Setting up Qt's digital cockpit demo to run in a hypervized system

Real world experience

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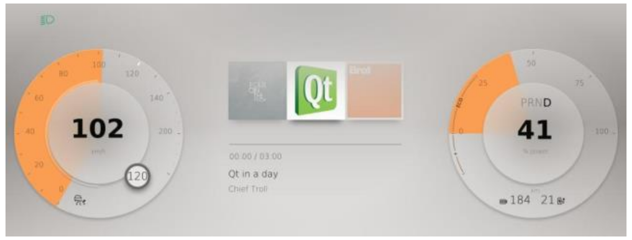
8th May 2019

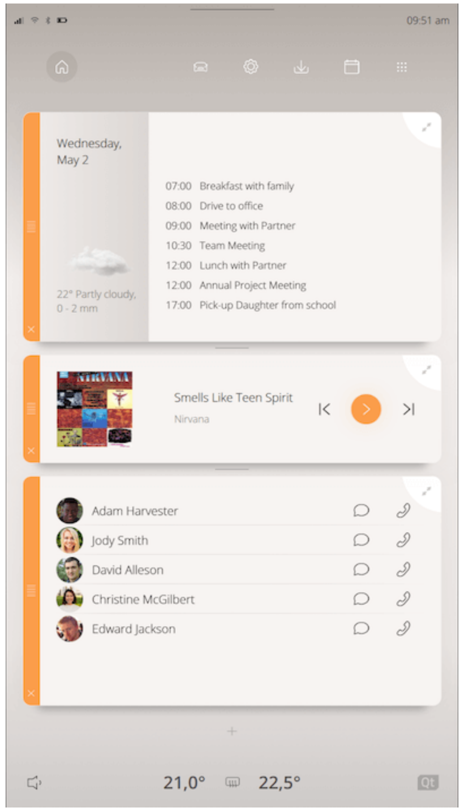
Digital cockpit setup

Instrument cluster



Functional safety telltales

Center console IVI



09:51 am

Wednesday, May 2

22° Partly cloudy, 0 - 2 mm

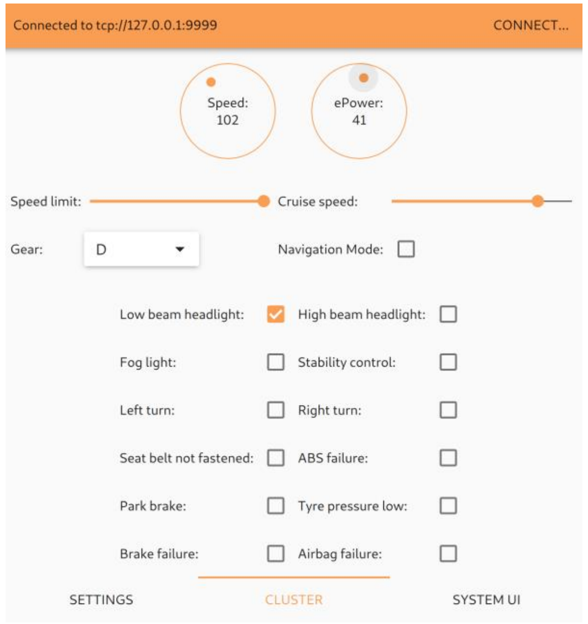
07:00 Breakfast with family
08:00 Drive to office
09:00 Meeting with Partner
10:30 Team Meeting
12:00 Lunch with Partner
12:00 Annual Project Meeting
17:00 Pick-up Daughter from school

Smells Like Teen Spirit
Nirvana

Adam Harvester
Jody Smith
David Alleson
Christine McGilbert
Edward Jackson

21,0° 22,5°

Smartphone companion app



Connected to tcp://127.0.0.1:9999 CONNECT...

Speed: 102
ePower: 41

Speed limit:
Cruise speed:

Gear: D
Navigation Mode: ☐

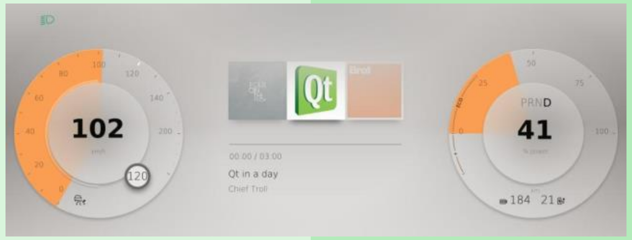
Low beam headlight:	✓	High beam headlight:	☐
Fog light:	☐	Stability control:	☐
Left turn:	☐	Right turn:	☐
Seat belt not fastened:	☐	ABS failure:	☐
Park brake:	☐	Tyre pressure low:	☐
Brake failure:	☐	Airbag failure:	☐

