HACKING YOUR CAR THE EASY WAY

HACK YOUR CAR LIKE A CHEAPSKATE, DRIVE LIKE A PRO

Huh?

Huh?

Zeroth things zeroth:

Nate Willis: nate@lwn.net
@n8willis
freesoftwhere.org
TXLF

Huh?

Ɛ-th things ɛ-th:

Amateur IVI “enthusiast”

Huh?

ε-th things ε-th:

Amateur IVI “enthusiast”
Non-millionaire

Huh?

First things first:

SCALE12x

Huh?

First things first:

SCALE12x
“The Free Ride”

SCALE 12x
The Twelfth Annual
Southern California Linux Expo

The Free Ride

Nathan Willis

Audience: Everyone **Topic:** Hot Applications

Automotive computing is the next big playing field for Linux and free software, with automakers and tier-1 equipment suppliers basing their next-generation in-vehicle infotainment (IVI) platforms on Linux. But the length time-to-market of products in the car business makes it hard for the average open source user to follow the development of automotive Linux, much less to get started in the garage.

This talk will provide an overview of the major automotive Linux and open source efforts -- GENIVI, Automotive Grade Linux (AGL), Tizen, Ford's OpenXC, and others -- explaining how the pieces work together and where they overlap, with an eye toward helping the interested hacker to get started. The practical topics covered include the availability and status of Linux software for the car, car-specific hardware challenges, and interfacing with vehicle data systems like OBD-II and CAN Bus. The talk will also examine open questions and challenges for free software in automobiles, such as closed specifications, security, and licensing pitfalls. Finally, the speaker will pass on his advice to homebrew Linux IVI builders, based on the lessons he has learned designing and deploying his own Linux-based automotive computing rig.

Presentation:
scale12x-willis-the_free_ride-automotive_linux.pdf

Room:

Building your own IVI machine

My personal experience

- Micro-ITX board, trunk installed in 2005 Mustang
- 7-in Xenarc display
- Tizen IVI
- M4ATX DC-DC power supply
- Whole mess of cables and wiring crammed in everywhere

“I felt so bad for you. You should have used a Pandaboard; it would've saved you so much money.”

– anonymous

Eh. Not really.

Expensive components of an IVI build:

- SSDs, networking hardware, sensors

Eh. Not really.

Expensive components of an IVI build:

- SSDs, networking hardware, sensors
- Audio ... if you're doing audio

Eh. Not really.

Expensive components of an IVI build:

- SSDs, networking hardware, sensors
- Audio ... if you're doing audio
- Limited choices in IO and power hardware

Eh. Not really.

Expensive components of an IVI build:

- SSDs, networking hardware, sensors
- Audio ... if you're doing audio
- Limited choices in IO and power hardware
- Wiring, wiring, wiring, wiring, wiring, wiring, wiring, wiring, wiring, wiring, wiring, wiring, wiring, and wiring.

Eh. Not really.

... but it got me thinking.

Roadmap

- Cheaper Tizen builds
- Android for IVI
- SBCs
- Microcontrollers
- A reminder of why you should care
- Some open questions

Without repetition....

Last year's slides:

