Internationalized Domain Names (IDNs)

Where Are We Now?

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ICANN

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1 Introduction

"The Web does not just connect machines, it connects people," said Tim Berners-Lee, inventor of the World Wide Web. He is quoted in the article, The Digital Language Divide, which further explains that "Language is just as important to building human connections online as it is offline." Looking at linguistic diversity and multilingualism on the Internet from a broader perspective, UNESCO explains that "Increasingly, information and knowledge are key determinants of wealth creation, social transformation and human development. Language is a primary vector for communicating information and knowledge, thus the opportunity to use one's language on the Internet will determine the extent to which one can participate in emerging knowledge societies."

The world is home to an estimated 7,000 languages, at least half of which are written languages with the remainder representing unwritten oral languages. Many different scripts are used to write these languages. For example, the Arabic language is written in the Arabic script, the Chinese language is written in the Han script, the English and French languages are written in the Latin script, and the Russian language is written in the Cyrillic script.

In order to increase digital inclusivity, end users should be able to navigate the Internet using the Domain Name System (DNS) in local languages and scripts. This would give users around the globe the ability to communicate online more effectively. ICANN's mission notes "…the foregoing prohibitions are not intended to limit ICANN's authority or ability to adopt or implement policies or procedures that take into account the use of domain names as natural-language identifiers." However, support of local languages must be done while preserving the security and the stability of the DNS (e.g., see recommendations in Unicode Standard Annex #31 on some limitations on the use of scripts in identifiers).

The Internet community realized early on that for the Internet to be a true global resource, the DNS would need to be internationalized (see history) to enable broader global reach and promote linguistic diversity. Internationalization efforts made by the community led to the eventual development of the first protocol for Internationalized Domain Names (IDNs) by the Internet Engineering Task Force (IETF) in 2003. Around the same time, ICANN published the IDN Implementation Guidelines. The IDN protocol by IETF was revised to IDNA2008, which is the currently applicable version. The IDNA2008 standard is defined in RFCs 5890 – 5894.

This report provides data available on IDN TLDs and IDN registrations at the second level. It also summarizes the current work underway at ICANN to support IDNs. Finally, the report presents the universal acceptance challenges of domain names and email addresses across various applications, tools, and technologies. The report is intended to share data and does not go into more details on the factors leading to this data.

2 Status of IDNs

The first IDN top-level domains (TLDs) were delegated in 2010 under the IDN country code top-level domain (ccTLD) Fast Track process. To date, 62 strings have been successfully evaluated for 43 countries and territories (61 delegated, one pending delegation), as shown in Figure 1.

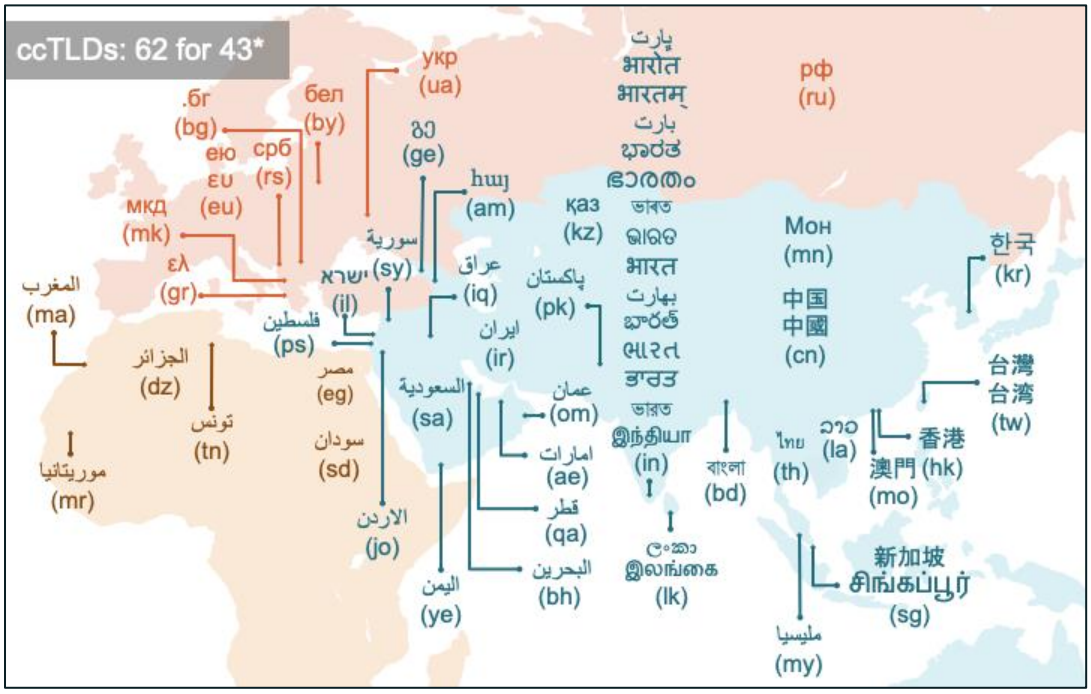
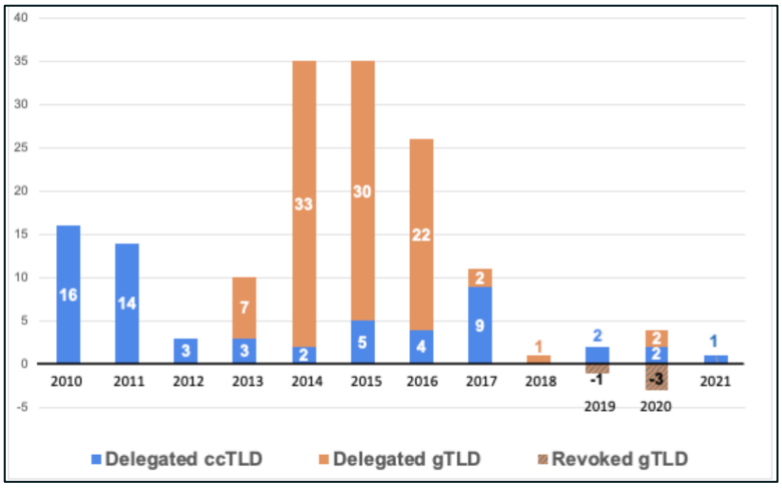


Figure 1: IDN ccTLDs Successfully Evaluated Under the IDN ccTLD Fast Track Process

Applicants were also able to apply for IDN generic top-level domains (gTLDs) in the new gTLD application round in 2013. Currently, 93 IDN gTLDs are delegated.

The delegation history by category (ccTLD and gTLD) of the 154 IDN TLDs is given in Figure 2. In addition, Figure 2b shows how the cumulative number of IDN TLDs (ccTLD and gTLD) delegated has increased since 2010 (when the first IDN TLDs were delegated, excluding the test IDN TLD delegations by IANA).

