

**Federal Communications Commission (FCC)
North American Numbering Council (NANC)**

**Interoperable Video Calling Working Group
(IVC WG)**

Report on Interoperable Video Calling

Final Report to the NANC

July 28, 2020

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1. Executive Summary

As video conferencing products become increasingly popular with consumers, interoperability amongst different video conferencing products remains rare. Video calling using ten-digit telephone numbers (TNs) as part of an interconnected telephone network is also limited to VRS arrangements or some business and enterprise based private deployments, for example, but is not a widely supported technique similar to larger telephone peering arrangements. More recently, services that support video calling using ten-digit telephone numbers (TNs) have become increasingly common, including Apple's FaceTime, Google's Duo, and Facebook's WhatsApp. These services route calls as part of private networks using telephone numbers as identifiers for addressing. These over-the-top (OTT), internet-based services generally use a proof-of-possession model to determine ownership of a given number. As mentioned, one notable exception: the video relay services (VRS) market, wherein a variety of video conferencing endpoints from four interoperable VRS Providers can call and connect with one another using TNs in a more formal interconnected structure.

In 2018, the FCC's Wireline Competition Bureau (Bureau) tasked the North American Numbering Council (NANC) with creating an Interoperable Video Calling (IVC) Working Group. The FCC directed this group to explore how to facilitate the provision of interoperable TN-based video calling with a goal of increasing the use of video calling for consumers, including people with hearing and speech disabilities, using different, otherwise incompatible video calling equipment and services.

This mission, broad in nature, guided the IVC Working Group's first term, which ended with the working group identifying two approaches to facilitating TN-based video calling: a "database approach" utilizing a mechanism similar to the iTRS Directory and a "platform approach" using existing telephone service network capabilities like IMS.

The working group concludes its second term with a recommendation that TN-based interoperable video calling be enabled by a new Interoperable Video Calling Governance Authority (IVC-GA) comprised of IVC Providers and/or appropriate industry representatives of groups of IVC providers, who will in turn determine a funding model to support the sustained operation of the IVC-GA. The working group further recommends the use of a new distributed database as the backbone of the IVC ecosystem, allowing video calling providers wishing to engage in IVC to share in the costs of both administering the IVC-GA and in operating the distributed database via a IVC Policy Administration (IVC-PA) role.

2. Background

Chairman Ajit Pai originally asked the NANC to form the IVC Working Group in July of 2018 to "assist the North American Numbering Council (NANC) in carrying out its work," specifically focusing on "how to facilitate the provision of interoperable telephone number-based

video calling, allowing service providers to voluntarily offer, to any customer, the capability to make or receive a video call between 10-digit North American Numbering Plan numbers.”¹

In its final first-term report to the NANC in 2019, the IVC Working Group noted that, “(c)onsumers are increasingly relying on a variety of real-time video technologies for personal, educational, occupational, and emergency communications.” The video conferencing market has seen rapid growth from the time the current working group’s membership was announced in late 2019. Communication technologies like the telephone and video conferencing have been indispensable in allowing consumers to stay in touch with family and friends and to telework in the face of social distancing restrictions and work-from-home policies. During the second and third weeks of March, when many states had implemented or were preparing to implement stay-at-home orders, total voice traffic rose 25% for one of the nation’s largest carriers.² During the same period, usage of video conferencing grew at a record pace, and downloads of two of the most popular video conferencing apps climbed 1,700 and 3,000 percent respectively.³

As part of the IVC WG work, there is a need to focus on accessibility as a primary requirement within the IVC eco-system and to use standardized technologies for both the routing and video calling as part of the interconnected video calling network. This will help expand and enable greater access to those that are dependent on video calling to reach, for example, 9-1-1 services as well as many potential IVC enabled services in the future.

On December 17, 2019, the FCC’s Wireline Competition Bureau (WCB) released a Charge Letter announcing the continuation of the IVC Working Group. As was the case with the initial term of the IVC Working Group, the FCC welcomed participation by industry stakeholders holding an interest in IVC for both hearing individuals and people with hearing and speech disabilities who may currently use different, otherwise incompatible equipment and services.

The WCB further directed the NANC, through the working group, to provide a final report of its findings by June 29, 2020.

3.Current IVC Charge and Scope

In the Charge Letter⁴ announcing the continuation of the IVC Working Group, the WCB directed the IVC Working Group to “develop more specific recommendations on how to implement the ‘database approach’”, including specifically:

¹ *Administration of the North American Numbering Plan*, WC Docket No. 92-237, Public Notice, DA 18- 697 (July 3, 2018).

² <https://www.telecompetitor.com/verizon-traffic-surge-on-network-during-pandemic-includes-dramatic-increase-in-something-familiar/>

³ <https://techcrunch.com/2020/03/30/video-conferencing-apps-saw-a-record-62m-downloads-during-one-week-in-march/>

⁴ . Dec 16, 2019 Letter from Kris Monteith, Chief, Wireline Competition Bureau (WCB), FCC to Jennifer McKee, Chair, North American Numbering Council (NANC), (“IVC working group Charge Letter”)

- “Whether it is preferable to use one or more existing numbering databases or to establish a new database;”
- “The performance and security measures that would need to be established for interoperable video calling to work effectively, using any endpoint, whether fixed, mobile, or interconnected Voice/Video over IP; and”
- “How the database(s) should be funded, and which parties should bear the costs.”

In addition, the working group was asked to “evaluate the technical and operational feasibility of interoperating with Telecommunications Relay Services to ensure that persons with disabilities can connect directly to Public Safety Answering Point telecommunicators.”

The Bureau further directed the NANC to approve a written report of its finding on those issues, and to transmit that report to the Bureau. The NANC approved this report on July 28, 2020, which is publicly available at nanc-chair.org/

The IVC WG is tasked with determining whether it is preferable to use a new or existing database registry to manage routing information for interoperable IP-based video calling between traditional or OTT providers that wish to provide video calling services using a telephone number as a global identifier.

With the end goal of the recommendations produced by this working group being the basis for implementation of interoperable telephone number-based video calling, members concur that it is preferable for the system to work in a complementary manner to how telephone number management traditionally works, recognizing that there are fundamental differences between voice and video calling, both in operation and in terms of the user base.

4. Selection of IVC Number Management Database Technology

4.1. Background on current number management and databases

Telephone number assignment is currently performed in three organizations. The North American Numbering Plan Administrator (NANPA), managing the NANP Administration System (NAS), the NANP Pooling Administrator (PA) administering thousand-block assignments and managing the Pooling Administration System (PAS), and the Toll Free Number Administrator (TFNA) managing the Toll-Free Number Registry (TFNR) which is the authoritative source for Toll-Free number assignment, porting, and routing based on Responsible Organization (Resp Org) input identified by Resp Org ID. These organizations provide number assignments for the different types of numbers, most of which are ultimately represented in the current telephone databases.

Of the three existing primary telephone databases, first, the iconectiv LERG™ Routing Guide (LERG) provides routing data at the NPA-NXX, block, and Location Routing Number (LRN)

level obtained from the iconectiv Business Integrated Routing and Rating Database System (BIRRDS) into which data is entered by Service Providers (SPs) and/or their agents. The LERG reflects the current state of active network data as well as future modifications (additions, deletions and changes) within the North American Numbering Plan (NANP), as reported by SPs. The LERG is updated and distributed in its entirety on a monthly basis. In addition, the LERG One Day Changes process provides daily routing changes. Operating Company Numbers (OCN) used to represent service providers in the databases are assigned by iconectiv based on Company Codes assigned by National Exchange Carrier Association (NECA).

Second, the U.S. Number Portability Administration Center (NPAC) is the authoritative source for phone number porting information for all Service Providers in the United States, including wireline, wireless and Voice over Internet Protocol (VoIP) providers. There are approximately 850M active ported and pooled telephone number records in the NPAC database. The data is used by authorized Service Providers and Providers of Telecom-Related Services (PTRS) for routing, rating, billing and network maintenance. In addition, businesses and organizations that are not authorized service providers or PTRS can access and use specific NPAC data for multiple purposes via ancillary services. These organizations include:

- Law enforcement and Public Safety (ELEP ancillary service)
- Telemarketers (Wireless Do Not Call ancillary service)
- Financial institutions (Port Data Validate ancillary service)

Third, the iTRS Directory is an ENUM database regulated by the FCC and paid for through the Telecommunications Relay Services (TRS) Fund. The iTRS Directory facilitates ten-digit number-based dialing for video calls placed using endpoints distributed by providers of VRS. The iTRS Directory was built to support the several hundred thousand telephone numbers that are in the ITRS Directory today.

4.2.Considerations on using existing number databases

The working group was tasked to look at existing databases; NPAC was one of the existing databases that was looked at. During its discovery, the IVC WG met with the North American Portability Management (NAPM) LLC Co-Chairs to discuss a potential database approach using the existing Number Portability Administration Center (NPAC) numbering database. The NAPM Co-Chairs provided comments to IVC WG NPAC related questions including:

- Today, only telecommunication carriers contribute to the funding of the NPAC.
- The data source for determining the NPAC funding contribution factor is the total telecom revenue derived from FCC Form 499A.
- Re-purposing the NPAC for IVC would require an amendment of the Master Services Agreement in each of the seven NPAC database regions.

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- NPAC access Users are ONLY authorized to use the NPAC for the purpose of telephone number porting, call routing, rating and network maintenance. NPAC Users are not authorized to access the NPAC for any other purposes.
- Direct NPAC access is a READ/WRITE service.
- Not all numbers are in the NPAC today. It is an exception database.
- The NAPM, LLC's Operating Agreement allows for Service Providers or Associations that engage in voice telephone number porting to become NAPM, LLC Members if all criteria are met including an annual financial contribution, which are member dues to support the NAPM, LLC operating costs. IVC Providers would not automatically qualify for Membership in the NAPM, LLC.

Aside from questions related to re-purposing the NPAC, the NAPM Co-Chairs provided comments to the IVC WG around ancillary services, which the NPAC vendor, iconectiv, provides. These services are not to be confused with the direct access to the NPAC described above. Their comments around ancillary services included:

- There are three NPAC Ancillary Services, each of which provides access to different subsets of NPAC data without permitting direct access to the NPAC itself. Access to the relevant data sets is facilitated via a near real-time copy of the specific NPAC data elements derived for the purpose of delivering the Ancillary Service.
- Users of Ancillary Services bear the application fee and an annual cost for use of the Service. Traditional Users of the NPAC do not pay for the cost of an Ancillary Service unless they are also users of the new Service.
- The provision of currently offered NPAC Ancillary Services do not permit direct access to the NPAC. These Ancillary Services utilize a "near real-time" copy of subsets of the NPAC data, and the data elements that are provided is limited and access to the data is READ only.
- The potential development of a new Ancillary Service to support IVC would require a technical determination of the specific NPAC data elements necessary to facilitate the Service, and approval of the permitted uses defined as a first step. Each prospective new User of the IVC Ancillary Service would need to apply and qualify for access, as well as enter into User Agreement with the vendor. A condition set forth in a User Agreement commits the User for only using the data for permitted purposes as defined by that Agreement.

