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NICC Document

Report containing the options to support the verification of mobile roaming calls

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Foreword

This NICC Document (ND) has been produced by NICC Nuisance Call and CLI MNO Subgroup.

Introduction

A huge percentage of scam related calls using spoofed numbers come from non-UK networks and the measures to block calls using non-mobile numbers has driven the spoofers to use UK mobile numbers (i.e. CLIs beginning +447).

Ofcom has asked NICC to find a solution which will allow the inclusion of a blocking criteria for UK mobile CLIs to ND1447 [2]. Calls using spoofed UK mobile CLIs originating internationally cannot be blocked in the same manner as calls using spoofed UK geographic number, as this would prevent some legitimate calls from completing.

Due to the situation described above a sub-group of the NICC N&CLI group was set-up to investigate potential solutions. Participation was sought from UK MNOs, MVNOs with their own call control (otherwise known as ‘Thick’ MNVOs) and international gateway providers to determine the most suitable solution to block illegitimate inbound mobile calls.

It must be noted that once the global mobile network operator community evolves to 4G/5G IMS VoLTE roaming, all roaming calls will be Home Network Routed. Therefore, any near-term solution is seen to be temporary and needs to be quick and inexpensive to deploy.

1 Scope

This document is a report on the process and observations of the sub-group which assessed the various solutions presented to the sub-group on how to treat an internationally originating mobile call when received at a UK international gateway.

The sub-group agreed that the focus of the solution was UK mobile CLIs which are used for the delivery of mobile calls at an international gateway. Therefore, use cases of UK mobile CLIs which are not associated with a SIM and other innovative uses of SIMs, were considered to be out of scope, as they are not valid roaming numbers as stated in the Ofcom National Telephone Numbering Plan [1].

Following the presentations and discussion on each solution individual CP preferences were captured after evaluation which took into account issues including –

- costs
- ease of implementation
- complexity
- efficacy
- timescales
- implementation and recommendations in other countries

2 References

2.1 Normative references

[1] Ofcom National Telephone Numbering Plan

[2] ND1447 Guidance on blocking of inbound international calls with UK Network Number as CLI

3 Definitions and abbreviations

3.1 Definitions

Temporary Home Routeing Number: a temporary UK mobile number allocated from a pool of numbers belonging to the operator to which the call will route.

3.2 Abbreviations

2G	2nd Generation
3G	3rd Generation
4G	4th Generation
5G	5th Generation
API	Application Programming Interface
CAMEL	Customised Applications for Mobile network Enhanced Logic
CEPT	European Conference of Postal and Telecommunications
CLI	Calling Line Identity
CLIR	Calling Line Identity Restriction
CP	Communications Provider
DoS	Denial of Service
ENUM	Telephone Number Mapping
GDPR	EU General Data Protection Regulation
HNR	Home Network Routeing
HTTP	Hypertext Transfer Protocol
ID	Identity
IDP	Initial Detection Point
IMS	IP Multimedia Subsystem
IN	Intelligent Network
IP	Internet Protocol
MAP	Mobile Application Part
MNO	Mobile Network Operator
MNP	Mobile Number Portability
MVNO	Mobile Virtual Network Operator
N-CLI	Nuisance call and Calling Line Identity
SIM	Subscriber Identity Module
SIP	Session Initiation Protocol
SRI	Send Routeing Information
SS7	Signalling System No.7
THRN	Temporary Home Routeing Number
TSR	Telecoms Security Act
UK	United Kingdom
URL	Uniform Resource Locator
VoLTE	Voice over Long Term Evolution

4 The methodology adopted by the subgroup

Suspected scam/nuisance calls destined to terminate in the UK using UK CLIs primarily originate outside the UK. Measures have been put in place to curb the use of UK non-mobile CLIs and are proving effective. However, the ability for mobile users to take their mobile outside the UK and make calls (known as roaming) provides a loophole.

Bad actors are exploiting this by spoofing UK mobile CLIs when making their calls. To close this loophole, a solution is required that will attempt to identify genuine roaming UK users.