(a)



(b)

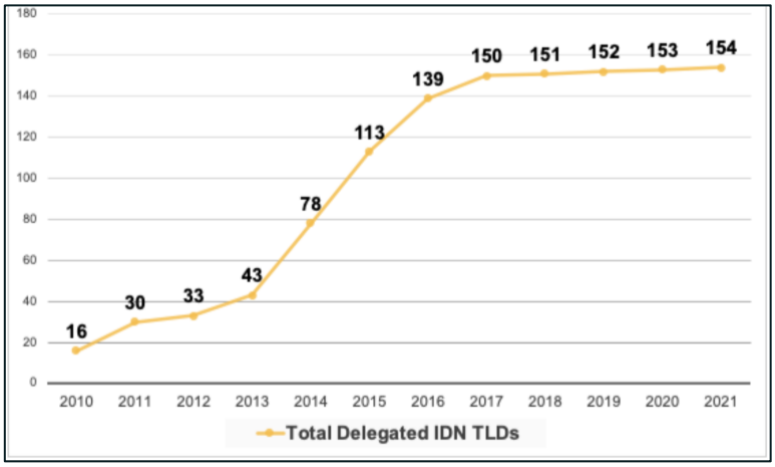


Figure 2: (a) History, and (b) Cumulative Delegations of IDN ccTLDs and IDN gTLDs

The IDN TLDs delegated to date represent 37 languages in 23 scripts.

The languages include Arabic, Armenian, Assamese, Bangla, Belarusian, Bengali, Bulgarian, Chinese, Georgian, Greek, Gujarati, Hebrew, Hindi, Japanese, Kannada, Kashmiri, Kazakh, Korean, Lao, Macedonian, Malay, Malayalam, Mongolian, Oriya, Persian, Punjabi, Russian, Sanskrit, Santali, Serbian, Sindhi, Sinhalese, Tamil, Telugu, Thai, Ukrainian, and Urdu.

The scripts include Arabic, Armenian, Bengali, Cyrillic, Devanagari, Georgian, Greek, Gujarati, Gurmukhi, Han, Hangul, Hebrew, Hiragana, Kannada, Katakana, Lao, Latin, Malayalam, Oriya, Sinhala, Tamil, Telugu, and Thai. The TLDs are grouped by scripts and presented in Figure 3[1].

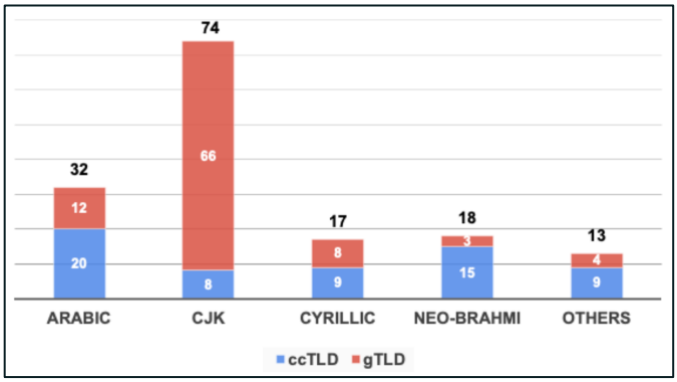


Figure 3: Delegated IDN ccTLDs and IDN gTLDs by Script

Figure 4 presents historical data of IDN registrations under ccTLDs and gTLDs from the IDN World Report. The data shows a steady increase since 2010. The registrations increased from less than 2 million in 2009 to a total of 9 million in 2019. The large fluctuation in the registration data can be attributed to many factors, including policy changes. For example, the IDN registrations under the Vietnamese ccTLD (.vn) significantly dropped from 1 million to only 5,000 in 2017 when the ccTLD changed its registration policy for IDNs[2].

[1] CJK represent Chinese, Japanese and Korean scripts. Neo-Brahmi include nine scripts: Bengali, Devanagari, Gujarati, Gurmukhi, Kannada, Malayalam, Oriya, Tamil and Telugu.

[2] "The decline in .vn IDNs came about due to VNNIC introducing a registration fee for IDN domain names in the Vietnamese country code top level domain. Until January 2017, VNNIC offered free registrations of second level IDNs under .vn and this resulted in nearly 1 million registrations. During 2017, VNNIC brought its IDNs in line with its ASCII

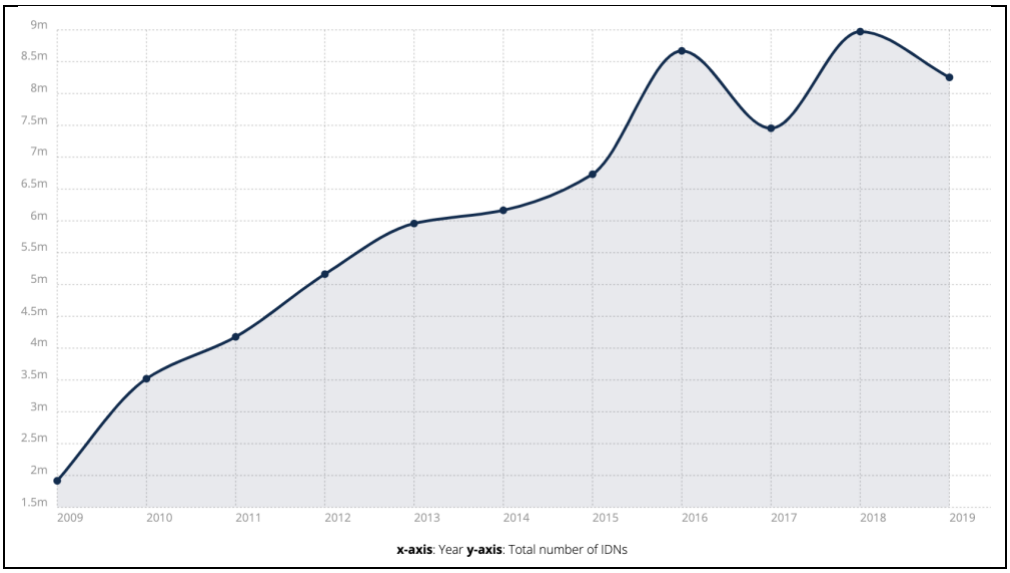


Figure 4: Total IDN Registrations Under IDN ccTLDs and IDN gTLDs from 2009 to 2019.

More recent data on IDN registrations at the second level under these gTLDs, grouped by script, are provided in Table 1[3]. Currently, there are 1.618 million total IDN registrations under all gTLDs. Comparing the data in 2019 between Figure 4, which shows about 8.3 million total IDN registrations, and Table 1, which shows 1.892 million IDN registrations under gTLDs, indicates that about 23 percent of IDN registrations were under gTLDs whereas slightly over 77 percent of IDN registrations were under ccTLDs.

