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Contents

1 Executive summary

In order to increase innovation, competition, and consumer choice, the Internet Corporation for Assigned Names and Numbeds (ICANN) significantly increased the number of top-level domain names in use and made them more international. These new domain names (referred to as gTLDs and IDNs) are not always universally accepted by all software, limiting the benefits from their introduction. Universal Acceptance (UA) refers to the process by which software is updated to accept all valid domain names and email addresses.

The new domains (gTLDs, Generic Top Level Domains which allow any text string using Latin letters, and IDNs, Internationalised Domain Names which allow domain names in most of the world's languages) have seen strong growth in registrations. Over 25 million have been registered to date, of which over 2.6 million are IDNs, including both country-code and top-level IDNs. This popularity demonstrates the value that Internet users place on the new domains, and also helps to drive the key benefits of UA.

The cultural, social, and economic benefits of UA accrue to Internet end users, the domain registrants who use the domain names as online identifiers, and to software owners themselves. Internet end users benefit because the Internet "works" without extra configuration. Domain registrants benefit because they can use their online identities effectively (including identities that can be local or regional, in local or regional languages). Software owners benefit because they gain access to a new set of customers who use the new domains. These three sets of benefits can create a virtuous circle, where UA helps to drive further registrations of new domains, which increases the benefits of UA. In addition, the acceptance of new IDNs could help to draw more speakers of languages that do not use the Latin script (such as Chinese, Russian, or Arabic) onto the Internet. We conservatively estimate that annual benefits from UA could be **USD 9.8 billion** per annum, just in the first year, from new and existing users.

Significant progress has been made towards UA, although acceptance is not universal. Certain industry bodies have performed testing and research to determine this. For instance, the company responsible for the .club domain has performed testing of 600 popular online applications to determine their acceptance of the .club domain. It found that an average of **65%** of these applications accepted the domain. In addition, ICANN commissioned research to determine the acceptance of the new domains by web browsers. It found that the new gTLDs were accepted **96%** of the time, whereas the IDNs were accepted **80%** of the time[1].

The effort required by software and application owners to implement UA is driven by the software development and coding work required to make the relevant changes. This is typically not onerous, with most companies treating UA issues as "bug fixes". Indeed, many companies, such as Adobe, Twitter,

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[1] Source: http://www.potaroo.net/reports/Universal-Acceptance/UA-Report.pdf. A domain was accepted if when, when clicking on a link to the domain presented by Google Adwords, the end user's browser successfully received the relevant content.

Verizon, and also banks such as Wells Fargo, have addressed UA issues rapidly when brought to their attention.

These factors highlight the benefits to application and software owners from implementing UA, so that the Internet continues to realise its full cultural, social and economic benefits.

2 Introduction[2]

In order to increase the cultural, social and economic benefits of the Internet, the Internet Corporation for Assigned Names and Numbers (ICANN) increased the number of top-level domain names in use and made them more international (see box). The number of domains in use has grown from 22 in 2012, to over 1200 in 2016. These new domain names are not always universally accepted by all software, limiting the benefits from their introduction. Universal Acceptance (UA) refers to the process by which software and applications are updated to accept the new domain names as valid.

All organisations should make their software UA ready. The Internet has grown and thrived as a result of interoperability, allowing more than 3.2 billion users, and growing, to use an increasing variety of Internet-enabled devices to communicate, engage in commerce and interact with their governments, such as by filing tax returns or registering to vote. When they choose a new domain name to identify themselves, and it is not accepted by an organisation, it not only frustrates the user and reduces the opportunities for the organisation to win a new customer, but also lessens the cultural, social and economic benefits made possible by the Internet.

This paper, written for the Universal Acceptance Steering Group (UASG, at www.uasg.tech) explores the progress made towards UA across the Internet, as well as the benefits that accrue to organisations which implement UA. We show that increased revenues from existing gTLD users could be **USD 3.6 billion**, just from increased online purchases, while up to **17 million** new users may come online with UA of IDNs, each of whom may spend up to USD360 per annum online, based on current (2016) averages.

Our research shows that the efforts required by software and application owners to implement UA are not particularly onerous, and are outweighted by the benefits that could be realised by doing so. In fact, we find that the main impediment to UA is a lack of awareness of the issue, a roadblock which this paper seeks to help overcome.

Domain names are the main online identifiers for organisations and individuals on the Internet. For email, a name might be john@doe.com, while the corresponding website might be www.doe.com. From left to right, 'john' is the individual email address, 'doe' is the second-level domain name identifying the organisation, and '.com' is known as a generic top-level domain (gTLD). While all domain names originally were in the Latin characters used in English, new internationalised domain names, or IDNs, include Latin characters with diacritics and ligatures as well as non-Latin scripts such as Arabic, Chinese, Cyrillic and Thai.

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[2] Analysys Mason has produced this white paper on behalf of the Universal Acceptance Steering Group (UASG).

3   An overview of the new domain names and Universal Acceptance

Here we introduce the new gTLDs and IDNs. We describe what they are, how they are structured and why they are used. We also describe the set of entities involved in managing them, registering them, and selling them to the public. Finally, we introduce UA and discuss implementation issues.

Introduction to the new gTLDs and IDNs

ICANN has released a new set of gTLDs with registrations (see box for history). They are intended to address limitations in the traditional set of top-level domain names, which originally ended in three letters (e.g. .com, .net, .gov, .org) or two character country codes.[3] In addition, traditional top-level domains were expressed in ASCII characters.[4] These limitations restricted the identities available to Internet users and website owners, limiting brand and name recognition.

A brief history of gTLDs

There were originally seven gTLDs: .com, .org, .gov, .edu, .mil, .net and .int.

In the early 2000s, ICANN introduced a number of new ones. These included the first ones with more than three characters (such as .museum and .info) and also the first sponsored domains, where the registry controlling the domain ensured that the organisations using them met certain criteria, such as .aero, sponsored by SITA, being reserved for airlines, airports and other parts of the air travel industry.

More recently, ICANN implemented the latest significant expansion, with over 1200 new gTLDs authorised, including about 100 top-level IDNs (a number of country-code IDNs have also been registered).

The new gTLDs include domains that end in three or more characters. This allows website owners to create online identities that better match their requirements. Examples include generic domains such as .photography and .blog; industry domains such as .bank and .insurance; geographical domains based on cities or regions, such as .london, .berlin or .bayern; and brand domains, such as .bmw, .google and .apple.

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[3]   Top-level domains are distinct from country-code top-level domains (ccTLDs), which end in a two-letter country code (e.g. .uk for the United Kingdom, .de for Germany, .fr for France).

[4]   ASCII (the American Standard Code for Information Interchange) is a way of encoding Latin letters, numbers and punctuation in a way that is readable by computers. ASCII includes the characters of the Latin alphabet, the numbers 0 to 9, and certain punctuation marks.