In summary, re-purposing the NPAC to allow direct access to IVC Providers to populate and utilize for purposes of video capability has several challenges including required changes to the NPAC Master Service Agreement, inability of video providers to fund the NPAC through the existing funding mechanisms, required changes to NAPM, LLCs operation procedures, and expansion of the exception database to include all telephone numbers. These challenges as well as challenges raised in past reports around security/privacy/access make the NPAC exception database an unattractive choice for IVC.

Although the NPAC vendor, iconectiv, could develop a new Ancillary Service for IVC there is no reason why this needs to be exclusive to that vendor or any vendor. Hence, our recommendation is to develop a new distributed database, with no specific vendor to be named or recommended. The working group discussed the possibility of recommending modifications to allow the ITRS Directory, administered by the FCC through contract with iconectiv and funded with money drawn from the Interstate Telecommunications Relay Services Fund, to support nationwide IVC beyond the VRS ecosystem. However, due to the lack of a governance authority and a system for collecting funds from IVC Providers, the Working Group decided that recommending modifications to the ITRS Directory is not the preferred way to facilitate IVC.

Since IVC deployment will have a more diverse set of industry participants that may or may not provide telephone services or have telephone number assignments directly, the working group reached consensus that there would be challenges both technically and economically to make the models of existing databases work successfully. IVC services are going to be operated and calls will be routed and processed in very different ways, completely over IP networks. It is the working group's opinion that it is a good opportunity to foster the success of IVC services by having a complementary simplified and more open model for managing and operating the database and telephone number associations in IVC.

4.3.The Use of Distributed Database Technology for IVC

Working group members agree that an IVC environment is best accomplished using a new distributed database as opposed to repurposing and/or expanding existing databases such as the NPAC or the iTRS Directory. A distributed database utilizing mature and widely implemented gossip and consensus protocols was already under consideration as a modern technology approach towards shared telephone number registries in the IETF modern working group, and allows IVC Providers to stand up their own copy of the IVC database to support their own operations, creating a scenario where the IVC environment scales in parallel with the number of providers. This environment should include a newly formed and independent governance and funding model for IVC Providers to share in the costs of administration.

The working group proposes utilizing certificates and digital signatures for confirming authorization to enable a TN in the registry, both at an administrator/authority level as well as a participant level. The upcoming section of the document will provide the detailed working group recommendations for technical requirements and details of what the distributed database should support. The following diagram provides a high-level example view of how distributed database technology can provide all IVC Providers a local copy of the database while maintaining consistent and pseudo-real-time updates for all IVC Providers across the distributed nodes with redundant links. To ensure security, records are signed by each IVC Provider, while the IVC-PA acts as the root of trust of the database.

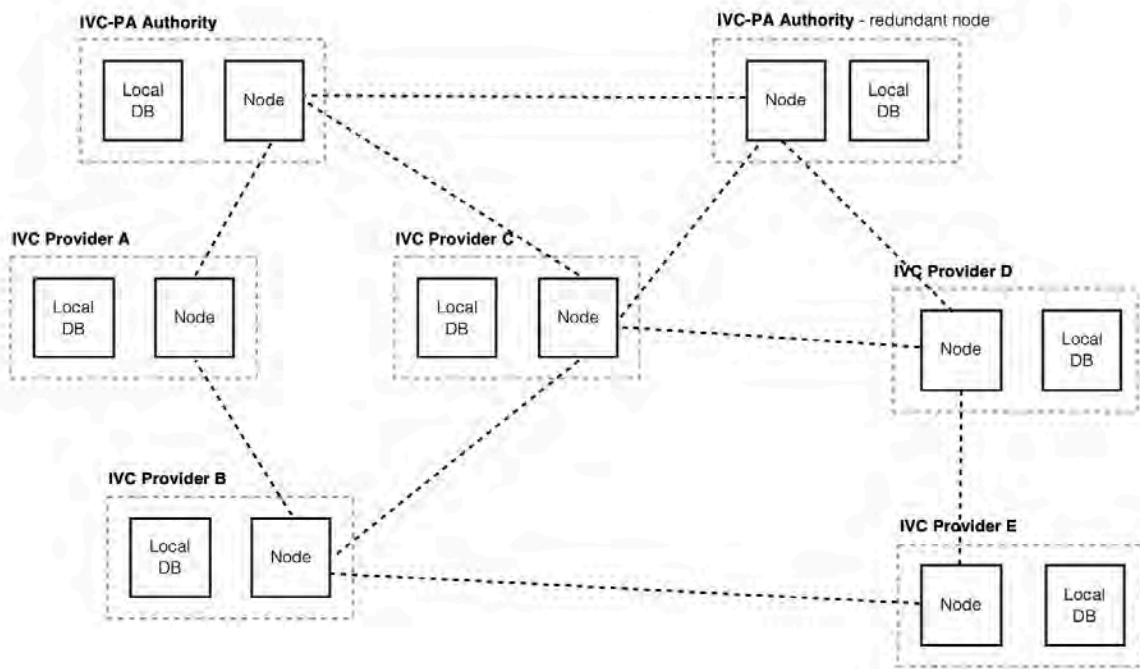


Figure 1: Example Distributed Database with Local Data Store Managed by IVC Provider

5. Distributed Database Requirements

A distributed database allows IVC Providers to stand up their own copy of the IVC database to support their own operations, creating a scenario where the IVC environment scales in parallel with the number of providers. This environment should include a newly formed and independent governance and funding model for IVC Providers to share in the costs of administration.

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The working group discussed the technical requirements that would be needed to support a nationwide IVC environment with a potential user base of several hundred million people and identified recommendations to support the performance and security requirements for an IVC ecosystem. The working group also discussed technical requirements to support emergency service, and to support Telecommunication Relay Service users' interactions with IVC users. These requirements are detailed in the following subsections.

5.1. IVC Participants and Roles

The main participants in the IVC ecosystem will guide the use of the IVC database.

- **IVC-GA** – The IVC Governance Authority is comprised of IVC Providers as industry representatives, is the authoritative role that determines the policies and funding model for the IVC database
- **IVC PA** — The IVC Policy Administrator is the authority role that validates the TN and TFN relationship with users and authorizes an IVC Provider association into IVC database
- **STI-CA** – The Certification Authority that provides certs used both for STIR/SHAKEN signing of calls as well as signing records created/modified in the IVC database
- **TSP** – A telephone service provider that has acquired the right to use a telephone number or telephone number block by getting TN/TFNs assigned through NANPA (number allocation), PA (thousand blocks), or the TFNA (toll free)
- **IVC Provider** – An entity that provides IVC services for a customer/end-user that is associated with a TN or TFN (Note: TSP and IVC Provider could be the same or different entities)
- **IVC user** — A person who wants to use IVC services with an IVC Provider and have an association with a TSP and a telephone number
- **TRS Provider** – An entity that offers TRS (Telecommunication Relay Service)
- **TRS user** – A person who is eligible for and uses a TRS Service and has selected a TRS Provider
- **IVC PSAP Provider:** An IVC Provider that serves PSAPs that accept IVC emergency calls. In Next Generation 9-1-1, this is the Emergency Service Routing Proxy for incoming emergency calls, and the Outgoing Call Interface Function for call backs

5.2. Performance and Reliability

In its charge to the NANC, the FCC asked for recommendations as to what performance or security measures would be needed for IVC to work effectively using any endpoint.

We recommend using distributed database technologies to manage IVC routing information, where each participating IVC Provider maintains a complete replica of IVC database for call routing purpose. This supports local lookups with better efficiency and reliability than using a centralized database and supports provisioning and porting IVC Users in a scalable and timely manner.

The distributed nature of the database will require providers wishing to engage in IVC to stand up a copy of the database, sharing in the responsibilities of operating the IVC environment. While the overall size of the database and the rate at which the distributed database replicates it's data consistently across all of the participating nodes at each IVC Provider will be dependent on the size of the IVC user base, the rate of queries and query response time are only dependent on the scale of the infrastructure an individual IVC Provider deploys.

The working group discussed performance related to both replication activities and call queries. Based on the design objectives identified in this document, replication activities (additions, modifications, and deletions to the database) should propagate to all nodes rapidly. When a user changes their preferred video calling provider, they will expect that change to be in effect for the next call. Since that call may happen immediately after the provider change, to ensure a consistent experience for all callers, the IVC Governance authority board should consider requiring performance measures such as “95th percentile propagation delay under one minute”.

Request response time is controlled by individual node design and load. Given that call setup delay directly impacts call connection rate, the IVC Governance authority board should consider requiring node administrators to meet baseline performance measures such as “95 percentile query latency under 500 milliseconds”, in order to ensure a consistent experience for all callers.

5.3.Security

IVC members agree that access to the database must be controlled to prevent misuse of the database i.e. use other than facilitating interoperability between video endpoints.

Database security mechanisms should include but are not limited to:

- Prevention of read access by unauthorized entities
- Prevention of write access by unauthorized entities, or against the user's wishes
- Prevention of trawling, i.e., bulk querying of the database contents by endpoints
- Prevention of denial of service attacks

For example, to ensure the integrity of the database, records can be signed by authorized entities via existing PKI similar to the system that manages TN/TFN authority for the SHAKEN ecosystem. Other database nodes can also verify these signatures and ensure that any records added by unauthorized entities are immediately detected.

When supported by IVC Providers, end-to-end encryption capabilities between endpoints should be preserved.

5.4.Support for TRS Users

In our work, the working group considered how TRS users would interact with IVC, specifically detailed in Section 9 of this document. In these use cases, we have presented call scenarios that allow for full participation of TRS users with IVC, including calls to and from TRS users with non-TRS users and calls to and from 9-1-1 from both TRS users and non-TRS users. In the design of the database and the calling scenarios, we have assumed that the IVC database replaces the existing iTRS database. Integrating IVC and TRS in the way we propose here has privacy concerns: IVC providers have access to TRS eligibility data. Importantly, we observe that any integration of IVC and TRS would leak some privacy information and we observe that the existing iTRS database integration with the NPAC leaks some of this data already. It may be possible to restrict the TRS data more than the proposal we have made here, and some

exploration of these issues should be part of any succeeding IVC work. There may be other ways to integrate TRS into VRS that use the existing iTRS database. The working group has not explored other options.

5.5.Support for 911

The last directive assigned to the working group by the WCB is to “evaluate the technical and operational feasibility of interoperating with Telecommunications Relay Services to ensure that persons with disabilities can connect directly to Public Safety Answering Point telecommunicators.”

The working group considered this directive specifically in the context of Next Generation 9-1-1 (NG9-1-1). Supporting 9-1-1 requires both the ability to call 9-1-1, as well as the ability for a PSAP to call back the user who placed the original call. The work group considered both scenarios in its work.