Table 1: Second-Level IDN Registrations Under All gTLDs (in thousands)

Script/ Language	2015	2016	2017	2018	2019	2020	April 2021
Chinese	1,162	1,251	1,119	1,207	995	877	824
Latin	300	306	316	359	353	364	374
Japanese	347	482	435	341	222	140	123
Korean	112	131	126	143	146	136	139
Cyrillic	68	139	190	109	93	85	83
Thai	31	32	33	38	36	37	38
Arabic	26	26	26	27	24	21	20
Hebrew	9	7	7	12	9	7	7
Others	9	13	14	16	15	8	10
Total	**2,063**	**2,388**	**2,267**	**2,252**	**1,892**	**1,675**	**1,618**

domain offerings, with registrations available through its network of registrars for a fee. By the end of 2017, second level IDNs under .vn had dropped to just over 5,000", in IDNs on the Decline In 2017: IDN World Report.

[3] This data is collected by ICANN org internally using the gTLD zone files data.

Interestingly, there is a gradual decrease in total number of IDN registrations for the different scripts under gTLDs over the past two to three years as shown in Table 1, except for registrations in the Latin script, which continue to grow. Although there is significant demand for Latin IDNs at the second level, in the new gTLD round of 2013 only two Latin IDN gTLDs were delegated. There are no other Latin IDN TLDs because the current IDN ccTLD Fast Track Process does not allow countries and territories to apply for IDN ccTLDs in the Latin script.

Looking at the data for April 2021 in Table 1, Figure 5 shows the relative number of IDN registrations for the different scripts under gTLDs. Most IDN registrations are in the Chinese script followed by the Latin script.

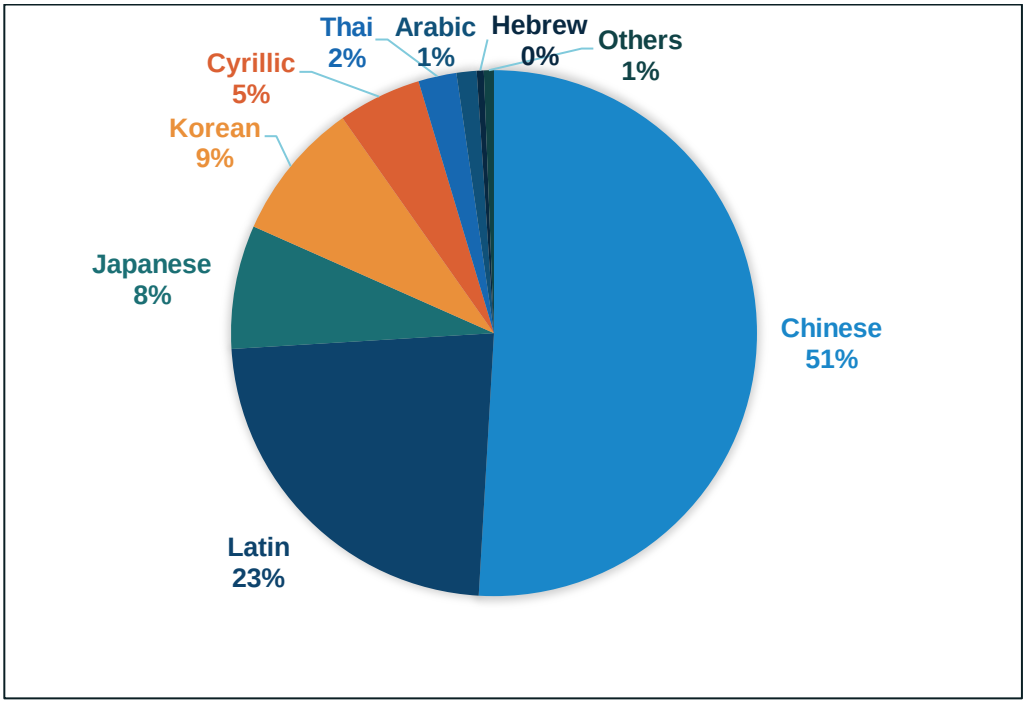


Figure 5: Percentage IDN Registrations by Script Under gTLDs in April 2021

It is worth noting that the total number of domain name registrations reported at the end of 2020 was 366.3 million[4], of which 158.9 million registrations are under ccTLDs and 207.4 million registrations are under gTLDs. At the end of 2020, there were 1,675,179 IDN registrations under gTLDs based on data from their zone files (see Table 1), which is merely 0.8 percent of total gTLD registrations under gTLDs, as shown in Figure 6.

[4] Source: https://www.verisign.com/assets/domain-name-report-Q42020.pdf.

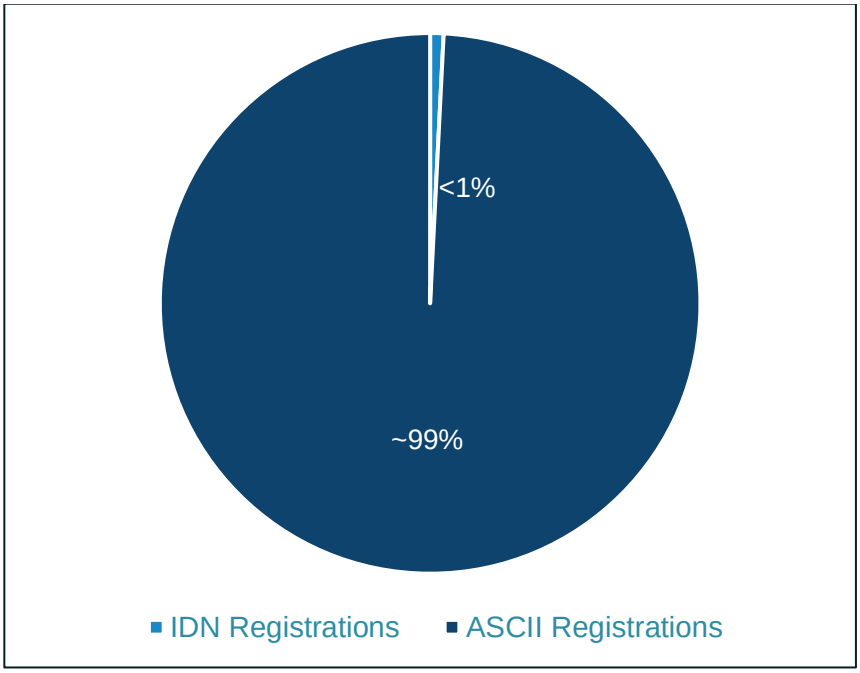


Figure 6: Percentage of ASCII and IDN Registrations Under gTLDs at the End of 2020

A more detailed look at the March 2021 data in Table 2 indicates that IDN registrations at the second level are distributed across all the different ASCII and IDN gTLDs. A total of 449 gTLDs have IDN registrations. Interestingly, most IDN registrations (69 percent) are under gTLDs that were delegated before the new gTLDs. In addition, only 21 percent of IDN registrations are under IDN gTLDs.

