

# Carrier Registrations in User ENUM (CRUE)

## Introduction

Production of this document was initiated by members of the UK ENUM Group (UKEG) at the end of 2005. It has undergone substantial revision following discussion by UKEG and consultation with other interested parties. The proposal put forward in this document, CRUE, suggests a simple way to bulk populate the UK ENUM tree under the 4.4.e164.arpa domain. The document has now been passed from UKEG to the UK ENUM Consortium Ltd (UKEC) for publication.

## 1. Overview

A proposal for a new type of registration within the UK ENUM tree, called Carrier Registrations in User ENUM (CRUE) is described in this document. This registration is performed by a Communications Service Provider (CSP) — typically a telephony company — directly with the registry. The registry in turn enters each domain into the zone with a small set of predetermined NAPTR records.

The UK regulator, Ofcom, currently uses the term “Communications Service Provider” (CSP) to define an entity that provides communications services in the UK using E.164 numbers. These are typically a traditional telephone company or a new entrant to the market offering internet-based telephony service. This document follows the Ofcom definition.

CRUE is intended to protect legal and regulatory considerations on privacy, data protection and competition policy. It is also designed to be compatible with the already established mechanisms and business practices in the telephony/CSP environment to protect confidentiality.

Finally, CRUE is not meant to just be a pump-primer or stop-gap bootstrapping mechanism but as a permanent feature of the UK ENUM system.

### 1.1. Why CRUE Is Needed

The uptake of ENUM in the UK is hampered by an almost intractable chicken-and-egg problem. The public 4.4.e164.arpa tree is very sparsely populated. For a variety of reasons there are few registrations. This in turn means there is little incentive to roll out services and applications that do ENUM lookups. In almost all cases those lookups would not return useful data. With few applications and services, there is no encouragement for users and organisations to register their phone numbers and get the corresponding domain names delegated.

An additional complication is the somewhat heavyweight requirement for authentication and validation of UK ENUM delegations for end-users. This adds to the costs and overheads for those participating in ENUM. Since the number of registrations is low, the business case for developing on-line authentication and validation schemes is poor.

CRUE proposes a method of breaking this log-jam. It suggests a way of adding significant amounts of data to the public ENUM tree. That would create value for some CSPs who would then be able to deploy ENUM-aware software which could exploit that data. This would increase the visibility of ENUM and further encourage the uptake of ENUM in the UK. If implemented properly, this scheme could evolve into a ubiquitous, commercial ENUM system in the UK.

## 1.2. Consequences Of Not Deploying CRUE

The danger is that unless a scheme can be provided via the official public ENUM tree, telephone companies and other CSPs may well develop their own solutions for this problem. These could include ad-hoc naming schemes which fragment the market, create user confusion and make interworking impractical. To some extent the uptake of Skype — admittedly not based around E.164 numbers — indicates the potential for alternative and proprietary schemes to gain wide acceptance. A further danger is that these ad-hoc naming schemes could be deployed by organisations that don't care about the UK regulatory principles such as opt-in, data protection and privacy; competition policy; complaint handling; dispute resolution and so on. They may well be operating outside UK jurisdiction beyond the reach of the regulator.

## 1.3. Objective Of CRUE

It should of course be understood that the purpose of CRUE is to stimulate ENUM in the UK by populating `4.4.e164.arpa`. Rather than construct a general-purpose scheme that could work for any potential number, initial efforts have been concentrated on a scheme that has a narrow focus and a clear objective. If that can be demonstrated to work successfully, CRUE could then be extended to deal with “corner cases” that would otherwise be too difficult to solve from the outset.

In principle this scheme can be applied to any valid UK telephone number. However some parts of the number space may present problems. These could include premium-rate, non-geographic and free phone numbers because they are probably not allocated on a block basis by Ofcom to CSPs. If these numbers are not in the Ofcom database it may be difficult to validate which CSP uses them “*for the purpose of service provision*”. Alternative solutions could be deployed for these numbers. For instance, a participating CSP might provide some other means of proving that they provide service for say, premium-rate numbers.

