

# **OFFensive Swarm-Enabled Tactics (OFFSET)**

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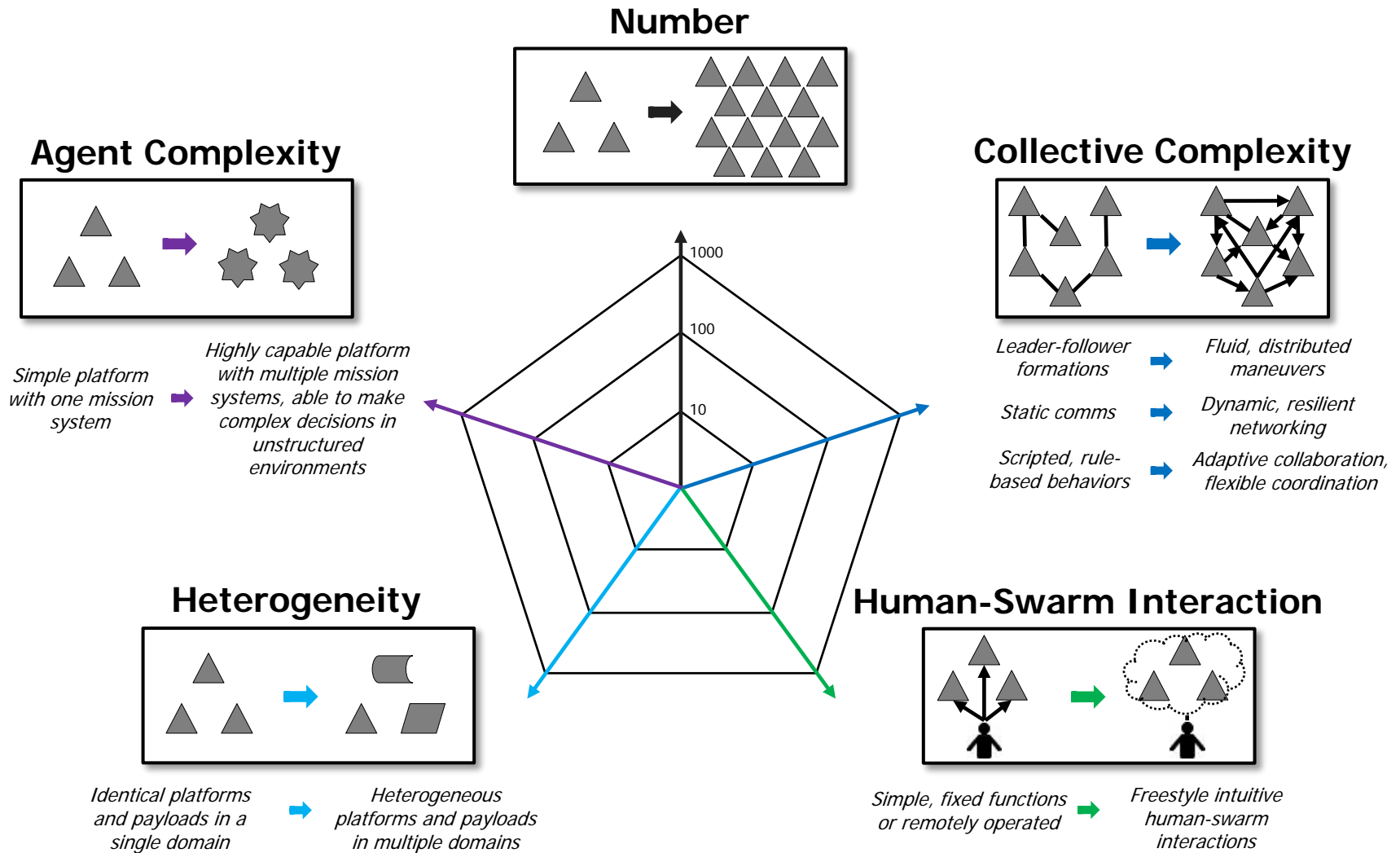
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Tactical Technology Office

Briefing Prepared for OFFSET Proposers Day





# Why are Swarms Hard: Complexity of Swarms





# OFFSET Program Vision, Goal, and Objective

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## *Vision*

OFFSET seeks to inspire the generation of innovative swarm tactics that **disruptively create new opportunities** for future swarm system capabilities to assert and maintain **superiority of the urban operating environment**.

## *Goal*

OFFSET aims to design, develop, and demonstrate a **swarm system architecture** – encoded in a realistic **game-based environment** and embodied in **physical swarm autonomous platforms** – to advance the innovation, interaction, and integration of novel swarm tactics.

## *Objective*

OFFSET seeks to create **highly capable, heterogeneous swarm systems** with **upwards of 250** collaborating autonomous swarm elements, **across multiple spatial and temporal scales** of tactical interest, e.g., conducting urban operations in built-up areas up to **eight city blocks** in size over mission durations of up to **six hours**.



- Embrace **Complexity of Swarms**
- Discover **Disruptive Swarm Capabilities**
- Overcome **Challenges of Urban Operations**



# Challenges of Urban Combat Operations

- Urban environments are complex, dynamic, and unpredictable
  - Channelized
  - Vertical
  - Occluded
- Urban operations doctrine dictates:

**Centralized planning**  
**Decentralized execution**



Source: U.S. Army RDECOM-TARDEC

## Small Unit Needs

Improved force protection  
More fire power  
Improved precision effects  
Expanded ISR

## Potential Swarm Impacts

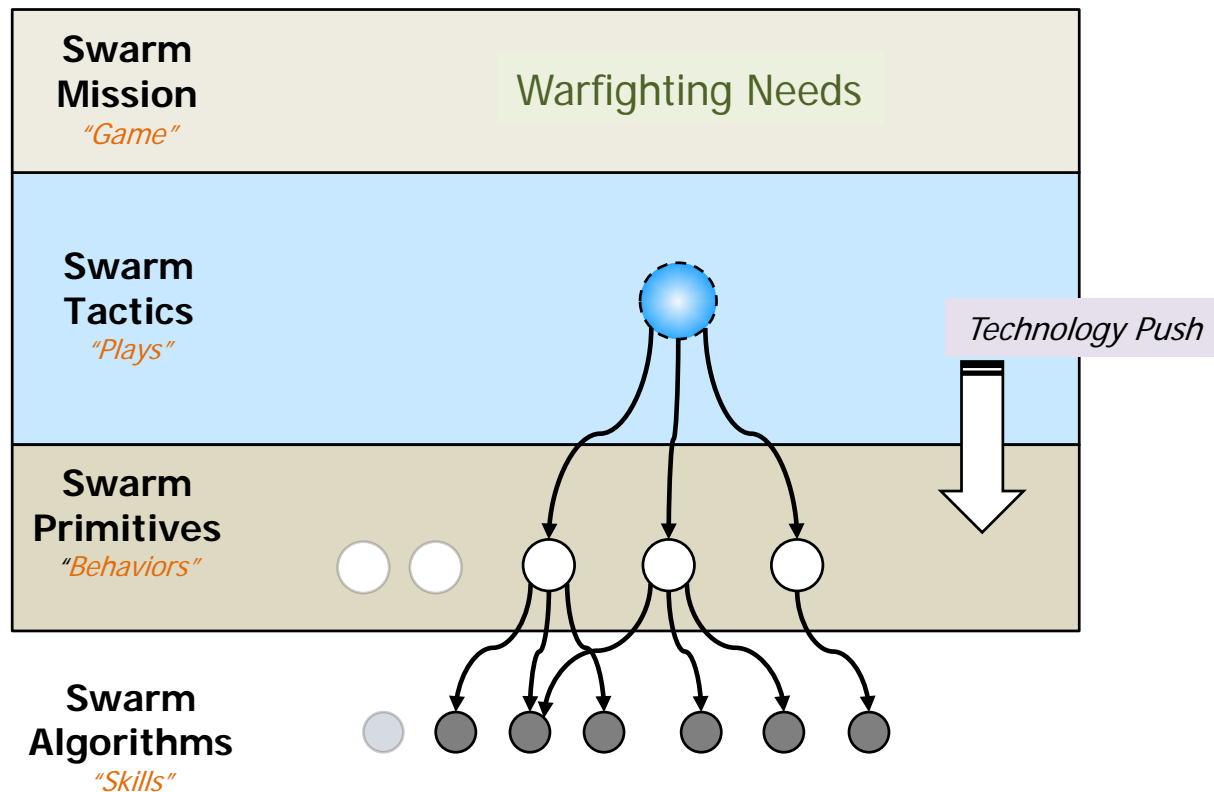
Expanded standoff distance  
More assets and weapons  
Multi-resolution sensing/targeting, BDA  
Distributed, dispersed sensors



# Swarm Tactics Informing Swarm Technologies

Tactics provide an ideal level of abstraction for capturing commander's intent

## OFFSET Focus

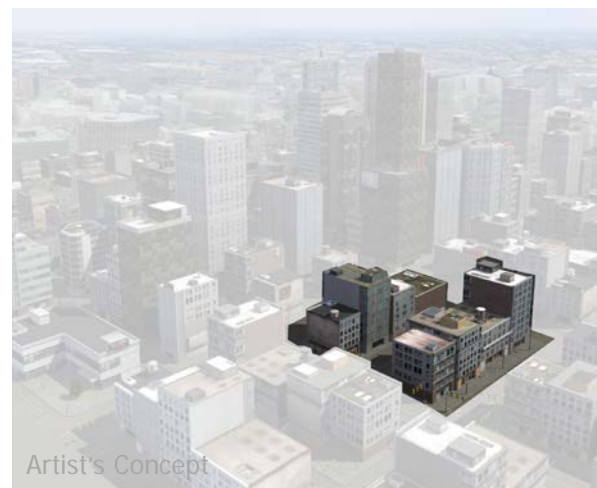
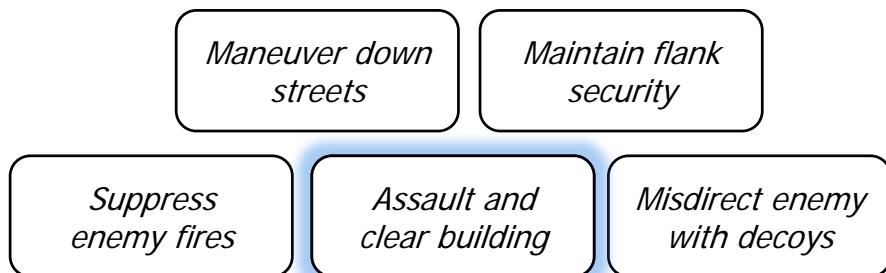




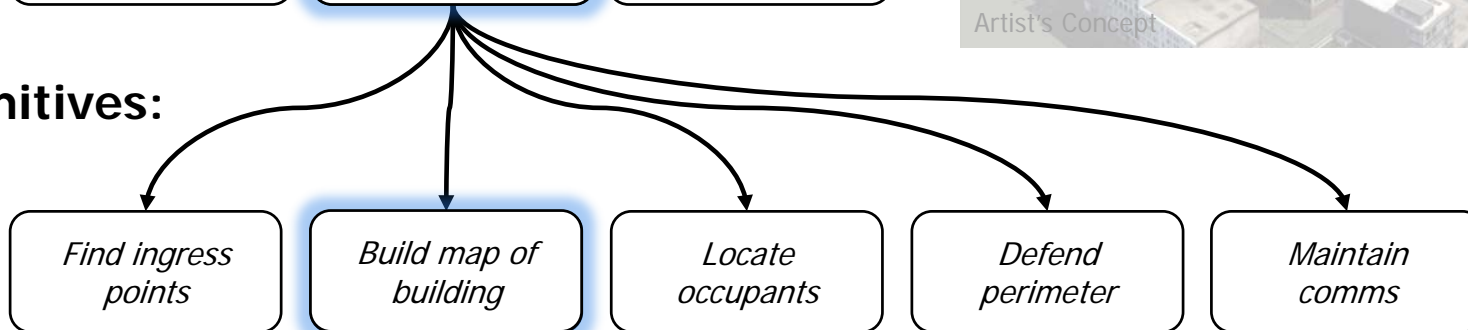
# Representative OFFSET Swarm Operational Thread