In addition, IDNs seek to address the limitations of traditional domain names for Internet users who speak a language with a writing system other than the Latin alphabet. Instead of restricting domain names to ASCII characters, IDNs allow Unicode characters to be used. Unicode allows the encoding, representing and handling of characters in many more languages.[5]

This means that IDNs allow domains to be expressed in most of the world's written languages, and not just English. Examples include French (.musée), German or Spanish, Russian (.ОНЛАЙН), and Chinese (.网络, and .信息). In contrast to country-code TLDs (ccTLDs) that use ASCII characters, country-code IDNs (e.g. .ОНЛАЙН.рф) require UA. This is because their use of Unicode characters in the fields before the country code means that they may not necessarily be accepted by existing software and applications.

The process for registering and managing gTLDs and IDNs is the same as for traditional gTLDs. It involves three key parties – registries, registrars and registrants – in addition to ICANN. An Internet registry manages the administration of a domain (such as .bank). The registry certifies registrars to allocate names within a domain to registrants. A registrant can be an organisation or an individual who registers a domain name for identification with online service such as websites and email.

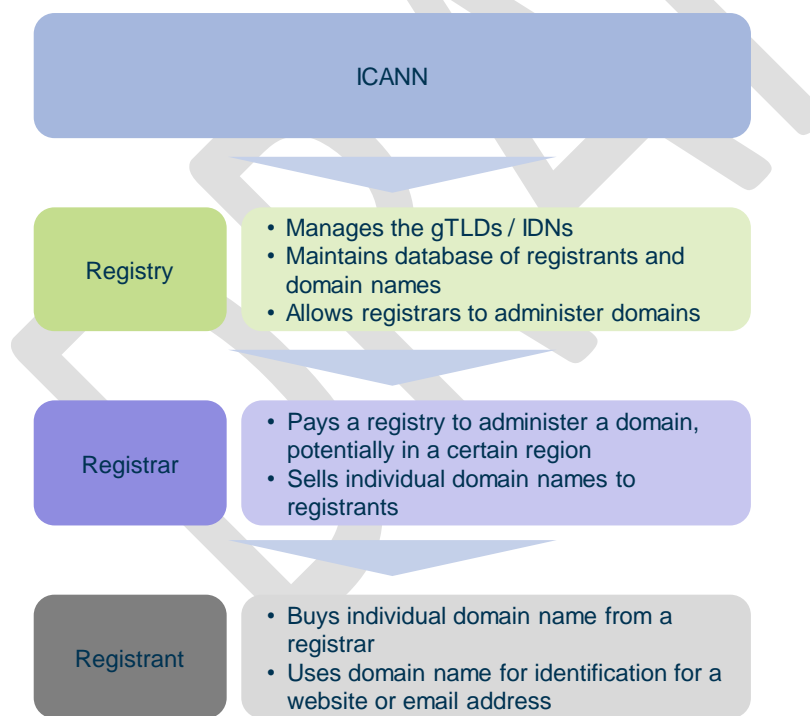This set of entities and corresponding relationships is illustrated in Figure 1.

Figure 1: Illustration of the relationship between Internet registries, registrars, and registrants [Source: Analysys Mason, 2016]

ICANN

Registry
- Manages the gTLDs / IDNs
- Maintains database of registrants and domain names
- Allows registrars to administer domains

Registrar
- Pays a registry to administer a domain, potentially in a certain region
- Sells individual domain names to registrants

Registrant
- Buys individual domain name from a registrar
- Uses domain name for identification for a website or email address

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[5] Unicode is a standard for the consistent encoding, representation and handling of text expressed in most of the world's writing systems.

Take-up of the new domains

The new domains have seen strong growth in take-up. This growth is a key driver of the benefits of UA, which we discuss in more detail in Section 4. gTLDs, in particular, have seen significant growth, with close to 25 million domain names registered. Of these, approximately 10 million domain names are used[6]. By this, we mean that they contain more than just a generic landing page. The

> **Over 1200** new domains
> **24,476,319** new domain names registered as at Q3 2016
> **951,940** IDNs registered as at Q3 2016

other 14 million domains are "parked". These domains either redirect elsewhere or just contain a single landing page.[7] This is illustrated in Figure 2.
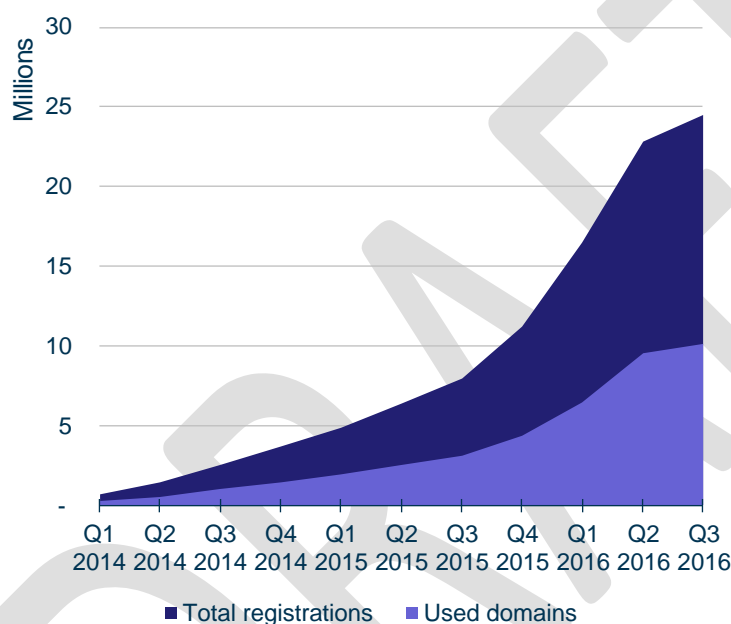

Figure 2: Take-up and usage of new gTLDs [Source: ntldstats.com, 2016]

Domain names have been registered in over 1200 gTLDs. These include generally useful text strings such as .online, .photography or .club, as well as brand-specific domains (.sony, .audi, .barclays), and geographical domains (.bayern, .london, .paris). These registrations are concentrated in the top-ten domains, which make up 64% of the total. A large proportion of the recent growth in registrations (40% of the registrations between Q4 2015 and Q2 2016 were accounted for by the .xyz domain). This is illustrated in Figure 3.

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6 By "used" we mean that the domain name points to a website that contains live content.

