8.6 Data Handling and Storage

The data handling and storage system was designed to accommodate the needs of the mission. The system includes a main computer and a backup computer to ensure data integrity. The main computer is connected to the mission control center and the backup computer is used in case of failure.

8.6.1 Flight Data System

- The flight data system records all critical flight data, including altitude, speed, and fuel consumption.
- It also provides real-time updates to the mission control center.
- The system is designed to withstand harsh environmental conditions.

8.6.2 Launch Pad Operations

- The launch pad operations are coordinated with the flight data system to ensure smooth launch procedures.
- The system is responsible for initiating the launch sequence and communicating with the launch vehicle.
- It also provides real-time updates to the mission control center.

8.6.3 In-Flight Operations

- The in-flight operations are managed by the flight data system, which communicates with the flight crew.
- The system is responsible for managing the flightpath and ensuring the safety of the crew.
- It also provides real-time updates to the mission control center.

8.6.4 Landing Operations

- The landing operations are managed by the flight data system, which communicates with the landing team.
- The system is responsible for guiding the spacecraft to a safe and successful landing.
- It also provides real-time updates to the mission control center.

8.6.5 Post-Landing Operations

- The post-landing operations are managed by the flight data system, which communicates with the support team.
- The system is responsible for providing data to the mission control center to assess the mission's success.
- It also provides real-time updates to the mission control center.
Innovation

- To change or renew
Product or Service designed to assist the Human Being to better interpret and/or interact with their environment
Situational awareness involves being aware of what is happening in the vicinity to understand how information, events, and one's own actions will impact goals and objectives, both immediately and in the near future.

Lacking or inadequate situational awareness has been identified as one of the primary factors in accidents attributed to human error.

Thus, situational awareness is especially important in work domains where the information flow can be quite high and poor decisions may lead to serious consequences.

Having complete, accurate and up-to-the-minute SA is essential where technological and situational complexity on the human decision-maker are a concern.

Situational awareness has been recognized as a critical, yet often elusive, foundation for successful decision-making across a broad range of complex and dynamic systems.
Where are we today?
GNS 400W/500W
- GPS/Nav/Comm solution
- **Status:** Currently Available

Next Generation Panel Mount
- Garmin GNS 400 series navigators were introduced in 1998 followed by the GNS 500 series in 2000.
- GNS 400W/500W product line is aging
- Garmin has introduced upgraded products
Communication and Navigation
Form Factor & Display
• **Dedicated Function Knobs**
  - Push buttons: “Home” & “Direct To”
  - Knobs: Dual concentric & rotary volume

• **Virtual buttons (touchscreen)**
  - Large graphical buttons – define function
  - Easy keyboard entry as optional input platform
Design Philosophy

- Consistency Among Garmin Product Line
  - G3000 G5000 (Evolution IFD based upon core G1000)
  - GTN (replacing GNS 400W/500W Series)
Functionality not requiring touchscreen

- Com/Nav tuning
- Com/Nav volume
- Direct To entry
- Home key and default nav
Displays

- **GDU 620 and 620R (G500H)**
  - Combines PFD and MFD in single 10” wide bezel
  - Two 6.5” diagonal flat-panel LCDs
  - RGB backlighting supports Class A or B NVIS compatibility
  - 620H puts PFD on the right side to support right-side PIC helicopter applications
  - **Status:** Currently available;
G500(H) Capabilities

- **Primary flight data**
  - Attitude
  - Air data
  - HSI – Heading and course guidance

- **Multi function display**
  - Color moving maps
  - Chart display
  - Airport data

- **Hazard avoidance**
  - Terrain awareness
    - Synthetic Vision
      - Terrain, traffic, airports
      - HTAWS
  - XM satellite datalink weather
  - Traffic detection and display
  - Airborne weather radar

- **Communication via GNS 400W/500W or GTN 650/750 and GTX XPDR**
  - VHF com
  - Mode S Extended Squitter Transponder

- **Navigation via GNS 400W/500W or GTN 650/750**
  - WAAS enabled GPS
  - VHF nav/loc/GS
  - FMS functionality
    - Most ARINC leg types
    - Arrivals, Departures, Approaches
    - Single Point VNAV
G500H for Helicopters

- Simple user interface
- Form factor – helicopter instrument panels and consoles are small – PFD and MFD functionality fit within allowed space
- The new standard for VFR helicopters
- Purposefully integrated with Garmin GNS navigators
- Helicopter functionality
  - moving maps - detailed
  - synthetic vision
  - radar altimeter
  - video display
  - satellite datalink
  - traffic display
- NVIS/NVG – Class B compatible
- Retrofittable
Capabilities Added Via Software

- TAWS - Class A, Class B, HTAWS
- Chartview
- FliteCharts
- SafeTaxi
- Autopilot Coupled ARINC 424 Leg Types
- Airways
- CMC/Diagnostics
- Trend and Exceedance Monitoring and Storage
- Crew Alerting System
- Synoptics
- Synthetic Vision
- Performance Calculations
The GTS 8XX Traffic Advisory System (TAS) and Traffic Collision Avoidance System (TCAS I) use active interrogations of Mode S (GTS 820 and GTS 850 only) and Mode C transponders to provide traffic awareness and advisories to the pilot, independent of the air traffic control system.

