UAV Data Links
Present and Future
Outline of the presentation

- Speaker: Barry RP Jackson
  - COO Cahon Systems Inc.

Outline:
- First
  - Where we are today.
- Second
  - Where are we going in the next few years.
- Third
  - Looking into the future?
- Questions.
The BST100-1 satellite data link on the Guardian UAV has over 3 years flight time with no failures as of March 2013.

Ground Station Component

Designed and built in the California 50th Congressional District.

Airborne Component

Cahon Systems Inc
Concept to Reality

437 Vernon Way
El Cajon, California 92020
Phone (619) 596-3100
Email sales@cahonsystems.com
The Guardian
Joint DHS Maritime Variant

- Predator B airframe
- External centerline radar pod
- Enhanced Raytheon SeaVue Radar/Upgraded MTS-B EO/IR
- AIS and multi-comms
- Laser Altimeter/Pitch Indicator
BST (Broadband Satellite Terminal) Data Link Network Diagram

**Satellite**
- IP Connection to Inmarsat Network (Double Hop)

**Ground**
- Static IP
  - E/N
  - Gnd Test
  - IP Video
  - Serial
  - Serial
  - Voice
  - Voice

**Aircraft**
- Static IP
  - E/N
  - Gnd Test
  - IP Video
  - Serial
  - Serial
  - Voice
  - Voice

**Gateway**
- May Be Same Satellite & Gateway

**BST 210**
- BST 210

**BST 110**
- BST 110

**INMARSAT GLOBAL IP NETWORK**
- MILNET, Internet, VPN, T1/E1, VSAT

**Direct**
- IP Connection to Inmarsat Network (Single Hop)
BST Data Link System Capabilities

- Inmarsat I4 Compatible
  - SwiftBroadband and BGAN
- Voice
  - 2 to 4 VoIP channels, wired telephone network toll quality.
  - Push-to-talk supervision transmitted in-band.
  - Full Duplex capable, each direction independent.
  - Uses bandwidth only when talking (background).
- Video or Other UDP Data
  - 10/100Base-T (UDP).
  - 32 kbps, 64 Kbps, 128 Kbps, 256 Kbps fixed streaming or variable background (selectable).
- Many Async Serial Data Channels
  - Full Duplex, optional hardware flow control.
  - Telemetry & Command (T&C), 38.4 Kbps (default rate).
  - Payload Data, up to 115.2 Kbps.
BST Security & Redundancy

- Inmarsat Encryption
  - Satellite air interface segment commercially encrypted by the Inmarsat network.
  - NSA Type-1 encryption on satellite command links.
- BST End to End Encryption
  - AES 256 (using a FIPS 140-2 certified S/W module).
  - User selectable for each interface individually.
- User Encrypted Payloads
  - BST delivers externally encrypted payloads transparently.
- Redundant Connection, BST Ground Station to SAS
  - Direct T1/E1, VPN, Mil Net, VSAT, Internet – Single Hop.
  - Satellite (BGAN) backup – Double Hop.
**BST Interfaces**

- **PSTN Quality VoIP Audio, 2 to 4 Channels**
  - Transformer Coupled, 150 Ohm or 600 Ohm balanced.
  - Input level – 1Vpp to 50Vp-p (ARC-210 compatible).
  - Output level – 1Vpp to 3Vp-p.
  - 28V Logic ground for push-to-talk (PTT & Squelch) in and out.
  - Full Duplex capable, each direction independent.

- **10/100Base-T Ethernet (UDP)**
  - User data or video, streaming or background.

- **RS-422 Async Serial Data**
  - Full duplex asynchronous data, up to 115.2 Kbps (w/optional flow control).

- **RS-232/422 Async Serial Data**
  - EIA-232/422, selectable by wiring.
  - Full duplex asynchronous data, up to 115.2 Kbps (w/optional flow control).

- **RS-422 Async Serial Control (Terminal Administration)**
  - Configuration and status monitoring of terminal, up to 115.2 Kbps (w/optional flow control).
BST SWaP & Temperature

SWaP (Size, Weight and Power)
- **Airborne Equipment**
  - Chassis Size < 0.6 cu ft (10” x 18” x 5”), excluding connectors.
  - System Weight ≤ 30 lbs, including HLD & antenna.
  - System Power ≤ 300 W, including HLD & antenna.

- **Ground Equipment**
  - Chassis Size: 2U (3.5” high), 19” rack mount.
  - Chassis Weight ≤ 20 lbs, excluding radome (< 50 lbs).
  - System Power ≤ 400W, including radome.

Temperature
- **Airborne Equipment**
  - Antenna (-73° C (start-up) to +49° C (start-up)).
  - Chassis (-40° C (start-up) to +70° C (start-up)).

- **Ground Equipment**
  - Antenna (-32° C (start-up) to +49° C (start-up)).
  - Chassis (-32° C (start-up) to +35° C (start-up)).
BST Airborne Terminal
Amplifier/Diplexer (HLD) & HGA-6000 Antenna
BST Ground Terminal & Antenna
Strengths and Weaknesses

- 3 plus years of in service use with no faults.
- Extra encryption added on a channel by channel basis.
- ProtoBus™ architecture flexible; easily allows additional data streams to be accommodated:
  - e.g. MIL Std 1553 and 1773, ARINC 429.
- All input data and voice can be selected for background or streaming transmission.
- Current system not DO-178 or DO-254 approved for flight safety – More Later.
- Current system will be expensive to certify to DO-178.
- Software implementation will throttle maximum data throughput.
The integration of Unmanned Aircraft Systems (UAS) into civilian airspace presents the next frontier in the air transportation industry. And it is one that faces numerous technological, regulatory and public perception issues as it moves forward towards its 2015 deadline.

