Pango

An open-source Unicode
text layout engine

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25th Internationalization and Unicode Conference
Washington, DC
March/April 2004

Outline

Open source

- Source code made available to user, who can modify, redistribute
- No longer unfamiliar
  - Linux, Apache
  - Libraries such as libpng, libjpeg, libxml, ICU...
- High Quality
  - Development process incorporates code review: small group of core developers take contributions from broad user community
- Responsive to needs of users

Open source and text layout

- Ability to contribute back code very interesting for a layout engine
  - Most users have relatively simple needs
  - But “minor” scripts still have thousands or millions of users
  - Some of these users will be developers interested in contributing back code

The idea of Pango

- General purpose layout library; not restricted to complex scripts
- Highly modular
  - Add new scripts
  - Add new backends
- Use throughout system; adding support for a language to Pango enables it everywhere
  - Config tools, dialog boxes, spreadsheets, web browsers, ...

The Name

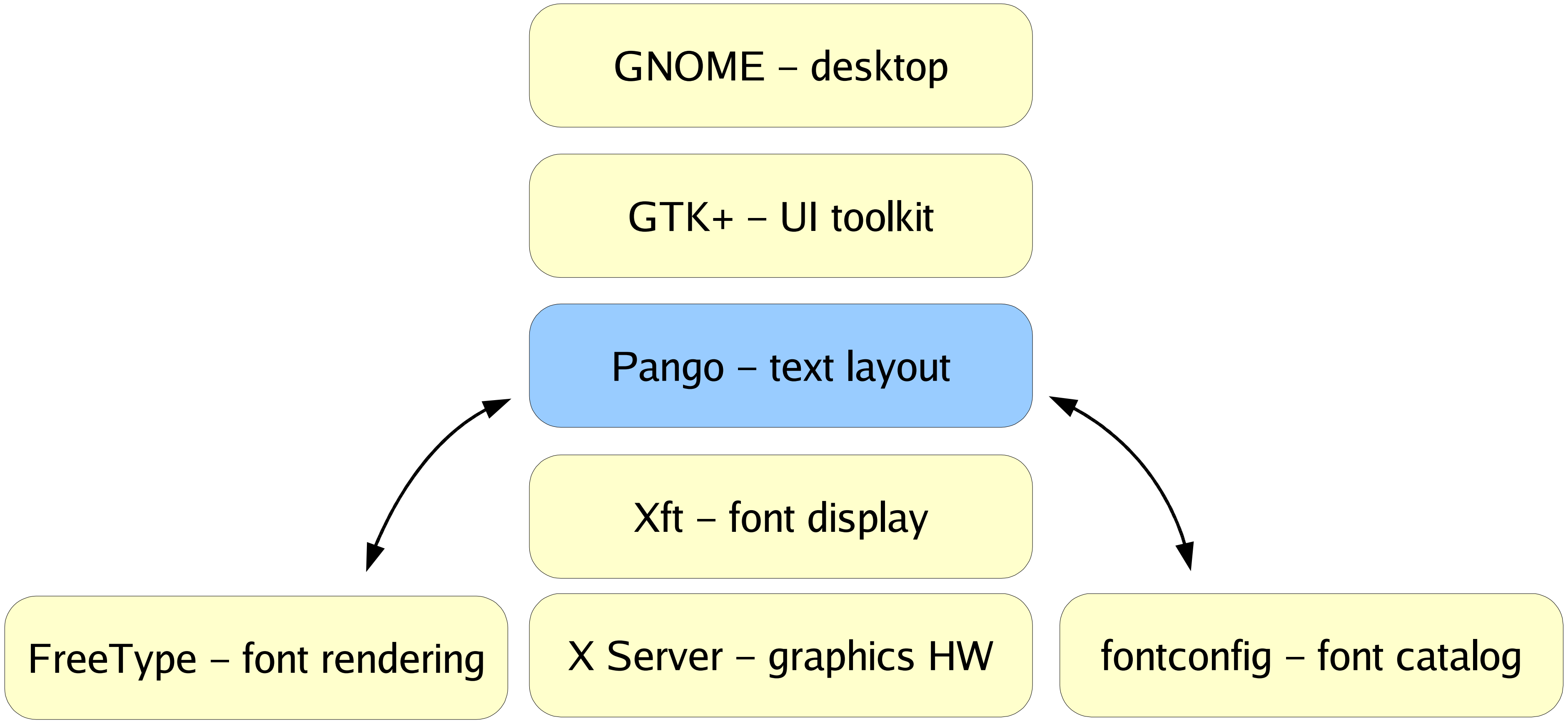
Παν語

- Greek “pan” - all + Japanese “go” language
- “go” character means “spoken language” in Chinese...