Table 2: Number of gTLDs with Second-Level IDN Registrations in March 2021

	Earlier gTLDs	**IDN New gTLDs**	**ASCII New gTLDs**	**Total**
TLDs	9	55	385	449
IDN Registrations	1,126,472 (69%)	344,414 (21%)	168,579 (10%)	1,639,465

Another way to look at this: 79 percent of IDN registrations are under ASCII gTLDs, whereas only 21 percent of IDN registrations are under IDN gTLDs. This indicates potential for IDN registrations under IDN gTLDs because there is generally more demand for IDN registrations, which IDN gTLDs have not been able to exploit for various reasons.

The IANA Repository for IDN tables lists 828 gTLDs that offer IDN registrations in different languages and scripts, while data shows that only 449 of these actually register IDNs. The analysis of the repository shows that many languages and scripts are offered for registration under these gTLDs, given that more than 14,000 IDN tables are listed. In addition, many gTLDs offer a broad set of choices, as shown in Table 3 below.

Table 3: The Number of IDN Tables Offered by the Number of gTLDs

Count of IDN Tables Covering Various Languages or Scripts	Number of gTLDs Offering the IDN Table Counts	Examples
50+	50	.AZURE, .BBVA, .SWATCH, .VISA, .कॉम, .คอม .香格里拉, .yahoo, .קום , .كوم
20 - 49	95	.GLOBAL, .BLUE, .GODADDY, .LAMGORHINI, .RICH, .. グーグル, .みんな, . 大众汽车
10-19	336	.AUDIBLE, .CAREERS, .FISH, .IMDB, PRIME, .ONLINE,. .ストア, .亚马逊
2 - 9	180	.GAME, .LINK, .LOL, .TOP, .ارامكو , .我爱你,
1	167	.BAYER, .BRUSSELS, .CAT, .YOKOHAMA, .삼성, .公司, .москва, .срб, .بازار

The familiarity of earlier gTLDs may make them more favorable for IDN registrations. Another potential factor is the lack of Universal Acceptance of new gTLDs, which may be driving the demand of IDN registrations under earlier gTLDs but preventing the growth of IDN registrations under new (ASCII and IDN) gTLDs.

Looking at IDN registrations under gTLDs from a registrar perspective, Figure 7 shows the number of registrars registering IDNs in the second half of 2020. The figure shows that only 17 percent of registrars register Chinese domain names, with IDNs in other scripts supported by even fewer registrars[5].

[5] Source: https://opendata.icann.org/explore/dataset/number-and-percentage-of-distinct-gtld-registrar-entities-with-idn-gtld-domain-r/information/.

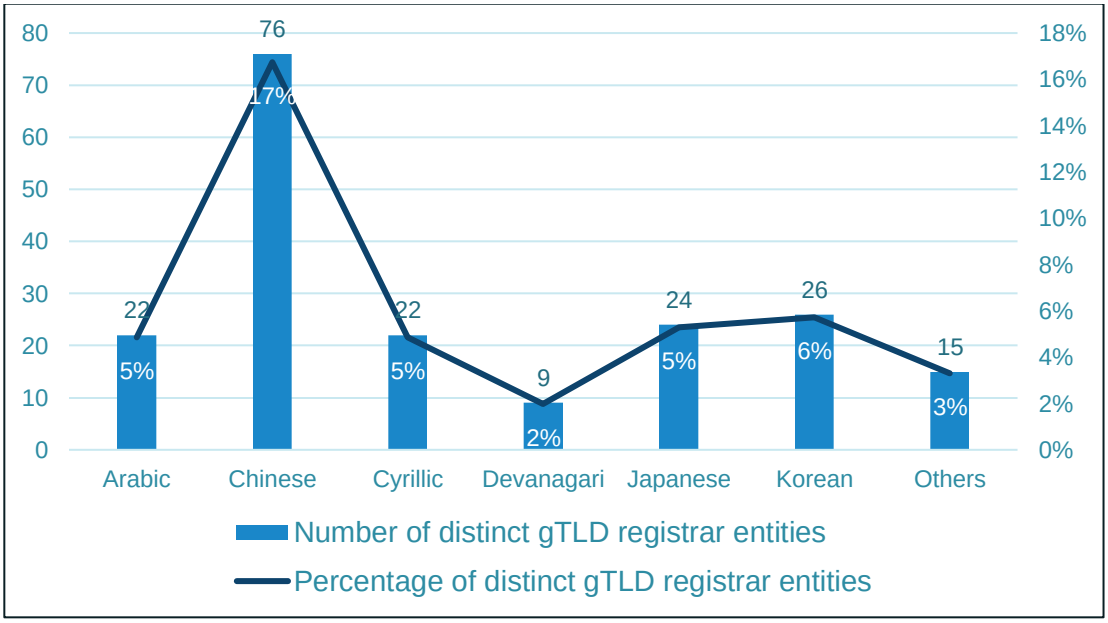


Figure 7: Distinct gTLD Registrar Entities with IDN Registrations (by Script) in H2 2020

Figure 8 shows a comparison of data for the registrations under 154 IDN TLDs (61 IDN ccTLDs and 93 IDN gTLDs) in 2020[6]. It should be noted that this comparison does not take into account the IDN registrations under ASCII ccTLDs and ASCII gTLDs.

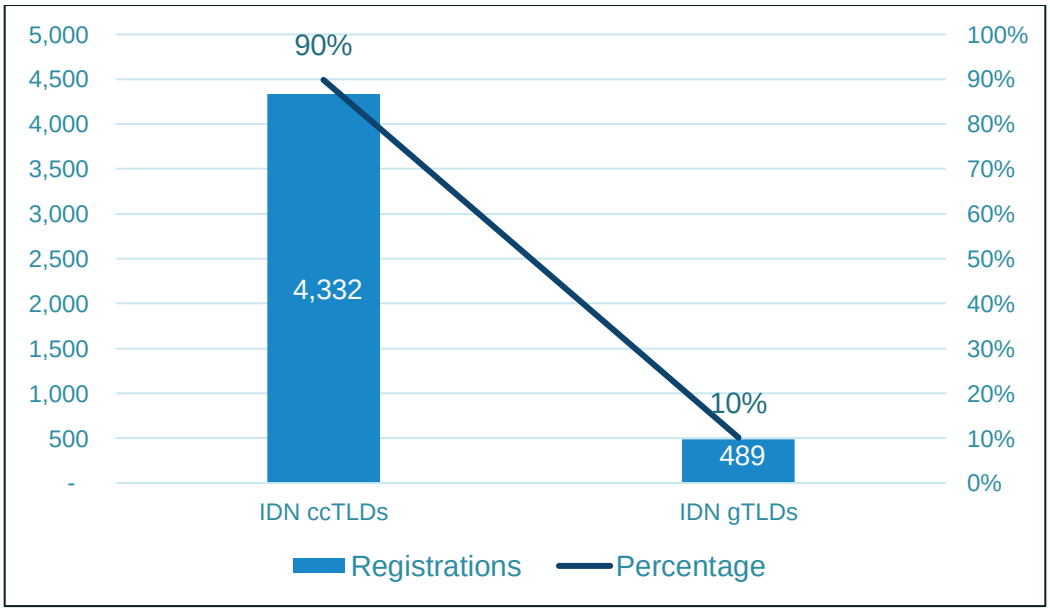


Figure 8: Registrations (in thousands) and the Percentage Under IDN TLDs in 2020

The IDN World Report also presents a useful correlation between local language content and the language of the domain name, shown in Figure 9. The report presents "A comparison of the native language of the global population, the primary language of all web content, and the

[6] Source: https://opendata.icann.org/explore/dataset/number-of-domains-by-tld-category/information/?sort=reporting_period.

primary language of IDN web content" and concludes that "With IDNs, the web content is more linguistically diverse."