Based on data available to the FCC, the majority of 9-1-1 jurisdictions in the United States, spanning the spectrum of initial planning and budgeting to full statewide implementation, are engaged in transitioning away from E9-1-1, an older analog technology incapable of supporting video calling, to NG9-1-1. NG9-1-1 is IP-based and handles text, audio, video and data, covering many media types and all forms of TRS, including TTY, captioned telephone, and VRS. In terms of the latter, NG9-1-1 supports the ability to host 3-way video calls, making it possible for VRS users to call and connect directly to NG9-1-1 public safety answering points (PSAPs). Use cases, demonstrating how the proposed database model would support direct 9-1-1 connections for IVC users needing relay services, are provided in Section 9 of this document.

The working group notes that the Emergency Access Advisory Committee (EAAC), chartered by Congress to study the best manner in which to provide access to emergency services for people who are Deaf or hard of hearing, proposed an alternate model using Media Communication Line Services (MCLS) call centers staffed with qualified sign language interpreters (SLIs) and Communication Assistants (CAs) with emergency expertise. While the outlined calling scenarios set forth in Section 9 depict VRS being bridged in to support 9-1-1 callers speaking American Sign Language (ASL), the same process that supports bridging in VRS during a 9-1-1 call also supports bridging in SLIs and CAs via MCLS.⁵ The working group further notes that the proposed IVC database closes a gap identified by the EAAC to implementing direct 9-1-1 access for those who use ASL: the lack of a language negotiation mechanism, such as the ones defined in Sections 9.8.1 and 9.8.2 of this report.

To place a 9-1-1 call in an NG9-1-1 environment, the main technical standard, NENA-STA-010 would need to be modified slightly to handle any differences in signaling for IVC that are not reasonably covered by its existing video calling standard. NG9-1-1 handles audio, video and text, so all media (and thus all relay services) could be handled. To place a call back, NG9-1-1 already has consideration for sending calls back to the service provider who handled the call, as well as

⁵ EAAC Working Group 3 Recommendations on Current 9-1-1 and NG 9-1-1 Media Communication Line Services Used to Ensure Effective Communication with Callers with Disabilities.

providing marking that the call is a call back so that the service provider can direct the call back to the device that originally placed the call (as opposed to voice mail or another device). To correctly route a call back, the NG9-1-1 system would need access to the distributed database that our proposed solution envisions.

Having considered how any IVC user could call 9-1-1 and receive a call back, the extension of those capabilities to users who need relay services was straightforward. This means that an IVC Provider can provide access to 9-1-1 for all of its users including those who require relay. Calling scenarios, both calling and call back for IVC Users with and without VRS are illustrated in Section 9.

6.IVC Provider Database Provisioning and Usage

6.1.Database Records

The database records should contain enough information to route TN/TFN-based video calls between different IVC Providers.

The records should also contain enough information for an IVC Provider to involve a default TRS service into the call session when a Communication Assistant is needed. The recommended signaling approaches are detailed in Section 9 IVC Use Cases and Call Flows.

The database should support the following entries at a minimum to support an IVC calling environment:

- Telephone Number – The phone number associated with the current IVC service
- Current IVC URI (Uniform Resource Identifier) – This information used to identify and route calls to/from the call participant associated with the TN/TFN.
- TRS Service Eligibility – This information is used to determine whether the call participant is eligible to use TRS. Different eligibility fields are used for different types of TRS such as VRS (Video Relay Service) and CTS (Captioned Telephone Service).
- Default TRS service URI – URI of the default TRS service chosen by an eligible TRS user. Like the above, different types of TRS services may be included.

The database should be extensible to allow future addition of new fields. Proposals for modification and addition of database fields should be reviewed and approved by the IVC Governance Authority board.

6.2.Database Access Rights

We recommend role-based access rights for the IVC database to ensure the consistency and ease of maintenance of the information, and to provide privacy protection. The following table depicts

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the proposed access rights for the roles involved in the IVC database. A provider may adopt multiple roles, for instance an IVC TRS Provider may also be an IVC Provider.

These rights may change based on the model used for Communication Assistant engagement and the specific call flow implementation details, which are beyond the scope of this working group. Changes to access rights must be approved by IVC-GA.

Role/Access	TN/TFN, current IVC	Current IVC URI	TRS Eligibility (1..n)	TRS URI (1..n)
IVC Policy Administrator	Write ¹	No Access	No Access	No Access
URD Administrator	Read ²	No Access	Write	No Access
IVC Provider	Read	Write	Read	Read
IVC PSAP provider	Read	Read	Read	Read
IVC TRS Provider	Read	No Access	Read	Write
TSP	No Access			
IVC PSAP endpoint	No Access			
IVC user endpoint	No Access			

¹ Write access is limited and should reflect the service models. Write access includes Read access.

² Read access indicates that the information is needed for setting up calls.

6.3.TN/TFN Enablement Process for IVC Users

The following flow chart and description is an example of the recommended flow to be considered for how a TN or TFN should be enabled in the IVC distributed registry. The important requirements considered are how the consumer can have a friendly, easy-to-use process for the selection of an IVC Provider, while maintaining security and accuracy in the verification of the telephone number legitimately associated with the consumer in the telephone world and the provisioning of that telephone number association in the IVC distributed registry.

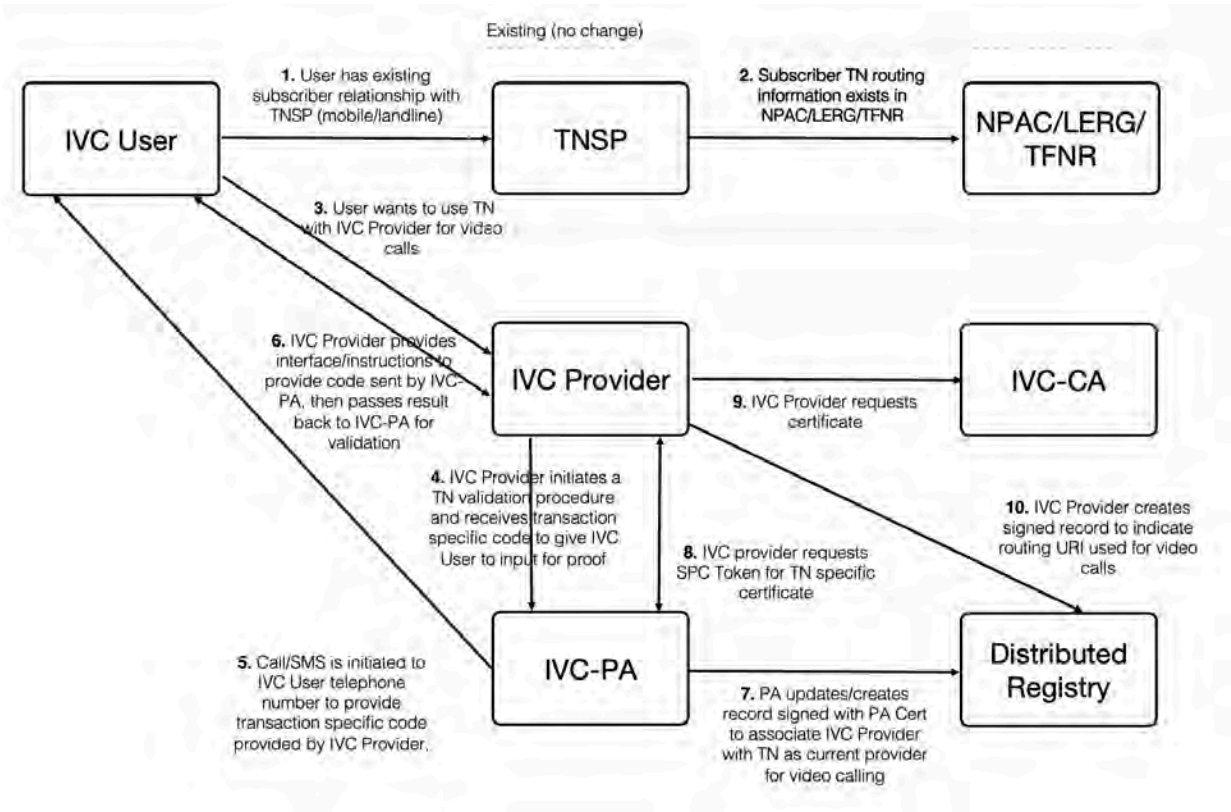


Figure 2: High level flow for provisioning/porting of new IVC User with an IVC Provider

High Level flow for provisioning/porting of new IVC User with an IVC Provider

1. IVC Users have an existing relationship with a TSP via cellphone or landline account and TN routing information exists in NPAC/LERG databases or Toll-Free Number Registry (TFNR)
2. IVC User would like to use an IVC Provider for video calling services
3. IVC User requests to IVC Provider to associate telephone number with video service
4. IVC Provider initiates validation process with IVC PA
5. IVC PA sends SMS or Call to IVC user telephone number with code to user
6. IVC Provider presents an interface to IVC User to input code that will come from SMS or Call
7. IVC User enters code received into IVC Provider interface, the response is then sent to IVC PA to validate the correct response
8. If TN/TFN validation with IVC User is successful, IVC Provider is authorized for that TN/TFN in Registry

9. IVC PA writes record for TN/TFN association authorization, signed with IVC PA cert
10. IVC PA can now provide Service Provider Code (SPC) token for IVC Provider to get TN/TFN certificate
11. IVC Provider creates/modifies and finalizes TN/TFN record with signed routing URI details, other providers can validate proper IVC Provider by checking for valid routing signature/certificate as well as IVC PA signed record that authorizes the IVC Provider
12. Signed routing details and IVC PA authorization propagate across distributed registry to all IVC Providers
13. Calling IVC Providers on behalf of other IVC Users can now query their local database to get routing details for new IVC Users

7. Governance and Economics

7.1. Governance

The working group recommends the governance of the IVC database should be structured similarly to the current STIR/SHAKEN STI-GA model. The STI-GA model supports industry led governance and has many of the functions already established, which may be modified as necessary to meet the different requirements of IVC. Basing the new IVC-GA off an existing governance model should result in cost savings and minimize industry effort in addition to the opportunity to extend the learnings of business, legal, and policy related issues with setting up the legal entity.

Under the IVC-GA model, an IVC Governance authority board, comprised of IVC Providers and/or industry organization representatives of IVC Providers where appropriate, should be established as a policy and decision-making body to determine the funding model necessary to cover costs for development, administration and governance of the database.

All IVC Providers and providers of relay services with IVC features should participate in the governance of the IVC database.

The Policy Administrator (IVC-PA) is the day-to-day administrator and primary trust anchor of the system that ensures that IVC certificates used to authenticate and verify authorized TN/TFN enablement in the IVC database. The IVC-PA implements and manages the PKI including managing approved IVC-CAs, managing central Certificate Revocation List (CRL), and provides interface for getting authorized tokens required for certificates by the approved and authenticated IVC Providers.

Certificates should be managed as commercial agreements between the IVC Provider and the Certificate authorities for signing and other purposes as defined by the IVC Governance.

