

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

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Tactical Technology Office

Briefing Prepared for OFFSET Proposers Day

January 30, 2017





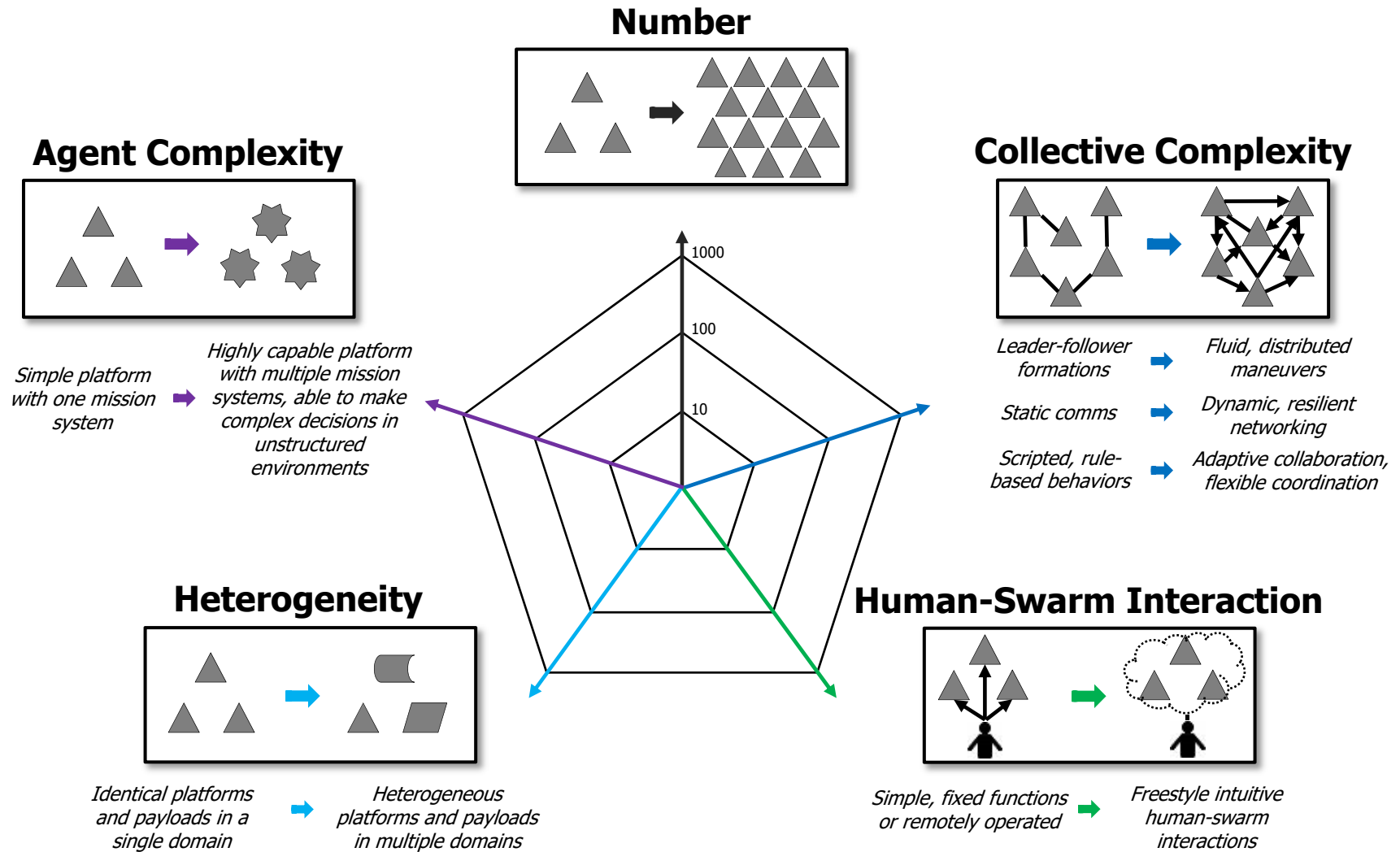
### **OFFSET Proposers Day Agenda**

- Welcome Remarks
- Administrative Topics
  - Contracting with DARPA
  - Security
- Introduction to DARPA and the Tactical Technology Office
- OFFSET Program Description
- Invited Speakers
- Questions and Answers

Questions?  
Ask [OFFSET@darpa.mil](mailto:OFFSET@darpa.mil)



