Screen Sharing on Raspberry Pi 5 Using VNC in Weston and Wayland with the Yocto Project and OpenEmbedded

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In Previous Episode
Agenda

- Wayland and Weston
- VNC
- Weston and the Yocto Project Releases
- core-image-weston with VNC demo on Raspberry Pi 5
Wayland & Weston

- Wayland is a display protocol that specifies the communication between a display server and its clients
- Started in 2008 with the aim to replace the X Window System in GNU/Linux and Unix-based distributions
- Security by design through isolation of the input and output of every window
- Weston is the reference Wayland compositor, there are many other compositors
- Weston 13.0 was released on November 27, 2023
Remote Desktop Options in Weston and Wayland

- Remote Desktop Protocol (RDP)
- Virtual Network Computing (VNC)
Virtual Network Computing (VNC)

- Graphical desktop-sharing system based on Remote Frame Buffer protocol (RFB)
- Initially Olivetti Research Laboratory developed and published RFB in 1998, next versions of the protocol were published by RealVNC Ltd
- Pixel based
- Works with all windowing systems and applications, including MS Windows, Mac OS, X11 and Wayland
## RDP vs VNC

<table>
<thead>
<tr>
<th></th>
<th><strong>RDP</strong> (Remote Desktop Protocol)</th>
<th><strong>VNC</strong> (Virtual Network Computing)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protocol</td>
<td>ITU-T T.128</td>
<td>Remote Frame Buffer protocol (RFB)</td>
</tr>
<tr>
<td>Type</td>
<td>Semantic (aware of controls, fonts and other graphical primitives)</td>
<td>Pixel based</td>
</tr>
<tr>
<td>Weston version</td>
<td>2.0 and newer</td>
<td>12.0 and newer</td>
</tr>
<tr>
<td>Weston support since</td>
<td>2016</td>
<td>2022</td>
</tr>
</tbody>
</table>
VNC in Weston

backend-vnc: add VNC support using Neat VNC library

Closed  Stefan Agner requested to merge a agners/weston:rfc-vnc-su.. into main 3 years ago

Overview  54  Commits  3  Pipelines  10  Changes  10

This adds basic VNC protocol support using the Neat VNC library (https://github.com/any1/neatvnc). This implementation does not support authentication and hardcodes the pixel format currently. It also does more copying than necessary at this point.

Signed-off-by: Stefan Agner stefan@agner.ch

This is a new attempt in trying to implement a (upstreamable) version of the VNC backend (see my previous attempt !279 (closed), I decided to create a new merge request as this is a different approach). This time I make use of the liberally license library Neat VNC which I only found recently.
backend-vnc: add VNC support using Neat VNC library

Merged Philipp Zabel requested to merge PH5/weston-backend-vnc into main 1 year ago

Overview 105  Commits  3  Pipelines  47  Changes  14

I've rebased !362 (closed) onto current Weston and added my suggested fixes. If @agners doesn't mind, I'd be happy to try and move this forward.

Merge request pipeline #714090 passed

Merge request pipeline passed for ad936f1d 1 year ago

View 0 exposed artifacts
VNC in Weston

- VNC backend is available in Weston 12 and newer version
- VNC backend for Weston depends on NeatVNC
- NeatVNC is an open source VNC server library with a clean interface, started by Andri Yngvason with code available at GitHub under ISC license
- NeatVNC has build dependencies on libdrm, meson and pkg-config
- NeatVNC has a runtime dependency on aml (Andri's Main Loop)
The Yocto Project

- Open source collaborative project of the Linux foundation for creating custom Linux-based distributions for embedded devices using the OpenEmbedded Build System
- **OpenEmbedded** Build System includes BitBake and OpenEmbedded Core
- **Poky** is a reference distribution of the Yocto Project provided as metadata, without binary files, to bootstrap your own distribution for embedded devices
- Bi-annual release cycle
- Long term support (LTS) release covering two-year period
The Yocto Project Releases

<table>
<thead>
<tr>
<th>Codename</th>
<th>Version</th>
<th>Release Date</th>
<th>Support Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scarthgap</td>
<td>5.0</td>
<td>April 2024</td>
<td>Future – LTS (until April 2028)</td>
</tr>
<tr>
<td>Nanbield</td>
<td>4.3</td>
<td>November 2023</td>
<td>Until May 2024</td>
</tr>
<tr>
<td>Kirkstone</td>
<td>4.0</td>
<td>May 2022</td>
<td>LTS (until Apr. 2026)</td>
</tr>
<tr>
<td>Dunfell</td>
<td>3.1</td>
<td>April 2020</td>
<td>LTS (until Apr. 2024)</td>
</tr>
</tbody>
</table>
Wayland and Weston in Yocto and OpenEmbedded

