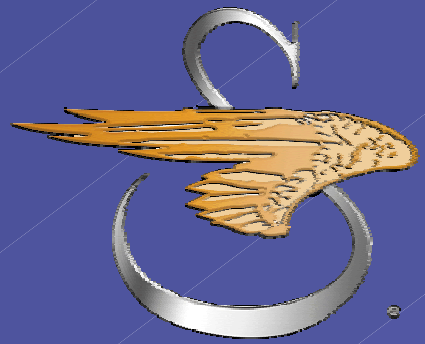

Autonomous VTOL Scalable Logistics Architecture

Feasibility Study

USRA Grant 07600-056

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Outline

- Organization description
- Study description
- Work plan
- Initial concepts
- Relevant Sikorsky experience
- Payoffs
- Future Work
- Opportunities for Collaboration
- Summary

Organization Description

Sikorsky Aircraft is a world leader in the design and development of VTOL aircraft.

Study Description

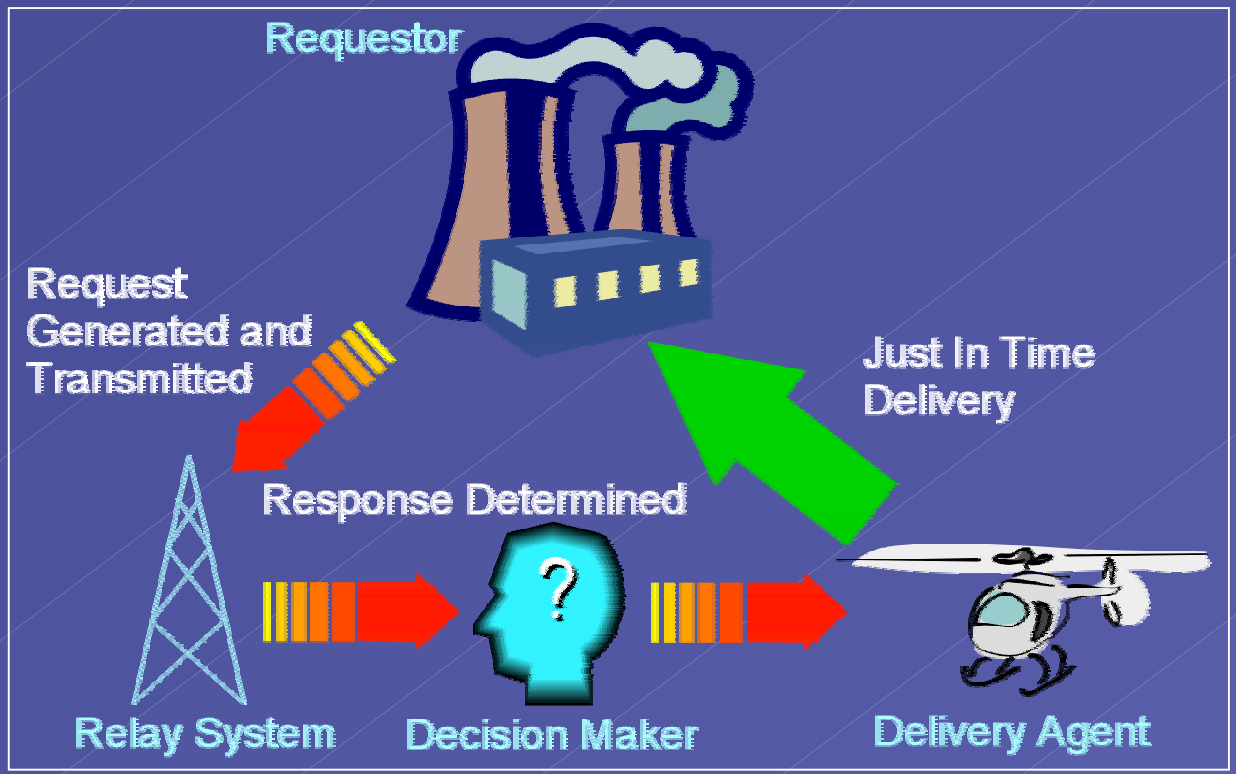
Autonomous VTOL Scalable Logistics Architecture (AVSLA)

- Architecture study
- Air vehicle independent
- Study seeks to answer three questions about an AVSLA:
  - How are decisions made?
  - How are routes determined?
  - How are responses timed?
- Focus on Northeast U.S. corridor and regional military engagement.