The system also uses passive surveillance by means of an Automatic Dependent Surveillance – Broadcast (ADS-B) receiver which is enabled when installed with a 1090 MHz ADS-B transmit class of equipment, or other complementary ADS-B link transmit class of equipment (such as UAT).

### Necessary Components

<table>
<thead>
<tr>
<th>Product Description</th>
<th>Applicable TSOs</th>
<th>Power/ Active Interrogation Range</th>
<th>GTS Processor Unit</th>
<th>Power Amp/Low-Noise Amp</th>
<th>Top Antenna</th>
<th>Bottom Antenna</th>
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<tbody>
<tr>
<td>GTS 800 TAS</td>
<td>C147, C166a</td>
<td>40 W / 12 nm</td>
<td>GTS 800</td>
<td>None</td>
<td>1 x GA 58</td>
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<td></td>
<td></td>
<td>1 x GA 58 or omni</td>
</tr>
</tbody>
</table>
- ADS-B mandate in effect for North Sea operations
- Gulf of Mexico mandate to take effect in 2020
  - ADS-B equipped aircraft currently get preferred routes in Gulf of Mexico
- Dual link architecture in the US, 1090 and UAT (978)
- ADS-B Out required for FAA critical services
  - ATC services
- ADS-B In optional for FAA essential services
  - Broadcast services including TIS-B and FIS-B
- FIS-B graphical/textual weather on UAT link only
Garmin has approved ADS-B products in use everyday in AK, ERAU, UND, China

Customers value the capabilities of ADS-B equipment and improved traffic awareness

FAA is making a substantial investment on the NextGen ATC System

Garmin offers a broad range of ADS-B devices with interfaces to panel mount GPS units, MFD’s, portable products, and integrated avionics suites
Datalink (Iridium/WiFi) Overview

**WiFi & Data Storage - GDL 59**
- Flight parameter recorder
- High speed data link between the aircraft systems and ground computers using 802.11g (“Wi-Fi”) while the aircraft is on the ground
- Supports transmission of logged data reports including engine trend and exceedance data and CAS messages (HUMS)
- Planned future features
  - Automatic flight plan uploading and downloading
  - Automatic database updates
- **Status:** Currently Available

**Iridium - GSR 56**
- Airborne low speed data link and voice communication capability
- Utilizes Iridium satellite network
- Satellite Phone
  - Fully integrated with G3000/G1000/G500H
  - GMA provides cockpit audio interface (via TEL button)
  - Dialing interface provided via MFD
  - “Incoming Call” message prioritized with other aural messages
- **Status:** Currently Available
XM Weather and Radio

- **GDL 69A**
  - XM satellite radio and digital datalink weather receiver (U.S and Canada only)
  - **Status:** Currently Available

- **XM Radio Remote Controller**
  - Features
    - GDL 69A receiver provides XM radio and datalink weather
    - XM Radio entertainment control on MFD or using remote control (GRC 10)
    - Wireless link
  - GRC 10
    - Allows passengers to control entertainment functions
    - Selection of channel, music category, presets, and volume
  - GRT 10
    - RS-232 connection to GDL 69A
  - **Status:** Currently Available
User Interface and Software Features
Enhanced Vision System/Video Support

- Display Units support 2 sources of external video input which may be used for EVS or cameras
- Displayed on MFD AUX page
  - Adjustable Contrast
  - Adjustable Brightness
  - Video 1 / 2 source selection
  - Digital zoom
- Future plans include fusion of synthetic vision and enhanced vision
Jeppesen Data
  - Airport Diagrams
  - Approach Charts
  - Departure Procedures
  - Arrival Procedures

Most charts geo-referenced so aircraft symbol can be shown

Many different views available and charts are easily zoomed and panned
- Detailed airport diagrams for over 800 airports in U.S. from NACO data
  - Leverages Garmin’s in-house cartography resources
- Seamlessly integrated into main MFD navigation map and PFD inset map
  - SafeTaxi adds data to the existing basemap
  - No need for a separate airport diagram chart
  - Requires no pilot action to display
  - Information automatically appears at appropriate ‘map range’ setting
- Geo-referenced data with selectable attributes including:
  - All current runways and taxiways
  - Public services (terminals, fire dept, post office, etc.)
  - FBOs, hangars, customs and more
- Easy Updates
  - Database updates available at www.garmin.com
  - Available every 56 days
- Status: Currently Available
- Delivering TSO-C151b Class B and Class A TAWS in G1000 and GNS 5XXW products
- Developed HTAWS for use in helicopter applications
  - Certified in accordance with TSO-C194
  - Available in GNS 430W/530W
  - Status: Currently Available
Synoptics

