Internationalization in Names and Other Identifiers

IAB

Goals

- The plenary's goal is to inform the community
  - Internationalization is often understood by a relatively small number of experts, but affects a large number of protocols
- IAB draft contains some recommendations regarding choice of encodings
  - draft-iab-idn-encoding-01.txt still in progress
- More work is needed and should continue

Why is Internationalization Important and Timely?

Introduction

- Names can have non-ASCII characters and are embedded in various ways:
  - Hostname / IDN: café.com
    (Internationalized Domain Name)
  - Email: 例え@テスト.com
  - URL (actually IRI): http://مثال.إختبار
    - (Internationalized Resource Identifier)
  - UNC path: \\例えテスト\public\file.doc
    (Universal Naming Convention =
    file paths common in Windows-based environments)
- Users want to browse the web, etc. in their own language
  - Imagine typing in a name in a script & language you don't know

Situation Today/Soon

- China uses IDNs for all govt. sites and has IDN TLDs (.中国, .公司 and .网络)
  - But are not in the public root today
- 35.2% of Taiwan domains are IDNs
- 13.7% of Korean domains are IDNs
- Vocal demand from the Arabic-script world
- ICANN is expected to start issuing IDN country-code Top Level Domains soon

Introduction and Terminology

Some Unicode Terminology

- **Unicode:** A set of integer code points in the range 1 – 1,114,111 (1 – 0x10FFFF) where each code point represents (with some exceptions) a human-meaningful visual "character"
- **UTF-32:** Each Unicode integer code point stored using a single 32-bit integer (so endianness matters)
- **UTF-16:** Each Unicode integer code point encoded using one or two 16-bit integers (so endianness matters)
- **UTF-8:** Each Unicode integer code point encoded using one to four 8-bit integers (so no endianness problems)

RFC 2277: IETF Policy on Character Sets and Languages

January 1998

```
Protocols MUST be able
to use the UTF-8 charset
```

UTF-8

- Code points 0x00 – 0x7F same as ASCII
  - Code points 0x00 – 0x7F encoded using octet values 0x00 – 0x7F
  - So all current 7-bit ASCII files are also valid UTF-8
    - with the same meaning
  - Existing files already assigning other meanings to octet values 0x80 - 0xFF (e.g. ISO 8859-1) are not automatically compatible
- Higher code points use multi-octet sequences
  - Multi-octet sequences use octet values 0x80 – 0xF4

UTF-8 Multi-Octet Sequences

Single octet ASCII character (Code points 1-127)	First octet of 2, 3, 4-octet sequences	Continuation octets of multi-octet sequences
0 X X X X X X X	1 1 0 X X X X X	1 0 X X X X X X
	1 1 1 0 X X X X	
	1 1 1 1 0 X X X	

UTF-8 Multi-Octet Sequences

00000 – 0007F	0 X X X X X X X			
00080 – 007FF	1 1 0 X X X X X	1 0 X X X X X X		
00800 – 0FFFF	1 1 1 0 X X X X	1 0 X X X X X X	1 0 X X X X X X	
10000 –	1 1 1 1 0 X X X	1 0 X X X X X X	1 0 X X X X X X	1 0 X X X X X X

UTF-8 Properties

- No mid-string zero octets
- Stateless character boundary detection
  - Robust to insertions, deletions, errors, etc.
- Strong heuristic detection
  - E.g. Any lone octet with top bit set signals text as not valid UTF-8
- Byte-wise, sorts same order as raw Unicode

Compactness:

How many octets does it take to represent a string?

- Everyone creating their own ‘optimal’ solution (optimal in some specific context) comes at a high price in terms of interoperability
- Relative compactness for different encodings is not nearly as important on today's systems as in the past
  - Text is tiny compared to today’s other data:
    - Images, Audio, Video
- Even international text often contains ASCII markup
  - E.g. HTML tags in otherwise international text file

Case Study:
Localization Strings in Apple's Mail.app

- /Applications/Mail.app/Contents /Resources/Japanese.lproj/Localizable.strings
- UTF-16: 117,624 bytes
- UTF-8:   68,693 bytes

"UNDO_MARK_READ" = "開封済みにする";

Punycode

- Used for Internationalized Domain Names
- A method of encoding a string of Unicode integer code points using only the following octet values:
  - 0x2D
  - 0x30 – 0x39
  - 0x61 – 0x7A
- i.e. octet values that, if (mis)interpreted as US ASCII, correspond to the following US ASCII characters:
  - Hyphen
  - Digits 0 – 9
  - Letters a – z

A Question of Interpretation: ASCII or not?

网络

A Question of Interpretation: ASCII or not?

