Digital Simplicity:
Basic Hardware Meets All Flying Needs

Received by a universal access transceiver, this traffic information service displays a 3-D picture of traffic relative to position.

BY SCOTT M. SPANGLER

During aviation's just-ended analog era, choosing the right avionics system for your airplane was not unlike assembling a stereo system in the 1970s, with each component, a tuner, turntable and tape decks (open reel and those newfangled cassettes) embodied in a bulky expensive box. In the living room or the cockpit, it was a paradox of wants and needs constrained by space and available funds.

Today, pocket-sized digital systems carry gigabyte libraries of audio and visual entertainment, replacing walls of components and shelves full of vinyl and tape. The same transition is well under way in general aviation cockpits, causing a paradigm shift in avionics practices born in the 1940s, when the pilot's mission determined what boxes were in the panel.

Old-school VFR aviators who lived in uncontrolled airspace could — and still do — fly quite happily with no radios at all. On their rare adventures to an airport with a control tower, a handheld radio eventually replaced their circling request for light-gun signals. VFR pilots who wanted to fully exploit their airplane's cross-country capabilities needed more: a six-pack of round flight instruments, a single VOR nav/com, and an altitude-reporting transponder.

Some time in the 1990s, they likely purchased their first piece of digital avionics: a handheld GPS receiver.

Earning and exercising an instrument rating called for a second nav/com with an ILS indicator. Serious travelers who frequently met Mother Nature added an ADF and DME to their stack, then RNAV and an autopilot to reduce their IFR workload. Many wedged a Loran receiver into the panel, only to replace it later with a GPS receiver for "auxiliary" navigation.

As their systems grew, pilots carried more processed wood pulp. The seed, an airport guide like the "AOPA Airport Directory" and sectional charts, grew into robust trunks of IFR en route and terminal charts, subdivided into thick binders standing together like growth rings on a geographic tree.

The Cessna Turbo 210 is still an excellent IFR traveling machine, and upgrading it with Avidyne's Entegra will give it free range in NextGen.

Every 28 days, pilots spent hours updating the leaves.

This accumulation of components is flying today in most GA airplanes, a sizeable population of which was born during the heyday of analog aviation, from the 1960s to the early 1980s, when American airframers annually fledged them by the tens of thousands. These airplanes still have plenty of life ahead of them, but their analog avionics are on their last legs, with the cost of repairs and lack of parts heralding their retirement.

Their replacements can be seen in the seemingly empty panels of most of today's new airplanes, from light-sport aircraft to high-performance piston singles. Collectively, it's called "glass," for the eye-catching, full-color display component integrating aircraft operation, navigation, communications and information to make flight safer, capabilities once reserved for the early adopters of digital avionics: business and commercial operators.

It's all about the software. With a few exceptions, the Dynon EFIS-D100 primary flight display and EMS-D120 engine monitoring system used in many LSAs deliver capabilities similar to Avidyne's Entegra, Garmin's G1000 (and its offspring), and L3's SmartDeck. Certification decides what functions pilots can employ legally.

Adding capabilities to a digital avionics system (synthetic vision is the latest) often requires little more than a software upgrade and any applicable peripherals. For the cost-conscious aviator, this can help make it simpler to build a new digital avionics system one component at a time.

Garmin's G600 is just one upgrade option for a growing number of airplanes built during the heyday of analog aviation.

As any avionics technician will attest, interfacing — getting all of the digital components to talk to each other reliably — can be a challenge, especially when introducing a digital newcomer to a legacy system. Like the new kid on the playground, some play well with others, while some do not.

To avoid these conflicts, your avionics shop is a key ally, because its technicians know who gets along with what. Together, you can plan a digital system that will give you full access to the Next Generation Air Transportation System, known as NextGen.

NEXTGEN AVIONICS

NextGen is another paradigm shift. It replaces the 1940s technology of ground-based surveillance and navigation — radar and VORs — with dynamic 21st century technology, satellite navigation and digital communications networks.