Consideration was given to the changing technologies in the mobile environment and that once networks have implemented VoLTE or 5G home routeing, then 'is roaming' checking solutions would no longer be required. However, solutions would be needed until all networks around the world have migrated to home routeing.

At the request of Ofcom NICC set up a N-CLI sub-group to explore possible solutions. This document summarises those solutions for the regulator's consideration.

The NICC N-CLI MNO sub-group was run under normal NICC rules. There was limited engagement from non-NICC member international gateway providers and very limited engagement from MVNOs.

The sub-group discussed how to ensure all the relevant stakeholders involved with the utilisation and delivery of international inbound calls with a UK mobile CLI could be involved in the group. International gateway operators and MVNOs were highlighted as two important groups of operators who should be represented.
Ofcom, on receipt of information from the MNOs engaged with various MVNOs and discussed attendance at the NICC sub-group. Despite this exercise, few MVNOs engaged.

Input only came from NICC members who attended the sub-group meetings, despite efforts to expand the participation. This sub-group met frequently to receive presentations from various sources with respect to potential solutions and discussed the characteristics and appropriateness of each solution. This process resulted in the evaluation the most appropriate solutions.

During the process, developments from other jurisdictions were noted, e.g. the CEPT recommendation 'Measures to handle incoming international voice calls with suspected spoofed national E.164 numbers'.

The sub-group received three presentations on solutions that were not considered to be viable for the UK market because they had limited application, were vendor specific or didn't meet all of the requirements. These were;

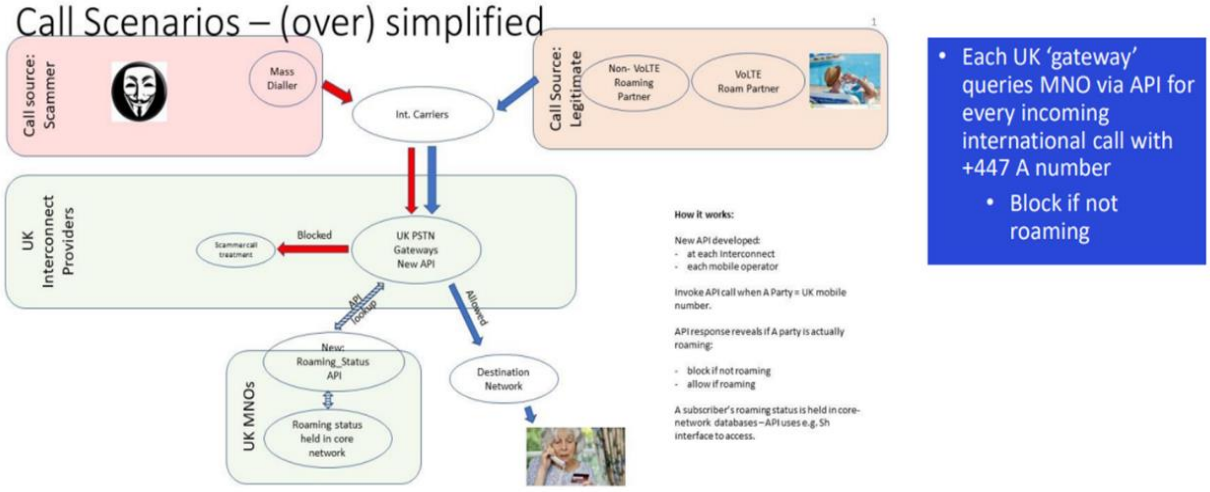
Source	Title	NICC reference
From Warwick University	Spoofing Against Spoofing: Towards Caller ID Verification In Heterogeneous Telecommunication Systems	N-CLI 121(23)04 Caller ID Verification
From Ribbon	Mobile Roaming – Spoofing Fraud	N-CLI MNO 04(23)06 Roaming Fraud Discussion V3 + N-CLI MNO 06(24)07 Roaming Fraud Discussion V4
From Mobileum	To Block or not to Block – that is the question (SMSs containing URLs)	No slides

5 Summary of options

Various solutions were presented to the subgroup. These are described in sub-section 5.1 to 5.5.