## 2. Proposed Implementation

### 2.1. Registering For Participation

Any CSP that wishes to participate in CRUE needs to register with the registry first. This is either so that they can register numbers, or so that they can provide their contact details in order to be notified about any registration requests that appear to concern a block that has been allocated to them. See Section 2.3 for further details.

This registration also allows for the creation of a secure channel so that future communication between the CSP and the registry can be authenticated easily. In other words, it can be verified that requests have actually come from the CSP and that responses are securely delivered back.

### 2.2. Registering The Numbers

A participating CSP can register any number that is either:

- taken from those allocated to them by Ofcom;
- or from a sub-allocation made to them from another CSP;
- or a number that has been ported to them from another CSP.

This registration specifies the first and last numbers and an IP endpoint type (explained in Section 2.4), plus any excluded numbers (explained in Section 2.7), or by specifying individual numbers.

## **2.3. Registry Authentication**

For each number in the registration, the registry needs to follow an authentication process to see if the CSP can make the registration. In principle this means checking this against the public Ofcom database, which shows which ranges have been allocated to specific CSPs (the range holder).

Four potential registration scenarios have been identified and are explained below:

### **2.3.1. Registration by the range holder**

If the CSP making the request is the range holder for that number block, no further authentication takes place. The registry then provisions NAPTR records as described in Section 2.4 provided no user ENUM registration exists in the requested number range. Where a user ENUM registration does exist, no change will be made to the zone file for that number for the duration of the user ENUM registration.

### **2.3.2. Registration by third party but range holder has pre-notified registry**

Range holders may supply the registry, potentially in private, with details of the ranges that they have sub-allocated and whom. If a CRUE request is received for one of these ranges by the CSP to whom it is sub-allocated, then it is automatically authenticated.

### **2.3.3. Registration by third party but range holder has not pre-notified registry**

If the CSP making the request is not the same as the range holder, then the registry contacts the latter and gives them an opportunity to object to the registration. If this CSP has registered with the registry then the contact details are already known. If not then the contact is made via whatever public details can be found. The initial mechanism is likely to be an automated email system, though a more sophisticated solution may emerge over time.

The range holder then has a fixed time within which they can object to the registration request, after which this number is authenticated if there has been no response from the range holder.

### **2.3.4. Registration by third party but carrier registration already exists**

If there is already a carrier registration for this number then the range holder is not contacted and authentication for this number automatically fails.

There is the possibility that this fails when the number has been ported and the original range holder has not yet withdrawn the registration. In that case the failure needs to be pursued in the manner in which any problem with number portability might be handled, possibly leading to an official complaint to Ofcom.

## **2.4. Registry Creates DNS Entries**

Assuming the checks are successful, the registry will create two NAPTR records for each number, excluding exceptions. It does not delegate any number in the registration request to the CSP.

One of these NAPTR records will point to a `tel:` URI containing the corresponding number. In DNS terms, the zone file would resemble:

```
0.0.0.1.2.3.4 NAPTR "tel: +444321000"
1.0.0.1.2.3.4 NAPTR "tel: +444321001"
      . . . .
9.9.9.1.2.3.4 NAPTR "tel: +444321999"
```

The purpose of these `tel:` NAPTRs is to indicate to ENUM-aware applications how each number can be reached from the PSTN: i.e. which number the application should dial. This gives an ENUM-aware application a way to terminate a call on the PSTN when it is unable to use the second NAPTR record.

The second NAPTR record would contain a URI for the specific type of endpoint chosen. For example if SIP were chosen (rather than H.323, SMS or MMS) then unique NAPTR records would be created for each domain which identifies the SIP gateway or proxy that the CSP has provided for that number range. The DNS zone file entries would resemble:

```
0.0.0.1.2.3.4 NAPTR "sip: +444321000@sip-box.telco.net"
1.0.0.1.2.3.4 NAPTR "sip: +444321001@sip-box.telco.net"
      . . . .
9.9.9.1.2.3.4 NAPTR "sip: +444321999@sip-box.telco.net"
```

Please note that the syntax of both sets of NAPTRs is incorrect but sufficiently illustrative for this proposal. The numbers shown above are not complete UK E.164 numbers and for the `sip:` URIs a regular expression would more than likely be used. The object is to outline how the scheme would be implemented without confusing non-experts.

