UNCLASSIFIED//FOUO

Cloak Blade: Inherently Stealthy Micro-Copter

Presented to: RADM T. B. Kraft, Commander, Navy Warfare Development Command

Thomas A. Hawkins, Program Manager / Pl James D. Reeves, Lead Network Engineer Ken Sparks, Lead Platform Engineer

Updated: 19 Sep 2012

Last Time We Met We Discussed:

- Cloud and JHU/APL Cloud Test Bed
 - Cloud Test Bed potential tool for supporting analysis and model validation
- FOENEX (Laser (10 Gbps)/hybrid CDL (Ku))
 - Fully integrated COP/Cloud amongst all platforms JALN
 - Netted sensors and weapons
- Demonstrating Cloud support of micro-copter (Cloak Blade) ISR (laaS)

○ PED of micro-copter ISR to static IP

RADM Leigher and RDML Herbert

- RADM Leigher said to equip Cloak Blade with image recognition SW and he would "buy a box of them for each LCS"
- RDML Herbert is interested in Cloak Blade demo and revisiting FOENEX for comms robustness
- Led to over 12 other Flag or SES briefs

TW-13 considering all three technologies

How did we get where we are?

- Cloak Blade picked up as a late FY12 year IRAD
 - Effort started in June 2012
 - \$45K granted initially for purchases // testing
 - Additional \$30K added for sensor and Cloud integration
 - Ken Sparks leading Engineering effort
- Micro-copters arrived in late July early Aug
- Unmanned IFF Copter white paper prepared in August 2012 and sent to NWDC / OPNAV N2N6
 - Help determine vessel(hostile) intentions
 - Communicate with approaching vessel



UNCLASSIFIED//FOUO

4PI ⁴

Cloak Blade Controller, Software, Hero HD



UNCLASSIFIED//FOUO

Cloak Blade – Phase I Demo



UNCLASSIFIED//FOUO

D 5

JHU/APL Cloak Blade Cloud laaS



Cloak Blade – Quick Facts

Facts:

- Can lift ~2 KGs, greater capacity in larger versions
- Top speed ~ 30+ MPH; has held GPS position in gusts over 30 kts
- $_{\odot}$ Helicopter can be flown via AES encrypted Wireless,
 - or via GPS waypoints
- Ceiling 3000+ feet
- Full Motion Video (FMV) and Voice for HI
- **o** Inherently stealthy
- Design goals:
 - Add diesel generator or Fuel Cell
 - Add Language Translator (LT on PC, Microphone//Speaker on Cloak Blade)