It should be noted that for all of the options, it will be necessary to retain the exception handling set out in ND1447 [2] (other than that for which the CLI begins +447).

5.1 REST API lookup by international gateways



Upon receipt of a call with a UK mobile CLI the international gateway queries the mobile network that is assigned the range of the UK mobile CLI over an API, asking the question 'is the caller roaming?'

Assuming that the mobile user has not ported their number away from the range holder, a status response will be returned. If the caller is deemed to be roaming, the call is allowed to continue; if not roaming, the call is rejected. If it cannot be determined that the caller is 'roaming' then the call could be allowed to continue with modified CLI information (e.g. CLI withheld).

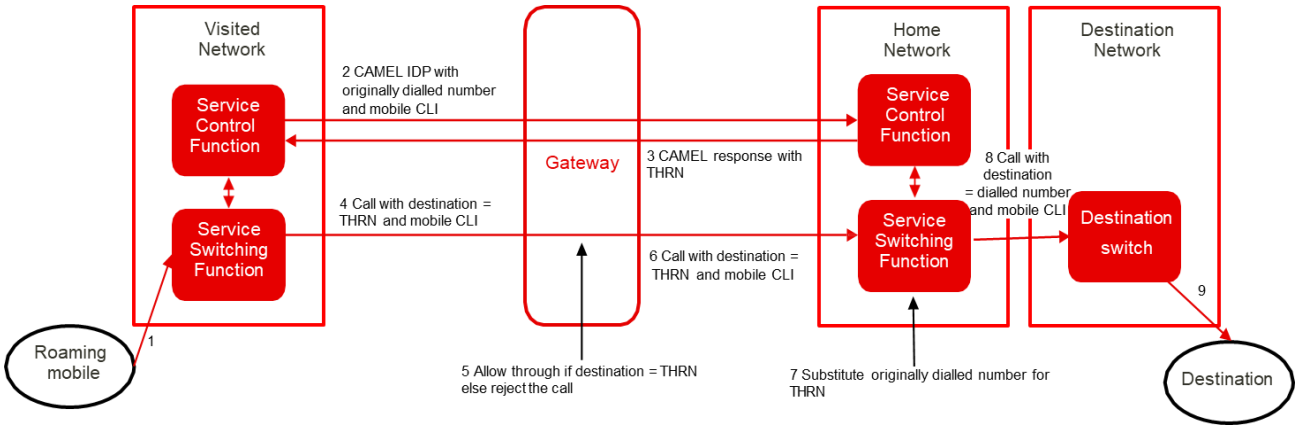
In cases where the range holder mobile network does not host the caller, a method of identifying and querying the ported-to network is required. This can be achieved by one of the following options -

- The range holder network forwards the query to the ported-to network and passes back the response.

- The range holder network provides the identity of the ported-to network to the international gateway