## 2.5. Single Versus Multiple Registrations

All the numbers in a single CRUE request will be treated identically by the registry. It will not be acceptable for one number to just have one NAPTR record or for a `sip:` URI to point at a different SIP server from the other numbers in the request. If that effect is intended then the CSP will need to make individual registrations for each number or set of numbers that need a differing NAPTR.

At first glance it may appear that a CSP could just make a series of individual registrations for each number, thereby getting a discrete set of NAPTR records for each number. However it is very likely that registry pricing will include two components, one for the registration and one for the quantity of numbers per registration. This should provide enough incentive for CSPs to minimise the number of discrete CRUE requests.

## 2.6. Time To Live Considerations

Within DNS each resource record has a TTL (Time To Live) value. The TTL tells a DNS client how long it can cache the data in an answer to a query before having to issue a new query to see if the data has changed. [In practice most clients re-request long before the TTL has expired.] This TTL value is essentially a promise from the DNS that the underlying data will not change until at least the TTL expiration has been reached.

With CRUE, all NAPTR entries from all CSPs will be given the same TTL and the CSP will not be able to change them. The assigned TTL value will be chosen to conform to the timescales given in the Section 18 number portability rules. This ensures that a correctly implemented client does not retain stale DNS data beyond the point where a number port should have been completed.

Similar considerations apply to the negative caching times set by the registry: the TTL returned in a "number does not exist" response from the DNS.

## 2.7. Excluded Numbers

A CSP can specify an arbitrary number of excluded numbers, if registering a range, or not register whatever numbers they wish. This information can be changed throughout the lifetime of the registration. How this is managed is to be decided later. The reasons for excluding a number are not specified and there is no requirement to disclose why any number has been excluded. However there is a requirement for a CSP participating in CRUE to exclude a number that has been ported to another CSP.

CSPs may choose to exclude numbers that are not in service from a CRUE registration. Since including all numbers is not a requirement of these registrations, all that should be inferred from the absence of these numbers from the DNS is that the CSP has chosen not to publish any information about them. This approach could be abused for anti-competitive practices such as slamming or customer lock-in. However these could be addressed through a code of conduct as well as existing regulatory mechanisms.

To be clear, when a number is excluded from a CRUE request it is removed entirely from ENUM, which means the corresponding domain name will be absent from the DNS. ENUM lookups for excluded or removed numbers would not return any NAPTR records at all. The response from the DNS on looking up an excluded number would be the equivalent of saying the domain name that represents the number did not exist. It does not follow from such a response that the number is not in service or has been ported or whatever. All that can be inferred is that the number has not been entered into the public ENUM system.

It could be argued that there is no need for excluded numbers given that a carrier could register the surrounding numbers in discrete CRUE registrations. However, as explained in Section 2.5 that would probably entail an additional cost incurred by the CSP. It would also mean that if a CSP was the donor for a ported number then they would need to create new registrations, rather than just indicate that the ported number was now an excluded number.

## 2.8. Interaction With End User Delegations

When an end user opts-in and takes control of their own ENUM delegation then their registration takes precedence within the registry. In this case the NAPTR records for the user-controlled numbers would be removed and replaced with the NS records specified by the user to make a full delegation. The end user will then be responsible for the delegated zone for that number, including the management of the zone's contents and provision of DNS service for that zone. CSPs could of course offer these facilities as value-added services.

In the event that the user-controlled registration lapses, whether it is because they no longer require it or because they cease that service, then the delegation is withdrawn and replaced with the carrier registration details. In other words the NS records are then removed and replaced with the appropriate NAPTR records for that carrier registration. The mechanism by which the end-user registration lapses, is an ordinary feature of UK ENUM and not specific to CRUE.