In conclusion, the STIR/SHAKEN Governance model has many complementary aspects that can be utilized and built upon for a more forward-looking model for the IVC-GA. The Commission

should consider directing the industry to establish the IVC-GA as the legal entity that will govern the distributed database and act as the authority over the IVC-PA, which should be the responsible entity for administering the trust anchor for signatures and certificates used for signing database records.

7.2.Economics

One of the benefits of using the STIR/SHAKEN Governance model is having a good basis for a reasonable economic model, funded by the IVC Providers with a board made up of industry representatives. The IVC Governance will be separate from the current SHAKEN Governance.

The IVC Governance authority board, comprised of IVC Providers and/or industry organization representatives of IVC Providers where appropriate, should determine the funding model necessary to cover costs for development, administration and governance of the database.

In order to ensure interoperability and a common ecosystem, all IVC Providers should participate in the financial contribution to the IVC Governance costs of the system. Certificates should be managed as commercial agreements between the SP and the Certificate authorities for signing and other purposes as defined by the IVC Governance.

Depending on the requirements for the IVC database and after considering any associated TRS Users 'privacy concerns, consideration should be given to folding in the functionality of the iTRS Directory into the IVC database. Should the FCC determine the IVC system would be used for TRS functions, funding for those functions will need to be determined. Making this change may affect many aspects of funding for TRS services, which would have to be considered by the FCC.

The IVC Policy Administrator (IVC-PA) should be a contracted vendor paid for by the IVC Governance (IVC-GA).

8. IVC Working Group Recommendations

After a very active, productive, and collaborative set of working group sessions over the past few months, where many of the subject-matter experts invited to participate and guest experts that were consulted by the working group provided very relevant and critical input into many of the various dependencies of what an IVC eco-system implementation might look like providing a proper baseline for our recommendations. To answer the specifically charged questions from the FCC around both the recommended technologies, governance and economic questions, and support for those systems and consumers that have a critical dependency for IVC, the second session of the IVC Working Group has the following summarized recommendations based on the details of the proceeding sections, as well as, for an important reference, use-cases that are detailed in Section 9 of this document.

The following are the recommendations of the second IVC Working Group:

To address question 1a. **“Whether it is preferable to use one or more existing numbering databases or to establish a new database”**, the working group further evaluated and conferred

with industry experts and in the case of the NPAC, spoke with NAPM, LLC to re-enforce our understanding of the financial and technical operation and functionality of the NPAC and considered a proposal detailing the potential use of the NPAC. For the iTRS database, the working group had many of the key subject matter experts participating in the working group. The working group recommends following the “establish a new database” path, with the additional guidance to pursue the industry technical work to define standards around the use of distributed database technologies and a distributed registry as defined by the requirements provided in this report. The working group recommends the utilization of appropriate internationally recognized standards that address the IP based video calling signaling, database and other dependent protocols and security standards for digital signatures and other appropriate cryptographic standards, such as from the IETF, as well as, where appropriate, establishing U.S.-based standards that can build the appropriate governance and best practice standards for the U.S.-specific IVC ecosystem, such as from ATIS or SIP Forum or other U.S.-serving video calling expert forums.

To address question 1b, **“The performance and security measures that would need to be established for interoperable video calling to work effectively, using any endpoint, whether fixed, mobile, or interconnected Voice/Video over IP”**, the working group has provided many detailed recommended requirements as part of Section 5 with specifics to the database characteristics like performance and security. In Section 6, the working group has detailed specific requirements that are recommended for the use and provisioning of TN and TFN specific entries and the roles that are authoritative and should have read or write access to these entries. Additionally, the working group has provided a set of what it believes is the baseline set of IVC use cases that should be investigated as a supplement to our recommendation to help the FCC provide context to any future policy and standards for the video call specific protocols necessary to extend the NANC and IVC work beyond the recommendations specific to the distributed registry and its operation.

For question 1c, **“How the database(s) should be funded, and which parties should bear the costs”**, the working group recommends to adopt and follow a similar model to what has been established in the recommendations of the NANC CATA Working Group for STIR/SHAKEN, which we all believe has been a very successful model in many respects. Therefore, as part of the recommendation, we have defined the concept of an IVC-GA and IVC-PA, for the specific participation of industry representatives of the IVC Providers to establish the legal entity and financial funding of the IVC distributed database operational dependencies and the trust anchor that protects the authorized use and authenticated access into the database. Section 7 provides the detailed requirements and recommendations relative to the establishment of the governance and the economic considerations for the continued funding of the operations by the IVC Providers. The working group does not provide any specific recommendations on how VRS, and specifically, the iTRS Directory, can participate in the IVC ecosystem and share in its costs.

For question 2, **“Evaluate the technical and operational feasibility of interoperating with Telecommunications Relay Services to ensure that persons with disabilities can connect directly to Public Safety Answering Point telecommunicators”** the working group, with the

help of many of the subject-matter experts in these specific technologies and services, provided detailed use-cases including both general IVC calling scenarios as well as many of the call scenarios that directly address this question. The working group recommends that both in the context of our distributed database approach recommendation as well as through evaluating the above mentioned use-cases, we have confidence that our recommendations in this document will support the operation and interoperation of general IVC calling with TRS services and the ability for both to connect to PSAP telecommunicators and support 9-1-1 and NG9-1-1 calling and communications scenarios.

Both the co-chairs of this session of the IVC working group have observed almost unanimous consensus on the recommendations detailed both in this section as well as throughout this report. Not all aspects have complete unanimous consensus, but given the complexity and comprehensive nature of all of the technologies, policies, and economics that IVC needs to cover and work in a complementary way to how the telephone network operates based on many years of established regulatory policy and technology choices, we, the working group, have confidence that the recommendations coming out of this session of the IVC Working Group provide a foundation that can help to establish an eco-system based on future looking video calling technologies, more easily allow for participation in the eco-system, has less barriers to restrict future innovation, and does not disrupt or jeopardize the established practices of the current telephone network, but rather complements them as a parallel set of resources that can use the telephone numbering system across both in an equitable way.

9.IVC Use Cases and Call Flows

The working group has developed use cases to demonstrate how the proposed database model would support an IVC implementation. The use cases cover the most common and critical scenarios and are not intended to cover every possible scenario. The use cases listed below were examined by the WG:

1. IVC User to IVC User Video Call
2. IVC user to PSTN (no Video capability) Call
3. PSTN (No Video Capability) Caller to IVC user
4. IVC User to 9-1-1 (PSAP) Video Call
5. 9-1-1 (PSAP) Video Callback to IVC User
6. IVC User to IVC TRS User with VRS CA (Interpreter)
7. VRS User to 9-1-1 (PSAP) Video Call with VRS CA (Interpreter)
8. 9-1-1 (PSAP) Video Callback to VRS user with VRS CA (Interpreter)
9. Other Relay Services

These use cases are representative and are not intended to cover all possible IVC scenarios or to imply that all use cases will be supported by all IVC Providers. While implementation models are outside of the scope of this working group, two potential implementations are shown for each use case. Both implementation models examined work the same way for simple video calls but differ for the handling of TRS- and PSAP-involved calls. These differences are identified within each use case.

Note that the database model and these use cases only address whether a caller is eligible for TRS, not whether TRS is desired for a particular call. The database model and use cases assume that managing scenarios where a caller who is eligible for relay services but does not want relay services for a particular call will be handled within the call signaling, not within the IVC database.

Similarly, the use cases only determine whether each caller is capable of video calls. Most, if not all, video clients allow each user to choose independently to block audio or video at any point during a call. The use cases do not address whether audio or video is in use, only that the IVC Provider and client support it.

The roles in the use cases are defined below. It is possible for an entity to fulfill more than one role at a time. For example, a VRS Provider may fulfill both the IVC Provider and Relay Provider roles if the VRS Provider offers to be an IVC Provider and a user chooses his default VRS Provider as his IVC Provider.

IVC Use Case Roles and Definitions:

- IVC Service: A two-way interactive video communications service
- IVC User: A person who uses IVC Services that has a telephone number assigned and has selected an IVC Provider
- IVC Provider: An entity that offers IVC services
- TRS: A relay service operated under a national regulatory scheme
- TRS User: A person who is eligible for, and uses a TRS Service and has selected a TRS Provider
- TRS Provider: An entity that offers TRS
- VRS: A Video TRS for people who are deaf or hard of hearing
- VRS User: A person who is eligible for, and uses a VRS and has selected a VRS Provider
- VRS Provider: An entity that offers a VRS
- IVC TRS User: a TRS user who is also an IVC user and gets video service for TRS via his IVC Provider
- PSAP: A Public Safety Answering Point, the call center that answers emergency calls

- Next Generation 9-1-1: A redesign of the North American emergency call system based on IP networks
- IVC PSAP Provider: An IVC Provider that serves PSAPs that accept IVC emergency calls. In Next Generation 9-1-1, this is the Emergency Service Routing Proxy for incoming emergency calls, and the Outgoing Call Interface Function for call backs)
- IVC PSAP: A PSAP that accepts IVC calls
- iTRS Directory: The TRS Numbering Directory. The database administered by the TRS Numbering Administrator, the purpose of which is to map each registered internet based TRS user's NANP telephone number to his or her end device or TRS Provider.
- Emergency Services Routing Proxy: The routing engine for NG9-1-1 systems. Accepts calls from all Originating Service Providers, including IVC Providers and TRS Providers and routes emergency calls to the correct PSAP

9.1. Use Case: IVC User to IVC User Video Call

In this use case, an IVC user (IVC User A), using one IVC Provider (IVC Provider A) calls another IVC user (IVC User B) using a different IVC Provider (IVC Provider B). No relay services are involved. If both users were using the same IVC Provider, the call would be completed using the IVC Provider's native capabilities.