License

- GNU *Library* General Public License (LGPL)
- If an application just links to Pango
  - No requirement to reveal source code
  - No royalties
- If you modify Pango, must make the source code available to your users

Big Picture on X



- Also used on Win32, in embedded systems, etc.

Timeline

- 1999 – work started
- 2001 – 1.0 release; used in version 2.0 of GTK+ user interface toolkit.
- 2002 – 1.2 released; Indic OpenType fonts, fontconfig, Uniscribe backend on Win32
- 2004 – 1.4 release; Unicode-4.0 support, GPOS positioning for Arabic

Basic idea

- Input
  - Unicode text
  - Attributes (font family, language tags, colors,etc.)
- Output
  - Positioned *glyphs*
- Positioned glyphs
  - rendered to the screen, printer
  - converted to outlines for a drawing program
  - ...

An example

```
PangoContext *context;
PangoLayout *layout;
int width, height;

context = pango_xft_get_context (display, screen);
layout = pango_layout_new (context);
pango_layout_set_text (layout, "Hello, world");
/* ... or ... */
pango_layout_set_markup (layout,
     <span size='x-large'>Big</span> text”);

pango_layout_get_pixel_size (layout, &width, &height);
pango_xft_layout_render (xft_draw, xft_color,
                         layout, 10, 10);
```

PangoLayout

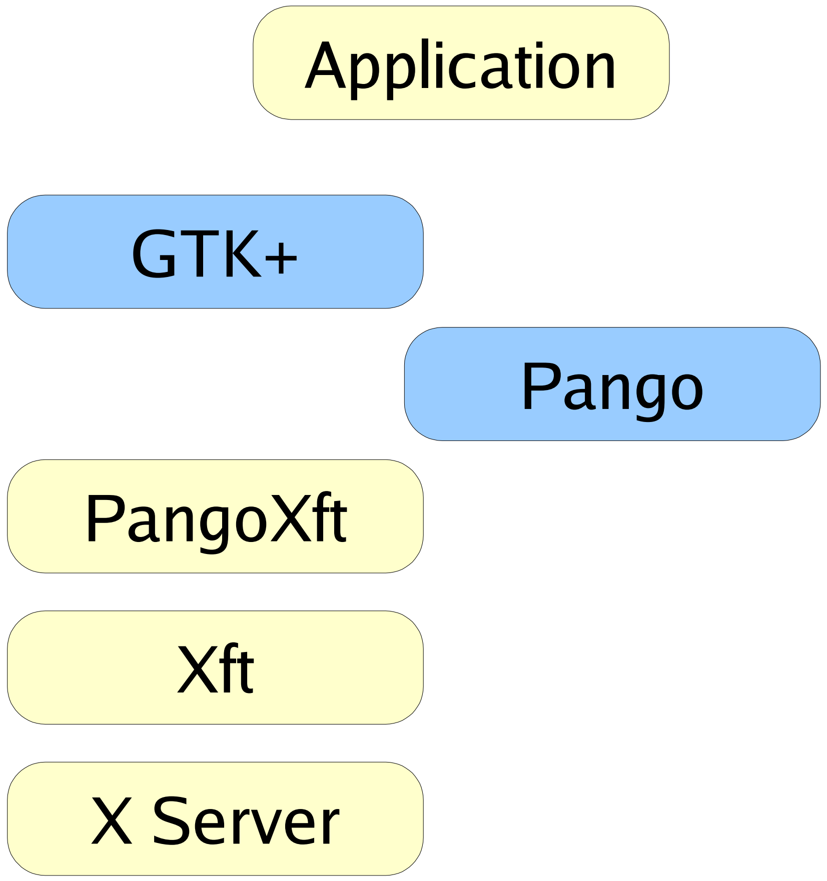
- High-level PangoLayout object holds one or more paragraphs of text + attributes
- Interfaces provided for:
  - Hit testing
  - Determining cursor locations
  - Iterating through text in visual or logical order
  - etc.