- OpenEmbedded-Core is a layer containing the core metadata for current versions of OpenEmbedded
- OpenEmbedded-Core provides recipes for Wayland and Weston
## The Yocto Project, Wayland and Weston Versions

<table>
<thead>
<tr>
<th>Codename</th>
<th>Version</th>
<th>Wayland</th>
<th>Weston</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scarthgap</td>
<td>5.0</td>
<td>1.22 (?)</td>
<td>13.0.0 (?)</td>
</tr>
<tr>
<td>Nanbield</td>
<td>4.3</td>
<td>1.22</td>
<td>12.0.2</td>
</tr>
<tr>
<td>Kirkstone</td>
<td>4.0</td>
<td>1.20</td>
<td>10.0.2</td>
</tr>
<tr>
<td>Dunfell</td>
<td>3.1</td>
<td>1.18</td>
<td>8.0.0</td>
</tr>
</tbody>
</table>
Extend the recipe for building Weston:

- Enable VNC backend:
  
  ```
  PACKAGECONFIG:append = " vnc"
  ```

  This will enable `-Dbackend-vnc=true` and add `neatvnc` (from layer meta-oe) as a build dependency

- Place a PAM configuration file in the package:
  
  ```
  FILES:${PN}:append = " ${sysconfdir}/pam.d/weston-remote-access"
  ```

- For example, `weston_%bbappend`:
  
aml and neatvnc in meta-oe

<table>
<thead>
<tr>
<th>Commit</th>
<th>Author</th>
<th>Message</th>
</tr>
</thead>
<tbody>
<tr>
<td>90f1e305c538b1368cd655e5e5687e794b37a859</td>
<td>Leon Anavi <a href="mailto:leon.anavi@konsulko.com">leon.anavi@konsulko.com</a></td>
<td>neatvnc: upgrade 0.7.0 -&gt; 0.7.1</td>
</tr>
<tr>
<td>90c8d972c27214f8f9b23abe863352f68063374</td>
<td>Khem Raj <a href="mailto:raj.khem@gmail.com">raj.khem@gmail.com</a></td>
<td>neatvnc: Specify the version in the recipe file name</td>
</tr>
<tr>
<td>8f8621c4af2995b1f4333a14a117468ea663b79</td>
<td>Leon Anavi <a href="mailto:leon.anavi@konsulko.com">leon.anavi@konsulko.com</a></td>
<td>neatvnc: upgrade 0.6.0 -&gt; 0.7.0</td>
</tr>
<tr>
<td>2023-11-08</td>
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<td>2023-11-07</td>
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<td>2023-11-05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2023-08-26</td>
<td></td>
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</tbody>
</table>

aml: add new recipe
Add a new recipe for aml (Andri's Main Loop) v0.3.0. It is required for neatvnc which is required for building Weston with VNC backend.

Signed-off-by: Leon Anavi <leon.anavi@konsulko.com>
Signed-off-by: Khem Raj <raj.khem@gmail.com>
Bitbaking NeatVNC for Weston with VNC

- Enable TLS:
  
  ```
  PACKAGECONFIG:append = " tls"
  ```

- `libweston/backend-vnc/meson.build` from Weston 12 and 13:
  
  ```
  dep_neatvnc = dependency('neatvnc', version: ['>= 0.6.0', '< 0.7.0'], required: false, fallback: ['neatvnc', 'neatvnc_dep'])
  ```

- `libweston/backend-vnc/meson.build` from Weston branch main:
  
  ```
  dep_neatvnc = dependency('neatvnc', version: ['>= 0.7.0', '< 0.8.0'], required: false, fallback: ['neatvnc', 'neatvnc_dep'])
  ```

- Select NeatVNC matching Weston requirements, for example:
  
  ```
  PREFERRED_VERSION_neatvnc = "git"
  ```
Set password `weston` (from `mkpasswd -m sha256crypt`) for user `weston`:

```
WESTONPASSWD = "\$5\$409x651F5vyY1.4o\$luplll7/qNSEcflYNjH..0zwylmyLsbZdZGS6hBcro5"
USERADD_PARAM: ${PN} = "--home /home/weston --shell /bin/sh --user-group -G
video,input,render,wayland -p '${WESTONPASSWD}' weston"
```