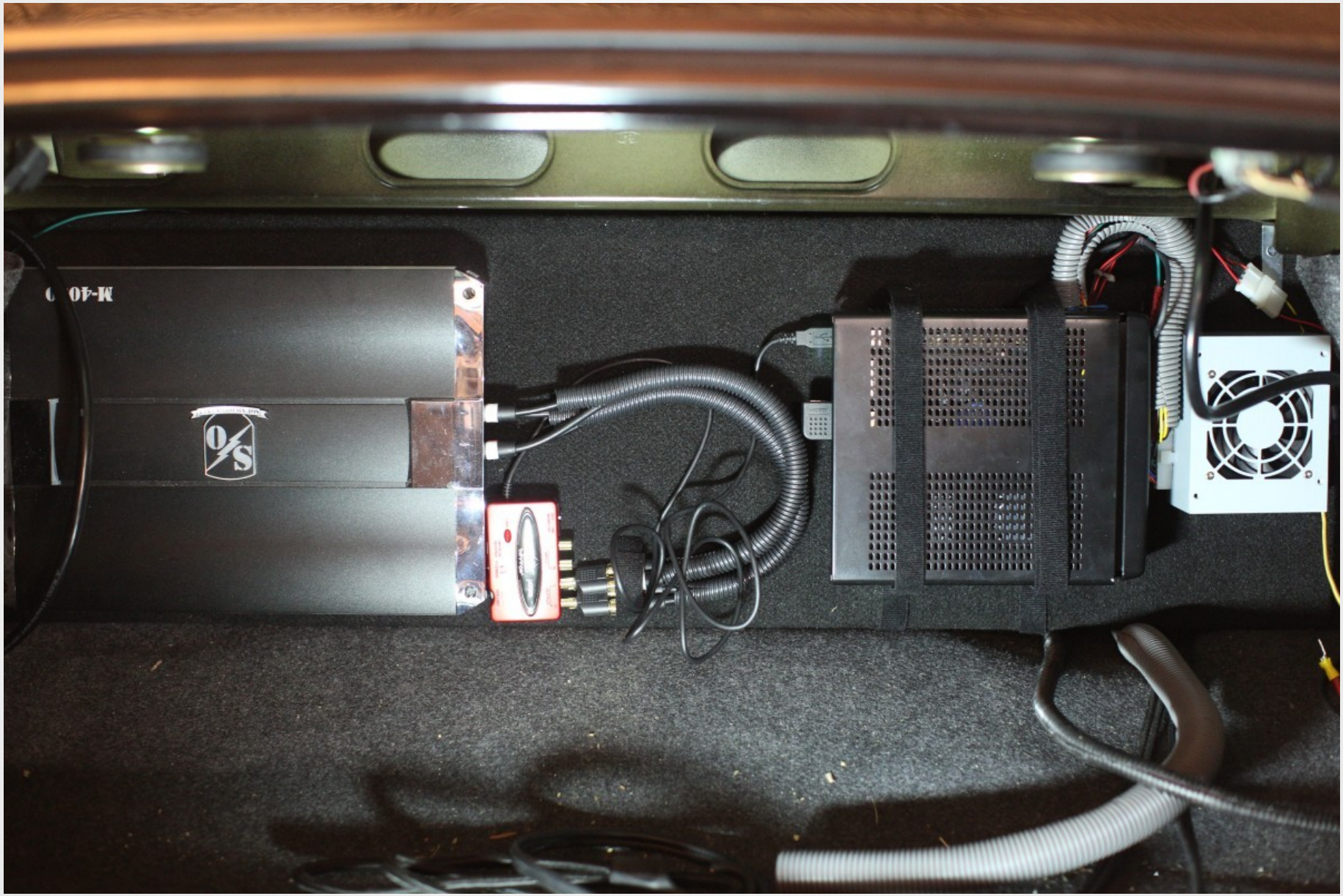
http://www.socallinuxexpo.org/scale12x/presentations/free-ride.html

Last month's video:

https://www.youtube.com/watch?v=SoZXCyDlbnw

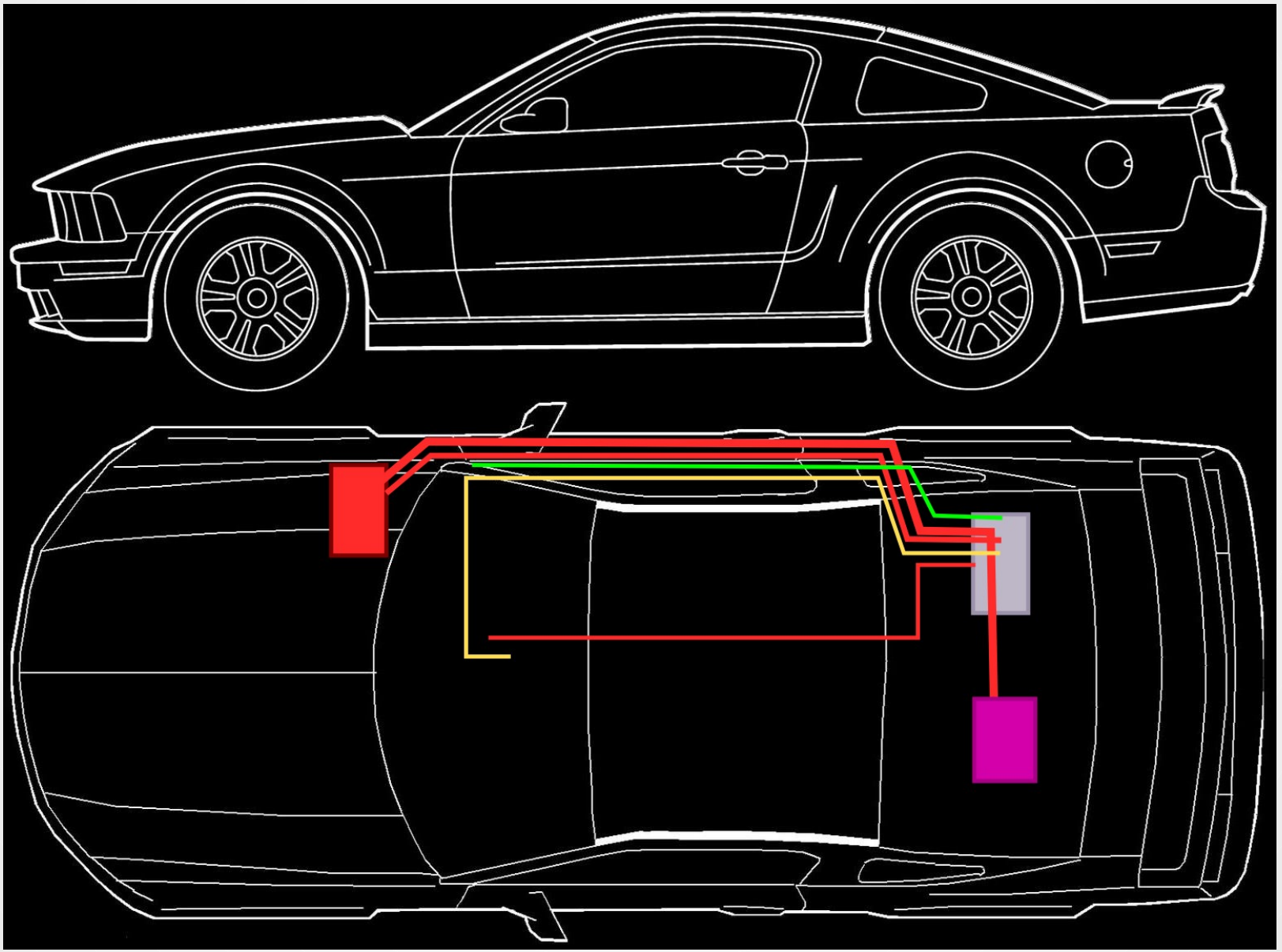
The Natemobile

The Natemobile



The Natemobile

The Natemobile



Nate's Tizen IVI build

mini-ITX motherboard
i3 CPU
M4ATX power supply
USB sound card
Xenarc touchscreen
OBD-II Bluetooth adapter
Bunch o' USB stuff

Tizen IVI has changed

3.0 releases available for NUC and MinnowBoard MAX

MinnowBoard MAX

Tizen IVI has changed

3.0 releases available for NUC and MinnowBoard MAX

(not that the NUC is all that special....)