In both proposed implementation models, the call flow is as follows:

1. IVC User A initiates a video call to IVC User B's telephone number
2. IVC Provider A performs a destination lookup in their local IVC database replica.
3. The IVC database replica returns information that IVC Provider A uses to:
 - a. Identify whether the phone number for IVC User B is in the database. If not, an IVC call is not possible and IVC Provider A falls back to use case 9.2, IVC user to PSTN (no IVC capability).
 - b. Determine the IVC User B URI
 - c. Determine that IVC User A and IVC User B are not eligible for VRS. If one user is eligible for VRS, then VRS is needed. If both or neither user is eligible for VRS then VRS is not needed. In this case, Provider A falls back to use case 9.6, IVC User to IVC Video Call with VRS CA (Interpreter). Other forms of TRS are discussed in section 9.9.1, Other Relay Services
 - d. Route the call to IVC Provider B
4. IVC Provider A connects the call to IVC Provider B
5. IVC User B receives the call

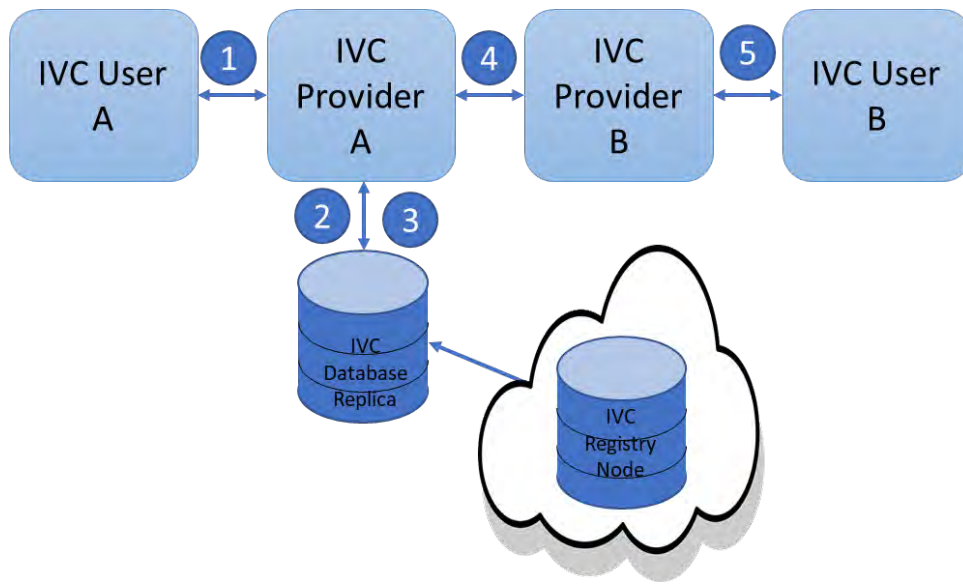


Figure 3: IVC User to IVC User Video Call

9.2. Use Case: IVC user to PSTN (no IVC capability)

An IVC User may initiate a call to a phone number that is not associated with an IVC Provider. In this case, an IVC call is not possible, but depending on the IVC Provider's capabilities, and user preference, a PSTN (audio) call may be possible. For this to work, the IVC Provider must be a TSP or have a relationship with the TSP that serves the telephone number. A PSTN call is not the same as completing an IVC call that requests no video (audio only). Requesting an IVC call with no video would be covered by use case 9.1, *IVC User to IVC User Video Call* and the enabling or disabling of audio and video would be managed by the IVC Provider or client.

In both proposed implementation models, the call flow is as follows:

1. The IVC User initiates a video call to IVC User B's telephone number
2. The IVC Provider performs a destination lookup in their local IVC database replica.
3. The IVC database replica returns information that the IVC Provider uses to:
 - a. Identify that the phone number is NOT in the IVC database and therefore the destination is not IVC capable.
4. If the IVC Provider supports the capability, the IVC Provider completes the call as a PSTN call. If not, the call is rejected.

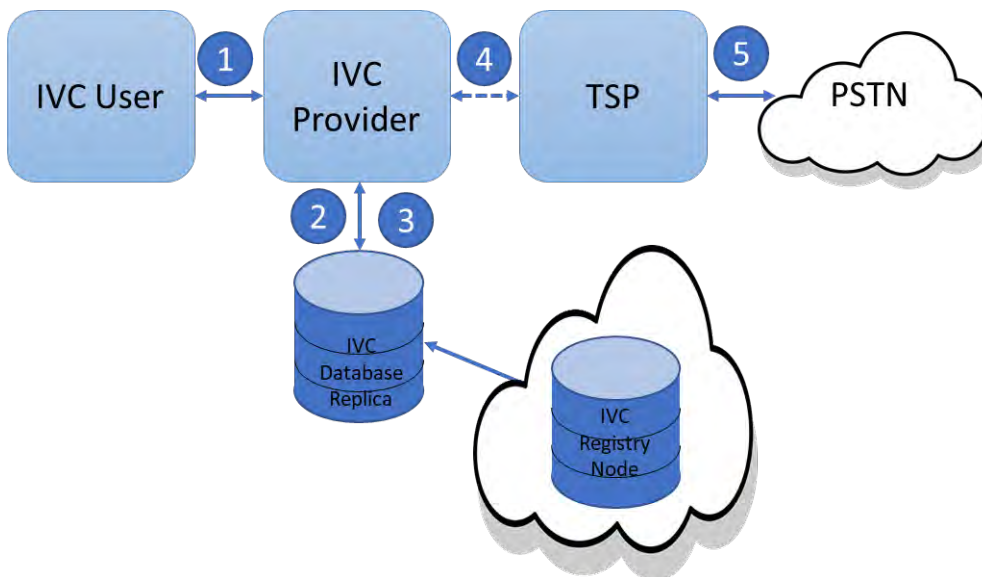


Figure 4: IVC user to PSTN (no video capability)

9.3.Use Case: PSTN (no IVC capability) caller to IVC user

A user initiating a call from a PSTN device may initiate a call to an IVC user. In this case, the user's TSP would perform a database lookup only to determine TRS eligibility and would route the call via PSTN. For this to work, the IVC Provider must be a TSP or have a relationship with the TSP that serves the telephone number

Note that this is the model currently used by VRS. PSTN calls are routed to the VRS Provider, who, using a VRS CA (interpreter) as a relay, bridges a video call to the user.

9.4. Use Case: IVC User to 9-1-1 (PSAP) Video Call

In this use case, an IVC user dials 9-1-1. No TRS is involved. The call flow is as follows:

1. The IVC User initiates a video call to 9-1-1
2. The IVC Provider's Location Information Server (LIS) obtains location data from end device or registered location
3. The IVC Provider queries ECRF with IVC User A's location data
4. ECRF provides PSAP route
5. The IVC Provider routes the call to the PSAP IVC Provider
6. The PSAP receives the call

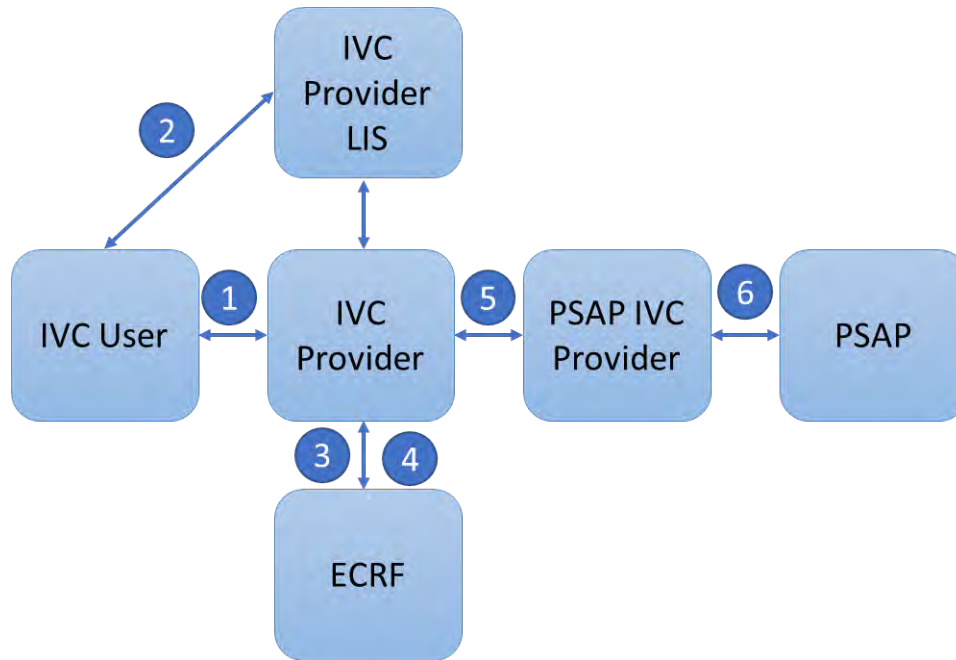


Figure 4: IVC User to 9-1-1 Video Call

9.5. Use Case: 9-1-1 (PSAP) Video Callback to IVC User

In this use case, a PSAP places an outbound call to an IVC User. No TRS is involved. The call flow is as follows (identical to 9.1, IVC User to IVC User Video Call, except originator is PSAP):

1. The PSAP initiates a video call to IVC User's telephone number
2. The IVC Provider performs a destination lookup in their local IVC database replica.
3. The IVC database replica returns information that the IVC Provider uses to:
 - a. Determine the current IVC User URI
 - b. Determine that the IVC User is not eligible for TRS
 - c. Route the call to the IVC Provider
4. The IVC Provider connects the call to IVC User
5. The IVC User receives the call

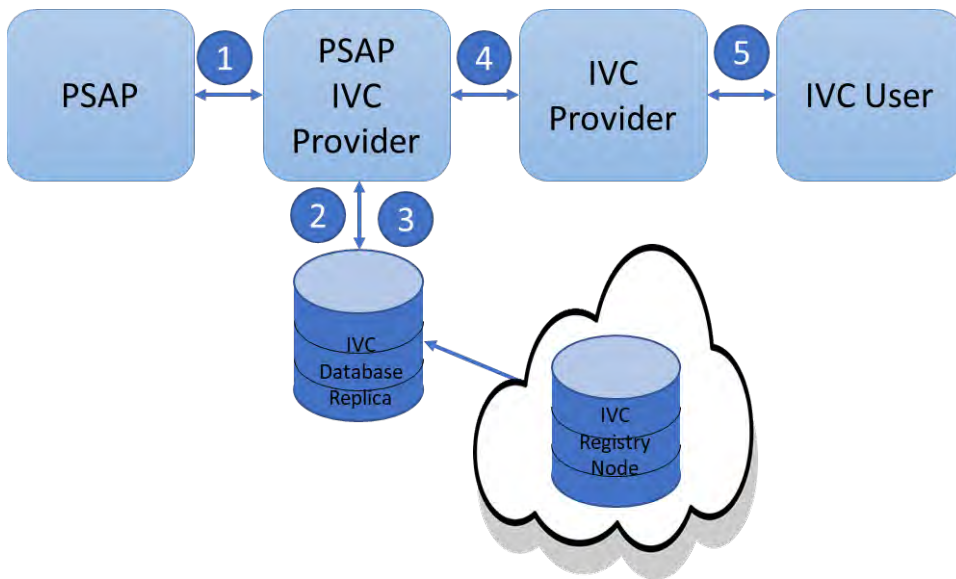


Figure 5: 9-1-1 Video Callback to IVC User

9.6. Use Case: IVC User to IVC Video Call with VRS CA (Interpreter)

The working group identified two approaches to enable support for VRS/IP-Relay/CTS or other forms of interpreter support in IVC. These two models demonstrate that the IVC Data model identified in Section 6 is sufficient to allow IVC functionality. Other models are also possible but not explored in this section. The choice of implementation model is beyond the scope of this working group.

Employing a VRS CA (Interpreter) is a decision based on eligibility (which is in the database), the capabilities of the user (for example, can they sign), and some notion of user request (for this call, do I want to use relay), where the latter two can be signaled. One of the IVC Providers uses the eligibility, capability and user request information to decide whether to engage VRS. When VRS is to be used, the database contains the IVC user's VRS Provider, although this can be overridden with signaling. Whenever an Interpreter is used, a bridge is needed to create a multiparty conference, because there are more than two parties in the call. The two models differ in the signaling layout and who provides the bridge. In the Interpreter Add model, IVC Provider B makes the decision of whether VRS is needed and it provides the bridge. Current implementations of CTS follow the Interpreter Add model.

