



## New gTLD Program Explanatory Memorandum

### Board Response to the GAC on Root Zone Scaling

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### Background – New gTLD Program

Since ICANN was founded in 1998 as a not-for-profit, multi-stakeholder organization dedicated to coordinating the Internet's addressing system, one of its foundational principles, recognized by the United States and other governments, has been to promote competition in the domain-name marketplace while ensuring Internet security and stability. The expansion of the generic top-level domains (gTLDs) will allow for more innovation, choice and change to the Internet's addressing system, now represented by 22 gTLDs.

The decision to introduce new gTLDs followed a detailed and lengthy consultation process with all constituencies of the global Internet community represented by a wide variety of stakeholders – governments, individuals, civil society, business and intellectual property constituencies, and the technology community. Instrumental to this process were ICANN's Governmental Advisory Committee (GAC), At-Large Advisory Committee (ALAC), Country Code Names Supporting Organization (ccNSO), and Security and Stability Advisory Committee (SSAC). The consultation process resulted in a policy on the introduction of New gTLDs completed by the Generic Names Supporting Organization (GNSO) in 2007, and adopted by ICANN's Board in June 2008.

This explanatory memorandum is part of a series of documents published by ICANN to assist the global Internet community in understanding the requirements and processes presented in the Applicant Guidebook, currently in draft form. Since late 2008, ICANN staff has been sharing the program development progress with the Internet community through a series of public comment fora on the applicant guidebook drafts and supporting documents. To date, there have been over 250 consultation days on critical program materials. The comments received continue to be carefully evaluated and used to further refine the program and inform development of the final version of the Applicant Guidebook.

For current information, timelines and activities related to the New gTLD Program, please go to <http://www.icann.org/en/topics/new-gtld-program.htm>.

Please note that this is a discussion draft only. Potential applicants should not rely on any of the proposed details of the new gTLD program as the program remains subject to further consultation and revision.

## Summary of Key Points in this Paper

- This document builds on past work and provides explanatory details as to how ICANN will undertake to address concerns regarding root scaling.
- The root zone currently has around 300 delegations. In the first year, the root zone is expected to grow by 200 to 300 delegations with a worst case of under 1000 new delegations, resulting in an increase in size of between 100,000 to 150,000 bytes with a worst case projected to be 500,000 bytes.
- Root scaling areas of concern are related to root server query response and root system provisioning, the latter being defined as the process of accepting, validating, authorizing, implementing, and notifying the requester of changes in the root zone.
- Root zone scaling is unlikely to have significant impact on root server query response.
- Provisioning changes to the root zone will increase, with anticipated growth being between 40 and 140 additional updates per month, with a worst case being as many as 280 updates per month.
- ICANN will monitor the root provisioning system to ensure any potential overload conditions are detected and mitigated.
- Modifications to ICANN and IANA operations will be made as necessary to adjust to increased requirements resulting from implementation of the new gTLD program.

## Introduction

In ongoing efforts to deploy new generic top-level-domains (gTLDs), ICANN's Government Advisory Committee (GAC) has provided a document entitled "GAC indicative scorecard on new gTLD outstanding issues listed in the GAC Cartagena Communique"<sup>1</sup>, also known as the "GAC Scorecard". After consultation with the GAC, ICANN's Board has published a response that accepts the GAC's advice and enumerates plans to address the ongoing concerns identified within the GAC Scorecard. In the context of root scaling, ICANN states<sup>2</sup>:

- *ICANN will establish a process for reporting root zone metrics.*

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<sup>1</sup> <http://www.icann.org/en/topics/new-gtlds/gac-scorecard-23feb11-en.pdf>

<sup>2</sup> <http://www.icann.org/en/topics/new-gtlds/gac-comments-new-gtlds-26may11-en.pdf>

- ICANN will implement a process with a clearly established chain of command that enables the delegation of TLDs to be slowed or stopped in the event that there is a strain on the root zone system.
- ICANN commits to review the effects of the new gTLD program on the operations of the root zone system, and to postpone delegations in a second round until it is determined that the delegations in the first round have not jeopardized the root zone system's security or stability (as stated in the AG).
- ICANN commits to ensuring that the operation of the IANA functions and ICANN's coordination of the root zone system will not be negatively affected.

