Technical White Paper: Internationalized Domain Name Resolution Testbed Deployment

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1 Introduction

The VeriSign Global Registry Services (GRS) Internationalized Domain Name (IDN) Testbed provides for both the registration and resolution of IDNs. The Testbed will be conducted in three stages, with the final stage being done in three phases:

Stage 1. Certification and Preparation of Registrars.
Stage 2. IDN Registration.
Stage 3. IDN Resolution.
- Phase 3.1. Resolution of IDNs as Hostnames in *mltbd* Zones.
- Phase 3.2. Delegation of IDNs in *mltbd* Zones.
- Phase 3.3. Full-Featured Resolution in *com* and *net* Zones.

This paper focuses only on Stage 3, the resolution of IDNs and the deployment of IDN resolution, known as the Resolution Testbed. For additional information about Stages 1 and 2, please see http://www.verisign-grs.com/idn.

The approach to IDN resolution described in this document provides for a controlled deployment of IDN capabilities on the Internet. It effectively mitigates risks and allows time for gradual deployment of IDN resolution on the gTLD constellation. The deployment will be executed using a phased approach, which will help to ensure that the stability of the Internet is not jeopardized and that the resolution of domain names under the *com* and *net* top-level domains will not be interrupted.

2 Acronyms and Definitions

ACE ASCII Compatible Encoding. The resolution testbed currently supports RACE, an early IETF proposal for an ASCII compatible encoding that has been superceded by punycode.

<ACE> A convention used to denote an ACE encoding of an internationalized string.

DNS Domain Name System [1], [2].

gTLD Generic Top Level Domain.

IDNWG Internationalized Domain Name Working Group of the IETF.

IETF Internet Engineering Task Force.

IDN Internationalized Domain Name
A DNS domain name containing one or more characters outside the ASCII subset specified in the DNS protocol specifications [3]. Implementations of RACE and Name Prep require as input an internationalized name consisting of Unicode code values.

Localized Environment
A testbed environment, not part of the *com* and *net* gTLD constellation.

mltbd Two zones (specifically, mltbd.com and mltbd.net) that are part of the IDN testbed, owned and run by VeriSign GRS, and hosted on VeriSign GRS name servers.

Name Prep A convention used to denote the preprocessing (name preparation) of an internationalized string according to the IETF proposal entitled *Preparation of Internationalized Host Names* [5].

Punycode The ACE that will replace RACE in the IDN Testbed.

RACE Row-based ASCII Compatible Encoding. An early IETF proposal specifying an ASCII-compatible encoding for internationalized domain names. Input to the RACE algorithm [6] is an internationalized string [3] consisting of UTF-16 values [7], and output is an ASCII string compliant with DNS specifications [2]. This has been superceded by punycode.

Testbed Name Server

	Refers to the DNS name server used throughout the testbed period. For deployment phases 3.1 and 3.2, this term refers to the authoritative name server for the *mltbd.com* and *mltbd.net* zones, and for Phase 3.3 this term refers to both the authoritative name server for the *mltbd* zones as well as the authoritative name server for the *com*, and *net* top level zones.
UCS	Universal Character Set.
UTF-16	UCS Transformation Format, 16-bit form. A variable-width encoding form defined in Annex Q of ISO/IEC 10646-1:1993, and also described in the Unicode Standard, version 3.0 [7].
VeriSign GRS	VeriSign Global Registry Services.

3 Testbed Deployment

The deployment of IDN resolution during the testbed will be executed in three consecutive phases. As indicated in Figure 1 below, the phases of IDN resolution are referred to as Phase 3.1, Phase 3.2, and Phase 3.3. Each phase will begin on a different date, and the duration of the phases will vary, with some overlapping into others. Each consecutive phase serves to enable partial resolution capability, and all the phases together incrementally contribute to the migration from partial to full-featured IDN resolution capability in the gTLD constellation.