7 Registrants park domain names for many reasons. For instance, it simply can take time to set up a website once a domain name has been registered, or it can be reserved in anticipation of a future use.
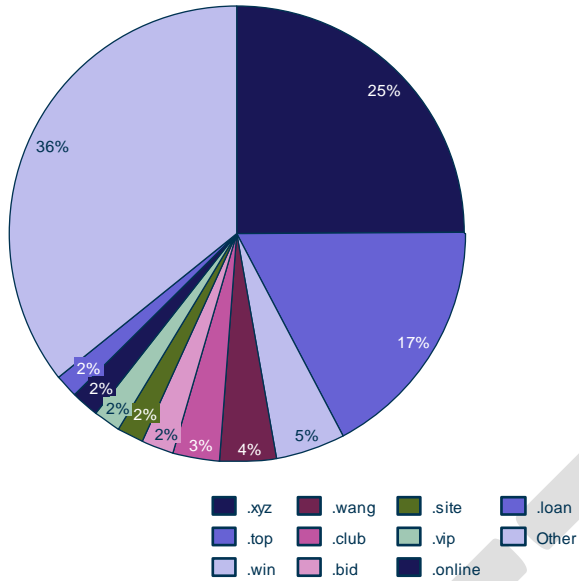
analysys mason

Figure 3: Proportion of registered gTLDs in each domain [Source: ntldstats.com, 2016]

At the top level, there has also been rapid growth (142% per annum CAGR between Q4 2014 and Q4 2016) in the registration of IDNs. The majority of these are in Chinese. Top-level cumulative IDN registrations are illustrated below in Figure 4.
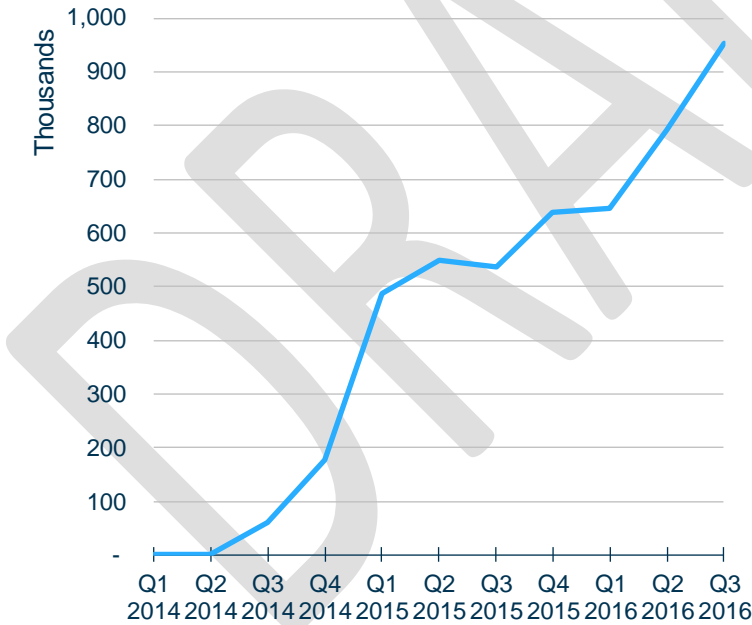

Figure 4: Cumulative registrations of new top-level IDNs [Source: ntldstats.com, 2016]

There are also a large number of IDN ccTLD registrations. The most significant of these have been in Russian, Korean and Chinese, with approximately 900,000 Russian[8] ccTLDs registered as at November 2016, and a similar number of Chinese domains registered.

Overall, these numbers lend urgency to the goal of UA. The millions of gTLD based domain names need to be accepted, in order both to encourage continued growth, but also to ensure usage. At the same

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8 Source: http://stat.nic.ru/en_rf/2016/11/07/rating-20161107.shtml

time, the internationalised domain names have the promise of delivering the complete Internet experience to those who do not use Latin alphabets, with corresponding benefits to the organisations accepting those new names.

What do we mean by Universal Acceptance?

Domains are used in many ways beyond simply identifying a website or the creation of email addresses (e.g. www.acme.company allows email addresses of the form name@acme.company). They can also be used by the users of the domain name and its associated email addresses to interact with a range of software and applications. Key examples of this include:

- Internet users can use their email addresses and domains to sign up for and use online applications and services, such as e-commerce, social media and other applications.

- Internet users can interact with government and regulatory services (e.g. registering to vote, filing tax returns, submitting regulatory filings and disclosures) using their domain names and email addresses.

- Traditional software packages, such as word processing or spreadsheets, interact with domain names and email addresses. For example, if a user types a domain name into a word processing package, it is automatically recognised as a domain name, and turned into a hyperlink (known as 'linkification').

These are just a small sample of the many ways in which domain names and their associated email addresses are used beyond simply identifying websites. It is these uses that are the focus of UA.

It is not automatic that the newly created gTLDs and IDNs will work in every application. For security reasons, applications may check that domain names and email addresses are valid. If a new domain does not pass the validation rules imposed by an application, it will not work with the application. When this happens, the domain is not "accepted" by the application.

UA means that software and applications have been updated to accept the new gTLDs and IDNs. This means that any end user with one of the new domain names can use the application's full functionality with no compromise on performance.

Clearly UA is crucial to the success of the new domains. However, UA is not within the control of the users, registrars or registries of the new domains. Instead, it depends on the owners and operators of software and applications. These organisations must invest in updating their systems to accept the new domains, with corresponding benefits in accepting new users and usages.

4 The benefits of Universal Acceptance

There are potentially significant benefits to the wide implementation of UA by all relevant software and applications, which can be categorised into cultural, social and economic benefits. These benefits accrue to all users of the Internet – end users, domain and website owners, and application owners. This can create a virtuous circle where application owners implement UA, which spurs further registrations of the new domains, which benefits end users and spurs further UA, similar to that experienced by the Hong Kong museum community, as discussed below.

In this section, we discuss how UA benefits different categories of Internet users, and how this can spur a virtuous circle. We then discuss and estimate some of the cultural, social and economic benefits of UA.

4.1 How UA can contribute to a virtuous circle of acceptance and registrations

The benefits of UA are closely related to the benefits of the new domains themselves. For users of the new domains to benefit from their use, the domains must be accepted by software and applications. The benefits to software and application owners of implementing UA flow from the widespread use of the new domains amongst Internet users who make up the customers of software and application owners. We have already seen in Section 3 that the new domains are popular, and have seen significant growth in registrations and use.

The benefits of UA flow to three categories of Internet users. The end users themselves, domain name and website owners, and application and software owners, among whom we seek to encourage UA. We discuss each in turn:

- *End users* gain from UA, fundamentally because it means the Internet "works" without extra configuration or attempts to fix problems. The general community of Internet end users benefits because they can use websites that use the new domain names in their own languages and their own scripts. They can also send and receive emails to other users who use the new domain names. Users of the new domain names and email addresses will have access to all the services and applications that they would normally use.

- *Domain name and website owners* gain from UA because it allows them to receive the full benefits of the new domain names themselves. The new domain names allow a stronger or new identity, in the local language if relevant, helping with marketing or awareness. This identity could be based on many things, including brand, regional or national identity, or identity as a cultural or educational institution. UA means the domains work, therefore contributing to a positive user experience. This will also help to drive further registrations.

- *Application and software owners* (the focus of this paper) benefit from UA because it means they can successfully serve all Internet users as customers. If an application does not accept new domains, it will fail to work adequately for a large and increasing number of potential customers.

This causes a problem in proportion to the number of customers using the new domains. The benefit of UA to application and software owners grows with the number of new domains registered and in use. These benefits may differ somewhat between gTLDs and IDNs, depending on the software. A local business in the USA is less likely to benefit from accepting Russian-language IDNs than a business in Russia. However, the existence of a centralised database of registered domains (see section 6) reduces the impact of this problem in practical terms.