## 3. Further Considerations

### 3.1. Number Portability

CRUE mirrors as closely as possible the agreements concerning number portability in the existing voice market. Where there are portability agreements, such as for PATS, then there are procedures here that attempt to mirror those. When there are no portability agreements then there are no procedures here. CRUE cannot be the place to start a number port. It must be initiated through the normal processes first and then reflected in CRUE.

All ported numbers must be excluded from any registration made by the donor CSP. If a number is already registered and then ported then it must be de-registered.

As described in Section 2.3.2 there is a mechanism to send the donor CSP a notification that numbers in their block are being registered by someone else and a chance given for them to object. If any mistake is made then it is assumed that this would be dealt with by the current contracts between carriers governing number portability.

There are two technical features of CRUE that support number portability. The first is the choice of TTLs for the DNS records, which is documented in Section 2.6. The second is that the `tel:` URI is always the number in the registration. Simply falling back to the conventional phone network should always work, no matter to whom the number is ported, because call delivery would just trombone through the CSP infrastructure as all PSTN calls to ported numbers do now. In fact if a number is ported between two CSPs, both of whom use CRUE then the `tel:` URI will not change as a result of that move.

One subtle issue about privacy and number portability is explained in Section 3.2.2.

## 3.2. Data Privacy

### 3.2.1. Personal Data

This proposal has been specifically designed in such a way that it does not allow any personal data to be exposed. The registry is not implementing a delegation, just two NAPTR records, which are only technical in nature.

As a result there is no requirement for the CSP to seek any permission from the end user for their number to be included in CRUE. No possible information about the number other than the CSP who makes the carrier registration can be inferred. This information is already publicly available from Ofcom and so this proposal does not introduce any changes to the privacy model for either ENUM or telephone systems.

### 3.2.2. Carrier Identification In NAPTR

Ofcom have indicated one area of concern that will need to be addressed by CSPs intending to use CRUE. Currently it is not possible to determine by simple examination of a database whether a number has been ported and to whom it has been ported. With CRUE, it may be possible to obtain this information by use of DNS lookups and cross-referencing those results with the details on IP address allocation held by Regional Internet Registries.

Ofcom are clear that it is not practical to completely prevent such information exposure, but that suitable measures must be put into place to ensure that it is not trivial. They have therefore concentrated on the name of the server given in the `sip:` URI. If the identity of the operating CSP is immediately obvious from reading the name of the SIP server (e.g. `sip1234.british-telecom.com`) then this is not acceptable. If it is not obvious (e.g. `sip1234.obfuscated-csp.co.uk`) then this is acceptable.

## 3.3. Number Not In Service

Standard techniques exist for PSTN calls where the number is not in service. For calls to IP endpoints where the number is not in service, a CSP servicing a given carrier registration is at liberty to take a number of different actions. For instance they could decide to de-register the number. Or they could configure the SIP server handling requests for that registration to reject the call or redirect it to some suitable end-point. Whatever choice was made would be at the discretion of the CSP responsible for that number.

## 3.4. CSP Infrastructure Architecture Exposure

The names and addresses of the access points and border IP gateways of CSPs would be made public if this proposal is implemented. That information tends not to be generally available. Those details could be exploited to deduce information about the CSP's network.

For instance SIP traffic to some number range is routed to servers at a specific internet exchange. This may be commercially sensitive.

### **3.5. Fit With The DTI Consultation**

The DTI consultation stated that no number would be entered into ENUM without the permission of the end user, which this proposal appears to contradict. However the purpose of that statement in the consultation was to prevent personal information from being published without the consent of the end user. As this proposal explicitly ensures that purpose, there is no contradiction. A more specific wording in the consultation document would have made this easier to explain.

The second point is that this proposal is very clear that an end user who registers their number themselves immediately takes precedence over the carrier registration. This preserves the end user control of their delegation that the consultation document specifies.