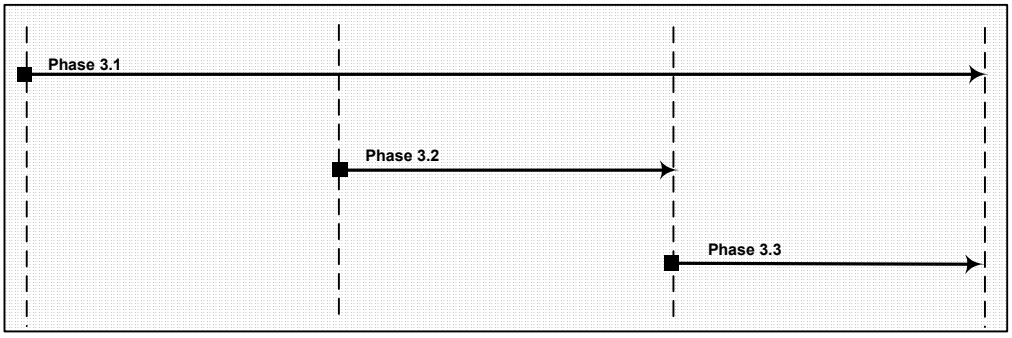

Figure 1. Resolution Testbed Timeline

The behavior of resolution during each phase will vary and will be based on the set of supported features. Table 1 below shows a mapping of resolution features to resolution phases, and provides more detailed information than what is conveyed in Figure 1. As shown in Table 1, Phases 3.1 and 3.2 will have no impact on the gTLD constellation. Features of overlapping phases can be combined to determine the full scope of resolution capability during a particular phase within the resolution timeline. The technologies used by VeriSign GRS throughout the testbed period to enable IDN resolution are intended to be transitional. These transitional

technologies were developed based on the IETF proposed standards for IDNs. Recently, the IETF published the IDN standards and VeriSign GRS is migrating to those standards

Table 1: Testbed Resolution Features

Features	Phase 3.1	Phase 3.2	Phase 3.3
Support ACE queries	√	√	√
mltbd resolution to VeriSign GRS web site	√		
ACE in *mltbd* zones	√	√	
Delegation of IDNs under *mltbd*		√	
ACE in *gTLD* zones			√
Delegation of IDNs under *gTLD*			√

3.1 Phase 3.1

The purpose of Phase 3.1 (see Table 2) is to allow a registrant to verify his or her IDN registration with a DNS query and response, and to allow the testbed name servers to respond to these verification queries while operating in a controlled environment. Testbed participants must register internationalized second level domains as Name Prepped ACE encodings prior to attempting resolution. The resolution testbed will exit Phase 3.1 when open source zone administration tools are available. These zone tools will enable zone administrators to generate Name Prepped ACE in the zones.

Table 2: Phase 3.1 Criteria

Phase 3.1 Objectives	Phase 3.1 Resolution Criteria	Phase 3.1 Exit Criteria
• To allow a registrant to verify IDN registrations with an ACE query. • To allow testbed name servers to resolve internationalized queries within a controlled environment.	• An IDN **<ace>.com** must be registered as Name Prepped ACE. • The end-user must attempt to resolve the registered name as **<ace>.mltbd.com.**	• Availability of zone administration tools enabling Name Prep processing and ACE conversion.

In this phase, registered IDNs *cannot* be resolved by the gTLD authoritative name servers since these domain names will not appear in the gTLD zones. As part of registration procedures, the registrar must specify authoritative name servers for the IDN. During this phase, however, the specified name servers will not appear in either the gTLD zones nor the *mltbd* zones and so there is no delegation of the registered domain.

A mapping of the set of DNS queries and responses supported during this phase of the resolution testbed is shown in Table 3. In this set of queries and responses, the indicated IDN query is sent

to an authoritative name server for the *mltbd* zones, which returns the indicated response. For a given registered domain of the form **<ace>.com**, the *mltbd* name server will only resolve **<ace>.mltbd.com**. The only type of query that can be resolved during this phase is a query for the IP address of the host name (an A record query). The IP address returned in the DNS response is that of a web server run by VeriSign GRS, which will return only a single web page as an indication that the resolution of the internationalized host name was successful. Note that attempts to resolve the IDN in the form **<ace>.com** will result in a "no such domain" response (this is true for *all* DNS record types). *See* Appendix A for an example of resolution during Phase 3.1.

Phase 3.1 was exited in early 2001.

Table 3. Phase 3.1 Queries and Responses

Phase 3.1 DNS Query	Phase 3.1 DNS Response
Query IP address (A records) of <ACE>.mltbd.com	<ACE>.mltbd.com A <IP address>
Query IP address (A records) of <ACE>.com	NXDOMAIN (no such domain)

3.2 Phase 3.2

The purpose of Phase 3.2 (see Table 4) is to allow testbed participants administering internationalized zones to begin to identify issues relevant to the administration of internationalized zones. Testbed participants must register internationalized second level domains as Name Prepped ACE encodings prior to attempting resolution. The resolution testbed will exit Phase 3.2 when open source ACE toolkits are available to application developers. This will enable applications to generate Name Prepped ACE domain names.