Operations Today

Old technology logistics network

Future Operations



The future offers:

- Automated request generation
- More intelligent decision maker
- Improved delivery timing

All logistics networks use the same system components. New architectures require improved components.

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AVSLA Benefits

- Autonomy
  - "request and forget"
  - reduced staffing lowers operating costs
  - allows integration with future automatic ordering
- VTOL
  - flexibility (increases available landing sites)
  - minimizes transport infrastructure investment
- Scalable
  - responsive to changes in demand level and structure
  - future growth is designed into the system

Key Questions

The study seeks to answer 3 key questions:

- How are decisions made?
  - distributed vs. centralized decision making
- How are routes determined?
  - routing efficiency vs. system flexibility
- How are responses timed?
  - scheduled service vs. priority and posture-based scheduling

Decision Making Models

- Dictatorship
  - controlled by a single central unit
- Oligarchy
  - a few power centers make all decisions
- Republic
  - elected representatives decide together
  - geographic or functional constituencies
- Democracy
  - all members have equal participation
  - can be global or organic

Routing Options

- Prescribed
  - destinations and routes are pre-defined
  - minimal flexibility
- Constrained
  - routes are variable, but constrained
  - constraints may be static or dynamic
- Unconstrained
  - “free flight”

Scheduling Options

- Scheduled service
  - reliable customer expectations
  - “public transit” syndrome -- no ability to react to emergencies or high priorities
- Priority-based service
  - pickup and delivery times are based on priority
  - who decides what items are high-priority in a multi-user environment?
- Posture-based service
  - timings are based on current asset posture
- Predictive-adaptive service
  - future response is pre-planned based on past experience

Work Plan

1. Logistics Analysis
   - determine the type, amount, and urgency of cargo being carried in the study area.
   - understand baseline “hub and spoke” system
   - develop architecture evaluation metrics
   - evaluate alternate concepts
2. System Architecture Concept Creation
3. Economic Analysis

