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Interworking ISDN Call Control User Information with SIP

Abstract

The motivation and use cases for interworking and transporting User-to-User Information (UUI) from the ITU-T Digital Subscriber Signalling System No. 1 (DSS1) User-user information element within SIP are described in RFC 6567. As networks move to SIP, it is important that applications requiring this data can continue to function in SIP networks as well as have the ability to interwork with this ISDN service for end-to-end transparency. This document defines a usage (a new package called the ISDN UUI package) of the User-to-User header field to enable interworking with this ISDN service.

This document covers interworking with both public ISDN and private ISDN capabilities, so the potential interworking with QSIG will also be addressed.

The package is identified by the new value "isdn-uui" of the "purpose" header field parameter.

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1. Overview

This document describes a usage of the User-to-User header field defined in [RFC7433] to enable the transport of UUI in ISDN interworking scenarios using SIP [RFC3261]. Specifically, this document discusses the interworking of the following items, which are call control related: ITU-T Recommendation Q.931 DSS1 User-user information element [Q931], ITU-T Recommendation Q.957.1 DSS1 User-to-User Signalling (UUS) supplementary service [Q957.1], and ITU-T Recommendation Q.763 User-to-User information parameter [Q763] data in SIP. Today, UUI is widely used in the Public Switched Telephone Network (PSTN) in contact centers and call centers that are transitioning away from ISDN to SIP.

This usage is not limited to scenarios where interworking will occur. Rather it describes a usage where interworking is possible if interworking is met. That does not preclude its usage directly between two SIP terminals.

2. Terminology

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [RFC2119].

3. Summary of the ISDN User-to-User Service

3.1. The Service

ISDN defines a number of related services. Firstly, there is a user signalling bearer service that uses the information elements / parameters in the signalling channel to carry the data and does not establish a related circuit-switched connection. For DSS1, this is specified in ITU-T Recommendation Q.931, Sections 3.3 and 7 of [Q931]. Secondly, it defines a User-to-User Signalling (UUS) supplementary service that uses the information elements / parameters in the signalling channel to carry additional data but that is used in conjunction with the establishment of a related circuit-switched connection. This reuses the same information elements / parameters as the user signalling bearer service, with the addition of other signalling information, and for DSS1 this is specified in ITU-T Recommendation Q.957.1 [Q957.1].

ISDN defines three variants of the UUS supplementary service as follows:

UUS1: User-to-User Information exchanged during the setup and clearing phases of a call by transporting DSS1 User-user information elements within call control messages. This in itself has two subvariants, UUS1 implicit and UUS1 explicit. In UUS1 implicit, it is the presence of the user signalling data itself that constitutes the request for the service. UUS1 explicit uses additional supplementary service control information to control the request and granting of the service, as in UUS2 and UUS3. As a result, UUS1 explicit also allows the requester to additionally specify whether the parallel circuit-switched connection should proceed if the UUS1 service cannot be provided (preferred or required);

UUS2: DSS1 User-user information elements exchanged from the sender's point of view during call establishment, between the DSS1 ALERTING and DSS1 CONNECT messages, within DSS1 USER INFORMATION messages; and

UUS3: DSS1 User-user information elements exchanged while a call is in the Active state, within DSS1 USER INFORMATION messages.

The service is always requested by the calling user.

This document defines only the provision of the ISDN UUS1 implicit supplementary service to interworking scenarios, this being the most widely deployed and used of the various ISDN User-to-User services, and is indeed the one that matches the requirements specified in [RFC6567].

The above comes from the ISDN specifications defined for public networks. There is a parallel set of ISDN specifications defined for private networks (QSIG). These specifications do not define a UUS1 implicit supplementary service. However, implementation of such a UUS1 implicit supplementary service for private networks can readily be constructed in a proprietary fashion based on the specifications for public networks, and evidence suggests that some vendors have done so. On this basis, there is no reason why this package cannot also be used to support interworking with such a private network service, on the assumption that the constraints are exactly the same as those for the public network.

The ISDN UUS1 service has the following additional characteristics as to the data that can be transported:

The maximum number of octets of user information that can be transported is 128 octets plus a protocol discriminator. It is noted that some early ISDN implementations had a limitation of 32 octets, but it is understood that these are not currently deployed. While this package does not prohibit longer data fields, the mechanism at any interworking point discards data elements that are too long to handle. The handled length can normally be assumed to be 128 octets.