5.2 CAMEL home network routeing

5.2.1 THRN range pin holing

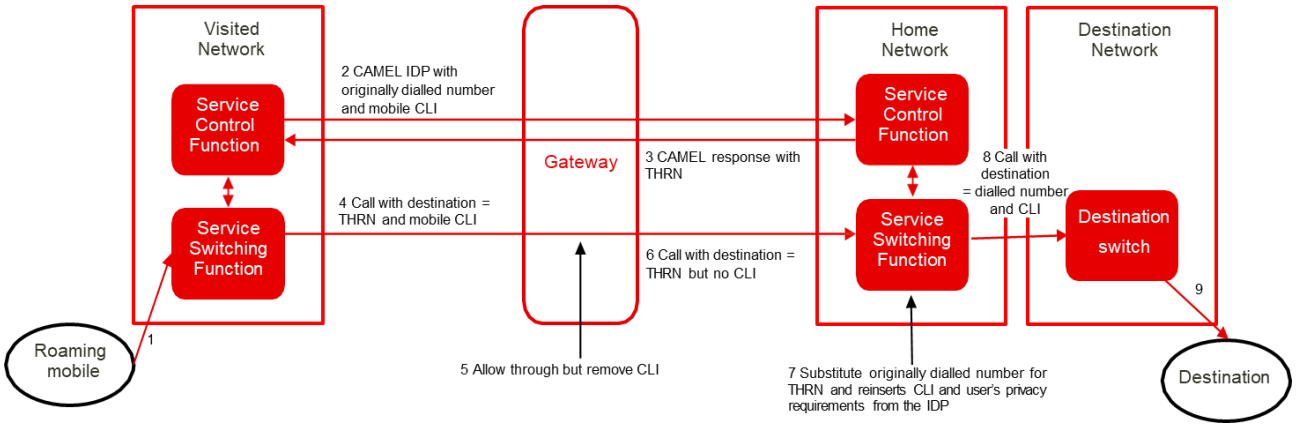


The called number is replaced by the visited network with an THRN provided by the home network via the CAMEL interface. The call is then routed towards its destination.

At the international gateway, the called number is determined to be an THRN so the call is allowed to continue towards the home network without modification. At the home network the THRN is replaced with the original called number and then routed towards its destination by the home network.

In cases where the called number is not an THRN the international gateway will reject the call.

5.2.2 CLI removed at international gateways (number unavailable)



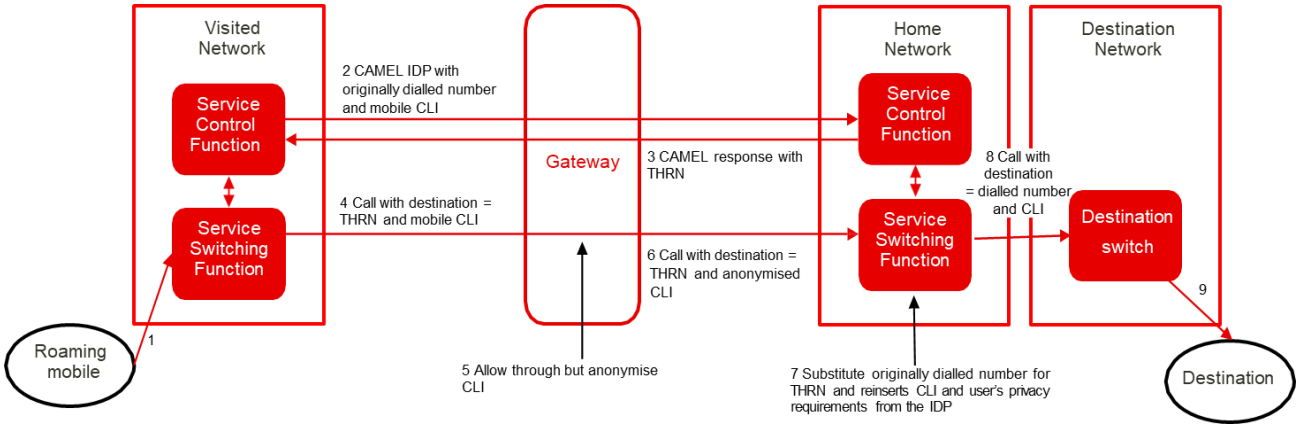
The called number is replaced by the visited network with an THRN provided by the home network via the CAMEL interface. The call is the routed towards its destination.

For any call received with a UK mobile CLI the international gateway will make the CLI unavailable for display. The call is then allowed to continue.

If the called number had been replaced with an THRN the call will route to the home network where the original called number and caller's CLI are reinstated. The call is then routed towards its destination by the home network where the CLI will be available for display unless the caller has requested privacy

In cases where the call does not contain an THRN the call will continue to its destination, and the CLI will not be displayed.