**Mission:** Seize a block or group of buildings

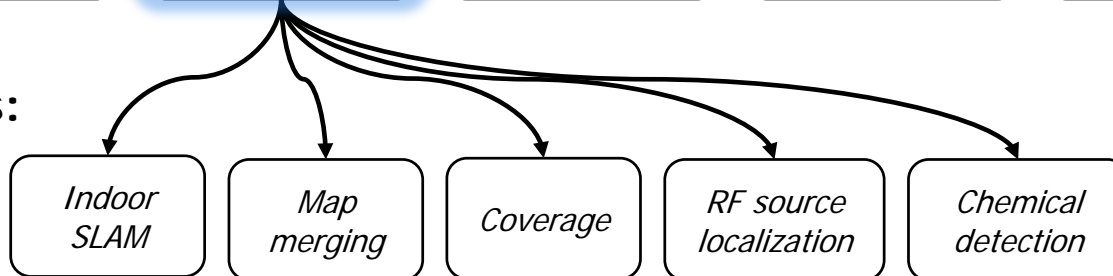
**Tactics:**



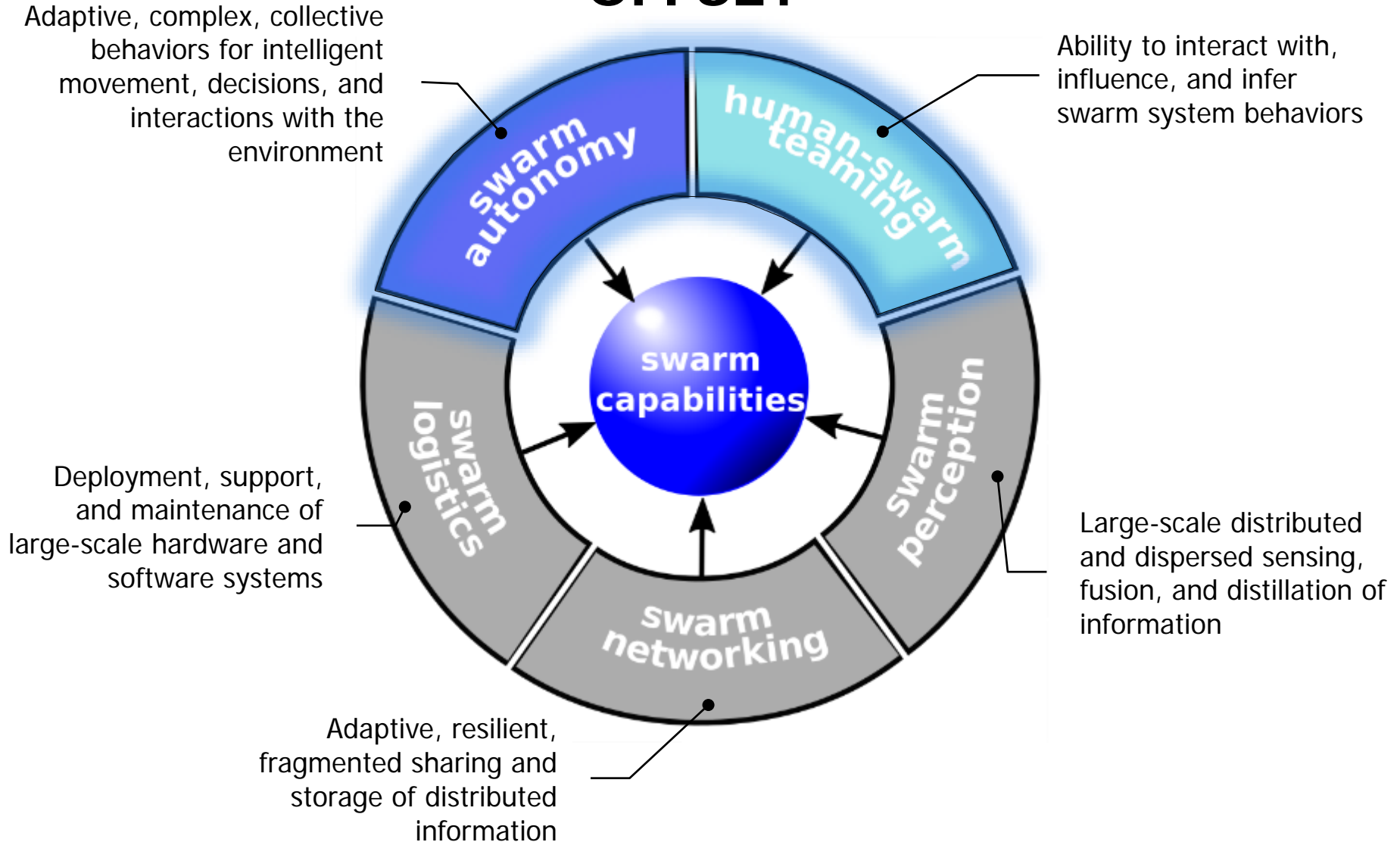
**Primitives:**



**Algorithms:**



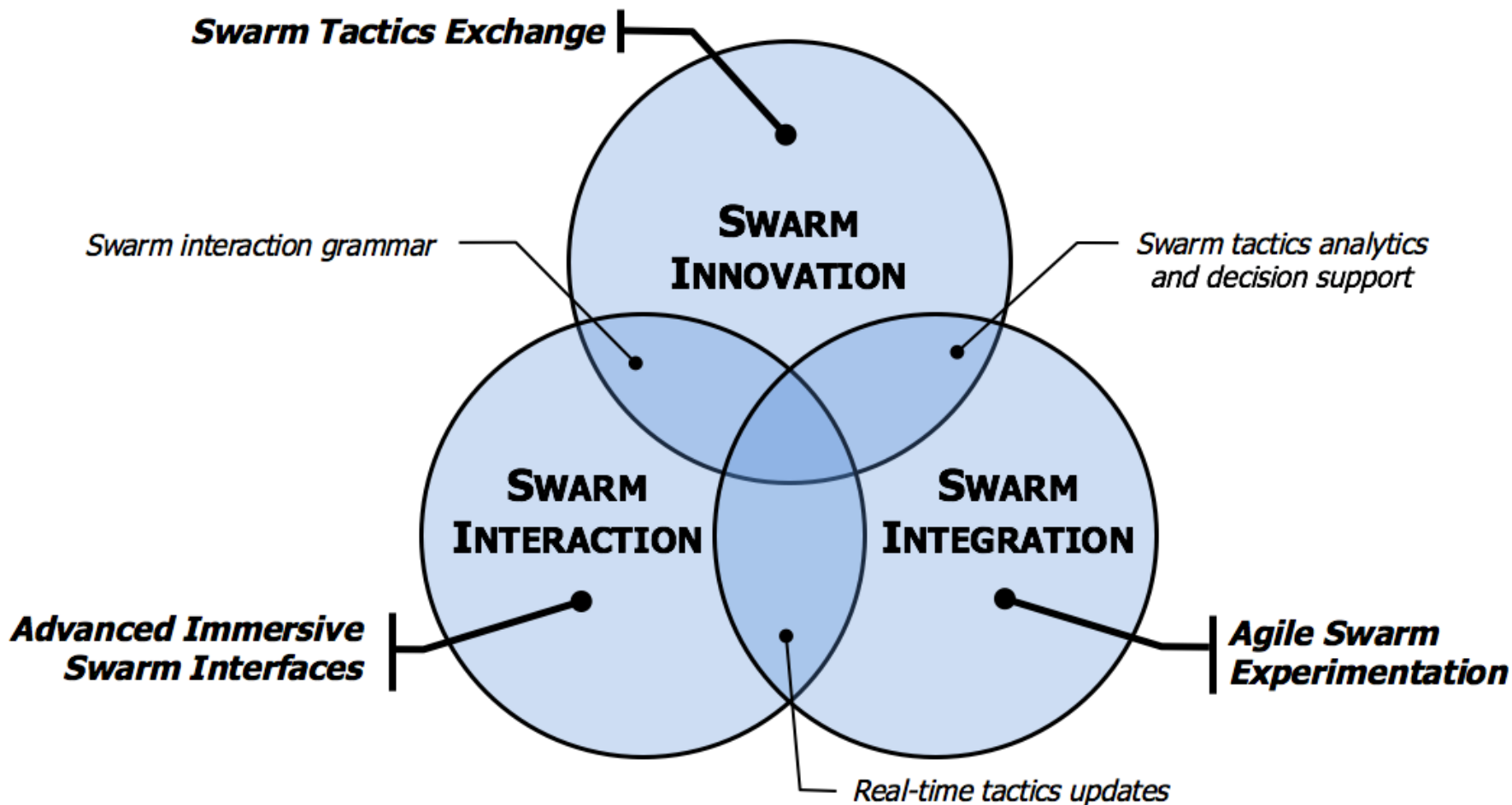
## OFFSET



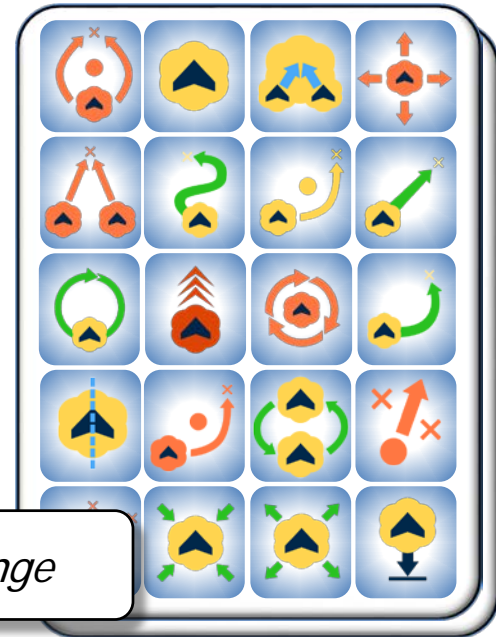




# Core Elements of the OFFSET Swarm System



**Goal:** *Design a tactics-focused game to rapidly explore, evolve, and evaluate swarm tactics*



*Swarm Tactics Exchange*

- Extensible architecture for end user-generated swarm tactics
- Community cultivation and harvesting of most successful swarm tactics
- Rapid integration into physical swarm systems for field test and validation



# Design Advanced Human-Swarm Interfaces

**Goal:** *Create a novel swarm tactics-focused command interface*



Artist's Concept

- Leverage rapidly emerging technologies in immersive technologies
- Enable real-time tactics updates with automated deployment technologies
- Design a swarm interaction grammar for intuitive swarm operations