SETTINGS CLUSTER SYSTEM UI

OS domain separation

INTEGRITY

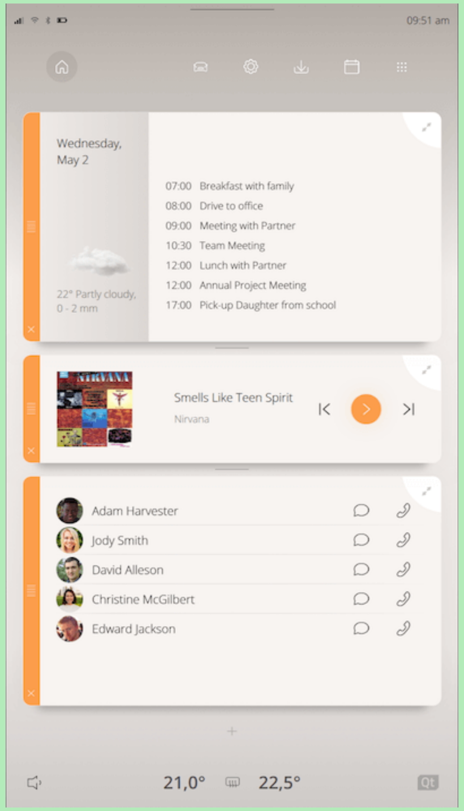
Instrument cluster



Functional safety telltales

Linux

Center console IVI



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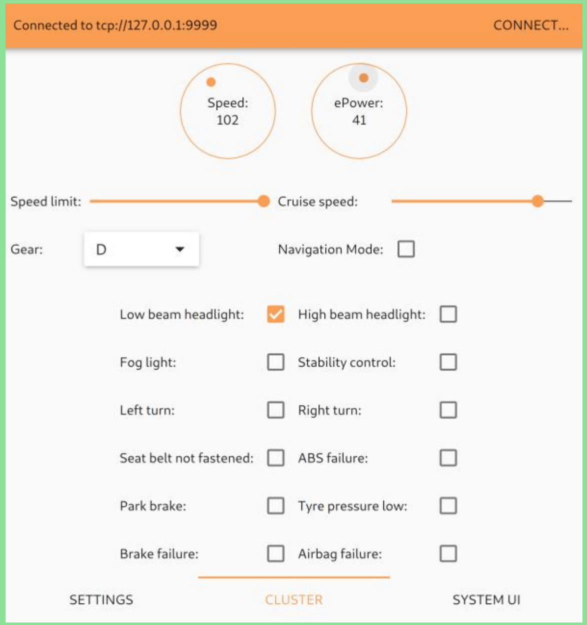
Mobile

Smartphone companion app



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SETTINGS CLUSTER SYSTEM UI

Instrument cluster

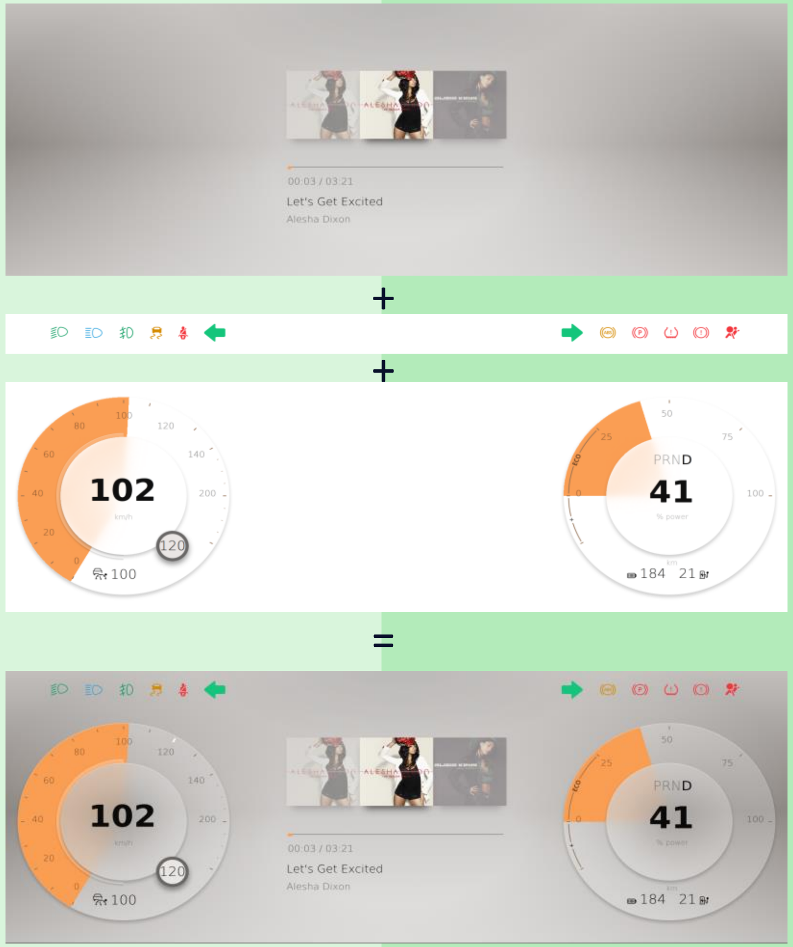
INTEGRITY

Linux

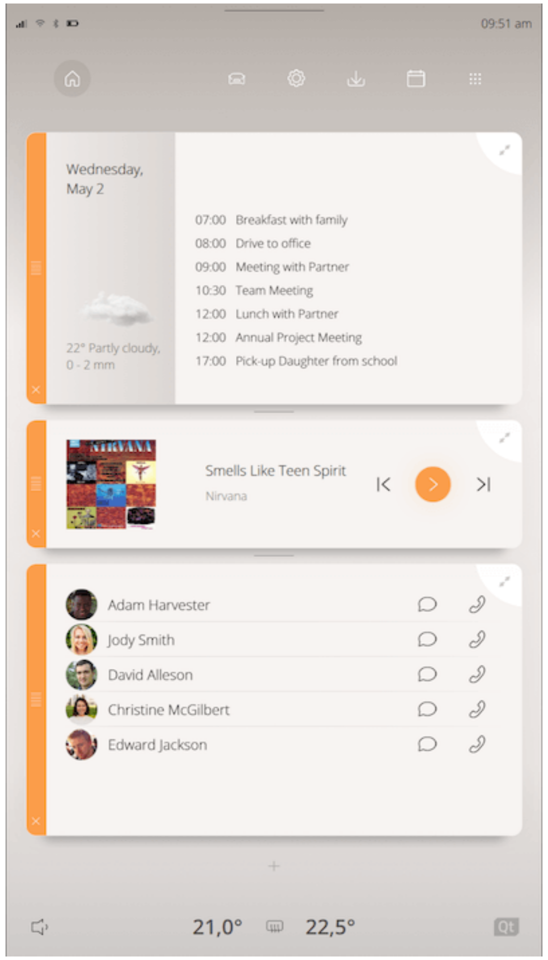
Qt Safe Renderer runs natively in a dedicated process

Gauge application runs natively with Qt

Linux domain renders the background of the cluster including the music display



Center console IVI



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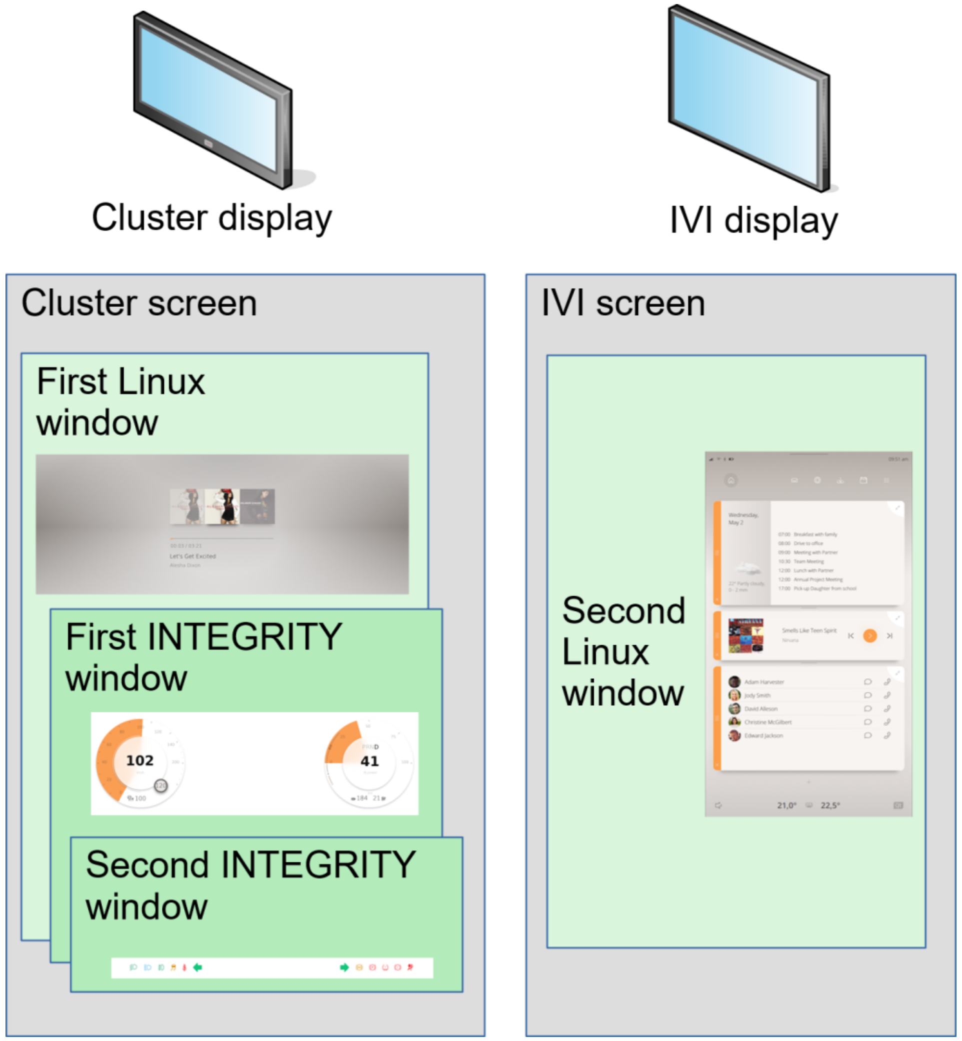
› Neptune3-UI is a reference implementation demonstrating the features of Qt automotive suite

› Qt Application Manager is a Wayland compositor, which also controls the lifecycle of Qt applications in a multi-process system

› The Linux domain sees a regular graphics card even though it is virtualized

› Displays are configured in the INTEGRITY domain by Renesas Window Manager

Graphics sharing



Renesas Window Manager is used to configure the mapping and z-ordering of the window surfaces

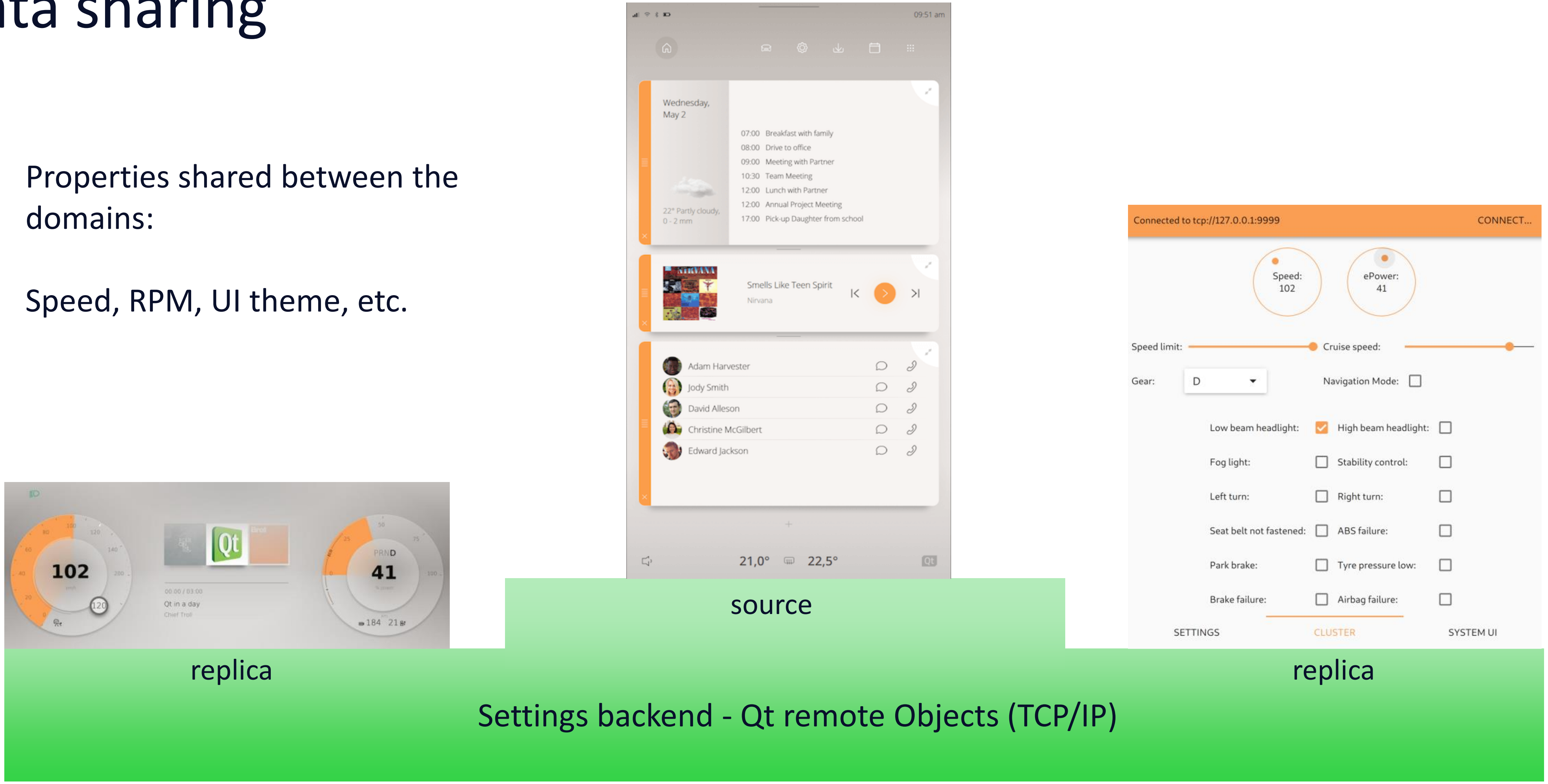
Graphics sharing - Alternative approaches