# 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*

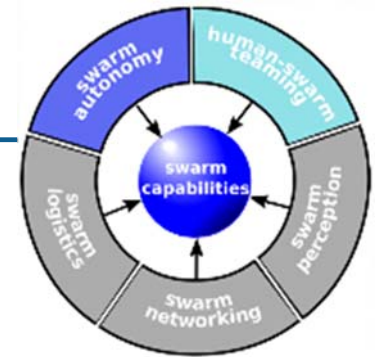
OFFSET aims to design, develop, and demonstrate a **swarm system architecture** – encoded in a realistic **game-based environment** and embodied in **physical swarm autonomous platforms** – to advance the innovation, interaction, and integration of novel swarm tactics.

## *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.**



# Desired OFFSET Goals and Metrics



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

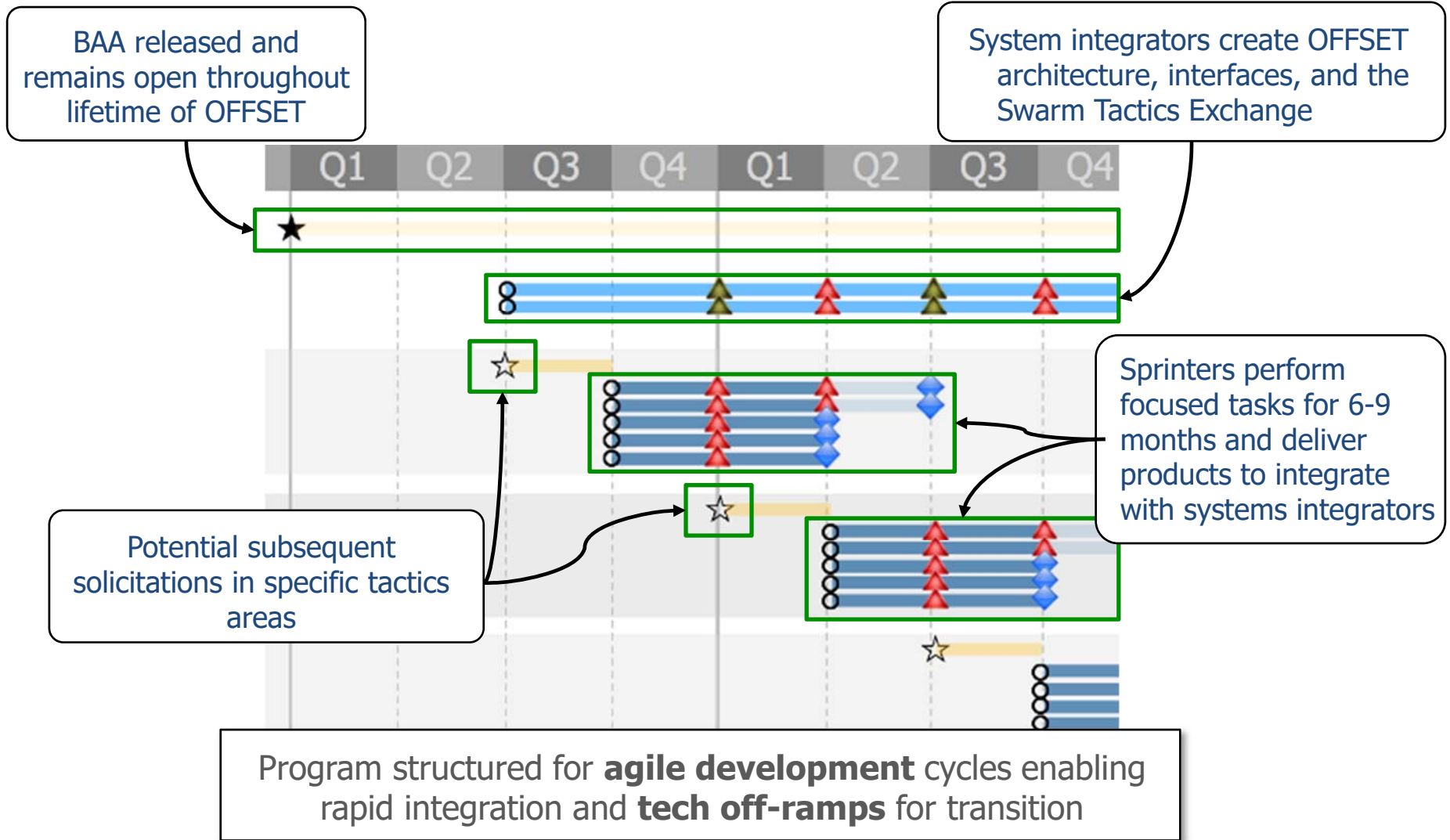
Design operationally relevant swarm tactics in game-based environment	Number created per calendar quarter	> 10 tactics
Perform swarm tactics assessment in game-based swarm mission	Time to assess new tactic	< 15 minutes
Integrate swarm tactics architecture on physical swarm platforms	Integration time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





