Universal Acceptance

Evaluation of Websites for Acceptance of a Variety of Email Addresses

25 September 2017

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Introduction

Universal Acceptance is the concept that all domain names and all email addresses work in all applications. But, isn't this the case already? We conduct a survey of hundreds of popular websites and found that no, not all domain names nor all email addresses work in all applications.

Universal Acceptance (UA) is required for a truly multilingual Internet, one in which people around the world can navigate entirely in local languages. It is also the key to unlocking the potential of new generic top-level domains (gTLDs) to foster competition, consumer choice and innovation in the domain name industry. This provides consumers with a wider choice of identities to choose from when choosing their own domain names. When an online system, such as a website or online form, is UA-ready, it means that it can accept ALL email addresses.

The Universal Acceptance Steering Group (UASG) is a community initiative supported by ICANN and dedicated to advancing awareness and adoption of UA worldwide.

The UASG conducted this study of more than 1000 websites to determine if they would accept a variety of email addresses based on new top-level domains (TLDs), including long TLDs and TLDs in non-English characters. The study also evaluated non-English mailbox names.

The results show that there is much work to be done before the world's websites are UA-ready. Longer top-level domains don't do as well as short ones, introducing non-English characters in the domain name markedly reduces the acceptance rate, and introducing non-English characters into the mailbox name further reduces the acceptance rate.

In addition, a supplementary study was carried out to provide some insight into the software that drove the range of behaviours observed. This small study examined only a handful of the 1000 sites from the main study, concentrating on those that failed most or all tests, or those that passed all the tests. The results of this supplementary study are provided in Appendix A. They do not constitute official UASG recommendations at this point but are considerations for future work in this area.

The Evaluation

Building on work started by domain name registry business Donuts, the UASG has, through ICANN's Global Support Center team, evaluated more than 1000 websites (based on Alexa ranking) to see if they allow registration with a variety of email structures:

ascii@ascii.newshort	info1@ua-test.link
ascii@ascii.newlong	info2@ua-test.technology
ascii@idn.ascii	info3@普遍接受-测试.top
ascii@ascii.idn	info4@ua-test.世界
Unicode@ascii.ascii	测试1@ua-test.link
Unicode@idn.idn	测试5@普遍接受-测试.世界
Arabic.arabic@arabic	دون@رسيل.السعودية

For each website tested, a page that allowed registration of an email address was found and attempts were made to register each of the evaluation cases.

Results

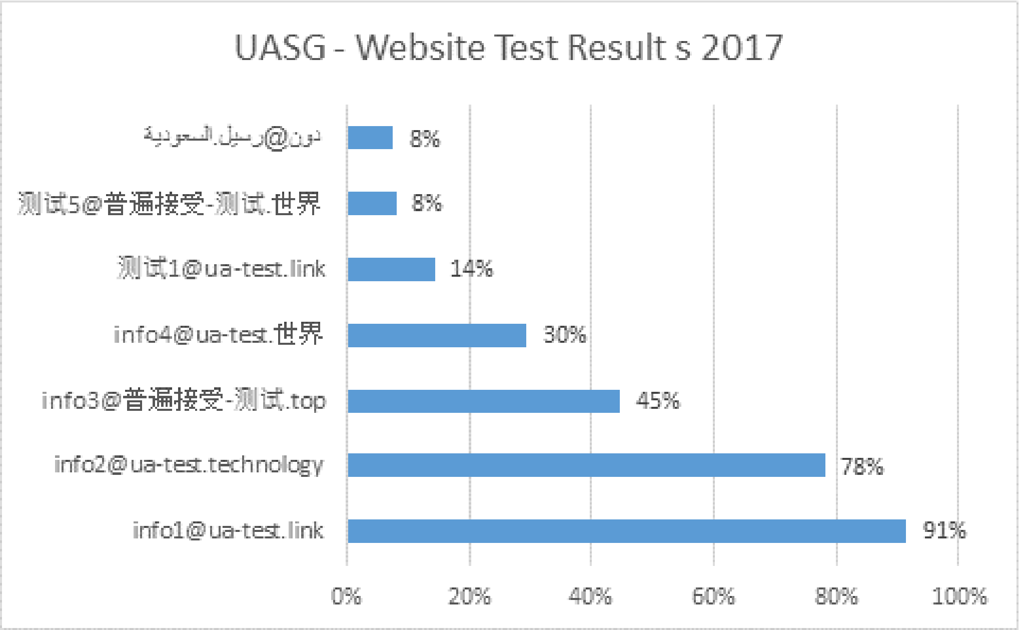
1262 websites were considered for evaluation. Out of these, 749 websites included email fields that could be tested. Seven different email addresses were tested on each website.