According to a new report from the Aerospace Industries Association (AIA), the integration of UAS into civil airspace is projected to generate $89 billion over the next decade. The report states that today the U.S. flies more than 1 million unmanned flight hours annually, and the Department of Defense operates more than 7,000 UAS; and that usage is expected to grow with integration into civil airspace.

FAA is targeting 2015 for integration of UAS into the National Airspace System (NAS), however that date will be hard to achieve due to the budget and regulatory challenges faced by the agency. There remains an issue of certification of new UAS technologies, and allocation of airspace for UAS to operate in alongside other commercial and private aircraft.

Additionally, securing the necessary bandwidth and electromagnetic spectrum for civilian UAS communications between the aircraft and the ground station is another matter the industry must overcome.
“This is an issue a lot of people don’t think about with UAS,” said George Novak, assistant vice president of Civil Aviation at AIA.

“You’re looking at a feedback from the vehicle, of both avionics data, so you have position, engine speed, altitude, everything that’s coming back, that a pilot would normally have in front of him or her in the aircraft. All of that is being transmitted back and forth. At the same time, as we’re looking at a see and avoid mechanism, where you possibly have full video being transmitted from the aircraft — this requires an extensive amount of bandwidth, and this has not been contemplated in allocation of bandwidth as we’ve looked at it for other uses, such as cellular telephones, HD TV, radio communications and other things. Reallocation of the spectrum and that bandwidth is something that we’re examining both on the national basis through the FCC and on an international basis through the International Telecommunications Union (ITU),” Novak added.

The U.S. government has presented the option of fixed satellite service to ITU, which is in abundance and can safely support projected growth of UAS over the next decade. Security issues can be addressed through hardware modification and design for UAS networks and encryption of the signal, according to Novak.
“Progress has been made in obtaining additional dedicated radio-frequency spectrum for UAS operations, but additional dedicated spectrum, including satellite spectrum, is still needed to ensure secure and continuous communications for both small and large UAS operations,” according to a spokesperson for FAA’s UAS Integration Office.

Other concerns expressed by lawmakers, stakeholders and airspace users have been the issue of how UAS will operate in the same airspace as commercial aircraft.

Novak said the deployment of NextGen, and the shift from radar to a satellite-based air traffic control system in the United States, will help to automate the allocation of airspace and traffic avoidance between UAS and manned aircraft.

Additionally, this will open up additional civilian applications for UAS, including crop surveillance, firefighting, aerial photography and more.

“I don’t know that UAS manufacturers are really developing platforms with a specific market in mind, but I think that manufacturers understand that the United States and the world are going to be big users of unmanned aircraft, for a variety of reasons, sports and media coverage, real estate photography, weather monitoring, environmental monitoring and more,” said Gretchen West, executive vice president of the Association for Unmanned Vehicle Systems International (AUVSI).
F.A.A. Do Nothing
Current thoughts on Flight safety

- L band satcom seems to be the preferred route for safety of flight in UAVs. Both the R.T.C.A. committee looking into setting standards and F.A.A. seem set on the L band satcom approach.
- Prime safety of flight requirements seem to be:
  - Near real-time telemetry from the UAV.
  - Near real-time flight commands to the UAV.
  - Sense and avoid system on the UAV.
  - At least one remotely controlled on board the UAV radio.
  - Get you home algorithm for lost link scenarios within the UAV.
  - Nose wheel camera system transmitted from the UAV.
  - All systems Do-178 and Do-254 certified.
    - Certification to what standard?
A new approach - Flight Safety

Patent Pending

Dual L-Band Airborne
Integration with I5 and other data links

Optional Power Isolation

L-Band & Ka-Band Airborne
In a logical extension of the “those things just about fly themselves” line of thinking, a European study is exploring the possibility of single-pilot airline operations. Launched in January, the $40 million, 42-month research project is called ACROSS, an acronym for “Advanced Cockpit for Reduction of Stress (and workload).”

The research is funded, in part, by the European Commission under its Seventh Framework Program, with a consortium of 35 participants led by avionics maker Thales. That company’s Thierry Malet is the project coordinator for ACROSS, which involves three phases. The first, he said, is “to develop, integrate and test new cockpit solutions that facilitate the management of peak workload situations that can occur during a flight, in order to improve safety and ensure the reduction of accident risks through the reduction of stress.”

The second phase will be to explore new equipment designed to permit “reduced crew operations” under “limited number of well defined conditions,” such as long-range cruise. This phase will also explore using pilot aids to assist a single pilot should the second pilot become incapacitated and to fly the airplane to a safe landing should both pilots become incapacitated. The third objective of the program is to identify “remaining open issues” barring implementation of single-pilot airline operations.

A website for the ACROSS program is scheduled for launch in July.
The future

- Need a Modem that has an Ethernet input only.
- Modem should be of the style of the Cobham SDU7315.
- Global Xpress modem should cover part of the Military and Commercial bands if possible.
- After UAVs are accepted into controlled civilian airspace, what next?
- 10 to 15 years Freighter aircraft flying with 1 pilot?
- 20 years passenger aircraft with 1 pilot?
- 25 years UAV freighter aircraft on long haul routes?
- 30 years passenger UAVs on long haul routes?
Our Team

- The Cahon team of communications and video compression industry veterans has many decades of combined experience in architecture, design, manufacture, integration, sales, marketing, and program management.