A Question of Interpretation: ASCII or not?

```
xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
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xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
xxxxxxxxxx
xxxxxxxxxx                                                           xx
xxxxxxxxxx                      xxxxxxxxx                           xxxxxxxxxxxx
xxxxxxxxxx                      xxxxxxxxxxxx                        xxxxxxxxxxxx
xxxxxxxxxx                      xxxxxxxxxxxx                        xxxxxxxxxxxx
xxxxxxxxxx                      xxxxxxxxxxx                         xxxxxxxxxx
xxxxxxxxxx        x             xxxxxxxxxxx                         xxxxxxxxxx
xxxxxxxxxx      xxxxx           xxxxxxxxx          xx               xxxxxxxxxx
xxxxxxxxxx    xxxxxxxxx       xxxxxxxxxxx         xxxxx             xxxxxxxx
xxxxxxxxxx    xxxxxxxxxxx     xxxxxxxxxxx     xxxxxxxxxxxxx       xxxxxxxxxx
xxxxxxxxxx    xxxxxxxxxxxx    xxxxxxxxxxx       xxxxxxxxxxxx      xxxxxxxxxx
xxxxxxxxxx      xxxxxxxxxxxx  xxxxxxxxxxx       xxxxxxxxxxxx      xxxxxxxxxx
xxxxxxxxxx        xxxxxxxxxxxxxxxxxxxxxxx         xxxxxxxxxxxx    xxxxxxxxxx
xxxxxxxxxx         xxxxxxxxxxxxxxxxxxxx            xxxxxxxxxxxxx  xxxxxxxxx
xxxxxxxxxx         xxxxxxxxxxxxxxxxxxxx              xxxxxxxxxxxxxxxxxxxxxx
```
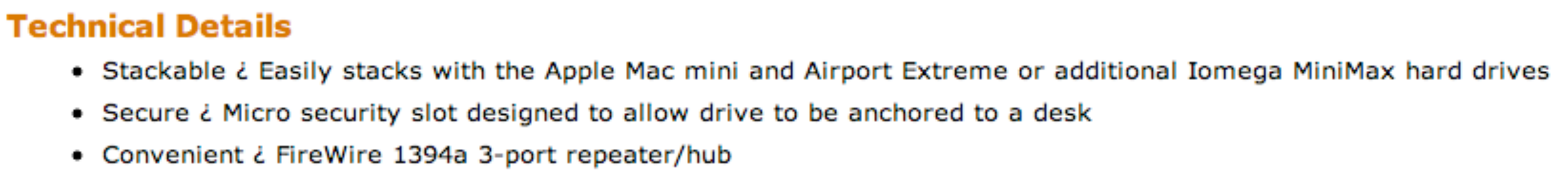
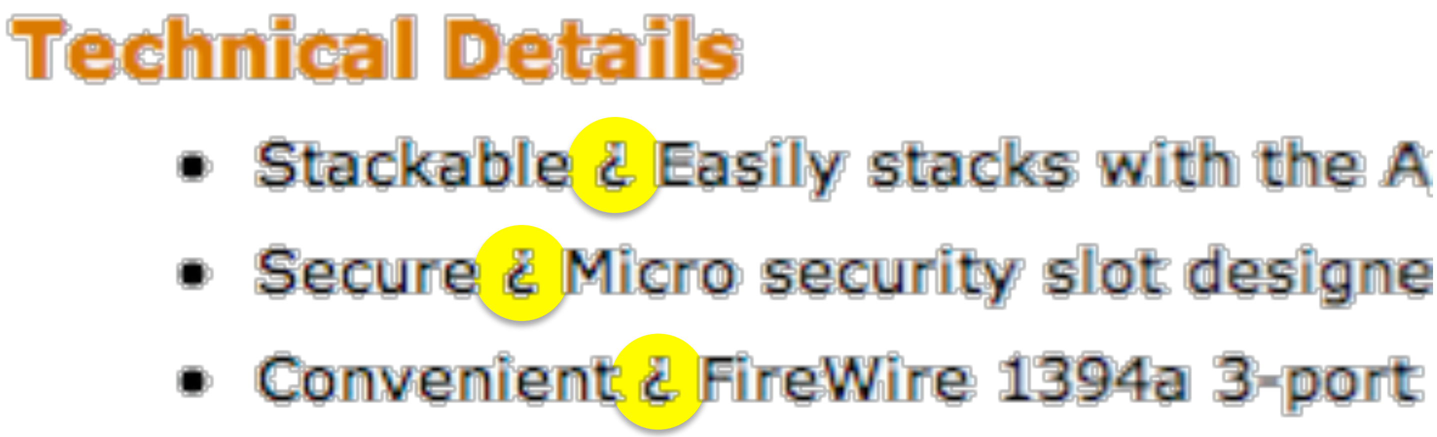

Today’s Text Chaos



Technical Details

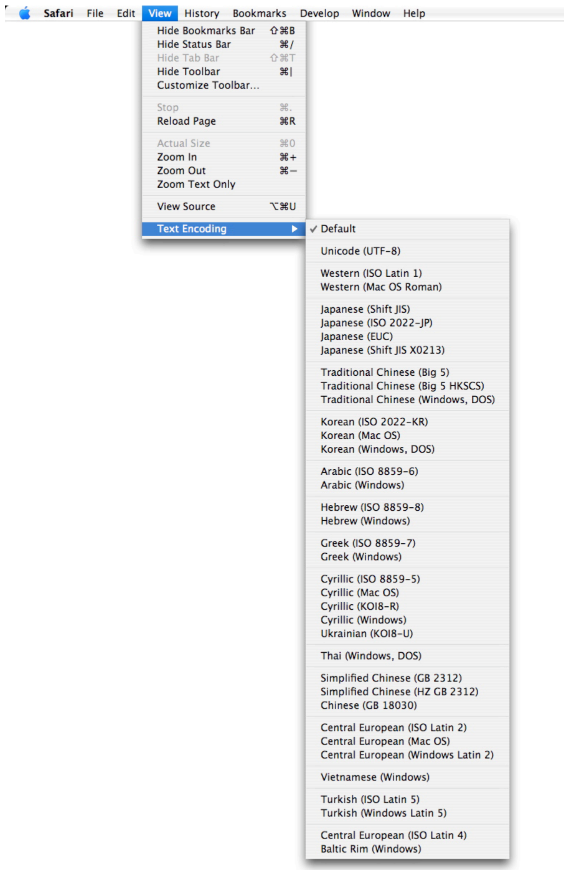
- Stackable ¿ Easily stacks with the Apple Mac mini and Airport Extreme or additional Iomega MiniMax hard drives
- Secure ¿ Micro security slot designed to allow drive to be anchored to a desk
- Convenient ¿ FireWire 1394a 3-port repeater/hub