This document builds on past work and provides explanatory details as to how ICANN will undertake to address the ICANN community's and GAC's concerns regarding root scaling.

## Past Work

ICANN has undertaken several efforts to address the question of scaling the root zone. As described in the Introduction to SAC 046 "Report of the Security and Stability Advisory Committee on Root Scaling"<sup>3</sup>:

*ICANN Board of Directors' Resolution 2009-02-03-04, dated 3 February 2009, asked the Root Server System Advisory Committee (RSSAC), the Security and Stability Advisory Committee (SSAC), and ICANN staff to study the potential impact on the stability of the root level of the Domain Name System (DNS) when IPv6 address records, IDN (Internationalized Domain Name) top level domains (TLD), other new TLDs, and new resource records to support DNS security (DNSSEC) are added to the root zone. The Board resolution asked that the study consider both the technical and operational issues related to expanding the root zone. From the study, the Board sought to better understand the impact of each new addition separately and in aggregate.*

As a result of that Board resolution, a number of efforts were undertaken:

- A root scaling study Terms of Reference was written and published on 5 May 2009, resulting in the creation of a Root Scaling Study Team (RSST)<sup>4</sup>;
- The output of the RSST, "Scaling the Root: Report on the Impact on the DNS Root System of Increasing the Size and Volatility of the Root Zone" was published on 7 September 2009<sup>5</sup>. This document provided an analysis the root system and discussed a qualitative model created by The Netherlands Organization (TNO)<sup>6</sup> that was used to attempt to understand the dynamics of root provisioning, publication, and operation. This document observed that based on the model, "Growth to 1,120 TLDs, without a change in any other parameters, does not yet cause a significant change in the outcome";

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<sup>3</sup> <http://www.icann.org/en/committees/security/sac046.pdf>

<sup>4</sup> <http://www.icann.org/en/committees/dns-root/root-scaling-study-tor-05may09-en.pdf>

<sup>5</sup> <http://www.icann.org/en/committees/dns-root/root-scaling-study-report-31aug09-en.pdf>

<sup>6</sup> <http://www.icann.org/en/committees/dns-root/root-scaling-model-description-29sep09-en.pdf>

- A study unrelated to the RSST study that focused on the scaling characteristics of an analog of the “L” root server was performed by the DNS Operations Analysis and Research Center (DNS OARC) and published as “Root Zone Augmentation and Impact Analysis” on 17 September 2009<sup>7</sup>. This study demonstrated that at least the “L” root server would be able to grow to millions of delegations with no significant negative impact in root server operations;
- An analysis of new gTLD delegation rates was performed and published as “Delegation Rate Scenarios For New gTLDs,” on 6 October 2010<sup>8</sup>. This analysis established that with anticipated application load, the average provisioning rate was expected to range between 108 and 263 delegations per year, with a maximum possible throughput of up to 965 delegations in the first year, 924 delegations thereafter;
- ICANN's SSAC reviewed the findings on root scaling and published SAC 046 “Report of the Security and Stability Advisory Committee on Root Scaling” on 6 December 2010<sup>9</sup>. This document observed the root system had undergone expansion in terms of technologies deployed in the root zone (such as IPv6, IDNs, and DNSSEC) and recommended 5 steps be undertaken before the new gTLD program be initiated;
- The Chair of the RSSAC sent an electronic mail message with the subject “RSSAC response to the root scaling report” on 25 November 2010<sup>10</sup>. In that message, RSSAC stated that introduction of new capabilities should be studied on an as needed basis and that *“In the case of the proposed gradual expansion of no more than 1000 entries per year for the next several years, RSSAC expects the system to remain stable and robust.”*;
- A document summarizing the impact of root zone scaling entitled “Summary of the Impact of Root Zone Scaling” was published on 6 October 2010<sup>11</sup>; and
- Public comments were solicited on the Summary of the Impact of Root Zone Scaling from 6 October 2010 to 5 November 2010, with a summary and analysis of comments received published as “Summary of the Impact of Root Zone Scaling: Summary of Comments and Analysis” on 21 February 2011<sup>12</sup>. This document noted the SSAC recommendations should be implemented and that there were a number of additional areas in which further investigation might prove fruitful such as coordination of TLD operators in the face of attack, how the root management systems could be improved, and what impact the growth of the root zone might have on negative caches.