Backends

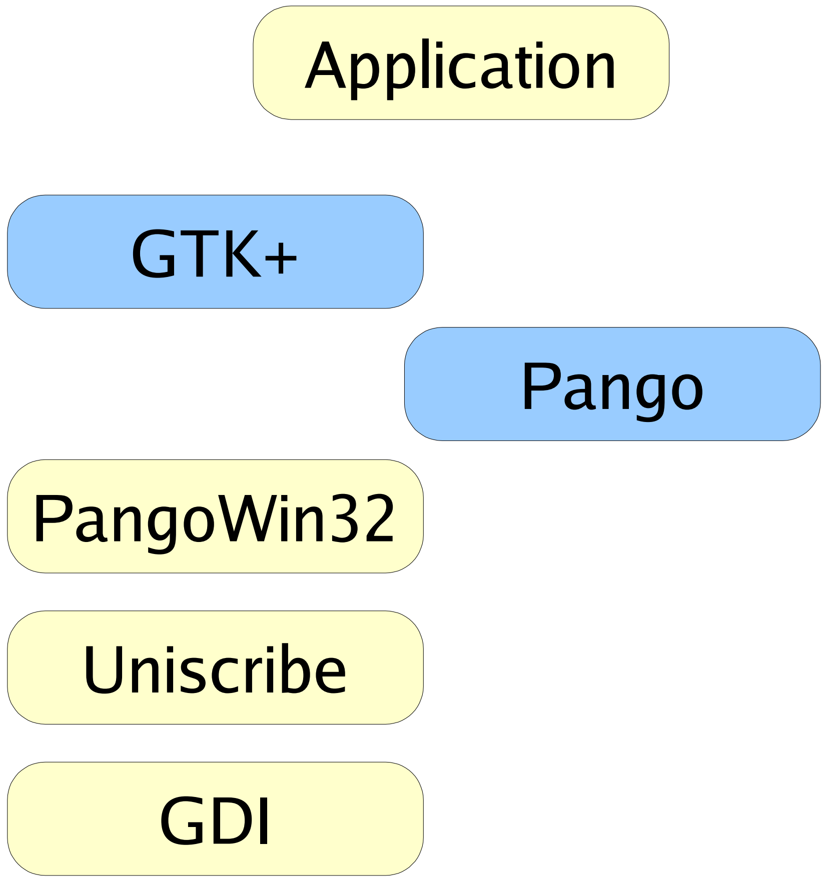
- Pango doesn't shield user from the backend
- A larger system (e.g., GTK+) can

```
PangoContext *context;
PangoLayout *layout;
int width, height;

context = gtk_widget_get_pango_context (widget);
layout = pango_layout_new (context);
pango_layout_set_text (layout, "Hello, world");

pango_layout_get_pixel_size (layout, &width, &height);
gdk_draw_layout (widget->window, widget->style->black_gc,
                 10, 10, layout);
```

Backends (cont.)