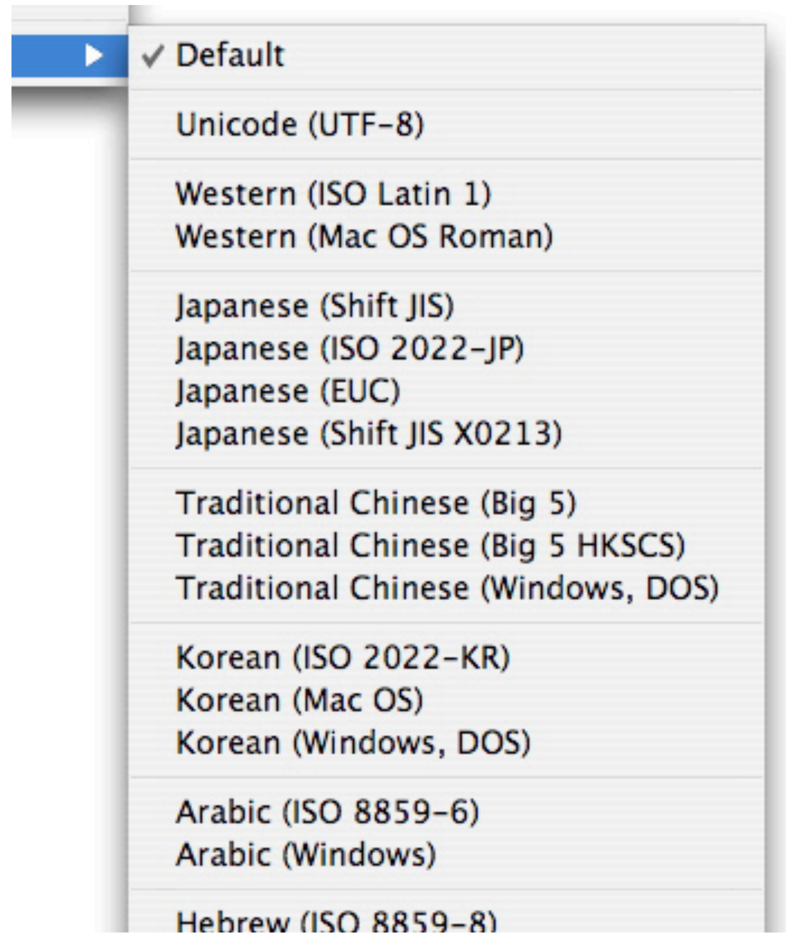


Technical Details

- Stackable ¿ Easily stacks with the A
- Secure ¿ Micro security slot designe
- Convenient ¿ FireWire 1394a 3-port

Today’s Text Chaos





IDNs in Other Identifiers

There can be many ways to get to the same file.   For example...

Using HTTP:

1. http://dthαler/Public/test.htm
2. http://xn--dthler-rxe/Public/test.htm
3. http://dth%CE%B1ler/Public/test.htm
4. http://dthαler/Public/test.htm

Using CIFS/SMB (file system protocols using UNC):

1. file://dthαler/Public/test.htm
2. file://xn--dthler-rxe/Public/test.htm
3. file://dth%CE%B1ler/Public/test.htm
4. file://dthαler/Public/test.htm
5. \\dthαler\Public\test.htm
6. \\xn--dthler-rxe\Public\test.htm

Plenary Announcement to ietf-announce@ietf.org

smooth and interoperable functioning  of the Internet depends on text strings  being interpreted in the same way  by all systems connected to it.

How Many Layers of Encoding?

- How do we encode:
  A domain name…
  in an email address…
  in a "mailto" URL…
  in a web page?
- Do we use:
  - Punycode ("xn--…") encoding for the domain name?
  - Email Quoted-Printable ("=XX") encoding?
  - URL percent ("%XX") escaping?
  - HTML ampersand ("&#xxxx;") codes?
- All of the above?

IDNs in Email

- Two test emails
- From: user@chɛshíɾɛ.stuartcheshire.org
- In each email, address appears in two places:
  - in "From" line
  - and in body text
- First email encoded IDN using Punycode:
  - xn--chshr-38d3be
- Second email encoded IDN using direct UTF-8
  - chɛshíɾɛ

Punycode Email

Header

```
Subject: Punycode
From: user@xn--chshr-38d3be.stuartcheshire.org

The "From" address for this email was
"user@xn--chshr-38d3be.stuartcheshire.org"
(i.e. using punycode encoding)
```

Body

UTF-8 Email

```
Subject: UTF-8
From: user@chεshírε.stuartcheshire.org

The "From" address for this email was
"user@chεshírε.stuartcheshire.org"
(i.e. using direct UTF-8 encoding)
```

Punycode Email: xn--chshr-38d3be

Client	From (Punycode)	Body (Punycode)
Gmail / IE	xn--chshr-38d3be	xn--chshr-38d3be
Gmail / Firefox 3	xn--chshr-38d3be	xn--chshr-38d3be
Apple Mail	xn--chshr-38d3be	xn--chshr-38d3be
Penelope	xn--chshr-38d3be	xn--chshr-38d3be
Mulberry 4.08	xn--chshr-38d3be	xn--chshr-38d3be
Thunderbird 2.0.0.16	xn--chshr-38d3be	xn--chshr-38d3be
Eudora 6 on Mac OS X	xn--chshr-38d3be	xn--chshr-38d3be
Lotus Notes 7.03 & 8.01	xn--chshr-38d3be	xn--chshr-38d3be
Outlook 2007	chɛshírɛ	xn--chshr-38d3be
Outlook E-Mail (WM6)	xn--chshr-38d3be	xn--chshr-38d3be
Outlook Web Access / IE	xn--chshr-38d3be	xn--chshr-38d3be

