Border Security
Midterm Presentation

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Professor Baras
Professor Austin

Ground Team
Jessica Jones
Matthew Marsh
Aaron Olszewski
Senay Tekle
Phil Tucci

Air Team
Antonio Busalacchi
Dan Flesher
Oluseyi Oni
Aaron Sassoon

Outline

- Problem Statement
- Use Cases, Textual Scenarios, Activity and Sequence Diagrams
- Preliminary Requirements
- Models of System Behavior and Structure
- Challenges Ahead
- Summary
- Questions

Problem Statement

- US-Mexico border is a current hot political topic
- Border is not entirely secure
  - Leaves door open to potential terrorist attacks
  - Estimated 500,000 illegal entries each year
- Boeing tried to take on problem in 2006
  - Last January, DHS canceled funding for project for being over budget and not meeting requirements

Description of Border

- Wide variety of terrain
  - Deserts (e.g. Chihuahuan and Sonoran)
  - Rivers (e.g. Colorado and Rio Grande)
  - Cities (e.g. San Diego, CA to Brownsville, TX)
  - Mountains (e.g. Sierra Madres)
- Spans 1969 miles
- Temperature Range: 32° F to 113° F

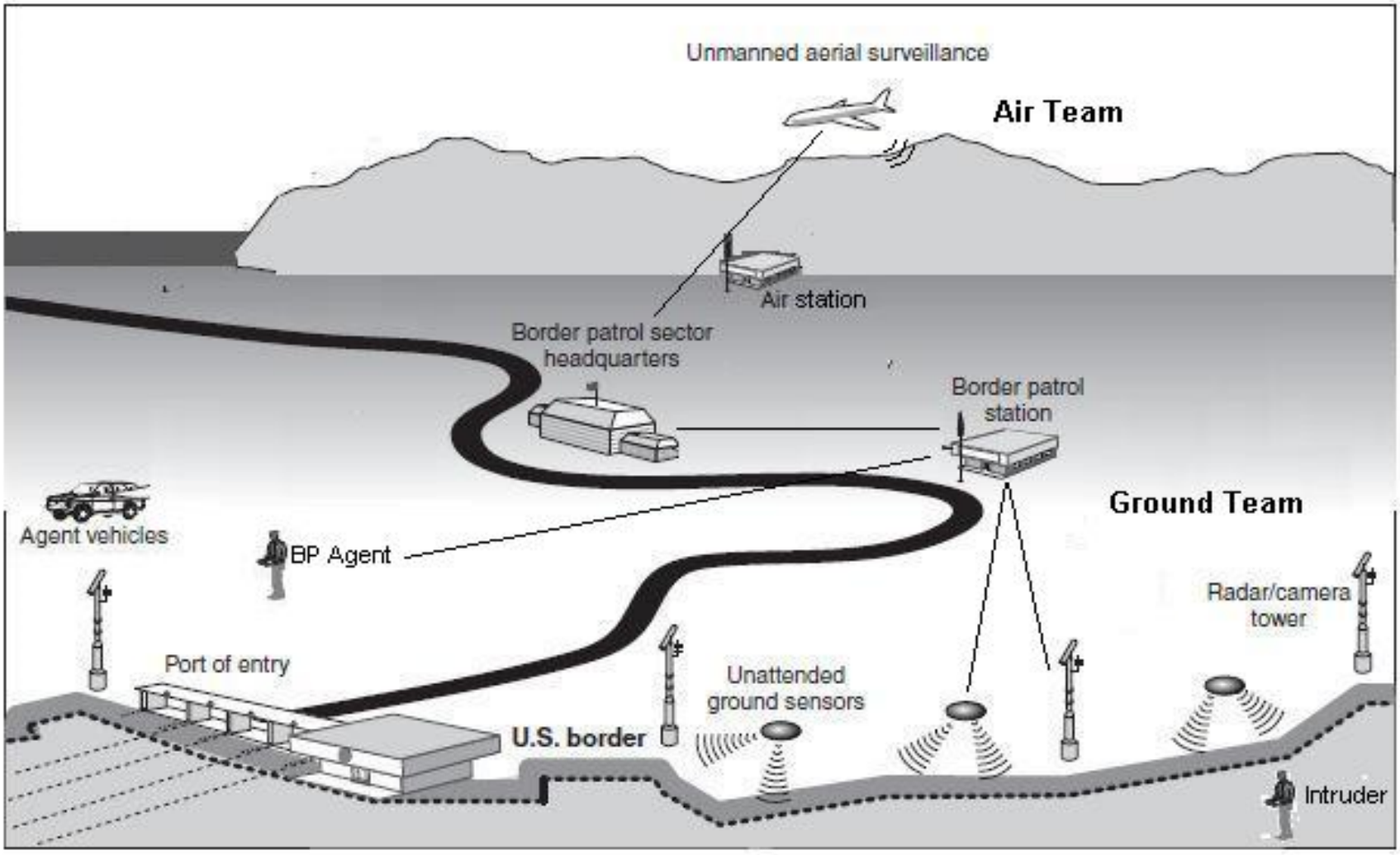
Boeing's SBInet

- Was going to cover both borders (Canada and Mexico)
- Would employ
  - Tower system (sensors and/or border agents) (1800 towers)
  - Command centers
  - Border Patrol Agents with GPS devices
  - UAVs
- Cost $67 million to build 28 mile pilot section in Arizona
- Estimates for completion of entire SBInet (6000 miles) range from $2 billion to $8 billion
- "SBInet cannot meet its original objective of providing a single, integrated border security technology solution" – J. Napolitano, Secretary of Homeland Security, January 14, 2011