Work Plan

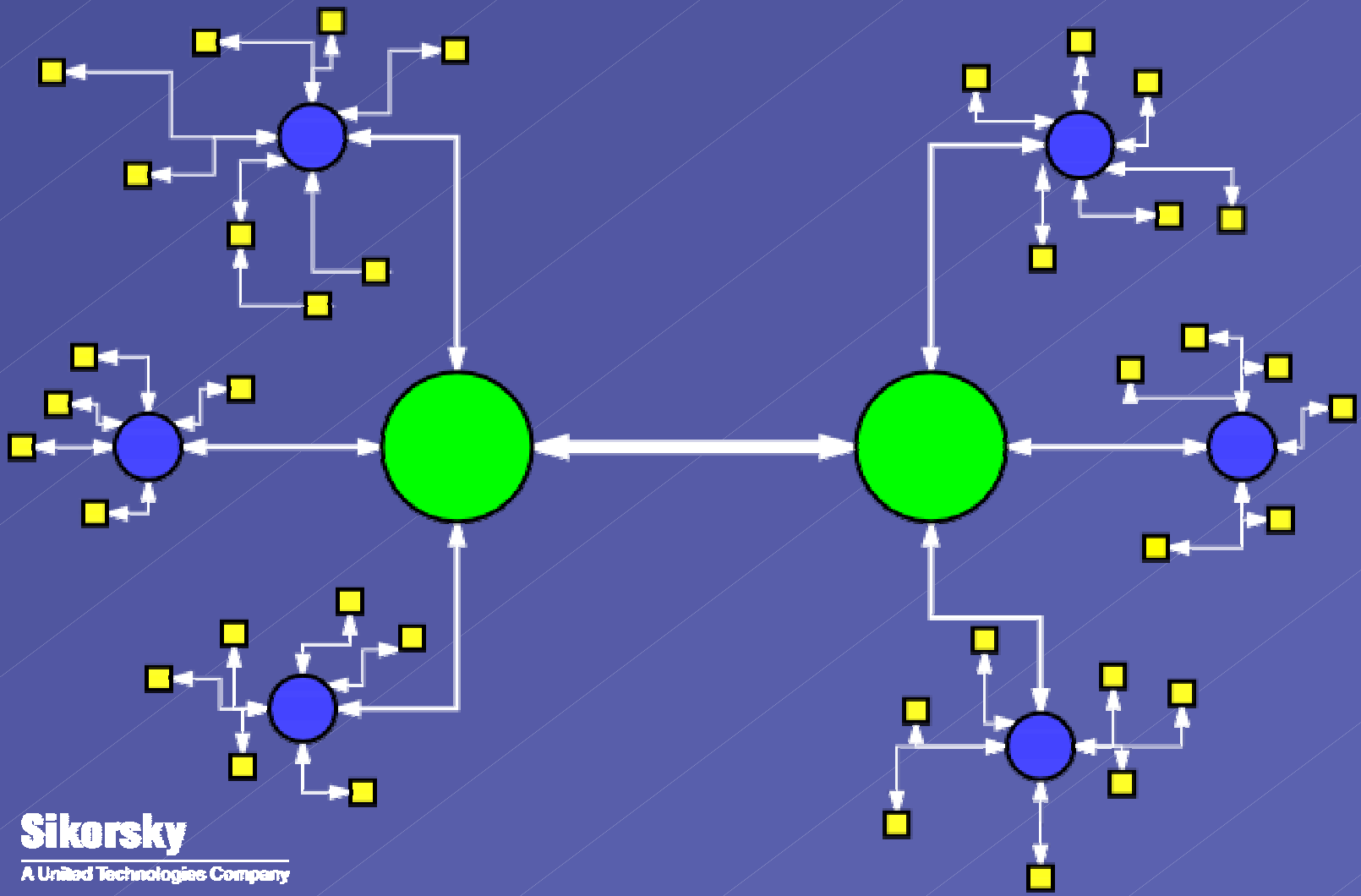
1. Logistics Analysis
2. System Architecture Definition
   - generate an integrated concept based on results of step 1
   - establish vehicle and information technology requirements for each architecture
   - conceptualize air vehicles
   - determine technology requirements and opportunities for risk reduction
3. Economic Analysis

Work Plan

1. Logistics Analysis
2. System Architecture Concept Creation
3. Economic Analysis
   - establish required initial capital investment
   - determine break even requirements
   - examine investment savings
   - study applicability to military supply environment

