Attacking Internationalized Software

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iSEC PARTNERS

Information Security Partners, LLC
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Attacking Internationalized Software

- **Introduction**
- **Background**
  - Internationalization Basics
  - Platform Support
  - The Internationalization “Stack”
- **Historical Attacks**
  - Width calculation
  - Encoding attacks
- **Current Attacks**
  - Conversion to Unicode
  - Conversion from Unicode
  - Encoding Attacks
- **Tools**
  - I18Attack
- **Q&A**

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Introduction

- **Who are you?**
  - Founding Partner of Information Security Partners, LLC (iSEC Partners)
  - Application security consultants and researchers
- **Why listen to this talk?**
  - Every application uses internationalization (whether you know it or not!)
  - A great deal of research potential
- **Platforms**
  - Much of this talk will use Windows for examples
  - *Internationalization is a cross-platform concern!*

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Background – Internationalization Basics

- **Internationalization Defined**
  - Provides support for *potential* use across multiple languages and locale-specific preferences
  - Most of this talk will focus on character manipulation
- **Code Pages A-Plenty**
  - Single-Byte: Most pages for European languages, ISO-8859-*…
  - Multi-Byte: Japanese (Shift-JIS), Chinese, Korean
  - Unicode
- **Encodings to match A-Plenty**
  - EBCDIC, ASCII, UTF-7, UTF-8, UTF-16, UCS-2…

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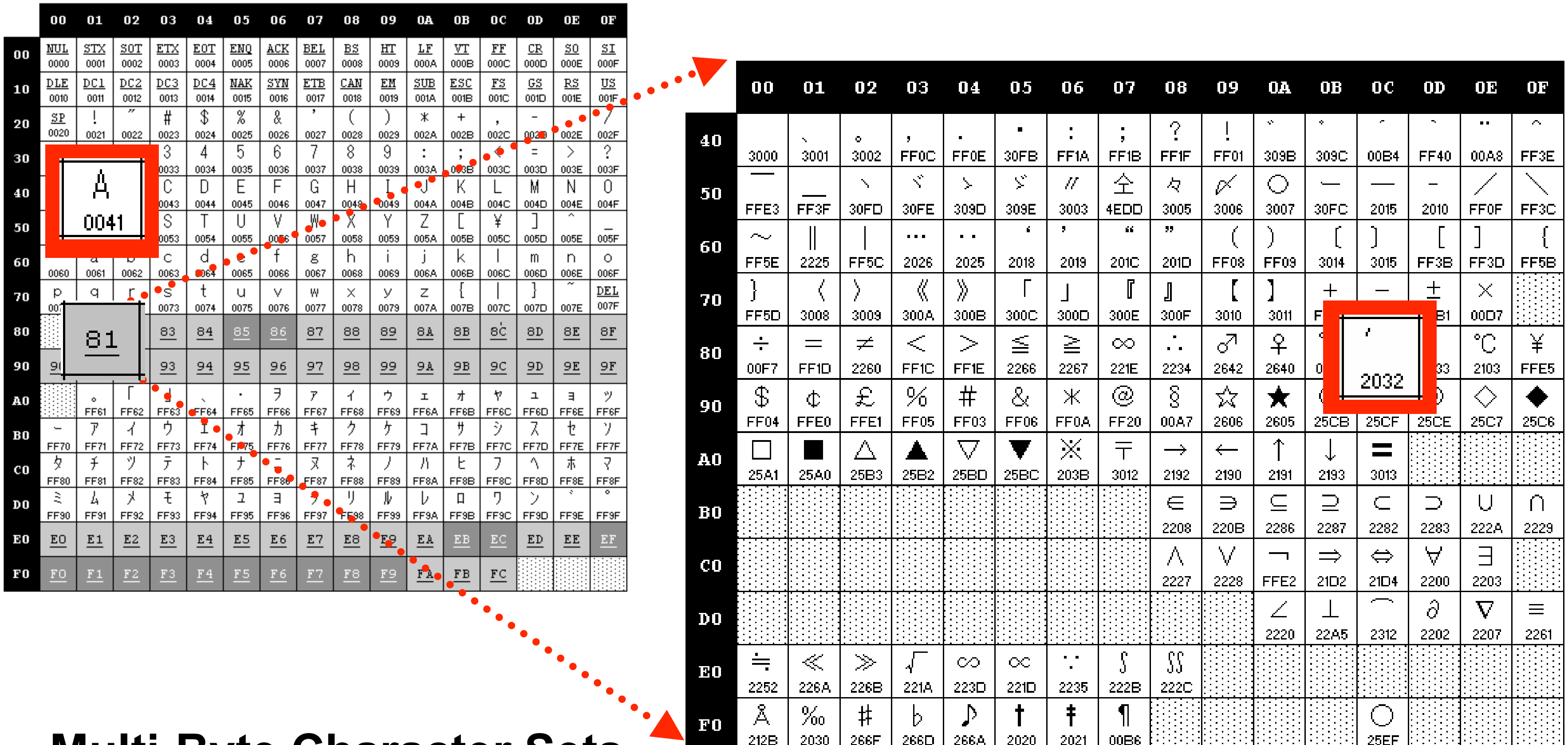
Background – Internationalization Basics



- **Multi-Byte Character Sets**
  - –0x41 = U+0041 = LATIN CAPITAL LETTER A
  - –0x81 0x8C = U+2032 = PRIME

See http://www.microsoft.com/globaldev for others

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Background – Internationalization Basics

- **Unicode**
  - One code page to rule them all!
  - Current standards specify a 21-bit character space
- **Encodings vs. Code Points**
  - Code pages describe sets of points, encodings translate those points to 1s and 0s
  - Though Unicode is often associated with 8 or 16-bit chars, these are just the most common encodings
  - Many encodings available: UTF-32, UTF-16, UCS-2, UTF-8, UTF-7
  - UTF-16 surrogate pairs: U+D800 to U+DBFF high & U+DC00 to U+DFFF low

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Background – Platform Support

- **Almost every platform has support for internationalization**
  - Results depend on Unicode standard supported by platform
- **Newer platforms tend to play nicer with Unicode**
  - .Net & Java use native Unicode encodings, though they can convert to others
- **Cool, I use one of those!***
  - Not so fast – you still depend on internationalization support of underlying OS, servers they interact with, etc.

*Also “Damn, they use one of those!”

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Background – Windows

- **Windows is built with Unicode at its core**
  - Most native API functions take UTF-16 strings
  - In many cases, this requires that SBCS and MBCS code pages be converted, often several times
- **Broad, generalized support though OS and applications**
  - Serves as a good example for today's demos
  - Not all localized builds support the same code pages out of the box
  - Install language packs, and test with native builds if you *really* want coverage
- **Character set conversion has two core APIs**
  - Though we are Win32-specific here, the idea translates to other platforms

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Background – Windows

- **MultiByteToWideChar – Convert to Unicode**
  - CodePage - can use default which will vary by system
  - Note all of the length specifiers!

```
int MultiByteToWideChar(
  UINT CodePage,          // code page
  DWORD dwFlags,          // character-type options
  LPCSTR lpMultiByteStr,  // string to map
  int cbMultiByte,        // number of bytes in string
  LPWSTR lpWideCharStr,   // wide-character buffer
  int cchWideChar         // size of buffer
);
```

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Background – Windows

- **WideCharToMultiByte – Convert from Unicode**
  - dwFlags – modifies conversion properties
    - WC_NO_BEST_FIT_CHARS is your friend!
  - lpDefaultChar – allows you to specify error character

```
int WideCharToMultiByte(
  UINT CodePage,              // code page
  DWORD dwFlags,              // performance and mapping flags
  LPCWSTR lpWideCharStr,      // wide-character string
  int cchWideChar,            // number of chars in string
  LPSTR lpMultiByteStr,       // buffer for new string
  int cbMultiByte,            // size of buffer
  LPCSTR lpDefaultChar,       // default for unmappable chars
  LPBOOL lpUsedDefaultChar    // set when default char used
);
```

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*Background – *nix*

- **General support assumptions are hard to make**
  - POSIX Locale offers some standardization
  - Many libraries and application-specific approaches fill the void
- **Pushes i18n concerns “up the stack”**
  - Less internationalization support offered “for free” to developers
  - For example – using non-English or non-UTF-8 characters often requires using alternate editors/shells/etc. See open18n.org.
- **This is good and bad**
  - Less pixie dust means that internationalization support is often intentional
  - Then again, it’s complicated, error prone, and often implemented insecurely.

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*Background – *nix*

- **Common Utilities/Libraries that offer support**
  - International Components for Unicode – open source library, cross-language
  - iconv – common utility on most linux distros. Converts files across many encodings
  - Libiconv: API for the same
  - Roll your own – everybody else does!*

- **Standardization**
  - www.opengroup.org – POSIX locale guidelines
  - www.open18n.org – Internationalization guidelines defined in LSB

*Please don't!

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Background – Everything Else

- **Support isn't just from the OS**
  - Programming language
  - Virtual machines
  - Application only
- **This offers a unique attack surface**
  - Cross-OS, Language, Application Class, and Implementation
  - A great place to start is with standards that stipulate I18N support
  - In short, this hits almost every application out there

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Background – The Internationalization Stack

- **Every application has internationalization dependencies**
  - Development platform
  - External libraries
  - Operating System
  - Application Server
  - Database Server - collations!
  - Clients

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Background – The Internationalization Stack

- **Web applications**
  - Code page can be set on both HTTP request and response
  - Code page is set on first line of every XML document
- **The Default Code Page**
  - Remember CP_ACP?
  - Change system and user locales
  - Ever tried to test your app on Japanese…you'll see why you should!