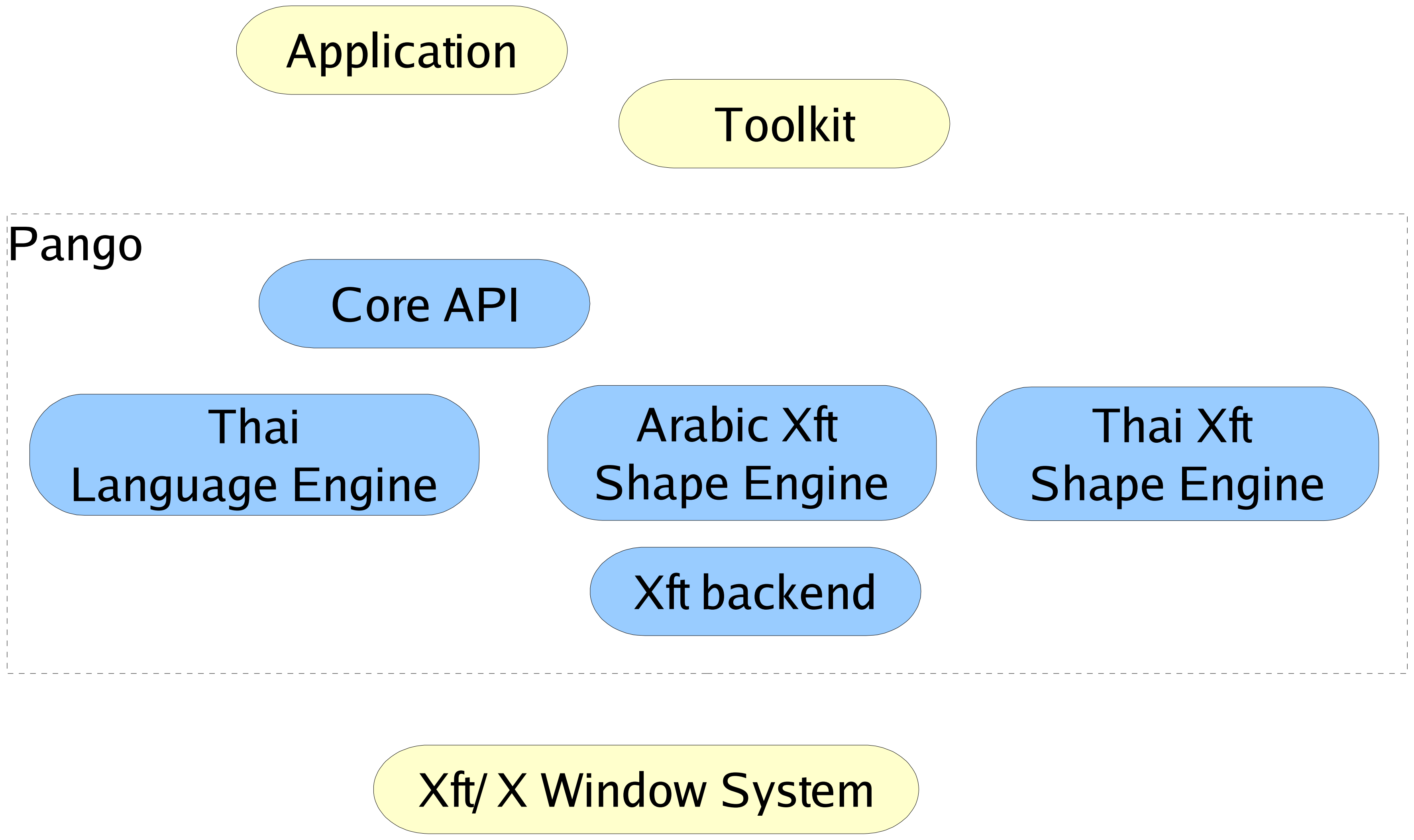


On Linux/Unix



On Win32

Internal architecture



Pango pieces

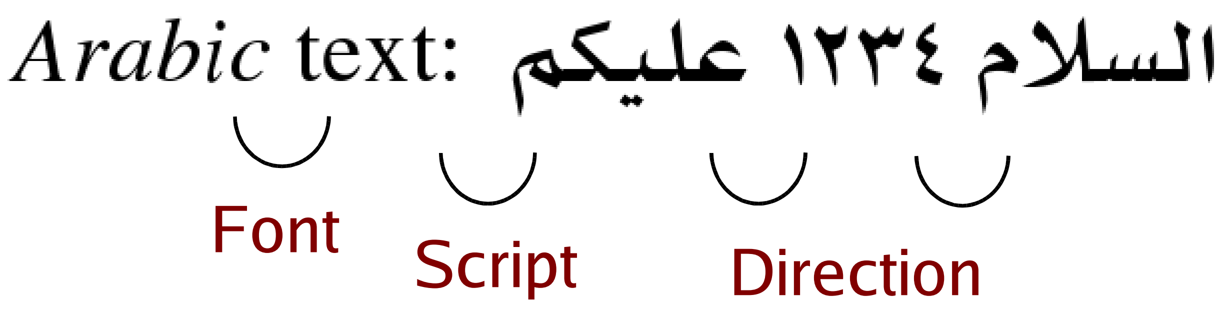
- Core: PangoLayout, layout pipeline driver logic
- Language engines: language specific logic for line breaks, etc.
- Backend library: public/private interfaces for a particular backend
- Shape engines: layout logic for a particular backend/script combination