Fifty-four (7 percent) websites accepted all seven types of email. Forty-seven websites (6 percent) rejected all seven types of email addresses.   The rest accepted some, but not all, of our test cases.

EMAILS TESTED		**Rate of Acceptance (out of 749 websites)**	
ascii@ascii.newshort	info1@ua-test.link	**685**	**91%**
ascii@ascii.newlong	info2@ua-test.technology	**585**	**78%**
ascii@idn.ascii	info3@普遍接受-测试.top	**335**	**45%**
ascii@ascii.idn	info4@ua-test.世界	**221**	**30%**
Unicode@ascii.ascii	测试1@ua-test.link	**108**	**14%**
Unicode@idn.idn	测试5@普遍接受-测试.世界	**61**	**8%**
Arabic.arabic@arabic	دون@رسيل.السعودية	**57**	**8%**

Analysis

Clearly an ascii@ascii.ascii had the highest acceptance rate and Arabic.arabic@arabic (as well as Unicode@idn.idn) the lowest.



When we looked at the source code we expected to find common approaches and common code. However, we found that this was not the case when we delved deeper into the code. Very few called server-side libraries for validation. Most used a Regular Expression (RegEx) to provide first line validation. But we did not find a consistent RegEx deployed. Instead, it appears as if developers would fetch a RegEx from GitHub, Stack Overflow or some other source code repository, and then apply their own customisation.

Conclusion

There is much work to be done to get many of the world’s websites UA and EAI-ready. Where we thought we could address just a few applications and code repositories, that does not appear to be the case.

Instead, we will supplement library evaluation and mitigation work with greater awareness-raising efforts among the developer community.

Appendix A

Why do some websites reject internationalized email addresses that others accept?

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Introduction

Taking the results of the Evaluation of Websites for Acceptance of a Variety of Email Addresses study, we attempted to take a further look at why some websites reject addresses, and why some websites accept addresses others reject. The raw data is available here.[1]

[1] https://docs.google.com/spreadsheets/d/1T7sbUUBqDTsNWeUrkwXZLcpjlxt8qi-Ty6eH6DrOVdg/edit

We looked at three categories of websites:

- A random subset of sites that rejected some email address to see if there was any commonality in the underlying algorithm
- The set of websites that rejected all email addresses to understand the underlying cause
- The set of websites that accepted all email addresses to understand if they performed any validation at all

The following sections present the results for each category. Following those, we present an analysis of the results and suggest some mitigation actions.

Results

Sample validation failures

Here we inspected a random subset of sites to see if we could determine the algorithm responsible for rejecting the addresses. In most cases, we could not - either because the validation was performed on the server, or (in a few cases) simply because the location of validation was obscure and could not be found in a timely fashion. Table 1 below presents a sample of 10 cases where the algorithm could be identified i.e., where some validation was performed in the client which failed.