The content of the user information octets is described by a single octet protocol discriminator (see Table 4-26 of ITU-T Recommendation Q.931) [Q931]. That protocol discriminator may describe the protocol used within the user data, the structure of the user data, or leave it entirely open. Note that not all values within the protocol discriminator necessarily make sense for use in the ISDN User-to-User service, as the content is aligned with the protocol discriminator that appears at the start of all DSS1 messages (see Table 4-1 of ITU-T Recommendation Q.931) [Q931]. The protocol discriminator value has no impact on the interworking capability.

Only a single piece of UUI data can be transported in each message.

The ISDN service works without encryption or integrity protection. The user trusts the intermediate network elements, and therefore the operator of those elements, not to modify the data and to deliver all the data to the remote user. On a link-by-link basis, message contents are protected at Layer 2 by standard cyclic redundancy check mechanisms -- this allows loss on a link-level basis to be detected but does not guard against fraudulent attacks on the link itself. This does not prevent the use of additional encryption or integrity protection within the UUI data itself, although the limit on the size of the UUI data (protocol discriminator plus 128 octets) will restrict this.

3.2. Impacts of the ISDN Service on SIP Operation

The ISDN service has the following impacts that need to be understood within the SIP environment.

Call transfer: ISDN call transfer cancels all ISDN User-to-User supplementary services. In the ISDN, if User-to-User data is required after call transfer, then UUS3 has to be renegotiated, which is not provided by this SIP extension. The impact of this restriction on the SIP environment is that UUI header fields cannot be exchanged in transactions clearing down the SIP dialog after call transfer has occurred.

Conference: ISDN conferencing allows the user to still exchange User-to-User data after the conference is created. As far as UUS1 is concerned, it is not permitted. The ISDN three-party supplementary service is similar in many ways to conferencing but is signalled using a different mechanism. This means that on clearing, the controller using UUS1 implicit does have the choice of sending data to either or both remote users. Because SIP conferencing cannot completely emulate the ISDN three-party supplementary service at the served user, UUS1 implicit is not possible.

Diversion: When ISDN diversion occurs, any UUS1 User-to-User data is sent to the forwarded-to-user (assuming that the call meets requirements for providing the service -- this is impacted by the explicit service only). If the type of diversion is such that the call is also delivered to the forwarding user, they will also receive any UUS1 User-to-User data.

4. Relation to SIP-T

A method of transport of ISDN User-to-User data is to use SIP-T [RFC3372] and transport the UUI information end-to-end (as part of an ISUP message or QSIG message) as a MIME body. If the SIP-T method of encapsulation of ISDN instead of interworking is used, this is a reasonable mechanism and does not require any extensions to existing SIP-T. However, if true ISDN interworking is being done, and therefore SIP-T would not otherwise be used, this approach is not reasonable because then implementation of the many elements of the ISUP syntax would be required to understand one element of data. Instead, the better approach is to interwork the ISDN User-to-User data using the native SIP UUI transport mechanism, the User-to-User header field. The rest of this document describes this approach.

5. Transition Away from ISDN

This interworking usage of the SIP UUI mechanism will likely begin with one UA as an ISDN gateway while the other UA is a native SIP endpoint. As networks transition away from ISDN, it is possible that both UAs could become native SIP endpoints. In this case, there is an opportunity to transition away from this ISDN usage to a more general usage of [RFC7433].

The SIP UUI mechanism provides a way to achieve this transition. As an endpoint moves from being an ISDN gateway to a native SIP endpoint, and a future package for some form of enhanced UUI has been standardized, the endpoint can carry the UUI data both as ISDN and as the future package in parallel and in the same messages or in different messages depending on the needs of the application. This will permit the other endpoint to use the UUI according to the ISDN UUI package if it is an ISDN gateway or according to the future package if it is a native SIP endpoint.

6. ISDN Usage of the User-to-User Header Field

This document defines the package for the ISDN interworking of UUI that interoperates with ISDN UUS, a supplementary service in which the user is able to send/receive a limited amount of information to/from another ISDN user over the signalling channel in association with a call to the other ISDN user.

Two examples of ISDN UUI with redirection (transfer and diversion) are defined in [ANSII] and [ETSI].

One objective of the design of this package has been to keep the functionality at the interworking point as simple as possible. As a result, there is also only one encoding value specified.