The virtuous circle created by these benefits is illustrated below.

Figure 5: Illustration of the virtuous circle of benefits from UA [Source: Analysys Mason, 2016]
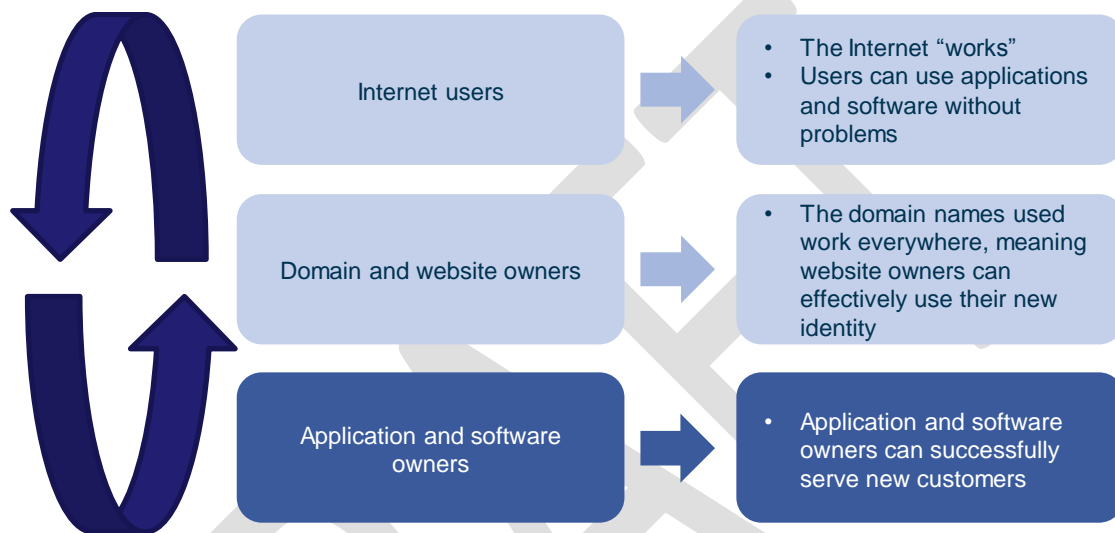
4.2 The cultural, social and economic benefits of UA

As discussed above, the benefits that accrue from UA can be categorised as *cultural, social* and *economic*. In this section, we explore and seek to estimate some of these benefits.

Cultural and social benefits: localisation, language, and the .bayern case study

The new domains significantly broaden the range of new domain names and identities that can be created. This allows cultural organisations and communities to create their own, highly relevant, online identities. These can be expressed in their own languages and scripts, and are not limited by the dominance of English and the Latin script on the Internet. These benefits are qualitative by nature and difficult to quantify. As such, we will illustrate them by means of a case study. We also discuss further cultural and social benefits in the box below, which examines language benefits.

Bayern Connect has registered and administers the .bayern domain. This domain is intended to provide a regional identity for the Bavarian region of Germany. It is used by local sporting, cultural and tourist organisations. It has also facilitated the use of the local Bavarian dialect on the Internet, in addition to standard German. From a brand perspective, the domain has several advantages. Regional organisations

can express their brands more effectively. They can create more trust amongst Internet end users, especially within the regional community. More broadly, the new domains allow a proliferation of innovative and diverse cultural and economic enterprises, as they allow the creation of an infinite number of domain names.

Bayern Connect, as part of its role as the registry for the .bayern domain, helps its clients with UA issues. Its aim is to ensure that the domain is widely accepted by software and applications, in order to maximise its cultural benefits to the Bavarian region. In the view of Bayern Connect, the domain is now accepted in 80% to 90% of cases, although in its first year of existence, it was not accepted by key Internet applications, including Facebook and Twitter. This high acceptance of the domain has helped regional Bavarian entities reap the cultural benefits promised by their use of the new domain.

The language benefits from IDNs may be particularly important towards increased growth of the Internet. With the widespread availability of mobile broadband, the availability of Internet access in emerging regions is no longer the impediment it once was – instead, the challenge is to increase interest in the Internet to convince non users to adopt, and existing users to increase their usage. As such, local content, relevant to local interests, is key, and language is a signicant element of locally created content.

As can be seen in the graph below, English language content far outweighs English speakers in general, as well as English speakers online, whereas languages such as Chinese and Arabic are significantly underrepresented online. Increasing the ability to use domain names in those languages with UA would help decrease these unbalances, and bring the cultural, social, and economic benefis of the Internet to everyone, not least the software and application providers who accept the new domain names.

Figure 6: Proportion of Internet users, websites and native language speakers [Source: internetworldstats.com, ethnologue.com, 2016]
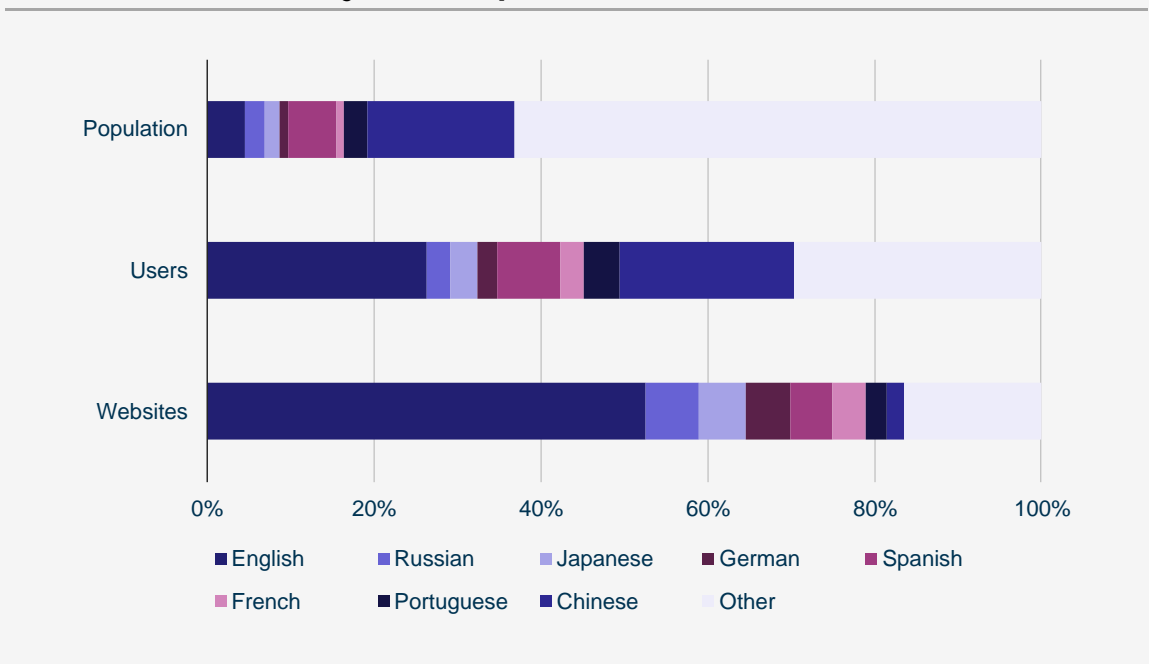
Cultural benefits: Hong Kong Science Museum case study

As part of our work, we spoke with the Hong Kong Science Museum, which highlighted some of the cultural benefits of UA, as well as some of the challenges.

The Hong Kong Science Museum is a long-time user of the .museum domain. Its website is http://hk.science.museum. The experience of the Hong Kong Science Museum regarding the acceptance of its domain is positive. The museum's view is that in its key markets of Hong Kong and Greater

China, the progress of UA has been strong. It has not experienced any problems with the domain being accepted by the applications and websites important for museums (such as government ministries and email software)[9]. This has helped to create a virtuous circle. All museums in Hong Kong and many throughout China use the .museum domain. This means it is well known amongst both the museum community and the application and software providers that serve it. As such, there is a strong incentive for application and software providers to implement UA.

According to the museum, this contrasts with the situation in Japan and South Korea, where the majority of museums use legacy, country-level domain names in ASCII format For example, the Tokyo National Muesum uses www.tnm.jp., and the National Museum of Korea uses www.museum.go.kr. At the same time, in Japan and Korea, in the experience of the Hong Kong Science Museum, there is limited acceptance of the new domains. As such the staff of the Hong Kong Science Museum experience difficulties when interacting with relevant applications in Japan and Korea. The museums in Japan and Korea may have been reacting to the lack of acceptance when choosing their names; however, the result is today that there may be less push for UA than there was in Hong Kong and China.

Economic benefits of UA of IDNs and gTLDs

As discussed above, acceptance of the new domains can yield economic benefits as well as social and cultural ones. We have made a very high-level, and conservative, estimation of the potential yearly magnitude of these benefits, for both IDNs and gTLDs. We first look at the additional spending of existing users who have new gTLDs that would result from UA, and then at new users who might come on as a result of UA.

One of the key benefits of acceptance of the new gTLDs is that it gives owners of software the opportunity to serve new customers who are using the new domain names. These new customers can generate revenue for, say, e-commerce companies which accept the new domains. We have estimated the potential new revenue from accepting the new domains. We define this as the potential total e-commerce revenue generated by the users of the new domains that is generated when applications are updated to accept them. We have produced a conservative estimate of this as follows:

- First, we estimate the total e-commerce revenue currently generated globally. This is estimated by Statista at USD 1 548 billion.

- Second, we estimate the average revenue per existing email address. We do this by estimating the total number of email addresses in the world at 4.3 billion, based on numbers from Verizon and Radicati regarding the total number of domains in the world, and average email addresses per domain. This gives us an average revenue per email address of USD 360 per annum.

- We then calculate the number of email addresses that are based on new gTLDs. We do this by multiplying the average number of email addresses per domain (13) by the total number of domains registered using gTLDs (11.7 million).

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[9]   The .museum domain was released earlier, so is less likely to experience UA issues

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- We then apply the revenue per email address to the number of email addresses created with the new domain names. This yields a high-level estimate of the total e-commerce revenue that could potentially be generated by all users of the new domains if the retailers accepted all registrations with new gTLDs.

- To determine the proportion of this that could be unlocked with UA, we multiply by the proportion of e-commerce websites that are not currently UA ready (13%), based on the results of industry testing (in the next section).

This methodology yields a potential revenue of **USD 3.6 billion** per annum globally, just in the first year. Note that this figure does not take account potential future growth in e-commerce spend, or in the registrations of the new domains. It is therefore a conservative metric.

One of the key benefits of IDNs is that they can help lower barriers to Internet take-up amongst people who speak languages that do not use the Latin script. Acceptance of these domains will most likely spur a proportion of non-users to take up Internet services. We estimate the additional value created by looking at five major languages and language groups that would benefit from IDNs since they use non-Latin scripts (Russian, Chinese, Arabic, Vietnamese, and Indian languages as a group[10]). We have done this as follows:

- First, we estimate the number of non users of the Internet amongst speakers of each language. This is based on data from Ethnologue and Internet World Stats. We estimate that there are 68 million Russian speakers, 550 million Chinese speakers, 131 million Arabic speakers, 19 million Vietnamese speakers, and 805 million speakers of Indian languages who are not Internet users.

- Second, based on prior research commissioned by Analysys Mason,[11] we estimate the proportion of non users for whom a lack of local language content is a barrier (this is estimated at 22% for countries similar to these).

- Finally, to be conservative we assume that just 5% of these will take up Internet services because of UA of the new domains, each of whom will begin to spend money online, equal to the global average for e-commerce spend.

This methodology yields 17 million new users, and if each spends an average amount online, that is a total annual benefit of UA of the new IDNs of approximately **USD 6.2 billion** per annum, for these five language groups, driven by additional take-up of Internet services amongst non users. Again, this does not take account of future growth in online spend per user, nor the other languages benefitting from UA, and as such is a conservative estimate.

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[10] Note that statistics regarding Internet users are not available for individual Indian or Chinese languages. As such, we make the calculation for these two language groups as a whole.

[11] Source: http://www.analysysmason.com/Research/Content/Reports/Broadband-in-Asia-Pacific-investment-partnerships-policy/.

5 Progress towards the implementation of Universal Acceptance

There has, to date, been meaningful progress towards the implementation of UA amongst application owners, with some companies making significant efforts. However, this process is not complete, and a significant number of applications still do not accept the new domains. UA has progressed less for IDNs than for ASCII gTLDs. We can draw this conclusion by looking at testing performed by key players in the industry

Various bodies involved in the registration and management of the new domains have conducted a number of tests to determine the extent of UA. The registry responsible for .club (.Club Domains LLC), which makes up 3% of all registrations of new gTLDs and IDNs, conducted testing in May 2016 to determine the extent of acceptance of the .club domain. The results of these tests help us determine the acceptance of all gTLDs, since it is likely that an update to accept one gTLD means accepting all of them (see Section 6 for more details).