UTF-8 Email: chεshίrε

Client	From (UTF-8)	Body (UTF-8)
Gmail / IE	xn--chshr-38d3be	chεshίrε
Gmail / Firefox 3	xn--chshr-38d3be	chεshίrε
Apple Mail	chεshίrε	chεshίrε
Penelope	chεshίrε	chεshίrε
Mulberry 4.08	chεshίrε	chεshίrε
Thunderbird 2.0.0.16	chεshίrε	chεshίrε
Eudora 6 on Mac OS X	chÎµshÎ¯rÎµ	chεshίrε
Lotus Notes 7.03 & 8.01	chÎµshÎ¯rÎµ	chεshίrε
Outlook 2007	ch??sh??r??	chεshίrε
Outlook E-Mail (WM6)	ch??sh??r??	chεshίrε
Outlook Web Access / IE	ch??sh??r??	chεshίrε

More Terminology in this Presentation

- **Mapping:** converting one string to another "equivalent" string
  - "CONTOSO.com" ⇒ "contoso.com"
- **Matching:** checking two strings for equivalence
  - "CONTOSO.com" ~ "contoso.COM"
  - "möhringen.de" ≠ "moehringen.de"
- **Sorting:** determining which string comes first
  - "contoso.com" < "Microsoft.com"
- **Encoding:** same string can be encoded in different ways
  - including issues of combining characters: é vs e + ´

IDN Identifier Space

- **IDNA-valid string:**
  no invalid characters, legal length, etc.
- **U-label:** a Unicode IDNA-valid string
- **A-label:** “xn--” followed by
  Punycode-encoded IDNA-valid string

More Variety Brings More Ambiguity

• Computer Systems:	2	(binary)
• Telephone Numbers:	10	(0-9)
• ASCII Domain Names:	37	(A-Z, 0-9, -)
• International Domain Names:	Tens of thousands	

Matching

Confusable Strings (1/4)

- Two strings that are easily confused by a human

ETHIOPIA.com ↔ ETHIOPIA.corn

More confusion

Greek alphabet! Plain “ASCII” confusion

- Lower-casing will reveal the ETHIOPIA issue
  - ετηιορια is fairly distinctive
  - current trend is to deprecate upper-case and other mapping-required forms in IRIs etc.
  - IDNA2008 treats these characters as DISALLOWED

Confusable Strings (2/4)

- Another example:

jessica.py ↔ jessica.py

.ru = Russia

.py = Paraguay

Cyrillic alphabet

- "jessica" actually uses Cyrillic characters from two separate languages
  - A registry may restrict registrations to only characters in their language
- Other examples exist without mixing languages
  - epoxy.py ↔ epoxy.py

Confusable Strings (3/4)

- People see what they expect to see
  - Russian restaurant: “ресторан”
  - Non-Russians might read “pectopah”

- Given sufficiently creative use of fonts forced by style sheets etc., confusion can be easy

It Depends on What You Know – and Expect

Is the second character "A"? If you were not familiar with Latin script, or didn't know what to expect, would you be sure? Could it be a star of some sort? Are you sure that the first character is an ASCII dot (the DNS cares – a lot)?

Are these two strings identical? Are you sure? Would you be sure if you didn't know Latin script or the organization involved?

Confusable Strings (4/4)

- Other kinds of “equivalence” — equality in some contexts
- 中国 and 中國
  Two code points, same concept
- السعودية and السعودية
  Two code points for same letter (more or less)

Are the Following Equivalent?

Arabic-Indic	٠ ١ ٢ ٣ ٤ ٥ ٦ ٧ ٨ ٩
Eastern Arabic-Indic	۰ ۱ ۲ ۳ ۴ ۵ ۶ ۷ ۸ ۹
Chinese Suzhou	〡 〢 〣 〤 〥 〦 〧 〨 〩
European (ASCII)	0 1 2 3 4 5 6 7 8 9
Devanagari (Hindi)	० १ २ ३ ४ ५ ६ ७ ८ ९
Tibetan	༠ ༡ ༢ ༣ ༤ ༥ ༦ ༧ ༨ ༩
Tamil	௦ ௧ ௨ ௩ ௪ ௫ ௬ ௭ ௮ ௯

“Suspect” Names

- Potential for phishing attacks
  - but could be innocent or accidental
- Names with scripts not used by the user’s locale
- Names with mixed scripts (e.g. Cyrillic + Latin)
- UI might want to warn the user when displaying any of these from an untrusted source
  - Some browsers display A-labels (“xn--…”) in address bar, but that confuses humans

Universal Confusable String

- Few user systems have all possible characters and display fonts for them installed.
- If character cannot be represented locally, a six-character string might appear as
  - ? ? ? ? ? ? or
  - □□□□□□
- This should be a warning
  (but remember what users do when they see a warning they don't understand)

Mapping

Why Mapping?