Layout pipeline

- Can go directly to low-level layout process
  - But usually, PangoLayout is more convenient
- Steps are
  - Itemization
  - Text boundary determination
  - Shaping
  - Line breaking
- Note similarity to Uniscribe
  - helps when layering Pango on top of Uniscribe on Win32

Itemization

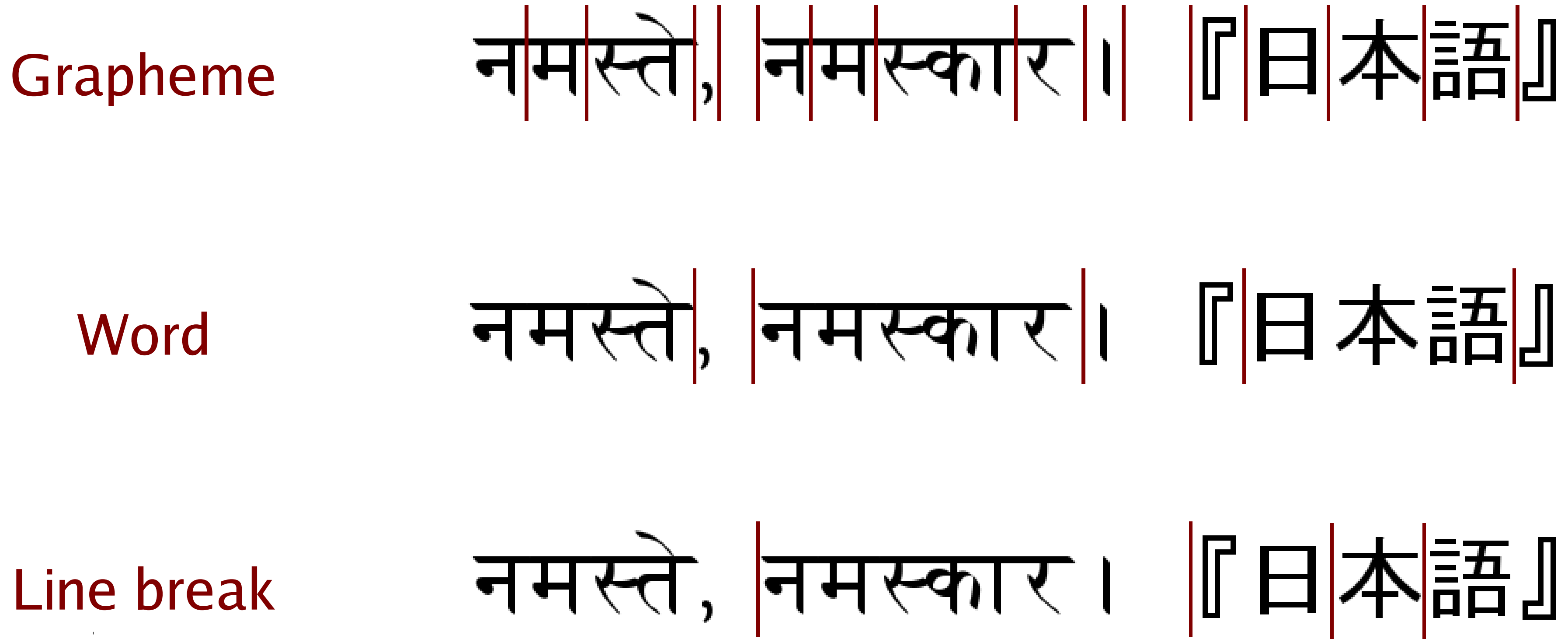
- text broken into segments with unique font, direction, shape engine