Responsibility for respecting the limits has been transferred to the end UA. If an interworking point is reached, and the limitations of the ISDN (see Section 3.1) are not met, then the UUI data will not be transferred, although the SIP request will otherwise be interworked. This is rather than have the interworking point attempt to resolve the non-compliance with the limitations of ISDN.

The general principals of the UUI mechanism package are, therefore, as follows:

The sending application is expected to limit their sending requirements to the subset provided by the ISDN User-to-User service.

The SIP UA will not allow the reception of more than one User-to-User header field relating to the "isdn-uui" package in the same SIP request or response; it will only allow it in a request or response of the appropriate method (INVITE or BYE). What happens to User-to-User header fields relating to other packages is outside the scope of this document.

An interworking point trying to interwork UUI data that is too long will discard the UUI data but proceed with the interworking. There is no notification of such discard back to the sending user. If the SIP user knows that it is interworking with the ISDN, then the UUI application at the SIP endpoint should limit its communication to packets of 128 octets plus the protocol discriminator, with the knowledge that discard will occur if it does not. The UUI application at the SIP endpoint has complete control over what occurs. It should be noted that this was exactly the envisaged operation when early ISDN implementations that only supported 32 octets interworked with those supporting 128 octets. It also corresponds to the interworking with ISDNs that do not support the supplementary service at all, as discard will occur in these circumstances as well. Note that failure to include the User-to-User data into the ISDN SETUP message (when discard occurs) will result in the service being unavailable for the remainder of the call when UUS1 implicit operation is used.

7. UAC Requirements

The User Agent Client (UAC) MUST meet the requirements of [RFC7433] in addition to the requirements defined in this document.

The UAC MUST only use this UUI mechanism extension package in association with the initial INVITE method and the BYE method relating to an INVITE dialog. Usage on transactions associated with any other type of dialog, or on methods not associated with a dialog, is precluded. Usage on other methods within the INVITE dialog, and on re-INVITE transactions with the INVITE dialog, is also precluded.

If the UAC wishes to use or permit the sending of UUI data at any point in the dialog, the UAC MUST include in the INVITE request for that dialog a User-to-User header field. The UAC SHOULD set the "purpose" header field parameter to "isdn-uui". Non-inclusion of the "purpose" header field parameter is permitted, but this is primarily to allow earlier implementations to support this package. This initial header field constitutes the implicit request to use the UUI service and is, therefore, included even when there is no data except the protocol discriminator octet to send at that point in time.

The UAC MUST NOT include the User-to-User header field with a "purpose" header field parameter set to "isdn-uui", or with no "purpose" header field parameter, in any message of an INVITE dialog if the original INVITE request did not include the User-to-User header field, either with a "purpose" header field parameter set to "isdn-uui" or with no "purpose" header field parameter included.

When sending UUI for the ISDN UUI package, if the "purpose" header field is included, the UAC MUST set the User-to-User "purpose" header field parameter to "isdn-uui". The UAC MUST NOT include more than one User-to-User header field for this package in any SIP request or response.

When receiving UUI, when multiple User-to-User header fields are received in the same response with the "purpose" header field parameter set to "isdn-uui", or with no "purpose" header field parameter, or with some combination of these, the UAC MUST discard all these header fields. There are no mechanisms for determining which ones are the intended UUI data, so all are discarded.

The application designer will need to take into account the ISDN service restrictions; failure to do so can result in information being discarded at any interworking point with the ISDN. This document makes no further normative requirements based on those constraints because those constraints may vary from one ISDN to another. It is reasonable to expect that a limitation of 128 octets (plus a protocol discriminator) can be imposed by the ISDN; therefore, UUI data longer than this will never reach the destination if such interworking occurs. Note that the 128-octet limit (plus a protocol discriminator) applies before the encoding (or after the decoding) using the "hex" encoding. The "hex" encoding is defined in [RFC7433].

A "uui" option tag for use with the UUI mechanism extension is defined in [RFC7433]. Because the service is UUS1 implicit for the ISDN User-to-User service, the inclusion of the "uui" option tag in a Supported header field conveys no additional information over and above the presence, in the INVITE request, of the User-to-User header field with the "purpose" header field parameter set to "isdn-uui". While there is no harm in including the "uui" option tag, and strictly it should be included if the extension is supported, it performs no function. The presence of the "uui" option tag in the Require header field of an INVITE request will cause the request to fail if it reaches a UAS or ISDN interworking gateway that does not support this extension; such usage is allowed but will produce results that are inconsistent with the mechanisms defined in the ISDN UUS supplementary service.