- Instead of intelligent matching algorithm:
  - Map each string to a defined canonical form
  - Simple test if canonical forms are bitwise identical
  - Does not permit “close enough” or other fuzzy matching
- Conversion of one visual form to another that is more locally understandable
  - E.g. Traditional Chinese (中國) to Simplified (中国)

Mapping

- Mapping inherently loses information
  - Case conversion, half/full width, NFC/NFKC/etc
- Upper/lower casing differs by language
  - Latin alphabet: I ⇔ i
  - Turkish: I ⇔ ı İ ⇔ i
- tolower('I') = ???
- toupper('i') = ???
- tolower(toupper('ı')) ≠ 'ı'
- Turks aren't too happy about this…

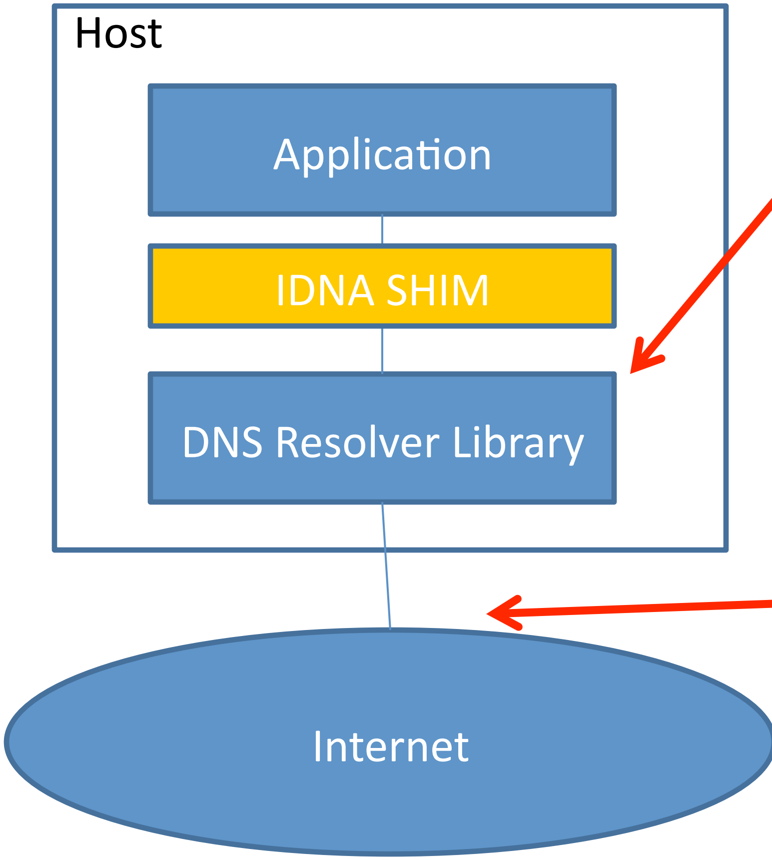
Mapping

- Summary:
  - Never roll your own mapping
  - Correct mapping for user depends on language context, which we often don't know

Encodings

draft-iab-idn-encoding-01.txt

(Over) Simplified Architecture



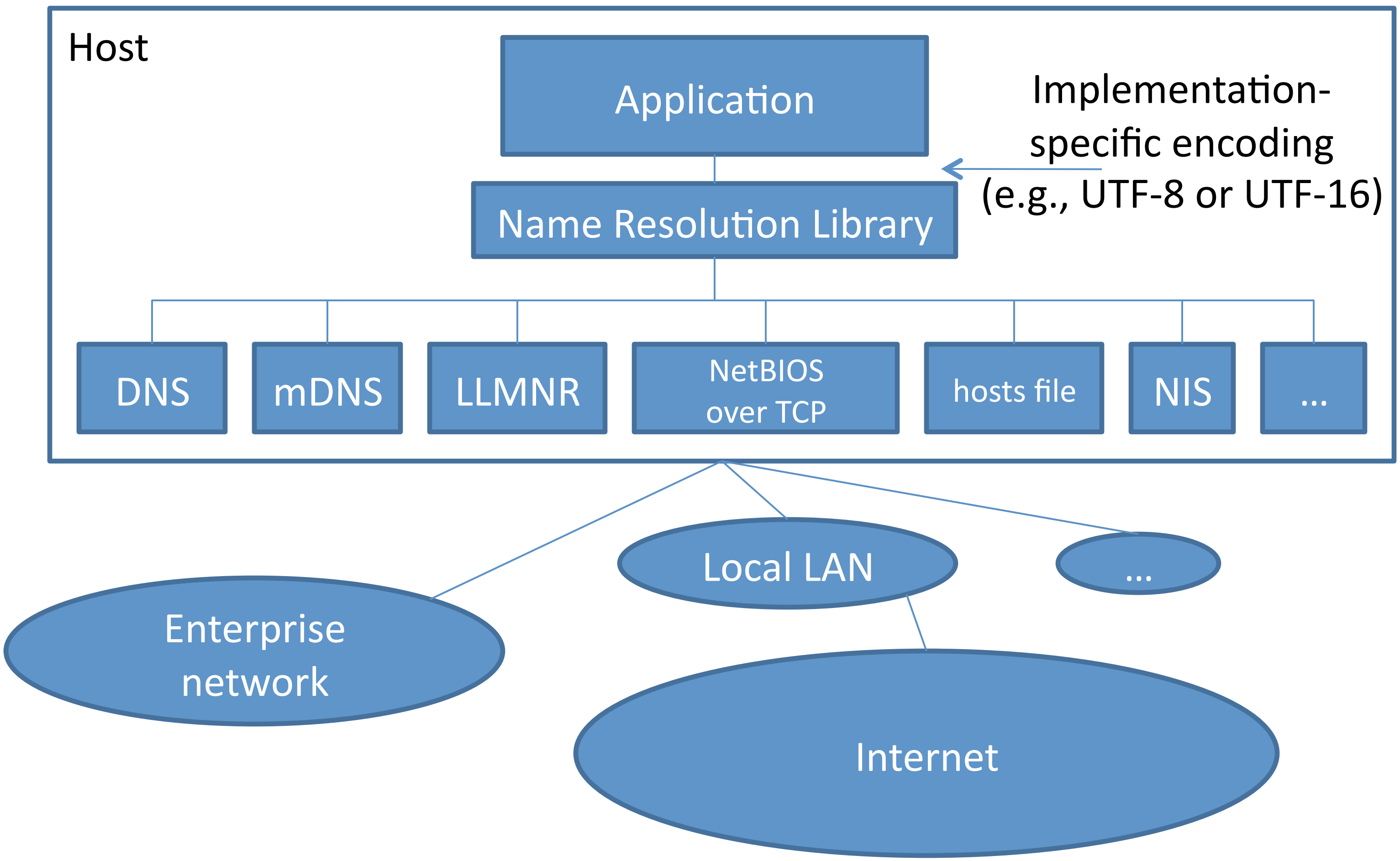
Problem #1: DNS isn't the only name resolution protocol