Table 1 - Sample validation failures

<table>
<tr><th>Website</th><th>Failing Email</th><th>Processing: example code and means of validation</th></tr>
<tr><td>twitter.com</td><td>info4@ua-test.世界</td><td>email:/^[\w-]+([^@,\s<>()]*[\w-]+)?@[\w-]+(\.[\w-]+)*\.[a-z]{2,}$/i
Regular expression check in Javascript.</td></tr>
<tr><td>ibm.com</td><td>info4@ua-test.世界</td><td>emailFormat: /^(([^\.@"]+(\.[^<>()\[\]\\.*,;:\s@=/&"]+)*)|(".+"))@((\[[0-9]{1,3}\.[0-9]{1,3}\.[0-9]{1,3}\.[0-9]{1,3}])|(([a-zA-Z\-0-9]+\.)+[a-zA-Z]{2,}))$/, email: /^[_A-Za-z0-9-!#$%'?^~`\{\}\|\+]+(\.[_A-Za-z0-9-!#$%'?^~`\{\}\|\+]+)*@((\[[0-9]{1,3}\.[0-9]{1,3}\.[0-9]{1,3}\.[0-9]{1,3}]com)|(([a-zA-Z\-0-9]+\.)+[a-zA-Z]{2,}))$/,
An email address must pass both of these Javascript regular expressions. The first supposedly checks for a valid email format, the second for invalid chars in the address.</td></tr>
<tr><td>meetup.com</td><td>info4@ua-test.世界</td><td>isEmail:function(){return this.value.match(/^([a-zA-Z0-9_.-])+@(([a-zA-Z0-9-])+\.)+([a-zA-Z0-9]{2,4})+$/)?!1:{key:"isEmail", message:a("register.mobile.emailErrBadEm","Doesn't look like an email address")}}, isNotEmail:function(){return this.value.match(/^([a-zA-Z0-9_.-])+@(([a-zA-Z0-9-])+\.)+([a-zA-Z0-9]{2,4})+$/)?{key:"isNotEmail",message:a("validation.error.emailNotAllow</td></tr>
</table>

		ed","Can't be an email address")}:!1}, hasBrackets:function(){return this.value.match(/.*?(?:<|>).*/)?{key:"hasBrackets",message:a("validation.error.noBracketsAllowed","Should not have a &lt; or a &gt;")}:!1} Regular expression checks in Javascript.
indiatimes.com	info4@ua-test.世界	var reg = /^([A-Za-z0-9_\-\.])+\@([A-Za-z0-9_\-\.])+\.([A-Za-z]{2,5})$/; Regular expression check in Javascript.
in.bookmyshow.com	info4@ua-test.世界	<input type="text" pattern="[a-z0-9._%+-]+@[a-z0-9.-]+\.[a-z]{2,4}$" class="email-input _error" placeholder="Enter your Email ID" id="iUserName" required="" minlength="1"> HTML5 input field with regular expression.
choicehotels.com	info4@ua-test.世界	<input type="email" aria-describedby="membershipEmailError" class="form-control ng-invalid ng-valid-minlength ng-dirty ng-touched ng-valid-email ng-valid-maxlength ng-not-empty ng-valid-required ng-invalid-pattern" id="membershipEmail" name="email" ch-focus-if="missingPartnerHubField === 'email'" ng-class="{'rentals-input text-left text-mondo text-bold': $root.featureFlags.VACATION_RENTALS_NEW_INPUTS}" ng-focus="clearGuestInfoError('email', guestInfoForm.email)" ng-maxlength="60" ng-minlength="5" ng-model="guestInfo.email" ng-pattern="/^[_a-z0-9-]+(\.[_a-z0-9-]+)*@[a-z0-9-]+(\.[a-z0-9-]+)*(\.[a-z]{2,4})$/i" ng-required="true" required="required" aria-invalid="true"> Regular expression validation on a HTML input field using Angular JS.
fodors.com	info4@ua-test.世界	var emailregex = /\b[a-zA-Z0-9._%-]+@[a-zA-Z0-9.-]+\.[a-zA-Z]{2,6}\b/; Regular expression check in Javascript. Checking the Javascript, we found another 2 email validation routines in the Javascript files loaded by the page, each with a different regular expression and/or other processing.
ft.com	info3@普遍接受-测试.top	function(e){return/^(([^<>()[\]\\.,;:\s@"]+(\.[^<>()[\]\\.,;:\s@"]+)*)|(".+"))@((\[[0-9]{1,3}\.[0-9]{1,3}\.[0-9]{1,3}\.[0-9]{1,3}])|(([a-zA-Z\-0-9]+\.)+[a-zA-Z]{2,}))$/.test(e)} Regular expression check in Javascript.

sears.com	info4@ua-test.世界	reEmail = /^([\w-]+(?:\.[\w-]+)*)@((?:[\w-]+\.)*\w[\w-]{0,66})\.([a-z]{2,6}(?:\.[a-z]{2})?)$/i,
		reEmailUser = /^(root@|abuse@|spam@)/i,
		Regular expression checks in Javascript.