5.2.3 CLI withheld at international gateways (number anonymised)



The called number is replaced by the visited network with an THRN provided by the home network via the CAMEL interface. The call is the routed towards its destination.

For any call received with a UK mobile CLI the international gateway will make the CLI restricted from display. The call is then allowed to continue.

If the called number had been replaced with an THRN the call will route to the home network where the original called number and caller's CLI privacy preference are reinstated. The call is then routed towards its destination by the home network where the CLI will be available for display unless the caller has requested privacy.

In cases where the call does not contain an THRN the call will continue to its destination, but the CLI will not be displayed.

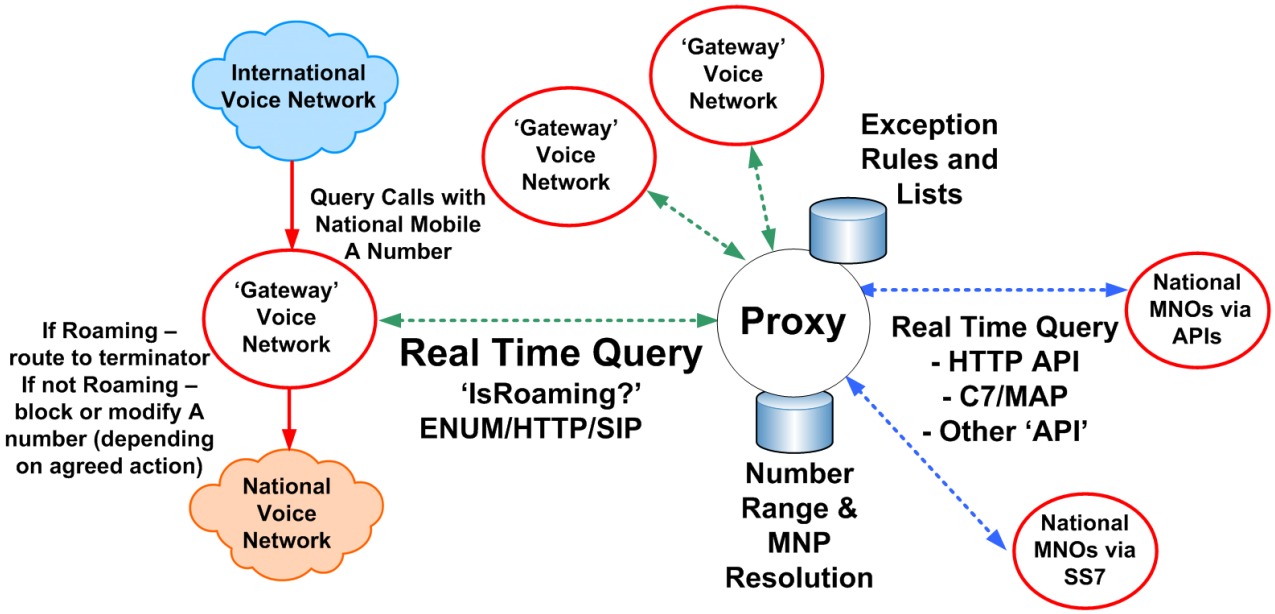
5.3 Real-time 'IsRoaming' lookup via proxy

The 'IsRoaming' Proxy/Hub service provides multi-protocol support for real-time query from international gateways (e.g. SIP, HTTP, ENUM), and securely interfaces with relevant MNO via range of supported protocols (e.g. API, MAP-ATI/SRI, Data feed).

The international gateway operators and MNOs can choose which protocols to use to best suit their network, and the proxy will mediate as well as providing a single (logical) connection rather than MxN connections.

Upon receipt of an 'IsRoaming' check response, the international gateway would treat the call as set out in section 5.1.

The proxy solution would be deployed in the national network and designed to provide a carrier grade service with high availability, including geographic redundancy to support resilience and minimise transport latency.



5.4 CAMEL home network routeing and real-time 'is roaming' lookup - hybrid

A hybrid solution is where any of the CAMEL home network routeing solutions (section 5.2) and an 'IsRoaming' Proxy (section 5.3) combine.