Different protocols use different encodings today

Problem #2: The public Internet name space isn't the only name space

Different name spaces use different encodings today

Realistic Network Architecture



Other Name Resolution Protocols

- Many defined to use *the same syntax*
  - Hosts file, DNS, mDNS, NetBIOS-over-TCP, etc.
- Name resolution library decides what protocols to try in what order
  - Apps cannot tell from the name what protocols will be used for resolution
  - Different libraries may use different order and hence find different name targets
- Different protocols specify use of different encodings
  - Apps cannot tell what encodings will be needed for resolution

What's a Legal Name?

- In 1985, RFC 952 defined the format of the hosts file:
  - "**Internet host/net/gateway/domain name**" contains ASCII letters, digits, hyphens (LDH)

- In 1989, RFC 1035 defined DNS:
  - **"*Preferred* name syntax"**: LDH
  - But does "preferred" mean MAY/SHOULD/MUST?

Legal DNS Names

- In 1997, RFC 2181 clarified:
  - Any binary string whatever can be used as the label of any resource record
  - Any binary string can serve as the value of any record that includes a domain name
  - *Applications* can have restrictions imposed on what particular values are acceptable in their environment
- Same year:
  - IETF policy on character sets and languages…

IETF Policy on Character Sets and Languages (RFC 2277)

- It says:
  - Protocols MUST be able to use the UTF-8 charset
  - Protocols MAY specify, in addition, how to use other charsets or other character encoding schemes
  - Using a default other than UTF-8 is acceptable
- Silent on different *forms* within UTF-8 (e.g. case, encoding of combining characters, sort order)
  - Two Unicode strings often cannot be compared to yield results users expect without additional processing
- Per RFC 2181, DNS complies

Use of Different Encodings in DNS

- Starting that year (1997), some systems began using UTF-8 in DNS in private name spaces
  - Private name space here means names are not resolvable from outside the specific network
- About five years later, IDNA development (including Punycode) began for use in the public DNS name space

Length Issues

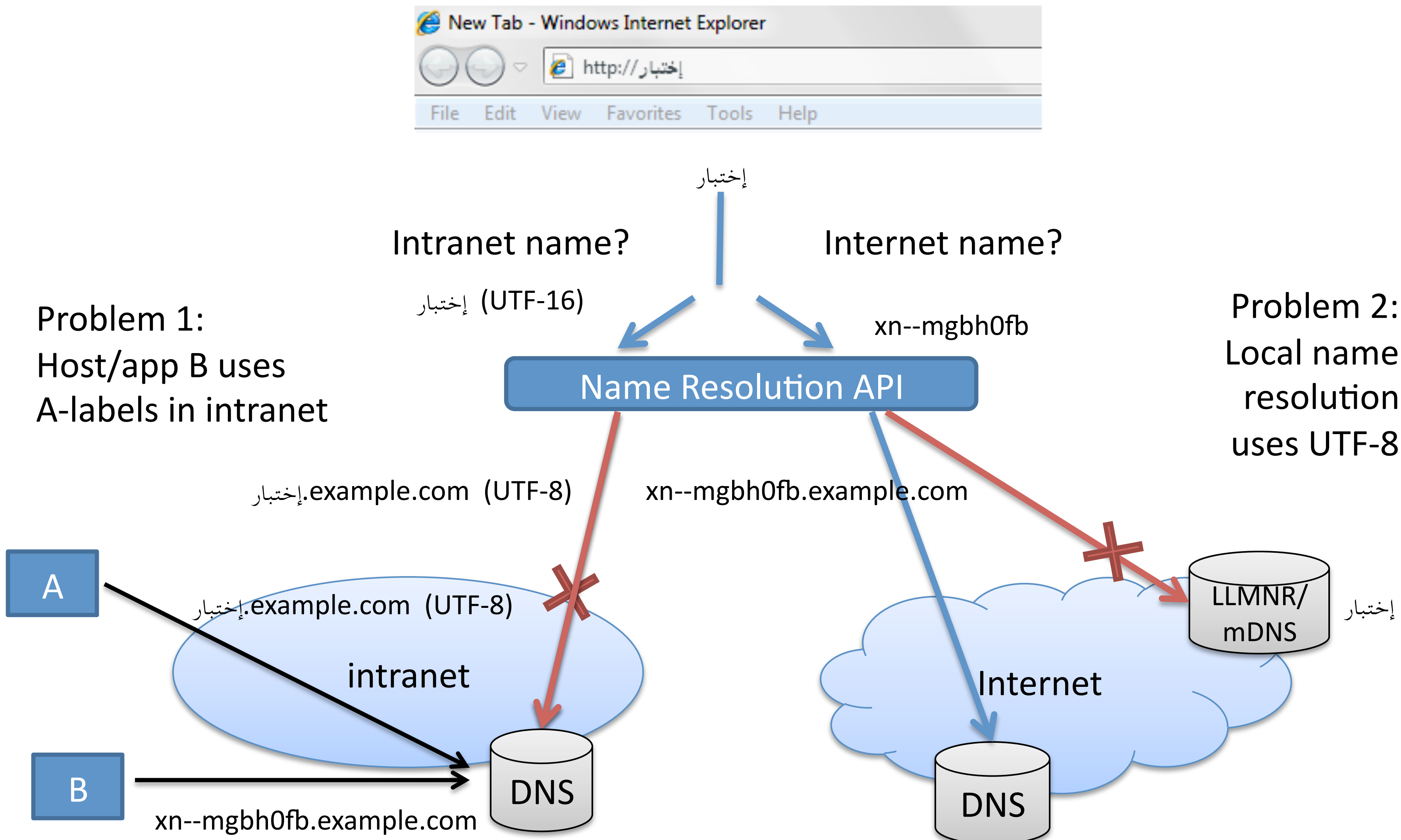
- DNS names have
  - 63 octets per label
  - 255 octets per name (not counting zero at the end)
- Most application APIs use NULL-terminated strings
- Non-ASCII characters use a variable number of octets in UTF-8, UTF-16 and Punycode
  - 256 UTF-16 octets ≠ 256 UTF-8 octets ≠ 256 A-label octets
- Some names can be represented (within length) in Punycode A-labels but not in UTF-8
- Some names can be represented (within length) in UTF-8 but not in Punycode A-labels