- Provide graphical representation of key engine and other airframe systems
- Airframe-specific implementation similar to current EICAS
- Synoptic pages add new “SYSTEM” page group for display on MFD

Example Fuel Synoptic

Example Heater Synoptic
Central Maintenance/HUMS Function

Data Logging

- The data logging system has access to any data available to the GDUs within the avionics system (HSDB, discretes, analog, ARINC 429, etc.)
- Fault report or basic data can be stored in the GDU, GDL 59, or both
  - Each GDU provides 1 MB of non-volatile memory for logged data storage
  - The GDL 59 provides 2 GB of non-volatile memory for logged data storage
- Within the GDL 59, logged data is organized into reports that can be automatically or manually transmitted via Wi-Fi or Iridium (requires GSR 56)

<table>
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<tr>
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<th>Date</th>
<th>Time</th>
<th>KIAS</th>
<th>ALT(FT)</th>
<th>FF(GPH)</th>
<th>Ng(%RPM)</th>
<th>Np(RPM)</th>
<th>Torque(LB-FT)</th>
<th>ITT (C)</th>
<th>Vacuum (in-HG)</th>
<th>OT (C)</th>
<th>OP (PSI)</th>
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Exceedances

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</table>
Flight Data Services

- **Airborne Telephone via Iridium Voice Capability**
  - Requires GSR 56 Iridium datalink
  - **Status:** Initial support in Q3 2009 requires GDL 59 also. Software TSOA planned Q2 2010 does not require GDL 59

- **Aircraft Data Logging and Transmission**
  - GDL 59 provides highly-configurable data logging capabilities
  - Transmission of data via Wi-Fi (GDL 59) on the ground or Iridium (GSR 56) in flight
  - Raw aircraft data provided automatically to OEM by Garmin servers
  - **Status:** Currently Available

- **Flight Planning Capability Added to Fly.Garmin.com Website**
  - Synch flight plans with Pilot My-Cast
  - Future capability to upload flight plans via SD card or wirelessly to cockpit
  - **Status:** Currently Available

- **Basic Electronic Logbook Added to Fly.Garmin.com Website**
  - Basic capabilities to record and edit pilot logbook entries
  - Provides infrastructure to support future logged data review services
  - **Status:** Planned to launch Q1, 2011
G1000 currently incorporates Search and Rescue FMS functionality including 3 search patterns:
- Expanding Square
- Parallel Track
- Sector Search

Functionality may be expanded to include Mark on Target and Search Suspend/Resume capabilities

Incorporation of search and rescue functionality for navigators installed in helicopters is planned for future products.

US Civil Air Patrol flying search and rescue missions with G1000 since 2005
Helicopter Support Experience

- Retrofit installs of various avionics on all makes and models of helicopters

Programs of note
  - USCG MH-68
  - USA AH-64D
  - DoD DemVal (H-60, H-1)
  - Kansas City ENG and KCPD ADS-B safety program
  - Royal Australian Army OH-58 upgrade
Helicopter Projects

- G1000H and G500H LRU Vibration Qualification
- AHRS/Magnetometer Helicopter Specific Development
- ADC Helicopter Development
- G500H STC
  - Bell 206/407
  - EC 130 (In cooperation with Air Methods)
  - AS 350 (In cooperation with Air Methods)
- Helicopter Product, Feature, and Function Development
Garmin recently completed testing of the GRS 77 AHRS and GMU 44 magnetometer in the helicopter flight environment

- Flown with software modified for helicopter flight characteristics
- Results:
  - Good performance in primary mode during all maneuvers and in-air realignments
  - Good heading/pitch/roll performance in reversion-no-GPS mode
  - Good pitch/roll performance in reversion-no-mag mode and reversion-no-mag-no-air model

An AHRS “free gyro mode” to support operations for limited duration in the presence of magnetic anomalies
Future Garmin display products intended for use in helicopters will address the need for NVG compatibility in accordance with SAE AS 5452 and MIL-L-85762 Class B

Garmin is pursuing NVG compatibility:
- G1000H – Support third party mod
- G500H – RGB color palette change via software in display
- NVG compliant backlight for pilot viewable bezels and knobs
Garmin has conducted vibration testing on LRUs for G1000 and G500H systems

- Testing conducted based on DO-160F Category U, Curve G vibration levels
  - Tested the following LRUs:
    - Display units (GDU)
    - Integrated avionics unit (GIA)
    - AHRS (GRS)
    - Magnetometer (GMU)
    - Air data computer (GDC)
    - Audio panel (GMA)
    - Transponder (GTX)
    - Engine and airframe interface unit (GEA)
    - XM weather and datalink unit (GDL)
    - TAS (GTS)

- Design modifications required for noted susceptibilities
  - Air data computer and AHRS designs have been finalized and TSOA
  - All LRUs currently TSO approved for helicopter vibration