Arabic	text:	السلا	١٢٣٤	عليكم

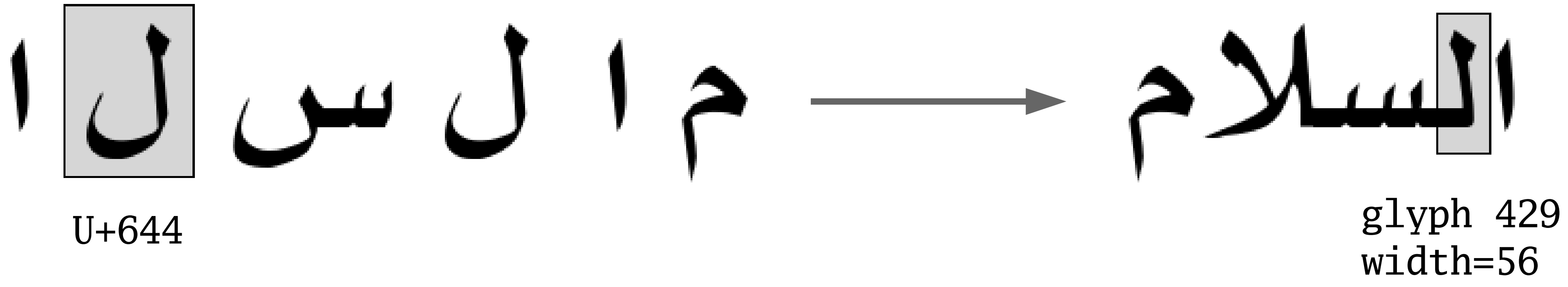
`Nimbus Roman Italic`
`Bidi-level=0`
`Basic shaper`
	`Nimbus Roman`
	`Bidi-level=0`
	`Basic shaper`
		`KacstLetter`
		`Bidi-level=1`
		`Arabic shaper`
			`KacstLetter`
			`Bidi-level=2`
			`Arabic shaper`
				`KacstLetter`
				`Bidi-level=1`
				`Arabic shaper`

Text boundaries


Grapheme
न|म|स्ते|,| |न|म|स्का|र| |।| |『|日|本|語|』
Word
नमस्ते|, |नमस्कार|। 『|日本語|』
Line break
नमस्ते, |नमस्कार। |『日|本|語』

- Line break boundaries affect shaping
- Grapheme, word boundaries for editing

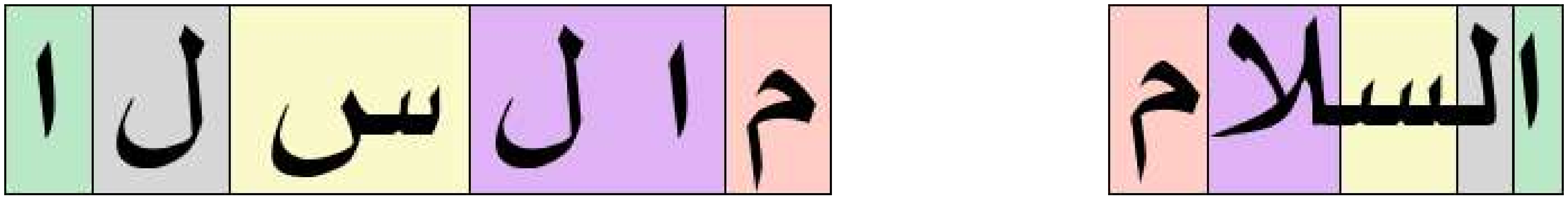
Shaping



- Input: font, Unicode text
- Output: positioned glyphs
- Done by script-specific “shape engine”

