Framebuffer access via read() and write()
IOCTL supports direct memory-mapped framebuffer access
Framebuffer Driver Graphics Applications

Pdcurses
- Public domain implementation of ncurses ported to NuttX
- Operates on Framebuffer Driver
- Also over Serial or Telnet
LittlevGL

- Developed by Gábor Kiss-Vámosi
- https://littlevgl.com/
- Uses framebuffer character driver
- Great color effects!
- Single user task only
- Adds *vertical* Z dimension
- Supports *multi-threaded* displays: One thread per window
NX Graphics Server

Applications

libnx

POSIX Message Queue

NX Server

- Serializes Graphic Operations
- Supports Windows
- Support multi-threaded access

Framebuffer Driver

Serial LCD Driver

Framebuffer Graphics Hardware

Serial Graphics Hardware

Analogous to Xorg X Server
**NX Graphics Libraries**

- **NxWidgets**
  Provides C++ library of widgets
  *Buttons, radio buttons, keypads, images, text boxes, sliders, scrollbars, progress bars, keypads, etc.*
  *Very extensive.. based on Whoopsi*
  *Implemented as a user space library*

- **NxTerm**
  *Provides a text-based terminal window*
  *Analogous to Xterms*
  *Implemented as a OS character driver*
Screenshot
Capture current framebuffer display in TIFF file

Two Window Managers:

- **Tmx4Nx** (see above)
  Port of Tom's Window Manager (TWM) to NX Server and NxWidgets
  Converted to C++
  Full desktop window system
  Best for larger displays

- **NxWM** (next slide)
Graphics Applications (Cont'd)

- **NxWM**
  Tiny window manager intended for very small displays

  Focused windows
  Built on top of the NX Server

  Toolbar + Start Window + Focused Windows