- The non-safe content of the cluster screen could be shared with other means as well
  - Surface sharing (Video stream)
  - Shared state (Qt Remote Objects)
  - API remoting (Qt WebGL steaming)
- The current solution was selected because the simple cluster design allows using transparency
- This approach provides best performance because of the low overhead of hardware rendering to layers
- Tied to specific system setup supported by the underlying OS

Data sharing

Properties shared between the domains:

Speed, RPM, UI theme, etc.



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SETTINGS [✓ CLUSTER] SYSTEM UI

Qt Remote Objects

› The *Qt Remote Objects* module provides an easy way to share Qt APIs between processes and devices

› Integrity cluster application and mobile companion app communicate with the IVI system using Remote Objects

› Selected remote objects because it is cross-platform. Uses TCP/IP connection

  › It would be possible to create a shared memory interface for Remote Objects for faster communication

The building blocks

- The R-Car H3 SoC is compliant with the ISO 26262 (ASIL-B) functionality safety standard for automotive
  - High end SoC and the evaluation board has enough memory to run two operating systems
- Renesas provided us a Yocto based distribution that included a BSP for INTEGRITY Multivisor.
  - Integration was needed with Qt automotive suite Yocto layer and we needed to decide which part was easier to integrate to the other. Qt5 and Qt automotive layers are pretty much self-contained, so we decided to add them on top of the Renesas Yocto distribution
- INTEGRITY 19.0.0
  - GHS MULTI Compiler 2018.1

Problems encountered in integration

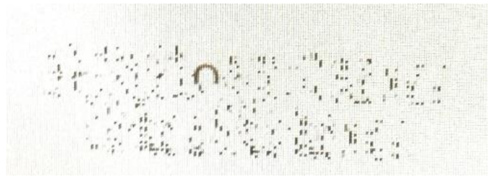
Blank screen

Problems encountered in integration

- Window initialization from Linux
- We had blank screen at first from Qt applications while the Wayland example application was working
  - Enabled tracing from Direct Rendering connection INTEGRITY Service
  - Did a full GDB step by step run from Linux
  - Found out that the sample application using Weston was calling drmModeSetCrtc() -function always, while Qt did not
    - Luckily, we already have an environment variable QT_QPA_EGLFS_ALWAYS_SET_MODE, which allowed easy workaround for the problem

Problems encountered in integration

- Fonts were corrupted randomly across the Linux screen



- We suspected corrupted glyph cache first, but it was a dead end
- After extensive debugging found out that Rich text caused corruption
  - Rich text has a different rendering path inside Qt
- Found out that distance field font rendering was broken
- did a full step by step debugging and found out the place where corruption happens
- did a workaround in Qt - disabled it with environment variable QML_DISABLE_DISTANCEFIELD

Problems encountered in integration

› Qtbase 5.11 needed small patches to compile against the INTEGRITY 19.0.0 and the respective Renesas Window Manager version.

Performance

- The neptune3-ui demo is quite demanding for the hardware since it is built to include most of the available APIs in Qt automotive suite and the 3d assets are large
- The previous version of Renesas INTEGRITY support package provided quite low performance
- Upgrading to the INTEGRITY 19.0.0 version improved the performance clearly

Thank you!