Initial Concepts

Baseline “Hub and Spoke” Architecture



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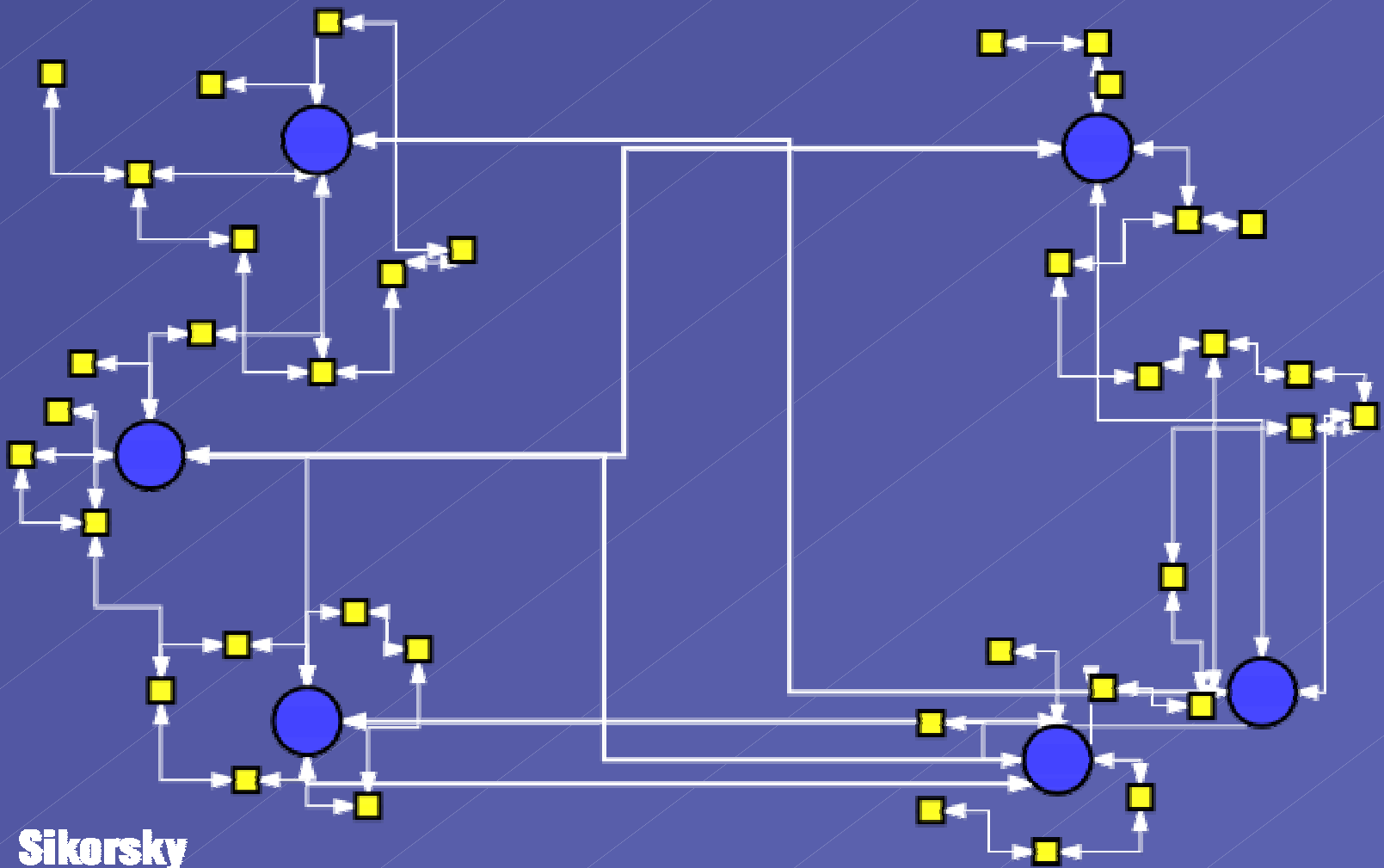
Initial Concepts