Objective & Approach

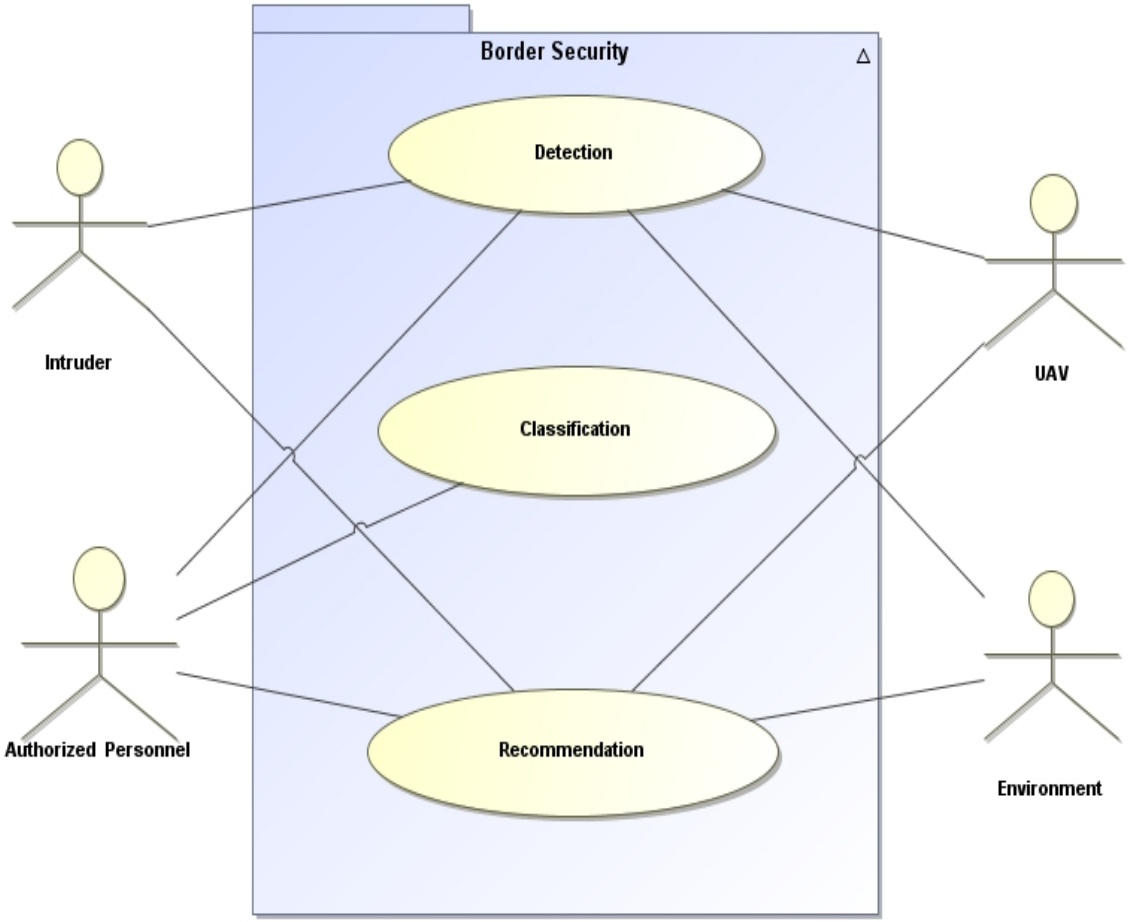
- Use existing infrastructure
- Increase cost efficiency over Boeing's SBInet
- Focus on detection of illegal entry attempts across US-Mexico border
- Not concerned with interception/detention of intruders
- Two teams (Air and Ground)

Example of System



Ground Team

Use Case Diagram



Textual Scenarios

Sector Ground Base Analysis Case:

Description: Analyzed data from possible intruder

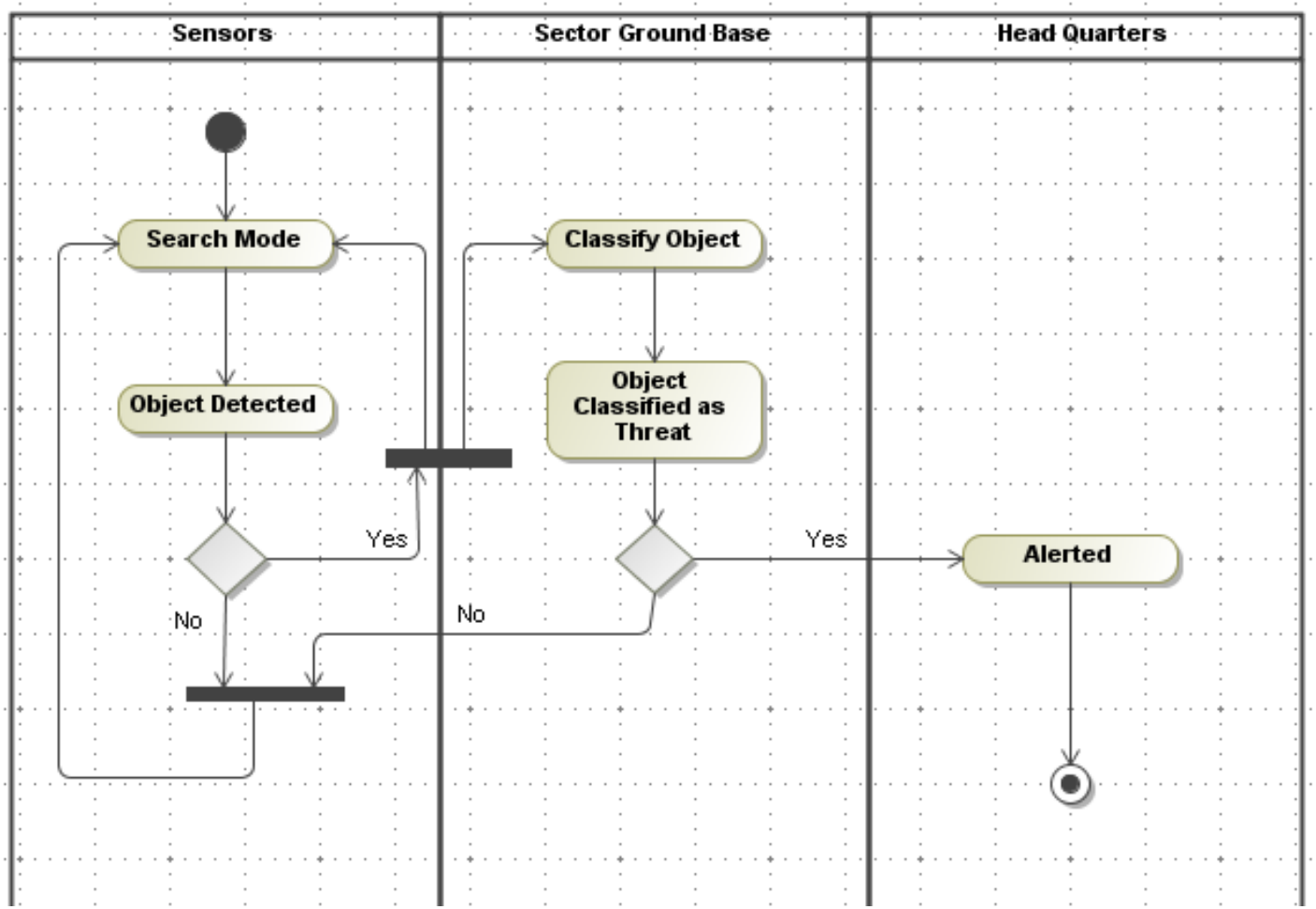
Primary Actors: Intruder, Authorized