.Club Domains tested 600 popular websites to determine if the applications running on them accepted the use of the .club domain. The websites included free email services, retailers and e-commerce websites, travel sites, social networks, email newsletter services, and music services. The results are set out in Figure 7.
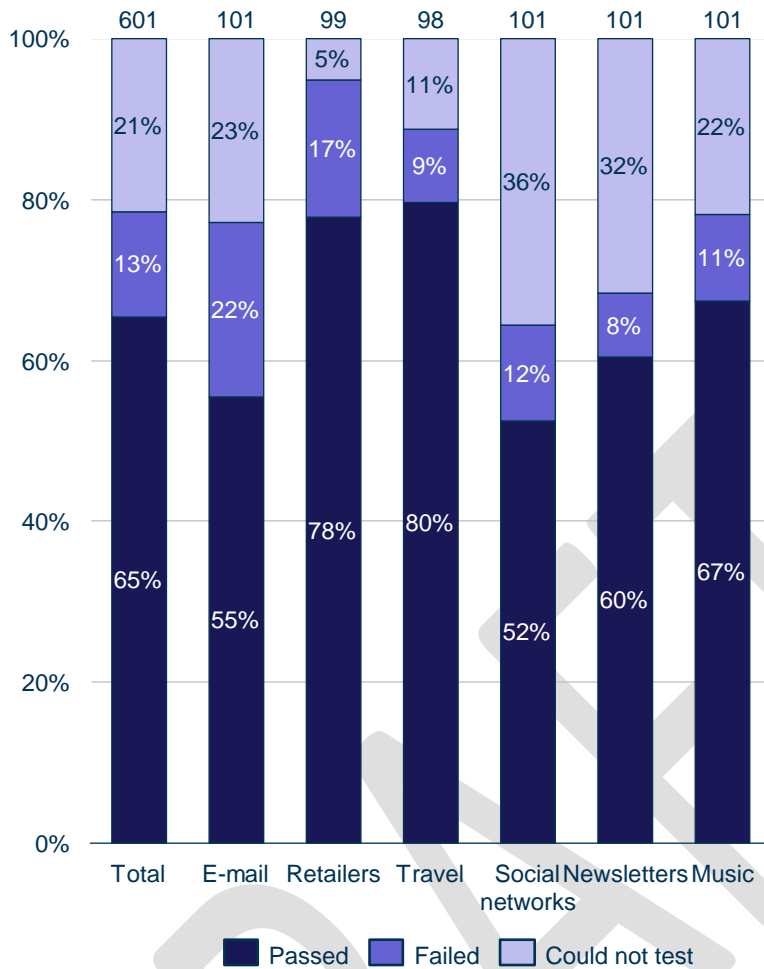
Figure 7: Acceptance of .club domains [Source: .Club Domains LLC, 2016]

It can be seen that, of the sites tested, a total of 65% accepted the new .club domain names. A further 13% failed, showing that these sites have not implemented UA. The remainder could not be tested, in most cases because the application did not require an email address or domain to be used. In certain cases, the test failed for reasons other than a lack of UA. These cases were categoriesd as "could not test".

65% acceptance of .club among all popular websites
13% failure to accept .club

The types of application with the greatest level of UA are retailers and travel sites (which include airlines and online travel agents). The applications with the lowest level of acceptance were free e-mail services and social media sites.

A similar set of tests was conducted in August 2015, when ICANN commissioned APNIC to perform systematic testing of the acceptance of 294 new gTLDs and 10 IDNs.[12] This testing examined whether the new domains were visible to Web browsers. That is, whether, when clicking on a link to the domain presented by Google Adwords, the end user's browser successfully received the relevant content. This testing was done on a very large scale using a Google advertising campaign, with over 100 million tests

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[12]   http://www.potaroo.net/reports/Universal-Acceptance/UA-Report.pdf.

run. Every domain was tested by at least 299 000 users. APNIC found that, across 294 of the domains, the results were highly consistent, showing acceptance rates consistently close to 95%. For the remaining 10 domain names, all of which were IDNs, the performance was systematically worse[13].

APNIC's results are shown in Figure 8. APNIC specifically tested whether the request was successful, and if not, whether it failed at the DNS, whether it failed at the web server, whether it was blocked, or whether the requested content was delivered outside the time window of the test.
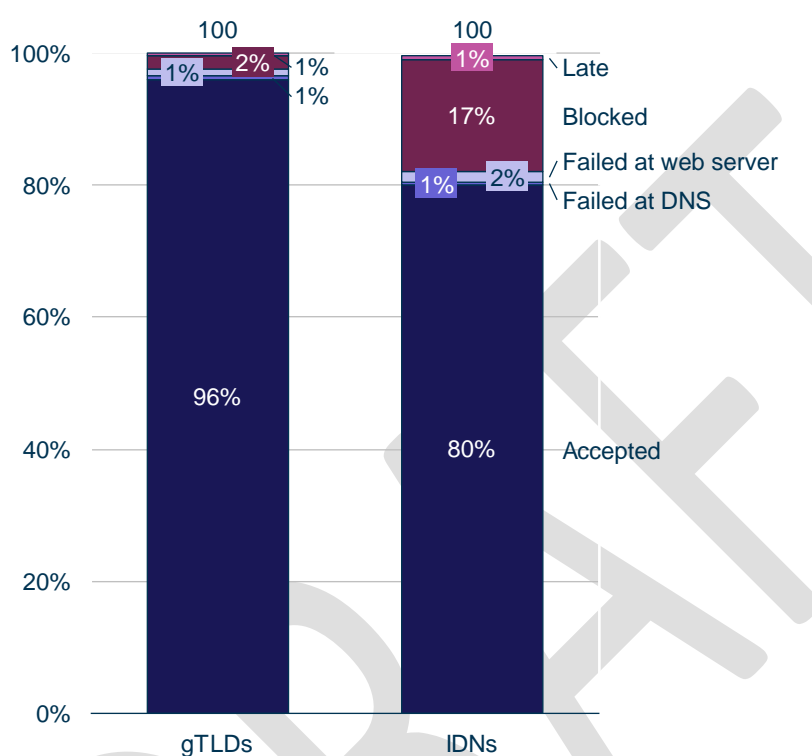

Figure 8: Results of APNIC UA testing [Source: ICANN, 2015]

It can be seen that there is significant (but not universal) acceptance of the gTLDs, with lower acceptance of IDNs. The main reason for the poorer acceptance of IDNs is that they were blocked. APNIC investigated this further, and found that blocking occurred amongst users of Internet Explorer and Firefox, but not Chrome, Opera or Safari. It concluded after further testing that the combination of the use of Adobe Flash and Internet Explorer or Firefox caused problems with IDNs.

Although this testing does show broadly strong acceptance of the new domains, it should be noted that this research tested whether the domains worked successfully when accessing the relevant websites through a Web browser. Whilst this does help to understand their usefulness in Web browsing, and potential differences with IDNs, it does not give insights into their acceptance amongst broader software and applications.

Finally, UASG conducted similar testing in 2016. UASG created a number of email accounts based on gTLDs and IDNs, and tested to see if they were accepted by a number of popular websites. This process

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13   This poorer performance for IDNs was isolated to Flash on Internet Explorer and Firefox, but not Chrome (which uses a Google implementation of Flash). Flash had problems accepting Unicode IDNs.

was conducted manually, with the testers registering with the websites using the mailboxes. A domain was considered to be accepted if the website did not reject it. UASG tested a mailbox with a short, ASCII-based gTLD, a long, ASCII-based gTLD, an IDN with a .com suffix, a Unicode mailbox with a short ASCII-based gTLD domain, a right-to-left IDN (in Arabic), and a full Unicode IDN. UASG found significantly higher acceptance amongst ASCII-based gTLDs than Unicode-based IDNs. The results are shown below.