“Flattened” Hub and Spoke Architecture



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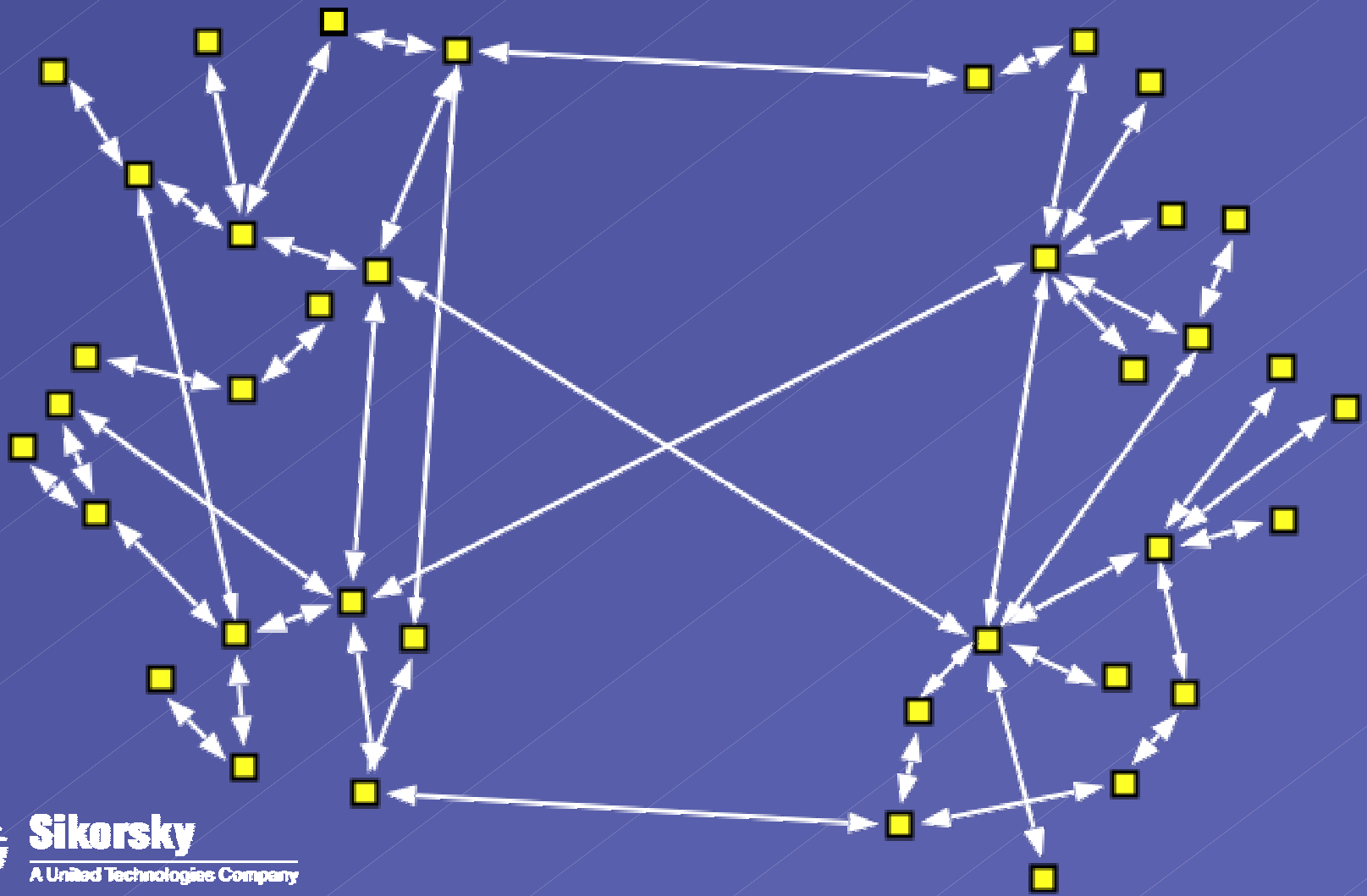
Initial Concepts

Distributed Architecture



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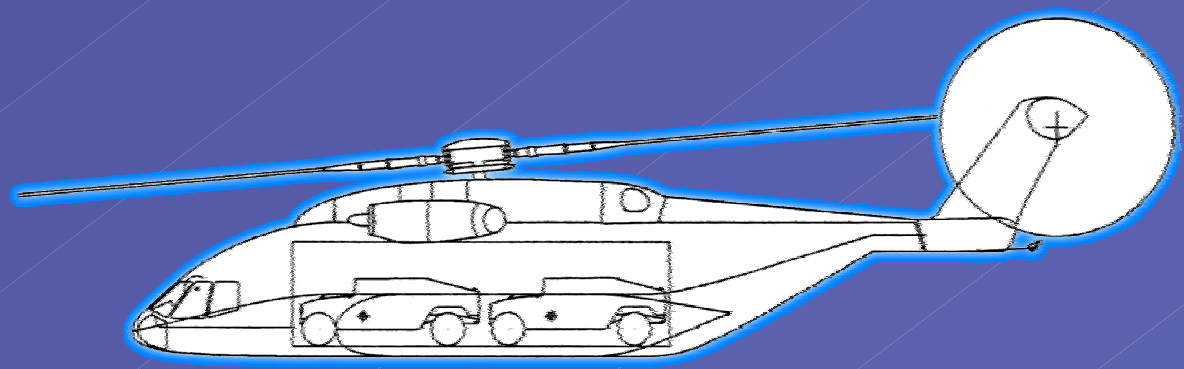
Relevant Sikorsky Experience

ACA Cypher Package Express

The Advanced Cargo Aircraft study, conducted for the U.S. Army in 1990, evaluated the loads that the Army needed to transport and determined the aircraft parameters that would best fulfill Army needs. This study required an understanding of the transport needs and methods employed by the Army.



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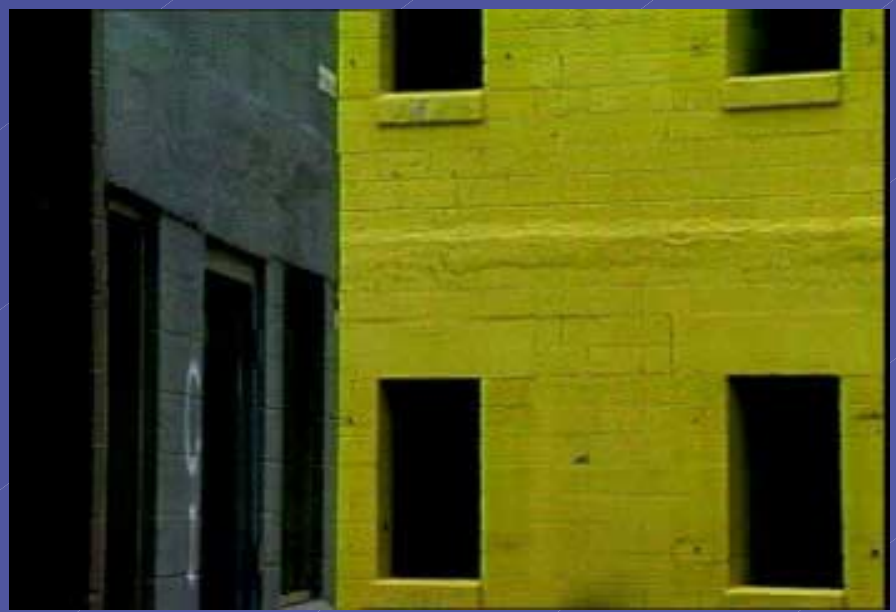
Relevant Sikorsky Experience

ACA Cypher Package Express



The Cypher UAV was developed by Sikorsky. It has successfully demonstrated several autonomous flight modes:

- hover
- takeoff
- landing
- waypoint navigation

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Relevant Sikorsky Experience

ACA Cypher Package Express

The Package Express AHS student design competition was sponsored by Sikorsky and was based on the requirements and desires of Federal Express. The project examined the feasibility of creating a VTOL cargo transport network to improve FedEx operations.

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Payoffs

It is intended that this study will produce

- Logistics needs of customers
- Preferred system architecture that drives
  - Technology requirements for AVSLA
  - Vehicle requirements for AVSLA
  - IT requirements for AVSLA
  - Required autonomous capabilities for AVSLA vehicles

Future Work

Planned Phase II efforts will include:

- Better definition of air vehicle requirements
- Refinement of autonomous operation mode requirements
- Robustness of scalability
  - National scale
  - Local scale
- Applicability to other geographic areas
- Non-terrestrial applications

Opportunities for Collaboration

Phase I

- current transportation infrastructure
- package handling
- architecture input

Phase II

- National Airspace integration (autonomous flight over population centers?)
- vehicle requirements refinement
- national-scale architecture requirements
- extra-terrestrial and non-planetary applications

Opportunities for Collaboration

Beyond NIAC

- control algorithm development
- autonomous cargo handling robotics
- “order-to-delivery” system integration
- vehicle design
- concept demonstration

Opportunities for Collaboration

Potential Partners Include

- Department of Transportation
- Express Package Industry
- Department of Defense
- Federal Aviation Administration
- NASA
- Academia