In the Interpreter Inline model, IVC Provider A makes the decision of whether TRS is needed and the VRS Provider supplies the bridge. Current implementations of VRS follow the Interpreter Inline model.

Because there are two IVC Services involved, standardization will be required to specify how the bridge operates. While our current scope is limited to two party calls in general, VRS is inherently multiparty. This is complicated by the fact that, for a 9-1-1 call, the PSAP must provide the bridge, regardless of the model. For the Interpreter Add model, the bridge must provide a way for the VRS Provider to facilitate VRS features such as virtual teaming (where multiple VRS CAs are required to handle, for instance, emergency calls) and VRS CA transfer (for instance in long calls). In the Interpreter Inline model, IVC Provider B must have mechanisms to handle conference calls similarly to how it provides non-assisted multi-party calls. Both models must also consider standardization of media negotiation, media distribution and media control.

This document does not make assumptions that any of the calling patterns described are mandatory or optional, including the support of 9-1-1 for callers requiring assistance or not. It merely describes how they may provide the functionality. If not all IVC Providers provide support for VRS features, and 9-1-1 calling, there may be discriminatory effects for those persons that need assistive technologies to make calls on certain IVC platforms. Care should be taken to allow for TRS fallback call flows as IVC is adopted and where some video platforms may support IVC where others do not. If support for relay in IVC calls is non-mandatory, then fallback to current VRS models must be implicit. Consideration should also be given to any

confusion that may result from a patchwork level of support for IVC calling and whether a-priori a call will or will not be able to have a VRS CA included on the call.

The placement of the conference bridge also becomes critical when considering multi-party conferences; that are now common. In addition to the considerations of floor control, participant identification and media issues highlighted above, further consideration must be made of what the users 'experience is in a multi-party interpreted call: in video terms, who sees who, and in audio terms whose audio is distributed to who. For instance, protocols must be standardized for "pinning" of video streams (to allow deaf user and VRS CA to maintain visibility of each other) as well as audio controls, for instance, for courtesy muting of inadvertently noisy participant environments. Standardization for these features may be required regardless of who provides the bridge.

Real Time Text (RTT, T.140) is now commonly used in VRS to facilitate improved communication between a deaf user and a VRS CA. Where the conference bridge is not hosted by the VRS Provider consideration should be made for how to standardize RTT in a multi-party call.

Further differences exist in the timing of when a VRS CA is engaged in a call. The Interpreter Add model permits the CA to be requested before or after alerting to IVC User B. Requesting after alerting, allows more dynamic information from IVC User B to be used to make a decision on whether to engage VRS, but it could lead to confusion on the call if the hearing party is unfamiliar with receiving or making calls to people who are deaf, and may lead to premature call termination. However, more experienced callers and callees may desire to proceed with their call as quickly as possible and be content to have a VRS CA join the call when one is available. The Interpreter Inline model cannot make use of any information from User B (other than the eligibility information in the database) when considering whether to engage, so options may be more limited.

Variations and hybrids of the two models are envisioned that may address some or all the concerns.

This working group recommends that studies be performed into the relative merits of the two models, and envisioned variations, along with user trials of those approaches.

With both approaches, eligibility to use TRS can be verified by the TRS-URD (User Registration Database) Administrator and the resulting verification status may be included in the database. Both models change the TRS-URD to expand the sources of data the URD administrator acquires and require the URD administrator to provide data to the IVC distributed database.

The two models are shown below.

9.6.1. Interpreter Add Model

In the Interpreter Add model, the call flow is as follows:

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1. IVC User A initiates a video call to IVC User B's telephone number. IVC User B is an IVC TRS User.
2. IVC Provider A performs a destination lookup in their local IVC database replica.
3. The IVC database replica returns information that Provider A uses to:
 - a. Identify whether the phone number for IVC User B is in the database. If not, an IVC call is not possible and IVC Provider A may fall back to use case 9.2, *IVC user to PSTN (no IVC capability)*.
 - b. Determine the IVC User B URI
4. IVC Provider A routes the call to IVC Provider B
5. VRS eligibility lookups for both B and A, are performed in their local IVC database replica.
6. The IVC database replica returns TRS eligibility for both A and B. If one user is eligible for VRS, then VRS may be needed. If both or neither user is eligible for VRS then VRS is not permitted. Then desirability is determined by signaling from IVC Provider A's, static information for IVC User B or, possibly dynamically from IVC User B via signaling. A determination is made if TRS will be engaged. If not, Provider A falls back to use case 9.1, *IVC User to IVC Video Call*. Other forms of TRS are discussed in Section 9.9.1, *Other Relay Services*
7. IVC Provider B engages IVC VRS Provider using its bridge and routes media appropriately
8. IVC User B receives the call.

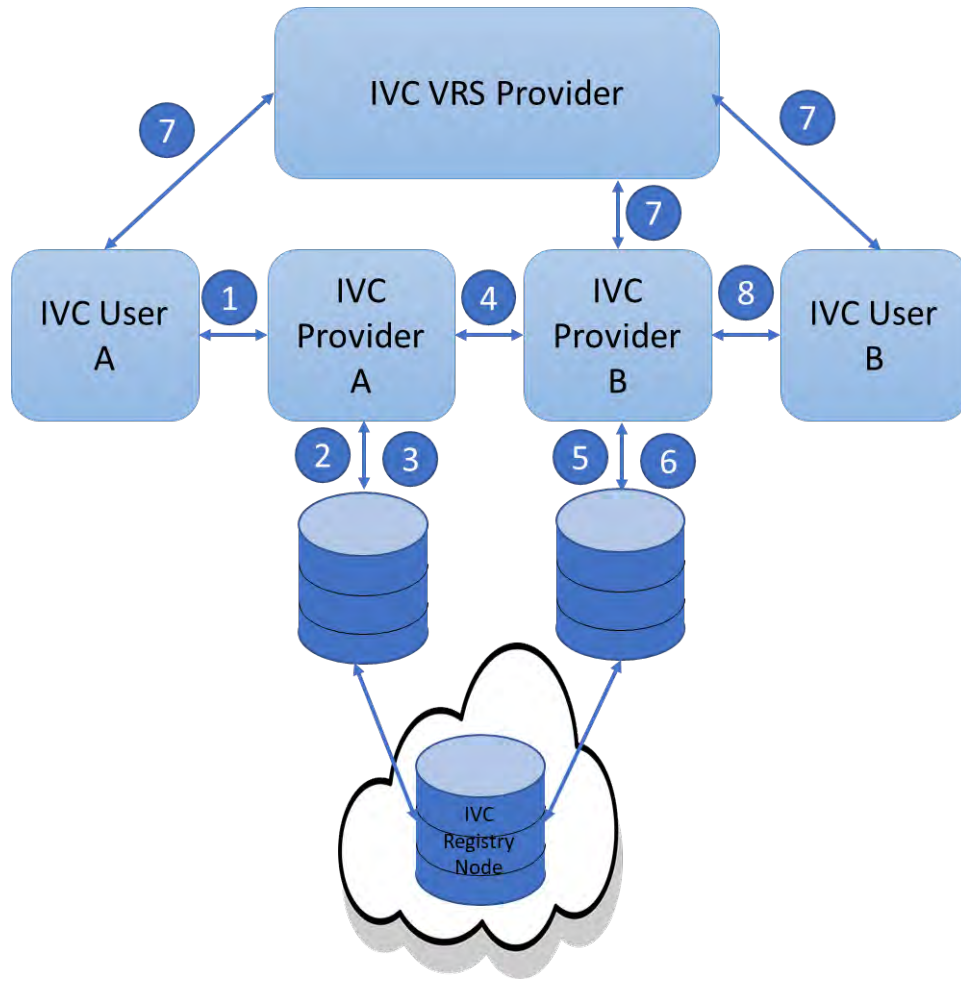


Figure 6: IVC User to IVC Video Call with Interpreter – Interpreter add model

9.6.2. Interpreter Inline Model

In the Interpreter Inline model, the call flow is as follows:

1. IVC User A initiates a video call to IVC User B's telephone number. IVC User B is an IVC TRS User. IVC Provider A performs a destination lookup in their local IVC database replica.
The IVC database replica returns information that Provider A uses to determine:
 - a. That one of IVC User A or IVC User B is eligible for TRS. If one User is eligible for VRS, then VRS may be needed. If both or neither user is eligible for VRS then VRS is not allowed. Then desirability is determined by signaling from IVC User A and static information for IVC User A known by IVC Provider A. If TRS is not to be used then IVC Provider A falls back to use case 9.1, IVC User to IVC Video Call.
2. IVC Provider A routes the call to the VRS Provider
3. IVC Provider A routes the call to the VRS Provider
4. The VRS Provider performs a destination lookup in their local IVC database replica.
5. The IVC database replica returns information that VRS Provider uses to confirm that either IVC User A or IVC User B is eligible for TRS
6. VRS Provider engages its bridge and routes the call to IVC Provider B
7. IVC Provider B receives the call