Table 4. Phase 3.2 Criteria

Phase 3.2 Objectives	Phase 3.2 Resolution Criteria	Phase 3.2 Exit Criteria
• To enable those administering internationalized zones to identify issues relevant to the administration of zones containing ACE-encoded IDNs.	• An IDN **<ace>.com** must be registered as Name Prepped ACE • Authoritative servers for internationalized zones must store the zone in Name Prepped ACE format	• Availability of open source ACE toolkit for application developers.

In this phase VeriSign GRS will enable the delegation of IDNs. Every registered IDN will be delegated to its list of corresponding name servers specified at registration time. Although the testbed as a whole moves to Phase 3.2, testbed participants may choose to remain under Phase 3.1 behavior and can inhibit delegation by specifying a predetermined list of VeriSign GRS name servers during registration (or changing the list after testbed resolution begins.) Currently these name servers are *mltbd-ns1.verisign-grs.net* and *mltbd-ns2.verisign-grs.net*.

In this phase, registered IDNs will not appear in the gTLD zones and so the gTLD name servers will be unable to resolve these domains. A domain remaining under Phase 3.1 behavior will continue to appear as a single A record with a hostname of **<ace>.mltbd.com** in the appropriate *mltbd* zone. A domain moving to Phase 3.2 behavior will be delegated from the appropriate *mltbd* zones (i.e., NS records for **<ace>.mltbd.com** will appear). A records for name servers specified for delegated domains will appear in the *mltbd* zones.

Table 5 shows the possible set of DNS queries and responses during Phase 3.2 of the testbed deployment, and reflects only the *delegation* resolution behavior of the testbed name servers. (*Those domains remaining under Phase 3.1 resolution behavior will be resolved according to the query and response mapping for Phase 3.1*). An IDN registered in the form of **<ace>.com** may only be resolved in the form of **<ace>.mltbd.com**. Queries for the IP address (A record) of some host, e.g. *www.<ace>.mltbd.com,* will result in a referral response containing the names and IP addresses of authoritative name servers (NS and A records) for the appropriate zone. Note that any queries for IDN names in the form of **<ace>.com** will result in a "no such domain" error response (this is true for *all* DNS record types). Additionally, the name servers authoritative for the *mltbd* zones are non-recursive. *See* Appendix B for an example of resolution during Phase 3.2.

The Testbed is currently in Phase 3.2.

Table 5. Phase 3.2 Queries and Responses

Phase 3.2 DNS Query	Phase 3.2 DNS Response
Query IP address (A records) of www.<ACE>.mltbd.com	<ACE>.mltbd.com NS <name server> <name server> A <IP address>
Query IP address (A records) of www.<ACE>.com	NXDOMAIN (no such domain)

3.3 Phase 3.3

The purpose of Phase 3.3 (see Table 6) is to allow full-featured IDN resolution capabilities in the gTLD constellation. Testbed participants may resolve registered domains as ACE queries, and authoritative name servers for internationalized zones must store the zones in Name Prepped ACE format. Because the testbed is a transitional entity, the testbed will exit Phase 3.3 once there is an IETF standard for internationalized domain names and VeriSign GRS has adopted that standard. VeriSign GRS is currently migrating to the final IDN standard that the IETF recently published.

Table 6. Phase 3.3 Criteria

Phase 3.3 Objectives	Phase 3.3 Resolution Criteria	Phase 3.3 Exit Criteria
• To allow testbed participants to resolve registered IDNs using ACE queries • To enable delegation of registered domains as second level domains under *com* and *net* top level domains, and NOT as third level domains under the *mltbd* testbed domain.	• An IDN **<ace>.com** must be registered as Name Prepped ACE • The end-user attempts to resolve the ACE version of registered IDN • Authoritative name servers for internationalized zones must store the zone in Name Prepped ACE format	• There is an IETF standard for IDNA and it is adopted by VeriSign GRS.

In this phase IDN resolution will be enabled for second level domains under *com* and *net* top-level domains. Delegations of registered IDNs to registered name servers will appear in the gTLD zones, and thus the gTLD authoritative name servers will be able to resolve internationalized ACE queries (see Table 7). Registered IDNs of the form **<ace>.com** may be queried as **<ace>.com.** Note that Phase 3.1 behavior will continue for domains whose registered name servers are either *mltbd-ns1.verisign-grs.net* or *mltbd-ns2.verisign-grs.net* (Figure 1). Please refer to Appendix C for an example of resolution during this phase.