## OFFSET Motivations

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- 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

*UAS – unmanned aerial system*

*ISR – intelligence, surveillance, reconnaissance*

*BDA – battle damage assessment*

Distribution A – Approved for Public Release, Distribution Unlimited

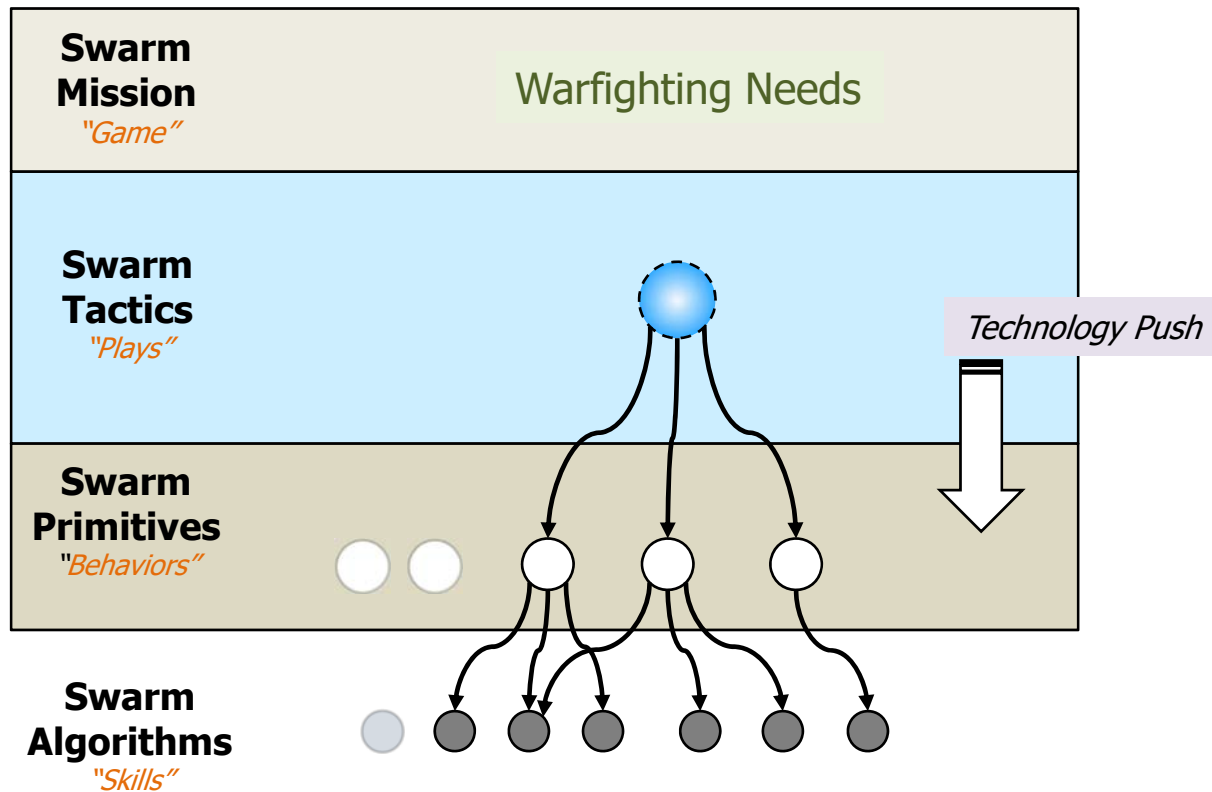




# Swarm Tactics Informing Swarm Technologies

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

## *OFFSET Focus*

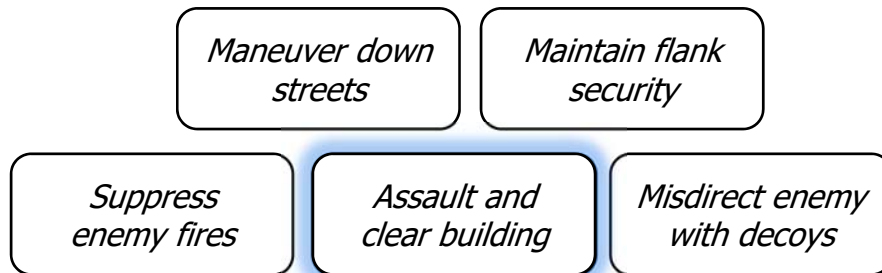




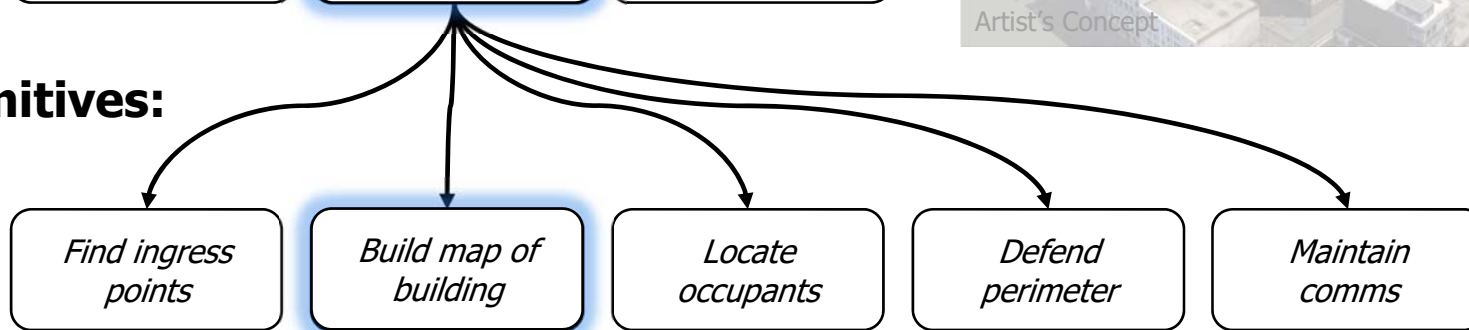
# Representative OFFSET Swarm Operational Thread