Create a directory on the target device to store TLS key and certificate:

```
do_install:append(){
   install -m 0755 -d ${D}${sysconfdir}/vnc/keys/
   chown weston:weston ${D}${sysconfdir}/vnc/keys/
}
FILES:${PN} += "\n   ${sysconfdir}/vnc/keys \
   "
```

TLS security

- Generate a key and certificate files to use with TLS security:

  mkdir -p ~/.pki/CA/private/
cd ~/.pki/CA
  openssl genrsa -out private/cakey.pem 2048
  openssl req -new -x509 -nodes -days 365000 -key private/cakey.pem -out cacert.pem
  openssl genrsa -out tls.key 2048
  openssl req -new -key tls.key -out tls.csr
  openssl req -new -key tls.key -out tls.csr -subj "/CN=raspberrypi5"
  openssl x509 -req -days 365 -in tls.csr -out tls.crt -CA cacert.pem -CAkey private/cakey.pem
Using VNC on Weston

- Copy `tls.crt` and `tls.key` to `/etc/vnc/keys` on the target device, e.g. Raspberry Pi 5
- Enable VNC screen sharing in `/etc/xdg/weston/weston.ini`:
  ```ini
  [screen-share]
  command=/usr/bin/weston --backend=vnc-backend.so
  --vnc-tls-cert=/etc/vnc/keys/tls.crt --vnc-tls-key=/etc/vnc/keys/tls.key --
  shell=fullscreen-shell.so
  ```
- After loading Weston, press `ctrl+alt+s` to launch screen sharing
VNC Automatic Startup

- Launch Weston with `screen-share.so`, for example in Weston systemd service:
  
  ```
  ExecStart=/usr/bin/weston --modules=systemd-notify.so,screen-share.so
  ```

- Add `start-on-startup=true` to section `[screen-share]` in `weston.ini`:
  
  ```
  [screen-share]
  command=/usr/bin/weston --backend=vnc-backend.so
  --vnc-tls-cert=/etc/vnc/keys/tls.crt --vnc-tls-key=/etc/vnc/keys/tls.key --
  shell=fullscreen-shell.so
  start-on-startup=true
  ```
Remote Connection

- From another computer in the same network connect to the embedded device using a VNC client, for example with vinagre, an open source remote desktop viewer for Linux and the GNOME Desktop:

`vinagre --gtk-vnc-debug`
VNC Demo

- Vinagre on Ubuntu 22.04.3 LTS with X11 and GNOME 42.9
- core-image-weston with Weston version 12.0.2 on Raspberry Pi 5 (using BSP layer meta-raspberrypi)
VNC Frames per Second on Raspberry Pi 5

- With VNC enabled, `weston-simple-egl` runs with up to 20fps on Raspberry Pi 5

![Image of Weston VNC backend - Remote Desktop Viewer](image)
QA

- Raspberry Pi 5
- Raspberry Pi 4
- ROCK Pi 4
- Toradex Verdin i.MX8M Plus SoM

**Notes:**
As of the moment Weston 12 (or newer) with etnaviv open source driver should be used on NXP i.MX6, i.MX7, i.MX8, etc.
The fork weston-imx for Vivante proprietary GPU driver hasn’t been upgraded to Weston 12 yet. Therefore VNC backend is still not available in weston-imx.
Conclusions

- VNC is a pixel based graphical desktop-sharing system
- VNC backend was added in Weston version 12
- VNC backend in Weston depends on NeatVNC and aml
- Generate appropriate key and certificate files for TLS encryption
- The latest versions of the Yocto Project and OpenEmbedded provide the necessary tools and dependencies to build core-image-weston and to enable VNC
- Layer `meta-weston-remote-desktop` provides example integrations of both VNC and RDP in Weston
Thank You!

**Useful links**

- Wayland
  [https://wayland.freedesktop.org/](https://wayland.freedesktop.org/)
- Weston source code
  [https://gitlab.freedesktop.org/wayland/weston](https://gitlab.freedesktop.org/wayland/weston)
- The Yocto Project
  [https://www.yoctoproject.org/](https://www.yoctoproject.org/)
- The Yocto Project releases
- Simple example Yocto/OE layer for VNC and RDP on Weston: