Build Your Own Car Computer

By

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1. Overview. If you're hands-on, then this is for you. Extending your computer/Internet life into your transportation is a very tangible goal provided you're not the type afraid to open your computer case and install PCI cards or similar. Modern automotive technology is nearly as much computer as much as it is motor but it's typically obfuscated from drivers as most of the computer systems offer nothing more than black-box controls that turn on idiot lights or interface with GPS systems at best.

The intent of this talk is not to interface a computer with your car's internal controls but rather un-tether you from the limited market of application specific devices currently offered on the market. These include GPS Systems, DVD Players, In-Dash Radios, and Bluetooth Devices. Each of these is nothing more than a computer itself but with the intent to address a very specific service.

It is assumed the reader already knows how to build a computer including connecting a motherboard, power, memory, and disk drives into a case. Additionally there should be comfort with installing an operating system and drivers. These skills are necessary and will be extended by applying them to this project.

1.1. What it Can't Do. Do not expect to see a screen with your tachometer, odometer, and other engine/driving statistics. Just like your home computer this project will be an "isolated' system, and just like your home computer it knows nothing about your car. But being an isolated system is not necessarily a hard cage to break out of. The ubiquity of the Internet with WiFi and 3G Cellular providers makes the possibility for this computer to be "on-line" very real.

Worth of mention is your car's OBDII port (see References). Most people don't even know about it, but in 1996 it became mandatory for all US cars have this port within proximity of your driving wheel. In fact it's usually easier to get to than your fuse panel. Many car enthusiats are already intimately aware of this port as there are plenty of adapters, applications, User Groups, and OpenSource software already available permitting this crowd to tune their cars and get diagnostic info. Expect the limits of integrating this project directly to the car's computer to be broken as things evolve.

1.2. What it Can Do. Theoretically it can do anything your home computer can do. It's just a smaller version of the same components only suffering from some limits on processing speeds due to the additional considerations of heat dissipation and environment. If this is a turn off then consider putting a gaming power user system in your car with a 12V-120VAC converter and a dashboard screen mount! Have realistic desires.

DVD player... no problem. Glorified music console... it's there. Navigation/GPS System... *well*, it can be done, but if using Google Maps, for instance, it'd be a violation of the end user rights. But given a broadband Internet subscription you could have youtoube-on-the-go, restaurant look-ups, gas prices, or just plain ol' email.

Imagination is the limit. Whatever can be dreamt is only limited by willingness to perspire.

2. Reference Model (Prices Effective 04/2009).

1. **Motherboard** - $183.
   VIA EPIA CN13000G Mini-ITX Mainboard.
   http://www.logicsupply.com/products/cn13000g
2. **Memory**.
   512MB DDR2.
3. **Storage** - $139.
   G.SKILL FM-25S2S-64GB 2.5" 64GB SATA II Internal Solid state disk (SSD).
   http://www.newegg.com/Product/Product.aspx?Item=N82E1682023122
4. **Case** - $79.
   VoomPC-2 Automotive Mini-ITX Case.
   http://www.logicsupply.com/products/voompc_2
5. **Screen** - $385.
   Phylon 10.2" VGA TFT Wide-Screen Display with Touchscreen.
   http://www.logicsupply.com/products/102tpc
6. **Time and Effort** - $?

3. Necessary Resources.
3.1. Skills. It's necessary to be comfortable building a computer and installing the operating system. And things like "drivers" should be common vocabulary.

If looking for the "1-2-3, Mount-It-And-Go Computer" then it's suggested looking to purchase one of the commercial solutions on the market. It's expected that this segment will grow, and likely to the point that's it's an option from car manufacturers too, but for the meantime it's necessary to Do-It-Yourself.

3.2 Parts.
3.2.1. MoBo. While there are several boards available specifically targeted to automotive uses, the more general market segment is for Industrial or Embedded Devices. The

devices available have been designed with the concerns of harsh environments, power consumption, and heat dissipation. Fortunately this is exactly what's needed.

VIA Inc. has been a pioneer of this arena. They've gone head first into miniturization and heat/power management. As such they've come up with two widely available form factors, the Mini-ITX and the Pico-ITX (there's even a Nano-ITX). The Mini-ITX is 170cm x 170cm and quite nice for the purposes at hand but if looking for something even smaller that can nestle into some nook of the glove box then this might be the choice but it comes with a price premium and some limits on processing power.

3.2.2. Case. Unlike a home computer, looks, flashing lights, and sleek lines are not a concern. Typically the case will be hidden somewhere out of site. Make considerations like, "What are the temperatures to which this computer will be exposed?" and "Is it near a vent?" These are questions industrial engineers have already answered for us. In fact, there's even water proof cases if planning to take a 4x4 through a river!

The reference case is Section 2 looks like an automotive audio amplifier. It has heat dissipation fins and is designed for trunk or under-seat installation. More modest intentions might get away with less industrial cases stuck in the glove box. Choose wisely.