Table 7. Phase 3.3 Queries and Responses

Phase 3.3 DNS Query	Phase 3.3 DNS Response
Query IP address (A records) of www.<ACE>.com	<ACE>.com NS <name server> <name server> A <IP address>

4 Interoperability and Compatibility

There are various potential interoperability and compatibility issues that may arise when attempting testbed resolution of registered IDNs. In this section the various inconsistencies are identified and possible solutions presented (see Table 8).

The resolution testbed currently supports both Name Prep and ACE, and consistent usage of these IETF proposals is critical to achieving successful resolution of IDNs. The purpose of applying Name Prep is to guarantee uniqueness of the IDN, by consistently reducing the input byte sequence to its simplest and most significant Unicode representation. The purpose of applying ACE is to preserve uniqueness of the IDN when it is converted to a corresponding unique ASCII domain compatible with existing DNS specifications. Used in conjunction with one another, (Name Prep followed by ACE encoding), Name Prep and ACE are intended to

bring about a consistently unique mapping of the registered IDN to its corresponding encoded value.

The goal of Name Prepped ACE is to enable users to enter their desired IDNs, and have those names successfully transformed to the canonical representation that is known by the DNS system. If the combinations of Name Prep and ACE are not consistently applied, then a single IDN may map to multiple ACE representations, and thus resulting in either non-resolution or false resolution of the given IDN.

Compatibility and interoperability issues may arise between a querying client and the testbed name servers, or between the testbed name servers and other internationalized authoritative name servers along the resolution path. Optimally, querying clients should transmit IDN queries as Name Prepped ACE, and all internationalized authoritative name servers along the resolution path MUST host IDNs as Name Prepped ACE in the zones.

Table 8. Testbed Resolution Interoperability Issues

	ISSUE	TO RESOLVE
Querying Clients	• Client sends non-Name Prepped ACE query/Testbed name servers has Name Prepped ACE in zones	• VeriSign GRS requires that ACE queries are Name Prepped, otherwise query will not resolve.
Other Authoritative Internationalized Name Servers	• Authoritative name servers have non-Name Prepped ACE in zones/Testbed name servers return Name Prepped ACE	• Authoritative servers must have Name Prepped ACE in the zones. • An appropriate ACE conversion utility may be used to encode zones

5 References

[1] Mockapetris, P., "Domain Names – Concepts and Facilities", RFC 1034, November, 1987.

[2] Mockapetris, P., "Domain Names – Implementation and Specification", RFC 1035, November, 1987.

[3] Seng, J., "Requirements of Internationalized Domain Names", Internet Draft, June 28, 2000.

[4] Hoffman, P., "Comparison of Internationalized Domain Name Proposals", Internet Draft, July 11, 2000.

[5] Hoffman, P., "Preparation of Internationalized Host Names", Internet Draft, July 3, 2000.

[6] Hoffman, P., "Row-based ASCII Compatible Encoding for IDN", Internet Draft, October 16, 2000.

[7] Hoffman, P., "UTF-16, an encoding of ISO 10646", RFC 2781, February, 2000.

6 Appendix A: Phase 3.1 Example Resolution

A user enters <*registered-native*>.mltbd.com at the web browser and is connected to the VeriSign GRS web site at 203.26.134.30 (not the actual IP address, only an example). Note that the resolution can only happen if the browser is able to convert the *registered-native* to the appropriate Name Prepped ACE, which can then be resolved.