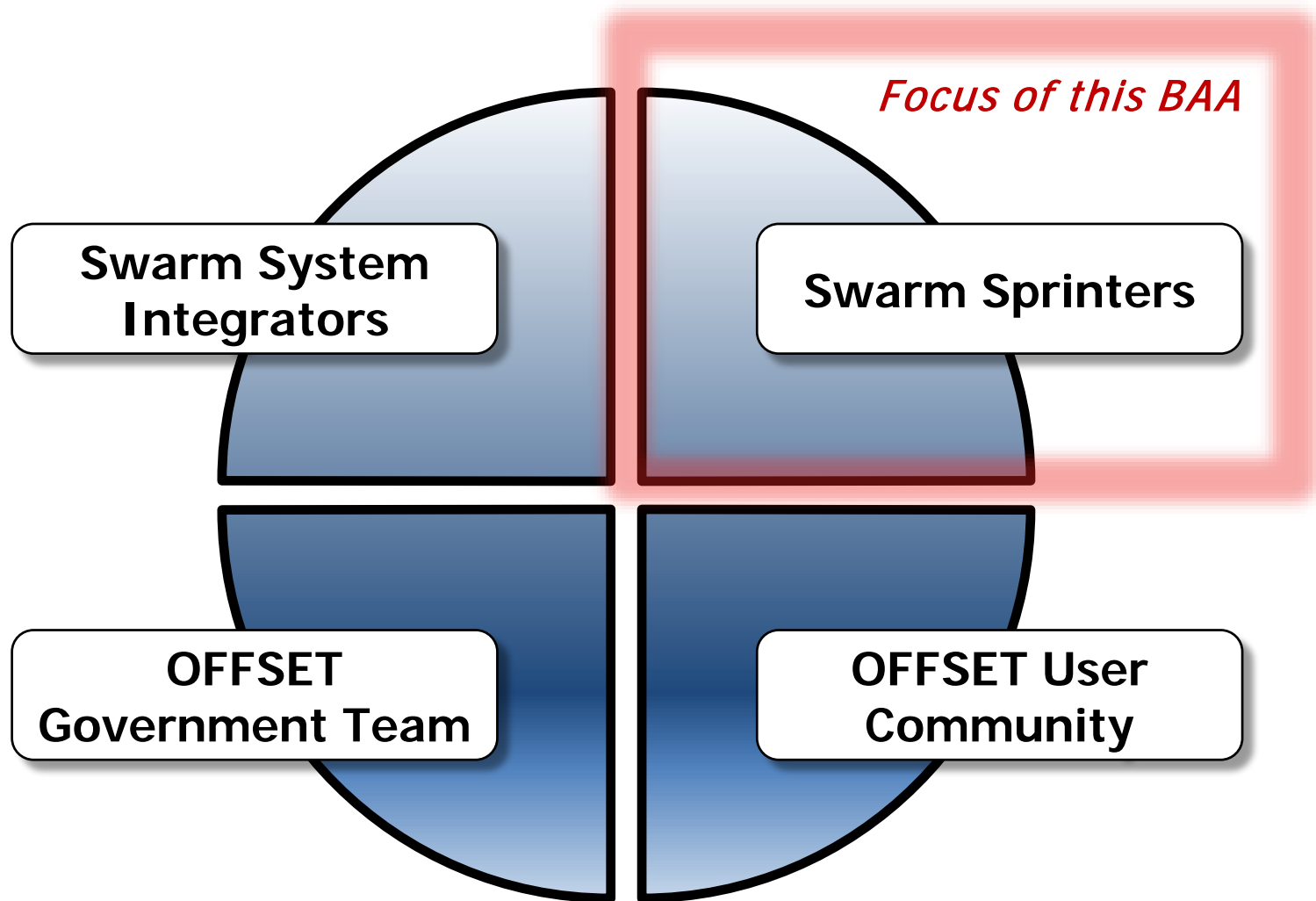


# Demonstrate Advanced Swarm System Capabilities

**Goal:** *Accelerate realization of new swarm tactics and technologies every six months via agile swarm experimentation*

Operational Context	Vignette 1	Vignette 2	Vignette 3
Representative Mission	<i>Isolate an urban objective</i>	<i>Conduct an urban raid</i>	<i>Seize key urban terrain</i>
Mission Duration	15-30 minutes	1-2 hours	4-6 hours
Area of Operations	Approx. two square city blocks	Approx. four square city blocks	Approx. eight square city blocks
Swarm Size	50	100	250

- Imagine novel operating concepts for swarm system employment
- Integrate baseline and modular swarm technologies for field tests
- Address real-world challenges and considerations impacting swarms





# OFFSET Capability-Based Experimentation

- Conduct capability-based experiments **every six months**
  - Red team (warfighter) injects and assessments
- Integrate quarterly prototype deliveries
  - Minimum Viable Products: OFFSET demonstration swarm tactics and technologies
- Focus on offensive tactical missions at company level and below

*Notional range: USMC Twenty-Nine Palms Combined Arms MOUT*



Notional surrogate platform characteristics:

- Expendable
- Affordable
- Robot Operating System-compatible



*Notional OFFSET robotic platforms, approximately to scale*



**OFFSET =**

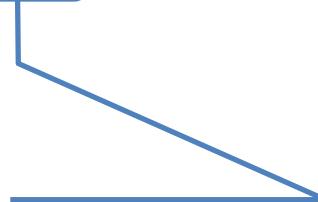
**Virtual  
World**

+

**Physical  
Testbed**

+

**Community**



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## Agent Architecture

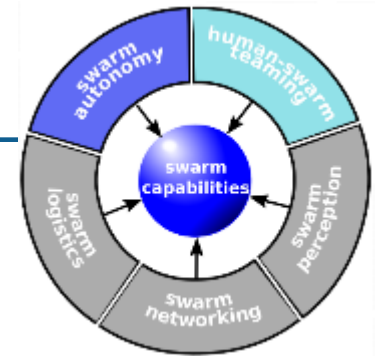
- Open middleware (e.g., Robot Operating System)
- Offer modular autonomy
- Streamline hardware, software deployment

## Swarm Architecture

- Open messaging definitions
- Use realistic/demonstrated networking solutions
- Support flexible operating concepts



# Desired OFFSET Goals and Metrics



## Swarm Autonomy: *Generate and assess 100+ swarm tactics*

Design operationally relevant swarm tactics in game-based environment	Number created per calendar quarter	> 10 tactics
Perform swarm tactics assessment in game-based swarm mission	Time to assess new tactic	< 15 minutes
Integrate swarm tactics architecture on physical swarm platforms	Integration time per 100 platforms	< 24 hours