Clusters

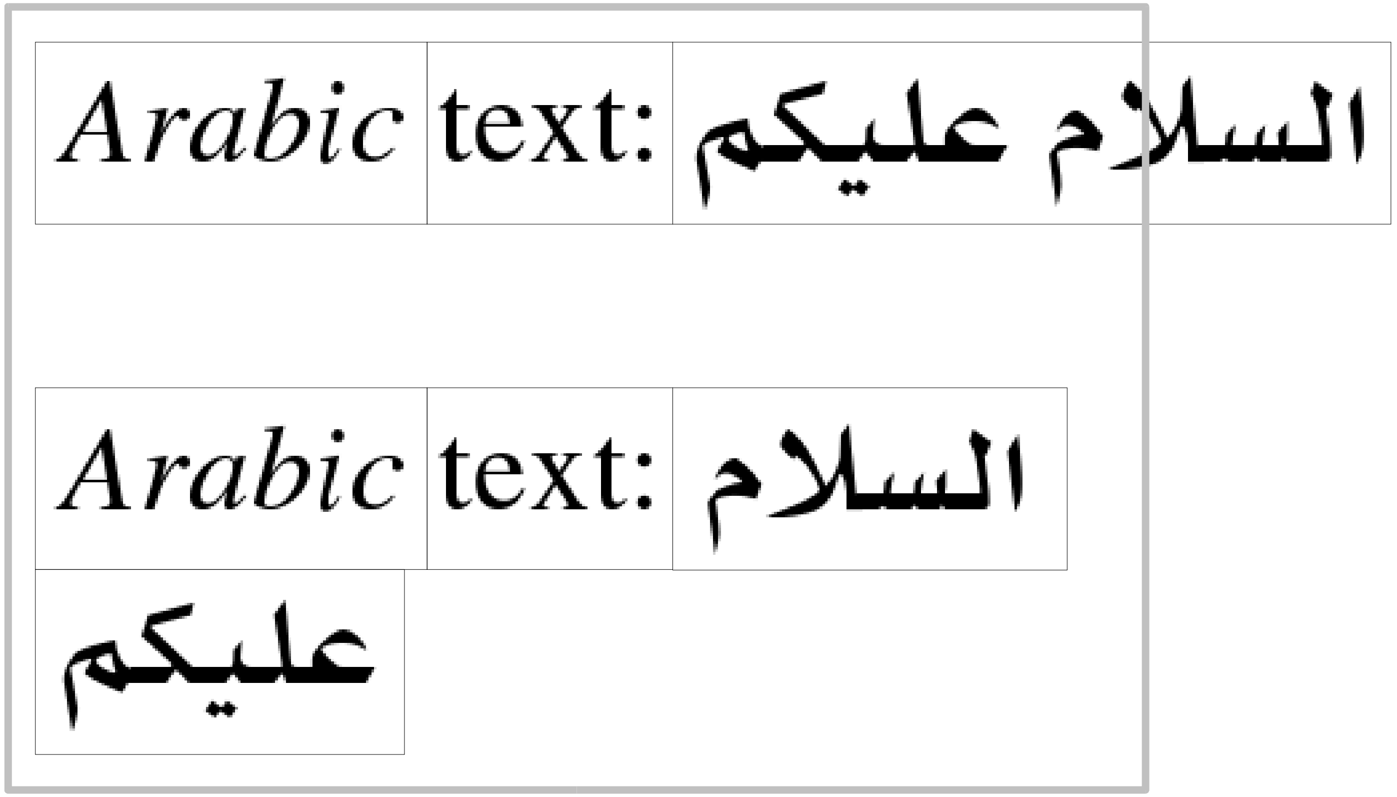
- Each output glyph is assigned to a cluster of input characters
  - needed for hit testing, drawing selections, etc.



- Can be
  - N characters to 1 glyph: ligature
  - 1 character to M glyphs: decomposition
  - N characters to M glyphs (e.g., Indic syllables)

Line Breaking

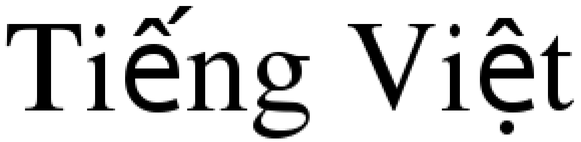
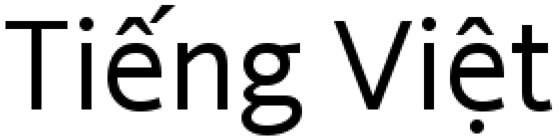
- Measure shaped items
- If necessary, break item at line break position, reshape pieces