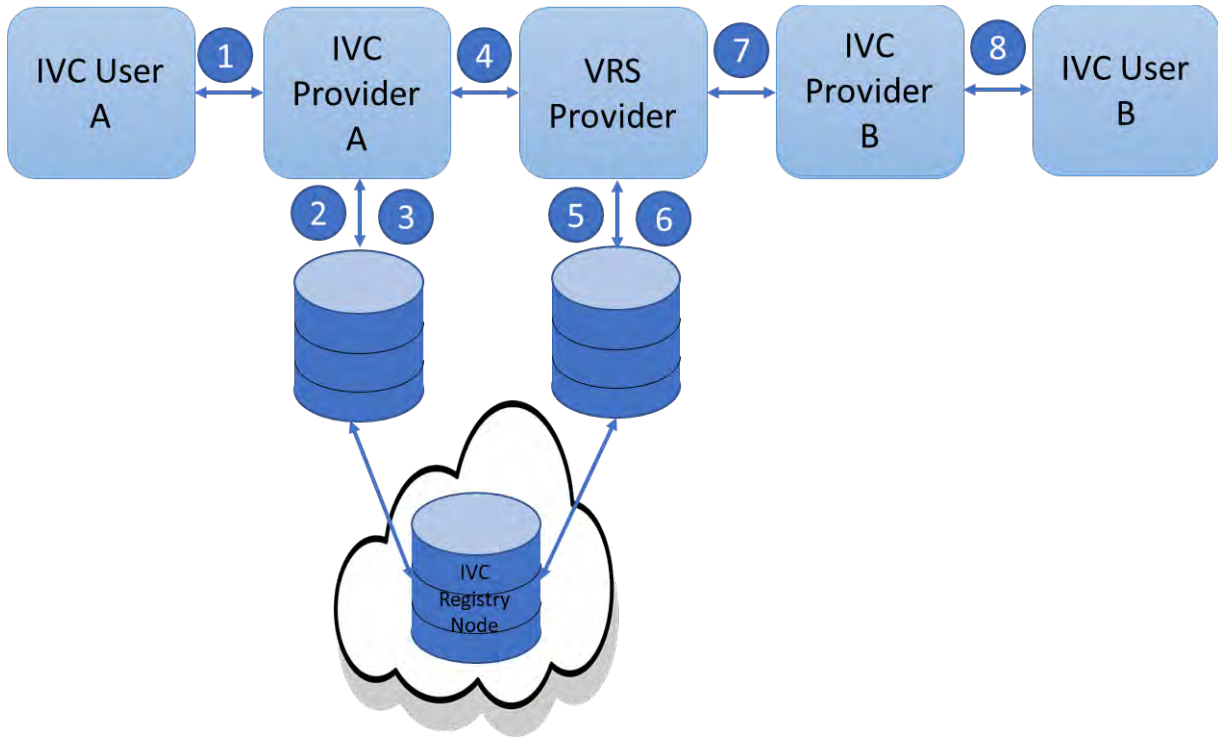


Figure 7: IVC User to IVC Video Call with Interpreter – Interpreter Inline Model

9.7. Use Case: VRS User to 9-1-1 (PSAP) Video Call with VRS CA (Interpreter)

Unlike the IVC user to IVC user with VRS CA model, for a call involving a PSAP we propose sending calls directly from the IVC Provider to a “IVC PSAP Provider” which would be the i3 “Emergency Services Routing Proxy”. In these models, 9-1-1 calls from users requiring Communication Assistants (CAs) or other assistive technologies would be direct; CAs would be added as needed by the PSAP.

How VRS and IVC works with 9-1-1 depends on if the PSAP that will get the call has been upgraded to Next Generation 9-1-1 (NG9-1-1). NG9-1-1 supports video and supports three-way (and sometimes additional) parties using its bridge. NG9-1-1 uses SIP based signaling and so can, with minor modifications, support IVC calling. E9-1-1 is audio only and uses a specialized service provider, a “VoIP Positioning Center” (VPC). This use case shows the NG9-1-1 flow.

This differs from proposals to change the choice of VRS CA from the user’s default choice to the choice of the PSAP. This proposal would use the existing default VRS Service, which changes i3 signaling somewhat and would need to be accommodated in NENA STA-010.4. This proposal also implies that IVC Providers would support calls to 9-1-1 for all callers, not just callers needing CAs. In this case, IVC Providers would need access to location for all callers, which may be considered an undue burden by prospective IVC Providers.

The mechanism allowing CAs to be added as needed by the PSAP can be used to invoke VRS and can support invoking independent Media Communication Line Services (MCLS) centers in the same manner as proposed by the Emergency Access Advisory Committee.

The working group was asked to “Evaluate the technical and operational feasibility of interoperating with Telecommunications Relay Services to ensure that persons with disabilities can connect directly to Public Safety Answering Point telecommunicators”. Both models presented in this section meet this requirement, with trade-offs. The following use cases focus on Video Relay Services, but the database design presented in Section 5, Distributed Database Requirements, applies equally well to captioning, teletypewriter (TTY), real-time text (RTT), and speech to speech relaying

In this use case, both models are the same:

1. IVC User A is an IVC TRS User and initiates a video call to 9-1-1
2. IVC Provider A’s location server queries the location of IVC User A.
3. The location server returns location data from the end device or registered location
4. IVC Provider A queries the ECRF with the IVC User A’s location data to obtain the PSAP route
5. IVC Provider A performs a destination lookup in their local IVC database replica.

6. The IVC database replica returns information that the IVC Provider uses to:
 - a. Identify that the phone number is associated with the PSAP (PSAP is video capable); if PSAP is not video capable, fall back to audio-only call
 - b. Determines the PSAP URI
7. The IVC Provider routes call to PSAP IVC Provider with location included
8. The PSAP IVC Provider routes the call to the PSAP using the included location
9. The PSAP IVC Provider performs a destination lookup in their local IVC database replica.
10. The IVC database replica returns information that the PSAP IVC Provider uses to determines that IVC User is eligible for VRS
11. The IVC Provider adds the VRS Provider into the call.

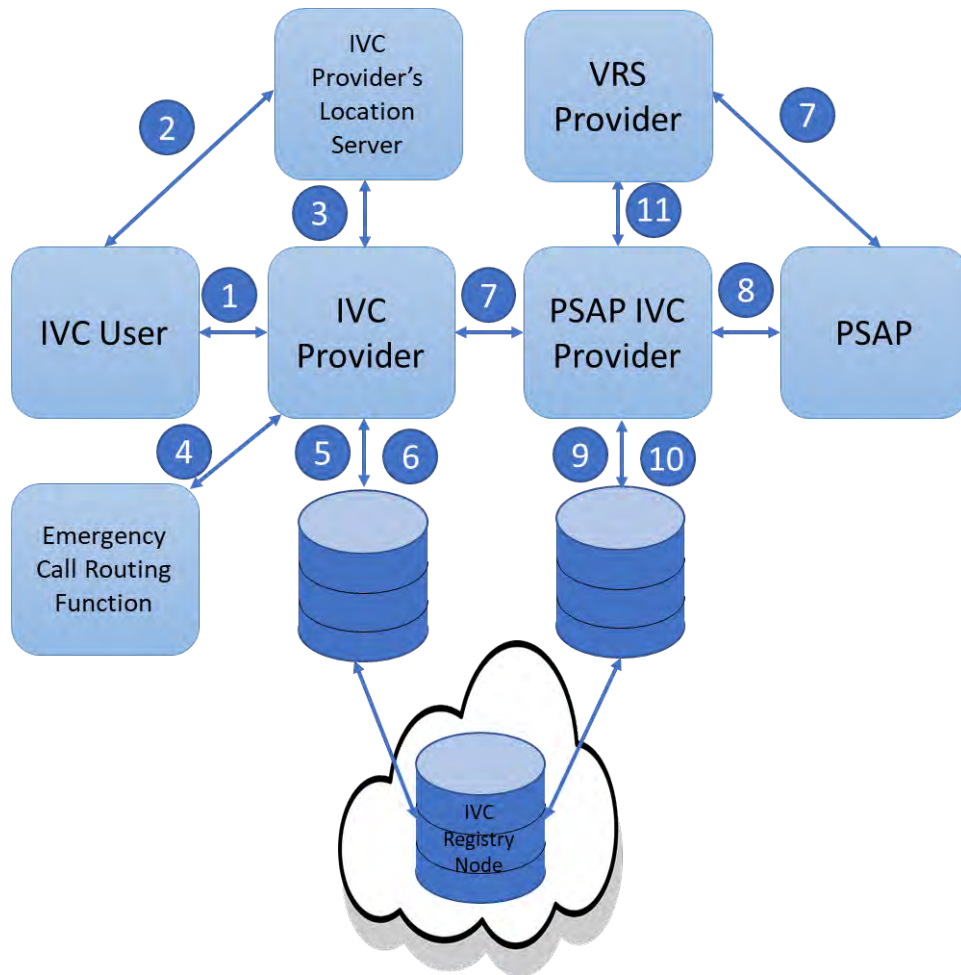


Figure 8: VRS User to 9-1-1 Call with Interpreter – Dial-Around Model

9.8.Use Case: 9-1-1 (PSAP) Video Callback to VRS User with VRS CA (Interpreter)

This use case combines the VRS User to IVC Video Call with VRS CA (Interpreter) with 9-1-1 (PSAP) Video Callback, and unlike the IVC user to IVC user with VRS CA model, for a call involving a PSAP the working group proposes sending calls directly from the IVC PSAP Provider to the IVC Provider. In these models CAs would be added as needed by the PSAP

9.8.1.Interpreter Add Model

In Interpreter Add model, the call flow is as follows:

1. The PSAP initiates a video call the VRS User's telephone number
2. The PSAP IVC Provider performs a destination lookup in their local IVC database replica.
3. The IVC database replica returns information that the PSAP IVC Provider uses to:
 - a. Determine the VRS user is IVC capable. If the VRS User is not IVC capable, the PSAP IVC Provider uses existing capability to return the call.
 - b. Determines that the VRS User is eligible for TRS, therefore is an IVC VRS User. If not, the PSAP Provider falls back to use case 9.5, *9-1-1 (PSAP) Video Callback to IVC User*.
4. The PSAP Provider Routes call to IVC Provider and adds the VRS Provider
5. The IVC VRS User receives the call

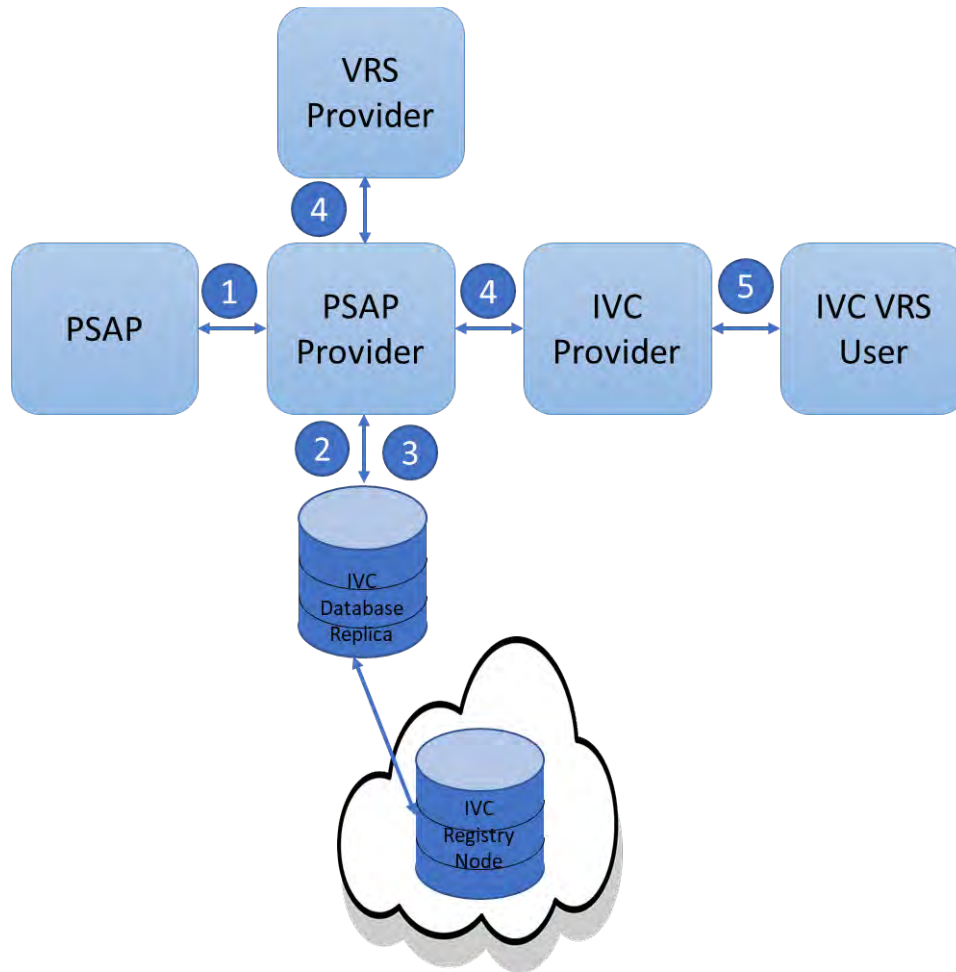


Figure 7: 9-1-1 callback to VRS user with Interpreter – Interpreter Add Model

9.8.2. Interpreter Inline Model

In the Interpreter Inline model, the call flow is identical to use case 9.6; *IVC User to IVC Video Call with VRS CA (Interpreter)*, except the call originates from a PSAP instead of IVC User A. While the VRS Provider and the IVC Provider roles are identified separately in this use case, both roles may be fulfilled by the VRS Provider if the VRS Provider offers to be an IVC Provider and a user chooses their default VRS Provider as their IVC Provider.