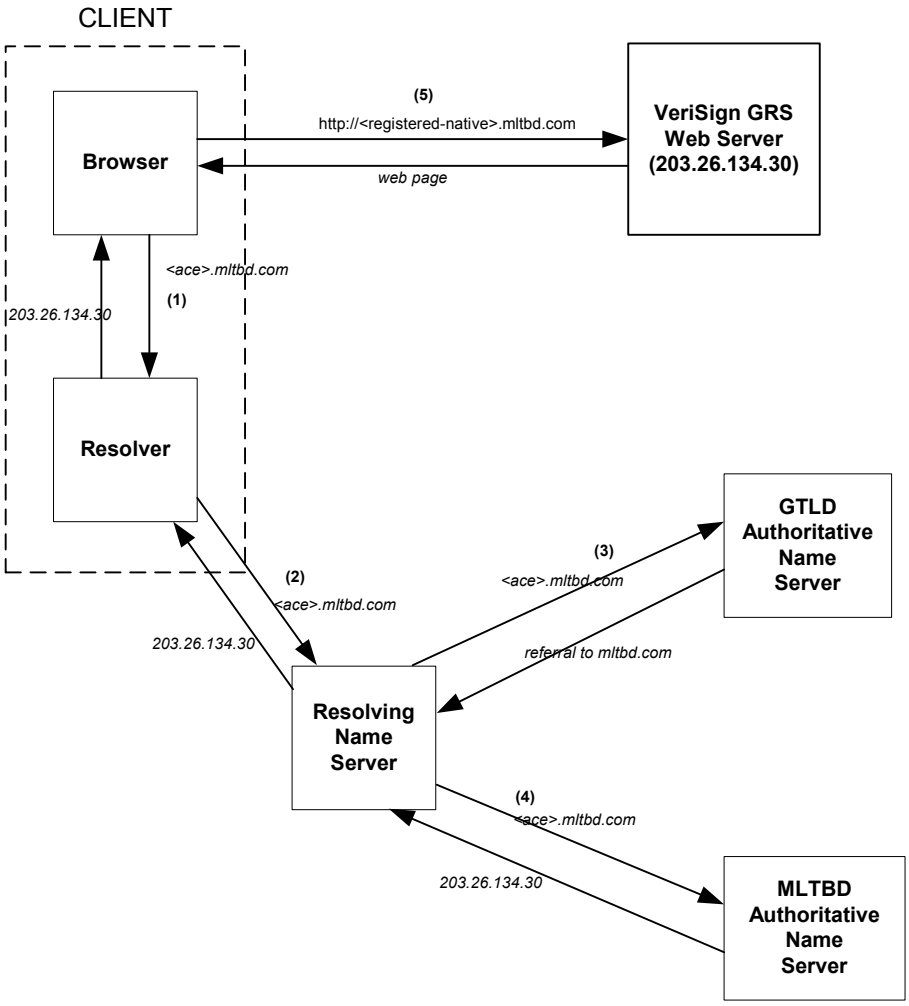

Figure 2. Phase 3.1 Resolution Diagram

7 Appendix B: Phase 3.2 Example Resolution

A user enters www.<*registered-native*>.mltbd.com at the web browser and is connected to a web site at 205.22.135.31 (not the actual IP address, only an example). Again, in order for resolution to occur, the browser must convert the *registered-native* string to the appropriate Name Prepped ACE value known to the DNS.