Tizen IVI has changed

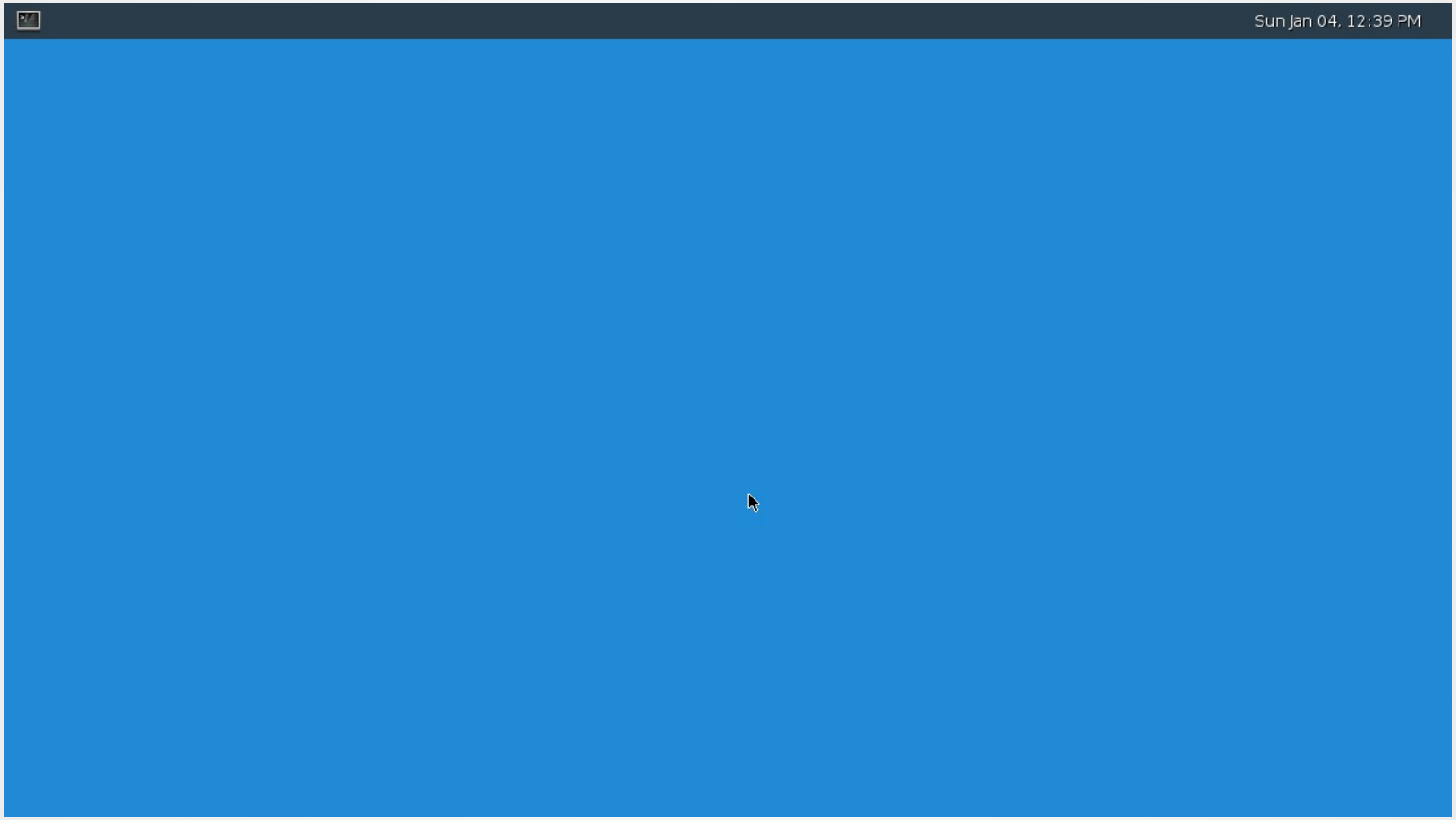
3.0 releases available for NUC and MinnowBoard MAX

(not that the NUC is all that special....)

Both these things have Intel GPUs although as far as you or I can prove, that's purely coincidental.

The Secret

You can actually use any Linux distro as an IVI platform if you have simple enough needs....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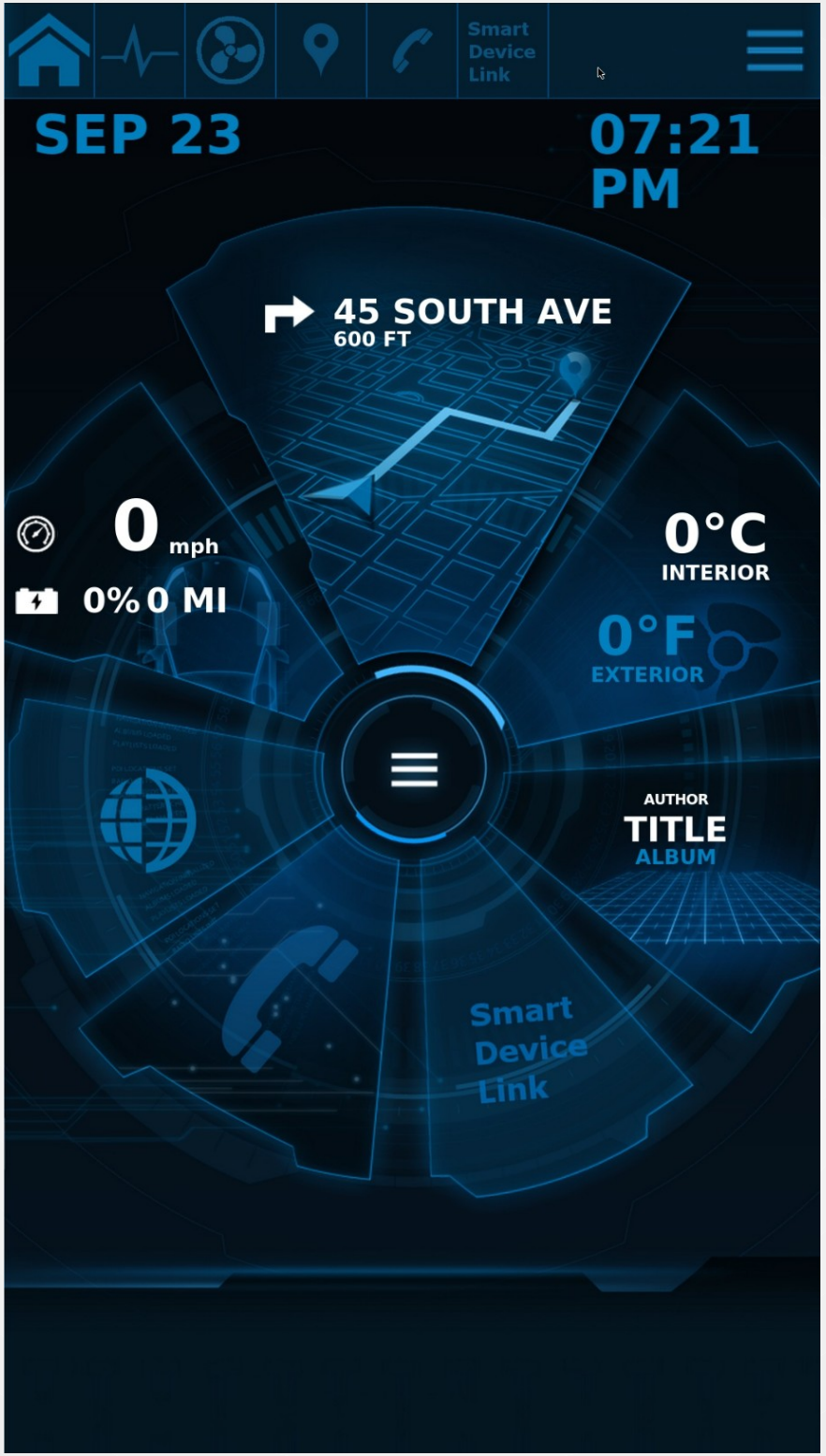