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

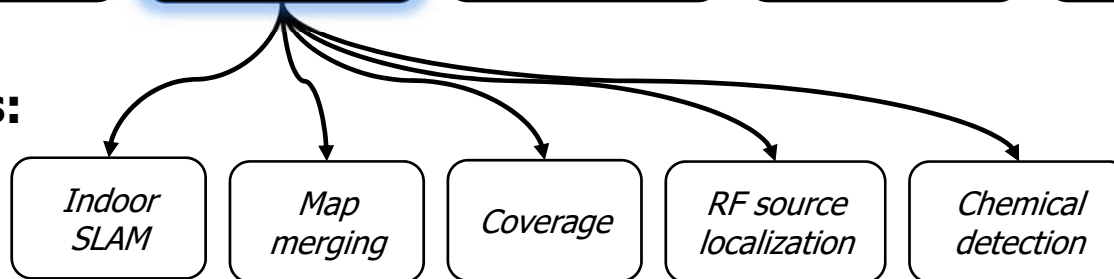
**Tactics:**



**Primitives:**



**Algorithms:**

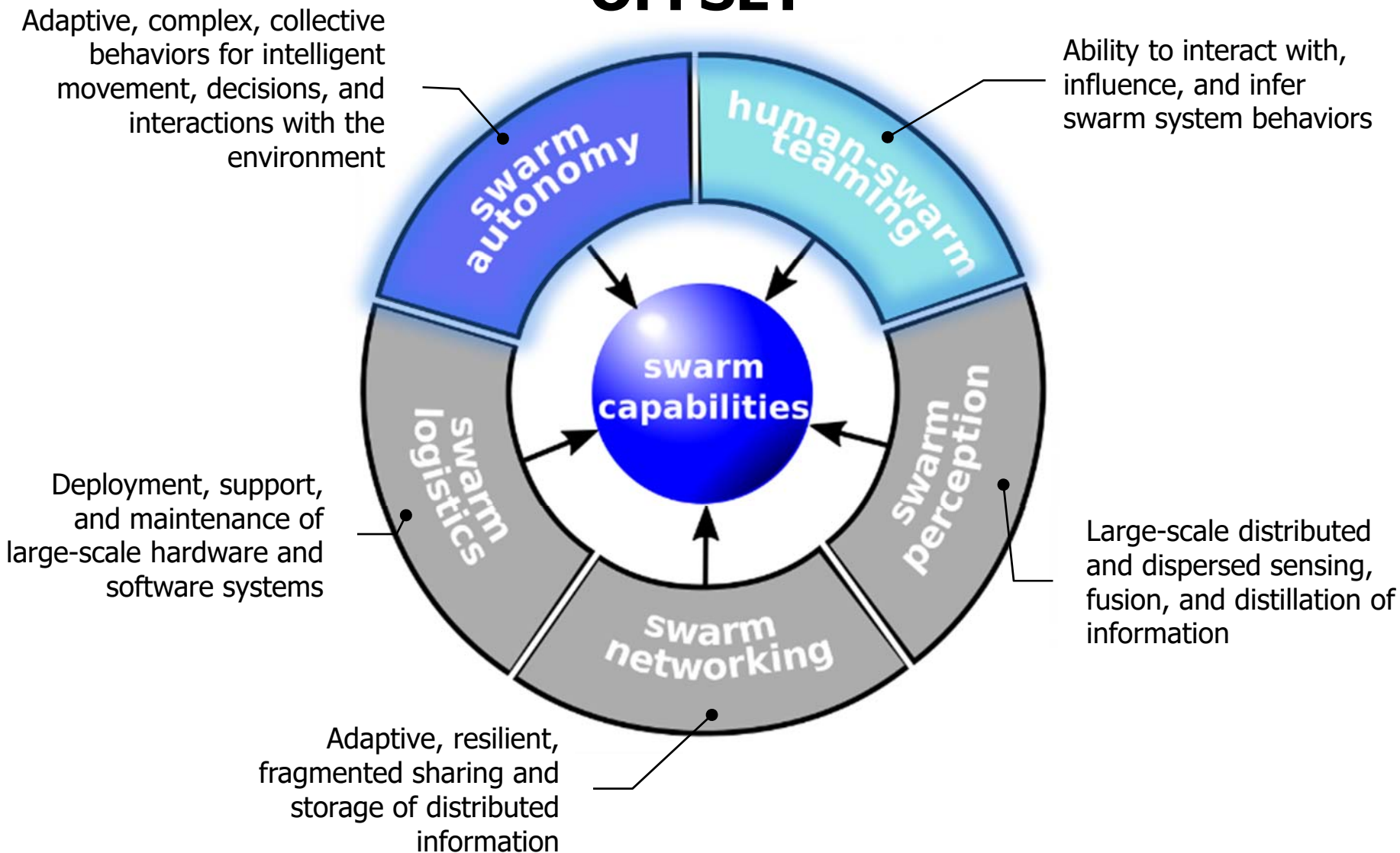


SLAM – simultaneous localization and mapping  