The 'IsRoaming' proxy service described in section 5.3 above can be configured to support both the real-time proxy method and the CAMEL Home Network Routeing method.

This can be configured to work in two operating modes depending on the MNO requirements and capabilities :-

- MNOs supports only either CAMEL HNR or 'IsRoaming' check
  - In this case each MNO chooses whether to operate using CAMEL HNR or 'IsRoaming' check methods, according to their preference and capabilities.
  - The international gateway queries the proxy for all UK mobile CLIs – the proxy determines whether the owning MNO operates in CAMEL HNR or IsRoaming check mode (using MNP lookup) and resolves the roaming status accordingly (i.e. performs an IsRoaming check, or CAMEL HNR range check)– returning a 'block or continue' response to the international gateway (using whichever protocol the international gateway has selected for the query).
- MNO with mixed CAMEL HNR and IsRoaming check capabilities
  - In this case a given MNO may support both CAMEL HNR and IsRoaming check.
  - When the proxy receives a query from the international gateway for an A number belonging to a 'mixed' MNO it checks whether the B number is an THRN, and allows the call. If the B number is not an THRN then the proxy launches an 'IsRoaming' check to determine roaming status and acts accordingly (which could include routeing the call with CLI unchanged, with modified CLI or blocking the

call). This method allows MNOs to implement the CAMEL HNR method covering the majority of calls, however, will also allow the legitimate calls where CAMEL HNR has failed for whatever reason (e.g. issue with CAMEL support in the visiting network).

- This method also off-loads traffic from the MNO IsRoaming check and only uses the IsRoaming check where CAMEL has been unsuccessful.

5.5 International indication inserted at international gateway

This additional indication provides a method for downstream/terminating networks to determine that the call had routed through an international gateway; the indication could be inserted by the international gateway regardless of any roaming check. It could also be used to provide the called party additional information.

NICC understands that in Germany the international gateway adds a privacy header, and also a private/German-specific header which indicates the call was received from overseas and the identity of the international gateway.

For information on the German solution, see - Spezifikation: NGN Ic Schnittstelle (aknn.de) section 15.2

6 Pros and cons

6.1 REST API lookup by international gateways

Pros	Cons
A degree of alignment with some international implementations, but there will be differences due to MNP solution differing between countries	Requires development in all international gateways and some/most UK mobile networks
API already implemented in some mobile networks	Requires a degree of standardisation of query/response
No changes needed in visited/roamed destinations	Treatment of number portability – which MNO to query? Implies either international gateway has to query multiple (~10?) mobile networks in parallel to see if any of them recognise CLI as a roamer, that range holder has to respond with identity of home network, or that range holder has to proxy request through to the home network. If asking all MNOs in parallel, problems with 'dangling' subscriber records (i.e. not yet removed from previous MNO following export). Whose answer do you believe (can't tell which is real vs dangling)?
	Impact on post dial delay while query(ies) carried out.
	Need to establish security policy that conforms with GDPR & TSR, and allows only legitimate international gateways access to the API whilst not being vulnerable to accusations of being anti-competitive. NB any opening of Sh interface externally represents a vulnerability that breaches TSRs
	Vulnerable to fraudsters scanning by generating mass calls with mobile CLIs until a roaming subscriber CLI is found that can be exploited (could potentially be mitigated by call treatment on +447 CLIs found not to be roaming?)
	Vulnerable to fraudsters checking that an individual subscriber is roaming then using this information for physical security threats (e.g. burglary at vacant home).
	Vulnerable to DoS attacks by mass calls with UK mobile CLIs