8. UAS Requirements

The UAS MUST meet the requirements of [RFC7433] in addition to the requirements defined in this document.

The UAS MUST only use this UUI mechanism extension package in association with the initial INVITE method and the BYE method relating to an INVITE dialog. Usage on transactions associated with any other type of dialog, or on methods not associated with a dialog, is precluded. Usage on other methods within the INVITE dialog, and on re-INVITE transactions with the INVITE dialog, is also precluded.

The UAS MUST NOT include the User-to-User header field with a "purpose" header field parameter set to "isdn-uui", or with no "purpose" header field parameter, in any message of an INVITE dialog if the original INVITE request did not include the User-to-User header field, either with a "purpose" header field parameter set to "isdn-uui" or with no "purpose" header field parameter included.

The UAS MAY include the User-to-User header field in responses to the initial INVITE request, or the BYE requests or responses for the dialog, only where the original INVITE request included a User-to-User header field with the "purpose" header field parameter set to "isdn-uui" or where no "purpose" header field parameter was included. When sending UUI for the ISDN UUI package, the UAS SHOULD set the User-to-User "purpose" header field parameter to "isdn-uui". Non-inclusion of the "purpose" header field parameter is permitted, but this is primarily to allow earlier implementations to support this package.

When sending UUI for the ISDN UUI package, if the "purpose" header field is included, the UAS MUST set the User-to-User "purpose" header field parameter to "isdn-uui". The UAS MUST NOT include more than one User-to-User header field for this package in any SIP request or response.

The "isdn-interwork" value for the "purpose" header field parameter was used in documents that led to the publication of the present document. Although these documents had no other status than "Work in Progress", this value is implemented by some vendors. While not defined by this document, implementations could find it useful for interoperability purposes to support parsing and interpreting "isdn-interwork" the same way as "isdn-uui" when receiving messages.

Where the UAS is acting as a redirect server, the UAS MUST NOT include the User-to-User header field in the header URI parameter in a 3xx response to an incoming request.

When receiving UUI, when a User-to-User header field is received in a request that is not from the originating user with the "purpose" header field parameter set to "isdn-uui", or with no "purpose" header field parameter, the UAS MUST discard this header field.

When receiving UUI, when multiple User-to-User header fields are received from the originating user in the same request with the "purpose" header field parameter set to "isdn-uui", or with no "purpose" header field parameter, or with some combination of these, the UAS MUST discard all these header fields. There are no mechanisms for determining which ones are the intended UUI data, so all are discarded.

9. UUI Contents

These requirements apply when the "purpose" header field parameter is set to "isdn-uui" or when there is no "purpose" header field parameter.

Processing for User-to-User header fields sent or received with values other than this value are outside the scope of this document, and the appropriate package document for that value applies.

The default and only content defined for this package is "isdn-uui". When sending UUI, the sending SIP entity MAY, but need not, include a "content" header field with a value set to "isdn-uui". A receiving SIP entity MUST ignore a received User-to-User header field if the "content" header field parameter is present and the value is some other value than "isdn-uui".

The default and only encoding defined for this package is "hex". When sending UUI, the sending SIP entity MAY, but need not, include an "encoding" header field with a value set to "hex". A receiving SIP entity MUST ignore a received User-to-User header field if the "encoding" header field parameter is present and the value is some other value than "hex".

When sending UUI, the sending application MUST include a protocol discriminator octet, conforming to Table 4-26 of ITU-T Recommendation Q.931 [Q931], as the first octet of the UUI data. It is up to the receiving application what it does with this value. This document places no other normative requirement on the use of the protocol discriminator; it is required at interworking gateways to allow mapping into the appropriate fields in the ISDN protocols; otherwise, the usage is entirely up to the application and is outside the scope of this document. Valid values are identified and documented by ITU-T, and there is no IANA registry for these values.

10. Considerations for ISDN Interworking Gateways

ISDN interworking gateways MUST support the requirements defined for UAS and UAC operation.

ISDN interworking gateways MUST support only the "isdn-uui" package on dialogs that are interworked.

ISDN interworking gateways will take octet-structured data from the ISDN side and encode it using the "hex" encoding scheme defined in [RFC7433] for inclusion as the UUI data in the User-to-User header field. In the reverse direction, it will take valid UUI data according to the "hex" encoding scheme and decode it to octet-structured data to send to the ISDN side.