Figure 5.9: Results of acceptance testing conducted by UASG [Source: UASG,2016]
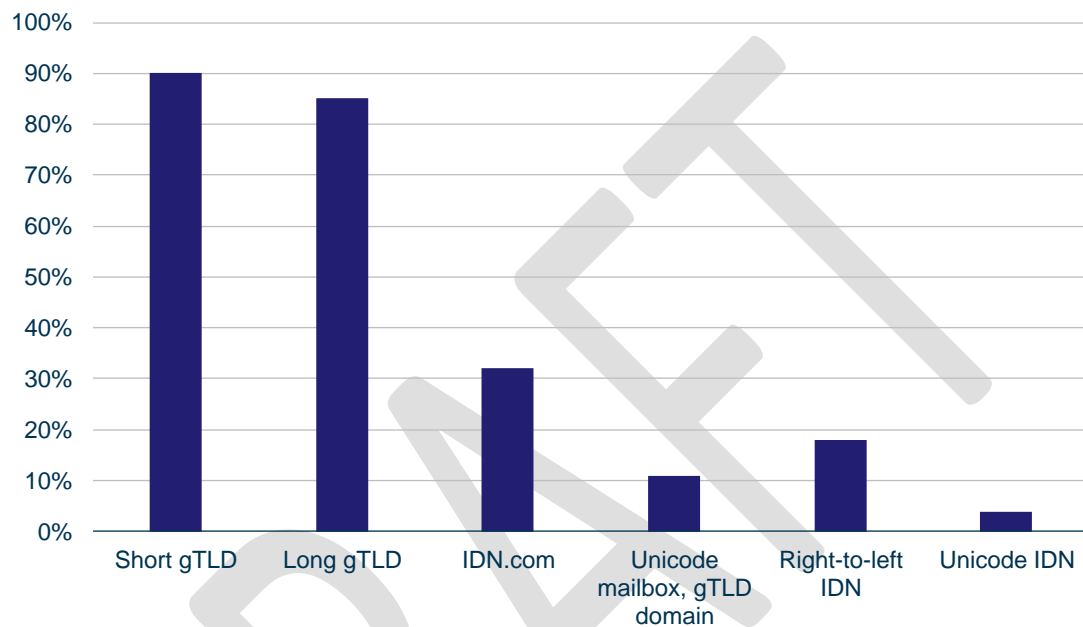
These 2016 tests show that, especially for IDNs, and email accounts using Unicode, there is still work to be done to implement UA.

6 The effort required for application owners to implement Universal Acceptance

Based on our research, we believe that the key impediment to UA is awareness of the issue, rather than the cost of implementation. In our case studies, below, anytime there has been an acceptance issue flagged to an organisation, it has been addressed successfully and quickly.

The cost to implement UA comes from the coding and software development effort to update and rectify software and applications. Software and applications, where they receive a domain name or an email address as an input, typically run a check to ensure that the entered domain name or email address is valid. This is partly to make sure that the email address is usable for the user's benefit, and partly for security reasons, to prevent attacks being initiated by inputting harmful code instead of an email address.[14]

Prior to the creation of the new gTLDs and IDNs, this validation process was simple. Domain names and email addresses took a limited number of forms. The software simply needed to check against a limited list of top-level domains (e.g. .com, .net, .org, .gov, .edu), and country codes (e.g. .au, .de, .uk, .fr). In some ways, the problem with UA is similar to the Y2K issue, where software or application developers coded in the last two digits of year, rather than all four. In this case, some simple domain name acceptance rules were hard-coded, such as ensuring that the top-level domains were two or three characters, or even checking against the limited list of gTLDs. Luckily, the issue does not appear to be as deeply embedded as Y2K in the cases we examined.

In order to implement UA, this validation process must be extended to include all registered gTLDs and IDNs. The exact software development effort to achieve this depends on the software, and especially the assumptions made by the engineers who originally designed it. However, the change is greatly simplified by the existence of a centralised list of new domains provided by ICANN that is continuously updated with the full list of registered domains (including gTLDs and IDNs, see below). UASG also provides a "how to" guide to help software and application owners implement UA.[15]

The acceptance of IDNs is simplified by the existence of punycodes. A punycode is a way of representing a Unicode IDN (readable by human end users) into an ASCII domain name (readable by computers).

.ОНЛАЙН is represented by the punycode .xn--80asehdb

.网络 is represented by the punycode .xn--io0a7i

As such, their acceptance is not necessarily more difficult than the acceptance of gTLDs. There can be a certain

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[14] An example is an SQL injection. This is an attack which involves entering a line of SQL code into an online form in place of an email address. If accepted, this code will then be executed and can initiate a number of harmful outcomes such as a data breach. See http://www.esecurityplanet.com/hackers/how-to-prevent-sql-injection-attacks.html for a discussion.

[15] Available at https://uasg.tech/become-universal-acceptance-ready/.

amount of additional development to accept IDNs, however. This is caused by the need to display them graphically on the screen in an accurate way. This requires the ability to read and display Unicode text. Whilst this may require additional development, Unicode is standardised, and there are available resources that help to ensure that it is correctly displayed.[16]

The key factor that may hold back software and application owners from implementing UA is therefore not technical, but to do with awareness of the problem and willingness to rectify it. In many cases, once a software and application owner has been made aware that UA is an issue, it has been able to rapidly address the problem. It is often treated as a "bug fix" and dealt with as part of the normal software debugging and update process. In areas where the changes are more likely to be seen as a new development effort (e.g. upgrading software to graphically represent Unicode characters accurately), it may be more difficult to get organisational approval to make the change.

The likelihood of these fixes and developments being made depends in part on the nature of the organisation. Large companies, such as Google, Microsoft, Twitter and Adobe, but also banks, airlines, travel companies and telecoms operators, typically have teams dedicated to fixing software bugs and managing new software releases when necessary. For these companies, implementation of UA is typically not a problem.

Very small local companies, such as restaurants, tradespeople, and small shops such as florists, which run websites typically use third-party software such as WordPress to develop the website, which has plug-ins that create online entry forms that can verify domain names. This third-party software may quickly address UA issues that arise, taking the burden from the companies that use them.

The greatest issues may come from mid-sized companies and organisations, and government agencies. Mid-sized companies and organisations, especially those in industries that are not very technology-oriented, may not have the awareness or software development resources to proactively implement UA. Also, government agencies can be slow to respond once UA issues have been brought to their attention. This may be because they are likely to be less focused on the needs of individual users and more focused on their policy and regulatory mandates.

A final complication in the implementation of UA is in software systems that interact with each other. A good example is in the travel industry. When an airline customer makes a booking for a flight, he or she provides an email address, which may use a new domain. However, as discussed in the case study below, that email address may not be transferred to another airline because of the current intercarrier network used by the airline trade association IATA (International Air Transport Association). That system is in the process of being upgraded.