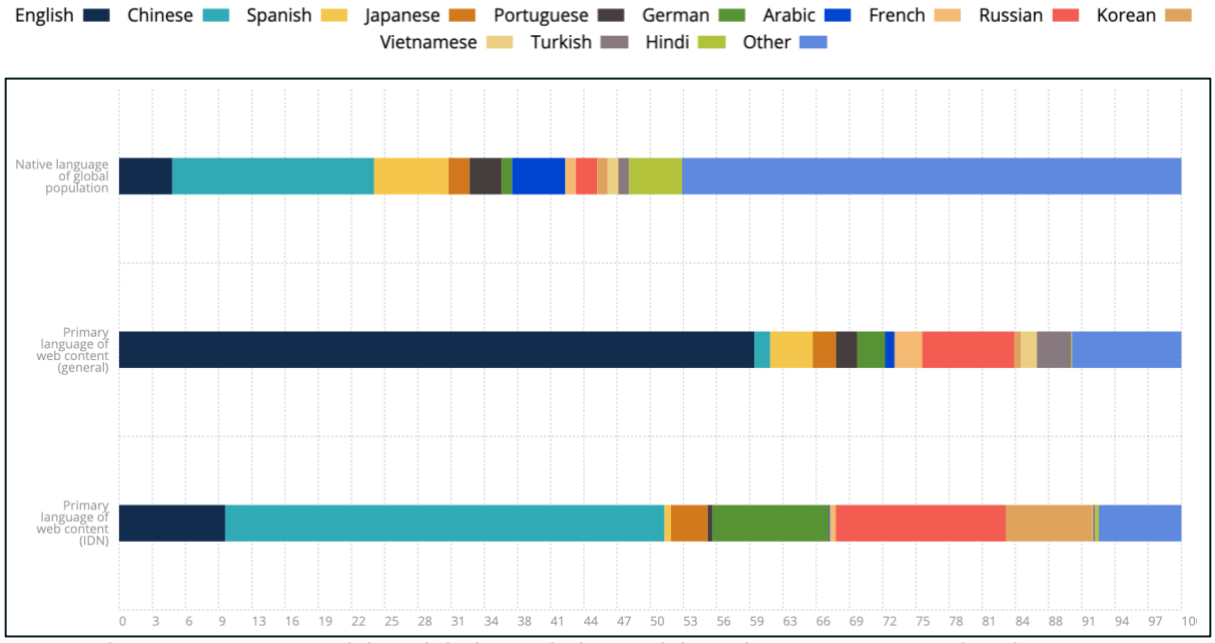


Figure 9: Language of the Global Population and the Primary Language of Web Content

3 Current Work on IDNs at ICANN

The ICANN community has been preparing for increased coverage of languages and scripts supported in the root zone. Through the Root Zone Label Generation Rules (RZ-LGRs) project, which initiated in 2003 following the resolution by the ICANN Board, the community has been striving to develop secure and stable mechanisms to determine valid strings and their variant labels. The community aims to support the following 27 scripts:

> Arabic, Armenian, Bangla, Chinese, Cyrillic, Devanagari, Ethiopic, Georgian, Greek, Gujarati, Gurmukhi, Hebrew, Japanese, Kannada, Khmer, Korean, Lao, Latin, Malayalam, Myanmar, Oriya, Sinhala, Tamil, Telugu, Thaana, Thai, and Tibetan.

All the commonly written languages using these scripts (which are in the hundreds) will be supported in the root zone. Figure 10 shows the status of progress by the various community-based panels.