6.2 CAMEL home network routeing

6.2.1 THRN range pin holing

Pros	**Cons**
Some commonality with international implementations	Any visited network not supporting/invoking CAMEL HNR will not support calls back to UK resulting in calls failing. There are a number of scenarios when this may be the case: • The home network has enabled CAMEL only on pre-paid subscribers not post-paid; • The roaming agreement with the visited network is not enabled with CAMEL support.
No new interface development	International gateways must enable all THRNs as valid destination for calls with UK mobile CLI
Only moderate development needed by international gateways (THRN pin-holing)	May need rewrite of home network services to interact with CAMEL HNR (e.g. if CAMEL HNR is implemented as an IN interaction in home network, any other services using IN interaction will need to be updated/tested for interoperability)
Could be supported by vast majority of visited networks	Additional capacity required via home networks
No scope for scanning CLIs to find an active roamer CLI that could be exploited (because CAMEL signalling means that the only destination number that can be reached is that dialled by a valid roamer)	Risk of DoS attacks if perpetrators launch mass calls towards THRN ranges (but this is already the case)
Minimal additional post-dial delay (additional routeing time via home mobile network)	Risk of exhaust of THRN ranges
No issues with number portability	
Maintains UK mantra that all calls must have valid CLIs	

6.2.2 CLI removed at international gateways (number unavailable)

Pros	**Cons**
No new interface development	Any visited network not supporting/invoking CAMEL HNR will result in calls without a CLI. There are a number of scenarios when this may be the case: • The home network has enabled CAMEL only on pre-paid subscribers not post-paid • The roaming agreement with the visited network is not enabled with CAMEL support.
Minimal international gateway development (remove CLI where +447 – NB scope for P-Asserted-Identity to be retained but From to be blanked?)	Needs changes in national networks to reverse rule blocking calls where the CLI has been removed
Could be supported by vast majority of visited networks	Calls from fraudsters with UK mobile CLIs would be allowed to complete (but as the CLI wouldn't be displayed, the motivation to use a UK mobile CLI would be removed)
Failsafe – if a visited network doesn't support HNR (at all, or is late), call will flow through, it just won't have a CLI displayed	May need rewrite of home network services to interact with CAMEL HNR (e.g. if CAMEL HNR is implemented as an IN interaction in home network, any other services using IN interaction will need to be updated/tested for interoperability)
No scope for scanning CLIs to find an active roamer CLI that could be exploited (because CAMEL signalling means that the only destination number that can be reached is that dialled by a valid roamer)	Confirmation needed that all home mobile networks are capable of re-inserting the CLI
Minimal additional post-dial delay (additional routeing time via home mobile network)	Additional capacity required via home networks
No issues with number portability	Risk of DoS attacks if perpetrators launch mass calls towards THRN ranges (but this is already the case)
	Risk of exhaust of THRN ranges

6.2.3 CLI withheld at international gateways (number anonymised)

Pros	**Cons**
Closer commonality with international implementations (Germany)	Any visited network not supporting/invoking CAMEL HNR will result in calls with anonymised CLI. There are a number of scenarios when this may be the case: • The home network has enabled CAMEL only on pre-paid subscribers not post-paid; • The roaming agreement with the visited network is not enabled with CAMEL support.
No new interface development	Calls from fraudsters with UK mobile CLIs would be allowed to complete (but as the CLI wouldn't be displayed, the motivation to use a UK mobile CLI would be removed)
Minimal international gateway development (restrict CLI where UK mobile)	May need rewrite of home network services to interact with CAMEL HNR (e.g. if CAMEL HNR is implemented as an IN interaction in home network, any other services using IN interaction will need to be updated/tested for interoperability)
Could be supported by vast majority of visited networks	Confirmation needed that all home mobile networks are capable of restoring the CLI
Failsafe – if a visited network doesn't support HNR (at all, or is late), call will flow through, it just won't have a CLI displayed	Additional capacity required via home networks
No scope for scanning CLIs to find an active roamer CLI that could be exploited (because CAMEL signalling means that the only destination number that can be reached is that dialled by a valid roamer)	Risk of DoS attacks if perpetrators launch mass calls towards THRN ranges (but this is already the case)
Minimal additional post-dial delay (additional routeing time via home mobile network)	Risk of exhaust of THRN ranges
No issues with number portability	Anonymising of CLI by the international gateway will remove the caller's ability to release their CLI to ensure call completion where the called customer has invoked anonymous call rejection.