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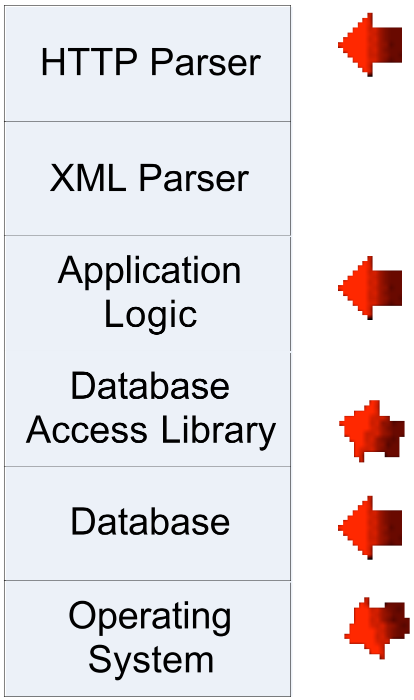
Background – The Internationalization Stack



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Most practical point of control for devs

Great research potential!

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Historical Attacks

- **Security and Internationalization has seen some attention…**
  - Chalk these up as "lesson learned," for the most part
- **Width Calculation**
  - Conversion functions
  - Count of bytes vs. Count of characters
    - sizeof(array) vs. sizeof(array)/sizeof(array[0])
  - Compile-time function specifiers (lstr*, tchars)
- **Non-minimal UTF-8 encodings in NT4 IIS**
  - http://.../web/index.html
  - http://.../web/../../blah
  - http://.../web/%2E%2E%2F%2E%2E%2F/blah
  - http://.../web/%C0%AE%C0%AE%C0%AF%C0%AE%C0%AE%CO%AF/blah

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Current Attacks – Conversion from Unicode

- **Scenario – Validation is performed on input, later converted to locale-specific text**

- **Attack Class – “Eating Characters”**
  - Especially damaging for any character string that “doubles up” to escape

- **Eating a SQL quotation character**
  - Shift-JIS MBCS Japanese Code Page
  - 0x8260 = U+FF21 = FULLWIDTH LATIN CAPITAL LETTER A
  - 0x8227 = nothing (but 0x27 is an apostrophe)
  - 0x822727 = nothing with an apostrophe
  - Converted to Unicode, this will likely become ?’!
  - …where user =‘blah?’ or 1-1--…

Demo

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Current Attacks – Conversion to Unicode

- **Scenario – Validation is performed, changed to Unicode**

- **Attack Class – “Character Conversion”**
  - Unicode’s character space is much larger than any locale-specific code page
  - Results in a many-to-one mapping for many characters
  - Code-page specific
  - Big reason why WC_NO_BEST_FIT_CHARS should *always* be specified

- **Sneaking an apostrophe in…**
  - U+2032 = PRIME
  - Converted to Latin-1252 it is 0x27 – Apostrophe
  - U+2032 isn’t the only apostrophe equivalent in Windows-1252!
  - Same thing happens for quotation marks, numbers, letters, etc.
  - Latin-1 isn’t the only code page, have you tried your JPN web client lately?

Demo

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Current Attacks – Conversion to Unicode

- **Attack Class – "Foiling Canonicalization"**
  - Back in the day %C0%AE was interpreted as 0x2E or simply '**.**'
  - Unicode standard has been changed to explicitly disallow all such conversions
  - Most UTF-8 parsers today choose to omit such characters

- **Attack - Directory Traversal**
  - http://.../web/index.html
  - http://.../web/../../blah
  - http://.../web/.%C0AE./.%C0AE./blah
  - ../ not found in input, so passed to file parser
  - File parser converts .%C0AE./.%C0AE./ to unicode (as NtCreateFile requires)
  - Non-minimal encodings dropped - ../../ remains

Demo

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Current Attacks – Encoding Attacks

- **Attack Class – “Mistaken Identity”**
  - We have been spoiled by the most common Unicode encodings
  - Unicode is just a set of code points, encoding is up to the parser
  - UTF-8, UTF-16, and UCS-2 all resemble ASCII

- **Sneak “garbage” data past validators**
  - Most interesting characters exist in ASCII – ‘, “, <, >, =…
  - Validation routines often take advantage of the ASCII resemblance
  - Many encodings can easily bypass this approach
  - ASCII, EBCDIC, UTF7..

Demo

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Tools – I18NAttack

- **Background**
  - Testing equivalence characters, “eaters,” alternate encodings is time consuming!
  - Goal is to provide a security-focused collection of characters and encodings that often trip up input validation routines
  - Using it is always going to be transport-dependent, but here is a tool to get you started…

- **I18NAttack**
  - HTTP POST/GET Parameter Fuzzer
  - Reference implementation for nasty character database
  - Will identify and fuzz problem characters across equivalents, unusual encodings, etc.
  - Use to bypass poor input validation

Demo

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Q&A

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