<table>
<tr><td>telegraph.co.uk</td><td>info4@ua-test.世界</td><td>email:/^[a-zA-Z0-9.!#$%&’ *+=?^_`{|}~-]+@[a-zA-Z0-9-]+(?:\.[a-zA-Z0-9-]+)*$/i

Regular expression check in Javascript.</td></tr>
</table>

Rejection of all email addresses

Next we looked specifically at websites that rejected all forms of email addresses used in the tests. There are not many of these (roughly 7 percent of the test samples) and usually the rejection was not, as far as we could determine, performed in the client. We found three sites which rejected all tested email addresses in the client; these are detailed in Table 2.

Table 2 - Sites which reject all addresses

<table>
<tr><th>Website</th><th>Processing: example code and means of processing</th></tr>
<tr><td>oomall.com</td><td>result=str.match(/^\w+((-\w+)|(\.\w+))*\@[A-Za-z0-9]+((\.|-)((com)|(net)|(cn))+)$/)
Regular expression check in Javascript.

This rejects all email addresses with non-ASCII domains, and further rejects any TLD that is not .com, .net or .cn.</td></tr>
<tr><td>cdc.gov</td><td><input autocomplete="on" class="form-control input-xxlarge input-validation-error" data-val="true" data-val-maxlength="Email address must be under 256 characters." data-val-maxlength-max="255" data-val-regex="Email does not appear to be a valid format." data-val-regex-pattern="^[\w-\.]{1,}\@([\da-zA-Z-]{1,}\.){1,}[\da-zA-Z-]{2,3}$" data-val-required="Please enter your email address." id="Email" maxlength="255" name="Email" placeholder="Enter your e-mail address" title="Please enter your e-mail address (required)" type="text" value="">

HTML5 input field with regular expression. This rejects non-ASCII domains, and further rejects any TLD that is not 2 or 3 characters long.</td></tr>
<tr><td>ajc.com</td><td>/^[-a-z0-9~!$%^&*_=+}{\'?]+(\.[-a-z0-9~!$%^&*_=+}{\'?]+)*@([a-z0-9_][-a-z0-9_]*(\.[-a-z0-9_]+)*\.(aero|arpa|biz|com|coop|edu|gov|info|int|mil|museum|name|net|org|pro|travel|mobi|[a-z][a-z])|([0-9]{1,3}\.[0-9]{1,3}\.[0-9]{1,3}\.[0-9]{1,3}))(:[0-9]{1,5})?$/i

Regular expression check in Javascript. This rejects all non-ASCII addresses, and further rejects any TLD that is more than 2 characters long and which is not in a hardcoded list of TLDs. It also appears that someone has attempted to support IPv4 domain literals, though without the required enclosing [] and allowing a trailing colon and a HTTP-like port number which is not permitted by RFC5321.</td></tr>
</table>

Accepting all email addresses

Finally, we looked specifically at websites that accepted all forms of email address used in the tests. Again, there are not many of these (as with sites that rejected all forms of addresses, roughly 7 percent of the test samples), and again there was usually no client validation performed as far as we could determine. Table 3 presents 3 sites that perform client validation and accepted all test addresses.