personnel, Environment

Preconditions: Intruders detected

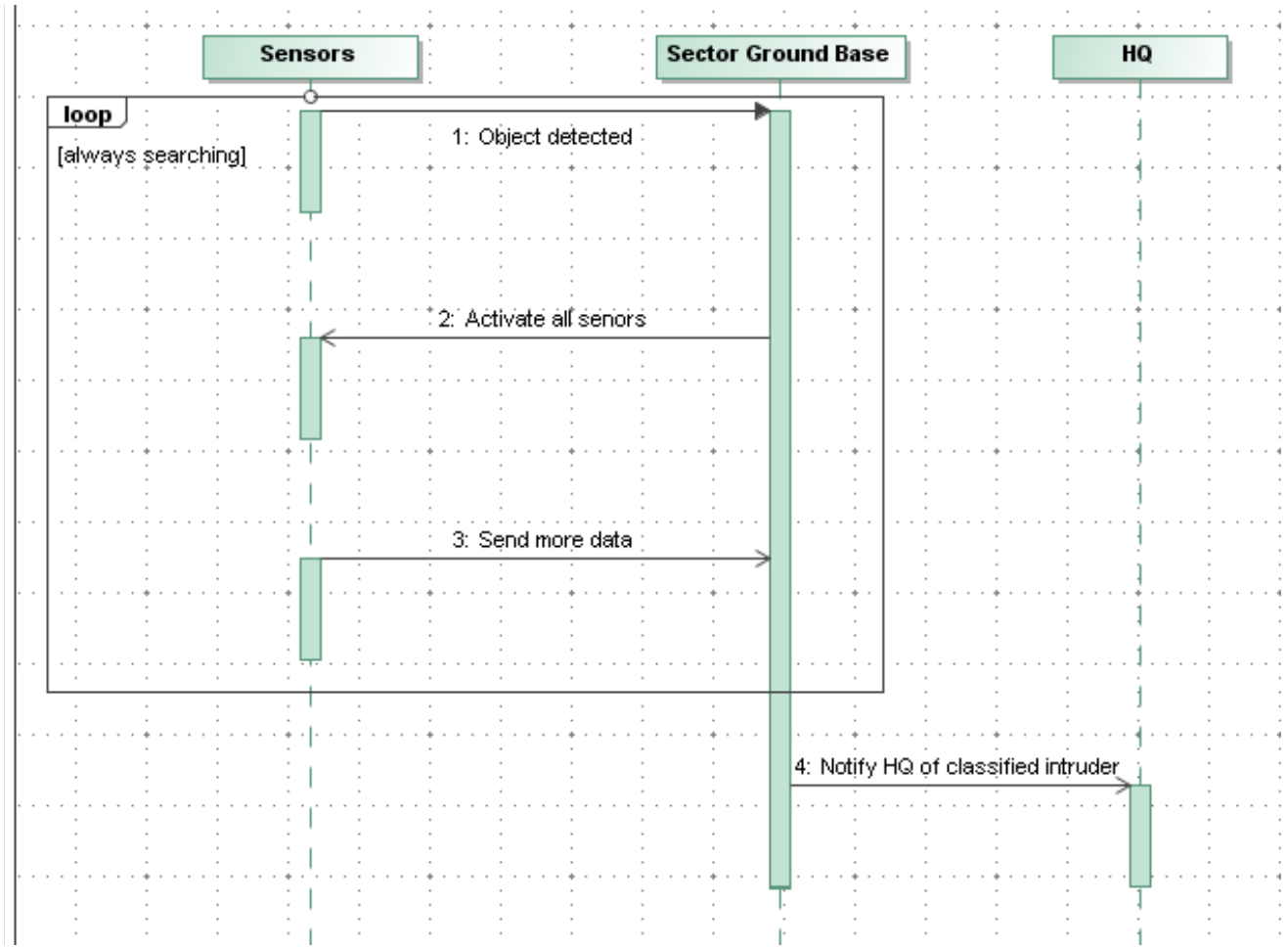
Flow of Events:

1. Commands all sensors in sector to turn on and track
2. Transmits grid coordinates of intruder location to UAVs
3. Classify intruder
    1. If intruder classified as border threat, then dispatch intercepting force. Continue communication with HQ
        a) Continue until intruder detained or neutralized
    2. If intruder classified as false alarm, then return to intelligence gathering case. Continue communication with HQ
4. HQ alerted
5. Wait for interrupt

Sample Activity Diagram - Sensors



Sample Sequence Diagram - Sensors



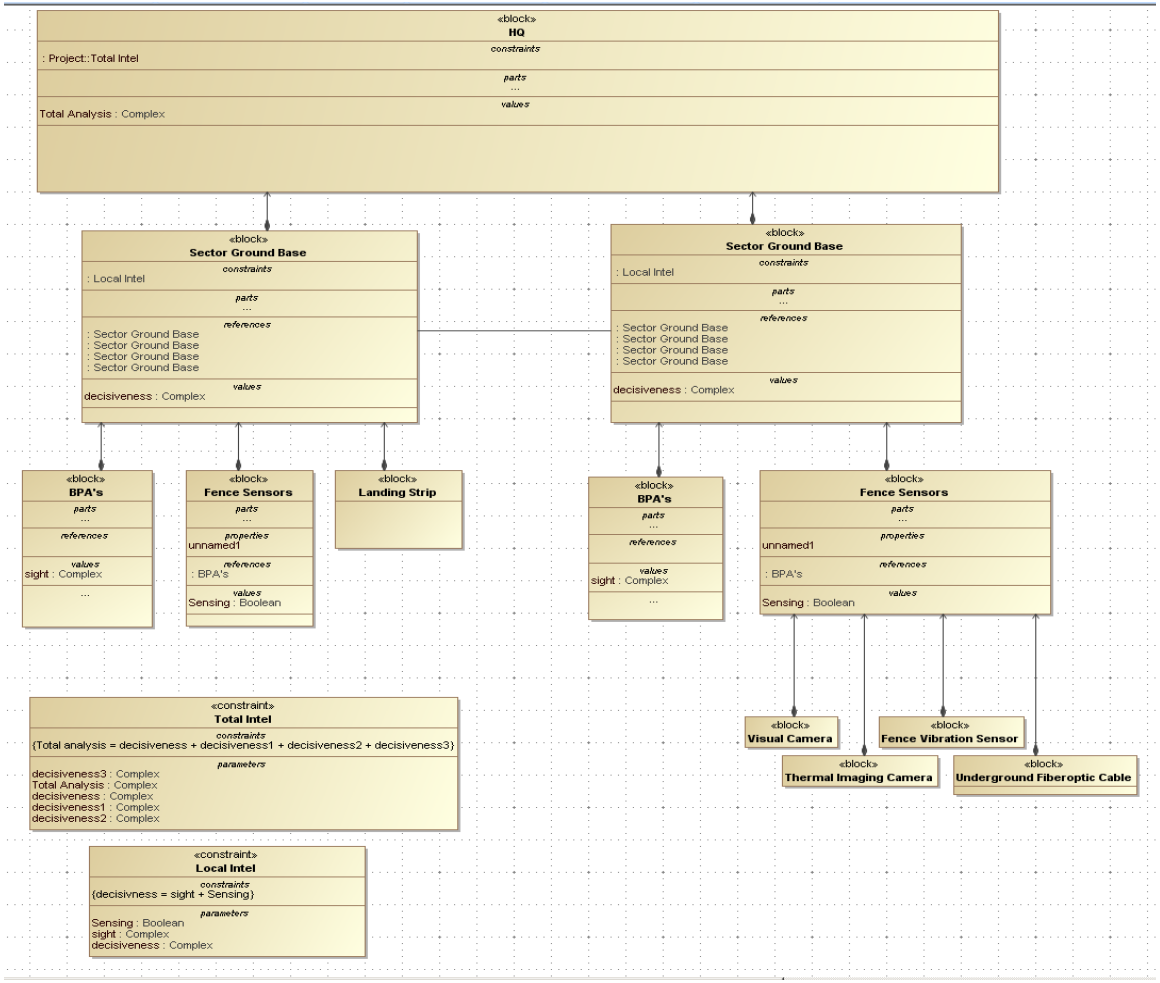
High Level Requirements

#	Description
1	System shall use sensors to detect all attempts to cross border by ground
2	System shall use sensors to classify border crossing as authorized or unauthorized
3	System shall allow authorized crossings and keep records of immigration for future use
4	System shall track unauthorized intruders and keep records of intrusion for future use
5	System shall be reliable with high probability of detection and low probability of false alarm
6	System shall interface with existing ground facilities
7	System shall facilitate communication between ground facilities
8	System shall withstand environmental conditions
9	System shall be easy to install and energy efficient
10	System shall use current, off-the shelf technology
11	System shall include airstrips for UAV component
12	System shall have redundancy to prevent no single point of failure and visual indicator of primary system failure
13	System shall stay within designated federal budget and time constraints
14	System shall maintain operational state without continuous access to electrical grid

Low Level Requirements

#	Description
1	The border shall be protected from unauthorized crossings.
2	Seismic fiber optic sensors with probability of detection > 80%, probability of false alarm < 10% will be used to detect attempts to tunnel across the border
3	Vibration sensors with probability of detection > 90%, probability of false alarm < 2% will be used to detect attempts to cut through or destroy the border fence
4	Thermal imaging and visual spectrum/night vision capable cameras will be used to detect above ground approaches to the border
5	The border fence will be constructed of corrugated steel topped with razor mesh
6	The border fence shall span all areas of the border where terrain allows crossing
7	Areas of the border not spanned by fence will be monitored by ground based sensors or patrolled by UAV
8	All sensors within a sector will be connected via communication network to the sector ground base
9	Intruder classification and determination will be conducted by border patrol agents within sector ground base
10	Date, time, and nature of all confirmed attempts to cross border shall be recorded for future use by border patrol agents
11	Agents shall be able to track intruder movements using the active sensors in their sector
12	It shall be impossible to disrupt the normal functioning of any sensor without triggering failure alert in sector ground base
13	Sector ground bases shall be linked by wired and communication to Ground Headquarters
14	Thermal imaging and visual spectrum/night vision capable cameras will be resistant to wind gusts <100 mph, precipitation
15	Cameras and vibration sensors shall be fully operation in temperatures -30 to 130 F
16	Seismic fiber optic sensor shall be resistant to inference by dirt, water, and subterranean wildlife
17	All sensors shall assume low-power passive search state when not activated
18	Sector ground bases will be equipped with solar and/or wind-based generator to provide system power in the event of power failure
19	Sensors will be off-the-shelf fence vibration sensor (RBTec SL-3), thermal imaging camera (HRC-X), seismic fiber optic sensor (...)

Sample Structure Diagram

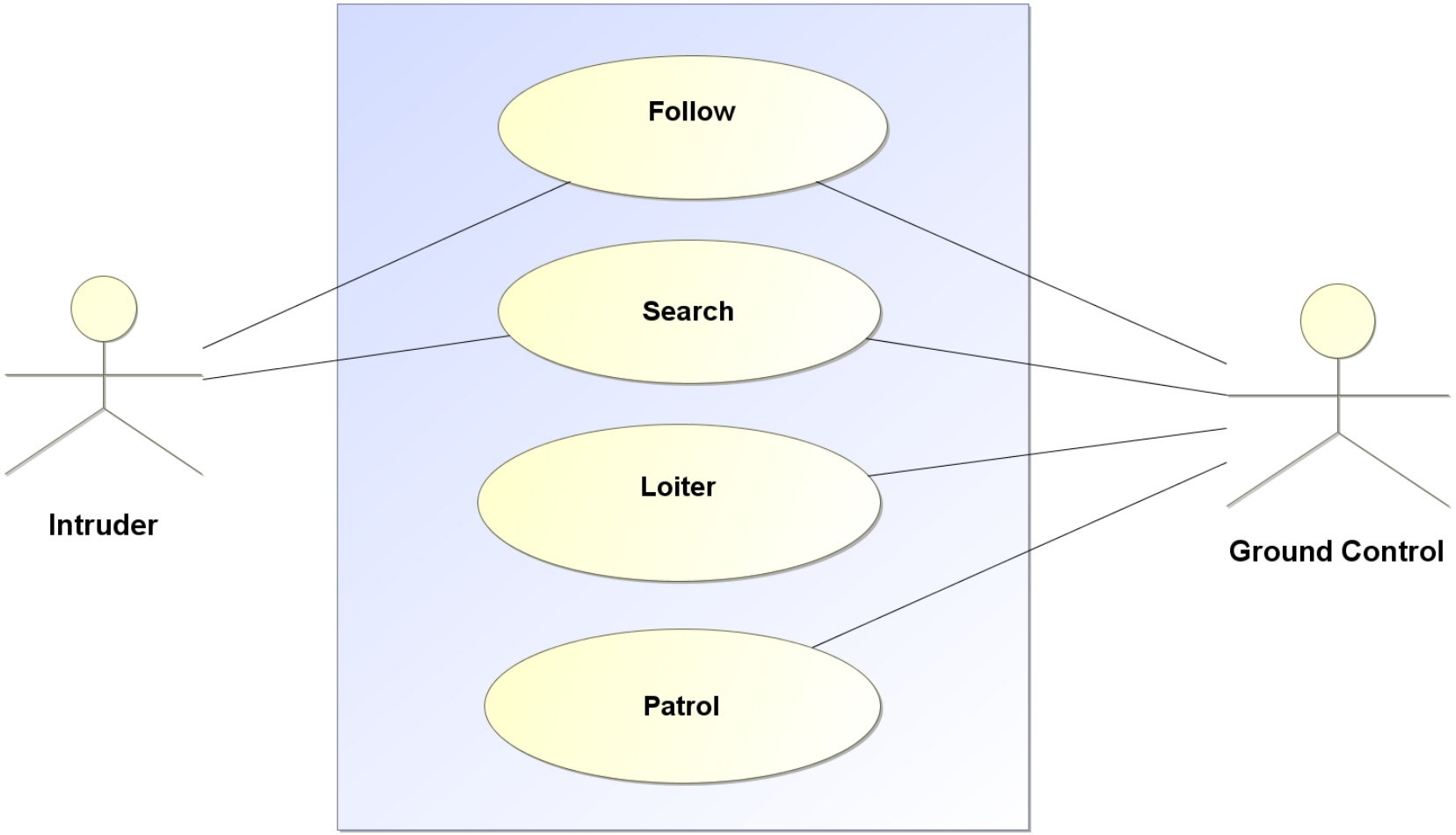


Sensors

- Types of illegal entry
  - Subterranean
  - Above ground
  - Day and night
- Four types of ground based sensors
  - Visual Cameras with Night Vision
  - Thermal Imaging Cameras
  - Fiber optic cable for ground vibration
  - Fence Vibration

Air Team

Use Cases



Textual Scenarios

Loiter:

Primary Actor(s): Ground Base

Description: UAV Holds position over pre determined location of interest.

Preconditions: UAV is in flight

Flow of Events:

1. Down-link current UAV status
2. Ground base upload loiter conditions
3. Sensors set to loiter mode
4. UAV executes loiter conditions
5. Communicate with ground base
6. UAV detects intrusion.
7. Communicates information to ground base.
8. UAV waits for target verification from ground base.

Textual Scenarios

Search:

Primary Actor(s): Ground Base, Intruder

Description: Ground Base reports a detected target to UAV. UAV reports to search location and begins search.

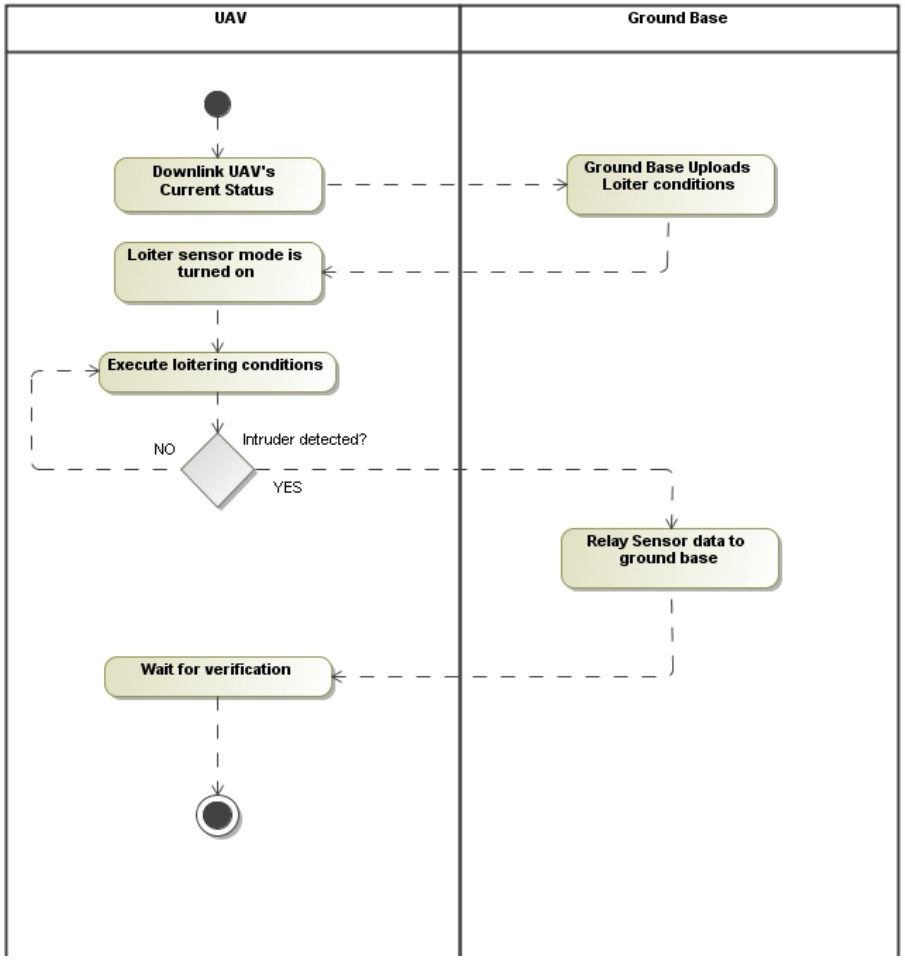
Preconditions: UAV in flight; target on ground detected.