In the intervening period of time from when the Board first requested the initiation of studies on scaling the root zone until today, most of the changes of concern relating to scaling the root have been deployed including IPv6 records in the root zone (in July 2004), IDNs in the root zone (beginning with limited test IDNs in August 2007), and DNSSEC in the root (in January 2010). The remaining change to the root zone called out in the

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<sup>7</sup> <http://www.icann.org/en/topics/ssr/root-zone-augmentation-analysis-17sep09-en.pdf>

<sup>8</sup> <http://www.icann.org/en/topics/new-gtlds/delegation-rate-scenarios-new-gtlds-06oct10-en.pdf>

<sup>9</sup> <http://www.icann.org/en/committees/security/sac046.pdf>

<sup>10</sup> <http://www.icann.org/en/correspondence/murai-to-board-25nov10-en.pdf>

<sup>11</sup> <http://www.icann.org/en/topics/new-gtlds/summary-of-impact-root-zone-scaling-06oct10-en.pdf>

<sup>12</sup> <http://www.icann.org/en/topics/new-gtlds/summary-analysis-root-zone-scaling-impact-21feb11-en.pdf>

Board resolution would be adding new TLDs. Much of the work above led to the conclusion that, given that IDNs, IPv6 and the signed root zone have been deployed, and that the delegation rates of new TLDs are limited, that the introduction of new TLDs will not negatively affect root server operations.

## Implications of the Addition of New TLDs

### Background

Adding a new top-level domain to the root implies the execution of a two-phase process. The first phase is evaluation, where the merits of the application are evaluated in accordance with the eligibility policy. The second phase is provisioning, where a new top-level domain that is deemed approved, and has executed the appropriate contracts with ICANN, is introduced into the DNS root zone.

The evaluation phase function for new gTLDs identifies those applications that are qualified to be forwarded to the provisioning (IANA) function. The TLD Application System (TAS), will accept applications, and those applications will be reviewed by a dedicated staff and independent evaluators allocated to the new gTLD program.

The second phase of the process, provisioning, ultimately ends with a notification to the requester regarding the creation within the root zone of a *delegation*, which is two or more name server ("NS") resource records, along with the address ("A" for IPv4 and "AAAA" for IPv6) resource records that correspond to the IP addresses of those name servers<sup>13</sup> and DNSSEC-related resource records used to ensure any in-transit corruption of the delegation information can be detected.

The size of delegations is generally small, at the time of this writing averaging slightly more than 508 bytes per delegation. Based on the analysis of the new gTLD provisioning rates that estimated an anticipated 200 to 300 new gTLDs per year, the size of the root zone can be expected to increase by about 100,000 to 150,000 bytes per year. In the worst case provided in the estimates for root zone growth as a result of the new gTLD program, the root zone would be expected to grow by as many as 1000 new gTLDs per year, resulting in a root zone growth of up to approximately 500,000 bytes. For context, at this writing, the size of the root zone is a bit over 150,000 bytes and has 311 delegations. Note that the 'L' root study showed no measurable impact in various root server performance metrics until millions of delegations were added and zone size was in the range of hundreds of millions of bytes.

### Implications Regarding Query Processing and Provisioning

As discussed in more detail in the documents cited above, the larger root zone resulting from the addition of new gTLDs on the scales enabled by the new gTLD program are extremely unlikely to lead to any significant change in query patterns to the root zone or to any impact on the ability of root servers to answer offered queries.

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<sup>13</sup> These address resource records are known as "glue" records. See [http://en.wikipedia.org/wiki/Domain\\_Name\\_System#Circular\\_dependencies\\_and\\_glue\\_records](http://en.wikipedia.org/wiki/Domain_Name_System#Circular_dependencies_and_glue_records) for more information on "glue" records.