3.2.2.1. Power Management. Like many traditional cases a power supply is included. Two things are of importance though. The first is a 12V interface which is specifically designed for cars. The second is a very unique power management system.

When a car is off one probably gives little thought about the alarm system's power consumption or the flashing LED on your dash. The engineers have already thought about this for OEM equipment but now it becomes a concern again. While these are designed to be lower power systems that's a very relative perspective. What may be only a fraction of a home computer's draw may kill the battery sitting over the weekend. No problem, just power off and on each time using the car. That would work but fortunately there's more elegant solutions. The power boards of certain cases are designed to detect when the car is turned off and have features to permit setting what should happen. Typically it's not desired to have the computer turn off as soon as the engine goes off as maybe it desired to look up a coupon, send an email, or log the trip. Likewise it would get frustrating to have to wait for a hibernate or boot cycle when just getting gas.

The solutions available permit setting the computer to get a hibernate/off signal after the car has been off for 5 minutes, 2 hours, or never. This solution really makes the finished product much more rugged and usable as opposed to being a constant concern. In the Reference model case listed in Section 2 the VoomPC-2 uses jumpers to choose the time-out period. Just like modem jumpers for COM port settings back in the day, it's likely such settings will eventually move into the BIOS or other more convenient areas.

3.2.3. Disks. Despite shock absorbers a car is a much more harsh environment than a living room (unless living in earthquake country). They cost more, but there are several

hard disk vendors offering disks tolerant of several G's of impact. Typically these suite the on-the-go businessman by protecting accidental drops and bumps. A car is likely to endure much more than what the toughest businessman can throw at their laptop.

It is highly recommended Solid State Disks (SSD's) be used. They use the same technology as flash drives and come in both IDE and SATA interfaces. Additionally, it's even the possibility to make the system boot and run from a USB flash drive as many motherboards now support booting from USB. Be aware of the performance trade offs though. Flash is fast, but not nearly as fast as disk technology. That said, be realistic about desires. A speed junkie might want blazing I/O performance when the reality is streaming one mp3 file at 192 kbps.

3.2.4. Screen. As this computer will be mounted in the dashboard it's won't benefit from the usual conveniences of a keyboard and mouse. Most likely a touch screen will be the best option- budget permitting. Also of consideration is screen size. While a wide variety of sizes are available don't neglect to consider it's planned location and what it might block, whether or not it's in arms distance of the driver's seat, and where cables will need to be run. All these obstacles will determine the best screen for your build. The Reference screen was chosen for it's size and movie viewing. If just looking for a music console something more modest would be appropriate.

3.2.5. Mounting. Not long ago mounting was the most challenging part of a car computer but the recent growth of the mobile devices market has led to many offerings being available. One nice benefit of this market is there are plenty of choices available not requiring dismantling of your dashboard panels or drilling. They simply snap into place for most popular vehicles.

Security should still be a concern though. Even with remove-and-go GPS devices many burglars are reported to target cars with suction cup mount circles on their windshield, as reported by police reports. Unfortunately the fruits of your project may become the desire of would-be robbers.

4. Building It.
4.1. Choosing Operating System.
4.1.1. Linux vs Windows. Given the wealth of packages and support available for GNU/Linux it is chosen as the preferred operating system. This may not be appropriate for everyone and the common comforts of Windows may be your choice. Windows XP will run quite well on the hardware available, especially Windows XP Embedded (XPe), and there are even several vendors selling front-ends for such systems.

As the market evolves for car computers expect to see many more Open Source and proprietary solutions out there. As for now, GNU/Linux is that frontier with a growing development community. Two such communities already exist which are backed by major sponsors. XX and YY. Note that these projects more generically target mobile devices with cars being a subset of those devices.
4.1.2. Existing Distros/MID Projects.

4.1.2.1. inCar Terminal. This project offers one of the most friendly touchscreen interfaces for automotive needs. Like the iPhone it's very finger friendly and makes the most used features easily available. And based on a GNU/Linux platform it offers endless possibilities for customization. This is the recommended interface for this project.

4.1.2.2. Ubuntu MID Edition. The popularity of Ubuntu has make niche extensions now including a Mobile Internet Device Edition with it's own support community. While this interface is generically targeted towards any mobile device be it netbook or mobile phone it may be a good fit here too. Note that it doesn't support all processor platforms and chipsets and is not finger-friendly out-of-the-box. Nonetheless it's highly customizable and has potential here.

4.1.2.3. Moblin. This project is backed by Intel and focuses on the Atom processor. The corporate backing appears to give this project the financing to advance it rapidly and offers a seemingly finger-friendly interface.

4.2. Choosing a Form Factor.
4.2.1. Mini-ITX vs Pico-ITX. Mini-ITX boards are typically sold as motherboard/processor combos, but can be purchased separately too. This leaves the simple choices of how much memory and storage are necessary. Both fan-less and fanned versions of these boards can be found. The fan-less ones tend to be more expensive as they foster more low-power technology. Considering road noise, music, and voices will far outshine a small fan it's not likely fan-less systems will win the cost-benefit analysis. On the other hand the choice of case may limit the clearance available for fans and/or large heat sinks. Be sure to check the case manufacturer's spec's on which motherboards are supported as many just won't fit.