Table 3 - Sites which accept all addresses

<table>
<tr><th>Website</th><th>Processing: example code and means of processing</th></tr>
<tr><td>beenverified.com</td><td>/^((([a-z]|\d|[!#\$%&'*\+\-\/=\?\^_`{\|}~]|[\u00A0-\uD7FF\uF900-\uFDCF\uFDF0-\uFFEF])+(\.([a-z]|\d|[!#\$%&'\*\+\-\/=\?\^_`{\|}~]|[\u00A0-\uD7FF\uF900-\uFDCF\uFDF0-\uFFEF])+)*)|((\x22)((((\x20|\x09)*(\x0d\x0a))?(\x20|\x09)+)?(([\x01-\x08\x0b\x0c\x0e-\x1f\x7f]|\x21|[\x23-\x5b]|[\x5d-\x7e]|[\u00A0-\uD7FF\uF900-\uFDCF\uFDF0-\uFFEF])|(\\([\x01-\x09\x0b\x0c\x0d-\x7f]|[\u00A0-\uD7FF\uF900-\uFDCF\uFDF0-\uFFEF]))))*(((\x20|\x09)*(\x0d\x0a))?(\x20|\x09)+)?(\x22)))@((([a-z]|\d|[\u00A0-\uD7FF\uF900-\uFDCF\uFDF0-\uFFEF])|(([a-z]|\d|[\u00A0-\uD7FF\uF900-\uFDCF\uFDF0-\uFFEF])([a-z]|\d|-|\.|_|~|[\u00A0-\uD7FF\uF900-\uFDCF\uFDF0-\uFFEF])*([a-z]|\d|[\u00A0-\uD7FF\uF900-\uFDCF\uFDF0-\uFFEF])))\.)+(([a-z]|[\u00A0-\uD7FF\uF900-\uFDCF\uFDF0-\uFFEF])|(([a-z]|[\u00A0-\uD7FF\uF900-\uFDCF\uFDF0-\uFFEF])([a-z]|\d|-|\.|_|~|[\u00A0-\uD7FF\uF900-\uFDCF\uFDF0-\uFFEF])*([a-z]|[\u00A0-\uD7FF\uF900-\uFDCF\uFDF0-\uFFEF])))$/i
Regular expression check in Javascript. This appears to accept allowed Unicode characters, though from the base multilingual plane only.
This website uses the JQuery validation plugin. This is not an official part of JQuery, but is written by a core JQuery developer. However, the plugins regular expression, which in the original source rejects all non-ASCII addresses, has been replaced by this site with the more flexible regular expression above.</td></tr>
<tr><td>Foxnews.com
Account sign in form.</td><td>/^.+@(?:[^.]+\.)+(?:[^.]{2,})$
Regular expression check in Javascript. This accepts any Unicode characters, only insisting that the domain must have more than one label and the TLD is 2 characters or longer.</td></tr>
<tr><td>intuit.com</td><td>/^((([a-z]|\d|[!#\$%&'*\+\-\/=\?\^_`{\|}~]|[\u00A0-\uD7FF\uF900-\uFDCF\uFDF0-\uFFEF])+(\.([a-z]|\d|[!#\$%&'\*\+\-\/=\?\^_`{\|}~]|[\u00A0-\uD7FF\uF900-\uFDCF\uFDF0-\uFFEF])+)*)|((\x22)((((\x20|\x09)*(\x0d\x0a))?(\x20|\x09)+)?(([\x01-\x08\x0b\x0c\x0e-\x1f\x7f]|\x21|[\x23-\x5b]|[\x5d-\x7e]|[\u00A0-\uD7FF\uF900-\uFDCF\uFDF0-\uFFEF])|(\\([\x01-\x09\x0b\x0c\x0d-\x7f]|[\u00A0-\uD7FF\uF900-\uFDCF\uFDF0-\uFFEF]))))*(((\x20|\x09)*(\x0d\x0a))?(\x20|\x09)+)?(\x22)))@((([a-z]|\d|[\u00A0-\uD7FF\uF900-\uFDCF\uFDF0-\uFFEF])|(([a-z]|\d|[\u00A0-\uD7FF\uF900-\uFDCF\uFDF0-\uFFEF])([a-z]|\d|-|\.|_|~|[\u00A0-\uD7FF\uF900-</td></tr>
</table>