A more realistic concern is in the provisioning phase in which root zone records are created or updated since this impacts the administrative aspects of the root management system (i.e., IANA processing, NTIA authorization, and Verisign implementation) as well as updates to the root server system. The current provisioning process for the creation of a new TLD can be described as:

- 1) The prospective TLD administrator submits a provisioning request to ICANN for the IANA function of TLD delegation.
- 2) IANA staff processes the provisioning request, verifying it is correctly formed and technically sound.
- 3) IANA staff requests authorization from NTIA for the delegation to proceed.
- 4) NTIA authorizes Verisign to create the appropriate records in the root zone to reflect the delegation.
- 5) Verisign updates the root zone and informs NTIA and IANA staff that the delegation has been made.
- 6) The new root zone is propagated to the root servers, per configuration and procedure by Verisign and the root server operators.
- 7) IANA staff ensures the delegation is published on the root servers and informs the TLD administrator that the provisioning request has been completed.

In the case of an update, the provisioning process is essentially the same. Many of the steps in the provisioning process can take not insignificant amounts of time: days, weeks, or in some cases months. As can be seen in Figure 1, the current provisioning load averages around 30 per month<sup>14</sup>.

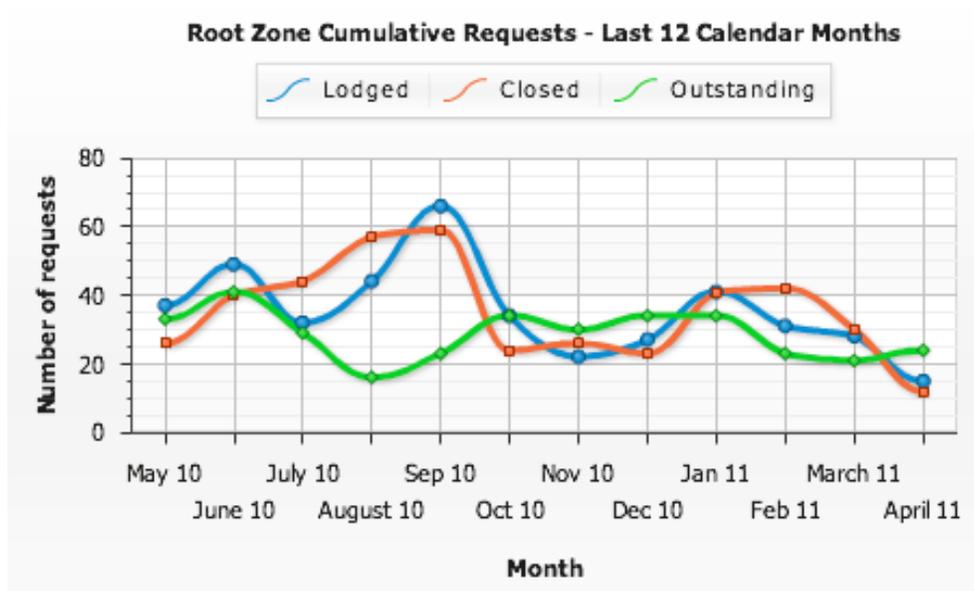


Figure 1. Root Zone Provisioning Load

<sup>14</sup> Taken from <https://charts.icann.org/public/index-iana-main.html> on 29 May 2011.

This provisioning load will obviously increase upon the initiation of the new gTLD program. Making the assumption that the average provisioning requests per month scales with the number of TLDs (and that the estimates for the number of new TLD applications remains constant), it can be anticipated that doubling the number of delegations in the root will double the number of provisioning requests. That is, the number of requests can be expected to climb from between 20 to 70 per month to between 40 and 140 per month. Even in the worst case anticipated in the estimates of new gTLD growth, namely a bit under 1000 new gTLDs, the growth in provisioning requests would be expected to be on the order of four times the current load or between 80 and 280 requests per month.