RF – radio frequency



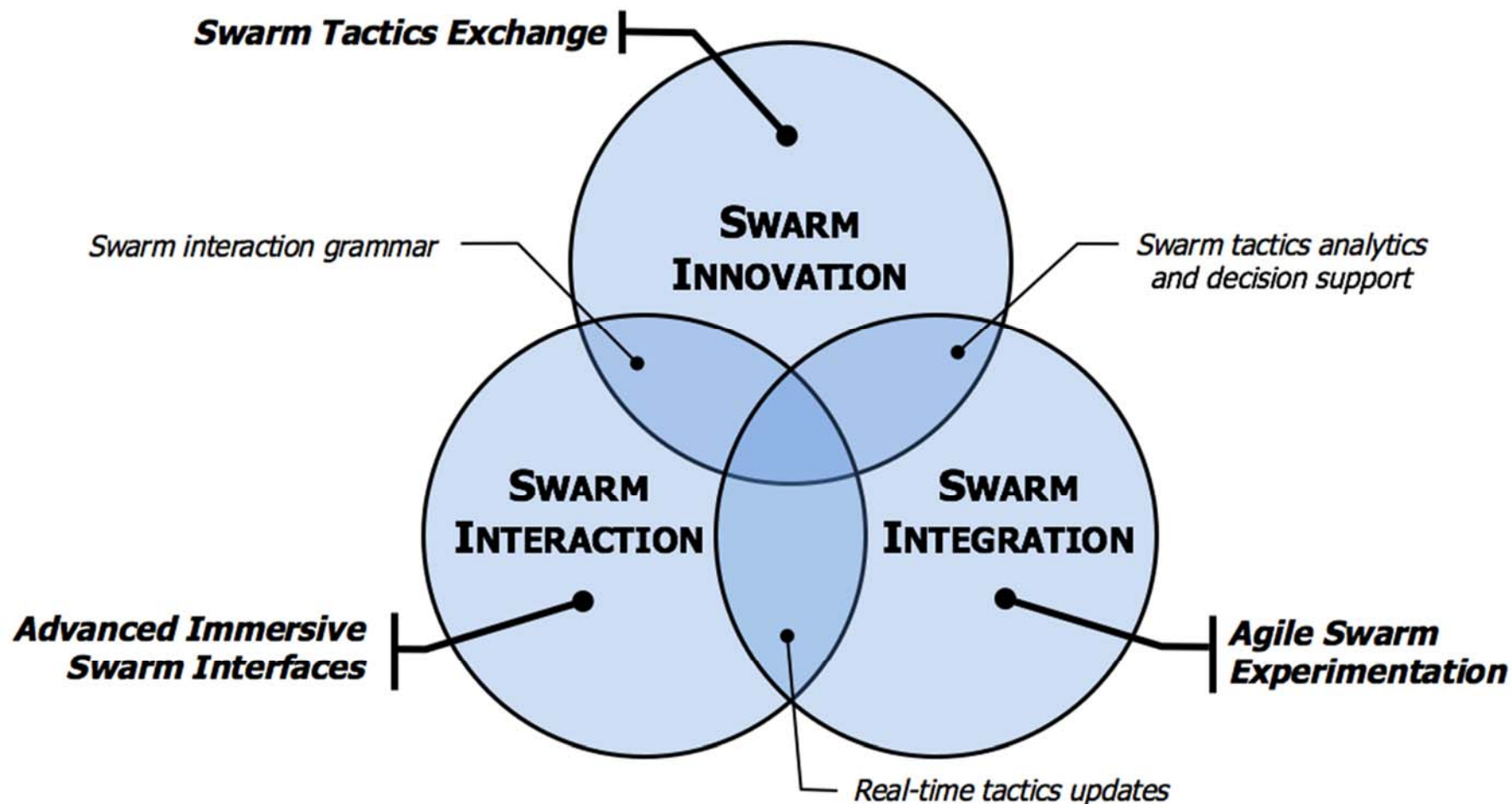
# Towards Autonomous Swarm Capabilities

## OFFSET





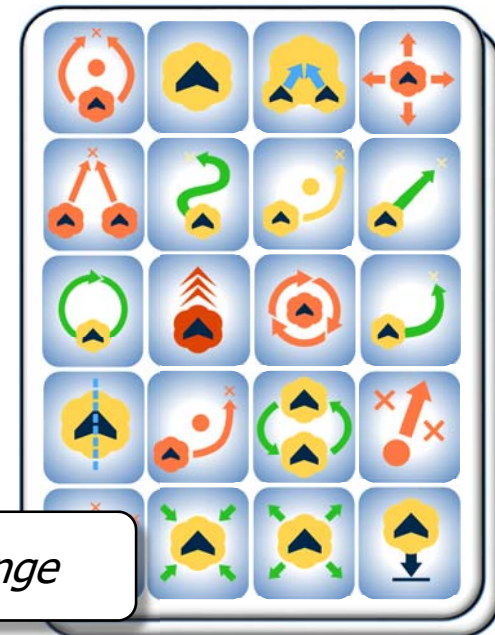
# Core Elements of the OFFSET Swarm System