Smart
Device
Link
SEP 23
07:21
PM
45 SOUTH AVE
600 FT
0 mph
0% 0 MI
0°C
INTERIOR
0°F
EXTERIOR
AUTHOR
TITLE
ALBUM
Smart
Device
Link

The Secret

You can actually use any Linux distro as an IVI platform if you have simple enough needs....

But if you don't otherwise have an opinion, your life will be easier if you choose Ubuntu.

Why The Secret Matters

Your automotive computer isn't going to be like your neighbor's.

```
shuffle (navigation,
         audio,
         data_logging);
```

Other Tizen cost savings

- Direct power or UPS
- Tie in to existing audio system (AUX or Bluetooth)
- Analog displays

Tizen power

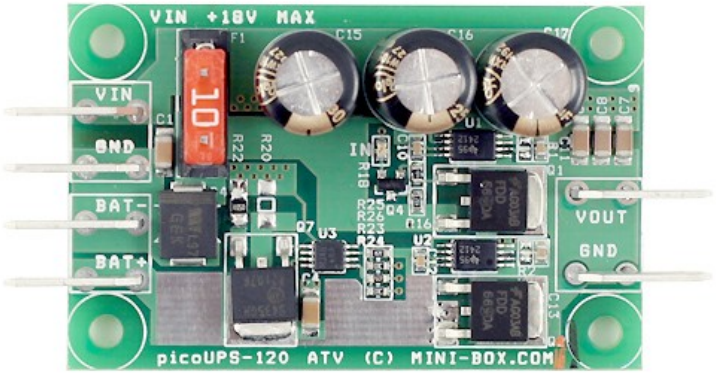
DCDC-USB:

http://www.mini-box.com/DCDC-USB?sc=8&category=981

Tizen power

PICO-UPS:

http://www.mini-box.com/picoUPS-120-12V-DC-micro-UPS-battery-backup



Tizen audio

The Great AUX

... if you have it

CD changer port if you don't

Tizen audio

Tizen audio

Tizen display “tech”

Tizen display “tech”

Tizen display “tech”

Android as IVI

Hardware issues and software issues

Android as IVI

Hardware issues:

Physical integration work
Power management
Audio
USB

Android as IVI

Hardware: Physical integration work

Android as IVI

Hardware: Physical integration work

Android as IVI

Hardware: Power

Li-Ion batteries and car batteries are not friends.

Android as IVI

Hardware: Power

Li-Ion batteries and alternators are not friends.

Android as IVI

Hardware: Power

Don't just plug your tablet into a DC-DC converter from the car battery. It will cry.