Flow of events:

1. Interrupt issued to UAV from ground base.
2. UAV downlinks current status.
3. Ground base uplinks intrusion locations and area to loiter in search mode.
4. UAV flies to target area to execute search mode.
5. Sensors set to search mode.
6. Communicate with ground base.
7. UAV detects intruder(s).
8. Communicates information to ground base.
9. UAV waits for target verification from ground base.

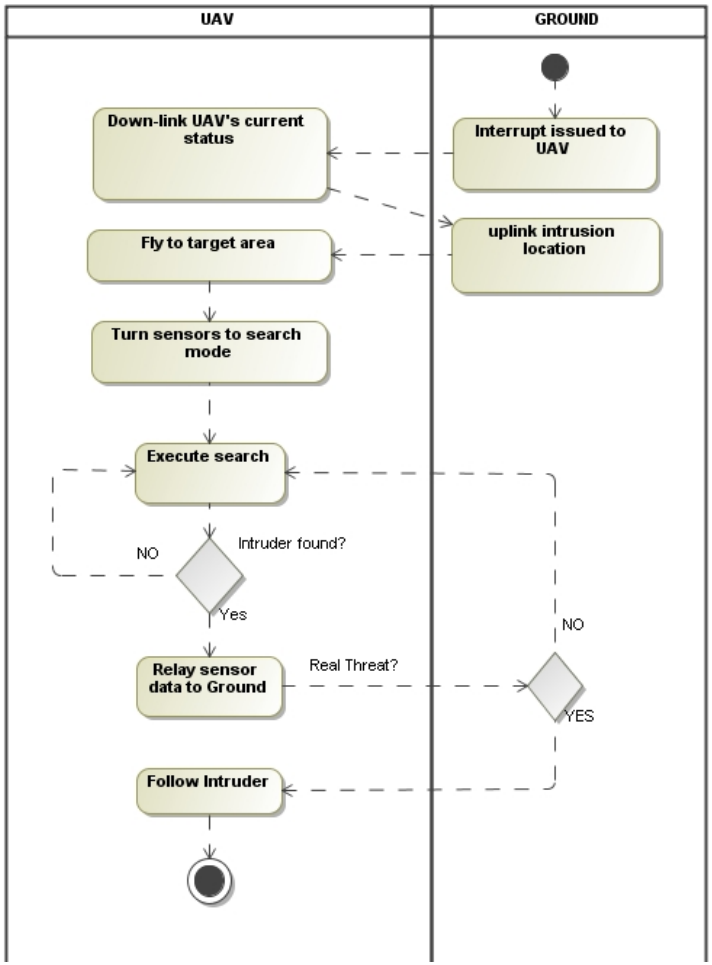
Sample Activity Diagram

Loiter



Sample Activity Diagram

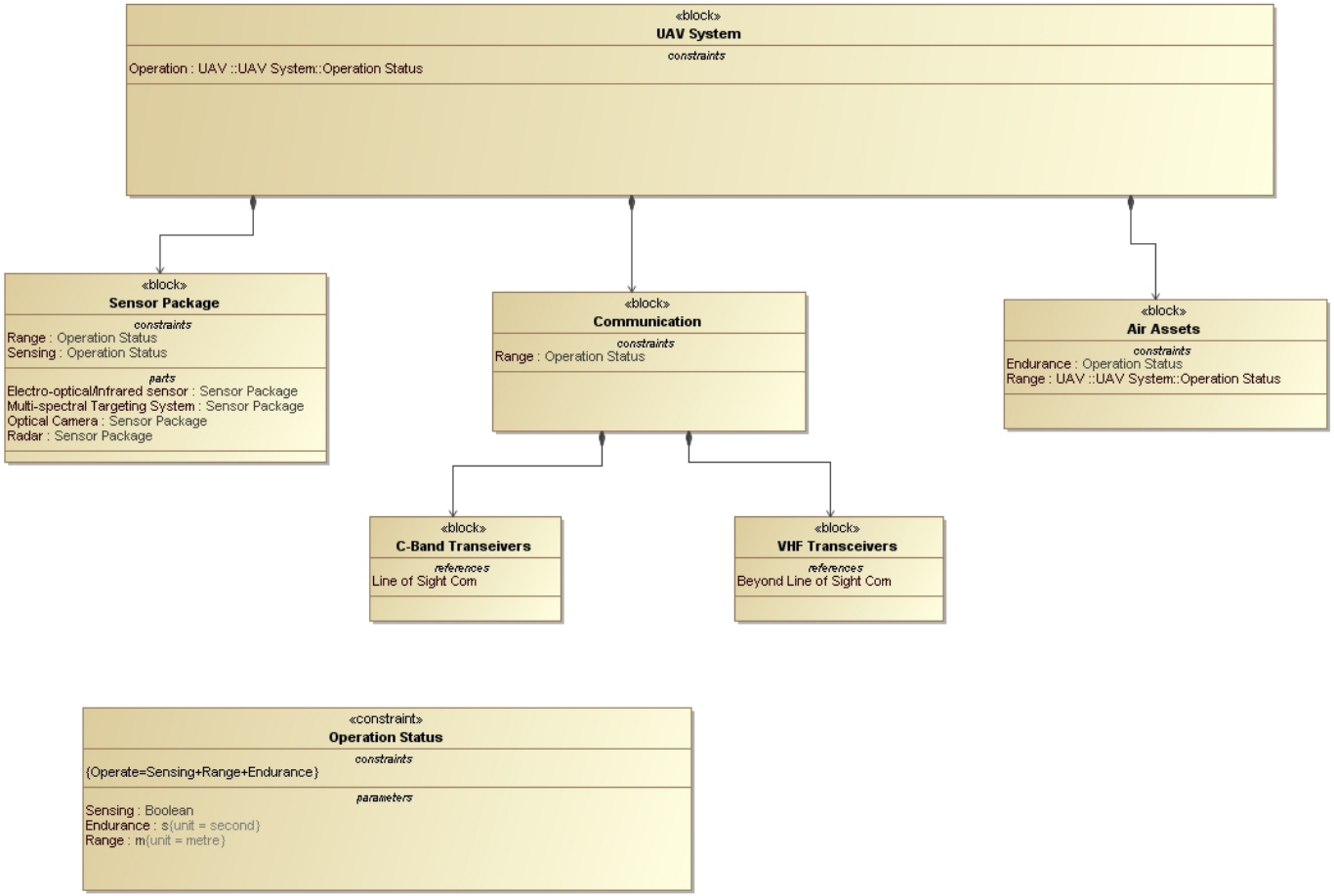
Search



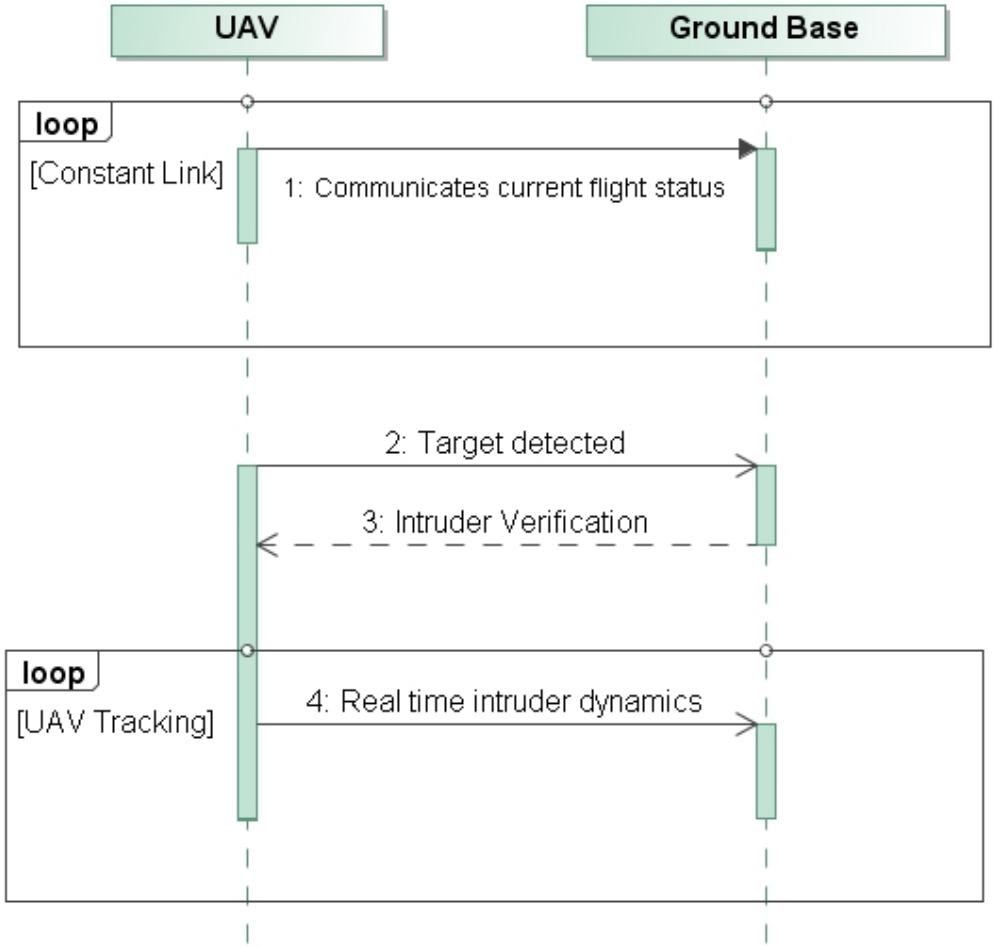
Requirements

#	Description
1	UAV's must have range of 1600+ miles
2	UAV's must have endurance of 24+ hours
3	Sensor package must be able to detect and follow moving ground targets
4	Sensor package must be able to operate regardless of environmental variability
5	Sensor package must be able to provide high quality color image/video to ground while tracking target
6	UAV must be able to communicate with ground base at a range of 90+ miles
7	UAV must be able to communicate with a geostationary satellites
8	UAV must be able to detect and follow dynamic moving targets
9	UAV must be capable of fully autonomous way point flight path
10	UAV must have the ability to execute real time changes in flight path

Sample Structure Diagram



Sample Sequence Diagram



Challenges Ahead

- Need to create 2 separate system level designs
- Perform tradeoff analysis of 2 systems
- Couple designs to MagicDraw
- Keep cost down

Summary

Ground Team focused on improving existing border security system

- More energy and cost efficient
- Higher detection rates
- Less patrols required

- Air Team focused on determining viable UAV systems to integrate into ground surveillance

QUESTIONS?