<table>
<tr><td></td><td>\uFDCF\uFDF0-\uFFEF])*([a-z]|\d|[\u00A0-\uD7FF\uF900-\uFDCF\uFDF0-\uFFEF])))\.)+(([a-z]|[\u00A0-\uD7FF\uF900-\uFDCF\uFDF0-\uFFEF])|(([a-z]|[\u00A0-\uD7FF\uF900-\uFDCF\uFDF0-\uFFEF])([a-z]|\d|-|\.|_|~|[\u00A0-\uD7FF\uF900-\uFDCF\uFDF0-\uFFEF])*([a-z]|[\u00A0-\uD7FF\uF900-\uFDCF\uFDF0-\uFFEF])))){2,}/i

Regular expression check in Javascript. This appears to accept allowed Unicode characters, though from the base multilingual plane only, and further insists the TLD must be at least 2 characters long.</td></tr>
</table>

Analysis of client validation

Key findings

In all cases the client validation of the email address was done using a regular expression embedded in the client code. The regular expressions typically had the following characteristics:

- In all cases (except those that accepted all test addresses), the regular expression prohibited the use of non-ASCII domain names in email addresses.
- Several regular expressions prohibited TLDs longer than three, four (or, in one case, six) characters.
- Two regular expressions prohibited TLDs not on a hardcoded list (one of these two did allow any two ASCII character TLD).
- In all but two cases (other than those that accepted all test addresses), non-ASCII mailbox identifiers were also prohibited.

Sites that accepted all the test email addresses generally performed only minimal validation via a regular expression (with two of the three specifically accepting Unicode characters from the base multilingual plane), with further validation presumably being done server-side.

Sites that rejected all the test email addresses generally did so because of a combination of a restriction on non-ASCII characters and a restriction on the accepted TLD.

Although the regular expressions used show a certain number of common features, they are all unique. Also, there was absolutely no commonality in the way in which each site used JavaScript to validate email.

None of the sites inspected directly used a library to perform client-side validation.

Implementation details

- In two cases, the HTML5 facility for adding a regular expression pattern to an input field was used. In all other cases, JavaScript was used directly for the validation.
- Three attempt to explicitly match an IPv4 literal address domain (i.e. username@[192.168.0.1]) although one site (ajc.com[ajc.com]) does this incorrectly by not allowing for the enclosing []. None of the sites examined attempt to match IPv6 literals."

Mitigation actions for client validation

Discussion

From the above (limited) data, it appears that any modifications to enable full UA will have to be per-site; there is no evidence in this sample of any use of common client-side libraries that might be fixed to leverage UA acceptance.

Reviewing recent developer forums and blog posts, many developers, when tasked with 'validate this email' will ask on a forum, have another user give them a regular expression saying, 'I use this' and plug that regular expression (or some small variant) in and mark the job done. Comments from an advanced developer pointing out that the regular expression will reject valid email addresses do not seem to create much attention.

The code examined in this study and the reviews of developer forums yielded no regular expression that is recognised to fully validate UA email addresses.

Partial mitigation

We note that in all the sites checked, the client-side validation is employed as a basic input check. The address is invariably submitted for server-side processing, for example, ensuring that no account with that email address has been registered at the site. Any server-side software should be validating all data that is passed from the client.

The UASG suggests that validation be kept to a minimum, focusing just on syntactical validation. Mailbox names (local part) can consist of any characters and domain names as well. Indeed, the domain name could be on either side of the '@' depending on whether a right-to-left or left-to-right script is used.

Full mitigation

Searching the NPM JavaScript package repository for email validation shows isemail to be the most popular package for email address validation by a significant margin. From release 3.0.0 of 22nd June 2017, this claims support for all domain names and email addresses.

Encouraging its adoption would seem, therefore, to be a promising recommendation to move towards full mitigation for client-side email address validation (note, however, that no formal evaluation of the library has been performed).

Unfortunately, it may well be the case that organizations will be reluctant to deploy more sophisticated client-side checking, as this will increase the amount of Javascript that must be downloaded before a page is ready for input. In this case, partial mitigation may be the only option.

Caveat

Both partial and full mitigation proposals above deal only with client-side validation. As noted, it is to be expected that further server-side validation is also being performed. Judging by the results of *Evaluation of Websites for Acceptance of a Variety of Email Addresses*, it is probable that further mitigation work will be required to ensure that valid UA addresses are not rejected by this server-side validation.