Android as IVI

Hardware: Power

Be lazy: connect ACC line + voltage converter
Be mostly lazy: ACC to OTS USB charger
Custom cabling if you have excess free time
Wireless charger?

Android as IVI

Android as IVI

Android as IVI

Android as IVI

Power:

All of your options are abusing the tablet charge cycle somehow or another....

Android as IVI

Audio:

USB digital-to-analog converters (DACs) are clean

Tablet audio out is designed for earbuds
(so, you know, buy an amp....)

Same integration possibilities as Tizen IVI

Android as IVI

Speaking of USB:

USB Host or USB OTG is (pretty much) required

Android as IVI

Software:

ROM culture
Apps
Freedom!

Android as IVI

ROMs:

USBROM

http://mehrvarz.github.io/nexus-7-usbrom/

AutoDroid

http://forum.xda-developers.com/nexus-7/3g-development/rom-slim-kat-t2826317

Android as IVI

Apps:

Lots of proprietary options!

About a dozen FOSS options.

Android as IVI

FOSS Apps:

CarCast - http://jadn.com/carcast

CarReport - https://bitbucket.org/frigus02/car-report

CarBusInterface - https://github.com/theksmith/CarBusInterface/

FillUp - https://github.com/wdkapps/FillUp

HUD - http://android.woju.eu/

Android as IVI

FOSS Apps part 2:

Navit - http://wiki.navit-project.org/index.php/Android

OBDIIReader - https://github.com/pires/android-obd-reader

OsmAnd - http://osmand.net/

PurpleDock - http://pfdock.purplefoto.com/

SpeedOfSound https://github.com/jpeddicord/speedofsound

TracCar https://www.traccar.org/

Android as IVI

FOSS Apps part 2.0000000000000001:

Autosleeper ?

http://forum.xda-developers.com/showthread.php?t=2670903

Android as IVI

Some good buildlogs:

http://www.instructables.com/id/Android-Tablet-as-Car-PC/?ALLSTEPS

http://forum.xda-developers.com/showthread.php?t=1372396

http://www.mp3car.com/show-off-your-project/155547-suzuki-grand-vitara-2006-android-tablet-install.html

http://www.bmdroid.co.nz/

Single-Board Computers

Why not?

As long as you know their limits, and so does your neighbor.

Single-Board Computers

Why not?

As long as you know their limits, and so does your neighbor...

...Meaning you might not get Navit or weird touchscreen support, or **every** peripheral running at once.

Single-Board Computers

MinnowBoard: CAN Bus on pins 28 & 30

BeagleBone: CAN interface on SoC
http://elinux.org/CircuitCo:CAN_Bus_Cape_RevA

Banana Pi: CAN Bus on pins 16 & 18 (CON3)
http://forum.lemaker.org/thread-13107-1-1-.html

Single-Board Computers

Raspberry Pi: as you'd expect, lots of takers....

Can CAN: http://elinux.org/RPi_CANBus

Arduinoish shields

http://www.cowfishstudios.com/blog/canned-pi-part1

http://url.ca/jrztp (trust me....)

Single-Board Computers

Expansion boards for data access:

- http://elinux.org/Beagleboard:TT3201_CAN_Cape
- http://elinux.org/BeagleBone_Serial_CAN_RS485_RS232_Cape
- http://elinux.org/CircuitCo:CAN_Bus_Cape_RevB

- PiCAN: http://www.beyond-kinetics.com/ProductDetails.asp?ProductCode=1827
- http://elinux.org/RPi_CANBus

- Arduino shields are adaptable
- Others options come and go

Single-Board Computers

Expansion boards for data access:

Don't forget expansion boards for power management, GPS, WiFi, 3G, audio, and whatnot....

Microcontrollers

Why shield your Pi?

Most projects geared toward data logging.

Microcontrollers

Why shield your Pi?

Most projects geared toward data logging...

...but there are a LOT of them.

Microcontrollers

Arduino shields:

- http://www.sparkfun.com/commerce/product_info.php?products_id=10039
- http://www.skpang.co.uk/catalog/product_info.php?cPath=140_142&products_id=706
- http://www.seeedstudio.com/wiki/CAN-BUS_Shield
- http://www.watterott.com/en/Arduino-CANdiy-Shield
- http://togglebit.net/product/arduino-due-can-shield/
- and many, many more....

