Advanced Command Destruct System (ACDS)
Enhanced Flight Termination System (EFTS)

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1999 Global Hawk Video
From AFFTC
Agenda

• Program Overview / Background

• Air Force Flight Test Center (AFFTC) / NASA Dryden Flight Research Center (DFRC) Integration
  - AFFTC / NASA DFRC Current Operating Capability (COC)
  - Current Operational Usage
  - Future Operating Capability (FOC) - ACDS - AFFTC and DFRC Combined Implementation Efforts

• Questions
Program Background
Program Background

• Current flight termination system (FTS) operates in UHF frequency band (420 – 450 MHz)

• 2 Major Common Types of FTS
  - Standard analog system (Uses three tones in a simple logic sequence to initiate termination, similar to FM radio)
  - High alphabet system (Uses combination of an eleven character, frequency modulated, tone pattern)
    - Secure but not encrypted

• EFTS initiated and propelled because of key events
  - Global Hawk inadvertent termination in Mar 1999
    - AF/CV and AFMC/CC tasking based on findings
    - Investigate encryption of command destruct links
    - Explore low-cost, lightweight space Communications Security (COMSEC) for FTS
  - Strategic Target System inadvertent termination in Nov 2001
Program Background (cont.)

• Range Commanders Council (RCC) Range Safety Group (RSG) study task, initiated in Apr 2000 and completed in Apr 2002, to select and document a robust, affordable, reliable technology that provides an encrypted FTS capability
  - EFTS Program team formed (Air Force, NASA, RSG, Telemetry Group, Telecommunications & timing Group, Academia, NSA, Industry)
  - Continuous Phase Frequency Shift Keying (CPFSK) aka PCM/FM selected as modulation
  - Triple Data Encryption Standard (TDES) selected for security
  - Digital message format
  - Forward Error Correction (FEC) to protect against interference

• Prototype phase, initiated in May 2002 and completed in Jan 2004, to validate proposed technology for range safety application
  - Prototype flight termination receivers and ground-based addressable Encoder for command transmitter developed by L-3 Cincinnati Electronics (L-3 CE)
  - Functionality validated on F-15B testbed aircraft at Edwards Air Force Base (AFB)
Program Background (cont.)

- Development of EFTS receiver and ground systems, initiated in Jan 2004 and completed in Apr 2007
  - Receiver contracts awarded August 2004 to L-3 CE to develop equipment that meet environmental requirements for Missile, Unmanned Aerial Vehicle, and Space-Launch applications
  - Ground Systems contract awarded August 2005 to L-3 CE for development of ground system equipment (encoder, monitor, and Triple DES Unit)

- Testing
  - Acceptance and qualification testing on flight termination receiver initiated in Oct 2005 and completed Apr 2007
    - Qualification test report accepted Aug 2007
  - Acceptance testing on ground equipment initiated in Dec 2005 and completed in Nov 2006
  - Demonstrated the system’s capabilities on an Advanced Medium Range Air-to-Air Missile (AMRAAM) at Eglin/Tyndall AFB
AFFTC / NASA DFRC Integration
NASA DFRC EFTS Background

• Current Operating Capability (COC) - NASA DFRC started working towards single vehicle EFTS system Jan 2008

• Future Operating Capability (FOC) - NASA DFRC and Air Force Flight Test Center (AFFTC) combined effort working towards multiple vehicle and multiple missions simultaneously – effort to be completed by Dec 2011, including full integration and system testing at NASA DFRC

• Current Users – Global Observer, Blended Wing Body, Phantom Ray – all unmanned aerial vehicles (UAVs)
EFTS Conceptual Drawing

Vehicle System

Ground System

- RSO Command Panel
- Command Controller
  - Encoder
  - Triple Data Encryption Standard Unit
- Command Controller
  - Encoder
  - Triple Data Encryption Standard Unit
- Modulator/Exciter (Legacy)
- High-Power Amplifier (Legacy)
- EFTS Receiver/Decoder
- Fail/Safe Logic (Monitors power and received signal. Fail/Safe issues Appropriate Command upon Combined failure)
- Power
- Safety Device
- EFTS Receiver/Decoder
- Terminate Method
- Coupler
- ANT
- EFTS Receiver/Decoder
- High-Power Amplifier (Legacy)
- Modulator/Exciter (Legacy)
- Command Controller
- Triple Data Encryption Standard Unit
- Encoder
- Modulator/Exciter (Legacy)
EFTS COC Hardware

Range Safety Officer Command Panel

Local Command Panel

Command Controller
EFTS – L-3 CE Hardware

- Enhanced Flight Termination Receivers (FTR)
- Triple DES Units (TDU)
- Encoders
- Monitors

[Images of hardware components]
Current Operating Capability

• Developed to support one vehicle per mission
• Developed to support one frequency per mission
• Supports UAVs at NASA DFRC and AFFTC
• Started development in Jan 2008
• Completed 95% of design and hardware builds by May 2008
• NASA DFRC software and system safety acceptance – May 2008 to Feb 2010
• COC accepted as “Operational” ready by NASA DFRC and AFFTC – Mar 2010
COC Approval

• Independent Review Team
  - Reviewed all design processes
  - Ensured software safety requirements met
  - Reviewed 100% of software critical code
  - Reviewed and partook in system testing

• Center Chief Engineer Review Board
COC Testing

• **Component level testing**
  - Fully tested each individual command path component
  - Exercised every possible error mode that could be thought of
  - Exercised every known and expected function
  - Followed test procedures
  - Recorded data – electronically and manually

• **System level testing**
  - End to end testing – open loop and closed loop
COC Testing cont.

- Full end-to-end system testing completed
  - Included exercising of Range Safety Officer (RSO) command panel through entire FTS network; transmitted out and fed into monitoring device to verify properly transmitted FTS commands
  - Viewed EFTS command signal response via the EFTS FTR and EFTS Monitor
COC Testing cont.

• Component Testing
  - Duration Testing – 48 hours

• Full End-to-End System Testing
  - Duration Testing – 48 hours

• Location Testing – Two Drives Tests on Base
  - On the EAFB Flightline – 7/1/2009

• Acceptance Testing Completed – 8/26/2009
COC Testing Locations
(Google Map Image)
Current Operational Usage

• Three projects using EFTS operationally:
  - Global Observer (GO)
  - X-48 / Blended Wing Body (BWB)
  - Phantom Ray

• One project anticipated by end FY2011:
  - Phantom Eye

• GO – successfully flew first flight with EFTS active on 7/9/2010 – first EFTS flight with production EFTS equipment

• X-48 – successfully flew with EFTS active
Current Operational Usage

• Full development of recertification process for EFTS FTRs
  - Recertification process coordinated with the RCC
  - Assisted RCC to develop the EFTS FTR testing requirements

• Successful recertification of nine EFTS FTRs

• About 80 successful operations with EFTS to date
  - 40 ground tests
  - 40 flight tests

• Zero failures of EFTS system, to date, in support of EFTS operations

• Zero mission impacts due to EFTS system failures, to date
Fox News Video

Article Title: New Generation of Military Gadgets Coming, From Large Spy Systems to Tiny Drones

Original URL: http://www.foxnews.com/scitech/2011/03/01/military-pour-millions-unmanned-aircrafts/#content
Future Operating Capability

• Advanced Command Destruct System
  - Request for proposal for full integration – won by WV Communications in Feb 2010
  - Supports NASA DFRC and AFFTC FTS missions
  - Developed to support five vehicles per mission
  - Developed to support two simultaneously missions

• FOC development work and requirements based upon the work done on the COC

• Expected operational at end CY2011
Questions??