5. Installing and Configuration.
5.1. The Operating System. As the guts of the miniaturized computer are no different than a typical home expect things proceed similarly. A USB connect CD drive or flash drive can be used for installation. Just check the BIOS to make sure the appropriate media is in the Boot Order configuration. In most instances the common installer images will not have preconfigured drivers for most touch screens thus it'll likely be convenient to have a keyboard and mouse available until all such drivers are installed and configured.

5.1.1. Ubuntu MID. The installer can be downloaded from ubuntu.org. Also provided there is the ImageWriter utility for writing this image to a flash drive. Once imaged to the flash drive boot the computer from this media and follow the on-screen procedures. This should be standard procedure for the computer hobbyist.

5.1.2. Windows XP/XPe. Windows is a viable choice but some consideration should be made about which version. Standard Windows XP will be just the same as home computing. Expect to purchase a licensed copy of Windows (NB- Windows has recently expired availability of XP) which might likely increase the cost of this project 50%. XP

Embedded (XPe) is a light wieght version of XP intended for devices just like a car computer. It has all the same bells and whistles as XP but tends to have less services running, thus reducing it's memory foot print- a big plus in these circumstances. Additionally XPe is licensed differently.

5.2. Configuration. Once installed it'll be much easier if an Internet connection is available on the new install to access downloading drivers and other packages. It may be just as easy to download such files on another computer and copy them with a flash drive.

First things first- the touch-screen. It's good to know most touch-screen manufacturers provide both GNU/Linux and Windows drivers which install just as easily as any other. What may cause some trouble is Power Management features such as APCI. Unlike a home computer which may benefit from such features as one comes and goes form their computer desk a car computer will be just like a radio- it's either in use or off. Given the headaches potentially available it's best to disable all APCI features until everything is working. Then they can be re-enabled one by one making sure no functionality is lost- specifically with touch-screen drivers. Unfortunately some level of APCI is necessary to take advantage fo the motherboard power features which signal the computer when the ignition has been turned off or on.

Next in line should be the installation of an on-screen keyboard. As not every application will be entirely finger-friendly there will be times it's necessary to type input. Once vehicle mounted a keyboard might not be available thus having some pop-up keyboard to finger in some text will inevitably be handy.

At this point the system's core is ready for use. How it's to be used will determine what applications are chosen for installation. Again, be touch-screen conscious. It may be tempting to install all a home computer's fun toys and utilities which may just become frustrating when trying to live with them without a keyboard.

6. Mounting. Choose a screen mounting specifically for your vehicle and screen. This will ensure a nice fit as well as being sturdy. Despite the simplicity of mounting running wires may not be necessarily as easily. Think in advance where the computer will be mounted and where options are available to run wires. Also consider power. It may be as easy as using a cigarette lighter or if more sleek designs are in mind then having power run behind dash panels may be extra effort. Radio Shack or similar stores have cigarette lighter adapters that can fork off existing cigarette lighter wirings and make a socket available for use behind the dash.

Keep in mind your dash console has already been engineer to cram as many knobs and controls into a finite space. The design engineers have given little consideration to the fact consumers might want to cram something more. Consider two cup holders generous these days. Adding a screen is more than likely going to block something else. In most cases some knobs can be spared their easy convenience. The most hearty enthusiasts might tear their dash open and build their own custom in-dash framing. Many blogs can be found on such endeavors.

Mounting the computer may or may not be complicated. In the most simple cases it can just sit snuggly in an under seat compartment. If using a Solid Sate Disk mounting should not be too much of a concern but if not a rubber buffer for the mounting or some sort should be used. A rubber mounting buffer or similar would help. Without any protection there's no way to know if (more likely "when") a pot hole might render the disk or system useless.

7. The Community.
There's a well established user base which continues to grow. The Internet provides the collaboration forum for finding out most anything about any vehicle car, computer, or configuration. Use this to it's fullest if troubles are encountered. There are several sites listed in Section A - References. Most note worthy is mp3car.com which has been around for quite some time. Long before touch-screen's were financially tangible for hobbiests users were putting custom mp3 players in their cars. This site is full of photos and videos to use as reference and stimulating imagination.

8. Getting Started on Your Own.
Lots of information has been presented... but now what?

Start off by thinking about your budget, your car, and your objectives. It's easy to over spend plenty on a project like this so be sure to set yourself some realistic limits. With that in mind now think about your car. Where can the screen be mounted and what might it block? Can you live without easy immediate access those controls? And where will the computer actually be mounted? The trunk is an obvious choice but weigh that with the complications of running more wire and knowing the trunk is more exposed to temperature extremes.

A. References.

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7. http://indashpc.org/new/
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