When mapping data content from the ISDN to SIP signalling, or from SIP signalling to the ISDN, the gateway needs to assume that all content is octet-structured binary, irrespective of the value of the received protocol discriminator. There are no requirements in the ISDN to ensure that the content matches the value of the protocol discriminator; the application usage sorts out any discrepancy. The same applies to the ISDN protocol discriminator as the first octet of the UUI data, as defined in Table 4-26 of ITU-T Recommendation Q.931 [Q931]; the interworking gateway will not perform any additional checking of this value.

A "uui" option tag for use with the UUI mechanism extension is defined in [RFC7433]. The option tag is not interworked at an ISDN interworking gateway. The ISDN interworking gateways MUST NOT take the omission of the "uui" option tag in a received INVITE request to indicate that interworking of a received header field is not to be performed.

11. Coding Requirements

This document defines "isdn-uui" as a new value of the User-to-User "purpose" header field parameter. The following ABNF adds to the production in [RFC7433]:

```
pkg-param-value =/ "isdn-uui"
```

This document defines "isdn-uui" as a new value of the User-to-User "content" header field parameter. A content value of "isdn-uui" indicates that the contents have a first octet that is a protocol discriminator (see Table 4-26 of ITU-T Recommendation Q.931 [Q931]) followed by UUI data that can be subject to a length limitation (before encoding or after decoding) that is generally 128 octets.

The following ABNF adds to the production in [RFC7433].

```
cont-param-value =/ "isdn-uui"
```

12. Media Feature Tag

This document defines the new media feature tag "sip.uui-isdn". This feature tag indicates that this ISDN UUI package is supported by the sender, and its usage is entirely in accordance with [RFC3840]. This document makes no additional provisions for the use of this feature tag.

13. IANA Considerations

Per this document, the following row has been added to the "UUI Packages" subregistry of the SIP parameter registry:

Value: isdn-uui

Description: The associated application is being used with constraints suitable for interworking with the ISDN User-to-User service, and therefore can be interworked at ISDN gateways.

Reference: RFC 7434

Per this document, the following row has been added to the "UUI Content" subregistry of the SIP parameter registry:

Value: isdn-uui

Description: The associated contents conform to the content associated with the ISDN User-to-User service. In the presence of the "purpose" header field parameter set to "isdn-uui" (or the absence of any "purpose" header field parameter), this is the default meaning and therefore need not be included in this case.

Reference: RFC 7434

This document defines the following media feature tag, which has been added to the features.sip-tree of the Media feature tags registry:

Media feature tag name: sip.uui-isdn

ASN.1 Identifier: 1.3.6.1.8.4.x

Summary of the media feature indicated by this tag: This media feature tag when used in a Contact header field of a SIP request or a SIP response indicates that the entity sending the SIP message supports the package "uui-isdn".

Values appropriate for use with this feature tag: none

Examples of typical use: Indicating that a mobile phone supports Single Radio Voice call Continuity (SRVCC) for calls in the alerting phase.

Related standards or documents: RFC 7434

Security Considerations: Security considerations for this media feature tag are discussed in Section 11.1 of [RFC3840]

14. Security Considerations

This document contains no specific requirements in regard to security over and above those specified in [RFC7433]. However, since this capability is designed to interwork with the ISDN, the general security considerations of SIP to ISDN User Part (ISUP) interworking defined in [RFC3398] apply. Any SIP/PSTN gateway implementing the ISDN User-to-User service should not blindly trust ISUP from the PSTN. In general, the overlying use case will define the security measures required. The underlying User-to-User header field extension provides a number of tools that can meet certain security requirements.

Information that might otherwise reveal private information about an individual, or where a level of authenticity needs to be guaranteed, may need a higher level of protection and may indeed not be suitable for this package, particularly taking into account the statement in the following paragraph.

As this capability is defined to interwork with the ISDN, if the ISDN forms part of the route, any usage needs to be aware that the security level of the ISDN service may be lower than the security of the SIP service. The ISDN security is itself not definable on an end-to-end basis and exists on a hop-by-hop basis. This can be high in some places (e.g., it can require physical access to a secure building) and in other places it can be low (e.g., the point where an ISDN access enters a building). If this level of security is not sufficient, then either a different package or indeed a different method of data transfer needs to be selected by the application user.

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The death of Francois Audet occurred before this document was finalized, and the authors would like to identify the significant contribution of Francois to this and a number of important RFCs and to express their condolences to his family. It was always a pleasure to work with Francois.

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