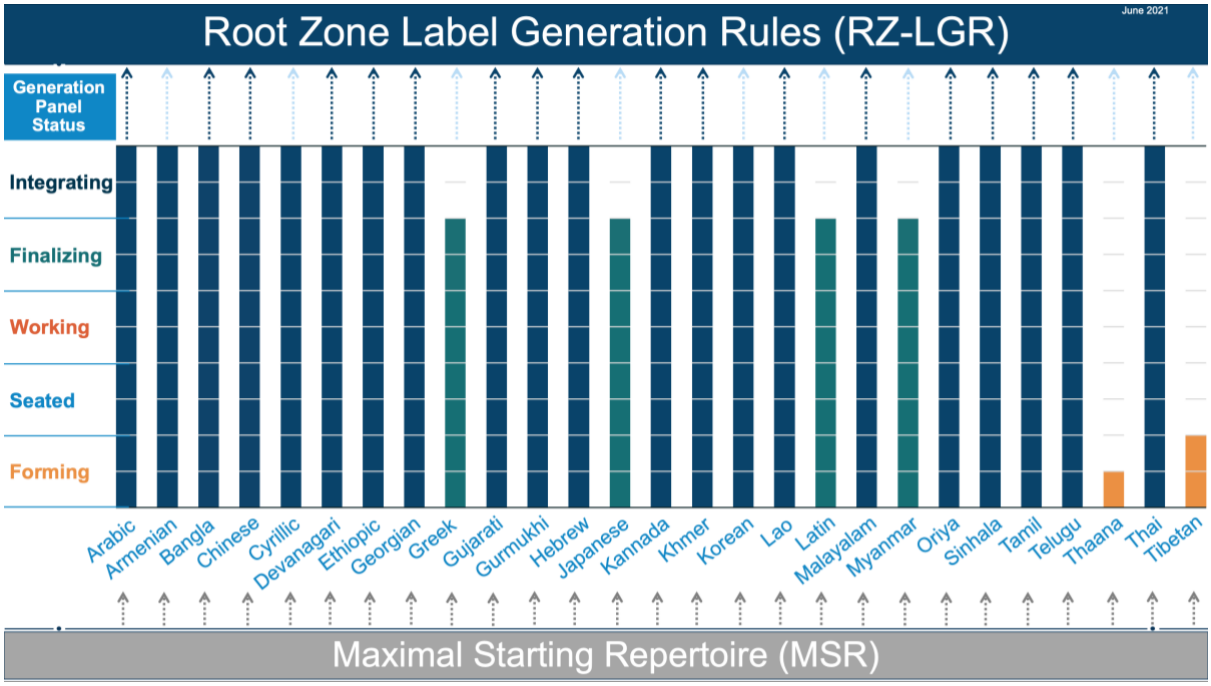


Figure 10: Status of Generation Panels Developing RZ-LGR Script Proposals

Both the Country Code Names Supporting Organization (ccNSO) and Generic Names Supporting Organization (GNSO) are engaged in policy development processes (PDPs) for ccTLDs and gTLDs, respectively to allow more comprehensive mechanisms to support IDN TLDs. RZ-LGRs determine valid IDNs and the variant labels for the root zone, helping to ensure the security and stability of the DNS. The policy development work being done by the ccNSO and GNSO also covers identifying, and possibly delegating, variant labels for IDN ccTLDs and IDN gTLDs, respectively. This work follows a detailed study published by ICANN organization (org) and adopted by the ICANN Board.

In addition, ICANN org is working with the community to publish reference second-level LGRs for use by registry operators. These reference LGRs are vetted for security and stability purposes. To date, 46 reference LGRs have been published:

> Thirty language-based LGRs: Arabic, Belarusian, Bosnian (Cyrillic), Bosnian (Latin), Bulgarian, Chinese, Danish, English, Finnish, French, German, Hebrew, Hindi, Hungarian, Icelandic, Italian, Korean, Latvian, Lithuanian, Macedonian, Montenegrin, Norwegian, Polish, Portuguese, Russian, Serbian, Spanish, Swedish, Thai, and Ukrainian.
>
> Sixteen script-based LGRs: Arabic, Bangla (Bengali), Devanagari, Ethiopic, Georgian, Gujarati, Gurmukhi, Hebrew, Kannada, Khmer, Lao, Malayalam, Oriya, Sinhala, Tamil, and Telugu.

ICANN org has also made available an LGR toolset for IDN tables and RZ-LGR, including a comprehensive set of operations to design, compare, and use LGRs.

4 Challenges Due to the Lack of Universal Acceptance

Users of newly delegated TLDs, particularly IDN TLDs, face a significant challenge because many current technology solutions consider them or identifiers using them invalid (including email addresses). This is because the tools these applications use, or the applications themselves, are outdated. Even more newly developed applications, as well as those that are in development, may not be properly configured to support new TLDs. Many technology developers are not familiar with the expanding TLD space and the need to support IDNs and associated email addresses in local languages. ICANN and volunteers around the world are working to educate developers about this issue and what needs to be done to ensure their solutions support the Universal Acceptance (UA) of all domain names and email addresses internationalized email addresses.

Due to the socio-economic significance of IDNs and UA, both have been included in the ICANN Strategic Plan for 2021-2025. The ICANN Board's IDN and UA Working Group has been tasked with overseeing this work. ICANN also funds and oversees the community-led Universal Acceptance Steering Group (UASG), which is exclusively focused on facilitating the Universal Acceptance of all domain names and email addresses in all software applications. Progress has been made, but recent gap analyses show that much more work needs to be done, as outlined below.

A recurring analysis of the top 1,000 global websites (UASG027, UASG025, and UASG017) shows that email addresses formed by using newer TLDs such as long TLDs, as well as those in local languages, are not well-accepted by these websites. Internationalized email addresses tested using Chinese and Arabic email addresses show that only about 11 percent were accepted by these websites, meaning 890 of the 1,000 websites rejected these valid email addresses incorrectly. This is summarized in Figure 11.

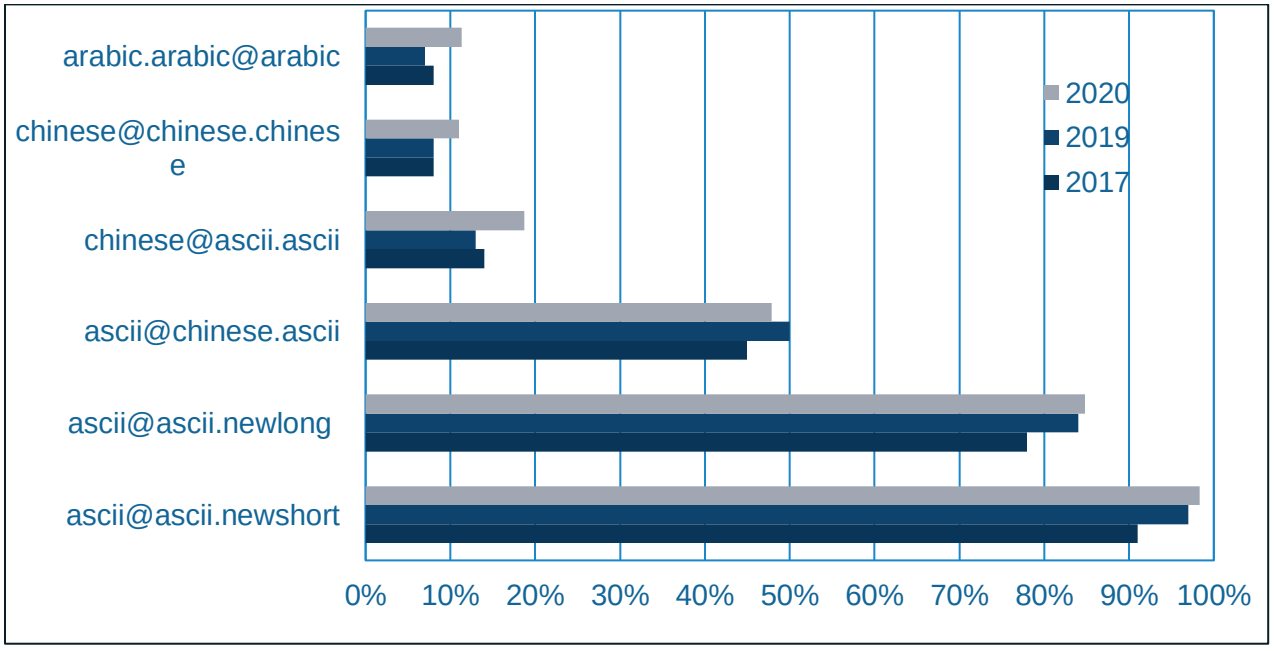


Figure 11: Gap in Universal Acceptance of Email Addresses by Top 1,000 Global Websites

Another study (UASG021D), which checked hundreds of thousands of mail-server configurations globally, shows that only 9.7 percent of these mail servers support email addresses in local languages. However, more email tools are becoming UA-ready and the situation is improving. For example, the configurations potentially improved with Microsoft Outlook supporting internationalized email addresses, as shown in Figure 12.