6.3 Real-time 'IsRoaming' lookup via proxy

Pros	Cons
Compared to the API solution, a One-to-Many model of connectivity reduces operational overheads across the whole ecosystem. Each international gateway requires a single logical connection and each MNO requires a single connection to the proxy. There are vendor proxy solutions available.	Unsuccessful 'isRoaming' checks result in calls being blocked or being presented with a modified CLI.
Proxy interface based on existing MNO interfaces, such as C7 MAP and/or APIs and SIP/ENUM and data feed of roaming telephone numbers	Need to select, deploy and fund ongoing operation of the proxy.
Allows each international gateway and MNO to implement the best solution for their network environment, i.e. SIP, ENUM or HTTP	Additional call set up latency introduced; however, this would typically be faster than the API approach. Further, some argue that this is likely to be no worse than the CAMEL HNR approach.
Provides MNP resolution to minimise query load.	The one-to-many nature of this solution will incur less resilience than a many-to-many solution.
Could support caching to minimise query load on MNOs, therefore, providing a broader checking function than just "IsRoaming".	Relies on the continued availability of C7 MAP interfaces, if no API developed.
Compared to the API method, facilitates ongoing moves and changes for international gateway or MNO network configurations while minimising operational impacts. A high availability carrier grade proxy solution (as envisaged) will significantly help address resilience concerns.	Requires international gateway development to query the proxy
	Need to establish security policy to govern the external interfaces that conforms with GDPR & TSR, and allows only legitimate international gateways access to the API whilst not being vulnerable to accusations of being anti-competitive. NB any opening of Sh interface externally represents a vulnerability that breaches TSRs
	Vulnerable to fraudsters scanning by generating mass calls with mobile CLIs until a roaming subscriber CLI is found that can be exploited (could potentially be mitigated by call treatment on UK mobile CLIs found not to be roaming?)
	Vulnerable to fraudsters checking that an individual subscriber is roaming then using this information for physical security threats (e.g. burglary at vacant home).

	Vulnerable to DoS attacks by mass calls with UK mobile CLIs

6.4 CAMEL home routeing and real-time 'is roaming' lookup - hybrid

Pros	**Cons**
International gateways don't need to know which method an MNO has used (now or in future) – and can select which protocols to use.	Need to select, deploy and fund ongoing operation of the proxy.
One to Many hubbing minimises implementation and management overheads compared to direct API method.	There is additional latency
A combined MNO HNR and API solution would pass more legitimate traffic with a displayable CLI (than the HNR solution) while minimising any overflow usage of the MNO API.	Reduces resilience as there are fewer network elements to support all traffic (note that the assumption is that the default would be to pass all traffic if all hubs were unavailable)
	Cost of development of the international gateway.

6.5 International indication inserted at international gateways (German model)

This option can be used either in conjunction with options described in 5.1 to 5.4 or on its own. Where used alongside another option, the pros and cons of that option apply in addition to those below.

Pros	**Cons**
Commonality with international implementations (Germany)	A new private header is required to be supported by all UK networks, which will require development.
Greater assurance that callers' privacy is maintained	

7 Evaluation of the options

The participants in the Subgroup debated the merits of the options at length, concluding -

- There was no support for mandating an API interface (Section 5.1).
- The majority of the sub-group supported one of CAMEL Home Network Routeing approaches (Section 5.2). Opinions as to which option were split based upon the relative priority participants assigned to
    - speed of implementation,
    - whether the goal was to prevent calls with spoofed CLIs being connected or alternatively was to prevent calls presenting spoofed CLIs, and
    - the importance of not blocking valid roaming calls.
- There was a small minority of support for the usage of a proxy, either standalone or combined with CAMEL Home Network Routeing (Sections 5.3 and 5.4).

History

Document history		
V1.1.1	20th September 2024	Initial publication