With this new technology comes "new procedures, including the shifting of certain decision-making responsibility from the ground to the cockpit," according to the FAA on its NextGen website, www.faa.gov/nextgen.

Good decision-making depends on accurate real-time information delivered through hardware on the ground and in the air. The government has accelerated its work on the ground, promising to have much of NextGen operational in the "midterm," between 2012 and 2018. As a whole, NextGen is scheduled to be operational nationwide by 2025.

According to the FAA, "Lesser equipped aircraft will still be accommodated in the NAS (National Airspace System)." It doesn't say where, which means building a compatible digital avionics system is the only way to keep flying where you want. (Only the communications radio makes the jump to aviation's digital era, and IFR pilots still will want two of them.)

NextGen is a performance-based system, meaning avionics must perform to certain tolerances. The FAA uses an IFR example; it requires a positional accuracy of 0.3 nautical miles, or required navigation performance of 0.3. RNP is RNAV with onboard performance monitoring, which tells the pilot how accurately the system is fixing the

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airplane's position. This increases the pilot's situational awareness and enables reduced obstacle clearance and closer route spacing.

GPS/WAAS meets this requirement with accuracy to spare, so it's a good foundation on which to build a digital avionics system (if you haven't already).

VFR pilots have two GPS/WAAS options: a handheld or panel-mounted unit. In VFR-only birds like LSAs, the defacto system is a Garmin GPSMAP 396/496 connected to aircraft power, fixed GPS and XM weather antennas, and glass with an AirGizmo panel mount.

Handheld systems are not approved for IFR. If the airplane is IFR-certified, the prudent investment is a panel-mounted GPS/WAAS. Even if you don't have an instrument rating, the airplane's next owner might.

The venerable Cessna Skyhawk has made the transition to digital aviation and now leaves the factory with the Garmin G1000.

The FAA already has commissioned more than 1,000 GPS/WAAS approaches, and it plans to increase this number by 500 each year until it runs out of eligible runways.

Panel-mounted GPS/WAAS is covered by two technical service orders: TSO-C145a, "Airborne Navigation Sensors Using the GPS Augmented by the Wide Area Augmentation System," or TSO-C146a, "Stand-Alone Airborne Navigation Equipment Using the GPS Augmented by the Wide Area Augmentation System." Go with the latter: C146a certifies GPS/WAAS as the primary source of navigation, meaning it replaces VORs.

ADS-B IN & OUT

In NextGen, automatic dependent surveillance–broadcast (ADS-B) will replace radar and, eventually, transponders. The ADS-B Out system sends precise GPS/WAAS position reports to Air Traffic Control (ATC) via 794 ground-based transceivers (GBTs), as well as directly to other aircraft equipped to receive and display this (and other) information.

ADS-B In receives and displays incoming information. It gets position reports from other aircraft, and from the GBTs, the traffic information service–broadcast (TIS-B) and the flight information service–broacast (FIS-B). Provided by the FAA, TIS-B essentially puts an ATC screen in your cockpit, showing the location of nearby traffic. FIS-B includes textual and graphical weather.

Currently, both systems are deployed in Miami, Fla.; they should be online in the Gulf of Mexico, Louisville, Ky., Philadelphia, Pa., Houston, Texas, and Juneau, Alaska, in 2010, and running nationwide in 2013, according to the FAA's "NextGen Commitments & FY09 Work Plan."

L-3 Avionics Systems' SmartDeck with synthetic vision and its Trilogy ESI-1000 electronic standby instrument.

As it stands now, ADS-B is a two-box system. Aircraft flying at FL240 and above must have a Mode S transponder-based system (called 1090 ES for extended squitter) certified under TSO-C166a, which is ADS-B Out only. To receive ADS-B In, an aircraft needs the other box, a universal access transceiver (UAT) that also covers ADS-B Out requirements up to FL240.

Flying since 1996, as part of the Capstone project in Alaska, nearly 2,000 UAT systems are now airborne. Both systems require two antennas, one above and below the fuselage, to provide coverage regardless of altitude.

