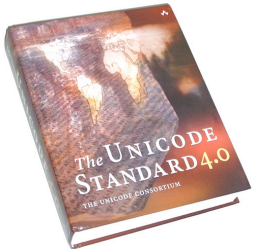
XeTeX: the Multilingual Lion

TeX meets Unicode and smart fonts



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What is XeTeX?

- TeX typesetting engine
  - including e-TeX extensions
- Supporting the Unicode character set
  - inherently multilingual/multiscript typesetting system
  - greatly simplifies language support at macro level
- Using modern font technologies
  - TrueType, OpenType (all fonts supported by platform)
- With "smart rendering" support
  - Apple Advanced Typography
  - OpenType Layout features
  - for typographic features and complex scripts

Multilingual typesetting with TEX

- Text input
  - escape sequences for non-ASCII characters
  - multiple 8-bit and double-byte codepages
  - use of active characters
  - preprocessors for complex scripts
- Font support
  - fonts limited to 256 glyphs
  - custom-encoded fonts with specific glyph sets
  - many different font encodings in use
- All tied together via complex TEX macros
  - difficult to understand and extend
  - difficult to integrate with other packages

Traditional TEX input conventions

- Input text is ASCII (or 8-bit codepage)

Source text	Typeset output	Notes
`\'{a}`	á	typical accent command
`\c{c}`	ç	
`\aa`	å	
`---`	—	ligature in typical TEX fonts
`$\alpha$`	α	math mode symbol
`{\dn acchaa}`	अच्छा	using custom preprocessor

Typesetting Unicode text with XeTeX

- Accented characters
  - many more than in any legacy codepage

```
\halign{#\hfil\quad&
 #\hfil\cr
dan&    dan\cr
dubok&  dubok\cr
džabe&  đak\cr
džin&   džabe\cr
Džin&   džin\cr
đak&    Džin\cr
Evropa& Evropa\cr}
```

dan	dan
dubok	dubok
džabe	đak
džin	džabe
Džin	džin
đak	Džin
Evropa	Evropa

Typesetting Unicode text with XeTeX

- CJK ideographs
  - they're just more characters, no special effort required

```
\font\han="STSong" at 16pt
\font\rom="Gentium" at 8pt
\def\hc#1#2{\vtop{\hbox{\han #1}
 \hbox{\kern10pt\rom #2}}}
\vtop{\hc{書く}{ka-ku}
 \hc{最も}{motto-mo}
 \hc{最後}{sai-go}
 \hc{働く}{hatara-ku}
 \hc{海}{umi}}
```

書く
ka-ku
最も
motto-mo
最後
sai-go
働く
hatara-ku
海
umi

Typesetting Unicode text with XeTeX

- Complex scripts
  - just simple character data in the source file

```
\c 1
\s دنيا جي پيدائش
\p
\v 1 شروعات ۾ خدا زمين ۽
آسمان کي پيدا ڪيو.
\v 2 ان وقت زمين بيترتيب
۽ ويران هئي. اونهي سمنڊ
جو مٿاڇرو اوندهہ سان ڍڪيل هو
۽ پاڻئَ جي مٿان خدا
جو روح ڦريو پئي ڪي
\v 3 تڏهن خدا حڪم ڏنو تہ ”روشني
ٿئي.“ سو روشني ٿي پيئي.
```

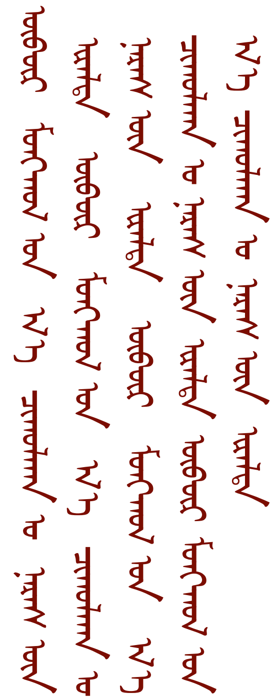
دنيا جي پيدائش

۱ شروعات ۾ خدا زمين ۽ آسمان کي
پيدا ڪيو. ۲ ان وقت زمين بي‌ترتيب ۽
ويران هئي. اونهي سمنڊ جو مٿاڇرو اوندهہ
سان ڍڪيل هو ۽ پاڻيءَ جي مٿان خدا جي
روح ڦريو پئي ڪي ۳ تڏهن خدا حڪم ڏنو
تہ ”روشني ٿئي.“ سو روشني ٿي پيئي.

Typesetting Unicode text with XƎTEX

- Vertical text (not fully supported)

```
\font\mon="Code2000:script=mong" at 18pt
\setbox0=\vbox{
 \hsize=3.6in \baselineskip=20pt
 \parindent=-12pt \leftskip=12pt
\revpar \mon
[illegible]
[illegible]
[illegible]
[illegible]
\par}
\special{x:gsave}\special{x:rotate -90}
\vskip-\ht0 \box0 \special{x:grestore}
```



A cleaner multilingual solution

- All required characters directly represented
  - no need for "escape sequences" to access characters not included in the current codepage
  - no need to switch between codepages according to the language/script being typeset
  - characters rendered via standard access codes
- Character/glyph model and modern font rendering technologies
  - encoded text represents characters, not glyphs
  - complex script behavior separated from the encoded text data, handled through standard "smart font" technologies

Character codes

- Basic character codes are 16-bit
  - representing Unicode in the UTF-16 encoding form
  - (except when using legacy custom-encoded fonts)
- Extended TEX primitives
  - `\char`, `\chardef` accept numbers up to 65,536
  - 4-digit hex notation using `^^^^abcd`

    `\char"5609^^^^6167` = 嘉慧
- What about Unicode characters beyond Plane 0?
  - handled using surrogates (UTF-16 representation)
  - adequate for rendering
  - does not allow full per-character programmability

Extended TEX code tables

- Per-character code tables `\catcode`, `\lccode`, `\uccode`, `\sfcode` enlarged
  - "plain XƎTEX" format initializes these tables based on Unicode character set
  - `\lowercase{DŽIN}`
    džin
  - `\uppercase{Esi eyama klɔ míaƒe nuvɔwo ɖa vɔ la}`
    ESI EYAMA KLƆ MÍAƑE NUVƆWO ƉA VƆ LA
  - `\catcode`王=\active \def王{...}`

Input encodings

- By default, input read as Unicode (UTF-8 or UTF-16)
  - encoding form automatically detected
- Non-Unicode input text
  - legacy codepages supported via ICU converters
  - set codepage of current input file:
    `\XeTeXinputencoding "`charset-name`"`
  - set initial codepage for newly-opened input files:
    `\XeTeXdefaultencoding "`charset-name`"`

Hyphenation patterns

- Extended for 16-bit characters
- Standard hyphenation files are encoding-specific
  - modified to load correctly under XETEX
- Simple hyphenation for scripts such as Devanagari
  - text is simple character data, no macros, active chars, etc.

```
% break before or after any independent vowel
1अ1
1आ1
1इ1
% break after any dependent vowel, but never before
2ा1
2ि1
```

Host platform fonts

- Use any font installed on the host computer
- `\font` command extended to accept "real" font names
- `\font\rm="Trebuchet MS" at 16pt \rm Hello World!`
  - Hello World!
- `\font\it="Times Italic" at 16pt \it Hello World!`
  - *Hello World!*
- `\font\ch="Apple Chancery" at 16pt \ch Hello World!`
  - *Hello World!*
- `\font\heiti="STHeiti" at 16pt \heiti 你好，武汉!`
  - 你好，武汉!
- No TFM files, etc., required to use new fonts!

Output device support

- Output driver uses the same fonts as the typesetting engine
  - no font name mapping files required
- Generate PDF as default output
  - there is actually an "extended DVI" (`.xdv`) intermediate
- Fonts automatically embedded and subsetted

Support for traditional TeX fonts

- TFM files still supported
  - required for math fonts to provide precise metrics
  - implies non-Unicode data, using character codes 0…255 only
- PDF back-end supports Type 1 fonts
  - uses `.pfb` files in the texmf tree, just like dvips
  - no support for bitmap fonts
  - currently no `.vf` support

Font mappings

- Traditional TeX keyboarding practices
  - typical input:

```
``\TeX''---a typesetting system
```

  - generates: ``TeX''---a typesetting system
- Font mapping for compatibility

```
; TECkit mapping for TeX input conventions
U+002D U+002D        <> U+2013 ; -- -> en dash
U+002D U+002D U+002D <> U+2014 ; --- -> em dash
U+0027         <>  U+2019 ; ' -> right single quote
U+0027 U+0027  <>  U+201D ; '' -> right double quote
U+0022          >  U+201D ; " -> right double quote
```

  - generates: “TeX”—a typesetting system
  - the “font mapping” is associated with a specific TeX font identifier

More fun with font mappings

```
\def\SampleText{Unicode -
    это уникальный
 код для любого символа,\\
 независимо от платформы,\\
 независимо от программы,\\
 независимо от языка.}
\font\gen="Gentium"
\gen\SampleText
\bigskip
\font\gentrans="Gentium:
  mapping=cyr-lat-iso9"
\gentrans\SampleText
```

Unicode - это уникальный
код для любого символа,
независимо от платформы,
независимо от программы,
независимо от языка.

Unicode - èto unikal'nyj
kod dlâ lûbogo simvola,
nezavisimo ot platformy,
nezavisimo ot programmy,
nezavisimo ot âzyka.

AAT font features

- Custom AAT features accessed via `\font` command
- `\font\x="Apple Chancery" at 16pt \x The quick brown fox jumps over the lazy dog.`
  - *The quick brown fox jumps over the lazy dog.*
- `\font\x="Apple Chancery:Letter Case=Small Caps;Design Complexity=Simple Design Level" at 16pt \x The quick…`
  - THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG.
- `\font\x="Apple Chancery:Design Complexity=Flourishes Set A" at 16pt \x The quick brown fox jumps over…`
  - *The quick brown fox jumps over the lazy dog.*

OpenType: language and script

- Fonts may support multiple languages with differing behavior

```
\font\Doulos="Doulos SIL/ICU"
\font\DoulosViet="Doulos SIL/ICU:language=VIT"
```

Unicode cung cấp
một con số duy
nhất cho mỗi ký tự

Unicode cung cấp
một con số duy
nhất cho mỗi ký tự

```
\font\Brioso="Brioso Pro"
\font\BriosoTrk="Brioso Pro:language=TRK"
```

… gelen firmaları
… tarafından …

… gelen firmaları
… tarafından …

OpenType: language and script

- Complex Asian scripts require specific "shaping engines"
- With no "script tag", only default Latin features applied

```
\font\x="Code2000" \x العربي हिन्दी
```

العربي हिन्दी

- Must load the font with the appropriate shaping engine

```
\font\x="Code2000:script=arab" \x العربي
```

العربي

```
\font\x="Code2000:script=deva" \x हिन्दी
```

हिन्दी

OpenType: optional features

- Font specification may include feature tags
  - `\font\x="Brioso Pro" \x Hello World! 0123456789`

    Hello World! 0123456789
  - `\font\x="Brioso Pro:+smcp"`

    Hello World! 0123456789
  - `\font\x="Brioso Pro:+sups"`

    Hello World! 0123456789
  - `\font\x="Brioso Pro Italic:+onum"`

    Hello World! 0123456789
  - `\font\x="Brioso Pro Italic:+swsh,+zero"`

    Hello World! Ø123456789

OpenType: optical sizing

- OpenType optical families automatically choose correct face for the size used
  - Brioso Pro at 7, 10, 18, 24pt sizes:

    seven ten eighteen twenty-four
- Can override with `/S=` modifier on font name
  - showing different optical sizes using the same "at size"
  - `Brioso Pro/S=7` Brioso Pro Caption
  - `Brioso Pro/S=10` Brioso Pro Text
  - `Brioso Pro/S=18` Brioso Pro Subhead
  - `Brioso Pro/S=24` Brioso Pro Display

Line-break positions

- Line breaking without word spaces
  - TEX normally breaks lines at "glue" arising from spaces
  - Chinese, Japanese, Thai, etc. do not use word spaces
  - 基本上，计算机只是处理数字。它们指定一个数字，来储存字母或其他字符。在
- Use ICU line-break algorithm
  - find permitted line-break locations according to a specific locale
  - `\XeTeXlinebreaklocale "zh"`

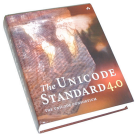
    基本上，计算机只是处理数字。它们指定一个数字，来储存字母或其他字符。在创造Ｕｎｉｃｏｄｅ之前，有数百种指定这些数字的编码系统。没有一个编码可以包含足够的字符：

Justification

- Text without spaces is difficult for TEX to justify
- Ragged-right setting is one solution
  - 基本上，计算机只是处理数字。它们指定一个数字，来储存字母或其他字符。在创造Ｕｎｉｃｏｄｅ之前，有数百种指定这些数字的编码系统。没有一个编码可以包含足够的字符:
- Alternatively, use `\XeTeXlinebreakskip` to introduce glue at each potential break
  - 基本上，计算机只是处理数字。它们指定一个数字，来储存字母或其他字符。在创造Ｕｎｉｃｏｄｅ之前，有数百种指定这些数字的编码系统。没有一个编码可以包含足够的字符:
- Could also use non-monospaced Latin characters
  - 基本上，计算机只是处理数字。它们指定一个数字，来储存字母或其他字符。在创造Unicode之前，有数百种指定这些数字的编码系统。没有一个编码可以包含足够的字符:

QuickTime image support

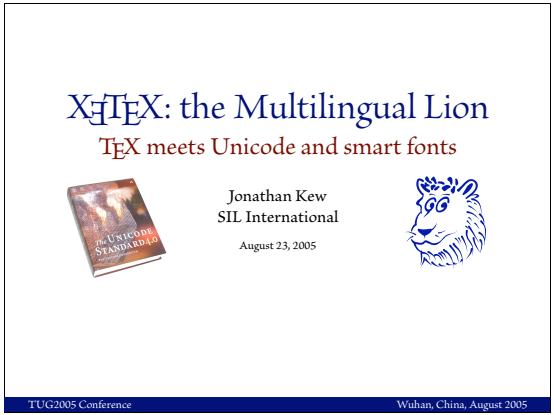
- Many graphic file formats directly supported
  - TIFF, JPEG, PNG, BMP, PICT, GIF, TGA, Photoshop, ...
  - `\setbox0=\hbox{\XeTeXpicfile "mypic.jpg"}`
- Optional keywords to modify image
  - scaled, xscaled, yscaled, width, height, rotated



- Image width and height available to TEX engine
- Can use via LATEX and ConTEXt commands

PDF documents

- Beware: QuickTime graphic importer accepts PDF
  - but renders as raster image at screen resolution!
- Use alternative command for true PDF inclusion
  - `\XeTeXpdffile "xetex-intro-slides.pdf" page 1 scaled 400`



fontspec.sty by Will Robertson

- Simple specification of native OS X fonts in LaTeX
- Integrates XeTeX font access with LaTeX commands
  - setting the default document fonts

```
\usepackage{fontspec}
\setromanfont{Adobe Garamond Pro}
\setmonofont[Scale=0.8]{Andale Mono}
```

  - on-the-fly font and feature changes

```
Welcome to Wuhan,
{\addfontfeature{LetterCase=SmallCaps}China}
```

Welcome to Wuhan, CHINA

```
August 25{\addfontfeature{VerticalPosition=Superior}th}
```

August 25th

xunicode.sty by Ross Moore

- Support for standard LaTeX input of many special characters when using Unicode fonts
  - accent commands, named characters, etc., mapped to Unicode values for font access
  - does not handle dashes, quotes (use `tex-text` font mapping)
- Allows many non-Unicode LaTeX documents to be processed using Unicode fonts

Using ConTeXt with XeTeX

- Reportedly works fairly readily, but not pre-configured "out of the box"
  - see http://www.contextgarden.net/XeTeX
- Use XeTeX font names and features in ConTeXt typescripts and other font definitions
  - see http://www.contextgarden.net/Fonts_in_XeTeX

```
\definedfont["Hoefler Text:
  mapping=tex-text;
  Style Options=Engraved Text;
  Letter Case=All Capitals;
  color=229966" at 32pt]
Big Title
```

What might be next for XeTeX?

- Ongoing bug-fixes and minor features
- Enhanced PDF back-end
  - leverage improved PDF support in Mac OS X 10.4
  - new `xdv2pdf` driver based on `dvipdfmx`
  - integration with pdfTeX output routine
- True Unicode math support
  - requires extensions to `\mathchar` etc., and underlying structures
  - also requires extended (at least 16-bit) font metric format
  - may be possible to make use of code from Ω
- XeTeX for non-Mac OS platforms
  - working towards integration with TeX Live sources

Questions… and answers?

- Contact information
  - mailto:jonathan_kew@sil.org
- XeTeX web site and mailing list
  - http://scripts.sil.org/xetex
  - http://tug.org/mailman/listinfo/xetex
  - svn://scripts.sil.org/xetex/TRUNK

ዩኒኮድ ምንድን ነው? ؟"يونكود" ما هي الشفرة الموحدة 什麼是Unicode (統一碼/標準萬國碼)? Što je Unicode? რა არის უნიკოდი? Tí εἶναι τὸ Unicode; ?מה זה יוניקוד यूनिकोड क्या है? Hvað er Unicode? ユニコードとは何か？ 유니코드에 대해? چیست یونی‌کُد Что такое Unicode? Unicode คืออะไร? ዩኒኮድ ኣንታይ ኢዩ?