In the Interpreter Inline model, the call flow is as follows:

1. The PSAP initiates a video call the VRS User's telephone number
2. The PSAP IVC Provider performs a destination lookup in their local IVC database replica.
3. The IVC database replica returns information that the PSAP IVC Provider uses to:
 - a. Determine the VRS User is IVC capable. If the VRS User is not IVC capable, the PSAP IVC Provider uses existing capability to return the call.

- b. Determines that the VRS User is eligible for TRS, therefore is an IVC VRS User.
If not, the PSAP Provider falls back to use case 9.5, 9-1-1 (PSAP) Video Callback to IVC User.
4. The PSAP Provider routes call to the VRS Provider
5. The VRS Provider performs a destination lookup in their local IVC database replica.
6. The IVC database replica returns information that VRS Provider uses to:
 - a. Identify that the phone number is associated with an IVC user (IVC user B is video capable); if the IVC User is not video capable, fall back to an audio-only call
 - b. Determine the current IVC User URI
 - c. Confirm that the IVC User is eligible for VRS
7. The VRS Provider Routes the call to the IVC Provider
8. The IVC User receives the call

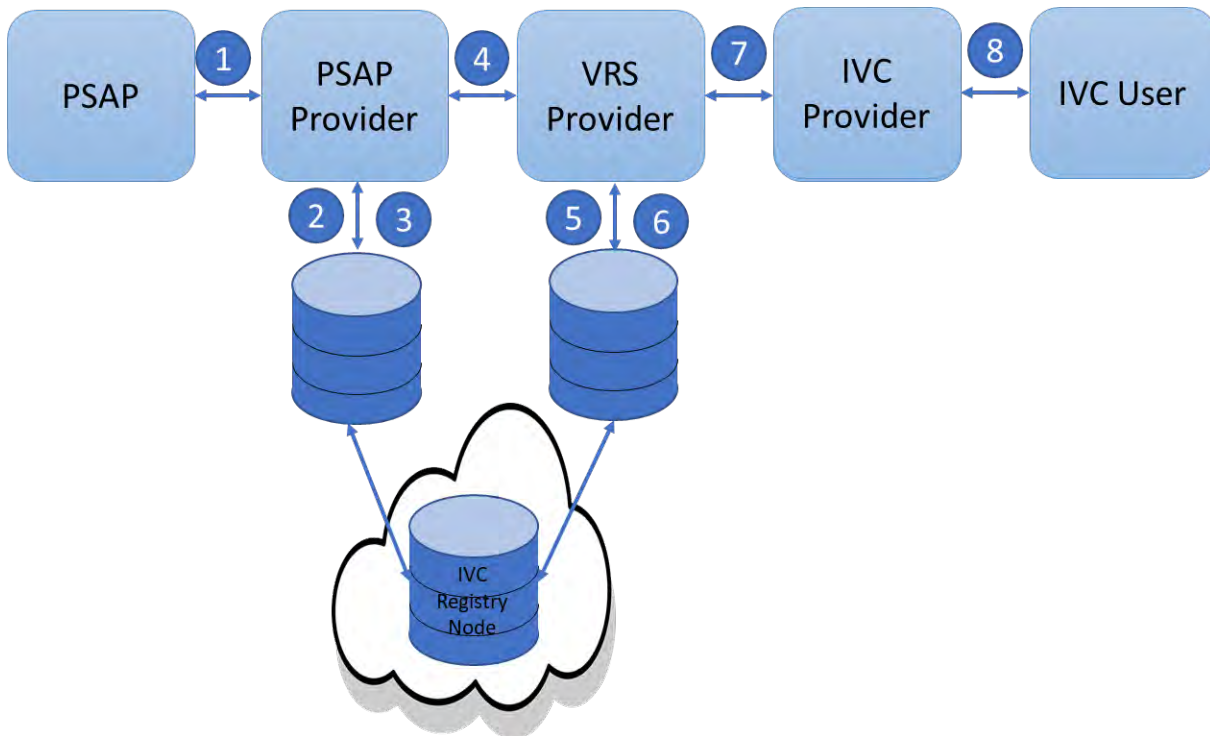


Figure 7: 9-1-1 (PSAP) Video Callback to VRS user

9.9. Other Use Cases

The use cases above are examples of how the proposed database model can effectively accommodate a variety of common and important use cases. The working group discussed several other use cases and believes that the proposed database model can also accommodate these cases. A non-exhaustive list of these use cases is shown below.

9.9.1. Other Relay Services

The use cases above address calls without relay services and calls using VRS. Other relay services can also be accommodated using the database model discussed in Section 6. Examples include:

- Captioned calls
- Speech to Speech relay services
- Video Relay Services
- TTY/TDD relay services
- Relay services to PSTN from IVC

There are many use cases for one user using one of these services or one user of a service calling another user of the same or different service (for example, a VRS User calling an IPCTS user). While the working group has not provided detailed call flows for each of these use cases, the database model provides the information required by IVC Operators to manage these calls successfully.

9.9.2. Roaming and International Calls

The working group did not address roaming (a user with a U.S. phone number and service travels outside of the U.S.) or international calls (a caller from outside of the U.S. is the sender or recipient of an IVC call). The database model proposed by the working group can accommodate these calls, but there are regulatory and administrative concerns that are beyond the scope of this working group. For example:

- In general, (there are exceptions), relay calls that originate outside of the U.S. are not compensable by the FCC. TRS Providers have mechanisms to identify these calls. IVC provides may need to make these determinations or supply information to the TRS Provider to support these determinations, but this information would not reside in the database.
- In the proposed database model, only information about users with numbers administered by the NANC would be included in the database. Without some additional mechanism all international calls will be identified as non-IVC calls and handled according to use case 9.2, IVC user to PSTN (no IVC capability)

Appendix A: Interoperable Video Calling Working Group Members

* Indicates a member organization of the North American Numbering Council. Each voting organization, member or otherwise, receives one vote

Co-Chair:

National Association for State Relay Administration

David Bahar, Director, Telecommunications Access of Maryland, Maryland Department of Information Technology

Co-Chair:

Comcast Corporation*

Chris Wendt, Director of Technical R&D for Comcast IP Communications Platforms

Members:

Apple

Maria Kirby, Senior Policy Counsel

AT&T Services, Inc.*

Martin Dolly, Lead Member of Technical Staff

Alternate: Aaron Bangor, Director Accessibility Solutions Engineer

Charter Communications, Inc.*

Glenn Clepper, Director, Regulatory

City of Los Angeles, Department of Disability

Richard Ray, ADA Technology Access Coordinator

Convo Communications, LLC

Kelley Duran, Lead Platform Engineer

CSDVRS (d/b/a ZVRS) and Purple Communications, Inc.

John Martin, Consultant

CTIA*

Matt Gerst, Vice President, Regulatory Affairs

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*National Association of Regulatory Utility Commissioners**

The Honorable Karen Charles Peterson, Commissioner, Massachusetts Department of Telecommunications and Cable

*Google Inc.**

Justin Uberti, Director

Alternate: Alex Wiesen, Engineering Lead

Sorenson Communications, LLC

Isaac Roach, Vice-President of Engineering

*Sprint Corporation**

Shaunna Forshee, Network Number Management

Alternate: Karen Riepenkroger, Network Program/Project Manager

Telnyx, Inc.

Ramon Torres, Senior Telephony Engineer

Non-Voting Members:

*iconectiv, LLC**

Natalie McNamer, Industry Relations Manager

*Somos, Inc.**

Mary Retka, VP for Industry Relations and Public Policy

Justen Davis, Senior Director for Industry Relations and Public Policy

Technical Advisor:

MITRE Corporation

Yin Bao, Lead Software Systems Engineer

Jim Malloy, Principal Information Technology Engineer

Brian Rosen, Consultant

Shareef Ali, Software Engineer, Rochester Institute of Technology/National Technical Institute for the Deaf

Appendix B: Glossary

Term	Definition
ATIS ESIF	Alliance for Telecommunications Industry Solutions Emergency Services Interconnection Forum
ATIS IP NNI	Alliance for Telecommunications Industry Solutions Internet Protocol Network-to-Network Interface Task Force
BIRRDS	Business Integrated Routing and Rating Database System
CA	Communication Assistant
CTS	Captioned Telephone Service
EAAC	Emergency Access Advisory Committee
ESRP	Emergency Services Routing Proxy
FCC	Federal Communications Commission
IETF	Internet Engineering Task Force
IP	Internet Protocol
IP CTS	IP Captioned Telephone Service
iTRS Directory	Internet-based Telecommunications Relay Services Directory
IVC	Interoperable Video Calling
IVC-GA	IVC Governance Authority
IVC-PA	IVC Policy Administrator
IVC WG	Interoperable Video Calling Working Group
LIS	Location Information Server

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Term	Definition
MCLS	Media Communication Line Services
NANC	North American Numbering Council
NANPA	North American Numbering Plan Administrator
NANP PA	NANP Pooling Administrator
NECA	National Exchange Carrier Association
NG9-1-1	Next Generation 911
NPAC	Number Portability Administration Center
OCIF	Outgoing Call Interface Function
OCN	Operating Company Number
OTT	Over-The-Top
PSAP	Public-Safety Answering Point
PSTN	Public Switched Telephone Network
SPC	Service Provider Code
RTT	Real Time Text
SME	Subject Matter Expert
TFNA	Toll Free Number Administrator
TN/TFN	10-digit telephone number assigned by NANPA/PA or Toll-Free Numbers assigned by the Toll-Free Number Administrator
TPS	Transactions per Second
TRS	Telecommunications Relay Service

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Term	Definition
TRS-URD	Telecommunications Relay Service - User Registration Database
TSP	Telephone Service provider
TTY	Teletypewriter
URI	Uniform Resource Identifier
ViLTE	Video Over LTE
VPC	VoIP Positioning Center
VRS	Video Relay Service
WG	Working Group