Let’s Recap Where We Are…

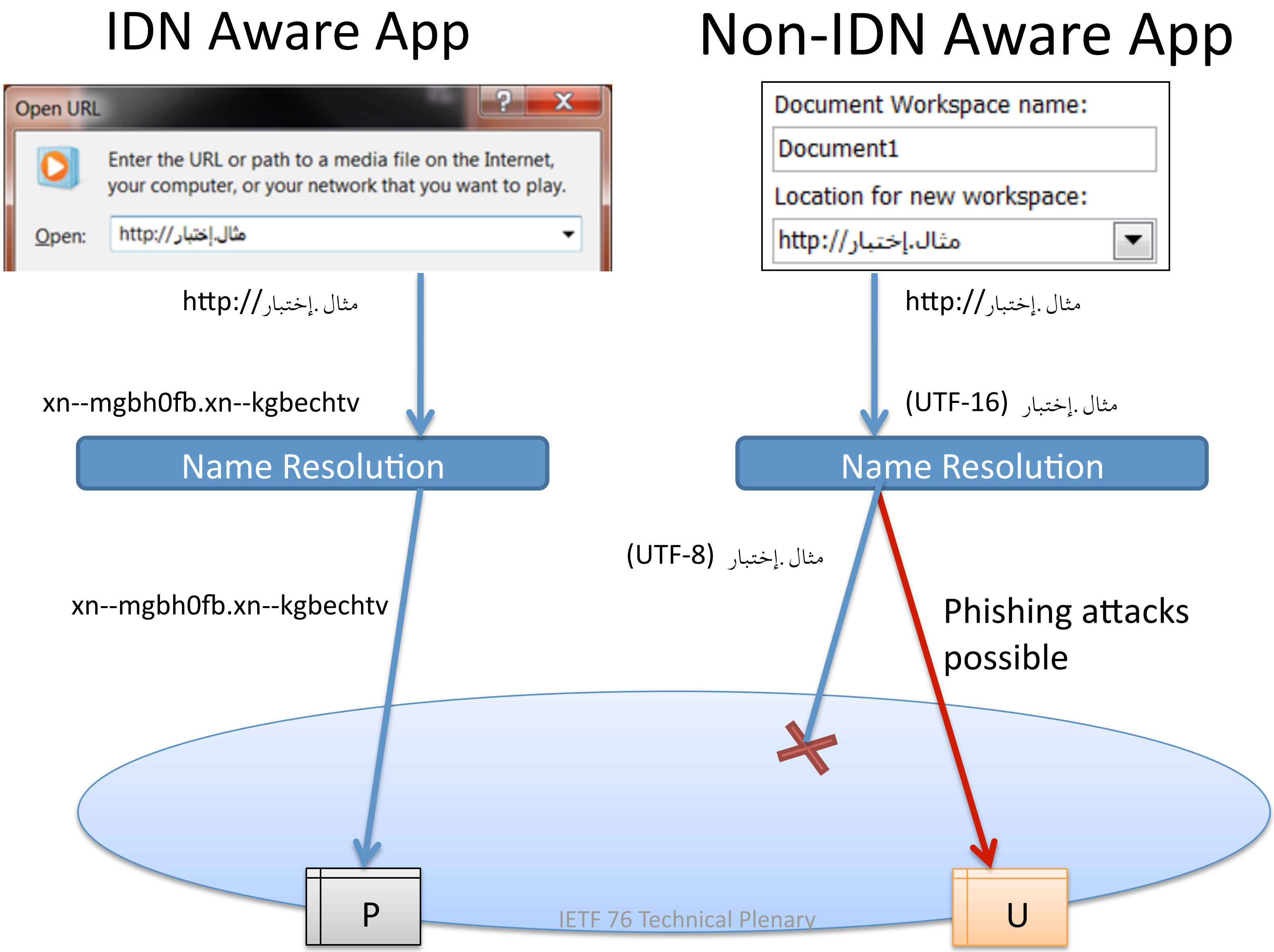
- Multiple encodings of same Unicode characters:
  - U-labels: مثال.إختبار
  - A-labels: xn--mgbh0f.xn--kgbechtv
- Different encodings used:
  - By different protocols
  - On different networks with DNS
    - Punycode A-labels used on Internet, UTF-8 in intranets
  - By different applications
- Results:
  - Failure — or worse — launching one app from another
  - Competitor switching incentives, and poor user experience when one app works and competitor doesn’t

Example "IDN-aware" app:

Browser picks encoding based on intranet vs. Internet

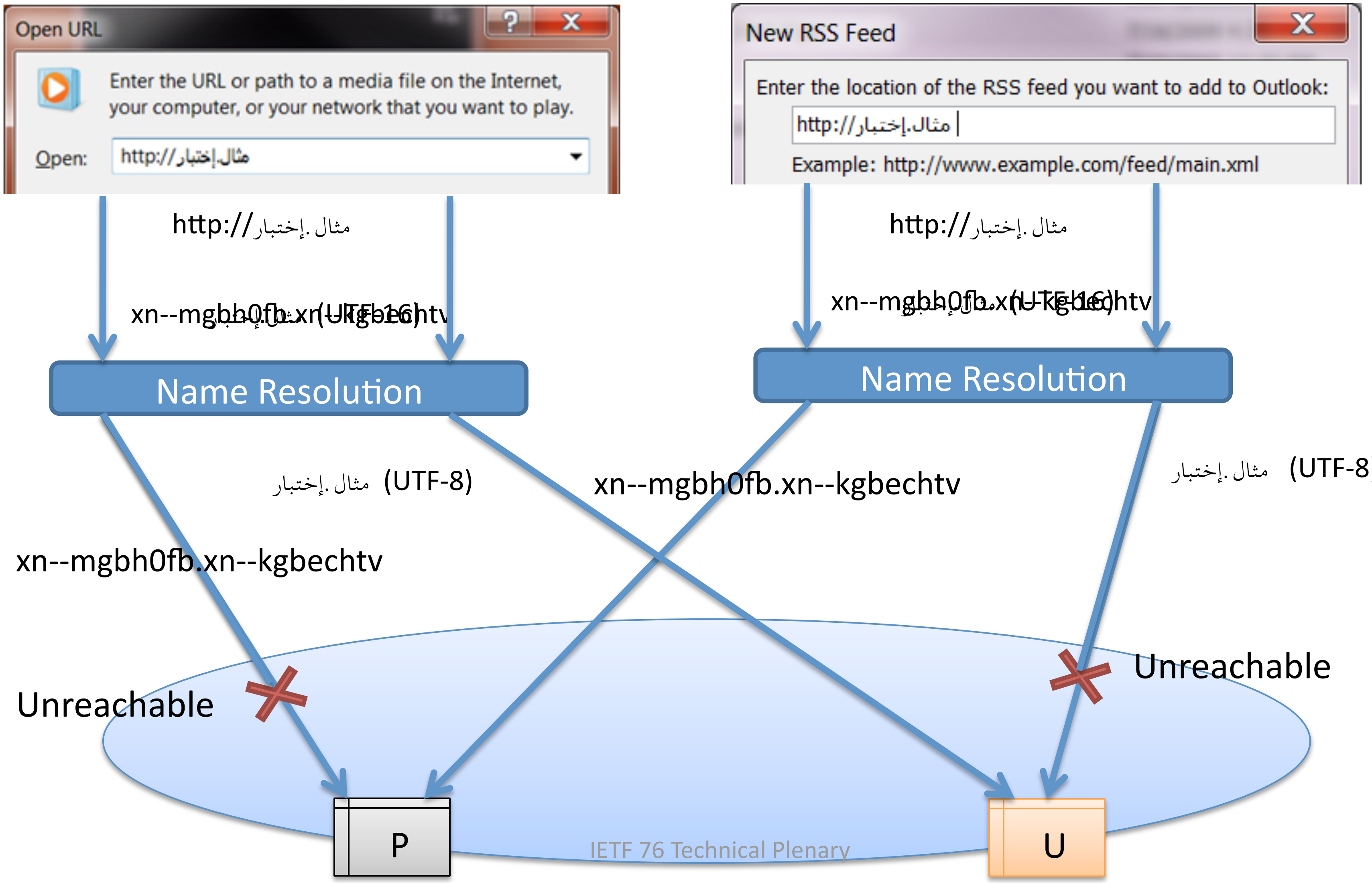


Inconsistent Experience Across Applications



Other IDN-Aware Apps

Lack consistency, causing non-deterministic experience



Basic Principle

- Conversion to A-labels, UTF-8, or whatever other encoding, can be done only by an entity that knows which protocol and name space will be used

Hard Issues 1 of 2

- Client has to guess or learn what encoding a {HTTP,DNS,SMTP,…} server expects for an identifier
- Names appear inside many other types of identifiers, e.g. email address, URLs, UNC paths, network access identifiers (NAIs)
  - Each identifier type has its own encoding conventions
  - Today, apps that extract host names need to convert encodings

Hard Issues 2 of 2

- Use of a single encoding is the easy part
  - Sufficient only if the only intent is to display
  - Comparison, matching, lookup, sorting, etc., all require more work.
  - Just as RFC 952 defined an ASCII subset for "hostname" identifiers, we need to define Unicode subsets for other types of identifiers.
- Optimal subset for one protocol may not be optimal for another.
- Interpretation and display of some strings may differ by operating systems – usually a bug, but sometimes no agreement as to which variation is the bug.

Conclusions

- Smooth and interoperable functioning of the Internet depends on text strings being interpreted in the same way by all systems connected to it
- The IETF has recognized this since RFC 20 specified ASCII for use in interchange in 1969 — the suggestions in this presentation extend and update that understanding as well as the understanding in RFCs 2277 and 5198

Conclusions

- To avoid confusion and ambiguity,
  it is not enough merely to support UTF-8
  as *one* of the text encoding options
  – Text in protocols on the wire should be in UTF-8
    and *only in* UTF-8
- For user-visible text in protocols:
  – If you don't use UTF-8, why not?
- For protocol identifiers not seen by users:
  – If you do allow the full Unicode character range, why?