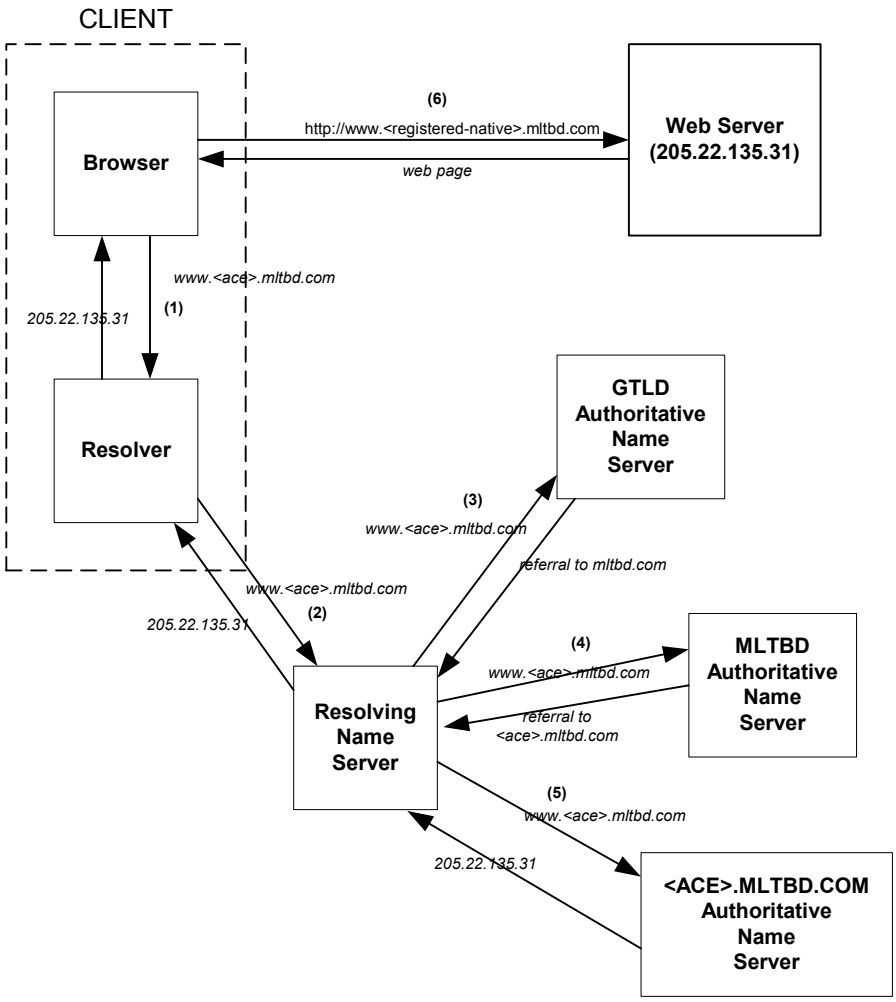

Figure 3. Phase 3.2 Resolution Diagram

8 Appendix C: Phase 3.3 Example Resolution

A user enters **www.*<registered-native>*.com** at the web browser and is connected to a web site at address 205.22.135.31. The browser must be able to convert the *registered-native* to the appropriate Name Prepped ACE value.

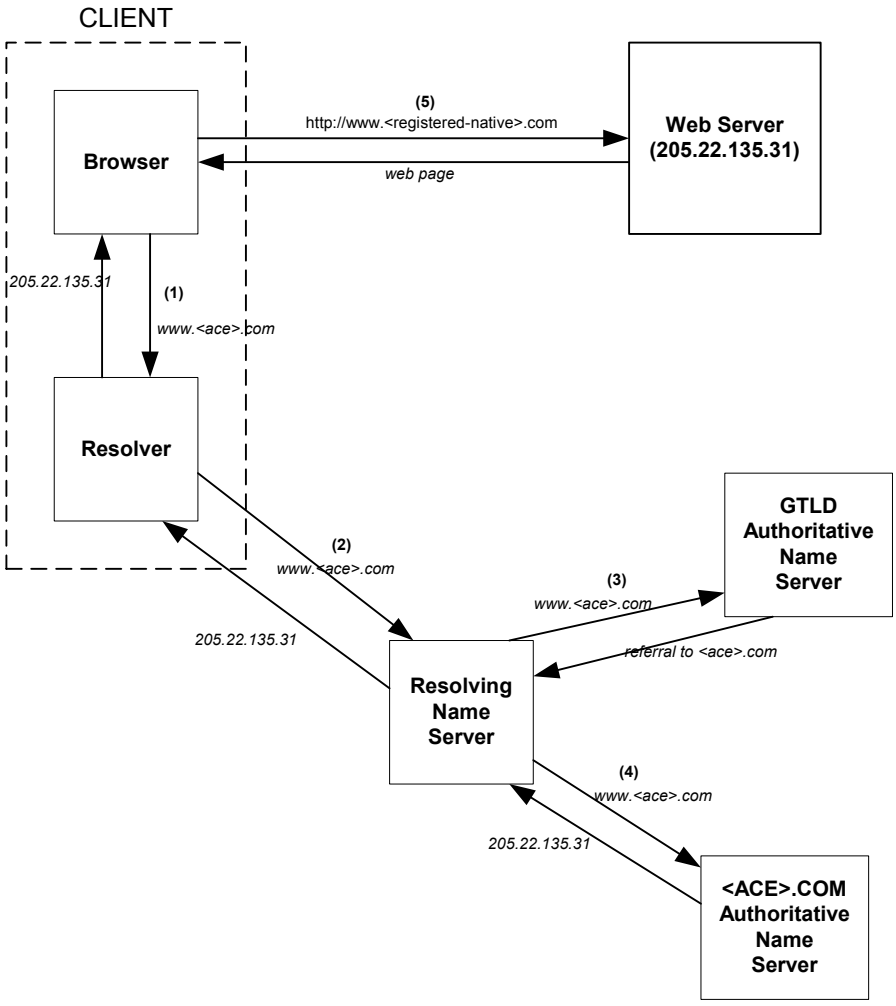

Figure 4. Phase 3.3 Resolution Diagram