Stabilized Mount with Optical Cameras



Hero HD camera and Sony 300 digital zoom video cameras



Top View of Cloak Blade



Side View of Cloak Blade





Cloak Blade Controller with Demo GPS Waypoints

Imagesize (1280x605) Position 39.168471 : -76.895635





Cloak Blade Demo GPS Way Pts Details

29 waypoints in Mission Plan

X

12

Waypoir	t-List	Waypo	int									
<u>^ 1</u>	Nr.	Time	Radius	WP-Even	t Climb rate	Altitude	Heading	Speed	CAM-Nick	Prefix	Latitude	Longitude
	1	20	10	100	60	100	P2	60	45	Р	39.1680884	-76.8952545
V 📇	2					5					39.1689161	-76.8932697
л. 🤳	3	2	10	100	30	30	P3	30	AUTO	Р	39.1689161	-76.8930375
~ 🚣	4	2	10	100	30	30	P3	30	AUTO	Р	39.1687888	-76.8931055
Xĥ	5	2	10	100	30	30	P3	30	AUTO	Р	39.1687361	-76.8932697
	6	2	10	100	30	30	P3	30	AUTO	Р	39.1687888	-76.8934338
	7	2	10	100	30	30	P3	30	AUTO	Р	39.1689161	-76.8935018
	8	2	10	100	30	30	P3	30	AUTO	Р	39.1690433	-76.8934338
	9	2	10	100	30	30	P3	30	AUTO	Р	39.1690961	-76.8932697
	10	2	10	100	30	30	P3	30	AUTO	Р	39.1690433	-76.8931055
	11	2	10	100	30	80	P3	30	AUTO	Р	39.1678888	-76.8943265
	12					2					39.1675935	-76.8958553
	13	2	10	100	30	40	P14	60	AUTO	Р	39.1675935	-76.8956232
	14	2	10	100	30	40	P14	30	AUTO	Р	39.1674662	-76.8956912
	15	2	10	100	30	40	P14	30	AUTO	Р	39.1674135	-76.8958552
	16	2	10	100	30	40	P14	30	AUTO	Р	39.1674662	-76.8960195
	17	2	10	100	30	40	P14	30	AUTO	Р	39.1675935	-76.8960874
	18	2	10	100	30	40	P14	30	AUTO	Р	39.1677208	-76.8960195
	19	2	10	100	30	40	P14	30	AUTO	Р	39.1677735	-76.8958552
	20	2	10	100	60	80	P14	30	AUTO	Р	39.1677208	-76.8956912
	21					3					39.1671942	-76.8963381
	22					3					39.1671901	-76.8965366
	23					3					39.167215	-76.8967619
	24	2	10	100	60	30	P21	30	AUTO	Р	39.1673564	-76.8962094
	25	2	10	100	30	30	P22	30	AUTO	Р	39.1673938	-76.8964883
	26	2	10	100	30	30	P23	30	AUTO	Р	39.167423	-76.8966975
	27	2	10	100	60	120	P12	60	AUTO	Р	39.1690283	-76.8962469
	28	2	10	100	60	40	P23	60	AUTO	Р	39.1682423	-76.8962845
	29	2	10	100	30	40	P14	60	AUTO	Р	39.1676434	-76.8963649

FY13 Cloak Blade IRaD and TW13 Goals

- Cloak Blade (CB) Phase II:
 - CB range solution = diesel generator
 - \odot Range: 10 30 miles with 2 to 4 hour mission time
 - Power Consumption: 1,000 watts, battery life ~35 mins
 - Fully integrate sensors and communications to host ship // land platform
 - **O Weatherproof CB platform**
 - Evaluate encryption devices
 - ${\rm \circ}$ Test inertial navigation devices
- Trident Warrior 13
 - Test three CB mission birds (EO/IR/Communications)
 - Fly from ship // Dam Neck
 - $\circ~$ Control using radio
 - $\,\circ\,$ ISRT data transfer via radio or cell



Reach Back to GIG/IC

Full Motion Video, Voice Relay, CB to SAG

CLOAK BLADE

CB with LT Voice Command, Relay to SAG Unit of Interest

UAV: ISR

Surface Action Group (SAG) Intelligence Carry On Package (ICOP)



Notes:

CB Monitors UOI, FMV to SAG

 SAG sends CB to Unit of Interest
 CB sends FMV to SAG/ICOP
 FMV sent from ICOP to IC
 CB opens Language Translator
 CB issues voice commands
 CB relays voice response from Unit of Interest
 SAG takes action IAW ROE

Where are we going next?

- High Altitude ASW / P-8A Unmanned Target Air System (UTAS) ONR FNC proposal
 - Foldable copter design proprietary
 - Canister-"ed" system
 - MAD sensor equipped
 - Swarm technology
- Deploy INS equipped version and test accuracy
- Deploy larger CB version with fuel cell
- Deploy "track and target" Cloak Blade
- Continue refining image recognition software and deploy when possible
- Other Navy input??

UNCLASSIFIED//FOUO

Questions?