Final ADS-B In requirements are up in the air still, and the notice of proposed rulemaking addressing them is to be published at some unknown future date. (And until the final rule is issued, airplanes still need an altitude-reporting transponder.)

Given the political pressure to accelerate NextGen implementation, changing the two-box requirement seems unlikely. The NextGen website indirectly supports this: "Minimize the business risk associated with early deployment of NextGen equipage, such as those resulting from application of initial certification standards," is one of the FAA's "Governing Principles for Avionics Equipage."

When building a digital system block by block, the immediate ADS-B concern is ensuring its compatibility with the system's other components and deciding whether to use one unit or two. As it stands now, if you fly at or above FL240, you'll need 1090 ES, and UAT if you want ADS-B In services. If you never fly higher than FL240, a UAT seems to be the best investment.

DISPLAYS & DATABASES

To take advantage of ADS-B and to tap the wealth of information provided by the onboard plethora of databases, the system needs a display. For VFR installations, a handheld unit might be all you need.

Garmin's portables — the 396, the 496 and new big-screen 696

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— display information from their databases and interface with its UAT, the GDL 90. There seems to be no “for sure” answer on other UAT handheld combinations because most ADS-B systems now flying report to a panel-mounted multi-function display.

For the greatest 3-D situational awareness, pilots will want the largest screen possible, one that lays TIS-B symbols on the GPS/WAAS moving map. On the horizontal plane, trend vectors extend from the TIS traffic icons, and to their right is the altitude difference and trend vector, if the traffic is climbing or descending at 500 fpm or more.

The ultimate in glass is replacing the airplane’s steam gauges with an integrated system built around a primary flight display and multi-function display. A number of manufacturers provide these upgrade systems, and the number of aircraft on their approved model lists is growing.

Database compatibility is another important part of any digital avionics system, and the available databases seem endless. The most common are instrument approach charts, terrain, obstacles, navigation and airport information. When shopping, remember to ask about update subscription fees and the update process. In many cases, you download the update from a secure website and transfer it to the airplane with a flash drive, which is great, if you have a computer and fast Internet connection. Never forget: An out-of-date database can affect the airplane’s airworthiness.

Finally, as you add new digital avionics blocks to your panel, pursue training that will enable you to get the most out of your new equipment. Start with a tutorial from the shop’s technician. Then, dig into the manufacturer’s CD or online training. As appropriate, fly with a qualified instructor.

If you’ve never before flown a GPS LPV approach, the stress level is much lower if you’re under the hood on a VFR day and there’s a CFI in the right seat giving you pointers. The same holds true when you add glass, especially an integrated system with PFD and MFD.

Technology is a good thing and it can make any pilot’s life better. But it’s also a siren’s song, an addiction to surfing the screens, searching for every last available bit of information. Digital avionics do not relieve pilots of their responsibility for safety, so don’t forget to look outside. ❑

A good percentage of new light-sport aircraft, such as this Flight Design CTLS, sport the same avionics package: Dynon glass, Garmin avionics, and a handheld GPS 396/496 with XM weather in an AirGizmo panel-mount.

GPS/WAAS Instrument Approaches

With the advent of WAAS, the FAA has renamed GPS instrument approach procedures to reflect the system’s increased capabilities:

- **LNAV: Lateral navigation is the new name for a nonprecision GPS approach. Because this approach does not have vertical guidance, it has a minimum descent altitude (MDA), just like a conventional nonprecision approach. Typically, an LNAV MDA is 400 feet above the runway.**
- **LNAV/VNAV: Lateral navigation/vertical navigation approach information is provided by an approved GPS/WAAS or a flight management system with a VNAV-approved barometric altimeter. With an electronic glidepath, the approach usually has a decision altitude 350 feet above the runway.**
- **LPV: Localizer performance with vertical guidance is a new approach requiring a WAAS unit approved for it. Much more precise than LNAV/VNAV, LPV is the operational equivalent of a Category I ILS approach and has a decision altitude between 200 to 250 feet above the runway.**