### **3.6. Routing Choices**

An open issue with CRUE is how an ENUM-aware application makes a routing decision. Without these registrations then in some circumstances it might be expected that the decision would be to use carrier ENUM, unless a user ENUM entry exists, in which case that is used. i.e. A decision based on the view that the user ENUM tree has priority. However with CRUE one can no longer assume that the information in the user ENUM tree was actually put there by an end user.

### **3.7. Conditions Of Use**

To ensure fairness and protect all parties the use of CRUE by CSPs and the registry comes with some conditions of use. These will be imposed through the registry contract and appropriate codes of conduct. Although detailed descriptions of these conditions of use are not appropriate for this document, the general principle is that CRUE is provided for the specific purpose as described here.

Infractions of the contract, such as claiming ported numbers when they have not been ported may lead to withdrawal of this service from a carrier and possible referral to UKEC for further action, such as the withdrawal of ENUM accreditation. The specific details of what is dealt with by the registry and what is dealt with by UKEC are for later determination.

Consideration may also need to be given to an explicit code of conduct on SIP peering policies, for example if CSPs publish sip: URIs that are unfair or anti-competitive because the SIP server has been configured to advantage one CSP over another.

### **3.8. CSP Control**

Carrier registrations are not entered into the public DNS without the express consent of the CSP who has been allocated that block by Ofcom.

A CSP will be able to change all of the NAPTR records in a carrier registration that has been allocated to them and entered into the ENUM system. Such changes would apply to all of the numbers in the carrier registration, except for delegated or excluded numbers of course. It is likely that changes like this could be possible for operational reasons such as transferring a range of numbers from one SIP server to another.

However if the CSP uses a prudent naming system, they would be able to effect these changes without any reference to the registry at all. The names and IP addresses of a CSP's SIP servers could be in domain(s) controlled by that CSP. Traffic to a given SIP server could be redirected simply by changing the relevant DNS resource records in those domains. In other words, the names for any SIP servers that were provided at registration time are

aliases for the actual names (or addresses) of those SIP servers.

#### **4. Why CRUE Is Not Infrastructure ENUM**

It may appear that this scheme resembles Infrastructure or Carrier ENUM, for some definitions of these terms. That is not the case. The following reasons explain why that is so.

- (1) The data is entered into the public ENUM tree of 4.4.e164.arpa on the Internet, not in a different tree designated for use for Carrier ENUM. Therefore CRUE does not replace Carrier ENUM and a CSP may still need to participate in Carrier ENUM.
- (2) Participating CSPs will have limited control over the DNS data for these carrier registrations. In a CRUE request, no delegations are made. Each number in the request will be given 2 NAPTR records by the registry. When the number gets assigned to an end user, that user will be given the option to get the corresponding domain name delegated to them. In those circumstances, the end user will decide which name servers the zone is delegated to and what content is entered into that zone. They may of course choose to have this provided by the CSP, say as part of a value-added service offering.
- (3) The public DNS infrastructure used will be under the control of the registry. They will determine operating requirements such as name server placement, service level agreements, selection of bandwidth providers, peering and transit policies, hardware and software, name server configuration, security and change management policies and so on. These may well be completely different from those that a CSP would use for telephony operations inside its own network. A participating CSP would be able to influence these registry decisions but not decide them. Each CSP participating in CRUE would need to determine if the operating environment was adequate for their needs and the expectations of their customers.
- (4) The data about a participating CSP's SIP gateways will be public. For security and operational reasons, most CSPs choose not publish details of their interconnect points and network topology. They may not even disclose this to other CSPs.

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### **6. Conclusion**

This proposal aims to provide a mechanism for large scale ENUM registrations to take place. A great deal of effort has been spent trying to meet the concerns that CSPs might have about confidentiality and the impact of CRUE on their existing business practices. Some policy issues remain open — notably on Codes of Conduct — and further work may need to be done to extend CRUE into some of the more awkward parts of the national numbering plan. If concerns remain then feedback is sought on how to improve this proposal to overcome them.