other devices which will also fulfill this requirement.

Annex O .1.2 User interface control function

The remote terminal must also have the control functions necessary to properly control the user interface. These functions are dependent upon the actual user interface device provided with the remote terminal. In the case of an analog phone, these functions include as a minimum:

1. the ability to detect “off-hook” and “on-hook” conditions
2. the ability to provide ring current to cause the phone to ring
3. the ability to convert between analog audio and digital G.711 encoded audio
4. optionally, the ability to detect and decode DTMF tones
5. optionally, provide call progress tones towards the user

In the case of other devices, this list might be different but at least the general functionality should be maintained.

Annex O .1.3 ISLAN16-T physical layer interface

In order for the remote terminal to communicate, the ISLAN16-T physical layer connection must be maintained. This implies that not only must a portion of the remote terminal be operational, but a significant portion of the ISLAN16-T infrastructure must also be functional. Minimally, the remote terminal must maintain the ISLAN16-T link between the remote terminal and the associated AU.

Annex O .1.4 Protocol control function

In order to establish and receive calls, there must be a protocol control function which is powered. This function must terminate protocol layers two and three and provide a minimal call control functionality. Since the required functionality for this call control is minimal, the bulk of the messaging may be in the form of pre-defined messages. In fact, it may be defined that under emergency conditions, the remote terminal will always be connected to a particular station when an off-hook condition is detected. The actual functionality of this function is an implementation specific consideration but it is the sense of the IEEE 802.9 working group that there be enough functionality present to allow for both the origination and reception of emergency calls.

Annex O .1.5 User information stream mapping function

As a final consideration, there must be a mapping function provided to allow the G.711 digitally encoded audio from the user interface device to be transmitted on a c-channel within the ISLAN16-T isochronous portion and vice versa. This may be as simple as always using channel 1 or it may be more complex as desired by the specific implementation.

Annex O .2 Routine functionality

Routine functionality comes into play when it is desired that the remote terminal provide more than emergency functionality while in the line powered state. This might be the case if the remote terminal is a standalone device or if it is desired that the remote terminal provide more sophisticated functionality in the absence of the primary host processor. The primary difference between this mode and the emergency mode is the complexity of the protocol control function. By adding to this functionality, the implementers can provide a very complete audio communications function in the absence of any other support. It is beyond the scope of this document to provide the details of such functionality.

Annex O .3 Summary

In summary, it is the intent of the IEEE 802.9 ISLAN working group that if the optional remote terminal line powering specification is implemented, that at a minimum, the remote terminal be able to function in the emergency mode. Beyond that functionality is the domain of the actual implementations and is beyond the scope of this document.

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