We illustrate these points by way of examples, focusing on three case studies. These are fTLD, the registry responsible for the .bank and .insurance domains; Bridge Community Bank, one of the early adopters of the .bank domain; and IATA, the international body responsible for the air travel industry.

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[16]   See http://www.unicode.org for detalis.

Case study: fTLD

fTLD is the Internet registry that administers the .bank and .insurance domains. In its role as a registry, it also helps its customers deal with UA issues as they arise.

> The .bank domain is an example of a sponsored domain, aimed at financial institutions. Every financial institution using .bank must provide online security features that are designed to foster consumer trust in online banking services. fTLD maintains and monitors these security requirements. The economic value of .bank depends on its usage, and its usage is governed by its Universal Acceptance, among other things. fTLD also is the registry for .insurance, which has similar security features and requirements.

fTLD has interacted directly with a number of software and application owners in its work to promote UA of the .bank domain. Two examples of software and application owners that fTLD has worked with are Twitter and Adobe. In both cases, the changes required to implement UA were treated as bug fixes, and included in the relevant company's normal software update cycle.

In April 2016, fTLD noticed that its .insurance domain was not recognised by Twitter. URLs ending in .insurance that were included in a tweet were not recognised as legitimate domain names (known as *linkification*). Twitter therefore did not create a hyperlink in the tweet. fTLD contacted Twitter about this UA problem. Twitter fixes problems such as this in its regular schedule of batch updates. These updates typically take between four to five weeks, since they must be coordinated between Twitter's various platforms and departments. In this case, UA was added to the batch update process. Twitter now recognises the new domain names as legitimate, and creates the relevant hyperlinks.

In May 2016, it was brought to the attention of fTLD that the Adobe Event Manager software did not accept email addresses based on the new domains during registration. Adobe confirmed that the problem was that the domain was not included in the validation process used by the Event Manager software, confirming that the problem was one of UA. This confirmation is important in the context of the .bank domain (as opposed to other domains) because, due to the additional security features of the domain, problems can sometimes be related to security rather than UA. Adobe agreed to include the updates required for UA in its next software release cycle. The problem was rectified in August 2016, three months after it was raised as an issue.

Case study: Bridge Community Bank

Bridge Community Bank is a small bank based in the US state of Iowa, with locations in the towns of Mechanicsville, Mount Vernon and Solon. It is an early adopter of the .bank domain, and has therefore experienced issues with acceptance of the domain in third-party applications. In most, but not all, cases, these were resolved quickly and easily. We will discuss interactions Bridge Community bank has had with Verizon, Wells Fargo and the US Treasury.

In August 2016, Bridge Community Bank discovered that an application run by Wells Fargo, a major US bank, did not accept email addresses using the new .bank domain. The software indicated that the email address used was not a valid address. This is illustrated below.

Figure 10: Screenshot of Wells Fargo [Source: Analysys Mason, 2016]

Bridge Community Bank contacted Wells Fargo via fTLD about this problem. It was rapidly resolved, as Wells Fargo recognised the need to accept the new domain in order to help interact and transact with other banks.

Likewise, in May 2016, the Bridge Community Bank discovered a UA issue when trying to claim a discount with its main telecoms connectivity provider, Verizon. Verizon's systems did not accept email addresses with a .bank domain name. The bank contacted the local Verizon customer service

representative. This person was able to resolve the problem quickly and of her own initiative, without needing approval from Verizon headquarters. This took four hours to fix.

Finally, the Bank discovered in October 2016 that the website of the US Treasury, Treasury.gov, did not accept email addresses using the .bank domain. The system requires that email addresses end in a three-letter domain, a two-letter country code, or .coop. The bank brought this to the attention of the US Treasury. The problem is yet to be resolved at the time writing.

Case study: IATA

For the airlines, there are two sets of systems of relevance; the airlines own customer-facing reservation system, which must be upgraded to accept new gTLDs, and the distribution network used to transfer reservations and other information between airlines. The airline industry, via the IT company dedicated to serving the needs of the air transport industry, SITA (Société Internationale de Télécommunications Aéronautiques) was an early adopter of a new gTLD, as the sponsor of .aero, and experienced some of the challenges of introducing a new gTLD with more than 3 letters. As a result of that experience, the new ASCII gTLDs are unlikely to present any issue for the airlines or for the intercarrier system itself.

IDNs, on the other hand, are likely to pose challenges, for several reasons. First, the airlines themselves would choose whether to update their systems to accept IDNs from customers. There is, however, a significant security challenge, that the name accepted on reservation must match the official name on the passport, which, in Europe, for instance, cannot include accents or umlauts. As a result, the airlines may not update their websites to accept non-ASCII characters, including possibly for the email addresses. Furthermore, once in the system there is a significant constraint as well today.

The airline's software communicates with the systems of airports, centralised booking systems, government immigration authorities, and other entities. If the customer's email address must be passed between these systems, this can complicate the UA process. This is because if one of the systems does not accept the new domains, it can cause problems for the entire chain. The system used by IATA to enable communications between airlines uses Teletype. Teletype is a legacy system that was written using ASCII, at a time when computer memory came at a premium cost (similar to the constraints that led to the Y2K problem). As such, these systems cannot accept IDN names directly (in Unicode), and cannot transfer the names even in punycode, given the length. A new distribution network is being developed to replace the legacy teletype system, and this one will be able to accept IDNs passed on to them by the airlines.

7   Conclusion

It is our view that, for software and application owners implementing UA, the benefits of doing so will outweigh the costs, and that the main impediment, from the interviews that we conducted, was awareness of the issue, which was then typically quickly resolved.

The benefits of UA to software and application owners accrue from the wide usage of the new domains. As we have seen, there have been almost 25 million domain names registered under the new domains. There have also been over 2.6 million IDNs, registered, both country-code and top-level. (largely concentrated in the Russian and Chinese languages). This provides a large, and rapidly growing, pool of Internet users who will want to use their new domains to sign up for and interact with applications and services.

In addition, as more software and application owners implement UA, the attractiveness of the new domains will increase. This will encourage further registrations, which will in turn generate a larger customer pool for applications.

The costs of implementing UA do depend on the original design of the software in question. However, the existence of a centralised, continuously updated database of all the new registered domains, together with documentation provided by UASG, means that this task is rarely onerous. In our research, we did not come across a situation where there had been serious technical difficulties in implementing UA.

In addition, we estimate that the benefits, in terms of spending by existing users of gTLDs and IDNs as well as new users, is significant, and justifies the cost of UA readiness. We have estimated that universal acceptance of gTLDs could generate an additional annual benefit of **USD 3.6 billion** in new e-commerce revenues, and that universal acceptance of IDNs could bring 17 million more Internet users online, with incremental annual spend online of **USD 6.2 billion**. These are conservative estimates in our view.

These factors combine to mean that it makes sense for application and software owners to implement UA, so that the Internet continues to realise its full cultural, social and economic benefits.