Microcontrollers

Arduino full-kit options also exist:

- http://arduinodev.com/store/index.php?product_id=58
- http://ecomodder.com/wiki/index.php/MPGuino

Microcontrollers

Arduino shields:

- Almost all use Microchip MCP2515 controller and MCP2551 transceiver.
- Kits just save you assembly time.
- Most shields come with a library (or use a common one).

Microcontrollers

Build logs: Jonathan Oxer

- The canonical starting point
- www.geekmyride.org/wiki/index.php/Jon%27s_RX-8
- www.practicalarduino.com/projects/vehicle-telemetry-platform
- https://code.google.com/p/opengauge/wiki/OBDuino

Microcontrollers

Build logs:

- http://www.instructables.com/id/Geo-Data-Logger-ArduinoGPSSDAccelerometer-to-I/?ALLSTEPS
- http://theansweris27.com/category/projects/data-logging-and-telemetry/
- http://www.openhardwarehub.com/projects/40-Arduino-CAN-BUS-OBD-Gas-Gauge

Microcontrollers

The unusual:

- Ford's OpenXC: http://openxcplatform.com/hardware.html

Microcontrollers

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- CAN to JSON, just like mom used to make

Microcontrollers

The unusual:

- Ford's OpenXC: http://openxcplatform.com/hardware.html
- CAN to JSON, just like mom used to make
- Completely open source; Bug Labs hardware

Microcontrollers

The unusual and also cool:

- CANBus Triple

Microcontrollers

The unusual and also cool:

- CANBus Triple

- Three CAN transceivers
- BLE
- USB serial

Microcontrollers

The unusual and also cool:

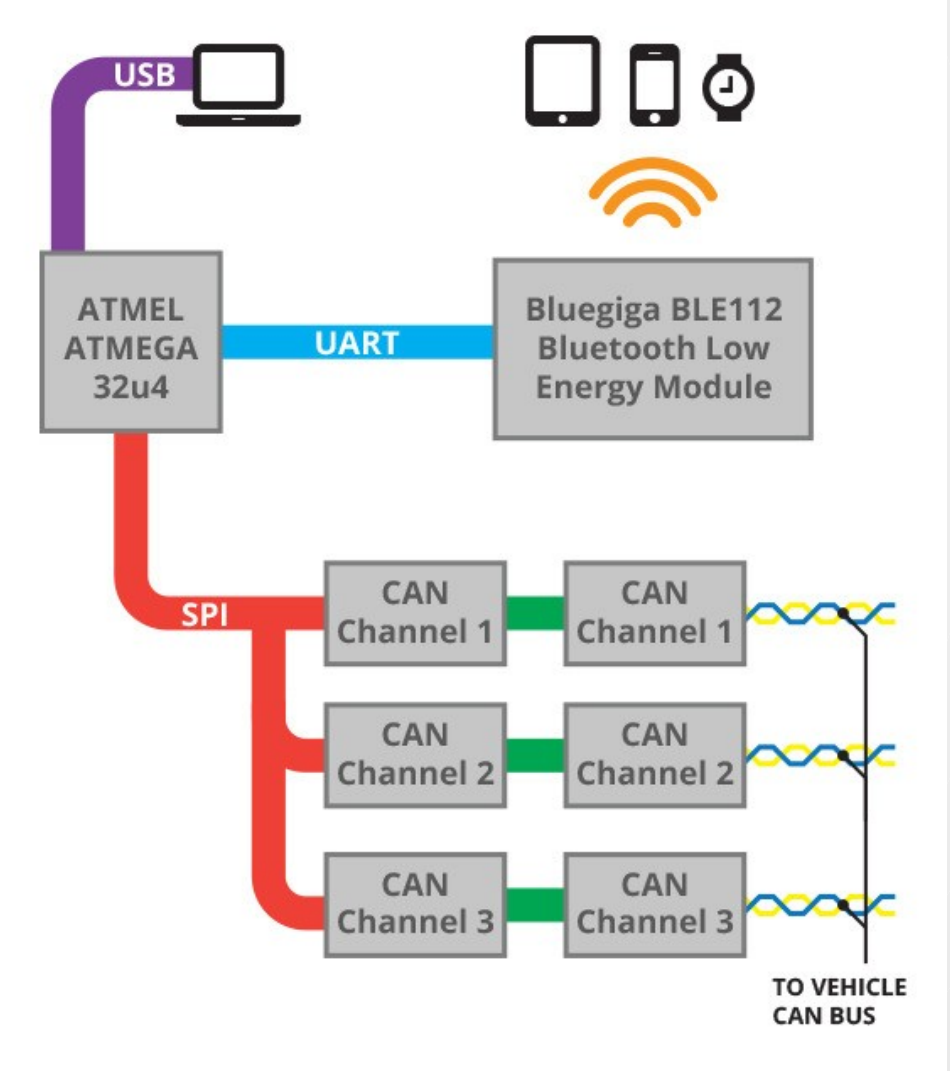
- CANBus Triple

- Three CAN transceivers - capable of MITM
- BLE
- USB serial

Microcontrollers

The unusual and also cool:

- CANBus Triple



Microcontrollers

The unusual and also cool:

- CANBus Triple

- Three CAN transceivers - can run separate bus
- BLE
- USB serial

Microcontrollers

The unusual and also cool:

- CANBus Triple

- Arduino IDE support
- Serial to Linux box
- Open Hardware as well as software

Microcontrollers

Go old school:

WHO NEEDS A MICROCONTROLLER?

Microcontrollers

Go old school:

Microcontrollers

Go old school:

Microcontrollers

Go old school:

Microcontrollers

Go old school:

Reading signals without CAN

12V ≠ 3.3V

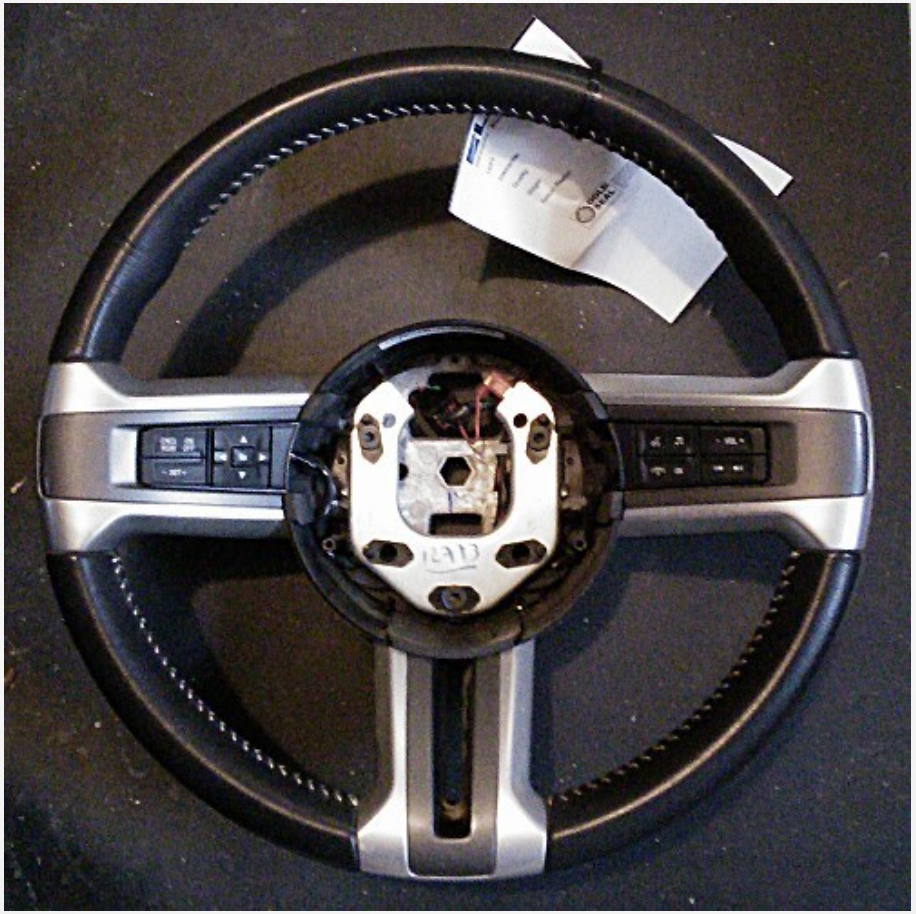
Reading signals without CAN

12V ≠ 3.3V

So you should probably convert it....

Linear regulators (LM7805) = auxiliary heater
Switch-mode power supplies = your new best friend

Reading signals without CAN



Reminder why you care

Your car is probably the second-most-expensive thing you buy.

A lot of BIG companies are investing in automotive Linux.

But they're building for new cars, two-to-seven years away.

Some open questions

V2X networking?

W3C community group

Web resources

Thanks for listening

All fonts by Vernon Adams:

Bangers
Oswald
Sancreek
Niconne