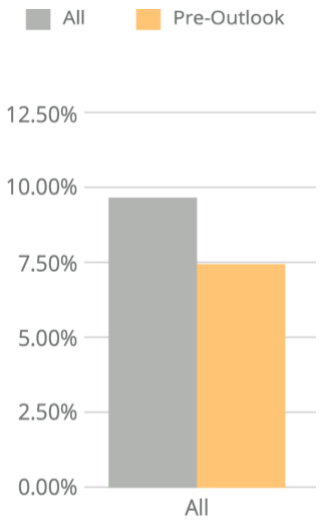


Figure 12: Percentage of Email Servers Configured to Support EAI

Additional studies show that gaps in underlying technologies exist, which exacerbates the situation by preventing UA-readiness from the start. Below are the results of the gap analysis studies done by the UASG for various kinds of tools, with detailed results in the reports linked. Note: the Green color generally shows UA-readiness, whereas pink or red indicates that the tool is only partially UA-ready or not UA-ready at all, respectively.

Figure 13 shows support of different programming languages able to support functions for UA. This is discussed in UASG018A in more detail.

Language	Library Name	Compliance on Dataset (%)	Type of Test
c	libcurl	84.3	Email Syntax
c	libidn2	95.2	ASCII to/from Unicode
csharp	mailkit	84.3	Email Syntax
csharp	microsoft	83.9	ASCII to/from Unicode
go	idna	79	ASCII to/from Unicode

go	mail	100	Email Syntax
go	smtp	19.6	Email Syntax
java	commons-validator	85.5	Email Syntax, Domain Name Syntax
java	guava	77.8	Domain Name Syntax
java	icu	93.5	ASCII to/from Unicode
java	jakartamail	82.4	Email Syntax
java	jre	71	ASCII to/from Unicode

js	idna-uts46	85.5	ASCII to/from Unicode
js	nodemailer	84.3	Email Syntax
js	validator	94.2	Email Syntax, Domain Name Syntax
python3	django_auth	48.1	Email Syntax, Unicode ID
python3	email_validator	86.3	Email Syntax
python3	encodings_idna	67.7	ASCII to/from Unicode
python3	idna	100	ASCII to/from Unicode
python3	smtplib	84.3	Email Syntax
rust	idna	87.1	ASCII to/from Unicode
rust	lettre	7.8	Email Syntax

Figure 13: UA Gap Analysis of Programming Languages

A similar analysis for email tools shows that many of the Mail User Agents (MUA), Mail Transfer Agents (MTA), Mail Delivery Agents (MDA), and Mail Submission Agents (MSA), and Mail Service Providers (MSP) do not support internationalized email addresses. More details are provided in UASG030.

Name	MUA	MSA	MTA	MDA	MSP	Web mail
Coremail	Few	All L2	Most L2	Few	All L2	Most L2
MS Outlook.com	Most L1	Most L1	Most L1	None	None	Most L1
Yandex Mail	Few	None	None	Few	Part	Few
Roundcube	Most L2					
Apple Mail	Few					
Apple iOS Mail 14.x	Most L2					
Mozilla Thunderbird	Few					
MS Outlook	Most L1					
MS Exchange Server		All L1	All L1	Few		
Exim		Most L2	All L2			
Postfix		All L2	All L2			
Sendmail		Not tested	Not tested			
Fetchmail				Not tested		
Courier		All L2	All L2	All L2		
Gmail	All L1	All L1	All L1	Few		
XgenPlus		Not tested	Not tested	Not tested	All L2	Not tested

Figure 14: UA Gap Analysis of Email Tools

Content Management Systems (CMS) are popular frameworks used to develop websites. Among them are WordPress, Drupal, Joomla, and many others. WordPress powers around 42 percent[7] of websites globally. A pilot study tested WordPress and some of its popular extensions for functions that may use domain names and email addresses to check for UA support. The results shown in Figure 15 indicate support for IDNs but little support for email addresses with mailbox names in local languages. See UASG032 for more detail.

[7] See https://w3techs.com/technologies/details/cm-wordpress.

(a) For IDNs:

Extension	Plugin Name	IDN UA Readiness
CMS	WordPress Instance	B-Level
Extension 1 Subscription Management	MailChimp	B-Level
	Mailster	C-Level
	OptinMonster	B-Level
	Newsletter	B-Level
	Sumo List Builder	C-Level
Extension 2 Membership Management	MemberPress	B-Level
	WooCommerce	B-Level
	Restrict Content Pro	B-Level
	Paid Memberships Pro	B-Level
	S2Member	C-Level
Extension 3 Event Management	Events Manager	B-Level
	WP Event Manager	C-Level
	Event Organiser	B-Level
	All - in - One Event Calendar	B-Level
	Event Espresso 4 Decaf	B-Level

(b) For Emails:

Extension	Plugin Name	Categories					
		ascii@ascii.ascii 1	ascii@idn.idn 2	unicode@idn.idn 3	unicode@RTL.RTL 4	ascii@RTL.RTL 5	ascii@punycode.punycode 6
CMS	WordPress Instance	A-Level	A-Level	C-Level	C-Level	A-Level	A-Level
Extension 1 Subscription Management	MailChimp	B-Level	C-Level	C-Level	C-Level	C-Level	C-Level
	Mailster	A-Level	A-Level	C-Level	C-Level	A-Level	A-Level
	OptinMonster	B-Level	C-Level	C-Level	C-Level	C-Level	C-Level
	Newsletter	A-Level	A-Level	C-Level	C-Level	A-Level	A-Level
	Sumo List Builder	B-Level	C-Level	C-Level	C-Level	C-Level	B-Level
Extension 2 Membership Management	MemberPress	A-Level	A-Level	C-Level	C-Level	A-Level	A-Level
	WooCommerce	A-Level	A-Level	C-Level	C-Level	A-Level	C-Level
	Restrict Content Pro	A-Level	C-Level	C-Level	C-Level	C-Level	A-Level
	Paid Memberships Pro	A-Level	A-Level	C-Level	C-Level	A-Level	C-Level
	S2Member	A-Level	A-Level	C-Level	C-Level	A-Level	C-Level
Extension 3 Event Management	Events Manager	A-Level	C-Level	C-Level	C-Level	C-Level	A-Level
	WP Event Manager	A-Level	C-Level	C-Level	C-Level	C-Level	A-Level
	Event Organiser	A-Level	A-Level	C-Level	C-Level	A-Level	C-Level
	All - in - One Event Calendar	A-Level	A-Level	C-Level	C-Level	A-Level	C-Level
	Event Espresso 4 Decaf	A-Level	C-Level	C-Level	C-Level	C-Level	A-Level

Figure 15: UA Gap Analysis of WordPress Content Management System

A survey of popular applications in GitHub shows that most of the applications in Java use outdated methods to validate domain names and email addresses. However, the applications in Python use libraries that provide UA support, as indicated in Figure 16. A study with this data will soon be published as UASG033 at www.uasg.tech.