APL¹⁶

UNCLASSIFIED//FOUO

CLOAK BLADE: Unmanned ID, Friend or Foe

CLOAK BLADE UIFF

Surface Action Group (SAG)

Reach Back to

GIG/IC

USV: ISR

Full Motion Video

Tether

UUV: ISR

ice Relay, CB

CLOAK BLADE

CB with LT Voice

Command, Relay to SAG

Tactical OV-1

with ICOP

Background Facts:

- Inherently Stealthy Mini-Copter
- Top speed ~ 30+ MPH
- Ceiling 3000+ feet
- Outfitted for Full Motion Video (FMV)
- Can be used as an Communicator and Interrogator with Language Translator in maritime environment (UIFF)
- Communicator has loud speaker and voice pickup/relay to SAG
- CLOAK BLADE hovers in near vicinity of Unit of Interest to perform voice relay

CLOAK BLADE Enhancements:

- Inertial (A2AD) and Dynamic Waypoint Navigation
- Evasive Maneuvers
- Autonomous Flight Control
- Sensor Data Acquisition and Recording
- Microphone and Speaker for LOS UIFF

(7) SAG takes action IAW ROE Example Use Case: <u>Unmanned ID, Friend of Foe (UIFF)</u>

UAV: ISR

Unit of Interest

Notes:

CB Monitors UOI, FMV to SAG

(1) SAG sends CB to Unit of Interest

4) CB opens Language Translator

(2) CB sends FMV to SAG/ICOP

(5) CB issues voice commands (6) CB relays voice response from

(3) FMV sent from ICOP to IC

Unit of Interest

- Copter goes straight up to create instant SA, Perform 360 degree sweep of area, locates unit of interest
- Travel to unit of interest and Issue pre-planned commands, or Interrogate with Language Translator
- Full Motion Video stream from encounter with unit of interest, data ingest to ICOP
- Maritime Threat ID by Unmanned Sensor

Cloak Blade – Top Level Specifications

Initial Draft Specifications:¹

- UAV Configuration: Micro-copter, Octo-rotor
- \circ Range: 10 30 miles with 2 to 4 hour mission time
- **Power Source:** Battery or diesel generator//fuel cell
- Power Consumption: 1,000 watts, battery life ~35 mins
- Frequencies and Modulation: L Band 900 MHz, 1.2 GHz
- Protocol Translation (to and from IP): RF signal is encapsulated as IP packets
- Full Motion Video (FMV), Voice, and Language Translation
- MANET for BLOS use
- Link Budget for signal TBD, current estimate at 20 miles (very conservative estimate, manufacturer – 40 miles)

1 Note: Cloak Blade specifications will be operationally driven, and may vary with Its operational mission. Frequency may vary from 700 MHz to 2.4 GHz.

Cloak Blade – Near Term Design Goals

Near Term Design Goals:

- Add diesel generator for 2 4 hour airborne time
 - More weight on the micro-copter, but creates its own lift, and may further increase dwell time and mission capability
- Add AES Wireless encryption
 Java software AES available
- Add Language Translator, boom microphone and speaker, high gain receive antenna
 - LT software will reside on the Cloak Blade controller PC, Micro-copter will act as voice relay to/from Unit of Interest

D 19

What Could Cloak Blade do for War Fighter?

First Steps

COTS

 $_{\odot}$ Added an HD FMV Camera and Recorder

- Add First Person Video (FPV) (Testing)
 Stream video via RF to local personnel display
 Add own vehicle parameters in heads up format
- Add local personnel display capability
 - Handheld
 - Embedded in glasses









20

Cloak Blade and Situational Awareness

Pop-Up Situation Awareness (PUSA)

• Copter goes straight up to create instant SA

- Different steps in altitude (30m, 50m, 100m, ...)
- See "over the hill," or "over the horizon"
- CLOAK BLADE flight tested PUSA up to 1,500 feet altitude

○ Perform 360 sweep

 Identify and Investigate Areas of Interest (AOI's)
 Travel to Unit of Interest, stream FMV and issue commands/interrogate with Language Translator

o Return and Maintain Stealth



P_21

Enhanced Maneuvers for Cloak Blade

- On Board Processing
 - **o Inertial (A2AD) and Dynamic Waypoint Navigation**
 - > Mid-Course Changes
 - Operation in GPS denied areas
 - o Evasive Maneuvers
 - Small Gunfire Avoidance
 - o "Ziggy" Returns
 - Help prevent visual following of vehicle with binoculars
 - Autonomous Flight Control
 - > Swarming
 - Multiple Image Coord. Extract (MICE)
 - Passive Ranging