Scripts

- Shape engine primarily selected based on script (Cyrillic, Arabic, Devanagari, Latin, Han, ...)
- *Neutral characters* – combining marks, whitespace, zero-width characters – need to be passed to same shaper
  - Performance; don't want lots of little items
  - Correctness; characters such as ZWJ affect
- Identify *script runs*
  - Algorithm borrowed from ICU

Font selection

- Need to resolve multiple-font aliases, like “Serif”
- Using first font in alias for each character gives “ransom-note” typography: 
Tiếng Việt
- Language tags help; prefer fonts in alias that have *all* the characters needed to write the language: 
Tiếng Việt

Underlying technology

- GLib: data structures, portability routines, Unicode algorithms/properties
- GObject: object oriented programming in C
- fribidi: Unicode bidirectional algorithm

Linux/Unix font handling

- FreeType: font loading and
  - Pango also uses code from FreeType project to parse OpenType tables
- fontconfig: font catalog; font naming
- Xft: display fonts with antialiasing
- OpenType Indic code from ICU

Supported scripts

- “Basic” scripts
- Arabic
- Hangul
- Hebrew
- Indic: Bengali, Devanagari, Gurmukhi, Gujarati, Kannada, Malayalam, Oriya, Tamil, Telugu,
- Thai

Current users

- GTK+ toolkit
  - GNOME desktop
  - GIMP, other cross-platform applications
- Core text library for GNOME desktop
  - Red Hat Enterprise Linux, Sun Java Desktop, etc.
- XSLT stylesheets `(http://pangopdf.sourceforge.net)`
- Mozilla web browser

Future directions

- More scripts: Khmer (patches exist), Tibetan, etc.
- SIL Graphite
- Better typography
  - Justification
  - Hyphenation
  - Vertical layout for CJK

Contributors

Abigail Brady, Hans Breuer, Matthias Clasen,
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Noah Levitt, Tor Lillqvist, Eric Mader, Keith Packard,
Havoc Pennington, Roozbeh Pournader, Changwoo Ryu,
Jungshik Shin, Chookij Vanatham, Qingjiang (Brian) Yuan

... and more than 90 others

More information:

- These slides:

  `http://people.redhat.com/otaylor/iuc25/`

- Pango web page:

  `http://www.pango.org`

Extra Slides

UTF-8

Language tag refinement

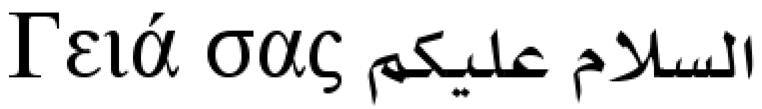
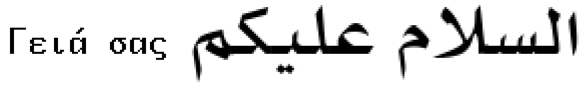
Normalization

Weird mark combinations

UTF-8

- UTF-8 used for both input and output
- Advantages:
  - Compatibility with existing code
  - Seemless beyond BMP handling
  - Emphasizes strings based, not char based methods
- Disadvantages
  - Algorithmic complexity (but not more than UTF-16)
  - Mismatch with UTF-16 based systems

Wrong language tags

- “Serif” alias
  - GreekFont: el,en
  - ArabicFont: ar,en
  - UglyFont: ar,el,en,ru,ab,...
- No language tags: 
  Γειά σας السلام عليكم
- 'ar' language tag: 
  Γειά σας السلام عليكم
  - UglyFont is preferrred to GreekFont for Greek

Language Tag Refinement

- Initial language tags come from document or user's environment
- May not match text: 'ar' language tag applied to Greek script
- In case of mismatch, default language tag for the script is used instead: 'el' for Greek script.

Normalization

- Display should be independent of normalization form
- What doesn't work:
  - Require normalized text as input: hard on application developers
  - Normalize on input: need to preserve mapping
- Ideas
  - Make individual shapers handle it
  - Normalize to NFD before passing to shaper; post-process clusters

Weird mark combinations

- During itemization text split by font
- Base character with mark from a different font?
- Ideas:
  - Forbid: use fallback (dotted circle)
  - Have a “mark font” that is logically merged in with every font. (32 bit glyph indices give spare space)