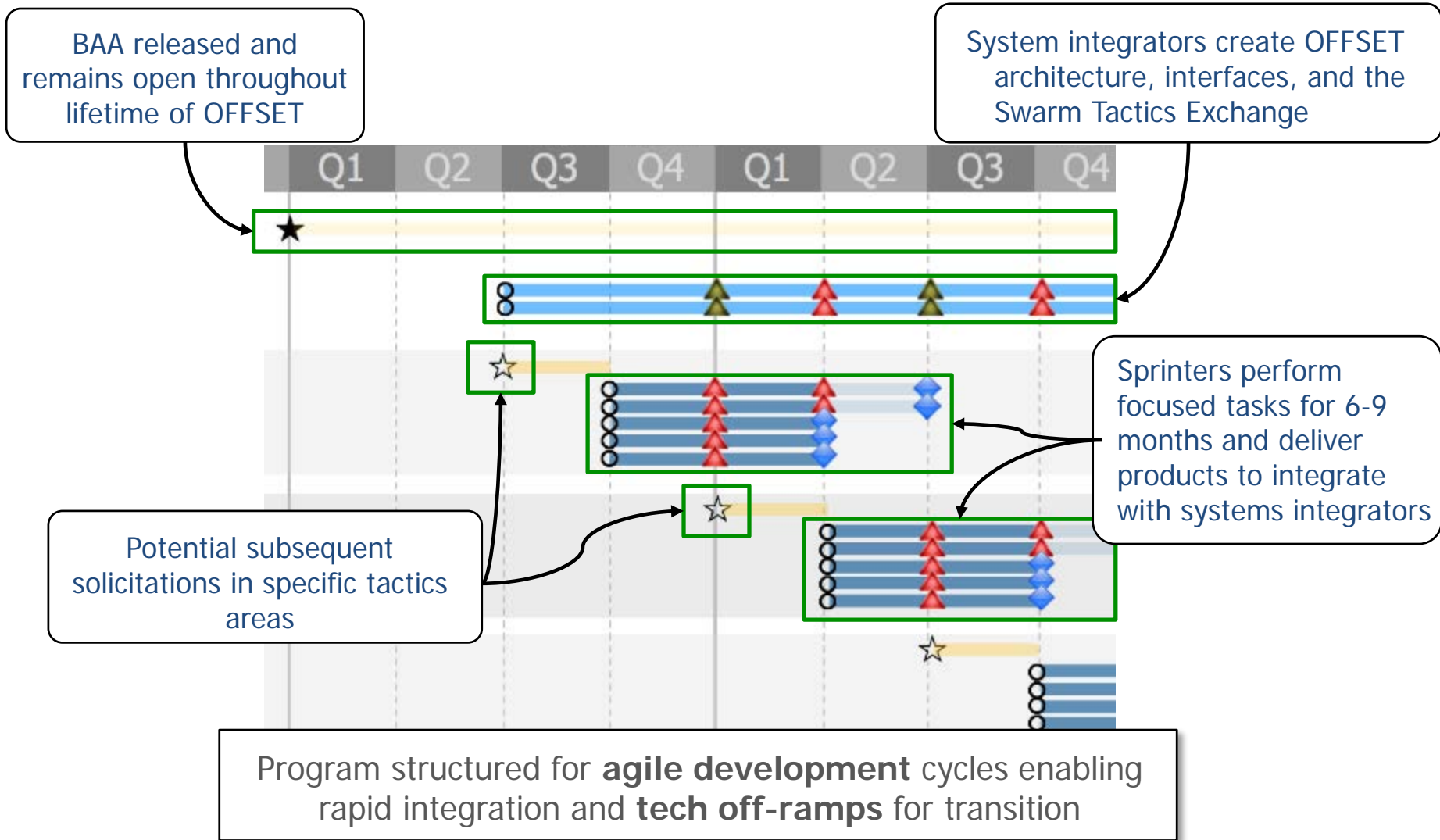
## Human-Swarm Teaming: *Demonstrate dynamic, real-time interactions with swarm sizes > 100*

Perform secure, over-the-air tactics updates to deployed swarms	Time to deploy new tactic	< 1 minute
Construct viable swarm tactics-based courses-of-action (COAs) in 1 minute	Number of alternate COAs	> 3 COAs
Enable scalable swarm operations that adapt with addition or attrition	Percentage deviation in swarm size	+/- 50%





# OFFSET Notional Program Structure





## **DARPA OFFSET is interested in:**

- Strong, multi-faceted teams across all OFFSET functional areas
- “Test early, test often” philosophy, especially for field experiments
- Open technology development\* best practices

*\*Ref: DoD Chief Information Officer (CIO), “Open Technology Development (OTD): Lessons Learned and Best Practices for Military Software”, Washington, D.C., 2011*



[www.darpa.mil](http://www.darpa.mil)