## Discover and Develop Novel Swarm Tactics

**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*



- 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

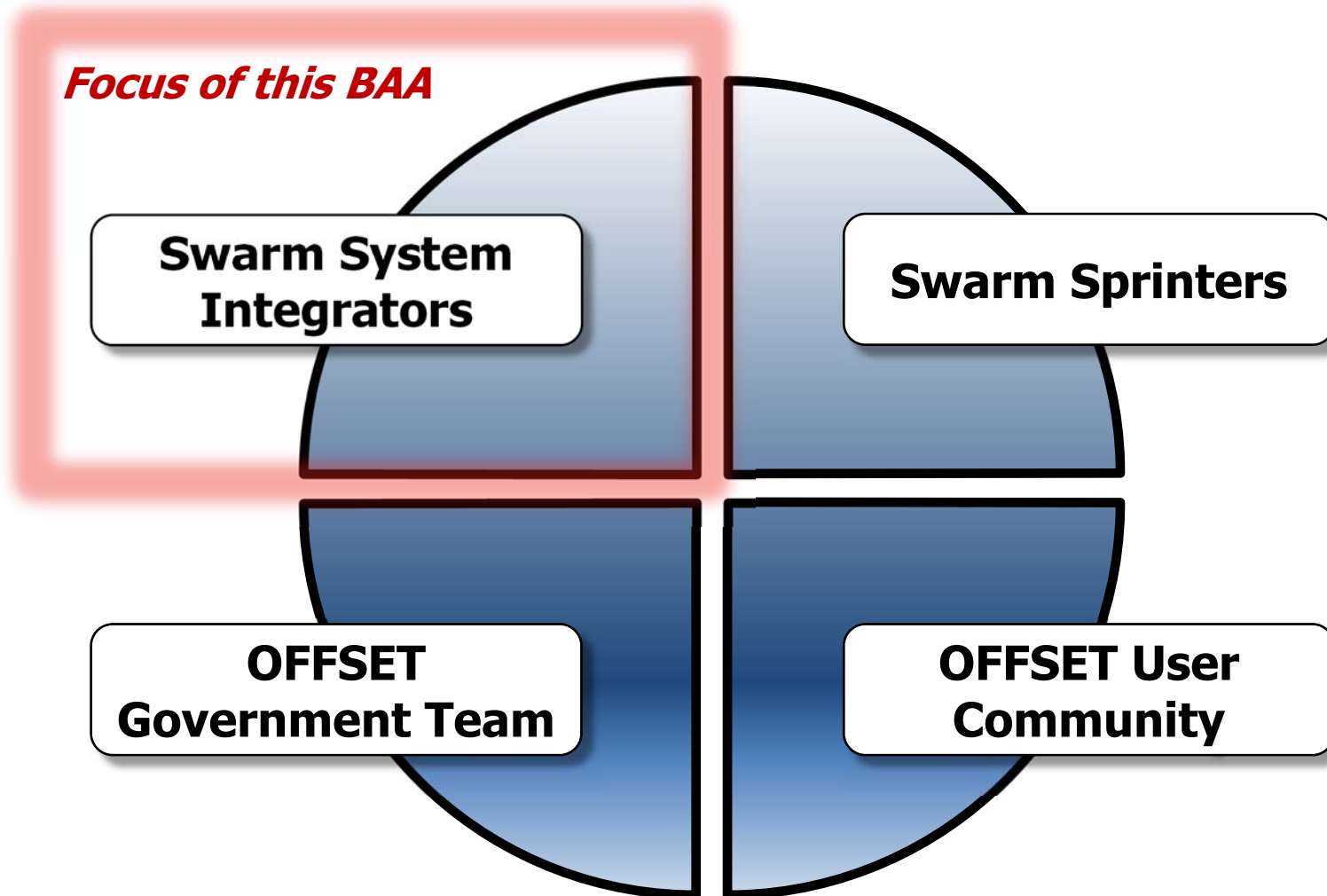
**Goal:** *Accelerate realization of new swarm tactics and technologies every six months via agile swarm experimentation*

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







# 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*

*MOUT – military operations in urban terrain  
ROS – robot operating system*



# OFFSET Swarm System Architecture

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**OFFSET =**

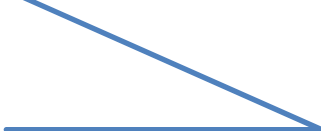
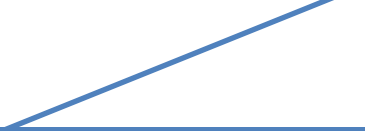
**Virtual  
World**

**+**

**Physical  
Testbed**

**+**

**Community**



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**Agent Architecture**

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

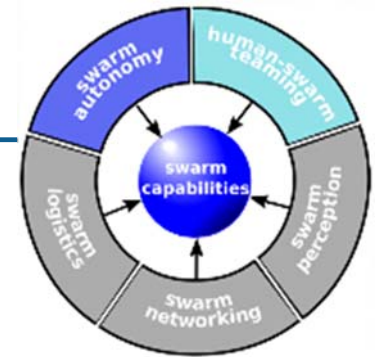
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**Swarm Architecture**