While much of the TLD provisioning process, specifically steps 2 through 5 and 7, is in the final stages of being automated (and step 6 has always been automated), it is impossible to fully automate the entire provisioning process. As such, there will be an increase in the load in the provisioning process as a result of the new gTLD program. It should, however, be noted that the timescale associated with this load is quite long: the amount of time quoted for the provisioning process at the time of this writing for an ideal case is quoted as taking "as little as a month or two"<sup>15</sup>.

## Summary

The root zone currently contains a bit over 300 delegations, making the size of the root zone over 150,000 bytes. Based on current estimates of new gTLD applications, between 200 to 300 new gTLDs are expected in the first year, implying the root zone will grow by between 100,000 and 150,000 bytes in the first year of the new gTLDs program, with a worst case estimate of nearly 1000 new gTLDs, implying a growth in the root zone size of approximately 500,000 bytes. Growth of this scale will have no noticeable impact on the ability of the root server system to respond to queries. With regards to provisioning, there may be impact, albeit the timeframe associated with that impact will be on the order of weeks or even months.

## Addressing Concerns

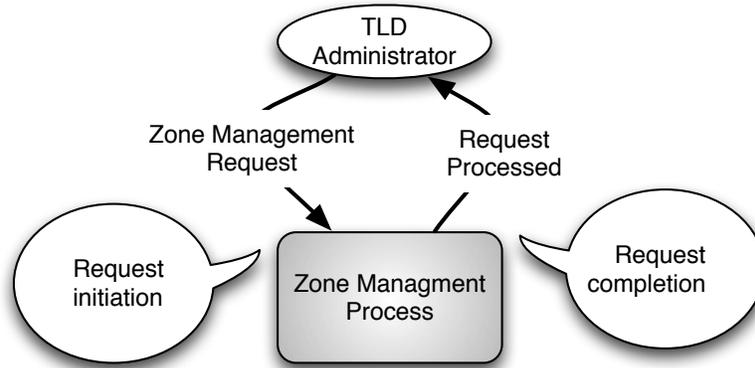
In order to address root scaling concerns expressed by the GAC, ICANN plans to implement both operational and administrative safeguards.

The primary concern relevant to scaling the root is that some part or parts of the root zone provisioning system will be unable to cope with the increase in either the number of root zone additions or the frequency of update requests that would likely correlate with the number of TLDs in the root zone. Previous efforts to model the root zone provisioning system have not been entirely successful due to the large number of parties involved and the varied inter-relationships of those parties. Despite this, monitoring the root zone provisioning system is necessary to ensure that any system overload is detected prior to that overload becoming an issue.

In order to detect potential overload, ICANN will monitor the number of addition or change requests being made by TLD administrators, and a single measurable output, the number of requests processed as reported back to the TLD administrators.

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<sup>15</sup> See <http://www.iana.org/domains/root/delegation-guide/>, Common Questions, "How long does a request take?"



**Figure 2. Simple Root Zone Provisioning Model**

This model, depicted in Figure 2, intentionally ignores the sub-components associated with root management such as IANA processing (including request and receipt of confirmations), NTIA authorizations, Verisign implementation, root server publication, etc., lumping all of these sub-processes into the “Zone Management Process” black box. Instead, this model focuses on the view of end users and TLD administrators: a request is made and after some time, notification of the request being processed is received.

At any given time there will be a queue of requests that are being processed in the root management system. If the processing ability of the aggregate of all the various parties involved in managing root zone requests is higher than the input rate, the size of the queue will be bounded and would be indicative of the system not being overloaded. However, if this processing rate is less than the input rate, a queue of requests will grow. If the queue of requests continues to grow over time, a state of provisioning system overload would be indicated.

As such, ICANN will monitor the average processing rate and the average input rate, along with variances of those rates as well as continue to monitor the queue depth as currently shown on the IANA Dashboard. If any of these measurements suggest an overload condition, the monitoring system will generate alerts that trigger actions described later.

Clearly, it is important for ICANN to establish a baseline for the average processing and input rates and average queue depth along with deviations from that baseline prior to new gTLDs addition requests being entered into the system. Anticipated advances in provisioning system automation would suggest that periodic re-establishment of this baseline would be warranted.