• Sensor Data Acquisition and Recording





Additional Enhancements to Cloak Blade

Additional sensors

- **o Local Environment Obstacle Avoidance**
 - > Altitude
 - Proximity (Horizontal & Vertical)
- Enhanced Imaging and targeting
 - High Resolution Optical
 - Independently controlled Gimbaled Camera Mounts
 - IR and target lasing
- Enhanced Communications
 FSOC//FOENEX²
 Cloud Edge Point Access

Improved Accuracy GPS

² Note: Could require larger form factor for Micro-copter





NIST SP 500-292

NIST Cloud Computing Reference Architecture

2. Cloud Computing Reference Architecture: An Overview

2.1 The Conceptual Reference Model

Figure 1 presents an overview of the NIST cloud computing reference architecture, which identifies the major actors, their activities and functions in cloud computing. The diagram depicts a generic high-level architecture and is intended to facilitate the understanding of the requirements, uses, characteristics and standards of cloud computing.





APL

NIST SP 500-292

NIST Cloud Computing Reference Architecture

Actor	Definition
Cloud Consumer	A person or organization that maintains a business relationship with, and uses service from, <i>Cloud Providers</i> .
Cloud Provider	A person, organization, or entity responsible for making a service available to interested parties.
Cloud Auditor	A party that can conduct independent assessment of cloud services, information system operations, performance and security of the cloud implementation.
Cloud Broker	An entity that manages the use, performance and delivery of cloud services, and negotiates relationships between <i>Cloud Providers</i> and <i>Cloud Consumers</i> .
Cloud Carrier	An intermediary that provides connectivity and transport of cloud services from <i>Cloud Providers</i> to <i>Cloud Consumers</i> .

Table 1: Actors in Cloud Computing



Figure 16: Cloud Provider - Cloud Service Management

NIST SP 500-292

NIST Cloud Computing Reference Architecture

Appendix B: Examples of Cloud Services

Some example cloud services available to a cloud consumer are listed below [13]:

- SaaS services:
 - Email and Office Productivity: Applications for email, word processing, spreadsheets, presentations, etc.
 - Billing: Application services to manage customer billing based on usage and subscriptions to products and services.
 - Customer Relationship Management (CRM): CRM applications that range from call center applications to sales force automation.
 - Collaboration: Tools that allow users to collaborate in workgroups, within enterprises, and across enterprises.
 - Content Management: Services for managing the production of and access to content for web-based applications.
 - Document Management: Applications for managing documents, enforcing document production workflows, and providing workspaces for groups or enterprises to find and access documents.
 - Financials: Applications for managing financial processes ranging from expense processing and invoicing to tax management.
 - Human Resources: Software for managing human resources functions within companies.
 - Sales: Applications that are specifically designed for sales functions such as pricing, commission tracking, etc.
 - Social Networks: Social software that establishes and maintains a connection among users that are tied in one or more specific types of interdependency.
 - Enterprise Resource Planning (ERP): Integrated computer-based system used to manage internal and external resources, including tangible assets, financial resources, materials, and human resources.

- PaaS Services:
 - Business Intelligence: Platforms for the creation of applications such as dashboards, reporting systems, and data analysis.
 - Database: Services offering scalable relational database solutions or scalable non-SQL datastores.
 - Development and Testing: Platforms for the development and testing cycles of application development, which expand and contract as needed.
 - Integration: Development platforms for building integration applications in the cloud and within the enterprise.
 - Application Deployment: Platforms suited for general purpose application development. These services provide databases, web application runtime environments, etc.

- IaaS Services:
 - Backup and Recovery: Services for backup and recovery of file systems and raw data stores on servers and desktop systems.
 - Compute: Server resources for running cloud-based systems that can be dynamically provisioned and configured as needed.
 - Content Delivery Networks (CDNs): CDNs store content and files to improve the performance and cost of delivering content for web-based systems.
 - Services Management: Services that manage cloud infrastructure platforms. These tools often
 provide features that cloud providers do not provide or specialize in managing certain
 application technologies.
 - Storage: Massively scalable storage capacity that can be used for applications, backups, archival, and file storage.