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



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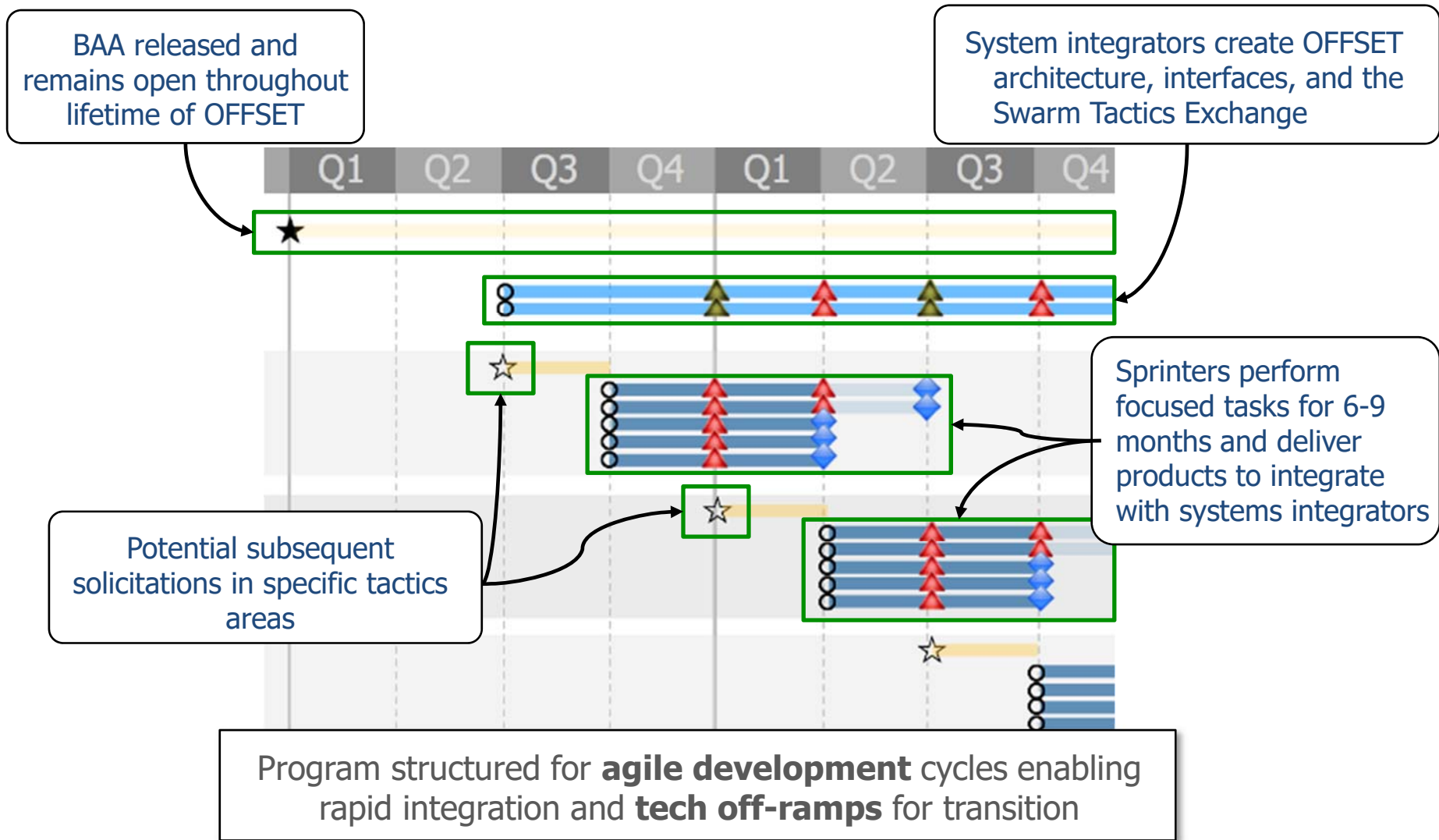
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## Additional OFFSET Things-to-Consider

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

- Strong, multi-faceted teams across all OFFSET functional areas
- Robust integration plans for OFFSET community engagement
- “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*



## OFFSET Parting Shots

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- Q&As during Proposers Day
  - Write and submit your questions on provided index cards or [OFFSET@darpa.mil](mailto:OFFSET@darpa.mil)
- OFFSET Proposers Day program slides available on OFFSET website
- OFFSET Teaming Website to sharing expertise areas
- Frequently Asked Questions
  - Posted to FedBizOpps



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