### ***Slowing and/or Suspending TLD Delegations***

As mentioned previously, ICANN will monitor the provisioning system to establish whether it is overloaded. In the event that a provisioning system overload condition is detected, either by the monitoring systems or via internal or external notification, an IANA Analysis team will review the overload condition. The composition of the IANA Analysis team, its terms of reference, operational practices and capabilities are areas in which further study is needed, and ICANN commits to providing the details of the IANA Analysis team prior to requests from the new gTLD program entering the provisioning system. In addition, specific definitions for an overload condition will be created when the numbers

of applications are known and are combined with planned staffing levels to define anticipated throughput levels and queue lengths.

After review by the IANA Analysis team, a determination will be made whether the overload can be immediately addressed with no impact to applicants or existing TLD administrators. If so, the overload condition will be mitigated, and the event closed. If not, or if the mitigation fails, acceptance of new gTLD provisioning requests will be suspended.

The IANA Analysis team will review the overload condition and ensure appropriate resources are brought to bear to address the situation. Based on the severity of the condition, the provisioning system elements involved, and the impact to the security and stability of the provisioning system, ICANN's executive team will make a determination as to whether delegation provisioning can be resumed and at what rate. In all cases, while the overload condition is being addressed, priority will be given to processing updates to the root system over new delegations.

Upon mitigation of the overload condition, ICANN will create an incident report detailing the root cause of the overload condition, how the overload condition was detected, and the steps taken to address the overload condition, and whatever actions taken or planned to be taken to ensure the overload condition does not reoccur.

It should be noted that due to the relatively long timeframes associated with provisioning and with the understanding that changes to existing delegations will continue to be processed, suspension of delegation provisioning would not affect root system stability. More generally, as discussed previously, the implementation of new gTLDs is not expected to impose any significant load to either the root server query response system (that is, the root servers) or the root zone provisioning systems and the load that is added will be done over timeframes counted in months. As such, should issues arise, there will be time to identify and mitigate those issues long before any negative impact on the root system is publicly apparent. However, due to the critical importance of the root systems, ICANN is committing to erring on the side of prudence with respect to monitoring and suspension of additions to the root zone should any overload conditions be detected.

### ***Deferring New TLD Acceptance Rounds***

Prior to the initiation of a round of accepting new gTLD applications, an examination process will be undertaken to determine if a new round of accepting applications should be initiated or deferred. This examination process will examine all data relating to both DNS root operations and root system provisioning to determine if any of those systems were stressed as a result of the deployment of the new TLDs. If any indicator of stress is identified, any and all efforts undertaken to address that stress will be examined. If the potential exists for the system stress to reoccur, subsequent new gTLD rounds will be deferred.

### ***Continued ICANN and IANA Operations***

As the growth in the root zone, and hence the manpower requirements necessary to effectively manage that growth, is anticipated to be relatively slow, adjustments to ICANN's operational plan can be made using ICANN's regular operational planning and budgeting mechanisms. In the case of indications of potential provisioning system overload as indicated by growth trends in data collected by ICANN's monitoring systems, ICANN will adjust budgetary and staffing plans as necessary to ensure that sufficient resources are available to mitigate any potential overload situations.

## Conclusions

As the new gTLD program moves forward, growth in the root system is anticipated. While the magnitude of growth is not expected to pose any significant issues with respect to scaling of the root system, ICANN accepts the GAC's advice that it would be prudent to monitor the root system, be in a position to delay or stop adding new gTLDs should stress in the system be detected, and defer additional rounds of acceptance of new gTLD applications should stress be observed on the root system.

ICANN will be deploying and/or making use of monitoring and alerting systems to track the state of the root system over time, in particular ensuring the provisioning system does not show signs of overload. ICANN will periodically publish the state of the root system in a report entitled the "Root Zone Safety Report". If this monitoring detects any issues that impact the ability of the root system to function normally, an incident response plan with a clear escalation path will be initiated in order to determine the cause(s) of the issues and how to address those issues in an orderly fashion.

With these efforts, ICANN believes concerns regarding scaling the root system will be addressed.