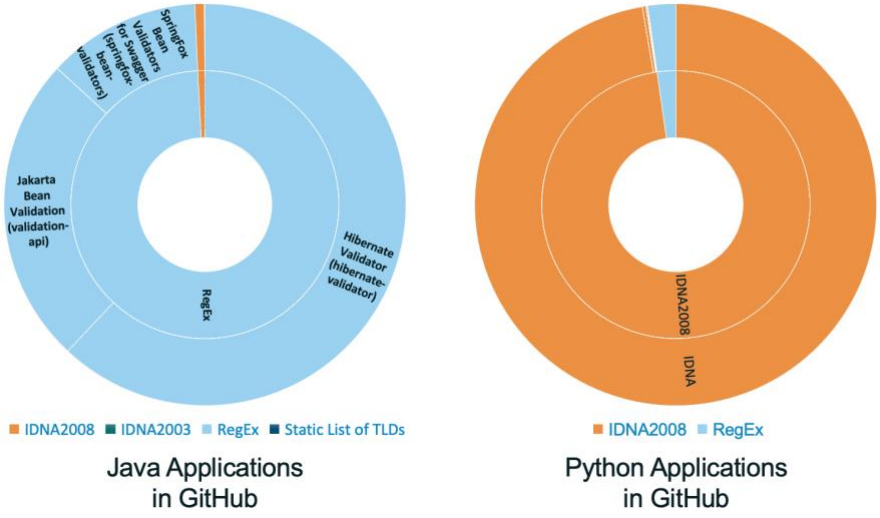


Figure 16: UA Gap Analysis of Open Source Software

A short study of networking tools also shows limited or outdated support for IDNs, as summarized in Figure 17 and explained further in UASG024.

Tool	MacOS 10.14 (BSD/Mach)	FreeBSD 12 (BSD)	Ubuntu 18 (linux)	Centos 7 (linux)	Windows 10
host	No	No	No	Yes*(D)	
ping	Yes*	No	Yes*(D)	Yes*(D)	Yes[1]
ping6	Yes*	No	Yes*(D)	Yes(D)	
traceroute	Yes*	No	Yes*(D)	Yes(D)	
traceroute6	Yes*	No	Yes*(D)	Yes(D)	
dig	No		No	Yes*(D)	
nslookup	No		No	Yes*(D)	No
telnet	Yes*	No	No		
openssl	Yes*	No	Yes*	No	
gnutls-cli		Yes	Yes		
tracert					Yes

Yes means that the command at least Accepts, Validates, and Processes. Yes(D) means it also displays domain names and shows IDNs as U-labels.
Yes* means that the command accepts IDNs, but processes them with IDNA2003 rather than IDNA2008
An empty box means that the system is not distributed with that tool.

Figure 17: Gap Analysis of Networking Tools

Browsers show promising support for IDNs on laptop computers but more work is needed on mobile platforms, as shown in Figure 18 below and detailed in UASG016.

(a) On laptop computers:

Test ID	Test Data	Chrome	Firefox	Opera	Safari	Edge	IE	Vivaldi
1	ua-test.link	Y	Y	Y	Y	Y	Y	Y
2	ua-test.technology	Y	Y	Y	Y	Y	Y	Y
3	普遍接受-测试.top	Y	Y	Y	Y	Y	Y	B
4	ua-test.世界	Y	Y	Y	Y	Y	Y	B
5	普遍接受-测试.世界	Y	Y	Y	Y	Y	Y	B
6	普遍接受-测试。世界	Y	A	Y	A	Y	Y	A
7	ua-test.xn--rhqv96g	Y	Y	Y	Y	Y	Y	B
8	xn----f38am99bqvcd5liy1cxsg.top	Y	Y	Y	Y	Y	Y	B
9	xn----f38am99bqvcd5liy1cxsg.xn--rhqv96g	Y	Y	Y	Y	Y	Y	B
10	اختبار-القبولالعالمي.top	C	Y	C	C	C	Y	B
11	اختبار-القبولالعالمي.شبكة	Y	Y	Y	Y	Y	Y	B
12	ua-test.link/我的页面	Y	Y	Y	Y	Y	Y	Y
13	ua-test.technology/我的页面	Y	Y	Y	Y	Y	Y	Y
14	普遍接受-测试.top/我的页面	Y	Y	Y	Y	Y	Y	B
15	ua-test.世界/我的页面	Y	Y	Y	Y	Y	Y	B
16	普遍接受-测试.世界/我的页面	Y	Y	Y	Y	Y	Y	B
17	普遍接受-测试。世界/我的页面	Y	A	Y	A	Y	Y	B

(b) On mobile platform:

Test ID	Test Data	Chrome		Firefox		Opera		Safari	Samsung Browser
		Android	iOS	Android	iOS	Android	iOS	iOS	Android
1	ua-test.link	Y	Y	Y	Y	Y	Y	Y	Y
2	ua-test.technology	Y	Y	Y	Y	Y	Y	Y	Y
3	普遍接受-测试.top	Y	Y	Y	B	B	B	Y	Y
4	ua-test.世界	Y	Y	Y	B	B	B	Y	Y
5	普遍接受-测试.世界	Y	Y	Y	B	B	B	Y	Y
6	普遍接受-测试。世界	Y	Y	A	A	B	A	A	Y
7	ua-test.xn--rhqv96g	Y	Y	Y	B	B	B	Y	Y
8	xn----f38am99bqvcd5liy1cxsg.top	Y	Y	Y	B	B	B	Y	Y
9	xn----f38am99bqvcd5liy1cxsg.xn--rhqv96g	Y	Y	Y	B	B	B	Y	Y
10	اختبار-القبولالعالمي.top	C	C	C	B + C	B + C	B + C	C	B
11	اختبار-القبولالعالمي.شبكة	Y	Y	Y	B + C	B + C	B + C	Y	Y
12	ua-test.link/我的页面	Y	Y	B	B	Y	B + E	Y	E
13	ua-test.technology/我的页面	Y	Y	B	B	Y	B + E	Y	E
14	普遍接受-测试.top/我的页面	Y	Y	B	B	B	B + E	Y	E
15	ua-test.世界/我的页面	Y	Y	B	B	B	B + E	Y	E
16	普遍接受-测试.世界/我的页面	Y	Y	B	B	B	B +E	Y	E
17	普遍接受-测试。世界/我的页面	Y	Y	A	A	B	A	A	E

Figure 18: Gap Analysis of Browsers

5 Concluding Remarks

Good progress has been made in ensuring that domain names are available in local languages and scripts. However, more work must be done to facilitate a more digitally inclusive Internet. This work should identify the challenges in the awareness and usability of IDNs and identifiers using IDNs, like the internationalized email addresses, and then address these challenges. A broader use of IDNs would help with realizing the significant benefits they bring to the communities using local languages around the world and help ICANN meet its mission to serve the community globally.

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